REVISIONS TO THE RED HILL GROUNDWATER PROTECTION PLAN

Date: December 2009
Document Title: Red Hill Bulk Fuel Storage Facility Final Groundwater Protection Plan, Pearl Harbor, Hawaii of January 2008

No.	Page	Section	Revision	Comment
1.	ES-2	Executive Summary	Paragraph 4, Line 10 – Delete "These data will also be provided to the HDOH quarterly."	Soil vapor monitoring points were installed under each of the 18 active USTs. Samples have been collected monthly, but results have been inconclusive. No trends in soil vapor concentrations have been observed. The HDOH UST Case Officer, Mr. Rich Takaba, concurred with the Navy's recommendation to exclude soil vapor monitoring results from the quarterly reports
2.	ES-3	Executive Summary	Paragraph 2, Line 2 – Revise "The U.S. Navy will provide the results of the API inspections and maintenance reports to the HDOH with the quarterly reports associated with groundwater and soil vapor monitoring." to "The U.S. Navy will provide the API inspection and maintenance reports to the HDOH upon completion."	The API inspection and maintenance reports will be submitted to the HDOH under separate cover from the quarterly groundwater monitoring reports upon request
3.	1-14	Figure 1-4	Added the location of RHMW05	An additional groundwater monitoring well, RHMW05, was installed between RHMW01 and US Navy Well 2254-01 in July 2009.
4.	3-8	3 3.1.1	Delete Bullet 2 – "Results from any soil vapor testing that is conducted."	Same as Comment 1
5.	3-8	3.3.1.1	Delete Bullet 5 – "Modified API 653 Inspection and Repair scheduling and reports."	Same as Comment 2. In addition, the HDOH UST Case Officer concurred that the inclusion of the inspection and repair schedule in the quarterly monitoring report is not necessary
6.	3-9	Table 3-1	The table of Tank Inspections and Scheduling has been updated to reflect completed inspections and revised schedule.	
7.	4-5	Table 4-2	- U.S Navy Pumping Well 2254-01, Results Category 1 – Delete "P" - Specific Response J – Revise to "Immediately evaluate tanks for leaks" - Revise column header to "RHMW02, RHMW03, or RHMW05"	- There is no Specific Response "P" - Tank inventories will be checked for any unexplained decreases in fuel volume. Manual tank gauging will be performed in the area of concern. Soil vapor monitoring data will be re-evaluated in the area of concern - An additional groundwater monitoring well, RHMW05, was installed between RHMW01 and US Navy Well 2254-01 in July 2009.

Enclosure (1)

EXECUTIVE SUMMARY

This Groundwater Protection Plan was developed to mitigate the risk associated with inadvertent releases of fuel from the United States (U.S.) Navy Red Hill Bulk Fuel Storage Facility, Oahu, Hawaii (the Facility). Previous environmental Site Investigations (SIs) at the Facility showed that past inadvertent releases have contaminated the fractured basalt, basal groundwater, and soil vapor beneath the Facility with petroleum hydrocarbons. In response to these findings, the State of Hawaii Department of Health (HDOH) requested that the U.S. Navy:

- Conduct a detailed environmental SI at the Facility;
- Develop a groundwater model of the surrounding aquifers to evaluate the risk associated with petroleum releases to the groundwater; and
- Prepare a contingency plan to protect the U.S. Navy well 2254-01, which lies down gradient from the Facility and provides drinking water to the U.S. Navy Pearl Harbor Water System (PHWS).

The Facility consists of 20 underground storage tanks (USTs), each with the capacity to hold 12.5 million gallons (Mgal) of petroleum-based fuel as a reserve for the U.S. Navy Pacific Fleet. It was constructed in the field, entirely underground within the Red Hill Ridge for security and confidentiality reasons and was activated in 1943 to maintain the war effort. At the same time, the U.S. Navy well 2254-01 was installed approximately 3,000 feet downgradient from the Facility, and included a water tunnel, known as an infiltration gallery, which extends across the water table to within 1,560 feet of the Facility. The U.S. Navy well 2254-01 currently provides approximately 24 percent of the potable water to the PHWS, which serves approximately 52,200 military consumers. Model simulations of the measured contaminant concentrations beneath the Facility did not show contaminants entering the infiltration gallery at measurable concentrations. However, similar simulations showed hypothetical future releases of the jet propellant (JP-5 and JP-8) most commonly stored in the Facility USTs had the potential to contaminate the water that enters the infiltration gallery, if they are not identified quickly. In addition, the SI concluded that the aging of the Facility will increase the possibility that such a release could occur as a result of leaks breaching both the steel liners and concrete containment of the tanks. While the tank steel liners have been repaired, the concrete containment cannot be maintained.

