# Preliminary Assessment Report
# FWS – Hawaiian Islands National Wildlife Refuge: Tern Island
# French Frigate Shoals, Hawai‘i

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# List of Acronyms

| | |
|---|---|
| % | percent |
| µg/L | micrograms per liter |
| bgs | below ground surface |
| CBD | Center for Biological Diversity |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| Chase | Chase Environmental Group, Inc. |
| DDE | dichlorodiphenyldichloroethylene |
| DERP | Defense Environmental Restoration Program |
| DOI | United States Department of the Interior |
| EI | Environmental Investigation |
| EPA | United States Environmental Protection Agency |
| ETI | Environmental Technologies International |
| FFS | French Frigate Shoals |
| FUDS | Formerly Used Defense Sites |
| FWS | United States Fish and Wildlife Service |
| HDLNR | Hawaiʻi Department of Land and Natural Resources |
| HRS | Hazard Ranking System |
| IAA | Inter-Agency Agreement |
| kg | kilograms |
| LORAN | Long Range Aid to Navigation |
| mg/kg | milligrams per kilogram |
| mg/L | milligrams per liter |
| Navy | U.S. Navy |
| NCP | National Contingency Plan |
| NOAA | National Oceanic and Atmospheric Administration |
| NPL | National Priorities List |
| NWHI | Northwestern Hawaiian Islands |
| PA | Preliminary Assessment |
| PCB | polychlorinated biphenyl |
| PMR | Pacific Missile Range |
| POP | Persistent Organic Pollutant |
| RCRA | Resource Conservation and Recovery Act |
| SEMS | Superfund Enterprise Management System |
| STCZ | Subtropical Convergence Zone |
| TPH | Total Petroleum Hydrocarbons |
| TSCA | Toxic Substances Control Act |
| TSD | Technical Support Document |
| UH | University of Hawaiʻi |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| URSGWC | URS Greiner Woodward Clyde |
| USCG | United States Coast Guard |
| UST | Underground Storage Tank |
| WCFS | Woodward Clyde Federal Services |
| WWII | World War II |

# 1.0 INTRODUCTION

## 1.1 Regulatory Background

Under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the U.S. Environmental Protection Agency (EPA) is conducting a Preliminary Assessment (PA) of the U.S. Fish and Wildlife Service (FWS) – Hawaiian Islands National Wildlife Refuge: Tern Island (Tern Island) Site (the Site) in the French Frigate Shoals (FFS), Hawaiʻi.

The purpose of a PA is to review existing information on a site with potential releases of a hazardous substance and its environs to assess the threats, if any, posed to public health, welfare or the environment and to determine if further investigation under CERCLA is warranted. The scope of a PA generally includes review of existing information available from federal, state and local agencies.

Using existing information sources, a site is then evaluated using EPA's Hazard Ranking System (HRS) criteria to assess the relative threat associated with actual or potential releases of hazardous substances at the site. The HRS has been adopted by EPA to help set priorities for further evaluation and eventual remedial action at hazardous substance sites. The HRS is the primary method of determining a site's eligibility for placement on the National Priorities List (NPL). The NPL is a list compiled by EPA of uncontrolled hazardous substance releases in the United States that are priorities for long-term remedial evaluation and response. This report summarizes the findings of these preliminary investigative activities at the Site.

Given Tern Island's rich history, the universe of related documents was too voluminous to fully summarize in the limited PA format. Therefore, a Technical Support Document (TSD) was developed concurrently with the PA and is included as Appendix A, with complete references for both documents in Appendix B. The TSD includes and distills a wider array of the existing literature and data relevant to the environmental condition, challenges, constraints and vulnerabilities on Tern Island.

On July 19, 2004, EPA added the Site under the name "FWS – Hawaiian Islands National Wildlife Refuge" to its Federal Agency Hazardous Waste Compliance Docket #19 (the Docket) [69 Fed. Reg. 42993 (1994)] as required by CERCLA. The Docket contains information about federal facilities that manage hazardous waste or from which hazardous substances have been or may be released. The Site was identified to EPA through FWS's submission of its biennial inventory of hazardous waste sites that it owns or operates as required by section 3016 of the Resource Conservation and Recovery Act (RCRA) (EPA, 2004). CERCLA Section 120(d)(1) requires that EPA take steps to assure that a PA be completed, and the Federal Register notes that for every federal facility included on the Docket, an evaluation shall be completed within a reasonable schedule, 69 Fed. Reg. 42990 (July 19, 2004). This PA satisfies any of FWS's obligations to complete a PA for Tern Island under Section 120(d)(1) of CERCLA.

The Docket site name was updated to "FWS – Hawaiian Islands National Wildlife Refuge: Tern Island" on January 26, 2014, Docket #26 (EPA, 2014a).

A "Discovery Date" of July 19, 2004 was entered into the Superfund Enterprise Management System (SEMS) for the Site. This date corresponds to the Site's listing on the Docket. The SEMS ID is HI0000906379 (EPA, 2014c).

On December 11, 2012, the Center for Biological Diversity (CBD) petitioned EPA to conduct a PA of the Northwestern Hawaiian Islands (NWHI), an area including over 139,000 square miles of the Pacific Ocean, with the goal of assessing the impacts of marine debris on threatened and endangered species such as the Hawaiian monk seal. EPA responded on November 14, 2013, indicating that it would partner with FWS to conduct a more limited scope PA of Tern Island, and would include an evaluation of the release, or threat of release, of hazardous substances from Tern Island, including hazardous substances that may adsorb to plastic marine debris in the surrounding surface water (CBD, 2012; EPA, 2013b).

Because Tern Island is within the jurisdiction, custody, and control of FWS, FWS has the delegated CERCLA lead agency authority to complete the PA. FWS has chosen to enter into an Inter-Agency Agreement (IAA) with EPA to conduct the PA in partnership with EPA (EPA, 2014d).

More information about the Superfund program is available on EPA's website at http://www.epa.gov/superfund.

## 1.2 Overview

Tern Island is part of the Papahānaumokuākea Marine National Monument (the Monument). Tern Island also lies within other existing federal and state conservation areas including the NWHI Coral Reef Ecosystem Reserve, the Hawaiian Islands National Wildlife Refuge, and the State of Hawai'i's NWHI Marine Refuge. In 2010, the Monument was inscribed as a cultural and natural United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage site (NOAA, FWS, HDLNR, 2008).

The NWHI are located within the North Pacific Subtropical Convergence Zone (STCZ). The STCZ migrates between 23 degrees north and 37 degrees north with changes in atmospheric pressure (Pichel et al., 2007). A high concentration of marine debris accumulates within the STCZ, including plastics (EPA, 2011b; Friedlander et al., 2009; Pichel et al. 2007). Persistent organic pollutants (POPs), such as polychlorinated biphenyls (PCBs), are commonly found in trace quantities in seawater. Plastics are known to attract and hyperconcentrate the POPs on the plastic particle surface. The ability of plastics to sorb POPs at concentrations far greater than the surrounding seawater is referred to as hyperconcentration (Rochman et al., 2013a; Rochman et al., 2014). Recent evidence shows that ingestion of microplastics (particles 5 millimeters and below) serves to biomagnify contaminants up the food chain (Engler, 2012; Rochman et al., 2013b; Rochman et al., 2014).

FFS, including Tern Island, is designated critical habitat for the Hawaiian monk seal (*Monachus schauinslandi*), a federally listed endangered species. The Hawaiian green sea turtle (*Chelonia mydas*), a federally listed threatened species, is known to nest on Tern Island (Amerson, 1971; Friedlander et al., 2009; NOAA, 2013a).

From 1942 through 1979, Tern Island was used by the U.S. Navy (Navy) and the U.S. Coast Guard (USCG), first as a Naval Air Facility, used as an airfield and aircraft refueling stop, then as a Long Range Aid to Navigation (LORAN) Station. From 1960 to 1963, the Navy also installed and operated a Pacific Missile Range (PMR) facility, which included a 50,000-gallon neoprene fuel tank, generators and electrical switching equipment. During this time, materials including scrap metal, cable, wire, batteries and electronic equipment, such as capacitors and transformers, were landfilled on Tern Island. These materials have been shown to contain hazardous substances such as PCBs and lead (Amerson, 1971; FWS, 2002; URS, 1999; USCG, 2000).

During sampling investigations conducted from 1992 through 2004, PCBs, lead and other hazardous substances were detected in soils, sediments, ground water, surface water and biota samples collected on and around Tern Island (Lorenz et al., 2002; Miao et al., 1999; Miao et al., 2000a; Miao et al., 2000b; URS, 1999; USCG, 2000; Willcox et al., 2004).

Based on studies showing high concentrations of PCBs in marine species, the study authors concluded that there are PCB source(s) in FFS, including Tern Island. The high average concentrations of the sum of PCBs in different food chain levels suggest pollution sources around Tern Island (Miao et al., 1999; Miao et al., 2000a; Miao et al., 2000b).

Studies conducted around Tern Island concluded that there was clear evidence of bioaccumulation in the aquatic food chain that resulted in high concentrations of lipophilic contaminants such as PCBs in organisms that occupy high trophic levels (URS, 1999; USCG, 2000).

## 2.0 SITE DESCRIPTION

### 2.1 Location

The Site is located in FFS, NWHI, Hawai‘i. The geographic coordinates for the Site are 23° 52' 11" N latitude and 166° 17' 5" W longitude. The location of the Site is shown in Figure 1-1.

