FINAL

Remedial Investigation Quality Assurance Project Plan West Bend Army Aviation Support Facility #1 and Armory West Bend, Wisconsin

Remedial Investigations (RI) / Feasibility Studies (FS), Decision Documents, Time Critical Removal Actions (TCRA) for Per- and Polyfluoroalkyl Substances (PFAS) Impacted Sites, Army National Guard Installations, Nationwide

December 2023

Prepared for:

Army National Guard Bureau
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Acronyms and Abbreviations

%	percent
°C	degrees Celsius
°F	degrees Fahrenheit
µg/kg	micrograms per kilogram
AASF	Army Aviation Support Facility
AECOM	AECOM Technical Services, Inc.
AFFF	aqueous film-forming foam
AHA	Activity Hazard Analysis
AOI	Area of Interest
APP	Accident Prevention Plan
ARNG	Army National Guard
ASTM	American Society for Testing and Materials
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
btoc	below top of casing
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CoC	chain of custody
COC	chemical of concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CPR	cardiopulmonary resuscitation
CSM	conceptual site model
DA	Department of the Army (US)
DERP	Defense Environmental Restoration Program
DL	detection limit
DO	dissolved oxygen
DoD	Department of Defense
DPT	Direct Push Technology
DQI	data quality indicator
DQL	data quality limit
DQO	data quality objective
DUA	data usability assessment
ECF	electrochemical fluorination
EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
ELCR	excess lifetime cancer risk
EM	Engineering Manual
ERA	Ecological Risk Assessment
FD	field duplicate
FRB	field reagent blank

FS	Feasibility Study
FTA	fire training area
FTOH	fluorotelomer alcohol
FTS	fluorotelomer sulfonic acid
gpm	gallons per minute
GIS	geographic information system
GPS	global positioning system
HA	Health Advisory
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high-density polyethylene
HFPO-DA	hexafluoropropylene oxide dimer acid
HHRA	Human Health Risk Assessment
HI	Hazard Index
IDQTF	Intergovernmental Data Quality Task Force
IDW	investigation-derived waste
ISC	instrument sensitivity check
ITRC	Interstate Technology Regulatory Council
K_{oc}	organic carbon-normalized distribution coefficients
LC/MS/MS	liquid chromatography tandem mass spectrometry
LOD	limit of detection
LOQ	limit of quantitation
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
MPC	measurement performance criteria
mph	miles per hour
MS	matrix spike
MSD	matrix spike duplicate
mV	millivolts
NELAP	National Environmental Laboratory Accreditation Program
N-EtFOSAA	2-(N-Ethylperfluorooctanesulfonamido) acetic acid
ng/L	nanograms per liter
N-MeFOSAA	2-(N-Methylperfluorooctanesulfonamido) acetic acid
NTU	nephelometric turbidity unit
ORP	oxidation-reduction potential
OSD	Office of the Secretary of Defense
OSHA	Occupational Safety and Health Administration
PA	Preliminary Assessment
PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity
PFAA	perfluoroalkyl acid
PFAS	per- and polyfluoroalkyl substances
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid

PFC	perfluorinated compound
PFCA	perfluoroalkyl carboxylic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFDS	perfluorodecanesulfonic acid
PFHpA	perfluoroheptanoic acid
PFHpS	perfluoroheptanesulfonic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFNS	perfluorononanesulfonate
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFOSA	perfluorooctanesulfonamide
PFPA	perfluoropentanoic acid
PFPeA	perfluoropentanoic acid
PFPeS	perfluoropentanesulfonate
PFSA	perfluoroalkyl sulfonic acid
PFTeA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUdA	perfluoroundecanoic acid
PID	photoionization detector
PPE	personal protective equipment
PRG	Preliminary Remediation Goal
PVC	poly-vinyl chloride
PWS	Performance Work Statement
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QL	quantitation limit
QSM	Quality Systems Manual
RAGS	Risk Assessment Guidance for Superfund
RI	Remedial Investigation
ROE	right of entry
RSL	Regional Screening Level
SC	specific conductivity
SDG	sample delivery group
SERDP	Strategic Environmental Research and Development Program
SI	Site Inspection
SL	Screening Level
SLERA	Screening-Level Ecological Risk Assessment
SOP	standard operating procedure
SP	screen point

SS	Site Supervisor
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SU	sampling unit
TAT	turn-around time
TBD	to be determined
TCRA	time critical removal action
TO	task order
TOC	total organic carbon
TPP	technical project planning
TSA	Technical System Audit
UCL	upper confidence limit
UFP	Uniform Federal Policy
US	United States
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UU/UE	unlimited use/unrestricted exposure
WIARNG	Wisconsin Army National Guard
WIDMA	Wisconsin Department of Military Affairs
WIDNR	Wisconsin Department of Natural Resources

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1.0 Introduction

1.1 Project Authorization

This Remedial Investigation (RI) Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) addresses RI activities to be completed at the West Bend Army Aviation Support Facility (AASF) #1 and Armory (also referred to as the "West Bend AASF #1 and Armory" and the "facility"), in West Bend, Wisconsin. RI activities for the facility will be conducted over multiple mobilizations.

The Army National Guard (ARNG) G-9 is the lead agency in performing *Remedial Investigations (RI)/ Feasibility Studies (FS), Decision Documents (DD), Time Critical and Non-Time Critical Removal Actions (TCRA/NTCRA) for Per- and Polyfluoroalkyl Substances (PFAS) Impacted Sites, ARNG Installations, Nationwide*. This work is supported by the United States Army Corps of Engineers (USACE) Baltimore District and their contractor AECOM Technical Services, Inc. (AECOM) under Contract Number W912DR-19-D0001, TO W912DR21F0349, issued 17 September 2021.

Programmatically, the ARNG is assessing the potential environmental impacts primarily from aqueous film-forming foam (AFFF) and similar chemical releases suspected at their properties related to processes that used PFAS (e.g., fire training, firefighting, and metal plating). A Preliminary Assessment (PA) and Site Inspection (SI) were performed under a separate contract vehicle on behalf of the ARNG. The PA determined whether or not there were a potential release to the environment related to processes that use PFAS. Based on the findings of the PA, the facility moved forward to the SI phase. The SI concluded there was a release to the environment from Areas of Interest (AOIs) identified in the PA and determined the presence of perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and perfluorobutanesulfonic acid (PFBS) at or above screening levels (SLs) established in a memorandum from the Office of the Secretary of Defense (OSD) dated 15 October 2019 (Assistant Secretary of Defense, 2019). Updated United States Environmental Protection Agency (USEPA) Regional SLs (RSLs) were published in May 2022 (USEPA, 2022a). These changes prompted a new OSD memorandum (OSD memo) issued in July 2022 that lowered the SLs of PFOS and PFOA, maintained the SL for PFBS, and expanded the list of compounds to include perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA) (Assistant Secretary of Defense, 2022). The updated SLs will replace the previously used SLs at the West Bend AASF #1 and Armory as documented in the Final SI Report (AECOM, 2022).

RI activities for the facility will be conducted in multiple mobilizations. The Prescriptive Phase at the West Bend AASF #1 and Armory will aim to refine the onsite occurrence of PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA in groundwater and soil at the potential PFAS source and release areas, evaluate the occurrence of these compounds in surface water and sediment on and near the facility, and assess the exceedance of the SLs for these compounds in the groundwater aquifer. The analytical data from the Prescriptive Phase will be used to develop the approach for the Adaptive Phase. As regulations surrounding PFAS continue to evolve and federal standards are updated, any changes made to the OSD memo as a result will be reflected by comparing RI results to the most up-to-date SLs.

The RI project elements will be performed by AECOM in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; USEPA, 1980), as amended, the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations [CFR] Part 300; USEPA, 1994), and in compliance with United States (US) Department of the Army (DA) requirements and guidance for field investigations, including specific requirements for sampling for PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA as well as the group of related compounds known in the industry as PFAS. The term PFAS will be used throughout this plan to encompass all PFAS chemicals being evaluated; however, the term "relevant compounds" will be used when referring specifically to PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA, which are the key components of the suspected releases being evaluated.

1.1.1 RI Purpose

The objective of the RI is to determine the extent of PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA at or above SLs at the AOIs identified in the PA where the presence of these PFAS was confirmed during the SI.

Additionally, the RI will gather sufficient data to define release areas, potential migration pathways, potential receptors, and associated exposure routes. The data will support informed risk management decisions, including:

- Determining whether, or to what extent, a threat to human health or the environment exists.
- Developing and evaluating remedial alternatives (including the no-action alternative).
- Supporting future enforcement or cost-recovery activities.

This work will be accomplished through a dynamic RI sampling design. Building on the SI data, the Prescriptive Phase will include source area sampling and downgradient vertical aquifer profile transects to evaluate potential off-site migration. The Adaptive Phase scope will largely be based on the results of the Prescriptive Phase and include on-site step-in and step-out refinement borings/wells at sources and transects. Quick turn-around time (TAT) laboratory analyses or screening techniques will be used for rapid site characterization (RSC) and supporting data interpretation during the Adaptive Phase. The technical approach for the RSC sampling associated with the Adaptive Phase are described in this document, but details regarding the Adaptive Phase sampling locations and rationale will be included in an RI QAPP Addendum after completion of the Prescriptive Phase field mobilization. Subsequent phases of work including the FS, DDs, and TCRA/NTCRA, will be prepared under separate cover, as applicable.

1.1.2 QAPP Document Organization

This QAPP meets the requirements and elements set forth in the UFP for QAPPs (Intergovernmental Data Quality Task Force [IDQTF], 2005a-c) and *EPA Requirements for Quality Assurance Project Plans* (USEPA, 2001). The QAPP is comprehensive to the extent practicable and does not refer to or rely on separate work plans, consistent with the USEPA's intent that the QAPP be the premier planning document for an entire project (IDQTF, 2012). Minimizing the existence of separate work plans maintains consistency across project elements and optimizes the administrative effort required to review and revise project documents. The components that are covered under this QAPP are described in **Table 1-1** below.

Table 1-1 Components of the RI QAPP

Site-Specific QAPP Worksheets
Worksheets #1 & #2 - Title and Approval Page and QAPP Identifying Information
Worksheets #3 & #5 - Project Organization and QAPP Distribution
Worksheets #4, #7, & #8 - Personnel Qualifications and Sign-off Sheet
Worksheet #6 - Communication Pathways
Worksheet #9 - Technical Project Planning Session Summary

Site-Specific QAPP Worksheets
Worksheet #10 - Conceptual Site Model
Worksheet #11 - Project/Data Quality Objectives
Worksheet #12 - Measurement Performance Criteria
Worksheet #13 - Secondary Data Uses and Limitations
Worksheets #14 and #16 - Project Tasks and Schedule
Worksheet #15 - Project Data Quality Limits and Laboratory-Specific Detection/Quantitation Limits
Worksheets #17 & #18 - Sampling Design and Rationale
Worksheets #19 & #30 - Sample Containers, Preservation, and Hold Times
Worksheet #20 - Field Quality Control Summary
Worksheet #21 - Field Standard Operating Procedures
Worksheet #22 - Field Equipment Calibration, Maintenance, Testing, and Inspection
Worksheet #23 - Analytical Standard Operating Procedures
Worksheet #24 - Analytical Instrument Calibration
Worksheet #25 - Analytical Instrument and Equipment Maintenance, Testing, and Inspection
Worksheets #26 & #27 - Sample Handling, Custody, and Disposal
Worksheet #28 - Analytical Quality Control and Corrective Actions
Worksheet #29 - Project Documents and Records
Worksheets #31, #32, & #33 - Assessments and Corrective Action
Worksheet #34 - Data Verification and Validation Inputs
Worksheet #35 - Data Verification Procedures
Worksheet #36 - Data Validation Procedures
Worksheet #37 - Data Usability Assessment

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QAPP Worksheets #1 & #2: Title and Approval Page and QAPP Identifying Information

Site Name/Project Name: Remedial Investigations (RI)/ Feasibility Studies (FS), Decision Documents, Time Critical Removal Actions (TCRA) for Per- and Polyfluoroalkyl Substances (PFAS) Impacted Sites, ARNG Installations, Nationwide

Installation: West Bend Army Aviation Support Facility #1 and Armory, West Bend, Wisconsin

Contract Work Assignment Number: USACE Contract No. W912DR-19-D-0001
Delivery Order No. W912DR21F0349

Relevant Plans and Reports from Previous Investigations: Relevant plans and reports from previous investigations are identified in the references cited in the introductory text that precedes these worksheets and in subsequent worksheets, as appropriate.

	Mitchell, Claire — Digitally signed by Mitchell, Claire DN: cn=Mitchell, Claire, ou=USSTL1, email=claire.mitchell@aecom.com Date: 2023.12.01 13:29:23 -05'00'
Investigative Organization Project Manager	Signature / Date
Printed Name / Organization	Claire Mitchell / AECOM Project Manager
	Gettier, Sarah — Digitally signed by Gettier, Sarah Date: 2023.12.01 14:13:14 -05'00'
Investigative Organization Quality Manager	Signature / Date
Printed Name / Organization	Sarah Gettier / AECOM Project QC Officer
	SOLOMON.JENNIFER.LYNN.1286954568 — Digitally signed by SOLOMON.JENNIFER.LYNN.1286954568 Date: 2023.12.01 15:42:15 -05'00'
Army National Guard	Signature / Date
Printed Name / Organization	Jennifer Solomon / ARNG Program Manager
	RICKARD.SCOTT.ERIC.1136924962 — Digitally signed by RICKARD.SCOTT.ERIC.1136924962 Date: 2023.12.01 14:52:06 -06'00'
Wisconsin Department of Military Affairs	Signature / Date
Printed Name / Organization	Scott Rickard / Environmental Branch Chief
	CLINE.EMILY.JORDAN.1536813884 — Digitally signed by CLINE.EMILY.JORDAN.1536813884 Date: 2023.12.01 15:17:57 -05'00'
Contract Organization Project Manager	Signature / Date
Printed Name / Organization	Emily Cline / USACE, Baltimore District

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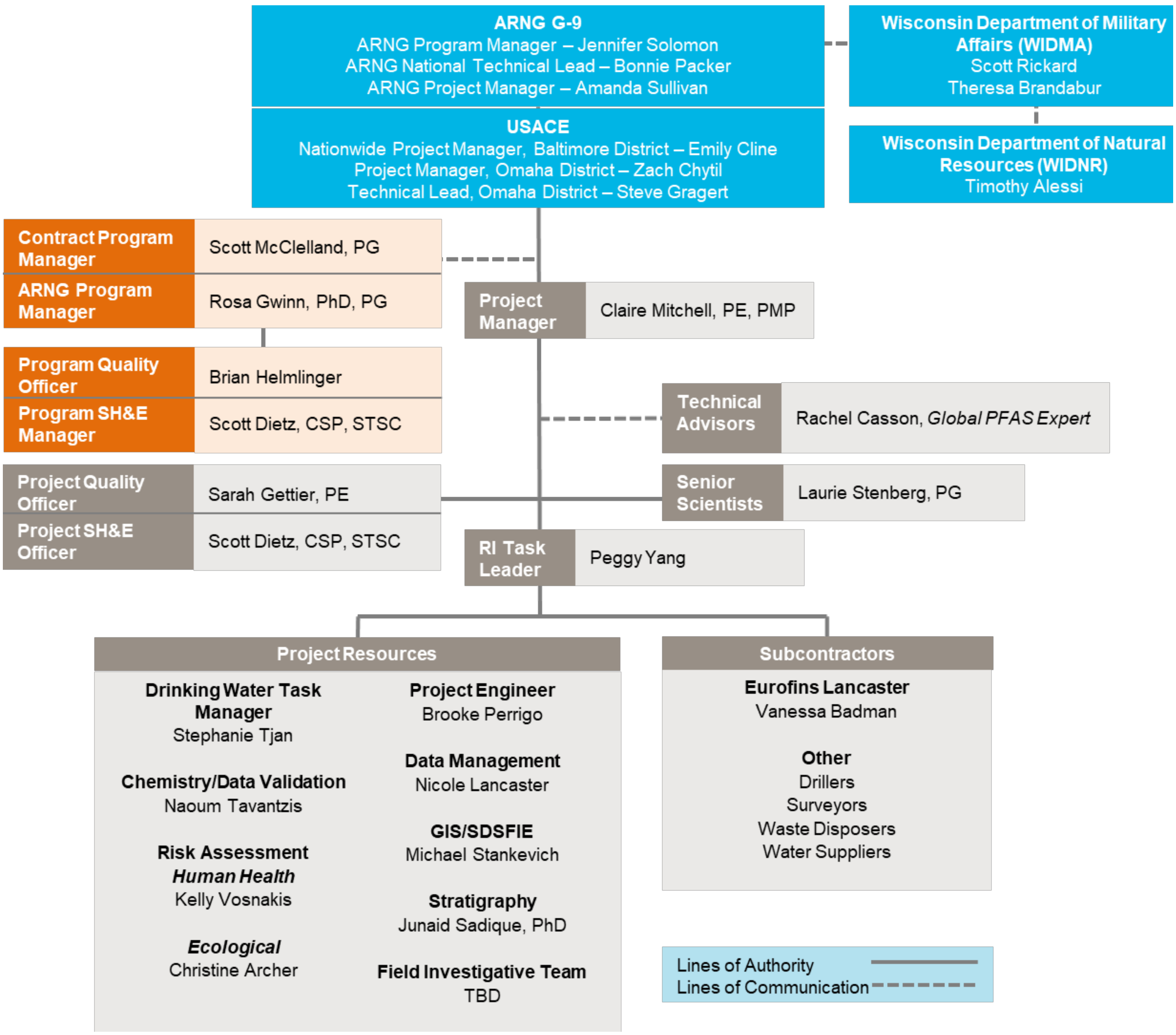
QAPP Worksheets #3 & #5: Project Organization and QAPP Distribution

The organization chart in **Figure 3-1** identifies key project personnel, as well as lines of authority and communication among the ARNG, USACE, prime contractor (AECOM), joint venture contractor SERES/Arcadis, and other stakeholders. The QAPP will be distributed to all parties noted in the figure below.

Figure 3-1 Project Organizational Chart



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QAPP Worksheets #4, #7 & #8: Personnel Qualifications and Sign-off Sheet

This worksheet contains a list of the key project personnel who are identified as performing the tasks that are defined in this QAPP and includes the personnel's organization, project role, education/experience, and specialized training/certifications. The personnel have signed and dated the worksheet to signify that they agree with the information in this QAPP and agree to implement it.

Name	Organization	Project Role	Education/Experience	Specialized Training / Certifications	Signature/Date
Scott McClelland, PG	Prime Contractor (AECOM)	Contract Program Manager	Education: BA, Geology; MS, Geology Experience. 31+ years; executing and managing environmental investigation and remediation projects including program management of USACE Baltimore contracts.	Professional Geologist, KY AECOM Certified Project Manager	Signature available upon request.
Rosa Gwinn, PG, PhD	AECOM	ARNG Program Manager	Education: BA, Geology; MS, Geology; PhD, Geology Experience: 34+ years; managed 4 ORA Phase II TOs of similar scope, complexity, and duration for USACE and ARNG; experience with PFAS investigations.	Professional Geologist, WA, UT AECOM Certified Project Manager OSHA 40hr HAZWOPER OSHA 8hr Refresher AECOM PFAS Sampling Training	Signature available upon request.
Jessica Travis	SERES/Arcadis	ARNG Program Manager	Education: BS, Environmental Engineering Experience: 21+ years; managed environmental investigation remediation projects; provide programmatic QC on PFAS investigations for Active Army	Professional Engineer, DE OSHA 40hr HAZWOPER OSHA 8hr Refresher	Signature available upon request.
Rhonda Stone	SERES/Arcadis	ARNG Program Manager	Education: B.S. Environmental Science Experience: 27 years of experience. Program/PM for Hazardous, Toxic and Radioactive Waste projects and USAEC Environmental Remediation Multiple Award contracts. Previously a Program Manager for the Army's Operational Range Assessment Program for the USAEC and USACE	PMP Arcadis Certified Project Manager OSHA 40hr HAZWOPER OSHA 8hr Refresher Arcadis PFAS Training	Signature available upon request.

Name	Organization	Project Role	Education/Experience	Specialized Training / Certifications	Signature/Date
Claire Mitchell, PE, PMP	AECOM	Project Manager	Education: BS, Civil Engineering Experience: 11+ years; environmental engineering experience, including task management for PFAS investigations for DoD clients; PFAS Technical Practice Lead Verifier.	Professional Engineer, MO PMP Certification AECOM Certified Project Manager OSHA 40hr HAZWOPER OSHA 8hr Refresher AECOM PFAS Sampling Training	Signature available upon request.
Joe Quinnan, PE, PG	SERES/Arcadis	Senior Scientist	Education: BS, MS Geological Engineering Experience: 30+ years; served as Global lead for site characterization, North American lead for emerging contaminants and technical lead for US Army PFAS PA/SI program, program technical lead for Army and Air Force PFAS RI program; technical lead for several USACE-led remediation projects for DoD, Principal Investigator for three ESTCP projects and three AFCEC BAA projects	Professional Engineer, WI Professional Geologist, WI Arcadis PFAS Training	Signature available upon request.
Peggy Yang	AECOM	RI Task Manager	Education: BS, Environmental Health MS, Environmental Health Experience: 20+ years; Served as the PM for ANG MMRP Sis, provided project management and technical support for Sis and RIs under the CERCLA and RCRA program, experience with PFAS evaluations.	OSHA 40hr HAZWOPER OSHA 8hr Refresher	Signature available upon request.
Laurie Stenberg, PG	AECOM	Lead Verifier, PFAS	Education: BA, Geology Experience: 28+ years; served as senior scientist for ORA Phase II TOs; experience with PFAS investigations; PFAS Technical Practice Lead Verifier.	Professional Geologist, PA AECOM Certified Project Manager OSHA 40hr HAZWOPER OSHA 8hr Refresher AECOM PFAS Sampling Training	Signature available upon request.

Name	Organization	Project Role	Education/Experience	Specialized Training / Certifications	Signature/Date
Rachel Casson	AECOM	Technical Advisor, PFAS	Education: BS, Physical Geography and Marine Science Experience: 21+ years; global expertise in fate and transport, risks, management and treatment/ remedial options for PFAS; experience collaborating on a global level with other PFAS-related discipline experts.	NA	Signature available upon request.
Brooke Perrigo	AECOM	Project Engineer	Education: BS, Environmental Science, MS, Environmental Planning and Management Experience: 12 years environmental engineering experience, including task management for PFAS investigations and preparing environmental investigation reports for DoD.	OSHA 40hr HAZWOPER OSHA 8hr Refresher AECOM PFAS Sampling Training	Signature availble upon request.
Brian Helmlinger, PMP	AECOM	Program QA Officer	Education: BA, Business; MA, Risk Assessment Experience: 27+ years; managing projects, managing programs, and developing and implementing project and program quality management plans for US Federal Government clients, including USACE, USN, USMC, USAF, and USFS.	PMI PMP	Signature available upon request.
Sarah Gettier, PE	AECOM	Project QA Officer	Education: BS, Civil Engineering MS, Environmental/ Environmental Health Engineering Experience: 16+ years direct experience developing QAPPs and other environmental planning documents	Professional Engineer, MD AECOM Certified Project Manager OSHA 40hr HAZWOPER OSHA 8hr Refresher	Signature available upon request.

Name	Organization	Project Role	Education/Experience	Specialized Training / Certifications	Signature/Date
Scott Dietz, CSP, STSC	AECOM	Federal Program Safety, Health, and Environment Manager	Education: BS, Safety Sciences Experience: 24+ years; managing safety, health, and environment on construction, environmental, and remediation projects including government projects requiring compliance with the USACE Engineering Manual 385-1-1.	CSP, STSC OSHA 40hr HAZWOPER OSHA 500 Trainer for Occupational Safety and Health Standards for Construction Industry OSHA 510 Occupational Safety and Health Standards for the Construction Industry OSHA 30hr Construction OSHA 10hr Construction OSHA 8hr Refresher	Signature available upon request.
Robert Kennedy	AECOM	Senior Chemist	Education: BA, Chemistry Experience: 28+ years; served as senior scientist for ORA Phase II TOs; experience with PFAS investigations.	Auditing/Data Review training AECOM PFAS Sampling Training	Signature available upon request.
Naoum Tavantzis	AECOM	Project Chemist	Education: BA, Environmental Science; MBA Experience: 11+ years; project chemist for ORA Phase II TOs; PFAS Investigations, data validation, laboratory coordination; project chemist for ANG expanded SIs; PFAS Technical Practice Lead Verifier.	OSHA 40hr HAZWOPER OSHA 8hr Refresher OSHA 8hr Site Supervisor	Signature available upon request.
Michael Stankevich	AECOM	GIS Specialist	Education: BA, Geography – Environmental Track Experience: 10+ years; completed SDSFIE submittals for multiple ARNG installations	NA	Signature available upon request.

Name	Organization	Project Role	Education/Experience	Specialized Training / Certifications	Signature/Date
Kelly Vosnakis	AECOM	Human Health Risk Assessor	Education: BA, Environmental Studies; MS, Environmental health Experience: 27+ years; performing human health risk assessments; expertise in evaluating potential risks and hazards to human health posed by PFAS and other chemicals at DoD and other facilities; expertise in evaluating contaminant fate and transport for validity of exposure pathways.	NA	Signature available upon request.
Christine Archer	AECOM	Ecological Risk Assessor	Education: BS, Zoology Experience: 21+ years; experience with ERAs, environmental toxicity testing, and sediment/water quality evaluations for DoD sites; experience with PFAS evaluations.	OSHA 40hr HAZWOPER OSHA 8hr Refresher First Aid/CPR	Signature available upon request.
Junaid Sadeque, PhD	AECOM	Senior Stratigrapher	Education: BS, Geology and Mining MS, Petroleum Geology PhD, Sequence Stratigraphy Experience: 20+ years; executing subsurface geological investigations both in the petroleum and environmental industry. Recognized Subject Matter Expert in sedimentology. Playing a pivotal role in applying sequence stratigraphic concepts for predicting contamination flow paths, and developing CSMs. Experienced in integrating stratigraphic, hydrogeological and chemical data for predictive stratigraphic modeling.	GIS Training for Geologists Applied Clastic Stratigraphy Application of Well-log Correlation GoCAD, Petrel, and Geographix for stratigraphic interpretation	Signature available upon request.
Ben Campanaro	AECOM	Geologist/ Stratigrapher	Education: BA, Geosciences Experience: 3+ years; experience performing sequence stratigraphic analysis (PRISM™) and building visual conceptual site mpodels at Sites across North America.	OSHA 40hr HAZWOPER OSHA 8hr Refresher	Signature available upon request.

Name	Organization	Project Role	Education/Experience	Specialized Training / Certifications	Signature/Date
Nicole Lancaster	AECOM	Data Management	Education: BS, Marine Biology, MS Chemistry Experience: 11+ years, experience with data validation, data management, laboratory coordination, and field sampling.	OSHA 40hr HAZWOPER OSHA 8hr Refresher First Aid/CPR AECOM PFAS Sampling Training	Signature available upon request.
Vanessa Badman	Eurofins Lancaster Laboratories	Laboratory Project Manager	Education: BS Biology Experience: 8 years' experience as a Project Manager/client services	NA	Signature available upon request.

Notes:
AL = Alabama
ASQ = American Society for Quality
BA = Bachelor of Arts
BS = Bachelor of Science
CHMM = Certified Hazardous Materials Manager
CMQ/OE = Certified Manager of Quality/Organizational Excellence
CPR = cardiopulmonary resuscitation
CQA = Certified Quality Auditor
DoD = Department of Defense
ERA = Ecological Risk Assessment
ESA = Ecological Society of America
GIS = Geographic Information System
HAZWOPER = Hazardous Waste Operations and Emergency Response
HHRA = human health risk assessment
hr = hour
IN = Indiana
KY = Kentucky
LSP = Licensed Site Professional
MA = Massachusetts
MBA = Master of Business Administration
ME = Maine
MMRP = Military Munitions Response Program
MO = Missouri
MS = Master of Science
NA = not applicable
NDNODS = Non-Operational Non-Department of Defense Site
NH = New Hampshire
ORA= Operational Range Assessments
OSHA = Occupational Safety and Health Administration
PE = Professional Engineer
PG = Professional Geologist
PhD = Doctor of Philosophy
PMP = Project Management Professional
PRISM™ = PRedictive Integrated Stratigraphic Modelling
QA = quality assurance
QSM = Quality Systems Manual
SDSFIE = Spatial Data Standards for Facilities, Infrastructure, and Environment
STSC = Safety Trained Supervisor Construction
TO = task order
UT = Utah
WA = Washington

QAPP Worksheet #6: Communication Pathways

Worksheet #6 documents the communication drivers that trigger the need to communicate with other project personnel or stakeholders. The purpose of **Worksheet #6** is to ensure there are procedures in place for providing the appropriate notifications and generating the appropriate documentation when handling important communications, including those involving regulatory interfaces, unexpected events, emergencies, non-conformances, and stop-work orders.

Communication Driver	Organization	Name	Contact Information	Procedure (Timing, Pathway, Documentation)
Program Manager decisions and modification	USACE Baltimore District Nationwide Project Manager	Emily Cline	410-962-7966 emily.j.cline@usace.army.mil	Award work and options. Track project progress through monthly reporting and daily field reporting. Stop work for quality or performance concerns.
Program technical review	USACE Omaha District Technical Leads	Zach Chytil Steve Gragert	402-657-1430 Zach.A.Chytil@usace.army.mil 402-995-2743 Steven.Gragert@usace.army.mil	The AECOM PM will obtain USACE technical review and concurrence of the QAPP and project documents and any field modifications/QAPP changes, as necessary. Approved modifications will be included in QAPP revisions (prior to field work). USACE technical review and comments will be incorporated into the QAPP and project documents and a record of USACE comments saved in project files for documentation.
Project Manager and program technical review	ARNG Program Manager and Technical Leads	Jennifer Solomon (Program Manager) Bonnie Packer, PhD (National Technical Lead) Amanda Sullivan (Project Manager)	703-607-7589 jennifer.L.solomon20.civ@army.mil 703-607-7977 bonnie.m.packer.ctr@mail.mil 304-642-6000 Amanda.d.sullivan7.ctr@army.mil	The AECOM PM will obtain ARNG technical review and concurrence of the QAPP and project documents and any field modifications/QAPP changes, as necessary. Approved modifications will be included in QAPP revisions (prior to field work). ARNG technical review and comments will be incorporated into the QAPP and project documents and a record of ARNG comments saved in project files for documentation.
Installation interface	Wisconsin Department of Military Affairs	Scott Rickard	608-242-3364 scott.rickard@widma.gov	Communicate project scope/schedule and coordinate logistics between project team and installation personnel on an as-needed basis, documented via phone records and emails.

Communication Driver	Organization	Name	Contact Information	Procedure (Timing, Pathway, Documentation)
Regulatory agency interface		Theresa Brandabur	608-242-3653 Theresa.m.brandabur.nfg@army.mil	Communicate technical approaches and decisions directly to regulatory agencies' representative(s) on an as-needed basis, documented via phone records and emails.
Community/ media interface		CPT Keith Peter (Director WIDMA Public Affairs Office)	(608) 242-3050 keith.j.peter.mil@army.mil ng.wi.wiarng.mbx.wi-pao@army.mil	Communicate information directly to communities or media on an as-needed basis.
Manage all project phases Field progress reports Field modifications/QAPP changes	AECOM Project Manager	Claire Mitchell, PE, PMP	716-698-5705 claire.mitchell@aecom.com	All materials and information about the project will be forwarded from the AECOM PM to ARNG/ USACE. The AECOM PM will obtain ARNG/ USACE approval/ concurrence for field modifications/QAPP changes as necessary. All approved modifications will be included in QAPP revisions (prior to field work) or non-conformance report(s) (during field work), and resolution / corrective action identified.
	AECOM RI Task Manager	Peggy Yang	540-446-1794 peggy.yang@aecom.com	Support AECOM PM in implementing RI tasks/procedures.
	AECOM Project QA Officer	Sara Gettier, PE	301-820-3166 sarah.gettier@aecom.com	Oversees/conducts quality audits to assure field program performed in accordance with approved protocols. Supports AECOM PM, Technical Task Manager, and Team Leaders to assure quality reviews are completed on project deliverables, including consistency and conformance with applicable regulatory and DoD guidance and with industry practices. Works with Project Chemist to resolve performance problems with contracted analytical laboratory.
Analytical laboratory modifications and performance problems	AECOM Project Chemist/ Data Validator	Naoum Tavantzis	301-267-8761 naoum.tavantzis@aecom.com	Notify AECOM PM and QA Officer in a timely manner of performance problems encountered by the contracted analytical laboratory. PM will secure approval for modifications to the QAPP as necessary from ARNG/ USACE. All approved modifications will be included in non-conformance Reports.

Communication Driver	Organization	Name	Contact Information	Procedure (Timing, Pathway, Documentation)
Data verification issues (e.g., incomplete records) and data validation issues (e.g., non-compliance with procedures)				Verify/validate all analytical chemistry sample results from analytical laboratories with criteria developed in this QAPP and deliver to the PM and the Project QA Managers.
Data review corrective actions				Notify Laboratory PMs to identify resolution/corrective actions.
Sample receipt variances	Eurofins Lancaster Laboratories	Vanessa Badman	717-556-9762 vanessa.badman@eurofinset.com	Report all project non-conformances and problems to the AECOM Project Chemist. AECOM and laboratory chemists will resolve all non-conformances with appropriate error codes in verification processes.
Laboratory QC variances				Report all project non-conformances and problems to the AECOM Project Chemist. AECOM and laboratory chemists will resolve all non-conformances with appropriate error codes in verification processes.
Analytical corrective actions				Report all project non-conformances and problems to the AECOM Project Chemist. AECOM and laboratory chemists will resolve all non-conformances with appropriate error codes in verification processes.
Laboratory modifications and performance problems				Report all project non-conformances and problems to the laboratory PMs. Laboratory PMs will report to AECOM Project Chemist. AECOM and laboratory chemists will resolve all non-conformances with appropriate error codes in verification processes.

Notes:
DoD = Department of Defense
MS = Master of Science
PE = Professional Engineer
PMP = Project Management Professional
QA = quality assurance
QC = Quality Control

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QAPP Worksheet #9: Technical Project Planning Session Summary

This worksheet will serve as a record of future Technical Project Planning (TPP) sessions. The intent is to provide a concise record of participants, key decisions or agreements reached, and action items. Minutes and the accompanying slide deck will be approved by project team prior to being implemented into the QAPP (**Appendix A**).

AECOM will implement the TPP process as listed in Engineering Manual (EM) 200-1-2 (USACE, 2016), including facility-specific meetings in a professional and organized manner to obtain consensus on specific Data Quality Objectives (DQOs) for the RI work. Per the Performance Work Statement (PWS), eight TPP meetings will be held, in person or via teleconference, as described below:

- Meeting 1 (RI) - Introduce project team members and stakeholders to ARNG's PFAS RI program, discuss the overall planned RI approaches, discuss the project schedule, and gain input on stakeholder preferences (December 2022).
- Meeting 2 (RI) - Present the facility-specific QAPP for the Prescriptive Phase, including planned approaches implementation. Ensure all stakeholders are in agreement with planned investigative strategies, work schedules, and notification procedures to ensure smooth execution of field work (date to be determined [TBD]).
- Meeting 3 (RI) - Present the results for the Prescriptive Phase, the evaluation of the plume and source area(s) extent to date, and a preview of the anticipated scope for the Adaptive Phase (date TBD).
- Meeting 4 (RI) - Resolve comments or concerns on the Adaptive Phase Memo (documenting scope and rationale for Adaptive Phase) or implementation not already addressed during response to comments (date TBD).
- Meeting 5 (RI) - Present findings of the RI (Prescriptive and Adaptive Phase). Gain concurrence on presentation of findings in the RI Report (date TBD).
- Meeting 6 (FS) - Discuss potential remedial action objectives and remedial alternatives to support development of the FS (date TBD).
- Meeting 7 (FS) - Present FS remedial action alternatives, discuss the evaluation of those alternatives, and gain consensus on preferred remedy to be presented in the Proposed Plan and Decision Document (date TBD).
- Meeting 8 (as needed) - Additional meeting to address any unforeseen issue that requires further discussion (date TBD).

TPP meeting minutes will be prepared after each TPP meeting and added as an attachment to the corresponding document. TPP Meeting Minutes are included in **Appendix A**.

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QAPP Worksheet #10: Conceptual Site Model

10.1 Facility Location and Description

West Bend AASF #1 and Armory is in Washington County, Wisconsin, approximately 2 miles east of West Bend, 30 miles northwest of Milwaukee, and 75 miles northeast of Madison. The facility is accessible from East Washington Street by Chopper Drive and Trenton Road. The facility location is shown on **Figure 10-1**.

West Bend AASF #1 was constructed in 2004 on a parcel of land approximately 35 acres that is owned by the City of West Bend and leased to the Wisconsin Army National Guard (WIARNG); the current lease agreement expires September 2075. The current West Bend AASF #1 and Armory facilities include administrative offices, classrooms, and hangars for the operation, maintenance, and repair of WIARNG rotary-winged aircraft.

10.2 Facility Environmental Setting

West Bend AASF #1 and Armory lies within the Milwaukee River Basin, which encompasses several land tributaries to the Milwaukee River. The topography of the area is comprised of rolling hills and numerous drumlins. The elevation of the facility is approximately 896 feet above mean sea level. The surrounding area is covered by cropland, grasslands, wooded area, and wetlands (Wisconsin Department of Natural Resources [WIDNR, 2001]). The facility topography of West Bend AASF #1 and Armory is shown on **Figure 10-2**.

10.2.1 Geology

West Bend AASF #1 and Armory is situated in the Southeast Glacial Plains, which are characterized by having a rolling topography with silt loam soils, an outstanding array of glacial landforms, and numerous wetlands (WIDNR, 2015). The surficial geology is strongly influenced by the Pleistocene glacial advance, which modified the land surface by carving and gouging out soft bedrock and depositing hills and ridges of sand and gravel, as well as flat lake beds of sand, silt, and clay (Wisconsin Geological and Natural History Survey, 2005). The thickness of these deposits typically ranges up to 100 feet but can exceed 500 feet in the bedrock valleys (Young and Batten, 1980).

The facility is underlain by Quaternary-aged sediments. Towards the Milwaukee River, on the southern portion of the facility, the surficial geology is composed of postglacial sand and silt. The rest of the facility is directly underlain by the silt and sand facies of the Waubeka Member of the Holy Hill Formation. This member is composed primarily of well-sorted silt with some sand and clay (Mickelson and Syverson, 1997). Underlying the Waubeka Member is the New Berlin Member of the Holy Hill Formation. At the facility, this member is characterized as diamicton, gravel, and sand (Mickelson and Syverson, 1997).

Beneath the Quaternary-aged sediments, West Bend AASF #1 and Armory partially overlies a bedrock valley. Directly to the east of the facility, the uppermost bedrock is undifferentiated Silurian-aged dolomite, while bedrock directly beneath the facility is primarily Ordovician-aged shale of the Maquoketa Formation (**Figure 10-3**; Evans et al., 2004a). The precise extent of the Silurian dolomite near the facility is uncertain; it may be partially present beneath glacial deposits at the eastern portion of the facility, near the West Bend Municipal Airport (Evans et al., 2004a). The dolomite is often undifferentiated; however, the uppermost dolomite is known to be of the Manistique Formation, which is composed of gray, fine- to medium-grained dolomite with thin to medium bed thickness (Evans et al., 2004a). Depth to bedrock at the facility ranges between 200 and 400 feet below ground surface (bgs) (Evans et al., 2004b). Regionally, thickness of the undifferentiated dolomite ranges from 0 to 700 feet, depending on the degree of post-depositional erosion. Near the facility, the estimated dolomite thickness is believed to be the same as the saturated thickness of the Eastern Dolomite aquifer, which is between 100 to 200 feet. Directly underlying the dolomite is the Ordovician-aged Maquoketa Shale of the Maquoketa Formation (**Figure 10-3**; Young and Batten, 1980). All bedrock units dip regionally eastward toward Lake Michigan (Young and Batten, 1980).

10.2.2 Hydrogeology

The facility is directly underlain by a surficial aquifer that resides within the unconsolidated sand and gravel deposits of glacial outwash, glacial-lake deposits, or alluvium. Wells screened in this aquifer have historically been used for domestic purposes and have a wide range of yields; the wells at West Bend have reached high yields of 500 to 1,750 gallons per minute (gpm) (Young and Batten, 1980).

Directly east of the facility, the surficial aquifer is underlain by the Eastern Dolomite aquifer (also known as the Silurian or Niagaran aquifer). This aquifer resides within the undifferentiated Silurian-aged dolomites and produces water from interconnected cracks, pores, and dissolution channels. The Eastern Dolomite aquifer is thickest along the east side of Wisconsin and thins to the west (Wisconsin Geological and Natural History Survey, 2019). Historically, the Eastern Dolomite aquifer has been sourced for domestic, public, industrial, and agricultural purposes, with yields typically ranging between 150 and 500 gpm (Young and Batten, 1980). The Eastern Dolomite aquifer is unconfined near the facility and is particularly vulnerable to contamination where the unconsolidated deposits are relatively thin. Vertical cracks and cavities may also result in the quick vertical migration of groundwater (Wisconsin Geological and Natural History Survey, 2019).

The facility is primarily underlain by the Maquoketa Shale, which separates the Eastern Dolomite aquifer from the Cambrian-Ordovician aquifer. The shale restricts the vertical migration of groundwater and therefore acts as a regional aquiclude (Young and Batten, 1980). The Cambrian-Ordovician aquifer resides in the Ordovician- and Cambrian-aged sandstone and dolomite units below the Maquoketa Shale, yielding water from fractures and pore spaces between the sand grains or from cracks and fractures (Wisconsin Geological and Natural History Survey, 2019).

Depth to groundwater in the general region ranges from 5 to 25 feet bgs. Shallow groundwater on the east and west side of the facility likely flows either towards the Milwaukee River or to Wingate Creek, which discharges into the Milwaukee River just south of the facility. Groundwater in the regional bedrock aquifers is expected to flow generally east towards Lake Michigan. Aquifer recharge is predominantly through infiltration of precipitation, although some recharge occurs from open water sources (Stantec Consulting Services, Inc., 2018). During the SI, depth to water ranged from 3.2 feet bgs to 13.7 feet bgs. SI temporary well depths ranged from 10 feet bgs to 25 feet bgs, with 5 foot screened intervals ranging from 5 feet bgs to 25 feet bgs. Groundwater elevations were calculated, and an updated groundwater flow map indicated that (at the time of the SI) groundwater generally flowed south toward the Milwaukee River (**Figure 10-4**).

No known municipal drinking water supply wells are located within the boundary of the West Bend AASF #1 and Armory; however, public supply, domestic, and unknown well types exist within 4 miles of the facility. Domestic and unknown wells are downgradient of West Bend AASF #1 and Armory; and other unknown wells are locally up-, down-, and cross-gradient and therefore, may be impacted by potential PFAS releases. Several public drinking water wells are located side gradient and regionally upgradient of the facility but are unlikely to be impacted by potential PFAS releases, as West Bend AASF #1 and Armory is downgradient of the modeled combined contributing areas of the City of West Bend’s municipal wells (Bradbury and Hart, 2006). The modeled combined contributing areas of the City of West Bend’s municipal wells are proportional to pumping rates, well construction, and transmissivity around each well. Drinking water for West

Bend AASF #1 and Armory is supplied by the City of West Bend, which uses the Lake Michigan and the bedrock aquifers as its drinking water sources (WIDNR, 2001).

Results of recent PFAS sampling of municipal supply wells are discussed in Section 10.5.

10.2.3 Hydrology

West Bend AASF #1 and Armory is within the Milwaukee River Basin, which includes six main watersheds. The facility is located within the Village of Newburg-Milwaukee Watershed (**Figure 10-5**), which is a sub watershed within the East and West Branches Milwaukee River Watershed. The tributary that runs between West Bend AASF #1 and the Armory is Wingate Creek, which discharges to the Milwaukee River. The WIARNG Armory is located on the east side of West Bend AASF #1. The facility is currently connected to the City of West Bend sanitary sewer system. On the west side of the facility, the surface water flows to the south via the stormwater system and overland runoff towards the stormwater detention basin, which is located 250 feet west of Wingate Creek and 275 feet north of the Milwaukee River, near the southwestern portion of the facility boundary. Surface water infiltrates within the basin and there is no outlet structure from the basin. On the east side of the facility, surface water flows northwest and southwest to Wingate Creek, then to the Milwaukee River.

10.2.4 Climate

The climate of West Bend consists of warm summers, and winters with freezing, dry, and windy months. Seasonally, temperatures vary from summer highs of 81.5 degrees Fahrenheit (°F) to winter lows of 9.1°F; the average temperature is 55.0°F. Average precipitation is 31.2 inches of rain, and the average snowfall is 43.3 inches (World Climate, 2021). The area is subject to severe storms in the winter.

10.2.5 Current and Future Land Use

West Bend AASF #1 and Armory is a controlled access facility and is adjacent to the West Bend Municipal Airport. The facility consists of a storage hangar, repair hangar, shops, and a two-story office area. Exterior features are vehicle parking areas, roads, aircraft parking, taxiways, and a 90-foot clear-span bridge. The West Bend Municipal Airport is owned and operated by the City of West Bend and provides private, commercial, corporate, cargo, and military air service. Future infrastructure improvements, land acquisitions, and land use controls are not anticipated to change. Reasonably anticipated future land use is not expected to change from the current land use described above.

10.2.6 Critical Habitat and Threatened/ Endangered Species

The following species are listed as federally endangered, threatened, proposed, and/ or candidate species in Washington County, Wisconsin (United States Fish and Wildlife Service [USFWS], 2023a).

- Birds: Whooping crane, *Grus americana* (non-essential experimental population)
- Mammals: Tricolored bat, *Perimyotis subflavus* (proposed endangered); Northern long-eared bat, *Myotis septentrionalis* (threatened)
- Plants: Eastern prairie fringed orchid, Platanthera leucophaea (Threatened)
- Insects: Rusty patched bumble bee, *Bombus affinis* (endangered); Monarch butterfly, *Danaus plexippus* (under consideration)

No critical habitats have been proposed or established in the area of the facility or Washington County (USFWS, 2023a).

10.3 History of AFFF Use

The primary source of PFAS at the facility is related to hangar fire suppression system testing and a single fire training exercise. The main hangar is equipped with a fire suppression system that is supplied by two 500-gallon tanks filled with 3 percent (%) AFFF. Bulk 55-gallon drums of AFFF that supply the fire suppression system are housed in a building connected to the hangar. The fire suppression system has been tested annually, since 2004, by occasionally dispensing 20-40 gallons of 3% AFFF used during testing onto the grassy area behind the building. A stormwater catch-basin is located approximately 100 feet north of the grassy area. This catch-basin collects stormwater, which then flows into the facility stormwater system, and then discharges to a stormwater detention basin on the south side of the property, which receives stormwater runoff from all of the western half of the facility. Stormwater runoff typically infiltrates within the basin and there is no outlet to Wingate Creek or the Milwaukee River. In addition, there was a one-time reported training event with one TriMax™ fire extinguisher that occurred in a grassy area on the east side of the Armory. The exact date, amount, and concentration of AFFF used are unknown. The overlying surface water flow from the release area is north, then west to Wingate Creek, which ultimately discharges to the Milwaukee River. A more thorough description of the releases is presented in **Section 10.6.1**.

10.4 Historical PFAS Investigations

In 2019, the ARNG conducted a PA at West Bend AASF #1 and Armory that identified two potential PFAS release areas (AECOM, 2019) and defined as separate AOIs in the PA (**Figure 10-4**). Descriptions of the potential release areas and AOIs are presented as part of the preliminary conceptual site model (CSM) in **Section 10.6.** An SI was subsequently conducted at the facility to determine the presence or absence of PFOA, PFOS, and PFBS at the AOIs at concentrations at or above the OSD SLs, the applicable standard at the time of the investigation. The SI field work included sampling of surface and subsurface soil and temporary monitoring well installation and grab sampling. The field effort was conducted from 26 to 29 October 2020 (AECOM, 2022).

Additionally, potable water sampling was conducted after the initial SI field work on 8 December 2021 at five off-facility potable wells located downgradient of the AOIs. Sampling results are presented in **Section 10.5**.

Based on the results of the SI, PFOA, PFOS, PFBS, PFHxS, and PFNA were detected in soil and groundwater at AOI 1 and AOI 2. The findings of the SI at the AOIs are included in the summary of the nature and extent of contamination presented in **Section 10.6.2**.

10.5 Drinking Water Sampling

West Bend AASF #1 and Armory receives its potable water from the City of West Bend's municipal water utility; however, domestic wells are located sidegradient and upgradient of AOI 1 and AOI 2, within 4 miles of the facility. The municipal water utility primarily sources its drinking water from Lake Michigan and the bedrock aquifers as its drinking water sources (WIDNR, 2001).

The facility receives its potable water from the City of West Bend Water Utility. The Utility pumps groundwater from wells throughout the City. On 8 December 2021, ARNG collected off-facility drinking water samples from five nearby off-facility residential properties with private wells in closest proximity to the facility boundary, downgradient of AOI 1 and AOI 2 (see **Figure 10-6**). This sampling was conducted due to the exceedance of SLs observed in groundwater during the October 2021 SI (results presented in **Section 10.6.2**). PFAS, analyzed in water collected from outdoor spigots, were non-detect at each of the five residences. The results of the drinking water sampling were provided in letters to residents. The results are discussed in **Section 10.6.2** and provided in **Appendix F** of the SI Report (AECOM, 2022).

PFAS were monitored in source wells in May 2022. Using analytical method USEPA 537.1, PFOS and PFOA were detected in three production wells within the City's water supply (Well 4, Well 11, Well 12) (City of West Bend Water Utility, 2023). The concentrations of PFOS and PFOA combined in Well 4 in May 2022 was 86.7 nanograms per liter (ng/L), and in treated water at the discharge point to the distribution system was 83.9 ng/L, above the Wisconsin Maximum Contaminant Level (MCL) of 70 ng/L (NR 809.20). Well 4 was immediately taken out of service. Samples collected in June 2022 showed concentrations of PFOS and PFOA combined of 57.3 ng/L in Well 4 and 5.15 ng/L in the treated water at the discharge point. Sampling of the municipal water utility for PFOS and PFOA conducted in 2023 indicated that PFAS were detected, though in concentrations below the Wisconsin MCL.

10.6 Preliminary Conceptual Site Model

A summary of the preliminary CSM for the West Bend AASF #1 and Armory is presented below. A description of the primary PFAS release mechanism(s) at AOI 1 and AOI 2 are presented in **Section 10.6.1**. The current interpretation of the nature and extent of PFAS contamination at each AOI is presented in **Section 10.6.2**. The fate and transport of PFAS in environmental media are discussed in **Section 10.6.3**. Lastly, the potential receptors and exposure pathways are discussed in **Section 10.6.4**. Sampling locations completed during the SI are presented on **Figure 10-7**.

The preliminary CSM presents the current understanding of the site conditions with respect to known and suspected sources, potential transport mechanisms and migration pathways, and potentially exposed receptors. An exposure pathway is considered potentially complete when each of the following conditions are present:

1. Contaminant source;
2. Environmental fate and transport;
3. Exposure point;
4. Exposure route; and
5. Potentially exposed populations.

In their anionic forms, PFAS are water-soluble and can migrate readily from soil to groundwater or surface water via leaching and run-off. Given the length of time since the AFFF releases, the average precipitation at the facility, and degree of soil permeability, potential PFAS contamination at the AOIs may have leached from the soil to groundwater.

10.6.1 Summary of Potential Release Areas

Based on the findings of the PA, the potential PFAS release areas were grouped into two AOIs, based on proximity and direction of groundwater flow. The AOIs are shown on **Figure 10-8** and described in the subsections below:

- AOI 1: Fire Suppression System Testing
- AOI 2: Tri-Max™ Release

Three potential off-facility sources of PFAS were identified during the PA and are adjacent to the West Bend AASF #1 and Armory and are not under the control of the WIARNG: West Bend Municipal Airport, Americraft Cookware Manufacturing, and West Bend Wastewater Treatment Plant. These potential sources are also shown on **Figure 10-8** for informational purposes. These locations are up-gradient to cross-gradient of and in proximity to the facility (not under the control of ARNG) and were therefore not previously evaluated as part of the SI. The former firetruck storage area contained no suspected PFAS releases and was therefore not previously evaluated as part of the SI.

Additionally, following the SI, the GFL Landfill and American Metal and Paper Recycling Inc. located to the northwest of West Bend AASF #1 and Armory were identified as potential off-facility sources of PFAS. Sampling performed upgradient of the AOIs during the Prescriptive Phase will determine if any off-facility sources need to be accounted for during the Adaptive Phase sampling.

10.6.1.1 AOI 1 Fire Suppression System Testing

AOI 1 is the Fire Suppression System Testing area, where 20-40 gallons of 3% AFFF were dispensed annually onto the grassy area behind the building, which took place annually from 2004 to 2019. The main hangar fire suppression system is supplied by two 500-gallon tanks filled with 3% AFFF. The AFFF tanks, pumps, and four bulk 55-gallon drums of AFFF that supply the fire suppression system are housed in a building connected to the hangar. The stormwater drain north of AOI 1 flows through the stormwater system to the south, where it discharges to a stormwater detention basin on the south side of the property, which receives stormwater runoff from all the western half of the facility. Additionally, if there is flooding at the stormwater detention basin, surface water can overflow to the Milwaukee River. In 2018, the AFFF dispensed during the annual fire suppression system testing was containerized and removed from the facility for offsite disposal. Since then, the annual inspections no longer include flow testing, and therefore no AFFF is discharged or disposed.

10.6.1.2 AOI 2 Tri-Max™ Release

AOI 2 is the Tri-Max™ Release area, where a one-time reported training event with one Tri-Max™ fire extinguisher occurred in a grassy area located on the east side of the Armory. The exact date, amount, and concentration of AFFF used are unknown. The surface water flows northwest and southwest toward Wingate Creek, and ultimately to the Milwaukee River.

10.6.2 Current Understanding of Nature and Extent of Contamination

The current understanding of the nature and extent of PFAS contamination at AOI 1 is presented in the subsections below. The summaries are based on review and evaluation of available analytical results from historical PFAS investigations, as summarized in **Section 10.4**. Sampling included multi-interval soil samples and groundwater sampling of temporary monitoring wells. During the SI, surface and subsurface samples were analyzed for the target list of 25 PFAS (liquid chromatography tandem mass spectrometry [LC/MS/MS] compliant with QSM 5.1 Table B-15. Additionally, potable water samples were subsequently collected from private properties down-gradient of the facility.

The Department of Defense (DoD) has adopted a policy to retain facilities in the CERCLA process based on risk-based SLs calculated by the OSD for soil and groundwater (Assistant Secretary of Defense, 2022). The SLs are shown in **Table 10-1**, with SI sampling results discussed below. The SI results have been reevaluated for comparison against the 2022 SLs shown in **Table 10-1**.

Table 10-1 Screening Levels (Soil and Groundwater)

Analyte	Residential (Soil) (µg/kg)[a] 0-2 feet bgs	Industrial/ Commercial Composite Worker (Soil) (µg/kg)[a] 2-15 feet bgs	Tap Water (Groundwater) (ng/L)[a]
PFOA	19	250	6
PFOS	13	160	4
PFBS	1,900	25,000	601
PFNA	19	250	6
PFHxS	130	1,600	39
HFPO-DA	23	350	6

Notes:

a.) Assistant Secretary of Defense, 2022. Based on United States Environmental Protection Agency's (USEPA's) Regional Screening Level Table. Hazard Quotient= 0.1 and Target Cancer Risk Level = 1E-6. 6 July 2022.

µg/kg = micrograms per kilogram
bgs = below ground surface
ng/L = nanograms per liter

Analytical results from the SI are presented in **Table 10-2** through **Table 10-4** and shown in **Figure 10-9** through **Figure 10-15**. The combined results from the SI are further summarized in the subsections below.

AOI 1

Based on the SI findings, PFOA, PFOS, PFBS, and PFNA were detected in AOI 1 (see **Figure 10-9**, **Figure 10-10**, **Figure 10-11**, **Figure 10-12**, and **Figure 10-13**, respectively, for soil sampling results). The following statements present the SI findings for AOI 1.

Soil was sampled at AOI 1 from three depth intervals at boring locations AOI01-1, AOI01-02, AOI01-03, and AOI01-04 during the SI: shallow interval (0 to 2 feet bgs), intermediate interval (6 to 8 feet bgs), and deep interval (7 to 17 feet bgs). PFOS, PFOA, and PFBS were detected in soil at concentrations several orders of magnitude lower than the SLs as summarized below.

- PFOS was detected in the shallow soil interval at all four locations with concentrations ranging from 0.220 J micrograms per kilogram (µg/kg) to 0.827 J µg/kg but not detected in the intermediate or deep intervals.
- PFOA was detected in the shallow soil interval at all four locations with concentrations ranging from 0.214 J µg/kg to 0.380 J µg/kg. PFOA was detected in the intermediate and deep soil intervals at AOI01-01 with concentrations of 0.606 J µg/Kg and 0.504 J µg/kg, respectively.
- PFBS was detected in the shallow soil interval at location AOI01-02 with a concentration of 3.41 µg/kg but was not detected in the intermediate or deep soil intervals.
- PFHxS was not detected in any surface or subsurface soil samples at AOI 1.
- PFNA was detected in the shallow soil interval at two locations, AOI01-01 and AOI01-02, with concentrations of 0.426 J µg/kg and 0.188 J µg/kg respectively. PFNA was detected in the intermediate soil interval at AOI01-01 at a concentration of 0.168 J µg/kg.

Groundwater samples were collected from four temporary monitoring well locations at AOI 1 during the SI (AOI01-01-GW [screen interval 20-25 ft bgs], AOI01-02-GW [screen interval 15-20 ft bgs], AOI01-03-GW [screen interval 16-21 ft bgs], and AOI01-04-GW [screen interval 15-20 ft bgs]). The deeper range of the screen interval represents the total depth of the temporary monitoring well.

- PFOS was detected above the SL of 4 ng/L at AOI01-01-GW with a concentration of 18.3 J ng/L. The SL of 6 ng/L for PFOA was exceeded at AOI01-01-GW with a concentration of 990 ng/L.
- PFBS was detected below the SL of 601 ng/L at two well locations, with concentrations ranging from 0.860 J ng/L to 1.34 J ng/L, with the maximum concentration occurring at AOI01-03-GW.
- PFHxS was non-detect in groundwater at AOI 1. The SL of 6 ng/L for PFNA was exceeded at AOI01-01-GW with a concentration of 117 ng/L.

See **Figure 10-14** and **Figure 10-15** for groundwater sampling results.

AOI 2

Soil was sampled at AOI 2 from two depth intervals at boring locations AOI02-01, AOI02-02, AOI02-04, and AOI02-05 during the SI: shallow interval (0 to 2 feet bgs) and intermediate interval (3 to 5 feet bgs); from three depth intervals at boring location AOI02-03: shallow interval (0 to 2 feet bgs), intermediate interval (3 to 5 feet bgs), and deep interval (7 to 9 feet bgs); and from one depth interval at AOI02-SS01, AOI02-SS02, AOI02-SS03, AOI02-SS04, AOI02-SS05, and AOI02-SS06: shallow (0 to 2 feet bgs). PFOS, PFOA, PFBS, PFHxS, and PFNA were detected in soil at concentrations below the SLs (see **Figure 10-9**, **Figure 10-10**, **Figure 10-11**, **Figure 10-12**, and **Figure 10-13**, respectively, for soil sampling results).

- PFOS was detected in the shallow soil interval at all eleven locations with concentrations ranging from 0.828 J µg/kg to 6.85 µg/kg. PFOS was detected in the intermediate soil interval at AOI02-01, AOI02-03, AOI02-04, and AOI02-05 with concentrations ranging from 0.344 J µg/kg to 5.75 µg/kg. PFOS was not detected in the deep interval.
- PFOA was detected in the shallow soil interval at AOI02-01, AOI02-03, AOI02-04, and AOI02-05 locations with concentrations ranging from 0.163 J µg/kg to 0.262 J µg/kg but was not detected in the intermediate or deep intervals.
- PFBS was not detected in soil at AOI 2.
- PFHxS was detected in the shallow surface soil interval at three locations, AOI02-03, AOI02-SS01, and AOI02-SS05 with concentrations between 0.182 J µg/kg and 2.56 µg/kg. PFHxS was detected in one deep interval soil sample, AOI02-03, at a concentration of 0.678 J µg/kg.
- PFNA was detected in the shallow surface soil interval at two locations, AOI02-02 and AOI02-04, at concentrations of 0.156 J µg/kg and 0.111 J µg/kg, respectively. PFNA was not detected in any subsurface soil sample at AOI 2.

Groundwater samples were collected from five temporary monitoring well locations at AOI 2 during the SI (AOI02-01-GW [screen interval 5-10 ft bgs], AOI02-02-GW [screen interval 5-10 ft bgs], AOI02-03-GW [screen interval 20-25 ft bgs], AOI02-04-GW [screen interval 5-10 ft bgs], and AOI02-05-GW [screen interval 5-10 ft bgs]). The deeper range of the screen interval represents the total depth of the temporary monitoring well.

- The SL of 4 ng/L for PFOS was exceeded at AOI02-01-GW, AOI02-02-GW, AOI02-04-GW, and AOI2-05-GW, and AOI02-05-GW-FD with concentrations of 702 J- ng/L, 232 ng/L, 492 ng/L, 225 ng/L, and 193 ng/L, respectively.

- PFOA was detected below the SL of 6 ng/L at three well locations (AOI02-01-GW, AOI02-03-GW, and AOI02-05-GW) with concentrations ranging from 3.29 J ng/L to 5.88 ng/L. PFOA exceeded the SL at AOI02-02-GW and AOI02-04-GW, with the maximum concentration of 21.0 ng/L occurring at AOI02-02-GW.
- PFBS was detected below the SL of 601 ng/L at all well locations, with concentrations ranging from 1.44 J ng/L to 8.12 ng/L, with the maximum concentration occurring at AOI02-03.
- PFHxS was detected in groundwater at concentrations exceeding the SL of 39 ng/L at AOI02-01-GW and AOI02-02-GW with a maximum concentration of 88.1 ng/L.
- PFNA was detected above the SL of 6 ng/L at AOI02-02-GW with a concentration of 17.0 ng/L.

See **Figure 10-14** and **Figure 10-15** for groundwater sampling results.

During a later mobilization after completion of SI field work, potable water samples were collected from five private residential wells, POTABLE-01 through POTABLE-05 (**Figure 10-6**). PFAS compounds were non-detect at all five potable wells sampled.

Based on the results of the SI, PFOA, PFOS, and PFNA exceeded the SLs within the AOI 1 boundary in groundwater. There were no SL exceedances in groundwater either upgradient or downgradient of AOI 1. PFOA, PFOS, PFHxS and PFNA exceeded the SLs in groundwater upgradient of AOI 2. PFOS and PFHxS exceeded the SLs in groundwater within the AOI 2 boundary. PFOS exceeded the SLs in groundwater downgradient of AOI 2. PFBS did not exceed the SLs in groundwater at any sample location. PFOA, PFOS, PFBS, and PFNA were detected in surface soil at AOI 1; however, the detected concentrations were below the soil SL. PFOA and PFNA were detected in subsurface soil in AOI 1; however, the detected concentrations were an order of magnitude lower than the soil SL. PFOA, PFOS, PFHxS and PFNA were detected in surface soil at AOI 2. Though the detected concentrations in surface soil at AOI 2 were lower than the SLs, PFOS concentrations were approaching the soil SL of 13 µg/kg. PFOS and PFHxS were detected in subsurface soil at AOI 2; however, the detected concentrations were an order of magnitude lower than the soil SL. Data quality limits (DQLs) for these media are presented in **Worksheet #15** and will be considered during the evaluation of RI sampling results. Based on the currently available data, data gaps exist that require further evaluation with supplemental work as part of this RI.

Data Gaps for PFAS

Based on the evaluation of soil and groundwater data presented above, the presence of PFAS has been confirmed in groundwater at both AOI 1 and AOI 2, with exceedances of the SLs in groundwater. However, the exact locations of the PFAS releases to soil at AOI 2 and the migration pathways between the release areas at AOI 1, AOI 2 and boundaries are not fully understood. Of the six PFAS compounds presented in the 6 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of the SI. Based on the CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at the facility because HFPO-DA is generally not a component of MIL-SPEC AFFF and based on its history, including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS. However, because it was not an analyte during the SI, the presence or absence of HFPO-DA is considered a data gap. Detailed descriptions of the approach for addressing the PFAS data gaps are presented in the sampling design and rationale tables in **Worksheet #17**.

10.6.3 Fate and Transport of PFAS

Contaminant fate and transport is an evaluation of the changes that occur in constituents and concentrations as they move through different environmental media. Understanding the fate and transport of chemicals is important in evaluating their potential impacts to receptors. Fate is a summary of all the physical and chemical processes that act on the constituents during transport. Transport is the simple movement of the constituents, for example, with the flow of groundwater or surface water.

The primary source of PFAS at West Bend AASF #1 and Armory is likely from fire suppression system testing and fire training activities / releases attributable to ARNG activities. Multiple AFFF formulations have been produced over the years, and the exact composition of any given AFFF used or manufactured in any given year is highly variable (Backe et.al, 2013). AFFF contains highly diverse mixtures of PFAS which may vary based on the production process used: electrochemical fluorination (ECF) or fluorotelomerization. The ECF process results in a PFAS mixture dominated by perfluoroalkyl acids (PFAAs), both perfluoroalkyl sulfonic acid (PFSA) and perfluoroalkyl carboxylic acid (PFCA) homologues, while the fluorotelomerization process produces AFFF formulations dominated by polyfluorinated compounds with lesser amounts of PFAAs (Houtz et al., 2013). In general, ECF-based AFFF is the dominant source of PFAS at AFFF-impacted sites (Interstate Technology Regulatory Council [ITRC], 2018a).

Both the PFSA and PFCA homologues produced as part of AFFF manufacture (including PFOA and PFOS) are long-chain PFAS chemicals that are persistent in the environment, bioaccumulative in wildlife and humans, and are toxic to laboratory animals and wildlife, producing reproductive, developmental, and systemic effects in laboratory tests. Shorter-chain PFSAs, such as PFBS and PFHxS, are generally less toxic and less bioaccumulative in wildlife and humans, and alternative products containing these shorter-chain chemicals have been introduced as replacements for long-chain PFAS. Increasing levels of PFBS and PFHxS in surface water have been observed indicating that short-chain alternatives to PFOA and PFOS are also persistent in the environment (Buck et al., 2011).

Precursors typically are raw materials or intermediary compounds in the PFAS manufacturing process. Generally, they consist of polyfluorinated alkyl compounds that can be biotically and abiotically transformed into PFAA terminal “end-member” compounds (i.e., PFAS) in the environment. Transformation of these precursors to PFAAs has been shown to occur in a variety of environmental media and can result in unexpected temporal and spatial trends in PFAS occurrence. The susceptibility of individual precursors to transformation processes can also influence how each will bioconcentrate and bioaccumulate within various biotic species. The analysis of precursor compounds in surface soils can be used to help identify source release areas because precursor compounds tend to be larger, transform slowly and adsorb more strongly to soil. Fluorotelomer alcohols (FTOHs) and fluorinated sulfonamides, such as N-ethyl perfluorooctane sulfonamidoethanol (EtFOSE), are examples of such precursor compounds (Houtz et al., 2013).

PFAS most commonly detected in the environment typically have a carbon-fluorine “tail” and a nonfluorinated “head” consisting of a polar functional group. The tail is hydrophobic and lipophobic, while the head groups are polar and hydrophilic. These competing tendencies of the head and the tail can lead to a wide distribution in the environment. Important PFAS partitioning mechanisms include hydrophobic and lipophobic effects, electrostatic interactions, and interfacial behaviors. The hydrophobic and lipophobic effects drive the association with organic carbon in soils and sediments (ITRC, 2018a). Because the head and the tail compete, partitioning to interfaces of environmental media such as soil/water, air/water and water/non-aqueous phase liquid co-contaminants can occur (Guelfo and Higgins, 2013; McKenzie et al., 2016; Brusseau, 2018). Preferential accumulation of PFAS above the water table within the vadose zone is a common example of partitioning at the air/water interface.

PFCAs and PFSAs are present as organic anions at most pH levels found in the environment and are therefore relatively mobile in groundwater (Xiao et al., 2015) but tend to associate with the organic carbon fraction that may be present in soil or sediment (Higgins and Luthy, 2006; Guelfo and Higgins, 2013). When sufficient organic carbon is present, organic carbon-normalized distribution coefficients (K_{oc} values) can help in evaluating transport potential, though other geochemical factors (for example, pH and presence of polyvalent cations) may also affect PFAS sorption to solid phases (ITRC, 2018a).

Sorption and retardation of PFAS compounds show correlations with carbon chain length and structure. Sorption generally increases with increasing perfluoroalkyl tail length (Higgins and Luthy, 2006; Guelfo and Higgins, 2013; Sepulvado et al., 2011), indicating that the short-chain PFSAs, like PFBS and PFHxS, are retarded less than longer chain chemicals like PFOA and PFOS. Also, branched versus linear isomers of the same compound display different sorptive behavior, with linear isomers tending to sorb more strongly than their branched counterparts.

Sorption of PFCAs and PFSAs is also affected by soil solution chemistry, with decreased pH and increased levels of polyvalent cations (for example, calcium $[Ca]^{2+}$) leading to increased sorption and retardation (Higgins and Luthy, 2006; McKenzie et al., 2015). Vapor pressures of these compounds are generally low, and water solubilities are high, limiting partitioning from water to air (USEPA, 2000).

Once organic chemicals are released to soils, a variety of processes may occur that cause them to become immobilized or to be mobilized to another environmental medium. Chemicals may be taken up and held on soil particles by adsorption (sticking to a particle surface) or absorption (diffusion into the particle). Chemicals may sorb directly to the soil grains or to organic or metal oxyhydroxide coatings on the grains. The degree of sorption of a particular chemical in the environment is controlled by both soil properties (i.e., organic carbon content, metal oxyhydroxide content, clay content, or specific surface area) and by chemical properties (i.e., partition coefficients, solubility, polarity). PFOS adsorbs to soil and sediment and does not readily desorb once adsorbed to these matrices. The fate properties of PFOA are similar to those of PFOS, while PFBS and PFHxS are slightly less likely to sorb to soil (ITRC, 2018a).

Chemicals may be transported downward through the soil strata by liquids that infiltrate through the soils or by water from precipitation. Chemicals released to, or transported into, soils beneath the groundwater surface may be leached from the soils by groundwater and transported downgradient in groundwater. Leaching potential is a function of both media properties (for example, pH, redox conditions, and increased partitioning with organic-rich soil) and PFAS structural properties (for example, ionic charge, and chain length) (Gellrich, Stahl, and Knepper, 2012). PFAS may be transported to the sediment and surface water through direct discharges from drainage outfalls, overland runoff/erosion, and groundwater discharge.

10.6.4 Potential Receptors and Exposure Pathways

As described above, soil and groundwater may have been impacted by PFAS releases associated with historical ARNG activities at two AOIs within the West Bend AASF #1 and Armory. Therefore, human and ecological receptors present within these AOIs may be exposed to PFAS. In addition, PFAS in these media may have migrated via stormwater flow into the stormwater system and subsequently to Wingate Creek and the Milwaukee River. Human and ecological receptors may be exposed to PFAS in sediment, surface water, and biological organisms within these waterways.

The currently understood human health and ecological receptors and potentially complete exposure pathways under current and reasonably anticipated future land use scenarios are summarized below and are presented on **Figure 10-16**. The human health and ecological receptors and exposure pathways identified below may be refined based on data from the

Prescriptive Phase of the RI. Further evaluations of the exposure pathways will be considered during future mobilization(s).

Human Health

Current human receptors at the facility include on-facility workers and approved visitors (e.g., National Guard/Army Reserve trainees). Outdoor workers may contact surface soil on the facility while performing maintenance or other similar activities. Visitors and trainees may also contact soil on the facility but are anticipated to have a lower exposure potential as compared to outdoor workers who would presumably be present more frequently and perform more soil-intense activities, such as landscaping. Construction/utility workers may also be present and access facility soil in the future if redevelopment or utility activities were to occur.

The West Bend AASF #1 and Armory is a controlled-access facility; therefore, entry by trespassers is considered unlikely. The facility is currently surrounded by a security fence with barbed wire extension; therefore, entry by trespassers is considered unlikely. However, it is conservatively assumed that trespassers may access surface soil at the facility in the future if there is no longer controlled access.

As discussed in **Section 10.5**, the facility receives its potable water from the City of West Bend Water Utility. There are no potable wells on the facility. However, domestic wells are located downgradient of AOI 1 and AOI 2, within 4 miles of the facility. As further discussed in **Section 10.5**, in December 2021, ARNG collected potable water samples from five nearby off-facility residential water wells in closest proximity to the facility boundary, downgradient of AOI 1 and AOI 2 (see **Figure 10-6**). PFAS were non-detect at each of the five potable water wells. Therefore, potential exposure to PFAS in drinking water is currently incomplete both on and off facility. Future use of groundwater as a drinking water source is conservatively assumed for the HHRA.

Non-military land uses in off-facility areas adjoining the facility include commercial, residential, and agricultural use, where access is open to the public.

Reasonably anticipated future land use is not expected to change from the current land use described above. However, the Human Health Risk Assessment (HHRA) (to be performed as part of the RI following the Adaptive Phase) will conservatively evaluate an unlimited use/unrestricted exposure (UU/UE) scenario to inform future risk-management decisions in the FS, if applicable. This scenario includes the evaluation of a hypothetical future on-facility residential scenario and the evaluation of on-facility groundwater as a source of drinking water. A remedial response will not necessarily be taken based on the results of the future UU/UE scenario, given it is not a reasonably anticipated future use for the facility, per the DoD Defense Environmental Restoration Program (DERP) Management Manual, which states “The DoD Component shall consider current and reasonably anticipated future land uses in risk assessments. The DoD Component does not have to assume that the reasonably anticipated future land use is residential.” (DoD, 2012).

The receptors and exposure pathways that will be evaluated in the HHRA were selected based on current and potential future land use based on the preliminary facility specific CSM and are presented in the following table. For purposes of the HHRA, it is conservatively assumed that future land-use scenarios may involve some level of construction to convert the area to the desired use. Under this scenario, it is assumed that current subsurface soils may be brought to the surface and become available for exposure by future receptors. Potential exposure to airborne particles in outdoor air (from soil) will not be quantitatively evaluated in the HHRA because toxicity values for the inhalation exposure route are not available from USEPA’s sources for PFAS; therefore, quantitative assessment of the inhalation exposure pathway cannot be performed. The associated uncertainties will be discussed in the HHRA.

Area	Receptor	Exposure Pathway(s)
On-facility	Outdoor Worker	Current: Exposure to on-facility surface soil (0-2 feet bgs) through incidental ingestion and dermal contact. Exposure to surface water and sediment via incidental ingestion and dermal contact if conditions are wet during the time of sampling in the on-facility stormwater detention basin. If conditions are dry, then sediment samples will be treated like surface soil.
		Future: Exposure to on-facility combined surface and subsurface soil (0 to 15 feet bgs [or the top of the water table if it is shallower]) through incidental ingestion and dermal contact. Exposure to groundwater via ingestion as drinking water. Exposure to surface water and sediment via incidental ingestion and dermal contact if conditions are wet during the time of sampling in the on-facility stormwater detention basin. If conditions are dry, then sediment samples will be treated like surface soil.
	Construction/Utility Worker	Future: Exposure to on-facility combined surface and subsurface soil (0 to 15 feet bgs [or the top of the water table if it is shallower]) through incidental ingestion and dermal contact. Exposure to on-facility shallow groundwater (to a maximum depth of 15 feet bgs) via incidental ingestion and dermal contact in an excavation trench. Exposure to groundwater is possible since the depth to groundwater observed during the SI ranged from 3.2 to 14.7 feet bgs.
	Trespasser (Adolescent)	Future: Exposure to on-facility surface soil (0-2 feet bgs) through incidental ingestion and dermal contact.
	Hypothetical On-facility Resident (Adult and Child)	Future: Exposure to on-facility combined surface and subsurface soil (0 to 15 feet bgs [or the top of the water table if it is shallower]) through incidental ingestion and dermal contact. Exposure to groundwater via ingestion of drinking water and dermal contact during bathing/showering.
Off-facility	Off-facility Recreational User (Adult and Child)	Current/Future: Exposure to sediment and surface water in Wingate Creek will be evaluated under a wading scenario, and surface water and sediment in the Milwaukee River will be evaluated under a swimming scenario, which is protective of other recreational activities such as boating, kayaking, etc. Consumption of fish may be evaluated for the Milwaukee River if a complete migration pathway is identified and PFAS in the river are attributable to facility activities.
	Commercial/Industrial Worker	Current/Future: Exposure to off-facility groundwater via ingestion of drinking water.
	Off-facility Resident (Adult/Child)	Current/Future: Exposure to groundwater via ingestion of drinking water and dermal contact during bathing/showering.

Notes:
These off-facility receptors will only be evaluated if downgradient impacts to drinking water are identified and can be attributed to ARNG activities on the facility.

Ecological

The majority of the current facility is paved with limited grassy areas. The terrestrial habitats associated with AOI 1 and AOI 2 are limited due to the continuing military land uses and actively mowed, disturbed, and maintained areas where PFAS releases occurred. Although bird and mammal species may access the fragmented areas of open space within the AOIs that surround paved areas, roads, and buildings, these upland habitats offer limited ecological foraging resources. Upland habitats that would support significant plant or animal communities are not expected to be present within the AOIs. However, it is conservatively assumed that terrestrial plants and soil invertebrates may serve as food sources for birds and mammals that may be present in areas with viable habitat.

The primary exposure pathways for upland areas with viable habitat include:

- Soil invertebrates, terrestrial plants, reptiles, and amphibians directly exposed to PFAS in surface soil (0 to 2 feet bgs).
- Terrestrial birds and mammals exposed to PFAS through incidental ingestion of soil and by ingestion of contaminated plant and prey items impacted by surface soil. If present, burrowing mammals may be exposed to PFAS in sub-surface soils (2 to 4 feet bgs) through incidental soil ingestion while digging and grooming.

The on-facility stormwater detention basin, located near the southwestern boundary of the facility, receives stormwater flow from the drainage features on the western portion of the facility. The stormwater detention basin is dry except during or after heavy precipitation events. If present, surface water will be collected from the stormwater detention basin. Due to the lack of standing water in the stormwater detention basin, fish are not expected to be present. Given the ephemeral nature of water in the unlined stormwater detention, sediment is only expected to be present seasonally and the basin may not support a benthic community; therefore, solid material collected in the basin may be treated as soil for purposes of evaluating ecological exposures to PFAS. Observations made during the Habitat Assessment will be used to confirm the presence/absence of riparian or wetland plants species that would imply an aquatic habitat is seasonally present.

Wingate Creek bisects the facility and discharges to the Milwaukee River. Milwaukee River is located approximately 500 feet from the southern boundary of AOI 1. Wingate Creek is classified as an intermittent riverine system and includes associated with forested/shrub wetlands along its banks (USFWS, 2023b). In addition, approximately 2 acres of emergent wetland exist on the eastern side of the Wingate Creek directly outside of the AOI 2 boundary (USFWS, 2023b). It is conservatively assumed that aquatic receptors other than fish (e.g., amphibians, aquatic insects), may be found within Wingate Creek and associated emergent wetlands. The Milwaukee River supports aquatic and semi-aquatic wildlife year-round. Facility-related surface water from storm events may impact waters of Wingate Creek and Milwaukee River.

Ecological receptors are typically not directly exposed to groundwater; therefore, there are no complete exposure pathways between groundwater (observed at 3.2 to 14.7 feet bgs in the SI) and ecological receptors. However, exposure to PFAS present in groundwater may occur when groundwater discharges or seeps into a surface water body (e.g., Wingate Creek or Milwaukee River); this exposure pathway is addressed through the evaluation of surface water.

If surface water is collected from the stormwater detention basin, it will conservatively be assumed that aquatic receptors may be found seasonally within the stormwater detention basin. The primary exposure pathways for seasonal aquatic habitat in the stormwater detention basin and aquatic habitats associated with the Milwaukee River and Wingate Creek include:

- Benthic invertebrates and aquatic organisms (e.g., aquatic plants, aquatic invertebrates, and amphibians) directly exposed to PFAS in sediment and surface water in aquatic and semi-aquatic habitats.
- Aquatic-dependent birds and mammals exposed to PFAS through incidental ingestion of sediment, intentional ingestion of surface water, and by ingestion of contaminated plant and prey items impacted by sediment or surface water in aquatic and semi-aquatic habitats.

If surface water is not collected from the stormwater detention basin and the findings from the Habitat Assessment do not indicate that aquatic habitat is seasonally present, the solid material collected from the basin will be evaluated as surface soil; consistent with the potential exposure pathways identified for upland habitat in AOI 1 and AOI 2.

Due to the expected intermittent nature of Wingate Creek, fish are not expected to be present or exposed to Creek surface water and sediment; however, the Milwaukee River supports fish species and fish may be exposed to surface water and sediment.

In cases where receptor-specific PFAS toxicity information is not available, potential impacts on receptors (e.g., reptiles) will be considered qualitatively in the Screening-Level Ecological Risk Assessment (SLERA).

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Table 10-2
Site Inspection PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Surface Soil
RI QAPP, West Bend AASF #1 and Armory

	Area of Interest	AOI01								AOI02											
	Sample ID	AOI01-01-SB-0-2		AOI01-02-SB-0-2		AOI01-03-SB-0-2		AOI01-04-SB-0-2		AOI02-01-SB-0-2		AOI02-02-SB-0-2		AOI02-02-SB-0-2-FD		AOI02-03-SB-0-2		AOI02-04-SB-0-2		AOI02-05-SB-0-2	
	Sample Date	10/28/2020		10/28/2020		10/27/2020		10/28/2020		10/27/2020		10/27/2020		10/27/2020		10/27/2020		10/27/2020		10/27/2020	
	Depth	0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft	
Analyte	**OSD Screening Level [a]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (µg/Kg)																					
PFBS	1900	ND		3.41		ND		ND		ND		ND		ND		ND		ND		ND	
PFHxS	130	ND		ND		ND		ND		ND		ND		ND		2.56		ND		ND	
PFNA	19	0.426	J	0.188	J	ND		ND		ND		0.156	J	0.137	J	ND		0.111	J	ND	
PFOA	19	0.380	J	0.250	J	0.214	J	0.228	J	0.262	J	ND		ND		0.163	J	0.177	J	0.188	J
PFOS	13	0.220	J	0.827	J	0.474	J	0.598	J	5.53		3.76		4.56		4.35		6.85		4.51	

	Area of Interest	AOI02													
	Sample ID	AOI02-SS01		AOI02-SS02		AOI02-SS03		AOI02-SS03-FD		AOI02-SS04		AOI02-SS05		AOI02-SS06	
	Sample Date	10/26/2020		10/26/2020		10/26/2020		10/26/2020		10/26/2020		10/26/2020		10/26/2020	
	Depth	0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft	
Analyte	**OSD Screening**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (µg/Kg)															
8:2 FTS	-	ND		ND		ND		ND		ND		ND	UJ	ND	
NEtFOSAA	-	ND		ND		ND		ND		ND		ND		ND	
NMeFOSAA	-	ND		ND		ND		ND		ND		ND		ND	
PFBS	1900	ND		ND		ND		ND		ND		ND		ND	
PFHxS	130	0.182	J	ND		ND		ND		ND		0.298	J	ND	
PFNA	19	ND		ND		ND		ND		ND		ND		ND	
PFOA	19	ND		ND		ND		ND		ND		ND		ND	
PFOS	13	2.07		1.32		0.828	J	1.17		2.00		5.27	J-	2.68	

Grey Fill — Detected concentration exceeded OSD Screening Levels

References

a. Assistant Secretary of Defense, July 2022. Risk Based Screening Levels Calculated for PFOA, PFOS, PFBS, PFHxS, and PFNA in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1, May 2022. Soil screening levels based on residential scenario for incidental ingestion of contaminated soil.

Interpreted Qualifiers

J = Estimated concentration

J- = Estimated concentration, biased low

Chemical Abbreviations

PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
FD	Duplicate
ft	feet
HQ	Hazard quotient
ID	identification
LCMSMS	Liquid Chromatography Mass Spectrometry
ND	Analyte not detected above the LOD
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SB	soil boring
USEPA	United States Environmental Protection Agency
µg/Kg	micrograms per Kilogram
-	Not applicable

Table 10-3
Site Inspection PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Subsurface Soil
RI QAPP, West Bend AASF #1 and Armory

	Area of Interest	AOI01																	
	Sample ID	AOI01-01-SB-6-8		AOI01-01-SB-10-12		AOI01-02-SB-5-7		AOI01-02-SB-7-9		AOI01-03-SB-6-8		AOI01-03-SB-6-8-FD		AOI01-04-SB-6-8		AOI01-04-SB-13-15		AOI01-04-SB-13-15-FD	
	Sample Date	10/28/2020		10/28/2020		10/28/2020		10/28/2020		10/27/2020		10/27/2020		10/28/2020		10/28/2020		10/28/2020	
	Depth	6 - 8 ft		10 - 12 ft		5 - 7 ft		7 - 9 ft		6 - 8 ft		6 - 8 ft		6 - 8 ft		13 - 15 ft		13 - 15 ft	
Analyte	**OSD Screening Level [a]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (µg/Kg)																			
PFBS	1900	ND		ND		ND		ND		ND		ND		ND		ND		ND	
PFHxS	130	ND		ND		ND		ND		ND		ND		ND		ND		ND	
PFNA	19	0.168	J	ND		ND		ND		ND		ND		ND		ND		ND	
PFOA	19	0.606	J	0.504	J	ND		ND		ND		ND		ND		ND		ND	
PFOS	13	ND		ND		ND		ND		ND		ND		ND		ND		ND	

	Area of Interest	AOI02											
	Sample ID	AOI02-01-SB-3-5		AOI02-02-SB-3-5		AOI02-03-SB-3-5		AOI02-03-SB-7-9		AOI02-04-SB-3-5		AOI02-05-SB-3-5	
	Sample Date	10/27/2020		10/27/2020		10/28/2020		10/28/2020		10/27/2020		10/27/2020	
	Depth	3 - 5 ft		3 - 5 ft		3 - 5 ft		7 - 9 ft		3 - 5 ft		3 - 5 ft	
Analyte	**OSD Screening Level [a]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (µg/Kg)													
PFBS	1900	ND		ND		ND		ND		ND		ND	
PFHxS	130	ND		ND		ND		0.678	J	ND		ND	
PFNA	19	ND		ND		ND		ND		ND		ND	
PFOA	19	ND		ND		ND		ND		ND		ND	
PFOS	13	5.75		0.344	J	ND		ND		1.14	J	0.671	J
Grey Fill	Detected concentration exceeded OSD Screening Levels												

References

a. Assistant Secretary of Defense, July 2022. Risk Based Screening Levels Calculated for PFOA, PFOS, PFBS, PFHxS, and PFNA in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1, May 2022. Soil screening levels based on residential scenario for incidental ingestion of contaminated soil.

