FINAL
Site Inspection Report
Army Aviation Support Facility, Waterloo, Iowa

Perfluorooctane Sulfonic Acid (PFOS) and
Perfluorooctanoic Acid (PFOA) Impacted Sites
ARNG Installations, Nationwide

August 2021

Prepared for:

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

UNCLASSIFIED

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Table of Contents

Appendices

Figures

Tables

Acronyms and Abbreviations

6:2 FTS	6:2 Fluorotelomer sulfonate
8:2 FTS	8:2 Fluorotelomer sulfonate
µg/Kg	micrograms per kilogram
°C	degrees Celsius
°F	degrees Fahrenheit
%	percent
AASF	Army Aviation Support Facility
AECOM	AECOM Technical Services, Inc.
AFFF	aqueous film forming foam
AOI	Area of Interest
ARNG	Army National Guard
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CoC	chain of custody
CSM	conceptual site model
DA	Department of the Army
DoD	Department of Defense
DPT	direct-push technology
DQI	data quality indicator
DQO	data quality objective
EIS	extraction internal standards
ELAP	Environmental Laboratory Accreditation Program
EM	Engineering Manual
FedEx	Federal Express
FTA	Fire Training Area
gpm	gallons per minute
HA	health advisory
HDPE	high-density polyethylene
IAARNG	Iowa Army National Guard
IDW	investigation-derived waste
IGS	Iowa Geological Survey
ITRC	Interstate Technology Regulatory Council
LC/MS/MS	liquid chromatography with tandem mass spectrometry
LCS	laboratory control spike
LCSD	laboratory control spike duplicate
LOQ	limit of quantitation
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
NELAP	National Environmental Laboratory Accreditation Program
NEtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid
ng/L	nanograms per liter
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
OSD	Office of the Secretary of Defense

PA	Preliminary Assessment
PFAS	per- and polyfluoroalkyl substances
PFBA	perfluorobutyrate
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
PFUdA	perfluoroundecanoic acid
PID	photoionization detector
PVC	poly-vinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RI	Remedial Investigation
RPD	relative percent differences
SI	Site Inspection
SL	screening level
SOP	standard operating procedure
TOC	total organic carbon
TPP	Technical Project Planning
UFP	Uniform Federal Policy
UCMR3	Unregulated Contaminant Monitoring Rule 3
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

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Executive Summary

The Army National Guard (ARNG) is performing Preliminary Assessments (PAs) and Site Inspections (SIs) at per- and polyfluoroalkyl substances (PFAS)-impacted sites at ARNG facilities nationwide. The objective of the SI at each facility is to identify whether there has been a release to the environment from the Areas of Interest (AOIs) identified in the PA and determine the presence or absence of perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and perfluorobutanesulfonic acid (PFBS) at or above screening levels (SLs). An SI was completed at Waterloo Army Aviation Support Facility (AASF) in Waterloo, Iowa (hereafter referred to as the "facility").

Waterloo AASF is located in Black Hawk County, in Waterloo, Iowa, adjacent to the Waterloo Regional Airport. During the PA, two potential PFAS release areas were identified at two fire training areas (FTAs). These FTAs were grouped into two AOIs (AOI 1 and 2). Both AOIs were used in the past by the Iowa ARNG for fire training exercises, during which aqueous film forming foam was used to extinguish fires (AECOM, 2019). These AOIs were investigated during the SI. SI field activities included soil and groundwater grab sampling from temporary monitoring wells from 5 August to 6 August 2020.

To fulfill the project Data Quality Objectives set forth in the approved SI Quality Assurance Project Plan Addendum (AECOM, 2020a), samples were collected and analyzed for a subset of 18 PFAS by liquid chromatography with tandem mass spectrometry compliant with Quality Systems Manual 5.1 Table B-15. The 18 PFAS analyzed as part of the ARNG SI program are specified in **Section 5.7** of this report.

The Department of Defense (DoD) has adopted a policy to retain facilities in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process based on risk-based SLs for soil and groundwater, as described in a memorandum from the Office of the Secretary of Defense dated 15 October 2019 (Assistant Secretary of Defense, 2019). The ARNG PFAS SIs follow this DoD policy and, when the maximum concentration for sampled media exceed the SLs, the AOI will proceed to a Remedial Investigation (RI), the next phase under CERCLA. The SLs apply to three compounds, PFOA, PFOS, and PFBS, for both soil and groundwater, as presented in **Table ES-1**. All other results presented in this report are considered informational in nature and serve as an indication as to whether soil and groundwater contain or do not contain the 18 PFAS analyzed within the boundaries of the facility.

Sample chemical analytical concentrations were compared against the SLs as described in **Table ES-1**. A summary of the results of the SI data relative to the SLs is as follows:

- PFOA in groundwater at AOI 1: Middle Ramp Fire Extinguisher Training exceeded the individual SL of 40 nanograms per liter (ng/L), with a maximum concentration of 231 ng/L at location AOI01-01. Based on the results of the SI, further evaluation of AOI 1 is warranted in the RI.
- PFOA in groundwater at AOI 2: West Ramp Fire Extinguisher Training exceeded the SL of 40 ng/L, with a concentration of 130 ng/L at location AOI02-01. Based on the results of the SI, further evaluation of AOI 2 is warranted in the RI.
- The detected concentrations of PFOA, PFOS, and PFBS in soil samples from all AOIs were below the SLs.

Table ES-2 summarizes the SI results for soil and groundwater. Based on the conceptual site models developed and revised in light of the SI findings, there is potential for exposure to residential drinking water receptors caused by DoD activities at or adjacent to the facility.

Table ES-3 summarizes the rationale used to determine if an AOI should be considered for further investigation under CERCLA and undergo an RI. Based on the results of this SI, further evaluation is warranted in the RI for AOI 1: Middle Ramp Fire Extinguisher Training and AOI 2: West Ramp Fire Extinguisher Training.

Table ES-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	130	1,600	40
PFOS	130	1,600	40
PFBS	130,000	1,600,000	40,000

Notes:
a.) Assistant Secretary of Defense, 2019. Risk Based Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater and Soil using United States Environmental Protection Agency's Regional Screening Level Calculator. Hazard Quotient (HQ)=0.1. 15 October 2019.
bgs = below ground surface
ng/L = nanograms per liter
µg/Kg = micrograms per kilogram

Table ES-2 Summary of Site Inspection Findings

AOI	Potential PFAS Release Area	Soil – Source Area	Groundwater – Source Area	Groundwater – Facility Boundary
1	Middle Ramp Fire Extinguisher Training	◐	●	●
2	West Ramp Fire Extinguisher Training	◐	●	●
Upgradient Facility Boundary	Off-Facility	◐	◐	◐

Legend:
● = PFOS, PFOA, and/or PFBS detected; exceedance of the screening levels
◐ = PFOS, PFOA, and/or PFBS detected; no exceedance of the screening levels
○ = PFOS, PFOA, PFBS not detected

Table ES-3 Site Inspection Recommendations

AOI	Description	Rationale	Future Action
1	Middle Ramp Fire Extinguisher Training	Exceedances of SLs in groundwater at source area. No exceedances of SLs in soil.	Proceed to RI
2	West Ramp Fire Extinguisher Training	Exceedances of SLs in groundwater at source area. No exceedances of SLs in soil.	Proceed to RI
Upgradient Facility Boundary	Northern Facility Boundary	Detections in groundwater but no exceedances of SLs. No exceedances of SLs in soil.	No further action

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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) for Perfluorooctanesulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA) at Impacted Sites, ARNG Installations, Nationwide. This work is supported by the United States (US) Army Corps of Engineers (USACE) Baltimore District and their contractor, AECOM Technical Services, Inc. (AECOM), under Contract Number W912DR-12-D-0014, Task Order W912DR17F0192, issued 11 August 2017. The ARNG performed this SI at Waterloo Army Aviation Support Facility (AASF) in Waterloo, Iowa. The Waterloo AASF is referred to as the "facility" throughout this document.

The SI project elements were performed in compliance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; US 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 US Department of the Army (DA) requirements and guidance for field investigations including specific requirements for sampling for PFOA, PFOS, and perfluorobutanesulfonic acid (PFBS), and the group of related compounds known in the industry as per- and poly-fluoroalkyl substances (PFAS). The term PFAS is used throughout this report to encompass all PFAS chemicals being evaluated, including PFOA, PFOS, and PFBS, which are the key components of the suspected releases being evaluated, and the other 15 related compounds listed in the task order.

1.2 SI Purpose

A PA was performed at Waterloo AASF (AECOM, 2019) that identified two potential PFAS release areas, each identified as an Area of Interest (AOI). The objective of the SI is to identify whether there has been a release to the environment from the AOIs and determine the presence or absence of PFOA, PFOS, and PFBS at or above screening levels (SLs).

As stated in the *Federal Facilities Remedial Site Inspection Summary Guide* (USEPA, 2005), an SI has five goals:

1. Develop information to potentially eliminate a release from further consideration because it is determined that it poses no significant threat to human health or the environment;
2. Determine the potential need for a removal action;
3. Collect or develop data to evaluate potential release;
4. Collect data to better characterize the release for more effective and rapid initiation of a Remedial Investigation (RI), if determined necessary; and
5. Collect data to determine whether the release is more than likely the result of activities associated with the Department of Defense (DoD).

In addition to the USEPA-identified goals of an SI, the ARNG SI also identifies whether there are potential off-facility PFAS sources.

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2. Site Background

2.1 Facility Location and Description

The facility is in Black Hawk County, at 3106 Airport Boulevard, Waterloo, Iowa, adjacent to the Waterloo Regional Airport (**Figure 2-1**). Waterloo AASF is north of West Airline Highway, east of the Waterloo Regional Airport, south of West Big Rock Road, and east of Wagner Road. The communities of Waverly and Cedar Falls lie within 15 miles of the Waterloo AASF. The facility was constructed circa 1974 on a 26-acre parcel of land. An additional 6-acre parcel located on the east boundary was acquired in 2002; both parcels are owned by the State of Iowa.

2.2 Facility Environmental Setting

Waterloo AASF lies in the Iowan Surface region, a region characterized by glacial erratics, thin, discontinuous loess deposits, and northwest- to southeast-trending eolian features. The terrain of the area has been subjected to repeated periods of Quaternary-age glaciations and erosion, creating gently rolling hills with long slopes and low relief that slope toward nearby drainage features and wetlands (Iowa Geological Survey [IGS], 2017c). The elevation of the facility is approximately 875 feet above mean sea level. The elevation in the area decreases to the southwest toward the Cedar River. The facility topography is shown on **Figure 2-2**. Groundwater features, including off-facility wells, are displayed on **Figure 2-3**, and groundwater flow contours are shown on **Figure 2-4**. Surface water features are presented on **Figure 2-5**.

2.2.1 Geology

The Waterloo AASF is situated on Quaternary-age sand and gravel of the Noah Creek Formation. The sediments of the Noah Creek Formation have been interpreted as having a fluvial origin during the Wisconsin glaciation. The Noah Creek Formation ranges from 10 to 66 feet thick and is characterized as yellowish brown to gray, poorly to well-sorted, massive to well-stratified, coarse- to fine-grained feldspathic quartz sand and gravel. The Quaternary-aged till of the Wolf Creek and Alburnett formations sediments underly the Noah Creek Formation with, thicknesses ranging up to 148 feet (Tassier-Surine et al., 2012; Tassier-Surine et al., 2013). The Quaternary-age deposits are underlain by the dolomitic and argillaceous limestones of the Devonian-aged Little Cedar Formation, which ranges up to 121 feet in thickness and is part of the Cedar Valley Group (Witzke et al., 2010; Rowden et al., 2012; Witzke and Bunker, 2017).

2.2.2 Hydrogeology

The Waterloo AASF is within the Northeast Iowa Groundwater Province and is underlain by a sequence of aquifers that include the surficial, Silurian-Devonian, and Cambrian-Ordovician aquifers (Prior et al., 2003). The groundwater of the surficial aquifer is situated within the Quaternary-aged consolidated deposits. Three subcategories of the surficial aquifer occur near the vicinity of the facility: alluvial, glacial drift, and buried-valley. Surficial aquifers are generally not used as production wells in the Northeast Iowa Groundwater Province, as the bedrock aquifers are more productive and reliable; however, alluvial aquifer utilization does occur along the larger rivers, such as the Iowa, Cedar, and Wapsipinicon (Prior et al., 2003). Shallow groundwater flow in the surficial aquifer is generally to the southwest, toward the Cedar River. Shallow groundwater at the facility is approximately 5 to 12 feet below ground surface (bgs).

The surficial aquifer is underlain by the Silurian-Devonian aquifer, which is situated in the Silurian- and Devonian-aged bedrock units. At the facility, there is no confining layer between the unconsolidated sediments of the surficial aquifer and the Little Cedar Formation, which is locally the first geologic unit within the Silurian-Devonian aquifer. The surficial aquifer serves rural, public,

and industrial uses in eastern and northern Iowa (IGS, 2017a). Wells tapping the Silurian-Devonian aquifer are typically 100 to 700 feet deep. Municipal and industrial wells screened within the Silurian-Devonian aquifer yield 150 to 400 gallons per minute (gpm) (Prior et al., 2003). The Maquoketa Shale aquitard acts as a confining layer between the two bedrock aquifers. The Cambrian-Ordovician aquifer is situated within the Cambrian and Ordovician bedrock units, is a widespread source of water for high capacity wells, and is extensively used by municipalities and industries in eastern Iowa. Wells tapping the Cambrian-Ordovician aquifer are typically 300 to 2,000 feet deep (IGS, 2017b) and have yields over 1,000 gpm (Prior et al., 2003).

No potable water wells are located within the Waterloo AASF; however, domestic, private, commercial, and municipal water supply wells exist within 4 miles of the facility (**Figure 2-3**). Drinking water for the Waterloo AASF is supplied by the City of Waterloo. Drinking water for the City of Waterloo is predominantly sourced from the limestone bedrock of the Cedar Valley Group, which is part of the Silurian-Devonian aquifer; however, some of Waterloo's water supply is obtained from the alluvial aquifer along the Cedar River. Drinking water wells in and around the City of Waterloo range in depth from 76 feet to 225 feet (Waterloo Water Works, 2018). Observed groundwater elevations from the SI sampling event and corresponding contours are displayed on **Figure 2-4**.

The USEPA's Unregulated Contaminant Monitoring Rule 3 (UCMR3) data indicated that no PFAS were detected in a public water system above the USEPA Health Advisory (HA) within 20 miles of the facility (USEPA, 2017a). The HA is 70 nanograms per liter (ng/L) for PFOS and PFOA, individually or combined. PFAS analyses performed in 2016 had method detection limits (MDLs) that were higher than currently achievable. Thus, it is possible that low concentrations of PFAS were not detected during the UCMR3 but might be detected if analyzed today.

2.2.3 Hydrology

The Waterloo AASF is in the East Lake Watershed, and tributaries leading to the Cedar River are located less than 0.5 miles east of the Waterloo AASF (**Figure 2-5**). The facility is currently connected to the City of Waterloo sanitary sewer system; however, prior to 1994, the AASF was served by a septic system. Regional surface water features include the Cedar River, approximately 2 miles southwest of the Waterloo AASF, which empties to the Mississippi River, Fisher Lake, and George Wyth Lake.

2.2.4 Climate

The climate at the Waterloo AASF is humid continental with warm summers, cold winters, and wet springs. The average temperature is 48 degrees Fahrenheit (°F). Seasonally, temperatures vary from summer highs of 84 °F to winter lows of 10 °F (World Climate, 2020). Average precipitation is 35 inches. The prevailing wind is southerly, averaging 10 miles per hour, with gust speeds of 60 miles per hour (National Weather Service Forecast Office, 2020).

