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

Helemano Military Reservation, Hawaii

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

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Preliminary Assessment and Site Inspection of Per- and Polyfluoroalkyl Substances

Helemano Military Reservation, Hawaii

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

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

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

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Prepared by:

Arcadis U.S., Inc.

7550 Teague Road

Suite 210

Hanover

Maryland 21076

Arcadis Ref.:

30001994

Date:

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EXECUTIVE SUMMARY

The United States Army (Army) is performing preliminary assessments (PAs) and site inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA) at Army 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 Helemano Military Reservation (HMR) PA/SI 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 policy and guidance.

HMR is an approximately 300-acre reservation located in Wahiawa, central Oahu, between the Koolau and Waianae mountain ranges. The installation is primarily used to house approximately 1,600 military personnel and their dependents; however, portions of the reservation are used as training areas. The surrounding area is either undeveloped or used for agricultural purposes.

The HMR PA identified three AOPIs for investigation during the SI phase. SI sampling results from the three AOPIs were compared to risk-based screening levels calculated by the 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. 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 HMR 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 at all three AOPIs; however, none of the AOPIs had PFOS, PFOA, PFBS, PFNA, and/or PFHxS present at concentrations greater than the applicable risk-based screening levels. The HMR PA/SI identified that a CERCLA remedial investigation is not warranted at this time. **Table ES-1** below summarizes the PA/SI sampling results and provides recommendations for no further 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 HMR, and Recommendations

AOPI Name	PFOS, PFOA, PFBS, PFNA, and/or PFHxS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	GW[1]	SO	
Building 22: Fire Station #10	NS	No	No action at this time[1]
Car Fire	NS	No	No action at this time[1]
Retention Basin	NS	No	No action at this time[1]

Notes:
1 = Although representative groundwater samples were not collected at the AOPIs, twelve deep soil samples were collected from 5 to 30 feet below ground surface from two sample locations (six samples per location) at the Building 22: Fire Station #10 AOPI where surface soil concentrations were the highest to further evaluate the migration to groundwater potential at the installation. PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected above the applicable OSD risk screening levels in any of the soil samples collected, and the concentrations observed at the 30 ft intervals were lower than the concentrations observed at the surface. Therefore, the potential for PFAS migration to groundwater at the installation is low, and consequently no further action at this time is recommended at HMR.
GW – groundwater
NS – not sampled
SO – soil

1 INTRODUCTION

The United States (U.S.) Army (Army) is performing preliminary assessments (Pas) and site inspections (Sis) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), 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 Helemano Military Reservation (HMR), 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. HFPO-DA was not in the suite of PFAS compounds analyzed during the SI; therefore, there are no HFPO-DA SI analytical results to screen against the OSD risk screening levels. This report provides the PA/SI for HMR 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 2016). On 15 October 2019, the OSD provided guidance on the investigation of PFOS, PFOA, and PFBS at Department of Defense (DoD) restoration sites (OSD 2019). The DoD guidance provides risk screening levels for PFOS, PFOA, and PFBS in tap water and soil, calculated using the USEPA's Regional Screening Level (RSL) calculator for residential and industrial/commercial worker receptor scenarios. Following the issuance of the 2019 OSD 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 was conducted consecutively because the results of the PA yielded AOPIs that necessitated continuing onto the SI phase in accordance with CERCLA. Consequently, this report provides the combined objectives of both PA and SI reports.

1.2.1 PA Objectives

During the PA, investigators collect readily available information and conduct site reconnaissance. This PA will evaluate and document areas throughout HMR 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 HMR, PA/SI development followed the process as described below. **Section 3** provides a summary of the PA activities completed, and **Section 6** provides a summary of the SI activities completed for HMR. The PA and SI processes are documented in the PA/SI Quality Control Checklist included as **Appendix B**.

1.3.1 Pre-Site Visit

First, an installation kickoff teleconference was held between applicable points of contact (POCs) from United States Army Environmental Command (USAEC), United States Army Corps of Engineers (USACE), U.S. Army Garrison – Hawaii (USAG-HI; has oversight of HMR), and Arcadis U.S., Inc. (Arcadis). The kickoff call occurred on 07 January 2019, approximately 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 HMR.

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 PFAS PA kickoff call minutes
- An information paper on the PA portion of the Army's PFAS PA/SI
- Contact information for key POCs
- A list of the data sources requested and reviewed
- A list of preliminary locations identified during the kickoff call and pre-site visit records review to be evaluated for use, storage, and/or disposal of PFAS-containing materials, where additional information on those areas will be collected through personnel interviews, additional document review, and site reconnaissance.
- A list of roles for the installation POC to consider when recommending potential interviewees.

1.3.2 Preliminary Assessment Site Visit

The site visit was conducted in conjunction with multiple other Hawaii installations between 05 and 22 March 2019. An in-brief meeting was held to provide USAG-HI 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 HMR. The interviews focused on confirming information discussed in historical documents, collecting information that may have not been in historical documents, corroborating other interviewees' information.

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

An exit briefing was offered to installation personnel at the conclusion of the site visit to raise any items identified during the site visit, discuss any follow-up items, and review the schedule for submitting deliverables. The exit briefing was conducted on 21 March 2019 with USAG-HI to discuss preliminary findings of the PA site visit.

1.3.3 Post-Site Visit

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

1.3.4 Site Inspection Planning and Field Work

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

The objectives of the SI kickoff and scoping teleconference were 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 overlapping unexploded ordnance areas at Wheeler Gulch AOPI
- 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 2019). The PQAPP details general planning processes for collecting data and describes the implementation of quality assurance (QA) and quality control (QC) activities for the SI portion for Army installations nationwide. Additionally, an installation-specific QAPP Addendum was developed to define the DQOs, present the sampling design and rationale, and provide qualifications for project personnel. The SI field work was completed in accordance with the PQAPP (Arcadis 2019) and the approved installation-specific QAPP Addendum. A Site Safety and Health Plan (SSHP) was also developed as an attachment to the QAPP Addendum to identify specific health and safety hazards that may be encountered at the installation during sampling. The SSHP was designed to supplement the Accident Prevention Plan (Arcadis 2018), which was developed for Army installations nationwide. The QAPP Addendum and SSHP were submitted to the installation and finalized before commencement of field work.

[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 DQOs, sampling design and rationale, and field methods employed for the SI are summarized from the QAPP Addendum developed for HMR (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 HMR, including the location and layout, the installation mission(s) over time, a brief site history, current and projected land use, climate, topography, geology, hydrogeology, surface water hydrology, potable wells within a 5-mile radius of the installation, and applicable ecological receptors.

2.1 Site Location

HMR is an approximately 300-acre installation located in Wahiawa, central Oahu, Hawaii, between the Koolau and Waianae mountain ranges (**Figure 2-1**) (USAG-HI 2015). The installation is located approximately 3 miles north of the town of Wahiawa and approximately 5 miles northeast of Schofield Barracks. **Figure 2-2** details the installation layout of HMR.

2.2 Mission and Brief Site History

HMR was initially established in 1943 as a U.S. Army radio communications reception station. Its primary mission was to serve as the base of operations for the 125th Signal Battalion of the 25th Infantry Division (USAG-HI 1997).

Prior to housing units being constructed at the installation, the major facility at the installation was Building 300. Building 300 was, and still is, a combination of administrative facilities and enlisted men's barracks. There were two non-commissioned officer housing townhouses and a motor pool complex. The rest was vacant land covered with wild grass (USAG-HI 1997).

2.3 Current and Projected Land Use

The installation is primarily used to house approximately 1,600 military personnel and their dependents; however, portions of HMR are used as training areas, including a physical fitness center, courts for various recreational activities, and a swimming pool (USACE 2013, USAG-HI 1997). Current land use is not anticipated to change in the future.

2.4 Climate

The climate is sub-tropical with year-round temperatures ranging from approximately 60 to 80 degrees Fahrenheit. The area experiences a dry season between April and October and a rainy season between November and March, and the average annual rainfall is approximately 60 inches (USACE 2013). According to the Western Regional Climate Center (WRCC), the annual average total precipitation at Opaeula 870, Hawaii (517150), located near HMR, from October 1949 to November 2015 was 55.48 inches per year (WRCC 2023). Annual temperatures at Opaeula 870, Hawaii (517150), from October 1949 to November 2015 ranged from an average minimum of 63.2 degrees Fahrenheit to an average maximum of 78.1 degrees Fahrenheit (WRCC 2023).

2.5 Topography

The installation is situated on the northwestern flank of the Koolau volcanic shield. The topography at HMR is generally flat and land elevations range from 1,065 to 1,155 feet above mean sea level that slope gently towards the west/southwest (**Figure 2-3**).

2.6 Geology

Soils at HMR are Wahiawa silty clay, which is commonly found at the uplands of the island of Oahu. These soils are well drained with moderate permeability. These soils are characteristically dusty red, and typically consist of a 1-foot-thick silty clay overlying approximately 4 feet or more of dark reddish-brown, compacted subsoil. Underlying the compacted subsoil is weathered igneous rock (USACE 2013).

2.7 Hydrogeology

The aquifer beneath HMR is part of the Central Sector of the Wahiawa Aquifer System. The aquifer is an unconfined, high-level aquifer that occurs in dike compartments. The aquifer is classified as a currently developed groundwater source, used for drinking, 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 classifications (e.g., high, moderate, low, or no vulnerability to contaminants) are based on familiarity with environmental conditions (Mink and Lau 1990). The aquifer is used for drinking water distributed to municipal and private users on Oahu. The depth to groundwater beneath HMR is unknown; however, depth to groundwater in the area is estimated to be approximately 800 feet below ground surface (bgs) (USACE 2013). The direction of groundwater flow beneath the installation is unknown. However, regional groundwater generally flows from the mountainous interior areas towards the coast; therefore, the primary direction of groundwater flow in the area is presumed to be towards the northwest (Oki 1998).

2.8 Surface Water Hydrology

There are no surface water bodies located within the HMR installation boundary (USACE 2013). The closest perennial stream, Helemano Stream, is located approximately 250 feet to the north of the installation (CH2M Hill 1996, USACE 2013, USAG-HI 2015). Other nearby, off-site surface-water bodies are Poamoho Stream (approximately 1,000 feet to the southeast) and the Upper Helemano Reservoir/Tanada Reservoir (approximately 800 feet to the southwest). The northern portion of HMR drains to Helemano Stream, a tributary of Paukauila Stream. However, the majority of HMR drains to a vegetated retention basin (i.e., the Retention Basin Area AOPI) near the southwestern boundary of the installation where stormwater infiltrates and evaporates (USAG-HI 2015).

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 HMR.

2.9.1 Stormwater Management System Description

The northern portion of HMR drains to Helemano Stream, a tributary of Paukauila Stream; however, the majority of HMR drains to a vegetated retention basin (i.e., the Retention Basin AOPI) near the southwestern boundary of the installation where stormwater infiltrates and evaporates (USAG-HI 2015).

2.9.2 Sewer System Description

According to the USAG-HI Clean Water Program Manager interviewed during the PA site visit, wastewater generated at HMR drains to the Schofield Barracks wastewater treatment plant (WWTP). The Schofield Barracks WWTP is located on the Wheeler Army Airfield and also receives wastewater from Wheeler Army Airfield. It was originally constructed and became operational in approximately 1978 (Harding 1993). It was privatized by the Army in 2004 and Aqua Engineers, Inc. currently operates the plant (City and County of Honolulu Department of Design and Construction 2008). The Clean Water Program Manager indicated that the U.S. Navy removes the sludge from the WWTP and transports it off of Schofield Barracks for disposal. The Clean Water Program Manager did not know where the U.S. Navy disposes of the sludge.

Between 1970 and the early 1980s, HMR had its own sewage treatment plant (STP; HMR-04) (CH2M Hill 1996). The STP consisted of a primary clarifier, an aeration tank, secondary/final clarifier, chlorinator unit, sludge holding tank, and two sludge drying beds (USACE 2013, CH2M Hill 1996). The STP was removed in the early 1990s (USACE 2013). Two lined sediment ponds were formerly located just within the southern boundary of HMR and were connected to the STP and received flow from the STP during its period of operation (CH2M Hill 1996).

2.10 Potable Water Supply and Drinking Water Receptors

Groundwater beneath HMR is not used as a drinking water source for HMR; instead, HMR has a comingled drinking water system with water provided by the U.S. Army (Schofield Barracks production wells and drinking water treatment plant) and the U.S. Navy (wells not located on HMR). Provision of HMR's drinking water switches between the U.S. Army and U.S. Navy every 30 days.[2]

As stated in **Section 2.7,** the aquifer below HMR is used as a drinking water resource for the surrounding municipal and residential areas. However, given that groundwater in the vicinity of HMR is estimated to be approximately 800 feet bgs and the availability of drinking water provided by other nearby military sources, HMR will not likely be used as a drinking water source in the future.

The USAG-HI Safe Drinking Water Program Manager indicated during the PA site visit that there are off-installation wells that provide drinking water in nearby communities. The Safe Drinking Water Program Manager noted that these wells have different sources (than the Schofield Barracks wells; unknown where the U.S. Navy's wells that supply drinking water to HMR are located); however, it is unknown whether these sources are part of or are separate from the aquifer from which Schofield Barracks obtains its drinking water.

[2] Schofield Barracks was assessed under a separate site-specific USAEC PFAS PA/SI.

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 HMR, which along with state and county geographic information system provided by the installation identified several off-post public and private wells within 5 miles of the installation boundary (**Figure 2-4**). The direction of groundwater flow at HMR appears to be generally west (both northwest and southwest) of the installation, with no public supply wells located downgradient. However, agricultural wells are located to the west of HMR that may be considered downgradient. Additionally, there could potentially be downgradient off-post wells in the surrounding area; however, due to the various regional groundwater flow directions in the surrounding area, whether off-post wells are truly hydraulically downgradient of an AOPI has not been confirmed. The EDR report providing well search results provided as **Appendix D**.

