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

Fort Sill, Oklahoma

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Preliminary Assessment and Site Inspection of Per- and Polyfluoroalkyl Substances

Fort Sill, Oklahoma

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EXECUTIVE SUMMARY

The United States 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 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 or not 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. This Fort Sill (FTSL) PA/SI was completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, National Oil and Hazardous Substances Pollution Contingency Plan, and Army/Department of Defense policy and guidance.

FTSL is located in Comanche County, Oklahoma, and is located approximately 90 miles southwest of Oklahoma City. The installation consists of 93,687 acres, which includes 7,000 acres of cantonment area and 86,000 acres of rangeland. The main cantonment area lies in the southeastern portion of the installation. It borders the northern boundary of the city of Lawton, Oklahoma. The total population of Fort Sill is approximately 53,000, including 20,000 military and civilian personnel and 33,000 military family members. The mission of the Fires Center of Excellence and FTSL is to train, educate, and develop soldiers and leaders; create and develop capabilities; engage, collaborate, and partner with stakeholders; sustain and provide a Fires Force to support Joint Warfighting Commanders across the spectrum of operations in the Joint, Interagency, Intergovernmental, and Multinational environment (FTSL 2013).

The FTSL PA identified nine AOPIs for investigation during the SI phase. SI sampling results from the nine AOPIs were compared to risk 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, groundwater, sediment, and/or surface water at all nine AOPIs. Eight of the nine AOPIs had PFOS, PFOA, and/or PFBS present at concentrations greater than the OSD risk screening levels. The FTSL PA/SI identified the need for further study in a Comprehensive Environmental Response, Compensation, and Liability Act of 1980 remedial investigation. Groundwater underneath the main cantonment area is understood to flow to the south and southeast. Groundwater samples were collected from the southern installation boundary, located southeast from the Henry Post Airfield AOPIs [Fire Station 2 (B4914), Hangar (B4915), Old Fire Station (B5031), and Fire Station Storage (B5020), and south of the Former Firefighter Training Area (FFTA); FTSL-045]. Some of the samples collected here exceeded OSD risk screening levels. Therefore, it is recommended that the area downgradient of the FFTA and Henry Post Airfield AOPIs in the direction of the southern installation boundary be investigated up to the installation boundary as part of the 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 at each AOPI.

Table ES-1. Summary of AOPIs Identified during the PA, PFOS, PFOA, and PFBS Sampling at Fort Sill, and Recommendations

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/NS)				Recommendation
	GW	SO	SW	SE	
FFTA FTSL-045[1]	Yes	Yes	No	No	Future study in a remedial investigation
Fire Station 4 (B1617)	Yes	No	NS	No	Future study in a remedial investigation
Fire Station 3 (B3500)	No	No	NS	NS	No action at this time
Fire Station 2 (B4914)[1]	Yes	No	NS	No	Future study in a remedial investigation
Hangar (B4915)[1]	Yes	No	NS	No	Future study in a remedial investigation
Old Fire Station (B5031)[1]	Yes	No	NS	NS	Future study in a remedial investigation
Fire Station 1 (B6041)	Yes	No	NS	NS	Future study in a remedial investigation
Fire Station Storage (B5020)[1]	Yes	No	NS	NS	Future study in a remedial investigation
Dodge Hill Landfill	Yes	NS	NS	NS	Future study in a remedial investigation

Notes:

[1] The Southern Installation Boundary was sampled in association with these AOPIs, where groundwater exceedances of the tap water OSD risk screening level were observed.

Light gray shading – detection greater than the OSD risk screening level

GW – groundwater

NS – not sampled

SE – sediment

SO – soil

SW – surface water

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 PA/SI 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 PFAS PA/SI included two distinct efforts. The PA identified locations that are areas of potential interest (AOPIs) at Fort Sill (FTSL) 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 the PFOS, PFOA, and PFBS results were compared 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 provides the PA/SI for FTSL 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 Regulatory Council 2017). 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 (LHA) 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 groundwater (tap water) or 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 memo, on 08 April 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 15 September 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 site reconnaissance. This PA will 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 FTSL, PA/SI development followed the 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 FTSL. 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), FTSL, and Arcadis U.S., Inc. (Arcadis). The kickoff call occurred 12 July 2018, approximately 5 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.

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 FTSL.

A read-ahead package was prepared and submitted to the appropriate POCs 2 weeks before the site visit. The read-ahead package contained 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
- Contact information for key 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 on 21 to 24 August 2018. An in-brief meeting was held 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 was performed during the site visit.

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

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 the distance to the installation boundary. Access to existing groundwater monitoring wells, if present, were 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 24 August 2018 with the installation, USAEC, and USACE 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 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 serve as the basis for developing the SI scope of work presented in an installation-specific Quality Assurance Project Plan (QAPP) Addendum.

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 determine whether further investigation is warranted. First, an SI kickoff teleconference was held between the Army PA team and FTSL.

The objectives of the SI kickoff teleconference were to:

- discuss the AOPIs selected for sampling and the proposed sampling plan for each AOPI
- 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:

- identify 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 (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 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. The SI field work was completed in accordance with the PQAPP (Arcadis 2019) 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. The SSHP was designed to supplement the Accident Prevention Plan (Arcadis 2018), which was developed for Army installations nationwide. The QAPP Addendum (Arcadis 2020a) and SSHP (Arcadis 2020b) 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 FTSL (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 which 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) 5.1.1 (DoD 2018). 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 FTSL, including the location and layout, the installation mission(s) 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

FTSL is located in Comanche County, Oklahoma, consisting of 93,687 acres (FTSL 2013), approximately 90 miles southwest of Oklahoma City. The installation spans approximately 26 miles from east to west and 6 miles from north to south (**Figure 2-1**). The Wichita Mountains National Wildlife Refuge bounds the installation to the north, and the city of Lawton and towns of Cache and Indiahoma bound the installation to the south. FTSL is made up of approximately 7,000 acres of cantonment area and 86,000 acres of rangeland (Gene Stout and Associates [GSA] 2014). The total population of Fort Sill is approximately 53,000, including 20,000 military and civilian personnel and 33,000 military family members. The site layout is shown on **Figure 2-2.**

2.2 Mission and Brief Site History

FTSL was originally used as an isolated cavalry post when founded on 08 January 1869, by General Philip H. Sheridan. In 1902, the 29th Battery of Field Artillery was assigned to FTSL, which transformed FTSL into a field artillery center. In 1911, the School of Fire for Field Artillery was established and in 1915, the first U.S. military aircraft unit was assigned to the post. Shortly thereafter in 1917, Henry Post Airfield (HPA) was established. The Artillery Center was established in 1946 (FTSL 2013).

The mission of the Fires Center of Excellence and FTSL is to train, educate, and develop soldiers and leaders; create and develop capabilities; engage, collaborate, and partner with stakeholders; sustain and provide a Fires Force to support Joint Warfighting Commanders across the spectrum of operations in the Joint, Interagency, Intergovernmental, and Multinational (JIIM) environment (FTSL 2013). Major tenants include the 75th Fires Brigade, the 31st Air Defense Artillery Brigade, the Air Force Weather Station, the Logistics Readiness Center (LRC), the Marine Corps Detachment, and the Reynolds Army Health Clinic.

2.3 Current and Projected Land Use

Currently, FTSL houses the U.S. Army Field Artillery Center and an Army power project platform (FTSL 2013). Most of the land at FTSL is currently reserved for Military Training Areas, which are restricted from other uses. Land uses include the following (GSA 2014):

- Military Training Areas: There are 86 training areas at Fort Sill. They include all land except target and cantonment areas. They are either totally or partially closed to non-training uses or are on regular rotation.
    - Restricted Areas

        - There are four impact areas on the installation. These consist of two East Range impact areas (North Arbuckle and South Arbuckle), the West Range impact area and the Quanah Range impact area.
    - Demolition Areas
        - There are three demolition areas on the installation. Only the demolition area located on the granite outcrop of West Range is regularly used for demolition activities. It is occasionally partially open to hunting. The other two demolition areas are within the Quanah Range and South Arbuckle impact areas. The latter has not been used for over 30 years.
    - Firing Ranges
        - FTSL has 43 improved ranges for small arms and related training.
- Cantonment Area
    - The main cantonment area at FTSL comprises approximately 7,000 acres.
    - In the main cantonment area, soldier housing units (including barracks), shopping areas, and museums are present. Recreational amenities in the main cantonment area include sports venues, playgrounds and picnic areas, a golf course, campgrounds, and swimming pools.
- Agricultural Lease Areas
    - Approximately 7,000 acres of land are used for agriculture at FTSL, including use as wildlife food plots and commercial agricultural fields.
- Hunting and Recreational Areas
    - Approximately 71,000 acres are available for hunting and angling at variable times, depending on training area availability. Approximately 1,000 acres are open to different types of recreation, including picnicking, hiking, berry picking, and camping. One of these recreational areas include the Lake Elmer Thomas Recreational Area, located on the northwestern portion of the installation, near the northern boundary.
- Henry Post Airfield
    - HPA was established in 1917 as the first Army airfield. The Army Aviation School functioned at Fort Sill from 1945 until 1954. HPA has a 5,000- by 200-foot runway with two smaller sod runways. There are no air units currently stationed at the airfield.

2.4 Climate

FTSL and the surrounding area has a temperate, dry, sub-humid continental climate. Warm, moist air from the Gulf of Mexico along with modified marine air from the West Coast, and cold, dry air from the Arctic Circle control the weather patterns in the area. Prevailing winds are typically southerly, with northerly winds in January and February. Average wind speed is 12 miles per hour, with gusts of up to 30

to 50 miles per hour. Tornadoes have occurred in most of the county. Hailstorms are also known to occur in coincidence with severe thunderstorms (GSA 2014).

In this geographic region, winters are mild. The heaviest rainfall, most severe storms, and tornadoes occur in springtime when weather is most variable. Hot summer weather persists for a long season, and fall is characterized by cool nights and warm days with occasional severe storms in September and October. Average monthly temperatures range between 38 degrees Fahrenheit (ºF) in January and 84ºF in July. Freezing temperatures occur on average 74 days a year between October and April. Minimum readings of 0ºF or below occur every 6 years. Extreme temperatures up to 114ºF have been recorded (FTSL 2013).

Lawton, Oklahoma, has an average annual precipitation of 27.3 inches. The wettest month is typically May, when 20 percent (%) of the annual precipitation occurs. The driest month is January, when approximately 5% of annual precipitation occurs. Heavy 24-hour rains of 3 to 4 inches have occurred in April, May, June, September, and October. Snowfall in the region begins in November and can continue through April (FTSL 2013).

2.5 Topography

FTSL is generally characterized as a region of rolling topography and moderate relief with the Wichita Mountains located to the north (**Figure 2-3**). The installation lies within the Central Lowlands Province (EA Engineering, Science and Technology, Inc. [EA] 2014). About 51% of the land is nearly level with slightly sloping prairies; about 29% of the land has slopes of more than 5% grade, and 20% of the land has slopes of 3 to 5% grade (GSA 2014). The lowest elevation point on the installation is where East Cache Creek flows off site through the southern boundary (1,080 feet above sea level). The western portion of the installation features higher, more dramatic elevation changes than near the cantonment area. It is in the western portion of the installation where the highest elevation point may be found at 2,207 feet above mean sea level.

2.6 Geology

The installation sits in two geomorphic provinces: the Wichita Mountains and Central Red-Bed Plains. The Wichita Mountains make up the northern and western portions of the installation and consist of crystalline rocks. Carlton Rhyolite and Wichita Granite make up the core of the Wichita Mountains. This core has been uplifted several thousand feet along northwest-trending faults and are fractured by other smaller faults. Wichita Granite is the oldest, characterized by its pink-to-red coloration with coarse-to fine-grains. Carlton Rhyolite is pink, red, and dark gray, with fine grains. These igneous units are overlain by Upper Cambrian (Timbered Hill and Lower Arbuckle Groups) and Upper Cambrian/Lower Ordovician (Upper Arbuckle Group) shelf carbonates (AWD Technologies 1994). These bedrock units are greatly faulted and folded, with thicknesses ranging from 224 to 369 feet (University of Oklahoma 1983, Geo-Marine 1997). The Cambrian group consists, from oldest to youngest, of the Reagan Sandstone (lying directly on the granite and rhyolite intrusive units), Honey Creek Limestone, and FTSL and Signal Mountain Limestones. McKenzie Hill Limestone and Strange Dolomite makes up the Lower Ordovician Group which overlies the Cambrian units (Parsons Engineering Science [Parsons] 1996).

The Post Oak Conglomerate overlies the Cambrian and Ordovician units. This Permian-age granite-boulder conglomerate west of East Cache Creek grades eastward into rhyolite through Porphyry conglomerate. These conglomerates are fine grained in the southern portion of the installation (Parsons 1996). In the Central Red-Bed Plains, the Post Oak Conglomerate contains fragments of igneous rock eroded from the Wichita Mountains and calcareous rock eroded from the Arbuckle Group. The Post Oak Conglomerate grades laterally to the south into beds of shale, siltstone and sandstone of Hennessey, Garber and Wellington formations (Parsons 1996; Geo-Marine, Inc. 1997).

The Permian-age Hennessey Group overlies the Post Oak Conglomerate. It consists of red to gray shale and fine-grained sandstone. It is the predominantly outcropping bedrock east of East Cache Creek. It is overlain by mudstone conglomerate, Basal Permian Asphaltum Sandstone and Permian-age Garber Sandstone. This sandstone is fine grained and reddish brown (Parsons 1996).

Bedrock in the main cantonment area can be characterized as Post Oak Conglomerate and the Hennessey Group. The conglomerate varies in grain size between beaded pebble to boulder-sized clasts of granite, rhyolite, sandstone, and mudstone. In subsurface, this formation extends to Pennsylvanian rocks occurring at approximately 2,000 feet below ground surface (bgs) (EA 2014).

The southern portion of the installation, including the main cantonment area, is predominantly silty clay soils of low to high plasticity. Soil pans are typically developed in the soil. East range soils are primarily reddish clays and fine-grained sand assemblages. Bottomland soils in the area east of Interstate 44 are typically loams. Between the main cantonment area, Blue Beaver Valley, and Southern Wichita Mountains, the loam and clay soils developed on rhyolitic bedrock are generally well drained with low to very low permeability. Loams and sandy loams are also predominant in the western portion of the installation (EA 2014).

Seismic activity is known to occasionally occur throughout the region. The most recent significant earthquake occurred in 1959 and was identified as an earthquake between the magnitudes of 5.0 and 5.5. The epicenter was located 12 miles southwest of FTSL in Faxon, Oklahoma. This earthquake caused plaster and foundation cracks in Lawton. Since 1900, 19 episodes of seismic activity with magnitudes of at least 4.0 have occurred within a 100 mile-radius of FTSL (EA 2014).

2.7 Hydrogeology

Three aquifers exist beneath FTSL in the Quaternary alluvium, Permian Post Oak Conglomerate, and Cambro-Ordovician Arbuckle-Timbered Hills (Arbuckle Group) (GSA 2014).

Water-bearing Quaternary alluvium made up of sands and gravels lie in floodplains and near streams like East Cache Creek and its tributaries; the alluvial aquifer is most significant in the southern portion of the installation. The water level within the alluvium ranges from 5 to 30 feet bgs. The alluvium consists of approximately 5 to 50 feet of sand, clay and gravel. Estimated yields from wells in alluvium along East Cache Creek are less than 300 gallons per minute. Alluvial groundwater is recharged by precipitation and infiltration along stream channels during high stream stages; during gaining stream stages, the alluvial groundwater feeds into streams that flow across the installation (EA 2014, GSA 2014). Alluvial groundwater is used for domestic and stock use but is not typically used as a drinking water source due to its poor quality (i.e., elevated hardness and high background concentrations of metals and minerals) and insufficient yields (University of Oklahoma 1983; EA 2014; GSA 2014; Weston Solutions, Inc. 2002).

The Post Oak Conglomerate unit (which occurs from approximately 30 to 350 feet bgs) contains water-bearing zones in several depth intervals from approximately 120 to 250 feet bgs in the western region of East Cache Creek. Static water levels are observed to rise to 21 to 103 feet bgs in wells screened in the Post Oak Conglomerate confined aquifer (AWD Technologies 1994). Recharge to this aquifer occurs through precipitation and stream infiltration (GSA 2014; AWD Technologies 1994).

The Arbuckle Group aquifer is the largest groundwater source in the immediate area. It consists of limestone, dolomite, and shale approximately 6,000 feet thick. Fractures, faults and bedding planes allow for increased water storage and transmission (University of Oklahoma 1983). Aquifer depth ranges between approximately 700 and 1,020 feet bgs. The aquifer is confined under pressure. Artesian conditions are observed at wells near the Wichita Mountains, and static water levels are observed to rise to approximately 140 feet bgs. Recharge to the Arbuckle Group aquifer is from the overlying Post Oak Conglomerate aquifer (University of Oklahoma 1983; EA 2014).

Domestic and public supply wells within 4 miles of the installation receive water from one of three aquifers described above. Water not evaporated or carried via overland flow to adjacent surface water bodies has the potential to transport pollutants into groundwater. Groundwater flow in the vicinity of the installation follows the contours of consolidated and unconsolidated sediments deposited in the area from the erosion of the Wichita Mountains (EA 2014). Groundwater in all aquifers below the installation flow to the south and southeast (Weston Solutions, Inc. 2002).

2.8 Surface Water Hydrology

FTSL lies in the surface drainage basin of Red River. Lake Lawtonka and Lake Ellsworth sit to the north of the installation. Outflows from Lake Lawtonka move south towards East Cache Creek. This creek flows along the eastern portion of the main cantonment area, overtop the Quaternary Alluvium aquifer. It combines with West Cache Creek approximately 35 miles south of FTSL and eventually flows into the Red River (Weston Solutions, Inc. 2002). The Cache Creek System is the primary tributary for the Lawton and FTSL area, with East Cache Creek being the main fork. Much of the installation drains into perennial waterways that are tributaries to East Cache Creek.

FTSL and much of the surrounding area utilize surface water as their potable water resource, as discussed in **Section 2.10**.

There are several major perennial waterways on the installation, which include West Cache, Blue Beaver, Post Oak, Crater, East Cache, Medicine and Wolf creeks. They are established by Oklahoma Water Quality Standards as having uses, including public and private water supply, fisheries, agriculture, and primary body contact recreation (GSA 2014).

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 FTSL.

2.9.1 Stormwater Management System Description

May is generally the wettest month of the year and typically receives about 20% of the annual precipitation. Surface water within the main cantonment area runs off into 30 major outfalls that subsequently discharge to the following water bodies: Medicine, Sitting Bear, Wolf, Mission, and Cache Creeks. Stormwater flows from several industrial activity sites on the installation (i.e., the landfill, recycling facility, ground and rail transportation warehouse, and HPA) to Medicine, Sitting Bear, Wolf, Mission, and East Cache Creeks (Auxilio Management Solutions, Inc. 2018). Stormwater from the cantonment area is managed through a series of structural control devices (e.g., ditches, swales, oil/water separators) which are designed to collect runoff and direct it to natural and man-made drainage systems (Army Public Health Center 2016).

2.9.2 Sewer System Description

The main cantonment wastewater treatment plant (WWTP) treats sanitary sewer wastes and discharges treated effluent into East Cache Creek. Approximately 800 tons of sludge from the treatment facility is land-applied to 170 acres of crop fields annually (GSA 2014).

FTSL also utilizes a water reuse system fed by the sanitary sewer wastewater, post treatment (American Water Military Services Group [American Water] 2015). This water has several uses, including in the heating, ventilation, and air conditioning systems, for polo field irrigation, and watering the cemetery on post. The sanitary sewer is privately owned/operated by American Water. American Water is responsible for lift stations, improvements to the sewer system, reporting of violations and strengthening of controls. No on-site septic systems exist on the cantonment area (Army Public Health Center 2016).

Locations of potentially compromised infrastructure of the FTSL sewer system, which has received aqueous film-forming foam (AFFF) from the Hangar (B4915), the wash racks accompanying Fire Station 2 (B4914) and Fire Station 4 (B1617), have not been identified; leaks or cracks in piping may have led to secondary PFAS releases along the utility corridor.

2.10 Potable Water Supply and Drinking Water Receptors

According to interviews and state records, one public potable supply well exists on the installation at Camp Eagle, located in the western portion of the installation (**Figure 2-2**). It is listed as supplying fewer than 50 people with potable water. According to the standard operating procedure (SOP) for Camp Eagle training, units bring in their own potable water to the camp during use. An on-post domestic well was also identified in state records as occurring on the installation (**Figure 2-2**). However, the location of this well could not be verified through the information provided in the well log provided by the Oklahoma Water Resources Board (OWRB) or through installation personnel (**Table 2-1**). Therefore, it is suspected that this well does not exist within installation boundaries.

Surface water is the primary potable water source in the area. Groundwater is less frequently used as a potable water source due to the low porosity and permeability of the geologic formations in the shallow subsurface, which restrict recharge (Weston Solutions, Inc. 2002). However, recharge does occur when water not evaporated is carried via overland flow to surface water bodies. Due to low annual rainfall in the region, the groundwater recharge from infiltration is insignificant in areas that are not in immediate vicinity

to perennial waterways that contribute to the Quaternary alluvium aquifer. Therefore, FTSL purchases drinking water from the City of Lawton (American Water 2017).

The Lawton public water system withdraws water from surface water intakes on Lake Lawtonka. Lake Lawtonka sits approximately 1 mile north of the installation and is partially fed by Lake Ellsworth, which lies to the east. Lake Ellsworth is in turn supplied by Waurika Lake, located approximately 25 miles to the southeast of the installation. Surface water intakes on Lake Lawtonka take water to the Lawton Water Treatment Plant in Medicine Park, Oklahoma. After treatment, this potable water flows via two very large water mains, which run through the center of the installation, to FTSL and the City of Lawton (GSA 2014; American Water 2017).

The City of Lawton public water system is supplied currently only by surface water intakes. However, to provide resource security in the event of future droughts, the city has been searching to identify locations for three new groundwater production wells. Of the three wells, one has been proposed for installation in east Lawton, within 5 miles of the southeastern FTSL boundary and near East Cache Creek. The locations for the remaining two wells have yet to be determined.

FTSL also derives drinking water from surface water intakes on Lake Elmer Thomas, which is located on the northwest portion of the installation.

The OWRB and Oklahoma Department of Environmental Quality provided data on public water systems, domestic wells, and surface water intakes on and off the installation.

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 FTSL, which along with state and county GIS provided by the installation identified several off-post public and private wells within 5 miles of the installation boundary (**Figure 2-4**). **Figure 2-4** also depicts wells identified from the OWRB and Oklahoma Department of Environmental Quality well databases, as well as those identified during a windshield survey conducted by FTSL personnel. The EDR report providing well search results provided as **Appendix E**.

2.11 Ecological Receptors

The PA team collected information regarding ecological receptors that was available in the installation documents. The following information is provided for future reference should the Army decide to evaluate exposure pathways relevant to the ecological receptors.

The following information regarding ecological receptors at FTSL is excerpted in part from the 2014 Integrated Natural Resources Management Plan and Environmental Assessment (GSA 2014). FTSL is characterized as an ecological transition area where tall-grass prairie merges with short-grass prairie. West Range has a larger variety of habitat, ranging from midgrass prairie with scattered small streams (located to the east and west) and granite outcrops (located to the north and south). Quanah Range is characterized by rolling hills and midgrass prairie with scattered upland wooded areas and small streams. The National Wetland Inventory identified over 1,174 acres of wetlands at FTSL. East Range is rolling prairie and bottomland.

Typical big game species inhabiting FTSL include white-tailed deer and elk. Occasionally, other large mammals are seen on the installation, such as bison, mule deer, and mountain lion. Small mammals at

FTSL include coyote, bobcat, raccoon, striped skunk, cottontail rabbit, fox, squirrel, beaver, opossum, prairie vole, deer mouse, and white-footed mouse. Forty-five species of amphibians and reptiles have been surveyed on the installation and 39% of known Oklahoma species of arthropods have been identified at FTSL. On the installation, 22 special interest mammal species are known to occur, but none of these are federally or state listed. Approximately 45 special status bird species exist on the installation, 22 of which are confirmed or potential breeders there. This includes the barn owl, Bell's video, Bewick's wren, eastern bluebird, broad-winged hawk, burrowing owl, canyon wren, common poorwill, dickissel, ladder-backed woodpecker, least bittern, Lewis' woodpecker, loggerhead shrike, Mississippi kite, orchard oriole, red-headed woodpecker, red-shouldered hawk, rock wren, Rufous-crowned sparrow, scissor-tailed flycatcher, white-faced ibis, white-tailed kite, and white-winged dove.

2.12 Previous PFAS Investigations

Sampling of potable water systems within FTSL and in nearby municipalities have been conducted to evaluate the potential presence of PFAS-related constituents. In February, May, August, and November of 2013, under the third Unregulated Contaminant Monitoring Rule (UCMR3), American Water (operator of the FTSL water system) collected samples from the existing Building M7456 Water Treatment Plant. In 2013, the Pecan Valley Addition public water system and FTSL main water supply line, which purchase water from the Lawton public water system, were also sampled by the City of Lawton as part of UCMR3. PFAS were not detected at concentrations greater than the USEPA's LHA of 70 ng/L and/or the OSD risk screening levels. The Public Water System identifiers for Pecan Valley Addition, FTSL, and the City of Lawton are OK3001676, OK3001601, and OK1011303, respectively.

In 2014 and 2015, the City of Lawton conducted four sampling events at the North Plant and Southeast Water Treatment Plant (also referred to as the Medicine Park and Southeast Treatment Plants), which treat the public water supply for the City of Lawton. Samples were collected at the entry points of the distribution systems and were analyzed for various parameters, including PFOS and PFOA. PFOS and PFOA were not detected at concentrations greater than the OSD risk screening levels. The laboratories which analyzed samples under UCMR3 met the USEPA's UCMR3 Laboratory Approval Program application and Proficiency Testing criteria for USEPA Method 537 Version 1.1.

In 2015 and 2016, under the IMCOM Operations Order 16-088, potable water samples were collected from the Camp Eagle Pump House (OK2001641) and Lake Elmer Thomas Recreational Area Water Plant (OK1011310), which supplies drinking water to a campground on the northwestern border of the installation. Samples were analyzed for PFOS and PFOA. Neither constituent was detected at concentrations greater than the USEPA's LHA of 70 ng/L or the OSD risk screening levels. Data from these sampling events are presented in **Table 2-2**.

