Quarterly Groundwater Monitoring Report
Red Hill Fuel Storage Facility

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Table of Contents

List of Tables

List of Figures

List of Appendices

Executive Summary

This quarterly groundwater monitoring report presents the results of groundwater sampling conducted on October 13 and 14, 2009 at the United States (US) Navy Bulk Fuel Storage Facility at Red Hill, Oahu, Hawaii (the Facility). The sampling and reporting was conducted by TEC Inc. (TEC) for the Fleet and Industrial Supply Center (FISC) at Pearl Harbor, Hawaii. This report is part of a series of quarterly groundwater monitoring reports provided by the US Navy to the State of Hawaii Department of Health (HDOH) in accordance with HDOH's release response requirements. Currently, there are 18 active and 2 inactive, 12.5 million gallon, field-constructed underground storage tanks (USTs) located at the Facility.

Background

In 2002, the US Navy installed a groundwater monitoring well (currently named RHMW01) into the basal aquifer, directly down-gradient from the Facility, within the lower access tunnel. Groundwater samples from this well indicated that petroleum from the Facility has migrated to the basal aquifer (AMEC, 2002). In 2005, the US Navy began quarterly monitoring of the aquifer to protect their down-gradient drinking water resource associated with the US Navy Well 2254-01. US Navy Well 2254-01 is located approximately 3,000 feet down-gradient from the Facility USTs and provides approximately 24 % of the potable water to the Pearl Harbor Water System (PHWS).

By September 2005, the US Navy had installed two more groundwater monitoring wells (RHMW02 and RHMW03) within the Facility UST system, a background groundwater monitoring well (RHMW04) up-gradient from the Facility adjacent to the US Navy Firing Range, and a groundwater monitoring well within the US Navy Well 2254-01 infiltration gallery (RHMW2254-01).

All five wells were sampled twice as part of a comprehensive environmental investigation and risk assessment (TEC, 2006). For this investigation, groundwater samples were analyzed for petroleum constituents and compared against HDOH Drinking Water Environmental Action Levels (EALs) (HDOH, July 2005). In addition, a three-dimensional (3-D) groundwater model was developed to produce site-specific risk-based levels (SSRBLs) for compounds of concern. The results of this modeling effort indicated that Jet Propulsion (JP)–5 fuel presented the biggest risk to the US Navy water supply, due to its mobility and toxicity. Finally, the model determined that a non-aqueous plume (free product) of JP-5 would need to migrate to within 1,100 feet of the US Navy Well 2254-01 infiltration gallery for HDOH EALs to be exceeded within the gallery. Based on this, free-product must be observed at RHMW01 for EALs to be exceeded at the US Navy Well 2254-01.

In April 2009, another groundwater monitoring well (RHMW05) was installed down-gradient from the Facility, within the lower access tunnel between RHMW01 and RHMW2254-01. It was installed to identify the extent of contaminant migration down-gradient before it reaches the infiltration gallery at RHMW2254-01 (see Figure 1).

During the summer and fall of 2008, HDOH updated their EALs, which resulted in significant changes to the action levels associated with methylnaphthalenes. The HDOH Drinking Water

toxicity EAL for these compounds was 240 µg/L. This concentration assumed that methylnaphthalenes were not human carcinogens. Once evidence emerged and was accepted by the US Environmental Protection Agency (USEPA) that methylnaphthalenes are carcinogenic to humans, HDOH adopted more rigorous EALs of 4.7 µg/L for 1-methylnaphthalene and 24 µg/L for 2-methylnaphthalene (HDOH, 2008).

The HDOH Drinking Water EAL for naphthalene was also updated during this process. Previously, HDOH based their naphthalene EAL on USEPA Region 9 Preliminary Remediation Goal (USEPA PRG) of 6.2 µg/L, which is associated with a non-cancer Hazard Index of 1. In deference to the California Department of Public Health's Drinking Water Notification Levels, (HDOH, 2008) HDOH updated their naphthalene drinking water EAL to 17 µg/L.

Finally, the HDOH Drinking Water EAL for TPH-DRO was increased from 100 µg/L to 210 µg/L, although the Groundwater Gross Contamination EAL for TPH-DRO remains 100 µg/L.

Groundwater Protection Plan

In 2008, the US Navy completed the *Red Hill Bulk Fuel Storage Facility Final Groundwater Protection Plan* (TEC, 2008), which specified SSRBLs and various required actions based on the category status (i.e., categories 1 through 4) of each groundwater monitoring well. The main objective of the Plan is to protect the groundwater quality of US Navy Well 2254-01, which provides potable water to the PHWS. This is accomplished by comparing petroleum concentrations in the Facility wells to established SSRBLs and taking appropriate action. A secondary, but important objective of the Plan is to identify leaking USTs by evaluating increasing concentration trends, or the presence of free product in one or more groundwater monitoring wells. This quarterly report compares observed water quality to these established categories and associated actions.

Current Results

On October 13 and 14, 2009, five groundwater samples (i.e., RHMW01, RHMW02, RHMW03, RHMW05 and RHMW2254-01), along with the required quality control samples (duplicate, matrix spike, spike duplicate, and trip blank) were collected for analysis. Samples were analyzed for Total Petroleum Hydrocarbons (TPH) quantified as Diesel-Range Organics (DRO) and Gasoline Range Organics (GRO), Volatile Organic Compounds (VOCs), Polynuclear Aromatic Hydrocarbons (PAHs), and dissolved lead.

TPH-DRO

TPH-DRO was detected at 299 micrograms per liter (µg/L) in RHMW01, 2,570 µg/L (i.e., the average of normal and duplicate samples) in RHMW02, and at 673 µg/L in RHMW05. TPH-DRO was not detected above the laboratory method detection limit (MDL) at RHMW03 and RHMW2254-01. The HDOH Drinking Water EAL and SSRBL for TPH-DRO are 210 µg/L and 4,500 µg/L, respectively.

TPH-GRO

For TPH-GRO the HDOH Drinking Water EAL is 100 µg/L. In samples RHMW01, RHMW02D (i.e., the duplicate sample collected), RHMW03, RHMW05, and RHMW2254-01

TPH-GRO was not observed above the laboratory MDL (i.e., 30 µg/L). In the regular sample from RHMW02, TPH-GRO was detected at 36.9F µg/L [F indicates that the compound was identified, but the concentration was above the MDL and below the reporting limit (RL), therefore is considered an estimate], just above the laboratory MDL.

Other Parameters above HDOH Drinking Water EALs
At RHMW02, the average concentration between the normal and duplicate sample of naphthalene was 21.65 µg/L. This is above the HDOH Drinking Water EAL for naphthalene of 17 µg/L.

Trend Analysis
The following is a discussion of compounds that exceeded HDOH Drinking Water EALs during two or more recent consecutive sampling events, thus establishing a trend:

RHMW01
At RHMW01, concentrations of TPH-DRO have been greater than the HDOH Drinking Water EAL since September 2005, but less than 25 percent of the SSRBL of 4,500 µg/L. TPH-DRO had exhibited a decreasing trend since October 2008 with the lowest concentration (i.e., 248 µg/L) recorded in July 2009. In October 2009, this trend changed as TPH-DRO increased slightly to 299F µg/L.

RHMW02
From September 2005 through February 2009, TPH-DRO exceeded the HDOH Drinking Water EAL and was greater than 50 percent of the SSRBL (estimated solubility limit of 4,500 µg/L). However, there has been a decreasing trend since the SSRBL was exceeded in October 2008 to below 50 percent of the SSRBL in May and July 2009. However, in October 2009, TPH-DRO increased to 2,570 µg/L, above 50 percent of the SSRBL.

For other parameters, 1-methylnaphthalene and 2-methylnaphthalene have almost consistently averaged concentrations above HDOH Drinking Water EALs (i.e., 4.7 µg/L and 24 µg/L, respectively) since September 2005. However, a significantly decreasing trend since October 2008 has since brought these concentrations below the HDOH Drinking Water EALs. In October 2009, 1-methylnaphthalene decreased from the previous round with an average concentration (i.e., 3.245 µg/L) being the lowest of any round since September 2005. 2-methylnaphthalene decreased to an average concentration of 0.6345 µg/L after increasing in July 2009 from the lowest concentration recorded in May 2009. Naphthalene has exhibited a historical trend similar to 2-methylnaphthalene at RHMW02. However, in October 2009 naphthalene increased to an averaged 21.65 µg/L, greater than the HDOH Drinking Water EAL of 17 µg/L.

