FINAL PRELIMINARY ASSESSMENT AND SITE INSPECTION OF PER- AND POLYFLUOROALKYL SUBSTANCES

Redstone Arsenal, Alabama

Prepared For:
U.S. Army Corps of Engineers, Baltimore District
2 Hopkins Plaza
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Final

Preliminary Assessment and Site Inspection of Per- and Polyfluoroalkyl Substances

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Daria Navon
Site Inspection Project Manager, Arcadis U.S., Inc.

Rhonda Stone, PMP
Project Manager, Arcadis U.S., Inc.

Keith White
Principal Karst Hydrogeologist/Technical Expert, Arcadis U.S., Inc.

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Prepared by:

Arcadis U.S., Inc.

7550 Teague Road

Suite 210

Hanover

Maryland 21076

Arcadis Ref.:

30001992.3AC10

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EXECUTIVE SUMMARY

The United States (U.S.) Army is performing preliminary assessments (PAs) and site inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS), with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS), at Army installations (installations) nationwide. The PA identifies areas of potential interest (AOPIs) where PFAS-containing materials were used, stored, and/or disposed, or areas where known or suspected releases to the environment occurred. The SI includes multi-media sampling at AOPIs to determine whether a release has occurred. The SI may conclude further investigation is warranted, a removal action is required to address immediate threats, or no further action is required. The PA/SI for U.S. Army Garrison Redstone Arsenal (RSA) was completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), the National Oil and Hazardous Substances Pollution Contingency Plan, and Army/Department of Defense (DoD) policy and guidance.

RSA is located in Madison County, Alabama, adjacent to the cities of Madison and Huntsville. The installation encompasses approximately 38,300 acres and is approximately 10 miles long from north to south and 6 miles wide from east to west. In addition to the U.S. Army-controlled portions (approximately 36,459 acres), approximately 1,841 acres, located in the central portion of RSA, are leased to the National Aeronautics and Space Administration George C. Marshall Space Flight Center (MSFC). This PA/SI focuses on the U.S. Army-controlled portions of RSA and does not include MSFC.

The RSA PA identified 28 AOPIs for investigation during the SI phase. SI sampling results from the 28 AOPIs were compared to risk-based screening levels calculated by the Office of the Secretary of Defense (OSD) for PFOS, PFOA, and PFBS. PFOS, PFOA, and/or PFBS were detected in soil and/or groundwater at 27 AOPIs; 16 of the 27 AOPIs had PFOS, PFOA, and/or PFBS present at concentrations greater than the OSD risk-based screening levels. The RSA PA/SI identified the need for further study in a CERCLA remedial investigation. **Table ES-1** below summarizes the PA/SI sampling results and provides recommendations for further study in a remedial investigation or no action at this time for each AOPI.

Table ES-1. Summary of AOPIs Identified During the PA, PFOS, PFOA, and PFBS Sampling at Redstone Arsenal, and Recommendations

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	GW	SO	
Fire Station #2 (Building 3320)	Yes	Yes	Further study in a remedial investigation
Hangar 6312	No	No	No action at this time
Building 7370 – Thiokol Teflon-Coating Facility	Yes	No	Further study in a remedial investigation

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	GW	SO	
Fire Station #3 (Building 7801)	Yes	Yes	Further study in a remedial investigation
Transformer Fire	Yes	No	Further study in a remedial investigation
Old Fire Station #2 (Building 8014)	Yes	No	Further study in a remedial investigation
Fire House Pub (Building 114)	Yes	No	Further study in a remedial investigation
Mulcher Fire	NS	ND	No action at this time
Keyhole/Nozzle Testing Area	No	Yes	Further study in a remedial investigation
Fire Training Area	Yes	Yes	Further study in a remedial investigation
Fire Station #4 (Building 4810)	Yes	No	Further study in a remedial investigation
Fire Station #5 (Building 4813)	Yes	No	Further study in a remedial investigation[1]
Hangar 4815	Yes	No	Further study in a remedial investigation[1]
Hangar 4832	No	No	No action at this time
Hangar 4880	NS	No	No action at this time
Fire Station #1 (Building 4424)	Yes	No	Further study in a remedial investigation
Vehicle Fire (Building 4650)	No	No	No action at this time
Landfill Fire	No	No	No action at this time
Building 5681 Fire	No	NS	No action at this time
Old Fire Station #1 (Building 5414)	No	No	No action at this time
Fuel Tank Fire	Yes	No	Further study in a remedial investigation

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	GW	SO	
FBI – AFFF Storage Area (Building 7017)	No	No	No action at this time
FBI AFFF Storage Area– (Building 9061)	NS	No	No action at this time
Aircraft Crash Site	NS	No	No action at this time
Former Fire Station – Building T-3241	Yes	No	Further study in a remedial investigation
Inactive Sewage Treatment Plant #1	Yes	ND	Further study in a remedial investigation
Inactive Sewage Treatment Plant #3	Yes	No	Further study in a remedial investigation
Inactive Sewage Treatment Plant #4	No	No	No action at this time

Notes:

1. PFOS was detected in sample RSA-4815-GW-02, collected from the septic tank drain field that historically served both Fire Station #5 and Hangar 4815. During data validation, it was noted that the extracted internal standard recovery for PFOS was outside control limits. PFOS is considered present; however, the reported value has unknown bias, is unreliable, and cannot be compared to screening criteria. Another groundwater sample (RSA-FS4-GW-01) collected directly downgradient of both Fire Station #5 and Hangar 4815 had a detection of PFOS at 46 nanograms per liter (ng/L), exceeding the OSD risk screening level of 40 ng/L. Therefore, Fire Station #5 and Hangar 4815 are recommended for further study in a remedial investigation.

Light gray shading – detection greater than the OSD risk screening level
GW – groundwater
ND – non-detect
NS – not sampled
SO – soil

1 INTRODUCTION

The United States (U.S.) Army (Army) is performing preliminary assessments (PAs) and site inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS), with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS), at Army installations (installations) nationwide. The Army is the lead agency under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Executive Order 12580 and is conducting the PAs/SIs consistent with its authority under CERCLA, 42 United States Code §§ 9600, et seq. (as amended), and the Defense Environmental Restoration Program, 10 United States Code §§ 2701, et seq.

The U.S. Army Garrison Redstone Arsenal (RSA) PFAS PA/SI included two distinct efforts. The PA identified locations that are areas of potential interest (AOPIs) at RSA based on the use, storage, and/or disposal of PFAS-containing materials, in accordance with the 2018 Army Guidance for Addressing Releases of Per-and Polyfluoroalkyl Substances (Army 2018). The SI included multi-media sampling at AOPIs to determine whether a release has occurred, and comparison of the PFOS, PFOA, and PFBS results to the Office of the Secretary of Defense (OSD) PFOS, PFOA, and PFBS risk screening levels to determine whether further investigation is warranted. This report summarizes the PA/SI for RSA and was completed in accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan.

1.1 Project Background

PFAS are a class of compounds that have been used in a wide range of industrial applications and commercial products due to their unique surface tension/leveling properties. Due to industry and regulatory concerns about the potential health effects and adverse environmental impacts, there has been a reduction in the manufacture and use of PFAS worldwide. In the U.S., significant reductions in the production, importation, and use of PFOS and PFOA (two individual compounds in the PFAS class) occurred between 2001 and 2015 (Interstate Technology and Regulatory Council 2020a). PFBS replaced PFOS in some applications and is currently used and manufactured in the U.S.

In 2016, the United States Environmental Protection Agency (USEPA) established a lifetime health advisory of 70 nanograms per liter (ng/L) in drinking water for PFOS or PFOA and for the sum of PFOS and PFOA when both are present (USEPA 2016). On 15 October 2019, the OSD provided guidance on the investigation of PFOS, PFOA, and PFBS at Department of Defense (DoD) restoration sites (OSD 2019). The DoD guidance provides risk screening levels for PFOS, PFOA, and PFBS in tap water and soil, calculated using the USEPA's Regional Screening Level (RSL) calculator for residential and industrial/commercial worker receptor scenarios. Following the issuance of the 2019 OSD memorandum, on April 8, 2021, USEPA published an updated toxicity assessment for PFBS (USEPA 2021). Based on the updated toxicity assessment for PFBS, the OSD issued a memorandum on September 15, 2021 to include updated PFBS risk screening levels (OSD 2021). The September 2021 Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program is provided for reference as **Appendix A**. The OSD risk screening levels for tap water (also used to evaluate groundwater or surface water used as drinking water sources) are 40 ng/L for PFOS and PFOA,

and 600 ng/L for PFBS. The PFOS and PFOA soil screening levels for the residential and industrial/commercial scenarios are 0.13 milligrams per kilogram (mg/kg) (residential) and 1.6 mg/kg (industrial/commercial). The soil screening levels for PFBS are 1.9 mg/kg (residential) and 25 mg/kg (industrial/commercial). These screening criteria are discussed further in **Section 6.5**.

1.2 PA/SI Objectives

This PA/SI was conducted consecutively because the results of the PA yielded AOPIs that necessitated continuing onto the SI phase in accordance with CERCLA. Consequently, this report provides the combined objectives of both PA and SI reports.

1.2.1 PA Objectives

During the PA, investigators collect readily available information and conduct a site reconnaissance. The RSA PA was conducted to evaluate and document areas where PFAS-containing materials were used, stored, and/or disposed, so the Army can distinguish between sites that pose little or no threat to human health and the environment and sites that require further investigation.

1.2.2 SI Objectives

An SI is conducted when the PA determines an AOPI exists based on probable use, storage, and/or disposal of PFAS-containing materials. The SI includes multi-media sampling at AOPIs to determine whether a release has occurred. The SI may conclude further investigation is warranted, a removal action is required to address immediate threats, or no further action is required.

Installation-specific data quality objectives (DQOs) and the sampling design and rationale are summarized in **Sections 6.1** and **6.2**.

1.3 PA/SI Process Description

For RSA, PA/SI development followed a similar process as described below. **Section 3** provides a summary of the PA activities completed, and **Section 6** provides a summary of the SI activities completed for RSA. The PA and SI processes are documented in the PA/SI Quality Control Checklist included as **Appendix B**.

1.3.1 Pre-Site Visit

First, an installation kickoff teleconference was held between applicable points of contact (POCs) from United States Army Environmental Command (USAEC), United States Army Corps of Engineers (USACE), RSA, and Arcadis U.S., Inc. (Arcadis). The kickoff call occurred on September 20, 2018, approximately six weeks before the site visit, to discuss the goals and scope of the PA, project scheduling, installation access, timeline for the site visit, access to installation-specific databases, and to request available records.

A records review was conducted before the site visit to obtain electronically available documents from the installation and external sources for review. The purpose of the records research was to identify any area

on the installation that may have been a location where PFAS-containing materials were used, stored, and/or disposed, as well as to gather information on the physical setting and site history at RSA.

A read-ahead package was prepared and submitted to the appropriate POCs two weeks before the site visit. The read-ahead package contains the following information:

- The Installation Management Command (IMCOM) operation order
- The Army PA Operations Security requirements package, which includes the antiterrorism/operations security review cover sheet (**Appendix C**)
- The PFAS PA kickoff call minutes
- An information paper on the PA portion of the Army's PFAS PA/SI program
- Contact information for key program POCs
- A list of the data sources requested and reviewed
- A list of preliminary locations identified during the kickoff call and pre-site visit records review to be evaluated for use, storage, and/or disposal of PFAS-containing materials, where additional information on those areas will be collected through personnel interviews, additional document review, and site reconnaissance
- A list of roles for the installation POC to consider when recommending potential interviewees.

1.3.2 Preliminary Assessment Site Visit

The site visit was conducted from October 29 to 31, 2018. An in-brief meeting was held on October 29, 2018 to provide installation staff with the objectives of the site visit and team introductions. **Section 3** includes information regarding personnel interviewed and areas where site reconnaissance activities were performed during the site visit.

Personnel interviews were conducted with individuals having significant historical knowledge of RSA. The interviews focused on confirming information discussed in historical documents, collecting information that may not have been included in historical documents, and corroborating other interviewees' information.

The site reconnaissance included visual surveys that assessed the points of potential use, storage, and/or disposal of PFAS-containing materials, as well as potential secondary impacts, and the migration potential from each AOPI (e.g., stormwater drains, building drains and sumps, cracks in the floor/pavement). Physical attributes of the preliminary locations were documented, including local slope and ground and floor conditions (i.e., paved, unpaved, visual staining), surface water bodies and surface flow, potential receptors, and distance to the installation boundary. Access to existing groundwater monitoring wells, if present, was also noted during the site reconnaissance in case the monitoring wells could be proposed for SI sampling. Photo documentation of the preliminary locations was collected, and access limitations or advantages related to potential future sampling activities were noted.

An exit briefing was offered to installation personnel at the conclusion of the site visit to raise any items identified during the site visit, discuss any follow-up items, and review the schedule for submitting

deliverables. The exit briefing was conducted on October 31, 2018 with the installation and USAEC to discuss preliminary findings of the PA site visit.

1.3.3 Post-Site Visit

Information collected before, during, and after the site visit was reviewed and corroborated by cross-referencing records and reviewing interview details and observations noted during the site visit reconnaissance. A site visit trip report was completed and provided to the installation POC, applicable USAEC POCs, and USACE regional POCs following the site visit. The information collected during the pre-site visit and site visit activities was compiled to develop the installation-specific PA portion of the PA/SI report (**Section 3**). Site data obtained during the PA were used to develop preliminary conceptual site models (CSMs) for each AOPI, which served as the basis for developing the SI scope of work presented in an installation-specific Quality Assurance Project Plan (QAPP) Addendum (Arcadis 2020a).

1.3.4 Site Inspection Planning and Field Work

The SI process was initiated at the installation to evaluate PFOS, PFOA, and PFBS presence or absence at each AOPI and to determine whether further investigation is warranted. First, an SI kickoff teleconference was held between the Army PA team and RSA personnel.

The objectives of the SI kickoff teleconference were to:

- discuss the AOPIs selected for sampling and the proposed sampling plan for each AOPI
- gauge regulatory involvement requirements or preferences
- identify specific installation access requirements and potential schedule conflicts
- discuss general SI deliverable and field work schedule information and logistics.

Following development of the SI sampling technical approach, an SI scoping teleconference was held to obtain concurrence on the SI sampling plan from USAEC, USACE, and the installation. Additional discussion topics included:

- confirm regulatory involvement requirements or preferences
- identify overlapping unexploded ordnance (UXO) or cultural resource areas
- confirm the plan for investigation-derived waste (IDW) handling and disposal
- confirm specific installation access requirements and potential schedule conflicts
- provide an updated SI deliverable and field work schedule.

A Programmatic Uniform Federal Policy-Quality Assurance Project Plan (PQAPP) was developed and finalized in October 2019 for the USAEC PFAS PA/SI program (Arcadis 2019). The PQAPP details general planning processes for collecting data and describes the implementation of quality assurance (QA) and quality control (QC) activities for the SI portion of the program for Army installations nationwide. Additionally, an installation-specific QAPP Addendum was developed to define the DQOs, present the sampling design and rationale, and provide qualifications for project personnel (Arcadis 202a). The SI field work was completed in accordance with the PQAPP and the approved installation-specific QAPP

Addendum. A Site Safety and Health Plan (SSHP) was also developed as an attachment to the QAPP Addendum to identify specific health and safety hazards that may be encountered at the installation during sampling (Arcadis 2020b). The SSHP was designed to supplement the Accident Prevention Plan (Arcadis 2018), which was developed for Army installations nationwide. The QAPP Addendum and SSHP were submitted to the installation and finalized before commencement of field work.

The DQOs, sampling design and rationale, and field methods employed for the SI are summarized from the QAPP Addendum developed for RSA (Arcadis 2020a) in **Sections 6.1** through **6.3**.

After finalization of the QAPP Addendum and SSHP, field planning and coordination with the installation and subcontractors was completed. Once the schedule was determined, field teams mobilized to the installation to complete the scope of work defined in the QAPP Addendum.

1.3.5 Data Analysis, Validation, and Reporting

Environmental samples collected during the SI were submitted to a laboratory that is DoD Environmental Laboratory Accreditation Program (ELAP)-accredited for PFOS, PFOA, and PFBS analysis by liquid chromatography with tandem mass spectrometry and compliant with the DoD Quality Systems Manual (QSM) 5.3 (DoD and Department of Energy 2019). Laboratory analytical results were then validated and verified by a project chemist to assess the usability of the data collected. Validated analytical results were summarized in the context of OSD risk screening levels (defined in **Section 6.5**).

2 INSTALLATION OVERVIEW

The following subsections provide general information about RSA, including the location and layout, the installation mission over time, a brief site history, current and projected land use, climate, topography, geology, hydrogeology, surface water hydrology, potable wells within a 5-mile radius of the installation, and applicable ecological receptors.

2.1 Site Location

RSA is located in Madison County, Alabama, adjacent to the cities of Madison and Huntsville (**Figure 2-1**). The installation encompasses approximately 38,300 acres and is approximately 10 miles long from north to south and 6 miles wide from east to west. In addition to the U.S. Army-controlled portions (approximately 36,459 acres), approximately 1,841 acres, located in the central portion of RSA, are leased to National Aeronautics and Space Administration's (NASA) George C. Marshall Space Flight Center (MSFC). The Department of the Interior owns the 4,100-acre portion of Wheeler National Wildlife Refuge located in the southern portion of RSA and has permitted the land for use by RSA. An additional 2,905 acres of land adjacent to the northern shoreline of the Tennessee River is owned by the Tennessee Valley Authority, and is permitted for use by RSA (**Figure 2-2**).

RSA is bounded on the north and east by the City of Huntsville, on the west by the City of Madison, on the west and southwest by Wheeler National Wildlife Refuge, and on the south by the Tennessee River. The surrounding population of Huntsville and Madison totals approximately 485,000. Approximately 330 military families reside in government quarters on RSA, and approximately 34,000 government employees and contractors work at the facility.

2.2 Mission and Brief Site History

The land area of the present-day RSA was established in 1941 as three separate military facilities: the Redstone Ordnance Plant, the Huntsville Arsenal, and the Gulf Chemical Warfare Depot. These facilities worked together to produce conventional and chemical munitions for use during World War II. After World War II, the chemical manufacturing facilities were leased by the Army to privately owned firms for production of commercial chemicals and pesticides. From the late 1940s to the late 1970s, thousands of tons of commercial chemicals and pesticides, including dichlorodiphenyltrichloroethane (DDT), were produced at RSA. The current mission of RSA is the development, acquisition, testing, fielding, and sustainment of aviation and missile weapon systems. Most of the installation tenants support this effort; however, RSA is also home to such diverse activities as training for handling explosives and ordnance devices, Defense Intelligence Agency activities, and the production of iron carbonyl. RSA is home to more than 70 different tenant organizations (Redstone 2017a).

2.3 Current and Projected Land Use

Land use at RSA includes family housing and commercial, recreational, and medical centers in the northern portion; administrative facilities at NASA's MSFC in the central portion; properties administered by the U.S. Fish & Wildlife Service's Wheeler National Wildlife Refuge in the central and southern portions; an airfield with support hangars in the northwestern portion; industrial areas in the southeastern

portion; and missile/rocket ranges in the southern and western portions of RSA (CB&I Federal Services LLC [CB&I] 2015a). Most of RSA is undeveloped; buildings, roads, and other paved or impervious features occupy less than 4 percent of the total surface area of RSA (Shaw Environmental, Inc. [Shaw] 2003). The area surrounding the facility is mixed use and contains light industrial, residential, commercial, agricultural, and undeveloped properties. The population of the communities surrounding RSA totals approximately 485,000.

2.4 Climate

RSA is in a temperate climatic zone with hot summers and relatively mild winters. The average temperature ranges from approximately 49 degrees Fahrenheit (°F) in January to approximately 89°F in July. Average annual rainfall at RSA is approximately 52 inches, occurs throughout the year, and is variable on a monthly and seasonal basis (Shaw 2003). Peak rainfall occurs in February and March, while the lowest monthly rainfall typically occurs in August. In general, it is estimated that between 75 and 90 percent of incident rainfall is lost to evapotranspiration (Shaw 2003). Throughout summer, evapotranspiration exceeds monthly rainfall, resulting in a water deficit. In contrast, during the winter, evapotranspiration is minimal, and the resulting surplus of precipitation (approximately 5 to 13 inches) is available for groundwater recharge (Aptim Federal Services, LLC [Aptim] 2018b).

2.5 Topography

The general topography at RSA is gently rolling with elevations ranging from 555 to 650 feet above mean sea level (ft amsl). The terrain generally slopes toward the Tennessee River in the south (**Figure 2-3**). The terrain at RSA can be divided into two primary landform classes: erosional highlands and adjacent lowlands (Shaw 2003). Madkin, Weeden, and Hatton Mountains, as well as the highland area at the southern tip of RSA, are examples of the erosional highlands (Shaw 2003). With a height of 1,239 ft amsl, Madkin Mountain is the highest point at RSA. The erosional highlands extend across RSA, with the highest points located in the northern half of the installation with elevations decreasing to the south (860 ft amsl in the southern half of the installation). Flanking the erosional highlands are the adjacent lowlands. The lowlands can be described as slightly undulating, low-relief terrain that gradually slopes toward the Tennessee River to the south (Shaw 2003). Along the primary drainage features, the overall grades of these lowlands are on the order of 0.1 to 1 percent (Shaw 2003). The lowlands are characterized by elevations of approximately 555 to 560 ft amsl (Redstone Arsenal 2017b).

2.6 Geology

On a regional scale, the geology at RSA is relatively simple and is generally flat-lying carbonate and clastic sedimentary rocks inclined slightly to the south. Locally, however, complexities become apparent due to variations in the spatial extent of strata, lithology, and structural features. The variation in these features plays a significant role in the evolution of the karst terrain and the groundwater hydrology at RSA.

RSA is underlain by carbonate bedrock, which is covered by a mantle of unconsolidated material (i.e., regolith). Bedrock exposures are limited and generally restricted to the residual highlands and within the beds of RSA streams (Cook et al. 2015). Bedrock underlying RSA primarily consists of the Mississippian-

aged Tuscumbia Limestone and underlying Fort Payne Chert (Cook et al. 2015). In the erosional highlands (e.g., Madkin Mountain), which occupy a relatively small percentage of RSA, the following formations occur above the Tuscumbia Limestone: Pride Mountain shale and limestone, Hartselle sandstone, Bangor limestone, and Pennsylvanian Pottsville Formation (Cook et al. 2015). Typical depth to bedrock ranges from 10 to 86 ft below ground surface (bgs) and is highly variable even over short distances due to focused, solutional weathering of the bedrock surface (Shaw 2003). The regolith is classified as either residuum[1] or alluvium. Residuum at RSA typically consists of fat plastic clays containing lenses of fine sand, clayey sand, and silt, but can vary in composition and texture significantly throughout RSA (Shaw 2003). Alluvium can be recognized by significantly increased concentrations of coarse-grained clasts (sand, gravel, and cobbles) that are rounded to well rounded, micaceous, and markedly different in color. Most of the alluvial deposits at RSA are observed south of Huntsville Spring Branch (HSB) (Shaw 2003).

The stratigraphy identified at RSA includes a stacked sequence of Mississippian-aged limestones, the Tuscumbia Limestone, and underlying Fort Payne Chert, dipping gently to the south, with a dip angle of 0.4 to 1.4 degrees (Shaw 2003). The combined maximum thickness of the limestone bedrock is approximately 1,100 feet and thins to the north. Chert content increases with depth in the Tuscumbia Limestone to form a lithologically indistinct contact with the Fort Payne Chert below. The Fort Payne Chert ranges in thickness from 130 to 165 feet at RSA and can be described as a fossiliferous or dolomitic limestone with abundant chert nodules, lenses, and beds (Shaw 2003). Surficial exposure of the Fort Payne Chert is restricted to the northern portion of the installation. Beneath the Fort Payne Chert is the Mississippian-Devonian-aged Chattanooga Shale, which is approximately 2 to 10 feet thick at RSA. The Tuscumbia Limestone and Fort Payne Chert together form a highly prolific, karstic aquifer. The Chattanooga Shale forms the lower confining unit at the base of the Tuscumbia-Fort Payne aquifer.

2.7 Hydrogeology

The hydrogeology of RSA is complicated due to the presence of karst. Karst refers to a geologic terrane that is underlain by soluble rocks; at RSA this is the limestone. Groundwater dissolves the limestone, creating extremely complex underground drainage systems, caves, and sinkholes. The uppermost, highly weathered rind of the Tuscumbia Limestone is referred to as the epikarst. Recharge to the epikarst is both diffuse and focused. Diffuse recharge consists of relatively slow, uniform seepage of precipitation through the regolith. Where the water table occurs in the regolith, diffuse recharge occurs from regolith groundwater seeping into thin, relatively unweathered openings in the rock. Across much of RSA, the water table occurs in the regolith (Shaw 2003). As its name implies, focused recharge is concentrated at sinkholes and perhaps along a short reach of the HSB where bedrock crops out beneath it (Shaw 2003). During storm events, precipitation is essentially injected rapidly into the bedrock through solution-widened openings in the rock. The thickness of the epikarst varies widely but is inferred to average about 30 feet. The epikarst contains many cavities that are complexly connected to one another and filled with water, sediment, or some combination of the two. Where the water table occurs in the epikarst, some cavities

[1] Residuum consists of the unconsolidated weathered mineral material that has accumulated as consolidated limestone disintegrated in place.

may also be partially or entirely filled with air. Where the water table occurs in the regolith, some of the groundwater moves laterally toward six groundwater discharge boundaries: Indian Creek, McDonald Creek, HSB, Southeast Boundary Stream, Betts Spring Branch, and Tennessee River (Shaw 2003). However, much of the groundwater in the regolith moves downward into the epikarst. Collectively, the regolith and limestone bedrock comprise a single, unconfined aquifer.

Once in the epikarst, most groundwater moves through drainage system networks formed by interconnected, solution-widened conduits in the bedrock. Despite draining most of the groundwater moving through the limestone, these networks occupy a small volume of the rock; therefore, beneath the epikarst, most of the bedrock is relatively unweathered and poorly transmissive (Shaw 2003). The geometry of the networks is complex and cannot be reliably mapped. While the size and frequency of the solution-porosity networks decrease with depth, reducing the transmissivity of the aquifer, solution conduits carrying relatively young groundwater have been identified near the base of the limestone (Shaw 2003). Outside these networks, groundwater in the bedrock tends to be older, particularly with depth, and moves slowly toward the networks. Groundwater moving through the networks discharges at springs. Due to the drainage networks, groundwater flow velocities are higher than in non-karst settings. Velocities of hundreds of feet per day have been documented at RSA (Shaw 2003).

2.8 Surface Water Hydrology

Two primary stream systems drain RSA. HSB has a drainage area of approximately 86 square miles and flows southwesterly through low, swampy terrain across the installation where it joins Indian Creek. Indian Creek enters the installation along the northern boundary, flows south through western RSA, and has a drainage area of approximately 143 square miles (Redstone Arsenal 2017a). A small secondary stream, McDonald Creek, drains the northeastern portion of the installation and joins the upper reaches of HSB. A small perennial stream with a small but unquantified drainage area, named the Southeast Boundary Stream, flows along the southeastern boundary of RSA. These three systems empty into Wheeler Reservoir.[2] None of these surface streams are used for drinking water sources, but portions of HSB and Indian Creek may be used for recreational purposes.

The lower ends of both HSB and Indian Creek form permanent pools of the Wheeler Reservoir, within the Wheeler National Wildlife Refuge. The Tennessee River is used as a drinking water source for RSA and the surrounding communities.

In karst systems, groundwater flowing through conduits and fractures must discharge to the surface at some point. Most often this discharge is to one or more springs or spring systems, although discharge can be subaqueous to a river or other water body. As such, numerous springs are identified throughout RSA. Several additional surface water features are located within the boundaries of the RSA installation. Approximately one dozen small unnamed ponds are located throughout the installation. In the northwest, a small portion of Lady Anne Lake is located within the RSA boundary. In the southern portion of the

[2] Wheeler Reservoir was created when the Wheeler Dam was constructed across the Tennessee River in 1936; therefore, for the purposes of this report, the terms “Tennessee River” and “Wheeler Reservoir” are synonymous.

installation, there are three small ponds: Lees Pond, Cribbs Pond, and Rock Pond. These small surface water bodies are not used for drinking water, but several may be used for recreational purposes.

2.9 Relevant Utility Infrastructure

The following subsections provide general information regarding the installation's stormwater and wastewater management systems, as well as information on how the utility infrastructures may influence the fate and transport of PFAS constituents at RSA.

2.9.1 Stormwater Management System Description

The low overall topographic relief at RSA requires an extensive network of storm drains and ditches to rapidly convey rainfall away from industrialized portions of RSA, where impermeable surfaces such as buildings and paved areas limit infiltration. The channelization of streams is also necessary to convey runoff and limit flooding. McDonald Creek in the northeast, portions of HSB, and most of the ditches and small streams in and around RSA have been channelized to prevent localized flooding (Shaw 2003). Groundwater recharge may be limited in industrial areas due to paved surfaces, high building density, and associated stormwater management infrastructure, potentially resulting in local depressions in the potentiometric surface (Shaw 2003).

Due to the age of the stormwater management infrastructure at RSA, the system is potentially subject to leaking. These potentially leaky underground features may provide focused recharge and local groundwater mounding. The backfill surrounding the underground piping, where below the water table, may serve to facilitate transport of contaminants, occasionally in directions different from those implied by potentiometric surface mapping. The influence of these infrastructure elements has not been characterized but should be considered for sites within the industrialized portions of RSA. Similar age-related potential leakage issues may also impact the sanitary sewer system infrastructure components.

2.9.2 Sewer System Description

There is an extensive network of underground utilities, including sewer lines that drain to the sewage treatment plant (STP) located in the southern portion of RSA, off Buxton Road southeast of the intersection with Shield Road. Sanitary lines additionally flow to the inactive STP #3, which serves as overflow storage but is no longer used to actively treat sewage (CB&I 2015b). The active STP has been in operation since 1992, and is currently operated by PDR, Inc. Prior to 1992, sewage treatment was completed at four separate STPs, which are all currently designated as Installation Restoration Program (IRP) sites: STP #1 (RSA-011), STP #2 (RSA-228), STP #3 (RSA-009), and STP #4 (RSA-008). All treatment plants, except for STP #2, were operable during the period of AFFF use; therefore, they may have received PFAS contaminated wastes.

In addition to the sanitary sewer system, several septic systems are known to have been in use at the RSA airfield. These airfield septic systems are no longer in use. Septic systems at other locations around RSA are in use, particularly at test range buildings and in other remote areas. An extensive search for septic systems not associated with AOPIs was not conducted.

2.10 Potable Water Supply and Drinking Water Receptors

RSA receives drinking water from the Tennessee River, while the surrounding communities source water from both the Tennessee River and groundwater sources. Three water treatment plant (WTP) intakes are identified on the Tennessee River and within a 5-mile radius of RSA (**Figure 2-2**). The RSA WTP has a surface water intake in the southwestern portion of the installation. Two municipal WTPs owned by Huntsville Utilities are located on the Tennessee River, one upstream (South Parkway WTP) and one downstream (Southwest WTP) of RSA.

Groundwater resources at RSA are under an installation-wide land use control (LUC) per a 2007 Interim Record of Decision (IROD) such that "no drinking water wells shall be installed on the Arsenal; groundwater, including springs and seeps shall not be used for drinking water, or irrigation" (Shaw 2007). While no groundwater drinking water systems are active within the boundary of RSA, several potable groundwater systems are proximal to RSA and operated by Huntsville Utilities and the City of Madison. The primary water sources for Huntsville Utilities are intakes on the Tennessee River with supplemental supply from the Williams Well and the Lincoln and Dallas Well Treatment Plant and the Limestone County Water Authority's Turner WTP (Huntsville Utilities 2021). The primary water source for Madison Utilities is the newly constructed (March 2018) intake on the Tennessee River near Triana, which is treated at the Quarry WTP, with supplemental supply from the Drake Well during periods of high demand (Madison 2020). Additional seasonal backup water supply for Madison Utilities is sourced from several wells screening the Tuscumbia-Fort Payne aquifer. Groundwater produced by the wells is treated at the seasonally operated Keene WTP (Madison 2020).

The Williams and Drake Wells are located within 1 mile of the RSA installation boundary. The Williams Well, a 4.5-million-gallon-per-day well owned and operated by Huntsville Utilities, is located several hundred feet from the western RSA boundary (**Figure 2-2**). Communications with Huntsville Utilities indicate that the Williams Well has not been used for regular water supply since approximately 2012 and is currently designated as an emergency water source (EA and Arcadis 2015). The City of Madison operates the Drake Well, a 5-million-gallon-per-day supplemental groundwater supply well located approximately 2.3 miles north of the Williams Well (**Figure 2-2**).

An Environmental Data Resources, Inc. (EDR) report includes search results from a variety of environmental, state, city, and other publicly available databases for a referenced property. An EDR report was generated for RSA, which identified several off-post public and private wells within 5 miles of the installation boundary. The EDR report providing well search results is included as **Appendix E**. Although the City of Huntsville has an ordinance prohibiting the use of private groundwater supply wells, older residences in Madison County (outside of the City of Huntsville) may have private supply wells. According to the Madison County Health Department, if public water is available to a residential subdivision, private wells are prohibited within the subdivision (EA and Arcadis 2015). Well drilling has been strictly controlled through permitting in Madison County since the 1970s; no permits have been issued since that time (CB&I 2016).

2.11 Ecological Receptors

The PA team collected information regarding ecological receptors that was available in the installation documents. Additionally, a search of the U.S. Fish & Wildlife Service Information for Planning and

Consultation tool was completed. The following information is provided for future reference should the Army decide to evaluate exposure pathways relevant to the ecological receptors.

RSA is home to 52 species of concern, 13 of which are currently listed as threatened and endangered under the Endangered Species Act (Redstone Arsenal 2017b). Threatened species include a mammal (northern long-eared bat), a plant (Price's potato-bean), and a reptile (American alligator). Endangered species include mammals (gray bat and Indiana bat), gastropods (pink mucket, rough pigtoe, sheepnose mussel, snuffbox mussel, spectaclecase mussel, slender campeloma), crustaceans (Alabama cave shrimp), and flowering plants (Morefield's leather flower). The endangered Alabama cave shrimp is of particular note, as it has been identified in only five caves, all of which occur in Madison County, including Bobcat Cave on RSA and Muddy Cave to the southeast of RSA. Eight ecologically sensitive areas (including Bobcat Cave) spanning a total of approximately 3,500 acres have been identified at RSA (Redstone Arsenal 2017b).

2.12 Previous PFAS Investigations

In response to the third Unregulated Contaminant Monitoring Rule (UCMR3), water systems serving more than 10,000 individuals were sampled for PFAS compounds. Four public water supply (PWS) systems were sampled as part of UCMR3 sampling, covering Madison County, the City of Huntsville, and RSA. No detectable concentrations of PFOS, PFOA, or PFBS were found in these water system samples. The PWS systems sampled under UCMR3 in 2014 and/or 2015 are:

- Huntsville Utilities: PWS ID AL0000882
  - Lincoln/Dallas Treatment Plant (groundwater source)
  - Tennessee River (South Parkway) and Treatment Plant (river intake)
  - Tennessee River (Southwest) and Treatment Plant (river intake)
- Madison Waterworks and Sewer: PWS ID AL0000885
  - Kurt Keene Plant (river and groundwater sources)
  - Quarry Site #2 Treatment Plant (groundwater sources)
- Madison County Water Department: PWS ID AL0000888
  - Bo Howard Well Northwest Area and Treatment Plant (groundwater source)
  - Hazel Green Well and Treatment Plant (groundwater source)
  - Huntsville Intertie (system component)
  - Mountain Fort Water Treatment Facility (groundwater source)
- U.S. Army Aviation and Missile Command: PWS ID AL0000899
  - Tennessee River Plant 1 (river intake)
  - Tennessee River Plant 3 (river intake)

City of Madison water system components were sampled again for PFAS in 2019. Low-level detections of PFOS, PFOA, and PFBS were reported with maximum detections of 2 ng/L, 1 ng/L, and 3 ng/L,

respectively. The maximum total reported PFAS concentration was 10 ng/L (Madison 2020). In 2020, components of the Huntsville water systems were sampled again for PFAS. Low-level detections of PFBS (up to 5 ng/L) and total PFAS detections up to 10 ng/L were reported (Huntsville Utilities 2021).

3 SUMMARY OF PA ACTIVITIES

To document areas where any potential current and/or historical PFAS-containing materials were used, stored, and/or disposed at RSA, data were collected from three principal sources of information and are described in the subsections below:

1. Records review
2. Personnel interviews
3. Site reconnaissance.

Preliminary locations of potential use, storage, and/or disposal of PFAS-containing materials were then evaluated in the PA (during records review, personnel interviews, and/or site reconnaissance) and were categorized as AOPIs or as areas not retained for further investigation at this time based on a combination of information collected (e.g., records reviewed, personnel interviews, internet searches). A summary of the observations made and data collected through records reviews (**Appendix F**), installation personnel interviews (**Appendix G**), and site reconnaissance logs (**Appendix H**) during the PA process for RSA is presented in **Section 4**. Further discussion regarding rationale for not retaining areas for further investigation is presented in **Section 5.1**, and further discussion regarding categorizing areas as AOPIs is presented in **Section 5.2**.

3.1 Records Review

The records reviewed for this PA included, but were not limited to, various IRP administrative record documents, compliance documents, RSA fire department documents, RSA directorate of public works (DPW) documents, and GIS files. Internet searches were also conducted to identify publicly available and other relevant information. Additionally, an EDR report generated for RSA was reviewed to obtain off-post water supply well information. A list of the specific documents reviewed for RSA is provided in **Appendix F**.

3.2 Personnel Interviews

Interviews were conducted during the site visit. If a previously identified interviewee was not available during the site visit, attempts were made to complete the interview via telephone before or following the site visit or by contacting an alternate interviewee identified by the installation POC.

The list of roles for the installation personnel interviewed during the PA process for RSA is presented below (affiliation is with RSA unless otherwise noted):

- Airfield Manager
- Motor Pool Manager
- Environmental Restoration Branch Chief
- Environmental Restoration Project Manager
- Environmental Management Division Personnel

- Fire Chief
- Contractor (Wolf Creek Contractor)
- Pesticide Manager.

The compiled interview logs are provided in **Appendix G**.

3.3 Site Reconnaissance

Site reconnaissance and visual surveys were conducted at the preliminary locations identified at RSA during the records review process, the installation in-brief meeting, and the installation personnel interviews. The site reconnaissance logs are provided in **Appendix H**.

Access to existing groundwater monitoring wells, if present, was also noted during the site reconnaissance in case the monitoring wells were to be proposed for SI sampling.

4 POTENTIAL PFAS USE, STORAGE, AND/OR DISPOSAL AREAS

RSA was evaluated for all potential current and historical use, storage, and/or disposal of PFAS-containing materials. There are a variety of PFAS-containing materials used in relation to current and historical Army operations. However, the use, storage, and/or disposal of aqueous film-forming foams (AFFF) is the most prevalent potential source of PFAS chemicals at DoD facilities. As such, this section is organized to summarize the AFFF-related uses first, and all remaining potential PFAS-containing materials in the subsequent section.

4.1 AFFF Use, Storage, and Disposal Areas

AFFF was developed in the mid-1960s in response to a need for firefighting foams better suited to extinguish Class B, fuel-based fires. AFFF formulations consist of water, an organic solvent, up to 5 percent (%) hydrocarbon surfactants, and 1 to 3% PFAS (Interstate Technology and Regulatory Council 2020b). AFFF concentrate is designed to be diluted with water to become a 1, 3, or 6% foam. AFFF releases at DoD facilities may have occurred during firefighter training, emergency response actions, equipment testing, or accidental releases. The military still primarily uses AFFF for Class B fires; however, the current formulations of AFFF contain significantly lower amounts of PFOS, PFOA, and their precursors, and significant operational changes have been implemented to restrict uncontrolled releases and non-essential use of PFAS-containing foams. Army installations may still house AFFF, commonly stored in closed containers (e.g., 55-gallon drums, 5-gallon buckets), within designated storage buildings or at firehouses.

In 2016, as part of IMCOM Operations Order 16-040, the volume of AFFF stored at all installations was compiled. In total, 3,375 gallons of AFFF concentrate was identified as in storage or in use at RSA. AFFF was re-inventoried in 2017, and the total volume of AFFF at RSA was reassessed to be 1,925 gallons, with 1,760 gallons associated with RSA fire stations and 165 gallons associated with the airfield (in Hangars 4880 and 4832). According to the IMCOM data provided by USAEC, the reduction in AFFF volume between 2016 to 2017 indicates that 1,450 gallons had been removed from RSA and disposed. An additional 385 to 550 gallons of AFFF were identified to be stored by the Federal Bureau of Investigation (FBI), a tenant at RSA. The last of the AFFF stored by the FBI was removed from RSA on June 2, 2021.

By far, the largest volume of AFFF at RSA is, or has been, used by RSA's Fire and Emergency Services. RSA's Fire and Emergency Services consists of five active fire stations (FSs): FS #1 (Building 4424), FS #2 (Building 3320), FS #3 (Building 7801), FS #4 (Building 4810), and FS #5 (Building 4813). Additionally, three former FSs were identified during interviews and one former FS was identified during document research. Information regarding these FSs is provided in **Section 5**. Based on interviews with RSA Fire and Emergency Services personnel, nozzles and foam systems were regularly flushed at FSs. The frequency of this flushing was approximately two to three times annually at each FS, where approximately 3 gallons of AFFF concentrate were released to the area around the FS during each flushing event. Additionally, foam systems were reportedly flushed after each use during an emergency response. These flushing practices were also reportedly performed at the inactive FSs when those facilities were operational.

For emergency preparedness, RSA Fire and Emergency Services personnel were trained to use AFFF and performed nozzle testing with AFFF to calibrate optimal flow and AFFF mixture. Nozzle testing and system calibration involved spraying AFFF through fire equipment. Fire equipment training also included arc training to maximize the arc, reach, and distance covered by AFFF in an emergency response. As reported by RSA Fire and Emergency Services personnel, these trainings were restricted to the Fire Training Area (FTA), the adjacent nozzle testing area at the northern end of the eastern hangar line at the RSA Airfield (Keyhole Nozzle Testing Area), and occasionally FS #3.

According to interviews with Fire and Emergency Services personnel, nozzle testing and calibration were performed between 1995 and 2012; prior to 1995, no first-hand accounts are available. Nozzle testing and calibration released approximately 8 ounces of foam concentrate during each test, and testing was conducted daily. At the FTA, which has been operational for the past 40 years, use of AFFF for training purpose reportedly ceased 15 years ago. Fire and Emergency Services personnel stated that the volume of AFFF released is unknown, but that significant quantities of foam have been released at the site historically.

Fire and Emergency Services personnel provided a list of AFFF uses in response to emergencies that included: fuel tank farm fire (fuel tank fire), a transformer fire at the wastewater treatment plant (transformer fire), a bulldozer fire at the landfill (landfill fire), an equipment fire on the northwestern portion of the airfield (mulcher fire), a vehicle fire at Building 4650 (vehicle fire), an aircraft fire on the north end of the runway (aircraft crash), and a fire at Building 5681. Additional details regarding these emergency responses are provided in **Section 5**.

4.2 Other PFAS Use, Storage, and/or Disposal Areas

Following document research, personnel interviews, and site reconnaissance at RSA, areas related to wastewater treatment and historical Teflon-coating operations were also identified as preliminary locations for use, storage, and/or disposal of PFAS-containing materials. Three inactive STPs (STP #1, STP #3, and STP #4) were identified as facilities that were likely to have received PFAS-contaminated wastewaters from various identified AOPIs at RSA. From 1958 to 1996, Teflon-coating of the center cores of rockets was performed at Building 7370 using aerosolized Dupont Teflon™ Green product. The three STPs and Building 7370 are currently classified as IRP sites and are discussed in detail in **Section 5.2**.

The September 2018 Army Guidance for Addressing Release of Per- and Polyfluoroalkyl Substances indicates the mechanisms for potential use, storage, and/or disposal of PFAS-containing materials including metal plating operations (Army 2018). Two former metals plating areas were identified at RSA during the PA: Building. 5432 (plating operations for small circuit boards) and Building 7614 (former small-scale plating of tanks with cadmium and silver etching). Neither of these areas was retained as an AOPI for further investigation as no evidence of the use of PFAS-containing mist suppressants for metal plating operations was discovered during historical records review, personnel interviews, or site reconnaissance. Further description of each of these areas is provided in **Table 5-1** in **Section 5**. Other potential PFAS use, storage, and/or disposal applications not specifically listed in the September 2018 Army guidance were also considered. These include storage warehouses, pesticide use, prescribed burn areas, automobile maintenance shops, photo-processing facilities, laundry/water-proofing facilities, and car washes. Following document research, personnel interviews, and site reconnaissance at RSA, these

other potential PFAS use, storage, and/or disposal areas either were not identified at the installation or did not prompt further research or constitute categorization as AOPIs (see discussion in **Section 5.1**).

