FINAL PRELIMINARY ASSESSMENT OF PER- AND POLYFLUOROALKYL SUBSTANCES

USAG Kwajalein Atoll

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Preliminary Assessment of Per- and Polyfluoroalkyl Substances

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The United States (U.S.) Army (Army) is performing preliminary assessments (PAs) 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 worldwide. 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. This U.S. Army Garrison Kwajalein Atoll (USAG-KA) PA was completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, The National Oil and Hazardous Substance Pollution Contingency Plan, and Army/Department of Defense (DoD) policy and guidance.

Kwajalein Atoll is in the northern equatorial Pacific Ocean, approximately 700 nautical miles north of the equator and 2,100 nautical miles southwest of Honolulu, Hawaii. The atoll is approximately 75 nautical miles long, averages 15 nautical miles in width, and encompasses approximately 100 islands. The islands, which total 10.2 square miles of landmass, surround one of the largest lagoons in the world, covering over 900 square miles. All the islands of Kwajalein Atoll are low coral islands averaging 6 feet above mean sea level (amsl), with a few natural or man-made points rising above 15 feet amsl. This PA focuses on the Kwajalein and Roi-Namur islands.

Based on the results of the PA for the entire installation, 20 AOPIs were identified. Therefore, further PFAS investigation at USAG-KA is warranted at this time.

1 INTRODUCTION

The United States (U.S.) Army (Army) is performing preliminary assessments (PAs) 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. 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 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 purpose of this PA is to identify locations that are areas of potential interest (AOPIs) at U.S. Army Garrison Kwajalein Atoll (USAG-KA) 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). This report provides the PA for USAG-KA and was completed in accordance with CERCLA and The National Oil and Hazardous Substances Pollution Contingency Plan.

1.1 Project Background

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

In 2016, the United States Environmental Protection Agency (USEPA) established a lifetime health advisory (LHA) of 70 nanograms per liter (ng/L) in drinking water for PFOS or PFOA and for the sum of PFOS and PFOA when both are present (USEPA 2016). On 15 October 2019, the Office of the Secretary of Defense (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**.

1.2 PA Objectives

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

1.3 PA Process Description

For USAG-KA, the PA development process is described in **Sections 1.3.1** through **1.3.3** below. **Section 3** provides a summary of the PA activities completed at USAG-KA. The PA processes are documented in the PA 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 the U.S. Army Environmental Command (USAEC), U.S. Army Corps of Engineers (USACE), USAG-KA, and Arcadis U.S., Inc. (Arcadis). The kickoff call occurred on 16 October 2020 to discuss the goals and scope of the PA, project scheduling, timeline for the site visit, access to installation-specific databases, and to request available records.

Records research was conducted before scheduling 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 USAG-KA.

A read-ahead package was prepared and submitted to the appropriate POCs on 29 December 2020. The read-ahead package contains the following information:

- The Installation Management Command (IMCOM) operation order
- The Army PA Operations Security requirements package, which includes the antiterrorism/operations security review cover sheet (**Appendix C**)
- The PFAS PA kickoff call minutes
- An information paper on the PA portion of the Army's PFAS PA
- Contact information for key POCs
- A list of the data sources requested and reviewed
- A list of preliminary locations identified during the kickoff call 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 between 10 February 2021 and 11 June 2021. Due to the remote location of Kwajalein and COVID-19 related travel restrictions, Arcadis requested USAG-KA installation staff conduct the site visit. A site reconnaissance coordination meeting was held to provide installation staff with the objectives of the site visit.

Personnel interviews were conducted via telephone with individuals having significant historical knowledge at USAG-KA. The interviews focused on confirming information discussed in historical documents, collecting information that may not have been in historical documents, and corroborating other interviewees' information. **Section 3** includes information regarding interviewed personnel.

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 potential 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 (e.g., paved or unpaved, visual staining), surface water bodies and surface flow, potential receptors, and the distance to the installation boundary. Photo documentation of the preliminary locations was collected, and access limitations or advantages related to potential future sampling activities were noted.

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.

2 INSTALLATION OVERVIEW

The following subsections provide general information about USAG-KA, 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 water wells within a 5-mile radius of the installation, and applicable ecological receptors.

2.1 Site Location

Kwajalein Atoll is in the northern equatorial Pacific Ocean, approximately 700 nautical miles north of the equator and 2,100 nautical miles southwest of Honolulu, Hawaii (**Figure 2-1**). The atoll is approximately 75 nautical miles long, averages 15 nautical miles in width, and encompasses approximately 100 islands. The islands, which total 10.2 square miles of landmass, surround one of the largest lagoons in the world, covering over 900 square miles. All Kwajalein Atoll islands are low coral islands averaging 6 feet above mean sea level (amsl), with a few natural or manmade points rising above 15 feet amsl (DynCorp International, LLC [DynCorp] 2019). USAG-KA encompasses all or a portion of 11 islands within the Kwajalein Atoll of the Republic of the Marshall Islands; however, this PA focuses on the Kwajalein (**Figure 2-2a**) and Roi-Namur (**Figure 2-2b**) Islands. Kwajalein Island and Roi-Namur Island are located at the atoll's southern and northern extremity, respectively, with approximately 43.4 nautical miles spanning between them (WHPacific 2012).

2.2 Mission and Brief Site History

An Army garrison was established at U.S. Army Kwajalein Atoll (USAKA) in October 2013, which is now referred to as USAG-KA, although USAKA is still used often when referring to the geographic or physical location. USAG-KA consists of the 11 leased islands, but references to the 11 leased islands prior to October 2013 are properly (historically) referred to as USAKA. The population of USAG-KA is approximately 1,500 which includes military personnel, government civilians, technical support contractors, and family residents (DynCorp 2019).

Relatively little is known of the pre-Japanese-era history of Kwajalein Atoll (i.e., pre-1914). The Japanese took over administration of most of Micronesia, including the Marshall Islands, in 1914, shortly after the outbreak of World War I. In 1939, Japan began to fortify the Marshall Islands. Kwajalein Atoll became the headquarters for the Japanese 6th Base Force and Fourth Fleet, with principal military installations established on Kwajalein and Roi-Namur Islands by 1943. The Japanese turned the atoll, and Kwajalein Island in particular, into a stronghold, through which shipping, supplies, and reinforcements flowed to the other Marshall Islands atolls. Kwajalein Island contained communication and weather observation units and an airstrip. A major airstrip and submarine base were established at Roi-Namur Island, with other installations scattered on various islands throughout the atoll. Roi-Namur and Kwajalein Islands were primary targets in the U.S. invasion of the Marshall Islands. Kwajalein Atoll was the site of World War II fighting in late January and early February 1944 during "Operation Flintlock," which was the code name for the American landings. The atoll, particularly Roi-Namur and Kwajalein Islands, were subjected to heavy bombardment (DynCorp 2019).

Portions of Kwajalein Atoll have been continuously used for military purposes by the U.S. government since World War II. It was first a refueling and communications base, then a support facility for the testing of nuclear weapons at Bikini and Enewetak Atolls, and later a test site for the Nike-Zeus Anti-Missile Program. Army control of Kwajalein Atoll was established in 1964 after being transferred from the U.S. Navy. The U.S. Navy operated the facility from 1944 to 1964 after the U.S. liberation of the atoll from the Japanese during World War II. After several changes in command, the Kwajalein Missile Range, since renamed Reagan Test Site (RTS), was designated for testing guided and ballistic missiles, and anti-ballistic missile systems. Currently, 11 of the atoll's islands are controlled by USAG-KA (WHPacific 2012).

