FINAL
Site Inspection Report
Bethel Army Aviation Operating Facility
Bethel, Alaska

Site Inspections for Perfluorooctanoic Acid (PFOA), Perfluorooctanesulfonic Acid (PFOS), Perfluorohexanesulfonic Acid (PFHxS), Perfluorononanoic Acid (PFNA), Hexafluoropropylene oxide dimer Acid (HFPO-DA) and Perfluorobutanesulfonic Acid (PFBS)
ARNG Installations, Nationwide

September 2023

Prepared for:

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

UNCLASSIFIED

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
°F	Degrees Fahrenheit
%	Percent
K_{oc}	Organic carbon partition coefficient
µg/kg	Microgram(s) per kilogram
AAOF	Army Aviation Operating Facility
AECOM	AECOM Technical Services, Inc.
AFFF	Aqueous film-forming foam
AKARNG	Alaska Army National Guard
amsl	Above mean sea level
AOI	Area of Interest
ARNG	Army National Guard
bgs	Below ground surface
btoc	Below top of casing
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSM	Conceptual site model
DoD	Department of Defense
DPT	Direct-push technology
DQO	Data Quality Objectives
EA	EA Engineering, Science, and Technology, Inc., PBC
EIS	Extraction internal standards
ELAP	Environmental Laboratory Accreditation Program
EM	Engineer Manual
EB	Equipment blank
ELLE	Eurofins Lancaster Laboratories Environmental, LLC
FB	Field blank
FD	Field duplicate
ft	Foot (feet)
FTS	Fluorotelomer sulfonate
FSS	Fire suppression system
GAC	Granular activated carbon
HDPE	High-density polyethylene
HFPO-DA	Hexafluoropropylene oxide dimer acid
IDW	Investigation-derived waste
In.	Inch(es)
ITRC	Interstate Technology Regulatory Council

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

LC/MS/MS	Liquid chromatography tandem mass spectrometry
MIL-SPEC	Military Specification
MS	Matrix spike
MSD	Matrix spike duplicate
ng/L	Nanogram(s) per liter
No.	Number
pH	Potential hydrogen
OSD	Office of the Assistant Secretary of Defense
PA	Preliminary Assessment
PFAS	Per- and polyfluoroalkyl substances
PFBS	Perfluorobutanesulfonic acid
PFHxS	Perfluorohexane sulfonate
PFNA	Perfluorononanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PID	Photoionization detector
PVC	Polyvinyl chloride
QAPP	Quality Assurance Project Plan
QSM	Quality Systems Manual
RI	Remedial Investigation
SI	Site Inspection
SL	Screening level
TOC	Total organic carbon
TPP	Technical Project Planning
UFP	Uniform Federal Policy
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

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EXECUTIVE SUMMARY

The Army National Guard (ARNG) G9 is performing Preliminary Assessments (PAs) and Site Inspections (SIs) at ARNG facilities nationwide based on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on the six compounds presented in the memorandum from the Office of the Secretary of Defense (OSD) (Assistant Secretary of Defense) dated 6 July 2022. The six compounds listed in the OSD memorandum include perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA)[1]. These compounds are collectively referred to as “relevant compounds” throughout the document and the applicable Screening Levels (SLs) are provided below in Table ES-1.

The PA identified one Area of Interest (AOI), where PFAS-containing materials may have been stored, disposed, or released historically (see Table ES-2 for AOI location). The objective of the SI is to identify whether there has been a release to the environment from the identified AOI in the PA and to determine whether further investigation is warranted, a removal action is required to address immediate threats, or no further action is required based on a comparison of SI results to screening levels for the relevant compounds. This SI was completed at the Bethel Army Aviation Operating Facility (BAAOF) in Bethel, Alaska and determined further investigation is warranted for AOI 1: BAAOF. BAAOF will be referred to as the “Facility” throughout this document.

The Facility is operated by Alaska ARNG (AKARNG). The Facility consists of the AAOF and Armory, but the Armory was excluded from further evaluation at the end of the PA. The AAOF is comprised of two buildings, asphalt and concrete pavement, water and fuel/oil storage tanks, gates, and fences. The AAOF is connected by taxiway to the Bethel Airport runways. Together, the two facilities occupy 11 acres. The Bethel AAOF is on the west side of Bethel Airport, approximately 3 miles from downtown Bethel, the largest community in Alaska’s Unorganized Borough with a population of just over 6,000 persons. The AAOF is on the western bank of the Kuskokwim River, approximately 65 miles inland from the Bering Sea. The Bethel Census Area contains just over 17,000 inhabitants in an area of some 45,500 square miles (AECOM Technical Services, Inc. 2020). The AAOF was leased for 55 years from 1996 until 2051. The Alaska Guard acquired aqueous film-forming foam (AFFF) in the mid-1990s, well after AFFF came into wide-spread use by the Department of Defense (DoD) (1970).

The PA identified one AOI for investigation during the SI phase. SI sampling results from the AOI were compared to OSD SLs. **Table ES-2** summarizes the SI results for the AOI. Based on the results of this SI, and following the CERCLA process, a remedial investigation (RI) is

[1] 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 this SI. Based on the conceptual site model (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 military specification (MIL-SPEC) aqueous film forming foam (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.

warranted for AOI 1. Based on the results of this SI, further evaluation under CERCLA is warranted for the AOI identified.

Table ES-1. Screening Levels (Soil and Groundwater)

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

Notes:

1. Assistant Secretary of Defense. July 2022. Risk Based Screening Levels Calculated for Groundwater and Soil using U.S. Environmental Protection Agency's (USEPA's) Regional Screening Level Calculator. Hazard Quotient=0.1. May 2022.
2. 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 this 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.

µg/kg = Microgram(s) per kilogram
ng/L = Nanogram(s) per liter

Table ES-2. Summary of Site Inspection Findings and Recommendations

AOI	Potential Release Area	Soil Source Area	Groundwater Source Area	Groundwater Facility Boundary	Future Action
1	Bethel AAOF Hangar	◐	●	◐	Proceed to RI

Legend:
● = Detected; exceedance of screening levels
◐ = Detected; no exceedance of screening levels
○ = Not detected

1. INTRODUCTION

1.1 PROJECT AUTHORIZATION

The Army National Guard (ARNG) G9 is the lead agency in performing Preliminary Assessments (PAs) and Site Inspections (SIs) at ARNG facilities nationwide based on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on six compounds presented in the memorandum from the Office of the Secretary of Defense (OSD) dated 6 July 2022 (Assistant Secretary of Defense 2022). The six compounds listed in the OSD memorandum will be referred to as “relevant compounds” throughout this document and include perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), and hexafluoropropylene oxide-dimer acid (HFPO-DA)[2] at ARNG facilities nationwide. The ARNG performed this SI at the Bethel Army Aviation Operating Facility (AAOF) in Bethel, Alaska. The Bethel AAOF will be referred to as the “Facility” throughout this report.

The SI project elements were performed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (U.S. Environmental Protection Agency [USEPA] 1980), as amended, the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations Part 300; USEPA 1994), and in compliance with Army requirements and guidance for field investigations.

1.2 SITE INSPECTION PURPOSE

A PA was performed at Bethel AAOF (AECOM Technical Services, Inc. [AECOM] 2020) that identified one Area of Interest (AOI) where PFAS-containing materials were used, stored, and/or disposed, or areas where known or suspected releases to the environment occurred. The objective of the SI is to identify whether there has been a release to the environment from the AOI identified in the PA and to determine whether further investigation is warranted, a removal action is required to address immediate threats, or no further action is required based on screening levels (SLs) for the relevant compounds.

[2] 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 this SI. Based on the conceptual site model (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 military specification (MIL-SPEC) aqueous film forming foam (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.

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2. FACILITY BACKGROUND

2.1 FACILITY LOCATION AND DESCRIPTION

The Bethel AAOF and Armory are on the west side of the Bethel Airport, approximately 3 miles from downtown Bethel, the largest community in Alaska's Unorganized Borough with a population of a little over 6,000 persons. The AAOF and Armory are located on the western bank of the Kuskokwim River, approximately 65 miles inland from the Bering Sea.

Consisting of two blocks within Lot 1, the Bethel AAOF and Armory are operated by the Alaska ARNG (AKARNG) as an aviation operating facility and a reserve readiness center, respectively. The AAOF is in Block 50 and the Armory in Block 60. The AAOF comprises two buildings, asphalt and concrete pavement, water and fuel/oil storage tanks, gates and fences (**Figure 2-1**). The AAOF is connected by taxiway to the Bethel Airport runways. Together, the two facilities occupy approximately 11 acres. The AAOF was leased for 55 years in 1996 until 2051 and the current 25-year lease for the Armory will expire in 2024. The AAOF was the focus of the SI.

2.2 FACILITY ENVIRONMENTAL SETTING

The Facility is within the Yukon Delta National Wildlife Refuge, an approximately 30,000-square mile refuge comprising a large section of western Alaska. The refuge is largely unforested, with a 5 percent (%) tree cover existing predominately along the margins of the Yukon and Kuskokwim rivers. Topography of the Site slopes downward toward the north (**Figure 2-2**). The refuge is home to a vast population of wildlife with over 200,000 water birds (i.e., loons, cranes, and swans) returning here each spring from their winter migration in addition to the terrestrial, amphibious, marine life, and non-migratory bird populations (AECOM 2020).

2.2.1 Geology

The Bethel area is predominately covered by an extensive Quaternary deposit consisting of poorly consolidated fluvial, glaciofluvial, colluvial, eolian, and shallow marine sediments. The nearby Kuskokwim Group to the southeast of the Facility typically includes the interbedded greywacke and shale of a flysch deposit, indicating a near-shore marine depositional environment, but has also been shown to include deeper deltaic deposits and contain material from cherty and volcanic sedimentary provenances. Because of the multiplicity of source material and depositional environments, the Late Cretaceous age given to the Kuskokwim Group has been interpreted variously by others as slightly older (Early Cretaceous) or slightly younger (Paleocene) (AECOM 2020).

The area is glacial tundra, primarily sedge grasses and fine-grained, poorly sorted, poorly consolidated till deposits. Most soils in the area are silty, acidic, poorly drained, and are unsuitable for urban or agricultural uses. Bethel is within an area of discontinuous permafrost, defined as where permafrost underlies 50–90% of the landscape with a soil temperature range of -5 to 0 degrees Celsius (°C). Permafrost depths in the area range from 5–200 meters below ground surface (USEPA 2008).

Soil encountered during SI activities was largely consistent with the above expected lithology, mainly ranging from poorly graded gravel-sand mixtures to silty sands and silty clays within each of the borings. Areas of permafrost were encountered during drilling at borings AOI01-01 and BAAOF-01 at depths of 17–22 feet (ft) below ground surface (bgs). The presence or depth to permafrost beneath other areas of the Facility is not known.

2.2.2 Hydrogeology

Groundwater flow may be affected by the presence or absence of discontinuous permafrost in the area. For deep aquifers below the permafrost layer, clast size of the bedrock exhibits strong control over transmissivity, with coarser material bearing more water. For areas where permafrost exists, shallow groundwater flow above the permafrost may be unpredictable and affected by local topography and the topography of the top of the permafrost layer. In areas where permafrost does not exist, there may be hydrologic connections between the shallow groundwater above the permafrost and deeper aquifers beneath it. The presence and depth of permafrost at the AAOF is not well understood.

Regional static groundwater levels, determined from wells drilled in the area, range from 9 to 38 ft bgs. Regional groundwater flow is believed to the southeast toward the Kuskokwim River (**Figures 2-3** and **2-4)**. During the SI, depth to groundwater at Bethel AAOF ranged from 10.74 to 17.25 ft bgs. However, survey accuracy was diminished due to weather conditions. More information on survey accuracy is described in **Section 5.8**.

Groundwater elevations calculated using depth to groundwater measurements and level loop survey data collected during the SI indicate groundwater within the shallow aquifer flows to the northwest and southeast from a groundwater high point at the Bethel AAOF Hangar (**Figure 2-5**). Groundwater elevation patterns on-site are relative to the general site topography – both are higher near the center of the Site and are lower in elevation at the northwest and southeast portions of the Site. A sloped road connects the Bethel Armory and Bethel AAOF. Groundwater elevations may also vary due to the presence of permafrost, which can prevent or impede downward and horizontal migration of groundwater. As a result, the local groundwater flow direction varies from the regional groundwater flow but is not fully understood. Additionally, the groundwater gradient is steeper than expected especially northwest from the Hangar.

Drinking water for Bethel is provided by the Bethel Heights water system, which gets its water from two deep groundwater wells located at the Bethel Heights Water Treatment Plant at 900 Ridgecrest Drive, Bethel, Alaska. Bethel Heights water system is located approximately 2.5 miles northeast (cross-gradient) of the Facility (AECOM 2020). The Bethel water system was not sampled for PFAS under the Unregulated Contaminant Monitoring Rule 3, thus it is unknown if the Bethel drinking water system has been impacted by PFAS.

An Environmental Database Report (EDR)™ report included a well search for a 1-mile radius surrounding the Facility. Using additional online resources, such as state and local geographic information system databases, wells were further researched out to a 4-mile radius of the Facility. Four unknown type wells were identified as being located in the surrounding area within 4 miles (**Figure 2-3**); however, they all have an inactive status (AECOM 2020). Two of these wells are located approximately 1 mile northeast (cross-gradient) of the Facility. The other two wells are located less than 2 miles northwest (upgradient) of the Facility. The Bethel Airport reportedly contains a drinking water fountain which sourced groundwater from beneath the airport. This drinking water fountain was taken out of use during the Covid-19 pandemic and has not been in use since. In June 2022, it was reported that this well is contaminated with PFAS (ADEC 2023). Concentrations found in the airport drinking water were not divulged to ARNG.

Permafrost causes seasonal fluctuations in transmissivity and well production rates. Static water levels are also directly affected by the stages of the river and the tides; for example, water levels monitored in a well near the Bethel Hospital regularly fluctuate approximately 10 ft throughout the year based on tidal influence. The degree of influence is unknown and was not measured during this SI. Further characterization of tidal and permafrost influences on groundwater is warranted in future investigations.

2.2.3 Hydrology

The Facility is approximately 2 miles from the western shore of the Kuskokwim River (**Figure 2-4**). The River is mostly channelized but exhibits braiding in places where the loosely consolidated underlying sediment cannot give resistance to the meandering forces of the River. Its convoluted branches range from 75 ft to over 0.5 mile wide across its main channel. The tundra surrounding Bethel is classified by the U.S. Fish and Wildlife Service as freshwater, sparsely wooded, palustrine wetland, seasonally saturated and in some areas affected by the tidal influences of the Kuskokwim River (AECOM 2020). The landscape is dotted with lakes and streams.

Flooding is the only geophysical hazard of concern in Bethel; earthquakes are possible, but atypical, and the nearest volcano is over 250 miles to the southeast. Flooding typically occurs in spring when the thick build-up of river ice experiences rapid warming and in the late summer, when the heaviest rainfall occurs (AECOM 2020). The AAOF lies on relatively higher topography than the surrounding area, which exhibits better drainage and is less susceptible to flooding than the lower lying surrounding lands.