2.2.5 Current and Future Land Use

The Waterloo AASF is a controlled access facility and is adjacent to the Waterloo Regional Airport. The Waterloo Regional Airport is owned and operated by the City of Waterloo and provides commercial and general air service to the Waterloo and Cedar Falls area. Future land use is not anticipated to change.

2.2.6 Critical Habitat and Threatened/ Endangered Species

The following insects, plants, and mammals are federally endangered, threatened, proposed, and/or are listed as candidate species in Black Hawk County, Iowa (US Fish and Wildlife Service [USFWS], 2020).

- **Insects**: Rusty patched bumble bee, *Bombus affinis* (endangered)
- **Plants**: Prairie bush-clover, *Lespedeza leptostachya* (threatened); Western prairie fringed orchid, *Platanthera praeclara* (threatened)
- **Mammals**: Northern long-eared bat, *Myotis septentrionalis* (threatened)

There are no critical habitats listed at the facility (USFWS, 2020).

2.3 History of PFAS Use

Two potential PFAS release areas where aqueous film forming foam (AFFF) may have been used or released historically were identified at the Waterloo AASF during the PA(AECOM, 2019). AOI 1 is located on the middle of the ramp, south of the Waterloo AASF hangar. PFAS were potentially released between 2001 and 2003 during fire extinguisher training by the Iowa ARNG (IAARNG). AOI 2 is located on the ramp west of the hangar at the Waterloo AASF. PFAS were potentially released to concrete at AOI 2 by the IAARNG during fire extinguisher training between 2011 and 2013.

The Waterloo AASF facility currently houses Tri-Max™ and Halotron fire extinguishers. Halotron fire extinguishers, which do not contain PFAS, are intended to replace the Tri-Max™ extinguishers. Currently, two Tri-Max™ 30 fire extinguishers are stored on the ramp immediately outside the hangar, one Tri-Max™ 60 fire extinguisher is located in the building east of the hangar, and five Halotron fire extinguishers are stored on the ramp. Bulk AFFF is stored at the facility and used to refill the Tri-Max™ fire extinguishers after off-facility hydrostatic testing has been completed.

The potential PFAS release areas were grouped into two AOIs based on preliminary data and inferred groundwater flow. A description of each AOI is presented in **Section 3**.

150

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CLIENT	ARNG			
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Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	RG	12/8/2020

Facility Location

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 2-1

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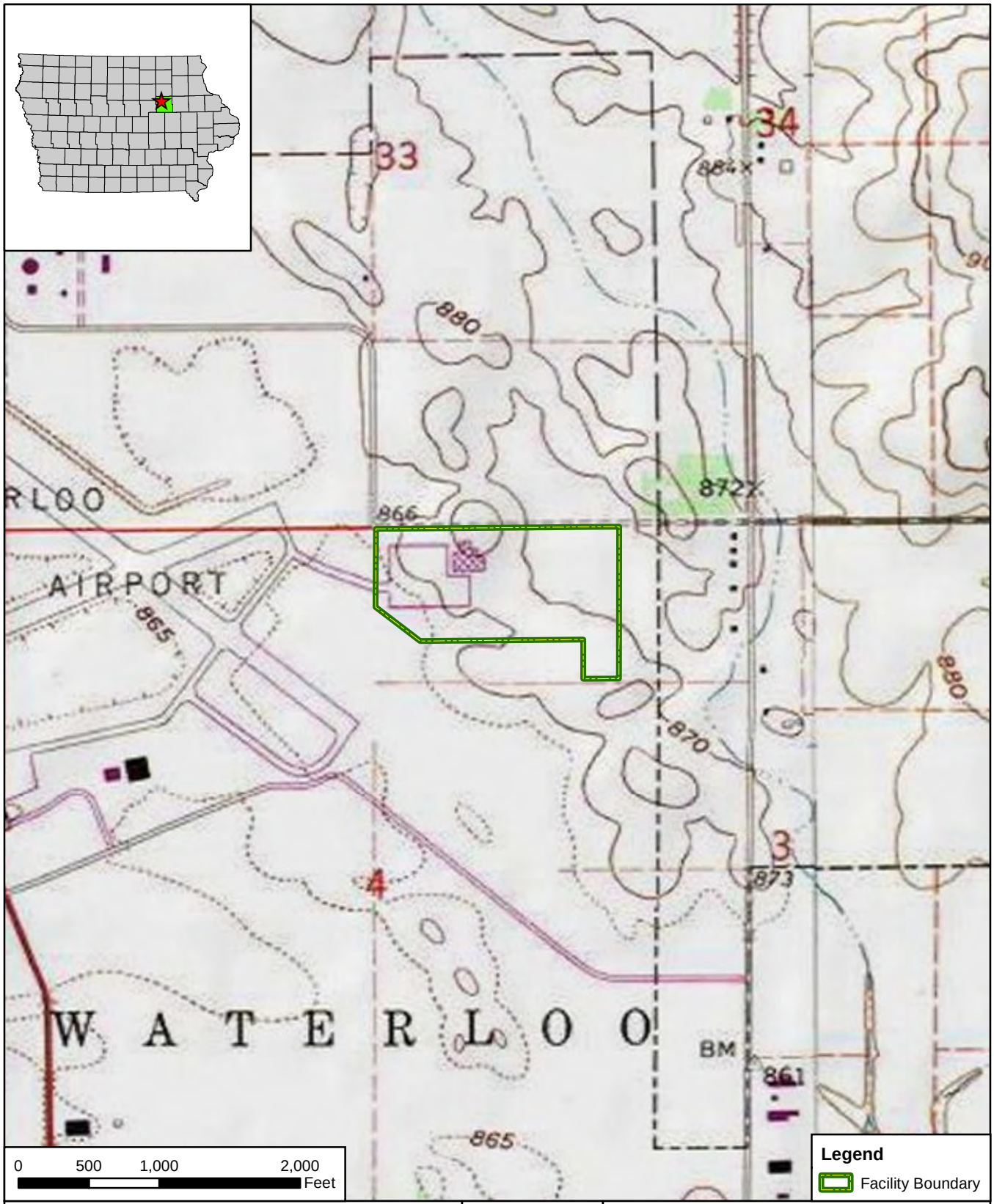

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Base Map: Copyright:© 2013 National Geographic Society, i-cubed		PM	RG	1/12/2021

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Facility Topography

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 2-2

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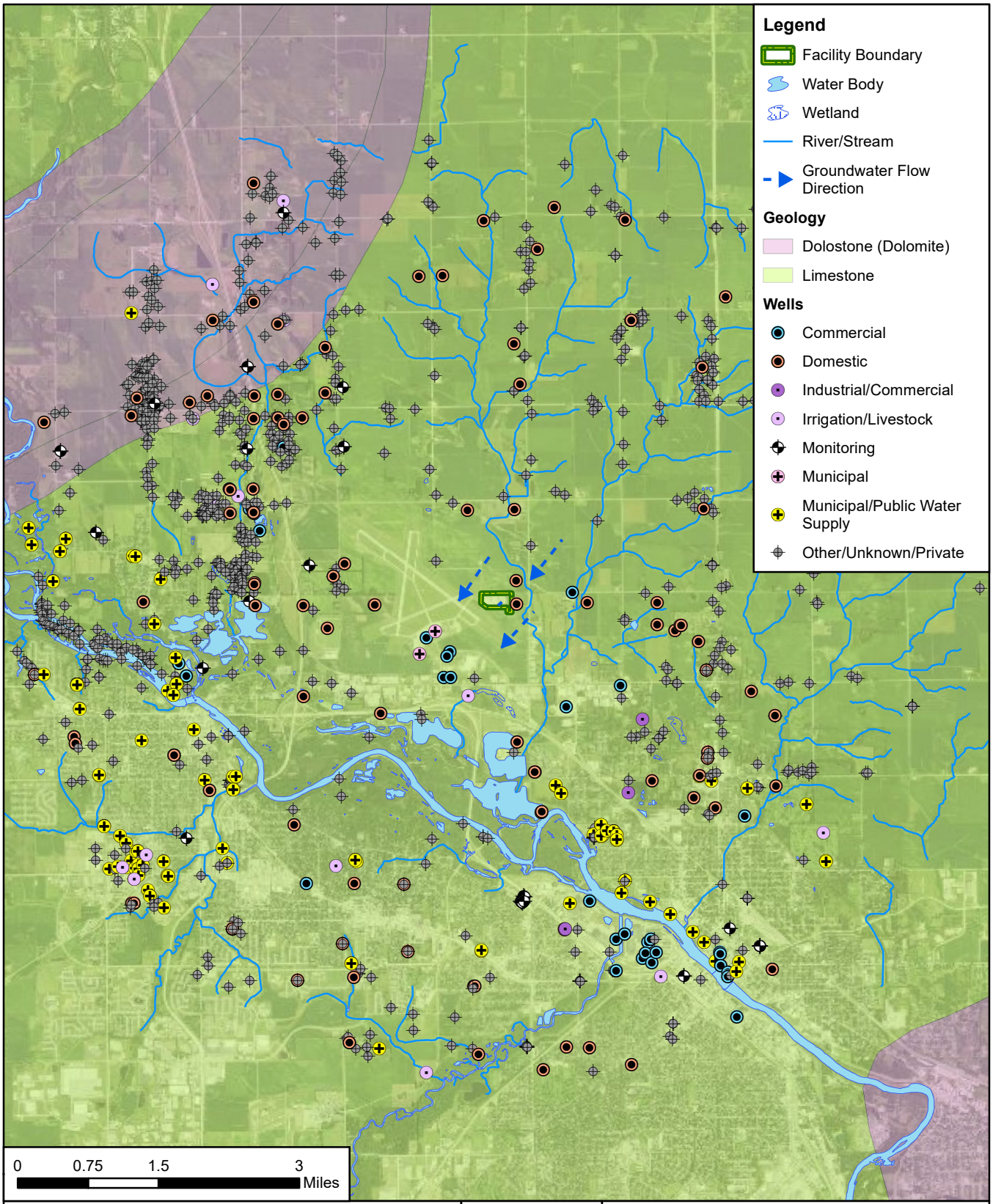

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Base Map: National Agricultural Imagery Program, 2016.		PM	RG	1/13/2021

Groundwater Features

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 2-3

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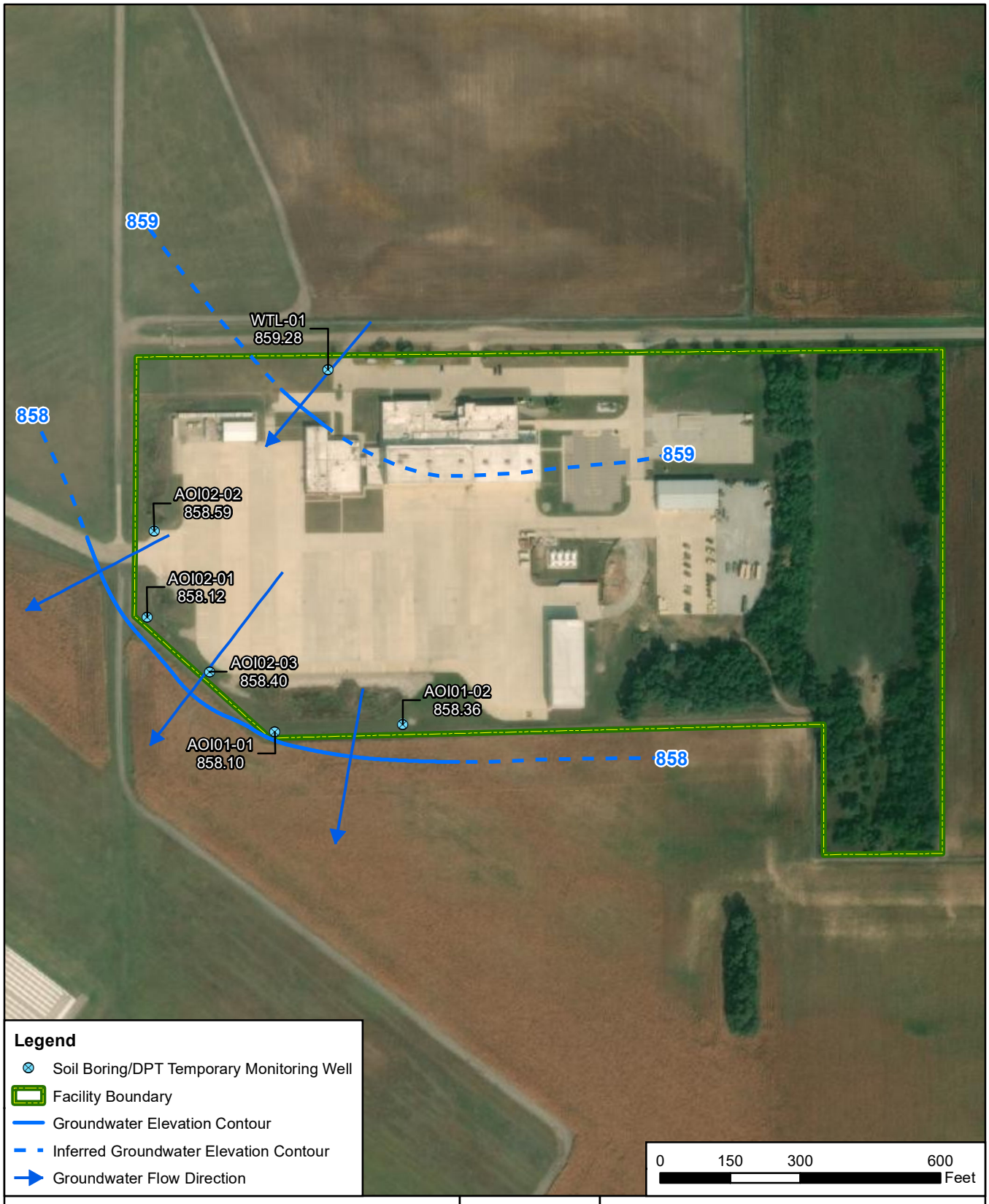

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Base Map: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS,		PM	CM	2/2/2021

