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

Fort Shafter and Fort DeRussy Military Reservation, Hawaii

Prepared For:
U.S. Army Corps of Engineers, Baltimore District
2 Hopkins Plaza
Baltimore, Maryland 21201

August 2023

Preliminary Assessment and Site Inspection of Per- and Polyfluoroalkyl Substances

Fort Shafter and Fort DeRussy Military Reservation, Hawaii

Nick Wood, PE
Site Inspection Project Manager, Arcadis U.S., Inc.

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

Johnsie Lang, PhD, EIT
Technical Expert, Arcadis U.S., Inc.

Prepared for:

U.S. Army Corps of Engineers

Contract No.: W912DR-18-D-0004

Delivery Order No.: W912DR1818F0685

Prepared by:

Arcadis U.S., Inc.

7550 Teague Road

Suite 210

Hanover

Maryland 21076

Arcadis Ref.:

30001994

Date:

August 2023

CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

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), perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA) at Army installations (installations) nationwide because the Office of the Secretary of Defense (OSD) has developed risk-based screening levels for these chemicals. 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 report provides the PA/SI for Fort Shafter (FTSHF) and the PA for its sub-installation Fort DeRussy Military Reservation (FTDR) that was completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), National Oil and Hazardous Substances Pollution Contingency Plan, and Army/Department of Defense (DoD) policy and guidance.

FTSHF is an active military installation located on the island of Oahu, approximately 3 miles northwest of downtown Honolulu on the southwest side of the Koolau Mountain Range. The installation occupies approximately 600 acres separated into two areas by Interstate H-201/Moanalua Freeway. The area northeast of H-201/Moanalua Freeway in known as the Main Post and the area located southwest of H-201/Moanalua Freeway is known as Fort Shafter Flats.

FTDR is an active military sub-installation located approximately 4.5 miles southeast of FTSHF. It is located on the waterfront in Honolulu, Oahu in the high rise, high intensity Waikiki resort district, and is separated into two areas by Kalia Road. Consisting of approximately 72 acres, the area is one of the last remaining open spaces along Waikiki Beach.

The FTSHF PA initially identified four AOPIs for investigation during the SI phase. Subsequently, a fifth AOPI (Building 1507 – Wing A: Former Metal Plating Shop) was identified at FTSHF for investigation during the SI phase. SI sampling results from the five AOPIs were compared to risk-based screening levels calculated by the Office of the Secretary of Defense (OSD) for PFOS, PFOA, PFBS, PFNA, and PFHxS. Of the six PFAS compounds presented in the 06 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI at FTSHF. Based on the conceptual site model developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at FTSHF because HFPO-DA is generally not a component of military specification aqueous film forming foam (AFFF) and based on its history including distribution limitations that restricted use of HFPO-DA, it is generally not a component of other products the military used. In addition, it is unlikely that HFPO-DA would be an individual chemical of concern in the absence of other PFAS. Therefore, there are no HFPO-DA SI analytical results to screen against the 2022 OSD risk screening levels. PFOS, PFOA, PFBS, PFNA and/or PFHxS were detected in soil, sediment, and/or groundwater at all of the AOPIs; three of the five AOPIs had PFOS, PFOA, PFBS, PFNA, and/or PFHxS present at concentrations greater than the risk-based screening levels. The FTSHF PA/SI identified the need for further study in a remedial investigation. Based on the results of the PA for FTDR, one AOPI was

identified; however, SI or sampling for PFOS, PFOA, PFBS, PFNA, and/or PFHxS was not determined to be appropriate based on the unlikely usage of AFFF, absence of groundwater receptors, and likely removal of any potentially impacted material at Building T-25: Former Fire Station.. **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, PFBS, PFNA, and PFHxS Sampling at FTSHF and FTDR, and Recommendations

AOPI Name	PFOS, PFOA, PFBS, PFNA, and/or PFHxS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	SO	GW	
FTSHF: AFFF Training Area	No	NS	Further evaluation[1]
FTSHF: Canal Car Accident	Yes	NS	Further study in a remedial investigation
FTSHF: Parking Lot Fires (Car Fire A and Car Fire B)	No	NS	Further evaluation[1]
FTSHF: Building 322: Former Fire Station #3	Yes	NS	Further study in a remedial investigation
FTSHF: Building 1507-Wing A: Former Metal Plating Shop	ND	Yes	Further study in a remedial investigation
FTDR: Building T-25: Former Fire Station	NS	NS	No action at this time[2]

Notes:
1 = Soil analytical data indicates PFOS, PFOA, PFBS, PFNA, and/or PFHxS presence below OSD risk screening levels, but because there is a potential for migration to groundwater, further evaluation is recommended.
2 =Building T-25: Former Fire Station was not sampled during the SI due to the following reasons: historic AFFF usage is very unlikely due to the Army's authorization of AFFF usage at installations the same year the fire station ceased operations; the absence of groundwater receptors due to the subsurface aquifers high saline content, which is a result of FTDRs proximity to the Pacific Ocean; the lack of construction details from the redevelopment of the area and likelihood that any potentially impacted media was excavated and removed; additionally, the historic AOPI location is now located under approximately 10 feet of fill material, below the Hale Koa hotel driveway and lobby area.
Light gray shading – detection greater than the OSD risk screening level
ND – non-detect
NS – not sampled
GW- groundwater
SO – soil

1 INTRODUCTION

The United States (U.S.) Army (Army) is performing preliminary assessments (PAs) and site inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA) at Army installations (installations) nationwide because the Office of the Secretary of Defense (OSD) has developed risk-based screening levels for these chemicals. 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 Shafter (FTSHF) and Fort DeRussy Military Reservation (FTDR), Hawaii based on the use, storage and/or disposal of PFAS-containing materials, in accordance with the 2018 Army Guidance for Addressing Releases of Per- and Polyfluoroalkyl Substances (Army 2018). The SI included multi-media sampling at AOPIs to determine whether or not a release has occurred, and the analytical results were compared to the Office of the Secretary of Defense (OSD) PFOS, PFOA, PFBS, PFNA, and PFHxS risk screening levels to determine whether further investigation is warranted. Of the six PFAS compounds presented in the 06 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. Based on the conceptual site model (CSM) developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at FTSHF because HFPO-DA is generally not a component of military specification aqueous film forming foam (AFFF) and based on its history including distribution limitations that restricted use of HFPO-DA, it is generally not a component of other products the military used. In addition, it is unlikely that HFPO-DA would be an individual chemical of concern in the absence of other PFAS. Therefore, there are no HFPO-DA SI analytical results to screen against the 2022 OSD risk screening levels. This report provides the PA/SI for FTSHF and PA for FTDR 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 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 2016a). On 15 October 2019, the OSD provided guidance on the investigation of PFOS, PFOA, and PFBS at Department of Defense (DoD) restoration sites (OSD

2019). The DoD guidance provides risk screening levels for PFOS, PFOA, and PFBS in tap water and soil, calculated using the USEPA's Regional Screening Level (RSL) calculator for residential and industrial/commercial worker receptor scenarios. Following the issuance of the 2019 OSD 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). On 18 May 2022, the USEPA published an update to the RSLs table. The May 2022 RSL table included six PFAS constituents: PFOS, PFOA, PFBS, PFNA, PFHxS, and HFPO-DA (USEPA 2022). On 06 July 2022, the OSD issued a memorandum to include revised risk screening levels based on the May 2022 USEPA RSLs (OSD 2022). The July 2022 Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program is provided for reference as **Appendix A**. These screening criteria are discussed further in **Section 6.5**.

1.2 PA/SI Objectives

This PA/SI at FTSHF was conducted consecutively because the results of the PA yielded AOPIs that necessitated continuing onto the SI phase in accordance with CERCLA. Additionally, a subsequent PA was conducted for the sub-installation FTDR which identified one AOPI. A SI was not determined to be appropriate due to the unlikely usage of AFFF, absence of groundwater receptors, and likely removal of any potentially impacted material due to redevelopment of the area around the AOPI. Consequently, this report provides the combined objectives of both PA and SI reports.

1.2.1 PA Objectives

During the PAs, investigators collected readily available information and conducted site reconnaissance (site reconnaissance was not conducted at FTDR due to significant redevelopment of the area since any potential AOPIs identified during the PA were present). The PAs evaluated and documented areas throughout FTSHF and FTDR 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

A 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 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.

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 FTSHF and sub-installation FTDR, PA and/or SI development followed the process as described below. **Section 3** provides a summary of the PA activities completed at both FTSHF and FTDR, and **Section 6** provides a summary of the SI activities completed for FTSHF. The PA and SI processes are documented in the PA/SI Quality Control Checklist included as **Appendix B**. Site reconnaissance was not conducted at FTDR; however, a windshield survey was conducted to confirm site conditions in the area of the AOPI.. The information presented in the subsections below is only relevant to FTSHF where site reconnaissance was conducted.

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), U.S. Army Garrison-Hawaii (USAG-HI), and Arcadis U.S., Inc. (Arcadis). The kickoff call occurred on 07 January 2019, 8 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 FTSHF.

A read-ahead package was prepared and submitted to the appropriate POCs 2 weeks before the site visit. The read-ahead package contains the following information:

- The Installation Management Command (IMCOM) operation order
- The Army PA Operations Security requirements package, which includes the antiterrorism/operations security review cover sheet.
- 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.

1.3.1.1 Sub-Installation Preliminary Assessment

Following the completion of the SI at FTSHF, USAEC identified the need for a PA to be performed at the sub-installation FTDR. Similarly to the FTSHF PA, a kickoff teleconference was held between applicable POCs from USAEC, USACE, USAG-HI, and Arcadis. The kickoff call occurred on 30 January 2023, to discuss the goals and scope of the PA, project scheduling, installation access, timeline for the site visit if needed, access to installation-specific databases, and to request available records.

A records review was conducted 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 FTDR. Additionally, personnel interviews were conducted with individuals having significant historical knowledge at FTDR. The interviews focused on confirming information discussed in historical documents, collecting information that may have not been in historical documents, and corroborating other interviewees' information. Upon completion of the records review and interviews, a windshield survey at the Hale Koa hotel was completed on 21 February 2023. Additionally, topographic and other publicly available geographic information was reviewed to confirm construction and modifications have changed the surface topography compared to the historical footprint of FTDR in the 1970s.

A post-PA teleconference was held on 11 April 2023 with applicable POCs from USAEC, USACE, USAG-HI, and Arcadis to discuss the results of the PA, which identified one AOPI, and confirmed that an SI would not be conducted at FTDR given the information available at the time of the PA.

1.3.2 Preliminary Assessment Site Visit

The site visit at FTSHF was conducted in conjunction with multiple other Hawaii installations between 05 and 22 March 2019. 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.

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

Site reconnaissance at FTSHF 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. An informal exit briefing was conducted on 21 March 2019 with USAG-HI to discuss preliminary findings of the PA site visit.

Site reconnaissance nor a formal site visit was conducted at FTDR during the PA. However, as stated in **Section 1.3.1.1**, a windshield survey of the AOPIs historic location was conducted to verify current site conditions.

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 identified at FTSHF, 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 FTSHF to evaluate PFOS, PFOA, PFBS, PFNA, and PFHxS presence or absence at each AOPI and determine whether further investigation is warranted. An SI kickoff and scoping teleconference was held between the Army PA team, USAG-HI, USAEC, and USACE.[1]

The objectives of the SI kickoff and scoping teleconference was to obtain concurrence on the SI sampling plan from USAEC, USACE, and the installation POCs, as well as a discussion of the following topics:

- AOPIs selected for sampling and the proposed sampling plan for each AOPI
- Identify specific installation access requirements and potential schedule conflicts
- General SI deliverable and field work schedule information and logistics
- Health and safety considerations

A Programmatic Uniform Federal Policy-Quality Assurance Project Plan (PQAPP) was developed and finalized in October 2019 for the USAEC PFAS PA/SI (Arcadis 2019a). 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 2019a) 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.

[1] The SI kickoff teleconference covered six installations on Oahu within USAG-HI's purview: Schofield Barracks, Wheeler Army Airfield, Helemano Military Reservation, Fort Shafter, Tripler Army Medical Center, and Aliamanu Military Reservation.

The SSHP was designed to supplement the Accident Prevention Plan (Arcadis 2018), which was developed for Army installations nationwide. The QAPP Addendum and SSHP were submitted to the installation and finalized before commencement of field work.

The DQOs, sampling design and rationale, and field methods employed for the SI are summarized from the QAPP Addendum developed for FTSHF (Arcadis 2022) 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, PFBS, PFNA, and PFHxS analysis by liquid chromatography with tandem mass spectrometry and compliant with the DoD Quality Systems Manual (QSM) 5.3 (DoD and Department of Energy 2019). Laboratory analytical results were then validated and verified by a project chemist to assess the usability of the data collected. Validated analytical results were summarized in the context of OSD risk screening levels (defined in **Section 6.5**).

2 INSTALLATION OVERVIEW

The following subsections provide general information about FTSHF and FTDR, 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. Subsections below provide installation overview information for FTSHF and FTDR as applicable/available.

2.1 Site Location

FTSHF is an active military installation located on the island of Oahu, approximately 3 miles northwest of downtown Honolulu on the southwest side of the Koolau Mountain Range as shown on **Figure 2-1**. The installation occupies approximately 600 acres separated into two areas by Interstate H-201/Moanalua Freeway (Arcadis 2022). The area northeast of H-201/Moanalua Freeway is known as the Main Post and the area located southwest of H-201/Moanalua Freeway is known as Fort Shafter Flats. The surrounding area consists of residential properties, commercial businesses, light industrial facilities, and land designated as forest reserve (Army 2016a). **Figure 2-2a** details the installation layout of FTSHF.

FTDR is located on the waterfront in Honolulu, Oahu in the high rise, high intensity Waikiki resort district, and is separated into two areas by Kalia Road. FTDR has been used by personnel from all branches of the military as a recreation center since World War II, particularly during the Vietnam conflict (Army 1992). Consisting of approximately 72 acres, the area is one of the last remaining open spaces along Waikiki Beach. **Figure 2-2b** details the installation layout of FTDR.

2.2 Mission and Brief Site History

FTSHF is an active USAG-HI installation. It was established in 1907 and is the oldest Army installation in Hawaii that serves as the Army, Pacific Command Headquarters. FTSHF's mission is to train, equip, and sustain Army forces in the Pacific Theater (Army 2016a).

FTSHF is situated within the ahupuaa of Kahauiki, a former native Hawaiian land unit of approximately 1,438 acres. Approximately 474 acres is under Army jurisdiction and the rest is owned or controlled by the State of Hawaii. Some of the earliest historical records of Kahauiki indicate that the land was used for agriculture, fishponds and grazing for dairy cows. In 1989 the land was designated as the Kahauiki Military Reservation. A portion of the Kahauiki Military Reservation was designated as Fort Shafter in 1907 (Army 2016a).

FTDR was established in 1909 as part of the Headquarters Coast Defenses of Oahu to protect Honolulu and Pearl Harbor. It was used as the Camouflage School and the U.S. Armed Forces Institute in the post-World War II and World War II era. Maluhia Hall was constructed in 1943 as a center for recreational and social activities (demolished in 1998). The U.S. Army Reserve Headquarters and training areas, Post Commander's Office, a parade ground, and heliport are no longer present but were historically located on the installation north of Kalia Road (Army 1992). FTDR supported several canons and anti-aircraft guns near the shore until the Coastal Artillery was disbanded in 1950 and FTDR was designated as an Armed Forces Recreation Area. The central section of FTDR has an open park area that pays tribute to the branches of the U.S. Armed Services (USAG-HI 2018).

2.3 Current and Projected Land Use

FTSHF consists of 156 buildings which are a total of 1.66 million square feet and 599 family housing units which are a total of 0.85 million square feet. The area surrounding FTSHF consists of residential properties, commercial businesses, light industrial facilities, and land designated as forest reserve. Although information regarding the population of FTSHF is not readily available, housing and recreational facilities including, but not limited to, a golf course and baseball field are located at the installation (**Figure 2-1**; **Figure 2-2a**; Arcadis 2022). There are no foreseeable future land use changes for FTSHF.

FTDR consists of the Daniel K. Inouye Asia-Pacific Center for Security Studies, Ainahau Triangle park, and a public parking lot to the north of Kalia Road, and the Hale Koa Hotel managed by the Armed Forces Recreation Center, the U.S. Army Museum, Hawaii (located in the historic Battery Randolph), and the U.S. Army Corps of Engineers Regional Visitor's Center (also in the historic Battery Randolph) to the south of Kalia Road. FTDR is an open post with park areas, tennis courts, a volleyball court, picnic area, and beachfront for both military and civilian use (**Figure 2-1**; **Figure 2-2b**; USAG-HI 2018). There are no foreseeable future land use changes for FTDR.

2.4 Climate

According to the Western Regional Climate Center (WRCC), the annual average total precipitation at Moanalua Station 770, Hawaii (516395), located near FTSHF, from January 1905 to May 2016 was 34.55 inches per year (WRCC 2020a). Recent temperature data is not available for Moanalua Station 770; however, WRCC data from another nearby climate station, Honolulu International Airport, Hawaii (511919), indicates annual temperatures ranged from an average minimum of 70.4 degrees Fahrenheit to an average maximum of 84.0 degrees Fahrenheit for the period of May 1940 to June 2016 (WRCC 2020b).

FTDR has a tropical and semi-arid type of climate. According to the WRCC, the annual average total precipitation at the Waikiki 717.2, Hawaii (519397) Station, located near FTDR, from January 1965 to June 2016 was 23.44 inches per year (WRCC 2023). Recent temperature data from the Waikiki 717.2, Hawaii (519397) Station indicates annual temperatures ranged from an average minimum of 69.2 degrees Fahrenheit to an average maximum of 84.5 degrees Fahrenheit from January 1965 to June 2016. According to Honolulu International Airport (HIA) National Weather Station Service data, there are noticeable diurnal and seasonal variations in wind speed and direction. Generally, the winter months are characterized by a more even distribution of directions and wind speeds (less than 11.5 kts) while summer months are strongly dominated by northeast to east-northeast trade winds at higher speeds (greater than 11.5 kts).

2.5 Topography

Fort Shafter Flats is generally flat, while the Main Post portion of FTSHF is built on the steeper eroded slopes of the Koolau Mountains (**Figure 2-3**). Most of the Fort Shafter Flats portion of the military reservation is located on an alluvial coastal plain. The terrain of the facility is generally flat, with ground elevations ranging from about 5 feet to 40 feet above mean sea level (Environet, Inc. 2006).

The FTDR terrain is relatively flat with elevations ranging from sea level to 6 feet; a man-made slope of 22 feet surrounds the Hale Koa Hotel (**Figure 2-3**; Army 1992).

2.6 Geology

Fort Shafter Flats and portions of the Main Post consist of a complex geologic sequence known as the Honolulu Plain. The southwest flank of the Koolau Mountain Range consists of the Honolulu Coastal Plain. The inland portion of the plain is covered by alluvium and colluvium deposits that extend southward to portions of Fort Shafter Flats. Additional information regarding geologic conditions beneath the Main Post is not readily available. The basement rock beneath Fort Shafter Flats is composed of Koolau basalt with the following characteristics: the basal basaltic unit is comprised of thin pahoehoe lavas interlayered with thick, massive lava flows; the interface between individual lava flow units is irregular and loose blocks, lava tubes, and contraction joints that allow for high water permeability; and the un-weathered basalts in the area are permeable to groundwater flow and water infiltration. Above the basaltic bedrock at the Fort Shafter Flats lies a deposit of poorly permeable weathered alluvium which has been overlain by marine sediments containing calcareous shells deposited when the sea level was a minimum of 95 feet above its present level some 450,000 years ago. Clay lenses are interbedded with these alluvium and marine sediment deposits. Tuffs and lava flows from post-erosional eruptions lie towards the top of the formation. Alluvial fans were built over the tuffs by streams issuing from the uplands to form Shafter Terrace, a slightly elevated surface between the post-erosional craters and mountains. Streams have slightly incised their courses into the soft sediments in the area creating a gently undulating surface (Environet, Inc. 2006).

FTDR is situated on a flat coastal area known as the Honolulu Plain. This physiographic land division is composed of weathered alluvium overlying marine sediments and wave-eroded basalt. Most of the reservation was constructed on coral-filled fishponds, marshlands, and sandy soils (Army 1992).

2.7 Hydrogeology

There are three aquifers underlying FTSHF, one beneath the northeastern portion of the Main Post and two (an upper and lower aquifer) beneath Fort Shafter Flats and the adjacent, southwestern portion of the Main Post. The aquifers are part of the Moanalua Aquifer System in the Honolulu Aquifer Sector and are characterized as follows (Mink and Lau 1990):

- The aquifer beneath the northeast portion of the Main Post is a basal, unconfined flank-type aquifer. The aquifer is classified as currently developed, having a salinity of less than 250 milligrams per liter of chloride (i.e., freshwater), being irreplaceable, and highly vulnerable to contamination. On Oahu, because of the limited resources, interconnection among groundwater sources, and the relatively rapid time of groundwater travel, most unconfined aquifers are vulnerable to contamination. The aquifer is used for drinking water distributed to residential and commercial users in the nearby municipalities in the City and County of Honolulu.
- The upper aquifer beneath Fort Shafter Flats and the adjacent, southwestern portion of the Main Post is a basal, unconfined, sedimentary aquifer with potential utility classified as neither used for drinking nor ecologically important, having moderate salinity of 1,000 to 5,000 milligrams per liter of chloride, being replaceable, and highly vulnerable to contamination. The lower aquifer is a basal, confined, flank

type aquifer classified as currently developed, having a salinity less than 250 milligrams per liter of chloride (i.e., freshwater), being irreplaceable, and with low vulnerability to contamination. The aquifer is used for drinking water distributed by the Moanalua, Kalauao, and Punani Wells and the Halawa Shaft to municipal and private users (Board of Water Supply 2022).

The regional direction of groundwater flow in the area is towards the west/southwest. In the southern portion of Fort Shafter Flats, groundwater flow is primarily towards the west.

Based on groundwater data collected during a previous investigation, depth-to-groundwater on the southern portion of Fort Shafter Flats has been observed to range between 4 and 12 feet below ground surface (bgs) (Arcadis 2019b). The depth at which each aquifer occurs at any given site within the installation boundary is undetermined from a review of readily available documents. However, the depth to the lower, freshwater aquifer on the southern portion of Fort Shafter Flats is estimated to vary between 120 and 250 feet bgs based upon the stratigraphy encountered in wells previously drilled in the area. The lower aquifer is under artesian pressure (Environet, Inc. 2006).

FTDR is located within the Palolo Hydrologic Unit/Aquifer System. The upper aquifer "flank aquifer" is in horizontally extensive lava. The aquifer is classified as currently developed, having a salinity of less than 250 milligrams per liter of chloride (i.e., freshwater) and is confined. The lower aquifer "sedimentary aquifer" is unconfined with moderate salinity and vulnerable to contamination because of its very shallow water table. In the vicinity of FTDR, an active artesian well (non-drinking water) is located approximately 2.4 miles northeast of FTDR. Depth to groundwater was 3.18 feet below land surface / 2.82 feet above local mean sea level. Salinity is 14,300 milligrams per liter (highly saline water is 10,000 to 35,000 parts per million).

