Final
Site Inspection Report
Camp Grayling JMTC, Grayling Army Airfield, MI

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

September 2019

Prepared for:

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

U.S. Army Corps of Engineers, Baltimore District
2 Hopkins Plaza
Baltimore, MD 21201

Prepared by:

AECOM
12420 Milestone Center Drive
Germantown, MD 20876
aecom.com

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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
°F	degrees Fahrenheit
AECOM	AECOM Technical Services, Inc.
AFFF	aqueous film forming foam
AM	Action Memorandum
AOI	Area of Interest
ARNG	Army National Guard
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
COC	chain-of-custody
CSM	conceptual site model
DoD	Department of Defense
DPT	Direct-Push Technology
DQI	Data Quality Indicator
DQO	Data Quality Objective
DUA	Data Usability Assessment
DVR	Data Validation Report
EGLE	Michigan Department of the Environment, Great Lakes, and Energy
ELAP	Environmental Laboratory Approval Program
FRB	Field Reagent Blank
ft	feet/foot
FTA	Fire Training Area
GAAF	Grayling Army Airfield
GCAL	Gulf Coast Analytical Laboratories, LLC
HA	Health Advisory
HAL	Health Advisory Limit
HDPE	high-density polyethylene
IED	Installations & Environment Division, Cleanup Branch
IDW	Investigation Derived Waste
ITRC	Interstate Technology Regulatory Council
JMTC	Joint Maneuver Training Center
LCS	laboratory control spike
LCSD	laboratory control spike duplicate
LOD	Level of Detection
LOQ	Level of Quantitation
MATES	Maneuver Area Training Equipment Site
MDEQ	Michigan Department of Environmental Quality
MDL	method detection limit
MDNR	Michigan Department of Natural Resources
MDMVA	Michigan Department of Military and Veteran Affairs

MIARNG	Michigan Army National Guard
MPART	Michigan PFAS Action Response Team
mph	miles per hour
MS	matrix spike
MSD	matrix spike duplicate
NELAP	National Environmental Laboratory Accreditation Program
NEtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid
ng/L	nanograms per liter
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
NOAA	National Oceanic and Atmospheric Administration
PA	Preliminary Assessment
PAL	Project Action Level
PCE	tetrachloroethylene
PFAS	Per- and polyfluoroalkyl substances
PFBA	Perfluorobutyrate
PFBS	Perfluorobutanesulfonic acid
PFCs	Perfluorinated compounds
PFDA	Perfluorodecanoic acid
PFDoA	Perfluoroheptanoic 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
PQAPP	Programmatic UFP-QAPP
PVC	poly-vinyl chloride
QAPP	Quality Assurance Project Plan
QC	Quality Control
QSM	Quality Systems Manual
RI	Remedial Investigation
RPD	relative percent differences
SI	Site Inspection
SP	Screen Point
TCE	Trichloroethylene
TCRA	Time Critical Removal Action
TOC	Total organic carbon
TPP	Technical Project Planning
UFP	Uniform Federal Policy
U.S.	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
VAP	Vertical Aquifer Profile

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Executive Summary

The Army National Guard (ARNG) performed this Site Inspection (SI) at Grayling Army Airfield (GAAF), a portion of Camp Grayling Joint Maneuver Training Center (JMTC) (also called Camp Grayling) in Grayling, Michigan.

Programmatically, the ARNG is assessing the potential environmental impacts primarily from aqueous film forming foam (AFFF) and similar chemical releases suspected at their properties under a task order titled *Preliminary Assessments and Site Inspections (PA/SI) for Perfluorooctanesulfonic Acid (PFOS) and Perfluorooctanoic Acid (PFOA) Impacted Sites, ARNG Installations, Nationwide*. The SIs assess the presence or absence of per- and polyfluoralkyl substances (PFAS) released through site activities (e.g., fire training firefighting, and metal plating). This project is executed by AECOM Technical Services, Inc. (AECOM) under Contract Number W912DR-12-D-0014, Task Order W912DR17F0192, issued 11 August 2017 by the United States (U.S.) Army Corps of Engineers (USACE) Baltimore District on behalf of the ARNG-Installations & Environment Division, Cleanup Branch (IED).

The purpose of this SI is to determine the presence or absence of PFAS contamination at GAAF and assess whether a complete exposure pathway exists between the PFAS source and potential human receptors. As stated in the *Federal Facilities Remedial Site Inspection Summary Guide* (United States Environmental Protection Agency [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)
5) Collect data to determine whether the release is more than likely the result of activities associated with the Department of Defense (DoD)

Camp Grayling is divided into two geographic areas: the North Post and South Post. This SI focuses on GAAF, which is a part of the North Post. GAAF is located immediately west and northwest of the City of Grayling, at the intersection of I-75 and West North Down River Road. GAAF is an approximately 921-acre active public- and military-operated airfield with two runways: Runway 5/23 and Runway 14/32. During the PA for PFAS, nine potential PFAS release areas were grouped into five areas of interest (AOIs) (AOI 1 through 5). Each of these areas were investigated during the SI.

SI field activities were conducted in two phases: Phase I included soil and groundwater grab sampling from 10 to 20 September 2018; Phase II included permanent groundwater monitoring well installation, development, and sampling from 6 to 22 October 2018.

To fulfill the project Data Quality Objectives (DQOs) set forth in the approved SI Quality Assurance Project Plan (QAPP) Addendum (AECOM, 2018e), samples were collected and analyzed for PFAS via LCMSMS Compliant with QSM 5.1 Table B-15 as follows:

- 66 soil grab samples from 22 boring locations;
- 31 groundwater grab samples from 22 temporary well locations, 5 existing permanent monitoring well locations and 4 Vertical Aquifer Profile (VAP) locations; and
- 11 groundwater samples from permanent monitoring well locations.

Sample chemical analytical concentrations were compared against Project Action Levels (PALs) for PFOS and PFOA in groundwater as described in **Table ES-1**. All other results presented in this report are considered informational in nature and serve as an indication as to whether soil and groundwater contain or do not contain PFAS within the boundaries of GAAF with the following results:

- PFOS and/ or PFOA in groundwater were confirmed to exceed the PAL of 70 nanograms per liter (ng/L) in groundwater at AOI 1, AOI 2, AOI 3, AOI 4 and AOI 5 at the source areas and/ or at downgradient facility boundary locations. As such, these AOIs will be evaluated further in a forthcoming RI.
- PFAS in soil and groundwater were confirmed at the source areas and the facility boundary in AOI 1, AOI 2, AOI 3, AOI 4 and AOI 5.
- Two specific potential PFAS release areas, Bivouac Area in AOI 5 and Northwestern End of Runway 14/32 in AOI 4, did not detect PFOS or PFOA in groundwater; and therefore, will have no further sampling or evaluation.
- A groundwater sample at boundary location VAP-01 in AOI 4, which is side gradient to potential PFAS release area Northwestern End of Runway 14/32, had an exceedance of the PAL, 70 ng/L for PFOA (97 ng/L). As such, the area proximal to VAP-01 will be evaluated further in a forthcoming RI.
- Monitoring well GAAF-MW-11, installed at the northern most boundary of GAAF, shows that PFAS are likely coming onto the facility property at low-level concentrations. PFOS was detected in groundwater at a concentration of 7.18 ng/L. Based on groundwater flow, it is unlikely that the PFAS detections observed in groundwater at this location are attributable to ARNG activities in this specific location. However, limited soil sampling is recommended within the vicinity of GAAF-MW-11 that will be completed under the RI phase of work to confirm no surface release occurred in this area.

Table ES-2 summarizes the SI groundwater data for analytes with promulgated and actionable standards (i.e., PFOS and PFOA). 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 from AOI 1, AOI 2, AOI 3, AOI 4 and AOI 5 caused by DoD activities. Off-facility investigations performed by Michigan Department of Environmental Quality[1] (MDEQ) indicate that drinking water receptors have impacts downgradient from on-facility AOIs.

Table ES-3 summarizes the rationale, based on PFOS and PFOA detections in groundwater, used to determine if the AOI should be considered for further action under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and undergo an RI. Based on the findings of this SI, it is recommended that this Site proceed to an RI.

[1] Effective 22 April 2019, MDEQ underwent a reorganization into the Michigan Department of the Environment, Great Lakes, and Energy (EGLE). Because the work described in this SI report was performed as “MDEQ”, the regulatory body is referred to as such throughout this document.

Table ES-1: Groundwater Action Levels

Analyte	USEPA Health Advisory Limit (HAL) (ng/L)[a]	MDEQ (ng/L)[b]
PFOA	70	70
PFOS	70	70
PFOA+PFOS	70	70

Notes:

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

b.) Michigan Department of Environmental Quality (MDEQ). 2018b. Remediation and Redevelopment Division. Environmental Contamination Response Activity Rules. Table 1. Groundwater: Residential and Nonresidential, Part 201 Generic Cleanup Criteria and Screening Levels. Effective January 10, 2018.

Table ES-2: Site Inspection Findings

AOI	Potential PFAS Release Area	Groundwater-Source Area	Groundwater-Near Boundary [a]
1	Building 1194 Ramp (Building 1195)	◐	●
1	Building 1160	●	●
2	Southeastern End of Runway 14/32	◐	●
2	Between Former MATES and Runway 14/32	●	●
3	Former MATES	●	●
4	Taxiway D	◐	●
4	Northwestern End of Runway 14/32	○	○
4	Area Near VAP-01	Not Applicable	●
5	Bivouac Area	○	○
5	City of Grayling Fire Department	◐	●

Legend:

● = exceedance of Project Action Levels

◐ = detected; no exceedance of Project Action Levels

○ = not detected

Notes:

a.) The facility boundary sample data collected near the off-facility receptors were collected in 2017 by Michigan Department of Military and Veteran Affairs (MDMVA) (Amec Foster Wheeler, 2017a).

Table ES-3: Site Inspection Recommendations

AOI	Description	Rationale	Future Action
1	Building 1194 Ramp (Building 1195)	Detections in groundwater at source area and exceedances of the PALs at facility boundary; downgradient exceedances in off-facility drinking water	Proceed to RI
1	Building 1160 Operations Building	Exceedances of the PALs in groundwater at source area and facility boundary; downgradient exceedances in off-facility drinking water	Proceed to RI
2	Southeastern End of Runway 14/32	Detections in groundwater at source area and exceedances of the PALs at facility boundary	Proceed to RI
2	Between Former MATES and Runway 14/32	Exceedances of the PALs in groundwater at source area and facility boundary	Proceed to RI
3	Former MATES	Exceedances of the PALs in groundwater at source area and facility boundary; downgradient exceedances in off-facility drinking water	Proceed to RI
4	Taxiway D	Detections in groundwater at source area and exceedances of the PALs at facility boundary; downgradient exceedances in off-facility drinking water	Proceed to RI
4	Northwestern End of Runway 14/32	Non-detect values in groundwater at source area	No further action
	Area Near VAP-01	Exceedances of the PALs at facility boundary location during previous investigation, side gradient to potential PFAS release area (Amec Foster Wheeler, 2017a)	Proceed to RI
5	Bivouac	Non-detect values in groundwater at source area	No further action
5	City of Grayling Fire Department	Detections in groundwater at source area and exceedances of the PALs at facility boundary	Proceed to RI

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1. Introduction

1.1 Project Authorization

The Army National Guard (ARNG) performed this Site Inspection (SI) at Grayling Army Airfield (GAAF; also referred to as the "Site"), a portion of Camp Grayling Joint Maneuver Training Center (JMTC) (also called Camp Grayling) in Michigan. GAAF will be referred to as the "Site" and Camp Grayling will be referred to as the "facility" throughout this document.

Programmatically, the ARNG is assessing the potential environmental impacts primarily from aqueous film forming foam (AFFF) and similar chemical releases suspected at their properties under a task order titled *Preliminary Assessments and Site Inspections (PA/SI) for Perfluorooctanesulfonic Acid (PFOS) and Perfluorooctanoic Acid (PFOA) Impacted Sites, ARNG Installations, Nationwide*. The SIs assess the presence or absence of per- and polyfluoralkyl substances (PFAS) released through site activities (e.g., fire training, firefighting, and metal plating). This project is executed by AECOM Technical Services, Inc. (AECOM) under Contract Number W912DR-12-D-0014, Task Order W912DR17F0192, issued 11 August 2017 by the United States (U.S.) Army Corps of Engineers (USACE) Baltimore District on behalf of the ARNG-Installations & Environment Division, Cleanup Branch (IED).

This report focuses on the SI performed at GAAF. The SI project elements were performed in compliance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended, the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations Part 300), and in compliance with USACE requirements and guidance for field investigations including specific requirements for sampling for PFOA, PFOS, and the group of related compounds known in the industry as PFAS. The term PFAS will be used throughout this report to encompass all PFAS chemicals being evaluated, including PFOS and PFOA, which are the key components of the suspected AFFF releases being evaluated, and the other 16 related compounds listed in the task order.

1.2 SI Purpose

A PA was performed at Camp Grayling (AECOM, 2018d) that identified nine potential PFAS release areas at GAAF which were grouped into five Areas of Interest (AOIs). The SI was performed as the next step in the CERCLA process. The purpose of this SI is to determine the presence or absence of PFAS contamination in the AOIs at GAAF and assess whether a complete exposure pathway exists between the PFAS source and potential human receptors.

As stated in the *Federal Facilities Remedial Site Inspection Summary Guide* (United States Environmental Protection Agency [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).
5) Collect data to determine whether the release is more than likely the result of activities associated with the Department of Defense (DoD)

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

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2. Site Background

2.1 Site Location and Description

Camp Grayling is in the north-central portion of the Lower Peninsula, approximately 200 miles northwest of Detroit and 80 miles south of Michigan's Upper Peninsula. Adjacent to the City of Grayling, Michigan, Camp Grayling covers portions of Crawford, Kalkaska, and Otsego counties (**Figure 2-1**). The camp is divided by Interstate Highway 75 and is bisected by the Au Sable River. Camp Grayling is the National Guard's largest training post, encompassing over 147,000 acres, and it provides training facilities and support services for the ARNG, Air National Guard, U.S. Army, U.S. Army Reserve units, and allied forces.

Camp Grayling is divided into North and South Post operational areas. The focus of this report will be GAAF, which is a part of the North Post of Camp Grayling.

GAAF is located immediately west and northwest of the City of Grayling, at the intersection of I-75 and West North Down River Road between the North and South Posts. The general geographic coordinates for the center of the airfield are 44°40′49″N; 84°43′44″W. The site layout at GAAF is shown on **Figure 2-2**.

The Site is an approximately 921-acre active public and military operated airfield with two runways: Runway 5/23 and Runway 14/32. Access to the facility is restricted by controlled gates. The Site has support buildings and facilities along its eastern boundary including the control tower, barracks, vehicle storage, and the Camp Grayling Fire Department. The former location of the Camp Grayling Maneuver Area Training Equipment Site (MATES) is located on the southwestern portion of the airfield at what is now the Former Bulk Fuel Storage Area. The former MATES was historically served by railroad tracks running along the western boundary of the airfield.

2.2 Facility Environmental Setting

Camp Grayling is located entirely within the Grayling Outwash Plain Regional Landscape Ecosystem of the Highplains District of Region II (Albert, 1995). This ecosystem is characterized as broad outwash plain including sandy ice-disintegration ridges, jack pine barrens, some white pine-red pine forest, and northern hardwood forest. Due to its inland location, northern latitude, and relatively high elevations, the Highplains District experiences the most severe climate in Lower Michigan.

Topography of the area has been shaped by glacial events that created two separate moraines at Camp Grayling: a southern moraine several hundred feet (ft) thick was deposited south of Lake Margrethe, and a northern moraine of similar thickness was deposited north of Lake Margrethe. Camp Grayling consists of portions of these two morainal highlands on the north and south, with a low marshy plain in between (Eugene A. Hickok and Associates, 1986). The Site is located within the low marshy plain area. The Site topography and the location of Lake Margrethe are shown on **Figure 2-3**. Surface water and groundwater features are presented on **Figures 2-4** and **2-5**, respectively.

2.2.1 Geology

Camp Grayling is in the north-central portion of the Michigan Basin; a symmetrical, circular, sedimentary basin in the Central Interior Platform of the U.S. During the Pleistocene epoch, four successive continental glaciers moved across parts of the Michigan Basin. The movement of the glaciers scoured the bedrock surface, deepening valleys and rounding hills. Advancing glaciers transported large quantities of glacial sediments, and when the ice melted, it deposited the glacial drift. The glacial drift is reported to extend to at least 600 ft below ground surface (bgs) and to a maximum thickness of 1,400 ft.

Camp Grayling is underlain by unconsolidated glacial sediments (i.e., glacial drift) that overlie sedimentary bedrock consisting of Middle to Late Mississippian Age bedrock from the Coldwater and Michigan formations. These interbedded layers of shale, sandstone, and limestone range in total thickness from 500 to 600 ft and were formed 325 to 350 million years ago from the deposition of marine sediments. The glacial deposits include lacustrine clay, sand, and gravel outwash plains, with glacial till providing highly variable discontinuous layers. The glacial drift is reported to extend to at least 600 ft bgs.

Soils at Camp Grayling are derived from glaciofluvial parent materials, with extensive deposits of sands and gravels that originated as glacial and ice-contact outwash (Zorn & Sendek, 2001). Intersecting fluvial deposits from the Au Sable River are present within the North Post and GAAF. The surficial soils are predominantly sandy soils that are somewhat to excessively drained. These soils exhibit relatively low fertility and vegetation production potentials but a high tolerance to the compaction and erosion impacts of tracked and wheeled vehicle use.

There are three primary soil series and four soil groups within Camp Grayling. The three distinct soil series, which comprise approximately 75 percent (%) of the facility, are the Graycalm (28%), Grayling (23% of the facility and 15% in soil complexes), and Rubicon (4.8% of the facility and 4.9% in soil complexes) soil series. At GAAF, Graycalm is the most dominant soil series. In general, the soils at Camp Grayling have a high wind erosion and low water erosion potential.

Soil borings completed during the SI found that soils at GAAF were dominated by well-graded sand with thin beds and lenses of gravel and mud clasts. These permeable sand intervals are widespread and commonly observed in excess of 30 ft thick. Intervening gravelly sands and mud clast beds range from 0.1 to 0.9 ft thick. Isolated occurrences of silty sands (up to 7.5 ft thick), well graded gravels (up to 7 ft thick), and fat clay (up to 6.5 ft thick) were also observed. The clay lenses observed in the southeastern and southwestern portion of GAAF appear to be discontinuous in nature, making three-dimensional flow patterns difficult to predict.

These site observations are consistent with sedimentary deposition from a braided river in a glaciofluvial environment. A braided river consists of a network of channels that intersect and split at channel bars to give a braided appearance. The well-graded sands represent the bulk of the sediment load transported and deposited in the braided river system, supplied by melting ice at the glacier terminus. The well-graded gravel intervals represent isolated point bar deposits, whereas the siltier and thin clayey intervals likely represent discontinuous floodplain deposits characteristic of braided rivers. Thicker clay deposits represent isolated channel fill, as the braids migrated and abandoned former channel flow paths.

2.2.2 Hydrogeology

Regional and local groundwater flow throughout the entire Camp Grayling facility appears to conform generally to surface water drainage patterns. Due to the extreme permeability of the sandy soils, nearly all precipitation infiltrates to the water table and flows underground towards stream channels (Zorn & Sendek, 2001; Rozich, 1998). Groundwater flow velocity on the North Post is approximately 1 to 1.5 ft per day (Michigan Department of Military and Veterans Affairs [MDMVA], 2007).

GAAF is located between the main branch and East Branch of the Au Sable River. Groundwater elevation was gauged in October 2018 at newly installed monitoring wells and existing piezometers. Depth to water at GAAF ranges from approximately 6 to 15 ft bgs. A groundwater divide was observed coincident with the approximate center line of GAAF trending north-south. Groundwater on the east of the airfield generally flows to the south-southeast, and groundwater on the west of the airfield generally flows to the south-southwest. Observed groundwater elevations from the October 2018 synoptic gauging event and corresponding contours are displayed on **Figure 2-6**.

2.2.3 Hydrology

GAAF is situated within two watersheds: the Simpson Creek Au Sable River Watershed and the East Branch Au Sable River Watershed. These watersheds intersect on the Site along a north-south divide.

There are no major surface water features within the Site boundary, and surface drainage eventually flows into the Au Sable River to the south. The Au Sable River is a major tributary to Lake Huron. Approximately 88,788 acres of Camp Grayling lands are in the Au Sable watershed, mostly the North Post. This land area, wherein about 60% of Camp Grayling lies, is drained by approximately 85 miles of streams. Mean discharge for the main branch of the Au Sable at Grayling is 76.1 cubic ft per second (cfs) (MDMVA, 2007). Two wetlands areas exist outside of the facility property, northwest and south of GAAF.

2.2.4 Climate

The Site's climate is predominantly continental in character as a result of its interior mid-Michigan location. The prevailing winds are westerly during the summer, as the Bermuda high pressure center pushes into the southeastern U.S. Secondary wind directions include the northwest through the southwest quadrants. Northeasterly winds are observed relatively infrequently. The annual mean wind speed is 9 miles per hour (mph); however, wind speeds of 40 mph have been observed during January, June, and November. The variations in weather are a result of the movement of pressure systems across the country; therefore, the Site and its vicinity do not often experience long periods of hot, humid, summer weather or extreme cold weather. However, climatic effects of Lake Michigan and Lake Huron are still discernible in their influence on snowfall and cloud cover during the late fall and early winter months (National Guard Bureau & MDMVA, 1994).

The annual mean temperature at Camp Grayling is 42.4 degrees Fahrenheit (°F). The average summer high temperature is 77.6 °F, and the average winter low temperature is 10.6 °F. The total mean annual precipitation is 33.61 inches. February is the driest month, with an average of 1.28 inches of precipitation, while August is the wettest month, with 3.78 inches of precipitation. Afternoon showers and thunderstorms are the major sources of summer precipitation. The average annual snowfall at Grayling is 105.1 inches (National Oceanic and Atmospheric Administration [NOAA], 2018).

2.2.5 Current and Future Land Use

According to a 2001 Land Condition-Trend Analysis Facility Report for Camp Grayling (Envirologic Technologies, Inc., 2003), most of Camp Grayling is used for tracked and wheeled vehicle maneuver training. Numerous active live-fire training ranges also occupy significant portions of the North and South Post. GAAF supports both public and military airport use. Non-Military land uses at Camp Grayling include Michigan Department of Natural Resources (MDNR) forestry activities, hunting, fishing, timber, and mineral extraction. Sand, gravel, and clay extraction is managed by MDNR, with consultation of Camp Grayling (MDMVA, 2007). Extreme northern and southern areas within Camp Grayling boundaries have been developed for oil and gas production. Administration of oil and gas development is provided by both MDNR and Michigan Department of Environmental Quality[2] (MDEQ) (MDNR, 2013). Active training areas (including ranges), the cantonment, and the Site have controlled access, while the remaining areas have open access to the public.

[2] Effective 22 April 2019, MDEQ underwent a reorganization into the Michigan Department of the Environment, Great Lakes, and Energy (EGLE). Because the work described in this SI report was performed as "MDEQ", the regulatory body is referred to as such throughout this document.

The predominant land use outside the facility boundaries is public lands, especially public forest lands. Private lands and residences abut portions of the camp including the City of Grayling, located east and southeast of GAAF, and the north and eastern shores of Lake Margrethe. Numerous residences that are occupied seasonally and permanently are present along the banks of the Au Sable River and Lake Margrethe. Both water bodies are heavily used for recreational activities, including swimming, canoeing, and fishing. Light industrial and heavy industrial zoning is found in portions of the City of Grayling and Grayling Township. These zonings apply to various kinds of manufacturing or value-added activities (MDMVA, 2007).

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

GAAF is an active airfield dominated by paved or mowed grass surfaces; therefore, it is generally not an attractive habitat for wildlife species. However, the following birds, plants, mammals, and reptiles are federally endangered, threatened, proposed, and/or are listed as candidate species near GAAF (U.S. Fish and Wildlife Service [USFWS], 2018).

- **Birds**: Kirtland's Warbler, *Setophaga kirtlandii* (endangered)
- **Plants**: Houghton's goldenrod, *Solidago houghtonii* (threatened)
- **Mammals**: Northern Long-Eared Bat, *Myotis septentrionalis* (threatened)
- **Reptiles**: Eastern Massasauga Rattlesnake, *Sistrurus catenatus* (threatened)

2.3 History of AFFF Use

Nine potential PFAS release areas were identified at GAAF during the PA, where AFFF may have been used or released historically (AECOM, 2018d). During the 1970s and 1980s, Camp Grayling firefighting personnel (1439th and 1440th units) routinely trained with AFFF. Although the Camp Grayling Fire Department did not have specialized equipment for AFFF use (i.e., mixing nozzles), firefighting personnel reported during interviews that mixed AFFF with water in tanker trucks to create what was referred to by interviewees as "wet water." The term "wet water" is a colloquial term used by firefighters for an aqueous solution that has been reportedly mixed using different formulations and wetting agents (e.g., AFFF concentrate, Class A foam concentrate, or dish washing soap). Where appropriate, this report will make the distinction between AFFF "wet water", where the formulation may have included the use of AFFF and other wetting agents or foams. AFFF "wet water" ceased being stored in firetruck tanks in approximately 1988 due to leaking and the use of the truck's water tanks for non-firefighting activities.