Interpreted Qualifiers

J = Estimated concentration

J- = Estimated concentration, biased low

Chemical Abbreviations

PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
FD	Duplicate
ft	feet
HQ	Hazard quotient
ID	identification
LCMSMS	Liquid Chromatography Mass Spectrometry
ND	Analyte not detected above the LOD
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SB	soil boring
USEPA	United States Environmental Protection Agency
µg/Kg	micrograms per Kilogram
-	Not applicable

Table 10-4
Site Inspection PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Groundwater
RI QAPP, West Bend AASF #1 and Armory

	Area of Interest	AOI01								AOI02											
	Sample ID	AOI01-01-GW		AOI01-02-GW		AOI01-03-GW		AOI01-04-GW		AOI02-01-GW		AOI02-02-GW		AOI02-03-GW		AOI02-04-GW		AOI02-05-GW		AOI02-05-GW-FD	
	Sample Date	10/29/2020		10/28/2020		10/28/2020		10/28/2020		10/27/2020		10/27/2020		10/28/2020		10/27/2020		10/27/2020		10/27/2020	
Analyte	**OSD Screening Level [a]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ng/L)																					
PFBS	601	ND		0.860	J	1.34	J	ND		2.43	J	3.37	J	8.12		1.97	J	1.44	J	1.84	J
PFHxS	39	ND		ND		ND		ND		66.6		88.1		24.8		33.2		11.8		13.0	
PFNA	6	117		ND		ND		ND		2.38	J	17.0		ND		ND		ND		ND	
PFOA	6	990		ND		4.03	J	2.51	J	5.88		21.0		4.91	J	7.49		4.78	J	3.29	J
PFOS	4	18.3	J	ND		1.64	J	1.33	J	702	J-	232		13.0		492		225		193	

Grey Fill — Detected concentration exceeded OSD Screening Levels

References
a. Assistant Secretary of Defense, July 2022. Risk Based Screening Levels Calculated for PFOA, PFOS, PFBS, PFHxS, and PFNA in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1, May 2022 Groundwater screening levels based on residential scenario for direct ingestion of groundwater.

Interpreted Qualifiers
J = Estimated concentration
J- = Estimated concentration, biased low
J+ = Estimated concentration, biased high
UJ = The analyte was not detected at a level greater than or equal to the adjusted DL. However, the reported adjusted DL is approximate and may be inaccurate or imprecise.

Chemical Abbreviations

PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
DL	detection limit
FD	Duplicate
GW	Groundwater
HQ	Hazard quotient
ID	identification
LCMSMS	Liquid Chromatography Mass Spectrometry
LOD	Limit of Detection
ND	Analyte not detected above the LOD
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
USEPA	United States Environmental Protection Agency
ng/L	nanogram per liter
-	Not applicable

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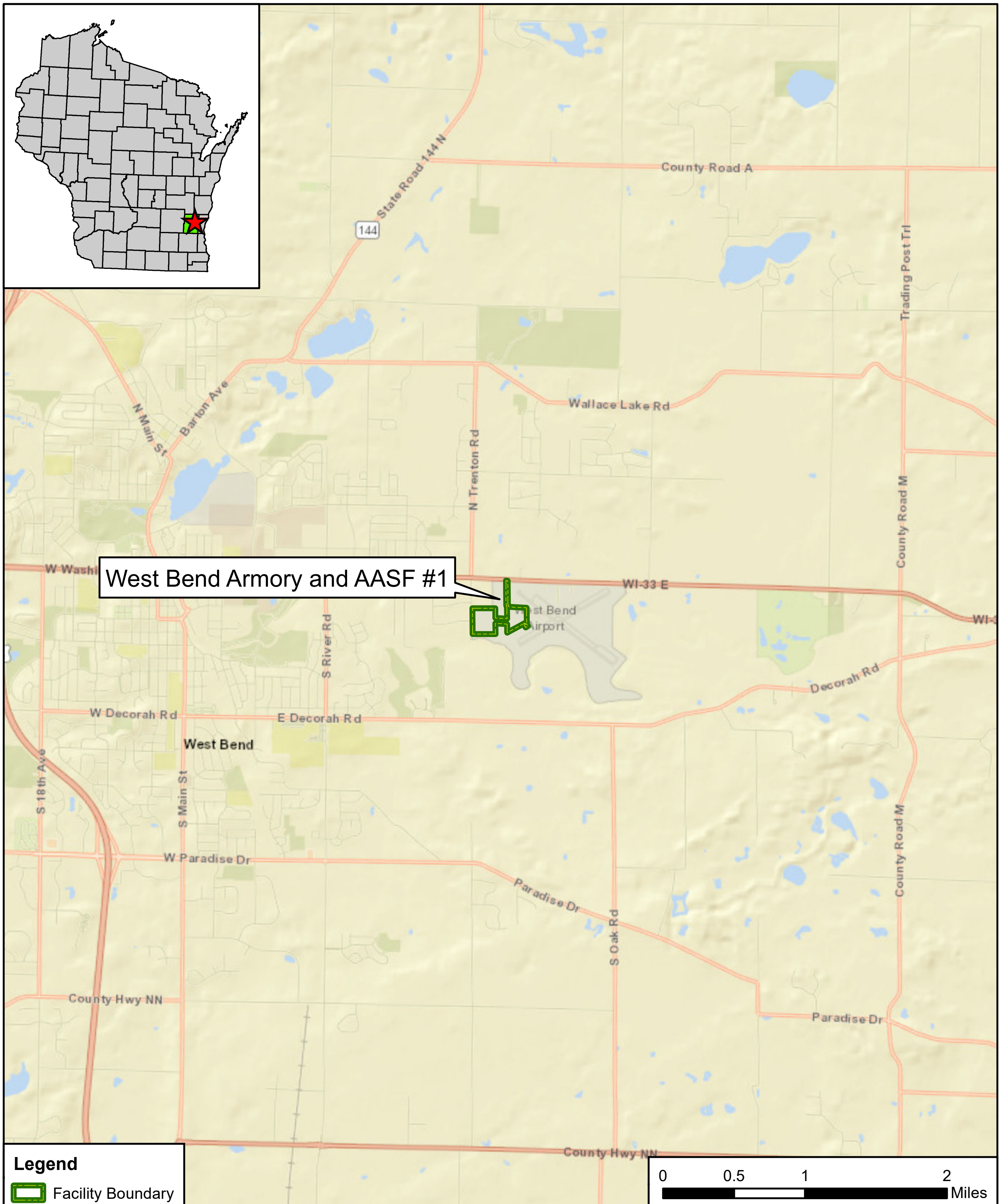


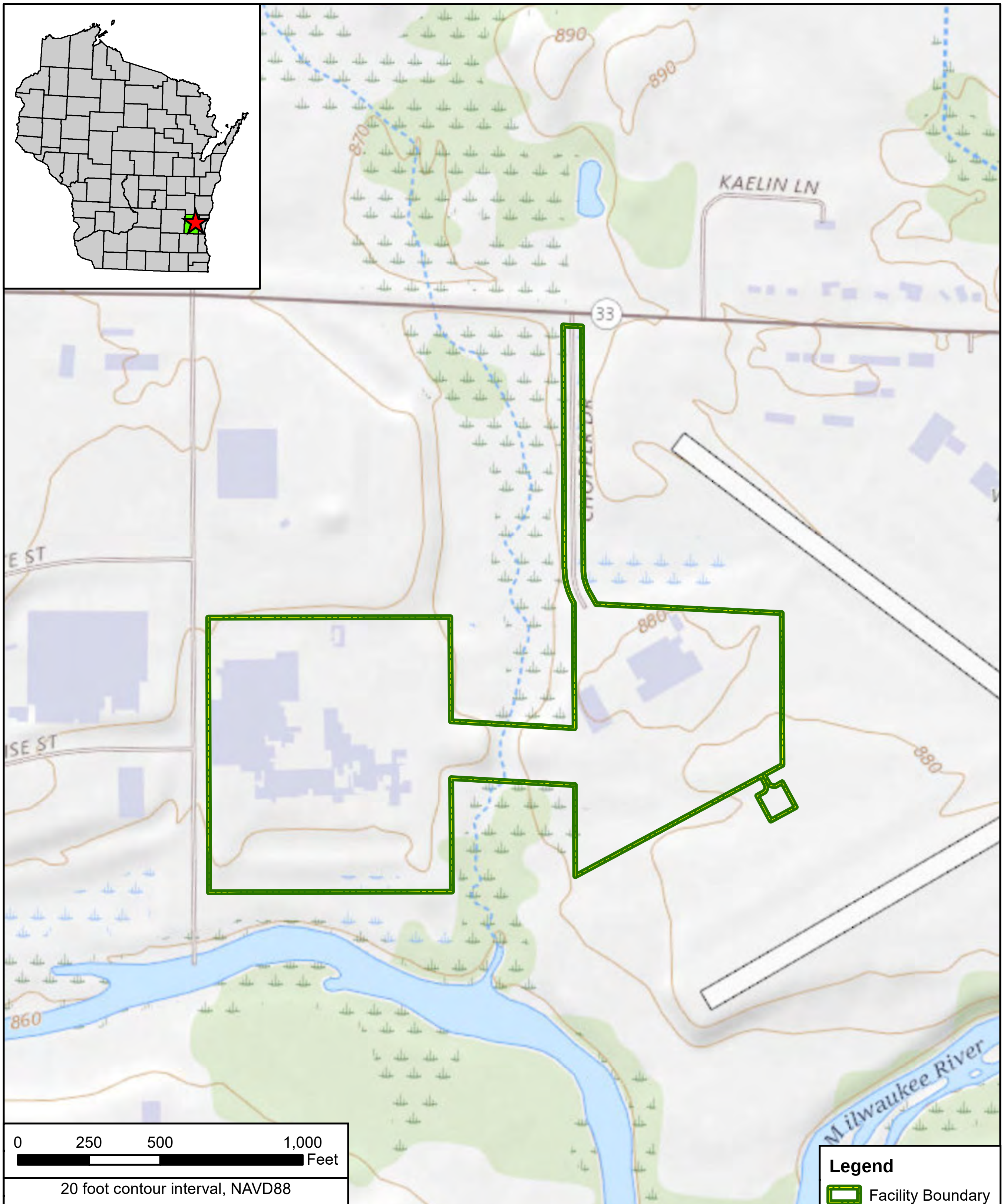
CLIENT	ARNG			
Remedial Investigation at West Bend, WI				
REVISED	3/9/2023	GIS BY	MS	3/9/2023
SCALE	1:63,360	CHK BY	BP	3/9/2023
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	CM	3/9/2023

N

Facility Location

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 10-1



CLIENT	ARNG			
Remedial Investigation at West Bend, WI				
REVISED	7/18/2023	GIS BY	MS	7/18/2023
SCALE	1:6,000	CHK BY	BP	7/18/2023
Base Map: USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program,		PM	CM	7/18/2023

Facility Topography

AECOM
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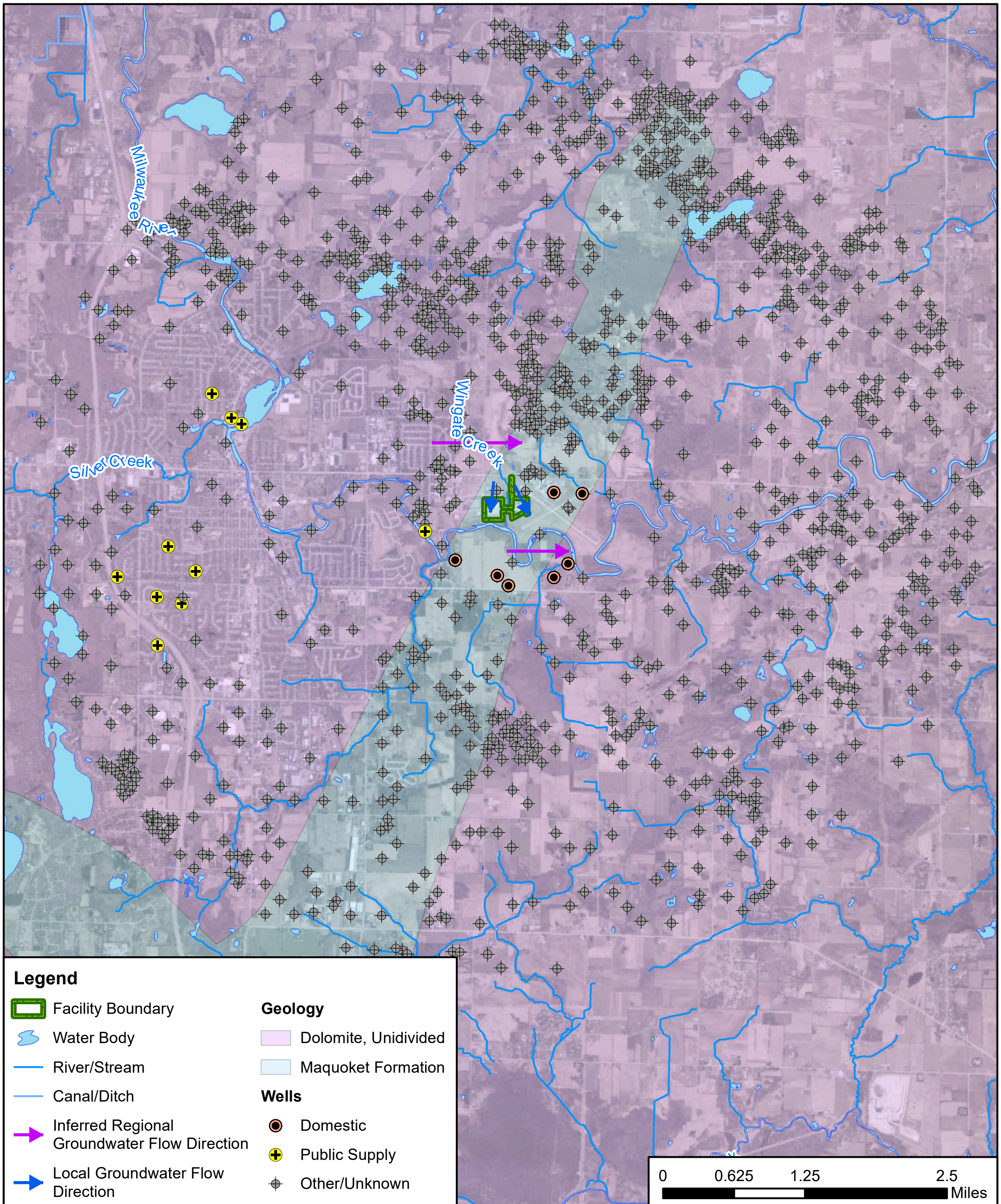
Germantown, MD 20876

Figure 10-2



CLIENT	ARNG			
Remedial Investigation at West Bend, WI				
REVISED	3/9/2023	GIS BY	MS	3/9/2023
SCALE	1:79,200	CHK BY	BP	3/9/2023
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community		PM	CM	3/9/2023

Groundwater Features

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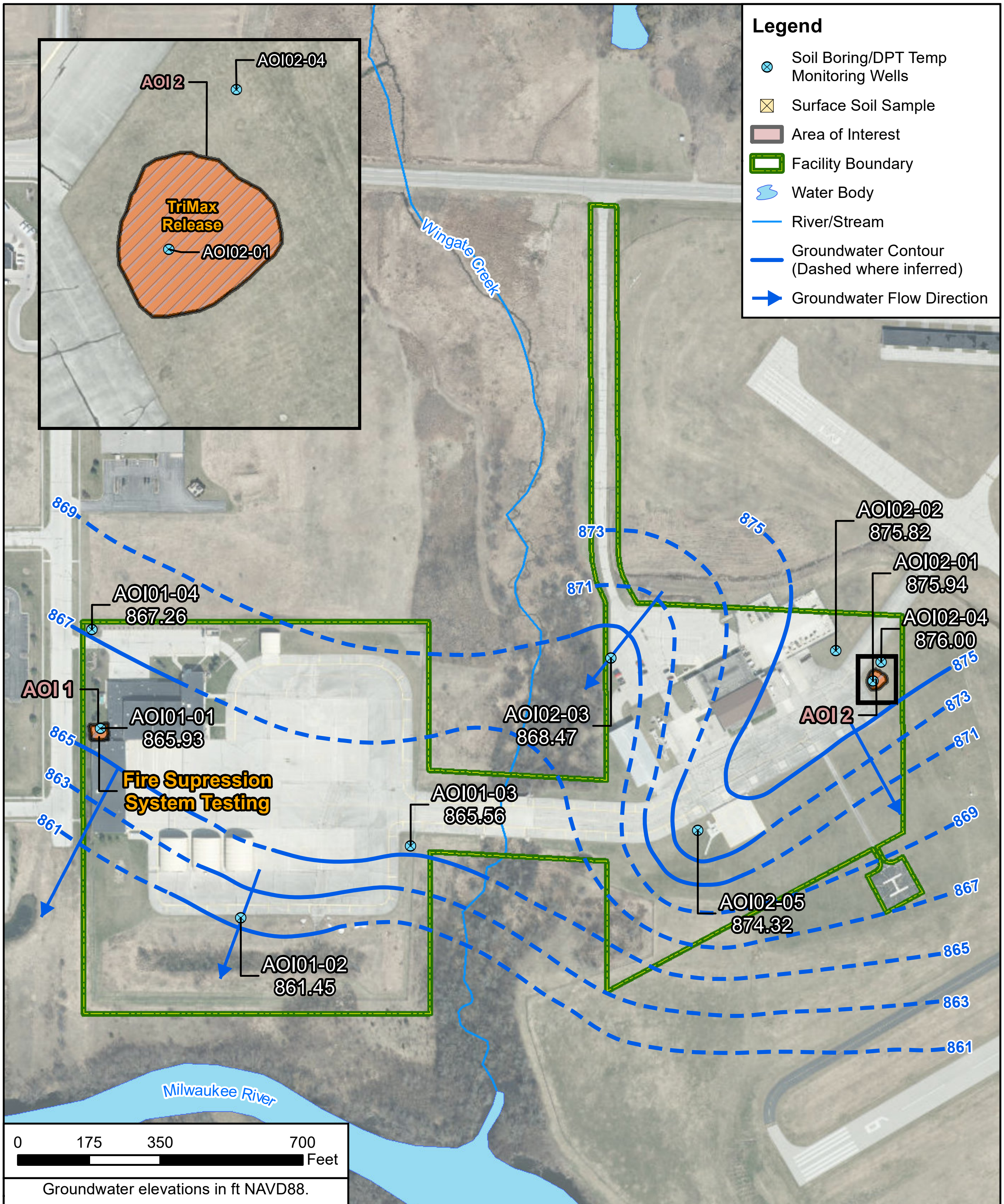
Germantown, MD 20876

Figure 10-3



CLIENT	ARNG			
Remedial Investigation at West Bend, WI				
REVISED	3/9/2023	GIS BY	MS	3/9/2023
SCALE	1:4,200	CHK BY	BP	3/9/2023
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community		PM	CM	3/9/2023

Groundwater Contours

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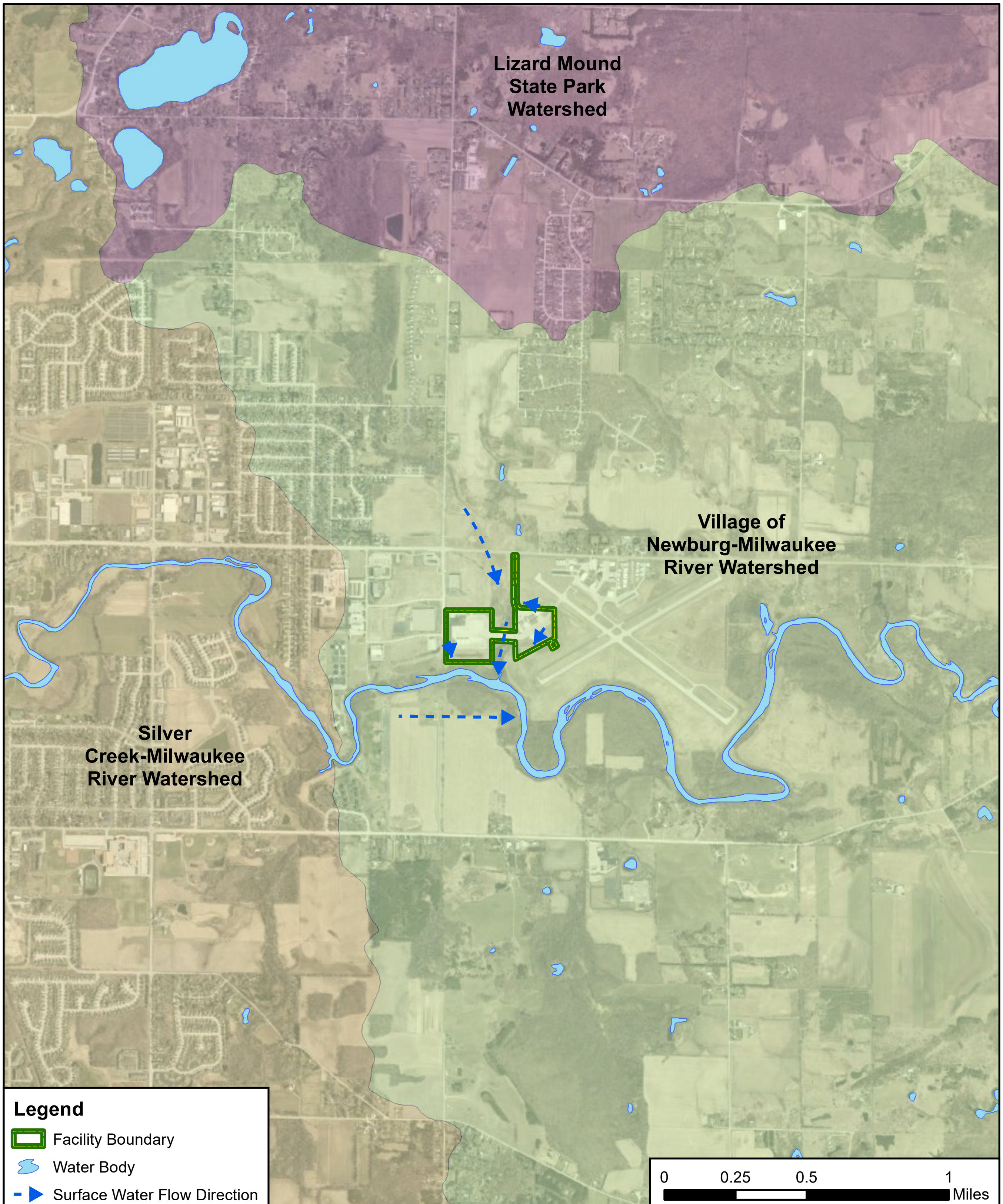
Germantown, MD 20876

Figure 10-4



CLIENT	ARNG			
Remedial Investigation at West Bend, WI				
REVISED	3/9/2023	GIS BY	MS	3/9/2023
SCALE	1:31,680	CHK BY	BP	3/9/2023
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community		PM	CM	3/9/2023

N

Surface Water Features

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Germantown, MD 20876

Figure 10-5

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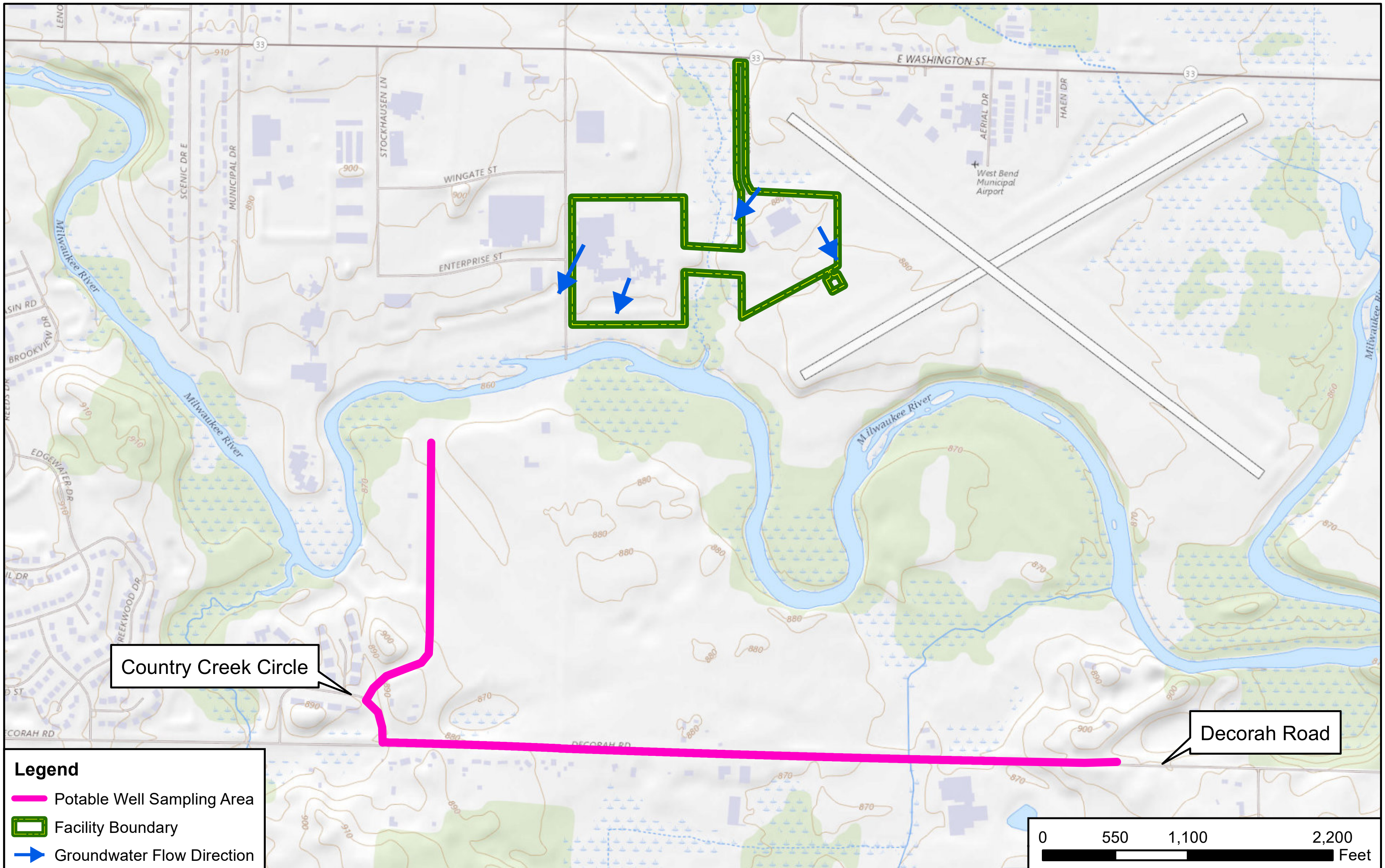

CLIENT	ARNG			
PROJECT	Remedial Investigation at West Bend, WI			
REVISED	3/10/2023	GIS BY	MS	3/10/2023
SCALE	1:13,200	CHK BY	BP	3/10/2023
Base Map: USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset,		PM	CM	3/10/2023

N

Potable Well Sampling Area

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Germantown, MD 20876

Figure 10-6

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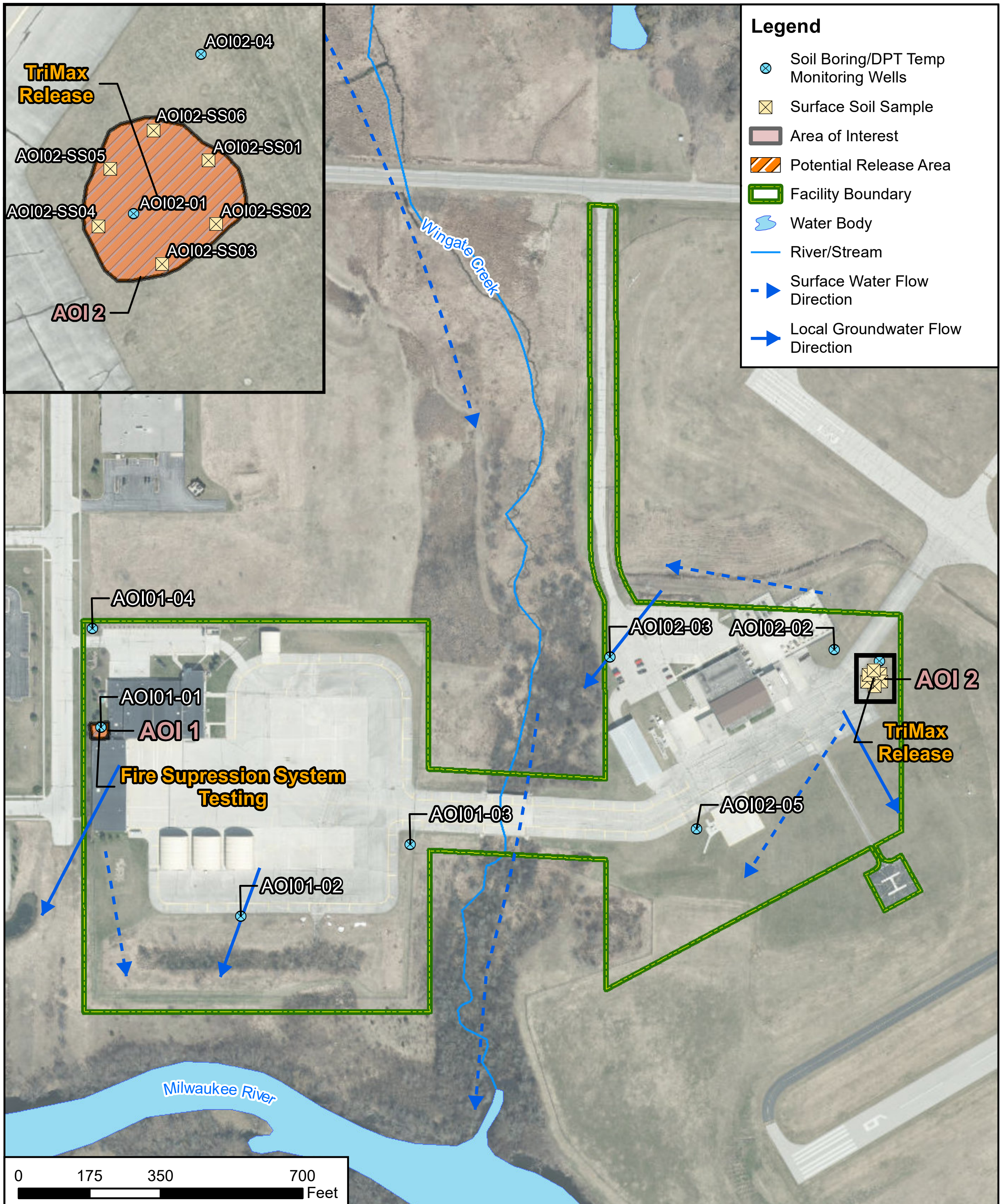

CLIENT	ARNG			
Remedial Investigation at West Bend, WI				
REVISED	3/9/2023	GIS BY	MS	3/9/2023
SCALE	1:4,200	CHK BY	BP	3/9/2023
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community		PM	CM	3/9/2023

N

Site Inspection Sample Locations

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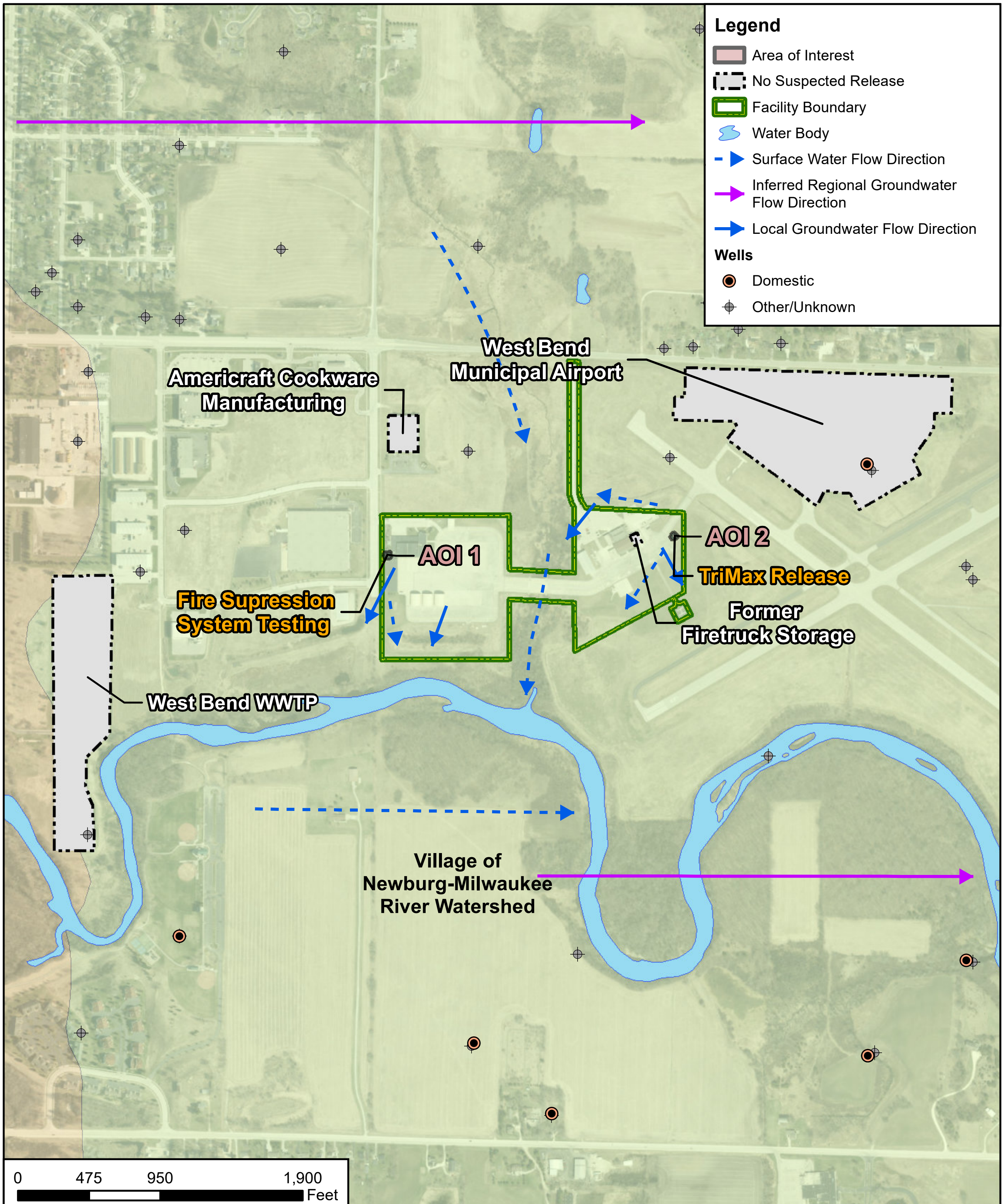
Germantown, MD 20876

Figure 10-7



CLIENT	ARNG			
Remedial Investigation at West Bend, WI				
REVISED 3/9/2023	GIS BY	MS	3/9/2023	
SCALE 1:11,400	CHK BY	BP	3/9/2023	
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community	PM	CM	3/9/2023	

Areas of Interest

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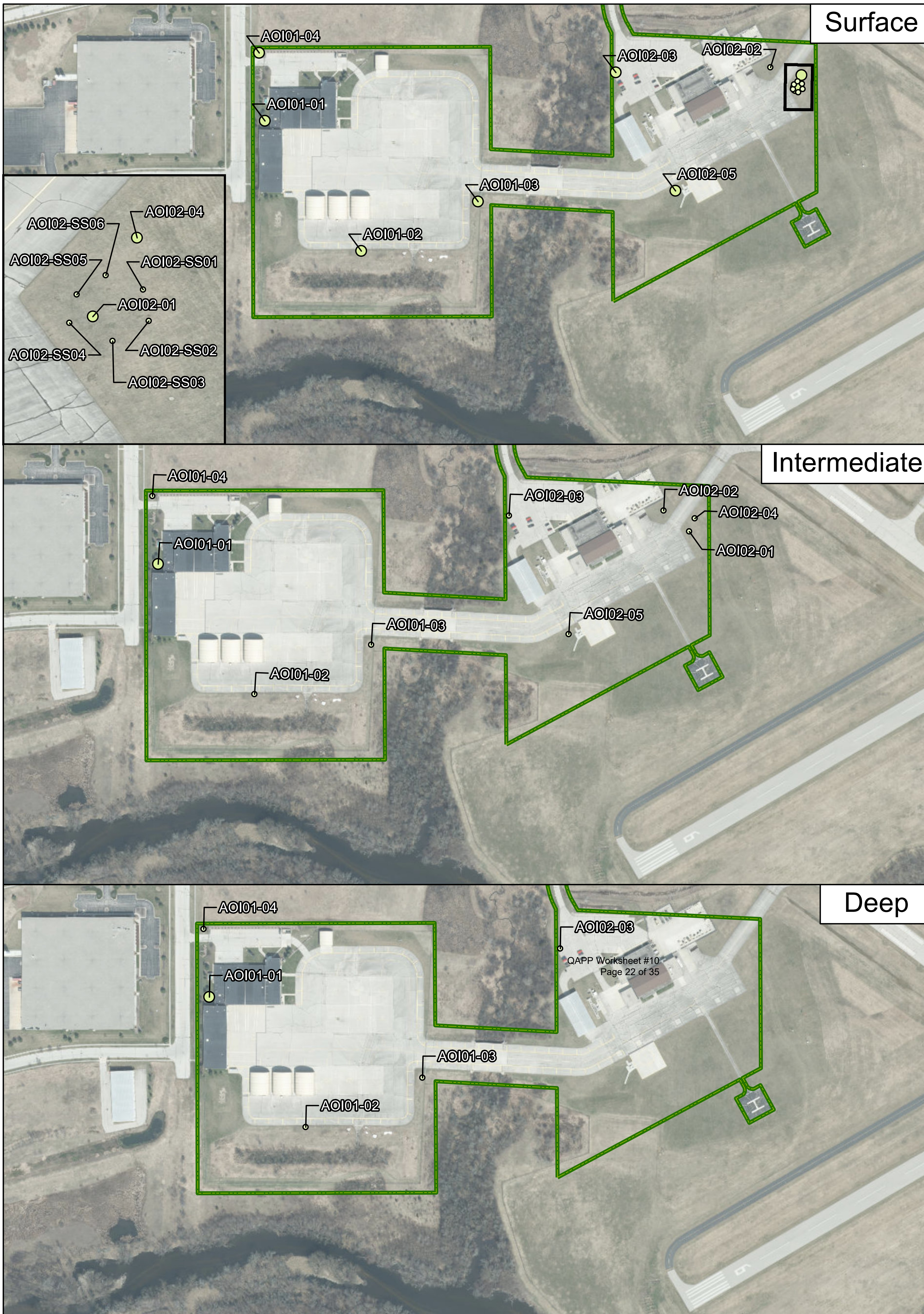
Germantown, MD 20876

Figure 10-8



Legend

Facility Boundary

PFOA Results (µg/Kg)

- ND
- >ND - 19
- >19 - 250
- >250 - 2,500
- >2,500

N

0 175 350 700 Feet

Exceedances of the OSD SL are depicted with a yellow halo.
Depth intervals shown represent respective sampling position within a given soil boring location.

PFOA Detections in Soil

CLIENT	ARNG			
PROJECT	Remedial Investigation at West Bend, WI			
REVISED	3/9/2023	GIS BY	MS	3/9/2023
SCALE	1:4,200	CHK BY	BP	3/9/2023
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community		PM	CM	3/9/2023

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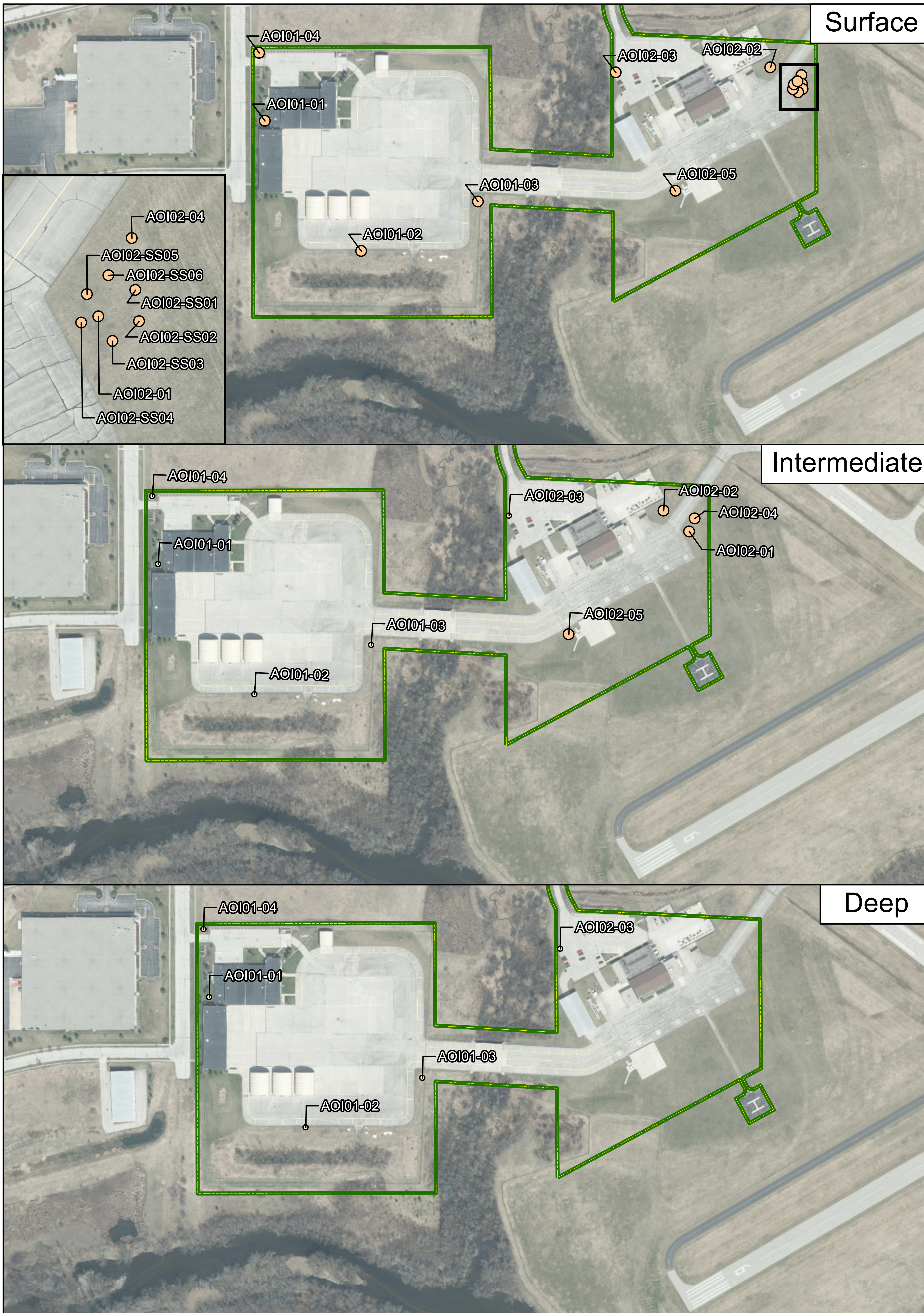
Figure 10-9



Legend

Facility Boundary

PFOS Results (µg/Kg)

- ND
- >ND - 13
- >13 - 160
- >160 - 1,600
- >1,600

N

0 175 350 700 Feet

Exceedances of the OSD SL are depicted with a yellow halo.
Depth intervals shown represent respective sampling position within a given soil boring location.

PFOS Detections in Soil

CLIENT	ARNG			
PROJECT	Remedial Investgation at West Bend, WI			
REVISED	3/9/2023	GIS BY	MS	3/9/2023
SCALE	1:4,200	CHK BY	SI	3/9/2023
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community		PM	CM	3/9/2023

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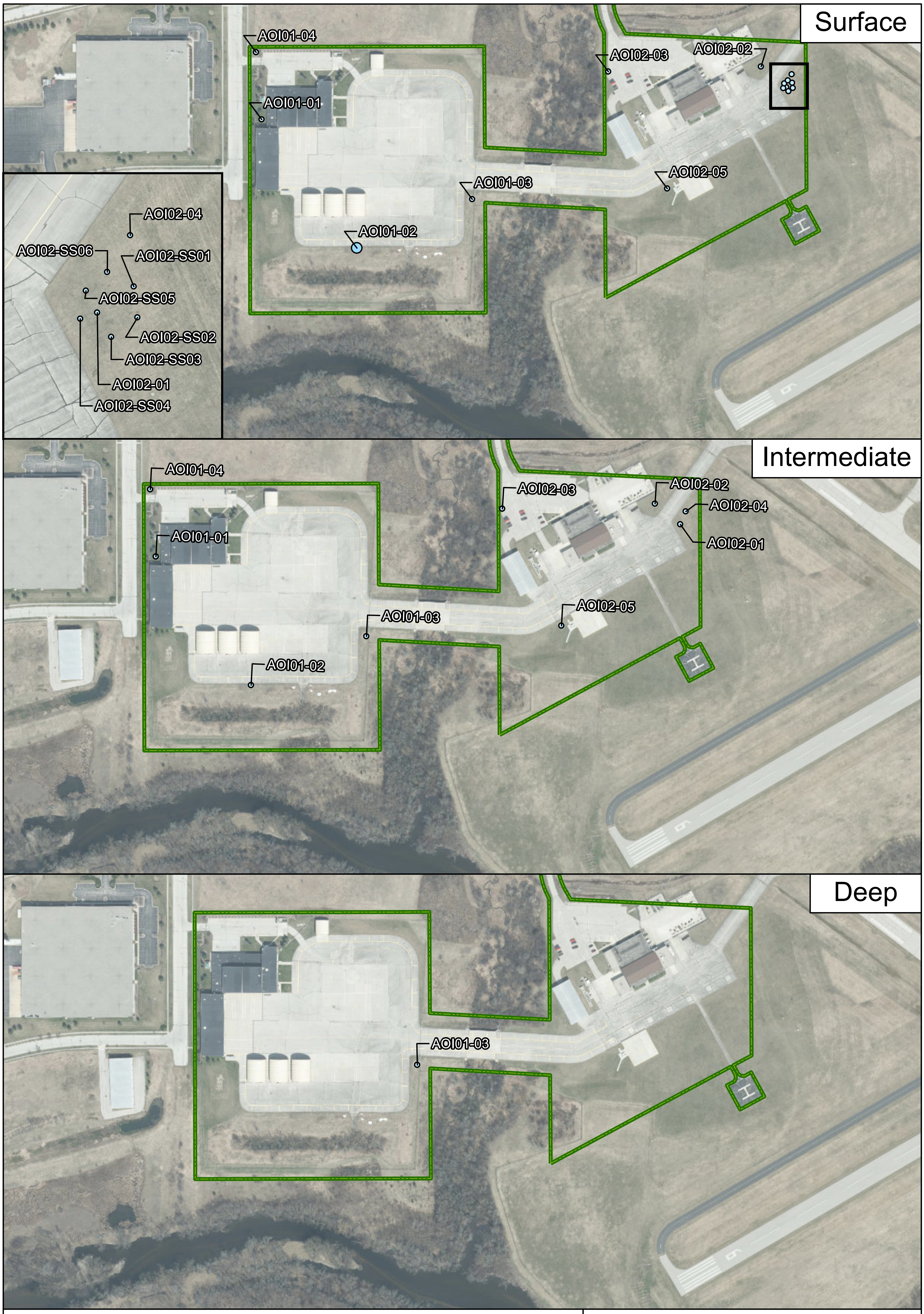
Figure 10-10



Legend

Facility Boundary

PFBS Results (µg/Kg)

- ND
- >ND - 10
- >10 - 1,900
- >1,900 - 25,000
- >25,000

N

0 175 350 700 Feet

Exceedances of the OSD SL are depicted with a yellow halo.
Depth intervals shown represent respective sampling position within a given soil boring location.

PFBS Detections in Soil

CLIENT	ARNG			
PROJECT	Remedial Investgation at West Bend, WI			
REVISED	3/9/2023	GIS BY	MS	3/9/2023
SCALE	1:4,200	CHK BY	SI	3/9/2023
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community		PM	CM	3/9/2023

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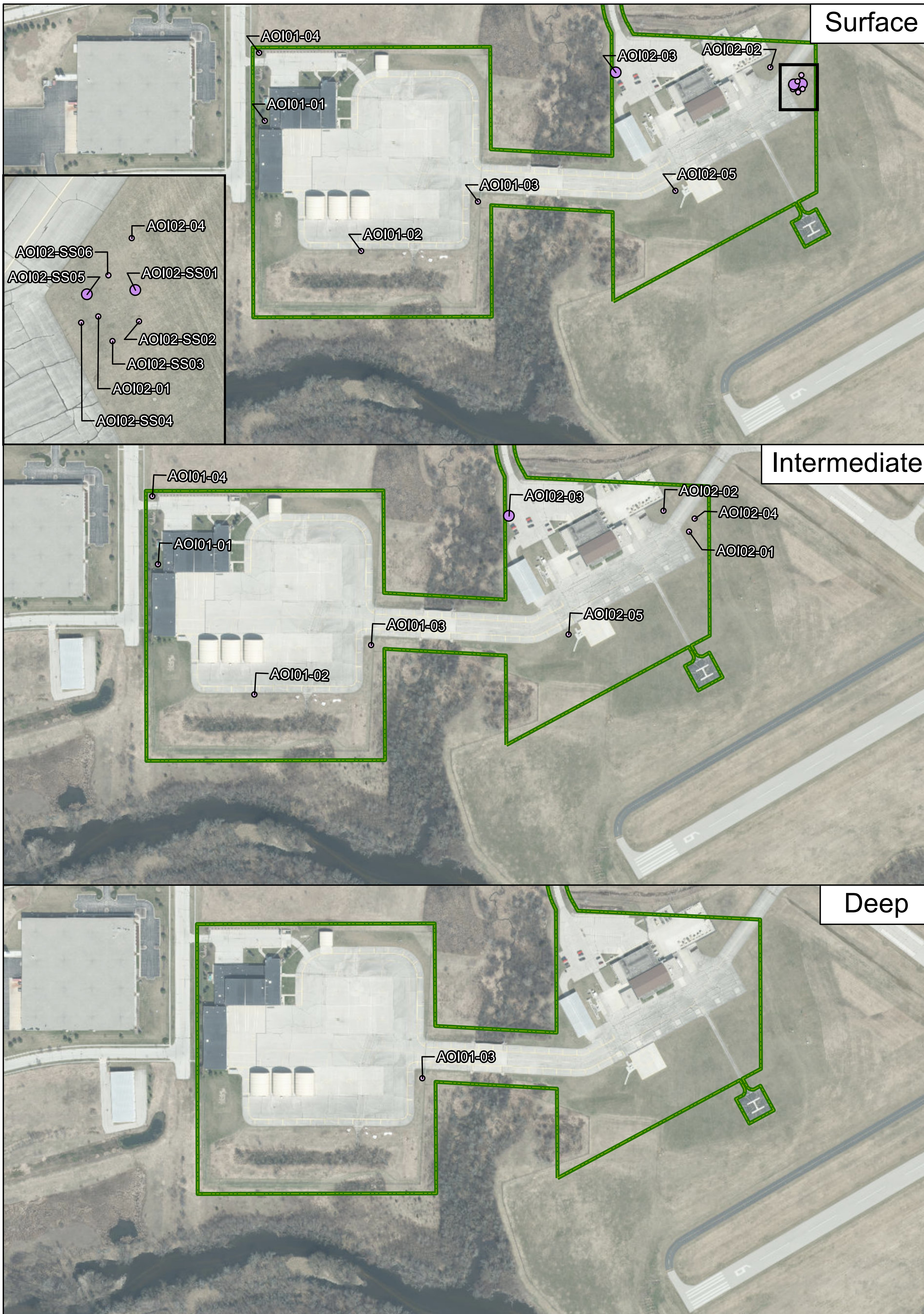
Figure 10-11



Legend

Facility Boundary

PFHxS Results (µg/Kg)

- ND
- >ND - 10
- >10 - 130
- >130 - 1,600
- >1,600

N

0 175 350 700 Feet

Exceedances of the OSD SL are depicted with a yellow halo.
Depth intervals shown represent respective sampling position within a given soil boring location.

PFHxS Detections in Soil

CLIENT	ARNG		
PROJECT	Remedial Investgation at West Bend, WI		
REVISED	3/9/2023	GIS BY	MS	3/9/2023
SCALE	1:4,200	CHK BY	SI	3/9/2023
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community		PM	CM	3/9/2023

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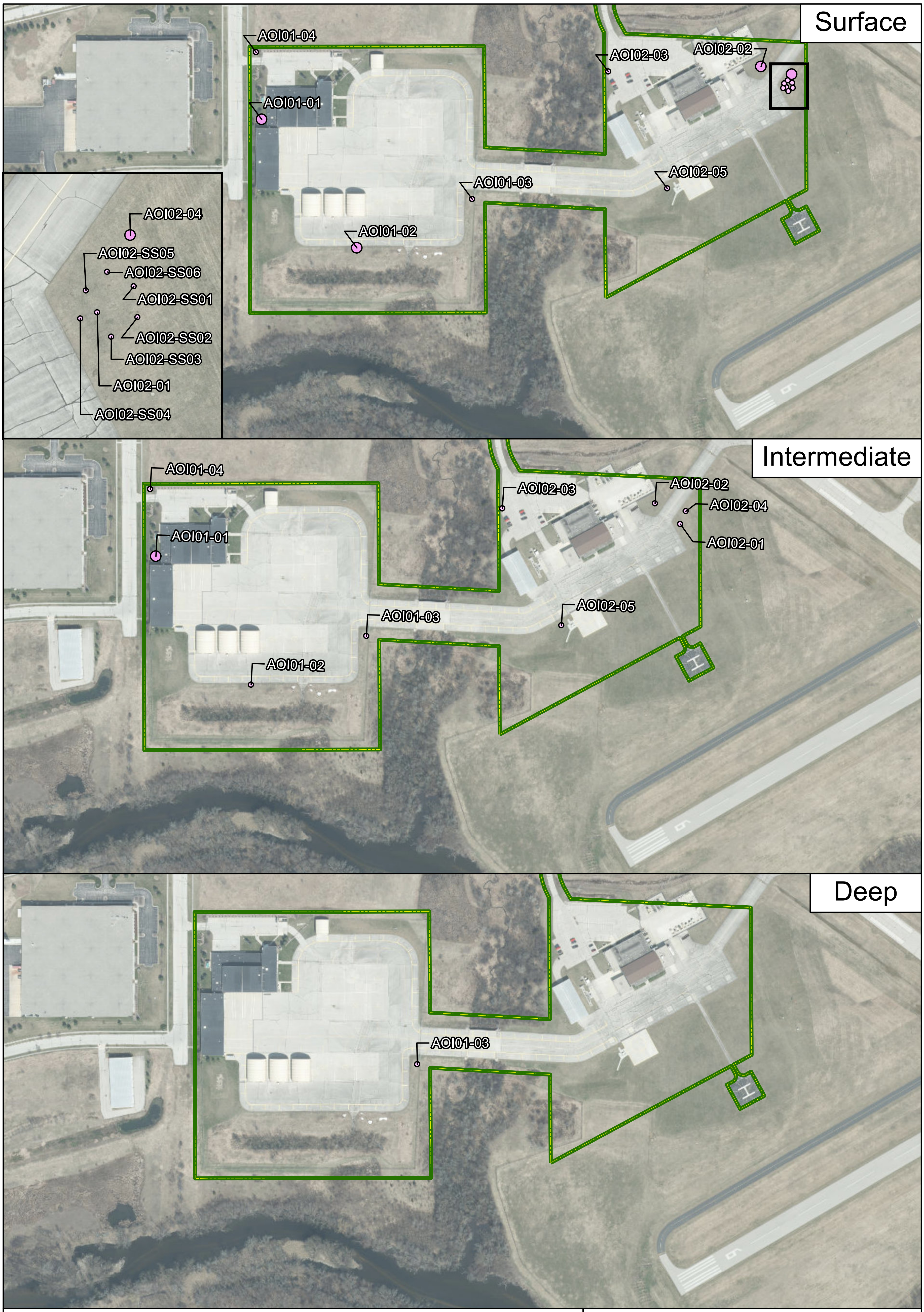
Figure 10-12



Legend

Facility Boundary

PFNA Results (µg/Kg)

- ND
- >ND - 19
- >19 - 250
- >250 - 2,500
- >2,500

N

0 175 350 700 Feet

Exceedances of the OSD SL are depicted with a yellow halo.
Depth intervals shown represent respective sampling position within a given soil boring location.

PFNA Detections in Soil

CLIENT	ARNG			
PROJECT	Remedial Investgation at West Bend, WI			
REVISED	3/9/2023	GIS BY	MS	3/9/2023
SCALE	1:4,200	CHK BY	SI	3/9/2023
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community		PM	CM	3/9/2023

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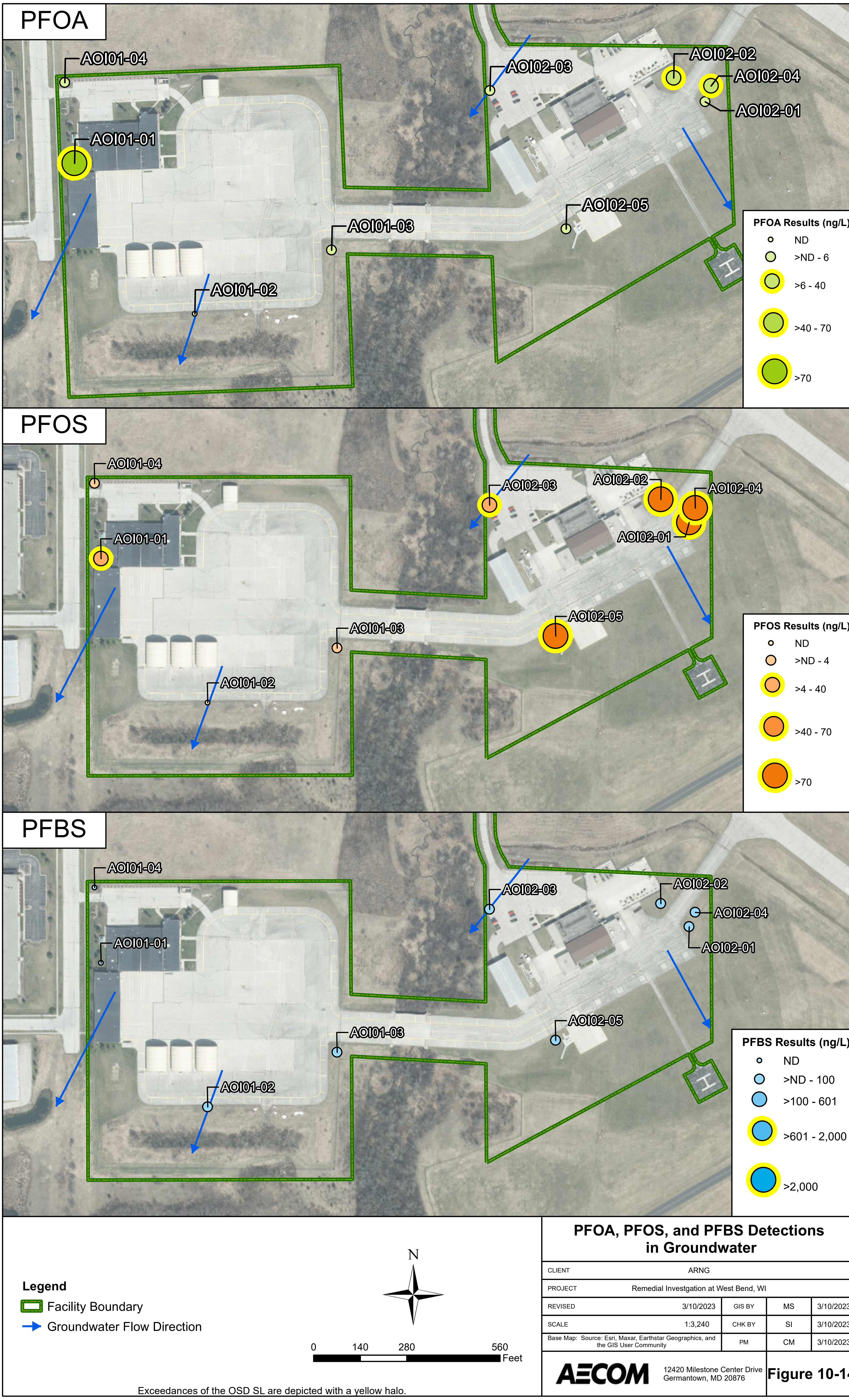
Figure 10-13



Exceedances of the OSD SL are depicted with a yellow halo.

PFOA, PFOS, and PFBS Detections in Groundwater

CLIENT	ARNG			
PROJECT	Remedial Investgation at West Bend, WI			
REVISED	3/10/2023	GIS BY	MS	3/10/2023
SCALE	1:3,240	CHK BY	SI	3/10/2023
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community		PM	CM	3/10/2023

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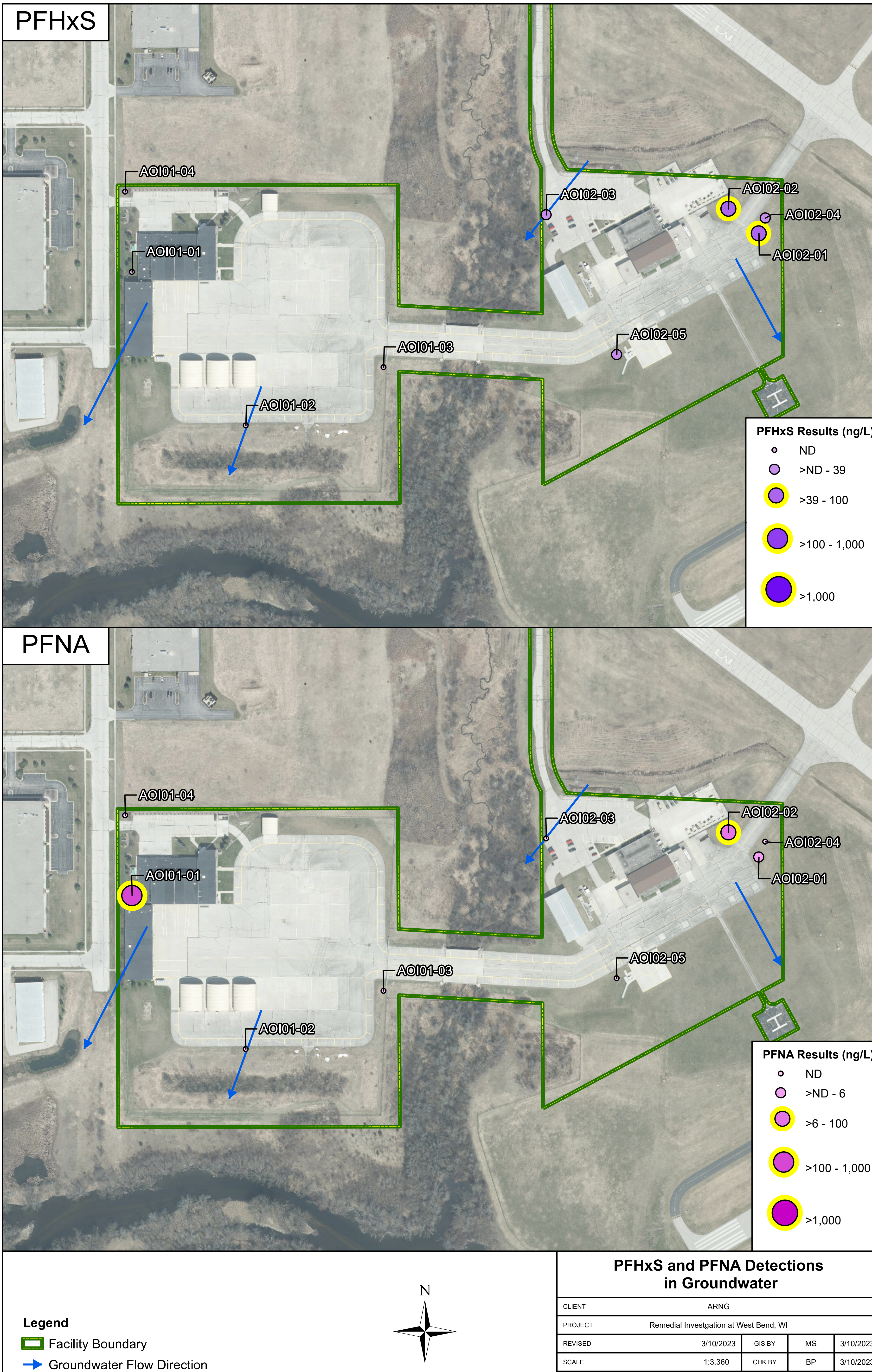
Figure 10-14



Exceedances of the OSD SL are depicted with a yellow halo.

PFHxS and PFNA Detections in Groundwater

CLIENT	ARNG			
PROJECT	Remedial Investgation at West Bend, WI			
REVISED	3/10/2023	GIS BY	MS	3/10/2023
SCALE	1:3,360	CHK BY	BP	3/10/2023
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community		PM	CM	3/10/2023

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Figure 10-15

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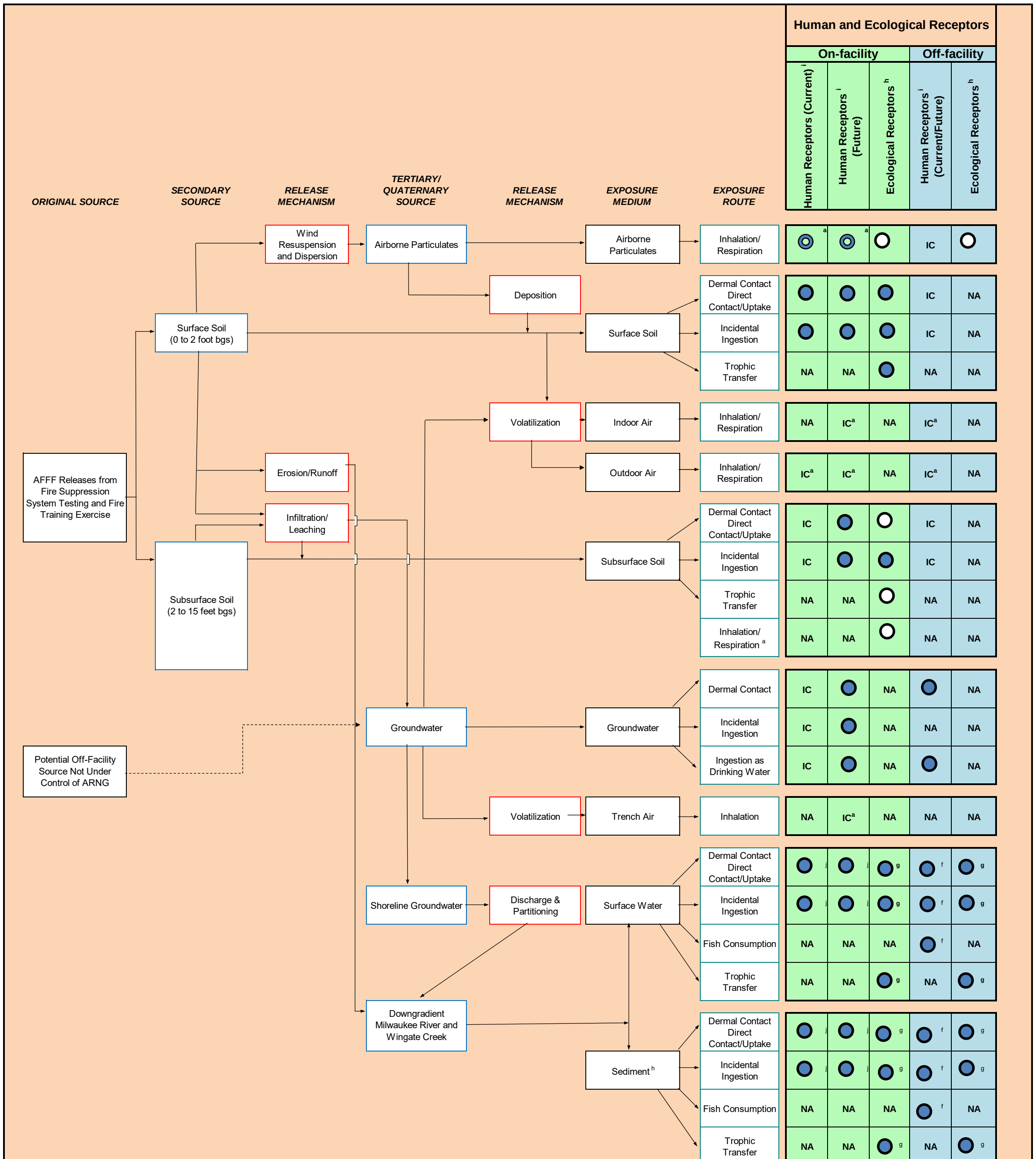

Legend

- Potentially complete pathway
- Potentially complete pathway; but not quantitatively evaluated, as discussed in the report text.
- Minor or insignificant pathway
- IC Incomplete
- NA Not Applicable

Notes

AFFF - Aqueous film forming foams.
bgs - below ground surface.
HHRA - human health risk assessment.
PFAS - Per- and polyfluoroalkyl substances.

(a) Potential exposure with airborne particulates will not be quantitatively evaluated in the HHRA because toxicity values for the inhalation exposure route are not available for PFAS. The associated uncertainties will be discussed in the uncertainty discussion of the HHRA. PFAS have low volatility and therefore are not considered to volatilize into air.
(b) It is conservatively assumed that there could be future redevelopment of the Site, and current subsurface soils may be brought to the surface and become available for exposure under a future use scenario.
(c) The evaluation of on-facility groundwater as a future source of drinking water will be performed for informational purposes to represent an unrestricted groundwater use scenario.
(d) Inhalation/respiration of airborne particulates (dust) is expected to be minor compared to soil exposure pathways for ecological receptors.
(e) It is conservatively assumed that exposure pathways between burrowing animals and surface soil (2 to 4 ft bgs) are potentially complete.
(f) Exposure to sediment and surface water in Wingate Creek will be evaluated via a wading scenario. Exposure to surface water and sediment in the Milwaukee River will be evaluated under a swimming scenario to conservatively represent multiple recreational pathways (e.g. boating, wading). Fish consumption will be evaluated in the Milwaukee River if impacts to the river are identified and can be attributed to ARNG activities at the facility.
(g) Potential ecological exposures pathways for surface water and sediment may be complete for the on-facility stormwater detention basin and off-facility Wingate Creek and Milwaukee River. The Habitat Assessment will evaluate the aquatic habitat associated with these areas. If surface water is not collected from the stormwater detention basin and the findings from the Habitat Assessment do not indicate that aquatic habitat is seasonally present in the basin, the solid material collected from the basin will be evaluated as surface soil.
(h) Not all exposure pathways are complete for all ecological receptors. Refer to Attachment E Figure E-2 for details by specific ecological receptor.
(i) Not all exposure pathways are complete for all human receptors. Refer to Attachment E Figure E-1 for details by specific human receptor.
(j) Assumes occasional exposure to surface water and sediment, if present, in the on-facility stormwater detention basin.

Project No. 60668768		
West Bend Army Aviation Support Facility #1 and Armory West Bend, Wisconsin	HUMAN HEALTH AND ECOLOGICAL CONCEPTUAL SITE MODEL	Figure 10-16

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QAPP Worksheet #11: Project/Data Quality Objectives

DQOs specify the level of data required to support the decision-making process for a project. Specific DQOs have been established for the RI at this facility and are described in this worksheet. The DQOs follow the USEPA's seven-step iterative process for DQO development. DQOs are influenced by the ongoing project planning discussions with stakeholders and will be updated if new consensus decisions materialize.

RI activities at the facility will be conducted in multiple mobilizations. This UFP-QAPP addresses DQOs for all phases of the RI.

State the Problem

PFAS are classified as emerging environmental contaminants that have garnered regulatory interest due to their potential risks to human health and the environment. The regulatory framework for managing PFAS at both the federal and state level continues to evolve. The DoD has adopted a policy to retain facilities in the CERCLA process based on risk-based SLs for soil and groundwater, as described in a memorandum from the OSD dated 6 July 2022 (Assistant Secretary of Defense, 2022). The ARNG program under which the SI was performed followed a similar DoD policy. The policy indicates that if the maximum concentration for sampled media exceed the SLs established in the OSD memorandum during the SI phase, the AOI will proceed to the RI phase under CERCLA. The SLs established in the most recent OSD memorandum apply to six compounds: PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA.

The presence of PFOA, PFOS and PFNA in excess of the OSD SLs has been confirmed at AOI 1. PFOA, PFOS, PFHxS and PFNA exceeded the OSD SLs upgradient of AOI 2. PFOS and PFHxS exceeded the OSD SLs within AOI 2 boundary. PFOS exceeded the OSD SLs downgradient of AOI 2. However, whether, or to what extent, potential risk is posed to human health or the environment from PFAS in environmental media at the facility and downgradient of the facility is currently unknown. If the results of the risk assessment performed as part of the RI report that will be prepared following this and subsequent mobilizations, as indicated in **Section 14.6**, identifies potential unacceptable risk as defined under the NCP (40 CFR Part 300.430; USEPA, 1994), then an FS will be recommended to evaluate remedial action alternatives.

Identify the Goals of the Study

The unique nature of PFAS was considered when establishing goals for the investigation. Because of the very low action levels and highly mobile nature of PFAS, the traditional characterization of nature and extent and definition of boundaries will be modified, focusing on data necessary to evaluate response actions. Additionally, the ubiquitous nature of PFAS was considered when establishing the goals. Many studies have been published that show widespread distribution of certain PFAS, such as PFAAs, in various matrices including sediment, surface water, groundwater, wildlife, and human blood (whole, plasma, and serum) (Kannan et al., 2004; Yamashita et al., 2005; Higgins et al., 2005; Rankin et al., 2016). Some PFAS (such as PFAAs) are found in many places throughout the globe, even in areas well beyond where they were initially used or manufactured (Houde et al., 2011).

The goals of the RI are:

1. Conduct a geological investigation to aid in geologic and hydrogeologic characterization in support of the RI drilling and sampling program. Based on data collected during the SI, the shallow subsurface soil has relatively low permeability and conductivity with soils dominated by silts and clay. Grain size analysis performed at AOI01-03 implies that what presents itself as lean clay in the field may in fact be clayey

silt (i.e., predominantly silt with a large clay component). This finding may have profound impacts on the vertical migration of groundwater at the facility since silt is more permeable and conductive. Sandy silt (silt with more than 30% sand) is found in the surface silts in the eastern portion of the facility, around AOI 2. Layers of sand-dominated soils can be found at AOI01-04, AOI02-01, AOI02-02, AOI02-04, and AOI02-05 at thicknesses ranging from 0.5 to 4 feet in thickness. Overall, these data would suggest that the subsurface lithology on the eastern and northern portions of the facility are more permeable and susceptible to vertical groundwater migration.

2. Identify potential PFAS release areas and refine the extent of PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA, attributable to ARNG activities in groundwater at concentrations above the OSD SLs on-facility at the West Bend AASF #1 and Armory (Assistant Secretary of Defense, 2022).
3. Evaluate the extent of PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA, attributable to ARNG activities in groundwater at concentrations above the OSD SLs downgradient of the West Bend AASF #1 and Armory (off-facility).
4. Collect vertical aquifer profile samples, where data gaps exist, to further assess the relative vertical and horizontal distribution of PFAS concentrations in groundwater in the surficial aquifer. The screening-level analytical data obtained from vertical aquifer profile sampling will be used to select the location and depth of subsequent permanent monitoring well installations.
5. Collect groundwater samples from newly installed permanent monitoring wells for analysis of PFAS to refine the extent of PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA attributable to ARNG activities in groundwater at concentrations above the OSD SLs on-facility at the West Bend AASF #1 and Armory. Determine whether the concentrations of these compounds in groundwater are more than likely the result of ARNG activities (originate on the facility). If PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA are detected, conduct preliminary screening and evaluate the results in the HHRA as part of the comprehensive RI report that will be prepared following completion of RI field activities, as indicated in **Section 14.6**, and as described in Goals 9 and 10 below.
6. Within an established AOI, locate the release areas in soil where PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA in soil are linked to groundwater containing these compounds that is attributable to ARNG activities. Refine the occurrence of PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA in soil to the OSD SLs (Assistant Secretary of Defense, 2022). If, due to significant site construction and soil movement, no release area is apparent, collect sufficient soil data to support a quantitative risk assessment. If PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA are detected, further evaluate these results in the risk assessment as part of the comprehensive RI report that will be prepared following completion of RI field activities, as described in Goals 8 and 9 below.
7. Collect surface water samples from Wingate Creek, the Milwaukee River, and if possible the on-facility stormwater detention basin to determine the presence or absence of PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA attributable to ARNG activities. If PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA are detected in the Prescriptive Phase, further evaluate these results via screening and additional data collection during the Adaptive Phase to inform the risk assessment as part of the comprehensive RI report that will be prepared following completion of RI field activities, as described in Goals 8 and 9 below.
8. Collect sediment samples from Wingate Creek, the Milwaukee River, and if possible, the on-facility stormwater detention basin to evaluate PFOA, PFOS, PFBS, PFNA,

PFHxS, and HFPO-DA in sediment where stormwater with PFAS impacts attributable to ARNG activities may have discharged. If PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA are detected in the Prescriptive Phase, further evaluate these results via screening and additional data collection during the Adaptive Phase to inform the risk assessment as part of the comprehensive RI report that will be prepared following completion of RI field activities, as described in Goals 8 and 9 below.

9. Collect data to evaluate facility characteristics that influence PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA fate and transport, support refinement of the CSM, and inform the potential remedial alternatives evaluation.
10. Collect and document data that is both representative of field conditions and defensible within the precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS) parameters. This includes sufficient field samples to fully characterize field conditions and heterogeneity as well as QC samples sufficient to demonstrate data quality. Collect legally defensible samples with an unbroken chain of custody maintained from sampling through analysis.
11. Conduct a facility-specific HHRA in accordance with USEPA Risk Assessment Guidance for Superfund (RAGS) and DA risk assessment guidance and policies (DA, 1999; Assistant Secretary of Defense, 2022) as part of the comprehensive RI report that will be prepared following this and subsequent mobilizations, as indicated in **Section 14.1.** The objective of the HHRA is to evaluate whether exposure to PFOS, PFOA, PFBS, PFHxS, PFNA, and HFPO-DA may pose a potential cancer risk and/or noncancer hazard to human health greater than the target risk levels described below. PFOS, PFOA, PFBS, PFHxS, PFNA, and HFPO-DA are the only PFAS for which toxicity values are currently available from the USEPA's hierarchy of sources (USEPA, 2003). Per the July 2022 OSD memo, these are the only PFAS for which DOD has identified screening values. Therefore, at this time these are the only PFAS evaluated in DOD risk assessments. **Appendix E** includes the Risk Assessment Work Plan.

If PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA are detected in on-facility or off-facility media at concentrations exceeding OSD SLs as described in Goals 5, 6 and 7, a SLERA will be conducted following completion of the Adaptive Phase data collection. The SLERA will be conducted in accordance with USEPA Ecological RAGS (USEPA, 1997) and DA risk assessment guidance (DA, 2010) for PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA, as well as other PFAS with relevant ecological screening values (e.g., perfluorododecanoic acid [PFDoA], perfluoroundecanoic acid [PFUdA], perfluorodecanoic acid [PFDA], perfluoroheptanoic acid [PFHpA], perfluorohexanoic acid [PFHxA], perfluoropentanoic acid [PFPeA], and PFBA). An exceedance of an ecological screening value does not necessarily correlate to an effect and a weight of evidence assessment will be used to determine the need for further evaluation. Lower trophic level receptors (e.g., invertebrates, plants) will be evaluated qualitatively on a community level basis. If the SLERA and subsequent SLERA refinement (Step 3a in the USEPA ecological risk assessment [ERA] process) identify the potential for adverse effects on ecological receptors due to exposure to PFAS in soil, sediment, or surface water, then a risk management decision will be made by the team regarding the need for further ecological evaluations.

Identify Information Inputs

Primary information inputs include:

- Findings from the CERCLA PA completed for the West Bend AASF #1 and Armory (AECOM, 2019). This information was used to identify potential release areas and mechanisms.

- Findings from the CERCLA SI completed for the facility, including PFAS analytical data from groundwater and soil from one AOI, as well as off-facility potable water samples (AECOM, 2022). The soil and groundwater data were used to determine the current understanding of nature and extent of contamination in these media, as described in **Worksheet #10**. Additionally, the data were used to refine the sampling approach for these media during the Prescriptive Phase, as described in **Worksheets #17 & #18**.
- The CSM will be refined in accordance with the field and analytical data collected during the Prescriptive and Adaptive Phase.
- Field data collected during the SI and RI, including water quality parameters in groundwater, surface water, sediment, and lithological data observed in soil borings. This information will be used to evaluate fate and transport, support refinement of the CSM, and inform the potential remedial alternatives evaluation.
- Groundwater elevation data from the SI and RI will be used to understand groundwater flow direction and gradient. This information will also be used to refine the preliminary CSM.

Define the Boundaries of the Study

The scope of the RI proposes sampling beyond the horizontal boundary of the West Bend AASF #1 and Armory facility boundary. PFAS were detected in soil and groundwater samples during the SI. As such, to meet DQOs, additional sampling will be performed from discrete intervals within water bearing zones (depth to be determine in the field based on initial observation of water).

Sampling beyond the facility boundaries has been proposed and is detailed in **Worksheets # 17 & 18**. Where off-facility sampling is required, the proper stakeholders will be notified, and right of entry (ROE) will be obtained by USACE and ARNG with property owner(s). The vertical boundaries of the investigation will be determined during the Prescriptive Phase. Vertical profile borings will be drilled, and discrete interval groundwater samples will be collected to determine the hydraulic connectivity of the aquifer and potential migration of contamination.

Develop the Analytic Approach

Environmental samples will be analyzed by a DoD Environmental Laboratory Accreditation Program (ELAP) and National Environmental Laboratory Accreditation Program (NELAP)-certified laboratory. Copies of the laboratory accreditation certificates are included in **Appendix C**. Analytical services are summarized on **Worksheets #19 & #30**. Analyses will be conducted in accordance with DoD Quality Systems Manual (QSM) Version 5.4 and the laboratory standard operating procedures (SOPs) cited.

Chemical analyses will be performed in accordance with the analytical methods identified in **Worksheet #23**. Analytical sensitivity for the methods selected is compared to project DQLs on **Worksheet #15**. Requirements for laboratory instrument calibration and equipment maintenance and testing are presented on **Worksheet #24** and **Worksheet #25**. Measurement performance criteria (MPC) for field and laboratory quality control (QC) samples are presented on **Worksheet #12** and **Worksheet #28**, respectively. The general analytic approach to achieve the goals outlined in Step 2 of this **Worksheet #10** is described below.

The environmental sampling program during the Prescriptive Phase and Adaptive Phase will include:

- Collection of soil samples via hand auger in soil grids for further characterization and refinement of the potential source areas and extent of potential impacts;

- Collection of multi-interval grab groundwater samples for analysis of PFAS (target list of 40 PFAS analytes) from vertical profile borings to be installed on-facility and off-facility;
- Collection of synoptic water levels in newly-installed temporary monitoring wells; and
- Collection of surface water and sediment samples off-facility for analysis of PFAS (target list of 40 PFAS analytes) from Wingate Creek and the Milwaukee River.
- Collection of surface water and sediment samples on-facility for analysis of PFAS (target list of 40 PFAS analytes) from the on-facility stormwater detention basin, if possible.

The specific details and rationale for the environmental sampling design, in addition to the sampling locations and methods, are presented in **Worksheets #17 & #18.**

Specify Performance/Acceptance Criteria

The performance and acceptance criteria are established in **Worksheet #12** and **Worksheet #28**. Laboratory data are considered usable if data validation criteria are met, as described in **Worksheet #34**, **Worksheet #35**, and **Worksheet #36**. Analytical data quality will be compared to DoD QSM (DoD, 2021) specification PARCCS. The analytical methods will provide the lowest available DLs using standard methods that will allow the data to be screened against the DQLs in **Worksheet #15**.

Develop the Detailed Plan for Obtaining Data

The detailed plan for obtaining data is established in **Worksheets #17 & #18** of this QAPP.