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 vegetation at the installation is primarily maintained landscaping, including short-mown grass, ornamentals, and recreational fields. The installation is located in the Agricultural State Land Use Zone; no threatened or endangered species were identified. The Poamoho Stream located south of the HMR supports local fish and is likely used as a fishery. There are no designated wetlands or sensitive areas identified along the stream. No designated protected or threatened species of fish are associated with the Poamoho Stream (USACE 2013).

2.12 Previous PFAS Investigations

Previous (i.e., pre-PA) PFAS investigations relative to HMR, including both those conducted and not conducted by the Army, are summarized to provide full context of available PFAS data for HMR. 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 2016). 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 (August and December), 2014 (February, March, May, June, July, September, November, and December), and 2015 (January) samples were collected from 8 to 12 public supply wells within a 5-mile radius of HMR (the locations of sampled wells were undetermined from readily available documents). 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 levels at the time of UCMR3 sampling were 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.

It is unknown whether drinking water (or water from the source wells) provided by the U.S. Navy has previously been analyzed for PFAS; no records were available to the PA team. Drinking water supplied by Schofield Barracks, however, has been analyzed for PFAS. Drinking water samples were collected from water supply wells located at Schofield Barracks on 19 March 2014, 09 September 2014, and 16 October 2017 for PFAS analysis using USEPA Method 537 (Naval Facilities Engineering Command [NAVFAC] 2014a; NAVFAC 2014b; Army 2017). Analytical results for samples collected on 19 March and 09 September 2014 indicate PFBS was not detected above the method reporting limit of 90 ng/L, PFOS was not detected above the method reporting limit of 40 ng/L, and PFOA was not detected above the method reporting limit of 20 ng/L (NAVFAC 2014a; NAVFAC 2014b). Analytical results for the sample collected 16 October 2017 indicate none of the analyzed constituents (including PFOS, PFOA, PFBS, PFNA, and PFHxS) were detected above the method reporting limit of 2.0 ng/L (Army 2017).[3]

[3] Additional information on previous drinking water PFAS investigations at Schofield Barracks is available in the Preliminary Assessment and Site Inspection of Per- and Polyfluoroalkyl Substances Report for Schofield Barracks, Hawaii.

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 HMR, 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 HMR is presented in **Section 4**. Further discussion regarding rationale for not retaining areas for further investigation is presented in **Section 5.1**, and further discussion regarding categorizing areas as AOPIs is presented in **Section 5.2**.

3.1 Records Review

The records reviewed for this PA included, but were not limited to, the EDR report generated for HMR, various Installation Restoration Program (IRP) administrative record documents, compliance documents, HMR fire department documents, HMR Directorate of Public Works documents, and geographic information system files. Internet searches were also conducted to identify publicly available and other relevant information. A list of the specific documents reviewed for HMR is provided in **Appendix E**.

3.2 Personnel Interviews

Interviews were conducted during the site visit. The list of roles for the installation personnel interviewed during the PA process for HMR is presented below.

- Deputy Fire Chief, Federal Fire Department (FFD), District 2
- Lieutenant, FFD, HMR
- Battalion Chief, FFD, Pearl Harbor
- Captain, FFD, Wheeler Army Airfield
- Lieutenant, FFD, Wheeler Army Airfield
- Lieutenant, FFD, Camp Smith
- Clean Water Program Manager, USAG-HI
- Safe Drinking Water Program Manager, USAG-HI

- Compliance Manager, Wheeler Army Airfield

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

3.3 Site Reconnaissance

Site reconnaissance and visual surveys were conducted at the preliminary locations identified at HMR 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.

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

HMR was evaluated for all potential current and historical use, storage, and/or disposal of PFAS-containing materials. 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. Furthermore, significant operational changes, such as Army directives discontinuing the use of AFFF at Army installations, 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.

FFD Fire Station #10 (Building 22) is situated in the center of HMR. The fire station was built in 1994 and at the time of this PA report it was still in operation. There is no indication from historical records or PA site visit interviews that a fire station was present at HMR prior to construction of the current station. Historically, AFFF has been stored at the station and in the trucks. FFD personnel interviewed during the PA stated that incidental spills of AFFF are likely to have occurred during filling of fire truck tanks. Any spills would have most likely occurred within the truck bays which have drains that discharge into the storm sewer system. During the reconnaissance of the building during the PA site visit, five 5-gallon pails of AFFF were observed to be stored at the station in a storage closet. The trucks are washed on the apron at the back of the building, which drains to an oil water separator and the sanitary sewer. Truck washing overspray (i.e., a portion of truck washing wastewater) likely drains to the storm sewer system. There were no fire training areas identified at HMR, and no fire training or related equipment testing activities (e.g., fire hose pressure testing) are known to be conducted at the fire station or elsewhere at HMR.[4]

Circa 2009, a car fire occurred in the street approximately 20 feet east of Fire Station #10's front apron. AFFF was used during emergency response efforts. Surface runoff in the area drains via the storm sewer system, which then discharges to a retention basin located in the southwest portion of the installation.

[4] According to the FFD District 1 Chief of Operations, as well as other FFD staff interviewed during the PA site visit, most fire training activities and fire truck maintenance and equipment testing activities take place at Joint Base Pearl Harbor-Hickam (U.S. Navy).

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

Following document research, personnel interviews, and site reconnaissance at HMR, a former STP, dump site, and a surface water retention basin were also identified as preliminary locations for use, storage, and/or disposal of PFAS-containing materials. A summary of information gathered in the PA for each of these preliminary locations is described below. Specific discussion regarding areas not retained for further investigation is presented in **Section 5.1** and specific discussion regarding areas retained as AOPIs is presented in **Section 5.2**.

There was a STP (IRP number [No.] HMR-04; Headquarters Army Environmental System [HQAES] 2209A.1004) at HMR that operated from 1970 until the early 1980s. The STP did not receive truck wash from the fire station on the installation (Building 22: Fire Station #10) because the plant was decommissioned and removed in the early 1990s before the fire station was built (USACE 2013).[5] This STP was located in and encompassed approximately 0.9 acre of the northwestern portion of HMR, and consisted of a primary clarifier, an aeration tank, secondary/final clarifier, chlorinator unit, sludge holding tank, and two sludge drying beds (USACE 2013).

Two lined holding or sediment ponds (IRP No. HMR-05; HQAES 2209A.1005) were formerly located just within the southern boundary of HMR. Each of the two ponds was approximately 9,000 square feet in size and was approximately 10 feet deep. These sediment ponds received flow from the STP during its period of operation (1970 to the early 1980s). During STP decommissioning, the pond liners were removed. During removal, they were observed to contain holes (the number and size of these holes was not documented). The ponds were backfilled with clean soil after the lines were removed (CH2M Hill 1996). The location is currently occupied by housing.

A solid waste dump site (IRP No. HMR-07; HQAES 2209A.1007) containing a waste pile was located on the south side of the Helemano Stream ravine on the northwestern boundary of HMR. It is downgradient of the former STP (USAG-HI 1997). The dump site was discovered adjacent to the inactive STP in the 1980s during activities associated with decommissioning the STP. It may have received "debris" from the STP during its operation from 1970 until the early 1980s (CH2M Hill 1996). It is unknown whether this waste pile precedes the STP.

HMR has a robust stormwater management system consisting of stormwater sewers that direct rainwater away from paved surfaces and buildings. Most of the stormwater sewer lines at HMR, including those in the vicinity of Fire Station #10, discharge to an approximately 5-acre, unlined retention basin located in the southwest portion of the installation.

During a telephonic interview with the IMCOM Pest Management Consultant, it was noted that products containing Sulfluramid (i.e., associated with insecticides) may have contained PFAS and were phased out in 1996. During the PA records review, the IMCOM Pest Management Consultant provided records of potentially PFAS-containing pesticides and insecticides used at and/or stored at Army installations and did not identify HMR as an installation having used or stored PFAS-containing pesticides/insecticides. Additionally, the PA team interviewed relevant staff during the PA site visit and no PFAS-containing pesticides were identified as being used, stored, or disposed at HMR by the Army.

[5] Note that the CH2M Hill 1996 report identifies the STP as being decommissioned in the early 1980s soon after it ceased operation.

Two abandoned wall lockers containing paints and solvents (IRP No. HMR-08) were found dumped and partially buried north of Building 300 on the edge of a ravine above Helemano Stream in the northern portion of HMR. It is unknown when these lockers were dumped at this location. This location was included in a 1990 assessment conducted by the U.S. Army Toxic and Hazardous Material Agency (USAG-HI 1997). Therefore, these lockers were discovered in or prior to 1990. When the lockers were investigated, the containers within were found to be in a deteriorated condition; however, soil samples collected at this location indicated no contamination was present when screened for volatile organic compounds and metals (USAG-HI 1997).

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 HMR) 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 HMR installation, none of these off-post sources are hydraulically upgradient (southeast) of HMR.

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

Facility Name	Facility Address	Type of Facility	Distance and Direction from Installation[1]
Fire Station #16 Wahiawa	640 California Avenue, Wahiawa, Hawaii 96786	Fire Station	2.40, Southwest
Rich's Whips	721 Kilani Avenue, Wahiawa, Hawaii 96786	Car Wash	2.25, Southwest
Aloha Gas	150 Kamehameha Highway, Wahiawa, Hawaii 96786	Car Wash	2.35, Southwest
Brunos Auto Detailing	10 South Kamehameha Highway, Wahiawa, Hawaii 96786	Car Wash	2.48, Southwest
Sunset Auto Services, Inc.	207 North Cane Street, Wahiawa, Hawaii 96786	Automotive Maintenance	2.12, Southwest
Ace Transmission and General Repair LLC	720 Kilani Avenue, Wahiawa, Hawaii 96786	Automotive Maintenance	2.23, Southwest
Oil Changers	961 Center Street, Wahiawa, Hawaii 96786	Automotive Maintenance	2.25, Southwest
Hawaii Rides INC	651 Kilani Avenue, Wahiawa, Hawaii 96786	Automotive Maintenance	2.29, Southwest
Gerber Collision and Glass	415-A Kilani Avenue, Wahiawa, Hawaii 96786	Automotive Maintenance	2.38, Southwest

Facility Name	Facility Address	Type of Facility	Distance and Direction from Installation[1]
Midas	25 Kamehameha Highway, Wahiawa, Hawaii 96786	Automotive Maintenance	2.45, Southwest
Jetso Auto Center Fire[2]	200 Block of Palm Street, Wahiawa, Hawaii 96786	Automotive Maintenance Fire	2.21, Southwest
Wahiawa General Hospital	128 Lehua Street, Wahiawa, Hawaii 96786	Hospital	2.30, Southwest
Walgreens Photo	135 South Kamehameha Highway, Wahiawa, Hawaii 96786	Photo Processing	2.62, Southwest
Pristine Painting and Coatings LLC	410 North Cane Street, Suite A7, Wahiawa, Hawaii 96786	Paint Facility / Manufacturer	2.03, Southwest

Notes:

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

2 = In November 2015, there was a blaze at the Jetso Auto Center in the 200 block of Palm Street in Wahiawa. “Eight fire companies with 34 personnel...were required to extinguish the main fire” (Marcel Honoré 2015). “’At the time of the fire, there was probably a threat of burning gas and oil and fuels and whatever fuels were in the building,’ said Fire Battalion Chief John Kino” (Rick Daysog 2015).

5 SUMMARY AND DISCUSSION OF PA RESULTS

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

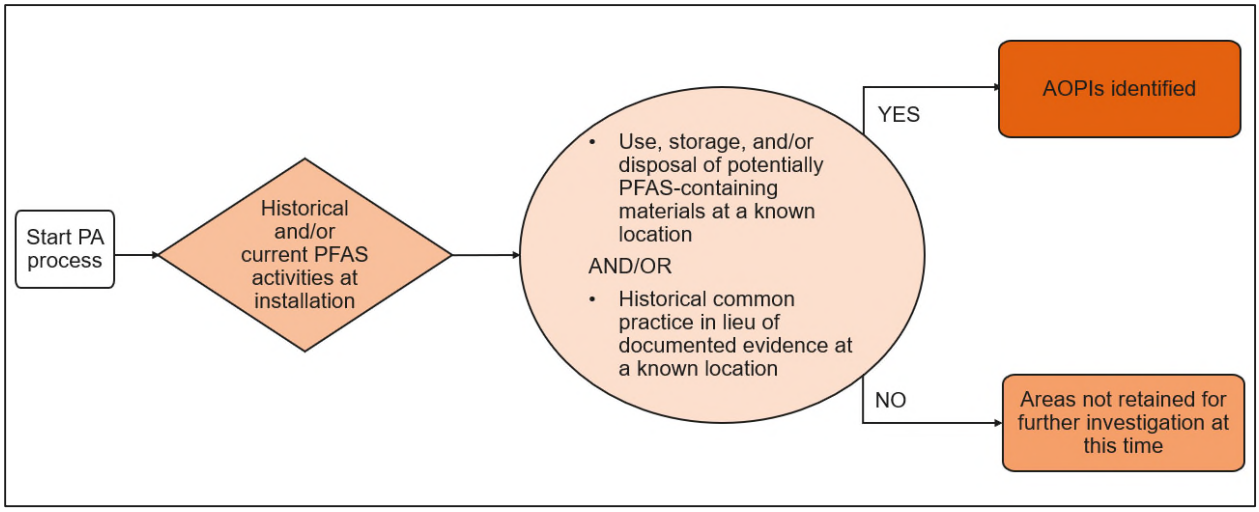

Figure 5-1: AOPI Decision Flowchart

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

Data limitations for this PA/SI at HMR 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
Former sewage treatment plant (IRP No. HMR-04; HQAES 2209A.1004)	1970 to early 1980s	The STP operated from 1970 until the early 1980s.The STP structures were removed from HMR in the early 1990s (USACE 2013). This STP was located in and encompassed approximately 0.9 acre of the northwestern portion of HMR. It consisted of a primary clarifier, an aeration tank, secondary/final clarifier, chlorinator unit, sludge holding tank, and two sludge drying beds (USACE 2013). Building 22: Fire Station #10 was constructed in 1994. Therefore, the STP did not receive wastewater from the fire station.	No confirmed receipt of PFAS-containing material
Former holding (sediment) ponds (IRP No. HMR-05; HQAES 2209A.1005)	1970 to early 1980s	Two lined holding/sediment ponds were formerly located just within the southern boundary of HMR. Each of the two ponds was approximately 9,000 square feet in size and approximately 10 feet deep. These ponds received flow from the STP during the STP's period of operation (1970 to the early 1980s). During STP decommissioning, the pond liners were removed. During removal, the liners were observed to contain holes (the number and size of these holes was not documented). The ponds were backfilled with clean soil after the lines were removed (CH2M Hill 1996). This location is currently occupied by housing.	No confirmed receipt of PFAS-containing material
Former solid waste dump site (IRP No. HMR-07; HQAES 2209A.1007)	Unknown to potentially the early 1980s	A solid waste dump site containing a waste pile was located on the south side of the Helemano Stream ravine on the northwestern boundary of HMR, north of and downgradient from the STP (CH2M Hill 1996, USAG-HI 1997). The waste pile was discovered adjacent to the inactive STP in the 1980s during activities associated with decommissioning the STP.	No specific evidence was identified confirming PFAS-containing materials were disposed here.