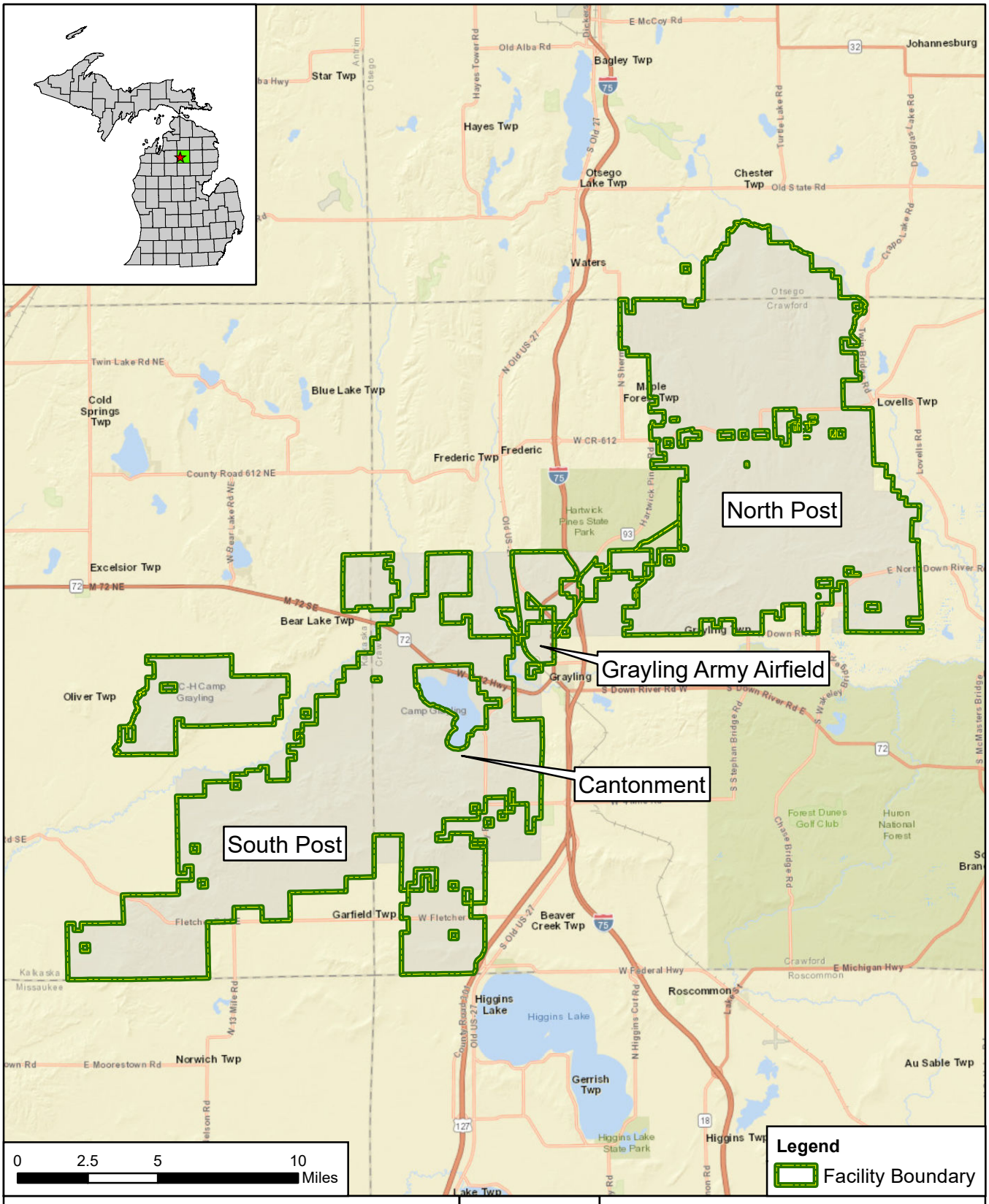
Camp Grayling has never discarded AFFF. Any excess AFFF, including off-specification or expired lots, was used during training activities. The potential PFAS release areas were grouped into AOIs based on proximity to one another and presumed groundwater flow. A description of each AOI is presented in **Section 3**.

2.4 Historical PFAS Investigations

The location of the Former Camp Grayling MATES, now referred to as the Former Bulk Fuel Storage Area, has an inactive groundwater pump and treat system (air stripper), remediating a tetrachloroethylene (PCE) and trichloroethylene (TCE) groundwater plume (labeled "Former MATES Location" on **Figure 2-2**). This remediation system is in the southwestern corner of the airfield. A network of monitoring wells associated with the PCE/TCE remediation system is in place.

In 2017, MDMVA conducted a PFAS investigation within the area of the existing remediation system as well as along the facility boundary. PFAS were detected in groundwater in excess of the USEPA Health Advisory (HA) Limit (HAL) (70 nanograms per liter [ng/L]) for the sum of PFOS and PFOA, the applicable standard at the time of the investigation, at several locations along the facility boundary. Drinking water samples were also collected from 185 homes within an area outside of the GAAF property boundary designated by MDEQ as the “priority area”. Exceedances of the USEPA HAL were observed in three homes (Amec Foster Wheeler, 2017b). The results of this investigation were considered during the PA to identify possible PFAS release areas of AFFF. Subsequently, MDEQ initiated a separate drinking water sampling program within the priority area. As of April 2019, MDEQ has collected 677 drinking water samples, 17 of which have exceeded the USEPA HAL of 70 ng/L for PFOA, PFOS, or the sum. See **Figure 2-7** for a summary of MDEQ’s drinking water sampling results for PFOA and PFOS combined (MDEQ, 2019). Through state funding, Michigan District Health Department #10- Crawford County, has provided single point-of-use in-home treatment filters for residences with any detections of PFOS and/or PFOA since 2017.

As of the date of this report, ARNG has drafted a Time Critical Removal Action (TCRA) Action Memorandum (AM) in response to the presence of PFAS in residential wells near GAAF (AECOM, 2019). The TCRA AM identified three potential options for providing affected residences whose drinking water exceeds the action level of 70 ng/L PFOS and/or PFOA, with a permanent solution for safe drinking water. The selected removal action is pending as of the date of this report.



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Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	RG	8/23/2019

Site Location

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 2-1

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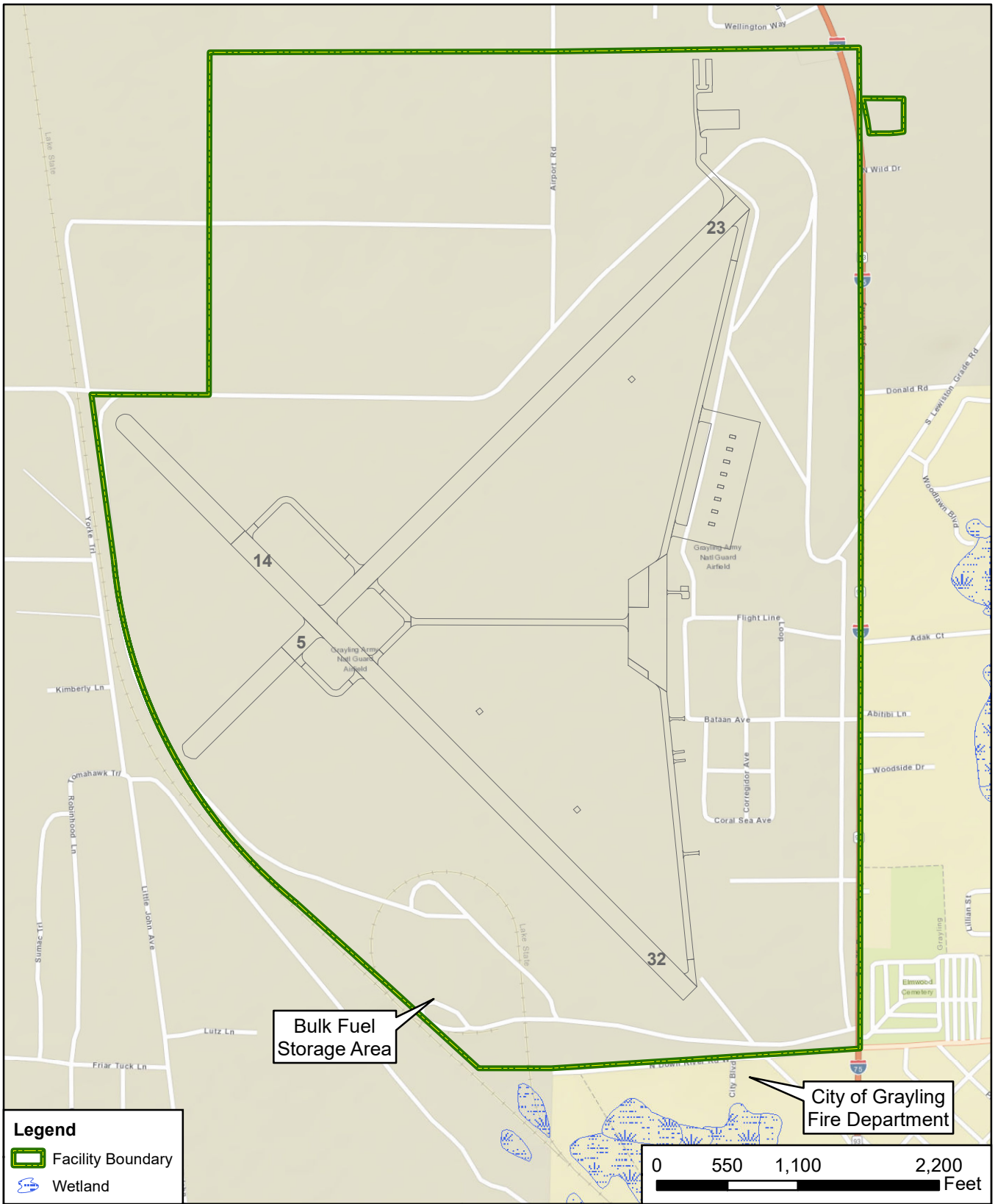

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Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	RG	8/23/2019

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Site Layout

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Figure 2-2

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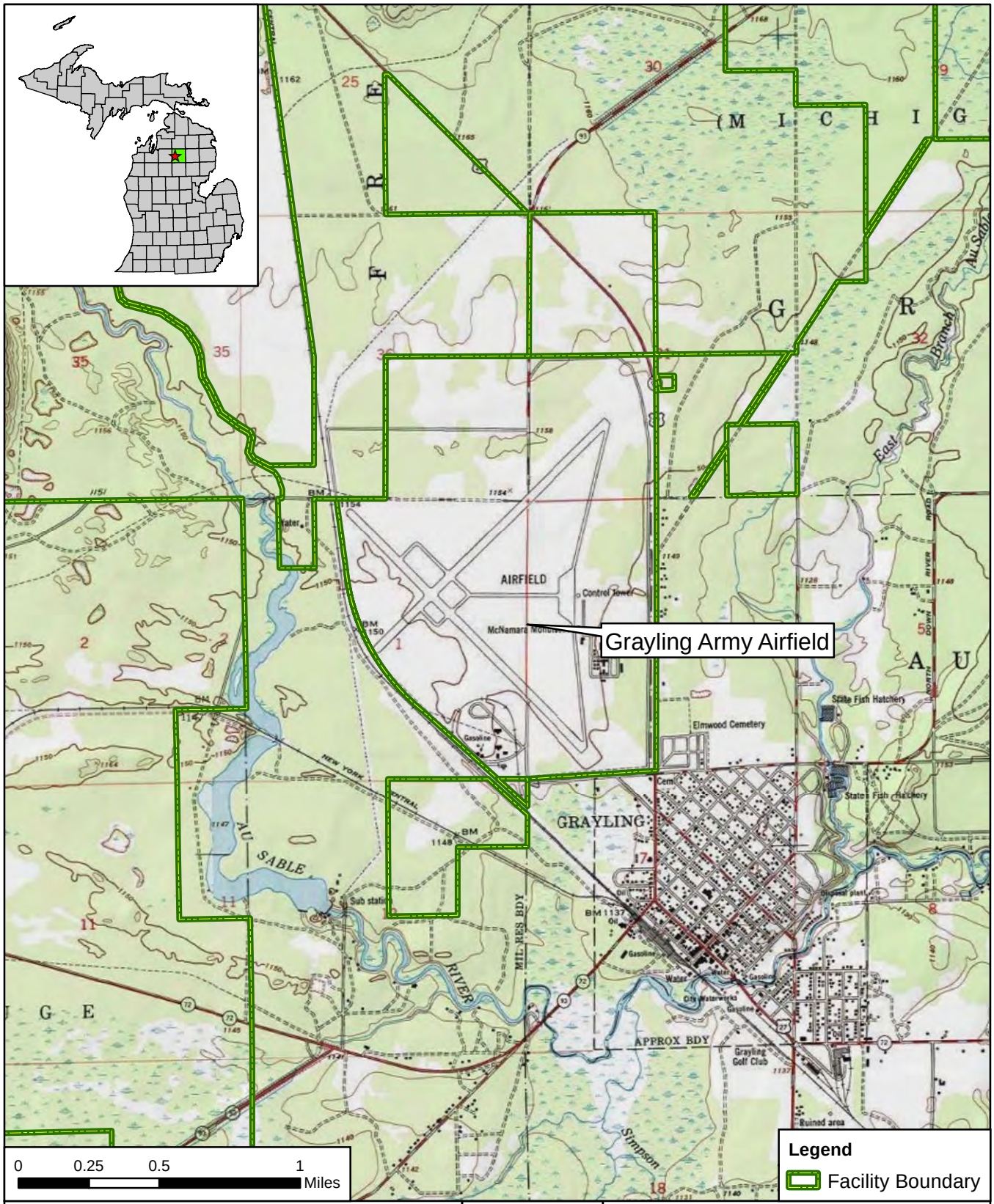

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SCALE	1:31,680	CHK BY	CM	8/15/2019
Base Map: Copyright:© 2013 National Geographic Society, i-cubed		PM	RG	8/15/2019

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Site Topography

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Figure 2-3

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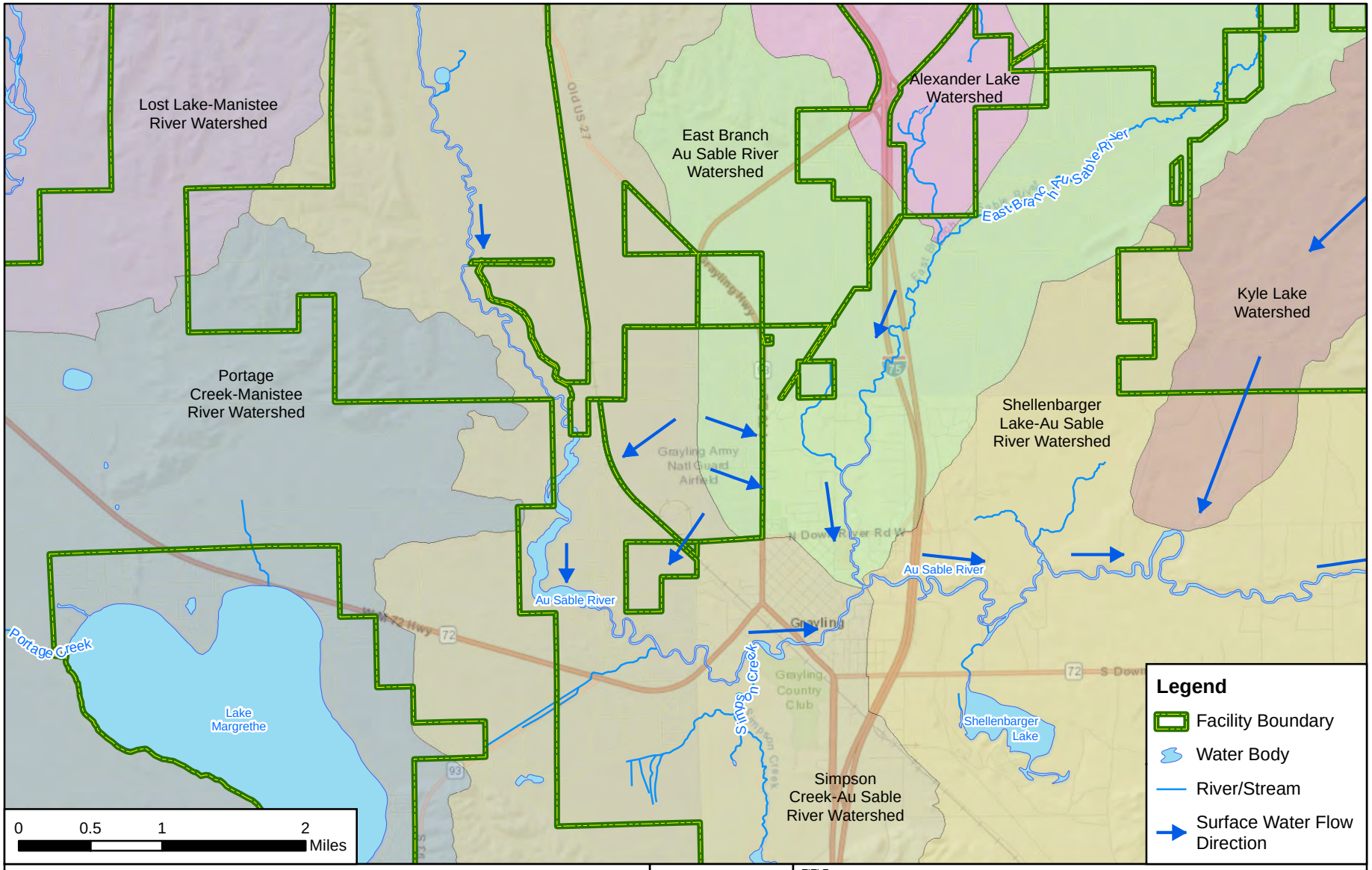

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PROJECT	Site Inspection Report, Camp Grayling Army Airfield Michigan			
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Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap		PM	RG	8/15/2019

TITLE

Surfacewater Features

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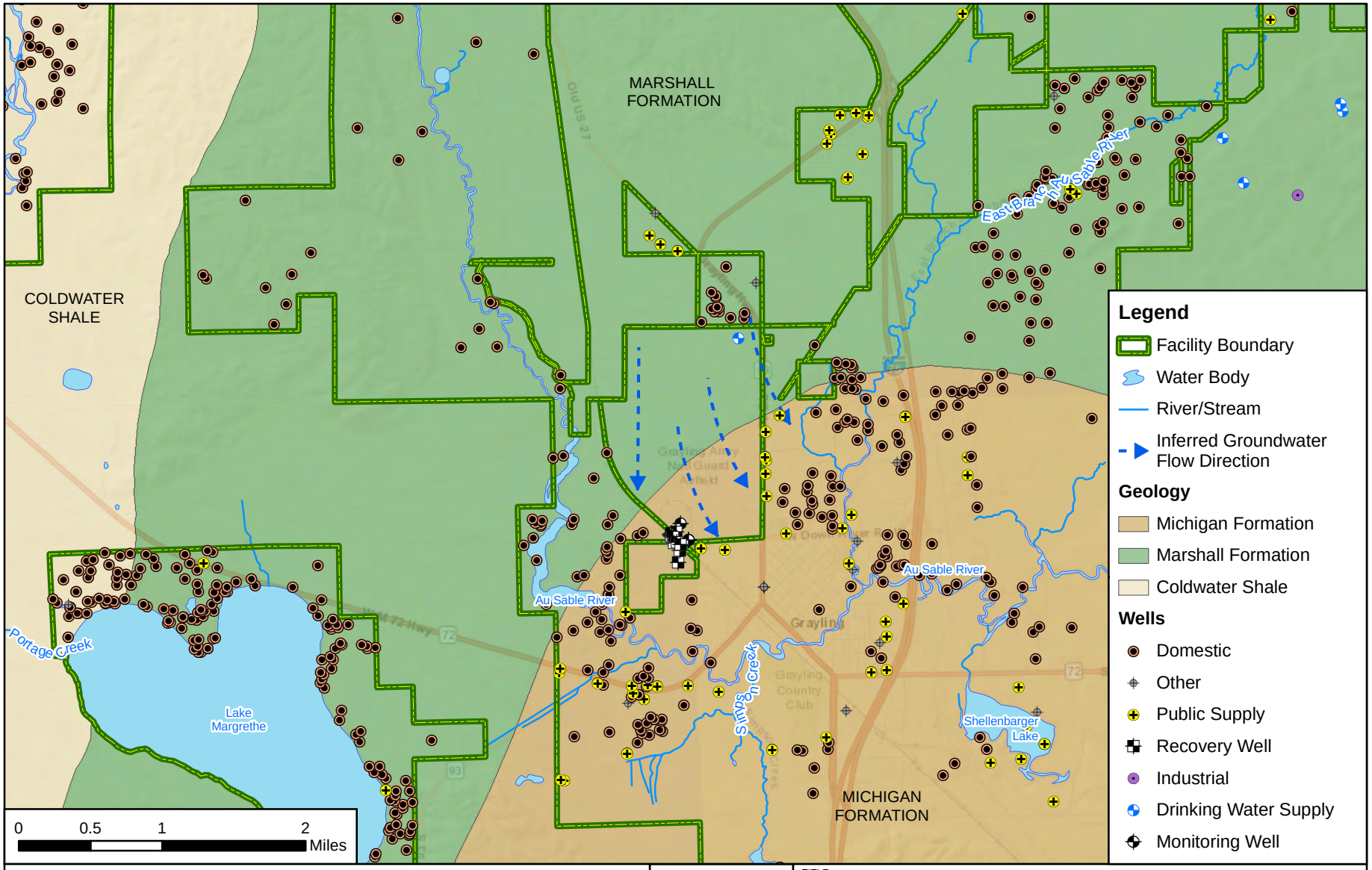
Figure 2-4

Q:\Projects\ENV\GEARS\GEO\MAES 2012 Unrestricted\Fort Meade\E. Data Management\GIS\MXDs\Chisholm_6th\March2017\ Fig_2-4_Grayling_AAF_Surfacewater_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	8/15/2019

N

TITLE

Groundwater Features

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Figure 2-5

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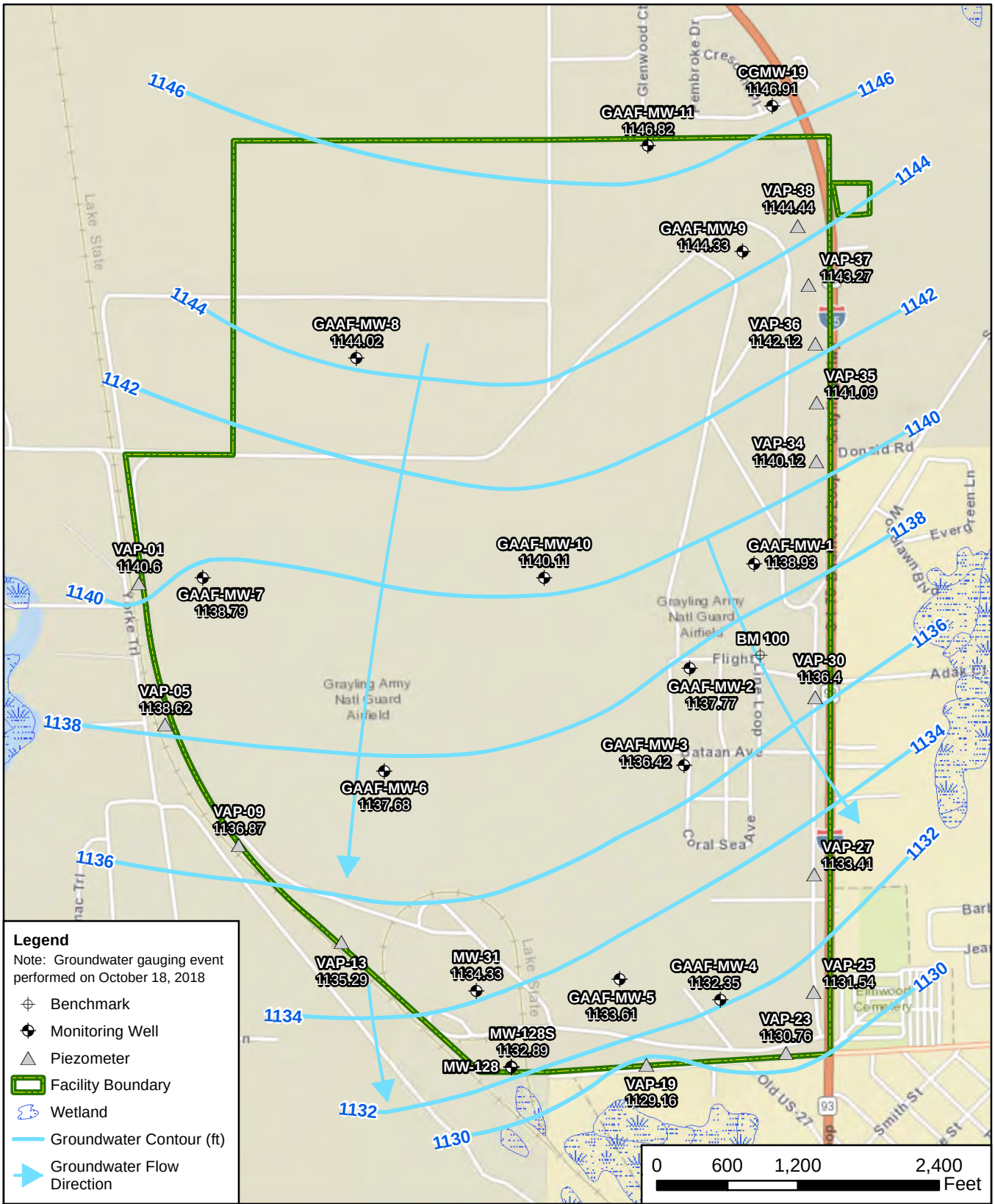

Legend

Note: Groundwater gauging event performed on October 18, 2018

- Benchmark
- Monitoring Well
- Piezometer
- Facility Boundary
- Wetland
- Groundwater Contour (ft)
- Groundwater Flow Direction

CLIENT	ARNG			
NOTES	Site Inspection Report, Camp Grayling Army Airfield Michigan			
REVISED	8/15/2019	GIS BY	MS	8/15/2019
SCALE	1:14,400	CHK BY	CM	8/15/2019
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P,		PM	RG	8/15/2019

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Groundwater Elevation Contours

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Figure 2-6

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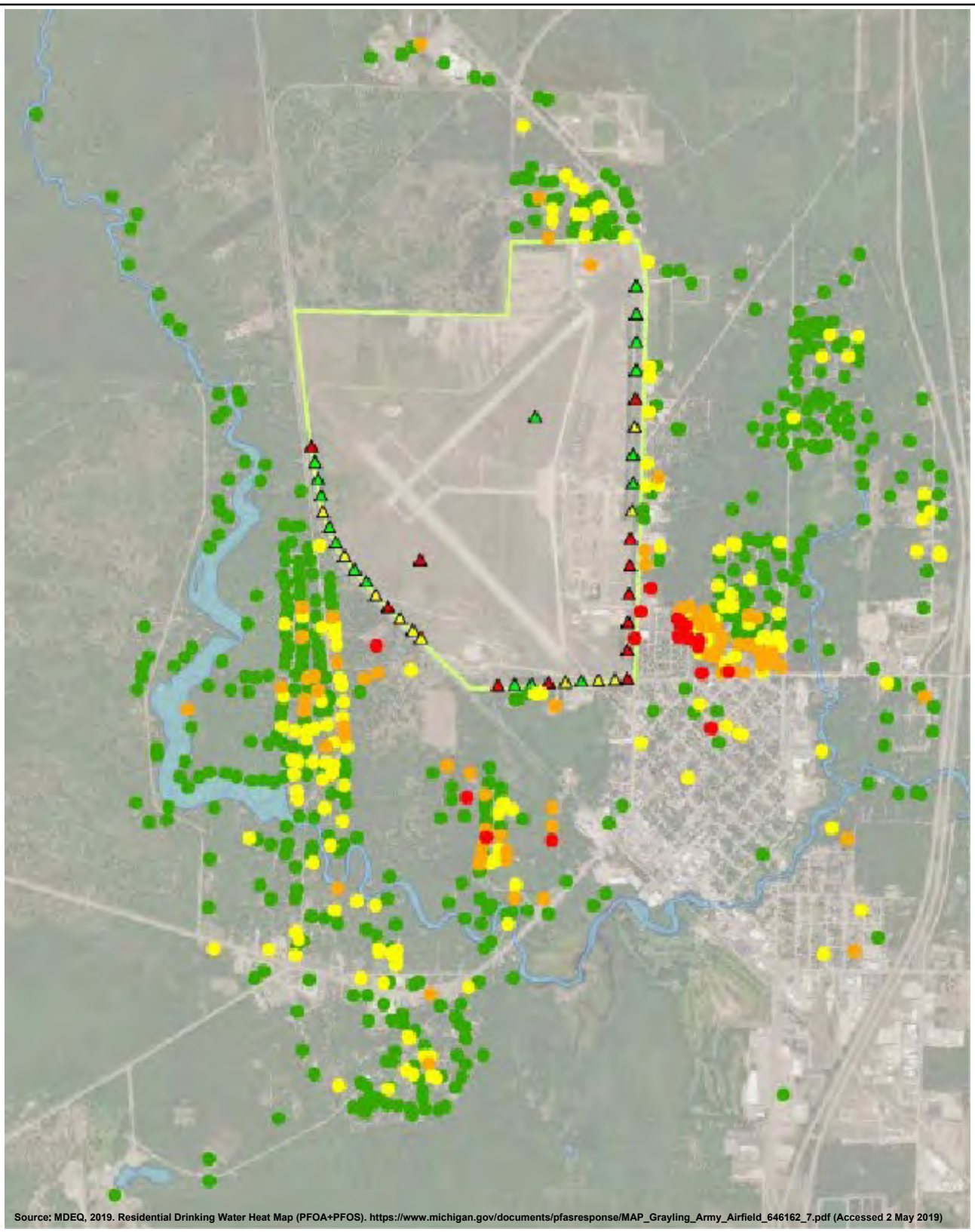

Source: MDEQ, 2019. Residential Drinking Water Heat Map (PFOA+PFOS). https://www.michigan.gov/documents/pfasresponse/MAP_Grayling_Army_Airfield_646162_7.pdf (Accessed 2 May 2019)

CLIENT	ARNG			
NOTES	Site Inspection Report, Camp Grayling Army Airfield Michigan			
REVISED	5/1/2019	GIS BY	MS	5/1/2019
		CHK BY	CM	5/1/2019
		PM	RG	5/1/2019

N

MDEQ Residential Drinking Water Heat Map (PFOA+PFOS)

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Figure 2-7

3. Summary of Areas of Interest

In the PA, the potential PFAS release areas were grouped into five (5) AOIs based on proximity and direction of groundwater flow (**Figure 3-1**). A summary of each AOI is presented below.