Stormwater surface flow at the facility generally moves away radially from the hangar. Stormwater moving to the east flows within ditches along the western edge of the airport taxiway. These ditches direct water to the north or south depending on which side of the hangar access taxiway the ditch is. Flow on the western side of the hangar moves westward towards a low-lying area west of the hangar.

2.2.4 Climate

Bethel’s climate is cool during the summer with an average temperature of around 60 degrees Fahrenheit (°F) and extremely cold during winter with an average temperature of 9°F. The warmest month of the year is July with an average maximum temperature of 63°F, while the coldest month of the year is January with an average minimum temperature of 1°F. The annual average rainfall is 18.54 inches (in.) with annual average of 61.8 in. of snowfall. The wettest month of the year is August with an average rainfall of 3.02 in. (AECOM 2020).

2.2.5 Current and Future Land Use

The property is currently under lease by the Alaska Army National Guard (AKARNG) and is operated as an AAOF, which services aircraft for the AKARNG. The AKARNG has leased the AAOF parcel from the Alaska Department of Transportation until 2051. Reasonably anticipated future land use is not expected to change from the current land use described above (AECOM 2020). The Facility has restricted access and is fenced. Access to the Facility must be coordinated with AKARNG.

2.2.6 Sensitive Habitat and Threatened/Endangered Species

A wildlife survey has not been conducted at the Facility, and the Facility does not include any significant areas of habitat. The following species have not been identified at the Facility but may be present in the surrounding area.

The following species are listed as federally endangered, threatened, proposed, and/or candidate species in Bethel, Alaska (U.S. Fish and Wildlife Services [USFWS] 2022):

- Birds: Short-tailed Albatross, *Phoebastria (=Diomedea) albatrus* (Endangered); Spectacled Eider, *Somateria fischeri* (Threatened); and Steller's Eider, *Polysticta stelleri* (Threatened).

- Marine Mammals: Polar Bear, *Ursus maritimus* (Threatened).

- Mammals: Wood Bison, *Bison athabascae* (Endangered).

2.3 HISTORY OF PFAS USE

One potential PFAS release area (non-Fire Training Area) was identified at the Site during the PA (AECOM 2020). Interviews and records obtained during the PA indicate that the Bethel AAOF Hangar is equipped with an aqueous film-forming foam (AFFF) fire suppression system (FSS), supplied with AFFF by two above ground tanks each with a capacity of 800-gallon (gal). The FSS has had no reported releases; however, the AFFF tank to the right has a leaky sight gauge. The gauge only leaks when checked, and less than 1 quart of AFFF foam is discharged each time the tank is serviced. Based on PA interview records it was only serviced a couple times over the last ten years (AECOM 2020). Additionally, one Tri-Max™ unit was found to be stored at the Bethel AAOF Hangar during the PA site visit, although no information pertaining to the use or maintenance of the Tri-Max™ was found during the PA interviews and data gathering. Based on the findings/presence of the AFFF FSS and storage of Tri-Max™ units, the SI included the hangar and surrounding leased area as a potential release area for investigation. A more detailed description of the AOI is presented in **Section 3**.

Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 2-1
Facility Location

Facility Data

Facility Boundary

Data Sources:
ESRI 2020
AECOM 2020

Date:..........................August 2022
Prepared By:............................EA
Prepared For:....................USACE
Projection:........WGS 84 UTM 4N

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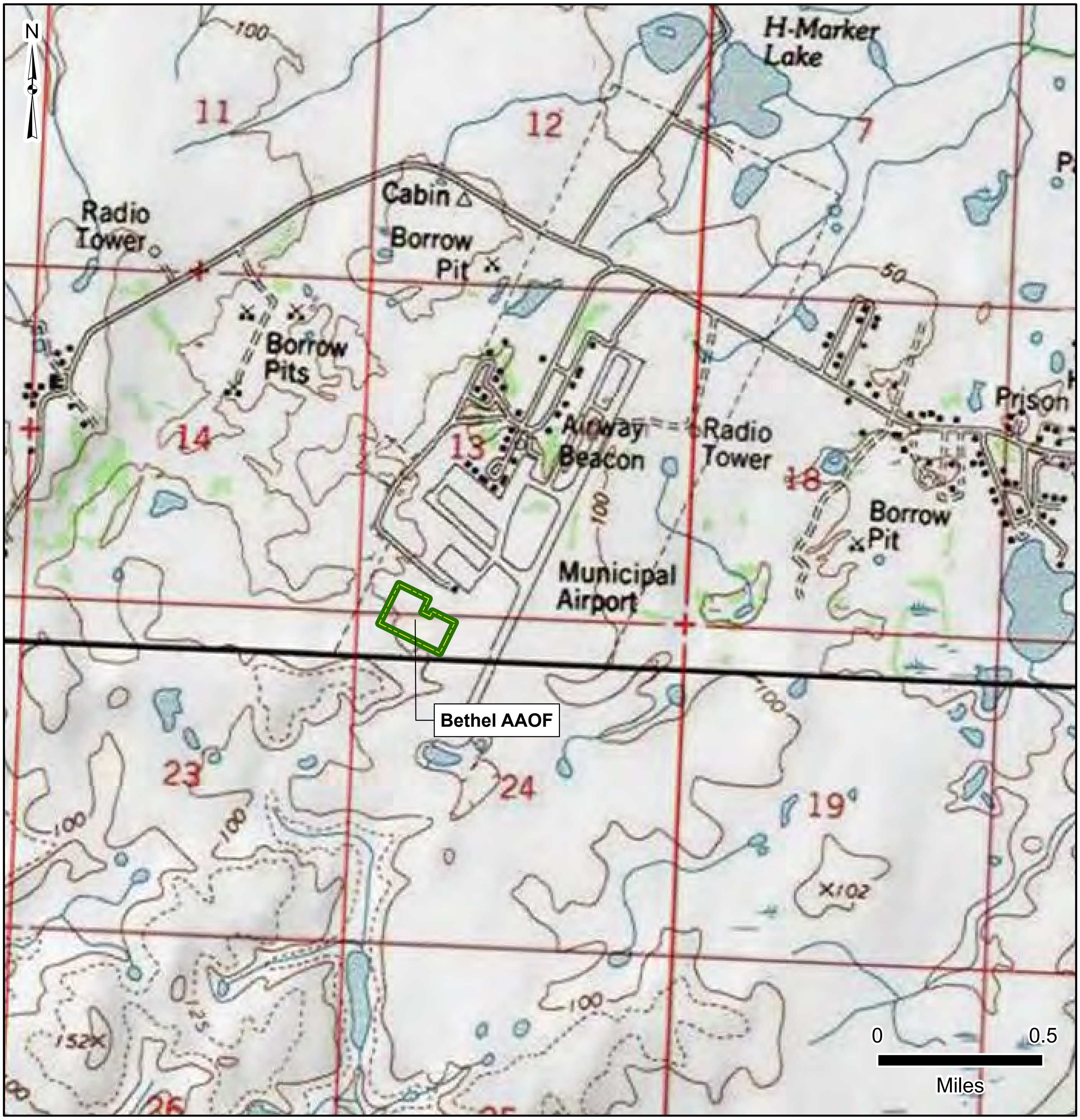
Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 2-2
Facility Topography



Facility Data

Facility Boundary

Data Sources:
ESRI 2020
AECOM 2020

Date:..........................August 2022
Prepared By:.............................EA
Prepared For:....................USACE
Projection:........WGS 84 UTM 4N

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Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 2-3
Groundwater Features

Facility Data

Facility Boundary

Hydrogeology/Hydrology

Unknown Well
Inferred Groundwater Flow Direction
River/Stream
Waterbody

Data Sources:
ESRI 2020
AECOM 2020

Date:..........................August 2022
Prepared By:.............................EA
Prepared For:...................USACE
Projection:........WGS 84 UTM 4N

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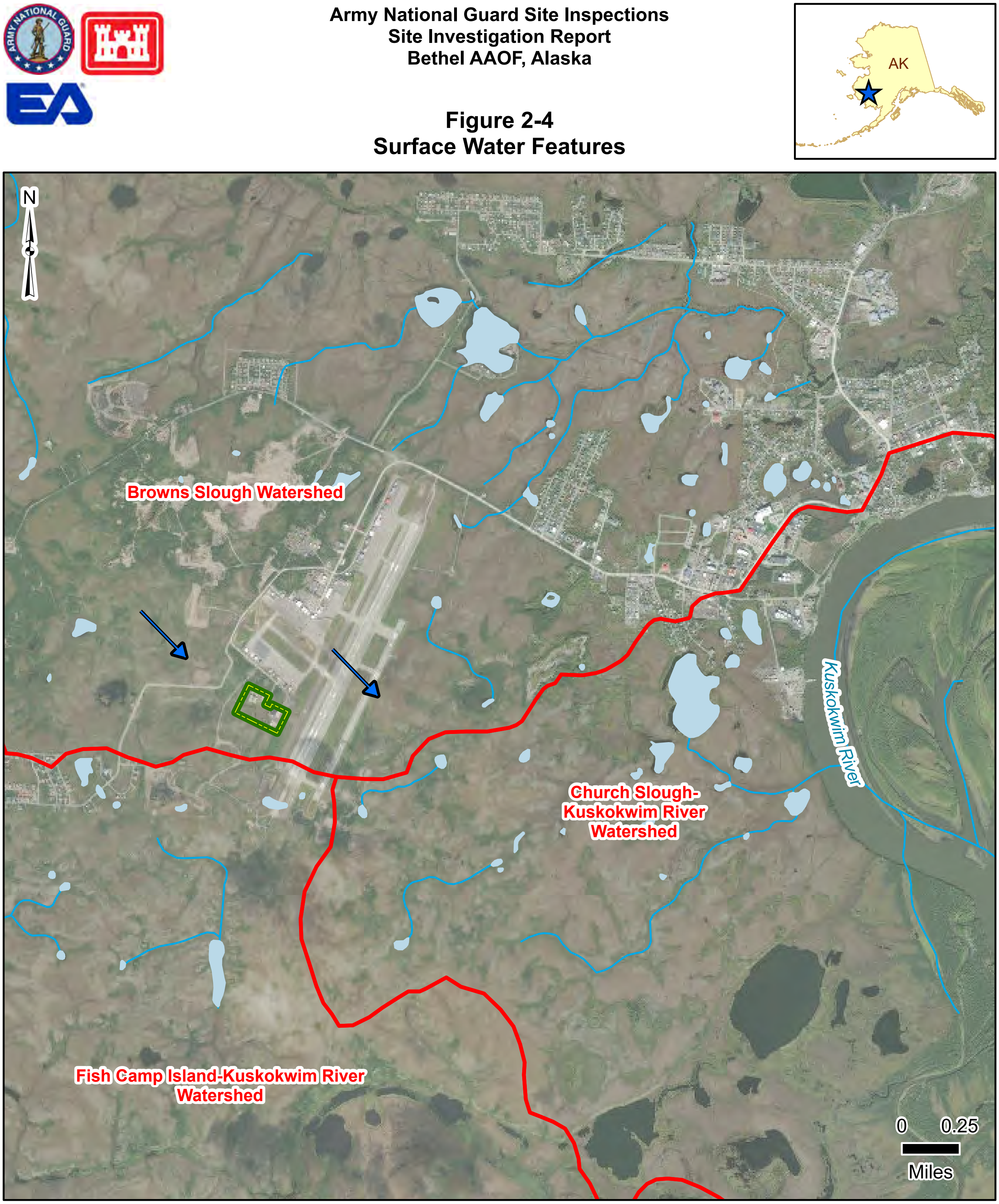
Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 2-4
Surface Water Features



Facility Data

Facility Boundary

Hydrology

Surface Water Flow Direction

River/Stream

Waterbody

Watershed Boundary

Data Sources:
ESRI 2020
AECOM 2020
USGS NHD 2021

Date:..........................August 2022
Prepared By:.............................EA
Prepared For:....................USACE
Projection:........WGS 84 UTM 4N

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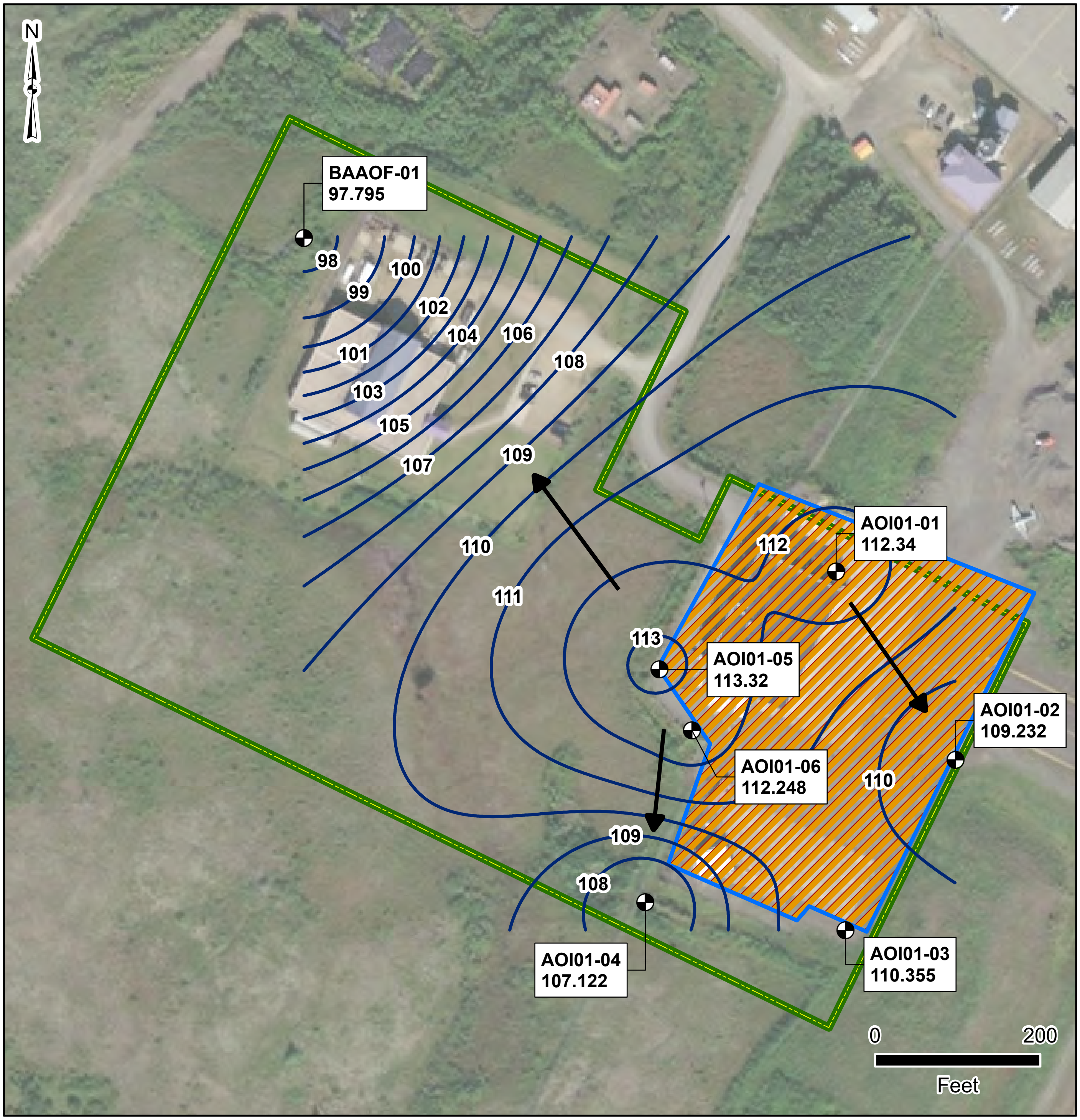
Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 2-5
Groundwater Elevations, September 2021



Facility Data

- Facility Boundary
- Area of Interest
- Potential PFAS Release

Hydrogeology

- Temporary Well Location
- Relative Groundwater Flow Direction
- Groundwater Elevation Contour (1 foot interval)
- Dashed where Inferred

Data Sources:
ESRI 2020
AECOM 2020
USGS NHD 2021

Date:..........................August 2022
Prepared By:............................EA
Prepared For:...................USACE
Projection:........WGS 84 UTM 4N

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3. SUMMARY OF AREAS OF INTEREST

The PA evaluated areas where PFAS-containing materials may have been used, stored, disposed, or released historically. Based on the PA findings, one potential release area was identified at the Bethel AAOF identified as: AOI 1 Bethel AAOF Hangar. The potential AOI and adjacent potential sources are shown on **Figure 3-1**.

