Quarterly Groundwater Monitoring Report-Outside (Non-Tunnel) Wells

Red Hill Bulk Fuel Storage Facility, Joint Base Pearl Harbor-Hickam, O‘ahu, Hawai‘i

Latitude: 21°22’15”N
Longitude: 157°53’33”W

DOH Facility ID No. 9-102271
DOH Release ID No. 99051, 010011, 020028

December 2011

Department of the Navy
Naval Facilities Engineering Command, Hawai‘i
400 Marshall Road
JBPHH HI 96860-3139

NAVFAC
Naval Facilities Engineering Command
NAVFAC HAWAII

Environmental Technical Services
Contract Number N62742-08-D-1930, CTO HC21

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List of Acronyms

µg/L	micrograms per liter
%	percent
amsl	above mean sea level
bTOC	below top of casing
COPC	chemical of potential concern
CTO	Contract Task Order
DL	detection limit or method detection limit (MDL)
DLNR	Department of Land and Natural Resources
DOH	State of Hawai‘i Department of Health
DON	Department of the Navy
DRO	diesel range organics
EAL	Environmental Action Level
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbon
F-76	marine diesel fuel
FLC	Fleet Logistics Center
GRO	gasoline range organics
HAR	Hawai‘i Administrative Rules
IDW	investigation-derived waste
J	Estimated result. Indicates that the compound was identified but the concentration was above the DL and below the LOQ.
JP	Jet Propellant
LOD	limit of detection
LOQ	limit of quantitation or reporting limit (RL)
MADEP	Massachusetts Department of Environmental Protection
MS	matrix spike
MSD	matrix spike duplicate
NA	not available
NAVFAC	Naval Facilities Engineering Command
NAVSUP	United States Naval Supply Systems Command
ND	not detected
PAHs	polycyclic aromatic hydrocarbons
pH	hydrogen activity
PHWS	Pearl Harbor Water System
PPE	personal protective equipment
Q	data qualifier
QC	quality control
RHSF	Red Hill Bulk Fuel Storage Facility
RPD	relative percent difference
TEC	The Environmental Company, Inc.
TOC	top of casing
TPH	total petroleum hydrocarbons
U	Indicates the compound or analyte was analyzed for but not detected. The result is reported as ND.
U.S.	United States
USGS	United States Geological Survey
UST	underground storage tank
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbon

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Executive Summary

There are 18 active and two inactive, 12.5 million gallon capacity, field-constructed underground storage tanks (USTs) located at the Red Hill Bulk Fuel Storage Facility (RHSF). Previous environmental site investigations indicated a release had occurred and contaminated the groundwater underlying the RHSF.

The United States (U.S.) Navy implemented a groundwater monitoring program, which includes collecting quarterly groundwater samples from U.S. Navy Well 2254-01 (RHMW2254-01) and four groundwater monitoring wells (RHMW01, RHMW02, RHMW03, and RHMW05) installed in the RHSF lower access tunnel. The U.S. Navy Well 2254-01 is located approximately 3,000 feet downgradient from the RHSF and provides approximately 24 percent (%) of the potable water to the Pearl Harbor Water System (PHWS). The groundwater samples are analyzed for petroleum constituents and compared against State of Hawai‘i Department of Health (DOH) Drinking Water Environmental Action Levels (EALs) (DOH, 2009).

In response to increasing concentrations of chemicals of potential concern (COPCs) in the groundwater monitoring wells within the facility (specifically RHMW02) during 2008, plans were made to conduct four quarterly monitoring events starting in August 2009 and ending in April 2010 at the following outside (non-tunnel) monitoring well locations:

- RHMW04;
- Oily Waste Disposal Facility Monitoring Well 01 (OWDFMW01); and
- Hālawa Deep Well 2253-03 (HDMW2253-03).

The four consecutive quarterly monitoring events indicated all COPC concentrations were below the EALs for samples collected at monitoring well RHMW04. In January 2010 concentrations of total petroleum hydrocarbons (TPH) diesel range organics (DRO) were above the EALs at OWDFMW01 and HDMW2253-03. As a result, quarterly monitoring was discontinued at RHMW04 and continued at the two remaining outside monitoring wells. This groundwater monitoring report presents the analytical results for samples collected on October 26, 2011 at the two outside monitoring wells (OWDFMW01 and HDMW2253-03).

Laboratory analytical results indicate that all COPC concentrations during the October 2011 monitoring event were below the EALs. Dissolved lead was detected at a concentration of 0.9 micrograms per liter (µg/L) in monitoring well HDMW2253-03 and at an estimated concentration of 0.19 µg/L in monitoring well OWDFMW01. Benzene was detected at an estimated concentration of 0.92 µg/L in monitoring well HDMW2253-03. All other COPCs were not detected at or above the limits of detection (LODs) and limits of quantitation (LOQs). All LODs and LOQs were generally below the EALs for COPCs where EALs were available. In the case where an EAL for a specific COPC is less than the LOQ, it is generally acceptable to consider the LOQ in place of the EAL (DOH, 2009). The results of this groundwater monitoring event indicate significant concentrations of COPCs detected within the facility are not impacting these two outside monitoring wells.

Collective concentrations of aliphatic and aromatic hydrocarbons were analyzed this monitoring event utilizing Massachusetts Department of Environmental Protection (MADEP) extractable petroleum hydrocarbon (EPH) and volatile petroleum hydrocarbon (VPH) methods to more accurately determine if the TPH-DRO detected is petroleum based or non-petroleum based (DOH, 2010, Appendix A). The subsequent three consecutive quarterly monitoring events will not include MADEP EPH and VPH analyses.

MADEP EPH analytical results for TPH-DRO typically have the majority of the hydrocarbons in the C_{10}-C_{20} range. Current analytical results have the majority of the hydrocarbons toward the higher carbon range (C_{19}-C_{36}) which indicate that the detected hydrocarbons are most likely from non-petroleum sources. Only C_{19}-C_{36} aliphatic hydrocarbons were detected at a concentration of 226 µg/L in monitoring well HDMW2253-03 and at an estimated concentration of 41.0 µg/L in monitoring well OWDFMW01. All COPC concentrations have been below the EALs for five and seven consecutive quarterly monitoring events for samples collected at monitoring wells OWDFMW01 and HDMW2253-03, respectively. Reduced frequency of sampling from quarterly to annual groundwater monitoring of both monitoring wells is recommended.

Section 1 Introduction

This report presents the results of the October 2011 quarterly groundwater monitoring event at the two outside monitoring wells (OWDFMW01 and HDMW2253-03) at the RHSF, Joint Base Pearl Harbor-Hickam (JBPHH), O‘ahu, Hawai‘i (Figure 1-1). The groundwater monitoring was performed by Environet for the Department of the Navy (DON), Naval Facilities Engineering Command (NAVFAC) Hawai‘i under Environmental Technical Services, Contract Number N62742-08-D-1930, Contract Task Order (CTO) HC21.

This groundwater monitoring event is considered supplemental to the quarterly groundwater monitoring program conducted within the tunnels of the RHSF. This supplemental groundwater monitoring was conducted in response to increasing concentrations of COPCs in a groundwater monitoring well within the RHSF, specifically RHMW02, during the October 2008 groundwater monitoring event. The field activities performed for the October 2011 quarterly groundwater monitoring event were conducted in accordance with the procedures described in the *Work Plan, Long-Term Monitoring, Red Hill Bulk Fuel Storage Facility, Pearl Harbor, O‘ahu, Hawai‘i* (Environet, 2010).

1.1 Project Objective

The groundwater monitoring was performed to evaluate the presence of COPCs in groundwater surrounding the RHSF. The groundwater monitoring was conducted to ensure the DON remains in compliance with DOH UST release response requirements as described in Hawai‘i Administrative Rules (HAR) 11-281 Subchapter 7, Release Response Action.

1.2 Background

The U.S. Navy implemented a groundwater monitoring program, which includes collecting quarterly groundwater samples from U.S. Navy Well 2254-01 (RHMW2254-01) and four groundwater monitoring wells (RHMW01, RHMW02, RHMW03, and RHMW05) installed in the RHSF lower access tunnel. The U.S. Navy Well 2254-01 is located approximately 3,000 feet downgradient from the RHSF and provides approximately 24% of the potable water to the PHWS. The groundwater samples are analyzed for petroleum constituents and compared against DOH Drinking Water EALs (DOH, 2009).

In response to increasing concentrations of COPCs in the groundwater monitoring wells within the facility (specifically RHMW02) during 2008, plans were made to conduct four quarterly monitoring events starting in August 2009 and ending in April 2010 at the following outside (non-tunnel) monitoring well locations:

- RHMW04;
- Oily Waste Disposal Facility Monitoring Well 01 (OWDFMW01); and
- Hālawa Deep Well 2253-03 (HDMW2253-03).

The four consecutive quarterly monitoring events indicated all COPC concentrations were below the EALs for samples collected at monitoring well RHMW04. In January 2010 concentrations of TPH-DRO were above the EALs at OWDFMW01 and HDMW2253-03. As a result, quarterly monitoring was discontinued at RHMW04 and continued at the two remaining outside monitoring wells. This groundwater monitoring report presents the analytical results for samples collected on October 26, 2011 at the two outside monitoring wells (OWDFMW01 and HDMW2253-03). The following sections provide a description of the site and information on the RHSF and USTs.

