Naval Facilities Engineering Command Hawaii
JBPHH HI

Final

Technical Memorandum
Phase III Remedial Investigation
Red Hill Oily Waste Disposal Facility

JOINT BASE PEARL HARBOR-HICKAM OAHU HI

PEARL HARBOR HI FISC SITE 22

October 2019

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Technical Memorandum
Red Hill Oily Waste Disposal Facility
Phase III Remedial Investigation
Joint Base Pearl Harbor-Hickam, Oahu, Hawaii

Naval Facilities Engineering Command, Hawaii, JBPHH HI
October 2019

This technical memorandum briefly summarizes previous investigations and analyses, and presents an overview of the proposed technical approach for evaluating and addressing recently observed anomalies in the chemistry of groundwater samples collected from the sole remaining monitoring well at the Red Hill Oily Waste Disposal Facility (OWDF), which is located on the island of Oahu approximately 2 miles northeast of the East Loch of Pearl Harbor (Figure 1). Previous investigations determined that the historical use of the site resulted in petroleum hydrocarbon impacts to soil and perched groundwater, but not to the underlying basal aquifer. Based on those investigations and completion of a source removal action, the Department of Health (DOH) determined in 2005 that no further action (NFA) was warranted for the site (DOH 2005). However, laboratory analyses of some of the groundwater samples collected between October 2012 and December 2015 from the site's sole remaining groundwater monitoring well ([redacted] have prompted the Navy to consider additional investigations at the site. Consequently, a site assessment is proposed to ascertain whether any response actions are warranted.

1. Background

The OWDF is located in the Koolau foothills within the boundaries of Red Hill Bulk Fuel Storage Facility (RHSF), which is owned by Defense Logistics Agency (DLA) and operated by Naval Supply Systems Command Fleet Logistics Center (NAVSUP FLC) Pearl Harbor. The 4-acre OWDF site is on sloping terrain ranging from approximately 120 to 150 feet (ft) above mean sea level (msl). Although previous investigations showed that the entire OWDF is underlain with a relatively shallow perched aquifer overlying multiple layers of low permeability clay, [redacted]

The OWDF was constructed in the 1940s as a collection point for oily waste water generated by the cleaning of the RHSF's 20 large-capacity underground storage tanks (USTs), which are situated approximately 3,000 ft east and topographically upgradient of the site. [redacted]

[redacted]

A series of two reclamation and disposal pits, the first unlined and its later replacement lined, were constructed at the OWDF in the same approximate location in 1943 and 1972. Each pit was used as a holding and settling pond for bottom sludge and rinse water generated from cleaning of the Red Hill USTs. Each pit functioned similarly: oily waste from periodic cleaning of the Red Hill USTs was pumped into the

pit, where recoverable oil was skimmed from the surface and collected in aboveground storage tanks (ASTs) at the site. The recovered oil was then transferred by an underground piping and delivery system to trucks for transport to a fuel processing facility at Pearl Harbor. The remaining water either evaporated, infiltrated, or was otherwise disposed of. The historical use of the disposal pit was as follows.

- The original pit (the Oily Waste Disposal Pit) operated from 1943 to 1948. The Oily Waste Disposal Pit was earthen-bermed, lined with lava rock at its base, and used two nearby 8,000-gallon ASTs as holding tanks for the recovered fuel before transferring the fuel to trucks for offsite transport and processing. After use of the original pit was discontinued in 1948, an unsuccessful attempt was made to burn off the sludge with gasoline, and the pit was later excavated to a point below visible subsurface contamination (DON 1996a).
- Between 1948 and 1972, the pit was not used and oily wastes from the cleaning of Red Hill USTs were stored directly in the two ASTs.
- The second pit (the Stilling Basin) operated from 1972 to 1986. The Stilling Basin was a lined basin that was constructed in the same approximate position and used in essentially the same fashion as the Oily Waste Disposal Pit. After its asphalt lining began to crack shortly after construction, the Stilling Basin was reconstructed with a concrete lining. A 40,000-gallon AST was installed at the site to replace the two 8,000-gallon ASTs as a holding tank. Use of the Stilling Basin was terminated in 1986 following initial subsurface investigation of the site; thereafter, oily wastes generated from cleaning of the Red Hill USTs were collected directly in the 40,000-gallon AST before transferring the liquid to trucks for offsite transport and processing (DON 1996a).

2. Previous Investigations, Removal Action, and Site Status

Site investigations at the OWDF began after the *Initial Assessment Study of Pearl Harbor Naval Base* (NEESA 1983) identified the area as one that potentially posed a threat to human health or the environment. The Red Hill Geographic Study Area (with primary focus on the OWDF) was included in the Pearl Harbor Naval Complex National Priorities List (NPL) site in October 1992 (U.S. Environmental Protection Agency [EPA] identification [ID]: HI4170090076). Following preliminary investigations, a two-phase remedial investigation (RI) and removal action were conducted:

- *The Phase I RI* commenced in 1991 and investigated several areas of potential concern that could have been impacted by historical site activities (Figure 2). Four shallow monitoring wells were completed along the borders of the disposal pit in a perched groundwater lense encountered beneath the site, in the locations shown in Figure 1. The deepest of these four shallow wells was installed to a depth of approximately 86 ft msl (40 ft below ground surface [bgs]), where it terminated in a low permeability confining layer that was later confirmed to extend throughout and beyond the OWDF site. Hydrocarbon contamination was detected in samples taken from disposal pit liquids and sludges, surface and subsurface soil, and the perched groundwater. Analytes with elevated concentrations included total fuel hydrocarbons (TFH) and total petroleum hydrocarbons (TPH). In addition, several volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), and phenols were detected. The Phase I RI concluded that the Stilling Basin was the primary source of contamination at the OWDF, and recommended a removal action and further investigation of potential impacts to basal groundwater (DON 1996a).
- *The Removal Action* commenced in 1995 and included removing sludge and liquids from the Stilling Basin, demolishing the structure, and excavating approximately 20 ft of impacted underlying soil for off-site treatment. The excavation was backfilled with treated and clean soil, and a low-permeability geosynthetic cap was installed over the area to minimize recharge by rainfall. Detected concentrations of TPH in several confirmation soil samples collected at the base of the excavation after the removal action exceeded the cleanup criterion; however, because the excavation was capped and petroleum hydrocarbons were not detected in groundwater samples

after completion of the removal action, the removal and treatment of the disposal pit was deemed successful (DON 1996b).