Area Description	Dates of Operation	Relevant Site History	Rationale
		The waste pile may have received "debris" from the STP during its operation (1970 until the early 1980s (CH2M Hill 1996). It is unknown whether this waste pile precedes the STP. Deteriorated drums were observed in the waste pile (CH2M Hill 1996).	
Buried paint lockers (Building 300) **(IRP No. HMR-08; HQAES 2209A.1008)**	Unknown	Two abandoned wall lockers containing paints and solvents were discovered partially buried on the edge of a ravine above Helemano Stream in the northern portion of HMR to the north of Building 300 (USAG-HI 1997). It is not known when these two partially buried lockers were dumped at this location or when they were discovered. However, the 1997 Installation Action Plan (USAG-HI 1997) references a 1990 U.S. Army Toxic and Hazardous Material Agency assessment, which included this location in the subsequent report). The containers of paint and solvents found in the lockers were in a deteriorated condition. However, soil samples collected at this location indicated no contamination was present when screened for volatile organic compounds and metals (USAG-HI 1997).	No specific evidence was identified confirming PFAS-containing materials were disposed here.

5.2 AOPIs

Overviews for each AOPI identified during the PA process are presented in this section. None of the AOPIs overlap with HMR IRP sites and/or Headquarters Army Environmental System sites (**Figure 5-2**). The AOPI and current site status are discussed within each AOPI subsection presented below. At the time of this PA, none of the HMR IRP sites have historically been investigated or are currently being investigated for the possible presence of PFAS.

The AOPI locations are shown on **Figure 5-2**. Figures that show the footprint of each AOPI and also show the approximate extent of AFFF use (if applicable) are presented on **Figures 5-3** through **5-5**.

5.2.1 Building 22: Fire Station #10

The Building 22: Fire Station #10 is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to storage of known PFAS containing materials at this location (**Figure 5-3**).

Building 22 was built in 1994 as a fire station. Since its construction, FFD Fire Station #10 has been active and based out of Building 22. Historically, AFFF has been stored at the station and in the trucks. FFD personnel noted that incidental spills are likely to have occurred at this fire station during filling of the fire truck tanks. Any spills would have most likely occurred within the truck bays which have drains that discharge into the storm sewer system. During the PA site visit in March 2019, five 5-gallon pails of AFFF were observed to be stored in a storage closet off of the garage bay.

The trucks are washed on the apron at the back of the building, which drains to an oil water separator and the sanitary sewer. HMR wastewater drains via sanitary sewer to the Schofield Barracks WWTP located at Wheeler Army Airfield. Truck washing overspray (i.e., a portion of truck washing wastewater) likely drains to the storm sewer system, which discharges to the retention basin (Retention Basin AOPI, see **Section 5.2.3**) in the southwest portion of the installation.

5.2.2 Car Fire

The Car Fire is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to use of known PFAS containing materials at this location (**Figure 5-4**).

Circa 2009, a car fire occurred in the roadway near Building 22: Fire Station #10. AFFF was used to extinguish the fire. Surface runoff in the street drains via grates along the edges of the street into the storm sewer system and then discharges to a retention basin (Retention Basin AOPI, see **Section 5.2.3**) in the southwest corner of the installation.

5.2.3 Retention Basin

The Retention Basin is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to disposal of known PFAS containing materials at this location (**Figure 5-5**).

The majority of stormwater runoff at HMR drains via the storm sewer system to the Retention Basin AOPI on the southwest portion of the installation. AFFF releases associated with the Car Fire AOPI and potentially associated with the Building 22: Fire Station #10 AOPI would have most likely drained to the Retention Basin AOPI.

6 SUMMARY OF SI ACTIVITIES

Based on the results of the PA at HMR, an SI for PFOS, PFOA, PFBS, PFNA, and PFHxS was conducted in accordance with CERCLA. SI sampling was completed at HMR at three of the 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 2019) and to detail the site-specific proposed scopes of work for the SI. A preliminary CSM was prepared for each of the installation's AOPIs in accordance with the USACE Engineer Manual on Conceptual Site Models, EM 200-1-12 (USACE 2012). The preliminary CSMs identified potential human receptors and chemical exposure pathways based on current and/or reasonably anticipated future land uses. The preliminary CSMs identified soil, groundwater, surface water, and sediment pathways as potentially complete which guided the SI sampling. The QAPP Addendum details the sampling design and rationale based on each AOPI's preliminary CSM. Through the collection of field data and analytical samples, the SI scope of work to collect shallow soil samples was completed in October 2022, and the supplemental SI scope of work to collect deep soil samples was completed in July 2023.

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 2019). The subsections below summarize the DQOs, sampling design and rationale, sampling activities and methods, and data analyses procedures for the SI phase at HMR. 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 evaluated shallow soil samples for PFOS, PFOA, PFBS, PFNA, and PFHxS presence or absence at each of the sampled AOPIs. Additionally, deep soil samples were collected from the Building 22: Fire Station #10 AOPI to further evaluate the potential for PFOS, PFOA, PFNA and PFHxS migration to groundwater at the installation.

6.2 Sampling Design and Rationale

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

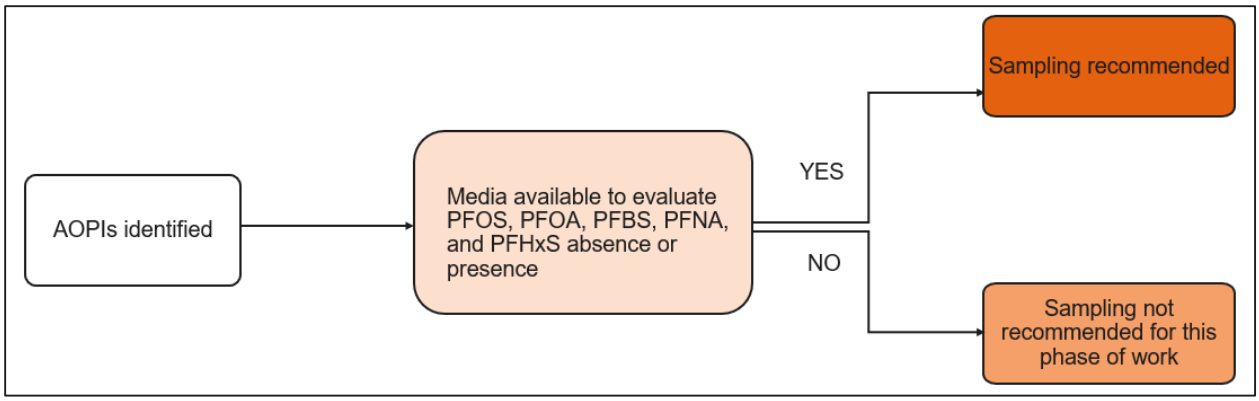

Figure 6-1: AOPI Sampling Decision Tree

The sampling design for SI sampling activities at HMR is detailed in Worksheet #17 of the QAPP Addendum (Arcadis 2022). Briefly, soil samples were collected from all three AOPIs at HMR: Building 22: Fire Station #10, Car Fire, and the Retention Basin. For each of the three AOPIs, samples were collected at locations of known or suspected use, storage, and/or disposal of PFAS-containing materials, locations of surface runoff collection, and downgradient locations if exact use, storage, or disposal locations are unknown. Sample locations were selected based on site-specific historical evidence and surface runoff / surface conditions observed in the field at each sampled AOPI. The targeted sampling areas were positioned in the center, downgradient, and/or cross-gradient of suspected PFAS (including PFOS, PFOA, PFBS, PFNA, and PFHxS) use, storage, and/or disposal areas. 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 three AOPIs to assess the presence of PFOS, PFOA, PFBS, PFNA, and PFHxS. One soil sample per AOPI was also analyzed for total organic carbon (TOC), pH, and grain size. These data are collected as they may be useful in future fate and transport studies. The targeted soil sampling areas at each AOPI are believed to have the potential for the greatest PFAS (including PFOS, PFOA, PFBS, PFNA, and PFHxS) concentrations closest to known or suspected use, storage, and/or disposal of PFAS-containing materials.

The soil sample locations at the Building 22: Fire Station #10 were selected to capture any overspray or inadvertent spills of AFFF on either side of the station's rear apron. Fire trucks are washed on the rear apron, and liquids on the apron itself drain to an oil water separator that is plumbed to the sanitary sewer system (HMR's sanitary sewer system is connected to the WWTP at Wheeler Army Airfield)[6]. Any liquids on the front station apron flow into the street and then the stormwater sewer system.

The soil sample locations at the Car Fire AOPI were selected to capture any potential AFFF overspray to the grass during the fire response. No soil samples were planned from beneath the street because runoff in the street drains to the stormwater sewer via sewer grates along the curbs. One soil sample was planned to be collected from 4 to 6 feet bgs due to that being the depth at which leakage would be likely to occur from the storm drain collection basin.

[6] Wheeler Army Airfield was assessed under a separate site-specific USAEC PFAS PA/SI.

There are no permanent surface water bodies present at HMR. Although there is the potential for complete exposure pathways for surface water and sediment in the form of intermittent stormwater within the Retention Basin AOPI, this basin is presumably dry except during and immediately following rain events (Arcadis 2022). Therefore, due to the inconsistent presence of stormwater in the basin, no stormwater (i.e., surface water) or sediment samples were planned for the Retention Basin AOPI. Instead, soil samples were collected from within the basin at locations downslope from the stormwater sewer outfalls/discharge points for those lines of the stormwater sewer system most likely to drain stormwater from the Building 22: Fire Station #10 and Car Fire AOPIs.

Given the significant depth to groundwater in the area (groundwater is estimated to be approximately 800 feet bgs), and the fact that no drinking water wells are located on the installation due to the availability of other military sources nearby, groundwater sampling was not included within the scope of the initial SI. However, supplemental deep soil sampling was conducted at the two locations with highest concentrations of PFOS, PFOA, PFBS, PFNA and/or PFHxS detections from the initial SI at the installation (Sample locations FS-2 and FS-3 at the Building 22: Fire Station #10 AOPI). The deeper soil sampling plan was designed to further evaluate the potential migration to groundwater and CSM exposure pathway.

6.3 Sampling Methods and Procedures

Environmental data were collected and analyzed in accordance with the PQAPP (Arcadis 2019), the SOPs and TGIs included as Appendix A to the PQAPP, the QA/QC requirements identified in Worksheet #20 of the PQAPP, the approved scope and sampling methods outlined in the site-specific QAPP Addendum (Arcadis 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 2019) 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, sample collection logs, tailgate health and safety forms, and utility and structures 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 shallow soil samples were collected from 0 to 2 feet bgs using a 3.25 inch diameter nickel plated alloy steel hand auger. Most of the samples were homogenized over the entirety of the top 2-feet interval. However, in one instance at the Building 22: Fire Station #10 AOPI, a sample was collected from a shallower soil interval (0 to 1.5 feet bgs) due to encountering refusal or difficult auger conditions. One soil sample was collected from 2 to 4 feet bgs due to that being the depth at which leakage would be

likely to occur from storm drain collection basin (Car Fire AOPI). Soil collected with the hand auger 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.

Composite deep soil samples were collected at roughly 5-foot intervals from 5 to 30 feet bgs using direct push technology in accordance with the TGI for PFAS-Specific Drilling and Monitoring Well Installation (Arcadis 2022, Attachment #4). Six deep soil samples were collected from the FS-2 soil sample location, and an additional six deep soil samples were collected from the FS-3 soil sample location. Utility clearance was conducted and due to subsurface anomalies observed at both sample locations, the borehole at FS-2 was hand augered to 3 feet bgs and the borehole at FS-3 was hand augered to 4 feet bgs. Soil collected with the hand auger 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. To collect the deeper soil samples, after each drilling run the driller extracted and cut open the soil core liners, exposing the soil for characterization. The soil from each sampling depth interval was then transferred into 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.

During both shallow and deep soil sample collection procedures, a new pair of nitrile gloves and sleeves made of un-coated flash spun high density polyethylene fibers were worn to collect each soil sample to prevent PFAS cross-contamination. Additionally, 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.

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

6.3.2 Quality Assurance/Quality Control

Worksheets #20 of the PQAPP and QAPP Addendum provide QA/QC requirements for field duplicates, matrix spike/matrix spike duplicates, equipment blanks (EBs), source blanks for water used in the initial decontamination step, 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 are a hand auger and stainless-steel bowl. A source blank was collected from deionized water used during decontamination of the 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 HMR SI work.

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

- FCR-HMR-01: One of the three soil samples (HMR-CF-2-SO-102522) at the Car Fire AOPI was planned to be collected at an interval of 4 to 6 feet bgs. However, a utility was present at 3 to 4 feet bgs in the vicinity of this sampling. Therefore, the boring was terminated at 4 feet bgs and the soil sample was collected at an interval of 2 to 4 feet bgs.