3.1 AOI 1 – BETHEL AAOF HANGAR

The Bethel AAOF Hangar (60°46'31.44"N, 161°50'45.91"W) has been continuously occupied by the AKARNG since 1995, a few years after its construction, and is equipped with an FSS supplied with AFFF by two 800-gal tanks. The FSS has had no reported releases; however, the AFFF tank has a leaky sight gauge. The gauge only leaks when checked, and less than 1 quart of AFFF foam is discharged each time the tank is serviced. Servicing is performed by a third-party company, Frontier Fire. According to interviews with maintenance personnel, the system has been serviced twice in the past 10 years. Each release is wet mopped immediately and disposed of through the Facility’s drainage system. The Facility drainage system is connected to an RGF Environmental sediment/hydrocarbon filter, which does not filter for PFAS, and wastewater is not chemically tested before or after being filtered. A holding tank contains the wastewater until it is pumped out by a Bethel municipal service.

Documentation was not available on testing of the FSS after installation or any subsequent testing; therefore, Bethel AAOF is considered a potential PFAS release area. Additionally, Tri-Max™ fire extinguishers have been stored at the Facility. Based on interviews, AKARNG did not train with the Tri-Max™ extinguishers. The contents of the Tri-Max™ units, exact location of their historical storage, and the maintenance schedule are unknown.

3.2 ADJACENT SOURCES

Three potential off-facility sources of PFAS are adjacent to the Facility and are not under the control of the AKARNG. A description of each off-facility source is presented below and shown on **Figure 3-1**.

3.2.1 Bethel Airport Fire Department

The Bethel Airport Fire Department is maintained by the Alaska Department of Transportation and is required by the Federal Aviation Administration to perform a yearly hydrostatic testing of their equipment; annually since approximately 2012, a single short blast of AFFF is released from the firetruck onto the Fire Department’s front ramp. The Bethel Airport Fire Department is hydrologically downgradient from the AAOF and Armory. The type, amount, and concentration of AFFF used during annual nozzle testing are unknown (AECOM 2020).

3.2.2 Skyvan Crash

In 1992, a Skyvan crashed approximately 800 ft southeast of the former Bethel AAOF in a patch of grass between two taxiways (60°46'52.18"N, 161°50'19.50"W). The crash was responded to by the Bethel Municipal Fire Department with 500 gal each of AFFF and water. According to personnel interviews, the fire was extinguished in less than 8 minutes. The Skyvan crash area is hydrologically downgradient from the AAOF and Armory. The type and concentration of AFFF used during the emergency response is unknown (AECOM 2020).

3.2.3 Grant Aviation Crash

On 8 July 2019, a Grant Aviation aircraft crash-landed in the grassy drainage ditch between Bethel Airport's two main runways. The crash was responded to by the Bethel Airport Fire Department and the Bethel Municipal Fire Department. According to the Spill Incident Report, approximately 80 gal of 3% AFFF was applied to the aircraft fire at the incident site. The Grant Aviation crash area is hydrologically downgradient from the AAOF and Armory.

Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 3-1
Areas of Interest

Facility Data

- Facility Boundary
- Area of Interest
- Potential PFAS Release
- Active Contaminated Site

Known or Suspected AFFF Release Location

Hydrology/Hydrogeology

- Unknown Well
- Surface Water Flow Direction
- Groundwater Flow Direction

River/Stream
Waterbody

Data Sources:
ESRI 2020
AECOM 2020
ADEC

Date:..............................July 2023
Prepared By:...........................EA
Prepared For:...................USACE
Projection:........WGS 84 UTM 4N

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4. PROJECT DATA QUALITY OBJECTIVES

As identified during the data quality objective (DQO) process and outlined in the SI Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) Addendum (EA Engineering, Science, and Technology, Inc., PBC [EA] 2021a), the objective of the SI is to identify whether there has been a release to the environment at the AOI identified in the PA. For the AOI, ARNG determines if further investigation is warranted, a removal action is required to address immediate threats, or whether no further action is warranted. This SI evaluated groundwater and soil for presence or absence of the relevant compounds at the AOI.

4.1 PROBLEM STATEMENT

ARNG will recommend the AOI for remedial investigation (RI) if site-related soil and groundwater samples have concentrations of the relevant compounds above the OSD risk-based screening levels. The SLs are presented in **Section 6.1** of this report.

4.2 INFORMATION INPUTS

Primary information inputs for the SI include the following:

- The PA Report for Bethel AAOF, Alaska (AECOM 2020)
- Analytical data from groundwater and soil samples collected as part of this SI in accordance with the site-specific UFP-QAPP Addendum (EA 2021a)
- Field data collected during the SI, including groundwater elevation and water quality parameters measured at the time of sampling.

4.3 STUDY BOUNDARIES

The scope of the SI was bounded horizontally by the property limits of the Facility (**Figure 2-2**). Off-Facility sampling was not included in the scope of this SI. If future off-Facility sampling is required, the proper stakeholders will be notified, and necessary rights of entry will be obtained by ARNG with property owner(s). Temporal boundaries were limited to available field resources availability and the period of maximum thaw in the region.

4.4 ANALYTICAL APPROACH

Samples were analyzed by Eurofins Lancaster Laboratories Environmental, LLC (ELLE), accredited under the DoD Environmental Laboratory Accreditation Program (ELAP); (Accreditation No. 1.01). PFAS data underwent 100 percent (%) Stage 2B validation in accordance with the DoD General Data Validation Guidelines (2019a) and DoD Data Validation Guidelines Module 3: Data Validation Procedure of Per- and Polyfluoroalkyl Substances Analysis by Quality Systems Manual (QSM) Table B-15 (2020). PFAS data were compared to applicable SLs and decision rules as defined in the UFP-QAPP Addendum (EA 2021a).

4.5 DATA USABILITY ASSESSMENT

The Data Usability Assessment (DUA), which is provided in **Appendix A**, 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 determines whether project execution and the resulting data have met installation-specific DQOs. Both sampling and analytical activities are considered to assess whether the collected data are of the right type, quality, and quantity to support the decision-making (DoD 2019b, 2019a; USEPA 2006).

Based on the DUA, the environmental data collected during the SI were found to be acceptable and usable for this SI evaluation with the qualifications documented in the DUA and its associated data validation reports. These data are of sufficient quality to meet the objectives and requirements of the UFP-QAPP Addendum (EA 2021a).

5. SITE INSPECTION ACTIVITIES

This section describes the environmental investigation and sampling activities that occurred as part of the SI. The SI sampling approach was based on the findings of the PA and was implemented in accordance with the following approved documents:

- *Final Preliminary Assessment Report, Bethel Army Aviation Operating Facility and Armory, Alaska*, dated August 2020 (AECOM 2020)
- *Final Programmatic Uniform Federal Policy-Quality Assurance Project Plan, Site Inspections for Per- and Polyfluoroalkyl Substances Impacted Sites, ARNG Installations Nationwide*, dated December 2020 (EA 2020a)
- *Final Site Inspection Uniform Federal Policy-Quality Assurance Project Plan Addendum, Bethel Army Aviation Operating Facility and Armory, Alaska*, dated September 2021 (EA 2021a)
- *Final Programmatic Accident Prevention Plan, Revision 1*, dated November 2020 (EA 2020b)
- *Accident Prevention Plan/Site Safety and Health Plan Addendum, Site Inspections for Per- and Polyfluoroalkyl Substances Impacted Sites ARNG Installations, Nationwide, Bethel Army Aviation Operating Facility and Armory, Alaska, Revision 2*, dated September 2021 (EA 2021b).

The SI field activities were conducted from 26 to 30 September 2021 and consisted of hand auger coring, direct-push technology (DPT) drilling, boring advancement, surface and subsurface soil sample collection, temporary monitoring well installation, grab groundwater sample collection, surveying, and site restoration activities. Sampling in late September, during the projected maximum thaw, allowed the collection of water and soil samples at the maximum depths that would be thawed during the year. Sampling efforts at other times of the year would likely encounter frozen soils nearer to the surface and may not adequately characterize potential PFAS impacts in groundwater. Field activities were conducted in accordance with the UFP-QAPP Addendum (EA 2021a), except as noted in **Section 5.8**.

The following samples were collected during the SI and analyzed for a subset of 24 PFAS via liquid chromatography/tandem mass spectrometry (LC/MS/MS) compliant with QSM Version 5.3 Table B-15 to fulfill the project DQOs:

- Twenty one (21) soil samples from seven soil boring locations
- Seven (7) grab groundwater samples from seven temporary well locations.
- Eight (8) quality assurance/quality control samples.

Figure 5-1 provides the sample locations for all media across the Facility. **Table 5-1** presents the list of samples collected for each medium. Field documentation is provided in **Appendix B**. A log of Daily Notice of Field Activity was completed throughout the SI field activities, which is provided in **Appendix B1**. The field logbook is also provided in **Appendix B1**. Field sampling forms are provided in **Appendix B2**. Survey information is provided in **Appendix B3.** A field change request form is provided in **Appendix B4**. Additionally, a photographic log of field activities is provided in **Appendix C**.

5.1 PRE-INVESTIGATION ACTIVITIES

In preparation for the SI field activities, project team members participated in Technical Project Planning (TPP) meetings and performed utility clearance. Details of these activities are presented below.

5.1.1 Technical Project Planning

The U.S. Army Corps of Engineers (USACE) TPP Process, Engineer Manual (EM) 200-1-2 (Department of the Army 2016) defines four phases to project planning: (1) defining the project phase; (2) determining data needs; (3) developing data collection strategies; and (4) finalizing the data collection plan. The process encourages stakeholder involvement in the SI, beginning with defining overall project objectives, including DQOs, and formulating a sampling approach to address the AOIs identified in the PA.

A combined TPP Meeting 1 and 2 was held on 3 August 2021, prior to SI field activities with stakeholders. The combined TPP Meeting 1 and 2 was conducted in general accordance with EM 200-1-2. The stakeholders for this SI include ARNG, AKARNG, USACE, and the Alaska Department of Environmental Conservation (ADEC) representatives familiar with the Facility, the regulations, and the community. Stakeholders were provided the opportunity to make comments on the technical sampling approach and methods at the combined TPP Meeting 1 and 2. The outcome of the combined TPP Meeting 1 and 2 was memorialized in the UFP-QAPP Addendum (EA 2022).

A TPP Meeting 3 was held on 19 May 2023 to discuss the results of the SI. Meeting minutes for TPP 3 are included in **Appendix D** of this report. Future TPP meetings will provide an opportunity to discuss the results and findings, and future actions, where warranted.

5.1.2 Utility Clearance

EA contacted the local utilities to notify them of intrusive work at the Facility. Upon arrival at the Facility prior to conducting SI activities, the EA field team consulted with and received verbal confirmation from the City of Bethel Public Works Director and with the Bethel Native Alaskan Electrical Cooperative that no public utilities or any underground utilities are located in the vicinity of the Bethel AAOF and Armory. An unofficial visual utility clearance was performed with airport personnel at each of the proposed boring locations on 28 September 2021 by the EA field team.

Additionally, the top 0–2 ft of each boring was pre-cleared by EA's drilling subcontractor, GeoTek Alaska, and EA field team using a hand auger to verify utility clearance in shallow subsurface soil where utilities would typically be encountered. Hand augering was not conducted to a depth of 5 ft as outlined in the UFP-QAPP because rocky gravel at several locations made hand augering extremely difficult. This is addressed as a deviation from the Work Plan (EA 2021a) in **Section 5.8.**

5.1.3 Source Water and PFAS Sampling Equipment Acceptability

Laboratory-provided PFAS-free water was used for decontamination of drilling equipment.

Materials that were used within the sampling zone were confirmed as acceptable for use in the PFAS sampling environment. The checklist of acceptable materials for use in the PFAS sampling environment was provided in the Standard Operating Procedures (Appendix A) to the Programmatic UFP-QAPP (EA 2020a).

5.2 SOIL BORINGS AND SOIL SAMPLING

Soil samples were collected via DPT drilling methods in accordance with Standard Operating Procedure 047 *Direct-Push Technology Sampling* (EA 2020a). A Geoprobe® 6620DT drill rig and MacroCore® sampling system was used to collect continuous soil cores to the target depth. A hand auger was used to collect soil from the top approximately 2 ft of the boring. Hand augering was not conducted to a depth of 5 ft for utility clearance as outlined in the UFP-QAPP because rocky gravel at several locations made hand augering extremely difficult. This is addressed as a deviation from the Work Plan (EA 2021a) in **Section 5.8**.

Three discrete soil samples were collected for chemical analysis from each soil boring: one sample at the surface (0 to 2 ft bgs) and two subsurface soil samples. One subsurface soil sample was collected approximately 1 ft above the groundwater table, and one subsurface soil sample was collected at the mid-point between the surface and the groundwater table (not to exceed 15 ft bgs). Groundwater was encountered at depths ranging from approximately 10 to 17 ft bgs during drilling. Total boring completion depths, to accommodate temporary well installation, ranged from 14.08 to 22.35 ft bgs. During SI drilling activities, permafrost was encountered in boring AOI01-01 at approximately 17 ft bgs and in boring BAAOF-01 at approximately 22 to 25 ft bgs. Frozen soils were not encountered in any of the other borings but may exist at deeper depths.

Soil sample locations are shown on **Figure 5-1**, and boring sample depths are provided in **Table 5-1**. The soil boring locations were selected based on the AOI information provided in the PA (AECOM 2020) and as agreed upon by stakeholders during the TPP and review of the UFP-QAPP Addendum (EA 2021a).