- *The Phase II RI* commenced in 1998 to address recommendations of the Phase I RI, including an evaluation of the potential connection between the perched groundwater and the basal aquifer, and potential impacts to the basal aquifer. Three deep basal aquifer monitoring wells were constructed in the areas shown in Figure 1. A fourth deep well was advanced but abandoned due to perched water leaking into the basal aquifer (DON 2006). The deep well borings revealed multiple low-permeability soil formations between the perched aquifer and the basal aquifer, and the basal aquifer was found to be locally confined by a massive basalt layer that extended at least 20 feet below the regional basal groundwater level in each boring. In addition, material above the basal aquifer was "very dry", indicating that there was no evidence of hydraulic communication between the perched and basal aquifers. The three deep basal aquifer monitoring wells and the four shallow perched wells were sampled during two different events in July and October of 1998. Generally, perched groundwater samples had low levels of TPH (and pyrene in one well during one event), and no TPH or PAHs were detected in basal groundwater samples. The Phase II RI concluded that the OWDF did not pose a threat to human health or the environment (DON 2000).

After completion of the Phase I and Phase II RI, EPA and DOH agreed that the OWDF was impacted solely by petroleum hydrocarbons, and therefore would be regulated by the DOH pursuant to the Hawaii Environmental Response Law, rather than by the EPA, despite the site being listed on the federal NPL (DON 2001). After additional soil investigations in 2002, DOH determined that the site warranted NFA (DON 2016). Subsequently, all of the monitoring wells at the OWDF except for one basal well (b) (9) [redacted] were abandoned (DON 2006). Table 1 lists relevant reports that detail the investigations and response actions conducted at the site.

Table 1: Relevant Site Investigation Reports

Report	Date
Phase I Remedial Investigation Report, Red Hill Oily Waste Disposal Facility, Fleet and Industrial Supply Center, Pearl Harbor, Oahu, Hawaii.	January 1996
Final Remediation Verification Report, Closure and Removal of Red Hill Stilling Basin, Fleet and Industrial Supply Center - Pearl Harbor, Red Hill, Hawaii.	March 1996
Phase II Remedial Investigation, Red Hill Oily Waste Disposal Facility, Halawa, Oahu, Hawaii.	September 2000
8,000-Gallon AST Area Total Petroleum Hydrocarbon-Diesel Characterization Report, Red Hill Oily Waste Disposal Facility, Hawaii.	December 2003
Well Abandonment Technical Memorandum, Red Hill Oily Waste Disposal Facility, Hawaii.	August 2006

The following two sections summarize the RI findings regarding the site geology and hydrogeology.

3. Site Geology

Figure 3 and Figure 4 show the geological cross-sections prepared during the RI to summarize the site geology (DON 2000). Generally, surface and near-surface soils consist of clay and rocky gravel (alluvium). In most areas of the site, the alluvium is underlain by perched groundwater contained within a weathered tuff layer occurring at depths of 26 to 36 ft bgs (86 to 95 ft msl), which grades into a confining layer of weathered, dense clay between 30 and 40 ft bgs (90 to 99 ft msl) (DON 1996a). Below this uppermost confining layer, additional layers of interbedded low permeability confining clays and clayey gravel extended vertically to the underlying basalt formation and laterally beyond the perimeter of the OWDF. A layer of dry, massive basalt was encountered to depths below zero ft msl in each of the three deep borings (DON 2000).

4. Site Hydrogeology

Two separate aquifers were encounter during the RI: the deep basal aquifer and a relatively shallow perched aquifer.

Basal Aquifer: According to the regional aquifer classification adopted by the DOH, the OWDF is located over the unconfined Pearl Harbor basal aquifer system (Mink and Lau 1990), with an expected basal groundwater elevation around Halawa Valley of approximately 17 ft above msl (Mink 1980). However, information on geology and hydrology acquired during the Phase I and II RI indicates that the basal aquifer beneath the OWDF is locally confined by zones of massive basalt and additional low permeability clay layers (DON 2000). During installation of the three onsite Phase II basal aquifer monitoring wells, basal groundwater was initially encountered at depths corresponding to elevations of 1.3, 2.8, and 20.3 ft ***below*** msl. After release from confinement, groundwater potentiometric heads in these wells rose to a static water level of approximately 17 ft above msl, i.e., the expected regional basal water elevation (DON 2000). Regional information including nearby borings drilled by the Hawaii Department of Transportation in preparation for construction of the Interstate H-3 Freeway confirm that these locally confining conditions extend beyond the perimeters of the OWDF—borings drilled 2,500 ft northwest (108-1D) and 2,000 ft west (108-04) of the OWDF did not encounter groundwater at total depths of 2.5 ft above msl and 26.5 ft below msl, respectively (HDOT 1988, in DON 2000).

The three basal wells were installed in a triangular pattern to evaluate basal groundwater flow direction beneath the OWDF, which was expected to be makai (to the west). The pattern of groundwater level fluctuations illustrated on Figure 5, however, indicates that (b) (9) consistently had the lowest basal groundwater elevation of the three wells. Triangulation of groundwater elevations measured in the three wells during the July to September 1998 period indicated a gentle gradient toward the nearby Red Hill Shaft Pumping Station to the northeast, which appears to alter the regional groundwater flow in the localized region beneath the OWDF.

The influence of pumping on the basal aquifer underlying the OWDF is illustrated by the trends of water levels measured in the pumping station and in the basal wells (Figure 5). Localized basal groundwater levels beneath the OWDF decrease approximately 2 to 6 ft in response to pumping, dependent on the number of pumps in operation. The plots clearly illustrate:

- Rapid drawdown of groundwater levels in the pumping station followed by successive drawdown in all of the OWDF basal monitoring wells as pumps were brought on line; and
- Rapid recovery of groundwater levels in the pumping station followed by successive recovery in all of the OWDF basal monitoring wells as pump were turned off.

Taken together, all of the available data indicates that the OWDF lies within the radius of influence or cone of groundwater depression (b) (9), resulting in a localized flow direction that differs from the regional mauka-to-makai hydrogeology.