3.1 AOI 1

3.1.1 Building 1194 Ramp/ Building 1195

Building 1194 Ramp is designated as a hangar and is located within the northern portion of the eastern-most Michigan ARNG (MIARNG) controlled area of the Site. The geographic coordinates of the building are 44°40'50.14"N; 84°43'22.94"W. There is no AFFF fire suppression system within the hangar. During SI field activities, additional information was learned regarding the location of the potential PFAS release area. Firetruck staging was recalled by a former Camp Grayling Firefighter to be further south, outside and/or inside of Building 1195.

During the 1970s and 1980s, Camp Grayling firetrucks routinely parked on standby adjacent to Building 1195. Truck tanks reportedly leaked as much as 80 gallons each day and were topped off every night with AFFF mixed with water. The frequency at which the firetrucks were parked at Building 1195 is unknown; however, because the current Camp Grayling Fire Department (Building 1150) was constructed in 2006, it is suspected that trucks were parked adjacent to or within Building 1195 during all active training seasons from the early 1970s through approximately 1986. This period represents the period of active AFFF use at Camp Grayling. A drain observed in Building 1195 represents a potential migration pathway. The configuration of the drain beneath the building is unknown.

3.1.2 Building 1160 (Operations Building)

During interviews, former firefighters specifically identified Building 1160 as a location of historic fire training activities and AFFF use in the 1970s through 1980s. Specifically, firetrucks containing “wet water” or a 3 or 6% AFFF concentrate and water mixture were parked on the western side of Building 1160 during training activities. The geographic coordinates are 44°40'38.94"N; 84°43'23.17"W.

3.2 AOI 2

3.2.1 Southeastern End of Runway 14/32

During interviews, former firefighters identified a location at the end of Runway 14/32, where fire training activities and active AFFF use occurred in the 1970s through 1980s. The geographic coordinates are 44°40'17.32"N; 84°43'21.69"W.

3.2.2 Between the Former MATES and Runway 14/32

During interviews, former firefighters identified another location of fire training activities and active AFFF use between the Former MATES and Runway 14/32 in the 1970s through 1980s. The geographic coordinates are 44°40'20.922"N; 84°43'30.542"W.

3.3 AOI 3

3.3.1 Former MATES Location

During interviews, former firefighters identified another location of fire training activities and active AFFF use at the Former MATES firefighter in the 1970s through 1980s. The geographic coordinates are 44°40'57.02"N; 84°44'14.98"W.

3.4 AOI 4

3.4.1 Northwestern End of Runway 14/32

During interviews, former firefighters identified another location of fire training activities and active AFFF use at the northwestern end of Runway 14/32 in the 1970s through 1980s. The geographic coordinates are 44°40'57.02"N; 84°44'14.98"W. This potential source areas is east of VAP-01 which had an exceedance of the USEPA LHA in groundwater (Amec Foster Wheeler, 2017a)

3.4.2 Taxiway D

According to the City of Grayling Fire Department Chief, joint training with Camp Grayling fire units was conducted approximately twice between 1984 and 1986 near Taxiway D, where runways 5/23 and 14/32 cross. The approximate geographic coordinates are 44°40'45.87"N; 84°43'54.19"W. Joint training was also periodically conducted at this location by Camp Grayling units and Ohio and Indiana National Guard units, between approximately 1978 and the late 1980s. Training reportedly consisted of igniting approximately 5 gallons of “Jet Propellant 8” jet fuel, or a mix of gasoline and diesel fuel, spread on the ground or within a brush pit and using AFFF to extinguish the resulting fire.

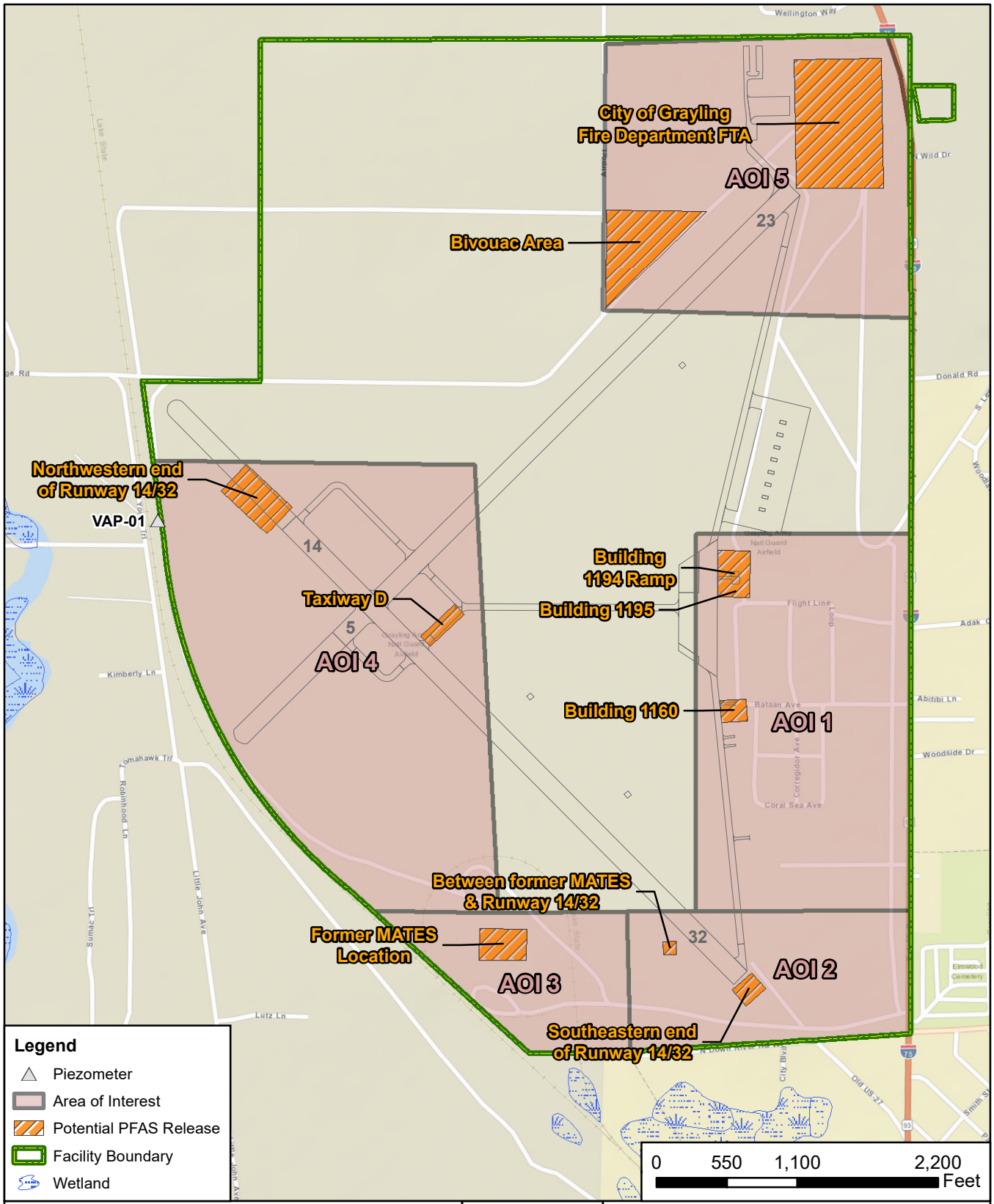
3.5 AOI 5

3.5.1 Bivouac Area

A former Camp Grayling firefighter reported that the forested area located in the northern portion of the Site was used as a bivouac for a 2-week period during the summers of two separate years. During this time, firetrucks would be stationed on stand-by within the area to quickly respond to fires. The exact years, concentration of any potential AFFF stored or used, the precise location where the bivouac activities occurred, and where firetrucks were parked are not known. During a follow-on interview, a former Camp Grayling firefighter recalled being able to see the runway from where the trucks were stationed on stand-by and identified an area on the northwestern side of runway 5/23. The approximate geographic coordinates are 44°41'15.26"N; 84°43'33.24"W; however, the precise bivouac area is unknown.

3.5.2 City of Grayling Fire Department

Prior to in-person interviews, former firefighters suggested that fire training activities occurred in the vicinity of the north end of Runway 5/23. During follow-up interviews with former Camp Grayling firefighters, an area immediately north of the north end of Runway 5/23 that was developed for use by the municipal airport was identified as the location where the City of Grayling Fire Department performed fire training a few times during the late 1970s to early 1980s. The training at the Site seems to have predominantly occurred at the end of the runways. Because of this pattern and groundwater sampling results from the Site boundary, training may also have occurred in the northern area near geographic coordinates 44°41'24.56"N; 84°43'10.75"W.



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SCALE	1:13,200	CHK BY	CM	8/23/2019
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	RG	8/23/2019

Areas of Interest

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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. 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

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 at both federal and state levels continues to evolve. The USEPA issued Drinking Water HAs for PFOA and PFOS in May 2016. In the absence of federal Maximum Contaminant Levels, some states, including Michigan, have adopted their own promulgated drinking water standards for PFAS. The state of Michigan promulgated Generic Cleanup Criteria[3] for PFOA and PFOS on 10 January 2018, adopting the USEPA HAs for PFOA and PFOS (MDEQ, 2018b). Additionally, DoD recognizes the State of Michigan Surface Water Quality Values for PFOS and PFOA[4] as properly promulgated values; however, these are not applicable to this SI because no surface water features are present on the site property.

Army policy forms (US Army, 2016) the basis for this SI:

- "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 (PFCs) are known or suspected to have been released, with the priority being those sites within 20 miles of the public systems that tested above USEPA HA levels."

4.2 Goals of the Study

The goals of this SI are to:

1) Determine the presence or absence of PFAS contamination at the Site.
2) Develop information to potentially eliminate a release from further consideration because it is determined that it poses no significant threat to human health or the environment.
3) Determine the potential need for a removal action.
4) Collect data to better characterize the release areas for more effective and rapid initiation of a RI.

[3] Part 201 Generic Cleanup Criteria and Screening Levels, Table 1. Groundwater: Residential and Nonresidential
[4] Rule 57 Water Quality Values. Surface Water Assessment Section. 21 October 2016.

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 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:

- PA for Camp Grayling, MI (AECOM, 2018d)
- Analytical data collected as part of MDEQ drinking water and environmental sampling efforts around the Site (MDEQ, 2019)
- Analytical data collected at site boundary sample locations (i.e., Vertical Aquifer Profile [VAP]) by MDMVA as part of a boundary investigation at GAAF (Amec Foster Wheeler, 2017a)
- Groundwater and soil samples collected in accordance with the Site Specific Uniform Federal Policy (UFP)-Quality Assurance Project Plan (QAPP) Addendum (AECOM, 2018e)
- Field data including groundwater elevation and water quality parameters measured at the time of sampling.

4.4 Study Boundaries

The scope of the SI sampling approach was bounded by the property limits of the Site (**Figure 2-2**). Off-facility sampling is currently being performed in Grayling, MI, adjacent to the Site, by MDEQ. Off-facility sampling was not included in the scope of this SI; however, the off-facility sampling efforts being performed by MDEQ, and the 2017 boundary sampling performed by MDMVA were taken into consideration for development of the SI sampling approach.

4.5 Analytical Approach

All samples were analyzed by Gulf Coast Analytical Laboratories, LLC (GCAL), accredited under the DoD Environmental Laboratory Accreditation Program (DoD ELAP; Accreditation Number 74960) and the National Environmental Laboratory Accreditation Program (NELAP; Certificate Number 01955). Data were compared to applicable PALs and decision rules as defined in the Programmatic UFP-QAPP (PQAPP). Decision rules were developed for groundwater and soil, and they applied to all data collected. 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:

<u>Groundwater</u>:

- Is there a human receptor within 4-miles of the site?
- What is the concentration of PFAS constituents at the potential PFAS release area?
- What is the concentration of PFAS constituents at the facility boundary upgradient and downgradient of potential PFAS release areas?

- What does the CSM suggest in terms of source, pathway and receptor?

Soil:

- What is the concentration of PFAS constituents in shallow surface soil (0 to 2 ft bgs)?
- What is the concentration of PFAS constituents 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 PFAS release areas. Groundwater was encountered at approximately 6 to 15 ft bgs. Boundary sampling has been performed by MDEQ, and PFAS were detected in groundwater at varying depths and concentrations.

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.

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, laboratory control spike (LCS), and matrix spike (MS) duplicate RPD.

Extraction internal standards were added by the laboratory during sample extraction to measure relative responses of target analytes and ensure that extraction efficiency criteria were met. Several field samples displayed extraction internal standard percent recoveries associated with multiple analytes that were outside the quality control (QC) limits. The positive field sample results associated with percent recoveries greater than the upper QC limits were qualified “J+” by the laboratory. This anomaly is considered minor, and the result is usable as qualified but should be considered as an estimated value with a positive bias. Positive field sample results associated with percent recoveries less than the lower QC limits were qualified “J”, while non-detects were qualified “UJ”. These anomalies are considered minor, and the results are usable as qualified but should be considered as an estimated value with a negative bias.

Calibration verifications were performed routinely to ensure that instrument responses for all calibrated analytes were within established QC criteria. Three calibration verifications displayed percent differences greater than the upper QC limit of 20 percent for N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA), Perfluorohexanesulfonic acid (PFHxS), and/or PFOS. The positive associated field sample results were qualified “J”. These anomalies

were considered minor, and the results are usable as qualified but should be considered as estimated values with a possible positive bias.

Laboratory control spike/laboratory control spike 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. All LCS/LCSD samples were within the RPD precision limits presented in the QAPP Addendum (AECOM, 2018e).

Matrix spike/matrix spike 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 percent. All MS/MSD samples were within the RPD precision limits presented in the QAPP Addendum (AECOM, 2018e).

Field duplicate samples were collected at a rate of 10 percent 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 with the exception of total organic carbon (TOC). TOC exceeded the upper control limit in field duplicate samples AOI5-3-SB-5-6.8 and AOI2-5-SB-0-2. The positive associated parent sample and field duplicate sample results were qualified “J”. These anomalies are considered minor, and the results are usable as qualified but should be considered as estimated values with an indeterminate bias.

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 one exception. One LCS sample performed in sample delivery group 218092203 displayed a percent recovery greater than the upper QC limit for PFOS. The associated field sample results were non-detect; therefore, no data qualifying action was required.

MS/MSD samples were prepared, analyzed, and reported at a rate of 5 percent. MS/MSD samples demonstrated that the analytical system was in control for the matrix being tested, with one exception. The MS/MSD for field sample AOI5-VAP34-22 displayed percent recoveries for PFOS greater than the upper QC limit. The parent sample result was positive and was qualified “J+”. This anomaly is considered minor, and the result is usable as qualified but should be considered as an estimated value with a positive 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.

Field QC samples were collected to assess the representativeness of the data collected. Field duplicates were collected at a rate of 10 percent for all field samples, while MS/MSD samples were collected at a rate of 5 percent. 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, 2018e) for all analyses.

Instrument blanks and method blanks were prepared by the laboratory in each batch as a negative control. Several PFAS instrument blanks and method blanks displayed detections greater than the detection limit for multiple target analytes. In total, 39 field sample results were qualified "U" during data validation due to associated detections in instrument and/or method blanks. The reported field sample result values were adjusted to be equal to the level of detection (LOD); the LOD was elevated to the concentration of the blank detection in instances where the blank concentration was greater than the LOD. The results are usable as qualified but should be considered false positives and treated as non-detect.

Equipment blanks and trip blanks were also collected for groundwater and soil samples. Trip blanks TB-092018 and TB-092118 displayed detections for PFOS greater than the detection limit.

Equipment blank EB-SPIGOT displayed a detection for PFHxS greater than the detection limit. A sample of the water used for decontamination of the drill rig was collected in advance of the field effort. PFHxS, an unregulated PFAS, was detected at an estimated value of 1.48 J ng/L. All other PFAS were not detected. Field sample results for PFHxS at concentrations approximate to those found in the blank detection (5 times blank detection) were qualified with a "U" and were considered a likely false positive. This result impacted PFHxS aqueous samples with concentrations that were less than 7.4 ng/L (5 times the blank detection). Soil samples are not impacted because of the conversion. Based on the sample results, the potable water source was deemed acceptable for use during the investigation for decontamination of drilling equipment and during well installation.

In total, eight field sample results were qualified "U" during data validation due to associated equipment blank and/or trip blank detections. The reported field sample result values were adjusted to be equal to the LOD, and the LOD was elevated to the concentration of the blank detection in instances where the blank concentration was greater than the LOD. The results are usable as qualified but should be considered false positives and treated as non-detect.

Overall, the data are usable for evaluating the presence or absence of PFAS at the Site. Sufficient usable data were obtained for each AOI to meet the objectives of the SI and to complete the risk assessment.

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 helps ensure comparability. Standard field sampling and typical laboratory protocols were used during the SI and are considered comparable to ongoing investigations.

This SI also considers data collected by MDMVA (Amec Foster Wheeler, 2017a) to determine presence or absence of PFAS at the facility boundary, as well as drinking water data collected by MDEQ for consideration as part of the CSM. Data collected by MDMVA reported in a letter report dated 25 September 2017 underwent 100% DoD Stage 2a Data Validation.

According to MDEQ and documented in Technical Project Planning (TPP) 2 meeting minutes, the first 200-300 residential sample results underwent data validation. Based on the "good" laboratory performance, as of March 2018, subsequent results were being validated at a rate of 10%, which

expedited distribution of results to residents (AECOM, 2018e). As such, the data collected by MDEQ is not used for direct comparison to SI data, but as data to consider as part of the CSM.

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 PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 at 100%
- PFAS in soil by PFAS by LCMSMS Compliant with QSM 5.1 Table B-15at 100%
- pH in soil by USEPA Method 9045D at 100%
- 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 LOQ (e.g. 12-hour Sensitivity Check as per DoD QSM Table B-15). 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, 2018e). 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, 2018e), the laboratory reported all field sample results at the lowest possible dilution. Two samples, AOI4-2-SB-6.5-8.1 and AOI4-3-SB-5-6.4, required a dilution factor greater than one. Both samples were analyzed at dilution factors of five. All dilutions were performed appropriately and correctly. Additionally, any analytes detected below the level of quantitation (LOQ) and above the detection limit 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, Camp Grayling, Michigan* dated August 2018 (AECOM, 2018d)
- *Final Site Inspection Programmatic Uniform Federal Policy-Quality Assurance Project Plan* dated March 2018 (AECOM, 2018a)
- *Final Site Inspection Uniform Federal Policy-Quality Assurance Project Plan Addendum, Camp Grayling Army Airfield* dated August 2018 (AECOM, 2018e)
- *Final Programmatic Accident Prevention Plan* dated July 2018 (AECOM, 2018b)
- *Final Site Safety and Health Plan, Grayling Army Airfield and Range 30 Complex, Camp Grayling, Michigan* dated July 2018 (AECOM, 2018c)

SI field activities were conducted in two phases. Phase I was completed from 10 to 20 September 2018 and consisted of soil and groundwater grab sampling. Phase II was completed from 6 to 22 October 2018 and consisted of permanent groundwater monitoring well installation, development, and sampling. Field activities were conducted in accordance with the QAPP Addendum (AECOM, 2018e), except as noted in **Section 5.9**.

The following samples were collected at GAAF and analyzed for PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 to fulfill the project DQOs:

- Collection of 66 soil grab samples from 22 boring locations;
- Collection of 31 groundwater grab samples from 22 temporary well locations, 5 existing permanent monitoring well locations, and 4 VAP locations; and
- Collection of 11 groundwater samples from permanent monitoring well locations.

Figures 5-1 and **5-2** provide the sample locations for all media across the Site for Phase I and II, respectively. **Table 5-1** presents all samples collected for each media. Daily reports were completed throughout Phase I and II activities, which are provided in **Appendix B**. 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 TPP meetings, performed utility clearance, and sampled decontamination source water, each of which is discussed in more detail below.

5.1.1 Technical Project Planning

The USACE TPP Process, 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.

TPP meetings 1 and 2 were held on 1 March 2018 and 6 June 2018, respectively, 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 (USACE, 2016).

The stakeholders for this SI include the ARNG, MIARNG, USACE, MDEQ, Camp Grayling, Michigan Department of Human Health Services and District Health Department #10, representatives familiar with the Site, the regulations, and the community. Stakeholders provided the opportunity to make comments on the technical sampling approach and methods in the TPP 2 meeting. The outcome of TPP meetings 1 and 2 were memorialized in the SI QAPP Addendum. Future TPP meetings will provide an opportunity to discuss the results and findings, and future actions, where warranted.

In 2017, the State of Michigan formed the Michigan PFAS Action Response Team (MPART), which is a group made up of state agencies representing health, environment, natural resources and other branches of the state government to conduct research, identify, recommend, and implement PFAS response actions throughout the state (Michigan, 2019). Several of the participants in the MPART team are also stakeholders for the work being performed at Camp Grayling.

5.1.2 Utility Clearance

Utility clearance was conducted by Camp Grayling Department of Public Works, 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 ft 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

A sample from a local potable water source at GAAF was collected on 3 August 2018, prior to Phase I mobilization, and analyzed via PFAS by LCMSMS Compliant with QSM 5.1 Table B-15. The potable water source at GAAF is supplied by one of the two wells operated by the City of Grayling. The results of the potable well sample are provided in **Appendix I**. A discussion of the results is presented in **Section 4.6.3**.

All 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 is provided in PQAPP Appendix C, Table 1 (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

Soil samples were collected via direct-push technology (DPT), in accordance with the QAPP Addendum (AECOM, 2018e). A GeoProbe® 7822DT dual-tube sampling system was used to collect continuous soil cores to the target depth. Three discrete soil samples were collected for chemical analysis from each soil boring. A hand auger was used to collect samples from (0 to 2 ft bgs) to be compliant with utility clearance procedures. One subsurface soil sample approximately 1 foot above the groundwater table, and one subsurface soil sample at the mid-point between the surface and the groundwater table, were collected at each boring using DPT.

The Phase I soil boring locations are shown on **Figure 5-1,** and 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.

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 E**) 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. Drilling activities at AOI 2-6 were terminated due to a three-foot thick clay layer to avoid penetrating the competent clay layer. The boring logs are provided in **Appendix F**

Each 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 under standard chain-of-custody (COC) procedures to the laboratory and analyzed for PFAS by LCMSMS Compliant with QSM 5.1 Table B-15, TOC (USEPA Method 9060A) and pH (USEPA Method 9045D) in accordance with the QAPP Addendum (AECOM, 2018e). For cases in which non-dedicated sampling equipment was used, such as a stainless-steel scoop and mixing bowl used for the 0 to 2 ft bgs soil samples, equipment blank samples were collected and analyzed for the same parameters as the soil samples.

Field duplicate samples were collected at a rate of 10 percent and analyzed for the same parameters as the accompanying samples. MS/MSDs were collected at a rate of 5 percent and analyzed for the same parameters as the accompanying samples. A temperature blank was placed in each cooler to ensure that samples were preserved at or below four degrees Celsius during shipment.

DPT borings were converted to temporary wells, which were subsequently abandoned in accordance with the QAPP Addendum (AECOM, 2018e) using bentonite chips at completion of sampling activities. All 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® 7822DT dual-tube sampling system. Once the borehole was advanced to the desired depth, wherever conditions allowed, a temporary well was constructed of a 5-ft 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.

In some cases, flowing sands prevented placing PVC well materials in the ground to the desired depth. As a result, ten (10) temporary wells were set and sampled using the GeoProbe® stainless steel Screen Point (SP16) groundwater sampling system. The SP16 groundwater sampling system was used at temporary wells, as identified in **Table 5-2**. The screen intervals for all temporary wells are also provided in **Table 5-2**. The SP16 sampler was decontaminated between each location, and an equipment blank sample was collected and analyzed for the same parameters as the groundwater samples.

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, oxidation–reduction potential) were measured and recorded on the field sampling form (**Appendix E**) after each grab sample was collected. Water quality parameters were measured using a water quality meter and flow-through cell. Groundwater samples were collected using a peristaltic pump with PFAS-free HDPE tubing. Each sample was collected into laboratory-supplied PFAS-free HDPE bottles and labeled using a PFAS-free marker or pen. Samples were packaged on ice and transported via Federal Express under standard COC procedures to the laboratory and analyzed for PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 in accordance with the QAPP Addendum (AECOM, 2018e).

Field duplicate samples were collected at a rate of 10 percent and analyzed for the same parameters as the accompanying samples. MS/MSDs were collected at a rate of 5 percent and analyzed for the same parameters as the accompanying samples. Field Reagent Blanks (FRB) were 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 four degrees Celsius during shipment.

Temporary wells were abandoned in accordance with the QAPP Addendum (AECOM, 2018e) by removing the PVC or the SP16 system and backfilling the hole with bentonite chips. All temporary wells were installed in grass areas to avoid disturbing concrete or asphalt.

5.4 Permanent Well Installation and Groundwater Sampling

Eleven (11) permanent monitoring wells in total were installed. Three of the wells installed are considered “background wells”, which are intended to serve as boundary points, upgradient of potential PFAS release areas and placed in strategic locations to assist with the understanding of groundwater flow direction at the Site. These wells include: GAAF-MW-08, GAAF-MW-10, and GAAF-MW-11. The remaining eight (8) locations were installed within or downgradient of potential source areas.