During the drilling, the soil cores were continuously logged for lithological descriptions by a field geologist using the Unified Soil Classification System. A photoionization detector (PID) was used to screen the breathing zone during boring activities as a part of personal safety requirements. Observations and measurements were recorded on sampling forms (**Appendix B2**) and in a non-treated/non-Rite-in-the-Rain® field logbook. Depth interval, recovery thickness, PID readings, moisture, relative density, Munsell color, and Unified Soil Classification System texture were recorded. The boring logs are provided in **Appendix E**.

Each sample was collected into a laboratory-supplied PFAS-free high-density polyethylene (HDPE) bottle and labeled using a PFAS-free marker or pen. Samples were packaged on PFAS-free gel ice and transported via Federal Express (FedEx) under standard chain-of-custody procedures to the laboratory and analyzed for PFAS (LC/MS/MS compliant with QSM Version 5.3 Table B-15), total organic carbon (TOC) (USEPA Method 9060A) and pH (USEPA Method 9045D) in accordance with the UFP-QAPP Addendum (EA 2021a).

Field duplicate (FD) samples were collected at a rate of 10% and analyzed for the same parameters as the accompanying samples. Matrix spike (MS)/matrix spike duplicate (MSDs) were collected at a rate of 5% and analyzed for the same parameters as the accompanying samples. In instances when non-dedicated sampling equipment was used, such as a hand auger for the shallow soil samples, one equipment blank (EB) was collected per day and analyzed for the same parameters as the soil samples. A temperature blank was placed in each cooler to ensure that samples were preserved at or below 6°C during shipment.

DPT borings were converted to temporary wells, which were subsequently abandoned after sampling and surveying in accordance with the UFP-QAPP Addendum (EA 2021a). After removal of the casings, boreholes were abandoned using soil cuttings and bentonite chips. Borings were installed in grassy or gravelly areas to avoid disturbing concrete or asphalt surfaces.

5.3 TEMPORARY WELL INSTALLATION AND GROUNDWATER GRAB SAMPLING

Seven temporary wells were installed using a GeoProbe® 6620DT drill rig. Once each borehole was advanced to the desired depth, a temporary well was constructed of either a 5- or 10-ft section of 1-in. Schedule 40 polyvinyl chloride (PVC) screen and sufficient casing to reach the ground surface. New PVC pipe and screen were used at each location to avoid cross-contamination between locations. The screen intervals for the temporary wells are provided in **Table 5-2**.

Groundwater samples were collected, after a period of time following well installation (generally a couple hours between installation and sampling, although some periods were longer) to allow groundwater to infiltrate and recharge the temporary well intervals, using a peristaltic pump with PFAS-free HDPE tubing. Each sample was collected in laboratory-supplied PFAS-free HDPE bottles and labeled using a PFAS-free marker or pen. The temporary wells were purged at a rate determined in the field to reduce turbidity and draw down prior to sampling. Water quality parameters (e.g., temperature, specific conductance, pH, dissolved oxygen, and oxidation-reduction potential) were measured using a water quality meter and recorded on the field sampling form (**Appendix B2**) before each grab sample was collected in a separate container. In addition to groundwater samples, a subsample of each groundwater sample was collected, and shaker test was performed to identify whether any foaming was present. No shaker tests produced foam. Samples were packaged on PFAS-free gel ice and transported via FedEx under standard chain-of-custody procedures to the laboratory and analyzed for PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15 in accordance with the UFP-QAPP Addendum (EA 2021a).

FD samples were collected at a rate of 10% or one per day and analyzed for the same parameters as the accompanying samples. MS/MSDs were collected at a rate of 5% and analyzed for the same parameters as the accompanying samples. Two field blanks (FBs) were collected in accordance with the UFP-QAPP Addendum (EA 2021a). A temperature blank was placed in each cooler to ensure that samples were preserved at or below 6°C during shipment.

5.4 SYNOPTIC WATER LEVEL MEASUREMENTS

Groundwater levels were used to monitor Facility-wide groundwater elevations and assess groundwater flow. Synoptic water level elevation measurements were collected from the newly installed temporary monitoring wells, taken from the survey mark on the northern side of the well casing. Groundwater elevation data is provided in **Table 5-3**.

5.5 SURVEYING

Each new temporary well's vertical location was calculated using level loop survey techniques and post processing. Lines 1, 2, and 3 were run using level loop survey techniques to encompass the seven temporary wells that were installed during SI activities. Temporary well casings were left in ground until vertical survey activities were complete. The survey logbook and data table are provided in **Appendix B3** for further detail.

Horizontal locations, using the northern side of each new temporary well casing as a reference point, were surveyed and recorded using a Trimble® Geo7x handheld global positioning system. Positions were collected in the applicable Universal Transverse Mercator zone projection with World Geodetic System 1984 datum (horizontal). Surveying data were collected on 27 and 30 September 2021 and are provided in **Appendix B3**.

Note that the vertical accuracy requirement was not met for some wells due to extreme weather conditions. More information on survey accuracy can be found in **Section 5.8**.

5.6 INVESTIGATION-DERIVED WASTE

As of the date of this report, the disposal of PFAS investigation-derived waste (IDW) is not regulated federally. IDW generated during the SI is considered non-hazardous waste and was managed in accordance with the UFP-QAPP Addendum (EA 2021a).

Soil IDW (i.e., soil cuttings) generated during the SI activities were incorporated as backfill in each boring during site restoration, and liquid IDW (i.e., purge water and decontamination fluids) generated during the SI activities was run through the granular activated carbon (GAC) filter and discharged to the ground at a designated location at the Facility in accordance with the UFP-QAPP (EA 2021). The location of liquid IDW application/GAC filtration to ground surface is shown on **Figure 5-1**. The Carbon GAC filter unit was removed from the Facility and it is awaiting disposition in a subtitle C landfill.

Other solids such as spent personal protective equipment, plastic sheeting, tubing, rope, unused monitoring well construction materials, and other environmental media generated during the field activities were disposed of at a licensed solid waste landfill.

5.7 LABORATORY ANALYTICAL METHODS

Samples were analyzed for PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15 at ELLE, in Lancaster, Pennsylvania, a DoD ELAP- and National Environmental Laboratory Accreditation Program-certified laboratory.

Soil samples were also analyzed for TOC using USEPA Method 9060A and pH by USEPA Method 9045D.

5.8 DEVIATIONS FROM SITE INSPECTION UFP-QAPP ADDENDUM

Deviations from the UFP-QAPP Addendum occurred based on conditions encountered during the field investigation activities. These deviations were discussed between EA, ARNG, USACE, and the Alaska Department of Environmental Conservation. Deviations from the UFP-QAPP Addendum are noted below:

- Due to subsurface lithology and semi-frozen coarse gravels and soils, hand auger drilling methods were utilized from 0 to 2 ft bgs in each boring, instead of 0 to 5 ft bgs as proposed in the UFP-QAPP Addendum (EA 2021a).

- Vertical elevation survey accuracies for level loop surveys ‘Line 1’ and ‘Line 2’ were outside of the 0.01 ft requirement as proposed in the UFP-QAPP Addendum (EA 2021a) and exceeded program accuracy requirements. The EA field team consulted with the EA Alaska Task Manager regarding this deviation in the field. The total height differences for Lines 1 and 2 were 0.10 ft and 0.07 ft, respectively, whereas the total height difference for Line 3 was 0.001 ft, which met the ARNG vertical accuracy requirement defined in the UFP-QAPP Addendum (EA 2021a) of 0.01 ft. Sustained winds up to 28 to 30 miles per hour blowing north to south, and snowy conditions were present all day on 30 September 2021 during level loop vertical survey activities. Since Lines 1 and 2 ran approximately north-south, these lines were more affected by the wind than Line 3, which ran more approximately east-west. Because wind speeds maintained and grew over the course of the day, and the EA field team’s demobilization from Bethel was planned for that evening, Lines 1 and 2 were not repeated to attempt higher accuracy closures.

- The GAC filter was used during sampling to filter liquid IDW before the treated water was disposed to the ground surface. At the completion of the field work, the intention was to retain the GAC filter for use in future investigations at the Facility. The GAC filter was then transported to Anchorage for storage. However, USACE later decided that the GAC filter was not needed and should be disposed of. The GAC filter was then sampled, and a “Contaminated Media Transport and Treatment or Disposal Approval Form” was prepared. The form was approved by ADEC and the GAC filter will be disposed of in a Subtitle C landfill.

Table 5-1. Samples by Medium
Bethel Army Aviation Operating Facility, Bethel, Alaska
Site Inspection Report

Sample Identification	Sample Collection Date	Sample Depth (ft bgs)	PFAS (USEPA Method 537 Modified)	TOC (USEPA Method 9060A)	pH (USEPA Method 9045D)	Comments
Soil Samples						
AOI01-01-SB-00-02	9/28/2021	0-2	X	X	X	
AOI01-01-SB-08-10	9/28/2021	8-10	X	X	X	
AOI01-01-SB-14-16	9/28/2021	14-16	X	X	X	
AOI01-02-SB-00-02	9/28/2021	0-2	X	X	X	
AOI01-02-SB-05-08	9/28/2021	5-8	X	X	X	
BAAOF-SB99-0928	9/28/2021	5-8	X	X	X	FD
AOI01-02-SB-13.5-14.5	9/28/2021	13.5-14.5	X	X	X	
AOI01-03-SB-00-02	9/28/2021	0-2	X	X	X	
AOI01-03-SB-09-10	9/28/2021	9-10	X	X	X	
AOI01-03-SB-14-15	9/28/2021	14-15	X	X	X	
AOI01-04-SB-00-02	9/28/2021	0-2	X	X	X	
AOI01-04-SB-04-05	9/28/2021	4-5	X	X	X	
AOI01-04-SB-09-10	9/28/2021	9-10	X	X	X	
AOI01-05-SB-00-02	9/29/2021	0-2	X	X	X	
AOI01-05-SB-09-10	9/29/2021	9-10	X	X	X	
AOI01-05-SB-12-14	9/29/2021	12-14	X	X	X	
AOI01-06-SB-00-02	9/29/2021	0-2	X	X	X	
BAAOF-SB99-0929	9/29/2021	0-2	X	X	X	FD
AOI01-06-SB-07-08	9/29/2021	7-8	X	X	X	
AOI01-06-SB-14-15	9/29/2021	14-15	X	X	X	
BAAOF-01-SB-00-02	9/29/2021	0-2	X	X	X	
BAAOF-01-SB-09-11	9/29/2021	9-11	X	X	X	
BAAOF-01-SB-15-17	9/29/2021	15-17	X	X	X	
Groundwater Samples						
AOI01-01-GW	9/28/2021	-	X	-	-	
AOI01-02-GW	9/29/2021	-	X	-	-	
AOI01-03-GW	9/28/2021	-	X	-	-	
BAAOF-GW99-0928	9/28/2021	-	X	-	-	FD
AOI01-04-GW	9/29/2021	-	X	-	-	
AOI01-05-GW	9/29/2021	-	X	-	-	
AOI01-06-GW	9/29/2021	-	X	-	-	
BAAOF-GW99-0929	9/29/2021	-	X	-	-	FD
BAAOF-01-GW	9/29/2021	-	X	-	-	
Blank Samples						
BAAOF-EB-01	9/28/2021	-	X	-	-	EB
BAAOF-EB-02	9/29/2021	-	X	-	-	EB
BAAOF-FB-01	9/28/2021	-	X	-	-	FB
BAAOF-FB-02	9/29/2021	-	X	-	-	FB

Notes:
AOI = area of interest
BAAOF = Bethel Army Aviation Operating Facility
ft bgs = feet below ground surface

EB = equipment blank
FB = field blank
FD = field duplicate
GW = groundwater
PFAS = per- and polyfluoroalkyl substances
pH = potential hydrogen
SB = soil boring
TOC = total organic carbon
USEPA = United States Environmental Protection Agency
X = sample collected for analysis

Table 5-2. Soil Boring Depths and Temporary Well Screen Intervals
Bethel Army Aviation Operating Facility, Bethel, Alaska
Site Inspection Report

Area of Interest	Boring ID	Soil Boring Depth (ft bgs)	Temporary Well Screen Interval (ft bgs)
1	AOI01-01	21.50	11-21
	AOI01-02	20.00	14-19
	AOI01-03	20.00	14-19
	AOI01-04	14.08	9-14
	AOI01-05	20.00	14-19
	AOI01-06	18.87	13.8-18.8
	BAAOF-01	22.35	12-22

Notes:
AOI = area of interest
BAAOF = Bethel Army Aviation Operating Facility
ft bgs = feet below ground surface
ID = identification

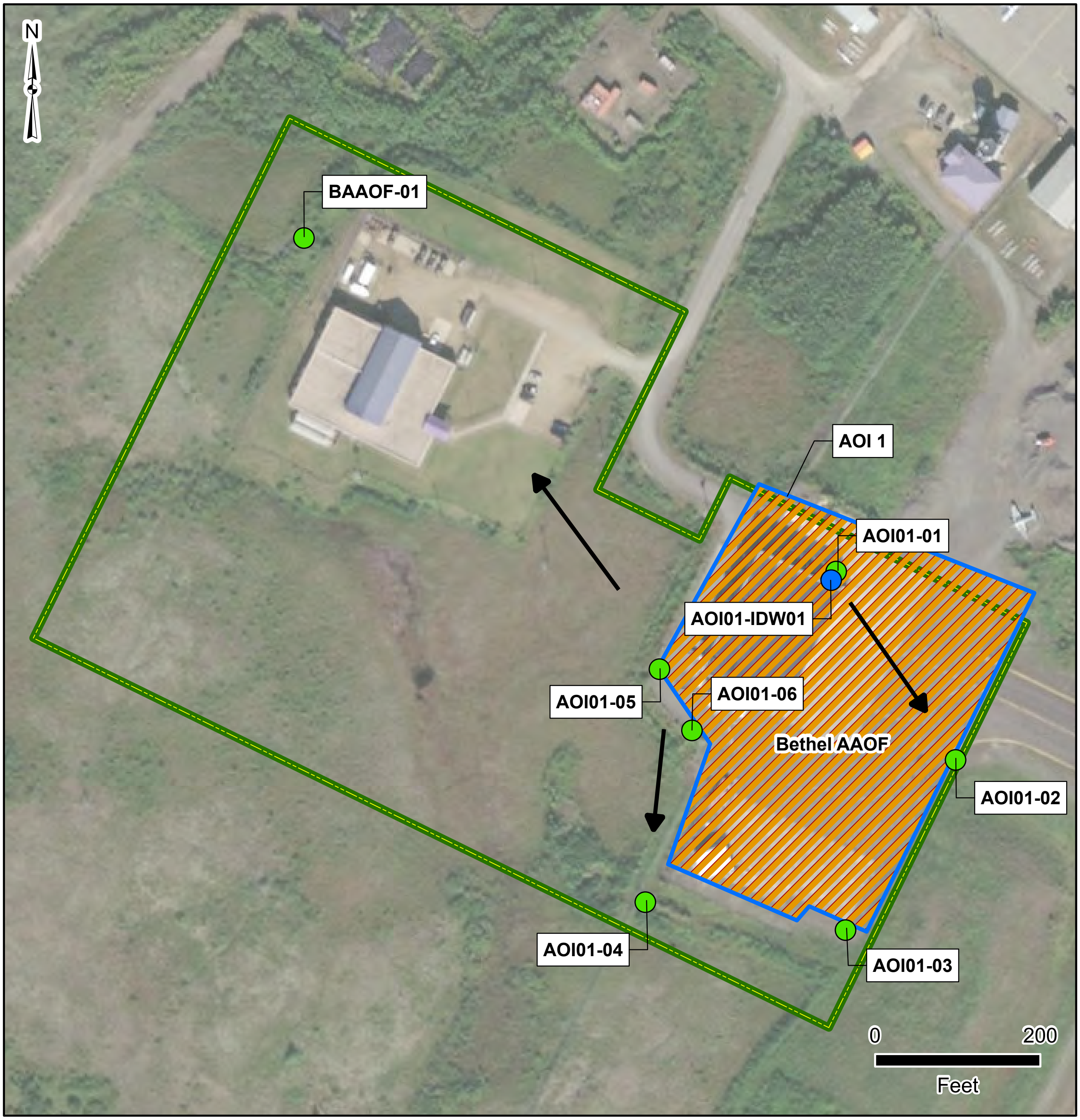
Table 5-3. Groundwater Elevation
Bethel Army Aviation Operating Facility, Bethel, Alaska
Site Inspection Report