During a telephone interview with the IMCOM pest management consultant, it was noted that products containing Sulfluramid (i.e., associated with insecticides) may have contained PFAS and were phased out in 1996. During the PA records review, the IMCOM pest management consultant provided records of potentially PFAS-containing pesticides and insecticides used at and/or stored at Army installations, and did not identify RSA as an installation having used or stored PFAS-containing pesticides/insecticides. Additionally, the PA team reviewed available pesticide use inventory documentation provided by the installation and did not identify PFAS-containing pesticide use, storage, or disposal.

4.3 Readily Identifiable Off-Post PFAS Sources

An exhaustive search to identify all potential off-post PFAS sources (i.e., not related to operations at RSA) is not part of the PA/SI. However, potential off-post PFAS sources within a 5-mile radius of the installation that were identified during the records search and site visit are described below.

The City of Huntsville and the City of Madison both operate several FSs located within a 5-mile radius of RSA; the type of firefighting materials used by these entities is unknown. Several manufacturing facilities, including metal plating operations, are identified near RSA (particularly to the north of RSA); use of PFAS-containing substances is unknown. Additionally, there are several identified metal plating sites operated by NASA at the MSFC property within RSA. Metal plating conducted by NASA is performed at Buildings 4760, 4707, 4619, and 4550. No information was obtained regarding the types of metal plating or specific processes. Additionally, other uses of PFAS compounds used by NASA were not identified but cannot be excluded as this was outside the scope of the Army PFAS team research.

5 SUMMARY AND DISCUSSION OF PA RESULTS

The preliminary locations evaluated for potential use, storage, and/or disposal of PFAS-containing materials at RSA were further refined during the PA process and identified either as an area not retained for further investigation or as an AOPI. In accordance with the established process for the PA/SI, 28 areas have been identified as AOPIs. The process used for refining these areas is presented on **Figure 5-1**, below.

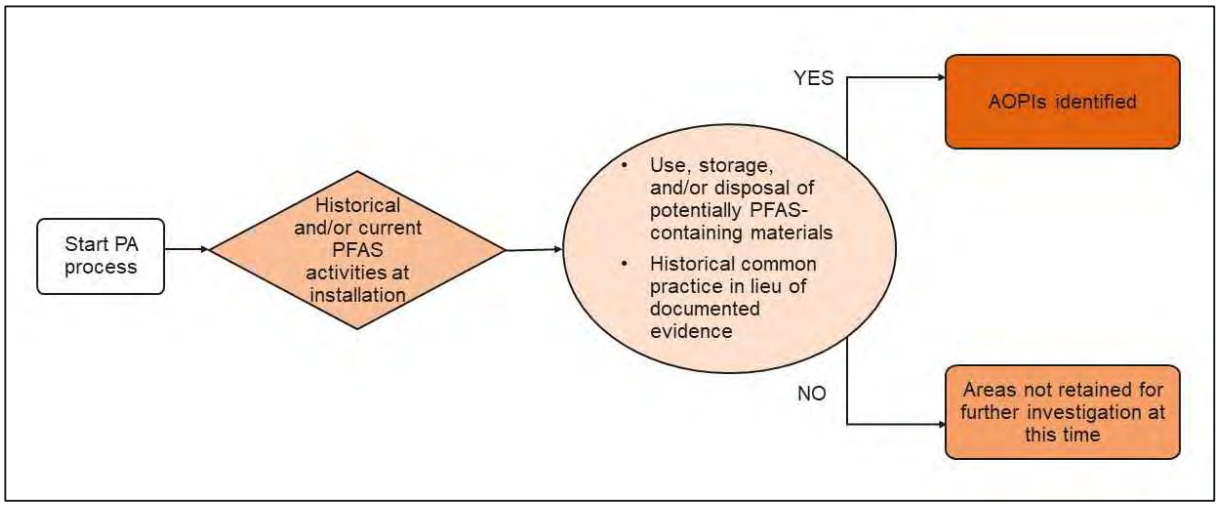

Figure 5-1. AOPI Decision Flowchart

The areas not retained for further investigation are presented in **Section 5.1**. The areas retained as AOPIs are presented in **Section 5.2**.

Data limitations for the PA/SI at RSA are presented in **Section 8**.

5.1 Areas Not Retained for Further Investigation

Through the evaluation of information obtained during records review, personnel interviews, and/or site reconnaissance, the areas described below were categorized as areas not retained for further investigation at this time.

A brief site history and rationale for areas not retained for further investigation are presented in **Table 5-1**, below.

Table 5-1. Installation Areas Not Retained for Further Investigation

Area Description	Dates of Operation	Relevant Site History	Rationale
Carwashes (Public) – Transportation Division and Morale, Welfare, and Recreation	Unknown - Present	Transportation division and Morale, Welfare and Recreation vehicle washes. Shops contained soap and waxes, but Safety Data Sheets did not indicate any PFAS in these products.	No documented use of Simoniz or other PFAS-containing materials used, stored, and/or disposed of at the car washes.
Metal Plating Areas – (Building 5432, Building 7614)	Building 5432: 1974-2000 Building 7614: 1979-1985	Building 5432 was used for plating operations for small circuit boards. There is no indication that PFAS-containing mist suppressants were used in the electroplating operations. Building 7614 was used for small-scale plating of tanks with cadmium and silver etching. No mist suppressants were reported to have been used. Historical knowledge dates back to approximately 1985 for both buildings.	No documented PFAS-containing material use, storage, and/or disposal at these locations.
Photo/Film Labs	Building 7628: 1957-1995 Building 7345: 1960-1996 Building 7173: 1950-1970s	Building 7628 is the former photographic lab and change house. Building 7345 is the former radiographic inspection lab (x-rays). Building 7173 (RSA-275) was used as a film processing laboratory. Safety Data Sheets were reviewed for chemicals listed as having been used at these facilities, and none were identified as PFAS-containing materials.	No documented PFAS-containing material use, storage, and/or disposal at these locations.

5.2 AOPIs

Overviews for each AOPI identified during the PA process are presented in this section. Ten of the 28 AOPIs overlap fully or partially with RSA IRP sites and/or Headquarters Army Environmental System (HQAES) sites, while three AOPIs are adjacent to IRP sites. The AOPI, overlapping IRP site identifier, HQAES number, and current site status are discussed within each AOPI subsection presented below. At the time of this PA, none of the RSA IRP sites have historically been investigated or are currently being investigated for the possible presence of PFAS.

The AOPI locations are shown on **Figure 5-2**. Aerial photographs of each AOPI that also show the approximate extent of AFFF use (if applicable) are presented on **Figures 5-3** through **5-28** and include active monitoring wells in the vicinity of each AOPI.

5.2.1 Fire Station #2 (Building 3320)

FS #2 (Building 3320) is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to confirmed AFFF releases to the environment. Since at least 1995, it has been common practice to flush the fire truck nozzles at the FS two to three times annually, releasing approximately 3 gallons of AFFF mixture per flushing event onto the grounds surrounding the FS.

An aerial photograph of FS #2 (Building 3320) is provided on **Figure 5-3**. FS #2 is located within the northeastern portion of RSA, east of Vincent Drive, west of Snooper Road, and south of Redeye Road. The FS was constructed in 1983 and is currently still active. FS #2 has paved and cement surfaces surrounding the station building, which divert surface water runoff to a drainage ditch that flows north to an apparent wetland. A wash rack outside the FS has a drain that flows to an oil water separator (OWS); the OWS sludge is periodically pumped out and taken to the STP. While this portion of RSA has historically been designated for training, the current and planned future land use is industrial. FS #2 does not overlap with any IRP sites.

5.2.2 Hangar 6312

Hangar 6312 is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to the presence of a 400-gallon AFFF fire suppression system (Ansulite AFC-5A). There have been no reported releases. The hangar was constructed in 2008; therefore, its known spill history covers the entire time period that this hangar has been in operation.

An aerial photograph of Hangar 6312 is provided on **Figure 5-4**. The exterior of the hangar building is surrounded by paved and cement areas that drain to a large stormwater runoff network. The current and planned future land use at Hangar 6312 is industrial.

Hangar 6312 is located on the periphery but within the boundary of the High Explosive Impact Test Site, Area D IRP site (RSA-074; 01202.1087). The primary contaminants of concern are munitions and explosives of concern. RSA-074 is listed as receiving concurrence from regulators for no further action in February 1991 (Redstone Arsenal 2017a).

5.2.3 Building 7370 – Thiokol Teflon™-Coating Facility

Former Building 7370 – Thiokol Teflon™ Coating Facility is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to the historical use of PFAS-containing Teflon™ products at this building. Building 7370 was constructed for the Thiokol Corporation in 1958 to support rocket motor manufacturing operations at RSA. From 1958 to 1996, operations at Building 7370 included casing cleanout, tool cleaning, and core preparation. The elongated machined cores (steel, aluminum, and plastic) were grit/sand blasted to remove any residue and oil remaining from the machining process. The cores were cleaned further with solvent-soaked cleaning cloths to remove any residue resulting from the grit/sand blasting and sprayed with Teflon™ to allow for easier extraction from the cast rocket motors (Shaw 2013). Teflon™ coating of the center cores of the rockets (approximately 4 to 5 inches in diameter by 5 feet long) was accomplished with aerosolized Dupont Teflon™ Green product that may have been mixed with solvents to facilitate application by spraying. Finished or refurbished cores were transferred from the building for use in propellant casting. Cores were placed on coaster trailers, which held two to four cores per trailer. The trailers were staged for up to three weeks in

the paved area west of the building and covered for protection from the elements. Building 7370 was decommissioned in 1996 and was razed in 2002 (Shaw 2013). The building was ventilated in the ceiling, and excess Teflon™ product may have been discharged from the building vents and settled on surficial soil outside the building. No floor drains were reported to be in the facility. Waste was disposed of by standard waste disposal procedures and/or drummed and taken off site with other paint waste for disposal.

An aerial photograph of the Building 7370 AOPI is provided on **Figure 5-5**. Surfaces outside the building are generally flat and surface water flows to the south. The current and planned future land use of the area surrounding former Building 7370 is industrial.

Former Building 7370 is located within the boundary of the Chlorinated Solvent Distillation IRP site (RSA-095; 01202.1108). The contaminants of concern are volatile organic compounds (VOCs), primarily trichloroethene (Redstone Arsenal 2017a). Electrical resistance heating remediation was conducted at RSA-095 from 2014 to 2015. Twelve electrodes were placed within the southern footprint of the former Building 7370 to reduce concentrations of VOCs in the approximately 1,500-cubic-yard vadose zone treatment area (CB&I 2017a). Surface media at RSA-095 have received no further action (NFA) status from the Alabama Department of Environmental Management (ADEM). Additional groundwater corrective measures to be implemented at RSA-095 will be addressed under site RSA-146 (01202.1157; Groundwater Unit GW-02). Potable groundwater use is precluded per the terms of the IROD (Shaw 2007).

5.2.4 Fire Station #3 (Building 7801)

FS #3 (Building 7801) is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to confirmed PFAS-containing AFFF releases to the environment. Since at least 1995, it has been common practice to flush the fire truck nozzles at the FS two to three times annually, releasing approximately 3 gallons of AFFF mixture per flushing event onto the grounds surrounding the FS. This FS has reportedly been used more frequently than the other FSs for foam system maintenance.

An aerial photograph of FS #3 is provided on **Figure 5-6**. FS #3 was constructed in 1983 and remains an active FS presently. The FS is located on the south side of RSA, on the southwest corner of the intersection of Redstone and Patton Roads. FS #3 has paved and cement surfaces surrounding the station building, which divert surface water runoff to open culverts and ditches and to the south toward an OWS behind the FS. Stormwater drain lines are located along the west (front) of the FS, and flow toward the ditch on the southwest side of the structure and subsequently drain to the wooded area to the south. The current and planned future land use of FS #3 is industrial. FS #3 does not overlap with any IRP sites.

5.2.5 Transformer Fire

The Transformer Fire is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to confirmed PFAS-containing AFFF release to the environment. A pole-mounted transformer located near Buxton Road at the STP caught fire in 1996. Approximately 10 gallons or less of AFFF concentrate were used to extinguish the fire, with overspray impacting the grassy area to the north of the STP. The direction of surface runoff flow is to the south toward the STP. An aerial photograph of

the Transformer Fire AOPI is provided on **Figure 5-7**. The current and planned future land use of the treatment plant area is industrial. The Transformer Fire AOPI does not overlap with any IRP sites.

The transformer fire incident was originally misidentified as having occurred at the RSA WTP, when in fact it occurred at the STP. Additional details are provided in **Section 6.3.3**.

5.2.6 Old Fire Station #2 (Building 8014)

Old FS #2 (Building 8014) is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to confirmed PFAS-containing AFFF releases to the environment. Old FS #2 is located at the intersection of Buxton and Shield Roads, in the southern portion of RSA. Former Building 8014 was constructed in 1943 as a fire and police station and operated as an FS until 1971. From 1971 to 1983, the documented use for Building 8014 was listed as a yacht club (Shaw 2006). The building was demolished in approximately 2001. RSA Fire and Emergency Services personnel confirmed that the FS likely would have had approximately 3 gallons of AFFF mixed foam flushed from fire trucks approximately two to three times a year onto the grounds surrounding the building during the period of operation as an FS coincident with AFFF use.

An aerial photograph of the Old FS #2 AOPI is provided on **Figure 5-8**. Surrounding Old FS #2 are grassy areas as well as a cement/paved driveway. Stormwater runoff flows toward drainage ditches to the south and southeast of the former building. The current and planned future land use at the Old FS #2 area is industrial.

Old FS #2 is located east of the adjacent RSA-263 IRP site (01202.1263). The primary contaminants of concern are manganese, carbon tetrachloride, and polycyclic aromatic hydrocarbons (PAHs) in groundwater (CB&I 2015c). No active remediation efforts are currently underway for this IRP site and potable groundwater use is precluded per the terms of the IROD (Shaw 2007).

5.2.7 Firehouse Pub (Building 114)

The Firehouse Pub (Building 114) is a former FS that is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to PFAS-containing AFFF potentially released to the environment. RSA Fire and Emergency Services personnel indicated that, similar to other FSs, approximately 3 gallons of AFFF mixed foam would have been flushed from fire trucks approximately two to three times a year onto the grounds surrounding the FS up until 1995. Further research into the building history, however, indicates that the use of the building by Fire and Emergency Services likely predated the use of AFFF (Shaw 2006). However, the accuracy of the historical details is uncertain and therefore the Firehouse Pub was retained as an AOPI.

An aerial photograph of the Firehouse Pub is provided on **Figure 5-9**. The Firehouse Pub is an inactive FS located in the north-central portion of RSA, north of Goss Road and west of Hawkins Drive. The former FS is situated on a southward sloping hill. Building 114 was constructed in 1942 and served as an active FS through the mid-1950s, serving the Permanent Administration Area. From the 1960s through the 1990s, the building was used as a Youth Activity Center before being transitioned into the clubhouse for the Non-Commissioned Officers Club and subsequently a restaurant and bar (Firehouse Pub). The land surrounding the Firehouse Pub consists of paved and cement surfaces that divert surface water runoff to the southwest toward a paved road and then to an open earthen ditch. The current and planned

future land use at the Firehouse Pub is commercial and industrial. The Firehouse Pub AOPI does not overlap with any IRP sites.

5.2.8 Mulcher Fire

The Mulcher Fire is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to a confirmed PFAS-containing AFFF release to the environment. In approximately 2003-2005 (exact date unknown), a piece of heavy machinery (a mulcher) caught fire and RSA's Fire and Emergency Services responded and utilized AFFF to extinguish the fire. RSA Fire and Emergency Services personnel stated that approximately 30 gallons of AFFF concentrate were used to extinguish the fire.

An aerial photograph of the Mulcher Fire AOPI is provided on **Figure 5-10**. This AOPI is an open grassy area, generally flat, and adjacent to westward tree line on the northwest edge of the airfield. The location of this emergency response was reportedly near the second circle (old turnaround) on the runway; however, there is some uncertainty regarding the exact location of the fire. The current and planned future land use of the Mulcher Fire area is industrial. The Mulcher Fire AOPI does not overlap with any IRP sites.

5.2.9 Keyhole/Nozzle Testing Area

The Keyhole/Nozzle Testing Area is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to confirmed PFAS-containing AFFF releases to the environment. The Keyhole/Nozzle Testing Area is confirmed by RSA's Fire and Emergency Services personnel to have had PFAS-containing AFFF training activities and fire nozzle flushing with a minimum of approximately 1 cup of AFFF concentrate flushed to the ground almost daily from 1995 to 2012.

An aerial photograph of the Keyhole/Nozzle Testing Area AOPI is provided on **Figure 5-11**. This AOPI is a grassy hill just to the east of the airfield and northwest of the FTA AOPI (**Section 5.2.10**), and has a moderate downward slope to the east. A narrow gravel road leads past cement parking pads ("keyhole slots"), used to practice parking fire engines, to a round gravel turnaround area. AFFF was released as part of the nozzle and proportioner testing from the round gravel turnaround to the grassy area from the 11 to 4 o'clock position and to a distance of up to 230 feet. The current and planned future land use of the Keyhole/Nozzle Testing Area is industrial. The Keyhole/Nozzle Testing Area AOPI does not overlap with any IRP sites.

5.2.10 Fire Training Area

The FTA is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to confirmed PFAS-containing AFFF released to the environment. The FTA is confirmed by RSA's Fire and Emergency Services personnel to have had PFAS-containing AFFF training activities with unknown quantities and at unknown frequencies.

Based on historical imagery, the FTA was initially constructed between 1984 and 1992. The original construction of the FTA burn pit reportedly consisted of a curbed firebrick base lined with high-density polyethylene. The initial construction of the burn pit did not include a method to remove the fuel and water from the pit after completion of training exercises. During heavy rains, the burn pit filled with rainwater,

resulting in overflows that contained training residues. In the 1990s, the burn pit was rebuilt using concrete. Deficiencies in the selected concrete were noted in the form of cracks that occurred due to the high heat of fire training exercises. The burn pit was rebuilt again in the late 1990s using refractory concrete and a 14-foot-wide catch apron with drains. In its current form, the burn pit consists of an 80-foot-diameter concrete circle 16 inches deep constructed of 1-foot-thick refractory concrete, underlain by a 30-millimeter high-density polyethylene liner approximately 2 feet below the bottom of the pit. The catch apron drains are routed to an OWS that discharges to a drainage ditch located in the southeastern portion of the site. A 2012 interview with RSA Fire and Emergency Services personnel indicated that the burn pit was being used two to three times per year for local training exercises and a few other times per year by an Air National Guard unit from a base located in Birmingham, Alabama (CB&I 2017b).

An aerial photograph of the FTA is provided on **Figure 5-12**. The AOPI is located within an undeveloped area in the northwestern portion of RSA, northeast of the airfield. The AOPI area is generally clear of vegetation and surrounded by a fence with a locked security gate across a gravel entrance in the southwest corner of the site. The major site features include the following structures, which are used to support fire training activities: a fire burn pit, a diesel fuel aboveground storage tank (AST), a training tower, a drafting pit, a propane AST, and an OWS. Additionally, decommissioned hulls of an airplane and a helicopter are located in the northeastern portion of the FTA AOPI; these hulls are used to practice emergency personnel extraction techniques. The AOPI is flat with a gentle downward slope toward the southeast. The current and planned future land use of the FTA is industrial.

The FTA AOPI coincides with IRP site RSA-284 (01202.1291), which received NFA status in 2020 (ADEM 2020). Revision 2 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) report indicates that none of the analytes assessed (i.e., VOCs, semi-volatile organic compounds [SVOCs], and metals) are present in soil or groundwater at concentrations that warrant further action (CB&I 2017b).

5.2.11 Fire Station #4 (Building 4810)

FS #4 (Building 4810) is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to confirmed PFAS-containing AFFF releases to the environment. Since at least 1995, it has been common practice to flush the fire truck nozzles at the FS two to three times annually, releasing approximately 3 gallons of AFFF mixture per flushing event onto the grounds surrounding the FS.

An aerial photograph of FS #4 (Building 4810) is provided on **Figure 5-13**. FS #4 is an active fire station located on the east side of the main road that runs north and south on the southeast side of the airfield. FS #4 has paved and cement surfaces surrounding the station, which divert surface water runoff to an open earthen ditch to the east that is oriented north to south. The current and planned future land use of the FS #4 area is industrial. AOPIs FS #5 and Hangar 4815 are located in proximity to FS #4 (**Figure 5-13**).

FS #4 is located proximal to IRP site RSA-034, Waste Aviation Fuel Temporary Storage (01202.1047). Site RSA-034 is listed in RSA's RCRA permit as requiring no further action with dates of concurrence of February 1991 and June 2005 (Redstone Arsenal 2017a).

5.2.12 Fire Station #5 (Building 4813)

FS #5 (Building 4813) is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to confirmed PFAS-containing AFFF releases to the environment. Since at least 1995, it has been common practice to flush the fire truck nozzles at the FS two to three times annually, releasing approximately 3 gallons of AFFF mixture per flushing event onto the grounds surrounding the FS.

An aerial photograph of FS #5 (Building 4813) is provided on **Figure 5-13**. FS #5 was constructed in 1961 and has remained an airport fire/rescue station or a crash rescue team station to present day. The FS is located on the flight line along the western main road that runs north and south on the southeast side of the airfield (across the road from FS #4). FS #5 has paved and cement surfaces surrounding the station, which divert surface water runoff to the east across the paved road and then to an open earthen ditch oriented north to south. Historically, a sanitary line from the FS drained to a septic system shared with Hangar 4815, located directly south of FS #5 (**Figure 5-13**). The current and planned future land use of the FS #5 area is industrial.

5.2.13 Hangar 4815

Hangar 4815 is identified as an AOPI following personnel interviews that identified a 30-gallon portable AFFF cart that had previously been stored in the hangar. This portable AFFF cart would have contained a 3M foam and was not stored in the hangar for long, although the precise duration is unknown. No AFFF spills were reported at Hangar 4815.

An aerial photograph of Hangar 4815 is provided on **Figure 5-13**. Hangar 4815 is an active hangar located approximately 100 feet south of FS #5 on the eastern side of the airfield. Hangar 4815 has paved and cement surfaces surrounding the building, which divert surface water runoff to the east across the paved road and then to an open earthen ditch oriented north to south. Sanitary drainage from the hangar was formerly tied into a septic system that flowed to a drain field approximately 500 feet to the east of the hangar. Sanitary drainage from FS #5 was tied into the same septic system. The current and planned future land use of the Hangar 4815 area is industrial.

IRP site MSFC-033, Former Waste Accumulation Area, was located southeast of the original Building 4815 footprint and was operated by NASA Maintenance and Supply Operations at the RSA Airfield. A soil removal action was planned for MSFC-033, but before the removal action could be completed, the Army's expansion of Building 4815 in 2009 to 2010 resulted in approximately 3.7 cubic yards of PAH-contaminated soil from MSFC-033 being inadvertently relocated, and creating a new IRP site, MSFC-033A (Surface Soils East of Building 4815; 01202.1323). The original MSFC-033 was covered with the expanded Building 4815 footprint. In 2010, the newly created MSFC-033A (approximately 0.01 acre in size) was then partially covered by a concrete utility pad for storage of electrical equipment and a concrete walkway for the Building 4815 addition. The MSFC-033A RFI report concluded that inaccessible soil beneath the expanded area of Building 4815 and soil beneath the concrete utility pad require a corrective measure due to the potential for unacceptable risks to human health from PAH-contaminated soil. The selected corrective measure consists of LUCs to prevent exposure to the soil, including posting signs to warn of potential site hazards, preparation of a worker and visitor advisory fact sheet, and routine inspections (Aptim 2018a).

5.2.14 Hangar 4832

Hangar 4832 is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to a confirmed PFAS-containing AFFF release inside the building. Due to its use as a helicopter/missile testing hangar, Hangar 4832 is outfitted with an AFFF fire suppression system. In 1997, approximately 1,600 gallons of C-8 PFAS-containing AFFF concentrate were released into a storage room. The storage room is equipped with an OWS that drains to a sanitary sewer. The storage room currently holds two 800-gallon AFFF tanks (reportedly, 3M 3% foam).

An aerial photograph of Hangar 4832 is provided on **Figure 5-14**. Hangar 4832 is located toward the south end of the airfield; the storage room is on the north side of the hangar. The surrounding area just outside the storage room of Hangar 4832 is surrounded by concrete and/or paved, relatively flat surfaces, which drain to surface runoff areas and to a large stormwater drainage network. The current and planned future land use of the Hangar 4832 area is industrial.

5.2.15 Hangar 4880

Hangar 4880 is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to a confirmed PFAS-containing AFFF release to the building. Approximately 20 gallons of Buckeye 3% Milspec AFFF concentrate were released into the hangar due to a failed proportioner valve gasket in 2013 or 2014, according to RSA Fire and Emergency Services personnel. The AFFF was contained within an underground storage tank (UST) beneath the hangar, after which most of the AFFF was pumped out of the UST and discharged to the sanitary sewer while an unknown amount of AFFF remained in the UST.

An aerial photograph of Hangar 4880 is provided on **Figure 5-15**. Hangar 4880 is located toward the southwest corner of the airfield; the main hangar area, where the AFFF was released, is a large, flat open area with floor drains. Paved and cement areas surrounding the hangar drain to a large stormwater drainage network. The current and planned future land use of the Hangar 4880 area is industrial.

The western portion of Hangar 4880 is located within the boundary of IRP site RSA-072-R-01, Former Mortar Test Site (Not in Range), Operable Unit 15 (01202.1278). The RSA-072-R-01 RFI report concluded that there were no releases of chemicals that pose an unacceptable risk to human health or the environment (Aptim 2019a). However, small amounts of munitions and explosives of concern may pose an unacceptable risk to site receptors. The selected corrective measure consists of LUCs to prevent direct human contact with munitions and explosives of concern, including posting signs to warn of potential site hazards, maintaining on-call UXO construction support for intrusive activities, restricting future land use, and conducting routine inspections (Aptim 2019a).

5.2.16 Fire Station #1 (Building 4424)

FS #1 (Building 4424) is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to confirmed PFAS-containing AFFF releases to the environment. Since at least 1995, it has been common practice to flush the fire truck nozzles at the FS two to three times annually, releasing approximately 3 gallons of AFFF mixture per flushing event onto the grounds surrounding the FS.

An aerial photograph of FS #1 is provided on **Figure 5-16**. Fire Station #1 is an active fire station in the central area of RSA. FS #1 has paved and cement surfaces surrounding the station with surface water runoff flow to the east toward an open ditch that directs flow to the south. The current and planned future land use of the FS #1 area is industrial. The FS#1 AOPI does not overlap with any IRP sites.

5.2.17 Vehicle Fire (Building 4650)

The Vehicle Fire (Building 4650) is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to a confirmed PFAS-containing AFFF release to the environment. The Vehicle Fire occurred in 1999 in the parking lot of Building 4650, in the central portion of RSA. The fire was extinguished using approximately 20 gallons or less of AFFF concentrate. The parking lot where the fire occurred is flat and mostly paved with asphalt or cement. Surface runoff from the presumed Vehicle Fire location flows to the east toward a drainage ditch that directs flow to the south. An aerial photograph of the Vehicle Fire (Building 4650) AOPI is provided on **Figure 5-17**. The current and planned future land use of the Building 4650 area is industrial. The Vehicle Fire (Building 4650) AOPI does not overlap with any IRP sites.

5.2.18 Landfill Fire

The Landfill Fire is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to a confirmed PFAS-containing AFFF release to the environment. The Landfill Fire started when a large Caterpillar bulldozer caught fire in 2003. RSA's Fire and Emergency Services responded and used approximately 20 gallons of AFFF concentrate to extinguish the fire. During interviews with RSA Fire and Emergency Services personnel, it was reported that the fire was extinguished within the landfill boundary and no surface water runoff occurred. A "slurry" of AFFF and soil was mixed within the landfill and at the location of the fire.

An aerial photograph of the Landfill Fire AOPI is provided on **Figure 5-18**. The area surrounding the Landfill Fire location consists of a former sanitary landfill that was closed in 1992. An active construction and demolition debris landfill is permitted and currently operational within a portion of the boundary of the former sanitary landfill. Several monitoring wells are located along the periphery of the landfill on outwardly sloping landfill boundaries. The Landfill Fire AOPI location has a gradual slope to the west, over which surface runoff flows toward an earthen ditch. The current and planned future land use of the landfill areal is industrial.

The Landfill Fire AOPI is located within IRP site RSA-010, Closed Sanitary Landfill (01202.1023). The primary contaminants of concern are metals, pesticides, PAHs, VOCs, and SVOCs in vadose zone soil and groundwater (CB&I 2015d). The anticipated remedy for RSA-010 is excavation, capping, long-term monitoring, and LUCs (Redstone Arsenal 2017a).

5.2.19 Building 5681 Fire

The Building 5681 Fire is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to a confirmed PFAS-containing AFFF release to the environment. The Building 5681 Fire was an indoor fire that occurred on the first level of the building sometime between 1990 and

1995. RSA's Fire and Emergency Services responded with approximately 10 gallons or less of AFFF concentrate applied inside the building to extinguish the flames.

An aerial photograph of the Building 5681 Fire AOPI is provided on **Figure 5-19**. Building 5681 is located near the center of RSA. It was constructed in 1942 and used to fill incendiary bombs between March 1943 and June 1945. From 1947 through 1952, Building 5681 was used for the grinding and bagging of pesticides that were manufactured in other locations at RSA. Between 1952 and 1995, the building was used as an administrative facility. Friable asbestos was removed from the building in the 1980s and early 1990s. In 1996, the building was renovated to provide office space for more than 600 personnel from facilities in St. Louis, Missouri relocated as part of Base Realignment and Closure. During renovations, contaminated building materials were removed or encapsulated. Building 5681 is a large, rectangular building surrounded by paved and cement areas, with some grassy open areas. Surface runoff around Building 5681 is conveyed generally to the south. The current and planned future land use of the Building 5681 area is commercial/industrial.

Building 5681 is located within the boundary of IRP site RSA-252, Incendiary Bomb Facility Plant 2 (01202.1252). The primary contaminants of concern are pesticides and VOCs in groundwater and PAHs and pesticides in soil. The selected corrective measures consist of excavation and off-site disposal of PAH- and pesticide-contaminated soil and monitored natural attenuation for groundwater at RSA-252 (Aptim 2020a).

5.2.20 Old Fire Station #1 (Building 5414)

Old FS #1 (Building 5414) is a former FS identified as an AOPI following document review, personnel interviews, and site reconnaissance due to potential use and/or storage of PFAS-containing AFFF. RSA Fire and Emergency Services personnel indicated that, similar to other FSs, approximately 3 gallons of AFFF mixed foam would have been flushed from fire trucks approximately two to three times a year onto the grounds surrounding the FS up until 1995. Further research into the building history, however, indicates that the use of the building by Fire and Emergency Services likely predated the use of AFFF (Shaw 2009). However, the accuracy of the historical details is uncertain and therefore Old FS #1 was retained as an AOPI.

An aerial photograph of the Old FS #1 AOPI is provided on **Figure 5-20**. Old FS #1 was constructed in 1943 and was an operational FS until at least 1968. Building records dated 1968 and 1971 indicate that the building was used for civilian personnel training and development. There is record of this building being used as a plumbing shop from 1968 to 1972 (Shaw 2009). From 1976 through 1991, the building was designated as a facility engineer utility building. Currently, the building is operated by Chugach Management Services and is designated for administration use. The date when fire response activities ceased is unknown. Old FS #1 has paved and cement surfaces surrounding the station, which divert surface water runoff to the southwest toward a paved road and then to an open earthen ditch. The current and planned future land use of the Old FS #1 area is industrial. The Old FS #1 (Building 5414) AOPI does not overlap with any IRP sites.

5.2.21 Fuel Tank Fire

The Fuel Tank Fire at the fuel tank farm is identified as an AOPI following document review, personnel interviews, and site reconnaissance due to a confirmed PFAS-containing AFFF release to the environment. The Fuel Tank Fire was started by a lightning strike in 1995 to a large aboveground fuel tank (Tank No. 5631). RSA Fire and Emergency Services personnel reported that four fire engines with approximately 55 to 150 gallons of AFFF concentrate responded to the Fuel Tank Fire, although the precise volume of AFFF used is unknown.

An aerial photograph of the Fuel Tank Fire AOPI is provided on **Figure 5-21**. The Fuel Tank Fire AOPI is located in an industrial area in the eastern-central portion of RSA. The site is grassy with a gradual slope as a result of the area having been raised using engineered fill when the fuel farm was constructed in the 1940s. The fuel farm originally housed tanks for storage of ethyl alcohol and fuel oil, which were used to produce mustard and fill bombs in two plants located east-northeast of the fuel tank farm. After bomb production ended in 1945, the tank farm was not used for several years. In the early 1950s, the area was converted to a bulk fuel storage facility and the tanks were converted to store diesel fuel, No. 2 fuel oil, kerosene, and gasoline. The area operated as the primary bulk fuel farm for RSA until 2005, when six of the former ASTs were closed and removed from the site. Tank No. 5631 was formerly used to store diesel and was removed in 2003 (Aptim 2020b). Surface runoff from the area of the Fuel Tank Fire AOPI is toward the southeast and an open earthen ditch. The current and planned future land use of the former fuel tank farm area is industrial.

The Fuel Tank Fire AOPI is adjacent to the closed IRP site RSA-028, In-Ground Oil/Waster Separator, 5693 Area (01202.1041). The primary contaminants of concern are metals, PAHs, and VOCs in soil, groundwater, and surface water. A Corrective Measures Implementation Plan will be prepared to address these media (Aptim 2020b). Potable groundwater use is precluded per the terms of the IROD (Shaw 2007).

5.2.22 FBI AFFF Storage Area (Building 7017)

The FBI AFFF Storage Area (Building 7017) is identified as an AOPI following personnel interviews due to confirmed PFAS-containing AFFF storage. FBI personnel stated that approximately six drums of AFFF concentrate were stored for approximately four or five years at Building 7017. The AFFF drums were removed from RSA in June 2021 and disposed of through the Defense Logistics Agency.

An aerial photograph of Building 7017 is provided on **Figure 5-22**. Building 7017 is located in the southeast portion of RSA, off Post Road and within the FBI Training Center. The building is currently being used as a gym, but previously served as a humidity-controlled warehouse. Building 7017 has paved and cement surfaces to the northwest and exposed ground surrounding the remainder of the building. Surface runoff flows toward the southeast. The current and planned future land use of the Building 7017 area is industrial. The FBI AFFF Storage Area (Building 7017) AOPI does not overlap with any IRP sites.

5.2.23 FBI AFFF Storage Area (Building 9061)

The FBI AFFF Storage Area (Building 9061) is identified as an AOPI following personnel interviews due to confirmed PFAS-containing AFFF storage. FBI personnel stated that approximately three drums of

AFFF concentrate were stored for approximately six to eight months in Building 9061. The AFFF drums were removed from RSA in June 2021 and disposed of through the Defense Logistics Agency.

An aerial photograph of Building 9061 is provided on **Figure 5-23**. Building 9061 is located in the southeastern portion of RSA, south of the intersection of Line and Mathews Roads and within the FBI Training Center. The building is currently used for FBI training purposes. Building 9061 has paved and cement surfaces to the northeast and exposed ground and pine forest surrounding the remainder of the building. The current and planned future land use of the Building 9061 area is industrial. The FBI AFFF Storage Area (Building 9061) AOPI does not overlap with any IRP sites.

5.2.24 Aircraft Crash Site

The Aircraft Crash Site is identified as an AOPI following personnel interviews due to confirmed PFAS-containing AFFF released to the environment. RSA Fire and Emergency Services personnel indicated that an aircraft crash occurred circa 2004/2005 and flames may have been extinguished using approximately 20 to 25 gallons of AFFF. Airfield personnel confirmed that the aircraft crash occurred in the 2004-2005 timeframe, but records were unavailable. The aircraft accident reportedly occurred near the northern turnaround on the airfield. Several repairs to the runway and turnarounds have been documented since the aircraft accident occurred. The concrete at the northern turnaround was replaced in 2009. Based on aerial imagery, it does not appear that the soil disturbance resulting from the concrete replacement was extensive. Additional areas of the airfield were excavated and resurfaced in 2020, but no records for this activity were found to determine the potential impact to the identified aircraft crash location.

An aerial photograph of the Aircraft Crash Site AOPI is provided on **Figure 5-24**. The Aircraft Crash Site AOPI has cement surfaces surrounded by open grassy surfaces. The turnaround is designed to convey water from the paved surface to the ground via runoff and drains that discharge toward the northeast. The current and planned future land use of the airfield is industrial. The Aircraft Crash Site AOPI does not overlap with any IRP sites.

5.2.25 Former Fire Station (Building T-3241)

The Former FS (Building T-3241) is identified as an AOPI following document review and personnel interviews due to confirmed use of the building as an FS and the potential release of PFAS-containing AFFF to the environment. The Former FS (Building T-3241) was an active FS from 1957 through the 1960s and 1970s (Shaw 2009). The FS appears on a 1981 drawing but had been replaced by a fast-food restaurant on a 1987 drawing. Therefore, Building T-3241 may have served as an active FS from 1957 through 1981. Based on aerial photographs, the building was demolished between 2011 and 2012.

An aerial photograph of the Former FS (Building T-3241) is provided on **Figure 5-25**. The Former FS (Building T-3241) was located in the northern portion of RSA, southeast of the intersection of Goss Road SW and Vincent Drive. The Former FS (Building T-3241) has paved surfaces to the south and west and grassy open areas to the north and east. The former footprint of the building is adjacent to several large trees. Around the building footprint, surface water is diverted to a creek located to the northeast of the site. The current and planned future land use of the former Building T-3241 area is commercial.

The Former FS (Building T-3241) AOPI is located adjacent to the eastern boundary of IRP site RSA-143, Underground Storage Tank Spills (01202.1154). The primary contaminants of concern are petroleum-related compounds in soil and groundwater as well as metals, VOCs, and explosives in groundwater. A Corrective Measures Implementation Plan will be prepared to address these media (Aptim 2019b). Potable groundwater use is precluded per the terms of the IROD (Shaw 2007).

5.2.26 Inactive Sewage Treatment Plant #1

Inactive STP #1 is identified as an AOPI following document review and personnel interviews due to likely PFAS-containing AFFF use or storage in facilities that previously drained to the STP. Inactive STP #1 consisted of two plants, Plant 1A (constructed in 1942) and Plant 1B (constructed in 1946). Inactive STP #1 was removed from service in 1992. When operational, the plant was used for treatment of domestic sewage generated in the eastern portion of RSA and wastewaters from the propellant manufacturing operations generated at the North Plant Facility. PFAS-containing materials may have been released to the sanitary lines that fed Inactive STP #1, where they would have accumulated in the sludge drying beds. Sludge wastes were periodically removed and disposed of in the sanitary landfill (RSA-010). The public was permitted to remove wastes from the sludge beds and transport the waste off site for their own use.

An aerial photograph of Inactive STP #1 is provided on **Figure 5-26**. The Inactive STP #1 site consists of a large open area, surrounded by forest, with most of the original STP structures, including the sludge drying beds, still in place. The sludge drying beds are located between the primary structures of Plants 1A and 1B, with additional drying beds near the southern boundary of the site. Surface water runoff is conveyed radially to the east, north, and west. The current and planned future land use of the inactive STP #1 area is industrial.

Inactive STP #1 coincides with IRP site RSA-011 (01202.1024; Inactive STP). RSA-011 received regulatory concurrence for no further action in September 2007 (Redstone Arsenal 2017a).

5.2.27 Inactive Sewage Treatment Plant #3

Inactive STP #3 is identified as an AOPI following document review and personnel interviews due to likely PFAS-containing AFFF use or storage in facilities that previously drained to the STP. Inactive STP #3 is in the central portion of RSA, near the intersection of Martin Road SW and Centaur Street. Originally constructed in 1942, operations ceased in 1992. The STP historically treated sewage generated in the central portion of RSA as well as discharges from the MSFC. Based on sanitary wastewater infrastructure, several AOPIs with confirmed PFAS storage or use likely drained to STP #3 including Old FS #1 (Building 5414), Building 5681, FS #3 (Building 7801), and Old FS #2 (Building 8014). As of 2015, the plant is still used for storage of sewage but does not operate any active treatment processes.

An aerial photograph of Inactive STP #3 is provided on **Figure 5-27**. Inactive STP #3 consists of a large open area, surrounded by forest, with most of the original STP structures still in place. The remnants of the sludge drying beds are located in the northeastern portion of the former STP. Based on site topography, surface water runoff is conveyed to the southwest. The current land use of the inactive STP area is industrial; future land use is anticipated to be research, development, testing, and evaluation.

Inactive STP #3 coincides with IRP site RSA-009 (01202.1022; Inactive STP). The primary contaminants of concern are metals and polychlorinated biphenyls (Redstone Arsenal 2017a). The anticipated remedy is excavation of contaminated soil from the sludge drying beds with off-site disposal. Groundwater contamination will be addressed by NASA (Redstone Arsenal 2017a).

5.2.28 Inactive Sewage Treatment Plant #4

Inactive STP #4 is identified as an AOPI following document review and personnel interviews due to likely PFAS-containing AFFF use or storage in facilities that previously drained to the STP. Inactive STP #4 is in the northeastern portion of RSA, north of Martin Road SW and west of the southern end of Triana Boulevard. Originally constructed in 1959, operations ceased in 1992; however, it is still used on an as-needed basis. The plant was used for treatment of domestic sewage and wastewaters generated in the northern portion of RSA. It also received floor wash water from some of the research laboratories and motor pools, as well as water separated by the OWS in the area. Based on sanitary wastewater infrastructure, several AOPIs with confirmed PFAS storage or use likely drained to STP #4 including FS #1 (Building 4424), FS #2 (Building 3320), Firehouse Pub, and potentially the AOPIs located at and near the airfield.

An aerial photograph of Inactive STP #4 is provided on **Figure 5-28**. The Inactive STP #4 site consists of a large open area, bounded by forest to the east and south, with most of the original STP structures still in place. The sludge drying beds are visible on the aerial photograph and located in the northwestern portion of the former plant site. Based on site topography, surface water runoff generally flows toward the southeast. The current and planned future land use of the inactive STP #4 area is as a sewer lift station and as storage for raw sewage if repairs or an emergency event cause the influent capacity of the current treatment system to be exceeded.

Inactive STP #4 coincides with IRP site RSA-008 (01202.1021; STP #4). The primary contaminants of concern are VOCs (primarily trichloroethene), pesticides, and metals (primarily arsenic) in groundwater. A Corrective Measures Implementation Plan will be prepared to address the contaminants of concern in groundwater (Aptim 2020c). Potable groundwater use is precluded per the terms of the IROD (Shaw 2007).

6 SUMMARY OF SI ACTIVITIES

Based on the results of the PA at RSA, an SI for PFOS, PFOA, and PFBS was conducted in accordance with CERCLA. SI sampling was completed at RSA at all 28 AOPIs to evaluate presence or absence of PFOS, PFOA, and PFBS in comparison with the OSD risk screening levels. As such, an installation-specific QAPP Addendum (Arcadis 2020a) was developed to supplement the general programmatic information provided in the PQAPP (Arcadis 2019) and to detail the site-specific proposed scopes of work for the SI. A preliminary CSM was prepared for each of the installation's AOPIs in accordance with the USACE Engineer Manual on Conceptual Site Models, EM 200-1-12 (USACE 2012). The preliminary CSMs identified potential human receptors and chemical exposure pathways based on current and/or reasonably anticipated future land uses. The preliminary CSMs identified nine soil, groundwater, surface water, and/or sediment pathways as potentially complete, which guided the SI sampling. The QAPP Addendum details the sampling design and rationale based on each AOPI's preliminary CSM. The SI scope of work was completed through the collection of field data and analytical samples over several mobilizations as follows: September 28 through October 8, 2020; November 3 to November 20, 2020; December 17, 2020; August 2 to August 4, 2021; and August 23 to August 25, 2021.

The SI field work was completed in accordance with the standard operating procedures (SOPs), technical guidance instructions (TGIs), sampling design, and QA/QC requirements as detailed in the QAPP Addendum (Arcadis 2020a) and PQAPP (Arcadis 2019). The subsections below summarize the DQOs, sampling design and rationale, sampling activities and methods, and data analyses procedures for the SI phase at RSA. Non-conformances to the prescribed procedures in the PQAPP and QAPP Addendum are described in **Section 6.3.3**. Analytical results obtained through SI field activities are summarized in **Section 7**.

