Preliminary Work Plan
Red Hill Fuel Storage Facility

Pearl Harbor, Oahu, Hawaii
Latitude: 21°22’15” N
Longitude: 157°53’33” W

DOH Facility ID No. 9-102271
DOH Release ID No. 140010

March 2014

Prepared for:

Naval Supply Systems Command
Fleet Logistics Center Pearl Harbor
1942 Gaffney Street, Suite 100
JBPHH, Hawaii 96860-4549

Table of Contents

Executive Summary

Naval Facilities Engineering Command, Hawaii (NAVFAC Hawaii) prepared this preliminary Work Plan in response to the State of Hawaii Department of Health (DOH) release response letters dated February 12, 2014 and February 26, 2014 for the Red Hill Fuel Storage Facility. The objective of this Work Plan is to address the three elements described in the initial February 12, 2014 letter and reiterated in the February 26, 2014 letter.

The Facility is located in the south-central portion of the Island of Oahu, Hawaii, in Halawa Heights. There are 18 active and 2 inactive, 12.5 million gallon, field-constructed underground storage tanks (USTs) located at the Red Hill Fuel Storage Facility. A confirmed release of Jet Propellant 8, also known as Jet Propulsion fuel, type 8 (JP-8) from Tank 5 was reported on January 24, 2014. Immediately following notification to the DOH, the Navy collected groundwater samples from monitoring wells to determine if the release had impacted groundwater beneath the Facility or the nearby water supply well. Results indicated no fresh fuel from Tank 5 in the groundwater or drinking water samples.

Summarized below is the Navy's response to the DOH request to provide a preliminary work plan that includes three elements:

1. *Models to estimate downward vertical migration of free product* – The Navy is in the process of hiring a qualified contractor with the expertise to perform this work.
2. *Methods or options for non-invasive scanning of basalt to determine area and volume of contaminant mass prior to any drilling investigation* – The Navy has queried the subject matter experts (SMEs) at Navy headquarters in Washington, D.C. to determine if there are other known locations where this technology has been used. The SMEs indicate that modeling to investigate vertical subsurface movement of pure petroleum liquid product has not been undertaken at other Navy sites with similar subsurface features due to the unusual nature of the subsurface.
3. *Methods and locations for borings to most efficiently characterize the extent of contamination* – The Navy is in the process of hiring a qualified contractor with the expertise to perform this work. Additionally, the Navy intends to evaluate various removal and remediation technologies that would be effective and feasible for future full-scale implementation.

The Navy has implemented a comprehensive drinking water and groundwater monitoring program to ensure the safety and viability of the drinking water aquifer beneath the facility. The monitoring program includes collecting groundwater samples quarterly from U.S. Navy well 2254-01 (RHMW2254-01) and three wells installed in the Facility lower access tunnel (RHMW01, RHMW02, RHMW05). The U.S. Navy well 2254-01 is located approximately 3,000 feet downgradient from the Red Hill Fuel Storage Facility and provides a percentage of the potable water to the Pearl Harbor Water System. The groundwater samples are analyzed for petroleum constituents and compared against DOH Drinking Water Environmental Action Levels (EALs) (DOH, 2005a).

Compliance sampling to date indicate that all Federal and State safe drinking water standards are attained.

The Navy is committed to providing safe drinking water to its users as well as ensuring the safety of the surrounding Pearl Harbor aquifer for all other users, while operating and maintaining the Red Hill Fuel Storage Facility. To accomplish this, the Navy will continue to provide weekly status reports to the DOH and will communicate all aspects of the investigation and remediation with the DOH.

1.0 Introduction

There are 18 active and 2 inactive, 12.5 million gallon, field-constructed underground storage tanks (USTs) located at the Red Hill Fuel Storage Facility (hereafter referred to as "the Facility"). The Facility is located at Joint Base Pearl Harbor-Hickam (JBPHH), Oahu, Hawaii. The Facility is operated by Naval Supply Systems Command (NAVSUP) Fleet Logistics Center Pearl Harbor (FLCPH).

As requested in DOH letter U0204RT of February 12, 2014, and DOH letter U0210RK of February 26, 2014, this preliminary Work Plan presents methods for achieving the requirements in Hawaii Administrative Rules (HAR) 11-281 Subchapter 7, Release Response Action. The release response actions are required in response to the confirmed release of Jet Propulsion fuel 8 (JP-8) from Tank 5. A copy of the DOH letter is presented as Appendix A.

The following are included in this preliminary Work Plan:

1. Models to estimate downward vertical migration of free product.
2. Methods or options for non-invasive scanning of basalt to determine area and volume of contaminant mass prior to any drilling investigation.
3. Methods and locations for borings to most efficiently characterize the extent of contamination.

1.1 Background

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

1.1.1 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). Figure 1 shows the Facility location.

The U.S. Navy Public Works Department operates a potable water supply shaft and associated pumping station, which, in spite of its largely lateral configuration is officially designated as "well 2254-01". The station consists of a water infiltration shaft that is approximately 1,300 feet long connected to a water supply pumping station located approximately 3,000 feet downgradient (west) of the Facility. The pumping station provides a percentage of the potable water to the Pearl Harbor Water System, which serves approximately 52,200 military consumers (TEC, 2008).

1.1.2 Facility Information

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

1.1.3 UST Information

The USTs were constructed in the early 1940s. The tanks were constructed of steel and are currently used to store Jet Propellant 5, also known as Jet Fuel (JP-5), Jet Propellant 8, also known as Jet Propulsion fuel, type 8 (JP-8), and Diesel Fuel Marine (DFM, or F-76). Previously, several tanks stored Navy Special Fuel Oil, Navy Distillate, aviation gasoline, and motor gasoline. Each tank measures approximately 250 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 Groundwater Monitoring Wells

Five groundwater monitoring wells were installed at the Facility: RHMW01, RHMW02, RHMW03, RHMW04, and RHMW05. The locations of the monitoring wells are shown on Figure 2. Boring logs and well construction logs are presented as Appendix B.

RHMW01: From 1998 to 2001, the Navy conducted an investigation at the Facility to assess potential releases from the fuel storage Facility. In February 2001, the Navy installed a one-inch diameter sentinel well (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. At the time of well completion, depth to water in MW-V1D was measured at 86 feet below grade (Dawson, 2006). Monitoring well MW-V1D was later renamed RHMW01.

RHMW02, RHMW03, RHMW04: As part of a site investigation, TEC, Inc. 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.

RHMW05: In April 2009, groundwater monitoring well RHMW05 was installed down-gradient from the Facility, within the lower access tunnel between RHMW01 and RHMW2254-01. The well was installed to identify contaminant migration before it reaches the infiltration gallery at RHMW2254-01.

2.0 Vertical Migration Models

At this time, it is unknown exactly where on Tank 5 the JP-8 release occurred and if or how much volume has migrated past the tank structure to the surrounding rock substrate. Since the monitoring wells located within the Facility were installed in the lower access tunnel, the boring logs for those monitoring wells provide geologic information for the subsurface located below the bottom of the USTs. To initiate the vertical modeling effort, the boring logs may be used to generalize the geology of the subsurface from the top of the ridge to the bottom of the USTs.

A survey of subject matter experts (SMEs) at Navy headquarters in Washington, D.C. indicate that modeling to investigate vertical subsurface movement of pure petroleum liquid product has

not been undertaken at other Navy sites with similar subsurface features due to the unusual nature of the subsurface: a combination of complex, alternating fractured and competent (i.e., "solid") basalt rock layers with occasional thin layers of ash and other less competent rock. However, the Navy has extended the search for appropriate transport models for this type of environment. The Navy has initiated the process to hire a contractor with demonstrated expertise and experience with non-Navy sites with similar subsurface conditions to identify any appropriate models to estimate downward vertical migration of free product.

3.0 Non-Invasive Scanning

A survey of Navy SMEs also indicate that there are no remote sensing (geophysical) applications for non-invasive scanning that can feasibly determine area and volume of contaminant mass in environments like the alternating competent/fractured basalt observed at the Facility. There is too much subsurface variability, complexity, and obstruction in the observed substrate for non-intrusive geophysical approaches such as seismic, ground penetrating radar (GPR), time-domain reflectometry (TDR), thermal, etc. to produce usable information.

In the absence of useful geophysical methods, the usual approach for differentiating/ delineating the extent of contaminant plumes for saturated and unsaturated is by way of intrusive methods. Research done to explore options for minimally intrusive methods for characterizing near surface contamination such as laser induced fluorescence (LIF) with a direct push rig is intended for consistent nonconsolidated (e.g., soil) substrate and is not suitable for the competent /fractured basalt substrate at the Facility.

Conversations within the Navy and with other agencies such as the United States Environmental Protection Agency (EPA) have indicated that the Facility is unique not only for the size of the features but also for the unusual nature and extreme complexity of the substrate. Therefore, the majority of conventional methods that would typically be appropriate for conventional-sized facilities with conventional conditions will either not be feasible or not yield usable information.

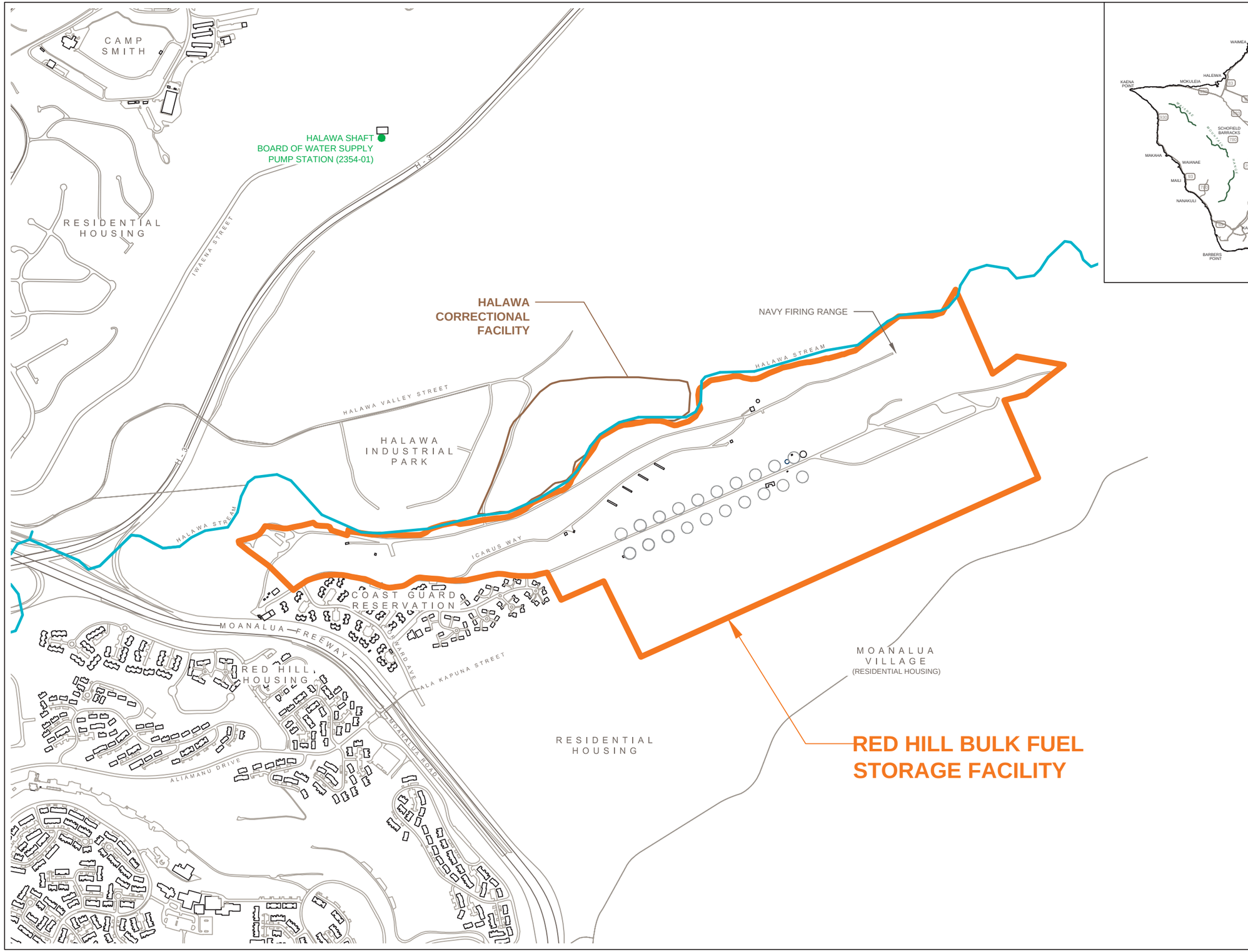
The only two methods available to determine approximate area and volume of contaminant mass are borings for intervals of less competent rock, and coring to penetrate more frequent competent and fractured rock intervals, combined with sampling, in-field screening, and laboratory analytical confirmation analyses. The limitations of these available methods are that they provide information to a limited extent and are also the most involved in terms of cost, level of effort, and logistics, particularly factoring in the relative immensity of the tank size and the substrate.