Perched Aquifer: As described above, a relatively shallow perched aquifer was encountered in all of the shallow wells near the former disposal pits, at elevations above approximately 86 ft msl, which is approximately 90 feet above the confined basal aquifer and approximately 70 feet above the potentiometric surface of the basal aquifer. Data from the Phase II RI showed that the site has a low potential for flow through the multiple potential confining layers between the perched and basal aquifers. Geotechnical samples from the first encountered perched zone confirm that the material demonstrates extremely low measured permeability, ranging from 3.56×10^{-7} to 6.69×10^{-9} centimeter per second (cm/sec), and other low-permeability clay and gravelly clay layers were also identified between the major perched groundwater zone and the confined basal aquifer (DON 2000). Moreover, the drillers noted that the layers of massive basalt and low permeability clay layers that overlay and confine the basal aquifer in the vicinity of the

OWDF were "very dry" in each deep well until the confining layers were breached, which released the confined basal groundwater into the borehole (DON 2000). All of these features and layers illustrate that hydrogeologic barriers inhibit downward groundwater migration in the vicinity of the OWDF. As described above, the groundwater data collected from the perched (impacted) and basal (non-impacted) groundwater during the Phase II RI lent further weight to this conclusion.

5. Recent Groundwater Data in Samples Taken from OWDFMW01

In January 2008, the Navy published its Groundwater Protection Plan for the RHSF, which sets forth procedures to monitor area wells located within and around the RHSF; the plan (b) (9) has been sampled on a quarterly basis since August 2009. For the first few years, there were very few, sporadic, low-level detections of hydrocarbons in OWDFMW01 at concentrations far below level of potential concern.

Subsequently, from November 2012 through July 2015, and sporadically during other events, the laboratories reported concentrations of TPH diesel range organics (TPH-d) and specific analytes in samples taken from OWDFMW01. TPH-d exceeded the screening criterion during quarterly monitoring events in 2010, 2012, 2013, and 2015 (Figure 6). TPH-o, 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene were occasionally detected at concentrations generally orders of magnitude below the respective screening criteria. No individual analyte has exceeded (or even approached) the screening levels, and the chromatographs do not clearly indicate petroleum contamination. The analytical chromatograms produced by the laboratories when TPH-d and TPH-o were detected during the quarterly monitoring events do not confirm that the reported detections can be attributed to a petroleum release, and if so, when and where that release may have occurred.

From 2016 to the present, after the relatively brief period of TPH-d exceedances, elevated levels of TPH-d have not been detected and the concentration of most analytes decreased to non-detect levels, with a few sporadic exceptions. Consequently, it is not clear whether ongoing impacts to the basal aquifer underlying the OWDF persist, and if so, what and where the source may be or may have been.

6. Proposed Site Assessment.

To further investigate the detection of TPH-d above levels of potential concern, an additional site assessment is proposed to be conducted in general conformance with the state contingency plan and the DOH's technical guidance manual (TGM). Thus, a site investigation is proposed to update the conceptual site model and evaluate the nature and extent of contamination at the OWDF, which will include a detailed forensic evaluation of detected hydrocarbons and analysis of source degradation, and a potential assessment of biodegradation potential, as appropriate. Specifically, the site investigation will be designed to enable an environmental hazard evaluation to quantify any potential hazards and to determine whether any additional response actions are warranted, the ongoing utility of groundwater monitoring wells, and whether the NFA remains valid for the site.

A Tier 1 Work Plan will be developed for DOH review to achieve these goals. The Work Plan will incorporate applicable procedures specified in the Naval Facilities Engineering Command (NAVFAC) Pacific Environmental Restoration Program *Project Procedures Manual* (DON 2015) and be consistent with the TGM. The Work Plan is anticipated to detail the following general activities.

- *Installation of Groundwater Monitoring Wells:* Several perched and basal groundwater wells will be installed at the site to further investigate the site stratigraphy, confirm the presence or absence of contamination in groundwater, investigate basal groundwater flow, and evaluate the degree of hydrological communication between the upper and lower aquifers, if any.

- *Soil Sampling:* Representative soil samples will be collected from key geologic strata encountered during the installation of new groundwater monitoring wells to evaluate characteristics that may govern contaminant fate and transport, chemical partitioning, and bioavailability.
- *Groundwater Sampling:* Multiple rounds of groundwater sampling will be conducted to evaluate the nature and extent of COPCs at the site and evaluate other parameters affecting fate and transport phenomena.
- *Sample Analysis:* Soil and groundwater samples will be analyzed for site COPCs as natural attenuation and bioremediation parameters (NAPs), and other parameters affecting fate and transport of COPCs, such as geotechnical parameters, bacteria and fatty acid counts, silica gel analyses, and other forensic tests that will be described more fully in the work plan submitted for DOH review.
- *Water Level Study:* Groundwater levels will be measured in the wells under different conditions to characterize flow within and between the OWDF aquifers, if any, and to evaluate the effects of pumping at the nearby Red Hill Shaft Pumping Station.

7. Conclusion and Proposed Next Steps

Based on existing site data, the degree, nature, and potential persistence of contamination in the basal aquifer beneath the OWDF (if any) is not clear. Therefore, to investigate the increase in TPH-d and potentially related analytes observed (b) (9) during the 2012-2016 timeframe, the Navy will develop a detailed work plan. The plan will include the advancement of both deep and relatively shallow borings, installation and sampling of monitoring wells, and related field investigations and analyses recommended to assess the nature and extent of contamination, if any persists. Upon completion of the site investigation, an environmental health evaluation will be conducted, and the potential need for response actions and recommendations regarding groundwater monitoring and wells will be developed in consultation with the regulators.

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Acronyms and Abbreviations

µg/L	microgram per liter
AOC	Administrative Order on Consent
AST	aboveground storage tank
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/sec	centimeter per second
COPC	chemical of potential concern
CSM	conceptual site model
DLA	Defense Logistics Agency
DOH	Department of Health, State of Hawaii
EAOC	exposure area of concern
EPA	U.S. Environmental Protection Agency
F-76	Marine Diesel Fuel
FS	feasibility study
ft	foot or feet
ID	identification
JBPHH	Joint Base Pearl Harbor-Hickam
JP	Jet Fuel Propellant

mg/kg	milligram per kilogram
msl	mean sea level
NAP	natural attenuation parameter
NAVFAC	Naval Facilities Engineering Command
NAVSUP FLC	Naval Supply Systems Command Fleet Logistics Center
NFA	no further action
NPL	National Priorities List
OWDF	Oily Waste Disposal Facility
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
RHSF	Red Hill Bulk Fuel Storage Facility
RI	remedial investigation
SVOC	semivolatile organic compound
TFH	total fuel hydrocarbons
TGM	Technical Guidance Manual for the Implementation of the Hawai‘i State Contingency Plan
TIC	tentatively identified compound
TPH	total petroleum hydrocarbons
TPH-d	total petroleum hydrocarbons – diesel range organics
TPH-g	total petroleum hydrocarbons – gasoline range organics
USCS	Unified Soil Classification System
UST	underground storage tank
VOC	volatile organic compound