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QAPP Worksheet #12: Measurement Performance Criteria

Matrix Groundwater/ Surface Water/ Potable Wells
Analytical Group PFAS
Concentration Low

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling, Analytical, or Both
Accuracy/Bias	LCS/LCSD and MS/MSD shall be spiked with all analytes. Analyte recovery limits per Worksheet #15	LCS/LCSD, MS/MSD	A
Precision	Laboratory duplicates analysis should have an RPD < 30%	LCS/LCSD, MS/MSD	A
Precision	Values > 5X LOQ: RPD must be ≤ 30%; Values ≤ 5X LOQ: Absolute difference ≤ 2x the LOQ	Field Duplicates	S
Accuracy/ Contamination	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	Method Blank, Field Reagent Blanks, Equipment Rinsate Blanks	A
Sensitivity	Detection limits ≤ to acceptance criteria Instrument Sensitivity Check concentrations must be within ±30% of their true values	Detection Limits, Instrument Sensitivity Check	A
Completeness	Completeness criteria will be considered met if 95% of all planned sample data (as requested on CoC in lab reports and EDD; including requested reanalyses) are collected	Reported Sample Data	S & A
Comparability	Based on accuracy and media comparison	Use of standardized SOPs in field and laboratory	S & A
Representativeness	Based on accuracy and media comparison	Laboratory Receipt Checklist, Cooler Temperature Blank	S
Accuracy/Bias	LCS/LCSD and MS/MSD shall be spiked with all analytes. Analyte recovery limits per Worksheet #15	LCS/LCSD, MS/MSD	A

Notes:
< = less than
> = greater than
≤ = less than or equal to
A = analytical
CoC = chain of custody
EDD = electronic data deliverable
LCS/LCSD = laboratory control spike/ laboratory control spike duplicate
LOQ = limit of quantitation
MS/MSD = matrix spike/ matrix spike duplicate
RPD = relative percent difference
S = sampling

Matrix Soil/ Sediment
Analytical Group PFAS
Concentration Low

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling, Analytical, or Both
Accuracy/ Bias	LCS/LCSD and MS/MSD shall be spiked with all analytes. Analyte recovery limits per Worksheet #15	LCS/LCSD, MS/MSD	A
Precision	Laboratory duplicates analysis should have a RPD < 30%	LCS/LCSD, MS/MSD	A
Precision	Values > 5X LOQ: RPD must be ≤ 50% Values ≤ 5X LOQ: Absolute difference ≤ 4x the LOQ	Field Duplicates	S
Accuracy/ Contamination	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	Method Blank, Field Reagent Blanks, Equipment Rinsate Blanks	A
Sensitivity	Detection limits ≤ to acceptance criteria Instrument Sensitivity Check concentrations must be within ±30% of their true values	Detection Limits, Instrument Sensitivity Check	A
Completeness	Completeness criteria will be considered met if 90% of all planned sample data (as requested on CoC in lab reports and EDD; including requested re-analyses) are collected	Reported Sample Data	S & A
Comparability	Based on accuracy and media comparison	Use of standardized SOPs in field and laboratory	S & A
Representativeness	Samples met conditions per Worksheet #19/30	Laboratory Receipt Checklist, Cooler Temperature Blank	S

Notes:
< = less than
> = greater than
≤ = less than or equal to
A = analytical
CoC = chain of custody
EDD = electronic data deliverable
LCS/LCSD = laboratory control spike/ laboratory control spike duplicate
LOQ = limit of quantitation
MS/MSD = matrix spike/ matrix spike duplicate
RPD = relative percent difference
S = sampling

Matrix Solid
Analytical Group Total Organic Carbon (TOC)

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling, Analytical, or Both
Accuracy/ Bias	LCS/LCSD: 72-122% for soil; 87-112% for water MS/MSD: 72-122% for soil; 87-112% for water	LCS/LCSD and MS/MSD	A
Precision	Laboratory duplicates analysis should have RPD ≤ 20% for soil; RPD ≤ 10% for water	Matrix Duplicate	A
Accuracy/ Contamination	Target compound < RL	Method Blank	A
Completeness	Completeness criteria will be considered met if 100% of all planned sample data (as requested on CoC in lab reports and EDD; including requested re-analyses) are collected	Reported Sample Data	S & A
Comparability	Based on accuracy and media comparison	Use of standardized SOPs in field and laboratory	S & A

Notes:
A = analytical
CoC = chain of custody
EDD = electronic data deliverable
LCS/LCSD = laboratory control spike/ laboratory control spike duplicate
MS/MSD = matrix spike/ matrix spike duplicate
RL = reporting limit
RPD = relative percent difference
S = sampling

Matrix Solid
Analytical Group pH

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling, Analytical, or Both
Accuracy/ Bias	85-115% for soil	LCS/LCSD	A
Precision	RPD ≤ 20% for soil	Matrix Duplicate	A
Completeness	Completeness criteria will be considered met if 100% of all planned sample data (as requested on CoC in lab reports and EDD; including requested reanalyses) are collected	Reported Sample Data	S & A
Comparability	Based on accuracy and media comparison	Use of standardized SOPs in field and laboratory	S & A

Notes:
A = analytical
CoC = chain of custody
EDD = electronic data deliverable
LCS/LCSD = laboratory control spike/ laboratory control spike duplicate
LOQ = limit of quantitation
RPD = relative percent difference
S = sampling

Matrix Solid
Analytical Group Grain Size

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Precision	RPD ≤ 20%	Sample Duplicate	A
Completeness	Completeness criteria will be considered met if 100% of all planned sample data (as requested on CoC in lab reports and EDD; including requested re-analyses) are collected	Reported Sample Data	S & A
Comparability	Based on accuracy and media comparison	Use of standardized SOPs in field and laboratory	S & A

Notes:
A = analytical
CoC = chain of custody
EDD = electronic data deliverable
QC = quality control
RPD = relative percent difference
S = sampling

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QAPP Worksheet #13: Secondary Data Uses and Limitations

Secondary data sources, uses, and limitations are tabulated below. Original source documents were reviewed for uncertainty discussions that may identify additional or more suitable data limitations.

Data Type	Source	Data Uses Relative to Current Project	Factors Affecting Reliability of Data and Limitations on Data Use
Meteorological	National Weather Service	Estimates of seasonal fluctuations in precipitation.	Meteorological data are generally for a regional area. Actual site conditions may vary.
Topographic	USGS	Inferred groundwater flow pathways based on local topography at each facility. Groundwater flow maps will ultimately rely upon groundwater measurements from monitoring wells.	Topography of some sites may have been altered by building or grading activities.
Soil and groundwater chemistry, groundwater monitoring data, and data gaps identification	Historical site reports	Applicable to the evaluation of historical site conditions in soil and groundwater to supplement data being collected under this delivery order.	The data may not represent current conditions because of the age of some of the data. Reliability of second- or third-party data quality.
Historical site records (i.e., material inventories)	Purchase records, site inventories, on-facility records, safety data sheets	Applicable to the evaluation of potential constituents of concern and release areas.	Records may be incomplete or inaccurate.
Periodicals (i.e., news articles)	Local newspapers, magazines, or other periodicals	Applicable to the evaluation of the use of potential constituents of concern at off-facility locations or mutual use/ aid agreements with local fire department or other entities.	Records may be incomplete or inaccurate.

Notes:
USGS = United States Geological Survey

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QAPP Worksheet #14 & #16: Project Tasks and Schedule

Worksheet #14 & 16 provide the project schedule and detail the general project tasks that are expected to be completed as part of the RI. The RI program will include tasks as detailed in the following sections:

- **Section 14.1** – Mobilization
- **Section 14.2** – Field Investigation Activities
- **Section 14.3** – Laboratory Analysis
- **Section 14.4** – Data Management, Review, and Validation
- **Section 14.5** – Human Health and Ecological Risk Assessment
- **Section 14.6** – Report Preparation

The RI field activities for the West Bend AASF #1 and Armory will consist of multiple phases. This RI QAPP specifically addresses the activities to be performed during the RI Prescriptive Phase, as developed in conjunction with the data from the SI (AECOM, 2022). During the Prescriptive Phase, discrete soil, grab groundwater, surface water, and sediment samples will be collected to further refine the nature and extent of impacts previously identified, as summarized in **Worksheet #10**. As part of the Prescriptive Phase, the objectives, approach, and rationale for RI sample locations are to further delineate the presence/absence of PFAS, similar to those outlined in the SI. Any results in exceedance of the SLs will be considered for ongoing refinement during the RI Adaptive Phase. The technical aspects of the Adaptive Phase are described in this document (soil and groundwater sampling), but details regarding the Adaptive Phase sampling locations, intervals, and rationale will be included in an RI QAPP Addendum after completion of the Prescriptive Phase field mobilization.

The specific details and rationale for the Prescriptive Phase sampling design, in addition to sampling locations and methods, are presented in **Worksheets #17 & #18.** Field activities will be completed per the SOPs in **Appendix D**.

Table 14-1 below presents the schedule for the RI as anticipated based on ongoing project planning discussions with stakeholders, to be updated if new consensus decisions materialize.

Table 14-1 RI Schedule

Task	Start Date	End Date
RI QAPP (Prescriptive)	March 2023	August 2023
Pre-mobilization (Mobilization 1)	August 2023	August 2023
Mobilization (Mobilization 1)	September 2023	September 2023
Field Work (Mobilization 1)	September 2023	October 2023
Demobilization (Mobilization 1)	October 2023	October 2023
Data Analysis/Data Validation (Mobilization 1)	November 2023	January 2024
RI QAPP Addendum (Adaptive)	January 2024	March 2024
Pre-mobilization (Mobilization 2)	March 2024	April 2024
Field Work (Mobilization 2)	April 2024	May 2024
Demobilization (Mobilization 2)	May 2024	June 2024
Data Analysis/Data Validation (Mobilization 2)	June 2024	August 2024

Task	Start Date	End Date
Reporting	August 2024	January 2025

14.1 Mobilization

The following subsections present field tasks that may be completed as part of the mobilization activities.

Right of Entry Documentation Support

ROE will be required to complete the Prescriptive Phase of the RI. ROE documentation and property identification will be sent by Omaha District USACE PM at least 60 days prior to entry onto a property. ROE property data will include a property parcel number, legal description, owner name, mailing and physical addresses, phone number, and a map of the property. AECOM will work with ARNG G-9, USACE (Omaha District), and Wisconsin Department of Military Affairs (WIDMA) to identify property owners where sample locations are proposed and facilitate access through obtaining signed ROEs. Monitoring wells and other sample locations will be installed, within public rights-of-way, to the extent possible. Access will be coordinated with the City of West Bend as needed. Additional ROEs may be necessary during the Adaptive Phase.

Health and Safety Requirements

Health and safety requirements for field activities will be specified in the Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP) (AECOM, TBD). Personnel mobilized to the facility will be required to meet training requirements identified in Federal Regulation 29 CFR 1910.120 and applicable Occupational Safety and Health Administration (OSHA) training, including Hazardous Waste Operations and Emergency Response (HAZWOPER) and medical surveillance requirements. At least two personnel trained in first aid and cardiopulmonary resuscitation (CPR) will be on-facility during field activities. Training certificates for personnel (HAZWOPER 40-hour training; current HAZWOPER 8-hour refresher training; and first aid/CPR) will be maintained on-facility.

The Site Safety and Health Officer (SSHO) will have completed the 30-hour OSHA General Industry or Construction Industry Safety Class or equivalent, as specified in *EM 385-1-1* (USACE, 2014). For non-construction related field activities (such as groundwater, surface water or sediment sampling) an HTRW SSHO may be utilized. The HTRW SSHO must have a minimum of 1 year of experience implementing health and safety programs and meet the training requirements listed in *EM 385-1-1* (USACE, 2014). The SSHO will be responsible for managing, implementing, and enforcing the health and safety program in accordance with the accepted APP/SSHP. The SSHO will be a competent person that can identify existing and predictable hazards in the working environment or working conditions that are dangerous to personnel, and who has authorization to take prompt corrective measures to eliminate them.

The Site Supervisor (SS) will have completed the 8-hour OSHA Supervisor training, as specified in EM-385. The SS will lead field operations, coordinate field activities, and act as the liaison between site and laboratory personnel, among other responsibilities.

In general, field personnel will wear PFAS-free Level D personal protective equipment (PPE). If elevated levels of PPE are warranted based on site conditions, it will be established in the site-specific SSHP. Detailed Activity Hazard Analysis (AHA) forms identifying the physical, chemical, and biological hazards that may be encountered at the facility and the associated mitigation methods are presented in the APP/SSHP.

Personnel and visitors who enter the facility will be required to review the APP/SSHP and sign the acknowledgement form. Site workers will be required to sign the daily tailgate safety meeting form and fill out daily AHA forms. Safety issues that arise during implementation of field activities will be addressed during tailgate safety meetings held daily before the workday and will be documented in the daily tailgate safety meeting form.

Additional Personnel Qualifications

In addition to the health and safety requirements specified above, personnel mobilized to the facility will complete the DoD's *Operations Security Awareness for Military Members, DoD Employees, and Contractors* and *Level 1 Antiterrorism Awareness Training*. AECOM employees that will be performing sample collection will also take an internal PFAS sampling guidance training.

The field work at the facility will be performed adjacent to and on the West Bend Municipal Airport. Field personnel may be required to participate in Airfield Safety Training or similar facility-specific training as necessary.

Permits and Notifications

Utility clearance is required for intrusive work, regardless of planned intrusive depth. Prior to intrusive activities, a site walk will be scheduled with the appropriate ARNG personnel to mark out locations of the subsurface utilities. AECOM or its drilling subcontractor will contact Wisconsin 811, the local one-call utility location system. Additionally, a private utility locator will be contracted to clear utilities onsite. Precautionary measures (e.g., geophysical survey, air knifing methods, hand-digging to 5 feet, etc.) are required if utility clearance is not confirmed. Lack of confirmation can include urban locations, areas adjacent to roadways, areas not previously assessed, areas with insufficient utility information, or areas with multiple utility lines. The location of utilities will be noted and recorded during the site walk and referenced when selecting investigation locations. Utility Clearance will be conducted in accordance with *SOP 3-01: Utility Clearance* (**Appendix D**). All field work will be coordinated with the WIDMA Environmental Branch Chief and/or his/her designee, and following intrusive work requirements (e.g., dig permits) if applicable.

Federal Aviation Administration notifications and approval will be required for sample locations on the West Bend Municipal Airport property. AECOM will work with ARNG G-9, USACE (Omaha District), and WIDMA to submit the request at least 60 business days prior to the scheduled start of the field activities.

AECOM will also contact the WIDMA Environmental Branch Chief at least 20 business days prior to the scheduled start of the field activities. Field work will be coordinated with the Environmental Branch Chief and/or his/her designee to ensure investigation activities do not impact facility operations.

Site Preparation

Preparation activities for the RI field investigation operations include mobilization of field team personnel and equipment. No vegetation clearance is planned during field investigation activities, as the investigation sampling locations are generally free of vegetation or debris that would inhibit ingress and egress.

Additionally, traffic control measures may be required to complete investigations at sampling locations at or near roadways. Procedures will be outlined in the SSHP.

14.2 Field Investigation Activities

The following subsections present field tasks that may be completed as part of the RI field efforts. Field tasks will be completed following the SOPs listed in **Worksheet #21** and provided in **Appendix D**. In instances where deviations from the field protocols established in the Worksheet are made due to unforeseen conditions, a Field Change Request Form will be generated to document the change and request feedback from the AECOM Task and Project Managers, USACE, and ARNG G-9.

Habitat Assessment

An initial habitat assessment will be performed as part of the Prescriptive Phase to identify representative habitats and species present in the vicinity of the sampling locations. The habitat assessment findings may be used to confirm the receptors and exposure pathways identified in the preliminary CSM (**Worksheet #10**) and may be considered in the characterization of potential adverse impacts, if identified based on comparisons to screening values. Habitats will initially be identified through the review of existing maps, available geographic information system (GIS) data, and aerial images.

It is anticipated that the primary areas of interest for the habitat assessment will be the on-facility AOIs, the stormwater detention basin, Wingate Creek, and the Milwaukee River. A site visit will be conducted to identify potential habitat within these areas. A brief qualitative survey of up to six locations will be conducted.

Although these assessments are not intended to be threatened and endangered (T&E) species surveys, the biologists will be familiar with the habitat requirements and appearance of the federally listed species and any observations of relevant habitats or listed species, as well as other general habitat and species observations, will be recorded.

If needed based on the results of the initial habitat assessment and the evaluation of the data collected during the Prescriptive and Adaptive Phases, additional assessment may be needed during subsequent mobilization(s) of the RI. Risk management decisions related to performing additional receptor or habitat surveys will be made by the project team and additional efforts may include wetland delineation, vegetation surveys, T&E species surveys, or other methods, as needed. If no potential for adverse impacts on ecological receptors are identified, additional, more intensive habitat or receptor survey efforts will not be warranted.

Field Instrument Calibration and Quality Control

Equipment will be checked to ensure its completeness and operational readiness. Any equipment found damaged or defective will be returned to the point of origin, and a replacement will be secured. Instruments and equipment that require routine maintenance and/or calibration will be checked initially upon arrival and then prior to use each day, if needed, to support that day's operations. Equipment calibration and daily checks will be documented in accordance with appropriate SOPs.

This system of checks ensures that the equipment is functioning properly. If an equipment check indicates that any piece of equipment is not operating properly, and field repair cannot be made, the equipment will be tagged and removed from service, and a request for replacement equipment will be placed immediately. Replacement equipment will meet the same specifications for accuracy and precision as the equipment removed from service.

PFAS Site Water Supply Sampling and Sampling Equipment Acceptability

A sample from the potable water source (i.e., decontamination water) will be collected prior to mobilization to confirm that it is acceptable for use for during field activities. The water source is acceptable for use if the detected concentration is less than or equal to 1/2 the SL if the water is intended for downhole drilling use. If the drilling water has concentrations greater than 1/2 the SL, the project team will determine whether the water is acceptable for its intended use based on site-specific factors (i.e., drilling methodology, relevant sample media). Potable water used for decontamination of non-disposable sampling equipment must be less than or equal to the SLs. If the water is deemed unacceptable, water will be brought on-facility from another source confirmed to be PFAS-free.

Materials being purchased or rented for field work will be confirmed as acceptable for use in the PFAS sampling environment. A summary of acceptability of materials for use in the PFAS sampling environment is provided in *SOP 3-41: Perfluoroalkyl Substance Field Sampling Protocol* (**Appendix D**). As an additional layer of control, prior to the start of field work each day, a PFAS Sampling Checklist will be completed. The checklist will serve as a reminder to each field team member regarding the allowable materials within the sampling environment. An example of the checklist is included in the SOP.

Additionally, all field staff is required to complete AECOM's internal *PFAS Sampling Training*. This training accounts for correct equipment, prohibited field items, clothing, personal care products, sunscreen, insect repellants, and additional confirmed or suspected sources of environmental sample contamination. The ITRC guidance on *Site Characterization, Considerations, Sampling Precautions, and Laboratory Analytical Methods for PFAS* was referenced in the development of this guidance (ITRC, 2018b).

Soil Sample Collection

Soil samples will be collected from multiple depth intervals at borings across the facility using various drilling methods as described in the next paragraph. At all locations, an air knife and hand auger will be used to pre-clear boring locations to depths up to 5 feet bgs depending on the targeted sampling interval at a given location. Due to the shallow depth of the water table, as observed during field work for the SI, the subsurface soil samples are expected to be collected no deeper than 15 ft bgs. Specific sampling locations and rationales are detailed in **Worksheets #17 & #18**. Proposed boring locations are shown on **Figure 17-1**. All drilling and sampling materials will be PFAS-free. An exclusion zone will be established with cones surrounding the drilling operation. The drilling team will place plastic sheeting under the direct push technology (DPT) drill rig and will pull it up around the tracks to act as a containment barrier. The DPT drill will be advanced through a tube or surface casing at the ground surface.

Two soil samples will be collected from each location within each of the five soil grids: one surface soil sample (0 to 2 feet bgs) via hand auger, and one subsurface soil sample directly above the groundwater table (expected to be no deeper than 15 ft bgs). If groundwater is encountered within 5 ft bgs of hand augering, the subsurface soil sample will be collected at that time, at the groundwater interface. Otherwise, if groundwater is not encountered within 5 ft bgs, the subsurface soil will be collected via DPT. In addition to the soil grid sampling, soil samples will be taken from two depth intervals at four total vertical profile borings using DPT: two locations on the west side of the facility (VP-01 and VP-02) and two locations on the east side of the facility (VP-06 and VP-12). The soil samples will be collected as specified in **Worksheets #17 & #18**. Drilling methodologies for the vertical profiling and the associated grab groundwater sampling procedures are described below in *Grab Groundwater Sample Collection using Direct Push Technology*.

The sampling locations within the soil grids were generated using Visual Sample Plan (VSP) version 7 software, developed by the Pacific Northwest National Laboratory, in order to generate a statistical sampling plan within the established sampling areas (VSP Development Team, 2020). From 45 locations, a total of 90 samples (two depths per location) will be collected. These 45 locations are placed on a systematic triangular grid with a random start location to minimize bias and maximize spatial coverage and representativeness. The VSP software projected a sample size of 45 per depth provides at least 95% confidence level and 90% to 95% power of detection to detect an average of one standard deviation difference for a data set that follows a normal distribution (i.e., parametric). If a non-parametric distribution is assumed, the aforementioned statistical error rates are expected to be moderately reduced.

Recovered soil will be continuously logged for lithological descriptions by a field geologist using the Unified Soil Classification System (USCS). Details regarding the air monitoring procedures and specific action levels are provided in the APP. Observations and measurements will be recorded on field forms and in a non-treated field logbook. Photographs of the recovered cores will also be taken. At a minimum, depth interval, recovery thickness, photoionization detector (PID) concentrations, moisture, relative density, color (using a Munsell soil color chart), and texture (using the USCS) will be recorded. Additional observations to be recorded may include groundwater or perched water depth, organic material, or cultural debris. Refer to *SOP 3-16: Soil and Rock Classification* and *SOP 3-21: Surface and Subsurface Soil Sampling Procedures* (**Appendix D**) for additional details.

It is anticipated that all borings will be advanced in areas without surface cover; however, if a boring is required in asphalt, it will be abandoned (as needed) by backfilling with bentonite chips to approximately 6 inches bgs, and the remainder of the borehole will be patched with an asphalt cold patch. Borings into concrete will be avoided, if possible; however, if borings are advanced into concrete, the borings will be abandoned by backfilling with bentonite chips to approximately 6 inches bgs, and the remainder of the borehole will be filled with concrete to provide as flush a surface as possible. The surface at each location will be restored to match the surrounding area. Boring locations on and close to active runways or ramps will be thoroughly cleaned to avoid potential foreign objective debris interfering with ARNG training activities. Boring abandonment will be in accordance with all applicable Federal, State and local regulations.

Each sample will be collected into laboratory-supplied bottleware and submitted to the laboratory for analysis of selected parameters. Surface and subsurface samples will be analyzed under standard TAT for the target list of 40 PFAS (Draft USEPA Method 1633). If West Bend AASF #1 and Armory is selected as one of the facilities to support a Demonstration of Method Applicability (DMA) under a separate work plan, split samples will also be collected for PFAS analysis by ASTM D8421 (**Appendix F**). Additionally, total organic carbon (TOC) (USEPA Method 9060A), pH (USEPA Method 9045D), and grain size (American Society for Testing and Materials [ASTM] D-422) will be analyzed in 25% of soil samples per soil unit to support evaluation of PFAS fate and transport, in addition to the remedial alternatives analysis. The laboratory method DLs for these analytes are presented in **Worksheet #15**. The required sample containers, preservatives, and holding times are specified in **Worksheets #19 & #30**. The sampling design and rationale, as well as the sampling locations and methods, are presented in **Worksheet #17 & #18**. However, based on the soil and/or groundwater analytical results and the field findings, modifications to these sampling locations and/or the sampling approach may be considered. In this event, a Field Change Request Form will be generated to document the change and request feedback from the AECOM Task and Project Managers, USACE, and ARNG.

Grab Groundwater Sample Collection using Direct Push Technology

Discrete grab groundwater samples will be collected from two depth intervals at each vertical profile boring location using DPT drilling. Specific sampling locations and rationales are specified in **Worksheets #17 & #18**. Proposed vertical profile boring locations are shown on **Figure 17-1**. All drilling materials will be PFAS-free.

Borings will be advanced via DPT drill rig. The soil cores will be continuously logged to the top of the water table for lithological descriptions by a field geologist using USCS. In accordance with the APP/SSHP (AECOM, TBD), the soil core will be screened for volatile organic compounds (VOCs) with a PID immediately upon recovery. Details regarding the air monitoring procedures and specific action levels are provided in the APP. Observations and measurements will be recorded on field forms and in a non-treated field logbook. Photographs of the boring cores will also be taken. At a minimum, depth interval, recovery thickness, PID concentrations, moisture, relative density, color (using a Munsell soil color chart), and texture (using the USCS) will be recorded. Additional observations to be recorded may include groundwater or perched water depth, organic material, or cultural debris. Refer to *SOP 3-16: Soil and Rock Classification* and *SOP 3-21: Surface and Subsurface Soil Sampling* (**Appendix D**) for additional details. Soil characterization will be performed until the top of the water table is reached.

Once the top of the water table has been encountered, the core barrel will be retracted, and a temporary screen point (SP) sampler will be attached and advanced to the target depth to create a temporary well. Groundwater samples will be collected via the SP sampler from the shallowest interval first. The tooling will then be retracted and decontaminated in preparation for the next sampling interval. The core barrel will be reattached, advanced at least another 5 feet into the aquifer, cased off with temporary casing, and retracted. Two discrete grab groundwater samples will be collected from each vertical profile boring. Target depths for the shallowest interval at each vertical profile location are dependent on the observed top of water table. The vertical location and the screen intervals of the proposed on-facility multi-interval temporary monitoring wells may be adjusted in the field based on lithologic observations (i.e., the presence of clay confining layers). Specific sampling locations and rationales are specified in **Worksheets #17 & #18**.

Grab groundwater samples will be collected from each interval using a peristaltic pump with tubing that has been determined to be PFAS-free (i.e., high-density polyethylene [HDPE] or other PFAS-free material). If the peristaltic pump cannot generate enough hydraulic lift to bring the groundwater to the surface, groundwater samples will be collected using a PFAS-free submersible pump. Non-disposable sampling equipment will be decontaminated between each temporary well. Prior to sampling, the exposed screened interval will be purged to remove sediment, to the extent reasonable, in an effort to minimize the turbidity of the sample. Refer to *SOP 3-37: Grab Groundwater Sampling Techniques* (**Appendix D**) for additional details. The degree of purging will be dependent on groundwater recharge within the well. If sufficient groundwater recharge is observed, the well will be purged until the turbidity is ≤ 25 nephelometric turbidity unit (NTU), stabilizes at a level above 25 NTU, or for a maximum duration of 1 hour, whichever occurs first. In borings with limited groundwater recharge, the sample will be collected using the available groundwater.

In addition to turbidity, other water quality parameters (e.g., dissolved oxygen [DO], specific conductance [SC], oxidation-reduction potential [ORP], pH, temperature, and turbidity) will be measured and recorded on the field sampling form every 5 minutes until the above turbidity criteria are met. Water quality parameters will be measured using a water quality meter and flow-through cell. Refer to *SOP 3-24: Water Quality Parameter Testing* **(Appendix D)** for additional details. The multi-parameter water quality meter will be calibrated initially and continually throughout its usage each day, as needed. A calibration check will be performed at the end of each day.

Once the water quality parameters reach stabilization, each groundwater sample will be collected into laboratory-supplied bottleware and submitted to the laboratory for analysis of selected parameters. Sample containers will be PFAS-free, and the samples will not be filtered. In addition, a subsample of each groundwater sample will be collected in a separate container and undergo a shaker test to identify if there is any foaming. If foaming is observed, the observation will be noted on the chain of custody (CoC) to notify the laboratory prior to analysis. Groundwater samples from temporary monitoring wells will be analyzed under standard TAT for the target list of 40 PFAS (Draft USEPA Method 1633). If West Bend AASF #1 and Armory is selected to support the DMA, split samples will also be collected for PFAS analysis by ASTM D8421 (**Appendix F**). The laboratory method DLs for these analytes are presented in **Worksheet #15**. The required sample containers, preservatives, and holding times are specified in **Worksheets #19 & #30**. Non-disposable sampling equipment will be decontaminated between each well.

Permanent Monitoring Well Installation, Development and Sampling

Though no permanent monitoring wells will be installed during the Prescriptive Phase, permanent monitoring wells will be installed during the Adaptive Phase and in accordance with Wisconsin Administrative Code Chapter NR 141. Details regarding the Adaptive Phase sampling locations, intervals, and rationale will be included in an RI QAPP Addendum after completion of the Prescriptive Phase field mobilization. The following subsections regarding permanent monitoring wells are applicable to anticipated work during the Adaptive Phase.

Permanent Monitoring Well Installation

It is anticipated that monitoring wells will be installed during the Adaptive Phase. Well installation will be completed in accordance with *SOP 3-12: Monitoring Well Installation* (**Appendix D**). The specific monitoring locations and target screen intervals will be determined in part on identified data gaps from the SI as specified in **Worksheets #17 & #18**. It is anticipated permanent monitoring wells will be installed during the Adaptative Phase based on the analytical data collected during the Prescriptive Phase. Details pertaining to location, depth, and rationale for the Adaptive Phase will be provided in a future RI QAPP Addendum.

Soil borings will be advanced using a DPT drill rig (GeoProbe® 7822DT, or similar) with a dual-tube sampling system or macro-core sampling system. If refusal is encountered before reaching the target depth, a second attempt will be made at an offset location within 10 feet of the original boring. Soil cores will be characterized as described above in *Soil Sample Collection*.

Individual monitoring wells will be constructed of 2-inch diameter, schedule 40 poly-vinyl chloride (PVC), 10-foot long 0.01-inch slotted screens, and 5-foot sections of schedule 40 PVC flush threaded riser pipe. A silica sand filter pack material will then be placed in the annulus between the well pipe and casing. The height of the filter pack above the top of the screen interval will be 2 feet. As the filter pack is placed in the borehole, the temporary casing will periodically be vibrated and pulled up, allowing the well materials to settle into the annular space. Time-release bentonite chips will be placed in the annulus, above the filter pack, and allowed to hydrate (water will be added to hydrate the bentonite chips as needed). Water added to hydrate the bentonite chips will be PFAS-free (tested before use). The bentonite seal will be at least 2 feet thick. The hydration time will be per the recommendations of the bentonite manufacturer, which is 2 hours for typical types of bentonite chips. Once the bentonite seal has hydrated, cement-bentonite grout will be placed in the annulus from the top of the bentonite seal up to the ground surface. Cement-bentonite grout placement will continue until the outer casing is removed from the borehole. All monitoring wells will be completed as flush mounts (bgs) using an 8-inch diameter, bolt-down manhole cover with 12-inch poly skirt. The manhole will be centered in a 2 foot by 2 foot by 6-inch thick concrete pad.

The installation of monitoring well pairs will depend on the vertical profile samples collected during the Prescriptive Phase. Installation of these will not be performed until the Adaptive Phase and only if determined necessary to further evaluate vertical distribution of PFAS in the aquifer. In the event they are required, well pairs will be placed within several feet of each other and have at least 5 feet of vertical separation between screened intervals. All other well construction details will be as outlined above.

Permanent Monitoring Well Development

Permanent monitoring wells will be developed at a minimum of 24 hours after completion of well installation or in accordance with state-specific guidance. Development will be completed by a combination of surging with a surge block and over-pumping with a submersible pump or Waterra pump and associated HDPE tubing, in accordance with *SOP 3-13: Monitoring Well Development* (**Appendix D**).

Following the initial removal of the bulk sedimentation in the well, water clarity will be visually monitored and water quality parameters, including temperature, SC, pH, DO, and ORP will be measured using a flow-through cell every 5 minutes during purging to determine progress of development in accordance with *SOP 3-24: Water Quality Parameter Testing for Groundwater Sampling* (**Appendix D**). The water quality meter will be calibrated initially and continually throughout its usage each day, as needed. A calibration check will be performed at the end of each day. Each well will be developed until the well produces clear (silt-free) water with a minimum of 3 stable water quality readings as outlined below:

- pH – within ± 0.2 units
- DO – within ± 10%
- SC – within ± 3%
- ORP – within ± 10 millivolts (mV)
- Temperature – within ±1 degree Celsius (°C)
- Turbidity – at or below 10 NTU or within ± 10% if above 10 NTU

If the well has slow groundwater recharge and is purged dry, the well will be considered developed when bailed or pumped dry three times in succession and the turbidity has decreased. If any water is added to the borehole during drilling or development, three times the volume of water lost to the borehole (i.e., not returned to the surface during drilling) will also be removed during well development. Excess soil or groundwater generated will be containerized, managed, and disposed of as investigation-derived waste (IDW). Refer to *SOP 3-13: Monitoring Well Development* (**Appendix D**) and the **Investigative Derived Waste Management** section below for more details.

Groundwater Sample Collection from Permanent Monitoring Wells

Permanent monitoring wells will be sampled a minimum of 24 hours after completion of well development, in accordance with *SOP 3-14: Groundwater Sampling* (**Appendix D**). The specific monitoring wells selected for groundwater sample collection are specified in **Worksheets #17 & #18** and shown on **Figure 17-1**. The monitoring wells will be purged following low-flow sampling techniques using a bladder pump equipped with a PFAS-free bladder and disposable tubing that has been determined to be PFAS-free (i.e., HDPE). The bladder and tubing will be replaced with unused materials at each well location.

Water clarity will be visually monitored and water quality parameters, including DO, SC, ORP, pH, temperature, and turbidity will be measured using a flow-through cell per the *SOP 3-24: Water Quality Parameter Testing for Groundwater Sampling* (**Appendix D**). Readings will be collected every 5 minutes until the well produces clear (silt-free) water with a minimum of 3 stable water quality readings, as outlined below:

- pH – within ± 0.2 units
- DO – within ± 10%

- SC – within ± 3%
- ORP – within ± 10 mV
- Temperature – within ±1°C
- Turbidity – at or below 10 NTU, or within ± 10% if above 10 NTU

The multi-parameter water quality meter will be calibrated initially and continually throughout its usage each day, as needed. A calibration check will be performed at the end of each day.

Once the water quality parameters reach stabilization, each groundwater sample will be collected into laboratory-supplied bottleware and submitted to the laboratory for analysis of selected parameters. Sample containers will be PFAS-free, and the samples will not be filtered. Groundwater samples from permanent monitoring wells will be analyzed under standard TAT for the target list of 40 PFAS (Draft USEPA Method 1633). If West Bend AASF #1 and Armory is selected to support the DMA, split samples will also be collected for PFAS analysis by ASTM D8421 (**Appendix F**). The laboratory method DLs for these analytes are presented in **Worksheet #15**. The required sample containers, preservatives, and holding times are specified in **Worksheets #19 & #30**. Non-disposable sampling equipment will be decontaminated between each well. Refer to *SOP 3-14: Monitoring Well Sampling and SOP 3-24: Water Quality Parameter Testing* (**Appendix D**) for additional details.

In addition, a subsample of each groundwater sample will be collected in a separate container and undergo a shaker test to identify if there is any foaming. If foaming is observed, the observation will be noted on the CoC to notify the laboratory prior to analysis.

Surface Water and Sediment Sample Collection

Co-located surface water and sediment will be collected from upstream and downstream locations within Wingate Creek and the Milwaukee River, along with two proposed locations within the on-facility stormwater detention basin if sufficient surface water exists at the time of field work. Specific sampling locations are specified in **Worksheets #17 & #18**. Sampling will occur from downstream to upstream to prevent agitation of the sediment and surface water.

Surface water samples will be collected first at each location, prior to sediment sampling. The surface water samples will be collected from a single point in the waterbody by dipping the sample container in the water, just below the surface. Sampling will be performed deliberately and methodically to minimize disturbance of bottom sediments, and as quickly as possible to ensure a representative sample is collected. After the surface water sample is collected, water quality parameters, including ORP, pH, SC, salinity, temperature, DO, and turbidity, will be measured with a water quality meter and recorded in the field logbook or sampling form. Physical characteristics of the sampling locations (e.g., water depth and stream width) will be documented. Additionally, at each location, the depth of water and width of channel will be recorded. Refer to *SOP 3-10: Surface Water and Liquid Sampling* (**Appendix D**) for additional details.

After surface water sampling is complete, sediment samples will be collected from 0 to 1 feet bgs using a hand-driven coring barrel. The sediment will be transferred to a stainless-steel bowl or other PFAS-free container (i.e., 1-gallon Ziploc® bags) from which material such as twigs, leaves, and stones will be removed prior to homogenization and documented in the field log or field forms. Sediment samples will target fine-grained material from depositional areas and will be collected while standing on the bank of Wingate Creek and the Milwaukee River. Refer to *SOP 3-22: Sediment Sampling* (**Appendix D**) for additional details. The sediment coring device and water quality probe will be stainless steel or another PFAS-free material.

Each sample will be collected into laboratory-supplied bottleware and submitted to the laboratory for analysis of selected parameters. Sample containers will be PFAS-free, and the aqueous samples will not be filtered. Surface water and sediment will be analyzed under standard TAT for the target list of 40 PFAS (Draft USEPA Method 1633). If West Bend AASF #1 and Armory is selected to support the DMA, split samples will also be collected for PFAS analysis by ASTM D8421 (**Appendix F**). Additionally, 25% of sediment samples will be analyzed for TOC (USEPA Method 9060A) and pH (USEPA Method 9045D). The laboratory method DLs for these analytes are presented in **Worksheet #15**. The required sample containers, preservatives, and holding times are specified in **Worksheets #19 & #30**.

In addition, a subsample of each surface water sample will be collected in a separate container and undergo a shaker test to identify if there is any foaming. If foaming is observed, the observation will be noted on the CoC to notify the laboratory prior to analysis.

Synoptic Groundwater and Surface Water Level Measurements

Synoptic groundwater level measurements will be collected from newly installed groundwater monitoring wells. Synoptic groundwater level measurements from newly installed wells will be collected a minimum of 24 hours after completion of well development. The specific locations of groundwater measurements are specific in **Worksheets #17 & #18**.

The synoptic groundwater gauging round will be conducted within as short a time period as reasonably feasible and will follow a period of little to no precipitation. The water level gauging event will be conducted on a day when little to no precipitation is forecasted.

Hydraulic Conductivity (Slug) Tests

In-situ hydraulic conductivity test data, via rising or falling head slug tests, will not be conducted during the Prescriptive Phase, as no permanent monitoring wells are being installed. During the Adaptive Phase, hydraulic conductivity test data via rising or falling head slug tests will be conducted at select permanent monitoring wells to assess the hydraulic conductivity of the soil surrounding the tested monitoring well. Hydraulic conductivity values can be used to estimate rates of groundwater flow, estimate responses of aquifers to applied stresses (such as pumping), estimate the rate of movement of various chemicals in subsurface zones, and construct and calibrate groundwater flow models. The specific monitoring well locations where slug tests will be completed are specified in **Worksheets #17 & #18**.

The slug testing will commence at least a week after installation, development, or sampling to allow the well to return to equilibrium. An initial round of static water level measurements will be collected prior to initiating the slug tests. The standard slug test will entail measurement of water level changes resulting from submergence or withdrawal of a solid cylinder of known volume. Water levels will be monitored and recorded until the water level returns to static conditions or sufficient data are collected to perform the hydraulic conductivity calculations.

The response of the water level will be monitored using an In-Situ Level Troll 700 Data Logger or equivalent. The datalogger will be lowered into each monitoring well and hung at a field-determined depth below top of casing (btoc). The datalogger depth will be set low enough to fully submerge the slug. Each datalogger will be programed using a Win-Situ Software application through use of an In-Situ Rugged Reader, laptop, or cell phone. Test results will be monitored real-time in the field. Equipment that comes into contact with groundwater will be decontaminated between each test location. Hydraulic conductivity testing will be conducted in accordance with *SOP 3-35: In-Situ Hydraulic Conductivity Testing via Rising or Falling Head Slug Testing* (**Appendix D**).

Field Quality Control Samples

Field QC samples will include field duplicates (FDs), matrix spike (MS)/MS duplicates (MSDs), field reagent blanks (FRBs), and temperature blanks. FD samples will be collected at a rate of 10% and analyzed for the same parameters as the accompanying samples. MS/MSD samples will be collected at the rate of 5% and analyzed for the same parameters as the accompanying samples. FRBs will be collected at a rate of one per sampling event for groundwater, soil, surface water, and sediment media, or one per day or one per 10 samples (whichever is more) for drinking water media, as needed based on collection. A temperature blank shall be placed in each cooler to ensure that samples are preserved at or below 6 °C during shipment.

If non-dedicated sampling equipment is used, an equipment blank will be collected at a rate of 5% and analyzed for the same parameters as the accompanying samples.

Sampling Handling, Storage, and Transport

Samples will be stored on ice, packaged, and submitted to the analytical laboratory for analysis as specified in **Worksheet #15**. **Worksheets #17 & #18** provides the sampling design and rationale. **Worksheets #17 & #18**, **Worksheets #19 & #30**, and **Worksheet #20** provide sample identifications, necessary sample volume and preservative requirements, and hold time limitations. Samples will be QC checked by the SS (label correctness and completeness) and recorded on CoC forms. Samples will be packaged on ice and transported via overnight by commercial carrier or a laboratory courier under standard custody procedures to the laboratory. See *SOP 3-04: Sample Handling, Storage, and Shipping* (**Appendix D**) for additional information.

Field Documentation

Field documentation will be performed in accordance with *SOP 3-02: Logbooks* (**Appendix D**). Sample collection information will be recorded in bound field notebooks, tablet computers, or specific field forms. A summary of field activities will be properly recorded in a bound logbook with consecutively numbered pages that cannot be removed. Logbooks will be assigned to field personnel and stored in a secured area when not in use. Entries will be written in indelible ink, and no erasures will be made. If an incorrect entry is made, striking a single line through the incorrect information will correct the text, and the person making the correction will initial and date the change. Sampling forms and other field forms will also be used to document field activities. *See SOP 3-02: Logbooks* (**Appendix D**) for additional information.

Borehole Abandonment & Site Restoration

All boring locations will be abandoned using bentonite chips at completion of sampling activities unless they are being converted into monitoring wells. If the boring is required in asphalt, it will be abandoned by backfilling with soil cuttings to approximately 6 inches bgs, and the remainder of the borehole will be patched with an asphalt cold patch. Borings into concrete will be avoided if possible and are not proposed during the Prescriptive Phase. However, if borings are advanced into concrete, the borings will be abandoned by backfilling with soil cuttings to approximately 6 inches bgs, and the remainder of the borehole will be filled with concrete to provide as flush a surface as possible. The surface at each location will be restored to match the surrounding area. The field team will make the necessary adjustments if state regulations dictate the use of bentonite or grout to abandon soil borings or monitoring wells. See *SOP 3-15: Monitoring Well and Borehole Abandonment* (**Appendix D**) for more details.

Equipment Decontamination

The team will utilize dedicated and disposable sampling equipment to the extent possible to avoid cross contamination due to inadequate decontamination processes. The dedicated/disposable sampling equipment will include disposable polyethylene tubing, disposable gloves, and laboratory-supplied sample bottles.

Non-disposable or non-dedicated sampling equipment (e.g., water level meters, water quality meters, etc.) will be decontaminated prior to sampling and between sample locations. Decontamination will generally consist of a water rinse station to remove gross contamination, followed by a non-phosphate detergent (e.g., Liquinox®) water rinse, and a double rinse with PFAS-free, de-ionized water. Water used for the initial and non-phosphate rinse (facility water) will be tested prior to use (see **PFAS Site Water Supply Sampling and Sample Equipment Acceptability** section above). Paper towels containing recycled paper content are prohibited. Decontamination activities will be performed in accordance with *SOP 3-06: Decontamination* (**Appendix D**).

Land Surveying and Geographic Position Measurement

Sample locations that are not permanent monitoring wells (i.e., vertical profile borings, surface water/sediment locations) will be documented using a handheld global positioning system (GPS) (Trimble Geo 7 or equivalent) with a level of accuracy of (+/-) 1 meter.

During the Adaptive Phase, newly installed permanent monitoring wells will be surveyed by a state-registered surveyor to a horizontal accuracy of 0.1 feet and a vertical accuracy of 0.01 feet. A small notch will be cut on the northern side of the well casing, which will be surveyed. The top of casing and ground surface elevation will be surveyed for each newly installed well. The data will be collected in the following datums:

- Horizontal - North American Datum 1983 (NAD83) State Plane, Linear Units: Feet; and
- Vertical - North American Vertical Datum 1988 (NAVD88), Linear Units: Feet..

Refer to *SOP 3-07: Land Surveying* (**Appendix D**) for more details.

Investigation-Derived Waste Management

Currently, the disposal of PFAS IDW is not regulated. PFAS IDW is considered a non-hazardous waste and will be managed in accordance with USEPA Management of IDW (USEPA, 2014) and applicable state regulations. If waste requires containerization, it will be managed in accordance with the Army Guidance for Addressing Releases of PFAS, Q18 (DA, 2018). Disposal of IDW will follow the procedures described in the approved *Work Plan for Investigation-Derived Material Disposal, West Bend Army Aviation Support Facility #1 and Armory* (EA Engineering, Science, and Technology [EA], 2022).

Non-hazardous solid IDW (i.e., soil cuttings) generated on-facility and off-facility during RI activities will be containerized in 55-gallon drums for characterization and proper disposal. Soil IDW will assume the PFAS characteristics of the associated soil samples collected from that source location. A composite soil sample will be collected representative of the staged solid IDW drums for waste classification purposes, if boring specific soil data does not exist. IDW classification samples will be analyzed for analytical parameters required by the receiving permitted disposal facility. See *SOP 3-05: Investigation-Derived Waste Management* (**Appendix D**) for more details.

Liquid IDW (e.g., purge water and decontamination fluids) generated on-facility during RI activities will be containerized in 55-gallon drums or a frac tank for characterization and proper disposal. The containerized IDW will be segregated based on location, to the extent possible, and the material will assume the characteristics of the associated sample. If the IDW cannot be characterized with analytical results from a sample, then a composite IDW sample will be collected and analyzed for PFAS and analytical parameters required by the receiving permitted disposal facility. Alternatively, if liquid IDW exceeds the SLs, it will be run through granulated active carbon filters for treatment. If the liquid IDW does not exceed the SLs, it will be discharged to the sanitary sewer.

Other solids such as spent PPE, plastic sheeting, tubing, rope, unused monitor well construction materials, and other environmental media generated during the field activities will be disposed of at a licensed solid waste landfill.

Adaptive Phase field activities will generally follow the same technical approach as outlined above. If a new technology is incorporated to that phase, a revised **Worksheet #14** will be provided in the RI QAPP Addendum. Details regarding RSC sampling of soil and groundwater (to be performed during the Adaptive Phase) are included in **Worksheet #17**.

14.3 Laboratory Analysis

Chemical analyses will be performed by Eurofins Lancaster Laboratories. Pace South Carolina Laboratory has been identified as a back-up laboratory should additional analytical capacity be required. Both Eurofins Lancaster and Pace South Carolina are DoD ELAP and NELAP certified laboratories. Copies of the laboratory accreditation certificates are included in **Appendix C**. Analytical services are summarized on **Worksheets #19 & #30**. PFAS analyses will be conducted in accordance with DoD QSM Version 5.4 (DoD, 2021) and the laboratory SOPs cited.

Chemical analyses will be performed in accordance with the analytical methods identified in **Worksheet #23**. Analytical sensitivity for the methods selected is compared to project screening criteria on **Worksheet #15**. Requirements for laboratory instrument calibration, and equipment maintenance and testing are presented on **Worksheet #24** and **Worksheet #25**. MPC for field and laboratory QC samples are presented on **Worksheet #12** and **Worksheet #28**, respectively.

The laboratory will provide Contract Laboratory Program-like Level IV data packages, which will include summary forms containing QC information and raw data (Stage IV data packages as described in the DoD QSM v5.4).

14.4 Data Management, Review, and Validation

The principal data generated for this project will be from laboratory analytical data. Copies of the field forms, CoCs, air bills, and logbooks will be placed in the project files after completion of the field program. The field logbooks for this project will be used only for this facility and will also be categorized and maintained in the project files after the completion of the field program. Project records will be maintained in a secure location.

Data Tracking

The AECOM RI Task Manager is responsible for the overall tracking and control of data generated for the project. Data are tracked from generation to archiving in the project-specific files. The Project Chemist, or designee, is responsible for tracking the samples collected and shipped to the contracted laboratory. The laboratory will report data using AECOM format Electronic Data Deliverables (EDDs) along with a hard copy of the laboratories final data report, which will include supporting documentation such as chromatographs and instrument calibrations. Upon receipt of the data packages from the analytical laboratory, the Project Chemist will oversee the data validation effort, which includes verifying that the data packages are complete, and that results for samples have been delivered by the analytical laboratory.

Data Review and Validation

Upon receipt of data packages from the analytical laboratory, the AECOM Project Chemist will oversee the data validation effort, which includes verifying data completeness as specified on **Worksheet #34**. To evaluate whether the analytical results meet the project quality objectives, the laboratory data will undergo verification and validation as cited in **Worksheet #34**, **Worksheet #35**, and **Worksheet #36.** The usability assessment processes are described in **Worksheet #37**.

Prior to data validation, electronic laboratory data will be verified for accuracy against the hardcopy laboratory report and the QAPP will be established using the project-specific criteria defined in **Worksheet #12**, **Worksheets #19 & #30**, and **Worksheet #28**. The laboratory will be requested to resubmit electronic data found to be inaccurate. Laboratory calibration will be assessed against the criteria presented in **Worksheet #24**.

Data Storage, Archiving, and Retrieval

After the data are validated, the data packages are entered into the AECOM file system and archived in secure files. The field records including field logbooks, sample logs, CoC records, and field calibration logs will be submitted by the AECOM field team lead to be entered into the file system before archiving in secure project files. Project files will be kept in a secured, limited access area. AECOM will add electronic data to the existing project database.

Data Security

Laboratory data, provided in electronic format, will be verified for accuracy prior to use and during the data review process. After data are reviewed, the electronic data results will be uploaded into the AECOM database for use in data evaluation and subsequent report preparation. The project database will be on a password protected secure network, and access to changing data files will be restricted to qualified personnel. The AECOM RI Task Manager, or designee, is responsible for the overall tracking and control of data generated for the project. File and data backup procedures are routinely performed.

14.5 Human Health and Ecological Risk Assessment

A HHRA and SLERA will be conducted in accordance with CERCLA and USACE risk assessment guidance following completion of RI field activities (Adaptive Phase) as part of the comprehensive RI report that will be prepared following this and subsequent mobilizations, as indicated in **Section 14.6**. If updated guidance or standards for human health or ecological risk become available, the most current version available at the time the risk assessment is initiated will be used and appropriately referenced in the reports. The results of the SLERA, in conjunction with the SLERA refinement (Step 3a) and the habitat assessment, will determine whether an optional Baseline Ecological Risk Assessment (BERA) is needed.

Human Health Risk Assessment

The primary objective of the HHRA is to evaluate whether chemicals attributable to facility activities have the potential to cause unacceptable adverse health effects to human receptors within the area under investigation. The HHRA will perform quantitative estimation of potential excess lifetime cancer risk (ELCR) and noncancer hazard (as a Hazard Index [HI]) to current and potential future human receptors that may contact facility-related concentrations of PFOS, PFOA, PFNA, PFHxS, HFPO-DA, and PFBS in soil, groundwater, surface water, and sediment. For each associated exposure scenario (i.e., receptor/medium) with a potential ELCR or HI above USEPA targets, Chemicals of Concern (COCs) will be selected from those chemicals of potential concern significantly contributing to the cumulative ELCR or target organ HI.

The HHRA conclusions will inform risk management decisions. If remedial action is determined to be necessary based upon the results of the HHRA, the HHRA will be used to inform the development of risk-based target levels to be considered in conjunction with federal and state-specific Applicable or Relevant and Appropriate Requirements in the selection of Preliminary Remediation Goals (PRGs) in the FS.

Ecological Risk Assessment

The primary objective of the ERA is to evaluate the potential for adverse effects on ecological receptors due to exposures to PFAS detected in relevant media, including soil and seasonally resent surface water and to provide input to remedial decision-making that will protect the health of local populations and communities of biota.

The USEPA (1997) and DA (2010) ERA process follows a tiered approach that incorporates different levels of assessment complexity and provides an opportunity to off-ramp from the ERA process prior to proceeding to the next tier based on the available findings. The tiered approach may be implemented in its entirety depending upon the level and magnitude of risk that is determined in prior tiers. This approach consists of the following two tiers as summarized below:

- Tier 1 – SLERA
- Tier 2 – BERA

The primary objective for a SLERA is to determine which, if any, exposure pathways and chemicals of potential ecological concern (COPECs) warrant immediate action or require further evaluation in a more refined ERA. The SLERA includes Steps 1 and 2 of the eight step USEPA ERA (USEPA, 1997) process:

- Identification and summarization of relevant datasets.
- Development of a preliminary CSM.
- Comparison of maximum detected concentrations to ecological SLs to identify COPECs.

Based on the outcome of the SLERA, certain media, COPECs, and pathways may be eliminated from further evaluation due to the level of conservatism built into the SLERA process. In cases where sites are fully paved, there is no upland habitat present, soil contamination is below the reach of ecological receptors, or contaminated groundwater does not discharge to surface water habitats, documentation that the potential ecological exposure pathways are incomplete will be sufficient to address ecological concerns. In the event that potentially complete and significant ecological exposure pathways are identified, and maximum concentrations of certain COPECs exceed the generic SLs, additional evaluation may be recommended.

Prior to beginning problem formulation in the BERA (Step 3), the results of the SLERA may be refined in Step 3a, as described below. The decision to continue beyond the SLERA does not indicate that adverse effects are occurring or that risk reduction is necessary, rather it indicates that a more focused evaluation and characterization of the potential for risk and accompanying uncertainty is needed (DA, 2010).

The primary purpose of the BERA is to assess the potential for adverse effects on the focused list of ecological receptors due to exposure to the COPECs identified upon completion of the SLERA. The BERA includes Steps 3 through 7 of the eight step USEPA ERA (USEPA, 1997) process and uses site-specific information whenever possible:

Step 3a (SLERA refinement) provides a refinement of the conservative assumptions and resulting risk estimates identified in the SLERA. This step is conducted to refine some of the conservative assumptions used in the SLERA and assess whether more realistic assumptions would reduce the risk estimates to acceptable levels prior to implementing a site-specific BERA with associated sampling and analyses. A weight of evidence evaluation that considers the Step 3a results, available habitat, wildlife management goals for the areas evaluated, and other relevant factors as appropriate will be conducted to determine whether a BERA is recommended.

Completion of Steps 3b through 7 for pathways and COPECs retained after the completion of Step 3a. These steps include identifying endpoints to be evaluated, the laboratory and field methods to be used to collect additional data, the statistical analyses to be used for evaluating data, and the methods to be used for estimating and characterizing the potential for adverse effects on ecological receptors.

A BERA (including Steps 3b through 7) will only be warranted if the results of the SLERA and SLERA refinement indicate that adverse ecological effects are likely. In the event a BERA is warranted, the evaluation will be focused on the key receptors, pathways, and PFAS of potential concern identified following a weight of evidence assessment included in the SLERA refinement. The BERA would consider more detailed aspects related to the COPECs, receptors, and exposure pathways retained at the end of Step 3a and could include food web modeling, tissue sampling, additional habitat assessments, or collection of other site-specific data.

If the outcome of the ERA process indicates the need for risk management measures, ecological PRGs may be developed for PFAS showing the potential for risk to guide remedial decision-making. PRGs may be based on available ecological SLs, site-specific background concentrations, calculated values based on food web modeling, and/or site-specific toxicity data, if available.

Results from the HHRA and SLERA/BERA will be used to update and refine the RI CSM.

14.6 Report Preparation

Following the completion of data collection from Prescriptive Phase, laboratory analysis, and data validation, the Adaptive Phase will be considered and an RI QAPP Addendum will be prepared to outline additional data gaps identified following the Prescriptive Phase. The RI QAPP Addendum for the Adaptive Phase will refer the reader to this document for elements that are the same and only update those specific worksheets required to detail the scope to be completed during the Adaptive Phase. Following this and any additional mobilizations deemed necessary, a comprehensive RI Report will be prepared per CERCLA guidance. The RI report will present the methods used for the RI, the refined CSM resulting from the investigation (including exposure pathways and receptors), the results of the site characterization and risk assessment, and a recommendation of whether further remedial action is needed.

The RI Report will include the following elements:

- Restatement of program goals;
- Facility background, environmental setting, previous investigations, current and reasonably expected future land use both on- and off-facility, and potential off-facility PFAS sources;
- Summary of field investigation conducted (e.g., sampling dates, soil samples collected, wells sampled, parameters analyzed, and field procedures);
- Physical characteristics of the study area, including soils, geology, hydrogeology, hydrology, and ecological setting;
- Habitat Assessment discussion;

- Deviations from the initial site-specific QAPP and/or any QAPP modifications;
- Tables summarizing the samples collected and sample analytical data;
- Figures showing the layout of each sampling area, updated site features, results of geophysical surveys, soil boring locations, and summaries of pertinent analytical results;
- Discussion of data validation and PARCCS;
- Data evaluation;
- Fate and transport discussion, including potential routes of migration, contaminant persistence, and contaminant migration;
- HHRA and SLERA/BERA summaries (full HHRA and SLERA/BERA documentation to be included as attachments to the Mobilization 1 RI report); and,
- Conclusions and summary of the RI findings.

QAPP Worksheet #15: Project Data Quality Limits and Laboratory-Specific Detection/ Quantitation Limits

The following tables specify the list of target analytes for soil, groundwater, surface water, and sediment and the associated DQLs and laboratory-specific detection/ quantitation limits [QLs] for the target analytes. The analytical laboratory reference limits include the limits of detection [LODs], limits of quantitation [LOQs], and DLs. The objective is for the laboratory to achieve LOQs low enough to measure analytes at concentrations less than the DQLs to obtain a dataset of known quality and sufficient sensitivity to meet the project DQOs established in **Worksheet #11**. The DQLs represent the lowest of the relevant criteria that may be used in the RI and later stages of the CERCLA process (e.g., FS). These criteria use the most applicable human health and ecological screening values, as further described below. Conservative assumptions were made when selecting screening values for use as DQLs for purposes of achieving an appropriate level of data quality. Site-specific refinements may be made during application of screening values for use in the evaluation of analytical data. The DQLs are not intended to be used as cleanup levels. Concentrations above the DQLs would not automatically trigger a response action but would suggest further site-specific consideration is appropriate. Details on the medium-specific DQL selection are provided in the notes below the following media-specific tables.

Target Analyte List for PFAS

A target list of 40 PFAS has been established for the project. Six of these compounds were identified in the memorandum from the OSD updated 6 July 2022 (Assistant Secretary of Defense, 2022). The OSD Memo was updated in response to the changes included in the USEPA RSLs published in May 2022. The six compounds included PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA.

RI Screening Levels for PFAS

The DoD has adopted a policy within the CERCLA process to compare analytical results for PFAS to risk-based human health SLs for soil and groundwater (Assistant Secretary of Defense, 2022). The ARNG program under which this RI is being performed follows this DoD policy. The SLs established in the OSD memorandum apply to six compounds: PFOA, PFOS, PFHxS, PFNA, PFBS, and HFPO-DA. The SLs were calculated using the USEPA RSL On-Line Calculator (USEPA, 2022). Wisconsin MCL drinking water standards were reviewed and considered, though not included as a DQL, as the combined or individual MCL is greater than the SLs established by the OSD memorandum.

Additional Screening Levels for Human Health

Risk-based human health SLs for surface water and sediment were also calculated in accordance with the OSD memorandum. The risk-based surface water SLs are lower than the Wisconsin promulgated surface water criteria for PFOS and PFOA.

Ecological Screening Criteria for PFAS

Ecological screening criteria for PFAS have not been developed by USEPA. Risk-based SLs for ecological receptors to be used in the SLERA are identified in Appendix E and are included in the DQLs. Ecological risk-based SLs for soil, surface water, and sediment were identified primarily from SERDP guidance documents (Conder, et al., 2020; Divine, et al., 2020) and recent documentation from Argonne National Laboratory (Grippo, et al., 2021).

Laboratory: Eurofins Lancaster Laboratories
Matrix: Groundwater
Analyte Group: PFAS (40 Compound List)
Method: Draft USEPA 1633/QSM B-24

Analyte	Abbreviation	CAS Number	DQL (ng/L) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (ng/L)	LOD (ng/L)	LOQ (ng/L)
4:2 Fluorotelomer sulfonate	4:2 FTS	757124-72-4	NA	--	40	150	1.70	3.80	8.00
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2	NA	--	40	150	2.50	7.60	8.00
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4	NA	--	40	150	2.60	7.70	8.00
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6	NA	--	40	150	0.700	1.40	2.00
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9	NA	--	40	150	1.20	2.40	4.00
Perfluorobutanesulfonic acid	PFBS	375-73-5	601	HH; Tap Water SL	40	150	0.300	1.00	2.00
Perfluorobutanoic acid	PFBA	375-22-4	NA	--	40	150	2.00	4.00	8.00
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	--	40	150	0.500	1.00	2.00
Perfluorodecanoic acid	PFDA	335-76-2	NA	--	40	150	0.500	1.00	2.00
Perfluorododecanoic acid	PFDoA	307-55-1	NA	--	40	150	0.500	1.00	2.00
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	--	40	150	0.520	1.00	2.00
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	--	40	150	0.400	1.00	2.00
Perfluorohexanesulfonic acid	PFHxS	355-46-4	39	HH; Tap Water SL	40	150	0.570	1.10	2.00
Perfluorohexanoic acid	PFHxA	307-24-4	NA	--	40	150	0.500	1.00	2.00
Perfluorononanoic acid	PFNA	375-95-1	6	HH; Tap Water SL	40	150	0.500	1.00	2.00
Perfluorononanesulfonic acid	PFNS	68259-12-1	NA	--	40	150	0.400	1.00	2.00
Perfluorooctanesulfonamide	PFOSA	754-91-6	NA	--	40	150	0.500	1.00	2.00
Perfluorooctanesulfonic acid	PFOS	1763-23-1	4	HH; Tap Water SL	40	150	0.500	1.00	2.00
Perfluorooctanoic acid	PFOA	335-67-1	6	HH; Tap Water SL	40	150	0.640	1.30	2.00
Perfluoropentanoic acid	PFPA	2706-90-3	NA	--	40	150	1.00	2.00	4.00
Perfluoropentanesulfonic acid	PFPS	2706-91-4	NA	--	40	150	0.500	1.00	2.00
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	--	40	150	0.500	1.00	2.00
Perfluorotridecanoic acid	PFTriDA	72629-94-8	NA	--	40	150	0.500	1.00	2.00
Perfluoroundecanoic acid	PFUnA	2058-94-8	NA	--	40	150	0.500	1.00	2.00
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	6	HH; Tap Water SL	40	150	2.00	4.00	8.00
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	NA	--	40	150	0.900	1.90	2.00
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	NA	--	40	150	0.500	1.00	2.00
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2	NA	--	40	150	0.500	1.00	2.00
2-(N-methylperfluoro-1-octanesulfonamido) ethanol	NMeFOSE	24448-09-7	NA	--	40	150	5.00	10.0	20.0

Analyte	Abbreviation	CAS Number	DQL (ng/L) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (ng/L)	LOD (ng/L)	LOQ (ng/L)
2-(N-ethylperfluoro-1-octanesulfonamido) ethanol	NEtFOSE	1691-99-2	NA	--	40	150	5.00	10.0	20.0
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	--	40	150	1.50	3.80	8.00
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	NA	--	40	150	1.00	2.00	4.00
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	NA	--	40	150	1.00	2.00	4.00
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	NA	--	40	150	1.00	3.80	8.00
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	--	40	150	2.00	7.60	8.00
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	NA	--	40	150	0.500	1.80	4.00
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	NA	--	40	150	1.50	5.00	10.0
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	NA	--	40	150	10.0	25.0	50.0
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	NA	--	40	150	10.0	25.0	50.0
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	NA	--	40	150	0.500	2.00	4.00

Notes:

1.) DQLs for groundwater are the following:

Risk-based tap water SLs calculated in accordance with the OSD Memorandum (Assistant Secretary of Defense, 2022). The OSD SLs were calculated using the USEPA RSL Calculator (USEPA, 2022) for a residential tap water exposure scenario using USEPA default exposure assumptions and toxicity values and based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

% = percent
CAS = Chemical Abstracts Service
DL = detection limit
DQL = data quality limit
HH = human health based DQL
LCS = laboratory control spike
LOD = limit of detection
LOQ = limit of quantitation
NA = not available
ng/l = nanograms per liter
OSD = Office of the Secretary of Defense
QSM = Quality Systems Manual
RSL = Regional Screening Level
SL = screening level
USEPA = United States Environmental Protection Agency

Laboratory: Eurofins Lancaster Laboratories
Matrix: Surface Water (40 Compound Target List)
Analyte Group: PFAS
Method: Draft USEPA 1633/QSM B-24

Analyte	Abbreviation	CAS Number	DQL (ng/L) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (ng/L)	LOD (ng/L)	LOQ (ng/L)
4:2 Fluorotelomer sulfonate	4:2 FTS	75124-72-4	NA	--	40	150	1.70	3.80	8.00
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2	NA	--	40	150	2.50	7.60	8.00
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4	NA	--	40	150	2.60	7.70	8.00
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6	NA	--	40	150	0.700	1.40	2.00
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9	NA	--	40	150	1.20	2.40	4.00
Perfluorobutanesulfonic acid	PFBS	375-73-5	1,000	HH; Fish Consumption SL	40	150	0.300	1.00	2.00
Perfluorobutanoic acid	PFBA	375-22-4	64,600	Eco; Aquatic life ESV	40	150	2.00	4.00	8.00
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	--	40	150	0.500	1.00	2.00
Perfluorodecanoic acid	PFDA	335-76-2	660	Eco; Wildlife ESV	40	150	0.500	1.00	2.00
Perfluorododecanoic acid	PFDoA	307-55-1	72,000	Eco; RWQ RBSL	40	150	0.500	1.00	2.00
Perfluoroheptanoic acid	PFHpA	375-85-9	870,000	Eco; RWQ RBSL	40	150	0.520	1.00	2.00
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	--	40	150	0.400	1.00	2.00
Perfluorohexanesulfonic acid	PFHxS	355-46-4	49	HH; Fish Consumption SL	40	150	0.570	1.10	2.00
Perfluorohexanoic acid	PFHxA	307-24-4	28,800	Eco; Aquatic life ESV	40	150	0.500	1.00	2.00
Perfluorononanoic acid	PFNA	375-95-1	2.7	HH; Fish Consumption SL	40	150	0.500	1.00	2.00
Perfluorononanesulfonic acid	PFNS	68259-12-1	NA	--	40	150	0.400	1.00	2.00
Perfluorooctanesulfonamide	PFOSA	754-91-6	NA	--	40	150	0.500	1.00	2.00
Perfluorooctanesulfonic acid	PFOS	1763-23-1	0.46	HH; Fish Consumption SL	40	150	0.500	1.00	2.00
Perfluorooctanoic acid	PFOA	335-67-1	10	HH; Fish Consumption SL	40	150	0.640	1.30	2.00
Perfluoropentanoic acid	PFPA	2706-90-3	140,000	Eco; RWQ RBSL	40	150	1.00	2.00	4.00
Perfluoropentanesulfonic acid	PFPS	2706-91-4	NA	--	40	150	0.500	1.00	2.00
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	--	40	150	0.500	1.00	2.00
Perfluorotridecanoic acid	PFTriDA	72629-94-8	NA	--	40	150	0.500	1.00	2.00
Perfluoroundecanoic acid	PFUnA	2058-94-8	49,000	Eco; RWQ RBSL	40	150	0.500	1.00	2.00
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	100	HH; Recreational SL	40	150	2.00	4.00	8.00
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	NA	--	40	150	0.900	1.90	2.00
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	NA	--	40	150	0.500	1.00	2.00
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2	NA	--	40	150	0.500	1.00	2.00
2-(N-methylperfluoro-1-octanesulfonamido) ethanol	NMeFOSE	24448-09-7	NA	--	40	150	5.00	10.0	20.0

Analyte	Abbreviation	CAS Number	DQL (ng/L) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (ng/L)	LOD (ng/L)	LOQ (ng/L)
2-(N-ethylperfluoro-1-octanesulfonamido) ethanol	NEtFOSE	1691-99-2	NA	--	40	150	5.00	10.0	20.0
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	--	40	150	1.50	3.80	8.00
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	NA	--	40	150	1.00	2.00	4.00
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	NA	--	40	150	1.00	2.00	4.00
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	69,000	Eco; RWQ RBSL	40	150	1.00	3.80	8.00
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	--	40	150	2.00	7.60	8.00
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	NA	--	40	150	0.500	1.80	4.00
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	NA	--	40	150	1.50	5.00	10.0
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	NA	--	40	150	10.0	25.0	50.0
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	NA	--	40	150	10.0	25.0	50.0
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	NA	--	40	150	0.500	2.00	4.00

Notes:

1.) DQLs for surface water were selected based on the lower of the following:

Risk-based surface water SLs protective of incidental ingestion and dermal contact by recreational users. Values were calculated using the USEPA RSL Calculator (USEPA, 2022) for a recreational scenario based on an exposure frequency of 52 days/year, exposure time of 2.6 hours/day, and incidental ingestion rate of 0.011 L/hour. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Risk-based surfaced water SLs protective of fish consumption by humans. Values were calculated by application of published chemical-specific bioaccumulation factors (Divine et al. 2020) to fish tissue SLs calculated using the USEPA RSL Calculator (USEPA, 2022), based on a fish consumption rate of 0.011 kg fish per day. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Risk-based surface water SLs protective of incidental ingestion and dermal contact by onsite outdoor workers. Values were calculated using the USEPA RSL Calculator (USEPA, 2022) based on an exposure frequency of 35 days/year, exposure time of 2 hours/day, incidental ingestion rate of 0.011 L/hour, and surface area exposed 2,277 cm^2. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Guidance for Assessing the Ecological Risks of PFAS to Threatened and Endangered Species at Aqueous Film Forming Foam-Impacted Sites (Conder et al., 2020). The following value was used:

- Ecological aquatic life 5% hazardous concentration.

Approach for Assessing PFAS Risk to Threatened and Endangered Species (Divine et al., 2020). The following values were used:

- Lowest NOAEL RBSL for surface water for aquatic wildlife (Wildlife RBSL).
- Freshwater chronic screening level for aquatic life (RWQ RBSL).

Derivation of PFAS Ecological Screening Values. Argonne National Laboratory (Grippo, et al., 2021). The following values were used:

- Surface water ESV for aquatic-dependent wildlife (Wildlife ESV).
- Freshwater chronic ESV for aquatic life (Aquatic life ESV).

Notes:

% = percent
CAS = Chemical Abstracts Service
DL = detection limit
DQL = data quality limit
Eco = ecological based DQL
ESV = ecological screening value
HH = human health based DQL
L = liter
L/hour = liter per hour
LCS = laboratory control spike
LOD = limit of detection
LOQ = limit of quantitation
NA = not available
ng/l = nanograms per liter
NOAEL = No Observed Adverse Effect Level
PPRTV = Provisional Peer-Reviewed Toxicity Values
QSM =Quality Systems Manual
RBSL = risk-based screening level
RSL = Regional Screening Level
RWQ = Recommended Water Quality
SL = screening level
USEPA = United States Environmental Protection Agency

Laboratory: Eurofins Lancaster Laboratories
Matrix: Soil
Analyte Group: PFAS (40 Compound Target List)
Method: Draft USEPA 1633/QSM B-24

Analyte	Abbreviation	CAS Number	DQL (µg/kg) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)
Perfluorobutanoic acid	PFBA	375-22-4	2,980	Eco; Wildlife ESV	40	150	0.100	0.400	0.800
Perfluorobutanesulfonic acid	PFBS	375-73-5	817	Eco; Wildlife ESV	40	150	0.0500	0.100	0.200
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	--	40	150	0.100	0.200	0.400
Perfluorohexanoic acid	PFHxA	307-24-4	6,200	Eco; Wildlife ESV	40	150	0.0590	0.120	0.200
Perfluorohexanesulfonic acid	PFHxS	355-46-4	2.8	Eco; Wildlife ESV	40	150	0.0500	0.100	0.200
Perfluoroheptanoic acid	PFHpA	375-85-9	1,000	Eco; Invert. NOEC	40	150	0.0500	0.100	0.200
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	--	40	150	0.0500	0.100	0.200
Perfluorooctanesulfonic acid	PFOS	1763-23-1	8.7	Eco; Wildlife ESV	40	150	0.0510	0.100	0.200
Fluorotelomer sulfonic acid 6:2	FTS 6:2	27619-97-2	NA	--	40	150	0.350	0.800	1.00
Perfluorooctanoic acid	PFOA	335-67-1	19	HH; Residential Soil SL	40	150	0.0510	0.100	0.200
Perfluorooctanesulfonamide	PFOSA	754-91-6	NA	--	40	150	0.0500	0.100	0.200
Perfluorononanoic acid	PFNA	375-95-1	19	HH; Residential Soil SL	40	150	0.0500	0.100	0.200
Perfluoroundecanoic acid	PFUdA	2058-94-8	NA	--	40	150	0.0500	0.100	0.200
Perfluorodecanoic acid	PFDA	335-76-2	67.7	Eco; Wildlife ESV	40	150	0.0500	0.100	0.200
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	--	40	150	0.0500	0.100	0.200
Fluorotelomer sulfonic acid 8:2	FTS 8:2	39108-34-4	NA	--	40	150	0.350	0.800	1.00
Perfluorododecanoic acid	PFDoA	307-55-1	NA	--	40	150	0.0500	0.100	0.200
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	--	40	150	0.0500	0.100	0.200
Perfluorotetradecanoic acid	PFTeA	376-06-7	NA	--	40	150	0.0500	0.100	0.200
2-(N-Ethylperfluorooctanesulfonamido) acetic acid	N-EtFOSAA	2991-50-6	NA	--	40	150	0.0500	0.100	0.200
2-(N-Methylperfluorooctanesulfonamido) acetic acid	N-MeFOSAA	2355-31-9	NA	--	40	150	0.0500	0.100	0.200
Fluorotelomer sulfonic acid 4:2	FTS 4:2	757124-72-4	NA	--	40	150	0.200	0.400	0.800
Perfluorononanesulfonic acid	PFNS	68259-12-1	NA	--	40	150	0.0500	0.100	0.200
Perfluoropentanesulfonic acid	PFPeS	2706-91-4	NA	--	40	150	0.0500	0.100	0.200
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	23	HH; Residential Soil SL	40	150	0.100	0.400	0.800
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	NA	--	40	150	0.0500	0.100	0.200
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	NA	--	40	150	0.0500	0.100	0.200
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2	NA	--	40	150	0.0500	0.100	0.200
2-(N-methylperfluoro-1-octanesulfonamido) ethanol	NMeFOSE	24448-09-7	NA	--	40	150	0.500	1.00	2.00

Analyte	Abbreviation	CAS Number	DQL (µg/kg) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)
2-(N-ethylperfluoro-1-octanesulfonamido) ethanol	NEtFOSE	1691-99-2	NA	--	40	150	0.500	1.00	2.00
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	--	40	150	0.200	0.400	0.800
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	NA	--	40	150	0.100	0.200	0.400
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	NA	--	40	150	0.104	0.200	0.400
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	NA	--	40	150	0.200	0.400	0.800
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	--	40	150	0.200	0.400	0.800
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	NA	--	40	150	0.100	0.200	0.400
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	NA	--	40	150	0.250	0.500	1.00
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	NA	--	40	150	1.00	2.50	5.00
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	NA	--	40	150	1.00	2.50	5.00
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	NA	--	40	150	0.100	0.200	0.400

Notes:

1.) DQLs for soil were selected based on the lower of the following:

Risk-based soil SLs calculated in accordance with the OSD Memorandum (Assistant Secretary of Defense, 2022). The OSD SLs values were calculated using the USEPA RSL Calculator (USEPA, 2022) for a residential exposure scenario using USEPA default exposure assumptions and toxicity values based on a target hazard quotient of 0.1 and a target risk level of 1E-06.

Guidance for Assessing the Ecological Risks of PFAS to Threatened and Endangered Species at Aqueous Film Forming Foam-Impacted Sites (Conder et al., 2020). Recommended Toxicity Benchmarks for Terrestrial Plants and Invertebrates; based on NOECs (Plant Tox. and Invert. Tox.).

Approach for Assessing PFAS Risk to Threatened and Endangered Species (Divine et al., 2020). The following values were used:

- Lowest NOAEL-based RBSL for soil for terrestrial wildlife (Wildlife RBSL).
- NOEC-based soil screening level for plants (Plant NOEC).
- NOEC-based soil screening level for invertebrates (Invert. NOEC).

Derivation of PFAS Ecological Screening Values. Argonne National Laboratory (Grippo, et al., 2021). The following values were used:

- Lowest soil ESV for birds and mammals (Wildlife ESV).
- Soil ESV for terrestrial plants (Plant ESV).
- Soil ESV for terrestrial invertebrates (Invert. ESV).

Notes:

µg/kg = micrograms per kilogram
CAS = Chemical Abstracts Service
DL = detection limit
DQL = data quality limit
Eco = ecological based DQL
ESV = ecological screening value
FTS = fluorotelomer sulfonic acid
HH = human health based DQL
LCS = laboratory control spike
LOD = limit of detection
LOQ = limit of quantitation
NA = not available
NOAEL = No Observed Adverse Effect Level
NOEC = No Observed Effect Concentration
OSD = Office of the Secretary of Defense
QSM = Quality Systems Manual
RSL = Regional Screening Level
SL = Screening Level

USEPA = United States Environmental Protection Agency

Laboratory: Eurofins Lancaster Laboratories
Matrix: Sediment
Analyte Group: PFAS (40 Compound Target List)
Method: Draft USEPA 1633/QSM B-24

Analyte	Abbreviation	CAS Number	DQL (µg/kg) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)
Perfluorobutanoic acid	PFBA	375-22-4	1,600	Eco; Wildlife RBSL	40	150	0.100	0.400	0.800
Perfluorobutanesulfonic acid	PFBS	375-73-5	730	Eco; Wildlife RBSL	40	150	0.0500	0.100	0.200
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	--	40	150	0.100	0.200	0.400
Perfluorohexanoic acid	PFHxA	307-24-4	1,800	Eco; Wildlife RBSL	40	150	0.0590	0.120	0.200
Perfluorohexanesulfonic acid	PFHxS	355-46-4	0.64	HH; Fish Consumption SL	40	150	0.0500	0.100	0.200
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	--	40	150	0.0500	0.100	0.200
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	--	40	150	0.0500	0.100	0.200
Perfluorooctanesulfonic acid	PFOS	1763-23-1	0.077	HH; Fish Consumption SL	40	150	0.0510	0.100	0.200
Fluorotelomer sulfonic acid 6:2	FTS 6:2	27619-97-2	NA	--	40	150	0.350	0.800	1.00
Perfluorooctanoic acid	PFOA	335-67-1	0.49	HH; Fish Consumption SL	40	150	0.0510	0.100	0.200
Perfluorooctanesulfonamide	PFOSA	754-91-6	NA	--	40	150	0.0500	0.100	0.200
Perfluorononanoic acid	PFNA	375-95-1	0.09	HH; Fish Consumption SL	40	150	0.0500	0.100	0.200
Perfluoroundecanoic acid	PFUdA	2058-94-8	NA	--	40	150	0.0500	0.100	0.200
Perfluorodecanoic acid	PFDA	335-76-2	NA	--	40	150	0.0500	0.100	0.200
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	--	40	150	0.0500	0.100	0.200
Fluorotelomer sulfonic acid 8:2	FTS 8:2	39108-34-4	NA	--	40	150	0.350	0.800	1.00
Perfluorododecanoic acid	PFDoA	307-55-1	NA	--	40	150	0.0500	0.100	0.200
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	--	40	150	0.0500	0.100	0.200
Perfluorotetradecanoic acid	PFTeA	376-06-7	NA	--	40	150	0.0500	0.100	0.200
2-(N-Ethylperfluorooctanesulfonamido) acetic acid	N-EtFOSAA	2991-50-6	NA	--	40	150	0.0500	0.100	0.200
2-(N-Methylperfluorooctanesulfonamido) acetic acid	N-MeFOSAA	2355-31-9	NA	--	40	150	0.0500	0.100	0.200
Fluorotelomer sulfonic acid 4:2	FTS 4:2	757124-72-4	NA	--	40	150	0.200	0.400	0.800
Perfluorononanesulfonic acid	PFNS	68259-12-1	NA	--	40	150	0.0500	0.100	0.200
Perfluoropentanesulfonic acid	PFPeS	2706-91-4	NA	--	40	150	0.0500	0.100	0.200
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	160	HH; Recreational SL	40	150	0.100	0.400	0.800
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	NA	--	40	150	0.0500	0.100	0.200

Analyte	Abbreviation	CAS Number	DQL (µg/kg) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	NA	--	40	150	0.0500	0.100	0.200
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2	NA	--	40	150	0.0500	0.100	0.200
2-(N-methylperfluoro-1-octanesulfonamido) ethanol	NMeFOSE	24448-09-7	NA	--	40	150	0.500	1.00	2.00
2-(N-ethylperfluoro-1-octanesulfonamido) ethanol	NEtFOSE	1691-99-2	NA	--	40	150	0.500	1.00	2.00
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	--	40	150	0.200	0.400	0.800
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	NA	--	40	150	0.100	0.200	0.400
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	NA	--	40	150	0.104	0.200	0.400
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	NA	--	40	150	0.200	0.400	0.800
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	--	40	150	0.200	0.400	0.800
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	NA	--	40	150	0.100	0.200	0.400
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	NA	--	40	150	0.250	0.500	1.00
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	NA	--	40	150	1.00	2.50	5.00
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	NA	--	40	150	1.00	2.50	5.00
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	NA	--	40	150	0.100	0.200	0.400

Notes:

1.) DQLs for sediment were selected based on the lower of the following:

Risk-based sediment SLs protective of incidental ingestion and dermal contact by recreational users. Values were calculated using the USEPA RSL Calculator (USEPA, 2022) for a recreational scenario based on an exposure frequency of 52 days/year and exposure time of 2.6 hours/day. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Risk-based sediment SLs protective of fish consumption by humans. Values were calculated by application of published chemical-specific bioaccumulation sediment accumulation factors (Divine et al. 2020) to fish tissue SLs calculated using the USEPA RSL Calculator (USEPA, 2022), based on a fish consumption rate of 0.011 kg fish per day. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Risk-based sediment SLs protective of incidental ingestion and dermal contact by onsite outdoor workers. Values were calculated using the USEPA RSL Calculator (USEPA, 2022) based on an exposure frequency of 35 days/year, sediment ingestion rate of 50 mg/day, exposed surface area of 2,277 cm^2, and an adherence factor of 0.3 mg/cm^2. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Approach for Assessing PFAS Risk to Threatened and Endangered Species (Divine et al., 2020). The following values were used:
Lowest NOAEL-based RBSL for sediment for aquatic wildlife (Wildlife RBSL).
Chronic effects and thresholds for estuarine and marine benthic organism exposure to perfluorooctane sulfonic acid (PFOS)-contaminated sediments: Influence of organic carbon and exposure routes (Simpson, et al., 2021). PC99 in estuarine and marine sediment based on 1% organic carbon.

