Groundwater Sampling Frequency Recommendations
Red Hill Bulk Fuel Storage Facility
Joint Base Pearl Harbor-Hickam, Oahu, Hawaii
Naval Facilities Engineering Command, Hawaii, JBPHH HI
March 6, 2026

1. Introduction

Groundwater sampling at Red Hill has been performed under several different programs, including Long-Term Monitoring (LTM), Notice of Interest (NOI) Sampling, Consolidated Sampling, and subsets and variations of each. Each of these programs has been implemented with specific objectives ranging from release detection monitoring during active storage, to emergency response delineation, to the current consolidated monitoring program. In each program, sampling locations, parameters, and frequencies were customized to meet specific needs. As an example, sampling frequencies have been as short as twice weekly for release detection purposes and as long as quarterly for LTM objectives.

The intent of this document is to present the following lines of evidence to support a return to quarterly groundwater sampling that had been in place from the initiation of recurring sampling in 2005 until the implementation of NOI Sampling immediately following the May 2021 release event.

- Tank defueling was completed in March 2024, which successfully removed all flowable fuels from Red Hill tanks and piping (Section 3), thereby exponentially minimizing the risk of future releases that could potentially be detected by high-frequency groundwater sampling.
- Ongoing pumping at Red Hill Shaft influences basal aquifer hydraulics in Red Hill Shaft and lessens the likelihood of potential uncontrolled migration of chemicals of potential concern (COPCs), while no observation of contaminant migration has occurred to date (Section 4).
- Groundwater geochemistry is ideal for natural biodegradation of chemicals of potential concern (COPCs). Observed geochemical conditions, COPC trends, and the presence of degradation products (Section 5) confirm the presence of robust attenuation processes.
- Concentrations of Red Hill−specific fuel-related chemicals of potential concern (COPCs) have decreased dramatically from peaks detected following the 2021 fuel release events over three and half years ago (Section 5).
- Detection frequencies for COPCs have also significantly decreased since the 2021 fuel release events to levels at or below pre-NOI averages (Section 6).
- Comparison of COPC detection frequencies in quarterly sampling events to higher-frequency sampling events (twice a week, weekly, twice-monthly and monthly) shows no significant differences in trends and demonstrates that a return to quarterly sampling will not result in missed trends that could indicate uncontrolled migration (Section 6).
- Detections of total petroleum hydrocarbons (TPH) at wells other than onsite wells RHMW01R, RHMW02, and RHMW03 (and at RHMW2254-01 following the November 2021 release event) show sporadic, mostly low-level concentrations that are not consistent with fuel impacts from the recent releases that prompted increased NOI monitoring, and in any case may continue to be detected via quarterly sampling as they were prior to NOI sampling (Section 6).
- Detections of fuel-related and pyrogenic polynuclear aromatic hydrocarbons (PAHs) at wells other than tank farm wells RHMW01R, RHMW02, and RHMW03 are not associated with fuel releases, mitigating these detections as evidence of plume mobility (Section 7). Detections at locations other than RHMW01R, RHMW02, and RHMW03 over the past 2 years have occurred at only 7 of 43 sampling locations, and all have occurred at frequencies below 0.7% , which is not consistent with fuel-related impacts.

2. Groundwater Monitoring Programs

Groundwater sampling has been conducted at Red Hill for over 20 years under multiple programs that have been merged and optimized based on prior data needs and monitoring objectives. This section summarizes the three main programs that are recognized today.

Recurring groundwater monitoring at the Red Hill Bulk Fuel Storage Facility (Facility) was originally implemented under the LTM Program starting in 2005. A primary intent of LTM was to meet the requirements of the approved Groundwater Protection Plan (GWPP) (DON 2014) and remain in compliance with the State of Hawaii Department of Health (DOH) Underground Storage Tank release response requirements as described in Hawaii Administrative Rules Chapter 11-281 Subchapter 7, Release Response Action. As such, LTM was conducted on a quarterly basis. LTM sampling continued through May 2023 (sometimes overlapping with other sampling programs), when it was replaced with Consolidated Sampling starting in June 2023.

The NOI Program was initiated in May 2021 in response to the DOH's NOI letter issued for the May 6, 2021 release (DOH 2021). Although NOI sampling and LTM sampling operated concurrently from May 2021 through May 2023, it is the increased-frequency sampling (twice weekly, weekly, twice monthly, and monthly) beginning in May 2021 that is commonly referred to as the NOI Program. NOI sampling frequencies were varied in response to specific events, first monthly to identify plume capture and mobility following the release events and then increasing to as much as twice weekly during defueling. NOI and LTM sampling continued through May 2023, when the Consolidated Program was implemented.

The current Consolidation and Optimization of Groundwater Sampling Programs, initiated on June 1, 2023, and further optimized in 2024, combines the LTM and NOI Sampling Programs into a single program to eliminate inefficiencies and inconsistencies that were present with two simultaneous groundwater sampling programs. The Revised Consolidated Program (DOH 2024) specifies monthly groundwater sampling frequency during continuous Red Hill Shaft pumping (4.3 million gallons per day [mgd]) and twice-monthly sampling during reduced flow conditions (e.g., 1.8 mgd). Twice-monthly sampling is intended to provide an added layer of protection to detect the potential for hydrocarbon migration, which has not materialized.

The Consolidated Program includes 48 groundwater monitoring wells as of March 2026 and the RHSF-PUMP sampling point at Red Hill Shaft (Attachment 1), with additional wells slated to be sampled as their construction is completed. All samples are analyzed for a comprehensive list of analytes, including fuel-related COPCs identified under the 2015 Administrative Order on Consent (AOC) (EPA Region 9 and DOH 2015) and established in February 2016 (EPA Region 9 and DOH 2016), natural attenuation parameters, and geochemical parameters (screening and analytic). The ten fuel-related COPCs are:

- TPH gasoline range organics (GRO), diesel range organics (DRO), and residual oil range organics (ORO)
- The polynuclear aromatic hydrocarbons (PAHs) 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene
- Benzene, toluene, ethylbenzene, and total xylenes (BTEX)

The combination of the number of wells sampled, the substantial analyte list, and the frequency of sampling results in a significant commitment of public resources, which is recommended to be further optimized in light of Facility tank defueling and the current groundwater conditions, as described below. Data analysis presented below includes data collected through May 2025, when only 45 wells were being sampled.

3. Defueling and Tank Closure Operations

On June 30, 2022, the Secretary of the United States Department of the Navy (Navy), in coordination with Defense Logistics Agency, issued a defueling plan for the Naval Facilities Engineering Systems Command Pacific, on behalf of the United States Department of Defense (DoD) (DoD 2022). The Joint Task Force Red Hill command oversaw the safe and expeditious defueling of 104 million gallons of DoD-specification fuels from the Facility's bulk fuel storage tanks and pipelines. Defueling operations began on October 16, 2023, and successfully concluded on March 6, 2024. The vast majority of distribution pipelines to Pearl Harbor were subsequently cleared of fluids and sludges in preparation for pipeline removal. Non-flowable residue remaining in the tank bottoms and a few isolated sections of distribution pipelines are currently being removed.