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 FTSL, data was collected from three principal sources of information and are described in 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**), site reconnaissance photos (**Appendix H**), and site reconnaissance logs (**Appendix I**) during the PA process for FTSL 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 Installation Restoration Program (IRP) administrative record documents, compliance documents, FTSL fire department documents, FTSL Directorate of Public Works documents, and GIS files. Internet searches were also conducted to identify publicly available and other relevant information. Additionally, an EDR report (provided in **Appendix E**) was generated for FTSL and was reviewed to obtain off-post water supply well information. A list of the specific documents reviewed 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 FTSL is presented below (affiliation is with FTSL unless otherwise noted).

- American Water General Manager
- Directorate of Public Works Master Planning
- Pesticide Manager
- GIS Manager
- Range Control Staff

- Aviation Division Chief
- Fire Chief
- Cultural Resources Historian
- Environmental Compliance Branch Chief
- Environmental Quality Division Chief
- Logistics Support Team Chief
- USACE Regional Lead
- USACE Fire Protection Specialist
- Waste Manager
- Logistics Resource Center staff

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 FTSL during the records review process, the installation in-brief meeting, and/or during the installation personnel interviews. A photo log from the site reconnaissance is provided in **Appendix H**; photos were used to assist in verification of qualitative data collected in the field. The site reconnaissance logs are provided in **Appendix I**.

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

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 I)** during the PA process for FTSL 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**.

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

FSTL 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 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% hydrocarbon surfactants, and 1 to 3% PFAS (Interstate Technology Regulatory Council 2020). 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. AFFF was used at FTSL during firefighter training activities up until 2016. As of the PA site reconnaissance visit in 2018, AFFF was being stored on the installation for emergency use only.

For emergency preparedness, installation/fire department personnel were trained to performed nozzle testing with AFFF to ensure optimal flow and use of the AFFF mixture. Fire Station 2 (Building 4914) was commissioned in 2008 and is located on HPA. Fort Sill Fire Department personnel conducted occasional fire training and annual nozzle testing on the aviation apron behind Fire Station 2. Nozzle testing involved spraying AFFF through fire equipment and was indicated in personnel interviews to have been allowed to run off or dissipate from the concrete pad near Fire Station 2. Fire equipment training also included arc training to maximize the arc, reach, and distance covered by AFFF in an emergency response. During training activities, discharged AFFF potentially flowed into the wash rack and storm drains on the tarmac to the southeast of Fire Station 2. Wash racks are drainage areas over which installation vehicles and aircraft are cleaned. After moving through oil water separators, water is treated at the WWTP and discharged to East Cache Creek located approximately 0.5 mile to the east. The stormwater drain would also flow to the WWTP for treatment. Stormwater captured in nearby concrete-lined ditches otherwise discharges to an unnamed East Cache Creek Tributary, approximately 0.5 mile to the east. Annual use of AFFF at this fire station was estimated to be about 50 gallons. Since 2016, AFFF has not been used in firefighter training at Fire Station 2. However, in the summer of 2019, an unintentional release of AFFF occurred onto the concrete apron over an approximately 15-second period. Spent material was collected into buckets and sent for disposal with other AFFF material by the Defense Logistics Agency.

Currently, firefighter training takes place at an off-installation location, and AFFF is not utilized. The exact commission date of this firefighter training area is unknown.

According to a 2016 inventory provided by the Army, FTSL has four fire engines each having a capacity for 15 gallons of AFFF concentrate. Additionally, the installation owns one “Crash-22” vehicle that has a capacity for 130 gallons of AFFF concentrate. While not confirmed during the PA site visit, the Great Plains Technology Center and HPA are listed as locations that store AFFF. The 2017 AFFF inventory provided by the installation states that as of 2017, 1,590 gallons of AFFF were stored on site. During the period of AFFF use at FTSL, about 50 gallons of AFFF were used annually. Interviews in 2018 indicate that 640 gallons of AFFF remained on post in fire trucks and in storage.

Brush trucks at the installation were acquired in 1999 and outfitted with Class A foam systems between 2007 and 2008, and Class A foam was kept in these trucks until 2010. No records detailing their instances of use were available.

As identified in the list of 2018 assets provided by the installation and confirmed during PA site visit interviews with FTSL fire department personnel, AFFF is stored in the following locations:

- Fire Station Storage Building (B5020)
- Old Fire Station (B5031)

There are several chemicals kept within these buildings for fire retardation. Those which are AFFF include “ESF - Extreme!” and Chemguard 3%. Stored with the AFFF are other fire retardation chemicals like Chemguard Purple K, Buckeye Platinum Class A Foam, and Pinnacle Class A Foam.

Personnel interviews indicated that generally, fire station storage was frequently moved to buildings listed for demolition. No records identifying these buildings are available. As a result, there are likely several demolished buildings which at one point did store AFFF but were not sampled or investigated. However, interviews indicate that no spills have occurred in these areas. A complete list of these storage buildings does not exist.

The Former Firefighter Training Area (FFTA), located approximately 1 mile east of the HPA, was used to train firefighters biannually between 1976 and 1987. The site was formally closed in 1992. At the FFTA, AFFF was used to extinguish fuel-fed fires which were ignited over three pits; the pits covered approximately 43,000 square feet. When burns were conducted, fuel was fed via pipes to the pits. Vehicle props were placed in these pits during training exercises as well. During each event, the resident 500-gallon fuel tank would be emptied, and AFFF was utilized to extinguish the fires. The site was remediated under the IRP and the fuel tank was removed in 1992. During the site’s remediation, 650 cubic yards of soil were excavated from the burn pit areas, 675 cubic yards of soil were excavated from the tank area, and 5 cubic yards of soil were removed around the piping which supplied ignition fuel. The excavated soil was taken to a soil farm (located at the current Dodge Hill Landfill) where the soil was bioremediated and eventually transported to landfill cells to apply as cover (FTSL 1993). Between 1995 and 2003, the referenced soil farm was converted to a lagoon, which was later excavated, backfilled, and remediated in 2018.

One Hangar (B4915), located on HPA was reported as having had a release of AFFF which occurred sometime between 2000 and 2010. The type of AFFF in the foam supply tank at the time of release could not be confirmed with the installation. Currently, the foam supply tank holds 400 gallons of Rockwood Jet-X high expansion foam concentrate and not PFAS-containing foam. The timeline of completion and change-out procedures (i.e., flushing practices and/or AFFF and system component disposal) for

updating foam systems in the Hangar (B4915) from AFFF to high-expansion foams is unknown, if it did occur. As such, residual AFFF may remain in the piping infrastructure of these hangar fire suppression systems. It is unknown if Building 4908 – Hangar ever used AFFF in their fire suppression systems prior to high-expansion foams.

A retired FTSL fire department staff member who was interviewed during the PA site visit provided details about two aircraft crashes that occurred on HPA. In 1980, it was reported that one crash occurred south of the airstrip where the airstrip intersects the unnamed road extending from Thomas Street. Another aircraft crash in 1987 was reported to have occurred northwest of that airstrip. Due to the proximity of firefighting resources, immediate response required minimal foam use. Fire response at these HPA crash locations could contribute the presence of PFOS, PFOA, and/or PFBS at HPA. However, as the exact locations of these airfield crashes could not be confirmed, this area could not be named as an AOPI. Additional aircraft crashes have occurred in the range areas of the installation. In 1980, a C-123 Aircraft crashed on the West Range, although no records indicated that AFFF was used.

Three fire stations were not visited during PA site reconnaissance: Fire Station 1 (B6041), Fire Station 3 (B3500), and Fire Station 4 (B1617). As indicated by record reviews and interviews, the primary missions of these fire stations include activities which could involve the use of AFFF, including structural firefighting, emergency medical response, wildland management, burn control, aircraft rescue, and automobile extractions/rescues. The fire department personnel interviewed recalled the use of both Class A foams and AFFF during these response activities. It is likely that all these sites have historically stored AFFF. It is also likely that equipment containing AFFF was cleaned/flushed at these locations, which may have released some AFFF in the process.

Due to a mold infestation, all physical historical fire response logs were destroyed. The earliest records that exist from the National Fire Incident Reporting System are from 2010, and emergency response records date back to 2005. Fire response records indicating AFFF use are not available. However, during the personnel interviews, the fire department recalled a few instances where foams were used for automobile extraction, wildland response, and aircraft rescue control. In October 2010, a vehicle fire occurred on the installation, during which responders “foamed [the] interior,” according to a document housed by the FTSL fire department. This document and the location of the vehicle fire was not provided. “Wet lining”, or “foam lining”, where AFFF concentrate was diluted with greater amounts of water and sprayed over vegetation, was also known to have been routinely practiced to prevent the spread of brush fires prior to 2016.

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

Following document research, personnel interviews, and site reconnaissance at FTSL, metal plating operations, WWTPs, landfills, and pesticide storage areas were also identified as preliminary locations for use, storage, and/or disposal of PFAS-containing materials. A summary of information gathered in the PA for each of these preliminary locations is described below. Specific discussion regarding areas not retained for further investigation is presented in **Section 5.1** and specific discussion regarding areas retained as AOPIs is presented in **Section 5.2**.

Potential PFAS use associated with metal plating activities may also be relevant to Army installations. During metal plating operations, a metal surface may be treated with a layer of electrochemically

deposited metals in an acid bath. PFAS, specifically PFOS, have been used in metal plating operations as surface tension-reducing wetting agents to mitigate the release of aerosolized chemicals into a working environment. Hard chromium plating is one type of metal plating operation where PFAS-containing mist suppressants were commonly used. Historically, it was common for spent plating baths from metal plating operations to be disposed of in a lined or unlined pit or into a sanitary or storm sewer. Therefore, PFAS present in mist suppressants during the metal plating process could be released to the environment.

Interviews with installation personnel indicated that metal plating operations do not occur at FTSL. However, records provided by USAEC identified the “Area 1 Weapons Repair” facility as a location at FTSL in which industrial electroplating was conducted.

During the PA site visit, no record of this area could be identified in property searches or in archived documents to confirm its existence or site history. According to interviews with Fort Sill personnel, the Department of Logistics / LRC was speculated to be the only possible location for this type of activity, but interviews with LRC staff indicated there is no documented history of chromium plating at the Department of Logistics / LRC. If it had existed, it would have been before the current contract workforce was in place. This is estimated to be prior to 1980. Installation personnel could not verify that chromium plating was performed during that time. Based on document research and personnel interviews, no current chromium plating operations were identified at FTSL.

During a telephonic 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 IMCOM installations, and did not identify FTSL 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 pesticides use, storage, or disposal.

Dodge Hill Landfill consists of a former Soil Farm, Municipal Solid Waste Landfill (MSWLF), and Construction and Demolition Landfill. Soil from the FFTA was taken to the former Soil Farm at Dodge Hill Landfill in 1992 for treatment of petroleum hydrocarbons. The Soil Farm was established within the fence line of the current landfill for remediation of fuels-contaminated soils. Treated soil was then added as cover primarily on the MSWLF. An estimated 90% of the treated soil was placed on the MSWLF, and the remaining volume was placed as cover on the Construction and Demolition Landfill.

The main WWTP at FTSL treats sanitary sewer wastes and discharges treated effluent into East Cache Creek. Water from the wash pads located at Fire Station 4 (before its demolition) flowed and at the Hangar (B4915) eventually flows through this WWTP. FTSL also utilizes a “purple water” reuse system fed by the sanitary sewer wastewater, post treatment (American Water 2015). This water has several uses, including in the heating, ventilation, and air conditioning systems, for polo field irrigation, and watering the cemetery on post.

As described in **Section 2.9**, sludge from the WWTP is used to fertilize agricultural plots at FTSL. Approximately 800 tons of sludge from the treatment facility is land-applied to 170 acres of crop fields annually (GSA 2014). Sludge from the FTSL Soil Farm was also used to fertilize these agricultural plots until it was closed in the late 2010s. These food plots, along with 341 acres of alfalfa and 1,187 acres of

other crops planted as a part of the agricultural leasing program support wildlife needs. Game animals include white-tailed deer, elk, feral hogs, bobwhite quail, turkeys, rabbits, squirrel, raccoon, coyote, and waterfowl. Waterfowl species that can be hunted include Canada geese, wood duck, and doves. Only authorized sportsmen are permitted to hunt game animals at the installation. Poaching is extremely uncommon (GSA 2014).

Further discussion regarding areas not retained for further investigation and retained as AOPIs is presented in **Section 5.1** and **Section 5.2**, respectively.

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 FTSL) 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 PA records search and site visit are described below.

Local volunteer fire departments, including the Lawton Fire Department, have AFFF in their fire trucks. The Lawton Fire Department has reportedly used AFFF nearing expiration to extinguish brush fires.

5 SUMMARY AND DISCUSSION OF PA RESULTS

The preliminary locations evaluated for potential use, storage, and/or disposal of PFAS-containing materials at FTSL, 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, nine areas have been identified as AOPIs. The process used for refining these areas is presented on **Figure 5-1**, below.

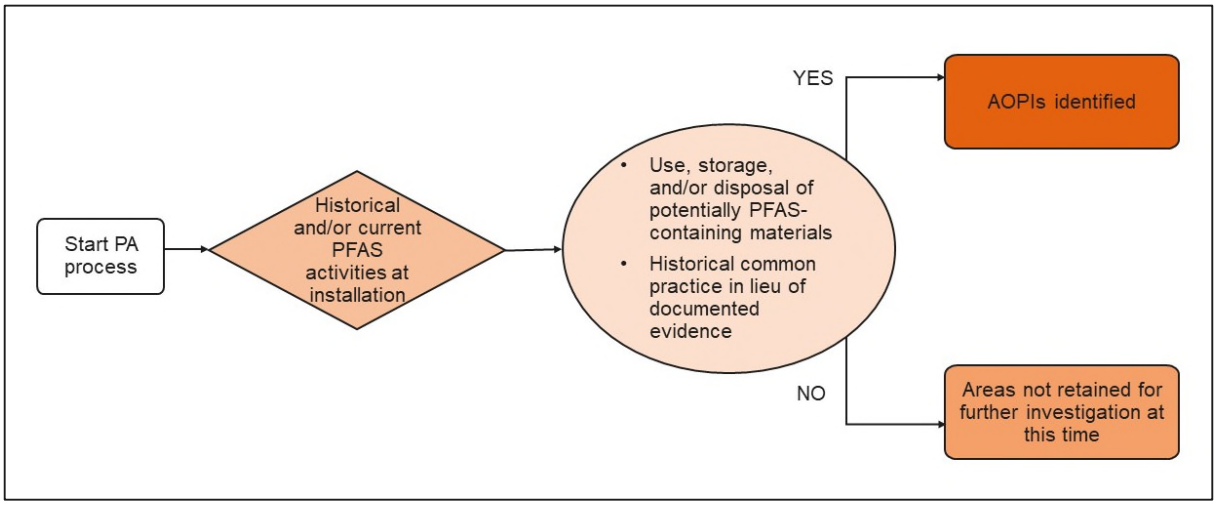

Figure 5-1: AOPI Decision Flowchart

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 this PA/SI at FTSL are presented in **Section 9**.

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 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
Building 4908 – Hangar	Unknown start date to current	Two hangars which are outfitted with fire suppression systems. The hangars are currently used for storage of materials/equipment rather than aircraft. The foam stored in this system is Rockwood Jet-X High Expansion Foam Concentrate, which do not contain PFAS.	No evidence of PFOS, PFOA, or PFBS-containing materials used, stored, and/or disposed of at this location.
Building 1947 – Pesticide Storage	At least 1960s to current	This building houses pesticides.	No evidence of PFOS, PFOA, or PFBS-containing materials used, stored, and/or disposed of at this location.
Building 1948 – Pesticide Mixing Area	At least 1960s to current	Used for pesticide mixing and equipment wash-off. The drains surrounding the building collect fluids and transport under the building into a cleaning system, which is eventually discharged into sanitary waste.	No evidence of PFOS, PFOA, or PFBS-containing materials used, stored, and/or disposed of at this location.
Building 2286 – Administration Building6 – Administration Building	Unknown	Identified by installation staff as possible location of the “Area 1 Weapons Repair” area that reportedly housed electroplating operations. Prior to current use, the building supported logistical activities related to the nuclear program. Currently, the building is used as offices for the LRC. The USAEC metal plating record which indicated this “Area 1 Weapons Repair” area shows an operation start date of 1989.	No evidence of PFOS, PFOA, or PFBS-containing materials used, stored, and/or disposed of at this location. There was no evidence that this building was the Area 1 Weapons Repair.
Building 2287-Shop Control and Administration	Unknown	Identified by installation staff as possible location of the “Area 1 Weapons Repair” area that reportedly housed electroplating operation. Prior to current use, the building supported logistical and maintenance, painting, and storage activities related to the nuclear program. Currently, the building is used as offices and for storage by the LRC. The USAEC metal plating record which indicated this “Area 1 Weapons Repair” area shows an operation start date of 1989.	No evidence of PFOS, PFOA, or PFBS-containing materials used, stored, and/or disposed of at this location. There was no evidence that this building was the Area 1 Weapons Repair.

Area Description	Dates of Operation	Relevant Site History	Rationale
Landfill 10 **IR Site: FTSL-014** **HQAES Number: 40755.1014**	1971 to 1985	Used primarily for disposal of sanitary waste, paint sludge, asbestos, wash rack wastes, and pesticides. Additionally, electrostatic etch solution and cyanide waste potentially tied to electroplating activities were reportedly disposed of here. The landfill is surrounded by East Cache Creek and Beef Creek.	No evidence of PFOS, PFOA, or PFBS-containing materials used, stored, and/or disposed of at this location.
Wastewater Treatment Plant **IR Site: FTSL-037/ HQAES Number: 40755.1035**	2015 to current	Wastewater treatment facility that treats sanitary wastes from the installation. Potentially received PFAS-containing wastes from the airfield through sewer lines coming from the wash rack. Sludge generated by the Wastewater Treatment Plant was used at land application areas on post. In addition, the new “purple” water re-use system (employed since 2015) utilizes 10% of the total treated wastewater for application at the post cemetery and polo grounds.	Potential PFAS presence at this site would have been through the airfield wash rack sewer lines and not the stormwater inlets. The area was sampled as part of the SI as an extension of HPA AOPIs.
1980 HPA Aircraft Crash	1980	A retired FTSL fire department staff member interviewed during the PA site visit provided details about two aircraft crashes that have occurred on HPA. In 1980, it was reported that an aircraft crash occurred south of the airstrip at the point where the airstrip intersects the unnamed road extending from Thomas Street. Due to the proximity of firefighter resources, immediate response required minimal foam use.	The exact location of this crash could not be confirmed.
1987 HPA Aircraft Crash	1987	The retired FTSL fire department staff member recounted another aircraft crash in 1987 which occurred somewhere northwest of the point where the airstrip intersects the unnamed road extending from Thomas Street. Due to the proximity of firefighting resources, immediate response required minimal foam use.	The exact location of this crash could not be confirmed.

Interviews with FTSL Fire Department personnel identified several occasions when AFFF may have been used during fire responses off-post. Vehicle fires on the highway were responded to by the Fort Sill Fire Department. In 1992 and 1993, helicopter crashes occurred off post, but because records of AFFF used during crash responses were unavailable, the approximate location and amount of foam used is unknown.

A mutual aid agreement exists between Fort Sill and Comanche County Fire Support as well as the Wichita Mountain Wildlife Refuge. In 1995, because of a mutual aid agreement with the town of Cyril, FTSL responded to an off-post tank battery lightning strike with AFFF, but the exact location could not be identified.

5.2 AOPIs

Overviews for each AOPI identified during the PA process are presented in this section. Two of the AOPIs overlap with FTSL IRP sites and/or Headquarters Army Environmental System (HQAES) sites (**Figure 5-2**). The AOPI, overlapping IRP site identifier, HQAES number, and current site status are discussed within each AOPI subsection presented below. At the time of the PA, none of the FTSL 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 **5-9**.

5.2.1 Fire Station 2 (B4914)

Fire Station 2 is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to repeated biannual nozzle testing, including the use of AFFF. Between 2008 to 2016, the Fort Sill Fire Department conducted biannual fire response training, which included nozzle testing using AFFF. AFFF was sprayed to extinguish training fires to the southwest of Fire Station 2, onto the tarmac and concrete. It flowed to the drains and wash rack on the tarmac to the southeast of the building and next to the B4915 Hangar. AFFF which did not flow into the drains was allowed to evaporate off the concrete. The wash rack contains an oil water separator and ultimately leads to the WWTP located near East Cache Creek. AFFF is no longer used in these training operations. In the summer of 2019, an unintentional release of AFFF occurred onto the concrete apron over an approximately 15-second period. Spent material was collected into buckets and sent for disposal with other AFFF material by the Defense Logistics Agency.

An aerial photograph of Fire Station 2 is provided on **Figure 5-3**. Adjacent to the south and west of Fire Station 2 is HPA, a paved area with occasional storm inlets and a wash rack. An aerial photograph of the WWTP is provided on **Figure 5-9.** Surrounding HPA is a grass field.

5.2.2 Hangar (B4915)

The Hangar (B4915) is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to potential use/storge of AFFF in the hangar's fire suppression system. An AFFF release from a hangar fire suppression system occurred here in 2008. The doors of the hangar were opened in response to the foam being released and foam blew out onto the pavement. Foam entered the floor drain trenches, storm drain, and nearby wash rack. The wash rack leads to the WWTP plant located near East Cache Creek. The type of AFFF in the foam supply tank at the time of release could not be confirmed. The foam currently stored in this system is Rockwood Jet-X High Expansion Foam Concentrate.

An aerial photograph of Hangar (B4915) is provided on **Figure 5-3**. This AOPI is a large airplane hangar on the tarmac at the HPA. The area is paved and includes multiple intermittent drains. An aerial photograph of the WWTP is provided on **Figure 5-9.** Roads and grassy area exist around the AOPI.

5.2.3 Old Fire Station (B5031)

The Old Fire Station is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to the storage of AFFF and the high likelihood that nozzle testing and the cleaning of equipment containing AFFF occurred here. This was the first fire station at the installation, originally using horses for its fire responses. Currently, the building is used for vehicle and chemical storage. Upon establishment of Fire Station 2, primary firefighting operations shifted from Old Fire Station to the new building (Fire Station 2).

An aerial photograph of the Old Fire Station is provided on **Figure 5-3**. This AOPI is a paved area northeast of HPA with grassy areas surrounding the north and west. Drainage ditches from the AOPI lead southeast. Residential areas sit approximately 700 feet away from the Old Fire Station to the north and east.

5.2.4 Fire Station Storage (B5020)

The Fire Station Storage Building is identified as an AOPI following personnel interviews and site reconnaissance due to the storage of AFFF. Part of the HPA complex, this storage area was historically a helicopter simulator building. Since approximately the 1990s, it has been utilized by the FTSL Fire Department for miscellaneous storage, including AFFF. There are no drains within this building and the area is surrounded by landscaped grasses.

An aerial photograph of the Fire Station Storage (B5020) is provided on **Figure 5-3**. This AOPI is a paved area north of HPA.

5.2.5 Fire Station 1 (B6041)

Fire Station 1 is identified as an AOPI following records research and personnel interviews due to the possibility that nozzle testing and the cleaning of equipment containing AFFF occurred here. Built in 1994, the primary mission of this fire station is structural firefighting, emergency medical response, wildland management, and light rescue capability (automobile extraction). The station provides automatic aid to incidents on Interstate 44. Auto incidents and wildland management activities have occasionally been responded to with AFFF according to FTSL personnel interviews. The secondary mission of the fire station is hazardous materials mitigation, technical rescue, and aircraft rescue firefighting. A structural pumper, type VII engine, and mobile command emergency vehicle are housed at this fire station.

An aerial photograph of the Fire Station 1 is provided on **Figure 5-4**. This AOPI is a flat-paved office and equipment storage area to the west of East Cache Creek.

5.2.6 Fire Station 3 (B3500)

Fire Station 3 (B3500) is identified as an AOPI following records research and personnel interviews due to the possibility of nozzle testing and the cleaning of equipment containing AFFF. Built in 2008, the

primary mission of this fire station is structural firefighting, emergency medical response, and light rescue capability (auto extraction). The secondary mission is executing the controlled burn plan, hazardous materials mitigation, and technical rescue. It provides aid to the main cantonment area. A structural pumper, tanker, and two type VII engines are housed here.

An aerial photograph of the Fire Station 3 is provided on **Figure 5-5**. This AOPI is located on a flat, paved area surrounded by grass.

5.2.7 Fire Station 4 (B1617)

Fire Station 4 (B1617) is identified as an AOPI following records research and personnel interviews due to the possibility that nozzle testing and the cleaning of equipment containing AFFF. Built in 1919, the primary mission of this fire station is structural firefighting, emergency medical response, wildland management, and light rescue capability (auto extraction). The secondary mission is hazardous materials mitigation, technical rescue, and aircraft rescue firefighting. This fire station provides aid to the main cantonment area, West Range, and Quanah Range. A structural pumper, Battalion 1 engine, and two type VII engines are housed here. A wash rack had existed immediately northwest of the station between 1979 and 2015. The former wash rack likely led to the WWTP plant located near East Cache Creek.

An aerial photograph of Fire Station 4 is provided on **Figure 5-6**. The Fire Station 4 is a paved area with a grassed athletic field to the northwest and a songbird management area to the east. An aerial photograph of the WWTP is provided on **Figure 5-9.**

5.2.8 Former Firefighter Training Area (FFTA; FTSL-045/40755.1043)

The FFTA is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to reported AFFF use in historical firefighting training operations. It is located near the bottom of a valley, bordered by a hill to the south and Sitting Bear Creek to the north and east. The creek flows to the southeast. Between 1976 and 1987, AFFF was sprayed on fuel-fed fires lit within three pits about 180 by 240 feet in size in the FFTA. During burns, fuel was fed via pipes to the pits, which contained training vehicles. Foam was applied to the pits and the surrounding soil to retard the fires. With each event, the 500-gallon fuel tank was emptied. The site was remediated under the IRP and the tank was removed in 1992. Six hundred-fifty cubic yards of soil were excavated from the burn pit areas, 675 cubic yards of soil from the tank area, and 5 cubic yards around the piping. Excavated soil was taken to the former Soil Farm for remediation and disposal.

