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

Aliamanu Military Reservation, Hawaii

Prepared For:
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Preliminary Assessment and Site Inspection of Per- and Polyfluoroalkyl Substances

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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 Aliamanu Military Reservation (AMR) PA/SI was completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, National Oil and Hazardous Substances Pollution Contingency Plan, and Army/Department of Defense policy and guidance.

AMR is a military housing community located west of the Koolau Mountain Range and east of Pearl Harbor on the island of Oahu, Hawaii. The installation occupies approximately 600-acres and is comprised of two separate areas, the inside of Aliamanu Crater and a smaller area to the northeast separated by Interstate H-201/Moanalua Freeway. AMR consists of multi-family dwellings, apartment complexes, community buildings, recreational facilities, stores, and a gas station.

The AMR PA identified two AOPIs for investigation during the SI phase. SI sampling results from the two AOPIs were compared to risk-based screening levels calculated by the Office of the Secretary of Defense (OSD) for PFOS, PFOA, PFBS, PFNA, and PFHxS. Of the six PFAS compounds presented in the 06 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. 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 AMR 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 and/or groundwater at both AOPIs; both of the AOPIs had PFOS, PFOA, PFBS, PFNA, and/or PFHxS present at concentrations greater than the risk-based screening levels. The AMR PA/SI identified the need for further study in a Comprehensive Environmental Response, Compensation, and Liability Act remedial investigation. **Table ES-1** below summarizes the PA/SI sampling results and provides recommendations for further study in a remedial investigation at each AOPI.

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

AOPI Name	PFOS, PFOA, PFBS, PFNA and/or PFHxS detected greater than OSD Risk Screening Levels? (Yes/No)		Recommendation
	GW	SO	
Vehicle Fire Location 1	Yes	No	Further study in a remedial investigation[1]
Former Fire Station #6	Yes	No	Further study in a remedial investigation

Notes:
1 = The parent and duplicate groundwater samples had detections greater than the OSD risk screening level; however, the degree to which those sample results are biased high, if at all, is uncertain. This AOPI is recommended for further study in remedial investigation due to the uncertainty of the results and to confirm if exceedances above OSD risk screening levels exist.
Light gray shading – detection greater than the OSD risk screening level
GW – groundwater
SO – soil

1 INTRODUCTION

The United States (U.S.) Army (Army) is performing preliminary assessments (PAs) and site inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA) at Army installations (installations) nationwide because the Office of the Secretary of Defense (OSD) has developed risk-based screening levels for these chemicals. The Army is the lead agency under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Executive Order 12580 and is conducting the PA/SI consistent with its authority under CERCLA, 42 United States Code §§ 9600, et seq. (as amended), and the Defense Environmental Restoration Program, 10 United States Code §§ 2701, et seq. The PFAS PA/SI included two distinct efforts. The PA identified locations that are areas of potential interest (AOPIs) at Aliamanu Military Reservation (AMR) 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 OSD PFOS, PFOA, PFBS, PFNA, and PFHxS risk screening levels to determine whether further investigation is warranted. Of the six PFAS compounds presented in the 06 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. Based on the conceptual site model (CSM) developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at AMR because HFPO-DA is generally not a component of military specification (MIL-SPEC) 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 OSD risk screening levels. This report provides the PA/SI for AMR and was completed in accordance with CERCLA and The National Oil and Hazardous Substances Pollution Contingency Plan.

1.1 Project Background

PFAS are a class of compounds that have been used in a wide range of industrial applications and commercial products due to their unique surface tension/leveling properties. Due to industry and regulatory concerns about the potential health effects and adverse environmental impacts, there has been a reduction in the manufacture and use of PFAS worldwide. In the U.S., significant reductions in the production, importation, and use of PFOS and PFOA (two individual compounds in the PFAS class) occurred between 2001 and 2015 (Interstate Technology Regulatory Council 2017). PFBS replaced PFOS in some applications and is currently used and manufactured in the U.S.

In 2016, the United States Environmental Protection Agency (USEPA) established a lifetime health advisory of 70 nanograms per liter (ng/L) in drinking water for PFOS or PFOA and for the sum of PFOS and PFOA when both are present (USEPA 2016a). On 15 October 2019, the OSD provided guidance on the investigation of PFOS, PFOA, and PFBS at Department of Defense (DoD) restoration sites (OSD 2019). The DoD guidance provides risk screening levels for PFOS, PFOA, and PFBS in tap water and

soil, calculated using the USEPA's Regional Screening Level (RSL) calculator for residential and industrial/commercial worker receptor scenarios. Following the issuance of the 2019 OSD memo, on 08 April 2021, USEPA published an updated toxicity assessment for PFBS (USEPA 2021). Based on the updated toxicity assessment for PFBS, the OSD issued a memorandum on 15 September 2021 to include updated PFBS risk screening levels (OSD 2021). On 18 May 2022, the USEPA published an update to the RSLs table. The May 2022 RSL table included six PFAS constituents: PFOS, PFOA, PFBS, PFNA, PFHxS, and HFPO-DA (USEPA 2022). On 06 July 2022, the OSD issued a memorandum to include revised risk screening levels based on the May 2022 USEPA RSLs (OSD 2022). The July 2022 Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program is provided for reference as **Appendix A**. These screening criteria are discussed further in **Section 6.5**.

1.2 PA/SI Objectives

This PA/SI 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 AMR 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 AMR, 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 AMR. 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 AMR), 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 AMR.

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 AMR. 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. An 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. A SI kickoff and scoping teleconference was held between the Army PA team, USAG-HI, USAEC, and USACE.[1]

The objectives of the SI kickoff and scoping teleconference 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 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

[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.

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.

The DQOs, sampling design and rationale, and field methods employed for the SI are summarized from the QAPP Addendum developed for AMR (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 AMR, 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

AMR is a military housing community located west of the Koolau Mountain Range and east of Pearl Harbor on the island of Oahu, Hawaii (**Figure 2-1**). The installation occupies approximately 600-acres and is comprised of two separate areas, the inside of Aliamanu Crater and a smaller area to the northeast separated by Interstate H-201/Moanalua Freeway (**Figure 2-2**). The majority of land surrounding AMR consists of residential properties, with Salt Lake and Honolulu Country Club Golf Course to the south and Moanalua Golf Course and Tripler Army Medical Center to the east.

2.2 Mission and Brief Site History

The following mission and site history is provided in a 1997 Installation Action Plan prepared for AMR: AMR was originally utilized by the military in 1913 when infantry earthworks were constructed on the slopes of Aliamanu Crater for use as a fortified area; in 1928, AMR was transferred to the Hawaiian Ordnance Depot as an ideal location for magazine tunnels for the centralized storage of Army ammunitions; in the early 1930s, the crater was planted in sugarcane; in 1934, construction of the ammunition tunnels began and continued through the late 1930s; and, in 1936 and 1937, Crater Rim Road was completed to provide access to the tunnels (USAG-HI 1997). During World War II and until 1975, the tunnels were used to store munitions; thereafter, the bunkers were converted to dry storage areas (USAG-HI 1997). In the 1970s, as a result of a housing shortage for military families on the island of Oahu, AMR was developed into a military housing community (USAG-HI 1997).

2.3 Current and Projected Land Use

AMR serves as a military housing community which consists of multi-family dwellings, apartment complexes, community buildings, recreational facilities, stores, and a gas station (USAG-HI 1997). Current population data was not specified in readily available documents; however, an Installation Action Plan from 1997 indicates the installation had “2,597 housing units within 1,212 buildings and a 1990 population of approximately 7,000 people” (USAG-HI 1997). In addition to housing, there are “154 ammunition storage bunkers/tunnels (in 40 bunker groups) along the crater rim” (Woodward-Clyde Federal Services [Woodward] 1997). Readily available documents did not specify any foreseeable land use changes for AMR.

2.4 Climate

Western Regional Climate Center (WRCC) data from the nearby climate station Honolulu International Airport, Hawaii (511919) for the period of May 1940 to June 2016 indicates annual temperatures ranged

from an average minimum of 70.4 degrees Fahrenheit to an average maximum of 84.0 degrees Fahrenheit, and the average annual total precipitation was 20.20 inches (WRCC 2022).

2.5 Topography

Aliamanu Crater is an elliptical shaped crater measuring approximately 6,200 feet east-west and 4,000 feet north-south across the top rim (Woodward 1997). Elevations range from approximately 50 feet above mean sea level (amsl) on the crater floor to 486 feet amsl at the top of the north rim (Woodward 1997). A topographic map of Aliamanu Crater, AMR, and the surrounding area is included as **Figure 2-3**.

2.6 Geology

Aliamanu Crater erupted during the post-erosional stage of volcanism of Koolau Volcano, roughly 1 to 1.5 million years after cessation of the main shield building stage of volcanism and is largely composed of pyroclastic material of melilite-nephelinite composition (Woodward 1997). Soil in the crater basin is identified as Makalapa clay with shallow surface profile "composed of dark grayish-brown clay about 8 inches thick overlain by an 18- to 36-inch-thick dark grayish-brown clay to silty clay loam with a subangular blocky structure"; that unit "is underlain by light gray to dark grayish-brown, weathered volcanic tuff" (Woodward 1997). The soil has low permeability, runoff is slow, the erosion hazard of shallow soils is slight, and the shrink-swell potential is high (Woodward 1997). Although significant quantities of groundwater are probably not permanently stored within the Aliamanu and Salt Lake tuffs due to the fine-grained, impermeable character of the airfall deposits, "ephemeral perched groundwater bodies may form shortly after large rainfall events within the coarser airfall deposits within the Salt Lake tuff and within the intercalated alluvial silts and gravels present within the Aliamanu tuff" (Woodward 1997). The Salt Lake tuff is "characterized by excellent stratification in the finer-grained layers, whereas the underlying Aliamanu tuff lacks well developed stratification and an abundance of angular xenoliths of Koolau lithology" (Woodward 1997).

2.7 Hydrogeology

Static groundwater was measured at depths of approximately 27 feet below ground surface (bgs) and 42 feet bgs at two AMR groundwater sampling locations during the SI. A summary of SI activities is discussed further in **Section 6**. The aquifer beneath AMR is part of the Moanalua Aquifer System in the Honolulu Aquifer Sector (Mink and Lau 1990). The aquifer is a basal, unconfined flank-type aquifer classified as currently developed for drinking water use by municipal and private users, having a salinity of less than 250 milligrams per liter of chloride, being irreplaceable, and highly vulnerable to contamination (Mink and Lau 1990). 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 (Mink and Lau 1990).

The Hawaii Groundwater & Geothermal Resource Center (HGGRC) water well database indicates a well was drilled on the northern inner slope of Aliamanu Crater in 1941 (HGGRC 2020). The HGGRC database does not provide additional information regarding that well; however, according to the Environmental Data Resources, Inc. (EDR) Report, that the well is abandoned/sealed (**Appendix D**).In addition, a previous AMR investigation report indicates the following: the well was drilled at an altitude of

95 feet amsl on the northern inner slope of Aliamanu Crater; the well “penetrated roughly 47 feet of Salt Lake tuff, underlain by a 31-feet-thick melilite-nepheline lava flow, 17 feet of older alluvium and Koolau basalt”; and, the well was under artesian conditions (Woodward 1997). It was “hypothesized that a relatively fresh basal water body (less than 300 parts per million chloride) underlies portions of Aliamanu Crater under semi-confined conditions with a hydraulic head of roughly 17 to 18 feet above mean sea level” (Woodward 1997).

The direction of groundwater flow beneath the installation is unknown. Regional groundwater generally flows from the mountainous interior areas towards the coast; therefore, the primary direction of groundwater flow in the area is towards the southwest (Oki 1998).

2.8 Surface Water Hydrology

There are no surface water bodies on AMR, and surface water is not used as a drinking water source. Surface water features in proximity to AMR include Salt Lake and the Honolulu Country Club Golf Course water hazards to the south, Halawa Stream to the north, and Moanalua Stream to the east. Surface water features in proximity to the installation are not likely used for drinking water.