Historically, Kwajalein represented a permanent dwelling or residence island. It contained base headquarters/operations, housing, community support, communications, radar/optical sensors, meteorological rocket launches, range support, and ordnance disposal. Because of major alterations to the island by the Japanese, and later by Americans, most traditionally used and frequented sites remain buried under various fill layers. Studies have consistently revealed there is a post-World War II layer of fill (of varying depths) covering most of the island's surface (DynCorp 2019).

Historically, Roi-Namur Island contained radars, missile launches, optical sensors, housing, community support, range support, and ordnance disposal. Similar to Kwajalein Island, Roi-Namur Island also underwent considerable alterations in shape and size. Roi-Namur was originally composed of four islands, Roi, Enedrikdrik, Kottepina, and Namur, then connected through a causeway built by the Japanese, and later completely filled in by the Americans. Significant traditional sites were located in the intra-island area including bathing pools and dwellings (DynCorp 2019).

2.3 Current and Projected Land Use

Numerous organizations operate at the 11 islands utilized by USAG-KA under direction of the Garrison Commander or under host-tenant agreements. Other organizations arrive periodically to use the facilities under temporary agreements. The RTS is a tenant organization to USAG-KA, a subordinate command of the U.S. Army Space and Missile Defense Command/U.S. Army Forces Strategic Command. The installation supports the RTS in support of theater missile defense, ballistic missile defense, and intercontinental ballistic missile testing. Kwajalein Atoll also has a missile and space objects tracking mission utilizing an array of powerful radar dishes located on Roi-Namur Island. In addition, Kwajalein Atoll supports other DoD training activities as well as commercial space launch operations (WHPacific 2012). Additionally, the U.S. Air Force, Missile Defense Agencies and others are on-site tenants. The isolated location, coupled with one of the world's largest lagoons and specialized state-of-the-art data-gathering devices, makes USAG-KA uniquely suited for research, development, and testing activities for these tenant organizations (DynCorp 2019).

There are a variety of historic properties on the USAG-KA islands including a significant number of historical Cold War Era buildings and structures, a WWII Battlefield National Landmark (occupying most of Kwajalein and Roi-Namur), a number of historic structures and ruins associated with pre-war Japanese occupation, and a number of archaeological sites ranging from prehistoric settlement through the Cold War Era. Only a few Japanese structures remain standing on Kwajalein Island because of the heavy bombardment during the battle and major development of the island by the U.S. during the post-war years. The surviving structural remains on Roi-Namur, however, are representative of a wide range of

Japanese World War II activities, including the command post, ordnance and machine gun bunkers, artillery posts, oxygen production complex, hospital, and support facilities (DynCorp 2019).

2.4 Climate

Kwajalein Atoll has a tropical marine climate that exhibits little variation through the year. The atoll experiences a relatively dry windy season from mid-December to mid-May, and a relatively wet calm season from mid-May to mid-December. Normal annual rainfall is approximately 100 inches; approximately 72 percent (%) of the annual rainfall occurs during the wet season and 28% during the dry season. On average, the prevailing wind direction is from the east-northeast during the entire year, although winds may become more variable during the wet season when occasional southerly or even westerly winds occur. The average wind speed is approximately 17 miles per hour (mph) from December to April, and 12 mph from May to November. The average daily maximum temperature is 86.5 degrees Fahrenheit (ºF); the average minimum temperature is 77.6º F. The extreme temperatures recorded at the atoll are 97 ºF and 68 ºF. Average relative humidity ranges from 83% at local noon to 78% at midnight. Most of the rainfall on Kwajalein Atoll comes from rain showers; thunderstorm occurrences are infrequent. On average, thunderstorms occur fewer than 12 days each year. The frequency of thunderstorms ranges from 0.1 per month from January to March to two per month in September. Since 1919 (during the modern era of recordkeeping), a fully developed typhoon has never struck Kwajalein Atoll; however, tropical storms with sustained winds from 40 to 74 mph impact the atoll on average about once every 4 to 7 years. Rainfall varies significantly across the atoll with Roi-Namur receiving roughly 60% to 70% of the Kwajalein Island average of approximately 100 inches per year (WHPacific 2012).

2.5 Topography

All Kwajalein Atoll islands are low coral islands averaging 6 feet amsl. The islands in the atoll are relatively flat, with few natural points exceeding 15 feet amsl and virtually no natural depressions (e.g., lakes). Wave action has the effect of leveling the sandy soil, contributing to the islands' relative flatness (DynCorp 2020b).

2.6 Geology

Atolls are formed through a combination of geological and biological processes including volcanic action, sea floor subsidence, changes in sea level, and coral reef growth. The shallow undersea slopes of young volcanoes are colonized by lime-secreting coral polyps and coralline algae species that grow to form a calcareous fringing reef. The reef continues to grow even as the volcanic island reaches maturity and starts the process of erosion and subsidence. Eventually, a barrier reef surrounds the island. As subsidence and erosion continues, the volcanic island core disappears below sea level, leaving a ring of intertidal reef flats and islands of accumulated sand and rubble. The undersea mountains on which the Marshall Islands rest are believed to have formed by an emergence of magma during the Cretaceous period and range in age from approximately 68 to 140 million years. Additionally, the land surfaces of the Marshall Islands were exposed during the Holocene period in geologic history, some 2,000 to 5,000 years ago, when sea levels rose and dropped. The islands are dynamic structures that continue to move, grow, and retreat in response to changing seas and vegetation, and have been modified by human habitation since shortly after their emergence above sea level, with particularly rapid change in the past 100 years (DynCorp 2019).

Soils on Kwajalein Atoll mainly consist of unconsolidated, reef-derived calcium carbonate sand and gravel with minor consolidated layers of coral, sandstone, and conglomerate. Core samples and drilling logs at Kwajalein Island indicate mostly unconsolidated carbonate sediments down to just over 100 feet below ground surface, with hard layers being more prevalent on the ocean side of the island. Studies on Kwajalein Island have shown that the lagoon side of the island consists of unconsolidated sediments that are thicker and contain a greater proportion of low-permeability back-reef sand than the ocean side. Drilling logs suggest a greater proportion of coarse, high-permeability rubble on the ocean side (WHPacific 2012).

2.7 Hydrogeology

The thick accumulation of limestone layers, unconformities caused by sea level changes over time, and tidal activity play an important role in the fresh groundwater dynamics. Groundwater is very shallow throughout the atoll at depths ranging from 4 to 9 feet below ground surface. A thin freshwater lens lies atop the brackish groundwater on the largest islands, including Kwajalein and Roi-Namur Islands. Lens thickness is proportional to island width and rate of groundwater recharge and is inversely proportional to hydraulic conductivity. The groundwater lens was identified as thickest near the lagoon (on Kwajalein Island), where unconsolidated sediments were thickest and contained a greater proportion of low-permeability back-reef sand. The lens was thinner near the ocean, where historical drilling logs suggested a greater proportion high-permeability rubble (WHPacific 2012).