The successful defueling of Red Hill tanks and lines has exponentially reduced the risk of release and mitigated the associated benefit of high-frequency (twice-monthly) Consolidated Sampling.

4. Flow Optimization Study

A flow optimization study was conducted at Red Hill Shaft between April 7 and June 20, 2023, to determine an optimized contaminant capture zone around Red Hill Shaft and tank farm target areas corresponding to the 2016 and 2021 releases, while minimizing groundwater resource impacts to the sole-source unconfined basal aquifer (DON 2023). Transducers were deployed in groundwater monitoring wells near Red Hill Shaft to evaluate groundwater elevations and constituents during three pumping rates (averaging 4.3, 2.9, and 1.7 mgd). The flow optimization study used multiple analytical, graphical, and numerical methods to analyze capture by Red Hill Shaft, and concluded that the capture of both target areas was sufficient at the evaluated pumping rates. Although DOH did not agree with all the conclusions of the flow optimization study, they did recognize the importance of conserving the island's natural resources and approved reduced Red Hill Shaft pumping accompanied by increased groundwater monitoring (twice-monthly and monthly Consolidated Sampling) following completion of tank defueling activities (DOH 2023).

5. Natural Attenuation

Natural attenuation is the combined result of dispersion, dilution, sorption, precipitation, volatilization, and microbial transformation (EPA 1998). Due to the naturally occurring high levels of dissolved oxygen (>5 milligrams per liter [mg/L]), neutral pH, and stable groundwater temperature, the unconfined basal aquifer is particularly well-suited for petroleum biodegradation due to its ability to support the metabolic activities of aerobic hydrocarbon-degrading microorganisms. Location of the 2014 and 2021 releases at the Red Hill Bulk Fuel Storage Facility were confined to a location within a subterranean tunnel system (from the tank gallery to Adit 3) that is highly aerated (e.g. oxygenated).

Review of COPC analytical data clearly illustrates the highest dissolved concentrations are proximate to RHMW02 (located near the January 2014 release location) and, to a lesser extent, downgradient well RHMW01R. The surrounding Red Hill monitoring and delineation wells bound the known extent of dissolved-phase contamination. Lower-concentration COPC detections at RHMW03 and Red Hill Shaft indicate that the impacts to groundwater resulting from the May and November 2021 release events were quickly mitigated and did not result in lasting impacts to the basal aquifer when compared to RHMW02 and RHMW01R data.

A review of the time series graphs for DRO (primary COPC) at all wells—especially source area wells RHMW01R, RHMW02, RHMW03 and RHMW2254-01 and downgradient wells RHMW05, RHMW08, RHMW09, RHMW14, and RHMW15—indicates degradation of DRO over time, consistent with natural attenuation, including biodegradation. Noted spikes of TPH detections following the 2021 release events are likely the by-product of a change in laboratories and analytical extraction methods. Nonetheless, the overall downward trend is clear, and concentrations have largely stabilized and returned to levels similar to those prior to the 2021 and 2014 releases. Refer to Attachment 2 for time-series graphs of DRO at the referenced wells.

Review of monitoring data for wells RHMW01R and RHMW02—which exhibit consistent detections of dissolved hydrocarbons, dissolved oxygen levels of <1 mg/L, and negative oxidation reduction potential (ORP) measurements—conclusively indicates that aerobic respiration of oxygen as a primary source of energy for petroleum-degrading microorganisms is occurring. Further, depleted nitrate and sulfate levels evident at RHMW01R and RHMW02 provide additional evidence of microbially-mediated anaerobic degradation. Additionally, metabolic byproducts including methane and ferrous iron are also detected at these wells. Finally, the inconsistent and lower-concentration COPC detections in downgradient Red Hill wells add an additional layer of confirmation that the observed plume of dissolved COPCs approximately centered at RHMW02 is undergoing natural attenuation.

With continued groundwater pumping at Red Hill Shaft, an influx of naturally aerobic groundwater provides oxygen for the continued biodegradation of the hydrocarbon plume via the faster aerobic biodegradation pathway.

6. Analyses of COPC Detection Frequency

Between October 18, 2016, and May 31, 2025, more than 5,400 groundwater samples have been analyzed under the Red Hill monitoring programs for at least DRO and ORO, with most samples analyzed for all ten COPC analytes described above, resulting in approximately 47,000 COPC analytical data points (Note: some samples were analyzed multiple times for the same parameters). Table 1 shows that the overall detection frequency (the number of COPC detections divided by the number of COPC data points) is significantly higher for in-tunnel wells RHMW01R, RHMW02, and RHMW03 (proximal to the identified COPC plume) at 33.7% versus all other sampling locations at 2.7%, again identifying the core of the plume. This table and these statistics do not include silica gel cleanup (SGC) analyses, which specifically remove polar compounds and are evaluated separately (Section 7).

Table 1: Groundwater COPC Analyses and Detection Frequencies: October, 2016 through May, 2025

Frequency Group	Number of Data Points	COPC Detection Frequency
High-Frequency-Detection Wells (RHMW01R, RHMW02, RHMW03)	6,394	33.7%
All Other Sampling Locations	40,837	2.7%

These statistics average out high and low frequencies of select COPCs (e.g., DRO is detected in 100% of data points and benzene in 4% of data points from RHMW02). Combining data from all COPCs into a single pool provides a simplified evaluation (two data points as compared to 470 or more data points) of relative frequencies of in-tunnel wells versus all other wells. Attachment 3 presents counts and detection frequencies for COPC analyses. Attachment 3A provides COPC detection frequencies for each COPC at each sampling location, sorted by overall frequency of detection. Attachment 3A data indicate the frequency of COPC detection at in-tunnel wells (RHMW01R, RHMW02, and RHMW03) ranges from 15.9% to 56.3%, while at all other wells is 7.8% or lower.

Table 2 summarizes the number of data points collected and the detection frequency of monitoring wells present during the entire evaluation period, October 18, 2016 to May 31, 2025. Table 2 considers only wells that were in operation during the entire referenced period because the addition of new delineation and sentinel wells with a significant count of non-detect analyses would skew the frequency of detections downwards. These data clearly indicate that TPH-range organics are the most frequently detected COPCs, and that the frequency of those detections increased during the NOI period (following the May 6, 2021 release event) but have since decreased in the Consolidated Program to levels below the historical pre-NOI

Program levels. Attachment 3B provides a related table detailed by analyte and grouped by high and low-frequency sampling locations as well as sampling period.