2.8 Surface Water Hydrology

Surface water at the installation is not used as a drinking water source, given that groundwater sources from aquifers in the area provide drinking water to municipal and private users. Two streams, an unnamed stream and Kahauiki Stream, flow onto FTSHF across the northeast installation boundary (**Figure 2-2a**). The unnamed stream merges with Kahauiki Stream near the center of the Main Post and flows to a brick-lined drainage canal with a concrete bottom that transects the southwest portion of the Main Post. Another unnamed stream flows to a second drainage canal near the southwest boundary of the Main Post. The two drainage canals merge near the southwest installation boundary of the Main Post and continue southwest as Kahauiki Stream through Fort Shafter Flats. Although identified as perennial streams in the Hawaii rivers and streams geographic information system (GIS) database, the streams/drainage canals on FTSHF can be relatively dry at any given time. Additional water features in the surrounding area include Kalihi Stream to the southeast, Moanalua Stream to the west, and an unnamed stream and Manaiki Stream to the northwest (**Figure 2-2a**). Surface water features in proximity of the installation are not likely used for drinking water (Arcadis 2022). Additionally, there is also no evidence that surface water features in the surrounding area, with the exception of Keehi Lagoon located approximately 1,600 feet south of Fort Shafter Flats, are used for recreational purposes.

No streams run through FTDR. The Ala Wai Canal is located to the north and east of FTDR (**Figure 2-2b**).

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 FTSHF and FTDR.

2.9.1 Stormwater Management System Description

Stormwater from the FTSHF installation drains via overland runoff and storm drains to Kahauiki Stream and tributaries of Moanalua Stream and eventually to Keehi Lagoon, located approximately 1,600 feet south of Fort Shafter Flats (Army 2015).

Except for a small stormwater drainage system at the Bruyeres Quadrangle, all the subsurface drain lines serving FTDR are located in the area between Kalia Road and the beach. The system consists of 2,300 linear feet of subsurface concrete pipe networks and drain lines (8 to 36 inches diameter), numerous shallow surface infiltration pockets, swales, and sumps (catch basins and drain manholes). This network is organized into two systems: one drains the Hale Koa Hotel complex and discharges stormwater to the ocean, and the other drains the area north of the historic Battery Randolph and conveys the runoff to a City and County of Honolulu box culvert. The storm drainage system is designed to handle storm runoff primarily by infiltration with ponding during storm events.

2.9.2 Sewer System Description

Sanitary sewage from FTSHF drains to a municipal wastewater treatment plant at Sand Island. Sludge from the wastewater treatment plant at Sand Island has historically either been incinerated at 1400 to 1500 degrees Fahrenheit and/or disposed at Waimanalo Gulch Landfill.

The sanitary sewer system within FTDR consists of four primary collection networks, totaling approximately 5,000 linear feet of 12-inch through 6-inch piping. The largest network collects sewage from the Hale Koa Hotel and U. S. Army Reserve Maintenance Shop, discharging it into the FTDR pump station. At the time of the PA, data on wastewater generation were unavailable. Sewage is discharged to the City and County of Honolulu's collection system at various connection points (Army 1992).

2.10 Potable Water Supply and Drinking Water Receptors

According to Directorate of Public Works staff, FTSHF has its own water source/wells. USAG-HI GIS data indicates there are two installation drinking water wells on post. These wells are not presented on **Figure 2-2a** per Operations Security guidance. Artesian conditions exist at these wells that have a measured piezometric head of 19.8 feet with a corresponding surface elevation of 19.6 feet. The depths of the wells could not be determined from readily available documents. (Environet, Inc. 2006).

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 FTSHF 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. None of these wells were determined to be downgradient of the installation (**Figure 2-4**). However, Army owned-wells/water sources and on-post installation wells/water sources, if present, are not shown or identified on

figures in this PA/SI report due to operational security guidance/requirements. The EDR report providing well search results is provided as **Appendix D**.

FTDR derives its water from the City and County of Honolulu municipal system. All known off-post drinking water source wells are upgradient to the northwest of FTDR.

The available EDR report did not contain well data within a 5-mile radius to the northeast, east, and southeast of FTDR. An independent well search from local databases was performed and no potable water supply wells were identified or found to be within the area northeast, east, and southeast of FTDR.

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 results of a botanical survey conducted in December of 2003 indicated the areas of botanical interest within Fort Shafter Flats have been severely disturbed, such that no native species were found. The seven sites inventoried consist mostly of paved and landscaped areas with fairly low species diversity that were dominated primarily by invasive species. Landscaped areas are comprised of mostly common trees such as the Shower tree (*Cassianealia*), Coral tree (*Erythrina crista-galli*), King palms (*Archontopheonix alexandrae*), and Autograph trees (*Clussia rosea*). Manicured lawns consist of invasive grass species including Swollen finger grass (Chloris barbata), Bermuda grass (*Cynodon dactylon*), and Goose grass (*Eleusine indica*). Patches of these three varieties of grass species are found throughout Shafter Flats intermixed with various weeds such as Spurge (*Chmaesyce spp.*), Beach wiregrass (*Dactylotenium aegyptium*), Love grass (*Eragrostis tenella*), and Chinese violet (*Asystasia gangetica*) (Environet, Inc. 2006).

Streams converging in the FTSHF area have a variety of macrofauna which are typically euryhaline (i.e., fluctuating salinity) with some marine stenohaline (consistent salinity) species near the outlet near the intersection with Moanalua Stream. Past studies have revealed that populations of introduced species of fish and crustaceans are primarily found in Kahauiki Stream. This situation is typical of most channeled streams found throughout Oahu (Environet, Inc. 2006).

Birds inhabit the vegetated strips of mangrove and other vegetation surrounding the streams and drainage channels crossing Fort Shafter Flats. The bird species consists of native, migratory, and alien species. Other than birds, there are a limited variety of mammals, mainly consisting of introduced species of rats, the house mouse, mongoose, feral cats, feral dogs, and feral pigs. Of the avifaunal species observed and recorded, one endangered species, the Hawaiian Moorhen (*Alae Ula*) was observed within the project boundaries. While no other endangered species were observed in and around the project area, the Hawaiian Duck (*Koloa*), Hawaiian Owl (*Pueo*), and the mammal Hawaiian Hoary Bat (*Lasiurus cinereus semontus*) are listed as endangered species known to inhabit areas on Oahu. The areas within Fort Shafter Flats are not considered nesting habitat for these birds (Environet, Inc. 2006).

On 27 July 1989, a field survey of the botanical resources located at FTDR was performed. The general vegetation at the installation consists of open lawn areas with plantings of trees and shrubbery located generally along roadsides, parking areas and around buildings. In the areas south of Kalia Road, single trees and clusters of trees are scattered throughout the lawn area. Large groves of coconut palms (*Cocos*

nucifera) are a common feature. Other trees frequently found throughout the site include shower trees (*Cassia sp.*); several different kinds of banyan (*Ficus spp.*); monkey pods (*Samanea saman*); a number of tall date palms (*Phoenix damyhtera*); and milo (*Thespesia populnea*). Of particular interest are six specimens of the native coral tree or wiliwili (*Erythrina sandwicensis*) located along the fence surrounding the U. S. Army Reserve Tactical Vehicle Motor Pool. The trees are about 15 feet tall and were blooming profusely during the botanical survey. Common weedy species associated with lawn areas are hierba del cabello (*Calyptocarpus vialis*), pitted beardgrass (*Andropogan pertusa*), prostrate indigo (*Indigofera spicata*), garden spurge (*Euphorbia hirta*) and swollen fingergrass (*Chloris barbata*). Wiregrass (*Eleusine indica*) grows where there is heavy pedestrian traffic and the ground has been compacted. Shrubs used for hedge material include mock orange (*Murrya paniculata*), vitex (*Vitex trifolia*), various Hibiscus cultivars, star jasmine (*Jasminum multillorum*), croton (*Codiaeum variegation*) and beach naupaka (*Scaevola taccada*).

None of the plants found at FTDR are officially listed as threatened or endangered species; nor are any of the plant species recommended or candidate for such status. Similarly, none of the trees found on the site have been designated as Exceptional Trees under the City and County of Honolulu Exceptional Tree Ordinance, nor have any been nominated by the Arborist Advisory Committee (Army 1992).

No endemic land birds were recorded, nor would any be expected given the nature of the habitat at FTDR. The site may have contained endemic waterbirds when it was a wetland, i.e., prior to the filling of the Waikiki area with dredged spoil material. Similarly, no migratory indigenous (native) birds were recorded. Migratory birds that undoubtedly frequent and inhabit the site during the September to April period include Pacific Golden Plover (*Pluvialis fulva*), Wandering Tattler (*lieteroscelus incanus*), Ruddy Turnstone (*Arenaria interpres*) and Sanderling (*Calidris alba*) (Army 1992).

No resident indigenous land birds were recorded at FTDR, nor would any be expected given the nature of the habitat. The only species of seabird recorded at FTDR was the White (Fairy) Tern (*Gygis alba*) (Army 1992).

In general, the present environmental and habitat characteristics of FTDR provide a limited range of habitats that are used by the typical array of exotic (introduced) birds. A total of 11 species of exotic (introduced) birds were recorded during the survey. The most abundant species were Zebra Dove (*Ceopelia striata*), Red-vented Bulbul (*Pycnonotus cafer*) and Common Myna (*Acridotheres tristis*). Exotic species not recorded but which conceivably could occur at the site include the Common Barn Owl (*Tyto alba*), Nutmeg Mannikin (*Lonchura punctulata*), Chestnut Mannikin (*Lonchura malacca*), Northern Mockingbird (*Mimus polyglottos*), and possibly, Northern Cardinal (*Cardinalis cardinalis*). The latter species prefers brushy habitat and thus may rarely occur on the site (Army 1992).

2.12 Previous PFAS Investigations

Previous (i.e., pre-PA) PFAS investigations relative to FTSHF, including both those conducted and not conducted by the Army, are summarized to provide full context of available PFAS data for FTSHF. However, only data collected by the Army will be used to make recommendations for further investigation.

The USEPA conducted the third Unregulated Contaminant Monitoring Rule (UCMR3) monitoring between 2013 and 2015. UCMR3 is a national program that collects data for contaminants that are suspected to be present in drinking water and do not have health-based standards set under the Safe Drinking Water

Act (USEPA 2016b). The UCMR3 included the analysis of PFOS, PFOA, PFBS, PFNA, and PFHxS in public water systems serving more than 10,000 people between 2013 to 2015. During monitoring events conducted in 2013 (April, June, October, and December) and 2014 (April and June), samples were collected from 30 to 40 public supply wells within a 5-mile radius of FTSHF (the location of various wells was undetermined from readily available documents but did not include the two drinking water wells located on the Main Post of FTSHF). Results indicated that PFOS, PFOA, PFBS, PNFA, and PFHxS were not detected in any of the samples collected from the public supply wells. The minimum reporting level at the time of UCMR3 sampling was 40 ng/L for PFOS, 20 ng/L for PFOA, 90 ng/L for PFBS, 20 ng/L for PFNA, and 30 ng/L for PFHxS. The laboratory that analyzed the samples under UCMR3 met the USEPA's UCMR3 Laboratory Approval Program application and Proficiency Testing criteria for USEPA Method 537 Version 1.1.

In addition, based on laboratory reports provided by the U.S. Army Public Health Center, drinking water samples were collected from drinking water wells at FTSHF (Building 509) on 17 October 2016 and 16 October 2017 for PFAS (including PFOS, PFOA, PFBS, PFNA, and PFHxS) analysis using USEPA Method 537. The sampling site identified on the chain of custody record for the drinking water sample collected 16 October 2017 is "FS Bldg 509 Post Chlorination EPTDS", where EPTDS is presumably the entry point to the distribution system, and not a point of use. None of the analyzed constituents were detected above the method reporting limit of 2.0 ng/L (Army 2016b; Army 2017). No historical figures/tables are presented as part of this PA/SI report.

A review of readily available documents and information indicated that no historical PFAS investigations (including PFOS, PFOA, PFBS, PFNA, and/or PFHxS) have been conducted at FTDR.

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 FTSHF and FTDR, data was collected from three principal sources of information and are described in the subsections below:

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

Preliminary locations of potential use, storage, and/or disposal of PFAS-containing materials were then evaluated in the PA (during records review, personnel interviews, and/or site reconnaissance) and were categorized as AOPIs or as areas not retained for further investigation at this time based on a combination of information collected (e.g., records reviewed, personnel interviews, internet searches). A summary of the observations made, and data collected through records reviews (**Appendix E**), installation personnel interviews (**Appendix F**), site reconnaissance photos (**Appendix G**), and site reconnaissance logs (**Appendix H**) during the PA process for FTSHF and FTDR are 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, federal fire department documents, USAG-HI Directorate of Public Works documents, and GIS files. Internet searches were also conducted to identify publicly available and other relevant information. A list of the specific documents reviewed for FTSHF and FTDR is provided in **Appendix E**.

3.2 Personnel Interviews

Interviews were conducted during the site visit at FTSHF.

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

- Hazardous Waste Program Manager
- Safe Drinking Water and Clean Air Program Manager
- Lieutenant
- Fire Fighter
- Engineer
- General Engineer Supervisor
- Operations and Maintenance Division Chief

- Supply Branch Chief
- Battalion Chief
- Architectural Historian
- Cultural Resources Archivist

A site visit was not conducted at FTDR; therefore, interviews were conducted telephonically and via email.

The list of roles for the installation personnel interviewed via telephone and email for FTDR is presented below (affiliation is with FTDR unless otherwise noted).

- Regional Chief of the Federal Fire Department
- Directorate of Public Works
- Archeologist
- Facilities Manager
- Hale Koa Hotel Directorate of Public Works liaison
- Information Specialist
- Real Estate Specialist
- Federal Fire Department Lieutenant

The compiled interview logs for both FTSHF and FTDR are provided in **Appendix F**.

3.3 Site Reconnaissance

Site reconnaissance and visual surveys were conducted at the preliminary locations identified at FTSHF 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 G**; photos were used to assist in verification of qualitative data collected in the field. The site reconnaissance logs are provided in **Appendix H**.

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.

Site reconnaissance was not conducted at FTDR in accordance with findings presented in Section 1.3.1.1. However, a photo from the windshield survey showing the driveway and lobby elevation above the original elevation, approximately at street level, is provided in **Appendix G**.

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

FTSHF and FTDR were evaluated for all potential current and historical use, storage, and/or disposal of PFAS-containing materials. Unless otherwise specified in the subsections below, all information presented is relevant for FTSHF due to limited relevant information available for FTDR. As such, this section is organized to summarize the AFFF-related uses first, and all remaining potential PFAS-containing materials in the subsequent section.

4.1 AFFF Use, Storage, and Disposal Areas

AFFF was developed in the mid-1960s in response to a need for firefighting foams better suited to extinguish Class B, fuel-based fires. AFFF formulations consist of water, an organic solvent, up to 5 percent (%) hydrocarbon surfactants, and 1 to 3% PFAS (Interstate Technology 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.

As identified and confirmed during site visit interviews with the Federal Fire Department staff, AFFF was stored at Building 322: Former Fire Station #3, which moved operations offsite to Tripler Army Medical Center (TAMC) in the 1980s. The location and amount of AFFF that was stored onsite is unknown. Although no AFFF releases were confirmed, installation personnel noted that incidental releases are likely to have occurred during standard fire station activities (e.g., filling truck foam tanks, nozzle testing, truck washing).

For emergency preparedness, installation/fire department personnel were trained to perform nozzle testing with AFFF to ensure optimal flow and use of the AFFF mixture. Nozzle testing involved spraying AFFF through fire equipment. Fire equipment training also included arc training to maximize the arc, reach, and distance covered by AFFF in an emergency response. Federal Fire Department staff confirmed AFFF training was conducted at an AFFF Training Area one to three times in the 10 years prior to the March 2019 site reconnaissance visit. A fire truck from TAMC was parked along a curb in the roadway and AFFF was sprayed across a grassy area toward the adjacent, heavily vegetated stream/drainage canal. AFFF was sprayed long enough to make the foam flow, and then was shut off. According to interviews Federal Fire Department staff, all training with AFFF was discontinued in 2017 per a U.S. Navy directive and staff were informed that no more AFFF would be issued.

There are three known crash/fire responses at FTSHF in which AFFF was utilized in 2013. Two separate car fires (Car Fire A and Car Fire B) occurred in the parking lot near Building 232 and Building 214. AFFF was used in response to both incidents. The amount of AFFF used and the duration of use during each response is unknown. Additionally, a car crashed through an access gate, over a curb, and into the

concrete drainage canal that transects the southwest portion of the Main Post at Funston Road and Yamanaga Street. The accident did not result in a fire; however, fuel leaked into the canal, which can be dry at any given time. AFFF was sprayed directly into the canal for approximately 10 minutes. During this incident, a fire truck from TAMC also leaked approximately 4 gallons of mixed foam (with approximately 1 gallon of AFFF concentrate) onto the adjacent, asphalt roadway. The AFFF reservoir was not completely emptied, and the lines were flushed onsite after the response.

According to document research and personnel interviews conducted in 2023, Building T-25: Former Fire Station at FTDR ceased operations in 1970—the same year that AFFF use was authorized at Army installations. Therefore, while AFFF storage and incidental AFFF release could have occurred during standard activities (e.g., filling truck foam tanks, nozzle testing, truck washing) at this historic location, it is very unlikely. Additionally, no history of live fire training, helicopter crashes, or fire incidents at FTDR have been reported or documented in readily available information.

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

Metal plating operations were also identified as preliminary locations for use, storage, and/or disposal of PFAS-containing materials following document research, personnel interviews, and site reconnaissance at FTSHF. 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.

Building 1507 – Wing A (IRP No. FTSHF-23), located southwest of the Main Post at Fort Shafter Flats, was a former location for metal plating operations. As described in the site reconnaissance logs, this section of the building is currently abandoned and used for furniture storage, but the former equipment used is still in place. Several floor drains within the area likely flow to the large pipe along the east end of the building, and then drain to the concrete sump outside the south side of the building near its eastern corner. On 18 April 1995, the sump contents were sampled for Toxicity Characteristic Leaching Procedure (TCLP) metals analysis using EPA Methods 1311 and 6010A. The analytical results indicated that TCLP metals concentrations (i.e., arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) were not detected above reporting limits, therefore the sump and its contents were deemed nonhazardous. The sump and associated piping were removed in 1997 (PRC 1998). On 16 January 1997, the soil beneath the sump was sampled for TCLP metals analysis using EPA Methods 1311 and 6010A to assess potential leaching of metals from the sump to the soil. The analytical results indicated that TCLP metals concentrations in the soil samples did not exceed TCLP metals criteria. Available

documents did not contain information about plating shop operations or materials used, including whether any of the materials contained PFAS compounds, and interviewees did not have this information.

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 FTSHF) is not part of the PA/SI. However, potential off-post PFAS sources within a 5-mile radius of the installation that were identified during the records search and site visit are described below. A comprehensive list of potential off-post sources can be found in the EDR report (**Appendix D**). Although these sources are within a 5-mile radius of the FTSHF installation, none of these off-post sources are hydraulically (northeast) upgradient of FTSHF.

Table 4-1. FTSHF Readily Identifiable Off-Post PFAS Sources

Facility Name	Facility Address	Type of Facility	Distance and Direction from Installation[1]
Moanalua Fire Station #30	2835 Ala Ilima Street, Honolulu, Hawaii 96818	Fire Station	0.5, Southwest
Honolulu Fire Department – 32 Kalihi Uka	1861 Kamehameha IV Road, Honolulu, Hawaii 96819	Fire Station	0.5, East
Honolulu Fire Department – Station 30	2835 Ala Ilima Street, Honolulu, Hawaii 96818	Fire Station	1.0, West
Honolulu Fire Department – Station 31-Kalihi Kai	1334 N Nimitz Highway E, Honolulu, Hawaii 96817	Fire Station	2.0, Southeast
Daniel K. Inouye International Airport – Fire Station 2	31 Lagoon Drive, Honolulu, Hawaii 96819	Fire Station	2.4, Southwest
United Laundry Services	2291 Alahao Place, Honolulu, Hawaii 96819	Laundry/Water Proofing	0.5, South
Alexanders Automotive	1305 Middle Street, Honolulu, Hawaii 96819	Automotive Maintenance	0.05, East
CVS Photo	1620 N School Street, Honolulu, Hawaii 96817	Photo Processing	0.9, Southeast
Sumida Farm Inc.	98-160 Kamehameha Highway, Aiea, Hawaii 96701	Farm	4.3, Northwest
Maluhia Hospital	1027 Hala Drive, Honolulu, Hawaii 96817	Hospital	1.5, Southeast
St. Francis Medical Center	2226 Liliha St, Honolulu, Hawaii, 96817	Hospital	2.1, Southeast
Thirsty Cars	2122 Kaliawa Sreet #3A, Honolulu, Hawaii 96819	Car Wash	0.9, South

Notes:

1 = Distance in miles from the installation to the off-post PFAS source.

Table 4-2. FTDR Readily Identifiable Off-Post PFAS Sources

Facility Name	Facility Address	Type of Facility	Distance and Direction from Installation[1]
Honolulu Fire Department Station 2 - Pawaa	1610 Makaloa Street, Honolulu, Hawaii 96814	Fire Station	0.95, Northwest
Honolulu Fire Department Station 7 - Waikiki	381 Kapahulu Ave, Honolulu, Hawaii 96815	Fire Station	1.24, Southeast
iDo Laundry	1922 Kalakaua Avenue, Honolulu, Hawaii 96815	Laundry/Water Proofing	0.5, Northeast
Ena Road Laundromat	478 ‘Ena Road, Unit A, Honolulu, Hawaii 96815	Laundry/Water Proofing	0.48, Northeast
Straub Medical Center	888 S King Street, Honolulu, Hawaii 96813	Hospital	1.9, Northwest
Tenney’s Algaroba Auto Repair	1918 Algaroba Street, Honolulu, Hawaii 96826	Automotive Maintenance	1.02, North
CVS Photo	2155 Kalakaua Avenue, Honolulu, Hawaii 96815	Photo Processing	0.25, East
Yajima Auto Detailing	1326 Liona Street, Honolulu, Hawaii 96814	Car Wash	1.35, Northwest

5 SUMMARY AND DISCUSSION OF PA RESULTS

The preliminary locations evaluated for potential use, storage, and/or disposal of PFAS-containing materials at FTSHF and FTDR 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, five areas have been identified as AOPIs at FTSHF and one area has been identified as an AOPI at FTDR. The process used for refining these areas is presented on **Figure 5-1**, below.