Only Kwajalein and Roi-Namur islands have a developed lens well system that can collect groundwater for potable water use. These shallow, heterogeneous, unconfined aquifers are composed mostly of unconsolidated, reef-derived, calcium-carbonate sand and gravel with a few layers of consolidated rock derived from coral. The fresh groundwater lens is formed from rainwater infiltration and is very thin. Density differences between freshwater and saltwater create a lens-shaped body of freshwater that floats on top of the saltwater. The thickness of the freshwater lens and the extent of the transitional zone can be approximated by the Ghyben-Herzberg principle, which states that in permeable rocks along the coast, saltwater is first encountered at a depth below sea level about 40 times the height of the freshwater table above sea level. However, a sharp interface between freshwater and saltwater does not exist under dynamic equilibrium. The thickness of the transition zone (thus the amount of freshwater that can be withdrawn) depends on regional and local recharge mechanisms, such as precipitation, diurnal and seasonal tidal fluctuations, natural freshwater loss to the ocean across hydraulic gradients, and pumping rate of any groundwater that is withdrawn. Freshwater is most abundant in the central part of both Kwajalein and Roi-Namur islands where the aircraft runways are located. On Kwajalein Island, the freshwater lens is thicker on the lagoon side than on the ocean side, with a maximum thickness of 37 feet. On Roi-Namur, the freshwater lens is roughly circular, with a maximum thickness of 23 feet; however, the lens may be absent or very thin on the Namur side because of the high evapotranspiration rate (DynCorp 2020b).

Groundwater gradients radiate out from groundwater mounds near the center of the islands. The shallow depth to groundwater and the high permeability of the soils makes the groundwater systems of the Kwajalein Atoll islands highly vulnerable to contamination by chemicals. Historical studies on Kwajalein

Island indicate that aquifer tidal efficiency (i.e., the ratio of feet of tidal change to feet of change in aquifer water level) increases with depth and proximity to the ocean and lagoon shores and is somewhat higher on the ocean side. This included areas of native soil and areas created with dredge fill (WHPacific 2012).

The atoll soils may be characterized as highly permeable with poor fertility as a result of coarse-grained sand and gravel, low organic content and nutrients, and high alkalinity. This type of dispersive medium is very conducive to the vertical and horizontal movement of water and contaminants through the soil (DynCorp 2020b).

2.8 Surface Water Hydrology

Surface water resources at USAG-KA include the ocean and lagoon waters surrounding the atoll. USAG-KA ocean waters are considered to be of excellent water quality and support a large diversity of marine species. There are no substantial lakes or other surface water features (such as streams, rivers, wetlands) on the USAG-KA-controlled islands. With a mean elevation of less than 6 feet, streams and lakes do not develop. However, two islands (Roi-Namur and Legan) have saltwater ponds that are influenced by tidal forces. On Roi-Namur, there is a tidal pond between Roi and Namur that has developed following the construction of the fill area between the islands. These areas serve as habitat for certain birds, insects, and emergent plants (DynCorp 2020b).

The ocean waters surrounding the Kwajalein Atoll are considered relatively pristine, due in part to the high level of mixing caused by prevailing trade winds and the lack of influence by any large nearby land masses. The atoll itself resulted from volcanic activity over 70 million years ago. As the volcanoes subsided, coral reefs grew upward and formed a ring of islands. Reef flats typically extend a few hundred feet off the islands and are exposed at low tide. Ocean depths on the outside of the reef flat increase rapidly to as much as 13,000 feet within 5 miles of the atoll (DynCorp 2020b).

Kwajalein Atoll is one of the largest atolls in the world, enclosing over 900 square miles of lagoon waters. The lagoon depth varies from between 120 and 180 feet, although numerous coral heads lie just beneath or even emerge from the lagoon surface. The lagoon waters tend to be slightly warmer than the deeper ocean waters and many beaches line the lagoon-side of the islands. Approximately 25 natural passages through the atoll ring allow for water exchange with the ocean driven by tidal forces as well as prevailing trade winds and wave-generated currents. The colder ocean water flows westerly or southwesterly through the passages and, at higher tide, over the reef into the lagoon. The general surface flow within the lagoon is southwesterly at a surface speed of 2 to 4 knots. This circulation pattern is not subject to reversal with tidal stage, but instead intensifies during tidal change, reaching its peak velocity at mid-tide. All these factors serve to keep the lagoon relatively well mixed and the dissolved oxygen, salinity, and pH levels of the lagoon similar to those of general oceanic conditions. However, the fill area between Roi and Namur islands do not have culverts to allow water to flow through. This has the potential to adversely affect circulation within the lagoon, but specific studies have not been done. In addition, other activities such as unlined landfills utilized by the Republic of the Marshall Islands and the U.S. and point-source discharges (e.g., stormwater run-off, cooling waters, and Wastewater Treatment Plant [WWTP] effluent) may also affect the water quality of the lagoon (DynCorp 2020b).

Rainwater is a valuable resource as it constitutes the major source of drinking water for USAG-KA residents. Rainwater catchment areas on the Kwajalein and Roi-Namur airfields provide raw water to the drinking water plants. Because of the porosity of soils at USAG-KA, rainwater that is not captured percolates quickly into groundwater or runs off via stormwater conveyance systems (DynCorp 2020b).

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-containing materials at USAG-KA.

2.9.1 Stormwater Management System Description

USAG-KA soil is very permeable because of its sandy, coraline make-up so there is a higher likelihood that pollutants will make their way into groundwater. However, the islands of Kwajalein and Roi-Namur have large percentages of land area that is paved for aircraft landing strips, roads, or industrial activities. Therefore, stormwater is channeled into conduits or drains that run into surface waters.

There are 12 residential stormwater outfalls and 26 industrial stormwater outfalls on Kwajalein Island (DynCorp 2020b). Stormwater runoff from the residential portion of Kwajalein Island, including from houses and streets, is collected, and discharged to the lagoon by a series of inlets and interceptor pipes. These structures drain the narrow unpaved perimeter road. Stormwater runoff from the industrial portion of Kwajalein Island is collected through inlets and interceptor pipes that drain most of the area. The exceptions are the heavily paved maintenance and fuel storage areas that are drained by uncovered, concrete-lined channels (DynCorp 2014). Best management practices, including physical barriers and materials management, are put in place to protect discharges. Both general and site-specific best management practices are identified in the USAG-KA Stormwater Pollution Prevention Plan (DynCorp 2020b). Stormwater, along with wastewater, is treated at the Kwajalein WWTP and utilized as reclaimed water. Treated water that doesn't meet applicable standards is discharged into the lagoon. There are no stormwater outfalls on Roi-Namur Island (DynCorp 2020b). There are several industrial stormwater discharges to the lagoon and to the ocean (DynCorp 2014).

2.9.2 Sewer System Description

Most of the domestic wastewater generated on Kwajalein is collected by an island-wide sewer system and treated at the Kwajalein WWTP. The plant is designed to provide secondary treatment using the activated sludge process for an average daily flow of 0.45 million gallons per day and peak flow of 0.6 million gallons per day. Approximately 85% of the treated wastewater is diverted to the reclaimed water system where it receives additional treatment with sand filtration and chlorination to make it suitable for non-potable uses such as sanitation and irrigation. The treatment plant effluent that is not diverted to the reclaimed water system is discharged to the lagoon at the end of the fuel pier through a submerged outfall pipe that is attached to the full length of the fuel pier. There are buildings located in the industrial area that are not connected to the domestic wastewater collection system. These buildings are served by septic tank and leach field systems that do not have point-source discharges to surface waters (DynCorp 2014).