Table 2: Groundwater COPC Group Analyses and Detection Frequencies Over Time

COPC Group	LTM/Pre-NOI Period (October 18, 2016 to May 5, 2021)		Combined LTM and NOI Period (May 6, 2021 to May 31, 2023)		Consolidated Period (June 1, 2023 to May 31, 2025)	
	Number of Data Points	Frequency of Detections	Number of Data Points	Frequency of Detections	Number of Data Points	Frequency of Detections
TPH	1,163	17.3%	4,461	30.4%	2,721	12.2%
PAHs	1,173	10.2%	4,537	11.2%	2,589	8.1%
BTEX	1,548	1%	5,880	2.8%	4,216	0.1%

Note: Only wells in operation during the entire period are included in the listed data (RHMW2254-01, RHMW01R, RHMW02, RHMW03, RHMW04, RHMW05, RHMW06, RHMW08, RHMW09, RHMW10, RHMW11, RHMW13, RHMW14, RHMW15, RHMW16, RHMW19, and HDMW2253-03).

These detection trends are further illustrated in Attachment 4, where detection frequency is plotted over time for quarterly sampling events vs. higher-frequency events (twice-weekly, weekly, twice-monthly, and monthly) for all COPCs, with the high-frequency sampling data grouped by month. Attachment 4A plots the in-tunnel wells (RHMW01R, RHMW02 and RHMW03), and Attachment 4B plots all other locations present during the entire evaluated time period (RHMW2254-01, RHMW04, RHMW05, RHMW06, RHMW08, RHMW09, RHMW10, RHMW11, RHMW13, RHMW14, RHMW15, RHMW16, and RHMW19).

Attachment 4 and Table 2 show the same overall trend, an increase in detections during the NOI period (May 6, 2021 to May 23, 2023) followed by a decrease in detections during the Consolidated Sampling period (June 1, 2023 to May 31, 2025) equal to or below historical levels. Additionally, Attachment 4 shows that the trend demonstrated in quarterly sampling closely matches the trend in higher frequency sampling events.

The often-higher detection frequency shown in quarterly sampling for both charts is the result of different United States Environmental Protection Agency (EPA) extraction methods for TPH, with the quarterly laboratory (Energy) employing EPA Method 3520, which produces more detections for TPH (Method 3520 is more efficient at extracting and reporting polar compounds). The monthly data are a combination of all analyses and extraction methods (EPA Methods 3510 and 3520) performed in the calendar month.

Thus, the conditions that prompted the increased NOI sampling frequency have subsided, fuel is no longer stored in the tanks, and groundwater concentrations are now similar to conditions prior to the 2014 and 2021 releases.

7. Fuel-Related Detections

An analysis of all detections of DRO and ORO in groundwater samples dating from the May 6, 2021, release to present has been conducted to determine whether these detections indicate any conclusive relation to fuels previously stored at the Facility. This analysis, described in detail in *Evaluation of Chromatograms for Understanding TPH Detections in Monitoring Wells, Red Hill Bulk Fuel Storage Facility* (DON 2020), compared the laboratory-provided chromatograms of detections of DRO and ORO to chromatograms of fresh and weathered Jet Fuel Propellant (JP)-5 fuels. Additionally, other evidence was considered, including headspace readings, gauging of light nonaqueous-phase liquid (LNAPL), and the presence or absence of fuel-related PAHs, BTEX, and other fuel-related compounds analyzed under the Red Hill groundwater sampling programs.

The analysis indicates that RHMW01R and RHMW02 have consistent detections of DRO and ORO related to fuel, as did RHMW2254-01 immediately following the November 2021 release event. Detections of

DRO and ORO at all other sampling locations are sporadic in nature, and associated chromatograms do not resemble fuel. Inconsistent, low-level detections of DRO and ORO near or below reporting limits are generally not confirmed by split samples.

Additionally, comparison of TPH analyses with and without SGC (i.e., removal of polar constituents) from samples collected at wells not located in the source areas indicates that these TPH detections are primarily composed of polar, non-petroleum components (Attachment 5). This provides additional evidence that inconsistent TPH detections at wells located away from the tank farm are not petroleum-related and not indicative of an expanding plume and are more likely related to naturally occurring hydrocarbons or other sources.

Fuel-related PAH COPCs are consistently detected at RHMW02 and much less frequently at RHMW01R. Concentrations at RHMW01R are currently at levels that are below DOH Environmental Action Levels (EALs) and have been determined to be affiliated with a historical release pre-dating 2021. Review of all PAH detection data (fuel-related and pyrogenic) indicates that detections are sporadic and have occurred at only 7 of 43 sampling locations (aside from RHMW01R, RHMW02, and RHMW03) in the past 2 years at frequencies below 0.7% (Attachment 6). As such, these detections are not evidence of an expanding or mobile concentration of COPCs and should not be further considered when evaluating the occurrence and distribution of the identified plume approximately centered at RHMW02.

8. Conclusions and Recommendations

With large-scale defueling of the Facility’s fuel storage tanks and piping at the tank farm completed in March 2024, the most significant source of potential groundwater impacts has been removed. Flow optimization and other studies indicate capture of target areas with continued pumping at Red Hill Shaft. Favorable natural geochemical conditions, specifically high dissolved oxygen, are present to support the metabolic activities of aerobic hydrocarbon-degrading microorganisms. Additionally, evidence of anaerobic degradation is seen. Conclusive evidence for natural attenuation including biodegradation exists at the site.

Groundwater COPC concentrations suggest stable or contracting fuel impacts that have returned to pre-release conditions, with impacts centered at RHMW02. Comparison of trends in the detection frequencies for quarterly and higher-frequency sampling events shows a strong similarity, indicating that quarterly sampling accurately captures trends in COPC detections. Short-term upward fluctuations are anticipated to most likely be sporadic, and overshadowed by the long-term reduction in detections exhibited in the Red Hill Groundwater Monitoring Network. Continued Red Hill Shaft pumping and natural attenuation will effectively contribute to the stabilization and continued reduction in COPC detections while remedial investigations and tank closure efforts are ongoing.

Based on the robust data set analyzed in this memorandum, the Navy recommends returning the groundwater sampling frequency under the Consolidated Program back to the previous LTM quarterly schedule at all wells, which would continue to accurately and sufficiently capture the groundwater conditions at the plan-specified locations at and surrounding Red Hill. No reductions to sampling locations or analytes are currently recommended.

9. Attachments

Attachment 1: Location of Releases and Consolidated Groundwater Sampling Locations

Attachment 2: DRO Concentrations Over Time

Attachment 3: COPC Analyses Counts and Detection Frequencies

Attachment 4: Quarterly versus Monthly Detection Frequency Trend Analysis Charts

Attachment 5: Pre- and Post-Silica Gel Cleanup Detection Frequencies

Attachment 6: PAH Detection Frequencies Over Time

10. References

Department of Defense, United States (DoD). 2022. *Defueling Plan, Red Hill Bulk Fuel Storage Facility, Oahu, Hawaii*. Prepared by Secretary of the Navy (SECNAV), in Coordination with Director, Defense Logistics Agency (DLA), on Behalf of DoD. June 30, 2022.