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 AMR.

2.9.1 Stormwater Management System Description

Surface runoff within the crater drains to a Y-shaped storm drainage channel that connects to a tunnel through the south side of the installation (Army 2015). Stormwater flows through the tunnel, down the slopes of the crater and into Salt Lake (Army 2015). The smaller, northeast portion of the installation, across Interstate H-201/Moanalua Freeway, drains north towards Halawa Stream (Army 2015).

2.9.2 Sewer System Description

According to USAG-HI Directorate of Public Works (DPW) personnel, the sanitary system at AMR drains to the municipal wastewater treatment plant at Sand Island. Given that the wastewater treatment plant is a municipal facility (i.e., not operated by USAG-HI), USAG- HI DPW personnel did not know where the sludge is disposed.

2.10 Potable Water Supply and Drinking Water Receptors

According to USAG-HI DPW personnel, drinking water is provided to AMR by “the Navy”. Groundwater at AMR is not used as potable water for the installation; instead, USAG-HI PFOS/PFOA testing documentation indicates the Aliamanu Water System is a consecutive system that receives wholesale drinking water from the Joint Base Pearl Harbor-Hickam Water System. USAG-HI records also indicate that the water is chlorinated and fluoridated at three Pearl Harbor water well sources. Based on HGGRC records, the three water well sources where the water is chlorinated and fluoridated are located in the

inferred upgradient direction from AMR (HGGRC 2020). USAEC personnel indicated that after chlorination and fluoridation, drinking water is processed through an Army-owned granular activated carbon treatment system before it is provided to consumers.

An 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 AMR, which along with state and county geographic information system (GIS) provided by the installation identified several off-post public and private wells within 5 miles of the installation boundary (**Figure 2-4**). However, Army-owned wells and on-post wells/water sources, if present, are not shown or identified on figures in this PA/SI report due to operational security guidance/requirements. The EDR report with well search results is 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.

AMR is occupied primarily by apartment complexes, multi-family dwellings, and other buildings that are surrounded by vegetation consisting mainly of heavily manicured introduced grasses, ornamental trees, and shrubs (Woodward 1997). There are also several grass playing fields on AMR, and the internal slopes of Aliamanu Crater are mostly covered with Koa Haole (*Leucaena leucocephala*) (Woodward 1997). The vegetation on the crater slopes is dominated by non-native, introduced plant species similar to lower elevation areas on the island of Oahu (Woodward 1997).

In 1997, as part of a site investigation, an ecological survey was conducted to evaluate whether threatened or endangered species were present at AMR (Woodward 1997). The 1997 AMR site-investigation report indicates the following: the United States Fish and Wildlife Service did not have any records indicating that threatened or endangered species reside at AMR, but did indicate that two endangered birds, the Hawaiian stilt (*Himantopus mexicanys knudseni*) and the Hawaiian coot (*Fulica alai*), occurred at Salt Lake (adjacent to AMR); the endangered Hawaiian duck (*Anas wyvilliana*) had been sighted at Salt Lake, but not since 1984; the United States Fish and Wildlife Service noted that "these and other wetland species are attracted to ponds, mudflats, and shorelines"; Hawaiian stilt were seen feeding on AMR, and the Hawaiian coot was seen at Salt Lake (adjacent to AMR); the Hawaiian stilt were likely feeding mostly on aquatic invertebrates; the Hawaiian coot is more likely to feed on a mixture of aquatic plants and aquatic invertebrates; there is no suitable nesting habit for the stilt or the coot at AMR; and no bats were detected during a one-night survey conducted at AMR (Woodward 1997).

2.12 Previous PFAS Investigations

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

USAG-HI PFOS/PFOA testing documentation indicates the Aliamanu Water System receives wholesale drinking water from the Joint Base Pearl Harbor-Hickam Water System. USAG-HI records also indicate that the water is chlorinated and fluoridated at three Pearl Harbor water well sources. USAEC personnel

indicated that after chlorination and fluoridation, drinking water is processed through an Army-owned granular activated carbon treatment system before it is provided to consumers. According to the PFOS/PFOA testing documentation for AMR, water was collected from AMR drinking water sources at sample locations identified as EPTDS (where EPTDS is presumably the entry points to the distribution system) on 03 December 2013, 09 December 2013, and 10 December 2013 (prior to installation of the granular activated carbon treatment system in 2021) and analyzed for PFOA and PFOS. The water sample type was post-treatment/finished water (where water is chlorinated and fluoridated). PFOA was not detected above the minimum reporting level of 20 ng/L and PFOS was not detected above the minimum reporting level of 40 ng/L.

The USEPA conducted the third Unregulated Contaminant Monitoring Rule (UCMR3) monitoring between 2013 and 2015. UCMR3 is a national program that collects data for contaminants that are suspected to be present in drinking water and do not have health-based standards set under the Safe Drinking Water Act (USEPA 2016b). The UCMR3 included the analysis of PFOS, PFOA, PFBS, PFNA, and PFHxS in public water systems serving more than 10,000 people between 2013 and 2015. During monitoring events conducted in 2013 (April, June, October, and December) and 2014 (April and June), samples were collected from 30 to 40 public supply wells within a 5-mile radius of AMR. The location of various wells was undetermined from readily available documents but did include the Joint Base Pearl Harbor - Hickam water well sources that supply drinking water to AMR. Results indicated that PFOS, PFOA, PFBS, PNFA, and PFHxS were not detected in any of the samples collected from the public supply wells. The minimum reporting level at the time of UCMR3 sampling was 40 ng/L for PFOS, 20 ng/L for PFOA, 90 ng/L for PFBS, 20 ng/L for PFNA, and 30 ng/L for PFHxS. The laboratory that analyzed the samples under UCMR3 met the USEPA's UCMR3 Laboratory Approval Program application and Proficiency Testing criteria for USEPA Method 537 Version 1.1.

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 AMR, 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 AMR 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, various Installation Restoration Program administrative record documents, compliance documents, Federal Fire Department (FFD) documents, USAG-HI DPW documents, and GIS files. Internet searches were also conducted to identify publicly available and other relevant information. A list of the specific documents reviewed for AMR is provided in **Appendix E**.

3.2 Personnel Interviews

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

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

- Fire Chief, FFD
- Acting District Chief, FFD
- Battalion Chief, FFD
- Lieutenant, FFD
- Fire Fighter, FFD
- Safe Drinking Water and Clean Air Program Manager, DPW

- Clean Water Program Manager, DPW
- Clean Water Program Support, DPW

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 AMR 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

AMR 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.

During site visit interviews, FFD personnel recalled a vehicle fire incident where AFFF was used at AMR between 2009 and 2019. FFD personnel provided a description of the vehicle fire location, and site reconnaissance activities were conducted at two possible locations that fit the vehicle fire location description. During the site interviews, FFD personnel also indicated the following: a garbage truck fire occurred at AMR between 2002 and 2004; Former Fire Station #6 operated at AMR for at least three years (between approximately 2006 and 2009); the fire truck used at Former Fire Station #6 carried AFFF in the truck reservoir, however, FFD personnel confirmed AFFF was not stored at the station; and, fire truck maintenance was conducted off installation at a naval base facility. Given that FFD personnel indicated AFFF was not stored at the station and that fire truck maintenance was conducted off installation at a naval base facility, AFFF was presumably stored off installation (presumably at the off installation naval base facility where truck maintenance was conducted).

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

Following document research, personnel interviews, and site reconnaissance at AMR, the bunkers/tunnels along the crater rim where the pesticide Paris Green (copper acetoarsenite) was used 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 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**.

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 AMR as an installation having used or stored PFAS-containing pesticides/insecticides. Additionally, the PA team reviewed available pesticide use inventory documentation provided by USAG-HI and did not identify PFAS-containing pesticides use, storage, or disposal.

4.3 Readily Identifiable Off-Post PFAS Sources

An exhaustive search to identify all potential off-post PFAS sources (i.e., not related to operations at AMR) 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 AMR installation, none of these sources are hydraulically upgradient (northeast) of AMR.

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

Facility Name	Facility Address	Type of Facility	Distance and Direction from Installation[1]
Moanalua Fire Station #30	2835 Ala Ilima Street, Honolulu, Hawaii 96818	Fire Station	0.97, Southeast
Mokulele Fire Station #8	800-860 Valkenburgh Street, Honolulu, Hawaii 96818	Fire Station	1.35, Southwest
Aiea Fire Station #10	98-1225 Ulune Street, Aiea, Hawaii 96701	Fire Station	1.57, Northwest
Honolulu Fire Department – 32 Kalihi Uka	1861 Kamehameha IV Road, Honolulu, Hawaii 96819	Fire Station	2.35, Southeast
Kalihi Fire Station 06	1742 N King Street, Honolulu, Hawaii 96819	Fire Station	2.55, Southeast
Pearl City Fire Station #20	880 1st Street, Pearl City, Hawaii 96782	Fire Station	3.80, Northwest
Goodyear Auto Service	4510 Salt Lake Boulevard, Honolulu, Hawaii 96818	Automotive Maintenance	0.45, Northwest
Fantastik Auto Repair	2031 Colburn Street, Honolulu, Hawaii 96819	Automotive Maintenance	2.45, Southeast
Kaiser Permanente Moanalua Medical Center	3288 Moanalua Road, Honolulu, Hawaii 96819	Hospital	0.1, East
Kaiser Māpunapuna	2828 Paa Street, Honolulu, Hawaii 96819	Hospital	1.05, Southeast
Salt Lake Laundromat	848 Ala Lilikoi Street, Honolulu, Hawaii 96818	Laundry	0.55, South

Facility Name	Facility Address	Type of Facility	Distance and Direction from Installation[1]
Hawaii Laundry Services	98-820 Moanalua Road, Aiea, Hawaii 96701	Laundry	2.70, Northwest
CVS Photo	848 Ala Lilikoi Street, Honolulu, Hawaii 96818	Photo Processing	0.66, South
CVS Photo	98-130 Pali Momi Street, Aiea, Hawaii 96701	Photo Processing	1.86, Northwest
Sumida Farm, Inc.	98-160 Kamehameha Highway, Aiea, Hawaii 96701	Farm	2.02, Northwest

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

5 SUMMARY AND DISCUSSION OF PA RESULTS

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

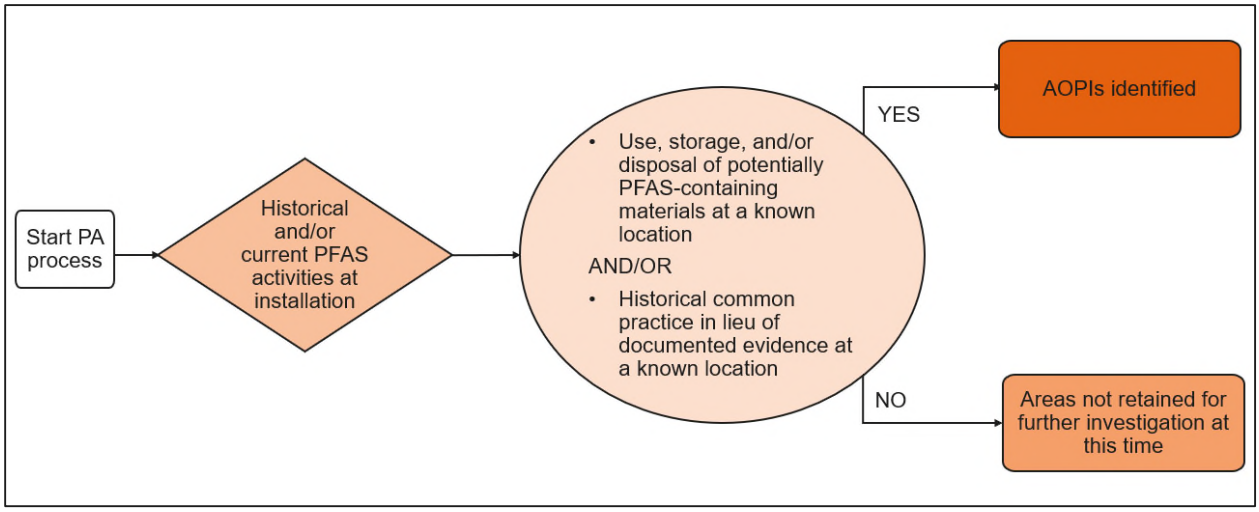

Figure 5-1: AOPI Decision Flowchart

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 AMR 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**.