RHMW03
At RHMW03, historically, concentrations of TPH-DRO have fluctuated around the HDOH Drinking Water EAL, but have been significantly lower than corresponding values observed at RHMW01 and RHMW02. However, during the last three sampling events (i.e., May, July, and October 2009), TPH-DRO was not detected above the laboratory MDLs. These results represent a continuing decreasing trend for TPH-DRO that has existed since October 2008.

RHMW05
At RHMW05 there is an increasing trend for TPH-DRO. The October 2009 concentration was 673 µg/L, an increase as compared with the May and July 2009 concentrations of 200 µg/L and 491 µg/L, respectively. The October 2009 concentration remains above the HDOH EAL and below 25 percent of the SSRBL for TPH-DRO.

US Navy Well 2254-01
At US Navy Well 2254-01, no compounds have been detected above the laboratory MDLs since trace concentrations of TPH-GRO and 2-methylnaphthalene that were observed in the February and May 2009.

Current Groundwater Status
To date, there is no observation of a trend (i.e., two or more consecutive events) of light-non aqueous phased liquids (LNAPL), otherwise known as free product, presence on groundwater at any of the Facility monitoring wells.

US Navy Well 2254-01
Based upon the October 2009 sampling event, the US Navy Well 2254-01 is not eligible for any category status change since no compounds were detected above the laboratory MDLs.

RHMW03
Based upon the October 2009 sampling event, RHMW03 is not eligible for any category status change since no compounds were detected above the laboratory MDLs.

Category 1 Status Locations
There are no Category 1 status locations.

Category 2 Status Locations
RHMW01
The October 2009 sampling event indicates that RHMW01 should remain in Category 2 status. This is because the TPH-DRO concentration of 299F µg/L is greater than the HDOH Drinking Water EAL (210 µg/L), but less than half the SSRBL of 4,500 µg/L (estimated solubility limit of JP-5).

RHMW05
Based upon the October 2009 sampling event RHMW05 should remain in a Category 2 status. TPH-DRO at RHMW05 (i.e., 673 µg/L) is above the drinking water EAL of 210 µg/L and has been showing an increasing trend over the last three rounds (i.e., 200 µg/L in May 2009 and 491 µg/L in July 2009).

Category 2 for RHMW01 and RHMW05 requires:
1. Quarterly reports to be sent to HDOH; and
2. Initiation of a leak determination program to identify if tanks are leaking.

Category 3 Status Locations

RHMW02

Results from the October 2009 sampling event indicate that RHMW02 is presently in Category 3 status (i.e., upgraded from Category 2 status observed during the July 2009 sampling event), since TPH-DRO [2,570 µg/L and 2,570 µg/L (duplicate)] is greater than the HDOH Drinking Water EAL (210 µg/L), and is between one half and the established SSRBL value of 4,500 µg/L (estimated solubility limit of JP-5). In addition, the HDOH Drinking Water EAL of 17 µg/L for naphthalene was exceeded [i.e., 23.3 µg/L and 20 µg/L (duplicate)].

Category 3 response at RHMW02 requires:

1. Send quarterly reports to HDOH;
2. Initiation of a leak determination program to identify if tanks are leaking;
3. Increase free product monitoring frequency to once per month (if concentrations increasing);
4. Notify HDOH verbally within 7 days and follow with written notification in 30 days;
5. Remove sampling pumps, measure product in pertinent wells with interface probe, re-install pumps if product is not detected; and
6. Immediately evaluate tanks for leaks.

Category 4 Status Locations

There are no Category 4 status locations.

Conclusions and Recommendations

There is no indication of an immediate threat of disruption to drinking water resources of the US Navy Well 2254-01 as a result in the October 2009 data. Based upon the October 2009 data, the US Navy Well 2254-01 is not eligible for a category status change since no compounds were detected above the laboratory MDLs.

With the exception of RHMW03 and RHMW2254-01, compound concentrations for all the other monitoring wells (i.e., RHMW01, RHMW02, and RHMW05) are exhibiting increasing contaminant trends for TPH-DRO relative to the concentrations observed in July 2009, among the lowest since September 2005. However, current results are still at concentration levels on the lower end of the historical range, with the exception of RHMW05. As a result of the October 2009 sampling event, RHMW03 is not eligible for a category status change.

Quarterly groundwater sampling for TPH-DRO, TPH-GRO, VOCs, PAHs, and dissolved lead will continue at the Facility until such time that data indicates that a different monitoring plan is warranted. It is recommended that future quarterly analytical results be closely assessed at RHMW05, since it continues to exhibit an increasing contaminant trend (i.e., 200 µg/L in May 2009, 491µg/L in July 2009, and 673 µg/L in October 2009 for TPH-DRO).

1.0 Introduction

This report presents the results of the 17th groundwater sampling event, conducted in October 2009 at the Red Hill Fuel Storage Facility, Oahu, Hawaii (hereafter referred to as "the Facility"). The Facility consists of 18 active and 2 inactive underground storage tanks (USTs) operated by the Fleet and Industrial Supply Center (FISC), Pearl Harbor. The groundwater sampling and analysis event is part of a groundwater monitoring program for the UST site in response to past UST releases, previous environmental investigations, and recommendations from the State of Hawaii Department of Health (HDOH).

1.1 Project Objective

This groundwater sampling project was performed to evaluate the presence of chemicals of potential concern in groundwater underlying the Facility. The project was conducted to ensure the Navy remains in compliance with HDOH UST release response requirements as described in Hawaii Administrative Rules (HAR) 11-281 Subchapter 7, Release Response Action. The groundwater sampling program followed the procedures described in *Red Hill Bulk Fuel Storage Facility Groundwater Protection Plan* [TEC Inc. (TEC), 2008], also referred to as "the Plan".

This groundwater sampling event was conducted by TEC under United States (US) Navy Contract Number N47408-04-D-8514, Task Order No. 54.

1.2 Previous Reports

The following groundwater monitoring reports were previously submitted to the HDOH:

1. Groundwater Sampling Report, First Quarter 2005 (submitted April 2005);
2. Groundwater Sampling Report, Second Quarter 2005 (submitted August 2005);
3. Groundwater Sampling Report, Third Quarter 2005 (submitted November 2005);
4. Groundwater Sampling Report, Fourth Quarter 2005 (submitted February 2006);
5. Groundwater Monitoring Results, July 2006 (submitted September 2006);
6. Groundwater Monitoring Results, December 2006 (submitted January 2007);
7. Groundwater Monitoring Results, March 2007 (submitted May 2007);
8. Groundwater Monitoring Results, June 2007 (submitted August 2007);
9. Groundwater Monitoring Results, September 2007 (submitted October 2007);
10. Groundwater Monitoring Results, January 2008 (submitted March 2008);
11. Groundwater Monitoring Results, April 2008 (submitted May 2008);
12. Groundwater Monitoring Results, July 2008 (submitted October 2008);
13. Groundwater Monitoring Results, October and December 2008 (submitted February 2009);
14. Groundwater Monitoring Results, February 2009 (submitted May 2009);

15. Groundwater Monitoring Results, May 2009 (submitted July 2009); and
16. Groundwater Monitoring Results, July 2009 (submitted September 2009).

1.3 Background

The following sections provide a description of the site and information on the Facility and USTs.

1.3.1 Site Description

The Facility is located in Halawa Heights on Oahu, Hawaii. Land adjacent to the north of the Facility is occupied by Halawa Correctional Facility and private businesses. Land to the south and west of the Facility includes the Coast Guard Reservation. Moanalua Valley is located east of the Facility (Dawson, 2006).

The Navy Public Works Department operates a potable water infiltration tunnel approximately 1,550 feet hydraulically down-gradient from the Facility (Dawson, 2006). The US Navy Well 2254-01 is located approximately 3,000 feet down-gradient (west) of the Facility and provides approximately 24% of the potable water to the Pearl Harbor Water System (PHWS), which serves approximately 52,200 military consumers (TEC, 2008).