6.3.4 Decontamination

Non-dedicated reusable sampling equipment (i.e., stainless-steel bowl, hand auger, and drilling shoe) that came into direct contact with sampling media was decontaminated before first use, between sampling locations/intervals, and before demobilization in accordance with P–09, TGI - Groundwater and Soil Sampling Equipment Decontamination (Arcadis 2019, Appendix A).

6.3.5 Investigation-Derived Waste

Investigation-derived waste (IDW), including soil cuttings and decontamination fluids, were disposed on the ground at the point of collection in accordance with the PQAPP (e.g., soil cuttings were returned to the boring, purge water was disposed of on the ground immediately downgradient of the well, and decontamination water was discharged to the ground at the point of sample collection). 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 and Pace Analytical, ELAP-accredited laboratories 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 2019). Eighteen PFAS-related compounds, including PFOS, PFOA, PFBS, PFNA, and PFHxS, were analyzed for in soil samples using an analytical method that is ELAP-accredited and compliant with QSM 5.3 (DoD and Department of Energy 2019), Table B15. Additionally, the following general chemistry and physical characteristic analyses were completed for select soil samples in accordance with Worksheet #18 of the QAPP Addendum (Arcadis 2022) by the analytical method noted:

- TOC by Solid Waste Test Method 846 9060A
- Grain size analysis by American Society for Testing and Materials D422-63
- pH by Solid Waste Test Method 846 9045D.

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

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

6.4.2 Data Validation

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

6.4.3 Data Usability Assessment and Summary

A data usability assessment was completed for all analytical data associated with SI sampling at HMR. 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 HMR during the SI were found to be acceptable and usable for this SI evaluation with the qualifications documented in the DUSR and its associated data validation reports (**Appendix M**), and as indicated in the full analytical tables (**Appendix N**) provided for the SI results. These data are of sufficient quality to meet the objectives and

requirements of the PQAPP (Arcadis 2019) and HMR QAPP Addendum (Arcadis 2022). Data qualifiers applied to laboratory analytical results for samples collected during the SI at HMR 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 6-1**.

Table 6-1 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 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. Soil samples collected from greater than 2 feet but less than 15 feet bgs will be compared to the industrial/commercial risk screening levels only, and soil samples collected from greater than 15 feet bgs will not be compared to either risk screening level.
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 HMR 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. Therefore, there are no HFPO-DA SI analytical results to screen against the 2022 OSD risk screening levels.
mg/kg = milligram per kilogram
ng/L = nanograms per liter
ppm = parts per million
ppt = parts per trillion

While the current and most likely future land uses of the AOPIs at HMR are residential, both residential and industrial/commercial soil risk screening levels for PFOS, PFOA, PFBS, PFNA, and PFHxS will be used to evaluate detected soil concentrations. The data from the SI sampling event are compared to the OSD risk screening levels in **Section 7**. If concentrations of PFOS, PFOA, 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 HMR (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.

Table 7-1 provides a summary of the soil analytical results for PFOS, PFOA, PFBS, PFNA, and PFHxS. **Table 7-2** lists the 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. **Figures 7-1** through **7-3** show the PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results in soil 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 data collected during the SI are reported in mg/kg, or parts per million. Soil descriptions are provided on the field forms in **Appendix J**. The results of the SI are grouped by AOPI.

Table 7-2 AOPIs and OSD Risk Screening Level Exceedances

AOPI Name	OSD Exceedances (Yes/No)
Building 22: Fire Station #10	No
Car Fire	No
Retention Basin	No

7.1 Building 22: Fire Station #10

The subsection below summarizes the soil PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with the Building 22: Fire Station #10 AOPI. The sampling locations and analytical results are presented on **Figure 7-1**. The soil analytical results are presented in **Table 7-1**.

7.1.1 Shallow Soil

Three soil samples were collected via hand auger. Two soil samples (HMR-FS-1-SO-102622 and HMR-FS-2-SO-102622) were collected from native soil at an interval of 0 to 2 feet bgs and one soil sample (HMR-FS-3-SO-102622) was collected at an interval of 0 to 1.5 feet bgs. Analytical results are as follows (duplicate results are shown in brackets):

- PFOS was detected in all three samples at concentrations ranging from 0.0011 mg/kg (HMR-FS-1-SO-102622) to 0.0063 mg/kg (HMR-FS-2-SO-102622). 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 all three samples at concentrations ranging from 0.00041 mg/kg (HMR-FS-1-SO-102622) to 0.0063 mg/kg (HMR-FS-2-SO-102622). 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 the three 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 all three samples at concentrations ranging from of 0.00033 mg/kg (HMR-FS-1-SO-102622) to 0.0088 mg/kg (HMR-FS-3-SO-102622). 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).
- PFHxS was detected in all three samples at concentrations ranging from of 0.000065 J (the analyte was positively identified; however, the associated numerical value is an estimated concentration only) mg/kg (HMR-FS-3-SO-102622) to 0.00018 mg/kg (HMR-FS-2-SO-102622). 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).

7.1.2 Deep Soil

A total of twelve deep soil samples were collected from boreholes drilled to 30 feet bgs using direct push technology. Six soil samples were collected from the FS-2 location and six soil samples were collected from the FS-3 location at roughly 5-foot intervals to further evaluate the potential migration to groundwater. As noted in **Section 6.5**, soil samples collected from greater than 2 feet but less than 15 feet bgs were only compared to the industrial/commercial risk screening levels, and soil samples collected from greater than 15 feet bgs were not compared to risk screening levels. PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected above the applicable OSD risk screening levels in any of the deep soil samples collected. Furthermore, the concentrations observed at the 30 ft intervals were lower than the concentrations observed at the surface. Therefore, the potential for PFAS migration to groundwater at HMR is low.

- PFOS concentrations were detected in 11 of 12 deep soil samples at FS-2 and FS-3 ranging from 0.000399 J mg/kg (HMR-FS-2-SO-15.0-07192023) to 0.0291 J [0.0152 J] mg/kg (HMR-FS-3-SO-6.0-07192023). PFOS was not detected at the 30 feet bgs interval at FS-2 (HMR-FS-2-SO-30.0-07192023). The detected concentrations do not exceed the OSD industrial/commercial risk screening level (0.16 mg/kg).
- PFOA concentrations were detected in the 5 feet and 30 feet interval soil samples at FS-2 and from all six deep soil samples at FS-3 ranging from 0.000427 J mg/kg (HMR-FS-2-SO-30-07192023) to 0.00257 [0.00138] mg/kg (HMR-FS-3-SO-6-07192023). The detected concentrations do not exceed the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFBS was not detected in any of the 12 deep soil samples at FS-2 and FS-3. Therefore, there were no exceedances of the OSD industrial/commercial risk screening level (25 mg/kg).

- PFNA concentrations were detected in all of the 12 deep soil samples at FS-2 and FS-3 ranging from 0.000158 J mg/kg (HMR-FS-2-SO-10-07192023) to 0.00852 J [0.00376 J] mg/kg (HMR-FS-3-SO-6-07192023).
- PFHxS was detected at a concentration of 0.000229 J mg/kg in soil sample HMR-FS-2-SO-5-07192023 and 0.000140 J [0.00226 U] mg/kg in sample HMR-FS-3-SO-6-07192023. The detected concentrations do not exceed the OSD industrial/commercial risk screening level (1.6 mg/kg).

7.2 Car Fire

The subsection below summarizes the soil PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with the Car Fire AOPI. The sampling locations and analytical results are presented on **Figure 7-2**. The soil analytical results are presented in **Table 7-1**.

7.2.1 Soil

Three soil samples were collected via hand auger. Two soil samples (HMR-CF-1-SO-102522 and HMR-CF-3-SO-102522) were collected from native soil at an interval of 0 to 2 feet bgs and one soil sample (HMR-CF-2-SO-102522) was collected at an interval of 2 to 4 feet bgs.

- PFOS was detected in all three samples at concentrations ranging from 0.00015 J+ (the result is an estimated quantity; the result may be biased high) mg/kg (HMR-CF-3-SO-102522) to 0.00034 J+ mg/kg (HMR-CF-1-SO-102522). 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 all three samples at concentrations ranging from of 0.000066 J mg/kg (HMR-CF-3-SO-102522) to 0.00056 J+ mg/kg (HMR-CF-1-SO-102522). 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 the three 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 all three samples at concentrations ranging from of 0.000039 J+ mg/kg to 0.00053 J+ mg/kg (HMR-CF-1-SO-102522). 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).
- PFHxS was detected in one of the three samples at a concentration of 0.00011 J mg/kg (HMR-CF-1-SO-102522). The detected concentration does 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 Retention Basin

The subsection below summarizes the soil PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with the Retention Basin AOPI. The sampling locations and analytical results are presented on **Figure 7-3**. The soil analytical results are presented in **Table 7-1**.

7.3.1 Soil

Three soil samples (HMR-RB-1-SO-102422, HMR-RB-2-SO-102422, and HMR-RB-3-SO-102422) and one duplicate sample (HMR-FD-1-SO-102522 / HMR-RB-3-SO-102522) were collected via hand auger from native soil at an interval of 0 to 2 feet bgs.

- PFOS was detected in all three samples and the duplicate sample at concentrations ranging from 0.00032 J+ mg/kg (HMR-RB-2-SO-102522) to 0.00089 J mg/kg (HMR-RB-1-SO-102522). 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 two of the three samples and the duplicate sample at concentrations ranging from of 0.00019 J mg/kg (HMR-FD-1-SO-102522 / HMR-RB-3-SO-102522) to 0.0005 mg/kg (HMR-RB-1-SO-102422). 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 detected in one of the three samples (and the associated duplicate sample) at a maximum concentration of 0.00018 J mg/kg (HMR-RB-3-SO-102522). The detected concentrations do not exceed 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 all three samples and the duplicate sample at concentrations ranging from 0.000091 J mg/kg (HMR-RB-3-SO-102522) to 0.00065 mg/kg (HMR-RB-1-SO-102522). 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).
- PFHxS was not detected in the three samples or the duplicate 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).

7.4 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 12,400 mg/kg (Building 22: Fire Station #10 AOPI) to 97,000 J- (the result is an estimated quantity; the result may be biased low) mg/kg (Retention Basin AOPI). The TOC concentrations at two of the three AOPIs at HMR are within range of what is typically observed in topsoil (5,000 to 30,000 mg/kg). The TOC in the soil at the Retention Basin AOPI (97,000 mg/kg) is indicative of soil with a high level of organic material. This is to be expected as the Retention Basin AOPI receives discharge from the installation's stormwater sewer system.

The combined percentage of fines (i.e., silt and clay) in soils at HMR ranged from 37.3% (Retention Basin AOPI) to 84.7% (Car Fire AOPI) with an average of 62.0%. 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 ranged from 19.5% to 31.2% with an average of 28.2%, which is typical for clay (0 to 20%). The pH of the soil was slightly acidic (4 to 6 standard units) to almost neutral (approximately 7 standard units).

Based on these geochemical and physical soil characteristics (i.e., high percentage of fines and higher TOC) observed underlying the installation during the SI, PFAS constituents are expected to be relatively less mobile at HMR than in soils with lower percentages of fines and TOC.

7.5 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**.

7.6 Conceptual Site Models

The preliminary CSMs presented in the QAPP Addendum (Arcadis 2022) were re-evaluated and updated based on the SI sampling results. The CSMs presented on **Figures 7-4** and **7-5** and in this section therefore represent the current understanding of the potential for human exposure.

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 and groundwater, and may include surface water and sediment. Release and transport mechanisms include dissolution/desorption from soil to groundwater, transport via sediment carried in and dissolution to stormwater and surface water, discharge/recharge between groundwater and surface water, and adsorption/desorption between surface water and sediment. Generic categories of potential human receptors and their associated exposure scenarios that are typically evaluated in a CERCLA human health risk assessment were considered and include on-installation site workers (e.g., industrial/commercial workers, utility workers, or future construction workers who could be exposed to chemicals in soil at an AOPI or to chemicals in tap water in an industrial/commercial building), on-installation residents (e.g., adults and children who could be exposed to chemicals in tap water in a residence), and on-installation recreational users (e.g., hikers or hunters who could be exposed to chemicals in waterways at an installation). Off-installation receptor types could include drinking water receptors (i.e., commercial/industrial workers or residents) and recreational users.

Human exposure pathways are shown as “complete”, “potentially complete”, or “incomplete” on the CSM figures. A complete exposure pathway consists of a constituent source and release mechanism, a

transport or retention medium, an exposure point where human contact with the contaminated medium could occur, and an exposure route at the exposure point. If any of these elements 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 and were combined where source media, potential migration pathways and exposure media, and human exposure pathway determinations are congruent. For the Building 22: Fire Station #10 and Car Fire AOPIs, the CSM is the same and, thus, shown on the same figure (**Figure 7-4**). The CSM for the remaining AOPI, the Retention Basin, is shown on **Figure 7-5.** The following exposure pathway determinations apply to **Figures 7-4** and **7-5**:

- Although there are no surface water bodies on HMR, stormwater runoff from the Building 22: Fire Station #10 and Car Fire AOPIs drains via the storm sewer system to the Retention Basin AOPI on the southwest corner of the installation; therefore, the Retention Basin is a potential point of exposure associated with all three AOPIs. PFOS, PFOA, PFBS, and PFNA were detected in sediment/soil samples from the Retention Basin, and site workers (i.e., installation personnel) could contact constituents in the Retention Basin sediment/soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the Retention Basin sediment/soil exposure pathway for on-installation site workers is complete.
- Site workers (i.e., installation personnel) could also contact constituents in stormwater (due to rain events) in the Retention Basin, including stormwater runoff that drains to the basin from the Building 22: Fire Station #10 and Car Fire AOPIs. Therefore, the intermittent stormwater exposure pathway (via incidental ingestion and dermal contact) for on-installation site workers at the Retention Basin is considered to be potentially complete.
- The Retention Basin AOPI is not likely to be regularly accessed by on-installation residents or recreational users; therefore, the intermittent stormwater and sediment/soil exposure pathways at the Retention Basin for those receptors are incomplete. Additionally, given that stormwater infiltrates and evaporates in the Retention Basin (i.e., does not enter off-installation surface water bodies), stormwater and sediment/soil exposure pathways for off-installation receptors are also considered to be incomplete.
- Groundwater at HMR is not used as potable water for the installation; instead, drinking water is supplied to HMR by off-site Army and U.S. Navy water wells. Given the significant depth-to-groundwater in the area (i.e., groundwater is estimated to be approximately 800 feet bgs) and the availability of other drinking water sources, groundwater at HMR will not likely be used as a drinking water source in the future. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are incomplete. In addition, recreational users are not likely to contact groundwater during outdoor recreational activities; therefore, the groundwater exposure pathway for on-installation recreational users is incomplete.
- Given the significant depth-to-groundwater in the area, it is unlikely that constituents in sediment or soil would migrate to groundwater. However, in the absence of land use controls preventing potable

use of off-post groundwater, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is considered to be potentially complete.

