FINAL
Site Inspection Report Grand Ledge Army Aviation Support Facility and Armory, Michigan

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

February 2021

Prepared for:

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UNCLASSIFIED

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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
AASF	Army Aviation Support Facility
AECOM	AECOM Technical Services, Inc.
AFFF	aqueous film forming foam
amsl	above mean sea level
AOI	Area of Interest
ARNG	Army National Guard
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CoC	chain of custody
CSM	conceptual site model
DA	United States Department of the Army
DL	detection limit
DLZM	DLZ Michigan, Inc.
DO	dissolved oxygen
DoD	Department of Defense
DPT	direct-push technology
DQI	data quality indicator
DQO	data quality objective
DUA	data usability assessment
DVR	data validation report
EDR™	Environmental Data Resources, Inc.™
EGLE	Michigan Department of the Environment, Great Lakes, and Energy
EIS	extraction internal standards
ELAP	Environmental Laboratory Accreditation Program
FedEx	Federal Express
FOIA	Freedom of Information Act
EM	Engineer’s Manual
ERB	equipment rinsate blank
FRB	Field Reagent Blank
FTA	Fire Training Area
GC/MS	gas chromatography/ mass spectrometry
GPS	global positioning system
HA	Health Advisory
HDPE	high-density polyethylene
HQ	Hazard Quotient
IDW	investigation-derived waste
ITRC	Interstate Technology Regulatory Council

LC/MS/MS	liquid chromatography with tandem mass spectrometry
LCS	laboratory control spike
LCSD	laboratory control spike duplicate
LOD	limit of detection
LOQ	limit of quantitation
MDEQ	Michigan Department of Environmental Quality
MDL	method detection limit
MIARNG	Michigan Army National Guard
MS	matrix spike
MSD	matrix spike duplicate
NELAP	National Environmental Laboratory Accreditation Program
NEtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid
NFG	National Functional Guidelines for Organic Data Review
ng/L	nanograms per liter
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
ORP	oxidation-reduction potential
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
PPE	personal protective equipment
PQAPP	Programmatic UFP-QAPP
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
US	United States
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

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 PFOA, PFOS, and perfluorobutanesulfonic acid (PFBS) at or above screening levels (SLs). An SI was completed at the Grand Ledge Army Aviation Support Facility (AASF) and Armory in Grand Ledge, Michigan. The Grand Ledge AASF and Armory will be referred to as the “facility” throughout this document.

Grand Ledge AASF and Armory is in Grand Ledge, in Clinton County, Michigan, approximately 1 mile north of the Grand River. The facility falls within Watertown Township, where Clinton County borders Eaton County along West Eaton Highway. The facility is bordered to the north by Abrams Municipal Airport, to the east and west by residences and agricultural land, and the south by residences and commercial/industrial operations. The AASF and Armory facilities comprise approximately 35 acres (DLZ Michigan, Inc. [DLZM], 2015). The facility has a main area that consists of the AASF and Armory as well as an Annex located southwest of the main area. The PA Report for Grand Ledge AASF and Armory identified three potential per- and polyfluoroalkyl substances (PFAS) release areas which were grouped into two AOIs (AOIs 1 and 2) (AECOM, 2019c). Each of these areas was investigated during the SI. SI field activities were conducted in two on-facility mobilizations and two off-facility mobilizations. Mobilization 1 included soil, sediment, surface water, and groundwater grab sampling from temporary monitoring wells and was conducted from 7 to 10 May 2019. Mobilization 2 was performed as a supplemental SI investigation and included permanent groundwater monitoring well installation, development, and sampling; soil, sediment, and surface water grab sampling. Mobilization 2 was conducted from 4 November to 20 December 2019. As part of a separate action, residential well sampling was performed by ARNG at 25 residencies south, west, and east of the Grand Ledge AASF and Armory in two mobilizations (22 - 23 January 2020 and 28 - 29 July 2020).

To fulfill the project Data Quality Objectives (DQOs) set forth in the approved SI Quality Assurance Project Plan (QAPP) Addendum (AECOM, 2019b), samples were collected and analyzed for a program-specific list of 18 PFAS by liquid chromatography with tandem mass spectrometry (LC/MS/MS) compliant with Quality Systems Manual (QSM) 5.1 Table B-15. The 18 PFAS analyzed as part of the ARNG SI program are specified in **Section 5.9** 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 (OSD) dated 15 October 2019 (Assistant Secretary of Defense, 2019). The ARNG PFAS SIs follow this DoD policy, and when the maximum site 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, groundwater, sediment, and surface water contain or do not contain the 18 PFAS analyzed within the boundaries of the facility.

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

- PFOA and PFOS in groundwater at AOI 1 exceeded the individual SLs of 40 nanograms per liter (ng/L), with concentrations of 53.0 ng/L and 60.0 ng/L, respectively, at location AOI 1-5. Based on the results of the SI, further evaluation of AOI 1 is warranted in the RI.
- The detected concentrations of PFOA, PFOS, and PFBS in groundwater samples from AOI 2 were below the SLs.

- The detected concentrations of PFOA, PFOS, and PFBS in soil samples from all AOIs were below both industrial/ commercial and residential SLs.

- Twenty-five (25) private, residential wells located south, east, and west of the facility were sampled for PFAS. No samples exceeded the SLs or the USEPA Health Advisory (HA) of 70 nanograms per liter (ng/L) for PFOA and/or PFOS, and 23 samples had no detections of PFAS. Only one residential well sample had an estimated PFOS detection of 3.38 J ng/L; however, this well is located side-gradient to AOI 2.

Table ES-2 summarizes the SI results for soil and groundwater. Based on the conceptual site models (CSMs) 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 for one residential well with a minor detection of PFOS (3.38 ng/L); however, this residential well is located side-gradient to AOI 2 and would not likely be impacted by a PFAS release at the facility, given the southeasterly direction of groundwater flow determined during the SI. The data do not support a potential for exposure to drinking water receptors at any of the remaining 24 adjacent, private, residential wells that were sampled for PFAS. Additionally, PFOA, PFOS, and PFBS were not detected in drinking water samples collected by the Michigan Department of Environment, Great Lakes, and Energy (EGLE) at the Abrams Municipal Airport upgradient of the facility in August 2020. It is not known whether any shallow drinking water wells further downgradient exist and are impacted.

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: AASF Hangar and Armory (Former AASF).

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

Analyte	Residential (Soil) (µg/kg)[a,b] 0-2 feet bgs	Industrial/ Commercial Composite Worker (Soil) (µg/kg)[a,b] 2-15 feet bgs	Tap Water (Groundwater) (ng/L)[a,b]
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. HQ=0.1. 15 October 2019.

b.) If only one PFAS is present, a Hazard Quotient (HQ) of 1 applies and the values presented would increase by a factor of x10.

Table ES-2: Summary of Site Inspection Findings

AOI	Potential PFAS Release Area	Soil – Source Area	Groundwater – Source Area
1	AASF Hangar and Armory (Former AASF)	◐	●
2	Annex Building	◐	◐

Legend:

● = detected; exceedance of the screening levels

◐ = detected; no exceedance of the screening levels

○ = not detected

Table ES-3: Site Inspection Recommendations

AOI	Description	Rationale	Future Action
1	AASF Hangar and Armory (Former AASF)	Exceedances of SLs in groundwater at the source area. No exceedances of SLs in soil.	Proceed to RI
2	Annex Building	Detections in groundwater and soil but no exceedances of SLs.	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 at ARNG Facilities 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 the Grand Ledge Army Aviation Support Facility (AASF) and Armory in Grand Ledge, Michigan. The Grand Ledge AASF and Armory 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; United States Environmental Protection Agency [USEPA], 1980), as amended, the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations [CFR] Part 300; USEPA, 1994), and in compliance with 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 Grand Ledge AASF and Armory (AECOM, 2019c) that identified three potential PFAS release areas, which were grouped into two Areas of Interest (AOIs). 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. Facility Background

2.1 Facility Location and Description

Grand Ledge AASF and Armory is in Grand Ledge, in Clinton County, Michigan, approximately 1 mile north of the Grand River. The facility falls within Watertown Township, where Clinton County borders Eaton County along West Eaton Highway. The facility is bordered to the north by Abrams Municipal Airport, to the east and west by residences and agricultural land, and the south by residences and commercial/industrial operations. The AASF and Armory comprise approximately 35 acres (DLZ Michigan, Inc. [DLZM], 2015). The facility has a main area that consists of the AASF and Armory as well as an Annex located southwest of the main area. The facility layout at Grand Ledge AASF and Armory is shown on **Figure 2-1.**

Grand Ledge AASF and Armory provides training and maintenance for the various aviation units that support the Michigan ARNG (MIARNG). The AASF consists of a maintenance shop, office areas, a maintenance hangar, wash bay, and an unheated “cold” storage building. The Armory includes a shop area, fenced motor pool, aircraft parking area, and various small storage buildings. An Annex Building that is used for storage and training purposes including flight simulations is on the southwestern portion of the property, on the corner of Wright Road and Eaton Highway; historical aerial imagery indicates the Annex Building was built between 1986 and 1993. Prior to 2007, the AASF was located in what is today the current Armory. Historical aerial photography indicates that the current Armory building was constructed between 1974 and 1981 (Environmental Data Resources, Inc. [EDR™], 2018). According to interviews with facility personnel and historical aerial photography, construction of the current AASF hangar began in 2005 and was completed in January/February of 2007. The construction also involved the removal/replacement of old pavement and soil excavation/grading. An old drainage ditch was previously situated at the western edge of the old tarmac and flowed north before connecting with an off-facility drainage ditch at Abrams Municipal Airport. As a result of the construction activities, the drainage ditch was filled in and paved over, and then a stormwater retention basin was established to the northwest of the current tarmac. The Grand Ledge AASF and Armory property was acquired by the State of Michigan, Department of Military Affairs through two separate land deeds dated 29 May 1975 and 31 August 2000.

2.2 Facility Environmental Setting

The Grand Ledge AASF and Armory is in the lower peninsula of Michigan, in the Central Lowlands Physiographic Province of the US. The province is part of the Interior Plains division of the US and is characterized by flat lands with glacial geomorphic remnants. The majority of the Central Lowlands province is bounded by higher relief and comprises elevations of 2,000 feet or less (National Park Service, 2017). Elevation at the Grand Ledge AASF and Armory ranges from 829 to 860 feet above mean sea level (amsl), with an average of 850 feet amsl, possessing a gentle gradient to the north and west (EDR™, 2018).

The topography at the Grand Ledge AASF and Armory is relatively flat, with a gentle slope towards the northwest in the direction of a stormwater retention basin. Local topographic changes exist, with ground surface elevation from the southern side of the Abrams Municipal Airport sloping in the direction of Grand Ledge AASF and Armory. The facility topography of Grand Ledge AASF and Armory is shown on **Figure 2-2**. The facility geology and groundwater features are presented on **Figure 2-3**, and surface water features are presented on **Figure 2-4**.

2.2.1 Geology

The bedrock formations of the Lower Michigan Basin are typically sedimentary deposits of Carboniferous age, and the bedrocks of the Grand Ledge area fall under this classification. Structural deformation in the region was limited to the actions of the last glacial advance and retreat, resulting only in minor jointing of the bedrock; therefore, bedrock aquifer conductivity is dependent on the primary porosity of the unit. The Saginaw Formation is one such sedimentary bedrock deposit that acts as the main aquifer for much of central Michigan, including Michigan's capital, Lansing, which is located about 10 miles east of Grand Ledge AASF and Armory. In the Grand Ledge area, 0 to over 100 feet of unconsolidated glacial sediments overlie the bedrock. These sediments were deposited during glacial advance and retreat cycles that took place from approximately 35,000 to 10,000 years before the present. Twelve residential well logs supplied by the Barry-Eaton District Health Department list bedrock at depths of 35-82 feet below ground surface (bgs) immediately south of the facility. Well-sorted fluvial deposits, lacustrine type clay deposits, and poorly-sorted glacial till deposits are all present in the surficial geology of central Michigan. Given the heterogeneous nature of glacial processes, the clay units in this area are expected to be localized, not regionally continuous (US Geological Survey [USGS] & Michigan Department of Environmental Quality [MDEQ], 2007).

Six shallow borings were completed in AOI 1 (locations AOI 1-1 through AOI 1-6) during Mobilization 1, most of which revealed deposits of clay with varying descriptions and sand components ranging from 0% to 20% within 5-10 feet bgs. Soils at AOI 1-5, located northeast of the Armory, were predominantly silt with sand from 0-10 feet bgs and potentially contains reworked facility soil or backfill from off-facility. Three borings logged at AOI 2 (locations AOI 2-1, AOI 2-2, and AOI 2-3) all exhibited layers of clay with 10% to 25% sand within 0-10 feet bgs. Due to the presence of apparent thick clay layers underlying the facility, vertical migration of contamination would be considered limited; however, given the lack of a regionally extensive unit, the connectivity of the observed clay layers in the borings is unknown. At AOI 1-4 and AOI 1-6, poorly- to well-graded sand was observed at 18-21 feet bgs, which is evidence for the presence of potential glacial outwash deposits buried beneath the fine-grained surficial deposits at the facility.

The clay layer found in the AOI 1-6 boring located along the northern facility boundary was encountered at ground surface and extended to 18 feet bgs; this shallow clay layer likely explains the formation of an artesian well that resulted from installation of the temporary monitoring well at AOI 1-6. The stormwater retention basin located nearby in the northern area of the facility extends from the ground surface to approximately 16 feet bgs at its deepest point. Since it is unknown if the uppermost clay layer is continuous between borings, vertical groundwater transport cannot be ruled out. This uncertainty suggests the stormwater retention basin may receive groundwater as well as surface water from the nearby area (i.e., the AASF and Abrams Municipal Airport). The closest monitoring well, AOI 1-11, is immediately south of the stormwater retention basin ridge, and groundwater was gauged within the well at approximately 12 feet bgs. The presence of the groundwater table at an elevation above the stormwater retention basin is indicative of groundwater to surface water migration.

Seven additional deep borings were drilled during Mobilization 2 in an attempt to understand groundwater conditions for nearby private, drinking water wells screened at a similar depth. Six of these borings were completed at AOI 1 (AOI 1-10 through AOI 1-15). At all AOI 1 borings, except AOI 1-11, the geology is generally characterized by lean clays down to approximately 35 to 50 feet bgs, followed by layers of more permeable sediments, such as sand and gravel. These permeable sediments range from 4 to more than 25 feet in thickness and are observed shallower in the northern sample locations (AOI 1-11 and AOI 1-12). Minor coarse-grained components of sand, gravel, and cobbles are present in sections of the lean clay. AOI 1-11 is unique in that sandy facies predominate the first 17 feet of the boring, followed by lean clay from 17 to 28 feet bgs, and sand from 28 to 31 feet bgs. Historical aerial imagery shows that AOI 1-11 was previously the location of an old building that has since been removed. The location was heavily impacted by the construction of the stormwater retention basin, and the soils potentially contain reworked facility soil or backfill from off-facility. Bedrock was encountered in all borings at AOI 1, except at AOI 1-14, with depths to bedrock ranging from 35 to 90 feet bgs. Silty and clayey layers above the bedrock most likely represent weathered bedrock. The boring at AOI 1-10 appears to define a channel cut into the bedrock and may be screened in a hydrologic unit distinct from the unit screened by other borings. AOI 1-10 has mixture of fines and coarse material above the bedrock that may act as a confining unit from more shallow groundwater.

One additional boring was completed at AOI 2 (location AOI 2-4) that had a total depth of 50 feet bgs. The first 3 feet of soil at AOI 2-4 were characterized by well-graded gravel with silt and sand, followed by approximately 22 feet of fine-grained material (i.e., silts and clays), with the content of sand and gravel each ranging from 0 to 25%. Additionally, a small layer of interbedded elastic silt with 30-45% gravel was observed at 20.0 to 21.4 feet bgs. Sandstone bedrock was encountered at 30.5 feet bgs and was overlain by 5 feet of well-graded gravel with silt, sand, and cobbles.

The thickness of clay and silt observed in the deep borings drilled during Mobilization 2 appear to support the concept of limited vertical migration of contaminants at the facility. Permeable sediments, underlying the clay, were most shallow in AOI 1-11, AOI 1-12, and AOI 2-4, with a range of encountered depths of 25.5 to 36.5 feet bgs. Permeable sediments in all other sample locations had encountered depths ranging from 42 to 50 feet bgs. Underneath the fine-grained material resides layers of permeable, coarser-grained sediments. Depth to bedrock across the facility ranged from 30.5 to 90 feet bgs, which is similar to the depths to bedrock recorded in the residential wells by the Barry-Eaton District Health Department.

2.2.2 Hydrogeology

According to data received from the EDR™ report for the facility and the EGLE Wellogic database (EGLE, 2018), several federal and state-documented groundwater wells are located at and within 1 mile of the facility (**Figure 2-3**). The majority of these wells are private domestic wells, and there are additional undocumented private wells located in the immediate vicinity that were discovered through a Freedom of Information Act (FOIA) request during drinking water sampling (see **Section 2.4**). There are also two public water supply wells within 1 mile; one is located within facility boundaries and provides drinking water for the Annex Building, and another public water supply well is located approximately 1,000 feet to the southwest of the facility boundary. Grand Ledge AASF and Armory receives its potable water from the City of Grand Ledge's municipal water utility, with the exception of the Annex Building, which receives water from an on-facility public supply groundwater well. Drinking water from the Annex Building's well was previously sampled by the National Guard Bureau in May 2017 and found to be non-detect for PFAS. Additionally, PFOA, PFOS, and PFBS were not detected in drinking water samples collected by EGLE at the Abrams Municipal Airport upgradient of the facility in August 2020.

All local domestic and public water supply wells identified from the EGLE database are situated in the Saginaw aquifer at depths of approximately 100 to 180 feet bgs, with the exception of a single well installed in 1942 that was installed at a depth of 404 feet bgs (EDR™, 2018). During May 2019 SI (Mobilization 1) sampling activities, groundwater in shallow temporary wells at AOI 1 was encountered at depths ranging from 2 to 14 feet bgs, except for sample location AOI 1-6. An artesian well was formed at sample location AOI 1-6 upon installation of the temporary well. A synoptic gauging event performed on 8 January 2020 measured groundwater depths ranging from 10 to 36 feet bgs from permanent monitoring wells. Observed groundwater elevations from the 8 January 2020 synoptic gauging event and corresponding contours are displayed on **Figure 2-5.** The groundwater elevation for AOI 1-10 was excluded from **Figure 2-5** because this well appears to be set in a separate and distinct hydrologic unit (see **Section 2.2.1**). Groundwater at the facility was measured to flow in the south-southeast direction.

2.2.3 Hydrology

Although the Grand River is located approximately 1 mile south of the facility, the AASF and Armory fall within the Husted and Landenburg Drain-Looking Glass River Watershed. There are no perennial surface water bodies within the property boundaries of the Grand Ledge AASF and Armory (US Fish and Wildlife Service [USFWS], 2018). The majority of the facility is paved with grassy areas surrounding the perimeter. Prior to 2007, when the new hangar and cold storage facility were built, the area west of the Armory was largely unpaved. Drainage ditches and catchments surround the property and direct stormwater from paved areas to the stormwater retention basin located at the northwest corner of the facility. Overflow from the retention pond drains to Reed Drain, a small drainage creek located 0.25 miles north of the retention pond that ultimately drains to the Looking Glass River via Husted and Landenburg Drain. Given the shallow clay layer encountered at the northern boundary of the facility at location AOI 1-6, the depth of the stormwater retention basin could extend into the saturated groundwater zone allowing groundwater to discharge to surface water.

2.2.4 Climate

The climate of the Grand Ledge AASF area is temperate, with an average temperature of 48.7 degrees Fahrenheit (°F). Seasonally, temperatures vary from summer highs of 84 °F to winter lows of 15 °F. Precipitation falls primarily as snowfall in the winter months well into April, with an average of 7.8 inches of snowfall per month. The remainder of precipitation falls as rain, which is distributed evenly throughout the summer months at an average of 3.2 inches per month. The prevailing wind is typically from the west at 8.5 miles per hour (National Oceanic and Atmospheric Administration, 2018).

2.2.5 Current and Future Land Use

Current Grand Ledge AASF and Armory operations include training and maintenance for the various aviation units that support the MIARNG. In addition to aircraft maintenance and aircraft support for MIARNG, periodic training exercises and course work for the National Guard/Army Reserve units are conducted at the facility's flight simulators located in the Annex Building. The facility is staffed by both full- and part-time employees and shares tarmac space with the neighboring Abrams Municipal Airport to the north.

Portions of the eastern and western borders of Grand Ledge AASF and Armory are abutted primarily by rural residences and agricultural land use. Two residential homes are located between the AASF Hangar and Armory buildings and the Annex Building. Abrams Municipal airport bounds the northern boundary of the facility. South of Eaton Highway, a rural two-lane highway that demarcates the facility's southern border is a small industrial park and lightly-wooded areas. Several residences are also located south of Eaton Highway in the immediate vicinity of the facility. The closest urban center is the City of Grand Ledge, approximately 1.5 miles to the southwest.

Reasonably anticipated future land use is not expected to change from the current land use described above.

2.2.6 Critical Habitat and Threatened/ Endangered Species

The following species are listed as federally endangered, threatened, proposed, and/or candidate species in Clinton and Eaton County, Michigan (USFWS, 2020):

- **Clams**: Snuffbox mussel, *Epioblasma triquetra* (endangered).
- **Plants**: Eastern prairie fringed orchid, *Platanthera leucophaea* (threatened).

- **Mammals**: Indiana bat, *Myotis sodalist* (endangered); Northern Long-Eared Bat, *Myotis septentrionalis* (threatened).
- **Reptiles**: Eastern Massasauga Rattlesnake, *Sistrurus catenatus* (threatened).

None of these sensitive species have been recorded within the Grand Ledge AASF and Armory.

2.3 History of PFAS Use

The AASF hangar is currently equipped with an aqueous film forming foam (AFFF) fire suppression system that contains a 700-gallon tank of 3% Ansulite. The current Armory building was the previous location of the AASF, prior to the new hangar's construction in 2007. The Armory historically housed a certified firefighting unit in the 1980s that was disbanded in the early 1990s. During the PA, former Grand Ledge AASF and Armory personnel commented during their interview that a firetruck used to be stationed within a garage located in the Armory building during approximately the 1980s to early 1990s (prior to disbandment of the firefighting unit in the early 1990s). The Annex Building has storage of empty Tri-Max™ 30 fire extinguishers and bulk and expired AFFF in both 55-gallon drums and 5-gallon buckets. Based on the above information, the three potential PFAS release areas (AASF Hangar, Armory, and Annex Building) were identified at the Grand Ledge AASF and Armory during the PA (AECOM, 2019c). The potential PFAS release areas where AFFF may have been used or released historically were grouped into two AOIs based on proximity to one another and presumed groundwater flow. A description of each AOI is presented in **Section 3**.

After Mobilization 1 field activities, additional information was obtained regarding PFAS use at the Armory. Based on interviews with retired AASF personnel in December 2019, Tri-Max™ 30 extinguishers and a firetruck may have been used for fire training with AFFF on the tarmac north of the Armory, the adjacent motor pool to the east, and the adjacent wash bay to the west. An additional potential PFAS release area at the current location of Transfast Trucking, Inc., a privately-owned trucking company, was also identified. According to interviews with retired AASF personnel, this location was a former AASF hangar until about the 1980s. One of the interviewees stated that there was an incident in the hangar, where fuel was spilled from an aircraft, and AFFF may have been used to wash off the fuel. There was also a firetruck located at the former hangar, but it is unknown if the firetruck had foam capabilities. This firetruck was an older model than the firetruck previously located at the Armory. The Transfast Trucking, Inc. (Former Hangar) is neither located within an AOI nor investigated during the SI due to it being off facility property.

2.4 Drinking Water Sampling

Grand Ledge AASF and Armory receives its potable water from the City of Grand Ledge's municipal water utility, except for the Annex Building, which receives water from an on-facility public supply groundwater well. Drinking water from the Annex Building's well was previously sampled by the National Guard Bureau in May 2017 and found to be non-detect for PFAS.

On 22 - 23 January 2020 and 28 - 29 July 2020, ARNG collected off-facility drinking water samples from private residential wells due to the exceedance of SLs observed in groundwater during the May 2019 SI (Mobilization 1) from temporary well location AOI 1-5 (results presented in **Section 6.0**). Additionally, during Mobilization 2, three permanent monitoring wells could not be installed at the targeted depth of 80 to 100 feet bgs, screened similarly to nearby private residential wells. Therefore, to better understand groundwater migration conditions, twenty-five (25) properties along West Eaton Highway, Wright Road, Hartel Road, and Bauer Road were selected to be sampled due to their proximity to Grand Ledge AASF and Armory (see **Figure 2-6**). PFAS were non-detect at 23 properties. One property had an estimated PFOS detection of 3.38 J nanograms per liter (ng/L), and another property had an estimated perfluorohexanoic acid (PFHxA) detection of 2.37 J ng/L. The results of the drinking water sampling were provided in letters to the residents and are also provided in **Table 2-1**. These results indicate that there are no down- or side-gradient impacts to drinking water attributable to ARNG activities at Grand Ledge AASF and Armory, as there were no exceedances of the USEPA Health Advisory (HA) of 70 ng/L for PFOA and/or PFOS and only one well had a minor detection of PFOS.