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

Area Description	Dates of Operation	Relevant Site History	Rationale
Truck Fire (Potential Location #2)	Between 2009 and 2019	During site visit interviews, FFD personnel indicated a vehicle fire incident where AFFF was used occurred at AMR between 2009 and 2019. FFD personnel provided a description of the vehicle fire location, and site reconnaissance activities were conducted at two possible locations that fit the vehicle fire location description. One possible location was the area later identified as AOPI Vehicle Fire Location 1 (discussed in **Section 5.2**) and the other was an area identified as Truck Fire (Potential Location #2). Based on information obtained during the site reconnaissance, it was determined that the vehicle fire did not occur in the area identified as Truck Fire (Potential Location #2).	Site reconnaissance activities confirmed the vehicle fire that took place between 2009 and 2019 did not occur in the area identified as Truck Fire (Potential Location #2).
Garbage Truck Fire Response	Unknown	During site visit interviews, FFD personnel recalled that a garbage truck fire had occurred at AMR. One individual thought AFFF was used; however, another individual did not believe AFFF was used during the incident response. The incident could not be corroborated during interviews with FFD personnel or with electronically available response logs. The incident date and incident location were also unknown.	The incident could not be corroborated with FFD personnel or with electronically available response logs. No evidence regarding the incident date or incident location were identified.
Pesticide Use at Bunkers/Tunnels Along the Crater Rim	1960s	In the 1960s, the pesticide Paris Green (copper acetoarsenite) was used to treat dry wood termite infestation of wooden pallets (used to store munitions) and crates in ammunition storage bunkers/tunnels along the crater rim at AMR (USAG-HI 1997). The pesticide was also dusted throughout the bunkers and the bunker expansion joints (USAG-HI 1997). The site consisted of 154 ammunition storage bunkers (USAG-HI 1997). A site investigation conducted in 1994 and 1995 showed that Paris Green had migrated from the bunkers (i.e., sweeping the bunkers and tracking the pesticide on shoes) into the surrounding area (USAG-HI 1997). According to a remedial investigation report prepared in	No evidence of PFAS-containing materials used, stored, and/or disposed of at this location.

Area Description	Dates of Operation	Relevant Site History	Rationale
		1997, arsenic and copper concentrations in soil samples collected from AMR exceeded background levels, and a recommendation was made that, as a precautionary measure, all the bunkers should be sealed and should not be used for human occupancy (Woodward 1997). As indicated in Section 4.2, the IMCOM Pest Management Consultant provided records of potentially PFAS-containing pesticides used at and/or stored at Army installations and did not identify AMR as an installation having used or stored PFAS-containing pesticides. No readily available information (including web-based safety data sheets for Paris Green that identify copper acetoarsenite as the hazardous ingredient) provided evidence that Paris Green is a PFAS containing pesticide.	

5.2 AOPIs

Overviews for each AOPI identified during the PA process are presented in this section. No Installation Restoration Program sites and/or Headquarters Army Environmental System sites were identified on AMR.

The AOPI locations are shown on **Figure 5-2**. Detailed views of each AOPI showing the approximate extent of AFFF use (if applicable) are presented on **Figures 5-3** and **5-4** and includes active monitoring wells (if present) in the vicinity of each AOPI.

5.2.1 Vehicle Fire Location 1

Vehicle Fire location 1 is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to known/suspected use of PFAS-containing materials at this location (**Figure 5-3**). During site visit interviews, FFD staff indicated a vehicle fire occurred at Vehicle Fire Location 1 between 2009 and 2019 and that AFFF was used during incident response efforts. Vehicle Fire Location 1 is located in an area used for recreation, adjacent to a baseball field and a construction staging area. The area slopes towards a swale that flows to a drainage channel that discharges to the south side of the installation, down the slopes of the crater and into Salt Lake.

5.2.2 Former Fire Station #6

Former Fire Station #6 is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to known/suspected PFAS-containing materials (i.e., AFFF) in the fire truck formerly

parked at this location (**Figure 5-4**). During site visit interviews, FFD personnel indicated Former Fire Station #6 operated at AMR for at least three years (between approximately 2006 and 2009) and that fire fighters did not train at AMR. According to FFD personnel, the fire station consisted of a large house that was converted to a fire station building and a parking area north of that building. The parking area was comprised of a gravel driveway and a grassy area east of the driveway. A temporary parking structure for the fire truck was also constructed in the driveway. Fire truck maintenance was completed at an offsite maintenance yard.

Prior to construction of the temporary parking structure, the fire truck would be parked in the gravel driveway and in the grassy area east of the driveway. FFD personnel indicated during site interviews that the fire truck used at Former Fire Station #6 carried AFFF in the truck reservoir, however, FFD personnel confirmed AFFF was not stored at the station and that fire truck maintenance was conducted off installation at a naval base facility. Given that FFD personnel indicated AFFF was not stored at the station and that fire truck maintenance was conducted off installation at a naval base facility, AFFF was presumably stored off installation (presumably at the off installation naval base facility where truck maintenance was conducted). The AOPI boundary encompasses the Former Fire Station #6 driveway and grassy area east of the driveway, however, the AOPI boundary does not include the Former Fire Station #6 building. The former fire station and temporary parking structure have been replaced with residential housing. Based on surface elevation data from aerial imagery, the former parking area sloped towards the south.

6 SUMMARY OF SI ACTIVITIES

Based on the results of the PA at AMR, a SI for PFOS, PFOA, PFBS, PFNA, and PFHxS was conducted in accordance with CERCLA. SI sampling was completed at AMR at two 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. The SI scope of work was completed in August and October 2022 through the collection of field data and analytical samples.

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

6.1 Data Quality Objectives

As identified during the DQO process and outlined in the site-specific QAPP Addendum (Arcadis 2022), the objective of the SI is to identify whether there has been a release to the environment at the AOPIs identified in the PA and to determine if further investigation is warranted. This SI evaluated groundwater and soil for PFOS, PFOA, PFBS, PFNA, and PFHxS presence or absence at each of the sampled AOPIs.

6.2 Sampling Design and Rationale

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

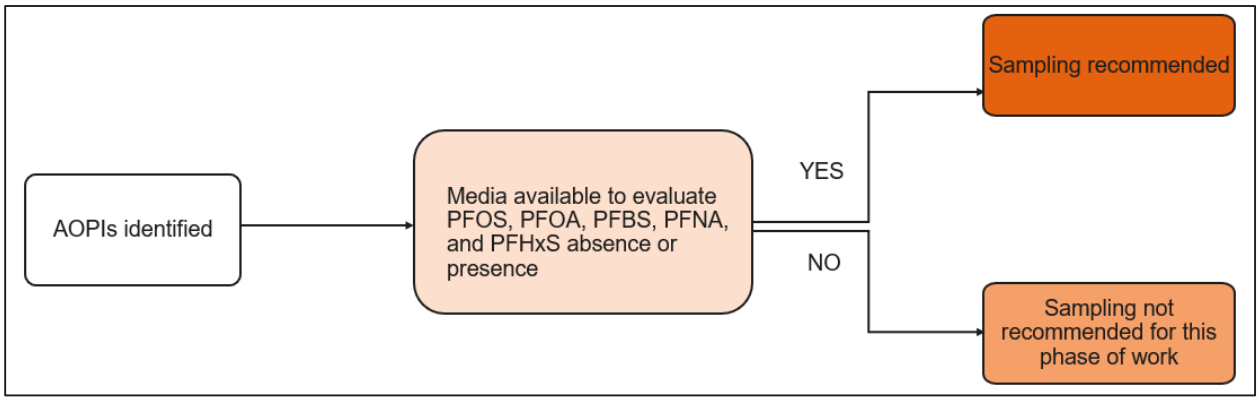

Figure 6-1: AOPI Sampling Decision Tree

The sampling design for SI sampling activities at AMR is detailed in Worksheet #17 of the QAPP Addendum (Arcadis 2022). For AOPIs Vehicle Fire Location 1 and Former Fire Station #6, samples were collected at locations of known or suspected former use and/or former storage of PFAS-containing materials, areas where surface runoff may have occurred, and downgradient locations if exact former use or former storage locations are unknown. Sample locations were selected based on site-specific historical evidence and/or ground surface conditions observed in the field. 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 (i.e., soil and groundwater) were based on media most likely to confirm the presence or absence of PFOS, PFOA, PFBS, PFNA, and PFHxS. Soil and groundwater samples were collected from each AOPI. Composite soil samples were collected from the upper 2 feet of native soil, as determined by the field geologist. Shallow (first encountered) single-interval groundwater samples were collected from temporary wells.

The CSM for AOPI Vehicle Fire Location 1 in the QAPP Addendum indicated there are potentially complete exposure pathways for surface water and sediment; however, surface water and sediment samples were not collected at that AOPI (Arcadis 2022). The swale adjacent to AOPI Vehicle Fire Location 1 flows to the nearby drainage channel, which drains to Salt Lake. The sampling design included collection of a composite soil sample within the swale area. If PFAS containing-materials drained (and are still present) outside the AOPI, PFOS, PFOA, PFBS, PFNA, and PFHxS would likely be present within the swale area. If PFOS, PFOA, PFBS, PFNA, and PFHxS are not present within the swale area, it would be unlikely that PFOS, PFOA, PFBS, PFNA, and PFHxS from the AOPI would be present in intermittent stormwater/surface water and/or soil/sediment within the drainage channel, and by extension in surface water and/or sediment at Salt Lake. Therefore, intermittent stormwater/surface water and sediment/soil samples from the drainage channel and surface water and sediment samples from Salt Lake were not collected; instead, the soil sample collected from the swale area is to be used to verify the presence of PFOS, PFOA, PFBS, PFNA, and PFHxS within the stormwater system associated with the AOPI.

The CSMs for AOPI Vehicle Fire Location 1 and AOPI Former Fire Station #6 in the QAPP Addendum indicated there are potentially complete exposure pathways for off-site groundwater; however, off-site groundwater samples were not collected (Arcadis 2022). Instead, a groundwater sample was collected from each AOPI to verify the presence of PFOS, PFOA, PFBS, PFNA, and PFHxS in groundwater

beneath those areas. If PFOS, PFOA, PFBS, PFNA, and PFHxS are detected in groundwater from either AOPI, off-installation groundwater may be evaluated at a future date.

Groundwater samples were collected from temporary wells using five-foot pre-packed temporary screens. **Table 6-1** includes the temporary monitoring well details for the wells sampled during the SI.

6.3 Sampling Methods and Procedures

Environmental data were collected and analyzed in accordance with the PQAPP (Arcadis 2019), the SOPs and TGIs included as Appendix A to the PQAPP, the QA/QC requirements identified in Worksheet #20 of the PQAPP, the approved scope and sampling methods outlined in the site-specific QAPP Addendum (Arcadis 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, groundwater sampling forms, utility clearance checklist, and tailgate health and safety forms) documenting the SI sampling activities are included in **Appendices I** and **J**, respectively. Photographs of the sampling activities are included in **Appendix K**.

6.3.1 Field Methods

Composite soil samples were collected from AOPI Vehicle Fire Location 1 and AOPI Former Fire Station #6 from 0 to 2 feet bgs using a 3.25-inch diameter nickel plated alloy steel hand auger and stainless-steel trowel. In general, sampling points were positioned in the center, downgradient, and/or cross-gradient of a suspected release area. Soil collected with the hand auger and trowel was transferred to a stainless-steel bowl where it was mixed for homogenization. A portion of the homogenized soil was then placed in the sample container and packed with ice in a cooler to meet the preservation temperature requirements. 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. Soil lithological descriptions were continuously logged and documented on field forms and coordinates for each sampling location were recorded using a handheld global positioning system device.