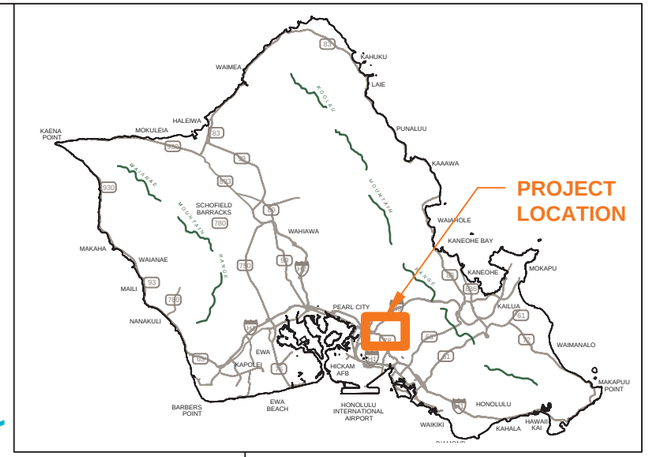
4.0 Methods and Locations for Borings

Because the feasible intrusive sampling characterization methods will yield information on a comparatively localized area, the Navy will try to direct the investigation to the most appropriate area that can be practicably identified. Planned inspection of the Tank 5 interior after draining and safety preparations have been completed pose the best possibility of identifying the most appropriate area to localize the location of the release. The tank inspection will commence after Tank 5 has been vented and deemed safe for entry.

While the tank is being vented, the Navy will hire a contractor to determine methods and locations for borings to most efficiently characterize the extent of contamination. Based on the tank inspection findings, the contractor will be expected to propose locations to determine if the fuel might be trapped in the interstitial space between the steel tank wall and the outer concrete wall, or if the fuel has migrated beneath the tank, and if so, to what depth.

The Navy intends to evaluate the performance of a pilot study to evaluate the effectiveness and feasibility of bioventing, soil vapor extraction, or other appropriate methods to reduce the volume of trapped product in-place, and if feasible, light non-aqueous phase liquid (LNAPL) removal from fractured basalt. Bioventing is being used at other Navy sites on Oahu with similar geology and is proven to be successful at reducing contaminant concentrations in both the vadose zone and groundwater.





NOTES

The accuracy of this document is limited to the quality and scale of the source information. This document is not a legal representation of an engineered survey.

SOURCES

Pearl Harbor Base Map

Navy GIS files

NORTH

GRAPHIC SCALE

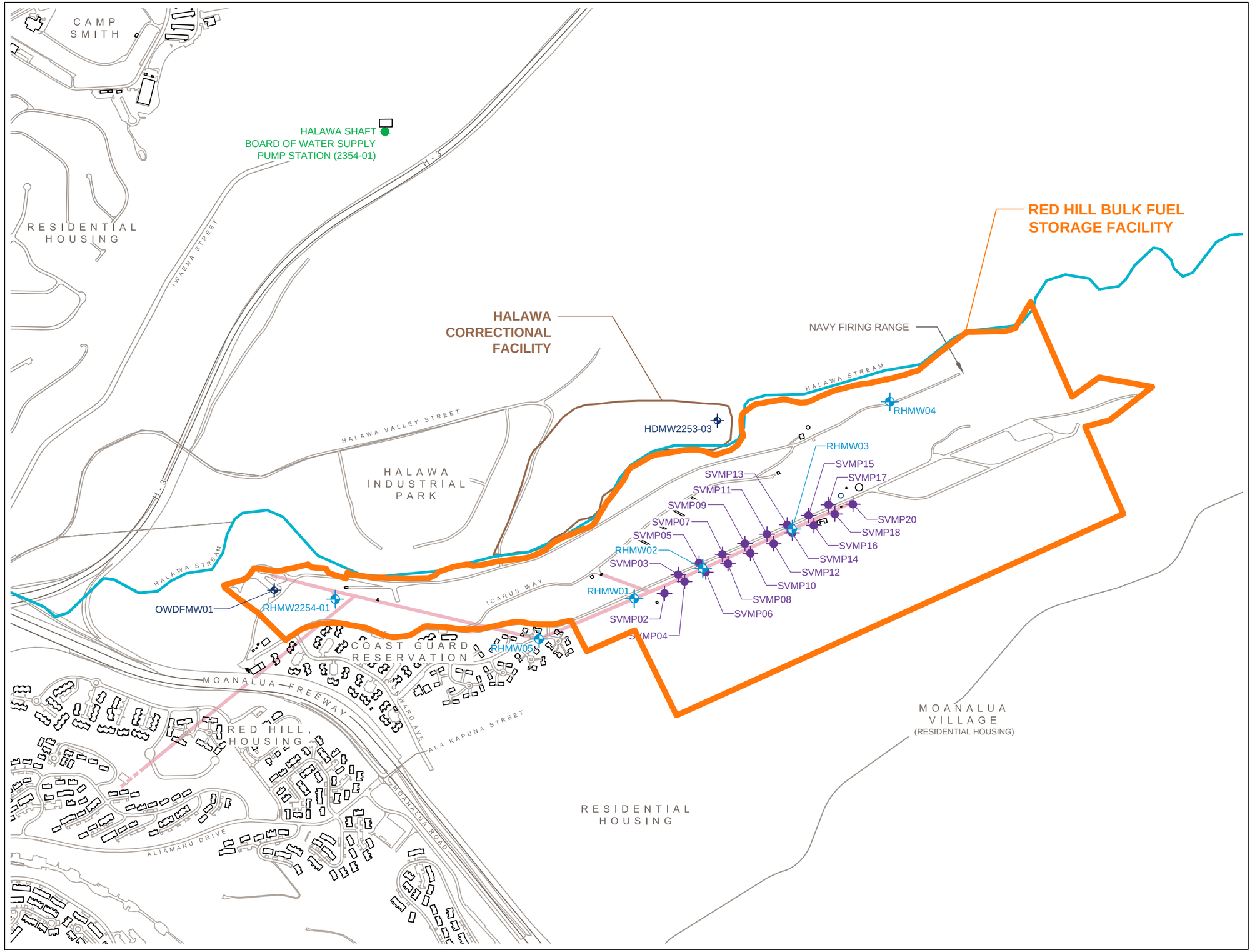
900 0 900

Scale in Feet

FIGURE 1

SITE LOCATION

GROUNDWATER MONITORING
RED HILL BULK FUEL STORAGE FACILITY
NAVAL SUPPLY SYSTEM COMMAND (NAVSUP)
FLEET LOGISTICS CENTER
JBPHH, OAHU, HAWAII



LEGEND

- RED HILL BULK FUEL STORAGE FACILITY
- HALAWA CORRECTIONAL FACILITY
- HALAWA STREAM
- BUILDING
- ROAD
- ABOVEGROUND STORAGE TANK
- WATER TANK
- SOIL VAPOR MONITORING POINT
- GROUNDWATER MONITORING WELL LOCATED INSIDE TUNNEL
- GROUNDWATER MONITORING WELL LOCATED OUTSIDE TUNNEL
- BOARD OF WATER SUPPLY PUMP STATION
- TUNNEL

NOTES

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SOURCES

Pearl Harbor Base Map

Navy GIS files

NORTH

GRAPHIC SCALE

800 0 800

Scale in Feet

FIGURE 2

SITE LAYOUT

GROUNDWATER MONITORING
RED HILL BULK FUEL STORAGE FACILITY
NAVAL SUPPLY SYSTEM COMMAND (NAVSUP)
FLEET LOGISTICS CENTER
JBPHH, OAHU, HAWAII

5.0 References

Dawson Group, Inc. 2006. *Fourth Quarter 2005 Groundwater Sampling Report, Red Hill Fuel Storage Facility, Hawaii.* February.

Hawaii Administrative Rules, Title 11, Chapter 281, Subchapter 7.

State of Hawaii Department of Health. 2005a. *Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Volume 1: Summary Tier 1 Lookup Tables.* Interim Final. May.

State of Hawaii Department of Health. 2005b. *Use of May 2005 Environmental Action Levels ("EALs") at Leaking Underground Storage Tank Sites.* Memo. 15 July.

The Environmental Company, Inc. 2006. *Red Hill Bulk Fuel Storage Facility, Final – Addendum Planning Documents, Pearl Harbor, Hawaii.* May.

The Environmental Company, Inc. 2008. *Red Hill Bulk Fuel Storage Facility, Final Groundwater Protection Plan, Pearl Harbor, Hawaii.* January.

Appendix A
DOH Correspondence

- ***Letter of February 12, 2014***
- ***Letter of February 26, 2014***

action - RF

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

DIRECTOR OF HEALTH

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

In reply, please refer to:
File:

February 12, 2014 U0204RT

Mr. Aaron Poentis
Program Director
Environmental Department
Navy Region Hawaii
850 Ticonderoga St. Suite 110
Pearl Harbor, Hawaii 96860

Dear Mr. Poentis:

SUBJECT: Red Hill Tank Complex
Facility ID 9-102271/Release ID 140010

The U.S. Navy notified the Department of Health's Hazard Evaluation and Emergency Response (HEER) Office on Monday, January 13, 2014 to report a suspected underground storage tank release from Tank 5 of the Red Hill Tank Complex. The capacity of the tank is 12.7 million gallons. The DOH-HEER Office initiated an Incident Command structure and began gathering data from the Navy and coordinating the DOH response. Meetings were conducted by the DOH-HEER Office with participants from the Navy, DOH-Safe Drinking Water Branch, DOH-Solid and Hazardous Waste's Underground Storage Tank (UST) Section, and the Honolulu Board of Water Supply.