A Boart Longyear MiniSonic LS250 drill rig was used to install eleven (11) 2-inch diameter monitoring wells. The monitoring wells were constructed with Schedule 40 PVC, flush threaded 10-ft 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 results of the Phase I (direct push soil sampling and groundwater grab sampling) targeting zones, where more permeable materials that may serve as preferential flow pathways were observed. A filter pack of 20/40 silica sand was installed in the annulus around the well screen to a minimum of 2-ft above the well screen. A 2-ft 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 QAPP Addendum (AECOM, 2018e). 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**.

The newly installed monitoring wells were developed no sooner than 24 hours following installation by pumping and surging using a variable speed submersible pump. Development of wells was completed in accordance with the QAPP Addendum (AECOM, 2018e).

Samples were collected in accordance with the QAPP Addendum (AECOM, 2018e) and no sooner than 24 hours following development via low-flow sampling methods (using a QED Sample Pro® bladder pump with disposable tubing). Water levels were measured to the nearest 0.01 inch and recorded. The pump tubing used for each well was PFAS-free (e.g. HDPE) and placed at the center of the well screen. Groundwater samplers were decontaminated between boring locations. 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, transported via Federal Express under standard COC procedures to the laboratory, and analyzed for PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 in accordance with the QAPP Addendum (AECOM, 2018e).

Field duplicate samples were collected at a rate of 10 percent and analyzed for the same parameters as the accompanying samples. MS/MSDs were collected at a rate of 5 percent and analyzed for the same parameters as the accompanying samples. FRBs accompanied each cooler containing samples for PFAS analysis and were analyzed for select PFAS. A temperature blank was placed in each cooler to ensure that samples were preserved at or below four degrees Celsius during shipment.

5.5 Synoptic Water Level Measurements

A synoptic groundwater gauging event was performed on 18 October 2018. Groundwater elevation measurements were collected from the 11 new monitoring wells, 5 existing monitoring wells, and 14 existing VAP wells. Water level measurements were taken from the northern side of the well casing. A groundwater flow contour map is provided in **Figure 2-6**. Groundwater elevation data is provided in **Table 5-4**.

5.6 Surveying

The northern side of each well casing was surveyed by Michigan-Licensed land surveyors on 15 November 2018 in the Universal Transverse Mercator Zone 16 projection with World Geodetic System 84 datum. The surveyed well data is provided in **Appendix G**.

5.7 Investigation Derived Waste

As of the date of this report, the disposal of PFAS investigation derived waste (IDW) is not regulated. PFAS IDW generated during Phase I and Phase II of this project is considered a non-hazardous waste and was managed in accordance with the QAPP Addendum (AECOM, 2018e) and QAPP Addendum, **Worksheet #17g** (rev. 1) approved by MDEQ on 8 October 2018 (AECOM, 2018f). The approach for IDW was modified between Phase I and II due to the issuance of *Army Guidance for Addressing Releases of PFAS* dated September 2018.

5.7.1 Phase I

During Phase I, all solid (i.e., soil cuttings) and liquid (i.e., purge water and decontamination fluids) IDW generated during the SI activities was containerized in properly labeled 55-gallon drums. The IDW was stored within the fenced boundary of Camp Grayling, at a location designated by ARNG. ARNG is responsible for waste profiling and arranging transportation and disposal of the IDW.

5.7.2 Phase II

Solid IDW (i.e., soil cuttings) generated during the SI activities were left in place at the point of the source. The soil cuttings were distributed evenly around the borehole. This IDW was not sampled and assumes the PFAS characteristics of the associated soil samples collected from that source location.

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

AECOM collected global positioning system points (i.e., polygon) around each location where IDW was placed. The polygons are displayed on a figure in **Appendix H**.

Other solids such as spent 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.

5.8 Laboratory Analytical Methods

Samples were analyzed for PFAS using PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 at GCAL 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.

5.9 Deviations from QAPP Addendum

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

- The QAPP Addendum listed 10 permanent monitoring wells to be installed during Phase II of the field work at the Site. An additional well was requested by ARNG, MIARNG, and USACE; therefore, an additional well (GAAF-MW-11) was installed at the selected location in the northern portion of the Site.
- During the installation of temporary monitoring wells, heaving or flowing sands were encountered in some areas to the extent that temporary PVC wells could not successfully be installed. In these cases, a GeoProbe® SP16 groundwater sampling system was used to collect the groundwater grab samples. The SP16 system was decontaminated between each sample location. This modification to sample collection methodology was discussed with ARNG, MIARNG, and USACE in the field and documented in daily reports.
- AOI 1-1 and 1-2 were re-located based on information provided by a former Camp Grayling firefighter while field crews were onsite for Phase I field activities. Based on the new information gathered, Camp Grayling firetrucks believed to have been routinely parked as standby on the ramp adjacent to Building 1194 were parked further south than originally identified. The updated location is in front of Building 1195 and within Building 1195.

Table 5-1
Samples by Medium
Site Inspection Report, Camp Grayling Army Airfield

Sample Identification	Sample Collection Date	Sample Depth (feet bgs)	PFAS (USEPA Method 537 Modified)	TOC (USEPA Method 9060A)	pH (USEPA Method 9045D)	Comments
Phase 1 Soil Samples						
AOI1-1-SB-0-2	9/15/2018	0 - 2	x	x	x	
AOI1-1-SB-6-8	9/19/2018	6 - 8	x	x	x	
AOI1-1-SB-10-12	9/19/2018	10 - 12	x	x	x	
AOI1-2-SB-0-2	9/15/2018	0 - 2	x	x	x	
AOI1-2-SB-6-8	9/20/2018	6 - 8	x	x	x	
AOI1-2-SB-15-17	9/20/2018	15 - 17	x	x	x	
AOI1-3-SB-0-2	9/15/2018	0 - 2	x	x	x	
AOI1-3-SB-7-9	9/20/2018	7 - 9	x	x	x	
AOI1-3-SB-15-17	9/20/2018	15 - 17	x	x	x	
AOI1-4-SB-0-2	9/15/2018	0 - 2	x	x	x	
AOI1-4-SB-5-7	9/19/2018	5 - 7	x	x	x	
AOI1-4-SB-15-17	9/19/2018	15 - 17	x	x	x	
AOI1-5-SB-0-2	9/15/2018	0 - 2	x	x	x	
AOI1-5-SB-6-8	9/20/2018	6 - 8	x	x	x	
AOI1-5-SB-11-13	9/20/2018	11 - 13	x	x	x	
AOI1-6-SB-0-2	9/15/2018	0 - 2	x	x	x	
AOI1-6-SB-5-7	9/18/2018	5 - 7	x	x	x	
AOI1-6-SB-10-12	9/18/2018	10 - 12	x	x	x	
AOI2-1-SB-0-2	9/14/2018	0 - 2	x	x	x	
AOI2-1-SB-5.5-5.7	9/14/2018	5.5 - 5.7	x	x	x	
AOI2-1-SB-10.4-12.4	9/14/2018	10.4 - 12.4	x	x	x	
AOI2-1-SB-10.4-12.4 DUP	9/14/2018	10.4 - 12.4	x			Field Duplicate
AOI2-2-SB-0-2	9/14/2018	0 - 2	x	x	x	
AOI2-2-SB-5-7	9/18/2018	5 - 7	x	x	x	
AOI2-2-SB-10-12	9/18/2018	10 - 12	x	x	x	
AOI2-3-SB-0-2	9/14/2018	0 - 2	x	x	x	
AOI2-3-SB-0-2 DUP	9/14/2018	0 - 2	x			Field Duplicate
AOI2-3-SB-5-6.6	9/14/2018	5 - 6.6	x	x	x	
AOI2-3-SB-6.6-8.3	9/14/2018	6.6 - 8.3	x	x	x	
AOI2-4-SB-0-2	9/15/2018	0 - 2	x	x	x	MS/MSD
AOI2-4-SB-0-2 DUP	9/15/2018	0 - 2	x			Field Duplicate
AOI2-4-SB-7-9	9/17/2018	7 - 9	x	x	x	
AOI2-4-SB-10-12	9/17/2018	10 - 12	x	x	x	
AOI2-5-SB-0-2	9/14/2018	0 - 2	x	x	x	
AOI2-5-SB-5-8	9/18/2018	5 - 8	x	x	x	
AOI2-5-SB-5-8 DUP	9/18/2018	5 - 8	x			Field Duplicate
AOI2-5-SB-11-13	9/18/2018	11 - 13	x	x	x	
AOI2-6-SB-0-2	9/15/2018	0 - 2	x	x	x	
AOI2-6-SB-5-6.5	9/18/2018	5 - 6.5	x	x	x	
AOI2-6-SB-10-12	9/18/2018	10 - 12	x	x	x	
AOI3-1-SB-0-2	9/12/2018	0 - 2	x	x	x	
AOI3-1-SB-6.1-8.1	9/13/2018	6.1 - 8.1	x	x	x	
AOI3-1-SB-15-16.8	9/13/2018	15 - 16.8	x	x	x	
AOI4-1-SB-0-2	9/12/2018	0 - 2	x	x	x	MS/MSD
AOI4-1-SB-5-6.5	9/12/2018	5 - 6.5	x	x	x	
AOI4-1-SB-6.5-8	9/12/2018	6.5 - 8	x	x	x	
AOI4-2-SB-0-2	9/12/2018	0 - 2	x	x	x	

Table 5-1
Samples by Medium
Site Inspection Report, Camp Grayling Army Airfield

Sample Identification	Sample Collection Date	Sample Depth (feet bgs)	PFAS (USEPA Method 537 Modified)	TOC (USEPA Method 9060A)	pH (USEPA Method 9045D)	Comments
AOI4-2-SB-5-6.5	9/13/2018	5 - 6.5	x	x	x	MS/MSD
Phase 1 Soil Samples (continued)						
AOI4-2-SB-5-6.5 DUP	9/13/2018	5 - 6.5	x			Field Duplicate
AOI4-2-SB-6.5-8.1	9/13/2018	6.5 - 8.1	x	x	x	
AOI4-3-SB-0-2	9/12/2018	0 - 2	x	x	x	
AOI4-3-SB-5-6.4	9/12/2018	5 - 6.4	x	x	x	
AOI4-3-SB-6.4-7.9	9/12/2018	6.4 - 7.9	x	x	x	
AOI4-4-SB-0-2	9/13/2018	0 - 2	x	x	x	MS/MSD
AOI4-4-SB-5-7	9/13/2018	5 - 7	x	x	x	
AOI4-4-SB-10-11.8	9/13/2018	10 - 11.8	x	x	x	
AOI4-5-SB-0-2	9/13/2018	0 - 2	x	x	x	
AOI4-5-SB-5-7	9/13/2018	5 - 7	x	x	x	
AOI4-5-SB-10-11	9/13/2018	10 - 11	x	x	x	
AOI4-6-SB-0-2	9/12/2018	0 - 2	x	x	x	
AOI4-6-SB-5-7	9/13/2018	5 - 7	x	x	x	
AOI4-6-SB-5-7 DUP	9/13/2018	5 - 7	x			Field Duplicate
AOI4-6-SB-10-11.4	9/13/2018	10 - 11.4	x	x	x	
AOI5-1-SB-0-2	9/11/2018	0 - 2	x	x	x	
AOI5-1-SB-6.3-8.3	9/11/2018	6.3 - 8.3	x	x	x	
AOI5-1-SB-15.2-17.2	9/11/2018	15.2 - 17.2	x	x	x	
AOI5-2-SB-0-2	9/11/2018	0 - 2	x	x	x	
AOI5-2-SB-0-2 DUP	9/11/2018	0 - 2	x			Field Duplicate
AOI5-2-SB-5-6.7	9/11/2018	5 - 6.7	x	x	x	
AOI5-2-SB-10-12	9/11/2018	10 - 12	x	x	x	
AOI5-3-SB-0-2	9/11/2018	0 - 2	x	x	x	
AOI5-3-SB-5-6.8	9/11/2018	5 - 6.8	x	x	x	
AOI5-3-SB-10.8-12.8	9/11/2018	10.8 - 12.8	x	x	x	
Phase 1 Groundwater Samples						
AOI1-1-GW-55	9/20/2018	55	x			
AOI1-2-GW-29	9/21/2018	29	x			
AOI1-3-GW-59	9/20/2018	59	x			
AOI1-4-GW-58	9/19/2018	58	x			
AOI1-5-GW-29	9/21/2018	29	x			
AOI1-6-GW-59	9/19/2018	59	x			
AOI1-6-GW-59 DUP	9/19/2018	59	x			Field Duplicate
AOI2-1-GW-54	9/15/2018	54	x			
AOI2-2-GW-29	9/19/2018	29	x			
AOI2-3-GW-58	9/17/2018	58	x			
AOI2-4-GW-50	9/18/2018	50	x			
AOI2-5-GW-28	9/19/2018	28	x			
AOI2-6-GW-45	9/18/2018	45	x			
AOI3-1-GW-28	9/14/2018	28	x			
AOI3-MW128D-35	9/14/2018	35	x			
AOI3-MW128S-25	9/14/2018	25	x			MS/MSD
AOI3-MW13D-24	9/15/2018	24	x			
AOI3-MW13S-15	9/15/2018	15	x			
AOI3-MW31-19	9/14/2018	19	x			
AOI3-MW31-19 DUP	9/14/2018	19	x			Field Duplicate

Table 5-1
Samples by Medium
Site Inspection Report, Camp Grayling Army Airfield

Sample Identification	Sample Collection Date	Sample Depth (feet bgs)	PFAS (USEPA Method 537 Modified)	TOC (USEPA Method 9060A)	pH (USEPA Method 9045D)	Comments
AOI4-1-GW-29	9/12/2018	29	x			
AOI4-2-GW-29	9/13/2018	29	x			
Phase 1 Groundwater Samples (continued)						
AOI4-3-GW-29	9/13/2018	29	x			
AOI4-4-GW-29	9/13/2018	29	x			
AOI4-5-GW-29	9/13/2018	29	x			
AOI4-6-GW-29	9/13/2018	29	x			
AOI5-1-GW-29	9/12/2018	29	x			
AOI5-2-GW-29	9/12/2018	29	x			
AOI5-3-GW-28	9/12/2018	28	x			
AOI5-VAP-32-21	9/11/2018	21	x			
AOI5-VAP-32-21 DUP	9/11/2018	21	x			Field Duplicate
AOI5-VAP-33-22	9/11/2018	22	x			
AOI5-VAP34-22	9/11/2018	22	x			MS/MSD
AOI5-VAP34-22 DUP	9/11/2018	22	x			Field Duplicate
AOI5-VAP-35-22	9/11/2018	22	x			
Phase 2 Groundwater Samples						
GAAF MW-01-101918	10/19/2018	27.5	x			
GAAF MW-02-102218	10/22/2018	27.5	x			
GAAF MW-03-102218	10/22/2018	27.5	x			
GAAF MW-04-102218	10/22/2018	22.5	x			
GAAF MW-05-102018	10/20/2018	22.5	x			
GAAF MW-06-101918	10/19/2018	27.5	x			MS/MSD
GAAF MW-07-101918	10/19/2018	27.5	x			
GAAF MW-07-101918 DUP	10/19/2018	27.5	x			Field Duplicate
GAAF MW-08-101918	10/19/2018	22.5	x			
GAAF MW-09-101918	10/19/2018	27.5	x			
GAAF MW-10-101918	10/19/2018	27.5	x			
GAAF-MW-10-101918-DUP	10/19/2018	27.5	x			Field Duplicate
GAAF MW-11-102018	10/20/2018	22.5	x			

Notes:
ft = feet
MS/MSD = matrix spike/ matrix spike duplicate
PFAS = per- and polyfluoroalkyl substances
TOC =total organic carbon
USEPA = United States Environmental Protection Agency

Table 5-2
Soil Boring Depths and Temporary Well Screen Intervals (Phase I)
Site Inspection Report, Camp Grayling Army Airfield

Area of Interest	Boring Location	Soil Boring Depth (feet bgs)	Temporary Well Screen Interval (feet bgs)
1	1-1	60	52.7 – 56.1*
	1-2	30	25.0 – 30.0
	1-3	60	56.7 – 60.1*
	1-4	60.2	56.8 – 60.2*
	1-5	30	24.9 – 29.9
	1-6	60.5	57.1 – 60.5*
2	2-1	60	50.3 – 55.3
	2-2	30	25.0 - 30.0
	2-3	60	55.8 – 59.2*
	2-4	60	48.7 – 52.1*
	2-5	30	24.6 – 29.6
	2-6	50	43.2 – 46.6*
3	3-1	30	24.0 – 29.0
4	4-1	30	29.0 - 32.4*
	4-2	30	24.9 – 29.9
	4-3	31.8	26.8 – 31.8
	4-4	30	25.0 – 30.0
	4-5	30	24.9 – 29.9
	4-6	30	25.0 - 30.0
5	5-1	30	27.0 – 30.4*
	5-2	30	26.3 – 29.7*
	5-3	30	23.4 – 26.8*

Notes:
bgs = below ground surface
* = sample collected using SP16 sampling tool

Table 5-3
Monitoring Well Screen Intervals (Phase II)
Site Inspection Report, Camp Grayling Army Airfield

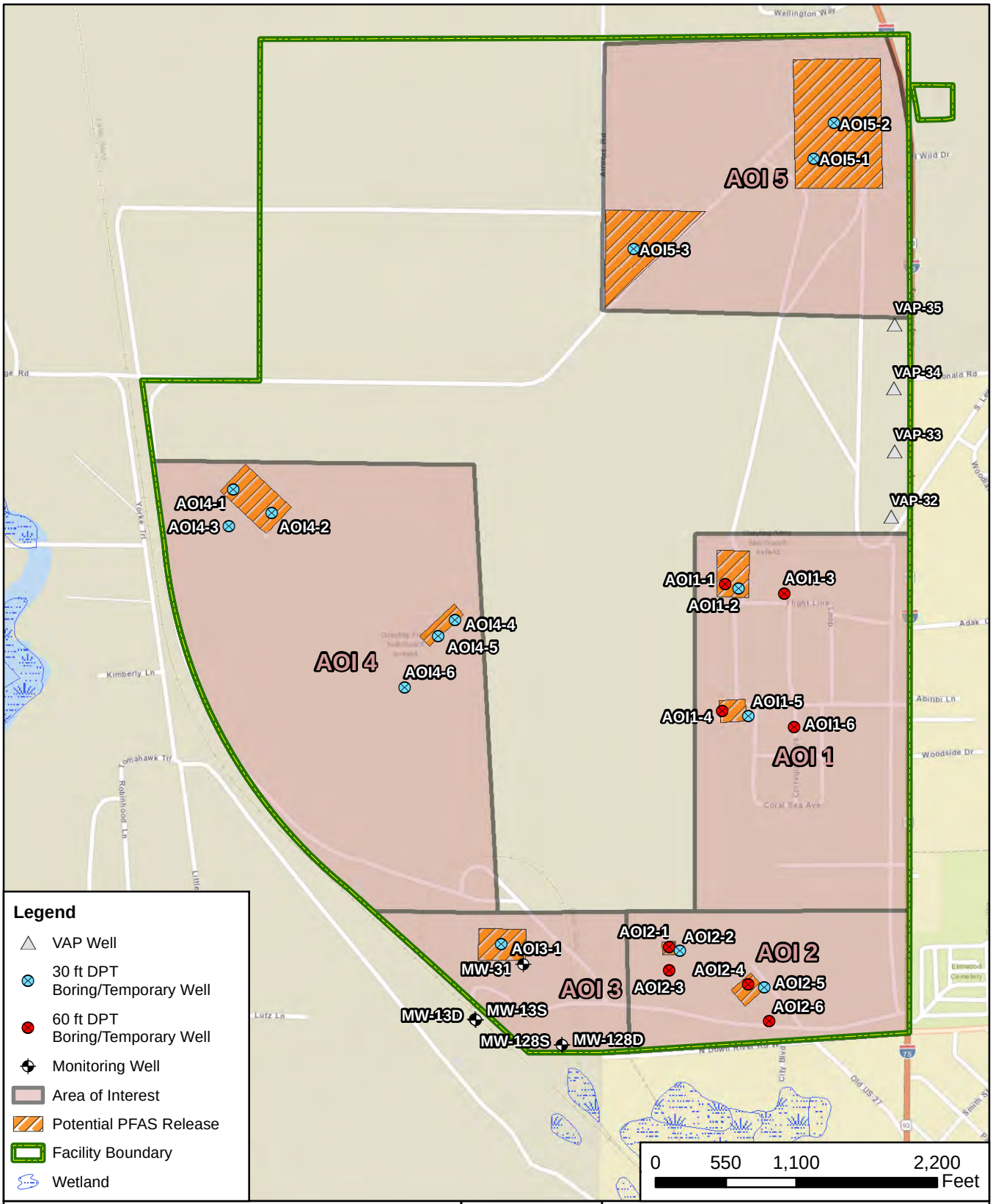
Monitoring Well ID	Screen Interval (feet bgs)
GAAF-MW-01	25 – 29.6
GAAF-MW-02	25 – 29.6
GAAF-MW-03	25 – 29.6
GAAF-MW-04	20 – 24.6
GAAF-MW-05	20 – 24.6
GAAF-MW-06	25 – 29.6
GAAF-MW-07	25 – 29.6
GAAF-MW-08	20 – 24.6
GAAF-MW-09	25 – 29.6
GAAF-MW-10	25 – 29.6
GAAF-MW-11	20 – 24.6

Notes:
bgs = below ground surface

Table 5-4
Groundwater Elevation
Site Inspection Report, Camp Grayling Army Airfield

Monitoring Well ID	Top of Casing Elevation (ft amsl)	Depth to Water (ft btoc)	Groundwater Elevation (ft amsl)
GAAF-MW-01	1150.77	11.84	1138.93
GAAF-MW-02	1150.59	12.82	1137.77
GAAF-MW-03	1150.37	13.95	1136.42
GAAF-MW-04	1142.83	10.48	1132.35
GAAF-MW-05	1147.31	13.70	1133.61
GAAF-MW-06	1147.49	9.81	1137.68
GAAF-MW-07	1149.48	10.69	1138.79
GAAF-MW-08	1154.95	10.93	1144.02
GAAF-MW-09	1157.19	12.86	1144.33
GAAF-MW-10	1151.83	11.72	1140.11
GAAF-MW-11	1156.88	9.66	1147.22
MW-31	1149.39	15.06	1134.33
MW-128S	1145.97	13.08	1132.89
CG-MW019 (15)	1156.86	9.95	1146.91
CG-MW019 (32)	1156.84	9.93	1146.91
CG-MW019 (55)	1156.84	9.94	1146.90
CG-MW019 (80)	1156.78	9.86	1146.92
CG-MW019 (100)	1156.74	9.82	1146.92
VAP-01	1150.91	10.31	1140.60
VAP-05	1149.72	11.10	1138.62
VAP-09	1150.88	14.01	1136.87
VAP-13	1149.76	14.47	1135.29
VAP-19	1138.45	9.29	1129.16
VAP-23	1142.62	11.86	1130.76
VAP-25	1145.64	14.10	1131.54
VAP-27	1146.27	12.86	1133.41
VAP-30	1148.38	11.98	1136.40
VAP-34	1152.82	12.70	1140.12
VAP-35	1155.03	13.94	1141.09
VAP-36	1156.42	14.30	1142.12
VAP-37	1156.33	13.06	1143.27
VAP-38	1157.25	12.81	1144.44

Notes:
amsl = above mean sea level
btoc = below top of casing
ft = feet



CLIENT	ARNG			
NOTES	Site Inspection Report, Camp Grayling Army Airfield Michigan			
REVISED	8/16/2019	GIS BY	MS	8/16/2019
SCALE	1:13,200	CHK BY	CM	8/16/2019
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	RG	8/16/2019

Phase I Sample Locations

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 5-1

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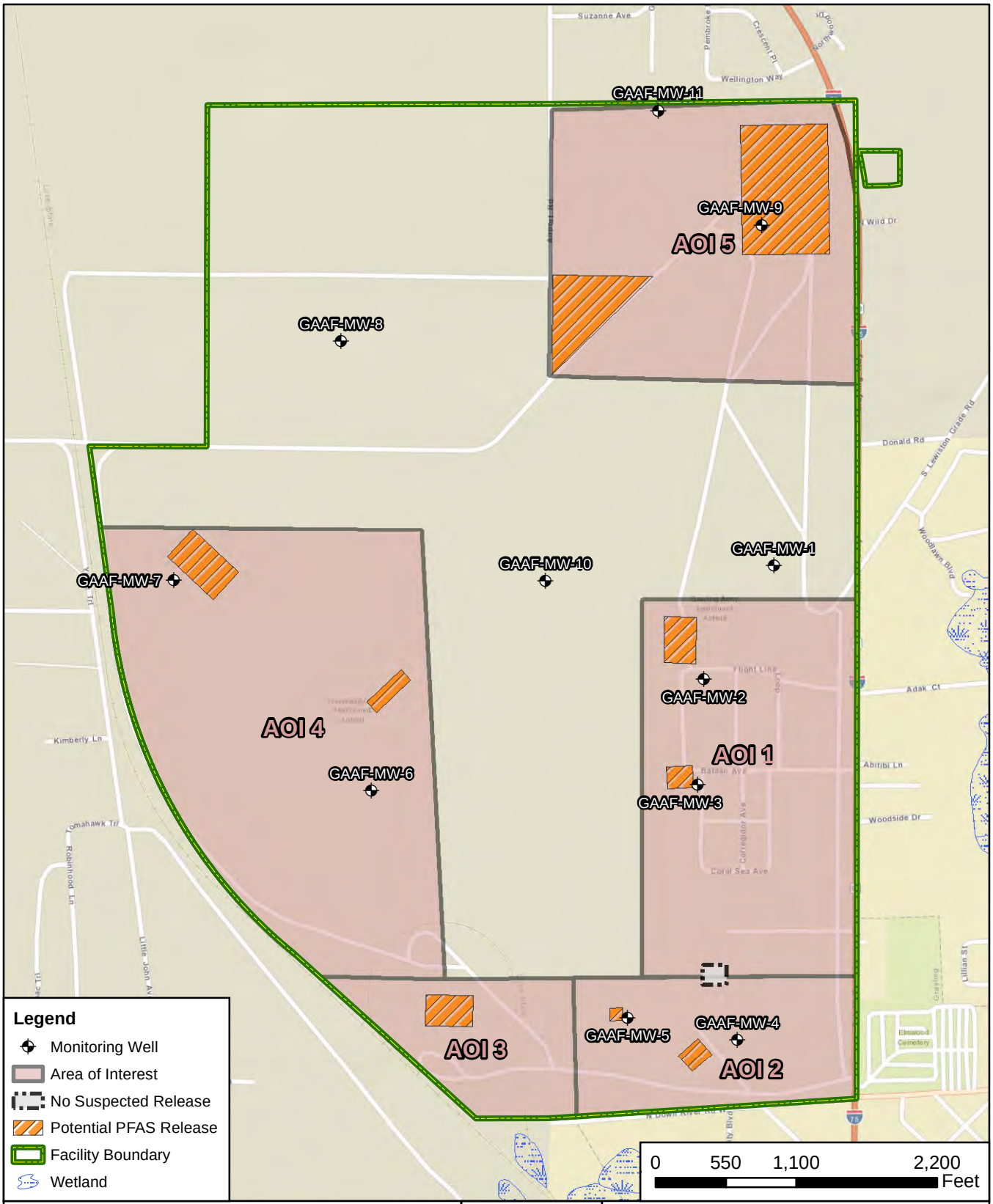

CLIENT	ARNG			
NOTES	Site Inspection Report, Camp Grayling Army Airfield Michigan			
REVISED	8/16/2019	GIS BY	MS	8/16/2019
SCALE	1:13,200	CHK BY	CM	8/16/2019
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	RG	8/16/2019

Phase II Sample Locations

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 analytical results are reported and evaluated in the subsequent sections.