### 2.2 Site Description

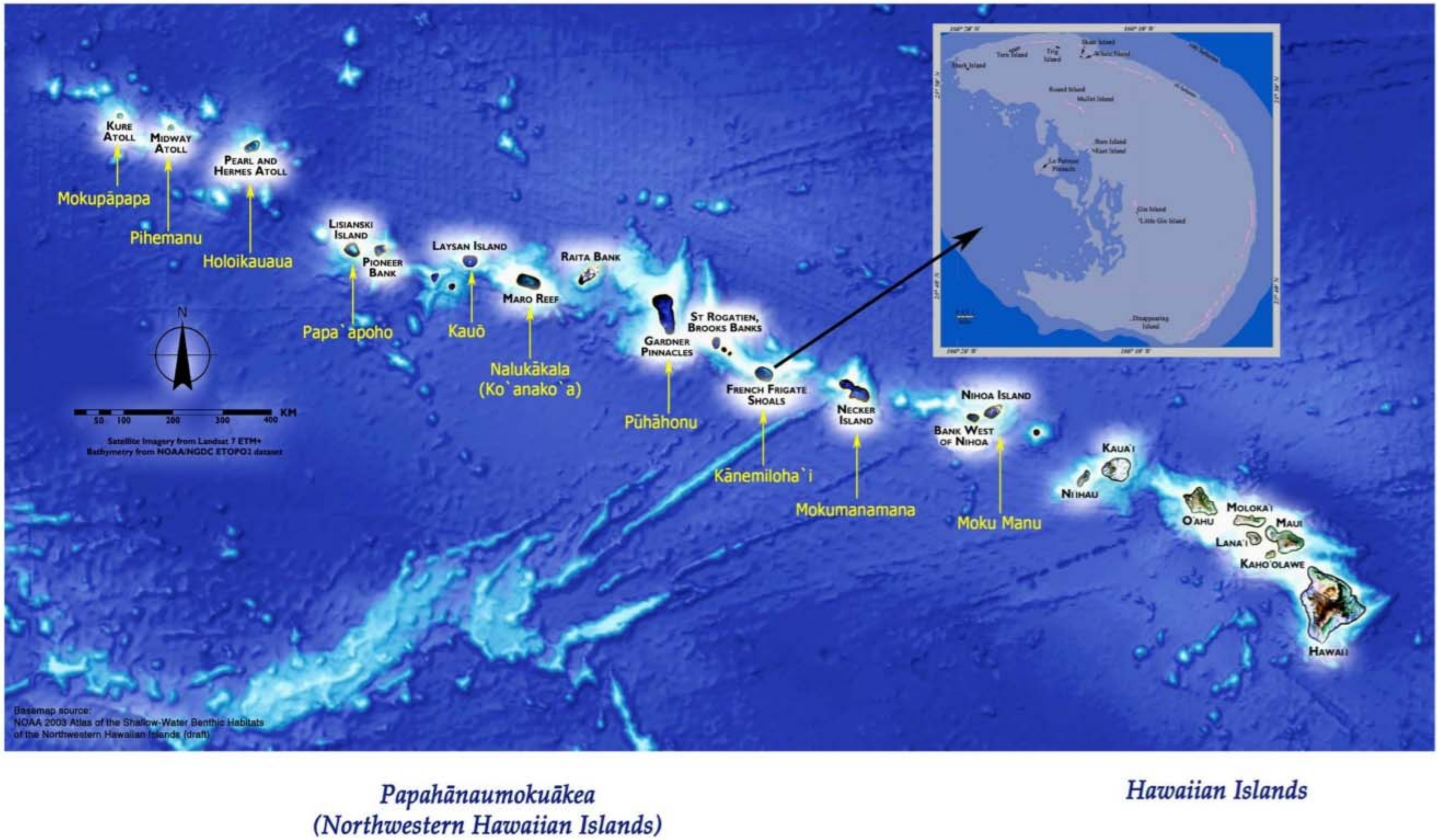
Tern Island is the largest of twelve small sand islands contained within the low-lying FFS coral atoll. FFS is located approximately 490 nautical miles north-northwest of Honolulu, Hawai‘i. The FFS atoll includes approximately 230,000 acres of coral reef habitat and approximately 67 acres of emergent land, making it the largest atoll in the NWHI. FFS consists of two crescent-shaped reefs surrounding a large 140-square-mile lagoon. The crescent reefs composing the outer boundary of the atoll formed around the perimeter of a once active volcano. The approximately 30-acre Tern Island is located along the northwest tip of the outer reef. When discovered in 1786, Tern Island was a small carbonate sand shoal (Amerson, 1971; FWS, 2002; Hartzell et al., 2012; NOAA, 2013b).

FFS is nesting habitat for 95 percent (%) of the population of Hawaiian green sea turtles (listed as federally threatened), is pupping habitat for 16% of the Hawaiian monk seal (listed as federally endangered), and approximately 6% of the world’s black footed albatross (International Union for Conservation of Nature threatened) nest there (FWS, 2013b). Tern Island is also the breeding site of 18 species of seabirds, earning it the distinction as the island with the highest avian species richness in the NWHI (FWS, 2002). The NWHI represent a global biodiversity hotspot. Populations are among the most isolated on earth, and, due to the lack of human influence, the remaining reefs of the NWHI are nearly pristine. An overall global decline in marine biodiversity means that endemic hotspots like the NWHI are important areas for biodiversity conservation. However, the unique biota, high conservation value and low-lying elevation make the NWHI distinctly vulnerable to the effects of climate change, such as sea level rise. Due to the higher elevation of Tern Island relative to the other islands in FFS, it offers refuge to species that would otherwise be displaced.

Tern Island and FFS are part of the Hawaiian Islands National Wildlife Refuge and the Monument. The Monument, established in 2006, encompasses nearly 140,000 square miles of Pacific Ocean and is dotted with small islands, islets, and atolls and a complex array of marine and terrestrial ecosystems (NOAA, FWS, HDLNR, 2008).

The NWHI are located within the North Pacific STCZ, which migrates between 23 degrees north and 37 degrees north with changes in atmospheric pressure (Pichel et al., 2007). A high concentration of marine debris accumulates within the STCZ, including plastics (EPA, 2011b; Friedlander et al., 2009; Pichel et al., 2007).

**Figure 1- 1 Proximity of FFS to the Main Hawaiian Islands**



The U.S. military modified Tern Island in 1942, creating a landing strip to support Navy air traffic during World War II (WWII). The Navy dredged 660,000 cubic yards of coral from the adjacent lagoon to construct a landing strip and a channel. Construction of Tern Island was completed by creating a seawall out of approximately 5,000 feet of double-walled steel sheet piling to hold the sea back and to contain the island. The seawall around the perimeter encapsulated the dredged coralline material, giving the island structure. Tern Island's modified dimensions measured 3,100 feet by 350 feet (Amerson, 1971; FWS, 2002; Woodbury, 1946).

Various sections of the sheet piling have subsequently been repaired or replaced with rock armor on multiple occasions, as exposure to the elements and waves have damaged their integrity. Tern Island has two wooden piers at its western corner adjacent to a 260,000-square-foot turning basin that connects to a small boat channel leading to the open ocean. Tern Island has four small beaches around its perimeter. The lagoon-facing shore (south-southeast) has a 2,800-foot sand beach that has naturally added a 100- to 175-foot section of sand extending from the north-northeast corner of the island. Tern Island is home to various structures including barracks, pump houses, water tanks and sheds (Amerson, 1971; FWS, 2002; FWS, 2013c; FWS, NOAA, HDLNR, 2008).

While renovating the Navy's facilities in 1964, USCG demolished the Navy's power generation facility. According to FWS, USCG demolished and buried equipment (including transformers and batteries) at on-site "landfills." Waste materials were believed to be used as fill between the old deteriorated seawall and newer repaired sections of steel sheet piling. Some of the debris has been subsequently exposed by corrosion of the seawall, erosion of fill material and storm activity (FWS, 2002; URS, 1999).

## 2.3 Operational History

The first European contact at FFS was French explorer La Perouse on November 7, 1786. Polynesians are believed to have visited FFS prior to 1786, but no archeological evidence of their presence on Tern Island has been found. After the French discovery, the islands remained unclaimed by any nation until January 4, 1859. U.S. Navy Lt. John M. Brooke was on a sounding mission finding a route for an undersea telegraph cable from San Francisco to Japan when he took formal possession of FFS under the 1856 U.S. Guano Act (Amerson, 1971).

The Republic of Hawai‘i took possession of FFS on January 13, 1895, when President Sanford B. Dole appointed Hawai‘i Minister of the Interior James A. King as Special Commissioner to claim the Hawaiian atoll. The Republic officially claimed the atoll on July 13, 1895 (Amerson, 1971). The Republic of Hawai‘i was annexed by the United States on July 7, 1898 and subsequently became a U.S. Territory on April 30, 1900 (30 Stat. 750, 31 Stat. 141). With the annexation, FFS came under the jurisdiction of the United States.

As a result of egg and feather poaching in the NWHI, in 1909, President Theodore Roosevelt signed Executive Order No. 1019 protecting all of the NWHI (except Midway) under the designation of a Hawaiian Island Reservation. This action marked the first move by the United States to actively manage and protect the resources at FFS. The atoll was placed under the U.S. Department of Agriculture Bureau of Biological Survey, the predecessor agency to FWS, and from 1912 to 1936, the U.S. Revenue Cutter Service sent various patrols to the NWHI looking for poachers. The U.S. Revenue Cutter Service would later be merged with the U.S. Life-Saving Service to form USCG (Amerson, 1971; FWS, 2002).

By the late 1920s, the Navy, realizing the strategic value of FFS, classified many of the hydrographic charts that had been created for the atoll. The NWHI were placed under a new designation (i.e., Hawaiian Islands National Wildlife Refuge) by Presidential Proclamation No. 2416 in 1940. This transferred jurisdiction of the atoll to the U.S. Department of Interior (DOI). With the 1941 attack on Pearl Harbor and the attack on Midway in June of 1942, the United States constructed a Naval Air Facility at Tern Island in 1942 (FWS, 2002).

The modification of Tern Island into a Naval Air Facility was completed in March of 1943. The island took on the appearance of an aircraft carrier when viewed from above. By 1944, 123 enlisted men and four officers operated the facility on 3-month shifts. The facility saw very little action during the war and when the war ended, the facility was placed on a “caretaker status” (URS, 1999).