Groundwater samples were also collected from AOPI Vehicle Fire Location 1 and AOPI Former Fire Station #6. Single-interval, shallow (first encountered), grab groundwater samples were collected from temporary wells via a hollow stem auger and 5-foot prepacked screens at discrete sampling locations. A portable bladder pump with disposable high-density polyethylene tubing was used to purge the temporary wells prior to sampling and to collect the groundwater samples.

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 (SBs) for water used in the initial decontamination step, and a field blank for laboratory-supplied water used in the final decontamination step.

QA/QC samples were collected at the frequencies specified in the QAPP Addendum (Arcadis 2022), typically at a rate of 1 per 20 parent samples. Field duplicates and matrix spike/matrix spike duplicate samples were collected for media sampled for PFOS, PFOA, PFBS, PFNA, and PFHxS only. EBs were collected for media sampled for PFOS, PFOA, PFBS, PFNA, and PFHxS, at a frequency of one per piece of relevant equipment for each sampling event, as specified in the QAPP Addendum (Arcadis 2022). The decontaminated reusable equipment from which EBs were collected include the drill casing, the hand auger, the stainless-steel bowl, the water-level meter, and the bladder pump as applicable to the sampled media. SBs were collected from the water provided and used by the drillers for decontamination of drill tooling and from deionized water used during decontamination of soil sampling equipment. Analytical results for blank samples are discussed in **Section 7.5**.

6.3.3 Field Change Reports

No instances of major scope modifications (i.e., those that may have had a significant impact on the project scope and/or data usability/quality, or required stop-work, and warranted discussion with USACE) were encountered during the AMR 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-AMR-01: Former Fire Station #6 AOPI: Soil sample AMR-FFS6-2-SO was relocated approximately 5 feet west of the proposed sampling location to avoid a telecommunication line.

6.3.4 Decontamination

Non-dedicated reusable sampling equipment (e.g., hand augers, stainless-steel bowls, drill casing, water-level meters, bladder pumps) 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, groundwater, and decontamination fluids were disposed on the ground at the point of collection in accordance with the PQAPP (Arcadis 2019). However,

the total soil volume extracted during drilling at the temporary well locations could not fit into the borings. The excess soil generated from the temporary well locations were drummed in Department of Transportation-approved 55-gallon drums and transported by Pacific Commercial Services, Inc. for disposal offsite as non-hazardous waste at the PVT Land Company Limited landfill under clearance number 141440.

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, garbage bags, and high-density polyethylene tubing) that may come in contact with sampling media. IDW disposal documents (e.g., request for clearance number form, soil profile form, clearance number approval form, and two copies of the waste manifest [i.e., one copy of the final manifest, where the handwritten text is blurry, and one copy of the transporter manifest, where the handwritten text is easier to discern]) are provided in **Appendix M**. Analytical results for IDW samples collected during the SI are discussed in **Section 7.3**.

6.4 Data Analysis

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

6.4.1 Laboratory Analytical Methods

Analytical samples collected during the SI were submitted to Eurofins Lancaster Laboratories Environmental, an ELAP-accredited laboratory for PFAS analysis, including PFOS, PFOA, PFBS, PFNA, and PFHxS, by liquid chromatography with tandem mass spectrometry. Laboratory analyses associated with the SI were completed in accordance with Worksheets #12.1 through #12.5 in the PQAPP (Arcadis 2019). Eighteen PFAS-related compounds, including PFOS, PFOA, PFBS, PFNA, and PFHxS, were analyzed for in groundwater and soil samples using an analytical method that is ELAP-accredited and compliant with QSM 5.3 (DoD and Department of Energy 2019), Table B-15.

Additionally, the following general chemistry and physical characteristic analyses were completed for select soil samples in accordance with Worksheet #18 of the QAPP Addendum (Arcadis 2022) by the analytical method noted:

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

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

The laboratory limit of detection (LOD) is defined as “the lowest concentration for reliable reporting of a non-detect of a specific analyte in a specific matrix with a specific method at 99 percent confidence” (DoD 2017). The lowest concentration of a substance that produces a quantitative result within specified limits of precision and bias is known as the limit of quantitation (LOQ; DoD 2017). Concentrations detected between the LOD and LOQ, therefore, are considered estimates and are qualified as such on laboratory

analytical reports. Instrument-specific detection limits (e.g., the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration with 99 percent confidence; DoD 2017), as provided for each analyte by the laboratory, are reported along with the LODs and LOQs in the laboratory analytical reports included in the Data Usability Summary Report (DUSR) (**Appendix N**).

6.4.2 Data Validation

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

6.4.3 Data Usability Assessment and Summary

A data usability assessment was completed for all analytical data associated with SI sampling at AMR. Documentation generated during the data usability assessments, which were compiled into a DUSR (**Appendix N**), 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 AMR 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 N**), and as indicated in the full analytical tables (**Appendix O**) provided for the SI results. These data are of sufficient quality to meet the objectives and requirements of the PQAPP (Arcadis 2019) and AMR QAPP Addendum (Arcadis 2022). Data qualifiers applied to laboratory analytical results for samples collected during the SI at AMR are provided in the data tables, data validation reports, and the Data Usability Summary Table located at the end of DUSR. Qualifiers for data shown on figures are defined in the notes of figures.

6.5 Office of the Secretary of Defense Risk Screening Levels

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

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

Chemical	Residential Scenario Risk Screening Levels Calculated Using USEPA RSL Calculator		Industrial/Commercial Scenario Risk Screening Levels Calculated Using USEPA RSL Calculator
	Tap Water (ng/L or ppt) [1]	Soil (mg/kg or ppm) [1,2]	Soil (mg/kg or ppm) [1,2]
PFOS	4	0.013	0.16
PFOA	6	0.019	0.25
PFBS	601	1.9	25
PFNA	6	0.019	0.25
PFHxS	39	0.13	1.6
HFPO-DA[3]	6	0.023	0.35

Notes:
1. Risk screening levels for tap water and soil provided by the OSD. 2022. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. July 06 (**Appendix A**).
2. All soil data will be screened against both the Residential Scenario and Industrial/Commercial risk screening levels (if collected from less than 2 feet bgs), regardless of the current and projected land use of the AOPI.
3. Of the six PFAS compounds presented in the 06 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. Based on the CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at AMR because HFPO-DA is generally not a component of MIL-SPEC 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 (parts per million)
ng/L = nanograms per liter
ppm = parts per million
ppt = parts per trillion

The OSD residential tap water risk screening levels will be used to compare all groundwater data for this Army PFAS PA/SI. 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 AMR (field duplicate results are provided in the associated tables). Sampled media and QA/QC samples were analyzed for the constituents prescribed per Worksheet #18 of the QAPP Addendum (Arcadis 2022). The sample results discussion below focuses on the PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results because they have OSD risk screening levels. The Army will make subsequent investigation decisions based on these constituents' concentrations relative to the OSD risk screening levels.

Tables 7-1 and **7-2** provide a summary of the groundwater and soil analytical results for PFOS, PFOA, PFBS, PFNA, and PFHxS. **Table 7-3** summarizes AOPIs and whether their SI results exceed the OSD risk screening levels. **Appendix O** includes the full suite of analytical results for these media, as well as for the QA/QC samples. An overview of AOPIs at AMR with OSD risk screening level exceedances is depicted on **Figure 7-1**. **Figures 7-2** and **7-3** show the PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results in groundwater and 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. Groundwater data collected during the SI are reported in ng/L, or parts per trillion, and soil data are reported in mg/kg, or parts per million.

Field parameters measured for groundwater during low-flow purging and sample collection are provided on the field forms in **Appendix J**. Soil descriptions are also provided on the field forms in **Appendix J**. The results of the SI are grouped by AOPI and discussed for each medium as applicable. As indicated in the Field Notes dated 26 October 2022 and 28 October 2022 (**Appendix I)**, groundwater was first encountered at a depth of approximately 35 feet bgs at AOPI Vehicle Fire Location 1 and at a depth of approximately 45 feet bgs at AOPI Former Fire Station #6.

Table 7-3 AOPIs and OSD Risk Screening Level Exceedances

AOPI Name	OSD Exceedances (Yes/No)
Vehicle Fire Location 1	Yes
Former Fire Station #6	Yes

7.1 Vehicle Fire Location 1

Although the CSM for AOPI Vehicle Fire Location 1 in the QAPP Addendum indicated there are potentially complete exposure pathways for surface water and sediment, surface water and sediment samples were not collected at AOPI Vehicle Fire Location 1 (Arcadis 2022). If PFOS, PFOA, PFBS, PFNA, and PFHxS are not present in the soil sample collected from the swale area, it would be unlikely that PFOS, PFOA, PFBS, PFNA, and PFHxS from the AOPI would be present in intermittent stormwater/surface water and/or soil/sediment within the drainage channel, and by extension in surface water and/or sediment at Salt Lake. Therefore, the soil sample collected from the swale area will be used

to verify the presence of PFOS, PFOA, PFBS, PFNA, and PFHxS within the stormwater system associated with the AOPI.

In addition, although the CSM for AOPI Vehicle Fire Location 1 in the QAPP Addendum indicated there are potentially complete exposure pathways for off-site groundwater, off-site groundwater samples were not collected (Arcadis 2022). Instead, a groundwater sample was collected from the AOPI to verify the presence of PFOS, PFOA, PFBS, PFNA, and PFHxS in groundwater beneath the AOPI. If PFOS, PFOA, PFBS, PFNA, and PFHxS is detected in groundwater from the AOPI, off-installation groundwater may be evaluated at a future date.

The subsections below summarize the groundwater and soil PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with Vehicle Fire Location 1.

7.1.1 Groundwater

One groundwater sample (AMR-VF-1-GW-44FT-102622) was collected from a temporary well at the Vehicle Fire Location 1 AOPI on 26 October 2022. One field duplicate (AMR-FD-1-GW-102622) was collected from the same temporary well (i.e., the field duplicate corresponds to parent sample AMR-VF-1-GW-44FT-102622). The field duplicate sample results are shown in brackets below following the parent sample results.

- PFOS was detected in the groundwater sample at a concentration of 4.9 J+ (estimated quantity; may be biased high) [4.1 J+] ng/L. The detected concentration exceeds the OSD tap water risk screening level (4 ng/L).
- PFOA was detected in the groundwater sample at a concentration of 1.7 J (estimated concentration) [1.5 J] ng/L. The detected concentration does not exceed the OSD tap water risk screening level (6 ng/L).
- PFBS was detected in the groundwater sample at a concentration of 0.58 J [0.47 J] ng/L. The detected concentration does not exceed the OSD tap water risk screening level (601 ng/L).
- PFNA was detected in the groundwater sample at a concentration of 0.69 J [0.90 J] ng/L. The detected concentration does not exceed the OSD tap water risk screening level (6 ng/L).
- PFHxS was detected in the groundwater sample at a concentration of 1.4 J [1.3 J] ng/L. The detected concentration does not exceed the OSD tap water risk screening level (39 ng/L).

Groundwater analytical results for the Vehicle Fire Location 1 AOPI are presented on **Figure 7-2** and **Table 7-1**.

7.1.2 Soil

Six surface soil samples were collected from 0 to 2 feet bgs via hand auger at the Vehicle Fire Location 1 AOPI on 30 August 2022. Five soil samples (AMR-VF-1-SO-083022, AMR-VF-2-SO-083022, AMR-VF-3-SO-083022, AMR-VF-4-SO-083022, and AMR-VF-5-SO-083022) were collected within the AOPI, and one soil sample (AMR-VF-6-SO-083022) was collected in the adjacent swale. One field duplicate (AMR-FD-1-SO-083022) was also collected and corresponds to parent sample AMR-VF-4-SO-083022. The field duplicate sample results are shown in brackets below following the parent sample results.