Figure 7-4 shows the CSM for AOPIs Building 22: Fire Station #10 and Car Fire. AFFF was likely released to soil and/or paved surfaces at the Building 22: Fire Station #10 AOPI from AFFF storage containers and during truck maintenance activities. AFFF was released to soil and/or paved surfaces at the Car Fire AOPI during an emergency response effort. The following additional exposure pathway descriptions apply for **Figure 7-4**:

- PFOS, PFOA, PFHxS, and PFNA were detected in soil samples from the Building 22: Fire Station #10 and Car Fire AOPIs, and site workers (i.e., installation personnel) could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the soil exposure pathway for on-installation site workers is complete.
- The AOPIs are not likely regularly accessed by on-installation residents or recreational users, or by off-installation receptors. Therefore, the soil exposure pathways for these receptors are incomplete.

Following the SI sampling, all three 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 7-2**).

8 CONCLUSIONS AND RECOMMENDATIONS

The PFAS PA/SI included two distinct efforts. The PA identified AOPIs at HMR 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.

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 HMR. Following the evaluation, three AOPIs were identified.

As discussed in **Section 2.10**, groundwater beneath the installation is not used for drinking water. HMR's drinking water is provided by the U.S. Army (Schofield Barracks production wells and drinking water treatment plant) and the U.S. Navy (wells not located on HMR). Previous PFAS analyses of Schofield Barracks drinking water have not detected concentrations of any of the PFAS analyzed. Any PFAS analytical data collected from the U.S. Navy's drinking water supply wells or finished drinking water supplied to HMR were not available or provided to Arcadis at the time of this PA.

All AOPIs were sampled during the SI at HMR to identify presence or absence of 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. Based on the CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at HMR 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. Therefore, there are no HFPO-DA SI analytical results to screen against the 2022 OSD risk screening levels. The SI scope of work was completed in accordance with the Final PQAPP (Arcadis 2019) and the HMR QAPP Addendum (Arcadis 2022).

All three AOPIs had detections of PFOS, PFOA, PFBS, PFNA, and PFHxS in soil. The maximum detected concentrations of PFOS (0.0291 J mg/kg), PFOA (0.0036 mg/kg), PFNA (0.0088 mg/kg), and PFHxS (0.000229 J mg/kg) were from soil samples collected at the Building 22: Fire Station #10 AOPI. The maximum detected concentration of PFBS (0.00018 J mg/kg) was from a soil sample collected at the Retention Basin AOPI. None of the detected concentrations exceeded the applicable OSD risk screening levels for soil.

Following the SI sampling, all three AOPIs with confirmed PFOS, PFOA, PFBS, PFNA, and/or PFHxS presence were considered to have complete or potentially complete exposure pathways. The soil exposure pathways for on-installation site workers are complete at the Building 22: Fire Station #10 and Car Fire AOPIs where PFOS, PFOA, PFHxS, and PFNA were detected in soil. The Retention Basin AOPI is associated with the other two AOPIs, and PFOS, PFOA, PFBS, and PFNA were detected in sediment/soil samples from the Retention Basin AOPI. Therefore, the sediment/soil exposure pathway is

complete, and the intermittent stormwater exposure pathway is potentially complete for on-installation site workers at the Retention Basin AOPI. Although it is unlikely that constituents in sediment or soil could migrate to groundwater (estimated to be at approximately 800 feet bgs), due to a lack of land-use controls off-installation and downgradient of HMR, the groundwater exposure pathways for off-installation drinking water receptors are potentially complete for all three AOPIs.

Although the CSMs indicate complete or potentially complete exposure pathways may exist, the recommendation for future study in a remedial investigation or no action at this time is based on the comparison of the SI analytical results for PFOS, PFOA, PFBS, PFNA, and PFHxS to the OSD risk screening levels (**Table 6-1**). **Table 8-1** below summarizes the AOPIs identified at HMR, PFOS, PFOA, PFBS, PFNA, and PFHxS sampling and recommendations for each AOPI.

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

AOPI Name	PFOS, PFOA, PFBS, PFNA, and/or PFHxS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	GW[1]	SO	
Building 22: Fire Station #10	NS	No	No action at this time[1]
Car Fire	NS	No	No action at this time[1]
Retention Basin	NS	No	No action at this time[1]

Notes:
1 = Although representative groundwater samples were not collected at the AOPIs, twelve deep soil samples were collected from 5 to 30 feet below ground surface from two sample locations (six samples per location) at the Building 22: Fire Station #10 AOPI where surface soil concentrations were the highest to further evaluate the migration to groundwater potential at the installation. PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected above the applicable OSD risk screening levels in any of the soil samples collected, and the concentrations observed at the 30 ft intervals were lower than the concentrations observed at the surface. Therefore, the potential for PFAS migration to groundwater at the installation is low and consequently no further action at this time is recommended at HMR.
GW – groundwater
NS – not sampled
SO – soil

Data collected during the PA (**Sections 3** through **5**) and SI (**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 HMR are discussed below.

It is the understanding of the Army PA team that FFD personnel are generally stationed at a FFD fire station for approximately 2 years before rotating to another fire station. The HMR fire station (Building 22: Fire Station #10 AOPI) was built in 1994. The PA site visit team was able to interview a FFD lieutenant currently stationed at Fire Station #10 (stationed at HMR for approximately 1.3 years by the time of the PA site visit) as well as one other FFD fire fighter who had previously been stationed at Fire Station #10.

There is the potential for other historical fire responses with AFFF on HMR about which interviewees were unaware.

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

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

The 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.

Finally, the available PFOS, PFOA, PFBS, PFNA, and PFHxS analytical data are limited to soil samples collected from areas outside of and adjacent to the known or suspected AFFF use areas (e.g., likely AFFF overspray location) or from secondary source discharge (i.e., disposal) points in the Retention Basin AOPI. Soil beneath the rear apron of the Building 22: Fire Station #10 AOPI or the road at the Car Fire AOPI were not sampled on the assumption that runoff on these paved surfaces would enter the stormwater sewage system and discharge at the Retention Basin AOPI or, at the fire station rear apron, flow to the oil-water separator and then the Schofield Barracks WWTP located at Wheeler Army Airfield. Material in the fire station's oil-water separator was not sampled during the SI. The maintenance schedule for the oil-water separator was not shared with Arcadis. Groundwater was not sampled during the SI; however, groundwater beneath HMR is anticipated to be located at a depth of approximately 800 feet bgs and is not used for drinking water on HMR. Available data, including for PFOS, PFOA, PFBS, PFNA, and PFHxS which were analyzed per the selected analytical method, are listed in **Appendix N**. HFPO-DA was not in the suite of PFAS compounds analyzed during the SI at HMR 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.

Results from this PA/SI indicate no further investigation at HMR is warranted at this time in accordance with the guidance provided by the OSD.

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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
FCR	Field Change Report
FFD	Federal Fire Department
GW	groundwater
HFPO-DA	hexafluoropropylene oxide dimer acid
HMR	Helemano Military Reservation
IDW	investigation-derived waste
IMCOM	Installation Management Command
installation	United States Army or Reserve installation
IRP	Installation Restoration Program
LOD	limit of detection
LOQ	limit of quantitation
mg/kg	milligrams per kilogram (parts per million)
NAVFAC	Naval Facilities Engineering Command
ng/L	nanograms per liter (parts per trillion)
No.	number
NS	not sampled
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
SI	site inspection
SO	soil
SOP	standard operating procedure
SSHP	Site Safety and Health Plan
STP	sewage treatment plant
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
WWTP	wastewater treatment plant

TABLES

Table 7-1 PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results - Soil
USAEC PFAS Preliminary Assessment/Site Inspection
Helemano 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
HMR-CF-1-SO	HMR-CF-1-SO-102522	10/25/2022	N	**0.00034**	J+	**0.00056**	J+	0.00026	U	**0.00053**	J+	**0.00011**	J
HMR-CF-2-SO	HMR-CF-2-SO-102522	10/25/2022	N	**0.00016**	J+	**0.000081**	J+	0.00025	UJ	**0.00005**	J+	0.00025	UJ
HMR-CF-3-SO	HMR-CF-3-SO-102522	10/25/2022	N	**0.00015**	J+	**0.000066**	J	0.00024	U	**0.000039**	J+	0.00024	U
HMR-FS-1-SO	HMR-FS-1-SO-102622	10/26/2022	N	**0.0011**		**0.00041**		0.00024	U	**0.00033**		**0.000086**	J
HMR-FS-2-SO	HMR-FS-2-SO-102622	10/26/2022	N	**0.0063**		**0.00068**		0.00028	U	**0.00097**		**0.00018**	J
	HMR-FS-2-SO-5.0-07192023	07/19/2023	N	**0.00541**		**0.000793**	J	0.00134	U	**0.00105**	J	**0.000229**	J
	HMR-FS-2-SO-10.0-07192023	07/19/2023	N	**0.000432**	J	0.00134	U	0.00134	U	**0.000158**	J	0.00134	U
	HMR-FS-2-SO-15.0-07192023	07/19/2023	N	**0.000399**	J	0.00128	U	0.00128	U	**0.000173**	J	0.00128	U
	HMR-FS-2-SO-20.0-07192023	07/19/2023	N	**0.00058**	J	0.00131	U	0.00131	U	**0.000214**	J	0.00131	U
	HMR-FS-2-SO-25.0-07192023	07/19/2023	N	**0.000834**	J	0.00129	U	0.00129	U	**0.000215**	J	0.00129	U
	HMR-FS-2-SO-30.0-07192023	07/19/2023	N	**0.00284**		**0.000427**	J	0.00144	U	**0.00046**	J	0.00144	U
HMR-FS-3-SO	HMR-FS-3-SO-102622	10/26/2022	N	**0.0051**		**0.0036**		0.00025	U	**0.0088**		**0.000065**	J
	HMR-FS-3-SO-6.0-07192023	07/19/2023	N	**0.0291**	J	**0.00257**		0.00127	U	**0.00852**	J	**0.00014**	J
	HMR-FD-1-SO-07192023 / HMR-FS-3-SO-6.0-07192023	07/19/2023	FD	**0.0152**	J	**0.00138**		0.00126	U	**0.00376**	J	0.00126	U
	HMR-FS-3-SO-10.0-07192023	07/19/2023	N	**0.00312**		**0.000815**	J	0.00137	U	**0.0017**		0.00137	U
	HMR-FS-3-SO-15.0-07192023	07/19/2023	N	**0.00163**		**0.000594**	J	0.00134	U	**0.000896**	J	0.00134	U
	HMR-FS-3-SO-20.0-07192023	07/19/2023	N	**0.00153**		**0.00064**	J	0.00131	U	**0.000703**	J	0.00131	U
	HMR-FS-3-SO-25.0-07192023	07/19/2023	N	**0.00132**	J	**0.000767**	J	0.00138	U	**0.000403**	J	0.00138	U
	HMR-FS-3-SO-30.0-07192023	07/19/2023	N	**0.0033**		**0.000646**	J	0.00136	U	**0.00064**	J	0.00136	U
HMR-RB-1-SO	HMR-RB-1-SO-102422	10/24/2022	N	**0.00089**	J	**0.0005**		0.00025	U	**0.00065**		0.00025	U
HMR-RB-2-SO	HMR-RB-2-SO-102522	10/25/2022	N	**0.00032**	J+	0.00042	UJ	0.00028	U	**0.000056**	J	0.00028	U
HMR-RB-3-SO	HMR-RB-3-SO-102522	10/25/2022	N	**0.00084**		**0.00021**	J	**0.00018**	J	**0.000091**	J	0.00028	U
	HMR-FD-1-SO-102522 / HMR-RB-3-SO-102522	10/25/2022	FD	**0.00075**		**0.00019**	J	**0.00017**	J	**0.000074**	J	0.00027	U

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

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection
2. Data are compared to the 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). Soil data were screened against both the Residential Scenario and Industrial/Commercial Scenario risk screening levels (if collected from less than 2 feet bgs), regardless of the current and projected land use of the area of potential interest. Soil samples collected from greater than 2 feet but less than 15 feet bgs were compared to the industrial/commercial risk screening levels only, and soil samples collected from greater than 15 feet bgs were not be compared to either risk screening level.