1.3.2 Facility Information

The Facility consists of 18 active and 2 inactive USTs operated by Navy FISC Pearl Harbor. Each UST has a capacity of 12.5 million gallons. The Facility is located approximately 100 feet above the basal aquifer (Dawson, 2006).

1.3.3 UST Information

The USTs were constructed in the early 1940s. The tanks were constructed of steel and currently contain Jet Propulsion (JP)–5 fuel and F-76 (diesel marine fuel). Previously, several tanks stored Navy Special Fuel Oil, Navy Distillate, aviation gasoline, and motor gasoline. Each tank measures approximately 245 feet in height and 100 feet in diameter. The upper domes of the tanks lie at depths varying between approximately 100 feet and 200 feet below the existing ground surface (TEC, 2006).

1.4 Previous Environmental Investigations

1998 to 2001: From 1998 to 2001, the Navy conducted an investigation at the Facility to assess potential releases from the fuel storage USTs and piping systems. In February 2001, the Navy installed a one-inch diameter RHMW01 (previously known as MW-V1D) to monitor for contamination of the basal aquifer underlying the Facility. The well was installed and completed at approximately 100 feet below grade within the lower access tunnel. At the time of well completion, depth to water in RHMW01 was measured at 86 feet below grade (Dawson, 2006).

In February 2001, groundwater samples collected from RHMW01 contained total petroleum hydrocarbons (TPH) concentrations ranging from 883 micrograms per liter (µg/L) to 1,050 µg/L and total lead ranging from 10.4 µg/L to 15 µg/L. The maximum total lead concentration in the samples was equal to the primary drinking water standard of 15 µg/L for lead and exceeded the HDOH Tier 1 groundwater action level of 5.6 µg/L (Dawson, 2006).

2005 – Groundwater Sampling: The Navy began quarterly groundwater sampling at existing monitoring wells in 2005. Dawson Group, Inc. collected groundwater samples from RHMW01 and the Red Hill Navy Pump Station (US Navy Well 2254-01) in February, June, September, and December 2005.

Samples collected in February and June 2005 were not filtered in the field prior to analysis for lead. Analytical results for samples collected from RHMW01 indicated concentrations of total lead were above the HDOH Tier 1 action level of 5.6 μg/L. The results were not considered appropriate for risk assessment since the sample had not been filtered. In addition, lead was not a component of fuels from the tanks near RHMW01. Lead may have been part of the Facility construction material (TEC, 2007).

Samples were filtered in September and December 2005, and dissolved lead concentrations were below the HDOH Tier 1 action level. Concentrations of all other contaminants of potential concern were below HDOH Tier 1 action levels.

2005 – Site Investigation: As part of a site investigation, TEC installed three groundwater monitoring wells at the Facility between June and September 2005. Well RHMW02 was installed in the lower access tunnel near Tanks 5 and 6. Well RHMW03 was installed in the lower access tunnel near Tanks 13 and 14. Well RHMW04 was installed hydraulically upgradient of the USTs to provide geochemistry for water moving through the basal aquifer beneath the Facility. Wells RHMW02 and RHMW03 were completed to depths of approximately 125 feet below the tunnel floor, and well RHMW04 was completed to a depth of approximately 300 feet below ground surface outside the tunnel. Groundwater samples were collected from the three newly installed wells and two existing wells (RHMW01 and US Navy Well 2254-01) in September 2005.

Naphthalene and trichloroethylene were detected in samples collected from RHMW02 at concentrations greater than the HDOH Tier 1 action levels. Lead was detected in the sample collected from RHMW01 at a concentration greater than the HDOH Tier 1 action level; however, the sample was not filtered in the field prior to analysis. Analytical results for filtered samples obtained by Dawson during the same period indicated concentrations of dissolved lead were below the HDOH Tier 1 action level.

2006 – Site Investigation: Dedicated sampling pumps were installed in five wells (RHMW01, RHMW02, RHMW03, RHMW04, and US Navy Well 2254-01). TEC collected groundwater samples from the wells in July 2006. The groundwater samples were analyzed for petroleum constituents. Naphthalene was detected in samples collected from RHMW02 at concentrations above the HDOH Tier 1 action level.

In September 2005, with concurrence from the HDOH, the Navy decided to use the newer HDOH Environmental Action Levels (EALs) for the Red Hill Site Investigation and Risk Assessment project. The EALs are current and provide action levels for more chemicals, and are much more useful for conducting screening risk assessments. Since the HDOH (HDOH May 2005) Policy Letter stated that the two sets of action levels should not be mixed, the Tier 1

screening levels presented in HAR Section 11-281-78 would no longer be used to evaluate environmental impact at the Facility.

2006 – Groundwater Sampling: Groundwater samples were collected in December 2006. Analytical results indicated the following:

- No chemicals were detected in groundwater from US Navy Well 2254-01 or RHMW03;
- TPH as diesel range organics (TPH-DRO) was detected in groundwater above the HDOH Drinking Water EALs in RHMW01; and
- TPH as gasoline range organics (TPH-GRO), TPH-DRO, and naphthalene were detected in groundwater above the HDOH Drinking Water EALs in RHMW02.

2007 – Groundwater Sampling: Groundwater samples were collected in March, June, and September 2007. Analytical results indicated the following:

- No chemicals were detected above HDOH Drinking Water EALs at US Navy Well 2254-01;
- TPH-DRO exceeded HDOH Drinking Water EALs at RHMW01 during all three sampling events;
- TPH-GRO exceeded HDOH Drinking Water EALs at RHMW02 in March;
- TPH-DRO and naphthalene exceeded HDOH Drinking Water EALs at RHMW02 during all three sampling events;
- 1-methylnaphthalene and 2-methylnaphthalene exceeded the HDOH Groundwater Gross Contamination EAL at RHMW02 during all three sampling events; and
- TPH-DRO exceeded HDOH Drinking Water EALs at RHMW03 in June.

2008 – Groundwater Sampling: Groundwater samples were collected in January, April, July, and October 2008. Analytical results indicated the following:

- No chemicals were detected above HDOH Drinking Water EALs at US Navy Well 2254-01;
- Trace detections of 1-methylnaphthalene and naphthalene prompted a resample event in December at US Navy Well 2254-01, no chemicals were detected above the MDL;
- TPH-DRO exceeded HDOH Drinking Water EALs at RHMW01 during all four sampling events;
- TPH-GRO did not exceed HDOH Drinking Water EALs at RHMW02;
- TPH-DRO, naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene exceeded HDOH Drinking Water EALs at RHMW02; and
- TPH-DRO exceeded HDOH Drinking Water EALs at RHMW03 during all four sampling events.

2009 – Groundwater Sampling: Groundwater samples were collected in February, May, and July 2009. Analytical results indicated the following:

- No chemicals have been detected above HDOH Drinking Water EALs at US Navy Well 2254-01;
- Trace TPH-GRO at US Navy Well 2254-01 was detected above the laboratory MDL and significantly below the laboratory reporting limit and HDOH EAL, in February and May 2009;

- TPH-DRO exceeded HDOH Drinking Water EALs at RHMW01 during all three sampling events;
- TPH-GRO has not exceed HDOH Drinking Water EALs at RHMW02;
- TPH-DRO exceeded HDOH Drinking Water EALs at RHMW02 during all three sampling events;
- Naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene exceeded HDOH Drinking Water EALs at RHMW02 in February 2009, however only 1-methylnaphthalene exceeded the HDOH Drinking Water EALs in May and July 2009;
- TPH-DRO exceeded HDOH Drinking Water EALs at RHMW03 in February, but not in May or July; and
- TPH-DRO exceeded HDOH Drinking Water EAL at RHMW05 during the July 2009 sampling event.