An aerial photograph of the FFTA is provided on **Figure 5-7**. The FFTA is located on a sloped grassy area.

5.2.9 Dodge Hill Landfill (FTSL-020/40755.1020)

The Dodge Hill Landfill is identified as an AOPI following records research and personnel interviews which indicated the emplacement of impacted soil from the FFTA. Dodge Hill Landfill consists of a MSWLF, Compost Landfill, and Construction and Demolition Landfill. Soil from the FFTA was taken to the former Soil Farm at Dodge Hill Landfill in 1992. The Soil Farm was established within the fence line of the current landfill for remediation of contaminated soils containing petroleum hydrocarbons. Treated soil was then added as cover material; an estimated 90% of the treated soil was placed on the MSWLF, and the

remaining volume was placed as cover on the Construction and Demolition Landfill. Between 1995 and 2003, the Soil Farm was converted to a lagoon. The lagoon was closed, excavated, backfilled, and remediated in 2018.

An aerial photograph of the Dodge Hill Landfill is provided on **Figure 5-8**. This AOPI is located on flat, earthen terrain. Beef Creek is located west of the landfill with Beef Creek tributaries to the southwest and east.

6 SUMMARY OF SI ACTIVITIES

Based on the results of the PA at FTSL, an SI for PFOS, PFOA, and PFBS was conducted in accordance with CERCLA. SI sampling was completed at FTSL at all nine 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 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 soil, groundwater, surface water, and 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 performed in two phases. The Phase I SI scope of work was completed in April 2020 through the collection of field data and analytical samples. A follow-up field event (referred to as Phase II of this SI) was conducted at the FFTA and in an area south of the FFTA known as the southern installation boundary (SIB) in September 2020. The Phase II SI was conducted to further evaluate the FFTA and SIB. The SIB is defined as downgradient from the FFTA and may also be downgradient from the main cantonment area, including the HPA AOPIs, in proximity to several other AOPIs.

The SI field work was completed in accordance with the 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 FTSL. Non-conformances to the prescribed procedures in the PQAPP and QAPP Addendum are described in **Section 6.3.4**. 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, soil, surface water, and sediment 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.

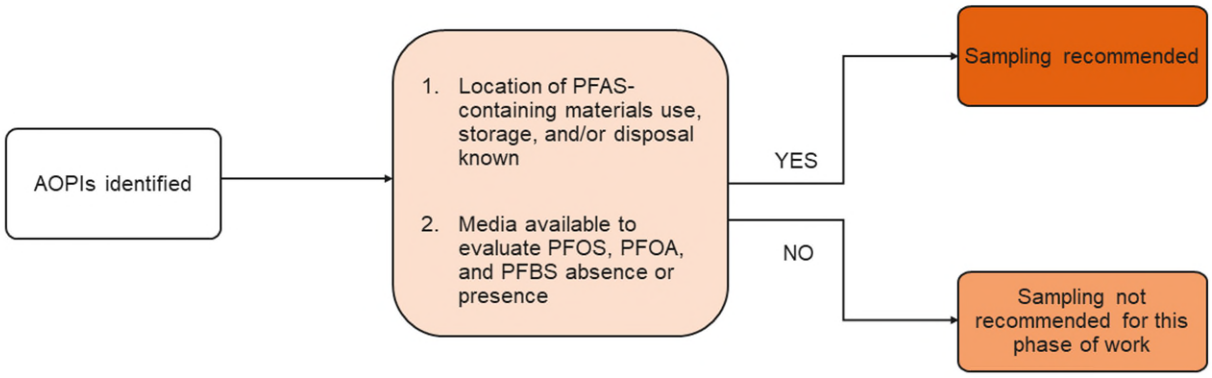

Figure 6-1: AOPI Sampling Decision Tree

The sampling design for Phase I SI sampling activities at FTSL is detailed in Worksheet #17 of the QAPP Addendum (Arcadis 2020a) and Field Change Report (FCR)-FTSL-14. A follow-up field event (referred to as Phase II of this SI) was conducted at the FFTA and in the area south of the FFTA known as the SIB to evaluate potential impacts in environmental media in the downgradient and downstream direction of the main cantonment area. The Phase II SI was executed as a result of the elevated PFOS, PFOA, and PFBS concentrations detected at the FFTA and other AOPIs as well as observations made by installation personnel that an unusual amount of foam was observed in surface water in Sitting Bear Creek near the FFTA in June 2020. The volume of foam was described as enough to fill the cabin of a vehicle. As a result, the FFTA underwent additional sampling and the media near the SIB was sampled. The SIB is downgradient from the FFTA and may also be downgradient from the main cantonment area, including the HPA AOPIs. This sampling was conducted after a rain event. This foam was not observed during the Phase II sampling event but was identified in October 2020 following another rain event.

Groundwater and/or soil samples were collected at or downgradient of all nine AOPIs to capture any releases resulting from use, storage, or disposal of PFAS-containing materials. Due to the proximity of HPA AOPIs to one another, groundwater samples collected around the airfield may inform presence at multiple AOPIs. For example, groundwater at Fire Station 2 (B4914) was collected 700 feet downgradient from the building itself, where nozzle testing runoff would have first contacted soil. Fire Station 2 is located 300 feet upgradient from the Hangar, and the Fire Station 2 sample location is 200 feet downgradient from the Hangar (B4915). Therefore, the samples collected from the Fire Station 2 AOPI may also reflect PFOS, PFOA, and PFBS presence due to releases from the hangar area. The groundwater sample collected from Old Fire Station (B5031) is also located 700 feet downgradient from Fire Station Storage (B5020). The four direct-push technology (DPT) sampling points at the downgradient boundary of the installation at the SIB were located west of East Cache Creek and downgradient of the AOPIs, to assess groundwater quality potentially flowing off post.

Two sediment samples were collected from areas downgradient from four AOPIs [the FFTA, Fire Station 2 (B4914), Fire Station 4 (B1617), and the Hangar (B4915)], and two sediment samples were collected from the SIB. The SIB sediment samples were placed at an upstream and downstream location after reports from installation personnel that foam was identified in Sitting Bear Creek after the June 2020 rain event. The rationale was to potentially capture PFAS constituents downgradient of the AOPIs nearby, and at the point where the creek leaves the installation. A sediment sample was also collected from the

WWTP to investigate whether aqueous media from other potentially PFOS, PFOA, and/or PFBS influenced AOPIs [i.e., Fire Station 4 (B1617), the Hangar (B4915), and/or Fire Station 2 (B4914)] impacted downgradient media via the sanitary system.

Sampling depths noted on figures for existing monitoring wells represent approximately the center of the saturated screened interval.

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.

Soil samples were not collected at Dodge Hill Landfill (FTSL-020) due to uncertainty of the exact disposal location of PFAS-containing soils within the landfill. Rather, PFOS, PFOA, and PFBS were detected in groundwater samples collected downgradient of the Dodge Hill Landfill.

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 J** and **K**, respectively. Photographs of the sampling activities are included in **Appendix L**.

6.3.1 Field Methods

Surface soil samples were collected from the top 2 feet of native soil. They were collected using the DPT methods when paired with a groundwater sample. Otherwise, they were collected using a decontaminated stainless-steel hand auger or shovel. If possible, boring locations were positioned within the suspected release area and composited between 0 to 2 feet.

At groundwater sampling locations, either boreholes were advanced using DPT and temporary monitoring wells were set, or samples were collected from existing monitoring wells. Depending on field conditions, either a peristaltic pump with PFAS-free disposable high-density polyethylene (HDPE) tubing using low-flow purging methods or a PFAS-free disposable bailer was used to collect groundwater samples in these temporary or existing wells. Samples using low-flow purging methods were collected from approximately the center of the saturated screened interval and those collected using disposable bailers were collected from first encountered groundwater.

When available, monitoring wells within or downgradient of an AOPI were sampled at the depth described in **Table 6-1**. **Table 6-1** includes the monitoring well construction details for the wells sampled during the SI. Five monitoring wells were sampled as part of the SI. At existing monitoring wells, groundwater samples were collected from approximately the center of the saturated screened interval with a portable pump via low-flow methods 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).

Additionally, 17 boreholes were advanced via DPT drilling methods for grab groundwater sample collection, including four samples at the SIB. The samples collected via DPT were collected at first encountered groundwater through a decontaminated screen-point sampler via low-flow methods.

The sediment samples were collected from the upper 4 inches of sediment using a hand auger; the sediment sample was decanted before bottling for laboratory analysis.

Surface water samples were collected via direct-fill methods just below the water surface. No other non-dedicated or disposable equipment was used for surface water sample collection. Field parameters (temperature, dissolved oxygen, oxidation/reduction potential, pH, and conductivity) were measured in the surface water body following sample collection.

Decontamination procedures for non-dedicated equipment used during sampling are described in **Section 6.3.5**.

6.3.2 Quality Assurance/Quality Control

Worksheets #20 of the PQAPP, QAPP Addendum, and FCR-FTSL-14 provide QA/QC requirements for field duplicates, matrix spike/matrix spike duplicates, equipment blanks (EBs), source blanks for water used in the initial decontamination step for drill tooling, and field blanks 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) and FCR-FTSL-14 (**Appendix M**), 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 the water level meter, silicone tubing, HDPE tubing, the cutting shoe, the hand auger attachment for collecting the sediment sample, stainless steel trowel, putty knife, and the hand auger attachment for collecting the soil samples. Source blanks were collected from the water used to pressure-wash drill tooling. Analytical results for blank samples are discussed in **Section 7.10**.

6.3.3 Dedicated Equipment Background

During the SI sampling event, low-density polyethylene tubing was found in MW-572. However, this tubing was not utilized for sampling and thus a dedicated equipment background sample was not collected. Additionally, groundwater was purged and parameters were stabilized before collecting the associated groundwater samples. Thus, any concern over leached PFOS, PFOA, and/or PFBS from any low-density polyethylene tubing into groundwater and the associated samples was mitigated.

6.3.4 Field Change Reports

No instances of major scope modifications (i.e., those that may have had a significant impact on the project scope and/or data usability/quality, or required stop-work, and warranted discussion with USACE) were encountered during the FTSL SI work.

Non-conformances to the approved sampling plan which affect the DQOs are documented in Non-Conformance Reports included as **Appendix N** and are summarized below:

- One of the two planned field blank samples proposed in the QAPP was collected as a field duplicate (FTSL-FB-1-041420). DQOs were still met despite not collecting two field blanks. There are enough other field QC samples to meet the DQOs. However, the field sampling plan was not met.

In some cases, clarifications to the established scope of work were needed but did not necessarily constitute a non-conformance from the sampling plans described in the QAPP Addendum. Minor modifications and clarifications to the procedures and scope of work detailed in the QAPP Addendum and PQAPP and that did not affect DQOs are documented in Field Change Reports (FCRs) included as **Appendix M** and are summarized below:

- FCR-FTSL-01 – Fire Station 4 (B1617) - Sample location FTSL-B1617-1-SO/GW was moved south of the planned location due to proximity to underground (water) and above ground (electrical) utilities.
- FCR-FTSL-01 – Fire Station 4 (B1617) - Sample location FTSL-B1617-2-GW was moved east of the planned location by approximately 10 feet due to proximity to underground utilities.
- FCR-FTSL-01 – Fire Station 3 (B3500) - Sample location FTSL-B3500-1-GW was moved from the planned location (west side of Tracy Street) to the east side of Tracy Street due to proximity to underground utilities (water and geothermal).
- FCR-FTSL-04 – Sample FTSL-B4915-1-SO taken from the top 1 foot of soil, rather than the top 2 feet of soil in its planned location due to the presence of nearby underground utilities.
- FCR-FTSL-04 – Sample FTSL-B4915-1-GW was moved 50 feet northeast of the planned location. It was collected to the north side of Post Road due to proximity of underground and aboveground utilities at the planned location.
- FCR-FTSL-04 – Due to the existence of utilities in the planned sampling location, the sample location was moved, and a revised utility locate was called in for FTSL-B4915-1-GW. Thus, sample FTSL-B4915-1-GW was rescheduled to be drilled after Monday 13 April 2020, when the utility locate was scheduled for completion.
- The following samples from DPT/temporary wells were planned to be collected as low-flow samples. Due to a low recharge rate, groundwater samples were collected as grab samples from disposable bailers.
    - FCR-FTSL-02: FTSL-B6041-1-GW
    - FCR-FTSL-02: FTSL-B6041-2-GW

  - FCR-FTSL-03: FTSL-FTSL-045-3-GW
  - FCR-FTSL-05: FTSL-B5031-1-GW
  - FCR-FTSL-06: FTSL-B4914-1-GW
  - FCR-FTSL-07: FTSL-B1617-1-GW
  - FCR-FTSL-08: FTSL-B1617-2-GW
  - FCR-FTSL-07: FTSL-B1617-3-GW
  - FCR-FTSL-10: FTSL-B4915-1-GW
  - FCR-FTSL-16: FTSL-SIB-3-GW
- FCR-FTSL-09 – An additional AOPI at the Fire Station Storage Area (Building 5020) was added to the sampling plan, including three soil samples (FTSL-B5020-1-SO, FTSL-B5020-2-SO, and FTSL-B5020-3-SO).
- FCR-FTSL-11 – The EB sample identifications were updated from what was presented in the QAPP to appropriately reflect the equipment used for sampling on site.
  - EB-2: previously identified as “groundwater tubing”, the blank would be taken from the silicone tubing used for groundwater sampling. This is because the tubing weight described in EB-3 was not needed to reach the well screen.
  - EB-3: previously identified as “tubing weight”, the blank would be taken from the HDPE tubing used for groundwater sampling because the tubing weight was not needed to reach the well screen.
  - EB-4: previously described as “drill equipment”, the equipment used has been specified as the cutting shoe.
  - EB-5: previously described as the “stainless steel trowel”. The hand auger was utilized here to reach the sediment in the creek bed. The hills sloping toward the creek bed were steeper than anticipated. To collect the sample from a safe position, the hand auger was utilized.
  - EB-7: previously described as “other”, the putty knife was selected for the sample.
  - EB-8: previously described as “other”, the hand auger attachment used for soil sampling was selected. The soil was much drier than the sediment (EB-5), so decontamination procedures on the hand auger could have had a difference in effectiveness between the media type.
- FCR-FTSL-12 – FTSL-B1617-3-GW was mistakenly labeled as FTSL-B1617-2-GW in field records and in the chain of custody.
- FCR-FTSL-13 – Installation personnel initially indicated that there was no dedicated equipment present in the monitoring wells located at Dodge Hill Landfill and as a result, no dedicated equipment background sample was planned. During the SI sampling event, low-density polyethylene tubing was found in MW-572. However, this tubing was not utilized for sampling,

parameters in the groundwater were allowed to stabilize, and a dedicated equipment background sample was not collected.

- FCR-FTSL-14 – Elevated concentrations of PFOS, PFOA, and PFBS were observed in the soil and groundwater samples at the FFTA from the Phase I SI sampling event. Due to the elevated PFOS, PFOA, and PFBS detections and observations of foam in the nearby Sitting Bear Creek, the USAEC requested additional samples from the SIB and the FFTA.
- FCR-FTSL-15 – The groundwater sample planned for the Phase II sampling of the FFTA (FTSL-FTSL-045-4-GW) could not be collected due to refusal at shallow bedrock.
- FCR-FTSL-16 – The groundwater sample FTSL-SIB-3-GW was originally planned to be taken as a low-flow sample. Due to a very low recharge rate in this area, groundwater was collected as grab samples using bailers.

6.3.5 Decontamination

Non-dedicated reusable sampling equipment (e.g., stainless-steel trowels, hand augers, drill cutting shoes and casing) 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).

6.3.6 Investigation-Derived Waste

Investigation-derived waste (IDW), including soil cuttings, groundwater, decontamination fluids, and disposable equipment were stored in two 55-gallon drums during Phase I sampling. A third drum was present but not used. The drummed IDW was sampled after the conclusion of the Phase I field event on 16 April 2020. During Phase II sampling, another two drums were used for storing IDW. The drums were collected and disposed of by Defense Logistics Agency Disposition Services. Equipment IDW includes personal protective equipment and other disposable materials (e.g., gloves, plastic sheeting, Lexan tubes, and HDPE and silicon tubing) that may come in contact with sampling media. Analytical results for IDW samples collected during the SI are discussed in **Section 7.8**.

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 Eurofins Lancaster Laboratories Environmental, 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, soil,

surface water, and sediment samples using an analytical method that is ELAP-accredited and compliant with QSM 5.1.1, Table B-15 (DoD 2018).

Additionally, the following general chemistry and physical characteristic analyses were completed for select soil and sediment 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 American Society for Testing and Materials 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 report (DUSR) (**Appendix O)**.

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 5.1.1 (DoD 2018) or 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 DUSR in **Appendix O**. The Level IV analytical reports are included within **Appendix O** 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 FTSL. Documentation generated during the data usability assessments, which were compiled into a DUSR (**Appendix O**), 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 Guidelines Module 3: 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 DUSR.

Based on the final data usability assessment, the environmental data collected at FTSL 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 O**), and as indicated in the full analytical

tables (**Appendix P**) provided for the SI results. These data are of sufficient quality to meet the objectives and requirements of the PQAPP (Arcadis 2019) and FTSL QAPP Addendum (Arcadis 2020a). Data qualifiers applied to laboratory analytical results for samples collected during the SI at FTSL are provided in the data tables, data validation reports, and the Data Usability Summary Table located at the end of 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, and 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 by the OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September 15 (**Appendix A**).
2. All soil and sediment data will be screened against both the Residential Scenario and Industrial/Commercial risk screening levels (if collected from less than 2 feet 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 and surface water data for this Army PFAS PA/SI. While the current and most likely future land uses of the AOPIs at FTSL are industrial/commercial, both residential and industrial/commercial soil risk screening levels for PFOS, PFOA, and PFBS will be used to evaluate detected soil and sediment 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 9**.

7 SUMMARY AND DISCUSSION OF SI RESULTS

This section summarizes the analytical results obtained from samples collected during the SI at FTSL (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), Field Change Report No. FCR-FTSL-14, and as noted in **Table 6-1**. 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 these constituents' concentrations relative to the OSD risk screening levels.

Tables 7-1 through **7-4** provide a summary of the groundwater, soil, sediment, and surface water analytical results for PFOS, PFOA, and PFBS, respectively. **Table 7-5** summarizes AOPIs and whether their SI results exceed the OSD risk screening levels. **Appendix P** includes the full suite of analytical results for these media, as well as for the QA/QC samples. An overview of AOPIs at FTSL with OSD risk screening level exceedances is depicted on **Figure 7-1**. **Figures 7-2** through **7-9** show the PFOS, PFOA, and PFBS analytical results in groundwater, soil, sediment, and surface water for each AOPI, the WWTP, and the SIB. Non-detected results are reported as less than the LOQ. Detections of PFOS, PFOA, and/or 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 and surface water data collected during the SI are reported in ng/L, or parts per trillion, and soil and sediment data are reported in mg/kg, or parts per million.

Field parameters measured for groundwater during low-flow purging and sample collection are provided on the field forms in **Appendix K**. Soil and sediment lithological descriptions are provided on the field forms in **Appendix K**. The results of the SI are grouped by AOPI and discussed for each medium as applicable. Groundwater was generally first encountered at depths of approximately 3 to 20 feet bgs.

Table 7-5 AOPIs and OSD Risk Screening Level Exceedances

AOPI Name	OSD Exceedances (Yes/No)
Fire Station 1 (B6041)	Yes
Fire Station 2 (B4914)	Yes
Fire Station 3 (B3500)	No
Fire Station 4 (B1617)	Yes
Fire Station Storage (B5020)	Yes
Old Fire Station (B5031)	Yes
Hangar (B4915)	Yes
FFTA	Yes
Dodge Hill Landfill	Yes

7.1 Henry Post Airfield AOPIs

The subsections below summarize the analytical results for PFOS, PFOA, and PFBS in groundwater, soil, and sediment associated with the four AOPIs located adjacent to the HPA [Fire Station 2 (B4914), the Hangar (B4915), Fire Station Storage (B5020), and Old Fire Station (B5031)]. The WWTP outfall, downgradient from two of these AOPIs [Fire Station 2 (B4914) and the Hangar (B4915)], was sampled as well. These AOPIs are located in the southeastern portion of the installation, west of East Cache Creek and upgradient from several off-post domestic wells. Groundwater in this area is known to flow to the south and southeast.

7.1.1 Groundwater

Three soil borings were advanced via a DPT drill rig to collect groundwater grab samples at first encountered groundwater downgradient of the four AOPIs at HPA (FTSL-B4914-1-GW, FTSL-B4915-1-GW, and FTSL-B5031-1-GW; **Figure 7-2)**. Groundwater was first encountered at 9 feet bgs at FTSL-B4914-1-GW, 10 feet bgs at FTSL-B4915-1-GW, and 16 feet bgs at FTSL-B5031-1-GW. A summary of PFOS, PFOA, and PFBS groundwater analytical results is provided in **Table 7-1**.

PFOS and PFOA were detected at concentrations greater than the OSD tap water risk screening level of 40 ng/L in all three groundwater samples. The lowest PFOS and PFOA concentrations were 79 ng/L and 74 ng/L at FTSL-B4915-1-GW, which is downgradient of all four AOPIs. The highest PFOS and PFOA concentrations were 6,700 J ng/L and 2,500 J ng/L at FTSL-B5031-1-GW, which is downgradient of Old Fire Station (B5031) and Fire Station Storage (B5020) (**Figure 7-2**). The qualifier of J indicates that the result is an estimated quantity. PFBS concentrations exceeded the OSD tap water risk screening level (600 ng/L) at FTSL-B5031-1-GW (2,100 DJ ng/L) which is downgradient of Old Fire Station (B5031) and Fire Station Storage (B5020).

7.1.2 Soil

Surface soil samples were collected from the top 2 feet of native soil from each of the four AOPIs in the HPA area. One to three soil samples were collected per AOPI for a total of six soil samples collected (FTSL-B4914-1-SO, FTSL-B4915-1-SO, FTSL-B5020-1-SO, FTSL-B5020-2-SO, FTSL-B5020-3-SO, and FTSL-B5031-1-SO; **Figure 7-2**). All soil samples were located within the inferred area of AFFF use or release. A summary of PFOS, PFOA, and PFBS soil analytical results is provided in **Table 7-2**.

PFOS was detected in five of the six soil samples. It was detected below the OSD residential and commercial/industrial risk screening levels (0.13 mg/kg and 1.9 mg/kg, respectively). Detections range between 0.00063 J mg/kg at FTSL-B5020-1-SO and 0.044 mg/kg at FTSL-B4914-1-SO. The qualifier of J indicates that the result is an estimated quantity.

PFOA was detected in four of the six soil samples. It was detected below the OSD residential and commercial/industrial risk screening levels (0.13 mg/kg and 1.9 mg/kg, respectively). Detections range between 0.00055 J mg/kg at FTSL-B4915-1-SO and 0.0054 mg/kg at FTSL-B5031-1-SO.

PFBS was not detected in any of the soil samples collected from within the area.

7.1.3 Sediment

One sediment sample was collected from the outfall from the main cantonment area WWTP to identify potential downgradient transport of PFAS-containing material from two AOPIs at HPA [Fire Station 2 (B4914) and the Hangar (B4915)] as well as from Fire Station 4 (B1617), which is not located at the HPA. There were no detections of PFOA, PFOS, or PFBS in the sample collected from this location (FTSL-WWTP-1-SE). **Figure 7-3** shows the WWTP sediment sample location and analytical results. **Table 7-3** shows the analytical results for the primary and field duplicate sediment samples.

7.2 Fire Station 1

The subsections below summarize the analytical results for PFOS, PFOA, and PFBS in groundwater and soil associated with Fire Station 1. This AOPI is located in the southeastern portion of the installation, west of East Cache Creek but east of HPA and upgradient from several off-post domestic wells. Groundwater in this area is known to flow to the south and southeast.

7.2.1 Groundwater

Two soil borings were advanced via a DPT drill rig to collect groundwater grab samples at first encountered groundwater downgradient of the AOPI (FTSL-B6041-1-GW and FTSL-B6041-2-GW; **Figure 7-4**). Groundwater was first encountered at FTSL-B6041-1-GW and FTSL-B6041-2-GW at 18 and 19 feet bgs, respectively. A summary of PFOS, PFOA, and PFBS groundwater analytical results is provided in **Table 7-1**.

PFOS was detected at concentrations above the OSD tap water risk screening level (40 ng/L) at FTSL-B6041-1-GW (190 J- ng/L) and at FTSL-B6041-2-GW (54 J- ng/L). The qualifier of J- indicates that the result is an estimated quantity and may be biased low.

PFOA was detected at concentrations above the OSD tap water risk screening level (40 ng/L) at FTSL-B6041-1-GW (47 J- ng/L) and at FTSL-B6041-2-GW (82 J- ng/L).

PFBS was detected at concentrations below the OSD tap water risk screening level (600 ng/L) at FTSL-B6041-1-GW (11 J- ng/L) and at FTSL-B6041-2-GW (17 J- ng/L).

7.2.2 Soil

The surface soil sample (FTSL-B6041-1-SO) was collected from the top 2 feet of native soil for the single soil sample collected, which was within the inferred area of AFFF use or release.

PFOS was detected below the OSD residential and commercial/industrial risk screening levels (0.13 mg/kg and 1.9 mg/kg, respectively) at FTSL-B6041-1-SO (0.00068 BJ+). The qualifier of BJ+ indicates that the analyte was detected in an associated blank and that the result is an estimated quantity and may be biased high.

PFOA and PFBS were not detected in this sample. A summary of PFOS, PFOA, and PFBS soil analytical results is provided in **Table 7-2**.

7.3 Fire Station 3 (B3500)

The subsections below summarize the analytical results for PFOS, PFOA, and PFBS in groundwater and soil associated with Fire Station 3. This AOPI is located in the southeastern portion of the installation, west of East Cache Creek and HPA and upgradient from several off-post domestic wells. Groundwater in this area is known to flow to the south and southeast.

7.3.1 Groundwater

Two soil borings were advanced via a DPT drill rig to collect groundwater grab samples at first encountered groundwater downgradient of the AOPI (FTSL-B3500-1-GW and FTSL-B3500-2-GW; **Figure 7-5**). Groundwater was first encountered at FTSL-B3500-1-GW and FTSL-B3500-2-GW at 6 and 2 feet bgs, respectively. A summary of PFOS, PFOA, and PFBS groundwater analytical results is provided in **Table 7-1**.