Notes:

µg/kg = micrograms per kilogram

CAS = Chemical Abstracts Service
DL = detection limit
DQL = data quality limit
Eco = ecological based DQL
HH = human health based DQL
LCS = laboratory control spike
LOD = limit of detection
LOQ = limit of quantitation
mg/day = milligrams per day
NA = not available
NOAEL = No Observed Adverse Effect Level
OSD = Office of the Secretary of Defense
QSM = Quality Systems Manual
RBSL = Risk-Based Screening Level
RSL = Regional Screening Level
SL = screening level
USEPA = United States Environmental Protection Agency

Laboratory: Eurofins Lancaster Laboratories
Matrix: Solid (Soil/ Sediment)
Analyte Group: TOC
Method: USEPA 9060A

Analyte	DQL (µg/kg)	DQL Source	Screening Standard and Source	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	Accuracy Control Limit (%R)	Precision Control Limit RPD
Total Organic Carbon	NA	--	NA	150,000	200,000	25,000	90-120	≤20

Notes:
%R = percent recovery
µg/kg = micrograms per kilogram
CAS = Chemical Abstracts Service
DL = detection limit
DQL = data quality limit
LOD = limit of detection
LOQ = limit of quantitation
NA = not available
RPD = relative percent difference
TOC = total organic carbon
USEPA = United States Environmental Protection Agency

Laboratory: Eurofins Lancaster Laboratories
Matrix: Solid (Soil/ Sediment)
Analyte Group: pH
Method: SM USEPA 9045D

Analyte	CAS Number	DQL (SU)	DQL Source	Screening Standard and Source	LOQ (SU)	LOD (SU)	DL (SU)	Accuracy Control Limit (%R)	Precision Control Limit RPD
pH	NA	NA	--	1	1	1	0.1	±0.05	±0.1

Notes:
%R = percent recovery
CAS = Chemical Abstracts Service
DL = detection limit
LOD = limit of detection
LOQ = limit of quantitation
NA = not available
RPD = relative percent difference
SU = standard unit
USEPA = United States Environmental Protection Agency

Laboratory: Pace South Carolina
Matrix: Groundwater
Analyte Group: PFAS (40 Compound List)
Method: Draft USEPA 1633/QSM B-24

Analyte	Abbreviation	CAS Number	DQL (ng/L) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (ng/L)	LOD (ng/L)	LOQ (ng/L)
4:2 Fluorotelomer sulfonate	4:2 FTS	757124-72-4	NA	--	40	150	0.4	1.5	4
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2	NA	--	40	150	2	4.6	5
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4	NA	--	40	150	0.61	1.5	4
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6	NA	--	40	150	0.29	0.8	1
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9	NA	--	40	150	0.29	0.8	1
Perfluorobutanesulfonic acid	PFBS	375-73-5	601	HH; Tap Water SL	40	150	0.094	0.4	1
Perfluorobutanoic acid	PFBA	375-22-4	NA	--	40	150	0.51	1.6	4
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	--	40	150	0.16	0.4	1
Perfluorodecanoic acid	PFDA	335-76-2	NA	--	40	150	0.14	0.4	1
Perfluorododecanoic acid	PFDoA	307-55-1	NA	--	40	150	0.11	0.4	1
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	--	40	150	0.21	0.8	1
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	--	40	150	0.19	0.4	1
Perfluorohexanesulfonic acid	PFHxS	355-46-4	39	HH; Tap Water SL	40	150	0.18	0.7	1
Perfluorohexanoic acid	PFHxA	307-24-4	NA	--	40	150	0.14	0.4	1
Perfluorononanoic acid	PFNA	375-95-1	6	HH; Tap Water SL	40	150	0.1	0.4	1
Perfluorononanesulfonic acid	PFNS	68259-12-1	NA	--	40	150	0.15	0.4	1
Perfluorooctanesulfonamide	PFOSA	754-91-6	NA	--	40	150	0.2	0.4	1
Perfluorooctanesulfonic acid	PFOS	1763-23-1	4	HH; Tap Water SL	40	150	0.25	0.7	1
Perfluorooctanoic acid	PFOA	335-67-1	6	HH; Tap Water SL	40	150	0.21	0.8	1
Perfluoropentanoic acid	PFPA	2706-90-3	NA	--	40	150	0.18	0.4	2
Perfluoropentanesulfonic acid	PFPS	2706-91-4	NA	--	40	150	0.26	0.8	1
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	--	40	150	0.27	0.8	1
Perfluorotridecanoic acid	PFTriDA	72629-94-8	NA	--	40	150	0.19	0.4	1
Perfluoroundecanoic acid	PFUnA	2058-94-8	NA	--	40	150	0.25	0.8	1
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	6	HH; Tap Water SL	40	150	0.99	2.4	4
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	NA	--	40	150	0.15	0.4	1
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	NA	--	40	150	0.22	0.8	1
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2	NA	--	40	150	0.13	0.4	1
2-(N-methylperfluoro-1-octanesulfonamido) ethanol	NMeFOSE	24448-09-7	NA	--	40	150	0.63	2	10

Analyte	Abbreviation	CAS Number	DQL (ng/L) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (ng/L)	LOD (ng/L)	LOQ (ng/L)
2-(N-ethylperfluoro-1-octanesulfonamido) ethanol	NEtFOSE	1691-99-2	NA	--	40	150	0.61	2	10
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	--	40	150	0.66	2.3	4
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	NA	--	40	150	0.39	1.3	2
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	NA	--	40	150	0.58	1.3	2
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	NA	--	40	150	0.67	2.2	4
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	--	40	150	0.87	2.3	4
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	NA	--	40	150	0.36	1.1	2
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	NA	--	40	150	0.6	2	5
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	NA	--	40	150	4.3	10	25
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	NA	--	40	150	4.2	10	25
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	NA	--	40	150	0.18	0.6	2

Notes:

1.) DQLs for groundwater were selected based on the lower of the following:

(a) Risk-based tap water SLs calculated in accordance with the OSD Memorandum (Assistant Secretary of Defense, 2022). The OSD SLs were calculated using the USEPA RSL Calculator (USEPA, 2022) for a residential tap water exposure scenario using USEPA default exposure assumptions and toxicity values and based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

% = percent
CAS = Chemical Abstracts Service
DL = detection limit
DQL = data quality limit
HH = human health based DQL
LCS = laboratory control spike
LOD = limit of detection
LOQ = limit of quantitation
NA = not available
ng/l = nanograms per liter
OSD = Office of the Secretary of Defense
QSM = Quality Systems Manual
RSL = Regional Screening Level
SL = screening level
USEPA = United States Environmental Protection Agency

Laboratory: Pace South Carolina
Matrix: Surface Water (40 Compound List)
Analyte Group: PFAS
Method: Draft USEPA 1633/QSM B-24

Analyte	Abbreviation	CAS Number	DQL (ng/L) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (ng/L)	LOD (ng/L)	LOQ (ng/L)
4:2 Fluorotelomer sulfonate	4:2 FTS	75124-72-4	NA	--	40	150	0.4	1.5	4
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2	NA	--	40	150	2	4.6	5
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4	NA	--	40	150	0.61	1.5	4
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6	NA	--	40	150	0.29	0.8	1
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9	NA	--	40	150	0.29	0.8	1
Perfluorobutanesulfonic acid	PFBS	375-73-5	1,000	HH; Fish Consumption SL	40	150	0.094	0.4	1
Perfluorobutanoic acid	PFBA	375-22-4	64,600	Eco; Aquatic life ESV	40	150	0.51	1.6	4
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	--	40	150	0.16	0.4	1
Perfluorodecanoic acid	PFDA	335-76-2	660	Eco; Wildlife ESV	40	150	0.14	0.4	1
Perfluorododecanoic acid	PFDoA	307-55-1	72,000	Eco; RWQ RBSL	40	150	0.11	0.4	1
Perfluoroheptanoic acid	PFHpA	375-85-9	870,000	Eco; RWQ RBSL	40	150	0.21	0.8	1
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	--	40	150	0.19	0.4	1
Perfluorohexanesulfonic acid	PFHxS	355-46-4	49	HH; Fish Consumption SL	40	150	0.18	0.7	1
Perfluorohexanoic acid	PFHxA	307-24-4	28,800	Eco; Aquatic life ESV	40	150	0.14	0.4	1
Perfluorononanoic acid	PFNA	375-95-1	2.7	HH; Fish Consumption SL	40	150	0.1	0.4	1
Perfluorononanesulfonic acid	PFNS	68259-12-1	NA	--	40	150	0.15	0.4	1
Perfluorooctanesulfonamide	PFOSA	754-91-6	NA	--	40	150	0.2	0.4	1
Perfluorooctanesulfonic acid	PFOS	1763-23-1	0.46	HH; Fish Consumption SL	40	150	0.25	0.7	1
Perfluorooctanoic acid	PFOA	335-67-1	10	HH; Fish Consumption SL	40	150	0.21	0.8	1
Perfluoropentanoic acid	PFPA	2706-90-3	140,000	Eco; RWQ RBSL	40	150	0.18	0.4	2
Perfluoropentanesulfonic acid	PFPS	2706-91-4	NA	--	40	150	0.26	0.8	1
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	--	40	150	0.27	0.8	1
Perfluorotridecanoic acid	PFTriDA	72629-94-8	NA	--	40	150	0.19	0.4	1
Perfluoroundecanoic acid	PFUnA	2058-94-8	49,000	Eco; RWQ RBSL	40	150	0.25	0.8	1
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	100	HH; Recreational SL	40	150	0.99	2.4	4

Analyte	Abbreviation	CAS Number	DQL (ng/L) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (ng/L)	LOD (ng/L)	LOQ (ng/L)
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	NA	--	40	150	0.15	0.4	1
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	NA	--	40	150	0.22	0.8	1
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2	NA	--	40	150	0.13	0.4	1
2-(N-methylperfluoro-1-octanesulfonamido) ethanol	NMeFOSE	24448-09-7	NA	--	40	150	0.63	2	10
2-(N-ethylperfluoro-1-octanesulfonamido) ethanol	NEtFOSE	1691-99-2	NA	--	40	150	0.61	2	10
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	--	40	150	0.66	2.3	4
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	NA	--	40	150	0.39	1.3	2
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	NA	--	40	150	0.58	1.3	2
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	69,000	Eco; RWQ RBSL	40	150	0.67	2.2	4
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	--	40	150	0.87	2.3	4
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	NA	--	40	150	0.36	1.1	2
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	NA	--	40	150	0.6	2	5
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	NA	--	40	150	4.3	10	25
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	NA	--	40	150	4.2	10	25
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	NA	--	40	150	0.18	0.6	2

Notes:

1.) DQLs for surface water were selected based on the lower of the following:

Risk-based surface water SLs protective of incidental ingestion and dermal contact by recreational users. Values were calculated using the USEPA RSL Calculator (USEPA, 2022) for a recreational scenario based on an exposure frequency of 52 days/year, exposure time of 2.6 hours/day, and incidental ingestion rate of 0.011 L/hour. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Risk-based surfaced water SLs protective of fish consumption by humans. Values were calculated by application of published chemical-specific bioaccumulation factors (Divine et al. 2020) to fish tissue SLs calculated using the USEPA RSL Calculator (USEPA, 2022), based on a fish consumption rate of 0.011 kg fish per day. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Risk-based surface water SLs protective of incidental ingestion and dermal contact by onsite outdoor workers. Values were calculated using the USEPA RSL Calculator (USEPA, 2022) based on an exposure frequency of 35 days/year, exposure time of 2 hours/day, incidental ingestion rate of 0.011 L/hour, and surface area exposed 2,277 cm^2. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Guidance for Assessing the Ecological Risks of PFAS to Threatened and Endangered Species at Aqueous Film Forming Foam-Impacted Sites (Conder et al., 2020). The following value was used:

- Ecological aquatic life 5% hazardous concentration.

Approach for Assessing PFAS Risk to Threatened and Endangered Species (Divine et al., 2020). The following values were used:

- Lowest NOAEL RBSL for surface water for aquatic wildlife (Wildlife RBSL).
- Freshwater chronic screening level for aquatic life (RWQ RBSL).

Derivation of PFAS Ecological Screening Values. Argonne National Laboratory (Grippo, et al., 2021). The following values were used:

- Surface water ESV for aquatic-dependent wildlife (Wildlife ESV).
- Freshwater chronic ESV for aquatic life (Aquatic life ESV).

% = percent
CAS = Chemical Abstracts Service
DL = detection limit
DQL = data quality limit
Eco = ecological based DQL
ESV = ecological screening value
HH = human health based DQL
L = liter
L/hour = liter per hour
Notes (continued):
LCS = laboratory control spike
LOD = limit of detection
LOQ = limit of quantitation
NA = not available
ng/l = nanograms per liter
NOAEL = No Observed Adverse Effect Level
PPRTV = Provisional Peer-Reviewed Toxicity Values
QSM = Quality Systems Manual
RBSL = risk-based screening level
RSL = Regional Screening Level
RWQ = Recommended Water Quality
SL = screening level
USEPA = United States Environmental Protection Agency

Laboratory: Pace South Carolina
Matrix: Soil
Analyte Group: PFAS (40 Compound List)
Method: Draft USEPA 1633/QSM B-24

Analyte	Abbreviation	CAS Number	DQL (µg/kg) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)
Perfluorobutanoic acid	PFBA	375-22-4	2,980	Eco; Wildlife ESV	40	150	0.1	0.32	0.8
Perfluorobutanesulfonic acid	PFBS	375-73-5	817	Eco; Wildlife ESV	40	150	0.021	0.07	0.07
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	--	40	150	0.041	0.16	0.4
Perfluorohexanoic acid	PFHxA	307-24-4	6,200	Eco; Wildlife ESV	40	150	0.025	0.08	0.2
Perfluorohexanesulfonic acid	PFHxS	355-46-4	2.8	Eco; Wildlife ESV	40	150	0.02	0.07	0.07
Perfluoroheptanoic acid	PFHpA	375-85-9	1,000	Eco; Invert. NOEC	40	150	0.025	0.08	0.2
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	--	40	150	0.033	0.08	0.08
Perfluorooctanesulfonic acid	PFOS	1763-23-1	8.7	Eco; Wildlife ESV	40	150	0.02	0.07	0.07
Fluorotelomer sulfonic acid 6:2	FTS 6:2	27619-97-2	NA	--	40	150	0.165	0.61	0.8
Perfluorooctanoic acid	PFOA	335-67-1	19	HH; Residential Soil SL	40	150	0.029	0.08	0.2
Perfluorooctanesulfonamide	PFOSA	754-91-6	NA	--	40	150	0.014	0.04	0.2
Perfluorononanoic acid	PFNA	375-95-1	19	HH; Residential Soil SL	40	150	0.026	0.08	0.2
Perfluoroundecanoic acid	PFUdA	2058-94-8	NA	--	40	150	0.028	0.08	0.2
Perfluorodecanoic acid	PFDA	335-76-2	67.7	Eco; Wildlife ESV	40	150	0.029	0.08	0.2
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	--	40	150	0.03	0.08	0.08
Fluorotelomer sulfonic acid 8:2	FTS 8:2	39108-34-4	NA	--	40	150	0.082	0.31	0.8
Perfluorododecanoic acid	PFDoA	307-55-1	NA	--	40	150	0.032	0.08	0.2
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	--	40	150	0.04	0.08	0.2
Perfluorotetradecanoic acid	PFTeA	376-06-7	NA	--	40	150	0.029	0.08	0.2
2-(N-Ethylperfluorooctanesulfonamido) acetic acid	N-EtFOSAA	2991-50-6	NA	--	40	150	0.044	0.16	0.2
2-(N-Methylperfluorooctanesulfonamido) acetic acid	N-MeFOSAA	2355-31-9	NA	--	40	150	0.04	0.08	0.2
Fluorotelomer sulfonic acid 4:2	FTS 4:2	757124-72-4	NA	--	40	150	0.098	0.3	0.8
Perfluorononanesulfonic acid	PFNS	68259-12-1	NA	--	40	150	0.025	0.08	0.08
Perfluoropentanesulfonic acid	PFPeS	2706-91-4	NA	--	40	150	0.022	0.08	0.08
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	23	HH; Residential Soil SL	40	150	0.32	0.8	1
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	NA	--	40	150	0.024	0.08	0.08
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	NA	--	40	150	0.015	0.04	0.2
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2	NA	--	40	150	0.034	0.08	0.2

Analyte	Abbreviation	CAS Number	DQL (µg/kg) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)
2-(N-methylperfluoro-1-octanesulfonamido) ethanol	NMeFOSE	24448-09-7	NA	--	40	150	0.209	0.8	2
2-(N-ethylperfluoro-1-octanesulfonamido) ethanol	NEtFOSE	1691-99-2	NA	--	40	150	0.291	0.8	2
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	--	40	150	0.248	0.76	0.8
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	NA	--	40	150	0.109	0.32	0.4
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	NA	--	40	150	0.348	0.8	1
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	NA	--	40	150	0.327	0.75	1
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	--	40	150	0.227	0.76	0.8
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	NA	--	40	150	0.122	0.29	0.4
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	NA	--	40	150	0.213	0.8	1
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	NA	--	40	150	1.415	4	5
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	NA	--	40	150	1.734	4	5
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	NA	--	40	150	0.124	0.32	0.4

Notes:

1.) DQLs for soil were selected based on the lower of the following:

Risk-based soil SLs calculated in accordance with the OSD Memorandum (Assistant Secretary of Defense, 2022). The OSD SLs values were calculated using the USEPA RSL Calculator (USEPA, 2022) for a residential exposure scenario using USEPA default exposure assumptions and toxicity values based on a target hazard quotient of 0.1 and a target risk level of 1E-06.

Guidance for Assessing the Ecological Risks of PFAS to Threatened and Endangered Species at Aqueous Film Forming Foam-Impacted Sites (Conder et al., 2020). Recommended Toxicity Benchmarks for Terrestrial Plants and Invertebrates; based on NOECs (Plant tox. and Invert. tox.).

Approach for Assessing PFAS Risk to Threatened and Endangered Species (Divine et al., 2020). The following values were used:

- Lowest NOAEL-based RBSL for soil for terrestrial wildlife (Wildlife RBSL).
- NOEC-based soil screening level for plants (Plant NOEC).
- NOEC-based soil screening level for invertebrates (Invert. NOEC).

Derivation of PFAS Ecological Screening Values. Argonne National Laboratory (Grippo, et al., 2021). The following values were used:

- Lowest soil ESV for birds and mammals (Wildlife ESV).
- Soil ESV for terrestrial plants (Plant ESV).
- Soil ESV for terrestrial invertebrates (Invert. ESV).

µg/kg = micrograms per kilogram
CAS = Chemical Abstracts Service
DL = detection limit
DQL = data quality limit
Eco = ecological based DQL
ESV = ecological screening value
FTS = fluorotelomer sulfonic acid
HH = human health based DQL
LCS = laboratory control spike
LOD = limit of detection
LOQ = limit of quantitation
NA = not available
NOAEL = No Observed Adverse Effect Level
NOEC = No Observed Effect Concentration
OSD = Office of the Secretary of Defense
QSM = Quality Systems Manual
RSL = Regional Screening Level
SL = Screening Level
USEPA = United States Environmental Protection Agency

Laboratory: Pace South Carolina
Matrix: Sediment
Analyte Group: PFAS (40 Compound Target List)
Method: Draft USEPA 1633/QSM B-24

Analyte	Abbreviation	CAS Number	DQL (µg/kg) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)
Perfluorobutanoic acid	PFBA	375-22-4	1,600	Eco; Wildlife RBSL	40	150	0.1	0.32	0.8
Perfluorobutanesulfonic acid	PFBS	375-73-5	730	Eco; Wildlife RBSL	40	150	0.021	0.07	0.07
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	--	40	150	0.041	0.16	0.4
Perfluorohexanoic acid	PFHxA	307-24-4	1,800	Eco; Wildlife RBSL	40	150	0.025	0.08	0.2
Perfluorohexanesulfonic acid	PFHxS	355-46-4	0.64	HH; Fish Consumption SL	40	150	0.02	0.07	0.07
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	--	40	150	0.025	0.08	0.2
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	--	40	150	0.033	0.08	0.08
Perfluorooctanesulfonic acid	PFOS	1763-23-1	0.077	HH; Fish Consumption SL	40	150	0.02	0.07	0.07
Fluorotelomer sulfonic acid 6:2	FTS 6:2	27619-97-2	NA	--	40	150	0.165	0.61	0.8
Perfluorooctanoic acid	PFOA	335-67-1	0.49	HH; Fish Consumption SL	40	150	0.029	0.08	0.2
Perfluorooctanesulfonamide	PFOSA	754-91-6	NA	--	40	150	0.014	0.04	0.2
Perfluorononanoic acid	PFNA	375-95-1	0.09	HH; Fish Consumption SL	40	150	0.026	0.08	0.2
Perfluoroundecanoic acid	PFUdA	2058-94-8	NA	--	40	150	0.028	0.08	0.2
Perfluorodecanoic acid	PFDA	335-76-2	NA	--	40	150	0.029	0.08	0.2
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	--	40	150	0.03	0.08	0.08
Fluorotelomer sulfonic acid 8:2	FTS 8:2	39108-34-4	NA	--	40	150	0.082	0.31	0.8
Perfluorododecanoic acid	PFDoA	307-55-1	NA	--	40	150	0.032	0.08	0.2
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	--	40	150	0.04	0.08	0.2
Perfluorotetradecanoic acid	PFTeA	376-06-7	NA	--	40	150	0.029	0.08	0.2
2-(N-Ethylperfluorooctanesulfonamido) acetic acid	N-EtFOSAA	2991-50-6	NA	--	40	150	0.044	0.16	0.2
2-(N-Methylperfluorooctanesulfonamido) acetic acid	N-MeFOSAA	2355-31-9	NA	--	40	150	0.04	0.08	0.2
Fluorotelomer sulfonic acid 4:2	FTS 4:2	757124-72-4	NA	--	40	150	0.098	0.3	0.8
Perfluorononanesulfonic acid	PFNS	68259-12-1	NA	--	40	150	0.025	0.08	0.08
Perfluoropentanesulfonic acid	PFPeS	2706-91-4	NA	--	40	150	0.022	0.08	0.08

Analyte	Abbreviation	CAS Number	DQL (µg/kg) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits		
							DL (µg/kg)	LOD (µg/kg)	LOQ (µg/kg)
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	160	HH; Recreational SL	40	150	0.32	0.8	1
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	NA	--	40	150	0.024	0.08	0.08
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	NA	--	40	150	0.015	0.04	0.2
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2	NA	--	40	150	0.034	0.08	0.2
2-(N-methylperfluoro-1-octanesulfonamido) ethanol	NMeFOSE	24448-09-7	NA	--	40	150	0.209	0.8	2
2-(N-ethylperfluoro-1-octanesulfonamido) ethanol	NEtFOSE	1691-99-2	NA	--	40	150	0.291	0.8	2
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	--	40	150	0.248	0.76	0.8
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	NA	--	40	150	0.109	0.32	0.4
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	NA	--	40	150	0.348	0.8	1
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	NA	--	40	150	0.327	0.75	1
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	--	40	150	0.227	0.76	0.8
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	NA	--	40	150	0.122	0.29	0.4
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	NA	--	40	150	0.213	0.8	1
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	NA	--	40	150	1.415	4	5
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	NA	--	40	150	1.734	4	5
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	NA	--	40	150	0.124	0.32	0.4

Notes:

1.) DQLs for sediment were selected based on the lower of the following:

Risk-based sediment SLs protective of incidental ingestion and dermal contact by recreational users. Values were calculated using the USEPA RSL Calculator (USEPA, 2022) for a recreational scenario based on an exposure frequency of 52 days/year and exposure time of 2.6 hours/day. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Risk-based sediment SLs protective of fish consumption by humans. Values were calculated by application of published chemical-specific bioaccumulation sediment accumulation factors (Divine et al. 2020) to fish tissue SLs calculated using the USEPA RSL Calculator (USEPA, 2022), based on a fish consumption rate of 0.011 kg fish per day. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Risk-based sediment SLs protective of incidental ingestion and dermal contact by onsite outdoor workers. Values were calculated using the USEPA RSL Calculator (USEPA, 2022) based on an exposure frequency of 35 days/year, sediment ingestion rate of 50 mg/day, exposed surface area of 2,277 cm^2, and an adherence factor of 0.3 mg/cm^2. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Approach for Assessing PFAS Risk to Threatened and Endangered Species (Divine et al., 2020). Lowest NOAEL-based RBSL for sediment for aquatic wildlife (Wildlife RBSL).

Chronic effects and thresholds for estuarine and marine benthic organism exposure to perfluorooctane sulfonic acid (PFOS)-contaminated sediments: Influence of organic carbon and exposure routes (Simpson, et al., 2021). PC99 in estuarine and marine sediment based on 1% organic carbon.

Notes:

µg/kg = micrograms per kilogram
CAS = Chemical Abstracts Service
DL = detection limit
DQL = data quality limit
Eco = ecological based DQL
HH = human health based DQL
LCS = laboratory control spike
LOD = limit of detection
LOQ = limit of quantitation
mg/day = milligrams per day
NA = not available
NOAEL = No Observed Adverse Effect Level
OSD = Office of the Secretary of Defense
QSM = Quality Systems Manual
RBSL = Risk-Based Screening Level
RSL = Regional Screening Level
SL = screening level
USEPA = United States Environmental Protection Agency

QAPP Worksheet #17 & #18: Sampling Design and Rationale

Worksheets #17 & #18 provide the sampling design and rationale, in addition to the sampling locations and methods, for the West Bend AASF #1 and Armory RI. The sampling program was designed to meet the DQOs established in **Worksheet #11**, while considering the CSM summarized in **Worksheet #10**. As discussed in **Worksheet #10**, two AOIs with exceedances of the OSD SLs were identified at the facility during the SI (AECOM, 2022):

- AOI 1: Fire Suppression System Testing
- AOI 2: Tri-Max^{TM} Release

The RI field activities for the West Bend AASF #1 and Armory will be conducted over two phases. During the Prescriptive Phase, soil, grab groundwater, surface water, and sediment samples will be collected and analyzed for PFAS from multiple intervals at biased sampling locations surrounding known impacts as identified during the SI. Data collected during the Prescriptive Phase will be used to refine the approach for permanent monitoring well installation during the subsequent Adaptive Phase. Grab groundwater data collected during the Prescriptive Phase are screening-level data that will not be used in the risk assessments; however, soil data obtained during the Prescriptive Phase may be considered in the risk assessments, which will be compiled following the Adaptive Phase. This Worksheet describes the sampling design and rationale for the initial Prescriptive Phase.

Analytical data from the 2021 ARNG SI (AECOM, 2022) within the investigation area were used to refine the approach for the Prescriptive Phase. The data from this source are considered screening-level and will not be used in the risk assessment.

The sampling program for the Prescriptive Phase will include:

- Collection of discrete soil samples from 5 soil grids and DPT vertical profile locations.
- Collection of grab groundwater samples from multi-interval vertical profile locations; and
- Collection of co-located surface water and sediment from Wingate Creek and the Milwaukee River.

The following subsections provide the specific sampling design and rationale for the selection of sampling locations for the Prescriptive Phase. The proposed locations of samples to be collected are presented on **Figure 17-1**. The specific design rationale for each task, in addition to the sampling locations and methods, are included in **Table 17-1** through **Table 17-3**. Analytical requirements to achieve project objectives and support the quantification of potential risks are detailed in **Worksheet #15**. Field activities will be completed in accordance with the procedures outlined in **Worksheet #14** and the SOPs in **Appendix D**.

In instances when deviations from this sampling design and rationale are made necessary due to unforeseen conditions, a Field Change Request Form will be generated to document the change and request feedback from the AECOM Task and Project Managers, USACE, and ARNG.

17.1 Sampling Design and Rationale

The RI field activities for the West Bend AASF #1 and Armory will consist of at least two phases. During the Prescriptive Phase, soil, grab groundwater, surface water and sediment samples will be collected for PFAS analysis in the vicinities where sampling locations during the SI previously identified exceedances of the OSD SLs, along the facilities boundaries, and off-facility to investigate potential PFAS source areas. The exact locations of these PFAS releases to soil, their full lateral and/or vertical extent of impacts to groundwater, and/or the migration pathways between the source areas and boundaries are not fully understood. Therefore, to fill data gaps in both the vertical and horizontal distribution of PFAS in groundwater and soil, a total of 19 vertical profile boring locations will be completed using DPT, with a minimum of 8 soil samples and 38 grab groundwater samples (not including QC samples). Additionally, five soil grids, each comprised of 9 soil borings, will be evaluated. At AOI 1, 20-40 gallons of 3% AFFF were dispensed annually onto the grassy area behind the main hangar building. During the SI, PFAS were detected in groundwater exceeding the OSD SLs within the source area, but not upgradient or downgradient of the source area. The location of the SL exceedances in groundwater did align with the potential release area; however, additional sampling is required to determine the full lateral and/or vertical extent of impacts associated with this AOI. Additionally, PFAS were detected in soil at AOI 1, though did not exceed SLs. Additional soil sampling is required within the source area to determine the full lateral and / or vertical extent of impacts.

At AOI 2, a one-time Tri-Max™ release occurred for a fire training exercise. During the SI, PFAS were detected in groundwater exceeding the OSD SLs within the potential release area, and also upgradient, side gradient and downgradient of the potential release area. There were SL exceedances that did align with the potential release area; however, additional sampling is required to determine the full lateral and/or vertical extent of impacts associated with this AOI, as there were SL exceedances in groundwater beyond the potential release area boundary. Additionally, PFAS were detected in soil at AOI 2, though did not exceed SLs. Additional soil sampling is recommended nearby the SI groundwater SL exceedances to determine the full lateral and / or vertical extent of impacts.

17.2 Soil Sampling Design and Rationale

Five soil sampling grids (SU01 through SU05) have been proposed for sampling during the Prescriptive Phase, with a total of 45 soil boring locations, with two depth intervals at each boring location. All surface soil samples within the five soil grids, including the subsurface soil samples that will be collected within the first 5 ft bgs, are expected to be advanced via hand auger. Subsurface samples beyond 5 ft bgs will be collected via DPT. Due to the shallow depth of the water table, as observed during field work for the SI, the subsurface soil samples are expected to be taken no deeper than 15 ft bgs. The purpose of the soil sampling at these soil grid locations is to supplement the existing soil data collected during the SI with additional surface and subsurface soil data within the source areas and areas associated with elevated concentrations of PFAS to conduct preliminary screening and evaluate the results as part of the comprehensive HHRA and ERA.

Additionally, during the Prescriptive Phase, soil borings will be advanced using DPT drilling techniques at four locations (WB-VP01, WB-VP02, WB-VP06, and WB-VP12) designated for vertical profiling. The location of each soil sample taken from a vertical profiling location may be adjusted at the time of drilling and based on encountered field conditions, such as depth to groundwater. The purpose of the soil sampling at the vertical profile borings is to supplement the existing soil data collected during the SI with additional surface and subsurface soil data beyond the source areas to conduct preliminary screening and evaluate the results as part of the comprehensive HHRA and ERA.

A dual-tube sampling system (or equivalent) will be used to collect continuous soil cores to the target depth; however, an air knife and hand auger will be used to clear the top 5 feet of the boring in accordance with AECOM utility clearance protocols. The number of samples per boring and sampling interval is based on the location relative to the identified potential release area at each AOI. Soil grids have been located within areas where elevated PFAS results were encountered during the SI in order to supplement the existing soil data. Additionally, during the Adaptive Phase, geotechnical soil samples will be collected to support the evaluation of aquifer permeability at the permanent monitoring well locations where slug testing will be completed.

Soil samples will be collected in accordance with the procedures presented in **Worksheet #14** and further detailed in *SOP 3-21: Surface and Subsurface Soil Sampling Procedures* (**Appendix D**). The proposed boring locations and soil sample grids are shown on **Figure 17-1**. Detailed figures depicting proposed soil sampling locations within each grid are shown in **Figures 17-2 through 17-6.** The rationale for the sample locations is provided in **Table 17-1.**

17.3 Groundwater Sampling Design and Rationale

During the Prescriptive Phase, grab groundwater samples will be collected upgradient of each of the AOI locations on-facility, downgradient of AOI 2 on-facility, and downgradient of each AOI off-facility. Groundwater samples collected during the Prescriptive Phase will be used to refine the approach for the Adaptive Phase, which is currently anticipated to include further groundwater sampling and the installation of permanent monitoring wells. The purpose of the Prescriptive Phase is to perform additional screening-level sampling at each AOI and downgradient of the facility to refine the geometry of the potential source area contamination and determine the extent of the groundwater impacts beyond the facility boundary.

Groundwater and soil samples will be analyzed under standard TAT for the target list of 40 PFAS by Draft USEPA Method 1633, as specified in **Worksheet #15**. If West Bend AASF #1 and Armory is selected to support the DMA, split samples will also be collected for PFAS analysis by ASTM D8421 (**Appendix F**). Additionally, 25% of soil samples per soil unit will be analyzed for TOC (USEPA Method 9060A), pH (USEPA Method 9045D), and grain size with sieve and hydrometer (ASTM D-422). Sampling results will be used to allow for modifications and ongoing refinement of Adaptive Phase sampling locations, as possible, in combination with any other observations (e.g., the presence of clay confining units).

The sample locations are shown on **Figure 17-1**. The sampling design and rationale for the groundwater sample locations are provided in **Table 17-2**. Sampling activities will be conducted in accordance with the procedures established in **Worksheet #14** and in the SOPs (**Appendix D**).

17.4 Surface Water and Sediment Sampling Design and Rationale

Surface water and sediment samples will be collected from Wingate Creek, the Milwaukee River, and the on-facility stormwater basin. A minimum of nine samples per media will be collected in order to refine the nature and extent of PFAS within these surface waterbodies, both upgradient and downgradient of West Bend AASF #1 and Armory.

As a conservative approach, sample locations will be biased to locations of suspected stormwater flow transport**.** Surface water and sediment samples will be analyzed under standard TAT for the target list of 40 PFAS by Draft USEPA Method 1633, as specified in **Worksheet #15**. If West Bend AASF #1 and Armory is selected to support the DMA, split samples will also be collected for PFAS analysis by ASTM D8421 (**Appendix F**). Additionally, 25% of sediment samples will be analyzed for TOC (USEPA Method 9060A), pH (USEPA Method 9045D), and grain size with sieve and hydrometer (ASTM D-422). The sediment samples analyzed for TOC, pH, and grain size will be selected to represent the range of habitat and substrate types available at the sampling locations. The approximate locations of the surface water and sediment samples are shown on **Figure 17-**

1; however, the locations will be adjusted in the field based on field conditions. The rationale for the sampling locations is provided in **Table 17-3**. Sampling activities will be conducted in accordance with the procedures established in **Worksheet #14** and the sampling procedures are further detailed in *SOP 3-10: Surface Water Sampling* and *SOP 3-22: Sediment Sampling* (**Appendix D**).

17.5 Groundwater Gauging Design and Rationale

As part of the Prescriptive Phase, groundwater levels will be measured from vertical profile locations. The purpose is to determine the potentiometric surface and calculation of the groundwater gradient at the facility. The groundwater gauging round will be conducted within as short a time period as reasonably feasible and will follow a period of little to no precipitation. The vertical profile locations are those as outlined below and shown in **Figure 17-1**. The procedures for collection of water levels from vertical profile locations are presented in **Worksheet #14**.

Table 17-1: Prescriptive Phase Soil Sampling Design and Rationale

Area of Interest	Figure	Rationale	Location Identifier	Sample Identifier	Number of Samples	Target Sample Depth (feet bgs)	Matrix	Sampling Tool	Analyte Group
AOI 1	17-1	WB-VP01 will be located upgradient of AOI 1 to confirm observed on-facility SI detections are not attributed to potential upgradient off-facility sources.	WB-VP01	WB-VP01-SO-00-02	1	0-2	Surface Soil	Air knife/hand auger	PFAS, Target 40 Compound List (Draft USEPA 1633, QSM 5.4 Table B-24)[1] Grain Size/Clay Content (ASTM D-422) TOC (USEPA Method 9060A) pH (USEPA Method 9045D)^
	17-1	WB-VP02 will be located just downgradient and off-facility of AOI 1. This location will help determine the potential horizontal extent of PFAS impacts migrating from the source area off-facility.	WB-VP02	WB-VP02-SO-00-02	1				
	17-2	Soil Unit 1 soil samples will evaluate the soil in AOI 1 where there were reportedly several fire suppression system releases that occurred. Additionally, OSD SL exceedances in groundwater were encountered within this area during the SI. The results obtained from this soil grid in RI Prescriptive Phase will inform if additional soil unit step outs are needed in the RI Adaptive Phase, should the data suggest an obvious source in soil.	WB-SU01-SB01	WB-SU01-SB01-00-02	1				
			WB-SU01-SB02	WB-SU01-SB02-00-02	1				
			WB-SU01-SB03	WB-SU01-SB03-00-02	1				
			WB-SU01-SB04	WB-SU01-SB04-00-02	1				
			WB-SU01-SB05	WB-SU01-SB05-00-02	1				
			WB-SU01-SB06	WB-SU01-SB06-00-02	1				
			WB-SU01-SB07	WB-SU01-SB07-00-02	1				
			WB-SU01-SB08	WB-SU01-SB08-00-02	1				
			WB-SU01-SB09	WB-SU01-SB09-00-02	1				
AOI 2	17-1	WB-VP06 will be located along the upgradient portion of the facility boundary on the eastern side of the facility to confirm observed on-facility detections are not attributed to potential off-facility sources. Additionally, this location will help to refine the horizontal extent of PFAS beyond the AOI 2 source area boundary on-facility based on OSD SL exceedances observed during the SI.	WB-VP06	WB-VP06-SO-00-02	1				
	17-1	WB-VP12 will be located downgradient of AOI 2 source area and other OSD SL exceedances observed during the SI to help refine the potential horizontal extent of PFAS off-facility.	WB-VP12	WB-VP12-SO-00-02	1				
	17-3	Soil Unit 2 soil samples will evaluate the soil in the area upgradient of AOI 2, where no known releases occurred, but OSD SL exceedances in groundwater were encountered during the SI. The results obtained from this soil grid in RI Prescriptive Phase will inform if additional soil unit step outs are needed in the RI Adaptive Phase, should the data suggest an obvious source in soil.	WB-SU02-SB01	WB-SU02-SB01-00-02	1				
			WB-SU02-SB02	WB-SU02-SB02-00-02	1				
			WB-SU02-SB03	WB-SU02-SB03-00-02	1				
			WB-SU02-SB04	WB-SU02-SB04-00-02	1				
			WB-SU02-SB05	WB-SU02-SB05-00-02	1				
			WB-SU02-SB06	WB-SU02-SB06-00-02	1				
			WB-SU02-SB07	WB-SU02-SB07-00-02	1				
			WB-SU02-SB08	WB-SU02-SB08-00-02	1				
			WB-SU02-SB09	WB-SU02-SB09-00-02	1				
	17-4	Soil Unit 3 soil samples will evaluate the soil in AOI 2 where there was reportedly a Tri-Max™ fire extinguisher release that occurred, Additionally, OSD SL exceedances in groundwater were encountered within this area during the SI. The results obtained from this soil grid in RI Prescriptive Phase will inform if additional soil unit step outs are needed in the RI Adaptive Phase, should the data suggest an obvious source in soil.	WB-SU03-SB01	WB-SU03-SB01-00-02	1				
			WB-SU03-SB02	WB-SU03-SB02-00-02	1				
			WB-SU03-SB03	WB-SU03-SB03-00-02	1				
			WB-SU03-SB04	WB-SU03-SB04-00-02	1				
			WB-SU03-SB05	WB-SU03-SB05-00-02	1				
			WB-SU03-SB06	WB-SU03-SB06-00-02	1				
			WB-SU03-SB07	WB-SU03-SB07-00-02	1				
			WB-SU03-SB08	WB-SU03-SB08-00-02	1				
			WB-SU03-SB09	WB-SU03-SB09-00-02	1				
	17-5	Soil Unit 4 soil samples will evaluate the soil in the area downgradient of AOI 2, where no known releases occurred. The results obtained from this soil grid in RI Prescriptive Phase will inform if additional soil unit step outs are needed in the RI Adaptive Phase, should the data suggest an obvious source in soil.	WB-SU04-SB01	WB-SU04-SB01-00-02	1				
			WB-SU04-SB02	WB-SU04-SB02-00-02	1				
			WB-SU04-SB03	WB-SU04-SB03-00-02	1				
			WB-SU04-SB04	WB-SU04-SB04-00-02	1				
			WB-SU04-SB05	WB-SU04-SB05-00-02	1				
			WB-SU04-SB06	WB-SU04-SB06-00-02	1				
			WB-SU04-SB07	WB-SU04-SB07-00-02	1				
			WB-SU04-SB08	WB-SU04-SB08-00-02	1				
			WB-SU04-SB09	WB-SU04-SB09-00-02	1				
	17-6	Soil Unit 5 soil samples will evaluate the soil in the area downgradient of AOI 2, where no known releases occurred. Additionally, OSD SL exceedances in groundwater were encountered within this area during the SI. The results obtained from this soil grid in RI Prescriptive Phase will inform if additional soil unit step outs are needed in the RI Adaptive Phase, should the data suggest an obvious source in soil.	WB-SU05-SB01	WB-SU05-SB01-00-02	1				
			WB-SU05-SB02	WB-SU05-SB02-00-02	1				
			WB-SU05-SB03	WB-SU05-SB03-00-02	1				
			WB-SU05-SB04	WB-SU05-SB04-00-02	1				
			WB-SU05-SB05	WB-SU05-SB05-00-02	1				
			WB-SU05-SB06	WB-SU05-SB06-00-02	1				
			WB-SU05-SB07	WB-SU05-SB07-00-02	1				
			WB-SU05-SB08	WB-SU05-SB08-00-02	1				
			WB-SU05-SB09	WB-SU05-SB09-00-02	1				
AOI 1	17-1	See above for rationale on associated surface soil sampling location. A deep soil sample will be collected to complete the assessment of vertical migration of PFAS across the facility.	WB-VP01	WB-VP01-SO-[Start Depth-End Depth]	1	TBD in the field, directly above water table	Subsurface Soil	DPT*	
	17-1	See above for rationale on associated surface soil sampling location. A deep soil sample will be collected to complete the assessment of vertical migration of PFAS off-facility.	WB-VP02	WB-VP02-SO-[Start Depth-End Depth]	1				
	17-2	See above for rationale on associated surface soil sampling location. A deep soil sample will be collected to complete the assessment of vertical migration of PFAS across the facility.	WB-SU01-SB01	WB-SU01-SB01-[Start Depth-End Depth]	1				
			WB-SU01-SB02	WB-SU01-SB02-[Start Depth-End Depth]	1				
			WB-SU01-SB03	WB-SU01-SB03-[Start Depth-End Depth]	1				
			WB-SU01-SB04	WB-SU01-SB04-[Start Depth-End Depth]	1				
			WB-SU01-SB05	WB-SU01-SB05-[Start Depth-End Depth]	1				
			WB-SU01-SB06	WB-SU01-SB06-[Start Depth-End Depth]	1				
			WB-SU01-SB07	WB-SU01-SB07-[Start Depth-End Depth]	1				
			WB-SU01-SB08	WB-SU01-SB08-[Start Depth-End Depth]	1				
			WB-SU01-SB09	WB-SU01-SB09-[Start Depth-End Depth]	1				
AOI 2	17-1	See above for rationale on associated surface soil sampling location. A deep soil sample will be collected to complete the assessment of vertical migration of PFAS across the facility.	WB-VP06	WB-VP06-SO-[Start Depth-End Depth]	1				
	17-1	See above for rationale on associated surface soil sampling location. A deep soil sample will be collected to complete the assessment of vertical migration of PFAS off-facility.	WB-VP12	WB-VP12-SO-[Start Depth-End Depth]	1				
	17-3	See above for rationale on associated surface soil sampling location. One deep soil sample will be collected to assess the potential PFAS impacts to soil directly above the groundwater table (potentially contributed from any unidentified off-facility sources).	WB-SU02-SB01	WB-SU02-SB01-[Start Depth-End Depth]	1				
			WB-SU02-SB02	WB-SU02-SB02-[Start Depth-End Depth]	1				
			WB-SU02-SB03	WB-SU02-SB03-[Start Depth-End Depth]	1				
			WB-SU02-SB04	WB-SU02-SB04-[Start Depth-End Depth]	1				
			WB-SU02-SB05	WB-SU02-SB05-[Start Depth-End Depth]	1				
			WB-SU02-SB06	WB-SU02-SB06-[Start Depth-End Depth]	1				
			WB-SU02-SB07	WB-SU02-SB07-[Start Depth-End Depth]	1				
			WB-SU02-SB08	WB-SU02-SB08-[Start Depth-End Depth]	1				
			WB-SU02-SB09	WB-SU02-SB09-[Start Depth-End Depth]	1				
	17-4	See above for rationale on associated surface soil sampling location. A deep soil sample will be collected to complete the assessment of vertical migration of PFAS across the facility.	WB-SU03-SB01	WB-SU03-SB01-[Start Depth-End Depth]	1				
			WB-SU03-SB02	WB-SU03-SB02-[Start Depth-End Depth]	1				
			WB-SU03-SB03	WB-SU03-SB03-[Start Depth-End Depth]	1				
			WB-SU03-SB04	WB-SU03-SB04-[Start Depth-End Depth]	1				
			WB-SU03-SB05	WB-SU03-SB05-[Start Depth-End Depth]	1				
			WB-SU03-SB06	WB-SU03-SB06-[Start Depth-End Depth]	1				
			WB-SU03-SB07	WB-SU03-SB07-[Start Depth-End Depth]	1				
			WB-SU03-SB08	WB-SU03-SB08-[Start Depth-End Depth]	1				
			WB-SU03-SB09	WB-SU03-SB09-[Start Depth-End Depth]	1				
	17-5	See above for rationale on associated surface soil sampling location. A deep soil sample will be collected to complete the assessment of vertical migration of PFAS across the facility.	WB-SU04-SB01	WB-SU04-SB01-[Start Depth-End Depth]	1				
			WB-SU04-SB02	WB-SU04-SB02-[Start Depth-End Depth]	1				
			WB-SU04-SB03	WB-SU04-SB03-[Start Depth-End Depth]	1				
			WB-SU04-SB04	WB-SU04-SB04-[Start Depth-End Depth]	1				
			WB-SU04-SB05	WB-SU04-SB05-[Start Depth-End Depth]	1				
			WB-SU04-SB06	WB-SU04-SB06-[Start Depth-End Depth]	1				
			WB-SU04-SB07	WB-SU04-SB07-[Start Depth-End Depth]	1				
			WB-SU04-SB08	WB-SU04-SB08-[Start Depth-End Depth]	1				
			WB-SU04-SB09	WB-SU04-SB09-[Start Depth-End Depth]	1				
	17-6	See above for rationale on associated surface soil sampling location. A deep soil sample will be collected to complete the assessment of vertical migration of PFAS across the facility.	WB-SU05-SB01	WB-SU05-SB01-[Start Depth-End Depth]	1				
			WB-SU05-SB02	WB-SU05-SB02-[Start Depth-End Depth]	1				
			WB-SU05-SB03	WB-SU05-SB03-[Start Depth-End Depth]	1				
			WB-SU05-SB04	WB-SU05-SB04-[Start Depth-End Depth]	1				
			WB-SU05-SB05	WB-SU05-SB05-[Start Depth-End Depth]	1				
			WB-SU05-SB06	WB-SU05-SB06-[Start Depth-End Depth]	1				
			WB-SU05-SB07	WB-SU05-SB07-[Start Depth-End Depth]	1				
			WB-SU05-SB08	WB-SU05-SB08-[Start Depth-End Depth]	1				
			WB-SU05-SB09	WB-SU05-SB09-[Start Depth-End Depth]	1				
Total Samples (not including QC)					**98**				

Notes:
1) If West Bend AASF is selected as one of the facilities to support the DMA, split samples will also be collected for PFAS analysis by ASTM D8421.

AOI = area of interest
bgs = below ground surface
bgs = below ground surface
LC/MS/MS = liquid chromatography tandem mass spectrometry
NA = not applicable
PFAS = per- and polyfluoroalkyl substances
QC = quality control
^ 25% of soil samples per soil unit will be analyzed for TOC (USEPA Method 9060A), pH (USEPA Method 9045D), and grain size.
* DPT, only if necessary based on depth of water table. Groundwater is expected to be encountered at many of these locations within the first 5 ft bgs during hand-augering.

QSM = Quality Systems Manual
SB = soil boring
SG = soil grid
TOC = total organic carbon
USEPA = United States Environmental Protection Agency

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Table 17-2: Prescriptive Phase Groundwater VP Sampling Design and Rationale

Area of Interest	Figure	Rationale	Location Identifier	Well Status	Target Screen Interval [6] (feet bgs)	Sample Identifier	Number of Samples per Location	Sampling Tool	Analyte Group
AOI 1	17-1	WB-VP01 will be located upgradient of AOI 1 to refine groundwater flow direction just north of the facility and confirm observed on-facility detections are not attributed to potential off-facility sources. Two depth intervals will be sampled from each location to determine the vertical extent of PFAS impacts to the subsurface groundwater.	WB-VP01	proposed	10 - 15 (top of groundwater)	WB-VP01-GW-[Start Depth-End Depth]	1	DPT discrete groundwater sampler	PFAS, Target 40 Compound List (Draft USEPA 1633, QSM 5.4 Table B-24)[c]
				proposed	25 - 30	WB-VP01-GW-[Start Depth-End Depth]	1		
		WB-VP02 and WB-VP03 will be located just downgradient and off-facility of AOI 1. These locations will help determine the horizontal extent of PFAS impacts migrating from the source area off-facility. Two depth intervals will be sampled from each location to determine the vertical extent of PFAS impacts to the subsurface groundwater. Due to an OSD SL exceedance during the SI in the vicinity, a secondary depth interval has been proposed for these locations that is deeper than the OSD SL exceedance observed during the SI.	WB-VP02	proposed	10 - 15 (top of groundwater)	WB-VP02-GW-[Start Depth-End Depth]	1		
				proposed	30 - 35	WB-VP02-GW-[Start Depth-End Depth]	1		
			WB-VP03	proposed	10 - 15 (top of groundwater)	WB-VP03-GW-[Start Depth-End Depth]	1		
				proposed	30 - 35	WB-VP03-GW-[Start Depth-End Depth]	1		
		WB-VP04 and WB-VP05 will be located to refine groundwater flow direction just southwest of the facility and confirm observed on-facility detections are not attributed to potential off-facility sources. Two depth intervals will be sampled from each location to determine the vertical extent of PFAS impacts to the subsurface groundwater.	WB-VP04	proposed	10 - 15 (top of groundwater)	WB-VP04-GW-[Start Depth-End Depth]	1		
				proposed	20 - 25	WB-VP04-GW-[Start Depth-End Depth]	1		
			WB-VP05	proposed	10 - 15 (top of groundwater)	WB-VP05-GW-[Start Depth-End Depth]	1		
				proposed	20 - 25	WB-VP05-GW-[Start Depth-End Depth]	1		
AOI 2		WB-VP06, WB-VP07, WB-VP08, WB-VP09, and WB-VP10 will be located along the upgradient portion of the facility boundary on the eastern side of the facility to refine groundwater flow direction just northeast of the facility and confirm observed on-facility detections are not attributed to potential off-facility sources. Additionally, these locations will help to refine the horizontal extent of PFAS beyond the AOI 2 source area boundary on-facility based on OSD SL exceedances observed during the SI. Two depth intervals will be sampled from each location to determine the vertical extent of PFAS impacts to the subsurface groundwater. Due to OSD SL exceedances during the SI in the vicinity, a secondary depth interval has been proposed for these locations that is deeper than the OSD SL exceedance observed during the SI.	WB-VP06	proposed	5 - 10 (top of groundwater)	WB-VP06-GW-[Start Depth-End Depth]	1		
				proposed	25 - 30	WB-VP06-GW-[Start Depth-End Depth]	1		
			WB-VP07	proposed	5 - 10 (top of groundwater)	WB-VP07-GW-[Start Depth-End Depth]	1		
				proposed	25 - 30	WB-VP07-GW-[Start Depth-End Depth]	1		
			WB-VP08	proposed	5 - 10 (top of groundwater)	WB-VP08-GW-[Start Depth-End Depth]	1		
				proposed	25 - 30	WB-VP08-GW-[Start Depth-End Depth]	1		
			WB-VP09	proposed	5 - 10 (top of groundwater)	WB-VP09-GW-[Start Depth-End Depth]	1		
				proposed	25 - 30	WB-VP09-GW-[Start Depth-End Depth]	1		
			WB-VP10	proposed	5 - 10 (top of groundwater)	WB-VP10-GW-[Start Depth-End Depth]	1		
				proposed	25 - 30	WB-VP10-GW-[Start Depth-End Depth]	1		

Table 17-2: Prescriptive Phase Groundwater VP Sampling Design and Rationale

Area of Interest	Figure	Rationale	Location Identifier	Well Status	Target Screen Interval [6] (feet bgs)	Sample Identifier	Number of Samples per Location	Sampling Tool	Analyte Group
AOI 2		WB-VP11 and WB-VP12 will be located downgradient of AOI 2 source area and other OSD SL exceedances observed during the SI to help refine the horizontal extent of PFAS on-facility. Two depth intervals will be sampled from each location to determine the vertical extent of PFAS impacts to the subsurface groundwater.	WB-VP11	proposed	5 - 10 (top of groundwater)	WB-VP11-GW-[Start Depth-End Depth]	1		
				proposed	25 - 30	WB-VP11-GW-[Start Depth-End Depth]	1		
			WB-VP12	proposed	5 - 10 (top of groundwater)	WB-VP12-GW-[Start Depth-End Depth]	1		
				proposed	25 - 30	WB-VP12-GW-[Start Depth-End Depth]	1		
	17-1	WB-VP13, WB-VP14, WB-VP-15, WB-VP-16, WB-VP-17 and WB-VP18 will be located downgradient of AOI 2, to refine groundwater flow direction just southeast of the facility. Two depth intervals will be sampled from each location to determine the vertical extent of PFAS impacts to the subsurface groundwater.	WB-VP13	proposed	5 - 10 (top of groundwater)	WB-VP13-GW-[Start Depth-End Depth]	1		
				proposed	20 - 25	WB-VP13-GW-[Start Depth-End Depth]	1		
			WB-VP14	proposed	5 - 10 (top of groundwater)	WB-VP14-GW-[Start Depth-End Depth]	1		
				proposed	20 - 25	WB-VP14-GW-[Start Depth-End Depth]	1		
			WB-VP15	proposed	5 - 10 (top of groundwater)	WB-VP15-GW-[Start Depth-End Depth]	1		
				proposed	20 - 25	WB-VP15-GW-[Start Depth-End Depth]	1		
			WB-VP16	proposed	5 - 10 (top of groundwater)	WB-VP16-GW-[Start Depth-End Depth]	1		
				proposed	20 - 25	WB-VP16-GW-[Start Depth-End Depth]	1		
			WB-VP17	proposed	5 - 10 (top of groundwater)	WB-VP17-GW-[Start Depth-End Depth]	1		
				proposed	20 - 25	WB-VP17-GW-[Start Depth-End Depth]	1		
			WB-VP18	proposed	5 - 10 (top of groundwater)	WB-VP18-GW-[Start Depth-End Depth]	1		
				proposed	20 - 25	WB-VP18-GW-[Start Depth-End Depth]	1		
AOI 1	17-1	WB-VP19 will be located downgradient of the stormwater detenion basin to determine if stormwater infiltration has led to PFAS impacts to subsurface groundwater. Two depth intervals will be sampled	WB-VP19	proposed	5-10 (top of groundwater)	WB-VP19-GW-[Start Depth-End Depth]	1		
				proposed	20 - 25	WB-VP19-GW-[Start Depth-End Depth]	1		
			Total Samples (not including QC)				38		

Notes:

a) The groundwater vertical profile locations and the screened intervals may be adjusted in the field based on lithologic observations (i.e., the presence of clay confining layers).
b) The quantity of groundwater samples included in this table includes 36 planned groundwater samples from proposed multi-interval vertical profile locations.
c) If West Bend AASF is selected as one of the facilities to support the DMA, split samples will also be collected for PFAS analysis by ASTM D8421.

AOI = area of interest
bgs = below ground surface
GW = groundwater
J = estimated
LC/MS/MS = liquid chromatography tandem mass spectrometry
MMDDYY = two-digit month, day, year
DPT = direct push technology
GW = groundwater

PFAS = per- and polyfluoroalkyl substances
QC = quality control
QSM = Quality Systems Manual
RI = Remedial Investigation
TBD = to be determined
TIR = thermal infrared imagery
VP = vertical profile

Table 17-3: Prescriptive Phase Surface Water and Sediment Sampling Design and Rationale

Area of Interest	Location Identifier	Sample Identifier	Number of Sample Locations	Target Sample Depth (feet bgs)	Matrix	Sampling Tool	Analyte Group	Rationale
AOI 1 AOI 2	WB-SW/SD01	WB-SW01	1	Top of water column	Surface Water	Dip Sampler	PFAS, Target 40 Compound List (Draft USEPA 1633, QSM 5.4 Table B-24)[1]	WB-SW/SD01, WB-SW/SD02, WB-SW/SD03, and WB-SW/SD05 will be located upstream of the AOIs in Wingate Creek and the Milwaukee River to determine if there may be off-facility properties contributing to PFAS in surface waters. WB-SW/SD06, WB-SW/SD07, WB-SW/SD08 and WB-SW/SD09 will be located downstream of the AOIs in Wingate Creek and the Milwaukee River to refine the nature and extent of PFAS in surface waters. WB-SW/SD04 will be located within the on-facility stormwater pond to determine if PFAS may have traveled through the facilitiy's stormwater infrastructure and drainage system via stormwater flow.
	WB-SW/SD02	WB-SW02	1					
	WB-SW/SD03	WB-SW03	1					
	WB-SW/SD04	WB-SW04	1					
	WB-SW/SD05	WB-SW05	1					
	WB-SW/SD06	WB-SW06	1					
	WB-SW/SD07	WB-SW07	1					
	WB-SW/SD08	WB-SW08	1					
	WB-SW/SD09	WB-SW09	1					
	WB-SW/SD01	WB-SD01	1	0-1	Sediment	Coring Device		
	WB-SW/SD02	WB-SD02	1					
	WB-SW/SD03	WB-SD03	1					
	WB-SW/SD04	WB-SD04	1					
	WB-SW/SD05	WB-SD05	1					
	WB-SW/SD06	WB-SD06	1					
	WB-SW/SD07	WB-SD07	1					
	WB-SW/SD08	WB-SD08	1					
	WB-SW/SD09	WB-SD09	1					
Total Samples per Media (not including QC)			**9**					

Notes:

1) If West Bend AASF is selected as one of the facilities to support the DMA, split samples will also be collected for PFAS analysis by ASTM D8421.

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CLIENT	ARNG			
PROJECT	Remedial Investigation at West Bend, WI			
REVISED	11/21/2023	GIS BY	MS	11/21/2023
SCALE	1:4,200	CHK BY	BP	11/21/2023
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community		PM	CM	11/21/2023

Legend

- Proposed Vertical Profiling
- Proposed Vertical Profiling/Soil Sample
- Proposed Surfacewater/Sediment Sample
- Proposed Soil Sampling Grid
- Facility Boundary
- Water Body
- River/Stream

N

Proposed Sample Locations

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 17-1

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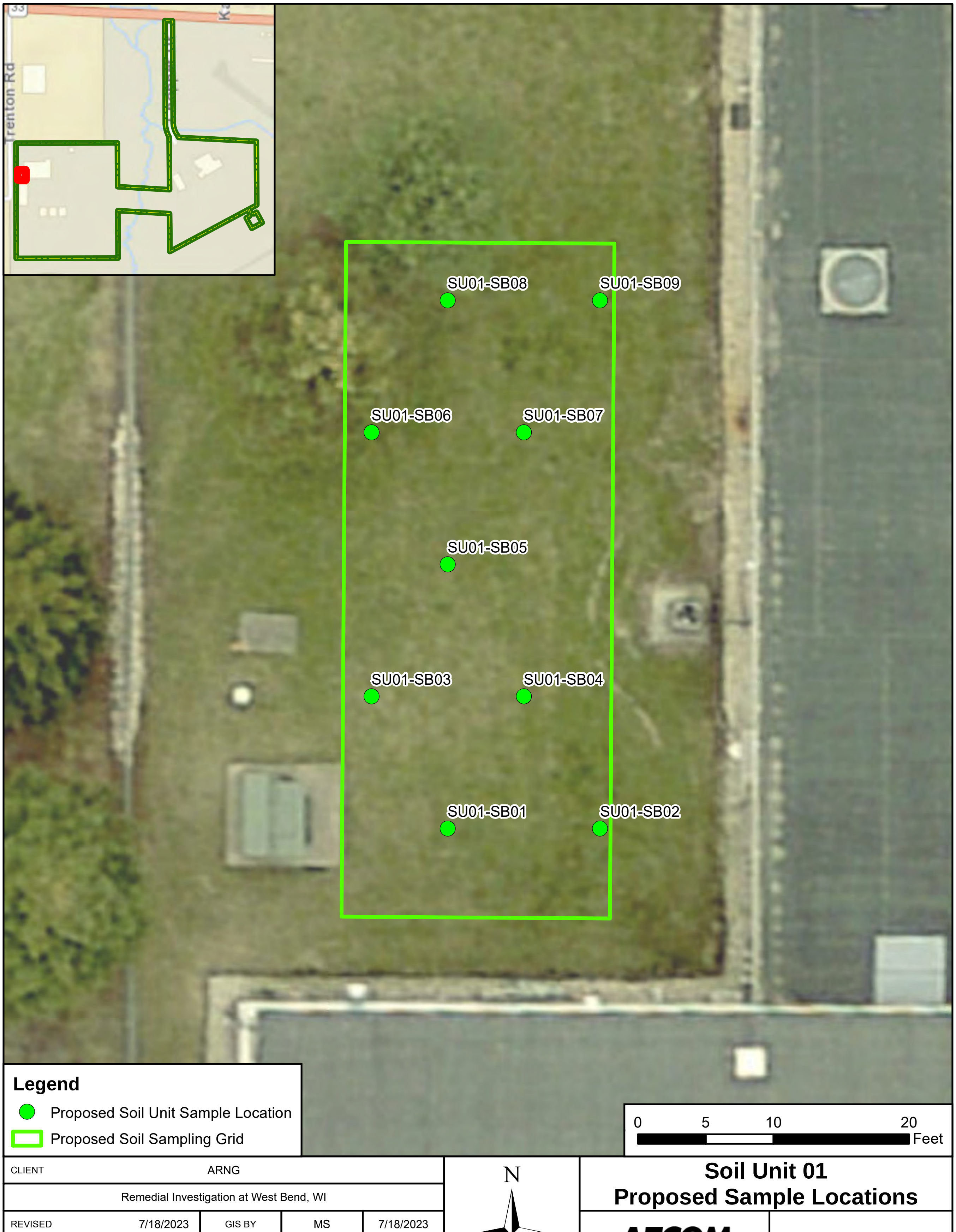
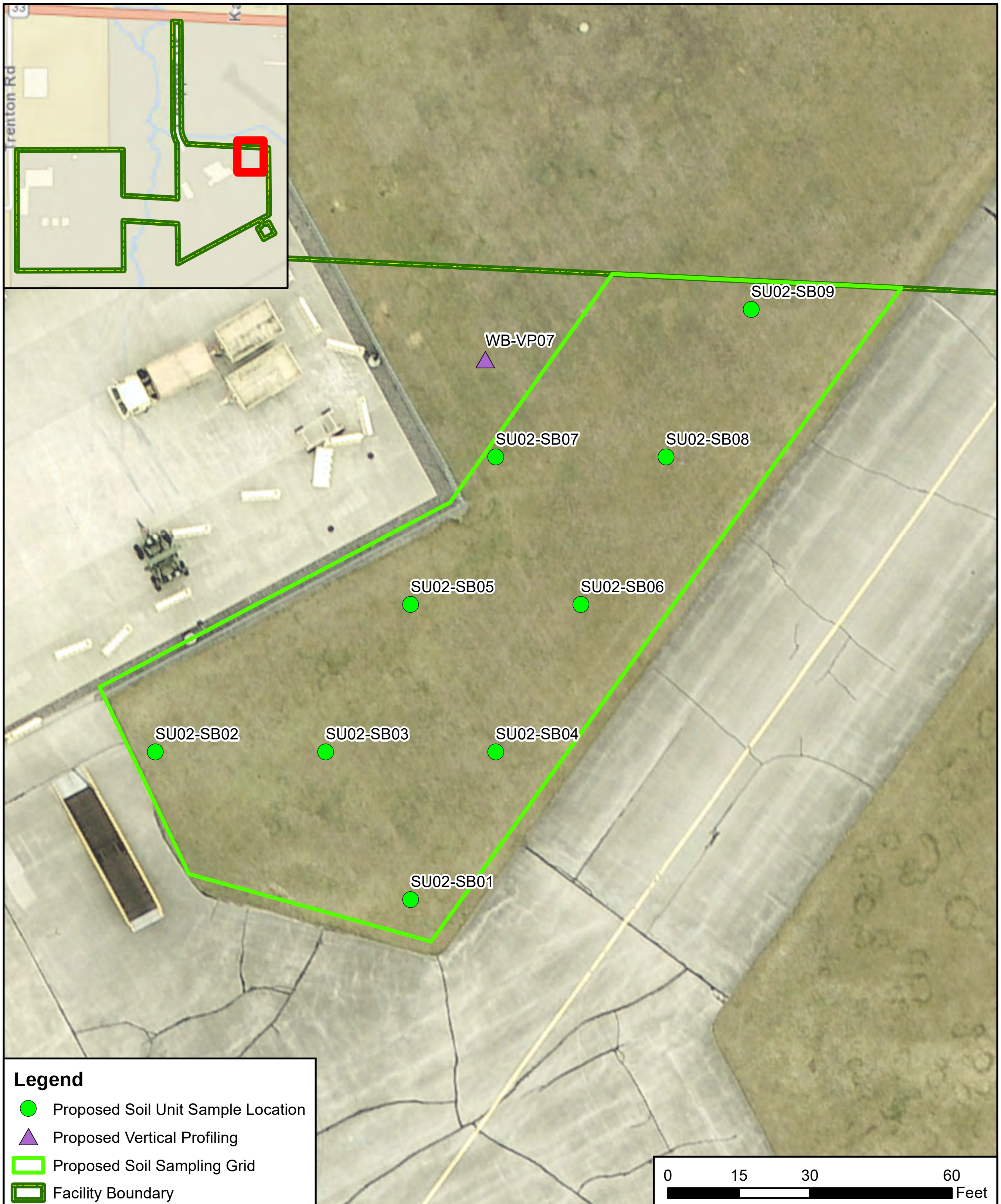


CLIENT	ARNG			
Remedial Investigation at West Bend, WI				
REVISED	7/18/2023	GIS BY	MS	7/18/2023
SCALE	1:120	CHK BY	BP	7/18/2023
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	CM	7/18/2023

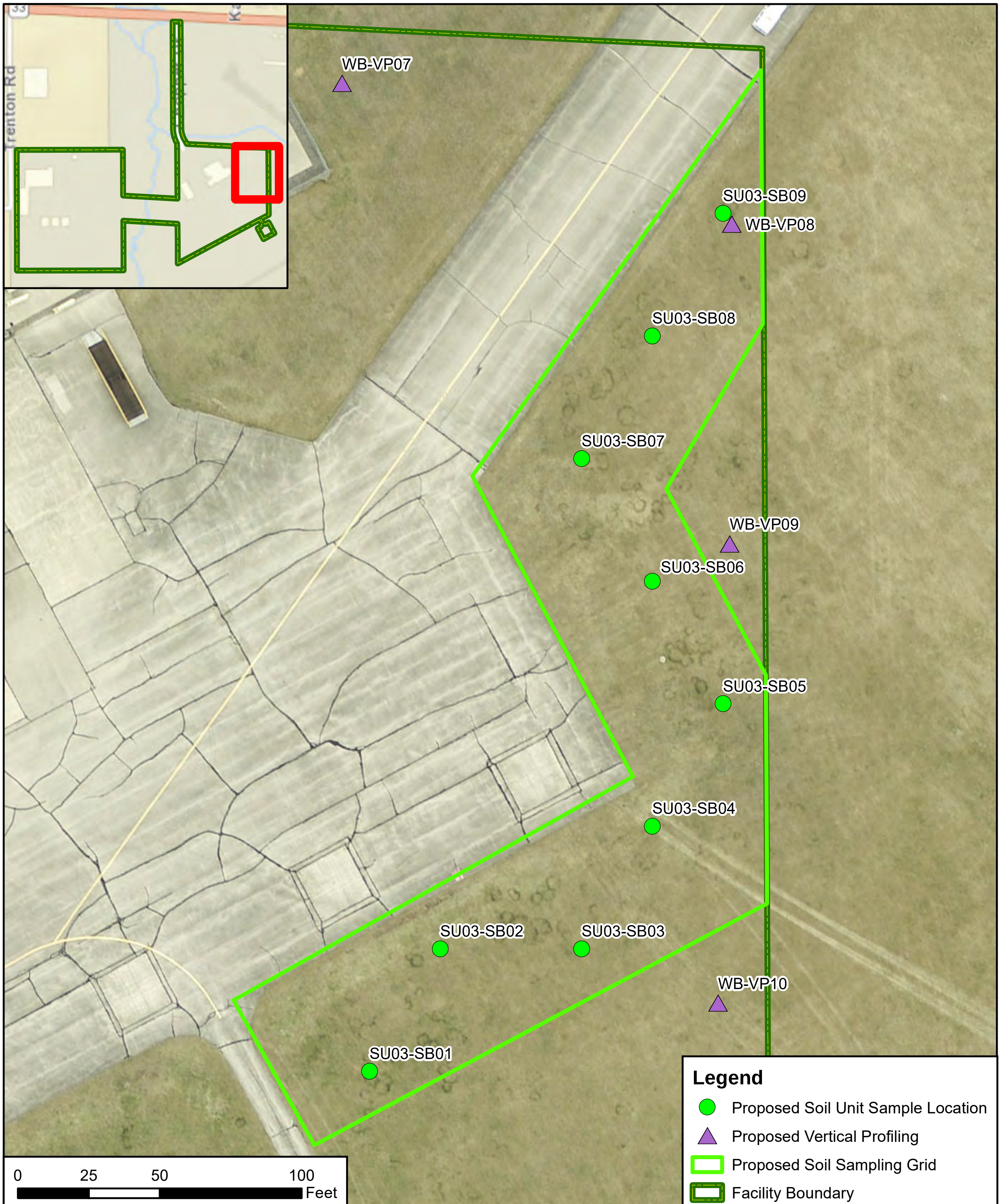
Soil Unit 01
Proposed Sample Locations

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 17-2



CLIENT	ARNG				N	Soil Unit 02 Proposed Sample Locations
Remedial Investigation at West Bend, WI						
REVISED	7/18/2023	GIS BY	MS	7/18/2023		AECOM 12420 Milestone Center Drive Germantown, MD 20876 / Figure 17-3
SCALE	1:360	CHK BY	BP	7/18/2023		
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	CM	7/18/2023		

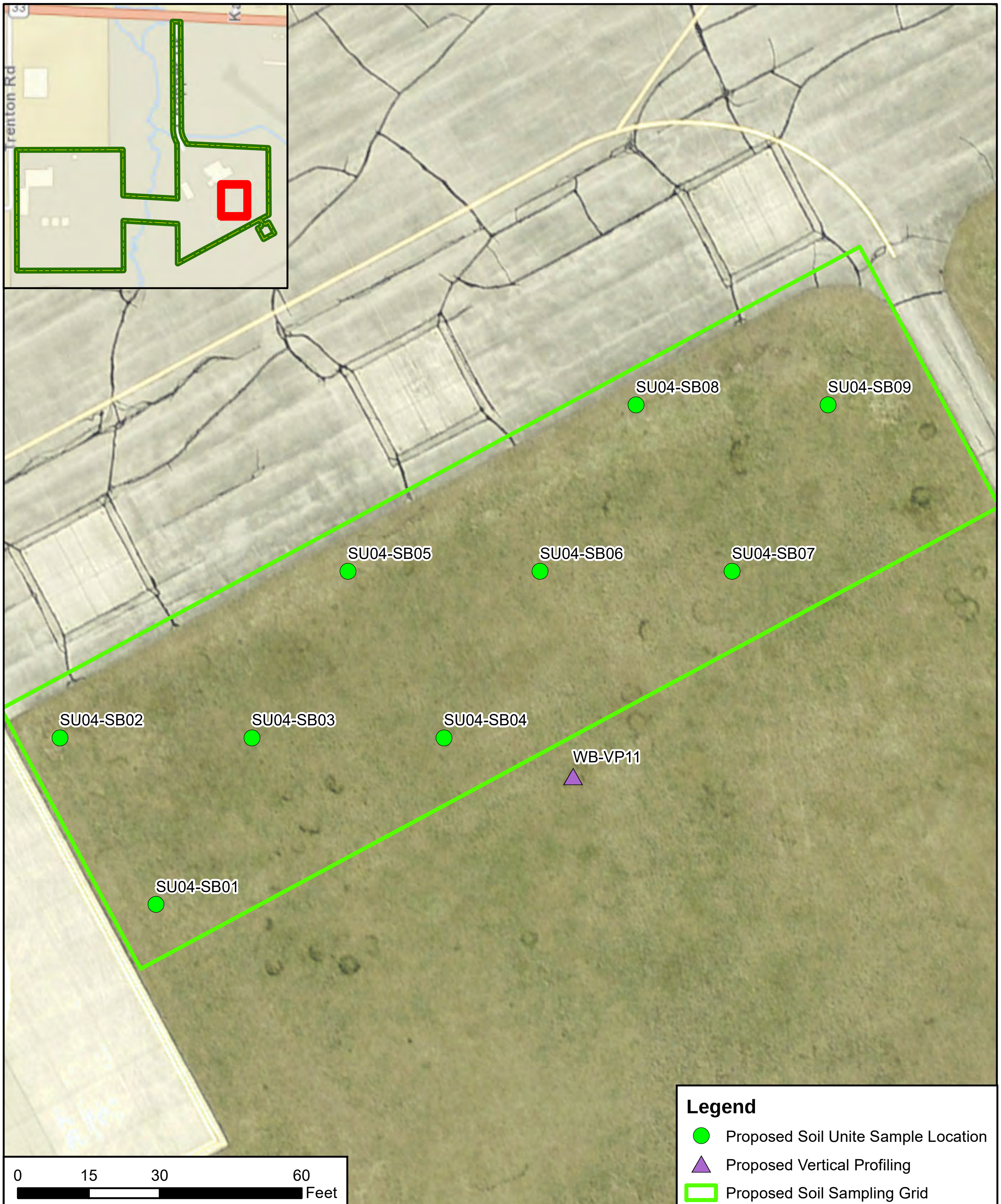


CLIENT	ARNG			
Remedial Investigation at West Bend, WI				
REVISED	7/18/2023	GIS BY	MS	7/18/2023
SCALE	1:600	CHK BY	BP	7/18/2023
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	CM	7/18/2023

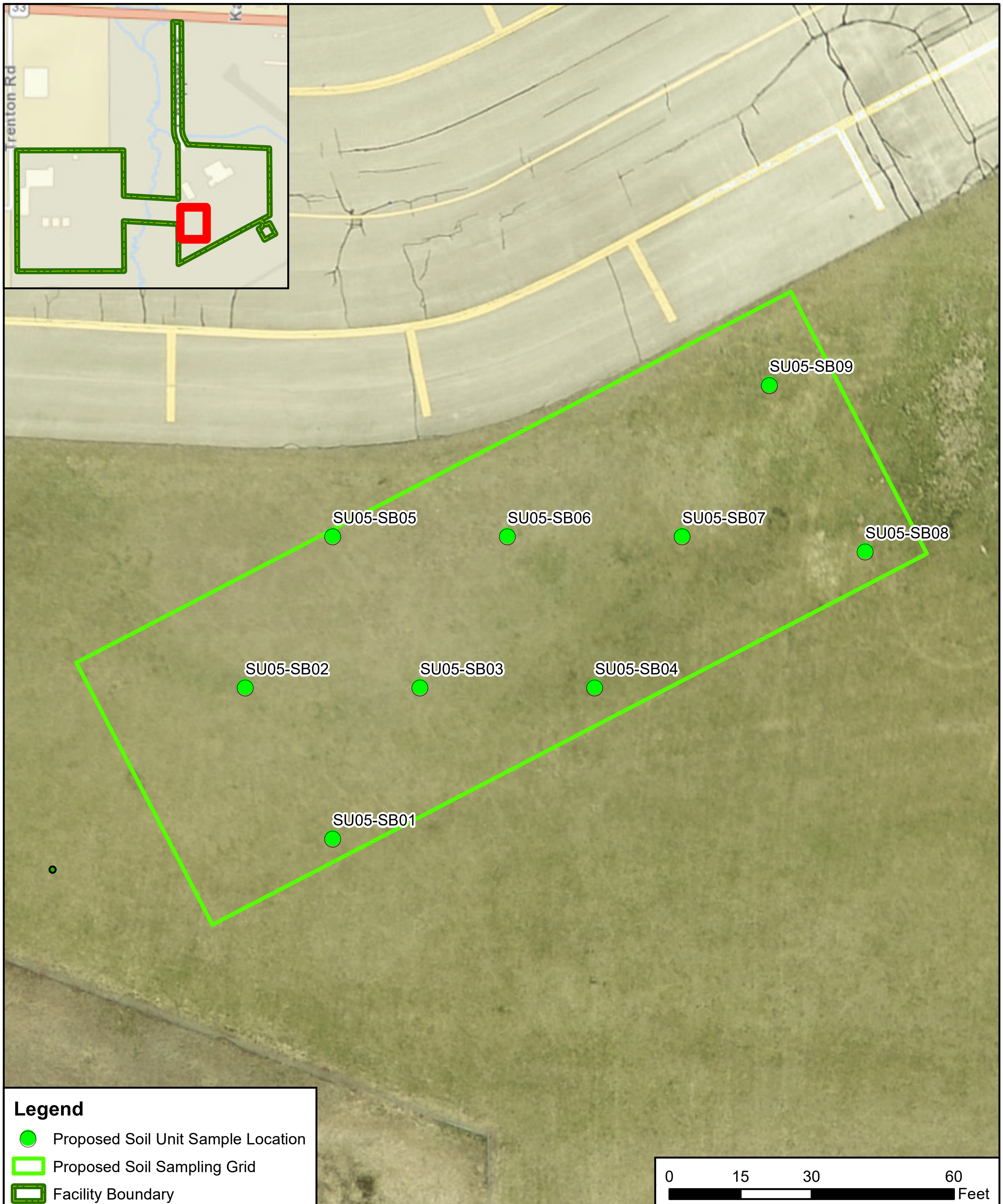
Soil Unit 03
Proposed Sample Locations

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 17-4



CLIENT	ARNG				N	Soil Unit 04 Proposed Sample Locations	
Remedial Investigation at West Bend, WI							
REVISED	7/18/2023	GIS BY	MS	7/18/2023		AECOM 12420 Milestone Center Drive Germantown, MD 20876	Figure 17-5
SCALE	1:360	CHK BY	BP	7/18/2023			
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	CM	7/18/2023			



CLIENT	ARNG			
Remedial Investigation at West Bend, WI				
REVISED	11/17/2023	GIS BY	MS	11/17/2023
SCALE	1:360	CHK BY	BP	11/17/2023
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	CM	11/17/2023

Soil Unit 05
Proposed Sample Locations

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 17-6

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QAPP Worksheet #19 & #30: Sample Containers, Preservation, and Hold Times

Laboratory: Eurofins Lancaster Laboratories
2425 New Holland Pike
Lancaster, PA 17601
717-656-2300
List any required accreditations/certifications: DoD ELAP
Back-up Laboratory: Pace South Carolina
Sample Delivery Method: FedEx

Analyte/ Analyte Group	Matrix	Method/SOP	Accreditation Expiration Date	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
PFAS	Aqueous	PFAS by Draft USEPA 1633, QSM 5.4 Table B-24/ WI46412	DoD-ELAP: 11/30/2024	2 X 500 mL HDPE container	None, 0-6°C	28 days	28 days	Standard
PFAS	Solid	PFAS by Draft USEPA 1633, QSM 5.4 Table B-24/ WI48593	DoD-ELAP: 11/30/2024	4 oz. PP specimen containers with polyethylene screw caps	None, 0-6°C	28 days at 0-6°C and 90 days at -20°C (could extend the hold time)	28 days	Standard
Total Organic Carbon	Solid	SW-846 9060A/ WI11627	DoD-ELAP: 11/30/2024	4-ounce glass jar	Cool, 0-6°C	28 days	28 days	28 days
pH	Solid	SW-846 9045C modified/ 29-22 WI11518	DoD-ELAP: 11/30/2024	4-ounce glass jar	Cool, 0-6°C	n/a	28 days	28 days
Grain Size	Solid	ASTM D422/ WI11514	DoD-ELAP: 11/30/2024	16-ounce glass jar	Cool, 0-6°C	n/a	28 days	28 days

Notes:
1.) pH determination is intended to be an in-situ parameter. ELLE is located in Lancaster, PA and commits to analyzing pH samples received at its facility in an “as soon as possible” manner. Resulting data is qualified to reflect the variance to the method’s assumptions.

Notes (continued):

°C = degrees Celsius
ASAP = as soon as possible
DoD = Department of Defense
ELAP = Environmental Laboratory Accreditation Program
HDPE = high-density polyethylene
LC/MS/MS = liquid chromatography tandem mass spectrometry
mL = milliliter
NA = not applicable
oz = ounce
PFAS = per- and polyfluoroalkyl substances
QAPP = Quality Assurance Project Plan
QSM = Quality Systems Manual
SOP = standard operating procedure
USEPA = United States Environmental Protection Agency

Laboratory: Pace South Carolina
106 Vantage Point Drive
West Columbia, SC 29172
803-683-9550
List any required accreditations/certifications: DoD ELAP
Back-up Laboratory: NA
Sample Delivery Method: FedEx

Analyte/ Analyte Group	Matrix	Method/SOP	Accreditation Expiration Date	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
PFAS	Aqueous	Draft USEPA Method 1633/ ENV-SOP-WCOL-0158	11/18/2024	HDPE w/PP linerless cap 2 x 500 mL 1 x 125 mL	Cool, 0-6C[1] Freeze, ≤-20C[2]	28 days 90 days	90 days	28 days
PFAS	Solid	Draft USEPA Method 1633/ ENV-SOP-WCOL-0158	11/18/2024	PP w/PP linerless cap 1 x 90 mL	Cool, 0-6C[1]	90 days	90 days	28 days

Notes:

1.) Maintain all samples protected from light at 0 - 6 ºC from the time of collection until shipped to the laboratory. Samples must be shipped as soon as practical with sufficient ice to maintain the sample temperature below 6 ºC during transport and be received by the laboratory within 48 hours of collection. The laboratory must confirm that the sample temperature is 0 - 6 ºC upon receipt.

2.) If requested by client, preparation holding time can be extended to 90 days if stored ≤-20C. Must be requested in writing and additional fees may apply.

°C = degrees Celsius
ASAP = as soon as possible
DoD = Department of Defense
ELAP = Environmental Laboratory Accreditation Program
HDPE = high-density polyethylene
LC/MS/MS = liquid chromatography tandem mass spectrometry
mL = milliliter
NA = not applicable
oz = ounce
PFAS = per- and polyfluoroalkyl substances
QAPP = Quality Assurance Project Plan
QSM = Quality Systems Manual
SOP = standard operating procedure
USEPA = United States Environmental Protection Agency

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QAPP Worksheet #20: Field Quality Control Summary

The table below provides a summary of the quantities of field QC samples to be collected. The remaining tables in **Worksheet #20** establish the MPC.

Matrix	Analytical Group	Field Samples	Field Duplicates	Matrix Spikes	Matrix Spike Duplicates	Field Reagent Blanks	Equipment Rinsate Blanks[1]	Total Samples
Groundwater	PFAS (40)	38	4	2	2	1	2	49
Soil	PFAS (40)	98	10	5	5	0	2	120
Surface Water	PFAS (40)	9	2	1	1	0	1	14
Sediment	PFAS (40)	9	2	1	1	0	1	14
Decontamination Water	PFAS (40)	1	0	0	0	0	0	1

Notes:
1.) ERBs apply only if use of non-dedicated sampling equipment is necessary. ERBs for solid matrices are aqueous samples.

ERB = equipment rinsate blank
PFAS = per- and polyfluoroalkyl substances

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QAPP Worksheet #21: Field Standard Operating Procedures

A summary of SOPs is provided in the table below which can be found in **Appendix D**. Field staff will be trained through AECOM's internal PFAS Sampling Training prior to performing any sampling activities. A summary of the acceptability of certain materials for use in the PFAS sampling environment and a daily PFAS sampling checklist are provided in *SOP 3-41: Per- and Polyfluoroalkyl Substance Field Sampling Protocol* (**Appendix D**).

Reference Number	Title, Revision Date, and/or Number	Originating Organization	Modified for Project Work?	Comments
3-01	*Utility Clearance*	AECOM	Y	Modified for programmatic details
3-02	*Logbooks*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-03	*Recordkeeping, Sample Labeling and Chain of Custody*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-04	*Sample Handling, Storage, and Shipping*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-05	*Investigation-Derived Waste Management*	AECOM	Y	Modified for programmatic details
3-06	*Equipment Decontamination*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-07	*Land Surveying*	AECOM	Y	Modified for programmatic details
3-09	*Geophysics*	AECOM	Y	Modified for programmatic details
3-10	*Surface Water Sampling*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-12	*Monitoring Well Installation*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-13	*Monitoring Well Development*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-14	*Monitoring Well Sampling*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-15	*Monitoring Well Abandonment*	AECOM	Y	Modified for programmatic details
3-16	*Soil and Rock Classification*	AECOM	Y	Modified for programmatic details
3-17	*Direct Push Sampling Techniques*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-20	*Operation and Calibration of Photoionization Detector*	AECOM	Y	Modified for programmatic details

Reference Number	Title, Revision Date, and/or Number	Originating Organization	Modified for Project Work?	Comments
3-21	*Surface and Subsurface Soil Sampling Procedures*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-22	*Sediment Sampling*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-24	*Water Quality Parameter Testing for Groundwater Sampling*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-33	*Subsurface Soil Sampling by Split Spoon*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-37	*Grab Groundwater Sampling Techniques*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-41	*Per- and Polyfluoroalkyl Substance Field Sampling Protocol*	AECOM	Y	Modified for PFAS sampling and programmatic details
3-42	*Potable Well Sampling*	AECOM	Y	Modified for PFAS sampling and programmatic details

Notes:
AECOM = AECOM Technical Services, Inc.
PFAS = per- and polyfluoroalkyl substances
Y = yes

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

Worksheet #22 addresses procedures for calibrating, maintaining, testing, and/or inspecting field equipment (e.g., tools, pumps, gauges, pH meters, water-level measurement devices). **Equipment that will come into contact with sample media will be evaluated for PFAS-containing components prior to use.**

Field Equipment	Calibration Activity	Maintenance Activity	SOP Reference	Testing Activity	Inspection Activity	Title or Position of Responsible Person	Frequency	Calibration Acceptance Criteria	Corrective Action
Water Quality Meter (pH, ORP, DO, conductivity, temperature, turbidity)	Calibrate with standard solutions	Per page 8 of SOP 3-24	SOP 3-24	Operational equipment check and calibration	Visually inspect for cleanliness and obvious defects (broken/missing parts)	Field Technician Lead	Prior to use	pH: ± 0.01 pH units Conductivity: ± 0.01 µS/cm Turbidity: ± 0.01 NTU DO: ± 0.01 mg/L Temperature: ± 0.01 °C	Minor: Repair Major: Replace instrument
MiniRAE 2000 (Photoionization Detector)	Calibrate with fresh air and isobutylene calibration gas	Per page 4 of SOP 3-20	SOP 3-20	Operational equipment check and calibration	Visually inspect for cleanliness and obvious defects (broken/missing parts)	Field Technician Lead	Prior to use	0-99 ppm ± 0.1 ppm 100-1,999 ppm ± 1.0 ppm 2000-10,000 ppm ± 10 ppm	Minor: Repair Major: Replace instrument
QED MP10 Controller (Bladder Pump Controller Box)	NA	NA	SOP 3-14	Operational equipment check	Visually inspect for cleanliness and obvious defects (broken/missing parts)	Field Technician Lead	Prior to use	NA	Minor: Repair Major: Replace instrument
QED SamplePro (Stainless Steel Submersible Bladder Pump)	NA	Per page 7 of SOP 3-14	SOP 3-14	Operational equipment check	Visually inspect for cleanliness and obvious defects (broken/missing parts)	Field Technician Lead	Prior to use	NA	Minor: Repair Major: Replace instrument

Field Equipment	Calibration Activity	Maintenance Activity	SOP Reference	Testing Activity	Inspection Activity	Title or Position of Responsible Person	Frequency	Calibration Acceptance Criteria	Corrective Action
Solinst 101 (Water Level Meter)	NA	Per page 5 of SOP 3-14	SOP 3-14	Operational equipment check	Visually inspect for cleanliness and obvious defects (broken/missing parts)	Field Technician Lead	Prior to use	NA	Minor: Repair Major: Replace instrument
Geotech GeoPump (Peristaltic Pump)	NA	NA	SOP 3-14	Operational equipment check	Visually inspect for cleanliness and obvious defects (broken/missing parts)	Field Technician Lead	Prior to use	NA	Minor: Repair Major: Replace instrument

Notes:
°C = degrees Celsius
DO = dissolved oxygen
mg/L = milligrams per liter
NA = not applicable
NTU = nephelometric turbidity unit
ORP = oxidation-reduction potential
PFAS = per- and polyfluoroalkyl substances
ppm = parts per million
SOP = standard operating procedure
µS/cm = micro Siemens per centimeter

QAPP Worksheet #23: Analytical Standard Operating Procedures

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data[1]	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
WI46412	Analysis of Per and Polyfluoroalkyl Substances (PFAS) in Aqueous Samples by LC-MS/MS Using Draft Method 1633/QSM5.4 Table B24, rev. 2, effective 08/31/2022	N/A	PFAS	LC/MS/MS	Eurofins	N
WI23588	Preventative and Corrective Maintenance for the API 4000 and AB Sciex 4500, 5500, 5500+ Liquid Chromatograph Mass Spectrometers (LC/MS/MS), Rev 3, effective 02/21/2022	N/A	PFAS	LC/MS/MS	Eurofins	N
WI53304	Total Suspended Solids (TSS Gravimetric) Prescreen by Draft USEPA Method 1633 Revision 2 in Aqueous Samples, Rev 1, effective 9/28/2022	N/A	PFAS	LC/MS/MS	Eurofins	N
WI48593	Analysis of Per and Polyfluoroalkyl Substances (PFAS) in Solid Samples by LC-MS/MS Using Draft Method 1633/QSM5.4 Table B24, Version 2, effective 10/05/2022	N/A	PFAS	LC/MS/MS	Eurofins	N
WI46585	PFAS Leaching Procedure (TCLP, SPLP) by EPA 1311-Modified and 1312-Modified in Solids and Wastes, Version 1, effective 11/11/2021	N/A	SPLP/TCLP	NA	Eurofins	N
ENV-SOP-WCOL-0158	Draft Method 1633, Revision 2	Definitive	PFAS	Sciex 5500 Triple Quad LC-MS/MS	Pace	N
WI11637	Total Organic Carbon, Dissolved Organic Carbon, and Inorganic Carbon by SM 5310C or USEPA 415.1 in Waters, Rev 16, effective 9/25/18	Definitive	TOC	TOC Analyzer	Eurofins	N
WI11518	pH by EPA 9045C, 9045D and Corrosivity by SW-846 Chap 7 of Solids, Soils, and Solvents using Electrometric Methods, Ver 13, effective 7/8/19	Definitive	pH	pH meter	Eurofins	N

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data[1]	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
WI11514	Particle Size Distribution of Soils and Solids/Grain Size Classification by ASTM D-422-63, Rev 10, effective 1/24/19	Definitive	Grain Size	Hydrometer	Eurofins	N

Notes:

1.) Definitive or screening data are defined per the Part 2B, Quality Assurance/Quality Control Compendium: Minimum QA/QC Activities (IDQTF, 2005c):

Screening data can support an intermediate or preliminary decision but should eventually be supported by definitive data before a project is complete.