- PFOS was detected in two of the six soil samples at concentrations of 0.00063 J mg/kg and 0.0028 mg/kg at AMR-VF-5-SO-083022 and AMR-VF-6-SO-083022, respectively. The detected concentrations do not exceed the OSD residential risk screening level (0.013 mg/kg) or the OSD industrial/commercial risk screening level (0.16 mg/kg).
- PFOA was detected in one of the six soil samples (AMR-VF-6-SO-083022) at a concentration of 0.0009 mg/kg. The detected concentration does not exceed the OSD residential risk screening level (0.019 mg/kg) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFBS was not detected in any of the six soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (1.9 mg/kg) or the OSD industrial/commercial risk screening level (25 mg/kg).
- PFNA was not detected in any of the six soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (0.019 mg/kg) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFHxS was detected in one of the six soil samples (AMR-VF-6-SO-083022) at a concentration of 0.0013 mg/kg. 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).

Soil analytical results for the Vehicle Fire Location 1 AOPI are presented on **Figure 7-2** and **Table 7-2**.

7.2 Former Fire Station #6

The CSM for AOPI Former Fire Station #6 in the QAPP Addendum indicated there are potentially complete exposure pathways for off-site groundwater, off-site groundwater samples were not collected (Arcadis 2022). Instead, a groundwater sample was collected from the AOPI to verify the presence of PFOS, PFOA, PFBS, PFNA, and PFHxS in groundwater beneath the AOPI. If PFOS, PFOA, PFBS, PFNA, and PFHxS is detected in groundwater from the AOPI, off-installation groundwater may be evaluated at a future date.

The subsections below summarize the groundwater and soil PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with Former Fire Station #6.

7.2.1 Groundwater

One groundwater sample (AMR-FFS6-1-GW-47.5-102822) was collected from a temporary well at the Former Fire Station #6 AOPI on 28 October 2022.

- PFOS was detected in the groundwater sample at a concentration of 78 ng/L. The detected concentration exceeds the OSD tap water risk screening level (4 ng/L).
- PFOA was detected in the groundwater sample at a concentration of 15 ng/L. The detected concentration exceeds the OSD tap water risk screening level (6 ng/L).
- PFBS was detected in the groundwater sample at a concentration of 7.2 ng/L. The detected concentration does not exceed the OSD tap water risk screening level (601 ng/L).

- PFNA was detected in the groundwater sample at a concentration of 3.7 ng/L. The detected concentration does not exceed the OSD tap water risk screening level (6 ng/L).
- PFHxS was detected in the groundwater sample at a concentration of 10 ng/L. The detected concentration does not exceed the OSD tap water risk screening level (39 ng/L).

Groundwater analytical results for the Former Fire Station #6 AOPI are presented on **Figure 7-3** and **Table 7-1**.

7.2.2 Soil

Three surface soil samples were collected from 0 to 2 feet bgs via hand auger at the Former Fire Station #6 AOPI on 30 August 2022. Two soil samples (AMR-FFS6-1-SO-083022 and AMR-FFS6-3-SO-083022) were collected near the southern edge of the AOPI, and one soil sample (AMR-FFS6-2-SO-083022) was collected west of the AOPI.

- PFOS was detected in two of the three soil samples at concentrations of 0.0013 mg/kg and 0.0043 mg/kg at AMR-FFS6-1-SO-083022 and AMR-FFS6-2-SO-083022, respectively. The detected concentrations do not exceed the OSD residential risk screening level (0.013 mg/kg) or the OSD industrial/commercial risk screening level (0.16 mg/kg).
- PFOA was detected in two of the three soil samples at concentrations of 0.0015 mg/kg and 0.00048 J mg/kg at AMR-FFS6-2-SO-083022 and AMR-FFS6-3-SO-083022, respectively. The detected concentrations do not exceed the OSD residential risk screening level (0.019 mg/kg) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFBS was not detected in any of the three soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (1.9 mg/kg) or the OSD industrial/commercial risk screening level (25 mg/kg).
- PFNA was not detected in any of the three soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (0.019 mg/kg) or the OSD industrial/commercial risk screening level (0.25 mg/kg).
- PFHxS was not detected in any of the three soil samples. Therefore, there were no exceedances of the OSD residential risk screening level (0.13 mg/kg) or the OSD industrial/commercial risk screening level (1.6 mg/kg).

Soil analytical results for the Former Fire Station #6 AOPI are presented on **Figure 7-3** and **Table 7-2**.

7.3 Investigation Derived Waste

The excess soil IDW generated at AOPI Vehicle Fire Location 1 was stored in three 55-gallon drums, two were full and one was half full, and the excess soil IDW generated at AOPI Former Fire Station #6 was stored in one 55-gallon drum, which was half full. The soil IDW weighed approximately 500 pounds per full drum; therefore, the total soil IDW from both AOPIs totaled approximately 1,500 pounds. Two multi-incremental composite soil samples (one from IDW at AOPI Vehicle Fire Location 1 and one from IDW at

AOPI Former Fire Station #6) were collected and analyzed for PFAS-related compounds, including PFOS, PFOA, PFBS, PFNA, and PFHxS, ignitability, pH, toxicity characteristic leaching procedure (TCLP) volatile organic compounds, TCLP semi-volatile organic compounds, TCLP Resource Conservation and Recovery Act 8 metals, and total petroleum hydrocarbons as gasoline, diesel, and oil.

Based on the analytical results, the soil was classified as non-hazardous waste. Analytical results for PFOS, PFOA, PFBS, PFNA, and PFHxS are summarized below:

- PFOS was detected at a concentration of 0.00060 mg/kg in the soil IDW sample from AOPI Former Fire Station #6 and at a concentration of 0.00010 J mg/kg in the soil IDW sample from AOPI Vehicle Fire Location 1.
- PFOA was detected at a concentration of 0.00011 J mg/kg in the soil IDW sample from AOPI Former Fire Station #6 and was not detected in the soil IDW sample from AOPI Vehicle Fire Location 1.
- PFBS was not detected the soil IDW sample from AOPI Former Fire Station #6 or the soil IDW sample from AOPI Vehicle Fire Location 1.
- PFNA was detected at a concentration of 0.000046 J mg/kg in the soil IDW sample from AOPI Former Fire Station #6 and was not detected in the soil IDW sample from AOPI Vehicle Fire Location 1.
- PFHxS was not detected the soil IDW sample from AOPI Former Fire Station #6 or the soil IDW sample from AOPI Vehicle Fire Location 1.

The PFOS, PFOA, PFBS, PFNA, and PFHxS concentrations observed did not exceed the OSD risk screening levels. The soil IDW was transported by Pacific Commercial Services, Inc. for disposal offsite as non-hazardous waste at the PVT Land Company Limited landfill under clearance number 141440 (**Appendix M**). The full analytical results (i.e., for all constituents analyzed) for IDW samples collected during the SI are included in **Appendix O**.

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. TOC was detected at 10,900 J+ mg/kg in the soil sample collected from AOPI Vehicle Fire Location 1 and at 19,800 J+ mg/kg in the soil sample collected from AOPI Former Fire Station #6. The TOC at this installation was within range of what is typically observed in topsoil (5,000 to 30,000 mg/kg). The combined percentage of fines (i.e., silt and clay) in soils at AMR ranged from 61.1 to 80.9% with an average of 71%. In general, PFAS constituents tend to be more mobile in soils with less than 20% fines (silt and clay) and lower TOC. The percent moisture of the soil at AMR ranged from 9.1 to 20% with an average of 14.87% which is typical for clay soils (0 to 20%). The pH of the soil at both AOPIs was slightly alkaline (7 to 9 standard units). While PFAS constituents are relatively less mobile in soils with high percentages of fines, depleted TOC may allow for enhanced mobility of the constituents in soil.

7.5 Blank Samples

Detections of PFOS, PFOA, PFBS and PFHxS constituents are summarized below for blank samples. PFNA was not detected in blank samples and, other than those noted below, PFOS, PFOA, PFBS, and PFHxS were not detected in any other blank samples.

- PFOS was detected in EB sample AMR-EB-5-102822 collected on 28 October 2022 from the drill casing used for groundwater sampling. PFOS was detected at a concentration of 3.5 ng/L. As indicated in the DUSR Data Usability Summary Table (**Appendix N**), PFOS results for the parent and field duplicate groundwater samples collected from AOPI Vehicle Fire Location 1 were issued a J+ qualifier (estimated quantity; may be biased high) due to EB contamination.
- PFOA, PFBS, and PFHxS were detected in SB sample AMR-SB-2-102822 collected on 28 October 2022 from the water provided and used by the drillers for decontamination of drill tooling. PFOA, PFBS, and PFHxS were detected in the SB sample at concentrations of 2.1 ng/L, 2.4 ng/L, and 2.4 ng/L, respectively. These detections were not identified in the DUSR as having an impact on the validity of the collected groundwater samples (**Appendix N**).

The Source Blank AMR-SB-2-102822 exhibited PFAS detections. The source blank was used for the initial rinse for decontaminating the drill followed by rinses with PFAS free water. EB AMR-EB-5-102822 is associated with the decontamination of the sampling equipment. The final rinse, followed by the EB indicates if any contamination from either the source blank or drilling operation remained on the equipment. Associated sample results are qualified for the PFAS detections in the EBs. The full analytical results for blank samples collected during the SI are included in **Appendix O**.

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.

A CSM figure was developed for each AOPI. The following exposure pathway determinations apply to both CSMs:

- PFOS, PFOA, and PFHxS were detected in soil at the Vehicle Fire Location 1 AOPI. PFOS and PFOA were detected in soil at the Former Fire Station #6 AOPI. 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 at both AOPIs is considered to be complete.
- The AOPIs are wholly located within the installation boundaries, and it is unlikely that off-installation receptors would routinely access the AOPIs. Therefore, the soil exposure pathway for off-installation receptors is considered to be incomplete.
- PFOS, PFOA, PFBS, PFNA, and PFHxS were detected in groundwater samples collected at the AOPIs. Drinking water is provided to AMR from off-installation water sources. There are no on-post drinking water wells. However, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for site workers and residents are potentially complete to account for potential future use of the downgradient on-post groundwater.
- Recreational users are not expected to contact groundwater during outdoor recreational activities. Therefore, the groundwater exposure pathway for on-installation recreational users is considered to be incomplete.
- Groundwater originating at the AOPIs likely flows off-post through the installation’s southwestern boundary, and there are several groundwater wells within a 5-mile radius of AMR. Therefore, the groundwater exposure pathway for off-installation receptors (via drinking water ingestion and dermal contact) is potentially complete.

Figure 7-4 shows the CSM for Vehicle Fire Location 1. AFFF was historically released to soil during an incident response effort at the AOPI.

- PFOS, PFOA, and PFHxS were detected in soil at the Vehicle Fire Location 1 AOPI. On-installation residents will likely access the AOPI when participating in recreational activities (i.e., as recreational users). On-installation recreational users participating in outdoor recreational

activities could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the soil exposure pathway for on-installation recreational users is complete.

- Stormwater from the swale adjacent to the AOPI drains to a nearby channel that flows toward the southern installation boundary. Surface runoff within the crater drains via a storm drain channel, through a tunnel on the south side of the installation and down the slopes of the crater to Salt Lake (located approximately 1,400 feet south/southeast of the AOPI) (Army 2015). Site workers and recreational users accessing the drainage channel could contact constituents (if present) in intermittent stormwater/surface water and soil/sediment within the drainage channel via incidental ingestion and dermal contact. Therefore, the stormwater/surface water and soil/sediment exposure pathways for those receptors are potentially complete.
- Off-installation receptors, including recreational users and personnel at the Honolulu Country Club Golf Course, could contact constituents (if present) in surface water and sediment at Salt Lake through incidental ingestion and dermal contact. Therefore, the surface water and sediment exposure pathways for off-installation receptors are potentially complete.