PFOS was detected in groundwater at concentrations below the OSD tap water risk screening level (40 ng/L) in both samples collected. PFOS concentrations were 21 ng/L and 28 J- ng/L at FTSL-B3500-1-GW and FTSL-B3500-2-GW, respectively. The qualifier of J indicates that the result is an estimated quantity and the qualifier of J- also indicates that the result may be biased low.

PFOA was detected at a concentration below the OSD tap water risk screening level (40 ng/L) at FTSL-B3500-2-GW (12 J ng/L).

PFBS was detected at a concentration below the OSD tap water risk screening level (600 ng/L) at FTSL-B3500-2-GW (12 J- ng/L).

7.3.2 Soil

One surface soil sample was collected from an area adjacent to the driveway, where runoff from the AOPI may accumulate (FTSL-B3500-1-SO); **Figure 7-5**). A summary of PFOS, PFOA, and PFBS soil analytical results is provided in **Table 7-2**.

PFOS was detected at a concentration below the OSD residential and commercial/industrial risk screening levels (0.13 mg/kg and 1.9 mg/kg, respectively) at FTSL-B3500-1-SO (0.0043 mg/kg).

PFOA was detected at a concentration below the OSD residential and commercial/industrial risk screening levels (0.13 mg/kg and 1.9 mg/kg, respectively) at FTSL-B3500-1-SO (0.0019 mg/kg).

PFBS was not detected in soil at this AOPI.

7.4 Fire Station 4 (B1617)

The subsections below summarize the analytical results for PFOS, PFOA, and PFBS in groundwater, soil, and sediment associated with Fire Station 4 (B1617). This AOPI is located in the southeastern portion of the installation, west of East Cache Creek but east of and upgradient from several off-post domestic wells. Groundwater in this area is known to flow to the south and southeast.

7.4.1 Groundwater

Three soil borings were advanced via a DPT drill rig to collect groundwater grab samples at first encountered groundwater downgradient of the AOPI (FTSL-B1617-1-GW, FTSL-B1617-2-GW, and FTSL-B1617-3-GW; **Figure 7-6**). Groundwater was first encountered in these borings at 10, 11, and 11 feet bgs, respectively. A summary of PFOS, PFOA, and PFBS groundwater analytical results is provided in **Table 7-1**.

PFOS was detected at concentrations above the OSD tap water risk screening level (40 ng/L) in all three samples, at FTSL-B1617-1-GW (290 J ng/L), FTSL-B1617-2-GW (450 J ng/L), and FTSL-B1617-3-GW (1,100 J ng/L). The qualifier of J indicates that the result is also an estimated quantity.

PFOA was detected at concentrations above the OSD tap water risk screening level (40 ng/L) in all three samples, at FTSL-B1617-1-GW (65 ng/L), FTSL-B1617-2-GW (140 ng/L), and FTSL-B1617-3-GW (190 J ng/L).

PFBS was detected at concentrations below the OSD tap water risk screening level (600 ng/L) in all three samples. Detections ranged between 7.5 ng/L at FTSL-B1617-1-GW and 17 ng/L at FTSL-B1617-3-GW.

7.4.2 Soil

One soil sample was collected from the top 2 feet of native soil via DPT, which was within a nearby drainage ditch (FTSL-B1617-1-SO; **Figure 7-6**). This sample was collocated with FTSL-B1617-1-GW. A summary of PFOS, PFOA, and PFBS soil analytical results is provided in **Table 7-2**.

PFOS was not detected in soil at this AOPI.

PFOA was detected below the OSD residential and commercial/industrial risk screening levels (0.13 mg/kg and 1.9 mg/kg, respectively) at FTSL-B1617-1-SO (0.0014 mg/kg)

PFBS was not detected in soil at this AOPI.

7.4.3 Sediment

One sediment sample was collected from the outfall from the main cantonment area WWTP to identify potential downgradient transport of PFAS from Fire Station 4 (B1617), Fire Station 2 (B4914), and the Hangar (B4915). There were no detections of PFOA, PFOS, or PFBS in the sample collected from this location (FTSL-WWTP-1-SE). **Figure 7-3** shows the WWTP sediment sample location and analytical results. **Table 7-3** shows the analytical results for the primary and field duplicate sediment samples.

7.5 Former Firefighter Training Area

The subsections below summarize the analytical results for PFOS, PFOA, and PFBS in groundwater, soil, surface water and sediment associated with the FFTA (**Figure 7-7**). The maximum PFOS, PFOA, and PFBS concentrations observed during the SI in groundwater at FTSL were observed in samples collected at or in association with the FFTA. Groundwater flow direction is generally understood to be toward the southeast (EA 2014). **Table 7-1** shows the analytical results for the media sampled at this AOPI. Installation personnel reported that foam was detected in waterways downgradient from the FFTA led to the sampling of surface water and sediment in the Phase II SI. However, at the time of sampling, foam

was not visible in the waterway and thus could not be sampled. It could not be verified based on this Phase II sampling whether this foam was attributable to the presence of PFOS, PFOA, and PFBS in surface water. At the FFTA, there is a thin veneer of overburden material before encountering bedrock. At the eastern boundary of the FFTA, this veneer is as thin as 2 feet or less before encountering bedrock. The groundwater presence at FFTA within overburden and at the overburden/interface is very susceptible to evaporation from the surface and draining of the material into the creek. The bedrock outcrops at Sitting Bear Creek. The field conditions suggest that groundwater from the FFTA at the overburden/interface flows towards Sitting Bear Creek and draining out the sides of the stream cut into the creek. If this is the case, surges of PFOS- PFOA-, and/or PFBS-concentrated water may be encountered in groundwater and surface water during wet seasons and precipitation events.

7.5.1 Groundwater

Three soil borings were advanced via a DPT drill rig to collect groundwater grab samples at first encountered groundwater downgradient of the AOPI (FTSL-FTSL-045-1-GW, FTSL-FTSL-045-2-GW, and FTSL-FTSL-045-3-GW; **Figure 7-7**). Groundwater was first encountered in these borings at 3 feet bgs, 13 feet bgs, and 13 feet bgs, respectively. As part of the Phase II SI, collection of one groundwater sample, co-located with soil sample FTSL-FTSL-045-3-SO, was attempted; however, insufficient water was present at the time of sampling. A summary of PFOS, PFOA, and PFBS groundwater analytical results is provided in **Table 7-1**.

PFOS was detected at concentrations above the OSD tap water risk screening level (40 ng/L) at FTSL-FTSL-045-1-GW (160,000 EJ ng/L), FTSL-FTSL-045-2-GW (54,000 EJ ng/L), and FTSL-FTSL-045-3-GW (6,700 J- ng/L). The qualifier of EJ indicates that the result was above the limit of calibration range and the result is an estimated quantity which may be biased low.

PFOA was detected at concentrations above the OSD tap water risk screening level (40 ng/L) at FTSL-FTSL-045-1-GW (200,000 EJ ng/L), FTSL-FTSL-045-2-GW (29,000 EJ ng/L), and FTSL-FTSL-045-3-GW (25,000 J- ng/L).

PFBS was detected at concentrations above the OSD tap water risk screening level (600 ng/L) at FTSL-FTSL-045-1-GW (6,100 J ng/L), FTSL-FTSL-045-2-GW (2,200 J ng/L), and FTSL-FTSL-045-3-GW (1,300 J- ng/L). The qualifier of J indicates that the result is an estimated quantity. The qualifier of J- indicates that the result was an estimated quantity and may be biased low.

These highest PFOS, PFOA, and PFBS concentrations were detected from the groundwater sample location placed near the center of the FFTA (FTSL-045-1-GW).

7.5.2 Soil

Surface samples were collected from the top 2 feet of native soil from three sampling locations at the FFTA, within or downgradient of the inferred area of AFFF use or release (FTSL-FTSL-045-1-SO, FTSL-FTSL-045-2-SO, and FTSL-FTSL-045-3-SO; **Figure 7-7**). FTSL-FTSL-045-1-SO and FTSL-FTSL-045-2-SO were collocated with FTSL-FTSL-045-1-GW, FTSL-FTSL-045-2-GW. A summary of PFOS, PFOA, and PFBS soil analytical results is provided in **Table 7-2**.

PFOS was detected at concentrations above the OSD residential risk screening level (0.13 mg/kg) at one location (FTSL-FTSL-045-2-SO; 0.24 J mg/kg). This detection was below the OSD industrial/commercial

risk screening level (1.9 mg/kg). PFOS was detected at concentrations below the OSD residential and commercial/industrial risk screening levels in two locations at FTSL-FTSL-045-1-SO (0.035 mg/kg) and FTSL-FTSL-045-3-SO (0.12 J mg/kg). The qualifier of J indicates that the result is an estimated quantity.

PFOA was detected at concentrations below the OSD residential and commercial/industrial risk screening levels (0.13 mg/kg and 1.9 mg/kg, respectively) at FTSL-FTSL-045-1-SO (0.0030 mg/kg), FTSL-FTSL-045-2-SO (0.0080 J mg/kg), and FTSL-FTSL-045-3-SO (0.0065 J mg/kg).

PFBS was not detected in soil at this AOPI.

7.5.3 Surface Water and Sediment

As part of the Phase II SI, one surface water sample, co-located with a sediment sample, was collected from the Sitting Bear Creek, just east of the FFTA (FTSL-FTSL-045-1-SW and FTSL-FTSL-045-1-SE**;** **Figure 7-7**). Foam was observed by installation employees within Sitting Bear Creek in July and October 2020 downstream of the FFTA.

PFOS was detected below the OSD tap water risk screening level (40 ng/L) at FTSL-FTSL-045-1-SW (22 ng/L).

PFOA was detected below the OSD tap water risk screening level (40 ng/L) at FTSL-FTSL-045-1-SW (17 ng/L).

PFBS was detected below the OSD tap water risk screening level (600 ng/L) at FTSL-FTSL-045-1-SW (10 ng/L).

PFOS, PFOA, and PFBS were not detected in sediment at this AOPI. **Tables 7-3** and **7-4** show the analytical results for the sediment and surface water samples, respectively.

7.6 Dodge Hill Landfill (FTSL-020)

The subsections below summarize the groundwater PFOS, PFOA, and PFBS analytical results associated with Dodge Hill Landfill (FTSL-020), which is located northeast of the main cantonment area. Groundwater flows locally to the northwest but regionally to the southeast. Only groundwater was sampled from several existing downgradient monitoring wells at this AOPI. Soil samples were not collected due to uncertainty of the exact disposal location of PFAS-containing soils within the landfill.

7.6.1 Groundwater

Groundwater sampling was conducted at five existing monitoring wells at the Soil Farm and the MSWLF, which are downgradient from the suspected release areas (FTSL-MW572, FTSL-MW570, FTSL-MW-568, FTSL-MW-595, and FTSL-MW-567; **Figure 7-8**). Groundwater was encountered at depths ranging between 3 feet bgs at FTSL-MW570 and 11 feet bgs at FTSL-MW572. A summary of PFOS, PFOA, and PFBS groundwater analytical results is provided in **Table 7-1**.

PFOS was detected at concentrations below the OSD tap water risk screening level (40 ng/L) in all groundwater samples excluding FSTL-MW-595 which was non detect. Detections ranged between 0.98 J ng/L at FTSL-MW-567 and 17 ng/L at FTSL-MW-568. The qualifier of J indicates that the result is an estimated concentration.

PFOA was detected at concentrations above the OSD tap water risk screening level (40 ng/L) at FTSL-MW-568 (110 ng/L). PFOA was detected at concentrations below the OSD tap water risk screening level in three groundwater samples at FTSL-MW572 (37 ng/L), FTSL-MW570 (0.99 J ng/L), and FTSL-MW595 (2.0 J ng/L).

PFBS was detected at concentrations below the OSD tap water risk screening level (600 ng/L) in four groundwater samples. Detections ranged between 1.5 J ng/L at FTSL-MW-595 and 9.3 ng/L at FTSL-MW-568

The highest PFOS, PFOA, and PFBS detections were found at FTSL-MW-568, which is the closest well to Beef Creek in the direction of groundwater flow.

7.7 Southern Installation Boundary Samples

The subsections below summarize the analytical results for PFOS, PFOA, and PFBS in groundwater, surface water, and sediment samples collected at the SIB in Phase II of the SI to evaluate potential PFAS concentrations in the media flowing towards, at, or near the installation boundary (**Figure 7-9, Tables 7-1, 7-3,** and **7-4**). These samples were located along East Cache Creek, its tributary Sitting Bear Creek, and along the installation boundary in the southeastern portion of the installation. Groundwater in this area is generally understood to flow to the southeast.

7.7.1 Groundwater

Four soil borings were advanced via a DPT drill rig to collect groundwater grab samples at first encountered groundwater at the SIB (FTSL-SIB-1-GW, FTSL-SIB-2-GW, FTSL-SIB-3-GW, and FTSL-SIB-4-GW; **Figure 7-9**). Groundwater was first encountered at depths approximately between 10 feet bgs (FTSL-SIB-3-GW) and 18 feet bgs (FTSL-SIB-4-GW). **Table 7-1** presents the analytical results for the groundwater samples collected.

PFOS was detected at concentrations above the OSD tap water risk screening level (40 ng/L) at two locations, FTSL-SIB-1-GW (130 ng/L) and FTSL-SIB-2-GW (150 ng/L). PFOS was detected at concentrations below the OSD tap water risk screening level at two locations, FTSL-SIB-3-GW (22 ng/L) and FTSL-SIB-4-GW (2.8 ng/L).

PFOA was detected at concentrations above the OSD tap water risk screening level (40 ng/L) at two locations, FTSL-SIB-2-GW (97 ng/L) and FTSL-SIB-3-GW (48 ng/L). PFOA was detected at concentrations below the OSD tap water risk screening level at two locations, FTSL-SIB-1-GW (37 ng/L) and FTSL-SIB-4-GW (2.3 ng/L).

PFBS was detected at concentrations below the OSD tap water risk screening level (600 ng/L) at FTSL-SIB-1-GW (30 ng/L), FTSL-SIB-2-GW (120 ng/L), FTSL-SIB-3-GW (41 ng/L), and FTSL-SIB-4-GW (13 ng/L).

7.7.2 Sediment

At one location on Sitting Bear Creek approximately 0.5 mile upstream of the installation boundary and at the installation boundary, two surface water samples (FTSL-SIB-1-SW and FTSL-SIB-2-SW), collocated with sediment samples, were collected (FTSL-SIB-1-SE and FTSL-SIB-2-SE**; Figure 7-9**). Foam had

reportedly been identified by installation employees in the creek in July and October 2020. A sediment sample was placed where this foam had been previously observed and at the installation boundary. **Table 7-3** shows the analytical results for the primary and field duplicate sediment samples.

PFOS, PFOA, and PFBS were not detected in either sediment sample at the SIB.

7.7.3 Surface Water

At one location on Sitting Bear Creek approximately 0.5 mile upstream of the installation boundary and at the installation boundary, two surface water samples, were collected (FTSL-SIB-1-SW and FTSL-SIB-2-SW**; Figure 7-9**). Sediment samples were collocated with these surface water samples. **Table 7-4** shows the analytical results for the primary and field duplicate surface water samples.

PFOS was detected at concentrations below the OSD tap water risk screening level (40 ng/L) at both locations, FTSL-SIB-1-SW (4 ng/L) and FTSL-SIB-2-SW (5.1 ng/L).

PFOA was detected at concentrations below the OSD tap water risk screening level (40 ng/L) at both locations, FTSL-SIB-1-SW (6 ng/L) and FTSL-SIB-2-SW (4.8 ng/L).

PFBS was detected at concentrations below the OSD tap water risk screening level (600 ng/L) at both locations, FTSL-SIB-1-SW (3.8 ng/L) and FTSL-SIB-2-SW (3.4 ng/L).

7.8 Investigation Derived Waste

IDW, including soil cuttings, groundwater, decontamination fluids, and disposable equipment were stored in two 55-gallon drums during Phase I sampling. A third drum was present but not used. One wastewater sample and one soil composite sample were collected from their respective IDW drums after the conclusion of the field event on 16 April 2020. The Phase I results indicated the following concentrations in the wastewater: 67,000 ng/L PFOS, 45,000 ng/L PFOA, and 1,400 ng/L PFBS (**Appendix P**). The Phase I results indicated the following concentrations in the soil: 0.0082 mg/kg PFOS, 0.001 mg/kg PFOA, and 0.0022 mg/kg PFBS.

During Phase II sampling, another two drums were used for storing IDW. Composite samples were collected from these drums as well. The Phase II results indicated the following concentrations in the wastewater: 110 ng/L PFOS, 53 ng/L PFOA, and 50 ng/L PFBS (**Appendix P**). The full analytical results (i.e., for all constituents analyzed) for IDW samples collected during the SI are included in **Appendix P**.

All drums from both sampling events were collected and disposed of by Defense Logistics Agency Disposition Services.

7.9 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. The TOC in the soil samples ranged from 3870 J+ to 23500 J+ mg/kg. The TOC at this installation was typically within range of what is typically observed in topsoil (5,000 to 30,000 mg/kg). One exception was Fire Station 1 (B6041), which was below that range. The combined percentage of fines in soils at FTSL ranged from 31.7 to 67.7% with an average of 51.55%. PFAS tend to be more mobile in soils with less

than 20% fines (silt and clay) and lower TOC. The percent moisture of the soil 22.16% was typical for clay (0 to 20%). The pH of the soil was slightly alkaline (7 to 9). While PFAS are relatively less mobile in soils with high percentages of fines, depleted TOC may allow for enhanced mobility of the constituents in soil.

7.10 Blank Samples

Detections of PFOS, PFOA, and PFBS constituents are summarized below for blank samples. Most detected concentrations were low-level. Other than those noted below, concentrations of PFOS, PFOA, PFBS in all other blank samples were not detected. The full analytical results for blank samples collected during the SI are included in **Appendix P**.

One of the two planned field blank samples proposed in the QAPP was collected as a field duplicate (FTSL-FB-1-041420). DQOs were still met despite not collecting two field blanks.

PFOS was detected in the associated lab method blank for FTSL-SB-1-040920 and FTSL-B6041-1-SO-040820. The PFOS result for FTSL-SB-1-040920 (1.5 ng/L) was qualified as nondetect (UB) at the LOQ. The PFOS result for FTSL-B6041-1-SO-040820 was qualified BJ+ as the sample concentration was greater than the LOQ and less than five times the lab method blank concentration

Low level detections of PFOS and PFOA were made in five equipment blank samples and were originally given a B qualifier. However, the associated sample results were greater than the blank action limit or non-detect, as described in **Appendix O**, and do not influence the sample results. Therefore, the “B” qualifier was removed during validation, as shown in **Appendix P**. These equipment blank samples are described below.

- FTSL-EB-2-040720 - PFOS and PFOA detections were 7.9 ng/L and 2.1 ng/L, respectively. This sample was collected from the silicone tubing used to collect groundwater at FTSL-FTSL-045-1-GW.
- FTSL-EB-3-040820 - PFOS and PFOA detections were 6.3 ng/L and 3.4 ng/L, respectively. This sample was collected from the HDPE tubing stock used to collect groundwater at FTSL-FTSL-045-1-GW.
- FTSL-EB-4-040720 - PFOS and PFOA detections were 9.0 ng/L and 1.7 ng/L, respectively. This sample was collected from the cutting shoe used to collect soil at FTSL-FTSL-045-1-SO and FTSL-FTSL-045-2-SO.
- FTSL-EB-5-040620 - PFOS and PFOA detections were 16 ng/L and 4.3 ng/L, respectively. This sample was collected from the hand auger used to collect sediment at FTSL- WWTP-1-SE-040620.
- FTSL-EB-7-040620 - PFOS and PFOA detections were 9.4 ng/L and 2.6 ng/L, respectively. This sample was collected from the putty knife used to collect soil at FTSL-FTSL-045-1-SO and FTSL-FTSL-045-2-SO.

7.11 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 7-10** through

7-12 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 are surfactants (which do not volatilize) 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 at the AOPIs, affected media are likely to consist of soil, groundwater, surface water, and sediment.

Release and transport mechanisms include dissolution/desorption from soil to groundwater, transport via sediment carried in and dissolution to stormwater and surface water, discharge/recharge between groundwater and surface water, and adsorption/desorption between surface water and sediment. 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 are 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 consideration.

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:

- There are no residences in the immediate vicinity of the AOPIs, and the AOPIs are not likely to be accessed by on-installation residents and recreational users, or by off-installation receptors. Therefore, the soil exposure pathways for these receptors are incomplete.
- Groundwater originating at all AOPIs flows off-post through the installation’s southern boundary. PFOS, PFOA, and PFBS were detected in groundwater samples collected along the SIB. Due to a lack of land use controls off installation and downgradient of FTSL, groundwater exposure pathways for off-installation receptors are potentially complete.

- Because the Lawton Public Water System, which provides potable water to the installation, may in the future install potable groundwater supply wells in the vicinity and/or downgradient of the AOPIs, albeit withdrawing from deep aquifers, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for on-installation site workers and residents is considered to be potentially complete under a possible future use scenario. Recreational users are not likely to contact groundwater during outdoor recreational activities; therefore, the groundwater exposure pathway for on-installation recreational users is incomplete.
- Surface water bodies flow off post through East Cache Creek and Mission Creek. The surface runoff and groundwater adjacent to all AOPIs flows to tributaries of East Cache Creek. Surface water is the primary potable water source in the area, and East Cache Creek is designated for use by Oklahoma Water Quality Standards as public and private water supply. Therefore, the surface water exposure pathway (via drinking water ingestion and dermal contact) for off-installation drinking water receptors is potentially complete. Recreational users off post could contact constituents in surface water and sediment through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for off-installation recreational users are potentially complete.

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

Figure 7-10 shows the CSM for the HPA and Fire Station AOPIs, which include Fire Station 2 (B4914), Hangar (B4915), Fire Station 1 (B6041), Old Fire Station (B5031), Fire Station Storage (B5020), Fire Station 3 (B3500), and Fire Station 4 (B1617). AFFF was confirmed to have been used or stored at Fire Station 2 (B4914), Hangar (B4915), Old Fire Station (B5031), and Fire Station Storage (B5020). AFFF may have been used or stored at Fire Station 1 (B6041), Fire Station 3 (B3500), and Fire Station 4 (B1617).

- PFOS, PFOA, and/or PFBS were detected in soil at the HPA and Fire Station AOPIs. Site workers 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.
- Surface water bodies on post and downgradient of the AOPIs are not used for drinking water. On-installation site workers and residents are not likely to otherwise contact constituents in on-post water bodies; therefore, the surface water and sediment exposure pathways for these receptors are incomplete. Recreational users could contact constituents in East Cache Creek through incidental ingestion and dermal contact. Therefore, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete.

Figure 7-11 shows the CSM for the FFTA (FTSL-045). The FFTA is identified as an AOPI due to reported AFFF use in historical firefighting training and responses.

- PFOS and PFOA were detected in soil at the FFTA, and site workers 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.
- PFOS, PFOA, and PFBS were detected in surface water immediately adjacent to this AOPI but were not detected in sediment. Surface water bodies on post and downgradient of these AOPIs are not used for drinking water. On-installation site workers and residents are not likely to otherwise contact

constituents in on-post water bodies; therefore, the surface water and sediment exposure pathways for these receptors are incomplete. Recreational users could contact constituents in East Cache Creek through incidental ingestion and dermal contact. As PFOS, PFOA, and PFBS were detected in surface water, the surface water exposure pathway for on-installation recreational users is complete. Although PFOS, PFOA, and PFBS were not detected in the sediment, there is a potential for partitioning between surface water and sediment; therefore, the sediment exposure pathway for on-installation recreational users remains potentially complete.

Figure 7-12 shows the CSM for Dodge Hill Landfill. Soil which was potentially impacted by AFFF was placed within this area. Soil samples were not collected at this AOPI due to uncertainty of to the historical disposal location within the landfill. PFOS, PFOA, and PFBS were detected in groundwater samples collected downgradient of the Dodge Hill Landfill.

- Site workers (i.e., installation personnel) could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of dust; as such, the soil exposure pathway for on-installation site workers is potentially complete.
- Surface water bodies on post and downgradient of this AOPI are not used for drinking water. Recreational users could contact constituents in East Cache Creek through incidental ingestion and dermal contact. As such, the surface water and sediment exposure pathways for on-installation recreational users is potentially complete.

Following the SI sampling, all of the nine AOPIs 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 OFF-POST PRIVATE POTABLE WELL INVESTIGATION

Based on SI sampling results, off-post private potable wells were identified for potential sampling as part of the PA/SI investigation at FTSL to determine whether there are off-post impacts to drinking water potentially due to Army operations. These wells are downgradient of groundwater samples collected at the SIB where PFOS and PFOA concentrations were detected at concentrations greater than the USEPA LHA. To identify potential potable wells to include in this sampling effort that were downgradient of the eastern/southeastern installation boundary, an off-post well survey was completed using readily available information from the online OWRB and Oklahoma Department of Environmental Quality well databases, the City of Lawton digital utility line viewer, and a windshield survey that was conducted by FTSL personnel, specifically looking for wellhouses and associated equipment/materials. County records were also reviewed to compile a list of property owners. The FTSL installation team confirmed approximately four sections may have wells included within a 2-mile downgradient area, and the team agreed that all property owners included in the mapped area would be contacted by FTSL personnel via the U.S. Postal Service mail to ensure that the drinking water wells are included for sampling during this investigation.

FTSL personnel attempted to notify 12 property owners of this sampling event by letter delivered by the U.S. Postal Service approximately 06 April 2021. Each letter included a questionnaire regarding the presence of a drinking water well on the property, whether the well currently used for drinking water purposes, whether the owner would allow access to the property for sampling, and, if access is allowed, requested the owner determine an available date for their well to be sampled. Property access and permission to sample the wells on the properties was obtained by FTSL personnel prior to or during the sampling event.

Sampling protocols followed those outlined in this PA/SI report (**Section 6.2**), the Off-Post PQAPP (SERES-Arcadis Joint Venture 2021a) and the FTSL Off-Post Sampling QAPP Addendum (SERES-Arcadis Joint Venture 2021b). Off-post private potable well sampling was completed on 30 April 2021. Based on the results of the off-post sampling, the Army did not identify any locations where PFOS or PFOA concentrations in drinking water exceeded the USEPA LHA of 70 ppt for PFOS and PFOA, individually or combined. A letter report presenting a summary of the off-post private well investigation results and the associated laboratory reports will be included in a subsequent addendum.