1.5 Regulatory Updates

During the summer and fall of 2008, HDOH updated their EALs, which resulted in significant changes to the action levels associated with methylnaphthalenes. The drinking water toxicity EAL for these compounds was 240 μg/L. This concentration presumed that methylnaphthalenes were non-carcinogenic. Evidence that they are human carcinogens has now been accepted by the US Environmental Protection Agency (USEPA). As a result, HDOH adopted more rigorous EALs of 4.7 μg/L for 1-methylnaphthalene and 24 μg/L for 2-methylnaphthalene, corresponding to a residential tap water scenario, and a 1 in a million cancer risk (HDOH, 2008).

The drinking water EAL for naphthalene has also been updated during this process. Previously, HDOH based their naphthalene EAL on USEPA Region 9 Preliminary Remediation Goal (USEPA PRG) of 6.2 μg/L, which is associated with a non-cancer Hazard Index of 1. HDOH has updated their naphthalene drinking water EAL to 17 μg/L, in deference to the California Department of Public Health's Drinking Water Notification Levels, a Hazard Index of 2.7 (HDOH, 2008).

Finally, the HDOH Drinking Water EAL for TPH-DRO was increased from 100 μg/L to 210 μg/L, although the HDOH Groundwater Gross Contamination EAL for TPH-DRO remains 100 μg/L.

1.6 RHMW05 Installation

In April 2009, a new groundwater monitoring well, RHMW05, was installed by TEC under US Navy Contract Number N47408-04-D-8514, Task Order No. 54. RHMW05 is located down-gradient from the Facility, within the lower access tunnel between RHMW01 and RHMW2254-01(located at the US Navy Well 2254-01). It was installed to identify the extent of contaminant migration down-gradient prior to contaminants reaching the infiltration gallery at the US Navy Well 2254-01.

2.0 Sample Collection and Analyses

Field activities relating to groundwater sample collection were conducted on October 13 and 14, 2009. Groundwater samples were collected from four monitoring wells located inside the

Facility lower access tunnel and one monitoring well located at the Red Hill Navy Pump Station. Sampling and analysis were conducted according to *Red Hill Bulk Fuel Storage Facility Groundwater Protection Plan* (TEC, 2009). A total of eight samples were collected as follows:

- one environmental sample from RHMW2254-01 (i.e., located at the US Navy Well 2254-01), RHMW01, RHMW02, RHMW03, and RHMW05;
- one duplicate sample from RHMW02 (sampled as RHMWA01 and reported as RHMW02D); and
- one matrix spike and matrix spike duplicate from RHMW2254-01.

2.1 Monitoring Well Purging

All monitoring wells were purged prior to sampling. Well purging was considered complete when no less than three successive water quality parameter measurements had stabilized within approximately 10 percent. Field parameters were measured at regular intervals during well purging and included pH, temperature, specific conductivity, dissolved oxygen, and turbidity. Purge water was collected and disposed in the Facility oil/water separator system.

2.2 Groundwater Sample Collection

Each monitoring well was sampled immediately following purging. All wells were sampled directly from their dedicated bladder pump system, except for RHMW02 and RHMW05. RHMW02 and RHMW05 were sampled using disposable bailers. Samples were placed into sampling containers with appropriate preservatives [i.e., hydrochloric acid (HCl) for volatile organic analysis, nitric acid (HNO_3) for dissolved lead]. Dissolved lead samples were filtered in the field and placed in preserved bottles. Sample containers were labeled with the date, sample identification number, type of analysis, and sampler's name. The containers were placed on ice in sample coolers and transported under chain-of-custody procedures to the certified laboratory for analysis.

2.3 Groundwater Sample Analyses

Groundwater samples were analyzed by SGS Environmental Service, Inc. in Anchorage, Alaska for TPH-DRO and TPH-GRO by EPA Method 8015B, VOCs by EPA Method 8260B, PAHs by EPA Method 8270C SIM, and dissolved lead by EPA Method 6020.

3.0 Groundwater Sample Analytical Results

This section provides a summary of analytical results for groundwater samples collected from four monitoring wells located in the lower access tunnel of the Facility and one monitoring well located at the Red Hill Navy Pump Station. Duplicate sample results from monitoring well RHMW02 are reported in this document as RHMW02D. A summary of groundwater analytical results for TPH-DRO, TPH-GRO, VOCs, PAHs, and dissolved lead is included in Table 1. Complete analytical laboratory reports are provided in Appendix A.

3.1 October 2009 Sample Analytical Results

All groundwater samples were analyzed for TPH-DRO, TPH-GRO, VOCs, PAHs, and dissolved lead. The results for each groundwater monitoring well are discussed below.

RHMW01

TPH-DRO at 299F µg/L exceeded the HDOH Drinking Water EALs of 210 µg/L. Concentrations of acenaphthene, flourene, naphthalene, and methyl isobutyl ketone (2-butanone) were detected at 0.0177F µg/L, 0.0288F µg/L, 0.193 µg/L, and 4.27F µg/L, respectfully (Table 1). All of these concentrations are below the HDOH EALS for each constituent. No other constituents were detected above the laboratory MDL.

RHMW02

TPH-DRO, TPH-GRO, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, flourene, and naphthalene were detected at RHMW02. TPH-DRO was detected at RHMW02 in the normal and duplicate samples at 2,570 µg/L. This result exceeded the HDOH EAL of 210 µg/L, but not the site-specific risk based level (SSRBL) of 4,500 µg/L. TPH-GRO was detected above the laboratory MDL of 30 µg/L in the normal sample only (i.e., 36.9F µg/L).

Naphthalene was analyzed by USEPA Method 8270C SIM and USEPA Method 8260B. USEPA Method 8260B produced the highest naphthalene concentrations, which averaged 21.65 µg/L from the normal and duplicate sample (HDOH Drinking Water EAL is 17 µg/L). In addition, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, and flourene were detected at average concentrations of 3.245 µg/L, 0.6345 µg/L, 0.205 µg/L, and 0.0957 µg/L, respectively (Table 1). All of these concentrations are below the HDOH EALS for each constituent. No other constituents were detected above the laboratory MDL.

RHMW03

No parameters were detected above the laboratory MDLs at RHMW03 (Table 1).

RHMW05

TPH-DRO was detected at a concentration of 673 µg/L. This concentration exceeds the HDOH Drinking Water EAL of 210 µg/L and the HDOH Groundwater Gross Contamination EAL of 100 µg/L. The only other constituent that was detected above the laboratory MDL was pyrene at 0.0173F, just above the laboratory MDL and well below the HDOH EALs (Table 1).

Table 1. Analytical Results for Quarterly Groundwater Monitoring Release Response Report (October 13 and 14, 2009)
Red Hill Fuel Storage Facility, Pearl Harbor, Hawaii