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Groundwater Contours

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 2-4

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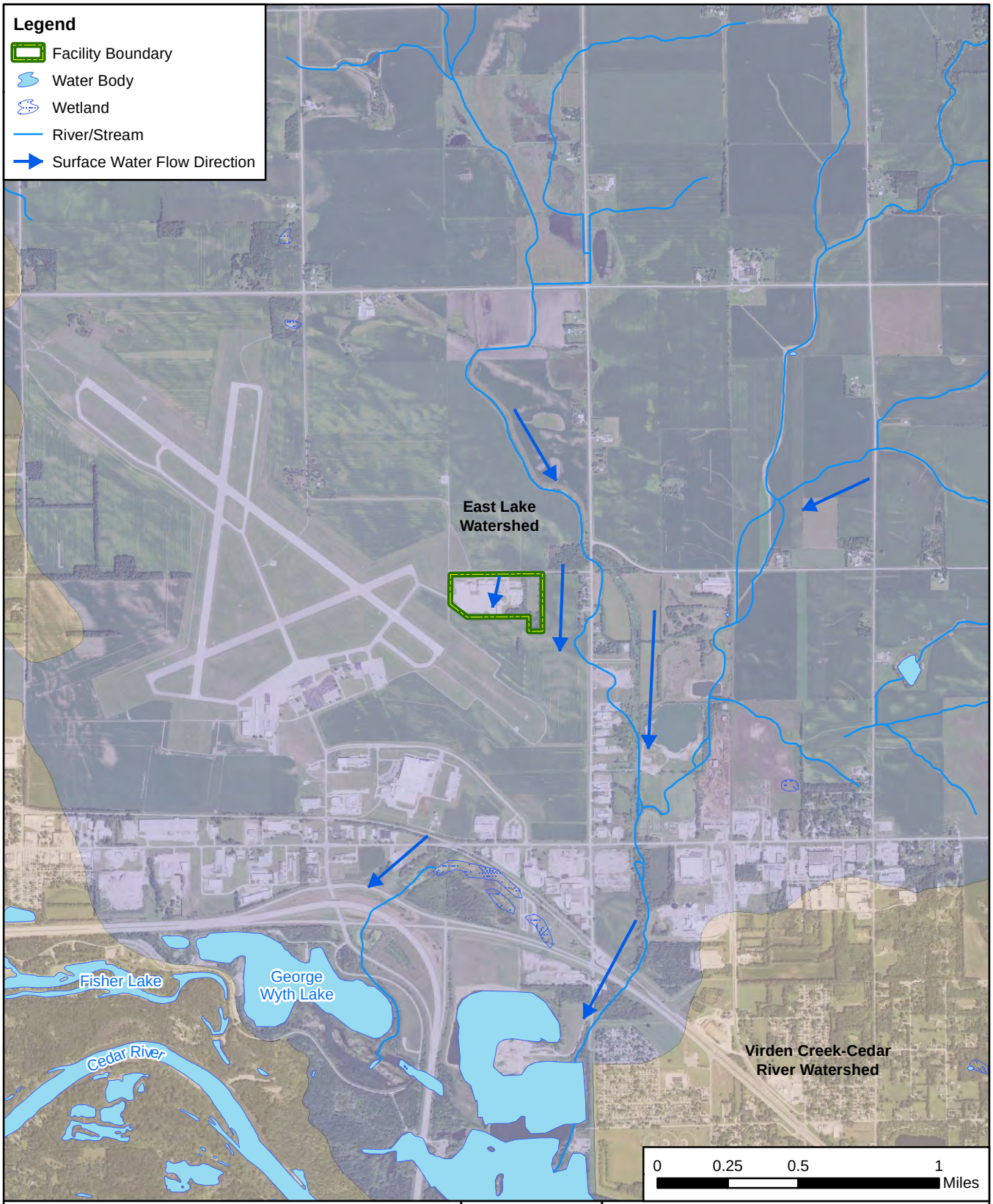

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Base Map: National Agricultural Imagery Program, 2016.		PM	RG	12/8/2020

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Surface Water Features

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 2-5

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157

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3. Summary of Areas of Interest

This section presents a summary of each potential PFAS release area by AOI. Two AOIs were identified based on preliminary data and inferred groundwater flow direction (**Figure 3-1**).

3.1 AOI 1

AOI 1 consists of one potential PFAS release area, as described below.

3.1.1 Middle Ramp Fire Extinguisher Training

AOI 1 is located on the middle of the ramp, south of the Waterloo AASF hangar. PFAS were potentially released to concrete pads surrounded by cracked asphalt at AOI 1 during fire extinguisher training by the IAARNG. The potential release occurred between 2001 and 2003. PFAS may have been released directly to surface soil through cracks in the asphalt on the ramp. The potential PFAS released also may have migrated via overland flow to the surface soil south of the middle ramp area. A ramp expansion in 2007 or 2008 replaced cracked asphalt on the ramp and created retention ponds to the west, southwest, and south of the ramp. The final disposition of the cracked asphalt is unknown. An unknown amount of soil surrounding the ramp was disturbed and removed during the ramp expansion. PFAS may remain in the surface soil south of AOI 1 and could potentially migrate to subsurface soil and groundwater.

3.2 AOI 2

AOI 2 consists of one potential PFAS release area, as described below.

3.2.1 West Ramp Fire Extinguisher Training

AOI 2 is located on the ramp west of the hangar at the Waterloo AASF. PFAS were potentially released to concrete at AOI 2 by the IAARNG during fire extinguisher training between 2011 and 2013. The potential PFAS releases to concrete at AOI 2 may have washed into the retention ponds on the west and southwest of the ramp via overland flow into surface water, sediment, and surface soil. PFAS are water soluble and can migrate readily from soil to groundwater via leaching. As such, PFAS could potentially migrate to subsurface soil and groundwater.

The Waterloo AASF facility currently houses Tri-Max™ and Halotron fire extinguishers. Halotron fire extinguishers, which do not contain PFAS, are intended to replace the Tri-Max™ extinguishers. Currently, two Tri-Max™ 30 fire extinguishers are stored on the ramp immediately outside the hangar, one Tri-Max™ 60 fire extinguisher is located in the building east of the hangar, and five Halotron fire extinguishers are stored on the ramp. Bulk AFFF is stored at the facility and used to refill the Tri-Max™ fire extinguishers after off-facility hydrostatic testing has been completed. Four five-gallon containers of 6 percent (%) AFFF were observed at the Waterloo AASF during the visual site inspection (AECOM, 2019).

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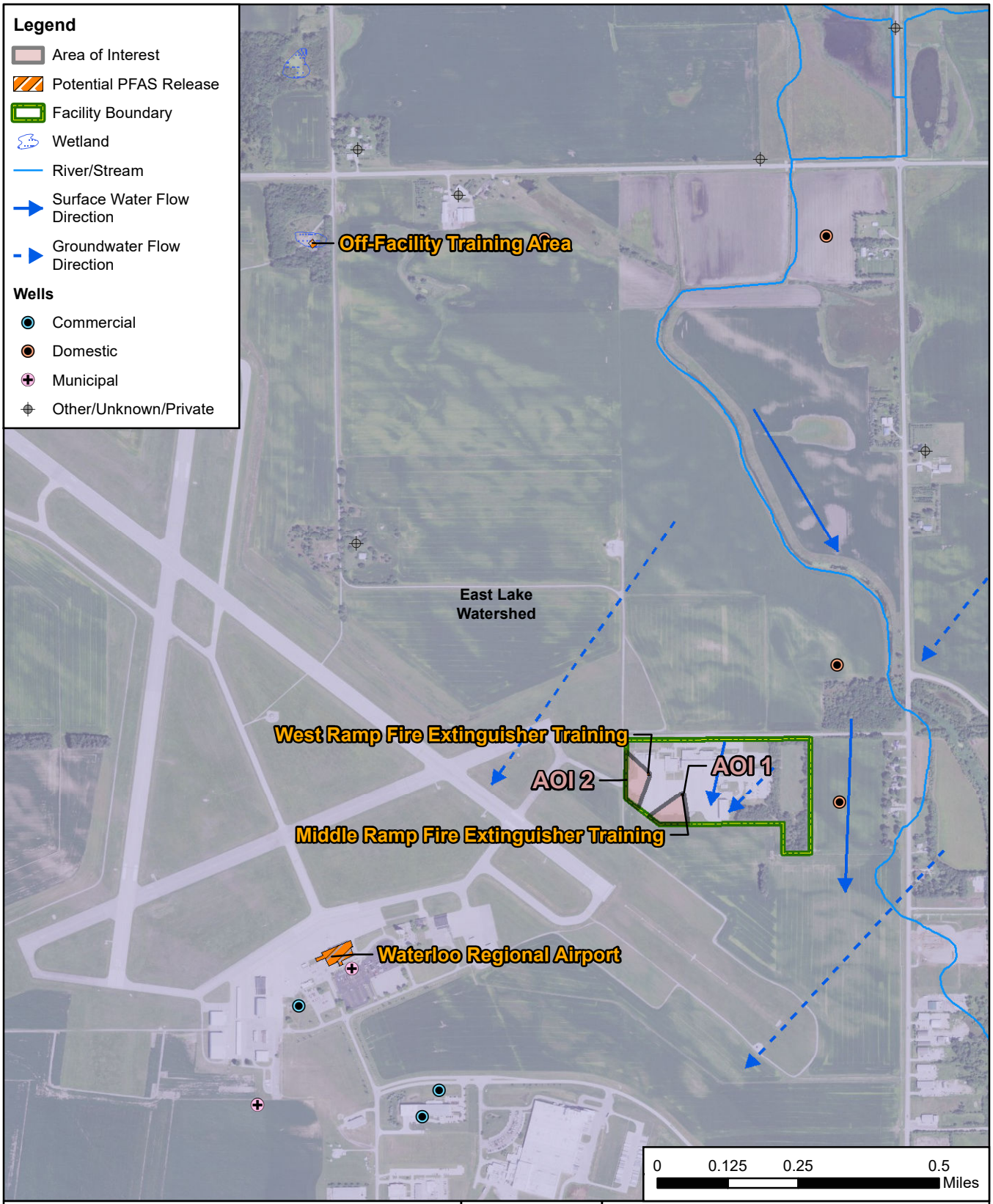

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Base Map: National Agricultural Imagery Program, 2016.		PM	RG	1/13/2021

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Areas of Interest

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 3-1

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194

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4. Project Data Quality Objectives

Project Data Quality Objectives (DQOs) are qualitative and quantitative statements that specify the quality of data and define the level of certainty required to support project decision-making process. The specific DQOs established for this facility are described below. These DQOs were developed in accordance with the USEPA's seven-step iterative process (USEPA, 2006).

4.1 Problem Statement

The following problem statement was developed during project planning:

The presence of PFAS, which may pose a risk to human health or the environment, in environmental media at the facility is currently unknown. PFAS are classified as emerging environmental contaminants that are garnering increasing 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 Office of the Secretary of Defense (OSD) dated 15 October 2019 (Assistant Secretary of Defense, 2019). The ARNG program under which this SI was performed follows this DoD policy. Should the maximum concentration for sampled media exceed the SLs established in the OSD memorandum, the AOI will proceed to the next phase under CERCLA. The SLs established in the OSD memorandum apply to three compounds: PFOS, PFOA, and PFBS. The SLs are presented in **Section 6.1** of this report.

The following quotes from the DA policy documents form the basis for this SI (DA, 2016; DA, 2018):

- "The Army will research and identify locations where PFOS- and/or PFOA-containing products, such as AFFF, are known or suspected to have been used. Installations shall coordinate with installation/facility fire response or training offices to identify AFFF use or storage locations. The Army will consider FTAs, AFFF storage locations, hangars/buildings with AFFF suppression systems, fire equipment maintenance areas, and areas where emergency response operations required AFFF use as possible source areas. In addition, metal plating operations, which used certain PFOS-containing mist suppressants, shall be considered possible source areas."
- "Based on a review of site records…determine whether a CERCLA PA is appropriate for identifying PFOS/PFOA release sites. If the PA determines a PFOS/PFOA release may have occurred, a CERCLA SI shall be conducted to determine presence/absence of contamination."
- "Identify sites where perfluorinated compounds are known or suspected to have been released, with the priority being those sites within 20 miles of the public systems that tested above USEPA HA levels" (USEPA, 2016a; USEPA, 2016b).

4.2 Goals of the Study

The following goals were established for this SI:

1. Determine the presence or absence of PFOA, PFOS, and PFBS at or above SLs.
2. Develop information to potentially eliminate a release from further consideration because it is determined that it poses no significant threat to human health or the environment.

3. Determine the potential need for a removal action.

4. Collect data to better characterize the release areas for more effective and rapid initiation of a RI.

5. Identify within 4 miles of the installation other potential PFAS sources (fire stations, major manufacturers, other DoD facilities) and receptors, including both groundwater and surface water receptors, to determine whether the ARNG is the likely source of PFAS, or whether there is an off-facility source of PFAS responsible for installation detections of PFAS (USEPA, 2005).

6. Determine whether a potentially complete pathway exists between the source and potential receptors and whether ARNG is the likely source of the contamination.

4.3 Information Inputs:

Primary information inputs included:

- The PA for Waterloo AASF, Iowa (AECOM, 2019);
- Analytical data from groundwater and soil samples collected as part of this SI in accordance with the site-specific Uniform Federal Policy (UFP)-Quality Assurance Project Plan (QAPP) Addendum (AECOM, 2020a); and
- Field data collected during the SI, including groundwater elevation and water quality parameters measured at the time of sampling.

4.4 Study Boundaries

The scope of the SI is horizontally bounded by the property limits of the Waterloo AASF. Off-facility sampling is not included in the scope of this SI; however, if future off-facility sampling is required, the proper stakeholders will be notified, and necessary rights of entry will be obtained by ARNG with the property owner(s).

4.5 Analytical Approach

Samples were analyzed by Pace Analytical Gulf Coast (formerly Gulf Coast Analytical Laboratories), accredited under the DoD Environmental Laboratory Accreditation Program (DoD ELAP; Accreditation Number 74960) and the National Environmental Laboratory Accreditation Program (NELAP; Certificate Number 01955). Data were compared to applicable SLs and decision rules as defined in the SI QAPP Addendum (AECOM, 2020a). These rules governed response actions based on the results of the SI sampling effort.

The decision rules described in the **Worksheet #11** of the QAPP Addendum identify actions based on the following:

Groundwater:

- Is there a human receptor within 4 miles of the site?
- What is the concentration of PFOA, PFOS, and PFBS at the potential release areas?
- What is the concentration of PFOA, PFOS, and PFBS at the facility boundary upgradient and downgradient of the potential release areas?
- What does the conceptual site model (CSM) suggest in terms of source, pathway and receptor?

Soil:

- What is the concentration of PFOA, PFOS, and PFBS in shallow surface soil (0 to 2 feet bgs)?
- What is the concentration of PFOA, PFOS, and PFBS in deep soil (i.e., capillary fringe)?
- What does the CSM suggest in terms of source, pathway, and receptor?

Soil and groundwater samples were collected from each of the potential release areas. Groundwater was encountered at approximately 5 to 12 feet bgs. The regional aquifer is significantly deeper (100-700 feet bgs) and was not subjected to drilling during this investigation.

4.6 Data Usability Assessment

The Data Usability Assessment 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, 2018a; DoD, 2018b; USEPA, 2017b).

Data Quality Indicators (DQIs) (Precision, Accuracy, Representativeness, Comparability, Completeness and Sensitivity) are important components in assessing data usability. These DQIs were evaluated in the subsequent sections and demonstrate that the data presented in this SI report are of high quality. Although the SI data are considered reliable, some degree of uncertainty can be associated with the data collected. Specific factors that may contribute to the uncertainty of the data evaluation are described below. The Data Validation Report (**Appendix A**) presents explanations for all qualified data in greater detail.

4.6.1 Precision

Precision is the degree of agreement among repeated measurements of the same characteristic on the same sample or on separate samples collected as close as possible in time and place. Field sampling precision is measured with the field duplicate relative percent differences (RPD); laboratory precision is measured with calibration verification, internal standard recoveries, laboratory control spike (LCS) and matrix spike (MS) duplicate RPD.

Extraction internal standards (EIS) were added by the laboratory during sample extraction to measure relative responses of target analytes and used to correct for bias associated with matrix interferences and sample preparation efficiencies, injection volume variances, mass spectrometry ionization efficiencies, and other associated preparation and analytical anomalies. The EIS samples were within the project established precision limits presented in the QAPP Addendum (AECOM, 2020a).

LCS/LCS duplicate (LCSD) pairs were prepared by addition of known concentrations of each analyte in a matrix-free media known to be free of target analytes. LCS/LCSD pairs were analyzed for every analytical batch to demonstrate the ability of the laboratory to detect similar concentrations of a known quantity in matrix-free media. The LCS/LCSD samples were within the project established precision limits presented in the QAPP Addendum (AECOM, 2020a), with one exception. An LCS/LCSD pair displayed an RPD outside the quality control (QC) limit for perfluorotetradecanoic acid (PFTeDA). The associated field sample results were non-detect; therefore, no data qualifying action was required. The associated parent sample results should be considered usable as reported.

