# Consolidation and Optimization of the Groundwater Sampling Programs, Red Hill Bulk Fuel Storage Facility

**Joint Base Pearl Harbor-Hickam, O'ahu, Hawai'i**

*Naval Facilities Engineering Systems Command, Hawaii, JBPHH HI*

*December 2023*

## 0. Document Management

This document supersedes the Navy's submission of the Consolidation and Optimization of the Groundwater Sampling Programs, Red Hill Bulk Fuel Storage Facility, May 2023, in its entirety.

## 1. Executive Summary

The Navy is consolidating Notice of Interest (NOI), Groundwater Long-Term Monitoring (GW LTM), delineation and sentinel wells into one comprehensive, optimized groundwater sampling program. The new program is based on Hawai'i Department of Health (DOH) guidance, the Red Hill Administrative Order on Consent (AOC), the Regulatory Agencies' (RAs') NOI requirements that expired November 13, 2022, the March 8, 2023 meeting with the U.S. Environmental Protection Agency (EPA) and DOH regarding future sampling requirements, the April 13, 2023 Red Hill Remediation Roundtable meeting, and reviews of NOI data collected and analyzed at least weekly from May 2021 through June 2023.

In September 2023, the Navy submitted a Final Report of Findings, Red Hill Shaft Flow Optimization Study (Flow Optimization Study) (DON 2023) to DOH, which presented data to evaluate the feasibility of reducing the flow from U.S. Navy Well 2254-01 (also known as "Red Hill Shaft" and "RHS") to meet the objective of long-term sustainability of the drinking water resource. Currently, RHS is pumping full-time to induce drawdown in the aquifer in the vicinity of RHS water development tunnel. This pumped water is treated through a granular activated carbon (GAC) treatment system, then discharged under a National Pollution Discharge Elimination System (NPDES) permit to South Halawa Stream.

On November 15, 2023, after reviewing the Final Report of Findings, the DOH submitted a letter to the Navy indicating that the study did not provide sufficient evidence that a reduction in pumping of RHS would not result in harm to human health or the environment. However, DOH recognized the importance of conserving the island's natural resources and outlined a path forward, upon DOH approval, to reduce pumping through an increase in monitoring and evaluation once tank defueling activities – defined as removal of fuel from the tank mains and flowable tank bottoms -- was completed.

The consolidated sampling approach includes the following changes:

- Integrating and coordinating all of the Red Hill groundwater sampling programs into a single program to facilitate better regulatory oversight, and sampling event execution throughout and in the vicinity of the Red Hill Bulk Fuel Storage Facility;
- Revising the previous-NOI analyte list, with a focus on fuel-related analytes;
- Optimizing the previous-NOI sampling frequency from weekly to monthly to facilitate quicker laboratory turn-around times;
- Optimizing previous-NOI monitoring locations to provide comprehensive assessment of the general area;
- Standardizing the previous-NOI sample collection method to use low-flow purging and sampling methodology, as recommended in the DOH Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan (TGM) (DOH 2021);
- Combining the quarterly GW LTM sampling events with the corresponding monthly events to eliminate duplicate analyses, results, and effort;

- Transition of PFAS sampling into the Environmental Restoration-Navy (ERN) program that manages restoration activities in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA);
- During reduced flow conditions at the Red Hill Shaft, increasing the sampling frequency to twice per month to closely monitor any changes in the groundwater quality in the basal aquifer drinking water resource that may indicate migration of contaminants under a reduced RHS average pumping rate;
- Documenting additional data evaluation procedures that will be conducted during reduced Red Hill Shaft flow conditions to identify changes in water quality that indicate uncontrolled fuel contaminant migration as light nonaqueous-phase liquid (LNAPL) or as dissolved-phase analytes;
- Documenting any uncontrolled migration of contaminants identified that presents a risk to human health or the environment.

# 2. Groundwater Sampling Program Improvements

## 2.1 SAMPLING PROGRAM INTEGRATION

To optimize the sampling programs to support accurate and timely analytical chemistry results and achieve more efficient data evaluation, the various programs have been integrated into a single, comprehensive groundwater sampling program. The Consolidated Groundwater Sampling Program requirements include the analytical suite, analytical methods, laboratory turnaround times, sampling locations, sample collection methods, and sampling frequency.

In accordance with the *Sampling and Analysis Plan, Investigation and Remediation of Releases and Groundwater Protection and Evaluation, Revision 01* (DON 2017), the U.S. Navy Environmental Restoration Program, Naval Facilities Engineering Systems Command Pacific, Project Procedures Manual (DON 2015), and the DOH TGM (DOH 2021), the Consolidated Groundwater Sampling Program includes NOI and GW LTM sampling of inside- and outside-tunnel sampling locations using low-flow sampling techniques. Groundwater sampling also includes measuring depth to groundwater and depth to well bottom from the top of casing and assessing the presence or absence of an immiscible phase. A photoionization detector (PID) is used to evaluate whether volatile organic compound levels in wells are above ambient conditions prior to deploying an oil/water interface probe.

Headspace monitoring for volatile organic compounds is performed at all locations, and fuel product thickness gauging is conducted at wells with screens that bracket the water table. Bailers are used to assess and photo document the presence or absence of floating product on the groundwater surface in wells installed in unconfined conditions.