This letter will address the requirements of the DOH-UST Program and the regulations governing USTs under Hawaii Administrative Rules (HAR) Chapter 11-281 Underground Storage Tanks http://gen.doh.hawaii.gov/sites/har/AdmRules1/11-281.pdf

Monitoring of oil/water interface probes, soil vapor, and groundwater monitoring wells have been performed at increased frequency since the release was discovered. The DOH-HEER Office, Safe Drinking Water Branch, and UST Section have provided comments and approved the proposed short-term increased monitoring schedule that will continue monitoring of these parameters until July 2014, with increased monitoring frequency specified if increasing concentrations are found.

The Initial Release Response Report is due within 90 days of reporting a confirmed UST release. The DOH received the Confirmation of UST Release form on January 24, 2014.

Please also include the following information in your Initial Release Response Report:

1. Date and time release was discovered.
2. Method of detection and measurements and calculations for determining fuel lost.
3. Time interval between discovery of release and commencement of tank draining.
4. Time interval to drain tank to bottom and remove all residual product.
5. Modification of 2008 Groundwater Protection Plan and 2009 revisions to comply with the requirements of Environmental Hazard Evaluations as specified in the DOH-HEER Guidance.
6. Models to estimate groundwater flow and capture zones using recent local groundwater elevations for the Navy's drinking water pump station and Honolulu Board of Water Supply wells.

The facility is unique in both construction and storage capacity. As responsible parties of this UST system, the Navy is responsible for compliance with Subchapter 7, "Release Response Action." Certain requirements that are routine for a UST release at a retail gasoline facility may be difficult to achieve for this subterranean facility constructed within the basalt.

In addition to the Initial Release Response Report, the DOH requests a preliminary Work Plan report to discuss methods for achieving the requirements of HAR 11-281 Subchapter 7. Please complete the preliminary report within 30 days of your receipt of this letter and discuss with the DOH if you encounter any challenges or obstacles to this deadline. The following should be included in the preliminary Work Plan report:

1. Models to estimate downward vertical migration of free product.

2. Methods or options for non-invasive scanning of basalt to determine area and volume of contaminant mass prior to any drilling investigation.

3. Methods and locations for borings to most efficiently characterize the extent of contamination.

Following review, the DOH-UST Section would like to meet with the Navy and other interested parties to discuss selection of methods before the final work plan is prepared and work commences.

The DOH-UST Section uses the DOH-HEER guidance for Environmental Action Levels (EALs), Environmental Hazard Evaluations (EHEs) and Environmental Hazard Management Plans. All sites with contamination exceeding the DOH-HEER EALs are

required to prepare an EHE. The data provided previously for the comprehensive risk assessment may be used and updated with data obtained since 2008.

The DOH-HEER EAL guidance: http://eha-web.doh.hawaii.gov/eha-cma/Leaders/HEER/environmental-hazard-evaluation-and-environmental-action-levels

The DOH-HEER Technical Guidance Manual (TGM) http://www.hawaiidoh.org/. For petroleum guidance and use of EALs, including for soil vapor sampling. The DOH-UST Section does not currently require multi-increment sampling for UST release sites but it is an option if responsible parties wish to perform MIS according to the DOH-HEER TGM.

The DOH UST homepage: http://health.hawaii.gov/shwb/underground-storage-tanks/.

If you have any questions regarding this letter, please contact Mr. Steven Chang, Program Manager, Solid & Hazardous Waste Branch at (808) 586-4226.

Sincerely,

STUART YAMADA, P.E., CHIEF
Environmental Management Division

c: Gary Gill, Deputy Director for Environmental Health
Steven Chang, Solid and Hazardous Waste Branch
Keith Kawaoka, Hazard Evaluation and Emergency Response Office
Joanna Seto, Safe Drinking Water Branch
Roger Brewer, Hazard Evaluation and Emergency Response Office
Ernest Lau, Honolulu Board of Water Supply
Wade Hargrove III, Hawaii Department of the Attorney General
Steven Linder, EPA Region 9
Bob Pallarino, EPA Region 9
Roy Hardy, Department of Land and Natural Resources

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

DIRECTOR OF HEALTH

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

In reply, please refer to:

February 26, 2014 U0205RK

Rear Admiral Richard L. Williams
Commander
Navy Region Hawaii
850 Ticonderoga Street Suite 110
JBPHH, HI 96860-5101

Captain Mark S. Wheeler
Commanding Officer
NAVSUP Fleet Logistics Center Pearl Harbor
1942 Gaffney Street Suite 100
JBPHH, HI 96860-4549

Dear Admiral Williams and Captain Wheeler:

SUBJECT: Red Hill Tank Complex
Facility ID 9-102271 / Release ID 140010

The purpose of this letter is to describe the Department of Health's understanding of the status of the response to the January 13, 2014 report of a suspected release of JP-8 jet fuel from Tank 5 of the Red Hill Tank Complex and to request specific follow up actions by the Navy.

The Department of Health (DOH) received the Confirmation of Underground Storage Tank (UST) Release form on January 24, 2014 for the confirmed UST release at Tank 5.

The DOH UST letter dated February 12, 2014 requested that the Navy prepare a preliminary work plan to be submitted by March 14, 2014. The requirements of the preliminary work plan were stated as follows:

1. Models to estimate downward vertical migration of free product.
2. Methods or options for non-invasive scanning of basalt to determine area and volume of contaminant mass prior to any drilling investigation.
3. Methods and locations for borings to most efficiently characterize the extent of contamination.

At the Unified Command meeting of January 15, 2014 at DOH, representatives of the Navy stated that venting of Tank 5 would take three to four weeks before workers could safely enter Tank 5 to begin investigating possible release point(s).

In communication with Unified Command, the Navy stated that draining of Tank 5 was completed on January 18, 2014. The DOH UST-Section learned on February 18, 2014 that ventilation of Tank 5 had not commenced.

Investigation of the release point(s) inside the tank is necessary to determine the location of the JP-8 released. Venting and inspection of Tank 5 are essential for identifying release points.

The DOH requests that the Navy undertake the following release response action items, which shall be initiated immediately and completed as soon as practicable or as otherwise stated below:

1. Provide a schedule for the ventilation of Tank 5 and an estimated date to commence the investigation of release point(s) within Tank 5.

2. The rate of vertical migration for the released JP-8 free product is unknown. Information from the previously collected basalt cores could be used for initial modeling of vertical migration. This information is necessary to protect drinking water resources from petroleum contamination.

   Prepare models for petroleum JP-8 releases of 10,000, 20,000 and 30,000 gallons from points at 25% intervals from the bottom to the top of Tank 5. Progress in developing these models should be included in the preliminary work plan.

3. Removal of petroleum free product from the area outside the tank will reduce downward migration of the released JP-8 free product. Characterization of the free product plume and recovery of free product with increased monitoring are required to address this plume.

4. Additional studies and procedures are required to address the potential and impact of any future releases from the USTs within the Complex. This will require new financial and personnel resources to complete. Funding for the preliminary work plan and all necessary following work is critical.

   Reserve and increase funding as needed for all phases of your release response including:

- Developing the work plan.
- Remediation and removal of contamination.
- Modeling the extent and fate & transport of the JP-8 free product plume.
- Planning for and installation of additional monitoring wells to the Northwest and South to serve as sentinel wells for the Honolulu Board of Water Supply's Halawa pump station and Moanalua pump station.
- Measures that will reduce or eliminate future spills and protect nearby drinking water wells.

5. Provide written weekly progress reports by email to the DOH-UST Section by 11am each Tuesday, followed by hard copy to the DOH-UST office.

   Navy Region Hawaii (NRH) is the registered Owner of the USTs in the Red Hill Tank Complex. Naval Supply Systems Command (NAVSUP) Fleet Logistics Center Pearl Harbor (FLCPH) is the Operator of these USTs. NRH and NAVSUP may collaborate on a single report or submit separate reports but in either case, the Navy's submissions to the DOH must reflect and acknowledge the collaborative effort required to successfully complete the release response action items. The DOH will provide a written response as deemed necessary.

If you have any questions regarding this letter, please contact Mr. Steven Chang of the Solid and Hazardous Waste Branch at (808) 586-4226.

Sincerely,

GARY GILL
Deputy Director for Environmental Health

c: Aaron Poentis, Navy Region Hawaii
Stuart Yamada, Environmental Management Division
Steven Chang, Solid and Hazardous Waste Branch
Joanna Seto, Safe Drinking Water Branch
Keith Kawaoka, Hazard Evaluation and Emergency Response Office
Ernest Lau, Honolulu Board of Water Supply
Wade Hargrove III, Hawaii Department of the Attorney General
Steven Linder, EPA Region 9

Appendix B
Boring Logs and Well Construction Logs

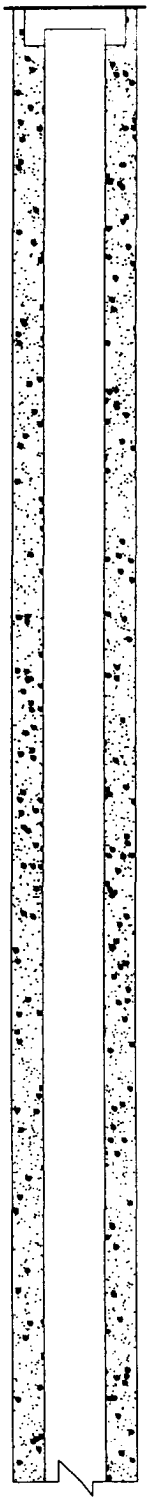
PROJECT: Red Hill Bulk Storage Facility
CLIENT: PACNAVFACENGCOM

Boring/Monitoring Well No. B-V1D
Project No. CTO 0229

LOCATION: V1D - Basal Aquifer	ELEVATION: 102.56		
DRILLER: Salisbury & Associates, Inc.	DATE DRILLED: 2/13/01	LOGGED BY: Lance Williams	
DRILL RIG: SAITECH EH5, Portable Core Drill	DEPTH TO WATER>	FIRST: 86.0	COMPL.: 86.1
BORING ANGLE: 90	WELL DIAMETER (inch): 1"		

Corrected Elevation/ Boring Length (ft)	Core Run Number	PID Reading (ppm)	Sample Number	Core Recovery %	Graphic Log	SOIL DESCRIPTION
102.56 (0)	1	NM		100		Concrete 0-2' over fine to coarse sand with fine gravel
102.06	2	172		83		and silt 2-2.5; basalt 2.5'; no odor
98.56	3	NM		71		Small to large vesicles; no odor; 10YR 3/1
		NM				Small to medium vesicles; no odor; 10YR 3/1 to 2/1
		99.2				
95.36	4	NM		0		Small vesicles; no odor; 5YR 3/2 to 10YR 2/2
94.16	5	NM		33		Small to medium vesicles; no odor; 5YR 3/2 to 10YR
93.66	6			100		2/2
91.76 (10)	7	124		105		Small to large vesicles; no odor; 10YR 2/2
	8			93		Small to large vesicles; no odor; 10YR 2/2 to 3/2
86.06	9	NM		96		Primarily small to medium vesicles; no odor; 10YR 2/2
81.66 (20)	10	NM		100		Small to primarily large vesicles; no odor; 10YR 2/2 to 5YR 3/2 to 10YR 3/1
76.26	11	3.2		100		Small to large vesicles; no odor; 10YR 3/1 to 5YR 3/2
71.26 (30)	12	10.8		100		Small to medium vesicles; no odor; 5YR 3/2 to 10YR 3/1
66.16	13	NM		102		Small to large vesicles; no odor; 5YR 3/2 to 10YR 3/1
60.96 (40)	14	NM		100		Small to large vesicles; no odor; 10YR 2/2 to 5YR 3/2
57.26						
56.91	15	NM		98		Small to medium vesicles; no odor; 10YR 2/2 to 5YR 3/2
						Void
53.06 (50)	16	NM		98		Small to medium vesicles; no odor; 10YR 2/2 to 5YR 3/2
48.06	17	1.0		89		Small to medium vesicles; no odor; 10YR 2/2 to 5YR 3/2
43.36 (60)	18	6.9		100		Small to large vesicles; no odor; 10YR 3/1 to 2/2 to 5YR 3/2
38.36	19	1.8		83		Small to large vesicles; no odor; 10YR 2/5 to 5YR 3/2
34.26 (70)	20	0.0		92		Small to medium vesicles; no odor; 10YR 2/1 to 2/2 tp 5YR 3/2
29.16	21	0.0	RH-BR-V1D-S01	102		Small vesicles; no odor; 10YR 2/1

WELL CONSTRUCTION



This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Corrected elevations are provided for angle borings.