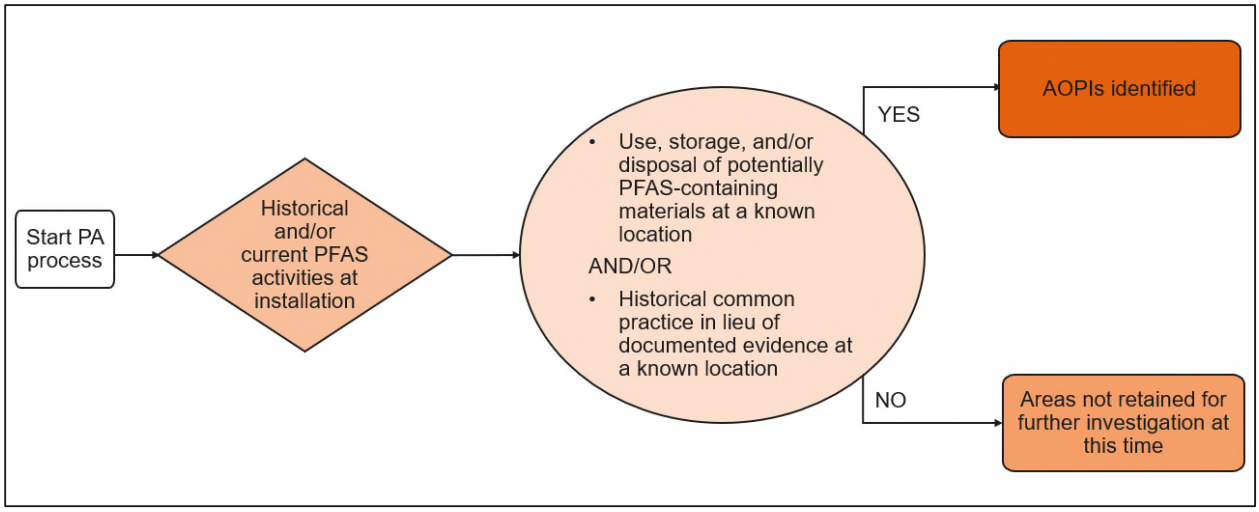


Figure 5-1: AOPI Decision Flowchart

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

Data limitations for this PA/SI at FTSHF and FTDR are presented in **Section 8**.

5.1 Areas Not Retained for Further Investigation

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

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

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

Area Description	Dates of Operation	Relevant Site History	Rationale
FTSHF: Building 42: Former Fire Station #3	Unknown to late 1940s	This former fire station was in Building 42 off Palm Circle and was torn down in the late 1940s.	Ceased operation before PFAS were used in fire-fighting foam.

Area Description	Dates of Operation	Relevant Site History	Rationale
FTDR: Former Hospital (Building T-15)	Unknown (since at least 1930 to no later than 1975)	The former Hospital (Building 15) was erected and became operational sometime between November 1908 and January 1930, and it ceased operation sometime between 1964 and 1975. There is no information available about whether x-rays were taken and developed on the premises.	No documentation of x-ray processing and disposal.
FTDR: Hale Koa Hotel (Computer Rooms 2)	1975 or later to Present	The Hale Koa Hotel has two computer rooms that utilize a FM200™ chemical sprinkler system. FM-200™ (HFC-227ea) is a replacement for Halon 1301 and provides fire suppression without using water or leaving behind residue. The chemical name for FM200™ is 1,1,1,2,3,3,3-heptafluoropropane. System potentially deployed during acceptance testing.	Gaseous fire extinguisher agent.
FTDR: Hale Koa Hotel Fire	Unknown (approximately 2018 to 2020)	There was a small fire that was fully extinguished by hotel staff with a fire extinguisher. The Honolulu Fire Department did respond and cleared the scene, but the fire was already extinguished.	No AFFF used
FTDR: Army Museum of Hawaii Fire	2019 or 2020	Circa 2019 or 2020, there was a small fire that was fully extinguished by museum staff with a fire extinguisher. The Honolulu Fire Department did not respond.	No AFFF used
FTDR: Asia Pacific Center External Shed Fire	Approximately 2020	The Asia Pacific Center facilities manager stated in 2020, around Thanksgiving, that the Honolulu Fire Department responded to a fire there. The fire was at a small external shed with "junk" but no chemical storage. The Honolulu Fire Department performed electronic records search as early as 2018 and was unable to confirm incident and stated Honolulu Fire Department trucks currently use Class A foams that do not contain PFAS. The Honolulu Fire Department did not confirm if other foams have been used historically or provide documentation/data sheet to confirm foam currently used is not PFAS containing.	Unable to confirm materials used in fire response action performed by HFD records search. No confirmed fuels storage in “junk” shed.

5.2 AOPIs

Overviews of each AOPI identified during the PA process is presented in this section. The AOPI locations for FTSHF are shown on **Figure 5-2a** and FTDR are shown on **Figure 5-2b**. Detailed views of each AOPI showing the approximate extent of AFFF use (if applicable) are presented on **Figures 5-3** through **5-8** and include active monitoring wells (if present) in the vicinity of each AOPI.

5.2.1 FSTHF: AFFF Training Area

The AFFF Training Area is identified as an AOPI following records research, personnel interviews, and site reconnaissance, due to the historical, occasional use for firefighting training activities with AFFF near the Child Development Center. The AFFF Training Area is located along Hase Drive west of Parks Road, north of the Fort Shafter Child Development Center (**Figure 5-3**). Federal Fire Department staff recalled that AFFF training was conducted at the AOPI approximately one to three times in the 10 years prior to the March 2019 site reconnaissance visit. A fire truck from TAMC was parked along a curb in the roadway and AFFF was sprayed across a grassy area toward the adjacent, heavily vegetated stream/drainage canal. AFFF was sprayed long enough to make the foam flow, and then was shut off. Surface runoff from the AOPI flows to the adjacent heavily vegetated stream/drainage canal, which may be dry at any given time. Federal Fire Department staff indicated the U.S. Navy directed them to stop training with AFFF circa 2017 and that no more AFFF was being issued.

The direction of surface runoff is toward a storm drain south of the AOPI near the Fort Shafter Child Development Center. Drainage from this area is likely conveyed to a drainage canal adjacent to the AOPI which eventually drains to Keehi Lagoon. The AFFF Training Area AOPI overlies the Main Post aquifer.

5.2.2 FTSHF: Canal Car Accident

The Canal Car Accident is identified as an AOPI following records research, personnel interviews, and site reconnaissance, due to a car crash, which occurred in 2013. The car crashed through the access gate, over the curb, and into the canal that transects the southwest portion of the Main Post at Funston Road and Yamanaga Street, leaking fuel into the concrete-lined canal. No fire occurred, however, an AFFF blanket was applied by spraying for approximately 10 minutes. During this incident, the fire truck from TAMC also leaked approximately 4 gallons of mixed foam (approximately 1-gallon AFFF concentrate) onto the roadway during the foam blanket spraying. The AFFF reservoir was not completely emptied and the lines were flushed on site after the response.

The canal is a part of Kahauiki Stream, which drains to Keehi Lagoon. The Canal Car Accident AOPI overlies the upper aquifer beneath Fort Shafter Flats and the adjacent, southwestern portion of the Main Post.

5.2.3 FTSHF: Parking Lot Fires (Car Fire A and Car Fire B)

The Parking Lot Fires area is identified as an AOPI following records research, personnel interviews, and site reconnaissance, due to AFFF use in response to two separate car fires circa 2013. The car fires occurred in the parking lot near Buildings 232 and 214 located at Funston Road and Otake Street. The amount and duration of AFFF used for both responses is unknown. The parking lot is bordered by a curb.

The direction of surface runoff is toward a storm drain on the west side of the parking lot that appears to discharge to open drainage south of the AOPI. Surface runoff that breaches the curb on the east side of the parking lot would likely flow towards the drainage canal east of the parking lot. Drainage from this area is likely conveyed to a drainage canal which eventually drains to Keehi Lagoon. The Parking Lot Fires AOPI overlies the upper aquifer beneath Fort Shafter Flats and the adjacent, southwestern portion of the Main Post.

5.2.4 FTSHF: Building 322: Former Fire Station #3

The Building 322: Former Fire Station #3 area is identified as an AOPI following records research, personnel interviews, and site reconnaissance, due to storage of AFFF, and a probable incidental release during standard activities (e.g., filling truck foam tanks, nozzle testing, truck washing) but none have been confirmed. Before Former Fire Station #3 ceased operations and moved to TAMC, circa 1987, it had previously operated at Joint Base Pearl Harbor Hickam. The location and amount of AFFF stored onsite is unknown.

Surface runoff drains to Kahauiki Stream and Moanalua Stream tributaries via a canal directly behind Building 322, which eventually drains to Keehi Lagoon. The Building 322: Former Fire Station #3 AOPI overlies the upper aquifer beneath Fort Shafter Flats and the adjacent, southwestern portion of the Main Post.

5.2.5 FTSHF: Building 1507 – Wing A: Former Metal Plating Shop

The Building 1507 – Wing A: Former Metal Plating Shop area is identified as an AOPI following records research, personnel interviews, and site reconnaissance, due to metal plating activities that previously took place at the site. Building 1507 was constructed as a communications repair shop in 1944. For an unknown period, a section of the building was used as a plating shop. All solutions from shop activities drained through a floor drain into an underground concrete sump (4 feet by 8 feet by 4 feet, 2-inch-thick concrete).

Shop activities ended prior to approximately 1990. Historical sample results indicated elevated levels of cadmium and chromium in the sump contents and in a shallow soil sample collected below the sump. The sump was removed in January 1997. Sample results indicated no contamination exceeding toxicity characteristic leaching procedure metals criteria exists in the area (PRC 1998).

5.2.6 FTDR: Building T-25: Former Fire Station

The Building T-25: Former Fire Station area is identified as an AOPI following records research and personnel interviews, due to possible storage of AFFF and/or a possible incidental release during standard activities (e.g., filling truck foam tanks, nozzle testing, truck washing)There is no additional information available regarding the fire station other than its footprint and period of operation. However, historic AFFF usage is very unlikely because Army use of AFFF was first authorized in 1970, the same year the Building T-25: Former Fire Station building ceased operation.

The Former Fire Station footprint is beneath the hotel structure, its paved driveway and guest drop-off area, and/or the landscaping. Construction details are unknown regarding excavation and/or fill at the Former Fire Station location.

6 SUMMARY OF SI ACTIVITIES

Based on the results of the PA at FTSHF an SI for PFOS, PFOA, PFBS, PFNA, and PFHxS was conducted in accordance with CERCLA. As described in **Section 5**, one AOPI was identified at FTDR, but it was not recommended for sampling during the SI due to the following reasons:

- Historic AFFF usage is very unlikely. Army use of AFFF was first authorized in 1970, the same year Building T-25: Former Fire Station ceased operation.
- Construction details are unknown regarding excavation and/or fill at the Former Fire Station location.
- The Building T-25: Former Fire Station location is now below the hotel driveway and lobby area and approximately 10 feet of fill, as determined by the comparison of the historic topographic map and current site features.
- Subsurface aquifer is not a drinking water resource due to high saline content, and there are no downgradient drinking water wells.
- The Pacific Ocean is hydraulically downgradient and located approximately 800 feet from Building T-25: Former Fire Station.

As a result, an SI was not determined to be appropriate at FTDR and the sub-installation will not be referenced again until the Conclusions and Recommendations section (**Section 8**).

SI sampling was completed at FTSHF at five AOPIs to evaluate presence or absence of PFOS, PFOA, PFBS, PFNA, and PFHxS in comparison with the OSD risk screening levels. As such, an installation-specific QAPP Addendum (Arcadis 2022) was developed to supplement the general information provided in the PQAPP (Arcadis 2019a) and to detail the site-specific proposed scopes of work for the SI. A preliminary CSM was prepared for AOPIs at FTSHF in accordance with the USACE Engineer Manual on Conceptual Site Models, EM 200-1-12 (USACE 2012). The CSMs were combined for three of five AOPIs (AFFF Training Area, Parking Lot Fires, and Building 322: Former Fire Station #3) where source media, potential migration pathways and exposure media, and human exposure pathway determinations are congruent. 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 completed in September 2022 through the collection of field data and analytical samples.

The SI field work was completed in accordance with the standard operating procedures (SOPs), technical guidance instructions (TGIs), sampling design, and QA/QC requirements as detailed in the QAPP Addendum (Arcadis 2022) and PQAPP (Arcadis 2019a). The subsections below summarize the DQOs, sampling design and rationale, sampling activities and methods, and data analyses procedures for the SI phase at FTSHF. Non-conformances to the prescribed procedures in the PQAPP and QAPP Addendum are described in **Section 6.3.3**. Analytical results obtained through SI field activities are summarized in **Section 7**.

6.1 Data Quality Objectives

As identified during the DQO process and outlined in the site-specific QAPP Addendum (Arcadis 2022), 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 planned to evaluate soil sediment, groundwater, and surface water for PFOS, PFOA, PFBS, PFNA, and PFHxS presence or absence at each of the sampled AOPIs.

6.2 Sampling Design and Rationale

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

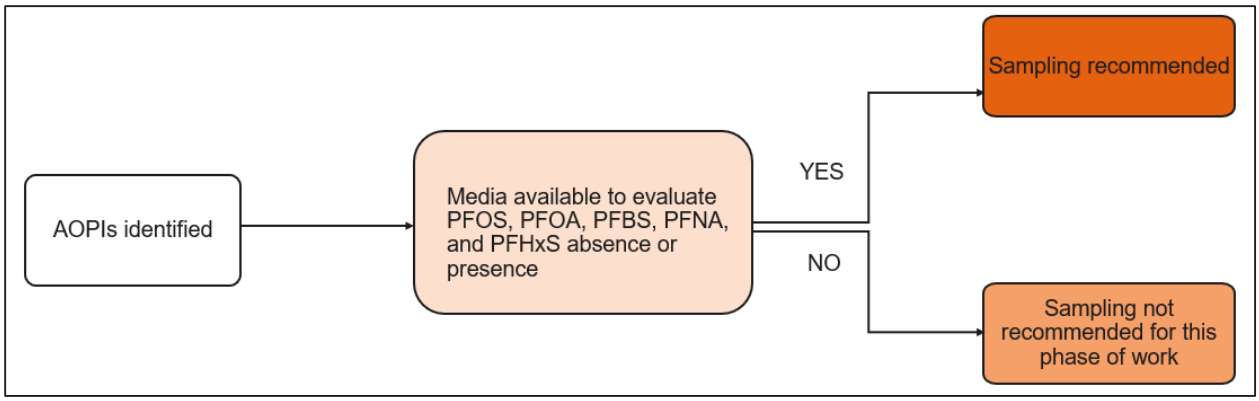


Figure 6-1: AOPI Sampling Decision Tree

The sampling design for SI sampling activities at FTSHF is detailed in Worksheet #17 of the QAPP Addendum (Arcadis 2022). For each of the five AOPIs at FTSHF, samples were collected at locations of known or suspected use, storage, and/or disposal of PFAS-containing materials, locations of surface runoff collection, and downgradient locations if exact use, storage, or disposal locations are unknown. Sample locations were selected based on site-specific historical evidence and surface runoff / surface conditions observed in the field at each sampled AOPI. Sample media types collected for each AOPI were based on media most likely to confirm the presence or absence of PFOS, PFOA, PFBS, PFNA, and PFHxS. Soil samples were collected from each of the five AOPIs at FTSHF. Soil samples from the original four AOPIs were collected over the 0 to 2 feet bgs interval or an interval of 2 feet bgs below any surface coverings (i.e., asphalt). Soil samples at the Building 1507 - Wing A: Former Metal Plating Shop AOPI were collected from 5 to 7 feet bgs to avoid clean backfill material associated with the former sump excavation from 0 to 5 feet bgs and to target the native material below 5 feet bgs. A groundwater sample was collected from the Building 322: Former Fire Station #3 and Building 1507 – Wing A: Former Metal Plating Shop AOPIs, and a sediment sample was collected from the stream at the AFFF Training Area AOPI.

Groundwater sampling is not included as part of the SI at the AFFF Training Area AOPI because of a potentially significant depth to groundwater. Groundwater was not sampled at the Canal Car Accident and Parking Lot Fires AOPIs because the concrete in the canal and pavement in the parking lot is assumed to be an impervious barrier preventing substantial dissolution of AFFF from the canal and parking lot

surfaces to the underlying groundwater. A groundwater sample (FTSHF-FFS-1-GW) was planned to be collected from the Building 322: Former Fire Station #3 AOPI. Although the depth to water at the AOPI is undetermined from readily available documents, it was anticipated to be approximately 40 feet bgs and considered shallow in comparison to other locations of FTSHF where the depth to water is estimated to be approximately 120 to 250 feet bgs. However, the groundwater sample could not be collected because the hollow stem augur drill rig was met with refusal in three separate attempts to reach groundwater.

Surface water and sediment sampling is not included as part of the SI at the Canal Car Accident AOPI because the canal was dry at the time of the SI. Surface water and sediment samples were not collected from the Parking Lot Fires AOPI because surface runoff flows to a storm drain on the west side of the parking lot that presumably discharges to open drainage south of the AOPI, which likely flows to Kahauiki Stream. Surface water and sediment samples were not collected from the Building 322: Former Fire Station #3 AOPI because the water and sediment in the canal directly north of the AOPI may have PFAS impacts from upstream sources.

6.3 Sampling Methods and Procedures

Environmental data were collected and analyzed in accordance with the PQAPP (Arcadis 2019a), 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 2022), and the safety procedures specified in the Accident Prevention Plan (Arcadis 2018) and SSHP (Arcadis 2022). The sampling methods described in the SOPs and TGIs establish equipment requirements, procedures for preparing equipment and containers before sampling, sampling procedures under various conditions, and procedures for storing samples to ensure that sample contamination does not occur during collection, and transport. In general, sampling techniques used in the SI were consistent with conventional sampling techniques used in the environmental industry, but special considerations were made regarding PFAS-containing materials and equipment and cross-contamination potential.

The sampling methods employed during the SI are detailed in the PQAPP (Arcadis 2019a) and QAPP Addendum (Arcadis 2022). 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, tailgate health and safety forms, utility and structures checklist, and vehicle inspection checklist) documenting the SI sampling activities are included in **Appendices I** and **J**, respectively. Photographs of the sampling activities are included in **Appendix K**.

6.3.1 Field Methods

Composite soil samples were collected from the AFFF Training Area, Canal Car Accident, Parking Lot Fires, and Building 322: Former Fire Station #3 AOPIs from 0 to 2 feet bgs using a 3.25 inch diameter nickel plated alloy steel hand auger and stainless-steel trowel. Composite soil samples were collected from the Building 1507 - Wing A: Former Metal Plating Shop AOPI from 5 to 7 feet bgs using direct push drilling methods. An asphalt coring drill was used to expose the soil beneath the asphalt at select sample locations at the Canal Car Accident, Parking Lot Fires, and Building 322: Former Fire Station #3 AOPIs. In general, sampling points were positioned in the center, downgradient, and/or cross-gradient of a suspected release area. Soil collected with the hand auger and trowel was transferred to a stainless-steel

bowl where it was mixed for homogenization. A portion of the homogenized soil was then placed in the sample container and packed with ice in a cooler to meet the preservation temperature requirements. Nitrile gloves and sleeves made of un-coated flash spun high density polyethylene fibers were worn during sample collection to prevent PFAS cross-contamination. Soil lithological descriptions were continuously logged and documented on field forms and coordinates for each sampling location were recorded using a handheld global positioning system device. After sampling was completed at the Canal Car Accident, Parking Lot Fires, and Building 322: Former Fire Station #3 AOPIs, the asphalt was repaired by placing the asphalt cores back in their respective bore holes and sealing the cores in place with a cold, liquid asphalt product (**Appendix K**).

One sediment sample was collected from the following location: the stream/drainage canal adjacent to the AFFF Training Area AOPI (**Figure 5-3**). The sediment sampling method used was determined based on the condition of the stream/drainage canals in accordance with TGI – Sediment, Surface Water, and Stormwater Sample Collection for PFAS Analysis, provided in Appendix A to the PQAPP (Arcadis 2019). The sediment sample was collected from the upper 5 centimeters of sediment accumulated beneath a boulder using a hand-held stainless-steel trowel. Since no surface water was present during the sampling event, decanting of the sediment sample was not necessary. The sediment description was documented on a field form and coordinates for the sediment sample location were recorded using a handheld global positioning system device.

One groundwater sample was planned to be collected from AOPI Building 322: Former Fire Station #3. The single-interval, shallow (first encountered), grab groundwater sample was to be collected using the hollow stem auger drilling method at a discrete sampling location in an open area where nozzle testing may have occurred west of the former fire station building (**Figure 5-6**). The boring was advanced in accordance with the TGI for PFAS-Specific Drilling and Monitoring Well Installation (Arcadis 2022, Attachment #4). However, as detailed in Section 6.3.3, the drill rig was met with refusal and the groundwater sample could not be collected. One temporary groundwater sample collection point was installed in the FTSHF-BLG1507-1-SO soil boring at the Building 1507 – Wing A: Former Metal Plating Shop AOPI using the direct push drilling method. The boring was advanced in accordance with the TGI for PFAS-Specific Drilling and Monitoring Well Installation (Arcadis 2022, Attachment #4). A 2-inch diameter polyvinyl chloride casing was installed to approximately 15 feet bgs and samples were collected utilizing the low-flow purging method with a peristaltic pump.

6.3.2 Quality Assurance/Quality Control

Worksheet #20 of the PQAPP and QAPP Addendum provide QA/QC requirements for field duplicates, matrix spike/matrix spike duplicates, equipment blanks (EBs), a source blank used for water in the initial decontamination step, 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 2022), 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, PFBS, PFNA, and PFHxS only. EBs were collected for media sampled for PFOS, PFOA, PFBS, PFNA, and PFHxS, at a frequency of one per piece of relevant equipment for each sampling event, as specified in the QAPP Addendum (Arcadis 2022). The decontaminated reusable equipment from which EBs were collected include the hand auger, stainless-

steel trowel, and stainless-steel bowl as applicable to the sampled media. A source blank was collected from the deionized water used during decontamination of soil sampling equipment. Analytical results for blank samples are discussed in **Section 7.5**.

6.3.3 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 FTSHF SI work.