MS/MS duplicate (MSD) samples were prepared, analyzed, and reported for all preparation batches. MS/MSD samples demonstrated that the analytical system was in control for the matrix being tested. MS/MSD samples were submitted to the laboratory for analysis at a rate of 5%. The MS/MSD samples were within the project established precision limits presented in the QAPP Addendum (AECOM, 2020a).

Field duplicate samples were collected at a rate of 10% to assess the overall sampling and measurement precision for this sampling effort. The field duplicate samples were analyzed for PFAS and general chemistry parameters. The field duplicate samples were within the project established precision limits presented in the QAPP Addendum (AECOM, 2020a).

4.6.2 Accuracy

Accuracy is a measure of confidence in a measurement. The smaller the difference between the measurement of a parameter and its "true" or expected value, the more accurate the measurement. The more precise or reproducible the result, the more reliable or accurate the result. Accuracy is measured through percent recoveries in the LCS/LCSD, MS/MSD, and surrogates.

LCS/LCSD samples were prepared by addition of known concentrations of each analyte in a matrix free media known to be free of target analytes. LCS/LCSD samples were analyzed for every analytical batch and demonstrated that the analytical system was in control during sample preparation and analysis. The LCS/LCSD samples were within the project established precision limits presented in the QAPP Addendum (AECOM, 2020a).

MS/MSD samples were prepared, analyzed, and reported at a rate of 5%. MS/MSD samples demonstrated that the analytical system was in control for the matrix being tested. The MS/MSD samples were within the project established precision limits presented in the QAPP Addendum (AECOM, 2020a).

Calibration verifications were performed routinely to ensure that instrument responses for all calibrated analytes were within established QC criteria. The calibration verifications were within the project established precision limits presented in the QAPP Addendum (AECOM, 2020a), with one exception. The laboratory provided a revised sample delivery group 220080814 because one calibration standard was not included in the calibration initially. This error was identified during data review and corrected; no impact on the data was assessed.

4.6.3 Representativeness

Representativeness qualitatively expresses the degree to which data accurately reflect site conditions. Factors that affect the representativeness of analytical data include appropriate sample population definitions, proper sample collection and preservation techniques, analytical holding times, use of standard analytical methods, and determination of matrix or analyte interferences.

Relating to the use of standard analytical methods, the laboratory followed the method as established in PFAS by liquid chromatography with tandem mass spectrometry (LC/MS/MS) Compliant with Quality Systems Manual (QSM) 5.1 Table B-15, including the specific preparation requirements (i.e. ENVI-Carb or equivalent used), mass calibration, spectra, all the ion transitions identified in Table B-15 were monitored, standards that contained both branch and linear isomers when available were used, and isotopically labeled standards were used for quantitation.

Field QC samples were collected to assess the representativeness of the data collected. Field duplicates were collected at a rate of 10% for all field samples, while MS/MSD samples were collected at a rate of 5%. All preservation techniques were followed by the field staff, and all

technical and analytical holding times were met by the laboratory. The laboratory used approved standard methods in accordance with the QAPP Addendum (AECOM, 2020a) for all analyses.

Instrument blanks and method blanks were prepared by the laboratory in each batch as a negative control. All associated instrument blanks and method blanks were non-detect for all target analytes.

Equipment blanks and field blanks were also collected for groundwater and soil samples. All equipment blanks and field blanks were non-detect for all target analytes.

A sample of the water used for decontamination of the drill rig was collected in advance of the field effort. The drill rig decontamination sample, CAMP DODGE DECON, displayed a concentration above the detection limit of 1.78 ng/L for perfluorobutyrate (PFBA) at 10.8 ng/L. The associated field sample results that displayed concentrations less than five times the concentration found in the blank were qualified “U”, and the associated numerical result was elevated to the quantitation limit.

Field samples were extracted and analyzed within the appropriate holding time in order to qualitatively express the degree to which data accurately reflect site conditions with one exception. The holding time for pH analysis is “immediate”; therefore, all field samples analyzed for pH were qualified “J” and should be considered usable as estimated values.

Overall, the data are usable for evaluating the presence or absence of PFAS at the facility. Sufficient usable data were obtained to meet the objectives of the SI.

4.6.4 Comparability

Comparability is the extent to which data from one study can be compared directly to either past data from the current project or data from another study. Using standardized sampling and analytical methods, units of reporting, and site selection procedures help ensure comparability. Standard field sampling and typical laboratory protocols were used during the SI and are considered comparable to ongoing investigations.

4.6.5 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount of data expected under normal conditions. The laboratory provided data meeting system QC acceptance criteria for all samples tested. Project completeness was determined by evaluating the planned versus actual quantities of data. Percent completeness per parameter is as follows and reflects the exclusion of ‘X” flagged data, if applicable:

- PFAS in groundwater by LC/MS/MS compliant with QSM 5.1 Table B-15 at 100%
- PFAS in soil by LC/MS/MS compliant with QSM 5.1 Table B-15 at 100%
- pH in soil by USEPA Method 9045D at 100%
- Total Organic Carbon (TOC) by USEPA Method 9060 at 100%

4.6.6 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 MDL study, and calibration standards at the limit of quantitation (LOQ). In order to meet the needs of the data users, project data must meet the measurement performance criteria for sensitivity and project

LOQs specified in the QAPP Addendum (AECOM, 2020a). The laboratory provided the requested MDL studies and provided applicable calibration standards at the LOQ. In order to achieve the DQOs for sensitivity outlined in the QAPP Addendum (AECOM, 2020a), the laboratory reported all field sample results at the lowest possible dilution. Additionally, any analytes detected below the LOQ and above the MDL were reported and qualified “J” as estimated values by the laboratory.

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 implemented in accordance with the following approved documents:

- *Final Site Inspection Programmatic Uniform Federal Policy-Quality Assurance Project Plan dated March 2018* (AECOM, 2018a);
- *Final Programmatic Accident Prevention Plan dated July 2018* (AECOM, 2018b);
- *Final Preliminary Assessment Report, Army Aviation Support Facility, Waterloo, Iowa dated June 2019* (AECOM, 2019);
- *Final Site Inspection Uniform Federal Policy-Quality Assurance Project Plan Addendum, Army Aviation Support Facility, Waterloo, Iowa dated June 2020* (AECOM, 2020a);
- *Final Site Safety and Health Plan, Army Aviation Support Facility, Waterloo, Iowa dated July 2020* (AECOM, 2020b).

SI field activities included soil and groundwater grab sampling from 5 August to 6 August 2020. Field activities were conducted in accordance with the QAPP Addendum (AECOM, 2020a), except as noted in **Section 5.8**.

The following samples were collected during the SI and analyzed for a subset of 18 PFAS by LC/MS/MS compliant with QSM 5.1 Table B-15 to fulfill the SI DQOs:

- 17 soil grab samples from 6 boring locations;
- 6 groundwater grab samples from 6 temporary well locations; and
- 14 Quality Assurance samples collected.

Figure 5-1 provides the sample locations for all media across the facility. **Table 5-1** presents the list of samples collected for each media. 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**. Sampling forms are provided in **Appendix B2**, and survey data are presented in **Appendix B3**. A Nonconformance and Corrective Action Report 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, SI team members participated in Technical Project Planning (TPP) meetings, performed utility clearance, and sampled decontamination source water. Details for each of these activities are presented below.

5.1.1 Technical Project Planning

The USACE TPP Process, Engineering Manual (EM) 200-1-2 (USACE, 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 quantitative and qualitative DQOs, and formulating a sampling approach to address the AOIs identified in the PA.

A combined TPP Meeting 1 and 2 was held on 28 April 2020, prior to SI field activities. Meeting minutes are provided in **Appendix D**. TPP meetings 1 and 2 were conducted in general accordance with EM 200-1-2.

The stakeholders for this SI include the ARNG, IAARNG, USACE, Iowa Department of Natural Resources, and 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 SI QAPP Addendum (AECOM, 2020a). Future TPP meetings will provide an opportunity to discuss the results and findings, and future actions, where warranted.

5.1.2 Utility Clearance

Utility clearance was conducted by the AECOM field team with assistance from local utilities and IAARNG personnel. AECOM's drilling subcontractor, Cascade Technical Services, LLC, contacted "Iowa 811," the one-call utility clearance contractor to notify them of intrusive work. Additionally, the first 5 feet of each boring were advanced using hand augering methods to verify utility clearance in shallow subsurface soil where utilities would typically be encountered.

5.1.3 Source Water and PFAS Sampling Equipment Acceptability

The potable water source used for decontamination of drilling equipment was confirmed to be PFAS-free prior to the start of field activities. A sample from the Camp Dodge, Johnston, Iowa potable water supply was collected from a water hose at Camp Dodge on 18 September 2019, prior to mobilization, and analyzed for PFAS by LC/MS/MS compliant with QSM 5.1 Table B-15. The results of the Camp Dodge potable well sample are provided in **Appendix G**. A discussion of the results is presented in **Section 4.6.3**.

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 (SOPs) appendix to the QAPP Addendum (AECOM, 2020a). Prior to the start of field work each day, a PFAS Sampling Checklist was completed as an additional layer of control. The checklist served as a daily reminder to each field team member regarding the allowable materials within the sampling environment.

5.2 Soil Borings and Soil Sampling

Soil samples were collected via direct-push technology (DPT) in accordance with the QAPP Addendum (AECOM, 2020a). A GeoProbe® 7822DT dual-tube sampling system was used to collect continuous soil cores to the target depth. A hand auger was used to collect soil from the top five feet of the boring to be compliant with utility clearance procedures.

Two to three discrete soil samples were collected from the vadose zone for chemical analysis from each soil boring, dependent on depth to surficial groundwater. Where possible, one subsurface soil sample was collected approximately 1 foot above the groundwater table, one subsurface soil sample at the mid-point between the ground surface and the groundwater table, and one surface soil sample at the 0 to 2 foot bgs depth interval were collected at each boring using DPT. Deviations from the QAPP Addendum (AECOM, 2020a) are discussed in **Section 5.8**.

The soil boring locations are shown on **Figure 5-1**, and sample depths are provided **Table 5-1**. The soil boring locations were selected based on the AOI information as agreed on through TPP and SI UFP-QAPP Addendum review.

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

Each soil sample was collected into laboratory-supplied PFAS-free high-density polyethylene (HDPE) bottles and labeled using a PFAS-free marker or pen. Samples were packaged on ice and transported via Federal Express (FedEx) under standard chain of custody (CoC) procedures to the laboratory and analyzed for PFAS (LC/MS/MS compliant with QSM 5.1 Table B-15), TOC (USEPA Method 9060A) and pH (USEPA Method 9045D) in accordance with the QAPP Addendum (AECOM, 2020a).

Field duplicate samples were collected at a rate of 10% 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. In instances when non-dedicated sampling equipment was used, such as a hand auger for the shallow soil samples, an equipment rinsate blank was collected at a rate of 5% 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 degrees Celsius (°C) during shipment.

DPT borings were converted to temporary wells, which were subsequently abandoned in accordance with the QAPP Addendum (AECOM, 2020a) using wetted bentonite chips at completion of sampling activities. All borings were installed in grassy areas to avoid disturbing concrete or asphalt surfaces.

5.3 Temporary Well Installation and Groundwater Grab Sampling

Temporary wells were installed using a GeoProbe® 7822DT dual-tube sampling system. Once the borehole was advanced to the desired depth, wherever conditions allowed, a temporary well was constructed of a 5-foot section of 1-inch Schedule 40 poly-vinyl chloride (PVC) screen with sufficient casing to reach ground surface. New PVC pipe and screen were used to avoid cross contamination between locations. The screen intervals for the temporary wells are provided in **Table 5-2**.

The temporary wells were purged for five to ten minutes after installation before collection of groundwater samples. After the recharge period, groundwater samples were collected using a peristaltic pump with PFAS-free HDPE tubing. Each sample was collected into 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**) after each grab sample was collected. Additionally, a subsample of each groundwater sample was collected in a separate container, and a shaker test was completed to identify if there were any foaming. No foaming was noted in any of the groundwater samples.

Each sample was collected into laboratory-supplied PFAS-free HDPE bottles and labeled using a PFAS-free marker or pen. Samples were packaged on ice and transported via FedEx under standard CoC procedures to the laboratory and analyzed for PFAS by LC/MS/MS Compliant with QSM 5.1 Table B-15 in accordance with the QAPP Addendum (AECOM, 2020a).

Field duplicate samples were collected at a rate of 10% 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. One field reagent blank was collected in accordance with the Programmatic UFP-QAPP (AECOM, 2018a). A temperature blank was placed in each cooler to ensure that samples were preserved at or below 6°C during shipment.

Temporary wells were abandoned in accordance with the QAPP Addendum (AECOM, 2020a) by removing the PVC and backfilling the hole with wetted bentonite chips. Temporary wells were installed in grass areas to avoid disturbing concrete or asphalt.

5.4 Synoptic Water Level Measurements

A synoptic groundwater gauging event was performed on 5 to 6 August 2020. Groundwater elevation measurements were collected from the six temporary monitoring wells installed during the SI. Water level measurements were taken from the northern side of the well casing. A groundwater flow contour map is provided in **Figure 2-4**. Groundwater elevation data are provided in **Table 5-3**.

5.5 Surveying

The northern side of each well casing was surveyed by an Iowa-Licensed land surveyor following guidelines provided in the SOPs provided in the SI QAPP Addendum (AECOM, 2020b). Survey data from the newly installed wells on the facility were collected on 7 August 2020 in the Universal Transverse Mercator Zone 15 North projection with World Geodetic System 84 datum. The surveyed well data are provided in **Appendix B3**.

5.6 Investigation-Derived Waste

As of the date of this report, the disposal of PFAS investigation-derived waste (IDW) is not regulated federally. PFAS IDW generated during the SI is considered non-hazardous waste and was managed in accordance with the QAPP Addendum (AECOM, 2020a) and with the Army Guidance for Addressing Releases of PFAS, Q18 (DA, 2018).

Soil IDW (i.e., soil cuttings) generated during the SI activities were left in place at the point of the source. The soil cuttings were distributed on the ground surface on the downgradient side of the boring. The soil IDW was not sampled and assumes the PFAS characteristics of the associated soil samples collected from that source location.

Liquid IDW generated during SI activities (i.e. purge water, development water, and decontamination fluids) were discharged directly to the ground surface slightly downgradient of the source. The liquid IDW was not sampled and assumes the PFAS characteristics of the associated groundwater samples collected from that source location.

Geographic coordinates were collected using a global positioning system around each location where IDW was placed (i.e., an IDW polygon). The IDW polygons are displayed on the figure in **Appendix F**.

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 a subset of 18 PFAS by LC/MS/MS compliant with QSM 5.1 Table B-15 at Pace Analytical Gulf Coast in Baton Rouge, Louisiana, a DoD ELAP and NELAP certified laboratory. The 18 PFAS analyzed as part of the ARNG SI program include the following:

- 6:2 fluorotelomer sulfonate (6:2 FTS)
- 8:2 fluorotelomer sulfonate (8:2 FTS)
- N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)
- N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)
- Perfluorobutyrate (PFBA)
- Perfluorobutanesulfonic acid (PFBS)
- Perfluorodecanoic acid (PFDA)
- Perfluorododecanoic acid (PFDoA)
- Perfluoroheptanoic acid (PFHpA)
- Perfluorohexanoic acid (PFHxA)
- Perfluorohexanesulfonic acid (PFHxS)
- Perfluorononanoic acid (PFNA)
- Perfluorooctanoic acid (PFOA)
- Perfluorooctanesulfonic acid (PFOS)
- Perfluoropentanoic acid (PFPeA)
- Perfluorotetradecanoic acid (PFTeDA)
- Perfluorotridecanoic acid (PFTrDA)
- Perfluoroundecanoic acid (PFUdA)

Soil samples were also analyzed for TOC using USEPA Method 9060A, pH by USEPA Method 9045D, and grain size by ASTM D-422.