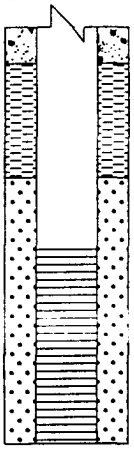
PROJECT: Red Hill Bulk Storage Facility
CLIENT: PACNAVFACENGCOM

Boring/Monitoring Well No. B-V1D
Project No. CTO 0229

LOCATION: V1D - Basal Aquifer	ELEVATION: 102.56		
DRILLER: Salisbury & Associates, Inc.	DATE DRILLED: 2/13/01	LOGGED BY: Lance Williams	
DRILL RIG: SAITECH EH5, Portable Core Drill	DEPTH TO WATER>	FIRST: 86.0	COMPL.: 86.1
BORING ANGLE: 90	WELL DIAMETER (inch): 1"		

Corrected Elevation/ Boring Length (ft)	Core Run Number	PID Reading (ppm)	Sample Number	Core Recovery %	Graphic Log	SOIL DESCRIPTION	WELL CONSTRUCTION
24.06	22	0		100		Medium vesicles; no odor; 10YR 2/2	
18.86	23	0.0	RH-BR-V1D-S02	106		Medium vesicles; no odor; 10YR 2/2	
15.66	24	0.0		96		Large vesicles; no odor; 10YR 2/1	
10.16							
9.56	25	0.0		86		Small vesicles; no odor; 10YR 2/2	
6.56						Clinker zone 93-100'	
4.96	26	0.0		56		Medium vesicles; clinker zone; no odor; 10YR 2/1	
4.96	27	0.0	RH-BR-V1D-S03	50		Medium vesicles; clinker zone; no odor; 10YR 2/2	
2.56						Clinker zone	
						B-V1D terminated at 100.0'	

80 90 100 110 120 130 140 150

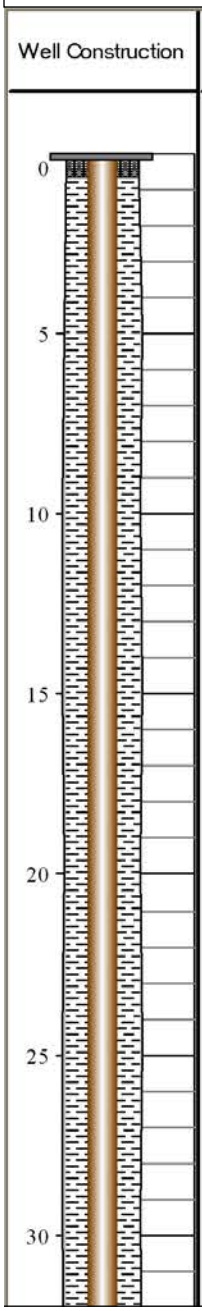


This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Corrected elevations are provided for angle borings.

GEOLOGIC BOREHOLE LOG

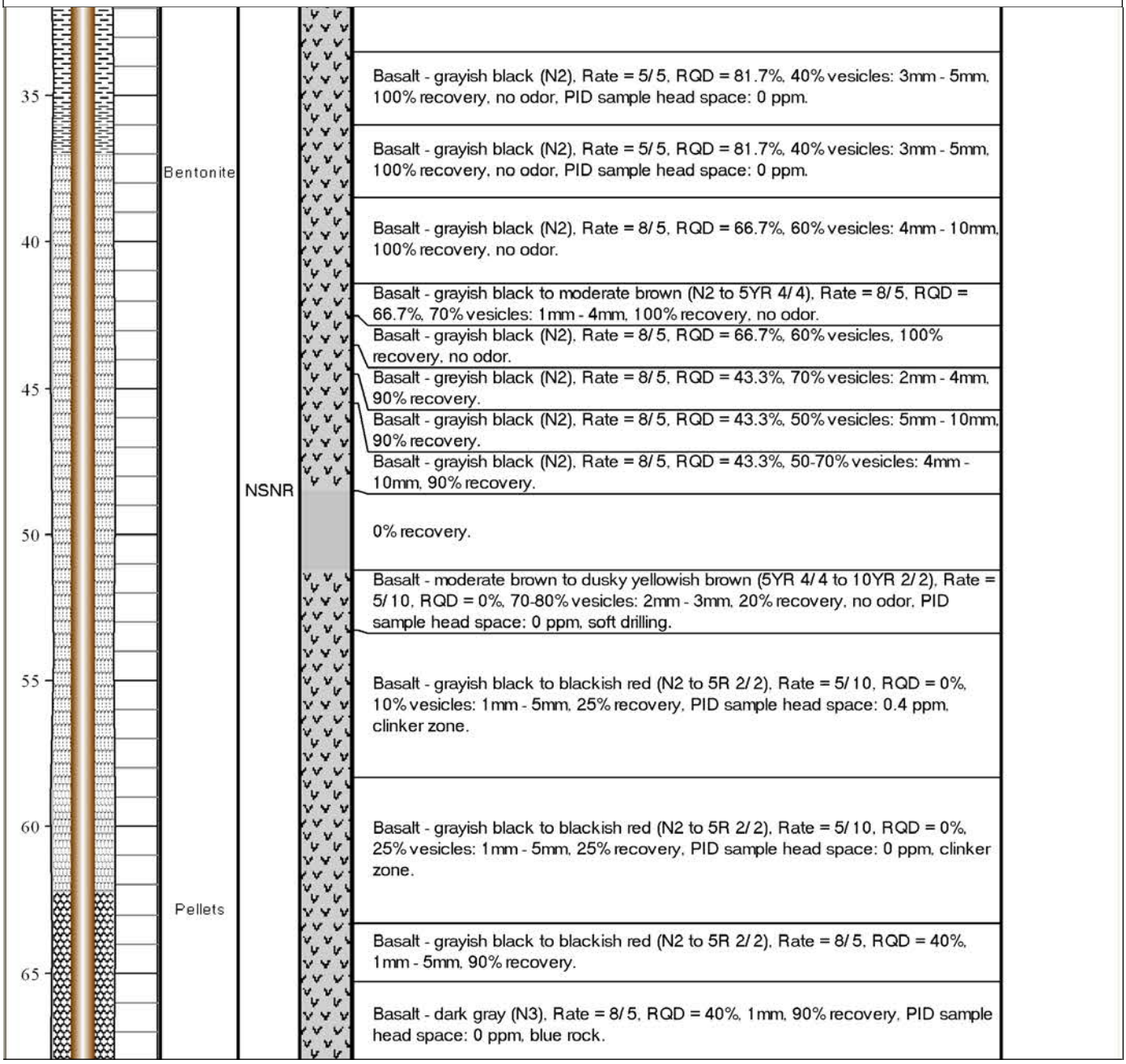
Location: **RHSF**	Station Name: **RHMW02**	Location Type: **Monitoring Well**
Location Description: **lower access tunnel, N of Tank 6**		Establishing Company: **TEC Inc.**
Drilling Foreman: **Dean McLure**		Drilling Company: **Valley Well Drilling**
Geologist: **N. Griffin/S. MacMillan**	Ground Surface Elevation (ft): **106.57**	Datum: **MSL**
Drilling Sampling Method: **Rock Coring**		Borehole Diameter (in): **5**
Total Depth (ft): **103.5**	Date Drilling Started: **27 July 2005**	Date Drilling Ended: **28 July 2005**
Remarks:		



Well Construction	Well Fill	USCS	Soil Description	Soil Sample
	Cement Grout	CON	Concrete - gray.	
		FILL	Sand base.	
		IE	Basalt boulders.	
		CON	Concrete - Rate = 5/ 10.5.	
			Basalt - brownish black (5YR 2/ 1), RQD = 68.3%, 60% vesicles: 3mm - 7mm, 100% recovery, no odor, PID sample head space: 0 ppm.	
			Basalt - brownish black (5YR 2/ 1), Rate = 1/ 4, RQD = 69.4%, 40% vesicles: 5mm - 1cm, 69% recovery, no odor, PID sample head space: 0 ppm.	
			Basalt - brownish black (5YR 2/ 1), Rate = 5/ 15, RQD = 100%, 10% vesicles: 0.5cm - 1cm, 100% recovery.	
			Basalt - brownish black (5YR 2/ 1), Rate = 5/ 10, RQD = 86.7%, 10% vesicles: 2mm - 4mm, 100% recovery, no odor, PID sample head space: 0 ppm.	
			Basalt - brownish black (5YR 2/ 1), Rate = 5/ 5, RQD = 80.8%, 80% vesicles: 1mm - 2mm, 100% recovery.	
			Basalt - brownish black (5YR 2/ 1), Rate = 5/ 5, RQD = 80.8%, 60% vesicles: 5mm, 100% recovery, verticle fractures present - possible shearing from drill.	
			Basalt - brownish black (5YR 2/ 1), RQD = 43.3%, 75% vesicles: 3mm - 5mm, 100% recovery.	
			Basalt - red, RQD = 43.3%, 80% vesicles: 2mm, 100% recovery.	
		IE	Basalt - dusky brown (5YR 2/ 2), Rate = 5/ 5, RQD = 46.7%, 60% vesicles: 2mm - 3mm, 100% recovery, no odor.	