Table 2-1
PFAS Detections in Residential Drinking Water
Site Inspection Report, Grand Ledge AASF and Armory

	Area of Interest	POTABLE																			
	Sample ID	POTABLE-01		POTABLE-02		POTABLE-03		POTABLE-04		POTABLE-04-FD		POTABLE-05		POTABLE-06		POTABLE-07		POTABLE-08		POTABLE-09	
	Sample Date	01/22/2020		01/22/2020		01/22/2020		01/22/2020		01/22/2020		01/22/2020		01/22/2020		01/22/2020		01/22/2020		01/22/2020	
Analyte	**EPA HA [a]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, PFAS via EPA 537.1 (ng/L)																					
PFHxA	-	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	
PFOS	70	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	
Total PFOA+PFOS	70	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	

Grey Fill	Detected concentration exceeded EPA HA

References

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

Interpreted Qualifiers

J = Estimated concentration

Chemical Abbreviations

PFHxA	perfluorohexanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

FD/DUP	Duplicate
EPA	United States Environmental Protection Agency
GL	Grand Ledge
HA	Health Advisory
Qual	Interpreted Qualifier
ng/L	nanogram per liter
-	Not applicable

Table 2-1
PFAS Detections in Residential Drinking Water
Site Inspection Report, Grand Ledge AASF and Armory

Area of Interest		POTABLE																			
Sample ID		POTABLE-10		POTABLE-11		GL-POTABLE-12		GL-POTABLE-12-DUP		GL-POTABLE-13		GL-POTABLE-14		GL-POTABLE-15		GL-POTABLE-16		GL-POTABLE-18		GL-POTABLE-19	
Sample Date		01/23/2020		01/23/2020		07/28/2020		07/28/2020		07/28/2020		07/29/2020		07/29/2020		07/28/2020		07/28/2020		07/29/2020	
Analyte	**EPA HA [a]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, PFAS via EPA 537.1 (ng/L)																					
PFHxA	-	ND		ND		ND		ND		ND		2.37	J	ND		ND		ND		ND	
PFOS	70	ND		3.38	J	ND		ND		ND		ND		ND		ND		ND		ND	
Total PFOA+PFOS	70	ND		3.38	J	ND		ND		ND		ND		ND		ND		ND		ND	

Grey Fill	Detected concentration exceeded EPA HA

References

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

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J = Estimated concentration

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PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

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EPA	United States Environmental Protection Agency
GL	Grand Ledge
HA	Health Advisory
Qual	Interpreted Qualifier
ng/L	nanogram per liter
-	Not applicable

Table 2-1
PFAS Detections in Residential Drinking Water
Site Inspection Report, Grand Ledge AASF and Armory

	Area of Interest	POTABLE															
	Sample ID	GL-POTABLE-20		GL-POTABLE-21		GL-POTABLE-21-DUP		GL-POTABLE-22		GL-POTABLE-23		GL-POTABLE-24		GL-POTABLE-25		GL-POTABLE-26	
	Sample Date	07/28/2020		07/29/2020		07/29/2020		07/28/2020		07/28/2020		07/28/2020		07/29/2020		07/29/2020	
Analyte	**EPA HA** [a]	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, PFAS via EPA 537.1 (ng/L)																	
PFHxA	-	ND		ND		ND		ND		ND		ND		ND		ND	
PFOS	70	ND		ND		ND		ND		ND		ND		ND		ND	
Total PFOA+PFOS	70	ND		ND		ND		ND		ND		ND		ND		ND	

Grey Fill	Detected concentration exceeded EPA HA

References

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

Interpreted Qualifiers

J = Estimated concentration

Chemical Abbreviations

PFHxA	perfluorohexanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

FD/DUP	Duplicate
EPA	United States Environmental Protection Agency
GL	Grand Ledge
HA	Health Advisory
Qual	Interpreted Qualifier
ng/L	nanogram per liter
-	Not applicable

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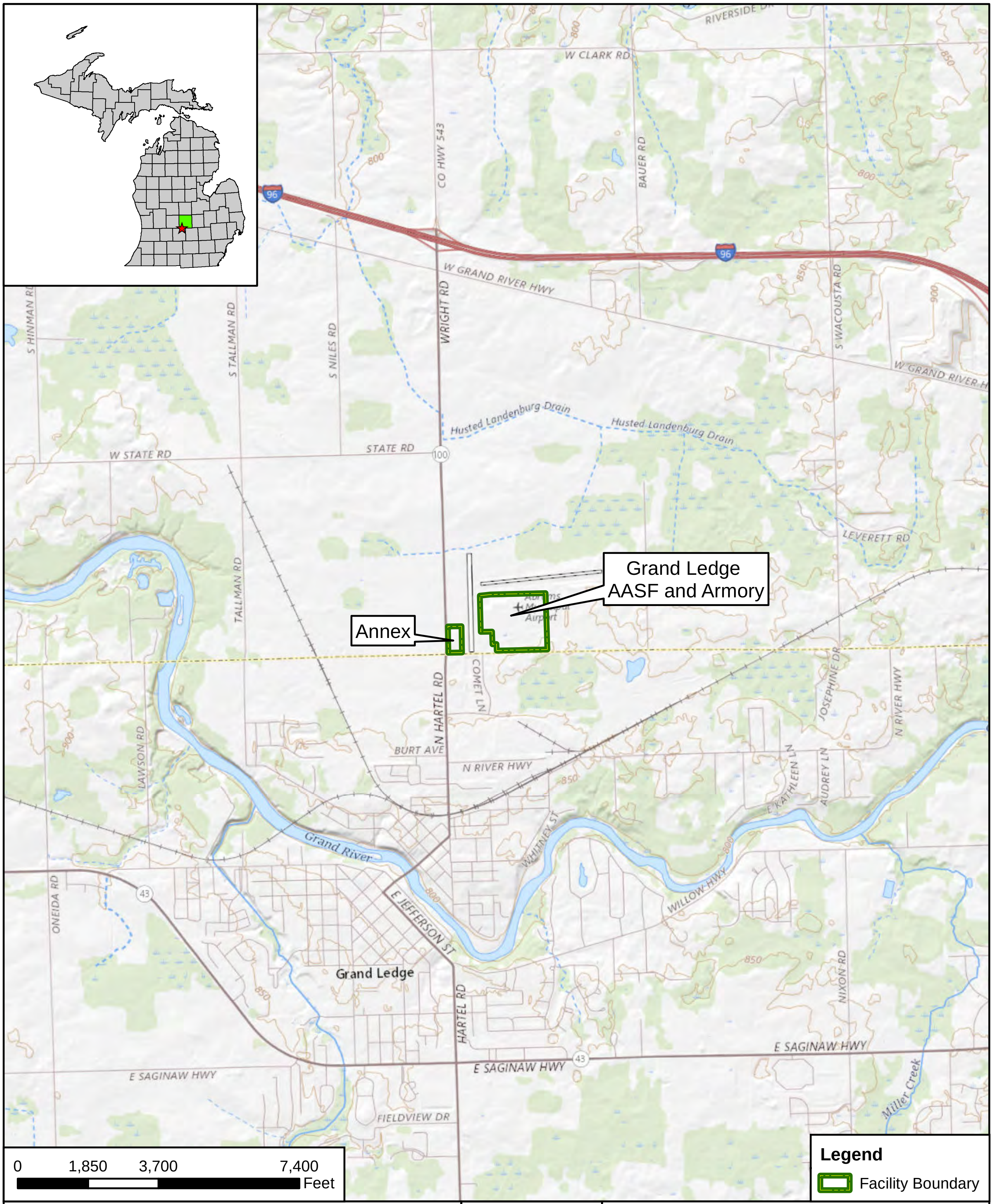

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SCALE	1:44,400	CHK BY	ST	8/13/2020
Base Map: USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program,		PM	RG	8/13/2020

N

Facility Location

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 2-1

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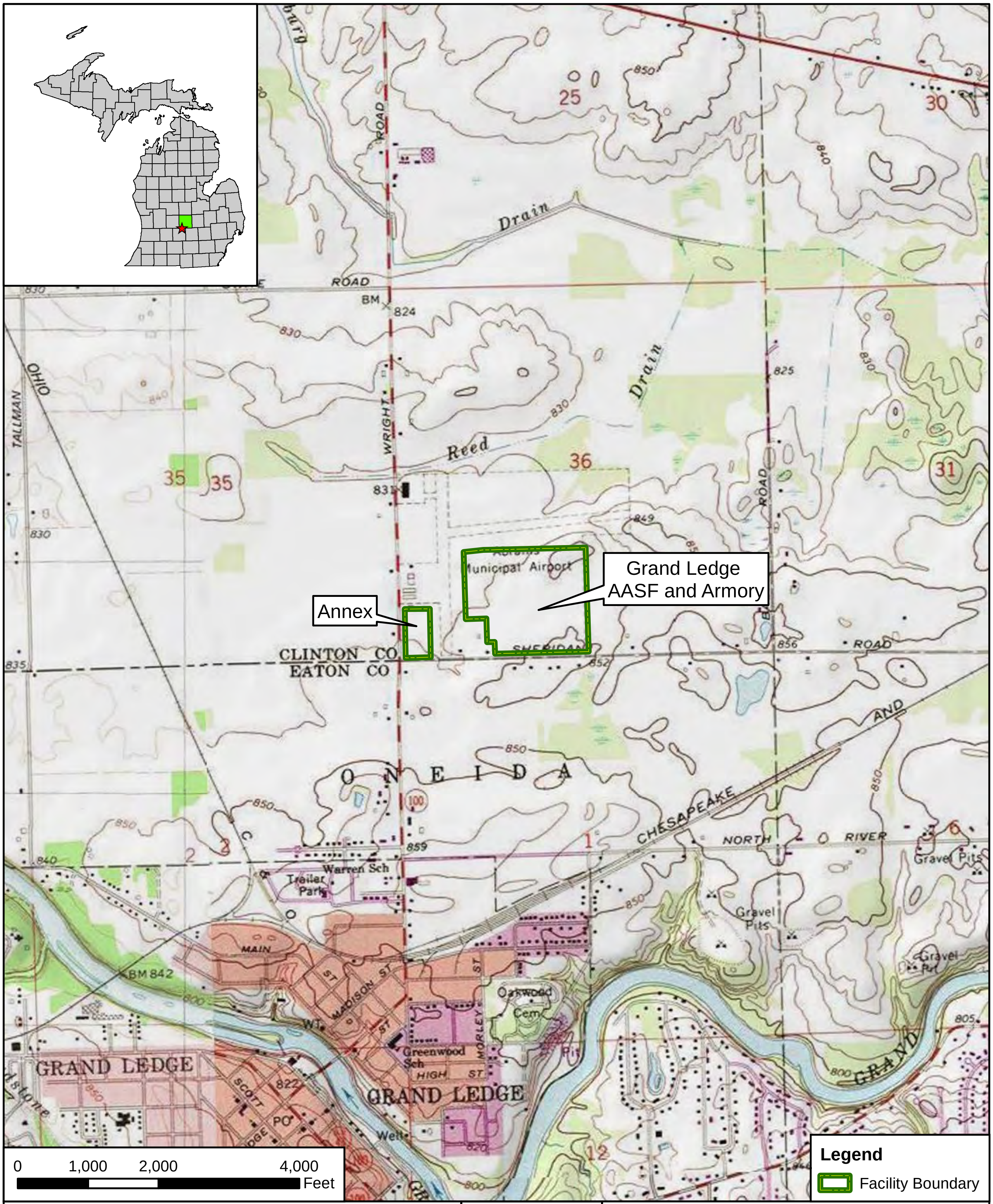

CLIENT	ARNG			
NOTES	Site Inspection for PFAS at Grand Ledge AASF and Armory, MI			
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SCALE	1:24,000	CHK BY	ST	9/2/2020
Base Map: Copyright:© 2013 National Geographic Society, i-cubed		PM	RG	9/2/2020

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Facility Topography

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Figure 2-2

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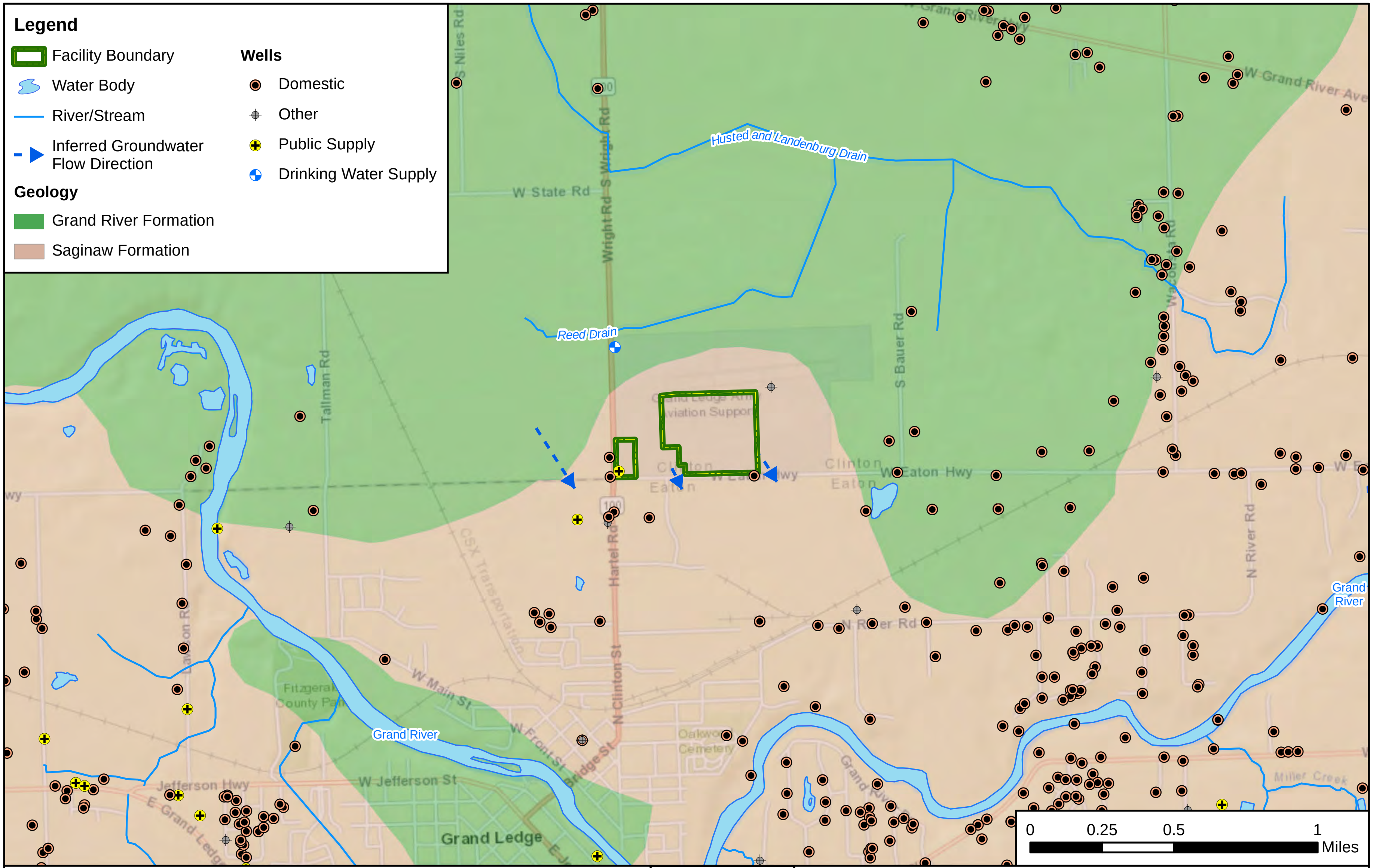

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SCALE	1:31,680	CHK BY	ST	9/2/2020
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri		PM	RG	9/2/2020

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Groundwater Features

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Figure 2-3

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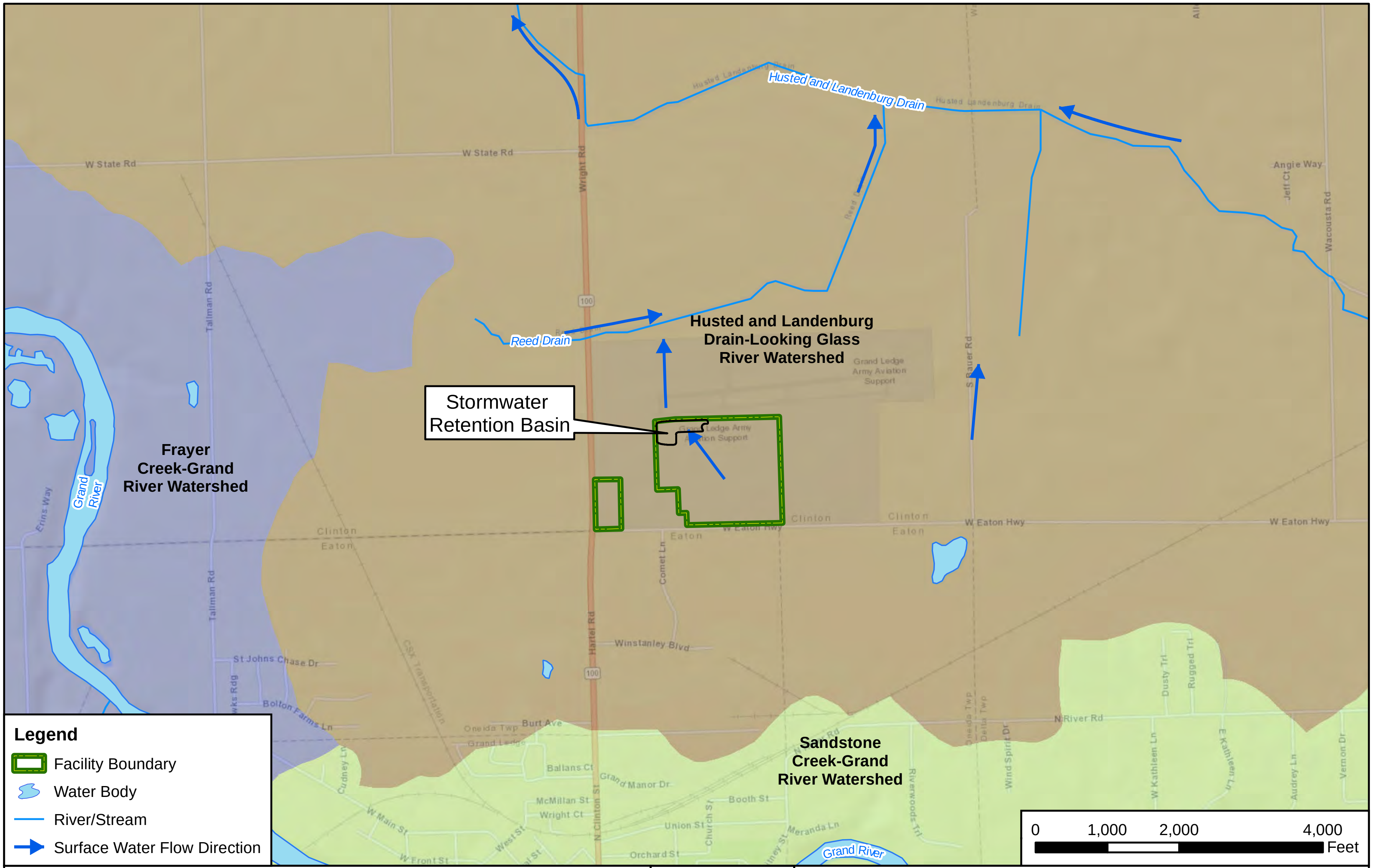

CLIENT	ARNG			
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SCALE	1:24,000	CHK BY	ST	9/2/2020
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri		PM	RG	9/2/2020

Surface Water Features

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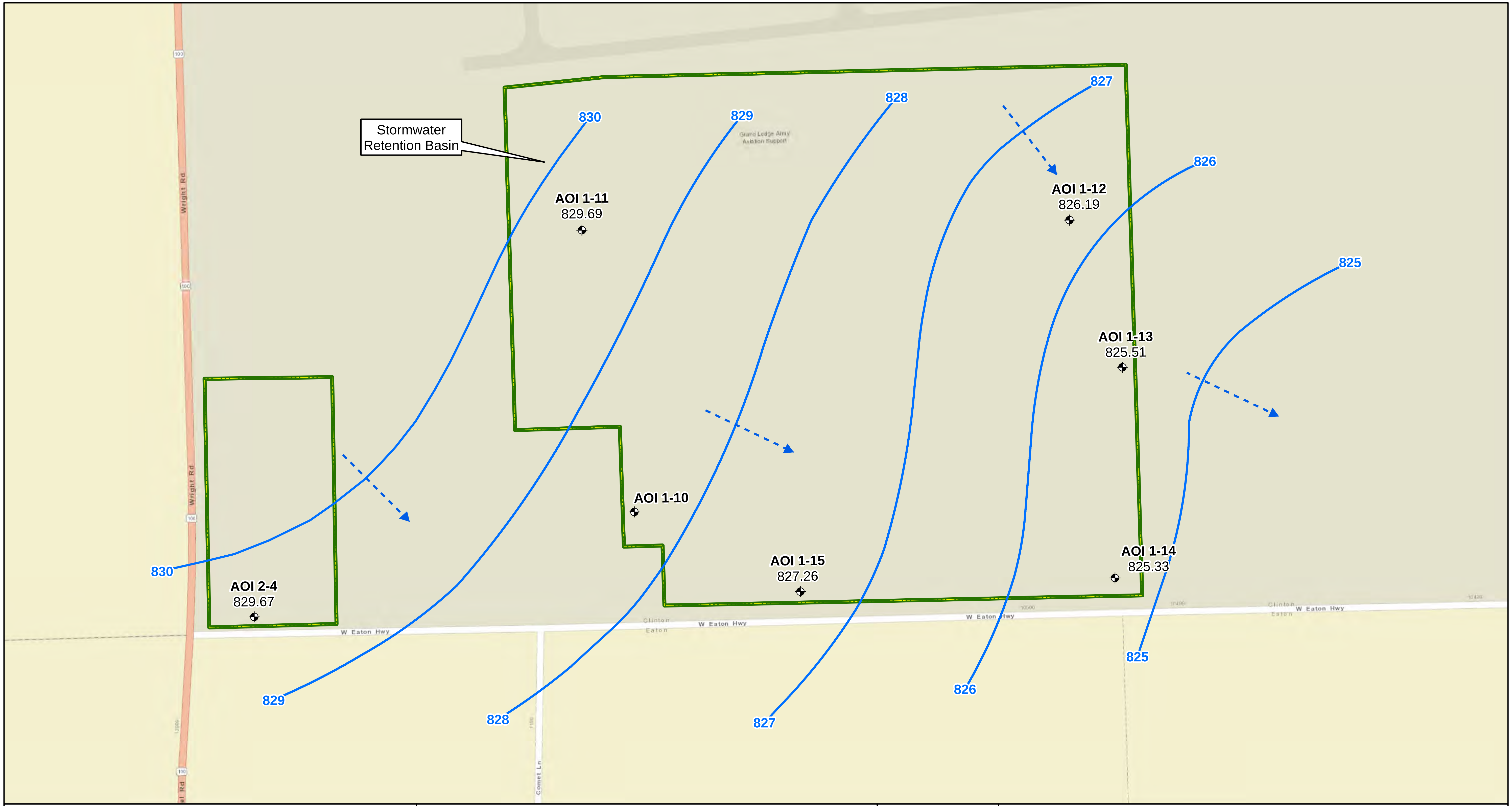
Figure 2-4

Q:\Projects\ENV\GEARS\GEO\MAES 2012 Unrestricted\Fort Meade\E. Data Management\GIS\MXDs\Chisholm_6thMarch2017\ Fig_2-4_Grand_Ledge_AASF_SI_Surface_Water_Features.mxd



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Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap		PM	RG	9/2/2020

⌖ Monitoring Well
🟩 Facility Boundary
— Groundwater Contour
- ▶ Groundwater Flow Direction

0 135 270 540
Feet

Groundwater elevations are presented in feet above mean sea level using North American Vertical Datum 1988.