5.8 Deviations from QAPP Addendum

Deviations from the QAPP Addendum occurred based on field conditions and discussion between AECOM, ARNG, and USACE. Deviations from the QAPP Addendum are noted below and are documented in the Nonconformance and Corrective Action Report:

The QAPP Addendum stated that three soil samples were to be collected from each direct-push boring location at representative depths of the surface soil, vadose soil, and intermediate soil. However, one out of six direct-push locations (AOI02-03) had a depth-to-water of approximately 5 feet bgs during drilling activities. Therefore, soil samples at these borings could only be collected from two depth intervals (0-2 feet bgs and 3-5 feet bgs) instead of three depth intervals. This action was documented in a Nonconformance and Corrective Action Report provided in **Appendix B4**.

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Table 5-1
Site Inspection Samples by Medium
Site Inspection Report, Waterloo AASF, Iowa

Sample Identification	Sample Collection Date	Sample Depth (feet bgs)	PFAS (LC/MS/MS compliant with QSM 5.1 Table B-15)	TOC (USEPA Method 9060A)	pH (USEPA Method 9045D)	Grain Size (ASTM D-422)	Comments
Soil Samples							
WTL-AOI01-01-SB-0-2	8/5/2020	0 - 2	x				
WTL-AOI01-01-SB-0-2-MS	8/5/2020	0 - 2	x				MS/MSD
WTL-AOI01-01-SB-0-2-MSD	8/5/2020	0 - 2	x				MS/MSD
WTL-AOI01-01-SB-4-6	8/5/2020	4 - 6	x				
WTL-AOI01-01-SB-4-6-FD	8/5/2020	4 - 6	x				Field Duplicate
WTL-AOI01-01-8-10	8/5/2020	8 - 10	x				
WTL-AOI01-02-SB-0-2	8/5/2020	0 - 2	x				
WTL-AOI01-02-SB-4-6	8/5/2020	4 - 6	x			x	
WTL-AOI01-02-SB-8-10	8/5/2020	8 - 10	x				
WTL-AOI02-01-SB-0-2	8/5/2020	0 - 2	x				
WTL-AOI02-01-SB-4-6	8/5/2020	4 - 6	x			x	
WTL-AOI02-01-SB-8-10	8/5/2020	8 - 10	x				
WTL-AOI02-02-SB-0-2	8/6/2020	0 - 2	x	x	x		
WTL-AOI02-02-SB-0-2-FD	8/6/2020	0 - 2		x	x		Field Duplicate
WTL-AOI02-02-SB-4-6	8/6/2020	4 - 6	x				
WTL-AOI02-02-SB-8-10	8/6/2020	8 - 10	x				
WTL-AOI02-03-SB-0-2	8/5/2020	0 - 2	x				
WTL-AOI02-03-SB-3-5	8/5/2020	3 - 5	x				
WTL-AOI02-03-SB-3-5-FD	8/5/2020	3 - 5	x				Field Duplicate
WTL-01-SB-0-2	8/5/2020	0 - 2	x	x	x		
WTL-01-SB-0-2-MS	8/5/2020	0 - 2		x	x		MS/MSD
WTL-01-SB-0-2-MSD	8/5/2020	0 - 2		x	x		MS/MSD
WTL-01-SB-6-8	8/5/2020	6 - 8	x				
WTL-01-SB-13-15	8/5/2020	13 - 15	x				
Groundwater Samples							
WTL-AOI01-01-GW	8/5/2020	5 - 10	x				
WTL-AOI01-01-GW-FD	8/5/2020	5 - 10	x				Field Duplicate
WTL-AOI01-02-GW	8/5/2020	10 - 15	x				
WTL-AOI01-02-GW-MS	8/5/2020	10 - 15	x				MS/MSD
WTL-AOI01-02-GW-MSD	8/5/2020	10 - 15	x				MS/MSD
WTL-AOI02-01-GW	8/6/2020	10 - 15	x				
WTL-AOI02-02-GW	8/6/2020	10 - 15	x				
WTL-AOI02-03-GW	8/5/2020	5 - 10	x				
WTL-01-GW	8/5/2020	10 - 15	x				
Blank Samples							
CAMP DODGE DECON	9/18/2019	NA	x				Decontamination Water Blank
FRB-072919	9/18/2019	NA	x				Field Reagent Blank
WTL-ERB-01	8/5/2020	NA	x				Equipment Rinsate Blank
WTL-FRB-01	8/5/2020	NA	x				Field Reagent Blank

Notes:
AASF = Army Aviation Support Facility
AOI = Area of Interest
ASTM = American Society for Testing Materials
bgs = below ground surface
ERB = equipment rinsate blank
FD = field duplicate
FRB = field reagent blank
GW = groundwater
LC/MS/MS = liquid chromatography with tandem mass spectrometry
MS/MSD = matrix spike/ matrix spike duplicate
NA = not applicable
PFAS = per- and polyfluoroalkyl substances
pH = potential for hydrogen
QSM = Quality Systems Manual
SB = soil boring
TOC = total organic carbon
USEPA = United States Environmental Protection Agency

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Table 5-2
Soil Boring Depths and Temporary Well Screen Intervals
Site Inspection Report, Waterloo AASF, Iowa

Area of Interest	Soil Boring ID	Soil Boring Depth (feet bgs)	Temporary Well Screen Interval (feet bgs)
AOI 1	AOI01-01-SB	15	5 - 10
	AOI01-02-SB	15	10 - 15
AOI 2	AOI02-01-SB	15	10 - 15
	AOI02-02-SB	15	10 - 15
	AOI02-03-SB	10	5 - 10
Upgradient Facility Boundary	WTL-01-SB	20	10 - 15

Notes:

AOI = area of interest

bgs = below ground surface

ID = identification

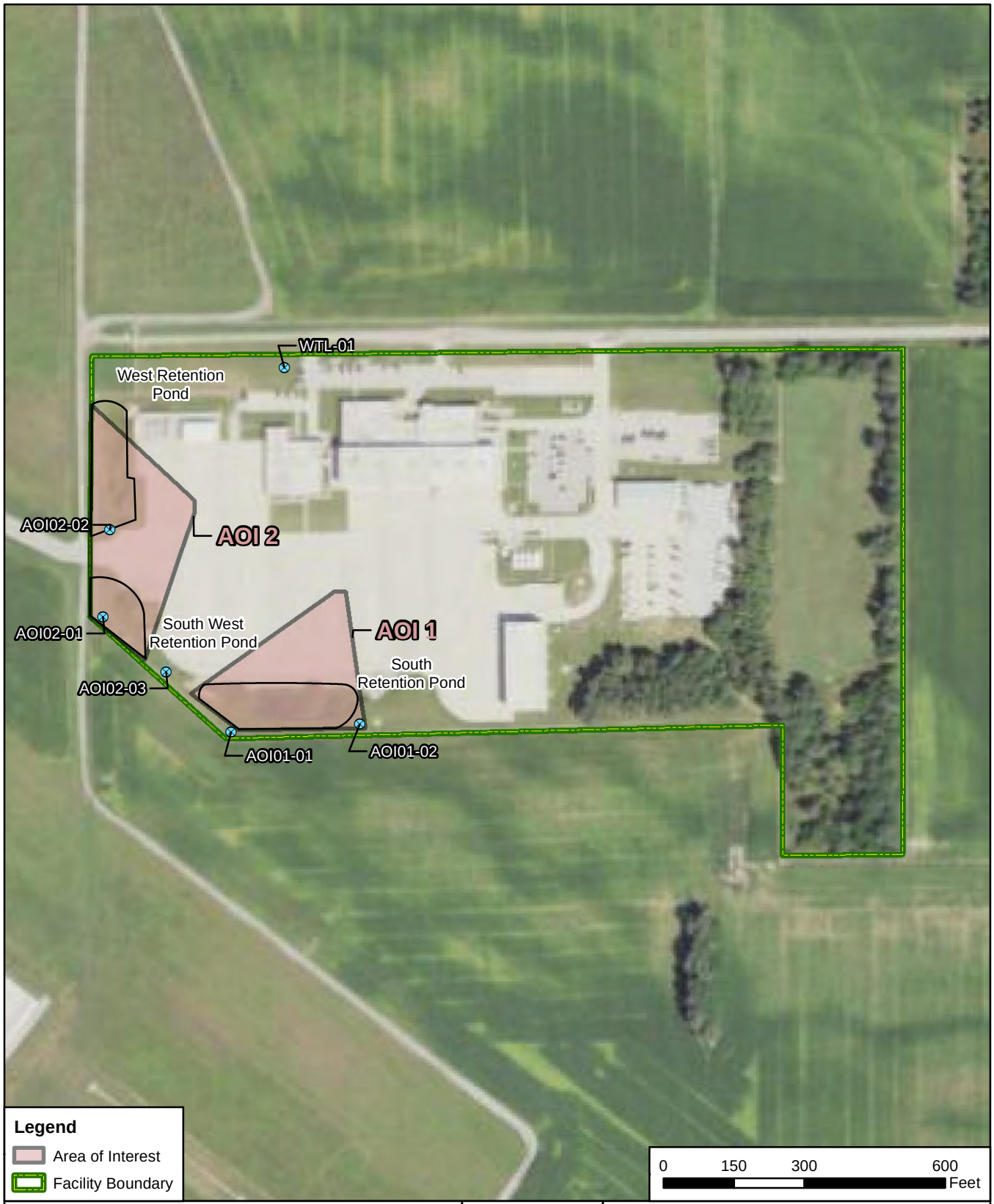
SB = soil boring

WTL = Waterloo

Table 5-3
Groundwater Elevations at Temporary Groundwater Monitoring Wells
Site Inspection Report, Waterloo AASF, Iowa

Temporary Groundwater Monitoring Well ID	Ground Surface Elevation (feet amsl)	Depth to Water (feet bgs)	Groundwater Elevation (feet amsl)
AOI01-01	864.70	6.60	858.10
AOI01-02	865.56	7.20	858.36
AOI02-01	865.02	6.90	858.12
AOI02-02	865.29	6.70	858.59
AOI02-03	863.10	4.70	858.40
WTL-01	871.38	12.1	859.28

Notes:
amsl = above mean sea level
bgs = below ground surface
ID = identification
AOI = Area of Interest
WTL = Waterloo



CLIENT	ARNG			
NOTES	Site Inspection for PFAS at Waterloo AASF, IA			
REVISED	1/12/2021	GIS BY	MS	1/12/2021
SCALE	1:3,600	CHK BY	JW	1/12/2021
Base Map: National Agricultural Imagery Program, 2016.		PM	RG	1/12/2021

N

Site Inspection Sample Locations

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 5-1

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6. Site Inspection Results

This section presents the analytical results of the SI for each AOI. The SLs used in this evaluation are presented in **Section 6.1**. A discussion of the results for each AOI is provided in **Section 6.3** through **Section 6.5**. **Table 6-2** through **Table 6-4** present PFAS results for samples with detections in soil or groundwater; only constituents detected in one or more samples are included. Tables that contain all results are provided in **Appendix G**, and the laboratory reports are provided in **Appendix H**.

6.1 Screening Levels

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 15 October 2019 (Assistant Secretary of Defense, 2019). The ARNG program under which this SI was performed follows this DoD policy. Should the maximum concentration for sampled media exceed the SLs established in the OSD memorandum, the AOI will proceed to an RI, the next phase under CERCLA. The SLs apply to three compounds, PFOA, PFOS, and PFBS, for both soil and groundwater, as presented in **Table 6-1**.

All other results presented in this report are considered informational in nature and serve as an indication as to whether soil and groundwater contain or do not contain PFAS within the boundaries of the facility.

Table 6-1 Screening Levels (Soil and Groundwater)

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

Notes:
a.) Assistant Secretary of Defense, 2019. 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 October 2019.
bgs = below ground surface
ng/L = nanograms per liter
µg/Kg = micrograms per kilogram

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 G** 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 (Koc 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).

6.3 AOI 1

This section presents the analytical results for soil and groundwater in comparison to SLs for AOI 1, which includes one potential PFAS release area: Middle Ramp Fire Extinguisher Training. The detected compounds in soil and groundwater are summarized on **Table 6-2** through **Table 6-4**. The detections of PFOS and PFOA in soil and groundwater are presented on **Figure 6-1** through **Figure 6-3**.

6.3.1 AOI 1 Soil Analytical Results

Soil was sampled at AOI 1 from three depth intervals at boring locations AOI01-01 and AOI01-02 during the SI: shallow (0 to 2 feet bgs), intermediate (4 to 6 feet bgs), and deep (8 to 10 feet bgs). PFOA was detected in the shallow soil interval at concentrations ranging from 0.243 J micrograms per kilogram (µg/Kg) to 0.431 J µg/Kg but was not detected in the intermediate or deep soil intervals. PFOS was detected in the intermediate soil interval at 0.372 J µg/Kg but was not detected in the shallow or deep soil intervals. PFBS was not detected in soil at AOI 1.

6.3.2 AOI 1 Groundwater Analytical Results

Groundwater samples were collected from two temporary monitoring well locations at AOI 1 during the SI: WTL-AOI01-01-GW and WTL-AOI01-02-GW. The SL of 40 ng/L for PFOA in groundwater was exceeded at WTL-AOI01-01-GW and WTL-AOI01-02-GW, with concentrations of 231 ng/L and 65.0 ng/L, respectively. PFOS was detected below the SL of 40 ng/L in both temporary well locations, with concentrations ranging from 7.93 J ng/L to 25.5 ng/L. PFBS was detected below the SL of 40,000 ng/L in both temporary well locations, with concentrations ranging from 4.03 J ng/L to 5.68 J ng/L in samples WTL-AOI01-02-GW and WTL-AOI01-01-GW-FD, respectively.

6.3.3 AOI 1 Conclusions

Based on the results of the SI, PFOA, PFOS, and PFBS were detected in soil and groundwater at AOI 1. The detected concentrations of PFOA, PFOS, and PFBS in soil were at least an order of magnitude lower than the individual soil SLs. PFOA was detected in groundwater at concentrations exceeding the individual SL of 40 ng/L. The detected concentrations of PFOS and PFBS in groundwater were below their respective SLs. Based on the exceedances of the SLs for PFOA in groundwater, further evaluation at AOI 1 is warranted.

6.4 AOI 2

This section presents the analytical results for soil and groundwater in comparison to SLs for AOI 2, which includes one potential PFAS release area: West Ramp Fire Extinguisher Training. The detected compounds in soil and groundwater are summarized on **Table 6-2** through **Table 6-4**. The detections of PFOS and PFOA in soil and groundwater are presented on **Figure 6-1** through **Figure 6-3**.

6.4.1 AOI 2 Soil Analytical Results

Soil was sampled at AOI 2 from three depth intervals at boring locations AOI02-01 and AOI02-02, and two depth intervals at AOI02-03 during the SI: shallow (0 to 2 feet bgs), intermediate (3 to 6 feet bgs), and deep (8 to 10 feet bgs). Soil was not collected from a third interval at AOI02-03 due

to shallow surficial groundwater, which was encountered at approximately 5 feet bgs during drilling (**Section 5.8**). PFOA was detected in the shallow and intermediate soil intervals, at concentrations ranging from 0.207 J µg/Kg to 1.14 µg/Kg, but it not detected in the deep soil interval. PFOS was detected in all three soil intervals, at concentrations ranging from 0.224 J µg/Kg to 0.384 J µg/Kg. PFBS was not detected in soil at AOI 2.