Definitive data should be suitable for final decision-making (of the appropriate level of precision and accuracy, as well as legally defensible).

2.) pH determination is intended to be an in-situ analysis. ELLE performs test remote to field operations.

DIA = data independent acquisition
LC/MS/MS = liquid chromatography tandem mass spectrometry
N = no
NPS = non-potable water
PFAS = per- and polyfluoroalkyl substances
SCM = solid/ chemical materials
SOP = standard operating procedure
SPE = solid phase extraction
TOC = total organic carbon
Y = yes

QAPP Worksheet #24: Analytical Instrument Calibrations

Instrument/ Equipment	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person(s) Responsible	SOP Reference
LC/MS/MS	Mass Calibration	Initially, annually, and after performing major maintenance	Per manufacturer specifications	NA	Analyst	W48593
LC/MS/MS	Tuning of LC/MS/MS	When masses fall outside ± 0.5 amu of true masses	Within 0.5 amu of true value	Retune and verify. If tuning fails acceptance criteria, perform a mass calibration and repeat the tune check.	Analyst	W48593
LC/MS/MS	Mass Spectral Acquisition Rate	Each analyte, labeled analyte, and injection internal standard	A minimum of 10 spectra scans are acquired across each chromatographic peak	NA	Analyst	W48593
LC/MS/MS	Initial calibration with a minimum 6 points	After continuing calibration fails	S/N ratio ≥10:1 for all ions used for quantification. % RSD of the RFs for all analytes must be </= to 20%. Linear or non-linear calibrations must have a r2 ≥0.99. Must use at least 6 points for a quadratic. Analytes must be within 70-130% of their true value for each calibration standard.	Perform more aggressive instrument maintenance and recalibrate	Analyst	W48593
LC/MS/MS	Instrument Sensitivity Check	Daily, prior to analysis with analyte concentrations at the lowest calibration level.	Recover within ±30% of their true value. S/N >/=3:1	Correct problem and rerun ISC. If problem persists, repeat ICAL	Analyst	W48593
LC/MS/MS	Retention Time Window	Every field sample, standard, blank and QC samples	RT should not vary from ICAL more than 0.4 minute for isotopically labeled compounds, 0.1 minute from their analog for native compounds with an exactly isotopically-labeled compound, or 0.4 minute from assigned analog for a native compound without an exact istopically labeled compound	Correct problem and reanalyze samples	Analyst	W48593

Instrument/ Equipment	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person(s) Responsible	SOP Reference
LC/MS/MS	ICV Standard	Once with every ICAL	Within ±30% of their true value	Reanalyze the ICV and samples associated with the non-compliant ICV. If ICV fails again do system maintenance, recalibrate, and reanalyze samples.	Analyst	W48593
LC/MS/MS	LOD standard	Quarterly	All compound must be detected	Reprep and reanalyze LOD.	Analyst	W48593
LC/MS/MS	LOQ Verification	Quarterly	Within 50% of true value	Reprep and reanalyze LOQ.	Analyst	W48593
LC/MS/MS	CCV Standard	Every 10 samples and at the end of a sequence	Analyte concentration at the mid-level of the calibration curve. Recover within ±30% of their true value	Reanalyze CCV in duplicate immediately. If both pass, samples can be report. If either fails or if immediate reanalysis of CCV in duplicate cannot be performed all samples since acceptable CCV must be reanalyzed. If the CCV fails high any associated samples that are ND can be reported.	Analyst	W48593
LC/MS/MS	Instrument Blanks	Immediately following the highest standard analyzed, daily at start of a sequence, and after each CCV.	Concentration of each analyte must be ≤1/2 LOQ	If criteria not met after highest calibration standard, must decrease that standard's concentration until criteria is met. If criteria not met for sample, run additional instrument blanks until criteria is met.	Analyst	W48593
LC/MS/MS	Ion transitions (Precursor --> Product)	Every field sample, standard, blank and QC samples	Use ion transitions from Table 2 of Draft Method EPA 1633.	N/A	Analyst	W48593
LC/MS/MS	Ion Reponse Ratio	Every field sample, standard, blank and QC samples	Ion reponse ration must fall within ±50% of the ratio observed in the mid-point ICAL standard.	If ion ratio for a compound differs from the expected ion ratio by more than 50%, a qualifier is placed on the raw data and on the sample report	Analyst	W48593

Instrument/ Equipment	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person(s) Responsible	SOP Reference
LC/MS/MS	Bile Salt Standard	Daily, prior to anlaysis of all matrix types.	The retention time of the bile salt peak must fall out of the retention time window of PFOS by at least one minute	N/A	Analyst	W48593
LC/MS/MS	MDL Verification	Quarterly	Per 40 CFR 136 Appendix B Rev 2.0. Goes through all preparative methods. Meets qualitative detection criteria. May be combined with the LOD verifications.	Re-prep and re-analyze the MDL standard. If needed, a new initial MDL study is performed with a higher concentration.	Analyst	SOP11892
TOC Analyzer: TOC (9060A; 5310B)	Initial calibration with a minimum 4 points	Monthly or after continuing calibration fails	$r^2 \geq 0.995$	Perform more aggressive instrument maintenance and recalibrate	Analyst, Supervisor, QA Manager	WI11627
TOC Analyzer: TOC (9060A; 5310B)	ICB Standard	After each initial calibration	No analytes detected > LOQ	Perform more aggressive instrument maintenance and recalibrate	Analyst, Supervisor, QA Manager	WI11627
TOC Analyzer: TOC (9060A; 5310B)	ICV Standard	After each initial calibration	Within +/- 10% of the nominal concentration	Reanalyze the ICV. If ICV fails again do system maintenance and recalibrate.	Analyst, Supervisor, QA Manager	WI11627
TOC Analyzer: TOC (9060A; 5310B)	MDL Standard	Yearly	All compounds must be detected	Repeat ICAL procedure prior to analyzing samples. Repeat maintenance if needed.	Analyst, Supervisor, QA Manager	WI11627
TOC Analyzer: TOC (9060A; 5310B)	CCV Standard	If instrument is idle > 4 hours, after every 10 field samples, and at the end of the sequence	Within +/- 10% of the nominal concentration	All affected samples are reanalyzed	Analyst, Supervisor, QA Manager	WI11627
TOC Analyzer: TOC (9060A; 5310B)	CCB Standard	If instrument is idle > 4 hours, after every 10 field samples, and at the end of the sequence	All affected samples are reanalyzed	All affected samples are reanalyzed	Analyst, Supervisor, QA Manager	WI11627

Instrument/ Equipment	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person(s) Responsible	SOP Reference
pH solid	3-point calibration	Each new run and continuing calibration per 10 samples	Independent and continuing calibration verification (CCV) within ±10%. CCB < RL.	Recalibrate, perform instrument maintenance if calibration cannot conform to criteria, recalibrate	Analyst, Supervisor, QA Manager	WI11518

Notes:

> = greater than
≥ = greater than or equal to
< = less than
≤ = less than or equal to
± = plus or minus
% = percent
amu = atomic mass unit
CAS = Chemical Abstract Service
CCB = Continuing Calibration Blank
CCV = Continuing Calibration Verification
DL = detection limit
EIS = extracted internal standard
ESI = electrospray ionization
ICAL = initial calibration for all analytes
ICV = independent calibration verification
ISC = instrument sensitivity check
LC/MS/MS = liquid chromatography tandem mass spectrometry
LCS = laboratory control spike
LOD = limit of detection
LOQ = limit of quantitation
MS = matrix spike
NA = not applicable
ppb = parts per billion
QA = quality assurance
QC = quality control
R^2 = coefficient of determination
RSD = relative standard deviation
RT = retention time
SOP = standard operating procedure
µg = microgram

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

Laboratory: Eurofins Lancaster Laboratories

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
LC/MS/MS	Backflush of column, injection port and pre-columns, cleaning of ion spray cone, adjustment of collision energies, others as needed	Calibration Check	Visual	As Needed	Initial calibration or calibration verification passes method specifications	Perform additional maintenance prior to instrument calibration or calibration verification	ELLE Analysts	WI23588
Orion 720 pH Meter	Check electrode	pH	Flush and refill electrode; clean electrode with methanol	As needed	No instrument error message	Clean or replace as necessary	Analyst, Supervisor QA Manager	WI11518
LC/MS/MS	Backflush of column, injection port and pre-columns, cleaning of ion spray	Calibration Check	Visual	As Needed	Initial calibration or calibration verification passes method	Perform additional maintenance prior to	ELLE Analysts	WI23588

Notes:
amu = atomic mass unit
ESI = electrospray ionization
LCMS = liquid chromatography/ mass spectrometry
LC/MS/MS = liquid chromatography tandem mass spectrometry
mg = milligrams
NA = not applicable
QA = quality assurance
QC = quality control
SOP = standard operating procedure
TOC = Total Organic Carbon

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QAPP Worksheet #26 & #27: Sample Handling, Custody, and Disposal

Sampling Organization: AECOM
Laboratory: Eurofins Lancaster Laboratories
Method of sample delivery (shipper/carrier): FedEx
Number of days from reporting until sample disposal: 60 Days

Activity	Organization and title or position of person responsible for the activity	SOP reference
Sample labeling	AECOM	*SOP 3-03 Recordkeeping, Sample Labeling, and Chain of Custody*
CoC form completion	AECOM	
Packaging	AECOM	*SOP 3-04 Sample Handling, Storage, and Shipping*
Shipping coordination	AECOM	
Sample receipt, inspection, and log-in	Eurofins Lancaster Laboratories	S-SA-WI10725: Environmental Sample Receipt and Unpacking; Rev 20; 12/7/2021
Sample custody and storage	Eurofins Lancaster Laboratories	S-SS-WI12042: Automated Storage Retrieval and Discarding of Samples; Rev 11; 6/28/2019
Sample disposal	Eurofins Lancaster Laboratories	S-SS-WI12042: Automated Storage Retrieval and Discarding of Samples; Rev 11; 6/28/2019

Notes:
AECOM = AECOM Technical Services, Inc.
CoC = chain of custody
SOP = standard operating procedure

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QAPP Worksheet #28: Analytical Quality Control and Corrective Actions

Laboratory: Eurofins Lancaster Laboratories
Matrix: Solid & Aqueous
Analytical Group: PFAS
Analytical Method: Draft USEPA 1633/QSM B-24
SOP Reference: WI46412
Certification Status: DoD ELAP/NELAP Certification

QC Sample	Frequency/Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible	Data Quality Indicator	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 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 sample or 1/10 the regulatory limit, whichever is greater
MS/MSD	1 per prep batch of up to 20 samples	In-house LCS limits unless project specific limits. If analytes aren't listed use in-house limits; RPD 30%	Flag outliers	ELLE Analyst	Accuracy/Bias/ Precision	Results within acceptance limits
LCS/LLLCS	1 set prep batch of up to 20 samples	In-house limits unless project specific limits. If analytes aren't listed use in-house limits; Preliminary in-house acceptance criteria of 40-150% from Table B-24 QSM 5.4 must be used until in-house limits are generated.	Reanalyze LCS, LLLCS, and associated samples. 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
Isotopically Labeled Extraction Standards	Per sample (including MS/MSD, LCS, and blanks) prior to preparation	In-house limits unless project specific limits; Preliminary in-house acceptance criteria of 20-150% must be used until in-house limits are generated.	If fails for QC sample, but the native compounds are within specification, report data. If fails for sample, re-extract and reanalyze and/or consult a supervisor for course of action.	ELLE Analyst	Accuracy	Results within acceptance limits
Non-extracted Internal Standards (NIS)	Per sample (including MS/MSD, LCS, and blanks) prior to preparation	NIS areas must be greater than 30% of the average areas of the calibration standards in undiluted sample extracts and sample extracts that require NIS to be added.	If fails, repeat the analysis using a fresh aliquot of the extract. If the failure confirms examine project requirements and contact the client.	ELLE Analyst	Accuracy	Results within acceptance limits

Notes:
> = greater than
≥ = greater than or equal to
< = less than
≤ = less than or equal to
% = percent
AFFF = aqueous film forming foam
CCV = continuing calibration verification
EIS = extracted internal standard
ICAL = initial calibration for all analytes
LC/MS/MS = liquid chromatography tandem mass spectrometry
LCS = laboratory control spike
LOQ = limit of quantitation
MD = matrix duplicate
MS/MSD = matrix spike/matrix spike duplicate
NA = not applicable
QA = quality assurance
QC = quality control
QSM = Quality Systems Manual
RPD = relative percent difference
S/N = signal to noise
SOP = standard operating procedure
SPE = solid phase extraction

Laboratory: Pace South Carolina
Matrix: Solid & Aqueous
Analytical Group: PFAS
Analytical Method: Draft USEPA 1633/QSM B-24
SOP Reference: ENV-SOP-WCOL-0158
Certification Status: DoD ELAP/NELAP Certification

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
AFFF samples	Each AFFF sample. Note: This does not include AFFF samples that are to be evaluated for MIL-PRF-14385 compliance. Those AFFF samples must be performed in compliance with DoD AFFF01, not EPA Draft Method 1633.	AFFF samples must be subsampled in duplicate for analysis in accordance with DoD AFFF01, Section 11.2.1 through 11.2.9. Note: In lieu of the LCSD required in Section 11.2.6 of DoD AFFF01, one MS/MSD pair must be prepared with each batch of AFFF samples. All AFFF samples must be processed in duplicate in the same manner as whole sample aqueous samples (SPE, carbon cleanup) per EPA Draft Method 1633.	NA	NA	A copy of the latest version of DoD AFFF01 can be found at https://denix.osd.mil/edqw/. Note that this document is only for QC reference purposes, and not the procedure, if AFFF samples are NOT being analyzed for compliance with MIL-PRF-14385.
Ion Transitions (Precursor-> Product)	Every field sample, standard, blank, and QC sample.	In addition to the requirements of EPA Draft Method 1633, the following must be met: 1) If a qualitative or quantitative standard containing an isomeric mixture (branched and linear isomers) of an analyte is commercially available for an analyte, the quantification ion used must be the quantification ion identified in Table 2 of EPA Draft Method 1633 unless interferences render the product ion unusable as the quantification ion. 2) In cases where interferences render the product ion unusable as the quantification ion, project approval is required before using the alternative product ion.	NA	Flagging is not appropriate. Provide technical justification in the Case Narrative.	Currently, qualitative or quantitative standards containing isomeric mixtures for an analyte are commercially available for PFOA, PFOS, PFHxS, NMeFOSAA, NEtFOSAA, PFNA, PFOSA, NMeFOSA, NEtFOSA, NMeFOSE, and NEtFOSE.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Ion Ratio	All analytes detected in a sample.	Must meet all the requirements of EPA Draft Method 1633.	Must meet all the requirements of EPA Draft Method 1633.	Document and discuss the failure in the Case Narrative. Apply I-flag to the result associated with the failure.	NA
Instrument Sensitivity Check (ISC)	Daily. At the beginning of each analytical sequence, prior to sample analysis.	In addition to the requirements of EPA Draft Method 1633, the following must be met: All analyte concentrations must be within ± 30% of their true values.	Correct problem, rerun ISC. If problem persists, repeat ICAL.	Flagging is not appropriate.	No samples shall be analyzed until acceptance criteria for ISC has been met.
Initial Calibration Verification (ICV)	Once after each ICAL, prior to sample analysis.	Must be made from a second source standard. All analyte concentrations must be within ± 30% of their true values.	Correct problem, rerun ICV. If problem persists, repeat ICAL.	Flagging is not appropriate.	No samples shall be analyzed until acceptance criteria for ICV has been met.
Instrument Blank (IB)	Immediately following the highest standard analyzed in the calibration, daily prior to analyzing standards, after each CCV, and immediately following samples with PFAS concentrations exceeding the quantification range	In addition to the requirements of EPA Draft Method 1633, the following must be met: 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 concentration for the highest standard until acceptance criteria is met. If sample concentration exceeds the highest calibration standard and the sample(s) following exceed this acceptance criteria (> 1/2 LOQ), they must be reanalyzed using a fresh aliquot of the sample extract.	Flagging is only appropriate in cases where the extract cannot be reanalyzed, and re-extraction is not possible.	EPA Draft Method 1633 equivalent to the CCV is the Calibration Verification (CV).

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Extracted Internal Standard (EIS) Compounds	Every field sample, standard, blank, and QC sample.	In addition to the requirements of EPA Draft Method 1633, the following must be met: 1) Isotopically labeled analogs of analytes must be used when they are commercially available. 2) QC samples and field samples must recover within in-house limits if project limits are not provided; otherwise, project limits must be met. Preliminary in- house acceptance criteria of 20-150% must be used until in- house limits are generated in accordance with Sections 9.4.1 and 9.4.2 of EPA Draft Method 1633.) The lower limit of in- house acceptance criteria cannot be <20%.	Repeat the analysis using a fresh aliquot of the extract. If failure does not confirm, report the second analysis. If the failure confirms, follow the requirements listed in EPA Draft Method 1633, Section 15.3.2. If EIS recoveries still fall outside of the acceptance range, the client must be contacted for additional measures to be taken.	Document and discuss the failure in the Case Narrative. Apply Q-flag to the result associated with the failure.	NA
Non-extracted Internal Standard (NIS) Compounds	Every field sample, standard, blank, and QC sample.	In addition to the requirements of EPA Draft Method 1633, the following must be met: 1) NIS areas must be greater than 30% of the average area of the calibration standards in undiluted sample extracts and sample extracts that required additional NIS to be added. 2) NIS areas corrected for the dilution factor must be greater than 30% of the average area of the calibration standards in diluted samples when additional NIS was not added post dilution of the extract.	Repeat the analysis using a fresh aliquot of the extract. If failure does not confirm, report the second analysis. If the failure confirms, examine the project-specific requirements. Contact the client as to additional measures to be taken.	Document and discuss the failure in the Case Narrative. Apply Q-flag to the result associated with the failure.	NA

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Method Blank (MB)	One per preparatory batch.	In addition to the requirements of EPA Draft Method 1633, the following must be met: No analytes detected > ½ LOQ or > 1/10th the amount measured in any associated sample or 1/10th the regulatory limit, whichever is greater.	Correct the problem. If required, re-extract and reanalyze MB and all QC samples and field samples processed with the contaminated blank. Samples may be re-extracted and analyzed outside of holding times, as necessary for corrective action associated with QC failure. Examine the project-specific requirements. Contact the client as to additional measures to be taken.	If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	NA
Matrix Duplicate (MD)	Each AFFF sample prepared using an aliquot of the field sample must be prepared in duplicate.	In addition to the requirements of EPA Draft Method 1633, the following must be met: RPD ≤ 30% (between sample and MD).	Examine the project-specific requirements. Contact the client as to additional measures to be taken. If the analyte(s) are not listed, use inhouse LCS limits if project limits are not specified.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative.	The data shall be evaluated to determine the source of difference. For Sample/MD: RPD criteria only applies to analytes whose concentration in the sample is ≥ LOQ.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Bile Salt Standards	Daily, prior to analysis of all matrix types (aqueous, solid, tissue, and AFFF).	All EPA Draft Method 1633 requirements for evaluation of the relationship of the retention time of the bile salt peak(s) to the retention time window of PFOS must be met for all matrix types. The retention time window of PFOS applies to the retention time of all isomers of PFOS. No samples shall be analyzed until acceptance criteria for the bile salt standard(s) has been met. The retention time of the bile salt(s) peak must fall out of the retention time window of PFOS by at least one minute.	NA	NA	NA
Laboratory Control Sample (LCS) and Low-Level Laboratory Control Standard (LLLCS)	One set per preparatory batch.	In addition to the requirements of EPA Draft Method 1633 the following must be met: 1) Analyte recoveries must be within in-house limits if project limits are not provided; otherwise, project limits must be met. Preliminary inhouse acceptance criteria of 40-150% must be used until inhouse limits are generated in accordance with Section 14.5.4 of EPA Draft Method 1633. 2) The lower limit of inhouse acceptance criteria cannot be < 40%.	In addition to the requirements of EPA Draft Method 1633, the following must be met: Samples may be re-extracted and analyzed outside of holding times, as necessary for corrective action associated with QC failure. Examine the project-specific requirements. Contact the client as to additional measures to be taken.	If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	EPA Draft Method 1633 equivalent to the LCS is the Ongoing Precision and Recovery Standard (OPR). EPA Draft Method 1633 equivalent to the LLLCS is Low-Level Ongoing Precision and Recovery Standard (LLOPR).

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Matrix Spike (MS) and Matrix Spike Duplicate (MSD)	One MS/MSD pair per prep batch.	In addition to the requirements of EPA Draft Method 1633, the following must be met: Analyte recoveries must be within in-house LCS limits if project limits are not provided; otherwise, project limits must be met. RPD ≤ 30% (between MS and MSD).	Examine the project-specific requirements. Contact the client as to additional measures to be taken. If the analyte(s) are not listed, use inhouse LCS limits if project limits are not specified.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative.	The data shall be evaluated to determine the source of the difference.

Notes:
> = greater than
≥ = greater than or equal to
< = less than
≤ = less than or equal to
% = percent
AFFF = aqueous film forming foam
CCV = continuing calibration verification
CV = calibration verification
EIS = extracted internal standard
EPA = environmental protection agency
ICAL = initial calibration for all analytes
ICV = initial calibration verification
ISC = instrument sensitivity check (ISC)
LCS = laboratory control spike
LLLCS = low -level laboratory control spike
LLOPR = low-level ongoing precision and recovery standard
LOQ = limit of quantitation
MB = method blank
MD = matrix duplicate
MS = matrix spike
MS/MSD = matrix spike/matrix spike duplicate
NA = not applicable
NEtFOSA = N-Ethyl perfluorooctanesulfonamide
NEtFOSAA = N-ethyl perfluorooctane sulfonamido acetic acid
NEtFOSE = N-ethyl perfluorooctane sulfonamido ethanol
NIS = non-extracted internal standard
NMeFOSA = N-methyl perfluorooctanesulfonamide
NMeFOSAA = N-methyl perfluorooctane sulfonamido acetic acid
NMeFOSE = N-methyl perfluorooctane sulfonamido ethanol
OPR = ongoing precision and recovery standard
PFAS = per- and polyfluoroalkyl substances
PFHxS = Perfluorohexanesulphonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid
PFOSA = Perfluorooctanesulfonamide
PFNA = Perfluorononanoic acid
QA = quality assurance
QC = quality control
QSM = Quality Systems Manual
RPD = relative percent difference
SOP = standard operating procedure
SPE = solid phase extraction

Matrix: Solid
Analytical Group: Grain Size
Analytical Method: ASTM D422
SOP Reference: WI11514
Certification Status: DoD ELAP/ NELAP Certification

QC Sample	Frequency/Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible	Measurement Performance Criteria
Sample Duplicate (MD)	One per batch of 20 samples or less	RPD < or = 20%	Examine the project-specific DQOs. Notify the lab QA Officer and Project Chemist of additional measures to be taken.	Analyst or Project Chemist	Evaluate to determine if sample is homogenous

Notes:
ASTM = American Society for Testing and Materials
DoD = Department of Defense
ELAP = Environmental Laboratory Accreditation Program
NA = not applicable
NELAP = National Environmental Laboratory Accreditation Program
QC = quality control
SOP = standard operating procedure

Matrix: Solid
Analytical Group: TOC
Analytical Method: USEPA 9060A
SOP Reference: WI11627
Certification Status: ELAP/NELAP Certification

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

QC Sample	Frequency/Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible	Data Quality Indicator
LCS	One per preparatory batch, maximum of 20 samples	See WS#15	If LCS fails to meet lab criteria, the source of inaccuracy should be investigated and samples reanalyzed. If additional sample is not available, report in a narrative.	Analyst, Supervisor, QA Manager	Accuracy/Bias
MS	One pair per batch (assuming sufficient volume exists) or as specified by client request.	See WS#15	If recovery is outside control limits and a lab error suspected, repeat the MS determination. If the LCS is within control limits and the matrix interference is indicated, analyze a post digestion spike and report results with a narrative.	Analyst, Supervisor, QA Manager	Accuracy/Bias
DUP/MSD	One pair per batch (assuming sufficient volume exists) or as specified by client request.	RPD should be ≤20	Investigate the source of the precision error. A source of precision error in the DUP/MSD may be the homogenous nature of the sample. If lab error is suspected, repeat analysis. If matrix issue is indicated, report with a narrative.	Analyst, Supervisor, QA Manager	Accuracy/Bias

Notes:
> = greater than
DQI = data quality indicator
DUP = duplicate
ELAP = Environmental Laboratory Accreditation Program
LCS = laboratory control spike
LOQ = limit of quantitation
MD = matrix duplicate
MS/MSD = matrix spike/matrix spike duplicate
NELAP = National Environmental Laboratory Accreditation Program
QA = quality assurance
QC = quality control
RPD = relative percent difference
TOC = Total Organic Carbon
SOP = standard operating procedure
USEPA = United States Environmental Protection Agency

Matrix: Solid
Analytical Group: pH
Analytical Method: USEPA 9045D
SOP Reference: WI11518
Certification Status: ELAP/NELAP Certification

QC Sample	Frequency/Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible	Data Quality Indicator
QC Check Buffer	Before sample analysis, after every 20 samples and at the end of analysis	Within ±0.05 pH of true value	Do not analyze samples without a daily LCS which meets criteria.	Analyst, Supervisor, QA Manager	Bias/Contamination
Duplicate	One per batch, maximum of 20 samples	Within 0.1 pH unit	Repeat if sample volume allows or narrate results	Analyst, Supervisor, QA Manage	Accuracy/Bias

Notes:
% = percent
≤ = less than or equal to
DQI = data quality indicator
ELAP = Environmental Laboratory Accreditation Program
LCS = laboratory control spike
MD = matrix duplicate
MS = matrix spike
NELAP = National Environmental Laboratory Accreditation Program
QC = quality control
SOP = standard operating procedure
SPE = solid phase extraction
USEPA = United States Environmental Protection Agency

QAPP Worksheet #29: Project Documents and Records

Record	Generation	Verification	Storage Location/Archival
Field Logbook or Data Collection Sheets	Field Task Leader	Facility Task Manager	Project Central File (electronic, Germantown Server/ hard copy, Germantown, MD Office)
Chain-of-Custody Forms	Field Task Leader	Facility Task Manager	Project Central File
Air Bills	Field Task Leader	Facility Task Manager	Project Central File
Contractor Daily QC Reports	Contractor Task Leader	Field Task Leader/Project Director	Project Central File
Custody Seals	Field Task Leader	Analytical Laboratory	Project Central File
Corrective Action Forms	Field Task Leader	Facility Task Manager	Project Central File
Field Sampling Forms	Field Task Leader	Facility Task Manager	Project Central File
Sample Location and Depth Data	Field Task Leader	Facility Task Manager	Project Central File
Field Equipment Calibration Logs	Field Task Leader	Facility Task Manager	Project Central File
Equipment Inspection Forms	Facility Task Leader	Facility Task Manager	Project Central File
Boring Logs	Field Task Leader	Facility Task Manager	Project Central File
Daily Tailgate SH&E Sign-In Sheet	Field Task Leader	Facility Task Manager	Project Central File
APP/ SSHP Acknowledgement	Field Task Leader	Facility Task Manager	Project Central File
Dig Permits	Drilling Contractor	Facility Task Manager	Project Central File
Sample Receipt, Custody, and Tracking Records	Analytical Laboratory	Facility Task Manager	Project Central File
Sample Prep Logs	Analytical Laboratory	Facility Task Manager	Project Central File
Equipment Calibration Logs	Field Task Leader	Facility Task Manager	Project Central File
Run Logs	Analytical Laboratory	Chemistry Lead	Project Central File
Reported Analytical Results	Analytical Laboratory	Chemistry Lead	Project Central File
Data Package Completeness Checklists	Chemistry Lead	Facility Task Manager	Project Central File
Sample Disposal Records	Analytical Laboratory	Chemistry Lead	Project Central File
Raw Data	Analytical Laboratory	Chemistry Lead	Project Central File
EQuIS™	Chemistry/Database Lead	Facility Task Manager	Project Central File
ROE Agreements	Field Task Leader	Facility Task Manager	Project Central File

Record	Generation	Verification	Storage Location/Archival
Photographic Logs	Field Task Leader	Facility Task Manager	Project Central File
Field Sampling Audit Records	Field Task Leader	Facility Task Manager	Project Central File
Laboratory Audit Records	Chemistry Lead	Facility Task Manager	Project Central File
Data Validation Reports	Chemistry Lead	Facility Task Manager	Project Central File
Data Usability Assessment Reports	Chemistry Lead	Facility Task Manager	Project Central File
Field Change Request Forms	Field Task Leader	Facility Task Manager	Project Central File

Notes:
APP/SSHP = Accident Prevention Plan/ Site Safety and Health Plan
CoC = chain of custody
EQuIS = Environmental Quality Information System
NA = not applicable
ROE = right of entry
SH&E = Safety, Health, and Environment

QAPP Worksheet #31, #32 & #33: Assessments and Corrective Action

This worksheet is used to document responsibilities for conducting project assessments, responding to assessment findings and implementing corrective action. Appropriately scheduled assessments allow management to implement corrective action in a timely manner, thereby correcting non-conformances and minimizing their impact on DQOs/Project Quality Objectives.

Assessments:

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Action	Person(s) Responsible for Monitoring Effectiveness of Corrective Action
PM Review	Monthly (for field efforts that are longer than one month)	Internal	AECOM	PM/AECOM	Field Sampling Team Leader/ AECOM	Field Sampling Team Leader/ AECOM	Project Manager/ AECOM
Review of CoC forms	Daily	Internal	AECOM	Project Chemist/ AECOM	Field Sampling Team Leader/ AECOM	Field Sampling Team Leader/ AECOM	Project Chemist/ AECOM
Laboratory Data Assessment (validation)	Once	Internal	AECOM	Data Validator	Project Chemist/ AECOM	Data Validator	Project Chemist/ AECOM
Daily QC Audits	Daily	Internal	AECOM	Field Sampling Team Leader/ AECOM	Field Sampling Team Leader/ AECOM	Field Sampling Team Leader/ AECOM	QA Officer/ AECOM
Field TSAs	Daily	Internal	AECOM	Field Sampling Team Leader/ AECOM	Field Sampling Team Leader/ AECOM	Field Sampling Team Leader/ AECOM	QA Officer/ AECOM
Field Performance Audits	Weekly	Internal	AECOM	PM/ AECOM or representative	Field Sampling Team Leader/ AECOM	Field Sampling Team Leader/ AECOM	Project Manager/ AECOM

Notes:
AECOM = AECOM Technical Services, Inc.
CoC = chain of custody
PM = project manager
QA = quality assurance
QC = quality control
TSA = technical system audit

Assessment Response and Corrective Action:

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Field Sampling Audit	Email	Field Sampling Team Leader/AECOM PM	Immediate	Daily QC Report/ Email	Project Quality Manager/ PM	24 hours after notification
PM Review	Email	Field Sampling Team Leader/ AECOM	Immediate	Daily QC Report/ Email	AECOM PM	24 hours after notification
Review of CoC forms	Email	Field Sampling Team Leader/AECOM PM	Immediate	Daily QC Report/ Email	Project Chemist	24 hours after notification
Laboratory Data Assessment (validation)	Written Audit Report	Laboratory QA Manager; AECOM Project Chemist	Within 24 hours after audit	Email	Data Validator	Up to 1 week after notification
Daily QC Audits	Email/ Daily QC Report	Field Sampling Team Leader/AECOM PM	Immediate	Daily QC Report/ Email	AECOM PM	24 hours after notification
Field TSAs	Email/ Daily QC Report	Field Sampling Team Leader/AECOM PM	Immediate	Daily QC Report/ Email	AECOM PM	24 hours after notification
Field Performance Audits	Email	Field Sampling Team Leader	Immediate	Daily QC Report/ Email	AECOM PM	24 hours after notification

Notes:
AECOM = AECOM Technical Services, Inc.
CoC = chain of custody
PM = project manager
QA = quality assurance
QC = quality control
TSA = technical system audit

Laboratory Assessments

Assessment Type	Responsible Party & Organization	Number/ Frequency	Estimated Dates	Assessment Deliverable	Deliverable Due Date
DoD/ELAP Accreditation	Accreditation body	Every 2 Years	NA	Certification	NA
Performance testing samples	Laboratory QA Manager	Accreditation	Per Accrediting Authority	Per Accrediting Authority	Per Accrediting Authority
Data Review	Naoum Tavantzis, AECOM	Once	45 days after receipt of data	Validation Report	45 days after receipt of data
External Laboratory Audit	Accreditation Body	Bi-annually	NA	Written Audit Report	NA
Internal Laboratory Audit	Contracted Laboratory	Annually	NA	Written Audit Report	NA

Notes:
AECOM = AECOM Technical Services, Inc.
DoD = Department of Defense
ELAP = Environmental Laboratory Accreditation Program
NA = not applicable
QA = quality assurance

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QAPP Worksheet #34: Data Verification and Validation Inputs

Item	Description	Verification (Completeness)	Validation (Conformance to Specifications)
Planning Documents/Records			
1	Approved QAPP	X	
2	Contract	X	
4	Field SOPs	X	
5	Laboratory SOPs	X	
Field Records			
6	Field logbooks	X	
7	Equipment calibration records	X	
8	CoC Forms	X	X
9	Sampling diagrams/surveys	X	
10	Drilling logs	X	
11	Relevant correspondence	X	
12	Change orders/deviations	X	
13	Field audit reports	X	
14	Field change request forms	X	
Analytical Data Package			
16	Cover sheet (laboratory identifying information)	X	X
17	Case narrative	X	X
18	Internal laboratory CoC	X	X
19	Sample receipt records	X	X
20	Sample chronology (i.e., dates and times of receipt, preparation, and analysis)	X	X
21	Communication records	X	
22	LOD/LOQ establishment and verification	X	
23	Standards traceability	X	
24	Instrument calibration records	X	X
25	Definition of laboratory qualifiers	X	
26	Results reporting forms	X	X
27	QC sample results	X	X
28	Corrective action reports	X	X
29	Raw data	X	X
30	Electronic data deliverable	X	X

Notes:
CoC = chain of custody
LOD = limit of detection
LOQ = limit of quantitation
QAPP = Quality Assurance Project Plan
QC = quality control
SOP = standard operating procedure

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QAPP Worksheet #35: Data Verification Procedure

This worksheet documents procedures that will be used to verify project data. The procedures apply to both field and laboratory records. Data verification is a completeness check to confirm that all required activities were conducted, all specified records are present, and the contents of the records are complete. As illustrated in the following example, verification often is performed at more than one step by more than one person.

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
Chain of custody forms and shipping forms	CoC, Shipping Documents	CoC forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the CoC should be initialled by the reviewer, a copy of the CoC retained in the site file, and the original and remaining copies taped inside the cooler for shipment.	Appropriate Field Sampling Team Leaders for the individual medias
Review of field logbooks	Field Logbooks	Review for completeness and accuracy.	Appropriate field Sampling Team Leaders
Field sampling TSAs	TSA Reports	Assessment of field sampling process prior to start of, or as close to the start of sampling as possible.	QA Manager or designee
Fixed laboratory analytical data review	Laboratory Data Package	Data controls are compared to this QAPP and DoD QSM 5.4 (PFAS by LC/MS/MS compliant with QSM 5.4 Table B-24/Draft USEPA Method 1633) in a Three-Tiered process using a minimum 100% peer review.	Laboratory PM
Fixed laboratory TSAs	Laboratory Data Package	ELAP audit and internal quality audits.	Laboratory QA Manager
Fixed laboratory data verification	Data Validation Reports	100% data verification/validation for water and soil.	AECOM Project Chemist
Fixed laboratory data validation	Data Validation Reports	Calculate and assess laboratory DQIs.	QA Manager, or designee

Notes:
% = percent
AECOM = AECOM Technical Services, Inc.
CoC = chain of custody
DoD = Department of Defense
DQI = data quality indicator
ELAP = Environmental Laboratory Accreditation Program
PFAS = per- and polyfluoroalkyl substances
PM = Project Manager
QA = quality assurance
QAPP = Quality Assurance Project Plan
QSM = Quality Systems Manual
TSA = technical system audit
USEPA = United States Environmental Protection Agency

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QAPP Worksheet #36: Data Validation Procedures

Data Validator: AECOM

Analytical Group/Method	Definitive Analytical Data	RSC Analytical Data **(if applicable)**
Analytical specifications	WS#24, WS #28 & Laboratory SOPs	
Measurement performance criteria	WS #12, WS#15, and WS#28	
Percent of data packages to be validated	100%	100%
Percent of raw data reviewed	10%	0%
Percent of results to be recalculated	10%	0%
Validation procedure and qualification	Department of Defense General Data Validation Guidelines, November 2019 (DoD, 2019b); Data Validation Guidelines Module 6: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-24 (DoD, 2022).	
Validation code	90% S2BVEM/S2BVM 10% S4VM	S2BVM
Electronic validation program/version	EarthSoft EQuIS™ Data Quality Manager	

Notes:
% = percent
AECOM = AECOM Technical Services, Inc.
DoD = Department of Defense
EQuIS = Environmental Quality Information System
SOP = standard operating procedure
USEPA = United States Environmental Protection Agency
WS = worksheet
[1] Stage 2A Deliverable includes review of batch-level QC including method blanks, LCS/MS percent recoveries, duplicate precision.

Flag	Interpretation
U	The analyte was not detected and was reported as less than the LOD or as defined by the customer. The LOD has been adjusted for any dilution or concentration of the sample. *
J+	Reported value may not be accurate or precise, but the result may be biased high.
J-	Reported value may not be accurate or precise, but the result may be biased low.
J	The analyte was positively identified, and the associated numerical value is the approximate concentration of the analyte in the sample (due either to the quality of the data generated because certain QC criteria were not met, or the concentration of the analyte was below the LOD.
UJ	The analyte was not detected at a level greater than or equal to the adjusted DL. However, the reported adjusted DL is approximate and may be inaccurate or imprecise.
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 QC 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.

*DoD Flag, “R” flag applied to replace X-flag in a final decision if data are determined to be not usable by project team

QAPP Worksheet #37: Data Usability Assessment

The Data Usability Assessment (DUA) is an evaluation at the conclusion of data collection activities that uses the results of both data verification and validation in the context of the overall project decisions or objectives. Using both quantitative and qualitative methods, the assessment will determine whether project execution and the resulting data the DQOs established in **Worksheet #11** were achieved. Both sampling and analytical activities will be considered with the ultimate goal to assess whether the final, qualified results support the decisions to be made with the data.

The following personnel are responsible for participating in the DUA:

AECOM Project Manager: Claire Mitchell

AECOM Project Chemist: Naoum Tavantzis

AECOM RI Task Manager: Peggy Yang

The DUA will be documented as a discussion within the Prescriptive Phase RI Report and refer to the Data Validation Report that will appear in an appendix of the Prescriptive Phase RI Report. The Data Validation Report will follow the procedures given in **Worksheet #36**.

The following steps summarize the processes used to determine whether the collected data are of the right type, quality, and quantity to support the environmental decision-making for ARNG related to PFAS contamination at certain installations and describe how data quality issues will be addressed and how limitations on the use of the data will be handled.

Step 1	**Review the project's objectives and sampling design.** The key components established in the DQOs (**Worksheet #11**) will be reviewed to ensure that they are still applicable. Also, the sampling design and how it was implemented in the field will be reviewed for consistency with the stated objectives. For example, this step in the DUA will: • Reevaluate whether comparison criteria (i.e., SL; **Worksheet #15**) were updated since QAPP generation and if laboratory QLs were sensitive enough for those changes (e.g., QLs remain lower than new criteria). It is important to note several states are in various stages of developing or finalizing limits for PFAS chemicals for different media; therefore, it is critical that SLs are regularly evaluated over the course of the project to ensure the SLs remain current. Additionally, project data must meet the MPC for sensitivity and project QLs specified in **Worksheets #15 & 28**. • Discuss the limitations and impact on the use of project data if validation reports indicate that project specific sensitivity goals or QLs were not achieved for a specific sampling or laboratory group, dataset or sample delivery group (SDG), matrix, analytical group, or concentration level.
Step 2	**Review the data verification and data validation outputs.** Available Quality Assurance (QA) reports, including both field and laboratory generated forms, will be reviewed for deviations from planned activities identified in Step 1 (e.g., number and locations of samples, holding time exceedances, damaged samples, non-compliant proficiency testing sample results, and SOP deviations) and determine their impacts on the data usability. Validated data will be summarized and/or compiled to identify patterns, trends, and anomalies as they relate to the data quality indicators (DQIs) precision, accuracy/bias,

	representativeness, comparability, completeness, and sensitivity. Descriptions of each DQI and examples of how each may be incorporated into the usability report follow.
Step 2 (cont.)	**Precision** Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, percent difference, or range, in either absolute or relative terms. QC measures for precision include FDs, laboratory duplicates, MSDs, analytical replicates, and surrogates. To meet the needs of the data users, RI project data must meet the MPC for precision specified in **Worksheet #12** of this QAPP. Precision errors may be the result of one or more of the following: PFAS cross-contamination, field instrument variation, analytical measurement variation, poor sampling technique, sample transport problems, or spatial variation (heterogeneous sample matrices). To identify the cause of imprecision, the field sampling design rationale and sampling techniques will be evaluated by the reviewer, and both field and analytical duplicate/replicate sample results will be compared. For example, if poor precision is indicated in both the field and analytical duplicates/replicates, then the laboratory may be the source of error. If poor precision is limited to the FD/replicate results, then the sampling technique, PFAS contamination, field instrument variation, sample transport, medium inhomogeneity, or spatial variability may be the source of error. If data validation reports indicate that analytical imprecision exists for a particular dataset or SDG, then the impact of that imprecision on usability will be discussed in the usability report.
	Accuracy/Bias Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) due to sampling and analytical operations. Examples of QC measures for accuracy include MSs, Laboratory Control Samples, and ERBs. A measurement is accurate when the reported value does not differ from the true value or known concentration of the spike or standard. To meet the needs of the data users, project data must meet the MPC for accuracy/bias specified in **Worksheet #12** of this QAPP. The usability report for each installation will: Discuss and compare data on contamination and accuracy/bias (when bias is observable) for each matrix, analytical group, and concentration level. Describe the limitations on the use of project data if extensive contamination, inaccuracy, or bias exists, or when inaccuracy is limited to a specific sampling or laboratory group, dataset or SDG, matrix, or concentration level. Discuss the impact of any qualitative and quantitative trends in bias on the sample data.
	Representativeness Representativeness is the measure of the degree to which data accurately and precisely represent a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition, and it is achieved through a well-designed sampling program and by using standardized sampling strategies, techniques, and analytical procedures. To meet the needs of the data users, project data must meet the MPC for sample representativeness specified in **Worksheet #12** of this QAPP. **Worksheet #28 & 35** discusses how the QA/QC activities (e.g., review of sampling design and SOPs, field sampling Technical System Audits (TSAs), and analysis audits) and QC sample data will be reviewed to assess sample representativeness. For example, if FD precision checks indicate potential spatial variability, additional scoping meetings and subsequent resampling may be needed to collect data that are more representative of a nonhomogeneous site. The usability report for each installation will: Discuss the impact of FD imprecision onsite representativeness. For example, when data variability is high among FD datasets (i.e., high relative standard deviation), calculation of the 95% UCL of the population mean is more likely to overestimate the true mean and therefore achieve better statistical coverage.

	Discuss the impact of laboratory and field sampling methods on sampling results and how they reflect site conditions.
Step 2 (cont.)	Discuss the effect of site heterogeneity on sampling results in light of sampling methods used. Describe the limitations on the use of project data when sampling results are non-representative for all data or for a specific sampling, group, dataset or SDG, matrix, analytical group, or concentration level.
	Comparability Comparability is the degree to which different methods, datasets, and decisions agree or can be represented as similar. Comparability describes the confidence (expressed qualitatively or quantitatively) that two datasets can contribute to a common analysis and interpolation. The RI results will be used as benchmarks for determining comparability for data collected during any future sampling events at the various installations using the same or similar sampling and analytical SOPs. At this time, data will not be compared to other datasets or data using different sampling or analytical SOPs. To ensure future comparability of data generated for the installations, standard sample collection procedures and approved analytical methods will be used. Sample analyses will be performed by the laboratory using approved methods and procedures. Comparability criteria will be considered met for the project if, based on data reviewed, the sample collection and analytical procedures (such as use of alternate preparation if indicated by a positive field shake test) are determined to have been followed or defined to show that variations did not affect the values reported. Deviations to sampling scope will be documented in sampling nonconformance reports which may contain some of the discussion of comparability. The usability reports will describe the limitations on the use of project data when project-required data comparability is not achieved for the overall project or is limited to a specific sampling or laboratory group, dataset or SDG, matrix, analytical group, or concentration level.
	Completeness Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under correct, normal circumstances. To meet the needs of the data users, project data must meet the MPC for data completeness. Completeness criteria will be considered met if 100% of all planned sample data are collected. As applicable, the usability report may also: Describe how the amount of valid data will be determined as a percentage of the number of valid measurements for each matrix, analytical group, and concentration level. Describe how critical data were assessed for completeness when certain sample locations or analytes and matrices are more critical than others in making project decisions. Evaluate the impact of missing information. Ensure that enough information was obtained for the data to be usable to meet the DQOs (**Worksheet #11**).
	Sensitivity Sensitivity is the capability of a test method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. Examples of QC measures for determining sensitivity include laboratory fortified blanks, a DL study, LOD/LOQ Verifications, and Instrument Sensitivity Checks (ISC). To meet the needs of the data users, project data must meet the MPC for sensitivity and project QLs specified in **Worksheets #15 & 28** of this QAPP. If appropriate, the usability report may also: Discuss and compare sensitivity and DL/LOD/LOQ from the datasets collected for the project for each matrix, analytical group, and concentration level. Discuss the impact of a lack of sensitivity or higher DL/LOD/LOQ on data usability, if validation reports indicate that sensitivity goals or DL/LOD/LOQ goals were not achieved.

Step 2 (cont.)	Describe the limitations on the use of project data when sampling results are non-representative for all data or for a specific sampling, group, dataset or SDG, matrix, analytical group, or concentration level.
Step 3	**Verify the assumptions of the selected statistical method** The use of statistical methods for data assessment for this project will be limited to estimating a 95% UCL (or mean as appropriate for the analyte) for the assessment of risks.
Step 4	**Implement the statistical method** Where statistical methods are used, the underlying assumptions will be assessed during the DUA. The consequences of selecting the incorrect alternative will be discussed, and uncertainty tolerances will be considered.
Step 5	**Document data usability and draw conclusions** The DUA will determine and document whether the data can be used as intended given any deviations and corrective actions that may have occurred. Limitations on data use will be considered and discussed as appropriate, and the performance of the sampling design assessed. Conclusions will be drawn taking any data limitations into consideration and documented in the Mobilization 1 RI Report.

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Appendix A
TPP1 Meeting Minutes

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Meeting Minutes
West Bend, WI
Technical Project Planning (TPP) – Meeting 1
Remedial Investigations (RI), Feasibility Studies (FS), Decision Documents (DD), and Time Critical / Non-Time Critical Removal Actions (TCRA/NTCRA) for Per-and Polyfluoroalkyl Substances (PFAS) Impacted Sites
Army National Guard (ARNG) Installations, Nationwide
Contract No. W912DR-19-D-0001, DO W912DR21F0349
Monday, 5 December 2022
1000-1045

Participants			
Name	**Affiliation***	**Phone**	**E-Mail**
Amanda Sullivan	ARNG G-9	304-642-6000	Amanda.d.sullivan7.ctr@army.mil
Steve Gragert	USACE, Omaha	402-995-2743	Steven.Gragert@usace.army.mil
Zach Chytil	USACE, Omaha	402-657-1430	Zach.A.Chytil@usace.army.mil
Emily Cline	USACE, Baltimore	410-962-7966	Emily.J.Cline@usace.army.mil
Tim Peck	USACE, Baltimore	410-962-3416	timothy.j.peck@usace.army.mil
Scott Rickard	WIDMA	608-242-3364	scott.rickard@widma.gov
Riley Neumann	WIDNR	414-750-7030	Riley.Neumann@wisconsin.gov
Tim Alessi	WIDNR	414-881-1015	timothy.alessi@wisconsin.gov
Savannah Wolfe	AECOM	310-465-6190	savannah.wolfe@aecom.com
Peggy Yang	AECOM	540-446-1794	peggy.yang@aecom.com
Matt Costakis	AECOM	301-944-5915	matt.costakis@aecom.com

** Notes: ARNG-G9 - Army National Guard-G9; WIDMA – Wisconsin Department of Military Affairs; WIDNR – Wisconsin Department of Natural Resources; USACE – United States Army Corps of Engineers*

Ms. Peggy Yang (AECOM) welcomed participants and reviewed the purpose of the meeting, outlined the agenda, and led a roundtable of introductions for everyone on the virtual Technical Project Planning (TPP) meeting. This was a TPP1 meeting with the purpose of discussing the Army National Guard (ARNG) Per- and Polyfluoroalkyl Substance (PFAS) Remedial Investigation (RI) project, the West Bend Army Aviation Support Facility (AASF) #1 and Armory site inspection (SI) findings, and proposed RI approach.

Presentation slides were provided to participants prior to the meeting and are included in **Attachment A**. Key points that supplement the presentation are summarized below.

A safety moment was provided to the participants. Ms. Yang discussed preparations for winter driving and provided a list of items to keep in your emergency car kit.

<u>Introductions and Programmatic Discussion (Slides 4–8):</u>

- The ARNG RI program is contracted through the Baltimore District of the United States Army Corps of Engineers (USACE) with support from the Omaha district for West Bend but is managed by the ARNG G-9.
- The program follows the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) progress. ARNG G-9 is the Lead Agency under CERCLA
- The first step in the CERCLA process is the Preliminary Assessment (PA), which has been finalized for this facility. The purpose of the PA was to determine the likelihood of release and whether any complete pathways existed to drinking water receptors. Results of the PA determined whether a specific Area of Interest (AOI) would move to the SI phase or be recommended for No Further Action, per the CERCLA process.
- The primary goal of the SI was to determine the presence or absence of PFAS at the source areas and facility boundary, the SI report was finalized in March 2022.
- Currently, ARNG is initiating the RI phase of the program, where the goal is to delineate the nature and extent of PFAS impact at AOIs that had been confirmed under the SI and conduct baseline risk assessments.
- Participants for the RI TPP1 included ARNG G-9, U.S. Army Corps of Engineers (USACE), Wisconsin Department of Military Affairs (WIDMA), Wisconsin Department of Natural Resources (WIDNR) and

AECOM; participants for the future RI TPP2 meeting may include the addition of other local stakeholders, such as the West Bend Municipal Airport.

West Bend SI Overview (Slides 9-18):

- Data quality objectives (DQOs) were presented for the SI. The primary DQOs were to confirm the presence or absence of a PFAS release at a potential source area and to gather data to refine the conceptual site model (CSM). Secondary goals are to determine the presence/absence at the ARNG facility boundary.
- The September 2021 Office of the Secretary of Defense (OSD) Screening Levels (SLs) were presented for groundwater and soil. The AOIs exceeding the OSD SLs during the SI were recommended to proceed to the RI phase.
- Ms. Savannah Wolfe (AECOM) provided a summary of the SI findings. No PFAS exceedances were observed in the surface or subsurface soil samples. At both AOIs 1 and 2, exceedances of SLs in groundwater at the source areas were observed. Based on results of the SI, both AOIs 1 and 2 were recommended for further evaluation under the RI phase.
- Updated OSD SLs (6 July 2022) were compared against site data. No overall change to the RI based on the new SLs for soil and groundwater, existing AOIs 1 and 2 will be delineated.

West Bend RI Approach (Slides 19-23):

- Ms. Yang provided an overview of the RI technical approach, which includes three primary phases of field work: predictive, adaptive, and final delineation/monitoring (Slide 19)
- A broad overview of the planned Predictive Phase (Mobilization 1) field work for the West Bend AOIs was presented.
- Rights-of-Entry (ROE) Coordination with the City of West Bend Municipal Airport was discussed.
    - Ms. Yang asked if any permits were required for work outside of the facility boundaries? Mr. Scott Rickard (WIDMA) said that the typical Federal Aviation Administration (FAA) permit would be required, he wasn't aware of any other permits. The Airport should be able to share a map with areas where any investigation work will be restricted or not permitted.
    - Ms. Amanda Sullivan (ARNG G-9) discussed the FAA permit process, stating the map with polygons will be utilized during the FAA notification process. She stated that as we move further along in the planning phase, ARNG G-9 will collaborate with USACE and WIARNG and reach out to the Airport early during the FAA notification process and to secure the ROE. AECOM will support the ROE coordination by providing a map with polygons showing the sampling areas.
- Ms. Yang also asked if there were any upcoming construction projects at the facility that AECOM should be aware of. Mr. Rickard said that as we get closer to mobilization, WIDMA will help relay any work restrictions (due to flight times) or any planned construction projects.
- The project schedule from the RI QAPP Addendum to the Predictive Phase mobilization was discussed.
    - Mr. Riley Neumann (WIDNR) asked when the Draft Final QAPP Addendum would be submitted to WIDNR for review. Ms. Yang said that it should be submitted by early spring 2023, prior to the RI TPP2 meeting.
    - Ms. Amanda Sullivan (ARNG G-9) asked when the project team would be having the internal Community Involvement Plan (CIP) Kick-Off call. Ms. Yang said that AECOM can schedule the CIP Kick-Off call for whatever future date works best for the project team.
    - Ms. Sullivan added that in addition to the CIP Kick-Off call, the internal prescriptive phase scoping meeting should be scheduled next, likely after the holidays.

<u>Open Discussion (Slide 24):</u>

- Ms. Sullivan asked Mr. Rickard to brief the project team on the status of Interagency Support Agreement (ISSA) funding. ISSA funding has been submitted and approved but inquired if the funds had been received yet. Mr. Rickard said that WIDMA has not received ISSA funds from ARNG G-9 yet.
- Ms. Sullivan said that she will help track the funding status as Mr. Dave Connolly has taken a new position. LTC Hunsaker can also help. The RI is funded under the Clean-up program, Operations and Maintenance. The goal is to fund the Feasibility Study under the Defense Environmental Restoration Program (DERP), which is currently in the process of requesting eligibility. The presentation ended at 1045 and the phone line was closed.

Attachment A – RI TPP 1 Briefing Slides

Technical Project Planning Meeting 1
West Bend Army Aviation Support Facility #1 and Armory, Wisconsin

5 December 2022

Remedial Investigations (RI), Feasibility Studies (FS), Decision Documents (DD), and Time Critical / Non-Time Critical Removal Actions (TCRA/NTCRA) for Per-and Polyfluoroalkyl Substances (PFAS) Impacted Sites Army National Guard (ARNG) Installations, Nationwide

Contract No. W912DR-19-D-0001
Task Order W912DR21F0349

Agenda

Introductions
Safety Moment
Technical Project Plan (TPP) Meeting Goals
Program Overview
Program Organization and Communication
Site Inspection (SI) Overview
RI Technical Approach
RI Community Involvement
Schedule
Questions and Open Discussion

Safety Moment –Prepare for Winter Driving

1. Ready your vehicle – battery, wipers, coolant, lights, tires, etc.

2. Ready yourself – learn how your vehicle handles in wet, icy or snow roads, allow for time for travel, increase your following distance, plan your route.

3. Ready for an emergency – obtain, check, and maintain emergency and safety car kit list.

4. Safe driving – safety belts for everyone, child age-appropriate seats – adjust for winter clothing, avoid distractions such as electronic driving.

Car Safety Kit List

Keep these items in a bag in your trunk:

- Battery-powered radio, flashlight, and extra batteries
- Blanket
- Booster cables
- Bottled water and nonperishable high-energy foods such as granola bars, raisins, and peanut butter
- Fire extinguisher (5-lb., A-B-C type)
- First-aid kit and manual
- Maps, shovel, electronic flares
- Tire repair kit and pump
- Spare tire

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Introductions

ARNG G-9

David Connolly, PFAS Program Manager

Bonnie Packer, Nationwide Project Manager

Amanda Sullivan, ARNG Project Manager

Wisconsin Department of Military Affairs (WIDMA)

Scott Rickard, Environmental Branch Chief

Theresa Brandabur, Water Resources Manager

United States Army Corp of Engineers (USACE)

Tim Peck, Nationwide Project Manager

Emily Cline, Nationwide Project Manager

Zach Chytil, Project Manager, Omaha District

Steve Gragert, Technical Lead, Omaha District

Wisconsin Department of Natural Resources (WIDNR)

Jared Seidl, Assigned Green Tier Point of Contact for Wisconsin ARNG

Trevor Nobile, Field Operations Direction

Judy Fassbender, Natural Resources (NR) Program

Timothy Alessi, NR Region Program Manager

Riley Neumann, Hydrologist Project Manager

AECOM

Claire Mitchell, Project Manager

Peggy Yang, AECOM RI Facility Task Leader

Savannah Wolfe, RI Field Leader

TPP Meeting Goals

- Provide an overview of the ARNG RI/FS Program
- Review regulatory framework
- Discuss SI Findings
- Define objectives for RI
- Encourage stakeholder involvement
- Review project schedule
- Capture action items

Program Overview – CERCLA Work Phases

Notes: *Current stage of activity

- Follows the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Process
- Preliminary Assessment and Site Inspection complete
- An interim removal action (e.g., TCRA or NTCRA) can be conducted or a No Further Action determination can be made at any phase

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Program Organization and Communication – West Bend Army Aviation Support Facility (AASF) #1 and Armory

- RI/ FS including supporting tasks (e.g., community outreach, TCRAs, bottled water supply, etc.) under this contract
- ARNG G-9 is the Lead Agency under CERCLA.
- USACE Omaha is providing contract management support.
- AECOM Project Management Office (PMO) is based out of Germantown, MD and supported through nationwide network

Program Overview - Organization and Communication

USACE and ARNG G9

MAES Program Manager
Scott McClelland, PG

ARNG Program Managers
Rosa Gwinn, PhD, PG
Jessica Travis*
Rhonda Stone, PMP*

MAES Safety Lead
Scott Dietz, CSP, STSC

MAES Quality Lead
Brian Helmlinger

Project Manager
Claire Mitchell, PE, PMP

Senior Scientist
Joseph Quinnan, MS, PE, PG*

Subject Matter Experts
Rachel Casson – PFAS Treatment
Jeff McDonough* - PFAS Treatment
Junaid Sadique, PhD – PRISM™

Project H&S Officer
Scott Dietz, CSP, STSC

Project Quality Officer
Sarah Gettier, PE

Facility Task Leaders

- McNary Field/Salem AASF, OR – Anthony Palmieri, LG, LHG, RG
- Davenport AASF, IA – Matt Costakis
- Boone AASF, IA – Matt Costakis
- Waterloo Big Rock AASF #2, IA – Matt Costakis
- Camp Dodge, IA – Matt Costakis
- Fort Indiantown Gap, PA – Meredith Braverman*
- Lakehurst AASF, NJ - Keith Sheppard*
- Helena AASF, MT – Andrew Borden, PG
- Topeka Forbes Field AASF #1, KS – Afton Hess ★
- West Bend AASF #1, WI – Peggy Yang
- Los Alamitos, CA – Sam Bartlett
- ★ Deputy PMs: TBD, Afton Hess*

Technical Resources

Community Outreach
Laurie Huber

Conceptual Site Models
David Parse Jr., PG
Ryan Samuels
(ESS PRISM™)

Geology/Hydrogeology
Chris Beza, PG
Allan Horneman, PG*
(Bedrock)
Patrick Curry*
(Stratigraphic Flux)

Field Sampling
Local staff

Site Safety & Health
Pool of 25+ SSHOs

Chemistry/ Data Validation
Naoum Tavantzis, MBA
Dennis Capria, PE*

Risk Assessment-Human
Julie Kabel
Gretchen Welshofer

Risk Assessment -Eco
Christine Archer
Heather Loso
Chris Day*

TCRA (Bottled Water)
Sarah Stinger, PG

NTCRA (EE/CA)
Sarah Gettier, PE
Jay Erickson*

Private Wells
Survey-Matt Blower*
Sampling-Savannah Wolfe

FS Alternatives
Corey Theirault, PE*

Treatability Studies
Rebecca Mora, EIT
Shangtao Liang, PhD
David Liles*

Database Management
Nicole Lancaster
Monica Dupre *

GIS/SDSFIE
Michael Stankevich
Charlie Penasack *

Whole House Filter Design
Bjorn Cuento, PE

Animal Tissue/ Agricultural Product Sampling
Sagar Thakali, PhD
David Riggs*

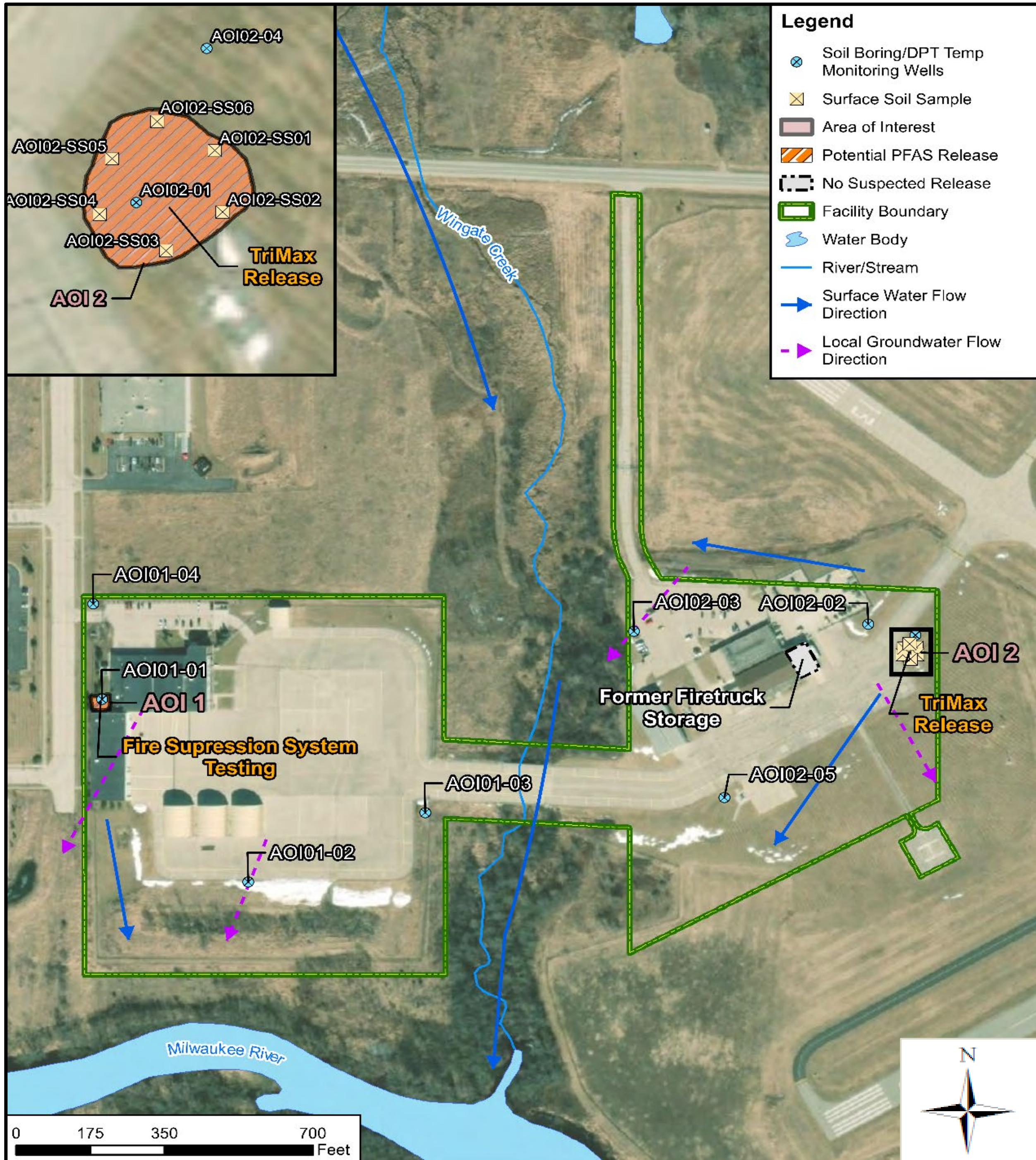
IDW Management
Ed Fahnline, PE
Kevin Engle*

Specialty Subcontractors
Drillers:
-Cascade and other local firms
Analytical Laboratories:
-Pace Gulf Coast (mobile)
-Eurofins
Surveyors:
-hired locally
Utility Locators
-GPRS

* Seres/Arcadis Personnel
Key Personnel
Reporting line
Communication line

SI Overview

- SI field work completed: October 2020
- SI report finalized: March 2022
- Primary data quality objective: presence or absence of perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and perfluorobutanesulfonic acid (PFBS) above screening levels
  - Note: hexafluoropropylene oxide-dimer acid (HFPO-DA commonly known as GenX) was not analyzed during the SI



SI Overview - Screening Levels

- Data screened against Office of the Secretary of Defense (OSD) Screening Levels (SLs) (15 September 2021) to determine if moving forward to RI

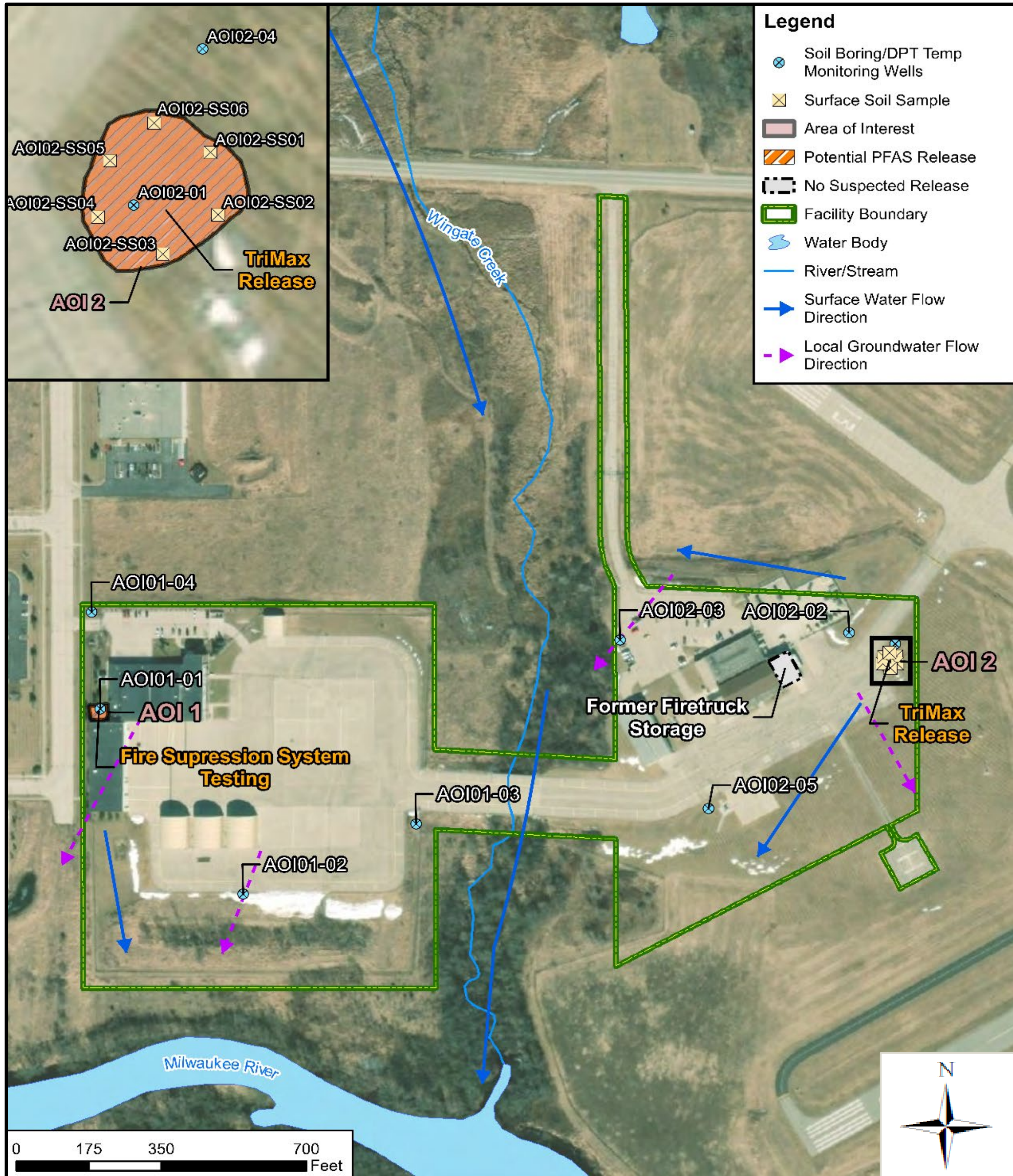
Analyte	Residential (Soil) (µg/kg)[a] 0-2 feet bgs	Industrial/ Commercial Composite Worker (Soil) (µg/kg)[a] 2-15 feet bgs	Tap Water (Groundwater) (ng/L)[a]
PFOA	130	1,600	40
PFOS	130	1,600	40
PFBS	1,900	25,000	600

Notes:
a.) Assistant Secretary of Defense, 2021. Risk Based Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater and Soil using United States Environmental Protection Agency's (USEPA's) Regional Screening Level Calculator. Hazard Quotient (HQ) = 0.1. 15 September 2021 .

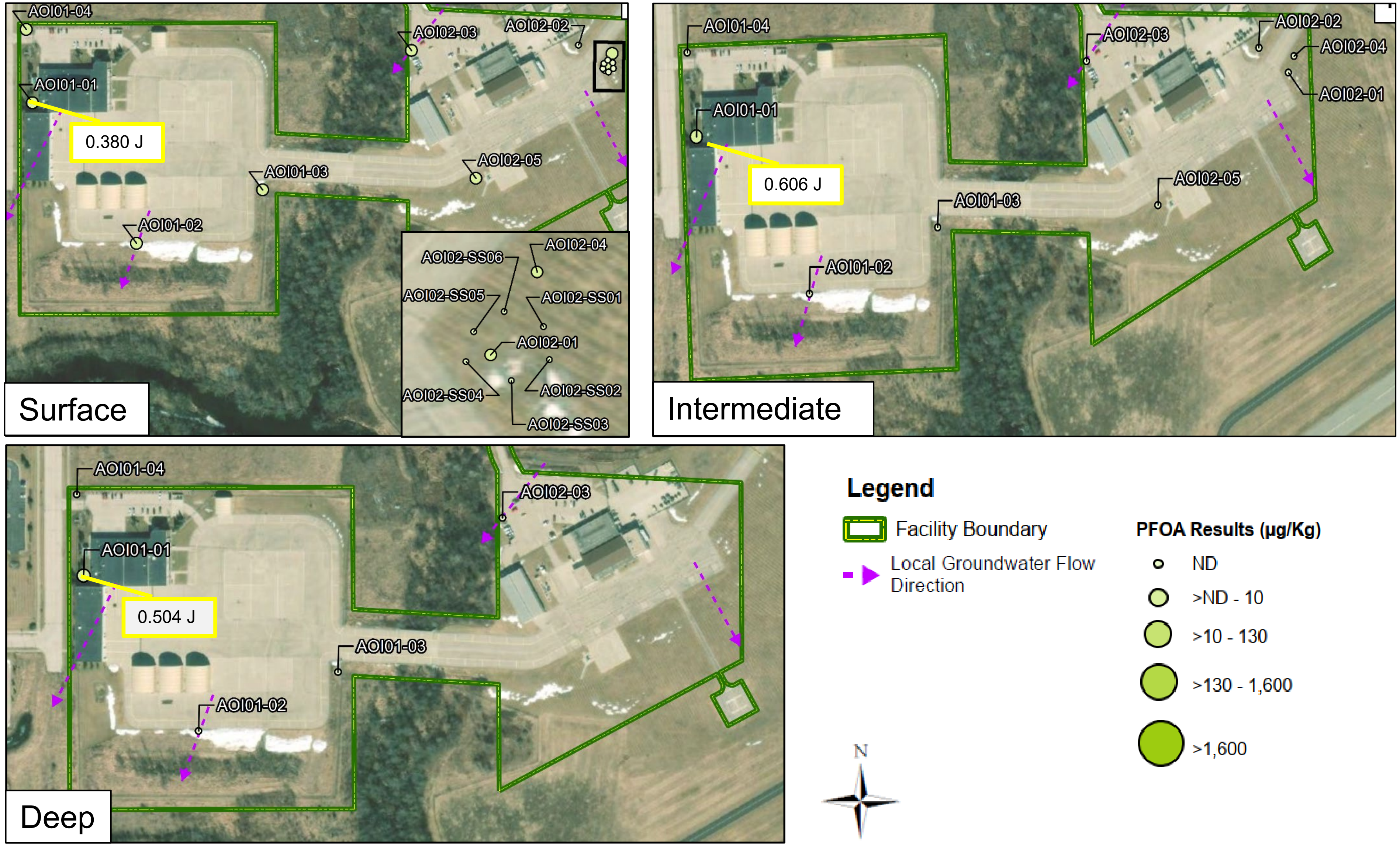
bgs = below ground surface
ng/L = nanograms per liter
OSD= Office of the Secretary of Defense
µg/kg = micrograms per kilogram

SI Overview

- Area of Interest (AOI) 1: Fire Suppression System Release
  - Release of aqueous film forming foam (AFFF) to the grassy area west of the hangar annually from 2004 to present
- AOI 2: Tri-Max™ Fire Extinguisher
  - AFFF released from one Tri-Max™ fire extinguisher during a fire training exercise
  - The concentration and exact date of release are unknown



SI Overview – Results: PFOA in Soil



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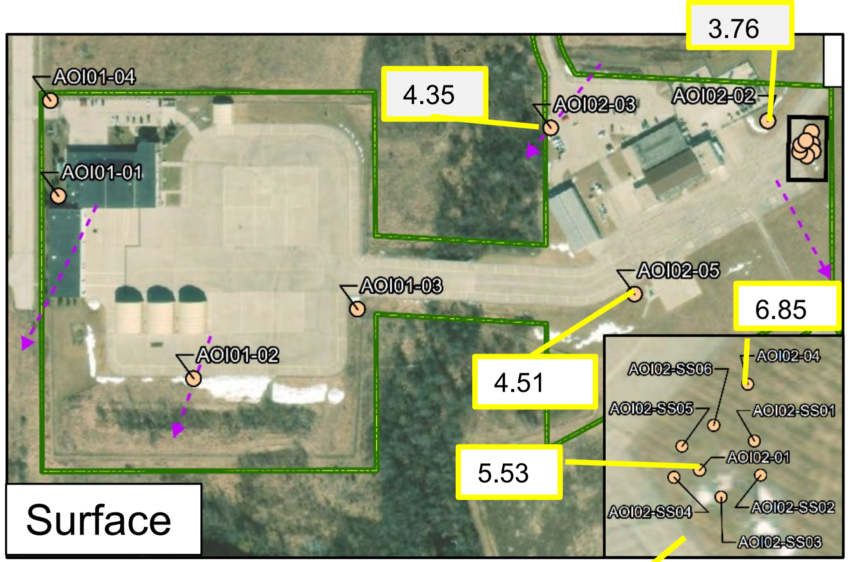
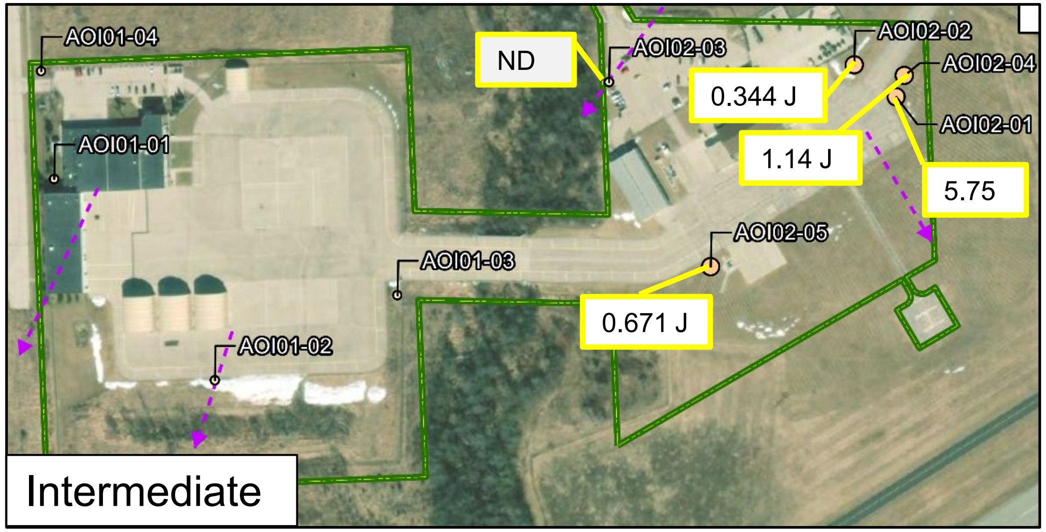
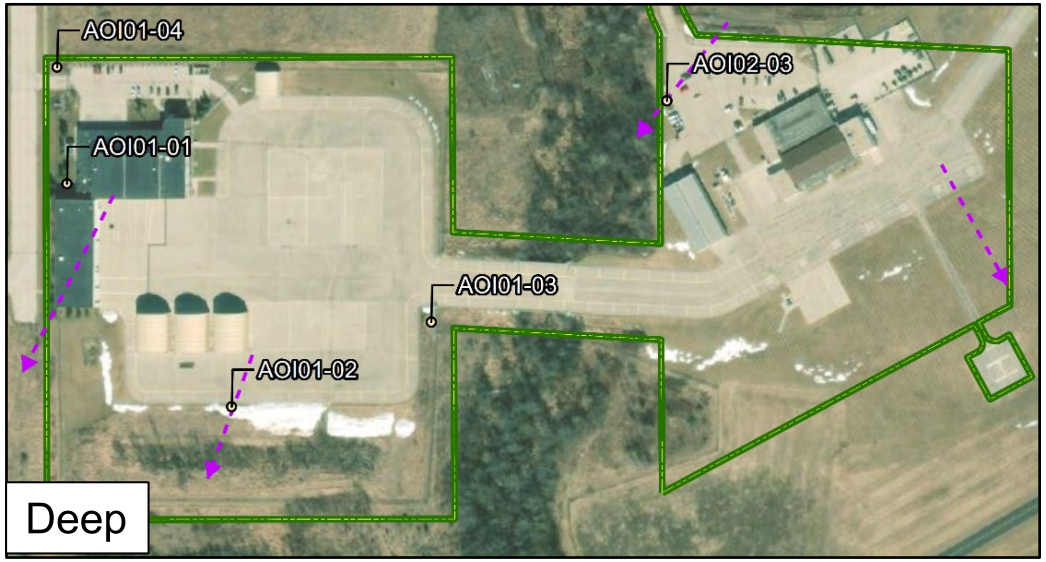
SI Overview – Results: PFOS in Soil



SS01	2.07
SS02	1.32
SS03	1.17
SS04	2.00
SS05	5.27 J-
SS06	2.68





PFOS Results (µg/Kg)

- ND
- >ND - 10
- >10 - 130
- >130 - 1,600
- >1,600

Legend

- Facility Boundary
- Local Groundwater Flow Direction

N

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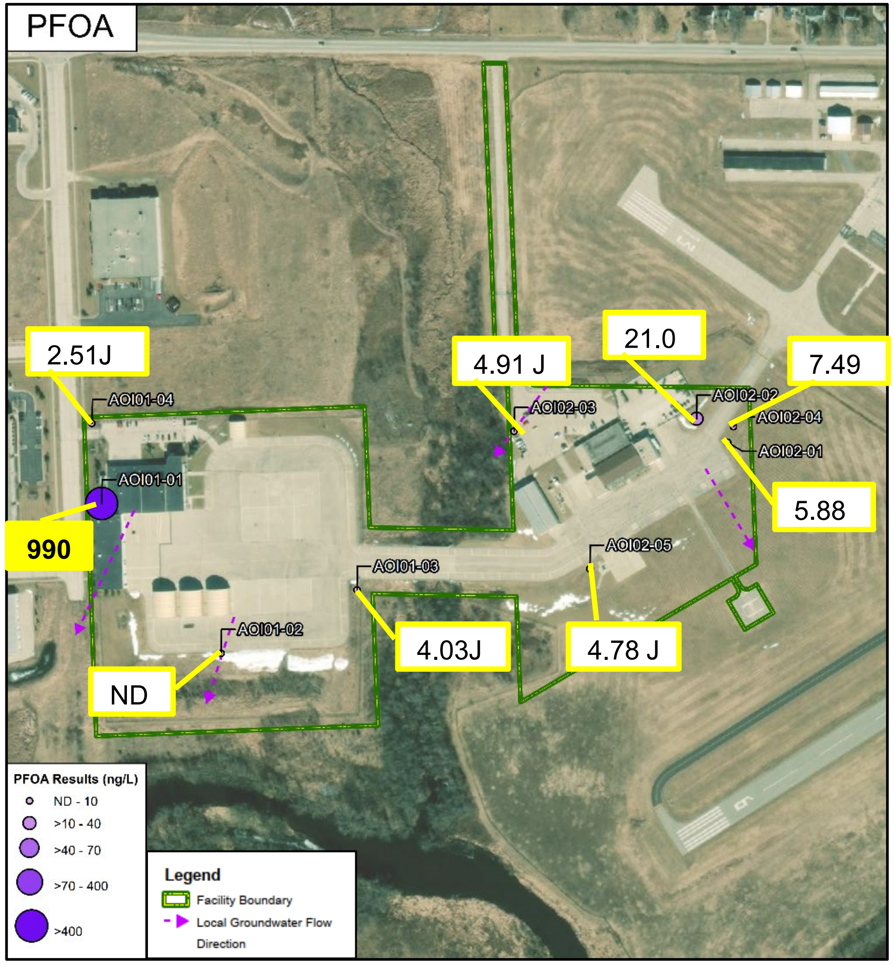
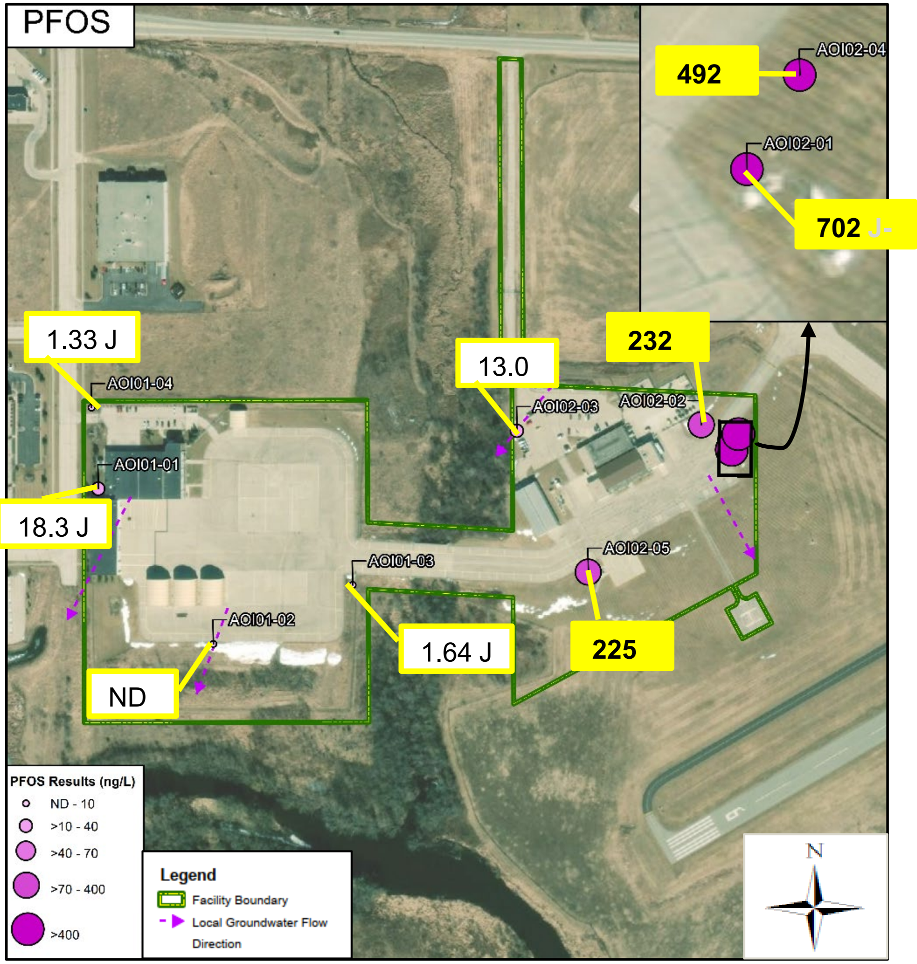
SI Overview – Results: PFOA and PFOS in Groundwater (GW)





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SI Overview – Results Summary

- PFAS in soil and GW confirmed at source areas and facility boundary at both AOIs
- Soil Findings
  - PFOA, PFOS, and PFBS detected in soil, but at concentrations several orders of magnitude below the SLs
- Groundwater Findings
  - AOI 1: PFOA in GW > 40 nanograms per liter (ng/L) at the source area; PFOS detected below 40 ng/L
    - Highest detection of PFOA in GW was 990 ng/L
  - AOI 2: PFOS in GW > 40 ng/L at five locations (at source area and at facility boundary); PFOA detected below 40 ng/L
    - Highest detection of PFOS in GW was 702 J- ng/L
  - PFBS detected in GW at both AOIs, but at concentrations several orders of magnitude below the SLs
  - Potential for PFAS coming onto facility at concentrations exceeding OSD GW SLs on eastern boundaries (AOI02-04)
- Private Drinking Well Sampling Results
  - Five potable wells were sampled in 2021 for PFAS. No PFAS compounds were detected above the laboratory detection limits in all samples

SI Overview – Results Summary

AOI	Potential PFAS Release Area	Soil – Source Area	Groundwater – Source Area	Groundwater – Facility Boundary
1	Fire Suppression System Testing	◐	●	●
2	Tri-Max™ Release	◐	●	●

Legend:

● = detected; exceedance of the screening levels

◐ = detected; no exceedance of the screening levels

○ = not detected

Updated Screening Criteria

- Updated OSD SLs (6 July 2022) compared against site data
- All environmental samples (soil, groundwater, surface water, and sediment) will be submitted to the analytical laboratory to be tested for 25 PFAS compounds via liquid chromatography with tandem mass spectrometry (LC/MS/MS) Quality Systems Manual (QSM) 5.3 Table B-15, including HFPO-DA

Analyte	Residential (Soil) (µg/kg)[a] 0-2 feet bgs	Industrial/ Commercial Composite Worker (Soil) (µg/kg)[a] 2-15 feet bgs	Tap Water (Groundwater) (ng/L)[a]
PFOA	19	250	6
PFOS	13	160	4
PFBS	1,900	25,000	601
PFHxS	130	1,600	39
PFNA	19	250	6
HFPO-DA[b]	23	350	6

bgs = below ground surface
ng/L = nanograms per liter
PFHxS = perfluorohexanesulfonic acid
PFNA = perfluorononanoic acid
OSD= Office of the Secretary of Defense
µg/kg = micrograms per kilogram

Notes:
a.) Assistant Secretary of Defense, 2021. Risk Based Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater and Soil using United States Environmental Protection Agency's (USEPA's) Regional Screening Level Calculator. Hazard Quotient (HQ) = 0.1. 6 July 2022 .
b.) Screening values for HFPO-DA were established after SI planning and execution and thus not included as an analyte. The RI phase will include HFPO-DA if warranted.