Method	Chemical	HDOH Drinking Water EALs[1] for Human Toxicity UG/L	HDOH Groundwater Gross Contamination EALs[2] UG/L	RHMW01 UG/L October 14, 2009				RHMW02 UG/L October 13, 2009				RHMW02D UG/L October 13, 2009				RHMW03 UG/L October 14, 2009				RHMW05 UG/L October 13, 2009				RHMW2254-01 UG/L October 14, 2009			
				Result	Q	MDL	RL	Result	Q	MDL	RL	Result	Q	MDL	RL	Result	Q	MDL	RL	Result	Q	MDL	RL	Result	Q	MDL	RL
8015B (Petroleum)	TPH as DIESEL RANGE ORGANICS	210	100	***299***	F	165	440	***2570***		169	449	***2570***		170	455	ND	U	163	435	***673***		169	452	ND	U	158	421
	TPH as GASOLINE RANGE ORGANICS	100	100	ND	U	30	100	36.9	F	30	100	ND	U	30	100	ND	U	30	100	ND	U	30	100	ND	U	30	100
8270C SIM (PAHs)	1-METHYLNAPHTHALENE	4.7	10	ND	U	0.0174	0.0581	2.46		0.017	0.0568	4.03		0.0893	0.298	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	2-METHYLNAPHTHALENE	24	10	ND	U	0.0174	0.0581	0.486		0.017	0.0568	0.783		0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	ACENAPHTHENE	370	20	0.0177	F	0.0174	0.0581	0.2		0.017	0.0568	0.21		0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	ACENAPHTHYLENE	240	2000	ND	U	0.0174	0.0581	ND	U	0.017	0.0568	ND	U	0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	ANTHRACENE	1800	22	ND	U	0.0174	0.0581	ND	U	0.017	0.0568	ND	U	0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	BENZO(a)ANTHRACENE	0.092	4.7	ND	U	0.0174	0.0581	ND	U	0.017	0.0568	ND	U	0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	BENZO(a)PYRENE	0.2	0.81	ND	U	0.0174	0.0581	ND	U	0.017	0.0568	ND	U	0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	BENZO(b)FLUORANTHENE	0.092	0.75	ND	U	0.0174	0.0581	ND	U	0.017	0.0568	ND	U	0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	BENZO(g,h,i)PERYLENE	1500	0.13	ND	U	0.0174	0.0581	ND	U	0.017	0.0568	ND	U	0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	BENZO(k)FLUORANTHENE	0.92	0.4	ND	U	0.0174	0.0581	ND	U	0.017	0.0568	ND	U	0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	CHRYSENE	9.2	1	ND	U	0.0174	0.0581	ND	U	0.017	0.0568	ND	U	0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	DIBENZ(a,h)ANTHRACENE	0.0092	0.52	ND	U	0.0174	0.0581	ND	U	0.017	0.0568	ND	U	0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	FLUORANTHENE	1500	130	ND	U	0.0174	0.0581	ND	U	0.017	0.0568	ND	U	0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	FLUORENE	240	950	0.0288	F	0.0174	0.0581	0.0979		0.017	0.0568	0.0935		0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	INDENO(1,2,3-c,d)PYRENE	0.092	0.095	ND	U	0.0174	0.0581	ND	U	0.017	0.0568	ND	U	0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	NAPHTHALENE	17	21	0.193		0.036	0.116	6.77		0.176	0.568	7.82		0.185	0.595	ND	U	0.0348	0.112	ND	U	0.0352	0.114	ND	U	0.0352	0.114
	PHENANTHRENE	240	410	ND	U	0.0174	0.0581	ND	U	0.017	0.0568	ND	U	0.0179	0.0595	ND	U	0.0169	0.0562	ND	U	0.017	0.0568	ND	U	0.017	0.0568
	PYRENE	180	68	ND	U	0.0174	0.0581	ND	U	0.017	0.0568	ND	U	0.0179	0.0595	ND	U	0.0169	0.0562	0.0173	F	0.017	0.0568	ND	U	0.017	0.0568
8260B (VOCs)	1,1,1,2-TETRACHLOROETHANE	0.52	50000	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5
	1,1,1-TRICHLOROETHANE	200	970	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	1,1,2,2-TETRACHLOROETHANE	0.067	500	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5
	1,1,2-TRICHLOROETHANE	5	50000	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	1,1-DICHLOROETHANE	2.4	50000	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	1,2,3-TRICHLOROPROPANE (TCP)	0.6	50000	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	1,2,4-TRICHLOROBENZENE	70	3000	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	1,2-DIBROMO-3-CHLOROPROPANE (DBCP)	0.04	10	ND	U	0.62	2	ND	U	0.62	2	ND	U	0.62	2	ND	U	0.62	2	ND	U	0.62	2	ND	U	0.62	2
	1,2-DIBROMOETHANE (EDB)	0.0065	50000	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	1,2-DICHLOROBENZENE	600	10	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	1,2-DICHLOROETHANE	0.15	7000	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5
	1,2-DICHLOROPROPANE	5	10	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	1,3-DICHLOROBENZENE	180	50000	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	1,4-DICHLOROBENZENE	75	5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5
	ACETONE	22000	20000	ND	U	3.1	10	ND	U	3.1	10	ND	U	3.1	10	ND	U	3.1	10	ND	U	3.1	10	ND	U	3.1	10
	BENZENE	5	170	ND	U	0.12	0.4	ND	U	0.12	0.4	ND	U	0.12	0.4	ND	U	0.12	0.4	ND	U	0.12	0.4	ND	U	0.12	0.4
	BROMODICHLOROMETHANE	0.22	50000	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5
	BROMOFORM	100	510	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	BROMOMETHANE	8.7	50000	ND	U	0.94	3	ND	U	0.94	3	ND	U	0.94	3	ND	U	0.94	3	ND	U	0.94	3	ND	U	0.94	3
	CARBON TETRACHLORIDE	5	520	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	CHLOROBENZENE	100	50	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5
	CHLOROETHANE	8600	16	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	CHLOROFORM	70	2400	ND	U	0.3	1	ND	U	0.3	1	ND	U	0.3	1	ND	U	0.3	1	ND	U	0.3	1	ND	U	0.3	1
	CHLOROMETHANE	1.8	50000	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	cis-1,2-DICHLOROETHYLENE	70	50000	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	cis-1,3-DICHLOROPROPENE	0.43	50000	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5
	DIBROMOCHLOROMETHANE	0.16	50000	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5	ND	U	0.15	0.5
	ETHYLBENZENE	700	30	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	HEXACHLOROBUTADIENE	0.86	6	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	M,P-XYLENE (SUM OF ISOMERS)	10000	20	ND	U	0.62	2	ND	U	0.62	2	ND	U	0.62	2	ND	U	0.62	2	ND	U	0.62	2	ND	U	0.62	2
	METHYL ETHYL KETONE (2-BUTANONE)	7100	8400	4.27	F	3.1	10	ND	U	3.1	10	ND	U	3.1	10	ND	U	3.1	10	ND	U	3.1	10	ND	U	3.1	10
	METHYL ISOBUTYL KETONE (4-METHYL-2-PENTANONE)	2000	1300	ND	U	3.1	10	ND	U	3.1	10	ND	U	3.1	10	ND	U	3.1	10	ND	U	3.1	10	ND	U	3.1	10
	METHYLENE CHLORIDE	4.8	9100	ND	U	1	5	ND	U	1	5	ND	U	1	5	ND	U	1	5	ND	U	1	5	ND	U	1	5
	NAPHTHALENE	17	21	ND	U	0.62	2	***23.3***		0.62	2	***20***		0.62	2	ND	U	0.62	2	ND	U	0.62	2	ND	U	0.62	2
	STYRENE	100	10	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	TETRACHLOROETHYLENE(PCE)	5	170	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	TOLUENE	1000	40	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	trans-1,2-DICHLOROETHENE	100	260	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	TRICHLOROETHYLENE (TCE)	5	310	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	VINYL CHLORIDE	2	3400	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1
	XYLENES, TOTAL	10000	20	ND	U	1	2	ND	U	1	2	ND	U	1	2	ND	U	1	2	ND	U	1	2	ND	U	1	2
6020	LEAD	15	50000	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1	ND	U	0.31	1

PAHs - Polynuclear aromatic hydrocarbons
VOCs - Volatile organic compounds
UG/L - Micrograms per Liter
Q - Data qualifier
U - Indicates that the compound was analyzed for but not detected at or above the stated limit
F - Indicates that the compound was identified but the concentration was above the MDL and below the RL
200 - Result exceeds one or both HDOH EALs
[1] Final Drinking Water Action Levels for Human Toxicity, Table D-3a, *Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater* , HDOH, 2009
[2] Groundwater Gross Contamination Action Levels, Table G-1, *Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater* , HDOH, 2009

MDL - Method detection limit
RL - Reporting limit
TPH - Total petroleum hydrocarbons
ND - Indicates that the compound was not detected above the stated method detection limit

US Navy Well 2254-01
No parameters were detected above the laboratory MDLs at the US Navy Well 2254-01 (Table 1).

3.2 Groundwater Contaminant Trend

Groundwater samples have been collected and analyzed by TEC since September 2005. Figure 1 shows TPH trends in groundwater at the Facility. Figure 2 shows PAH trends in groundwater at the Facility. In these figures, open icons (without data) represent locations where the compounds being analyzed were not detected.

The following is a discussion of compounds that exceeded HDOH Drinking Water EALs during two or more recent consecutive sampling events, thus establishing a trend:

RHMW01
At RHMW01, concentrations of TPH-DRO have been greater than the HDOH Drinking Water EAL since September 2005, but less than 25 percent of the SSRBL of 4,500 µg/L. TPH-DRO was exhibiting a decreasing trend since October 2008 with the lowest concentration observed during July 2009. In October 2009, TPH-DRO at RHMW01 increased slightly from the July 2009 concentration.