Figure 7-5 shows the CSM for Former Fire Station #6. An area north of the former fire station building was used as a parking area for a fire truck that contained AFFF.

- PFOS and PFOA were detected in soil at the Former Fire Station #6 AOPI. The AOPI is occupied by residential housing. On-installation residents could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the soil exposure pathway for on-installation residents is complete.

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

8 CONCLUSIONS AND RECOMMENDATIONS

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

PFOS/PFOA testing documentation provided by the Army for AMR indicates drinking water is provided to AMR from water sources that, based on HGGRC records, are located in the inferred upgradient direction from AMR (HGGRC 2020). USAG-HI records indicate that the water is chlorinated and fluoridated. In addition, USAEC personnel indicated that after chlorination and fluoridation, drinking water is processed through an Army-owned granular activated carbon treatment system before it is provided to consumers. Records provided by the Army indicate groundwater was collected from the AMR water sources at sample locations identified as EPTDS (where EPTDS is presumably the entry point to the water distribution systems) on 03 December 2013, 09 December 2013, and 10 December 2013 (prior to installation of the granular activated carbon treatment system in 2021) and analyzed for PFOA and PFOS. The water sample type was post-treatment/finished water (where water is chlorinated and fluoridated). PFOA was not detected above the minimal reportable level of 20 ng/L and PFOS was not detected above the minimal reportable level of 40 ng/L.

An EDR report was generated for AMR, which along with state and county GIS provided by the installation identified several off-post public and private wells within 5 miles of the installation boundary (**Figure 2-4**). No public supply wells identified are downstream, or hydraulically downgradient, of AMR. There is one well roughly 1 mile southeast of AMR's southeastern boundary, but it is not considered to be hydraulically downgradient given that regional groundwater flow in the area is to the southwest. Additionally, per Operations Security guidance/requirements no army-owned wells or on installation wells are shown on figures in the PA/SI report. The EDR report providing well search results is provided as **Appendix D**.

Two AOPIs were sampled during the SI at AMR 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 AMR because HFPO-DA is generally not a component of MIL-SPEC AFFF and based on its history including distribution limitations that restricted use of HFPO-DA, it is generally not a component of other products the military used. In addition, it is unlikely that HFPO-DA would be an individual chemical of concern in the absence of other PFAS. The SI scope of work was completed in accordance with the Final PQAPP (Arcadis 2019) and the AMR QAPP Addendum (Arcadis 2022).

Both AOPIs had detections of PFOS, PFOA, and/or PFHxS in soil. Both AOPIs had detections of PFOS, PFOA, PFBS, PFNA, and/or PFHxS in groundwater that exceeded OSD risk screening levels for PFOS and/or PFOA. The PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results are summarized below:

- PFOS was detected at a maximum concentration of 78 ng/L (above the OSD tap water screening level [4 ng/L]) in the groundwater sample collected from AOPI Former Fire Station #6. PFOS was also detected above the OSD tap water screening level in the parent and duplicate groundwater samples collected from AOPI Vehicle Fire Location 1 at concentrations of 4.9 J+ and 4.1 J+ ng/L, respectively. PFOS results for the parent and duplicate groundwater samples collected from AOPI Vehicle Fire Location 1 were issued a J+ qualifier (estimated quantity; may be biased high) due to EB contamination.

  PFOS was detected at a maximum concentration of 0.0043 mg/kg (below the soil residential risk screening level [0.013 mg/kg]) in a soil sample collected from AOPI Former Fire Station #6. PFOS was also detected at concentrations below the soil residential risk screening level in one additional soil sample from AOPI Former Fire Station #6 and two soil samples from AOPI Vehicle Fire Location 1.

- PFOA was detected at a maximum concentration of 15 ng/L (above the OSD tap water screening level [6 ng/L]) in the groundwater sample collected from AOPI Former Fire Station #6. PFOA was detected below the OSD risk screening level in the parent and duplicate groundwater samples collected from AOPI Vehicle Fire Location 1.

  PFOA was detected at a maximum concentration of 0.0015 mg/kg (below the soil residential risk screening level [0.019 mg/kg]) in a soil sample collected from AOPI Former Fire Station #6. PFOA was also detected at concentrations below the soil residential risk screening level in one additional soil sample from AOPI Former Fire Station #6 and one soil sample from AOPI Vehicle Fire Location 1.

- PFHxS was detected at a maximum concentration of 10 ng/L (below the OSD tap water screening level [39 ng/L]) in the groundwater sample collected from AOPI Former Fire Station #6. PFHxS was also detected below the OSD tap water screening level in the parent and duplicate groundwater samples collected from AOPI Vehicle Fire Location 1.

  PFHxS was detected at a maximum concentration of 0.0013 mg/kg (below the soil residential risk screening level [0.13 mg/kg]) in a soil sample collected from AOPI Vehicle Fire Location 1. PFHxS was not detected in any soil samples collected from Former Fire Station #6, or from any additional soil samples from AOPI Vehicle Fire Location 1.

- PFBS was detected at a maximum concentration of 7.2 ng/L (below the OSD tap water screening level [601 ng/L]) in the groundwater sample collected from AOPI Former Fire Station #6. PFBS was also detected below the OSD tap water screening level in the parent and duplicate groundwater samples collected from AOPI Vehicle Fire Location 1.

  PFBS was not detected in any soil samples collected from AOPI Former Fire Station #6 or AOPI Vehicle Fire Location 1.

- PFNA was detected at a maximum concentration of 3.7 ng/L (below the OSD tap water screening level [6 ng/L]) in the groundwater sample collected from AOPI Former Fire Station #6. PFNA was

also detected below the OSD tap water screening level in the parent and duplicate groundwater samples collected from AOPI Vehicle Fire Location 1.

PFNA was not detected in any soil sample collected from AOPI Former Fire Station #6 or AOPI Vehicle Fire Location 1.

Following the SI sampling, both AOPIs with confirmed PFOS, PFOA, PFBS, PFNA, and PFHxS presence were considered to have complete and potentially complete exposure pathways. Soil exposure pathways for on-installation site workers are complete at both AOPIs. The soil exposure pathway for on-installation recreational users is complete at the Vehicle Fire Location 1 AOPI, and for on-installation residents is complete at the Former Fire Station #6 AOPI. The groundwater exposure pathways for on-installation drinking water receptors are potentially complete to account for potential future potable use of the on-post groundwater downgradient of the AOPIs. Due to a lack of land use controls off-installation and downgradient of AMR, the groundwater exposure pathways for off-installation drinking water receptors are also potentially complete for both AOPIs. Site workers and recreational users could contact constituents in stormwater/surface water and sediment in the drainage channel near the Vehicle Fire Location 1 AOPI, or in the off-post Salt Lake, via incidental ingestion and dermal contact. Therefore, the surface water and sediment exposure pathways for on-installation site workers and recreational users, and for off-installation receptors, are potentially complete for the Vehicle Fire Location 1 AOPI.

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 6-2**). **Table 8-1** below summarizes the AOPIs identified at AMR, PFOS, PFOA, PFBS, PFNA, and PFHxS sampling and recommendations for each AOPI; further investigation is warranted at AMR. In accordance with CERCLA, site-specific risk will be assessed during a future phase to evaluate whether remedial actions are required.

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

AOPI Name	PFOS, PFOA, PFBS, PFNA and/or PFHxS detected greater than OSD Risk Screening Levels? (Yes/No)		Recommendation
	GW	SO	
Vehicle Fire Location 1	Yes	No	Further study in remedial investigation[1]
Former Fire Station #6	Yes	No	Further study in remedial investigation

Notes:
1 = The parent and duplicate groundwater samples had detections greater than the OSD risk screening level; however, the degree to which those sample results are biased high, if at all, is uncertain. This AOPI is recommended for further study in remedial investigation due to the uncertainty of the results and to confirm if exceedances above OSD risk screening levels exist.
Light gray shading – detection greater than the OSD risk screening level
GW – groundwater
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 AMR are discussed below.

PFOS was detected in the parent and field duplicate groundwater samples collected from AOPI Vehicle Fire Location 1 at concentrations of 4.9 ng/L and 4.1 ng/L, respectively, with J+ qualifiers (i.e., estimated quantities that may be biased high) due to EB contamination. Although those concentrations are biased high, further study of AOPI Vehicle Fire Location 1 in a remedial investigation is recommended because the groundwater results exceeded the OSD tap water risk screening level of 4 ng/L. 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 is limited to results from on-post soil and groundwater sampling locations. Available data, including PFOS, PFOA, PFBS, PFNA, and PFHxS, is listed in **Appendix O**, which were analyzed per the selected analytical method. HFPO-DA was not in the suite of PFAS compounds analyzed during the SI at AMR because it was not considered 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 further study in a remedial investigation is warranted at AMR in accordance with the guidance provided by the OSD.

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ACRONYMS

%	percent
AFFF	aqueous film-forming foam
AMR	Aliamanu Military Reservation
amsl	above mean sea level
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
DPW	Directorate of Public Works
DQO	data quality objective
DUSR	Data Usability Summary Report
EB	equipment blank
EDR	Environmental Data Resources, Inc.
ELAP	Environmental Laboratory Accreditation Program
EPTDS	entry points to the distribution system
FCR	Field Change Report
FFD	Federal Fire Department
GIS	geographic information system
HFPO-DA	hexafluoropropylene oxide dimer acid
HGGRC	Hawaii Groundwater & Geothermal Resource Center
IDW	investigation-derived waste
IMCOM	Installation Management Command
installation	United States Army or Reserve installation
LOD	limit of detection
LOQ	limit of quantitation
mg/kg	milligrams per kilogram (parts per million)

MIL-SPEC	military specification
ng/L	nanograms per liter (parts per trillion)
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
SB	source blank
SI	site inspection
SOP	standard operating procedure
SSHP	Site Safety and Health Plan
TCLP	Toxicity Characteristic Leaching Procedure
TGI	technical guidance instruction
TOC	total organic carbon
UCMR3	third Unregulated Contaminant Monitoring Rule
U.S.	United States
USAG-HI	United States Army Garrison, Hawaii
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command

USEPA	United States Environmental Protection Agency
Woodward	Woodward-Clyde Federal Services
WRCC	Western Regional Climate Center

TABLES

Table 6-1 Temporary Monitoring Well Details
USAEC PFAS Preliminary Assessment/Site Inspection
Aliamanu Military Reservation, Hawaii

Area of Potential Interest	Sampling Location ID[1]	Total Well Depth (ft bgs)	Measuring Point	Depth to Static Groundwater Level from MP (ft)	Screened Interval (ft bgs)	Casing Diameter (inches)
Former Fire Station #6	FFF6-1	50.30	Top of inner casing	42.44	45.3 - 50.3	2
Vehicle Fire Location 1	VF-1	45.31	Top of outer casing	26.93	40.31 - 45.31	2

Notes:
1. Groundwater samples were collected from temporary monitoring wells.
2. Screen interval is estimated.

Acronyms/Abreviations:
bgs = below ground surface
ft = feet
ID = identification
MP = measuring point

Source:
Groundwater sampling forms from October 2022 SI sampling (Appendix J).

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

Location	Sample/ Parent ID	Sample Date	Analyte	PFOS (ng/L)		PFOA (ng/L)		PFHxS (ng/L)		PFBS (ng/L)		PFNA (ng/L)	
			OSD Tapwater Risk Screening Level	4		6		39		601		6	
			Sample Type	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
AMR-FFS6-1-GW	AMR-FFS6-1-GW-47.5-102822	10/28/2022	N	**78**		**15**		**10**		**7.2**		**3.7**	
AMR-VF-1-GW	AMR-VF-1-GW-44FT-102622 / AMR-FD-1-GW-102622	10/26/2022	N	**4.9**	J+	**1.7**	J	**1.4**	J	**0.58**	J	**0.69**	J
		10/26/2022	FD	**4.1**	J+	**1.5**	J	**1.3**	J	**0.47**	J	**0.90**	J

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection.
2. Gray shaded values indicate the result was detected greater than the 2022 Office of the Secretary of Defense (OSD) risk screening levels, (OSD. 2022. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. July).