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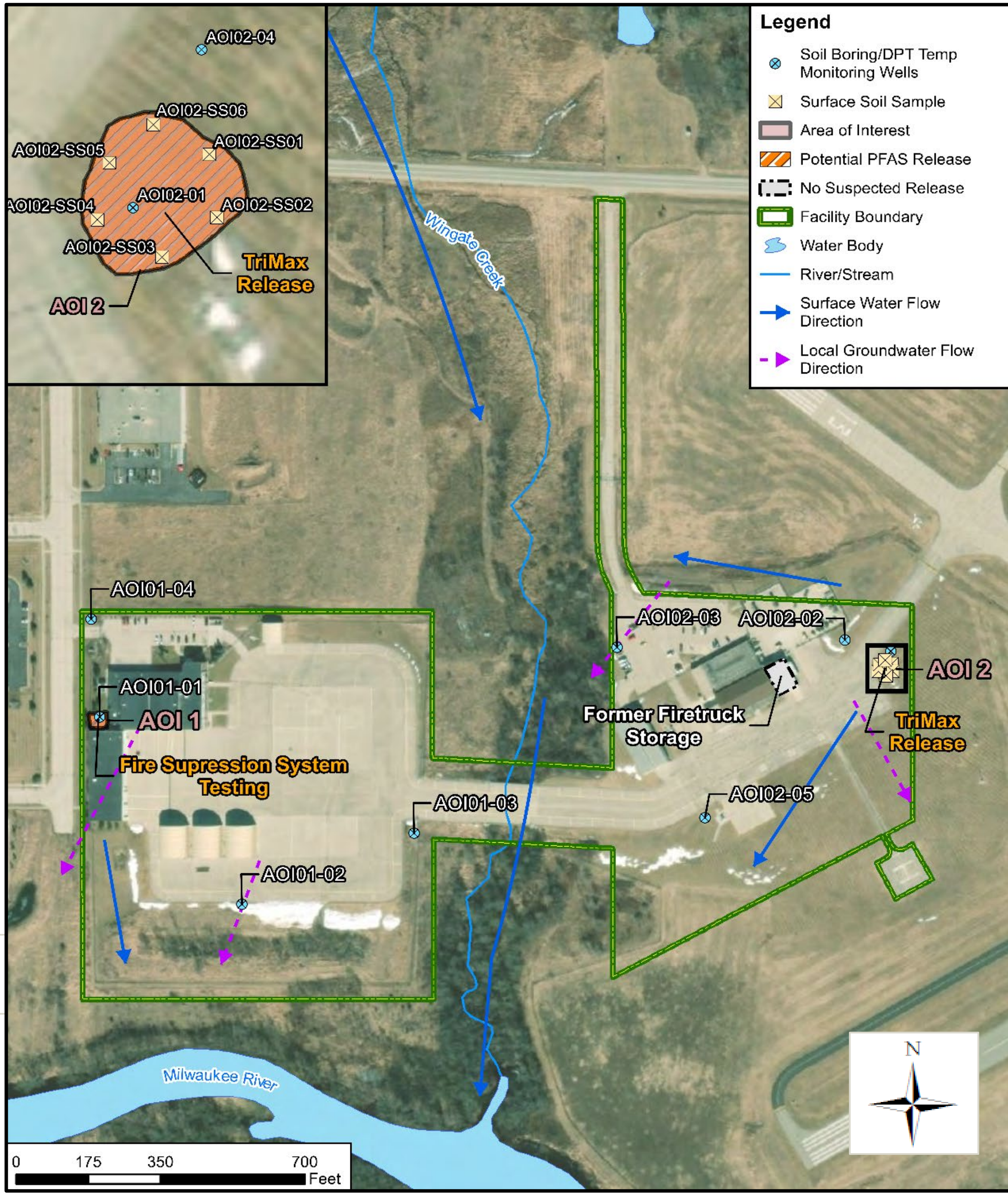
SI Results Revisited

- What changes with new SLs?
  - Original RI determination based on groundwater exceedances at AOI 1 and AOI 2
  - No overall change to the RI based on new SLs for soil and groundwater, existing AOIs 1 and 2 will be delineated
  - Soil Results
    - No exceedances in surface or subsurface soil samples
  - Groundwater Results
    - PFOA exceeds at AOI 1 (990 ng/L) and AOI 2 (21 ng/L) max concentrations
    - PFOS exceeds at AOI 1 (18.3 ng/L) and AOI 2 (492 ng/L) max concentrations
    - Perfluorohexanesulfonic acid (PFHxS) also exceeds at AOI 2 (88.1 ng/L)
    - Perfluorononanoic acid (PFNA) also exceeds at AOI 1 (117 ng/L) and AOI 2 (17 ng/L)



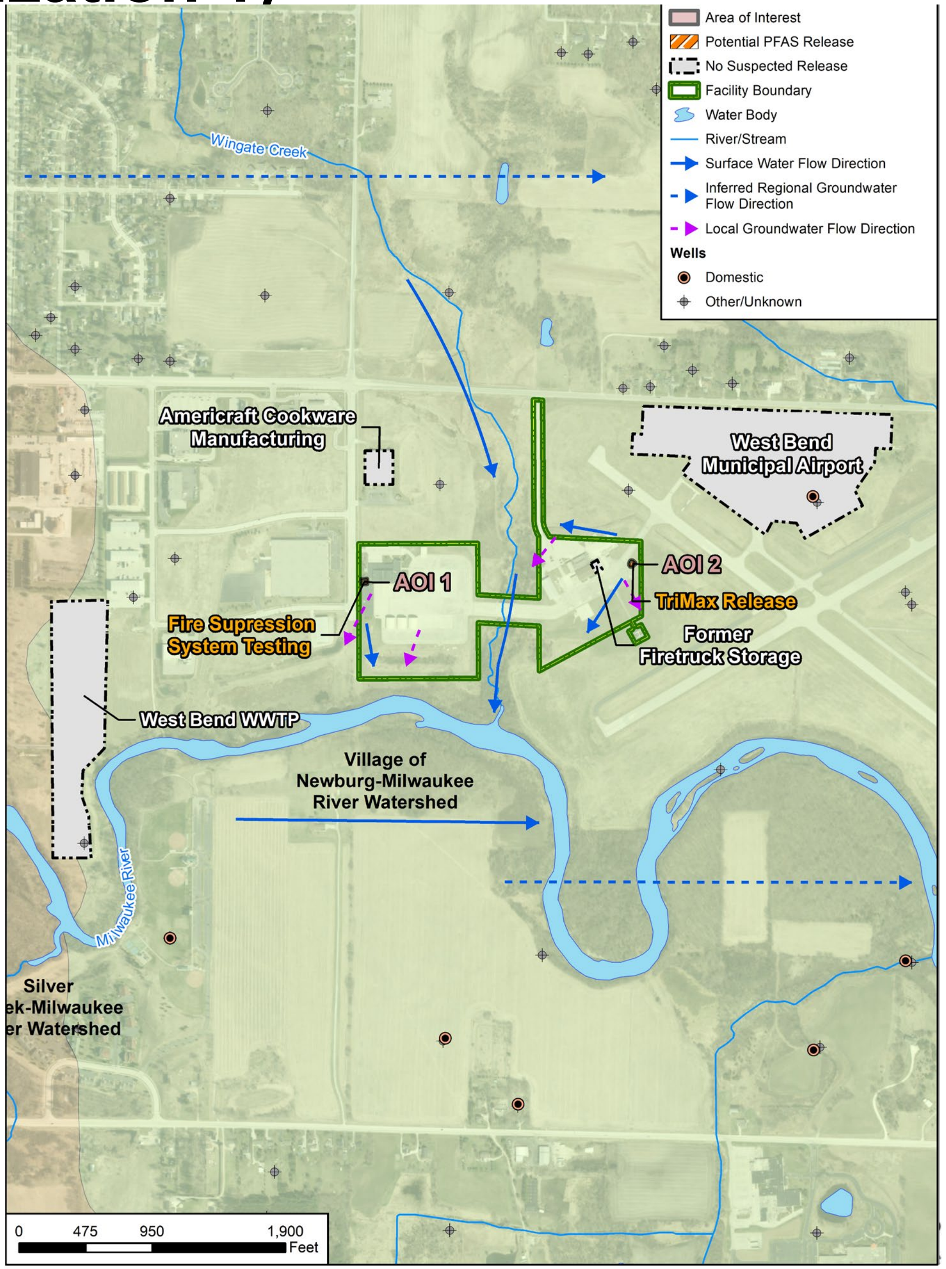
RI Technical Approach

Three primary phases of field work

- Predictive
  - Initial data gathering mobilization to inform next two phases of work
  - Develop characterization strategy using Preliminary Assessment/SI data and preliminary conceptual site model (CSM)
  - Refine the extent of PFAS impact to the groundwater through vertical aquifer profile sampling at the source areas, and upgradient and downgradient locations
  - Evaluate the horizontal extent of PFAS impact to the soil at the source areas through collection of surface soil samples
- Adaptive
  - Based on findings of predictive phase, continue to delineate sources and define geometry of plume(s)
- Final Delineation & Monitoring
  - Install groundwater well network
  - Complete well development, slug testing, and initiate quarterly monitoring.

RI Technical Approach – Predictive Phase (Mobilization 1)

- Predictive Phase
  - Initial data gathering mobilization to inform next two phases of work
  - Refine the extent of PFAS impact to the groundwater at AOIs 1 and 2 through vertical aquifer profile sampling at the source areas, and upgradient and downgradient locations
  - Evaluate the horizontal and vertical extent of PFAS impact to the soil at the AOI 1 and 2 source areas through collection of surface soil samples (fixed grids)
  - Evaluate if PFAS contamination in soil/groundwater has impacted surface water and sediment in Wingate Creek (bisects the facility) and the Milwaukee River



RI Technical Approach – Rights of Entry

- Rights-of-Entry Coordination
  - City of West Bend, Municipal Airport for off-site sample locations
  - Any permits or other notifications required by the airport?
  - Any other work restrictions to be aware of?

RI Community Involvement

- Community Involvement Plan (CIP) is a formal plan for community involvement activities
- Includes interviews from a cross-section of the community surrounding the facility in order to:
  - identify key concerns
  - gauge interest in the remedial investigation, and
  - identify the best fit (modes of communication) for outreach activities
- CIP interviews will be scheduled prior to initiation of the RI field activities, following submittal of the Draft Final Site-Specific Quality Assurance Project Plans
- Restoration Advisory Board (RAB) Solicitation
  - Initial interest in formation of a RAB will be gauged as part of the CIP interview process
  - A formal solicitation notice in the local newspaper for community stakeholder interest

Schedule

Task	Start Date	End Date
RI QAPP Addendum	Winter 2022	Winter 2023
TPP 2	March 2023	March 2023
Pre-mobilization (Predictive)	April 2023	April 2023
Mobilization (Predictive)	May/June 2023	May/June 2023

Questions and Open Discussion

Acronyms and Abbreviations

AASF – Army Aviation Support Facility

AFFF – aqueous film forming foam

AOI – Area of Interest

ARNG – Army National Guard

CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act

CIP – Community Involvement Plan

CSM – conceptual site model

DD – Decision Document

FS – Feasibility Study

GIS – Geographic Information Systems

GW – Groundwater

HFPO-DA - hexafluoropropylene oxide-dimer acid

LC/MS/MS - liquid chromatography with tandem mass spectrometry

MD – Maryland

ng/L – nanograms per liter

NR – Natural Resources

NTCRA – Non-Time Critical Removal Action

OSD – Office of the Secretary of Defense

PFAS – per- and polyfluoroalkyl substances

PFBS – perfluorobutanesulfonic acid

PFHxS - perfluorohexanesulfonic acid

PFNA - perfluorononanoic acid

PFOA – perfluorooctanoic acid

PFOS – perfluorooctanesulfonic acid

PMO – Project Management Office

QSM – Quality Systems Manual

RAB – Restoration Advisory Board

RI – Remedial Investigation

SL – Screening Level

SI – Site Inspection

TCRA – Time-Critical Removal Action

TPP – Technical Project Planning

USACE – United States Army Corps of Engineers

WI – Wisconsin

WIDMA – Wisconsin Department of Military Affairs

WIDNR - Wisconsin Department of Natural Resources

Thank you.

Appendix B
SI Analytical Data Tables

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	Area of Interest	AOI01																AOI02											
	Sample ID	AOI01-01-GW				AOI01-02-GW				AOI01-03-GW				AOI01-04-GW				AOI02-01-GW				AOI02-02-GW				AOI02-03-GW			
	Sample Date	10/29/2020				10/28/2020				10/28/2020				10/28/2020				10/27/2020				10/27/2020				10/28/2020			
Analyte	OSD Screening Level [a]	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual
Water, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ng/L)																													
6:2 FTS	-	871000	4000	10000	J	<	2.00	5.00	U	<	1.05	5.00	U	<	1.36	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	1.27	5.00	U
8:2 FTS	-	508	40.0	100	J+	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
NEtFOSAA	-	<	80.0	100	U	<	4.00	5.00	U	<	4.00	5.00	U	<	4.00	5.00	U	<	4.00	5.00	U	<	4.00	5.00	U	<	4.00	5.00	U
NMeFOSAA	-	<	80.0	100	U	<	4.00	5.00	U	<	4.00	5.00	U	<	4.00	5.00	U	<	4.00	5.00	U	<	4.00	5.00	U	<	4.00	5.00	U
PFBA	-	8200	40.0	100		<	2.24	5.00	U	<	7.18	5.00	U	<	4.54	5.00	U	<	4.95	5.00	U	<	10.7	5.00	U	<	7.91	5.00	U
PFBS	40000	<	40.0	100	U	0.860	2.00	5.00	J	1.34	2.00	5.00	J	<	2.00	5.00	U	2.43	2.00	5.00	J	3.37	2.00	5.00	J	8.12	2.00	5.00	
PFDA	-	20.9	40.0	100	J	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	1.08	2.00	5.00	J	<	2.00	5.00	U
PFDoA	-	<	40.0	100	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFHpA	-	4900	40.0	100		<	2.00	5.00	U	1.25	2.00	5.00	J	1.20	2.00	5.00	J	2.29	2.00	5.00	J	17.3	2.00	5.00		2.14	2.00	5.00	J
PFHxA	-	54700	2000	5000		<	2.00	5.00	U	1.24	2.00	5.00	J	1.66	2.00	5.00	J	8.58	2.00	5.00		16.0	2.00	5.00		7.72	2.00	5.00	
PFHxS	-	<	40.0	100	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	66.6	2.00	5.00		88.1	2.00	5.00		24.8	2.00	5.00	
PFNA	-	117	40.0	100		<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	2.38	2.00	5.00	J	17.0	2.00	5.00		<	2.00	5.00	U
PFOA	40	990	40.0	100		<	2.00	5.00	U	4.03	2.00	5.00	J	2.51	2.00	5.00	J	5.88	2.00	5.00		21.0	2.00	5.00		4.91	2.00	5.00	J
PFOS	40	18.3	40.0	100	J	<	2.00	5.00	U	1.64	2.00	5.00	J	1.33	2.00	5.00	J	702	2.00	5.00	J-	232	2.00	5.00		13.0	2.00	5.00	
PFPeA	-	49200	2000	5000		<	2.00	5.00	U	1.82	2.00	5.00	J	2.40	2.00	5.00	J	5.96	2.00	5.00		14.0	2.00	5.00		5.00	2.00	5.00	
PFTeDA	-	<	40.0	100	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	UJ	<	2.00	5.00	U	<	2.00	5.00	U
PFTrDA	-	<	40.0	100	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFUnDA	-	<	40.0	100	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U

Grey Fill	Detected concentration exceeded OSD Screening Levels

References
a. Assistant Secretary of Defense, 2019. Risk Based Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1. 15 October 2019. Groundwater screening levels based on residential scenario for direct ingestion of groundwater.

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J- = Estimated concentration, biased low
J+ = Estimated concentration, biased high
U = The analyte was not detected at a level greater than or equal to the adjusted detection limit (DL)
UJ = The analyte was not detected at a level greater than or equal to the adjusted DL. However, the reported adjusted DL is approximate and may be inaccurate or imprecise.

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
NEtFOSAA	N-ethyl perfluorooctane- sulfonamidoacetic acid
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
FD	Duplicate
GW	Groundwater
HQ	Hazard quotient
LCMSMS	Liquid Chromatography Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
USEPA	United States Environmental Protection Agency
ng/L	nanogram per liter
-	Not applicable
<	analyte not detected above the LOD

	Area of Interest	AOI02											
	Sample ID	AOI02-04-GW				AOI02-05-GW				AOI02-05-GW-FD			
	Sample Date	10/27/2020				10/27/2020				10/27/2020			
Analyte	**OSD Screening Level [a]**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**
Water, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ng/L)													
6:2 FTS	-	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
8:2 FTS	-	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
NEtFOSAA	-	<	4.00	5.00	U	<	4.00	5.00	U	<	4.00	5.00	U
NMeFOSAA	-	<	4.00	5.00	U	<	4.00	5.00	U	<	4.00	5.00	U
PFBA	-	<	7.46	5.00	U	<	3.56	5.00	U	<	3.87	5.00	U
PFBS	40000	1.97	2.00	5.00	J	1.44	2.00	5.00	J	1.84	2.00	5.00	J
PFDA	-	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFDoA	-	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFHpA	-	2.03	2.00	5.00	J	1.85	2.00	5.00	J	0.933	2.00	5.00	J
PFHxA	-	15.9	2.00	5.00		3.39	2.00	5.00	J	3.74	2.00	5.00	J
PFHxS	-	33.2	2.00	5.00		11.8	2.00	5.00		13.0	2.00	5.00	
PFNA	-	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFOA	40	7.49	2.00	5.00		4.78	2.00	5.00	J	3.29	2.00	5.00	J
PFOS	40	492	2.00	5.00		225	2.00	5.00		193	2.00	5.00	
PFPeA	-	4.17	2.00	5.00	J	1.79	2.00	5.00	J	1.25	2.00	5.00	J
PFTeDA	-	2.11	2.00	5.00	J	<	2.00	5.00	U	<	2.00	5.00	U
PFTrDA	-	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFUnDA	-	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U

Grey Fill — Detected concentration exceeded OSD Screening Levels

References
a. Assistant Secretary of Defense, 2019. Risk Based Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1. 15 October 2019. Groundwater screening levels based on residential scenario for direct ingestion of groundwater.

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PFOA	perfluorooctanoic acid
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PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
FD	Duplicate
GW	Groundwater
HQ	Hazard quotient
LCMSMS	Liquid Chromatography Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
USEPA	United States Environmental Protection Agency
ng/L	nanogram per liter
-	Not applicable
<	analyte not detected above the LOD

Area of Interest	Decon Water				QC															
Sample ID	WB-DECON-20200921				FB-20200921				WB-ERB-01				WB-ERB-02				WB-FRB-01			
Sample Date	09/21/2020				09/21/2020				10/28/2020				10/26/2020				10/28/2020			
Analyte	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**
Water, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ng/L)																				
6:2 FTS	<	4.00	10.0	U	<	4.00	10.0	U	1.81	2.00	5.00	J	2.79	2.00	5.00	J	0.897	2.00	5.00	J
8:2 FTS	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
NEtFOSAA	<	8.00	10.0	U	<	8.00	10.0	U	<	4.00	5.00	U	<	4.00	5.00	U	<	4.00	5.00	U
NMeFOSAA	<	8.00	10.0	U	<	8.00	10.0	U	<	4.00	5.00	U	<	4.00	5.00	U	<	4.00	5.00	U
PFBA	<	4.00	10.0	U	<	4.00	10.0	U	1.45	2.00	5.00	J	2.03	2.00	5.00	J	2.07	2.00	5.00	J
PFBS	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFDA	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFDoA	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFHpA	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFHxA	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFHxS	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFNA	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFOA	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFOS	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFPeA	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFTeDA	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFTrDA	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U
PFUnDA	<	4.00	10.0	U	<	4.00	10.0	U	<	2.00	5.00	U	<	2.00	5.00	U	<	2.00	5.00	U

Interpreted Qualifiers
J = Estimated concentration
U = The analyte was not detected at a level greater than or equal to the adjusted detection limit (DL)

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
NEtFOSAA	N-ethyl perfluorooctane- sulfonamidoacetic acid
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
ERB	Equipment reagent blank
FB/FRB	Field reagent blank
LCMSMS	Liquid Chromatography Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
QC	Quality Control
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
WB	West Bend
ng/L	nanogram per liter
<	analyte not detected above the LOD

	Area of Interest	Residential Drinking Water																							
	Sample ID	POTABLE-01				POTABLE-01-DUP				POTABLE-02				POTABLE-03				POTABLE-04				POTABLE-05			
	Sample Date	12/08/2021				12/08/2021				12/08/2021				12/08/2021				12/08/2021				12/08/2021			
Analyte	**EPA HA [a]**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**
Water, PFAS by LCMSMS Compliant with QSM 5.3 Table B-15 (ng/L)																									
11Cl-PF3OUdS	-	<	2.00	4.00	U	<	2.08	4.17	U	<	2.08	4.17	U	<	2.03	4.07	U	<	2.08	4.17	U	<	2.00	4.00	U
4:2 FTS	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
6:2 FTS	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
8:2 FTS	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
9Cl-PF3ONS	-	<	2.00	4.00	U	<	2.08	4.17	U	<	2.08	4.17	U	<	2.03	4.07	U	<	2.08	4.17	U	<	2.00	4.00	U
ADONA	-	<	2.00	4.00	U	<	2.08	4.17	U	<	2.08	4.17	U	<	2.03	4.07	U	<	2.08	4.17	U	<	2.00	4.00	U
FOSA	-	<	2.00	4.00	U	<	2.08	4.17	U	<	2.08	4.17	U	<	2.03	4.07	U	<	2.08	4.17	U	<	2.00	4.00	U
HFPO-DA	-	<	15.0	20.0	U	<	15.6	20.8	U	<	15.6	20.8	U	<	15.2	20.3	U	<	15.6	20.8	U	<	15.0	20.0	U
NEtFOSA	-	<	4.00	8.00	U	<	4.17	8.33	U	<	4.17	8.33	U	<	4.07	8.13	U	<	4.17	8.33	U	<	4.00	8.00	U
NEtFOSAA	-	<	4.00	8.00	U	<	4.17	8.33	U	<	4.17	8.33	U	<	4.07	8.13	U	<	4.17	8.33	U	<	4.00	8.00	U
N-EtFOSE	-	<	4.00	8.00	U	<	4.17	8.33	U	<	4.17	8.33	U	<	4.07	8.13	U	<	4.17	8.33	U	<	4.00	8.00	U
NMEFOSA	-	<	4.00	8.00	U	<	4.17	8.33	U	<	4.17	8.33	U	<	4.07	8.13	U	<	4.17	8.33	U	<	4.00	8.00	U
NMeFOSAA	-	<	4.00	8.00	U	<	4.17	8.33	U	<	4.17	8.33	U	<	4.07	8.13	U	<	4.17	8.33	U	<	4.00	8.00	U
NMeFOSE	-	<	4.00	8.00	U	<	4.17	8.33	U	<	4.17	8.33	U	<	4.07	8.13	U	<	4.17	8.33	U	<	4.00	8.00	U
PFBA	-	<	3.50	4.00	U	<	3.65	4.17	U	<	3.65	4.17	U	<	3.56	4.07	U	<	3.65	4.17	U	<	3.50	4.00	U
PFBS	-	<	2.00	4.00	U	<	2.08	4.17	U	<	2.08	4.17	U	<	2.03	4.07	U	<	2.08	4.17	U	<	2.00	4.00	U
PFDA	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
PFDoA	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
PFDoS	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
PFDS	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
PFHpA	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
PFHpS	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
PFHxA	-	<	2.00	4.00	U	<	2.08	4.17	U	<	2.08	4.17	U	<	2.03	4.07	U	<	2.08	4.17	U	<	2.00	4.00	U
PFHxS	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
PFNA	-	<	2.00	4.00	U	<	2.08	4.17	U	<	2.08	4.17	U	<	2.03	4.07	U	<	2.08	4.17	U	<	2.00	4.00	U
PFNS	-	<	3.50	4.00	U	<	3.65	4.17	U	<	3.65	4.17	U	<	3.56	4.07	U	<	3.65	4.17	U	<	3.50	4.00	U
PFOA	70	<	2.00	4.00	U	<	2.08	4.17	U	<	2.08	4.17	U	<	2.03	4.07	U	<	2.08	4.17	U	<	2.00	4.00	U
PFOS	70	<	2.00	4.00	U	<	2.08	4.17	U	<	2.08	4.17	U	<	2.03	4.07	U	<	2.08	4.17	U	<	2.00	4.00	U
PFPeA	-	<	2.00	4.00	U	<	2.08	4.17	U	<	2.08	4.17	U	<	2.03	4.07	U	<	2.08	4.17	U	<	2.00	4.00	U
PFPeS	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
PFTeDA	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
PFTrDA	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
PFUnDA	-	<	3.00	4.00	U	<	3.13	4.17	U	<	3.13	4.17	U	<	3.05	4.07	U	<	3.13	4.17	U	<	3.00	4.00	U
Total PFOA+PFOS	70	<	2		U	<	2.08		U	<	2.08		U	<	2.03		U	<	2.08		U	<	2		U

Grey Fill — Detected concentration exceeded EPA HA

References

a. United States Environmental Protection Agency (EPA). 2016. Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA). Office of Water (4304T). Health and Ecological Criteria Division, Washington, DC 20460. EPA Document Number: 822-R-16-005. May 2016. / EPA. 2016. Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS). Office of Water (4304T). Health and Ecological Criteria Division, Washington, DC 20460. EPA Document Number: 822-R-16-004. May 2016.

Interpreted Qualifiers

U = The analyte was not detected at a level greater than or equal to the adjusted detection limit

Acronyms and Abbreviations

AASF — Army Aviation Support Facility

Chemical Abbreviations

11Cl-PF3OUdS	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid
4:2 FTS	Fluorotelomer sulphonic acid 4:2
6:2 FTS	Fluorotelomer sulphonic acid 6:2
8:2 FTS	Fluorotelomer sulphonic acid 8:2
9Cl-PF3ONS	9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid
ADONA	4,8-Dioxa-3H-perfluorononanoic acid
FOSA	perfluorooctanesulfonamide
HFPO-DA	perfluoro-2-proxypropanoic acid
NEtFOSA	N-ethyl perfluorooctane sulfonamide
NEtFOSAA	2-(N-Ethylperfluorooctanesulfonamido) acetic acid
N-EtFOSE	N-ethyl perfluorooctane sulfonamido ethanol

AOI	Area of Interest
DUP	Duplicate
EPA	United States Environmental Protection Agency
HA	Health Advisory
LOD	Limit of Detection
LOQ	Limit of Quantitation
Qual	Interpreted Qualifier
ng/L	nanogram per liter
-	Not applicable
<	analyte not detected above the LOD

NMEFOSA	N-methyl perfluorooctane sulfonamide
NMeFOSAA	2-(N-Methylperfluorooctanesulfonamido) acetic acid
NMeFOSE	N-methyl perfluorooctane sulfonamido ethanol
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFDoS	perfluorododecane sulfonic acid
PFDS	perfluorodecanesulfonic acid
PFHpA	perfluoroheptanoic acid
PFHpS	perfluoroheptanesulfonic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFNS	perfluorononanesulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFPeS	perfluoropentanesulfonic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Area of Interest	AOI01								AOI02			
Sample ID	AOI01-01-SB-6-8				AOI01-01-SB-6-8-FD				AOI02-04-SB-3-5			
Sample Date	10/28/2020				10/28/2020				10/27/2020			
Depth	6 - 8 ft				6 - 8 ft				3 - 5 ft			
Analyte	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual
pH	8.12	1.00	1.00	J	7.96	1.00	1.00	J	7.93	1.00	1.00	J
Total Organic Carbon (mg/kg)	33400	200	250		33500	200	250		3060	200	250	

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
FD	Duplicate
ft	ft
LOD	Limit of Detection
LOQ	Limit of Quantitation
Qual	Interpreted Qualifier
mg/kg	milligram per kilogram
SB	Soil boring

Interpreted Qualifiers

J = Estimated concentration

Area of Interest	AOI01			
Sample ID	AOI01-03-SB-15-17			
Sample Date	10/27/2020			
Depth	15 - 17 ft			
Analyte	**Result**	**LOD**	**LOQ**	**Qual**
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ug/Kg)				
6:2 FTS	<	0.453	1.13	U
8:2 FTS	<	0.453	1.13	U
NEtFOSAA	<	0.453	1.13	U
NMeFOSAA	<	0.453	1.13	U
PFBA	<	0.453	1.13	U
PFBS	<	0.453	1.13	U
PFDA	<	0.453	1.13	U
PFDoA	<	0.453	1.13	U
PFHpA	<	0.453	1.13	U
PFHxA	<	0.453	1.13	U
PFHxS	<	0.453	1.13	U
PFNA	<	0.453	1.13	U
PFOA	<	0.453	1.13	U
PFOS	<	0.453	1.13	U
PFPeA	<	0.453	1.13	U
PFTeDA	<	0.453	1.13	U
PFTrDA	<	0.453	1.13	U
PFUnDA	<	0.453	1.13	U

Interpreted Qualifiers

U = The analyte was not detected at a level greater than or equal to the adjusted detection limit

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
NEtFOSAA	N-ethyl perfluorooctane- sulfonamidoacetic acid
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
ft	feet
LCMSMS	Liquid Chromatography Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SB	Soil boring
ug/Kg	micrograms per Kilogram
<	analyte not detected above the LOD

	Area of Interest	AOI01																											
	Sample ID	AOI01-01-SB-6-8				AOI01-01-SB-10-12				AOI01-02-SB-5-7				AOI01-02-SB-7-9				AOI01-03-SB-6-8				AOI01-03-SB-6-8-FD				AOI01-04-SB-6-8			
	Sample Date	10/28/2020				10/28/2020				10/28/2020				10/28/2020				10/27/2020				10/27/2020				10/28/2020			
	Depth	6 - 8 ft				10 - 12 ft				5 - 7 ft				7 - 9 ft				6 - 8 ft				6 - 8 ft				6 - 8 ft			
Analyte	OSD Screening Level [a]	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ug/Kg)																													
6:2 FTS	-	104	4.82	12.0	J-	122	5.10	12.8	J-	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
8:2 FTS	-	1.04	0.482	1.20	J	<	0.510	1.28	U	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
NEtFOSAA	-	<	0.482	1.20	U	<	0.510	1.28	U	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
NMeFOSAA	-	<	0.482	1.20	U	<	0.510	1.28	U	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFBA	-	1.95	0.482	1.20		2.77	0.510	1.28		<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFBS	1600000	<	0.482	1.20	U	<	0.510	1.28	U	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFDA	-	<	0.482	1.20	U	<	0.510	1.28	U	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFDoA	-	<	0.482	1.20	U	<	0.510	1.28	U	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFHpA	-	1.16	0.482	1.20	J	1.05	0.510	1.28	J	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFHxA	-	11.5	0.482	1.20		22.7	0.510	1.28		<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFHxS	-	<	0.482	1.20	U	<	0.510	1.28	U	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFNA	-	0.168	0.482	1.20	J	<	0.510	1.28	U	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFOA	1600	0.606	0.482	1.20	J	0.504	0.510	1.28	J	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFOS	1600	<	0.482	1.20	U	<	0.510	1.28	U	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFPeA	-	15.2	0.482	1.20		12.8	0.510	1.28		<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFTeDA	-	<	0.482	1.20	U	<	0.510	1.28	U	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFTrDA	-	<	0.482	1.20	U	<	0.510	1.28	U	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U
PFUnDA	-	<	0.482	1.20	U	<	0.510	1.28	U	<	0.458	1.15	U	<	0.467	1.17	U	<	0.479	1.20	U	<	0.463	1.16	U	<	0.442	1.11	U

Grey Fill — Detected concentration exceeded OSD Screening Levels

References
a. Assistant Secretary of Defense, 2019. Risk Based Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1. 15 October 2019. Soil screening levels based on industrial/commercial composite worker scenario for incidental ingestion of contaminated soil.

Interpreted Qualifiers
J = Estimated concentration
J- = Estimated concentration, biased low
U = The analyte was not detected at a level greater than or equal to the adjusted detection limit (DL)

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
NEtFOSAA	N-ethyl perfluorooctane- sulfonamidoacetic acid
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
FD	Duplicate
ft	feet
HQ	Hazard quotient
LCMSMS	Liquid Chromatography Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SB	Soil boring
SS	Surface Soil
USEPA	United States Environmental Protection Agency
ug/Kg	micrograms per Kilogram
-	Not applicable
<	analyte not detected above the LOD

	Area of Interest	AOI01								AOI02																			
	Sample ID	AOI01-04-SB-13-15				AOI01-04-SB-13-15-FD				AOI02-01-SB-3-5				AOI02-02-SB-3-5				AOI02-03-SB-3-5				AOI02-03-SB-7-9				AOI02-04-SB-3-5			
	Sample Date	10/28/2020				10/28/2020				10/27/2020				10/27/2020				10/28/2020				10/28/2020				10/27/2020			
	Depth	13 - 15 ft				13 - 15 ft				3 - 5 ft				3 - 5 ft				3 - 5 ft				7 - 9 ft				3 - 5 ft			
Analyte	**OSD Screening Level [a]**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ug/Kg)																													
6:2 FTS	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	0.314	0.487	1.22	J	0.862	0.493	1.23	J	<	0.459	1.15	U
8:2 FTS	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.459	1.15	U
NEtFOSAA	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.459	1.15	U
NMeFOSAA	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.459	1.15	U
PFBA	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.459	1.15	U
PFBS	1600000	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.459	1.15	U
PFDA	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.459	1.15	U
PFDoA	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.459	1.15	U
PFHpA	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.459	1.15	U
PFHxA	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	0.194	0.459	1.15	J
PFHxS	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	0.678	0.493	1.23	J	<	0.459	1.15	U
PFNA	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.459	1.15	U
PFOA	1600	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.173	1.15	U
PFOS	1600	<	0.446	1.11	U	<	0.477	1.19	U	5.75	0.461	1.15		0.344	0.438	1.09	J	<	0.487	1.22	U	<	0.493	1.23	U	1.14	0.459	1.15	J
PFPeA	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.459	1.15	U
PFTeDA	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.459	1.15	U
PFTrDA	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.459	1.15	U
PFUnDA	-	<	0.446	1.11	U	<	0.477	1.19	U	<	0.461	1.15	U	<	0.438	1.09	U	<	0.487	1.22	U	<	0.493	1.23	U	<	0.459	1.15	U

Grey Fill	Detected concentration exceeded OSD Screening Levels

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Chemical Abbreviations

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8:2 FTS	8:2 fluorotelomer sulfonate
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NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
FD	Duplicate
ft	feet
HQ	Hazard quotient
LCMSMS	Liquid Chromatography Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SB	Soil boring
SS	Surface Soil
USEPA	United States Environmental Protection Agency
ug/Kg	micrograms per Kilogram
-	Not applicable
<	analyte not detected above the LOD

	Area of Interest	AOI02			
	Sample ID	AOI02-05-SB-3-5			
	Sample Date	10/27/2020			
	Depth	3 - 5 ft			
Analyte	OSD Screening Level [a]	Result	LOD	LOQ	Qual
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ug/Kg)					
6:2 FTS	-	<	0.444	1.11	U
8:2 FTS	-	<	0.444	1.11	U
NEtFOSAA	-	<	0.444	1.11	U
NMeFOSAA	-	<	0.444	1.11	U
PFBA	-	0.196	0.444	1.11	J
PFBS	1600000	<	0.444	1.11	U
PFDA	-	<	0.444	1.11	U
PFDoA	-	<	0.444	1.11	U
PFHpA	-	<	0.444	1.11	U
PFHxA	-	<	0.444	1.11	U
PFHxS	-	<	0.444	1.11	U
PFNA	-	<	0.444	1.11	U
PFOA	1600	<	0.444	1.11	U
PFOS	1600	0.671	0.444	1.11	J
PFPeA	-	<	0.444	1.11	U
PFTeDA	-	<	0.444	1.11	U
PFTrDA	-	<	0.444	1.11	U
PFUnDA	-	<	0.444	1.11	U

Grey Fill — Detected concentration exceeded OSD Screening Levels

References

a. Assistant Secretary of Defense, 2019. Risk Based Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1. 15 October 2019. Soil screening levels based on industrial/commercial composite worker scenario for incidental ingestion of contaminated soil.

Interpreted Qualifiers

J = Estimated concentration

J- = Estimated concentration, biased low

U = The analyte was not detected at a level greater than or equal to the adjusted detection limit (DL)

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
NEtFOSAA	N-ethyl perfluorooctane- sulfonamidoacetic acid
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
FD	Duplicate
ft	feet
HQ	Hazard quotient
LCMSMS	Liquid Chromatography Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SB	Soil boring
SS	Surface Soil
USEPA	United States Environmental Protection Agency
ug/Kg	micrograms per Kilogram
-	Not applicable
<	analyte not detected above the LOD

	Area of Interest	AOI01																AOI02											
	Sample ID	AOI01-01-SB-0-2				AOI01-02-SB-0-2				AOI01-03-SB-0-2				AOI01-04-SB-0-2				AOI02-01-SB-0-2				AOI02-02-SB-0-2				AOI02-02-SB-0-2-FD			
	Sample Date	10/28/2020				10/28/2020				10/27/2020				10/28/2020				10/27/2020				10/27/2020				10/27/2020			
	Depth	0 - 2 ft				0 - 2 ft				0 - 2 ft				0 - 2 ft				0 - 2 ft				0 - 2 ft				0 - 2 ft			
Analyte	**OSD Screening Level [a]**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ug/Kg)																													
6:2 FTS	-	51.5	2.19	5.49	J-	0.210	0.476	1.19	J	<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
8:2 FTS	-	<	0.439	1.10	U	<	0.476	1.19	U	<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
NEtFOSAA	-	<	0.439	1.10	U	<	0.476	1.19	U	<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
NMeFOSAA	-	<	0.439	1.10	U	<	0.476	1.19	U	<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
PFBA	-	0.992	0.439	1.10	J	0.398	0.476	1.19	J	0.317	0.473	1.18	J	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
PFBS	130000	<	0.439	1.10	U	3.41	0.476	1.19		<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
PFDA	-	0.137	0.439	1.10	J	0.357	0.476	1.19	J	<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
PFDoA	-	<	0.439	1.10	U	0.394	0.476	1.19	J	<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
PFHpA	-	0.568	0.439	1.10	J	<	0.476	1.19	U	<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
PFHxA	-	3.53	0.439	1.10		<	0.195	1.19	U	<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
PFHxS	-	<	0.439	1.10	U	<	0.476	1.19	U	<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
PFNA	-	0.426	0.439	1.10	J	0.188	0.476	1.19	J	<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	0.156	0.409	1.02	J	0.137	0.406	1.01	J
PFOA	130	0.380	0.439	1.10	J	0.250	0.476	1.19	J	0.214	0.473	1.18	J	0.228	0.467	1.17	J	0.262	0.448	1.12	J	<	0.409	1.02	U	<	0.406	1.01	U
PFOS	130	0.220	0.439	1.10	J	0.827	0.476	1.19	J	0.474	0.473	1.18	J	0.598	0.467	1.17	J	5.53	0.448	1.12		3.76	0.409	1.02		4.56	0.406	1.01	
PFPeA	-	6.70	0.439	1.10		0.252	0.476	1.19	J	<	0.473	1.18	U	0.184	0.467	1.17	J	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
PFTeDA	-	<	0.439	1.10	U	<	0.476	1.19	U	<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
PFTrDA	-	<	0.439	1.10	U	<	0.476	1.19	U	<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U
PFUnDA	-	<	0.439	1.10	U	0.369	0.476	1.19	J	<	0.473	1.18	U	<	0.467	1.17	U	<	0.448	1.12	U	<	0.409	1.02	U	<	0.406	1.01	U

Grey Fill — Detected concentration exceeded OSD Screening Levels

References
a. Assistant Secretary of Defense, 2019. Risk Based Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1. 15 October 2019. Soil screening levels based on residential scenario for direct ingestion of contaminated soil.

Interpreted Qualifiers
J = Estimated concentration
J- = Estimated concentration, biased low
U = The analyte was not detected at a level greater than or equal to the adjusted detection limit (DL)
UJ = The analyte was not detected at a level greater than or equal to the adjusted DL. However, the reported adjusted DL is approximate and may be inaccurate or imprecise.

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
NEtFOSAA	N-ethyl perfluorooctane- sulfonamidoacetic acid
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
FD	Duplicate
ft	feet
HQ	Hazard quotient
LCMSMS	Liquid Chromatography Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SB	Soil boring
SS	Surface Soil
USEPA	United States Environmental Protection Agency
ug/Kg	micrograms per Kilogram
-	Not applicable
<	analyte not detected above the LOD

	Area of Interest	AOI02																											
	Sample ID	AOI02-03-SB-0-2				AOI02-04-SB-0-2				AOI02-05-SB-0-2				AOI02-SS01				AOI02-SS02				AOI02-SS03				AOI02-SS03-FD			
	Sample Date	10/27/2020				10/27/2020				10/27/2020				10/26/2020				10/26/2020				10/26/2020				10/26/2020			
	Depth	0 - 2 ft				0 - 2 ft				0 - 2 ft				0 - 2 ft				0 - 2 ft				0 - 2 ft				0 - 2 ft			
Analyte	**OSD Screening Level [a]**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**	**Result**	**LOD**	**LOQ**	**Qual**
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ug/Kg)																													
6:2 FTS	-	<	0.421	1.05	U	<	0.468	1.17	U	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
8:2 FTS	-	<	0.421	1.05	U	<	0.468	1.17	U	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
NEtFOSAA	-	<	0.421	1.05	U	<	0.468	1.17	U	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
NMeFOSAA	-	<	0.421	1.05	U	<	0.468	1.17	U	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
PFBA	-	<	0.421	1.05	U	<	0.468	1.17	U	0.226	0.441	1.10	J	0.161	0.465	1.16	J	0.245	0.470	1.17	J	0.179	0.432	1.08	J	0.181	0.439	1.10	J
PFBS	130000	<	0.421	1.05	U	<	0.468	1.17	U	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
PFDA	-	<	0.421	1.05	U	<	0.468	1.17	U	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
PFDoA	-	<	0.421	1.05	U	<	0.468	1.17	U	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
PFHpA	-	<	0.421	1.05	U	<	0.468	1.17	U	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
PFHxA	-	<	0.232	1.05	U	<	0.468	1.17	U	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
PFHxS	-	2.56	0.421	1.05		<	0.468	1.17	U	<	0.441	1.10	U	0.182	0.465	1.16	J	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
PFNA	-	<	0.421	1.05	U	0.111	0.468	1.17	J	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
PFOA	130	0.163	0.421	1.05	J	0.177	0.468	1.17	J	0.188	0.441	1.10	J	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
PFOS	130	4.35	0.421	1.05		6.85	0.468	1.17		4.51	0.441	1.10		2.07	0.465	1.16		1.32	0.470	1.17		0.828	0.432	1.08	J	1.17	0.439	1.10	
PFPeA	-	<	0.421	1.05	U	<	0.468	1.17	U	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
PFTeDA	-	<	0.421	1.05	U	<	0.468	1.17	U	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
PFTrDA	-	<	0.421	1.05	U	<	0.468	1.17	U	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U
PFUnDA	-	<	0.421	1.05	U	<	0.468	1.17	U	<	0.441	1.10	U	<	0.465	1.16	U	<	0.470	1.17	U	<	0.432	1.08	U	<	0.439	1.10	U

Grey Fill	Detected concentration exceeded OSD Screening Levels

References

a. Assistant Secretary of Defense, 2019. Risk Based Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1. 15 October 2019. Soil screening levels based on residential scenario for direct ingestion of contaminated soil.

Interpreted Qualifiers

J = Estimated concentration
J- = Estimated concentration, biased low
U = The analyte was not detected at a level greater than or equal to the adjusted detection limit (DL)
UJ = The analyte was not detected at a level greater than or equal to the adjusted DL. However, the reported adjusted DL is approximate and may be inaccurate or imprecise.

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
NEtFOSAA	N-ethyl perfluorooctane- sulfonamidoacetic acid
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
FD	Duplicate
ft	feet
HQ	Hazard quotient
LCMSMS	Liquid Chromatography Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SB	Soil boring
SS	Surface Soil
USEPA	United States Environmental Protection Agency
ug/Kg	micrograms per Kilogram
-	Not applicable
<	analyte not detected above the LOD

Appendix F Laboratory Data
Surface Soil
Site Inspection Report, West Bend AASF

	Area of Interest	AOI02											
	Sample ID	AOI02-SS04				AOI02-SS05				AOI02-SS06			
	Sample Date	10/26/2020				10/26/2020				10/26/2020			
	Depth	0 - 2 ft				0 - 2 ft				0 - 2 ft			
Analyte	OSD Screening Level [a]	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual	Result	LOD	LOQ	Qual
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ug/Kg)													
6:2 FTS	-	<	0.448	1.12	U	<	0.441	1.10	U	<	0.442	1.11	U
8:2 FTS	-	<	0.448	1.12	U	<	0.441	1.10	UJ	<	0.442	1.11	U
NEtFOSAA	-	<	0.448	1.12	U	<	0.441	1.10	U	<	0.442	1.11	U
NMeFOSAA	-	<	0.448	1.12	U	<	0.441	1.10	U	<	0.442	1.11	U
PFBA	-	0.215	0.448	1.12	J	0.217	0.441	1.10	J	0.239	0.442	1.11	J
PFBS	130000	<	0.448	1.12	U	<	0.441	1.10	U	<	0.442	1.11	U
PFDA	-	<	0.448	1.12	U	<	0.441	1.10	U	<	0.442	1.11	U
PFDoA	-	<	0.448	1.12	U	<	0.441	1.10	U	<	0.442	1.11	U
PFHpA	-	<	0.448	1.12	U	<	0.441	1.10	UJ	<	0.442	1.11	U
PFHxA	-	<	0.448	1.12	U	<	0.441	1.10	U	<	0.442	1.11	U
PFHxS	-	<	0.448	1.12	U	0.298	0.441	1.10	J	<	0.442	1.11	U
PFNA	-	<	0.448	1.12	U	<	0.441	1.10	U	<	0.442	1.11	U
PFOA	130	<	0.448	1.12	U	<	0.441	1.10	U	<	0.442	1.11	U
PFOS	130	2.00	0.448	1.12		5.27	0.441	1.10	J-	2.68	0.442	1.11	
PFPeA	-	<	0.448	1.12	U	<	0.441	1.10	U	<	0.442	1.11	U
PFTeDA	-	<	0.448	1.12	U	<	0.441	1.10	U	<	0.442	1.11	U
PFTrDA	-	<	0.448	1.12	U	<	0.441	1.10	U	<	0.442	1.11	U
PFUnDA	-	<	0.448	1.12	U	<	0.441	1.10	U	<	0.442	1.11	U

Grey Fill	Detected concentration exceeded OSD Screening Levels

References
a. Assistant Secretary of Defense, 2019. Risk Based Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1. 15 October 2019. Soil screening levels based on residential scenario for direct ingestion of contaminated soil.

Interpreted Qualifiers
J = Estimated concentration
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Chemical Abbreviations

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8:2 FTS	8:2 fluorotelomer sulfonate
NEtFOSAA	N-ethyl perfluorooctane- sulfonamidoacetic acid
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
FD	Duplicate
ft	feet
HQ	Hazard quotient
LCMSMS	Liquid Chromatography Mass Spectrometry
LOD	Limit of Detection
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OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
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SB	Soil boring
SS	Surface Soil
USEPA	United States Environmental Protection Agency
ug/Kg	micrograms per Kilogram
-	Not applicable
<	analyte not detected above the LOD

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Appendix C
Analytical Laboratory Documentation

(Provided upon request)

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Appendix D
Field Standard Operating Procedures

(Provided upon request)

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Appendix E
Risk Assessment Work Plan

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Final
Human Health and Ecological Risk Assessment Work Plan
West Bend Army Aviation Support Facility #1 and Armory
West Bend, Wisconsin

Remedial Investigations (RI) / Feasibility Studies (FS), Decision Documents,
Time Critical Removal Actions (TCRA) for Per- and Polyfluoroalkyl Substances (PFAS)
Impacted Sites at Army National Guard Installations, Nationwide

December 2023

Prepared for:

Army National Guard Bureau
111 S. George Mason Drive
Arlington, VA 22204

UNCLASSIFIED

Quality information

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List of Acronyms and Abbreviations

%	percent
µg/kg	micrograms per kilogram
AASF	Army Aviation Support Facility
ANL	Argonne National Laboratory
AOI	area of interest
ARAR	Applicable or Relevant and Appropriate Requirement
ARNG	Army National Guard
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	Bioaccumulation Factors
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BSAF	Biota-Sediment Accumulation Factor
CalEPA	California Environmental Protection Agency
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm^2	square centimeter
COC	chemicals of concern
COPC	chemicals of potential concern
COPEC	chemicals of potential ecological concern
CSM	conceptual site model
DA	Department of the Army
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
ELCR	excess lifetime cancer risk
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESTCP	Environmental Security Technology Certification Program
ESV	ecological screening values
FOD	frequency of detection
FS	feasibility study
GLI	Great Lakes Initiative
HEAST	Health Effects Assessment Summary Tables
HFPO-DA	hexafluoropropylene oxide dimer acid
HHRA	human health risk assessment
HI	hazard indices
HQ	hazard quotient
IPaC	Information for Planning and Consultation

IRIS	Integrated Risk Information System
kg	kilogram
L/hr	liters per hour
MCL	maximum contaminant level
mg/cm^2	milligrams per centimeters squared
mg/day	milligram per day
MRL	minimal risk level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ng/L	nanogram per liter
NOAEL	no observed adverse effect level
NOEC	No-observed effect concentration
OEHHA	Office of Environmental Health and Hazard Assessment
OSD	Office of the Assistant Secretary of Defense
PA	Preliminary Assessment
PC99	99% protection concentration
PFAS	per- and polyfluoroalkyl substances
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFUdA	perfluoroundecanoic acid
PPRTV	Provisional Peer-Reviewed Toxicity Value
PRG	preliminary remediation goal
RBSL	risk-based screening level
RME	reasonable maximum exposure
RI	remedial investigation
RSL	regional screening level
SERDP	Strategic Environmental Research and Development Program
SI	Site Inspection
SL	Screening Level
SLERA	screening level ecological risk assessment
TRV	toxicity reference value

TSERAWG	Tri-Services Environmental Risk Assessment Work Group
UCL	upper confidence limit
UFP-QAPP	Uniform Federal Policy Quality Assurance Project Plan
US	United States
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UU/UE	unlimited use/unrestricted exposure
WDNR	Wisconsin Department of Natural Resources
WIARNG	Wisconsin Army National Guard
WP	work plan

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1.0 Introduction

This Risk Assessment Work Plan (WP) is provided as **Appendix E** of the Remedial Investigation (RI) Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) for RI activities investigating the potential impacts of per- and polyfluoroalkyl substances (PFAS) associated with historical activities at West Bend Army Aviation Support Facility (AASF) (also referred to as the "West Bend AASF #1 and Armory" and the "facility").

West Bend AASF #1 and Armory is in Washington County, Wisconsin, approximately 2 miles east of West Bend, 30 miles northwest of Milwaukee, and 75 miles northeast of Madison. The facility was constructed in 2004 on a parcel of land, approximately 35-acres, owned by the City of West Bend, and leased to the Wisconsin Army National Guard (WIARNG); the current lease agreement expires September 2075. The current facilities include administrative offices, classrooms, and hangars for the operation, maintenance, and repair of WIARNG rotary-winged aircraft. The facility location is shown on Figure 10-1 of the UFP-QAPP.

A Preliminary Assessment (PA) and Site Inspection (SI) were performed under a separate contract vehicle on behalf of the United States Army National Guard (ARNG) (AECOM, 2019, 2022). The PA determined whether there were potential releases to the environment related to processes that use PFAS. Based on the findings of the PA, the facility moved forward to the SI phase. The SI concluded there was a release to the environment from two Areas of Interest (AOIs) identified in the PA and determined the presence of perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and perfluorobutanesulfonic acid (PFBS) at or above screening levels (SLs) established in a memorandum from the Office of the Assistant Secretary of Defense (OSD) dated 15 October 2019 (Assistant Secretary of Defense, 2019).

The United States Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) are the source of the SLs provided in the 2019 OSD memorandum. Updated RSLs were published in May 2022 (USEPA, 2022a). These changes prompted a new OSD memorandum (OSD memo) to be issued in July 2022 that lowered the SLs of PFOS and PFOA, maintained the SL for PFBS, and expanded the list of RSLs to include perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA) (Assistant Secretary of Defense, 2022).

The SI was finalized in March 2022, prior to the release of the 2022 OSD SLs. Therefore, the March 2022 SI Report compared sample concentrations to the 2019 OSD SLs. The updated SLs will replace the previously used SLs at the West Bend AASF #1 and Armory as documented in the Final SI Report (AECOM, 2022). The identified AOIs are discussed below.

- AOI 1: Fire Suppression Release System. PFOA, PFOS, and PFBS were detected in soil and groundwater at AOI 1. The detected concentrations of PFOA, PFOS, and PFBS in soil were several orders of magnitude lower than the 2019 OSD SLs for soil. Soil concentrations were also below the 2022 OSD SLs. PFOA was detected in groundwater at concentrations exceeding the 2019 OSD SL at the potential source area. The detected concentrations of PFOS and PFBS in groundwater were below their respective 2019 OSD SLs. A recommendation was made for further evaluation in an RI due based on the exceedances of PFOA in groundwater at AOI 1. In addition, detected concentrations of PFOS and PFNA in groundwater exceed their 2022 OSD SLs.
- AOI 2: TriMax™ Fire Extinguisher. PFOS was detected in soil at AOI 2; however, concentrations were an order of magnitude lower than the 2019 soil OSD SLs. Soil concentrations were also below the 2022 OSD SLs. PFOS was detected in groundwater at concentrations exceeding the 2019 OSD SL at the potential source area. The SI also concluded that detected concentrations of PFOA and PFBS in groundwater were below their

respective 2019 OSD SLs. A recommendation was made for further evaluation in an RI due the exceedances of PFOS in groundwater at AOI 2. In addition, detected concentrations of PFOS, PFOA, PFHxS, and PFNA in groundwater exceed their 2022 OSD SLs.

The RI project elements will be performed by AECOM in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; USEPA, 1980), as amended, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] Part 300; USEPA, 1994), and in compliance with United States (US) Department of the Army (DA) requirements and guidance for field investigations, including specific requirements for sampling for PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA as well as the group of related compounds known in the industry as PFAS. The term PFAS will be used throughout this plan to encompass all PFAS chemicals being evaluated, including PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA, for which SLs were established as of the July 2022 OSD memo.

RI activities for the facility will be conducted using a dynamic sampling design. Building on the SI data, the Prescriptive Phase will include source area sampling and downgradient vertical aquifer profiles to evaluate potential off-site migration. The Adaptive Phase scope will largely be based on the results of the Prescriptive Phase and include on-site step-in and step-out refinement borings/wells at sources. The previous detections of PFAS at the facility are summarized in **Worksheet #10** of the UFP-QAPP, and the full analyte lists for the RI are identified in **Worksheet #15** of the UFP-QAPP. Data collected during the Prescriptive Phase will be used to refine the approach for additional data collection needs during the subsequent Adaptive Phase. The risk assessments will include data from the SI and both phases of the RI.

The objective of this Risk Assessment WP is to provide the approach for the human health risk assessment (HHRA) and ecological risk assessment (ERA) performed as part of the RI. These objectives include identifying the human and ecological receptors and exposure pathways to be evaluated and the sources to be used to identify appropriate SLs, exposure assumptions, and toxicity values. The risk assessment approach was developed in accordance with the USEPA and DA risk assessment guidance, as referenced in this WP.

This Risk Assessment approach may be updated as new guidance, reference values, matrices, exposure scenarios, or exposure pathways that warrant an update are identified. In cases where more current reference sources and/or values are available at the time the HHRA or ERA calculations are being performed, the more current sources and values will be applied, as appropriate.

Additional background information and a preliminary Conceptual Site Model (CSM) for the study area are provided in **Worksheet #10** of the UFP-QAPP.

1.1 Facility Description

As noted previously, the facility encompasses approximately 35-acres of land. West Bend AASF #1 and Armory is a controlled access facility with public roads and is adjacent to the West Bend Municipal Airport. The facility consists of a storage hangar, repair hangar, shops, and a two-story office area. Exterior features are vehicle parking areas, roads, aircraft parking, taxiways, and a 90-feet clear-span bridge. The WIARNG Armory is located on the east side of the facility.

The facility lies within the Milwaukee River Basin, which includes six watersheds. The topography of the area is comprised of rolling hills and numerous drumlins. The surrounding area is covered by cropland, grasslands, wooded area, and wetlands (Wisconsin Department of Natural Resources [WDNR], 2001).

The facility is directly underlain by a surficial aquifer that resides within the unconsolidated sand and gravel deposits of glacial outwash, glacial-lake deposits, or alluvium. The facility is primarily underlain by the Maquoketa Shale, which separates the Eastern Dolomite aquifer from the Cambrian-Ordovician aquifer. The shale restricts the vertical migration of groundwater and therefore acts as a regional aquiclude (Young and Batten, 1980). The Cambrian-Ordovician aquifer resides in the Ordovician- and Cambrian-aged sandstone and dolomite units below the Maquoketa Shale, yielding water from fractures and pore spaces between the sand grains or from cracks and fractures (Wisconsin Geological and Natural History Survey, 2019).

West Bend AASF #1 and Armory is within the Milwaukee River Basin, which includes six main watersheds. The facility is located within the Village of Newburg-Milwaukee Watershed (**Figure 10-5** in UFP-QAPP), which is a sub watershed within the East and West Branches Milwaukee River Watershed. The facility is currently connected to the City of West Bend sanitary sewer system. Wingate Creek is a tributary that bisects the facility; it is classified as intermittent. The Creek discharges to the Milwaukee River, which is located approximately 500 feet from the southern boundary of AOI 1.

A stormwater catch-basin is located at the edge of the grassy area within AOI 1. This catch-basin collects stormwater, which then flows into the facility stormwater system, and then discharges to a stormwater detention basin on the southwestern portion of the property. The stormwater detention basin is located 250 feet west of Wingate Creek and 275 feet north of the Milwaukee Rive and receives stormwater runoff from the western half of the facility. Stormwater runoff typically infiltrates within the basin and there is no outlet to Wingate Creek or the Milwaukee River. Additionally, if there is flooding at the stormwater detention basin, surface water can overflow to the Milwaukee River. On the west side of the facility, the surface water flows to the south and east towards the stormwater detention basin. On the east side of the facility, surface water flows northwest and southwest to Wingate Creek, then to the Milwaukee River.

Depth to groundwater in the area ranges from 3.2 to 14.7 feet below ground surface (bgs). Shallow groundwater on the east and west side of the facility likely flows either towards the Milwaukee River or to Wingate Creek, which discharges into the Milwaukee River just south of the facility. Groundwater in the regional bedrock aquifers is expected to flow generally east towards Lake Michigan. Aquifer recharge is predominantly through infiltration of precipitation, although some recharge occurs from open water sources (Stantec Consulting Services, Inc., 2018). During the SI, depth to water ranged from 3.2 feet bgs to 13.7 feet bgs. Groundwater elevations were calculated, and an updated groundwater flow map indicated that (at the time of the SI) groundwater generally flowed south toward the Milwaukee River (Figure 10-4 of the UFP-QAPP).

It should be noted that transport of PFAS in groundwater from potential upgradient source areas identified in the SI may also contribute to potential PFAS contamination at the facility, which may ultimately expose human and ecological receptors to PFAS at the facility and in downgradient off-facility surface water bodies.

1.2 Data Selection and Evaluation

The risk assessments will include analytical data collected as part of the SI and RI field programs; however, grab groundwater samples and groundwater samples from temporary wells will not be used in the risk assessments. Analytical data from the SI (AECOM, 2022) within the investigation area and across the facility were used to refine the approach for the Prescriptive Phase. The Prescriptive Phase will include source area sampling and downgradient vertical aquifer profile transects to evaluate potential off-facility migration, including to Wingate Creek and the Milwaukee River surface water and sediment. The Prescriptive Phase data for sediment and surface water will aid in determining if there is an off-facility migration pathway in those media. The analytical data from the Prescriptive Phase will be used to develop the approach for the Adaptive Phase. Therefore, final data selection and risk evaluation will be conducted after all the data are available.

The data collected will be considered representative of current facility conditions and will be collected to meet data quality objectives for use in conducting the risk assessments. As described in **Worksheet #14** of the UFP-QAPP, samples will be collected from soil, groundwater, sediment, and surface water as part of RI. Habitat surveys conducted as part of RI will also be considered in the risk assessments.

Data selected for use in the risk assessments, including consideration of the sample locations, potential exposure media, exposure points, exposure pathways, land use(s), and receptors, as applicable, are based on the preliminary facility-specific CSM presented in **Worksheet #10** of the UFP-QAPP. Data selected for evaluation in the risk assessments will be grouped into facility-specific exposure areas, where appropriate.

Soil data will be divided into multiple depth intervals for evaluation in the risk assessments, as applicable. Surface soil will be defined as soil collected at a depth within 0 to 2 feet bgs. Subsurface soil for the HHRA will be defined as soil collected at a depth between 2 and 15 feet bgs or to the top of the water table. For future HHRA scenarios in which development of the area may occur, the surface soil and subsurface soil will be combined into a total soil column for future scenario evaluations (i.e., assume that land redevelopment occurs at the facility). In the ERA, subsurface soils from 2 to 4 feet bgs will be evaluated to assess potential exposures for burrowing animals that occur primarily through incidental soil ingestion while digging and grooming. If soils are not collected from the 2 to 4-foot bgs horizon, the shallowest subsurface soil horizon will be considered for burrowing animals. The soil data from the Prescriptive Phase will be collected using gridded systematic sampling, and the SI data were collected using a biased approach on an AOI basis. Summary statistics will be calculated separately biased and randomly collected samples. The soil data will be reviewed to assess whether the risk assessments will evaluate soil exposures on a grid or AOI-basis.

During the Prescriptive Phase, vertical profiling will be conducted to evaluate the extent of PFAS in each source area, as well as PFAS in upgradient and downgradient groundwater. The vertical profile samples, which will be collected from temporary wells, will be used to establish placement for permanent wells, but will not be used in the risk assessments. The data collected from permanent wells will be used in the risk assessments.

The ERA will not utilize groundwater data given that there are no complete exposure pathways between groundwater and ecological receptors (depth to groundwater observed during the SI ranged from 3.2 to 13.7 feet bgs). The surface water data that will be collected as part of RI are representative of exposure concentrations for aquatic biota, if present, and will be used to assess these ecological receptors. The surface water data will also be used to assess human receptors, where applicable.

If present, surface water will be collected from the stormwater detention basin; however, it is expected that the stormwater detention basin is dry except during heavy precipitation events. Sediment samples will be collected from the bottom of the stormwater detention basin. Given the ephemeral nature of water in the unlined stormwater detention, sediment is only expected to be present seasonally and is not expected to support a benthic community; therefore, solid material collected in the basin may be treated as soil for purposes of evaluating ecological exposures to PFAS. Observations made during the Habitat Assessment will be used to confirm the presence/absence of riparian or wetland plants species that would imply an aquatic habitat is seasonally present. For the HHRA, if the conditions of the stormwater detention basin are wet at the time of sampling, then the sediment samples will be treated as sediment in the HHRA calculations. If the basin is dry at the time of sampling, then the sediment will be treated as surface soil results in the HHRA.

Surface water and sediment samples will also be collected from both Wingate Creek and the Milwaukee River. Both upstream and downstream samples will be collected to evaluate whether PFAS from the facility soil or groundwater has impacted these waterbodies. The upstream locations will help determine whether sources upgradient of the facility are contributing.

Worksheet #14 of the UFP-QAPP describes the field sampling tasks, and **Worksheet #17** of the UFP-QAPP provides the sampling design and rationale for each medium and area.

1.3 Summary Statistics

For each medium/exposure area, the data will be compiled into summary statistics as discussed below for evaluation in the risk assessments, using the aggregation reporting functions within Earthsoft's EQuIS software (Earthsoft, 2022) (i.e., the software used for analytical data management). For each chemical detected at least once within an area/medium/depth interval (i.e., surface soil, subsurface soil, etc.), the summary statistics will include the minimum and maximum detected concentrations, average detected concentration, location of maximum detected concentration, frequency of detection (FOD), and the range of detection limits calculated in accordance with USEPA Risk Assessment Guidance for Superfund (USEPA, 1989).

For sample locations in which a duplicate sample was also collected, the duplicate sample results for each chemical/medium/area combination will be processed prior to the calculation of summary statistics. Duplicates will be resolved as follows:

- When both the sample and duplicate are detected, the average of field and duplicate will be used to calculate summary statistics;
- When both the sample and duplicate are non-detects, the sample with the lower limit of detection will be used; and
- When one of the pair is reported as not detected, and the other is detected, the detected result will be used.

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2.0 Human Health Risk Assessment

A facility-specific HHRA will be conducted to evaluate whether exposure to PFAS attributable to past operations at the West Bend AASF #1 and Armory may pose a potential cancer risk and/or noncancer hazard to human health above USEPA target levels defined in the NCP [40 US CFR § 300.430] (USEPA, 1991; USEPA, 1994). The evaluation will include quantitative estimation of potential cancer risk and noncancer hazard to current and potential future human receptors that contact facility-related PFAS in soil, groundwater, sediment, and surface water. The HHRA will be conducted in accordance with the USEPA, Department of Defense (DoD), and DA risk assessment guidance and policies, as applicable, and as referenced throughout this WP. Guidance/policies include, but are not limited to, the following:

- USEPA. 1989. *Risk Assessment Guidance for Superfund: Volume I. Human Health Evaluation Manual (Part A).* Interim Final. Office of Emergency and Remedial Response. US Environmental Protection Agency, Washington, D.C. EPA 540/1-89/002.
- USEPA. 1991. *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions.* OSWER Directive #9355.0-30. April.
- USEPA. 2003. *Human Health Toxicity Values in Superfund Risk Assessments.* OSWER Directive 9285.7-53. Washington, DC. 5 December.
- USEPA. 2001a. *Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments).* Final. Publication 9285.7-047. December.
- USEPA. 2004. *Risk Assessment Guidance for Superfund: Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).* Final. OSWER No. 9285.7-02 EP. Office of Emergency and Remedial Response. August.
- USEPA. 2014a. *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors.* Office of Superfund Remediation and Technology Innovation. OSWER Directive 9200.1-120. February 2014, updated September 2015.
- DoD. 2012. *Defense Environmental Restoration Program (DERP) Management Manual*, DoDM 4715.20. 9 March.
- Assistant Secretary of Defense. 2022. *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program.* United States Office of the Assistant Secretary of Defense. July.
- DA. 1999. *Risk Assessment Handbook, Volume I: Human Health Evaluation.* Engineer Manual. Department of the Army, U.S. Army Corps of Engineers. Washington, DC 20314-1000. EM 200-1-4. 31 January.

The HHRA conclusions will inform risk management decisions. If the results of the HHRA indicate potential risk/hazard above USEPA's target levels, as defined in the NCP [40 CFR § 300.430] (USEPA, 1991; USEPA, 1994), federal and state cleanup standards will be evaluated to determine if they are Applicable or Relevant and Appropriate Requirements (ARARs) as part of the Feasibility Study (FS). A weight of evidence evaluation that considers the HHRA results and ARARs will be conducted to determine the final list of Chemicals of Concern (COCs) for remedial action. The HHRA will be used to inform the development of risk-based target levels to be considered in conjunction with federal and state-specific ARARs in the selection of Preliminary Remediation Goals (PRGs) in the FS.

References cited herein are based on the most current versions of sources available as of the date of this Risk Assessment WP. In the case that updates to references become available, the most current version of the references available at the time the HHRA is initiated will be used and appropriately referenced in the HHRA.

USEPA's four step HHRA paradigm (USEPA, 1989) will be followed to conduct the HHRA, as follows. Each of the HHRA steps is discussed in further detail in the following subsections.

- Data Evaluation and Hazard Identification Exposure Assessment
- Toxicity Assessment
- Risk Characterization

2.1 Data Evaluation/Hazard Identification

The data evaluation and hazard identification step involves identification and summarization of facility data appropriate for use in the HHRA as well as the selection of chemicals of potential concern (COPCs) for quantitative evaluation in the HHRA. Analytical data will be grouped for evaluation in the HHRA, as discussed in **Section 1.2**, following resolution of duplicates, as discussed in **Section 1.3**.

2.1.1 Selection of Chemicals of Potential Concern

COPCs are a subset of the complete list of chemicals detected in environmental media (e.g., soil, groundwater) that are carried through the quantitative risk assessment process. The HHRA COPC selection process may consider low FOD, low toxicity and low concentration, consistency with background (if available), and whether the chemical is likely to be present due to laboratory contamination. PFAS are the only potential facility-related COPCs being evaluated under the scope of this RI. A background evaluation will not be conducted at this time for the facility.

2.1.1.1 Frequency of Detection

Chemicals will not be eliminated as COPCs based on low FOD alone, consistent with USEPA guidance (USEPA, 1989). Other lines of evidence to be considered include whether a COPC is also identified in other facility media and if historical and/or current facility-related activities support the presence of the chemical in the affected medium.

2.1.1.2 Comparison to Human-Health Screening Levels

Preliminary PFAS COPCs will be identified based on a comparison of the maximum detected concentrations of individual PFAS per media/area/depth interval (as applicable) to human health SLs. As discussed previously, if cleanup action is determined to be necessary based upon the results of the HHRA, federal and state ARARs will be incorporated into the selection of PRGs in the FS. Potential state ARARs include the Wisconsin maximum contaminant level (MCL) for the sum of PFOS and PFOA (NR 809.20) and surface water quality criteria for PFOS and PFOA (NR 102.03).

The SLs and toxicity values current at the time the HHRA is conducted will be used. The potential risks associated with PFAS lacking final toxicity values from USEPA's hierarchy of sources will be discussed qualitatively in the Uncertainty Analysis of the HHRA. PFAS (i.e., those with final toxicity values at the time the HHRA is initiated) detected at concentrations greater than the associated SLs will be identified as COPCs and will be quantitatively evaluated in the HHRA. Individual PFAS that are either not detected in a particular medium or that are detected at concentrations less than the associated SLs will be excluded from being COPCs and will not be evaluated further in the HHRA.

The human health SLs to be used in the screening assessment for soil, groundwater, surface water, and sediment are discussed by media below. SLs are developed for potentially applicable exposure pathways, including residential and non-residential exposure to soil, exposure to groundwater used as a source of potable water, and exposure to surface water and sediment during occupational or recreational activities. **Section 2.2** provides a more detailed discussion of the preliminary human health CSM and the potential exposure pathways.

Soil

The residential soil OSD SLs based on a target hazard quotient (HQ) of 0.1 or a cancer risk level of 1E-6 (where both are available, the lower value will be selected) will be used to select COPCs in soil. This method is considered conservative for the nonresidential exposure scenarios, where receptors are assumed to be exposed to soil fewer days per year and for fewer years than what is assumed for a residential scenario. Sediment samples collected from the stormwater detention basin during dry conditions will be treated like soil in the risk assessments; the USEPA residential soil RSLs will be used to screen detention basis sediment data even though sediment exposure is likely to be less frequent. If the basin conditions are wet at the time of sampling, then the samples will be treated as sediment in the HHRA risk calculations.

Toxicity values for the inhalation exposure route are not available from USEPA's recommended hierarchy of sources of dose-response values (USEPA, 2003 and 2022a). Therefore, potential exposure to airborne particles in outdoor air is not included in the development of human health soil SLs. The associated uncertainties will be discussed in the HHRA.

A comparison to SLs protective of the soil to groundwater migration pathway will not be included in the HHRA. Analytical groundwater data will be available and evaluated directly. Soil COPCs will be compared with groundwater COPCs to serve as an indicator of whether PFAS are potentially migrating from soil to groundwater.

Groundwater

The tapwater OSD SLs based on a target HQ of 0.1 or a cancer risk level of 1E-6 (where both are available, the lower value will be selected) will be used to select COPCs in groundwater. This method is considered conservative for the non-drinking water exposure scenarios.

Surface Water and Sediment

Published human health surface water and sediment SLs for PFAS are not available from the DoD (Assistant Secretary of Defense, 2022) or USEPA (2022a). Therefore, surface water and sediment SLs will be derived using the USEPA RSL Calculator (USEPA, 2022a), consistent with the 2022 OSD memo. SLs will be based on a target cancer risk level of 1E-6 (applicable to PFOA only) and a target HQ of 0.1. Toxicity values used in the derivation of SLs will be selected as discussed in **Section 2.3**. The calculated SLs will be used to select COPCs for surface water and sediment.

Surface water and sediment SLs protective of incidental ingestion of and dermal contact with surface water and sediment by a recreational user (adult/child) will be developed using USEPA recommended default exposure assumptions, where available. Recreational users may contact surface water and sediment while wading, swimming, or fishing in the Milwaukee River, or by wading in Wingate Creek. The following conservative inputs protective of a swimming exposure scenario will be used for COPC screening purposes:

- Exposure frequency = 52 days per year. Assumes exposure to surface water and sediment may occur while performing recreational activities for 2 days per week for the 6 warmest months (i.e., May through October; 26 weeks) per year.
- The following inputs are equal to the USEPA RSL calculator default values for a residential exposure scenario; soil defaults will be used for sediment (USEPA, 2022b):
    - Exposure duration (years) = 6 (child), 20 (adult)
    - Soil ingestion rate (milligram per day [mg/day]) = 200 (child), 100 (adult)
    - Skin surface area available for contact (square centimeter [cm^2]) = 2,373 (child), 6,032 (adult)
    - Soil adherence factor (milligram per square centimeter [mg/cm^2 per event]) = 0.2 (child), 0.07 (adult).
    - Body weight (kilogram [kg]) = 15 (child), 80 (adult)

  Other recreational exposure inputs include:

    - Surface water ingestion rate (liters per hour [L/hr]) = 0.12 (child), 0.11 (adult) (equal to the upper percentile water ingestion rates while swimming from Table 3.5 of USEPA, 2011 and Table 3.7 of USEPA, 2019a, respectively)
    - Exposure Time (hours per day) = 2.6 hours per day (equal to the national average exposure time for swimming [Exhibit 6-13 of USEPA, 1989])
    - Event Frequency (events per day) = 1

The recreational SLs for surface water will conservatively be used to select COPCs in the stormwater detection basin if water is present (as noted previously, sediment data from the detection basin will be compared to soil SLs). The above exposure assumptions are conservative for screening purposes and will be refined for use in further evaluation of COPCs in the facility-specific HHRA. **Table E-3** and **Table E-4** present the recreational exposure assumptions for use in the HHRA.

Surface water and sediment RSLs protective of fish ingestion by a recreational angler (adult) will be conservatively developed. The fish consumption pathway will only be evaluated in the HHRA where the migration pathway from the facility to the Milwaukee River is complete and impacts are related to ARNG activities. The RSLs will be based on the transfer of PFAS from sediment and surface water to fish tissue will be developed by application of published chemical-specific biota-sediment accumulation factors (BSAFs) and surface water bioaccumulation factors (BAFs) to risk-based fish tissue SLs. The following conservative inputs protective of a potential facility-specific fish ingestion exposure scenario will be used to derive the risk-based fish tissue SLs:

- Fish ingestion rate = 0.011 kg fish per day (11 grams [g] fish per day); equal to the 90^{th} percentile consumption rate of freshwater and estuarine fish (raw weight, edible portion) for the US adult population (22 g fish per day; USEPA, 2014b); assuming one-half of the total amount of fish consumed are caught, based on professional judgment. Note that in the RSL development, a fraction ingested term of 1 will conservatively be applied. If fish consumption is determined to be a complete pathway, a more realistic fraction ingested term will be used, assuming that half of a receptor's fish consumption is from the Milwaukee River and the rest is from other sources (e.g., grocery store, restaurant).

- The following inputs are equal to the USEPA default values for a residential exposure scenario (USEPA, 2014a; USEPA, 2022a):
    - Exposure frequency (days per year) = 350
    - Exposure duration (years) = 26
    - Body weight (kg) = 80

The above exposure assumptions are conservative for screening purposes and will be refined for use in further evaluation of COPCs in the facility-specific HHRA. **Table E-5** presents the recreational exposure assumptions for use in the HHRA, including both an adult and a child. The fish consumption SLs and exposure assumptions to not apply to the on-facility drainage features.

The BSAF is defined as the ratio of the PFAS concentration in fish to that in sediment and is expressed in units of kg sediment per kg fish tissue. The BAF is defined as the ratio of the PFAS concentration in fish to that in surface water and is expressed in units of liters surface water per kg fish tissue. There are no default USEPA BSAFs or BAFs available for PFAS; therefore, geometric mean BAFs/BSAFs for aquatic fish recommended in Divine et al. (2020) will be used, following the adjustment from dry weight to wet weight fish tissue, as applicable. Dry weight BSAFs and BAFs will be converted to wet weight values using the moisture content obtained from the individual studies, where available, or the USEPA-recommended default value of 75 percent (%) moisture for bony fish (USEPA,1993).

2.2 Exposure Assessment

The purpose of the exposure assessment is to provide a quantitative estimate of the magnitude and frequency of potential exposure to COPCs by a receptor. Potentially exposed individuals and the pathways through which those individuals may be exposed to COPCs are identified based on the physical characteristics as well as the current and reasonably foreseeable future uses of the facility. The extent of a receptor's exposure is estimated by constructing exposure scenarios that describe the potential pathways of exposure to COPCs and the activities and behaviors of individuals that might lead to contact with COPCs in the environment. This information is identified based on the preliminary facility-specific CSM, which is presented in **Worksheet #10** of the UFP-QAPP and summarized below.

2.2.1 Summary of Human Health CSM

As discussed in Section 1.1, the facility is located on approximately 35 acres and is a controlled access facility adjacent to the West Bend Municipal Airport. The facility is mostly covered by pavement, buildings, and landscaping, leaving few areas of exposed soil and little potential for soil exposure. Therefore, human exposure to PFAS in soil is expected to be low under the current scenario. Soil contact is possible in the future if ground-disturbing activities take place or if there is redevelopment.

Current human receptors at the facility include on-facility workers and approved visitors (e.g., National Guard/Army Reserve trainees. Outdoor workers may contact surface soil on the facility while performing maintenance or other similar activities. Visitors and trainees may also contact soil on the facility but are anticipated to have a lower exposure potential as compared to outdoor workers who would presumably be present more frequently and perform more soil-intense activities, such as landscaping.

The West Bend AASF #1 and Armory is a controlled-access facility; therefore, entry by trespassers is considered unlikely. The facility is currently surrounded by a security fence with barbed wire extension; therefore, entry by trespassers is considered unlikely. However, it is conservatively assumed that trespassers may access surface soil at the facility in the future if there is no longer controlled access. Construction/utility workers may also be present and access facility soil in the future if redevelopment or utility activities were to occur. Non-military land uses in off-facility areas adjoining the facility include commercial, residential, and agricultural use, where access is open to the public.

There are no potable wells on the facility; therefore, the only potential exposure to groundwater at the facility would be during ground-disturbing activities that reach groundwater. The facility receives its potable water from the City of West Bend Water Utility. The Utility pumps groundwater from wells throughout the City. PFAS were monitored in source wells in May 2022. PFOS and PFOA were detected in three wells within the City's water supply (Well 4, Well 11, Well 12). The concentrations of PFOS and PFOA combined in Well 4 in May 2022 was 86.7 nanogram per liter (ng/L), and in treated water at the discharge point to the distribution system was 83.9 ng/L, above the Wisconsin MCL of 70 ng/L (NR 809.20). Well 4 was immediately taken out of service. Samples collected in June 2022 showed concentrations of PFOS and PFOA combined of 57.3 ng/L in Well 4 and 5.15 ng/L in the treated water at the discharge point.

As noted previously, stormwater from the facility can discharge to both Wingate Creek and the Milwaukee River. Wingate Creek is a relatively small intermittent stream and as such, does not contain gamefish or support fishing. Human exposure could occur via wading. The Milwaukee River does support fishing, and human exposure could occur during swimming and other recreational activities as well as from fish consumption. While there could be some outdoor worker exposure to surface water and sediment within drainage features, this exposure is likely to be minor or insignificant.

The facility is adjacent to the West Bend Municipal Airport to the northeast. Comar's West Bend Plant is across Trenton Road to the west of the facility. Comar is a manufacturing company specializing in medical and packaging solutions. Beyond that is the West Bend Wastewater Treatment Plant, approximately 0.5 miles west and upgradient of the facility. The Milwaukee River is to the south, beyond which are residential, commercial, and agricultural areas. The 84^{th} Division Railsplitters Memorial Highway is to the north, beyond which are residential and commercial areas. Wingate Creek bisects the facility.

Reasonably anticipated future land use is not expected to change from the current land use described above. However, the HHRA (to be performed as part of the RI following the Adaptive Phase) will conservatively evaluate an unlimited use/unrestricted exposure (UU/UE) scenario to inform future risk-management decisions in the FS, if applicable. This scenario includes the evaluation of a hypothetical future on-facility residential scenario and the evaluation of on-facility groundwater as a source of drinking water. A remedial response will not necessarily be taken based on the results of the future UU/UE scenario, given it is not a reasonably anticipated future use for the facility, per the DoD DERP Management Manual, which states "The DoD Component shall consider current and reasonably anticipated future land uses in risk assessments. The DoD Component does not have to assume that the reasonably anticipated future land use is residential." (DoD, 2012).

2.2.2 Potential Exposure Scenarios

The receptors and exposure pathways that will be evaluated in the HHRA were selected based on current and potential future land use based on the preliminary facility specific CSM and are presented in the following table. For purposes of the HHRA, it is conservatively assumed that future land-use scenarios may involve some level of construction to convert the area to the desired use. Under this scenario, it is assumed that current subsurface soils may be brought to the surface and become available for exposure by future receptors. Potential exposure to airborne particles in outdoor air (from soil) will not be quantitatively evaluated in the HHRA because toxicity values for the inhalation exposure route are not available from USEPA's sources for PFAS; therefore, quantitative assessment of the inhalation exposure pathway cannot be performed. The associated uncertainties will be discussed in the HHRA.