RHMW02
At RHMW02, from September 2005 through February 2009, TPH-DRO exceeded the HDOH Drinking Water EAL and was greater than 50 percent of the SSRBL (estimated solubility limit of 4,500 µg/L). Specifically, the concentration of TPH-DRO was relatively stable at RHMW02 until July 2008, ranging from 2,250 to 2,995 µg/L. However, during the July and October 2008 sampling events, these average concentrations increased. The July 2008 average concentration was 4,055 µg/L and the October 2008 average concentration was 5,420 µg/L. Both of these values were significantly above the HDOH Drinking Water EAL of 210 µg/L, with the October 2008 average also exceeding the SSRBL of 4,500 µg/L.

However, TPH-DRO at RHMW02 has shown a decreasing trend since October 2008. The May 2009 average concentration (i.e., 1,810 µg/L) and the July 2009 average concentration (i.e., 1,375 µg/L) exceeded the HDOH Drinking Water EAL, but were below 50 percent of the SSRBL of 4,500 µg/L.

The October 2009 average TPH-DRO concentration shows an increase from the May and July 2009 sampling events. TPH-DRO is within the historical range from when TPH-DRO was considered relatively stable at RHMW02 (i.e., 2,570 µg/L), between September 2005 and July 2008. TPH-DRO at RHMW02 exceeds the HDOH Drinking Water EAL and 50 percent of the SSRBL.

For other parameters, the average concentration for 1-methylnaphthalene (i.e., 3.245 µg/L) continues to exhibit a decreasing trend and no longer exceeds the HDOH Drinking Water EAL of 4.7 µg/L. Naphthalene however, is showing an increasing trend since its lowest concentration

in May 2009. Naphthalene at RHMW02 (i.e., 21.65 µg/L) exceeds the HDOH Drinking Water EAL of 17 µg/L.

RHMW03
At RHMW03, historically, concentrations of TPH-DRO have fluctuated around the HDOH Drinking Water EAL, but have been significantly lower than corresponding values observed at RHMW01 and RHMW02. However, during the last three sampling events (i.e., May, July, and October 2009), TPH-DRO was not detected above the laboratory MDL. These results represent a continuing decreasing trend for TPH-DRO that has existed since October 2008.

RHMW05
At RHMW05 there is an increasing trend for TPH-DRO. The October 2009 concentration was 673 µg/L, an increase as compared with the May and July 2009 concentrations of 200 µg/L and 491 µg/L, respectively. The October 2009 concentration remains above the HDOH EAL and below 25 percent of the SSRBL for TPH-DRO.

US Navy Well 2254-01
At US Navy Well 2254-01, no compounds have been detected above the laboratory MDLs since trace concentrations of TPH-GRO and 2-methylnaphthalene that were observed in the February and May 2009.

3.3 Results of Oil/Water Interface Measurements

The presence and thickness of light-non aqueous phased liquids (LNAPL), otherwise known as free product, released from the USTs is monitored at the Facility (see Table 3). Static water levels and fuel thickness is measured to a precision of ± 0.01 feet.

In January 2008, fuel was measured in monitoring wells RHMW01 and RHMW02 at a thickness of < 0.01 ft, but has not been observed in other monitoring wells. Measurements to determine the presence and thickness of fuel were conducted at RHMW01, RHMW02, RHMW03, and RHMW05 prior to the October 2009 sampling round. At the end of October and November, subsequent rounds of oil/water interface measurements were conducted. During the last three rounds of measurements, no free product was observed in any of these wells.

Table 2. Oil/Water Interface Measurements

Date	RHMW01		RHMW02		RHMW03		RHMW05	
	SWL (ft)	LNAPL (ft)	SWL (ft)	LNAPL (ft)	SWL (ft)	LNAPL (ft)	SWL (ft)	LNAPL (ft)
January 2008	17.74	< 0.01	18.78	< 0.01	NT[1]	NT[1]	----	----
July 2008	19.04	0.00	18.91	0.00	18.86	0.00	----	----
October 2008	18.61	0.00	18.56	0.00	18.82	0.00	----	----
November 2008	18.50	0.00	18.45	0.00	18.51	0.00	----	----
January 2009	19.28	0.00	19.22	0.00	19.27	0.00	----	----
February 2009	NT[2]	NT[2]	18.66	0.00	18.75	0.00	----	----
March 2009	18.59	0.00	18.57	0.00	18.67	0.00	----	----
May 2009[3]	18.69	0.00	18.64	0.00	18.72	0.00	NT[5]	NT[5]
May 2009	18.91	0.00	18.86	0.00	18.90	0.00	NT[5]	NT[5]
July 2009[4]	18.66	0.00	18.59	0.00	18.64	0.00	17.91	0.00
August 2009	18.37	0.00	18.30	0.00	18.47	0.00	17.49	0.00
September 2009	18.20	0.00	18.17	0.00	18.24	0.00	17.39	0.00
October 2009	18.17	0.00	18.14	0.00	18.24	0.00	17.38	0.00
November 2009	18.50	0.00	18.45	0.00	18.50	0.00	17.75	0.00

SWL - Static water level, elevation above mean sea level (for RHMW05 this is estimated until the top well casing elevation has been determined)
LNAPL - Light Non-Aqueous Phased Liquid, fuel product on groundwater attributed to the Facility
ft - Feet
NT - Not Taken
[1] - The January 2008 measurement at RHMW03 was not taken due to equipment malfunction
[2] - During the February 2009 measurements, RHMW01 was inaccessible due to extensive work being conducted at Tank 02
[3] - The measurements scheduled for April 2009 were postponed until May 6, 2009 due to RHMW05 drilling activities
[4] – The June 2009 measurements were skipped due to the installation of dedicated oil/water interface probes
[5] - Oil/water interface measurements were not taken at RHMW05 until the installation of the oil/water interface probe was completed
---- - Time period prior to the installation of RHMW05
Oil/water interface measurements were not taken during in April 2008

3.4 Groundwater Status

Constituents of concern are defined as petroleum-related chemicals that have been observed in the groundwater samples above the HDOH EALs. In accordance with the *Red Hill Bulk Fuel Storage Facility Final Groundwater Protection Plan* (TEC, 2008), Table 4 defines the constituents of concern in groundwater at the Facility and the SSRBLs and updated EALs for each (HDOH 2008).

Table 3. Action Levels for Constituents of Concern

Chemical	EAL (µg/L)	SSRBL (µg/L)
Petroleum Mixtures		
TPH-DRO	210	4,500
TPH-GRO	100	4,500
Semi-Volatile Compounds		
1-Methylnaphthalene	4.7	NA
2-Methylnaphthalene	24	NA
Naphthalene	17	NA

NA – Not applicable or not determined
SSRBLs are applicable at RHMW01, RHMW02, RHMW03, and RHMW05
EALs are applicable at US Navy Well 2254-01

In addition, the Plan defines four results categories of groundwater status for the Facility, based on concentrations of constituents of concern in RHMW01, RHMW02, RHMW03 and the US Navy Well 2254-01, and requires specific responses when these categories are observed during quarterly groundwater sampling. Table 5 describes each of the four results categories and identifies response actions to be taken in accordance with the Plan.