Both the Facility and the U.S. Navy well 2254-01 are critical to the mission of the U.S. Navy in the Pacific and there are no alternative facilities to replace them. This Groundwater Protection Plan presents a strategy for ensuring that both the Facility and the U.S. Navy well 2254-01 can continue to operate at optimum efficiency into the future. This Groundwater Protection Plan focuses on long-term mitigation. It is not an emergency response plan.

The Facility USTs are deferred from many of the Federal and State UST regulations, including the requirement for release detection, because they are field constructed bulk fuel tanks. However, following the notification of releases from the Facility, HDOH strongly recommended

the installation of a leak detection system to protect U.S. Navy well 2254-01. Due to the importance of the groundwater resource, the U.S. Navy has evaluated methods to detect leaks at the Facility in the past and continues to do so. A final recommendation is expected in FY2008.

In addition, the U.S. Navy has installed three groundwater monitoring wells within the lower access tunnel of the Facility and conducted a soil vapor monitoring pilot study under seven of the 18 active USTs. In accordance with this Groundwater Protection Plan, the U.S. Navy has implemented a groundwater monitoring program in which groundwater samples are collected quarterly from three groundwater monitoring wells installed in the Facility lower access tunnel and the U.S. Navy well 2254-01. Samples are analyzed for specific petroleum compounds and mixtures in accordance with the HDOH EALs (HDOH, 2005). The U.S. Navy will:

- Maintain a complete database of chemical results from the groundwater sampling events;
- Evaluate concentration trends for chemicals of concern over time, evaluate chemical concentrations with respect to HDOH drinking water EALs;
- Monitor the groundwater for concentrations that may indicate that liquid fuel may be in direct contact with groundwater beneath the tanks; and
- Submit concentration trend data and comparisons of sampling results to drinking water EALs to HDOH quarterly.

In groundwater model simulations, an extended light non-aqueous-phase liquid (LNAPL) fuel plume of jet propellant (JP-5 or JP-8) within 1,099 feet of the U.S. Navy well 2254-01 infiltration gallery resulted in benzene concentrations greater than the Federal maximum contaminant level (MCL) of 5 μg/L in the infiltration gallery. It was estimated that a release as small as 16,000 gallons of JP-5 near Tanks 1 or 2 could result in this condition. The groundwater monitoring program provides Site-Specific, Risk-Based Levels (SSRBLs) for total petroleum hydrocarbons (4.5 mg/L) and benzene (0.75 mg/L). These are used as indicators that LNAPL is present. In addition, this Groundwater Protection Plan provides a table of recommended responses to contaminant levels and trends in each of the four wells that are sampled quarterly.

In accordance with this Groundwater Protection Plan, the U.S. Navy will implement a soil vapor monitoring program using the existing boreholes beneath each of the active tanks in the Facility to support leak detection and the groundwater monitoring program. Soil vapor monitoring beneath each tank can provide quick confirmation of potential leaks identified by the automatic system. This will potentially limit the size of a hypothetical fuel release, by shortening the confirmation and response time. Soil vapor will be analyzed for total volatile hydrocarbons (TVH) with calibrated field instruments, and data will be evaluated for changes in concentration which would indicate a release of fuel from the associated tank. Along with confirmation sampling at suspected leaking tanks on an as needed basis, the U.S. Navy will collect soil vapor samples from slant borings beneath each tank quarterly. The U.S. Navy will maintain a complete database of SVMP results to evaluate trends.