Monitoring Well ID	Top of Casing Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)[1]
AOI01-01	131.773	19.43	112.34
AOI01-02	127.042	17.81	109.232
AOI01-03	127.225	16.87	110.355
AOI01-04	118.402	11.28	107.122
AOI01-05	127.12	13.8	113.32
AOI01-06	127.348	15.1	112.248
BAAOF-01	117.095	19.3	97.795

Notes:
1. Elevation is relative based on the use of global positioning system survey methods.
ft amsl = feet above mean sea level
AOI = area of interest
BAAOF = Bethel Army Aviation Operating Facility
btoc = below top of casing
ID = Identification

Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 5-1
Site Inspection Sample Locations



Facility Data
- Facility Boundary
- Area of Interest
- Potential PFAS Release

Sample Locations
- Soil boring/Temporary Well Location
- IDW

Hydrogeology
- Groundwater Flow Direction

Data Sources:
ESRI 2020
AECOM 2020

Date:..........................August 2022
Prepared By:.............................EA
Prepared For:....................USACE
Projection:........WGS 84 UTM 4N

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6. SITE INSPECTION RESULTS

This section presents the analytical results of the SI. The SLs used in this evaluation are presented in **Section 6.1** and **Table 6-1**. A discussion of the results for the AOI is provided in **Section 6.3. Tables 6-2** through **6-5** present results for soil or groundwater for the relevant compounds. Tables that contain all results are provided in **Appendix F**, and the laboratory reports are provided in **Appendix G**.

6.1 SCREENING LEVELS

The SLs established in the OSD memorandum apply to the five compounds presented on **Table 6-1** below.

Table 6-1. Screening Levels (Soil and Groundwater)

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

Notes:
1. Assistant Secretary of Defense. July 2022. Risk-Based Screening Levels in Groundwater and Soil using USEPA's Regional Screening Level Calculator. Hazard Quotient=0.1. May 2022.
2. 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 this 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.

ft bgs = feet below ground surface
µg/kg = Microgram(s) per kilogram
ng/L = Nanogram(s) per liter

The data in the subsequent sections are compared against the SLs presented in **Table 6-1**. The SLs for groundwater are based on direct ingestion. The SLs for soil are based on incidental ingestion and are applied to the depth intervals reasonably anticipated to be encountered by the receptors identified at the Facility: the residential scenario is applied to surface soil results (0 to 2 ft bgs) and the industrial/commercial worker scenario is applied to shallow subsurface soil results (2 to 15 ft bgs). The industrial/commercial worker scenario was applied to shallow subsurface soil samples collected from mid-point at the soil borings (18-22 ft bgs) in the AOI, providing a conservative assessment of that potential exposure route for the industrial/commercial workers. The SLs are not applied to deep subsurface soil results (greater than 15 ft bgs) because 15 ft was the anticipated limit of construction activities.

6.2 SOIL PHYSICOCHEMICAL ANALYSES

To provide basic soil parameter information, soil samples were analyzed for TOC and pH, which are important for evaluating transport through the soil medium. **Appendix F** contains the results of the TOC and pH sampling.

The data collected in this investigation will be used in subsequent investigations, where appropriate, to assess fate and transport of PFAS contaminants. According to the Interstate Technology Regulatory Council (ITRC), several important PFAS partitioning mechanisms include hydrophobic and lipophobic effects, electrostatic interactions, and interfacial behaviors. At relevant environmental pH values, certain PFAS are present as organic anions; 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 2018).

Soil pH was measured as 7 in a sample collected from AOI 1. TOC was 0.98 milligrams per kilograms in a sample collected from AOI 1.

6.3 AOI 1

This section presents the analytical results for soil and groundwater in comparison to SLs for AOI 1, the Bethel AAOF Hangar. The detected compounds are summarized in **Tables 6-2** through **6-5**. Soil and groundwater results are presented on **Figure 6-1** through **Figure 6-7**.

6.3.1 AOI 1 – Soil Analytical Results

Tables 6-2 through **6-4** summarize the detected compounds in soil. **Figures 6-1** through **6-5** present the ranges of detections in soil. Soil was sampled in seven boring locations in AOI 1. Soil was sampled from three intervals at each location.

PFOA was detected in surface soil in two of the seven borings at concentrations ranging from 0.21 J µg/kg (AOI01-05) to 14 J µg/kg (AOI01-06), which are below the SL of 19 µg/kg. PFNA was detected in surface soil in two of the seven borings at concentrations ranging from 0.35 J µg/kg (AOI01-05) to 11 J µg/kg (AOI01-06), which are below the SL of 19 µg/kg. The highest PFOA and PFNA detections that occurred in the 0 to 2 ft bgs interval were within boring AOI01-06. PFOS, PFBS, and PFHxS were not detected in any surface soil samples.

PFOA was detected in shallow subsurface soil (2 to 15 ft bgs) in two of the seven borings (AOI01-05 and AOI01-06) at concentrations ranging from 0.55 J µg/kg (AOI01-05) to 2.6 J µg/kg (AOI01-06). These values are well below the SL of 250 µg/kg. The highest detection of PFOA that occurred in shallow subsurface soil was within boring AOI01-06 in the 7 to 8 ft bgs interval. PFNA was not detected in any shallow subsurface soil samples, except for AOI01-06 at a concentration of 0.61 J µg/kg, which is below the SL of 250 µg/kg. PFOS, PFBS, and PFHxS were not detected in any shallow subsurface soil samples.

6.3.2 AOI 1 – Groundwater Analytical Results

Figures 6-6 and 6-7 present the ranges of detections in groundwater. **Table 6-5** summarizes the groundwater results.

Groundwater samples were collected from seven temporary wells at AOI 1 during the SI. All five relevant compounds were detected in one or more of the seven temporary groundwater monitoring wells. PFOA was detected in two locations above the SL of 6 ng/L in temporary wells AOI01-05 and AOI01-06 at concentrations of 55 ng/L and 73 ng/L (77 ng/L in FD), respectively. PFOA was detected below the SL of 6 ng/L in temporary wells AOI01-01, AOI01-02, AOI01-03, AOI01-04, and BAAOF-01 at concentrations of 3.7 ng/L, 2.2 ng/L, 0.47 J ng/L (0.44 ng/L in FD), 1.9 ng/L, and 0.61 J ng/L, respectively. PFOS was detected below the SL of 4 ng/L in temporary wells AOI01-01, AOI01-02, AOI01-04, and AOI01-05 at concentrations of 2.6 ng/L, 1.3 J ng/L, 0.82 J ng/L, and 0.9 J ng/L, respectively. PFBS was detected below the SL of 601 ng/L in temporary wells AOI01-01, AOI01-05, and AOI01-06 at concentrations of 0.91 J ng/L, 2 ng/L, and 0.48 J ng/L, respectively. PFNA was detected below the SL of 6 ng/L in temporary wells AOI01-01, AOI01-02, AOI01-04, AOI01-05, and AOI01-06 at concentrations of 1.7 J ng/L, 0.78 J ng/L, 0.61 J ng/L, 2.7 ng/L, and 3.4 ng/L (4.5 ng/L in FD), respectively. PFHxS was detected below the screening level of 39 ng/L in temporary wells AOI01-01, AOI01-05, AOI01-06, and BAAOF-01 at concentrations of 0.72 J ng/L, 1.6 J ng/L, 1.8 ng/L (1.4 ng/L in FD), and 0.46 ng/L, respectively.

6.3.3 AOI 1 – Conclusions

Based on the results of the SI, PFOA and PFNA were detected in soil below their respective SLs. PFOA was detected in groundwater at concentrations above the SL. Based on the exceedances of the SL in groundwater, further evaluation at AOI 1 is warranted.

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Table 6-2. PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Surface Soil
Site Inspection Report, BAAOF

		Location ID	AOI01-01		AOI01-02		AOI01-03		AOI01-04		AOI01-05		AOI01-06		AOI01-06		BAAOF-01	
		Sample Name	AOI01-01-SB-00-02		AOI01-02-SB-00-02		AOI01-03-SB-00-02		AOI01-04-SB-00-02		AOI01-05-SB-00-02		AOI01-06-SB-00-02		BAAOF-SB99		BAAOF-01-SB-00-02	
		Parent Sample ID													AOI01-06-SB-00-02			
		Sample Date	9/28/2021		9/28/2021		9/28/2021		9/28/2021		9/29/2021		9/29/2021		9/29/2021		9/29/2021	
		Depth (ft bgs)	0-2		0-2		0-2		0-2		0-2		0-2		0-2		0-2	
Analyte	**Screening Level[1,2]**	**Unit**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15 (µg/kg)																		
Perfluorobutanesulfonic acid (PFBS)	1900	µg/kg	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
Perfluorohexanesulfonic acid (PFHxS)	130	µg/kg	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
Perfluorononanoic acid (PFNA)	19	µg/kg	ND	U	ND	U	ND	U	ND	U	0.35	J	11	J	10	J	ND	U
Perfluorooctanesulfonic acid (PFOS)	13	µg/kg	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
Perfluorooctanoic acid (PFOA)	19	µg/kg	ND	U	ND	U	ND	U	ND	U	0.21	J	14	J	4.2	J	ND	U

Notes:
J = Estimated concentration.
U = The analyte was not detected at a level greater than or equal to the adjusted Limit of Detection (LOD).
µg/kg = Microgram(s) per kilogram.
1. Assistant Secretary of Defense. July 2022. Risk-Based Screening Levels in Groundwater and Soil using EPA's Regional Screening Level Calculator. Hazard Quotient (HQ)=0.1. May 2022.
2. The Screening Levels for soil are based on a residential scenario for incidental ingestion of contaminated soil.
Values exceeding the Screening Level are shaded gray.
ft bgs = Feet below ground surface.
Qual = Qualifier.
ND = Analyte not detected above the LOD (LOD values are presented in Appendix F).

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Table 6-3. PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Shallow Subsurface Soil
Site Inspection Report, BAAOF

		Location ID	AOI01-01		AOI01-02		AOI01-02		AOI01-03		AOI01-04		AOI01-05		AOI01-06		BAAOF-01	
		Sample Name	AOI01-01-SB-08-10		AOI01-02-SB-05-08		BAAOF-SB99		AOI01-03-SB-09-10		AOI01-04-SB-04-05		AOI01-05-SB-09-10		AOI01-06-SB-07-08		BAAOF-01-SB-09-11	
		Parent Sample ID					AOI01-02-SB-05-08											
		Sample Date	9/28/2021		9/28/2021		9/28/2021		9/28/2021		9/28/2021		9/29/2021		9/29/2021		9/29/2021	
		Depth (ft bgs)	8-10		5-8		5-8		9-10		4-5		9-10		7-8		9-11	
Analyte	**Screening Level [1,2]**	**Unit**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15 (µg/kg)																		
Perfluorobutanesulfonic acid (PFBS)	25000	µg/kg	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
Perfluorohexanesulfonic acid (PFHxS)	1600	µg/kg	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
Perfluorononanoic acid (PFNA)	250	µg/kg	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	0.61	J	ND	U
Perfluorooctanesulfonic acid (PFOS)	160	µg/kg	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
Perfluorooctanoic acid (PFOA)	250	µg/kg	ND	U	ND	U	ND	U	ND	U	ND	U	0.55	J	2.6	J	ND	U

Notes:
J = Estimated concentration.
U = The analyte was not detected at a level greater than or equal to the adjusted Limit of Detection (LOD).
UJ = The analyte was not detected at a level greater than or equal to the adjusted Limit of Detection (LOD). Associated numerical value is approximate.
ug/kg = Microgram(s) per kilogram.
1. Assistant Secretary of Defense. July 2022. Risk-Based Screening Levels in Groundwater and Soil using EPA's Regional Screening Level Calculator. Hazard Quotient (HQ)=0.1. May 2022.
2. The Screening Levels for soil are based on incidental ingestion of soil in a industrial/commercial worker scenario.
Values exceeding the Screening Level are shaded gray.
ft bgs = Feet below ground surface.
Qual = Qualifier.
ND = Analyte not detected above the LOD (LOD values are presented in Appendix F).

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Table 6-4. PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Deep Subsurface Soil
Site Inspection Report, BAAOF

	Location ID	AOI01-01		AOI01-02		AOI01-03		AOI01-04		AOI01-05		AOI01-06		BAAOF-01	
	Sample Name	AOI01-01-SB-14-16		AOI01-02-SB-13.5-14.5		AOI01-03-SB-14-15		AOI01-04-SB-09-10		AOI01-05-SB-12-14		AOI01-06-SB-14-15		BAAOF-01-SB-15-17	
	Parent Sample ID														
	Sample Date	9/28/2021		9/28/2021		9/28/2021		9/28/2021		9/29/2021		9/29/2021		9/29/2021	
	Depth (ft bgs)	14-16		13.5-14.5		14-15		9-10		12-14		14-15		15-17	
Analyte	**Unit**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15 (µg/kg)															
Perfluorobutanesulfonic acid (PFBS)	µg/kg	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
Perfluorohexanesulfonic acid (PFHxS)	µg/kg	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
Perfluorononanoic acid (PFNA)	µg/kg	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
Perfluorooctanesulfonic acid (PFOS)	µg/kg	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
Perfluorooctanoic acid (PFOA)	µg/kg	ND	U	ND	U	ND	U	ND	U	0.43	J	0.25	J	ND	U

Notes.
J = Estimated concentration.
U = The analyte was not detected at a level greater than or equal to the adjusted Limit of Detection (LOD).
µg/kg = Microgram(s) per kilogram.
ft bgs = Feet below ground surface.
Qual = Qualifier.
ND = Analyte not detected above the LOD (LOD values are presented in Appendix F).