As a means of understanding whether PFAS are present at the Site, the full suite of 18 compounds listed in **Section 5.8** is evaluated for presence or absence; however, only PFOS and PFOA currently have established USEPA HALs and are regulated by MDEQ. Therefore, the results for PFOS and PFOA were evaluated to make recommendations for future actions at the Site.

The Project Action Levels (PALs) used in this evaluation are presented in **Section 6.1**. A discussion of the results for each AOI is provided in **Sections 6.3** through **6.8**. **Tables 6-2** through **6-12** present PFAS results for samples with detections in soil and groundwater for each AOI. Tables that contain all results are provided in **Appendix I**, and the laboratory reports are provided in **Appendix J**. Additionally, this SI references facility boundary data collected in 2017 by Amec Foster Wheeler; the report in which the boundary data is presented is included in **Appendix K**.

6.1 Project Action Levels

PFOA and PFOS in groundwater were compared against the PALs as described in **Table 6-1**. The PALs are the only values recognized by the DoD as properly promulgated and actionable. No properly promulgated values are available for the other compounds analyzed or for other media; however, the data are presented in this report for informational purposes only. The PALs for PFOS and PFOA in groundwater, are considered actionable under CERCLA.

The USEPA HAL for drinking water was updated in May 2016 for PFOS and PFOA. The HAL for PFOS and PFOA are 70 ng/L for each constituent; however, when PFOS and PFOA are both present, a conservative and health-protective approach is recommended that compares the sum of the concentrations (PFOS+PFOA) to the HAL value (70 ng/L) (USEPA, 2016). The groundwater PALs are provided in **Table 6-1** below.

Table 6-1: Groundwater Project Action Levels

Analyte	USEPA HAL (ng/L)[a]	MDEQ (ng/L)[b]
PFOA	70	70
PFOS	70	70
PFOA+PFOS	70	70

Notes:

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

b.) Michigan Department of Environmental Quality (MDEQ). 2018b. Remediation and Redevelopment Division. Environmental Contamination Response Activity Rules. Table 1. Groundwater: Residential and Nonresidential, Part 201 Generic Cleanup Criteria and Screening Levels. Effective January 10, 2018.

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 I** 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 for AOI 1, which includes two potential PFAS release areas: Building 1194 Ramp area/ Building 1195 and Building 1160 area. The detected compounds are presented in **Table 6-2**, **Table 6-3**, and **Table 6-12**. **Figures 6-1** through **6-4** present detections for PFOS and PFOA in soil and groundwater.

6.3.1 AOI 1 Soil Analytical Results

PFAS in soil were detected in both PFAS release areas in AOI 1. **Figures 6-1** and **6-2** present detections in soil for PFOS and PFOA.

During SI field activities, additional information related to the location of the potential PFAS release area Building 1194 Ramp was learned. The firetruck that was reportedly staged in front of Building 1194 was learned to have been parked further south, outside and/or inside Building 1195. As such, the sample locations were moved further south in front of and behind Building 1195. A drain was observed in Building 1195 in the area where the firetruck would have been parked in the 1970s and 1980s. Details regarding the configuration of the drain are unknown.

PFAS were detected in six of nine soil samples collected at the Building 1194 Ramp area/ Building 1195, with PFOS being the most frequently detected compound and the compound detected with the greatest concentration. The highest soil sample observed in this potential PFAS release area was AOI 1-2, between 6 to 8 ft bgs with a PFOS concentration of 12.5 micrograms per kilogram (µg/Kg). Generally, the greatest concentrations at each location were observed in samples collected within the intermediate intervals (5 to 9 ft bgs) and the second highest concentration in the shallow interval (0 to 2 ft bgs). Soil was sampled at three intervals from AOI 1-1, AOI 1-2 and AOI 1-3. The detected compounds from the soil sampling around the Building 1194 Ramp area/ Building 1195 are summarized in **Table 6-2**.

PFAS were detected in eight of nine soil samples collected at the Building 1160 area, with PFOS being the most frequently detected compound. PFOS was detected at a concentration of 73.4 µg/Kg in AOI 1-4 between 5 to 7 ft bgs, which was the highest detection observed in this area. This sample location corresponds to the area in front of Building 1160, where firetrucks containing AFFF “wet-water” were reportedly parked during training activities in the 1970s and 1980s. Soil was sampled at three intervals from AOI 1-4, AOI 1-5, and AOI 1-6 around Building 1160. The detected compounds are presented in **Table 6-2**.

6.3.2 AOI 1 Groundwater Analytical Results

PFOS and PFOA in groundwater exceeded the PALs at one source area, Building 1160 area, and at the facility boundary downgradient of AOI 1. PFAS were detected in the second source area, Building 1194 Ramp/Building 1195. **Figures 6-3** and **6-4** present the ranges of detections for PFOS and PFOA.

Within the Building 1160 potential PFAS release area, the highest concentration in groundwater was PFOS, at 344 ng/L, which was observed at AOI 1-5 between 24 to 29 ft bgs. AOI 1-5 was located due east of Building 1160, and the concentration is consistent with the soil detections observed within this area. The highest detection at the boundary observed during the 2017 investigation, downgradient of Building 1160 was PFOS, with a concentration of 430 ng/L in VAP-25 at a depth of 45 ft bgs (Amec Foster Wheeler, 2017a). During Phase I, groundwater was sampled from AOI 1-4, AOI 1-5, and AOI 1-6 around Building 1160. PFAS were detected in all three groundwater samples (including one duplicate sample) collected at the Building 1160 area. The detected compounds from the Phase I investigation are summarized in **Table 6-3**.

PFHxS was detected in one groundwater sample collected at Building 1194 Ramp area, near Building 1195, which does not have an associated PAL. The highest detection of PFAS at the boundary downgradient of Building 1194 Ramp area/ Building 1195 observed during the 2017 investigation was PFOS, with a concentration of 2,500 ng/L in VAP-27 at 45 ft bgs (Amec Foster Wheeler, 2017a). This concentration represents an exceedance of the PALs at the facility boundary. During Phase I, groundwater was sampled from AOI 1-1, AOI 1-2, and AOI 1-3 around Building 1194 Ramp area/Building 1195. The detected compounds from the Phase I investigation are summarized in **Table 6-3**.

Prior data from VAP locations at the southeastern boundary showed increasing PFAS concentration with depth in groundwater (Amec Foster Wheeler, 2017a). Consequently, certain AOI 1 groundwater samples for this SI were collected from deeper intervals (approximately 60 ft bgs) to confirm the presence or absence of PFAS deeper in the aquifer. PFAS were detected, however, the concentrations of PFOS and PFOA did not exceed the PALs in the deep groundwater samples in AOI 1.

During Phase II, groundwater was sampled from GAAF-MW-01, GAAF-MW-02, and GAAF-MW-03 in AOI 1. PFOS and PFOA were detected separately or combined in excess of the PALs at monitoring wells GAAF-MW-02 and GAAF-MW-03. The maximum detection was 166 ng/L for PFOS in GAAF-MW-03, which was screened from 25 to 29.6 ft bgs. The detected compounds from the Phase II investigation are summarized in **Table 6-12**.

6.3.3 AOI 1 Conclusions

Based on the SI findings and historical data (Amec Foster Wheeler, 2017a) collected at the Site, the presence of PFAS has been confirmed at the source and the facility boundary in AOI 1. Exceedances of the PALs were observed in groundwater for PFOS and PFOA at the facility boundary, downgradient of AOI 1, and at the source area near Building 1160.

6.4 AOI 2

This section presents the analytical results for soil and groundwater associated with AOI 2, which includes two potential PFAS release areas: Southeastern End of Runway 14/32 and Between Former MATES & Runway 14/32. The detected compounds are presented in **Table 6-4**, **Table 6-5**, and **Table 6-12**. **Figures 6-1** and **6-4** present detections for PFOS and PFOA in soil and groundwater.

6.4.1 AOI 2 Soil Analytical Results

PFAS in soil were detected in both potential source areas in AOI 2. **Figures 6-1** and **6-2** present detections in soil for PFOS and PFOA.

At the Between Former MATES & Runway 14/32 area, PFOS was the only compound detected and was observed in five of eleven soil samples (including one duplicate sample). The highest PFOS concentration in soil was 0.145 J+ µg/Kg in AOI 2-1, between 0 to 2 ft bgs. Detections were

mostly observed within the shallow (0 to 2 ft bgs) interval. This observation is consistent with the current understanding of PFAS behavior, which suggests that, in soil where surface releases occurred, PFAS remain in shallow surface soil (Casson and Chang, 2018). Soil was sampled at three intervals from AOI 2-1, AOI 2-2, and AOI 2-3 around the Between Former MATES & Runway 14/32 area. The detected compounds are summarized in **Table 6-4**.

At the Southeastern End of Runway 14/32 area, PFOS was the only compound detected and was observed in four of eleven soil samples (including one duplicate sample). The highest PFOS concentration in soil was 0.148 J+ µg/Kg in AOI 2-6 between 0 to 2 ft bgs. Detections were mostly observed within the shallow (0 to 2 ft bgs) interval, corresponding with the locations where surface releases potentially occurred from fire training activities and active AFFF use. Soil was sampled at three intervals from AOI 2-4, AOI 2-5, and AOI 2-6 around the Southeastern End of Runway 14/32 area. The detected compounds are summarized in **Table 6-4**.

6.4.2 AOI 2 Groundwater Analytical Results

PFAS in groundwater exceeded the PALs at one source area in AOI 2, Between Former MATES & Runway 14/32 area, and at the facility boundary downgradient of AOI 2. **Figures 6-3** and **6-4** present the concentration ranges of detections in groundwater for PFOS and PFOA.

PFAS were detected in two of three groundwater samples and exceeded the PALs for PFOS and PFOS/ PFOA combined at the Between Former MATES & Runway 14/32 area. The highest concentration in groundwater was PFOS, at 102 ng/L, which was observed at AOI 2-2 at a depth of 29 ft bgs. An exceedance of the PALs at the boundary was observed downgradient of AOI 2 during the 2017 investigation. The highest detection at the downgradient boundary location was PFOS, with a concentration of 740 ng/L at VAP-19 at 45 ft bgs (Amec Foster Wheeler, 2017a). During Phase I, groundwater was sampled from AOI 2-1, AOI 2-2, and AOI 2-3 around the Between Former MATES & Runway 14/32 area. The detected compounds from the Phase I investigation are summarized in **Table 6-5**.

PFAS were detected in all three groundwater samples collected around the Southeastern End of Runway 14/32 area; however, none of the samples exceeded the PALs. The highest detection was PFPeA, with a concentration of 16.0 ng/L at AOI 2-4 at a depth of 50 ft bgs. An exceedance at the boundary was observed downgradient of this potential source area during the 2017 sampling event. The highest detection was PFOS, with a concentration of 87 ng/L at VAP-24 at 45 ft bgs (Amec Foster Wheeler, 2017a). During Phase I, groundwater was sampled from AOI 2-4, AOI 2-5, and AOI 2-6 at the Southeastern End of Runway 14/32 area. The detected compounds from the Phase I investigation are summarized in **Table 6-5**.

During Phase II, groundwater was sampled from GAAF-MW-04 and GAAF-MW-05 in AOI 2. PFAS were detected in both groundwater samples but did not exceed the PALs. The maximum detection was 37.9 ng/L for PFOS in GAAF-MW-04, which was sampled at a depth of 22.5 ft bgs. The detected compounds from the Phase II investigation are summarized in **Table 6-12**.

6.4.3 AOI 2 Conclusions

Based on the SI findings and historical data (Amec Foster Wheeler, 2017a) collected at the Site, the presence of PFAS has been confirmed at the source and the facility boundary in AOI 2. Exceedances of the PALs were observed in groundwater for PFOS and PFOS/ PFOA combined at the Between Former MATES & Runway 14/32 area and at the facility boundary, downgradient of AOI 2.

6.5 AOI 3

This section presents the analytical results for soil and groundwater associated with AOI 3, which includes one potential PFAS release area: Former MATES Location. The detected compounds are presented in **Table 6-6** and **Table 6-7**. **Figures 6-1** through **6-3** present detections for PFOS and PFOA in soil and groundwater.

6.5.1 AOI 3 Soil Analytical Results

PFAS were detected in soil in two of three soil samples collected at the Former MATES Location, with PFOS being the most frequently detected, and the compound detected with the greatest concentration. The highest concentration in a soil sample observed in the potential PFAS release area was AOI 3-1, between 0 to 2 ft bgs, with a PFOS concentration of 0.735 J µg/Kg. The detection in the shallow interval is consistent with the current understanding of PFAS behavior in soil where surface releases occurred (Casson and Chang, 2018). PFOS was also detected in the deep interval soil sample, above the groundwater table. **Figures 6-1** and **6-2** present detections for compounds with PALs. Soil was sampled at three intervals from AOI 3-1, around the Former MATES Location. The detected compounds are summarized in **Table 6-6**.

6.5.2 AOI 3 Groundwater Analytical Results

PFAS in groundwater were detected with an exceedance of the PALs in several existing monitoring wells in the source area at AOI 3, and at the facility boundary downgradient of AOI 3. **Figure 6-3** presents detections for PFOS and PFOA.

During Phase I, groundwater was sampled from temporary well AOI 3-1 and existing wells MW-13S/D, MW31, and MW-128S/D around the Former MATES Location. PFAS in groundwater were detected in all seven groundwater samples (including one duplicate sample). The concentrations of PFOS and/or PFOS and PFOA combined exceeded the PALs in three samples. The PFAS detected with the highest concentration was PFOS at MW-128S, with a concentration of 257 µg/L at a depth of 25 ft bgs. The maximum detection at a downgradient boundary sample location, VAP-16, had a concentration of 160 ng/L for PFOS at 25 ft bgs (Amec Foster Wheeler, 2017a). The detected compounds from the Phase I investigation are summarized in **Table 6-7**.

An existing monitoring well network was established for an ongoing remediation effort for a chlorinated solvents plume at the Former MATES location. The PFAS data collected in this area during Phase I is consistent with historical data collected by MIARNG (Amec Foster Wheeler, 2017a).

6.5.3 AOI 3 Conclusions

Based on the SI findings and historical data (Amec Foster Wheeler, 2017a) collected at the Site, the presence of PFAS has been confirmed at the source and the facility boundary in AOI 3. Exceedances were observed in groundwater for PFOS and PFOS/ PFOA combined for the Former MATES Location source area and at the facility boundary downgradient of AOI 3.

6.6 AOI 4

This section presents the analytical results for soil and groundwater associated with AOI 4, which includes two potential PFAS release areas: Northwestern End of Runway 14/32 and Taxiway D. The detected compounds are presented in **Table 6-8**, **Table 6-9**, and **Table 6-12**. **Figures 6-1** through **6-4** present detections for PFOS and PFOA in soil and groundwater.

6.6.1 AOI 4 Soil Analytical Results

PFAS in soil were detected in both PFAS release areas in AOI 4. **Figures 6-1** and **6-2** present detections for PFOS and PFOA.

PFAS were detected in seven of ten soil samples (including one duplicate sample) collected at the Northwestern End of Runway 14/32 at low levels that are generally not consistent with a release area. Although the concentrations were low, PFOS was the most frequently detected compound. PFHxA had the maximum detection of 0.131 µg/Kg at AOI 4-3 between 0 to 2 ft bgs. Where detected, PFAS compounds were generally within the shallow and intermediate interval samples. Soil was sampled at three intervals from AOI 4-1, AOI 4-2, and AOI 4-3 around the Northwestern End of Runway 14/32. The detected compounds are summarized in **Table 6-8**.

PFAS were detected in seven of ten soil samples (including one duplicate sample) collected at Taxiway D. The maximum detection was observed at AOI 4-6 between 10-11.4 ft bgs (PFOS, 3.64 ug/Kg). This depth represents the capillary fringe above the groundwater table. In AOI 4-4, PFOS also displayed a higher detection in the deeper interval, above the groundwater table, than in the intermediate or shallow intervals. Otherwise, concentrations were variable at low level detections across the intervals at each location. Soil was sampled from AOI 4-4, AOI 4-5, and AOI 4-6 in the Taxiway D area. The detected compounds are summarized in **Table 6-8**.

6.6.2 AOI 4 Groundwater Analytical Results

PFAS in groundwater were detected in AOI 4 at the potential PFAS release area associated with Taxiway D and at the facility boundary downgradient of AOI 4. The PFOS/ PFOA concentration in groundwater at the facility boundary downgradient of AOI 4 were in excess of the PALs. PFAS were not detected in any of the groundwater samples collected around the Northwestern End of Runway 14/32 area; however, they were detected in a side gradient boundary location. **Figures 6-3** and **6-4** present detections for PFOS and PFOA.

At the Northwestern End of Runway 14/32 potential PFAS release area, no PFAS were detected in groundwater. An exceedance of the PAL in groundwater (97 ng/L, PFOA) was observed at VAP-01 in a previous investigation that is side gradient relative to the potential PFAS release areas (Amec Foster Wheeler, 2017a). Additionally, the PFAS concentration ratios at VAP-01 is not consistent with the ratios in groundwater that are generally observed in known PFAS release areas at GAAF. Based on site data, PFOS typically is the dominant PFAS compound detected in groundwater; however, PFOA is the dominant compound at VAP-01. This observation suggests the exceedance observed in VAP-01 did not originate from the Northwestern End of Runway 14/32; however, no adjacent sources were identified in the PA upgradient of this location.

Within the Taxiway D potential PFAS release area, PFAS were detected in two of three samples collected; however, no exceedances of the PALs were observed. The maximum detection was 9.5 J ng/L for PFOS in AOI 4-5, which was sampled a depth of 29 ft bgs. Two downgradient VAP wells, VAP-12 and VAP-40, exceeded the PALs for PFOS at 250 and 93 ng/L, respectively, at a depth of 25 ft bgs. VAP-40 is located at the approximate midpoint between Taxiway D and the facility boundary. Prior data from VAP locations at the western boundary showed decreasing PFAS concentration with increasing depth in groundwater (Amec Foster Wheeler, 2017a). Groundwater was sampled from AOI 4-4, AOI 4-5, and AOI 4-6 in the Taxiway D area. The detected compounds from the Phase I investigation are summarized in **Table 6-9**.

During Phase II, groundwater was sampled from GAAF-MW-06 and GAAF-MW-07, both at a depth of 27.5 ft bgs within AOI 4. The only detected compound was PFHxS at a concentration of 3.13 J ng/L in GAAF-MW-06. This detection from the Phase II investigation is summarized in **Table 6-12**.

6.6.3 AOI 4 Conclusions

Based on the SI findings and historical data (Amec Foster Wheeler, 2017a) collected at the Site, the presence of PFAS has been confirmed at the source and the facility boundary in the Taxiway D source area, only. Although exceedances were not observed during SI activities, historical exceedances in groundwater were observed hydraulically downgradient of Taxiway D (Amec Foster Wheeler, 2017a). No PFAS were detected in groundwater at the Northwestern End of Runway 14/32 potential PFAS release area; however, a side gradient exceedance was observed at the facility boundary at VAP-01 during the 2017 investigation.

6.7 AOI 5

This section presents the analytical results for soil and groundwater associated with AOI 5, which includes two potential PFAS release areas: City of Grayling Fire Department FTA and Bivouac Area. The detected compounds are presented in **Table 6-10**, **Table 6-11**, and **Table 6-12**. **Figures 6-1** through **6-4** present detections for PFOS and PFOA in soil and groundwater.

6.7.1 AOI 5 Soil Analytical Results

PFAS in soil were detected in both PFAS release areas in AOI 5. **Figures 6-1** and **6-2** present detections for PFOS and PFOA.

PFAS were detected in all seven samples (including one duplicate sample) collected at the City of Grayling Fire Department FTA potential PFAS release area. PFOS was the mostly frequently detected compound and the compound detected with the highest concentration. The highest concentration in soil was PFOS at 0.465 J µg/Kg at AOI 5-1 from 0 to 2 ft bgs. PFAS were detected at low levels in soil samples collected within all three intervals at both sample locations. Soil was sampled at three intervals from AOI 5-1 and AOI 5-2 around the City of Grayling Fire Department FTA potential PFAS release area. The detected compounds are summarized in **Table 6-10**.

PFAS were detected in soil samples in all three intervals collected at the Bivouac Area at low levels. The highest concentration in soil was PFHxA at 0.059 J µg/Kg at AOI 5-3, from 0 to 2 ft bgs. Soil was sampled at three intervals from AOI 5-3 around the Bivouac area. The detected compounds are summarized in **Table 6-10**.

6.7.2 AOI 5 Groundwater Analytical Results

PFAS in groundwater were detected in AOI 5 at the potential PFAS release area associated with the City of Grayling Fire Department FTA potential PFAS release area and at the facility boundary downgradient of AOI 5. The sample collected at the facility boundary exceeded the PALs. PFAS were not detected in the groundwater sample collected from the Bivouac Area. **Figures 6-3** and **6-4** present detections in groundwater for PFOS and PFOA.

PFAS were detected in groundwater sampled from AOI 5-1 and AOI 5-2 in the area associated with the City of Grayling Fire Department FTA potential PFAS release area. The highest concentration in soil was PFOS at 9.41 ng/L in AOI 5-2, which was sampled at a depth of 29 ft bgs. The detected compounds from the Phase I investigation are summarized in **Table 6-11**.

PFAS were not detected in the one Phase I groundwater sample collected in the Bivouac Area (AOI 5-3). The Bivouac Area had a high degree of uncertainty regarding the location of the potential PFAS release area as well as whether or not a release had occurred there. The data collected as part of this SI suggest that an AFFF release did not occur in this area.

During Phase I, groundwater was additionally sampled from four downgradient boundary wells (VAP-32, VAP-33, VAP-34, and VAP-35) to confirm the results of the 2017 boundary investigation

(Amec Foster Wheeler, 2017a). Consistent with the 2017 results, VAP-34 exhibited an exceedance of the PAL for PFOS, at 465 J ng/L, at a depth of approximately 25 ft bgs. Based on the direction of groundwater flow, it is possible that the concentrations observed at VAP-34 can be attributed to a release of PFAS within the City of Grayling Fire Department FTA. potential PFAS release area. The detected compounds from the Phase I investigation are summarized in **Table 6-11**.

During Phase II, groundwater was sampled from GAAF-MW-09 at a depth of 27.5 ft bgs. The detected PFOS concentration of 2.81 J ng/L was below the PAL. The detected compounds from the Phase II investigation are summarized in **Table 6-12**.

6.7.3 AOI 5 Conclusions

Based on the SI findings and historical data (Amec Foster Wheeler, 2017a) collected at the Site, the presence of PFAS has been confirmed at the source and the facility boundary in AOI 5 at the area associated with the City of Grayling Fire Department FTA potential PFAS release area in groundwater. Exceedances in groundwater were only observed at the facility boundary, downgradient of AOI 5.

6.8 Phase II Background Wells

This section presents the analytical results for groundwater associated with three permanent wells installed for the purposes of defining groundwater flow direction as well as establishing boundary points upgradient of potential PFAS release areas (GAAF-MW-08, GAAF-MW-10, GAAF-MW-11). The detected compounds are presented in **Table 6-12**. **Figure 6-4** presents detections for compounds with PALs.

6.8.1 Phase II Groundwater Analytical Results

PFAS were detected in two of four samples (including one duplicate sample) collected from the background wells. No PFAS were detected in GAAF-MW-08. GAAF-MW-10, installed to serve as a control point for groundwater flow, exhibited a low level PFOS detection (1.58 ng/L); however, the detection does not suggest a release occurred in this area due to the ubiquitous nature of PFAS in the environment (ATSDR, 2018). The highest concentration in groundwater was 7.18 ng/L for PFOS in GAAF-MW-11, which was sampled at a depth of 22.5 ft bgs. GAAF-MW-11 represents groundwater conditions at the northern most point of GAAF and is hydraulically upgradient of any on-facility PFAS release areas. The detected compounds from the Phase II groundwater sampling that was conducted to understand background contamination are summarized in **Table 6-12**.

6.8.2 Phase II Conclusions

PFAS in groundwater were detected at low levels in the Phase II Background Wells. GAAF-MW-11 was installed to better understand groundwater flow direction as well as to identify PFAS contamination at the northern facility boundary flowing onto the property. PFAS detections were observed at GAAF-MW-11, with the maximum PFAS detection of PFOS at 7.18 ng/L. This data combined with the known groundwater flow direction suggest that PFAS contamination may be flowing onto the property along the northern facility boundary. Drinking water samples collected by MDEQ from homes upgradient of GAAF indicated the presence of PFAS at levels below the PALs (MDEQ, 2019).