9 CONCLUSIONS AND RECOMMENDATIONS

The PFAS PA/SI included two distinct efforts. The PA identified AOPIs at FTSL 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 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 FTSL. Following the evaluation, nine AOPIs were identified.

PFOS, PFOA, and/or PFBS were detected at all nine AOPIs. OSD tap water risk screening levels for PFOS, PFOA, and/or PFBS (40 ng/L, 40 ng/L, and 600 ng/L) were exceeded at eight of these nine AOPIs [all AOPIs excluding Fire Station 3 (B3500)]. The maximum concentrations of PFOS, PFOA, and PFBS in groundwater were observed at the FFTA (FTSL-045; 160,000 EDJ ng/L, 200,000 EDJ ng/L, and 6,100 DJ ng/L, respectively). The next highest groundwater concentrations of PFOS, PFOA, and PFBS were noted at HPA. The groundwater sample collected near the Old Fire Station [(B5031); FTSL-B5031-1-GW], which is also downgradient from Fire Station Storage (B5020), had PFOS and PFOA concentrations of 6,700 DJ ng/L, 2,500 DJ ng/L, respectively. The sample collected near Fire Station 2 [(B4914); FTSL-B4914-1-GW], which is downgradient from Fire Station Storage (B5020), Old Fire Station (B5031), and Hangar (B4915) had the highest PFBS concentrations observed outside the FFTA, with a detection of 2,100 ng/L.

PFOS exceeded the soil OSD residential risk screening level (0.13 mg/kg) at one AOPI (the FFTA [FTSL-45]; 0.24 DJ mg/kg). PFOA did not exceed the OSD residential risk screening level (0.13 mg/kg) at any of the nine AOPIs but was observed at its highest detection at the FFTA (FTSL-045; 0.008 J mg/kg). PFBS was not detected in soil at any of the nine AOPIs. PFOS and PFOA were not detected at concentrations above the OSD commercial/industrial risk screening levels at any AOPI (1.9 mg/kg).

Groundwater underneath the main cantonment area is understood to flow to the south and southeast. As the SIB samples are located southeast from the HPA and south of the FFTA, it is recommended that the area downgradient of the FFTA and HPA AOPIs in the direction of the SIB be investigated up to the installation boundary as part of the remedial investigation.

Following the SI sampling, all nine of the AOPIs with confirmed PFOS, PFOA, and/or PFBS presence were considered to have complete or potentially complete exposure pathways.

Soil exposure pathways for on-installation site workers are potentially complete at one AOPI. Soil exposure pathways for on-installation site workers are complete at the remaining eight AOPIs. There are nine AOPIs at which the groundwater exposure pathways for on-post receptors are potentially complete. These AOPIs are upgradient of or potentially impacting future groundwater wells that may be developed to provide drinking water at FTSL in the future.

Due to a lack of land use controls off-installation and downgradient of FTSL, the groundwater exposure pathways for off-installation receptors are also potentially complete for nine AOPIs. Surface water bodies on-post and downgradient of these are not used for drinking water. Recreational users could contact constituents in East Cache Creek through incidental ingestion and dermal contact; as such, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete. Surface water bodies flow off-post through East Cache Creek and Mission Creek. The surface runoff and groundwater adjacent to all AOPIs flow to tributaries of East Cache Creek. East Cache Creek is established for use by Oklahoma Water Quality Standards as public and private water supply. Therefore, the surface water exposure pathway (via drinking water ingestion and dermal contact) for off-installation drinking water receptors is potentially complete. Recreational users off-post could contact constituents in surface water and sediment through incidental ingestion and dermal contact; as such, the surface water and sediment exposure pathways for off-installation recreational users are potentially complete.

Although the CSMs indicate complete or potentially complete exposure pathways may exist, the recommendation for future study in a remedial investigation or no action at this time 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 9-1** below summarizes the AOPIs identified at FTSL, PFOS, PFOA, and PFBS sampling and recommendations for each AOPI; further investigation is warranted at FTSL. In accordance with CERCLA, site-specific risk will be assessed during a future phase to evaluate whether remedial actions are required.

Table 9-1 Summary of AOPIs Identified during the PA, PFOS, PFOA, and PFBS Sampling at Fort Sill, and Recommendations

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/NS)				Recommendation
	GW	SO	SW	SE	
FFTA FTSL-045[1]	Yes	Yes	No	No	Future study in a remedial investigation
Fire Station 4 (B1617)	Yes	No	NS	No	Future study in a remedial investigation
Fire Station 3 (B3500)	No	No	NS	NS	No action at this time
Fire Station 2 (B4914)[1]	Yes	No	NS	No	Future study in a remedial investigation
Hangar (B4915)[1]	Yes	No	NS	No	Future study in a remedial investigation
Old Fire Station (B5031)[1]	Yes	No	NS	NS	Future study in a remedial investigation
Fire Station 1 (B6041)	Yes	No	NS	NS	Future study in a remedial investigation
Fire Station Storage (B5020)[1]	Yes	No	NS	NS	Future study in a remedial investigation

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/NS)				Recommendation
	GW	SO	SW	SE	
Dodge Hill Landfill	Yes	NS	NS	NS	Future study in a remedial investigation

Notes:

[1] The SIB was sampled in association with these AOPIs, where groundwater exceedances of the tap water OSD risk screening level were observed.

Light gray shading – detection greater than the OSD risk screening level

GW – groundwater

NS – not sampled

SE – sediment

SO – soil

SW – surface water

Data collected during the PA (**Sections 3** through **5**) and SI (**Sections 6** through **8**) were sufficient to draw conclusions and recommendations summarized above. The data limitations relevant to the development of this PA/SI for PFOS, PFOA, and PFBS at FTSL are discussed below.

Fire Department AFFF storage on the installation rotated frequently to buildings scheduled for demolition. However, a complete list of facilities used for AFFF storage was not identified. If AFFF had been spilled at a previous storage area that was later demolished, PFOS, PFOA, and/or PFBS may be present in the surrounding media.

The timeline of completion and change-out procedures (i.e., flushing practices and/or AFFF and system component disposal) for updating foam systems in the Hangar (B4915) from AFFF to high- expansion foams is unknown, if it did occur. If improper change-out procedures were used, residual AFFF may still be in the piping infrastructure of these hangar fire suppression systems. It is unknown if Building 4908 – Hangar ever used AFFF in their fire suppression systems prior to high-expansion foams.

Additionally, locations of potentially compromised infrastructure of the FTSL sewer system, which has received AFFF from the Hangar (B4915) and the wash racks accompanying Fire Station 2 (B4914) and Fire Station 4 (B1617), have not been identified; leaks or cracks in piping may have led to secondary releases of PFOS, PFOA, and/or PFBS along the utility corridor.

Furthermore, as the WWTP may have received PFAS-containing stormwater from the aforementioned operations, it may be present in the sludge applied to agricultural plots across the installation, used to grow crops to feed livestock animals. The locations of these plots and application dates have not been identified.

Landfill 10 was used primarily for disposal of sanitary waste, paint sludge, asbestos, wash rack wastes, and pesticides. Documents also reported electrostatic etch solution and cyanide waste tied to electroplating activities being disposed of here. Chromium plating is a technique of electroplating and although these sites indicate electroplating taking place, they do not necessarily involve chromium and the associated mist suppressants. Further information about this area and whether chromium plating may also have occurred here was not identified.

Interviews indicate that contaminated soil from the FFTA was excavated and remediated at the Soil Farm located at the Dodge Hill Landfill. However, the type of remediation performed on this soil was not identified.

Records reviewed during the PA process were limited in information regarding AFFF use; procurement records of AFFF, and documentation of AFFF used during crash responses or fire training activities were not available. Anecdotal accounts of AFFF (or other PFAS-containing material) use, storage, and disposal were limited to available installation personnel, whose knowledge of AFFF (or other PFAS-containing material) use, storage, and disposal may have been restricted by their time spent at the installation or previous roles held that limited their relevant knowledge PFAS-containing material use. In addition, anecdotal accounts did not always include the exact location of the use, storage, or disposal of a PFAS-containing material. For example, the retired FTSL fire department staff member who was interviewed during the PA site visit provided details about two aircraft crashes that have occurred on HPA. They could recount the general vicinity where the crash may have occurred, but not with sufficient detail to identify specific areas that could be documented as AOPIs. AFFF deployment during these crashes may potentially contribute to detections of PFOS, PFOA, and/or PFBS observed at the HPA. Furthermore, information regarding the exact location of the reported off-post helicopter crashes in 1992 and 1993 was not available. As a result, these locations could not be evaluated.

“Wet lining”, or “foam lining”, where AFFF concentrate was diluted with greater amounts of water and sprayed over vegetation, was also known to have been routinely practiced to prevent the spread of brush fires prior to 2016. However, locations where wet lining was performed was not identified.

Notifications from installation employees that foam was detected in waterways downgradient from the FFTA led to the sampling of surface water and sediment in the Phase II SI. However, at the time of sampling, foam was not visible in the waterway and thus could not be sampled. It could not be verified based on this Phase II sampling whether this foam was attributable to the presence of PFOS, PFOA, and PFBS in surface water. At the FFTA, there is a thin veneer of overburden material before encountering bedrock. At the eastern boundary of the FFTA, this veneer is as thin as 2 feet or less before encountering bedrock. The groundwater presence at FFTA within overburden and at the overburden/interface is very susceptible to evaporation from the surface and draining of the material into the creek. The bedrock outcrops out onto Sitting Bear Creek. The field conditions suggest that groundwater from the FFTA at the overburden/interface flows towards Sitting Bear Creek; weeping out the sides of the stream cut into the creek. If this is the case, surges of PFOS-, PFOA-, and/or PFBS-concentrated water may be encountered in groundwater and surface water during wet seasons and events. Phase I and Phase II sampling were limited to dry weather conditions.

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**).

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 documents research, installation personnel interviews, and site reconnaissance.

Finally, available data, including PFOS, PFOA, and PFBS, listed in **Appendix P**, were analyzed per the selected analytical method.

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

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ACRONYMS

°F	degrees Fahrenheit
%	percent
AFFF	aqueous film-forming foam
AOPI	area of potential interest
American Water	American Water Military Services Group
Arcadis	Arcadis U.S., Inc.
Army	United States Army
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CSM	conceptual site model
DoD	Department of Defense
DPT	direct-push technology
DQO	data quality objectives
DUSR	Data Usability Summary Report
EA	EA Engineering, Science and Technology, Inc.
EB	equipment blank
EDR	Environmental Data Resources, Inc.
ELAP	Environmental Laboratory Accreditation Program
FCR	Field Change Report
FFTA	former firefighter training area
FTSL	Fort Sill
GIS	geographic information system
GSA	Gene Stout and Associates
GW	groundwater
HDPE	high-density polyethylene
HPA	Henry Post Airfield
HQAES	Headquarters Army Environmental System
IDW	investigation-derived waste
IMCOM	Installation Management Command

installation	United States Army or Reserve installation
IRP	Installation Restoration Program
JIIM	Joint, Interagency, Intergovernmental, and Multinational
LHA	lifetime health advisory
LOD	limit of detection
LOQ	limit of quantitation
LRC	Logistics Readiness Center
mg/kg	milligrams per kilogram (parts per million)
MSWLF	Municipal Solid Waste Landfill
ND	non-detect
ng/L	nanograms per liter (parts per trillion)
NS	not sampled
OSD	Office of the Secretary of Defense
OWRB	Oklahoma Water Resources Board
PA	preliminary assessment
Parsons	Parsons Engineering Science
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic 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
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RSL	Regional Screening Level
SE	sediment

SI	site inspection
SIB	southern installation boundary
SO	soil
SOP	standard operating procedure
SSHP	Site Safety and Health Plan
SW	surface water
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
WWTP	wastewater treatment plant

TABLES

Table 2-1 - On-Post Potable Water Wells
USAEC PFAS Preliminary Assessment/Site Inspection
Fort Sill, Oklahoma

Well ID*	Well Type	Total Well Depth (ft bgs)	Well Casing Diameter (inches)	Top of Screen Depth (ft bgs)	Completion Date	Estimated Well Yield (gpm)	Geologic Material/Unit	Well Status
86728	Domestic	120	4	100	5/27/2004	10	Clay; sand	Active
Fort Sill Camp Eagle OK2001641 - WL002	Public Water Supply	NA	NA	NA	NA	NA	NA	NA

Table 2-2 - Historical PFOS, PFOA, and PFBS Analytical Data
USAEC PFAS Preliminary Assessment/Site Inspection
Fort Sill, Oklahoma

Data Source	Water System			Facility Name	Sample Date	Sample ID	Perfluorobutanesulfonic acid (PFBS) (µg/L)	Perfluorooctanoic acid (PFOA) (µg/L)	Perfluorooctane sulfonate (PFOS) (µg/L)
	ID	Name	Type						
EPA[1]	OK3001601	Fort Sill	SWP	Lawton Intertie/Pump Station 2	2/5/2013	3B06145-01	<0.09	<0.02	< 0.04
EPA[1]	OK3001601	Fort Sill	SWP	Lawton Intertie/Pump Station 2	5/7/2013	3E08119-01	<0.09	<0.02	< 0.04
EPA[1]	OK3001601	Fort Sill	SWP	Lawton Intertie/Pump Station 2	8/6/2013	3H07176-01	<0.09	<0.02	< 0.04
EPA[1]	OK3001601	Fort Sill	SWP	Lawton Intertie/Pump Station 2	11/5/2013	3K06191-01	<0.09	<0.02	< 0.04
EPA[1]	OK1011303	Lawton	SW	SE Water Treatment Plant	9/2/2014	4I03141-04	<0.09	<0.02	< 0.04
EPA[1]	OK1011303	Lawton	SW	SE Water Treatment Plant	6/3/2014	4F04087-04	<0.09	<0.02	< 0.04
EPA[1]	OK1011303	Lawton	SW	SE Water Treatment Plant	12/2/2014	4L03082-04	<0.09	<0.02	< 0.04
EPA[1]	OK1011303	Lawton	SW	SE Water Treatment Plant	3/3/2015	5C04049-04	<0.09	<0.02	< 0.04
EPA[1]	OK1011303	Lawton	SW	WTP #2 (North Plant)	6/3/2014	4F04087-01	<0.09	<0.02	< 0.04
EPA[1]	OK1011303	Lawton	SW	WTP #2 (North Plant)	9/2/2014	4I03141-01	<0.09	<0.02	< 0.04
EPA[1]	OK1011303	Lawton	SW	WTP #2 (North Plant)	12/2/2014	4L03082-01	<0.09	<0.02	< 0.04
EPA[1]	OK1011303	Lawton	SW	WTP #2 (North Plant)	3/3/2015	5C04049-01	<0.09	<0.02	< 0.04
EPA[1]	OK3001676	Pecan Valley Addition	SWP	Master Meter	1/15/2013	100235Q	<0.09	<0.02	< 0.04
EPA[1]	OK3001676	Pecan Valley Addition	SWP	Master Meter	4/1/2013	101059P	<0.09	<0.02	< 0.04
EPA[1]	OK3001676	Pecan Valley Addition	SWP	Master Meter	7/15/2013	101662P	<0.09	<0.02	< 0.04
EPA[1]	OK3001676	Pecan Valley Addition	SWP	Master Meter	10/28/2013	102543P	<0.09	<0.02	< 0.04
IMCOM[2]	N/A	Fort Sill	SWP	Camp Eagle Pump House	3/3/2015	N/A	NS	<0.02	<0.02
IMCOM[2]	N/A	Fort Sill	SWP	Camp Eagle Pump House	10/25/2016	3573577	NS	<0.02	<0.02
IMCOM[2]	N/A	Fort Sill	SWP	LETRA Water Plant	10/25/2016	3573575	NS	<0.02	<0.02

Notes:

[1]Data supplied by the EPA: https://www.epa.gov/dwucmr/occurrence-data-unregulated-contaminant-monitoring-rule#3. Samples collected by operators from these respective water systems

[2]Data and qualifiers are as provided by Installation Management Command PFOA/PFOS Water System Testing data. Samples collected by the City of Lawton

Method EPA 537 was utilized

ID = identification

N/A = not applicable

NS = not sampled

PFBS = perfluorobutanesulfonic acid

PFOA = perfluorooctanoic acid

PFOS = perfluorooctane sulfonate

SE- Southeast

SW- Surface Water

SWP - Purchased Surface Water

µg/L = micrograms per liter (parts per billion)

Table 6-1 - Monitoring Well Construction Details
USAEC PFAS Preliminary Assessment/Site Inspection
Fort Sill, Oklahoma

Well Identification	Elevation at TOC (ft amsl)	Ground Surface Elevation (ft amsl)	Total Depth (ft bgs)	Depth to Water (ft bgs)	Groundwater Elevation (ft amsl)	Screen Interval (ft bgs)	Well Diameter (inches)	Screened Lithologic Unit
Landfill Monitoring Wells								
MW572	1198.27	NS	35.83	10.87	1187.4	25.2 - 35.2	6	NS
MW570	1177.36	NS	72.39	3.21	1174.15	60.6 - 70.6	6	
MW568	1186.08	NS	50.20	6.34	1179.74	39.4 - 49.5	6	
MW567	1183.04	NS	23.99	8.92	1174.12	11.7 - 21.7	6	
MW595	1183.41	NS	37.61	7.1	1176.31	15.9 - 25.9	6	
Temporary Boreholes for Grab Groundwater Sampling[1]								
FTSL-B6041-1-GW	NS	NS	20	17.91	NC	15 – 20	1	Clay
FTSL-B6041-2-GW	NS	NS	20	18.51	NC	15 – 20	1	Sand
FTSL-045-1-SO/GW	NS	NS	10	3	NC	5 – 10	1	Clay
FTSL-045-2-SO/GW	NS	NS	7.5	4.5	NC	2.5 – 7.5	1	Clay
FTSL-045-3-GW	NS	NS	20	3.49	NC	15 – 20	1	Limestone
FTSL-B4915-1-SO/GW	NS	NS	15	8.76	NC	10 – 15	1	Sand
FTSL-B4914-1-SO/GW	NS	NS	15	9.8	NC	10 – 15	1	Gravel
FTSL-B5031-1-SO/GW	NS	NS	20	15.84	NC	15 – 20	1	Sand
FTSL-B1617-1-SO/GW	NS	NS	15	9.58	NC	10 – 15	1	Shale
FTSL-B1617-2-GW	NS	NS	15	11	NC	10 – 15	1	Gravel
FTSL-B1617-3-GW	NS	NS	15	11.1	NC	10 – 15	1	Gravel
FTSL-B3500-1-GW	NS	NS	20	6.44	NC	15 – 20	1	Clay
FTSL-B3500-2-GW	NS	NS	25	1.5	NC	20 – 25	1	Clay
FTSL-SIB-1-GW	NS	NS	20.12	15.92	NC	15 – 20	1	Clay
FTSL-SIB-2-GW	NS	NS	20.11	14.11	NC	15 – 20	1	Clay
FTSL-SIB-3-GW	NS	NS	10.11	9.7	NC	5 – 10	1	Clay
FTSL-SIB-4-GW	NS	NS	20.08	17.51	NC	15 – 20	1	Clay

Notes and Acronyms:

1. Temporary boreholes were advanced for grab groundwater sample collection at areas of potential interest. Groundwater was sampled at first encountered groundwater, and the boreholes were abandoned in accordance with state requirements after sample collection.

amsl – above mean sea level

bgs – below ground surface

ft – feet

NC – not calculated

NS – not surveyed

TOC – top of casing

Source:

URS Group, Inc. 2019. Groundwater Monitoring Report July 2019 Sampling Event Dodge Hill Municipal and Construction and Demolition Landfills, Permits 3516018 and 3516019, Fort Sill, Oklahoma. October.

Table 7-1 - Groundwater PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort Sill, Oklahoma

					Analyte	PFOS (ng/l)		PFOA (ng/l)		PFBS (ng/L)	
					OSD Tapwater Risk Screening Level	40		40		600	
Associated AOPI	**Location Type**	**Location**	**Sample ID / Parent Sample ID**	**Sample Date**	**Sample Type**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
FFTA (FTSL-045)	Groundwater boring	FTSL-045	FTSL-FTSL-045-1-GW-040720 / FTSL-FD-1-040720FD	04/07/2020	N	**160000**	EJ	**180000**	EJ	**6000**	J
				04/07/2020	FD	**150000**	EJ	**200000**	EJ	**6100**	J
			FTSL-FTSL-045-2-GW-040720	04/07/2020	N	**54000**	EJ	**29000**	EJ	**2200**	J
			FTSL-FTSL-045-3-GW-040820	04/08/2020	N	**6700**	J-	**25000**	J-	**1300**	J-
Fire Station 4 (B1617)	Groundwater boring	FTSL-B1617	FTSL-B1617-1-GW-041020	04/10/2020	N	**290**	J	**65**		**7.5**	
			FTSL-B1617-3-GW-041020	04/10/2020	N	**1100**	J	**190**	J	**17**	
			FTSL-B1617-2-GW-041320	04/13/2020	N	**450**	J	**140**		**14**	
Fire Station 3 (B3500)	Groundwater boring	FTSL-B3500	FTSL-B3500-2-GW-041320	04/13/2020	N	**21**		**12**	J	**12**	J-
			FTSL-B3500-1-GW-041320	04/13/2020	N	**28**	J-	20	UJ-	20	UJ-
Fire Station 2 (B4914)	Groundwater boring	FTSL-B4914	FTSL-B4914-1-GW-040920	04/09/2020	N	**370**	J	**1000**	J	**2100**	J
Hangar (B4915)	Groundwater boring	FTSL-B4915	FTSL-B4915-1-GW-041420	04/14/2020	N	**79**		**74**		**11**	
Old Fire Station (B5031) and Fire Station Storage (B5020)	Groundwater boring	FTSL-B5031	FTSL-B5031-1-GW-040920	04/09/2020	N	**6700**	J	**2500**	J	**460**	J
Fire Station 1 (B6041)	Groundwater boring	FTSL-B6041	FTSL-B6041-2-GW-040820	04/08/2020	N	**54**	J-	**82**	J-	**17**	J-
			FTSL-B6041-1-GW-040820	04/08/2020	N	**190**	J-	**47**	J-	**11**	J-
Dodge Hill Landfill (FTSL-020)	Monitoring well	FTSL-MW-567	FTSL-MW567-GW-041520	04/15/2020	N	**0.98**	J	1.8	U	1.8	U
		FTSL-MW-568	FTSL-MW568-GW-041520	04/15/2020	N	**17**		**110**		**9.3**	
		FTSL-MW570	FTSL-MW570-GW-041420	04/14/2020	N	**5.8**		**0.99**	J	**2.4**	
		FTSL-MW572	FTSL-MW572-GW-041420 / FTSL-FB-1-041420	04/14/2020	N	**6.4**		**37**		**6.5**	
				04/14/2020	FD	1.8	U	**2.0**	J	**1.5**	J
		FTSL-MW-595	FTSL-MW595-GW-041520	04/15/2020	N	**6.4**		**35**		**6.6**	
Southern Installation Boundary (SIB)	Groundwater boring	FTSL-SIB-1	FTSL-SIB-1-GW-092320 / FTSL-FD-2-GW-092320	09/23/2020	N	**120**		**37**		**29**	J-
				09/23/2020	FD	**130**		**37**		**28**	J+
		FTSL-SIB-2	FTSL-SIB-2-GW-092320	09/23/2020	N	**150**		**97**		**120**	J-
		FTSL-SIB-3	FTSL-SIB-3-GW-092320	09/23/2020	N	**22**	J	**48**		**41**	
		FTSL-SIB-4	FTSL-SIB-4-GW-092320	09/23/2020	N	**2.8**	J	**2.3**	J	**12**	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 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.).
3. One of the two planned field blank samples proposed in the QAPP was collected as a field duplicate (FTSL-FB-1-041420). Data quality objectives (DQOs) will still have been met despite not collecting two field blanks. There are enough other field quality control (QC) samples to meet the DQOs.

Acronyms/Abbreviations:

AOPI = Area of Potential Interest
E = The reported result is above the limit of the calibration range.
FD = field duplicate sample
FFTA = former firefighter training area
FTSL = Fort Sill
ID = identification
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.
N = primary sample
ng/L = nanograms per liter (parts per trillion)
PFBS = perfluorobutane sulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonic acid
Qual = qualifier
SIB = Southern Installation Boundary
U = The analyte was analyzed for but the result was not detected above the limit of quantitation.
UJ = The analyte was analyzed for but was not detected. The limit of quantitation is approximate and may be inaccurate or imprecise.

Table 7-2: Soil PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort Sill, Oklahoma

					Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
					OSD Industrial/Commercial Risk Screening Level	1.6		1.6		25	
					OSD Residentiall Risk Screening Level	0.13		0.13		1.9	
Associated AOPI	Location Type	Location	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
FFTA (FTSL-045)	Soil	FTSL-045	FTSL-FTSL-045-1-SO-040720	04/07/2020	N	**0.035**		**0.003**		0.0023	U
			FTSL-FTSL-045-2-SO-040720	04/07/2020	N	**0.24**	J	**0.008**	J	0.0022	U
			FTSL-FD-2-SO-092220 / FTSL-FTSL-045-3-SO-092220	09/22/2020	N	**0.077**	J+	**0.0065**	J	0.0022	U
				09/22/2020	FD	**0.12**		**0.014**	J	0.0021	U
Fire Station 4 (B1617)	Soil	FTSL-B1617	FTSL-B1617-1-SO-041020	04/10/2020	N	0.00067	U	**0.0014**		0.0022	U
Fire Station 3 (B3500)	Soil	FTSL-B3500	FTSL-B3500-1-SO-040920	04/09/2020	N	**0.0043**		**0.0019**		0.0023	U
Fire Station 2 (B4914)	Soil	FTSL-B4914	FTSL-B4914-1-SO-040920	04/09/2020	N	**0.044**		**0.00092**		0.0022	U
Hangar (B4915)	Soil	FTSL-B4915	FTSL-B4915-1-SO-041420 / FTSL-1-SO-041420FD	04/14/2020	N	**0.0013**		**0.00055**	J	0.0026	U
				04/14/2020	FD	**0.002**		**0.00074**		0.0024	U
Fire Station Storage (B5020)	Soil	FTSL-B5020	FTSL-B5020-1-SO-041620	04/16/2020	N	**0.00063**	J	0.00064	U	0.0021	U
			FTSL-B5020-2-SO-041620	04/16/2020	N	0.00065	U	0.00065	U	0.0022	U
			FTSL-B5020-3-SO-041620	04/16/2020	N	**0.018**		**0.001**		0.0024	U
Old Fire Station (B5031)	Soil	FTSL-B5031	FTSL-B5031-1-SO-040920	04/09/2020	N	**0.0057**		**0.0054**		0.0023	U
Fire Station 1 (B6041)	Soil	FTSL-B6041	FTSL-B6041-1-SO-040820	04/08/2020	N	**0.00068**	BJ+	0.00065	U	0.0022	U

Table 7-2: Soil PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort Sill, Oklahoma

Notes:

1. **Bolded** values indicate the result was detected greater than the limit of detection

3. Data are compared to the Office of the Secretary of Defense (OSD) risk screening levels for the residential and commerical/industrial scenario (OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September.).