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Table 6-5. PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Groundwater
Site Inspection Report, BAAOF

		Location ID	AOI01-01		AOI01-02		AOI01-03		AOI01-03		AOI01-04		AOI01-05		AOI01-06		AOI01-06		BAAOF-01	
		Sample Name	AOI01-01-GW		AOI01-02-GW		AOI01-03-GW		BAAOF-GW99		AOI01-04-GW		AOI01-05-GW		AOI01-06-GW		BAAOF-GW99		BAAOF-01-GW	
		Parent Sample ID							AOI01-03-GW								AOI01-06-GW			
		Sample Date	9/28/2021		9/29/2021		9/28/2021		9/28/2021		9/29/2021		9/29/2021		9/29/2021		9/29/2021		9/29/2021	
Analyte	**Screening Level[1]**	**Unit**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15 (ng/L)																				
Perfluorobutanesulfonic acid (PFBS)	601	ng/L	0.91	J	ND	U	ND	U	ND	U	ND	U	2		0.48	J	ND	U	ND	U
Perfluorohexanesulfonic acid (PFHxS)	39	ng/L	0.72	J	ND	U	ND	U	ND	U	ND	U	1.6	J	1.8		1.4	J	0.46	J
Perfluorononanoic acid (PFNA)	6	ng/L	1.7	J	0.78	J	ND	U	ND	U	0.61	J	2.7		3.4		4.5		ND	U
Perfluorooctanesulfonic acid (PFOS)	4	ng/L	2.6		1.3	J	ND	U	ND	U	0.82	J	0.9	J	ND	U	ND	U	ND	U
Perfluorooctanoic acid (PFOA)	6	ng/L	3.7		2.2		0.47	J	0.44	J	1.9		55		73		77		0.61	J

Notes:
J = Estimated concentration.
U = The analyte was not detected at a level greater than or equal to the adjusted Limit of Detection (LOD).
ng/L = Nanogram(s) per liter.
1. Assistant Secretary of Defense. July 2022. Risk-Based Screening Levels in Groundwater and Soil using EPA's Regional Screening Level Calculator. Hazard Quotient (HQ)=0.1. May 2022.
Values exceeding the Screening Level are shaded gray.
ND = Analyte not detected above the LOD (LOD values are presented in Appendix F).
Qual = Qualifier.

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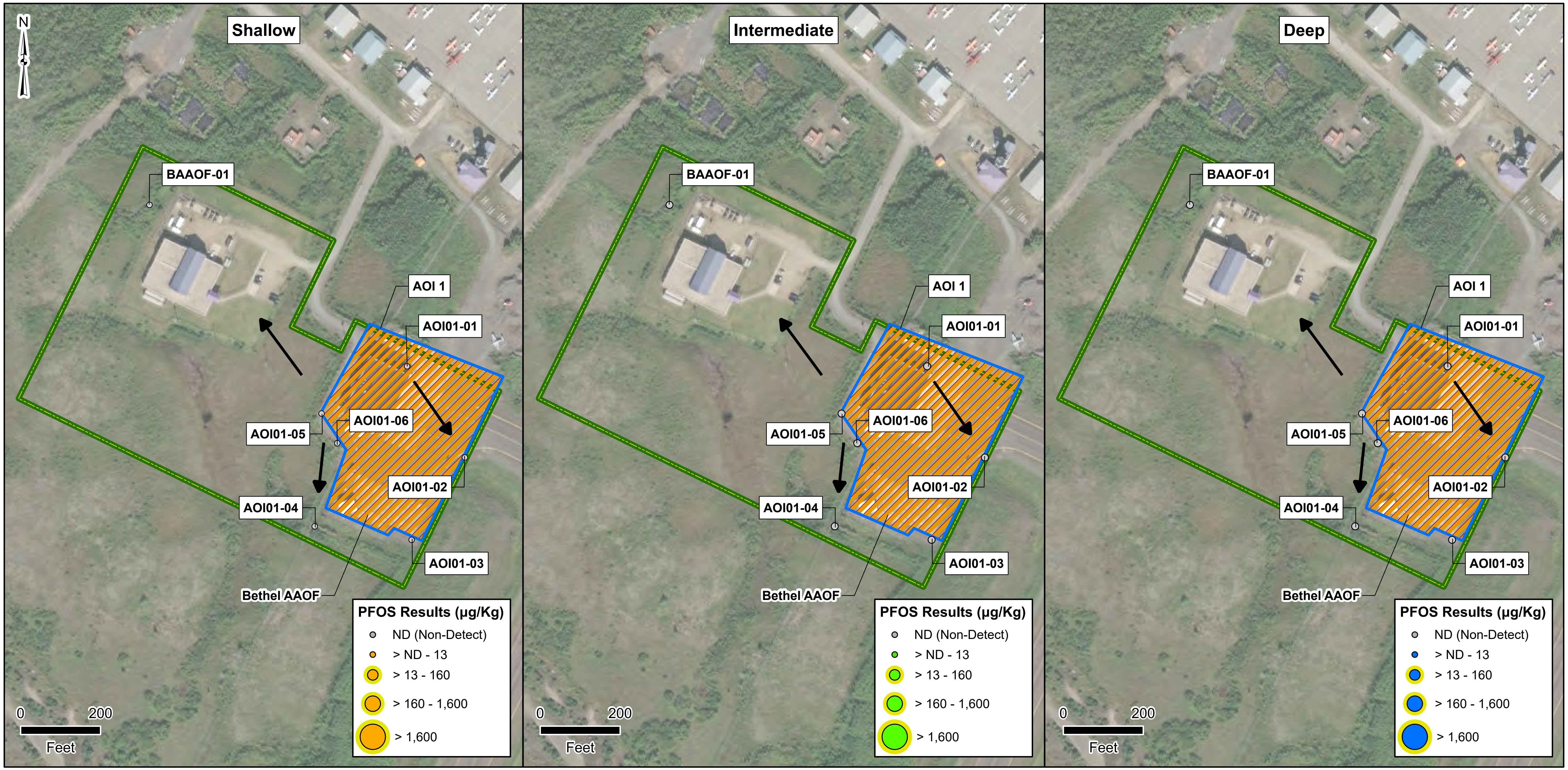
Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 6-1
PFOS Detections in Soil



Facility Data

- Facility Boundary
- Area of Interest
- Potential PFAS Release

Hydrogeology

- Groundwater Flow Direction

Notes:
PFOS = Perfluorooctanesulfonic acid
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:..........................August 2022
Prepared By:.............................EA
Prepared For:...................USACE
Projection:........WGS 84 UTM 4N

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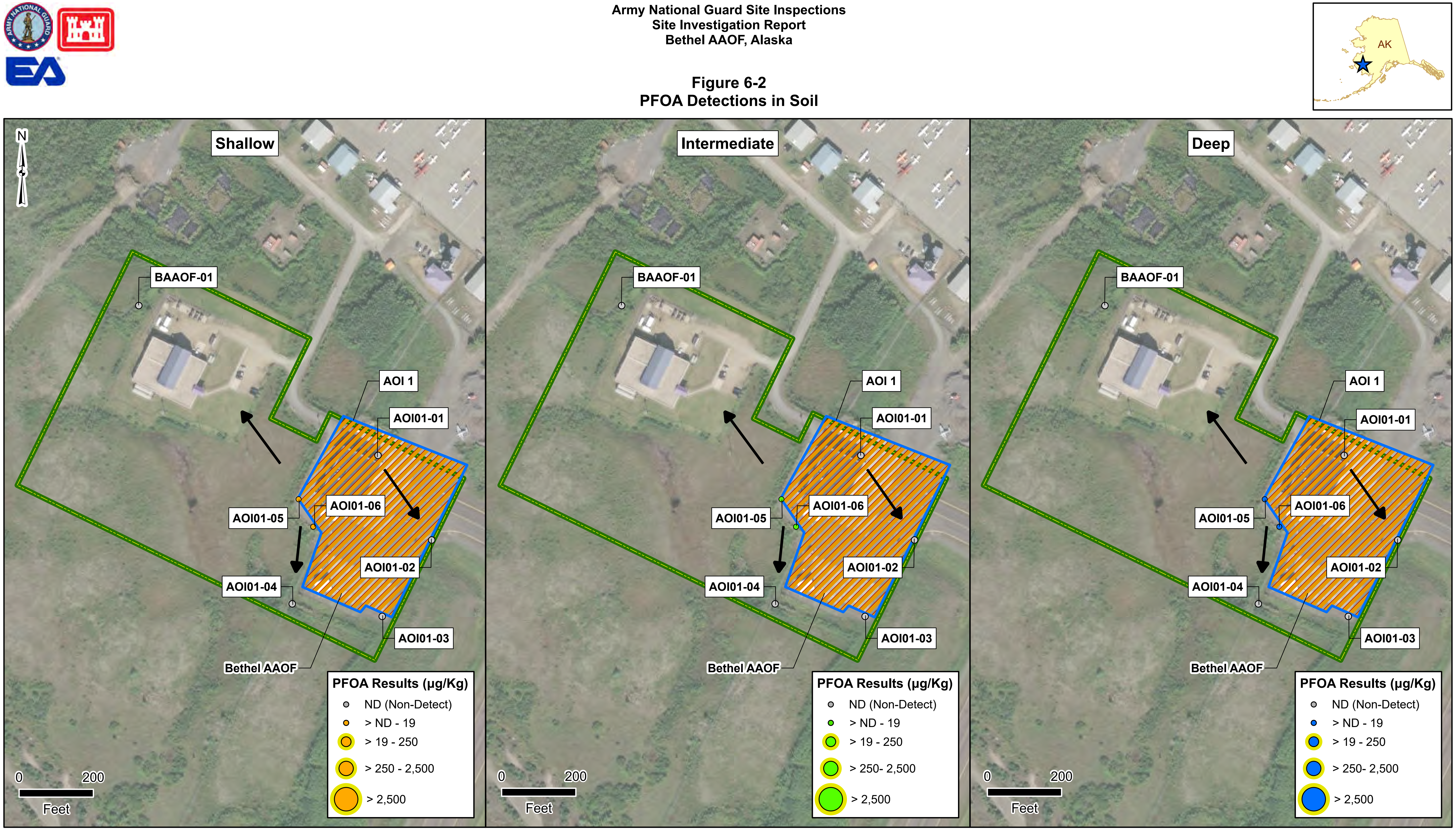
Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 6-2
PFOA Detections in Soil



Facility Data
Facility Boundary
Area of Interest
Potential PFAS Release

Hydrogeology
Groundwater Flow Direction

Notes:
PFOA = Perfluorooctanoic acid
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:..........................August 2022
Prepared By:.............................EA
Prepared For:...................USACE
Projection:........WGS 84 UTM 4N

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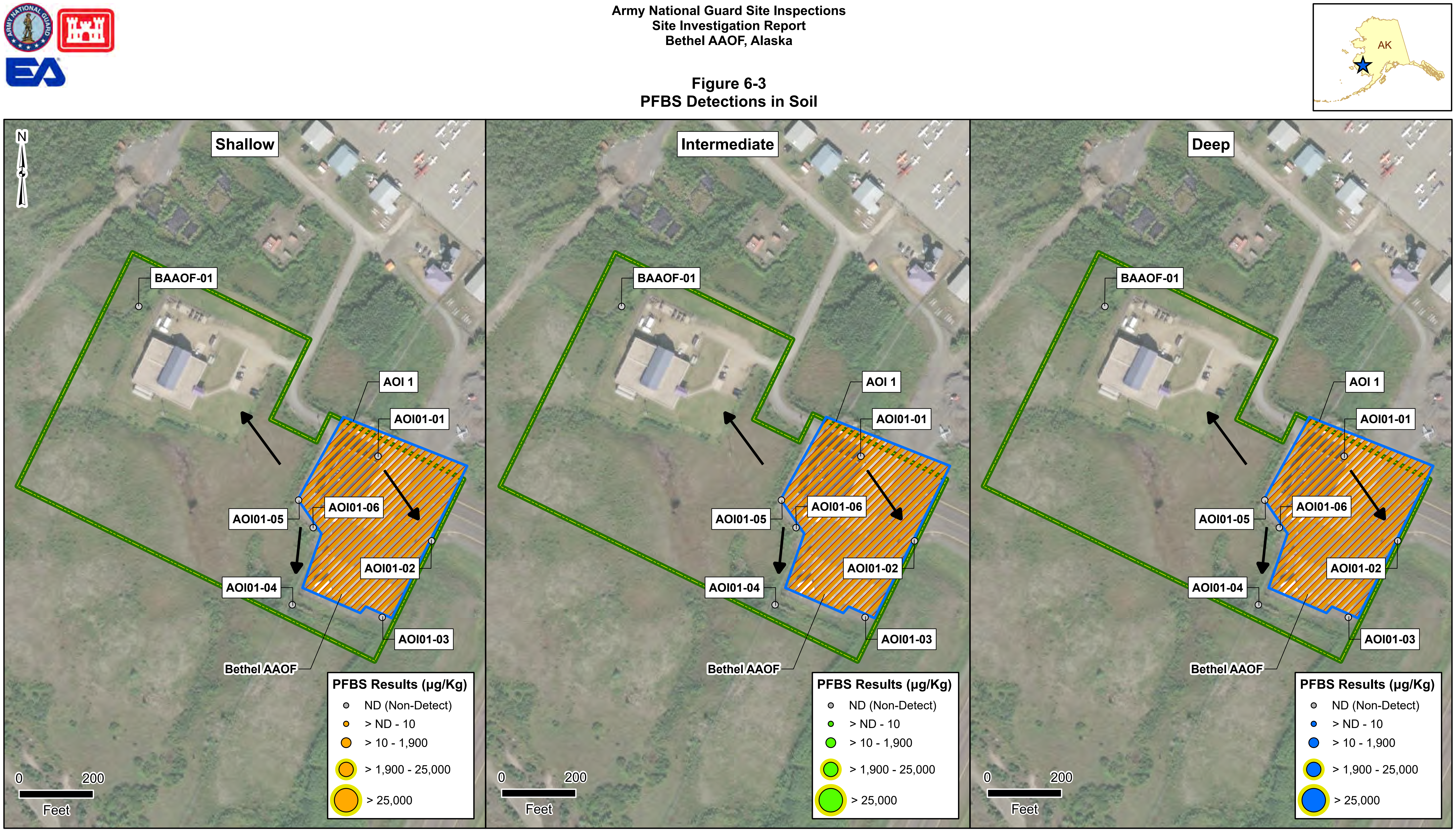
Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 6-3
PFBS Detections in Soil



Facility Data
- Facility Boundary
- Area of Interest
- Potential PFAS Release

Hydrogeology
- Groundwater Flow Direction

Notes:
PFBS = Perfluorobutanesulfonic acid
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:..........................August 2022
Prepared By:.............................EA
Prepared For:...................USACE
Projection:........WGS 84 UTM 4N