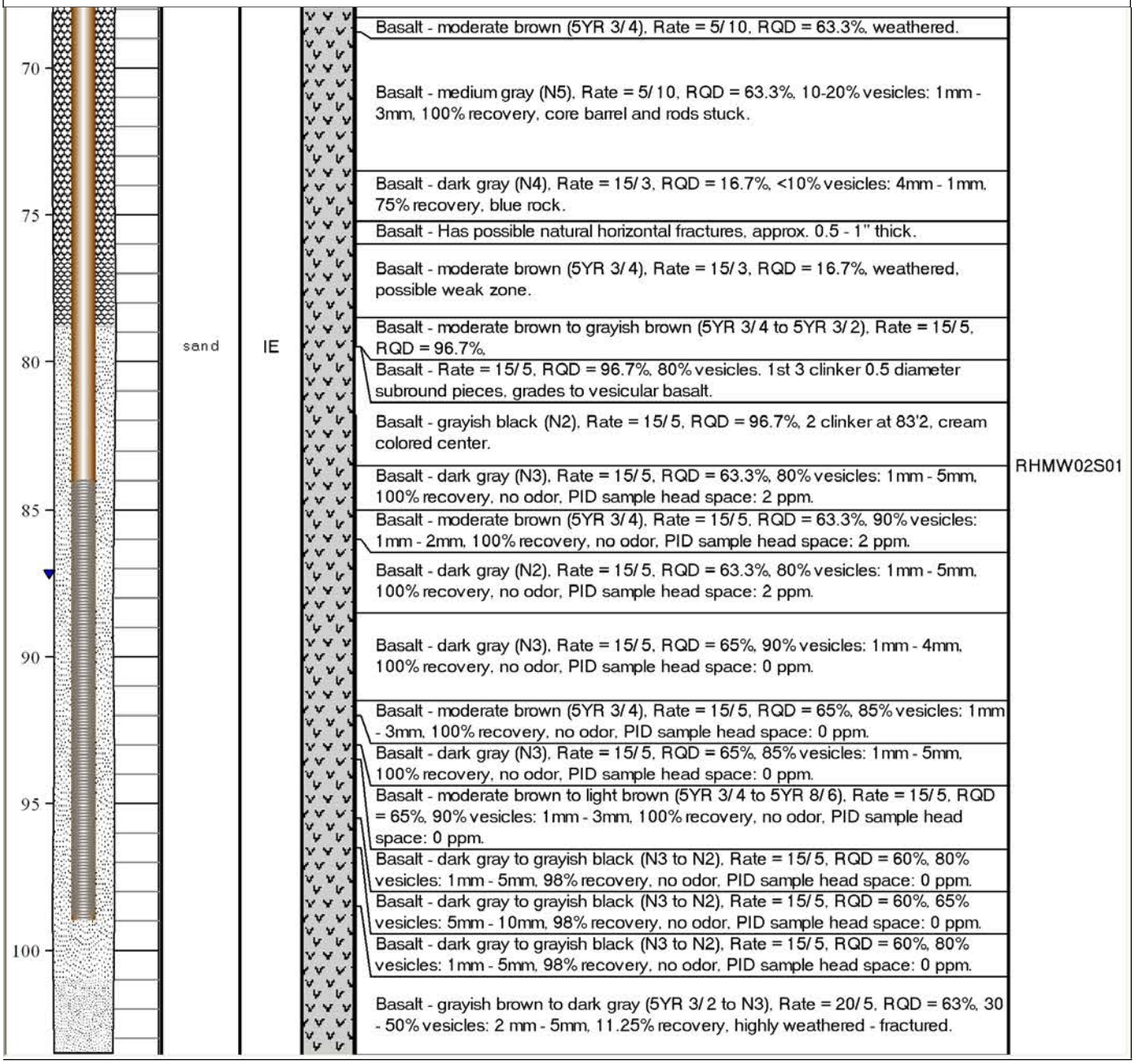
GEOLOGIC BOREHOLE LOG

Location: **RHSF**	Station Name: **RHMW02**	Location Type: **Monitoring Well**
Location Description: **lower access tunnel, N of Tank 6**		Establishing Company: **TEC Inc.**
Drilling Foreman: **Dean McLure**		Drilling Company: **Valley Well Drilling**
Geologist: **N. Griffin/S. MacMillan**	Ground Surface Elevation (ft): **106.57**	Datum: **MSL**
Drilling Sampling Method: **Rock Coring**		Borehole Diameter (in): **5**
Total Depth (ft): **103.5**	Date Drilling Started: **27 July 2005**	Date Drilling Ended: **28 July 2005**
Remarks:		



GEOLOGIC BOREHOLE LOG

Location: **RHSF**	Station Name: **RHMW02**	Location Type: **Monitoring Well**
Location Description: **lower access tunnel, N of Tank 6**		Establishing Company: **TEC Inc.**
Drilling Foreman: **Dean McLure**		Drilling Company: **Valley Well Drilling**
Geologist: **N. Griffin/S. MacMillan**	Ground Surface Elevation (ft): **106.57**	Datum: **MSL**
Drilling Sampling Method: **Rock Coring**		Borehole Diameter (in): **5**
Total Depth (ft): **103.5**	Date Drilling Started: **27 July 2005**	Date Drilling Ended: **28 July 2005**
Remarks:		



Well Construction Log

Location:	Red Hill BFSF	**Station ID:**		**Station Name:**	RHMW02	**Date:**	7/27/2005
Sys_Samp_Code:		**Elevation:**		**TD:**	103.5'	**Time**	**Start:**
Driller:	Dean	**CO.:**	VWD	**Date Finished:**	7/28/2005		**Finish:**

Drilling Protocol

Hole Diameter:	5"	**Drilling Method:**	Coring	**Inclination:**	90°	**Azimuth:**	n/a

Casing

Material:	PVC Sch 80	**Diameter**	**ID:**	1.939	**From:**	0'	
			OD:	2.375	**To:**	84'	

Screen

Material:	PVC Sch 80	**Diameter**	**ID:**	1.939	**From:**	84'	**Slot #:**	0.02	
			OD:	2.375	**To:**	99'			

Annular Fill

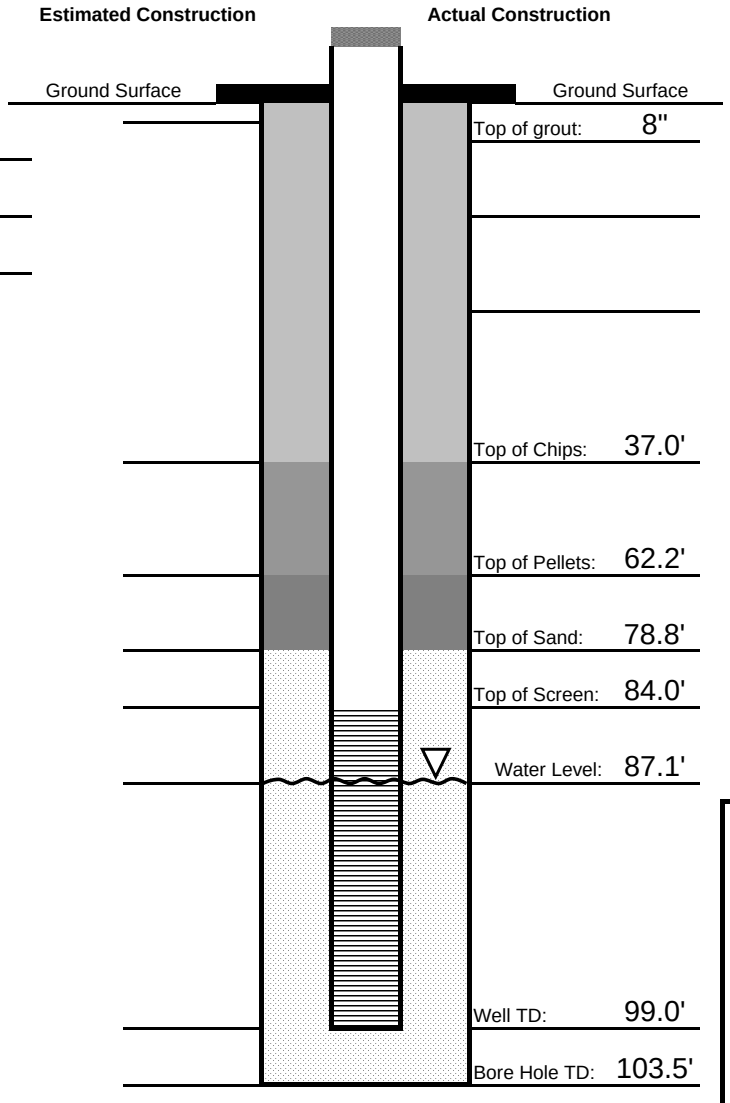
Sand:	Monterey #3	**Type**	**Bentonite**	**Chips:**	12	**Bags**	**Grout:**	0	**Bags**	
	4	**Bags**		**Pellets:**	2	**Bkts**	**Cement:**	10	**Bags**	

Surface Casing

Type: Traffic Cover

Diameter: 12"

Length: 12"



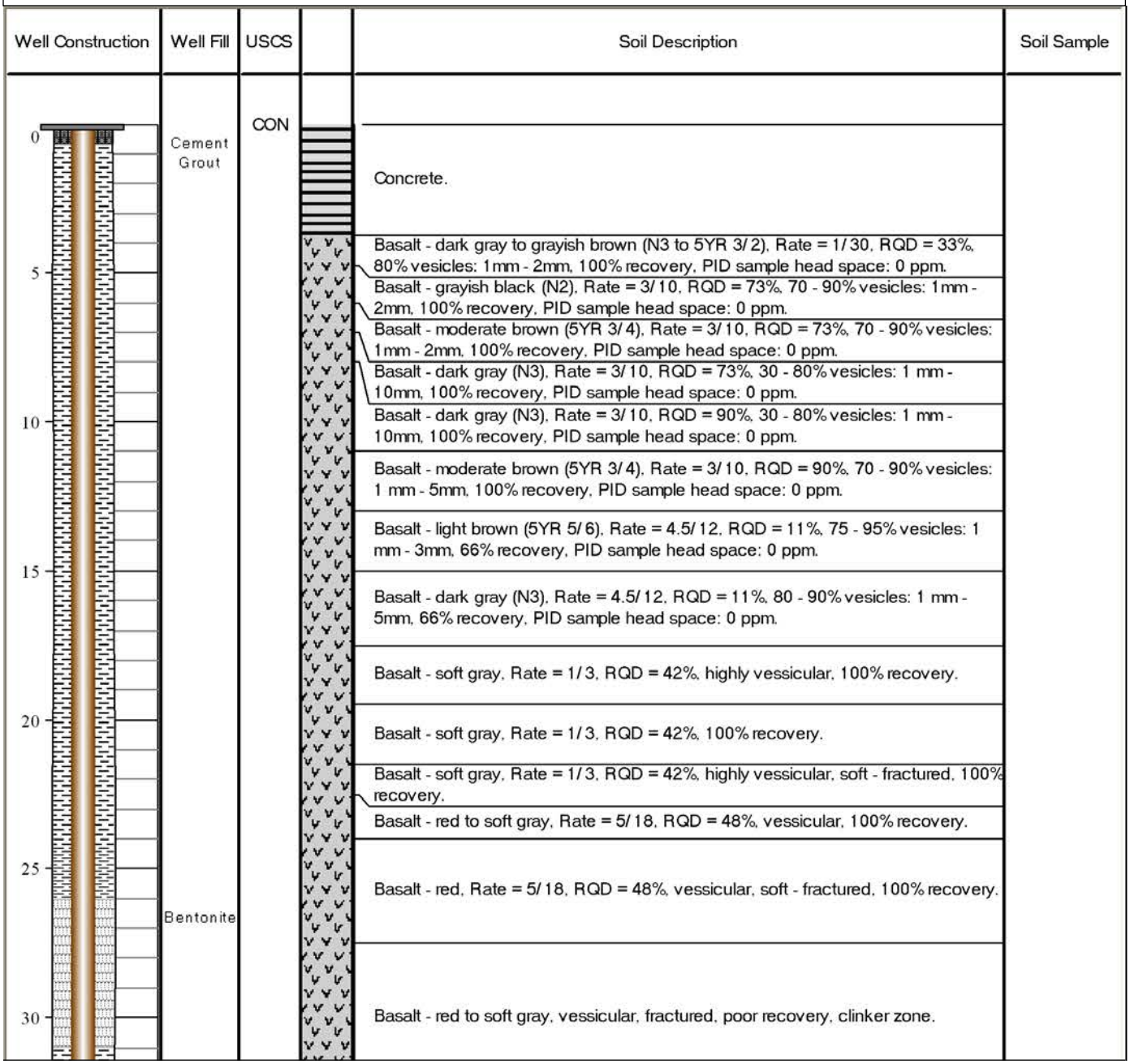
Cement
Grout
B. Chips
B. Pellets
Sand

Notes:

Borehole caved in to 99'

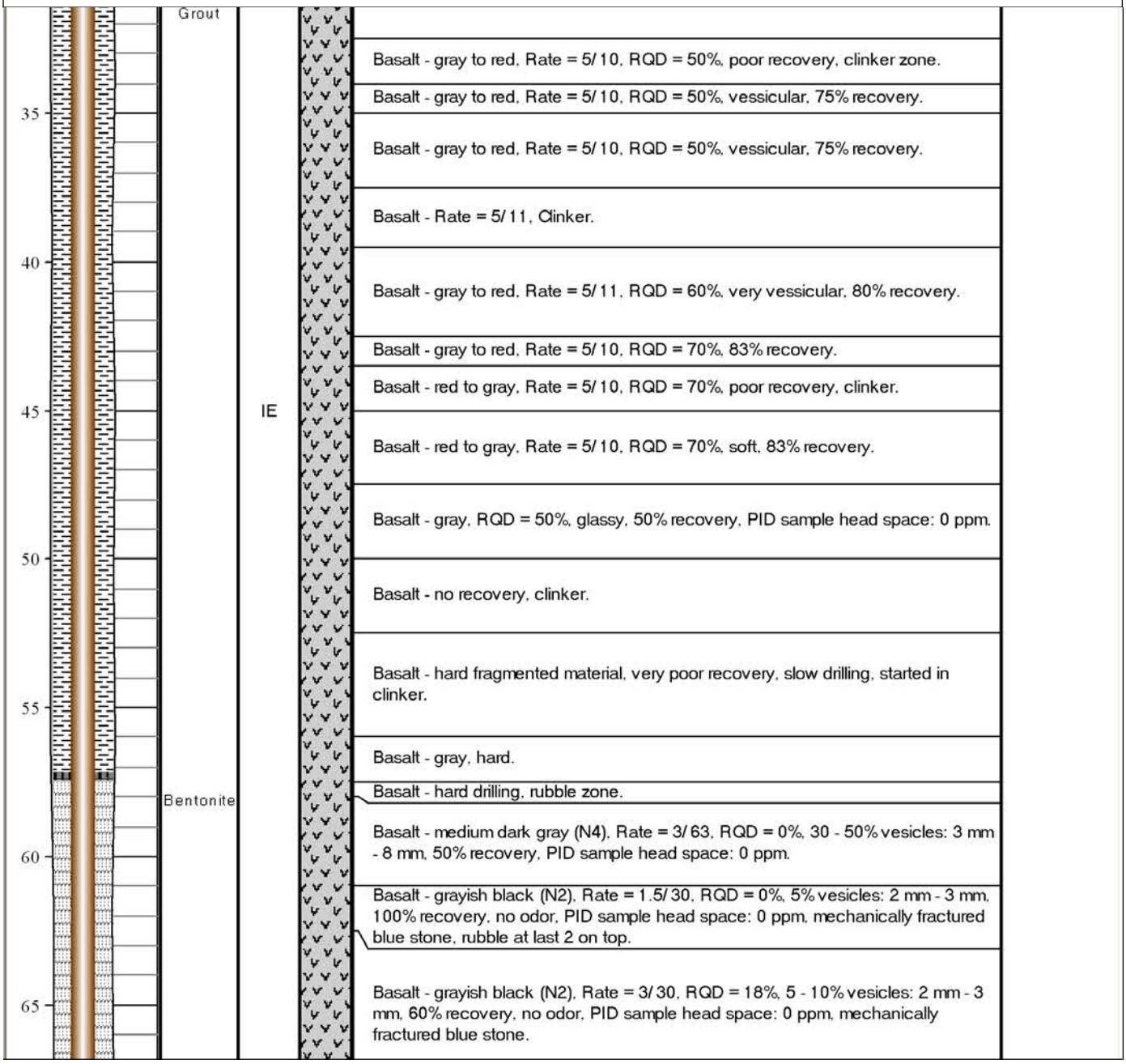
GEOLOGIC BOREHOLE LOG

Location: **RHFSF**	Station Name: **RHMW03**	Location Type: **Monitoring Well**
Location Description: **lower access tunnel, N of Tank 14**		Establishing Company: **TEC Inc.**
Drilling Foreman: **Tim Robertson**		Drilling Company: **Valley Well Drilling**
Geologist: **N. Griffin/S. MacMillan**	Ground Surface Elevation (ft): **122.11**	Datum: **MSL**
Drilling Sampling Method: **Rock Coring**		Borehole Diameter (in): **5**
Total Depth (ft): **118**	Date Drilling Started: **2 September 2005**	Date Drilling Ended: **7 September 2005**
Remarks:		



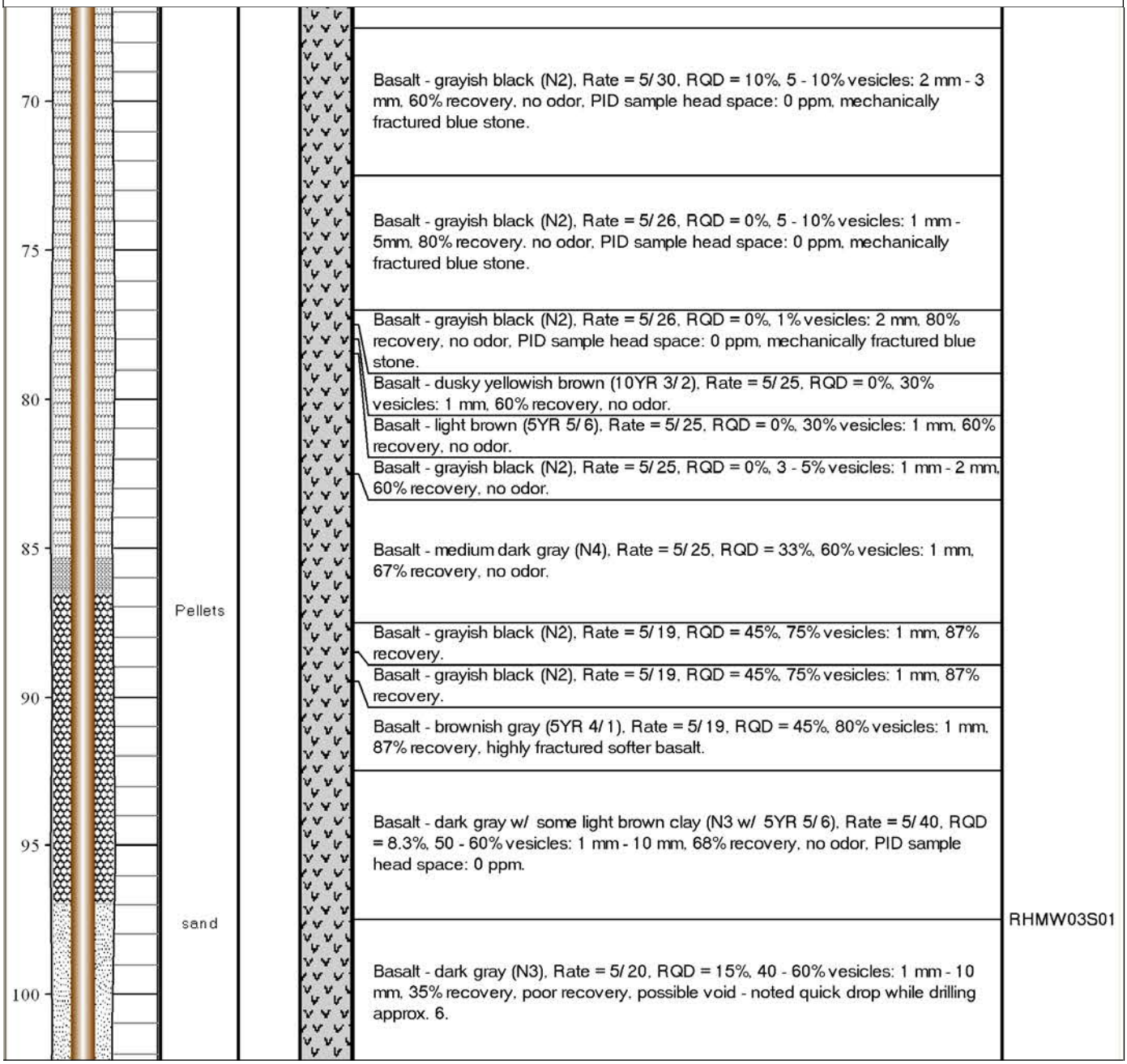
GEOLOGIC BOREHOLE LOG

Location: **RHFSF**	Station Name: **RHMW03**	Location Type: **Monitoring Well**
Location Description: **lower access tunnel, N of Tank 14**		Establishing Company: **TEC Inc.**
Drilling Foreman: **Tim Robertson**		Drilling Company: **Valley Well Drilling**
Geologist: **N. Griffin/S. MacMillan**	Ground Surface Elevation (ft): **122.11**	Datum: **MSL**
Drilling Sampling Method: **Rock Coring**		Borehole Diameter (in): **5**
Total Depth (ft): **118**	Date Drilling Started: **2 September 2005**	Date Drilling Ended: **7 September 2005**
Remarks:		