Reclaimed water is derived from the secondary wastewater treatment effluent of the Kwajalein WWTP. Since 1994, reclaimed water has been used for sanitary flushing and irrigation. Industrially, reclaimed water is used for concrete batching, dust control, water supply for high-pressure washing, washing/cleaning, trench compaction water, and some fire-fighting needs. Reclaimed water is pumped through the system previously used for saltwater distribution. This distribution system is separate from that of the potable water distribution system and the saltwater system that supplies the power plants. The reclaimed water system has proven valuable in both reducing freshwater consumption on Kwajalein by 25% as well as reusing 80% to 95% of the wastewater effluent previously discharged into the lagoon. The system has indirectly improved the operation of the WWTP and the distribution system by eliminating corrosion problems associated with saltwater in the previous system (DynCorp 2014).

The Roi-Namur WWTP was completed in 1997. Gravity lines that convey wastewater to the Roi-Namur WWTP collect most of the domestic wastewater generated on Roi and portions of Namur. The WWTP is designed to provide primary treatment using the gravity sedimentation process. The treated effluent is discharged to the ocean through an outfall pipe. USAG-KA is required to inspect the integrity of the outfall pipe annually. USAG-KA is also required to sample six separate locations in the perimeter of the ocean where the Roi-Namur WWTP outfall pipe is located. This is done to ensure the quality of receiving ocean waters since Roi-Namur provides only primary rather than secondary wastewater treatment. There are buildings located on Namur that are not connected to the domestic wastewater collection system. These buildings are served by septic tanks and leach field systems that do not have point-source discharges to surface waters (DynCorp 2014).

Sewage solids from the sewage drying beds on Kwajalein and Roi-Namur Islands are mixed with compost on Kwajalein or disposed in the landfill and mixed with soil cover layers. Sewage sludge or septage must meet the requirement of U.S. Army Kwajalein Atoll Environmental Standards prior to land application (DynCorp 2020b).

In addition to the WWTPs on Kwajalein and Roi-Namur, there are a number of septic tanks at USAG-KA. The water from toilets, sinks and showers, dishwashers, and washing machines passes from a building into a septic tank, where it undergoes anaerobic decomposition. Solid wastes settle out in the septic tank and the effluent flows to the distribution box. Through perforated lines, the effluent is evenly distributed throughout the absorption field (DynCorp 2020b).

2.9.3 Industrial Wastewater Management Description

Activities that discharge industrial wastewater to surface waters on Kwajalein Island include the adult and family saltwater swimming pools, fuel farm containment area, and the drinking water treatment plant reverse osmosis wastewater. The saltwater swimming pools are connected to the ocean-side saltwater pump station and are operated in the continuous overflow mode with outfall pipes located at the shoreline. Both pools are chlorinated. Wastewater from the reverse osmosis treatment system consists primarily of concentrated brine plus the membrane backwash water. The fuel farm periodically disposes of water that has accumulated in the bottom of the bulk fuel storage tanks. This water is directed to the sanitary sewer following pretreatment through an oil/water separator (DynCorp 2014).

Activities that discharge industrial wastewater to surface waters on Roi-Namur include the drinking water catchments, raw water storage tanks, and the fuel farm containment area. An outfall pipe located on the ocean shoreline north of the drinking water treatment plant is used to drain excess water off the catchments or from the raw water storage tanks. The fuel farm containment area oil/water separator drains to the lagoon. Industrial wastewaters generated for maintenance operations on Namur, including the radars, are discharged to septic tanks and do not create a point-source discharge to surface waters (DynCorp 2014).

2.9.4 Landfills

Most of the USAG-KA waste generation and disposal activities are concentrated on the islands of Kwajalein and Roi-Namur. All landfills lack a liner, leachate collection system, and low-permeability cover to prevent percolation and seepage to the groundwater. Surface water and groundwater are potentially affected by contaminated precipitation runoff and leachate that is formed from the liquids found in the waste as well as leaching of the solid waste by rainwater. The Soil and Groundwater Contamination Study of 1991, as well as several sources cited in the Soil and Groundwater Contamination Study, confirmed that the surface soil has been contaminated with chlorinated solvents, polycyclic aromatic hydrocarbons, and metals near the Kwajalein landfill (DynCorp 2020b).

2.10 Potable Water Supply and Drinking Water Receptors

Potable water resources at USAG-KA consist of rainwater obtained from catchments on four of the islands and groundwater lenses beneath Kwajalein and Roi-Namur. Seasonal rainfall is the primary source of freshwater at Kwajalein Atoll. Normal annual precipitation on Kwajalein is approximately 100 inches; however, the amount of precipitation is highly variable, ranging from 54.79 inches in 2013 to 149.13 inches in 1950. Roi-Namur typically gets about 25% less rain per year than Kwajalein. Normal annual precipitation on Roi-Namur is approximately 76 inches (utilizing data from 1998 through 2018); however, the amount of precipitation is variable ranging from 44.26 inches in 2008 to 117.83 inches in 2018. The wet season is typically from June through November, with an average monthly precipitation between 8 to 12 inches. During the dry season months (December through May), rainfall varies from 3 to 8 inches. Occasionally, severe droughts occur and last longer than a year, such as during 1983 to 1984, when the annual rainfall was approximately 40% below average. Rainwater is captured for potable water use via catchment areas and fresh groundwater lenses. Kwajalein and Roi-Namur Islands have a joint system of rain catchments and shallow lens wells (DynCorp 2020b).

On Kwajalein Island, rainfall is captured for use as potable water from a catchment area. The water is collected in two lined catchment areas, consolidated at a sump, and conveyed to raw water storage tanks. A third unlined catchment area serves to recharge the freshwater lens. Capture efficiency is currently estimated at about 800,000 to 900,000 gallons of water per inch of rainfall. The strategy at Kwajalein Island, as well as the other islands, is to collect rainwater during the rainy seasons and use some of that water during drier seasons. Water from Kwajalein is used to supply some of the other USAG-KA islands as well as visiting ships. On Roi-Namur, there are two lined catchment basins. These catchments yield a total of 250,000 to 800,000-gallons of water per month (DynCorp 2020b).

There are several potable supply wells on Kwajalein Island and Roi-Namur Island. See **Table 2-1** for a description of on-post potable wells.

Potential on-site receptors include current and future site workers (includes groundskeepers, operations personnel, and construction workers) and current and future residents (includes transient passersby and recreational users) (WHPacific 2012).

There are no off-post wells due to the remote location of USAG-KA. Consequently, an Environmental Data Resources, Inc. report was not generated for USAG-KA.

2.11 Ecological Receptors

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

Kwajalein Atoll has a variety of unique plant and animal species that require special regulatory consideration. The coral reef that is a habitat for various species is sensitive to pollution from sewage discharge, sediment accumulation, and dredging and filling. Rare, threatened, and endangered terrestrial and marine species, including sea turtles, giant clams, and seagrasses, are present at USAG-KA and in the surrounding ocean. Plant species ranging from broadleaf forests to exotic specimens characterize the flora of the atoll. Native plant species at USAG-KA provide breeding and feeding habitats for native and resident birds, breeding seabirds, migratory shorebirds, and freshwater birds. Plant species also provide protection from wind desiccation and support for animal species of special concern. Clearings for buildings, runways, and other structures have resulted in a net loss of nesting habitat and a decrease in the populations of some bird species (USAKA 2016).