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

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.

Table 7-2 Soil PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Aliamanu Military Reservation, Hawaii

Location	Sample/ Parent ID	Sample Date	Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFHxS (mg/kg)		PFBS (mg/kg)		PFNA (mg/kg)	
			OSD Industrial/Commercial Risk Screening Level	0.16		0.25		1.6		25		0.25	
			OSD Residential Risk Screening Level	0.013		0.019		0.13		1.9		0.019	
			Sample Type	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
AMR-FFS6-1-SO	AMR-FFS6-1-SO-083022	08/30/2022	N	**0.0013**		0.00061	U	0.00061	U	0.002	U	0.00061	U
AMR-FFS6-2-SO	AMR-FFS6-2-SO-083022	08/30/2022	N	**0.0043**		**0.0015**		0.00068	U	0.0023	U	0.00068	U
AMR-FFS6-3-SO	AMR-FFS6-3-SO-083022	08/30/2022	N	0.00064	U	**0.00048**	J	0.00064	U	0.0021	U	0.00064	U
AMR-VF-1-SO	AMR-VF-1-SO-083022	08/30/2022	N	0.00071	U	0.00071	U	0.00071	U	0.0024	U	0.00071	U
AMR-VF-2-SO	AMR-VF-2-SO-083022	08/30/2022	N	0.00075	U	0.00075	U	0.00075	U	0.0025	U	0.00075	U
AMR-VF-3-SO	AMR-VF-3-SO-083022	08/30/2022	N	0.0007	U	0.0007	U	0.0007	U	0.0023	U	0.0007	U
AMR-VF-4-SO	AMR-VF-4-SO-083022 / AMR-FD-1-SO-083022	08/30/2022	N	0.00063	U	0.00063	U	0.00063	U	0.0021	U	0.00063	U
		08/30/2022	FD	0.00068	U	0.00068	U	0.00068	U	0.0023	U	0.00068	U
AMR-VF-5-SO	AMR-VF-5-SO-083022	08/30/2022	N	**0.00063**	J	0.00067	U	0.00067	U	0.0022	U	0.00067	U
AMR-VF-6-SO	AMR-VF-6-SO-083022	08/30/2022	N	**0.0028**		**0.0009**		**0.0013**		0.0024	U	0.00071	U

Notes:
1. Bolded values indicate the result was detected greater than the limit of detection.
2. Data are compared to the Office of the Secretary of Defense (OSD) risk screening levels for both the residential as well as the industrial/commercial scenarios (OSD. 2022. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. July).

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

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

FIGURES

USAEC PFAS
Preliminary Assessment /
Site Inspection
Aliamanu Military Reservation, HI

ARCADIS

Figure 2-1
Site Location

Legend

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

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

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS
Preliminary Assessment /
Site Inspection
Aliamanu Military Reservation, HI

ARCADIS

Figure 2-2
Site Layout

Legend

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

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
Aliamanu Military Reservation, HI

ARCADIS

Figure 2-3
Topographic Map

Legend

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

Note: Elevation contour labels are in feet.

Notes:
1) 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 towards the southwest.
2) Surface water flow direction is based on hydrology and topography.

0 500 1,000
Feet

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
Aliamanu Military Reservation, HI

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Figure 2-4
Off-Post Potable Supply Wells

Legend

- Aliamanu Military Reservation
- Other Military Installation
- Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Public Water Supply System Well
- Other Public Supply Well
- Domestic Well
- Other Designated Use Water Well

Note: Public Water Supply System Well data from the Federal Reporting Data System and includes water systems that provide water to at least 25 people for at least 60 days annually. Other Designated Use Water Wells includes agricultural wells, industrial wells, irrigation wells and wells of other or unknown use.

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

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS
Preliminary Assessment /
Site Inspection
Aliamanu Military Reservation, HI

ARCADIS

Figure 5-2
AOPI Locations

Legend

- 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

Former Fire Station #6

Vehicle Fire Location 1

Aliamanu

Foster Village

Salt Lake

Halawa Stream

Moanalua Stream

Unnamed Stream

South Halawa Stream

Aloha Stadium

Halawa District Park

Aliamanu Park

Salt Lake District Park

Aliamanu Military Reservation

Naval Reservation

Coast Guard Reservation

Commander US Pacific Fleet

Makalapa Naval Reservation

The Mall at Pearl Harbor

Moanalua Golf Club

Honolulu Country Club

0 500 1,000
Feet

USAEC PFAS
Preliminary Assessment / Site Inspection
Aliamanu Military Reservation, HI

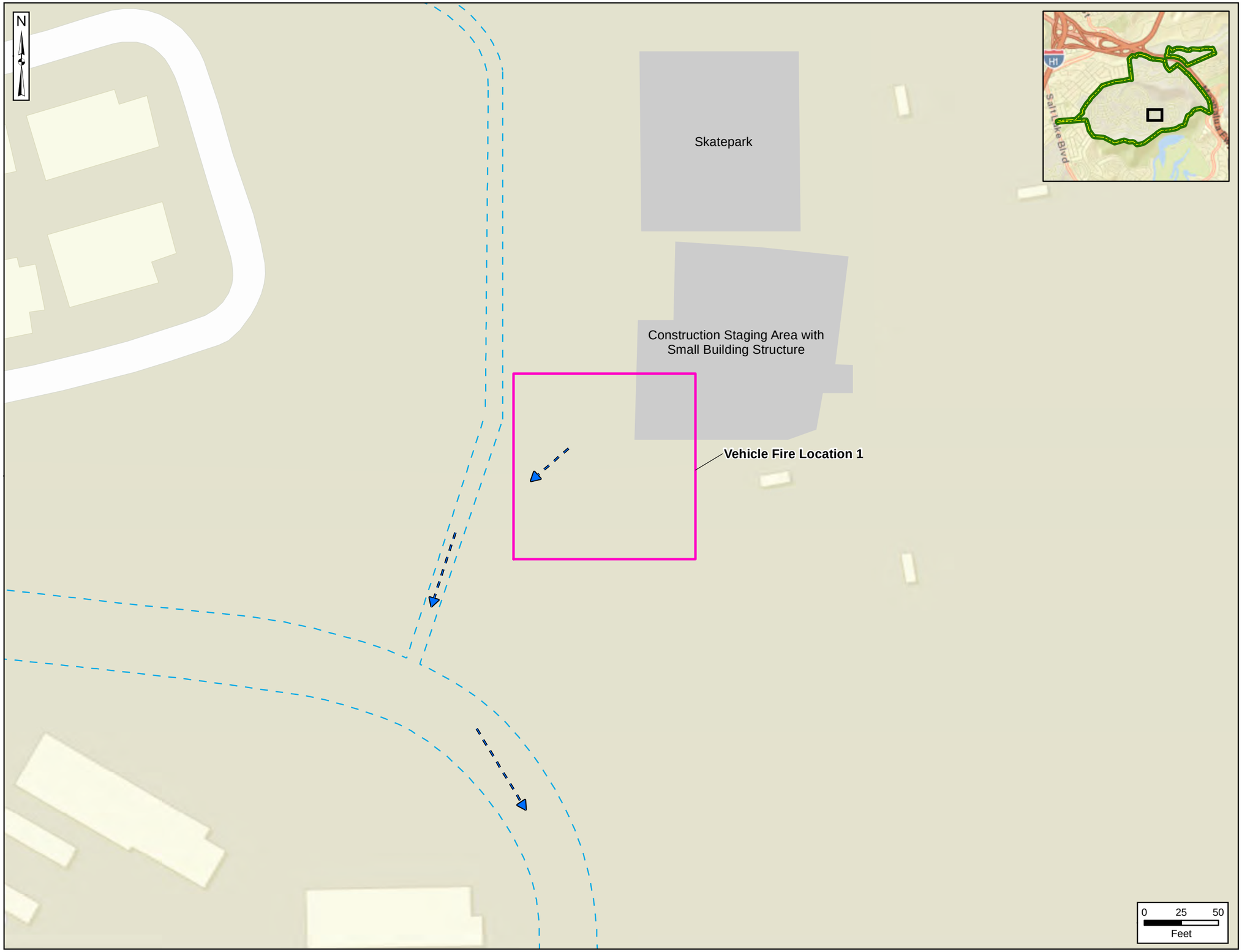

Figure 5-3
Vehicle Fire Location 1

Legend

- Installation Boundary
- AOPI
- Swale and Drainage Channel
- Assumed Stormwater/Surface Runoff Flow Direction

AOPI = area of potential interest

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

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS
Preliminary Assessment / Site Inspection
Aliamanu Military Reservation, HI

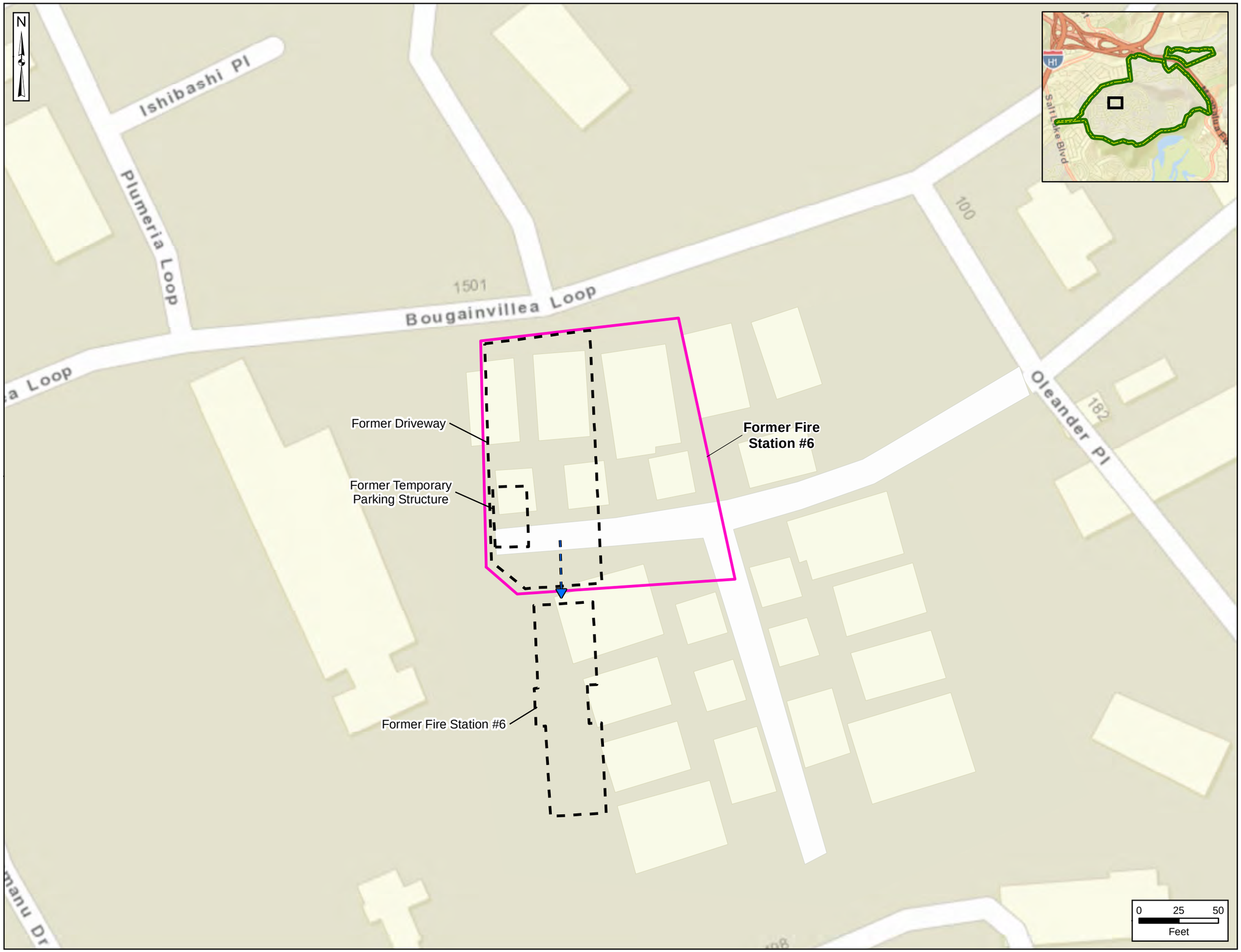

Figure 5-4
Former Fire Station #6

Legend

- Installation Boundary
- AOPI
- Historical Structure Footprint
- Assumed Stormwater/Surface Runoff Flow Direction

Notes:

1) Stormwater/surface runoff direction is based on surface elevation data from aerial imagery that indicates the former parking area slopes toward the south.