Observations, measurements, and field parameters collected during purging prior to groundwater sampling include water level measurements, observations (i.e., water clarity and condition, evidence of free product), dissolved oxygen measurements, and groundwater sampling parameters (turbidity, specific conductance, oxidation reduction potential, pH, and temperature).

Emergency response from the December 2022 aqueous fire-fighting foam (AFFF) release and baseline PFAS sampling has been completed. Additional PFAS sampling has moved to the Navy's ERN program in accordance with CERCLA.

## 2.2 ANALYTE LIST

NOI, GW LTM, delineation well, and sentinel well sampling has generated a substantial dataset characterizing the nature and extent of the fuel releases. The NOI sampling included analyses of chemicals

of potential concern (COPCs) and additional analytes including chemicals that are not associated with fuels. Therefore, this document presents the notification of changes to the ongoing NOI sampling program and integration of the various groundwater monitoring programs into one overall program based on the substantial body of laboratory results, DOH guidance, and the composition of the fuels, similar to the process employed under the AOC. Table 1 provides a summary of the analytical list for the consolidated groundwater monitoring program, which includes monthly analytes, analytical methods, and screening criteria.

**Table 1: Consolidated Groundwater Sampling Program**

| Parameter | Analytical Method | Analyte(s) | GW Screening Criterion (DOH EAL) (µg/L) | GW-LTM Parameters (Added Quarterly) | Consolidated Parameters [a] |
|---|---|---|---|---|---|
| TPH | EPA 8015 | TPH-g | 300 | X | X |
| | EPA 8015 | TPH-d | 400 | X [b] | X |
| | | TPH-o | 500 | X [b] | X |
| Total TPH | — | Reported as a non-overlapping sum of TPH-g/d/o with BTEX and methylnaphthalenes subtracted | — | | X |
| TPH with SGC | EPA 3630/8015 | TPH-d | — | X [b] | X |
| | | TPH-o | — | X [b] | X |
| VOCs | EPA 8260 | Benzene | 5 | X | X |
| | | Ethyl Benzene | 30 | X | X |
| | | Toluene | 40 | X | X |
| | | Total Xylenes | 20 | X | X |
| AOC / GW LTM PAHs | EPA 8270 SIM | 1-Methylnaphthalene | 10 | X | X |
| | | 2-Methylnaphthalene | 10 | X | X |
| | | Naphthalene | 17 | X | X |
| PAHs | EPA 8270 SIM | Acenaphthene | 20 | X | X |
| | | Acenaphthylene | 240 | X | X |
| | | Anthracene | 0.18 | X | X |
| | | Benzo(a)anthracene | 0.029 | X | X |
| | | Benzo(a)pyrene | 0.2 | X | X |
| | | Benzo(b)fluoranthene | 0.22 | X | X |
| | | Benzo(g,h,i)perylene | 0.13 | X | X |
| | | Benzo(k)fluoranthene | 0.4 | X | X |
| | | Chrysene | 1 | X | X |
| | | Dibenzo(a,h)anthracene | 0.022 | X | X |
| | | Fluoranthene | 13 | X | X |
| | | Fluorene | 240 | X | X |
| | | Indeno(1,2,3-cd)pyrene | 0.095 | X | X |
| | | Phenanthrene | 210 | X | X |
| | | Pyrene | 68 | X | X |
| Fuel Additives | EPA 8270 | Phenol | 300 | X | X |
| | EPA 8270 | 2-(2-Methoxyethoxy) Ethanol | 800 | X | |
| Lead Scavengers [c] | EPA 8011 | 1,2-Dibromoethane | 0.04 | X | X |
| | EPA 8260 | 1,2-Dichloroethane | 5 | X | X |
| NAPs | SM 3500-Fe | Ferrous Iron | — | X | |
| | RSK 175M | Methane | — | X | X |
| | EPA 300.0 | Nitrate, Sulfate, Chloride | — | X | |
| | EPA 353.2 | Nitrate-Nitrite as Nitrogen | — | X | |
| | SM 2320 | Carbonate, Bicarbonate, and Total Alkalinity | — | X | |
| | EPA 9060A | TOC | — | X | X |
| | EPA 9060A | NVDOC | — | X | X |
| General Chemistry [d] | EPA 300.0 | Bromide, Chloride, Fluoride, Nitrate, Sulfate | — | X | |
| | EPA 6010C | Calcium, Magnesium, Manganese, Potassium, Sodium | — | X | |
| | SMWW4500-Si-D / SIO2-C | Dissolved Silica, Total Silica | — | X | |

Notes:
µg/L micrograms per liter
BTEX benzene, toluene, ethylbenzene, and total xylenes
DOH EAL Hawaii Department of Health Environmental Action Level
GW groundwater
mgd million gallons per day
NAP natural attenuation parameter
NVDOC non-volatile dissolved organic carbon
PAH polynuclear (polycyclic) aromatic hydrocarbon
SGC silica gel cleanup
TPH-d total petroleum hydrocarbons - diesel range organics
TPH-g total petroleum hydrocarbons - gasoline range organics
TPH-o total petroleum hydrocarbons - residual range organics
VOC volatile organic compound
— not applicable
X Compound is included in the respective groundwater sampling program.
[a] Collected monthly during 4.3-mgd pumping and twice per month during reduced pumping at the Red Hill Shaft
[b] Uses 3510 extraction method for Consolidated. Additional 3520 for Quarterly
[c] Discontinued if one year's worth of sampling show levels are below DOH EALs
[d] Monitored on the first GW LTM event of a new well