2.12 Previous PFAS Investigations

While there are no previous (i.e., pre-PA) PFAS investigations relative to USAG-KA, there were historical PFAS sampling events that occurred in response to a reported aqueous film-forming foam (AFFF) release. The AFFF release incident is described in **Section 5.2.1.8**. The results of the sampling events are summarized to provide full context of available PFAS data for USAG-KA. However, only data collected by the Army will be used to make recommendations for further investigation.

PFOS and PFOA were analyzed in samples collected from nine sampling locations in 2019 and ten sampling locations in 2020. PFOS and/or PFOA were observed at concentrations above the limit of quantitation values at all sampling locations. Exceedances above the LHA of 70 ng/L in drinking water ranged from 83 to 220,000 ng/L (DynCorp 2020a). The reports from these sampling events are included as **Appendix D**.

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 USAG-KA, data were collected from three principal sources of information:

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

These information sources, along with their relative application to this PA, are discussed below. The specific findings of records review, personnel interviews, and site reconnaissance relevant to PFAS-containing materials at USAG-KA are described in **Section 4**.

3.1 Records Review

The records reviewed for this PA included, but were not limited to, compliance documents, USAG-KA fire department documents, and USAG-KA directorate of public works documents. Internet searches were also conducted to identify publicly available and other relevant information. A list of the specific documents reviewed for USAG-KA is provided in **Appendix E**.

3.2 Personnel Interviews

Interviews were conducted via telephone with individuals having significant historical knowledge at USAG-KA.

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

- Former Environmental Health and Safety Manager
- IMCOM Pest Management Consultant, USAEC
- On-Site Environmental Support Manager, USAEC
- Wastewater Supervisor, DynCorp
- Liquid Systems Manager, DynCorp
- Operations and Maintenance/Mission Director, DynCorp
- Environmental Manager, DynCorp
- Assistant Fire Chief (1), DynCorp
- Assistant Fire Chief (2), DynCorp
- Senior Fire Protection Engineer, Summit Fire Consulting
- Co-Op Administrator, TribalCo

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 USAG-KA 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**. The compiled 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 future sampling.

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

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

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

4.1 AFFF Use, Storage, and Disposal Areas

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

AFFF Storage Areas

AFFF used by USAG-KA fire department and military personnel has been historically stored at three locations at USAG-KA: Storage Building (Facility Number [FN] 715), Supply Drum Storage (FN 822), and Drum Storage Building (FN 1160).

Fire Stations

There are two fire stations operated by USAG-KA: Fire Station (FN 904) on Kwajalein and Fire Department (FN 8023) on Roi-Namur.

Fire Equipment Testing and Maintenance Areas

Fire truck washing, maintenance, and testing has historically occurred at five locations at USAG-KA: Automotive Building (FN 808), Hot Spot Fire Training Area, Nozzle & Hose Pressure Testing Areas, Foam Truck Test Area, and Auto Facility (FN 8034).

Fire Training Areas

Fire training has historically occurred at four locations at USAG-KA: Hot Spot Fire Training Area, Former Fire Training Pit, Former Fire Training Area, and Former AFFF Training Area.

Fire Response & Fire Suppression System Activities

In addition to fire training activities, AFFF use related to emergency fire responses and AFFF suppression system activities have occurred at three locations at USAG-KA: Fixed Wing Hangar (FN 997), Rotary Wing Hangar (FN 997), and Aircraft Incident.

All AFFF use, storage, and disposal areas described above are further detailed in **Section 5.2** below.

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

Following document research, personnel interviews, and site reconnaissance at USAG-KA, chrome plating operation areas, WWTPs, landfills, and compost piles were identified at the installation as preliminary locations for use, storage, and/or disposal of PFAS-containing materials.

Chrome Plating Operations

Potential PFAS-containing material use associated with metal plating activities may also be relevant to Army installations. During metal plating operations, a metal surface may be treated with a layer of electrochemically deposited metals in an acid bath. PFAS, specifically PFOS, have been used in metal plating operations as surface tension-reducing wetting agents to mitigate the release of aerosolized chemicals into a working environment. Hard chromium plating is one type of metal plating operation where PFAS-containing mist suppressants were commonly used. Historically, it was common for spent plating baths from metal plating operations to be disposed of in a lined or unlined pit or into a sanitary or storm sewer. Therefore, PFAS present in mist suppressants during the metal plating process could be released to the environment. Chrome plating historically occurred at one location at USAG-KA: Chrome Plating Building (FN 8130).

Wastewater Treatment Plants

There is one WWTP located on Kwajalein where potentially PFAS-containing waste was historically treated and subsequently dried at the associated WWTP Sludge Beds.

Landfills and Compost Piles

There is one landfill and compost pile where PFAS-containing waste from the WWTP Sludge Beds was potentially disposed of: Kwajalein Landfill and Compost Pile.

All PFAS use, storage, and disposal areas described above are further detailed in **Section 5.2** below.

Pesticides:

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 identify USAG-KA as an installation having used or stored PFAS-containing pesticides/insecticides. Sulfluramid was historically used on a total of eight bait stations at two locations at USAG-KA: Dome House (FN 179) and Quarters 135-E. Each bait station received a de minimis, one-time application of 2.3 grams of Sulfluramid that does not constitute a release to the environment; therefore, these areas were eliminated as preliminary locations for use, storage, and/or disposal of PFAS-containing materials.

Further discussion regarding areas not retained for further investigation is presented in **Section 5.1**.

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 USAG-KA) is not part of the PA. However, due to the remote location of USAG-KA, there were no potential off-post sources of PFAS-containing materials within a 5-mile radius of the installation that were identified during the records search and site visit.

5 SUMMARY AND DISCUSSION OF PA RESULTS

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

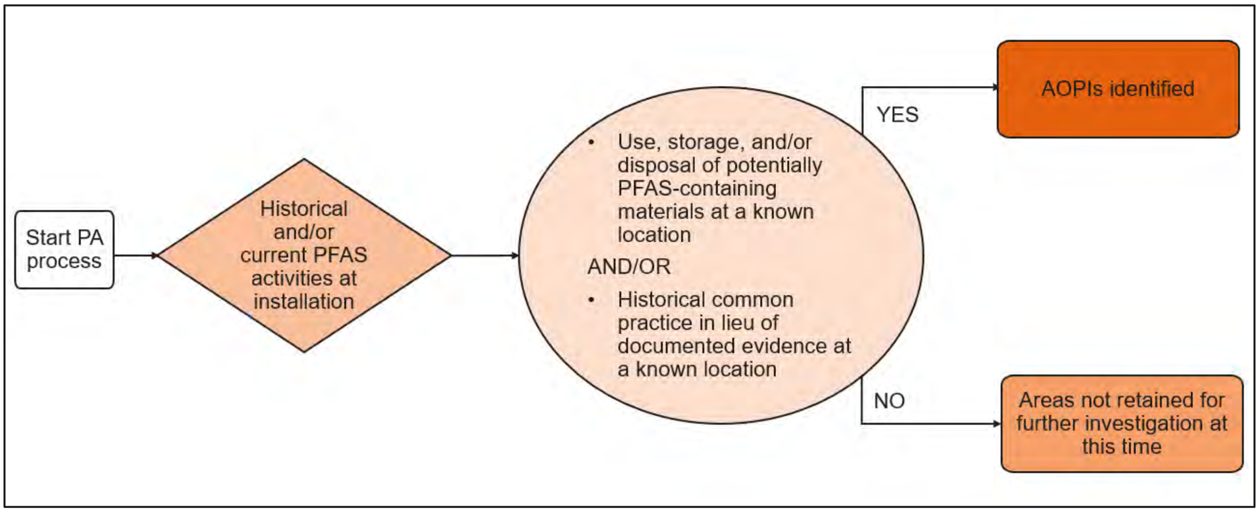

Figure 5-1: AOPI Decision Flowchart

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

Data limitations for this PA at USAG-KA are presented in **Section 6**.