Attachments

Figure 1: Site Location Map

Figure 2: EAOCs in the OWDF Phase I and II Remedial Investigations

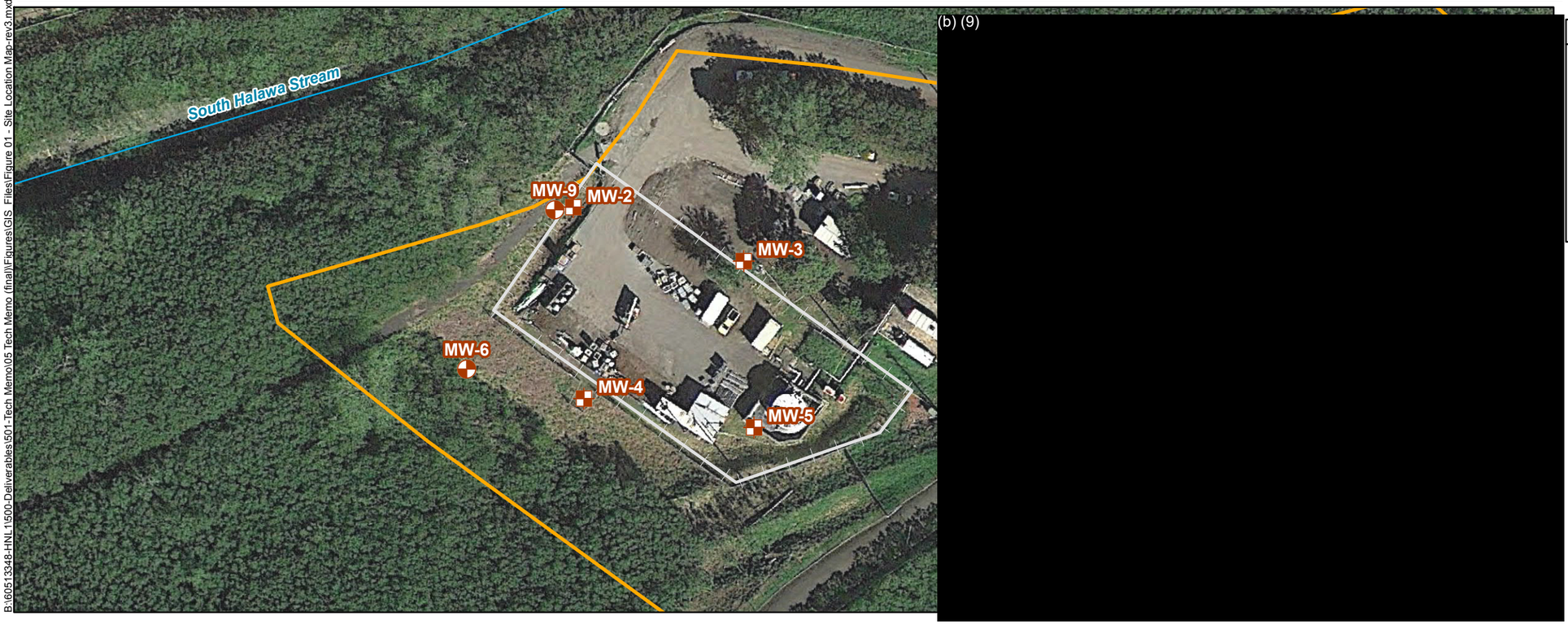
Figure 3: Geologic Cross Section A–A′

Figure 4: Geologic Cross Section B–B′

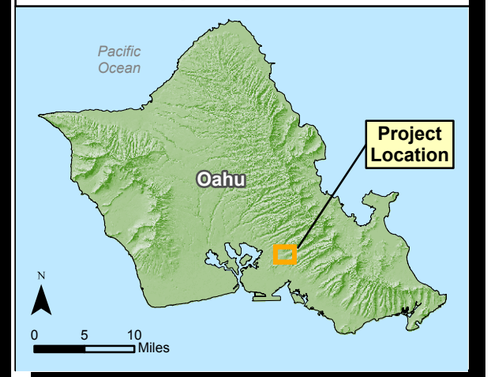
Figure 5: Basal Groundwater Surface Elevations from August 21, 1998 to August 24, 1998

Figure 6: TPH-d Concentrations Over Time in Monitoring Well OWDFMW01

(b) (9)