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Attachment 1:
Location of Releases and Consolidated Groundwater Sampling Locations

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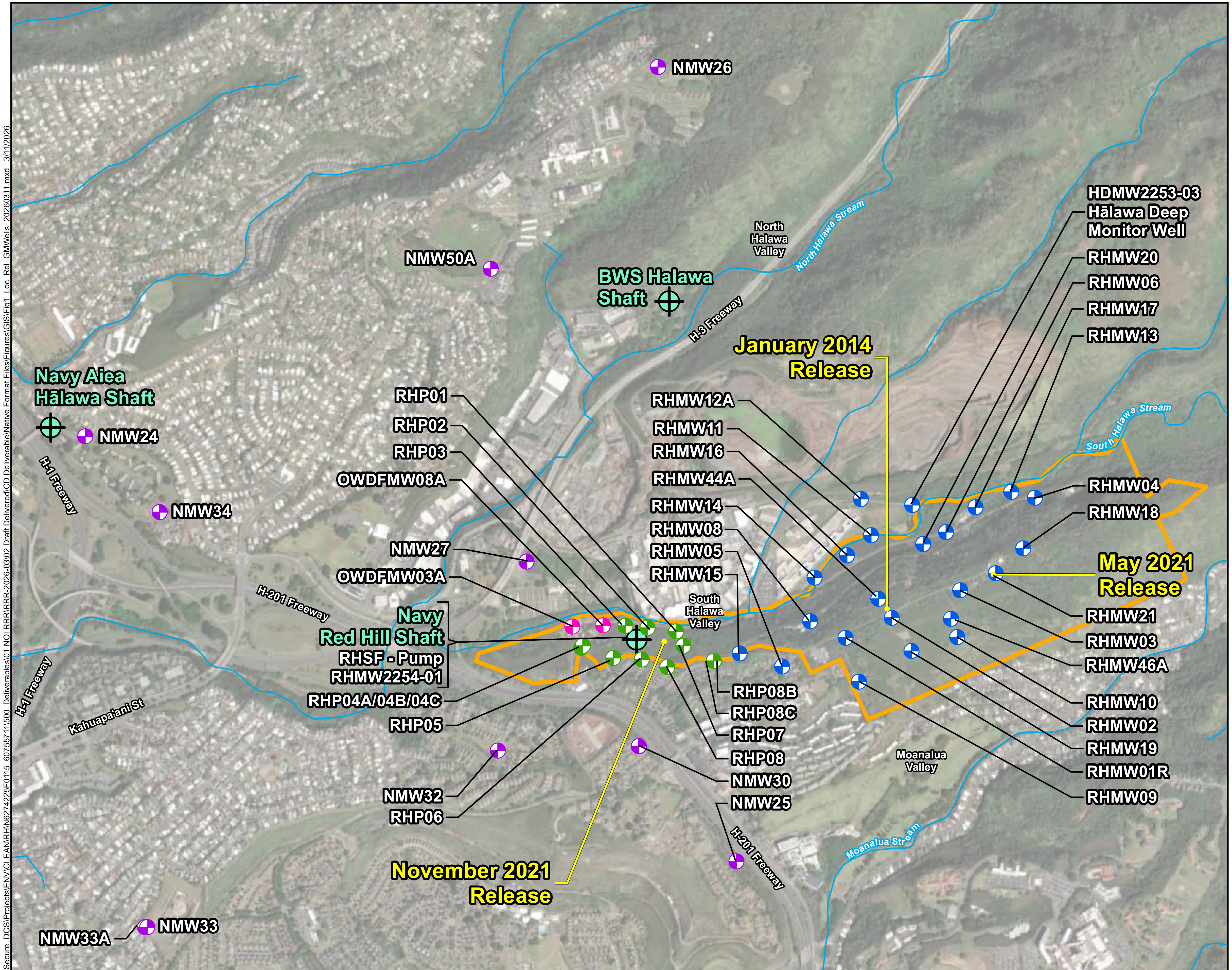
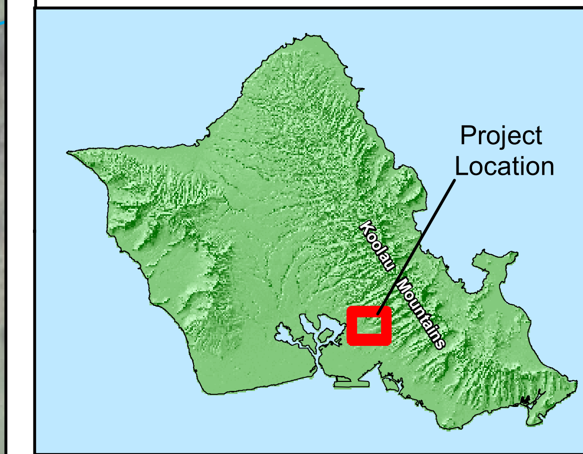


Location Map



Legend

- Facility Well
- Delineation Well
- Sentinel Well
- OWDF Monitoring Well
- Water Supply Well
- Red Hill Facility Boundary
- Stream

Notes

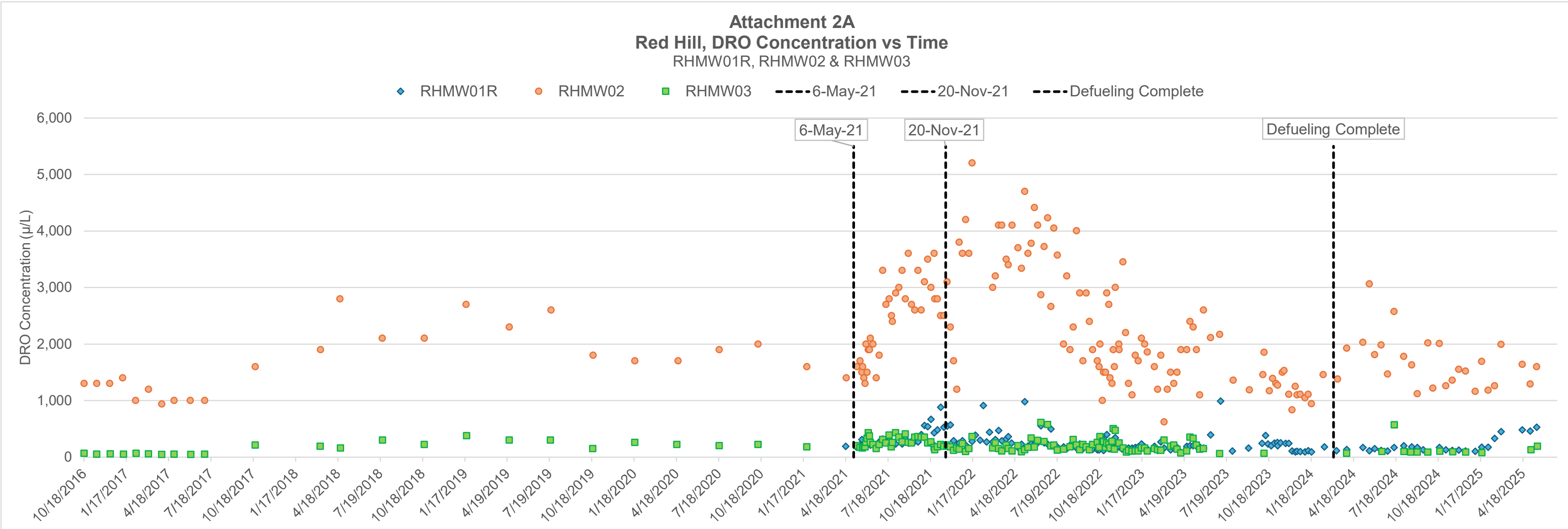
1. Map projection: NAD 1983 Hawaii State Plane Z3 ft
2. Base Map: Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. <u>Acronym</u>
   BWS - Board of Water Supply