In August 1945, with WWII ending, the Navy (not realizing that FFS was under the jurisdiction of the United States and part of a wildlife refuge managed by DOI) tried unsuccessfully to transfer the atoll to the then Territory of Hawaiʻi. The Naval Air Facility was officially decommissioned on June 9, 1946. The Territory of Hawaiʻi assumed control based on a misunderstanding over jurisdiction regarding FFS in 1948. The Territory of Hawaiʻi, allowed commercial fisherman to use the facilities at Tern Island beginning in June 1946. Other fishing interests visited the NWHI in the 1950s and 1960s with varying degrees of success (Manta Corp., 1979; URS, 1999; USCG, 1966).

In January 1952, the Territory of Hawaiʻi allowed USCG to construct a LORAN Station on Tern Island. Since FFS was under the jurisdiction of the United States and under the management of DOI, DOI questioned the legality of USCG occupation of Tern Island. In 1966, DOI and USCG reached an agreement with the former granting USCG official permission to operate the LORAN Station (Amerson, 1971).

During the period from 1960 to 1963, when USCG was operating the LORAN Station on Tern Island, a PMR facility was installed and operated by the Navy. The PMR facility included a 50,000-gallon neoprene fuel tank, generators and electrical switching equipment (Amerson, 1971; USCG, 2000).

When the LORAN Station was decommissioned in 1979, USCG returned Tern Island to DOI’s FWS, which took over management of the atoll (URS, 1999). From 1979 to 2012, FWS operated a field station on Tern Island, resulting in 35 years of uninterrupted monitoring data for Hawaiian green sea turtles and decades of monk seal and seabird research (FWS, 2013a; NOAA, 2014e; Spring, 2013).

In December 2000, President William Jefferson Clinton established the NWHI Coral Reef Ecosystem Reserve. In 2006, President George W. Bush placed the NWHI under the more protective designation of a National Monument. Later, the name of the Monument was officially changed to Papahānaumokuākea Marine National Monument. In 2010, the Monument was inscribed as a UNESCO World Heritage Site, and is the only Mixed Heritage site in the United States (NOAA, FWS, HDLNR, 2008; UNESCO, 2014).

## 2.4 Regulatory Involvement

FFS and Tern Island fall within concurrent and/or adjacent jurisdiction and/or management of the following entities and agencies:

- Hawaiian Islands National Wildlife Refuge, managed by FWS.
- Papahānaumokuākea Marine National Monument, managed jointly by FWS, the State of Hawaiʻi Department of Land and Natural Resources (HDLNR), National Oceanic and Atmospheric Administration (NOAA), and advised by the Office of Hawaiian Affairs.
- Northwestern Hawaiian Islands Marine Refuge, managed by the State of Hawaiʻi.
- Northwestern Hawaiian Islands Coral Reef Ecosystems Reserve, managed by NOAA.

### *2.4.1 U. S. Environmental Protection Agency*

On July 19, 2004, EPA added the Site under the name "FWS—Hawaiian Islands National Wildlife Refuge" to the Docket (69 Fed. Reg. 42993 (1994)) as required by CERCLA. The Docket contains information about federal facilities that manage hazardous waste or from which hazardous substances have been or may be released. The Docket name was updated to "FWS – Hawaiian Islands National Wildlife Refuge: Tern Island" on January 26, 2014, Docket #26 (EPA, 2004; EPA, 2014a).

On December 11, 2012, CBD petitioned EPA to conduct a PA of the entire NWHI, with the goal of assessing the impacts of marine debris on threatened and endangered species such as the Hawaiian monk seal. EPA responded to CBD on November 14, 2013, indicating that it would partner with FWS to conduct a more limited scope PA of Tern Island, and would include an evaluation of the release or the threat of release of hazardous substances from Tern Island, including hazardous substances that may adsorb to plastic marine debris in the surrounding surface water (CBD, 2012; EPA, 2013b).

### *2.4.2 Papahānaumokuākea Marine National Monument Co-Trustees*

Management of the Papahānaumokuākea Marine National Monument is the responsibility of the U.S. Department of the Interior (DOI) through FWS, the U.S. Department of Commerce through NOAA, and the State of Hawaiʻi through HDLNR (NOAA, FWS, HDLNR, 2008).

The Secretary of Commerce, through NOAA, has primary responsibility regarding the management of the marine areas of the Monument, in consultation with the Secretary of the Interior. The Secretary of the Interior, through FWS, has sole responsibility for the areas of the Monument that overlay the Midway Atoll National Wildlife Refuge and the Hawaiian Islands National Wildlife Refuge, in consultation with the Secretary of Commerce. The State of Hawaiʻi, through HDLNR, has primary responsibility for the Northwestern Hawaiian Islands Marine Refuge and the State Seabird Sanctuary at Kure Atoll (NOAA, FWS, HDLNR, 2008).

### *2.4.3 U.S. Fish and Wildlife Service*

Tern Island is managed by FWS; however, management of the waters surrounding Tern Island is shared by the federal and state Monument Co-Trustees. FWS has occupied the facilities on the island since 1979 when USCG ceased operation of the LORAN station. FWS maintained a field station on Tern Island until December 2012, at which time FWS ceased field camp activities due to a storm that damaged the barracks (FWS, 2013a; FWS, 2013c; Spring, 2013).

### *2.4.4 U.S. Coast Guard*

During USCG occupancy at Tern Island, an area on the north side of the island was used as a general dump and for burning garbage and trash. Waves, rust, and erosion slowly destroyed the northern seawall, and it was breached in late 1980, exposing the dump. Further erosion revealed scrap metal, cable, wire, batteries and electronic equipment, such as capacitors and transformers containing PCBs. PCBs were detected in the soil at concentrations up to 2,300 milligrams per kilogram (mg/kg) (CH2MHill, 2002).

In 2002, at the request of FWS, USCG conducted a cleanup of soils and landfill materials from Tern Island. As described in section 3, the cleanup removed some of the PCB-contaminated soils in a limited area to the agreed action level of 2 mg/kg; however, the cleanup was incomplete in multiple areas, including an area known as the Bulky Dump (Chase, 2002; CH2MHill, 2002; FWS, 2002).

## 3.0 INVESTIGATIVE AND RESPONSE EFFORTS

During sampling investigations conducted from 1990 through 2004, PCBs, lead and other hazardous substances were detected in soils, sediments, ground water, surface water and/or biota samples collected on and around Tern Island (Lorenz et al., 2002; Miao et al., 1999; Miao et al., 2000a; Miao et al., 2000b; URS, 1999; USCG, 2000; Willcox et al., 2004). These investigative efforts are described below and summarized in Appendix A, Tables 4-10 through 4-13. This section also describes the response efforts initiated as a result of the investigations.

### 1990 through 1992 Lead-Based Paint Cleanup

The woodshop was identified in 1990 as the source of lead based paint chips that potentially caused droop wing and chick mortality. The remediation effort by FWS to address the paint chips (placed 8,300 lbs of sand on and around the area) is no longer visible and it is presumed that lead-based paint chips are still present (FWS, 1990; FWS, 2014a).

### 1992 Removal of 21 USTs by USACE

In July 1991, a survey of Underground Storage Tank (UST) contents was conducted by Environmental Technologies International (ETI) (contracted by the U.S. Army Corps of Engineers) under the Formerly Used Defense Sites (FUDS) Program. The FUDS Program cleans up environmental contamination at properties formerly owned, leased, possessed, or used by the military services (Army, Navy, Air Force, or other Defense agencies). The Army is the Department of Defense executive agent for FUDS, and the U.S. Army Corps of Engineers is responsible for carrying out the program. The FUDS program is part of the Defense Environmental Restoration Program (DERP) and cleans up properties in accordance with CERCLA and the National Contingency Plan (NCP) (ETI, 1992; USACE, 2014).

The tanks were located in pairs on the PM side of the runway along most of the length of Tern Island (see Appendix A, Figure 4-12). ETI found that 5,000 to 6,500 gallons of fuel, 15,200 to 16,000 gallons of intruded sea water, and 5,500 gallons of sand remained in the tanks. The intruded sea water and sand indicated leaks in nearly all of the tanks. These findings also showed that fuel was left in the tanks after Navy and USCG activities concluded (ETI, 1992).

In 1992, ETI completed tank closures for the 21 USTs. Lead was detected in the tank sludge as high as 3.44 milligrams per liter (mg/L) and fuel product was found below some of the tanks. ETI found that one of the USTs located near the northwest side of the island had a 2-foot hole in it, and the ocean had washed out the entire contents of the tank. Lead concentrations in soil were detected ranging from 15.7 to 89.1 mg/kg. Total Petroleum Hydrocarbons (TPH) were detected at two locations at 130 mg/kg and 1,490 mg/kg, respectively. The tanks were cleaned, abandoned in place and filled with concrete to maintain the island's structural integrity (see Appendix A, Figure 4-12) (ETI, 1992).