1.2.1 *Site Description*

The RHSF is located on the island of O‘ahu, Hawai‘i, approximately 2.5 miles northeast of Pearl Harbor in Hālawa Heights (Figure 1-1). Land adjacent to the north of the RHSF is occupied by the Hālawa Correctional Facility and private businesses. Land to the south and west of the facility includes the Coast Guard Reservation and other residential neighborhoods. Moanalua Valley is located east of the facility (Environet, 2010).

The Navy Public Works Department operates a potable water infiltration tunnel approximately 1,550 feet hydraulically downgradient from the RHSF (Environet, 2010). The U.S. Navy Well 2254-01 is located approximately 3,000 feet downgradient (west) of the RHSF and provides approximately 24% of the potable water to the PHWS, which serves approximately 52,200 military consumers (The Environmental Company, Inc. (TEC), 2008).

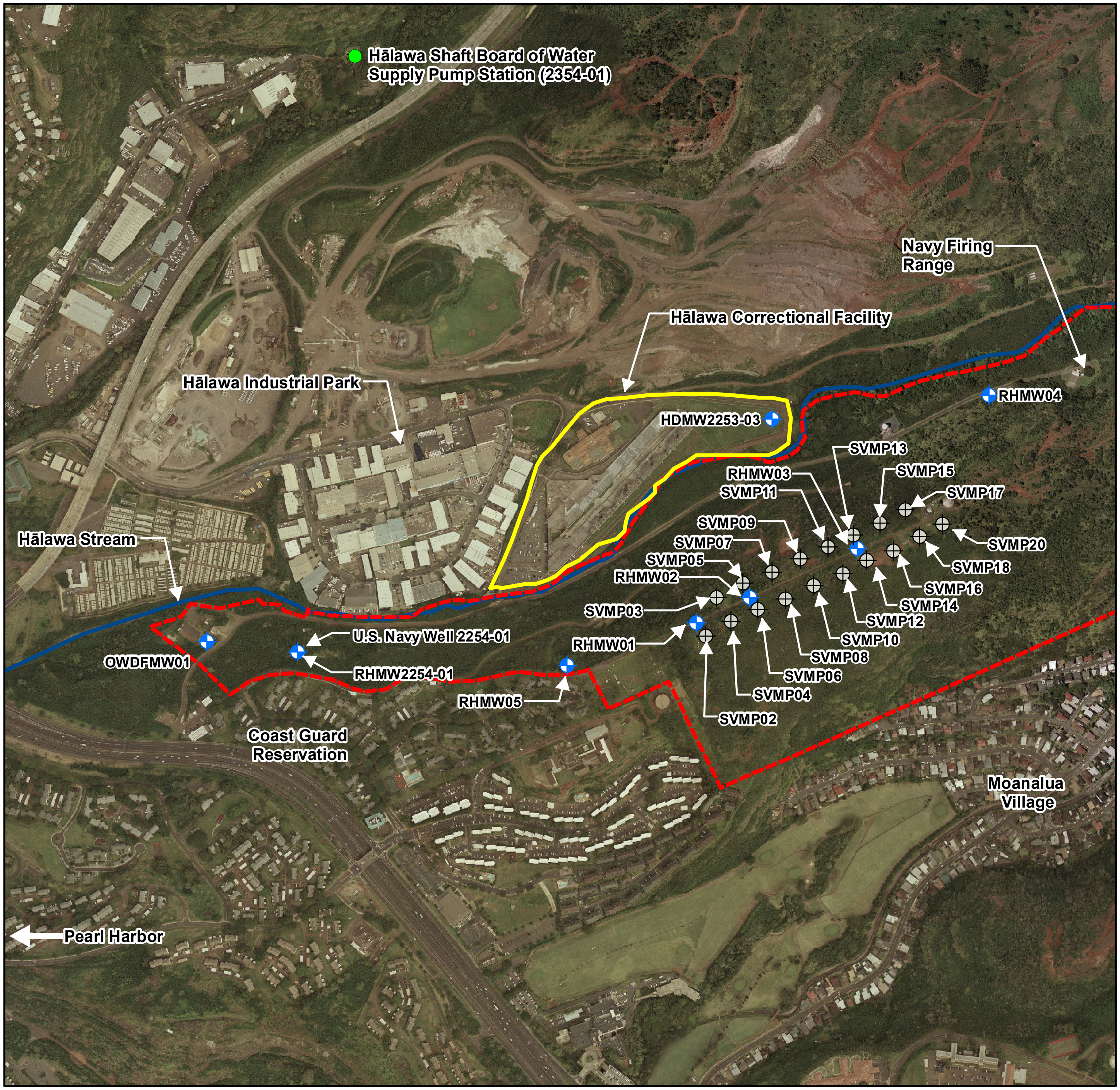
1.2.2 *Facility Information*

The RHSF consists of 18 active and two inactive USTs operated by the United States Naval Supply Systems Command (NAVSUP) Fleet Logistics Center (FLC) Pearl Harbor. Each UST has a capacity of 12.5 million gallons. The RHSF is located approximately 100 feet above the basal aquifer (Dawson Group, Inc., 2006).

In 2002, the U.S. Navy installed a groundwater monitoring well (RHMW01) into the basal aquifer, directly down-gradient from the RHSF, within the lower access tunnel. Groundwater samples from this well indicated that petroleum from the RHSF has migrated to the basal aquifer (AMEC Earth and Environmental, Inc., 2002). In 2005, the U.S. Navy began quarterly monitoring of the aquifer to protect their down-gradient drinking water resource associated with the U.S. Navy Well 2254-01.

By September 2005, the U.S. Navy had installed two more groundwater monitoring wells (RHMW02 and RHMW03) within the RHSF UST system, a groundwater monitoring well (RHMW04) north of the RHSF (adjacent to the U.S. Navy Firing Range), and a groundwater monitoring well within the U.S. Navy Well 2254-01 infiltration gallery (RHMW2254-01). Since 2005, RHMW01, RHMW02, RHMW03, and RHMW2254-01 have been sampled quarterly for TPH-DRO, TPH-gasoline range organics (GRO), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and dissolved lead.

Due to increasing concentrations of COPCs at the groundwater monitoring wells within the RHSF (specifically RHMW02) during 2008, response measures were warranted. In April 2009, another groundwater monitoring well (RHMW05) was installed within the lower access tunnel



LEGEND

⊕	Soil Vapor Monitoring Points
⊕	Groundwater Monitoring Wells
●	Board of Water Supply Pump Station
☐	Halawa Correctional Facility
☐	Red Hill Naval Reservation
—	Hālawa Stream

SOURCE

USGS, 2005

N

1,000 500 0 1,000 Feet

Figure 1-1
Groundwater Monitoring Well Location Map
Quarterly Groundwater Monitoring Report,
Red Hill Bulk Fuel Storage Facility,
JBPHH, O'ahu, Hawai'i

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between RHMW01 and RHMW2254-01. It was installed to identify the extent of contaminant migration in groundwater before it reaches the infiltration gallery at RHMW2254-01.

Additionally, plans were made to sample three monitoring wells surrounding and outside of RHSF: RHMW04, OWDFMW01, and HDMW2253-03 (Figure 1-1 and Table 1-1). RHMW04 was installed to evaluate groundwater within the basal aquifer upgradient from RHSF. OWDFMW01 (originally known as MW08) was installed into the basal aquifer in 1998 for a Phase II Remedial Investigation/Feasibility Study for the Red Hill Oily Waste Disposal Facility (Earth Tech, Inc., 2000). It is located geographically down-gradient of the USTs and U.S. Navy Well 2254-01. HDMW2253-03 is controlled by the State of Hawai‘i Commission on Water Resource Management. HDMW2253-03 is located between the RHSF and the municipal drinking water supply well which is operated by the City and County of Honolulu Board of Water Supply (Hālawa Shaft Pumping Station 2354-01) (Figure 1-1).

Table 1-1: Outside Monitoring Well Information

Groundwater Monitoring Well	bTOC Elevation (feet amsl)	Depth to Water (feet bTOC)	Total Depth of Well (feet)
RHMW04	313.03	---	320
OWDFMW01	138.94	120.00	142.8
HDMW2253-03	225	207. 73*	1,575

Notes:
*Depth to water provided by the Department of Land and Natural Resources (DLNR) on October 26, 2011.
--- Depth to water was not gauged at RHMW04 on October, 26 2011 because it is no longer a part of the sampling program.
amsl - above mean sea level
bTOC - below top of casing

1.2.3 *UST Information*

The USTs were constructed in the early 1940s. The tanks were constructed of steel and currently contain Jet Propellant (JP)-5 fuel, JP-8, and marine diesel fuel (F-76). 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).