The U.S. Navy will continue to conduct a rigorous maintenance schedule for all USTs in the Facility in accordance with the modified American Petroleum Institute (API) 653. The U.S. Navy will provide the results of the API inspections and maintenance reports to HDOH upon request.

Finally, the Groundwater Protection Plan provides an overview of actions that would be required to remediate the basal drinking water aquifer if a large release of fuel were to migrate to the water table. Well head treatment facilities at the U.S. Navy well 2254-01 may be required to ensure that adequate water is available to meet the U.S. Navy mission at Pearl Harbor. The U.S. Navy estimated $28,300,000 would be required for a granular activated carbon water purification plant for the U.S. Navy Waiawa well shaft. This system was proposed to remove low levels of agri-chemicals for a system with a maximum pumping capacity of 18 million gallons per day (mgd), and included a testing laboratory (see Appendix E). The U.S. Army estimated costs for an air stripping water purification facility in Schofield Barracks to remove low levels of trichloroethylene for a system with a maximum capacity of 4.3 mgd including capital costs and operations for 30 years at $3,990,000 (see Appendix E).

Under site conditions, remediation of a large fuel release would be extremely costly and technically difficult, due to the underground nature of the Facility, the steep ridgeline upon which the Facility in located, the distance from ground surface to the aquifer (between 400 and 500 feet on the Red Hill ridgeline), and finally because of the complex hydrogeology associated with the fractured basalt aquifers. Pump and treat methods could be implemented but would be costly and inefficient in this environment. Multi-phased extraction may be more efficient, but very complex at the depths required.

Downgradient enhanced bioremediation was considered through the addition of dissolved oxygen to the groundwater. An array of wells between the Facility and the potable water infiltration gallery would be required as oxygen distribution points to create a reactive permeable barrier to the transmission of dissolved petroleum compounds. Air sparging, while economical, is inefficient in saturating the groundwater to enhance bioremediation. Oxygen release compounds or gas infusion technology could be considered to increase the efficiency of the barrier by increasing the dissolved oxygen content of the groundwater and the radius of influence.