The following ten primary COPCs were established in February 2016 list (EPA Region 9 and DOH 2016) for the AOC investigations and the GW LTM program and will remain the same for the Consolidated Groundwater Sampling Program:

- Total petroleum hydrocarbons (TPH)-gasoline range organics (TPH-g), TPH-diesel range organics (TPH-d), and TPH-oil range organics (TPH-o)
- Naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene
- Benzene, toluene, ethylbenzene, and total xylenes (BTEX)

During a March 8, 2023 collaboration meeting between the Navy, EPA, and DOH, the Navy presented a list of reduced analytes for NOI sampling. The Navy showed that including non-fuel-related analytes to the target analyte list increased processing time for commercial laboratories, data validators, and shipping without adding valuable information to identify and characterize potential fuel release impacts. This contributed to delays in validation, reporting, and timely analyses of results and impeded rapid assessment of impacts to groundwater and the ability to quickly respond to changes in groundwater conditions. Although it was valuable during emergency response activities in late 2021 and early 2022, sampling and analysis of these non-fuel analytes ran counter to TGM guidance of "Do not simply list chemicals associated with specific laboratory methods that will be utilized to test samples collected at the site,"[1]; as such, certain analytes were previously discontinued from the Consolidated Groundwater Sampling Program.

Laboratory results from the comprehensive set of groundwater monitoring events show unsystematic low concentrations of non-fuel analytes and confirm that the analytes used as the AOC and GW LTM COPCs are appropriate. However, out of an abundance of caution, additional polynuclear (polycyclic) aromatic hydrocarbons (PAHs) analyzed for previous-NOI sampling will also continue as part of the Consolidated Groundwater Sampling Program because some PAHs are potentially associated with jet fuels at low concentrations. The Navy also previously agreed to add non-volatile dissolved organic carbon, and it has been added to the natural attenuation parameter (NAP) list for previous-NOI and LTM sampling.

This consolidation plan combines the GW LTM event that occurs every third month with the NOI sampling event that occurs at the same time. This combined GW LTM-NOI quarterly event will consist of all the previous-NOI sampling parameters and also include the additional GW LTM parameters listed below and shown in Table 1:

- TPH-d and TPH-o using the 3520 extraction method, as well as the previous-NOI-based TPH-d and TPH-o analyses using the 3510 extraction method
- Fuel additive 2-(2-methoxyethoxy) ethanol
- NAPs, including ferrous iron, nitrate, sulfate, chloride, nitrate-nitrite as nitrogen, carbonate, bicarbonate, and total alkalinity
- The general chemistry parameters calcium, iron, dissolved lead, total lead, magnesium, manganese, potassium, and sodium

## 2.3 OPTIMIZE SAMPLING FREQUENCY

### 2.3.1 Monthly Sampling

As discussed during the March 8, 2023 collaboration meeting, weekly NOI sampling conducted after the 2021 release events effectively captured the increase and subsequent decrease of COPC concentrations in the monitoring wells following the releases, which provided an understanding of the impacts of those releases. In addition, the data showed that concentrations have significantly decreased and stabilized, in

[1] https://health.hawaii.gov/heer/tgm/section-06/.

most cases returning to non-detectable or within historical ranges. As a result, weekly sampling frequency no longer provides added information that was not already captured by monthly (or quarterly) sampling. Reducing the sampling frequency to monthly (at full-time operation of the RHS GAC) allows for groundwater characterization and trend analyses without sacrificing accuracy, and reduces processing time for the commercial laboratories, the data validators, and sampling and shipping. The monthly sampling frequency is in accordance with the DOH TGM, which states: "Long-term monitoring of groundwater should be carried out at a frequency adequate to assess trends in potential environmental concerns and guide and monitor the effectiveness of remedial actions" (DOH TGM Section 6.6.8.5).[2]

### 2.3.2 Reduced Red Hill Shaft Pumping Rate Sampling Frequency

In accordance with DOH's November 15, 2023 letter, the Navy will implement reduced pumping and GAC-filtered discharge of water from RHS into South Halawa stream under strict evaluation measures to ensure fuel-related contaminants in the basal aquifer – a potable water resource – do not present an unacceptable risk to human health or the environment. The listed actions in Section 2.4 will be taken to ensure that potential migration of contaminants under a reduced RHS average pumping rate are identified in a timely manner.

In addition, the NPDES permit requires that RHS discharge water be sampled when the pumps are turned on after a shutoff period of 24 hours or greater. Details of this requirement are provided in *Red Hill Shaft Recovery Plan NPDES Compliance Sampling Protocol*, March 27, 2023 (IDWST 2023).

Sampling and analysis frequency will increase from monthly to twice per month during reduced pumping. The twice per month sampling events will be conducted with no less than ten (10) calendar days between the preceding or succeeding sampling events. In consultation with the Regulatory Agencies, the Navy may submit approval requests to adjust the sampling frequency based on the results of data evaluation.