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 is presented in **Table 5-1**, below.

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

Area Description	Dates of Operation	Relevant Site History	Rationale
Former Navy Dump	Unknown (operations ceased before 1960s)	One of several World War II dumps. Military AFFF use began in the late 1960s, after this dump was active.	No evidence of PFAS-containing materials used, stored, and/or disposed of at this location.
Aircraft Refueling Area (Building 901)	Not Applicable	Discharge area located at the Aircraft Refueling Area. No known AFFF use or release.	No evidence of PFAS-containing materials used, stored, and/or disposed of at this location.
Photo Lab	Not Applicable	Photo lab was not used as of at least 2011.	No evidence of PFAS-containing materials used, stored, and/or disposed of at this location.
Dome House (FN 179)	10 November 2011	A PFAS-containing pesticide (Sulfluramid) was applied. Four bait stations used across 32 linear feet	De minimis quantity. No evidence of PFAS-containing materials release at this location.
Quarters 135-E	17 February 2012 07 March 2012	A PFAS-containing pesticide (Sulfluramid) was applied. Two bait stations were used on two separate occasions in 2012.	De minimis quantity. No evidence of PFAS-containing materials release at this location.

5.2 AOPIs

Overviews for each AOPI identified during the PA process are presented in this section (**Figure 5-2a** and **Figure 5-2b**). The AOPIs are discussed within each subsection presented below and listed on **Table 5-2**. At the time of this PA, one AOPI was historically investigated for the possible presence of PFAS. At the time of this PA, no AOPIs were being investigated for the possible presence of PFAS.

Table 5-2. Areas of Potential Interest

AOPI Island	AOPI Name
Kwajalein	Storage Building (FN 715)
	Automotive Building (FN 808)
	Supply Drum Storage (FN 822)
	Wastewater Treatment Plant Sludge Beds
	Fixed Wing Hangar (FN 898)
	Drum Storage Building (FN 1160)
	Fire Station (FN 904)
	Rotary Wing Hangar (FN 997)
	Hot Spot Fire Training Area
	Kwajalein Landfill
	Former Fire Training Pit
	Former Fire Training Area
	Nozzle & Hose Pressure Testing Areas
	Foam Truck Test Area
	Former AFFF Training Area
	Compost Pile
Roi-Namur	Aircraft Incident
	Fire Department (FN 8023)
	Auto Facility (FN 8034)
	Chrome Plating Building (FN 8130)

5.2.1 Kwajalein AOPIs

Overviews for each AOPI identified on Kwajalein Island during the PA process are presented in this section. The AOPI locations are shown on **Figure 5-2a**.

5.2.1.1 Storage Building (FN 715)

The Storage Building is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to the historical storage of AFFF at this building. The Storage Building is a roof-covered, metal warehouse with open sides. Approximately 1,500 gallons worth of AFFF was historically stored in 55-gallon drums at this location starting in the late 1960s until an unknown date. There is no documented release of AFFF at this AOPI.

5.2.1.2 Automotive Building (FN 808)

The Automotive Building is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to the historical maintenance of fire trucks at this building starting in the late 1960s until the time of this PA. AFFF was historically drained from fire trucks into containers prior to maintenance at this building. The AFFF was then transferred back to the fire trucks once maintenance was complete. There is no documented release of AFFF at this AOPI.

5.2.1.3 Supply Drum Storage (FN 822)

The Supply Drum Storage is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to a historical release of AFFF on 14 June 2014. Approximately 25 gallons of AFFF was reportedly released from a hole in a storage drum onto the concrete. The spill migrated into an oil/water separator before subsequently flowing into the Kwajalein Lagoon. The building was demolished between 2015 and 2016.

5.2.1.4 Wastewater Treatment Plant Sludge Beds

The WWTP Sludge Beds is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to historical AFFF releases at the Fixed Wing Hangar (detailed in **Section 5.2.1.5** below) and the Rotary Wing Hangar (detailed in **Section 5.2.1.8** below) that migrated through the floor drain to the WWTP at an unknown date prior to 2013. Sludge was disposed of either in the Kwajalein Landfill (detailed in **Section 5.2.1.10** below) or in the Compost Pile (detailed in **Section 5.2.1.16** below).

5.2.1.5 Fixed Wing Hangar (FN 898)

The Fixed Wing Hangar is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to three historical releases of AFFF that occurred at this location. The Fixed Wing Hangar has a fire suppression system containing AFFF concentrate. The first release occurred at an unknown date, prior to 2013, when an unknown quantity of AFFF was spilled and flowed into floor drains and subsequently to the WWTP (detailed in **Section 5.2.1.4** above). The second occurrence involved the release of approximately 3,000 gallons of AFFF during a scheduled test that occurred in April 2013. The foam filled the entire floor area of the hangar and flowed into floor drains. The third release was an unplanned release of an unknown quantity of AFFF that occurred approximately one week after the scheduled test due to a fire suppression system sensor error.

5.2.1.6 Drum Storage Building (FN 1160)

The Drum Storage Building is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to the historical storage of AFFF that occurred at this location. This building is adjacent to the fire station and historically operated as USAG-KA fire department’s main AFFF storage area. AFFF drums were stored against a wall in the building. There is no documented release of AFFF at this AOPI.

5.2.1.7 Fire Station (FN 904)

The Fire Station is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to four historical AFFF releases at this location. The first release occurred on 13 May 2006, when less than a quart of AFFF was spilled. The second release occurred on 10 January 2017, when approximately 1 gallon of AFFF was spilled onto the pavement during routine fire truck checks. AFFF did not migrate to storm drains or waterways during the release or spill response activities. The third release occurred on 06 April 2017, when approximately 2 gallons of AFFF were spilled from a pump nozzle onto the pavement during routine fire truck checks. AFFF did not migrate to storm drains or waterways during the release or spill response activities. Recovered liquid from containment activities was containerized and labeled for waste removal. The fourth release occurred on 31 October 2020 when approximately half a gallon of AFFF overflowed from the fill port of a foam tanker truck onto the pavement southeast of the Fire Station during a rain event. An absorbent boom was placed in front of the nearby storm drain to prevent the AFFF from entering the storm drain conveyance system.