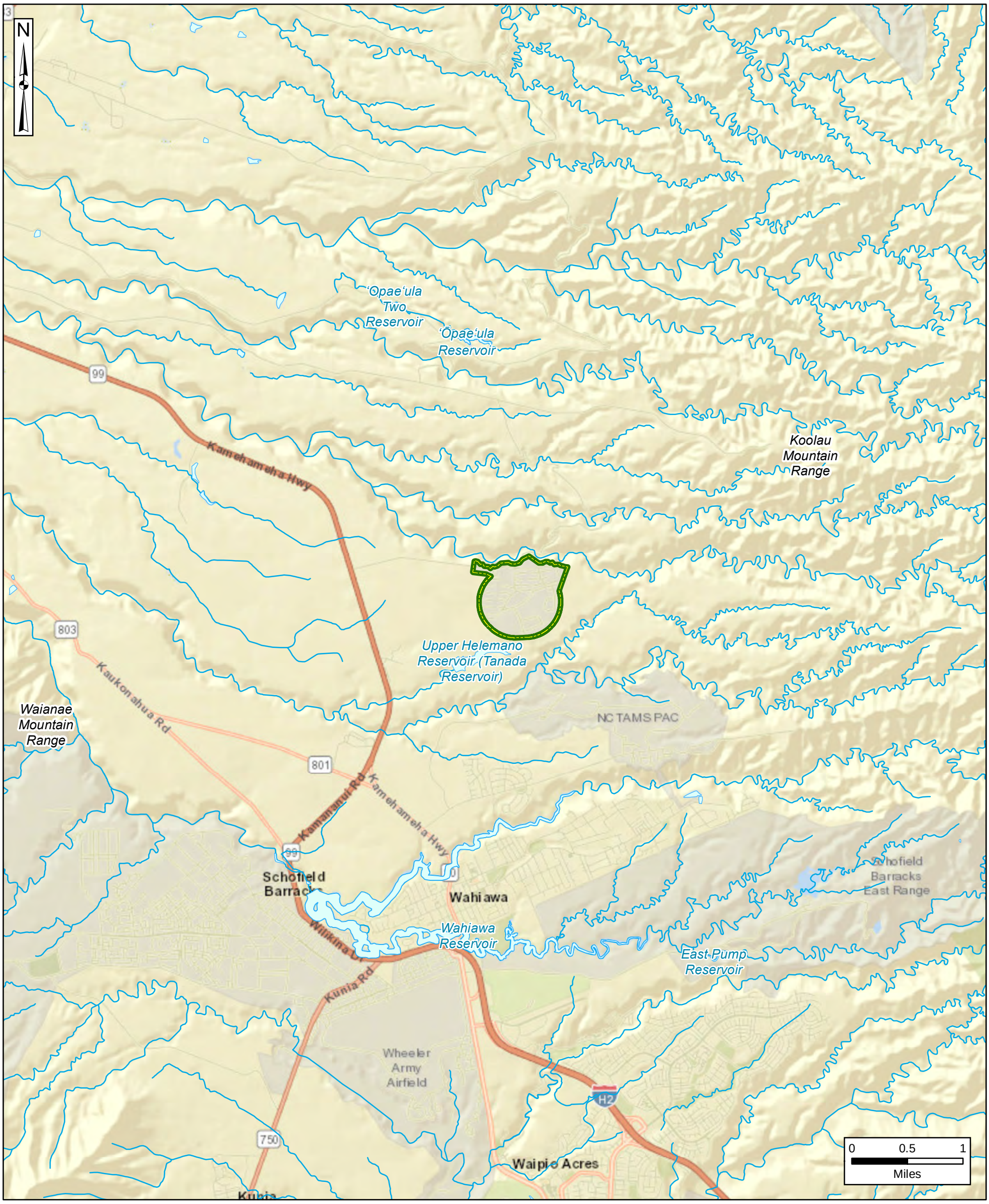
Acronyms/Abbreviations:
AOPI = area of potential interest
FD = field duplicate sample
ID = identification
mg/kg = milligrams per kilogram (parts per million)
N = primary sample
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFOA = perfluorooctanoic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

Qualifier
J = The analyte was positively identified; however the associated numerical value is an estimated concentration only.
J+ = The result is an estimated quantity; the result may be biased high.
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 LOQ is approximate and may be inaccurate or imprecise.

FIGURES

USAEC PFAS Preliminary Assessment / Site Inspection
Helemano Military Reservation, Hawaii

Figure 2-1
Site Location



Installation Boundary

Stream (Perennial)

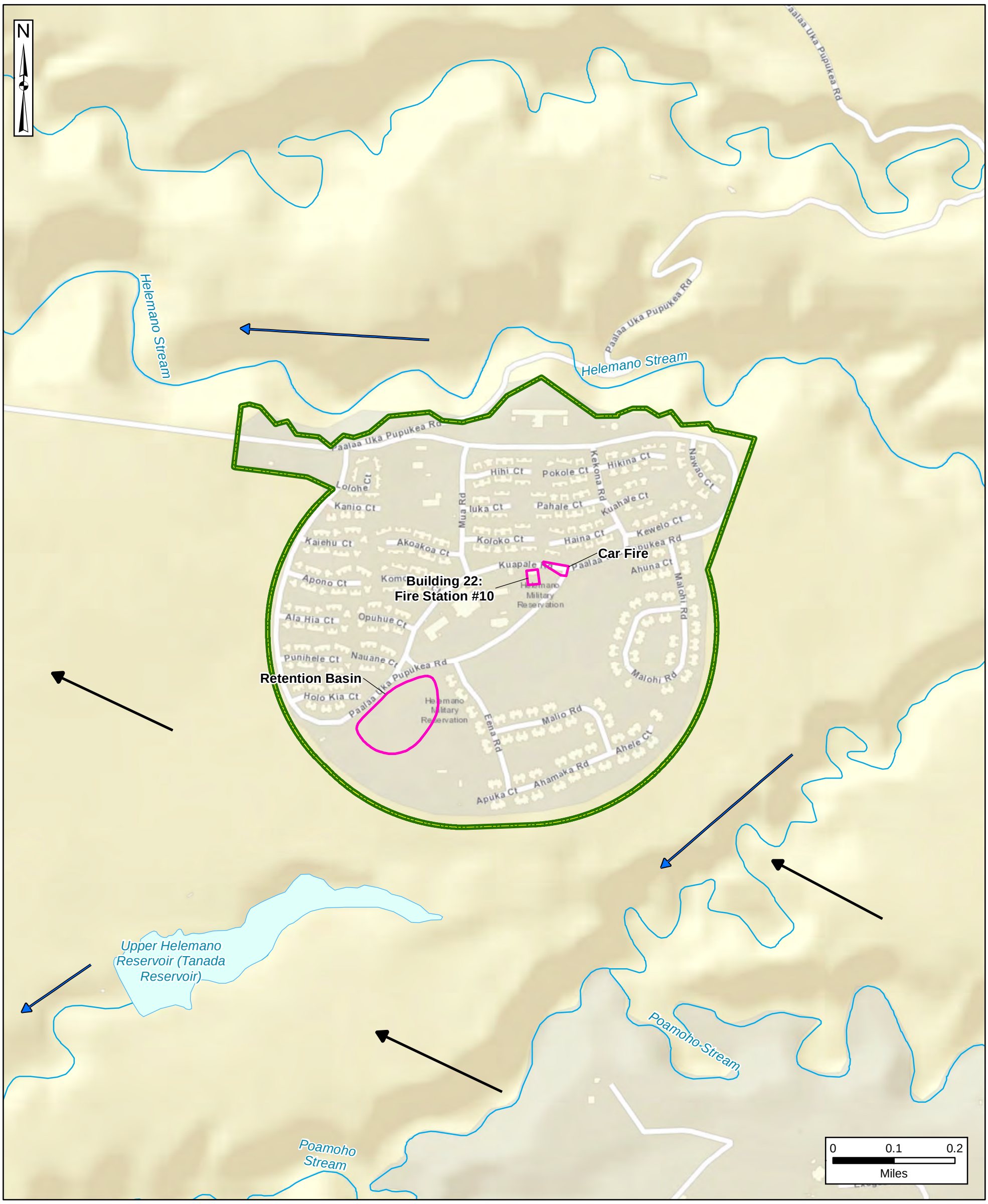
Water Body

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
Helemano Military Reservation, Hawaii

Figure 2-2
Site Layout



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

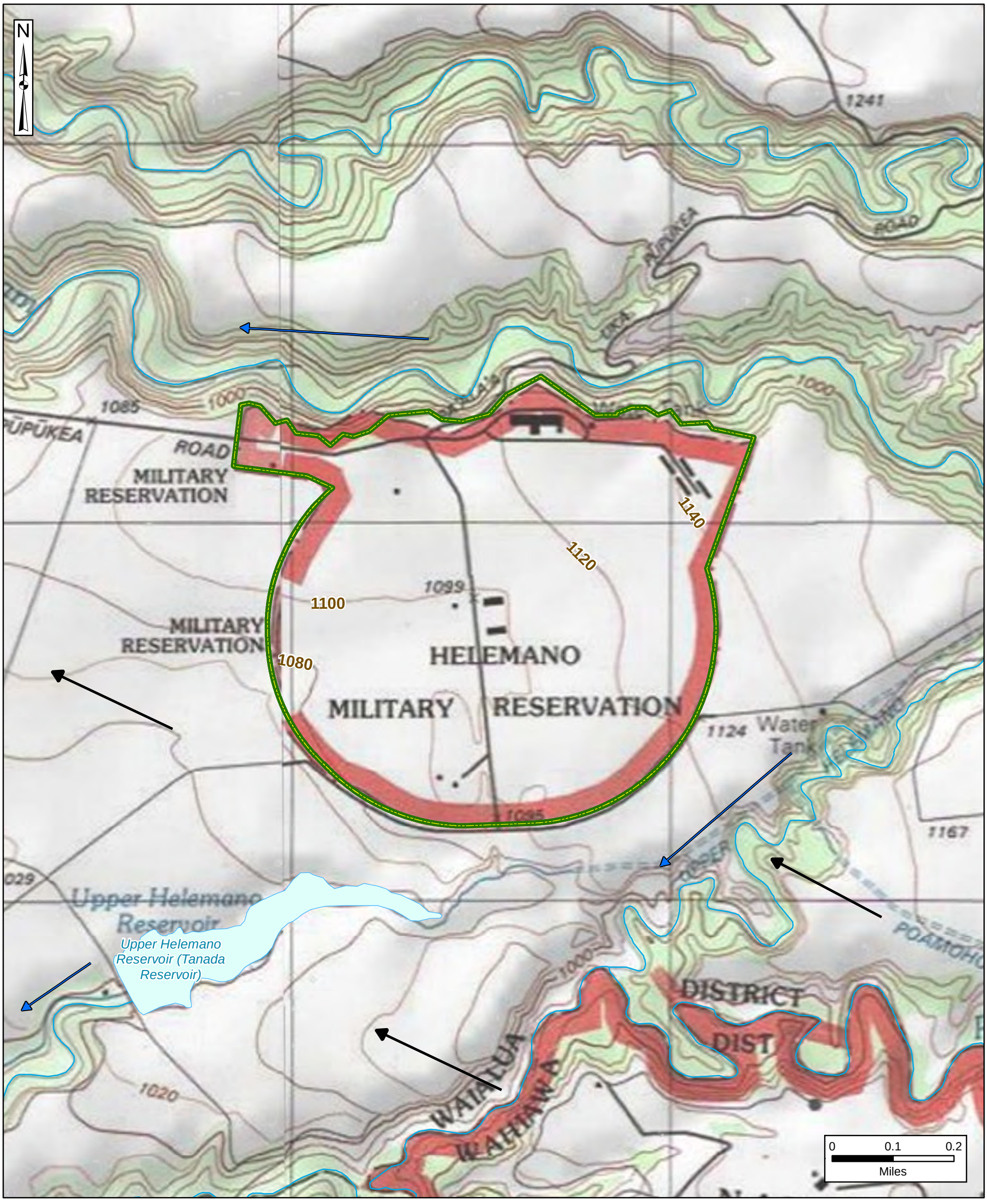
AOPI = area of potential interest

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
Helemano Military Reservation, Hawaii

Figure 2-3
Site Topography



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

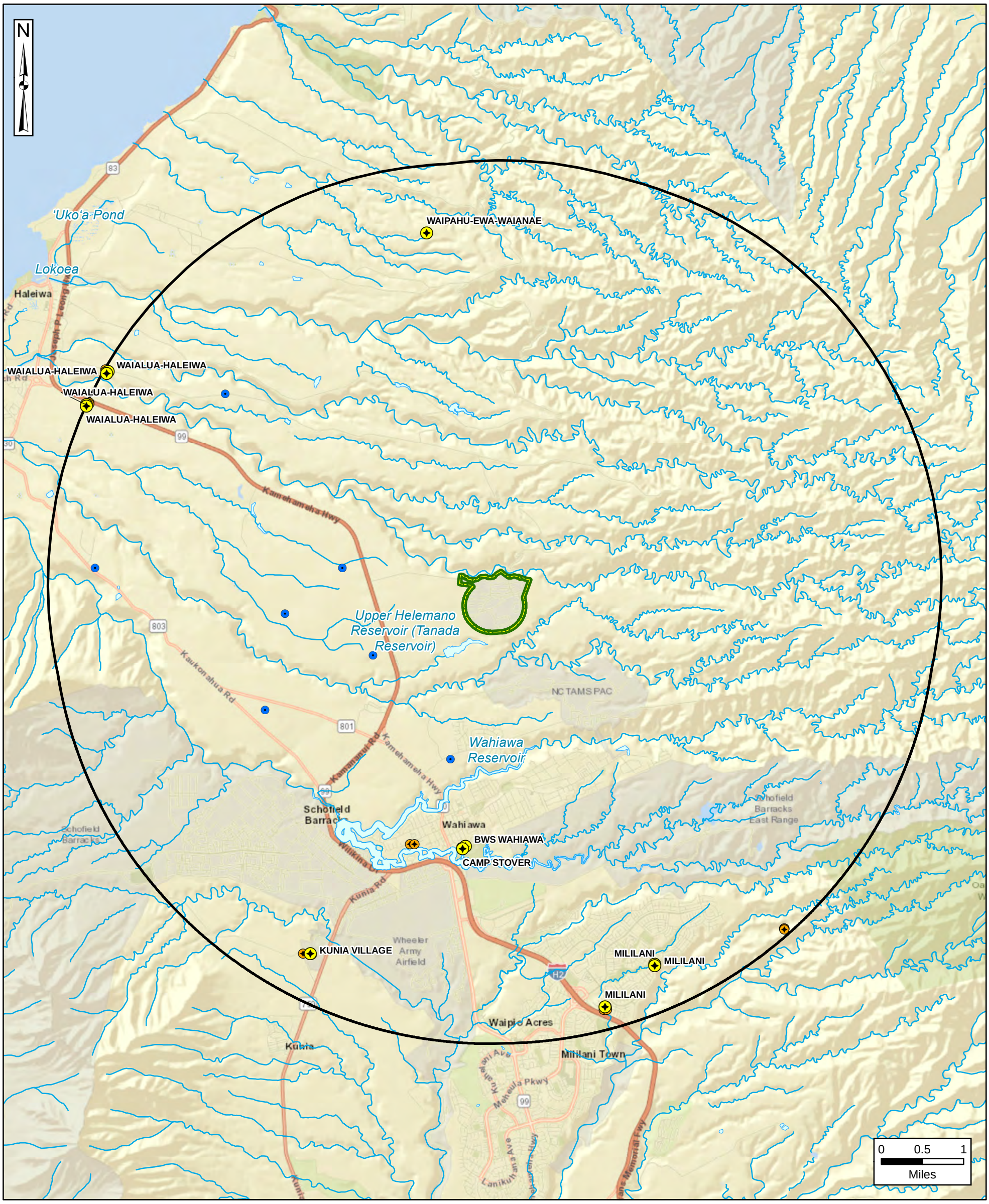
Notes:
1) Elevation contour labels are in feet.
2) The direction of groundwater flow beneath the installation is unknown. However, regional groundwater generally flows from the mountainous interior areas towards the coast; therefore, the primary direction of groundwater flow in the area is presumed to be towards the northwest (Oki 1998).
3) Surface water flow direction is based on hydrology and topography.