1.2.4 *Regulatory Updates*

During the summer and fall of 2008, DOH 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 U.S. Environmental Protection Agency (EPA). As a result, DOH 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 one in a million cancer risk (DOH, 2009). Also, the drinking water EAL for naphthalene was increased from 6.2 µg/L to 17 µg/L (DOH, 2009). Finally, the DOH Drinking Water EAL for TPH-DRO was increased from 100 µg/L to 210 µg/L, although the DOH Groundwater Gross Contamination EAL for TPH-DRO remains 100 µg/L.

1.3 Previous Reports

The following groundwater monitoring reports were previously submitted to the DOH for the groundwater monitoring wells within the RHSF:

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);
16. Groundwater Monitoring Results, July 2009 (submitted September 2009);
17. Groundwater Monitoring Results, October 2009 (submitted December 2009);
18. Groundwater Monitoring Results, January, February, and March 2010 (submitted April 2010);
19. Groundwater Monitoring Results, April 2010 (submitted May 2010);
20. Groundwater Monitoring Results, July 2010 (submitted August 2010);
21. Groundwater Monitoring Results, October 2010 (submitted December 2010);
22. Groundwater Monitoring Results, January 2011 (submitted March 2011);
23. Groundwater Monitoring Results, April 2011 (submitted June 2011); and
24. Groundwater Monitoring Results, July 2011 (submitted September 2011).

The following groundwater monitoring reports were previously submitted to the DOH for the groundwater monitoring wells outside the RHSF:

1. Groundwater Monitoring Results, August 2009 (submitted September 2009);

2. Groundwater Monitoring Results, October 2009 (submitted December 2009);
3. Groundwater Monitoring Results, January 2010 (submitted April 2010);
4. Groundwater Monitoring Results, April 2010 (submitted May 2010);
5. Groundwater Monitoring Results, July 2010 (submitted August 2010);
6. Groundwater Monitoring Results, October 2010 (submitted December 2010);
7. Groundwater Monitoring Results, January 2011 (submitted March 2011);
8. Groundwater Monitoring Results, April 2011 (submitted June 2011); and
9. Groundwater Monitoring Results, July 2011 (submitted September 2011).

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Section 2 Monitoring Activities

Groundwater monitoring was conducted on October 26, 2011 in accordance with the site specific Work Plan (Environet, 2010). Field activities were documented in the field notebook (Appendix B).

2.1 Groundwater Gauging

Groundwater gauging measurements were collected at the two monitoring wells (OWDFMW01 and HDMW2253-03) prior to purging and sample collection. A Solinst water level meter was used to measure the depth to groundwater to the nearest 0.01 foot within monitoring well OWDFMW01, according to the procedures described in Procedure I-C-3, *Monitoring Well Sampling* (DON, 2007). The depth to groundwater for monitoring well HDMW2253-03 was measured by a Department of Land and Natural Resources (DLNR) employee prior to well purging (Table 1-1).

2.2 Groundwater Sampling

Groundwater samples were collected from the two monitoring wells according to the procedures described in Procedure I-C-3, *Monitoring Well Sampling* (DON, 2007).

2.2.1 *Monitoring Well Purging*

Due to the well construction characteristics of OWDFMW01 and HDMW2253-03 (large casing diameter of approximately 12 inches from the top of casing (TOC) to approximately 50 feet below the groundwater surface then the well is open [not cased] from approximately 250 feet below TOC (bTOC) to 1,575 feet bTOC), three well casing volumes were not purged prior to sampling. Instead, water was purged using disposable bailers until three or more successive water quality parameter measurements had stabilized within 10%. A Horiba® U-22 multi-parameter water quality meter was used to measure hydrogen activity (pH), temperature, specific conductivity, dissolved oxygen, turbidity, and oxidation reduction potential. At least six readings were recorded on Groundwater Sampling Log data sheets (Appendix C).

2.2.2 *Groundwater Sample Collection*

Groundwater samples were collected from OWDFMW01 using four-inch and two-inch disposable bailers and were collected directly into laboratory provided, specially cleaned sample containers already containing the appropriate preservatives (i.e., nitric acid for dissolved lead or hydrochloric acid for aliphatic and aromatic hydrocarbon analyses). The dissolved lead samples were filtered in the field at OWDFMW01 and placed in polyethylene bottles containing the appropriate preservative.

Groundwater samples were collected from HDMW2253-03 using a four-inch double stop disposable bailer collected directly into laboratory provided, specially cleaned sample containers containing the appropriate preservatives. Due to the well construction characteristics of HDMW2253-03, a grab sample was collected at a depth below the solid casing (which extends about 50 feet below the water table) and within the open-holed portion of the well. Dissolved lead samples collected from HDMW2253-03 required laboratory filtration due to the doublestop bailer required to collect the sample.

2.2.3 *Sample Management and Shipment*

Each sample container sent to the laboratory was assigned a project-specific chain of custody identification number and a descriptive identification number. The sample identifiers provided specific data unique to each sample and were entered into the field notebook. The samples were labeled according to the procedures described in Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody* (DON, 2007).

Following sample collection and labeling, the sample containers were packaged with bubble wrap and placed into individual ZipLoc® bags, then immediately into insulated coolers with ice for preservation. The samples were shipped via FedEx to the laboratory on the same day of collection. The samples were managed under standard chain of custody protocol and documentation from collection to delivery to the laboratory. Sample handling, storage, and transport were performed according to the requirements described in Procedure III-F, *Sample Handling, Storage, and Shipping* (DON, 2007).

2.3 Analytical Program

During the October 2011 groundwater monitoring event, two sets of primary groundwater samples, one set of duplicate groundwater samples, and one set of quality control (QC) groundwater samples were submitted to APPL, Inc. located in Clovis, California. Groundwater samples were analyzed for VOCs and TPH-GRO by EPA Method 8260B, TPH-DRO by EPA Method 8015B, PAHs by EPA Method 8270D SIM, dissolved lead by EPA Method 6020, and collective aliphatic and aromatic hydrocarbons by MADEP EPH and VPH methods. The results of the laboratory analyses are presented and discussed in Section 3.

2.4 Field Quality Control Samples

Field QC procedures were followed to ensure viability and integrity of sample analytical data. Field duplicates were collected according to the procedures described in Procedure III-B, *Field QC Samples (Water, Soil)* (DON, 2007) and the Work Plan (Environet, 2010). Field duplicate samples were collected at a minimum of 10% of primary samples and analyzed for the same contaminants. Field rinsate samples were not required since disposable bailers were used.

2.5 Laboratory Quality Control Samples

Laboratory QC samples were analyzed as part of the standard laboratory QC protocols as presented in the Work Plan (Environet, 2010). Laboratory QC for the groundwater monitoring event consisted of matrix spike (MS)/matrix spike duplicate (MSD) samples for organic analysis. Laboratory QC samples were collected and analyzed according to the procedures described in Procedure III-A *Laboratory QC Samples (Water, Soil)* (DON, 2007). Laboratory QC MS/MSD samples are an aliquot (i.e., a subset) of the field sample; they are not separate samples, but a special designation of an existing sample. Laboratory QC MS/MSD samples were analyzed for the same constituents as the standard samples. At a minimum, one MS/MSD sample pair was required per 20 samples, including duplicates.

2.6 Equipment Decontamination

Decontamination of monitoring equipment was performed to ensure data quality, to prevent cross contamination, and to prevent the potential introduction of contaminants into previously un-impacted areas. Decontamination of monitoring equipment (i.e., Solinst water level meter and Horiba® U-22 water quality meter) was conducted between monitoring locations according to the procedures described in Procedure I-F, *Equipment Decontamination* (DON, 2007). Decontamination water generated at monitoring well OWDFMW01 was disposed of in the RHSF's lower tunnel oil/water separator sump.

2.7 Investigation-Derived Waste Management

Investigation-derived waste (IDW) was managed in accordance with the procedures described in Procedure I-A-6, *IDW Management* (DON, 2007). The various potential waste streams included the following:

- personal protective equipment (PPE) including: nitrile gloves, etc.;
- liquids including: equipment rinse water and purged groundwater; and
- disposable sampling equipment and supplies, including: bailers, poly sheeting, etc.

Equipment rinse water and purge water from OWDFMW01 was disposed of in the RHSF's lower tunnel oil/water separator sump. Purge water from monitoring well HDMW2253-03 was disposed of in the surrounding grass (as directed by DLNR) since it was of drinking water quality. Spent PPE and non-contaminated sample jars and bottles (acid free) were disposed of on a daily basis as solid waste.

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Section 3 Groundwater Analytical Results

This section provides a summary of analytical results for groundwater samples collected from the two outside monitoring wells on October 26, 2011. Complete analytical laboratory reports are provided in Appendix D (on CD-ROM).

3.1 Summary of Groundwater Analytical Results

OWDFMW01

Dissolved lead was detected in OWDFMW01 at an estimated concentration of 0.19 µg/L which is below both the Drinking Water EAL (15 µg/L) and the Gross Contamination EAL (5,000 µg/) (Table 3-1, Table 3-2).

All other COPCs were not detected at or above the LODs and LOQs in OWDFMW01. All LODs and LOQs were generally below the EALs. In the case where an EAL for a specific COPC is less than the LOQ, it is generally acceptable to consider the LOQ in place of the EAL (DOH, 2009).