Turnaround times for analytical results and data validation, field checks including headspace testing, and free product gauging will be expedited to allow timely decision-making for response actions based on these results. All groundwater samples will be scheduled so that they can be shipped to the laboratory on the day they are collected, with the objective of minimizing the transit time to one (1) calendar day. In some cases, transit time may necessarily be longer in duration based on sampling times, transportation options, weather delays, etc. Samples will be analyzed on an expedited preliminary result turnaround of five (5) business days (upon receipt at the laboratory) and will be validated on an expedited seven (7) business day turnaround (upon issuance of the analytical report). This schedule will provide for a review of the five business day preliminary analytical data prior to the next scheduled sampling event.

The standard field checks described in Section 2.1 will also detect potential contamination. Headspace monitoring will be performed at all locations, and fuel product thickness gauging will be conducted at wells with screens that bracket the water table. Bailers will be used to assess and photo-document the presence or absence of floating product on the groundwater surface in wells installed in unconfined conditions.

In conjunction with collection of liquid samples from the water table using a bailer, a portion of the liquids will be transferred to a clean 1-liter jar, which will be capped and shaken, then the headspace will be measured with a handheld PID. This concentration is representative of LNAPL/dissolved total VOC concentrations and will be used in lieu of headspace readings immediately above the water table.

[2] https://health.hawaii.gov/heer/tgm/section-06/.

Table 2 summarizes the frequency for each sampling location monitored twice per month, monthly, and quarterly under the Consolidated Groundwater Sampling Program. As additional monitoring wells are installed, they will be incorporated at similar frequencies as the existing wells.

**Table 2: Summary of Consolidated Plan Sampling Frequency by Program**

| Sampling Program | HDMW2253-03 | RHMW2254-01 | RHP01 | RHP02 | RHP03 | RHP04A | RHP04B | RHP04C | RHP05 | RHP06 | RHP07 | RHP08 | RHMW01R | RHMW02 | RHMW03 | RHMW04 | RHMW05 | RHMW06 | RHMW08 | RHMW09 | RHMW10 | RHMW11 | RHMW12A | RHMW13 | RHMW14 | RHMW15 | RHMW16 | RHMW17 | RHMW19 | RHMW20 | NMW24 | NMW25 | NMW30 | NMW32 | NMW33 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 AOC LTM | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q |
| Consolidated Sampling | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M | M |
| Consolidated Sampling (Reduced GAC Operation) | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M | 2M |

**Notes**

Q - Quarterly

M - Monthly

2M - Twice per month

## 2.4 DATA EVALUATION AND ACTIONS TAKEN IF POTENTIAL MIGRATION OF CONTAMINANTS IS IDENTIFIED DURING REDUCED PUMPING

Sample collection and expedited shipping, analysis, and review will be scheduled and performed to facilitate early evaluation of field data and preliminary analytical data such that any desired revisions to the next sampling event can be planned and implemented with haste.

To identify any changing trends, field parameter data will be tabulated upon collection (twice per month) and compared against the historical data set for the individual well and also the comprehensive data set for all wells. This data will be provided to the RAs through EDMS.

Twice per month, validated TPH-o and TPH-d data will be tabulated and plotted in time-series charts and reviewed for any potential anomalies or trends that may be indicative of uncontrolled fuel contaminant migration. Data validation will include review of TPH chromatographs by a subject matter expert to verify the results are from fuel-related analytes. SGC analyses will also be used to determine TPH degradation patterns. This data will be provided to the RAs through EDMS.

Additionally, in conjunction with contaminant analyses, validated natural-attenuation parameters will be tabulated and plotted in time-series charts and compared to field parameters, general chemistry, and contaminant concentrations to determine any changes or migration patterns associated with biogeochemical processes. This data will be provided to the RAs through EDMS.

Multiple lines of evidence will be used to evaluate potential uncontrolled fuel contaminant migration. Potential/primary indications of uncontrolled migration of fuel contaminants may include:

1. Observations of LNAPL in a monitoring well;
2. Multiple subsequent significant observations of naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene in a monitoring well. A significant result is defined as a one standard deviation (calculated from historic levels utilizing data collected since January 2022); increase above the immediate preceding result.
3. Multiple subsequent observations (> two observations) of TPH-d and/or TPH-o in a monitoring well, increasing by one standard deviation (calculated from historic levels utilizing data collected since January 2022) above the immediate preceding result;
4. Observations of TPH-d and/or TPH-o at concentrations exceeding the DOH EAL in a monitoring well that historically (utilizing data collected since January 2022) has not seen such an exceedance;

5. Any sufficiently overt data trend in onsite wells that may suggest mass and uncontrolled migration of contamination, noting the occurrence of NAPL and fluctuations in dissolved-phase contamination within the source zone and wells proximate to RHS may reasonably be expected in response to changed flow conditions and should not automatically be evaluated as uncontrolled migration.

Upon observing one or more lines of evidence from verified field observations or validated laboratory data, of uncontrolled fuel-related contaminant migration that present an unacceptable risk to human health or the environment, the Navy will notify DOH and implement appropriate actions in accordance with local, State, and Federal regulations. In addition, the Navy may choose to increase RHS pumping and GAC-filtered discharge rate to increase groundwater containment within the vicinity of RHS.