LOCATION MAP



LEGEND

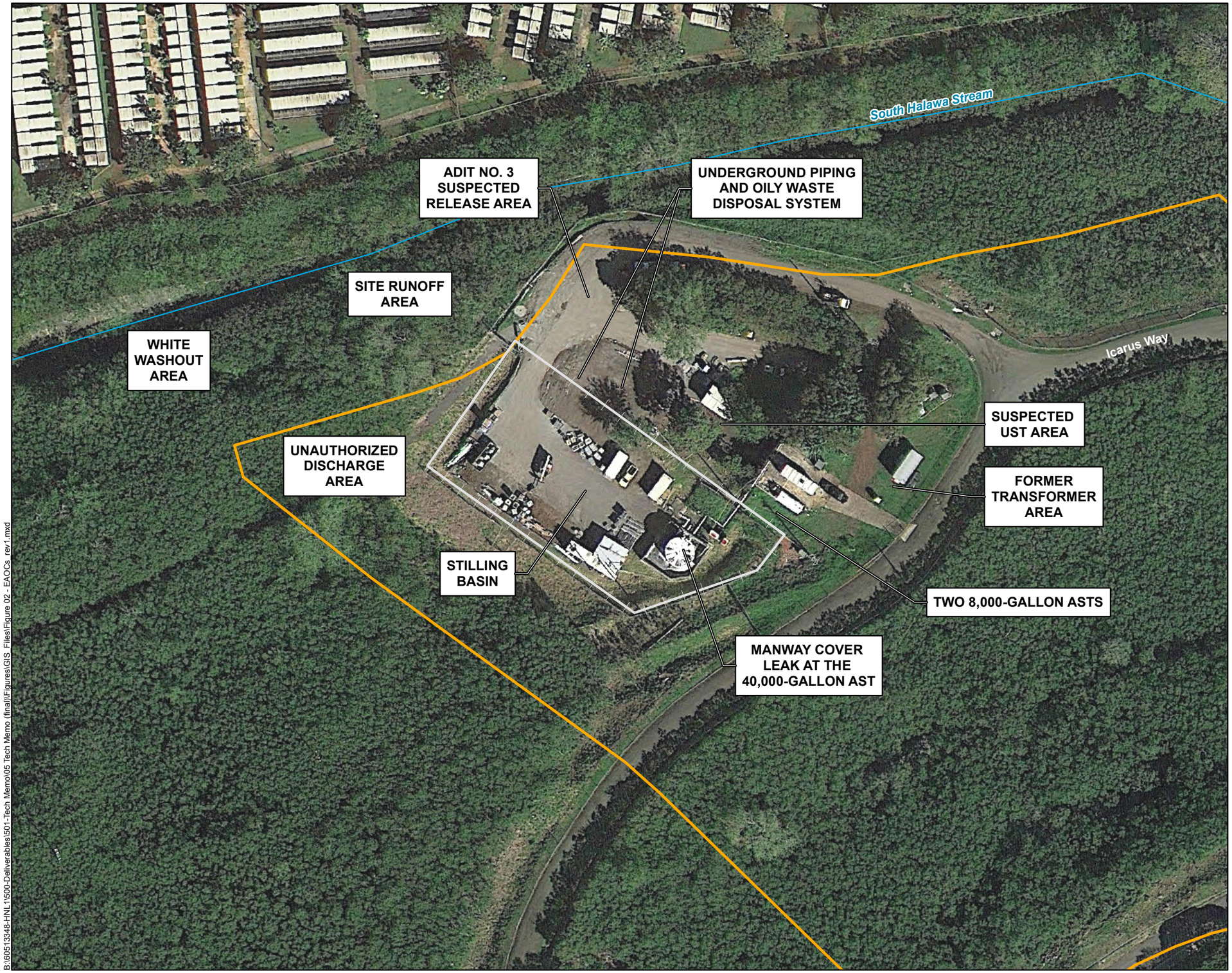
- Abandoned Basal Monitoring Well
- Abandoned Perched Monitoring Well
- Existing Observation Well
- Water Pumping Station
- Red Hill UST
- Oily Waste Disposal Facility
- Red Hill Installation Boundary
- Stream
- Fence

NOTES

1. Acronyms and Abbreviations:
   UST underground storage tank
2. Sources: Mink & Lau (1990); DLNR (1998); USGS (1983); DON (2016).
3. Basemaps:
   Top: DigitalGlobe and NRCS, 2011. https://gdg.sc.egov.usda.gov
   Bottom: Google Earth Pro V6.2.2.6613 (December 15, 2015). DigitalGlobe 2016, USGS 2016. http://www.earth.google.com [October 20, 2016].
4. Map projection: NAD 1983 UTM Zone 4N (meters).

Figure 1
Site Location Map
Technical Memorandum
Phase III Remedial Investigation
Red Hill Oily Waste Disposal Facility
JBPHH, Oahu, Hawaii

B:\60513348-HNL\1500-Deliverables\501-Tech Memo\05 Tech Memo (final)\Figures\GIS Files\Figure 01 - Site Location Map-rev3.mxd 10/22/2019



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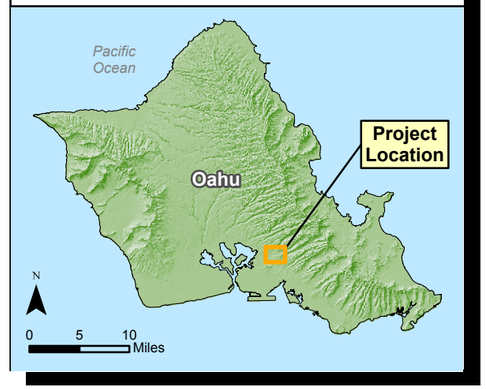
LOCATION MAP