Aliphatic hydrocarbons (C_{19}-C_{36}) by MADEP EPH method and aliphatic hydrocarbons (C_9-C_{12}) by MADEP VPH method were detected at estimated concentrations of 41.0 µg/L and 13.8 µg/L, respectively (Table 3-1, Table 3-2).

HDMW2253-03

Dissolved lead was detected in monitoring well HDMW2253-03 at a concentration of 0.9 µg/L which is below both the Drinking Water EAL (15 µg/L) and the Gross Contamination EAL (5,000 µg/L) (Table 3-1). Benzene was detected in monitoring well HDMW2253-03 at an estimated concentration of 0.92 µg/L which is below both the Drinking Water EAL (5 µg/L) and the Gross Contamination EAL (170 µg/L).All other COPCs were not detected at or above the LODs and LOQs in HDMW2253-03. All LODs and LOQs were generally below the EALs. In the case where an EAL for a specific COPC is less than the LOQ, it is generally acceptable to consider the LOQ in place of the EAL (DOH, 2009).

Aliphatic hydrocarbons (C_{19}-C_{36}) by MADEP EPH method were detected at a concentration of 226 µg/L (Table 3-1, Table 3-2).

3.1.1 *Data Quality Control Results*

The laboratory quality control results were all within the control limits. The relative percent difference (RPD) of field duplicates for all analytes were within the 50% criteria. The trip blank that accompanied the outside well samples did not contain detectable levels of any COPCs. The data quality control results indicate that the data obtained for this monitoring event are suitable for their intended use (Table 3-2).

3.2 Groundwater Contaminant Trend

Concentrations of PAHs and VOCs were previously not detected above the EALs during the August 2009, October 2009, January 2010, April 2010, July 2010, October 2010, January 2011, April 2011, and July 2011 groundwater monitoring events. These constituents were also not detected above the EALs during this October 2011 groundwater monitoring event.

TPH-DRO concentrations in OWDFMW01 have significantly decreased from January 2010 (1,490 µg/L) to April 2010 (288 µg/L) and to non-detect in October 2010, January 2011, April 2011, July 2011, and October 2011 (Table 3-1 and Table 3-3). The concentrations of TPH-DRO at this monitoring well have decreased to non-detect for five consecutive monitoring events (Table 3-3). TPH-DRO concentrations at this well are decreasing.

The concentrations of TPH-DRO at HDMW2253-03 have decreased to non-detect for seven consecutive groundwater monitoring events (Table 3-3).

The October 2010 detection of acetone at an estimated concentration below the DOH Drinking Water EAL was the first at monitoring well OWDFMW01. Acetone was also detected at an estimated concentration in the trip blank sample. This suggested that acetone was introduced to the samples during transport to and from the laboratory, and is not representative of groundwater at OWDFMW01. This conclusion was confirmed in the January 2011, April 2011, July 2011, and October 2011 monitoring events as acetone was not detected in any of the samples collected.

The October 2010 detections of lead at concentrations below the DOH Drinking Water EAL were the first at these two monitoring wells (OWDFMW01 and HDMW2253-03). Lead was not detected in any of the samples in the January 2011 monitoring event or during April 2011. Estimated concentrations of lead below the DOH Drinking Water EAL were detected at both wells during the July 2011 monitoring event. The October 2011 detections of lead at concentrations below the DOH Drinking Water EAL were the third at these two monitoring wells (OWDFMW01 and HDMW2253-03). Lead was detected at a concentration below the DOH Drinking Water EAL in monitoring well HDMW2253-03, and at an estimated concentration below the DOH Drinking Water EAL in monitoring well OWDFMW01 in this October 2011 monitoring event.

The January 2011 detection of benzene at an estimated concentration below the DOH Drinking Water EAL in OWDFMW01 was the first at this monitoring well. Benzene was detected at an estimated concentration in the duplicate sample collected from OWDFMW01 in April 2011, however it was not detected in the July 2011 or the October 2011 monitoring event.

The April 2011 detections of xylenes and toluene in OWDFMW01 and benzene in monitoring well HDMW2253-03 at estimated concentrations below the DOH Drinking Water EALs were the first at these monitoring wells. Xylenes, toluene and benzene were non-detect in July 2011. Xylenes and toluene were non-detect, but benzene was detected at an estimated concentration below the DOH Drinking Water EAL in monitoring well HDMW2253-03 in the October 2011 monitoring event (Table 3-1).

Table 3-1: Analytical Results for Quarterly Groundwater Monitoring-Outside (Non-Tunnel) Wells, October 2011

Method	Chemical	DOH Drinking Water EALs for Human Toxicity[a]	DOH Groundwater Gross Contamination EALs[a]	OWDFMW01 (ES055)					HDMW2253-03 (ES053)				
				Result	Q	LOQ	LOD	DL	Result	Q	LOQ	LOD	DL
MADEP EPH	C11-C22 Aromatics	-	-	ND	U	101		42.5	ND	U	101		42.5
	C19-C36 Aliphatic Hydrocarbons	-	-	41.0	J	101		31.6	226		101		31.6
	C9-C18 Aliphatic Hydrocarbons	-	-	ND	U	101		22.0	ND	U	101		22.0
MADEP VPH	C5-C8 Aliphatic	-	-	ND	U	30.0		3.31	ND	U	30.0		3.31
	C9-C10 Aromatic	-	-	ND	U	10.0		1.24	ND	U	10.0		1.24
	C9-C12 Aliphatic	-	-	13.8	J	20.0		3.20	ND	U	20.0		3.20
EPA 8015B (Petroleum)	TPH-DRO	210	100	ND	U	150	80.8	40.4	ND	U	150	80.8	40.4
EPA 8260B (Petroleum)	TPH-GRO	100	100	ND	U	20.0	12.12	6.06	ND	U	20.0	12.12	6.06
EPA 8270D SIM (PAHs)	Acenaphthene	370	20	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06
	Acenaphthylene	240	2000	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06
	Anthracene	1800	22	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05
	Benzo(a)anthracene	0.092	4.7	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07
	Benzo(g,h,i)perylene	1500	0.13	ND	U	0.2[b]	0.16	0.08	ND	U	0.2[b]	0.16	0.08
	Benzo(a)pyrene	0.2	0.81	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07
	Benzo(b)fluoranthene	0.092	0.75	ND	U	0.2[b]	0.12	0.06	ND	U	0.2[b]	0.12	0.06
	Benzo(k)fluoranthene	0.92	0.4	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07
	Chrysene	9.2	1	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05
	Dibenzo(a,h)anthracene	0.0092	0.52	ND	U	0.2[b]	0.10	0.05	ND	U	0.2[b]	0.10	0.05
	Fluoranthene	1500	130	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08
	Fluorene	240	950	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06
	Indeno(1,2,3-cd)pyrene	0.092	0.095	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07
	1,-Methylnaphthalene	4.7	10	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06
	2,-Methylnaphthalene	24	10	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06
	Naphthalene	17	21	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05
	Phenanthrene	240	410	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07
	Pyrene	180	68	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08
EPA 8260B (VOCs)	1,1,1-Trichloroethane	200	970	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14
	1,1,2-Trichloroethane	5	50,000	ND	U	1.0	0.40	0.20	ND	U	1.0	0.40	0.20
	1,1-Dichloroethane	2.4	50,000	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
	1,1-Dichloroethylene (1,1-Dichloroethene)	7	1,500	ND	U	1.0	0.60	0.30	ND	U	1.0	0.60	0.30
	1,2,3-Trichloropropane	0.6	50,000	ND	U	2.0[b]	0.78	0.39	ND	U	2.0[b]	0.78	0.39
	1,2,4-Trichlorobenzene	70	3,000	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21
	1,2-Dibromo-3-chloropropane	0.04	10	ND	U	2.0[b]	1.52	0.76	ND	U	2.0[b]	1.52	0.76
	1,2-Dibromoethane	0.0065	50,000	ND	U	1.0[b]	0.40	0.20	ND	U	1.0[b]	0.40	0.20
	1,2-Dichlorobenzene	600	10	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17
	1,2-Dichloroethane	0.15	7,000	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14
	1,2-Dichloropropane	5	10	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17
	1,3-Dichlorobenzene	180	50,000	ND	U	1.0	0.22	0.11	ND	U	1.0	0.22	0.11
	1,3-Dichloropropene (total of cis/trans)	0.43	50,000	ND	U	1.0	0.36	0.18	ND	U	1.0	0.36	0.18
	1,4-Dichlorobenzene	75	5	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
	Acetone	22,000	20,000	ND	U	10.0	1.90	0.95	ND	U	10.0	1.90	0.95
	Benzene	5	170	ND	U	1.0	0.32	0.16	0.92	J	1.0	0.32	0.16
	Bromodichloromethane	0.22	50,000	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14
	Bromoform	100	510	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14
	Bromomethane	8.7	50,000	ND	U	2.0	0.48	0.24	ND	U	2.0	0.48	0.24
	Carbon Tetrachloride	5	520	ND	U	1.0	0.20	0.10	ND	U	1.0	0.20	0.10
	Chlorobenzene	100	50	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21
	Chloroethane	8,600	16	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21
	Chloroform	70	2,400	ND	U	1.0	0.14	0.07	ND	U	1.0	0.14	0.07
	Chloromethane	1.8	50,000	ND	U	1.0	0.62	0.31	ND	U	1.0	0.62	0.31
	cis-1,2-Dichloroethylene (cis-1,2-Dichloroethene)	70	50,000	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16
	Dibromochloromethane (Chlorodibromomethane)	0.16	50,000	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19
	Ethylbenzene	700	30	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23
	Hexachlorobutadiene	0.86	6	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
	Methyl ethyl ketone (2-Butanone)	7,100	8,400	ND	U	10.0	1.20	0.60	ND	U	10.0	1.20	0.60
	Methyl isobutyl ketone (4-Methyl-2-pentanone)	2,000	1,300	ND	U	10.0	3.80	1.90	ND	U	10.0	3.80	1.90
	Methyl tert-butyl Ether	12	5	ND	U	1.0	0.52	0.26	ND	U	1.0	0.52	0.26
	Methylene chloride	4.8	9,100	ND	U	5.0	0.70	0.35	ND	U	5.0	0.70	0.35
	Styrene	100	10	ND	U	1.0	0.50	0.25	ND	U	1.0	0.50	0.25
	Tetrachloroethane, 1,1,1,2-	0.52	50,000	ND	U	1.0	0.26	0.13	ND	U	1.0	0.26	0.13
	Tetrachloroethane, 1,1,2,2-	0.067	500	ND	U	1.0[b]	0.20	0.10	ND	U	1.0[b]	0.20	0.10
	Tetrachloroethylene (Tetrachloroethene)	5	170	ND	U	1.0	0.48	0.24	ND	U	1.0	0.48	0.24
	Toluene	1,000	40	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17
	trans-1,2-Dichloroethylene (trans-1,2-Dichloroethene)	100	260	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
	Trichloroethylene (Trichloroethene)	5	310	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16
	Vinyl chloride	2	3,400	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23
	Xylenes	10,000	20	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19
EPA 6020	Lead	15	5,000	0.19	J	0.5	0.22	0.11	0.9		0.5	0.22	0.11