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

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Helemano Military Reservation, Hawaii

Figure 2-4
Off-Post Potable Supply Wells



Installation Boundary
Stream (Perennial)
Water Body
Public Water Supply System Well
Other Public Supply Well
Agricultural Well

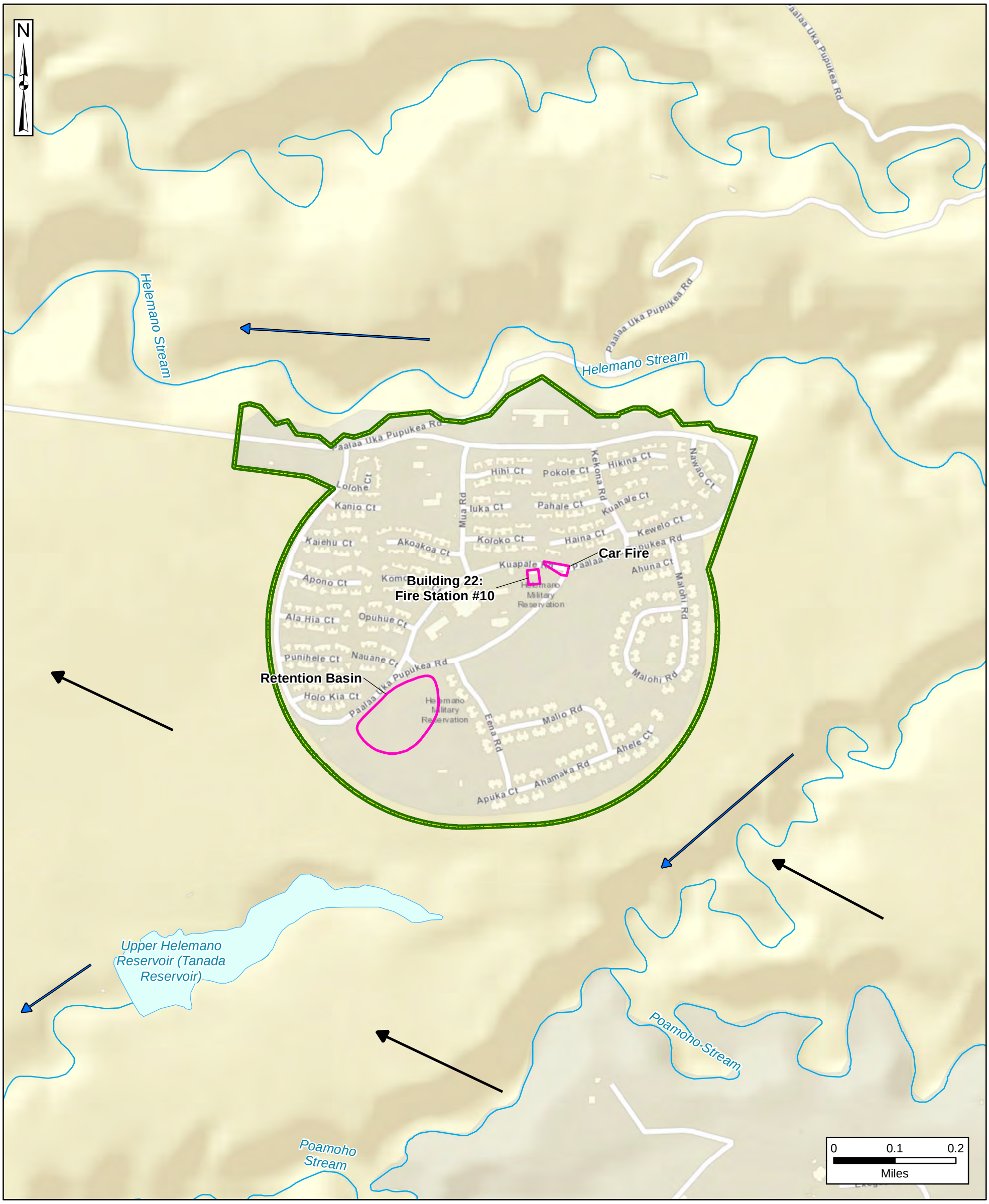
Note: Public Water Supply System Well data from the Federal Reporting Data System includes water systems that provide water to at least 25 people for at least 60 days annually.

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
Helemano Military Reservation, Hawaii

Figure 5-2
AOPI Locations



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

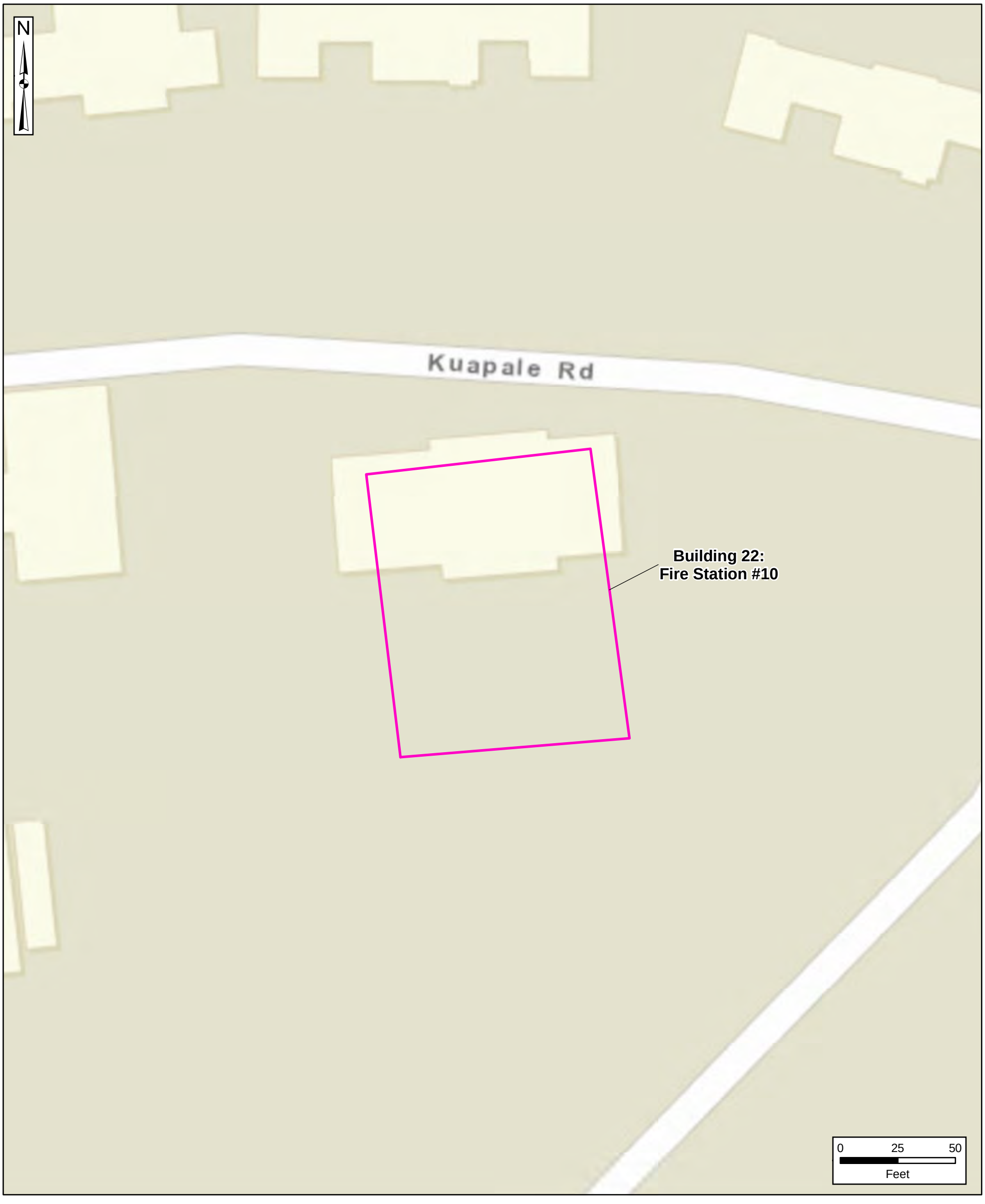
AOPI = area of potential interest

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
Helemano Military Reservation, Hawaii

Figure 5-3
Building 22: Fire Station #10



Installation Boundary

AOPI

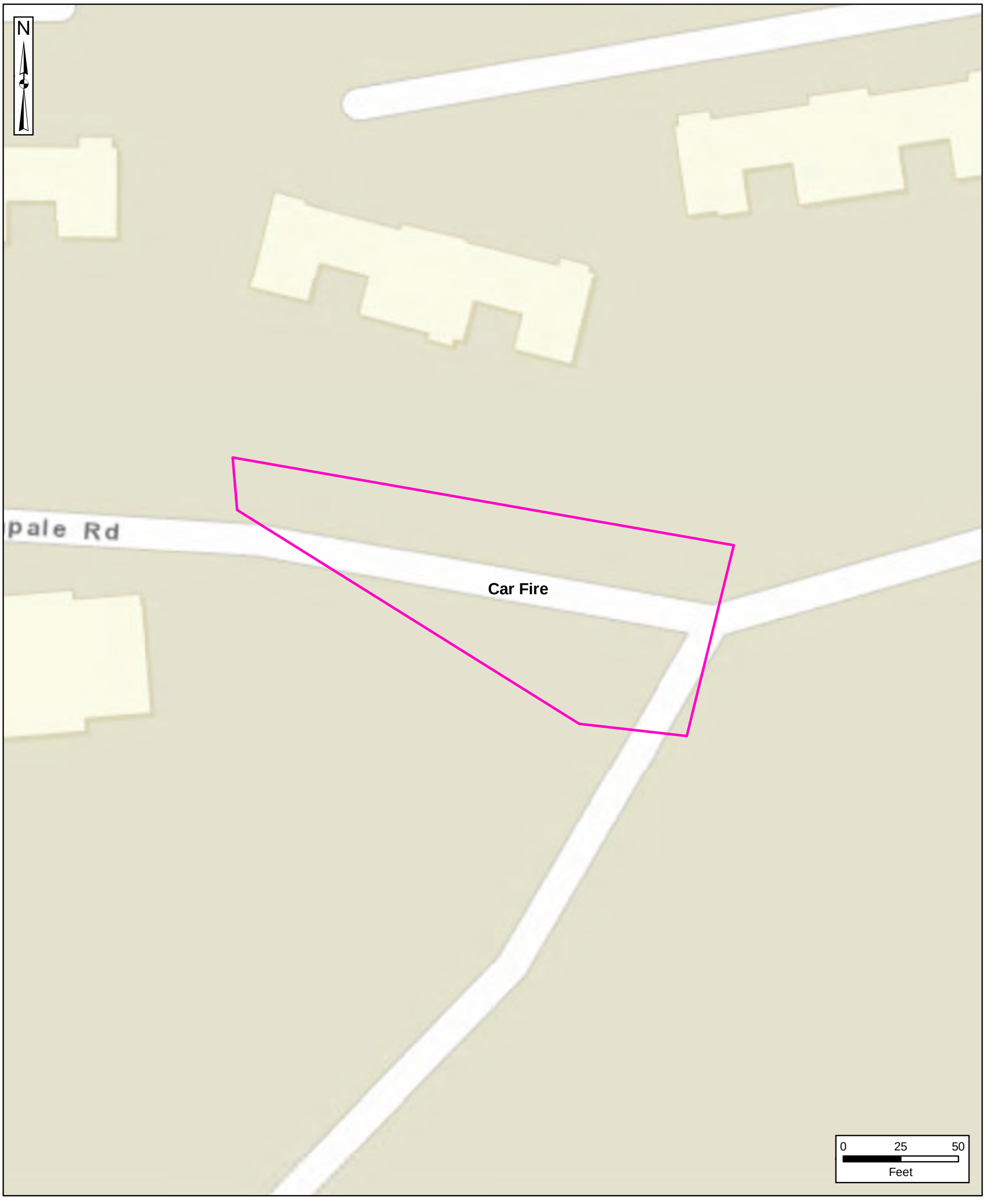
AOPI = area of potential interest

Data Sources:
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Helemano Military Reservation, Hawaii

Figure 5-4
Car Fire



Installation Boundary

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
Helemano Military Reservation, Hawaii

Figure 5-5
Retention Basin

N

2199

Nauane Ct

Kuapale Rd

Paalaa Uka Pupukea Rd

RB-OF-1

RB-OF-2

RB-OF-3

RB-OF-4

RB-OF-5

Retention Basin

0 50 100
Feet

Installation Boundary

AOPI

Stormwater/Surface Runoff Flow Direction

Outfall

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
Helemano Military Reservation, Hawaii