Table 6-2
Detections in Soil, AOI 1
Site Inspection Report, Camp Grayling Army Airfield

Area of Interest	AOI1													
Sample ID	AOI1-1-SB-0-2		AOI1-1-SB-10-12		AOI1-2-SB-0-2		AOI1-2-SB-6-8		AOI1-2-SB-15-17		AOI1-3-SB-0-2		AOI1-4-SB-0-2	
Sample Date	9/15/2018		9/19/2018		9/15/2018		9/20/2018		9/20/2018		9/15/2018		9/15/2018	
Depth	0 - 2 ft		10 - 12 ft		0 - 2 ft		6 - 8 ft		15 - 17 ft		0 - 2 ft			
Analyte	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Soil, PFAS EPA 537 Rev 1.1 Mod (µg/Kg)														
6:2 FTS	ND		ND		ND		ND		ND		ND		ND	
8:2 FTS	ND		ND		ND		ND		ND		ND		0.165	J
PFBA	ND		ND		ND		ND		ND		ND		0.156	J+
PFDA	0.172	J	ND		ND		ND		ND		ND		0.549	J
PFHpA	ND		ND		ND		ND		ND		ND		0.158	J
PFHxA	ND		ND		ND		ND		ND		ND		0.219	J+
PFHxS	ND		ND		ND		0.140	J	ND		0.091	J	0.561	J
PFNA	ND		ND		ND		ND		ND		ND		ND	
PFOA	ND		0.173	J	ND		ND		ND		ND		0.373	J
PFOS	1.22	J+	ND		1.98	J+	12.5	J	0.290	J	0.185	J	27.4	
PFPeA	ND		ND		ND		ND		ND		ND		0.230	J+
PFUdA	ND		ND		ND		ND		ND		ND		0.201	J

Interpreted Qualifiers

J = Estimated concentration

J+ = Estimated concentration, biased high

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

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
PFBA	Perfluorobutyrate
PFDA	Perfluorodecanoic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PFPeA	Perfluoropentanoic acid
PFUdA	Perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
ft	feet
Qual	Interpreted Qualifier
µg/Kg	micrograms per Kilogram
SB	soil boring
-	Not applicable

Table 6-2 (Continued)
Detections in Soil, AOI 1
Site Inspection Report, Camp Grayling Army Airfield

Area of Interest	AOI1													
Sample ID	AOI1-4-SB-5-7		AOI1-4-SB-15-17		AOI1-5-SB-0-2		AOI1-5-SB-6-8		AOI1-5-SB-11-13		AOI1-6-SB-0-2		AOI1-6-SB-10-12	
Sample Date	9/19/2018		9/19/2018		9/15/2018		9/20/2018		9/20/2018		9/15/2018		9/18/2018	
Depth	5 - 7 ft		15 - 17 ft		0 - 2 ft		6 - 8 ft		11 - 13 ft		0 - 2 ft		10 - 12 ft	
Analyte	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Soil, PFAS EPA 537 Rev 1.1 Mod (µg/Kg)														
6:2 FTS	0.207	J	ND		ND		ND		ND		ND		ND	
8:2 FTS	0.399	J	ND		ND		ND		ND		ND		ND	
PFBA	ND		ND		ND		ND		ND		ND		ND	
PFDA	ND		ND		ND		ND		ND		ND		ND	
PFHpA	ND		ND		ND		ND		ND		ND		ND	
PFHxA	ND		ND		ND		ND		ND		ND		ND	
PFHxS	1.36		ND		ND		ND		ND		ND		ND	
PFNA	0.651	J	ND		ND		ND		ND		ND		ND	
PFOA	0.429	J	ND		ND		ND		ND		ND		ND	
PFOS	73.4		0.335	J	0.704	J+	0.482	J	0.309	J	0.355	J+	0.046	J
PFPeA	ND		ND		ND		ND		ND		ND		ND	
PFUdA	ND		ND		ND		ND		ND		ND		ND	

Interpreted Qualifiers

J = Estimated concentration

J+ = Reported value may not be accurate or precise, but the result may be biased high.

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

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
PFBA	Perfluorobutyrate
PFDA	Perfluorodecanoic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PFPeA	Perfluoropentanoic acid
PFUdA	Perfluoro-n-undecanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
ft	feet
Qual	Interpreted Qualifier
µg/Kg	micrograms per Kilogram
SB	soil boring
-	Not applicable

Table 6-3
Detections in Groundwater, AOI 1
Site Inspection Report, Camp Grayling Army Airfield

	Area of Interest		AOI1											
	Sample ID		AOI1-1-GW-55		AOI1-3-GW-59		AOI1-4-GW-58		AOI1-5-GW-29		AOI1-6-GW-59		AOI1-6-GW-59 DUP	
	Sample Date		9/20/2018		9/20/2018		9/19/2018		9/21/2018		9/19/2018		9/19/2018	
Analyte	**EPA HA [a]**	**MDEQ [b]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, PFAS EPA 537 Rev 1.1 Mod (ng/L)														
6:2 FTS	-	-	ND		ND		ND		2.58	J	ND		ND	
PFBA	-	-	ND		ND		3.47	J	10.2		ND		ND	
PFBS	-	-	ND		ND		ND		2.43	J	ND		ND	
PFHpA	-	-	ND		ND		ND		6.83	J	ND		ND	
PFHxA	-	-	ND		ND		ND		30.3		ND		ND	
PFHxS	-	-	2.63	J	1.88	J	ND		75.2		2.26	J	2.01	J
PFOA	**70**	70	ND		ND		ND		5.37	J	ND		ND	
PFOS	**70**	70	ND		ND		13.3		**344**		ND		ND	
PFPeA	-	-	ND		ND		ND		33.0		ND		ND	
PFOA+PFOS Total	**70**	70					13.3		**349**					

Grey Fill	Detected concentration exceeded EPA HA
Bold Font	Detected concentration exceeded MDEQ Criteria

*Formats are combined for exceedances of multiple criteria

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.

b. Michigan Department of Environmental Quality (MDEQ). 2018. Remediation and Redevelopment Division. Environmental Contamination Response Activity Rules. Table 1. Groundwater: Residential and Nonresidential, Part 201 Generic Cleanup Criteria and Screening Levels. Effective January 10, 2018.

Interpreted Qualifiers

J = Estimated concentration

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

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
PFBA	Perfluorobutyrate
PFBS	Perfluorobutanesulfonic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PFPeA	Perfluoropentanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
GW	Groundwater
HA	Health Advisory
MDEQ	Michigan Department of Environmental Quality
Qual	Interpreted Qualifier
ng/L	nanogram per liter
-	Not applicable

Table 6-4
Detections in Soil, AOI 2
Site Inspection Report, Camp Grayling Army Airfield

Area of Interest	AOI2																	
Sample ID	AOI2-1-SB-0-2		AOI2-2-SB-0-2		AOI2-3-SB-0-2		AOI2-3-SB-0-2 DUP		AOI2-3-SB-5-6.6		AOI2-4-SB-0-2		AOI2-4-SB-7-9		AOI2-5-SB-0-2		AOI2-6-SB-0-2	
Sample Date	9/14/2018		9/14/2018		9/14/2018		9/14/2018		9/14/2018		9/15/2018		9/17/2018		9/14/2018		9/15/2018	
Depth	0 - 2 ft								5 - 6.6 ft		0 - 2 ft		7 - 9 ft		0 - 2 ft			
Analyte	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Soil, PFAS EPA 537 Rev 1.1 Mod (µg/Kg)																		
PFOS	0.145	J+	0.126	J+	0.139	J	0.131	J	0.105	J+	0.106	J	0.139	J	0.101	J+	0.148	J+

Interpreted Qualifiers

J = Estimated concentration

J+ = Estimated concentration, biased high

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

Chemical Abbreviations

PFOS	Perfluorooctanesulfonic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
ft	feet
Qual	Interpreted Qualifier
µg/Kg	micrograms per Kilogram
SB	soil boring
-	Not applicable

Table 6-5
Detections in Groundwater, AOI 2
Site Inspection Report, Camp Grayling Army Airfield

	Area of Interest		AOI2									
	Sample ID		AOI2-1-GW-54		AOI2-2-GW-29		AOI2-4-GW-50		AOI2-5-GW-28		AOI2-6-GW-45	
	Sample Date		9/15/2018		9/19/2018		9/18/2018		9/19/2018		9/18/2018	
Analyte	**EPA HA [a]**	**MDEQ [b]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, PFAS EPA 537 Rev 1.1 Mod (ng/L)												
PFBA	-	-	ND		2.70	J	6.45	J	ND		6.21	J
PFBS	-	-	ND		1.35	J	ND		ND		ND	
PFHpA	-	-	ND		ND		13.8		ND		7.84	J
PFHxA	-	-	4.23	J	3.97	J	15.0		ND		8.93	J
PFHxS	-	-	71.2		132		8.12	J	3.12	J	4.23	J
PFOA	**70**	70	4.51	J	6.45	J	7.92	J	ND		3.12	J
PFOS	**70**	70	68.3		**102**		ND		ND		ND	
PFPeA	-	-	ND		ND		16.0		ND		11.0	
PFOA+PFOS Total	**70**	70	**72.8**		**108**		7.92				3.12	

Grey Fill	Detected concentration exceeded EPA HA
Bold Font	Detected concentration exceeded MDEQ Criteria

*Formats are combined for exceedances of multiple criteria

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.

b. Michigan Department of Environmental Quality (MDEQ). 2018. Remediation and Redevelopment Division. Environmental Contamination Response Activity Rules. Table 1. Groundwater: Residential and Nonresidential, Part 201 Generic Cleanup Criteria and Screening Levels. Effective January 10, 2018.

Interpreted Qualifiers

J = Estimated concentration

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

Chemical Abbreviations

PFBA	Perfluorobutyrate
PFBS	Perfluorobutanesulfonic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PFPeA	Perfluoropentanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
GW	Groundwater
HA	Health Advisory
MDEQ	Michigan Department of Environmental Quality
Qual	Interpreted Qualifier
ng/L	nanogram per liter
-	Not applicable

Table 6-6
Detections in Soil, AOI 3
Site Inspection Report, Camp Grayling Army Airfield

Area of Interest	AOI3			
Sample ID	AOI3-1-SB-0-2		AOI3-1-SB-15-16.8	
Sample Date	9/12/2018		9/13/2018	
Depth	0 - 2 ft		15 - 16.8 ft	
Analyte	Result	Qual	Result	Qual
Soil, PFAS EPA 537 Rev 1.1 Mod (µg/Kg)				
PFBA	0.053	J	ND	
PFHxS	0.100	J	ND	
PFOA	0.059	J	ND	
PFOS	0.735	J	0.123	J+

Interpreted Qualifiers

J = Estimated concentration

J+ = Estimated concentration, biased high

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

Chemical Abbreviations

PFBA	Perfluorobutyrate
PFHxS	Perfluorohexanesulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
ft	feet
Qual	Interpreted Qualifier
µg/Kg	micrograms per Kilogram
SB	soil boring
-	Not applicable

Table 6-7
Detections in Groundwater, AOI 3
Site Inspection Report, Camp Grayling Army Airfield

	Area of Interest		AOI3													
	Sample ID		AOI3-1-GW-28		AOI3-MW128D-35		AOI3-MW128S-25		AOI3-MW13D-24		I3-MW13S	I3-MW13S	DI3-MW31-	DI3-MW31-	AOI3-MW31-19 DUP	
	Sample Date		9/14/2018		9/14/2018		9/14/2018		9/15/2018		9/15/2018		9/14/2018		9/14/2018	
Analyte	**EPA HA [a]**	**MDEQ [b]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, PFAS EPA 537 Rev 1.1 Mod (ng/L)																
6:2 FTS	-	-	ND		ND		ND		ND		23.6		ND		ND	
8:2 FTS	-	-	ND		ND		1.94	J	ND		ND		ND		ND	
PFBA	-	-	5.12	J	ND		3.22	J	3.64	J	36.2		2.16	J	2.66	J
PFBS	-	-	2.58	J	ND		ND		3.19	J	1.45	J	1.66	J	1.90	J
PFHpA	-	-	4.80	J	ND		10.2		4.06	J	31.6		3.60	J	3.62	J
PFHxA	-	-	9.84		ND		6.56	J	7.56	J	63.4		5.91	J	6.02	J
PFHxS	-	-	39.0		33.2		21.1		55.6		28.5		24.4		26.0	
PFOA	**70**	70	3.57	J	ND		4.35	J	4.32	J	20.5		3.37	J	3.69	J
PFOS	**70**	70	54.6		27.8		**257**		**172**		**96.3**		45.7		43.9	
PFPeA	-	-	12.1		ND		6.29	J	8.75	J	94.4		5.85	J	5.46	J
PFOA+PFOS Total	**70**	70	58.2		27.8		**261**		**176**		**117**		49.1		47.6	

Grey Fill	Detected concentration exceeded EPA HA
Bold Font	Detected concentration exceeded MDEQ Criteria

*Formats are combined for exceedances of multiple criteria

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.

b. Michigan Department of Environmental Quality (MDEQ). 2018. Remediation and Redevelopment Division. Environmental Contamination Response Activity Rules. Table 1. Groundwater: Residential and Nonresidential, Part 201 Generic Cleanup Criteria and Screening Levels. Effective January 10, 2018.

Interpreted Qualifiers

J = Estimated concentration

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

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
PFBA	Perfluorobutyrate
PFBS	Perfluorobutanesulfonic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PFPeA	Perfluoropentanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
GW	Groundwater
HA	Health Advisory
MDEQ	Michigan Department of Environmental Quality
Qual	Interpreted Qualifier
ng/L	nanogram per liter
-	Not applicable

Table 6-8
Detections in Soil, AOI 4
Site Inspection Report, Camp Grayling Army Airfield

Area of Interest	AOI4											
Sample ID	AOI4-1-SB-0-2		AOI4-1-SB-5-6.5		AOI4-1-SB-6.5-8		AOI4-2-SB-0-2		AOI4-2-SB-5-6.5		AOI4-2-SB-5-6.5 DUP	
Sample Date	9/12/2018		9/12/2018		9/12/2018		9/12/2018		9/13/2018		9/13/2018	
Depth	0 - 2 ft		5 - 6.5 ft		6.5 - 8 ft		0 - 2 ft		5 - 6.5 ft			
Analyte	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Soil, PFAS EPA 537 Rev 1.1 Mod (µg/Kg)												
NEtFOSAA	0.020	J	0.029	J	0.013	J	ND		ND		ND	
PFBA	ND		ND		ND		0.017	J	ND		0.047	J
PFDA	ND		ND		ND		ND		0.024	J	ND	
PFDoA	ND		0.024	J	ND		ND		ND		ND	
PFHpA	ND		ND		ND		ND		ND		ND	
PFHxA	ND		ND		ND		ND		ND		ND	
PFHxS	ND		0.019	J	ND		ND		0.021	J	ND	
PFOA	0.028	J	ND		ND		0.038	J	ND		ND	
PFOS	ND		0.061	J	0.040	J	ND		0.069	J	ND	

Interpreted Qualifiers

J = Estimated concentration

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

Chemical Abbreviations

NEtFOSAA	N-ethyl perfluorooctane- sulfonamidoacetic acid
PFBA	Perfluorobutyrate
PFDA	Perfluorodecanoic acid
PFDoA	Perfluorododecanoic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
ft	feet
Qual	Interpreted Qualifier
µg/Kg	micrograms per Kilogram
SB	soil boring
-	Not applicable

Table 6-8 (Continued)
Detections in Soil, AOI 4
Site Inspection Report, Camp Grayling Army Airfield

Area of Interest	AOI4															
Sample ID	AOI4-3-SB-0-2		AOI4-4-SB-0-2		AOI4-4-SB-10-11.8		AOI4-5-SB-5-7		AOI4-6-SB-0-2		AOI4-6-SB-5-7		AOI4-6-SB-5-7 DUP		AOI4-6-SB-10-11.4	
Sample Date	9/12/2018		9/13/2018		9/13/2018		9/13/2018		9/12/2018		9/13/2018		9/13/2018		9/13/2018	
Depth	0 - 2 ft				10 - 11.8 ft		5 - 7 ft		0 - 2 ft		5 - 7 ft				10 - 11.4 ft	
Analyte	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Soil, PFAS EPA 537 Rev 1.1 Mod (µg/Kg)																
NEtFOSAA	ND		ND		ND		0.013	J	ND		0.047	J	0.012	J	0.014	J
PFBA	0.115	J	0.048	J	ND		0.025	J	0.067	J	ND		ND		ND	
PFDA	ND		ND		ND		ND		ND		ND		ND		ND	
PFDoA	ND		ND		ND		ND		ND		ND		ND		ND	
PFHpA	ND		ND		ND		ND		0.041	J	ND		ND		ND	
PFHxA	0.131	J	ND		ND		ND		ND		ND		ND		0.042	J
PFHxS	ND		0.017	J	ND		ND		ND		ND		ND		0.199	J
PFOA	ND		0.047	J	ND		0.026	J	0.064	J	0.026	J	ND		ND	
PFOS	0.088	J	0.195	J	0.382	J+	ND		ND		ND		ND		3.64	

Interpreted Qualifiers

J = Estimated concentration

J+ = Reported value may not be accurate or precise, but the result may be biased high.

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

Chemical Abbreviations

NEtFOSAA	N-ethyl perfluorooctane- sulfonamidoacetic acid
PFBA	Perfluorobutyrate
PFDA	Perfluorodecanoic acid
PFDoA	Perfluorododecanoic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
ft	feet
Qual	Interpreted Qualifier
µg/Kg	micrograms per Kilogram
SB	soil boring
-	Not applicable

Table 6-9
Detections in Groundwater, AOI 4
Site Inspection Report, Camp Grayling Army Airfield

	Area of Interest		AOI4			
	Sample ID		AOI4-5-GW-29		AOI4-6-GW-29	
	Sample Date		9/13/2018		9/13/2018	
Analyte	EPA HA [a]	MDEQ [b]	Result	Qual	Result	Qual
Water, PFAS EPA 537 Rev 1.1 Mod (ng/L)						
PFHpA	-	-	ND		2.16	J
PFHxA	-	-	ND		2.54	J
PFOS	**70**	70	9.35	J	ND	
PFOA+PFOS Total	**70**	70	9.35			

Grey Fill	Detected concentration exceeded EPA HA
Bold Font	Detected concentration exceeded MDEQ Criteria

*Formats are combined for exceedances of multiple criteria

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.

b. Michigan Department of Environmental Quality (MDEQ). 2018. Remediation and Redevelopment Division. Environmental Contamination Response Activity Rules. Table 1. Groundwater: Residential and Nonresidential, Part 201 Generic Cleanup Criteria and Screening Levels. Effective January 10, 2018.

Interpreted Qualifiers

J = Estimated concentration

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

Chemical Abbreviations

PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
GW	Groundwater
HA	Health Advisory
MDEQ	Michigan Department of Environmental Quality
Qual	Interpreted Qualifier
ng/L	nanogram per liter
-	Not applicable

Table 6-10
Detections in Soil, AOI 5
Site Inspection Report, Camp Grayling Army Airfield

Area of Interest	AOI5													
Sample ID	AOI5-1-SB-0-2		AOI5-1-SB-6.3-8.3		AOI5-1-SB-15.2-17.2		AOI5-2-0-2		AOI5-2-0-2 DUP		AOI5-2-SB-5-6.7		AOI5-2-SB-10-12	
Sample Date	9/11/2018		9/11/2018		9/11/2018		9/11/2018		9/11/2018		9/11/2018		9/11/2018	
Depth	0 - 2 ft		6.3 - 8.3 ft		15.2 - 17.2 ft		0 - 2 ft				5 - 6.7 ft		10 - 12 ft	
Analyte	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Soil, PFAS EPA 537 Rev 1.1 Mod (µg/Kg)														
6:2 FTS	0.021	J	0.023	J	ND		ND		ND		ND		ND	
NEtFOSAA	ND		ND		0.038	J	ND		ND		0.022	J	0.034	J
NMeFOSAA	ND		ND		ND		ND		ND		0.059	J	ND	
PFBA	0.021	J	ND		ND		0.060	J	0.076	J	ND		0.023	J
PFHpA	ND		ND		ND		ND		0.026	J	ND		ND	
PFHxA	ND		ND		ND		0.092	J	ND		ND		ND	
PFHxS	0.124	J	0.031	J	0.025	J	0.035	J	ND		0.025	J	ND	
PFOA	0.062	J	ND		ND		0.054	J	0.062	J	ND		ND	
PFOS	0.465	J	0.111	J	0.077	J	0.067	J	0.170	J	0.124	J	0.095	J

Interpreted Qualifiers

J = Estimated concentration

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

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
NEtFOSAA	N-ethyl perfluorooctane- sulfonamidoacetic acid
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
PFBA	Perfluorobutyrate
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
ft	feet
Qual	Interpreted Qualifier
µg/Kg	micrograms per Kilogram
SB	soil boring
-	Not applicable

Table 6-10 (Continued)
Detections in Soil, AOI 5
Site Inspection Report, Camp Grayling Army Airfield

Area of Interest	AOI5					
Sample ID	AOI5-3-0-2		AOI5-3-5-6.8		AOI5-3-10.8-12.8	
Sample Date	9/11/2018		9/11/2018		9/11/2018	
Depth	0 - 2 ft		5 - 6.8 ft		10.8 - 12.8 ft	
Analyte	Result	Qual	Result	Qual	Result	Qual
Soil, PFAS EPA 537 Rev 1.1 Mod (µg/Kg)						
6:2 FTS	ND		ND		ND	
NEtFOSAA	ND		ND		ND	
NMeFOSAA	ND		ND		ND	
PFBA	0.038	J	ND		ND	
PFHpA	ND		ND		ND	
PFHxA	0.059	J	ND		ND	
PFHxS	0.019	J	ND		ND	
PFOA	ND		ND		ND	
PFOS	ND		0.048	J	0.029	J

Interpreted Qualifiers

J = Estimated concentration

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

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
NEtFOSAA	N-ethyl perfluorooctane- sulfonamidoacetic acid
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
PFBA	Perfluorobutyrate
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
ft	feet
Qual	Interpreted Qualifier
µg/Kg	micrograms per Kilogram
SB	soil boring
-	Not applicable

Table 6-11
Detections in Groundwater, AOI 5
Site Inspection Report, Camp Grayling Army Airfield

Area of Interest			AOI5													
Sample ID			AOI5-1-GW-29		AOI5-2-GW-29		AOI5-VAP-32-21		AOI5-VAP-32-21 DUP		AOI5-VAP-33-22		AOI5-VAP34-22		AOI5-VAP34-22 DUP	
Sample Date			9/12/2018		9/12/2018		9/11/2018		9/11/2018		9/11/2018		9/11/2018		9/11/2018	
Analyte	**EPA HA [a]**	**MDEQ [b]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, PFAS EPA 537 Rev 1.1 Mod (ng/L)																
6:2 FTS	-	-	ND		ND		ND		ND		1.73	J	ND		ND	
PFBA	-	-	2.68	J	2.06	J	ND		ND		5.62	J	3.33	J	3.06	J
PFBS	-	-	ND		2.36	J	1.86	J	ND		ND		ND		ND	
PFHpA	-	-	ND		ND		ND		ND		2.22	J	4.56	J	4.19	J
PFHxA	-	-	ND		ND		ND		ND		14.8		6.48	J	5.81	J
PFHxS	-	-	2.36	J	5.74	J	19.4	J	ND		ND		47.9		41.3	
PFOA	**70**	70	ND		6.53	J	2.25	J	ND		ND		4.50	J	4.65	J
PFOS	**70**	70	ND		9.41		9.93	J	1.96	J	2.54	J	**465**	J	**453**	
PFPeA	-	-	ND		4.00	J	ND		ND		22.0		5.19	J	4.57	J
PFOA+PFOS Total	**70**	70			15.9		12.2		1.96		2.54		**470**		**458**	

Grey Fill	Detected concentration exceeded EPA HA
Bold Font	Detected concentration exceeded MDEQ Criteria

*Formats are combined for exceedances of multiple criteria

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.

b. Michigan Department of Environmental Quality (MDEQ). 2018. Remediation and Redevelopment Division. Environmental Contamination Response Activity Rules. Table 1. Groundwater: Residential and Nonresidential, Part 201 Generic Cleanup Criteria and Screening Levels. Effective January 10, 2018.

Interpreted Qualifiers

J = Estimated concentration

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

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
PFBA	Perfluorobutyrate
PFBS	Perfluorobutanesulfonic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PFPeA	Perfluoropentanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
GW	Groundwater
HA	Health Advisory
MDEQ	Michigan Department of Environmental Quality
Qual	Interpreted Qualifier
ng/L	nanogram per liter
-	Not applicable

Table 6-12
Detections in Groundwater, Phase II Locations
Site Inspection Report, Camp Grayling Army Airfield

	Area of Interest		Phase 2													
	Sample ID		GAAF MW-01-101918		GAAF MW-02-102218		GAAF MW-03-102218		GAAF MW-04-102218		GAAF MW-05-102018		GAAF MW-06-101918		GAAF MW-09-101918	
	Sample Date		10/19/2018		10/22/2018		10/22/2018		10/22/2018		10/20/2018		10/19/2018		10/19/2018	
Analyte	**EPA HA [a]**	**MDEQ [b]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, PFAS EPA 537 Rev 1.1 Mod (ng/L)																
6:2 FTS	-	-	ND		ND		1.67	J	ND		ND		ND		ND	
PFBA	-	-	ND		2.26	J	9.99		ND		ND		ND		ND	
PFBS	-	-	ND		ND		1.72	J	ND		ND		ND		ND	
PFHpA	-	-	ND		2.12	J	7.94	J	1.98	J	ND		ND		ND	
PFHxA	-	-	ND		3.51	J	26.3		ND		ND		ND		ND	
PFHxS	-	-	1.63	J	11.7		75.5		6.07	J	22.6		3.13	J	2.23	J
PFOA	**70**	70	ND		2.18	J	5.16	J	2.44	J	2.17	J	ND		ND	
PFOS	**70**	70	ND		67.9		**166**		37.9		17.5		ND		2.81	J
PFPeA	-	-	ND		3.38	J	26.0		ND		ND		ND		ND	
PFOA+PFOS Total	**70**	70			**70.1**		**171**		40.3		19.7				2.81	

Grey Fill	Detected concentration exceeded EPA HA
Bold Font	Detected concentration exceeded MDEQ Criteria

*Formats are combined for exceedances of multiple criteria

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.

b. Michigan Department of Environmental Quality (MDEQ). 2018. Remediation and Redevelopment Division. Environmental Contamination Response Activity Rules. Table 1. Groundwater: Residential and Nonresidential, Part 201 Generic Cleanup Criteria and Screening Levels. Effective January 10, 2018.

Interpreted Qualifiers

J = Estimated concentration

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

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
PFBA	Perfluorobutyrate
PFBS	Perfluorobutanesulfonic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PFPeA	Perfluoropentanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
GW	Groundwater
HA	Health Advisory
MDEQ	Michigan Department of Environmental Quality
Qual	Interpreted Qualifier
ng/L	nanogram per liter
-	Not applicable

Table 6-12 (Continued)
Detections in Groundwater, Phase II Locations
Site Inspection Report, Camp Grayling Army Airfield

	Area of Interest		Phase 2			
	Sample ID		GAAF MW-10-101918		GAAF MW-11-102018	
	Sample Date		10/19/2018		10/20/2018	
Analyte	EPA HA [a]	MDEQ [b]	Result	Qual	Result	Qual
Water, PFAS EPA 537 Rev 1.1 Mod (ng/L)						
6:2 FTS	-	-	ND		ND	
PFBA	-	-	ND		ND	
PFBS	-	-	ND		1.38	J
PFHpA	-	-	ND		ND	
PFHxA	-	-	ND		3.34	J
PFHxS	-	-	ND		ND	
PFOA	**70**	70	ND		3.10	J
PFOS	**70**	70	1.59	J	7.18	J
PFPeA	-	-	ND			
PFOA+PFOS Total	**70**	70	1.59		10	

Grey Fill	Detected concentration exceeded EPA HA
Bold Font	Detected concentration exceeded MDEQ Criteria

*Formats are combined for exceedances of multiple criteria

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.

b. Michigan Department of Environmental Quality (MDEQ). 2018. Remediation and Redevelopment Division. Environmental Contamination Response Activity Rules. Table 1. Groundwater: Residential and Nonresidential, Part 201 Generic Cleanup Criteria and Screening Levels. Effective January 10, 2018.