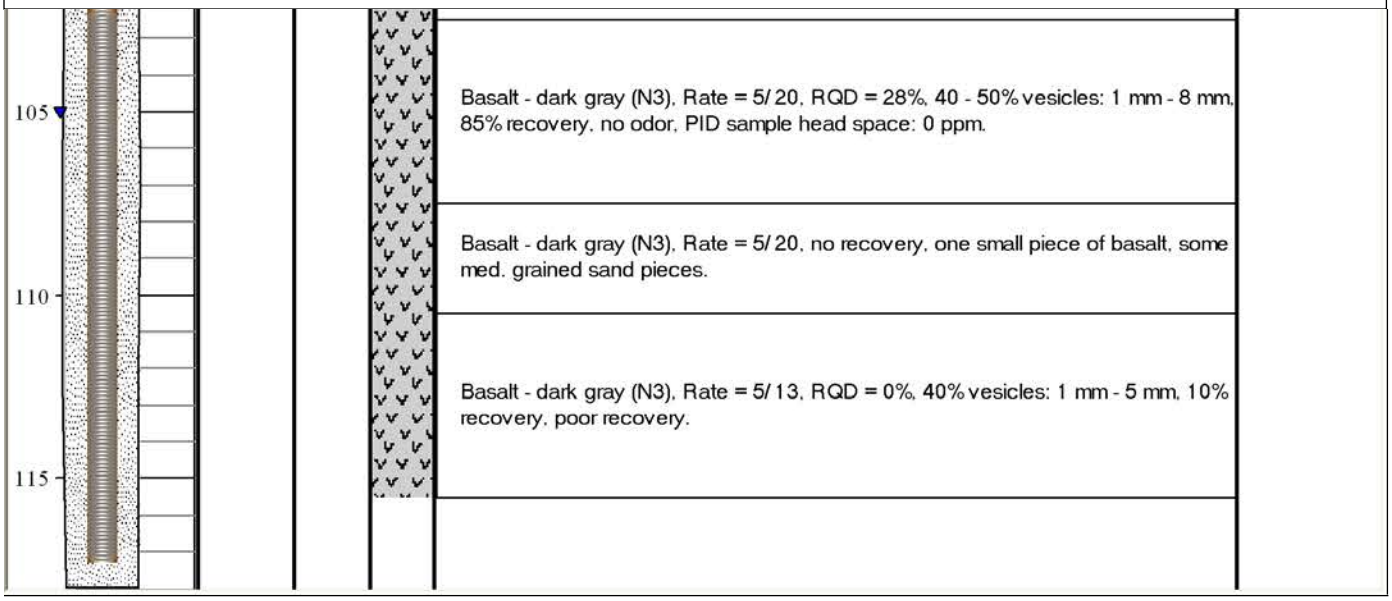
GEOLOGIC BOREHOLE LOG

Location: **RHFSF**	Station Name: **RHMW03**	Location Type: **Monitoring Well**
Location Description: **lower access tunnel, N of Tank 14**		Establishing Company: **TEC Inc.**
Drilling Foreman: **Tim Robertson**		Drilling Company: **Valley Well Drilling**
Geologist: **N. Griffin/S. MacMillan**	Ground Surface Elevation (ft): **122.11**	Datum: **MSL**
Drilling Sampling Method: **Rock Coring**		Borehole Diameter (in): **5**
Total Depth (ft): **118**	Date Drilling Started: **2 September 2005**	Date Drilling Ended: **7 September 2005**
Remarks:		



GEOLOGIC BOREHOLE LOG

Location: **RHFSF**	Station Name: **RHMW03**	Location Type: **Monitoring Well**
Location Description: **lower access tunnel, N of Tank 14**		Establishing Company: **TEC Inc.**
Drilling Foreman: **Tim Robertson**		Drilling Company: **Valley Well Drilling**
Geologist: **N. Griffin/S. MacMillan**	Ground Surface Elevation (ft): **122.11**	Datum: **MSL**
Drilling Sampling Method: **Rock Coring**		Borehole Diameter (in): **5**
Total Depth (ft): **118**	Date Drilling Started: **2 September 2005**	Date Drilling Ended: **7 September 2005**
Remarks:		



Well Construction Log

Location:	Red Hill BFSF	**Station ID:**		**Station Name:**	RHMW03	**Date:**	9/2/2005
Sys_Samp_Code:		**Elevation:**		**TD:**	118.0'	**Time**	**Start:**
Driller:	Tim	**CO.:**	VWD	**Date Finished:**	9/7/2005		**Finish:**

Drilling Protocol

Hole Diameter:	5"	**Drilling Method:**	Coring	**Inclination:**	90°	**Azimuth:**	n/a

Casing

Material:	PVC Sch 80	**Diameter**	**ID:**	1.939"	**From:**	0'	
			OD:	2.375"	**To:**	102.3'	

Screen

Material:	PVC Sch 80	**Diameter**	**ID:**	1.939"	**From:**	102.3'	**Slot #:** 0.02
			OD:	2.375"	**To:**	117.3'	

Annular Fill

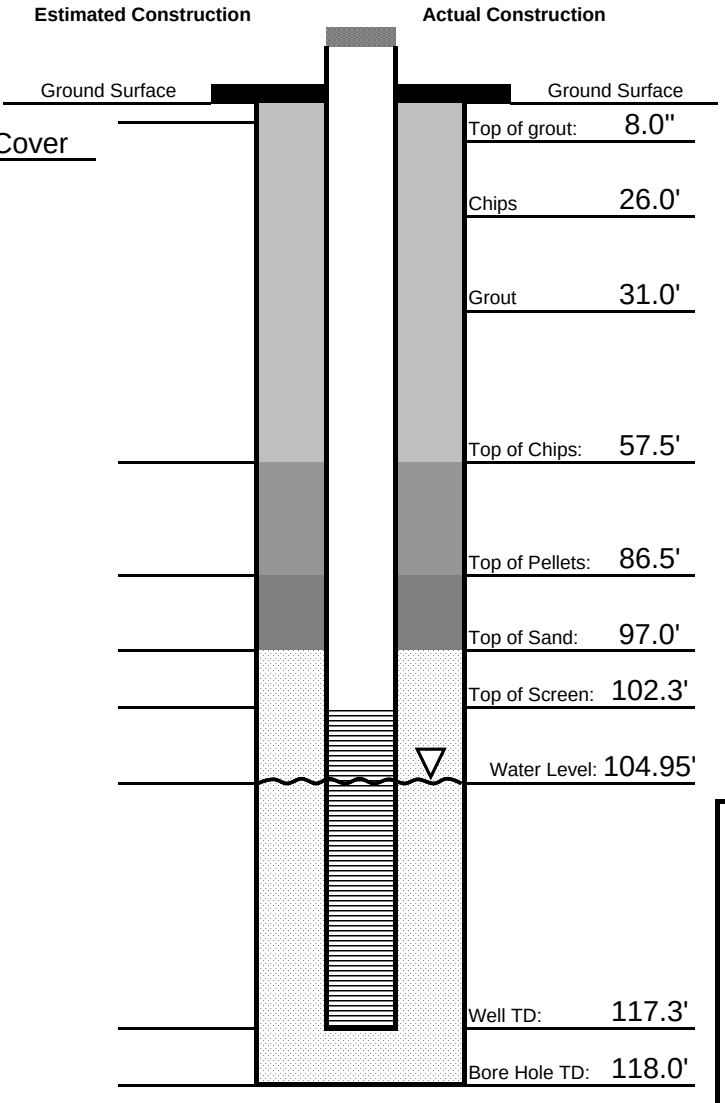
Sand:	Monterey #3	**Type**	**Bentonite**	**Chips:**	8	**Bags**	**Grout:**	0.5	**Bags**
	2	**Bags**		**Pellets:**	1.5	**Bkts**	**Cement:**	9	**Bags**

Surface Casing

Type: Flush Traffic Cover

Diameter: 12"

Length: 12"

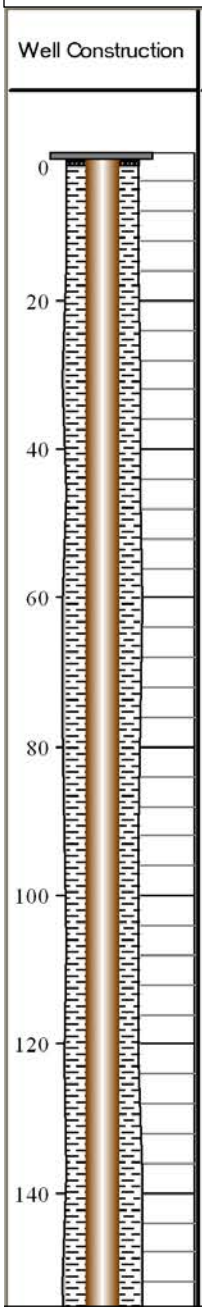


Cement
Grout
B. Chips
B. Pellets
Sand

Notes:

GEOLOGIC BOREHOLE LOG

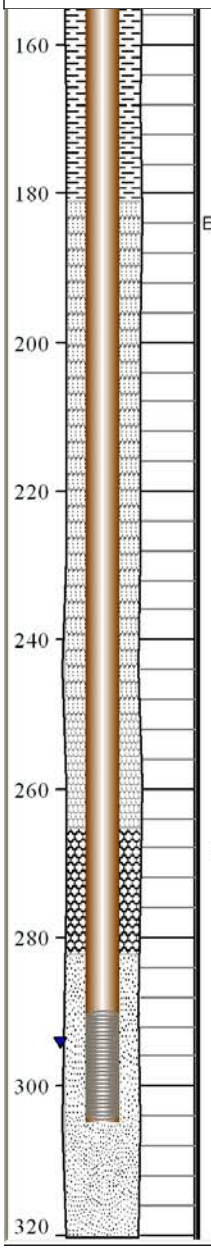
Location: **RHFSF**	Station Name: **RHMW04**	Location Type: **Monitoring Well**
Location Description: **west. access rd., S of Navy Firing Range**		Establishing Company: **TEC Inc.**
Drilling Foreman: **Tomas Fernandez**		Drilling Company: **Valley Well Drilling**
Geologist: **N. Griffin/S. MacMillan**	Ground Surface Elevation (ft): **313.03**	Datum: **MSL**
Drilling Sampling Method: **Rock Coring**		Borehole Diameter (in): **8**
Total Depth (ft): **320.5**	Date Drilling Started: **22 July 2005**	Date Drilling Ended: **26 July 2005**
Remarks:		



Well Construction	Well Fill	USCS	Soil Description	Soil Sample
	Cement Grout	GW	Well-graded gravel with sand - dark reddish brown (5YR 2.5/2), medium stiff, moist, 80% gravel, 15% fines, 5% fines, road base.	RHMW04S02
			Basalt bedrock.	
			Basalt - moderate brown (5YR 3/4), Rate = 5/5, 50 - 80% vesicles.	
			Basalt - dark gray (blue rock) (N3), Rate = 5/10, massive, 5% small crystals.	
		IE	Basalt - dark gray (N3), Rate = 5/10, 70 - 90% vesicles:small.	
			Basalt - dark gray (N3), Rate = 5/7, massive.	
			Basalt - dark gray (N3), Rate = 5/10, 70 - 90% vesicles.	
			Basalt - dark gray (N3), Rate = 5/10, vesicles.	
			Basalt - dark gray (N3), Rate = 5/10, vesicles.	
			Basalt - dark gray (N3), Rate = 5/12, vesicles.	
		NSNR	Rate = 5/18, no recovery.	
			Basalt - moderate brown to dark gray (5YR 3/4 to N3), Rate = 5/12, vesicles.	
			Basalt - dark gray (N3), Rate = 5/16, vesicles with min. deposits. Perched water encountered - to approx. 130 feet.	
			Basalt - dark gray (N3), Rate = 5/15, massive.	
			Basalt - dark reddish brown to dark gray (10YR 3/4 to N3), Rate = 5/20, vesicles.	
			Basalt - medium dark gray to dark gray (N4 to N3), Rate = 5/15, vesicles.	
		IE	Basalt - dark reddish brown to dark gray (10YR 3/4 to N3), Rate = 5/15, massive and vesicles.	
			Basalt - dark reddish brown (10YR 3/4), Rate = 5/10, vesicles.	
			Basalt - dark gray (N3), Rate = 5/12, vesicles.	