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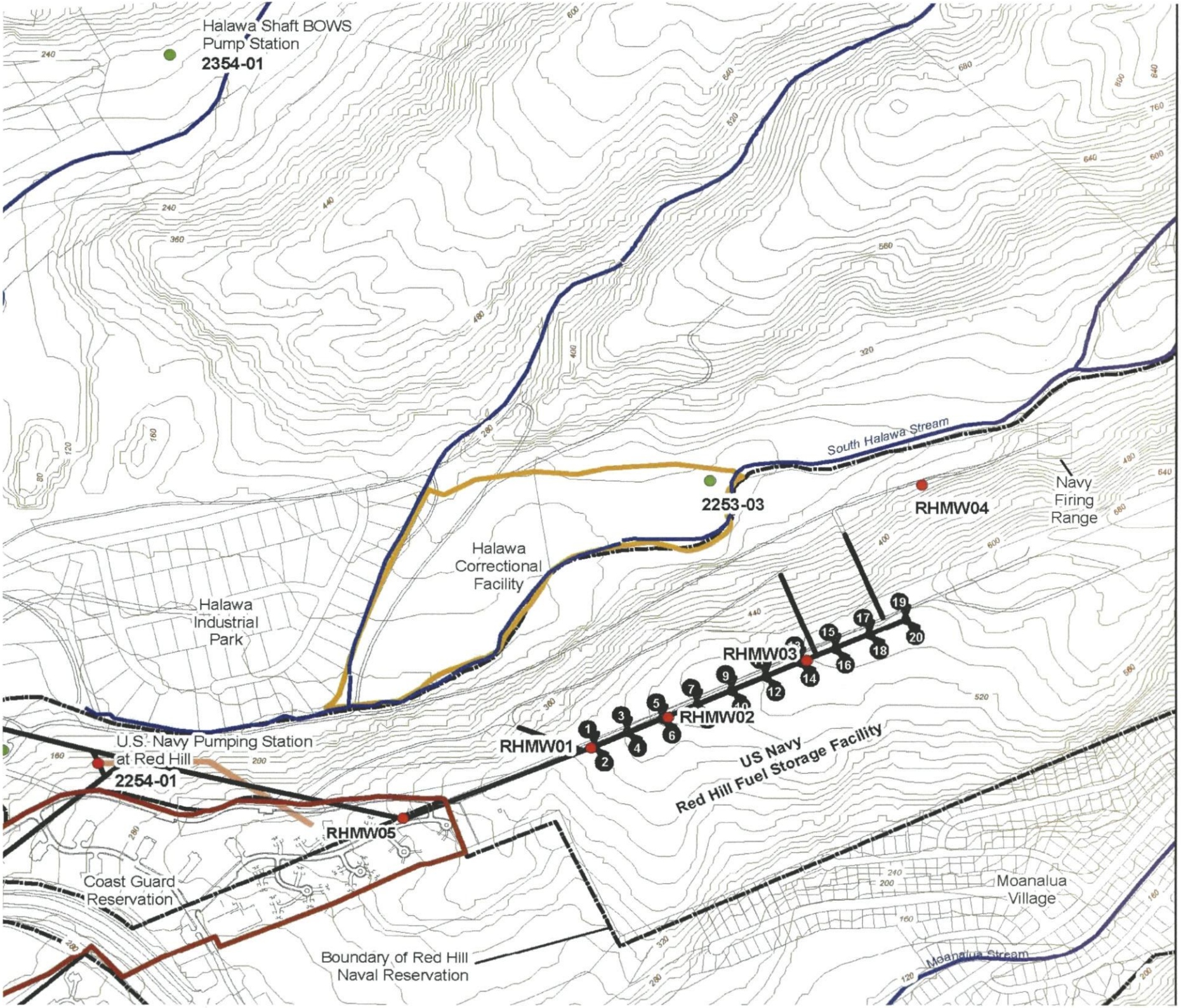
Halawa Shaft BOWS
Pump Station
2354-01
South Halawa Stream
2253-03
RHMW04
Navy
Firing
Range
Halawa
Correctional
Facility
Halawa
Industrial
Park
RHMW03
RHMW02
RHMW01
US Navy
Red Hill Fuel Storage Facility
U.S. Navy Pumping Station
at Red Hill
2254-01
RHMW05
Coast Guard
Reservation
Moanalua
Village
Boundary of Red Hill
Naval Reservation
Moanalua Stream

3.2.2 Groundwater Monitoring at the Facility

Although a groundwater monitoring program is currently in place at the Facility, this program is not a viable leak detection method, since leaks can occur that are not observed at the monitoring wells. Its purpose is to evaluate groundwater quality under the Facility to determine whether contamination presents a risk to consumers of the water within the Red Hill sub-basin. In addition, the groundwater monitoring program will also provide "triggers" to the groundwater protection responses presented in Table 4-2. Petroleum in groundwater from each well can be inferred to have come from upgradient sections of the Facility; however, the objective of the leak detection program is to verify and correct any leakage before the drinking water resource is impacted in order to minimize the chance that the responses presented in Table 4-2 are required.

In the current configuration, three groundwater monitoring wells are in place within the lower access tunnel of the Facility.

- RHMW01 is at the southwest edge of the Facility, between Tank 1 and the U.S. Navy well 2254-01. RHMW01 is considered to be hydraulically downgradient from the USTs and is the last sentry well before the U.S. Navy well 2254-01 infiltration gallery. RHMW01 will be the first point of detection for releases from Tanks 1 through 6.
- RHMW02 is upgradient of Tank 6, approximately 600 feet upgradient of RHMW01. It will be the first point of detection for Tanks 7 through 14.
- RHMW03 is upgradient of Tank 14, approximately 800 feet upgradient from RHMW02 and 600 feet downgradient from Tanks 19 and 20. It is the first point of detection for Tanks 15 through 20.

The current groundwater monitoring program consists of quarterly sampling events, and results generally take two to three weeks from the time of sample collection. While this is a very important part of the confirmation process, it does not provide timely information required for protection of the groundwater resource. A detailed groundwater monitoring program has been developed for the Facility. This program is described in Section 4 of this report and in Appendix C (Groundwater Monitoring Field Sampling and Analysis Plan).