## 2.5 OPTIMIZE MONITORING LOCATIONS

**Sampling locations in each program were evaluated and locations were retained or excluded to optimize future sampling. Locations were removed based on their representativeness of groundwater conditions, duplication of (e.g., close proximity to) other sampling locations, anomalous water levels (elevated) and response to pumping conditions or other factors that differ from surrounding wells, or inclusion in another groundwater sampling program.**

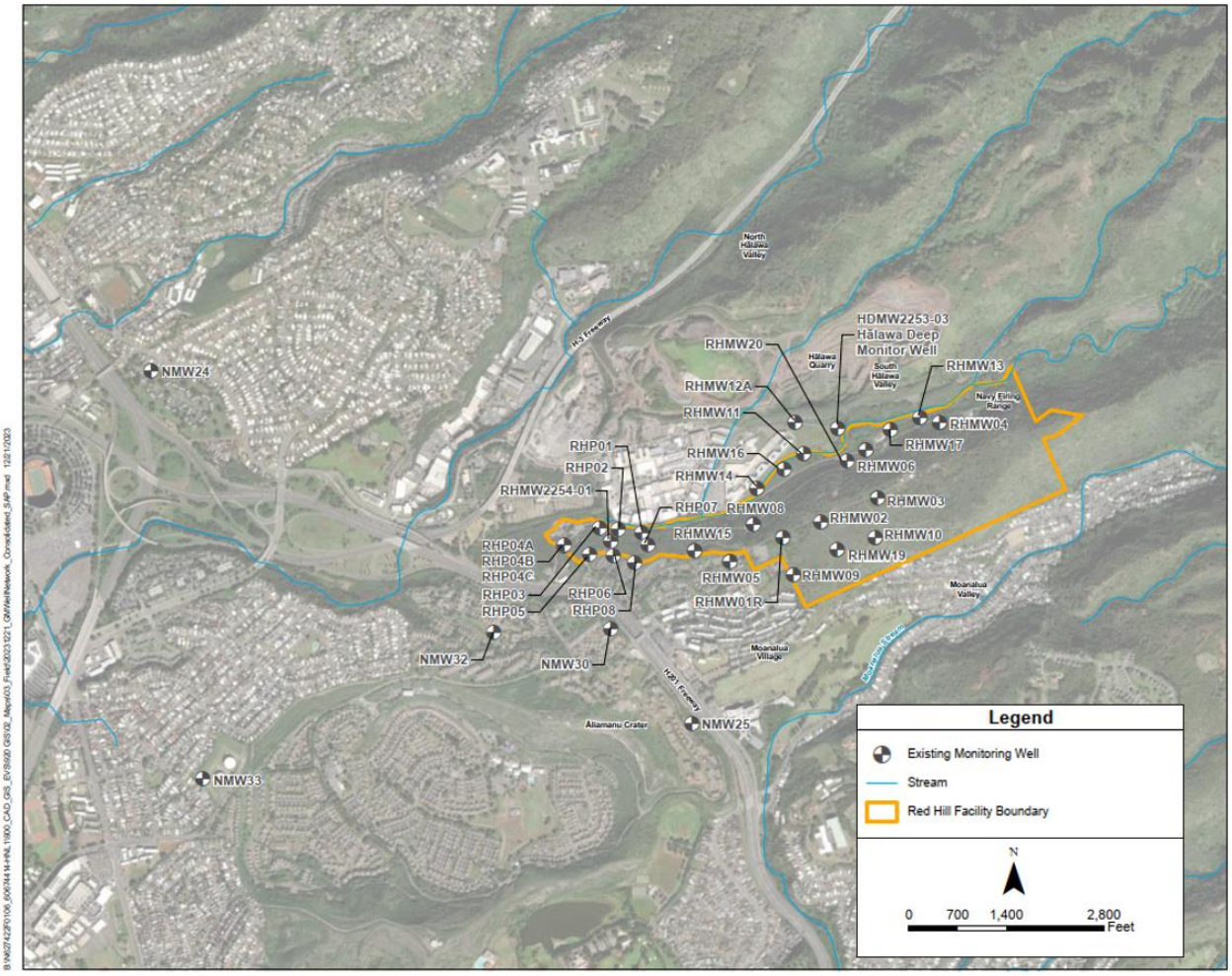

**Figure 1 shows the groundwater monitoring well sampling locations. Table 2 and**

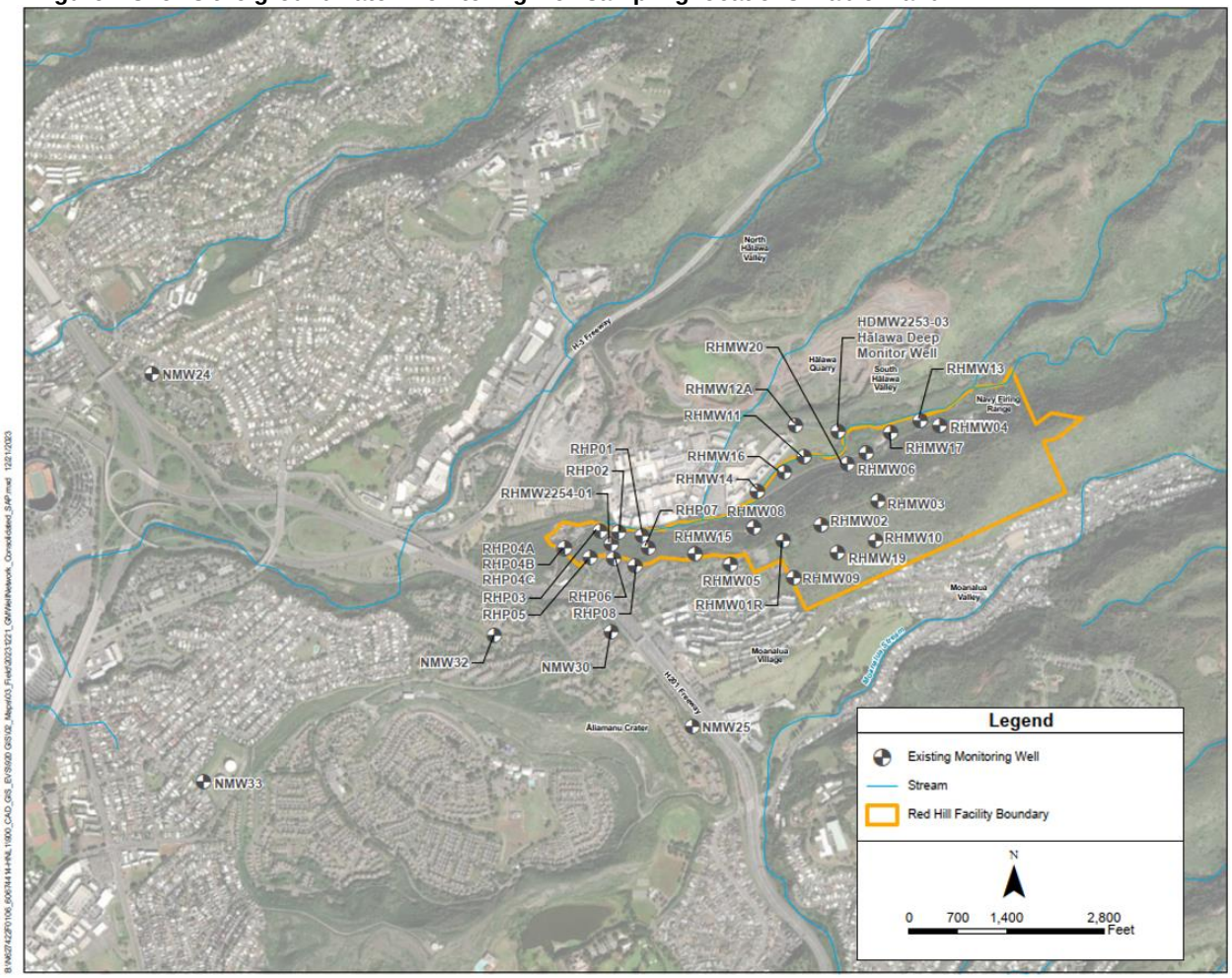


Figure 1, respectively, list and illustrate the locations of wells included and planned for in this Consolidated Groundwater Sampling Program. Additional wells will also be included in this sampling program as they are planned and installed.