6.1 Data Quality Objectives

As identified during the DQO process and outlined in the site-specific QAPP Addendum (Arcadis 2020a), the objective of the SI is to identify whether there has been a release to the environment at the AOPIs identified in the PA and to determine if further investigation is warranted. This SI evaluated groundwater and/or soil for PFOS, PFOA, or PFBS presence or absence at each of the sampled AOPIs.

6.2 Sampling Design and Rationale

The rationale for sampling at each AOPI is illustrated on **Figure 6-1** below.

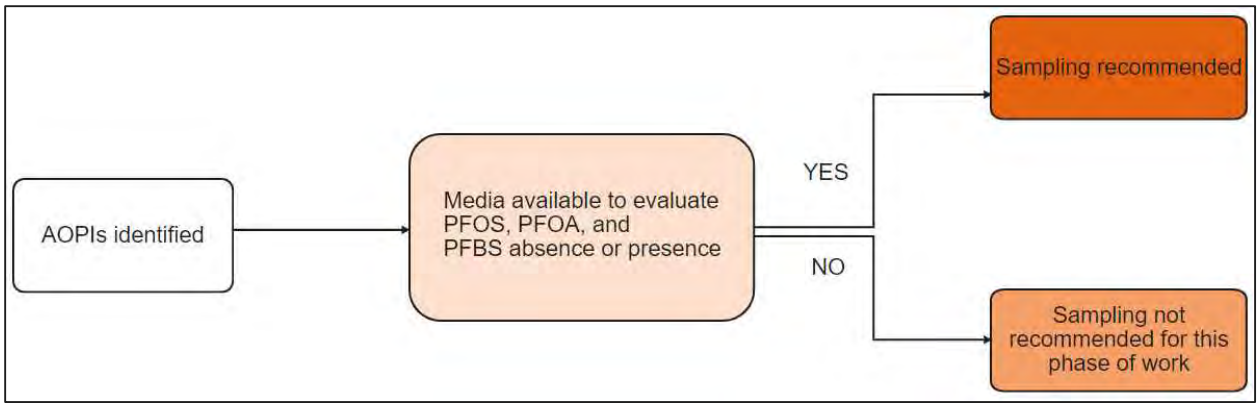

Figure 6-1. AOPI Sampling Decision Tree

The sampling design for SI sampling activities at RSA is detailed in Worksheet #17 of the QAPP Addendum (Arcadis 2020a). For each of the 28 AOPIs, samples were collected at locations of known or suspected use, storage, and/or disposal of PFAS-containing materials, locations of surface runoff collection, and downgradient locations if exact use, storage, or disposal locations are unknown. Sample locations were selected based on site-specific historical evidence, suspected groundwater flow conditions, and surface runoff/surface conditions observed in the field at each sampled AOPI. Sample media types (i.e., surface soil and groundwater) collected for each sampled AOPI were based on media most likely to confirm the presence of absence of PFOS, PFOA, and PFBS directly related to the AOPI.

The focus of the soil sampling was the upper 2 feet of native soil, as determined by the field geologist. The first encountered groundwater was the focus of groundwater sampling. Where available, groundwater samples were collected from existing downgradient on-installation monitoring wells. Temporary wells were installed to collect groundwater samples at AOPIs where no existing monitoring wells were present. The temporary wells generally were constructed with 10-foot screens and a sand filter pack (2040 silica sand) to the top of the screen. **Table 6-1** presents the construction details for the existing monitoring wells and temporary wells sampled during the SI.

6.3 Sampling Methods and Procedures

Environmental data were collected and analyzed in accordance with the PQAPP (Arcadis 2019), the SOPs and TGIs included as Appendix A to the PQAPP, the QA/QC requirements identified in Worksheet #20 of the PQAPP, the approved scope and sampling methods outlined in the site-specific QAPP Addendum (Arcadis 2020a), and the safety procedures specified in the Accident Prevention Plan (Arcadis 2018) and SSHP (Arcadis 2020b). The sampling methods described in the SOPs and TGIs establish equipment requirements, procedures for preparing equipment and containers before sampling, sampling procedures under various conditions, and procedures for storing samples to ensure that sample contamination does not occur during collection and transport. In general, sampling techniques used in the SI were consistent with conventional sampling techniques used in the environmental industry, but special considerations were made regarding PFAS-containing materials and equipment and cross-contamination potential.

The sampling methods employed during the SI are detailed in the PQAPP (Arcadis 2019) and QAPP Addendum (Arcadis 2020a). The subsections below provide a summary of the field methods and procedures utilized to complete the SI scope of work. Field notes and field forms (i.e., soil boring logs, groundwater purging logs, equipment calibration forms, tailgate health and safety forms, and sample collection logs) documenting the SI sampling activities are included in **Appendices I** and **J**, respectively. Photographs of the sampling activities, for locations where photographs were permitted, are included in **Appendix K**.

6.3.1 Field Methods

Grab groundwater samples were collected from temporary well screens installed using either direct-push technology (DPT) or rotary sonic drilling methods (15 locations) and from existing monitoring wells (21 locations) where available. For the temporary wells, first-encountered groundwater was sampled as determined by the field geologist. For existing monitoring wells, groundwater samples were collected from the center of the saturated screened interval. Groundwater samples were collected via low-flow purging methods using either a peristaltic pump or a bladder pump with PFAS-free disposable high-density polyethylene (HDPE) tubing. Field parameters (temperature, pH, specific conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential) were measured during purging and allowed to stabilize in accordance with the TGI for PFAS Sampling Procedures and Low-Flow Groundwater Purging for Monitoring Wells (P-11 in Appendix A to the PQAPP; Arcadis 2019) (or purged for a maximum of 20 minutes, whichever occurred first) before groundwater sampling to ensure a representative sample was collected and, potentially, to inform the interpretation of analytical data. In a few instances, a PFAS-free disposable bailer was used to collect groundwater samples from temporary wells when groundwater recharge rates were too slow to allow for low-flow purge sampling. Bailers were used for the following samples: RSA-4815-GW-02 and RSA-FBI7017-GW-01. Temporary monitoring wells were abandoned by a licensed Alabama driller by removing the well casing and adding bentonite chips or similar to fill the boring within 1 foot of ground surface. The remainder of the borehole was completed with material consistent with the surrounding ground surface (e.g., topsoil, gravel).

Surface soil samples were collected at a total of 76 discrete locations using a clean stainless steel hand auger. At each surface soil sampling point, a soil sample was collected and homogenized in stainless steel bowls. The majority of the soil samples were collected from the top 2 feet of native soil. In some instances (11 locations total), soil samples were collected from the top foot of native soil due to encountering refusal or difficult augur conditions below the top foot of soil. Coordinates for each soil sampling location were recorded using a handheld global positioning system unit.

Decontamination procedures for non-dedicated equipment used during sampling are described in **Section 6.3.4**.

6.3.2 Quality Assurance/Quality Control

Worksheet #20 of the PQAPP and QAPP Addendum provide QA/QC requirements for field duplicates, matrix spike/matrix spike duplicates, equipment blanks (EBs), source blanks (SBs) for water used in the initial decontamination step for drill tooling, and field blanks (FBs) for laboratory-supplied water used in the final decontamination step.

QA/QC samples were collected at the frequencies specified in the QAPP Addendum (Arcadis 2020a), typically at a rate of 1 per 20 parent samples. Field duplicates and matrix spike/matrix spike duplicate samples were collected for media sampled for PFOS, PFOA, and PFBS, and total organic carbon (TOC) only. EBs were collected for media sampled for PFOS, PFOA, and PFBS, at a frequency of one per piece of relevant equipment for each sampling event, as specified in the QAPP Addendum (Arcadis 2020a). The decontaminated reusable equipment from which EBs were collected include tubing, screen-point samplers, drill casing and cutting shoes, hand augers, water-level meters, acetate liners, and bailers as applicable to the sampled media. Source blanks were collected from the water used to pressure-wash drill tooling. Analytical results for blank samples are discussed in **Section 7.31**.

6.3.3 Field Change Reports

Major scope modifications (i.e., those that may have had a significant impact on the project scope and/or data usability/quality, required stop-work, or warranted discussion with USACE) were required during the RSA SI work. Specifically, following the initial SI field sampling event, seven additional AOPIs were identified, and it was discovered that one AOPI location had been misidentified. Additional soil and groundwater sample collection was required to confirm absence or presence of PFOS, PFOA, and PFBS at the newly identified AOPIs and at the corrected location of one AOPI. The additional sampling work was documented in Field Change Reports (FCRs) dated July 15, 2021 (FCR-01) and August 13, 2021 (FCR-02) included as **Appendix L** and summarized below:

- FCR-01 identified seven additional AOPIs as follows (see **Appendix L** for the rationale for the proposed soil and groundwater sampling at each AOPI):
    - AFFF Storage by FBI at Building 7017
    - AFFF Storage by FBI at Building 9061
    - Aircraft Crash Site located at the RSA Airfield
    - Former Fire Station (Building T-3241)
    - Inactive STP #1 (IRP site RSA-011)
    - Inactive STP #3 (IRP site RSA-009)
    - Inactive STP #4 (IRP site RSA-008)
- FCR-02 was prepared to document the misidentification of the location for the Transformer Fire AOPI. During the PA site visit interviews, it was reported that RSA's Fire and Emergency Services responded to a transformer fire at the "wastewater treatment plant." However, during the PA site reconnaissance, the PFAS PA team was escorted to the water treatment facility along the Tennessee River, leading to a misidentification of the fire location in the SI planning documents. Follow-up communications with a retired Fire and Emergency Services employee on August 5, 2021 confirmed that this fire had occurred at the wastewater treatment plant east of the intersection of Buxton and Shields Roads. Refer to **Appendix L** for the rationale for the proposed soil and groundwater sampling at the corrected Transformer Fire location.

Several other field modifications from the originally proposed sampling approach did not impact DQOs or significantly modify the scope and therefore were not included in FCRs. Explanations of these minor changes are provided below:

- Hangar 6312 – Soil sample RSA-6312-SO-04 was moved from the originally proposed location along the east side of the hangar to the north side of the building to align the sample location with a doorway.
- Firehouse Pub – Groundwater sample RSA-PUB-GW-01 was moved approximately 35 feet to the southwest of the proposed location to allow for easier drill rig access while maintaining the inferred downgradient direction.
- Mulcher Fire – Groundwater sample RSA-MLCH-GW-01 was not collected for the following reasons that were discussed with the Army during a conference call on March 23, 2021: 1) airfield access restrictions; 2) difficult bedrock drilling conditions encountered at adjacent AOPIs; 3) low confidence in the fire location; and 4) both soil samples collected from the AOPI had no detections of PFOS, PFOA, and PFBS. The Army concurred with the recommendation to not collect a groundwater sample from the Mulcher Fire.
- Fire Station #5 – Groundwater sample RSA-FS5-GW-01 was not obtained. Some moistness was observed in the epikarst during drilling; therefore, a temporary well screen was set at 39 to 54 ft bgs on top of the bedrock on November 18, 2020. The water level in this temporary well was rechecked on December 17, 2020, and there was no water accumulation in the screen. The well was abandoned on December 30, 2020. During a conference call with the Army on March 23, 2021, it was agreed that downgradient sample RSA-4815-GW-02, collected from the former FS #5 septic system drain field, as well as the groundwater sample collected from FS #4 across the street from FS #5 were sufficient to characterize groundwater at FS #5.
- Hangar 4815 – Groundwater sample RSA-4815-GW-01 was not obtained. A possible saturated zone was observed at approximately 52 ft bgs; therefore, a temporary well screen was set from 45 to 55 ft bgs on November 7, 2020. The water level in this temporary well was rechecked on December 17, 2020, and there was no water accumulation in the screen. The well was abandoned on December 30, 2020. During a conference call with the Army on March 23, 2021, it was agreed that downgradient sample RSA-4815-GW-02, collected from the former Hangar 4815 septic system drain field, as well as the groundwater samples collected from FS #4 across the street from Hangar 4815 and existing monitoring wells MW08 and RS1604 were sufficient to characterize groundwater.
- Hangar 4880 – Groundwater sample RSA-4880-GW-01 was not collected for the following reasons discussed with the Army during a conference call on March 23, 2021: 1) airfield access restrictions; 2) difficult bedrock drilling conditions encountered at adjacent AOPIs; 3) reportedly only a small (20-gallon) release of AFFF occurred and was contained within the hangar; and 4) three of the five soil samples collected around the hangar had no PFOS, PFOA, or PFBS detections, while the other two samples had very low soil detections that do not exceed OSD risk screening levels. The Army concurred with the recommendation to not collect a groundwater sample from Hangar 4880.
- Building 5681 Fire – Collection of a shallow soil sample was proposed in the RSA QAPP Addendum (Arcadis 2020a) contingent on the field team identifying the location of the building fire. The fire at Building 5681 occurred indoors on the first level of the building, and RSA's Fire and Emergency

Services responded with approximately 10 gallons or less of AFFF concentrate applied inside the building to extinguish the flames. Given that the AFFF was applied indoors, and the field crew was unable to ascertain the exact location of the fire, the soil sample was not collected.

- Building 9061 – One grab groundwater sample was proposed to be collected via DPT. The DPT boring was advanced to 23 ft bgs and encountered rock (limestone and chert) refusal. No moisture was encountered in the soil boring. Therefore, no temporary well screen was installed, and a groundwater sample was not obtained. This building was used to store three drums of AFFF concentrate for a short period of time (six to eight months) and no spills were reported. Two soil samples were collected, one on either side of the entrance to Building 9061. One of the samples had no PFOA, PFOS, or PFBS detections; the other sample had a trace detection of PFOS which did not exceed OSD risk screening levels. Since AFFF was stored for only a short period of time (less than a year) with no reported spills and given that the soil results are not indicative of an AFFF release, a groundwater sample was not further pursued.

6.3.4 Decontamination

Non-dedicated reusable sampling equipment (e.g., hand augers, drill cutting shoes and casing, screen-point samplers, water-level meters) that came into direct contact with sampling media was decontaminated before first use, between sampling locations/intervals, and before demobilization in accordance with P-09, TGI – Groundwater and Soil Sampling Equipment Decontamination (Arcadis 2019; Appendix A).

6.3.5 Investigation-Derived Waste

IDW, consisting of soil cuttings, groundwater, and decontamination fluids, was collected and placed in Department of Transportation-approved 55-gallon drums, labeled as non-hazardous (with the exception of purge water from Building 5681 monitoring wells), and segregated by medium (water and soil). In total during the first field mobilizations (October, November, and December 2020), 14 drums were filled to various volumes: 11 drums were used for soil wastes, 2 drums were used for purge and decontamination water, and a separate drum was used for groundwater purged from the monitoring wells at Building 5681. Except for the drum containing purge water from Building 5681, drums containing soil and liquid IDW were stored on the concrete foundation of a former building in the southeastern portion of RSA on Oriole Circle, as instructed by RSA personnel. Purge water from Building 5681 was drummed separately and labeled as U-listed hazardous waste (due to historical pesticide handling operations at this facility) and stored in Building 7700. Thirteen of the 14 drums (i.e., all of the drums except the one containing the Building 5681 water) were collected on January 29, 2021, and transported by HERR, Inc. (NCR000139816) to the permitted treatment and disposal facility operated by HERR Inc. (NCR000139816) located at 809 Blair Street, Thomasville, North Carolina. The drum holding the groundwater from Building 5681 was disposed of separately. This single drum was transported by HERR, Inc. (NCR000139816) to the permitted disposal facility operated by ECOFLO, Inc. (NCD980842123) located at 2750 Patterson Street, Greensboro, North Carolina.

One soil drum and one water drum were generated during the August 2021 field mobilizations. The two drums were removed from RSA on 18 November 2021 and transported by Waste Management to the permitted disposal facility operated by Chemical Waste Management (ALD000622464) located at

Highway 17 North, Mile Marker 163, Emelle, Alabama. Documentation related to IDW disposal (i.e., waste manifests) is included in **Appendix J**.

Other IDW, including personal protective equipment and other disposable materials (e.g., plastic sheeting, Lexan tubes, and HDPE and silicon tubing) that may have contacted sampling media, was collected in bags and disposed of in municipal waste receptacles. Analytical results for IDW samples collected during the SI are discussed in **Section 7.29**.

6.4 Data Analysis

The subsections below summarize the laboratory analytical methods and the methodology used to evaluate data collected during the SI through data verification and usability assessments (as completed by a project chemist, independent of the project team).

6.4.1 Laboratory Analytical Methods

Analytical samples collected during the SI were submitted to Pace South Carolina (formerly Shealy Environmental Services, Inc.), an ELAP-accredited laboratory, for PFAS analysis, including PFOS, PFOA, and PFBS, by liquid chromatography with tandem mass spectrometry. Laboratory analyses associated with the SI were completed in accordance with Worksheets #12.1 through #12.5 in the PQAPP (Arcadis 2019). Eighteen PFAS-related compounds, including PFOS, PFOA, and PFBS, were analyzed for in groundwater and soil samples using a PFAS analytical method that is ELAP-accredited and compliant with QSM 5.3 (DoD and Department of Energy 2019), Table B15.

Additionally, the following general chemistry and physical characteristic analyses were completed for select soil samples in accordance with Worksheet #18 of the QAPP Addendum (Arcadis 2020a) by the analytical method noted:

- TOC by Solid Waste Test Method 846 9060A
- Grain size analysis by ASTM International D422-63
- pH by Solid Waste Test Method 846 9045D.

These data are collected as they may be useful in future fate and transport studies.

The laboratory limit of detection (LOD) is defined as “the lowest concentration for reliable reporting of a non-detect of a specific analyte in a specific matrix with a specific method at 99 percent confidence” (DoD 2017). The lowest concentration of a substance that produces a quantitative result within specified limits of precision and bias is known as the limit of quantitation (LOQ; DoD 2017). Concentrations detected between the LOD and LOQ, therefore, are considered estimates and are qualified as such on laboratory analytical reports. Instrument-specific detection limits (e.g., the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration with 99 percent confidence; DoD 2017), as provided for each analyte by the laboratory, are reported along with the LODs and LOQs in the laboratory analytical reports included in the Data Usability Summary Reports (DUSRs; **Appendix M**).

6.4.2 Data Validation

All analytical data generated during the SI, except grain size and data generated from IDW profiling, were verified and validated in accordance with the data verification procedures described in Worksheets #34 through #36 of the PQAPP (Arcadis 2019). Each laboratory data package/sample delivery group underwent Stage 3 data validation in accordance with DoD QSM 5.3 (DoD and Department of Energy 2019). Additionally, 10% of the data underwent Stage 4 data validation. Copies of the data validation reports for each sample delivery group are included as attachments to the DUSRs in **Appendix M**. The Level IV analytical reports are included within **Appendix M** in the final electronic deliverable only.

6.4.3 Data Usability Assessment and Summary

A data usability assessment was completed for all analytical data associated with SI sampling at RSA. Documentation generated during the data usability assessments, which were compiled into DUSRs (**Appendix M**), was prepared in accordance with the USACE Engineer Manual 200-1-10 (USACE 2005), the Final DoD General Data Validation Guidelines (DoD 2019), and the Final DoD Data Validation Procedure for Per-and Polyfluoroalkyl Substances Analysis by QSM Table B-15 (DoD 2020), that reviewed precision, accuracy, completeness, representativeness, comparability, and sensitivity. A statement of overall data usability is included in the DUSRs.

During the validation process, certain PFAS analyte results were qualified as “X” in five groundwater samples due to extracted internal standards exhibiting recoveries less than 20%, which is indicative of matrix interference. Only PFAS analytes other than PFOS, PFOA, or PFBS were “X”-qualified in three of the samples. In these instances, the results for the “X”-qualified data were rejected as explained in the DUSRs. Two samples, RSA-4815-GW-02 and RSA-4832-GW-01, had PFOS detections that were qualified as “X” in addition to several other PFAS analytes also qualified as “X”. The non-PFOS analyte data for these two samples were rejected. The PFOS data for both samples are displayed as “present” since PFOS was detected and is a constituent of concern with associated screening criteria. PFOS is considered present in these samples; however, the reported values have unknown bias and are unreliable. Therefore, the PFOS results for samples RSA-4815-GW-02 and RSA-4832-GW-01 cannot be compared to the OSD tap water screening level for PFOS.

Based on the final data usability assessment, the remaining environmental data collected at RSA during the SI were found to be acceptable and usable for this SI evaluation with the qualifications documented in the DUSR and its associated data validation reports (**Appendix M**), and as indicated in the full analytical tables (**Appendix N**) provided for the SI results. These data are of sufficient quality to meet the objectives and requirements of the PQAPP (Arcadis 2019) and RSA QAPP Addendum (Arcadis 2020a). Data qualifiers applied to laboratory analytical results for samples collected during the SI at RSA are provided in the data tables, data validation reports, and the Data Usability Summary Table located at the end of the DUSR. Qualifiers for data shown on figures are defined in the notes of figures.

6.5 Office of the Secretary of Defense Risk Screening Levels

The OSD risk screening levels for PFOS, PFOA, and PFBS in groundwater (tap water) and soil were calculated using the USEPA’s RSL calculator for residential and industrial/commercial worker receptor scenarios and current toxicity values. These risk screening levels are shown in **Table 6-2**.

Table 6-2. OSD Risk Screening Levels Calculated for PFOS, PFOA, PFBS in Tap Water and Soil Using USEPA's Regional Screening Level Calculator

Chemical	Residential Scenario Risk Screening Levels Calculated Using USEPA RSL Calculator		Industrial/Commercial Scenario Risk Screening Levels Calculated Using USEPA RSL Calculator
	Tap Water (ng/L or ppt) [1]	Soil (mg/kg or ppm) [1,2]	Soil (mg/kg or ppm) [1,2]
PFOS	40	0.13	1.6
PFOA	40	0.13	1.6
PFBS	600	1.9	25

Notes:
1. Risk screening levels for tap water and soil provided in OSD's September 15, 2021 Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program (**Appendix A**).

2. All soil data will be screened against both the residential scenario and industrial/commercial risk screening levels (if collected from less than 2 ft bgs), regardless of the current and projected land use of the AOPI.
mg/kg = milligram per kilogram
ng/L = nanograms per liter
ppm = parts per million
ppt = parts per trillion

The OSD residential tap water risk screening levels will be used to compare all groundwater data for this Army PFAS PA/SI program. While the current and most likely future land uses of the AOPIs at RSA are industrial/commercial, both residential and industrial/commercial soil risk screening levels for PFOS, PFOA, and PFBS will be used to evaluate detected soil concentrations. The data from the SI sampling event are compared to the OSD risk screening levels in **Section 7**. If concentrations of PFOS, PFOA, or PFBS are detected greater than the applicable OSD risk screening levels, further study in a remedial investigation is recommended in **Section 8**.

7 SUMMARY AND DISCUSSION OF SI RESULTS

This section summarizes the analytical results obtained from samples collected during the SI at RSA (field duplicate results are provided in the associated tables). Sampled media and QA/QC samples were analyzed for the constituents prescribed per Worksheet #18 of the QAPP Addendum (Arcadis 2020a). The sample results discussion below focuses on the PFOS, PFOA, and PFBS analytical results because they have OSD risk screening levels. The Army will make subsequent investigation decisions based on the concentrations of these constituents relative to the OSD risk screening criteria.

Tables 7-1 and **7-2** (provided in the attached tables section) provide a summary of the groundwater and soil analytical results for PFOS, PFOA, and PFBS. **Table 7-3** below, summarizes AOPIs and whether their SI results exceed the OSD risk screening levels. **Appendix N** includes the full suite of analytical results for these media, as well as for the QA/QC samples. An overview of AOPIs at RSA with OSD risk screening level exceedances is depicted on **Figure 7-1. Figures 7-2** through **7-28** show the PFOS, PFOA, and PFBS analytical results for groundwater and soil for each AOPI. Non-detected results are reported as less than the LOQ. Detections of PFOS, PFOA, and PFBS greater than the applicable OSD risk screening levels are highlighted in summary tables and on figures. Final qualifiers applied to the data by the laboratory and the project chemist (as defined in **Section 6.4.3**) are presented on the analytical tables. Groundwater data collected during the SI are reported in ng/L, or parts per trillion, and soil data are reported in mg/kg, or parts per million.

Field parameters measured for groundwater during low-flow purging and sample collection and for surface water during sample collection are provided on the field forms in **Appendix J**. Soil descriptions are provided on the field forms in **Appendix J**. The results of the SI are grouped by AOPI and discussed for each medium as applicable. Groundwater was generally first encountered at an average depth of approximately 25 ft bgs. Depth to groundwater varied across the installation with the deepest groundwater encountered at the airfield (72.1 ft bgs) and near the Landfill Fire AOPI (59.74 ft bgs), generally north of HSB. The shallowest groundwater was encountered near FS #3 (3.39 ft bgs), located south of HSB.

Table 7-3. AOPIs and OSD Risk Screening Level Exceedances

AOPI Name	OSD Exceedances (Yes/No)
Fire Station #2 (Building 3320)	Yes
Hangar 6312	No
Building 7370 – Thiokol Teflon-Coating Facility	Yes
Fire Station #3 (Building 7801)	Yes
Transformer Fire	Yes
Old Fire Station #2 (Building 8014)	Yes
Fire House Pub (Building 114)	Yes
Mulcher Fire	No

AOPI Name	OSD Exceedances (Yes/No)
Keyhole/Nozzle Testing Area	Yes
Fire Training Area	Yes
Fire Station #4 (Building 4810)	Yes
Fire Station #5 (Building 4813)	Yes
Hangar 4815	Yes
Hangar 4832	No
Hangar 4880	No
Fire Station #1 (Building 4424)	Yes
Vehicle Fire (Building 4650)	No
Landfill Fire	No
Building 5681 Fire	No
Old Fire Station #1 (Building 5414)	No
Fuel Tank Fire	Yes
FBI – Building 7017	No
FBI – Building 9061	No
Aircraft Crash Site	No
Former Fire Station – Building T-3241	Yes
Inactive Sewage Treatment Plant #1	Yes
Inactive Sewage Treatment Plant #3	Yes
Inactive Sewage Treatment Plant #4	No

7.1 Fire Station #2 (Building 3320)

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with FS #2 (Building 3320).

7.1.1 Groundwater

A grab groundwater sample (RSA-FS2-GW-01) was collected from one boring advanced via DPT at FS #2. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 16.5 to 24.5 ft bgs. The boring was located in the grassy area to the east of the building where AFFF likely drained during AFFF equipment testing or spills (**Figure 7-2**). Groundwater sampling was completed on October 1, 2020.

PFOS (77,000 J ng/L)[3] and PFOA (5,200 J ng/L) were detected at concentrations exceeding the OSD risk screening level of 40 ng/L; PFBS (1,400 J ng/L) was detected at a concentration exceeding the OSD risk screening level of 600 ng/L. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.1.2 Soil

Two soil samples were collected via hand auger in the vicinity of FS #2 on October 1, 2020 (**Figure 7-2**). Surface soil sample RSA-FS2-SO-01 (0-2 ft bgs) was co-located with groundwater sample RSA-FS2-GW-01. Surface soil sample RSA-FS2-SO-02 (0-2 ft bgs) was collected at the edge of a paved area where AFFF may have been discharged during equipment testing.

PFOS (0.18 mg/kg) and PFOA (0.0045 mg/kg) were detected in RSA-FS2-SO-01. The PFOS result exceeds the residential OSD risk screening level of 0.13 mg/kg, but the PFOA concentration is less than the residential OSD screening level. PFOS (0.016 mg/kg) and PFOA (0.0006 J mg/kg) were detected in soil sample RSA-FS2-SO-02 at concentrations below the OSD risk screening level. PFBS was not detected in either soil sample. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.2 Hangar 6312

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with Hangar 6312.

7.2.1 Groundwater

A grab groundwater sample (RSA-6312-GW-01) was collected from one boring advanced via DPT at Hangar 6312. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 13.25 to 17.25 ft bgs. The boring was located in the grassy area to the southwest of the building where AFFF would likely drain during AFFF equipment testing or releases (**Figure 7-3**). Groundwater sampling was completed on October 5, 2020.

PFOS (8 ng/L), PFOA (8.2 ng/L), and PFBS (3.3 J ng/L) were detected at concentrations below their respective OSD risk screening levels of 40 ng/L for PFOS and PFOA and 600 ng/L for PFBS. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.2.2 Soil

Four soil samples were collected via hand auger near Hangar 6312 on September 29, 2020. RSA-6312-SO-01 (0-2 ft bgs), co-located with groundwater sample RSA-6312-GW-01, RSA-6312-SO-02 (0-2 ft bgs), and RSA-6312-SO-03 (0-2 ft bgs) were collected south of the hangar in the general direction of surface

[3] The “J” qualifier indicates that the analytes were positively identified, but the associated numerical values are estimated concentrations only.

runoff. RSA-6312-SO-04 (0-2 ft bgs) was collected from the north side of the hangar near the suppression system pump room (**Figure 7-3**).

PFOS was detected in two of the four surface soil samples, RSA-6312-SO-02 (0.0017 mg/kg) and RSA-6312-SO-03 (0.00062 J mg/kg), at concentrations lower than the residential OSD risk screening level of 0.13 mg/kg. PFOA was detected in RSA-6312-SO-02 (0.00098 J mg/kg) at a concentration lower than the residential OSD risk screening level of 0.13 mg/kg. PFOS and PFOA were not detected in the surface soil samples collected from the north and southwest of the hangar (RSA-6312-SO-01 and RSA-6312-SO-04). PFBS was not detected in any of the four surface soil samples. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.3 Building 7370 – Thiokol Teflon™ Coating Facility

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Building 7370 – Thiokol Teflon™ Coating AOPI.

7.3.1 Groundwater

A groundwater sample (RSA-RS1221-GW-01) was collected from existing monitoring well RS1221 at Building 7370. Monitoring well RS1221 is located in the grassy area to the northwest of the former building footprint near the reported staging/drying area of Teflon™-coated rocket cores (**Figure 7-4**). Groundwater sampling was completed on September 29, 2020. The groundwater sample was collected from approximately the center of the saturated screened interval of 25.75 to 35.75 ft bgs.

PFOS (15 ng/L), PFOA (550 ng/L), and PFBS (3.8 J ng/L) were detected. Only the PFOA concentration exceeded the OSD risk screening level of 40 ng/L; the PFOS and PFBS concentrations were below their respective OSD risk screening levels of 40 ng/L and 600 ng/L. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.3.2 Soil

Four surface soil samples, RSA-TEF-SO-01 (0-2 ft bgs), RSA-TEF-SO-02 (0-2 ft bgs), RSA-TEF-SO-03 (0-2 ft bgs), and RSA-TEF-SO-04 (0-1 ft bgs), were collected north, east, south, and west of the former Building 7370 footprint, respectively (**Figure 7-4**). The soil samples were collected via hand auger on September 29, 2020.

PFOA was detected in two of the soil samples at concentrations below the OSD risk screening level of 0.13 mg/kg: RSA-TEF-SO-02 (0.0011 mg/kg) and RSA-TEF-SO-04 (0.00053 mg/kg). These detections were limited to the east and west of the former building footprint. PFOA was not detected in soil sample RSA-TEF-SO-01 or RSA-TEF-SO-03. PFOS and PFBS were not detected in any of the four surface soil samples. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.4 Fire Station #3 (Building 7801)

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with FS #3 (Building 7801).

7.4.1 Groundwater

A grab groundwater sample (RSA-FS3-GW-01) was collected from one boring advanced via DPT at FS #3. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 4.8 to 9.8 ft bgs. The boring was located near the ditch in the grassy area to the southeast of the building where AFFF likely drained during AFFF equipment testing or release (**Figure 7-5**). Groundwater sampling was completed on October 8, 2020.

PFOS (6,400 J ng/L), PFOA (2,500 J ng/L), and PFBS (32,000 J ng/L) were detected at concentrations exceeding the OSD risk screening levels of 40 ng/L for PFOS and PFOA and 600 ng/L for PFBS. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.4.2 Soil

Two surface soil samples were collected via hand auger near FS #3 on September 30, 2020. Surface soil sample RSA-FS3-SO-01 (0-2 ft bgs) was co-located with groundwater sample RSA-FS3-GW-01. Surface soil sample RSA-FS2-SO-02 (0-2 ft bgs) was collected from the grassy region along the southern edge of the FS driveway, downslope of the paved entrance to the station (**Figure 7-5**).

PFOS (0.4 J mg/kg), PFOA (0.0042 mg/kg), and PFBS (0.0061 mg/kg) were detected in sample RSA-FS3-SO-01, with PFOS exceeding the residential OSD risk screening level of 0.13 mg/kg. PFOS (0.029 mg/kg) was detected in sample RSA-FS3-SO-02 at a concentration lower than the OSD residential risk screening level of 0.13 mg/kg; PFOA and PFBS were not detected in this sample. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.5 Transformer Fire

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Transformer Fire AOPI. Sampling for the Transformer Fire AOPI occurred on two occasions. The initial samples were collected from the current WTP (**Figure 7-6**) based on incorrect information regarding the location of the fire. The second sampling effort was performed at the current STP (**Figure 7-7**) after confirming with RSA Fire and Emergency Services in August 2021 that the transformer fire had occurred at this location. Data from both locations are presented below.

7.5.1 Groundwater

During the initial sampling event at the WTP, two groundwater samples were collected. One existing monitoring well (RS2291) was sampled on October 1, 2020. The groundwater sample (RSA-RS2291) was collected from approximately the center of the monitoring well's saturated screened interval of 20 to 30 ft bgs. A grab groundwater sample (RSA-TRAN-GW-01) was collected on November 3, 2020 from one boring advanced via DPT. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 2 to 17 ft bgs (**Figure 7-6**).

PFOS (5.8 ng/L) and PFBS (4.5 ng/L) were detected in the sample from monitoring well RS2291 at concentrations below the OSD risk screening levels of 40 ng/L for PFOS and 600 ng/L for PFBS; PFOA

was not detected in the sample collected from monitoring well RS2291. PFOS (8.4 J+ ng/L),[4] PFOA (4.4 ng/L), and PFBS (3.5 J ng/L) were detected in sample RSA-TRAN-GW-01 at concentrations below their OSD risk screening levels of 40 ng/L for PFOS and PFOA and 600 ng/L for PFBS.

During the sampling effort at the corrected transformer fire location, one grab groundwater sample (RSA-WWTP-GW-1) was collected from a boring advanced via DPT, south and downgradient of the presumed AFFF release area (**Figure 7-7**). The groundwater sample was collected on August 25, 2021 at first-encountered groundwater obtained from a temporary well screen installed at a depth of 25 to 35 ft bgs. PFOS (48 ng/L) and PFOA (70 ng/L) were detected at concentrations exceeding the OSD risk screening level of 40 ng/L; PFBS (13 ng/L) was detected below its OSD risk screening level of 600 ng/L. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.5.2 Soil

During initial sampling on September 30, 2020, two surface soil samples were collected via hand auger near the misidentified location of the transformer fire at the WTP (**Figure 7-6**). Surface soil sample RSA-TRAN-SO-01 (0-2 ft bgs) was co-located with groundwater sample RSA-TRAN-GW-01. Surface soil sample RSA-TRAN-SO-02 (0-2 ft bgs) was collected in the direction of surface water runoff. Reported PFOS concentrations (0.00058 J mg/kg at RSA-TRAN-SO-01 and 0.00092 J mg/kg at RSA-TRAN-SO-02) were below the residential OSD risk screening level of 0.13 mg/kg. PFOA and PFBS were not detected in either of the two surface soil samples.

During the sampling effort at the corrected transformer fire location on August 24, 2021, two surface soil samples were collected via hand auger from within the boundaries of the overspray area associated with the firefighting response (**Figure 7-7**). Surface soil sample RSA-WWTP-SO-01 (0-2 ft bgs) was co-located with groundwater sample RSA-WWTP-GW-1 and RSA-WWTP-SO-02 was collected in the direction of surface water runoff. Reported PFOS concentrations (0.0059 mg/kg at RSA-WWTP-SO-1 and 0.00072 J mg/kg at RSA-WWTP-SO-2) were below the residential OSD risk screening level of 0.13 mg/kg. PFOA and PFBS were not detected in either of the two surface soil samples. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.6 Old Fire Station #2 (Building 8014)

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Old FS #2 AOPI.

7.6.1 Groundwater

A grab groundwater sample (RSA-OFS2-GW-01) was collected from one boring advanced via DPT at Old FS #2. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 1 to 21 ft bgs. The boring was located in a grassy

[4] The "J+" qualifier indicates that the analyte was positively identified but the associated numerical value is estimated and may be biased high.

area to the east of the former FS driveway where AFFF may have drained during AFFF equipment testing or spills (**Figure 7-8**). Groundwater sampling was completed on November 3, 2020.

PFOS (57 ng/L) and PFOA (28 ng/L) were detected, with only the PFOS concentration exceeding the OSD risk screening level of 40 ng/L. PFBS was not detected in the groundwater sample. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.6.2 Soil

Two surface soil samples were collected via hand auger near the former footprint of Old FS #2 on September 30, 2020. Surface soil sample RSA-OFS2-SO-01 (0-2 ft bgs) was co-located with groundwater sample RSA-OFS2-GW-01 in the direction of surface runoff from the former building. RSA-OFS2-SO-02 was positioned west of the former FS driveway where AFFF may have drained toward a stormwater drainage swale (**Figure 7-8**).

PFOS (0.0015 mg/kg) was detected in sample RSA-OFS2-SO-01 at a concentration below the OSD residential risk screening level of 0.13 mg/kg; PFOA and PFBS were not detected in this sample. PFOS (0.001 J mg/kg) and PFOA (0.0007 J mg/kg) were detected in sample RSA-OFS2-SO-02 at concentrations below the OSD residential risk screening level of 0.13 mg/kg; PFBS was not detected in this sample. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.7 Firehouse Pub (Building 114)

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Firehouse Pub (Building 114) AOPI.

7.7.1 Groundwater

A grab groundwater sample (RSA-PUB-GW-01) was collected from one boring advanced via rotosonic drilling at the Firehouse Pub AOPI. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 2 to 10 ft bgs. The boring was located in the grassy area downslope of the building where AFFF may have drained during AFFF equipment testing or spills (**Figure 7-9**). Groundwater sampling was completed on November 8, 2020.

PFOS (13 ng/L), PFOA (53 ng/L), and PFBS (20 ng/L) were detected in the groundwater sample, with only the PFOA concentration exceeding the OSD risk screening level of 40 ng/L. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.7.2 Soil

Three surface soil samples were collected via hand auger near the Firehouse Pub on October 2, 2020. Surface soil sample RSA-PUB-SO-01 (0-2 ft bgs) was collected from the southern corner of the building, RSA-PUB-SO-02 (0-2 ft bgs) was collected from the western corner of the building, and RSA-PUB-SO-03 (0-2 ft bgs) was collected from along the south side of the building driveway (**Figure 7-9**).

PFOS (0.0033 mg/kg) was detected in sample RSA-PUB-SO-01; PFOA and PFBS were not detected in this sample. PFOA (0.00067 J mg/kg) was detected in sample RSA-PUB-SO-02; PFOS and PFBS were not detected in this sample. For RSA-PUB-SO-03, PFOS (0.0017 mg/kg) and PFOA (0.0006 J mg/kg) were detected and PFBS was not detected. None of the detected concentrations of PFOS or PFOA were greater than the OSD residential risk screening level of 0.13 mg/kg. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.8 Mulcher Fire

The subsection below summarizes the soil PFOS, PFOA, and PFBS analytical results associated with the Mulcher Fire AOPI. The originally proposed groundwater sample was not collected. During a conference call on March 23, 2021, the Army concurred with the recommendation to not collect a groundwater sample (as discussed in **Section 6.3.3**).

7.8.1 Soil

Two surface soil samples were collected via hand auger from the Mulcher Fire AOPI on November 19, 2020. Surface soil samples RSA-MLCH-SO-01 (0-2 ft bgs) and RSA-MLCH-SO-02 (0-2 ft bgs) were collected from the area where the fire is believed to have occurred (**Figure 7-10**). PFOS, PFOA, and PFBS were not detected in either surface soil sample. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.9 Keyhole/Nozzle Testing Area

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Keyhole/Nozzle Testing Area AOPI.

7.9.1 Groundwater

A grab groundwater sample (RSA-KEY-GW-01) was collected from one boring advanced via rotosonic drilling at the Keyhole/Nozzle Testing Area AOPI. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 27 to 57 ft bgs. The boring was located along the eastern side of the testing area, downgradient of the presumed groundwater flow direction (**Figure 7-11**). Groundwater sampling was completed on November 9, 2020.

PFOS (13 ng/L), PFOA (3.2 J ng/L), and PFBS (13 ng/L) were detected at concentrations below their respective OSD risk screening levels of 40 ng/L for PFOS and PFOA and 600 ng/L for PFBS. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.9.2 Soil

Four surface soil samples were collected via hand auger from the Keyhole/Nozzle Testing Area on October 1, 2020. Surface soil samples RSA-KEY-SO-01 (0-2 ft bgs), RSA-KEY-SO-02 (0-2 ft bgs), RSA-KEY-SO-03 (0-2 ft bgs), and RSA-KEY-SO-04 (0-2 ft bgs) were collected from locations within the testing area near the eastern, northern, western, and southern portions of the area, respectively (**Figure 7-11**). Soil sample RSA-KEY-SO-01 was co-located with groundwater sample RSA-KEY-GW-01.

PFOS (0.00098 J mg/kg) was detected in sample RSA-KEY-SO-01 at a concentration below the OSD residential risk screening level of 0.13 mg/kg; PFOA and PFBS were not detected in this sample. PFOS, PFOA, and PFBS were not detected in sample RSA-KEY-SO-02. PFOS (0.002 mg/kg) was detected in sample RSA-KEY-SO-03 at a concentration below the OSD residential risk screening level of 0.13 mg/kg; PFOA and PFBS were not detected in this sample. PFOS (0.22 mg/kg) was detected in sample RSA-KEY-SO-04 at a concentration greater than the OSD residential screening level (0.13 mg/kg) but lower than the OSD industrial/commercial risk screening level (1.6 mg/kg). PFOA (0.0023 mg/kg) was detected at a concentration below the OSD residential risk screening level (0.13 mg/kg) and PFBS was not detected in sample RSA-KEY-SO-04. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.10 Fire Training Area

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Fire Training Area AOPI.

7.10.1 Groundwater

Two groundwater samples (RSA-RS1576 and RSA-1577) were collected from existing monitoring wells RS1576 and RS1577. Both monitoring wells are located to the southeast of the fire training pit and in the inferred downgradient groundwater flow direction (**Figure 7-12**). Groundwater samples were collected from approximately the centers of the saturated screened intervals for RS1576 (screened 23 to 33 ft bgs) and RS1577 (screened 17 to 27 ft bgs). Groundwater sampling was completed on October 1, 2020.

PFOS, PFOA, and PFBS were detected in both groundwater samples. At RS1576, PFOS (110,000 J ng/L), PFOA (1,900 J ng/L), and PFBS (3,100 J ng/L) concentrations exceeded the OSD risk screening levels of 40 ng/L for PFOS and PFOA and 600 ng/L for PFBS. At RS1577, PFOS (660 ng/L) exceeded the OSD risk screening level of 40 ng/L, but PFOA (37 ng/L) and PFBS (21 ng/L) concentrations were lower than the OSD risk screening levels of 40 ng/L for PFOA and 600 ng/L for PFBS. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.10.2 Soil

Four surface soil samples were collected via hand auger from the FTA on October 2, 2020. Surface soil samples RSA-FTA-SO-01 (0-1 ft bgs), RSA-FTA-SO-02 (0-1 ft bgs), RSA-FTA-SO-03 (0-1 ft bgs), and RSA-FTA-SO-04 (0-1 ft bgs) were collected from locations north, east, south, and west of the fire training pit, respectively (**Figure 7-12**).

PFOS (0.0028 mg/kg) was detected in sample RSA-FTA-SO-01 at a concentration below the OSD residential risk screening level of 0.13 mg/kg; PFOA and PFBS were not detected in this sample. PFOS (0.0091 mg/kg) was detected in sample RSA-FTA-SO-02 at a concentration below the OSD residential risk screening level of 0.13 mg/kg; PFOA and PFBS were not detected in this sample. PFOS (0.25 J mg/kg) was detected in sample RSA-FTA-SO-03 at a concentration greater than the OSD residential screening level (0.13 mg/kg) but lower than the OSD industrial/commercial risk screening level (1.6 mg/kg). PFOA (0.0029 mg/kg) and PFBS (0.0099 mg/kg) were detected at concentrations below their respective OSD residential risk screening levels (0.13 mg/kg for PFOA and 1.9 mg/kg for PFBS). PFOS

(0.037 mg/kg) and PFOA (0.00077 J mg/kg) were detected in sample RSA-FTA-SO-04 at concentrations below the OSD residential risk screening level of 0.13 mg/kg; PFBS was not detected in this sample. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.11 Fire Station #4 (Building 4810)

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the FS #4 (Building 4810) AOPI.