Notes:

All units are in micrograms per liter (µg/L).

[a] DOH EALs (DOH, 2009): Table D-1b. Groundwater Action Levels (Groundwater is a current or potential drinking water resource; surface water body is not located within 150 meters of release site.)

[b] In the case where an EAL for a specific chemical is less than the LOQ for a commercial laboratory, it is generally acceptable to consider the LOQ in place of the action level (DOH, Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater 2008, updated March 2009).

- Chemical does not have DOH EALs.
DL - detection limit or method detection limit (MDL)
DRO - diesel range organics
GRO - gasoline range organics
J - Estimated result. Indicates that the compound was identified but the concentration was above the DL and below the LOQ.
LOD - limit of detection
LOQ - limit of quantitation or reporting limit (RL)
ND - not detected
PAHs - polycyclic aromatic hydrocarbons
Q - data qualifier
TPH - total petroleum hydrocarbons
U - Indicates the compound or analyte was analyzed for but not detected. The result is reported as ND.
VOC - volatile organic compound
LODs will be included in the final report.

Bold - Result exceeds one or both DOH EALs.

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Table 3-2: Field QC Results-Outside Wells, October 2011

Method	Chemical	DOH Drinking Water EALs for Human Toxicity[a]	DOH Groundwater Gross Contamination EALs[a]	OWDFMW01 ES055					OWDFMW01 dup ES056					RPD Duplicate (%)	Trip Blank (10/26/2011) ES054				
				Result	Q	LOQ	LOD	DL	Result	Q	LOQ	LOD	DL		Result	Q	LOQ	LOD	DL
MADEP EPH	C11-C22 Aromatics	-	-	ND	U	101		42.5	ND	U	101		42.5	0	--	--	--		--
	C19-C36 Aliphatic Hydrocarbons	-	-	41.0	J	101		31.6	66.0	J	101		31.6	47	--	--	--		--
	C9-C18 Aliphatic Hydrocarbons	-	-	ND	U	101		22.0	ND	U	101		22.0	0	--	--	--		--
MADEP VPH	C5-C8 Aliphatic	-	-	ND	U	30.0		3.31	ND	U	30.0		3.31	0	--	--	--		--
	C9-C10 Aromatic	-	-	ND	U	10.0		1.24	ND	U	10.0		1.24	0	--	--	--		--
	C9-C12 Aliphatic			13.8	J	20.0		3.20	ND	U	20.0		3.20	0	--	--	--		--
EPA 8015B (Petroleum)	TPH-DRO	210	100	ND	U	150	80.8	40.4	ND	U	150	80.8	40.4	0	--	--	--	--	--
EPA 8260B (Petroleum)	TPH-GRO	100	100	ND	U	20.0	12.12	6.06	ND	U	20.0	12.12	6.06	0	ND	U	20.0	12.12	6.06
EPA 8270D SIM (PAHs)	Acenaphthene	370	20	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06	0	--	--	--	--	--
	Acenaphthylene	240	2000	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06	0	--	--	--	--	--
	Anthracene	1800	22	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05	0	--	--	--	--	--
	Benzo(a)anthracene	0.092	4.7	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07	0	--	--	--	--	--
	Benzo(g,h,i)perylene	1500	0.13	ND	U	0.2[b]	0.16	0.08	ND	U	0.2[b]	0.16	0.08	0	--	--	--	--	--
	Benzo(a)pyrene	0.2	0.81	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	0	--	--	--	--	--
	Benzo(b)fluoranthene	0.092	0.75	ND	U	0.2[b]	0.12	0.06	ND	U	0.2[b]	0.12	0.06	0	--	--	--	--	--
	Benzo(k)fluoranthene	0.92	0.4	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	0	--	--	--	--	--
	Chrysene	9.2	1	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05	0	--	--	--	--	--
	Dibenzo(a,h)anthracene	0.0092	0.52	ND	U	0.2[b]	0.10	0.05	ND	U	0.2[b]	0.10	0.05	0	--	--	--	--	--
	Fluoranthene	1500	130	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08	0	--	--	--	--	--
	Fluorene	240	950	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06	0	--	--	--	--	--
	Indeno(1,2,3-cd)pyrene	0.092	0.095	ND	U	0.2[b]	0.14	0.07	ND	U	0.2[b]	0.14	0.07	0	--	--	--	--	--
	1,-Methylnaphthalene	4.7	10	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06	0	--	--	--	--	--
	2,-Methylnaphthalene	24	10	ND	U	0.2	0.12	0.06	ND	U	0.2	0.12	0.06	0	--	--	--	--	--
	Naphthalene	17	21	ND	U	0.2	0.10	0.05	ND	U	0.2	0.10	0.05	0	--	--	--	--	--
	Phenanthrene	240	410	ND	U	0.2	0.14	0.07	ND	U	0.2	0.14	0.07	0	--	--	--	--	--
	Pyrene	180	68	ND	U	0.2	0.16	0.08	ND	U	0.2	0.16	0.08	0	--	--	--	--	--
EPA 8260B (VOCs)	1,1,1-Trichloroethane	200	970	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14	0	ND	U	1.0	0.28	0.14
	1,1,2-Trichloroethane	5	50,000	ND	U	1.0	0.40	0.20	ND	U	1.0	0.40	0.20	0	ND	U	1.0	0.40	0.20
	1,1-Dichloroethane	2.4	50,000	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	0	ND	U	1.0	0.38	0.19
	1,1-Dichloroethylene (1,1-Dichloroethene)	7	1,500	ND	U	1.0	0.60	0.30	ND	U	1.0	0.60	0.30	0	ND	U	1.0	0.60	0.30
	1,2,3-Trichloropropane	0.6	50,000	ND	U	2.0[b]	0.78	0.39	ND	U	2.0[b]	0.78	0.39	0	ND	U	2.0[b]	0.78	0.39
	1,2,4-Trichlorobenzene	70	3,000	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	0	ND	U	1.0	0.42	0.21
	1,2-Dibromo-3-chloropropane	0.04	10	ND	U	2.0[b]	1.52	0.76	ND	U	2.0[b]	1.52	0.76	0	ND	U	2.0[b]	1.52	0.76
	1,2-Dibromoethane	0.0065	50,000	ND	U	1.0[b]	0.40	0.20	ND	U	1.0[b]	0.40	0.20	0	ND	U	1.0[b]	0.40	0.20
	1,2-Dichlorobenzene	600	10	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	0	ND	U	1.0	0.34	0.17
	1,2-Dichloroethane	0.15	7,000	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14	0	ND	U	1.0[b]	0.28	0.14
	1,2-Dichloropropane	5	10	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	0	ND	U	1.0	0.34	0.17
	1,3-Dichlorobenzene	180	50,000	ND	U	1.0	0.22	0.11	ND	U	1.0	0.22	0.11	0	ND	U	1.0	0.22	0.11
	1,3-Dichloropropene (total of cis/trans)	0.43	50,000	ND	U	1.0	0.36	0.18	ND	U	1.0	0.36	0.18	0	ND	U	1.0	0.36	0.18
	1,4-Dichlorobenzene	75	5	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	0	ND	U	1.0	0.38	0.19
	Acetone	22,000	20,000	ND	U	10.0	1.90	0.95	ND	U	10.0	1.90	0.95	0	ND	U	10.0	1.90	0.95
	Benzene	5	170	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	0	ND	U	1.0	0.32	0.16
	Bromodichloromethane	0.22	50,000	ND	U	1.0[b]	0.28	0.14	ND	U	1.0[b]	0.28	0.14	0	ND	U	1.0[b]	0.28	0.14
	Bromoform	100	510	ND	U	1.0	0.28	0.14	ND	U	1.0	0.28	0.14	0	ND	U	1.0	0.28	0.14
	Bromomethane	8.7	50,000	ND	U	2.0	0.48	0.24	ND	U	2.0	0.48	0.24	0	ND	U	2.0	0.48	0.24
	Carbon Tetrachloride	5	520	ND	U	1.0	0.20	0.10	ND	U	1.0	0.20	0.10	0	ND	U	1.0	0.20	0.10
	Chlorobenzene	100	50	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	0	ND	U	1.0	0.42	0.21
	Chloroethane	8,600	16	ND	U	1.0	0.42	0.21	ND	U	1.0	0.42	0.21	0	ND	U	1.0	0.42	0.21
	Chloroform	70	2,400	ND	U	1.0	0.14	0.07	ND	U	1.0	0.14	0.07	0	ND	U	1.0	0.14	0.07
	Chloromethane	1.8	50,000	ND	U	1.0	0.62	0.31	ND	U	1.0	0.62	0.31	0	ND	U	1.0	0.62	0.31
	cis-1,2-Dichloroethylene (cis-1,2-Dichloroethene)	70	50,000	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	0	ND	U	1.0	0.32	0.16
	Dibromochloromethane (Chlorodibromomethane)	0.16	50,000	ND	U	1.0[b]	0.38	0.19	ND	U	1.0[b]	0.38	0.19	0	ND	U	1.0[b]	0.38	0.19
	Ethylbenzene	700	30	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23	0	ND	U	1.0	0.46	0.23
	Hexachlorobutadiene	0.86	6	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	0	ND	U	1.0	0.38	0.19
	Methyl ethyl ketone (2-Butanone)	7,100	8,400	ND	U	10.0	1.20	0.60	ND	U	10.0	1.20	0.60	0	ND	U	10.0	1.20	0.60
	Methyl isobutyl ketone (4-Methyl-2-pentanone)	2,000	1,300	ND	U	10.0	3.80	1.90	ND	U	10.0	3.80	1.90	0	ND	U	10.0	3.80	1.90
	Methyl tert-butyl Ether	12	5	ND	U	1.0	0.52	0.26	ND	U	1.0	0.52	0.26	0	ND	U	1.0	0.52	0.26
	Methylene chloride	4.8	9,100	ND	U	5.0	0.70	0.35	ND	U	5.0	0.70	0.35	0	ND	U	5.0	0.70	0.35
	Styrene	100	10	ND	U	1.0	0.50	0.25	ND	U	1.0	0.50	0.25	0	ND	U	1.0	0.50	0.25
	Tetrachloroethane, 1,1,1,2-	0.52	50,000	ND	U	1.0	0.26	0.13	ND	U	1.0	0.26	0.13	0	ND	U	1.0	0.26	0.13
	Tetrachloroethane, 1,1,2,2-	0.067	500	ND	U	1.0[b]	0.20	0.10	ND	U	1.0[b]	0.20	0.10	0	ND	U	1.0[b]	0.20	0.10
	Tetrachloroethylene (Tetrachloroethene)	5	170	ND	U	1.0	0.48	0.24	ND	U	1.0	0.48	0.24	0	ND	U	1.0	0.48	0.24
	Toluene	1,000	40	ND	U	1.0	0.34	0.17	ND	U	1.0	0.34	0.17	0	ND	U	1.0	0.34	0.17
	trans-1,2-Dichloroethylene (trans-1,2-Dichloroethene)	100	260	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	0	ND	U	1.0	0.38	0.19
	Trichloroethylene (Trichloroethene)	5	310	ND	U	1.0	0.32	0.16	ND	U	1.0	0.32	0.16	0	ND	U	1.0	0.32	0.16
	Vinyl chloride	2	3,400	ND	U	1.0	0.46	0.23	ND	U	1.0	0.46	0.23	0	ND	U	1.0	0.46	0.23
	Xylenes	10,000	20	ND	U	1.0	0.38	0.19	ND	U	1.0	0.38	0.19	0	ND	U	1.0	0.38	0.19
EPA 6020	Lead	15	5000	0.19	J	0.5	0.22	0.11	ND	U	0.5	0.22	0.11	0	--	--	--	--	--