LEGEND

- SITE RUNOFF — EAOC Location
- Red Hill Installation Boundary
- Fence
- Stream

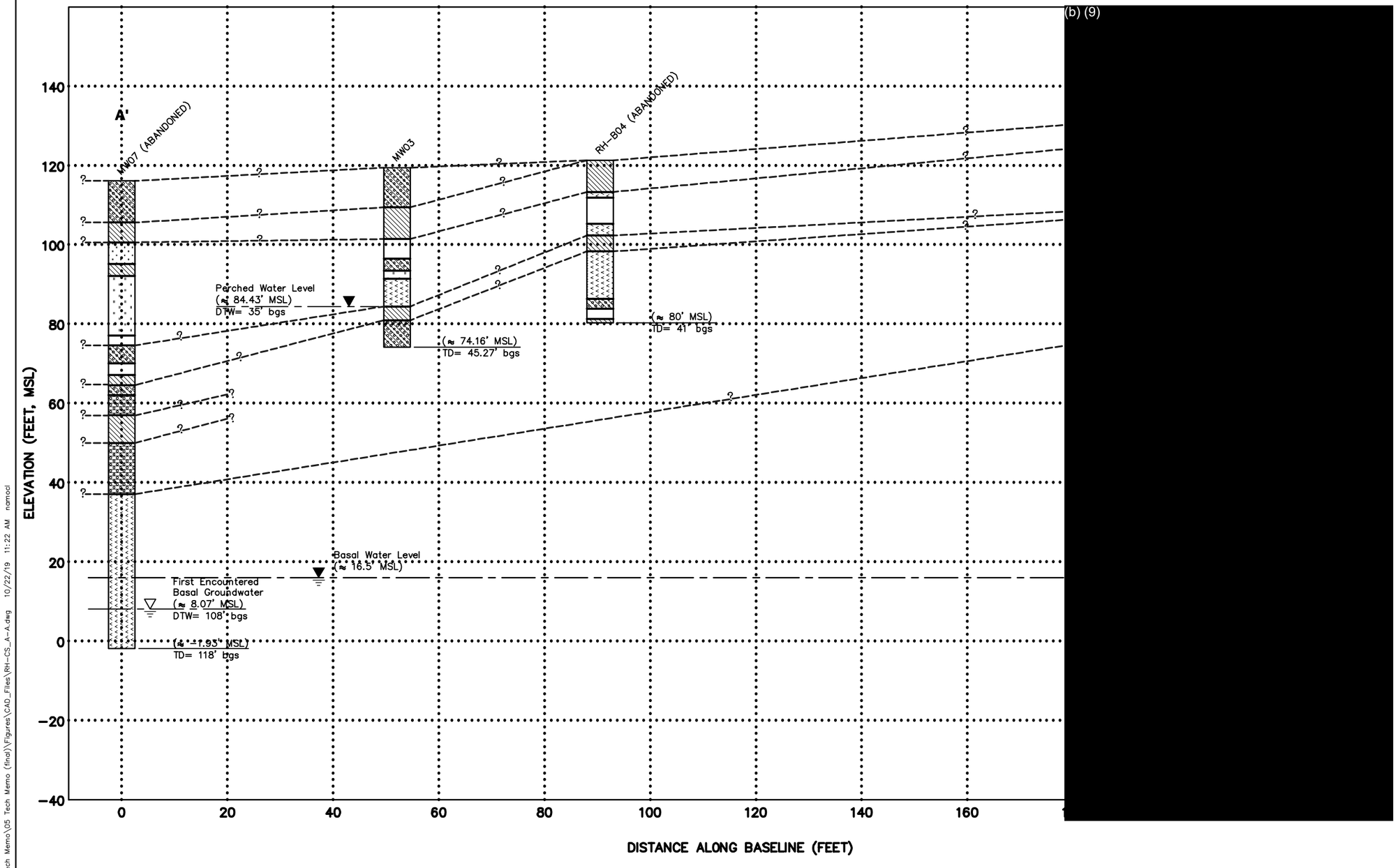
NOTES

1. Acronyms and Abbreviations:
   AST aboveground storage tank
   EAOC exposure area of concern
   UST underground storage tank
2. Source: DON (1996)
3. Basemap: Google Earth Pro V6.2.2.6613 (December 15, 2015). DigitalGlobe 2016, USGS 2016. http://www.earth.google.com [October 20, 2016].
4. Map projection: NAD 1983 UTM Zone 4N (meters).

N

0 70 140 Feet

Figure 2
EAOCs in the OWDF
Phase I and II Remedial Investigations
Technical Memorandum
Phase III Remedial Investigation
Red Hill Oily Waste Disposal Facility
JBPHH, Oahu, Hawaii



LEGEND

bgs	Below Ground Surface
MSL	Mean Sea Level
MW	Monitoring Well
TD	Total Depth of Boring in Feet Below Ground Surface (bgs)
DTW	Depth to Water
≈	Approximately equal
	Inferred Lithology Boundary
	Perched Water Level
	Basal Water level
	First Encountered Basal Groundwater
	Clayey Gravel
	Tuff
	Clay
	Interbed Clayey Gravel & Gravely Clay
	Sand
	No Recovery
	Basalt

SIMPLIFIED SITE MAP

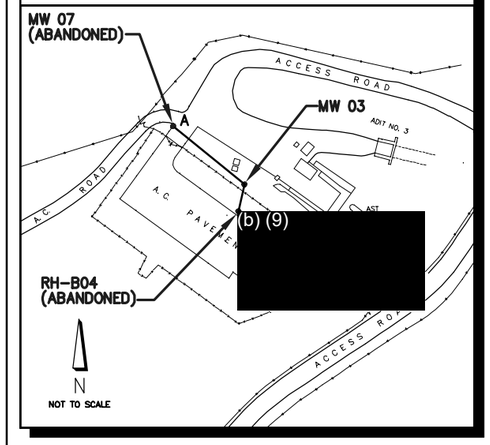
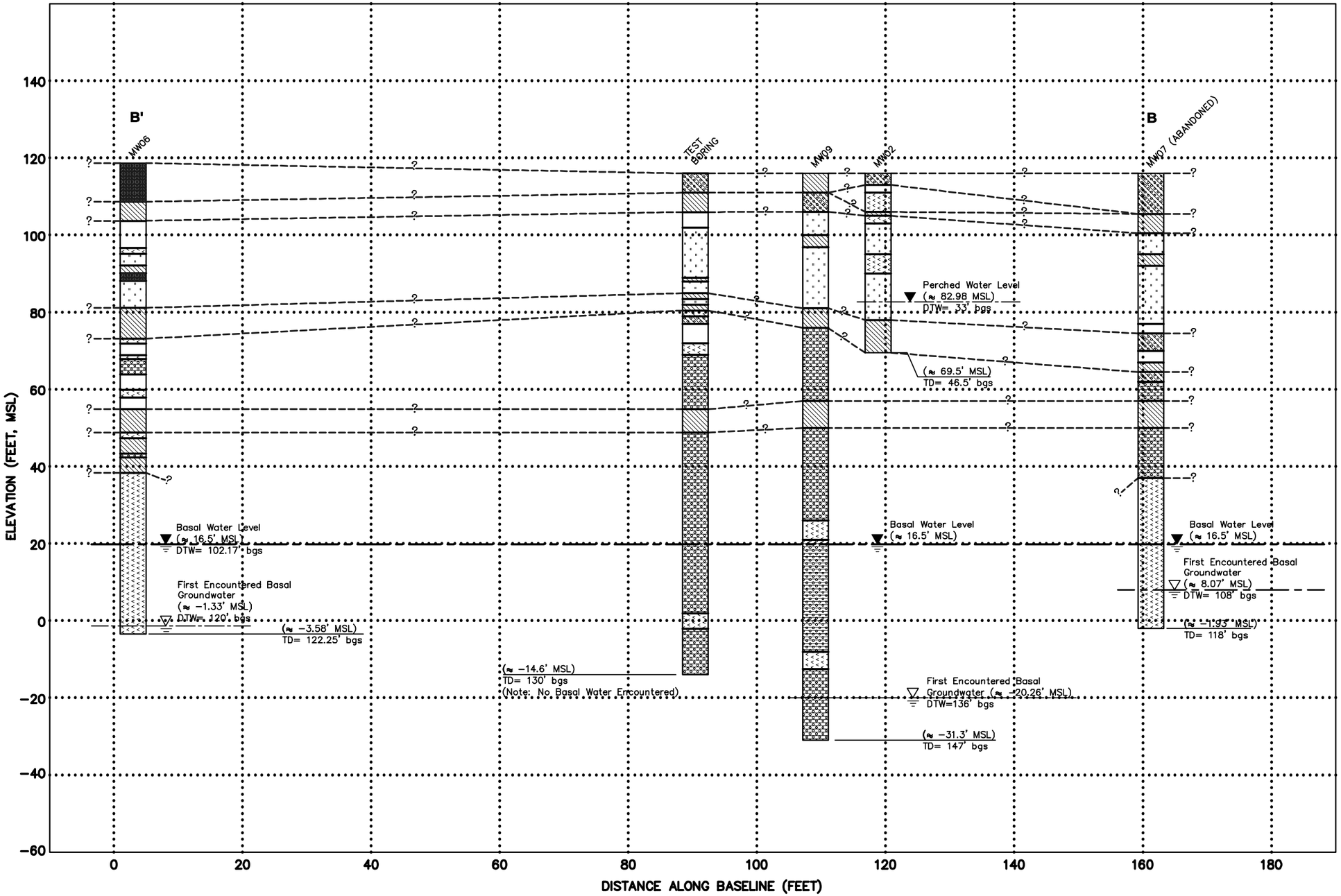