Non-conformances to the approved sampling scope and/or procedures occurred during the sampling event. Non-conformances were reviewed and approved in accordance with the following chain of communication: 1) minor modifications or clarifications were communicated within the field team; and 2) major modifications were communicated to USACE in the daily/periodic field status email updates submitted by the SI project manager during the sampling event. Non-conformances to the approved sampling plan which affect the DQOs are documented in Non-Conformance Reports (NCRs) included as **Appendix L** and are summarized below:

- NCR-FTSHF-01: Building 320: Former Fire Station #3 AOPI, planned sample FTSHF-FFS-1-GW: The hollow stem auger drill rig could not reach groundwater at the proposed sampling location. Three separate attempts to reach groundwater were made, with refusal encountered at 8 feet bgs, 12.5 feet bgs, and 4.5 feet bgs at location FTSHF-FFS-2-SO and in-between in the FTSHF-FFS-1-GW and FTSHF-FFS-2-SO locations. A groundwater sample could not be collected.
- NCR-FTSHF-02: Canal Car Accident AOPI, planned samples FTSHF-CCA-1-SE and FTSHF-CCA-1-SW: No surface water or sediment was present in the canal at the time of SI sampling. A surface water and sediment sample could not be collected due to insufficient available media.
- NCR-FTSHF-03: AFFF Training Area AOPI, planned sample FTSHF-AFFFTA-1-SW: No surface water was present at the time of SI sampling. A surface water sample could not be collected due to insufficient available media.

6.3.4 Decontamination

Non-dedicated reusable sampling equipment (e.g., stainless-steel trowel, hand auger, stainless-steel bowl) 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 2019a, **Appendix A**).

6.3.5 Investigation-Derived Waste

Investigation-derived waste (IDW), including soil cuttings, excess sediment, decontamination fluids, and disposable equipment were collected and disposed on the ground at the point of collection in accordance with the PQAPP. Disposable equipment IDW was collected in bags and disposed in municipal waste receptacles. Equipment IDW includes personal protective equipment and other disposable materials (e.g., nitrile gloves, sleeves made of un-coated flash spun high density polyethylene fibers, paper towels, and garbage bags) that may come in contact with sampling media.

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, PFBS, PFNA, and PFHxS, 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 2019a). Eighteen PFAS-related compounds, including PFOS, PFOA, PFBS, PFNA, and PFHxS, were analyzed for in soil and sediment samples using an analytical method that is ELAP-accredited and compliant with QSM 5.3 (DoD and Department of Energy 2019), Table B-15.

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 2022) by the analytical method noted:

- Total organic carbon (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 M**).

6.4.2 Data Validation

All analytical data generated during the SI, except grain size data, were verified and validated in accordance with the data verification procedures described in Worksheets #34 through #36 of the PQAPP (Arcadis 2019a). Each laboratory data package/sample delivery group underwent Stage 3 data validation in accordance with DoD QSM 5.3 (DoD and Department of Energy 2019). Additionally, 10% of the data underwent Stage 4 data validation. Copies of the data validation reports for each sample delivery group are included as attachments to the DUSR in **Appendix M**. The Level IV analytical reports are included within **Appendix N** 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 FTSHF. Documentation generated during the data usability assessments, which were compiled into a DUSR (**Appendix M**), was prepared in accordance with the USACE Engineer Manual 200-1-10 (USACE 2005), the Final DoD General Data Validation Guidelines (DoD 2019) and the Final DoD Data Validation 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 FTSHF during the SI were found to be acceptable and usable for this SI evaluation with the qualifications documented in the DUSR and its associated data validation reports (**Appendix M**), and as indicated in the full analytical tables (**Appendix N**) provided for the SI results. These data are of sufficient quality to meet the objectives and requirements of the PQAPP (Arcadis 2019a) and FTSHF QAPP Addendum (Arcadis 2022). Data qualifiers applied to laboratory analytical results for samples collected during the SI at FTSHF 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, PFBS, PFNA, PFHxS, and HFPO-DA in groundwater (tap water) and soil were calculated using the USEPA's RSL calculator for residential and industrial/commercial worker receptor scenarios and current toxicity values. These risk screening levels are shown in **Table 6-2**.

Table 6-2 OSD Risk Screening Levels Calculated for PFOS, PFOA, PFBS, PFNA, PFHxS, and HFPO-DA 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	4	0.013	0.16
PFOA	6	0.019	0.25
PFBS	601	1.9	25
PFNA	6	0.019	0.25
PFHxS	39	0.13	1.6
HFPO-DA[3]	6	0.023	0.35

Notes:
1. Risk screening levels for tap water and soil provided by the OSD. 2022. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. July 06 (**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.
3. Of the six PFAS compounds presented in the 06 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. Based on the CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at FTSHF because HFPO-DA is generally not a component of military specification AFFF and based on its history including distribution limitations that restricted use of HFPO-DA, it is generally not a component of other products the military used. In addition, it is unlikely that HFPO-DA would be an individual chemical of concern in the absence of other PFAS.
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/or surface water data (if the surface water is an expression of groundwater [i.e., springs/seeps] or if surface water is used as a drinking water source nearby) for this Army PFAS PA/SI if samples were collected. However, surface water samples were not collected during this SI due to insufficient media available for sampling and refusal during drilling, respectively. While the current and most likely future land uses of the AOPIs at FTSHF are industrial/commercial, both residential and industrial/commercial soil risk screening levels for PFOS, PFOA, PFBS, PFNA, and PFHxS will be used to evaluate detected soil and sediment (if sediment comparisons are appropriate e.g., if the sediment was collected from a dry streambed or a drainage way) concentrations. The data from the SI sampling event are compared to the OSD risk screening levels in **Section 7**. If concentrations of PFOS, PFOA, PFBS, PFNA, or PFHxS are detected greater than the applicable OSD risk screening levels, further study in a remedial investigation is recommended in **Section 8**.

7 SUMMARY AND DISCUSSION OF SI RESULTS

This section summarizes the analytical results obtained from samples collected during the SI at FTSHF (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 2022). The sample results discussion below focuses on the PFOS, PFOA, PFBS, PFNA, and PFHxS 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 **7-3** attached to the end of the report provide a summary of the soil, sediment, and groundwater analytical results for PFOS, PFOA, PFBS, PFNA, and PFHxS. **Table 7-4** summarizes AOPIs and whether their SI results exceed the OSD risk screening levels. **Appendix N** includes the full suite of analytical results for these media, as well as for the QA/QC samples. An overview of AOPIs at FTSHF with OSD risk screening level exceedances is depicted on **Figure 7-1**. **Figures 7-2** through **7-6** show the PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results in soil and sediment for each AOPI. Non-detected results are reported as less than the LOQ. Detections of PFOS, PFOA, PFBS, PFNA, and/or PFHxS 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. Soil and sediment data are reported in mg/kg, or parts per million. Soil and sediment descriptions are provided on the field forms in **Appendix J**. The results of the SI are grouped by AOPI and discussed for each medium as applicable.

Table 7-4 AOPIs and OSD Risk Screening Level Exceedances

AOPI Name	OSD Exceedances (Yes/No)
FTSHF: AFFF Training Area	No
FTSHF: Canal Car Accident	Yes
FTSHF: Parking Lot Fires (Car Fire A and Car Fire B)	No
FTSHF: Building 322: Former Fire Station #3	Yes
FTSHF: Building 1507- Wing A: Former Metal Plating Shop	Yes
FTDR: Building T-25: Former Fire Station	NS

Notes:
NS = not sampled

7.1 AFFF Training Area

The subsections below summarize the soil and sediment PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with the AFFF Training Area shown on **Figure 7-2** and **Table 7-1** and **7-2**.

7.1.1 Soil

Five surface soil samples were collected via hand auger at the AFFF Training Area AOPI on 13 and 15 September 2022. Soil samples FTSHF-AFFFTA-1-SO-091322 (0-1 foot bgs), FTSHF-AFFFTA-2-SO-

091322 (0-1.5 feet bgs), FTSHF-AFFFTA-3-SO-091522 (0-1.5 feet bgs), FTSHF-AFFFTA-4-SO091522 (0-2 feet bgs), and FTSHF-AFFFTA-5-SO-091522 (0-0.83 foot bgs) were located in a grassy area directly adjacent to the curb shown in **Figure 7-2**. A field duplicate (FTSHF-FD-1-SO-091322) was collected and corresponds to parent sample FTSHF-AFFFTA-2-SO-091322. The field duplicate sample results are shown in brackets below following the parent sample results.

- PFOS was detected in all five soil samples at concentrations of 0.0019 mg/kg, 0.0014 mg/kg [0.0015 mg/kg], 0.0015 mg/kg, 0.0012 mg/kg, and 0.00095 mg/kg at FTSHF-AFFFTA-1-SO-091322, FTSHF-AFFFTA-2-SO-091322 [FTSHF-FD-1-SO-091322], FTSHF-AFFFTA-3-SO-091522, FTSHF-AFFFTA-4-SO-091522, and FTSHF-AFFFTA-5-SO-091522, respectively. The detected concentrations do not exceed the OSD residential risk screening level (0.013 mg/kg) or the OSD industrial/commercial risk screening level (0.16 mg/kg).
- PFOA was detected in one of the five soil samples (FTSHF-AFFFTA-5-SO-091522) at a concentration of 0.001 mg/kg. The detected concentration does not exceed the OSD residential risk screening level (0.019 mg/kg) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFBS was not detected in any of the five of the soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (1.9 mg/kg) or the OSD industrial/commercial risk screening level (25 mg/kg).
- PFNA was detected in one of the five of the soil samples (FTSHF-AFFFTA-5-SO-091522) at a concentration 0.00087 mg/kg. The detected concentration does not exceed the OSD residential risk screening level (0.019 mg/kg) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFHxS was not detected in any of the five soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (0.13 mg/kg) or the OSD industrial/commercial risk screening level (1.6 mg/kg).

7.1.2 Sediment

One sediment sample was collected from the upper 5 centimeters of material in the stream/drainage canal adjacent to the AFFF Training Area AOPI. A field duplicate (FTSHF-FD-1-SE-091522) was collected and corresponds to parent sample FTSHF-AFFFTA-1-SE-091522. The field duplicate sample results are shown in brackets below following the parent sample results.

- PFOS was detected at a concentration of 0.00049 J (estimated concentration) mg/kg [0.00053 J mg/kg]. The parent and duplicate sample concentrations do not exceed the OSD residential risk screening level (0.013 mg/kg) or the OSD industrial/commercial risk screening level (0.16 mg/kg).
- PFOA was not detected in the sediment sample. Therefore, there were no exceedances of the OSD residential risk screening level (0.019 mg/kg) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFBS was not detected in the sediment sample. Therefore, there were no exceedances of the OSD residential risk screening level (1.9 mg/kg) or the OSD industrial/commercial risk screening level (25 mg/kg).

- PFNA was not detected in the sediment sample. Therefore, there were no exceedances of the OSD residential risk screening level (0.019) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFHxS was not detected in the sediment sample. Therefore, there were no exceedances of the OSD residential risk screening level (0.13 mg/kg) or the OSD industrial/commercial risk screening level (1.6 mg/kg).

7.2 Canal Car Accident

The subsections below summarize the soil PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with Canal Car Accident shown on **Figure 7-3** and **Table 7-1**.

7.2.1 Soil

Two soil samples were collected via hand auger at the Canal Car Accident AOPI on 14 September 2022. Soil samples FTSHF-CCA-1-SO-091422 (0 to 1.7 feet bgs) and FTSHF-CCA-2-SO-091422 (0 to 2 feet bgs) were collected in the road adjacent to the canal shown in **Figure 7-3**.

- PFOS was detected in both soil samples at concentrations of 0.015 mg/kg and 0.064 mg/kg at FTSHF-CCA-1-SO-091422 and FTSHF-CCA-2-SO-091422, respectively. Both detected concentrations exceed the OSD residential risk screening level (0.013 mg/kg) but not the OSD industrial/commercial risk screening level (0.16 mg/kg).
- PFOA was not detected in either of the soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (0.019 mg/kg) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFBS was not detected in either of the soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (1.9 mg/kg) or the OSD industrial/commercial risk screening level (25 mg/kg).
- PFNA was not detected in either of the soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (0.019 mg/kg) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFHxS was detected in both soil samples at concentrations of 0.0013 mg/kg and 0.0046 mg/kg at FTSHF-CCA-1-SO-091422 and FTSHF-CCA-2-SO-091422, respectively. The detected concentrations do not exceed the OSD residential risk screening level (0.13 mg/kg) or the OSD industrial/commercial risk screening level (1.6 mg/kg).

7.3 Parking Lot Fires (Car Fire A and Car Fire B)

The subsections below summarize the soil PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with the Parking Lot Fires AOPI (Car Fire A and Car Fire B) shown on **Figure 7-4** and **Table 7-1**.

7.3.1 Soil

Four soil samples were collected via hand auger at the Parking Lot Fires (Car Fire A and Car Fire B) AOPI on 14 and 15 September 2022. Soil samples FTSHF-PLF-1-SO-091422 (0-2 feet bgs), FTSHF-PLF-2-SO-091522 (0-1.9 feet bgs), FTSHF-PLF-3-SO-091422 (0-2 feet bgs), and FTSHF-PLF-4-SO-091422 (0-1.58 feet bgs) were located in the north, east, and southwest areas of the AOPI shown on **Figure 7-4**.

- PFOS was detected in one of the four soil samples (FTSHF-PLF-2-SO-091522) at a concentration of 0.00066 mg/kg. The detected concentration does not exceed the OSD residential risk screening level (0.013 mg/kg) or the OSD industrial/commercial risk screening level (0.16 mg/kg).
- PFOA was not detected in any of the four soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (0.019 mg/kg) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFBS was not detected in any of the four soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (1.9 mg/kg) or the OSD industrial/commercial risk screening level (25 mg/kg).
- PFNA was not detected in any of the four soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (0.019 mg/kg) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFHxS was not detected in any of the four soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (0.13 mg/kg) or the OSD industrial/commercial risk screening level (1.6 mg/kg).

7.4 Building 322: Former Fire Station #3

The subsections below summarize the soil PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with the Building 322: Former Fire Station #3 AOPI shown on **Figure 7-5** and **Table 7-1**.

7.4.1 Soil

Five soil samples were collected via hand auger at the Building 322: Former Fire Station #3 AOPI on 13, 14, and 15 September 2022. Soil samples FTSHF-FFS-1-SO-091322 (0-1.4 feet bgs), FTSHF-FFS-2-SO-091322 (0-1.6 feet bgs), FTSHF-FFS-3-SO-091522 (0-1.3 feet bgs), FTSHF-FFS-4-SO-091522 (0-2 feet bgs), and FTSHF-FFS-5-SO-091522 (0-2 feet bgs) were located to the north, south, and west of the former fire station building.

- PFOS was detected in all the soil samples at concentrations of 0.058 mg/kg, 0.015 mg/kg, 0.0017 mg/kg, 0.0013 mg/kg, and 0.0022 mg/kg at FTSHF-FFS-1-SO-091322, FTSHF-FFS-2-SO-091322, FTSHF-FFS-3-SO-091522, FTSHF-FFS-4-SO-091422, and FTSHF-FFS-5-SO-091322, respectively. Two of the five detected concentrations (FTSHF-FFS-1-SO-091322 and FTSHF-FFS-2-SO-091322) exceed the OSD residential risk screening level (0.013 mg/kg) but not the OSD industrial/commercial risk screening level (0.16 mg/kg).

- PFOA was detected in three of the five soil samples at concentrations of 0.0009 mg/kg, 0.001 mg/kg, and 0.01 mg/kg at FTSHF-FFS-1-SO-091322, FTSHF-FFS-2-SO-091322, and FTSHF-FFS-4-SO-091422, respectively. The detected concentrations do not exceed the OSD residential risk screening level (0.019 mg/kg) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFBS was not detected in any of the five soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (1.9 mg/kg) or the OSD industrial/commercial risk screening level (25 mg/kg).
- PFNA was not detected in any of the five soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (0.019 mg/kg) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFHxS was detected in three of the five soil samples at concentrations of 0.0009 mg/kg, 0.0021 mg/kg, and 0.025 mg/kg at FTSHF-FFS-1-SO-091322, FTSHF-FFS-2-SO-091322, and FTSHF-FFS-4-SO-091422, respectively. The detected concentrations do not exceed the OSD residential risk screening level (0.13 mg/kg) or the OSD industrial/commercial risk screening level (1.6 mg/kg).

7.5 Building 1507 – Wing A: Former Metal Plating Shop

The subsections below summarize the soil and groundwater PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with the Building 1507 – Wing A: Former Metal Plating Shop shown on **Figure 7-6** and **Table 7-1** and **7-3**.

7.5.1 Soil

Five soil samples were collected using direct push drilling methods at the Building 1507 – Wing A: Former Metal Plating Shop AOPI on 25 April 2023. Soil samples FTSHF-BLDG1507-1-SO-042523 (5-7 feet bgs), FTSHF-BLDG1507-2-SO-042523 (5-7 feet bgs), FTSHF-BLDG1507-3-SO-042523 (5-7 feet bgs), FTSHF-BLDG1507-4-SO-042523 (5-7 feet bgs), and FTSHF-BLDG1507-5-SO-042523 (5-7 feet bgs) were located at a former sump excavation in an asphalt parking lot adjacent to Building 1507 shown in **Figure 7-6**. A field duplicate (FTSHF-FD-1-SO-042523) was collected and corresponds to parent sample FTSHF-BLDG1507-2-SO-042523. The field duplicate sample results are shown in brackets below following the parent sample results. PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected in any of the five soil samples and therefore do not exceed the respective OSD residential risk screening levels.

7.5.2 Groundwater

One groundwater sample was collected at the Building 1507 – Wing A: Former Metal Plating Shop AOPI on 25 April 2023. Groundwater sample FTSHF-BLDG1507-1-GW-042523 and the corresponding field duplicate sample FTSHF-FD-1-042523 were collected from soil boring FTSHF-BLDG1507-1-SO in the middle of the former sump excavation.

- PFOS was detected in groundwater sample FTSHF-BLDG1507-1-GW-042523 and the corresponding field duplicate sample FTSHF-FD-1-042523 at a concentration of 17 ng/L in both samples. The detected concentrations exceed the OSD tap water risk screening level (4.0 ng/L).

- PFOA was detected in groundwater sample FTSHF-BLDG1507-1-GW-042523 and the corresponding field duplicate sample FTSHF-FD-1-042523 at concentrations of 15 ng/L and 18 ng/L, respectively. The detected concentrations exceed the OSD tap water risk screening level (6.0 ng/L).
- PFBS was detected in groundwater sample FTSHF-BLDG1507-1-GW-042523 and the corresponding field duplicate sample FTSHF-FD-1-042523 at concentrations of 60 ng/L and 55 ng/L, respectively. The detected concentrations do not exceed the OSD tap water risk screening level (601 ng/L).
- PFNA was detected in groundwater sample FTSHF-BLDG1507-1-GW-042523 and the corresponding field duplicate sample FTSHF-FD-1-042523 at concentrations of 4.6 ng/L and 4.5 ng/L, respectively. The detected concentrations do not exceed the OSD tap water risk screening level (6.0 ng/L).
- PFHxS was detected in groundwater sample FTSHF-BLDG1507-1-GW-042523 and the corresponding field duplicate sample FTSHF-FD-1-042523 at a concentration of 29 ng/L in both samples. The detected concentrations do not exceed the OSD tap water risk screening level (39 ng/L).

7.6 TOC, pH, and Grain Size

In addition to sampling soil for PFOS, PFOA, PFBS, PFNA, and PFHxS, 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 3,280 J to 16,500 mg/kg with an average of 7,430 mg/kg. The TOC at this installation was, on average, within range of what is typically observed in topsoil (5,000 to 30,000 mg/kg). The combined percentage of fines (i.e., silt and clay) in soils at FTSHF ranged from 18.5 to 72.2% with an average of 41.75%. In general, PFAS constituents tend to be more mobile in soils with less than 20% fines (silt and clay) and lower TOC. The percent moisture of the soil at FTSHF ranged from 4 to 19.3% with an average of 12.24% which is typical for clay soils (0 to 20%). The pH of the soil ranged from 7.4 J standard units to 8.1 J standard units and was on average 7.75 standard units, which is slightly alkaline. While PFAS constituents are relatively less mobile in soils with high percentages of fines, depleted TOC may allow for enhanced mobility of the constituents in soil.

7.7 Blank Samples

PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected in any of the blank samples collected during the SI work.

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

7.8 Conceptual Site Models

The preliminary CSMs presented in the QAPP Addendum (Arcadis 2022) were re-evaluated and updated, if necessary, based on the SI sampling results. The CSMs presented on **Figures 7-7** through **7-9** 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,

PFBS, PFNA, and PFHxS are each negatively charged at environmentally-relevant pH. The media potentially affected by PFOS, PFOA, PFBS, PFNA, and PFHxS 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 in the on-installation streams/drainage canals. Generic categories of potential human receptors and their associated exposure scenarios that are typically evaluated in a CERCLA human health risk assessment were considered and include on-installation site workers (e.g., industrial/commercial workers, utility workers, or future construction workers who could be exposed to chemicals in soil at an AOPI or to chemicals in tap water in an industrial/commercial building), on-installation residents (e.g., adults and children who could be exposed to chemicals in tap water in a residence), and on-installation recreational users (e.g., hikers or hunters who could be exposed to chemicals in waterways at an installation). Off-installation receptor types could include drinking water receptors (i.e., commercial/industrial workers or residents) and recreational users.

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

CSMs were developed for each individual AOPI, with the exception of FTDR, 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 at FTSHF:

- The AOPIs are not likely to be regularly accessed by on-installation residents and recreational users, or by off-installation receptors. Therefore, the soil exposure pathways for these receptors are incomplete.
- Recreational users are not likely to contact groundwater during outdoor recreational activities. Therefore, the groundwater exposure pathway for on-installation recreational users is incomplete.
- PFOS was detected in sediment collected from the stream/drainage canal adjacent to the AFFF Training Area AOPI. The streams/drainage canals at FTSHF are not used for drinking water; however, site workers and recreational users (e.g., site workers performing routine maintenance of

the canals and recreational users such as an adolescent trespasser) could potentially contact constituents in stormwater/surface water and/or sediment in streams/drainage canals on-installation. Therefore, the stormwater/surface water and sediment in streams/drainage canals exposure pathways (via incidental ingestion and dermal contact) for on-installation site workers and recreational users are considered to be potentially complete.

- The streams and drainage canals merge as Kahauiki Stream near the southwest boundary of the Main Post. Kahauiki Stream continues southwest through Fort Shafter Flats and flows off-installation towards the west to Moanalua Stream, which discharges to Keehi Lagoon. Although water features in proximity of the installation are not likely used for drinking water, off-installation recreational users could potentially contact constituents in surface water and sediment in streams/drainage canals through incidental ingestion and dermal contact. Therefore, the surface water and sediment in streams/drainage canals exposure pathways for off-installation recreational users are considered to be potentially complete.

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

Figure 7-7 shows the CSM for the following AOPIs: AFFF Training Area; Parking Lot Fires; and Building 322: Former Fire Station #3. The primary release mechanism and source media shown on **Figure 7-7** are AFFF releases to soil and/or paved surfaces during firefighting training exercises, during standard fire station activities (e.g., filling truck foam tanks, nozzle testing, truck washing), and during emergency fire response efforts. **Figure 7-8** shows the CSM for the Canal Car Accident AOPI. The primary release mechanisms and source media on **Figure 7-8** are leak and overspray of AFFF to paved surfaces and AFFF releases to surface water and sediment of the canal during an emergency response effort.