GEOLOGIC BOREHOLE LOG

Location: **RHFSF**	Station Name: **RHMW04**	Location Type: **Monitoring Well**
Location Description: **west. access rd., S of Navy Firing Range**		Establishing Company: **TEC Inc.**
Drilling Foreman: **Tomas Fernandez**		Drilling Company: **Valley Well Drilling**
Geologist: **N. Griffin/S. MacMillan**	Ground Surface Elevation (ft): **313.03**	Datum: **MSL**
Drilling Sampling Method: **Rock Coring**		Borehole Diameter (in): **8**
Total Depth (ft): **320.5**	Date Drilling Started: **22 July 2005**	Date Drilling Ended: **26 July 2005**
Remarks:		



IE	Basalt - dark gray (N3), Rate = 5/ 5, vesicles.
	Basalt - dark gray (N3), Rate = 5/ 15, vesicles.
	Basalt - dark gray (N3), Rate = 5/ 30, vesicles.
NSNR	Rate = 5/ 14, No recovery.
	Basalt - dark gray (N3), Rate = 5/ 10, vesicles.
IE	Basalt - dark gray (N3), Rate = 5/ 13, vesicles.
	Rate = 5/ 10, No recovery.
NSNR	Rate = 5/ 15, No recovery.
	Rate = 5/ 12, No recovery.
IE	Basalt - dark gray (N3), Rate = 5/ 12, vesicles.
	Basalt - medium dark gray (N4), Rate = 5/ 10, vesicles.
	Basalt - medium dark gray (N4), Rate = 5/ 10, vesicles.
	Basalt - medium dark gray (N4), Rate = 5/ 10, vesicles.
	Basalt - dark gray (N3), Rate = 5/ 10, vesicles.
	Basalt - dark gray (N3), Rate = 5/ 10, vesicles.
	Basalt - dark gray to blackish red (N3 to 5R 2/ 2), Rate = 5/ 8, vesicles, water at 311'.

Well Construction Log

Location:	Red Hill BFSF	**Station ID:**		**Station Name:**	RHMW04	**Date:**	7/22/2005
Sys_Samp_Code:		**Elevation:**		**TD:**	320.5'	**Time**	**Start:**
Driller:	Tomas	**CO.:**	VWD	**Date Finished:**	7/26/2005		**Finish:**

Drilling Protocol

Hole Diameter:	8"	**Drilling Method:**	Air Rotary	**Inclination:**	90°	**Azimuth:**	n/a

Casing

Material:	PCV Sch 80	**Diameter**	**ID:**	3.826"	**From:**	0'	
			OD:	4.5"	**To:**	290'	

Screen

Material:	PCV Sch 80	**Diameter**	**ID:**	3.826"	**From:**	290'	**Slot #:** 0.02
			OD:	4.5"	**To:**	305'	

Annular Fill

Sand:	Monterey #3	**Type**	**Bentonite**	**Chips:**	16	**Bags**	**Grout:** 2	**Bags**	
	6	**Bags**		**Pellets:**	6	**Bkts**	**Cement:** 40	**Bags**	

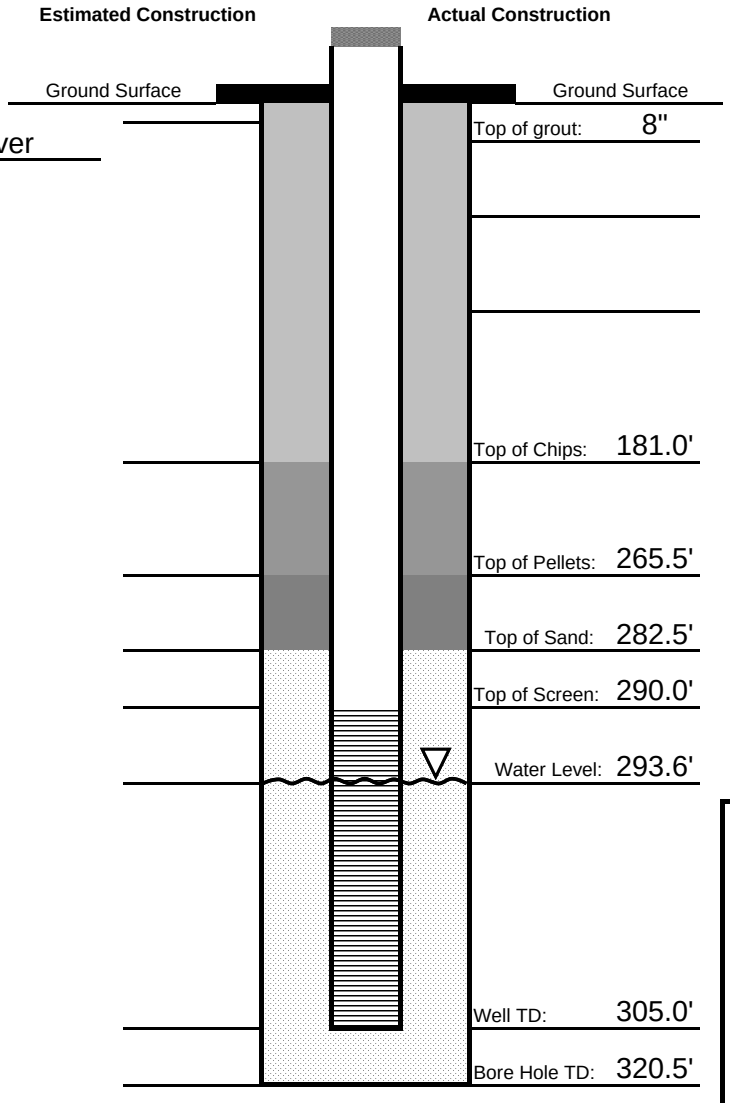
Surface Casing

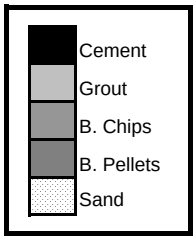
Type: Traffic Cover

Diameter: 12"

Length: 12"

Pad: 3X3

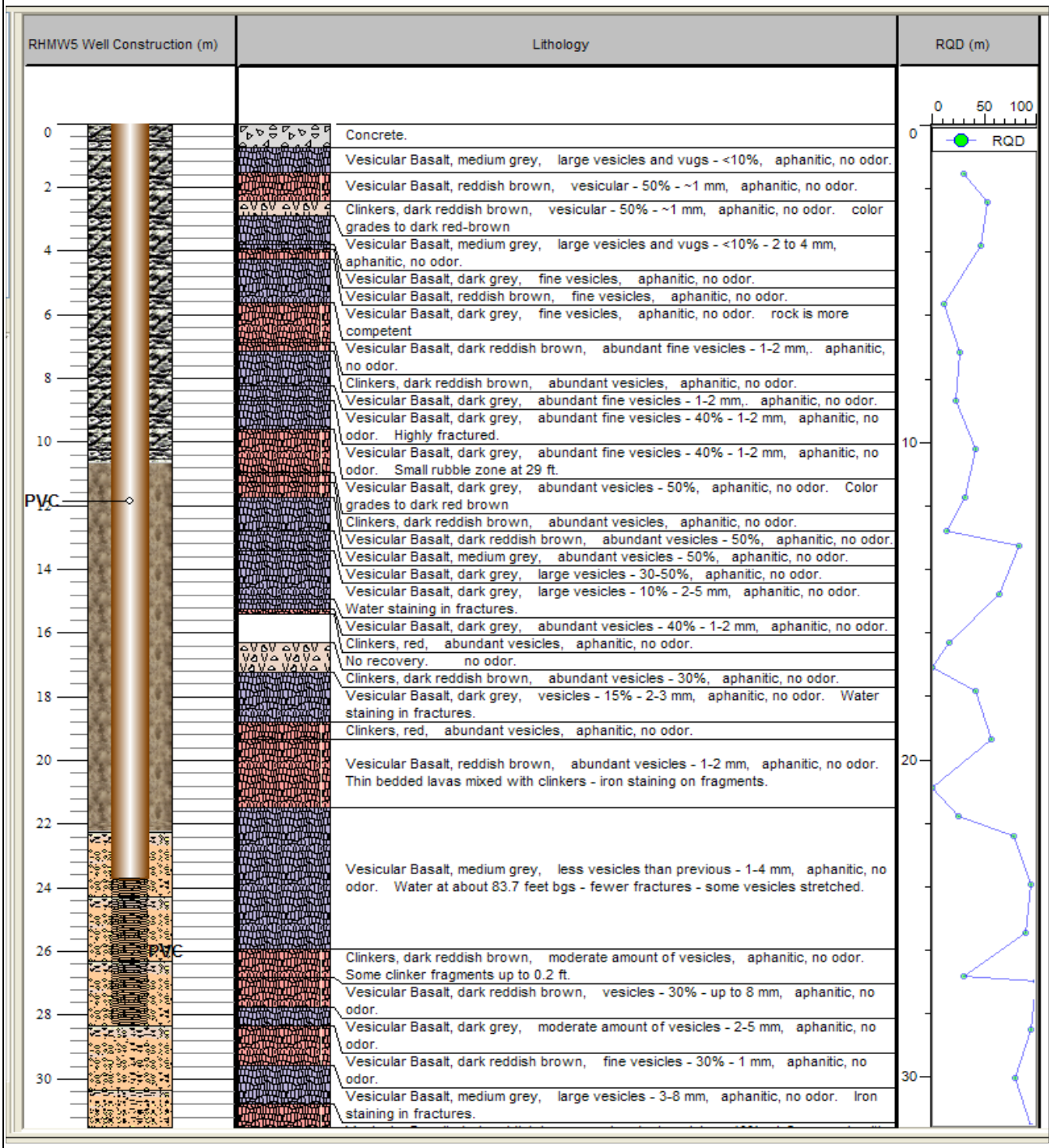




Notes:

	Project Name:	**Red Hill Bulk Fuel Storage Facility, LTM 2009**			
	Contract No:	N47408-04-D-8514, T.O. 54	**Location:**	At Bend in Lower Tunnel Between Adit 3 and Adit 5	
	Well Identifier:	RHMW05		**Drilling Technique:**	Air Rotary Coring
	Start Date:	April 10, 2009		**Bit Type/Size:**	Diamond Core /4.8-inches diam
	End Date:	April 24, 2009		**Filter Pack:**	1 mm, silica sand
	Completion Type:	Flush Mounted			
	Riser Material:	2-inch, Schedule 80 PVC, flush threaded		**Annular Seal:**	Bentonite Chips/Pellets
	Screen Material:	2-inch, Schedule 80 PVC, 0.02 slot size		**Groundwater Elevation**	
	Screened Interval:	78 ft to 93 ft below ground surface		**Range between 7/14/2009 and 3/25/2010**	

Coordinates (m):	Northing	Easting	Elevation	
NAD 83, HI State Plane, Zone 3, FIPS 5103	22,461	510,317	31	83.09 to 83.96 ft below top of casing



TEC Representative : Robert Whittier, P.G.

Driller: Tomas Fernandez; Valley Well Drilling, Inc.