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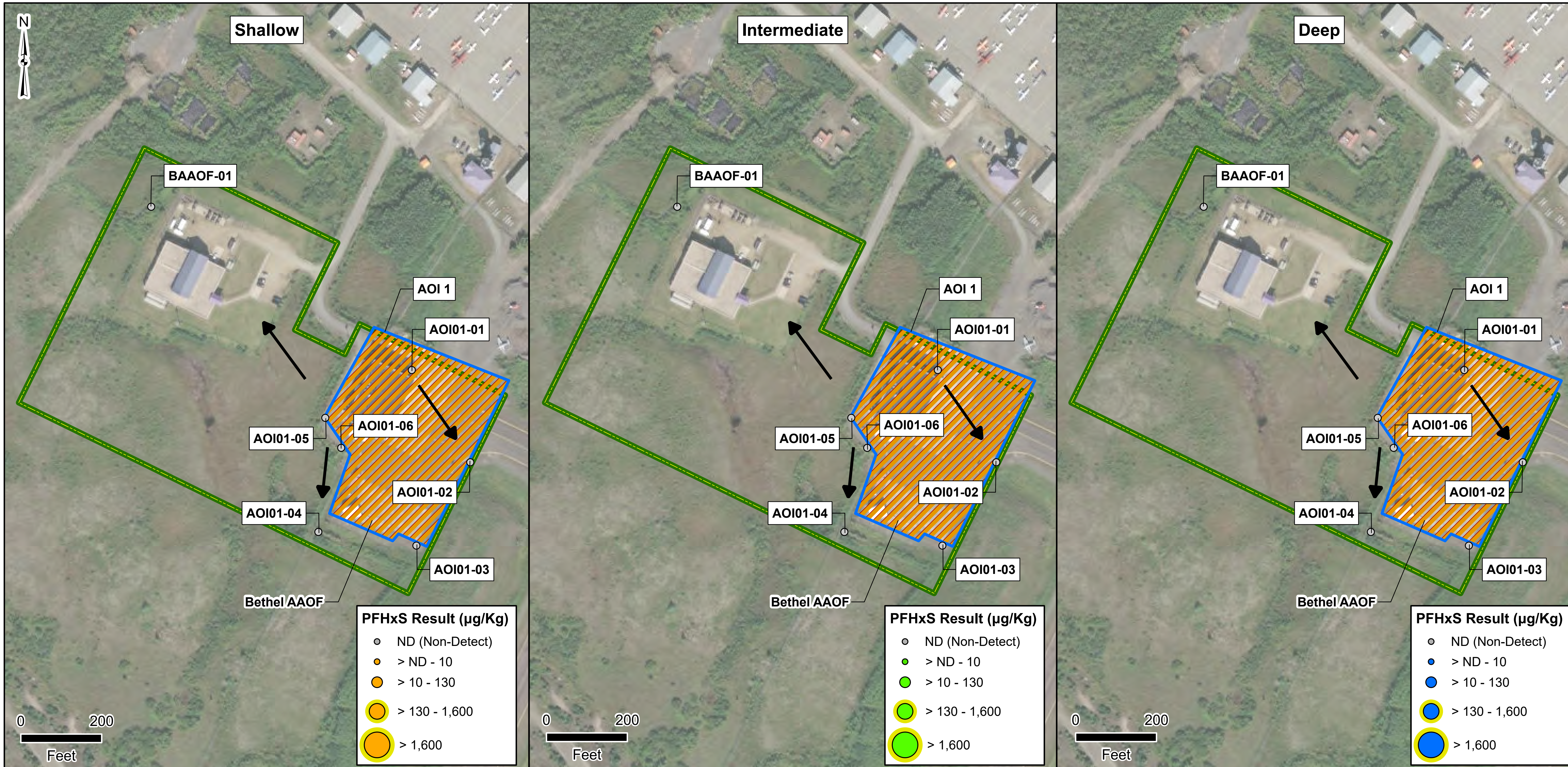
Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 6-4
PFHxS Detections in Soil



Facility Data
- Facility Boundary
- Area of Interest
- Potential PFAS Release

Hydrogeology
- Groundwater Flow Direction

Notes:
PFHxS = Perfluorohexanesulfonic acid
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:..........................August 2022
Prepared By:.............................EA
Prepared For:..................USACE
Projection:........WGS 84 UTM 4N

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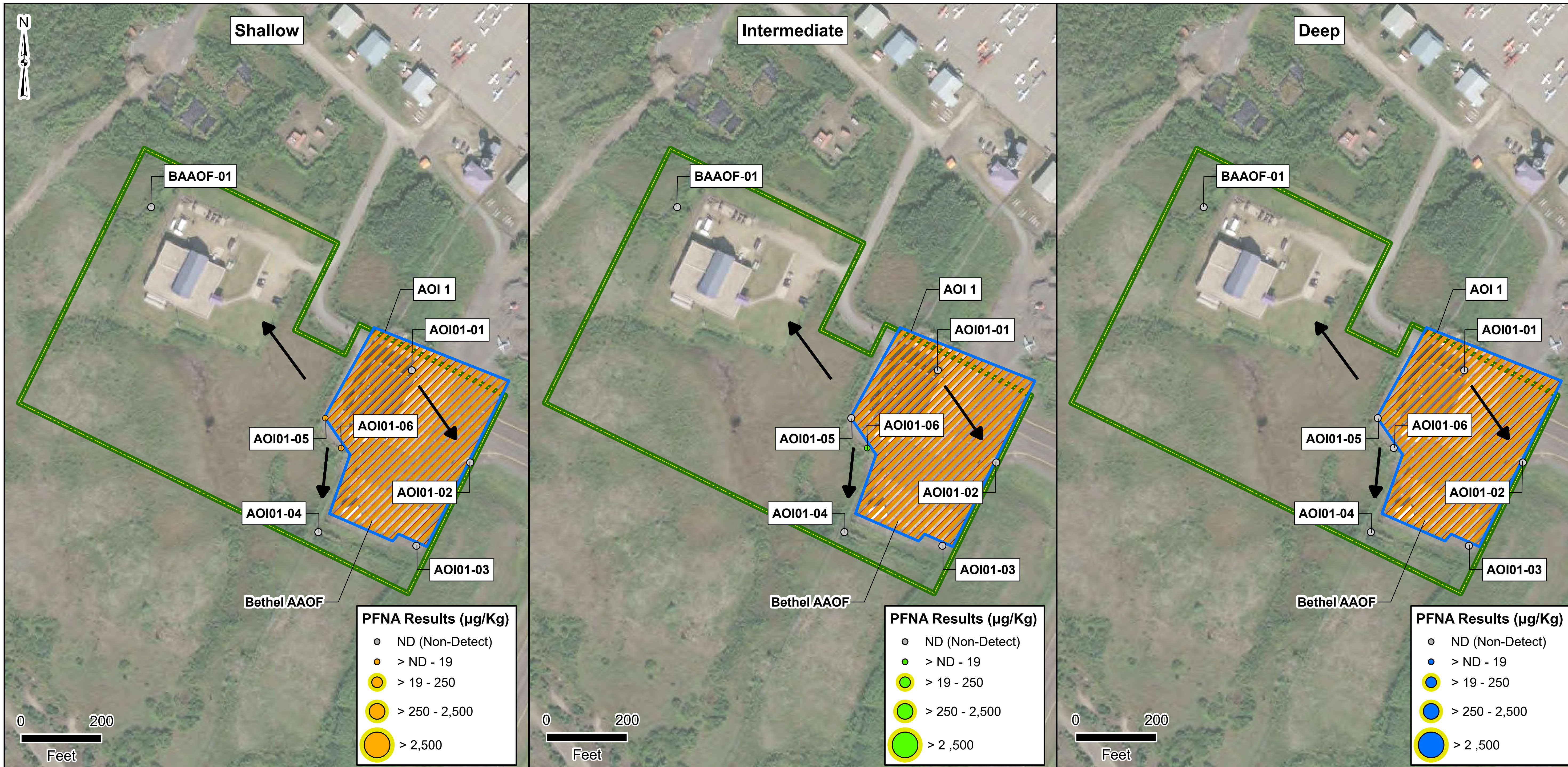
Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 6-5
PFNA Detections in Soil



Facility Data
Facility Boundary
Area of Interest
Potential PFAS Release

Hydrogeology
Groundwater Flow Direction

Notes:
PFNA = Perfluorononanoic acid
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:..........................August 2022
Prepared By:..............................EA
Prepared For:...................USACE
Projection:........WGS 84 UTM 4N

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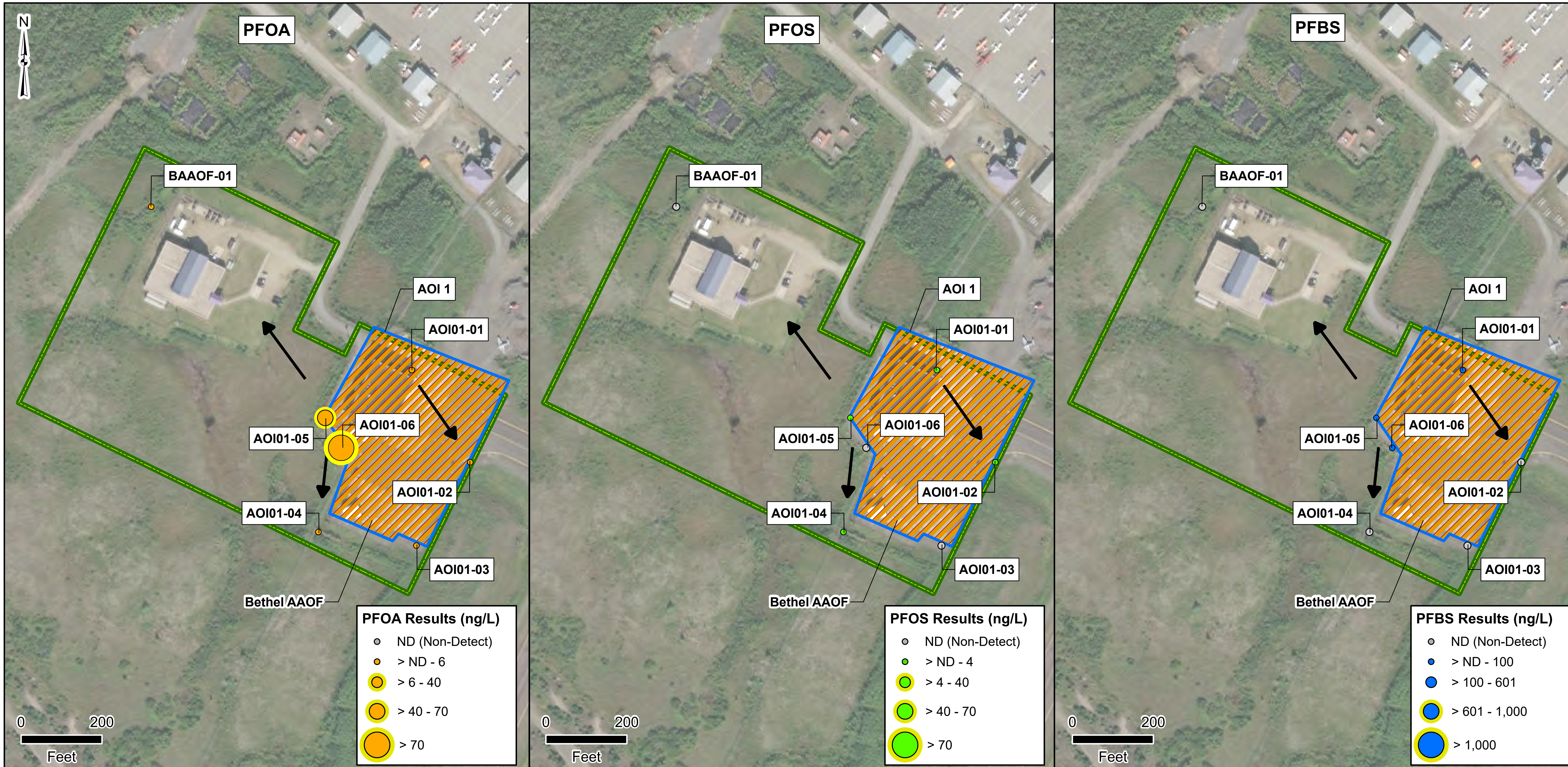
Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 6-6
PFOA, PFOS and PFBS Detections in Groundwater



Path: C:\Users\kwheatley\Desktop\PFAS\Bethel\PROJECTS\BethelSI.aprx

Facility Data
- Facility Boundary
- Area of Interest
- Potential PFAS Release

Hydrogeology
- Groundwater Flow Direction

Notes:
PFOA = Perfluorooctanesulfonic acid
PFOS = Perfluorooctanoic acid
PFBS = Perfluorobutanesulfonic acid
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:..........................August 2022
Prepared By:.............................EA
Prepared For:...................USACE
Projection:........WGS 84 UTM 4N

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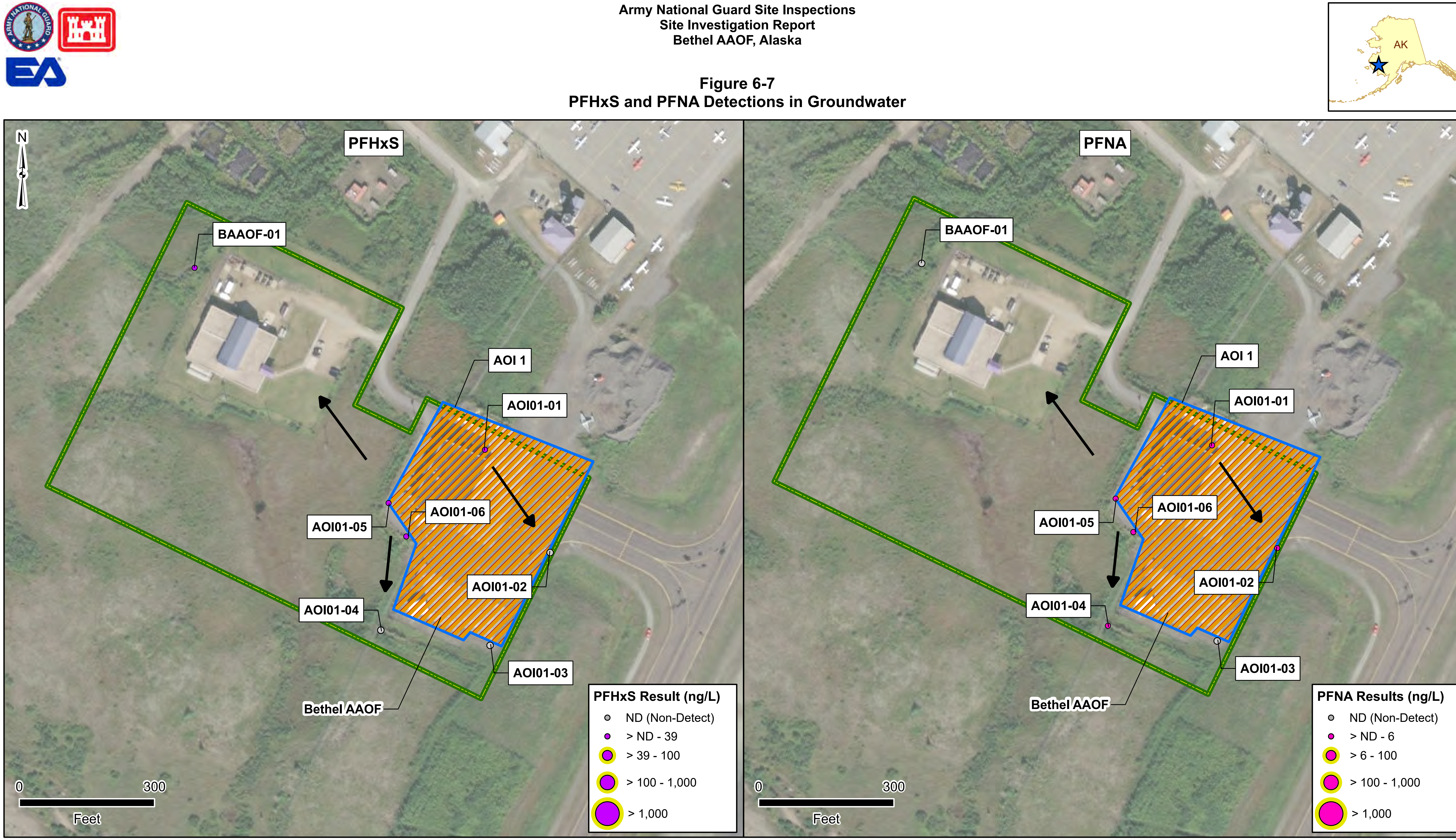
Army National Guard Site Inspections
Site Investigation Report
Bethel AAOF, Alaska