The following exposure pathway determinations apply to **Figure 7-7** and **Figure 7-8**:

- PFOS, PFOA, PFBS, PFNA, and/or PFHxS were detected in soil, 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.
- Groundwater samples were not collected from these AOPIs during the SI. PFOS, PFOA, PFBS, PFNA, and/or PFHxS were detected in soil and therefore may be present in the underlying groundwater. The AOPIs are located either upgradient or cross gradient of the two drinking water wells used to supply potable water to FTSHF. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are considered to be potentially complete.
- Groundwater originating at the AOPIs flows off-post through the installation's west/southwest boundary. Therefore, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is considered to be potentially complete.

Figure 7-9 shows the CSM for Building 1507 – Wing A: Former Metal Plating Shop. The primary release mechanism and source media on **Figure 7-9** is potential historical releases of PFAS-containing wastewater via the building floor drain and underground concrete sump.

- PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected in the five soil samples collected at this AOPI. Based on the SI sample results, the soil exposure pathway for on-installation site workers is incomplete.

- PFOS, PFOA, PFBS, PFNA, and PFHxS were detected in the one groundwater sample collected at Building 1507 – Wing A: Former Metal Plating Shop. This AOPI is downgradient or outside the vicinity of the two drinking water wells used to supply potable water to FTSHF. However, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete to account for potential future use of the downgradient on-post groundwater.
- Groundwater originating at the AOPI flows off-post through the installation's west/southwest boundary. Therefore, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is considered to be potentially complete.

Following the SI sampling, all 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, PFBS, PFNA, and PFHxS to the OSD risk screening levels (**Table 6-2**).

8 CONCLUSIONS AND RECOMMENDATIONS

The PFAS PA/SI included two distinct efforts. The PA identified AOPIs at FTSHF based on the use, storage, and/or disposal of PFAS-containing materials, in accordance with the 2018 Army Guidance for Addressing Releases of Per-and Polyfluoroalkyl Substances (Army 2018). The SI included multi-media sampling at AOPIs to determine whether or not a release of PFOS, PFOA, PFBS, PFNA, and PFHxS to the environment occurred. Additionally, a subsequent PA was conducted for the sub-installation FTDR which identified one AOPI.

OSD provided residential risk screening levels based on the USEPA oral reference dose for PFOS, PFOA, PFBS, PFNA, and PFHxS in soil and groundwater (tap water) and industrial/commercial risk screening levels for PFOS, PFOA, PFBS, PFNA, and PFHxS 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, PFBS, PFNA, and PFHxS use, storage, and/or disposal at FTSHF. Following the evaluation at FTSHF, five AOPIs were identified. Site reconnaissance was not conducted at FTDR; however, a windshield survey of the AOPIs historic location was conducted to verify current site conditions. Although the results of the PA at FTDR identified one AOPI, a SI was not conducted due to the AOPIs historic location which is currently below the Hale Koa hotel driveway, lobby area, and approximately 10 feet of fill; and the unlikely usage of AFFF at this historic location on account of the Former Fire Stations cease of operations in 1970, the same year AFFF usage was first authorized at Army installations. Additionally, no groundwater receptors are present due to the high saline content of the aquifer below the AOPI, which is not a drinking water resource, and the absence of downgradient drinking water wells.

All AOPIs at FTSHF were sampled during the SI to identify presence or absence of PFOS, PFOA, PFBS, PFNA, and PFHxS at each AOPI. Of the six PFAS compounds presented in the 06 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. Based on the CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at FTSHF because HFPO-DA is generally not a component of military specification AFFF and based on its history including distribution limitations that restricted use of HFPO-DA, it is generally not a component of other products the military used. In addition, it is unlikely that HFPO-DA would be an individual chemical of concern in the absence of other PFAS. The SI scope of work was completed in accordance with the Final PQAPP (Arcadis 2019) and the FTSHF QAPP Addendum (Arcadis 2022).

Based on laboratory reports provided by the U.S. Army Public Health Center, drinking water samples were collected from FTSHF (Building 509) on 17 October 2016 and 16 October 2017 for PFAS (including PFOS, PFOA, and PFBS) analysis using USEPA Method 537. None of the analyzed constituents were detected above the method reporting limit of 2.0 ng/L (Army 2016b; Army 2017). Five AOPIs were sampled during the SI at FTSHF to identify presence or absence of PFOS, PFOA, PFBS, PFNA, and PFHxS at each AOPI. The SI scope of work was completed in accordance with the Final PQAPP (Arcadis 2019a) and the FTSHF QAPP Addendum (Arcadis 2022).

PFOS, PFOA, PFBS, PFNA, and PFHxS, were detected in all of the groundwater samples at the Building 1507 – Wing A: Former Metal Plating Shop AOPI, and PFOS and PFOA concentrations in the groundwater sample exceeded OSD tap water risk screening levels. The soil samples at the Building

1507 – Wing A: Former Metal Plating Shop AOPI did not have any detections of PFOS, PFOA, PFBS, PFNA, or PFHxS. The four original AOPIs at FTSHF had detections of PFOS, PFOA, PFHxS, and/or PFNA in soil and/or sediment and PFOS concentrations at two AOPIs exceeded OSD risk screening levels:

- PFOS was detected in at least one soil sample at four of the five AOPIs. Additionally, PFOS was detected in the one sediment sample collected during the SI at the AFFF Training Area AOPI. The PFOS soil residential risk screening level (0.013 mg/kg) was exceeded in both soil samples collected at the Canal Car Accident AOPI, and two soil samples collected at Building 322: Former Fire Station #3 AOPI. The PFOS soil industrial/commercial risk screening level (0.16 mg/kg) was not exceeded in any of the soil or sediment samples. The maximum detected concentration of PFOS was 0.064 mg/kg (Canal Car Accident AOPI, FTSHF-CCA-2-SO-091422). PFOS was not detected in any of the five soil samples collected at the Building 1507 – Wing A: Former Metal Plating Shop AOPI but was detected in the groundwater sample collected at the Building 1507 – Wing A: Former Metal Plating Shop AOPI. The PFOS concentration detected in the groundwater sample was 17 ng/L which exceeded the tap water risk screening level (4.0 ng/L).
- PFOA was detected in at least one soil sample at two of the five AOPIs. The PFOA soil residential risk screening level (0.019 mg/kg) was not exceeded in any of the soil samples. The maximum detected concentration of PFOA in soil was 0.010 mg/kg (Building 322: Former Fire Station #3 AOPI, FTSHF-FFS-4-SO-091422). PFOA was not detected in the soil samples at the Building 1507 – Wing A: Former Metal Plating Shop AOPI but was detected in the groundwater sample at a concentration of 15 ng/L which exceeded the tap water risk screening level (6.0 ng/L).
- PFBS was not detected in soil samples at any of the five AOPIs. PFBS was detected in the groundwater sample at Building 1507 – Former Metal Plating Shop at a concentration of 60 ng/L which did not exceed the tap water risk screening level (601 ng/L).
- PFNA was detected in at least one soil sample at one of the five AOPIs. The PFNA soil residential risk screening level (0.0.19 mg/kg) was not exceeded in any of the soil samples. The maximum detected concentration of PFNA was 0.00087 mg/kg (AFFF Training Area AOPI, FTSHF-AFFFTA-5-SO-091522). PFNA was not detected in any of the soil samples at the Building 1507 – Wing A: Former Metal Plating Shop AOPI but was detected in the groundwater sample at a concentration of 4.6 ng/L which did not exceed the tap water risk screening level (6.0 ng/L).
- PFHxS was detected in at least one soil sample at two of the five AOPIs. The PFHxS soil residential risk screening level (0.13 mg/kg) was not exceeded in any of the soil samples. The maximum detected concentration of PFHxS was 0.025 mg/kg (Building 322: Former Fire Station #3 AOPI, FTSHF-FFS-4-SO-091422). PFHxS was not detected in any of the soil samples at the Building 1507 – Wing A: Former Metal Plating Shop AOPI but was detected in the groundwater sample at a concentration of 29 ng/L which did not exceed the tap water risk screening level (39 ng/L).

Following the SI sampling, all AOPIs with confirmed PFOS, PFOA, PFBS, PFNA, and/or PFHxS presence were considered to have complete or potentially complete exposure pathways. Soil exposure pathways for on-installation site workers are complete at four of the five AOPIs. The groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete at all five AOPIs. Due to a lack of land use controls off-installation and

downgradient of FTSHF, the groundwater exposure pathways for off-installation drinking water receptors are also potentially complete for all five AOPIs. Stormwater from FTSHF AOPIs drains to Kahauiki Stream and tributaries of Moanalua Stream and eventually drains southwest to Keehi Lagoon. The surface water and sediment exposure pathways for on-installation site workers and recreational users, and for off-installation receptors, are considered to be potentially complete.

Although the CSMs indicate complete or potentially complete exposure pathways may exist, the recommendation for future study in a remedial investigation, further evaluation, or no action at this time is based on the comparison of the SI analytical results for PFOS, PFOA, PFBS, PFNA, and PFHxS to the OSD risk screening levels (**Table 6-2**). **Table 8-1** below summarizes the AOPIs identified at FTSHF, PFOS, PFOA, PFBS, PFNA, and PFHxS sampling and recommendations for each AOPI; further investigation is warranted at FTSHF. In accordance with CERCLA, site-specific risk will be assessed during a future phase to evaluate whether remedial actions are required.

Table 8-1 Summary of AOPIs Identified during the PA, PFOS, PFOA, PFBS, PFNA, and PFHxS Sampling at FTSHF and FTDR, and Recommendations

AOPI Name	PFOS, PFOA, PFBS, PFNA, and/or PFHxS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	SO	GW	
FTSHF: AFFF Training Area	No	NS	Further evaluation[1]
FTSHF: Canal Car Accident	Yes	NS	Further study in a remedial investigation
FTSHF: Parking Lot Fires (Car Fire A and Car Fire B)	No	NS	Further evaluation[1]
FTSHF: Building 322: Former Fire Station #3	Yes	NS	Further study in a remedial investigation
FTSHF: Building 1507-Wing A: Former Metal Plating Shop	ND	Yes	Further study in a remedial investigation
FTDR: Building T-25: Former Fire Station	NS	NS	No action at this time[2]

Notes:
1 = Soil analytical data indicates PFOS, PFOA, PFBS, PFNA, and/or PFHxS presence below OSD risk screening levels, but because there is a potential for migration to groundwater, further evaluation is recommended.
2 = Building T-25: Former Fire Station was not sampled during the SI due to the following reasons: historic AFFF usage is very unlikely due to the Army's authorization of AFFF usage at installations the same year the fire station ceased operations; the absence of groundwater receptors due to the subsurface aquifers high saline content, which is a result of FTDRs proximity to the Pacific Ocean; the lack of construction details from the redevelopment of the area and likelihood that any potentially impacted media was excavated and removed; additionally, the historic AOPI location is now located under approximately 10 feet of fill material, below the Hale Koa hotel driveway and lobby area.

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

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

Records gathered for the use, storage and/or disposal of PFAS-containing materials were reviewed during the FTSHF and FTDR PA processes. Documentation specific to AFFF may have been limited (e.g., each AFFF use; procurement records, documentation of AFFF used during crash responses or fire training activities) due to lack of recordkeeping requirements for the full timeline of common AFFF practices. Anecdotal accounts of AFFF use (and therefore likely PFOS, PFOA, PFBS, PFNA, and PFHxS use) were limited to available installation personnel, whose knowledge of AFFF use may have been restricted by their time spent at the installation or previous roles held that limited their relevant knowledge of potential AFFF (or other PFAS-containing material) use. As presented in **Section 6.0**, the AOPI identified at FTDR was not sampled due to the absence of groundwater receptors and likely removal of any potentially impacted material due to redevelopment of the area around the AOPI

A comprehensive well survey was not completed as part of the FTSHF and FTDR PAs; therefore, the information reviewed regarding off-post wells is limited to what is contained in the off post well search results (**Appendix D**).

The FTSHF and FTDR searches for ecological receptors and off-post PFOS, PFOA, PFBS, PFNA, and PFHxS 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 at FTSHF (site reconnaissance was not conducted at FTDR due to lack of groundwater receptors and additional rationale listen in **Section 6**).

The available PFOS, PFOA, PFBS, PFNA, and PFHxS analytical data at FTSHF is limited to results from on-post soil and sediment sampling locations. Available data, including PFOS, PFOA, PFBS, PFNA, and PFHxS, is listed in **Appendix N**, which were analyzed per the selected analytical method. HFPO-DA was not in the suite of PFAS compounds analyzed during the SI at FTSHF because it was not considered to be a constituent of concern at the time; therefore, there are no HFPO-DA SI analytical results to screen against the 2022 OSD risk screening levels.

Finally, planned groundwater sample FTSHF-FFS-1-GW could not be collected from Building 320: Former Fire Station #3 AOPI because the hollow stem augur drill rig was met with refusal in three separate attempts to reach groundwater. Planned surface water samples FTSHF-AFFFTA-1-SW at AFFF Training Area AOPI and FTSHF-CCA-1-SW at Canal Car Accident AOPI could not be collected due to the absence of surface water at the time of sampling. Planned sediment sample FTSHF-CCA-1-SE at Canal Car Accident AOPI could not be collected due to insufficient sediment in the base of the canal.

Results from the PA/SI at FTSHF indicate further study in a remedial investigation is warranted in accordance with the guidance provided by the OSD. Additionally, given the current site conditions at

FTDR and readily available information, the results from the PA indicate no further action is warranted at this time.

9 REFERENCES

Arcadis U.S., Inc. (Arcadis). 2018. Accident Prevention Plan: A-E Services, PFASs Contamination in the Cleanup/Restoration Programs at Active Army Installations – Nationwide. Prepared for USACE, Baltimore District. March.

Arcadis. 2019a. Final Programmatic Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP), USAEC PFAS PA/SI, Active Army Installations, Nationwide, USA. October.

Arcadis. 2019b. Final Supplemental Remedial Investigation/Feasibility Study Report, Environmental Restoration Services to Conduct Supplemental Remedial Investigation at Fort Shafter Site 46, FTSHF-46, HQAES ID 15835.1040. January.

Arcadis. 2022. Final UFP QAPP Addendum, Revision 1, USAEC PFAS PA/SI, Fort Shafter, Hawaii. September. Army. 2015. United States Army Garrison Hawaii, Directorate of Public Works, Environmental Division, Stormwater Management Plan. October.

Army.1992. Final Environmental Impact Statement, Development of Armed Forces Recreation Center-Fort DeRussy, Waikiki, Hawaii. March.

Army. 2015. United States Army Garrison Hawaii, Directorate of Public Works, Environmental Division, Stormwater Management Plan. October.

Army. 2016a. Fiscal Year 2016, Fort Shafter, Army Defense Environmental Restoration Program Installation Action Plan. December 27.

Army. 2016b. (U.S. Army Public Health Center) Memorandum for USAG-HI, DPW, Env Division (Wheeler Army Airfield, IMHW-PWE/Liana Lee), 947 Wright Avenue, Bldg 105, Schofield Barracks, HI 96857, Subject: Laboratory Sciences (LAB) Final Analytical Report (Project Site: IMCOM PFC Samp FY17 – Ft. Shafter). November 15.

Army. 2017. (U.S. Army Public Health Center) Memorandum for DPW, Environmental Division (947 Wright Avenue/Kimberly De Caprio), Wheeler Army Airfield, Schofield Barracks, HI 96857, Subject: Laboratory Sciences (LAB) Final Analytical Report (Project Site: IMCOM PFCs FY18 – USAG-HI). November 14.

Army. 2018. Army Guidance for Addressing Releases of Per- and Polyfluoroalkyl Substances. September 4. Available online at: https://www.fedcenter.gov/admin/itemattachment.cfm?attachmentid=1150.

Board of Water Supply. 2022. Board of Water Supply Website, Find Your Report. Available online at: https://www.boardofwatersupply.com/water-quality/water-quality-report/search-ccr

Department of Defense (DoD). 2017. Fact Sheet: Detection and Quantitation – What Project Managers and Data Users Need to Know. October.

DoD. 2019. Environmental Data Quality Working Group: Final General Data Validation Guidelines. November 4.

DoD. 2020. Data Validation Guidelines Module 3: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-15. May 1.

DoD and Department of Energy. 2019. Consolidated Quality Systems Manual for Environmental Laboratories, Version 5.3. May.

Environet, Inc. 2006. Remedial Investigation and Risk Assessment for Various Sites, Fort Shafter, Oahu, Hawaii. September.

Interstate Technology Regulatory Council. 2017. History and Use of Per-and Polyfluoroalkyl Substances (PFAS). November. Available online at: https://pfas-1.itrcweb.org/wp-content/uploads/2017/11/pfas_fact_sheet_history_and_use__11_13_17.pdf.

Interstate Technology Regulatory Council. 2020. Section 3.1 Firefighting Foams. Updated April 14. Available online at: https://pfas-1.itrcweb.org/3-firefighting-foams/#3_1

Mink, John F. and Lau, L. Stephen. 1990. Aquifer Identification and Classification for Oahu: Groundwater Protection Strategy for Hawaii, Technical Report No. 179 (November 1987; Revised 1990). February.

Office of the Secretary of Defense (OSD). 2019. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. October.

OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September.

OSD. 2022. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. July.

PRC. 1998. Site Characterization and Remediation at the Pesticide Storage Building 225 and Plating Shop Building 1507. Fort Shafter, Hawaii. Final Remediation Completion Report. March 4.

USACE. 2005. Environmental Quality: Guidance for Evaluating Performance-Based Chemical Data, Engineer Manual 200-1-10, CEMP-RA/CECW-E, June 30.

USACE. 2012. Environmental Quality: Conceptual Site Models, Engineer Manual 200-1-12, CEMP-CE, December 28.

USAG-HI. 2010. Integrated Natural Resources Management Plan for the U.S. Army Garrison - Hawaii 2018, Island of OAHU, Pohakuloa. April.

USEPA. 2016a. Lifetime Health Advisories and Health Effects Support Documents for Perfluorooctanoic Acid and Perfluorooctane Sulfonate. EPA-HQ-OW-2014-0138; FRL-9946-91-OW. Federal Register/ Vol. 81. No. 101. May 25. Available online at: https://www.govinfo.gov/content/pkg/FR-2016-05-25/pdf/2016-12361.pdf.

USEPA. 2016b. The Third Unregulated Contaminant Monitoring Rule Fact Sheet for Assessment Monitoring (List 1 Contaminants) (UCMR3). May.

USEPA. 2021. Human Health Toxicity Values for Perfluorobutane Sulfonic Acid (CASRN 375-73-5) and Related Compound Potassium Perfluorobutane Sulfonate (CASRN 29420-49-3). EPA/600/R-20/345F. Center for Public Health and Environmental Assessment, Office of Research and Development, Washington DC. April.

USEPA. 2022. Regional Screening Levels (RSLs) – Generic Tables. Tables as of May 2022. Access online: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables.

WRCC. 2020a. WRCC Database. Available online at: https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?hi6395. Retrieved July 28, 2020.

WRCC. 2020b. WRCC Database. Available online at: https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?hi1919. Retrieved July 28, 2020.

WRCC. 2023. WRCC Database. Available online at: https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?hi1919. Retrieved July 11, 2023.

ACRONYMS

%	percent
AFFF	aqueous film-forming foam
AOPI	area of potential interest
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
DQO	data quality objective
DUSR	Data Usability Summary Report
EB	equipment blank
EDR	Environmental Data Resources, Inc.
ELAP	Environmental Laboratory Accreditation Program
FTDR	Fort DeRussy Military Reservation
FTSHF	Fort Shafter
GIS	geographic information system
HFPO-DA	hexafluoropropylene oxide dimer acid
IDW	investigation-derived waste
IMCOM	Installation Management Command
installation	United States Army or Reserve installation
IRP	Installation Restoration ProgramLOD limit of detection
LOQ	limit of quantitation
mg/kg	milligrams per kilogram (parts per million)
N	north
NCR	non-conformance report
ng/L	nanograms per liter (parts per trillion)
NS	not sampled
NW	northwest

OSD	Office of the Secretary of Defense
PA	preliminary assessment
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexane sulfonate
PFNA	perfluorononanoic 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
S	south
SE	sediment
SI	site inspection
SO	soil
SOP	standard operating procedure
SSHP	Site Safety and Health Plan
SW	southwest
TAMC	Tripler Army Medical Center
TCLP	Toxicity Characteristic Leaching Procedure
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
USAG-HI	United States Army Garrison, Hawaii
USEPA	United States Environmental Protection Agency
WRCC	Western Regional Climate Center

TABLES

Table 7-1 Soil PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort Shafter and Fort DeRussy Military Reservation, Hawaii

Location	Sample ID / Duplicate ID	Sample Date	Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)		PFNA (mg/kg)		PFHxS (mg/kg)	
			OSD Industrial/Commercial Risk Screening Level	0.16		0.25		25		0.25		1.6	
			OSD Residential Risk Screening Level	0.013		0.019		1.9		0.019		0.13	
			Sample Type	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
FTSHF-AFFFTA-1-SO	FTSHF-AFFFTA-1-SO-091322	09/13/2022	N	**0.0019**		0.00064	U	0.0021	U	0.00064	U	0.00064	U
FTSHF-AFFFTA-2-SO	FTSHF-AFFFTA-2-SO-091322	09/13/2022	N	**0.0014**		0.00064	U	0.0021	U	0.00064	U	0.00064	U
	FTSHF-FD-1-SO-091322	09/13/2022	FD	**0.0015**		0.00061	U	0.002	U	0.00061	U	0.00061	U
FTSHF-AFFFTA-3-SO	FTSHF-AFFFTA-3-SO-091522	09/15/2022	N	**0.0015**		0.0006	U	0.002	U	0.0006	U	0.0006	U
FTSHF-AFFFTA-4-SO	FTSHF-AFFFTA-4-SO-091522	09/15/2022	N	**0.0012**		0.00066	U	0.0022	U	0.00066	U	0.00066	U
FTSHF-AFFFTA-5-SO	FTSHF-AFFFTA-5-SO-091522	09/15/2022	N	**0.00095**		**0.001**		0.0022	U	**0.00087**		0.00065	U
FTSHF-BLD1507-1-SO	FTSHF-BLD1507-1-SO-042523	04/25/2023	N	0.00068	U	0.00068	U	0.0023	U	0.00068	U	0.00068	U
FTSHF-BLD1507-2-SO	FTSHF-BLD1507-2-SO-042523	04/25/2023	N	0.00061	UJ	0.00061	UJ	0.002	UJ	0.00061	UJ	0.00061	UJ
	FTSHF-FD-1-SO-042523	04/25/2023	FD	0.00065	UJ	0.00065	UJ	0.0022	UJ	0.00065	UJ	0.00065	UJ
FTSHF-BLD1507-3-SO	FTSHF-BLD1507-3-SO-042523	04/25/2023	N	0.00064	U	0.00064	U	0.0021	U	0.00064	UJ	0.00064	U
FTSHF-BLD1507-4-SO	FTSHF-BLD1507-4-SO-042523	04/25/2023	N	0.00061	U	0.00061	U	0.002	U	0.00061	U	0.00061	U
FTSHF-BLD1507-5-SO	FTSHF-BLD1507-5-SO-042523	04/25/2023	N	0.00063	U	0.00063	U	0.0021	U	0.00063	U	0.00063	U
FTSHF-CCA-1-SO	FTSHF-CCA-1-SO-091422	09/14/2022	N	**0.015**		0.00063	U	0.0021	U	0.00063	U	**0.0013**	
FTSHF-CCA-2-SO	FTSHF-CCA-2-SO-091422	09/14/2022	N	**0.064**		0.00064	U	0.0021	U	0.00064	U	**0.0046**	
FTSHF-FFS-1-SO	FTSHF-FFS-1-SO-091322	09/13/2022	N	**0.058**		**0.0009**		0.0022	U	0.00066	U	**0.0009**	
FTSHF-FFS-2-SO	FTSHF-FFS-2-SO-091322	09/13/2022	N	**0.015**		**0.001**		0.0023	U	0.00068	UJ	**0.0021**	
FTSHF-FFS-3-SO	FTSHF-FFS-3-SO-091522	09/15/2022	N	**0.0017**		0.00067	U	0.0022	U	0.00067	U	0.00067	U
FTSHF-FFS-4-SO	FTSHF-FFS-4-SO-091422	09/14/2022	N	**0.0013**		**0.01**		0.0021	U	0.00063	U	**0.025**	
FTSHF-FFS-5-SO	FTSHF-FFS-5-SO-091322	09/13/2022	N	**0.0022**		0.00068	U	0.0023	U	0.00068	U	0.00068	U
FTSHF-PLF-1-SO	FTSHF-PLF-1-SO-091422	09/14/2022	N	0.00071	U	0.00071	U	0.0024	U	0.00071	U	0.00071	U
FTSHF-PLF-2-SO	FTSHF-PLF-2-SO-091522	09/15/2022	N	**0.00066**		0.00061	U	0.002	U	0.00061	U	0.00061	U
FTSHF-PLF-3-SO	FTSHF-PLF-3-SO-091422	09/14/2022	N	0.00066	U	0.00066	U	0.0022	U	0.00066	U	0.00066	U
FTSHF-PLF-4-SO	FTSHF-PLF-4-SO-091422	09/14/2022	N	0.00068	U	0.00068	U	0.0023	U	0.00068	U	0.00068	U

Table 7-1 Soil PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort Shafter and Fort DeRussy Military Reservation, Hawaii

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 both the residential as well as the industrial/commercial scenarios (OSD. 2022. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. July).
3. Gray shaded values indicate the result was detected greater than the residential scenario risk screening levels (OSD 2022).