3. Gray shaded values indicate the result was detected greater than the residential scenario risk screening levels (OSD 2019).

Acronyms/Abbreviations:

-- = not applicable/not analyzed
AOPI = Area of Potential Interest
DPT = Direct-Push Technology
FD = field duplicate sample
FFTA = former firefighter training area
FTSL = Fort Sill
ID = identification
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.
mg/kg = milligrams per kilogram (parts per million)
N = primary sample
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutane sulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
Qual = qualifier
U = The analyte was analyzed for but the result was not detected above thelimit 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.

Table 7-3: Sediment PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort Sill, Oklahoma

					Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
					OSD Industrial/Commercial Risk Screening Level	1.6		1.6		25	
					OSD Residentiall Risk Screening Level	0.13		0.13		1.9	
Associated AOPI	Location Type	Location	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
Fire Station 2 (B4914), Hangar (B4915), and Fire Station 4 (B1617)	Sediment	FTSL-WWTP-1	FTSL-FD-1-SE-040620 / FTSL-WWTP-1-SE-040620	04/06/2020	N	0.00081	U	0.00081	U	0.0027	U
				04/06/2020	FD	0.00076	U	0.00076	U	0.0025	U
Former Firefighter Training Area	Sediment	FTSL-FTSL-045-1	FTSL-FTSL-045-1-SE-092120	09/21/2020	N	0.00075	U	0.00075	U	0.0025	U
Southern Installation Boundary (SIB)	Sediment	FTSL-SIB-1	FTSL-SIB-1-SE-092220	09/22/2020	N	0.00077	U	0.00077	U	0.0026	U
	Sediment	FTSL-SIB-2	FTSL-FD-2-SE-092120 / FTSL-SIB-2-SE-092120	09/21/2020	N	0.00078	U	0.00078	U	0.0026	U
				09/21/2020	FD	0.0008	U	0.0008	U	0.0027	U

Table 7-3: Sediment PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort Sill, Oklahoma

Notes:

1. **Bolded** values indicate the result was detected greater than the limit of detection
2. Data are compared to the Office of the Secretary of Defense (OSD) risk screening levels for the residential and commerical/industrial scenario (OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September.). No concentrations of PFBS, PFOS, or PFOA exceeded the OSD risk screening levels.

Acronyms/Abbreviations:

-- = not applicable/not analyzed
AOPI = Area of Potential Interest
DJ = The analyte was analyzed at dilution and the result is an estimated quantity
DPT = Direct-Push Technology
FD = field duplicate sample
ID = identification
FTSL = Fort Sill
M = Manual integrated compound
mg/kg = milligrams per kilogram (parts per million)
N = primary sample
PFBS = perfluorobutane sulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
Qual = qualifier
SIB = Southern Installation Boundary
U = The analyte was analyzed for but the result was not detected above thelimit of quantitation (LOQ).
WWTP = wastewater treatment plant

Table 7-4: Surface Water PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort Sill, Oklahoma

						PFOS (ng/l)		PFOA (ng/l)		PFBS (ng/L)	
					Analyte						
Associated AOPI	Location Type	Location	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
Former Firefighter Training Area	Surface Water	FTSL-FTSL-045-1	FTSL-FTSL-045-1-SW-092120	09/21/2020	N	**22**		**17**		**10**	J-
Southern Installation Boundary (SIB)	Surface Water	FTSL-SIB-1	FTSL-SIB-1-SW-092220	09/22/2020	N	**4.0**		**6.0**		**3.8**	J-
	Surface Water	FTSL-SIB-2	FTSL-SIB-2-SW-092120 / FTSL-FD-1-SW-092120	09/21/2020	N	**4.2**		**4.8**		**2.9**	
				09/21/2020	FD	**5.1**		**4.8**		**3.4**	

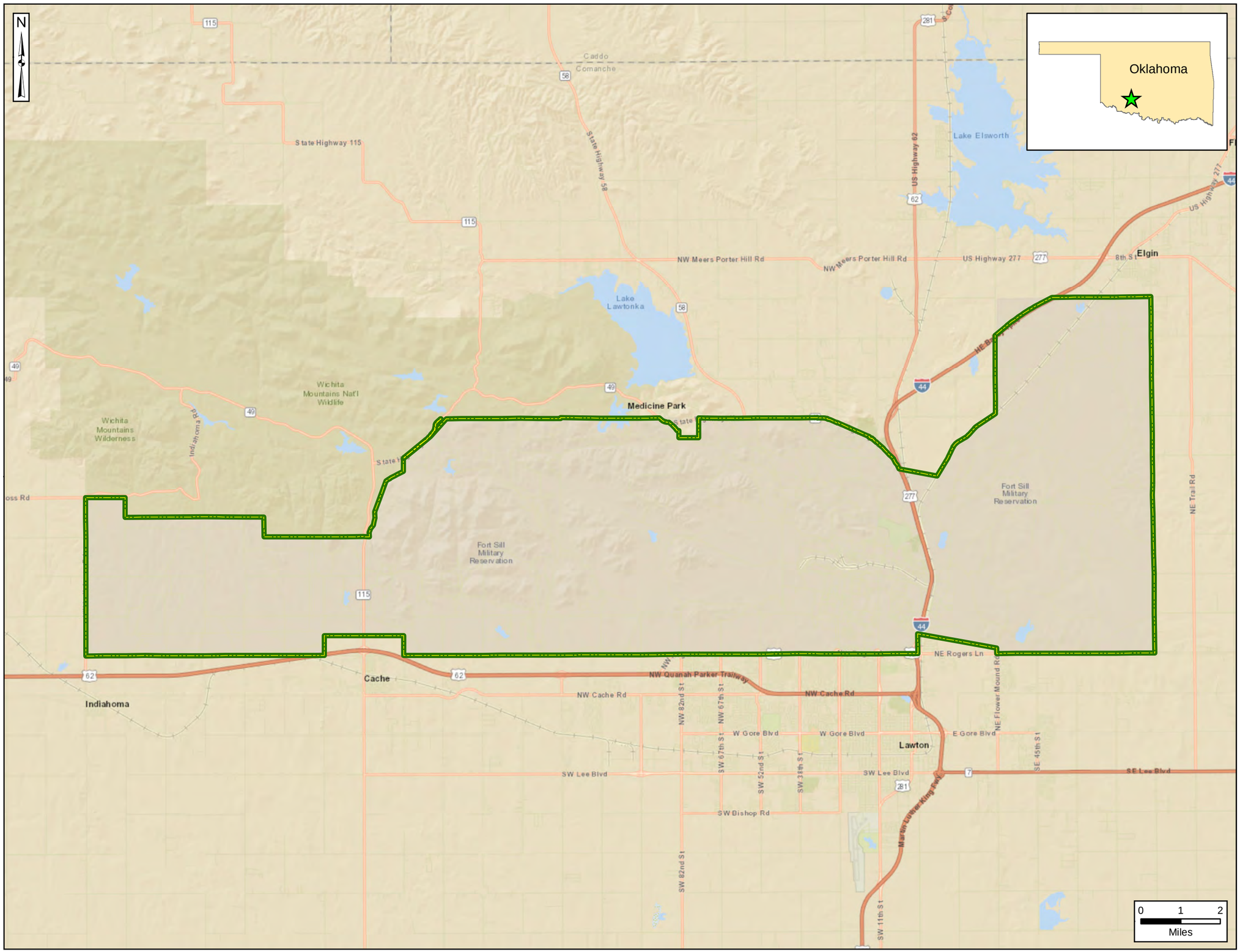
Notes:

1. **Bolded** values indicate the result was detected greater than the limit of detection

Acronyms/Abbreviations:

AOPI = Area of Potential Interest
FD = field duplicate sample
ID = identification
J- = The result is an estimated quantity; the result may be biased low.
M = Manually intergrated compound
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 = qualifier
SIB = Southern Installation Boundary

FIGURES



USAEC PFAS Preliminary Assessment / Site Inspection Fort Sill, OK

ARCADIS

Figure 2-1
Site Location

Legend

Installation Boundary

Data Sources:
Fort Sill, GIS Data, 2018
ESRI ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 14 North

USAEC PFAS Preliminary Assessment / Site Inspection Fort Sill, OK

ARCADIS

Figure 2-2 Site Layout

Legend

- Installation Boundary
- Cantonment Area
- Airfield
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Groundwater Flow Direction
- Surface Water Flow Direction
- Public Water Supply Surface Water Intake
- Public Supply Well
- Domestic Well
- Irrigation Well
- Monitoring Well

Data Sources:
Fort Sill, GIS Data, 2018
USGS, NHD Data, 2019
OK DEQ, Surface Water Intakes & PWS Wells, 2019
EA, ORAP Phase II, GW Flow Direction
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North

USAEC PFAS Preliminary Assessment / Site Inspection Fort Sill, OK

ARCADIS

Figure 2-3 Topographic Map

Legend

- Installation Boundary
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body

Data Sources:
Fort Sill, GIS Data, 2018
USGS, NHD Data, 2019
ESRI ArcGIS Online, USGS Topo Maps

Coordinate System:
WGS 1984, UTM Zone 14 North

USAEC PFAS Preliminary Assessment / Site Inspection Fort Sill, OK

ARCADIS

Figure 2-4
Off-Post Potable Supply Wells

Legend

- Installation Boundary
- 5-Mile Radius
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Public Water Supply Surface Water Intake
- Public Water System Supply Well
- Other Public Supply Well
- Domestic Well
- Well Identified during Windshield Survey
- Other Designated Use Water Well
- Proposed Public Drinking Water Well
- Abandoned Well

27163 Well ID

93234 Abandoned Well ID

OK DEQ = Oklahoma Department of Environmental Quality
OWRB = Oklahoma Water Resources Board

Notes:
1. The functional status of OWRB and OK DEQ features could not be verified for all locations.
2. Other public supply wells include commercial, institutional, municipal, and rural public supply wells.
3. Other designated use wells include agricultural, commercial, industrial, and irrigation wells, as well as wells with unknown use.

Data Sources:
Fort Sill, GIS Data, 2018
EDR, Public Water System Supply Wells, 2019
Fort Sill, Windshield Survey, 2021
OWRB, Other Wells, 2018
Lawton Constitution, Proposed Public Drinking Water Well, 2020
OK DEQ, Surface Water Intakes, 2019
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North

0 1 2 Miles

USAEC PFAS Preliminary Assessment / Site Inspection Fort Sill, OK

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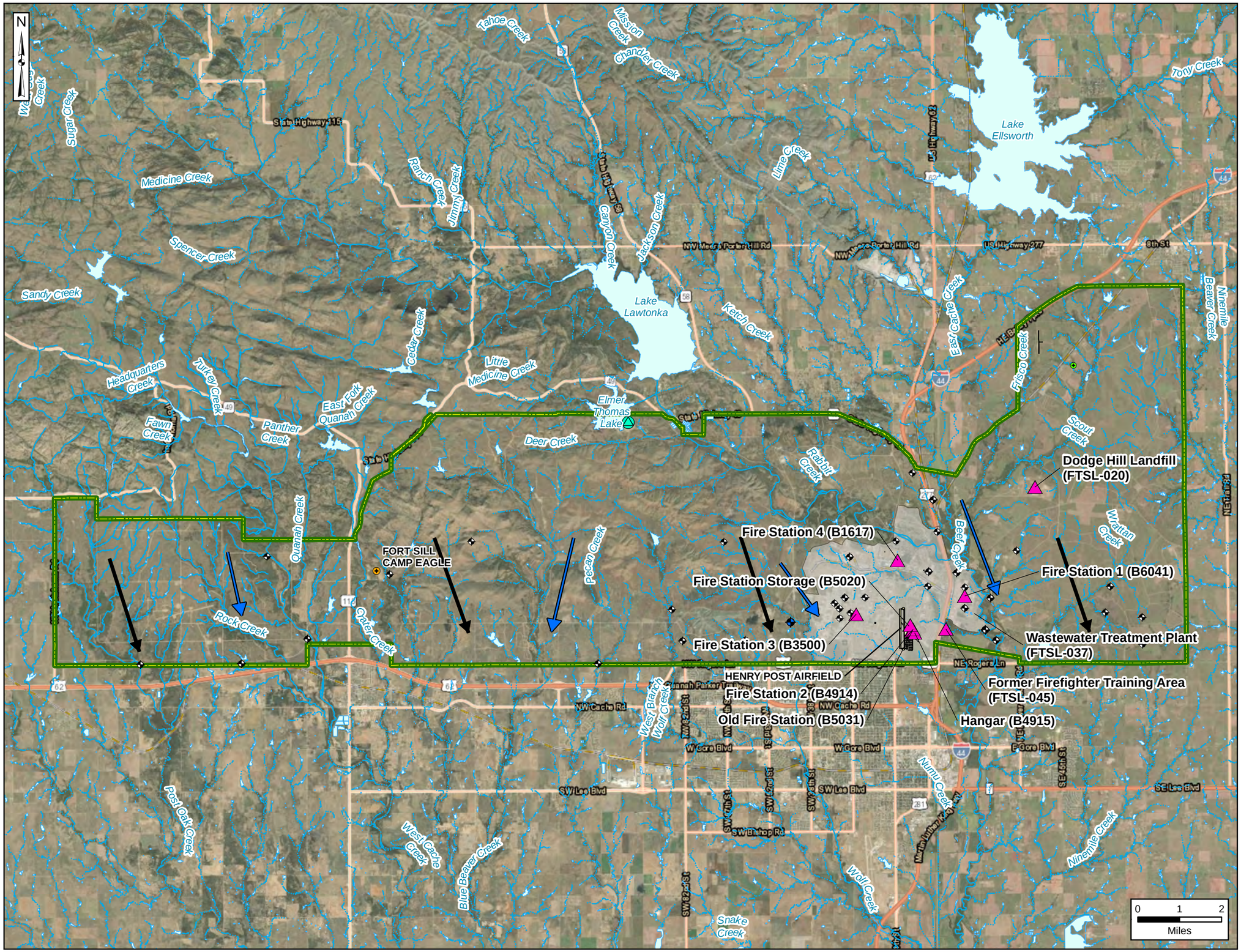
Figure 5-2 AOPI Locations



Legend

- Installation Boundary
- AOPI Location
- Cantonment Area
- Airfield
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Groundwater Flow Direction
- Surface Water Flow Direction
- Public Water Supply Surface Water Intake
- Public Supply Well
- Domestic Well
- Irrigation Well
- Monitoring Well

AOPI = area of potential interest

Data Sources:
Fort Sill, GIS Data, 2018
USGS, NHD Data, 2019
OK DEQ, Surface Water Intakes & Fort Sill Camp Eagle Well, 2019
Oklahoma Water Resource Board, Other Wells, 2018
EA, ORAP Phase II, GW Flow Direction
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North

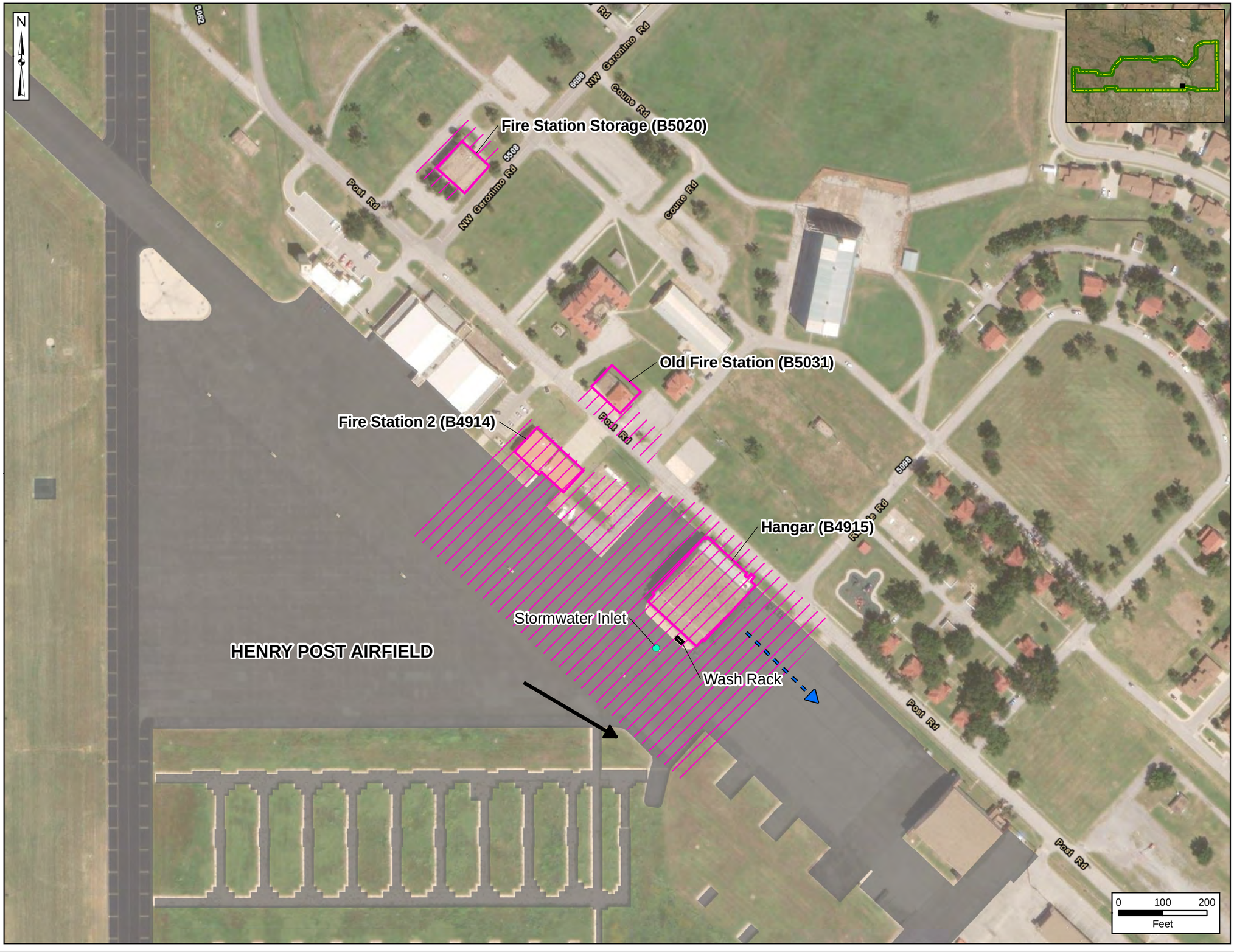


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Figure 5-3
Aerial Photo of
Fire Station Storage (B5020),
Fire Station 2 (B4914),
Old Fire Station (B5031),
and Hangar (B4915)

Legend

- Installation Boundary
- AOPI
- Possible Extent of AFFF Use
- Wash Rack
- Henry Post Airfield
- Stormwater Inlet
- Surface Runoff Flow Direction
- Approximate Groundwater Flow Direction

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

Data Sources:
Fort Sill, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North

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Figure 5-4
Aerial Photo of
Fire Station 1 (B6041)

Legend

- Installation Boundary
- AOPI
- Approximate Extent of AFFF Use
- Surface Runoff Flow Direction
- Approximate Groundwater Flow Direction

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

Data Sources:
Fort Sill, GIS Data, 2018
EA, ORAP Phase II, GW Flow Direction
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North

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Figure 5-5
Aerial Photo of
Fire Station 3 (B3500)

Legend

- Installation Boundary
- AOPI
- Approximate Extent of AFFF Use
- Surface Runoff Flow Direction
- Approximate Groundwater Flow Direction

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

Data Sources:
Fort Sill, GIS Data, 2018
EA, ORAP Phase II, GW Flow Direction
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North

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Figure 5-6
Aerial Photo of
Fire Station 4 (B1617)

Legend

- Installation Boundary
- AOPI
- Approximate Extent of AFFF Use
- Former Wash Rack
- Surface Runoff Flow Direction
- Approximate Groundwater Flow Direction

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

Data Sources:
Fort Sill, GIS Data, 2018
EA, ORAP Phase II, GW Flow Direction
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North

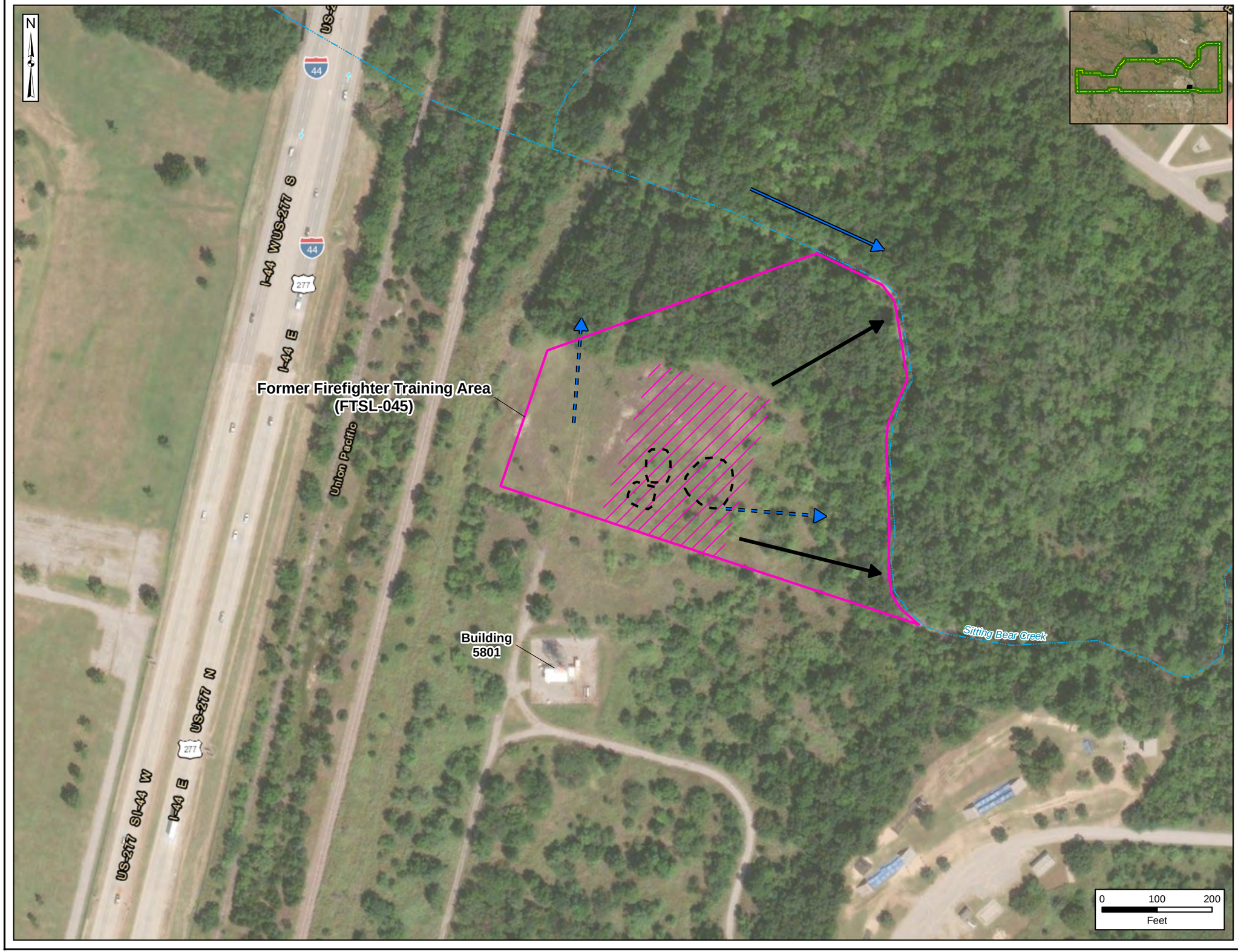

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Figure 5-7
Aerial Photo of
Former Firefighter Training Area
(FTSL-045)

Legend

- Installation Boundary
- AOPI
- Former Fire Pit
- Possible Extent of AFFF Use
- Stream (Intermittent)
- Surface Runoff Flow Direction
- Surface Water Flow Direction
- Approximate Groundwater Flow Direction

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

Data Sources:
Fort Sill, GIS Data, 2018
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North