N

Groundwater Elevations, January 2020

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Figure 2-5

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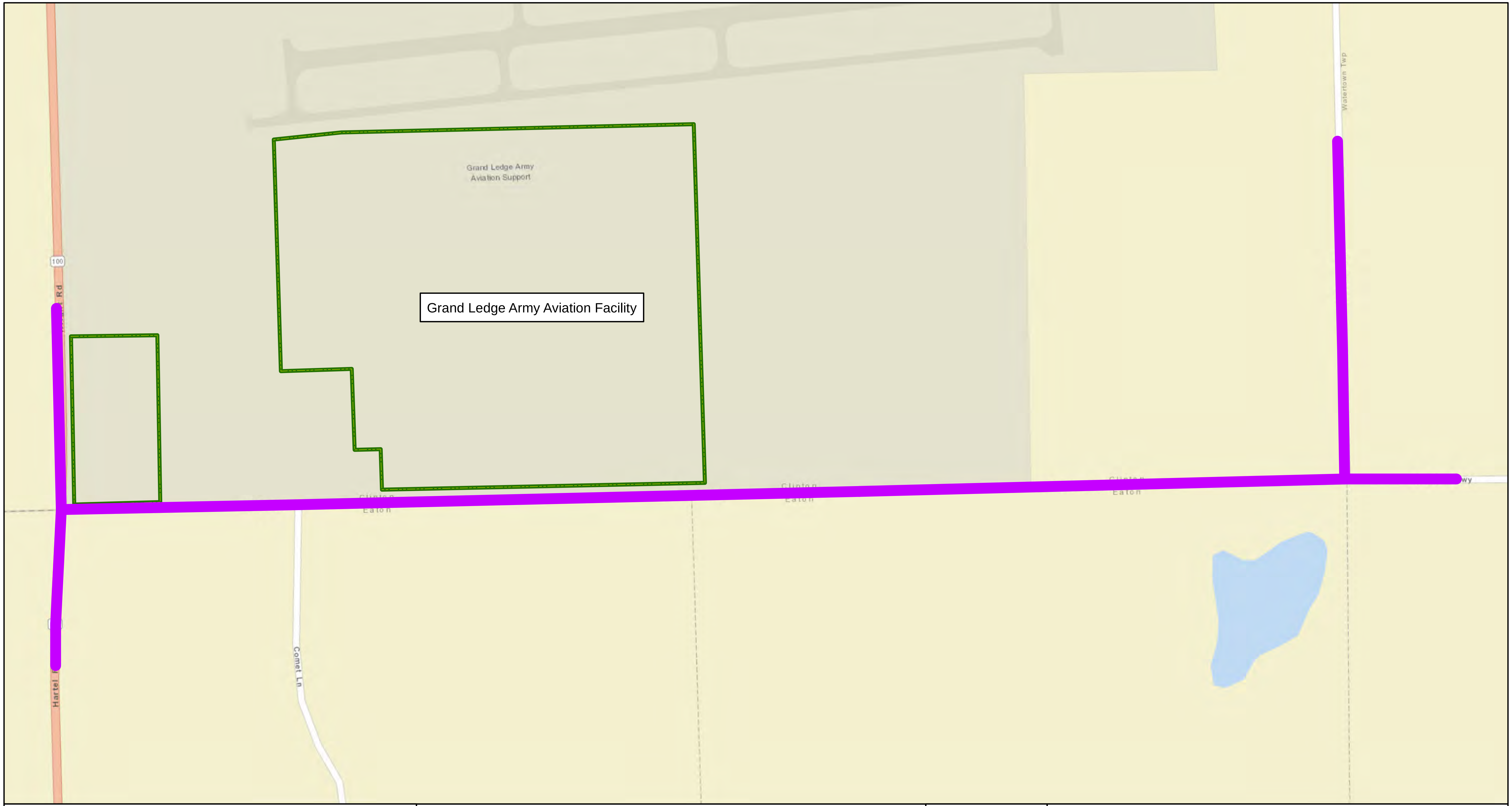

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SCALE	1:4,800	CHK BY	ST	8/18/2020
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	8/18/2020

🟩 Facility Boundary

▬ Private Drinking Water Well Sampling Target Zones

0 200 400 800
Feet

N

Residential Sampling Areas

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Figure 2-6

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3. Summary of Areas of Interest

This section presents a summary of each potential PFAS release area by AOI. The potential PFAS release areas were grouped into two AOIs based on proximity and direction of groundwater flow (**Figure 3-1**). Two additional potential PFAS release areas, Abrams Municipal Airport and Transfast Trucking, Inc. (Former Hangar), are also shown on **Figure 3-1** for informational purposes. Abrams Municipal Airport and Transfast Trucking, Inc. (Former Hangar) are adjacent to the facility (not under the control of ARNG) and were not evaluated as part of this SI.

3.1 AOI 1 – AASF Hangar and Armory (Former AASF)

AOI 1 consists of two potential PFAS release areas, as described below.

3.1.1 AASF Hangar

The AASF comprises the AASF administrative building and AASF hangar. Construction on the current hangar building was completed in January/February 2007, moving operations over from what is now the Armory. The hangar is equipped with an AFFF fire suppression system that contains a 700-gallon tank of 3% Ansulite. No leaks or releases, emergency or otherwise, have occurred from this system, and no evidence of leaking was observed during the visual site inspection (VSI). The system is tested and inspected annually by an outside contractor; system contents are not discharged during testing. In May 2014, the tank’s liner required a replacement; a contractor drained the system into a holding tank, relined the system tank, and pumped the original AFFF concentrate back into the system reportedly without incident or release. Trench drains are located in the hangar bay and maintenance/fueling areas and are connected to an oil/water separator that subsequently drains to the Grand Ledge municipal sanitary sewer. No known discharges of AFFF to the municipal sanitary sewer have occurred.

3.1.2 Armory (Former AASF)

The current Armory building was the previous location of the AASF, prior to the new hangar’s construction in 2007. The Armory has never been equipped with a foam fire suppression system. AFFF is not currently stored within the Armory. The use of dry chemical fire suppressant was noted at a storage area within the current Armory Building.

The Armory historically housed a certified firefighting unit in the 1980s that was disbanded in the early 1990s. During the PA, former Grand Ledge AASF and Armory personnel commented during their interview that a firetruck used to be stationed within a garage located in the Armory building during approximately the 1980s to early 1990s. The garage is currently used as general office/storage space. Personnel interviewed during the PA did not believe AFFF was stored on or in the firetruck. However, following Mobilization 1 field activities, additional information was obtained regarding the Armory.

Based on interviews with retired AASF personnel in December 2019, Tri-Max™ 30 extinguishers were used for fire training with AFFF on the tarmac north of the Armory, the adjacent motor pool to the east, and the adjacent wash bay to the west. There were variable accounts regarding the frequency of training and whether or not the firetruck parked at the Armory contained AFFF and was used for fire training as well. The residual AFFF from training activities would reportedly run-off into a drainage ditch formerly located along the western edge of the tarmac. Based on historical aerial imagery (EDR™, 2018), this drainage ditch existed prior to construction activities in 2005 and flowed north before connecting with an off-facility drainage ditch at Abrams Municipal Airport. As a result of the construction activities, the drainage ditch was filled in, and the stormwater retention basin was established. In addition, the construction involved the removal/replacement of old pavement and the excavation/grading of underlying soil in the former tarmac area. The original soil likely remains at the facility and was moved around during excavation and grading activities.

3.2 AOI 2 – Annex Building

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

3.2.1 Annex Building

The Annex Building, located on the corner of Wright Road and Eaton Highway, is used for general storage as well as housing flight simulators used for training. Bulk and expired AFFF is stored within the Annex Building in both 55-gallon drums and 5-gallon buckets. Manufacturer and percent concentrate varies among the AFFF stored in the Annex Building. The inventory recalled by interviewees includes the following:

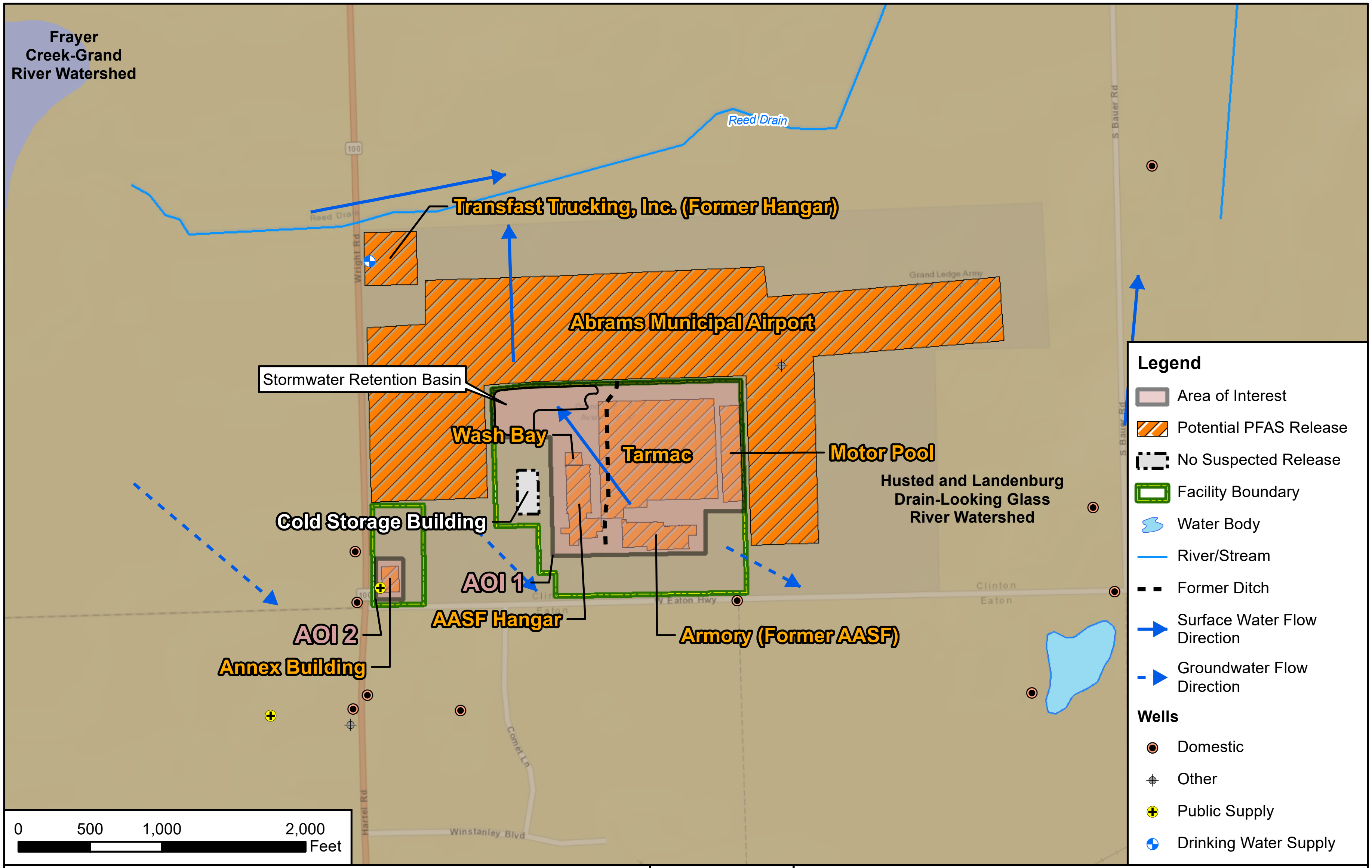
- 3% Concentrate: 20 55-gallon drums and 6 5-gallon buckets (1,130 gallons);
- 3% / 6% Concentrate: 32 5-gallon buckets (160 gallons); and
- 6% Concentrate: 46 5-gallon buckets (230 gallons)

In addition, approximately 16 empty compressed air foam portable fire suppression systems (Tri-Max™ 30 extinguishers) are stored in the Annex Building. All extinguishers are empty and tagged; however, it is not known if they were ever used or tested at the facility. Interviewees reported that no leaks or releases have occurred. Evidence of leaking was not observed during the VSI.

3.3 Off-facility Areas of Interest

An additional potential PFAS release area at the current location of Transfast Trucking, Inc., a privately-owned trucking company, was also identified. According to interviews with retired AASF personnel, this location was a former AASF hangar until about the 1980s. One of the interviewees stated that there was an incident in the hangar, where fuel was spilled from an aircraft, and AFFF may have been used to wash off the fuel. There was also a firetruck located at the former hangar, but it is unknown if the firetruck had foam capabilities. This firetruck was an older model than the firetruck previously located at the Armory. The Transfast Trucking, Inc. (Former Hangar) is neither located within an AOI nor investigated during the SI due to it being off facility property.

According to AASF personnel, local municipal fire departments occasionally train at the municipal airfield; however, training is conducted with water from hydrants, and firefighting foam has reportedly never been used.



CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Grand Ledge AASF and Armory, MI			
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SCALE	1:12,000	CHK BY	ST	10/13/2020
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan,		PM	RG	10/13/2020

N

Areas of Interest

AECOM

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Figure 3-1

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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 site 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 project (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 fire training areas (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 Health Advisory (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 an 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 following:

- The PA for Grand Ledge AASF and Armory, Michigan (AECOM, 2019c) and follow-on interviews conducted in December 2019;
- Analytical data from groundwater, surface water, sediment, 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, 2019b) and Supplemental SI UFP-QAPP Addendum (AECOM, 2019d); 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 was bounded by the property limits of the facility (**Figure 2-2**). Off-facility sampling was not included in the scope of this SI; however, residential drinking water sampling was performed at 25 properties along West Eaton Highway, Wright Road, Hartel Road, and Bauer Road to determine if a potentially complete drinking water pathway exists.

4.5 Analytical Approach

Samples were analyzed by Pace Analytical Gulf Coast, accredited under the DoD Environmental Laboratory Accreditation Program (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, 2019b). 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 10 to 36 feet bgs.

4.6 Data Usability Assessment

The Data Usability Assessment (DUA) is an evaluation at the conclusion of data collection activities that uses the results of both data verification and validation in the context of the overall project decisions or objectives. Using both quantitative and qualitative methods, the assessment 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, 2017).

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 (DVR) (**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, and 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. Several field samples displayed EIS area counts less than the quality control (QC) limit of 50%. The positive field sample results associated with EIS area counts less than the QC limit, but greater than 20%, were qualified “J+”, while non-detects were qualified “UJ”. The qualified results should be considered usable as estimated values with a positive bias. While the National Functional Guidelines for Organic Data Review (NFG) recommends rejection for non-detects associated with internal standard recoveries less than 20% (which is similar to the DoD Guidance), none of the data were rejected because 1) unlike the gas chromatography/mass spectrometry (GC/MS) methods discussed in the NFG, PFAS compounds are quantitated based on a normalized 100% internal standard percent recovery for this method, and 2) in matrix spike pairs with area counts less than 20%, the target compounds were shown to be able to be recovered. The project team determined the associated results were usable for project purposes and likely true negatives.

Calibration verifications were performed routinely to ensure that instrument responses for all calibrated analytes were within established QC criteria. All calibration verifications analyzed at the appropriate frequency presented in the QAPP Addendum (AECOM, 2019b). One initial calibration verification displayed a percent recovery for perfluorobutyrate (PFBA) greater than the upper QC limit of 130% but was associated with field sample results that were non-detect for PFBA so no impact on the data is anticipated.

LCS/LCS duplicate (LCS/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, 2019b).

MS/MS duplicate (MS/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%. MS pairs performed on field samples AOI-1-8-SW-0-1, AOI-1-4-GW-17-22, AOI 1-23-SW-0-0.5, AOI 1-23-SD-0-0.5, and Potable-05 displayed RPD outside of control limits for several compounds. These results were associated with recoveries outside the control limits for the target compounds so that the parent sample results were flagged for the accuracy anomaly, which was determined to cause the imprecision.

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, 2019b).

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, with the following exceptions. The LCS/LCSD prepared in batch 660319 displayed percent recoveries greater than the upper QC limit of 130% for perfluorotridecanoic acid (PFTrDA). The LCS/LCSD pair prepared in batch 671951 displayed percent recoveries greater than the upper QC limit of 130% for 6:2 fluorotelomer sulfonate (6:2 FTS), 8:2 fluorotelomer sulfonate (8:2 FTS), and PFOS. The LCS/LCSD pair prepared in batch 674086 displayed a percent recovery outside of the QC limits of 70-130% for n-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA) and PFTrDA. The field sample results associated with negative biases that were non-detect were qualified “UJ” while the positive biases were qualified “J-“. The qualified results should be considered usable as estimated with a negative bias. The positive field sample results associated with positive biases were qualified “J+” unless previously qualified by blank detection. The qualified results should be considered usable as estimated with a positive bias.

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, with a limited number of exceptions. Matrix spike pairs performed on field samples AOI-1-8-SW-0-1, AOI-1-4-GW-17-22, AOI 1-23-SD-0-0.5, AOI-1-5-SB-0-2, and Potable-05 displayed recoveries outside the QC limits. The parent sample results associated with positive biases were qualified “J+”. The qualified results should be considered usable as estimated with a positive bias. The parent sample results associated with the negative bias were positive and were qualified “J-“. The qualified results should be considered usable as estimated with a negative bias.

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 branched 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, 2019b) for all analyses.

Instrument blanks and method blanks were prepared by the laboratory in each batch as a negative control. A limited number of PFAS instrument blanks and method blanks displayed detections greater than the detection limit (DL) for multiple target analytes. In total, twelve field sample results were qualified “U” during data validation due to a detection in the associated blank. The reported field sample result value was adjusted to be equal to the limit of detection (LOD). The results are usable as qualified but were considered to be false positives and are treated as non-detects by the project team.

Field blanks, equipment blanks, and source water samples were also collected for groundwater and soil samples. Three field sample results for PFOS and perfluorotetradecanoic acid (PFTeDA) were qualified as “U”, and where appropriate, lab limits were elevated to detected concentrations due to detections in the field and equipment blanks. The results are usable as qualified but are considered to be false positives and are treated as non-detects by the project team.

Several field samples were re-prepared after the holding time had expired due to the anomalies discussed in this section. The positive field sample results were qualified J, while non-detects were qualified UJ. Typically, the two results were similar, the project team was generally recommended the initial results for data use by the project chemist.

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:

- PFAS in groundwater by DoD QSM Table B-15 at 100%;
- PFAS in soil by DoD QSM Table B-15 at 100%;
- PFAS in surface water by DoD QSM Table B-15 at 100%;
- PFAS in sediment by DoD QSM Table B-15 at 100%;
- PFAS in drinking water by USEPA Method 537 Rev. 1.1 at 100%;
- pH in soil by USEPA Method 9045D at 100%; and
- 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 method detection limit (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, 2019b). 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, 2019b), the laboratory reported all field sample results at the lowest possible dilution. Additionally, any analytes detected below the LOQ and above the DL 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 Preliminary Assessment Report, Grand Ledge Army Aviation Support Facility and Armory, Michigan* dated October 2019 (AECOM, 2019c);
- *Final Site Inspection Programmatic Uniform Federal Policy-Quality Assurance Project Plan* dated March 2018 (AECOM, 2018a);
- *Final Site Inspection Quality Assurance Project Plan Addendum, Grand Ledge Army Aviation Support Facility and Armory, Michigan* dated April 2019 (AECOM, 2019b);
- *Final Site Inspection Supplemental Quality Assurance Project Plan Addendum, Grand Ledge Army Aviation Support Facility and Armory, Michigan* dated November 2019 (AECOM, 2019d);
- *Final Programmatic Accident Prevention Plan* dated July 2018 (AECOM, 2018b); and
- *Final Site Safety and Health Plan, Grand Ledge Army Aviation Support Facility and Armory, Michigan* dated April 2019 (AECOM, 2019a).

SI field activities were conducted in two on-facility mobilizations and two off-facility mobilizations. Mobilization 1 included soil, sediment, surface water, and groundwater grab sampling from temporary monitoring wells from 7 to 10 May 2019. Mobilization 2 included permanent groundwater monitoring well installation, development, and sampling; and soil, sediment, and surface water grab sampling from 4 November to 20 December 2019. As part of a separate action, residential well sampling was performed by ARNG at 25 residencies south, west, and east of the Grand Ledge AASF and Armory in two mobilizations (22 - 23 January 2020 and 28 - 29 July 2020). Field activities were conducted in accordance with the QAPP Addendum (AECOM, 2019b) and Supplemental QAPP Addendum (AECOM, 2019d), except as noted in **Section 5.10**.

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

Mobilization 1 –

- 18 soil grab samples from 9 boring locations (boring depths from 10 to 22 feet bgs);
- 9 groundwater grab samples from 9 temporary well locations;
- 3 sediment and 3 surface water samples from 3 locations; and
- 10 Quality Assurance (QA) samples collected.

Mobilization 2 –

- 5 soil grab samples from 5 locations;
- 7 groundwater samples from 7 permanent monitoring well locations (boring depths from 50 to 100 feet bgs);
- 5 sediment samples from 5 locations;
- 8 surface water samples from 4 locations; and
- 8 QA samples collected.

Figures 5-1 and **5-2** provide 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 surveyed well data are provided in **Appendix B3**. Additionally, a photographic log of field activities is provided in **Appendix C**.

5.1 Pre-Investigation Activities

In preparation for the SI field activities, project team members participated in Technical Project Planning (TPP) meetings, 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, Engineer's 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 12 December 2018, 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, MIARNG, USACE, EGLE, Grand Ledge AASF and Armory, Michigan Department of Human Health Services, Clinton and Barry-Eaton District Health Departments, 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, 2019b). 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 Grand Ledge AASF and Armory, with input from the AECOM field team. AECOM's drilling subcontractor, Cascade Technical Services, LLC, contacted "Miss Digg" 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 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 potable water source at the facility was collected on 16 April 2019. The results of the 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 Programmatic UFP-QAPP (PQAPP) (AECOM, 2018a). 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

During Mobilization 1, soil samples were collected via direct-push technology (DPT), in accordance with the QAPP Addendum (AECOM, 2019b). GeoProbe® DT45 and DT60 dual-tube sampling system were 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.

Three discrete soil samples were planned to be collected for chemical analysis from each soil boring during Mobilization 1: one soil sample at the surface (0 to 2 feet bgs) and two subsurface soil samples (one approximately 1 foot above the groundwater table and one at the mid-point between the surface and the groundwater table). However, seven out of the nine direct-push locations had very shallow depths-to-water, ranging from 3 to 7 feet bgs. Therefore, soil samples at five borings (AOI 1-1, AOI 1-2, AOI 1-3, AOI 1-5, and AOI 2-2) could only be collected in two intervals, and soil samples at two borings (AOI 2-1 and AOI 2-3) could only be collected in one interval instead of three intervals. Refer to **Section 5.10** for additional details on deviations from the QAPP Addendum.

Additionally, during Mobilization 2, five surface soil locations (AOI 1-16 through AOI 1-20) were completed to 2 feet bgs using a hand auger, in accordance with the Supplemental QAPP Addendum (AECOM, 2019d).

All soil sample locations are shown on **Figures 5-1** and **5-2**, and boring 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 QAPP Addendum review.

During both Mobilizations 1 and 2, the 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 (i.e., composition notebook). 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, 2019b).

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, equipment rinsate blanks (ERBs) were 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 4 degrees Celsius (°C) during shipment.

DPT borings were converted to temporary wells, which were subsequently abandoned in accordance with the QAPP Addendum (AECOM, 2019b) using bentonite chips at completion of sampling activities. Borings were installed in grass areas to avoid disturbing concrete or asphalt surfaces.

5.3 Temporary Well Installation and Groundwater Grab Sampling

Temporary wells were installed using a GeoProbe® DT325 dual-tube sampling system. Once the borehole was advanced to the desired depth, a temporary well was constructed of a 10-feet 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 allowed to recharge for a minimum of 24 hours after installation before collection of groundwater samples, with the exception of location AOI 1-6. AOI 1-6 was immediately sampled after installation and then abandoned due to artesian conditions. After the recharge period, groundwater samples were collected using a peristaltic pump with PFAS-free HDPE tubing. 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 [DO], and oxidation-reduction potential [ORP]) 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, 2019b).

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 (FRB) was collected in accordance with the PQAPP (AECOM, 2018a). A temperature blank was placed in each cooler to ensure that samples were preserved at or below 4°C during shipment.

Temporary wells were abandoned in accordance with the QAPP Addendum (AECOM, 2019b) by removing the PVC and backfilling the hole with bentonite chips. Temporary wells were installed in grass areas to avoid disturbing concrete or asphalt.

5.4 Surface Water and Sediment Sampling

During Mobilization 1, surface water and sediment samples were collected from the stormwater retention basin at the three inlet pipes that drain from the facility into the stormwater retention basin. During Mobilization 2, the three inlet pipes were sampled again, and an additional surface water and sediment sample was collected at the discharge culvert that leads from the stormwater retention basin to Reed Drain before it leaves the facility property. One sediment sample was also collected from the drainage ditch on the northeastern side of the facility property during Mobilization 2 to examine a potential upgradient PFAS source area.

Sediment samples were co-located with surface water samples. The surface water sample was collected prior to the collection of the sediment sample. A surface water grab sample was collected from a single point in the waterbody using a dip sampler, approximately two-thirds up from the bottom of the water body. Sampling was performed deliberately and methodically to minimize disturbance of bottom sediments and as quickly as possible to ensure a representative sample was collected. The surface water sample was transferred to an appropriate sampling container. A sediment coring device was used to collect the sediment sample from the first 1 foot of sediment.

The sediment was transferred to a stainless-steel bowl, where stones in excess of 1 centimeter were removed.

During Mobilization 2, two sampling events were conducted, characteristic of one dry weather event and one qualifying storm event. A dry weather sampling event was defined as sampling that occurred following a period of at least 24 hours with no measurable precipitation. Both surface water and sediment samples were collected during the dry weather event on 5 November 2019. A qualifying storm event was defined as precipitation equal to or greater than 0.1 inches within a 24-hour period with sampling initiating within 14 hours after a qualifying storm event and at least 72 hours since the previous qualifying storm event. Surface water samples were collected during the qualifying storm event on 21 November 2019.

After collection of the surface water and sediment samples from each location, general water quality parameters (i.e., temperature, pH, conductivity, DO, and ORP) were collected with a water quality meter and recorded on the field sampling form (**Appendix B2**). The surface water and sediment sample locations are shown on **Figures 5-1** and **5-2**, and sample depths are provided **Table 5-1**.