7.11.1 Groundwater

Two groundwater samples were collected proximal to FS #4 (**Figure 7-13)**. One existing monitoring well (RS1278) was sampled on October 1, 2020. The groundwater sample (RSA-RS1278) was collected from approximately the center of the monitoring well's saturated screened interval of 72 to 87 ft bgs. A grab groundwater sample (RSA-FS4-GW-01) was collected on November 11, 2020 from a boring advanced via rotosonic drilling. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 60 to 70 ft bgs. The boring was located southeast of the FS and near an east-to-west ditch feature.

PFOS (2.9 J ng/L) and PFBS (1.8 J ng/L) were detected in the sample from monitoring well RS1278 at concentrations below the OSD risk screening levels of 40 ng/L for PFOS and 600 ng/L for PFBS; PFOA was not detected in the sample collected from monitoring well RS1278. PFOS (46 ng/L), PFOA (5.6 ng/L), and PFBS (5.6 ng/L) were detected in sample RSA-FS4-GW-01. Only the reported PFOS concentration exceeded the OSD risk screening level of 40 ng/L. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.11.2 Soil

Two surface soil samples were collected via hand auger near FS #4 on October 1, 2020. Sample RSA-FS4-SO-01 (0-2 ft bgs) was co-located with groundwater sample RSA-FS4-GW-01, and RSA-FS4-SO-02 was collected from the south side of the FS driveway where AFFF may have been released during equipment testing (**Figure 7-13**).

PFOS (0.0034 mg/kg) and PFOA (0.00053 J mg/kg) were detected in sample RSA-FS4-SO-01 at concentrations below the OSD residential risk screening level of 0.13 mg/kg. PFOS (0.0039 mg/kg) and PFOA (0.00084 J mg/kg) were detected in sample RSA-FS4-SO-02 at concentrations below the OSD residential risk screening level of 0.13 mg/kg. PFBS was not detected in either of the two samples. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.12 Fire Station #5 (Building 4813)

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the FS #5 (Building 4813) AOPI.

7.12.1 Groundwater

A boring was advanced at location RSA-FS5-GW-01 via rotosonic drilling on November 18, 2020 for the purpose of groundwater sample collection. Some moistness was observed in the epikarst and a temporary well screen was set at a depth interval of 39 to 54 ft bgs. No groundwater recharge was encountered after one month; therefore, the borehole was abandoned on December 30, 2020 and no groundwater sample was collected. A grab groundwater sample (RSA-4815-GW-02) was collected on November 20, 2020 from a boring advanced via rotosonic drilling. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 25 to 55 ft bgs. Groundwater sample RSA-4815-GW-02 was collected downgradient of both FS #5 and Hangar 4815, associated with the former septic system drainage field to which both buildings historically drained (**Figure 7-13)**. The groundwater sample collected from the FS #4 AOPI is also used to characterize FS #5 as it is located directly downgradient of FS #5 (**Figure 7-13**; **Section 7.11.1**).

PFOS (Present), PFOA (8.7 ng/L), and PFBS (4.1 J+ ng/L) were detected in sample RSA-4815-GW-02. During data validation, it was noted that the extracted internal standard recovery for PFOS was outside control limits. PFOS is considered present; however, the reported value has unknown bias and is unreliable. The result cannot be compared to screening criteria. The PFOA and PFBS concentrations were lower than their respective OSD risk screening levels (40 ng/L for PFOA and 600 ng/L for PFBS). Groundwater sample RSA-FS4-GW-01 is located directly downgradient of FS #5 (**Figure 7-13**). PFOS (46 ng/L), PFOA (5.6 ng/L), and PFBS (5.6 ng/L) were detected in sample RSA-FS4-GW-01. The reported PFOS concentration exceeded the OSD risk screening level of 40 ng/L. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.12.2 Soil

Two surface soil samples were collected via hand auger near FS #5 on October 1, 2020. Samples RSA-FS5-SO-01 (0-2 ft bgs) and RSA-FS5-SO-02 (0-2 ft bgs) were collected from locations along the south side of the FS driveway in the likely direction of surface water runoff (**Figure 7-13**).

PFOS (0.068 mg/kg in sample RSA-FS5-SO-01 and 0.019 mg/kg in sample RSA-FS5-SO-02) was detected at concentrations below the OSD residential risk screening level of 0.13 mg/kg in both samples. PFOA and PFBS were not detected in either of the two soil samples. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.13 Hangar 4815

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Hangar 4815 AOPI.

7.13.1 Groundwater

A boring was advanced at location RSA-4815-GW-01 via rotosonic drilling on November 18, 2020 for the purpose of groundwater sample collection. Some moistness was observed in the epikarst and a temporary well screen was set at a depth interval of 18 to 39 ft bgs. No groundwater recharge was

encountered after one month; therefore, the borehole was abandoned on December 30, 2020 and no groundwater sample was collected.

Four groundwater samples associated with Hangar 4815 were collected, two from nearby existing monitoring wells and two from temporary monitoring wells. Temporary well RSA-4815-GW-02 is associated with the historical septic drainage field for both FS #5 and Hangar 4815, as discussed in **Section 7.12.1** (**Figure 7-13**). Temporary well RSA-FS4-GW-01 is associated with FS #4 as well as with FS#5 and Hangar 4815 (see **Section 7.11.1**). Existing monitoring wells MW08 and RS1604 were sampled on November 11 and November 20, 2020, respectively. Groundwater samples were collected from approximately the center of each monitoring well's saturated screened interval of 57 to 67 ft bgs for MW08 and 115 to 130 ft bgs for RS1604. MW08 is located downgradient of the inferred groundwater flow direction from Hangar 4815 and monitoring well RS1604 is located upgradient of the hangar and within the airfield. Both monitoring wells were sampled because of drilling difficulties encountered during rotosonic drilling in the vicinity of Hangar 4815.

PFOS (Present), PFOA (8.7 ng/L), and PFBS (4.1 J+ ng/L) were detected in sample RSA-4815-GW-02. During data validation, it was noted that the extracted internal standard recovery for PFOS was outside control limits. PFOS is considered present; however, the reported value has unknown bias and is unreliable. The result cannot be compared to screening criteria. The PFOA and PFBS concentrations were lower than their respective OSD risk screening levels (40 ng/L for PFOA and 600 ng/L for PFBS). PFOS (39 ng/L), PFOA (12 ng/L) and PFBS (8.6 ng/L) were detected in sample RSA-MW08-01, at concentrations below the OSD risk screening levels (40 ng/L for PFOS and PFOA and 600 ng/L for PFBS). In the upgradient groundwater sample, RSA-RS1604, PFOA (2.6 J ng/L) was detected at a concentration below the OSD risk screening level of 40 ng/L; PFOS and PFBS were not detected. Groundwater sample RSA-FS4-GW-01 is located directly downgradient of Hangar 4815 (**Figure 7-13**). PFOS (46 ng/L), PFOA (5.6 ng/L), and PFBS (5.6 ng/L) were detected in sample RSA-FS4-GW-01. The reported PFOS concentration exceeded the OSD risk screening level of 40 ng/L. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.13.2 Soil

Three surface soil samples were collected via hand auger near Hangar 4815 on October 1, 2020. Sample RSA-4815-SO-01 (0-2 ft bgs) was collected from the grassy area west of (behind) the hangar, near the presumed AFFF storage tank location. Sample RSA-4815-SO-02 (0-2 ft bgs) was co-located with groundwater sample RSA-4815-GW-02 in the area of the historical septic tank drain field. Sample RSA-1815-SO-03 was collected from the northwest corner of Hangar 4815 (**Figure 7-13**).

PFOS (0.0012 J mg/kg) was detected in sample RSA-4815-SO-01 at a concentration below the OSD residential risk screening level (0.13 mg/kg). PFOA and PFBS were not detected in this sample. PFOS, PFOA, and PFBS were not detected in samples RSA-4815-SO-02 and RSA-4815-SO-03. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.14 Hangar 4832

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Hangar 4832 AOPI.

7.14.1 Groundwater

A grab groundwater sample (RSA-4832-GW-01) was collected from one boring advanced via rotosonic drilling at Hangar 4832. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 19 to 39 ft bgs. The boring was located west of Hangar 4832 in a grassy area adjacent to a stormwater ditch (**Figure 7-14**). Groundwater sampling of RSA-4832-GW-01 was completed on December 17, 2020.

PFOS (Present), PFOA (16 J+ ng/L), and PFBS (5.0 J+ ng/L) were detected in groundwater sample RSA-4832-GW-01. During data validation, it was noted that the extracted internal standard recovery for PFOS was outside control limits. PFOS is considered present; however, the reported value has unknown bias and is unreliable. The result cannot be compared to screening criteria. PFOA and PFBS concentrations were reported at concentrations lower than their OSD risk screening levels (40 ng/L for PFOA and 600 ng/L for PFBS). PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.14.2 Soil

Three surface soil samples were collected via hand auger near Hangar 4832 on September 30, 2020. Samples RSA-4832-SO-01 (0-2 ft bgs), RSA-4832-SO-02 (0-2 ft bgs), and RSA-4832-SO-03 (0-2 ft bgs) were collected west, east, and south of the hangar, respectively, to assess soil in the directions of surface runoff flow (**Figure 7-14**). Surface soil sample RSA-4832-SO-01 was co-located with groundwater sample RSA-4832-GW-01.

PFOS was detected in all three soil samples, RSA-4832-SO-01 (0.0047 mg/kg), RSA-4832-SO-02 (0.056 mg/kg), and RSA-4832-SO-03 (0.0017 mg/kg), at concentrations lower than the OSD residential risk screening level. PFOA and PFBS were not detected in any of the surface soil samples. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.15 Hangar 4880

The subsection below summarizes the soil PFOS, PFOA, and PFBS analytical results associated with the Hangar 4880 AOPI. As discussed in **Section 6.3.3**, a groundwater sample was not obtained for the Hangar 4880 site.

7.15.1 Soil

Five surface soil samples were collected via hand auger near Hangar 4880. Samples RSA-4880-SO-02 (0-2 ft bgs), RSA-4880-SO-03 (0-2 ft bgs), and RSA-4880-SO-04 (0-2 ft bgs) were collected on September 30, 2020 from east and west of the hangar. On November 19, 2020, two additional samples, RSA-4880-SO-01 (0-1 ft bgs) and RSA-4880-SO-05 (0-1 ft bgs), were collected south of the hangar near a stormwater drainage ditch (**Figure 7-15**).

PFOS, PFOA, and PFBS were not detected in samples collected from east and west of the hangar (RSA-4880-SO-02, RSA-4880-SO-03, and RSA-4880-SO-04). PFOS (0.00082 J mg/kg) and PFBS (0.0012 mg/kg) were detected in sample RSA-4880-SO-01 at concentrations lower than the OSD residential risk screening levels of 0.13 mg/kg for PFOS and 1.9 mg/kg for PFBS; PFOA was not detected in this sample. PFOS (0.0012 mg/kg) was detected in sample RSA-4880-SO-05 at a concentration lower than the OSD

residential risk screening level of 0.13 mg/kg; PFOA and PFBS were not detected in this sample. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.16 Fire Station #1 (Building 4424)

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the FS #1 (Building 4424) AOPI.

7.16.1 Groundwater

A grab groundwater sample (RSA-FS1-GW-01) was collected from one boring advanced via DPT at FS #1. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 5 to 15 ft bgs. The boring was located in the grassy area to the southeast of the building where AFFF may have drained during AFFF equipment testing or spills (**Figure 7-16**). Groundwater sampling was completed on November 3, 2020.

PFOS (50,000 J ng/L) and PFOA (2,200 J ng/L) were detected at concentrations greater than OSD risk screening levels of 40 ng/L for both PFOS and PFOA. PFBS (200 ng/L) was detected at a concentration lower than the OSD risk screening level of 600 ug/L. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.16.2 Soil

Two surface soil samples were collected via hand auger near FS #1 on September 28, 2020. Surface soil sample RSA-FS1-SO-01 (0-2 ft bgs) was co-located with groundwater sample RSA-FS1-GW-01 in the direction of inferred groundwater flow from the parking area at FS #1. Soil sample RSA-FS1-SO-02 (0-2 ft bgs) was collected on the western side of the parking lot where released AFFF may have drained (**Figure 7-16**).

PFOS (0.057 mg/kg) and PFOA (0.0034 mg/kg) in sample RSA-FS1-SO-01 and PFOS (0.053 mg/kg) and PFOA (0.0024 mg/kg) in sample RSA-FS1-SO-02 were detected at concentrations lower than the OSD residential risk screening level of 0.13 mg/kg for both compounds. PFBS was not detected in either soil sample. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.17 Vehicle Fire (Building 4650)

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Vehicle Fire AOPI, which occurred adjacent to Building 4650.

7.17.1 Groundwater

A grab groundwater sample (RSA-VF-GW-01) was collected from one boring advanced via DPT near the presumed location of the vehicle fire. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 1 to 16 ft bgs. The boring was located in the grassy area to the east of the Building 4650 parking lot near a stormwater drainage swale (**Figure 7-17**). Groundwater sampling was completed on November 3, 2020.

PFOS (23 BJ+ ng/L),[5] PFOA (7 J- ng/L),[6] and PFBS (3.5 J- ng/L) were detected at concentrations lower than their respective OSD risk screening levels (40 ng/L for PFOS and PFOA and 600 ng/L for PFBS). PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.17.2 Soil

Two surface soil samples were collected via hand auger near the Vehicle Fire AOPI on September 28, 2020. Surface soil sample RSA-VF-SO-01 was co-located with groundwater sample RSA-VF-GW-01 near a drainage swale in the direction of surface runoff flow from the presumed vehicle fire location. Surface soil sample RSA-VF-SO-02 was collected from the grassy area directly east of the reported vehicle fire location (**Figure 7-17**).

PFOS (0.001 mg/kg) and PFOA (0.00055 J mg/kg) were detected in sample RSA-FV-SO-01 at concentrations below the OSD risk screening level of 0.13 mg/kg for both compounds; PFBS was not detected in this sample. PFOS, PFOA, and PFBS were not detected in sample RSA-VF-SO-02. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.18 Landfill Fire

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Landfill Fire AOPI.

7.18.1 Groundwater

Two groundwater samples (RSA-RS091 and RSA-RS093) were collected from existing monitoring wells RS091 and RS093 near the Landfill Fire AOPI. RS091 is located approximately 350 feet to the west-southwest of the reported fire location and RS093 is located approximately 1,500 feet to the southeast of the reported fire location, in the inferred downgradient groundwater flow direction (**Figure 7-18**). Groundwater samples were collected from approximately the centers of the saturated screened intervals for RS091 (screened 60 to 70 ft bgs) and RS093 (screened 64 to 79 ft bgs). Groundwater sampling was completed on September 29, 2020.

PFOS (3.3 J ng/L), PFOA (2 J ng/L), and PFBS (2.3 J ng/L) in sample RSA-RS091 and PFOS (12 ng/L), PFOA (38 ng/L), and PFBS (5.3 ng/L) in sample RSA-RS093 were detected at concentrations that did not exceed the OSD risk screening levels (40 ng/L for PFOS and PFOA; 600 ng/L for PFBS). PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

[5] The “B” qualifier indicates that the analyte was detected above one-half the reporting limit in an associated blank sample.

[6] The “J-” qualifier indicates that the analyte was positively identified but the associated numerical value is estimated and may be biased low.

7.18.2 Soil

One surface soil sample was collected via hand auger from the Landfill Fire AOPI on September 29, 2020. Surface soil sample RSA-LFF-SO-01 was collected from the vicinity of the reported fire (**Figure 7-18**).

PFOS (0.00089 mg/kg) was detected in sample RSA-LFF-SO-01 at a concentration below the OSD residential risk screening level of 0.13 mg/kg. PFOA and PFBS were not detected. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.19 Building 5681 Fire

The subsection below summarizes the groundwater PFOS, PFOA, and PFBS analytical results associated with the Building 5681 Fire AOPI. Because AFFF use was limited to an indoor application and due to uncertainty with respect to the location of the reported fire, no soil sampling was conducted at this site (as discussed in **Section 6.3.3**).

7.19.1 Groundwater

Four groundwater samples (RSA-RS1684, RSA-RS1686, RSA-RS1994, and RSA-RS1681) were collected from existing monitoring wells RS1684, RS1686, RS1994, and RS1681 located on the north, south, east, and west sides of Building 5681, respectively (**Figure 7-19**). Groundwater samples were collected from approximately the centers of the saturated screened intervals for RS1684 (screened 16 to 27.7 ft bgs), RS1686 (screened 29 to 39 ft bgs), RS1994 (screened 23.25 to 33.25 ft bgs), and RS1681 (screened 21.6 to 31.6 ft bgs). Groundwater sampling was completed on November 11, 2020.

PFOS, PFOA, and PFBS were detected in all four wells at concentrations below the OSD risk screening levels (40 ng/L for PFOS and PFOA; 600 ng/L for PFBS). The highest PFOS (12 ng/L) and PFBS (4.6 ng/L) concentrations were detected in RSA-RS1994, collected from the east side of the building. The highest PFOA (23 ng/L) concentration was detected in RSA-RS1681, collected from the west side of the building. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.20 Old Fire Station #1 (Building 5414)

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Old FS #1 (Building 5414) AOPI.

7.20.1 Groundwater

A grab groundwater sample (RSA-OFS1-GW-01) was collected from one boring advanced via DPT at Old FS #1. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 0 to 19 ft bgs. The boring was located in the grassy area to the southeast of the building in the direction of surface water runoff from the parking lot (**Figure 7-20**). Groundwater sampling was completed on November 3, 2020.

PFOS (14 J+ ng/L) and PFOA (7.2 ng/L) were detected at concentrations lower than the OSD risk screening level of 40 ng/L for both compounds. PFBS was not detected in sample RSA-OFS-GW-01. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.20.2 Soil

Three surface soil samples were collected via hand auger near Old FS #1 on September 30, 2020. Surface soil sample RSA-OSF1-SO-01 (0-2 ft bgs) was co-located with groundwater sample RSA-OSF1-GW-01; sample RSA-OSF1-SO-02 (0-2 ft bgs) was collected directly southeast of the building; and sample RSA-OFS1-SO-03 (0-1 ft bgs) was collected from the west of the building, in a grassy area where released AFFF may have been conveyed (**Figure 7-20**).

PFOS, PFOA, and PFBS were not detected in samples RSA-OFS1-SO-01 and RSA-OFS-SO-02. PFOS (0.00056 J mg/kg) was detected in sample RSA-OFS1-SO-03, at a concentration below the OSD residential risk screening level of 0.13 mg/kg; PFOA and PFBS were not detected in this sample. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.21 Fuel Tank Fire

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Fuel Tank Fire AOPI.

7.21.1 Groundwater

Two groundwater samples (RSA-RS2195 and RSA-RS2481) were collected from existing monitoring wells RS2195 and RS2481. The monitoring wells are located to the south and southeast of the former fuel tank, in the inferred downgradient groundwater flow direction (**Figure 7-21**). Groundwater samples were collected from approximately the centers of the saturated screened intervals for RS2195 (screened 9.8 to 19.8 ft bgs) and RS2481 (screened 14.2 to 24.2 ft bgs). Groundwater sampling was completed on September 29, 2020.

PFOS, PFOA, and PFBS were detected in both groundwater samples. In RSA-RS2195, PFOS (18,000 J ng/L), PFOA (910 ng/L), and PFBS (2,500 J ng/L) were detected at concentrations exceeding the OSD risk screening levels (40 ng/L for PFOS and PFOA and 600 ng/L for PFBS). In RSA-RS2481, PFOS (3,000 J ng/L) and PFOA (160 ng/L) concentrations exceeded the OSD risk screening level (40 ng/L for both PFOS and PFOA); PFBS (230 ng/L) was detected at a concentration below the OSD risk screening level (600 ng/L). PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.21.2 Soil

Four surface soil samples were collected via hand auger from the Fuel Tank Fire AOPI on September 29, 2020. Surface soil sample RSA-FUEL-SO-01 (0-2 ft bgs) was collected from a location north of the former tank, RSA-FUEL-SO-02 (0-2 ft bgs) to the west, and RSA-FUEL-SO-03 (0-2 ft bgs) and RSA-FUEL-SO-04 (0-2 ft bgs) to the east (**Figure 7-21**).

PFOS was detected in all four of the samples at concentrations lower than the OSD residential risk screening level of 0.13 mg/kg: RSA-FUEL-SO-01 (0.035 mg/kg), RSA-FUEL-SO-02 (0.099 mg/kg), RSA-

FUEL-SO-03 (0.0022 mg/kg), and RSA-FUEL-SO-04 (0.0013 J mg/kg). PFOA and PFBS were not detected in any of the four surface soil samples. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.22 FBI AFFF Storage Area (Building 7017)

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the FBI AFFF Storage Area (Building 7017).

7.22.1 Groundwater

A grab groundwater sample (RSA-FBI-7017-GW-1) was collected from one boring advanced via DPT near Building 7017. The groundwater sample was collected at first-encountered groundwater obtained from a temporary well screen installed at a depth interval of 16.5 to 26.5 ft bgs. The boring was located at the northern corner of Building 7017, near the main building door and near where AFFF was previously stored (**Figure 7-22**). Groundwater sampling was completed on August 25, 2021.

PFOS (12 J+ ng/L), PFOA (18 ng/L), and PFBS (6.6 ng/L) were detected at concentrations lower than the OSD risk screening levels (40 ng/L for PFOS and POA and 600 ng/L for PFBS). PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.22.2 Soil

Two surface soil samples were collected via hand auger near Building 7017 on August 2, 2021. Surface soil sample RSA-FBI-7017-SO-1 (0-2 ft bgs) was co-located with groundwater sample RSA-FBI-7017-GW-1, near the northern corner of the building. Surface soil sample RSA-FBI-7017-SO-2 (0-2 ft bgs) was collected from the grassy area next to the building entrance at the northwest corner of the building (**Figure 7-22**).

PFOS, PFOA, and PFBS were not detected in sample RSA-FBI-7017-SO-1. PFOS (0.00072 J mg/kg) was detected in sample RSA-FBI-7017-SO-2 at a concentration lower than the OSD residential risk screening level of 0.13 mg/kg; PFOA and PFBS were not detected in this sample. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.23 FBI AFFF Storage Area (Building 9061)

The subsection below summarizes the soil PFOS, PFOA, and PFBS analytical results associated with the FBI AFFF Storage Area (Building 9061) AOPI. As discussed in **Section 6.3.3**, a groundwater sample was not obtained for the FBI AFFF Storage Area (Building 9061) AOPI.

7.23.1 Soil

Two surface soil samples were collected via hand auger near Building 9061 on August 2, 2021. Surface soil samples RSA-FBI-9061-SO-1 (0-1 ft bgs) and RSA-FBI-9061-SO-2 (0-1 ft bgs) were collected from the northwest and northeast corners of Building 9061 (i.e., from either side of the front of the building), respectively (**Figure 7-23**).

PFOS (0.001 J mg/kg) was detected in sample RSA-FBI-9061-SO-1 at a concentration lower than the OSD residential risk screening level (0.13 mg/kg); PFOA and PFBS were not detected in this sample. PFOS, PFOA, and PFBS were not detected in sample RSA-FBI-9061-SO-2. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.24 Aircraft Crash Site

The subsection below summarizes the soil PFOS, PFOA, and PFBS analytical results associated with the Aircraft Crash Site AOPI. As discussed in FCR-01 (**Appendix L**), no groundwater samples were planned for this AOPI due to airfield access restrictions.

7.24.1 Soil

Six surface soil samples were collected via hand auger in the vicinity of the Aircraft Crash Site AOPI. Samples RSA-ACS-SO-01 (0-2 ft bgs), RSA-ACS-SO-02 (0-2 ft bgs), RSA-ACS-SO-03 (0-2 ft bgs), RSA-ACS-SO-04 (0-2 ft bgs), RSA-ACS-SO-05 (0-2 ft bgs), and RSA-ACS-SO-06 (0-2 ft bgs) were collected on August 4, 2021. The soil samples were collected around the periphery of the northern airfield turn-around structure where the aircraft crash occurred (**Figure 7-24**).

PFOS was detected in all six surface soil samples at concentrations lower than the OSD residential screening level of 0.13 mg/kg. The lowest PFOS concentration was identified in sample RSA-ACS-SO-01 (0.00079 J mg/kg) and the highest concentration was reported in sample RSA-ACS-SO-02 (0.0024 J-mg/kg). PFOA was detected in only one of the six samples, RSA-ACS-SO-05 (0.0006 J mg/kg), at a concentration lower than the OSD residential screening level of 0.13 mg/kg. PFBS was not detected in any of the six surface soil samples. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.25 Former Fire Station (Building T-3241)

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Former FS (Building T-3241).

7.25.1 Groundwater

One groundwater sample (RSA-RS2651) was collected from existing monitoring well RS2651 at the Former FS (Building T-3241) AOPI. RS2651 is located to the east of the former building footprint and in the inferred downgradient groundwater flow direction (**Figure 7-25**). The groundwater sample was collected from approximately the center of the saturated screened interval for RS2651 (screened 33.3 to 43.3 ft bgs). Groundwater sampling was completed on August 3, 2021.

PFOS (3,900 J ng/L [4,000 J ng/L]), PFOA (310 ng/L [400 J ng/L]), and PFBS (290 ng/L [270 J ng/L]) were detected in sample RSA-RS2651 (field duplicate sample concentrations are provided in brackets). The reported PFOS and PFOA concentrations exceeded the OSD risk screening levels (40 ng/L for both PFOS and PFOA). The reported PFBS concentration was lower than the OSD risk screening level (600 ng/L). PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.25.2 Soil

Two surface soil samples were collected via hand auger near the Former FS (Building T-3241) AOPI on August 3, 2021. Surface soil sample RSA-FFS-SO-01 (0-2 ft bgs) was collected from the southwest corner of the former building footprint. Surface soil sample RSA-FFS-SO-02 (0-2 ft bgs) was collected from the southeast corner of the former building footprint (**Figure 7-25**).

PFOS (0.0061 mg/kg) was detected in soil sample RSA-FFS-SO-01 at a concentration below the OSD residential risk screening level (0.13 mg/kg); PFOA and PFBS were not detected in this sample. PFOS, PFOA, and PFBS were not detected in soil sample RSA-FFS-SO-02. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.26 Inactive Sewage Treatment Plant #1

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Inactive STP #1 AOPI.

7.26.1 Groundwater

One groundwater sample (RSA-RS867) was collected from existing monitoring well RS867 at Inactive STP #1. RS867 is located to the south of, and in the inferred downgradient groundwater flow direction from, the former sludge drying beds associated with the inactive STP (**Figure 7-26**). The groundwater sample was collected from approximately the center of the saturated screened interval for RS867 (screened 10 to 20 ft bgs). Groundwater sampling was completed on August 3, 2021.

PFOS (180 ng/L) was detected at a concentration exceeding the OSD risk screening level of 40 ng/L. PFOA (34 ng/L) and PFBS (4.9 ng/L) were detected at concentrations lower than the OSD risk screening levels (40 ng/L for PFOA and 600 ng/L for PFBS). PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.26.2 Soil

Two surface soil samples were collected via hand auger near the Inactive STP #1 sludge drying beds on August 3, 2021. Surface soil sample RSA-STP1-SO-01 (0-2 ft bgs) was collected from a location southwest of the drying beds, and sample RSA-STP1-SO-02 (0-2 ft bgs) from a location southeast of the drying beds; both sampling locations were positioned in the direction of surface runoff (**Figure 7-26**).

PFOS, PFOA, and PFBS were not detected in either surface soil sample. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.27 Inactive Sewage Treatment Plant #3

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Inactive STP #3 AOPI.

7.27.1 Groundwater

Two groundwater samples (RSA-RS1427 and RSA-RS900) were collected from existing monitoring wells RS1427 and RS900 at Inactive STP #3. RS1427 is located within the footprint of the former sludge drying beds. RS900 is located in the southwest corner of the inactive STP site and in the inferred downgradient groundwater flow direction (**Figure 7-27**). The groundwater samples were collected from approximately the center of the saturated screened intervals for RS1427 (screened 12 to 22 ft bgs) and RS900 (screened 6.75 to 16.75 ft bgs). Groundwater sampling was completed on August 23, 2021.

PFOS, PFOA, and PFBS were detected in both groundwater samples. In RSA-RS1427, PFOS (950 J ng/L) and PFOA (130 ng/L) concentrations exceeded the OSD risk screening level of 40 ng/L for PFOS and PFOA; the PFBS (5.6 ng/L) concentration was lower than the OSD risk screening level of 600 ng/L. In RSA-R900, PFOS (80 ng/L) exceeded the OSD risk screening level of 40 ng/L, but PFOA (13 ng/L) and PFBS (4.6 ng/L) concentrations were lower than the OSD risk screening levels of 40 ng/L for PFOA and 600 ng/L for PFBS. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.27.2 Soil

Two surface soil samples were collected via hand auger near the Inactive STP #3 sludge drying beds on August 23, 2021. Surface soil sample RSA-STP3-SO-1 (0-1 ft bgs) was collected from a location to the west of the sludge drying beds, and surface soil sample RSA-STP3-SO-2 (0-2 ft bgs) was collected from a location south of the sludge drying beds; both sampling locations were positioned in the direction of surface runoff (**Figure 7-27**).

PFOS (0.0053 mg/kg in sample RSA-STP3-SO-1 and 0.0059 mg/kg in sample RSA-STP3-SO-2) was detected at concentrations lower than the OSD residential risk screening level. PFOA and PFBS were not detected in either surface soil sample. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.28 Inactive Sewage Treatment Plant #4

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Inactive STP #4 AOPI.

7.28.1 Groundwater

Two groundwater samples (RSA-RS1280 and RSA-RS2589) were collected from existing monitoring wells RS1280 and RS2589 at Inactive STP #4. Monitoring well RS1280 is located adjacent to the southern border of the former sludge drying beds, and RS2589 is located along the eastern boundary of the inactive STP and in the inferred downgradient direction of groundwater flow (**Figure 7-28**). The groundwater samples were collected from approximately the center of the saturated screened intervals for RS1280 (screened 24.5 to 39.5 ft bgs) and RS2589 (screened 45 to 57 ft bgs). Groundwater sampling was completed on August 3, 2021.

PFOS (9.9 ng/L) and PFOA (6.6 ng/L) were detected in RSA-RS1280 at concentrations lower than the OSD risk screening level of 40 ng/L for both compounds; PFBS was not detected in this sample. PFOS

(2.1 J ng/L) was detected in RSA-RS2589 at a concentration lower than the OSD risk screening level of 40 ng/L; PFOA and PFBS were not detected in this sample. PFOS, PFOA, and PFBS groundwater analytical results are summarized in **Table 7-1**.

7.28.2 Soil

Two surface soil samples were collected via hand auger near the Inactive STP #4 sludge drying beds on August 3, 2021. Surface soil sample RSA-STP4-SO-01 (0-2 ft bgs) was collected from the grassy area to the east of the former sludge drying beds, and surface soil sample RSA-STP4-SO-02 (0-2 ft bgs) was collected from the south of the sludge drying beds (**Figure 7-28**).

PFOS (0.0053 mg/kg) and PFOA (0.00055 J mg/kg) were detected in sample RSA-STP4-SO-1 at concentrations lower than the residential screening level of 0.13 mg/kg for both compounds. PFOS (0.043 mg/kg) and PFOA (0.001 J mg/kg) were detected in sample RSA-STP4-SO-2 at concentrations lower than the residential screening level of 0.13 mg/kg for both compounds. PFBS was not detected in either sample. PFOS, PFOA, and PFBS soil analytical results are summarized in **Table 7-2**.

7.29 Investigation-Derived Waste

Composite samples were collected from both containerized liquid and solid IDW drums for waste characterization. After the first mobilizations (October, November, and December 2020), two composite samples were collected from the drums containing liquid, and one composite sample was collected from the drums containing soil IDW. Samples were analyzed for RCRA metals, VOCs, SVOCs, and pesticides (for the drum containing purge water from Building 5681 only). None of the analyte results exceeded RCRA toxicity characteristic criteria for hazardous waste. Therefore, the drums were disposed of as non-regulated waste as described in **Section 6.3.5**.

Two composite IDW characterization samples (one liquid and one solid) were collected at the end of the second field mobilization in August 2021 and submitted for analysis of VOCs, SVOCs, metals, and PFAS constituents. PFOS (570 ng/L) was detected in the liquid IDW sample at a concentration greater than the OSD risk screening level of 40 ng/L; PFOA and PFBS were not detected in this sample. PFOS (0.0023 mg/kg) was detected in the soil IDW sample at a concentration lower than the OSD residential screening level of 0.13 mg/kg; PFOA and PFBS were not detected in this sample. None of the analyte results exceeded RCRA toxicity characteristic criteria for hazardous waste. Therefore, the drums were disposed of as non-regulated waste as described in **Section 6.3.5**. The full analytical results (i.e., for all constituents analyzed) for IDW samples collected during the SI are included in **Appendix N**.

7.30 TOC, pH, and Grain Size

In addition to sampling soil for PFOS, PFOA, and PFBS, one soil sample per AOPI was analyzed for TOC, pH, moisture content, and grain size data as they may be useful in future fate and transport studies. TOC concentrations in the soil samples ranged from 2,110 to 62,200 mg/kg. TOC concentrations reported at 16 of the 28 AOPIs were within the lower range of what is typically observed in topsoil (5,000 to 30,000 mg/kg). TOC concentrations reported at 11 of the 28 AOPIs exhibited TOC concentrations more aligned with desert-type soils (less than 5,000 mg/kg). The combined percentage of fines (i.e., silt and clay) in soils at RSA ranged from 5.9% to 79.8% with an average of 51.2%. In general, PFAS constituents tend to

be more mobile in soils with less than 20% fines (silt and clay) and lower TOC. The percent moisture of the soil averaged approximately 16.1%, which is typical for clay (0 to 20%). The pH of the soil was neutral (approximately 7). Based on these geochemical and physical soil characteristics (i.e., generally low TOC and high percentage of fines), PFAS constituents are expected to exhibit enhanced mobility. While PFAS constituents are relatively less mobile in soils with a high percentage of fines, depleted TOC may allow for enhanced mobility of the constituents in soil.

7.31 Blank Samples

Detections of PFOS, PFOA, and PFBS in blank samples are summarized below. Most detected concentrations were low-level. Other than noted below, PFOS, PFOA, and PFBS were not detected in any other blank samples:

- PFOS (2.7 J ng/L) and PFBS (1.9 J ng/L) were detected in the source blank (RSA-SB-02) collected on October 2, 2020. This blank was sampled from the water obtained from RSA and used for drilling and decontamination during the field mobilization. Equipment blanks on equipment decontaminated using this source water identified no PFOS, PFOA, or PFBS detections, indicating that the final decontamination rinse using laboratory-certified PFAS-free water was sufficient at preventing cross-contamination.
- PFOS (6 ng/L) was detected in the field blank (RSA-FB-04) collected on November 3, 2020 at the Old FS #1 AOPI.
- PFOS (3 J ng/L) was detected in the equipment blank (RSA-EB-09) collected on November 2020, 2020. The equipment tested was the rotosonic rig drill bit.

The full analytical results for blank samples collected during the SI are included in **Appendix N**.

7.32 Conceptual Site Models

The preliminary CSMs presented in the QAPP Addendum (Arcadis 2020a) were re-evaluated and updated, if necessary, based on the SI sampling results. The CSMs presented on **Figures 7-29** through **7-33** and in this section therefore represent the current understanding of the potential for human exposure. For some AOPIs, the CSM is the same and thus shown on the same figure.

Many of the PFAS constituents found in AFFF and metal plating operations are surfactants (which do not volatize) and are found in a charged or ionic state at environmentally relevant pH (i.e., pH 5 to 9 standard units). PFOS, PFOA, and PFBS are each negatively charged at environmentally relevant pH. The media potentially affected by PFOS, PFOA, PFBS releases at Army installations are soil, groundwater, surface water, and sediment. Once released to the environment, a primary factor that inhibits the movement of PFAS constituents is the presence of organic matter and organic co-constituents in soils and sediments. Generally, PFAS constituents are mobile in the potentially affected media, and they are not known to be fully broken down by natural processes.

Based on the use, storage, and/or disposal of PFAS-containing materials and Teflon™ coating operations at the AOPIs, affected media are likely to consist of soil, groundwater, surface water, and sediment. The principal release mechanisms consist of dissolution/desorption from soil to groundwater (including sediments contained in the bedrock conduit system) and erosion of particulate matter to which PFAS

substances are adsorbed by stormwater. Transport mechanisms consist of downward movement of dissolved PFAS constituents to the water table, advection of dissolved PFAS constituents in groundwater, movement of PFAS constituents adsorbed to sediments entrained in bedrock groundwater by turbulent flow, transport of PFAS constituents adsorbed to surface soils by stormwater, transport of dissolved PFAS constituents and PFAS constituents adsorbed to suspended solids in surface water, transport via sediment carried in and dissolution to stormwater and surface water, and discharge/recharge between groundwater and surface water primarily via groundwater springs. Generic categories of potential human receptors and their associated exposure scenarios that are typically evaluated in a CERCLA human health risk assessment were considered and include on-installation site workers (e.g., industrial/commercial workers, utility workers, or future construction workers who could be exposed to chemicals in soil at an AOPI or to chemicals in tap water in an industrial/commercial building); on-installation residents (e.g., adults and children who could be exposed to chemicals in tap water in a residence); and on-installation recreational users (e.g., hikers or hunters who could be exposed to chemicals in waterways at an installation). Off-installation receptor types could include drinking water receptors (i.e., commercial/industrial workers or residents) and recreational users.

Human exposure pathways are shown as “complete,” “potentially complete,” or “incomplete” on the CSM figures. A complete exposure pathway consists of a constituent source and release mechanism, a transport or retention medium, an exposure point where human contact with the contaminated medium could occur, and an exposure route at the exposure point. If any of these elements is missing, the exposure pathway is incomplete. Pathways are “potentially complete” where data are insufficient to conclude the pathway is either “complete” or “incomplete.” Additionally, the CSMs do not include ecological receptors and exposure pathways. The potential for ecological exposures to PFOS, PFOA, and PFBS may be evaluated at a future date if those pathways warrant further discussion.

CSMs were developed for each individual AOPI and were combined where source media, potential migration pathways and exposure media, and human exposure pathway determinations are congruent. The following exposure pathway determinations apply to all CSMs:

- The AOPIs are not likely to be regularly accessed by on-installation residents or by off-installation receptors. Therefore, the soil exposure pathways for these receptors are incomplete.
- There are no drinking water systems supplied by groundwater that are active within the boundaries of RSA. Furthermore, groundwater use at RSA is prohibited, as per the terms of the IROD (Shaw 2007). Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are incomplete.
- Recreational users are not likely to contact groundwater during outdoor recreational activities. Therefore, the groundwater exposure pathway for on-installation recreational users is incomplete.
- On-installation site workers and residents are not likely to contact sediment in on-post water bodies; therefore, these exposure pathways are incomplete.

The following exposure pathway determinations apply to the CSMs for all AOPIs except the Mulcher Fire AOPI (which is discussed separately below):

- Releases potentially impacting groundwater at the AOPIs may migrate off-post. In the southeastern portion of the installation, groundwater is known to flow off-post. To the west of RSA, the Huntsville Utilities and the City of Madison each operate a water supply well. Given the challenges with estimating groundwater flow directions in karst aquifers and due to the absence of land-use

restrictions preventing potable use of groundwater off-post, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is potentially complete for all AOPIs except the Mulcher Fire AOPI.

- Surface water bodies flow off-post to the Tennessee River, which is a source of drinking water for RSA and surrounding communities. Therefore, the surface water exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents and for off-installation drinking water receptors are potentially complete.
- Recreational users could contact constituents in on-installation surface water bodies (e.g., Indian Creek, Macdonald Creek, and Huntsville Spring Branch) and in the off-post Tennessee River through incidental ingestion and dermal contact. Therefore, the surface water and sediment exposure pathways for on-installation recreational users and for off-installation receptors are potentially complete.

Additional exposure pathway descriptions for each CSM are provided below by figure.

Figure 7-29 shows the CSM for 23 AOPIs: FS #2, Hangar 6312, Building 7370, FS #3, Transformer Fire, Firehouse Pub, Keyhole/Nozzle Testing Area, Fire Training Area, FS #4, FS #5, Hangar 4815, Hangar 4832, Hangar 4880, FS #1, Vehicle Fire, Landfill Fire, Old FS #1, Fuel Tank Fire, FBI Storage – Building 7017, FBI Storage – Building 9061, Aircraft Crash Site, Former FS (Building T-3241), and Inactive STP #4. These AOPIs have the potential for PFOS, PFOA, and/or PFBS presence due to the use or storage of PFAS-containing materials associated with fire truck maintenance activities, nozzle testing/flushing, fire training, emergency responses, fire suppression systems, or Teflon™-coating operations. PFOS, PFOA, and/or PFBS were detected in soil, and site workers (i.e., installation personnel) could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the soil exposure pathway for on-installation site workers is complete.

Figure 7-30 shows the CSM for Building 5681. Soil samples were not collected at the Building 5681 AOPI because AFFF use was limited to the interior of the building and the exact location of the fire could not be pinpointed. However, based on the groundwater detections at this AOPI, the soil exposure pathway is deemed potentially complete for on-installation site workers.

Figure 7-31 shows the CSM for the Mulcher Fire AOPI. AFFF was deployed during a fire response where a mulcher caught fire during mowing operations. The location of the fire was described as near the secondary turn-around on the northern end of the runway. Due to access restrictions, only soil samples were collected. PFOS, PFOA, and/or PFBS were not detected in soil. Based on the SI sample results, all soil, groundwater, surface water, and sediment exposure pathways for on- and off-installation receptors are incomplete.

Figure 7-32 shows the CSM for the Old FS #2 and Inactive STP #3 AOPIs. PFOS, PFOA, and/or PFBS were detected in soil, and site workers (i.e., installation personnel) could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of dust. Additionally, these AOPIs overlap with permitted RSA hunting areas. Therefore, the soil exposure pathways for on-installation site workers and recreational users are considered complete.

Figure 7-33 shows the CSM for the Inactive STP #1 AOPI at RSA. This AOPI is associated with potential AFFF disposal through the sanitary system. PFOS, PFOA, and/or PFBS were not detected in soil. Therefore, the soil exposure pathway for on-installation site workers is incomplete.

Following the SI sampling, 27 of 28 AOPIs with confirmed PFOS, PFOA, and/or PFBS presence were considered to have complete or potentially complete exposure pathways. Although the CSMs indicate complete or potentially complete exposure pathways may exist, the recommendation for remedial investigation is based on the comparison of analytical results for PFOS, PFOA, and PFBS to the OSD risk screening levels (**Table 6-2**).

8 CONCLUSIONS AND RECOMMENDATIONS

The PFAS PA/SI included two distinct efforts. The PA identified AOPIs at RSA based on the use, storage, and/or disposal of PFAS-containing materials, in accordance with the 2018 Army Guidance for Addressing Releases of Per-and Polyfluoroalkyl Substances (Army 2018). The SI included multi-media sampling at AOPIs to determine whether or not a release of PFOS, PFOA, and PFBS to the environment occurred.

OSD provided residential risk screening levels based on the USEPA oral reference dose for PFOS, PFOA, and PFBS in soil and groundwater (tap water) and industrial/commercial risk screening levels for PFOS, PFOA, and PFBS in soil (**Appendix A**). A combination of document review, internet searches, interviews with installation personnel, and an installation site visit were used to identify specific areas of suspected PFOS, PFOA, and PFBS use, storage, and/or disposal at RSA. Following the evaluation, 28 AOPIs were identified.

RSA receives drinking water from the Tennessee River, while the surrounding communities source water from both the Tennessee River and groundwater sources. Three WTP intakes are identified on the Tennessee River and within a 5-mile radius of RSA (**Figure 2-2**). The RSA WTP has a surface water intake in the southwestern portion of the installation. Two municipal WTPs owned by Huntsville Utilities are located on the Tennessee River, one upstream (South Parkway WTP) and one downstream (Southwest WTP) of RSA. Groundwater resources at RSA are under an installation-wide LUC precluding the use of groundwater for drinking water or irrigation per the conditions of a 2007 IROD (Shaw 2007). While no groundwater drinking water systems are active within the boundary of RSA, several potable groundwater systems are proximal to RSA and operated by Huntsville Utilities and the City of Madison. The closest groundwater supply wells are the Williams and Drake Wells, located within 1 mile of the RSA installation boundary (**Figure 2-2**). Communications with Huntsville Utilities indicate that the Williams Well has not been used for regular water supply since approximately 2012 and is currently designated as an emergency water source (EA and Arcadis 2015). The City of Madison operates the Drake Well, a 5-million-gallon-per-day supplemental groundwater supply well located approximately 2.3 miles north of the Williams Well (**Figure 2-2**). The water systems associated with Huntsville Utilities and Madison County Waterworks were sampled in 2014/2015 as part of the UCMR3 efforts and yielded no detections of PFAS constituents. These water systems were again sampled for PFAS constituents in 2020 and yielded very low-level detections of PFAS constituents. Huntsville Utilities detected a maximum concentration of 10 ng/L of combined PFAS constituents. The City of Madison identified PFOS, PFOA, and PFBS detections of 2 ng/L, 1 ng/L, and 3 ng/L, respectively.