5.2.1.8 Rotary Wing Hangar (FN 997)

The Rotary Wing Hangar is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to AFFF storage and release at this location. The building has an AFFF fire suppression system that was built in the 1980s. During historical routine fire suppression system tests, AFFF was discharged to floor drains which lead to the WWTP (detailed in **Section 5.2.1.4** above). A check valve failure in April 2019 may have resulted in AFFF migration upstream in the raw water supply line. Sampling for PFOS and PFOA was conducted in response within the fire suppression system and nearby hydrants. Sampling occurred on 09 April 2019 and 07 July 2020. Both sampling events had detections of PFOS and/or PFOA at all sampling locations. Exceedances of the LHA ranged from 83 to 220,000 ng/L (DynCorp 2020a). Sampling results indicate that PFAS-containing materials may have migrated upstream in the raw water supply line as far as the power plant. The raw water supply line is assumed to be leaking underground based on consistent pressure loss that requires pumping to maintain system pressure.

5.2.1.9 Hot Spot Fire Training Area

The Hot Spot Fire Training Area is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to historical AFFF use and release at this location. This area was potentially used for firefighting training and nozzle testing with AFFF from the late 1960s until approximately 2005. Approximately 5 gallons of AFFF spilled onto the pavement on 05 January 2017. AFFF did not migrate to storm drains or waterways during the release or spill response activities.

5.2.1.10 Kwajalein Landfill

The Kwajalein Landfill is identified as an AOPI following records research, personnel interviews, and site reconnaissance because PFAS-containing sludge from the WWTP was disposed of at this location (see **Section 5.2.1.4** above). Dried sewage sludge generated at the Kwajalein WWTP was potentially sent to this location. The landfill lacks a liner, leachate collection system, and low-permeability cover to prevent percolation and seepage to the groundwater.

5.2.1.11 Former Fire Training Pit

The Former Fire Training Pit is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to firefighter training with AFFF at this location. Training with AFFF potentially occurred from the late 1960s to an unknown date at this location.

5.2.1.12 Former Fire Training Area

The Former Fire Training Area is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to historical firefighter training with AFFF at this location. This area included a lined pit in which waste oil would be ignited and extinguished with AFFF for training. Training with AFFF potentially occurred from the late 1960s to an unknown date at this location.

5.2.1.13 Nozzle & Hose Pressure Testing Areas

The Nozzle & Hose Pressure Testing Areas is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to potential AFFF release during historical firefighting training at this location. The USAG-KA fire department conducted nozzle and hose pressure testing from the late 1960s to the 2000s at this location.

5.2.1.14 Foam Truck Test Area

The Foam Truck Test Area is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to a historical AFFF release at this location. Foam truck testing occurred one time between 2010 and 2015. Approximately 5 to 10 gallons of AFFF were discharged onto a designated area consisting of landscaping debris, which were subsequently sent to an incinerator.

5.2.1.15 Former AFFF Training Area

The Former AFFF Training Area is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to historical training with AFFF at this location. Annual training occurred from the late 1960s until approximately 1991. AFFF was sprayed onto plastic liners and left to evaporate; remaining AFFF was sent to the WWTP (see **Section 5.2.1.4** above) for disposal.

5.2.1.16 Compost Pile

The Compost Pile is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to PFAS-containing sludge from the WWTP potentially being disposed of at this location (see **Section 5.2.1.4** above) prior to 2011. Compost from this location was historically used across the island for residential purposes, the golf course, and backfilling trenches.

5.2.2 Roi-Namur AOPIs

Overviews for each AOPI identified on Roi-Namur Island during the PA process are presented in this section. The AOPI locations are shown on **Figure 5-2b.**

5.2.2.1 Aircraft Incident

The Aircraft Incident is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to the historical AFFF release at this location. On 28 June 1977, an aircraft crashed during takeoff at the end of the runway resulting in a fire. Photos of the incident indicate AFFF was used to extinguish the fire.

5.2.2.2 Fire Department (FN 8023)

The Fire Department is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to a historical AFFF release at this location. Approximately 10 gallons of AFFF was released during operational truck testing on 23 May 2014. AFFF did not migrate to storm drains or waterways during the release or spill response activities.

5.2.2.3 Auto Facility (FN 8034)

The Auto Facility is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to a historical AFFF release at this location. Approximately 50 gallons of water containing AFFF spilled during routine fire truck maintenance onto the paved surface on the west side of the building on 27 August 2016. The spill migrated to an unpaved surface before spill response could occur. AFFF did not migrate to storm drains or waterways during the release or spill response activities.

5.2.2.4 Chrome Plating Building (FN 8130)

The Chrome Plating Building is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to historical chrome plating operations that occurred from an unknown date to approximately the 1980s at this location. Waste from the plating operations went down a drain that potentially discharged directly to the ground surface.

6 CONCLUSIONS AND RECOMMENDATIONS

The PFAS PA at USAG-KA evaluated preliminary locations for 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). A combination of document review, internet searches, interviews with installation personnel, and site reconnaissance were used to identify preliminary locations of suspected use, storage, and/or disposal of PFAS-containing materials at USAG-KA. Following the evaluation, 20 AOPIs were identified.

Data collected during the PA (**Sections 3** through **5**) were sufficient to draw the conclusions and recommendations summarized above. The data limitations relevant to the development of this PA at USAG-KA are discussed below.

Records gathered for the use, storage and/or disposal of PFAS-containing materials were reviewed during the PA process. Documentation specific to AFFF may have been limited (e.g., documentation of AFFF used during crash responses or fire training activities) due to lack of recordkeeping requirements for the full timeline of common AFFF practices. Anecdotal accounts of AFFF use (and therefore likely PFOS, PFOA, PFBS, PFNA, and PFHxS use) were limited to available installation personnel, whose knowledge of AFFF use may have been restricted by their time spent at the installation or previous roles held that limited their relevant knowledge of potential AFFF (or other PFAS-containing material) use. Personnel do not typically stay for long periods at USAG-KA (e.g., more than 2 years) in particular due to its remote location.

The searches for ecological receptors and off-post PFAS sources were not exhaustive and were limited to easily identifiable and readily available information evaluated during the relevant records review, installation personnel interviews, and site reconnaissance. Due to the remote location of USAG-KA, there were no potential off-post sources of PFAS-containing materials within a 5-mile radius of the installation that were identified during the records search and site visit.

Finally, there is no available PFOS, PFOA, PFBS, PFNA, and PFHxS environmental (e.g., groundwater) analytical data due to the absence of historical PFAS environmental investigations. Results from this PA indicate further study through a site investigation is warranted as USAG-KA.

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ACRONYMS

°F	degrees Fahrenheit
%	percent
AFFF	aqueous film-forming foam
amsl	above mean sea level
AOPI	area of potential interest
Arcadis	Arcadis U.S., Inc.
Army	United States Army
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DoD	Department of Defense
DynCorp	DynCorp International, LLC
FN	facility number
HFPO-DA	hexafluoropropylene oxide dimer acid
IMCOM	Installation Management Command
installation	United States Army or Reserve installation
LHA	lifetime health advisory
mph	miles per hour
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
RSL	Regional Screening Level
RTS	Reagan Test Site
U.S.	United States

USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USAG-KA	United States Army Garrison Kwajalein Atoll
USAKA	United States Army Kwajalein Atoll
USEPA	United States Environmental Protection Agency
WWTP	wastewater treatment plant