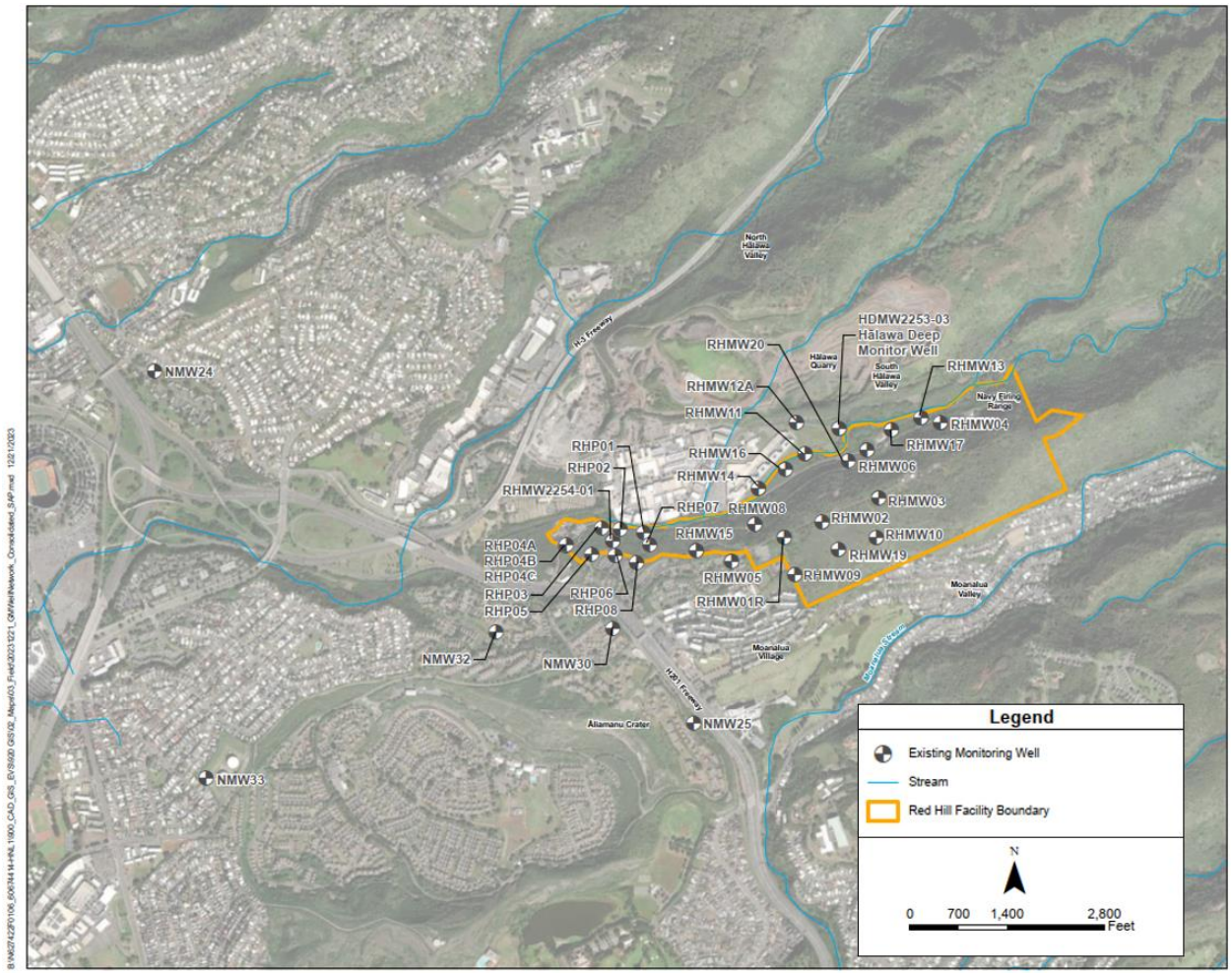


**Figure 1: Groundwater Monitoring Well Sampling Locations**

## 2.6 STANDARDIZE SAMPLE COLLECTION METHOD

NOI sampling was previously conducted using both unpurged bailer and low-flow (pump) purging. No fuel product has been observed at monitoring locations to date with the exception of RHS shortly after the November 2021 release event. The use of different sampling methods have resulted in notable differences in analyte concentrations between the NOI and GW LTM programs. The low-flow sampling method is widely accepted to produce results that are more representative of surrounding aquifer conditions, as indicated in the DOH TGM and as discussed in the following.[3] The inconsistency in sampling methods can impede long-term trend analysis of aquifer conditions.

The DOH TGM cautions against sampling with bailers, because "Bailers [are] prone to agitate the water column and result in loss of VOCs or inclusion of suspended sediment in sample if not used properly." In

[3] EPA also cautions against collecting unpurged bailer samples because "Stagnant water is subject to physiochemical changes and may contain foreign material, which can be introduced from the surface or during well construction, resulting in non-representative sample data. To safeguard against collecting a sample biased by stagnant water, specific well-purging guidelines and techniques should be followed." One of the appropriate sampling methods discussed in this EPA guidance is sampling via a low-flow sampling pump. *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers,* https://health.hawaii.gov/heer/files/2021/07/USEPA2002b.pdf

addition, the TGM states that "Caution should also be taken in the use of a bailer to collect samples that are to be tested for highly sorptive, semi-volatile and non-volatile organic compounds and metals due to the possible suspension of sediment in the bottom of the well and bias of data intended to be compared to action levels for dissolved-phase contaminants" (DOH TGM Section 6.6.7.4).[4] For these and other reasons, according to the TGM:

> "The HEER Office recommends that low-flow purging and sampling approaches be utilized whenever feasible in order to improve the representativeness of the sample data." (DOH TGM Section 6.6.5.3)[5]

Therefore, the Navy will collect samples in accordance with DOH and EPA's recommended low-flow methodology in the Consolidated Groundwater Sampling Program to ensure sample integrity, representativeness of aquifer conditions, and compatibility with environmental action levels.

The use of bailers will continue for field observations in wells installed in unconfined aquifer conditions, including photo-documentation, which consists of collecting bailer samples at the water surface in wells installed in unconfined conditions prior to purging or sampling and taking pictures of a clear bailer held against a white background to make observations of whether there are any signs of product or sheen.

## 3. Summary of Changes

Overall, the extensive groundwater data sets provide useful information for confirming that the COPC list (EPA Region 9 and DOH 2016) remains appropriate for groundwater monitoring at the Red Hill Bulk Fuel Storage Facility and should continue to be used in this Consolidated Groundwater Sampling Program.

The Navy has revised and consolidated the current groundwater sampling program to include the following:

1. **Transition of PFAS Sampling.** PFAS analytes will no longer be sampled under this program but will be incorporated by the Navy under the ERN program in accordance with CERCLA.
2. **Monitoring Wells**. Table 2 and Figure 1, respectively, update and illustrate the monitoring locations included in this Consolidated Groundwater Sampling Program. Appendix A explains the rationale for the well locations included in the consolidated program.
3. **Analytes**. Table 1 summarizes the parameters that will be analyzed in the Consolidated Groundwater Sampling Program.
4. **Frequency.** Table 2 summarizes the wells and frequency of sampling for each sampling program and GAC operation scenarios, and specifically includes twice per month sampling for reduced operation at RHS. In addition, NPDES sampling of RHS discharge water will occur when pumping at RHS resumes after being off for 24 hours or more, as detailed in the *Red Hill Shaft Recovery Plan NPDES Compliance Sampling Protocol*, March 27, 2023 (IDWST 2023).
5. **Sampling Methods**. Sampling of the monitoring wells and RHS will use the low-flow sampling methods recommended in the DOH TGM (DOH 2021), consistent with the quarterly GW LTM program. Bailers will continue to be used prior to purging and sampling to conduct field observations (including photo-documentation) in monitoring wells installed in unconfined conditions.