6.4.2 AOI 2 Groundwater Analytical Results

Groundwater samples were collected from three temporary monitoring well locations at AOI 2 during the SI: WTL-AOI02-01-GW, WTL-AOI02-02-GW, and WTL-AOO02-03-GW. The SL of 40 ng/L for PFOA in groundwater was exceeded at WTL-AOI02-01-GW, with a concentration of 130 ng/L. PFOA was also detected at concentrations below the SL at WTL-AOI02-02-GW and WTL-AOO02-03-GW, with concentrations ranging from 4.30 J ng/L to 8.05 J ng/L. PFOS was detected below the SL of 40 ng/L at all three temporary monitoring well locations, with concentrations ranging from 4.08 J ng/L to 13.1 ng/L. PFBS was detected below the SL of 40,000 ng/L at two temporary well locations, with concentrations ranging from 2.35 J ng/L to 18.8 ng/L.

6.4.3 AOI 2 Conclusions

Based on the results of the SI, PFOA, PFOS, and PFBS were detected in soil and groundwater at AOI 2. The detected concentrations of PFOA, PFOS, and PFBS in soil were at least an order of magnitude lower than the individual soil SLs. PFOA was detected in groundwater at a concentration exceeding the individual SL of 40 ng/L. The detected concentrations of PFOS and PFBS in groundwater were below their respective SLs. Based on the exceedance of the SL for PFOA in groundwater, further evaluation at AOI 2 is warranted.

6.5 Upgradient Facility Boundary

This section presents the analytical results for soil and groundwater in comparison to SLs for the Upgradient Facility Boundary, which was sampled to examine potential off-facility sources of PFAS located upgradient of Waterloo AASF. The detected compounds in soil and groundwater are summarized on **Table 6-2** through **Table 6-4**. The detections of PFOS and PFOA in soil and groundwater are presented on **Figure 6-1** through **Figure 6-3**.

6.5.1 Upgradient Facility Boundary Soil Analytical Results

Soil was sampled at the Upgradient Facility Boundary from three intervals at boring location WTL-01: shallow (0 to 2 feet bgs), intermediate (6 to 8 feet bgs), and deep (13 to 15 feet bgs). PFOA was detected in soil at WTL-01 in the shallow interval at a concentration of 0.220 J µg/Kg, but it was not detected in the intermediate or deep intervals. PFOS and PFBS were not detected in soil at WTL-01.

6.5.2 Upgradient Facility Boundary Groundwater Analytical Results

Groundwater was collected from one temporary monitoring well installed at WTL-01 during the SI: WTL-01-GW. PFOA was detected below the SL of 40 ng/L, at a concentration of 11.1 ng/L. PFOS and PFBS were not detected in groundwater collected at WTL-01.

6.5.3 Upgradient Facility Boundary Conclusions

Based on the results of the SI, PFOA was detected in soil and groundwater at the Upgradient Facility Boundary. The detected soil and groundwater concentrations were below the SLs. Based on the detected concentrations of PFOA in soil and groundwater, no further action is warranted at the Upgradient Facility Boundary.

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Table 6-2
PFAS Detections in Surface Soil
Site Inspection Report, Waterloo AASF, Iowa

Area of Interest		AOI 1				AOI 2						Upgradient Facility Boundary	
Sample ID		WTL-AOI01-01-SB-0-2		WTL-AOI01-02-SB-0-2		WTL-AOI02-01-SB-0-2		WTL-AOI02-02-SB-0-2		WTL-AOI02-03-SB-0-2		WTL-01-SB-0-2	
Sample Date		08/05/2020		08/05/2020		08/05/2020		08/06/2020		08/05/2020		08/05/2020	
Depth		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**
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (µg/kg)													
PFBA	-	ND		0.143	J	ND		ND		ND		ND	
PFHxA	-	ND		ND		0.157	J	ND		ND		ND	
PFHxS	-	ND		ND		0.378	J	ND		ND		ND	
PFOA	130	0.243	J	0.431	J	1.14		0.312	J	0.207	J	0.220	J
PFOS	130	ND		ND		0.318	J	0.300	J	0.384	J	ND	

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

Chemical Abbreviations

PFAS	per- and polyfluoroalkyl substances
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
ft	feet
HQ	Hazard quotient
ID	Identifier
LCMSMS	Liquid Chromatography Mass Spectrometry
ND	Analyte not detected above the limit of detection
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SB	Soil boring
USEPA	United States Environmental Protection Agency
ug/kg	micrograms per kilogram
WTL	Waterloo
-	Not applicable

Table 6-3
PFAS Detections in Subsurface Soil
Site Inspection Report, Waterloo AASF, Iowa

Area of Interest		AOI 1										AOI 2							
Sample ID		WTL-AOI01-01-SB-4-6		WTL-AOI01-01-SB-4-6-FD		WTL-AOI01-01-SB-8-10		WTL-AOI01-02-SB-4-6		WTL-AOI01-02-SB-8-10		WTL-AOI02-01-SB-4-6		WTL-AOI02-01-SB-8-10		WTL-AOI02-02-SB-4-6		WTL-AOI02-02-SB-8-10	
Sample Date		08/05/2020		08/05/2020		08/05/2020		08/05/2020		08/05/2020		08/05/2020		08/05/2020		08/06/2020		08/06/2020	
Depth		4 - 6 ft		4 - 6 ft		8 - 10 ft		4 - 6 ft		8 - 10 ft		4 - 6 ft		8 - 10 ft		4 - 6 ft		8 - 10 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)																			
PFOA	1600	ND		ND		ND		ND		ND		ND		ND		ND		ND	
PFOS	1600	ND		0.372	J	ND		ND		ND		0.236	J	ND		ND		ND	

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

Chemical Abbreviations

PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
FD	Feld duplicate
ft	feet
HQ	Hazard quotient
ID	Identifier
LCMSMS	Liquid Chromatography Mass Spectrometry
ND	Analyte not detected above the limit of detection
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
WTL	Waterloo
-	Not applicable

Table 6-3
PFAS Detections in Subsurface Soil
Site Inspection Report, Waterloo AASF, Iowa

Area of Interest		AOI 2				Upgradient Facility Boundary			
Sample ID		WTL-AOI02-03-SB-3-5		WTL-AOI02-03-SB-3-5-FD		WTL-01-SB-6-8		WTL-01-SB-13-15	
Sample Date		08/05/2020		08/05/2020		08/05/2020		08/05/2020	
Depth		3 - 5 ft		3 - 5 ft		6 - 8 ft		13 - 15 ft	
Analyte	OSD Screening Level [a]	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (µg/kg)									
PFOA	1600	ND		0.321	J	ND		ND	
PFOS	1600	ND		0.224	J	ND		ND	

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

Chemical Abbreviations

PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
FD	Field duplicate
ft	feet
HQ	Hazard quotient
ID	Identifier
LCMSMS	Liquid Chromatography Mass Spectrometry
ND	Analyte not detected above the limit of detection
OSD	Office of the Secretary of Defense
PFAS	per- and polyfluoroalkyl substances
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SB	Soil boring
USEPA	United States Environmental Protection Agency
µg/kg	micrograms per kilogram
WTL	Waterloo
-	Not applicable

Table 6-4
PFAS Detections in Groundwater
Site Inspection Report, Waterloo AASF, Iowa

Area of Interest		AOI 1						AOI 2						Upgradient Facility Boundary	
Sample ID		WTL-AOI01-01-GW		WTL-AOI01-01-GW-FD		WTL-AOI01-02-GW		WTL-AOI02-01-GW		WTL-AOI02-02-GW		WTL-AOI02-03-GW		WTL-01-GW	
Sample Date		08/05/2020		08/05/2020		08/05/2020		08/06/2020		08/06/2020		08/05/2020		08/05/2020	
Analyte	OSD Screening Level [a]	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)															
PFBA	-	12.0		12.9		2.58	J	3.57	J	8.31	J	3.66	J	ND	
PFBS	40000	5.28	J	5.68	J	4.03	J	ND		18.8		2.35	J	ND	
PFHpA	-	2.48	J	2.40	J	ND		2.18	J	ND		ND		ND	
PFHxA	-	5.32	J	4.81	J	ND		3.73	J	2.72	J	2.12	J	ND	
PFHxS	-	12.3		13.9		11.3		16.1		ND		ND		2.57	J
PFNA	-	2.64	J	2.77	J	ND		ND		ND		ND		ND	
PFOA	40	231		227		65.0		130		4.30	J	8.05	J	11.1	
PFOS	40	25.5		25.5		7.93	J	13.1		4.08	J	6.27	J	ND	

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.

Interpreted Qualifiers

J = Estimated concentration

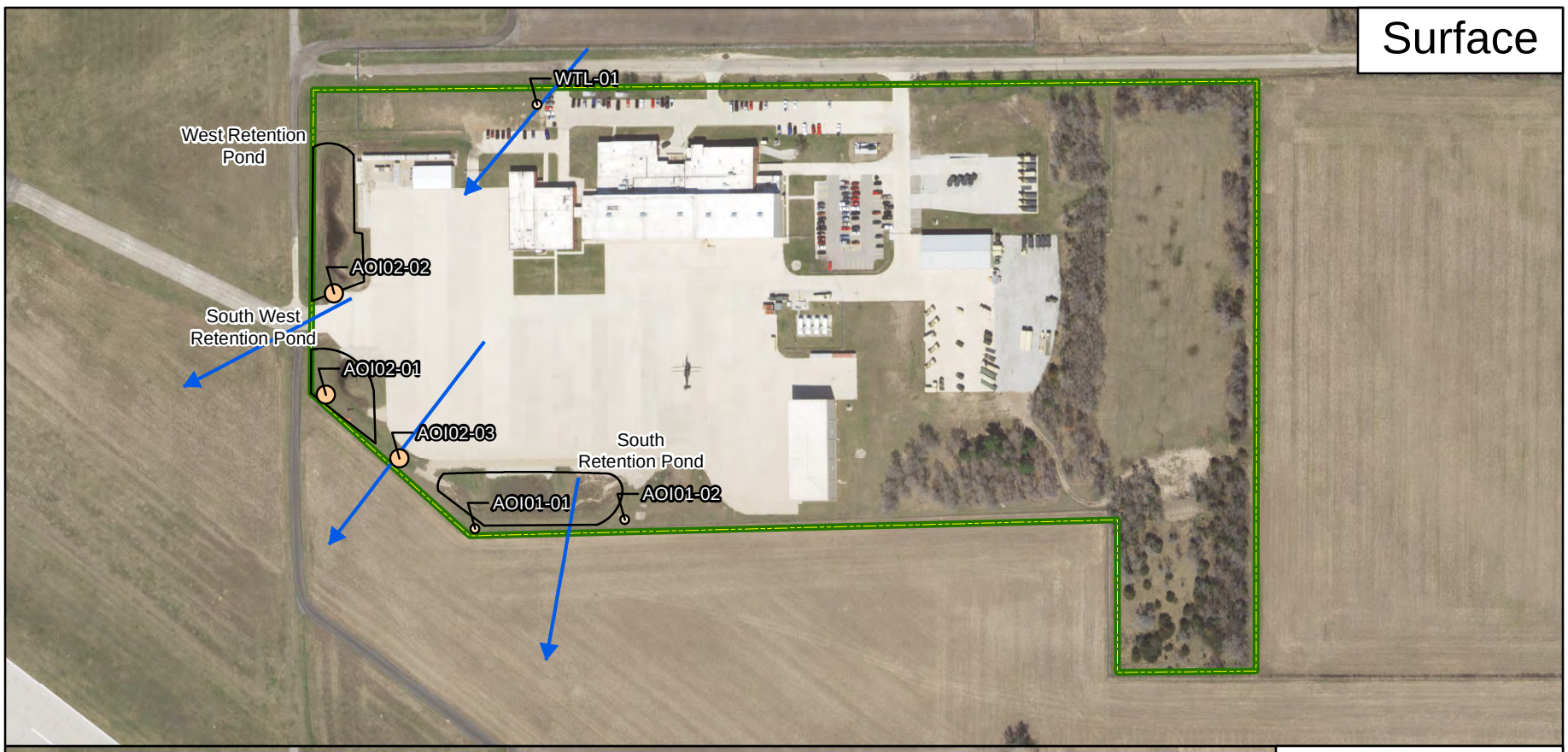
Chemical Abbreviations

PFAS	per- and polyfluoroalkyl substances
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

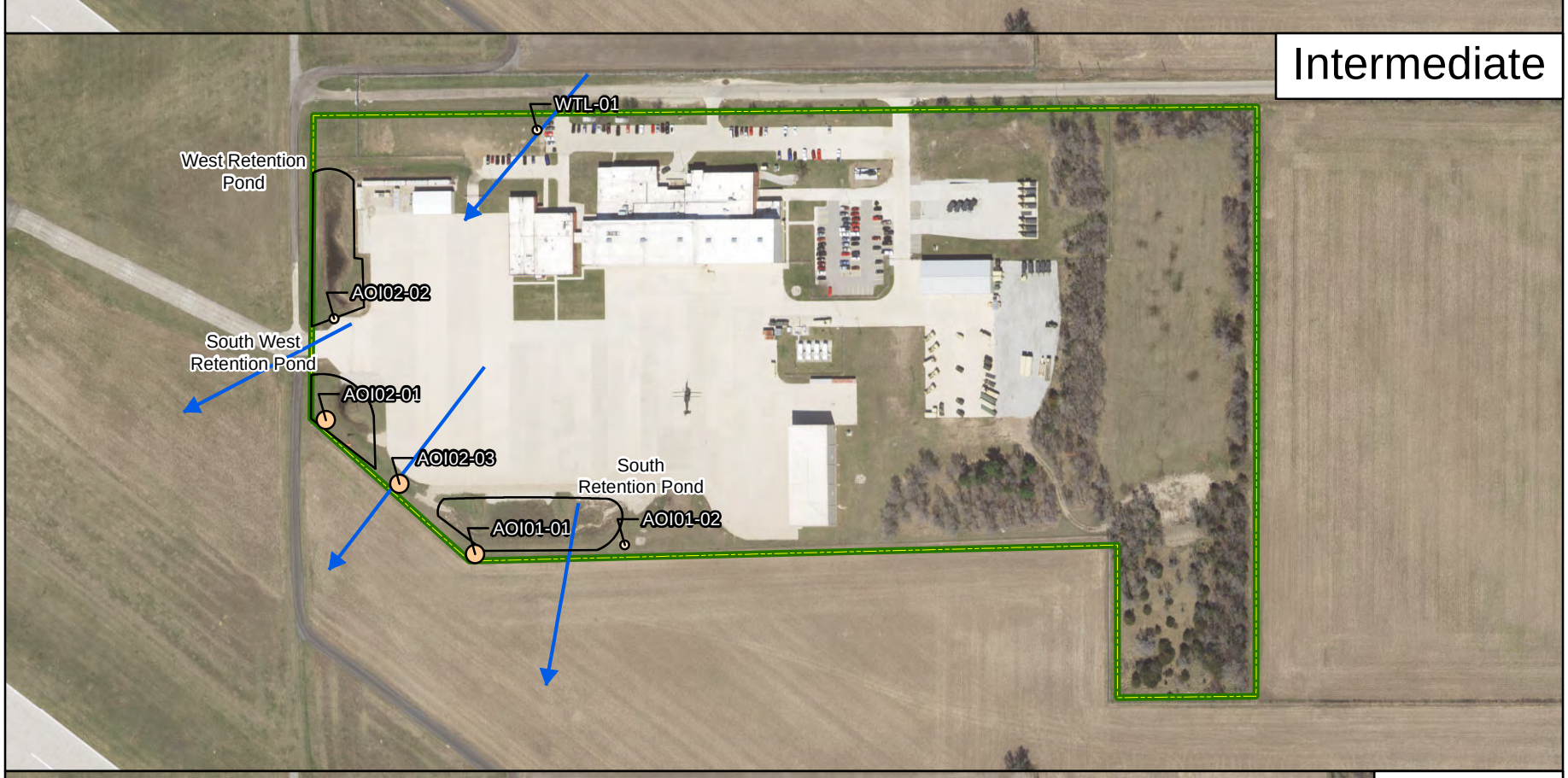
Acronyms and Abbreviations

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

Surface



Intermediate



Deep

Legend

- Facility Boundary
- Groundwater Flow Direction

PFOS Results (ug/kg)