All AOPIs were sampled during the SI at RSA to identify presence or absence of PFOS, PFOA, and PFBS at each AOPI. The SI scope of work was completed in accordance with the Final PQAPP (Arcadis 2019) and the RSA QAPP Addendum (Arcadis 2020a).

PFOS, PFOA, and/or PFBS were detected in groundwater and/or soil samples collected from 27 of 28 AOPIs. At least one sample from 16 AOPIs contained concentrations of PFOS, PFOA, and/or PFBS that exceeded OSD risk screening levels. In groundwater, the maximum PFOS (110,000 ng/L), PFOA (5,200 ng/L), and PFBS (32,000 ng/L) concentrations were identified at the Fire Training Area, FS #2, and FS #3, respectively. In soil, the maximum PFOS (0.4 mg/kg), PFOA (0.0045 mg/kg), and PFBS (0.0099 mg/kg) concentrations were identified at the FS #3, FS #2, and the Fire Training Area,

respectively. Only PFOS was found to exceed its OSD residential risk screening level in soil (0.13 mg/kg), and this occurred in four samples at four separate AOPIs: FS #2 (0.18 mg/kg), FS #3 (0.4 mg/kg), the Keyhole/Nozzle Testing Area (0.22 mg/kg), and the Fire Training Area (0.25 mg/kg).

Following the SI sampling, 27 of the 28 AOPIs with confirmed PFOS, PFOA, and/or PFBS presence are considered to have complete or potentially complete exposure pathways. Soil exposure pathways for on-installation workers are complete or potentially complete at 26 AOPIs. Due to a lack of LUCs off-installation and downgradient of RSA, the groundwater exposure pathways for off-installation receptors are also potentially complete for 27 AOPIs. Surface water bodies flow off-post to the Tennessee River, which is a source of drinking water for RSA and surrounding communities. Therefore, the surface water exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents and for off-installation drinking water receptors are potentially complete for 27 AOPIs. Similarly, recreational users and off-post receptors could contact constituents in sediments via incidental ingestion and dermal contact; therefore, the sediment exposure pathways are potentially complete for 27 AOPIs.

Although the CSMs indicate complete or potentially complete exposure pathways may exist, the recommendation for whether or not to conduct further study in the form of a remedial investigation is based on the comparison of the SI analytical results for PFOS, PFOA, and PFBS to the OSD risk screening levels (**Table 6-2**). **Table 8-1** below summarizes the AOPIs identified at RSA, identifies whether OSD risk screening levels were exceeded, and provides recommendations for each AOPI. As shown in the table, further investigation is warranted at 16 of the AOPIs investigated at RSA. In accordance with CERCLA, site-specific risk will be assessed during a future phase to evaluate whether remedial actions are required.

Table 8-1. Summary of AOPIs Identified during the PA, PFOS, PFOA, and PFBS Sampling at RSA, and Recommendations

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	GW	SO	
Fire Station #2 (Building 3320)	Yes	Yes	Further study in a remedial investigation
Hangar 6312	No	No	No action at this time
Building 7370 – Thiokol Teflon-Coating Facility	Yes	No	Further study in a remedial investigation
Fire Station #3 (Building 7801)	Yes	Yes	Further study in a remedial investigation
Transformer Fire	Yes	No	Further study in a remedial investigation
Old Fire Station #2 (Building 8014)	Yes	No	Further study in a remedial investigation
Fire House Pub (Building 114)	Yes	No	Further study in a remedial investigation

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	GW	SO	
Mulcher Fire	NS	ND	No action at this time
Keyhole/Nozzle Testing Area	No	Yes	Further study in a remedial investigation
Fire Training Area	Yes	Yes	Further study in a remedial investigation
Fire Station #4 (Building 4810)	Yes	No	Further study in a remedial investigation
Fire Station #5 (Building 4813)	Yes	No	Further study in a remedial investigation[1]
Hangar 4815	Yes	No	Further study in a remedial investigation[1]
Hangar 4832	No	No	No action at this time
Hangar 4880	NS	No	No action at this time
Fire Station #1 (Building 4424)	Yes	No	Further study in a remedial investigation
Vehicle Fire (Building 4650)	No	No	No action at this time
Landfill Fire	No	No	No action at this time
Building 5681 Fire	No	NS	No action at this time
Old Fire Station #1 (Building 5414)	No	No	No action at this time
Fuel Tank Fire	Yes	No	Further study in a remedial investigation
FBI – Building 7017	No	No	No action at this time
FBI – Building 9061	NS	No	No action at this time
Aircraft Crash Site	NS	No	No action at this time
Former Fire Station – Building T-3241	Yes	No	Further study in a remedial investigation

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	GW	SO	
Inactive Sewage Treatment Plant #1	Yes	ND	Further study in a remedial investigation
Inactive Sewage Treatment Plant #3	Yes	No	Further study in a remedial investigation
Inactive Sewage Treatment Plant #4	No	No	No action at this time

Notes:

1. PFOS was detected in sample RSA-4815-GW-02, collected from the septic tank drain field that historically served both Fire Station #5 and Hangar 4815. During data validation, it was noted that the extracted internal standard recovery for PFOS was outside control limits. PFOS is considered present; however, the reported value has unknown bias, is unreliable, and cannot be compared to screening criteria. Another groundwater sample collected directly downgradient of both Fire Station #5 and Hangar 4815 (RSA-FS4-GW-01) had a detection of PFOS at 46 ng/L, exceeding the OSD risk screening level of 40 ng/L. Therefore, Fire Station #5 and Hangar 4815 are recommended for further study in a remedial investigation.

Light gray shading – detection greater than the OSD risk screening level
GW – groundwater
ND – non-detect
NS – not sampled
SO – soil

Data collected during the PA (**Sections 3** through **5**) and SI (**Sections 6** and **7**) were sufficient to draw conclusions and recommendations summarized above. The data limitations relevant to the development of this PA/SI report for PFOS, PFOA, and PFBS at RSA are discussed below.

Records gathered for the use, storage, and/or disposal of PFAS-containing materials were reviewed during the PA process. Documentation specific to AFFF may have been limited (e.g., each AFFF use, procurement records, documentation of AFFF used during crash responses or fire training activities) due to lack of recordkeeping requirements for the full timeline of common AFFF practices. Anecdotal accounts of AFFF use (and therefore likely PFOS, PFOA, and PFBS use) were limited to available installation personnel, whose knowledge of AFFF use may have been restricted by their time spent at the installation or previous roles held that limited their relevant knowledge of potential AFFF (or other PFAS-containing material) use.

A comprehensive well survey was not completed as part of this PA; therefore, the information reviewed regarding off-post wells is limited to what is contained in the off-post well search results (**Appendix E**), and a review of the web-based Alabama Water Well Finder hosted by the Geological Survey of Alabama (GSA 2021).

The searches for ecological receptors and off-post PFOS, PFOA, and PFBS sources were not exhaustive and were limited to easily identifiable and readily available information evaluated during the relevant document research, installation personnel interviews, and site reconnaissance.

Finally, the available PFOS, PFOA, and PFBS analytical data are limited to groundwater collected at 24 of 28 AOPIs (no groundwater samples were obtained from the Mulcher Fire, Building 9061, Aircraft Crash Site, and Hangar 4880 AOPIs). The groundwater sample used to characterize FS #5 and Hangar 4815 was collected from an inferred downgradient location and thus may not be representative of PFAS constituents sourced to these AOPIs. Soil samples were not collected at Building 5681 because the fire response was limited to the interior of the building and the exact location of the fire could not be pinpointed; it is unclear, therefore, whether soils at this AOPI contain PFOS, PFOA, or PFBS. No direct PFOS, PFOA, or PFBS impacts to surface water features were identified; therefore, no surface water or sediment sampling was conducted as part of this SI. The lack of recognized surface water impacts does not preclude the possibility of surface water impacts at RSA. Available data, including PFOS, PFOA, and PFBS results, are included in **Appendix N**. All samples were analyzed per the selected analytical method.

Results from this PA/SI indicate further study in a remedial investigation is warranted at RSA in accordance with the guidance provided by the OSD.

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
%	percent
ADEM	Alabama Department of Environmental Management
AFFF	aqueous film-forming foam
amsl	above mean sea level
AOPI	area of potential interest
Aptim	Aptim Federal Services, LLC
Arcadis	Arcadis U.S., Inc.
Army	U.S. Army
AST	aboveground storage tank
bgs	below ground surface
CB&I	CB&I Federal Services LLC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CSM	conceptual site model
DoD	Department of Defense
DPT	direct-push technology
DPW	Directorate of Public Works
DQO	data quality objective
DUSR	Data Usability Summary Report
EB	equipment blank
EDR	Environmental Data Resources, Inc.
ELAP	Environmental Laboratory Accreditation Program
FB	field blank
FBI	Federal Bureau of Investigation
FCR	Field Change Report
FS	fire station
ft	feet
FTA	fire training area
GIS	geographic information system

GW	groundwater
HDPE	high-density polyethylene
HQAES	Headquarters Army Environmental System
HSB	Huntsville Spring Branch
IDW	investigation-derived waste
IMCOM	Installation Management Command
installation	U.S. Army or Reserve installation
IROD	Interim Record of Decision
IRP	Installation Restoration Program
LOD	limit of detection
LOQ	limit of quantitation
LUC	land use control
mg/kg	milligrams per kilogram (parts per million)
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
ND	non-detect
NFA	no further action
ng/L	nanograms per liter (parts per trillion)
NS	not sampled
OSD	Office of the Secretary of Defense
OWS	oil water separator
PA	preliminary assessment
PAH	polycyclic aromatic hydrocarbon
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
POC	point of contact
ppm	parts per million
ppt	parts per trillion
PQAPP	Programmatic Uniform Federal Policy-Quality Assurance Project Plan

PWS	public water supply
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RSA	U.S. Army Garrison Redstone Arsenal
RSL	regional screening level
SB	source blank
Shaw	Shaw Environmental, Inc.
SI	site inspection
SO	soil
SOP	standard operating procedure
SSHP	Site Safety and Health Plan
STP	sewage treatment plant
SVOC	semi-volatile organic compound
TGI	technical guidance instruction
TOC	total organic carbon
UCMR3	Third Unregulated Contaminant Monitoring Rule
U.S.	United States
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
UST	underground storage tank
UXO	unexploded ordnance
VOC	volatile organic compound
WTP	water treatment plant
WWTP	wastewater treatment plant

TABLES

Table 6-1 - Monitoring Well Construction Details
USAEC PFAS Preliminary Assessment/Site Inspection
Redstone Arsenal, Alabama

Area of Potential Interest	Sampling Location ID	Total Well Depth (ft bgs)	Measuring Point[1]	Measuring Point Elevation[2] (ft amsl)	Depth to Groundwater from MP (ft)	Ground water elevation (ft amsl)	Screened Interval (ft bgs)	Casing Diameter (inches)
Fire Station #2	RSA-FS2-GW-01	24.5	GS	NA	15.02	NA	16.5-24.5	1
Hangar 6312	RSA-6312-GW-01	17.25	GS	NA	12.40	NA	13.25-17.25	1
Bldg. 7370	RS1221	35.75	TOC	581.3	16.86	564.44	25.75-35.75	2
Transformer Fire (Misidentified)	RS2291	30	TOC	569.35	13.77	555.58	20-30	2
	RSA-TRANS-GW-01	17	GS	NA	8.57	NA	2.5-17	1
Transformer Fire	RSA-WWTP-GW-01	35	GS	NA	27.40	NA	25-35	1
Fire Station #3	RSA-FS3-GW-01	9.79	GS	NA	3.39	NA	4.79-9.79	1
Old Fire Station #2	RSA-OFS2-GW-01	21	GS	NA	11.55	NA	1-21	1
Firehouse Pub	RSA-PUB-GW-01	10	GS	NA	7.15	NA	2-10	1
Keyhole/Nozzle Testing Area	RSA-KEY-GW-01	57.88	GS	NA	55.83	NA	27-57	1
Fire Training Area	RS1576	33	TOC	610.37	28.20	582.17	23-33	2
	RS1577	27	TOC	608.01	25.85	582.16	17-27	2
Fire Station #4	RS1278	87	TOC	643.08	62.02	581.06	72-87	2
	RSA-FS4-GW-01	70	GS	NA	67.36	NA	60-70	1
Fire Station #5	RSA-FS5-GW-01	54	GS	NA	Dry	NA	39-54	1
Hangar 4815	MW08	67	TOC	642.12	62.65	579.47	57-67	2
	RS1604	130	TOC	652.42	72.10	580.32	115-130	2
	RSA-4815-GW-01	68	GS	NA	Dry	NA	45-55	1
	RSA-4815-GW-02	55	GS	NA	NA	NA	25-55	1
Hangar 4832	RSA-4832-GW-01	39	GS	NA	32.30	NA	19-39	1
Fire Station #1	RSA-FS1-GW-01	15	GS	NA	14.73	NA	5-15	1
Vehicle Fire	RSA-VF-GW-01	16	GS	NA	9.06	NA	1-16	1
Landfill Fire	RS091	70	TOC	623.83	59.74	564.09	60-70	2
	RS093	79	TOC	607.98	47.05	560.93	64-79	2
Bldg. 5681	RS1681	31.6	TOC	584.99	21.05	563.94	21.6-31.6	2
	RS1684	27.7	TOC	585.84	22.66	563.18	16-27.7	2
	RS1994	33.25	TOC	585.16	21.79	563.37	23.25-33.25	2
	RS1686	39	TOC	588.81	23.06	565.75	29-39	2
Old Fire Station #1	RSA-OFS1-GW-01	19	GS	NA	14.6	NA	0-19	1
Fuel Tank Fire	RS2481	24.2	TOC	586.73	14.13	572.60	14.2-24.2	2
	RS2195	NA	TOC	NA	15.76	NA	9.8-19.8	2
FBI AFFF Storage - Bldg. 7017	RSA-FBI-7017-GW-01	26.5	GS	NA	25.86	NA	16.5-26.5	1
Former Fire Station (Bldg. T-3241)	RS2651	43.3	TOC	NA	28.95	NA	33.3-43.3	2
Inactive STP #1	RS867	20	TOC	576.26	15.18	561.08	10-20	2
Inactive STP #3	RS900	16.75	TOC	573.58	12.9	560.68	6.75-16.75	2
	RS1427	22	TOC	579.57	18.65	560.92	12-22	2
Inactive STP #4	RS2589	57	TOC	581.2	12.97	568.23	47-57	2
	RS1280	39.5	TOC	580.11	10.65	569.46	24.5-39.5	2

Note:

1. The depth to water measuring point for temporary wells installed via direct-push technology or rotosonic drilling was the ground surface. The total depth listed for temporary wells indicates the final depth of the temporary borehole. The screened interval listed for temporary sampling points indicates the interval at which a temporary screen was installed to allow for groundwater sample collection.

2. Existing well elevations are surveyed measurements provided by RSA. For temporary groundwater monitoring locations, elevations are not available.

Acronyms/Abbreviations:

bgs = below ground surface
bldg. = building
FBI = Federal Bureau of Investigation
ft = feet
GS = ground surface
ID = identification
NA = not applicable
MP = measuring point
STP = sewage treatment plant
TOC = top of casing

Table 7-1 - Groundwater PFOS, PFOA, and PFBS Analytical Results
USACE PFAS Preliminary Assessment/Site Inspection
Redstone Arsenal, Alabama

ARCADIS

			Analyte	PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)	
			OSD Tapwater Risk Screening Level	40		40		600	
AOPI	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
FBI AFFF Storage Area (Building 7017)	RSA-FBI7017-GW-1-0825-21	08/25/2021	N	**12**	J+	**18**		**6.6**	
Inactive Sewage Treatment Plant #1	RSA-RS867-GW-080321	08/03/2021	N	**180**		**34**		**4.9**	
Inactive Sewage Treatment Plant #3	RSA-RS1427-GW-082321	08/23/2021	N	**950**	J	**130**		**5.6**	
	RSA-RS900-GW-082321	08/23/2021	N	**80**		**13**		**4.6**	
Inactive Sewage Treatment Plant #4	RSA-RS1280-GW-080321	08/03/2021	N	**9.9**		**6.6**		3.9	U
	RSA-RS2589-GW-080321	08/03/2021	N	**2.1**	J	3.8	U	3.8	U
Former Fire Station - Building T-3241	RSA-FD-03-GW-080321 / RSA-RS2651-GW-080321	08/03/2021	FD	**4000**	J	**400**	J	**270**	J
	RSA-RS2651-GW-080321	08/03/2021	N	**3900**	J	**310**		**290**	
Transformer Fire (WWTP)	RSA-WWTP-GW-1-082521	08/25/2021	N	**48**		**70**		**13**	
Transformer Fire (TRAN) - Misidentified	RSA-RS2291-100120	10/01/2020	N	**5.8**		4.0	U	**4.5**	
	RSA-TRANS-GW-01-110320	11/03/2020	N	**8.4**	J+	**4.4**		**3.5**	J
Building 5681 Fire	RSA-RS1681-111120	11/11/2020	N	**10**		**23**		**3.7**	J
	RSA-RS1684-111120	11/11/2020	N	**5.6**		**14**		**4.0**	J
	RSA-RS1686-111120	11/11/2020	N	**9.9**		**7.8**		**3.6**	J
	RSA-RS1994-111120	11/11/2020	N	**12**		**15**		**4.6**	
Building 7370 THIOKOL – Teflon Coating Site (Bldg. 7370)	RSA-FD-01-GW-092920 / RSA-RS1221-092920	09/29/2020	FD	**3.6**	J	**540**		**3.4**	J
	RSA-RS1221-092920	09/29/2020	N	**15**		**550**		**3.8**	J
Fire Station #1 (FS1)	RSA-FS1-GW-01-110320	11/03/2020	N	**50000**	J	**2200**	J	**200**	
Fire Station #2 (FS2)	RSA-FS2-GW-01-110320	11/03/2020	N	**77000**	J	**5200**	J	**1400**	J
Fire Station #3 (FS3)	RSA-FS3-GW-01-100820	10/08/2020	N	**6400**	J	**2500**	J	**32000**	J
Fire Station #4 (FS4)	RSA-FS4-GW-01-111120	11/11/2020	N	**46**		**5.6**		**5.6**	
	RSA-RS1278-100120	10/01/2020	N	**2.9**	J	3.5	U	**1.8**	J
Fire Training Area	RSA-RS1576-100120	10/01/2020	N	**110000**	J	**1900**	J	**3100**	J
	RSA-FD-02-100120 / RSA-RS1577-100120	10/01/2020	FD	**670**		**36**		**22**	
	RSA-RS1577-100120	10/01/2020	N	**660**		**37**		**21**	
Fuel Tank Fire	RSA-RS2195-092920	09/29/2020	N	**18000**	J	**910**		**2500**	J
	RSA-RS2481-092920	09/29/2020	N	**3000**	J	**160**		**230**	
Hangar 4815	RSA-4815-GW-02-112020	11/20/2020	N	**Present**		**8.7**		**4.1**	J+
	RSA-RS1604-112020	11/20/2020	N	4.2	U	**2.6**	J	4.2	U
	RSA-MW08-01-111120	11/11/2020	N	**39**		**12**		**8.6**	
Hangar 4832	RSA-4832-GW-01-121720	12/17/2020	N	**Present**		**16**	J+	**5.0**	J+
Hangar 6312	RSA-6312-GW-01-100520	10/05/2020	N	**8.0**		**8.2**		**3.3**	J
Keyhole/Nozzle Testing Area (KEY)	RSA-KEY-GW-01-110920	11/09/2020	N	**13**		**3.2**	J	**13**	
Landfill Fire (LFF)	RSA-RS091-092920	09/29/2020	N	**3.3**	J	**2.0**	J	**2.3**	J
	RSA-RS093-092920	09/29/2020	N	**12**		**38**		**5.3**	
Old Fire Station #1 (OFS1)	RSA-OFS1-GW-01-110320	11/03/2020	N	**14**	J+	**7.2**		3.9	U
Old Fire Station #2 (OFS2)	RSA-OFS2-GW-01-110320	11/03/2020	N	**57**		**28**		4.4	U
Firehouse Pub (PUB)	RSA-PUB-GW-01-110820	11/08/2020	N	**13**		**53**		**20**	
Vehicle Fire at Bldg. 4650 (VF)	RSA-VF-GW-01-110320	11/03/2020	N	**23**	BJ+	**7.0**	J-	**3.5**	J-

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection.
2. Gray shaded values indicate the result was detected greater than the 2021 Office of the Secretary of Defense (OSD) risk screening levels (OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program.September).

Acronyms/Abbreviations:
AOPI = Area of Potential Interest
Bldg. = building
FBI = Federal Bureau of Investigation
FD = field duplicate sample
ID = identification
N = primary sample
ng/L = nanograms per liter (parts per trillion)
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
Qual = qualifiers

Qualifiers

BJ+	The compound has been found in the sample as well as its associated blank; its presence in the sample may be suspect and reported result may be biased high.
J	The analyte was positively identified; however, the associated numerical value is an estimated concentration only
J+	The result is an estimated quantity; the result may be biased high.
J-	The result is an estimated quantity; the result may be biased low.
U	The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).
Present	The sample result was affected by serious deficiencies in the ability to analyze the sample and to meet published method and project quality control criteria. The analyte is considered present; however, the reported value has unkonwn bias and is unreliable. The result cannot be compared to screening criteria.

Table 7-2 - Soil PFOS, PFOA, and PFBS Analytical Results
USACE PFAS Preliminary Assessment/Site Inspection
Redstone Arsenal, Alabama

ARCADIS

			Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
			OSD Industrial/Commercial Risk Screening Level	1.6		1.6		25	
			OSD Residential Risk Screening Level	0.13		0.13		1.9	
AOPI	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
Aircraft Crash Site	RSA-ACS-SO-1-080421	08/04/2021	N	**0.00079**	J	0.00099	U	0.00099	U
	RSA-ACS-SO-2-080421	08/04/2021	N	**0.0024**	J-	0.001	U	0.001	U
	RSA-ACS-SO-3-080421	08/04/2021	N	**0.0011**		0.0011	U	0.0011	U
	RSA-ACS-SO-4-080421	08/04/2021	N	**0.00091**	J	0.00098	U	0.00098	U
	RSA-ACS-SO-5-080421	08/04/2021	N	**0.0016**		**0.0006**	J	0.0011	U
	RSA-ACS-SO-6-080421	08/04/2021	N	**0.0013**		0.0011	U	0.0011	U
FBI AFFF Storage Area (Building 7017)	RSA-FBI-7017-SO-1-080221	08/02/2021	N	0.0013	U	0.0013	U	0.0013	U
	RSA-FBI-7017-SO-2-080221	08/02/2021	N	**0.00072**	J	0.0012	U	0.0012	U
FBI AFFF Storage Area (Building 9061)	RSA-FBI-9061-SO-1-080221	08/02/2021	N	**0.001**	J	0.0011	U	0.0011	U
	RSA-FBI-9061-SO-2-080221	08/02/2021	N	0.0011	U	0.0011	U	0.0011	U
Former Fire Station - Building T-3241	RSA-FFS-SO-1-080321	08/03/2021	N	**0.0061**		0.0011	U	0.0011	U
	RSA-FFS-SO-2-080321	08/03/2021	N	0.0011	U	0.0011	U	0.0011	U
Inactive Sewage Treatment Plant #1	RSA-STP1-SO-1-080321	08/03/2021	N	0.001	U	0.001	U	0.001	U
	RSA-FD-04-SO-080321 / RSA-STP1-SO-2-080321	08/03/2021	FD	0.0012	U	0.0012	U	0.0012	U
	RSA-STP1-SO-2-080321	08/03/2021	N	0.0059	U	0.0059	U	0.0059	U
Inactive Sewage Treatment Plant #3	RSA-STP3-SO-1-082321	08/23/2021	N	**0.0053**		0.0011	U	0.0011	U
	RSA-STP3-SO-2-080321	08/03/2021	N	**0.0059**		0.0012	U	0.0012	U
Inactive Sewage Treatment Plant #4	RSA-STP4-SO-1-080321	08/03/2021	N	**0.0053**		**0.00055**	J	0.0011	U
	RSA-STP4-SO-2-080321	08/03/2021	N	**0.043**		**0.001**	J	0.0012	U
Transformer Fire (WWTP)	RSA-WWTP-SO-1-082421	08/24/2021	N	**0.0059**		0.0011	U	0.0011	U
	RSA-WWTP-SO-2-082421	08/24/2021	N	**0.00072**	J	0.0012	U	0.0012	U
Transformer Fire (TRAN) - Misidentified	RSA-TRAN-SO-01-093020	09/30/2020	N	**0.00058**	J	0.00097	U	0.00097	U
	RSA-TRAN-SO-02-093020	09/30/2020	N	**0.00092**	J	0.0013	U	0.0013	U
Building 7370 THIOKOL – Teflon Coating Site (7370)	RSA-TEF-SO-01-092920	09/29/2020	N	0.0012	U	0.0012	U	0.0012	U
	RSA-FD-02-092920 / RSA-TEF-SO-02-092920	09/29/2020	FD	0.0013	U	**0.0015**		0.0013	U
	RSA-TEF-SO-02-092920	09/29/2020	N	0.0013	U	**0.0011**	J	0.0013	U
	RSA-TEF-SO-03-092920	09/29/2020	N	0.0011	U	0.0011	U	0.0011	U
	RSA-TEF-SO-04-092920	09/29/2020	N	0.001	U	**0.00053**	J	0.001	U
Fire Station #1 (FS1)	RSA-FS1-SO-01-092820	09/28/2020	N	**0.057**		**0.0034**		0.0013	U
	RSA-FS1-SO-02-092820	09/28/2020	N	**0.053**		**0.0024**		0.0012	U
Fire Station #2 (FS2)	RSA-FS2-SO-01-100120	10/01/2020	N	**0.18**		**0.0045**		0.001	U
	RSA-FS2-SO-02-100120	10/01/2020	N	**0.016**		**0.0006**	J	0.0011	U
Fire Station #3 (FS3)	RSA-FS3-SO-01-093020	09/30/2020	N	**0.4**	J	**0.0042**		**0.0061**	
	RSA-FS3-SO-02-093020	09/30/2020	N	**0.029**		0.0011	U	0.0011	U
Fire Station #4 (FS4)	RSA-FS4-SO-01-100120	10/01/2020	N	**0.0034**		**0.00053**	J	0.001	U
	RSA-FD03-100120 / RSA-FS4-SO-02-100120	10/01/2020	FD	**0.0032**		**0.00096**	J	0.0011	U
	RSA-FS4-SO-02-100120	10/01/2020	N	**0.0039**		**0.00084**	J	0.0011	U
Fire Station #5 (FS5)	RSA-FS5-SO-01-100120	10/01/2020	N	**0.068**		0.0011	U	0.0011	U
	RSA-FS5-SO-02-100120	10/01/2020	N	**0.019**		0.0013	U	0.0013	U
Fire Training Area	RSA-FTA-SO-01-100220	10/02/2020	N	**0.0028**		0.00095	U	0.00095	U
	RSA-FTA-SO-02-100220	10/02/2020	N	**0.0091**		0.0012	U	0.0012	U
	RSA-FTA-SO-03-100220	10/02/2020	N	**0.25**	J	**0.0029**		**0.0099**	
	RSA-FTA-SO-04-100220	10/02/2020	N	**0.037**		**0.00077**	J	0.00099	U
Fuel Tank Fire (FUEL)	RSA-FUEL-SO-01-092920	09/29/2020	N	**0.035**		0.0013	U	0.0013	U
	RSA-FUEL-SO-02-092920	09/29/2020	N	**0.099**		0.00099	U	0.00099	U
	RSA-FUEL-SO-03-092920	09/29/2020	N	**0.0022**		0.0013	UJ	0.0013	UJ
	RSA-FUEL-SO-04-092920	09/29/2020	N	**0.0013**	J	0.0014	U	0.0014	U
Hangar 4815	RSA-4815-SO-01-100120	10/01/2020	N	**0.0012**	J	0.0014	U	0.0014	U
	RSA-4815-SO-02-100120	10/01/2020	N	0.00088	U	0.00088	U	0.00088	UJ
	RSA-4815-SO-03-100120	10/01/2020	N	0.0014	U	0.0014	U	0.0014	U

Table 7-2 - Soil PFOS, PFOA, and PFBS Analytical Results
USACE PFAS Preliminary Assessment/Site Inspection
Redstone Arsenal, Alabama

ARCADIS

			Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
			OSD Industrial/Commercial Risk Screening Level	1.6		1.6		25	
			OSD Residential Risk Screening Level	0.13		0.13		1.9	
AOPI	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
Hangar 4832	RSA-4832-SO-01-093020	09/30/2020	N	**0.0047**		0.0011	U	0.0011	U
	RSA-4832-SO-02-093020	09/30/2020	N	**0.056**		0.0012	U	0.0012	U
	RSA-4832-SO-03-093020	09/30/2020	N	**0.0017**		0.0011	U	0.0011	U
Hangar 4880	RSA-4880-SO-01-111920	11/19/2020	N	**0.00082**	J	0.0011	U	**0.0012**	
	RSA-4880-SO-02-093020	09/30/2020	N	0.0012	U	0.0012	U	0.0012	U
	RSA-4880-SO-03-093020	09/30/2020	N	0.0014	U	0.0014	U	0.0014	U
	RSA-4880-SO-04-093020	09/30/2020	N	0.0011	U	0.0011	U	0.0011	U
	RSA-4880-SO-05-111920	11/19/2020	N	**0.0012**		0.0011	U	0.0011	U
Hangar 6312	RSA-6312-SO-01-092920	09/29/2020	N	0.0011	U	0.0011	U	0.0011	U
	RSA-6312-SO-02-092920	09/29/2020	N	**0.0017**		**0.00098**	J	0.0012	U
	RSA-6312-SO-03-092920	09/29/2020	N	**0.00062**	J	0.0012	U	0.0012	U
	RSA-6312-SO-04-092920	09/29/2020	N	0.0011	U	0.0011	U	0.0011	U
Keyhole/Nozzle Testing Area (KEY)	RSA-KEY-SO-01-100120	10/01/2020	N	**0.00098**	J	0.0015	U	0.0015	U
	RSA-KEY-SO-02-100120	10/01/2020	N	0.0012	U	0.0012	U	0.0012	U
	RSA-KEY-SO-03-100120	10/01/2020	N	**0.002**		0.0011	U	0.0011	U
	RSA-KEY-SO-04-100120	10/01/2020	N	**0.22**		**0.0023**		0.0012	U
Landfill Fire (LFF)	RSA-LFF-SO-01-092920	09/29/2020	N	**0.00089**	J	0.0012	U	0.0012	U
Mulcher Fire (MLCH)	RSA-MLLH-SO-01-111920	11/19/2020	N	0.0011	U	0.0011	U	0.0011	U
	RSA-MLLH-SO-02-111920	11/19/2020	N	0.0011	U	0.0011	U	0.0011	U
Old Fire Station #1 (OFS1)	RSA-OFS1-SO-01-093020	09/30/2020	N	0.001	U	0.001	U	0.001	U
	RSA-OFS1-SO-02-093020	09/30/2020	N	0.0011	U	0.0011	U	0.0011	U
	RSA-OFS1-SO-03-093020	09/30/2020	N	**0.00056**	J	0.00083	U	0.00083	U
Old Fire Station #2 (OFS2)	RSA-OFS2-SO-01-093020	09/30/2020	N	**0.0015**		0.0012	U	0.0012	U
	RSA-OFS2-SO-02-093020	09/30/2020	N	**0.001**	J	**0.0007**	J	0.0013	U
Firehouse Pub (PUB)	RSA-PUB-SO-01-100120	10/02/2020	N	**0.0033**		0.0014	U	0.0014	U
	RSA-PUB-SO-02-100120	10/02/2020	N	0.0013	U	**0.00067**	J	0.0013	U
	RSA-PUB-SO-03-100120	10/02/2020	N	**0.0017**		**0.0006**	J	0.0012	U
Vehicle Fire at Building 4650 (VF)	RSA-VF-SO-01-092820	09/28/2020	N	**0.001**		**0.00055**	J	0.001	U
	RSA-FD-01-092820 / RSA-VF-SO-02-092820	09/28/2020	FD	0.0011	U	0.0011	U	0.0011	U
	RSA-VF-SO-02-092820	09/28/2020	N	0.0013	U	0.0013	U	0.0013	U

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection.
2. Data are compared to the 2021 Office of the Secretary of Defense (OSD) risk screening levels for the residential and commercial/industrial scenario (OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September).
3. Grey shaded values indicate the result was detected greater than or equal to the OSD risk screening level for the residential scenario.

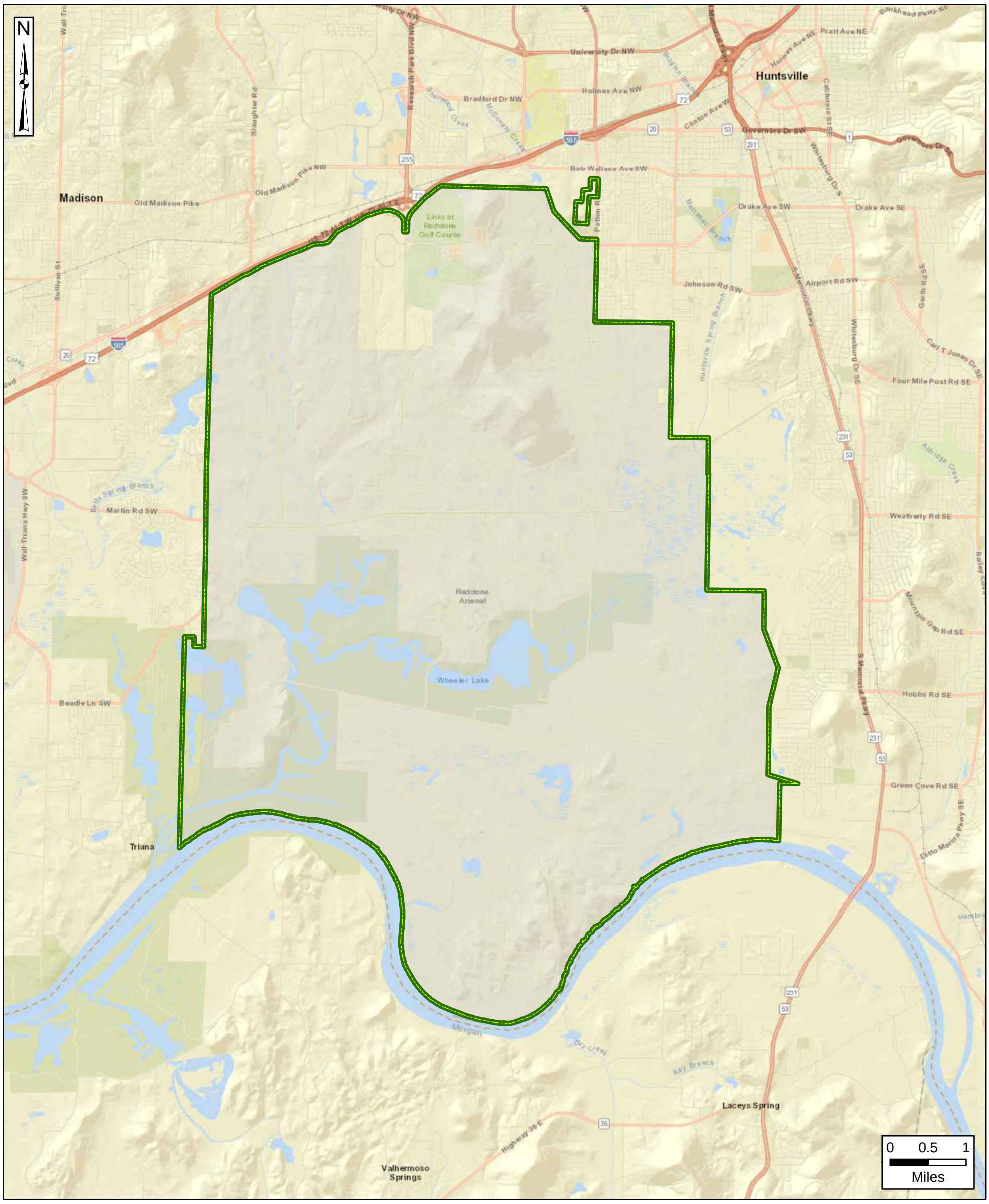
Acronyms/Abbreviations:
AOPI = Area of Potential Interest
FBI = Federal Bureau of Investigation
FD = field duplicate sample
ID = identification
mg/kg = milligrams per kilogram (parts per million)
N = primary sample
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
Qual = qualifier

Qualifiers	Description
J	The analyte was positively identified; however the associated numerical value is an estimated concentration only.
J-	The result is an estimated quantity; the result may be biased low.
U	The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).
UJ	The analyte was analyzed for but was not detected. The reported limit of quantitation (LOQ) is approximate and may be inaccurate or imprecise.

FIGURES

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 2-1
Site Location



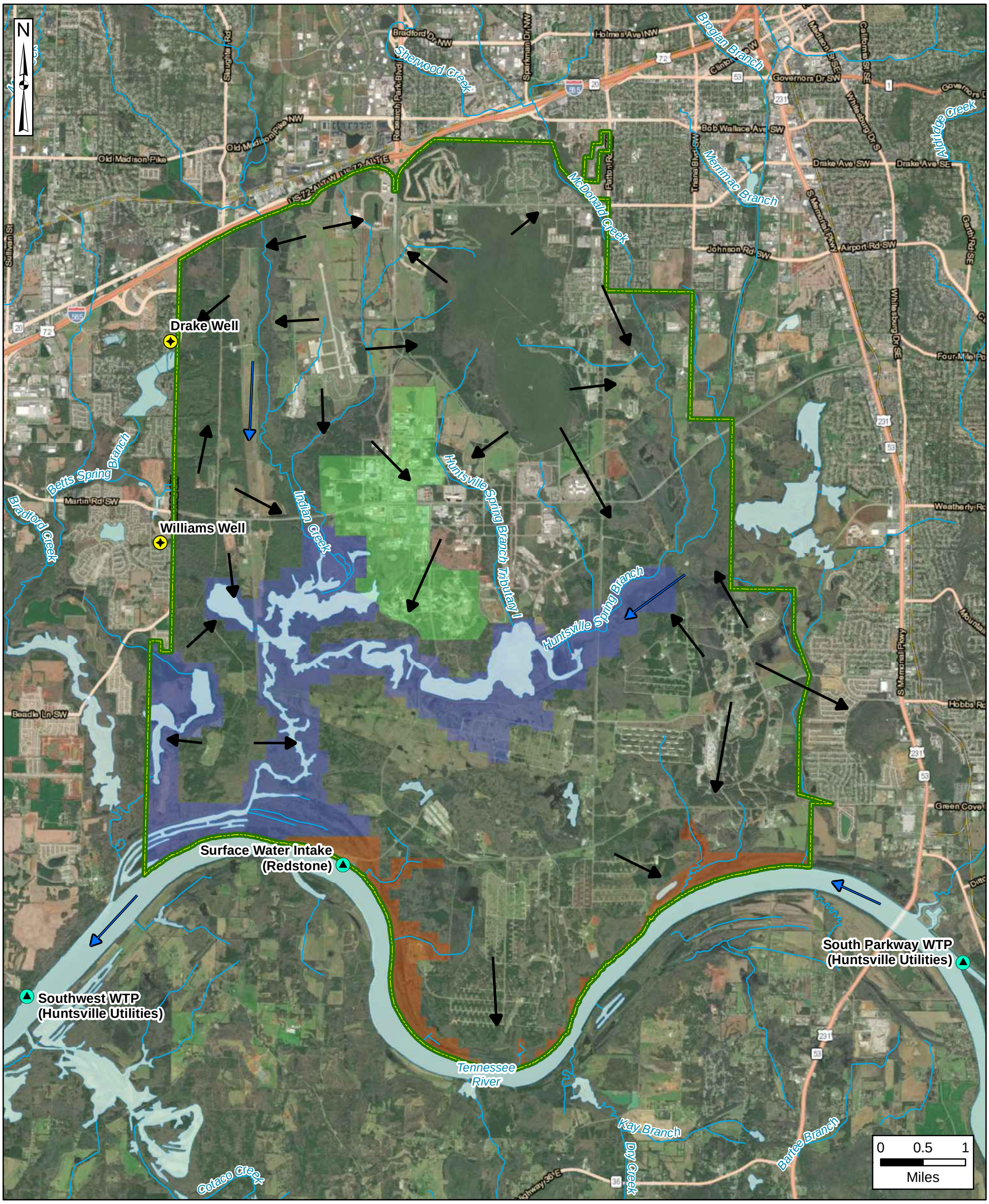
Installation Boundary

Data Sources:
ESRI ArcGIS Online, Street Map Data

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 2-2
Site Layout



- Installation Boundary
- River/Stream
- Water Body
- Surface Water Flow Direction
- Inferred Groundwater Flow Direction
- NASA Marshall Space Flight Center
- Tennessee Valley Authority
- USFWS Wheeler National Wildlife Refuge
- Water Treatment Plant
- Public Supply Well

NASA = National Aeronautics and Space Administration
USFWS = United States Fish and Wildlife Service
WTP = water treatment plant

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 2-3
Topographic Map

Installation Boundary

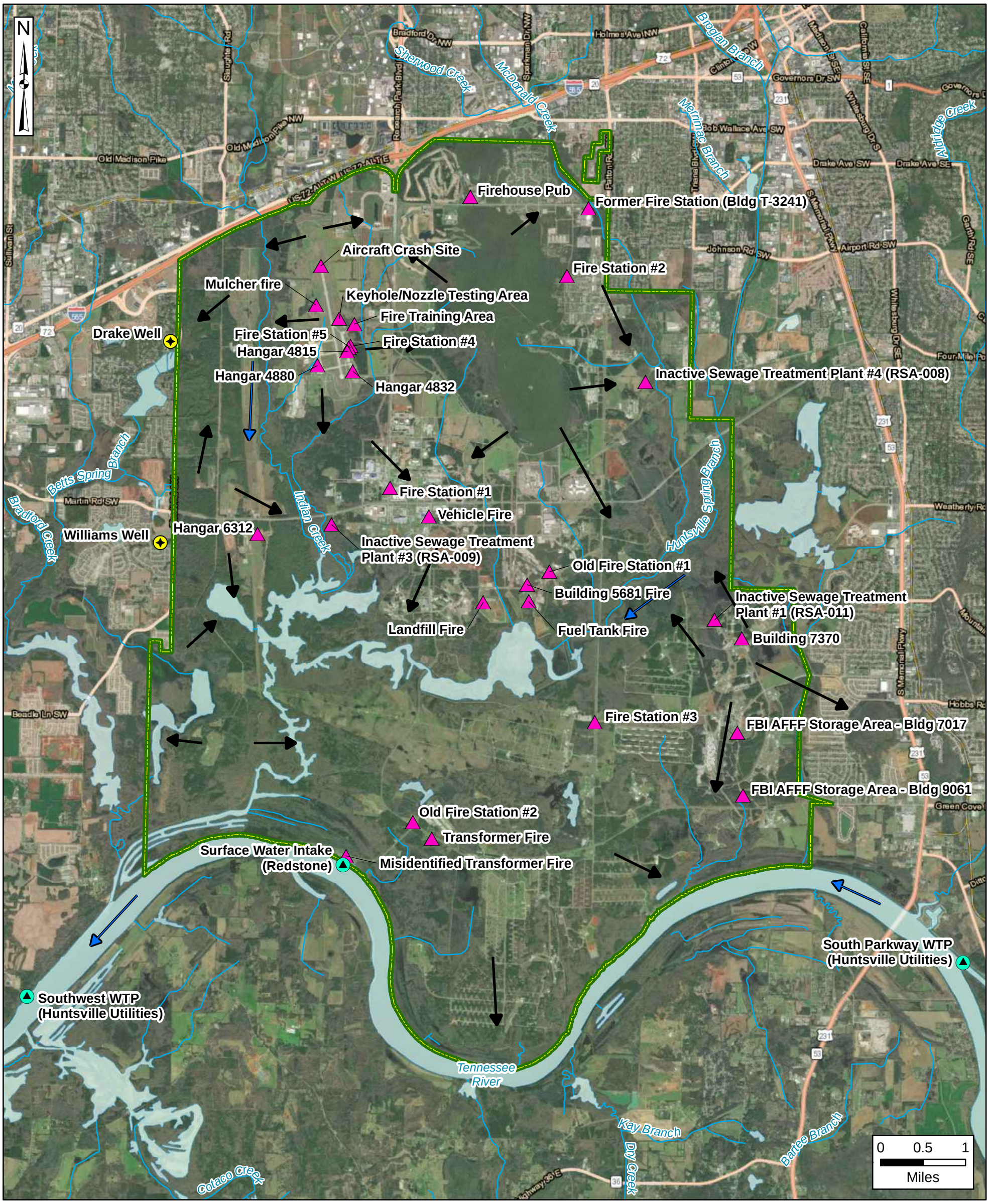
Elevation Contour (20 feet)