N

0 600 1,200 2,400 Feet

Figure 1
Location of Releases and Groundwater Monitoring Wells
Quarterly Release Response Report
Red Hill Bulk Fuel Storage Facility
JBPHH, Oahu, Hawaii

Attachment 2:
DRO Concentrations Over Time



Attachment 2A
Red Hill, DRO Concentration vs Time
RHMW01R, RHMW02 & RHMW03
RHMW01R
RHMW02
RHMW03
6-May-21
20-Nov-21
Defueling Complete
DRO Concentration (µ/L)
6,000
5,000
4,000
3,000
2,000
1,000
0
10/18/2016
1/17/2017
4/18/2017
7/18/2017
10/18/2017
1/17/2018
4/18/2018
7/19/2018
10/18/2018
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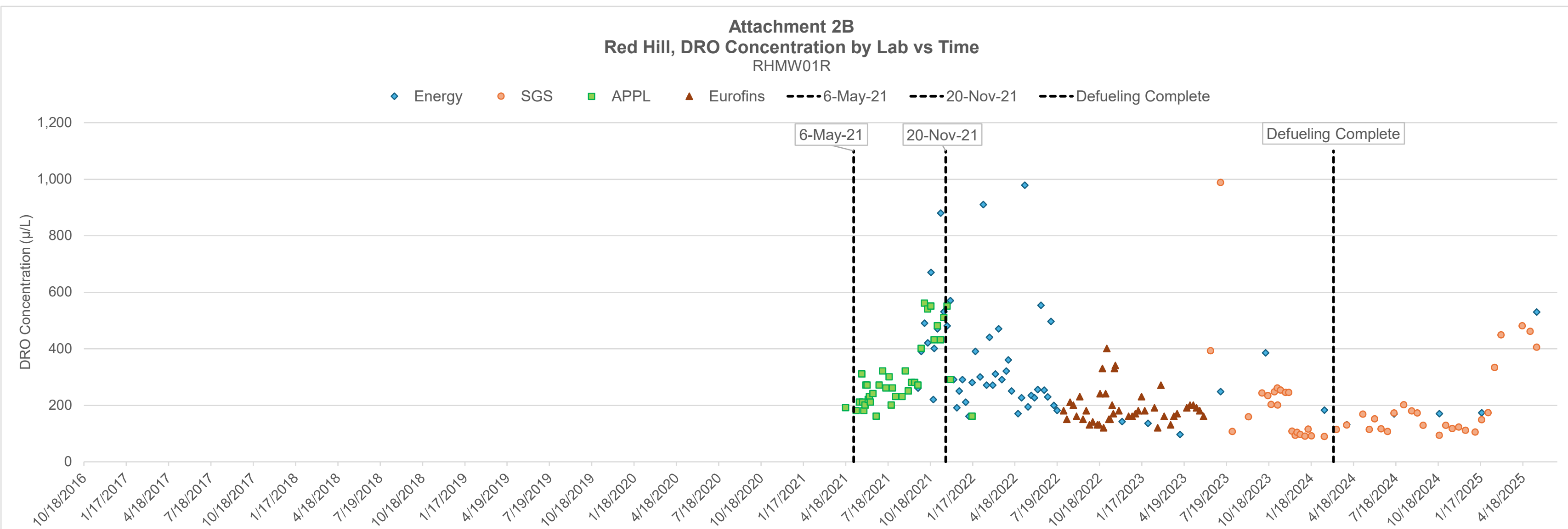