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

0 150 300 600 Feet

PFOS Detections in Soil

CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Waterloo AASF, IA			
REVISED	1/12/2021	GIS BY	MS	1/12/2021
SCALE	1:3,600	CHK BY	JW	1/12/2021
Base Map: State of Iowa Homeland Security and Emergency Management, Iowa State University GIS Facility		PM	RG	1/12/2021

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 6-1

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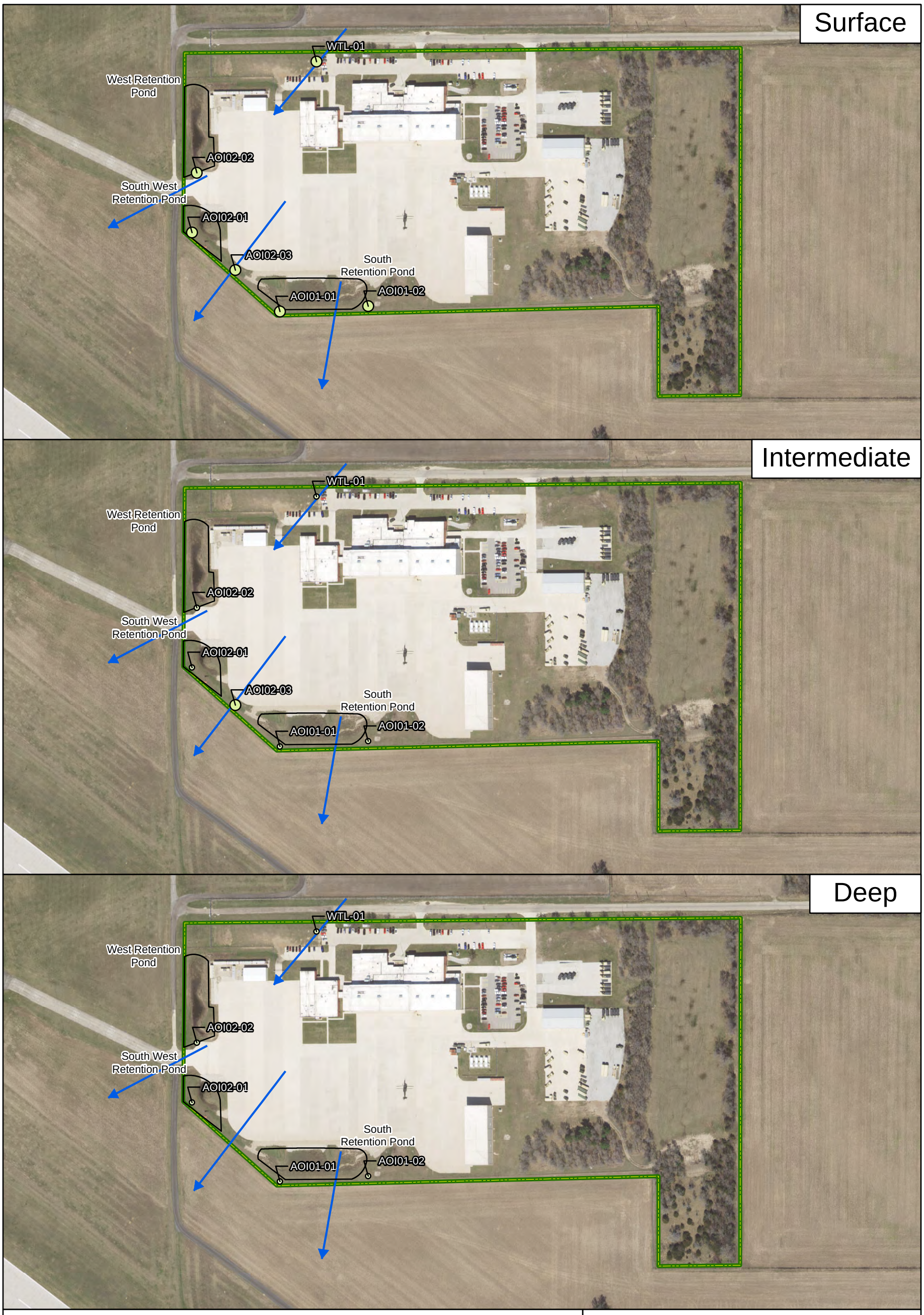

Legend

Groundwater Flow Direction

PFOA Results (µg/Kg)

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

0 150 300 600 Feet

PFOA Detections in Soil

CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Waterloo AASF, IA			
REVISED	1/12/2021	GIS BY	MS	1/12/2021
SCALE	1:3,600	CHK BY	JW	1/12/2021
Base Map: State of Iowa Homeland Security and Emergency Management, Iowa State University GIS Facility		PM	RG	1/12/2021

AECOM 12420 Milestone Center Drive Germantown, MD 20876

Figure 6-2

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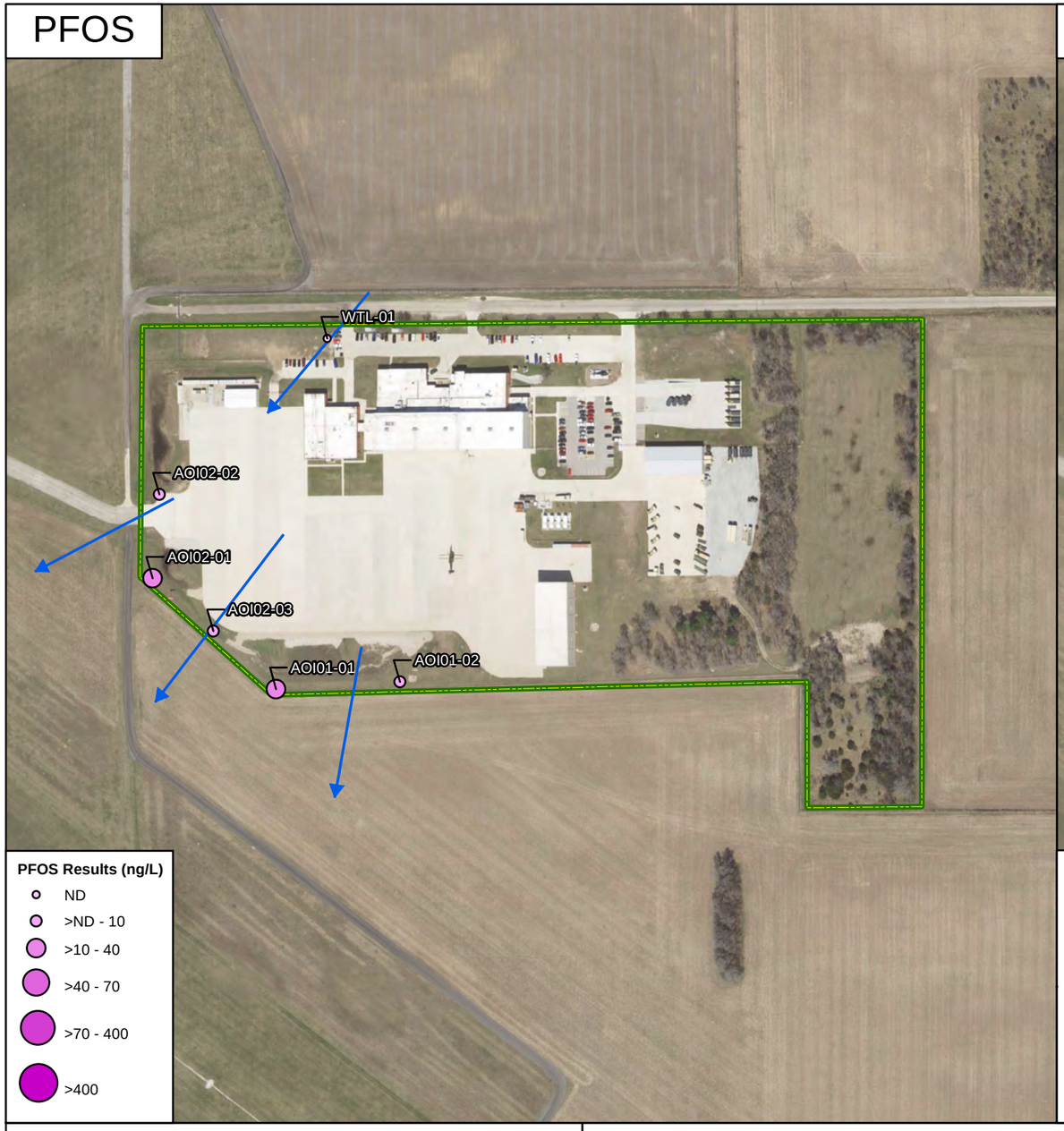
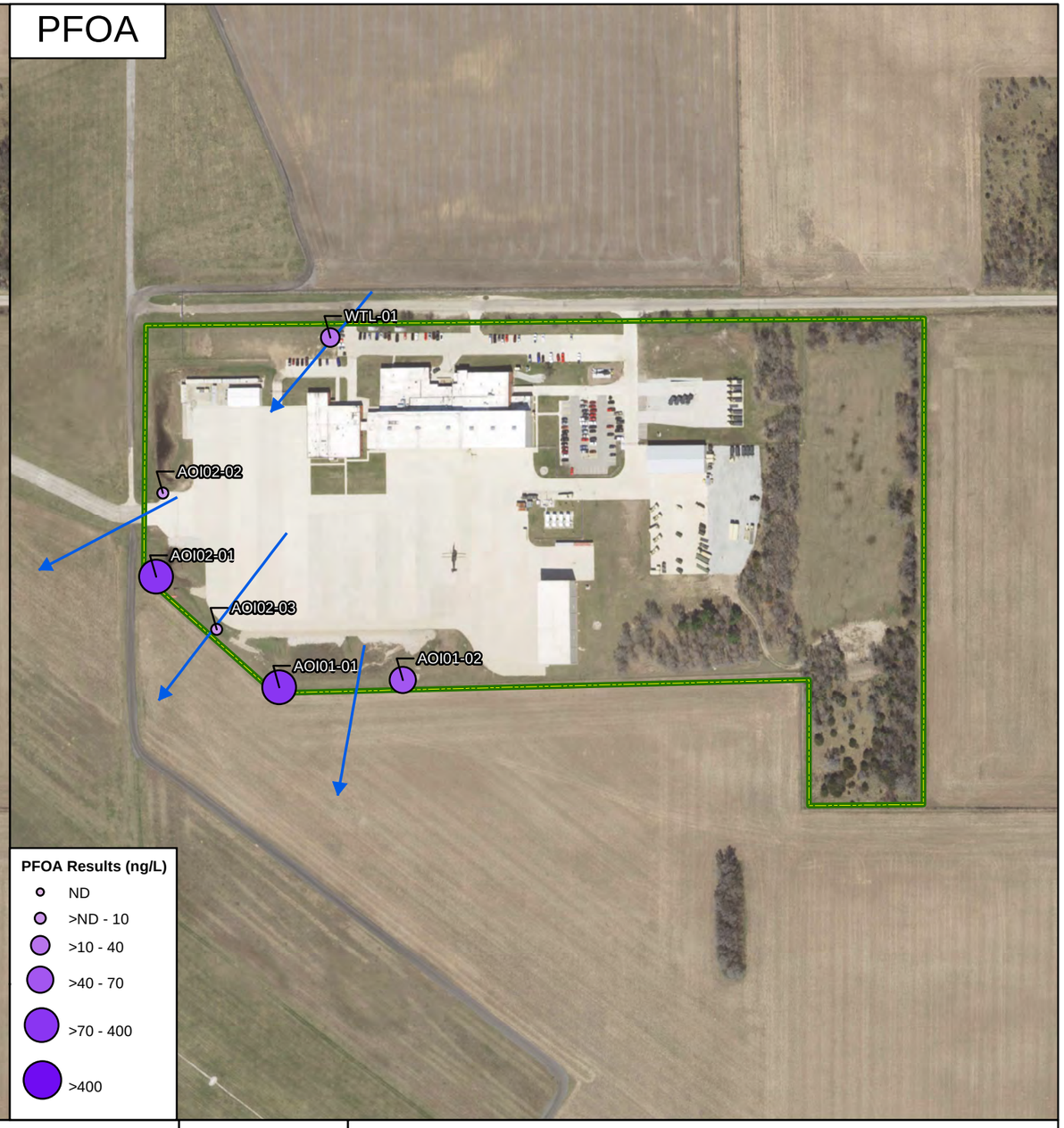
PFOS



PFOS Results (ng/L)

- ND
- >ND - 10
- >10 - 40
- >40 - 70
- >70 - 400
- >400

PFOA



PFOA Results (ng/L)

- ND
- >ND - 10
- >10 - 40
- >40 - 70
- >70 - 400
- >400

CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Waterloo AASF, IA			
REVISED	4/23/2021	GIS BY	MS	4/23/2021
SCALE	1:3,600	CHK BY	JW	4/23/2021
Base Map: State of Iowa Homeland Security and Emergency Management, Iowa State University GIS Facility		PM	RG	4/23/2021

Legend

- Facility Boundary
- Groundwater Flow Direction

0 150 300 600 Feet

N

PFOS and PFOA Detections in Groundwater

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 6-3

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7. Exposure Pathways

The CSMs for each AOI, revised based on the SI findings, are presented on **Figure 7-1**. 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:

1. Contaminant source;
2. Environmental fate and transport;
3. Exposure point;
4. Exposure route; and
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 an incomplete pathway generally warrant no further action. However, the pathway is considered potentially complete if PFOA, PFOS, or PFBS 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 PFOA, PFOS, or PFBS above the SLs. Areas with an identified potentially complete pathway may warrant further investigation.

In general, the potential routes of exposure to PFAS 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 PFAS toxicological study. The receptors evaluated are consistent with those listed in USEPA guidance for risk screening (USEPA, 2001). Receptors at the facility include site workers (e.g., facility staff and visiting soldiers), construction workers, trespassers (though unlikely due to restricted access), residents outside the facility boundary, and recreational users outside of the facility boundary. The CSMs for each AOI, revised based on the SI findings, are presented on **Figure 7-1**.

7.1 Soil Exposure Pathway

The SI results for PFOA, PFOS, and PFBS in 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

PFAS were potentially released to concrete pads surrounded by cracked asphalt at AOI 1 during fire extinguisher training by the IAARNG. The potential release occurred between 2001 and 2003. PFAS may have been released directly to surface soil through cracks in the asphalt on the ramp. The potential PFAS released also may have migrated via overland flow to the surface soil south of the middle ramp area. A ramp expansion in 2007 or 2008 replaced cracked asphalt on the ramp and created retention ponds to the west, southwest, and south of the ramp. The final disposition of the cracked asphalt is unknown. An unknown amount of soil surrounding the ramp was disturbed and removed during the ramp expansion.