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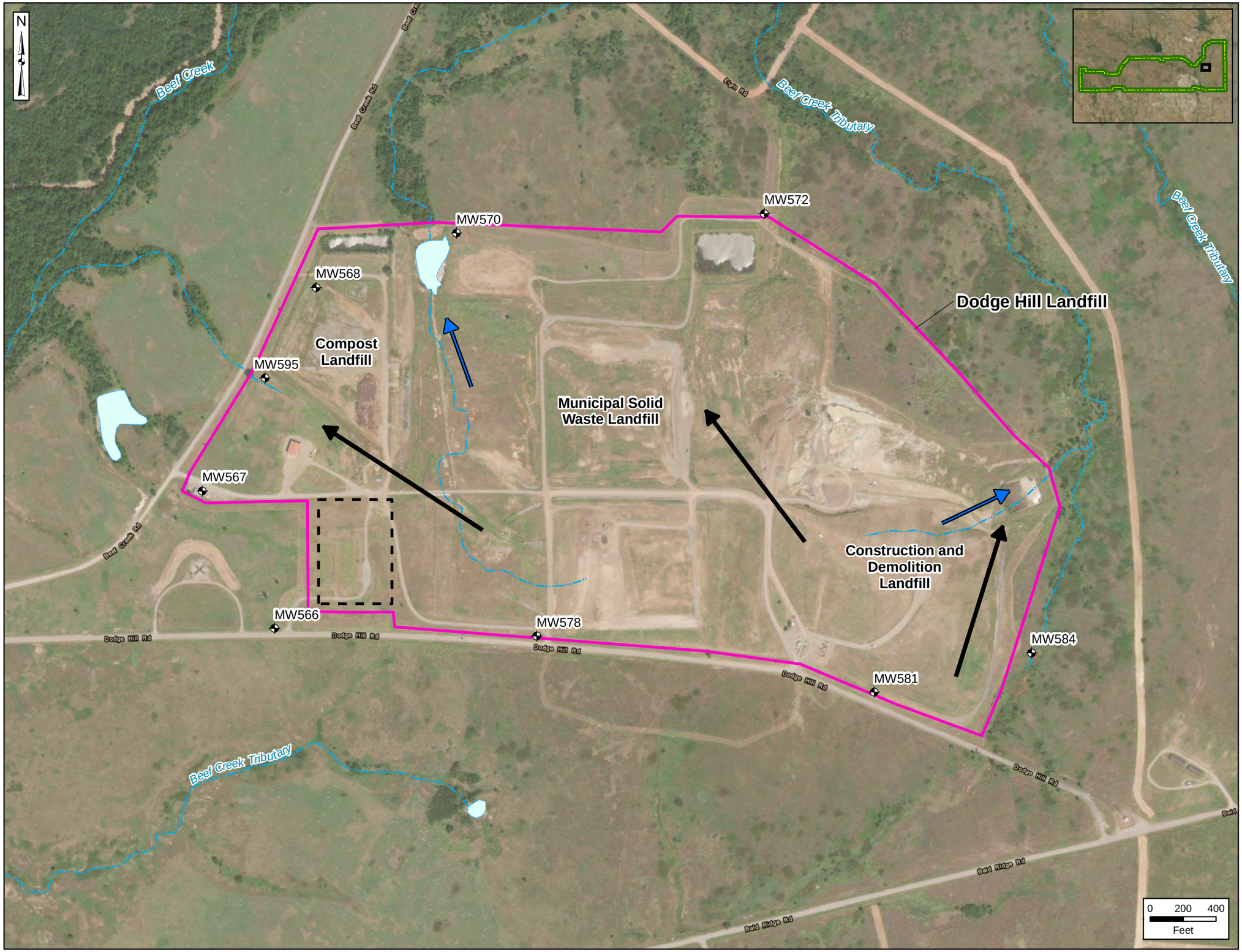

Figure 5-8
Aerial Photo of
Dodge Hill Landfill (FTSL-020)

Legend

- Installation Boundary
- AOPI
- Remediated Soil Farm
- Stream (Intermittent)
- Water Body
- Surface Water Flow Direction
- Approximate Groundwater Flow Direction
- Monitoring Well

AOPI = area of potential interest

Data Sources:
Fort Sill, GIS Data, 2018
EA, ORAP Phase II, GW Flow Direction
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North

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Figure 5-9
Aerial Photo of
Wastewater Treatment Plant
(FTSL-037)

Legend

- Installation Boundary
- Surface Runoff Flow Direction
- Approximate Groundwater Flow Direction

Data Sources:
Fort Sill, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North

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

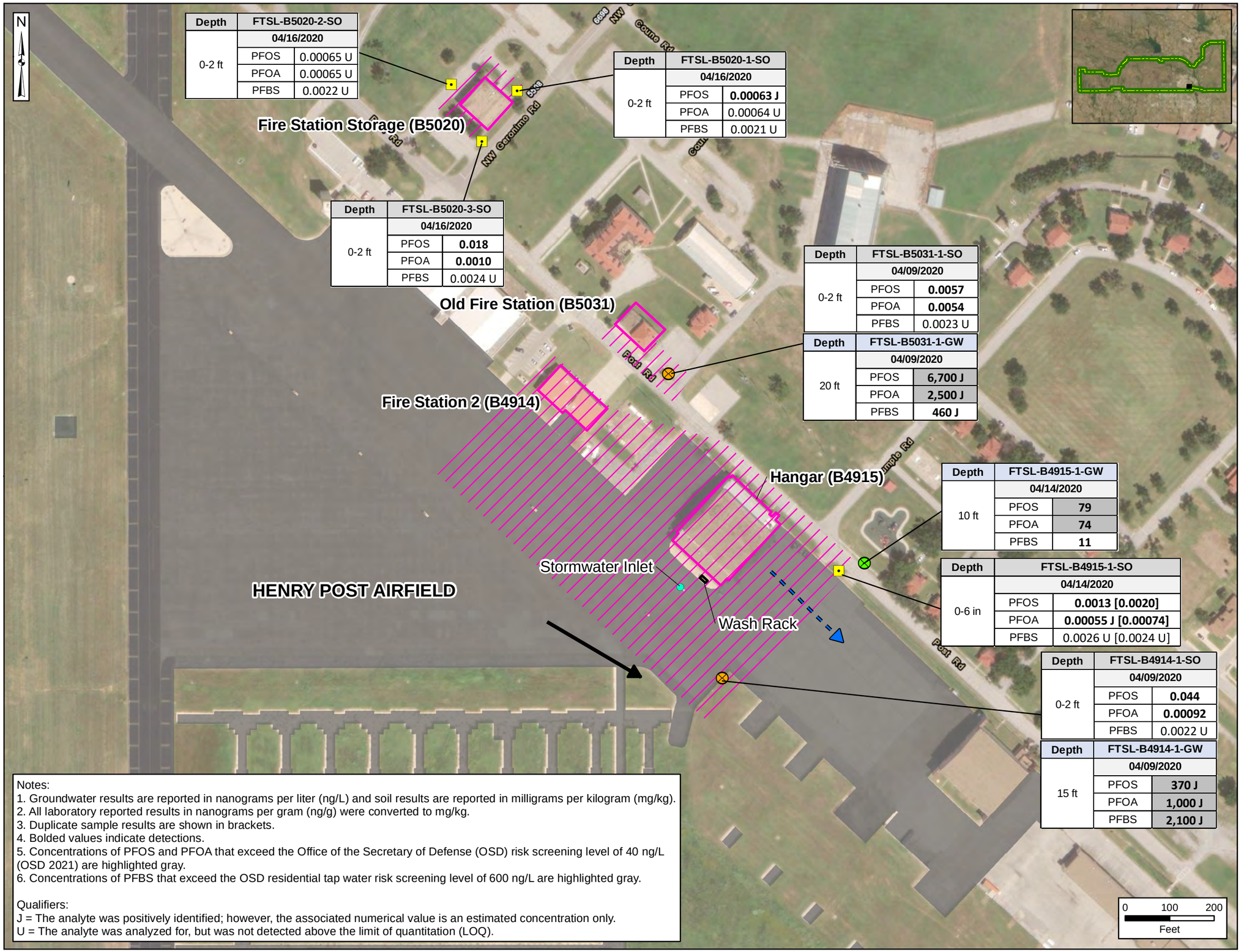
Legend

- Installation Boundary
- AOPI Location
- AOPI with OSD Risk Screening Level Exceedance
- Cantonment Area
- Airfield
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Groundwater Flow Direction
- Surface Water Flow Direction
- Public Water Supply Surface Water Intake
- Public Supply Well
- Domestic Well
- Irrigation Well
- Monitoring Well

AOPI = area of potential interest
OSD = Office of the Secretary of Defense

Data Sources:
Fort Sill, GIS Data, 2018
USGS, NHD Data, 2019
OK DEQ, Surface Water Intakes & Fort Sill Camp Eagle Well, 2019
Oklahoma Water Resource Board, Other Wells, 2018
EA, ORAP Phase II, GW Flow Direction
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North



Depth	FTSL-B5020-2-SO	
	04/16/2020	
0-2 ft	PFOS	0.00065 U
	PFOA	0.00065 U
	PFBS	0.0022 U

Depth	FTSL-B5020-1-SO	
	04/16/2020	
0-2 ft	PFOS	**0.00063 J**
	PFOA	0.00064 U
	PFBS	0.0021 U

Depth	FTSL-B5020-3-SO	
	04/16/2020	
0-2 ft	PFOS	**0.018**
	PFOA	**0.0010**
	PFBS	0.0024 U

Depth	FTSL-B5031-1-SO	
	04/09/2020	
0-2 ft	PFOS	**0.0057**
	PFOA	**0.0054**
	PFBS	0.0023 U

Depth	FTSL-B5031-1-GW	
	04/09/2020	
20 ft	PFOS	**6,700 J**
	PFOA	**2,500 J**
	PFBS	**460 J**

Depth	FTSL-B4915-1-GW	
	04/14/2020	
10 ft	PFOS	**79**
	PFOA	**74**
	PFBS	**11**

Depth	FTSL-B4915-1-SO	
	04/14/2020	
0-6 in	PFOS	**0.0013 [0.0020]**
	PFOA	**0.00055 J [0.00074]**
	PFBS	0.0026 U [0.0024 U]

Depth	FTSL-B4914-1-SO	
	04/09/2020	
0-2 ft	PFOS	**0.044**
	PFOA	**0.00092**
	PFBS	0.0022 U

Depth	FTSL-B4914-1-GW	
	04/09/2020	
15 ft	PFOS	**370 J**
	PFOA	**1,000 J**
	PFBS	**2,100 J**

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L) and soil results are reported in milligrams per kilogram (mg/kg).
2. All laboratory reported results in nanograms per gram (ng/g) were converted to mg/kg.
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) risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
6. Concentrations of PFBS that exceed the OSD residential tap water risk screening level of 600 ng/L 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 was not detected above the limit of quantitation (LOQ).

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Figure 7-2
Fire Station Storage (B5020), Fire Station 2 (B4914), Old Fire Station (B5031), and Hangar (B4915) PFOS, PFOA, and PFBS Analytical Results

Legend

- Installation Boundary
- AOPI
- Possible Extent of AFFF Use
- Wash Rack
- Henry Post Airfield
- Stormwater Inlet
- Surface Runoff Flow Direction
- Approximate Groundwater Flow Direction
- Surface Soil Sampling Location
- Soil and Groundwater Boring
- Groundwater Boring

AOPI = area of potential interest
AFFF = aqueous film-forming foam
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
in = inches
SO = soil

Data Sources:
Fort Sill, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North

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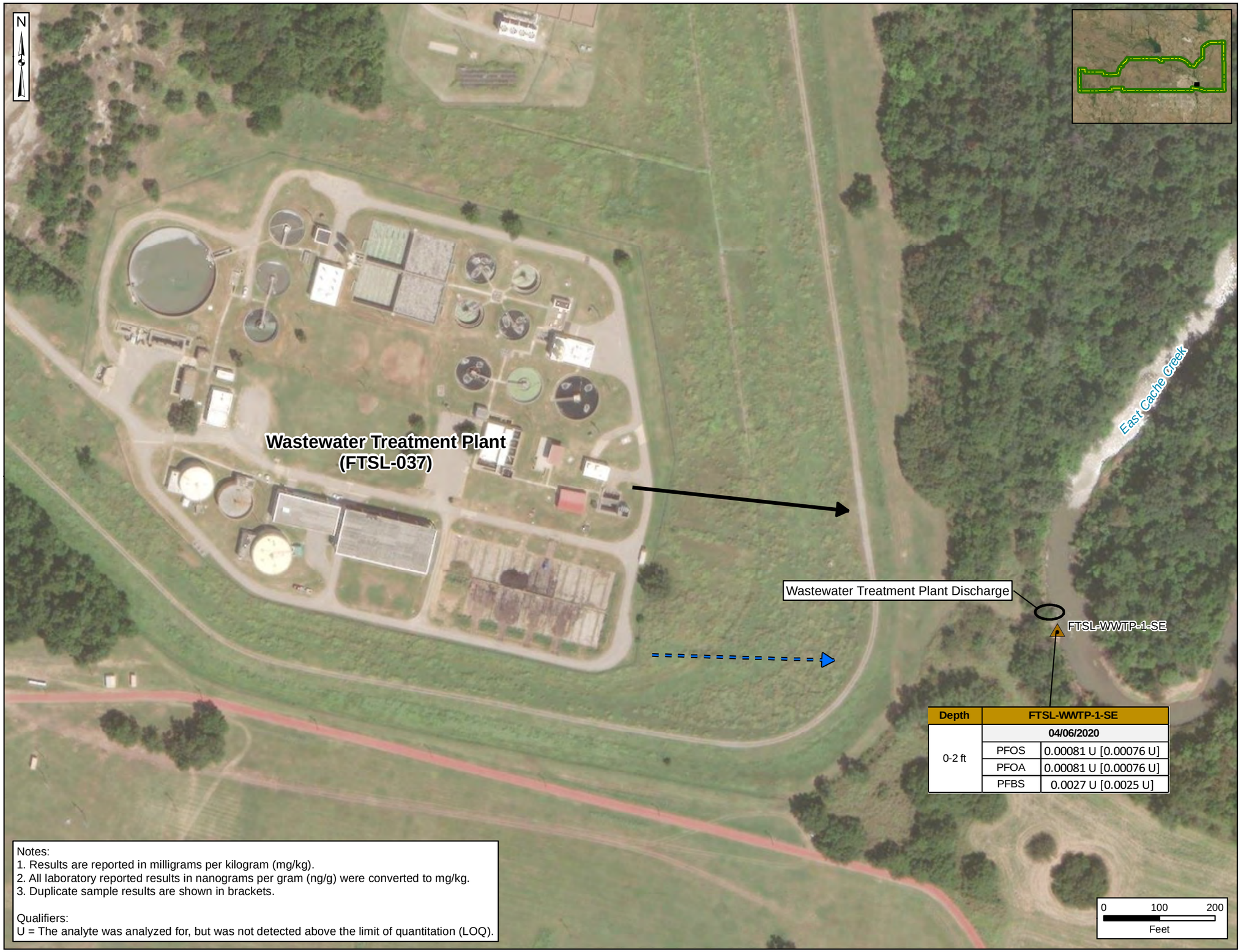
Figure 7-3
PFOS, PFOA, and PFBS Analytical Results for Wastewater Treatment Plant (FTSL-037) - Related to Potentially Impacted Waters from other AOPIs, i.e. Fire Station #2 (B4914), Fire Station #4 (B1617), and/or Hangar (B4915)



Depth	FTSL-WWTP-1-SE	
	04/06/2020	
0-2 ft	PFOS	0.00081 U [0.00076 U]
	PFOA	0.00081 U [0.00076 U]
	PFBS	0.0027 U [0.0025 U]

Notes:
1. Results are reported in milligrams per kilogram (mg/kg).
2. All laboratory reported results in nanograms per gram (ng/g) were converted to mg/kg.
3. Duplicate sample results are shown in brackets.

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

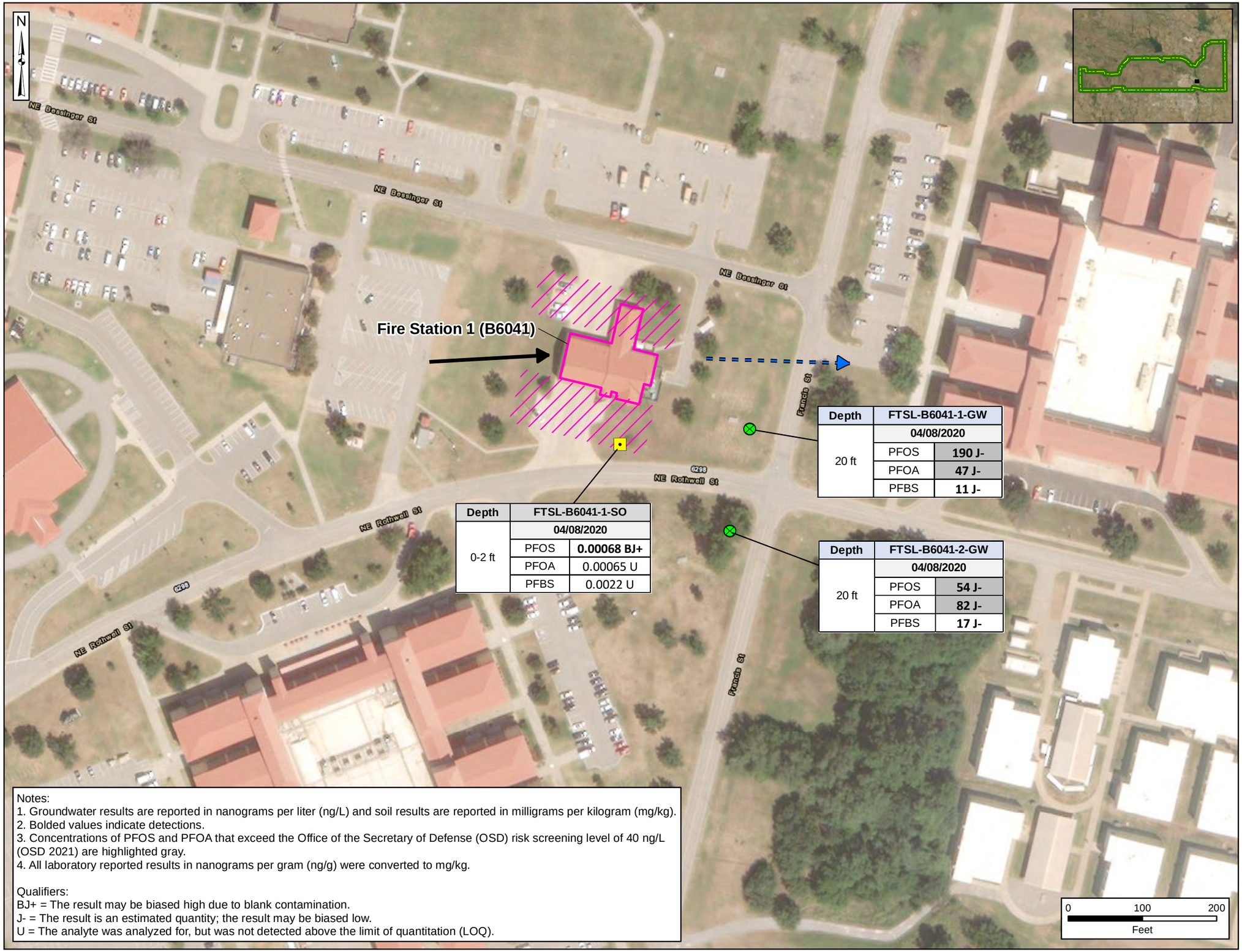
Legend

- Installation Boundary
- Surface Runoff Flow Direction
- Approximate Groundwater Flow Direction
- Sediment Sampling Location

AOPI = area of potential interest
ft = feet
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SE = sediment

Data Sources:
Fort Sill, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North



Depth	FTSL-B6041-1-GW	
20 ft	04/08/2020	
	PFOS	190 J-
	PFOA	47 J-
	PFBS	11 J-

Depth	FTSL-B6041-1-SO	
0-2 ft	04/08/2020	
	PFOS	0.00068 BJ+
	PFOA	0.00065 U
	PFBS	0.0022 U

Depth	FTSL-B6041-2-GW	
20 ft	04/08/2020	
	PFOS	54 J-
	PFOA	82 J-
	PFBS	17 J-

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L) and soil results are reported in milligrams per kilogram (mg/kg).
2. Bolded values indicate detections.
3. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
4. All laboratory reported results in nanograms per gram (ng/g) were converted to mg/kg.

Qualifiers:
BJ+ = The result may be biased high due to blank contamination.
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

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Figure 7-4
Fire Station 1 (B6041)
PFOS, PFOA, and PFBS Analytical Results

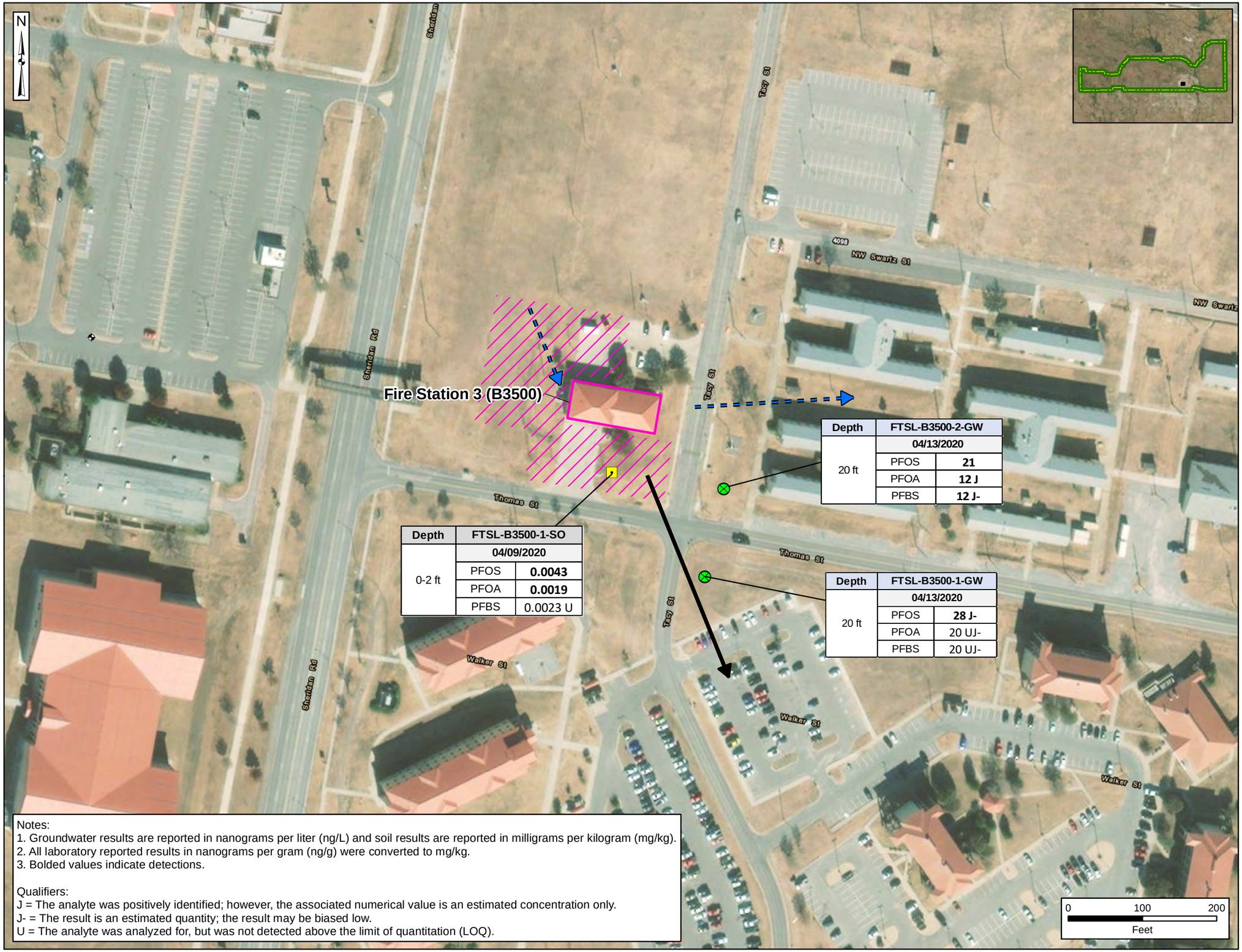
Legend

- Installation Boundary
- AOPI
- Approximate Extent of AFFF Use
- Surface Runoff Flow Direction
- Approximate Groundwater Flow Direction
- Surface Soil Sampling Location
- Groundwater Boring

AOPI = area of potential interest
AFFF = aqueous film-forming foam
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil

Data Sources:
Fort Sill, GIS Data, 2018
EA, ORAP Phase II, GW Flow Direction
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North



Notes:
1. Groundwater results are reported in nanograms per liter (ng/L) and soil results are reported in milligrams per kilogram (mg/kg).
2. All laboratory reported results in nanograms per gram (ng/g) were converted to mg/kg.
3. Bolded values indicate detections.

Qualifiers:
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 was not detected above the limit of quantitation (LOQ).