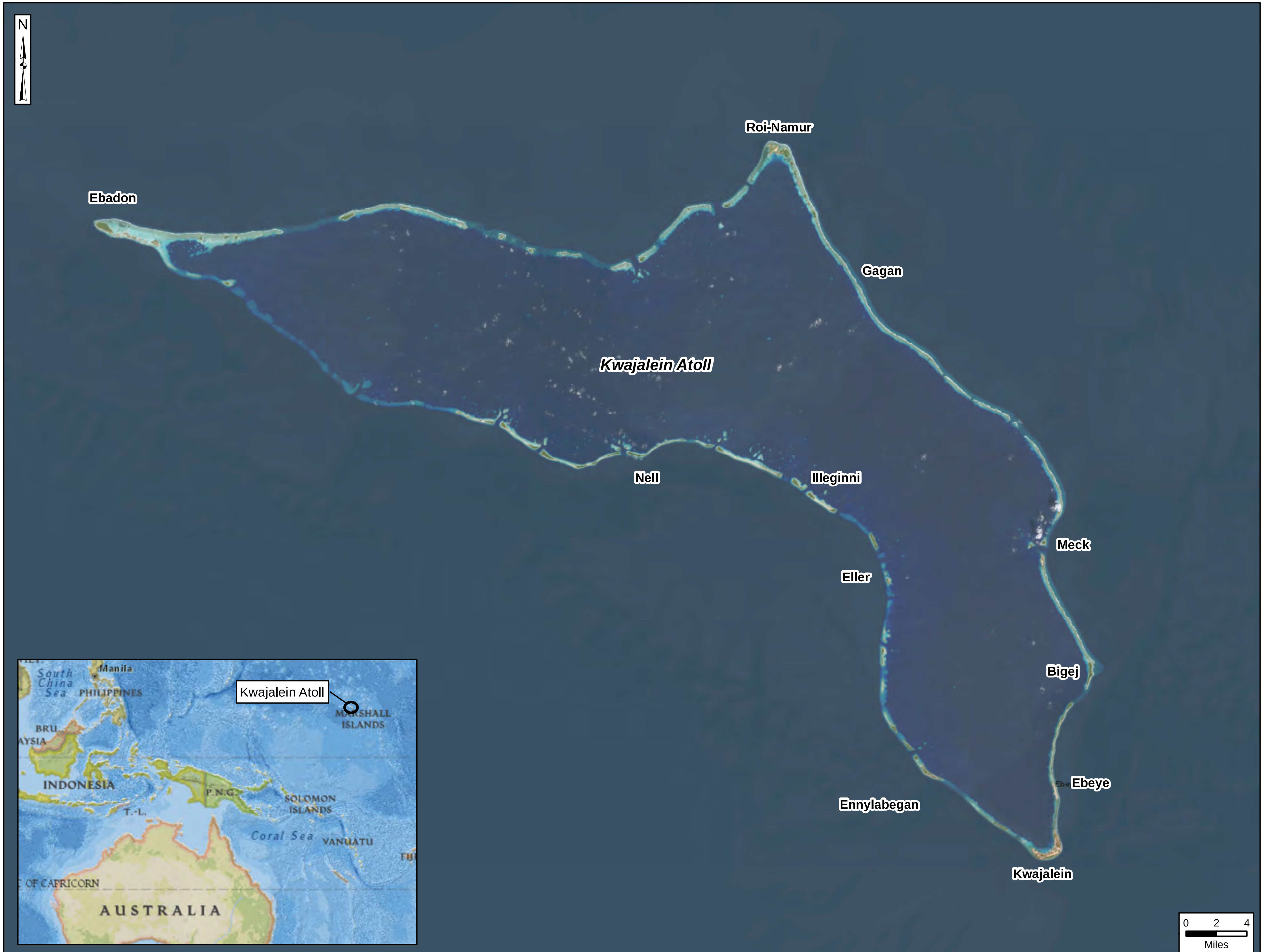
TABLES

Table 2-1
On-Post Potable Water Wells
USAEC PFAS Preliminary Assessment
USAG Kwajalein Atoll

Associated Island	Well Identification	Description
Kwajalein	LW-1	Single gallery 1,400 feet long
	LW-2	Main gallery 260 feet long, with 7 crossing laterals, 40 feet long
	LW-3	Now LW-8A; radial laterals 45 feet long
	LW-4	Now LW-81; radial laterals 45 feet long
	LW-5	Unperforated collection main, with 7 crossing laterals, 115 feet long
	LW-7	Total length 1,600 feet; Subsection A-H are individual sumps, each with dual parallel galleries 200 feet long
	LW-8	Total length 1,400 feet; Subsection B-H are individual sumps, each with dual parallel galleries 200 feet long. Subsections A and I are former wells LW-3 and LW-4, each with 8 laterals 45 feet long in a radial pattern
Roi-Namur	LW-3A-F	Total length 3,000 feet; Subsection A-F are individual sumps
	LW-3H	Two 180-foot lateral intake, installed 2012-2013
	LW-31	Two 180-foot lateral intake, installed 2012-2013
	LW-4A	Two 180-foot lateral intake, installed 2012-2013
	LW-4B	Two 180-foot lateral intake, installed 2012-2013

Source:
DynCorp. 2020. Water Quality Management Plan for Installation Activities at Kwajalein Atoll. March.

FIGURES



USAEC PFAS
Preliminary Assessment
USAG Kwajalein Atoll

ARCADIS

Figure 2-1
Site Location

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 58 North

USAEC PFAS
Preliminary Assessment
USAG Kwajalein Atoll

ARCADIS

Figure 2-2a
Kwajalein Atoll
Site Layout

Legend

Groundwater Flow Direction
Aircraft Wash Well
Irrigation (Golf Course) Well
Photographic Processing Well
Horizontal Lens Wells
Unused; WWII Japanese Well

Data Sources:
DynCorp International, *Water Quality Management Plan For Installation Activities at Kwajalein Atoll,*,
Groundwater Flow and Well Locations, 2020;
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 58 North

USAEC PFAS
Preliminary Assessment
USAG Kwajalein Atoll

ARCADIS

Figure 2-2b
Roi-Namur Site Layout

Legend

- Groundwater Flow Direction
- Irrigation (Golf Course) Well
- Monitoring Well
- Non-Potable Construction Well
- Tidal Pond

Horizontal Lens Wells

- Unused

Data Sources:
DynCorp International, *Water Quality Management Plan For Installation Activities at Kwajalein Atoll,*, Groundwater Flow and Well Locations, 2020;
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 58 North

USAEC PFAS
Preliminary Assessment
USAG Kwajalein Atoll

Figure 5-2a
Kwajalein Atoll
AOPI Locations

Legend

- AOPI
- Groundwater Flow Direction
- Aircraft Wash Well
- Irrigation (Golf Course) Well
- Photographic Processing Well

Horizontal Lens Wells

- Unused; WWII Japanese Well

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

Data Sources:
DynCorp International, *Water Quality Management Plan For Installation Activities at Kwajalein Atoll,*,
Groundwater Flow and Well Locations, 2020;
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 58 North

USAEC PFAS
Preliminary Assessment
USAG Kwajalein Atoll

ARCADIS

Figure 5-2b
Roi-Namur AOPI Locations

Legend

AOPI
Tidal Pond
Groundwater Flow Direction
Irrigation (Golf Course) Well
Monitoring Well
Non-Potable Construction Well
Horizontal Lens Wells
Unused

AOPI = area of potential interest

Data Sources:
DynCorp International, *Water Quality Management Plan For Installation Activities at Kwajalein Atoll,*, Groundwater Flow and Well Locations, 2020;
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Coordinate System:
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