2) The AOPI boundary represents the approximate perimeter of an area formerly used for parking a fire truck that contained aqueous film-forming foam (AFFF). AFFF was not stored within the former fire station building.

AOPI = area of potential interest

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

Coordinate System:
WGS 1984, UTM Zone 4 North

USAEC PFAS
Preliminary Assessment /
Site Inspection
Aliamanu Military Reservation, HI

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

Legend

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

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

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

Coordinate System:
WGS 1984, UTM Zone 4 North

0 500 1,000
Feet

USAEC PFAS Preliminary Assessment / Site Inspection Aliamanu Military Reservation, HI

ARCADIS

Figure 7-2
Vehicle Fire Location 1
PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

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

AMR-VF-2-SO	
Date	8/30/2022
Depth	0-2 ft
PFOS	0.00075 U
PFOA	0.00075 U
PFBS	0.0025 U
PFNA	0.00075 U
PFHxS	0.00075 U

AMR-VF-3-SO	
Date	8/30/2022
Depth	0-2 ft
PFOS	0.00070 U
PFOA	0.00070 U
PFBS	0.0023 U
PFNA	0.00070 U
PFHxS	0.00070 U

AMR-VF-6-SO	
Date	8/30/2022
Depth	0-2 ft
PFOS	**0.0028**
PFOA	**0.00090**
PFBS	0.0024 U
PFNA	0.00071 U
PFHxS	**0.0013**

AMR-VF-4-SO	
Date	8/30/2022
Depth	0-2 ft
PFOS	0.00063 U [0.00068 U]
PFOA	0.00063 U [0.00068 U]
PFBS	0.0021 U [0.0023 U]
PFNA	0.00063 U [0.00068 U]
PFHxS	0.00063 U [0.00068 U]

AMR-VF-5-SO	
Date	8/30/2022
Depth	0-2 ft
PFOS	**0.00063 J**
PFOA	0.00067 U
PFBS	0.0022 U
PFNA	0.00067 U
PFHxS	0.00067 U

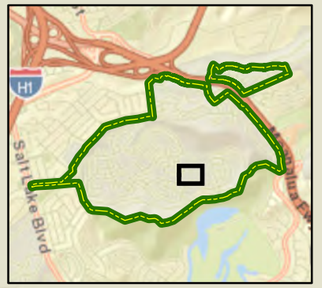
AMR-VF-1-SO	
Date	8/30/2022
Depth	0-2 ft
PFOS	0.00071 U
PFOA	0.00071 U
PFBS	0.0024 U
PFNA	0.00071 U
PFHxS	0.00071 U

AMR-VF-1-GW	
Date	10/26/2022
PFOS	**4.9 J+ [4.1 J+]**
PFOA	**1.7 J [1.5 J]**
PFBS	**0.58 J [0.47 J]**
PFNA	**0.69 J [0.90 J]**
PFHxS	**1.4 J [1.3 J]**

Skatepark

Construction Staging Area with Small Building Structure

Vehicle Fire Location 1



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

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).

Legend

- Installation Boundary
- AOPI
- Swale and Drainage Channel
- Assumed Stormwater/Surface Runoff Flow Direction
- Shallow Soil Sampling Location
- Shallow Soil and Groundwater Sampling Location

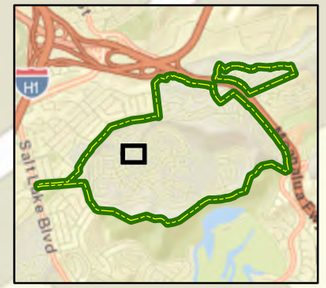
AOPI = area of potential interest
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil

0 25 50
Feet

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

Coordinate System:
WGS 1984, UTM Zone 4 North

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



Bougainvillea Loop
1501
Oleander Pl
100
182
Former Driveway
Former Temporary Parking Structure
Former Fire Station #6
Former Fire Station #6

AMR-FFS6-2-SO	
Date	8/30/2022
Depth	0-2 ft
PFOS	**0.0043**
PFOA	**0.0015**
PFBS	0.0023 U
PFNA	0.00068 U
PFHxS	0.00068 U

AMR-FFS6-3-SO	
Date	8/30/2022
Depth	0-2 ft
PFOS	0.00064 U
PFOA	**0.00048 J**
PFBS	0.0021 U
PFNA	0.00064 U
PFHxS	0.00064 U

AMR-FFS6-1-SO	
Date	8/30/2022
Depth	0-2 ft
PFOS	**0.0013**
PFOA	0.00061 U
PFBS	0.0020 U
PFNA	0.00061 U
PFHxS	0.00061 U
AMR-FFS6-1-GW	
Date	10/28/2022
PFOS	**78**
PFOA	**15**
PFBS	**7.2**
PFNA	**3.7**
PFHxS	**10**

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

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).

0 25 50
Feet

USAEC PFAS Preliminary Assessment / Site Inspection Aliamanu Military Reservation, HI

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Figure 7-3
Former Fire Station #6
PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

Legend
- Installation Boundary
- AOPI
- Historical Structure Footprint
- Assumed Stormwater/Surface Runoff Flow Direction
- Shallow Soil Sampling Location
- Shallow Soil and Groundwater Sampling Location

Notes:

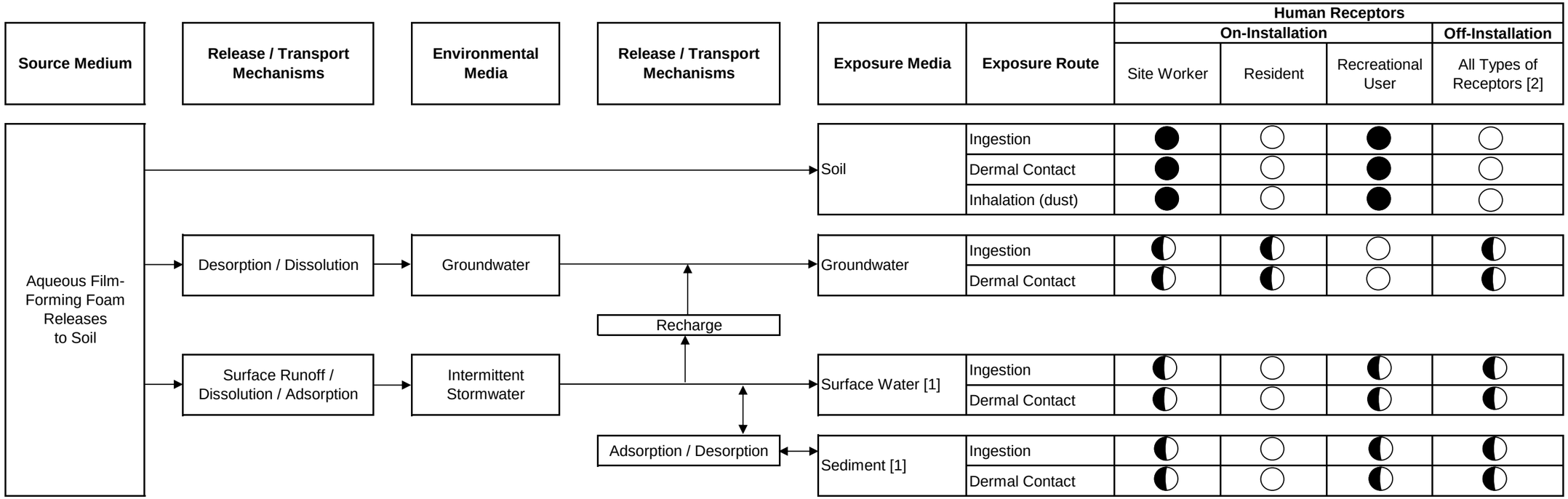
1) Stormwater/surface runoff direction is based on surface elevation data from aerial imagery that indicates the former parking area slopes toward the south.

2) The AOPI boundary represents the approximate perimeter of an area formerly used for parking a fire truck that contained aqueous film-forming foam (AFFF). AFFF was not stored within the former fire station building.

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

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

Coordinate System:
WGS 1984, UTM Zone 4 North



Legend:

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

Notes:
[1] Surface water and sediment exposure pathways describe incidental ingestion and dermal contact during work activities (for Site Workers) or outdoor recreational activities (for Recreational Users).
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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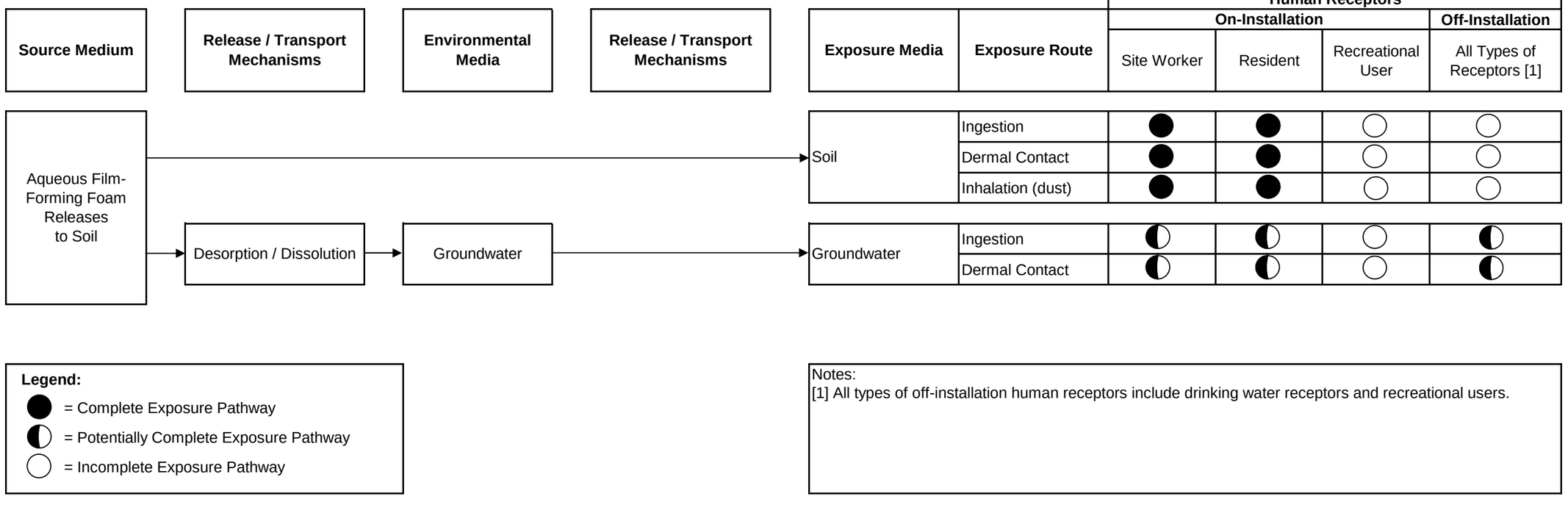
Conceptual Site Model for Vehicle Fire Location 1 AOPI
USAEC PFAS Preliminary Assessment / Site Inspection
Aliamanu Military Reservation, Hawaii

Figure 7-4



Conceptual Site Model for Former Fire Station #6 AOPI
USAEC PFAS Preliminary Assessment / Site Inspection
Aliamanu Military Reservation, Hawaii

Figure 7-5