Table 4. Results Categories and Response Actions to Changes in Groundwater Status

Results Category	**RHMW02 RHMW03 or RHMW05***	**RHMW01**	**US Navy Pumping Well 2254-01**
Results Category 1: Result above detection limit but below drinking water EAL and trend for all compounds stable or decreasing	A	A	A,D,M,E
Results Category 2: Trend for any compound increasing or drinking water EAL exceeded	A, B	A, B	A,B,C,D,E,F,G,K, L,O
Results Category 3: Result Between 1/10X SSRBL and SSRBL for benzene, or between 1/2X SSRBL and SSRBL for TPH	A,B,G,H,I,J	A,B,E,G,H,I,J	A,B,C,D,E,F,G,I,J, K,L,O
Results Category 4: Result Exceeding any SSRBL or petroleum product observed	A,C,D,E,F,I,J, K,M,N	A,C,D,E,F,I, J,K,M,N,O	A,C,D,E,F,G,I,J,K, L,O

*RHMW05 was installed in April 2009 and has been subsequently been added to this Table.
Specific Responses:
A. Send quarterly reports to HDOH
B. Begin program to determine the source of leak
C. Notify HDOH verbally within 1 day and follow with written notification in 30 days
D. Notify FISC Chain of Command within 1 day
E. Send Type 1 Report (see box below) to HDOH
F. Send Type 2 Report (see box below) to HDOH
G. Increase monitoring frequency to once per month (if concentrations increasing)
H. Notify HDOH verbally within 7 days and follow with written notification in 30 days
I. Remove sampling pumps, measure product in pertinent wells with interface probe, re-install pumps if product is not detected.
J. Immediately determine leaking tank
K. Collect samples from nearby Halawa Deep Monitoring Well (2253-03) and OWDF MW01
L. Provide alternative water source at 2254-01
M. Prepare for alternative water source at US Navy Well 2254-01
N. Re-measure for product every month with reports to HDOH

O. Install additional monitoring well downgradient

Report Types
HDOH Type 1 Report

- Re-evaluate Tier 3 Risk Assessment/groundwater model results
- Proposal to HDOH on a course of action

HDOH Type 2 Report

- Proposal for groundwater treatment

Free Product Measurements
In response to the previous Category 3 status at RHMW02, free product measurements have been collected at the Facility monitoring wells (Table 3). To date, there is no trend (i.e., two or more consecutive events) of fuel presence on groundwater at any of these wells.

US Navy Well 2254-01
Based upon the October 2009 sampling event, the US Navy Well 2254-01 is not eligible for any category status change since no compounds were detected above the laboratory MDLs.

RHMW03
Based upon the October 2009 sampling event, RHMW03 is not eligible for any category status change since no compounds were detected above the laboratory MDLs.

Category 1 Status Locations
There are no Category 1 status locations.

Category 2 Status Locations
RHMW01
The October 2009 sampling event indicates that RHMW01 should remain in Category 2 status. This is because the TPH-DRO concentration of 299F µg/L is greater than the HDOH Drinking Water EAL (210 µg/L), but less than half the SSRBL of 4,500 µg/L (estimated solubility limit of JP-5).

RHMW05
Based upon the October 2009 sampling event RHMW05 should remain in a Category 2 status. TPH-DRO at RHMW05 (i.e., 673 µg/L) is above the drinking water EAL of 210 µg/L and has been showing an increasing trend over the last three rounds (i.e., 200 µg/L in May 2009 and 491 µg/L in July 2009).

Category 2 for RHMW01 and RHMW05 requires:

1. Quarterly reports to be sent to HDOH; and
2. Initiation of a leak determination program to identify if tanks are leaking.

Category 3 Status Locations
RHMW02
Results from the October 2009 sampling event indicate that RHMW02 is presently in Category 3 status (i.e., upgraded from Category 2 status observed during the July 2009 sampling event), since TPH-DRO [2,570 µg/L and 2,570 µg/L (duplicate)] is greater than the HDOH Drinking Water EAL (210 µg/L), and is between one half and the established SSRBL value of 4,500 µg/L (estimated solubility limit of JP-5). In addition, the HDOH Drinking Water EAL of 17 µg/L for naphthalene was exceeded [i.e., 23.3 µg/L and 20 µg/L (duplicate)].

Category 3 response at RHMW02 requires:

1. Send quarterly reports to HDOH;
2. Initiation of a leak determination program to identify if tanks are leaking;
3. Increase free product monitoring frequency to once per month (if concentrations increasing);
4. Notify HDOH verbally within 7 days and follow with written notification in 30 days;
5. Remove sampling pumps, measure product in pertinent wells with interface probe, re-install pumps if product is not detected; and
6. Immediately evaluate tanks for leaks.

Category 4 Status Locations
There are no Category 4 status locations.

4.0 Summary and Conclusions

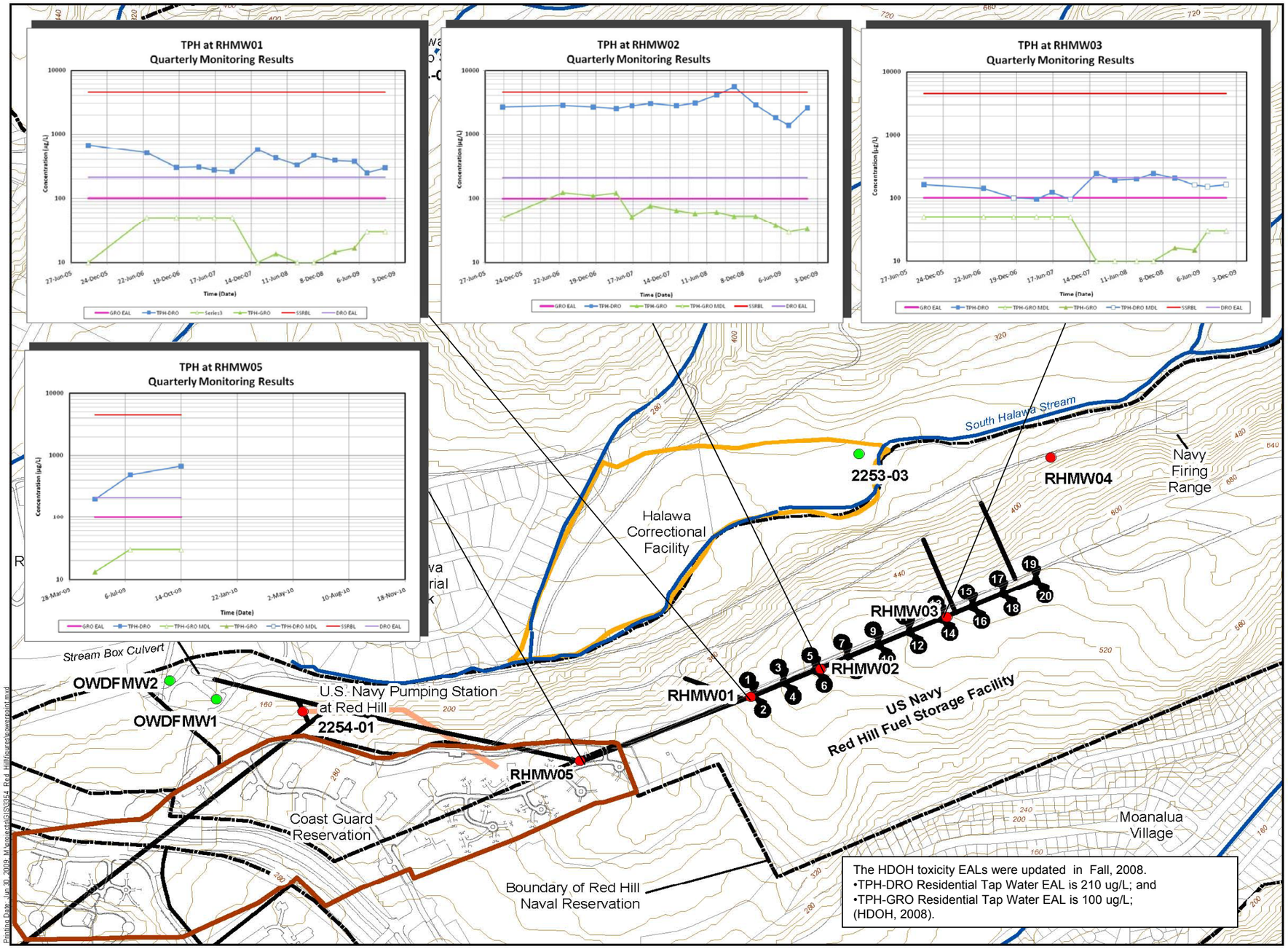
Summary
There is no indication of an immediate threat of disruption to drinking water resources of the US Navy Well 2254-01 as a result in the October 2009 data. As a result of the October 2009 sampling event, the US Navy Well 2254-01 is not eligible for a category status change.