Acronyms/Abbreviations:
-- = not applicable
AOPI = area of potential interest
FD = field duplicate sample
ID = identification
mg/kg = milligrams per kilogram (parts per million)
N = primary sample
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
PFNA = perfluorononanoic acid
PFHxS = perfluorohexane sulfonate
Qual = qualifier

Qualifier
U = The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ).
UJ = The analyte was analyzed for but was not detected. The reported limit of quantitation (LOQ) is approximate and may be inaccurate or imprecise.

Table 7-2 Sediment PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort Shafter and Fort DeRussy Military Reservation, Hawaii

Location	Sample ID / Duplicate ID	Sample Date	Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)		PFNA (mg/kg)		PFHxS (mg/kg)	
			OSD Industrial/Commercial Risk Screening Level	0.16		0.25		25		0.25		1.6	
			OSD Residential Risk Screening Level	0.013		0.019		1.9		0.019		0.13	
			Sample Type	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
FTSHF-AFFFTA-1-SE	FTSHF-AFFFTA-1-SE-091522	09/15/2022	N	**0.00049**	J	0.00063	U	0.0021	U	0.00063	U	0.00063	U
	FTSHF-FD-1-SE-091522	09/15/2022	FD	**0.00053**	J	0.0006	U	0.002	U	0.0006	U	0.0006	U

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 both the residential as well as the industrial/commercial scenarios (OSD. 2022. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. July).

Acronyms/Abbreviations:
FD = field duplicate sample
ID = identification
mg/kg = milligrams per kilogram (parts per million)
N = primary sample
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
PFNA = perfluorononanoic acid
PFHxS = perfluorohexane sulfonate
Qual = qualifier

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

Table 7-3 - Groundwater PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort Shafter and Fort DeRussy Military Reservation, Hawaii

Location	Sample/ Duplicate ID	Sample Date	Analyte	PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)		PFNA (ng/L)		PFHxS (ng/L)	
			OSD Tapwater Risk Screening Level	4		6		601		6		39	
			Sample Type	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
FTSHF-BLD1507-1-GW	FTSHF-BLD1507-1-GW-042523	04/25/2023	N	**17**		**15**		**60**		**4.6**		**29**	
	FTSHF-FD-1-042523	04/25/2023	FD	**17**		**18**		**55**		**4.5**		**29**	

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 2022 Office of the Secretary of Defense (OSD) risk screening levels, (OSD. 2022. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. July).

Acronyms/Abbreviations:
FD = field duplicate sample
ID = identification
N = primary sample
ng/L = nanograms per liter (parts per trillion)
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
PFNA = perfluorononanoic acid
PFHxS = perfluorohexane sulfonate
Qual = qualifier

FIGURES

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

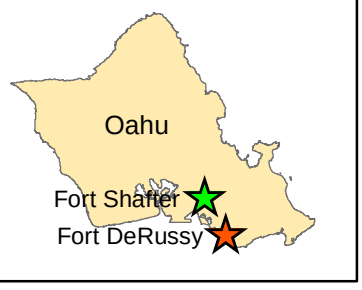
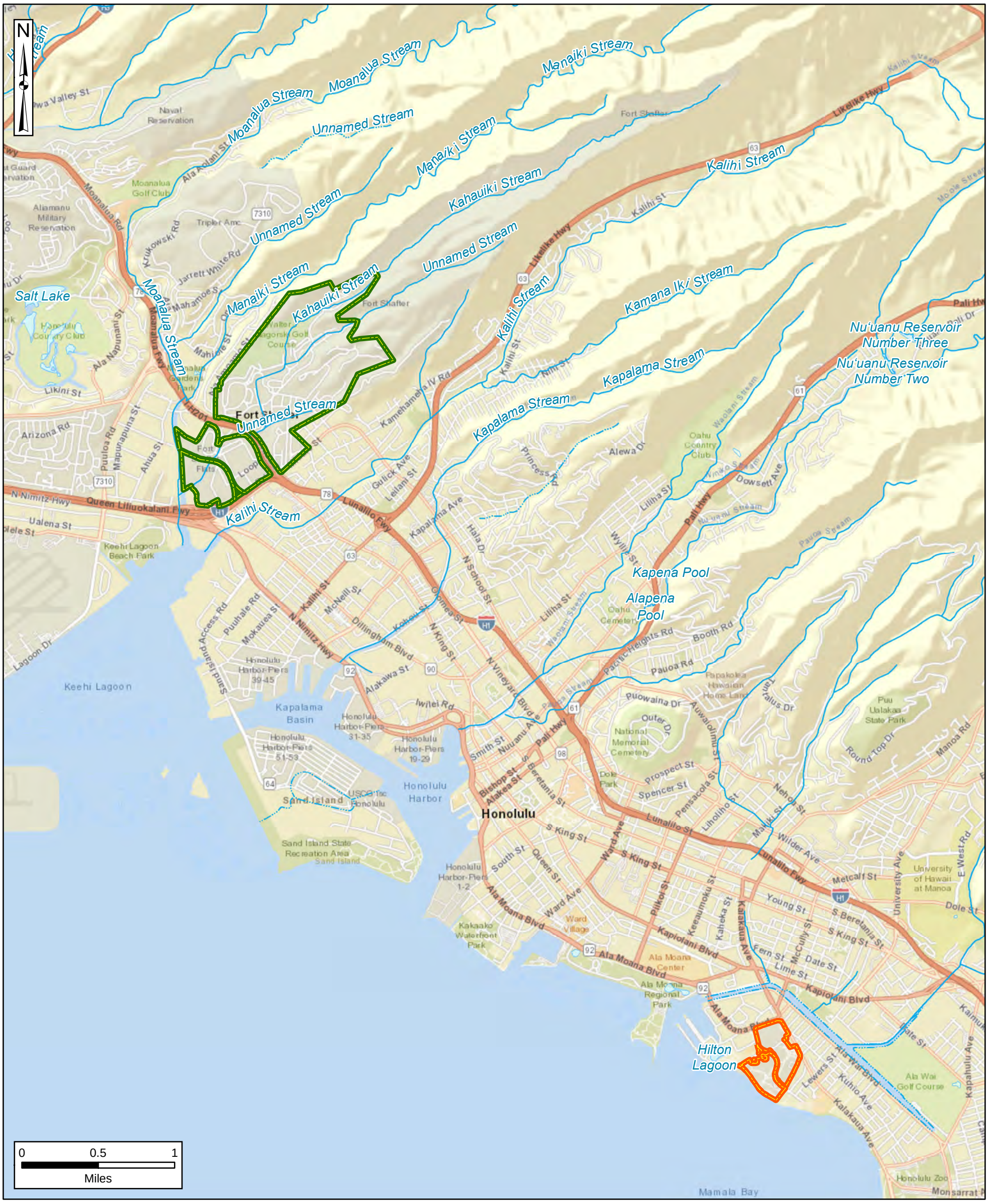


Figure 2-1
Site Location



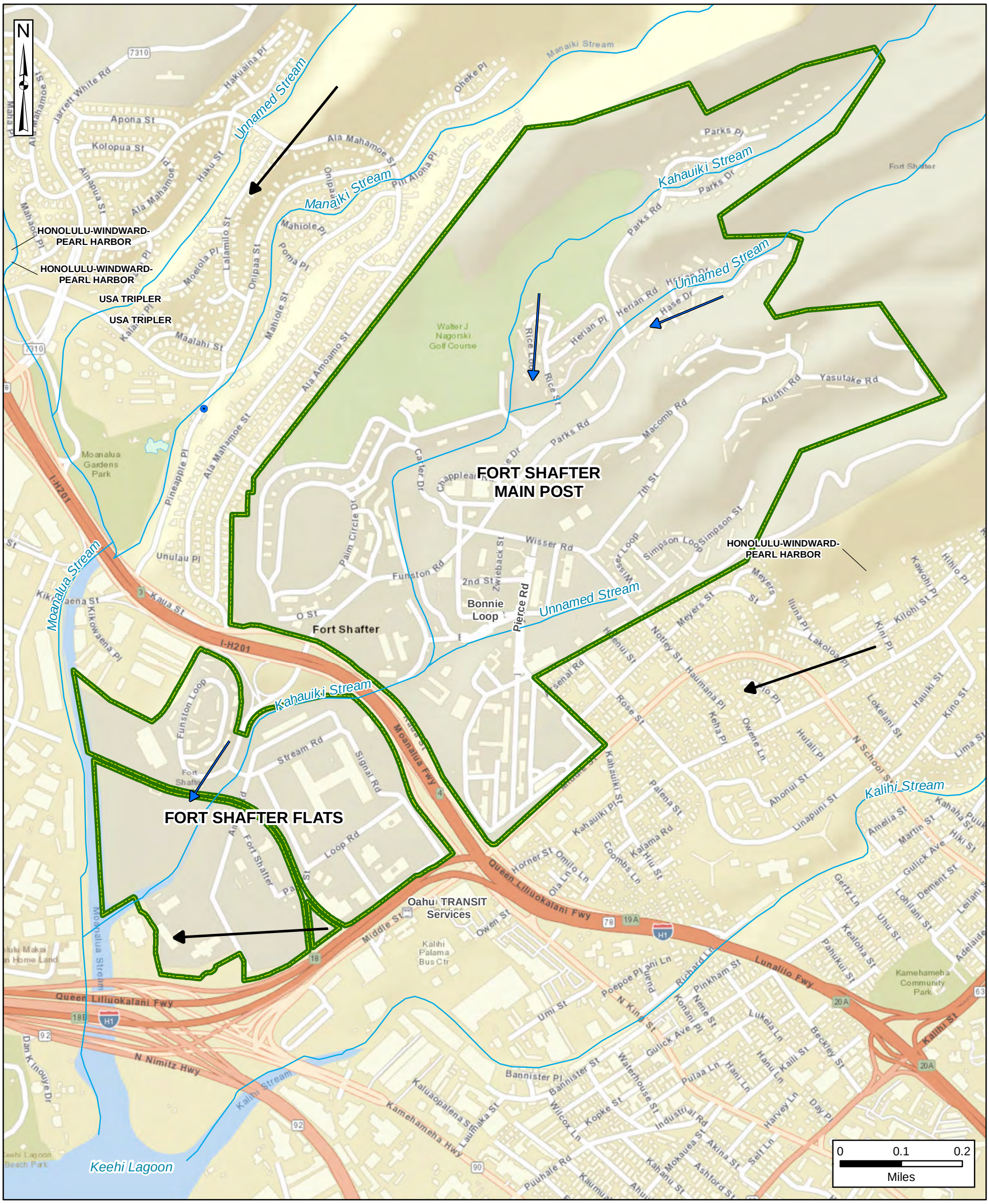
Fort Shafter
Fort DeRussy
Stream (Perennial)
Stream (Intermittent)

Data Sources:
USAG-HI, GIS Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 2-2a
Fort Shafter Site Layout



Fort Shafter

Stream (Perennial)

Surface Water Flow Direction

Assumed Groundwater Flow Direction

Other Designated Use Water Well

Note: Other Designated Use Water Wells includes agricultural wells, industrial wells, irrigation wells and wells of other or unknown use.

Data Sources:
USAG-HI, GIS Data, 2018
EDR, Well Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

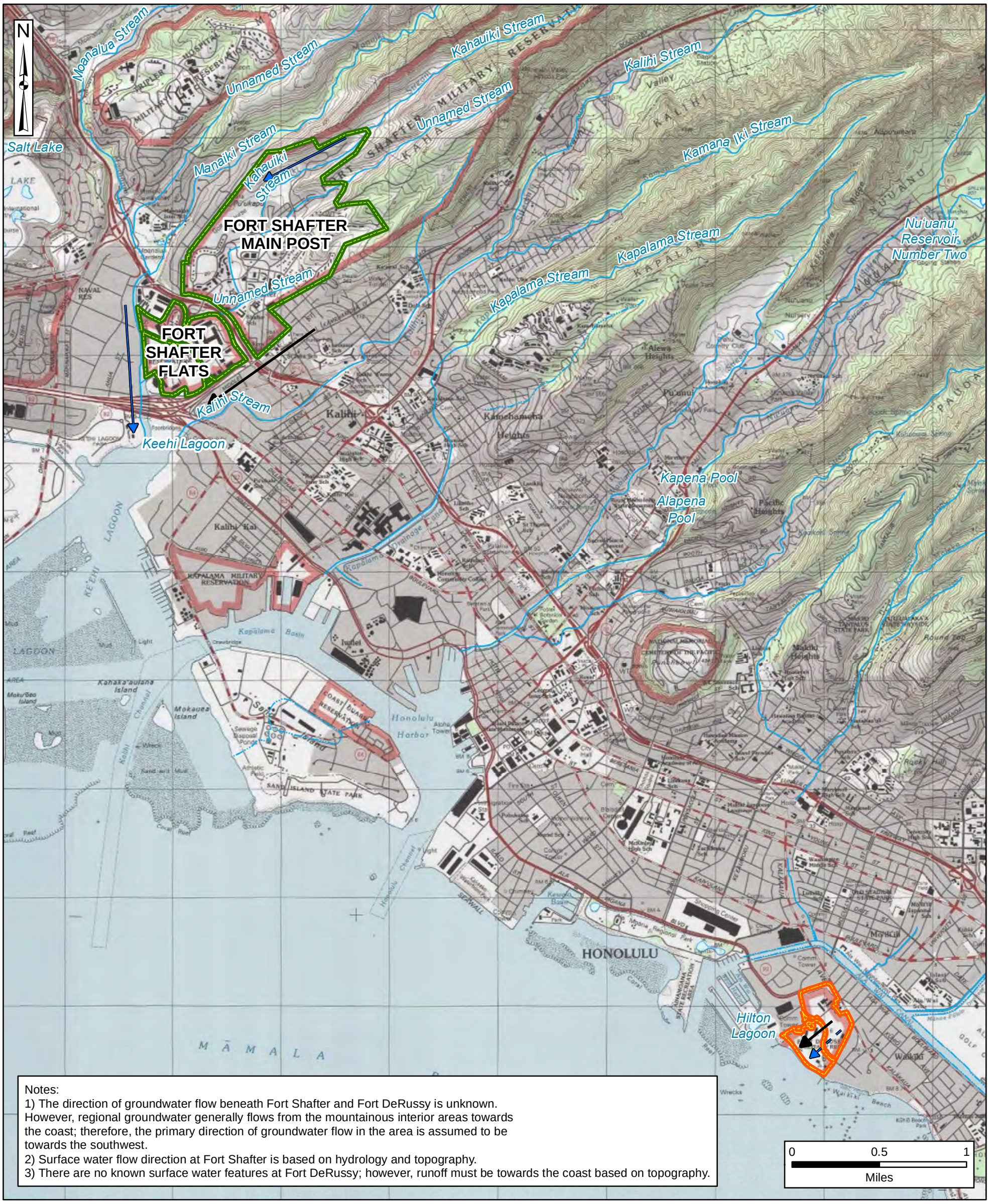
Figure 2-2b
Fort DeRussy Site Layout

Data Sources:
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

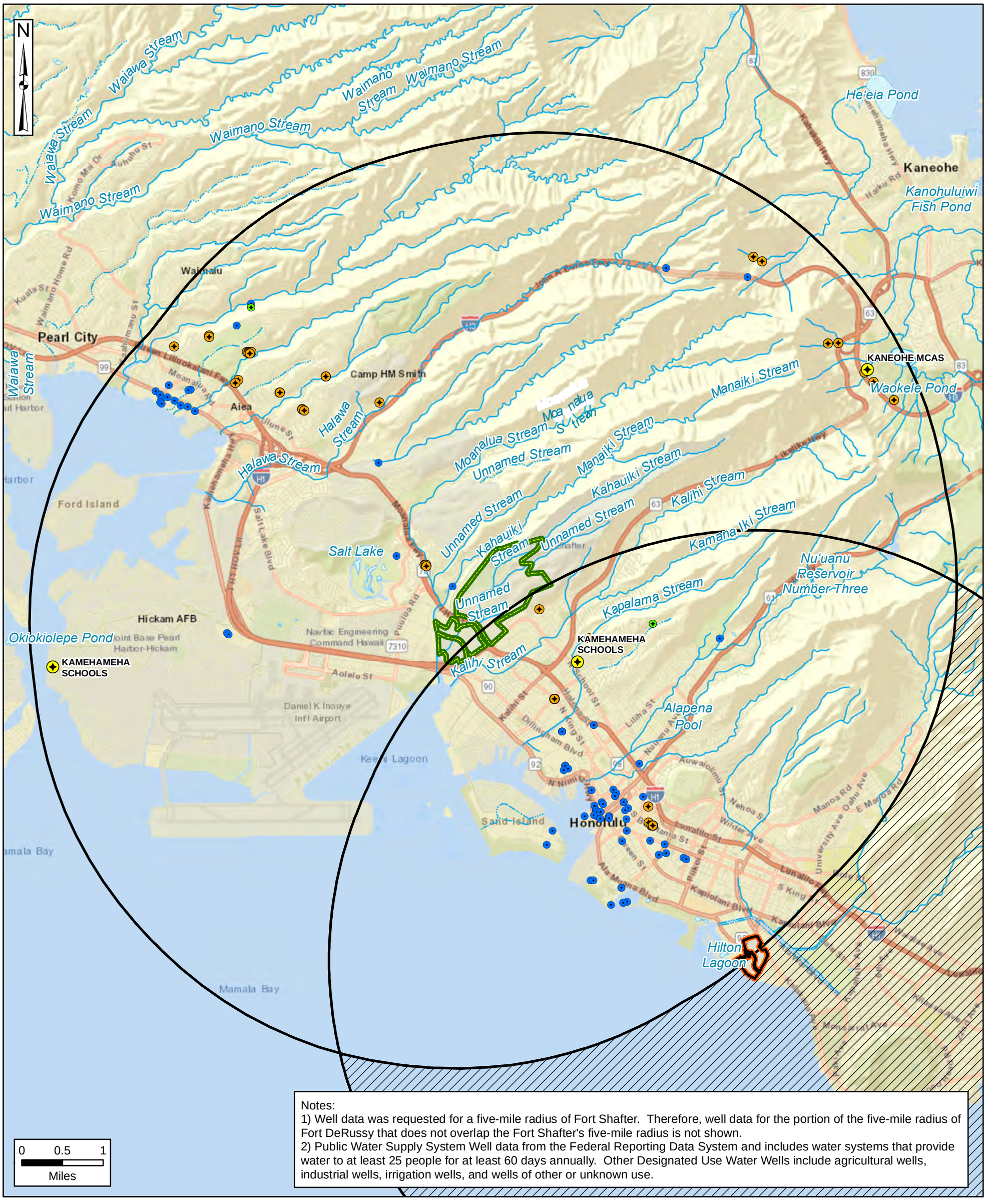
USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 2-3
Topographic Map



USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 2-4
Off-Post Potable Supply Wells



Notes:
1) Well data was requested for a five-mile radius of Fort Shafter. Therefore, well data for the portion of the five-mile radius of Fort DeRussy that does not overlap the Fort Shafter's five-mile radius is not shown.
2) Public Water Supply System Well data from the Federal Reporting Data System and includes water systems that provide water to at least 25 people for at least 60 days annually. Other Designated Use Water Wells include agricultural wells, industrial wells, irrigation wells, and wells of other or unknown use.