Figure 3
Geologic Cross Section A–A'
Technical Memorandum
Phase III Remedial Investigation
Red Hill Oily Waste Disposal Facility
JBPHH, Oahu, Hawaii



LEGEND

bgs	Below Ground Surface
MSL	Mean Sea Level
MW	Monitoring Well
TD	Total Depth of Boring in Feet Below Ground Surface (bgs)
DTW	Depth to Water
≈	Approximately equal
---?---	Inferred Lithology Boundary
—▼—	Perched Water Level
—▼—	Basal Water level
—▽—	First Encountered Basal Groundwater

- Clayey Gravel
- Clay
- Sand
- Basalt
- Tuff
- Interbed Clayey Gravel & Gravely Clay
- No Recovery

SIMPLIFIED SITE MAP

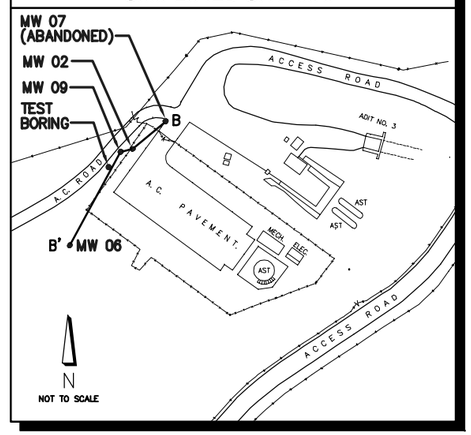


Figure 4
Geologic Cross Section B–B'
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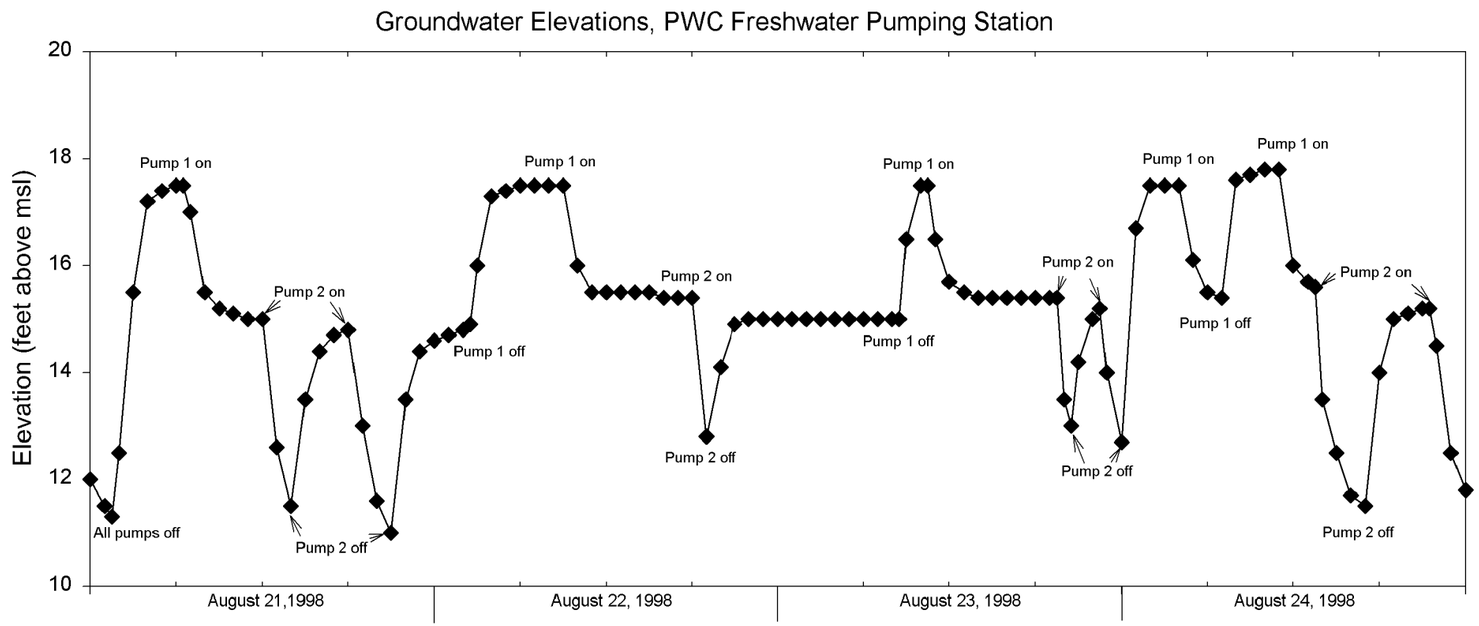
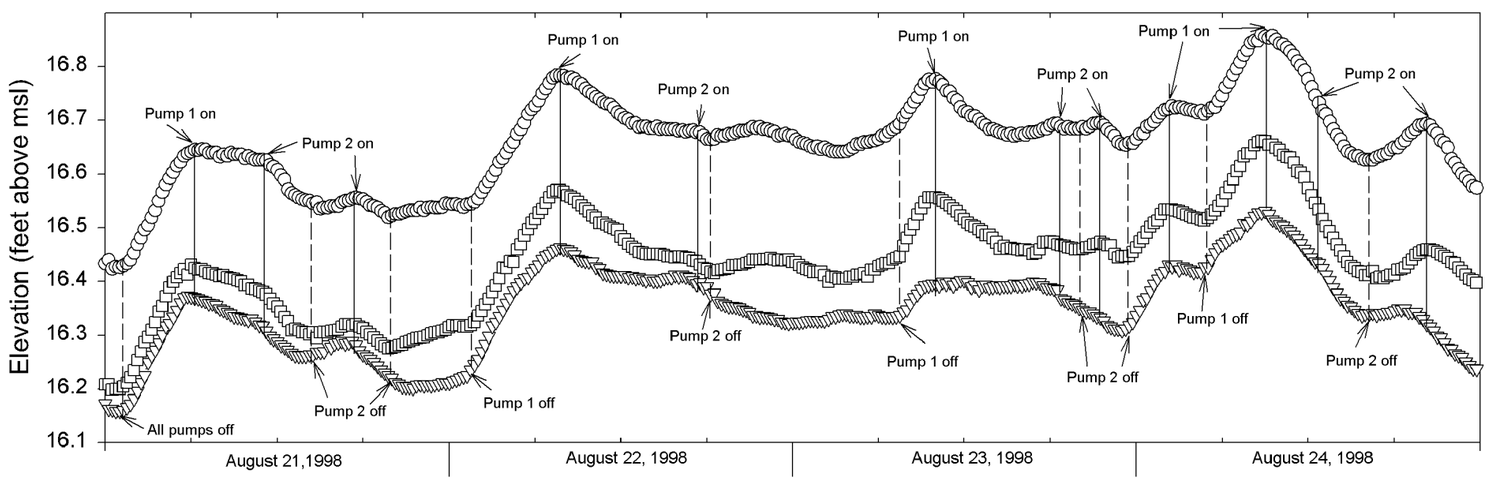
Red Hill Oily Waste Disposal Facility
JBPHH, Oahu, Hawaii