PFOS and PFOA were detected in soil at AOI 1 and confirm the release of PFAS to soil in AOI 1. Based on the results of the SI in AOI 1, ground-disturbing activities could potentially result in site

worker, future construction worker, and trespasser exposure to PFOS and PFOA via inhalation of dust or incidental ingestion of surface soil. Ground-disturbing activities could potentially result in future construction worker exposure to subsurface soil during trenching activities. No current construction is occurring at AOI 1. The CSM is presented on **Figure 7-1**.

7.1.2 AOI 2

PFAS were potentially released to concrete at AOI 2 by the IAARNG during fire extinguisher training between 2011 and 2013. The potential PFAS releases to concrete at AOI 2 may have washed into the retention ponds on the west and southwest of the ramp via overland flow into surface water, sediment, and surface soil. The Waterloo AASF facility currently houses Tri-Max™ and Halotron fire extinguishers. Halotron fire extinguishers, which do not contain PFAS, are intended to replace the Tri-Max™ extinguishers. Currently, two Tri-Max™ 30 fire extinguishers are stored on the ramp immediately outside the hangar, one Tri-Max™ 60 fire extinguisher is located in the building east of the hangar, and five Halotron fire extinguishers are stored on the ramp. Bulk AFFF is stored at the facility and used to refill the Tri-Max™ fire extinguishers after off-facility hydrostatic testing has been completed. Four 5-gallon containers of 6% AFFF were observed at the Waterloo AASF during the visual site inspection (AECOM, 2019). PFAS are water soluble and can migrate readily from soil to groundwater via leaching. As such, PFAS could potentially migrate to subsurface soil and groundwater.

PFOS and PFOA were detected in soil at AOI 2 and confirm the release of PFAS to soil in AOI 2. Based on the results of the SI in AOI 2, ground-disturbing activities could potentially result in site worker, future construction worker, and trespasser exposure to PFOS and PFOA via inhalation of dust or incidental ingestion of surface soil. Ground-disturbing activities could potentially result in future construction worker exposure to subsurface soil during trenching activities. No current construction is occurring at AOI 2. The CSM is presented on **Figure 7-1**.

7.2 Groundwater Exposure Pathway

No potable water wells are located within the Waterloo AASF; however, domestic and municipal/public water supply wells exist within 4 miles of the facility. Drinking water for the Waterloo AASF is supplied by the City of Waterloo. Drinking water for the City of Waterloo is predominantly sourced from the limestone bedrock Cedar Valley Aquifer, although some of Waterloo's water supply is obtained from an alluvial aquifer along the Cedar River. Drinking water wells in and around the City of Waterloo range in depth from 76 feet to 225 feet (Waterloo Water Works, 2018).

The SI results for PFOA, PFOS, and PFBS in groundwater were used to determine whether a potentially complete exposure pathway exists between the source and future construction workers at AOI 1, as well as off-facility residents, based on the aforementioned criteria.

7.2.1 AOI 1

PFOA, PFOS, and PFBS were detected in groundwater from two temporary monitoring wells at AOI 1, confirming the migration of PFAS to groundwater in AOI 1. PFOA exceeded the individual SL for this compound. The incidental groundwater exposure pathway is potentially complete for construction workers during trenching activities deep enough to encounter shallow groundwater. The exposure pathway is also potentially complete for off-facility residential drinking water receptors. The CSM is presented on **Figure 7-1**.

7.2.2 AOI 2

PFOA, PFOS, and PFBS were detected in groundwater from three temporary monitoring wells at AOI 2, confirming the migration of PFAS to groundwater in AOI 2. PFOA exceeded the individual SL for this compound. The incidental groundwater exposure pathway is potentially complete for construction workers during trenching activities deep enough to encounter shallow groundwater. The exposure pathway is also potentially complete for off-facility residential drinking water receptors. The CSM is presented on **Figure 7-1**.

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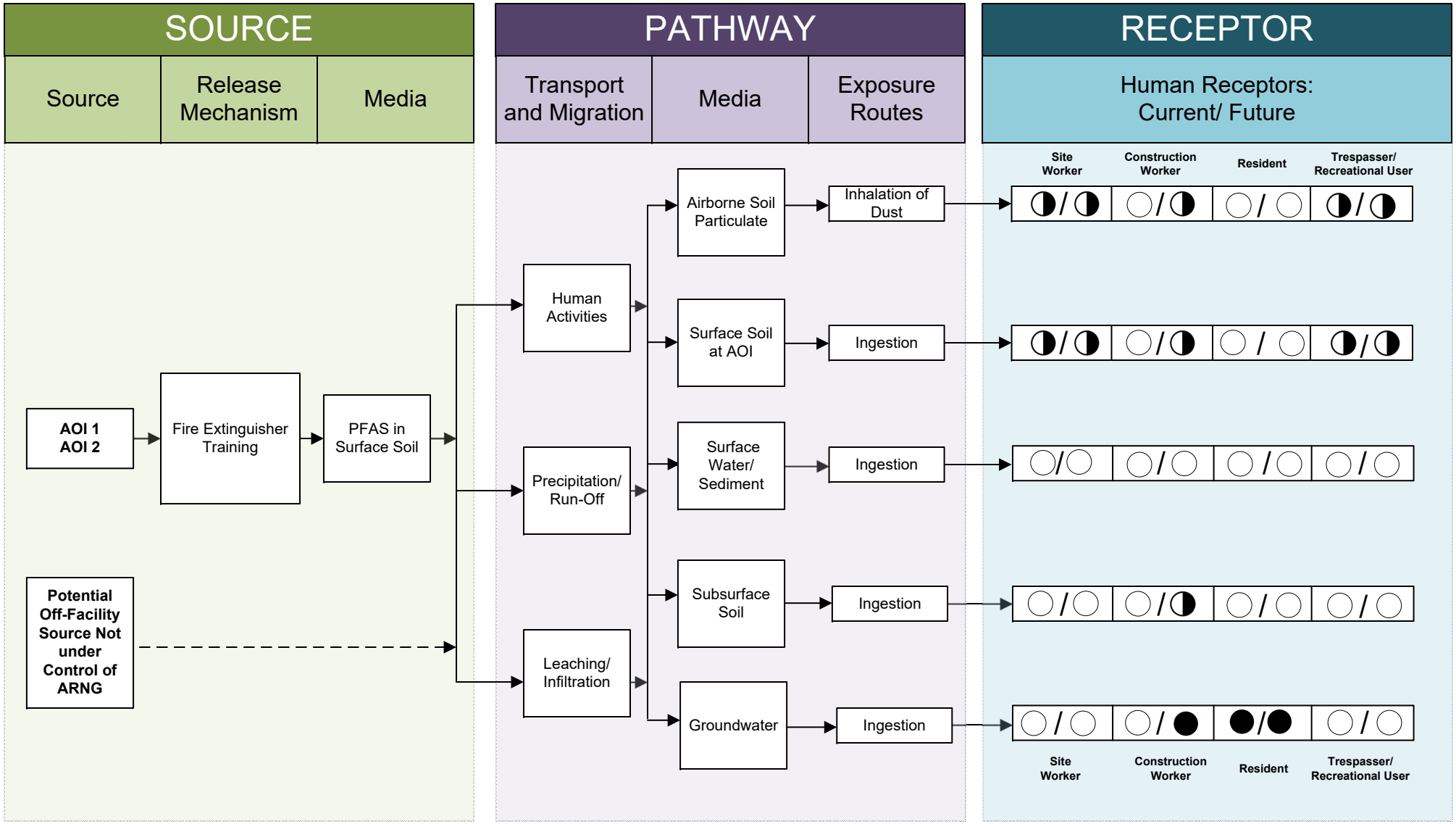

LEGEND

- Flow-Chart Stops
- Flow-Chart Continues
- Partial / Possible Flow
- Incomplete Pathway
- Potentially Complete Pathway
- Potentially Complete Pathway with Exceedance of SL

Notes:
1. The resident and recreational user receptors refer to off-facility receptors.
2. Dermal contact exposure pathway is incomplete for PFAS.

Figure 7-1
Conceptual Site Model
AOI 1 Middle Ramp Fire Extinguisher Training Area and AOI 2 West Ramp Fire Extinguisher Training Area, Waterloo AASF, Iowa

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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 SI Activities

SI field activities included soil and groundwater grab sampling from 5 August to 6 August 2020. Field activities were conducted in accordance with the QAPP Addendum (AECOM, 2020a), except as previously noted in **Section 5.8**.

To fulfill the project DQOs set forth in the approved SI QAPP Addendum (AECOM, 2020a), samples were collected and analyzed for a subset of PFAS by LC/MS/MS compliant with QSM Table B-15 as follows. The 18 PFAS analyzed as part of the ARNG SI program are specified in **Section 5.7** of this report.

- Seventeen (17) soil grab samples from six boring locations;
- Six groundwater grab samples from six temporary well locations; and
- Fourteen (14) Quality Assurance samples collected.

The information gathered during this investigation was used to determine if PFOA, PFOS, and/or PFBS were present at or above SLs. Additionally, the CSMs were refined to assess whether a potentially complete pathway exists between the source and potential receptors for potential exposure to PFOA, PFOS, and PFBS at the AOIs, which are described in **Section 7**.

8.2 SI Goals Evaluation

As described in **Section 4.2**, the SI activities were designed to achieve six main goals or DQOs. This section describes the SI goals and the conclusions that can be made for each based on the data collected during this investigation.

1. *Determine the presence or absence of PFOA, PFOS, and PFBS at or above SLs.*

   PFOA, PFOS, and PFBS were detected at the facility in soil and groundwater. PFOA, PFOS, and PFBS were detected at the source areas, and PFOA and PFOS were detected at the upgradient facility boundary. Detected concentrations of PFOA in groundwater at AOI 1 and AOI 2 exceeded the individual SL of 40 ng/L. Detected concentrations of PFOS and PFBS in groundwater were all below the individual SLs. Detected concentrations of PFOA, PFOS, and PFBS in all soil samples were below the SLs or non-detect.

2. *Develop information to potentially eliminate a release from further consideration because it is determined that it poses no significant threat to human health or the environment.*

   AOI 1 and AOI 2 were the only potential PFAS release areas identified during the PA and examined during the SI. PFOA was detected in groundwater above the SL at both AOIs; therefore, these areas may pose a threat to human health and the environment.

3. *Determine the potential need for a removal action.*

   Based on the data collected during this SI, there is not a complete pathway between source and on-facility drinking water receptors. Drinking water for Waterloo AASF is supplied by the City of Waterloo. Drinking water for the City of Waterloo is predominantly sourced from the limestone bedrock Cedar Valley Aquifer, although some of Waterloo's

water supply is obtained from an alluvial aquifer along the Cedar River. Therefore, the exposure pathway to on-facility drinking water receptors is considered incomplete.

There is a potentially complete pathway between source and off-facility residential drinking water receptors. Surficial groundwater at the facility is very shallow, with depth to water ranging from approximately 5 to 12 feet bgs and is therefore not considered a proxy for drinking water since downgradient public, private, and industrial wells tapping the Silurian-Devonian aquifer are typically 100 to 700 feet bgs (IGS, 2017a; IGS, 2020). However, the SI did not determine the presence of a defined confining layer or bedrock layer thick enough to prevent surficial groundwater from migrating into the Silurian-Devonian aquifer utilized by potential downgradient receptors for drinking water. Based on the CSM developed and revised in light of the SI findings, there is a potential for exposure to downgradient drinking water receptors caused by DoD activities at or adjacent to the facility.

4. *Collect data to better characterize the release areas for more effective and rapid initiation of a RI.*

The geological data collected as part of the SI indicate a highly permeable and conductive subsurface with soils dominated by the well- to poorly graded sands of the Noah Creek Formation. In all boreholes except AOI02-03, a thick bed of poorly graded sand was underlain by a thick bed of well-graded sand. The contact between the two lithologies ranged from 9 to 17.5 feet bgs. The graded bedding observed is consistent with an alluvial depositional environment that underwent a slowing of the paleocurrent.

Depth to water at the facility ranges from approximately 5 to 12 feet bgs. Groundwater flow direction at the facility is to the southwest towards the Cedar River. These geologic and hydrogeologic observations inform development of technical approach for the RI.

5. *Identify within 4 miles of the installation other potential PFAS sources (fire stations, major manufacturers, other DoD facilities) and receptors, including both groundwater and surface water receptors, to determine whether the ARNG is the likely source of PFAS, or whether there is an off-facility source of PFAS responsible for installation detections of PFAS (USEPA, 2005).*

Based upon the evaluation of groundwater and soil results in comparison to SLs, in combination with the groundwater flow direction analysis, the results of the SI indicate that the source of detected concentrations of PFOA, PFOS, and PFBS at the facility is likely attributable to ARNG activities.

6. *Determine whether a potentially complete pathway exists between the source and potential receptors and whether ARNG is the likely source of the contamination.*

Detections of PFOA and PFOS in soil at the source areas, as well as detections of PFOA in soil at the upgradient facility boundary, indicate there is a potentially complete exposure pathway between source and site workers, future construction workers, and trespassers. The PFOA SL exceedances in surficial groundwater indicate there is a potentially complete exposure pathway between source and future constructions workers, as well as off-facility residents.

8.3 Outcome

Based on the CSMs developed and revised in light of the SI findings, there is potential for exposure to off-facility residential drinking water receptors resulting from historical DoD activities at the Waterloo AASF. Sample chemical analytical concentrations collected during the SI were compared against the SLs for PFOA, PFOS, and PFBS in soil and groundwater, as described in **Table 6-1**. The following bullets summarize the SI results:

- PFOA in groundwater at AOI 1: Middle Ramp Fire Extinguisher Training exceeded the individual SL of 40 ng/L, with a maximum concentration of 231 ng/L at location AOI01-01. Based on the results of the SI, further evaluation of AOI 1 is warranted in the RI.

- PFOA in groundwater at AOI 2: West Ramp Fire Extinguisher Training exceeded the SL of 40 ng/L, with a concentration of 130 ng/L at location AOI02-01. Based on the results of the SI, further evaluation of AOI 2 is warranted in the RI.

- The detected concentrations of PFOA, PFOS, and PFBS in soil samples from all AOIs were below the SLs.

Table 8-1 summarizes the SI results for soil and groundwater. Based on the CSMs developed and revised in light of the SI findings, there is potential for exposure to off-facility residential drinking water receptors caused by DoD activities at or adjacent to the facility.

Table 8-2 summarizes the rationale used to determine if an AOI should be considered for further investigation under CERCLA and undergo an RI. Based on the results of this SI, further evaluation is warranted in the RI for AOI 1: Middle Ramp Fire Extinguisher Training and AOI 2: West Ramp Fire Extinguisher Training.

938 **Table 8-1 Summary of Site Inspection Findings**

AOI	Potential PFAS Release Area	Soil – Source Area	Groundwater – Source Area	Groundwater – Facility Boundary
1	Middle Ramp Fire Extinguisher Training	◐	●	●
2	West Ramp Fire Extinguisher Training	◐	●	●
Upgradient Facility Boundary	Off-Facility	◐	◐	◐

939 **Legend:**

940 ● = PFOS, PFOA, and/or PFBS detected; exceedance of the screening levels

941 ◐ = PFOS, PFOA, and/or PFBS detected; no exceedance of the screening levels

942 ○ = PFOS, PFOA, and PFBS not detected

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944 **Table 8-2 Site Inspection Recommendations**

AOI	Description	Rationale	Future Action
1	Middle Ramp Fire Extinguisher Training	Exceedances of SLs in groundwater at source area. No exceedances of SLs in soil.	Proceed to RI
2	West Ramp Fire Extinguisher Training	Exceedances of SLs in groundwater at source area. No exceedances of SLs in soil.	Proceed to RI
Upgradient Facility Boundary	Northern Facility Boundary	Detections in groundwater but no exceedances of SLs. No exceedances of SLs in soil.	No further action

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