Attachment 2B
Red Hill, DRO Concentration by Lab vs Time
RHMW01R
Energy
SGS
APPL
Eurofins
6-May-21
20-Nov-21
Defueling Complete
DRO Concentration (µ/L)
1,200
1,000
800
600
400
200
0
10/18/2016
1/17/2017
4/18/2017
7/18/2017
10/18/2017
1/17/2018
4/18/2018
7/19/2018
10/18/2018
1/17/2019
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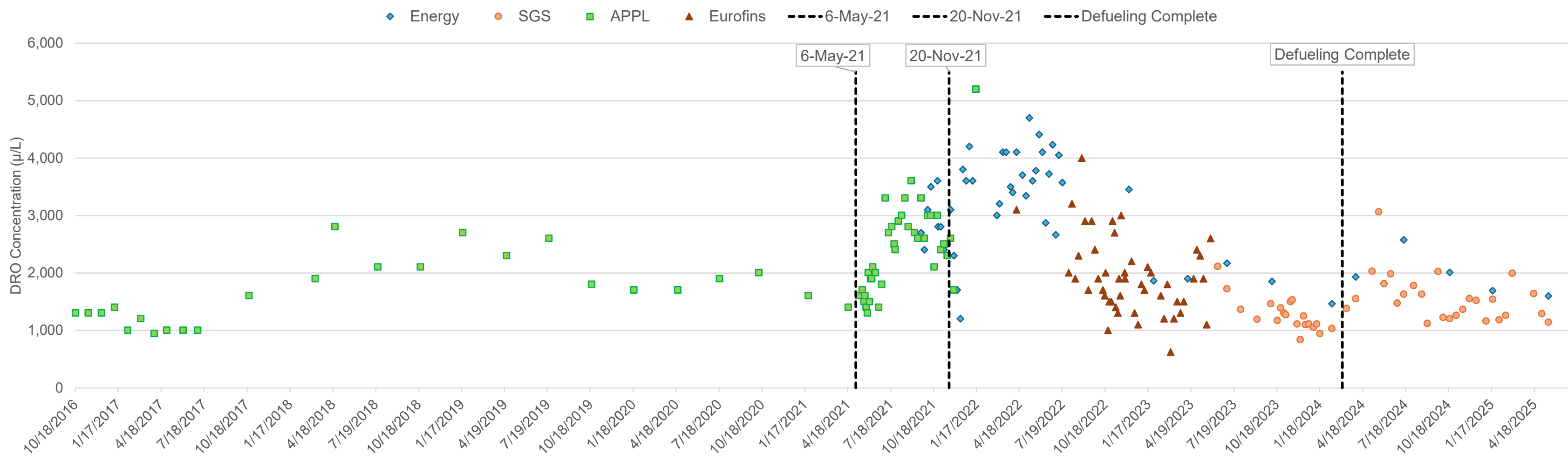
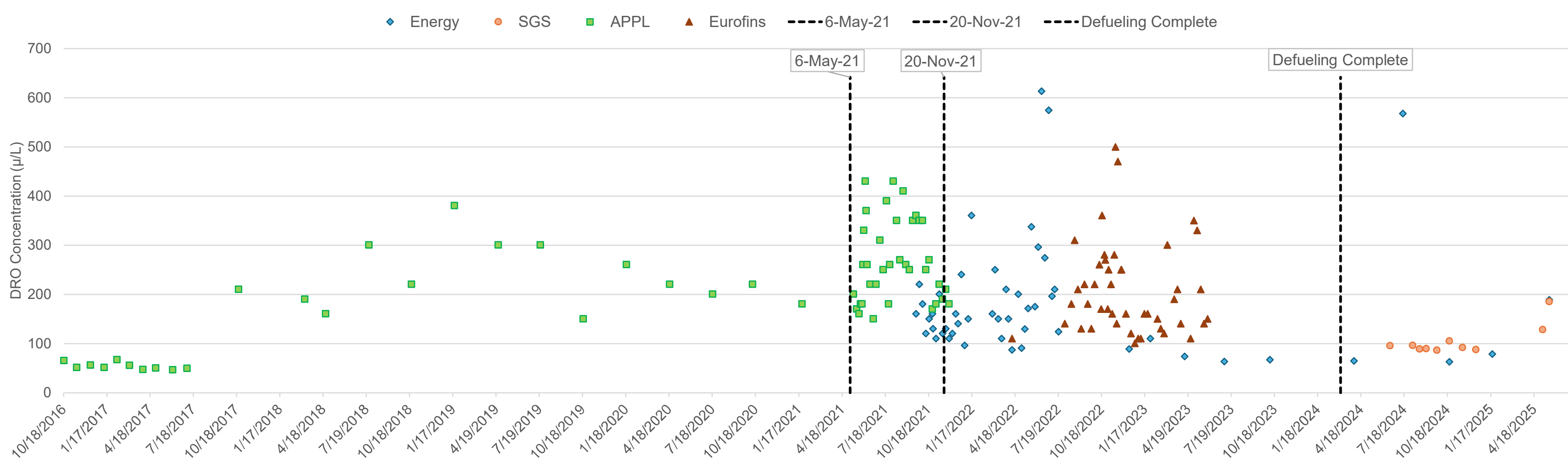
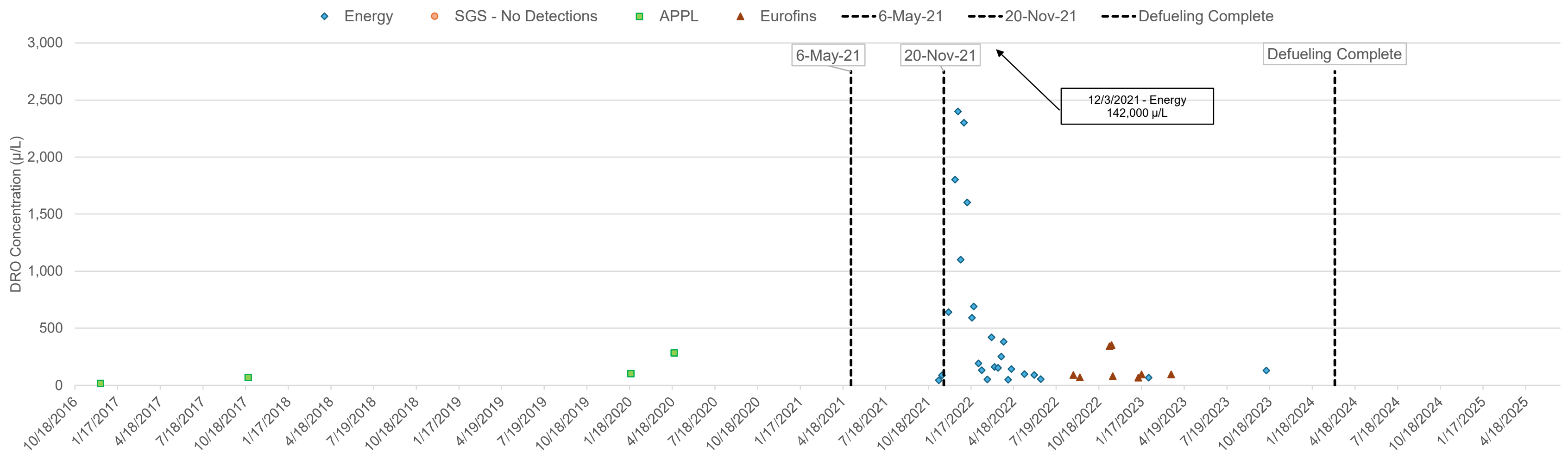
Attachment 2C
Red Hill, DRO Concentration by Lab vs Time
RHMW02



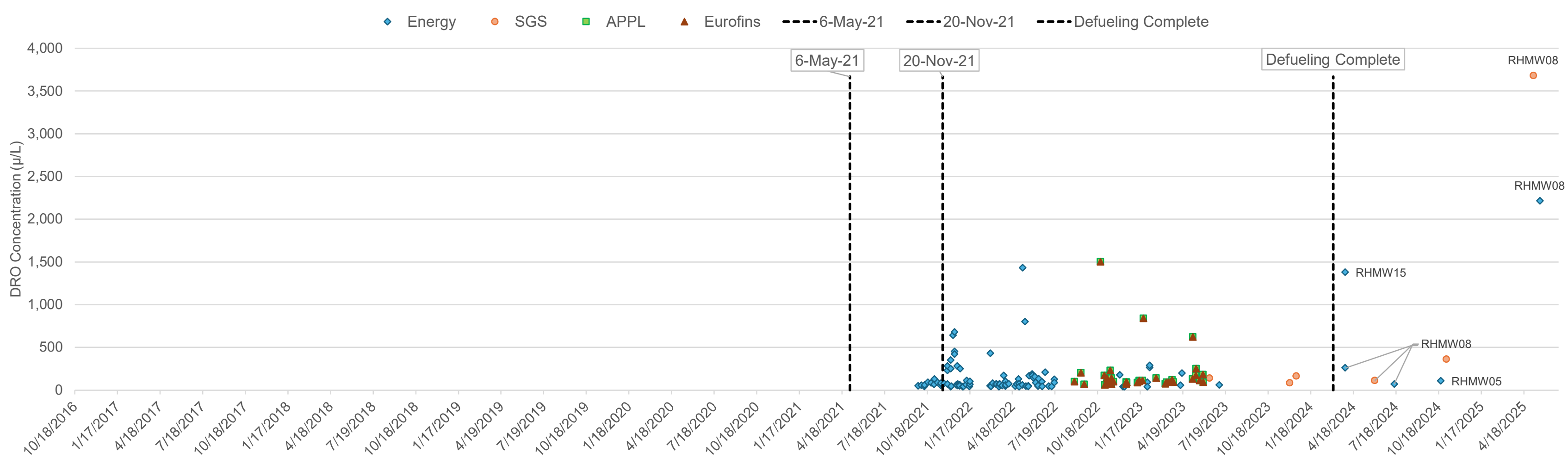
Attachment 2D
Red Hill, DRO Concentration by Lab vs Time
RHMW03