LEGEND

- PWC freshwater pumping station elevation
- Recorded MW06 elevation
- Recorded MW08 elevation
- Recorded MW09 elevation

NOTES

All elevations referenced to msl.

Figure 5
Basal Groundwater Surface Elevations
From August 21, 1998 to August 24, 1998
Phase III Remedial Investigation
Red Hill Oily Waste Disposal Facility
JBPHH, Oahu, Hawaii

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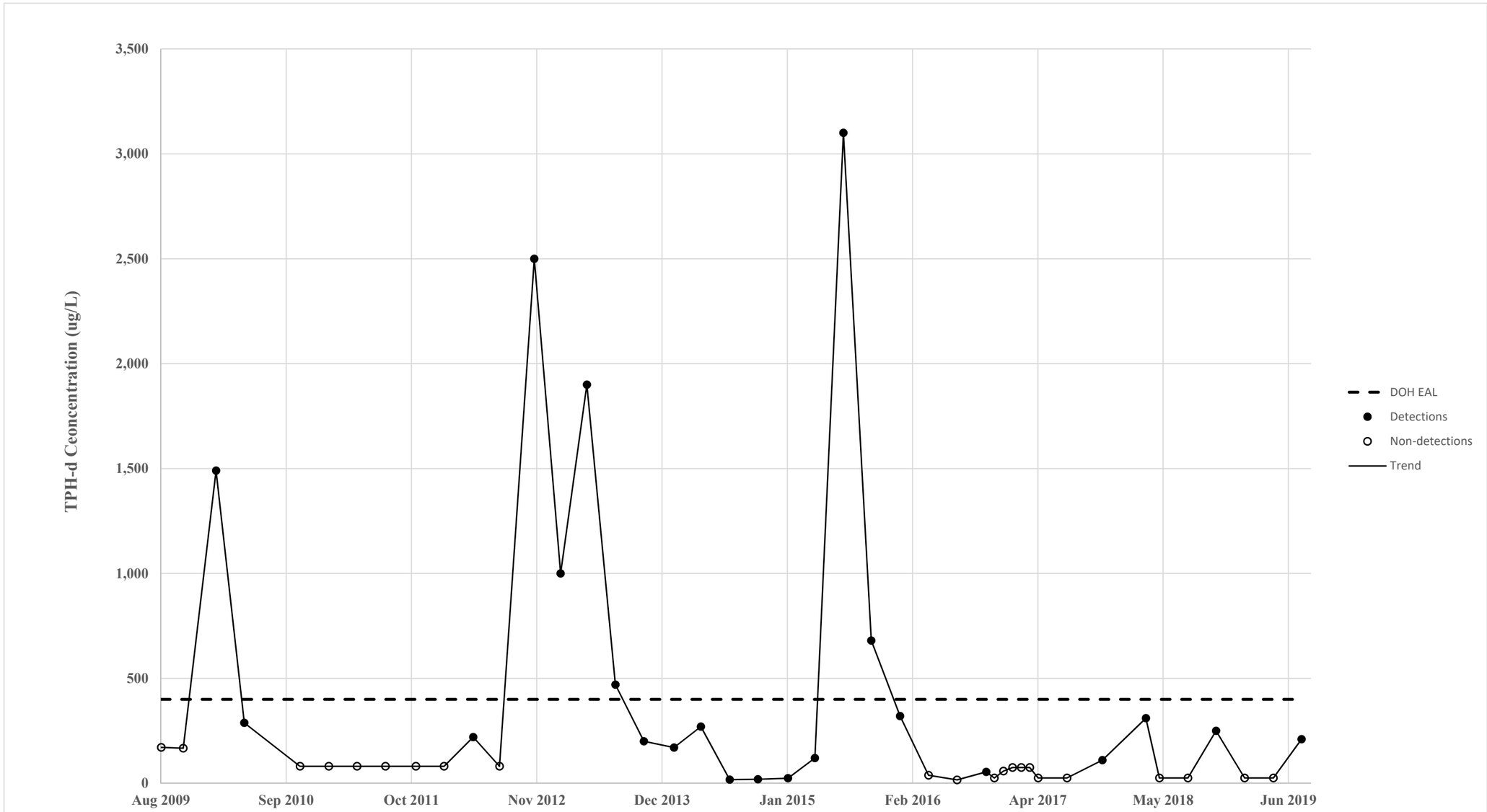

Figure 6
TPD-d Concentrations Over Time in Monitoring Well OWDFMW01
Technical Memorandum
Phase III Remedial Investigation
Red Hill Oily Waste Disposal Facility
JBPHH, Oahu, Hawaii