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Figure 7-5
Fire Station 3 (B3500)
PFOS, PFOA, and PFBS
Analytical Results

Legend

- Installation Boundary
- AOPI
- Approximate Extent of AFFF Use
- Surface Runoff Flow Direction
- Approximate Groundwater Flow Direction
- Surface Soil Sampling Location
- Groundwater Boring

AOPI = area of potential interest
AFFF = aqueous film-forming foam
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil

Data Sources:
Fort Sill, GIS Data, 2018
EA, ORAP Phase II, GW Flow Direction
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North

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Figure 7-6
Fire Station 4 (B1617)
PFOS, PFOA, and PFBS Analytical Results

Depth	FTSL-B1617-1-SO	
	04/10/2020	
0-2 ft	PFOS	0.00067 U
	PFOA	**0.0014**
	PFBS	0.0022 U

Depth	FTSL-B1617-1-GW	
	04/10/2020	
15 ft	PFOS	**290 J**
	PFOA	**65**
	PFBS	**7.5**

Depth	FTSL-B1617-3-GW	
	04/10/2020	
15 ft	PFOS	**1,100 J**
	PFOA	**190 J**
	PFBS	**17**

Depth	FTSL-B1617-2-GW	
	04/13/2020	
15 ft	PFOS	**450 J**
	PFOA	**140**
	PFBS	**14**

Fire Station 4 (B1617)

Myers Rd
1301
Myers Rd
Shade Ave
Shade Ave
Myers Rd
Randolph Rd
1999
NW Fort Sill Blvd
Randolph Rd

0 100 200
Feet

Legend

- Installation Boundary
- AOPI
- Approximate Extent of AFFF Use
- Former Wash Rack
- Surface Runoff Flow Direction
- Approximate Groundwater Flow Direction
- Soil and Groundwater Boring
- Groundwater Boring

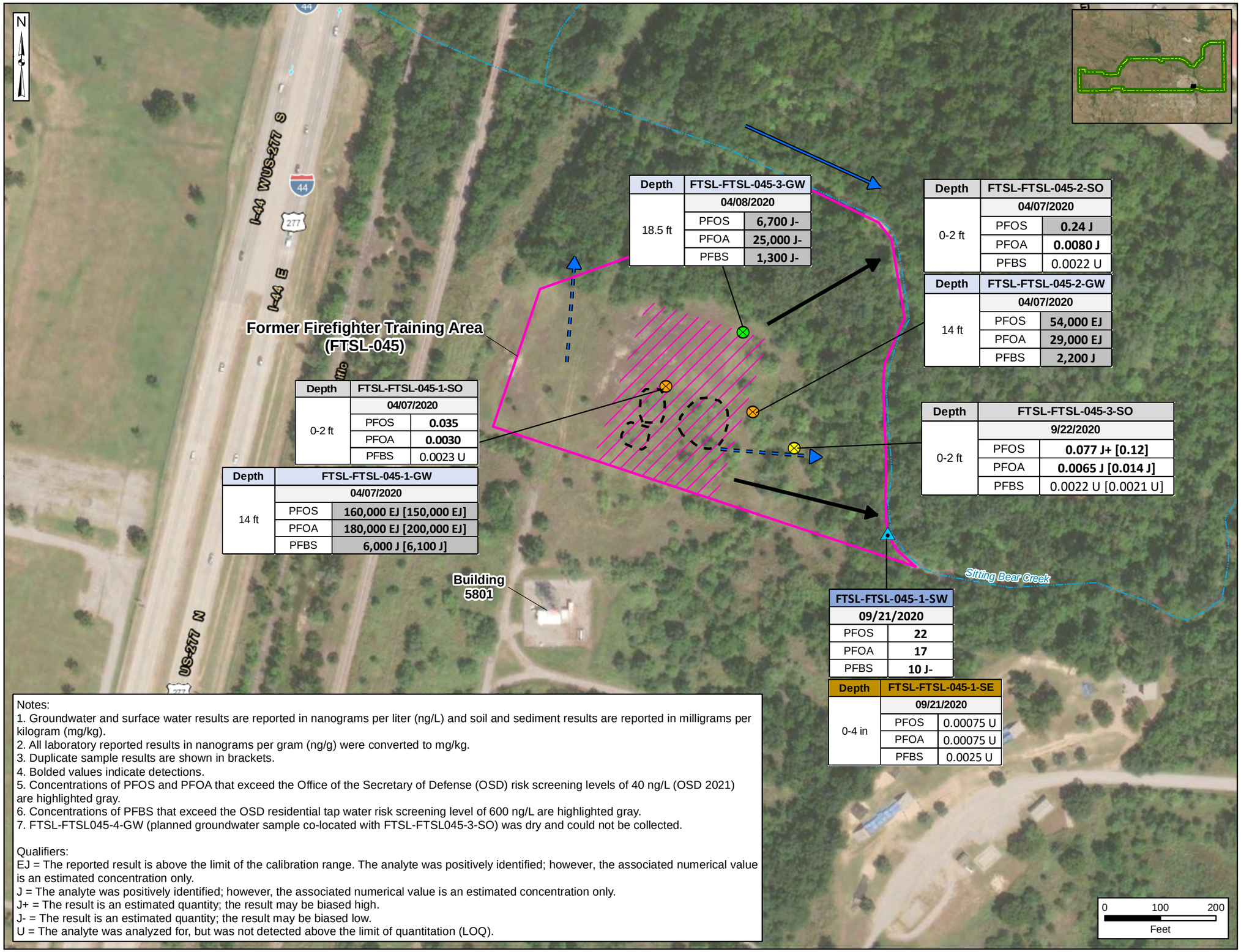
AOPI = area of potential interest
AFFF = aqueous film-forming foam
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L) and soil results are reported in milligrams per kilogram (mg/kg).
2. All laboratory reported results in nanograms per gram (ng/g) were converted to mg/kg.
3. Bolded values indicate detections.
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) 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 was not detected above the limit of quantitation (LOQ).

Data Sources:
Fort Sill, GIS Data, 2018
EA, ORAP Phase II, GW Flow Direction
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North



Depth	FTSL-FTSL-045-3-GW
	04/08/2020
18.5 ft	PFOS 6,700 J-
	PFOA 25,000 J-
	PFBS 1,300 J-

Depth	FTSL-FTSL-045-2-SO
	04/07/2020
0-2 ft	PFOS 0.24 J
	PFOA 0.0080 J
	PFBS 0.0022 U

Depth	FTSL-FTSL-045-2-GW
	04/07/2020
14 ft	PFOS 54,000 EJ
	PFOA 29,000 EJ
	PFBS 2,200 J

Depth	FTSL-FTSL-045-1-SO
	04/07/2020
0-2 ft	PFOS 0.035
	PFOA 0.0030
	PFBS 0.0023 U

Depth	FTSL-FTSL-045-3-SO
	9/22/2020
0-2 ft	PFOS 0.077 J+ [0.12]
	PFOA 0.0065 J [0.014 J]
	PFBS 0.0022 U [0.0021 U]

Depth	FTSL-FTSL-045-1-GW
	04/07/2020
14 ft	PFOS 160,000 EJ [150,000 EJ]
	PFOA 180,000 EJ [200,000 EJ]
	PFBS 6,000 J [6,100 J]

FTSL-FTSL-045-1-SW	
09/21/2020	
PFOS	22
PFOA	17
PFBS	10 J-

Depth	FTSL-FTSL-045-1-SE	
	09/21/2020	
0-4 in	PFOS	0.00075 U
	PFOA	0.00075 U
	PFBS	0.0025 U

Notes:
1. Groundwater and surface water results are reported in nanograms per liter (ng/L) and soil and sediment results are reported in milligrams per kilogram (mg/kg).
2. All laboratory reported results in nanograms per gram (ng/g) were converted to mg/kg.
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) risk screening levels of 40 ng/L (OSD 2021) are highlighted gray.
6. Concentrations of PFBS that exceed the OSD residential tap water risk screening level of 600 ng/L are highlighted gray.
7. FTSL-FTSL045-4-GW (planned groundwater sample co-located with FTSL-FTSL045-3-SO) was dry and could not be collected.

Qualifiers:
EJ = The reported result is above the limit of the calibration range. The analyte was positively identified; however, 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.
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 was not detected above the limit of quantitation (LOQ).

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Figure 7-7
Former Firefighter Training Area (FTSL-045)
PFOS, PFOA, and PFBS Analytical Results

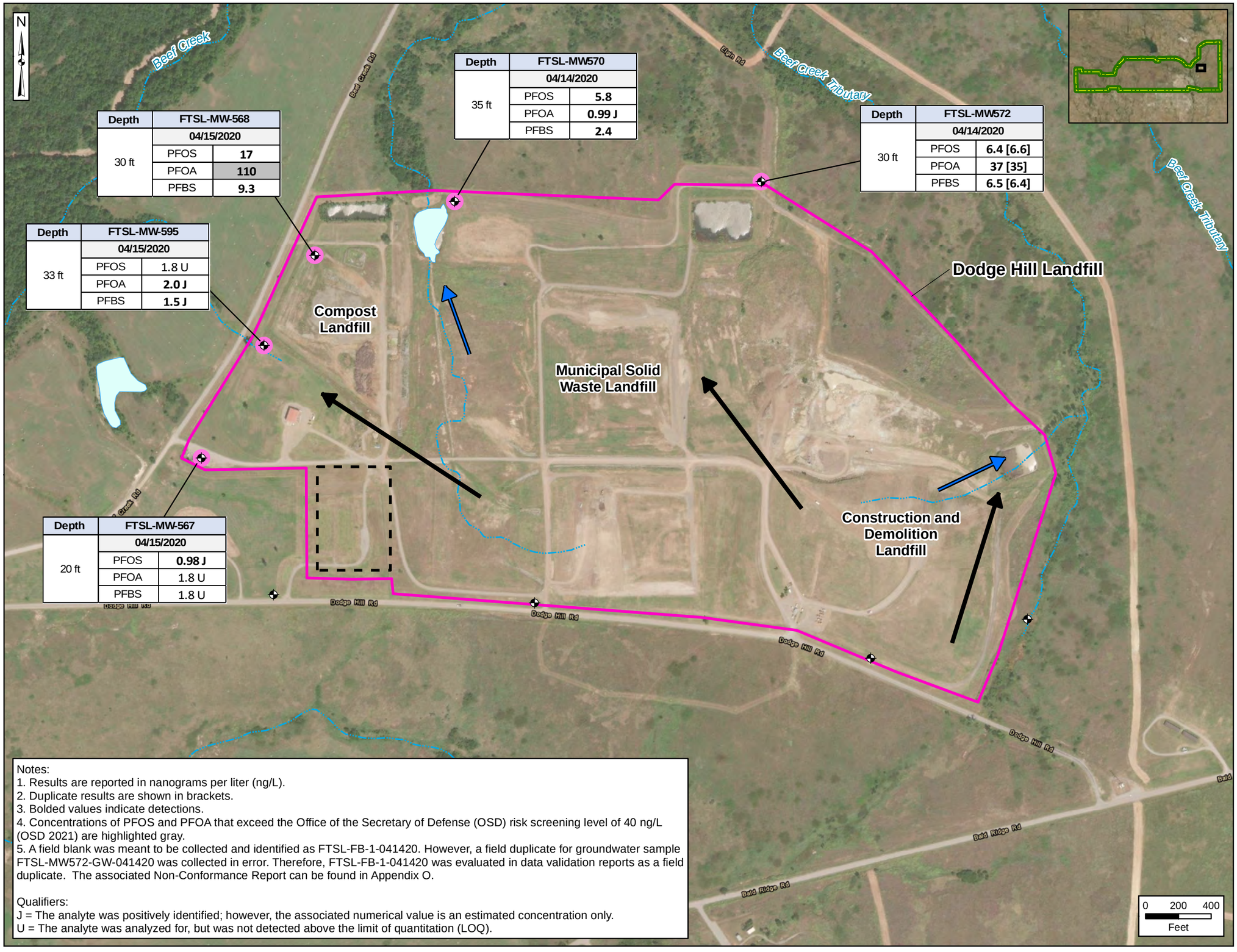
Legend

- Installation Boundary
- AOPI
- Former Fire Pit
- Stream (Intermittent)
- Surface Runoff Flow Direction
- Surface Water Flow Direction
- Approx. Groundwater Flow Direction
- Possible Extent of AFFF Use
- Soil Boring
- Soil and Groundwater Boring
- Groundwater Boring
- Surface Water and Sediment Sampling Location

AOPI = area of potential interest
AFFF = aqueous film-forming foam
ft = feet
in = inches
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SE = sediment
SO = soil
SW = surface water

Data Sources:
Fort Sill, GIS Data, 2018
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North



Depth	FTSL-MW-568	
	04/15/2020	
30 ft	PFOS	17
	PFOA	110
	PFBS	9.3

Depth	FTSL-MW570	
	04/14/2020	
35 ft	PFOS	5.8
	PFOA	0.99 J
	PFBS	2.4

Depth	FTSL-MW572	
	04/14/2020	
30 ft	PFOS	6.4 [6.6]
	PFOA	37 [35]
	PFBS	6.5 [6.4]

Depth	FTSL-MW-595	
	04/15/2020	
33 ft	PFOS	1.8 U
	PFOA	2.0 J
	PFBS	1.5 J

Depth	FTSL-MW-567	
	04/15/2020	
20 ft	PFOS	0.98 J
	PFOA	1.8 U
	PFBS	1.8 U

Notes:
1. Results are reported in nanograms per liter (ng/L).
2. Duplicate results are shown in brackets.
3. Bolded values indicate detections.
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
5. A field blank was meant to be collected and identified as FTSL-FB-1-041420. However, a field duplicate for groundwater sample FTSL-MW572-GW-041420 was collected in error. Therefore, FTSL-FB-1-041420 was evaluated in data validation reports as a field duplicate. The associated Non-Conformance Report can be found in Appendix O.

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

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Figure 7-8
Dodge Hill Landfill (FTSL-020) PFOS, PFOA, and PFBS Analytical Results

Legend

- Installation Boundary
- AOPI
- Remediated Soil Farm
- Surface Water Flow Direction
- Approx. Groundwater Flow Direction
- Monitoring Well
- Groundwater Sampling Location (Existing Well)
- Stream (Intermittent)
- Water Body

AOPI = area of potential interest
ft = feet
MW = Monitoring Well
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
Fort Sill, GIS Data, 2018
EA, ORAP Phase II, GW Flow Direction
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North

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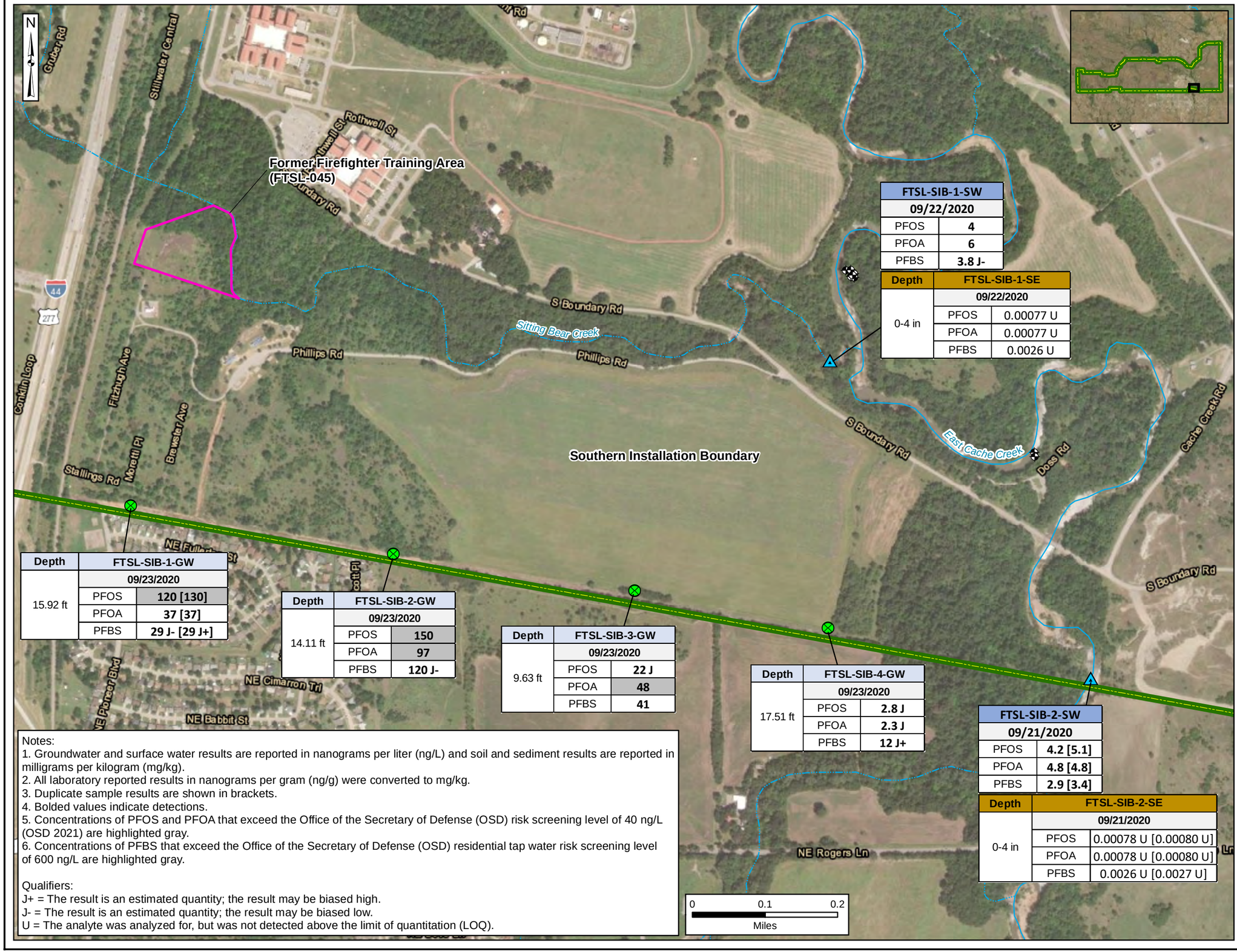
Figure 7-9
Southern Installation Boundary PFOS, PFOA, and PFBS Analytical Results



FTSL-SIB-1-SW	
09/22/2020	
PFOS	4
PFOA	6
PFBS	3.8 J-

Depth	FTSL-SIB-1-SE	
0-4 in	09/22/2020	
	PFOS	0.00077 U
	PFOA	0.00077 U
	PFBS	0.0026 U

Depth	FTSL-SIB-1-GW	
15.92 ft	09/23/2020	
	PFOS	120 [130]
	PFOA	37 [37]
	PFBS	29 J- [29 J+]

Depth	FTSL-SIB-2-GW	
14.11 ft	09/23/2020	
	PFOS	150
	PFOA	97
	PFBS	120 J-

Depth	FTSL-SIB-3-GW	
9.63 ft	09/23/2020	
	PFOS	22 J
	PFOA	48
	PFBS	41

Depth	FTSL-SIB-4-GW	
17.51 ft	09/23/2020	
	PFOS	2.8 J
	PFOA	2.3 J
	PFBS	12 J+

FTSL-SIB-2-SW	
09/21/2020	
PFOS	4.2 [5.1]
PFOA	4.8 [4.8]
PFBS	2.9 [3.4]

Depth	FTSL-SIB-2-SE	
0-4 in	09/21/2020	
	PFOS	0.00078 U [0.00080 U]
	PFOA	0.00078 U [0.00080 U]
	PFBS	0.0026 U [0.0027 U]

Notes:
1. Groundwater and surface water results are reported in nanograms per liter (ng/L) and soil and sediment results are reported in milligrams per kilogram (mg/kg).
2. All laboratory reported results in nanograms per gram (ng/g) were converted to mg/kg.
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) risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
6. Concentrations of PFBS that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 600 ng/L are highlighted gray.

Qualifiers:
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 was not detected above the limit of quantitation (LOQ).

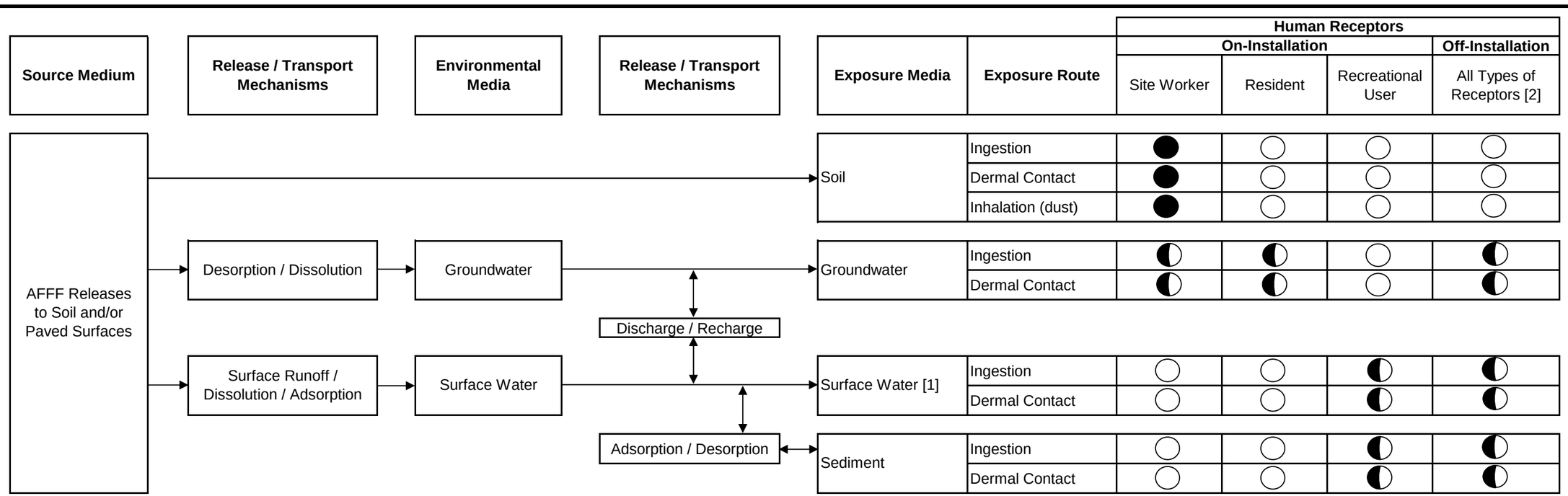
Legend

- Installation Boundary
- AOPI
- River/Stream (Perennial)
- Stream (Intermittent)
- Monitoring Well
- Groundwater Boring
- Surface Water and Sediment Sampling Location

AOPI = area of potential interest
in = inches
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SE = sediment
SW = surface water

Data Sources:
Fort Sill, GIS Data, 2018
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 14 North



Legend:

- = Complete Exposure Pathway
- = Potentially Complete Exposure Pathway
- = Incomplete Exposure Pathway

Notes:
Henry Post Airfield and Fire Station AOPIs include Fire Station 2 (B4914), Hangar (B4915), Fire Station 1 (B6041), Old Fire Station (B5031), Fire Station Storage (B5020), Fire Station 3 (B3500), and Fire Station 4 (B1617).
[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.
AFFF - aqueous film-forming foam

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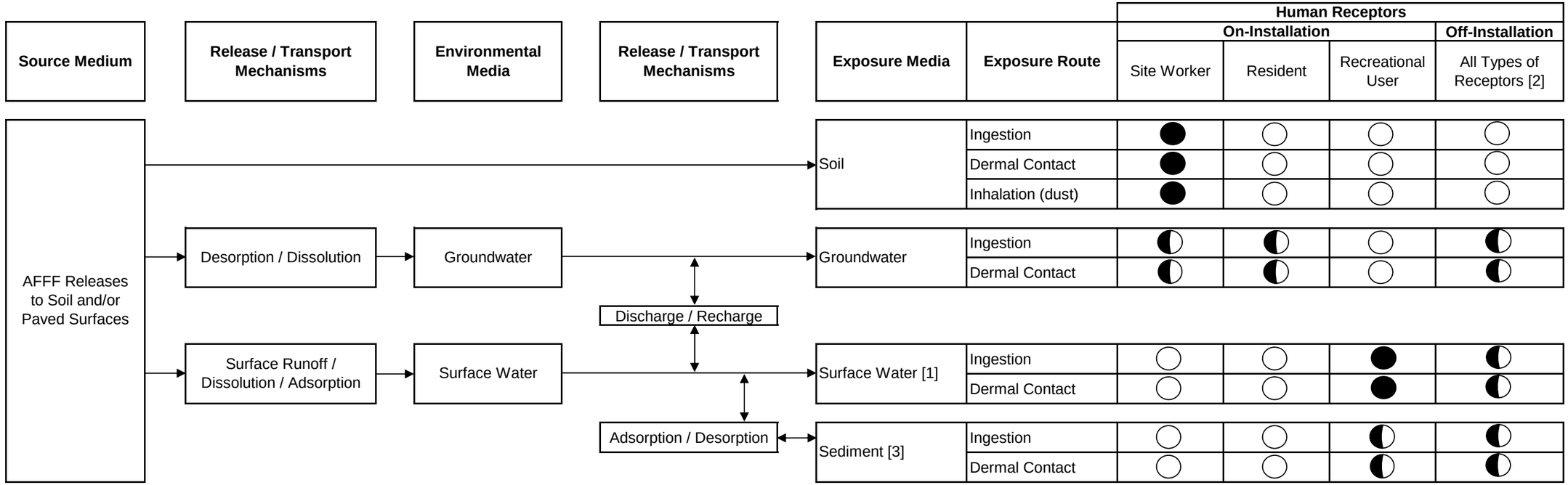
Conceptual Site Model - Henry Post Airfield and Fire Station AOPIs
USAEC PFAS Preliminary Assessment / Site Inspection
Fort Sill, Oklahoma

Figure 7-10



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] Although PFAS were not detected in sediment, there is a potential for partitioning between surface water and sediment. Therefore, the sediment exposure pathway for on-installation recreational users remains potentially complete.
AFFF - aqueous film-forming foam
PFAS - per- and polyfluoroalkyl substances

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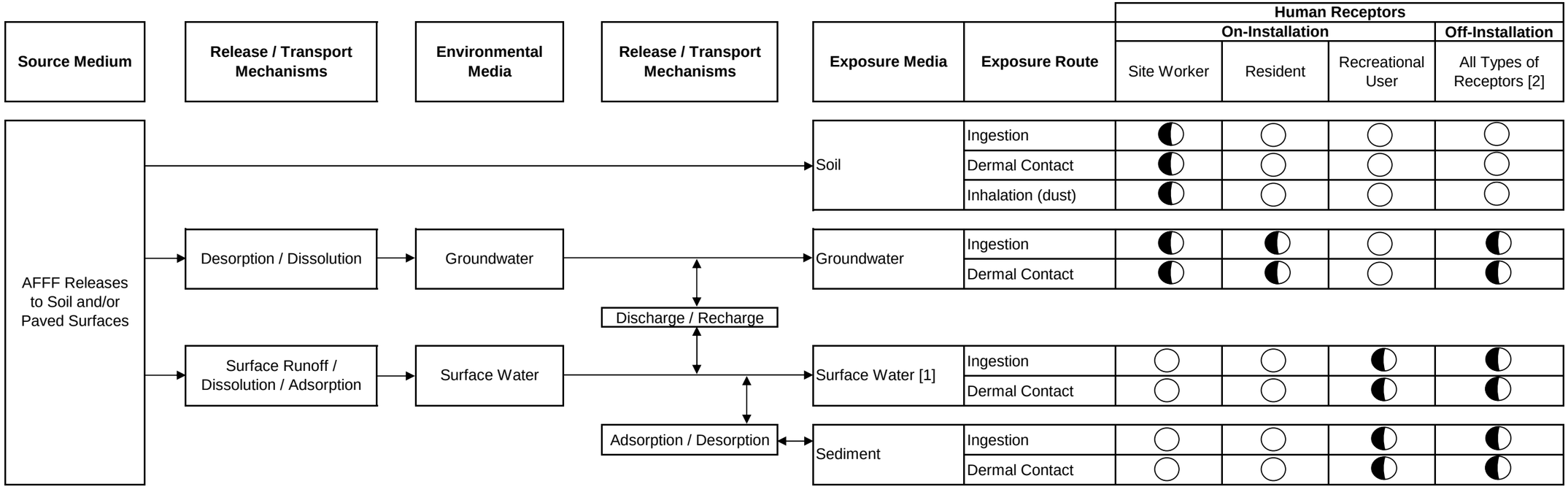
Conceptual Site Model - Former Firefighter Training Area (FTSL-045)
USAEC PFAS Preliminary Assessment / Site Inspection
Fort Sill, Oklahoma

Figure 7-11



Legend:

◐ = 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.
AFFF - aqueous film-forming foam

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Conceptual Site Model - Dodge Hill Landfill (FTSL-020)
USAEC PFAS Preliminary Assessment / Site Inspection
Fort Sill, Oklahoma

Figure 7-12

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