Data Sources:
ESRI ArcGIS Online, USGS Topo Map

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-2
AOPI Locations



Installation Boundary
AOPI
River/Stream
Water Body
Surface Water Flow Direction
Inferred Groundwater Flow Direction
Water Treatment Plant
Public Supply Well

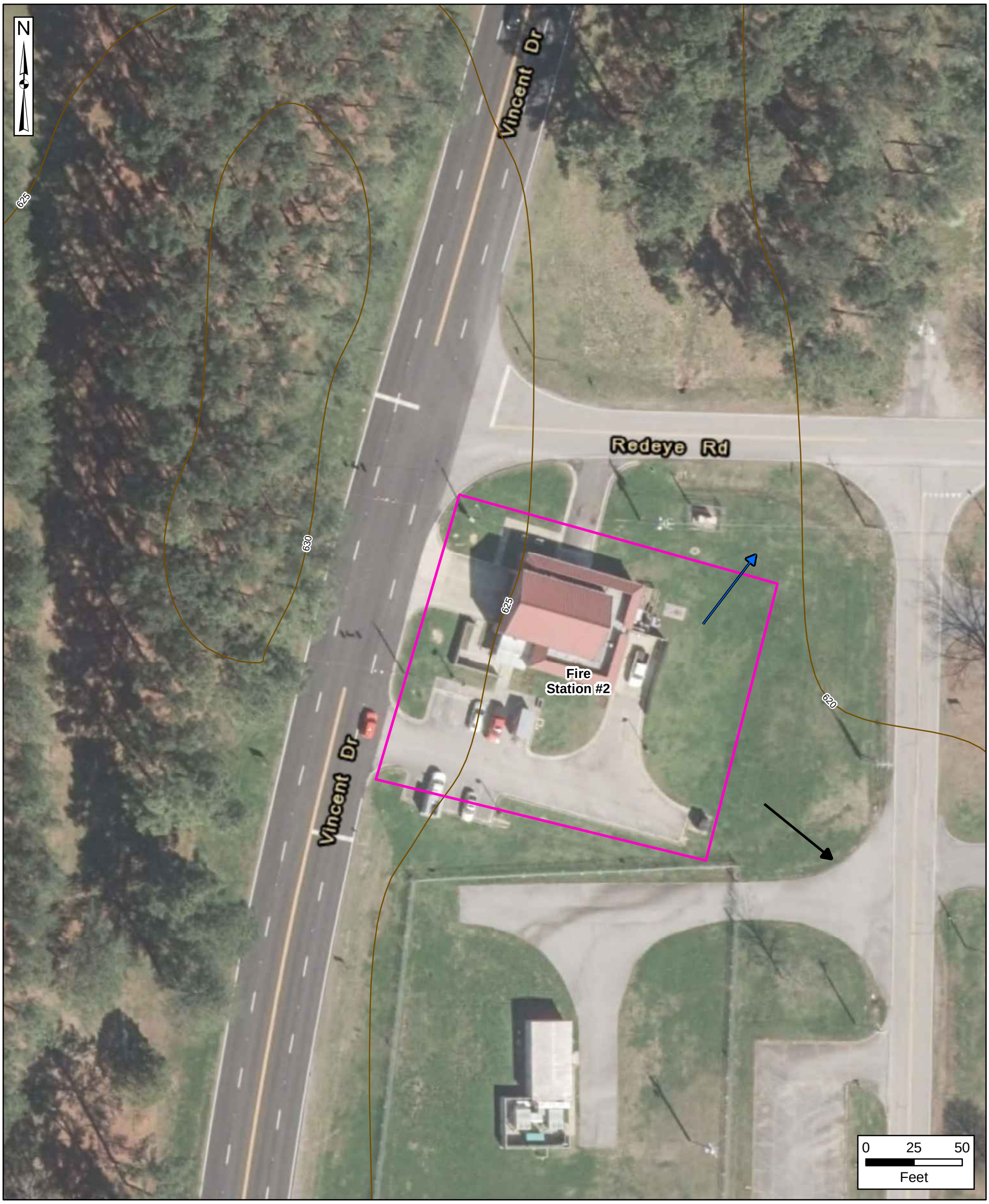
AFFF = aqueous film-forming foam
AOPI = area of potential interest
Bldg = building
WTP = water treatment plant

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-3
Aerial Photo of Fire Station #2 (Building 3320)



Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-4
Aerial Photo of Hangar 6312

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-5
Aerial Photo of Building 7370

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well

AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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Redstone Arsenal, AL

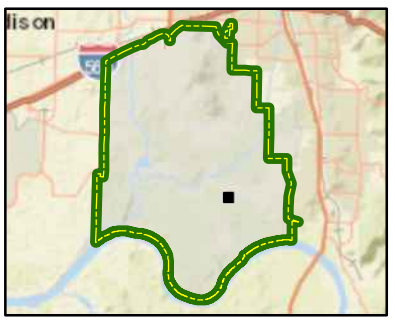

Figure 5-6
Aerial Photo of Fire Station #3 (Building 7801)

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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Redstone Arsenal, AL

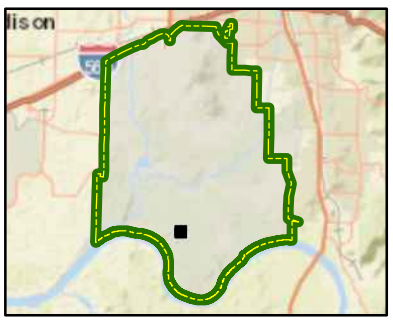
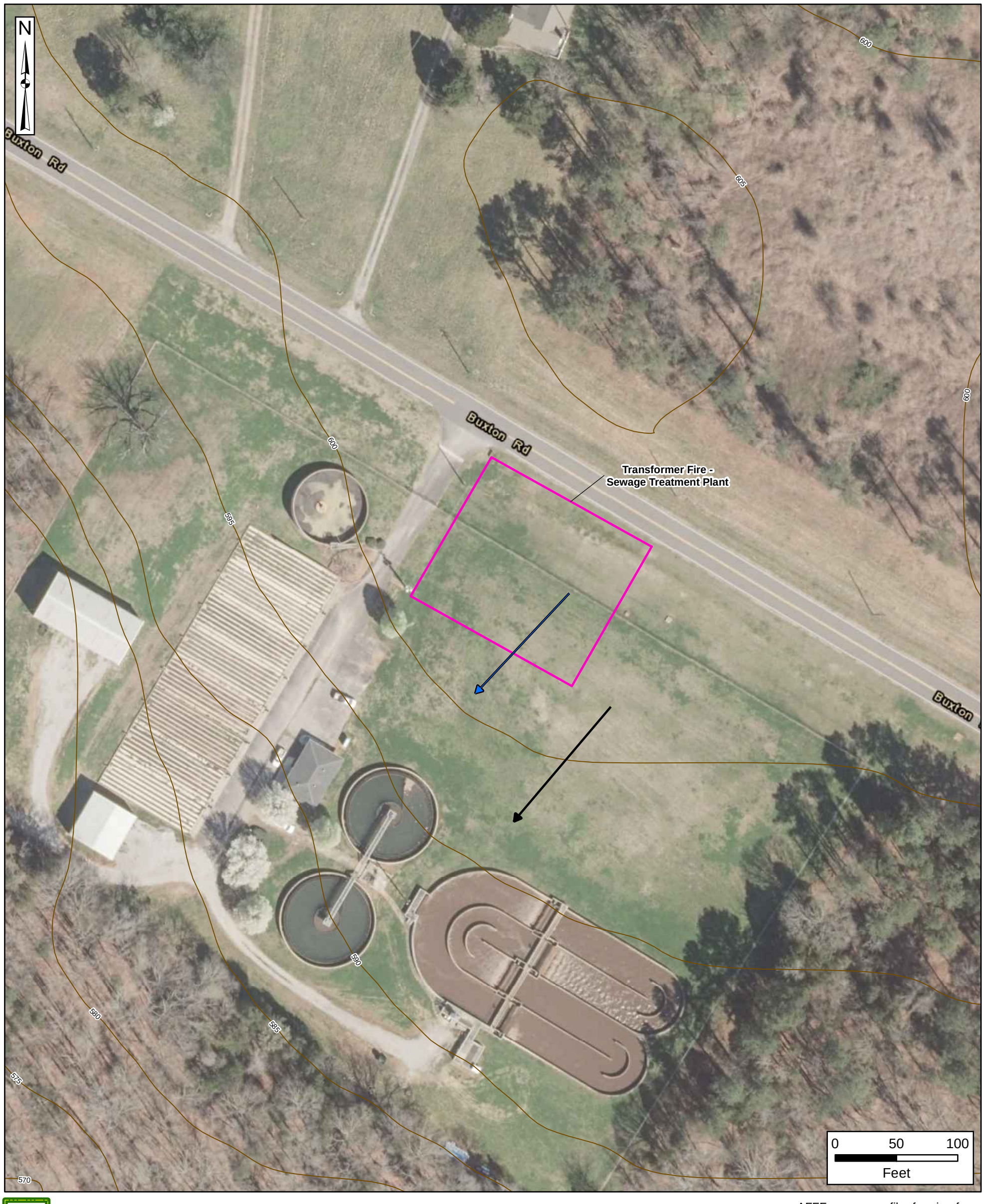


Figure 5-7
Aerial Photo of Transformer Fire



Installation Boundary
AOPI*
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

*The box shown delineates the AFFF spray and overspray area.

AFFF = aqueous film-forming foam
AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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Redstone Arsenal, AL

Figure 5-8
Aerial Photo of Old Fire Station #2
(Buxton and Shield Roads)

Installation Boundary
AOPI
Elevation Contour (feet)
Historical Building Footprint
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well

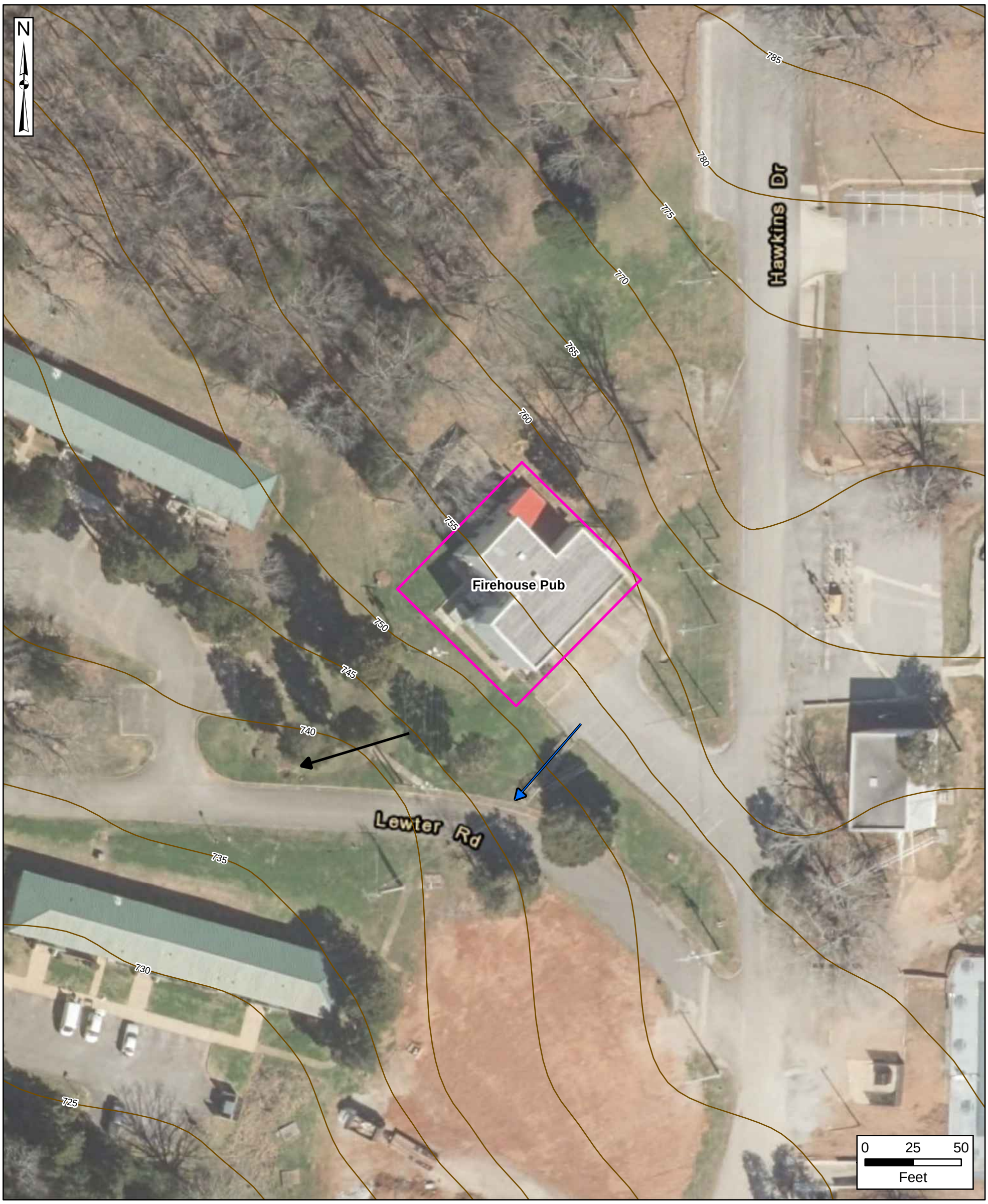
AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-9
Aerial Photo of Firehouse Pub (Building 114)



Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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Redstone Arsenal, AL

Figure 5-10
Aerial Photo of Mulcher Fire

N

680
690
685
680
675
670
670
670
665
660

Mulcher Fire

0 50 100
Feet

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

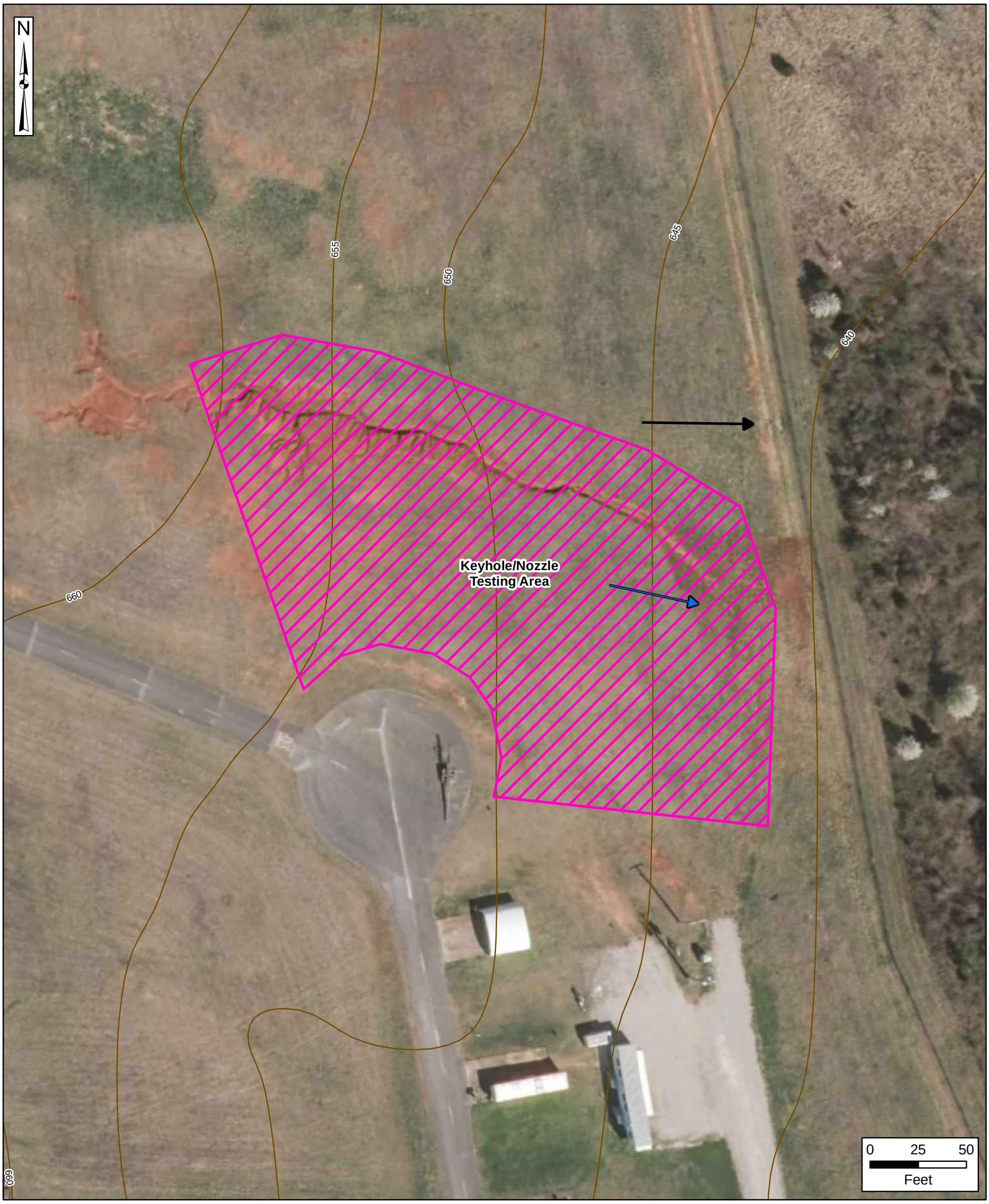
AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-11
Aerial Photo of Keyhole/Nozzle Testing Area



Installation Boundary
AOPI
Approximate AFFF Release Area
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

AFFF = aqueous film-forming foam
AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-12
Aerial Photo of Fire Training Area

Fire Training Area
Burn Pit
Diesel AST
OWS Valve Box
Small piles of sand used to practice temporary containment berm construction
Training Tower
OWS
Drafting Pit
Propane AST
630
625
620
615
610
605
600
595
590
0 50 100
Feet

Installation Boundary
AOPI
Approximate AFFF Release Area
Elevation Contour (feet)
River/Stream
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
OWS Discharge Line
Monitoring Well

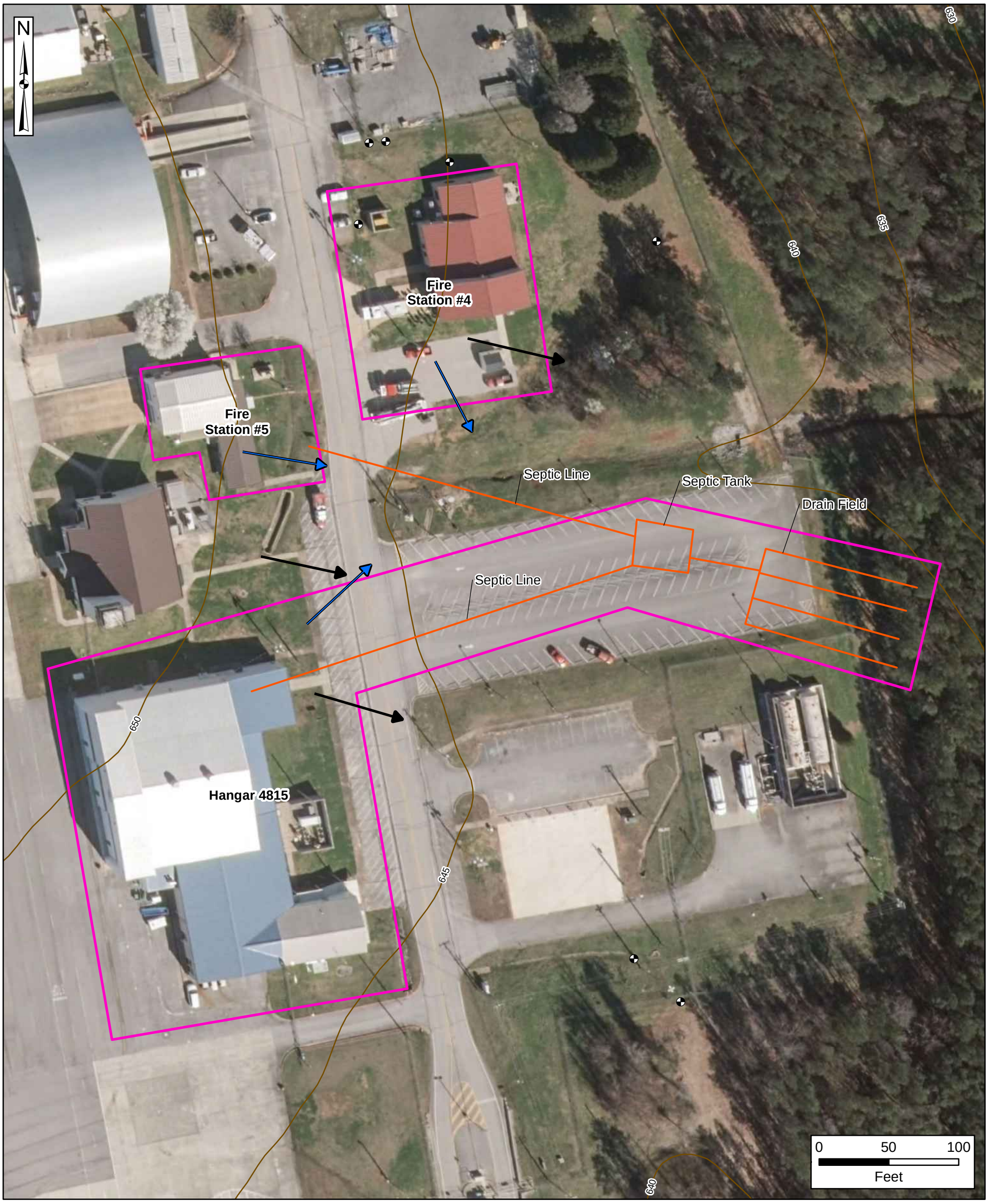
AFFF = aqueous film-forming foam
AOPI = area of potential interest
AST = above ground storage tank
OWS = oil water separator

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-13
Aerial Photo of Fire Station #4 (Building 4810), Fire Station #5 (Building 4813), and Hangar 4815



Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Sanitary Line
Monitoring Well

AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

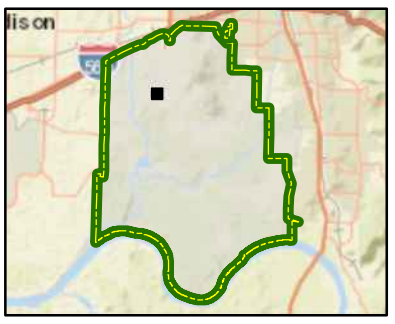
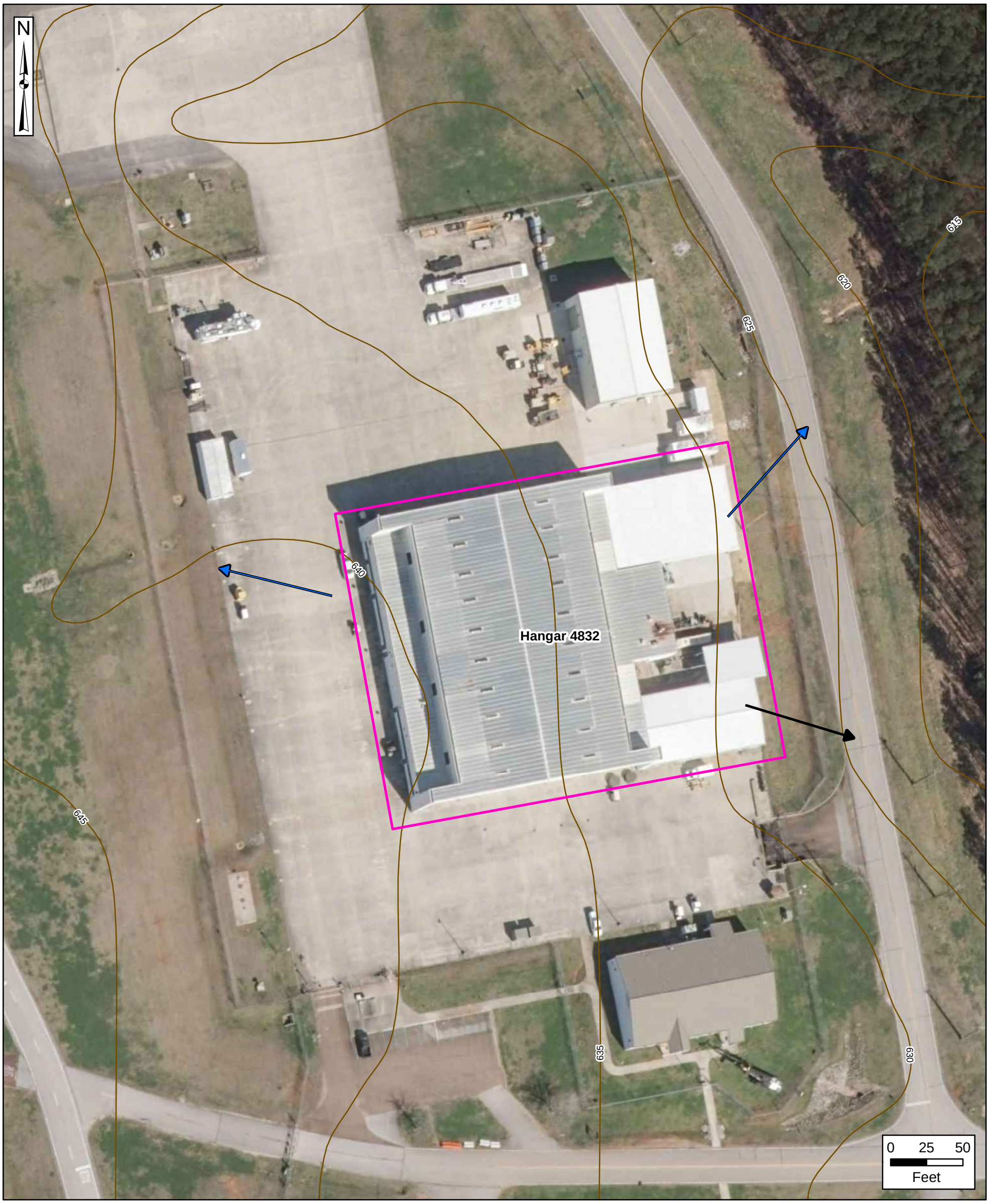


Figure 5-14
Aerial Photo of Hangar 4832



Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-15
Aerial Photo of Hangar 4880

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-16
Aerial Photo of Fire Station #1 (Building 4424)

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well
SB

AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-17
Aerial Photo of Vehicle Fire (Building 4650)

Installation Boundary
AOPI
Approximate AFFF Release Area
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

AFFF = aqueous film-forming foam
AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

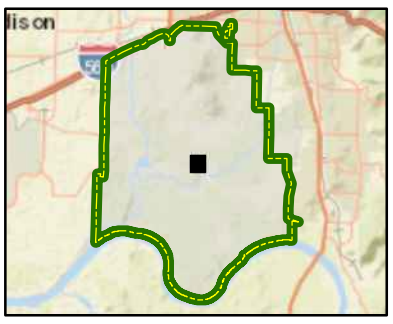


Figure 5-18
Aerial Photo of Landfill Fire

Installation Boundary
AOPI
Elevation Contour (feet)
River/Stream
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well
Extraction Well

AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-19
Aerial Photo of Building 5681

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well

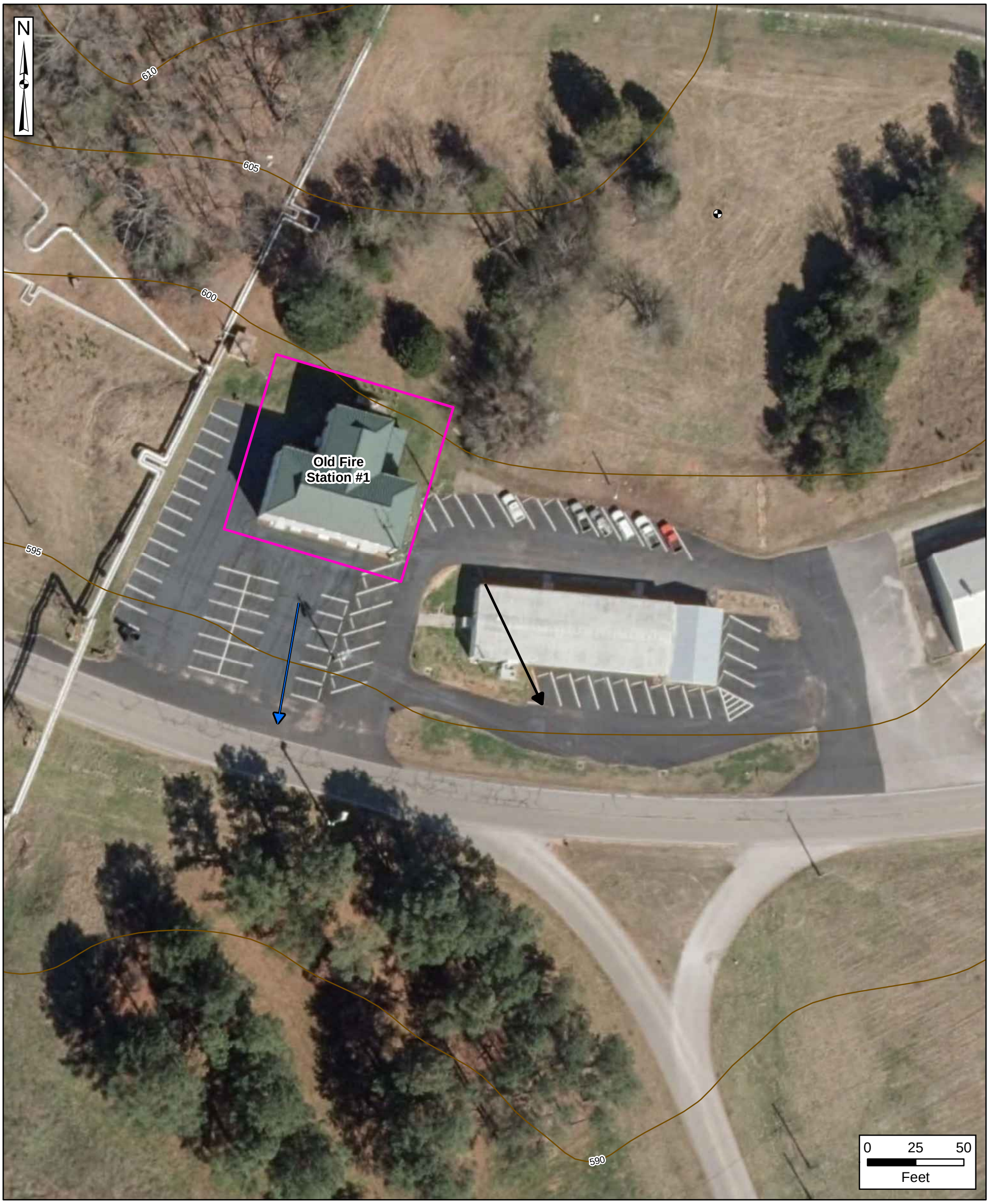
AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-20
Aerial Photo of Old Fire Station #1 (Building 5414)



Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well

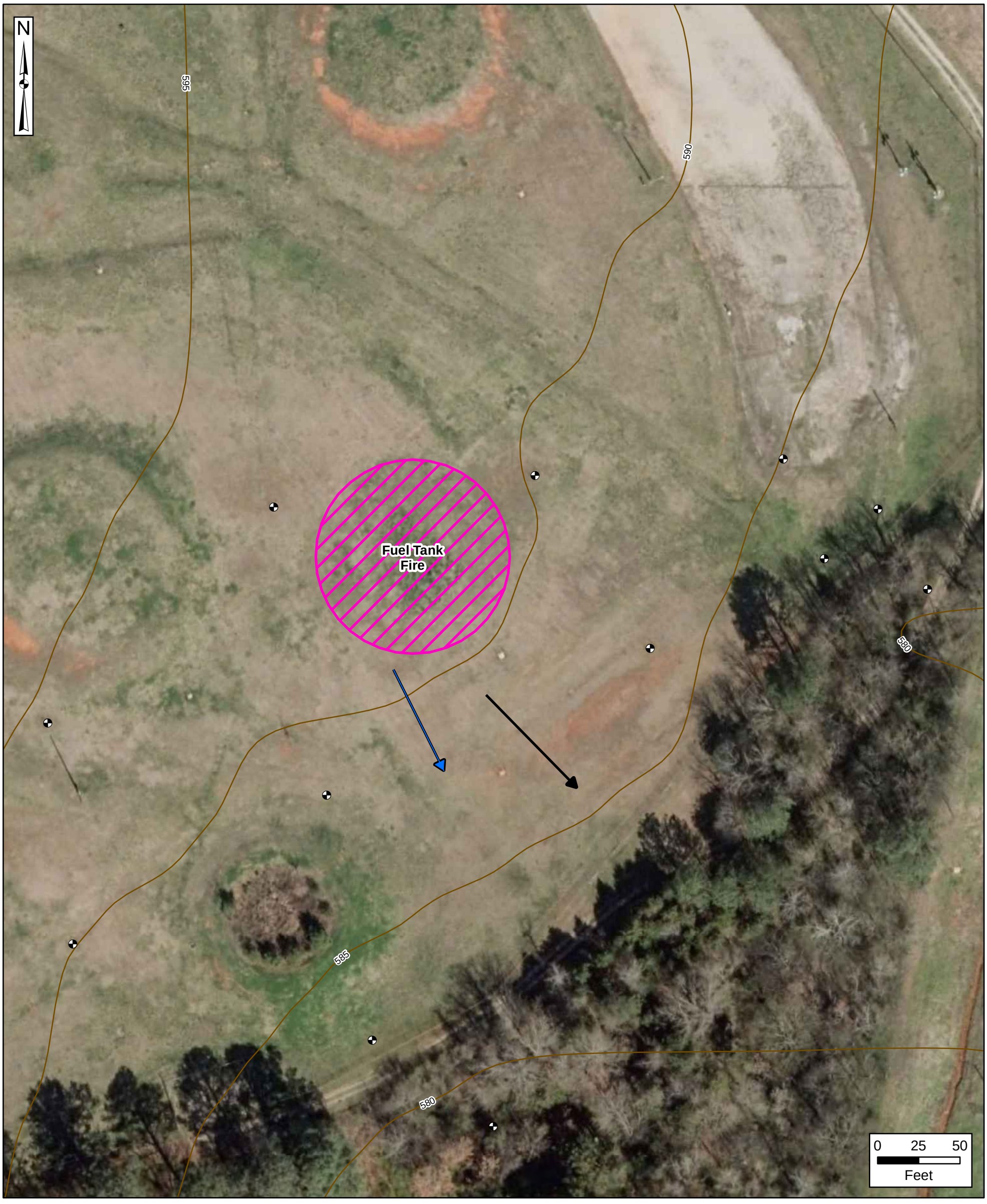
AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-21
Aerial Photo of Fuel Tank Fire



Installation Boundary
AOPI
Approximate AFFF Release Area
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well

AFFF = aqueous film-forming foam
AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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Redstone Arsenal, AL

Figure 5-22
Aerial Photo of
FBI AFFF Storage Area - Building 7017

Installation Boundary

AOPI

Elevation Contour (feet)

Inferred Surface Water Runoff Direction

Inferred Groundwater Flow Direction

AFFF = aqueous film-forming foam
AOPI = area of potential interest
Bldg = building

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-23
Aerial Photo of
FBI AFFF Storage Area - Bldg 9061

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

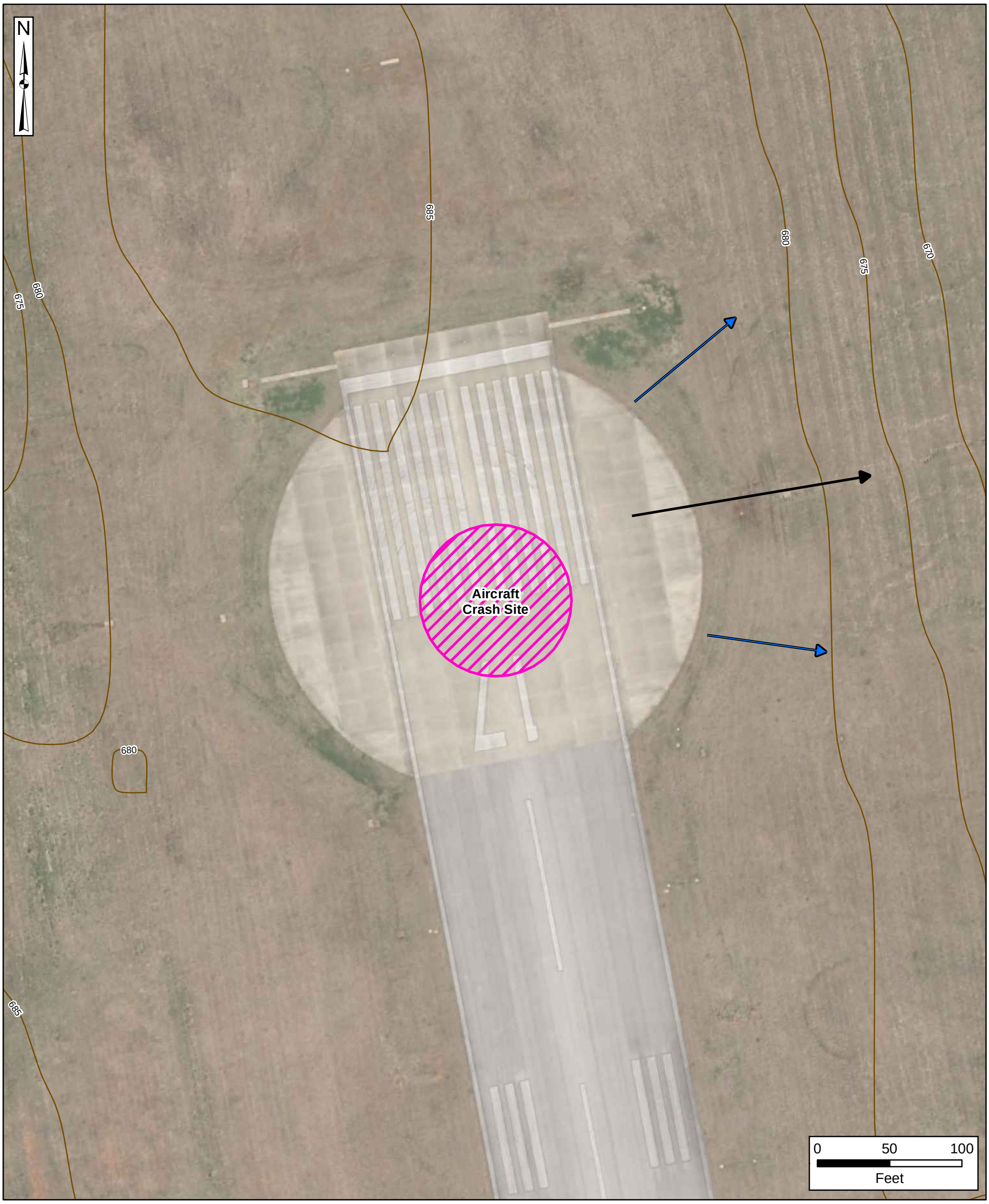
AFFF = aqueous film-forming foam
AOPI = area of potential interest
Bldg = building

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-24
Aerial Photo of Aircraft Crash Site



Installation Boundary
AOPI
Approximate AFFF Release Area
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

AFFF = aqueous film-forming foam
AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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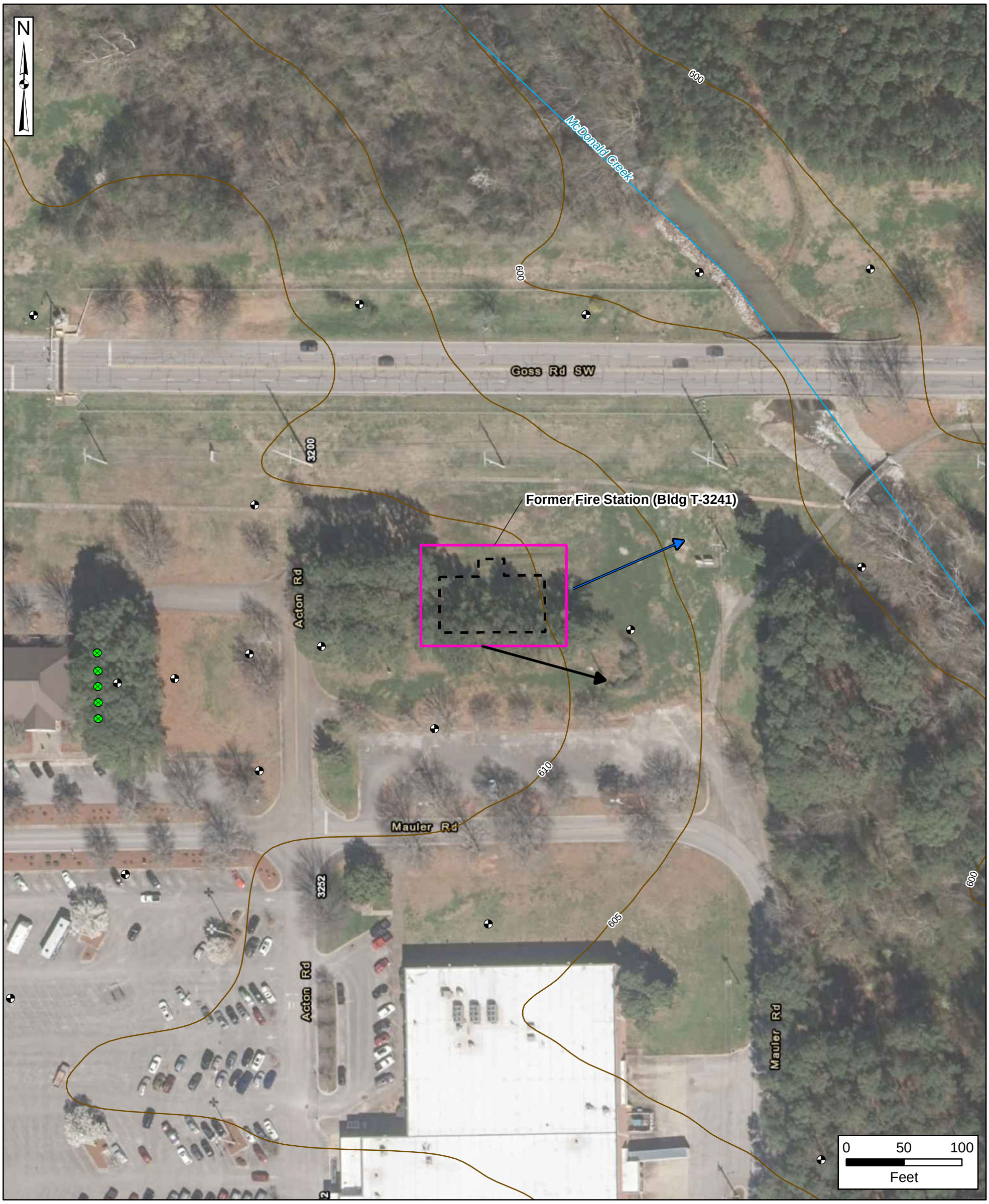
Redstone Arsenal, AL

Figure 5-25
Aerial Photo of Former Fire Station (Building T-3241)



Installation Boundary
AOPI
Former Building Footprint
River/Stream
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Elevation Contour (feet)
Monitoring Well
Extraction Well

AOPI = area of potential interest
Bldg = building

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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Redstone Arsenal, AL

Figure 5-26
Aerial photo of
Inactive Sewage Treatment Plant #1

Installation Boundary
AOPI
Sludge Drying Bed
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well

AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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Redstone Arsenal, AL

Figure 5-27
Aerial Photo of
Inactive Sewage Treatment Plant #3

Installation Boundary
AOPI
Sludge Drying Bed
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well