**Appendix A, Table 4-10 Timeline of Use and Investigations of Tern Island**

| Year and Agency | Investigation/Use | PCBs | Lead | Hydrocarbons | Heavy Metals | Dioxins | DDT |
|---|---|---|---|---|---|---|---|
| 1942-1946 U.S. Navy | The Navy built a U.S. Naval Air Facility on Tern Island. Built USTs ASTs and Barracks. | S | S | S | S | S | |
| 1946-1970s Commercial fishermen utilized Tern | Commercial fishermen utilized the airstrip to send fish back to Honolulu. Commercial fishing use of the airstrip declined when the waters were considered "fished out". | * | * | * | * | * | |
| 1944-1979 USCG | From 1944 to 1952, the USCG built and operated the LORAN Station on East Island in FFS. Later in 1952 the USCG built and operated a LORAN Station on Tern Island. The LORAN Station was decommissioned in 1979. | S | S | S | S | S | |
| 1960-1963 U.S. Navy | A Pacific Missile Range Facility was operated on Tern Island. | * | S | S | S | S | |
| 1967-1972 U.S. Atomic Energy Commission | U.S. Atomic Energy Commission monitoring station was in operation. | | S | S | S | S | |
| 1979-2013 FWS | FWS utilized Tern as a field camp for research of endangered species and avian populations. | | S | | | S | |
| 1982-Current NOAA | Hawaiian monk seal research camps have occupied Tern for the summer months since 1982. | | ◊ | | | | |
| 1982 NOAA | June 1982 Volume IV of The Cooperative Observer Pacific Region documents a National Weather Service facility that transmits weather data by satellite. Construction date unknown. | * | * | * | * | * | |
| 1991 USACE contracted ETI | UST Tank Survey of 21 tanks as part of the Defense Environmental Restoration Program (DERP) | | X | X | X | | |
| 1992 USACE contracted ETI | UST Tank Closure of 21 tanks as part of the DERP | | ◊ | ◊ | | | |
| 1992 FWS | Lead-based Paint Cleanup: An Activity Report documented construction of a fence in an attempt to keep chicks away from the paint chips. The fence proved to be ineffective and approximately 8,300 lbs of sand was used to cover the area. | | | | | | |
| 1997-December FWS | AST removal: There is little documentation and no sampling data to accompany this event. | | ◊ | ◊ | ◊ | | |
| 1997 USCG | Geophysical Investigation to find buried landfills | X | X | | X | | |
| 1997 USCG | Subsurface soil Sampling Investigation: Follow-up to the Geophysical Survey | X | X | | X | | |
| 1998 Navy | Navy Reserve HAZMAT MDSU Cleanup, funded by USCG Civil Engineering Unit: Divers remove two transformers and 30 lead acid batteries, although large scale batteries (900-1500 lbs) that were observed were not relocated for removal. | ◊ | ◊ | | | | |
| March 1999 USCG | Environmental Investigation of Tern Island: Established Hot Spots 1 and 2. | X | X | | X | | |
| 1998 FWS | FWS and UH Sediment and Biota Analysis (Miao et al., 2000a) | X | X | | X | | |
| 1999 USCG | Environmental Investigation of former LORAN Station on Tern Island FFS-Follow-up to Environmental Investigation of Tern Island to fill in data gaps left by previous investigation. | X | X | X | | X | X |
| May 1999-2001 | FWS Marine Sediment and Tissue Study; Miao et al. 2000b, 2001 metals and PCB published papers. | X | X | | X | | X |
| 2000 USCG | Ecological Risk Assessment. | | | | | | |
| 2001-2002 USCG | USCG Cleanup of former landfill areas on Tern. Remediation Verification Report was generated after the cleanup event. | ◊, X | ◊ | | | | |
| 2002 FWS | EA for the Reconstruction for the Shore Protection for Tern Island. | | | | | | |
| 2001-2002 UH, Lorenz et al. | Study of Organochlorines in Marine Organisms, Sand, and Sediment. | X | | | | | X |
| 2001 UH | Study: Distribution of PCBs in marine species from MMF, North Pacific Ocean, Miao et al. | X | | | | | |
| 2004 GeoEngineers contracted by FWS | Two USTs closed One left in place and one shipped off-island for recycling. | X | X, ◊ | X, ◊ | X, ◊ | | |
| 2004 Willcox et al. | OC levels in Monk Seals in French Frigate Shoals. | X | | | | X | X |
| 2008 Ylitalo et al. | OC levels in Monk Seals in the NWHI. | X | | | | | |

S-Potential Source of Contaminant.
◊-Clean-up Action.
X-The investigation sampled for the listed contaminant.
*-Insufficient documentation to determine whether use was a source of contamination.

## Appendix A, Table 4-11 Sediment Sampling Results

| Sampling Event | Matrix | Total Samples | PCBs | Lead | Arsenic | Cadmium | Chromium | Copper | Selenium | TPH (D or R) | Dioxins/Furans(ppt) | DDT/DDD/DDE (ng/g) | BTEX | Total Organic Carbon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1992 UST Closure Published in 1993** | | | | | | | | | | | | | | |
| | Subsurface | 11 | | 15.7 mg/kg to 89.1 mg/kg | 0.32 mg/kg to 0.43 mg/kg | 2.1 mg/kg to 4.6 mg/kg | 12.8 mg/kg to 20.0 mg/kg | | | R-ND to 1,490 mg/kg | | | ND to 0.007 mg/kg Benzene ND to 0.069 mg/kg Toluene ND to 0.041 mg/kg Ethylbenzene ND to 0.083 mg/kg Total Xylenes | |
| | Subsurface Background | 4 | | 15.6 mg/kg to 56.3 mg/kg | 0.53 mg/kg to 1 mg/kg | 3.1 mg/kg to 4.3 mg/kg | 15.6 mg/kg to 17.2 mg/kg | | | R- ND to 25 mg/kg | | | ND Benzene, Ethylbenzene and Xylenes ND-0.005 mg/kg Toluene | |
| **1997 USCG Subsurface Soil** | | | | | | | | | | | | | | |
| | Subsurface | 37 | <2 mg/kg | Average 23.4 mg/kg | | Average 2.1 mg/kg | Average 11.6 mg/kg | | | | | | | |
| **1999 URSGWC USCG Environmental Investigation on Tern Island** | | | | | | | | | | | | | | |
| | Surface Soil 57 samples Subsurface 34 samples | 57 | ND to 126 mg/kg in field ND to 2,300 mg/kg in Lab | ND-2,800 mg/kg in field and ND to 3,700 mg/kg in Lab | ND to 50 mg/kg | | | | | | | | | |
| **1999 Environmental Investigation of Former LORAN Station** | | | | | | | | | | | | | | |
| | Surface Soil-278 samples Subsurface Soil- 65 samples | 346 | 0.0099 mg/kg to 92 mg/kg in Lab | 0.19 mg/kg to 26,000 mg/kg | | | | | | | | 2.2 ng/g to 539 ng/g | | |
| | Sediment Reference (La Perouse) | 1 | ND | | | | | | | | D-1.8 ppt F-0.6 ppt | | | |
| | Soil-Grab | 10 | | | | | | | | D- 11 mg/kg to 660 mg/kg | ND to 506 ppt | | | 9,600 mg/kg to 56,000 mg/kg |
| | Marine Sediment | 28 | ND to 2.728 mg/kg by congener analysis | 0.0007 mg/kg to 0.111 mg/kg | | | | | | | | ND to DDT-5.2 ng/g DDD-20.0 ng/g DDE- 13.0 ng/g | | 0.11 to 0.21 percent |
| | Marine Sediment | 4 | ND | 0.0001 to 0.0002 mg/kg | | | | | | | | | | |

**Appendix A, Table 4-11 Sediment Sampling Results (Continued)**

| Sampling Event | Matrix | Total Samples | PCBs | Lead | Arsenic | Cadmium | Chromium | Copper | Selenium | TPH (D or R) | Dioxins/Furans(ppt) | DDT/DDD/DDE (ng/g) | BTEX | Total Organic Carbon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reference (Gin and Little Gin) | | | | | | | | | | | | | |
| | Beach Sand | 6 | ND to 0.024 mg/kg | 0.001 to 0.0016 mg/kg | | | | | | | | DDT-8.7 ng/g DDD-31.1 ng/g DDE-1.5 ng/g | | 0.11 to 0.16 percent |
| **1998 PCBs and Metals in Marine Species from FFS, North Pacific Ocean Dry Weight (Miao et al., 2000a),** | | | | | | | | | | | | | | |
| | Marine Sediment | 2 | 0.273 mg/kg and 0.274 mg/kg | 22 mg/kg to 44 mg/kg | 23 mg/kg to 24 mg/kg | 1.3 mg/kg | | | 21 mg/kg to 23 mg/kg | | | | | |
| | Sediment Reference (La Perouse) | 1 | 0.154 mg/kg | 20 mg/kg | 24 mg/kg | 1.0 mg/kg | | | 16 mg/kg | | | | | |
| **May 1999 Distribution of PCBs in marine species from MMF, North Pacific Ocean, (Miao et al., 2000b), Dry Weight and Comparative Concentrations of Metals in Marine Species from FFS, (Miao et al., 2001)** | | | | | | | | | | | | | | |
| | Marine Sediment | 3 | 0.119 mg/kg to 0.274 mg/kg | 0.013 mg/kg to 0.044 mg/kg | 0.023 mg/kg-0.028 mg/kg | 0.0004 mg/kg to 0.0013 mg/kg | 0.0122 mg/kg | 0.0368 mg/kg | 0.021 mg/kg to 0.023 mg/kg | | | | | |
| | Sediment Reference (Disappearing Island) | 1 | 0.085 mg/kg t | 0.0105 mg/kg | 0.0248 mg/kg | ND | 0.008 mg/kg | 0.0078 mg/kg | 0.0175 mg/kg | | | | | |
| **2002 Chase Remediation Verification Report for USCG** | | | | | | | | | | | | | | |
| | Sediment | 835 | ND to 54 mg/kg | | | | | | | | | | | |
| **2002 Study of Organochlorines in Marine Organisms, Sand, and Sediments by UH, Lorenz** | | | | | | | | | | | | | | |
| | Turtle Nest Sand | 18 | 0.00002 mg/kg to 0.0427 mg/kg | | | | | | | | | | | |
| **2004 UST Closure by GeoEngineers Contracted by FWS** | | | | | | | | | | | | | | |
| | Soil | 3 | 0.2 to 0.97 mg/kg | 8.6 to 11 mg/kg | | | 5.6 mg/kg to 6.8 mg/kg | | | D: 420 mg/kg to 42,000mg/kg Gasoline: 1.07 mg/kg | | | ND | |

Lab: results were obtained by laboratory analysis of the constituent
Field: results were obtained by a field analysis method (i.e. XRF)
ND: results were below the detection limit
TPH-D: TPH-Diesel Range
TPH-R: Total Recoverable Petroleum Hydrocarbons