<table>
<tr><th>Area</th><th>Receptor</th><th>Exposure Pathway(s)</th></tr>
<tr><td rowspan="5">On-facility</td><td rowspan="2">Outdoor Worker</td><td><u>Current</u>:
• Exposure to on-facility surface soil (0-2 feet bgs) through incidental ingestion and dermal contact.
• Exposure to surface water and sediment via incidental ingestion and dermal contact if conditions are wet during the time of sampling in the on-facility stormwater detention basin. If conditions are dry, then sediment samples will be treated like surface soil.</td></tr>
<tr><td><u>Future:</u>
• Exposure to on-facility combined surface and subsurface soil (0 to 15 feet bgs [or the top of the water table if it is shallower]) through incidental ingestion and dermal contact.
• Exposure to surface water and sediment via incidental ingestion and dermal contact if conditions are wet during the time of sampling in the on-facility stormwater detention basin. If conditions are dry, then sediment samples will be treated like surface soil.
• Exposure to groundwater via ingestion as drinking water.</td></tr>
<tr><td>Construction/Utility Worker</td><td><u>Future</u>:
• Exposure to on-facility combined surface and subsurface soil 0 to 15 feet bgs [or the top of the water table if it is shallower]) through incidental ingestion and dermal contact.
• Exposure to on-facility shallow groundwater (to a maximum depth of 15 feet bgs) via incidental ingestion and dermal contact in an excavation trench. Exposure to groundwater is possible since the depth to groundwater observed during the SI ranged from 3.2 to 14.7 feet bgs.</td></tr>
<tr><td>Trespasser (Adolescent)</td><td><u>Future:</u>
• Exposure to on-facility surface soil (0-2 feet bgs) through incidental ingestion and dermal contact.</td></tr>
<tr><td>Hypothetical
On-facility Resident
(Adult and Child)</td><td><u>Future</u>:
• Exposure to on-facility combined surface and subsurface soil 0 to 15 feet bgs [or the top of the water table if it is shallower]) through incidental ingestion and dermal contact.
• Exposure to groundwater via ingestion of drinking water and dermal contact during bathing/showering.</td></tr>
<tr><td rowspan="2">Off-facility</td><td>Off-facility Recreational User
(Adult and Child)</td><td><u>Current/Future:</u>
• Exposure to sediment and surface water in Wingate Creek will be evaluated under a wading scenario, and surface water and sediment in the Milwaukee River will be evaluated under a swimming scenario, which is protective of other recreational activities such as boating, kayaking, etc.
• Consumption of fish may be evaluated for the Milwaukee River if a complete migration pathway is identified and PFAS in the river are attributable to facility activities.</td></tr>
<tr><td>Commercial/Industrial</td><td><u>Current/Future:</u></td></tr>
</table>

Area	Receptor	Exposure Pathway(s)
	Worker	• Exposure to off-facility groundwater via ingestion of drinking water.
	Off-facility Resident (Adult/Child)	Current/Future: • Exposure to groundwater via ingestion of drinking water and dermal contact during bathing/showering.
Notes: These off-facility receptors will only be evaluated if downgradient impacts to drinking water are identified and can be attributed to ARNG activities the facility.		

The quantitative exposure assumptions for the reasonable maximum exposure (RME) scenario that will be used in the HHRA were selected in accordance with USEPA guidance (USEPA, 1989, 2002a, 2004, 2011, 2014a, 2017, 2019a, 2019b). The RME provides an estimate of the upper range of exposure in a population (the 90th percentile or greater of expected exposure, consistent with USEPA, 2019b) and is based on a combination of the upper-bound and central estimates of exposure parameters. USEPA guidance states that regulatory decisions are made using the results of the RME evaluation (USEPA, 1989). Exposure assumptions may differ from default values to factor in facility-specific considerations. Adjustments to the proposed exposure assumptions may be made based on additional facility-specific information and refinement of the human health CSM during the HHRA. If changes to the proposed exposure assumptions are made, the associated rationale will be provided in the HHRA report. **Figure E-1** presents the human receptors, exposure areas, exposure media, and exposure pathways that will be evaluated in the HHRA. **Table E-1** through **Table E-8** present the quantitative exposure assumptions that will be used.

For each receptor and exposure area, the exposure dose will be estimated for each COPC via each exposure pathway by which the receptor is assumed to be exposed. Exposure doses for oral and dermal exposure will be calculated using the following USEPA guidance (USEPA 1989 and 2004). In the absence of dermal toxicity values, oral toxicity values will be utilized with appropriate adjustments (USEPA, 2004). The potential uncertainty associated with this assumption will be discussed in the HHRA.

2.2.3 Exposure Point Concentrations

Exposure point concentrations (EPCs) for evaluation of soil, groundwater, surface water, and sediment will generally be equal to the 95% upper confidence limit (UCL) on the arithmetic mean concentration (USEPA, 2002b) per exposure area. Detection limits for results reported as not detected will be entered into the software without adjustment; ProUCL uses statistical methods to evaluate non-detects versus simple substitution (e.g., one-half detection limit). For datasets in which a reliable 95% UCL cannot be calculated using USEPA's ProUCL software (USEPA, 2022b), in which case it provides a warning or other message indicating a UCL is not recommended, the maximum detected concentration will be used as the EPC for evaluation of the RME scenario.

The most current version of USEPA's ProUCL software available at the time the HHRA starts will be used to calculate the ProUCL-recommended UCL (USEPA, 2022b). The general approach to be used for calculation of EPCs is discussed with respect to media, as presented below. Because the sampling will occur over a Prescriptive and Adaptive Phase, the total number of samples and the locations of samples that may be collected during the Adaptive Phase are not currently known. The approach for developing EPCs will be refined after all the data to be used in the HHRA are available.

Soil

Soil EPCs will be calculated for COPCs in surface soil (0-2 feet bgs) and total soil (i.e., combined surface and subsurface soil, 0-15 feet bgs, or the top of the water table is it is shallower)) for each exposure area. If conditions are dry during the sampling of the on-facility detection basis, the samples collected will be incorporated into the surface soil dataset. The Prescriptive Phase soil sampling design is described in **Worksheet #17** of the UFP-QAPP. If further sampling is necessary under the Adaptive Phase, sample density for risk assessment will be considered in the sampling design.

Groundwater

In accordance with USEPA guidance (USEPA, 2014c), facility-wide groundwater EPCs will be calculated for COPCs in groundwater using analytical groundwater data from permanent monitoring wells identified as being within the core of the plume, if present. In the absence of a clearly defined plume, professional judgment will be used to determine the appropriate dataset for calculation of reasonably conservative groundwater EPCs.

Surface Water and Sediment

If conditions at the time of sampling are wet, surface water and sediment samples will be collected from the on-facility drainage basin and will be used to derive EPCs.

Surface water and sediment samples will be collected from upstream and downstream locations within Wingate Creek and the Milwaukee River to evaluate whether PFAS from the facility have impacted surface water and sediment. Upgradient samples will be evaluated separately from downgradient samples (i.e., separate sets of EPCs will be derived). If further sampling is necessary under the Adaptive Phase, sample density for risk assessment will be considered in the sampling design.

2.3 Toxicity Assessment

The purpose of the toxicity or dose-response assessment is to identify the types of adverse health effects a chemical may potentially cause and to define the relationship between the dose of a chemical and the likelihood or magnitude of an adverse effect (response) (USEPA, 1989). The USEPA's guidance regarding the hierarchy of sources of human health dose-response values in risk assessment will be followed (USEPA, 2003), as follows:

- Tier 1: USEPA's Integrated Risk Information System (IRIS) (USEPA, 2023a).
- Tier 2: Provisional Peer-Reviewed Toxicity Values (PPRTVs) obtained from USEPA via the USEPA National Center for Environmental Assessment in Cincinnati, Ohio (USEPA, 2023b).
- Tier 3: Other sources of dose-response values will be selected in accordance with USEPA guidance (USEPA, 2013) and include, but are not limited to, California Environmental Protection Agency's (CalEPA) Office of Environmental Health and Hazard Assessment (OEHHA) Toxicity Criteria Database (CalEPA, 2023), Minimal Risk Levels (MRLs) published by the Agency for Toxic Substances and Disease Registry (ATSDR, 2023), and the Health Effects Assessment Summary Tables (HEAST; USEPA, 1997a).

As of the 2022 OSD memo and the May 2022 RSL release (USEPA, 2022a), USEPA had adopted toxicity factors for six PFAS, including HFPO-DA (or GenX), PFBS, PFHxS, PFNA, PFOS, and PFOA (USEPA, 2023a). Oral reference doses are available for these PFAS, and an oral cancer slope factor is available for PFOA only. These values will be used to quantitatively evaluate PFAS in the HHRA. Only final values will be considered in the HHRA (i.e., draft values will not be used).

USEPA guidance for early life exposure to carcinogens (USEPA, 2005a) requires that potential risks from chemicals that act by a mutagenic mode of action be calculated differently than chemicals that do not act via a mutagenic mode of action. PFOA, the only PFAS with USEPA cancer toxicity values, is not currently considered to be mutagenic; therefore, adjustments to the calculation of potential risks will not be required.

- Default values provided by USEPA's RSL calculator (USEPA, 2022a) will be used for the gastrointestinal absorption fraction (1 or 100%) and dermal absorption factor (0.1 or 10%) to assess potential risk to PFAS COPCs in soil. These estimates are uncertain and may result in an overestimation or underestimation of potential risk. Dermal exposure to PFAS is considered a minor exposure pathway due to studies that suggest dermal absorption of these chemicals is slow and does not result in significant absorption (ATSDR, 2021). The uncertainties associated with the toxicity values used will be discussed in the HHRA.

2.4 Risk Characterization

Risk characterization combines estimates of exposure with toxicity data to develop estimates of the probability that an adverse effect will occur under the specified conditions of exposure. Estimates of potential carcinogenic risks are expressed as probabilities of developing cancer reported as excess lifetime cancer risk (ELCR). Current HHRA practice considers carcinogenic risks to be additive when assessing exposure to a mixture of hazardous substances. Non-carcinogenic hazards are reported as pathway-specific hazard indices (HIs), which are the sum of individual COPC HQs for that pathway. A total HI is calculated for each receptor by summing the pathway-specific HIs within each media (e.g., summing dermal and ingestion soil HI estimates). As a first approximation, all COPCs will be conservatively assumed to have additive effects. If the total HI assuming additive effects is greater than USEPA's target level, HIs will be calculated separately for COPCs that have similar systemic effects (i.e., per target organ endpoint).

USEPA (1991) states that where the cumulative incremental current or future potential ELCR to an individual is less than 1E-4, action generally is not warranted unless there are adverse environmental impacts. USEPA also considers noncancer hazards by using a target HI per target organ of 1 (USEPA, 1991). For each associated exposure scenario (i.e., receptor/medium/exposure area) with a potential ELCR above a cancer risk threshold of 1E-04 and/or a HI of 1 (USEPA, 1991), COCs will be selected from those COPCs significantly contributing to the cumulative ELCR > 1E-4 or target organ HI > 1 (at one significant figure). COCs will be defined as chemicals with an individual chemical-specific ELCR > 1E-6 and/or HQ > 1.

2.5 Uncertainty Analysis

Within any of the steps of the HHRA process, assumptions must be made due to a lack of absolute scientific knowledge. Some of the assumptions are supported by considerable scientific evidence, while others have less support. Every assumption introduces some degree of uncertainty into the HHRA process. Regulatory HHRA methodology requires that conservative assumptions be made throughout the HHRA to ensure that public health is protected. Therefore, when all the assumptions are combined, it is much more likely that potential risks are overestimated rather than underestimated.

The assumptions that introduce the greatest amount of uncertainty in the HHRA, both facility-specific and those inherent to the HHRA process, will be discussed in the uncertainty section of the HHRA. Examples of facility-specific uncertainties are those associated with sampling/analysis methods, the COPC selection process, estimation of EPCs, representativeness of the exposure scenarios and input parameters, the availability of toxicity values, etc. Examples of uncertainties inherent to the HHRA process are the extrapolation of toxicity from animal studies to humans, from high to low doses, and the specific models used to develop dose-response values; the combination of upper-bound exposure estimates with upper-bound toxicity estimates, etc. Most of the uncertainties associated with the HHRA will be discussed in qualitative terms because, for most of the assumptions, there is not enough information to assign a numerical value to the uncertainty that can be factored into the calculation of potential risk.

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3.0 Ecological Risk Assessment

The purpose of the ERA will be to evaluate potential ecological effects of exposures to PFAS detected in on- and off-facility media, including soil, sediment, and surface water. The outcome of the ERA will provide input to remedial decision-making that will protect the health of local populations and communities of biota. The ERA will be conducted in accordance with USEPA and USACE risk assessment guidance and policies, as applicable.

The framework for the ERA will be consistent with USEPA methodology based on the following key guidance documents:

- USEPA. 1997b. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment - Interim Final.* US Environmental Protection Agency, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response. EPA 540/R-97/006. June.
- USEPA. 1998. *Guidelines for Ecological Risk Assessment*. US Environmental Protection Agency, Washington, D.C. EPA/630/R-95/002F. April.
- USEPA. 2001b. *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments*. ECO UPDATE. Interim Bulletin Number 12. US Environmental Protection Agency, Office of Solid Waste and Emergency Response.
- Tri-Services Environmental Risk Assessment Work Group (TSERAWG). 2008. *A Guide to Screening Level Ecological Risk Assessment*. TSERAWG TG-090801.
- USEPA. 2005b. *Guidance for Developing Ecological Soil Screening Levels – Revised Draft*, OSWER Directive 9285.7-55. February.
- DA. 2010. *Risk Assessment Handbook, Volume II: Environmental Evaluation*. Engineer Manual. Department of the Army, U.S. Army Corps of Engineers. Washington, DC 20314-1000. EM 200-1-4. 31 December.

The PFAS technical documents and tools developed by the DoD Environmental Security Technology Certification Program (ESTCP) and Strategic Environmental Research and Development Program (SERDP) and the recently published guidance from the Argonne National Laboratory (ANL) will also be considered for assessing ecological risk due to exposure to PFAS:

- Grippo, M. J. Hayse, I. Hlohowskyj, and K. Picel. 2021. *Derivation of PFAS Ecological Screening Values.* September. Updated November 2021.
- Conder, J., Arblaster, J., Larson, E., Brown, J., Higgins, C. 2020. *Guidance for Assessing the Ecological Risks of PFAS to Threatened and Endangered Species at Aqueous Film Forming Foam-Impacted Sites*. SERDP Project ER18-1614. January.
- Divine, C., Frenchmeyer, M., Dally, K., Osborn, E., Anderson, P., Zodrow, J. 2020. *Approach for Assessing PFAS Risk to Threatened and Endangered Species.* SERDP Project ER18-1653. March.

The ANL report (Grippo et al. 2021) is the most recently released ERA guidance for PFAS. The ecological screening values (ESVs) derived in the ANL report were developed in consultation with an interagency team of subject-matter experts from across the DoD services through the DoD Tri-Services ERA Work Group, including experts from the USEPA ERA Forum, to support screening-level assessments at US Air Force, Navy, Army, and other DoD sites. Although the latter two guidance documents listed above emphasize protection of threatened and endangered species, which may or may not be relevant to all sites, information provided therein can also be applied in ERAs for common species. These documents represent the most comprehensive ERA tools currently available. New ecotoxicity data are continuously being generated for PFAS, and additional sources of screening benchmarks and toxicity reference values (TRVs) will be consulted at the time of the ERA to ensure that the most recent toxicity data are used in the risk characterization.

Given the rapidly evolving nature of the PFAS ecotoxicity and exposure evaluation methods, and regulatory and DoD guidance, significant developments may occur within the timeframe of the project. To the extent reasonable and relevant, such developments will be incorporated in the proposed ERA.

A tiered approach will be followed that incorporates different levels of assessment complexity and provides an opportunity to off-ramp from the ERA process prior to proceeding to the next tier based on the available findings. The tiered approach may be implemented in its entirety depending upon the level and magnitude of risk that is determined in prior tiers. This approach consists of the following two tiers as summarized below:

- Tier 1 – Screening Level Ecological Risk Assessment (SLERA); and
- Tier 2 – Baseline Ecological Risk Assessment (BERA).

Tier 1 – Screening Level Ecological Risk Assessment

The primary objective for a SLERA is to determine which, if any, exposure pathways and chemicals of potential ecological concern (COPECs) warrant immediate action or require further evaluation in a more refined ERA. The SLERA includes Steps 1 and 2 of the eight step EPA ERA (USEPA, 1997b) process:

- Identification and summarization of relevant datasets.
- Development of a preliminary CSM which will identify potentially complete exposure pathways for ecological receptors.
- Comparison of EPCs to ecological SLs to identify COPECs.

Based on the outcome of the SLERA, certain media, COPECs, and pathways may be eliminated from further evaluation due to the level of conservatism built into the SLERA process. If potentially complete and significant ecological exposure pathways are identified, and maximum concentrations of certain COPECs exceed the generic SLs, additional evaluation may be recommended.

Prior to beginning problem formulation in the BERA (Step 3), the results of the SLERA may be refined in Step 3a, as described below. The decision to continue beyond the SLERA does not indicate the potential for adverse ecological effects or that risk reduction is necessary, rather, it indicates that a more focused evaluation and characterization of the potential for risk and accompanying uncertainty is needed (DA, 2010).

Tier 2 – Baseline Ecological Risk Assessment

The primary purpose of the BERA is to assess the potential for adverse effects on the focused list of ecological receptors due to exposure to the COPECs identified upon completion of the SLERA. The BERA includes Steps 3 through 7 of the eight step EPA ERA (USEPA, 1997b) process and uses facility-specific information whenever possible:

- Step 3a provides a refinement of the conservative assumptions and resulting risk estimates (e.g., HQs) identified in the SLERA. This step is conducted to refine some of the conservative assumptions used in the SLERA and assess whether more realistic assumptions would reduce the HQs to below unity prior to implementing a facility-specific BERA with associated sampling and analyses. A weight of evidence evaluation that considers the Step 3a results, available habitat, wildlife management goals for the areas evaluated, and other relevant factors as appropriate will be conducted to determine whether a BERA is recommended.

- Steps 3b through 7 are conducted for pathways and COPECs retained after the completion of Step 3a. These steps include identifying endpoints to be evaluated, the laboratory and field methods to be used to collect additional data, the statistical analyses to be used for evaluating data, and the methods to be used for estimating and characterizing the potential for adverse effects on ecological receptors.

For the West Bend AASF #1 and Armory evaluation, it is anticipated that a SLERA and Step 3a SLERA refinement will be completed, as needed, using the data collected under the SI and RI. If Step 3a identifies the need for further evaluation, an additional sampling effort may be proposed to support the BERA and additional BERA details will be provided prior to the sampling effort. Risk management decisions related to performing a BERA and the need for additional facility-specific sampling efforts to support a BERA will be made by the project team.

The following sections provide additional details for the ERA in the context of the following fundamental ERA components:

- Problem Formulation;
- Ecological Effects Assessment and Exposure Assessment; and
- Risk Characterization.

Facility-specific details are provided in the CSM presented in the UFP-QAPP (**Worksheet #10**) and in the ecological CSM figure (**Figure E-2**).

3.1 Problem Formulation

The Problem Formulation provides the framework for the ERA and serves to define the risk assessment objectives and identify the ecological receptors, exposure pathways, and endpoints to be evaluated. These components are presented in the following sections.

3.1.1 Environmental Setting

Sections 1.0 and 1.1 provide a facility description, including land use, hydrogeology, and hydrology. The environmental setting information provided below was primarily obtained from the SI Report completed in 2022 *(*AECOM, 2022).

As described in **Section 1.0**, the facility encompasses approximately 35-acres, owned by the City of West Bend, and leased to the WIARNG; the current lease agreement expires September 2075. West Bend AASF #1 and Armory is a controlled access facility with public roads and is adjacent to the West Bend Municipal Airport. The facility consists of a storage hangar, repair hangar, shops, and a two-story office area. Exterior features are vehicle parking areas, roads, aircraft parking, taxiways, and a 90-feet clear-span bridge. The WIARNG Armory is located on the east side of the facility. Reasonably anticipated future land use is not expected to change from the current land use.

The topography of the area is comprised of rolling hills and numerous drumlins. The surrounding area is covered by cropland, grasslands, wooded area, and wetlands (WNDR, 2001).

On-facility terrestrial habitat for wildlife is limited to actively mowed, disturbed, and maintained areas due to continuing military activities. In addition, most of the current facility is paved with limited grassy areas. Although bird and mammal species may access the fragmented areas of open space within the facility that surround paved areas, roads, and buildings, these habitats are expected to offer limited ecological foraging resources. However, it is conservatively assumed that terrestrial plants and soil invertebrates may serve as food sources for birds and mammals that may be present in the upland areas that could provide limited foraging habitat.

The primary exposure pathways for upland areas with viable terrestrial habitat include direct contact with surface soils by terrestrial plants, reptiles (e.g., snakes), amphibians, soil invertebrates, mammals, and birds, and indirect contact (via bioaccumulation) by birds and mammals from incidental ingestion of surface soil and by ingestion of contaminated plant and prey items.

The facility lies within the Milwaukee River Basin which includes six watersheds that all drain into Lake Michigan. The facility is located within the East and West Branches of the Milwaukee River Watershed. The Milwaukee River is located approximately 500 feet from the southern boundary of AOI 1. For assessment purposes the WDNR divides the Milwaukee River into 5 segments. The section that flows south of the facility is Assessment Unit Lime Kiln Dam to Gadow Mill Dam in West Bend (river miles 29.33 to 68.5). This segment is currently listed as impaired due to high total phosphorous levels recorded in samples collected in 2022 and has also previously been listed as impaired due to elevated water temperature (WDNR, 2023).

The Milwaukee River is considered a warm to cool mainstream habitat (WNDR, 2022). Two areas of the Milwaukee River (Fredonia to Saukville and Grafton to Thiensville) which are located downstream of the facility contain fishable numbers of smallmouth bass (*Micropterus dolomieu*). Wadable warm waters that support smallmouth bass also exist approximately 3.5 miles downstream and 2 miles upstream of the facility (WDNR, 2023). Additional fish species that occupy the river include northern pike (*Esox lucius*), walleye (*Sander vitreus*), channel catfish (*Ictalurus punctatus*) and panfish (*Lepomis*) (WDNR, 2023).

Wingate Creek is a tributary that bisects the facility and discharges to the Milwaukee River. The Creek is classified as an intermittent riverine system and includes associated forested/shrub wetlands along its banks (United States Fish and Wildlife Service [USFWS], 2023a). In addition, approximately 2 acres of emergent wetland exist on eastern side of the Creek directly outside of the AOI 2 boundary (USFWS, 2023a). It is conservatively assumed that aquatic receptors other than fish (e.g., amphibians, aquatic insects), may be found within the Creek and associated emergent wetlands.

On the west side of the facility, the surface water flows to the south via the stormwater system and overland runoff towards the stormwater detention basin located approximately 250 feet west of Wingate Creek and 275 feet north of the Milwaukee River. Stormwater typically infiltrates within the basin and there is no outlet to Wingate Creek or the Milwaukee River. However, if there is flooding at the stormwater detention basin, surface water can overflow to the Milwaukee River. The stormwater detention basin is expected to be dry except during or after precipitation events. Given the ephemeral nature of water in the unlined stormwater detention, sediment is only expected to be present seasonally and the basin may not support sediment-dependent receptors (e.g., benthic invertebrates).

The potential exposure pathways for semi-aquatic or aquatic habitats associated with the Milwaukee River, Wingate Creek, and the stormwater detention basin include direct contact with sediment and surface water by benthic invertebrates and aquatic organisms (e.g., aquatic plants, aquatic invertebrates), and indirect contact (via bioaccumulation) by aquatic-dependent birds and mammals consuming plants and prey that accumulate PFAS. Fish are present within the Milwaukee River and may be exposed to surface water and sediment. Due to the expected intermittent nature of Wingate Creek, fish are not expected to be present or exposed to Creek surface water and sediment and due to the lack of standing water in the stormwater detention basin, fish are not expected to be present in the basin.

Ecological receptors are typically not directly exposed to groundwater; therefore, there are no complete exposure pathways between groundwater (observed at 3.2 to 14.7 feet bgs in the SI) and ecological receptors. However, exposure to PFAS present in groundwater may occur when groundwater discharges or seeps into a surface water body (e.g., Wingate Creek or Milwaukee River); this exposure pathway is addressed through the evaluation of surface water.

The Habitat Assessment described in **Worksheet #14** of the UFP-QAPP will be used to evaluate potential terrestrial habitat within the AOIs and to evaluate the potential for semi-aquatic and aquatic habitat associated with the stormwater detention basin, Wingate Creek, and the Milwaukee River. In particular, the Habitat Assessment will confirm the presence/absence of riparian or wetland plant species that would imply an aquatic habitat is only seasonally present within the stormwater detention basin or intermittent portions of Wingate Creek. In addition, the Habitat Assessment will evaluate the vegetative ground cover present in and around the AOIs.

If surface water is not collected from the stormwater detention basin and the findings from the Habitat Assessment do not indicate that aquatic habitat is seasonally present, the basin will be considered to be terrestrial habitat.

3.1.1.1 Critical Habitat and Threatened/ Endangered Species

West Bend AASF #1 and Armory is an active facility and has limited access for wildlife. The following species are listed as federally endangered, threatened, proposed, and/or candidate species in Washington County, Wisconsin (USFWS, 2023b).

- **Insects**: Rusty patched bumble bee, *Bombus affinis* (endangered); Monarch butterfly, *Danaus plexippus* (under consideration)
- **Plants:** Eastern prairie fringed orchid, *Platanthera leucophaea* (Threatened)
- **Mammals**: Tricolored bat, *Perimyotis subflavus* (proposed endangered); Northern long-eared bat, *Myotis septentrionalis* (endangered)
- **Birds:** Whooping crane, *Grus americana* (non-essential experimental population)

No critical habitats have been proposed or established in the area of the facility or Washington County (USFWS, 2023b).

A desktop review of information regarding the potential presence of habitat for threatened and/or endangered species was conducted for West Bend AASF #1 and Armory. Specific data sources included the USFWS Information for Planning and Consultation (IPaC).

Attachment A-1 presents the special status species identified in the desktop review. This review identified one state-listed threatened mammal, the northern long-eared bat (*M. septentrionalis*) which was also listed as federally endangered. In addition, there was one mammal, the tricolored bat (*P. subflavus*) that was federally listed as proposed endangered but was not state-listed. Critical habitat was not identified on facility for either of these species (USFWS, 2023b). However, habitat for these species may exist at the facility.

One insect, the rusty patched bumble bee (*B. affinis*) was not state-listed but was federally listed as endangered. In addition, the monarch butterfly (*D. plexippus*) was not state-listed but was federally listed as under consideration for listing. Neither of these two insects were identified to have critical habitat on the facility (USFWS, 2023b). However, habitat for these species may exist at the facility.

One bird, the whooping crane (*Grus americana*), was federally listed as a non-essential experimental population. The whooping crane was not state-listed or identified to have any critical habitat on that facility.

A review of IPAC results identified 15 bird species as migratory birds of concern (USFWS, 2023b). Of these 15 bird species, one was identified as a state-listed endangered species (back tern [*Chlidonias niger*]). In addition, the cerulean warbler (*Dendroica cerulea*) was identified as a state-listed threatened species. The remaining 13 bird species were not state-listed (WI Natural Heritage, 2021). Although no critical habitat was identified for these migratory species on the Facility, due to the proximity of the facility to the Mississippi River Flyway, some habitat in the vicinity of the facility may be significant to migrating birds.

As described in **Worksheet #14** of the QAPP, a Habitat Assessment will be performed as part of the RI. This Habitat Assessment will occur within the same timeframe as the field sampling. Field staff will assess the available habitats in the vicinity of the soil sampling locations and the surface water and sediment sampling locations. The field staff will be familiar with the habitat requirements and appearance of the federally- and state-listed species. Any observations of relevant habitats or listed species, as well as other general habitat and common species observations (presence of burrows, scat, nests, *etc*.), will be recorded.

3.1.2 Selection of Specific Receptors and Exposure Pathways

Potentially complete ecological exposure pathways for ecological receptors potentially occurring within terrestrial portions of AOIs 1 and 2 will be evaluated in the SLERA. In addition, soil and groundwater may have been impacted by PFAS releases associated with historical ARNG activities on the facility and may have migrated via stormwater flow into the stormwater system and subsequently to Wingate Creek and the Milwaukee River; therefore, semi-aquatic and aquatic habitat of Wingate Creek and the Milwaukee River will be evaluated in the SLERA. Each exposure pathway includes a potential source of COPECs, an environmental medium, and a potential exposure route. In accordance with agency guidance, incomplete routes of exposure will not be evaluated in the SLERA. This approach is used to focus the assessment on exposure pathways that are considered to be potentially complete, and for which there are adequate data pertaining to the receptors, exposure, and toxicity.

The SLERA will not evaluate groundwater data given that there are no complete exposure pathways between groundwater and ecological receptors at this facility.

Exposure pathways differ in importance from species to species and from site to site. It is conservatively assumed that ecological receptors may come in contact with soil within terrestrial AOIs and with surface water and sediment in aquatic habitats. Aquatic habitats near the facility are expected to be limited to the Wingate Creek, Milwaukee River, and associated wetlands. On the west side of the facility, surface water from storm events flows to the south and east towards the stormwater detention basin located on the south side of the property approximately 250 feet west of Wingate Creek and 275 feet north of the Milwaukee River. Surface water infiltrates within the basin and there is no outlet structure from the basin. On the east side of the facility, surface water flows northwest and southwest to Wingate Creek, then to the Milwaukee River. As previously mentioned, Wingate Creek bisects the facility, and the Milwaukee River is located approximately 500 feet south from the southern boundary of AOI 1. Forested and emergent wetlands associated with the Creek and River occur along the banks of both features. The River, Creek, and wetlands are expected to support water-column and benthic receptors as well as birds and mammals. Given the ephemeral nature of water in the unlined stormwater detention, sediment is only expected to be present seasonally and the basin may not support a benthic community. Based on the findings of the Habitat Assessment (e.g., presence of riparian or wetland plants), the solid material collected in the basin may be treated as soil for purposes of evaluating ecological exposures to PFAS.

The following exposure pathways will be quantitatively evaluated in the SLERA:

- Soil invertebrates, terrestrial plants, reptiles, and amphibians directly exposed to PFAS in surface soil (0 to 2 feet bgs).
- Terrestrial birds and mammals exposed to PFAS through incidental ingestion of surface soil and by ingestion of contaminated plant and prey items impacted by soil. If present, burrowing mammals may be exposed to PFAS in sub-surface soils (2 to 4 feet bgs) through incidental soil ingestion while digging and grooming.
- Benthic invertebrates and aquatic organisms (e.g., aquatic plants, aquatic invertebrates, and amphibians) directly exposed to PFAS in sediment and surface water in aquatic and semi-aquatic habitats of the stormwater detention basin, Wingate Creek, and the Milwaukee River.
- Aquatic-dependent birds and mammals exposed to PFAS through incidental ingestion of sediment, intentional ingestion of surface water, and by ingestion of contaminated plant and prey items impacted by sediment or surface water in the stormwater detention basin, Wingate Creek, and the Milwaukee River.

As stated previously, due to the expected intermittent nature of Wingate Creek, fish are not expected to be present or exposed to Creek surface water and sediment; however, the Milwaukee River supports fish species and fish may be exposed to surface water and sediment. Fish are also not expected to be present in the stormwater detention basin.

If surface water is collected from the stormwater detention basin, it will conservatively be assumed that aquatic receptors may be found seasonally within the stormwater detention basin. If surface water is not collected from the stormwater detention basin and the findings from the Habitat Assessment do not indicate that aquatic habitat is seasonally present, the solid material collected from the basin will be evaluated as surface soil; consistent with the potential exposure pathways identified for upland habitat in AOI 1 and AOI 2.

3.1.3 Selection of Biological Endpoints

Based on the identification of potentially complete exposure pathways, assessment endpoints and measures of effect were identified. Assessment endpoints describe the characteristics of an ecosystem that have an intrinsic environmental value that is to be protected. Typically, assessment endpoints and receptors are selected for their potential exposure, ecological significance, economic importance, and/or societal relevance. For example, assessment endpoints usually focus on protection at the individual level for state- or federally-protected species and on the overall population for common species. The SLERA represents a very conservative SL assessment that consider the available habitat within the exposure areas and the management goals of the facility, as appropriate; the assessment endpoints are stated in generic terms. More specific assessment endpoints will be developed in a BERA, as needed.

Based on the general exposure pathways identified for the West Bend AASF #1 and Armory, the following assessment endpoints and their associated measures of effect will be addressed in the

SLERA through comparison of media concentrations to appropriate screening values. The potential for adverse effects is typically evaluated at the community, rather than individual, level in an ERA. Protection at the individual level will be afforded to special status species, if present in the vicinity of areas impacted by PFAS. Field staff will assess the available habitats and potential for the presence of special status species as part of the Habitat Assessment conducted in the vicinity of the sampling locations.

In the SLERA, an exceedance of a screening value does not indicate that an adverse effect is occurring, only that further evaluation is needed. In the event that concentrations of certain PFAS exceed available screening values, additional evaluation may be conducted in a SLERA refinement step (referred to as Step 3a and described in **Section 3.5**). Observations made during the Habitat Assessment described in **Worksheet #14** of the UFP-QAPP may be considered in the characterization of potential adverse effects, if identified, based on comparisons to screening values.

Assessment Endpoint	Measure of Effect
Protection and maintenance of indigenous terrestrial plant and soil invertebrate communities with viable upland habitat at levels similar to those of nearby populations not exposed to facility-related PFAS.	Comparison of concentrations of PFAS in surface soil to soil screening values derived for the protection of plants and soil invertebrates. PFAS with detected concentrations above screening values will be identified as preliminary COPECs for plants and soil invertebrates that warrant further evaluation in Step 3a.
Protection and maintenance of terrestrial birds that may forage with viable upland habitat at levels similar to those of nearby populations not exposed to facility-related PFAS.	Comparison of concentrations of PFAS in surface soil to soil screening values derived for the protection of birds. PFAS with detected concentrations above screening values will be identified as preliminary COPECs for terrestrial birds that warrant further evaluation in Step 3a.
Protection and maintenance of terrestrial mammals, including burrowing mammals, that may forage with viable upland habitat at levels similar to those of nearby populations not exposed to facility-related PFAS.	Comparison of concentrations of PFAS in surface soil and subsurface soil (2 to 4 feet bgs)[1] to soil screening values derived for the protection of mammals. PFAS with detected concentrations above screening values will be identified as preliminary COPECs for terrestrial mammals that warrant further evaluation in Step 3a.
Protection and maintenance of benthic invertebrate communities in the aquatic habitat at levels similar to those of nearby populations not exposed to facility-related PFAS.	Comparison of concentrations of PFAS in sediment from aquatic habitats to freshwater sediment screening values derived for the protection of invertebrates. PFAS with detected concentrations above screening values will be identified as preliminary COPECs for benthic invertebrates that warrant further evaluation in Step 3a.
Protection and maintenance of aquatic organisms (e.g., plants, invertebrates, amphibians) communities, if present, in aquatic habitats at levels similar to those of nearby populations not exposed to facility-related PFAS.[2]	Comparison of concentrations of PFAS in surface water from aquatic habitats to freshwater surface water screening values. PFAS with detected concentrations above screening values will be identified as preliminary COPECs for aquatic organisms that warrant further evaluation in Step 3a.
Protection and maintenance of aquatic wildlife receptors (i.e., birds and mammals) that may forage within potentially impacted aquatic habitats at levels similar to those of nearby populations not exposed to facility-related PFAS.[2]	Comparison of concentrations of PFAS in surface water and sediment from aquatic habitats to surface water and sediment screening values derived for the protection of birds and mammals.

Assessment Endpoint	Measure of Effect
	PFAS with detected concentrations above screening values will be identified as preliminary COPECs for semi-aquatic wildlife that warrant further evaluation in Step 3a.
[1] If soils are not collected from the 2 to 4-foot bgs horizon, the shallowest subsurface soil horizon will be considered for burrowing mammals. [2] Fish are not expected to be present within the stormwater detention basin or Wingate Creek but are expected to be present in the aquatic habitat of the Milwaukee River.	

In cases where receptor-specific PFAS screening values are not available, exposure pathways will be discussed qualitatively. For example, screening values for reptiles or for amphibians exposed to soil are generally not available so quantitative evaluations are not possible.

3.1.4 Conceptual Site Model

The end product of the problem formulation step is the development of an ecological CSM, which describes the COPEC origin, fate, transport, exposure pathways, and receptors of concern. The ecological CSM provides a clear and concise description of how ecological receptors may come into contact with facility-related COPECs via release mechanisms and exposure to soil, sediment, and/or surface water. The ecological CSM provides the framework for the ERA and will be used to identify appropriate exposure pathways and receptors for evaluation.

Figure E-2 provides the preliminary ecological CSM for the terrestrial habitat and aquatic habitat associated with the West Bend AASF #1 and Armory.

As described in **Worksheet #10** of the UFP-QAPP, PFAS are water soluble and can migrate readily from soil to groundwater or surface water via leaching and run-off. The ERA will not utilize groundwater data given that there are no complete exposure pathways between groundwater and ecological receptors. The surface water data that will be collected as part of the RI are representative of exposure concentrations for aquatic biota, if present, and will be used to assess these ecological receptors. Overland runoff of soil particles containing PFAS to surface water is a potentially complete transport pathway for ecological receptors.

PFAS in soil (0 to 2 feet bgs) may be contacted directly by terrestrial plants, reptiles, amphibians, soil invertebrates, birds, and mammals living in the soil or on the soil surface. PFAS in surface water and sediment within aquatic habitats may be contacted directly by aquatic plants, amphibians and reptiles, aquatic and benthic invertebrates, and fish living in the water column or in contact with sediment. Wildlife foraging within aquatic habitats could also be exposed directly to chemicals in these media through incidental ingestion of sediment, intentional ingestion to satisfy drinking water requirements, and indirectly by ingestion of contaminated plants and prey items. Other potentially complete but minor pathways, like direct contact with subsurface soil (>2 feet bgs), will be discussed qualitatively for burrowing animals.

The findings of the Habitat Assessment described in **Worksheet #14** of the UFP-QAPP will be used to refine or confirm the receptors and exposure pathways identified in the preliminary CSM.

3.2 Screening Level Ecological Effects Assessment and Exposure Assessment

This phase of the SLERA is based on the CSM developed in the problem formulation and characterizes potential ecological exposures and corresponding effects. The ecological exposure assessment involves the identification of potential exposure pathways and an evaluation of the magnitude of exposure by identified ecological receptors. The ecological effects assessment describes the potential adverse effects to ecological receptors from exposure to COPECs in environmental media. The data and methods that will be used to identify and characterize ecological exposure and effects are described in the following subsections.

3.2.1 Data Evaluation and Identification of COPECs

COPECs will be identified by comparing media-specific concentrations to ecologically-protective screening values. Analytical data will be grouped for evaluation in the SLERA, as discussed in **Section 1.2**. COPECs will be identified as detected PFAS that are carried through the quantitative risk assessment process. COPECs will be established per exposure area, medium, and depth interval (as appropriate). The soil, sediment, and surface water sampling designs are described in **Worksheet #17** of the UFP-QAPP.

Consistent with the HHRA COPC selection process, preliminary PFAS COPECs will be identified in the SLERA based on a comparison of the maximum detected concentrations of each detected PFAS per medium/area/depth interval (as applicable) to the ESVs. UCLs calculated using the most current version of USEPA's ProUCL software (USEPA, 2022b) may be used to refine the SLERA findings in Step 3a (as described in **Section 3.5**). The ESVs will be based on conservative endpoints and sensitive ecological effects data, and they represent tools used for a preliminary screening of surface soil, sediment, and surface water concentrations.

PFAS detected at concentrations above the ESVs will be identified as preliminary COPECs for further evaluation in the Tier 2 Step 3a refinement (as described in **Section 3.5**).

3.2.2 Ecological Effects Assessment

The preliminary ecological effects evaluation is an investigation of the relationship between the exposure to a chemical and the potential for adverse effects resulting from exposure. In this step, conservative ESVs for the ecological media of interest are identified.

Receptor- and media-specific ESVs will be used in the SLERA to identify preliminary COPECs and evaluate the potential for adverse effects on ecological receptors. These ESVs will be based on conservative endpoints and sensitive ecological effects data and will be used for a preliminary screening of PFAS levels to determine if there is a need to conduct further analyses or investigations.

The selected ESVs will focus on protecting the majority of the exposed communities (e.g., 95% of exposed taxa) from adverse effects related to survival, growth, and reproduction under conditions of chronic or sensitive life-stage exposure. Currently, ESVs for PFAS are still evolving and lack general consensus; however, there is extensive and increasing literature on biological uptake, bioaccumulation, and ecological toxicity of PFAS. USEPA has not published ESVs for PFAS[1], but DoD-funded studies under the ESTCP and SERDP have resulted in recent publications containing ecological SLs for soil, sediment, and surface water. In addition, PFAS ESVs have been developed under the Interagency Agreement between the U.S. Department of Energy, Air Force Civil Engineer Center, and ANL (Grippo et al., 2021). These will be the primary sources used to identify ESVs.

The following key sources will be used to select the ESVs for the various media to be sampled. The lowest of the available ESVs for each medium will be selected for the SLERA, and the more facility-specific of these ESVs will be considered for the Tier 2 Step 3a refinement, as needed. ESVs derived by Conder et al. (2020) and Divine et al. (2020) emphasize protection of threatened

[1] USEPA published draft aquatic life ambient water quality criteria for PFOS and PFOA in April 2022. These criteria will be considered in the ERA if they are finalized before the ERA is initiated.

and endangered species, which may or may not be relevant to all sites. The use of these ESVs will be evaluated in the Tier 2 Step 3a refinement.

Soil

- Conder et al., 2020 and Divine et al., 2020. No-observed effect concentration (NOEC) values with regard to survival, reproduction or growth as the endpoint for terrestrial plants and soil invertebrates.
- Grippo et al., 2021. Geometric mean NOEC values with regard to growth or germination as the typical endpoint for terrestrial plants; and survival, reproduction or growth as the endpoint for soil invertebrates.
- Divine et al., 2020. No-observed adverse effect level (NOAEL) based Risk-Based Screening Levels (RBSLs) for terrestrial wildlife derived using food web models based on consumption of plant and prey items impacted by PFAS in soil. SLs were derived for the meadow vole (*Microtus pennsylvanicus*), short-tailed shrew (*Blarina brevicauda*), little brown bat (*Myotis lucifugus*), long-tailed weasel (*Mustela frenata*), American goldfinch (*Spinus tristis*), house wren (*Troglodytes aedon*), and red-tailed hawk (*Buteo jamaicensis*).
- Grippo et al., 2021. Geometric mean NOAEL-based ESV for terrestrial wildlife derived using food web models based on consumption of plant and prey items impacted by PFAS in soil. ESVs were derived for the meadow vole, short-tailed shrew, long-tailed weasel, mourning dove (*Zenaida macroura*), American woodcock (*Scolopax minor*), and red-tailed hawk.

Surface Water

- Conder et al., 2020. Freshwater aquatic life protection values referred to as the 5% hazardous concentration. These values are protective of 95% of aquatic species, which reflects the level of protection afforded by USEPA's National Recommended Water Quality Criteria for Aquatic Organisms (USEPA, 2022c).
- Divine et al., 2020. Chronic recommended water quality RBSLs for aquatic life derived using USEPA's Water Quality Guidance for the Great Lakes System methodology (USEPA, 2012).
- Grippo et al., 2021. Freshwater ESVs for aquatic life were derived by following the two-tiered approach described in the Great Lakes Initiative (GLI) guidance (USEPA, 1995a, 1995b, 1995c). Final chronic freshwater ESVs for PFOA and PFOS are Tier I ESVs, while the remaining are Tier II ESVs.
- Divine et al., 2020. NOAEL based RBSLs for aquatic wildlife derived using food web models based on consumption of plant and prey items impacted by PFAS in water. SLs were derived for the muskrat (*Ondatra zibethicus*), little brown bat, river otter (*Lontra canadensis*), harbor seal (*Phoca vitulina*), mink (*Neovison vison*), red-winged blackbird (*Agelaius phoeniceus*), tree swallow (*Tachycineta bicolor*), and brown pelican (*Pelecanus occidentalis*).
- Grippo et al., 2021. Geometric mean NOAEL-based ESV for aquatic-dependent birds and mammals were derived using food web models based on consumption of plant and prey items impacted by PFAS in surface water. A two-tiered methodology was used to develop the ESVs, based on the 1995 GLI Tier I and Tier II guidance for deriving water quality criteria to protect wildlife (USEPA, 1995b, 1995c). ESVs were derived for the belted kingfisher (*Megaceryle alcyon*), herring gull (*Larus argentatus*), osprey (*Pandion*

haliaetus), mallard (*Anas platyrhynchos*), spotted sandpiper (*Actitis macularius*), mink and river otter.

- USEPA. 2022e. USEPA's recently published draft chronic ambient water quality criteria for PFOS and PFOA will be considered in the SLERA if they are finalized before the SLERA is performed.

<u>Sediment</u>

- Grippo et al., 2021. ESVs were not developed for sediment because they found that the science is not yet mature enough to develop them. Recent literature from Conder et al. (2020) and Divine, et al. (2020) were reviewed and likewise lacked available data for deriving empirically-based SLs benthic invertebrates.
- Simpson et al., 2021. The 99% protection concentration (PC99) for PFOS in estuarine and marine sediment (60 micrograms per kilogram (µg/kg) based on 1% organic carbon) was selected.
- Divine et al., 2020. NOAEL based RBSLs for aquatic wildlife derived using food web models based on consumption of plant and prey items impacted by PFAS in sediment. SLs were derived for the same aquatic-dependent wildlife listed above for surface water.

The ANL ESV guidance (Grippo et al., 2021) is a living document that is expected to undergo revisions as the state of the science progresses, and key updates may or may not be completed by the time the SLERA is performed. In that case, the selection of ANL ESVs will consider scientific confidence in the ANL ESVs and new developments in PFAS ecotoxicity.

In addition to the sources of SLs listed above, new literature sources may be considered given the ongoing research and publications on PFAS ecotoxicity. Based on a lack of toxicity information, not all individual PFAS compounds can be evaluated quantitatively in the SLERA. The basis of the selected ESVs and associated data limitations (e.g., ESVs based on limited data) will be discussed in the uncertainty section of the SLERA report.

In general, PFOS has been the focus of most regulatory interest with less toxicity data available for PFOA, PFBS, and other PFAS chemicals. In the recent SERDP studies cited above (Conder et al., 2020 and Divine et al., 2020) and ANL report (Grippo et al. 2021), toxicity data, and other chemical-specific parameters necessary to develop terrestrial and aquatic ecological benchmarks were compiled to establish SLs for several additional PFAS chemicals.

In soil, in addition to PFOA, PFOS, and PFBS, screening values are also available for perfluorodecanoic acid (PFDA), PFNA, perfluoroheptanoic acid (PFHpA), PFHxS, PFBA, and perfluorohexanoic acid (PFHxA). For sediment and surface water, wildlife-based screening values are available for PFOA, PFOS, PFBS, PFNA, PFHxA, PFHxS (surface water only) and PFBA. For aquatic life, screening values are available for a longer list of PFAS chemicals in addition to PFOS, PFOA, and PFBS: perfluorododecanoic acid (PFDoA), perfluoroundecanoic acid (PFUdA), PFDA, PFNA, PFHxS, PFHpA, PFHxA, perfluoropentanoic acid (PFPeA), and PFBA. For benthic invertebrates, only an estuarine/marine sediment screening value for PFOS is available.

Table E-9 presents the PFAS ESVs for soil for plants and invertebrates. **Table E-10** presents the wildlife-ESVs for soil, surface water, and sediment. **Table E-11** and **Table E-12** present the surface water ESVs for aquatic life and sediment ESV for benthic invertebrates, respectively.

There is notable uncertainty inherent in the food-chain-based ESVs protective of birds and mammals, which tend to be overly stringent. For example, surface water SLs available in the literature incorporate conservative BAFs and biomagnification factors to estimate tissue levels in fish from water, are based on conservative avian and mammalian toxicity values, and typically assume receptors consume an exclusive diet of contaminated fish (Divine et al., 2020; Giesy et al., 2010; Dutch National Institute for Public Health and the Environment, 2010). Similarly, a soil ESV based on a small mammal consuming a diet of contaminated earthworms is also likely to be overly conservative for most sites (Divine et al., 2020; Environment and Climate Change Canada, 2017). The uncertainties related to the selected ESVs will be discussed in the context of the potential to result in an over- or under-prediction of potential adverse effects in the exposure areas.

3.2.3 Ecological Exposure Assessment

In order to conclude whether a chemical has the potential to impact an ecological receptor, a relevant chemical concentration or dose must first be determined. That concentration/dose is then compared to the ecological effects data presented above (i.e., the ESVs). For the SLERA, the maximum detected concentration will be evaluated as the EPC, while a more realistic estimate of exposure by receptor communities and mobile species will be considered in the Tier 2 Step 3a refinement (i.e., the UCL).

Mechanisms for exposure of a representative species to PFAS depend on the physical and behavioral characteristics of the organism. Most exposure mechanisms for aquatic/benthic invertebrates, soil invertebrates, and plants can be loosely termed “direct contact”. Soil invertebrates have the ability to absorb chemicals from moist soil through external body surfaces or by intake of food or soil.

Wildlife species may be exposed to PFAS in soil, sediment, and surface water directly though ingestion (incidental or intentional) or indirectly by ingestion of contaminated food organisms. Most biological activity occurs at the soil surface, with deep-rooted plants and burrowing animals potentially occurring in soil below the surface.

Step 2 of the of the eight-step process is the SL exposure estimate and comparison to risk-based ESVs. In this step, the maximum detected concentrations in the relevant media will be compared to the associated ESVs. Data treatment and calculation of summary statistics for the ERA will be consistent with the rules described in **Section 1.3**. Maximum detected concentrations will be identified per exposure area and medium and will be used as the EPC for all ecological receptors in the SLERA.

3.2.4 SLERA Calculations

HQs will be calculated for each PFAS analyte in each medium (e.g., surface soil, surface water) by dividing the maximum detected concentration by the relevant ESVs for terrestrial and aquatic ecological receptors using the following formula:

$$HQ = \text{Maximum detected concentration} \div ESV$$

Individual PFAS that exceed their respective ESVs (i.e., HQs > 1), and analytes, media, and receptor groups without ESVs, will be retained for further evaluation in the Tier 2 Step 3a COPEC refinement.

Due to the consistently applied conservative assumptions implicit in a SLERA, the presence of HQs above 1 using the maximum detected concentration as the EPC does not necessarily constitute ecological risk; it only indicates the potential for adverse effects and that additional consideration is warranted. If the resulting HQ is equal to or less than 1, the potential for adverse effects due to that chemical can be considered negligible and therefore may be dropped from further consideration for that exposure pathway (DA, 2010).

The selection of preliminary COPECs is the final part of the SLERA. Chemicals selected as preliminary COPECs on the basis of an ESV exceedance will be further evaluated in Step 3a to determine if they should be retained as final COPECs. The preliminary COPECs will be selected if the comparison of soil, sediment, or surface water data to ESVs results in HQs above 1. The COPEC refinement process in Step 3a is discussed in **Section 3.5**.

3.3 Screening Level Risk Characterization

The results of the ecological effects assessment and exposure assessment will be analyzed and interpreted to determine whether particular exposure pathways, receptors, and chemicals can be eliminated from further evaluation. The SL risk characterization will summarize the results of the effects assessment and exposure assessment and provide interpretation of the ecologically significant findings. Aspects of ecological significance that may be considered to help place the SLERA results into a broader ecological context include the management goal plans in place for West Bend AASF #1 and Armory, the nature and magnitude of effects, the spatial and temporal patterns of effects, and the potential for recovery once a stressor has been removed. If the potential for adverse effects on ecological receptors is implied through the screening process using literature-based inputs, facility-specific validation studies (e.g., toxicity testing) conducted in the field or laboratory may be needed to verify these findings.

The documentation of the risk characterization will include a summary of assumptions, uncertainties (both generic and facility -specific), strengths and weaknesses of the analysis phase of work, and justification of conclusions regarding the ecological significance of the estimated (i.e., risk of harm) or actual (i.e., evidence of harm) potential for adverse effects. Some uncertainties bias the results of the risk assessment towards excessive risk, while others bias towards no significant risk. All discussions of uncertainty will include examination and review of several aspects of the SLERA including, but not limited to, sampling, data quality, study design, selection of indicator species, estimates of exposure, and selection of ESVs. The uncertainty section of the SLERA will identify limitations and assumptions and relate them to the potential effects these uncertainties may have on the overall conclusions of the ERA. As mentioned previously, the assumptions inherent in the ESVs for PFAS that are protective of birds and mammals, which may be highly conservative, are of particular interest in the uncertainty assessment. This is due to the strong influence of facility-specific conditions on the bioaccumulation and bioavailability potential of PFAS, as well as the relevancy of the types of species upon which the ESVs are based relative to the avian and mammalian species actually present at or near the facility.

3.4 SLERA Scientific/Management Decision Point

Consistent with USEPA guidance (1997b), a scientific/management decision point will be determined based on the outcome of the SLERA (Steps 1 and 2 of the eight-step USEPA process) to establish that (1) there is adequate information to conclude that ecological risks are negligible and therefore there is no need for remediation on the basis of ecological risk, (2) the information is not adequate to make a decision and the ecological risk process will continue to Step 3, or (3) the information indicates a potential for adverse ecological effects, and a more thorough assessment is warranted (e.g., additional sampling or analysis).

If the decision is made that further investigation is warranted for any specific receptors/pathways, a sub-tier of Step 3 (Step 3a) of the USEPA's eight-step ERA process may be conducted. USEPA (2001b) and DoD guidance (TSERAWG, 2008; DA, 2010) provide the basis to introduce sub-tiers into the SLERA process and the approach is described in the following sub-section.

3.5 Step 3a SLERA Refinement

Step 3a, a sub-tier of Step 3 (referred to as a refinement of the SLERA by TSERAWG [2008] and DA [2010]), serves to refine the list of preliminary COPECs identified in the conservative evaluation conducted in Steps 1 and 2 by considering additional facility-specific factors. It is anticipated that any preliminary COPECs identified in soil, surface water, or sediment will be further evaluated in Step 3a. The refinement step may include comparisons against background concentrations (if available) or re-evaluation of parameters considered in the SLERA (e.g., assumption of 100% bioavailability).

Only COPECs, pathways, and receptors retained after the Step 3a refinement process would potentially be considered for further evaluation in a BERA. In many cases, the Step 3a refinement provides the basis for defining potential risk drivers, which may be further evaluated for remedial decisions, or alternatively, a complete BERA may be initiated, which applies USEPA Step 3b through Step 8 of the ERA process. It is currently unknown if Step 3a will be warranted for any ecological receptors evaluated in the SLERA, but the following discussion provides the proposed approach.

The purpose of Step 3a is to reevaluate preliminary COPECs identified in the SLERA to identify and eliminate from further consideration those preliminary COPECs that were identified due to the use of overly conservative exposure scenarios (e.g., maximum concentrations). Using more realistic Step 3a assumptions, the SLERA HQs described in **Section 3.2.4** will be recalculated for the pathways and preliminary COPECs retained at the end of the SLERA, and a qualitative weight of evidence evaluation will be conducted to determine whether a BERA is recommended.

It is anticipated that the Step 3a re-evaluation/refinement process will follow these steps:

- Calculate alternative EPCs based on UCLs (rather than maximum concentrations).
- Revise ESV comparisons for community level receptors (e.g., plants and invertebrates) using alternative EPCs and alternative less conservative ESVs, if available, for the particular medium and receptor group (e.g., low effect concentrations rather than no effect concentrations).
- Evaluate food web exposure assumptions and TRVs upon which the bird and mammal ESVs are based to identify exposure and effects inputs that may not be applicable to facility conditions. These inputs may include uptake factors, exposure durations, area use factors, and both NOAEL-based and lowest observed adverse effect level-based TRVs. Sources for uptake factors and TRVs will include those used to derive NOAEL based RBSLs considered in the SLERA as well as other sources available in the literature (e.g., Zodrow, et al., 2020; Narizzano, et al., 2021).
- Revise ESV comparisons for avian and mammalian receptors using alternative EPCs and less conservative avian and mammalian ESVs (e.g., ESVs adjusted to be more representative of receptors or conditions present at the facility). The development of facility-specific dose and hazard estimates for wildlife receptors may also be considered.
- Identify COPECs with HQs less than 1 in the Step 3a ESV comparisons and eliminate the COPCs from further evaluation.
- For COPECs with a HQ greater than 1, compare media concentrations to background levels (if available). Identify COPECs present at concentrations below or consistent with background levels and propose these for elimination from further evaluation.

- For COPECs with a HQ greater than 1, consider bioavailability; identify COPECs likely to be biologically unavailable, and propose these for elimination from further evaluation.
- Review FOD to identify COPECs with low detection frequencies (and sufficient data for acceptable exposure area characterization). If a COPEC were detected in only a very small percentage of the samples collected (5% or less), the potential for adverse effects identified in the SLERA may be overestimated and further evaluation of the COPEC is not warranted.
- Conduct a qualitative weight of evidence evaluation that considers the Step 3a ESV comparisons, available habitat within the areas evaluated, wildlife management goals for the areas evaluated, and other relevant factors, as appropriate, to determine whether a BERA is recommended.

After the re-evaluation/refinement, the decision criteria for Step 3a include:

- If the Step 3a refinement does not identify the potential for adverse effects associated with the preliminary COPECs, then a no further action designation is warranted, and the facility exits the ERA process.
- If the re-evaluation of the conservative exposure assumptions identifies the potential for adverse effects associated with the preliminary COPECs, the BERA process continues to Step 3b and subsequent steps, or to remedial decisions.

In the event a BERA is warranted, this evaluation will be focused only on the receptors, pathways, and PFAS of potential concern identified following the weight of evidence assessment in Step 3a. The BERA would consider more detailed aspects related to the COPECs, receptors, and exposure pathways retained at the end of Step 3a and could include food web modeling, toxicity testing, additional habitat assessments, or collection of other facility-specific data.

3.6 Completing Steps 3b through Step 7

It is anticipated that the ERA for the exposure areas will be completed through the Step 3a phase, and a full Tier 2 BERA will not be warranted. If this is not the case, risk management decisions related to performing a BERA and the need for additional facility-specific sampling efforts to support a BERA will be made by the project team.

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Tables

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TABLE E-1

VALUES USED FOR DAILY INTAKE CALCULATIONS - SURFACE SOIL AND COMBINED SURFACE AND SUBSURFACE SOIL

REASONABLE MAXIMUM EXPOSURE

HUMAN HEALTH RISK ASSESSMENT

WEST BEND AASF #1 AND ARMORY

WEST BEND, WISCONSIN

Scenario Timeframe(s):	Current; Future
Medium:	Soil
Exposure Media:	Surface Soil and Combined Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point(s)	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Incidental Ingestion	Outdoor Worker	Adult	On-facility:	CS	Chemical Concentration in Soil	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
			Surface soil (current),	IR	Ingestion Rate	100	mg/day	USEPA, 2014	CS x IR x EF x ED x CF x FI x RBA
			Combined surface and	EF	Exposure Frequency	250	days/yr	USEPA, 2014	BW x AT
			subsurface soil (future)	ED	Exposure Duration	25	year	USEPA, 2014	
				FI	Fraction Ingested from Site	1	unitless	(1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				RBA	Relative Bioavailability Factor	1	unitless	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	9,125	days	USEPA, 1989	
	Resident	Adult	On-facility (Hypothetical);	CS	Chemical Concentration in Soil	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
			Combined surface and	IR	Ingestion Rate	100	mg/day	USEPA, 2014	CS x IR x EF x ED x CF x FI x RBA
			subsurface soil (future)	EF	Exposure Frequency	350	days/yr	USEPA, 2014	BW x AT
				ED	Exposure Duration	20	years	USEPA, 2014	
				FI	Fraction Ingested from Site	1	unitless	(1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				RBA	Relative Bioavailability Factor	1	unitless	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	7,300	days	USEPA, 1989	
		Child	On-facility (Hypothetical);	CS	Chemical Concentration in Soil	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
			Combined surface and	IR	Ingestion Rate	200	mg/day	USEPA, 2014	CS x IR x EF x ED x CF x FI x RBA
			subsurface soil (future)	EF	Exposure Frequency	350	days/yr	USEPA, 2014	BW x AT
				ED	Exposure Duration	6	years	USEPA, 2014	
				FI	Fraction Ingested from Site	1	unitless	(1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				RBA	Relative Bioavailability Factor	1	unitless	--	
				BW	Body Weight	15	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	2,190	days	USEPA, 1989	

TABLE E-1
VALUES USED FOR DAILY INTAKE CALCULATIONS - SURFACE SOIL AND COMBINED SURFACE AND SUBSURFACE SOIL
REASONABLE MAXIMUM EXPOSURE
HUMAN HEALTH RISK ASSESSMENT
WEST BEND AASF #1 AND ARMORY
WEST BEND, WISCONSIN

Scenario Timeframe(s):	Current; Future
Medium:	Soil
Exposure Media:	Surface Soil and Combined Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point(s)	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Incidental Ingestion	Trespasser	Adolescent	On-facility:	CS	Chemical Concentration in Soil	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
		(7 to <16 years)	Surface soil (future)	IR	Ingestion Rate	100	mg/day	USEPA, 2014 (2)	CS x IR x EF x ED x CF x FI x RBA
				EF	Exposure Frequency	52	days/yr	(3)	BW x AT
				ED	Exposure Duration	9	years	(4)	
				FI	Fraction Ingested from Site	0.5	unitless	(5)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				RBA	Relative Bioavailability Factor	1	unitless	--	
				BW	Body Weight	44	kg	USEPA, 2011 (6)	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	3,285	days	USEPA, 1989	
Incidental Ingestion	Construction/Utility Worker	Adult	On-facility:	CS	Chemical Concentration in Soil	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
			Combined surface and	IR	Ingestion Rate	330	mg/day	USEPA, 2002	CS x IR x EF x ED x CF x FI x RBA
			subsurface soil (future)	EF	Exposure Frequency	125	days/yr	(7)	BW x AT
				ED	Exposure Duration	0.5	year	(7)	
				FI	Fraction Ingested from Site	1	unitless	(1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				RBA	Relative Bioavailability Factor	1	unitless	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	183	days	USEPA, 1989	
Dermal	Outdoor Worker	Adult	On-facility:	CS	Chemical Concentration in Soil	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
			Surface soil (current),	SA	Surface Area	3,527	cm^2	USEPA, 2014 (8)	CS x SA x AF x ABS x EV x EF x ED x CF
			Combined surface and	AF	Adherence Factor	0.12	mg/cm^2-event	USEPA, 2014 (9)	BW x AT
			subsurface soil (future)	ABS	Dermal absorption fraction	Chemical Specific	unitless	--	
				EV	Event Frequency	1	event/day	(10)	
				EF	Exposure Frequency	250	days/yr	USEPA, 2014	
				ED	Exposure Duration	25	year	USEPA, 2014	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	9,125	days	USEPA, 1989	

TABLE E-1

VALUES USED FOR DAILY INTAKE CALCULATIONS - SURFACE SOIL AND COMBINED SURFACE AND SUBSURFACE SOIL

REASONABLE MAXIMUM EXPOSURE

HUMAN HEALTH RISK ASSESSMENT

WEST BEND AASF #1 AND ARMORY

WEST BEND, WISCONSIN

Scenario Timeframe(s):	Current; Future
Medium:	Soil
Exposure Media:	Surface Soil and Combined Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point(s)	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Resident	Adult	On-facility (Hypothetical);	CS	Chemical Concentration in Soil	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
			Combined surface and	SA	Surface Area	6,032	cm^2	USEPA, 2014 (11)	CS x SA x AF x ABS x EV x EF x ED x CF
			subsurface soil (future)	AF	Adherence Factor	0.07	mg/cm^2-event	USEPA, 2014 (12)	BW x AT
				ABS	Dermal absorption fraction	Chemical Specific	unitless	--	
				EV	Event Frequency	1	event/day	(10)	
				EF	Exposure Frequency	350	days/yr	USEPA, 2014	
				ED	Exposure Duration	20	years	USEPA, 2014	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	7,300	days	USEPA, 1989	
Dermal	Resident	Child	On-facility (Hypothetical);	CS	Chemical Concentration in Soil	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
			Combined surface and	SA	Surface Area	2,373	cm^2	USEPA, 2014 (13)	CS x SA x AF x ABS x EV x EF x ED x CF
			subsurface soil (future)	AF	Adherence Factor	0.2	mg/cm^2-event	USEPA, 2014 (14)	BW x AT
				ABS	Dermal absorption fraction	Chemical Specific	unitless	--	
				EV	Event Frequency	1	event/day	(10)	
				EF	Exposure Frequency	350	days/yr	USEPA, 2014	
				ED	Exposure Duration	6	years	USEPA, 2014	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				BW	Body Weight	15	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	2,190	days	USEPA, 1989	
Dermal	Trespasser	Adolescent	On-facility:	CS	Chemical Concentration in Soil	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
		(7 to <16 years)	Surface soil (future)	SA	Surface Area	3,693	cm^2	USEPA, 2011 (15)	CS x SA x AF x ABS x EV x EF x ED x CF
				AF	Adherence Factor	0.07	mg/cm^2-event	USEPA, 2004 (16)	BW x AT
				ABS	Dermal absorption fraction	Chemical Specific	unitless	--	
				EV	Event Frequency	1	event/day	(10)	
				EF	Exposure Frequency	52	days/yr	(3)	
				ED	Exposure Duration	9	years	(4)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				BW	Body Weight	44	kg	USEPA, 2011 (6)	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	3,285	days	USEPA, 1989	

TABLE E-1

VALUES USED FOR DAILY INTAKE CALCULATIONS - SURFACE SOIL AND COMBINED SURFACE AND SUBSURFACE SOIL

REASONABLE MAXIMUM EXPOSURE

HUMAN HEALTH RISK ASSESSMENT

WEST BEND AASF #1 AND ARMORY

WEST BEND, WISCONSIN

Scenario Timeframe(s):	Current; Future
Medium:	Soil
Exposure Media:	Surface Soil and Combined Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point(s)	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Construction/Utility Worker	Adult	On-facility:	CS	Chemical Concentration in Soil	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
			Combined surface and	SA	Surface Area	3,527	cm^2	USEPA, 2014 (8)	CS x SA x AF x ABS x EV x EF x ED x CF
			subsurface soil (future)	AF	Adherence Factor	0.3	mg/cm^2-event	USEPA, 2004 (17)	BW x AT
				ABS	Dermal absorption fraction	Chemical Specific	unitless	--	
				EV	Event Frequency	1	event/day	(10)	
				EF	Exposure Frequency	125	days/yr	(7)	
				ED	Exposure Duration	0.5	year	(7)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	183	days	USEPA, 1989	

Notes:

< = Less than.

RME = Reasonable Maximum Exposure.

USEPA = United States Environmental Protection Agency.

(1) Professional judgment; conservatively assumes 100 percent of soil ingested is from the facility.

(2) Default value for adult resident.

(3) Assumes exposure to soil may occur for an average of 1.5 days per week for 8 months of the year (i.e., April through November; 35 weeks) when the ground is not frozen or snow-covered, based on professional judgment.

(4) Exposure duration reflects age-range of 7 to <16 years.

(5) Assumes 50 percent of soil ingested is from the associated area, based on professional judgment.

(6) Weighted average body weight for adolescent ages 6 to <16 years old used to represent the 7 to <16 year old adolescent.

(7) Construction/utility activities are assumed to occur for 125 days over the course of a 6 month period, based on professional judgment.

(8) Represents the weighted mean surface area for males and females ages 21+, including head, hands, and forearms (USEPA, 2011; Table 7-2).

(9) Represents the arithmetic mean of weighted average of body-specific (hands, forearms, and face) mean adherence factors for adult commercial/industrial activities (USEPA, 2011; Table 7-20).

(10) Professional judgement; assumes one event per day.

(11) Represents the weighted mean surface area for male and female adults, including head, hands, forearms, and lower legs (USEPA, 2011; Table 7-2).

(12) Represents the geometric mean (50th percentile) of weighted average body-specific (head, hands, forearms, and lower legs) adherence factors for gardeners (USEPA, 2004; Exhibit C-2).

(13) Represents the weighted mean surface area for males and females ages 0 to <6 years old, including head, hands, forearms, lower legs, and feet (USEPA, 2011; Table 7-2).

(14) Represents the geometric mean (50th percentile) of weighted average body-specific (hands, forearms, lower legs and face) adherence factors for children playing (wet soil) (USEPA, 2004; Exhibit C-2).

(15) Represents the weighted mean surface area for males and females ages 7 to <16 years old, including hands, forearms, lower legs, and head (USEPA, 2011; Table 7-2). See Table E-6 for calculation.

(16) Represents the geometric mean (50th percentile) of weighted average body-specific (hands, forearms, lower legs and face) adherence factors for children playing (wet soil). See Table E-6 for calculation.

(17) Represents the 95th percentile of weighted average body-specific (face, forearms, and hands) adherence factors for construction workers (USEPA, 2004; Exhibit C-2).

Sources:

USEPA, 1989. Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

USEPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24. December 2002.

USEPA, 2004. Risk Assessment Guidance for Superfund. Part E, Supplemental Guidance for Dermal Risk Assessment. Final. EPA/540/R/99/005.

USEPA, 2011. Exposure Factors Handbook. September 2011.

USEPA, 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. February 6, 2014. Revised September 2015.

TABLE E-2

VALUES USED FOR DAILY INTAKE CALCULATIONS - GROUNDWATER

REASONABLE MAXIMUM EXPOSURE

HUMAN HEALTH RISK ASSESSMENT

WEST BEND AASF #1 AND ARMORY

WEST BEND, WISCONSIN

Scenario Timeframe(s):	Current/Future; Future
Medium:	Groundwater
Exposure Medium:	Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point(s)	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Outdoor Worker	Adult	On-facility (Hypothetical Future)	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	Intake (mg/kg-day) =
				IR	Ingestion Rate	1.25	liters/day	USEPA, 2014 (1)	CW x IR x EF x ED x CF
				EF	Exposure Frequency	250	days/yr	USEPA, 2014	BW x AT
				ED	Exposure Duration	25	years	USEPA, 2014	
				CF	Conversion Factor	0.001	mg/ug	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	9,125	days	USEPA, 1989	
Ingestion	Commercial/Industrial Worker	Adult	Off-facility (Current/Future)	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	Intake (mg/kg-day) =
				IR	Ingestion Rate	1.25	liters/day	USEPA, 2014 (1)	CW x IR x EF x ED x CF
				EF	Exposure Frequency	250	days/yr	USEPA, 2014	BW x AT
				ED	Exposure Duration	25	years	USEPA, 2014	
				CF	Conversion Factor	0.001	mg/ug	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	9,125	days	USEPA, 1989	
Ingestion	Resident	Adult	On-facility (Hypothetical future);	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	Intake (mg/kg-day) =
			Off-facility (Current/Future)	IR	Ingestion Rate	2.5	liters/day	USEPA, 2014	CW x IR x EF x ED x CF
				EF	Exposure Frequency	350	days/yr	USEPA, 2014	BW x AT
				ED	Exposure Duration	20	years	USEPA, 2014	
				CF	Conversion Factor	0.001	mg/ug	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	7,300	days	USEPA, 1989	
		Child	On-facility (Hypothetical future);	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	Intake (mg/kg-day) =
			Off-facility (Current/Future)	IR	Ingestion Rate	0.78	liters/day	USEPA, 2014	CW x IR x EF x ED x CF
				EF	Exposure Frequency	350	days/yr	USEPA, 2014	BW x AT
				ED	Exposure Duration	6	years	USEPA, 2014	
				CF	Conversion Factor	0.001	mg/ug	--	
				BW	Body Weight	15	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	2,190	days	USEPA, 1989	
Ingestion	Construction/Utility Worker	Adult	On-facility (Excavation Trench)	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	Intake (mg/kg-day) =
			(future)	IR	Ingestion Rate	0.011	liters/day	USEPA, 2019 (2)	CW x IR x EF x ED x CF
				EF	Exposure Frequency	125	days/yr	(3)	BW x AT
				ED	Exposure Duration	0.5	years	(3)	
				CF	Conversion Factor	0.001	mg/ug	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	183	days	USEPA, 1989	

TABLE E-2

VALUES USED FOR DAILY INTAKE CALCULATIONS - GROUNDWATER

REASONABLE MAXIMUM EXPOSURE

HUMAN HEALTH RISK ASSESSMENT

WEST BEND AASF #1 AND ARMORY

WEST BEND, WISCONSIN

Scenario Timeframe(s):	Current/Future; Future
Medium:	Groundwater
Exposure Medium:	Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point(s)	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (showering/bathing)	Resident	Adult	On-facility (Hypothetical future); Off-facility (Current/Future)	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	Intake (mg/kg/day) =
				DA_{event}	Dose Absorbed per Unit Area per Event	Chemical Specific	mg/cm^2-event	USEPA, 2004 (Calculated)	$\frac{DA_{event} \times SA \times EV \times EF \times ED}{BW \times AT}$
				SA	Surface Area	19,652	cm^2	USEPA, 2014	CW and t_{event} are factored into the Da_{event} equation.
				t_{event}	Event Time	0.71	hour/event	USEPA, 2014	
				EV	Event Frequency	1	event/day	USEPA, 2004	
				EF	Exposure Frequency	350	days/year	USEPA, 2014	
				ED	Exposure Duration	20	years	USEPA, 2014	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	7,300	days	USEPA, 1989	
		Child	On-facility (Hypothetical future); Off-facility (Current/Future)	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	Intake (mg/kg/day) =
				DA_{event}	Dose Absorbed per Unit Area per Event	Chemical Specific	mg/cm^2-event	USEPA, 2004 (Calculated)	$\frac{DA_{event} \times SA \times EV \times EF \times ED}{BW \times AT}$
				SA	Surface Area	6,365	cm^2	USEPA, 2014	CW and t_{event} are factored into the Da_{event} equation.
				t_{event}	Event Time	0.54	hour/event	USEPA, 2014	
				EV	Event Frequency	1	event/day	USEPA, 2004	
				EF	Exposure Frequency	350	days/yr	USEPA, 2014	
				ED	Exposure Duration	6	years	USEPA, 2014	
				BW	Body Weight	15	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	2,190	days	USEPA, 1989	
Dermal	Construction/Utility Worker	Adult	On-facility (Excavation Trench) (future)	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	Intake (mg/kg/day) =
				DA_{event}	Dermal Absorbed Dose per Event	Chemical Specific	mg/cm^2-event	USEPA, 2004 (Calculated)	$\frac{DA_{event} \times SA \times EV \times EF \times ED}{BW \times AT}$
				SA	Surface Area	3,527	cm^2	USEPA, 2014 (4)	CW and t_{event} are factored into the Da_{event} equation.
				t_{event}	Event Time	4	hour/event	(5)	
				EV	Event Frequency	1	event/day	USEPA, 2004	
				EF	Exposure Frequency	125	days/yr	(3)	
				ED	Exposure Duration	0.5	years	(3)	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 2014	
				ATnc	Averaging Time - noncancer	183	days	USEPA, 2014	

TABLE E-2

VALUES USED FOR DAILY INTAKE CALCULATIONS - GROUNDWATER

REASONABLE MAXIMUM EXPOSURE

HUMAN HEALTH RISK ASSESSMENT

WEST BEND AASF #1 AND ARMORY

WEST BEND, WISCONSIN

Scenario Timeframe(s):	Current/Future; Future
Medium:	Groundwater
Exposure Medium:	Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point(s)	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name

Notes:

RME = Reasonable Maximum Exposure.

USEPA = United States Environmental Protection Agency.

Off-facility receptors will only be evaluated for drinking water exposure if downgradient impacts to drinking water are identified and can be attributed to ARNG activities the facility.

(1) Equal to half of the default ingestion rate for a residential adult recommended by USEPA (2014).

(2) Upper percentile value for wading/splashing used as a proxy for potential ingestion during excavation activities, assuming one groundwater contact event per day (USEPA, 2019; Table 3-96).

(3) Construction/utility activities are assumed to occur for 125 days over the course of a 6 month period, based on professional judgment.

(4) Represents the weighted mean surface area for males and females ages 21+, including head, hands, and forearms (USEPA, 2011; Table 7-2).

(5) Construction worker is assumed to contact groundwater in an excavation trench for half of a typical 8-hour workday.

Sources:

USEPA, 1989. Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

USEPA, 2004. Risk Assessment Guidance for Superfund. Part E, Supplemental Guidance for Dermal Risk Assessment. Final. EPA/540/R/99/005.

USEPA, 2011. Exposure Factors Handbook. September 2011.

USEPA, 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. February 6, 2014. Revised September 2015.

USEPA, 2019. Update for Chapter 3 of the Exposure Factors Handbook. Ingestion of Water and Other Selected Liquids. EPA/600/R-18/259F. February 2019.

TABLE E-3
VALUES USED FOR DAILY INTAKE CALCULATIONS - SEDIMENT
REASONABLE MAXIMUM EXPOSURE
HUMAN HEALTH RISK ASSESSMENT
WEST BEND AASF #1 AND ARMORY
WEST BEND, WISCONSIN

Scenario Timeframe:	Current/Future
Medium:	Sediment
Exposure Medium:	Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point(s)	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Incidental Ingestion	Recreational User (Swimming and Wading Scenarios)	Adult	Milwaukee River and Wingate Creek (Current/Future)	CS	Chemical Concentration in Sediment	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
				IR	Ingestion Rate	50	mg/day	USEPA, 2017 (1)	CS x IR x EF x ED x CF x FI x RBA
				EF	Exposure Frequency	52	days/yr	(2)	BW x AT
				ED	Exposure Duration	20	years	USEPA, 2014	
				FI	Fraction Ingested from Site	0.5	unitless	(3)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				RBA	Relative Bioavailability Factor	1	unitless	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	7,300	days	USEPA, 1989	
		Child	Milwaukee River and Wingate Creek (Current/Future)	CS	Chemical Concentration in Sediment	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
				IR	Ingestion Rate	90	mg/day	USEPA, 2017 (1)	CS x IR x EF x ED x CF x FI x RBA
				EF	Exposure Frequency	52	days/yr	(2)	BW x AT
				ED	Exposure Duration	6	years	USEPA, 2014	
				FI	Fraction Ingested from Site	0.5	unitless	(3)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				RBA	Relative Bioavailability Factor	1	unitless	--	
				BW	Body Weight	15	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	2,190	days	USEPA, 1989	
Incidental Ingestion	Outdoor Worker	Adult	Onsite Stormwater Retention Basin (Current/Future)	CS	Chemical Concentration in Sediment	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
				IR	Ingestion Rate	50	mg/day	USEPA, 2017 (1)	CS x IR x EF x ED x CF x FI x RBA
				EF	Exposure Frequency	35	days/yr	(6)	BW x AT
				ED	Exposure Duration	25	years	USEPA, 2014	
				FI	Fraction Ingested from Site	1	unitless	--	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				RBA	Relative Bioavailability Factor	1	unitless	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	9,125	days	USEPA, 1989	

TABLE E-3

VALUES USED FOR DAILY INTAKE CALCULATIONS - SEDIMENT

REASONABLE MAXIMUM EXPOSURE

HUMAN HEALTH RISK ASSESSMENT

WEST BEND AASF #1 AND ARMORY

WEST BEND, WISCONSIN

Scenario Timeframe:	Current/Future
Medium:	Sediment
Exposure Medium:	Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point(s)	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Recreational User (Swimming and Wading Scenarios)	Adult	Milwaukee River and Wingate Creek (Current/Future)	CS	Chemical Concentration in Sediment	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
				SA	Surface Area	4,780	cm^2/day	USEPA, 2011 (4)	CS x SA x AF x ABS x EV x EF x ED x CF
				AF	Adherence Factor	0.4	mg/cm^2-event	USEPA, 2011 (5)	BW x AT
				ABS	Dermal absorption fraction	Chemical Specific	unitless	--	
				EV	Event Frequency	1	event/day	(2)	
				EF	Exposure Frequency	52	days/yr	(2)	
				ED	Exposure Duration	20	years	USEPA, 2014	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	7,300	days	USEPA, 1989	
		Child	Milwaukee River and Wingate Creek (Current/Future)	CS	Chemical Concentration in Sediment	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
				SA	Surface Area	2,057	cm^2/day	USEPA, 2011 (7)	CS x SA x AF x ABS x EV x EF x ED x CF
				AF	Adherence Factor	0.3	mg/cm^2-event	USEPA, 2004 (8)	BW x AT
				ABS	Dermal absorption fraction	Chemical Specific	unitless	--	
				EV	Event Frequency	1	event/day	(2)	
				EF	Exposure Frequency	52	days/yr	(2)	
				ED	Exposure Duration	6	years	USEPA, 2014	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				BW	Body Weight	15	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	2,190	days	USEPA, 1989	
Dermal	Outdoor Worker	Adult	Onsite Stormwater Retention Basin (Current/Future)	CS	Chemical Concentration in Sediment	Chemical Specific	mg/kg	--	Intake (mg/kg-day) =
				SA	Surface Area	2,277	cm^2	USEPA, 2011 (9)	CS x SA x AF x ABS x EV x EF x ED x CF
				AF	Adherence Factor	0.3	mg/cm^2-event	USEPA, 2011 (5)	BW x AT
				ABS	Dermal absorption fraction	Chemical Specific	unitless	--	
				EV	Event Frequency	1	event/day	(6)	
				EF	Exposure Frequency	35	days/yr	(6)	
				ED	Exposure Duration	25	years	USEPA, 2014	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	9,125	days	USEPA, 1989	

TABLE E-3

VALUES USED FOR DAILY INTAKE CALCULATIONS - SEDIMENT

REASONABLE MAXIMUM EXPOSURE

HUMAN HEALTH RISK ASSESSMENT

WEST BEND AASF #1 AND ARMORY

WEST BEND, WISCONSIN

Scenario Timeframe:	Current/Future
Medium:	Sediment
Exposure Medium:	Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point(s)	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name

Notes:

< = Less than.

RME = Reasonable Maximum Exposure.

USEPA = United States Environmental Protection Agency.

(1) Equal to the recommended upper percentile daily soil ingestion rates for soil for children and adults (USEPA, 2017; Table 5-1). Value does not include indoor settled dust component which is not applicable to sediment.

(2) Assumes recreational exposure to sediment may occur for 2 days per week, 1 event per day, for the 6 warmest months (i.e., May through October; 26 weeks, 52 days) per year, based on professional judgment.

(3) Assumes 50 percent of sediment ingested is from the associated area, based on professional judgment.

(4) Represents the weighted mean surface area for male and female adults (USEPA, 2011; Table 7-12 and 7-13). Assumes contact with sediment by hands, lower legs, and feet. See Table E-7 for calculation.

(5) Represents the geometric mean weighted adherence factor for reed gatherers (USEPA, 2011; Table 7-20). Calculated based on surface area exposed. See Table E-7 for calculation.

(6) Assumes the receptor is wading for 1 day per week, 1 event per day, 2 hours per event, for 8 months out of the year (35 weeks) from April through November (when ground is not frozen or covered with snow).

(7) Represents the weighted mean surface area for males and females ages 0 to <6 years old (USEPA, 2011; Table 7-2). Assumes contact with sediment by hands, forearms, lower legs, and feet. The skin surface area for a 1 to <7 year old child is used to represent potential exposure by a recreational child, since a <1 year old child is likely to have limited exposure to sediment. See Table E-8 for calculation.

(8) Geometric mean weighted adherence factor for a child playing in wet soil (Exhibit C-2; USEPA 2004). See Table E-8 for calculation.

(9) Represents the weighted mean surface area for male and female adults (USEPA, 2011; Table 7-12 and 7-13). Assumes contact with sediment in the stormwater retention basin by hands and forearms (wearing boots is assumed). See Table E-7 for calculation.

Sources:

USEPA, 1989. Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

USEPA, 2004. Risk Assessment Guidance for Superfund. Part E, Supplemental Guidance for Dermal Risk Assessment. Final. EPA/540/R/99/005.

USEPA, 2011. Exposure Factors Handbook. September 2011.

USEPA, 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. February 6, 2014. Revised September 2015.

USEPA, 2017. Update for Chapter 5 of the Exposure Factors Handbook. Soil and Dust Ingestion. EPA/600/R-17/384F. September.