Notes:

All units are in micrograms per liter (µg/L).

[a] DOH EALs (DOH, 2009): Table D-1b. Groundwater Action Levels (Groundwater is a current or potential drinking water resource; surface water body is not located within 150 meters of release site).

[b] In the case where an EAL for a specific chemical is less than the LOQ for a commercial laboratory, it is generally acceptable to consider the LOQ in place of the action level (DOH, Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater 2008, updated March 2009).

DL - detection limit or method detection limit (MDL)
DRO - diesel range organics
dup - duplicate
GRO - gasoline range organics
J - Estimated result. Indicates that the compound was identified but the concentration was above the DL and below the LOQ.
LOD - limit of detection
LOQ - limit of quantitation or reporting limit (RL)
PAHs - polycyclic aromatic hydrocarbons
Q - data qualifier
RPD - relative percent difference
TPH - total petroleum hydrocarbons
U - Indicates the compound or analyte was analyzed for but not detected. The result is reported as ND.
VOC - volatile organic compound
-- not analyzed
- Chemical does not have DOH EALs.
LODs will be included in the final report
Bold - Result exceeds one or both DOH EALs.

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Table 3-3: Historical and Current Groundwater Sample Analytical Results, August 2009 through October 2011

	OWDFMW01										HDMW2253-03									
	TPH-DRO					TPH-GRO					TPH-DRO					TPH-GRO				
	Result	**Q**	**LOQ**	**LOD**	**DL**	**Result**	**Q**	**LOQ**	**LOD**	**DL**	**Result**	**Q**	**LOQ**	**LOD**	**DL**	**Result**	**Q**	**LOQ**	**LOD**	**DL**
August 2009	ND	U	457	NA	171	ND	U	100	NA	30	--	--	--	NA	--	--	--	--	NA	--
October 2009	ND	U	444	NA	167	ND	U	100	NA	30	ND	U	494	NA	185	ND	U	100	NA	30
January 2010	**1490**		440	NA	165	ND	U	100	NA	30	**322**	J	460	NA	172	ND	U	100	NA	30
April 2010	**288**	J	471	NA	176	ND	U	100	NA	30	ND	U	471	NA	176	ND	U	100	NA	30
July 2010	--	--	--	--	--	--	--	--	--	--	ND	U	426	--	160	ND	U	100	--	30
October 2010	ND	U	150	80.8	40.4	ND	U	20.0	12.1	6.06	ND	U	150	80.8	40.4	ND	U	20.0	12.1	6.06
January 2011	ND	U	150	80.8	40.4	ND	U	20.0	12.1	6.06	ND	U	150	80.8	40.4	ND	U	20.0	12.1	6.06
April 2011	ND	U	150	80.8	40.4	ND	U	20.0	12.1	6.06	ND	U	150	80.8	40.4	ND	U	20.0	12.1	6.06
July 2011	ND	U	150	80.8	40.4	ND	U	20.0	12.1	6.06	ND	U	150	80.8	40.4	ND	U	20.0	12.1	6.06
October 2011	ND	U	150	80.8	40.4	ND	U	20.0	12.1	6.06	ND	U	150	80.8	40.4	ND	U	20.0	12.1	6.06

DOH Drinking Water EALs for Human Toxicity[a] *: TPH-DRO = 210 µg/L; TPH-GRO = 100 µg/L*

DOH Groundwater Gross Contamination EALs[a] *: TPH-DRO = 100 µg/L; TPH-GRO = 100 µg/L*

Notes:
All units are in micrograms per liter (µg/L)
[a] DOH EALs (DOH, 2009): Table D-1b. Groundwater Action Levels (Groundwater is a current or potential drinking water resource; surface water body is not located within 150 meters of release site.)
-- The monitoring well was not sampled.
DL - detection limit or method detection limit (MDL)
J - Estimated result. Indicates that the compound was identified but the concentration was above the DL and below the LOQ.
LOD - limit of detection
LOQ - limit of quantitation or reporting limit (RL)
NA - not available
ND - not detected
Q - data qualifier
U - Indicates that the compound was analyzed for but not detected. The result is reported as ND.
Bold - Result exceeds one or both DOH EALs.