With the exception of RHMW03 and RHMW2254-01, compound concentrations for all other Facility monitoring wells (i.e., RHMW01, RHMW02, and RHMW05) are exhibiting increasing contaminant trends relative to the concentrations observed in July 2009, among the lowest since September 2005. However, current results are still at concentration levels on the lower end of the historical range, with the exception of RHMW05. As a result of the October 2009 sampling event, RHMW03 is not eligible for a category status change. Currently, RHMW01 and RHMW05 maintain a Category 2 status, while RHMW02 has been upgraded to Category 3 status.

Conclusions/Recommendations
- To date, there is no trend (i.e., two or more consecutive events) of fuel presence on groundwater at the Facility wells (Table 3). In fact, fuel on the groundwater has been observed only once (i.e., in January 2008 in RHMW01 and RHMW02 at less than 0.01 ft.). It is recommended that the Facility continue regular monitoring of Facility wells for the presence of fuel on groundwater.
- The concentration of TPH-DRO measured at the new monitoring well, RHMW05, in October 2009 (i.e., 673 µg/L) exceeded the HDOH Drinking Water EAL, but was less

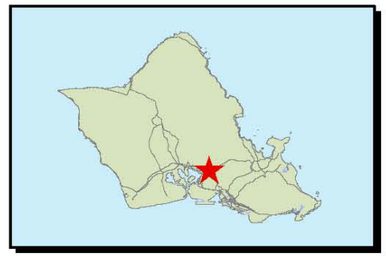
than half of the SSRBL. RHMW05 is located between RHMW01 and the US Navy Well 2254-01. It is recommended that future quarterly analytical results continue to be closely assessed at RHMW05 since this well continues to exhibit an increasing contaminant trend (i.e., 200 µg/L in May 2009, 491µg/L in July 2009, and 673 in October 2009 for TPH-DRO).

- RHMW01 and RHMW02 are exhibiting increasing contaminant trends, however, are still at concentration levels on the lower end of the historical range. It is recommended that quarterly monitoring of the Facility wells continue so that overall groundwater quality trends may be established/observed and proactive action taken if the groundwater quality shows greater evidence of deterioration.
- The US Navy Well 2254-01 is not imminently threatened at this time; however, monitoring should continue to evaluate the extent of contaminant migration from up-gradient locations.
- The following activities are planned to monitor and/or clarify the groundwater contamination situation at the Facility:
    1. Re-evaluate risk assessment and groundwater model (TEC, 2007) to ensure both are valid and protective of human health and the environment under the existing conditions;
    2. Continue monthly free product measurements at RHMW01, RHMW02, RHMW03, and RHMW05;
    3. Collect samples from nearby Halawa Deep Monitoring Well (2253-03), OWDF MW01, and RHMW04 to assess regional groundwater trends;
    4. Prepare for alternative water source at US Navy Well 2254-01, if appropriate.
    5. Continue quarterly groundwater monitoring of Facility wells for TPH-DRO, TPH-GRO, VOCs, PAHs, and lead until such time that new data indicates that a different monitoring program is warranted.



Legend

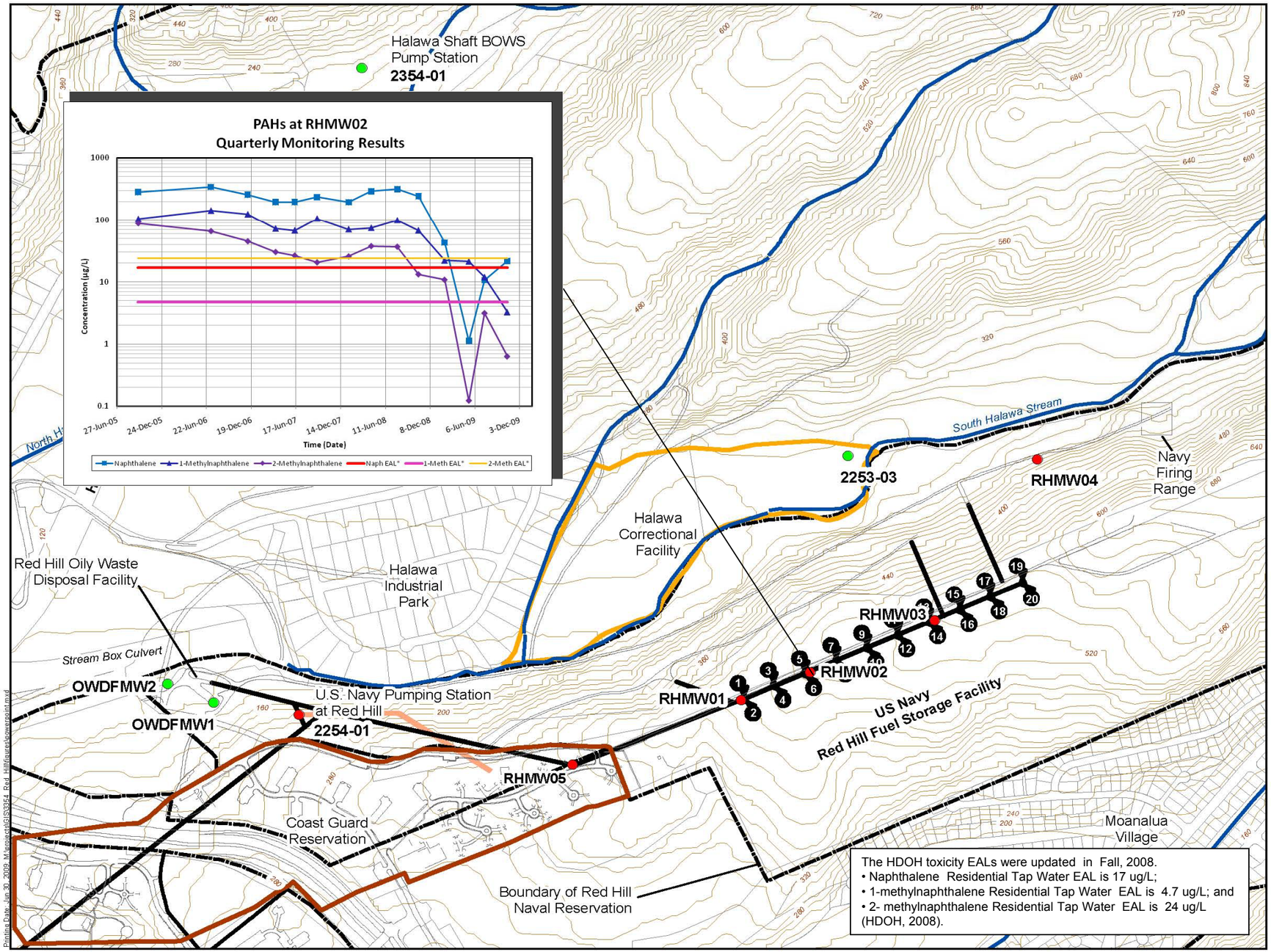
- Red Hill UST ID Number
- Parcel
- 40-foot Interval Contour Line
- Road
- Stream
- Red Hill Navy Installation Boundary
- Red Hill Tunnels
- 2254-01 Infiltration Gallery
- Halawa Correctional Facility Boundary
- Coast Guard Reservation



N

Meters
0 185 370
0 340 680 1,360
Feet

Figure 1
TPH Trends in Groundwater
Round 17 (October 13 and 14, 2009)
Red Hill Fuel Storage Facility
Oahu, Hawaii



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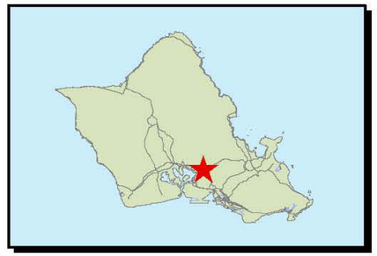

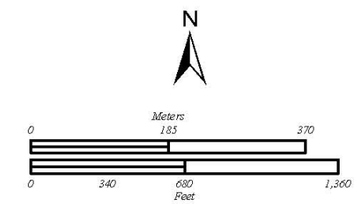

Figure 2
PAH Trends in Groundwater
Round 17 (October 13 and 14, 2009)
Red Hill Fuel Storage Facility
Oahu, Hawaii

5.0 References

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Appendix A
Laboratory Analytical Reports