Interpreted Qualifiers

J = Estimated concentration

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

Chemical Abbreviations

6:2 FTS	6:2 fluorotelomer sulfonate
PFBA	Perfluorobutyrate
PFBS	Perfluorobutanesulfonic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PFPeA	Perfluoropentanoic acid

Acronyms and Abbreviations

AOI	Area of Interest
EPA	U.S. Environmental Protection Agency
GW	Groundwater
HA	Health Advisory
MDEQ	Michigan Department of Environmental Quality
Qual	Interpreted Qualifier
ng/L	nanogram per liter
-	Not applicable

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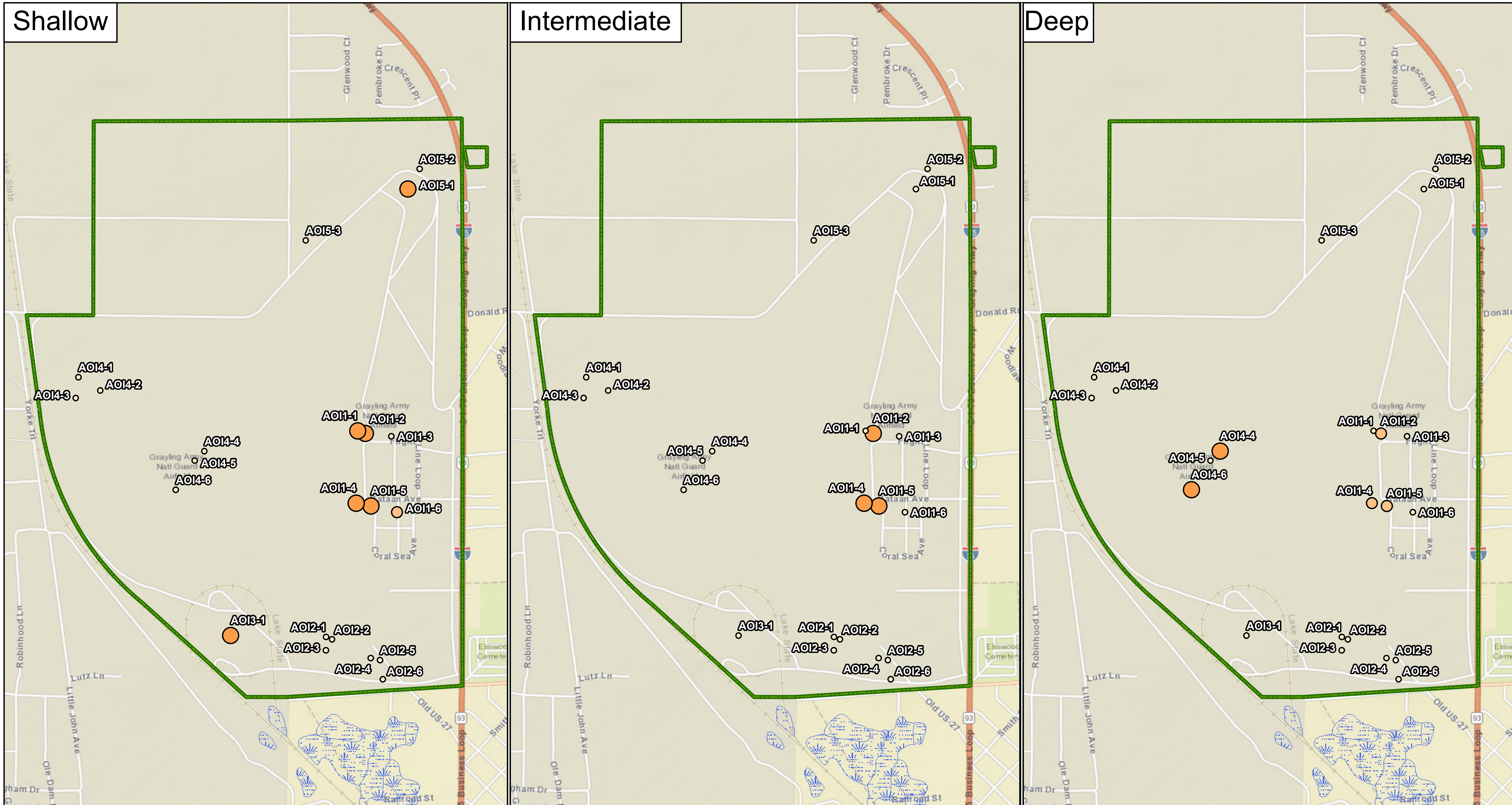


CLIENT	ARNG
PROJECT	Site Inspection for PFAS at Camp Grayling, GAAF, MI

REVISED	8/15/2019	GIS BY	MS	8/15/2019
SCALE	1:16,200	CHK BY	CM	8/15/2019
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	LS	8/15/2019

Facility Boundary
Wetland

PFOS results (µg/Kg)
- ND - 0.240
- > 0.240 - 0.378
- > 0.378 - 1260
- > 1260

0 675 1,350 2,700 Feet

N

PFOS Detections in Soil (AOI 1-5)

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 6-1

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MI\Grayling\SI_Figures\GAAF_SI_Figures\GAAF_SI_Results_Figures\Fig_6-1_SI_PFOS_Soil_Results_Shallow_Inter_Deep.mxd

Shallow

Intermediate

Deep

AOI5-2
AOI5-1
AOI5-3
AOI4-1
AOI4-2
AOI4-3
AOI4-4
AOI4-5
AOI4-6
AOI1-1
AOI1-2
AOI1-3
AOI1-4
AOI1-5
AOI1-6
AOI3-1
AOI2-1
AOI2-2
AOI2-3
AOI2-5
AOI2-4
AOI2-6
Glenwood Ct
Pembroke Dr
Crescent Pl
Donald Rd
Grayling Army Natl Guard
Oral Sea Ave
Lake State Railway
Yorke Trl
Robinhood Ln
Lutz Ln
Little John Ave
Ole Dam Rd
Old US-27
75 Business Loop
Railroad St
Elmwood Cemetery

CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Camp Grayling, GAAF, MI			
REVISED	8/15/2019	GIS BY	MS	8/15/2019
SCALE	1:16,200	CHK BY	CM	8/15/2019
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	LS	8/15/2019

Facility Boundary
Wetland

PFOA results (µg/Kg)

- ND - 0.172
- > 0.172 - 1,260
- > 1,260 - 10,000
- > 10,000

0 675 1,350 2,700 Feet

N

PFOA Detections in Soil (AOI 1-5)

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

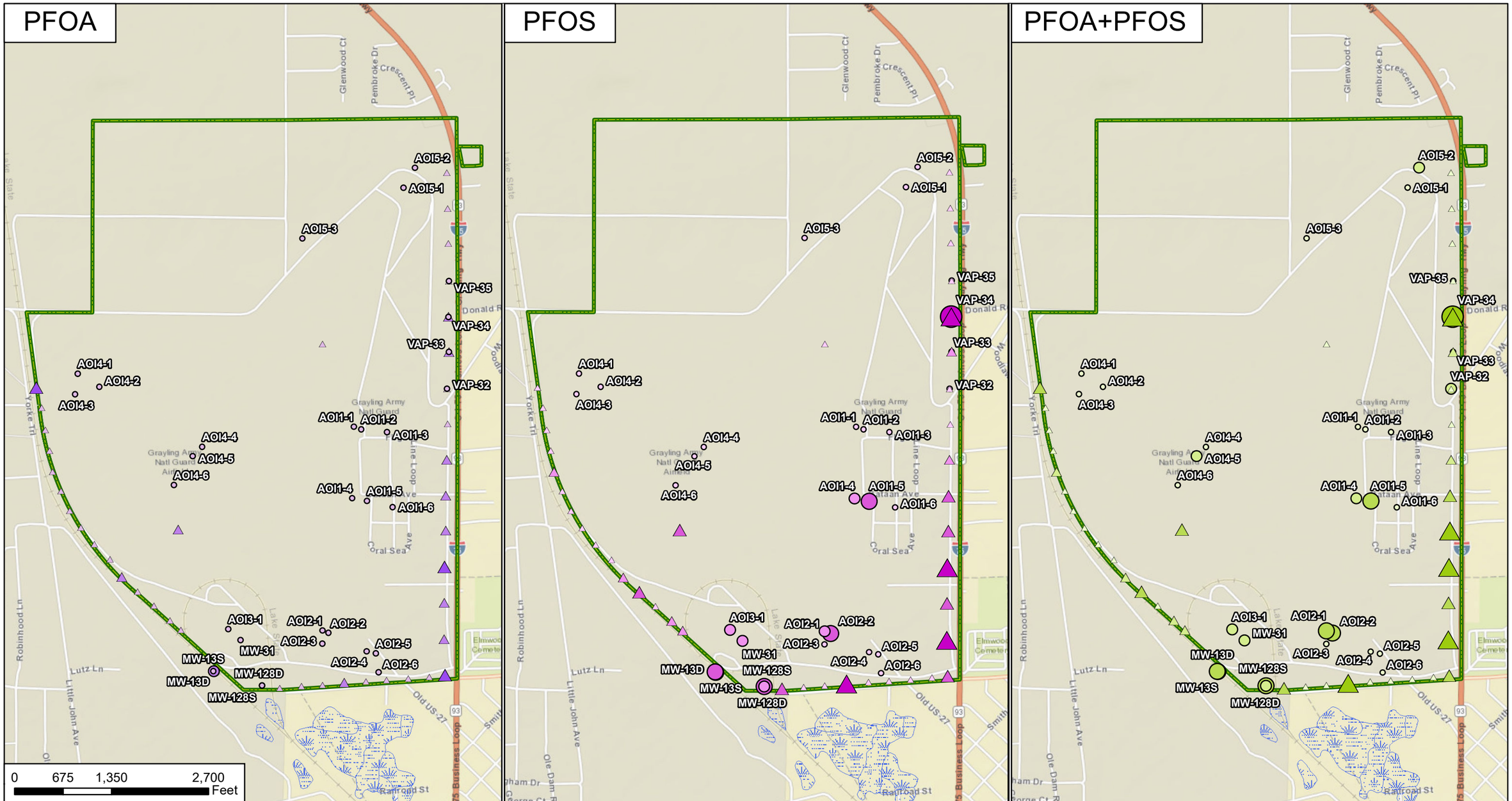
Figure 6-2

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MI\Grayling\SI_Figures\GAAF_SI_Figures\GAAF_SI_Results_Figures\Fig_6-2_SI_PFOA_Soil_Results_Shallow_Inter_Deep.mxd

PFOA

PFOS

PFOA+PFOS



CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Camp Grayling, GAAF, MI			
REVISED	8/23/2019	GIS BY	MS	8/23/2019
SCALE	1:16,200	CHK BY	CM	8/23/2019
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand),		PM	LS	8/23/2019

Facility Boundary

Wetland

PFOA Results (ng/L)	PFOS Results (ng/L)	PFOS + PFOA Results (ng/L)
ND - 10	ND - 10	ND - 10
> 10 - 70	> 10 - 70	> 10 - 70
> 70 - 400	> 70 - 400	> 70 - 400
> 400	> 400	> 400

1.) Sample data represented by circles were collected during Phase 1 of the 2018 ARNG SI. The facility boundary sample data represented by triangles were collected in 2017 by MDMVA (Amec Foster Wheeler. 2017a. PFCs Investigation – Camp Grayling Airfield, Grayling, Michigan, Amec Foster Wheeler Project No: 3310165033. 25 September 2017).

N

PFOA and PFOS Detections in Groundwater (AOI 1-5, Phase I)

AECOM
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Germantown, MD 20876

Figure 6-3

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MI\Grayling\SI_Figures\GAAF_SI_Figures\GAAF_SI_Results_Figures\Fig_6-3_SI_GW_Results_Phase_1_PFOA_PFOS_Combined.mxd

PFOA

PFOS

PFOA+PFOS

GAAF MW-11
GAAF MW-09
GAAF MW-08
GAAF MW-07
GAAF MW-10
GAAF MW-01
GAAF MW-02
GAAF MW-06
GAAF MW-03
GAAF MW-05
GAAF MW-04

Glenwood Ct
Pembroke Dr
Crescent Pl
Lake State
Donald R
Woodla
Yorke Tr
Grayling Army Natl Guard Airfield
Flight Line Loop
Oral Sea Ave
Robinhood Ln
Lutz Ln
Little John Ave
Old US-27
75 Business Loop
Railroad St
Elmwood Cemetery

0 675 1,350 2,700 Feet

CLIENT	ARNG			
PROJECT	Site Inspection for PFAS at Camp Grayling, GAAF, MI			
REVISED	8/15/2019	GIS BY	MS	8/15/2019
SCALE	1:16,200	CHK BY	CM	8/15/2019
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	LS	8/15/2019

Facility Boundary
Wetland

PFOA Results (ng/L)	PFOS Results (ng/L)	PFOS + PFOA Results (ng/L)
ND - 10	ND - 10	ND - 10
> 10 - 70	> 10 - 70	> 10 - 70
> 70 - 400	> 70 - 400	> 70 - 400
> 400	> 400	> 400

N

PFOA and PFOS Detections in Groundwater (AOI 1-5, Phase 2)

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 6-4

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MI\Grayling\SI_Figures\GAAF_SI_Figures\GAAF_SI_Results_Figures\Fig_6-4_SI_GW_Results_Phase_2_PFOA_PFOS_Combined.mxd

7. Exposure Pathways

A human exposure pathway for drinking water is considered complete when the following conditions are present (Agency for Toxic Substances and Disease Registry [ATSDR], 2005):

1. Contaminant source – analytical result above the PALs for PFOA and/or PFOS in groundwater contributing to drinking water;
2. Environmental fate and transport;
3. Exposure point – a drinking water supply;
4. Exposure route – ingestion of drinking water; and
5. Potentially exposed populations – a person drinking the water.

If any of these elements are missing, the pathway is considered incomplete. Areas with an identified potentially complete pathway may warrant further investigation. Areas with no identified complete pathway generally warrant no further action. The CSMs for each AOI have been updated based on the data collected during this SI.

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 is sparse and continues to be the subject of PFAS toxicological study. The receptors evaluated are consistent with those listed in USEPA guidance for risk screening (USEPA, 2018). Receptors at the Site include site workers (e.g., facility staff and visiting soldiers), construction workers, fulltime and part time residents outside the facility boundary, and recreational users outside of the facility boundary. The CSMs for each AOI, revised based on the SI findings, are presented on **Figures 7-1** through **7-5**.

7.1 Soil Exposure Pathway

The SI soil sampling objectives were to determine if soil was impacted by a PFAS release at the AOIs and to identify if a complete pathway exists between the source, groundwater, surface water, and potential receptors. Soil concentrations are used here, within the context of the SI, as a general indication as to whether the PFAS release was on ARNG property.

7.1.1 AOI 1

From the 1970s into the 1980s, AFFF was released to soil at two potential PFAS release areas within the AOI 1 through leaking firetruck tanks near Building 1194 Ramp/ Building 1195 and Building 1160. PFAS were detected in soil in this area and confirm the release of PFAS to soil in AOI 1. It is possible that AFFF was released within Building 1195 and migrated to the floor drain in the approximate center of the building, of which the configuration is unknown. Based on the results of the SI in AOI 1, ground disturbing activities would result in site worker and construction worker exposure to PFAS via inhalation of dust or ingestion of surface soil. Additionally, off-facility residents and recreational users may be exposed to PFAS 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

From the 1970s into the 1980s, AFFF was released to soil at two potential PFAS release areas within the AOI 2 through fire training activities that occurred at the Southeastern end of Runway 14/32 and the area Between Former MATES and Runway 14/32. PFAS were detected in soil in

this area at low-levels. The soil data assessed with the groundwater and downgradient drinking water results suggest the release of PFAS to soil in AOI 2. Based on the results of the SI in AOI 2, ground disturbing activities would result in site worker and construction worker exposure to PFAS via inhalation of dust or ingestion of surface soil. Additionally, off-facility residents and recreational users may be exposed to PFAS via inhalation of dust caused by on-facility ground disturbing activities. The CSM is presented on **Figure 7-2**.

7.1.3 AOI 3

From the 1970s into the 1980s, AFFF was released to soil at AOI 3 at the Former MATES. PFAS were detected in soil in this area and confirm the release of PFAS to soil in AOI 3 during historical fire training activities. Based on the results of the SI in AOI 3, ground disturbing activities would result in site worker and construction worker exposure to PFAS via inhalation of dust or ingestion of surface soil. Additionally, off-facility residents and recreational users may be exposed to PFAS via inhalation of dust caused by on-facility ground disturbing activities, although this exposure is likely insignificant. The CSM is presented on **Figure 7-3**.

7.1.4 AOI 4

From the 1970s into the 1980s, AFFF was released to soil at two potential PFAS release areas within the AOI 4 through fire training activities that occurred at Taxiway D and the Northwestern End of Runway 14/32. PFAS were detected in soil in this area. Low-levels of PFAS were observed at the Northwestern End of Runway 14/32, while more moderate levels were observed near Taxiway D. When assessed in conjunction with the groundwater data collected, only the Taxiway D area suggests the release of PFAS to soil due to the lack of PFAS in groundwater within the Northwestern End of Runway 14/32 potential source area. Based on the results of the SI in AOI 4, ground disturbing activities would result in site worker and construction worker exposure to PFAS via inhalation of dust or ingestion of surface soil. Additionally, off-facility residents and recreational users may be exposed to PFAS via inhalation of dust caused by on-facility ground disturbing activities, although this exposure is likely insignificant. The CSM is presented on **Figure 7-4**.

7.1.5 AOI 5

From the 1970s into the 1980s, AFFF was released to soil at two potential PFAS release areas within AOI 5 through fire training activities at the City of Grayling Fire Department FTA and the Bivouac area, where firetrucks containing AFFF “wet water” may have been staged for a 2-week period during the summers of two separate years (exact years are unknown). PFAS were detected in soil in this area at low-levels; however, when assessed in conjunction with the groundwater data collected, only the City of Grayling Fire Department FTA potential PFAS release area suggests the release of PFAS to soil. Based on the results of the SI at AOI 5, ground disturbing activities would result in site worker and construction worker exposure to PFAS via inhalation of dust or ingestion of surface soil. Additionally, off-facility residents and recreational users may be exposed to PFAS via inhalation of dust caused by on-facility ground disturbing activities, although this exposure is likely insignificant. The CSM is presented on **Figure 7-5**.

7.2 Groundwater Exposure Pathway

The SI groundwater sampling objectives were to determine if groundwater was impacted by a PFAS release at the AOIs, if concentrations of PFOA and PFOS were present and exceeded PALs, and to identify if a complete pathway exists between the source and potential receptors. Groundwater concentrations are used here as a basis for determination as to whether concentrations exceed the actionable level of 70 ng/L PFOS and/or PFOA at the source areas and facility boundary. Certain potential source areas were eliminated from further consideration

in the CERCLA process because it is determined that the area poses no significant threat to human health or the environment.

7.2.1 AOI 1

PFAS were detected in groundwater in both source areas and exceeded the PAL for PFOS in the Building 1160 PFAS release area. Additionally, PALs for PFOS and/ or PFOA were exceeded at the facility boundary, downgradient of AOI 1. Drinking water is supplied by the City of Grayling to the Site and most residents located south of North Down River Road. Municipal drinking water comes from one of two deep Type I water wells (screened approximately between 100 and 210 ft bgs) located along the western bank of the East Branch Au Sable River, on either side of North Down River Road (MDEQ, 2018a). Low levels of PFHxS have been detected in one Type 1 well (Well #1) during previous sampling events in 2017 (Amec Foster Wheeler, 2017b). Some residents southeast of GAAF still rely on shallow private drinking water wells. Residents to the north of North Down River Road, downgradient of AOI 1, are typically supplied by shallow private wells. PFAS have been detected in several of these private wells with exceedances of 70 ng/L PFOS and/ or PFOA; therefore, the ingestion exposure pathway for groundwater is complete for off-facility residents and recreational users outside the facility. The ingestion exposure pathway is also considered complete for construction workers during trenching activities deep enough to encounter shallow groundwater. CSM is presented on **Figure 7-1**.

7.2.2 AOI 2

PFAS were detected in groundwater in both the source areas and exceeded the PALs for PFOS and/or PFOA at the area Between Former MATES and Runway 14/32. Additionally, PALs for PFOS and/or PFOA were exceeded at the facility boundary, downgradient of AOI 2. A limited number of residents and businesses located on North Down River Road, downgradient of AOI 2, are supplied by shallow private drinking water wells. PFAS have been detected in these wells (MDEQ, 2018c); therefore, the ingestion exposure pathway for groundwater is complete for off-facility residents and recreational users outside the facility relative to the source area Between Former MATES and Runway 14/32. The ingestion exposure pathway is also considered complete for construction workers during trenching activities deep enough to encounter shallow groundwater. The CSM is presented on **Figure 7-2**.

7.2.3 AOI 3

PFAS were detected in groundwater at the source area at AOI 3 and exceeded the PAL for PFOS in existing onsite monitoring wells at the facility boundary. Residents south of the Former MATES, downgradient of AOI 3, are supplied by shallow private drinking water wells. PFAS have been detected in these wells with exceedances of 70 ng/L for PFOS and/or PFOA (MDEQ, 2018c); therefore, the ingestion exposure pathway for groundwater is complete for off-facility residents relative to the PFAS release area at the Former MATES. The ingestion exposure pathway is also considered complete for construction workers during trenching activities deep enough to encounter shallow groundwater.

The Former MATES area consists of one potable well, WW570, which is used to supply water for an emergency eyewash station in the Former Bulk Fuel Storage Area. In 2017, PFTeA was detected in a potable sample collected from WW570. Although, the well is not currently a drinking water source, there is the potential that it may be used in the future; therefore, the drinking water pathway is also considered partially complete for a site worker under a future scenario but incomplete under the present-day scenario. The CSM is presented on **Figure 7-3**.

7.2.4 AOI 4

PFAS were detected in groundwater at the source area associated with Taxiway D but were not detected at the Northwestern End of Runway 14/32. PFOS and/ or PFOA did not exceed the PALs at Taxiway D in the data collected as part of the SI; however, PFOS and/or PFOA did exceed the PALs at downgradient locations during the 2017 investigation along the facility boundary and at a location between Taxiway D and the facility boundary (Amec Foster Wheeler, 2017a). PFAS were detected in groundwater at boundary location VAP-01, which indicates there is a potential off-facility source that may be contributing to PFAS in groundwater on GAAF and off-facility, downgradient of the sample location.

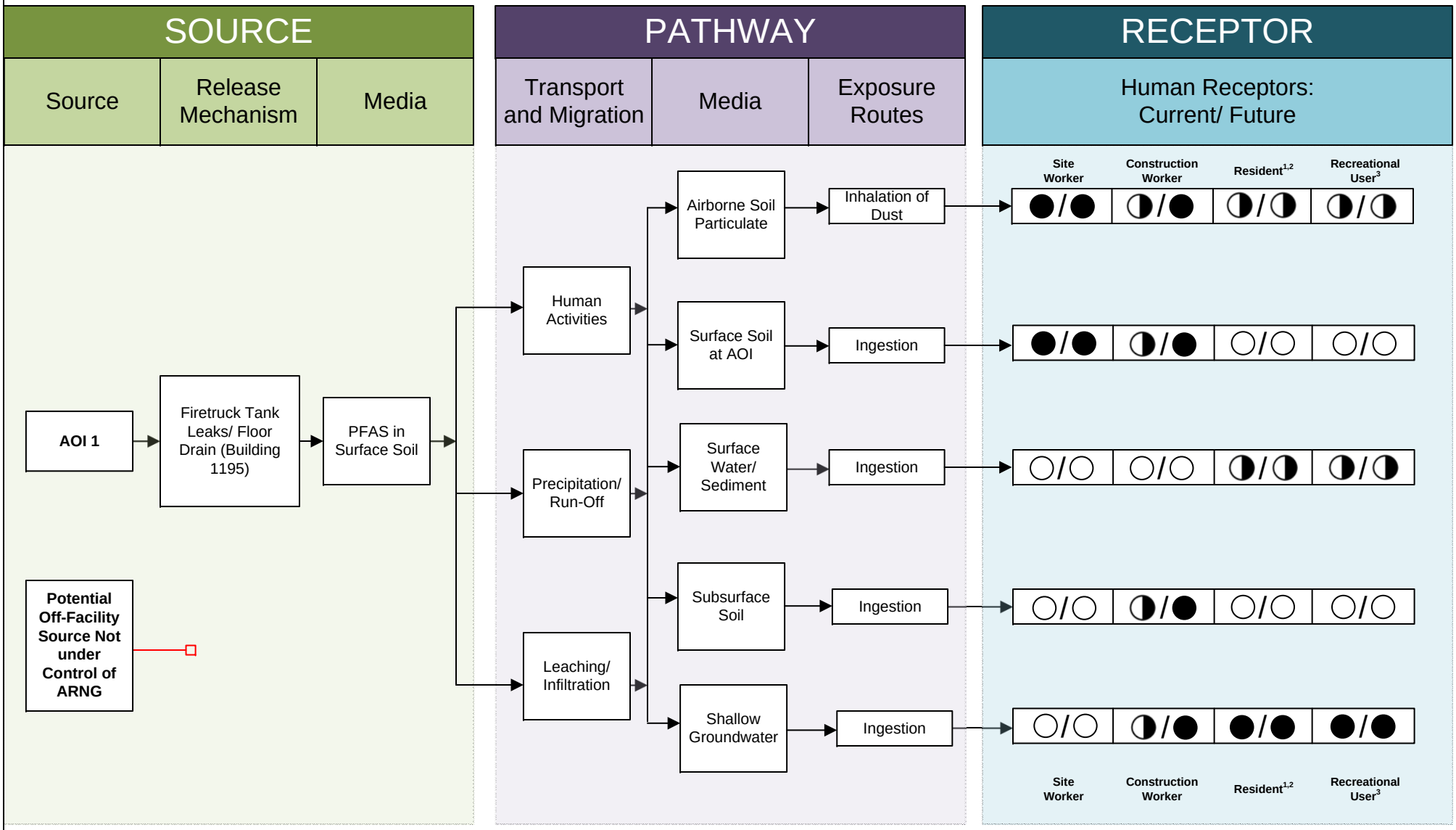
Residents southwest of Taxiway D, downgradient of AOI 4, are supplied by shallow private drinking water wells. PFAS have been detected in these wells with an exceedance of 70 ng/L for PFOS and/or PFOA at one location (MDEQ, 2018c); therefore, the ingestion exposure pathway for groundwater is complete for off-facility residents relative to the PFAS release area at Taxiway D. The ingestion exposure pathway is also considered complete for construction workers during trenching activities deep enough to encounter shallow groundwater. The ingestion exposure pathway is also considered complete for construction workers during trenching activities deep enough to encounter shallow groundwater. The CSM is presented on **Figure 7-4**.

7.2.5 AOI 5

PFAS were detected in groundwater at the City of Grayling Fire Department FTA but were not detected at the Bivouac Area. The detections at the City of Grayling Fire Department FTA did not exceed the PALs for PFOS and/ or PFOA; however, VAP-34 exceeded the PAL for PFOS at the facility boundary. Residents downgradient of the City of Grayling Fire Department FTA are supplied by shallow private drinking water wells. As such, the ingestion pathway for groundwater is complete for off-facility residents for the City of Grayling Fire Department FTA. The ingestion exposure pathway is also considered complete for construction workers during trenching activities deep enough to encounter shallow groundwater. The CSM is presented on **Figure 7-5**.