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Section 4 Summary, Conclusions, and Recommendations

4.1 Summary

Dissolved lead was detected at a concentration of 0.9 µg/L in monitoring well HDMW2253-03 and at an estimated concentration of 0.19 µg/L in monitoring well OWDFMW01 during this groundwater monitoring event. These dissolved lead concentrations are below the DOH Drinking Water EAL (15 µg/L) and the DOH Gross Contamination EAL (5,000 µg/L). Benzene was detected at an estimated concentration of 0.92 µg/L in monitoring well HDMW2253-03 below the DOH Drinking Water EAL (5 µg/L) and the DOH Gross Contamination EAL (170 µg/L). No other COPCs were detected in monitoring wells HDMW2253-03 and OWDFMW01 during the October 2011 monitoring event.

Aliphatic hydrocarbons (C_{19}-C_{36}) were detected at a concentration of 226 µg/L in monitoring well HDMW2253-03 and at an estimated concentration of 41.0 µg/L at monitoring well OWDFMW01 during this groundwater monitoring event. Aliphatic hydrocarbons (C_9-C_{12}) were detected at an estimated concentration (13.8 µg/L) in monitoring well OWDFMW01.

4.2 Conclusions

Concentrations of PAHs and VOCs were previously not detected above the EALs during the August 2009, October 2009, January 2010, April 2010, July 2010, October 2010, January 2011, April 2011, and July 2011 groundwater monitoring events. PAHs and VOCs were also not detected above the EALs during this monitoring event. An estimated concentration of benzene was detected during this monitoring event. The data continue to suggest that TPH-DRO was the only COPC present in any notable quantity for the site; however, it has been non-detect for at least the past five monitoring events.

TPH-DRO concentrations in OWDFMW01 significantly decreased from January 2010 (1,490 µg/L) to April 2010 (288 µg/L), and were not detected in the subsequent five monitoring events (Table 3-1 and Table 3-3). The concentrations of TPH-DRO at HDMW2253-03 have decreased to non-detectable levels for the previous seven consecutive quarterly monitoring events. The data suggest that TPH-DRO concentrations are attenuating naturally at the two outside wells.

The October 2010 detection of acetone at an estimated concentration below the DOH Drinking Water EAL was the first at monitoring well OWDFMW01. Acetone was also detected at an estimated concentration in the trip blank sample in October 2010. Acetone was not detected in the subsequent four monitoring events. This strongly suggests that acetone was introduced to the samples during transport to and from the laboratory. The October 2010 detection of acetone is not representative of groundwater at OWDFMW01.

The October 2010 detections of lead at concentrations below the DOH Drinking Water EAL were the first at these two monitoring wells (OWDFMW01 and HDMW2253-03). Lead was not detected in any samples during the January 2011 monitoring event or during the April 2011 monitoring event. Lead was detected at estimated concentrations below the DOH Drinking Water EAL at both monitoring wells during the July 2011 monitoring event. Lead was detected in monitoring well HDMW2253-03 at a concentration below the DOH Drinking Water EAL and in monitoring well OWDFMW01 at an estimated concentration below the DOH Drinking Water EAL during this October 2011 monitoring event.

The January 2011 detection of benzene at an estimated concentration below the DOH Drinking Water EAL in monitoring well OWDFMW01 was the first at this monitoring well. Benzene was again detected only in the duplicate sample from OWDFMW01 at an estimated concentration below the DOH Drinking Water EAL during the April 2011 monitoring event. Benzene was not detected in monitoring well OWDFMW01 in the July 2011 monitoring event and during this October 2011 monitoring event.

The April 2011 detections of xylenes and toluene in OWDFMW01 and benzene in HDMW2253-03 at estimated concentrations below the DOH Drinking Water EALs were the first at these monitoring wells. Xylenes, toluene and benzene were non-detect in both monitoring wells OWDFMW01 and HDMW2253-03 in the July 2011 monitoring event. Benzene was detected at an estimated concentration below the DOH Drinking Water EAL in HDMW2253-03 during this October 2011 monitoring event.

MADEP EPH analytical results for TPH-DRO typically have the majority of the hydrocarbons in the C_{10}-C_{20} range. Current analytical results have the majority of the hydrocarbons toward the higher carbon range (C_{19}-C_{36}) which indicate that the detected hydrocarbons are most likely from non-petroleum sources.

4.3 Recommendations

All COPC concentrations have been below the EALs for five and seven consecutive quarterly monitoring events for samples collected at monitoring wells OWDFMW01 and HDMW2253-03, respectively. Reduced frequency of sampling from quarterly to annual groundwater monitoring of both monitoring wells is recommended.

Section 5 References

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Environet, 2010. *Work Plan, Long-Term Monitoring, Red Hill Bulk Fuel Storage Facility, Pearl Harbor, O‘ahu, Hawai‘i*. September.

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Appendix A
DOH Correspondence

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. Box 3378
HONOLULU, HAWAII 96801-3378

In reply, please refer to:
File:

December 8, 2010

U1217RT

Ms. Raelynn Della Sala
Navy Region Hawaii
850 Ticonderoga Street, Suite 110
Pearl Harbor, Hawaii 96860-5101

Dear Ms. Della Sala:

SUBJECT: Red Hill Tank Complex
Facility ID 9-102271 / Release IDs 990051, 010011, 020028

The Department of Health (DOH) has reviewed the following reports:

1. *Quarterly Groundwater Monitoring Report Red Hill Fuel Storage Facility,* dated May 2008 and prepared by TEC, Inc.

2. *Quarterly Groundwater Monitoring Report Red Hill Fuel Storage Facility,* dated February 2009 and prepared by TEC, Inc.

3. *Quarterly Groundwater Monitoring Report Red Hill Fuel Storage Facility*, dated April 2009 and prepared by TEC, Inc.

4. *Quarterly Groundwater Monitoring Report Red Hill Fuel Storage Facility*, dated July 2009 and prepared by TEC, Inc.

5. *Quarterly Groundwater Monitoring Report Red Hill Fuel Storage Facility,* dated September 2009 and prepared by TEC, Inc.

6. *Quarterly Groundwater Monitoring Report – Outside (Non-Tunnel) Wells*, dated September 2009 and prepared by TEC, Inc.

7. *API 653 Inspection and Repair Records for Red Hill Tank 15*, dated December 7, 2009 and prepared by Dunkin & Bush, Inc.

8. *Quarterly Groundwater Monitoring Report – Outside (Non-Tunnel) Wells*, dated December 2009 and prepared by TEC, Inc.

9. *Quarterly Groundwater Monitoring Report Red Hill Fuel Storage Facility*, dated December 2009 and prepared by TEC, Inc.

10. *Quarterly Groundwater Monitoring Report Red Hill Fuel Storage Facility*, dated April 2010 and prepared by TEC, Inc.

11. *Quarterly Groundwater Monitoring Report – Outside (Non-Tunnel) Wells*, dated April 2010 and prepared by TEC, Inc.

12. *Quarterly Groundwater Monitoring Report Red Hill Fuel Storage Facility*, dated May 2010 and prepared by TEC, Inc.

13. *Quarterly Groundwater Monitoring Report – Outside (Non-Tunnel) Wells*, dated May 2010 and prepared by TEC, Inc.

14. *Type 1 Letter Report – Re-evaluation of the Tier 3 Risk Assessment/Groundwater Model & Proposed Course of Action Red Hill Bulk Fuels Storage Facility*, dated May 4, 2010 and prepared Tec, Inc.

15. *Quarterly Groundwater Monitoring Report Red Hill Fuel Storage Facility*, dated August 2010 and prepared by TEC, Inc.

16. *Quarterly Groundwater Monitoring Report – Outside (Non-Tunnel) Wells*, dated August 2010 and prepared by TEC, Inc.

17. *Work Plan, Long-Term Monitoring*, dated September 2010 and prepared by Naval Facilities Engineering Command.

Please note the reports have been placed with the public record.

Since 2009, groundwater samples from monitoring wells within and outside the Red Hill Tank Complex have revealed low levels of Total Petroleum Hydrocarbons – Gasoline Range Organics (TPH-GRO), Total Petroleum Hydrocarbons – Diesel Range Organics (TPH-DRO), naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene. The DOH Hazard Evaluation and Emergency Response (HEER) Office Environmental Action Levels (EALs) are being used at this site, as well as Site Specific Risk Based Levels (SSRBLs) for TPH-DRO.

In addition to TPH-GRO and TPH-DRO, the groundwater samples are analyzed for 18 poly-aromatic hydrocarbon (PAH) compounds, and approximately 40 volatile organic compounds (VOCs), and dissolved Lead. The five specific contaminants mentioned in the previous paragraph were the only compounds detected in these wells during 2009-2010. All others were non-detectable at minimum detection limits below HEER action levels. Due to the nature of the aquifer beneath the site as a current source of drinking water, as well as the

Navy's Drinking Water Pump Station nearby, the most stringent drinking water action levels are employed, the majority in the parts per billion range.