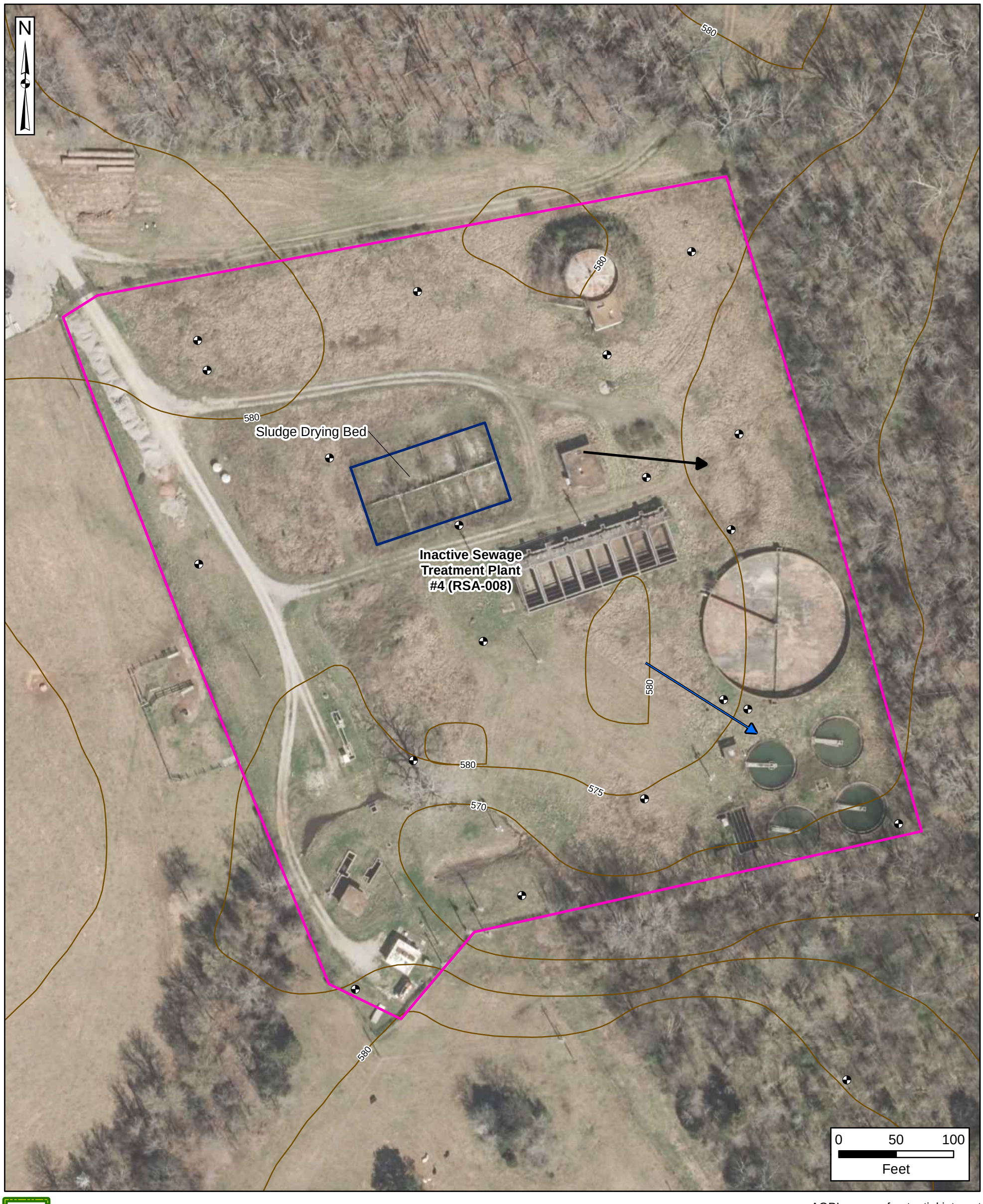
AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 5-28
Aerial Photo of
Inactive Sewage Treatment Plant #4



Installation Boundary
AOPI
Sludge Drying Bed
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well

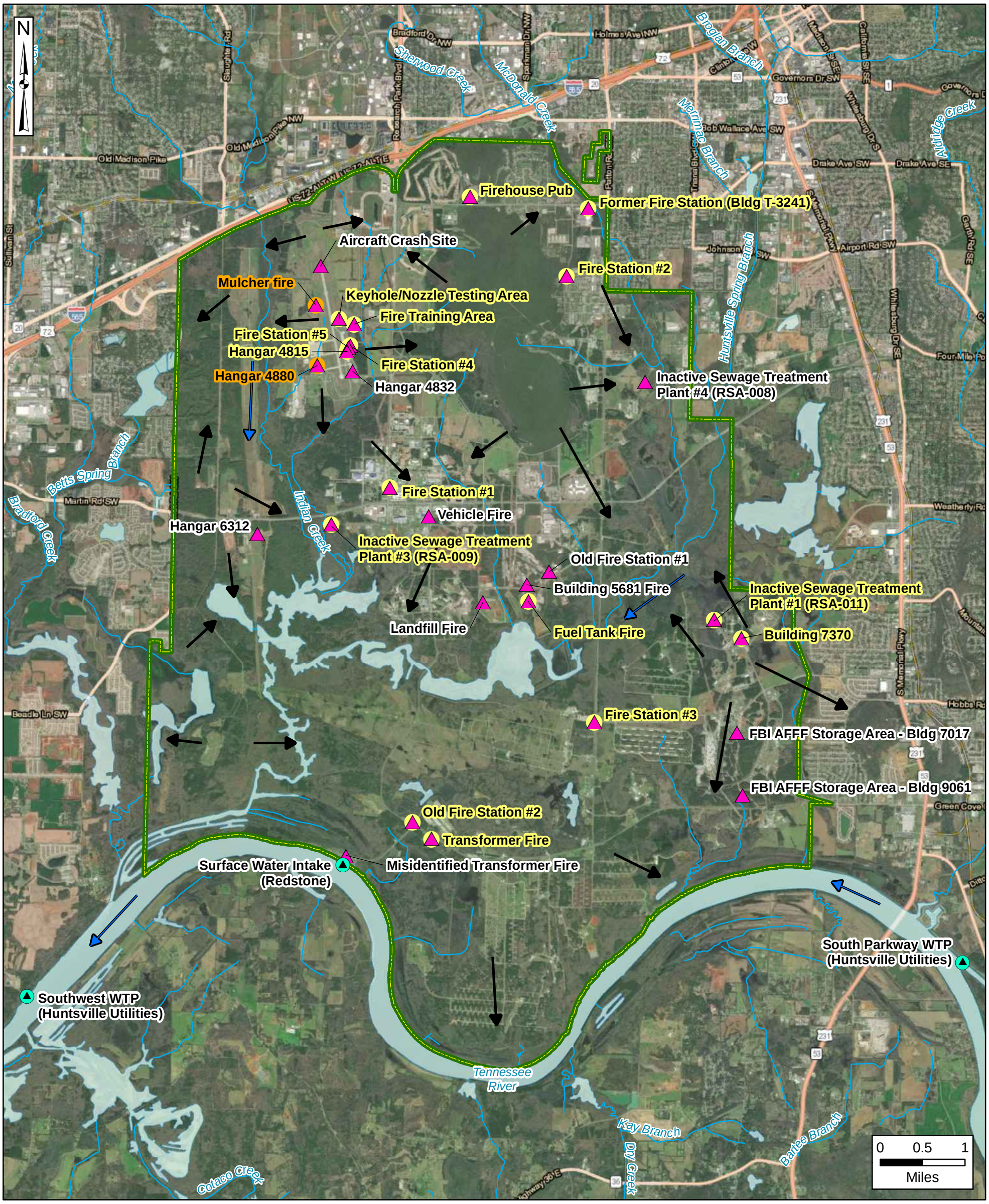
AOPI = area of potential interest

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-1
AOPI Locations and OSD
Risk Screening Level Exceedances



- Installation Boundary
- AOPI
- AOPI with OSD Risk Screening Level Exceedance
- AOPI Where Groundwater Was Not Collected
- River/Stream
- Water Body
- Surface Water Flow Direction
- Inferred Groundwater Flow Direction
- Water Treatment Plant

AFFF = aqueous film-forming foam
AOPI = area of potential interest
Bldg = building
OSD = Office of the Secretary of Defense
WTP = water treatment plant

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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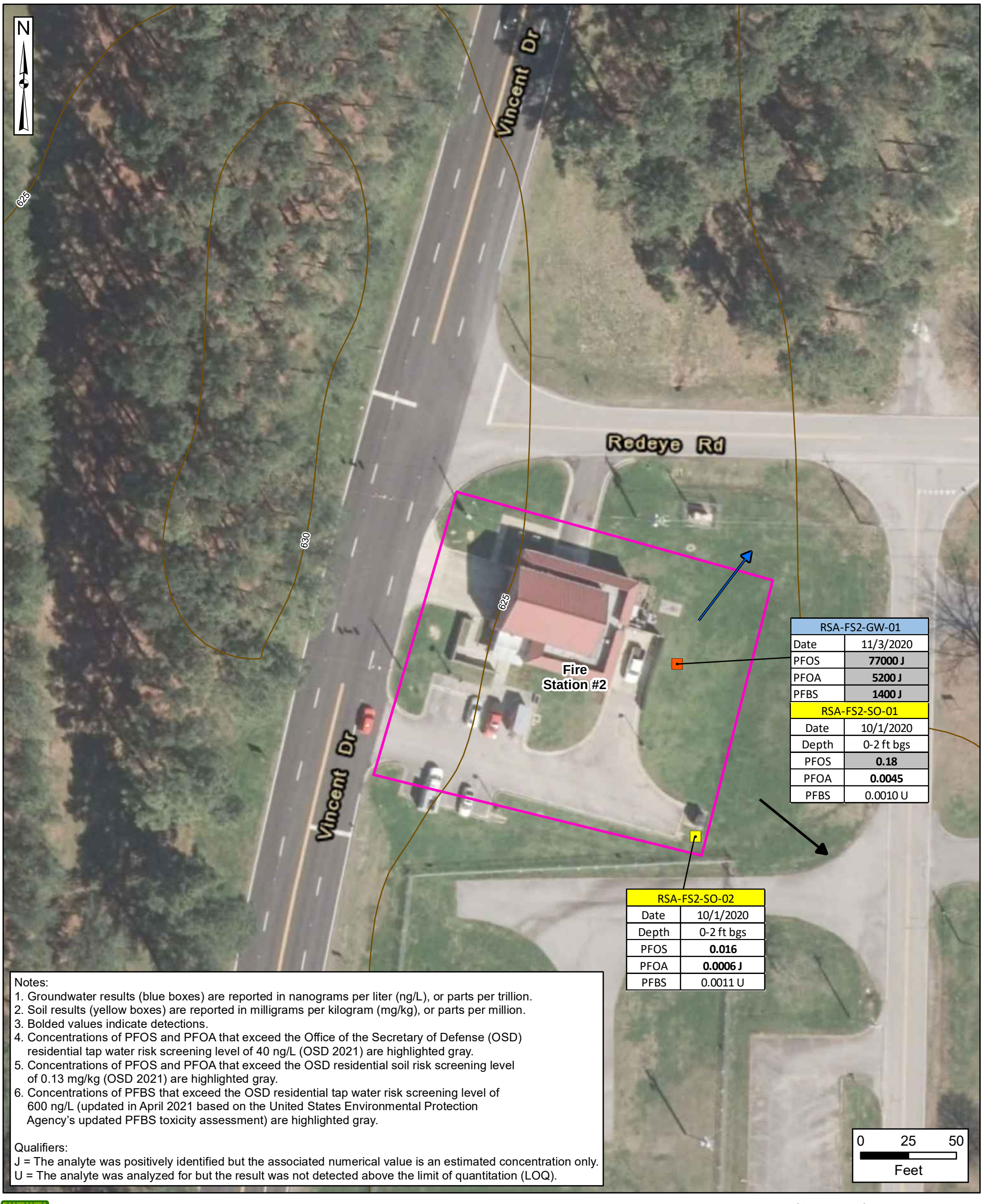
Redstone Arsenal, AL

Figure 7-2
PFOS, PFOA, and PFBS Analytical Results for Fire Station #2



Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
5. Concentrations of PFOS and PFOA that exceed the OSD residential soil risk screening level of 0.13 mg/kg (OSD 2021) are highlighted gray.
6. Concentrations of PFBS that exceed the OSD residential tap water risk screening level of 600 ng/L (updated in April 2021 based on the United States Environmental Protection Agency's updated PFBS toxicity assessment) are highlighted gray.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Sampling Locations

Surface Soil - Hand Auger
Soil and Groundwater - DPT Boring

AOPI = area of potential interest
DPT = direct-push technology
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-3
PFOS, PFOA, and PFBS Analytical Results for Hangar 6312

N

570

RSA-6312-SO-04	
Date	9/29/2020
Depth	0-2 ft bgs
PFOS	0.0011 U
PFOA	0.0011 U
PFBS	0.0011 U

Hangar 6312

RSA-6312-SO-03	
Date	9/29/2020
Depth	0-2 ft bgs
PFOS	**0.00062 J**
PFOA	0.0012 U
PFBS	0.0012 U

575

RSA-6312-GW-01	
Date	10/5/2020
PFOS	**8**
PFOA	**8.2**
PFBS	**3.3 J**

RSA-6312-SO-01	
Date	9/29/2020
Depth	0-2 ft bgs
PFOS	0.0011 U
PFOA	0.0011 U
PFBS	0.0011 U

RSA-6312-SO-02	
Date	9/29/2020
Depth	0-2 ft bgs
PFOS	**0.0017**
PFOA	**0.00098 J**
PFBS	0.0012 U

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

0 25 50
Feet

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Sampling Locations

Surface Soil - Hand Auger
Soil and Groundwater - Rotosonic Boring

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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Redstone Arsenal, AL

Figure 7-4
PFOS, PFOA, and PFBS Analytical Results for Building 7370 (THIOKOL Teflon Coating Facility)

N

RSA-7370-SO-01	
Date	9/29/2020
Depth	0-2 ft bgs
PFOS	0.0012 U
PFOA	0.0012 U
PFBS	0.0012 U

RSA-RS1221	
Date	9/29/2020
PFOS	**15 [3.6 J]**
PFOA	**550 [540]**
PFBS	**3.8 J [3.4 J]**

RSA-7370-SO-04	
Date	9/29/2020
Depth	0-1 ft bgs
PFOS	0.0010 U
PFOA	**0.00053 J**
PFBS	0.0010 U

Building 7370

RSA-7370-SO-02	
Date	9/29/2020
Depth	0-2 ft bgs
PFOS	0.0013 U [0.0013 U]
PFOA	**0.0011 J [0.0015]**
PFBS	0.0013 U [0.0013 U]

RSA-7370-SO-03	
Date	9/29/2020
Depth	0-2 ft bgs
PFOS	0.0011 U
PFOA	0.0011 U
PFBS	0.0011 U

590
585
580
580

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Results in brackets are field duplicate sample results.
4. Bolded values indicate detections.
5. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

0 25 50
Feet

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Monitoring Well

Sampling Locations

Surface Soil - Hand Auger
Groundwater - Existing Well

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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Redstone Arsenal, AL

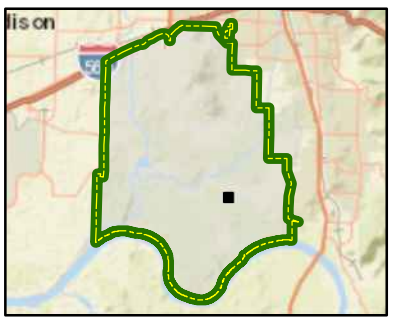


Figure 7-5
PFOS, PFOA, and PFBS Analytical Results for Fire Station #3

N

Patton Rd

Redstone Rd SW

Fire Station #3

570

RSA-FS3-SO-02	
Date	9/30/2020
Depth	0-2 ft bgs
PFOS	**0.029**
PFOA	0.0011 U
PFBS	0.0011 U

RSA-FS3-GW-01	
Date	10/8/2020
PFOS	**6400 J**
PFOA	**2500 J**
PFBS	**32000 J**
RSA-FS3-SO-01	
Date	9/30/2020
Depth	0-2 ft bgs
PFOS	**0.4 J**
PFOA	**0.0042**
PFBS	**0.0061**

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
5. Concentrations of PFOS and PFOA that exceed the OSD residential soil risk screening level of 0.13 mg/kg (OSD 2021) are highlighted gray.
6. Concentrations of PFBS that exceed the OSD residential tap water risk screening level of 600 ng/L (updated in April 2021 based on the United States Environmental Protection Agency's updated PFBS toxicity assessment) are highlighted gray.

Qualifiers:
J = The analyte was positively identified; however the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

0 25 50
Feet

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Sampling Locations

Surface Soil - Hand Auger
Soil and Groundwater - Rotosonic Boring

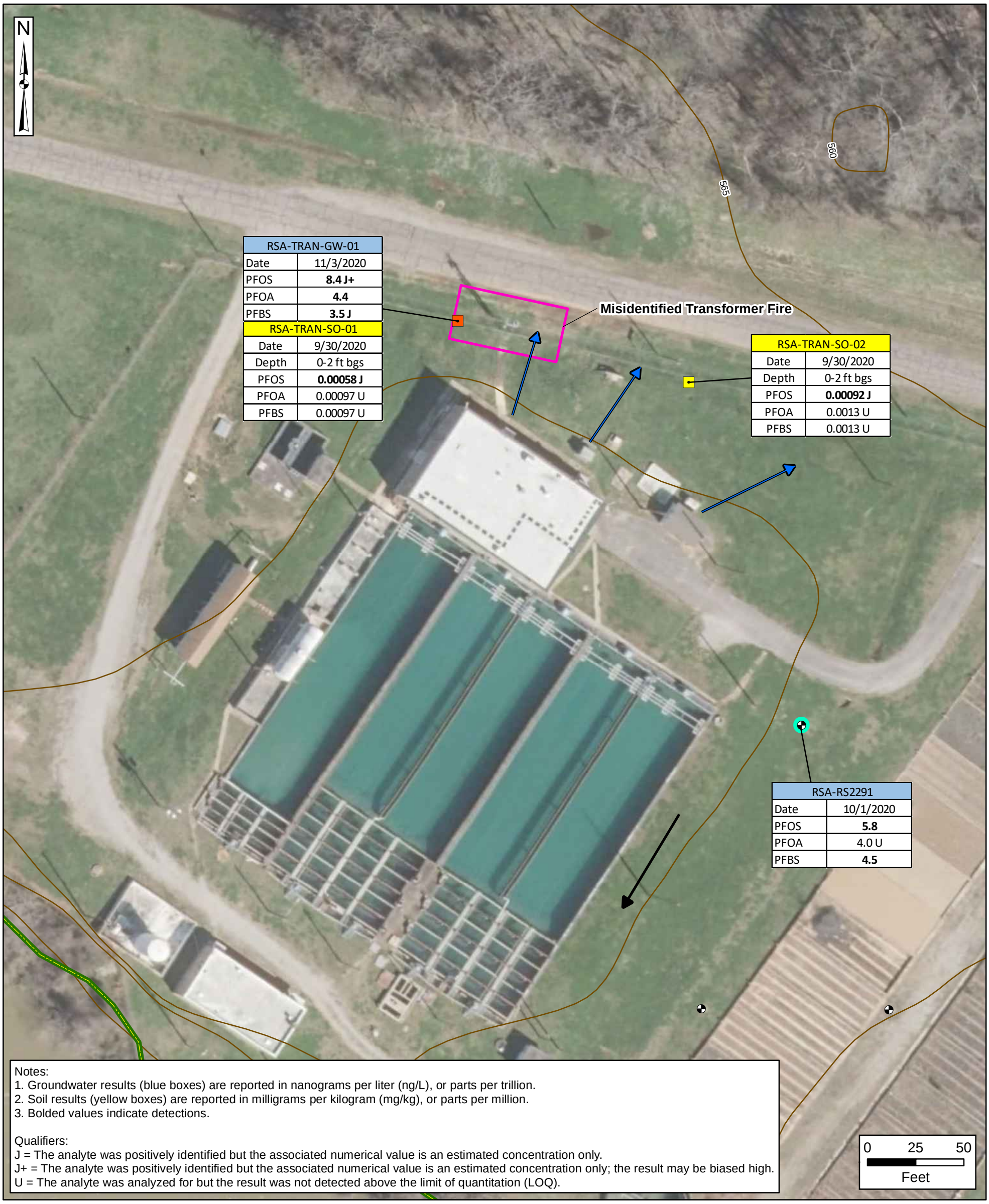
AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-6
PFOS, PFOA, and PFBS Analytical Results for Misidentified Transformer Fire



Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
J+ = The analyte was positively identified but the associated numerical value is an estimated concentration only; the result may be biased high.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

- Installation Boundary
- AOPI
- Elevation Contour (feet)
- Inferred Surface Water Runoff Direction
- Inferred Groundwater Flow Direction
- Monitoring Well

Sampling Locations

- Surface Soil - Hand Auger
- Soil and Groundwater - DPT Boring
- Groundwater - Existing Well

AOPI = area of potential interest
DPT = direct-push technology
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

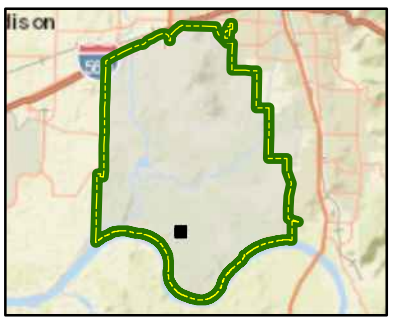
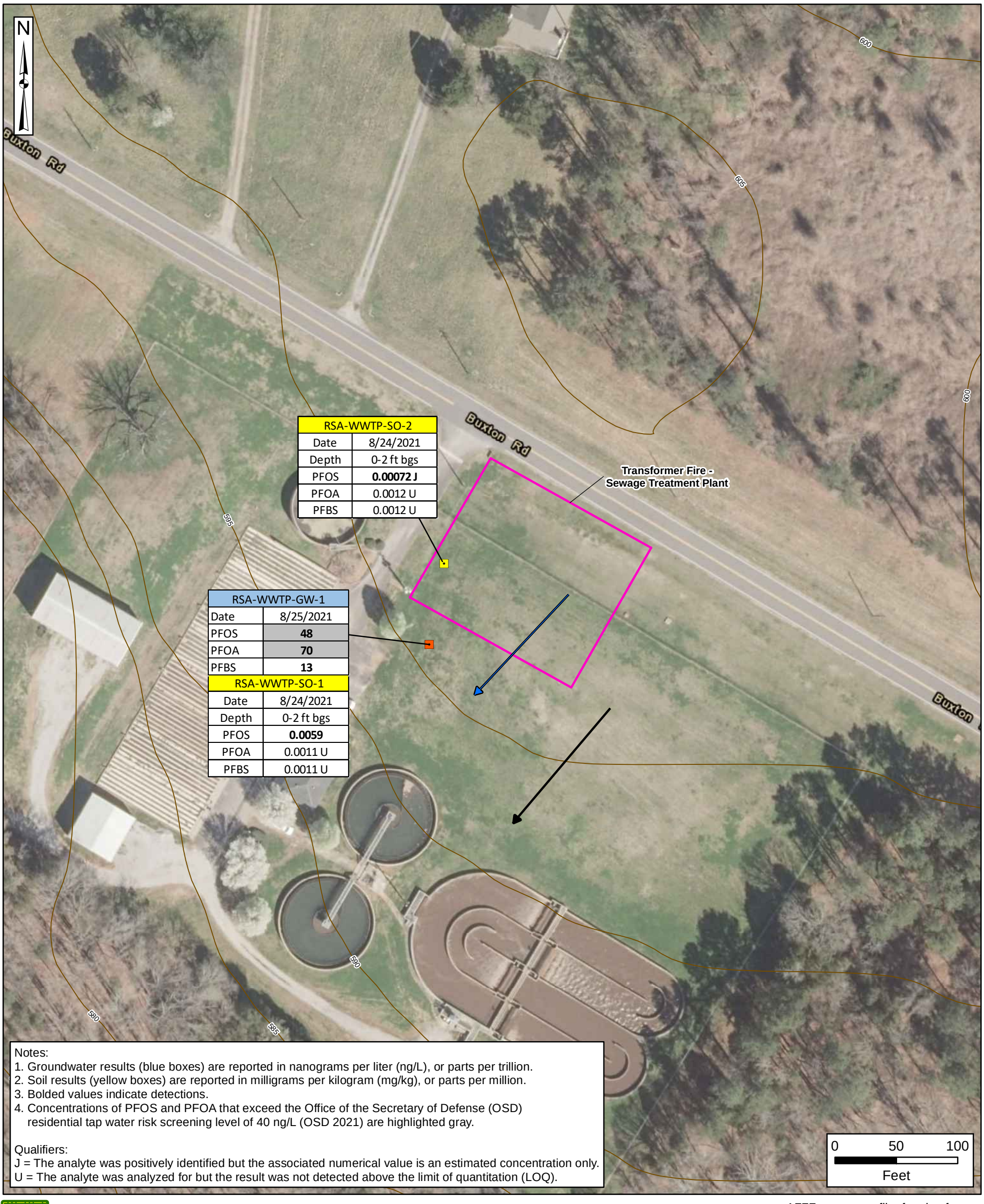


Figure 7-7
PFOS, PFOA, and PFBS Analytical Results for Transformer Fire



Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Sampling Locations

Surface Soil - Hand Auger
Soil and Groundwater - DPT

AFFF = aqueous film-forming foam
AOPI = area of potential interest
DPT = direct-push technology
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

*The box shown delineates the AFFF spray and overspray area.

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-8
PFOS, PFOA, and PFBS Analytical Results for Old Fire Station #2

N

570
575
580
Old Fire Station #2
Dodd Rd
Buxton Rd

RSA-OFS2-GW-01	
Date	11/3/2020
PFOS	**57**
PFOA	**28**
PFBS	4.4 U

RSA-OFS2-SO-01	
Date	9/30/2020
Depth	0-2 ft bgs
PFOS	**0.0015**
PFOA	0.0012 U
PFBS	0.0012 U

RSA-OFS2-SO-02	
Date	9/30/2020
Depth	0-2 ft bgs
PFOS	**0.001 J**
PFOA	**0.0007 J**
PFBS	0.0013 U

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

0 50 100
Feet

Installation Boundary
AOPI
Elevation Contour (feet)
Historical Building Footprint
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well

Sampling Locations

Surface Soil - Hand Auger
Soil and Groundwater - DPT Boring

AOPI = area of potential interest
DPT = direct-push technology
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-9
PFOS, PFOA, and PFBS Analytical Results for Firehouse Pub

N

Hawkins Dr

Lewter Rd

Firehouse Pub

RSA-PUB-SO-02	
Date	10/2/2020
Depth	0-2 ft bgs
PFOS	0.0013 U
PFOA	**0.00067 J**
PFBS	0.0013 U

RSA-PUB-SO-01	
Date	10/2/2020
Depth	0-2 ft bgs
PFOS	**0.0033**
PFOA	0.0014 U
PFBS	0.0014 U

RSA-PUB-SO-03	
Date	10/2/2020
Depth	0-2 ft bgs
PFOS	**0.0017**
PFOA	**0.0006 J**
PFBS	0.0012 U

RSA-PUB-GW-01	
Date	11/8/2020
PFOS	**13**
PFOA	**53**
PFBS	**20**

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

0 25 50
Feet

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Sampling Locations

Surface Soil - Hand Auger
Groundwater - DPT Boring

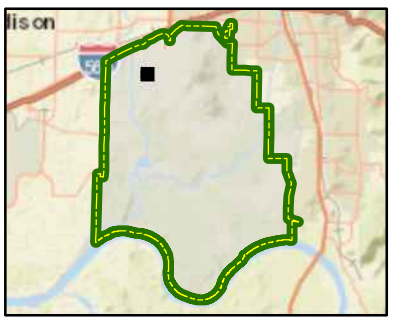
AOPI = area of potential interest
DPT = direct-push technology
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

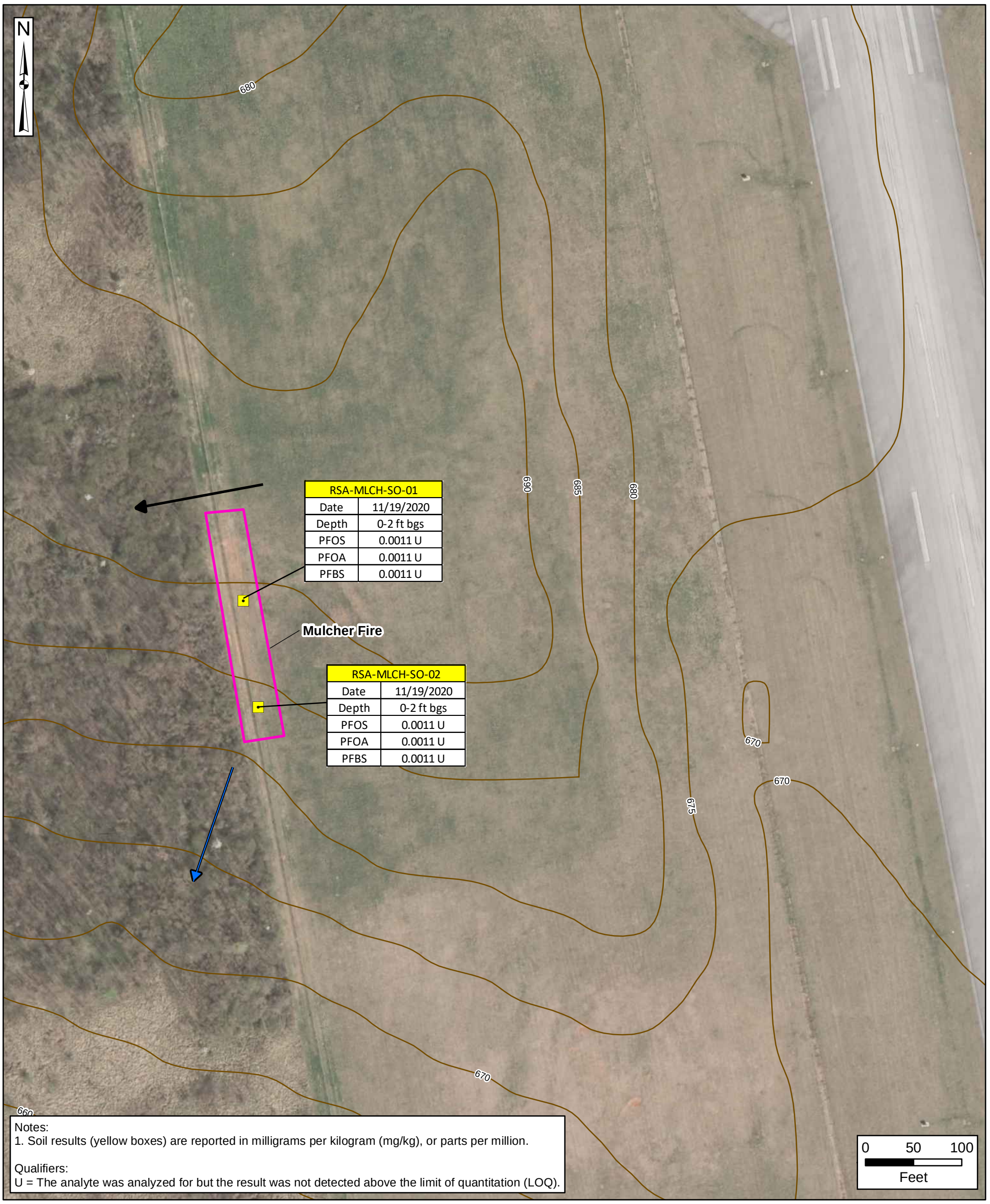
Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-10
PFOS, PFOA, and PFBS Analytical Results for Mulcher Fire





Notes:
1. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.

Qualifiers:
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Sampling Locations

Surface Soil - Hand Auger

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-11
PFOS, PFOA, and PFBS Analytical Results for Keyhole/Nozzle Testing Area

N

655
650
645
640
660

RSA-KEY-SO-02	
Date	10/1/2020
Depth	0-2 ft bgs
PFOS	0.0012 U
PFOA	0.0012 U
PFBS	0.0012 U

RSA-KEY-SO-03	
Date	10/1/2020
Depth	0-2 ft bgs
PFOS	**0.002**
PFOA	0.0011 U
PFBS	0.0011 U

Keyhole/Nozzle Testing Area

RSA-KEY-GW-01	
Date	11/9/2020
PFOS	**13**
PFOA	**3.2 J**
PFBS	**13**

RSA-KEY-SO-01	
Date	10/1/2020
Depth	0-2 ft bgs
PFOS	**0.00098 J**
PFOA	0.0015 U
PFBS	0.0015 U

RSA-KEY-SO-04	
Date	10/1/2020
Depth	0-2 ft bgs
PFOS	**0.22**
PFOA	**0.0023**
PFBS	0.0012 U

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) soil risk screening level of 0.13 mg/kg (OSD 2021) are highlighted gray.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

0 25 50
Feet

Installation Boundary
AOPI
Approximate AFFF Release Area
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Sampling Locations

Surface Soil - Hand Auger
Soil and Groundwater - Rotosonic Boring

AFFF = aqueous film-forming foam
AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-12
PFOS, PFOA, and PFBS Analytical Results for Fire Training Area

N

RSA-FTA-SO-01	
Date	10/2/2020
Depth	0-1 ft bgs
PFOS	**0.0028**
PFOA	0.00095 U
PFBS	0.00095 U

RSA-FTA-SO-02	
Date	10/2/2020
Depth	0-1 ft bgs
PFOS	**0.0091**
PFOA	0.0012 U
PFBS	0.0012 U

RSA-FTA-SO-04	
Date	10/2/2020
Depth	0-1 ft bgs
PFOS	**0.037**
PFOA	**0.00077 J**
PFBS	0.00099 U

RSA-FTA-SO-03	
Date	10/2/2020
Depth	0-1 ft bgs
PFOS	**0.25 J**
PFOA	**0.0029**
PFBS	**0.0099**

RSA-RS1576	
Date	10/1/2020
PFOS	**110000 J**
PFOA	**1900 J**
PFBS	**3100 J**

RSA-RS1577	
Date	10/1/2020
PFOS	**660 [670]**
PFOA	**37 [36]**
PFBS	**21 [22]**

Fire Training Area
Burn Pit
OWS Valve Box
Diesel AST
Training Tower
OWS
Drafting Pit
Propane AST
Small piles of sand used to practice temporary containment berm construction
630
615
610
605
600
595
590
0 50 100
Feet

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Results in brackets are field duplicate sample results.
4. Bolded values indicate detections.
5. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
6. Concentrations of PFOS and PFOA that exceed the OSD residential soil risk screening level of 0.13 mg/kg (OSD 2021) are highlighted gray.
7. Concentrations of PFBS that exceed the OSD residential tap water risk screening level of 600 ng/L (updated in April 2021 based on the United States Environmental Protection Agency's updated PFBS toxicity assessment) are highlighted gray.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

- Installation Boundary
- AOPI
- Approximate AFFF Release Area
- Elevation Contour (feet)
- River/Stream
- Inferred Surface Water Runoff Direction
- Inferred Groundwater Flow Direction
- OWS Discharge Line
- Monitoring Well

Sampling Locations

- Surface Soil - Hand Auger
- Groundwater - Existing Well

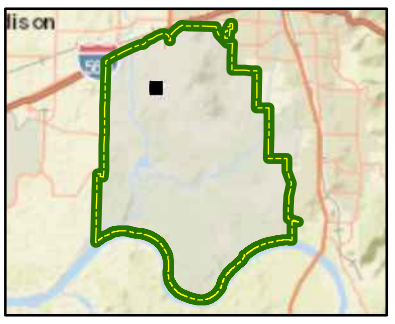
AFFF = aqueous film-forming foam
AOPI = area of potential interest
AST = above ground storage tank
ft bgs = feet below ground surface
OWS = oil water separator
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-13
PFOS, PFOA, and PFBS Analytical Results for Fire Station #4 (Building 4810), Fire Station #5 (Building 4813), and Hangar 4815



RSA-FS4-SO-02	
Date	10/1/2020
Depth	0-2 ft bgs
PFOS	**0.0039 [0.0032]**
PFOA	**0.00084 J [0.00096 J]**
PFBS	0.0011 U [0.0011 U]

RSA-RS1278	
Date	10/1/2020
PFOS	**2.9 J**
PFOA	3.5 U
PFBS	**1.8 J**

RSA-FS4-GW-01	
Date	11/11/2020
PFOS	**46**
PFOA	**5.6**
PFBS	**5.6**

RSA-FS4-SO-01	
Date	10/1/2020
Depth	0-2 ft bgs
PFOS	**0.0034**
PFOA	**0.00053 J**
PFBS	0.0010 U

RSA-FS5-SO-01	
Date	10/1/2020
Depth	0-2 ft bgs
PFOS	**0.068**
PFOA	0.0011 U
PFBS	0.0011 U

RSA-FS5-SO-02	
Date	10/1/2020
Depth	0-2 ft bgs
PFOS	**0.019**
PFOA	0.0013 U
PFBS	0.0013 U

RSA-4815-GW-02	
Date	11/20/2020
PFOS	Present
PFOA	**8.7**
PFBS	**4.1 J+**

RSA-4815-SO-02	
Date	10/1/2020
Depth	0-2 ft bgs
PFOS	0.00088 U
PFOA	0.00088 U
PFBS	0.00088 UJ

RSA-4815-SO-03	
Date	10/1/2020
Depth	0-2 ft bgs
PFOS	0.0014 U
PFOA	0.0014 U
PFBS	0.0014 U

RSA-4815-SO-01	
Date	10/1/2020
Depth	0-2 ft bgs
PFOS	**0.0012 J**
PFOA	0.0014 U
PFBS	0.0014 U

RSA-MW08	
Date	11/11/2020
PFOS	**39**
PFOA	**12**
PFBS	**8.6**

RSA-RS1604	
Date	11/20/2020
PFOS	4.2 U
PFOA	**2.6 J**
PFBS	4.2 U

Fire Station #4
Fire Station #5
Hangar 4815
Septic Line
Septic Tank
Drain Field
Septic Line
625
630
635
650

0 50 100
Feet

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Results in brackets are field duplicate sample results.
4. Bolded values indicate detections.
5. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
J+ = The analyte was positively identified but the associated numerical value is an estimated concentration only; the result may be biased high.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).
Present = The analyte is considered present; however, the reported value has unknown bias and is unreliable. The result cannot be compared to screening criteria.

- Installation Boundary
- AOPI
- Elevation Contour (feet)
- Inferred Surface Water Runoff Direction
- Inferred Groundwater Flow Direction
- Sanitary Line
- Monitoring Well

Sampling Locations

- Surface Soil - Hand Auger
- Soil and Groundwater - Rotosonic Boring
- Groundwater - Existing Well
- Attempted Boring – Abandoned

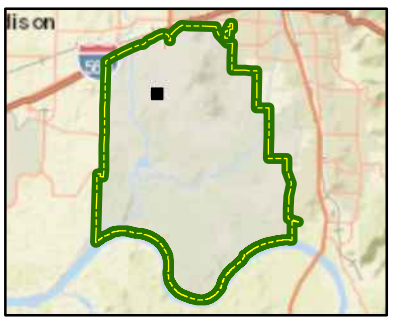
AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

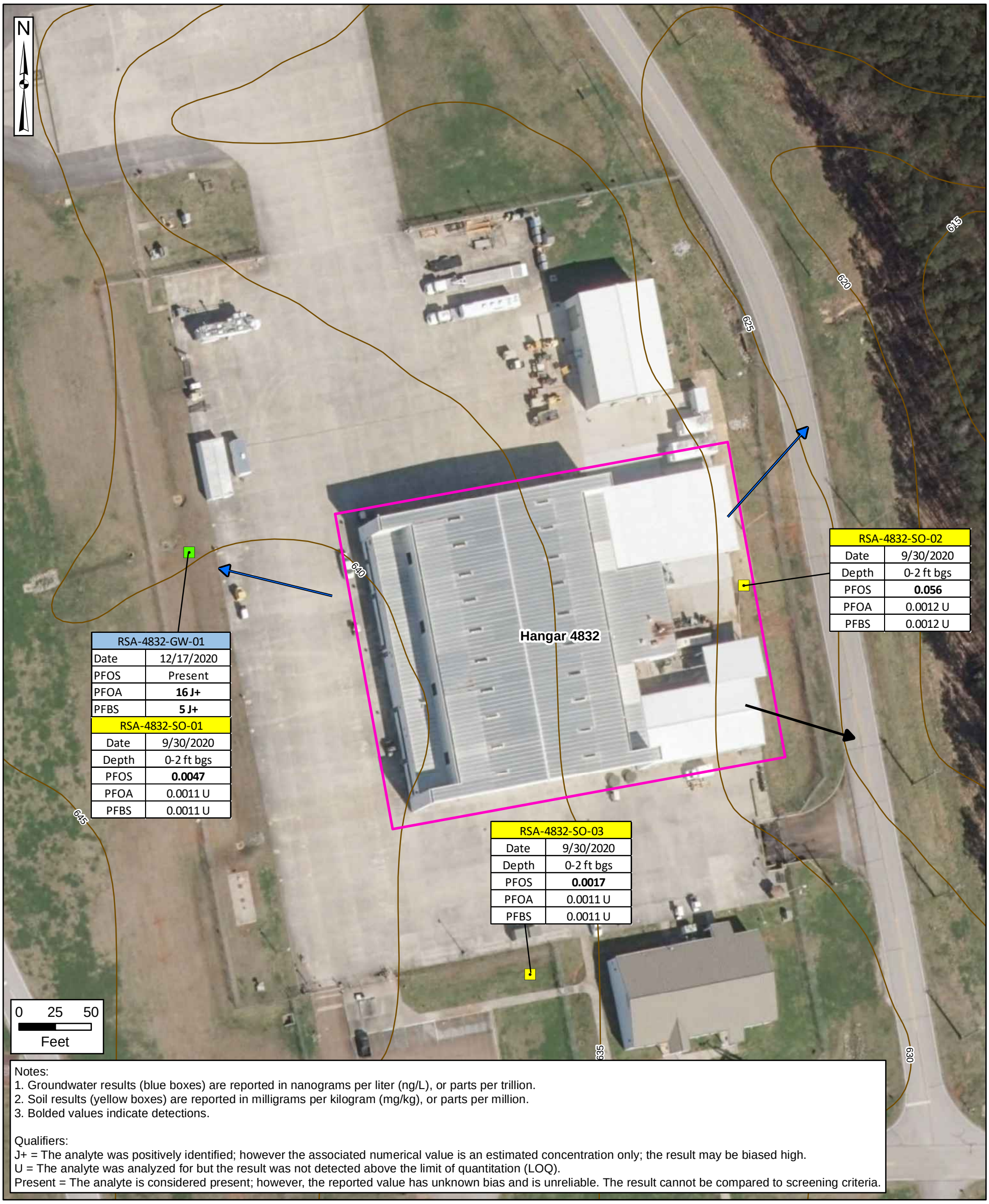
Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-14
PFOS, PFOA, and PFBS Analytical Results for Hangar 4832





Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.

Qualifiers:
J+ = The analyte was positively identified; however the associated numerical value is an estimated concentration only; the result may be biased high.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).
Present = The analyte is considered present; however, the reported value has unknown bias and is unreliable. The result cannot be compared to screening criteria.