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 for analysis of PFAS (USEPA Method 537 Compliant with QSM 5.1 Table B-15). Sediment samples were also analyzed for TOC (USEPA Method 9060A) and pH (USEPA Method 9045D), in accordance with the QAPP Addendum (AECOM, 2019b).

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, ERB samples were 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 4 °C during shipment.

5.5 Permanent Well Installation and Groundwater Sampling

During Mobilization 2 of the SI, seven permanent monitoring wells in total were installed within or downgradient of potential source areas. The locations of the wells are shown on **Figure 5-2**.

Rotosonic drilling technology was used to install seven 2-inch diameter monitoring wells. The monitoring wells were constructed with Schedule 40 PVC, flush threaded 10-feet sections of riser, 0.010-inch slotted well screen, and a threaded bottom cap. The location and depth of the permanent wells were determined based on the approximate depths of downgradient drinking water wells, with several of the wells proposed to be installed into bedrock. However, due to the lithologic conditions encountered, permanent monitoring wells AOI 1-14, AOI 1-15, and AOI 2-4 were installed at shallower depths than planned, and off-facility residential well sampling was performed at downgradient locations in lieu of well installation into bedrock. Refer to **Section 5.10** for additional details on deviations from the Supplemental QAPP Addendum. Three times the volume of water within the well or three times the volume of water used for drilling was removed from the well as part of the development process. A filter pack of 20/40 silica sand was installed in the annulus around the well screen to a minimum of 2 feet above the well screen. A 2-feet thick bentonite seal was placed above the filter sand and hydrated with distilled water. Bentonite grout was placed in the well annulus from the top of the bentonite seal to ground surface. The bentonite grout was allowed to set for 24-hours prior to well completion in accordance with the Supplemental QAPP Addendum (AECOM, 2019d). All monitoring wells were completed with flush mount well vaults. The screen interval of each of the groundwater monitoring wells is provided in **Table 5-3**.

Development and sampling of wells was completed in accordance with the Supplemental QAPP Addendum (AECOM, 2019d). The newly-installed monitoring wells were developed by pumping and surging using a variable speed submersible pump no sooner than 24 hours following installation. Samples were collected no sooner than 24 hours following development via low-flow sampling methods using a QED Sample Pro® bladder pump with disposable, PFAS-free, HDPE tubing. New tubing was used at each well, and the pumps were decontaminated between each well. The wells were purged at a rate determined in the field to reduce draw down prior to sampling. Water quality parameters (e.g., temperature, specific conductance, pH, DO, and ORP) were measured using a water quality meter and recorded on the field sampling form (**Appendix B2**). Water levels were measured to the nearest 0.01 inch and recorded. 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 Supplemental QAPP Addendum (AECOM, 2019d).

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 FRB was collected in accordance with the PQAPP (AECOM, 2018a). A temperature blank was placed in each cooler to ensure that samples were preserved at or below 4°C during shipment.

5.6 Synoptic Water Level Measurements

A synoptic groundwater gauging event was performed on 8 January 2020. Groundwater elevation measurements were collected from the seven new monitoring wells, and water level measurements were taken from the northern side of the well casing. A groundwater flow contour map is provided in **Figure 2-5**, and groundwater elevation data are provided in **Table 5-4**. The groundwater elevation for AOI 1-10 was excluded from **Figure 2-5**, because the well appears to be set in a distinct hydrologic unit (see **Section 2.2.1**).

5.7 Surveying

The northern side of each well casing was surveyed by Michigan-Licensed land surveyors following guidelines provided in *SOP 3-07 Land Surveying*. Survey data from the newly installed wells on the facility were collected on 8 January 2020. The surveyed well data are provided in **Appendix B3**.

5.8 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, 2019b), Supplemental QAPP Addendum (AECOM, 2019d), and the Army Guidance for Addressing Releases of PFAS, Q18 (DA, 2018).

Soil IDW (i.e., soil cuttings) generated during the SI activities were containerized in 55-gallon drums and stored at an on-facility location designated by Grand Ledge AASF and Armory and MIARNG personnel. The soil IDW will be held at the location pending analysis of soils and future CERCLA activities.

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 (GPS) 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 (PPE), 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.

5.9 Laboratory Analytical Methods

Samples were analyzed for a program-specific list 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 and pH by USEPA Method 9045D.

5.10 Deviations from QAPP Addendums

Derivations from the QAPP Addendum and Supplemental QAPP Addendum occurred based on field conditions and discussion between AECOM, ARNG, and USACE. Deviations from the QAPP Addendums are noted below:

- 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, shallow groundwater depths were encountered at 7 out of the 9 direct-push locations, ranging from 3 to 7 feet bgs. Therefore, soil samples at five borings (AOI 1-1, AOI 1-2, AOI 1-3, AOI 1-5, and AOI 2-2) could only be collected in two intervals, and soil samples at two borings (AOI 2-1 and AOI 2-3) could only be collected in one.
- The QAPP Addendum stated that groundwater samples of temporary wells were to be collected following recharge after installation. However, temporary well AOI 1-6 was installed beneath an overlying confining clay layer, which resulted in the creation of an

artesian well. No water bearing zone was observed above the clay layer. Subsequently, AOI 1-6 was quickly sampled and abandoned.

- Permanent monitoring wells AOI 1-14, AOI 1-15, and AOI 2-4 were not installed at the planned depths of 80 to 100 feet bgs due to difficult lithologic conditions. After discussion with ARNG, MIARNG, and USACE, concurrence was received to install AOI 1-15 to a proposed depth of 75 feet bgs, AOI 1-14 to a proposed depth of 67 feet bgs, and AOI 2-4 to a proposed depth of 50 feet bgs.

Table 5-1
Site Inspection Samples by Medium
Site Inspection Report, Grand Ledge AASF and Armory

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)	Comments
Mobilization 1 Soil Samples						
AOI 1-1-SB-0-2	5/9/2019	0 - 2	x	x	x	
AOI 1-1-SB-5-7	5/8/2019	5 - 7	x	x	x	
AOI 1-2-SB-0-2	5/9/2019	0 - 2	x	x	x	
AOI 1-2-SB-0-2 MS/MSD	5/9/2019	0 - 2	x			MS/MSD
AOI 1-2-SB-2-4	5/9/2019	2 - 4	x	x	x	
AOI 1-3-SB-0-2	5/10/2019	0 - 2	x	x	x	
AOI 1-3-SB-2-4	5/10/2019	2 - 4	x	x	x	
AOI 1-4-SB-0-2	5/10/2019	0 - 2	x	x	x	
AOI 1-4-SB-8-10	5/7/2019	8 - 10	x	x	x	
AOI 1-4-SB-17-19	5/7/2019	17 - 19	x	x	x	
AOI 1-4-SB-17-19 DUP	5/7/2019	17 - 19	x	x	x	Field Duplicate
AOI 1-5-SB-0-2	5/8/2019	0 - 2	x	x	x	
AOI 1-5-SB-0-2 MS/MSD	5/8/2019	0 - 2	x			MS/MSD
AOI 1-5-SB-2-4	5/8/2019	2 - 4	x	x	x	
AOI 1-6-SB-0-2	5/9/2019	0 - 2	x	x	x	
AOI 1-6-SB-2-4	5/9/2019	2 - 4	x	x	x	
AOI 1-6-SB-5-7	5/8/2019	5 - 7	x	x	x	
AOI 2-1-SB-0-2	5/9/2019	0 - 2	x	x	x	
AOI 2-2-SB-0-2	5/9/2019	0 - 2	x	x	x	
AOI 2-2-SB-2-4	5/9/2019	2 - 4	x	x	x	
AOI 2-2-SB-2-4-DUP	5/9/2019	2 - 4	x	x	x	Field Duplicate
AOI 2-3 SB-0-2	5/9/2019	0 - 2	x	x	x	
Mobilization 1 Groundwater Samples						
AOI 1-1-GW-7-12	5/9/2019	7 - 12	x			
AOI 1-2-GW-5-10	5/8/2019	5 - 10	x			
AOI 1-3-GW-4-9	5/8/2019	4 - 9	x			
AOI 1-3-GW-4-9 DUP	5/8/2019	4 - 9	x			Field Duplicate
AOI 1-4-GW-17-22	5/8/2019	17 - 22	x			
AOI 1-4-GW-17-22 MS/MSD	5/8/2019	17 - 22	x			MS/MSD
AOI 1-5-GW-5-10	5/9/2019	5 - 10	x			
AOI 1-6-GW-15-20	5/8/2019	15 - 20	x			
AOI 2-1-GW-5-10	5/9/2019	5 - 10	x			
AOI 2-2-GW-5-10	5/9/2019	5 - 10	x			
AOI 2-3-GW-5-10	5/10/2019	5 - 10	x			
Mobilization 1 Surface Water Samples						
AOI 1-7-SW-0-1	5/7/2019	0 - 1	x			
AOI 1-7-SW-0-1 DUP	5/7/2019	0 - 1	x			Field Duplicate

Table 5-1
Site Inspection Samples by Medium
Site Inspection Report, Grand Ledge AASF and Armory

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)	Comments
AOI 1-8-SW-0-1	5/7/2019	0 - 1	x			
AOI 1-8-SW-0-1 MS/MSD	5/7/2019	0 - 1	x			MS/MSD
AOI 1-9-SW-0-1	5/7/2019	0 - 1	x			
Mobilization 1 Sediment Samples						
AOI 1-7-SD-0-1	5/7/2019	0 - 1	x			
AOI 1-7-SD-0-1 DUP	5/7/2019	0 - 1	x			Field Duplicate
AOI 1-8-SD-0-1	5/7/2019	0 - 1	x			
AOI 1-8-SD-0-1 MS/MSD	5/7/2019	0 - 1	x			MS/MSD
AOI 1-9-SD-0-1	5/7/2019	0 - 1	x			
Mobilization 2 Soil Samples						
AOI 1-16-SS-0-2	11/6/2019	0 - 2	x			
AOI 1-16-SS-0-2MS/MSD	11/6/2019	0 - 2	x			MS/MSD
AOI 1-17-SS-0-2	11/6/2019	0 - 2	x			
AOI 1-18-SS-0-2	11/6/2019	0 - 2	x			
AOI 1-18-SS-0-2D	11/6/2019	0 - 2	x			Field Duplicate
AOI 1-19-SS-0-2	11/6/2019	0 - 2	x			
AOI 1-20-SS-0-2	11/6/2019	0 - 2	x			
Mobilization 2 Groundwater Samples						
AOI 1-10-GW-89	11/19/2019	80 - 100	x			
AOI 1-10-GW-89-D	11/19/2019	80 - 100	x			Field Duplicate
AOI 1-10-GW-89-MS/MSD	11/19/2019	80 - 100	x			MS/MSD
AOI 1-11-GW-35	12/18/2019	30 - 40	x			
AOI 1-12-GW-42	12/20/2019	47 - 57	x			
AOI 1-13-GW-47	12/19/2019	42 - 52	x			
AOI 1-14-GW-55	12/19/2019	50 - 60	x			
AOI 1-15-GW-67.50	12/19/2019	60 - 75	x			
AOI 2-4-GW-30	12/18/2019	25 - 35	x			
Mobilization 2 Surface Water Samples						
AOI 1-21-SW-0-0.5	11/5/2019	0 - 0.5	x			
AOI 1-21-SW-0-0.5	11/21/2019	0 - 0.5	x			
AOI 1-22-SW-0-0.5	11/5/2019	0 - 0.5	x			
AOI 1-22-SW-0-0.5D	11/5/2019	0 - 0.5	x			Field Duplicate
AOI 1-22-SW-0-0.5	11/21/2019	0 - 0.5	x			
AOI 1-23-SW-0-0.5	11/5/2019	0 - 0.5	x			
AOI 1-23-SW-0-0.5MS/MSD	11/5/2019	0 - 0.5	x			MS/MSD
AOI 1-23-SW-0-0.5	11/21/2019	0 - 0.5	x			
AOI 1-24-SW-0-0.5	11/5/2019	0 - 0.5	x			
AOI 1-24-SW-0-0.5	11/21/2019	0 - 0.5	x			

Table 5-1
Site Inspection Samples by Medium
Site Inspection Report, Grand Ledge AASF and Armory

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)	Comments
Mobilization 2 Sediment Samples						
AOI 1-21-SD-0-0.5	11/5/2019	0 - 0.5	x			
AOI 1-22-SD-0-0.5	11/5/2019	0 - 0.5	x			
AOI 1-22-SD-0-0.5D	11/5/2019	0 - 0.5	x			Field Duplicate
AOI 1-23-SD-0-0.5	11/5/2019	0 - 0.5	x			
AOI 1-23-SD-0-0.5MS/MSD	11/5/2019	0 - 0.5	x			MS/MSD
AOI 1-24-SD-0-0.5	11/5/2019	0 - 0.5	x			
AOI 1-25-SD-0-0.5	11/6/2019	0 - 0.5	x			
Equipment Blank Samples						
GL-SPIGOT-041619	4/16/2019	---	x			Equipment Blank
FRB-041619	4/16/2019	---	x			Equipment Blank
FQC-EB-050919-WL	5/9/2019	---	x			Equipment Blank
FQC-EB-050719-ROD	5/7/2019	---	x			Equipment Blank
FQC-EB-050719-HA	5/7/2019	---	x			Equipment Blank
FQC-EB-050719-SS-1	5/7/2019	---	x			Equipment Blank
FQC-EB-050719-SS-2	5/7/2019	---	x			Equipment Blank
EB-110619HA	11/6/2019	---	x			Equipment Blank
FRB-110619	11/6/2019	---	x			Equipment Blank
EB-112019WL	11/20/2019	---	x			Equipment Blank
EB-112019BP	11/20/2019	---	x			Equipment Blank
FRB-121819	12/18/2019	---	x			Equipment Blank
ERB-121819BP	12/18/2019	---	x			Equipment Blank

Notes:
ft = feet
LC/MS/MS = liquid chromatography with tandem mass spectrometry
MS/MSD = matrix spike/ matrix spike duplicate
PFAS = per- and polyfluoroalkyl substances
pH = potential for hydrogen
QSM = Quality Systems Manual
TOC =total organic carbon
USEPA = United States Environmental Protection Agency

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Table 5-2
Borings Depths and Temporary Well Screen Intervals
Site Inspection Report, Grand Ledge AASF and Armory

Area of Interest	Soil Boring ID	Soil Boring Depth (feet bgs)	Temporary Well Screen Interval (feet bgs)
AOI 1	AOI 1-1	20	7 - 12
	AOI 1-2	15	5 - 10
	AOI 1-3	10	4 - 9
	AOI 1-4	22	17 - 22
	AOI 1-5	10	5 - 10
	AOI 1-6	20	15 - 20
AOI 2	AOI 2-1	10	5 - 10
	AOI 2-2	10	5 - 10
	AOI 2-3	10	5 - 10

Notes:

bgs = below ground surface

Table 5-3
Permanent Monitoring Well Screen Intervals
Site Inspection Report, Grand Ledge AASF and Armory

Monitoring Well ID	Screen Interval (feet bgs)
AOI 1-10	80 - 100
AOI 1-11	30 - 40
AOI 1-12	47 - 57
AOI 1-13	42 - 52
AOI 1-14	50 - 60
AOI 1-15	60 - 75
AOI 2-4	25 - 35

Notes:

bgs = below ground surface

Table 5-4
Groundwater Elevation
Site Inspection Report, Grand Ledge AASF and Armory

Monitoring Well ID	Top of Casing Elevation (ft amsl)	Depth to Water[1] (ft btoc)	Groundwater Elevation (ft amsl)
AOI 1-10	844.86	20.16	824.70
AOI 1-11	842.08	12.39	829.69
AOI 1-12	842.63	16.44	826.19
AOI 1-13	845.09	19.58	825.51
AOI 1-14	861.11	35.78	825.33
AOI 1-15	853.99	26.73	827.26
AOI 2-4	839.22	9.55	829.67

Notes:

1. Synoptic gauging event occurred on 8 January 2020.

amsl = above mean sea level

btoc = below top of casing

ft = feet

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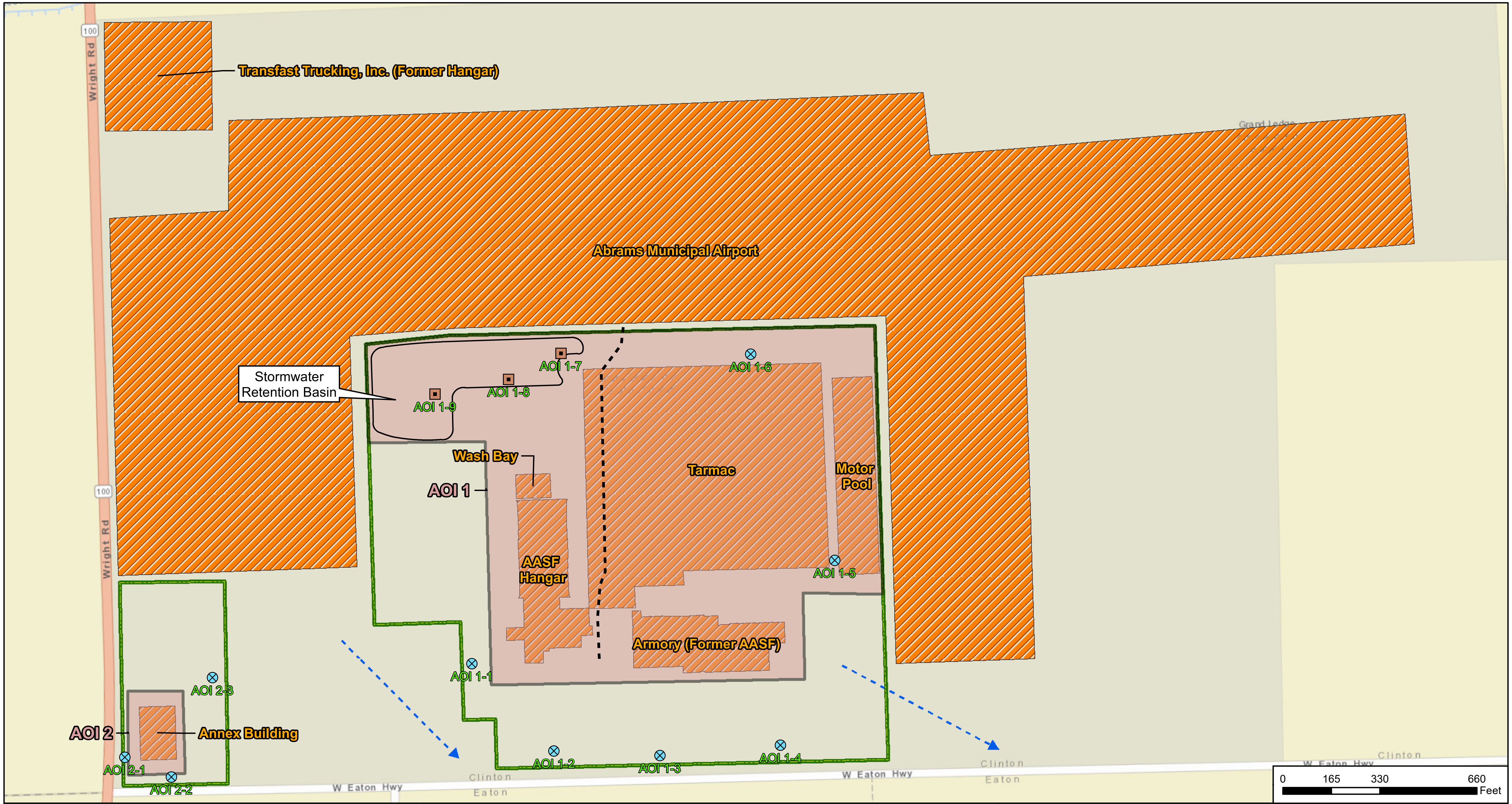

CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Grand Ledge AASF and Armory, MI			
REVISED	10/13/2020	GIS BY	GC	10/13/2020
SCALE	1:3,960	CHK BY	ST	10/13/2020
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap		PM	RG	10/13/2020

⊗ DPT Boring/Temporary Well
▣ Surface Water/Sediment Sample
▭ Area of Interest
▨ Potential PFAS Release
▭ Facility Boundary
- - Former Ditch
- ▶ Groundwater Flow Direction

N

Site Inspection Sample Locations (Mobilization 1)

AECOM

12420 Milestone Center Drive
Germantown, MD 20876

Figure 5-1

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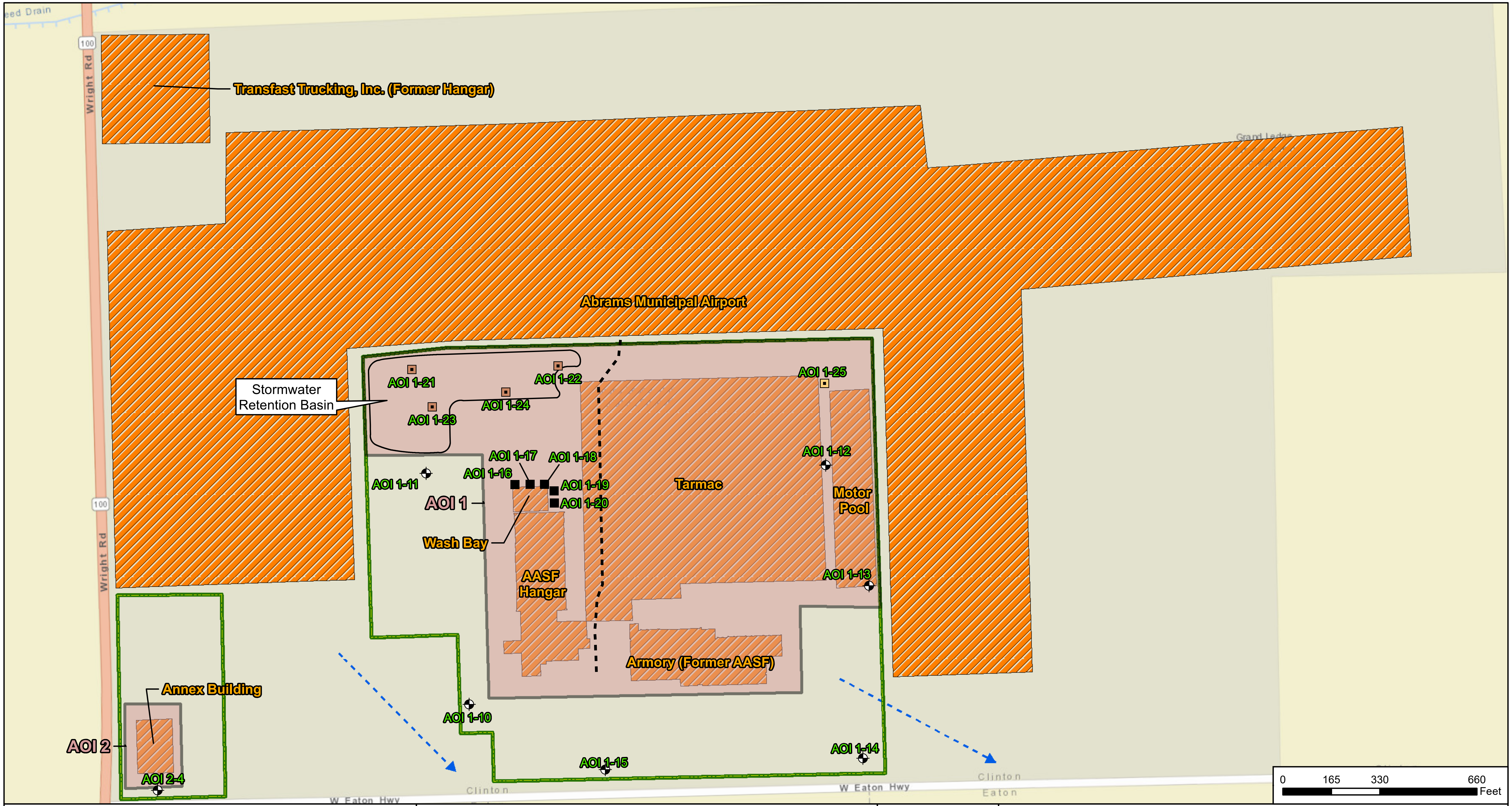

CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Grand Ledge AASF and Armory, MI			
REVISED	10/13/2020	GIS BY	GC	10/13/2020
SCALE	1:3,960	CHK BY	ST	10/13/2020
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap		PM	RG	10/13/2020

⊕ Permanent Monitoring Well

▣ Surface Water/Sediment Sample

▣ Sediment Sample

■ Surface Soil Sample

▭ Area of Interest

▨ Potential PFAS Release

▭ Facility Boundary

- - Former Ditch

- ▶ Groundwater Flow Direction

N

Site Inspection Sample Locations (Mobilization 2)

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 5-2

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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 6.9**. **Table 6-2** through **Table 6-7** present PFAS results for samples with detections in soil, sediment, surface water, 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 site concentration for sampled media exceed the SLs established in the OSD memorandum, the AOI will proceed to a 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, groundwater, sediment, and surface water 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,b] 0-2 feet bgs	Industrial/ Commercial Composite Worker (Soil) (µg/kg)[a,b] 2-15 feet bgs	Tap Water (Groundwater) (ng/L)[a,b]
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. HQ=0.1. 15 October 2019.

b.) If only one PFAS is present, a Hazard Quotient (HQ) of 1 applies and the values presented would increase by a factor of x10.