TPH-DRO, naphthalene, and 1-methylnaphthalene continue to be found in monitoring wells RHMW01, RHMW02, and RHMW02D. The July 2010 monitoring event revealed TPH-DRO from 228 to 3,110 parts per billion (ppb) vs. the HEER EAL of 210 ppb and SSRBL of 4,500 ppb. 1-methylnaphthalene was found at 7.05 to 7.43 ppb vs. the HEER EAL of 4.7 ppb. Naphthalene was found at 59 to 61 ppb by Method 8270C and 102 to 107 ppb by Method 8260B vs. the HEER EAL of 17 ppb. Water collected at the Navy's Drinking Water Pump Station was non-detectable for all contaminants above minimum detection limits.

In the wells outside the complex, naphthalene was detected for the first time in monitoring well HDMW2253-03 North of the Red Hill Complex in July 2010 at a concentration of 0.0596 ppb vs. the HEER EAL of 17 ppb. TPH-DRO was detected in this well in January 2010 at 322 ppb vs. the HEER EAL of 210 ppb and SSRBL of 4,500 ppb. TPH-DRO was found at 1,490 ppb vs. the HEER EAL of 210 ppb and SSRBL of 4,500 ppb in monitoring well OWDFMW2 that lies west of the Navy Drinking Water Pump Station.

The DOH concurs that monthly free product checks and soil vapor monitoring should continue as well as quarterly groundwater monitoring of the wells within the complex. It was stated that funding for sampling the wells outside the complex had been completed. The DOH concurs that consideration should be given for periodic sampling of these wells.

Regarding the Type 1 Letter Report, the DOH does not object to additional monitoring wells in the North-West direction. The DOH also concurs with utilizing the MADEP EPH VPH analyses with the current 8260B and 8270C analyses to more accurately determine if the TPH-DRO found is fuel based or from non-petroleum sources.

If you have any questions regarding this letter, please contact Mr. Richard Takaba of our Underground Storage Tank Section at (808) 586-4226.

Sincerely,

STEVEN Y.K. CHANG, P.E., CHIEF
Solid and Hazardous Waste Branch

c: Roger Brewer, DOH-HEER Office
✓Darren Uchima, Navy Region Hawaii
Glenn Yoshinaga, NAVFAC Pacific, Pearl Harbor
Jeff Hart, TEC, Inc., Honolulu

Appendix B
Field Notebook

10/26/2011

Activity: GW Sampling outside wells
Personnel: SK + SF
PPE Level D
0800 Met at Dole office
0820 Stopped by Storage to pick up supplies
0830 Bought ice.
0900 Arrived + checked in at prison gate.
0917 SK conducted Health + Safety meeting.
0925 Calibrate PID + Horiba.
0957 PID reading 0.0 ppm
207.73 at 9:22 dtw.
1043 Sampled after purging well.
1200 Mobilized to shade ~~to~~ fill out labels and pack samples
1337 Took Lunch break.
Mobilized to OW well.
1420 Begin purging @ RH-OW-FXAW01
~~1445 collect~~
DTW = 122.60 ft after purging
1445 collect sample E-055 + dup E-056

10/27/2011

Task: Soil Vapor Monitoring
Personnel: V. Dupra + C. Asselbaye
PPE: Hard Hat, safety vest, safety glasses, gloves, steel toe shoes
0930: SV02
0945: Completed measurements @ SV02
0946: Started purging @ SV03
0959: Completed measurements @ SV03
1000: Start purging @ SV04
1012: Completed measurements @ SV04
1014: Start purging @ SV06
1022: Completed measurements @ SV06
1024: Start purging @ SV07
1036: Completed measurement @ SV07
1037: Start purging @ SV08
1048: Completed measurement @ SV08
1055: Start purging @ SV09
1108 Completed measurement @

Appendix C
Groundwater Sampling Logs

GROUNDWATER SAMPLING LOG

WELL ID: OWDFMW01 LOCATION: Red Hill Bulk Fuel Storage Facility PROJECT NO: 1022-024

INITIAL WATER LEVEL: 120.12 feet bTOC

DATE: 10/26/2011 TIME: 1407

TOTAL DEPTH OF WELL: 142.8 feet bTOC

PERSONNEL INVOLVED: SF, SK

LENGTH OF SATURATED ZONE: 22.68 feet

WEATHER CONDITIONS: Sunny w/ wind

VOLUME OF WATER TO BE REMOVED: N/A

METHOD OF REMOVAL: 4" bailer

WATER LEVEL AFTER PURGING: 122.60 feet bTOC

PUMPING RATE: N/A

WELL PURGE DATA:

TIME	VOLUME REMOVED	pH	COND (S/m)	TURBIDITY (NTU)	DO (mg/l)	TEMP (^{o}C)	SALINITY (%)	REDOX (ORP) (mV)
1423	3 L	11.13	3.10	30.0	7.99	26.06	1.6	-59
1426	6 L	11.20	3.16	28.8	5.63	24.79	1.6	-61
1436	9 L	11.19	3.16	37.0	5.08	24.63	1.6	-49
1439	12 L	11.19	3.20	28.1	4.95	24.18	1.7	-49
1441	14L	11.16	3.20	37.5	6.61	24.00	1.7	-45

SAMPLE RETRIEVAL METHOD: 4" bailer, 2" bailer

SAMPLE ID: ES055

SAMPLE COLLECTION TIME: 1445

SAMPLED BY: SF, SK

APPEARANCE OF SAMPLE:

COLOR none

TURBIDITY none

SEDIMENT none

OTHER none

COMMENTS AND OBSERVATIONS: PID = 0.3 ppm

Collected Duplicate ES056

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES: TPH-GRO (EPA 8260B) & VOCs (EPA 8260B) with no preservative

TPH-DRO (EPA8015B) & PAHs (EPA 8270C SIM) with no preservative, and dissolved lead (EPA 6020) with nitric acid preservative, MADEP (VPH and EPH) with hydrocloric acid preservative

NUMBER AND TYPES OF SAMPLE CONTAINERS FILLED: Primary: (7) - 40 mL VOAs, (5) - 1 L amber bottle, (1) - 500 mL polyethylene bottle,

Duplicate: (7) - 40 mL VOAs, (5) - 1 L amber bottle, (1) - 500 mL polyethylene bottle, and MS/MSD: (21) - mL VOAs, (15) - 1 L amber bottle, (3) - 500 mL polyethylene bottle

DECONTAMINATION PROCEDURES: Alconox, triple rinse with distilled water

SAMPLES DELIVERED TO: APPL, Inc.

TRANSPORTERS: JT

SAMPLE DELIVERY DATE: 10/27/2011

SAMPLE DELIVERY TIME: 1400

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16; 4"-0.65; 6"-1.47; 8"-2.61; 10"-4.08; 12"-5.87

GROUNDWATER SAMPLING LOG

WELL ID: HDMW2253-03 LOCATION: Red Hill Bulk Fuel Storage Facility PROJECT NO: 1022-024

INITIAL WATER LEVEL: 20 7.73 feet bTOC DATE: 10/26/2011 TIME: 0957

TOTAL DEPTH OF WELL: 1,575 feet bTOC PERSONNEL INVOLVED: SF, SK

LENGTH OF SATURATED ZONE: N/A WEATHER CONDITIONS: Sunny

VOLUME OF WATER TO BE REMOVED: N/A METHOD OF REMOVAL: 4" bailer

WATER LEVEL AFTER PURGING: N/A PUMPING RATE: N/A

WELL PURGE DATA:

TIME	VOLUME REMOVED	pH	COND (mS/cm)	TURBIDITY (NTU)	DO (mg/l)	TEMP (^{o}C)	SALINITY (ppt)	REDOX (ORP) (mV)
1015	3 L	6.21	0.411	36.9	10.40	24.81	0.2	-28
1020	7 L	6.96	0.444	44.1	1.77	23.34	0.2	-29
1027	11 L	6.95	0.439	42.2	3.29	22.77	0.2	-151
1034	15 L	6.92	0.435	55.4	4.00	22.62	0.2	-158

SAMPLE RETRIEVAL METHOD: 4" bailer

APPEARANCE OF SAMPLE:
COLOR Gray
TURBIDITY None
SEDIMENT Lots of suspended sediment
OTHER None

SAMPLE ID: ES053
SAMPLE COLLECTION TIME: 1043
SAMPLED BY: SF, SK

COMMENTS AND OBSERVATIONS: PID = 0.0 ppm

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES: TPH-GRO (EPA 8260B) & VOCs (EPA 8260B) with no preservative
TPH-DRO (EPA8015B) & PAHs (EPA 8270C SIM) with no preservative, and dissolved lead (EPA 6020) with nitric acid preservative, MADEP (VPH and EPH) with hydrocloric acid

NUMBER AND TYPES OF SAMPLE CONTAINERS FILLED: (7) - 40 mL VOAs, (5) - 1 L amber bottle, (1) - 500 mL polyethylene bottle

DECONTAMINATION PROCEDURES: Alconox, triple rinse with distilled water
SAMPLES DELIVERED TO: APPL, Inc. TRANSPORTERS: JT
SAMPLE DELIVERY DATE: 10/27/2011 SAMPLE DELIVERY TIME: 1400

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16; 4"-0.65; 6"-1.47; 8"-2.61; 10"-4.08; 12"-5.87

Appendix D
Laboratory Analytical Results, October 2011 (on CD-ROM)