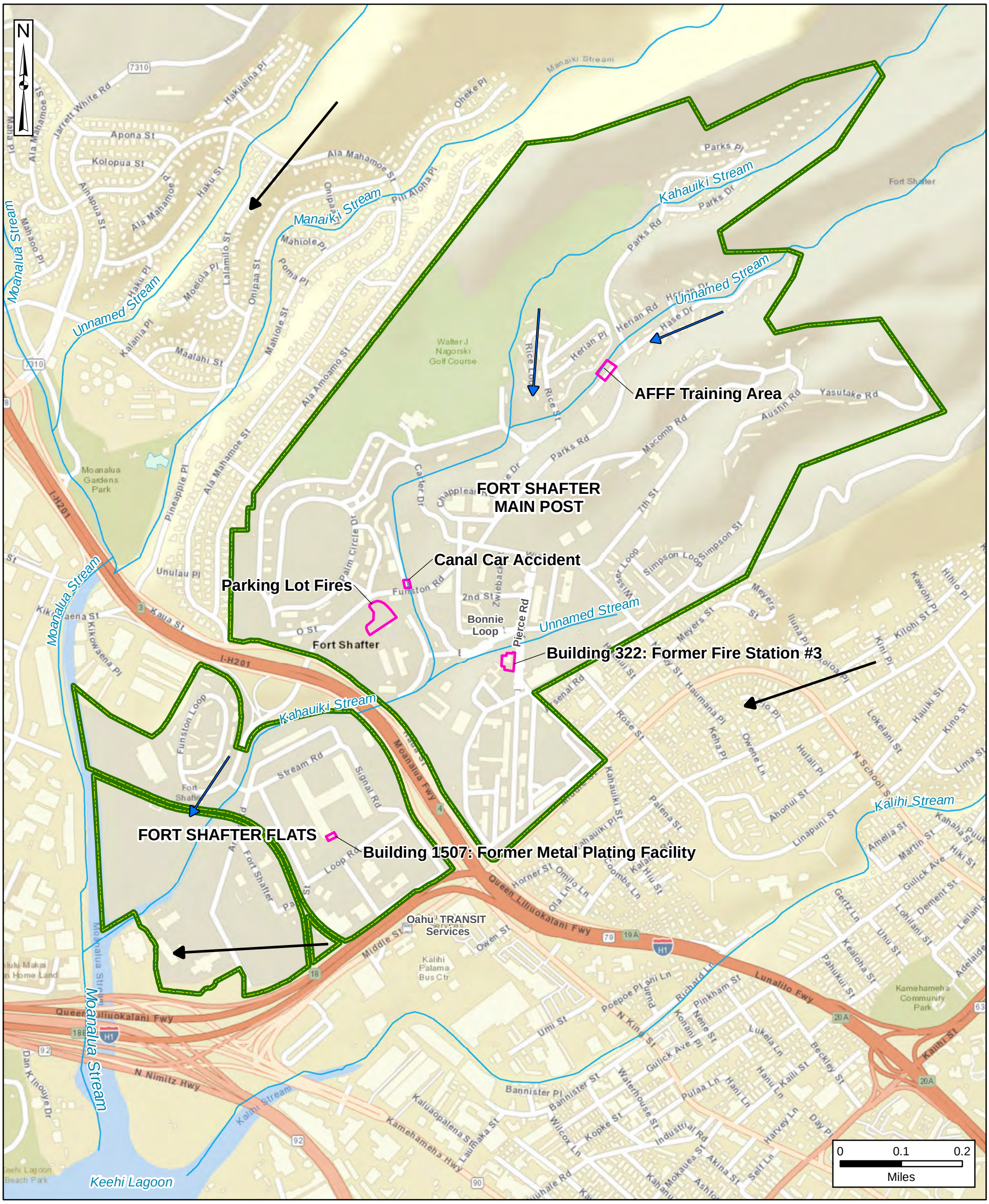
- Fort Shafter
- Fort DeRussy
- 5-Mile Radius
- Stream (Perennial)
- Stream (Intermittent)
- *Public Water Supply System Well*
- Other Public Supply Well
- Domestic Well
- Other Designated Use Water Well

Data Sources:
USAG-HI, GIS Data, 2018
EDR, Well Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 5-2a
Fort Shafter AOPI Locations



Installation Boundary
AOPI
Stream (Perennial)
Surface Water Flow Direction
Assumed Groundwater Flow Direction

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

Data Sources:
USAG-HI, GIS Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 5-2b
Fort DeRussy AOPI Locations

Fort DeRussy

AOPI

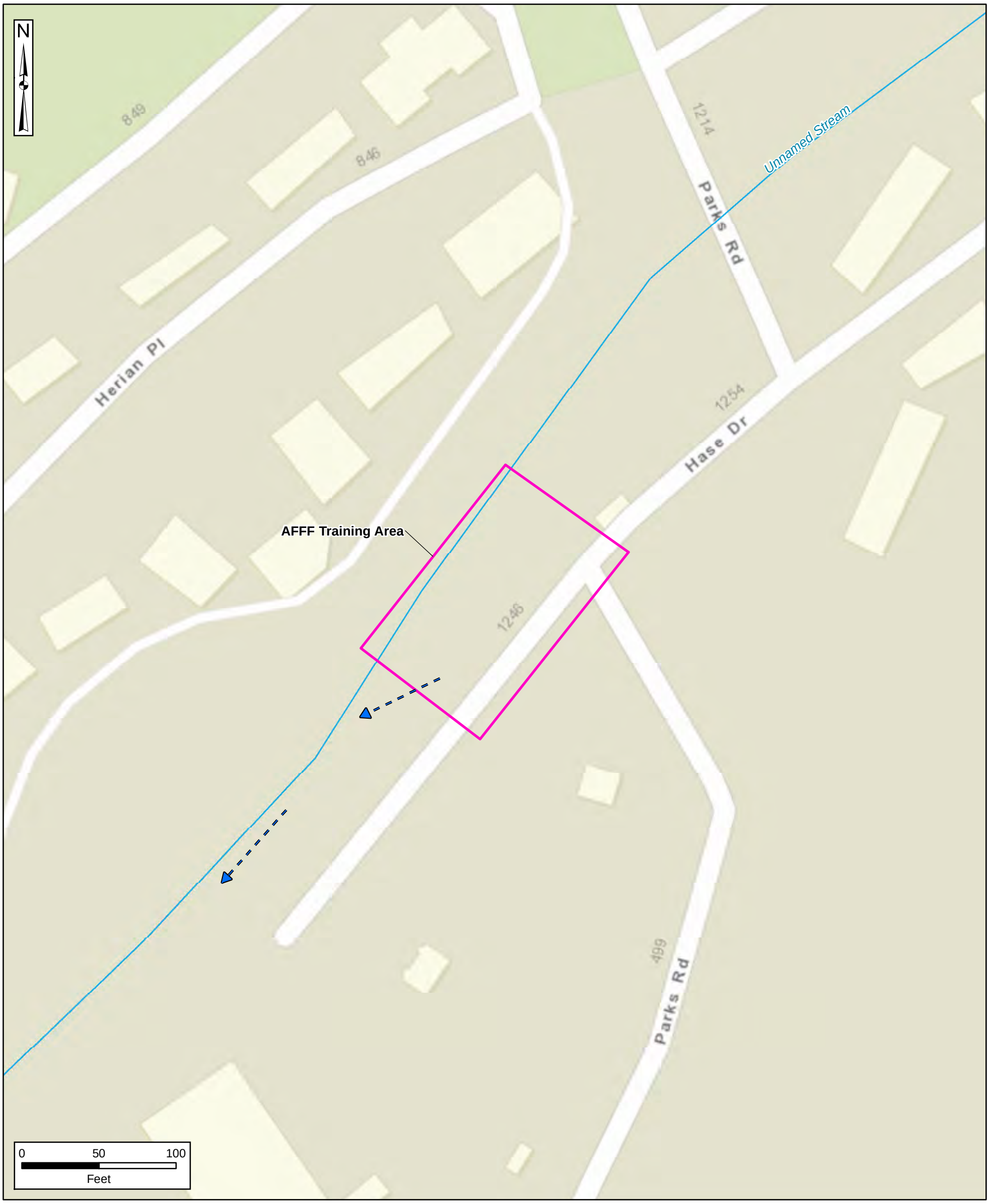
AOPI = area of potential interest

Data Sources:
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 5-3
AFFF Training Area



Fort Shafter
AOPI
Stream (Perennial) *
Stormwater/Surface Water Flow Direction

* Although identified as perennial in the Hawaii rivers and streams geographical information system database, the streams/drainage canals at Fort Shafter can be relatively dry at any given time, The unnamed stream was dry in the vicinity of the AFFF Training Area AOPI during the site inspection.

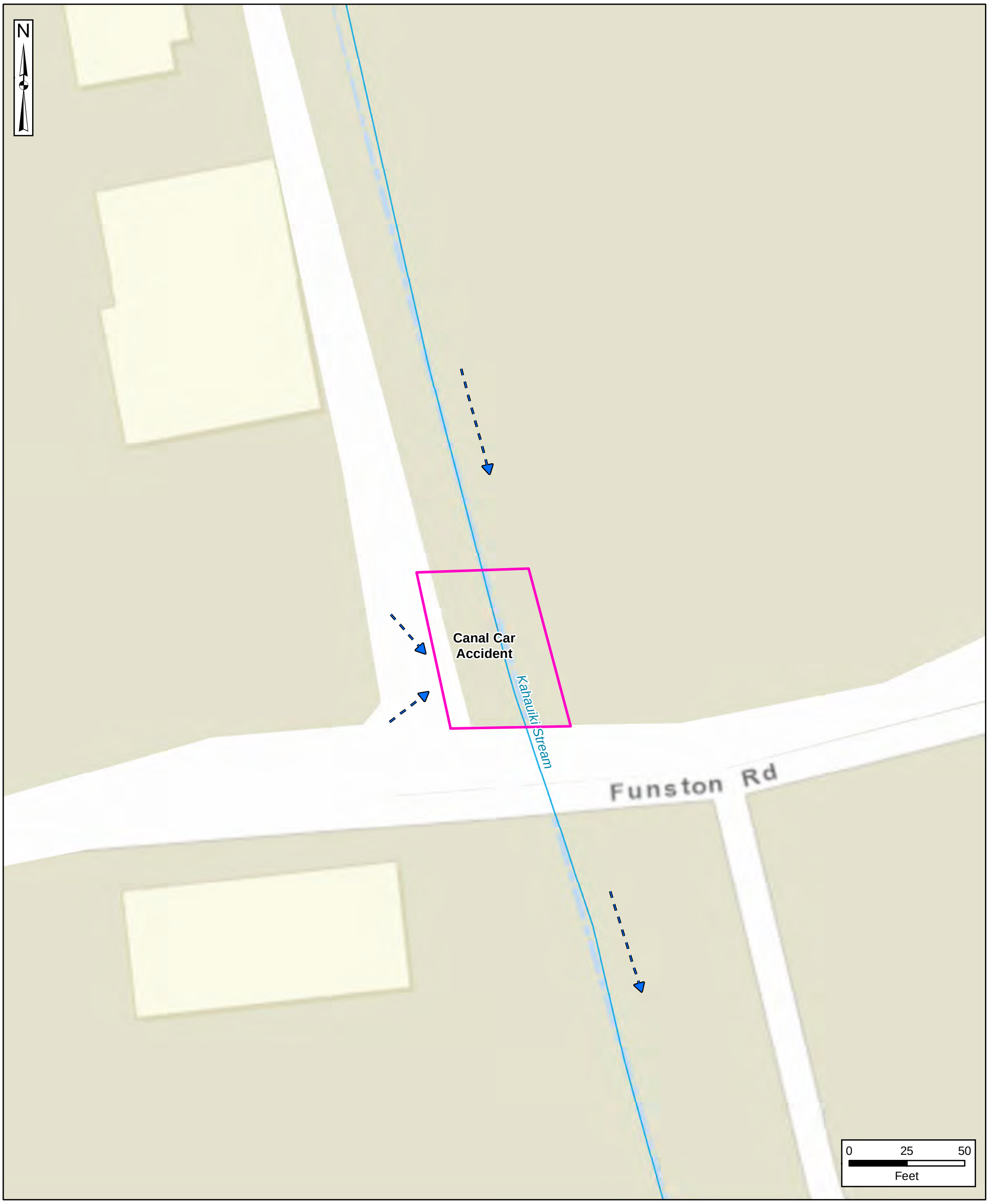
AFFF = aqueous film-forming foam
AOPI = area of potential interest

Data Sources:
USAG-HI, GIS Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 5-4
Canal Car Accident



Fort Shafter

AOPI

Stream (Perennial) *

Stormwater/Surface Water Flow Direction

* Although identified as perennial in the Hawaii rivers and streams geographical information system database, the streams/drainage canals at Fort Shafter can be relatively dry at any given time, Kahauiki Stream was dry in the vicinity of the Canal Car Accident AOPI during the site inspection.

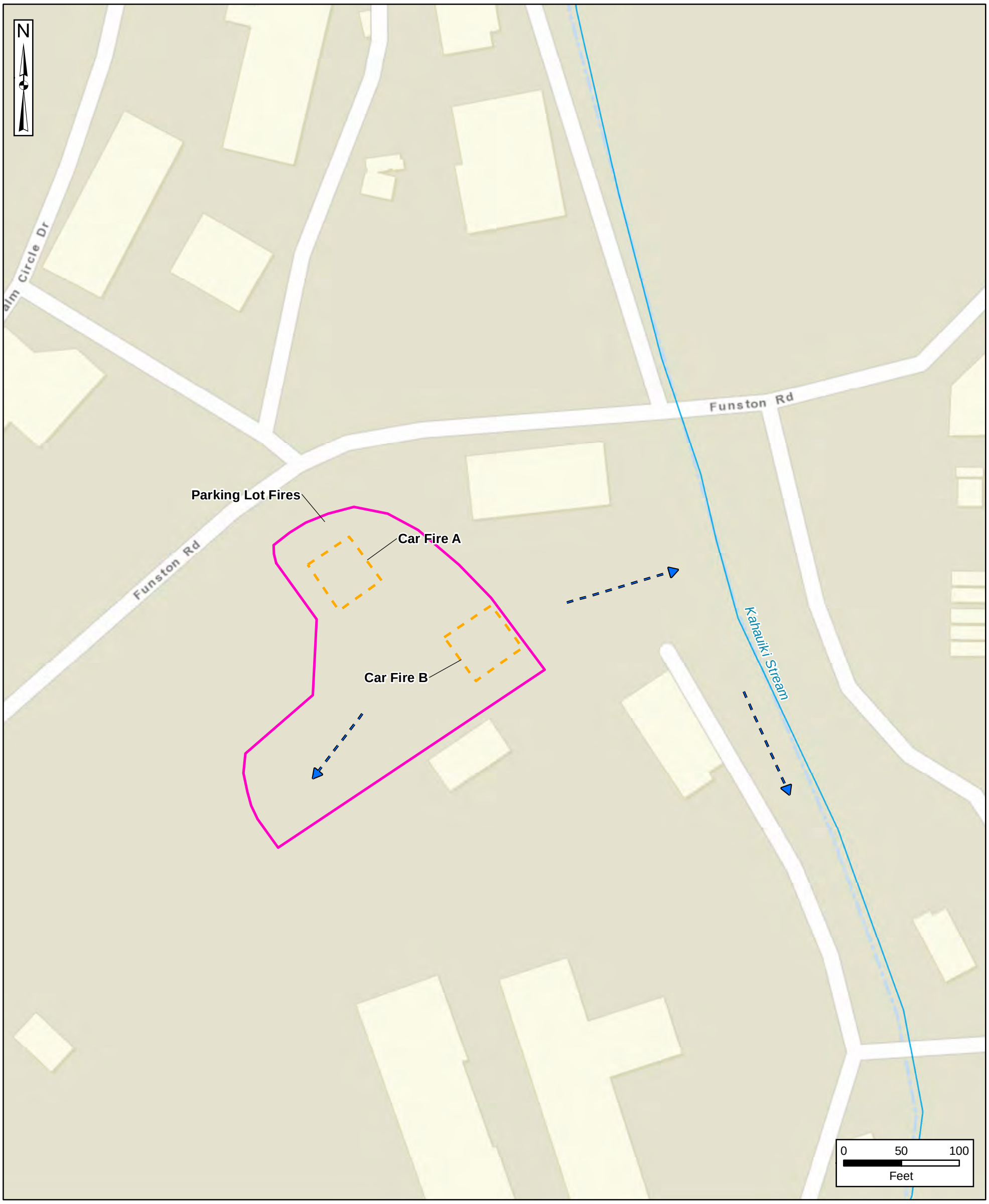
AOPI = area of potential interest

Data Sources:
USAG-HI, GIS Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 5-5
Parking Lot Fires



Fort Shafter
AOPI
Approximate Car Fire Location
Stream (Perennial)
Stormwater/Surface Water Flow Direction

AOPI = area of potential interest

Data Sources:
USAG-HI, GIS Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 5-6
Building 322: Former Fire Station #3

Fort Shafter
AOPI
Stream (Perennial)
Stormwater/Surface Water Flow Direction

AOPI = area of potential interest

Data Sources:
USAG-HI, GIS Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

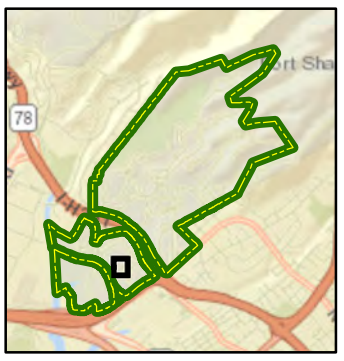
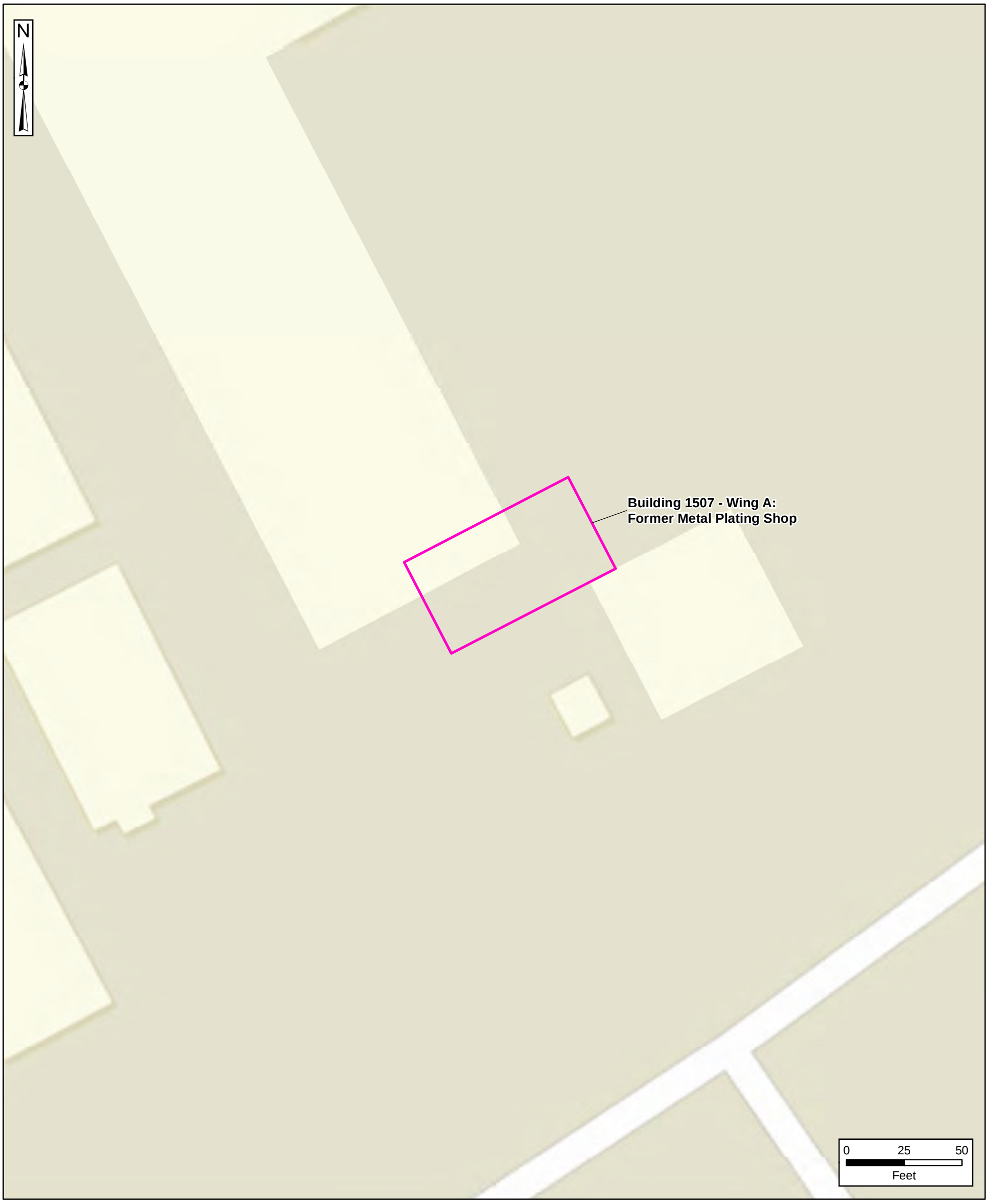


Figure 5-7
Building 1507 - Wing A: Former Metal Plating Shop



Fort Shafter

AOPI

AOPI = area of potential interest

Data Sources:
USAG-HI, GIS Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 5-8
Building T-25: Former Fire Station

Fort DeRussy

AOPI

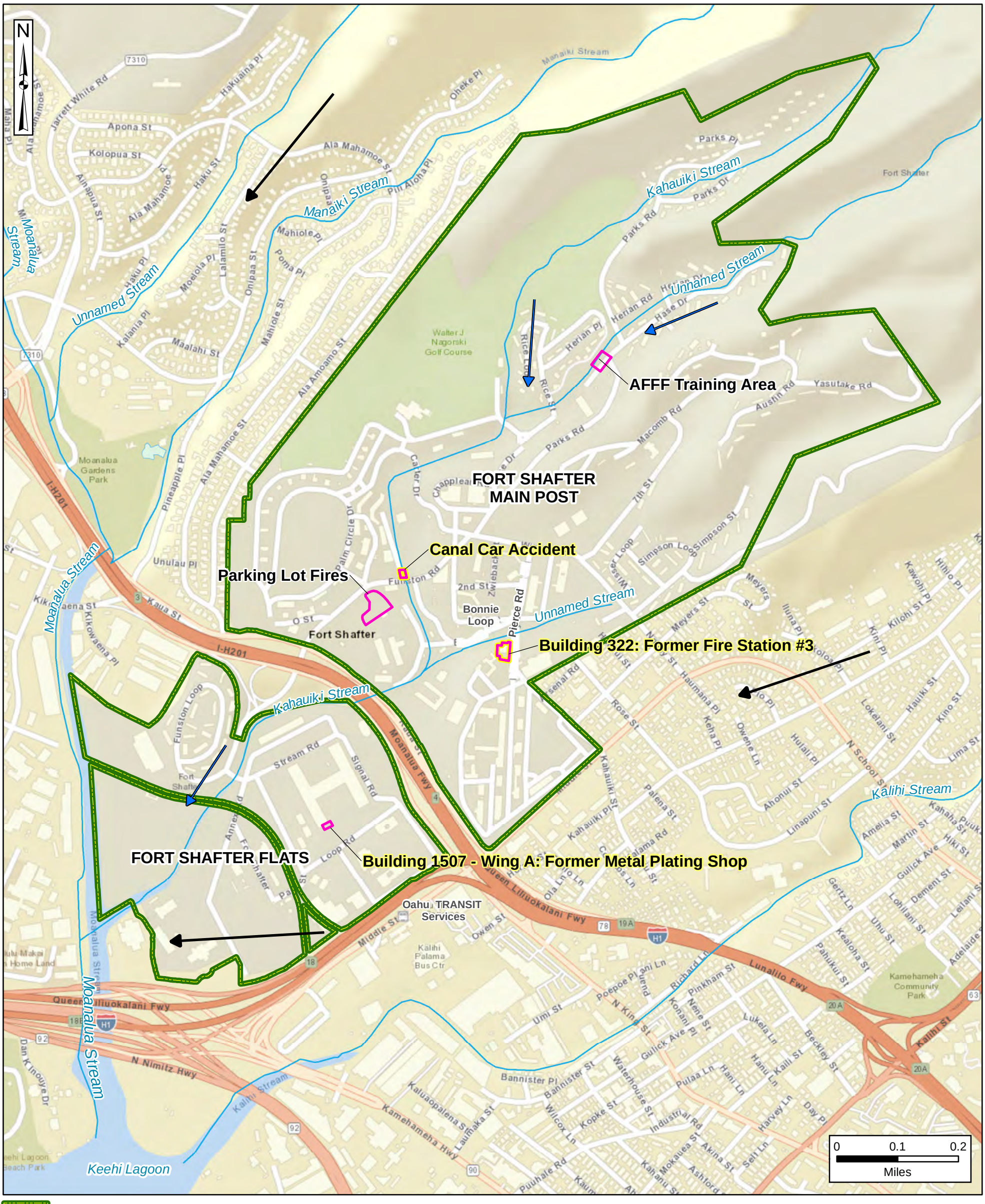
AOPI = area of potential interest

Data Sources:
USAG-HI, GIS Data, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