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. AOI 1 includes two potential PFAS release areas: AASF Hangar and Armory (Former AASF). The analytical results for surface water and sediment are also presented for informational purposes. The detected compounds are presented in **Table 6-2** through **Table 6-7**. The detections of PFOS and PFOA in soil, groundwater, sediment, and surface water are presented on **Figure 6-1** through **Figure 6-11**.

6.3.1 AOI 1 Soil Analytical Results

PFOA, PFOS, and PFBS concentrations in soil did not exceed the soil SLs at AOI 1. **Figure 6-1** through **Figure 6-4** present detections in soil for PFOS and PFOA. The detected compounds are summarized in **Table 6-2** through **Table 6-4**.

During Mobilization 1, soil was sampled at three intervals from two borings (AOI 1-4 and AOI 1-6) and two intervals from four borings (AOI 1-1, AOI 1-2, AOI 1-3, and AOI 1-5). PFOA, PFOS, and PFBS were detected in the surface interval at concentrations more than an order of magnitude lower than the residential soil SLs and in the shallow interval at concentrations more than three orders of magnitude lower than the industrial/commercial soil SLs. PFOA was detected at concentrations ranging from 0.00784 J micrograms per Kilogram (µg/Kg) to 0.171 J µg/Kg. PFOS was detected at concentrations ranging from 0.018 J µg/Kg to 2.22 J+ µg/Kg. PFBS was detected at concentrations ranging from 0.00424 J µg/Kg to 0.00917 J µg/Kg. The occurrence and concentration of individual PFAS varied across depth intervals and between sampling locations.

During Mobilization 2, surface soil was sampled from locations AOI 1-16 through AOI 1-20. The soil sample locations were placed around the existing wash bay, northwest of the AASF Hangar. PFOA and PFOS were detected in the surface soil at concentrations more than an order of magnitude lower than the residential soil SLs. PFBS was not detected in any of the surface soil locations. PFOA was detected at concentrations ranging from 0.181 J µg/Kg to 0.331 J µg/Kg. PFOS was detected at concentrations ranging from 0.802 J µg/Kg to 11.0 µg/Kg. The highest concentrations and most compounds detected were observed at AOI 1-19, located in the northeast corner of the pavement outside the AASF Hangar.

6.3.2 AOI 1 Groundwater Analytical Results

PFOA and PFOS concentrations in groundwater exceeded the groundwater SLs at AOI 1. **Figure 6-5** and **Figure 6-6** present the concentration ranges of detections in groundwater for PFOS and PFOA. The detected compounds from are summarized in **Table 6-5**.

During Mobilization 1, groundwater was sampled from temporary monitoring well locations AOI 1-1 through AOI 1-6. At location AOI 1-5, PFOA and PFOS were detected at concentrations 53.0 ng/L and 60.0 ng/L, respectively, exceeding the individual SLs of 40 ng/L. AOI 1-5 is located northeast of the Armory (Former AASF) source area. PFBS was detected at concentrations ranging from 1.58 J ng/L to 46.1 ng/L, below the SL of 40,000 ng/L.

During Mobilization 2, groundwater was sampled from permanent monitoring well locations AOI 1-10 through AOI 1-15. PFOA was detected at a concentration of 28.2 ng/L in AOI 1-12, PFOS was detected at a concentration of 1.97 J ng/L in AOI 1-11, and PFBS was detected at a concentration of 70.7 ng/L in AOI 1-12. All detections of PFOA, PFOS, and PFBS were below the respective SLs. The highest concentrations and most compounds detected were generally observed at AOI 1-12, located slightly north (upgradient) of temporary well AOI 1-5, which had the exceedances of the SLs for PFOA and PFOS.

6.3.3 AOI 1 Sediment Analytical Results

Figure 6-7 and **Figure 6-8** present the concentration ranges of detections in sediment for PFOS and PFOA. The detected compounds are summarized in **Table 6-6**.

During Mobilization 1, three sediment samples (AOI 1-7 through AOI 1-9) were collected from the stormwater retention basin at the three inlet pipes. PFOA was detected at concentrations ranging from 0.030 J µg/Kg to 7.15 J µg/Kg, PFOS was detected at concentrations ranging from 5.31 J+ µg/Kg to 26.3 J µg/Kg, and PFBS was detected at concentrations ranging from 0.00473 J µg/Kg to 0.225 J µg/Kg. The highest concentrations of individual compounds generally occurred at AOI 1-7, the easternmost inlet pipe.

During Mobilization 2, four sediment samples (AOI 1-21 through AOI 1-24) were collected from the stormwater retention basin at the three inlet pipes and one outlet pipe. Another sediment sample (AOI 1-25) was collected from the drainage ditch on the northeastern side of the facility property but had no detections of PFAS. PFOA and PFBS were not detected in any of the samples. PFOS was detected at concentrations ranging from 0.744 J µg/Kg to 5.89 J- µg/Kg. Consistent with Mobilization 1 results, the highest concentrations of individual compounds generally occurred at the easternmost inlet pipe.

6.3.4 AOI 1 Surface Water Analytical Results

Figure 6-9 through **Figure 6-11** present the concentration ranges of detections in surface water for PFOS and PFOA. The detected compounds are summarized in **Table 6-7.**

During Mobilization 1, three surface water samples (AOI 1-7 through AOI 1-9) were collected from the stormwater retention basin at the three inlet pipes. PFOA was detected at concentrations ranging from 1.64 J ng/L to 10.8 ng/L, PFOS was detected at concentrations ranging from 4.66 J ng/L to 141 ng/L, and PFBS was detected at concentrations ranging from 1.82 J ng/L to 6.66 J ng/L. The occurrence and concentration of individual PFAS varied between sampling locations.

During Mobilization 2, four surface water samples (AOI 1-21 through AOI 1-24) were collected from three inlet pipes and one outlet pipe during two separate sampling events, characteristic of a dry weather event and a qualifying storm event. In the dry weather event that occurred on 5 November 2019, PFOA was detected at concentrations ranging from 8.69 ng/L to 17.0 J ng/L, PFOS was detected at concentrations ranging from 19.0 ng/L to 283 J+ ng/L, and PFBS was detected at concentrations ranging from 3.75 J ng/L to 6.22 J ng/L. In the qualifying storm event that occurred on 21 November 2019, PFOA was detected at concentrations ranging from 1.85 J ng/L to 20.5 ng/L, PFOS was detected at concentrations ranging from 16.3 J+ ng/L to 51.1 J+ ng/L, and PFBS was detected at concentrations ranging from 1.41 J ng/L to 3.56 J ng/L. The occurrence and concentration of individual PFAS varied between sampling locations and between sampling events.

6.3.5 AOI 1 Conclusions

Based on the results of the SI, PFOA, PFOS, and PFBS were detected in soil at AOI 1; however, the detected concentrations were at least one to three orders of magnitude lower than the residential and industrial/commercial soil SLs. PFOA and PFOS were detected in groundwater at concentrations exceeding the SL of 40 ng/L in one temporary monitoring well, AOI 1-5. PFOA, PFOS, and PFBS were also detected in sediment and surface water at AOI 1. There are no established SLs for sediment and surface water; therefore, these results are presented for informational purposes only. Based on the exceedances of the SLs for PFOA and PFOS 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. AOI 2 includes one potential PFAS release area: Annex Building. The detected compounds in soil and groundwater are summarized on **Table 6-2**, **Table 6-3**, and **Table 6-5**. The detections of PFOS and PFOA in soil and groundwater are presented on **Figure 6-1** through **Figure 6-6**.

6.4.1 AOI 2 Soil Analytical Results

PFOA, PFOS, and PFBS concentrations in soil did not exceed the soil SLs at AOI 2. **Figure 6-1** and **Figure 6-2** present detections in soil for PFOS and PFOA. The detected compounds are summarized in **Table 6-2** and **Table 6-3**.

Soil was sampled at boring locations AOI 2-1, AOI 2-2, and AOI 2-3. Samples were collected at the surface interval (0 to 2 feet bgs) for all three locations and at a shallow interval (2 to 4 feet bgs) for AOI 2-2. PFOA, PFOS, and PFBS were detected in the surface interval at concentrations more than two orders of magnitude lower than the residential soil SLs and in the shallow interval at concentrations more than three orders of magnitude lower than the industrial/commercial soil SLs.

PFOA was detected in the surface/ shallow interval at concentrations ranging from 0.016 J to 0.117 J µg/Kg. PFOS was detected in the surface/ shallow interval at concentrations ranging from 0.123 J µg/Kg to 0.486 J µg/Kg. PFBS was detected in the surface interval at concentrations 0.011 J µg/Kg and 0.014 J µg/Kg. The greatest number of compounds were observed in the surface intervals of AOI 2-1 and AOI 2-3.

6.4.2 AOI 2 Groundwater Analytical Results

PFOA, PFOS, and PFBS concentrations in groundwater did not exceed the groundwater SLs at AOI 2. **Figure 6-5** and **Figure 6-6** present the concentration ranges of detections in groundwater for PFOS and PFOA. The detected compounds are summarized in **Table 6-5**.

During Mobilization 1, groundwater was sampled at temporary monitoring well locations AOI 2-1, AOI 2-2, and AOI 2-3. PFOA and PFBS were only detected at AOI 2-2, which is located in the most downgradient position from the Annex Building source area. The PFOA detection of 4.10 J ng/L was below the SL of 40 ng/L, and the PFBS detection of 4.21 J ng/L was below the SL of 40,000 ng/L. The maximum concentration of PFOS (31.7 ng/L) was also detected at AOI 2-2 below the SL of 40 ng/L.

During Mobilization 2, groundwater was sampled from permanent monitoring well location AOI 2-4. The permanent monitoring well had no detections of PFOA, PFOS, or PFBS.

6.4.3 AOI 2 Conclusions

Based on the results of the SI, PFOA, PFOS, and PFBS were detected in soil at AOI 2; however, the detected concentrations were more than two to three orders of magnitude lower than the residential and industrial/commercial soil SLs. PFOA, PFOS, and PFBS were also detected in groundwater from temporary monitoring wells sampled during Mobilization 1, but detected concentrations did not exceed the groundwater SLs. During Mobilization 2, PFOA, PFOS, and PFBS were not detected in groundwater from the one permanent monitoring well at location AOI 2-4. Therefore, further evaluation at AOI 2 is not warranted.

Table 6-2
PFAS Detections in Surface Soil
Site Inspection Report, Grand Ledge AASF and Armory

	Area of Interest	AOI1																			
	Sample ID	AOI-1-1-SB-0-2		AOI-1-2-SB-0-2		AOI-1-3-SB-0-2		AOI-1-4-SB-0-2		AOI-1-5-SB-0-2		AOI-1-6-SB-0-2		AOI 1-16-SS-0-2		AOI 1-17-SS-0-2		AOI 1-18-SS-0-2		AOI 1-18-SS-0-2D	
	Sample Date	05/09/2019		05/09/2019		05/10/2019		05/10/2019		05/08/2019		05/09/2019		11/06/2019		11/06/2019		11/06/2019		11/06/2019	
	Depth	0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft		0 - 2 ft	
Analyte	**OSD Screening Level [a]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ug/Kg)																					
NEtFOSAA	-	ND		ND		ND		ND		0.030	J	ND		ND		ND		ND		ND	
NMeFOSAA	-	ND		ND		0.00530	J	ND		0.028	J	ND		ND		ND		ND		ND	
PFBA	-	0.129	J	0.116	J	0.046	J	0.204	J	0.098	J	0.051	J	ND		ND		ND		ND	
PFBS	130000	0.00424	J	ND		ND		ND		ND		ND		ND		ND		ND		ND	
PFDA	-	ND		0.031	J	ND		0.045	J	ND		ND		ND		ND		ND		ND	
PFHpA	-	ND		0.057	J	0.011	J	0.056	J	0.057	J	0.027	J	ND		ND		ND		ND	
PFHxA	-	0.044	J	0.085	J	0.043	J	0.105	J	0.078	J	0.048	J	ND		0.282	J	0.209	J	ND	
PFHxS	-	ND		ND		ND		0.043	J	ND		0.032	J	0.213	J	1.09	J	0.223	J	0.216	J
PFNA	-	ND		0.052	J	ND		0.097	J	0.152	J	ND		ND		ND		0.113	J	ND	
PFOA	130	0.015	J	0.123	J	0.018	J	0.157	J	0.171	J	0.039	J	ND		0.212	J	0.182	J	0.181	J
PFOS	130	ND		0.936	J	0.033	J	0.444	J	2.22	J+	0.032	J	0.802	J	4.27		3.62		2.73	
PFPeA	-	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	
PFTeDA	-	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	
PFTrDA	-	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	
PFUnDA	-	0.00519	J	0.019	J	ND		0.031	J	0.012	J	ND		ND		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 residential scenario for direct ingestion of contaminated soil.

Interpreted Qualifiers

J = Estimated concentration

J+ = Estimated concentration, biased high

Chemical Abbreviations

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

Acronyms and Abbreviations

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

Table 6-2
PFAS Detections in Surface Soil
Site Inspection Report, Grand Ledge AASF and Armory

	Area of Interest	AOI1				AOI2					
	Sample ID	AOI 1-19-SS-0-2		AOI 1-20-SS-0-2		AOI-2-1-SB-0-2		AOI-2-2-SB-0-2		AOI-2-3-SB-0-2	
	Sample Date	11/06/2019		11/06/2019		05/09/2019		05/09/2019		05/09/2019	
	Depth	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**
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ug/Kg)											
NEtFOSAA	-	ND		ND		ND		0.026	J	ND	
NMeFOSAA	-	ND		ND		ND		ND		ND	
PFBA	-	0.186	J	ND		0.095	J	0.046	J	0.110	J
PFBS	130000	ND		ND		0.014	J	ND		0.011	J
PFDA	-	ND		ND		ND		0.018	J	0.028	J
PFHpA	-	0.225	J	ND		0.045	J	ND		0.028	J
PFHxA	-	0.492	J	0.237	J	0.094	J	ND		0.056	J
PFHxS	-	2.01		0.372	J	0.041	J	ND		0.011	J
PFNA	-	0.175	J	ND		0.029	J	ND		0.048	J
PFOA	130	0.331	J	ND		0.117	J	ND		0.069	J
PFOS	130	11.0		1.09	J	0.486	J	ND		0.175	J
PFPeA	-	ND		ND		0.078	J	ND		ND	
PFTeDA	-	ND		ND		0.019	J	ND		ND	
PFTrDA	-	ND		ND		ND		ND		0.014	J
PFUnDA	-	ND		ND		0.016	J	ND		0.018	J

Grey Fill	Detected concentration exceeded OSD Screening Levels

References

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

Interpreted Qualifiers

J = Estimated concentration

J+ = Estimated concentration, biased high

Chemical Abbreviations

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

Acronyms and Abbreviations

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

Table 6-3
PFAS Detections in Shallow Subsurface Soil
Site Inspection Report, Grand Ledge AASF and Armory

Area of Interest		AOI1														AOI2			
Sample ID		AOI-1-1-SB-5-7		AOI-1-2-SB-2-4		AOI-1-3-SB-2-4		AOI-1-4-SB-8-10		AOI-1-5-SB-2-4		AOI-1-6-SB-2-4		AOI-1-6-SB-5-7		AOI-2-2-SB-2-4		AOI-2-2-SB-2-4-DUP	
Sample Date		05/08/2019		05/09/2019		05/10/2019		05/07/2019		05/08/2019		05/09/2019		05/08/2019		05/09/2019		05/09/2019	
Depth		5 - 7 ft		2 - 4 ft		2 - 4 ft		8 - 10 ft		2 - 4 ft		2 - 4 ft		5 - 7 ft		2 - 4 ft		2 - 4 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 (ug/Kg)																			
8:2 FTS	-	ND		ND		ND		ND		ND		0.023	J	ND		ND		ND	
PFBA	-	0.033	J	0.052	J	0.032	J	0.055	J	0.130	J	0.029	J	0.040	J	0.033	J	0.035	J
PFBS	1600000	ND		ND		ND		ND		0.00917	J	ND		ND		ND		ND	
PFDA	-	ND		0.016	J	ND		0.00876	J	0.013	J	ND		ND		ND		0.013	J
PFDoA	-	ND		ND		ND		ND		ND		0.010	J	ND		ND		ND	
PFHpA	-	ND		ND		0.00825	J	ND		0.179	J	0.018	J	ND		ND		ND	
PFHxA	-	ND		0.043	J	ND		0.028	J	0.261	J	0.064	J	0.038	J	ND		0.040	J
PFHxS	-	ND		ND		ND		ND		0.199	J	ND		ND		ND		0.011	J
PFNA	-	ND		ND		ND		ND		0.062	J	ND		ND		ND		ND	
PFOA	1600	ND		0.031	J	ND		0.00784	J	0.171	J	0.017	J	ND		0.017	J	0.016	J
PFOS	1600	ND		0.285	J	ND		ND		0.541	J	0.018	J	ND		0.196	J	0.123	J
PFPeA	-	ND		ND		ND		ND		0.321	J	ND		ND		ND		ND	
PFTeDA	-	ND		0.014	J	ND		ND		ND		ND		ND		ND		ND	
PFUnDA	-	0.00497	J	0.00847	J	ND		ND		ND		ND		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

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

Acronyms and Abbreviations

AOI	Area of Interest
DUP	Duplicate
ft	feet
HQ	Hazard quotient
LCMSMS	Liquid Chromatography Mass Spectrometry
LOD	Limit of Detection
ND	Analyte not detected above the LOD
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SB	Soil boring
USEPA	United States Environmental Protection Agency
ug/Kg	micrograms per Kilogram
-	Not applicable

Table 6-4
PFAS Detections in Deep Subsurface Soil
Site Inspection Report, Grand Ledge AASF and Armory

Area of Interest	AOI1			
Sample ID	AOI-1-4-SB-17-19		AOI-1-4-SB-17-19-DUP	
Sample Date	05/07/2019		05/07/2019	
Depth	17 - 19 ft		17 - 19 ft	
Analyte	**Result**	**Qual**	**Result**	**Qual**
Soil, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ug/Kg)				
PFBA	0.068	J	0.046	J
PFDA	ND		0.012	J
PFHxA	0.032	J	ND	

Interpreted Qualifiers

J = Estimated concentration

Chemical Abbreviations

PFBA	perfluorobutyrate
PFDA	perfluorodecanoate
PFHxA	perfluorohexanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
D/DUP	Duplicate
ft	feet
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	Limit of Detection
ND	Analyte not detected above the LOD
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SB	Soil boring
ug/Kg	micrograms per Kilogram

Table 6-5
PFAS Detections in Groundwater
Site Inspection Report, Grand Ledge AASF and Armory

	Area of Interest	AOI1																	
	Sample ID	AOI-1-1-GW-7-12		AOI-1-2-GW-5-10		AOI-1-3-GW-4-9		AOI-1-3-GW-4-9-DUP		AOI-1-4-GW-17-22		AOI-1-5-GW-5-10		AOI-1-6-GW-15-20		AOI1-10-GW-89		AOI1-10-GW-89-D	
	Sample Date	05/09/2019		05/08/2019		05/08/2019		05/08/2019		05/08/2019		05/09/2019		05/08/2019		11/19/2019		11/19/2019	
Analyte	**OSD Screening Level [a]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ng/L)																			
6:2 FTS	-	ND		ND		ND	UJ	ND		ND		ND		87.0		1.69	J+	1.73	J+
PFBA	-	28.6		154		ND	UJ	ND		3.26	J	34.0		59.2		ND		2.86	J
PFBS	40000	1.58	J	5.36	J	ND	UJ	ND		2.66	J	13.5		46.1		ND		ND	
PFDoA	-	ND		ND		ND	UJ	ND		ND		ND		ND		ND		ND	
PFHpA	-	ND		ND		ND	UJ	ND		ND		36.7		65.9		ND		ND	
PFHxA	-	ND		6.83	J	ND	UJ	ND		ND		42.9		168		1.77	J	ND	
PFHxS	-	ND		5.08	J	ND	UJ	ND		4.47	J	87.8		12.1		ND		ND	
PFNA	-	ND		ND		ND	UJ	ND		ND		5.37	J	ND		ND		ND	
PFOA	40	ND		ND		ND	UJ	ND		ND		53.0		ND		ND		ND	
PFOS	40	ND		ND		ND	UJ	ND		ND		60.0		ND		ND		ND	
PFPeA	-	ND		9.09	J	ND	UJ	ND		ND		54.1		189		ND		ND	
PFTeDA	-	ND	UJ	ND	UJ	ND	UJ	ND	UJ	ND	UJ	ND	UJ	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. Groundwater screening levels based on residential scenario for direct ingestion of groundwater.

Interpreted Qualifiers

J = Estimated concentration

J+ = Estimated concentration, biased high

UJ = The analyte was not detected at a level greater than or equal to the adjusted DL. However, the reported adjusted DL is approximate and may be inaccurate or imprecise.

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
D/DUP	Duplicate
GW	Groundwater
HQ	Hazard quotient
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	Limit of Detection
ND	Analyte not detected above the LOD
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
USEPA	United States Environmental Protection Agency
ng/L	nanogram per liter
-	Not applicable

Table 6-5
PFAS Detections in Groundwater
Site Inspection Report, Grand Ledge AASF and Armory

	Area of Interest	AOI1										AOI2							
	Sample ID	AOI 1-11-GW-35		AOI 1-12-GW-42		AOI 1-13-GW-47		AOI 1-14-GW-55		AOI 1-15-GW-67.50		AOI-2-1-GW-5-10		AOI-2-2-GW-5-10		AOI-2-3-GW-5-10		AOI 2-4-GW-30	
	Sample Date	12/18/2019		12/20/2019		12/19/2019		12/19/2019		12/19/2019		05/09/2019		05/09/2019		05/10/2019		12/18/2019	
Analyte	OSD Screening Level [a]	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Water, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ng/L)																			
6:2 FTS	-	ND		327		ND		ND		ND		ND		ND		ND		ND	
PFBA	-	1.97	J	43.1		7.32	J	ND		ND		2.35	J	7.40	J	6.03	J	ND	
PFBS	40000	ND		70.7		ND		ND		ND		ND		4.21	J	ND		ND	
PFDoA	-	3.38	J+	ND	UJ	ND	UJ	ND		ND		ND		ND		ND		ND	UJ
PFHpA	-	ND		66.6		ND		ND		ND		ND		ND		ND		ND	
PFHxA	-	ND		160		4.45	J	ND		ND		ND		3.19	J	2.07	J	ND	
PFHxS	-	ND		227		ND		ND		ND		ND		44.9		ND		ND	
PFNA	-	ND		ND		ND		ND		ND		ND		ND		ND		ND	
PFOA	40	ND		28.2		ND		ND		ND		ND		4.10	J	ND		ND	
PFOS	40	1.97	J	ND		ND		ND		ND		3.46	J	31.7		ND		ND	
PFPeA	-	ND		153		16.1		ND		ND		ND		ND		ND		ND	
PFTeDA	-	40.1	J+	ND		ND	UJ	ND	UJ	ND		ND		ND	UJ	ND		ND	UJ

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

J+ = Estimated concentration, biased high

UJ = The analyte was not detected at a level greater than or equal to the adjusted DL. However, the reported adjusted DL is approximate and may be inaccurate or imprecise.

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
D/DUP	Duplicate
GW	Groundwater
HQ	Hazard quotient
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	Limit of Detection
ND	Analyte not detected above the LOD
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
USEPA	United States Environmental Protection Agency
ng/L	nanogram per liter
-	Not applicable

Table 6-6
PFAS Detections in Sediment
Site Inspection Report, Grand Ledge AASF and Armory

Area of Interest	AOI1																			
Sample ID	AOI-1-7-SD-0-1		AOI-1-7-SD-0-1-DUP		AOI-1-8-SD-0-1		AOI-1-9-SD-0-1		AOI 1-21-SD-0-0.5		AOI 1-22-SD-0-0.5		AOI 1-22-SD-0-0.5D		AOI 1-23-SD-0-0.5		AOI 1-24-SD-0-0.5		AOI 1-25-SD-0-0.5	
Sample Date	05/07/2019		05/07/2019		05/07/2019		05/07/2019		11/05/2019		11/05/2019		11/05/2019		11/05/2019		11/05/2019		11/06/2019	
Depth	0 - 1 ft		0 - 1 ft		0 - 1 ft		0 - 1 ft		0 - 0.5 ft		0 - 0.5 ft		0 - 0.5 ft		0 - 0.5 ft		0 - 0.5 ft		0 - 0.5 ft	
Analyte	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Sediment, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ug/Kg)																				
6:2 FTS	53.2		60.1	J+	0.153	J	0.049	J	ND		1.67	J	1.40	J	ND		ND		ND	
8:2 FTS	149		158	J+	0.183	J	ND		ND		3.03		2.55	J	ND		ND		ND	
NEtFOSAA	4.73	J	3.98	J+	ND		ND		ND		ND		ND		ND		ND		ND	
PFBA	ND		ND	UJ	0.221	J	0.077	J	ND		ND		ND		ND		ND		ND	
PFBS	ND		ND	UJ	0.225	J	0.00473	J	ND		ND		ND		ND		ND		ND	
PFDA	14.2	J	17.1	J+	0.164	J	ND		ND		ND		ND		ND		ND		ND	
PFDoA	33.0	J+	26.1	J+	ND		ND		ND		0.536	J	0.676	J+	ND		ND		ND	
PFHpA	ND		ND	UJ	ND		0.00688	J	ND		ND		ND		ND		ND		ND	
PFHxA	ND		ND	UJ	0.312	J	0.057	J	ND		ND		ND		ND		ND		ND	
PFHxS	ND		ND	UJ	1.91	J	ND		ND		ND		ND		ND		0.233	J	ND	
PFOA	7.15	J	6.58	J+	0.265	J	0.030	J	ND		ND		ND		ND		ND		ND	
PFOS	26.3	J	ND	UJ	5.31	J+	6.32		ND		0.744	J	1.15	J	5.89	J-	ND		ND	
PFPeA	ND		ND	UJ	ND		0.047	J	ND		ND		ND		ND		ND		ND	
PFTeDA	37.3	J+	28.2	J+	0.077	J	ND		ND		1.13	J+	0.843	J+	ND		ND	UJ	ND	
PFTrDA	18.2	J+	10.7	J+	0.096	J	ND		ND		3.09	J+	0.772	J+	ND		ND	UJ	ND	
PFUnDA	10.5	J+	ND	UJ	ND		ND		ND		ND		ND		ND		ND		ND	

Interpreted Qualifiers

J = Estimated concentration

J- = Estimated concentration, biased low

J+ = Estimated concentration, biased high

UJ = The analyte was not detected at a level greater than or equal to the adjusted DL. However, the reported adjusted DL is approximate and may be inaccurate or imprecise.