**Appendix A, Table 4-12 Water Contamination Sample Results**

| Sampling Event | Matrix | Total Samples | PCBs (µg/L) | Lead (µg/L) | Concentration of TPH (D or R) |
|---|---|---|---|---|---|
| **1999 Environmental Investigation of Former LORAN Station** | | | | | |
| | Groundwater | 6 | 1.2 µg/L to 10 µg/L | 12 µg/L to 430 µg/L | D-11,000 µg/L to 240,000 µg/L |
| | Off-shore Seawater | 2 | 0.000665 µg/L to 0.00449 µg/L | ND | |

**Appendix A, Table 4-13 Biota Contamination Sample Results**

| Sampling Event | Matrix | Total Samples | PCBs | Lead | Arsenic | Cadmium | Chromium | Copper | Selenium | Zinc | DDT/DDE/DDD | PAHs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1999 –URSGWC contracted by USCG Environmental Investigation on Tern Island;** | | | | | | | | | | | | |
| | Monk Seal Scat | 5 | ND to 0.36 mg/kg | | | | | | | | | |
| **1999 Environmental Investigation of Former LORAN Station** | | | | | | | | | | | | |
| | Fish | 18 | ND to 16.436 mg/kg | ND to 0.0002 mg/kg | | | | | | | ND | ND |
| | Reference Fish (Gin and Little Gin) | 16 | ND | ND to 0.0178 mg/kg | | | | | | | ND | ND |
| | Crab | 11 | ND mg/kg to 13.859 mg/kg | ND to 0.0038 mg/kg | | | | | | | DDT-27.9 ppb DDD-50.9 ppb | ND |
| | Reference Crab (Gin and Little Gin) | 4 | ND | 0.0007 mg/kg to 0.0133 mg/kg | | | | | | | ND | ND |
| **1998 Distribution of PCBs in marine species from MMF, North Pacific Ocean, (Miao et al., 2000a)** | | | | | | | | | | | | |
| | Corals | 2 | 0.237 mg/kg to 0.267 mg/kg | 12 mg/kg | 13 mg/kg to 14 mg/kg | 0.5 mg/kg to 0.6 mg/kg | | | 9 mg/kg | | | |
| | Coral Reference (Trig and La Perouse) | 2 | 0.120 mg/kg to 0.181 mg/kg | 13 mg/kg to 11 mg/kg | 15 mg/kg | 0.8 mg/kg to 0.4 mg/kg | | | 6 mg/kg to 10 mg/kg | | | |
| | Fish | 2 | 1.3 mg/kg 46.00 mg/kg | 16 mg/kg | 13 mg/kg | 1.1 mg/kg to 1.7 mg/kg | | | 16 mg/kg to 19 mg/kg | | | |
| | Fish Reference (Trig Island) | 1 | 2.66 mg/kg | 13 mg/kg | 16 mg/kg | 0.8 mg/kg | | | 13 mg/kg | | | |
| | Crab | 2 | 0.387 mg/kg, 4.5 mg/kg | 17 mg/kg to 28 mg/kg | 49 mg/kg to 51 mg/kg | 2.8 mg/kg to 3.6 mg/kg | | | 14 mg/kg to 20 mg/kg | | | |
| **1999 Distribution of PCBs in marine species from MMF, North Pacific Ocean, (Miao et al., 2000b), Dry Weight and Comparative Concentrations of Metals in Marine Species from FFS, (Miao et al., 2001)** | | | | | | | | | | | | |
| | Coral | 2 | 0.019 mg/kg to 0.021 mg/kg | 0.009 mg/kg to 0.0093 mg/kg | 0.0187 mg/kg | 0.0001 mg/kg | 0.0017 mg/kg to 0.002 mg/kg | 0.0053 mg/kg | 0.0103 mg/kg to | 0.0017 mg/kg to 0.0043 mg/kg | | |
| | Reference Coral (Disappearing) | 1 | 0.006 mg/kg | 0.0097 mg/kg | 0.0187 mg/kg | ND | 0.0027 mg/kg | 0.0053 mg/kg | 0.013 mg/kg | | | |
| | Reference Coral (Oahu) | | | 0.0004 mg/kg | 0.012 mg/kg | ND | 0.001 mg/kg | 0.008 mg/kg | 0.0077 mg/kg | 0.0023 mg/kg | | |
| | Eel | 4 | 0.403 mg/kg to 96.470 mg/kg | 0.006 mg/kg to 0.0095 mg/kg | 0.024 mg/kg to 0.296 mg/kg | 0.001 mg/kg to 0.0153 mg/kg | 0.003 mg/kg to 0.006 mg/kg | 0.004 mg/kg to 0.062 mg/kg | 0.018 mg/kg to 0.025 mg/kg | 0.079 mg/kg to 0.132 mg/kg | | |
| | Reference Eel (Disappearing Island) | 1 | 0.331 mg/kg | 0.008 mg/kg | 0.0395 mg/kg | 0.0028 mg/kg | 0.006 mg/kg | 0.035 mg/kg | 0.0245 mg/kg | 0.141 mg/kg | | |
| | Fish | 4 | 0.245 mg/kg to 28.546 mg/kg | 0.0093 mg/kg to 0.031 mg/kg | 0.0235 mg/kg to 0.0315 mg/kg | 0.0012 mg/kg to 0.0017 mg/kg | 0.0078 mg/kg to 0.024 mg/kg | 0.014 mg/kg to 0.125 mg/kg | 0.0223 mg/kg to 0.0275 mg/kg | 0.084 mg/kg to 0.189 mg/kg | | |
| | Reference Fish (Disappearing Island) | 4 | 0.331 mg/kg to 0.604 mg/kg | 0.013 mg/kg to 0.020 mg/kg | 0.024 mg/kg to 0.121 mg/kg | 0.0027 to 0.0063 mg/kg | 0.0075 mg/kg to 0.0115 mg/kg | 0.019 mg/kg to 0.119 mg/kg | 0.0215 mg/kg to 0.0278 mg/kg | 0.118 mg/kg to 0.273 mg/kg | | |
| | Crab/Lobster | 2 | 0.452 mg/kg to 19.460 mg/kg | 0.011 mg/kg to 0.0565 mg/kg | 0.0577 mg/kg to 0.116 mg/kg | 0.0029 mg/kg to 0.006 mg/kg | 0.005 mg/kg to 0.0468 mg/kg | 0.110 mg/kg to 0.343 mg/kg | 0.0257 mg/kg to 0.0301 mg/kg | 0.129 mg/kg to 0.301 mg/kg | | |
| | Reference Crab (Oahu) | 1 | | 0.0002 mg/kg | 0.0274 mg/kg0 | 0.0019 mg/kg | 0.0014 mg/kg | 0.0497 mg/kg | 0.0083 mg/kg | | | |
| **2002 Study of Organochlorines in Marine Organisms, Sand, and Sediments by UH, Lorenz** | | | | | | | | | | | | |

**Table 4-13 Biota Contamination Sample Result (Continued)**

| Sampling Event | Matrix | Total Samples | PCBs | Lead | Arsenic | Cadmium | Chromium | Copper | Selenium | Zinc | DDT/DDE/DDD | PAHs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Turtle Blood | 9 | ND to 0.0077 mg/kg | | | | | | | | | |
| | Turtle Eggs | Collected but not analyzed | | | | | | | | | | |
| **2004 Willcox et al. Study on Organochlorides in Hawaiian Monk Seals** | | | | | | | | | | | | |
| | Monk Seal | 48 | 0.730 to 14 mg/kg in blood 0.150 to 8.9 mg/kg in blubber | | | | | | | | DDT-ND to 8.1 mg/kg In blubber | |
| **2008 Ylitalo et al. Study on Organochlorides in Hawaiian Monk Seals** | | | | | | | | | | | | |
| | Monk Seal (158 Blood and 78 Blubber) | 158 | 1.8 to 6.3 mg/kg in blood 0.480 to 8.8 mg/kg in blubber | | | | | | | | DDE-0.270 to 1.5 mg/kg in blubber | |

J: Estimate- analytical result is below method reporting limit.
ND: results were below the detection limit

**1997 Geophysical Investigation**

In 1997, Woodward-Clyde Federal Services (WCFS), under contract with USCG, completed a geophysical investigation of the northern side of Tern Island in an attempt to locate the on-site landfills. The study set up a baseline transect north of the landing strip in the northwest corner of the island, and an investigation area was set up corresponding to that transect. The investigation included an area almost 3,000 feet in the east-west direction (the length of the runway) and 30 to 140 feet in the north-south direction. The results of the survey found that approximately 20% of the north side of the island had subsurface metal debris (URS, 1999).

**1997 Subsurface Soil Sampling USCG**

USCG personnel conducted a subsurface sampling investigation of Tern Island in September 1997. This study used the same base transect line (located north of the runway) created for the WCFS survey in 1997, so that any locations with detections could be spatially related to new detections (see Appendix A, Figure 4-13). Portable hand-augering equipment was used to collect soil samples from depths of 3 to 5 feet below ground surface (bgs). These samples were taken from areas that were determined to have subsurface anomalies during the WCFS survey. A total of 37 soil samples were collected and analyzed for total PCBs, lead, chromium, cadmium, and mercury. No PCBs were detected in the soils above the detection limit of 2 mg/kg. One sample showed an elevated lead concentration of 939 mg/kg. Lead values were determined to be approximately 23.4 mg/kg in soil at Tern Island (URS, 1999).

**1998 FWS Biota and Sediment PCBs and Metals in Marine Species**

In March 1998, FWS collected sediment and biota samples from Tern Island, Trig Island, and La Perouse Pinnacle that were submitted to UH for analyses of PCBs and metals. Total PCBs were 0.273 mg/kg and 0.274 mg/kg in sediments collected from Tern Island, and 0.154 mg/kg in sediments from La Perouse Pinnacle. Lead concentrations were 22 mg/kg and 44 mg/kg in sediments collected from Tern Island and 20 mg/kg in sediments from La Perouse Pinnacle (Miao.et al., 2000a).