[4] https://health.hawaii.gov/heer/tgm/section-06/, last accessed March 15, 2023.

[5] https://health.hawaii.gov/heer/tgm/section-06/, last accessed March 15, 2023.

6. **Wells and Methods for Evaluating Uncontrolled Off-site Migration During Reduced RHS Pumping Rates.** Section 2.4 references methods for evaluating data and establishes lines of evidence that may indicate offsite, uncontrolled migration of contaminants that may present an unacceptable risk to human health and/or the environment.

No other changes are made to the sampling program at this time. The scope and frequency of data collection may change, based on data obtained and additional work to identify the nature and extent of the fuel releases in the environment. When conditions allow, the Navy expects to eventually transition the consolidated sampling program to normal quarterly sampling, consistent with the GW LTM program.

## 4. References

Department of Health, State of Hawaii (DOH). 2021. *Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan*. Interim Final. Honolulu, HI: Hazard Evaluation and Emergency Response Office. November 12, 2008. Latest Update: July 2021.

Department of the Navy (DON). 2015. *Final Project Procedures Manual, U.S. Navy Environmental Restoration Program, NAVFAC Pacific*. JBPHH HI: Naval Facilities Engineering Command, Pacific. May.

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Environmental Protection Agency, United States, Region 9; and Department of Health, State of Hawaii (EPA Region 9 and DOH). 2015. *Administrative Order on Consent In the Matter of Red Hill Bulk Fuel Storage Facility, EPA Docket No: RCRA 7003-R9-2015-01; DOH Docket No: 15-UST-EA-01*. September.

———. 2016. *Final Scoping for AOC SOW Sections 6 and 7, and Navy's Proposed Chemical of Potential Concern (COPC) Recommendations*. Letter from EPA Red Hill Project Coordinator, and Hawaii DOH Red Hill Project Coordinator, to: Naval Facilities Engineering Command, Hawaii, Joint Base Pearl Harbor-Hickam. February 4, 2016.

Interagency Drinking Water System Team (IDWST). 2023. *Red Hill Shaft Recovery Plan NPDES Compliance Sampling Protocol, Red Hill Shaft GAC Water Treatment Unit, Joint Base Pearl Harbor-Hickam, Oahu, HI; March 27, 2023, V.03*. Update of V.1 Presented in IDWST January 2022, Red Hill Shaft Recovery and Monitoring Plan (RHSRMP), JBPHH, O'ahu, Hawai'i.

# Appendix A: Justification for Monitoring Location Changes

| Location | Description of Change | Reason For Change |
|---|---|---|
| Adit 3 Sump | Removal of monitoring location from NOI program | Not a basal groundwater location.<br><br>Location was appropriate initially during the emergency response phase of the NOI for source investigation, but not appropriate for assessing risk since the NOI has transitioned to groundwater monitoring. The sump water is sourced by drainage from the tunnel and vadose zone and water samples from the sump are not representative of groundwater. Contribution to detects at Adit 3 Sump are not necessarily attributed to fuel and instead are from external sources un-related to the fuel stored at the Facility. Sump sampling may occur intermittently during site characterization and remediation activities, as necessary. |
| RHMW01 | Removal of monitoring well from GW LTM program; replaced with RHMW01R | Duplicate well with better alternative available.<br><br>RHMW01 is submerged while 01R is screened across water table. RHMW01R was installed to replace RHMW01 and provide a well that can also be utilized to measure for the presence/absence of light non-aqueous phase liquid. |
| RHMW07 | Removal of monitoring well from GW LTM program; replaced with RHMW16 | Not representative; better alternative at RHMW16.<br><br>Well is screened in a zone lacking strong hydraulic connection with surrounding basal aquifer, as evidenced by elevated water levels and muted response to pumping and barometric pressure changes. RHMW16, located very close to RHMW07, will be included in the sampling program and is installed in a deeper zone with a strong connection to the basal aquifer. |
| RHMW10 | Add monitoring well in NOI program | RHMW10 fills in a potential gap to the southeast from the center of the tank farm; GW LTM and PFAS programs already sample this well. |
| RHMW16A | Removal of monitoring well from GW LTM program | Duplicate well - RHMW16 is screened in a deeper zone with a strong hydraulic connection to the basal aquifer while 16A is above water table. |
| Halawa Deep HDMW 2253-03 | Add monitoring well to NOI program | There is interest in sampling wells in the vicinity of the quarry to assess whether there is any potential COPC migration to the northwest towards Halawa Shaft; GW LTM and PFAS programs already sample at this well. |
| Oily Waste Disposal Facility Wells | Removal of monitoring wells; replaced with RHP wells | Prior to Plume Delineation well installations, OWDF wells were sampled because they were the only wells in that area. There are currently eight P-wells installed, and two more that will be completed, that are better suited for condition assessments from the release due to their proximity to the Red Hill Shaft and the 2021 fuel release. |
| RHP Wells | Add RHP wells in NOI and GW LTM program | Red Hill Plume Delineation wells have been installed both on and off the Red Hill facility to expand the groundwater monitoring network and evaluate the horizontal extent of fuel impacts that were observed following the November 2021 release. |
| Sentinel Wells | Add Sentinel Wells in NOI and GW LTM program | Similar to RHP wells, Sentinel wells have been installed on and off the Red Hill facility to characterize potential contaminant migration following the November 2021 release and understand the surrounding geology. |