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
NEtFOSAA	N-ethyl perfluorooctane- sulfonamidoacetic acid
PFBA	perfluorobutyrate
PFBS	perfluorobutane sulfonate
PFDA	perfluorodecanoate
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
D/DUP	Duplicate
ft	feet
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	Limit of Detection
ND	Analyte not detected above the LOD
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SD	Sediment
ug/Kg	micrograms per Kilogram

Table 6-7
PFAS Detections in Surface Water
Site Inspection Report, Grand Ledge AASF and Armory

Area of Interest	AOI1																			
Sample ID	AOI-1-7-SW-0-1		AOI-1-7-SW-0-1-DUP		AOI-1-8-SW-0-1		AOI-1-9-SW-0-1		AOI 1-21-SW-0-0.5		AOI1-21-SW-0-0.5		AOI 1-22-SW-0-0.5		AOI 1-22-SW-0-0.5D		AOI1-22-SW-0-0.5		AOI 1-23-SW-0-0.5	
Sample Date	05/07/2019		05/07/2019		05/07/2019		05/07/2019		11/05/2019		11/21/2019		11/05/2019		11/05/2019		11/21/2019		11/05/2019	
Analyte	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ng/L)																				
6:2 FTS	143		146		ND		35.5		10.1		27.9	J+	189		201		15.8	J+	122	
8:2 FTS	7.99	J	9.64		ND		7.64	J	ND		3.14	J+	2.89	J	3.23	J	ND		20.8	J
PFBA	16.0		17.3		19.8	J-	9.28	J+	14.1		18.6		20.0		20.5		3.63	J	26.0	J-
PFBS	3.39	J	3.87	J	6.66	J	1.82	J	6.22	J	3.56	J	3.75	J	4.10	J	ND		ND	
PFDA	ND		ND		ND		ND		ND		5.54	J	ND		ND		ND		ND	
PFHpA	18.2		18.6		ND		4.85	J	18.9		23.1		24.0		23.2		3.29	J	34.8	J-
PFHxA	34.1		35.2		7.34	J	11.2		43.4		50.1		44.2		45.6		6.78	J	43.4	J+
PFHxS	19.5		19.0		12.6		18.1		17.7		13.2		23.5		27.3		3.56	J	45.1	
PFNA	1.44	J	1.84	J	ND		ND		ND		2.72	J	ND		ND		ND		ND	
PFOA	10.6		10.8		1.64	J	5.59	J	8.69		20.5		12.5		13.2		1.85	J	17.0	J
PFOS	21.2		20.6		4.66	J	141		ND		16.3	J+	19.0		23.2		ND		283	J+
PFPeA	58.0		60.2		4.05	J	8.29	J	97.2		101		81.6		76.2		8.64		82.4	
PFTeDA	ND	UJ	ND		ND	UJ	ND		ND	UJ	ND		ND	UJ	ND	UJ	3.14	J	ND	
PFTrDA	ND	UJ	ND		ND	UJ	ND		ND	UJ	ND		ND	UJ	ND	UJ	2.62	J	ND	
PFUnDA	ND		ND		ND		ND		ND		ND		ND		ND	UJ	ND		8.79	J

Interpreted Qualifiers

J = Estimated concentration

J- = Estimated concentration, biased low

J+ = Estimated concentration, biased high

UJ = The analyte was not detected at a level greater than or equal to the adjusted DL. However, the reported adjusted DL is approximate and may be inaccurate or imprecise.

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
D/DUP	Duplicate
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	Limit of Detection
ND	Analyte not detected above the LOD
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SW	Surface water
ng/L	nanogram per liter

Table 6-7
PFAS Detections in Surface Water
Site Inspection Report, Grand Ledge AASF and Armory

Area of Interest	AOI1					
Sample ID	AOI1-23-SW-0-0.5		AOI 1-24-SW-0-0.5		AOI1-24-SW-0-0.5	
Sample Date	11/21/2019		11/05/2019		11/21/2019	
Analyte	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 (ng/L)						
6:2 FTS	17.7	J+	ND		ND	
8:2 FTS	9.35	J+	ND		ND	
PFBA	3.05	J	ND		4.06	J
PFBS	ND		ND		1.41	J
PFDA	1.53	J	ND		3.51	J
PFHpA	2.07	J	ND		ND	
PFHxA	4.45	J	ND		2.49	J
PFHxS	4.64	J	8.95	J	3.33	J
PFNA	ND		7.48	J	ND	
PFOA	2.05	J	ND		ND	
PFOS	51.1	J+	53.2		ND	
PFPeA	2.09	J	ND		ND	
PFTeDA	ND		ND	UJ	ND	
PFTrDA	ND		ND	UJ	ND	
PFUnDA	ND		ND		ND	

Interpreted Qualifiers

J = Estimated concentration

J- = Estimated concentration, biased low

J+ = Estimated concentration, biased high

UJ = The analyte was not detected at a level greater than or equal to the adjusted DL. However, the reported adjusted DL is approximate and may be inaccurate or imprecise.

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFPeA	perfluoropentanoic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
D/DUP	Duplicate
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	Limit of Detection
ND	Analyte not detected above the LOD
QSM	Quality Systems Manual
Qual	Interpreted Qualifier
SW	Surface water
ng/L	nanogram per liter

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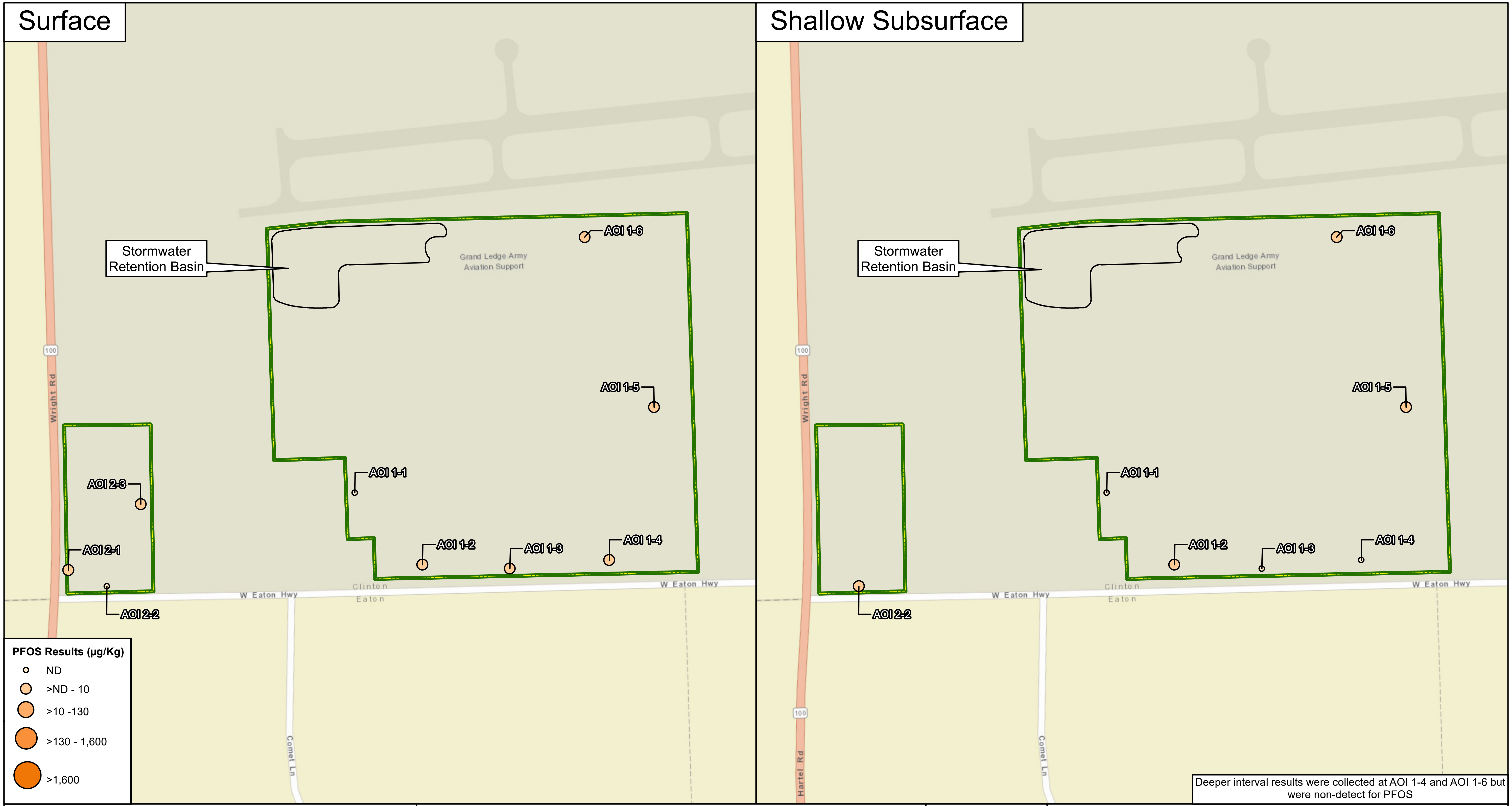

Deeper interval results were collected at AOI 1-4 and AOI 1-6 but were non-detect for PFOS

CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Grand Ledge AASF, MI			
REVISED	10/20/2020	GIS BY	MS	10/20/2020
SCALE	1:4,800	CHK BY	JW	10/20/2020
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	10/20/2020

🟩 Facility Boundary

0 200 400 800 Feet

N

PFOS Detections in Soil (Mobilization 1)

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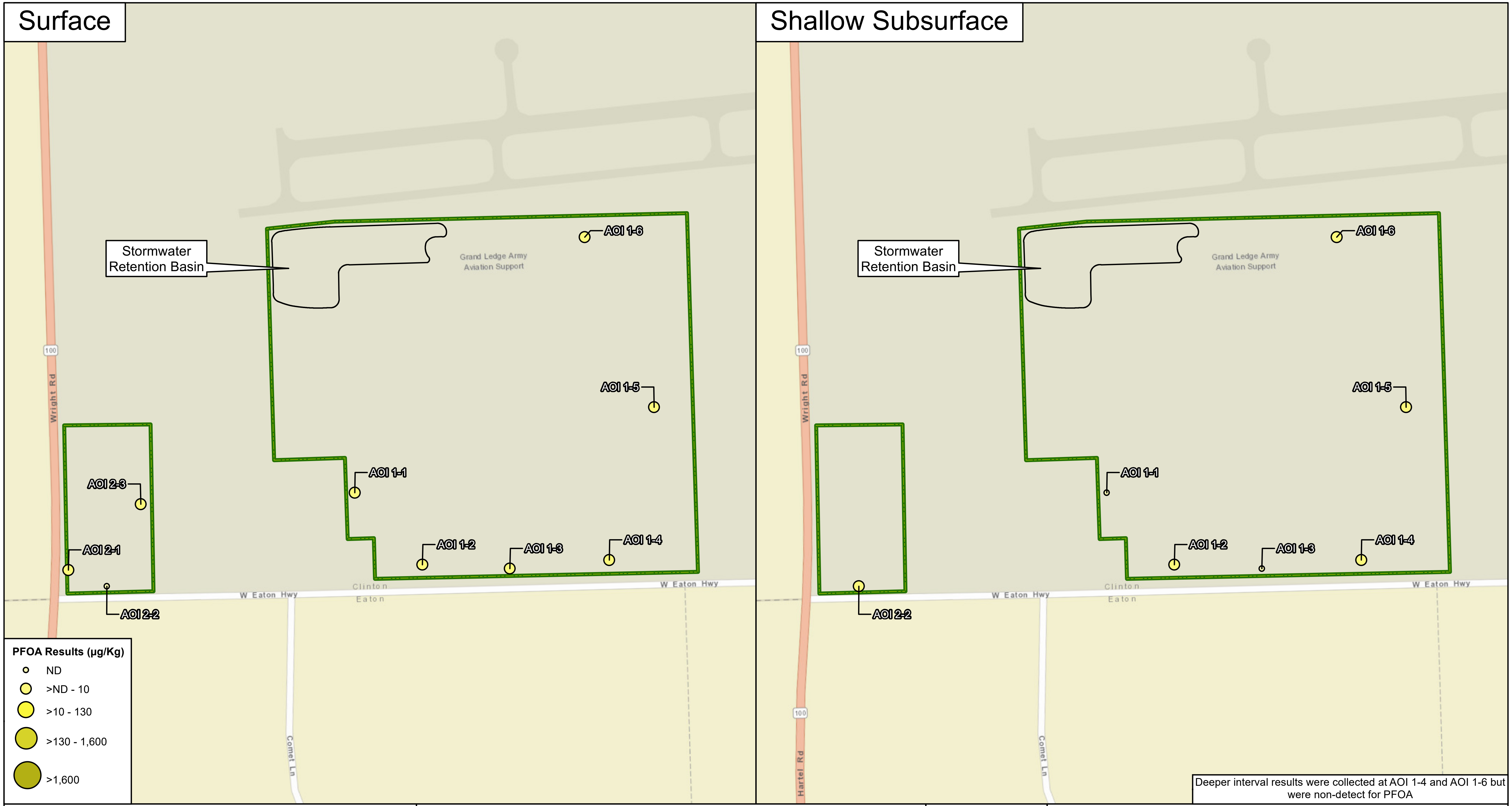
Figure 6-1

Q:\Projects\ENV\GEARS\GEO\MAES 2012 Unrestricted\Fort Meade\E. Data Management\GIS\MXDs\Chisholm_6thMarch2017\ Fig_6-1_Grand_Ledge_SI_PFOS_Mob_1_Soil_Results.mxd



Deeper interval results were collected at AOI 1-4 and AOI 1-6 but were non-detect for PFOA

CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Grand Ledge AASF, MI			
REVISED	10/20/2020	GIS BY	MS	10/20/2020
SCALE	1:4,800	CHK BY	JW	10/20/2020
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	10/20/2020

🟩 Facility Boundary

0 200 400 800 Feet

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PFOA Detections in Soil (Mobilization 1)

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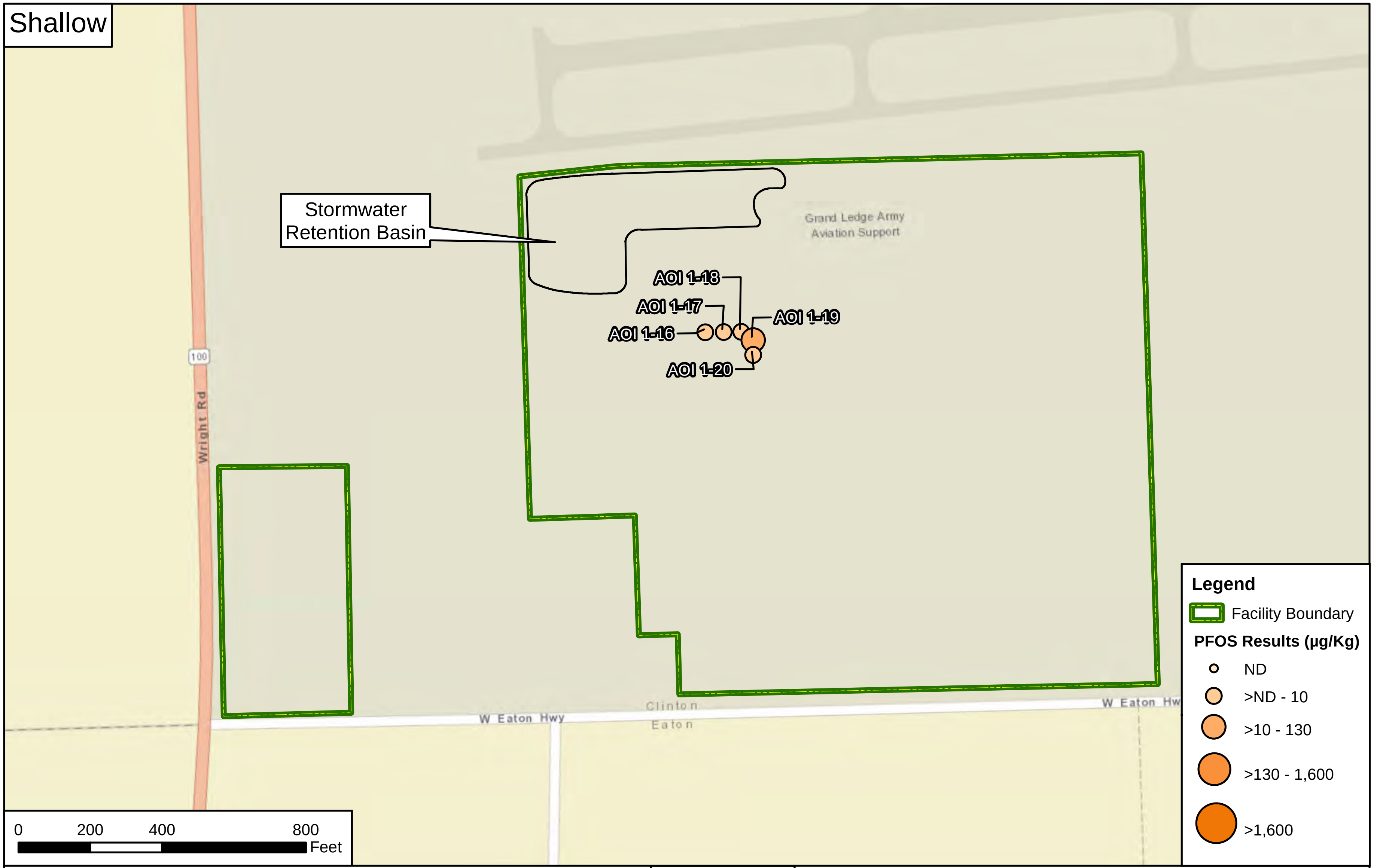
Figure 6-2

Q:\Projects\ENV\GEARS\GEO\MAES 2012 Unrestricted\Fort Meade\E. Data Management\GIS\MXDs\Chisholm_6thMarch2017\ Fig_6-2_Grand_Ledge_SI_PFOA_Mob_1_Soil_Results.mxd



CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Grand Ledge AASF, MI			
REVISED	8/17/2020	GIS BY	MS	8/17/2020
SCALE	1:4,800	CHK BY	JW	8/17/2020
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan,		PM	RG	8/17/2020

N

PFOS Detections in Soil (Mobilization 2)

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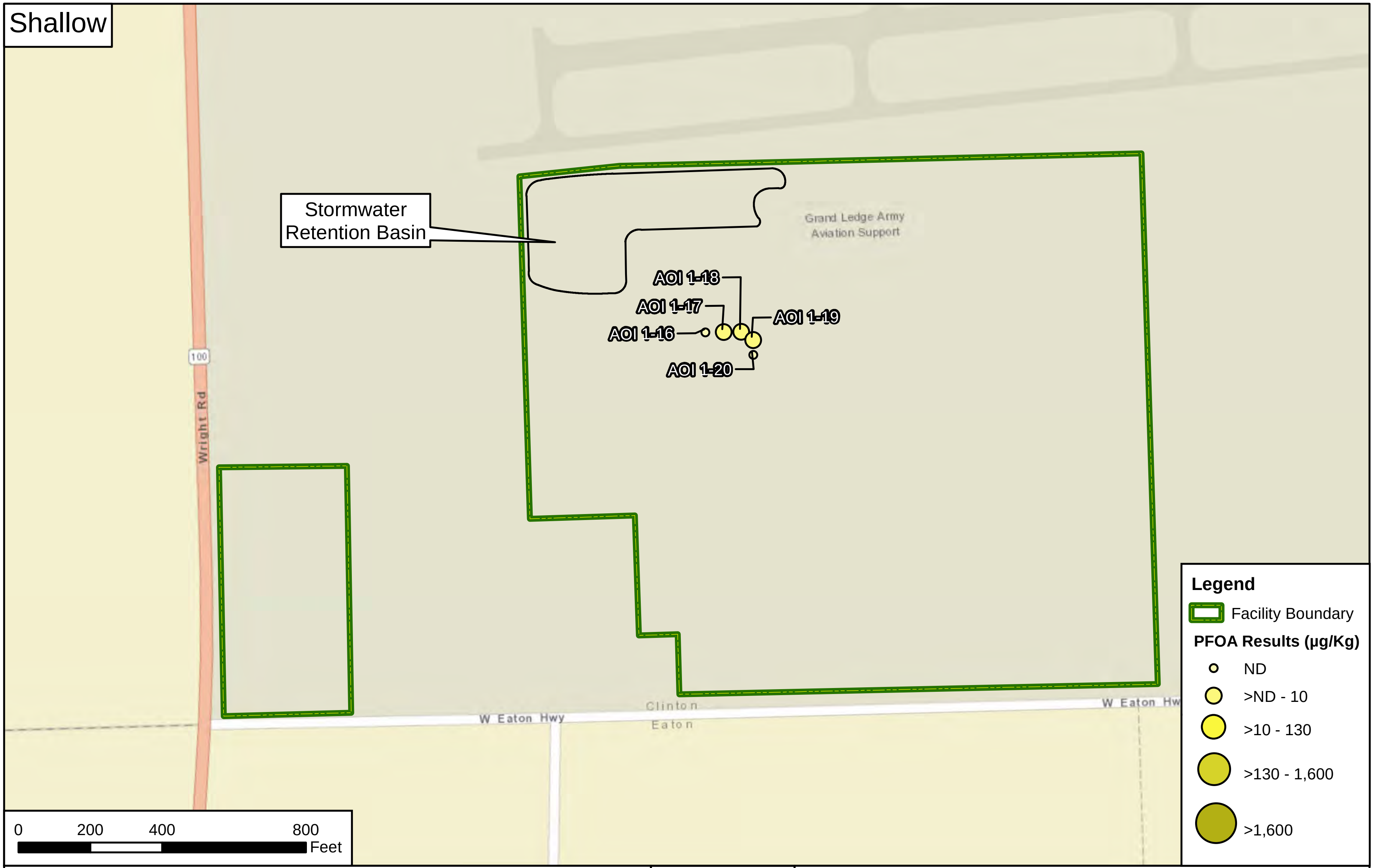
Figure 6-3

Q:\Projects\ENV\GEARS\GEO\MAES 2012 Unrestricted\Fort Meade\E. Data Management\GIS\MXDs\Chisholm_6th\March2017\ Fig_6-3_Grand_Ledge_SI_Mob_2_PFOS_Surface_Soil.mxd



PFOA Detections in Soil (Mobilization 2)

CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Grand Ledge AASF, MI			
REVISED	8/17/2020	GIS BY	MS	8/17/2020
SCALE	1:4,800	CHK BY	JW	8/17/2020
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan,		PM	RG	8/17/2020