Coral (*Porites lobata*), fish (*Stegastes fasciolatus*), and crab (*Grapsus tenuicrustatus*) samples were collected from the waters off the northwest and northeast corners of the Tern Island seawall. Reference samples were collected from Trig Island and La Perouse Pinnacle. Total PCBs were up to 0.267 mg/kg in corals from Tern Island and up to 0.181 mg/kg in corals from the reference locations. Total PCBs were up to 4.5 mg/kg in crabs from Tern Island (no reference sample), and up to 46 mg/kg in fishes from Tern Island with 2.66 mg/kg in fishes from the reference location. Average concentrations of lead were 12 mg/kg in corals, 16 mg/kg in fishes and 22.5 mg/kg in crabs from Tern Island, comparable to concentrations in the reference locations. The authors concluded that high concentrations of PCBs in marine species indicated there were PCB source(s) in FFS, especially Tern Island. The sediment and coral were predominated by lower chlorinated PCB congeners, whereas the fish and crab bioaccumulated mainly higher chlorinated congeners (Miao et al., 2000a).

**1998 US Navy Reserve HAZMAT SCUBA Cleanup**

In October and November 1998, U.S. Navy Reserve Dive/HAZMAT SCUBA divers observed two transformers during their dives. The first, located 20 feet south of the northwest corner of Tern Island, was observed to be empty with the side missing. The second, located 100 feet west of the corner of the seawall, was observed to have ruptured sides. These transformers were removed, along with over 30 lead-acid batteries and other hazardous materials during a cleanup of the nearshore waters (see Appendix A, Figure 4-14). Over 2,000 pounds of hazardous wastes were removed from Tern Island; however, large-scale batteries (900 to 1,500 pounds) that were observed by the divers were not relocated for removal (Navy, 1998).

**1998 USCG Environmental Investigation (EI) of Tern Island (report published in 1999)**

In October and November 1998, an Environmental Investigation (EI) conducted on behalf of USCG by URS Greiner Woodward Clyde (URSGWC) assessed the level and extent of lead and PCB soil contamination resulting from discarded batteries and electrical equipment observed on Tern Island. The base transect line for this investigation matched the baseline established during the 1997 geophysical investigation immediately north of the runway on the northwestern portion of the island. Thirteen trenches were excavated in the northwestern portion of Tern in areas that were identified as electromagnetic anomalies during the geophysical investigation. Surface soil samples were collected where batteries or electrical components were observed. The south-central portion of the island was also electromagnetically surveyed using a hand-held metal detector. Seven test pits were excavated in areas with strong metal detector signals. Where metal debris and batteries were observed, additional surface soil samples were collected. Subsurface composite soil samples were collected from excavated trenches where ash layers were encountered and where electrical equipment, batteries or metal debris were observed (Chase, 2002; URS, 1999; USCG, 2000).

Two areas of significant surface lead and PCB contamination were identified during the investigation and were designated Hot-spot Area 1 and Hot-spot Area 2 (see Appendix A, Figure 4-13). Hot-spot Area 1 extended from the baseline to about 50 feet north of the baseline and southeast of the break in the northern seawall. Hot-spot Area 2 was located from the baseline to about 150 feet north of the baseline directly behind the northern seawall to the east of the break. Most of the subsurface debris was found in trenches dug in Hot-spot Area 2. Contamination in the extreme northern part of this area was estimated to extend to 4 or more feet bgs (URS, 1999; USCG, 2000).

The EI report concluded that PCB concentrations were highest in the two hot-spot areas and that concentrations decreased with depth. Based on contoured data, it was estimated that roughly 1,170 cubic yards of soil contained PCB concentrations between 1 and 3 mg/kg, 500 cubic yards with PCB levels between 3 and 10 mg/kg, and 150 cubic yards with PCB levels greater than 10 mg/kg. The total mass of PCBs present in the investigation area was estimated to be approximately 11.8 kilograms (kg) (URS, 1999).

During this investigation, five Hawaiian monk seal scat samples were collected and analyzed in the field for PCBs. Three of the five scat samples contained detectable levels of PCBs with measured concentrations ranging from 0.02 to 0.36 mg/kg PCB as Aroclor 1254 (URS, 1999).

**1999 USCG Environmental Investigation of Former LORAN Station**

URSGWC, through USCG, performed a more comprehensive EI to refine the lateral and vertical extent of lead- and PCB-contaminated soils in the northwestern portion of Tern Island. Two fine (7.5- by 15-foot) grids were set up in Hot-spot Areas 1 and 2, which were delineated in the earlier URSGWC survey. A coarse (15- by 30-foot) grid was established from the western end of Tern to a point 810 feet east along the WCFS baseline, including all of the land north of the runway (see Appendix A, Figure 4-15). PCBs and lead were detected in surface and subsurface samples collected throughout the sampling grids. Most of the soil PCB patterns closely matched the Aroclor 1254 standard pattern; however, some evidence of weathering was interpreted in the patterns, meaning the less chlorinated PCB congeners were typically present in lower concentrations relative to the more highly chlorinated congeners, as compared to the reference standards for Aroclor 1254 (URS, 1999; USCG, 2000).

A total of 28 marine sediment samples were collected from three offshore locations, which were off the landfill and on the northwest and northeast sides of Tern Island (see Appendix A, Figure 4-16). At each location, sediments from 0 to 6 inches bgs were collected. In addition, six onshore beach sediment samples were collected from two locations along the southern shore of the island and a single site located along the northern shore of the island. The samples were collected from the near-surface and subsurface, and they were located to obtain representative contaminant levels that may be encountered by monk seals and sea turtles during their nesting and hauling out activities. Four background sediment samples were collected from offshore sediments on Gin Island and Little Gin Island, which are located approximately 9.5 and 11 miles southeast of Tern Island, respectively (see Figure 1-1). Thirteen of the offshore sediment samples, the six onshore beach sediment samples, and the four background sediment samples were analyzed for 28 PCB congeners. The other 15 offshore sediment samples were analyzed for total PCBs. The highest sediment PCB concentrations were detected in sediment samples collected offshore from the landfill area (sum of congeners range of non-detect to 2.7 mg/kg and total PCB range of 0.007 to 0.640 mg/kg). Concentrations were lower off the northwestern corner of the island (sum of congeners range of below the detection limit to 0.104 mg/kg and total PCB range of 0.008 to 0.260 mg/kg) and the northeastern corner of the island (total PCBs range of below the detection limit to 0.0092 mg/kg). PCBs were not detected in the three beach sand samples collected at Shell Beach and Crab Beach; however, they were detected in three of six beach sand samples collected from areas of South Beach known to be used by monk seals as resting areas and by green sea turtles for laying eggs. All three of these sand samples had sum of PCB congener concentrations of 0.012 mg/kg. Lead was detected in 22 sediment samples ranging from 0.0001 to 0.1111 mg/kg (URS, 1999; USCG, 2000).

Thirty-two marine biota tissue samples were collected from the area directly offshore from the landfill and from the northeastern, northwestern, southeastern and southwestern corners of Tern Island (see Appendix A, Figure 4-17). A total of 20 background samples were also collected from Gin Island and Little Gin Island. A total of 21 fish were collected from Tern Island and were analyzed, including 10 goatfish (*Mullidae* spp.) and 11 manini (*Acanthurus triostegus,* or common striped reef surgeonfish). Additionally, 11 intertidal crabs (*Grapsus sp*.) were collected from Tern Island. Sixteen fish and four intertidal crabs of similar size were collected from background areas. Biota samples were analyzed for 28 PCB congeners using EPA Method 8270. The highest PCB concentrations were detected in biota collected from areas directly offshore of the landfill area. PCB concentrations up to 16.4 mg/kg were detected in goatfish, manini and intertidal crab collected from this area. PCB concentrations up to 0.705 mg/kg were detected in all three types of biota samples collected from the northwestern corner of Tern Island. PCB concentrations up to 0.466 mg/kg were detected in all three types of biota samples collected from the northeastern corner of Tern Island. No PCBs were detected in the biota samples collected from the background locations around Gin Island and Little Gin Island. The study concluded that there was clear evidence of bioaccumulation in the aquatic food chain that resulted in high concentrations of lipophilic contaminants, such as PCBs in organisms that occupy high trophic levels (URS, 1999; USCG, 2000).

Ground water samples were collected from six boreholes and excavations in Hot-spot Area 2 that were drilled or hand dug to depths ranging from 2 to 5 feet bgs. Six grab samples were collected, using either direct grab methods or disposable bailers. Three water samples were analyzed for TPH-diesel because field personnel either smelled an organic odor or observed a hydrocarbon sheen. All three samples contained TPH ranging from 11,000 to 240,000 micrograms per liter (µg/L) (URS, 1999). An additional sample was collected from a background location on Tern Island. Three of the six ground water samples, as well as the background sample, were analyzed for PCBs via EPA Method 8081/8082. PCBs were detected in the background sample at a concentration of 0.41 µg/L and in the Hot-spot Area 2 samples at concentrations ranging from 1.2 to 10 µg/L. Lead was detected in five of the samples collected ranging from 12 to 430 µg/L (URS, 1999). The report concluded that elevated concentrations of hydrocarbons present in soils have facilitated the migration of PCBs bound to soil into the shallow underlying ground water (URS, 1999; USCG, 2000).

In addition, seawater samples were collected from two offshore sites surrounding Tern Island. One seawater sample was collected from just offshore of the main landfill area. The other sample was collected approximately 150 feet offshore of the southeast corner of the island. The seawater samples were collected by divers from approximately 3 feet beneath the sea surface. The seawater samples were analyzed for trace PCBs via Modified EPA Method 8290. Total PCBs detected were 0.00445 µg/L in the landfill area sample and 0.000665 µg/L in the southeast corner sample (URS, 1999).