Figure 6-7
PFHxS and PFNA Detections in Groundwater



Path: C:\Users\kwheatley\Desktop\PFAS\Bethel\PROJECTS\BethelSI.aprx

Facility Data
Facility Boundary
Area of Interest
Potential PFAS Release

Hydrogeology
Groundwater Flow Direction

Notes:
PFHxS = Perfluorohexanesulfonic acid
PFNA = Perfluorononanoic acid
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:..........................August 2022
Prepared By:...............................EA
Prepared For:...................USACE
Projection:........WGS 84 UTM 4N

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7. EXPOSURE PATHWAYS

The conceptual site model (CSM) for the AOI, revised based on the SI findings, is presented on **Figure 7-1**. Please note that while the CSM discussion assists in determining if a receptor may be impacted, the decision to move from SI to remedial investigation (RI) or interim action is determined solely based upon exceedances of the SLs for the relevant compounds. A 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 human receptors. A human exposure pathway is considered potentially complete when the following conditions are present. SLs are presented in **Section 6.1** of this report.

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

If any of these elements are missing, the pathway is incomplete. The CSM figure uses an empty circle symbol to represent an incomplete exposure pathway. Areas with no identified complete pathway generally warrant no further action. However, the pathway is considered potentially complete if the relevant compounds are detected, in which case the CSM figure uses a half-filled circle symbol to represent a potentially complete exposure pathway. Additionally, a completely filled circle symbol is used to indicate when a potentially complete exposure pathway has detections of relevant compounds above the SLs. Areas with an identified potentially complete pathway that have detections of the relevant compounds above the SLs may warrant further investigation. Although the CSM indicates whether potentially complete exposure pathways may exist, the recommendation for future study in a RI or no action at this time is based on the comparison of the SI analytical results for the relevant compounds to the SLs.

In general, the potential routes of exposure to the relevant compounds are ingestion and inhalation. Human exposure via the dermal contact pathway may occur, and current risk practice suggests it is an insignificant pathway compared to ingestion; however, exposure data for dermal pathways are sparse and continue to be the subject of toxicological study. The receptors evaluated are consistent with those listed in USEPA guidance for risk screening (USEPA 2001). Receptors at the Facility include Facility workers (e.g., Facility staff and visiting soldiers), construction workers, trespassers, residents outside the facility boundary, and recreational users who may fish or swim in the Kuskokwim River outside of the Facility boundary.

7.1 SOIL EXPOSURE PATHWAY

The SI results for soil were used to determine whether a potentially complete pathway exists between the source and potential receptors at each AOI based on the aforementioned criteria.

7.1.1 AOI 1

The Bethel AAOF Hangar contains an AFFF FSS, which when serviced, resulted in AFFF releases twice within the past 10 years. Releases were reported as less than a quart in size.

Tri-Max^{TM} fire extinguishers have also been stored at the Facility. It is possible that releases may have occurred due to the storage of AFFF. PFOA and PFNA were detected in soil at several orders of magnitude below the project SLs in two of seven boring locations completed at AOI 1, confirming a potential release of PFAS to soil at AOI 1. Based on the results of the SI in AOI 1, ground-disturbing activities in surface soil near AOI01-05 and AOI01-06 could result in Facility worker and construction worker exposure to PFOA via inhalation of dust and ingestion of surface soil. Ground-disturbing and/or trenching activities to subsurface soil could result in construction worker exposure to PFOA via ingestion. Therefore, the exposure pathways for inhalation and ingestion are potentially complete for these receptors. The CSM is presented in **Figure 7-1**.

7.2 GROUNDWATER EXPOSURE PATHWAY

The SI results for the relevant compounds in groundwater were used to determine whether a potentially complete pathway exists between the source and potential receptors based on the aforementioned criteria.

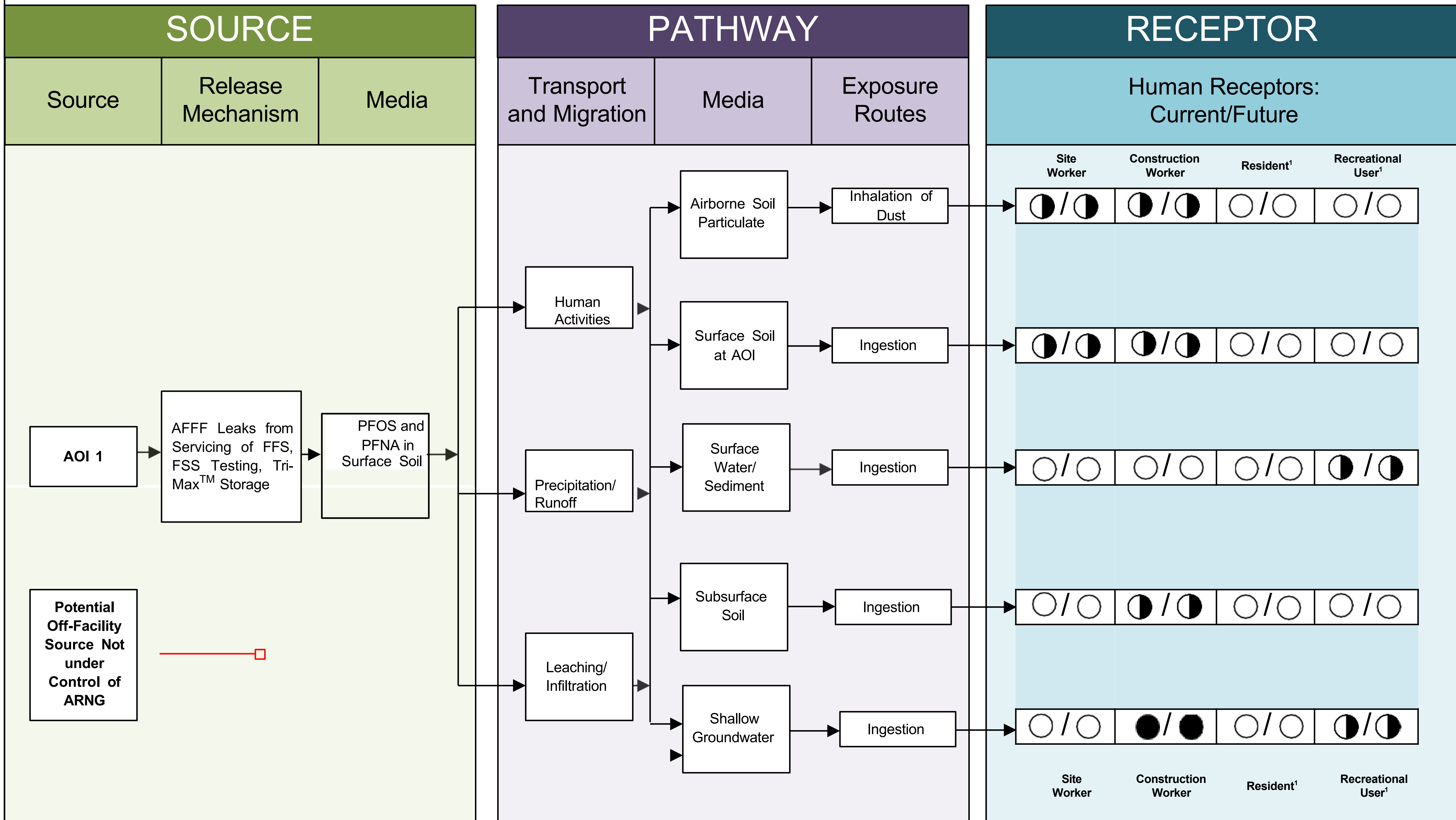
7.2.1 AOI 1

PFOA, PFOS, PFBS, PFNA, and PFHxS were all detected below the SLs in groundwater from at least one of the seven temporary monitoring wells. PFOA concentrations in two of seven temporary monitoring wells exceeded the SL. The two wells with exceedances (AOI01-05 and AOI01-06) are located on the western boundary of AOI 1. Regionally, groundwater flow direction is from northwest to southeast but may vary locally based on local topography and the presence of permafrost. Permafrost may prevent or impede downward and horizontal migration of groundwater, but the depth to permafrost beneath the facility is not fully understood and should be evaluated further.

PFOS, PFOA, and/or PFBS were detected in groundwater samples below SLs from wells located along the southeastern Facility boundary. It is undetermined if contaminated groundwater below SLs is migrating off-site.

The two deep groundwater wells that supply drinking water to the City of Bethel are likely drilled to a depth of 400 ft bgs or more; they are located regionally upgradient; and thus, they are unlikely to be affected by PFAS contamination attributable to AOI 1. No drinking water wells are known to be regionally downgradient from the Facility. Based on this information, the shallow groundwater ingestion exposure pathway is incomplete for off-facility residents, but potentially complete for recreational users on the Kuskokwim River, downgradient from AOI 1.

Ground-disturbing and/or trenching activities to shallow groundwater could result in construction worker exposure to PFOA, PFOS, and/or PFBS via ingestion. Based on this information and the PFOA exceedances found in two of the seven temporary monitoring wells, the ingestion exposure pathway is potentially complete for construction workers. The CSM is presented in **Figure 7-1**.



LEGEND

- Flow-Chart Stops
- Flow-Chart Continues
- Partial / Possible Flow
- ○ Incomplete Pathway
- ◑ Potentially Complete Pathway
- ● Potentially Complete Pathway with Exceedance of the Screening Level

NOTES

1. The resident and recreational users refer to off-site receptors.

Figure 7-1
Conceptual Site Model
AOI 1 Bethel AAOF

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8. SUMMARY AND OUTCOME

This section summarizes SI activities and findings. The most significant findings are summarized in this section and are reproduced directly or abstracted from information contained in this report. The outcome provides general and comparative interpretations of the findings relative to the SLs.

8.1 SITE INSPECTION ACTIVITIES SUMMARY

The SI field activities at the Facility were conducted from 26 to 30 September 2021. The SI field activities included soil sample collection, temporary monitoring well installation, grab groundwater sampling, and land surveying. Field activities were conducted in accordance with the UFP-QAPP Addendum (EA 2021a), except as previously noted in **Section 5.8**.

To fulfill the project DQOs set forth in the approved SI UFP-QAPP Addendum (EA 2021a), samples were collected and analyzed for a subset of 24 compounds by LC/MS/MS compliant with QSM Version 5.3 Table B-15 as follows:

- Twenty-one (21) soil grab samples from seven boring locations
- Seven (7) grab groundwater samples from seven temporary well locations
- Eight (8) quality assurance/quality control samples.

An SI is conducted when the PA determines an AOI exists based on probable use, storage, and/or disposal of PFAS-containing materials. The SI includes multi-media sampling at the AOI to determine whether or not a release has occurred. The SI may conclude further investigation is warranted, a removal action is required to address immediate threats, or that no further action is required. Additionally, the CSM was refined to assess whether a potentially complete pathway exists between the source and potential receptors for potential exposure to PFOA, PFOS, PFBS, PFNA, and/or PFHxS at the AOI, which is described in **Section 7**.

8.2 OUTCOME

Based on the results of this SI, further evaluation in the form of an RI is warranted for AOI 1. Based on the CSM developed for the PA and revised based on the SI findings, there is potential for exposure to receptors via inhalation and incidental ingestion of soil or groundwater on-site at the Facility and from ingestion of surface water in the Kuskokwim River downgradient from the Site from releases during historical DoD activities at the Facility.

Sample chemical analytical concentrations collected during this SI were compared against the project SLs in soil and groundwater, as described in **Table 6-1**. A summary of the results of the SI data relative to SLs is as follows:

- AOI 1:
    - — PFOA, PFOS, PFBS, PFHxS, and PFNA were detected below the SLs in at least one of the seven temporary groundwater wells installed at AOI 1. PFOA results exceeded the SL in groundwater in two of the seven temporary wells that were

installed at AOI 1, with a maximum concentration of 77 ng/L. PFOS and PFBS did not exceed the SL.

- PFOA and PFNA were detected in soil from two of seven borings advanced at AOI 1 at concentrations several orders of magnitude below the SL. PFOS, PFBS, and PFHxS were not detected in soil at AOI 1.

- At the boundary:

  - PFOA, PFOS, PFBS, PFHxS, and PFNA were not detected in soil near the upgradient facility boundary. PFOA, PFOS, PFBS, PFHxS, and PFNA detections below project SLs were present in a groundwater sample from temporary well AOI01-01, which is near the northeastern boundary of the Facility. PFOA and PFHxS detections blow the project SLs were present in a groundwater sample from temporary well BAAOF-01, which is near the northern upgradient boundary of the Facility. As PFOA, PFOS, PFBS, PFHxS, and/or PFNA below project SLs were detected in groundwater in the upgradient temporary wells, there is a potential that contributions from off-facility sources are coming on to the Site.

  - PFOA, PFOS, PFBS, PFHxS, and PFNA were not detected in soil near the downgradient facility boundary. PFNA, PFOA and/or PFOS detections below project SLs were present in groundwater from temporary wells AOI01-02, AOI01-03, and AOI01-04, which are near the downgradient boundary of the Facility. PFBS and PFHxS were not detected in groundwater in any of the downgradient temporary wells.

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 this 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.

Table 8-1 summarizes the SI results for soil and groundwater used to determine if an AOI should be considered for further investigation under CERCLA and undergo an RI.

Table 8-1. Summary of Site Inspection Findings and Recommendations

AOI	Potential Release Area	Soil Source Area	Groundwater Source Area	Groundwater Facility Boundary	Future Action
1	Bethel AAOF Hangar	◐	●	◐	Proceed to RI

Legend:
● = Detected; exceedance of screening levels
◐ = Detected; no exceedance of screening levels
○ = Not detected

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