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Figure 6-4

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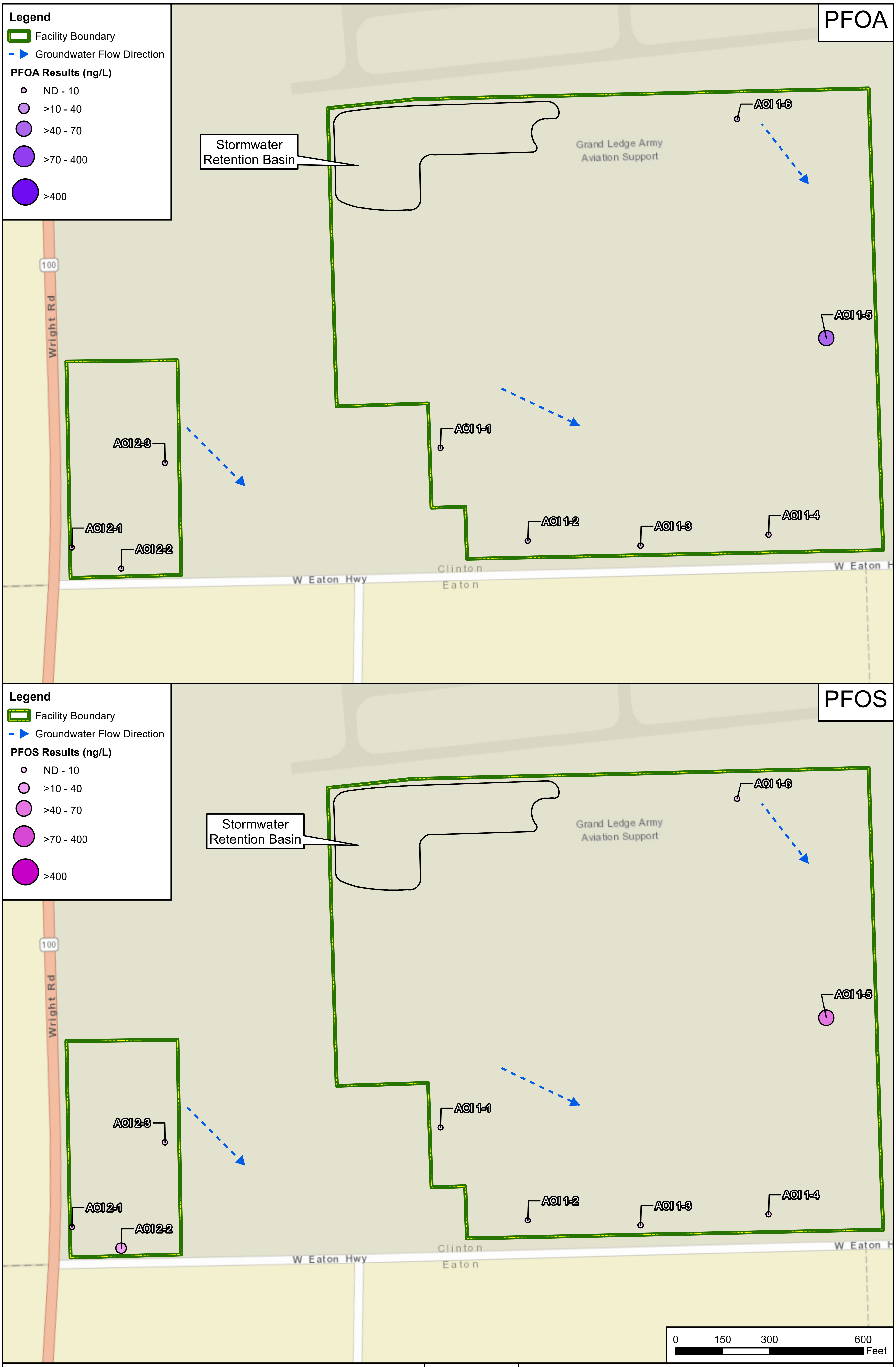

CLIENT ARNG				
PROJECT Site Inspection for PFAS at Grand Ledge AASF, MI				
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SCALE	1:3,600	CHK BY	JW	10/14/2020
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan,		PM	RG	10/14/2020

Q:\Projects\ENV\GEARS\GEO\MAES 2012 Unrestricted\Fort Meade\E. Data Management\GIS\MXDs\Chisholm_6th\March2017\ Fig_6-5_Grand_Ledge_SI_Mob_1_GW_Results.mxd

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PFOA and PFOS Detections in Groundwater (Mobilization 1)

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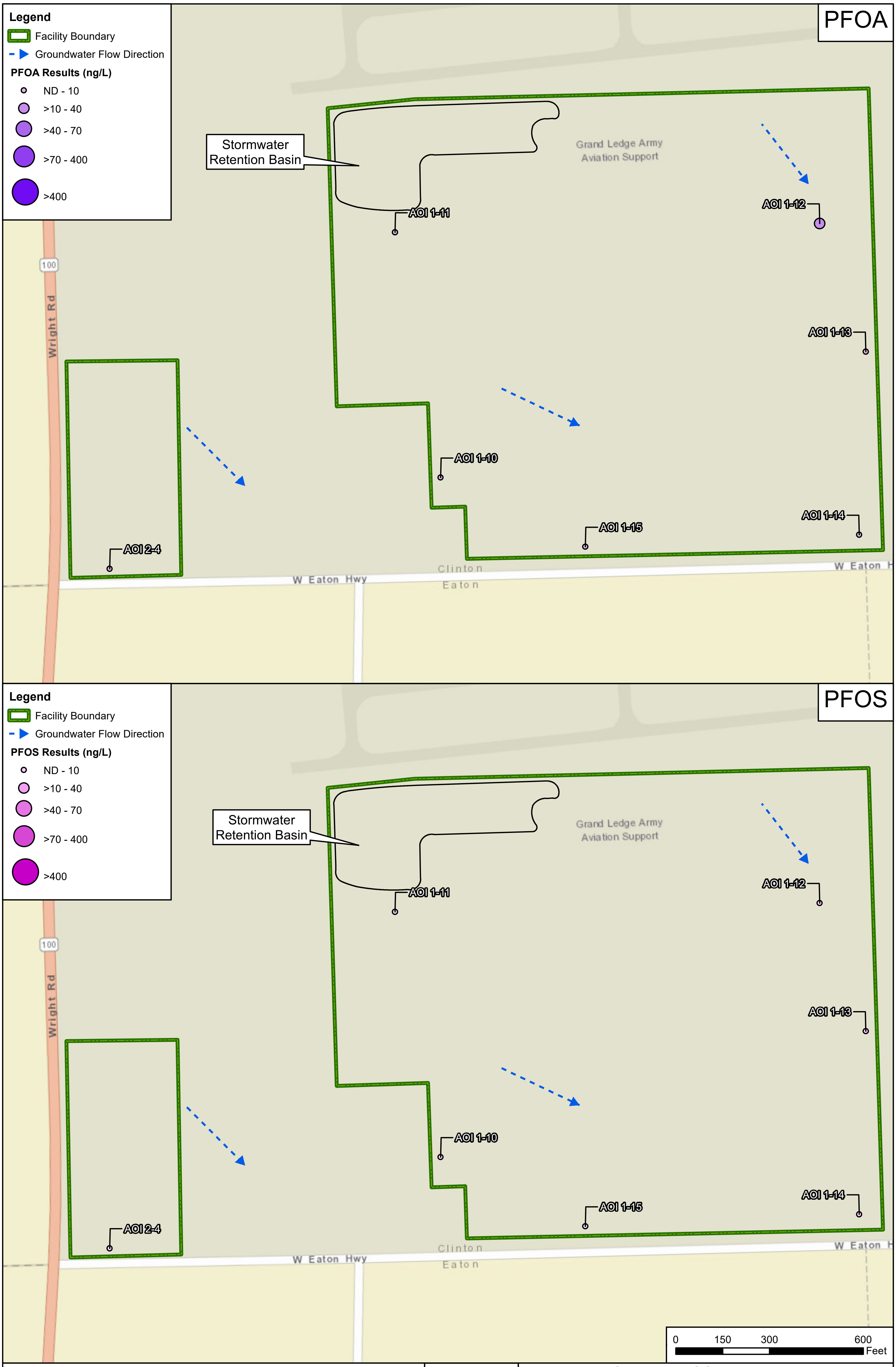
Figure 6-5



CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Grand Ledge AASF, MI			
REVISED	10/14/2020	GIS BY	MS	10/14/2020
SCALE	1:3,600	CHK BY	JW	10/14/2020
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan,		PM	RG	10/14/2020

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PFOA and PFOS Detections in Groundwater (Mobilization 2)

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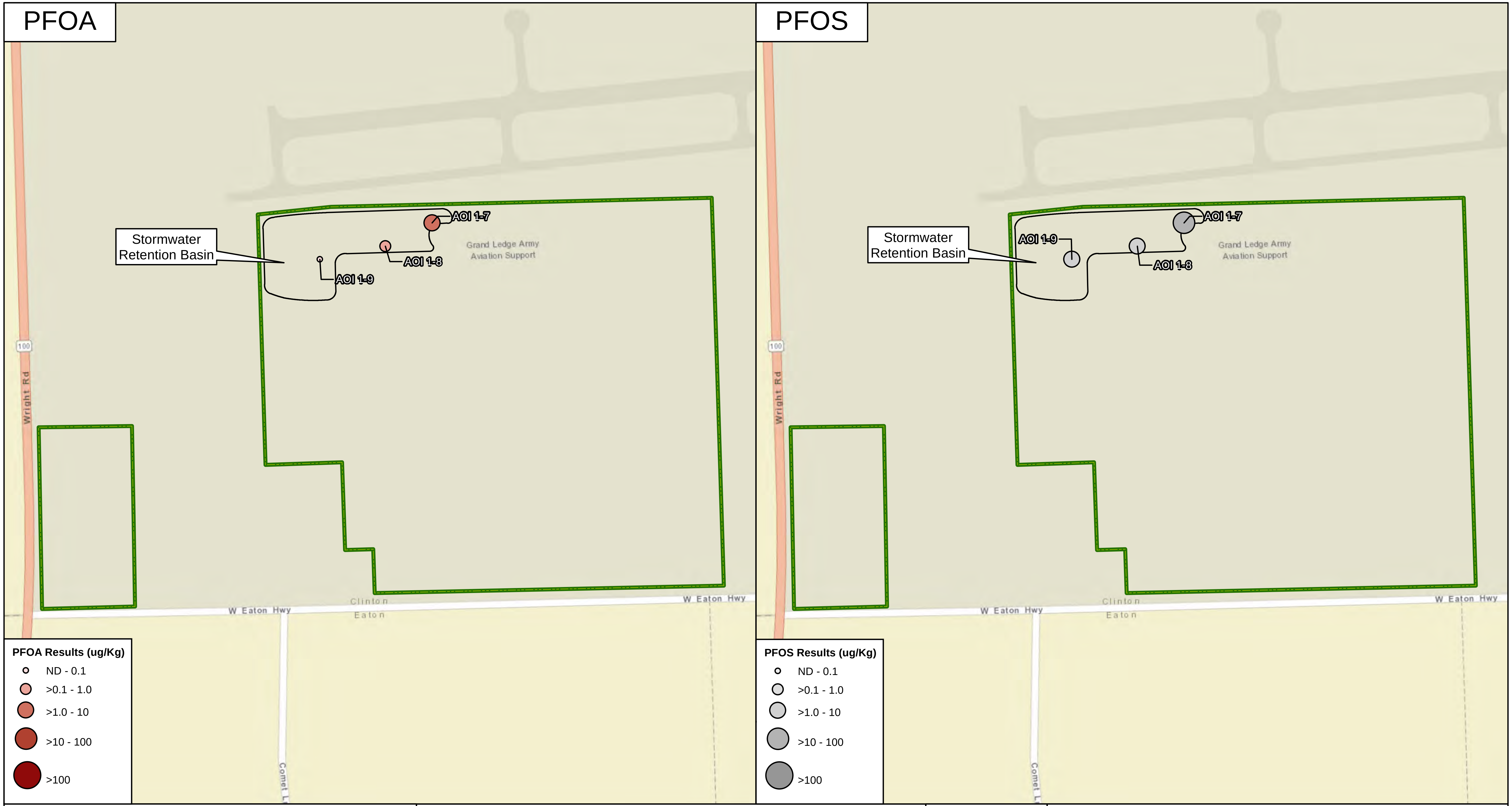
Figure 6-6

Q:\Projects\ENV\GEARS\GEO\MAES 2012 Unrestricted\Fort Meade\E. Data Management\GIS\MXDs\Chisholm_6th\March2017\ Fig_6-6_Grand_Ledge_SI_Mob_2_GW_Results.mxd



CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Grand Ledge AASF, MI			
REVISED	8/18/2020	GIS BY	MS	8/18/2020
SCALE	1:4,440	CHK BY	JW	8/18/2020
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	8/18/2020

🟩 Facility Boundary

0 185 370 740 Feet

N

PFOA and PFOS Detections in Sediment (Mobilization 1)

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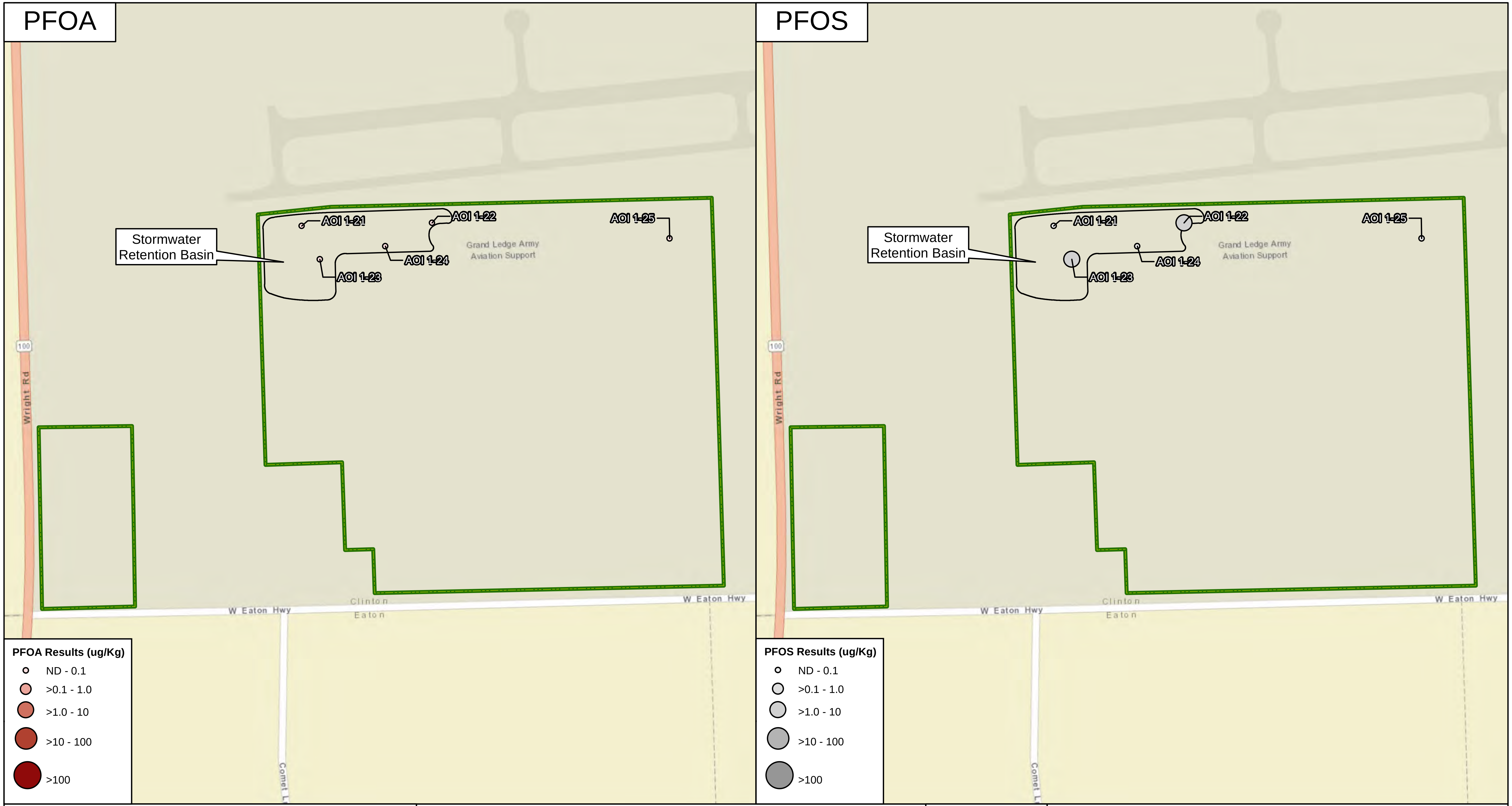
Figure 6-7

Q:\Projects\ENV\GEARS\GEO\MAES 2012 Unrestricted\Fort Meade\E. Data Management\GIS\MXDs\Chisholm_6thMarch2017\ Fig_6-7_Grand_Ledge_SI_Mob_1_Sediment_Results.mxd



PFOA and PFOS Detections in Sediment (Mobilization 2)

CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Grand Ledge AASF, MI			
REVISED	8/18/2020	GIS BY	MS	8/18/2020
SCALE	1:4,440	CHK BY	JW	8/18/2020
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	8/18/2020

🟩 Facility Boundary

0 185 370 740 Feet

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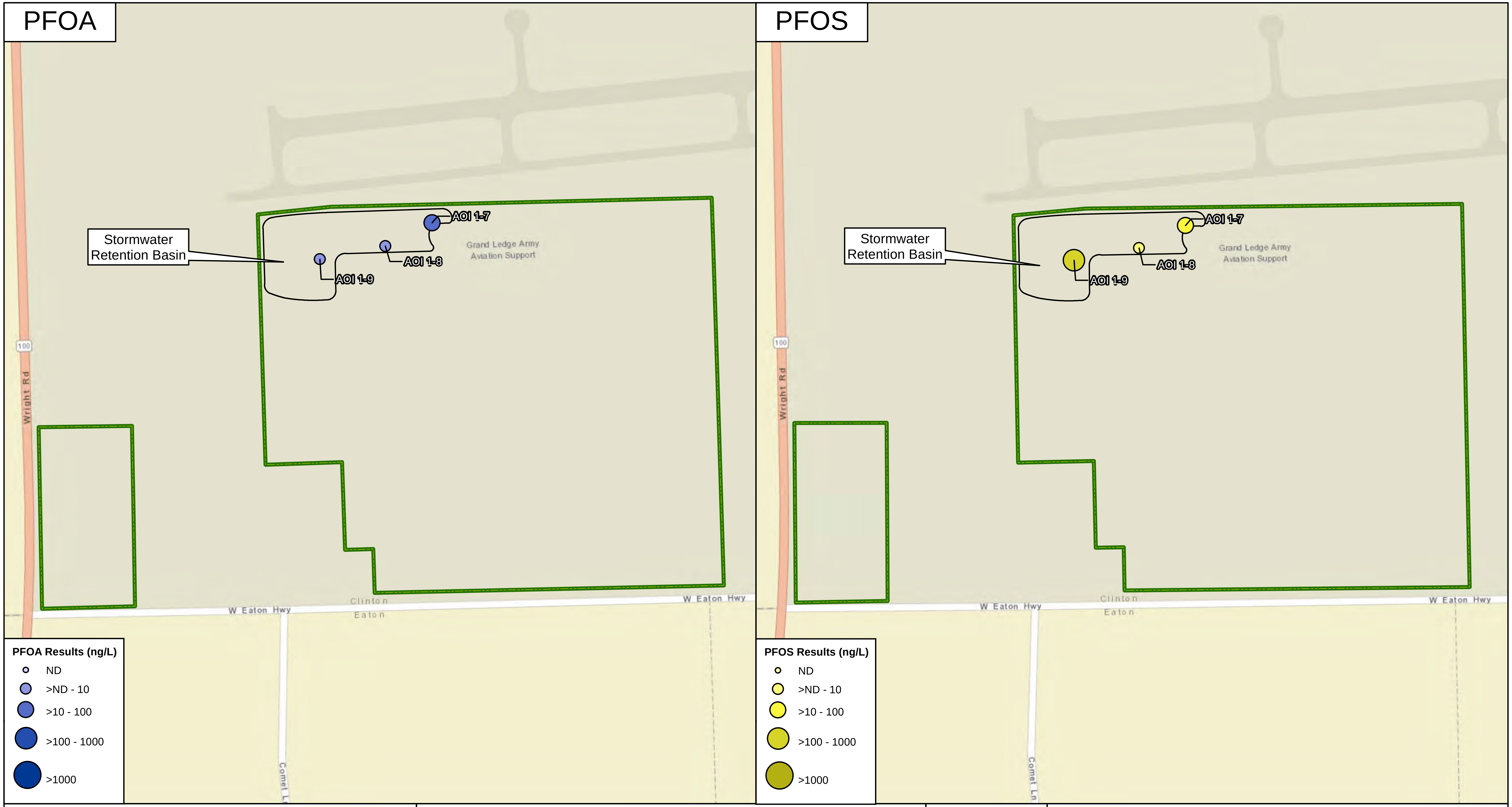
Figure 6-8

Q:\Projects\ENV\GEARS\GEO\MAES 2012 Unrestricted\Fort Meade\E. Data Management\GIS\MXDs\Chisholm_6th\March2017\ Fig_6-8_Grand_Ledge_SI_Mob_2_Sediment_Results.mxd



CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Grand Ledge AASF, MI			
REVISED	8/18/2020	GIS BY	MS	8/18/2020
SCALE	1:4,440	CHK BY	JW	8/18/2020
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	8/18/2020

🟩 Facility Boundary

0 185 370 740 Feet

N

PFOA and PFOS Detections in Surface Water (Mobilization 1)

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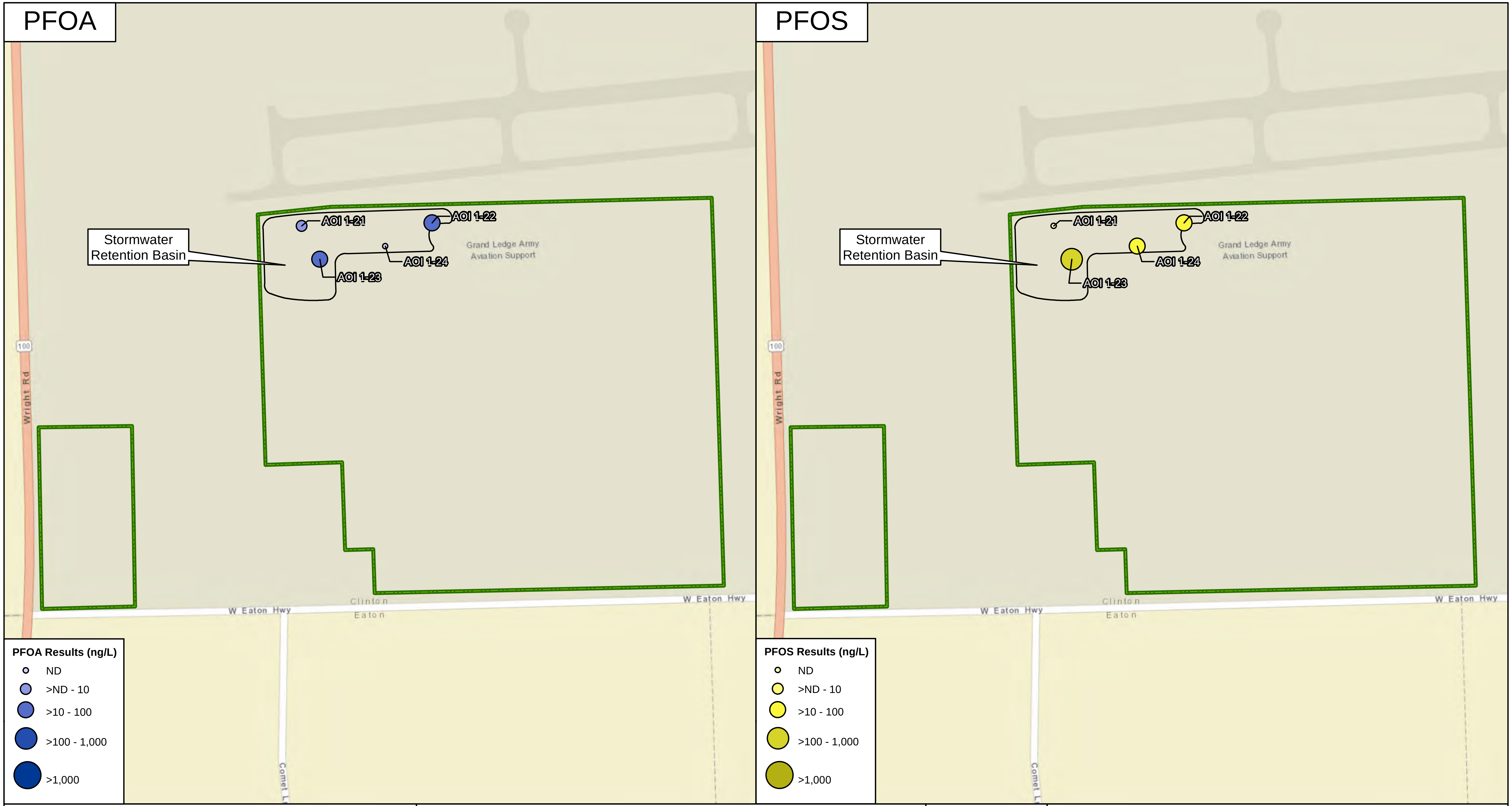
Figure 6-9

Q:\Projects\ENV\GEARS\GEO\MAES 2012 Unrestricted\Fort Meade\E. Data Management\GIS\MXDs\Chisholm_6thMarch2017\ Fig_6-9_Grand_Ledge_SI_Mob_1_SW_PFOA_PFOS.mxd



CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Grand Ledge AASF, MI			
REVISED	8/18/2020	GIS BY	MS	8/18/2020
SCALE	1:4,440	CHK BY	JW	8/18/2020
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	8/18/2020

🟩 Facility Boundary

0 185 370 740 Feet

N

Note: Samples were collected during a dry weather sampling event.