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Sampling Locations

Surface Soil - Hand Auger
Soil and Groundwater - Rotosonic Boring

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-15
PFOS, PFOA, and PFBS Analytical Results for Hangar 4880

Notes:
1. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
2. Bolded values indicate detections.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

N

RSA-4880-SO-03	
Date	9/30/2020
Depth	0-2 ft bgs
PFOS	0.0014 U
PFOA	0.0014 U
PFBS	0.0014 U

RSA-4880-SO-02	
Date	9/30/2020
Depth	0-2 ft bgs
PFOS	0.0012 U
PFOA	0.0012 U
PFBS	0.0012 U

RSA-4880-SO-04	
Date	9/30/2020
Depth	0-2 ft bgs
PFOS	0.0011 U
PFOA	0.0011 U
PFBS	0.0011 U

Hangar 4880

RSA-4880-SO-05	
Date	11/19/2020
Depth	0-1 ft bgs
PFOS	**0.0012**
PFOA	0.0011 U
PFBS	0.0011 U

RSA-4880-SO-01	
Date	11/19/2020
Depth	0-1 ft bgs
PFOS	**0.00082 J**
PFOA	0.0011 U
PFBS	**0.0012**

0 50 100
Feet

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Sampling Locations
Surface Soil - Hand Auger

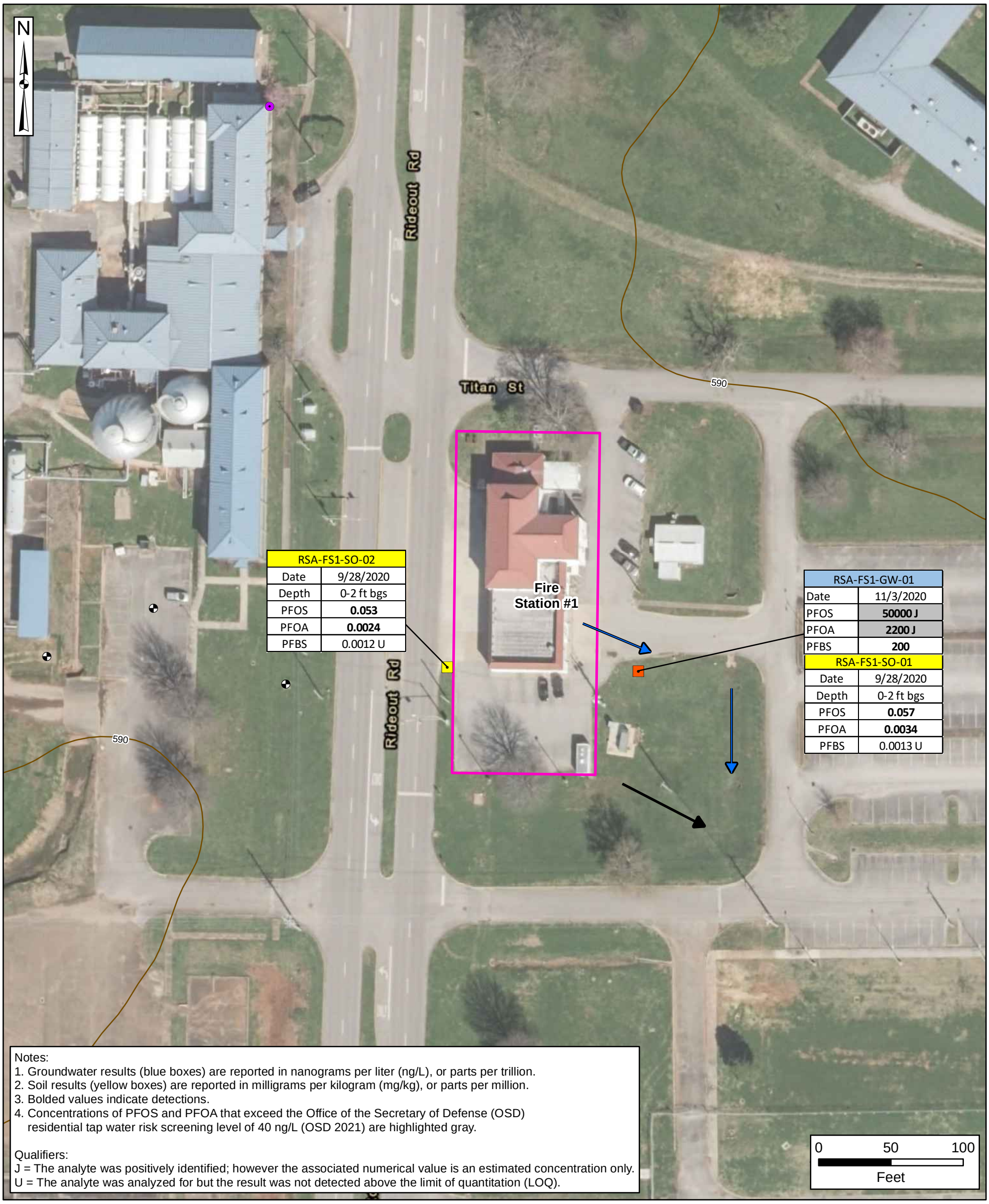
AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-16
PFOS, PFOA, and PFBS Analytical Results for Fire Station #1



Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.

Qualifiers:
J = The analyte was positively identified; however the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

- Installation Boundary
- AOPI
- Elevation Contour (feet)
- Inferred Surface Water Runoff Direction
- Inferred Groundwater Flow Direction
- Monitoring Well
- SB

Sampling Locations

- Surface Soil - Hand Auger
- Soil and Groundwater - DPT Boring

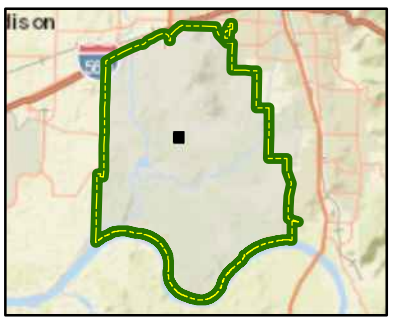
AOPI = area of potential interest
DPT = direct-push technology
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

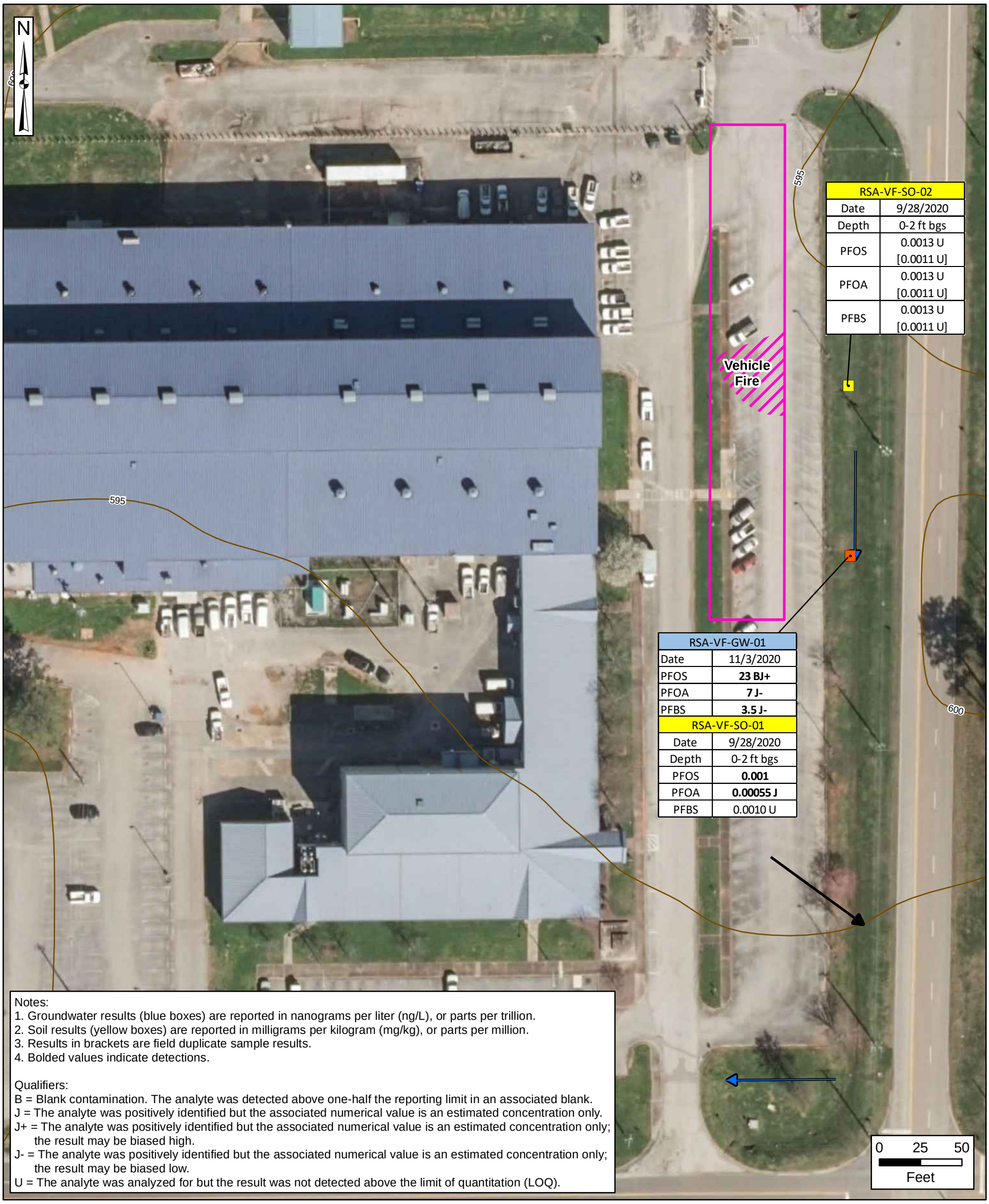
Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-17
PFOS, PFOA, and PFBS Analytical Results for Vehicle Fire





Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Results in brackets are field duplicate sample results.
4. Bolded values indicate detections.

Qualifiers:
B = Blank contamination. The analyte was detected above one-half the reporting limit in an associated blank.
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
J+ = The analyte was positively identified but the associated numerical value is an estimated concentration only; the result may be biased high.
J- = The analyte was positively identified but the associated numerical value is an estimated concentration only; the result may be biased low.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

Installation Boundary
AOPI
Approximate AFFF Release Area
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Sampling Locations

Surface Soil - Hand Auger
Soil and Groundwater - DPT Boring

AFFF = aqueous film-forming foam
AOPI = area of potential interest
DPT = direct-push technology
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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Redstone Arsenal, AL

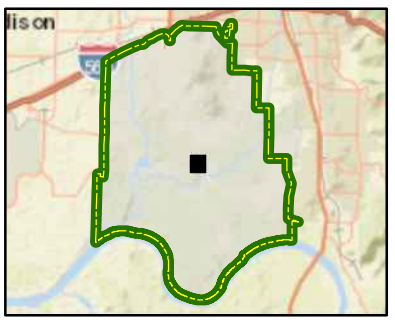


Figure 7-18
PFOS, PFOA, and PFBS Analytical Results for Landfill Fire

RSA-LFF-SO-01	
Date	9/29/2020
Depth	0-2 ft bgs
PFOS	**0.00089 J**
PFOA	0.0012 U
PFBS	0.0012 U

Landfill Fire

RSA-RS091	
Date	9/29/2020
PFOS	**3.3 J**
PFOA	**2 J**
PFBS	**2.3 J**

RSA-RS093	
Date	9/29/2020
PFOS	**12**
PFOA	**38**
PFBS	**5.3**

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

0 50 100
Feet

Installation Boundary
AOPI
Elevation Contour (feet)
River/Stream
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well
Extraction Well

Sampling Locations

Surface Soil - Hand Auger
Groundwater - Existing Well

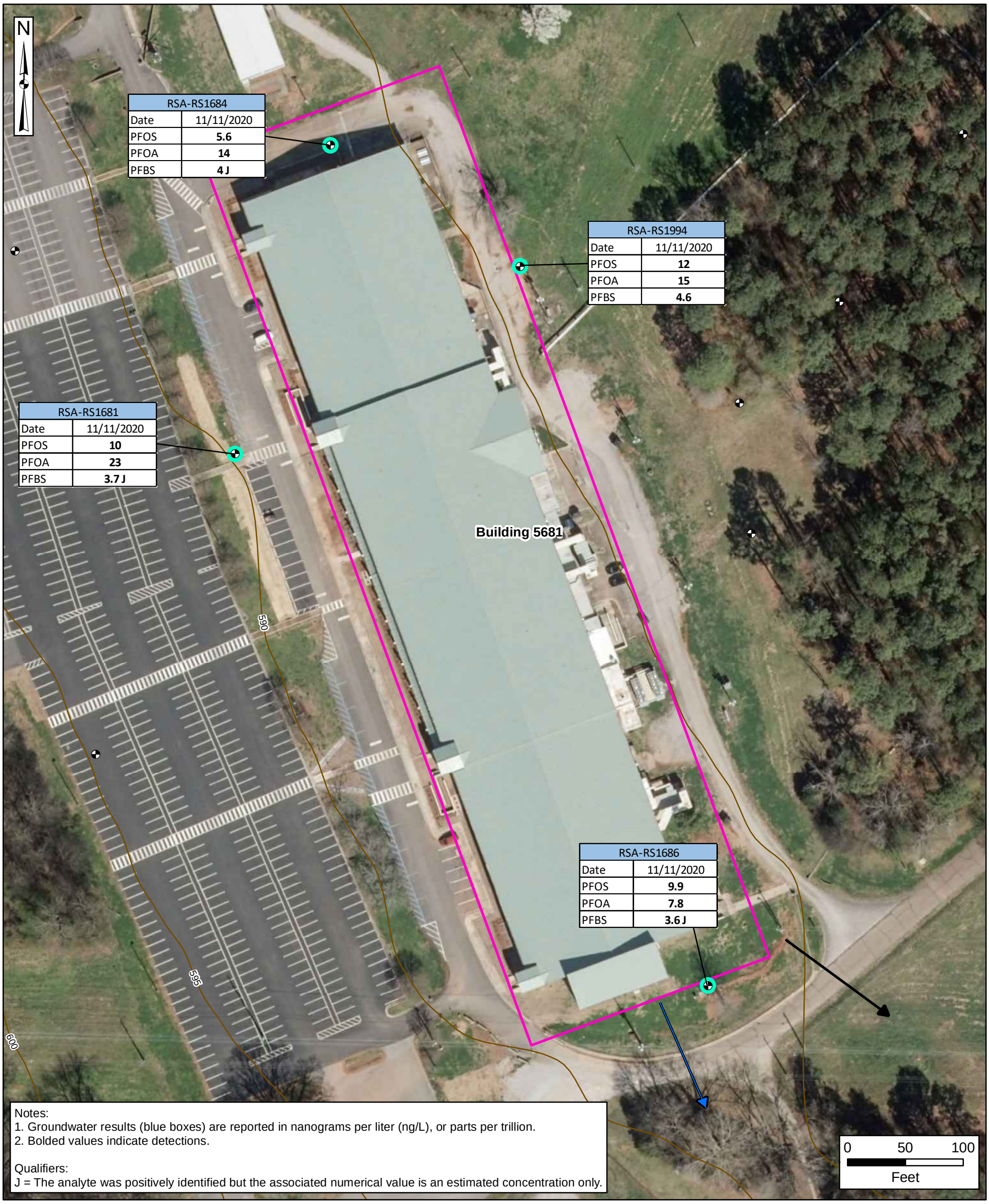
AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-19
PFOS, PFOA, and PFBS Analytical Results for Building 5681



Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Bolded values indicate detections.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well

Sampling Locations

Groundwater - Existing Well

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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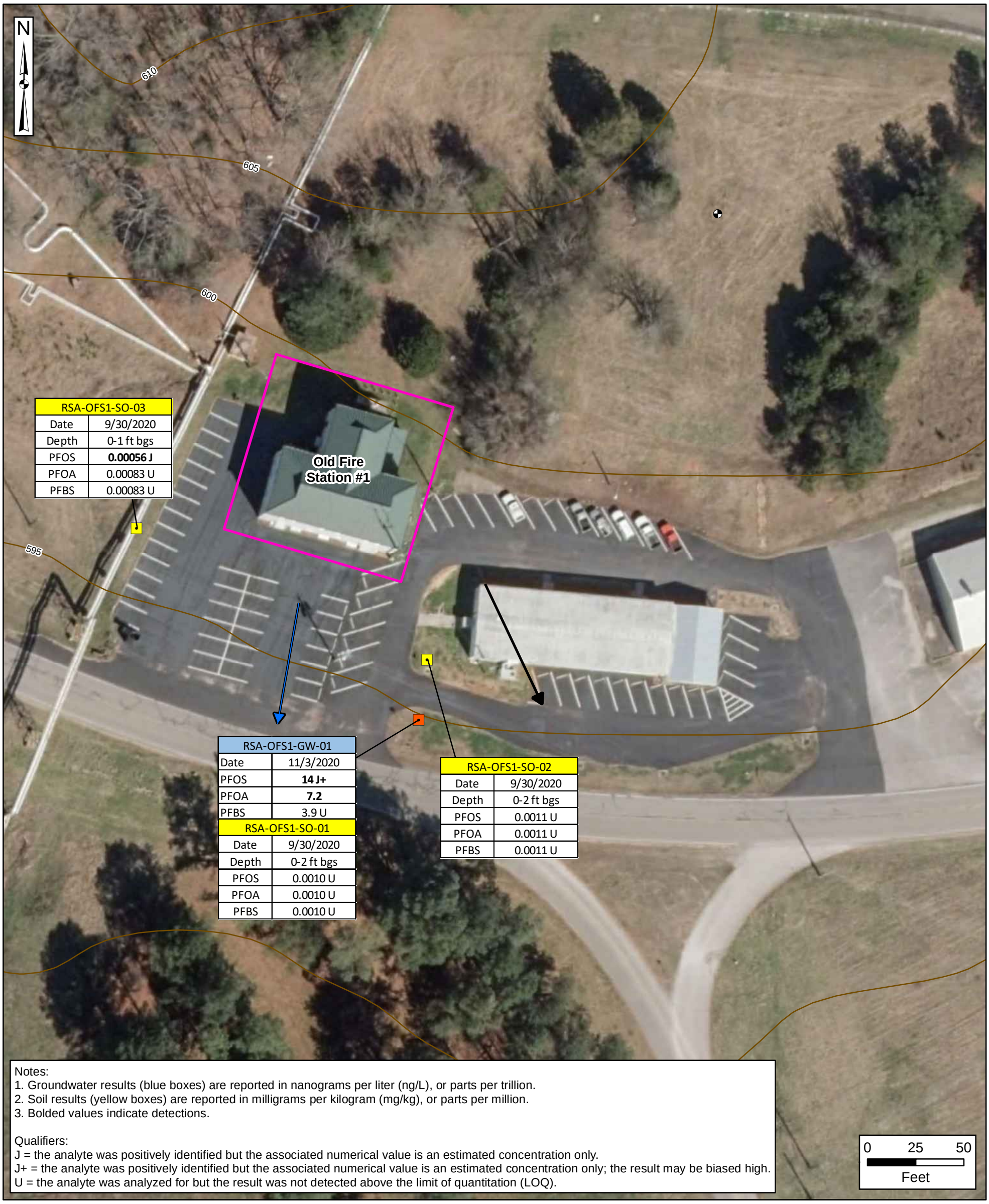
Redstone Arsenal, AL

Figure 7-20
PFOS, PFOA, and PFBS Analytical Results for Old Fire Station #1



Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.

Qualifiers:
J = the analyte was positively identified but the associated numerical value is an estimated concentration only.
J+ = the analyte was positively identified but the associated numerical value is an estimated concentration only; the result may be biased high.
U = the analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction
Monitoring Well

Sampling Locations

Surface Soil - Hand Auger
Soil and Groundwater - DPT Boring

AOPI = area of potential interest
DPT = direct-push technology
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-21
PFOS, PFOA, and PFBS Analytical Results for Fuel Tank Fire

N

595
590
580
585

RSA-FUEL-SO-01	
Date	9/29/2020
Depth	0-2 ft bgs
PFOS	**0.035**
PFOA	0.0013 U
PFBS	0.0013 U

RSA-FUEL-SO-04	
Date	9/29/2020
Depth	0-2 ft bgs
PFOS	**0.0013 J**
PFOA	0.0014 U
PFBS	0.0014 U

RSA-FUEL-SO-03	
Date	9/29/2020
Depth	0-2 ft bgs
PFOS	**0.0022**
PFOA	0.0013 UJ
PFBS	0.0013 UJ

Fuel Tank Fire

RSA-FUEL-SO-02	
Date	9/29/2020
Depth	0-2 ft bgs
PFOS	**0.099**
PFOA	0.00099 U
PFBS	0.00099 U

RSA-RS2481	
Date	9/29/2020
PFOS	**3000 J**
PFOA	**160**
PFBS	**230**

RSA-RS2195	
Date	9/29/2020
PFOS	**18000 J**
PFOA	**910**
PFBS	**2500 J**

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
5. Concentrations of PFBS that exceed the OSD residential tap water risk screening level of 600 ng/L (updated in April 2021 based on the United States Environmental Protection Agency's updated PFBS toxicity assessment) are highlighted gray.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

0 25 50
Feet

Installation Boundary
AOPI
Approximate AFFF Release Area
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Monitoring Well

Sampling Locations

Surface Soil - Hand Auger
Groundwater - Existing Well

AFFF = aqueous film-forming foam
AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-22
PFOS, PFOA, and PFBS Analytical Results for FBI AFFF Storage Area - Building 7017

RSA-FBI-7017-SO-1	
Date	8/2/2021
Depth	0-2 ft bgs
PFOS	0.0013 U
PFOA	0.0013 U
PFBS	0.0013 U

RSA-FBI-7017-GW-1	
Date	8/25/2021
PFOS	**12 J+**
PFOA	**18**
PFBS	**6.6**

RSA-FBI-7017-SO-2	
Date	8/2/2021
Depth	0-2 ft bgs
PFOS	**0.00072 J**
PFOA	0.0012 U
PFBS	0.0012 U

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
J+ = The analyte was positively identified; however the associated numerical value is an estimated concentration only; the result may be biased high.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Sampling Locations

Surface Soil - Hand Auger
Soil and Groundwater - DPT

AFFF = aqueous film-forming foam
AOPI = area of potential interest
Bldg = building
DPT = direct-push technology
ft bgs = feet below ground surface

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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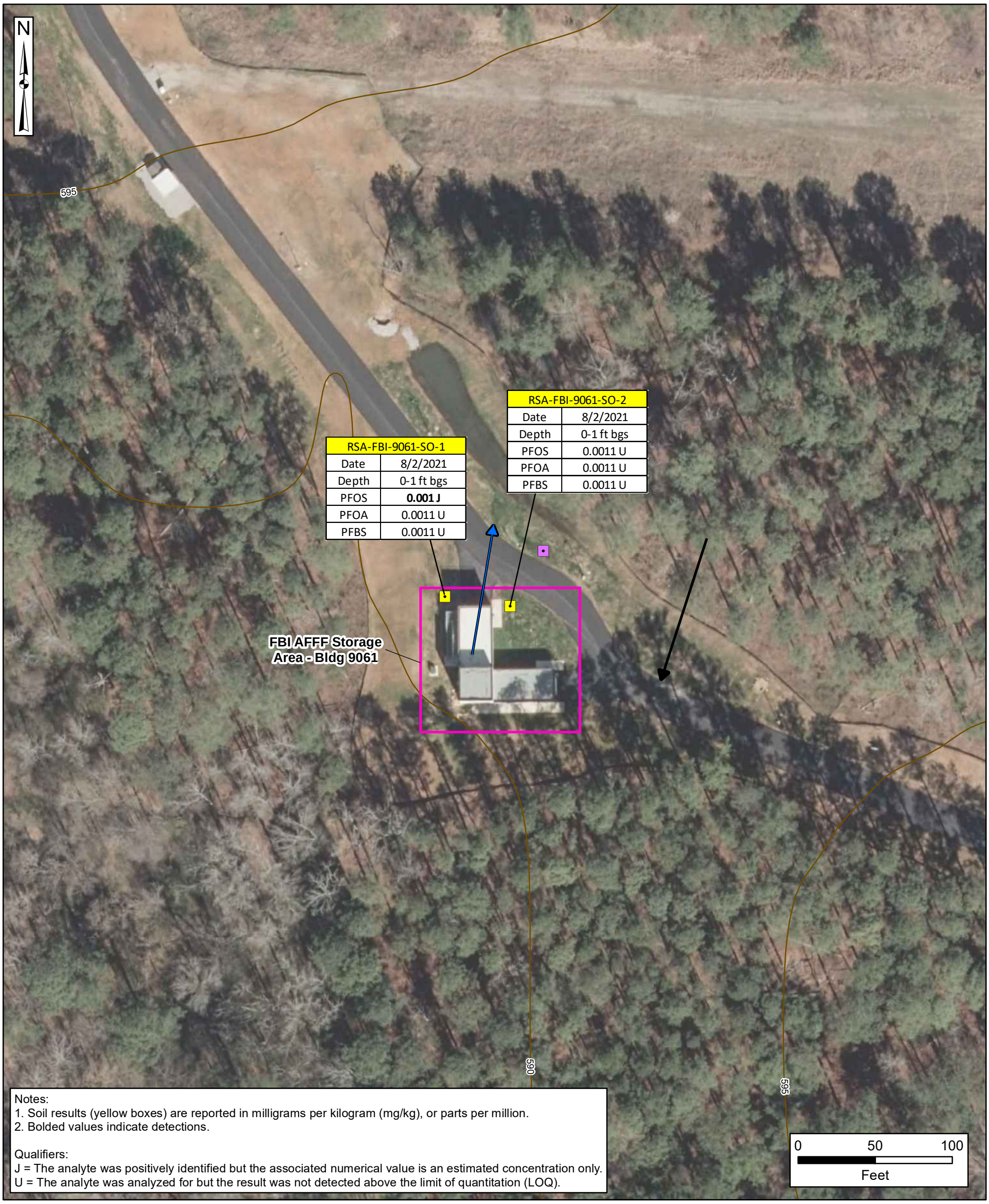
Redstone Arsenal, AL

Figure 7-23
PFOS, PFOA, and PFBS Analytical Results for FBI AFFF Storage Area - Bldg 9061



Notes:
1. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
2. Bolded values indicate detections.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

Installation Boundary
AOPI
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Sampling Locations

Surface Soil - Hand Auger
Attempted Boring – Abandoned

AFFF = aqueous film-forming foam
AOPI = area of potential interest
Bldg = building
ft bgs = feet below ground surface

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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Redstone Arsenal, AL

Figure 7-24
PFOS, PFOA, and PFBS Analytical Results for Aircraft Crash Site

RSA-ACS-SO-03	
Date	8/4/2021
Depth	0-2 ft bgs
PFOS	**0.0011**
PFOA	0.0011 U
PFBS	0.0011 U

RSA-ACS-SO-04	
Date	8/4/2021
Depth	0-2 ft bgs
PFOS	**0.00091 J**
PFOA	0.00098 U
PFBS	0.00098 U

RSA-ACS-SO-05	
Date	8/4/2021
Depth	0-2 ft bgs
PFOS	**0.0016**
PFOA	**0.0006 J**
PFBS	0.0011 U

RSA-ACS-SO-02	
Date	8/4/2021
Depth	0-2 ft bgs
PFOS	**0.0024 J-**
PFOA	0.0010 U
PFBS	0.0010 U

Aircraft Crash Site

RSA-ACS-SO-06	
Date	8/4/2021
Depth	0-2 ft bgs
PFOS	**0.0013**
PFOA	0.0011 U
PFBS	0.0011 U

RSA-ACS-SO-01	
Date	8/4/2021
Depth	0-2 ft bgs
PFOS	**0.00079 J**
PFOA	0.00099 U
PFBS	0.00099 U

Notes:
1. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
2. Bolded values indicate detections.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
J- = The analyte was positively identified; however the associated numerical value is an estimated concentration only; the result may be biased low.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

0 50 100
Feet

Installation Boundary
AOPI
Approximate AFFF Release Area
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Sampling Locations
Surface Soil - Hand Auger

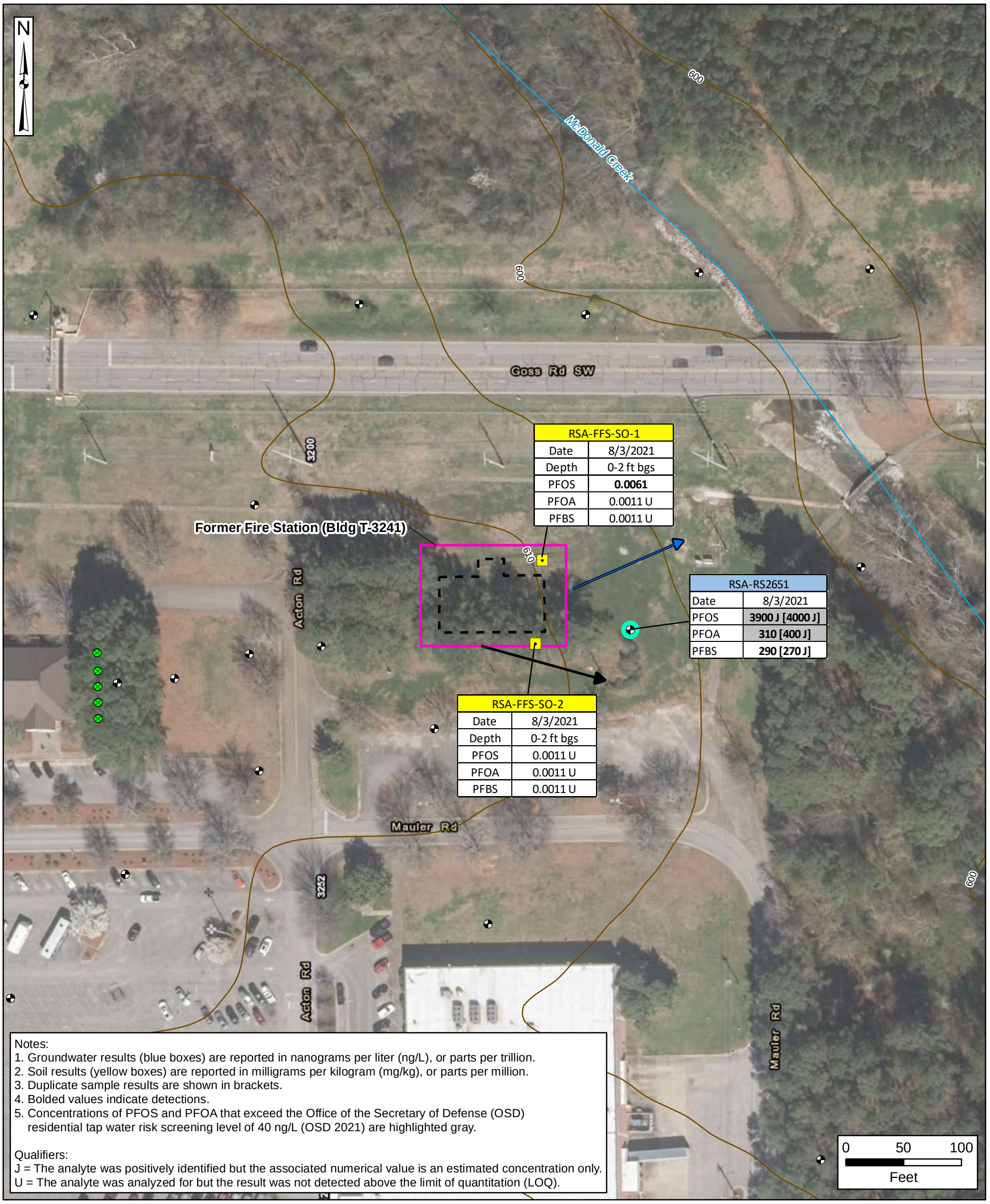
AFFF = aqueous film-forming foam
AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-25
PFOS, PFOA, and PFBS Analytical Results for Former Fire Station (Building T-3241)



Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Duplicate sample results are shown in brackets.
4. Bolded values indicate detections.
5. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

- Installation Boundary
- AOPI
- Former Building Footprint
- River/Stream
- Inferred Surface Water Runoff Direction
- Inferred Groundwater Flow Direction
- Elevation Contour (feet)
- Monitoring Well
- Extraction Well

Sampling Locations

- Surface Soil - Hand Auger
- Groundwater - Existing Well

AOPI = area of potential interest
Bldg = building
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-26
PFOS, PFOA, and PFBS Analytical Results for Inactive Sewage Treatment Plant #1

N

570

Inactive Sewage Treatment Plant #1 (RSA-011)

580

575

570

570

575

Sludge Drying Bed

Sludge Drying Bed

RSA-STP1-SO-1	
Date	8/3/2021
Depth	0-2 ft bgs
PFOS	0.0010 U
PFOA	0.0010 U
PFBS	0.0010 U

RSA-STP1-SO-2	
Date	8/3/2021
Depth	0-2 ft bgs
PFOS	0.0059 U [0.0012 U]
PFOA	0.0059 U [0.0012 U]
PFBS	0.0059 U [0.0012 U]

RSA-RS867	
Date	8/3/2021
PFOS	**180**
PFOA	**34**
PFBS	**4.9**

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Duplicate sample results are shown in brackets.
4. Bolded values indicate detections.
5. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.

Qualifiers:
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

0 50 100
Feet

Installation Boundary
AOPI
Sludge Drying Bed
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Monitoring Well

Sampling Locations

Surface Soil - Hand Auger
Groundwater - Existing Well

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, AL

Figure 7-27
PFOS, PFOA, and PFBS Analytical Results for Inactive Sewage Treatment Plant #3

RSA-STP3-SO-1	
Date	8/23/2021
Depth	0-1 ft bgs
PFOS	**0.0053**
PFOA	0.0011 U
PFBS	0.0011 U

RSA-RS1427	
Date	8/23/2021
PFOS	**950 J**
PFOA	**130**
PFBS	**5.6**

RSA-STP3-SO-2	
Date	8/3/2021
Depth	0-2 ft bgs
PFOS	**0.0059**
PFOA	0.0012 U
PFBS	0.0012 U

RSA-RS900	
Date	8/23/2021
PFOS	**80**
PFOA	**13**
PFBS	**4.6**

Sludge Drying Bed

Inactive Sewage Treatment Plant #3 (RSA-009)

Centaur St

565 570 575 580

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

0 50 100
Feet

Installation Boundary
AOPI
Sludge Drying Bed
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Monitoring Well

Sampling Locations

Surface Soil - Hand Auger
Groundwater - Existing Well

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North

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Redstone Arsenal, AL

Figure 7-28
PFOS, PFOA, and PFBS Analytical Results for Inactive Sewage Treatment Plant #4

RSA-RS1280	
Date	8/3/2021
PFOS	**9.9**
PFOA	**6.6**
PFBS	3.9 U

RSA-STP4-SO-1	
Date	8/3/2021
Depth	0-2 ft bgs
PFOS	**0.0053**
PFOA	**0.00055 J**
PFBS	0.0011 U

RSA-RS2589	
Date	8/3/2021
PFOS	**2.1 J**
PFOA	3.8 U
PFBS	3.8 U

RSA-STP4-SO-2	
Date	8/3/2021
Depth	0-2 ft bgs
PFOS	**0.043**
PFOA	**0.001 J**
PFBS	0.0012 U

Sludge Drying Bed

Inactive Sewage Treatment Plant #4 (RSA-008)

Notes:
1. Groundwater results (blue boxes) are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results (yellow boxes) are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.

Qualifiers:
J = The analyte was positively identified but the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).

0 50 100
Feet

Installation Boundary
AOPI
Sludge Drying Bed
Elevation Contour (feet)
Inferred Surface Water Runoff Direction
Inferred Groundwater Flow Direction

Monitoring Well

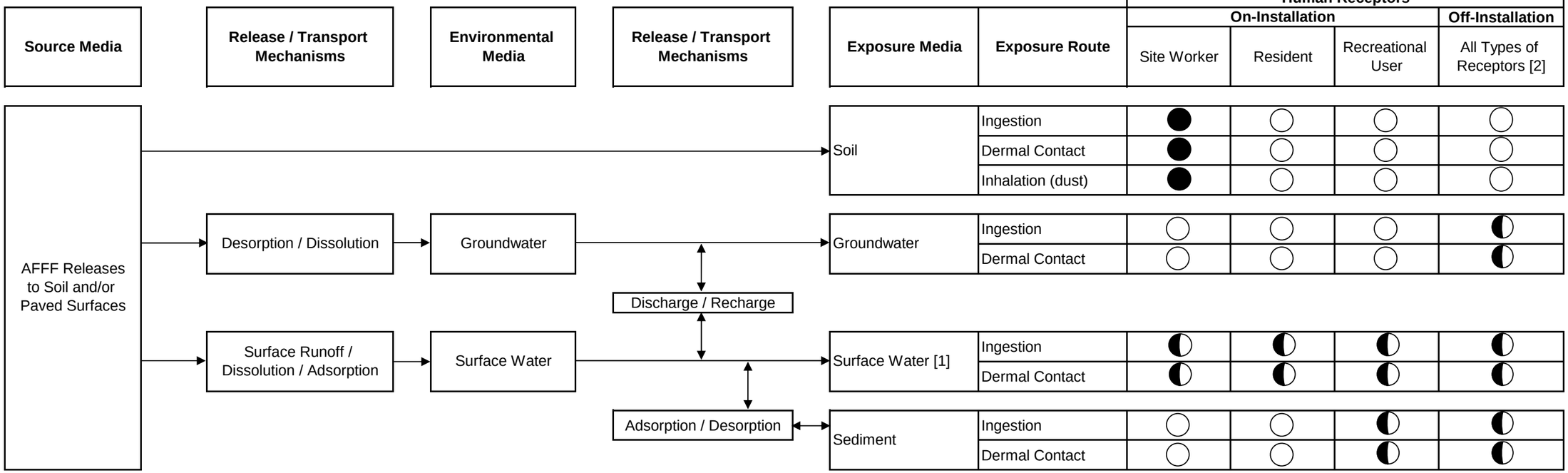
Sampling Locations

Surface Soil - Hand Auger
Groundwater - Existing Well

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
Redstone Arsenal, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 16 North



Legend:

● = Complete Exposure Pathway

◐ = Potentially Complete Exposure Pathway

○ = Incomplete Exposure Pathway

Notes:

[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.

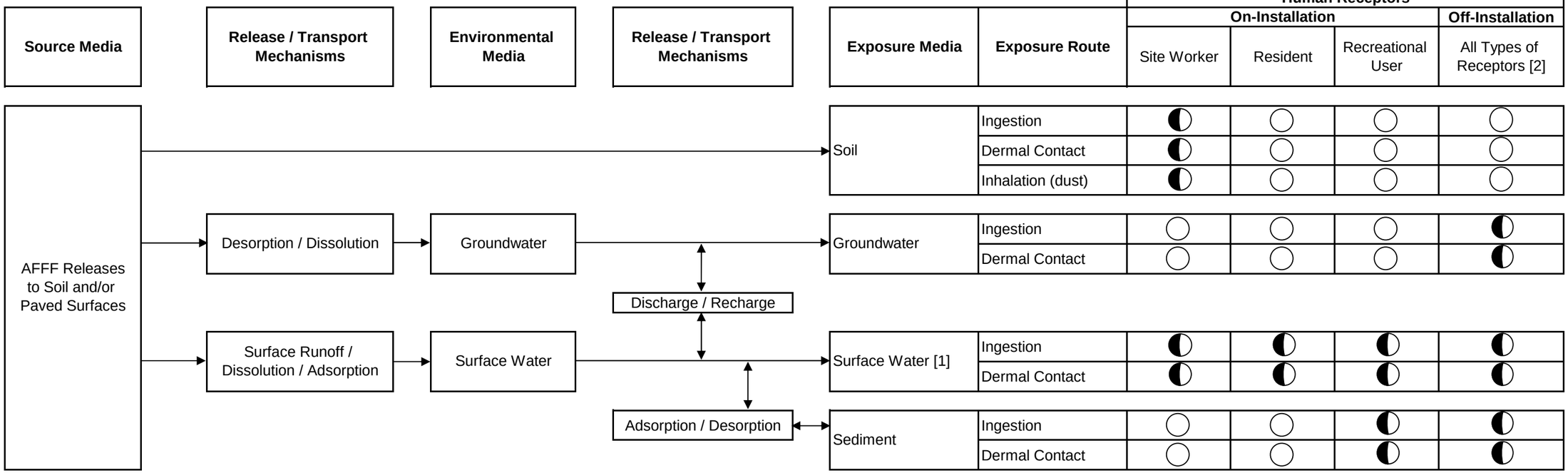
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

[3] The 23 AOPIs addressed by this figure include: Fire Station #2, Hangar 6312, Building 7370, Fire Station #3, Transformer Fire, Firehouse Pub, Keyhole/Nozzle Testing Area, Fire Training Area, Fire Station #4, Fire Station #5, Hangar 4815, Hangar 4832, Hangar 4880, Fire Station #1, Vehicle Fire, Landfill Fire, Old Fire Station #1, Fuel Tank Fire, FBI Storage - Building 7017, FBI Storage - Building 9061, Aircraft Crash Site, Former Fire Station (Building T-3241), and Inactive STP #4.

ARCADIS

Conceptual Site Model for 23 RSA AOPIs
USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, Alabama

Figure 7-29



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

ARCADIS

Conceptual Site Model for Building 5681
USAEC PFAS Preliminary Assessment / Site Inspection
Redstone Arsenal, Alabama

Figure 7-30

Source Medium	Release / Transport Mechanisms	Environmental Media	Release / Transport Mechanisms	Exposure Media	Exposure Route	Human Receptors: On-Installation: Site Worker	On-Installation: Resident	On-Installation: Recreational User	Off-Installation: All Types of Receptors [2]
AFFF Releases to Soil and/or Paved Surfaces				Soil	Ingestion	◯	◯	◯	◯
					Dermal Contact	◯	◯	◯	◯
					Inhalation (dust)	◯	◯	◯	◯
	Desorption / Dissolution	Groundwater		Groundwater	Ingestion	◯	◯	◯	◯
					Dermal Contact	◯	◯	◯	◯
			Discharge / Recharge						
	Surface Runoff / Dissolution / Adsorption	Surface Water		Surface Water [1]	Ingestion	◯	◯	◯	◯
					Dermal Contact	◯	◯	◯	◯
			Adsorption / Desorption	Sediment	Ingestion	◯	◯	◯	◯
					Dermal Contact	◯	◯	◯	◯

Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ◯ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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Conceptual Site Model - Mulcher Fire
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Figure 7-31

Source Media	Release / Transport Mechanisms	Environmental Media	Release / Transport Mechanisms	Exposure Media	Exposure Route	Human Receptors: On-Installation: Site Worker	On-Installation: Resident	On-Installation: Recreational User	Off-Installation: All Types of Receptors [2]
AFFF Releases to Soil and/or Paved Surfaces				Soil	Ingestion	●	○	●	○
					Dermal Contact	●	○	●	○
					Inhalation (dust)	●	○	●	○
	Desorption / Dissolution	Groundwater		Groundwater	Ingestion	○	○	○	◐
					Dermal Contact	○	○	○	◐
			Discharge / Recharge						
	Surface Runoff / Dissolution / Adsorption	Surface Water		Surface Water [1]	Ingestion	◐	◐	◐	◐
					Dermal Contact	◐	◐	◐	◐
			Adsorption / Desorption	Sediment	Ingestion	○	○	◐	◐
					Dermal Contact	○	○	◐	◐

Legend:

● = Complete Exposure Pathway

◐ = Potentially Complete Exposure Pathway

○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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Conceptual Site Model - Original Fire Station #2 and Inactive STP #3
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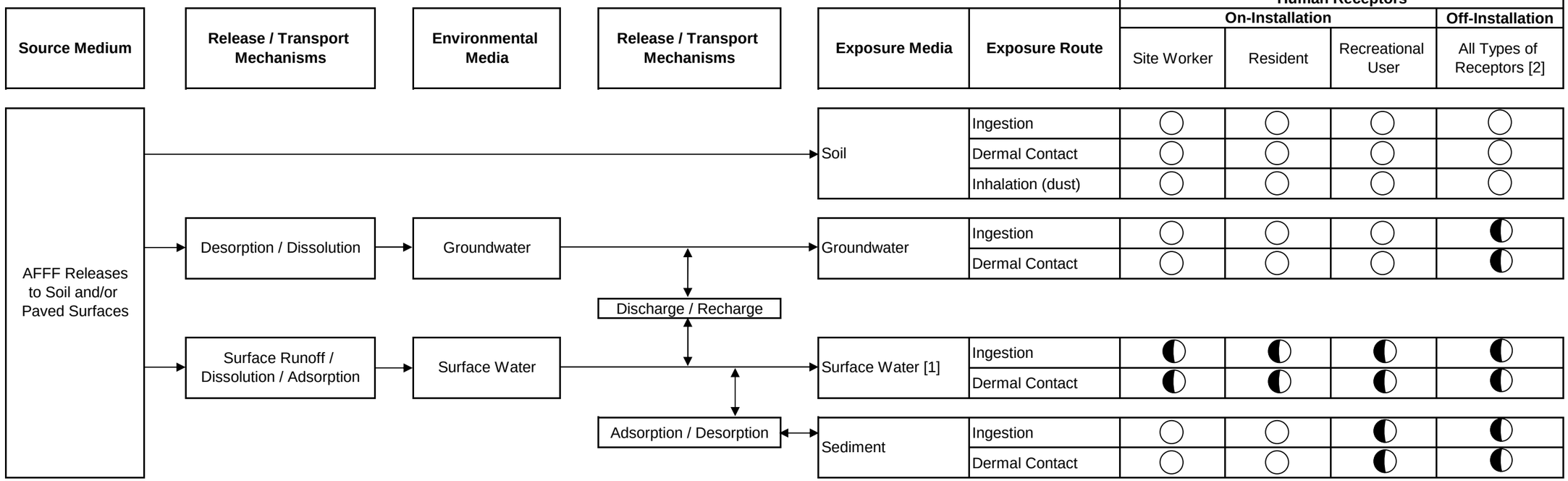
Redstone Arsenal, Alabama

Figure 7-32



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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Conceptual Site Model - Inactive Sewage Treatment Plant #1
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Figure 7-33

Arcadis U.S., Inc.

7550 Teague Road

Suite 210

Hanover, Maryland 21076

Tel 410 987 0032

Fax 410 987 4392

www.arcadis.com