TABLE E-4
VALUES USED FOR DAILY INTAKE CALCULATIONS - SURFACE WATER
REASONABLE MAXIMUM EXPOSURE
HUMAN HEALTH RISK ASSESSMENT
WEST BEND AASF #1 AND ARMORY
WEST BEND, WISCONSIN

Scenario Timeframe:	Current/Future
Medium:	Surface Water
Exposure Medium:	Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Incidental Ingestion	Recreational User	Adult	Milwaukee River	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	Intake (mg/kg-day) =
	(Swimming Scenario)		(Current/Future)	IR	Ingestion Rate	0.286	liters/day	USEPA, 2019 (1)	CW x IR x EF x ED x CF
				EF	Exposure Frequency	52	days/yr	(2)	BW x AT
				ED	Exposure Duration	20	years	USEPA, 2014	
				CF	Conversion Factor	0.001	mg/ug	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	7,300	days	USEPA, 1989	
		Child	Milwaukee River	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	Intake (mg/kg-day) =
			(Current/Future)	IR	Ingestion Rate	0.250	liters/day	USEPA, 2019 (3)	CW x IR x EF x ED x CF
				EF	Exposure Frequency	52	days/yr	(2)	BW x AT
				ED	Exposure Duration	6	years	USEPA, 2014	
				CF	Conversion Factor	0.001	mg/ug	--	
				BW	Body Weight	15	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	2,190	days	USEPA, 1989	
Incidental Ingestion	Recreational User	Adult	Wingate Creek	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	Intake (mg/kg-day) =
	(Wading Scenario)		(Current/Future)	IR	Ingestion Rate	0.0112	liters/day	USEPA, 2019 (4)	CW x IR x EF x ED x CF
				EF	Exposure Frequency	52	days/yr	(2)	BW x AT
				ED	Exposure Duration	20	years	USEPA, 2014	
				CF	Conversion Factor	0.001	mg/ug	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	7,300	days	USEPA, 1989	
		Child	Wingate Creek	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	Intake (mg/kg-day) =
			(Current/Future)	IR	Ingestion Rate	0.0112	liters/day	USEPA, 2019 (4)	CW x IR x EF x ED x CF
				EF	Exposure Frequency	52	days/yr	(2)	BW x AT
				ED	Exposure Duration	6	years	USEPA, 2014	
				CF	Conversion Factor	0.001	mg/ug	--	
				BW	Body Weight	15	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	2,190	days	USEPA, 1989	
Incidental Ingestion	Oudoor Worker	Adult	Facility Drainage Features	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	Intake (mg/kg-day) =
			(Current/Future)	IR	Ingestion Rate	0.022	liters/day	USEPA, 2019 (1)	CW x IR x EF x ED x CF
				EF	Exposure Frequency	35	days/yr	(8)	BW x AT
				ED	Exposure Duration	25	years	USEPA, 2014	
				CF	Conversion Factor	0.001	mg/ug	--	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	9,125	days	USEPA, 1989	

TABLE E-4

VALUES USED FOR DAILY INTAKE CALCULATIONS - SURFACE WATER

REASONABLE MAXIMUM EXPOSURE

HUMAN HEALTH RISK ASSESSMENT

WEST BEND AASF #1 AND ARMORY

WEST BEND, WISCONSIN

Scenario Timeframe:	Current/Future
Medium:	Surface Water
Exposure Medium:	Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Recreational User (Swimming Scenario)	Adult	Milwaukee River (Current/Future)	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	
				DA_{event}	Dose Absorbed per Unit Area per Event	Chemical Specific	mg/cm²-event	USEPA, 2004 (Calculated)	Intake (mg/kg/day) =
				SA	Surface Area	19,652	cm²	USEPA, 2014	
				t_{event}	Event Time	2.6	hour/event	USEPA, 1989 (Exhibit 6-13)	$\frac{DA_{event} \times SA \times EV \times EF \times ED}{BW \times AT}$
				EV	Event Frequency	1	event/day	USEPA, 2004	
				EF	Exposure Frequency	52	days/yr	(2)	CW and t_{event} are factored into the Da_{event} equation.
				ED	Exposure Duration	20	years	USEPA, 2014	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	7,300	days	USEPA, 1989	
		Child	Milwaukee River (Current/Future)	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	
				DA_{event}	Dose Absorbed per Unit Area per Event	Chemical Specific	mg/cm²-event	USEPA, 2004 (Calculated)	Intake (mg/kg/day) =
				SA	Surface Area	6,365	cm²	USEPA, 2014	
				t_{event}	Event Time	2.6	hour/event	USEPA, 1989 (Exhibit 6-13)	$\frac{DA_{event} \times SA \times EV \times EF \times ED}{BW \times AT}$
				EV	Event Frequency	1	event/day	USEPA, 2004	
				EF	Exposure Frequency	52	days/yr	(2)	CW and t_{event} are factored into the Da_{event} equation.
				ED	Exposure Duration	6	years	USEPA, 2014	
				BW	Body Weight	15	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	2,190	days	USEPA, 1989	
Dermal	Recreational User (Wading Scenario)	Adult	Wingate Creek (Current/Future)	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	
				DA_{event}	Dose Absorbed per Unit Area per Event	Chemical Specific	mg/cm²-event	USEPA, 2004 (Calculated)	Intake (mg/kg/day) =
				SA	Surface Area	4,780	cm²	USEPA, 2011 (5)	
				t_{event}	Event Time	1	hour/event	(6)	$\frac{DA_{event} \times SA \times EV \times EF \times ED}{BW \times AT}$
				EV	Event Frequency	1	event/day	USEPA, 2004	
				EF	Exposure Frequency	52	days/yr	(2)	CW and t_{event} are factored into the Da_{event} equation.
				ED	Exposure Duration	20	years	USEPA, 2014	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	7,300	days	USEPA, 1989	
		Child	Wingate Creek (Current/Future)	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	
				DA_{event}	Dose Absorbed per Unit Area per Event	Chemical Specific	mg/cm²-event	USEPA, 2004 (Calculated)	Intake (mg/kg/day) =
				SA	Surface Area	2,057	cm²	USEPA, 2011 (7)	
				t_{event}	Event Time	1	hour/event	(6)	$\frac{DA_{event} \times SA \times EV \times EF \times ED}{BW \times AT}$
				EV	Event Frequency	1	event/day	USEPA, 2004	
				EF	Exposure Frequency	52	days/yr	(2)	CW and t_{event} are factored into the Da_{event} equation.
				ED	Exposure Duration	6	years	USEPA, 2014	
				BW	Body Weight	15	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	2,190	days	USEPA, 1989	
Dermal	Outdoor Worker	Adult	Onsite Stormwater Retention Basin (Current/Future)	CW	Chemical Concentration in Water	Chemical Specific	ug/L	--	
				DA_{event}	Dose Absorbed per Unit Area per Event	Chemical Specific	mg/cm²-event	USEPA, 2004 (Calculated)	Intake (mg/kg/day) =

TABLE E-4
VALUES USED FOR DAILY INTAKE CALCULATIONS - SURFACE WATER
REASONABLE MAXIMUM EXPOSURE
HUMAN HEALTH RISK ASSESSMENT
WEST BEND AASF #1 AND ARMORY
WEST BEND, WISCONSIN

Scenario Timeframe:	Current/Future
Medium:	Surface Water
Exposure Medium:	Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
				SA	Surface Area	2,277	cm^2	USEPA, 2011 (9)	$\frac{DA_{event} \times SA \times EV \times EF \times ED}{BW \times AT}$
				t_{event}	Event Time	2	hour/event	(2)	
				EV	Event Frequency	1	event/day	USEPA, 2004	CW and t_{event} are factored into the Da_{event} equation.
				EF	Exposure Frequency	35	days/yr	(8)	
				ED	Exposure Duration	25	years	USEPA, 2014a	
				BW	Body Weight	80	kg	USEPA, 2014	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	9,125	days	USEPA, 1989	

Notes:

RME = Reasonable Maximum Exposure.

USEPA = United States Environmental Protection Agency.

(1) Based on the age-weighted upper percentile water ingestion rate for a 20 year exposure duration from age 6 to 21+ (USEPA, 2019; Table 3-7) mulitplied by the receptor-specific event time (dermal exposure parameter).

(2) Assumes recreational exposure to surface water may occur for 2 days per week for the 6 warmest months (i.e., May through October; 26 weeks, 52 days) per year, based on professional judgment.

(3) Based on the upper percentile water ingestion rate for children (ages 6 to 11) of 0.096 liters/hour (USEPA, 2019; Table 3-7) and a 2.6 hour swimming event per day (USEPA, 1989; Exhibit 6-13).

(4) Upper-bound value for wading and splashing (USEPA, 2019; Table 3-96) assuming a one hour exposure event.

(5) Represents the weighted mean surface area for male and female adults (USEPA, 2011; Table 7-12 and 7-13). Assumes contact with surface water while wading by hands, lower legs, and feet. See Table E-7 for calculation.

(6) Assumes exposure to surface water may occur for 1 hour per event, while wading, based on professional judgment.

(7) Represents the weighted mean surface area for males and females ages 0 to <6 years old (USEPA, 2011; Table 7-2). Assumes contact with surface water by hands, forearms, lower legs, and feet. The skin surface area for a 1 to <7 year old child is used to represent potential exposure by a recreational child, since a <1 year old child is likely to have limited exposure to surface water. See Table E-8 for calculation.

(8) Assumes the receptor is wading for 1 day per week for 8 months out of the year (35 weeks) from April through November (when ground is not frozen or covered with snow).

(9) Represents the weighted mean surface area for male and female adults (USEPA, 2011; Table 7-12 and 7-13). Assumes contact with surface water in the drainage basin by hands and forearms for the outdoor worker (See Table E-7 for calculation).

Sources:

USEPA, 1989. Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

USEPA, 2004. Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

USEPA, 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-09/052F.

USEPA, 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. February 6, 2014. Corrected February 2015.

USEPA, 2019. Update for Chapter 3 of the Exposure Factors Handbook. Ingestion of Water and Other Selected Liquids. EPA/600/R-18/259F. February 2019.

TABLE E-5

VALUES USED FOR DAILY INTAKE CALCULATIONS - FISH TISSUE

REASONABLE MAXIMUM EXPOSURE

DAVENPORT AVIATION SUPPORT FACILITY

WEST BEND AASF #1 AND ARMORY

WEST BEND, WISCONSIN

Scenario Timeframe:	Current/Future
Medium:	Fish Tissue
Exposure Medium:	Fish Tissue

Exposure Route	Receptor Population	Receptor Age	Exposure Point (Scenario Timeframe)	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Recreational User	Adult	Milwaukee River	CS	Chemical Concentration in Fish	Chemical Specific	mg/kg	--	Intake (mg/kg/day) =
			(Current/Future)	IR	Ingestion Rate	0.022	kg/day	USEPA, 2014a (1)	CS x IR x EF x ED x FI
				EF	Exposure Frequency	365	days/year	(2)	BW x AT
				ED	Exposure Duration	20	years	USEPA, 2014b	
				FI	Fraction Ingested from Source	0.5	unitless	(3)	
				BW	Body Weight	80	kg	USEPA, 2014b	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	7,300	days	USEPA, 1989	
		Child	Milwaukee River	CS	Chemical Concentration in Fish	Chemical Specific	mg/kg	--	Intake (mg/kg/day) =
			(Current/Future)	IR	Ingestion Rate	0.0054	kg/day	USEPA, 2014a (4)	CS x IR x EF x ED x FI
				EF	Exposure Frequency	365	days/year	(2)	BW x AT
				ED	Exposure Duration	6	years	USEPA, 2014b (5)	
				FI	Fraction Ingested from Source	0.5	unitless	(3)	
				BW	Body Weight	15	kg	USEPA, 2014b	
				ATc	Averaging Time - cancer	25,550	days	USEPA, 1989	
				ATnc	Averaging Time - noncancer	2,190	days	USEPA, 1989	

Notes:

RME = Reasonable Maximum Exposure.

USEPA = United States Environmental Protection Agency.

(1) Value is the 90th percentile consumption rate (raw weight, edible portion) of freshwater and estuarine fish for the United States adult population (USEPA, 2014a; Table 9a).

(2) Consistent with the fish ingestion rate being used, which is annualized over a 365 day per year period.

(3) Professional judgment. Assumes that half of the total amount of fish ingested is fish obtained from the Milwaukee River (versus fish from other sources).

(4) Value is the age-weighted 90th percentile consumption rate (raw weight, edible portion) of freshwater and estuarine fish for children ages 1 to <6 years old (USEPA, 2014a; Table 20).

(5) Children younger than 1 year old are not considered to consume fish. However, an exposure duration of 6 years is conservatively used.

Sources:

USEPA, 1989. Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A.

USEPA, 2014a. Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010). April 2014. EPA-820-R-14-002.

USEPA, 2014b. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. February 6, 2014.

TABLE E-6
CALCULATION OF BODY SURFACE AREA EXPOSED AND SOIL ADHERENCE FACTOR FOR TRESPASSER (ADOLESCENT)
HUMAN HEALTH RISK ASSESSMENT
WEST BEND AASF #1 AND ARMORY
WEST BEND, WISCONSIN

Adolescent (7 to <16 years, from 7th birthday to the day before 16th birthday)										
Mean Surface Area by Body Part, m^2 (EFH, Table 7-2, USEPA, 2011)										
Age	**legs**	**lower legs (a)**		**feet**	**head**	**face (j)**	**hands**	**arms**	**forearms**	
7<8 (data 6<11)	0.311	0.124	(b)	0.073	0.066	0.022	0.051	0.151	0.059	(d)
8<9 (data 6<11)	0.311	0.124	(b)	0.073	0.066	0.022	0.051	0.151	0.059	(d)
9<10 (data 6<11)	0.311	0.124	(b)	0.073	0.066	0.022	0.051	0.151	0.059	(d)
10<11 (data 6<11)	0.311	0.124	(b)	0.073	0.066	0.022	0.051	0.151	0.059	(d)
11<12 (data 11<16)	0.483	0.193	(c)	0.105	0.073	0.024	0.072	0.227	0.086	(e)
12<13 (data 11<16)	0.483	0.193	(c)	0.105	0.073	0.024	0.072	0.227	0.086	(e)
13<14 (data 11<16)	0.483	0.193	(c)	0.105	0.073	0.024	0.072	0.227	0.086	(e)
14<15 (data 11<16)	0.483	0.193	(c)	0.105	0.073	0.024	0.072	0.227	0.086	(e)
15<16 (data 11<16)	0.483	0.193	(c)	0.105	0.073	0.024	0.072	0.227	0.086	(e)
Average (age 7 to <16) (cm^2)	**4,066**	**1,626**		**908**	**699**	**233**	**627**	**1,932**	**741**	
Soil: hands, forearms, lower legs, and head (cm^2) =									**3,693**	

Body Part	**Body Surface Area Exposed to Soil (cm^2)**	**Soil Loading Rate (f) (mg/cm^2)**		**Total Soil Mass (mg)**
Head	699	0.052	(g)	36
Hands	627	0.190		119
Forearms	741	0.052	(h)	39
Lower legs (a)	1,626	0.033	(i)	54
Total	3,693	–		248
Area-Weighted Adherence Factor (mg/cm^2) = Soil mass/Surface area =				**0.07**

Notes:
EFH - 2011 Edition of the Exposure Factors Handbook (USEPA, 2011).
(a) Lower leg surface area = leg surface area x average of the ratios of the lower leg to the leg (EFH Table 7-8), average of male and female, consistent with methods used in USEPA, 2014.
(b) Ratios of the lower leg to the leg for the 6, 8 and 10 year-olds (0.4) (Table 7-8).
(c) Ratio of the lower leg to the leg for the 12 and 14 year-olds (0.4) (Table 7-8).
(d) Surface area for the arm x average of the ratios of the forearm to the arm for 6, 8 and 10 year-olds (0.39) (EFH Table 7-8).
(e) Surface area for the arm x average of the ratios of the forearm to the arm for 12 and 14 year-olds (0.38) (EFH Table 7-8).
(f) Data from USEPA (2004, Exhibit C-2). Geometric mean value, children playing in wet soil.
(g) Data for head are not available. Therefore, face data are used as a proxy.
(h) Data for forearms are not available. Therefore, arm data are used as a proxy.
(i) Data for lower legs are not available. Therefore, leg data are used as a proxy.
(j) Per USEPA (2011) Section 7.2.2, the face is assumed to be 1/3 the surface area of the head.

Sources:
USEPA, 2004. Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment Final. EPA/540/R/99/005.
USEPA, 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-09/052F.
USEPA, 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120.

TABLE E-7
CALCULATION OF BODY SURFACE AREA EXPOSED AND SEDIMENT ADHERENCE FACTORS FOR ADULT
HUMAN HEALTH RISK ASSESSMENT
WEST BEND AASF #1 AND ARMORY
WEST BEND, WISCONSIN

Adult (21 years and older)				
Body Part	Mean Body Surface Area for Adult			Average of Males and Females
	Male m^2	Female m^2		cm^2
Head	0.136	0.114		1,250
Face	0.045	0.038	(c)	417
Upper extremities				
Arms	0.314	0.237		2,755
Upper arms	0.172	0.13035	(a)	1,512
Forearms	0.148	0.11139	(a)	1,297
Hands	0.107	0.089		980
Lower extremities				
Legs	0.682	0.598		6,400
Lower legs	0.268	0.233		2,505
Feet	0.137	0.122		1,295
Recreational Wader: hands, lower legs, and feet (cm^2) =				**4,780**
Outdoor Worker: hands and forearms (cm^2) =				**2,277**

Adult Recreational User				
Body Part	Body Surface Area Exposed to Surface Sediment (cm^2)	Soil Loading Rate (b) (mg/cm^2)		Total Sediment Mass (mg)
Hands	980	0.66		647
Lower Legs	2,505	0.16		401
Feet	1,295	0.63		816
Total	4,780	–		1,863
Area-Weighted Adherence Factor (mg/cm^2) = Sediment mass/Surface area =				**0.4**

Adult Outdoor Worker				
Body Part	Body Surface Area Exposed to Surface Sediment (cm^2)	Soil Loading Rate (b) (mg/cm^2)		Total Sediment Mass (mg)
Hands	980	0.66		647
Forearms	1,297	0.036	(d)	47
Lower Legs	2,505	0.16	(d)	401
Feet	1,295	0.63		816
RME Total	2,277	–		693
RME Area-Weighted Adherence Factor (mg/cm^2) = Sediment mass/Surface area =				**0.3**

Notes:
EFH - 2011 Edition of the Exposure Factors Handbook (USEPA, 2011).
(a) In accordance with USEPA 2014 OSWER Directive on Recommended Default Exposure Factors (USEPA, 2014), the female forearms and upper arms surface areas were calculated as follows:
Female arms [0.237] x (Male forearm/Male arms) [0.47]
Female arms [0.237] x (Male upper arms/Male arms) [0.55]
(b) Data from USEPA (2011) Table 7-20. Geometric mean of values for reed gatherers.
(c) Per USEPA (2011) Section 7.2.2, the face is assumed to be 1/3 the surface area of the head.
(d) Data for forearms are not available. Therefore, arms data are used as a proxy.

Sources:
USEPA, 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-09/052F.
USEPA, 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120.

TABLE E-8
CALCULATION OF BODY SURFACE AREA EXPOSED AND SEDIMENT ADHERENCE FACTOR FOR RECREATIONAL CHILD
HUMAN HEALTH RISK ASSESSMENT
WEST BEND AASF #1 AND ARMORY
WEST BEND, WISCONSIN

Young Child (1 to <7 years, from 1st birthday to the day before 7th birthday) (j)									
Mean Surface Area by Body Part, m^2 (EFH, Table 7-2)									
Age	face	hands	arms	forearms (a)		legs	lower legs (a)		feet
1<2	0.029	0.030	0.069	0.028	(b)	0.122	0.051	(e)	0.033
2<3	0.017	0.028	0.088	0.035	(b)	0.154	0.065	(e)	0.038
3<4 (data 3<6)	0.020	0.037	0.106	0.042	(c)	0.195	0.078	(f)	0.049
4<5 (data 3<6)	0.020	0.037	0.106	0.042	(c)	0.195	0.078	(f)	0.049
5<6 (data 3<6)	0.020	0.037	0.106	0.042	(c)	0.195	0.078	(g)	0.049
6<7 (data 6<11)	0.022	0.051	0.151	0.059	(d)	0.311	0.124	(g)	0.073
Average (cm^2)	**215**	**367**	**1,043**	**415**		**1,953**	**791**		**485**
Sediment: hands, forearms, lower legs, and feet (cm^2) =									**2,057**

Offsite Child Recreational User			
Body Part	**Body Surface Area Exposed to Surface Sediment (cm^2)**	**Soil Loading Rate (h) (mg/cm^2)**	**Total Sediment Mass (mg)**
Hands	367	0.656	241
Forearms	415	0.015	6
Feet	485	0.656 (i)	318
Lower Legs	791	0.026	21
Total	2,057	–	585
Area-Weighted Adherence Factor (mg/cm^2) = Sediment mass/Surface area =			**0.3**

TABLE E-8
CALCULATION OF BODY SURFACE AREA EXPOSED AND SEDIMENT ADHERENCE FACTOR FOR RECREATIONAL CHILD
HUMAN HEALTH RISK ASSESSMENT
WEST BEND AASF #1 AND ARMORY
WEST BEND, WISCONSIN

Notes:
EFH - 2011 Edition of the Exposure Factors Handbook (USEPA, 2011).
(a) Lower leg surface area = leg surface area x average of the ratios of the lower leg to the leg
Forearm surface area = arm surface area x ratio of the forearm to the arm
(EFH Table 7-8), average of male and female, consistent with methods used in USEPA, 2014.
(b) Ratio of the forearm to the arm for the 2-year old, average of male and female (0.4) (EFH Table 7-8).
(c) Ratio of the forearm to the arm for the 4-year old, average of male and female (0.4) (EFH Table 7-8).
(d) Ratio of the forearm to the arm for 6, 8 and 10 year-olds (0.39) (EFH Table 7-8).
(e) Ratio of the lower leg to the leg for the 2-year old, average of male and female (0.42) (EFH Table 7-8).
(f) Ratio of the lower leg to the leg for the 4-year old, average of male and female (0.4) (EFH Table 7-8).
(g) Ratio of the lower leg to the leg for the 6, 8 and 10 year-olds (0.4) (EFH Table 7-8).
(h) Data from USEPA (2004, Exhibit C-2). Geometric mean value, children playing in wet soil.
(i) Data for feet are not available. Therefore, hand data are used as a proxy.
(j) The skin surface area for a 1 to <7 year old child is used to represent potential exposure by a recreational child, since a <1 year old child is likely to have limited exposure to sediment.

Sources:
USEPA, 2004. Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment Final. EPA/540/R/99/005.
USEPA, 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-09/052F.
USEPA, 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120.

TABLE E-9
PFAS SOIL SCREENING LEVELS FOR TERRESTRIAL PLANTS AND INVERTEBRATES
ECOLOGICAL RISK ASSESSMENT
WEST BEND AASF #1 AND ARMORY
WEST BEND, WISCONSIN

		Terrestrial Plant Screening Level				Terrestrial Invertebrate Screening Level			
		ANL Values	SERDP Values			ANL Values	SERDP Values		
Constituent	Abbreviation	NOEC-based ESVs (mg/kg soil) [1]	NOEC Soil Screening Level (mg/kg soil) [2]	LOEC Soil Screening Level (mg/kg soil) [2]	Toxicity Benchmark (NOEC Based) (mg/kg soil) [3]	NOEC-based ESVs (mg/kg soil) [1]	NOEC Soil Screening Level (mg/kg soil) [2]	LOEC Soil Screening Level (mg/kg soil) [2]	Toxicity Benchmark (NOEC Based) (mg/kg soil) [3]
Perfluorooctane sulfonic acid	PFOS	40.2	11	33	3.9	48.1	7.7	141	80
Perfluorooctanoic acid	PFOA	79.5	0.084	0.84	84	22.4	50	NA	10
Perfluorononanoic acid	PFNA	NA	46	NA	NA	10	1	100	NA
Perfluorohexanesulfonic acid	PFHxS	NA	NA	NA	NA	10	1	100	NA
Perfluoroheptanoic acid	PFHpA	NA	NA	NA	NA	NA	1	100	NA
Perfluorobutanesulfonic acid	PFBS	NA	NA	NA	NA	100	10	NA	NA
Perfluorodecanoic acid	PFDA	NA	51	NA	NA	NA	NA	NA	NA
Perfluorobutanoic acid	PFBA	NA	642	NA	NA	NA	NA	NA	NA

Notes:
Shading shows preliminary values to be considered in the Screening Level Ecological Risk Assessment (lowest value).
Other values may be used in Step 3a, as needed.
ANL - Argonne National Laboratory
ESV - Ecological Screening Value
LOEC - Lowest Observed Effect Concentration.
mg/kg - milligram per kilogram.
NA - Not Available.
NOEC - No Observed Effect Concentration.
SERDP - Strategic Environmental Research and Development Program

Sources:

1 - Grippo, M., J. Hayse, I. Hlohowskyj, and K. Picel, 2021. Derivation of PFAS Ecological Screening Values. Argonne National Laboratory, Environmental Science Division. Completed under Interagency Agreement between the U.S. Department of Energy, Argonne National Laboratory, and the Air Force Civil Engineer Center. September. Final.
2 - Divine, C., Frenchmeyer, M., Dally, K., Osborn, E., Anderson, P., Zodrow, J., 2020. Approach for Assessing PFAS Risk to Threatened and Endangered Species. Final Report. SERDP Project ER18-1653. March.
3 - Conder, J., Arblaster, J., Larson, E., Brown, J., Higgins, C., 2020. Guidance for Assessing the Ecological Risks of PFAS to Threatened and Endangered Species at Aqueous Film Forming Foam-Impacted Sites. Guidance Document. SERDP Project ER18-1614. January.

TABLE E-10
PFAS SCREENING LEVELS FOR WILDLIFE RECEPTORS
ECOLOGICAL RISK ASSESSMENT
WEST BEND AASF #1 AND ARMORY
WEST BEND, WISCONSIN

		Terrestrial Wildlife Screening Level for Soil								
		ANL Wildlife Values [1]		SERDP Wildlife RBSL [2]						
	Feeding Guild			Herbivore	Invertivore	Insectivore	Carnivore	Herbivore	Insectivore	Carnivore
	Receptor	ESV for Terrestrial Mammals	ESV for Terrestrial Birds	Meadow Vole	Short-Tailed Shrew	Little Brown Bat	Long-Tailed Weasel	American Goldfinch	House Wren	Red-Tailed Hawk
NOAEL-based RBSLs (mg/kg soil)										
Perfluorooctane sulfonic acid	PFOS	0.0087	0.0386	0.31	0.048	0.03	0.17	0.38	0.013	0.087
Perfluorooctanoic acid	PFOA	3.84	NA	5.8	1.3	0.84	0.57	NA	NA	NA
Perfluorononanoic acid	PFNA	0.0242	NA	2.3	1.5	1	1.5	NA	NA	NA
Perfluorohexanesulfonic acid	PFHxS	0.0028	NA	NA	NA	NA	NA	NA	NA	NA
Perfluorobutanesulfonic acid	PFBS	0.817	15.8	38	14	9.1	78	89	9.3	100
Perfluorodecanoic acid	PFDA	0.0677	NA	NA	NA	NA	NA	NA	NA	NA
Perfluorohexanoic acid	PFHxA	6.2	NA	120	340	250	160	NA	NA	NA
Perfluorobutanoic acid	PFBA	2.98	NA	29	78	58	130	NA	NA	NA
LOAEL-based RBSLs (mg/kg soil)										
Perfluorooctane sulfonic acid	PFOS	NA	NA	0.51	0.079	0.05	0.28	3.8	0.13	0.87
Perfluorooctanoic acid	PFOA	NA	NA	12	2.6	1.7	1.1	NA	NA	NA
Perfluorononanoic acid	PFNA	NA	NA	3	2	1.3	2	NA	NA	NA
Perfluorobutanesulfonic acid	PFBS	NA	NA	150	57	36	310	150	15	170
Perfluorohexanoic acid	PFHxA	NA	NA	260	700	530	330	NA	NA	NA
Perfluorobutanoic acid	PFBA	NA	NA	70	190	140	320	NA	NA	NA

		Aquatic-dependent Wildlife Screening Level for Sediment									
		ANL Wildlife Values [1]		SERDP Wildlife RBSL [2]							
	Feeding Guild			Herbivore	Insectivore	Carnivore	Carnivore	Carnivore	Omnivore	Invertivore	Piscivore
	Receptor	ESV Aquatic Mammals	ESV Aquatic Birds	Muskrat	Little Brown Bat	River Otter	Harbor Seal	Mink	Red-Winged Blackbird	Tree Swallow	Brown Pelican
NOAEL-based RBSLs (mg/kg sediment)											
Perfluorooctane sulfonic acid	PFOS	NA	NA	0.023	0.0053	0.047	0.046	0.038	0.007	0.0014	0.014
Perfluorooctanoic acid	PFOA	NA	NA	1.2	0.006	0.28	0.19	0.4	NA	NA	NA
Perfluorononanoic acid	PFNA	NA	NA	3.6	0.01	0.24	0.2	0.25	NA	NA	NA
Perfluorobutanesulfonic acid	PFBS	NA	NA	370	1.1	18	16	15	24	0.73	13
Perfluorohexanoic acid	PFHxA	NA	NA	240	1.8	29	26	25	NA	NA	NA
Perfluorobutanoic acid	PFBA	NA	NA	160	1.6	26	23	22	NA	NA	NA
LOAEL-based RBSLs (mg/kg sediment)											
Perfluorooctane sulfonic acid	PFOS	NA	NA	0.038	0.0088	0.077	0.077	0.063	0.07	0.014	0.14
Perfluorooctanoic acid	PFOA	NA	NA	2.3	0.012	0.57	0.39	0.8	NA	NA	NA
Perfluorononanoic acid	PFNA	NA	NA	4.7	0.013	0.32	0.27	0.33	NA	NA	NA
Perfluorobutanesulfonic acid	PFBS	NA	NA	1500	4.3	70	63	60	40	1.2	22
Perfluorohexanoic acid	PFHxA	NA	NA	510	3.8	61	55	53	NA	NA	NA
Perfluorobutanoic acid	PFBA	NA	NA	380	3.8	61	55	53	NA	NA	NA

TABLE E-10
PFAS SCREENING LEVELS FOR WILDLIFE RECEPTORS
ECOLOGICAL RISK ASSESSMENT
WEST BEND AASF #1 AND ARMORY
WEST BEND, WISCONSIN

		Aquatic-dependent Wildlife Screening Level for Surface Water									
		ANL Wildlife Values [1]		SERDP Wildlife RBSL [2]							
	Feeding Guild			Herbivore	Insectivore	Carnivore	Carnivore	Carnivore	Omnivore	Invertivore	Piscivore
	Receptor	ESV Aquatic Mammals	ESV Aquatic Birds	Muskrat	Little Brown Bat	River Otter	Harbor Seal	Mink	Red-Winged Blackbird	Tree Swallow	Brown Pelican
NOAEL-based RBSLs (mg/L water)											
Perfluorooctane sulfonic acid	PFOS	0.000117	0.00257	0.0011	0.00036	0.00028	0.00031	0.00021	0.00034	0.000091	0.000075
Perfluorooctanoic acid	PFOA	1.58	NA	0.018	0.0044	0.012	0.013	0.0094	NA	NA	NA
Perfluorononanoic acid	PFNA	0.00208	NA	0.0022	0.0047	0.0092	0.0097	0.0068	NA	NA	NA
Perfluorohexanesulfonic acid	PFHxS	0.0055	NA	NA	NA	NA	NA	NA	NA	NA	NA
Perfluorobutanesulfonic acid	PFBS	5.71	88.6	76	0.94	2	2.1	1.5	17	0.64	1.3
Perfluorodecanoic acid	PFDA	0.00066	NA	NA	NA	NA	NA	NA	NA	NA	NA
Perfluorohexanoic acid	PFHxA	2.21	NA	6.1	0.21	6.4	5	6.9	NA	NA	NA
Perfluorobutanoic acid	PFBA	8.37	NA	49	1.4	0.86	0.93	0.66	NA	NA	NA
LOAEL-based RBSLs (mg/L water)											
Perfluorooctane sulfonic acid	PFOS	NA	NA	0.0018	0.0006	0.00047	0.00051	0.00036	0.0034	0.00091	0.00075
Perfluorooctanoic acid	PFOA	NA	NA	0.036	0.0089	0.024	0.026	0.019	NA	NA	NA
Perfluorononanoic acid	PFNA	NA	NA	0.0029	0.0063	0.012	0.013	0.009	NA	NA	NA
Perfluorobutanesulfonic acid	PFBS	NA	NA	300	3.8	8	8.5	6	29	1.1	2.1
Perfluorohexanoic acid	PFHxA	NA	NA	13	0.44	13	10	14	NA	NA	NA
Perfluorobutanoic acid	PFBA	NA	NA	120	3.3	2.1	2.2	1.6	NA	NA	NA

Notes:

Shading shows values to be considered in the Screening Level Ecological Risk Assessment (lowest value).

These wildlife-based values do not reflect Site-specific receptors or conditions. If an exceedance of these values is noted in the Screening Level Ecological Risk Assessment, additional screening conducted in Step 3a will consider receptors and assumptions appropriate to the exposure areas.

ANL - Argonne National Laboratory
ESV - Ecological Screening Value
LOAEL - Lowest Observed Adverse Effects Level.
mg/kg - milligram per kilogram.
mg/L - milligrams per liter.
NA - Not Available.
NOAEL - No Observed Adverse Effects Level.
RBSL - Risk-Based Screening Level.
SERDP - Strategic Environmental Research and Development Program

Sources:

1 - Grippo, M., J. Hayse, I. Hlohowskyj, and K. Picel, 2021. Derivation of PFAS Ecological Screening Values. Argonne National Laboratory, Environmental Science Division. Completed under Interagency Agreement between the U.S. Department of Energy, Argonne National Laboratory, and the Air Force Civil Engineer Center. September. Final.
2 - Divine, C., Frenchmeyer, M., Dally, K., Osborn, E., Anderson, P., Zodrow, J., 2020. Approach for Assessing PFAS Risk to Threatened and Endangered Species. Final Report. SERDP Project ER18-1653. March.

TABLE E-11
PFAS SURFACE WATER SCREENING LEVELS FOR AQUATIC LIFE
ECOLOGICAL RISK ASSESSMENT
WEST BEND AASF #1 AND ARMORY
WEST BEND, WISCONSIN

Constituent	Abbreviation	Aquatic Life for Surface Water			
		ANL Values	SERDP Values		USEPA Values
		Aquatic Life ESV [1]	Water Quality RBSL [2]	Aquatic Life Protection Values [3]	Aquatic Life Criteria [4]
		Freshwater Chronic (ug/L)	Freshwater Chronic (ug/L)	Freshwater - HC5 (ug/L)	Freshwater Chronic (ug/L)
Perfluorooctane sulfonic acid	PFOS	22.6	51	5.85	8.4
Perfluorooctanoic acid	PFOA	307	3900	1112	94
Perfluorononanoic acid	PFNA	16.4	120	NA	NA
Perfluorohexanesulfonic acid	PFHxS	65.3	NA	NA	NA
Perfluoroheptanoic acid	PFHpA	NA	870	NA	NA
Perfluorobutanesulfonic acid	PFBS	400	3400	NA	NA
Perfluorodecanoic acid	PFDA	2.94	140	NA	NA
Perfluorododecanoic acid	PFDoA	NA	72	NA	NA
Perfluorohexanoic acid	PFHxA	28.8	2300	NA	NA
Perfluoroundecanoic acid	PFUnA	NA	49	NA	NA
Perfluorobutanoic acid	PFBA	64.6	470	NA	NA
Perfluoropentanoic acid	PFPA	NA	140	NA	NA

Notes:

Shading shows values to be considered in the Screening Level Ecological Risk Assessment (lowest value).

ANL - Argonne National Laboratory
ESV - Ecological Screening Value
HC5 - 5% Hazardous Concentration.
NA - Not Available.

ug/L - microgram per liter
RBSL - Risk-Based Screening Level.
SERDP - Strategic Environmental Research and Development Program
USEPA - United States Environmental Protection Agency.

Sources:

1 - Grippo, M., J. Hayse, I. Hlohowskyj, and K. Picel, 2021. Derivation of PFAS Ecological Screening Values. Argonne National Laboratory, Environmental Science Division. Completed under Interagency Agreement between the U.S. Department of Energy, Argonne National Laboratory, and the Air Force Civil Engineer Center. September. Final.

2 - Divine, C., Frenchmeyer, M., Dally, K., Osborn, E., Anderson, P., Zodrow, J., 2020. Approach for Assessing PFAS Risk to Threatened and Endangered Species. Final Report. SERDP Project ER18-1653. March. Marine screening levels were not derived.

3 - Conder, J., Arblaster, J., Larson, E., Brown, J., Higgins, C., 2020. Guidance for Assessing the Ecological Risks of PFAS to Threatened and Endangered Species at Aqueous Film Forming Foam-Impacted Sites. Guidance Document. SERDP Project ER18-1614. January.

4 - USEPA. 2022. Fact Sheet: Draft 2022 Aquatic Life Ambient Water Quality Criteria for Perfluorooctanoic acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS). EPA, Office of Water, EPA 842-D-22-005. April 2022. Final, not draft, values will be used in the Screening Level Ecological Risk Assessment.

TABLE E-12
PFAS SEDIMENT SCREENING LEVELS FOR BENTHIC INVERTEBRATES
ECOLOGICAL RISK ASSESSMENT
WEST BEND AASF #1 AND ARMORY
WEST BEND, WISCONSIN

Constituent	Abbreviation	PC99 (mg/kg)	PC95 (mg/kg)
Perfluorooctane sulfonic acid	PFOS	0.06	0.25

Notes:
Shading shows values to be considered in the Screening Level Ecological Risk Assessment.
Other values may be used in Step 3a, as needed.
mg/kg - milligram per kilogram.
PC99 - 99 percent protection concentration
PC95 - 95 percent protection concentration

Source:

Simpson et al. 2021. PC99 for PFOS in estuarine and marine sediment (60 µg/kg based on 1 percent organic carbon) selected for screening.

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Figures

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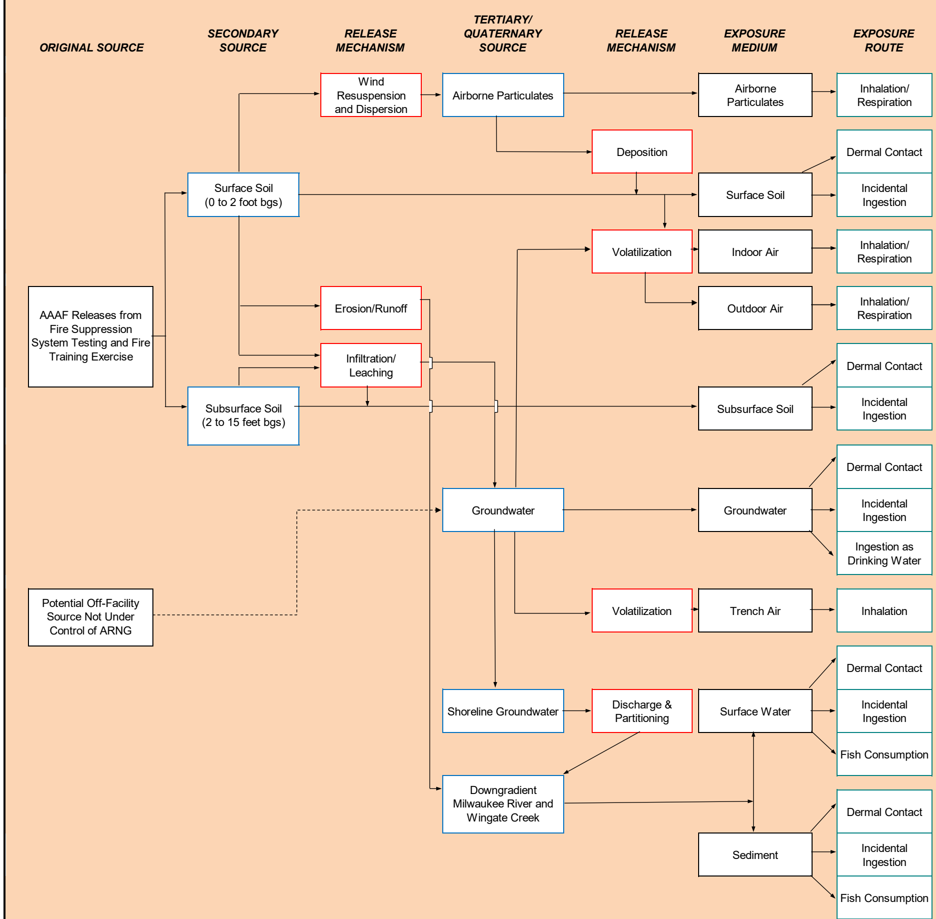


Human Receptors

Exposure Medium	Exposure Route	On-facility: Current Outdoor Worker	On-facility: Future Outdoor Worker	On-facility: Future Construction/ Utility Worker	On-facility: Future Trespasser (Adolescent)	On-facility: Hypothetical Future Resident (Adult/Child)[e]	Off-facility[g]: Current/Future Recreational User (Adult/Child)	Off-facility[g]: Current/Future Resident (Adult/Child)	Off-facility[g]: Current/Future Commercial/ Industrial Worker
Airborne Particulates	Inhalation/ Respiration	◎ [a]	◎ [a]	◎ [a]	◎ [a]	◎ [a]	IC	IC	IC
Surface Soil	Dermal Contact	●	●	●	●	●	IC	IC	IC
Surface Soil	Incidental Ingestion	●	●	●	●	●	IC	IC	IC
Indoor Air	Inhalation/ Respiration	NA	NA	NA	NA	IC[a]	NA	IC[a]	IC[a]
Outdoor Air	Inhalation/ Respiration	IC[a]	IC[a]	IC[a]	IC[a]	IC[a]	IC[a]	IC[a]	IC[a]
Subsurface Soil	Dermal Contact	IC	● [b]	●	IC	● [b]	IC	IC	IC
Subsurface Soil	Incidental Ingestion	IC	● [b]	●	IC	● [b]	IC	IC	IC
Groundwater	Dermal Contact	NA	NA	●	NA	● [c]	NA	●	NA
Groundwater	Incidental Ingestion	NA	NA	●	NA	NA	NA	NA	NA
Groundwater	Ingestion as Drinking Water	NA	● [c]	NA	NA	● [c]	NA	●	●
Trench Air	Inhalation	NA	NA	IC[a]	NA	NA	NA	NA	NA
Surface Water	Dermal Contact	● [h]	● [h]	NA	○ [d]	NA	● [f]	NA	NA
Surface Water	Incidental Ingestion	● [h]	● [h]	NA	○ [d]	NA	● [f]	NA	NA
Surface Water	Fish Consumption	NA	NA	NA	NA	NA	● [f]	NA	NA
Sediment	Dermal Contact	● [h]	● [h]	NA	○ [d]	NA	● [f]	NA	NA
Sediment	Incidental Ingestion	● [h]	● [h]	NA	○ [d]	NA	● [f]	NA	NA
Sediment	Fish Consumption	NA	NA	NA	NA	NA	● [f]	NA	NA

Legend

● Potentially complete pathway

◎ Potentially complete pathway; but not quantitatively evaluated, as discussed in the report text.

○ Minor or insignificant pathway

IC Incomplete

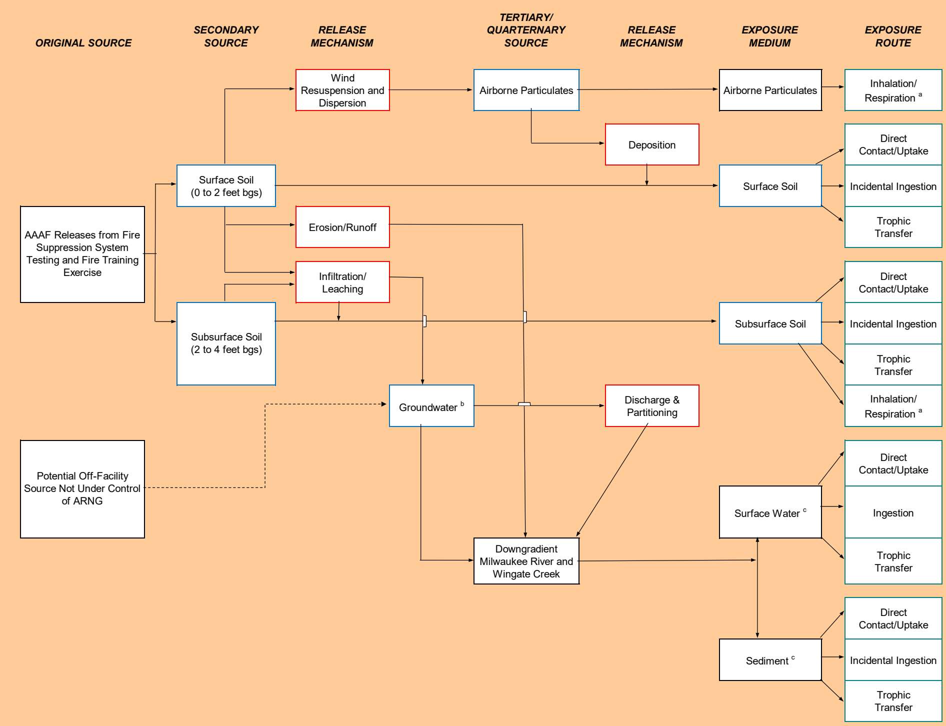
NA Not Applicable

Notes

AFFF - Aqueous film forming foams.
bgs - below ground surface.
PFAS - Per- and polyfluoroalkyl substances.

(a) Potential exposure with airborne particulates will not be quantitatively evaluated in the HHRA because toxicity values for the inhalation exposure route are not available for PFAS. The associated uncertainties will be discussed in the uncertainty discussion of the HHRA. PFAS have low volatility and therefore are not considered to volatilize into air.
(b) It is conservatively assumed that there could be future redevelopment of the facility, and current subsurface soils may be brought to the surface and become available for exposure under a future use scenario.
(c) The evaluation of on-facility groundwater as a future source of drinking water will be performed for informational purposes to represent an unrestricted groundwater use scenario.
(d) Wingate Creek bisects the facility, and could be accessed by outdoor workers or trespassers. However, given the intermittent nature of the stream, on-facility exposures are expected to be minimal. A recreational receptor will be evaluated for the off-facility portions of the creek.
(e) An on-facility resident is not a reasonable anticipated future use on the facility. However, for purposes of the HHRA, an unlimited use/unrestricted exposure (UU/UE) scenario will be conservatively evaluated for informational purposes.
(f) Exposure to sediment and surface water in Wingate Creek will be evaluated via a wading scenario. Exposure to surface water and sediment in the Milwaukee River will be evaluated under a swimming scenario to conservatively represent multiple recreational pathways (e.g. boating, wading). Fish consumption will be evaluated in the Milwaukee River if impacts to the river are identified and can be attributed to ARNG activities at the facility.
(g) The surrounding land use includes residential, commercial/industrial and agricultural properties. These off-facility receptors will only be evaluated if downgradient impacts to drinking water are identified and can be attributed to ARNG activities the facility.
(h) Assumes occasional exposure to surface water and sediment, if present, in the on-facility stormwater detention basin.

Project No. 60668768 — West Bend Army Aviation Support Facility #1 and Armory West Bend, Wisconsin	HUMAN HEALTH CONCEPTUAL SITE MODEL		Figure E-1



Ecological Receptors

Exposure Medium	Exposure Route	Terrestrial Plants	Soil Invertebrates	Terrestrial Reptiles / Amphibians [e]	Burrowing Wildlife	Non-burrowing Wildlife	Semi-Aquatic Reptiles / Amphibians [e]	Aquatic Organisms [f]	Benthic Invertebrates	Aquatic-Dependent Wildlife
		On-Facility Terrestrial Habitat					On- and Off-Facility Aquatic Habitat			
Airborne Particulates	Inhalation/ Respiration [a]	NA	○	○	○	○	○	NA	NA	○
Surface Soil	Direct Contact/Uptake	●	●	●	○	○	NA	NA	NA	NA
Surface Soil	Incidental Ingestion	NA	●	●	●	●	NA	NA	NA	NA
Surface Soil	Trophic Transfer	NA	NA	●	●	●	NA	NA	NA	NA
Subsurface Soil	Direct Contact/Uptake	●	NA	●	○	NA	NA	NA	NA	NA
Subsurface Soil	Incidental Ingestion	NA	NA	●	●	NA	NA	NA	NA	NA
Subsurface Soil	Trophic Transfer	NA	NA	○	○	NA	NA	NA	NA	NA
Subsurface Soil	Inhalation/ Respiration [a]	NA	NA	NA	○	NA	NA	NA	NA	NA
Surface Water [c]	Direct Contact/Uptake	NA	NA	NA	NA	NA	●	●	○	○
Surface Water [c]	Ingestion	NA	NA	○	○	○	●	●	○	●
Surface Water [c]	Trophic Transfer	NA	NA	NA	NA	NA	●	●	●	●
Sediment [c]	Direct Contact/Uptake	NA	NA	NA	NA	NA	●	○ [g]	● [g]	○
Sediment [c]	Incidental Ingestion	NA	NA	NA	NA	NA	●	○ [g]	● [g]	●
Sediment [c]	Trophic Transfer	NA	NA	NA	NA	NA	●	● [g]	NA	●

Legend

● Potentially complete pathway

○ Minor or insignificant pathway

NA Not Applicable

Notes

AFFF - Aqueous film forming foams.
bgs - below ground surface.
PFAS - Per- and polyfluoroalkyl substances.

(a) Inhalation/respiration of airborne particulates (dust) is expected to be minor compared to soil exposure pathways. Furthermore, PFAS have low volatility and therefore are not considered to volatilize into air.
(b) There are no direct complete ecological exposure pathways to groundwater.
(c) Potential exposures will be evaluated for surface water and sediment associated with the on-facility stormwater detention basin and off-facility Wingate Creek and Milwaukee River. If surface water is not collected from the stormwater detention basin and the findings from the Habitat Assessment do not indicate that aquatic habitat is seasonally present in the basin, the solid material collected from the basin will be evaluated as surface soil.
(e) Amphibians and reptiles may be exposed to PFAS in on- or off-facility habitats; however, media-specific screening values may not be available to evaluate these pathways. When screening values are not available, exposure pathways will be considered qualitatively.
(f) Aquatic organisms potentially associated with on-facility stormwater detention basin and off-facility Wingate Creek may include aquatic plants, aquatic invertebrates, and amphibians, but not fish. Aquatic organisms in the off-facility Milwaukee River also include fish.
(g) Aquatic and benthic organisms may be exposed to PFAS in sediment associated with aquatic habitats via ingestion or direct contact; however, screening values are generally not available for these sediment exposure pathways. These pathways will be considered qualitatively when screening values are not available.

Project No. 60668768	ECOLOGICAL CONCEPTUAL SITE MODEL	Figure E-2
West Bend Army Aviation Support Facility #1 and Armory West Bend, Wisconsin		

Attachment A-1
Species of Concern that Potentially Occur at the West Bend AASF #1 and Armory

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Attachment A-1
Species of Concern that Potentially Occur at the West Bend AASF #1 and Armory

Scientific Name	Common Name	State Rank	USFWS - Federal Rank	IPaC Review - Potentially Near Site?
Rare Species				
Birds				
Grus americana	Whooping Crane	NL	EXPN	Yes
Mammals				
Perimyotis subflavus	Tricolored Bat	NL	P END	Yes
Myotis septentrionalis	Northern Long-eared Bat	THR	END	Yes
Insects				
Danaus plexippus	Monarch Butterfly	NL	UC	Yes
Bombus affinis	Rusty Patched Bumble Bee	NL	END	Yes
Plants				
Platanthera leucophaea	Eastern prairie fringed orchid	END	THR	Yes
Migratory Birds				
Pluvialis dominica	American Golden-plover	NL	BCC	M
Haliaeetus leucocephalus	Bald Eagle	NL	BCC	M
Chlidonias niger	Black Tern	END	BCC	M
Coccyzus erythropthalmus	Black-billed Cuckoo	NL	BCC	M
Dolichonyx oryzivorus	Bobolink	NL	BCC	M
Cardellina canadensis	Canada Warbler	NL	BCC	M
Dendroica cerulea	Cerulean Warbler	THR	BCC	M
Chaetura pelagica	Chimney Swift	NL	BCC	M
Antrostomus vociferus	Eastern Whip-poor-will	NL	BCC	M
Vermivora chrysoptera	Golden-winged Warbler	NL	BCC	M
Ammodramus henslowii	Henslow's Sparrow	NL	BCC	M
Tringa flavipes	Lesser Yellowlegs	NL	BCC	M
Melanerpes erythrocephalus	Red-headed Woodpecker	NL	BCC	M
Euphagus carolinus	Rusty Blackbird	NL	BCC	M
Hylocichla mustelina	Wood Thrush	NL	BCC	M

Notes:

BCC - Bird of Conservation Concern
END = Endangered
EXPN = Experimental Population
IPaC = Information for Planning and Consultation
M - Migratory
NL = Not Listed
P END = Proposed Endangered
THR - Threatened
UC - Under Consideration

* Information obtained from IPaC Migratory Bird Probability of Presence graphs based on survey activities and species observations.

Sources:

Wisconsin Department of Natural Resources. 2021. Wisconsin Endangered and Threatened Species Laws & List. June. Accessed online February 2023. https://dnr.wisconsin.gov/topic/EndangeredResources/ETList

USFWS. 2023. Information for Planning and Consultation (IPaC). Accessedonline February 2023. https://ecos.fws.gov/ipac/

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Appendix F

Worksheets for ASTM D8421

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QAPP Worksheet #14 & #16: Project Tasks and Schedule

14.1 Support of Demonstration of Method Applicability (DMA)

ARNG G-9 is evaluating the use of screening analytical methods for PFAS laboratory analysis to expedite Remedial Investigation activities, shortening the overall time it takes to reach nature and extent and do so in a cost-effective manner. Screening methods could be used to make field decisions allowing step-out sampling and additional investigation to occur in one mobilization. Screening level data is not considered definitive. It will be supported by data collected via a DoD-accepted definitive analytical method (i.e., Draft EPA Method 1633). Only the definitive data would be considered decisionable for regulatory compliance, risk assessments, and/or remedial purposes.

ASTM D8421 has been selected to be evaluated for future use in the ARNG PFAS program; the efficacy of which is being evaluated in a DMA. A DMA Work Plan is being developed under a separate task which will describe the overall process for evaluating the data. The split samples will be analyzed via Draft EPA Method 1633 and ASTM D8421. The ASTM D8421 samples collected for the DMA will be collected in accordance with the worksheets included in Appendix F and the results will be presented in a technical memorandum. Use of ASTM D8421 as a screening method will only be applied if the DMA is accepted by to DoD.

QAPP Worksheet #15: Project Data Quality Limits and Laboratory-Specific Detection/ Quantitation Limits

Laboratory: Pace South Carolina
Matrix: Groundwater
Analyte Group: PFAS (40 Compound List)
Method: ASTM D8421

Analyte	Abbreviation	CAS Number	DQL (ng/L) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits	
							DL (ng/L)	LOQ (ng/L)
4:2 Fluorotelomer sulfonate	4:2 FTS	757124-72-4	NA	--	70	130	1.9	10
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2	NA	--	70	130	4.4	20
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4	NA	--	70	130	5.2	10
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6	NA	--	70	130	3.5	10
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9	NA	--	70	130	2.7	10
Perfluorobutanesulfonic acid	PFBS	375-73-5	601	HH; Tap Water SL	70	130	3.5	10
Perfluorobutanoic acid	PFBA	375-22-4	NA	--	70	130	8.3	50
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	--	70	130	2.6	10
Perfluorodecanoic acid	PFDA	335-76-2	NA	--	70	130	2.2	10
Perfluorododecanoic acid	PFDoA	307-55-1	NA	--	70	130	2	10
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	--	70	130	3.2	10
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	--	70	130	1.6	10
Perfluorohexanesulfonic acid	PFHxS	355-46-4	39	HH; Tap Water SL	70	130	1.6	10
Perfluorohexanoic acid	PFHxA	307-24-4	NA	--	70	130	1.4	10
Perfluorononanoic acid	PFNA	375-95-1	6	HH; Tap Water SL	70	130	2.2	10
Perfluorononanesulfonic acid	PFNS	68259-12-1	NA	--	70	130	1.9	10
Perfluorooctanesulfonamide	PFOSA	754-91-6	NA	--	70	130	1.6	10
Perfluorooctanesulfonic acid	PFOS	1763-23-1	4	HH; Tap Water SL	70	130	1.6	10

Analyte	Abbreviation	CAS Number	DQL (ng/L) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits	
							DL (ng/L)	LOQ (ng/L)
Perfluorooctanoic acid	PFOA	335-67-1	6	HH; Tap Water SL	70	130	4.1	10
Perfluoropentanoic acid	PFPA	2706-90-3	NA	--	70	130	14	50
Perfluoropentanesulfonic acid	PFPS	2706-91-4	NA	--	70	130	2.9	10
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	--	70	130	50(2)	50
Perfluorotridecanoic acid	PFTriDA	72629-94-8	NA	--	70	130	5.8	10
Perfluoroundecanoic acid	PFUnA	2058-94-8	NA	--	70	130	1.4	10
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	6	HH; Tap Water SL	70	130	2.4	10
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	NA	--	70	130	50(2)	50
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	NA	--	70	130	2.1	10
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2	NA	--	70	130	2.6	10
2-(N-methylperfluoro-1-octanesulfonamido) ethanol	NMeFOSE	24448-09-7	NA	--	70	130	4.5	10
2-(N-ethylperfluoro-1-octanesulfonamido) ethanol	NEtFOSE	1691-99-2	NA	--	70	130	2.6	10
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	--	70	130	1.7	10
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	NA	--	70	130	2	10
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	NA	--	70	130	1.8	10
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	NA	--	70	130	1.8	10
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	--	70	130	3	10
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	NA	--	70	130	1	10
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	NA	--	70	130	5	40
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	NA	--	70	130	4.9	40
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	NA	--	70	130	2.7	40
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	NA	--	70	130	1.4	10

Notes:

1.) DQLs for groundwater were selected based on the lower of the following:

(a) Risk-based tap water SLs calculated in accordance with the OSD Memorandum (Assistant Secretary of Defense, 2022). The OSD SLs were calculated using the USEPA RSL Calculator (USEPA, 2022) for a residential tap water exposure scenario using USEPA default exposure assumptions and toxicity values and based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

2.) A method detection limit for this compound could not be established. As such, the laboratory will report to the LOQ.

% = percent

ASTM = American Society for Testing Materials

CAS = Chemical Abstracts Service
DL = detection limit
DQL = data quality limit
HH = human health based DQL
LCS = laboratory control spike
LOD = limit of detection
LOQ = limit of quantitation
NA = not available
ng/l = nanograms per liter
OSD = Office of the Secretary of Defense
RSL = Regional Screening Level
SL = screening level
USEPA = United States Environmental Protection Agency

Laboratory: Pace South Carolina
Matrix: Surface Water (40 Compound List)
Analyte Group: PFAS
Method: ASTM D8421

Analyte	Abbreviation	CAS Number	DQL (ng/L) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits	
							DL (ng/L)	LOQ (ng/L)
4:2 Fluorotelomer sulfonate	4:2 FTS	75124-72-4	NA	--	70	130	1.9	10
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2	NA	--	70	130	4.4	20
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4	NA	--	70	130	5.2	10
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6	NA	--	70	130	3.5	10
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9	NA	--	70	130	2.7	10
Perfluorobutanesulfonic acid	PFBS	375-73-5	1,000	HH; Fish Consumption SL	70	130	3.5	10
Perfluorobutanoic acid	PFBA	375-22-4	64,600	Eco; Aquatic life ESV	70	130	8.3	50
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	--	70	130	2.6	10
Perfluorodecanoic acid	PFDA	335-76-2	660	Eco; Wildlife ESV	70	130	2.2	10
Perfluorododecanoic acid	PFDoA	307-55-1	72,000	Eco; RWQ RBSL	70	130	2	10
Perfluoroheptanoic acid	PFHpA	375-85-9	870,000	Eco; RWQ RBSL	70	130	3.2	10
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	--	70	130	1.6	10
Perfluorohexanesulfonic acid	PFHxS	355-46-4	49	HH; Fish Consumption SL	70	130	1.6	10
Perfluorohexanoic acid	PFHxA	307-24-4	28,800	Eco; Aquatic life ESV	70	130	1.4	10
Perfluorononanoic acid	PFNA	375-95-1	2.7	HH; Fish Consumption SL	70	130	2.2	10
Perfluorononanesulfonic acid	PFNS	68259-12-1	NA	--	70	130	1.9	10
Perfluorooctanesulfonamide	PFOSA	754-91-6	NA	--	70	130	1.6	10

Analyte	Abbreviation	CAS Number	DQL (ng/L) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits	
							DL (ng/L)	LOQ (ng/L)
Perfluorooctanesulfonic acid	PFOS	1763-23-1	0.46	HH; Fish Consumption SL	70	130	1.6	10
Perfluorooctanoic acid	PFOA	335-67-1	10	HH; Fish Consumption SL	70	130	4.1	10
Perfluoropentanoic acid	PFPA	2706-90-3	140,000	Eco; RWQ RBSL	70	130	14	50
Perfluoropentanesulfonic acid	PFPS	2706-91-4	NA	--	70	130	2.9	10
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	--	70	130	50(2)	50
Perfluorotridecanoic acid	PFTriDA	72629-94-8	NA	--	70	130	5.8	10
Perfluoroundecanoic acid	PFUnA	2058-94-8	49,000	Eco; RWQ RBSL	70	130	1.4	10
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	100	HH; Recreational SL	70	130	2.4	10
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	NA	--	70	130	50(2)	50
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	NA	--	70	130	2.1	10
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2	NA	--	70	130	2.6	10
2-(N-methylperfluoro-1-octanesulfonamido) ethanol	NMeFOSE	24448-09-7	NA	--	70	130	4.5	10
2-(N-ethylperfluoro-1-octanesulfonamido) ethanol	NEtFOSE	1691-99-2	NA	--	70	130	2.6	10
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	--	70	130	1.7	10
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	NA	--	70	130	2	10
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	NA	--	70	130	1.8	10
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	69,000	Eco; RWQ RBSL	70	130	1.8	10
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	--	70	130	3	10
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	NA	--	70	130	1	10
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	NA	--	70	130	5	40
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	NA	--	70	130	4.9	40
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	NA	--	70	130	2.7	40

Analyte	Abbreviation	CAS Number	DQL (ng/L) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits	
							DL (ng/L)	LOQ (ng/L)
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	NA	--	70	130	1.4	10

Notes:

1.) DQLs for surface water were selected based on the lower of the following:

Risk-based surface water SLs protective of incidental ingestion and dermal contact by recreational users. Values were calculated using the USEPA RSL Calculator (USEPA, 2022) for a recreational scenario based on an exposure frequency of 52 days/year, exposure time of 2.6 hours/day, and incidental ingestion rate of 0.011 L/hour. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Risk-based surfaced water SLs protective of fish consumption by humans. Values were calculated by application of published chemical-specific bioaccumulation factors (Divine et al. 2020) to fish tissue SLs calculated using the USEPA RSL Calculator (USEPA, 2022), based on a fish consumption rate of 0.011 kg fish per day. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Risk-based surface water SLs protective of incidental ingestion and dermal contact by onsite outdoor workers. Values were calculated using the USEPA RSL Calculator (USEPA, 2022) based on an exposure frequency of 35 days/year, exposure time of 2 hours/day, incidental ingestion rate of 0.011 L/hour, and surface area exposed 2,277 cm^2. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Guidance for Assessing the Ecological Risks of PFAS to Threatened and Endangered Species at Aqueous Film Forming Foam-Impacted Sites (Conder et al., 2020). The following value was used:

- Ecological aquatic life 5% hazardous concentration.

Approach for Assessing PFAS Risk to Threatened and Endangered Species (Divine et al., 2020). The following values were used:

- Lowest NOAEL RBSL for surface water for aquatic wildlife (Wildlife RBSL).
- Freshwater chronic screening level for aquatic life (RWQ RBSL).

Derivation of PFAS Ecological Screening Values. Argonne National Laboratory (Grippo, et al., 2021). The following values were used:

- Surface water ESV for aquatic-dependent wildlife (Wildlife ESV).
- Freshwater chronic ESV for aquatic life (Aquatic life ESV).

2.) A method detection limit for this compound could not be established. As such, the laboratory will report to the LOQ.

Notes:

% = percent
ASTM = American Society for Testing Materials
CAS = Chemical Abstracts Service
DL = detection limit
DQL = data quality limit
Eco = ecological based DQL
ESV = ecological screening value
HH = human health based DQL
L = liter
L/hour = liter per hour
LCS = laboratory control spike
LOD = limit of detection

LOQ = limit of quantitation
NA = not available
ng/l = nanograms per liter
NOAEL = No Observed Adverse Effect Level
PPRTV = Provisional Peer-Reviewed Toxicity Values
RBSL = risk-based screening level
RSL = Regional Screening Level
RWQ = Recommended Water Quality
SL = screening level
USEPA = United States Environmental Protection Agency

Laboratory: Pace South Carolina
Matrix: Soil
Analyte Group: PFAS (40 Compound List)
Method: ASTM D8421

Analyte	Abbreviation	CAS Number	DQL (µg/kg) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits	
							DL (µg/kg)	LOQ (µg/kg)
Perfluorobutanoic acid	PFBA	375-22-4	2,980	Eco; Wildlife ESV	50	150	0.01348	0.5
Perfluorobutanesulfonic acid	PFBS	375-73-5	817	Eco; Wildlife ESV	50	150	0.00727	0.1
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	--	50	150	0.03089	0.5
Perfluorohexanoic acid	PFHxA	307-24-4	6,200	Eco; Wildlife ESV	50	150	0.00354	0.1
Perfluorohexanesulfonic acid	PFHxS	355-46-4	2.8	Eco; Wildlife ESV	50	150	0.00445	0.1
Perfluoroheptanoic acid	PFHpA	375-85-9	1,000	Eco; Invert. NOEC	50	150	0.00972	0.1
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	--	50	150	0.00631	0.1
Perfluorooctanesulfonic acid	PFOS	1763-23-1	8.7	Eco; Wildlife ESV	50	150	0.00397	0.1
Fluorotelomer sulfonic acid 6:2	FTS 6:2	27619-97-2	NA	--	50	150	0.03453	0.2
Perfluorooctanoic acid	PFOA	335-67-1	19	HH; Residential Soil SL	50	150	0.01324	0.1
Perfluorooctanesulfonamide	PFOSA	754-91-6	NA	--	50	150	0.00308	0.1
Perfluorononanoic acid	PFNA	375-95-1	19	HH; Residential Soil SL	50	150	0.00599	0.1
Perfluoroundecanoic acid	PFUdA	2058-94-8	NA	--	50	150	0.00785	0.1
Perfluorodecanoic acid	PFDA	335-76-2	67.7	Eco; Wildlife ESV	50	150	0.0145	0.1
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	--	50	150	0.00618	0.1
Fluorotelomer sulfonic acid 8:2	FTS 8:2	39108-34-4	NA	--	50	150	0.02314	0.1
Perfluorododecanoic acid	PFDoA	307-55-1	NA	--	50	150	0.00611	0.1
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	--	50	150	0.00826	0.1
Perfluorotetradecanoic acid	PFTeA	376-06-7	NA	--	50	150	0.5 [(2)]	0.5
2-(N-Ethylperfluorooctanesulfonamido) acetic acid	N-EtFOSAA	2991-50-6	NA	--	50	150	0.01288	0.1
2-(N-Methylperfluorooctanesulfonamido) acetic acid	N-MeFOSAA	2355-31-9	NA	--	50	150	0.01052	0.1
Fluorotelomer sulfonic acid 4:2	FTS 4:2	757124-72-4	NA	--	50	150	0.01008	0.1
Perfluorononanesulfonic acid	PFNS	68259-12-1	NA	--	50	150	0.00465	0.1

Analyte	Abbreviation	CAS Number	DQL (µg/kg) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits	
							DL (µg/kg)	LOQ (µg/kg)
Perfluoropentanesulfonic acid	PFPeS	2706-91-4	NA	--	50	150	0.00663	0.1
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	23	HH; Residential Soil SL	50	150	0.00397	0.1
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	NA	--	50	150	0.5 [(2)]	0.5
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	NA	--	50	150	0.00576	0.1
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2	NA	--	50	150	0.00421	0.1
2-(N-methylperfluoro-1-octanesulfonamido) ethanol	NMeFOSE	24448-09-7	NA	--	50	150	0.01259	0.1
2-(N-ethylperfluoro-1-octanesulfonamido) ethanol	NEtFOSE	1691-99-2	NA	--	50	150	0.00377	0.1
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	--	50	150	0.0052	0.1
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	NA	--	50	150	0.00314	0.1
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	NA	--	50	150	0.00794	0.1
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	NA	--	50	150	0.0036	0.1
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	--	50	150	0.00433	0.1
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	NA	--	50	150	0.00458	0.1
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	NA	--	50	150	0.01356	0.4
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	NA	--	50	150	0.01782	0.4
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	NA	--	50	150	0.01265	0.4
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	NA	--	50	150	0.0034	0.1

Notes:

1.) DQLs for soil were selected based on the lower of the following:

Risk-based soil SLs calculated in accordance with the OSD Memorandum (Assistant Secretary of Defense, 2022). The OSD SLs values were calculated using the USEPA RSL Calculator (USEPA, 2022) for a residential exposure scenario using USEPA default exposure assumptions and toxicity values based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Guidance for Assessing the Ecological Risks of PFAS to Threatened and Endangered Species at Aqueous Film Forming Foam-Impacted Sites (Conder et al., 2020). Recommended Toxicity Benchmarks for Terrestrial Plants and Invertebrates; based on NOECs (Plant tox. and Invert. tox.).

Approach for Assessing PFAS Risk to Threatened and Endangered Species (Divine et al., 2020). The following values were used:

- Lowest NOAEL-based RBSL for soil for terrestrial wildlife (Wildlife RBSL).
    - NOEC-based soil screening level for plants (Plant NOEC).
    - NOEC-based soil screening level for invertebrates (Invert. NOEC).

Derivation of PFAS Ecological Screening Values. Argonne National Laboratory (Grippo, et al., 2021). The following values were used:

- Lowest soil ESV for birds and mammals (Wildlife ESV).
- Soil ESV for terrestrial plants (Plant ESV).
- Soil ESV for terrestrial invertebrates (Invert. ESV).

2.) A method detection limit for this compound could not be established. As such, the laboratory will report to the LOQ.

Notes (continued):
µg/kg = micrograms per kilogram
ASTM = American Socitey for Testing Materials
CAS = Chemical Abstracts Service
DL = detection limit
DQL = data quality limit
Eco = ecological based DQL
ESV = ecological screening value
FTS = fluorotelomer sulfonic acid
HH = human health based DQL
LCS = laboratory control spike
LOD = limit of detection
LOQ = limit of quantitation
NA = not available
NOAEL = No Observed Adverse Effect Level
NOEC = No Observed Effect Concentration
OSD = Office of the Secretary of Defense
RSL = Regional Screening Level
SL = Screening Level
USEPA = United States Environmental Protection Agency

Laboratory: Pace South Carolina
Matrix: Sediment
Analyte Group: PFAS (40 Compound Target List)
Method: ASTM D8421

Analyte	Abbreviation	CAS Number	DQL (µg/kg) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits	
							DL (µg/kg)	LOQ (µg/kg)
Perfluorobutanoic acid	PFBA	375-22-4	1,600	Eco; Wildlife RBSL	50	150	0.01348	0.5
Perfluorobutanesulfonic acid	PFBS	375-73-5	730	Eco; Wildlife RBSL	50	150	0.00727	0.1
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	--	50	150	0.03089	0.5
Perfluorohexanoic acid	PFHxA	307-24-4	1,800	Eco; Wildlife RBSL	50	150	0.00354	0.1
Perfluorohexanesulfonic acid	PFHxS	355-46-4	0.64	HH; Fish Consumption SL	50	150	0.00445	0.1
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	--	50	150	0.00972	0.1
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	--	50	150	0.00631	0.1
Perfluorooctanesulfonic acid	PFOS	1763-23-1	0.077	HH; Fish Consumption SL	50	150	0.00397	0.1
Fluorotelomer sulfonic acid 6:2	FTS 6:2	27619-97-2	NA	--	50	150	0.03453	0.2
Perfluorooctanoic acid	PFOA	335-67-1	0.49	HH; Fish Consumption SL	50	150	0.01324	0.1
Perfluorooctanesulfonamide	PFOSA	754-91-6	NA	--	50	150	0.00308	0.1
Perfluorononanoic acid	PFNA	375-95-1	0.09	HH; Fish Consumption SL	50	150	0.00599	0.1
Perfluoroundecanoic acid	PFUdA	2058-94-8	NA	--	50	150	0.00785	0.1
Perfluorodecanoic acid	PFDA	335-76-2	NA	--	50	150	0.0145	0.1
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	--	50	150	0.00618	0.1
Fluorotelomer sulfonic acid 8:2	FTS 8:2	39108-34-4	NA	--	50	150	0.02314	0.1
Perfluorododecanoic acid	PFDoA	307-55-1	NA	--	50	150	0.00611	0.1
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	--	50	150	0.00826	0.1

Analyte	Abbreviation	CAS Number	DQL (µg/kg) [1]	DQL Source	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Achievable Laboratory Limits	
							DL (µg/kg)	LOQ (µg/kg)
Perfluorotetradecanoic acid	PFTeA	376-06-7	NA	--	50	150	0.5 [2]	0.5
2-(N-Ethylperfluorooctanesulfonamido) acetic acid	N-EtFOSAA	2991-50-6	NA	--	50	150	0.01288	0.1
2-(N-Methylperfluorooctanesulfonamido) acetic acid	N-MeFOSAA	2355-31-9	NA	--	50	150	0.01052	0.1
Fluorotelomer sulfonic acid 4:2	FTS 4:2	757124-72-4	NA	--	50	150	0.01008	0.1
Perfluorononanesulfonic acid	PFNS	68259-12-1	NA	--	50	150	0.00465	0.1
Perfluoropentanesulfonic acid	PFPeS	2706-91-4	NA	--	50	150	0.00663	0.1
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	160	HH; Residential SL	50	150	0.00397	0.1
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	NA	--	50	150	0.5 [2]	0.5
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	NA	--	50	150	0.00576	0.1
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2	NA	--	50	150	0.00421	0.1
2-(N-methylperfluoro-1-octanesulfonamido) ethanol	NMeFOSE	24448-09-7	NA	--	50	150	0.01259	0.1
2-(N-ethylperfluoro-1-octanesulfonamido) ethanol	NEtFOSE	1691-99-2	NA	--	50	150	0.00377	0.1
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	NA	--	50	150	0.0052	0.1
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	NA	--	50	150	0.00314	0.1
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	NA	--	50	150	0.00794	0.1
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	NA	--	50	150	0.0036	0.1
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	NA	--	50	150	0.00433	0.1
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	NA	--	50	150	0.00458	0.1
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	NA	--	50	150	0.01356	0.4
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	NA	--	50	150	0.01782	0.4
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	NA	--	50	150	0.01265	0.4
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	NA	--	50	150	0.0034	0.1

Notes:

1.) DQLs for sediment were selected based on the lower of the following:

Risk-based sediment SLs protective of incidental ingestion and dermal contact by recreational users. Values were calculated using the USEPA RSL Calculator (USEPA, 2022) for a recreational scenario based on an exposure frequency of 52 days/year and exposure time of 2.6 hours/day. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Risk-based sediment SLs protective of fish consumption by humans. Values were calculated by application of published chemical-specific bioaccumulation sediment accumulation factors (Divine et al. 2020) to fish tissue SLs calculated using the USEPA RSL Calculator (USEPA, 2022), based on a fish consumption rate of 0.011 kg fish per day. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Risk-based sediment SLs protective of incidental ingestion and dermal contact by onsite outdoor workers. Values were calculated using the USEPA RSL Calculator (USEPA, 2022) based on an exposure frequency of 35 days/year, sediment ingestion rate of 50 mg/day, exposed surface area of 2,277 cm^2, and an adherence factor of 0.3 mg/cm^2. Other exposure assumptions are equal to USEPA default values provided in the calculator. USEPA default exposure assumptions and toxicity values and are based on a target hazard quotient of 0.1 and a target risk level of 1E-06 (USEPA, 2022).

Approach for Assessing PFAS Risk to Threatened and Endangered Species (Divine et al., 2020). The following values were used:
Lowest NOAEL-based RBSL for sediment for aquatic wildlife (Wildlife RBSL).
Chronic effects and thresholds for estuarine and marine benthic organism exposure to perfluorooctane sulfonic acid (PFOS)-contaminated sediments: Influence of organic carbon and exposure routes (Simpson, et al., 2021). PC99 in estuarine and marine sediment based on 1% organic carbon.

2.) A method detection limit for this compound could not be established. As such, the laboratory will report to the LOQ.

µg/kg = micrograms per kilogram
ASTM = American Society for Testing Materials
CAS = Chemical Abstracts Service
DL = detection limit
DQL = data quality limit
Eco = ecological based DQL
HH = human health based DQL
LCS = laboratory control spike
LOD = limit of detection
LOQ = limit of quantitation
mg/day = milligrams per day
NA = not available
NOAEL = No Observed Adverse Effect Level
OSD = Office of the Secretary of Defense
RBSL = Risk-Based Screening Level
RSL = Regional Screening Level
SL = screening level
USEPA = United States Environmental Protection Agency

QAPP Worksheet #19 & #30: Sample Containers, Preservation, and Hold Times

Laboratory: Pace South Carolina
106 Vantage Point Drive
West Columbia, SC 29172
803-683-9550
List any required accreditations/certifications: N/A*
Back-up Laboratory: N/A
Sample Delivery Method: FedEx

Analyte/ Analyte Group	Matrix	Method/SOP	Accreditation Expiration Date	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
PFAS	Solid	D8421/ D7968/ ENV-SOP-WCOL-0164	N/A (1)	90 mL PP	<6°C	28 days	28 days	48-hour upon agreement
PFAS	Aqueous	D8421/ D7968/ ENV-SOP-WCOL-0164	N/A (1)	3 x 15 mL PP (2)	<6°C	28 days	28 days	48-hour upon agreement

Notes:

1)Method undergoing single laboratory validation

2) For aqueous samples, do NOT fill the entire 15 mL tube. Each 15 mL container should contain 5 mL (± 1 mL) of sample volume.

°C = degrees Celsius
DoD = Department of Defense
mL = milliliter
PFAS = per- and polyfluoroalkyl substances
PP = polypropylene
QAPP = Quality Assurance Project Plan
QSM = Quality Systems Manual
SOP = standard operating procedure
N/A = not applicable

QAPP Worksheet #23: Analytical Standard Operating Procedures

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data[1]	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
ENV-SOP-WCOL-0164	PFAS by D8421-ID	Screening	PFAS	Sciex 5500 Triple Quad LC/MS/MS	Pace	N

Notes:
1.) Definitive or screening data are defined per the Part 2B, Quality Assurance/Quality Control Compendium: Minimum QA/QC Activities (IDQTF, 2005c):
Screening data can support an intermediate or preliminary decision but should eventually be supported by definitive data before a project is complete.
Definitive data should be suitable for final decision-making (of the appropriate level of precision and accuracy, as well as legally defensible).
LC/MS/MS = liquid chromatography tandem mass spectrometry
N = no
PFAS = per- and polyfluoroalkyl substances
SOP = standard operating procedure
Y = yes

QAPP Worksheet #24: Analytical Instrument Calibrations

Instrument/ Equipment	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person(s) Responsible	SOP Reference
LC/MS/MS	Mass Calibration	Instrument must have a valid mass calibration prior to any sample analysis. Mass calibration is verified after each mass calibration, prior to ICAL.	Calibrate the mass scale of the MS with calibration compounds and procedures described by the manufacturer. Mass calibration range must bracket the ion masses of interest. The most recent mass calibration must be used for every acquisition in an analytical run. Mass calibration must be verified to be ±0.5 amu of the true value, by acquiring a full scan continuum mass spectrum of a PFAS stock standard.	If the mass calibration fails, then recalibrate. If it fails again, consult manufacturer instructions on corrective maintenance.	Analyst, supervisor	1
LC/MS/MS	Calibration, Calibration Verification and Spiking Standards	All analytes. Note: Standards containing both branched and linear isomers are to be used during method validation and when reestablishing retention times, to ensure the total response is quantitated for that analyte. Technical grade standards cannot be used for quantitative analysis.	PFAS method analytes may consist of both branched and linear isomers, but quantitative standards that contain the linear and branched isomers do not exist for all method analytes. For PFAS that do not have a quantitative branched and linear standard, identify the branched isomers by analyzing a qualitative standard that includes both linear and branched isomers and determine retention times, transitions and transition ion ratios. Quantitate samples by integrating the total response (i.e., accounting for peaks that are identified as linear and branched isomers) and relying on the initial calibration that uses the linear isomer quantitative standard.	NA	Analyst, Supervisor	1

Instrument/ Equipment	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person(s) Responsible	SOP Reference
LC/MS/MS	Mass Spectral Acquisition Rate	Each analyte, EIS analyte.	A minimum of 10 spectra scans should be acquired across each chromatographic peak.	NA	Analyst, Supervisor	1
LC/MS/MS	ICAL; Calibration can be linear (minimum of 5 standards); weighting is allowed.	Prior to sample analysis: at instrument set-up and after major maintenance and/or ICV or CCV failure.	ICAL must meet one of the two options below: Option 1: The %RSD of the response factors (RFs_ for all analytes must be ≤30%. Option 2: Linear or non-linear calibrations must have % relative standard error (RSE) ≤30% for all compounds. The isotopically labeled analog of an analyte (Extracted Internal Standard Analyte) must be used for quantitation if commercially available (Isotope Dilution Quantitation).	Perform maintenance, if necessary, and repeat calibration if criterion is not met. No samples shall be analyzed until ICAL has passed.	Analyst, supervisor	1
LC/MS/MS	Instrument blank	Immediately following the highest standard analyzed during ICAL and daily, prior to sample analysis.	Concentration of each analyte must be ≤½ the LOQ. Instrument Blank must contain EIS to enable quantitation of contamination.	If acceptance criteria are not met after the highest calibration standard, calibration must be performed using a lower concentration for the highest standard until acceptance criteria is met.	Analyst, supervisor	1
LC/MS/MS	Initial calibration verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	Analyte concentrations must be within ± 30% of their true value.	Correct problem and verify second source standard; rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst, supervisor	1

Instrument/ Equipment	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person(s) Responsible	SOP Reference
LC/MS/MS	Continuing Calibration Verification (CCV)	Daily prior to sample analysis; after every 10 field samples; at end of analytical sequence	All analytes must be within ± 30% of their true value.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, or if two consecutive CCVs cannot be run, perform corrective action(s) and repeat CCV and all associated samples since last successful CCV. Alternately, recalibrate if necessary; then reanalyze all samples since the last acceptable CCV.	Analyst, supervisor	1

Notes:
> = greater than
≥ = greater than or equal to
< = less than
≤ = less than or equal to
± = plus or minus
% = percent
amu = atomic mass unit
CCV = Continuing Calibration Verification
DL = detection limit
EIS = extracted internal standard
ICAL = initial calibration for all analytes
ICV = independent calibration verification
LC/MS/MS = liquid chromatography tandem mass spectrometry
LOQ = limit of quantitation
MS = matrix spike
PFAS = per- and polyfluoroalkyl substances
ppb = parts per billion
RF = response factors
RSD = relative standard deviation
RSE = relative standard error
SOP = standard operating procedure

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

Laboratory: Pace South Carolina

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
LC/MS/MS	Check column pressure and mobile phase levels/ expirations daily. Perform the following as needed: prepare aqueous mobile phase, clean/replace injection needle, replace guard cartridge, backflush/replace column, replace injector seat, clean curtain/orifice plate, retune MS.	PFAS	Inspect all tubing connections at time of maintenance to assure no leaks present. Monitor instrument performance via calibrations, continuing calibration verifications (CCVs), and blanks.	Initially, after major maintenance, CCV not meeting 2X.	Same as initial calibration and continuing calibration verification.	Same as initial calibration and continuing calibration verification.	Analyst, Supervisor	ENV-SOP-WCOL-0164

Notes:
ICAL = initial calibration
CCV = Continuing Calibration Verification
ESI = electrospray ionization
LC = liquid chromatography
LC/MS/MS = liquid chromatography tandem mass spectrometry
mg = milligram
MS = mass spectrometer
PFAS = per- and polyfluoroalkyl substances
SOP = standard operating procedure

QAPP Worksheet #28: Analytical Quality Control and Corrective Actions

Laboratory: Pace South Carolina
Matrix: Solid & Aqueous
Analytical Group: PFAS
Analytical Method: ASTM D8421
SOP Reference: ENV-SOP-WCOL-0164
Certification Status: DoD ELAP/NELAP Certification

QC Sample	Frequency/ Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible	Data Quality Indicator	Measurement Performance Criteria
Sample PFAS Identification	All analytes detected in a sample	A minimum of two ion transitions (Precursor →quant ion and precursor →confirmation ion) and the ion transitions ratio per analyte are required for confirmation. Exception is made for analytes where two transitions do not exist (PFPrA, PFBA, PFPeA, PFOSA, NMeFOSE, NEtFOSE, PFMPA, PFMBA, FHUEA, and FOUEA). In-house acceptance criteria for evaluation of ion ratios must be used and must not exceed 70-130%. Signal to Noise Ratio (S/N) must be ≥3 for all ions used for quantification and must be ≥3 for all ions used for confirmation.	Any detected quantitation ion peak that does not meet the ion ratio or S/N criteria should be closely reviewed to determine whether the peak should be rejected or not; generally, these peaks should be rejected unless qualitative measures show interference.	Analyst	Sample PFAS Identification	All analytes detected in a sample
Retention Time (RT) window position establishment	Once per ICAL.	Position shall be set using the midpoint standard of the ICAL curve.	NA	NA	NA	NA

QC Sample	Frequency/ Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible	Data Quality Indicator	Measurement Performance Criteria
RT window width	Every field sample standard, blank, and QC sample.	RT of each analyte and EIS analyte must fall within 0.4 minutes of the predicted retention times from the midpoint standard of the ICAL. Analytes must elute within 0.1 minutes of the associated EIS; this criterion applies only to analyte and labeled analog pairs.	Correct problem and reanalyze samples.	Analyst	NA	NA
Extracted Internal Standard Analytes (EIS, aka SUR)	Every field sample, standard, blank, and QC sample.	Added to aqueous samples prior to preparation. Extracted Internal Standard Analyte recoveries must be within 50% to 150%.	Correct problem. If required, re-prepare and reanalyze affected field and QC samples.	Analyst, supervisor	Apply Q-flag and discuss in the Case Narrative only if reanalysis confirms failures in the same manner.	Failing analytes shall be thoroughly documented in the Case Narrative.
Method Blank (MB)	One per preparatory batch.	No analytes detected > ½ LOQ or > 1/10th the amount measured in any sample, whichever is greater.	Correct problem. If required, re-prepare and reanalyze MB and all QC samples and field samples processed with the contaminated blank. Examine the project-specific requirements. Contact the client as to additional measures to be taken.	Analyst, supervisor	If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Results may not be reported without a valid MB. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

QC Sample	Frequency/ Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible	Data Quality Indicator	Measurement Performance Criteria
Laboratory Control Sample (LCS)	One per preparatory batch.	Blank spiked with all analytes at a concentration near the mid-level calibration concentration. Recoveries must be 50%-150%.	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available. Examine the project-specific requirements. Contact the client as to additional measures to be taken.	Analyst, supervisor	If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply flag to specific analyte(s) in all samples in the associated preparatory batch.	Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per preparatory batch, if possible and/or requested.	Sample spiked with all analytes at a concentration near the mid-level calibration concentration. Recoveries must be 50%-150%.	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	Analyst, supervisor	For the specific analyte(s) in the parent sample, apply flag if acceptance criteria are not met and explain in the Case Narrative.	For matrix evaluation only. If MS results are outside the limits, the data shall be evaluated to determine the source(s) of difference (i.e., matrix effect or analytical error).

QC Sample	Frequency/ Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible	Data Quality Indicator	Measurement Performance Criteria
Matrix Spike Duplicate (MSD)	One per preparatory batch, if possible and/or requested.	Sample spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration. Recoveries must be 50%-150%. RPD ≤ 30% (between MS and MSD).	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	Analyst, supervisor	For the specific analyte(s) in the parent sample, apply flag if acceptance criteria are not met and explain in the Case Narrative.	The data shall be evaluated to determine the source or difference.

Notes:
> = greater than
≥ = greater than or equal to
≤ = less than or equal to
% = percent
EIS = extracted internal standard
ICAL = initial calibration for all analytes
LCS = laboratory control spike
LOQ = limit of quantitation
MB = method blank
MS = matrix spike
MSD = matrix spike duplicate
NA = not applicable
PFAS = per- and polyfluoroalkyl substances
QC = quality control
RPD = relative percent difference
RT = retention time
S/N = signal to noise
SOP = standard operating procedure