Attachment 2E
Red Hill, DRO Concentration by Lab vs Time
RHMW2254-01



Attachment 2F
Red Hill, DRO Concentration by Lab vs Time
Down Gradient Wells



Data Legend and Notes:
Sampling locations are down gradient of RHMW02, and include wells RHMW05, RHMW08, RHMW09, RHMW14 and RHMW15.

Attachment 3:
COPC Analyses Counts and Detection Frequencies

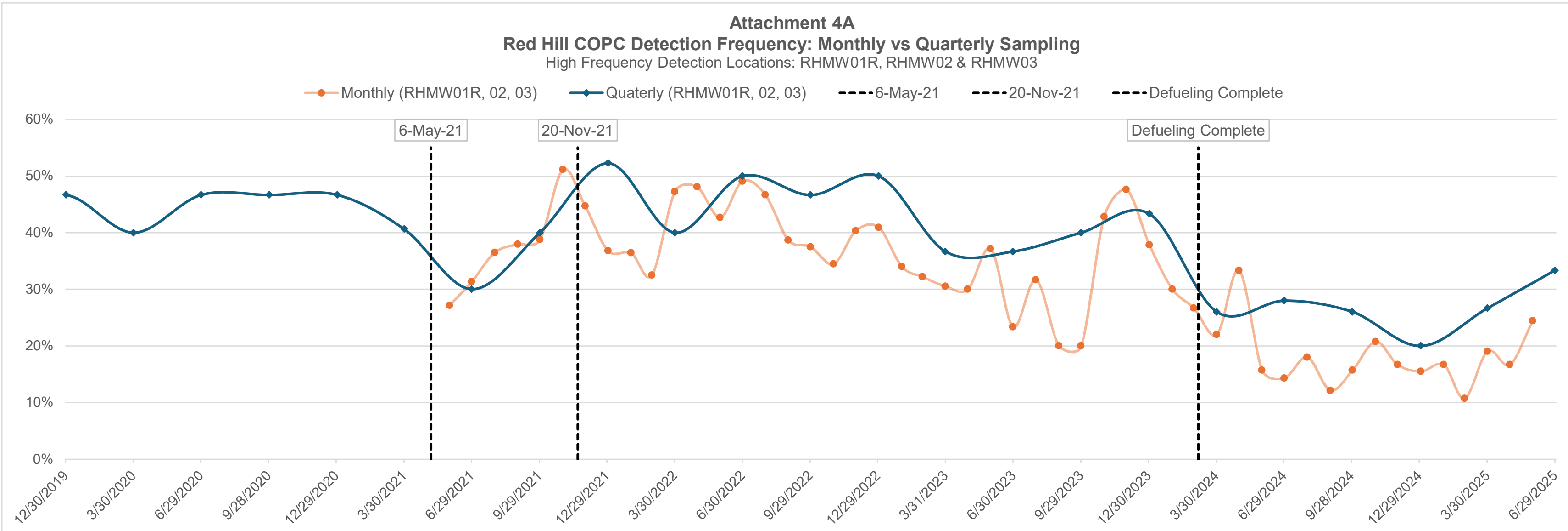
Attachment 3A: COPC Detection Frequencies at Each Consolidated Sampling Location