**1999 FWS Marine Sediment and Tissue Analysis**

In May 1999, FWS collected biota and sediment samples from the waters off the barge location and the northeast and northwest corners of the Tern Island seawall (see Appendix A, Figure 4-18). The barge location is offshore of the central part of the island between the northeast and northwest corners. Reference samples were collected from Disappearing Island, located in FFS approximately 16 miles from Tern Island. PCBs were analyzed in sediment; coral (*Porites evermanni*); fish (*Stegastes fasciolatus*, *Neoniphon sammara*, *Acanthurus triostegus* and *Mulloidichthys anicolensis*); crab (*Grapsus tenuicrustatus*); lobster (*Panulirus marginatus*); and eel (*Conger cinereus*, *Gymnothorax flavimarginatus*, *G. undulatus* and *G. meleagris*) samples. In general, high trophic species, such as eels, were found to highly bioaccumulate PCBs. The total average PCB concentrations were as high as 96.470 mg/kg and 28.546 mg/kg dry weight in eels and damselfish, respectively, from Tern Island. The authors concluded that the high average concentrations of the sum of PCBs in different food chain levels suggest pollution sources around Tern Island (0.274 mg/kg, 0.273 mg/kg, 0.119 mg/kg) and possibly around Disappearing Island (0.085 mg/kg) (Miao et al., 2000b).

In order to assess organochlorine levels in Hawaiian monk seals, whole blood and blubber samples were collected from 46 free-ranging Hawaiian monk seals at FFS, and were analyzed for eight dioxin-like PCBs, as well as six other PCB congeners, DDT and DDT metabolites. Average levels of PCBs in blood samples from adult male, juvenile and reproductive female groups were 4.8 mg/kg, 4.0 mg/kg and 03.0 mg/kg lipid weight, respectively. Average levels of total PCBs in blubber were 3.2 mg/kg, 1.3 mg/kg and 1.2 mg/kg, respectively (Willcox et al., 2004).

On behalf of FWS, UH conducted a study of organochlorines in marine organisms, sand and sediments collected from Tern Island and other islands of the NWHI National Wildlife Refuge. One of the objectives of the study was the evaluation of PCBs in Hawaiian green sea turtle samples from Tern Island. Turtle blood and egg samples, as well as sand samples from nesting sites, were collected and analyzed for PCBs and organochlorine pesticides. Concentrations of total PCBs in turtle blood ranged from below the detection limit to 0.007.7 mg/kg in the nine individuals tested. Concentrations of total PCBs in nest sands ranged from 0.00002 to 0.0427 mg/kg in the 18 nests that were tested (Lorenz et al., 2002).

**2002 USCG Remediation Verification Report**

Chase Environmental Group, Inc. (Chase) was contracted by USCG to conduct a cleanup of the landfills. USCG, in cooperation with FWS and EPA, agreed upon the Toxic Substances Control Act (TSCA) PCB cleanup level of 2 mg/kg. USCG coordinated with FWS to conduct the work, which began in September 2001. Construction debris, soils, transformers and batteries located during previous site investigations were removed from Tern Island using an excavator. Portions of batteries and capacitors were removed from several locations in the landfill. Several electrical devices, such as capacitors and transformers, were removed from the Bulky Dump, located in the northwest portion of the island just west of the landfill. The remainder of the Bulky Dump was not remediated during the landfill cleanup (see Appendix A, Figure 4-28) (CH2MHill, 2002; Chase, 2002).

The Remediation Verification Report generated by Chase contains conflicting data about the amount of waste removed from the Site (CH2MHill, 2002; Chase, 2002). The sampling methods used in the remediation verification sampling were not those that were accepted in the Sampling and Analysis Plan (Chase, 2002). The cleanup was considered incomplete by FWS and EPA for multiple reasons, including the omission of excavating in the Bulky Dump, along the northern sea wall, and the burn pit where nesting Shearwater birds had burrows that prevented excavation. In addition, the cleanup goal of 2 mg/kg was not achieved in all areas, partly because USCG failed to obtain the necessary U.S. Army Corps of Engineers Clean Water Act section 10 and section 404 permits to excavate and backfill in this area. In response, EPA stated that further action was necessary as the cleanup left unacceptable levels of PCBs on Tern Island (EPA, 2003).

The Marine Mammal Commission, an independent federal agency created by the authority of the Marine Mammal Protection Act, sent a correspondence to USCG stating that further cleanup was necessary and that the Hawaiian monk seal was threatened by the remaining contamination. In a response to the Marine Mammal Commission, USCG stated that it would undertake no further cleanup on Tern Island (MMC, 2003; MMC, 2005; USCG, undated).

# 4.0 HAZARD RANKING SYSTEM FACTORS

## 4.1 Sources of Contamination

For HRS purposes, a source is defined as an area where a hazardous substance has been deposited, stored, disposed or placed, plus soils that have become contaminated from migration of a hazardous substance.

Potential hazardous substance sources associated with the Site include, but may not be limited to:

- Landfills where materials containing hazardous substances were historically buried on Tern Island. Some of the debris has been subsequently exposed by corrosion of the seawall and erosion of fill material. During the 2002 USCG cleanup action, electrical devices, such as capacitors and transformers, were found and removed from the Bulky Dump, located in the northwest portion of Tern Island. The remainder of the Bulky Dump was not remediated during the landfill cleanup (see Appendix A, Figure 4-20) (CH2MHill, 2002; Chase, 2002; FWS, 2002; FWS, 2014; URS, 1999).

- Soils and sediments contaminated by historical operations on Tern Island. Hazardous substances such as PCBs and lead have been detected in Tern Island soils and sediments (Lorenz et al., 2002; Miao et al., 1999; Miao et al., 2000a; Miao et al., 2000b; URS, 1999; USCG, 2000; Willcox et al., 2004).

## 4.2 Ground Water Pathway

In determining a score for the ground water migration pathway, the HRS evaluates: 1) the likelihood that sources at a site actually have released, or potentially could release, hazardous substances to ground water; 2) the characteristics of the hazardous substances that are available for a release (i.e., toxicity, mobility and quantity); and 3) the people (targets) who actually have been, or potentially could be, impacted by the release. For the targets component of the evaluation, the HRS focuses on the number of people who regularly obtain their drinking water from wells that are located within 4 miles of the site. The HRS emphasizes drinking water usage over other uses of ground water (e.g., food crop irrigation and livestock watering) because, as a screening tool, it is designed to give the greatest weight to the most direct and extensively studied exposure routes.

The hydrogeology of Tern Island is such that there is very little to no fresh water available in the subsurface. Rain events may lead to the accumulation of short-term fresh water lenses in localized locations. These lenses may exist by temporarily sitting above the tidally-influenced seawater, which flows through the native and constructed carbonate and sand fill. Typically brackish ground water is available from 5 to 8 feet bgs. Water catchment, filtration and other means are utilized for field personnel operating on Tern Island (USCG, 1999). Ground water within the target distance limit is not used for drinking water. Therefore, this pathway was not included.

## 4.3 Surface Water Pathway

To determine the score for the surface water pathway, the HRS evaluates: 1) the likelihood that sources at a site actually have released, or potentially could release, hazardous substances to surface water (e.g., streams, rivers, lakes and oceans); 2) the characteristics of the hazardous substances that are available for a release (i.e., toxicity, persistence, bioaccumulation potential and quantity); and 3) the people or sensitive environments (targets) who actually have been, or potentially could be, impacted by the release. For the targets component of the evaluation, the HRS focuses on drinking water intakes, fisheries and sensitive environments associated with surface water bodies within 15 miles downstream of the site.

### *4.3.1 Hydrological Setting*

The perimeter of Tern Island is approximately 7,120 feet, most which is supported by a sheet-pile seawall. Due to age, weathering conditions and erosion, the majority of the seawall is no longer intact. The ocean can freely flow through parts of the seawall structure, causing erosion of the island. Large sections of the seawall have collapsed into the ocean. The worst erosion has manifested on the north and west sides and the on the southeast corner (FWS, 2002).

Upper ocean currents in the NWHI have been shown to have highly variable speeds and directions. The averaged flow is dominantly from east to west, resulting from the predominant northeasterly trade winds. However, with the NWHI, water circulation patterns are highly variable based on wind conditions, water depth, and the shape of existing coral structures. The ocean floor modifications made by the U.S. military’s dredging activities around Tern Island have changed localized flow patterns around the island. The channel is typically around 20 feet deep. Mean high water at nearby East Island is 1.10 feet (FWS, 2002).

The coupling of atmospheric and oceanographic processes creates the North Pacific STCZ, located north of the Hawaiian Islands between the mid-latitude westerlies and the easterly trade winds. The STCZ migrates between 23°N and 37°N with changes in atmospheric high pressure (Pichel et al., 2007; EPA, 2011b). Using satellite imagery, a study in 2005 confirmed the STCZ contains high densities of marine debris (Morishige et al., 2007) and that the islands and atolls of Hawaiʻi receive marine debris as a result of the STCZ (Pichel et al. 2007).

A 16-year study spanning from 1990 through 2006 examined the factors affecting marine debris deposition at FFS. During that time, a total of 52,442 marine debris items were deposited on Tern Island beaches with the annual deposition ranging from 1,116 in 2001 to 5,195 items in 2004. Plastics composed 71% of the marine debris deposited on Tern Island during the study, followed by glass at 17%, with Styrofoam, rope, metal, rubber and wood composing less than 13% as a group (Friedlander et al., 2005; Morishige et al., 2007). The vast majority (90%) of plastic debris found in the pelagic environment is generally less than 5 millimeters in diameter, which are known as microplastics (Eriksen et al., 2013, Browne et al., 2010; Thompson et al., 2004; Rochman et al., 2014).

### *4.3.2 Surface Water Targets*

Tern Island and FFS are located within the Hawaiian Islands National Wildlife Refuge and the Northwestern Hawaiian Islands Coral Reef Ecosystems Reserve. In addition, waters around Tern Island and FFS are designated as the Northwestern Hawaiian Islands Marine Refuge by the State of Hawaiʻi (NOAA, FWS, HDLNR, 2008).