Figure 7-1
Building 22: Fire Station #10
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

HMR-FS-2-SO							
Date	10/26/2022	7/19/2023					
Depth	0-2 ft	5 ft	10 ft	15 ft	20 ft	25 ft	30 ft
PFOS	**0.0063**	**0.00541**	**0.000432 J**	**0.000399 J**	**0.000580 J**	**0.000834 J**	0.00284
PFOA	**0.00068**	**0.000793 J**	0.00134 U	0.00128 U	0.00131 U	0.00129 U	**0.000427 J**
PFBS	0.00028 U	0.00134 U	0.00134 U	0.00128 U	0.00131 U	0.00129 U	0.00144 U
PFNA	**0.00097**	**0.00105 J**	**0.000158 J**	**0.000173 J**	**0.000214 J**	**0.000215 J**	**0.000460 J**
PFHxS	**0.00018 J**	**0.000229 J**	0.00134 U	0.00128 U	0.00131 U	0.00129 U	0.00144 U

Kuapale Rd

Building 22:
Fire Station #10

HMR-FS-1-SO	
Date	10/26/2022
Depth	0-2 ft
PFOS	**0.0011**
PFOA	**0.00041**
PFBS	0.00024 U
PFNA	**0.00033**
PFHxS	**0.000086 J**

HMR-FS-3-SO							
Date	10/26/2022	7/19/2023					
Depth	0-1.5 ft	6 ft	10 ft	15 ft	20 ft	25 ft	30 ft
PFOS	**0.0051**	**0.0291 J [0.0152 J]**	**0.00312**	**0.00163**	**0.00153**	**0.00132 J**	**0.00330**
PFOA	**0.0036**	**0.00257 [0.00138]**	**0.000815 J**	**0.000594 J**	**0.000640 J**	**0.000767 J**	**0.000646 J**
PFBS	0.00025 U	0.00127 U [0.00126 U]	0.00137 U	0.00134 U	0.00131 U	0.00138 U	0.00136 U
PFNA	**0.0088**	**0.00852 J [0.00376 J]**	**0.00170**	**0.000896 J**	**0.000703 J**	**0.000403 J**	**0.000640 J**
PFHxS	**0.000065 J**	**0.000140 J** [0.00126 U]	0.00137 U	0.00134 U	0.00131 U	0.00138 U	0.00136 U

Notes:
1. Soil results are reported in milligrams per kilogram (mg/kg).
2. Duplicate sample results are shown in brackets.
3. Bolded values indicate detections.
4. Soil results collected from depths less than or equal to 2 feet were compared to residential and industrial/ commercial risk screening levels.
5. Soil results collected from depths greater than 2 feet and less than or equal to 15 feet were compared to industrial/commercial risk screening levels.
6. Results from soil samples collected at depths greater than 15 feet were not compared to risk screening levels.

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 25 50
Feet

Installation Boundary
AOPI
Shallow Soil Sampling Location
Soil Boring

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

Data Sources:
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Helemano Military Reservation, Hawaii

Figure 7-2
Car Fire
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

HMR-CF-2-SO	
Date	10/25/2022
Depth	2-4 ft
PFOS	**0.00016 J+**
PFOA	**0.000081 J+**
PFBS	0.00025 UJ
PFNA	**0.000050 J+**
PFHxS	0.00025 UJ

HMR-CF-3-SO	
Date	10/25/2022
Depth	0-2 ft
PFOS	**0.00015 J+**
PFOA	**0.000066 J**
PFBS	0.00024 U
PFNA	**0.000039 J+**
PFHxS	0.00024 U

HMR-CF-1-SO	
Date	10/25/2022
Depth	0-2 ft
PFOS	**0.00034 J+**
PFOA	**0.00056 J+**
PFBS	0.00026 U
PFNA	**0.00053 J+**
PFHxS	**0.00011 J**

Notes:
1. Soil results are reported in milligrams per kilogram (mg/kg).
2. Bolded values indicate detections.
3. Soil results collected from depths less than or equal to 2 feet were compared to residential and industrial/ commercial risk screening levels.
4. Soil results collected from depths greater than 2 feet and less than or equal to 15 feet were compared to industrial/commercial risk screening levels.

Qualifiers:
J = The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
J+ = The result is an estimated quantity; the result may be biased high.
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 limit of quantitation (LOQ) is approximate and may be inaccurate or imprecise.

Installation Boundary
AOPI
Shallow Soil Sampling Location
Soil Boring

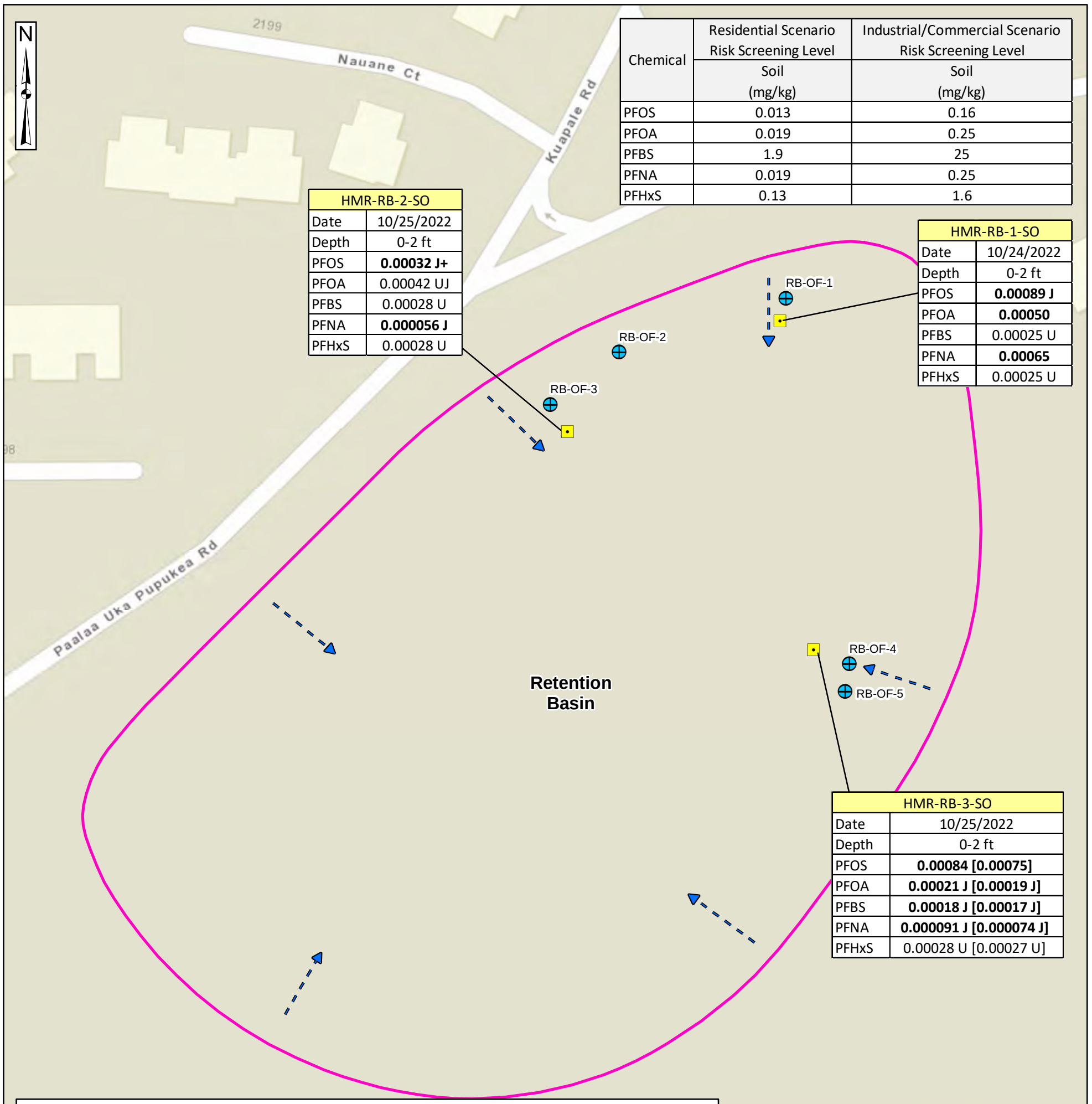
AOPI = area of potential interest
ft = feet
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS Preliminary Assessment / Site Inspection
Helemano Military Reservation, Hawaii

Figure 7-3
Retention Basin
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

HMR-RB-2-SO	
Date	10/25/2022
Depth	0-2 ft
PFOS	**0.00032 J+**
PFOA	0.00042 UJ
PFBS	0.00028 U
PFNA	**0.000056 J**
PFHxS	0.00028 U

HMR-RB-1-SO	
Date	10/24/2022
Depth	0-2 ft
PFOS	**0.00089 J**
PFOA	**0.00050**
PFBS	0.00025 U
PFNA	**0.00065**
PFHxS	0.00025 U

HMR-RB-3-SO	
Date	10/25/2022
Depth	0-2 ft
PFOS	**0.00084 [0.00075]**
PFOA	**0.00021 J [0.00019 J]**
PFBS	**0.00018 J [0.00017 J]**
PFNA	**0.000091 J [0.000074 J]**
PFHxS	0.00028 U [0.00027 U]

Notes:
1. Soil results are reported in milligrams per kilogram (mg/kg).
2. Duplicate sample results are shown in brackets.
3. Bolded values indicate detections.
4. Soil results collected from depths less than or equal to 2 feet were compared to residential and industrial/ commercial risk screening levels.

Qualifiers:
J = The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
J+ = The result is an estimated quantity; the result may be biased high.
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 limit of quantitation (LOQ) is approximate and may be inaccurate or imprecise.

Installation Boundary
AOPI
Stormwater/Surface Runoff Flow Direction
Outfall
Shallow Soil Sampling Location

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

Data Sources:
ESRI, ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 4 North

Source Medium	Release / Transport Mechanisms	Environmental Media	Release / Transport Mechanisms	Exposure Media	Exposure Route	Human Receptors: On-Installation: Site Worker	On-Installation: Resident	On-Installation: Recreational User	Off-Installation: All Types of Receptors [2]
Aqueous Film-Forming Foam Releases to Soil and/or Paved Surfaces				Soil (Building 22: Fire Station #10 and Car Fire)	Ingestion	●	○	○	○
					Dermal Contact	●	○	○	○
					Inhalation (Dust)	●	○	○	○
	Desorption / Dissolution	Groundwater		Groundwater	Ingestion	○	○	○	◐
					Dermal Contact	○	○	○	◐
			Recharge						
	Surface Runoff / Dissolution / Adsorption	Intermittent Stormwater (Drains to Retention Basin)		Intermittent Stormwater [1] (Retention Basin)	Ingestion	◐	○	○	○
					Dermal Contact	◐	○	○	○
			Adsorption / Desorption	Sediment / Soil [1] (Retention Basin)	Ingestion	●	○	○	○
					Dermal Contact	●	○	○	○
					Inhalation (Dust)	●	○	○	○

Legend:

● = Complete Exposure Pathway

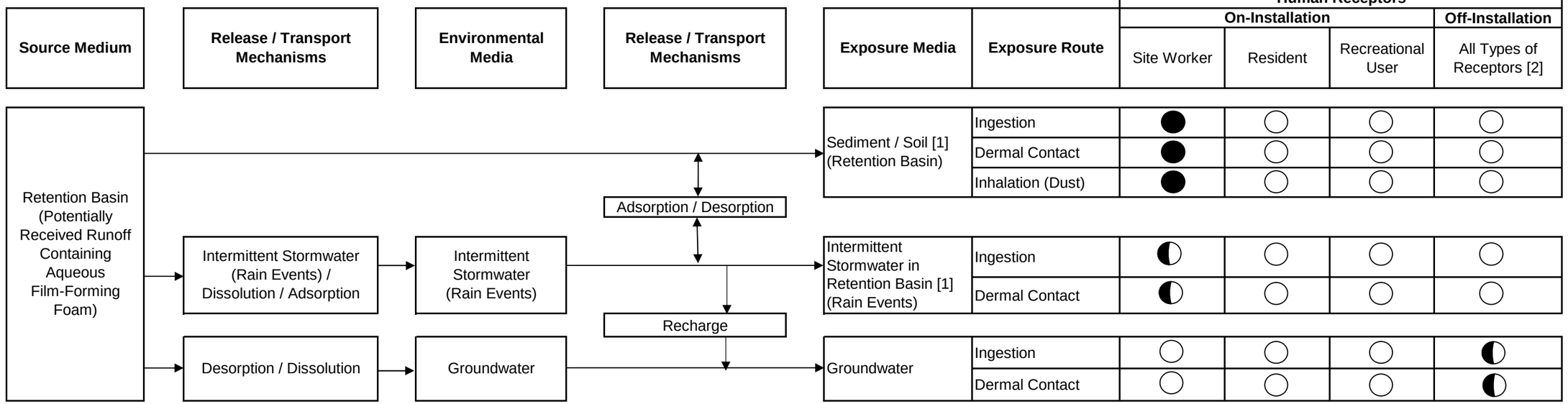
◐ = Potentially Complete Exposure Pathway

○ = Incomplete Exposure Pathway

Notes:
[1] Intermittent stormwater and sediment/soil exposure pathways for Site Workers describe incidental ingestion and dermal contact during outdoor work activities.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.
AOPI = area of potential interest

Conceptual Site Model for Building 22: Fire Station #10 and Car Fire AOPIs
USAEC PFAS Preliminary Assessment / Site Inspection
Helemano Military Reservation, Hawaii

Figure 7-4



Legend:

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

Notes:
[1] Intermittent stormwater and sediment/soil exposure pathways for Site Workers describe incidental ingestion and dermal contact during outdoor work activities.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.
AOPI = area of potential interest

ARCADIS

Conceptual Site Model for Retention Basin AOPI
USAEC PFAS Preliminary Assessment / Site Inspection
Helemano Military Reservation, Hawaii

Figure 7-5