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



Installation Boundary
AOPI
AOPI with OSD Risk Screening Level Exceedance
Stream (Perennial)
Surface Water Flow Direction
Assumed Groundwater Flow Direction

AFFF = aqueous film-forming foam
AOPI = area of potential interest
OSD = Office of the Secretary of Defense

Data Sources:
USAG-HI, GIS Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 7-2
AFFF Training Area
PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

Chemical	Residential Scenario Risk Screening Level	Industrial/Commercial Scenario Risk Screening Level
	Soil (mg/kg)	Soil (mg/kg)
PFOS	0.013	0.16
PFOA	0.019	0.25
PFBS	1.9	25
PFNA	0.019	0.25
PFHxS	0.13	1.6

FTSHF-AFFFTA-2-SO	
Date	9/13/2022
Depth	0-1.5 ft
PFOS	**0.0014 [0.0015]**
PFOA	0.00064 U [0.00061 U]
PFBS	0.0021 U [0.0020 U]
PFNA	0.00064 U [0.00061 U]
PFHxS	0.00064 U [0.00061 U]

FTSHF-AFFFTA-5-SO	
Date	9/15/2022
Depth	0-0.83 ft
PFOS	**0.00095**
PFOA	**0.0010**
PFBS	0.0022 U
PFNA	**0.00087**
PFHxS	0.00065 U

FTSHF-AFFFTA-1-SO	
Date	9/13/2022
Depth	0-1 ft
PFOS	**0.0019**
PFOA	0.00064 U
PFBS	0.0021 U
PFNA	0.00064 U
PFHxS	0.00064 U

FTSHF-AFFFTA-1-SE	
Date	9/15/2022
PFOS	**0.00049 J [0.00053 J]**
PFOA	0.00063 U [0.00060 U]
PFBS	0.0021 U [0.0020 U]
PFNA	0.00063 U [0.00060 U]
PFHxS	0.00063 U [0.00060 U]

FTSHF-AFFFTA-3-SO	
Date	9/15/2022
Depth	0-1.5 ft
PFOS	**0.0015**
PFOA	0.00060 U
PFBS	0.0020 U
PFNA	0.00060 U
PFHxS	0.00060 U

FTSHF-AFFFTA-4-SO	
Date	9/15/2022
Depth	0-2 ft
PFOS	**0.0012**
PFOA	0.00066 U
PFBS	0.0022 U
PFNA	0.00066 U
PFHxS	0.00066 U

AFFF Training Area

Unnamed Stream

Herlan Pl

Parks Rd

Hase Dr

1214

1254

1246

499

Notes:
1. Soil and sediment results are reported in milligrams per kilogram (mg/kg).
2. Duplicate sample results are shown in brackets.
3. Bolded values indicate detections.

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).

0 50 100
Feet

Installation Boundary
AOPI
Stream (Perennial) *
Stormwater/Surface Water Flow Direction
Shallow Soil Sampling Location
Sediment Sampling Location

AFFF = aqueous film-forming foam
AOPI = area of potential interest
ft = feet
SE = sediment
SO = soil
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
USAG-HI, GIS Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

* Although identified as perennial in the Hawaii rivers and streams geographical information system database, the streams/drainage canals at Fort Shafter can be relatively dry at any given time, The unnamed stream was dry in the vicinity of the AFFF Training Area AOPI during the site inspection.

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 7-3
Canal Car Accident
PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

N

Chemical	Residential Scenario Risk Screening Level	Industrial/Commercial Scenario Risk Screening Level
	Soil (mg/kg)	Soil (mg/kg)
PFOS	0.013	0.16
PFOA	0.019	0.25
PFBS	1.9	25
PFNA	0.019	0.25
PFHxS	0.13	1.6

FTSHF-CCA-1-SO	
Date	9/14/2022
Depth	0-1.7 ft
PFOS	**0.015**
PFOA	0.00063 U
PFBS	0.0021 U
PFNA	0.00063 U
PFHxS	**0.0013**

FTSHF-CCA-2-SO	
Date	9/14/2022
Depth	0-2 ft
PFOS	**0.064**
PFOA	0.00064 U
PFBS	0.0021 U
PFNA	0.00064 U
PFHxS	**0.0046**

Canal Car Accident

Kahauiki Stream

Funston Rd

Notes:
1. Soil results are reported in milligrams per kilogram (mg/kg).
2. Bolded values indicate detections.
3. Results that exceed Office of the Secretary of Defense (OSD) residential scenario risk screening levels (OSD 2022) are highlighted gray.

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

0 25 50
Feet

Installation Boundary
AOPI
Stream (Perennial) *
Stormwater/Surface Water Flow Direction
Shallow Soil Sampling Location

* Although identified as perennial in the Hawaii rivers and streams geographical information system database, the streams/drainage canals at Fort Shafter can be relatively dry at any given time, Kahauiki Stream was dry in the vicinity of the Canal Car Accident AOPI during the site inspection.

AOPI = area of potential interest
ft = feet
SO = soil
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
USAG-HI, GIS Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 7-4
Parking Lot Fires
PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

Chemical	Residential Scenario Risk Screening Level	Industrial/Commercial Scenario Risk Screening Level
	Soil (mg/kg)	Soil (mg/kg)
PFOS	0.013	0.16
PFOA	0.019	0.25
PFBS	1.9	25
PFNA	0.019	0.25
PFHxS	0.13	1.6

FTSHF-PLF-3-SO	
Date	9/14/2022
Depth	0-2 ft
PFOS	0.00066 U
PFOA	0.00066 U
PFBS	0.0022 U
PFNA	0.00066 U
PFHxS	0.00066 U

FTSHF-PLF-2-SO	
Date	9/15/2022
Depth	0-1.9 ft
PFOS	**0.00066**
PFOA	0.00061 U
PFBS	0.0020 U
PFNA	0.00061 U
PFHxS	0.00061 U

FTSHF-PLF-4-SO	
Date	9/14/2022
Depth	0-1.58 ft
PFOS	0.00068 U
PFOA	0.00068 U
PFBS	0.0023 U
PFNA	0.00068 U
PFHxS	0.00068 U

FTSHF-PLF-1-SO	
Date	9/14/2022
Depth	0-2 ft
PFOS	0.00071 U
PFOA	0.00071 U
PFBS	0.0024 U
PFNA	0.00071 U
PFHxS	0.00071 U

Parking Lot Fires
Car Fire A
Car Fire B
Funston Rd
Funston Rd
Kahauiki Stream
Palm Circle Dr

Notes:
1. Soil results are reported in milligrams per kilogram (mg/kg).
2. Bolded values indicate detections.

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

0 50 100
Feet

Installation Boundary
AOPI
Approximate Car Fire Location
Stream (Perennial)
Stormwater/Surface Water Flow Direction
Shallow Soil Sampling Location

AOPI = area of potential interest
ft = feet
SO = soil
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
USAG-HI, GIS Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 7-5
Building 322: Former Fire Station #3
PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

Chemical	Residential Scenario Risk Screening Level	Industrial/Commercial Scenario Risk Screening Level
	Soil (mg/kg)	Soil (mg/kg)
PFOS	0.013	0.16
PFOA	0.019	0.25
PFBS	1.9	25
PFNA	0.019	0.25
PFHxS	0.13	1.6

FTSHF-FFS-5-SO	
Date	9/13/2022
Depth	0-2 ft
PFOS	**0.0022**
PFOA	0.00068 U
PFBS	0.0023 U
PFNA	0.00068 U
PFHxS	0.00068 U

FTSHF-FFS-1-SO	
Date	9/13/2022
Depth	0-1.4 ft
PFOS	**0.058**
PFOA	**0.00090**
PFBS	0.0022 U
PFNA	0.00066 U
PFHxS	**0.00090**

FTSHF-FFS-2-SO	
Date	9/13/2022
Depth	0-1.6 ft
PFOS	**0.015**
PFOA	**0.0010**
PFBS	0.0023 U
PFNA	0.00068 UJ
PFHxS	**0.0021**

FTSHF-FFS-3-SO	
Date	9/15/2022
Depth	0-1.3 ft
PFOS	**0.0017**
PFOA	0.00067 U
PFBS	0.0022 U
PFNA	0.00067 U
PFHxS	0.00067 U

FTSHF-FFS-4-SO	
Date	9/14/2022
Depth	0-2 ft
PFOS	**0.0013**
PFOA	**0.010**
PFBS	0.0021 U
PFNA	0.00063 U
PFHxS	**0.025**

Bonnie Loop
Burr Rd
Unnamed Stream
Pierce Rd.
400
399
Building 322: Former Fire Station #3

Notes:
1. Soil results are reported in milligrams per kilogram (mg/kg).
2. Bolded values indicate detections.
3. Results that exceed Office of the Secretary of Defense (OSD) residential scenario risk screening levels (OSD 2022) are highlighted gray.

Qualifiers:
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).
UJ = The analyte was analyzed for but was not detected. The reported limit of quantitation (LOQ) is approximate and may be inaccurate or imprecise.

0 50 100
Feet

Installation Boundary
AOPI
Stream (Perennial)
Stormwater/Surface Water Flow Direction
Shallow Soil Sampling Location

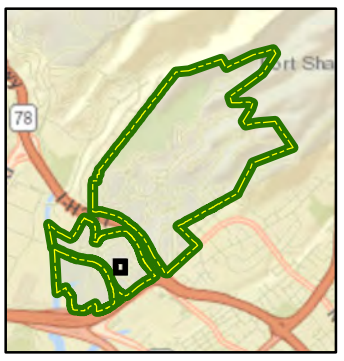
AOPI = area of potential interest
ft = feet
SO = soil
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
USAG-HI, GIS Data, 2018
HI State GIS, Rivers/Streams, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter and Fort DeRussy, Hawaii

Figure 7-6
Building 1507: Former Metal Plating Facility
PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results



N

Chemical	Residential Scenario Risk Screening Level		Industrial/Commercial Scenario Risk Screening Level
	Tap Water (ng/L)	Soil (mg/kg)	Soil (mg/kg)
PFOS	4	0.013	0.16
PFOA	6	0.019	0.25
PFBS	601	1.9	25
PFNA	6	0.019	0.25
PFHxS	39	0.13	1.6

FTSHF-BLDG1507-2-SO	
Date	4/25/2023
Depth	5-7 ft
PFOS	0.00061 UJ [0.00065 UJ]
PFOA	0.00061 UJ [0.00065 UJ]
PFBS	0.0020 UJ [0.0022 UJ]
PFNA	0.00061 UJ [0.00065 UJ]
PFHxS	0.00061 UJ [0.00065 UJ]

FTSHF-BLDG1507-4-SO	
Date	4/25/2023
Depth	5-7 ft
PFOS	0.00061 U
PFOA	0.00061 U
PFBS	0.0020 U
PFNA	0.00061 U
PFHxS	0.00061 U

Building 1507: Former Metal Plating Facility

FTSHF-BLDG1507-3-SO	
Date	4/25/2023
Depth	5-7 ft
PFOS	0.00064 U
PFOA	0.00064 U
PFBS	0.0021 U
PFNA	0.00064 UJ
PFHxS	0.00064 U

FTSHF-BLDG1507-5-SO	
Date	4/25/2023
Depth	5-7 ft
PFOS	0.00063 U
PFOA	0.00063 U
PFBS	0.0021 U
PFNA	0.00063 U
PFHxS	0.00063 U

FTSHF-BLDG1507-1-SO	
Date	4/25/2023
Depth	5-7 ft
PFOS	0.00068 U
PFOA	0.00068 U
PFBS	0.0023 U
PFNA	0.00068 U
PFHxS	0.00068 U

FTSHF-BLDG1507-1-GW	
Date	4/25/2023
PFOS	**17 [17]**
PFOA	**15 [18]**
PFBS	**60 [55]**
PFNA	**4.6 [4.5]**
PFHxS	**29 [29]**

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L).
2. Soil results are reported in milligrams per kilogram (mg/kg).
3. Bolded values indicate detections.
4. Duplicate sample results are shown in brackets.
5. Results that exceed Office of the Secretary of Defense (OSD) residential scenario risk screening levels (OSD 2022) are highlighted gray.

Qualifiers:
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).
UJ = The analyte was analyzed for but was not detected. The reported limit of quantitation (LOQ) is approximate and may be inaccurate or imprecise.

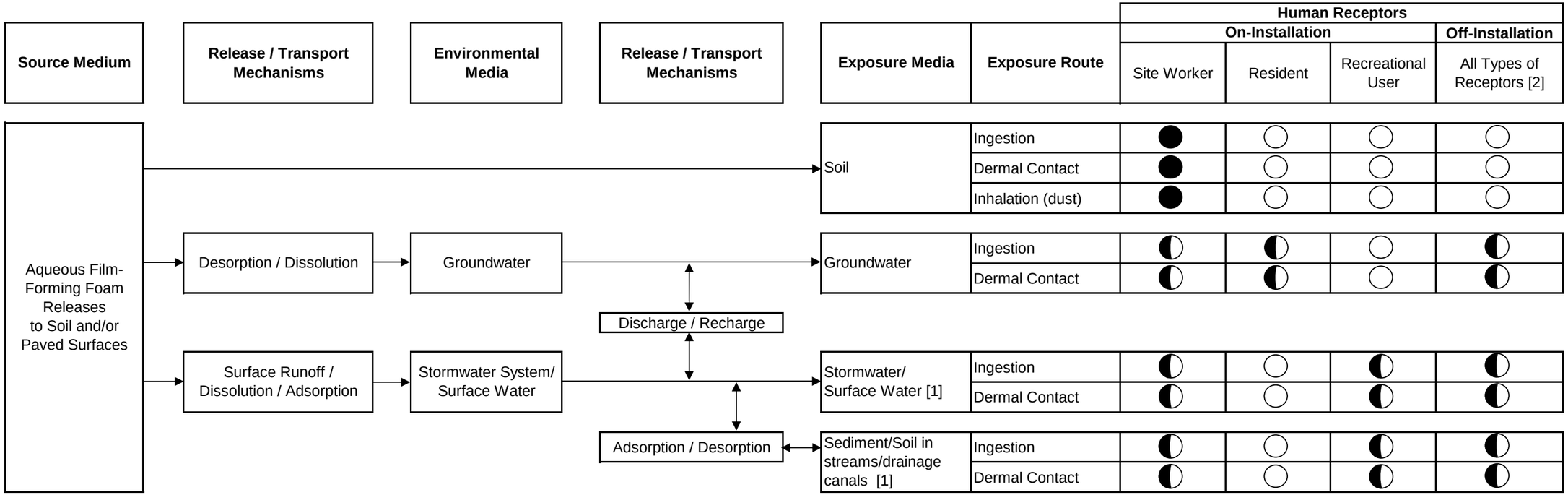
0 25 50
Feet

Installation Boundary
AOPI
Soil Sampling Location (DPT Boring)
Soil and Groundwater Sampling Location (DPT Boring / Temporary Well)

AOPI = area of potential interest
DPT = direct push technology
ft = feet
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
GW = groundwater
SO = soil

Data Sources:
USAG-HI, GIS Data, 2018
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North



Legend:

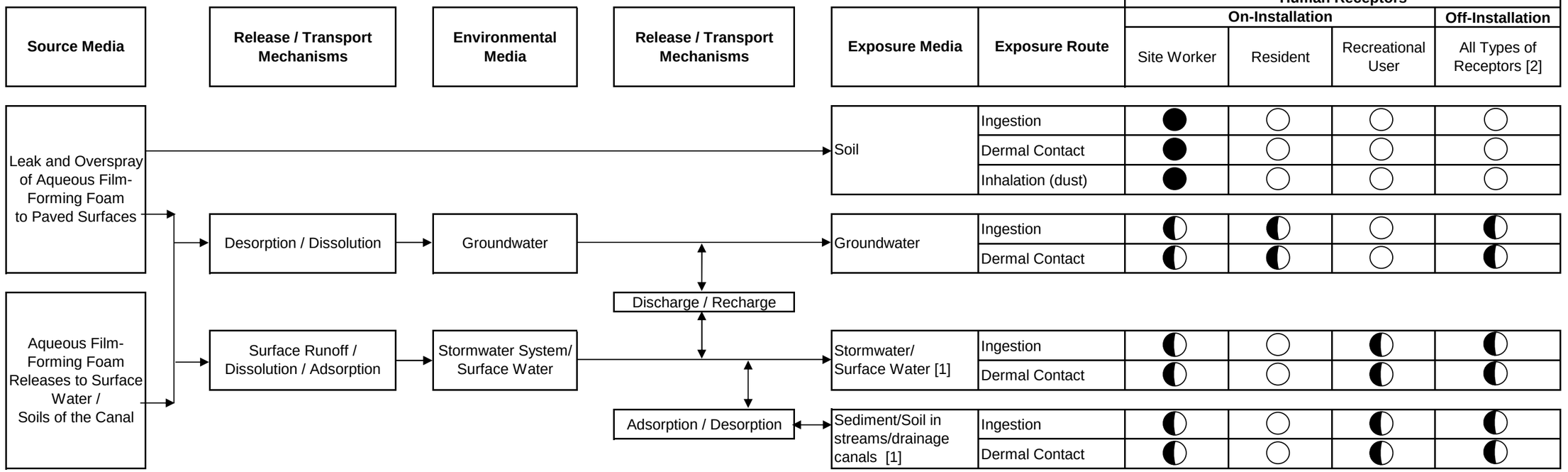
- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Stormwater/surface water and sediment/soil in streams/drainage canals exposure pathways for Site Workers and Recreational Users describes incidental ingestion and dermal contact during outdoor work activities or outdoor recreational activities.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

ARCADIS

Conceptual Site Model for AFFF Training Area, Parking Lot Fires, and Building 322: Former Fire Station #3 AOPI
USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter, Hawaii

Figure 7-7



Legend:

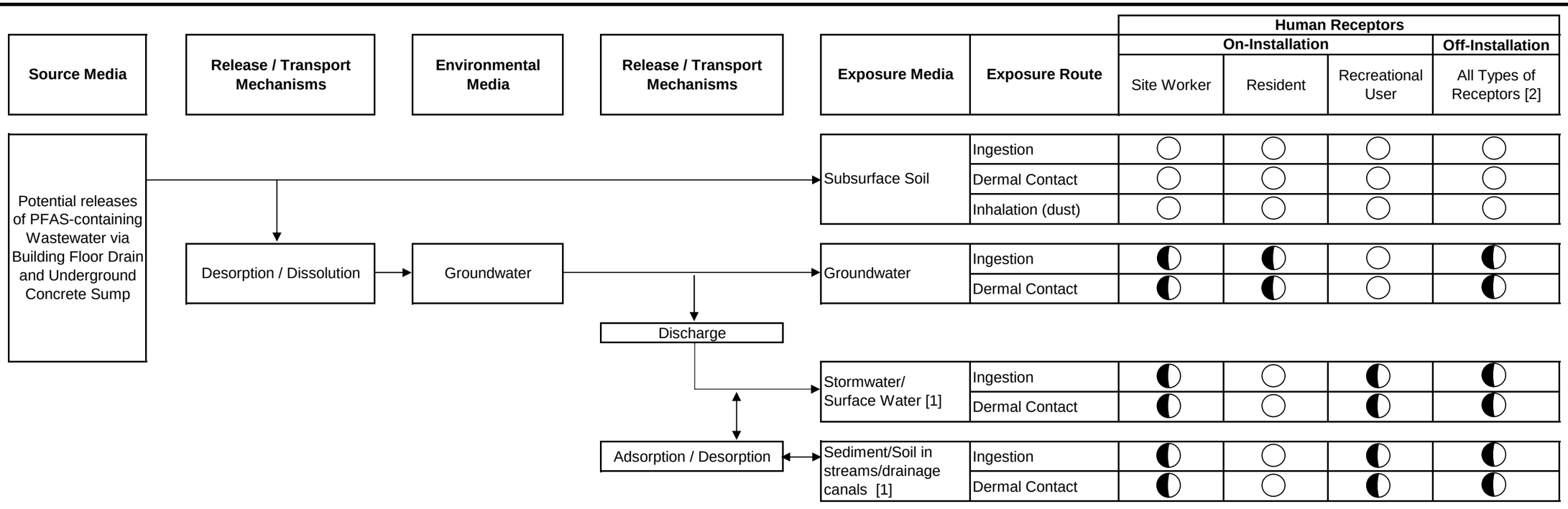
- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Stormwater/surface water and sediment/soil in streams/drainage canals exposure pathways for Site Workers and Recreational Users describes incidental ingestion and dermal contact during outdoor work activities or outdoor recreational activities.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

ARCADIS

Conceptual Site Model for Canal Car Accident AOPI
USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter, Hawaii

Figure 7-8



Legend:

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

Notes:
[1] Stormwater/surface water and sediment/soil in streams/drainage canals exposure pathways for Site Workers and Recreational Users describes incidental ingestion and dermal contact during outdoor work activities or outdoor recreational activities.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

ARCADIS

Conceptual Site Model for Building 1507 – Wing A: Former Metal Plating Shop AOPI
USAEC PFAS Preliminary Assessment / Site Inspection
Fort Shafter, Hawaii

Figure 7-9