3.3 Ongoing Groundwater Protection Activities

1. Continue to conduct modified API 653 tank inspections and repairs for USTs (see proposed schedule in Table 3-1). This process is an extension of previous tank inspection and repair procedures that have been conducted to date. Tanks will continue to be inspected periodically at time intervals based on the results of the latest inspection (no greater than 20 years).
2. Expand vapor monitoring program to all active Red Hill tanks. Currently seven active tanks are fitted with SVMPs. Install SVMPs in existing borings in the eleven remaining tanks as part of the overall fuel management program. The estimated cost to equip each tank with SVMPs is approximately $15,000, for a total cost of $165,000. An additional

$10,000 is estimated for field instrumentation for real-time measurement of fuel vapors. Coordinate vapor monitoring of Tanks to same quarterly cycle as the well water monitoring cycle. An estimate of the cost to sample and assess a complete round of SVMPs from 18 tanks is approximately $3,000. Integrate vapor monitoring into TIMP.

3. Continue quarterly groundwater monitoring of three wells within the Facility and the U.S. Navy well 2254-01 as required by the HDOH Release Response Requirements. The annual cost for the groundwater monitoring is approximately $40,000.
4. Implement a market survey to evaluate best available technologies for leak detection on large field constructed bulk fuel storage facilities, such as the Facility. This will be a multi-phased project involving both identification of available technologies and pilot testing of potential candidate technologies. The initial step will consist of traditional research (internet, vendor specifications/literature, previous research studies, third party certification evaluations, etc.) to identify potential technologies. The study will evaluate systems based on applicability to the following Red Hill parameters:
    - Proposed system leak detection sensitivity;
    - Operational challenges; Relative costs; and
    - Third party certifications.
5. Implement pilot studies of technologies that show promise on one or more of the tanks at Red Hill. Pilot testing will be done to evaluate the challenges associated with testing these tanks as well as the results versus cost to implement.

3.3.1.1 Reporting Tank Inspections, Leaks, and Releases to HDOH

Quarterly reports will continue to be provided to HDOH. These reports will contain the following:

1. Monitoring results from quarterly groundwater sampling.
2. Progress in developing a leak detection system for tank fluids and results from leak detection testing after the method is certified and accepted by FISC.
3. Any other information regarding leaks or groundwater contamination.
4. Notification that tanks were taken out-of-service (HDOH Form 1).

Table 3-1. Tank Inspections and Scheduling

Tank #	Prior Years	FY06	FY07	FY08	FY09	FY10	FY11
1		RFS					
2					Completed		
3							
4							Scheduled
5						Ongoing	
6			Completed				
7	Completed FY98						
8	Completed FY98						
9	Completed FY95						
10	Completed FY98						
11							
12							
13							
14							
15		Completed					
16		Completed					
17						Ongoing	
18							
19			RFS				
20						Completed	

RFS – Removed from Service (HDOH Form 1 submitted)
Schedule may be changed based on the needs of the U.S. Navy

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Table 4-2. Responses to Groundwater Monitoring Results

Results Category	RHMW02, RHMW03, or RHMW05	RHMW01	U.S. 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 measured or 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

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 (see Appendix C), measure product in pertinent wells with interface probe, re-install pumps if product is not detected.
J. Immediately evaluate tanks for leaks
K. Collect samples from nearby Halawa Deep Monitoring Well (2253-03) and OWDF MW01
For permission to sample 2253-03, call DLNR Commission on Water Resource Management (808) 587-0214, DLNR.CWRM@Hawaii.gov
L. Provide alternative water source at 2254-01
M. Prepare for alternative water source at U.S. 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

If an anomalous result is suspected, the Navy may immediately resample a well or may have results validated by a third party before these results are accepted. These will be completed within 30 days from receipt of the original result.

4.4 Responsibilities

Navy Region Hawaii, Regional Environmental Department has the ultimate responsibility for implementation of this plan, including reporting to HDOH. Other responsibilities are shown in Table 4-3.