PFOA and PFOS Detections in Surface Water (Mobilization 2 / 5 November 2019)

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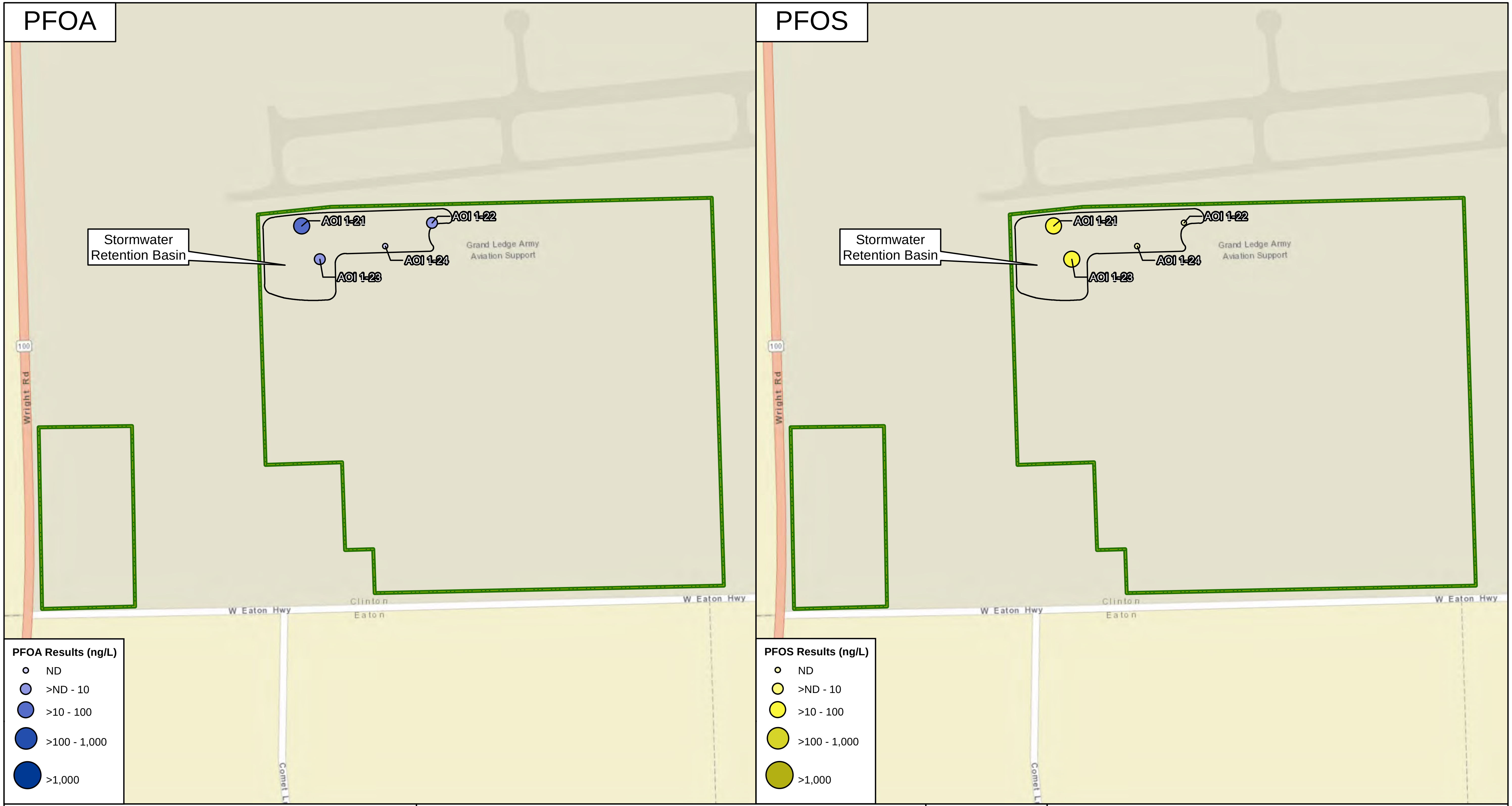
Figure 6-10

Q:\Projects\ENV\GEARS\GEO\MAES 2012 Unrestricted\Fort Meade\E. Data Management\GIS\MXDs\Chisholm_6thMarch2017\ Fig_6-10_Grand_Ledge_SI_Mob_2_SW_PFOA_PFOS_Nov5.mxd



CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Grand Ledge AASF, MI			
REVISED	8/18/2020	GIS BY	MS	8/18/2020
SCALE	1:4,440	CHK BY	JW	8/18/2020
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	8/18/2020

🟩 Facility Boundary

0 185 370 740 Feet

N

Note: Samples were collected during a qualifying storm event.

PFOA and PFOS Detections in Surface Water (Mobilization 2 / 21 November 2019)

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Figure 6-11

Q:\Projects\ENV\GEARS\GEO\MAES 2012 Unrestricted\Fort Meade\E. Data Management\GIS\MXDs\Chisholm_6thMarch2017\ Fig_6-11_Grand_Ledge_SI_Mob_2_SW_PFOA_PFOS_Nov21.mxd

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7. Exposure Pathways

The CSMs for each AOI, revised based on the SI findings, are presented on **Figure 7-1** and **Figure 7-2**. 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 figures use 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 PFAS exposure pathways 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.

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 via inhalation of dust and/or incidental ingestion of soil based on the aforementioned criteria.

7.1.1 AOI 1

According to interviewee accounts, AFFF was released to soil during training activities that occurred near the Armory (Former AASF). The AASF Hangar also contains an AFFF fire suppression system, although this system has never been discharged or known to leak.

PFOA, PFOS, and PFBS were detected in soil below the SLs 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 and future construction worker exposure to PFOA, PFOS, and PFBS via inhalation of dust or incidental ingestion of surface soil, and ground-disturbing activities could potentially result in future construction worker exposure to subsurface soil. No current construction is occurring at AOI 1. Additionally, off-facility residents may potentially be exposed to PFOA, PFOS, and PFBS via inhalation of dust caused by on-facility ground disturbing activities, although this exposure is likely insignificant. The CSM is presented on **Figure 7-1**.

7.1.2 AOI 2

The Annex Building has storage of empty Tri-Max™ 30 fire extinguishers and bulk and expired AFFF in both 55-gallon drums and 5-gallon buckets. Although there was no documented release or use of AFFF at AOI 2, PFOA, PFOS, and PFBS were detected in soil below the SLs 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 and future construction worker exposure to PFOA, PFOS, and PFBS via inhalation of dust or incidental ingestion of surface soil, and ground-disturbing activities could potentially result in future construction worker exposure to subsurface soil. No current construction is occurring at AOI 2. Additionally, off-facility residents may potentially be exposed to PFOA, PFOS, and PFBS via inhalation of dust caused by on-facility ground disturbing activities, although this exposure is likely insignificant. The CSM is presented on **Figure 7-2**.

7.2 Groundwater Exposure Pathway

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

7.2.1 AOI 1

PFOA and PFOS exceeded the SLs in one temporary monitoring well, AOI 1-5, situated northeast of the Armory (Former AASF) source area during Mobilization 1. The buildings within AOI 1 receive potable water from the City of Grand Ledge's municipal water utility, so the ingestion pathway for site workers is considered incomplete. PFOA, PFOS, and PFBS were not detected in drinking water from private residential wells that were sampled downgradient of AOI 1. These lines of evidence indicate that there is not a complete exposure pathway from impacted groundwater at the facility to these off-facility drinking water receptors (i.e., residents). Due to the presence of shallow groundwater (less than 15 feet bgs), which is further exemplified by the accidental creation of an artesian well during Mobilization 1 field activities at AOI 1, future construction workers may be potentially exposed to contaminated groundwater under trenching scenarios. A potential adjacent source of PFAS, Abrams Municipal Airport, is located hydraulically upgradient from AOI 1, so it is possible that this source may be contributing to groundwater contamination; however, PFOA, PFOS, and PFBS were not detected in drinking water samples collected by EGLE at the Abrams Municipal Airport in August 2020, and ARNG has not interviewed Airport officials regarding AFFF use. The CSM is presented on **Figure 7-1**.

7.2.2 AOI 2

PFOA, PFOS, and PFBS were detected in groundwater at concentrations below the SLs near the Annex Building within AOI 2. The Annex Building receives water from an on-facility public supply groundwater well. Drinking water from the Annex Building's well has previously been sampled by the National Guard Bureau in May 2017 and found to be non-detect for PFAS; therefore, the site worker ingestion exposure pathway is considered incomplete. One private residential drinking water well downgradient of AOI 2 had a detection of PFOS below the HA; therefore, the exposure pathway for off-facility residents is potentially complete. The ingestion exposure pathway is potentially complete for construction workers during trenching activities deep enough to encounter shallow groundwater. The CSM is presented on **Figure 7-2**.

7.3 Surface Water and Sediment Exposure Pathway

The SI results for PFOA, PFOS, and PFBS in surface water and sediment were used to determine whether a potentially complete pathway exists between the source and potential receptors at AOI 1 based on the aforementioned criteria.

7.3.1 AOI 1

AFFF was potentially released to paved areas in AOI 1 and then transported via stormwater runoff directed by drainage ditches and catchments into the stormwater retention basin. Overflow from the stormwater retention basin drains to Reed Drain, a small drainage creek located 0.25 miles north of the stormwater retention basin that ultimately drains to the Looking Glass River via Husted and Landenburg Drain. Recreational users and residents are unlikely receptors, based on the location and nature of these surface water bodies. However, site workers and construction workers have access to the stormwater retention basin, as it is located within the facility.

PFOA, PFOS, and PFBS were detected in surface water and sediment samples collected at AOI 1. Therefore, the incidental ingestion exposure pathway for surface water and for sediment is considered potentially complete for site workers and future construction workers. Groundwater interaction with surface water is also possible, given the shallow clay layer encountered at the northern boundary that could extend the saturated groundwater zone into the stormwater retention basin. The CSM is presented on **Figure 7-1**.

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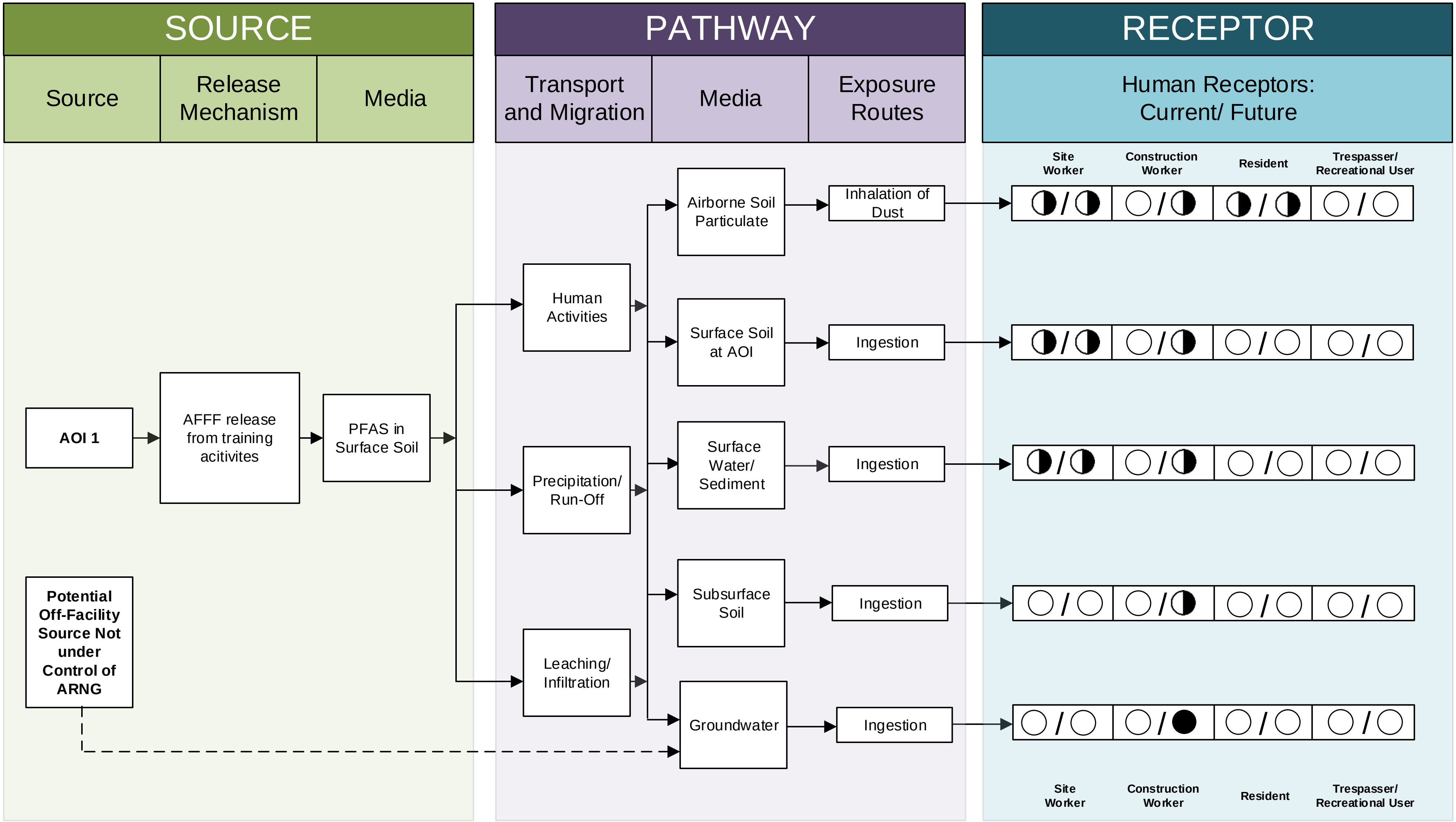


SOURCE

Source	Release Mechanism	Media

PATHWAY

Transport and Migration	Media	Exposure Routes

RECEPTOR

Human Receptors: Current/ Future

AOI 1 → AFFF release from training acitivites → PFAS in Surface Soil

Human Activities

Precipitation/ Run-Off

Leaching/ Infiltration

Potential Off-Facility Source Not under Control of ARNG

Media	Exposure Routes	Site Worker	Construction Worker	Resident	Trespasser/ Recreational User
Airborne Soil Particulate	Inhalation of Dust	◐ / ◐	○ / ◐	◐ / ◐	○ / ○
Surface Soil at AOI	Ingestion	◐ / ◐	○ / ◐	○ / ○	○ / ○
Surface Water/ Sediment	Ingestion	◐ / ◐	○ / ◐	○ / ○	○ / ○
Subsurface Soil	Ingestion	○ / ○	○ / ◐	○ / ○	○ / ○
Groundwater	Ingestion	○ / ○	○ / ●	○ / ○	○ / ○

LEGEND

Flow-Chart Stops

Flow-Chart Continues

Partial / Possible Flow

○ Incomplete Pathway

◐ Potentially Complete Pathway

● Potentially Complete Pathway with Exceedance of SL

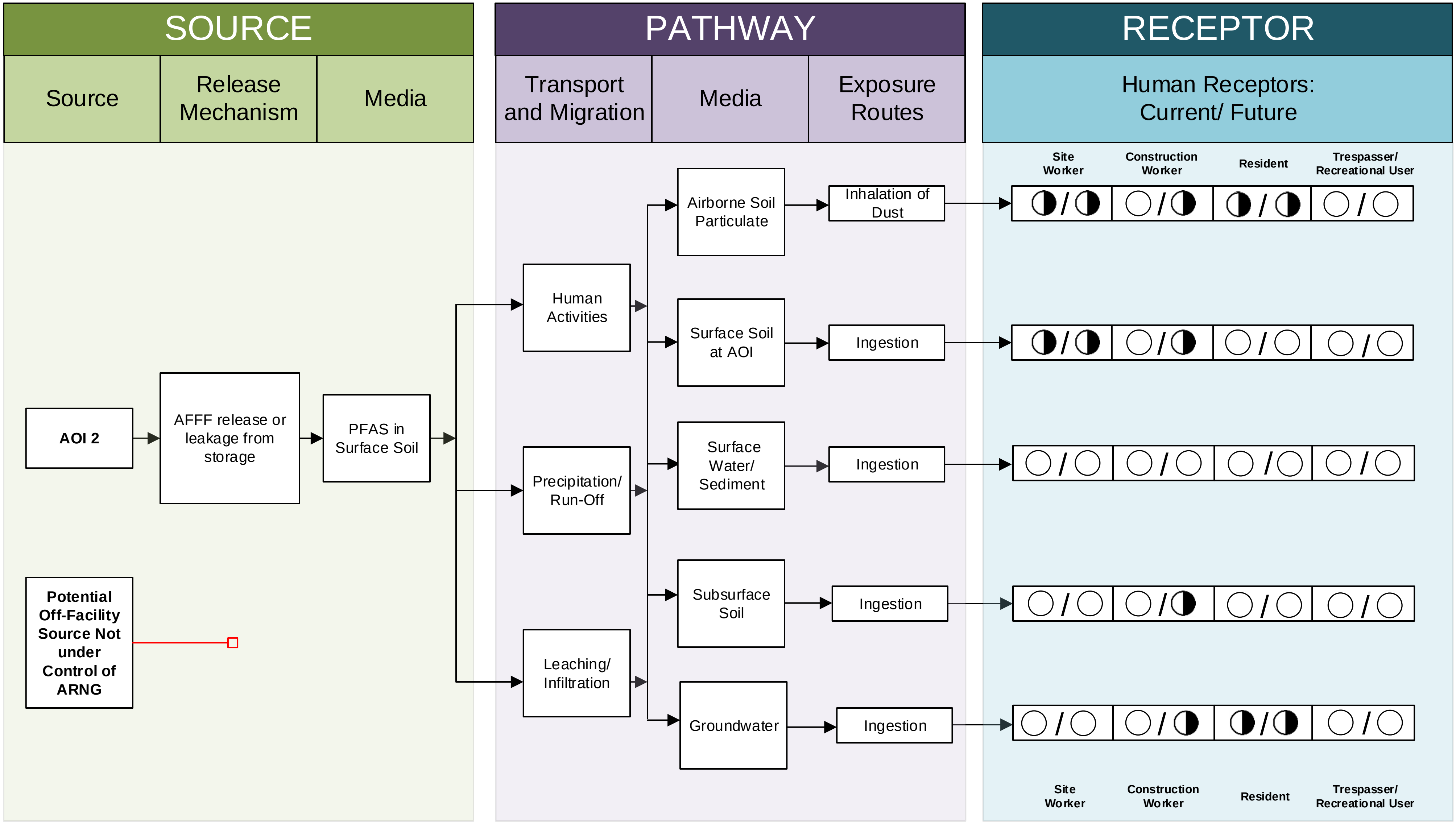
Notes:

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

Figure 7-1

Conceptual Site Model, AOI 1

Grand Ledge AASF and Armory



Media	Exposure Routes	Site Worker	Construction Worker	Resident	Trespasser/ Recreational User
Airborne Soil Particulate	Inhalation of Dust	◐ / ◐	○ / ◐	◐ / ◐	○ / ○
Surface Soil at AOI	Ingestion	◐ / ◐	○ / ◐	○ / ○	○ / ○
Surface Water/ Sediment	Ingestion	○ / ○	○ / ○	○ / ○	○ / ○
Subsurface Soil	Ingestion	○ / ○	○ / ◐	○ / ○	○ / ○
Groundwater	Ingestion	○ / ○	○ / ◐	◐ / ◐	○ / ○

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-site receptors. resident or recreational user.
2. Dermal contact exposure pathway is incomplete for PFAS.

Figure 7-2
Conceptual Site Model, AOI 2
Grand Ledge AASF and Armory

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 were conducted in two on-facility mobilizations and two off-facility mobilizations. Mobilization 1 included soil, sediment, surface water, and groundwater grab sampling from temporary monitoring wells from 7 to 10 May 2019. Mobilization 2 included permanent groundwater monitoring well installation, development, and sampling; soil, sediment, and surface water grab sampling was conducted from 4 November to 20 December 2019. As part of a separate action (Mobilizations 3 and 4), residential well sampling was performed by ARNG at 25 residencies south, west, and east of the Grand Ledge AASF and Armory on 22 - 23 January 2020 and 28 - 29 July 2020. PFAS were non-detect at 23 properties. One property had an estimated PFOS detection of 3.38 ng/L, and another property had an estimated PFHxA detection of 2.37 ng/L. Residents were notified by letter of sampling results. Field activities were conducted in accordance with the QAPP Addendum (AECOM, 2019b) and Supplemental QAPP Addendum (AECOM, 2019d), except as noted in **Section 5.10**.

To fulfill the project DQOs set forth in the approved SI QAPP Addendum (AECOM, 2019b), 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 5.9** of this Report.

Mobilization 1 –

- 18 soil grab samples from 9 boring locations;
- 9 groundwater grab samples from 9 temporary well locations;
- 3 sediment and 3 surface water samples from 3 locations; and
- 10 QA samples collected.

Mobilization 2 –

- 5 soil grab samples from 5 locations;
- 7 groundwater samples from 7 permanent monitoring well locations;
- 5 sediment samples from 5 locations;
- 8 surface water samples from 4 locations; and
- 8 QA samples collected.

The information gathered during this investigation was used to determine if PFOA, PFOS, and/or PFBS were present at or above SLs and whether residential drinking water samples exceeded the USEPA HA of 70 ng/L for PFOA and/or PFOS. 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, groundwater, sediment, and surface water. Detections of PFOA and PFOS in groundwater at AOI 1: AASF Hangar and Armory (Former AASF) exceeded the SL of 40 ng/L. Detections of PFOA, PFOS, and PFBS in soil samples from all AOIs were below the 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.*

   AOI 2: Annex Building was removed from further consideration based on the groundwater and soil data collected during this SI. PFOA, PFOS, and PFBS were not detected in groundwater and/ or soil above the SLs in AOI 2; therefore, AOI 2 poses no significant threat to human health or the environment.

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

   As described in **Section 2.4**, in January and July 2020, ARNG collected off-facility drinking water samples due to the exceedance of SLs observed in groundwater during Mobilization 1 field activities. Twenty-five (25) properties along West Eaton Highway, Wright Road, Hartel Road, and Bauer Road were selected to be sampled due to their proximity to Grand Ledge AASF and Armory. Only one property had a minor detection of PFOS (3.38 ng/L) in drinking water below the HA. Therefore, the need for a removal action due to an impacted drinking water receptor does not exist.

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

   The geology is generally characterized by lean clays down to approximately 35 to 50 feet bgs, followed by layers of more permeable sediments, such as sand and gravel. The thickness of clay and silt observed in the deep borings drilled during Mobilization 2 appears to support the concept of limited vertical migration of contaminants at the facility. Underneath the fine-grained material resides layers of permeable, coarser-grained sediments, which is evidence for the presence of weathered bedrock and/or potential glacial outwash deposits buried beneath the fine-grained surficial deposits at the facility. Depth to bedrock across the facility ranged from 30.5 to 90 feet bgs, which is similar to the depths to bedrock recorded in the residential wells by the Barry-Eaton District Health Department.

   Depth to water was encountered at depths ranging from 4 to 17 feet bgs in temporary monitoring wells and from 10 to 36 feet bgs in deeper, permanent monitoring wells. The groundwater flow direction at Grand Ledge is to the southeast. These geologic and hydrogeologic observations inform development of the 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 more than 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.*

   As determined through residential drinking water sampling described under goal #3, detections of PFOA, PFOS, and PFBS in soil and groundwater at source areas, in concert with a known PFOS detection in one side-gradient residential drinking water sample, indicate there is a potentially complete pathway between source and receptor for one residential well. The remaining 24 adjacent, private, residential wells have an incomplete pathway between source and receptor, because there are no detections of PFOA and/or PFOS or exceedances of the HA.

8.3 Outcome

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

- PFOA and PFOS in groundwater at AOI 1 exceeded the individual SLs of 40 ng/L, with concentrations of 53.0 ng/L and 60.0 ng/L, respectively, at location AOI 1-5. Based on the results of the SI, further evaluation of AOI 1 is warranted in the RI.
- The detected concentrations of PFOA, PFOS, and PFBS in groundwater samples from AOI 2 were below the SLs.
- The detected concentrations of PFOA, PFOS, and PFBS in soil samples from all AOIs were below both industrial/ commercial and residential SLs.
- Twenty-five (25) private, residential wells located south, east, and west of the facility were sampled for PFAS. None exceeded the USEPA HA of 70 ng/L for PFOA and/or PFOS, and 23 wells had no detections of PFAS. Only one residential well had an estimated PFOS detection of 3.38 ng/L and is side-gradient to AOI 2.

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 residential drinking water receptors caused by DoD activities at or adjacent to the facility for one residential well with a minor detection of PFOS (3.38 ng/L). The data do not support a risk to drinking water receptors at any of the remaining 24 adjacent, private, residential wells that were sampled for PFAS. It is not known whether any shallow drinking water wells further downgradient exist and are impacted.

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: AASF Hangar and Armory (Former AASF).

Table 8-1: Summary of Site Inspection Findings

AOI	Potential PFAS Release Area	Soil – Source Area	Groundwater – Source Area
1	AASF Hangar and Armory (Former AASF)	◐	●
2	Annex Building	◐	◐

Legend:
● = detected; exceedance of the screening levels
◐ = detected; no exceedance of the screening levels
○ = not detected

Table 8-2: Site Inspection Recommendations

AOI	Description	Rationale	Future Action
1	AASF Hangar and Armory (Former AASF)	Exceedances of SLs in groundwater at source area. No exceedances of SLs in soil.	Proceed to RI
2	Annex Building	Detections in groundwater and soil but no exceedances of SLs.	No further action

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