7.3 Surface Water and Sediment Exposure Pathway

The main stream and East Branch of the Au Sable River lay to the west and east of the GAAF boundary, respectively, off-facility, and are both hydraulically downgradient. Groundwater elevation data suggest the presence of a subtle groundwater divide at the Site between the river branches (**Figure 2-6**). Infiltration of rainfall recharges groundwater and likely follows a shallow flow system that discharges to either branch of the river, supporting water levels. Surface water and sediment in the Au Sable River were not sampled as part of this SI, as the scope of sampling was limited to the presence or absence of PFAS within the facility property. Therefore, the ingestion exposure pathways for surface water and sediment are potentially complete for off-facility residents and recreational users outside the facility of the Au Sable and the East Branch Au Sable (e.g., swimming and fishing).



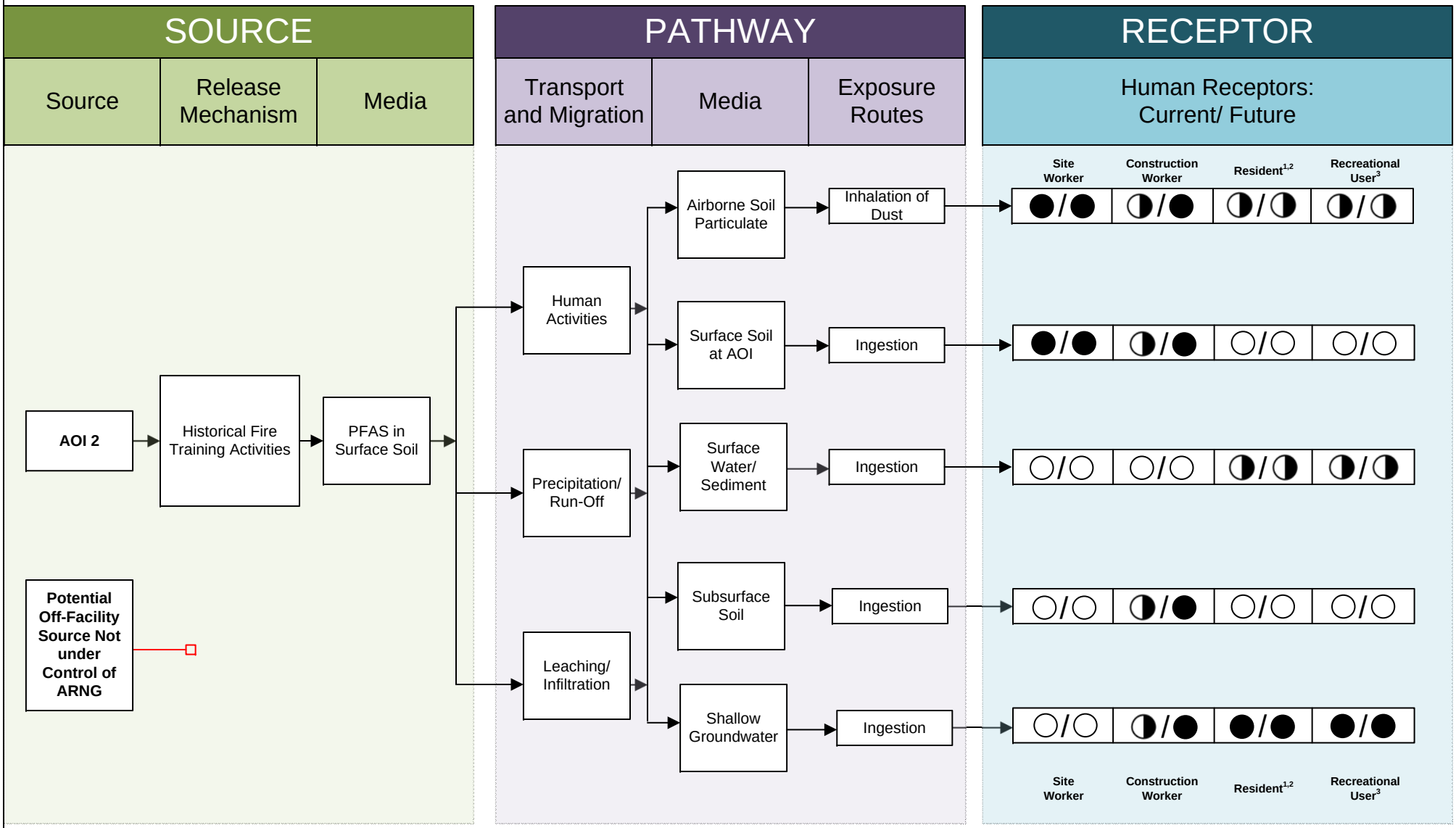
LEGEND

- Flow-Chart Stops
- Flow-Chart Continues
- Partial / Possible Flow
- Incomplete Pathway
- Potentially Complete Pathway
- Complete Pathway

NOTES

1. The resident receptor refers to an off-site resident.
2. Inhalation of dust for off-site receptors is likely insignificant.
3. Human consumption of fish potentially affected by PFAS is possible.

Figure 7-1
Conceptual Site Model
AOI 1 Grayling Army Airfield



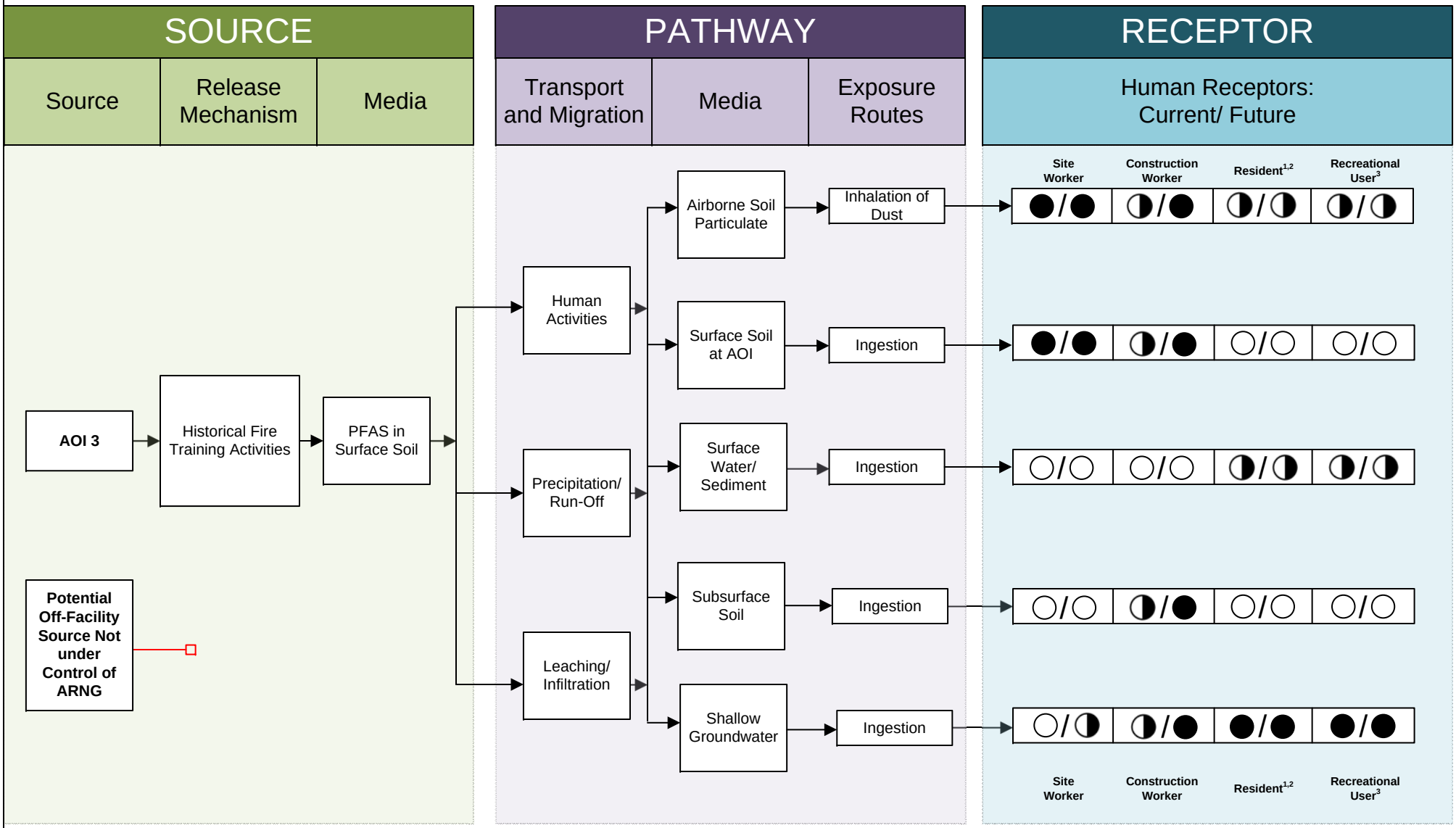
LEGEND

- Flow-Chart Stops
- Flow-Chart Continues
- Partial / Possible Flow
- Incomplete Pathway
- Potentially Complete Pathway
- Complete Pathway

NOTES

1. The resident receptor refers to an off-site resident.
2. Inhalation of dust for off-site receptors is likely insignificant.
3. Human consumption of fish potentially affected by PFAS is possible.

Figure 7-2
Conceptual Site Model
AOI 2 Grayling Army Airfield



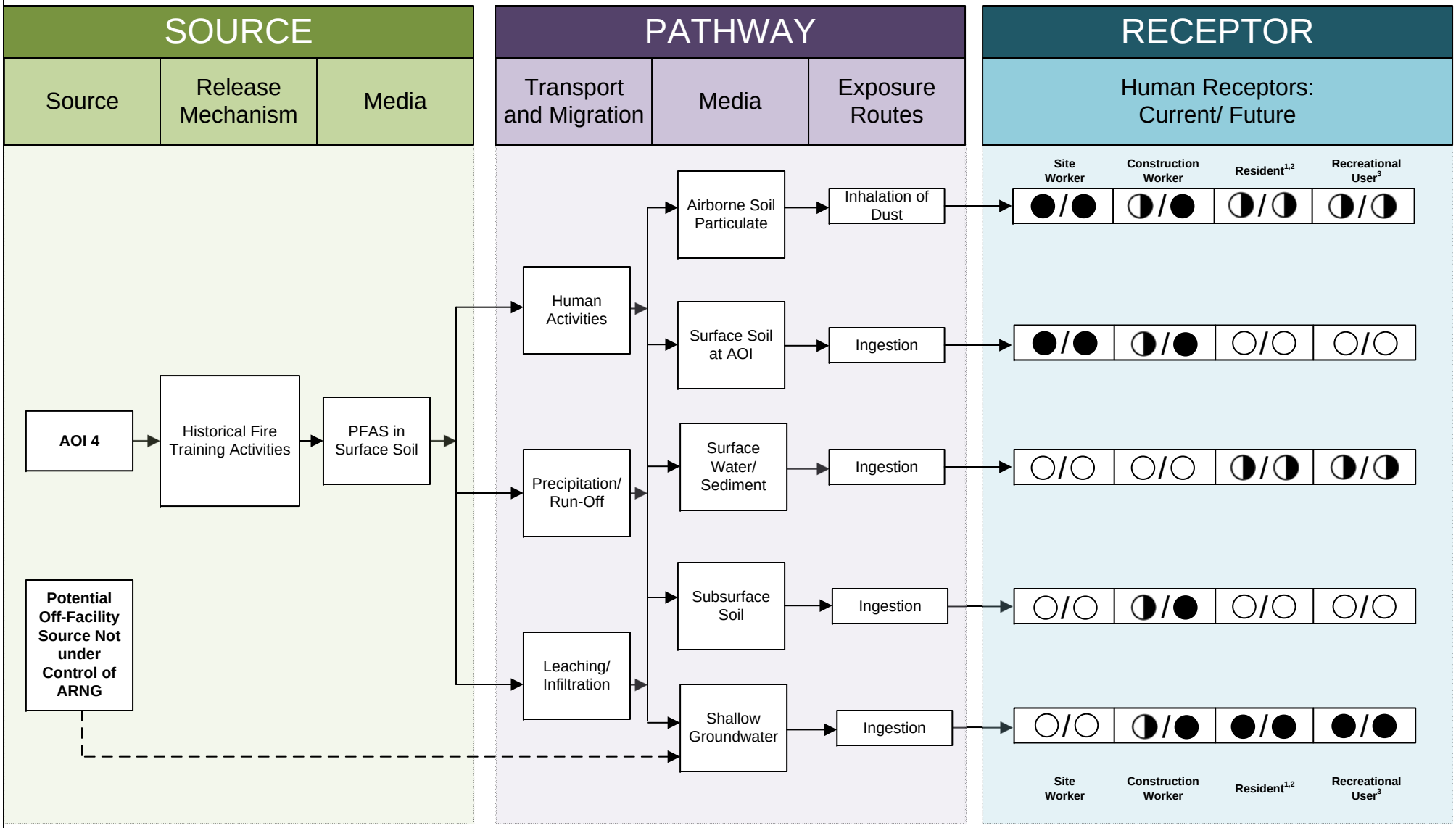
LEGEND

- Flow-Chart Stops
- Flow-Chart Continues
- Partial / Possible Flow
- Incomplete Pathway
- Potentially Complete Pathway
- Complete Pathway

NOTES

1. The resident receptor refers to an off-site resident.
2. Inhalation of dust for off-site receptors is likely insignificant.
3. Human consumption of fish potentially affected by PFAS is possible.

Figure 7-3
Conceptual Site Model
AOI 3 Grayling Army Airfield



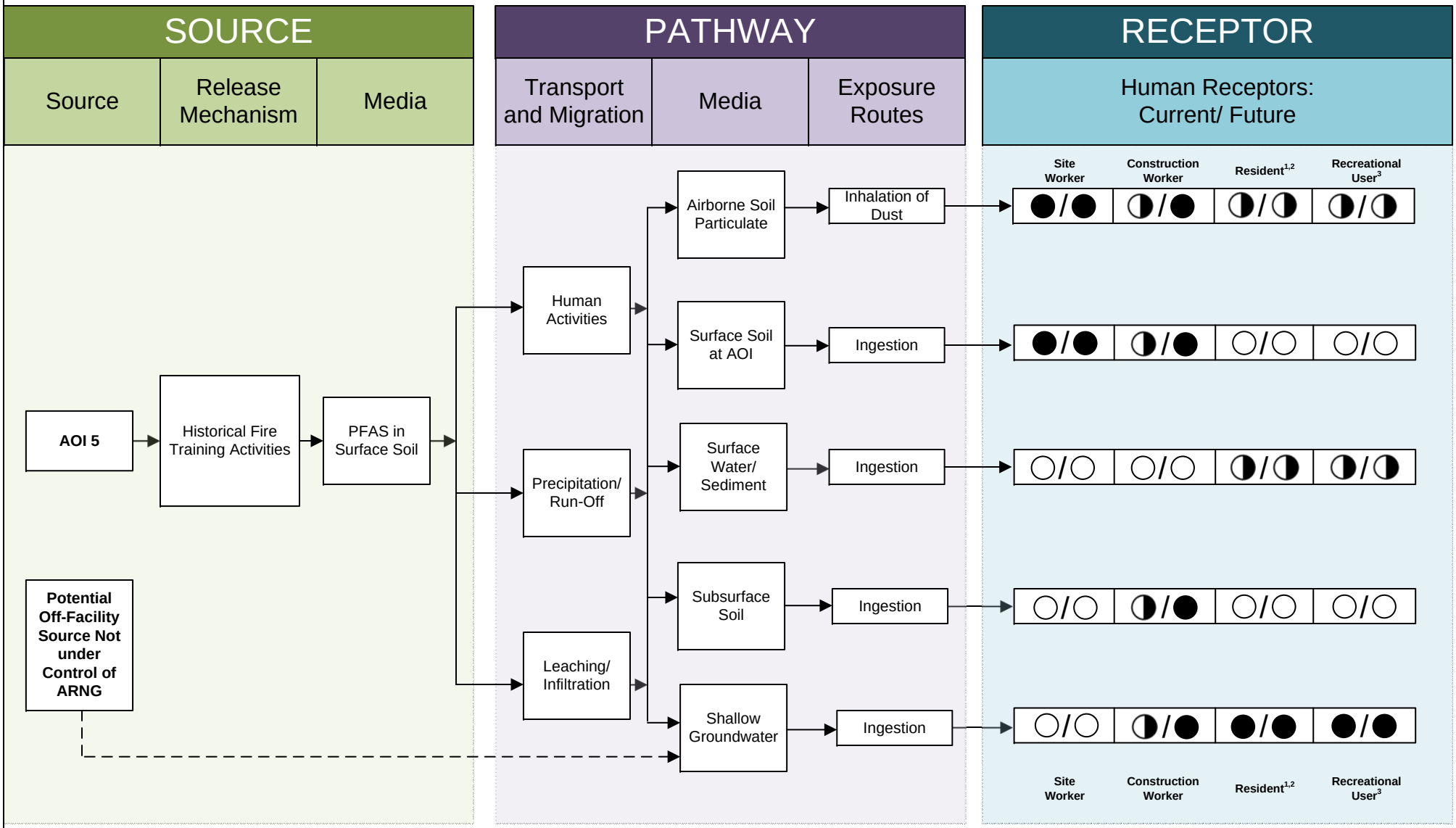
LEGEND

- Flow-Chart Stops
- Flow-Chart Continues
- Partial / Possible Flow
- Incomplete Pathway
- Potentially Complete Pathway
- Complete Pathway

NOTES

1. The resident receptor refers to an off-site resident.
2. Inhalation of dust for off-site receptors is likely insignificant.
3. Human consumption of fish potentially affected by PFAS is possible.

Figure 7-4
Conceptual Site Model
AOI 4 Grayling Army Airfield



LEGEND

- Flow-Chart Stops
- Flow-Chart Continues
- Partial / Possible Flow
- Incomplete Pathway
- Potentially Complete Pathway
- Complete Pathway

NOTES

1. The resident receptor refers to an off-site resident.
2. Inhalation of dust for off-site receptors is likely insignificant.
3. Human consumption of fish potentially affected by PFAS is possible.

Figure 7-5
Conceptual Site Model
AOI 5 Grayling Army Airfield

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8. Summary and Outcome

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

8.1 SI Activities

SI field activities were conducted in two phases. Phase I was completed from 10 to 20 September 2018 and consisted of temporary well installation and abandonment and soil and groundwater grab sampling. Phase II was completed from 6 to 22 October 2018 and consisted of permanent groundwater monitoring well installation, development, and sampling. Field activities were conducted in accordance with the QAPP Addendum (AECOM, 2018e), except as previously noted in **Section 5.9**.

To fulfill the project DQOs set forth in the approved SI QAPP Addendum (AECOM, 2018e), samples were collected and analyzed for PFAS via PFAS by LCMSMS Compliant with QSM 5.1 Table B-15 as follows:

- 66 soil grab samples from 22 boring locations;
- 31 groundwater grab samples from 22 temporary well locations, 5 existing permanent monitoring well locations and 4 VAP locations; and
- 11 groundwater samples from permanent monitoring well locations.

This information gathered during this investigation was used to determine the presence or absence of PFAS, and if PFOS and PFOA concentrations exceeded the PALs. Additionally, the CSMs were refined to assess whether a complete pathway exists between the source and potential receptors for potential exposure to PFAS 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 PFAS contamination at the Site.*

PFAS contamination was confirmed to be present at the Site in both soil and groundwater. PFAS were detected both at the source areas as well as at the facility boundary between source areas and potential drinking water receptors. Detections in groundwater exceeded the DoD action level (i.e., PAL) of 70 ng/L in all AOIs.

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.*

Two potential PFAS release areas were removed from further consideration based on the groundwater data collected during this SI: Northwestern End of Runway 14/32 in AOI 4 and the Bivouac area in AOI 5. PFAS were not detected in groundwater above the PALs in either of these areas; therefore, these areas pose no significant threat to human health or the environment.

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

Based on the data collected during this SI, the facility boundary sampling performed in 2017 by MDMVA, and the off-facility residential well sampling being performed by MDEQ, the need for a

removal action was identified for the area surrounding GAAF. As described in **Section 2.4**, a TCRA AM has been drafted for the affected properties with PFOS and/or PFOA concentrations in excess of the 70 ng/L action level in groundwater and is currently under review as of the date of this report. Through state funding, Michigan District Health Department #10-Crawford County has implemented PFAS mitigation measures by providing single point-of-use in-home treatment filters for residences with any detections of PFOS and/or PFOA since 2017; therefore, the pathway for consumption of PFAS impacted drinking water has been disrupted.

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

The geological data collected as part of the SI indicate a highly permeable and conductive environment with soils dominated by well-graded sand with thin beds and lenses of gravel and mud clasts. The clay lenses observed in the southeastern portion of GAAF appear to be discontinuous in nature, making three-dimensional flow patterns difficult to predict.

These site observations are consistent with sedimentary deposition from a braided river in a glaciofluvial environment. The well-graded sands represent the bulk of the sediment load transported and deposited in the braided river system, supplied by melting ice at the glacier terminus. The well-graded gravel intervals represent isolated point bar deposits, whereas the siltier and thin clayey intervals likely represent discontinuous floodplain deposits characteristic of braided rivers. Thicker clay deposits represent isolated channel fill, as the braids migrated and abandoned former channel flow paths.

Depth to water at GAAF ranges from approximately 6 to 15 ft bgs. A groundwater divide was observed running along the approximate center line of GAAF in a north-south trending direction. Groundwater on the eastern portions of the airfield generally flows to the southeast, and groundwater on the western portions of GAAF generally flows to the south-southwest. Due to the highly permeable and conductive nature of the subsurface in this area, groundwater flow velocity is very fast; approximately 1 to 1.5 ft per day (MDMVA, 2007). These geologic and hydrogeologic observations inform development of technical approach for the RI.

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

Based upon the qualitative evaluation of soil results in combination with quantitative groundwater results and groundwater flow direction analysis, all but one sampling location indicate that the source of PFAS contamination is likely the result of historical DoD activities. The groundwater results observed at GAAF-MW-11, which is located at the northern most end of the facility property, indicate that PFAS likely originates at a location other than DoD, as groundwater is flowing onto the facility property in a north to south direction. As such, ARNG will not evaluate the area surrounding GAAF-MW-11 further.

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

Positive detections of PFAS in soil and groundwater at source areas and the facility boundary, in concert with known PFAS detections in downgradient residential drinking water samples collected by MDEQ, indicate there is a complete pathway between source and receptor.

8.3 Outcome

Based on the CSMs developed and revised in light of the SI findings, there is potential for exposure to residential drinking water receptors from AOI 1, AOI 2, AOI 3, AOI 4, and AOI 5 from

sources on GAAF from AFFF releases resulting from historical DoD activities. Off-facility investigations performed by MDEQ indicate that drinking water receptors have impacts downgradient from on-facility AOIs.

Sample chemical analytical concentrations collected during this SI and past investigations (Amec Foster Wheeler, 2017a) were compared against the PALs for PFOS and PFOA in groundwater. The following bullets summarize the SI results:

- PFOS and/ or PFOA in groundwater were confirmed to exceed the PAL of 70 ng/L in groundwater at AOI 1, AOI 2, AOI 3, AOI 4, and AOI 5 at the source areas and/or at downgradient facility boundary locations. As such, these AOIs will be evaluated further in a forthcoming RI.
- PFAS in soil and groundwater were confirmed at the source areas and the facility boundary in AOI 1, AOI 2, AOI 3, AOI 4, and AOI 5.
- Two specific potential PFAS release areas, Bivouac Area in AOI 5 and Northwestern End of Runway 14/32 in AOI 4, did not detect PFOS or PFOA in groundwater; and therefore, will have no further sampling or evaluation.
- A groundwater sample at boundary location VAP-01 in AOI 4, which is side-gradient to potential PFAS release area Northwestern End of Runway 14/32, had an exceedance of the PAL, 70 ng/L, for PFOA (97 ng/L). As such, the area proximal to VAP-01 will be evaluated further in a forthcoming RI.
- Monitoring well GAAF-MW-11, installed at the northern most boundary of GAAF, shows that PFAS are likely coming onto the facility property at low-level concentrations. PFOS was detected in groundwater at a concentration of 7.18 ng/L. Based on groundwater flow, it is unlikely that the PFAS detections observed in groundwater at this location are attributable to ARNG activities in this specific location. However, limited soil sampling is recommended within the vicinity of GAAF-MW-11 that will be complted under the RI phase of work to confirm no surface release occurred in this area.

Tables 8-1 and **8-2** summarize the SI groundwater data findings for analytes with promulgated and actionable standards (i.e., PFOS and PFOA) used to determine if the AOI should be considered for further action under CERCLA and undergo an RI. Based on the findings of this SI, it is recommended that this Site proceed to an RI.

Table 8-1: Site Inspection Findings

AOI	Potential PFAS Release Area	Groundwater-Source Area	Groundwater-Near Boundary [a]
1	Building 1194 Ramp (Building 1195)	◐	●
1	Building 1160	●	●
2	Southeastern End of Runway 14/32	◐	●
2	Between Former MATES and Runway 14/32	●	●
3	Former MATES	●	●
4	Taxiway D	◐	●
4	Northwestern End of Runway 14/32	○	○
4	Area Near VAP-01	Not Applicable	●
5	Bivouac Area	○	○
5	City of Grayling Fire Department	◐	●

Legend:

● = exceedance of the Project Action Levels

◐ = detected; no exceedance of the Project Action Levels

○ = not detected

Notes:

a.) The facility boundary sample data collected near the off-facility receptors were collected in 2017 by MDMVA (Amec Foster Wheeler, 2017a).

Table 8-2: Site Inspection Recommendations

AOI	Description	Rationale	Future Action
1	Building 1194 Ramp (Building 1195)	Detections in groundwater at source area and exceedances of the PALs at facility boundary; downgradient exceedances in off-facility drinking water	Proceed to RI
1	Building 1160 Operations Building	Exceedances of the PALs in groundwater at source area and facility boundary; downgradient exceedances in off-facility drinking water	Proceed to RI
2	Southeastern End of Runway 14/32	Detections in groundwater at source area and exceedances of the PALs at facility boundary	Proceed to RI
2	Between Former MATES and Runway 14/32	Exceedances of the PALs in groundwater at source area and facility boundary	Proceed to RI
3	Former MATES	Exceedances of the PALs in groundwater at source area and facility boundary; downgradient exceedances in off-facility drinking water	Proceed to RI
4	Taxiway D	Detections in groundwater at source area and exceedances of the PALs at facility boundary; downgradient exceedances in off-facility drinking water	Proceed to RI
4	Northwestern End of Runway 14/32	Non-detect values in groundwater at source area	No further action
	Area Proximal to VAP-01	Exceedances of the PALs at facility boundary location during previous investigation, side gradient to potential PFAS release area (Amec Foster Wheeler, 2017a)	Proceed to RI
5	Bivouac	Non-detect values in groundwater at source area	No further action
5	City of Grayling Fire Department	Detections in groundwater at source area and exceedances of the PALs at facility boundary	Proceed to RI

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