FFS, including Tern Island, is designated critical habitat for the Hawaiian monk seal (*Monachus schauinslandi*), a federally listed endangered species. The critical habitat designation includes all beach areas, sand spits and islets, including all beach crest vegetation to its deepest extent inland, lagoon waters, inner reef waters and ocean waters out to a depth of 20 fathoms around FFS. FFS has the largest Hawaiian monk seal breeding site and breeding subpopulation (NOAA, 2013a).

Approximately 95% of the federally listed threatened Hawaiian green sea turtles (*Chelonia mydas*) are known to nest in FFS, including on Tern Island (Amerson, 1971; Friedlander et al., 2009).

Additional surface water Sensitive Environments, as identified in HRS Table 4-23, are present within the Target Distance Limit from the Site. However, the Sensitive Environments were not evaluated because they do not significantly affect the assessment decision.

### *4.3.3 Surface Water Pathway Conclusion*

A release from Tern Island to surface water of the FFS lagoon and the Pacific Ocean is likely. PCBs, lead and other hazardous substances have been detected in sediment, biota and seawater samples collected around Tern Island. These hazardous substances are attributable to the Site because they have been detected at elevated concentrations in soils and landfill materials on the island. In addition, erosion of the seawall is directly exposing landfill materials to surface waters of the FFS lagoon and the Pacific Ocean (Lorenz et al., 2002; Miao et al., 1999; Miao et al., 2000a; Miao et al., 2000b; URS, 1999; USCG, 2000; Willcox et al., 2004).

Tern Island and surface waters immediately around the island are habitat for threatened and endangered species, such as the Hawaiian monk seal and the Hawaiian green sea turtle (Amerson, 1971; Friedlander et al., 2009; NOAA, 2013a).

Due to the location of Tern Island with respect to the North Pacific STCZ, large quantities of marine debris, including plastics and microplastics, are deposited on Tern Island (EPA, 2011b; Friedlander et al., 2005; Morishige et al., 2007; Pichel et al. 2007). Plastics are known to hyperconcentrate POPs such as PCBs, trace quantities of which are commonly found in seawater. Plastic debris has been shown to sorb PCBs and dichlorodiphenyldichloroethylene (DDE) about 100 times better than naturally-occurring suspended organic matter (Engler, 2012). Recent evidence shows that ingestion of microplastics (particles 5 millimeters and below) serves to biomagnify contaminants up the food chain (Engler, 2012; EPA, 2011b). EPA believes that this exposure pathway may contribute to the loading of PCBs and other contaminants found in the sensitive environments on and around Tern Island. A more detailed discussion of plastics on Tern Island and in the environment may be found in Appendix A.

## 4.4 Soil Exposure and Air Migration Pathways

In determining the score for the soil exposure pathway, the HRS evaluates: 1) the likelihood that there is surficial contamination associated with the site (e.g., contaminated soil that is not covered by pavement or at least 2 feet of clean soil); 2) the characteristics of the hazardous substances in the surficial contamination (i.e., toxicity and quantity); and 3) the people or sensitive environments (targets) who actually have been, or potentially could be, exposed to the contamination. For the targets component of the evaluation, the HRS focuses on populations that are regularly and currently present on or within 200 feet of surficial contamination. The four populations that receive the most weight are residents, students, daycare attendees and terrestrial sensitive environments.

In determining the score for the air migration pathway, the HRS evaluates: 1) the likelihood that sources at a site actually have released, or potentially could release, hazardous substances to ambient outdoor air; 2) the characteristics of the hazardous substances that are available for a release (i.e., toxicity, mobility and quantity); and 3) the people or sensitive environments (targets) who actually have been, or potentially could be, impacted by the release. For the targets component of the evaluation, the HRS focuses on regularly occupied residences, schools, and workplaces within 4 miles of the site. Transient populations, such as customers and travelers passing through the area, are not counted.

### *4.4.1 Physical Conditions*

Tern Island is remote and inaccessible to the general public. The ocean can freely flow through the deteriorating seawall, increasing the rate of erosion of the island. Historical landfill materials are currently being exposed through this erosion process (see Appendix A, Figure 4-20) (FWS, 2002; FWS, 2013c).

### *4.4.2 Soil Exposure and Air Targets*

There are currently no full-time workers on Tern Island, though FWS and NOAA personnel camp on the island for several months during field seasons. Terrestrial sensitive environments, including the Hawaiian Islands National Wildlife Refuge, critical habitat for the Hawaiian monk seal, and habitat for the Hawaiian green sea turtle, are located on the Site (Amerson, 1971; Friedlander et al., 2009; FWS, 2002; NOAA, 2013a).

### *4.4.3 Soil Exposure and Air Pathway Conclusions*

Observed contamination of surface soils is likely, based on sampling showing the presence of PCBs, lead and other hazardous substances in surface soils on Tern Island. In addition, landfill materials are still present on the island. Tern Island provides terrestrial habitat for the endangered Hawaiian monk seal and the threatened Hawaiian green sea turtle. It is also designated as a Wildlife Refuge (Lorenz et al., 2002; Miao et al., 1999; Miao et al., 2000a; Miao et al., 2000b; URS, 1999; USCG, 2000; Willcox et al., 2004).

No known air sampling has been conducted for Tern Island or FFS. The air pathway was not evaluated because it does not significantly affect the assessment decision.

## 5.0 REMOVAL EVALUATION CONSIDERATIONS

Under the National Contingency Plan [40 CFR 300.415 (b)(3)], a PA may identify sites that warrant a removal evaluation to assess whether a removal action is appropriate. EPA, in partnership with FWS, is assessing whether such an evaluation is warranted.

## 6.0 SUMMARY

The Tern Island Site is located in French Frigate Shoals (FFS), Northwestern Hawaiian Islands (NWHI), Hawaiʻi. The NWHI are located within the North Pacific Subtropical Convergence Zone (STCZ), where a high concentration of marine debris has been observed to accumulate. Tern Island is the largest of twelve small sand islands contained within the low-lying FFS coral atoll. FFS is located approximately 490 nautical miles north-northwest of Honolulu, Hawaiʻi.

When discovered in 1786, Tern Island was a small carbonate sand shoal. With the attack on Pearl Harbor in 1941 and the attack on Midway in June of 1942, Tern Island was enlarged and used by the U.S. Navy as a Naval Air Facility. Live coral reef and sand were dredged from around the island and were used to create a 3,100-foot long compacted coralline runway. Construction of Tern Island was completed by creating a seawall out of approximately 5,000 feet of double-walled steel sheet piling to hold the sea back and contain the island. As a consequence of military operations, Tern Island became home to various structures including barracks, pump houses, water tanks and sheds. The modification of Tern Island was completed in March of 1943, and by 1944, 123 enlisted men and four officers operated the station on three-month shifts. The station was officially decommissioned in 1946.

In 1952 the U.S. Coast Guard (USCG) constructed a Long Range Aid to Navigation (LORAN) Station on Tern Island. When the LORAN Station was decommissioned in 1979, USCG returned management of Tern Island to FWS. From 1979 to December 2012, FWS operated a field station on Tern Island, resulting in 35 years of uninterrupted monitoring data for Hawaiian green sea turtles and seabirds. Decades of monk seal research and recovery, as well as focused seabird research, were supported by the field station. Tern Island is part of the Hawaiian Islands National Wildlife Refuge, the Papahānaumokuākea Marine National Monument (the Monument), the Northwestern Hawaiian Islands Marine Refuge, and the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve. In 2010 the Monument was inscribed as a cultural and natural United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage site.

During USCG and Navy control of Tern Island, materials including scrap metal, cable, wire, batteries and electronic equipment, such as capacitors and transformers, were landfilled on the island. These materials have been shown to contain hazardous substances such as polychlorinated biphenyls (PCBs) and lead. During sampling investigations conducted from 1992 through 2004, PCBs, lead and other hazardous substances were detected in soils, sediments, ground water, surface water and/or biota samples collected on and around Tern Island. A cleanup conducted by USCG in 2002 did not completely remove all areas of known contamination.

The following pertinent Hazard Ranking System factors are associated with the Site:

- A release from Tern Island to surface waters of the FFS lagoon and the Pacific Ocean is likely. PCBs, lead and other hazardous substances have been detected in sediment, biota, and seawater samples collected around Tern Island. These hazardous substances are attributable to the Site because they have been detected at elevated concentrations in soils and landfill materials on the island. In addition, erosion of the seawall is directly exposing landfill materials to surface waters of the FFS lagoon and the Pacific Ocean.

- Surface water sensitive environments within the release include the Hawaiian Islands National Wildlife Refuge, the Northwestern Hawaiian Islands Coral Reef Ecosystems Reserve, and the Northwestern Hawaiian Islands Marine Refuge. In addition, FFS, including Tern Island, is designated critical habitat for the Hawaiian monk seal (*Monachus schauinslandi*), a federally listed endangered species. The federally listed, threatened Hawaiian green sea turtle (*Chelonia mydas*) is also known to nest in FFS, including on Tern Island.

- Observed contamination of surface soils is likely based on sampling showing the presence of PCBs, lead, and other hazardous substances in surface soils on Tern Island. In addition, landfill materials are still present on the island.

- Terrestrial sensitive environments are present on Tern Island, including the Hawaiian Islands National Wildlife Refuge, critical habitat for the endangered Hawaiian monk seal, and habitat for the threatened Hawaiian green sea turtle.

## 7.0 REFERENCES

The reference list is provided in Appendix B. Complete copies of the references are on file and available upon request.

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# Appendix A:
# Technical Support Document

# Appendix B: References

# Appendix C:
# Transmittal List

# TRANSMITTAL LIST

**Date:** September 2014
**Site Name:** FWS – Hawaiian Islands National Wildlife Refuge: Tern Island
**EPA ID No.:** HI0000906379

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