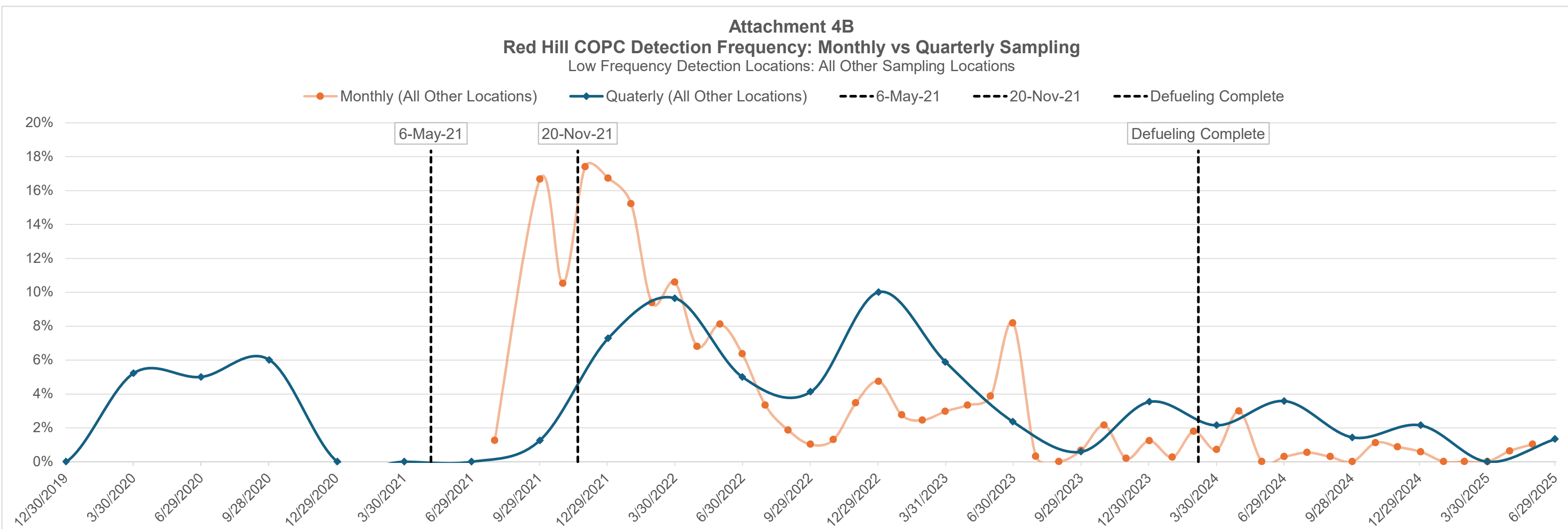
Location ID	Overall COPC Detection Frequency	GRO	DRO	ORO	1-Methylnaphthalene	2-Methylnaphthalene	Naphthalene	Benzene	Ethylbenzene	Toluene
RHMW02	56.3%	52.6%	100.0%	73.2%	94.5%	85.5%	99.1%	4.1%	30.6%	0.0%
RHMW01R	23.6%	26.4%	98.7%	41.4%	30.0%	3.9%	33.5%	0.0%	0.5%	0.5%
RHMW03	15.9%	2.1%	80.6%	74.9%	0.5%	0.5%	0.0%	0.0%	0.0%	0.5%
RHP04B	7.7%	0.0%	45.2%	31.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHMW05	5.9%	1.9%	28.9%	25.1%	0.6%	0.0%	1.7%	0.6%	0.0%	0.6%
RHMW08	5.9%	1.4%	27.1%	24.9%	1.2%	0.6%	1.2%	0.0%	0.6%	0.6%
RHMW2254-01	5.3%	8.1%	17.6%	14.1%	3.0%	2.0%	1.7%	0.0%	1.6%	0.7%
RHMW18	4.5%	6.3%	15.8%	15.8%	0.0%	0.0%	0.0%	0.0%	0.0%	7.1%
RHMW09	3.8%	1.4%	17.9%	14.1%	1.3%	1.3%	1.9%	0.0%	0.0%	0.0%
RHMW04	3.5%	1.5%	18.8%	13.9%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%
RHMW17	3.4%	2.2%	16.7%	12.0%	0.0%	0.0%	1.4%	0.5%	0.0%	1.6%
RHMW11	3.3%	0.0%	29.2%	4.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHMW19	3.3%	0.8%	16.3%	15.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHSF-PUMP	3.2%	5.9%	14.4%	10.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%
RHMW13a	2.9%	0.0%	8.8%	20.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHMW21	2.9%	1.5%	15.2%	11.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%
RHP08B	2.8%	3.3%	11.7%	10.9%	0.0%	0.0%	0.0%	0.0%	0.0%	1.7%
RHP08	2.6%	2.9%	2.8%	13.1%	2.8%	2.8%	1.4%	0.0%	0.0%	0.0%
RHMW06	2.6%	2.0%	11.5%	9.6%	0.7%	0.7%	0.7%	0.0%	0.0%	0.6%
NMW24	2.3%	1.5%	13.5%	8.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NMW26	2.2%	6.7%	5.3%	10.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHMW15	2.0%	5.6%	7.1%	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHMW16	2.0%	1.3%	8.3%	0.0%	3.8%	3.8%	2.5%	0.0%	0.0%	0.0%
OWDFMW08A	1.9%	0.7%	10.3%	8.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHP04A	1.8%	0.8%	7.9%	7.9%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%
RHMW13	1.8%	2.0%	6.3%	7.0%	0.6%	0.6%	1.3%	0.0%	0.0%	0.0%
NMW25	1.7%	1.4%	8.7%	7.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NMW30	1.7%	3.1%	7.9%	2.6%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%
RHMW10	1.4%	2.5%	4.6%	6.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHP04C	1.3%	2.8%	6.4%	3.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHMW14	1.3%	3.4%	7.7%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHP05	1.2%	1.3%	2.4%	1.2%	2.6%	1.3%	2.6%	0.0%	0.0%	1.0%
NMW32	1.2%	0.7%	6.8%	4.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHP03	1.1%	6.0%	1.7%	1.7%	0.0%	0.0%	2.0%	0.0%	0.0%	0.0%
RHP01	0.8%	2.2%	1.9%	3.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHMW20	0.8%	0.0%	3.3%	3.3%	1.2%	0.0%	0.0%	0.0%	0.0%	0.0%
RHP02	0.7%	2.2%	1.0%	3.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%
HDMW2253-03	0.6%	5.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHP08C	0.5%	0.0%	2.7%	2.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NMW33	0.5%	0.0%	2.6%	2.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NMW34	0.4%	0.0%	2.1%	2.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHP07	0.2%	0.0%	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RHP06	0.2%	0.0%	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NMW33A	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NMW27	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OWDFMW03A	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Attachment 3B: COPC Detection Frequencies and Number of Analyses by Group and Over Time, by Sampling Period

Frequency Group	Analyte Name	Total No. of Analyses	Detection Frequencies by Sampling Period		
			Prior to NOI	NOI	Consolidated
High-Frequency-Detection Wells (RHMW01R, RHMW02, RHMW03)	GRO	464	54.5%	33.6%	8.5%
	DRO	686	98.5%	99.3%	82.0%
	ORO	688	63.2%	78.4%	35.0%
	1-Methylnaphthalene	633	59.7%	43.9%	42.2%
	2-Methylnaphthalene	633	59.7%	33.2%	24.0%
	Naphthalene	631	59.7%	48.4%	42.2%
	Benzene	664	0.0%	2.8%	0.0%
	Ethylbenzene	666	0.0%	20.3%	0.9%
	Toluene	664	0.0%	0.6%	0.0%
	Xylenes, Total	665	12.1%	14.0%	0.9%
All Other Sampling Locations	GRO	2058	0.3%	3.2%	1.9%
	DRO	2225	8.8%	21.3%	5.3%
	ORO	2224	8.1%	17.6%	4.4%
	1-Methylnaphthalene	2130	0.0%	1.4%	0.0%
	2-Methylnaphthalene	2134	0.0%	1.0%	0.0%
	Naphthalene	2138	0.0%	1.5%	0.1%
	Benzene	2249	0.0%	0.1%	0.0%
	Ethylbenzene	2249	0.6%	0.2%	0.0%
	Toluene	2249	0.6%	0.7%	0.3%
	Xylenes, Total	2238	0.9%	0.9%	0.0%

Attachment 4:
Quarterly versus Monthly Detection Frequency Trend Analysis Charts





Data Legend & Notes

Data is based on all validated and unvalidated (subject to change) sampling results available in EDMS from 10/18/2016, through May 31, 2025.

COPCs include TPH, BTEX and all PAHs defined in the 2016 AOC.

High frequency wells include RHMW01R, RHMW02 and RHMW03. These wells have the highest detection frequencies since Q4 of2016, compared to all other sampling locations, greater than 10%.

Low frequency detection locations combine all wells and sampling points with COPC detection frequencies of less than 10%, which excludes RHMW01R, RHMW02 and RHMW03. These locations include wells currently being sampled that were also sampled under historical LTM and NOI: HDMW2253-03, RHMW04, RHMW05, RHMW06, RHMW08, RHMW09, RHMW10, RHMW11, RHMW13, RHMW14, RHMW15, RHMW16, RHMW19 and RHMW2254-01

Attachment 5:
Pre- and Post-Silica Gel Cleanup Detection Frequencies

Attachment 5: Pre- and Post-Silica Gel Cleanup Detection Frequencies

Location ID	No. of Data Points	Pre-SGC Detection Frequency	Post-SGC Detection Frequency
RHMW02	493	86.2%	57.4%
RHMW01R	434	70.5%	29.0%
RHP08	138	15.2%	9.4%
RHMW18	68	17.6%	8.8%
RHMW03	405	77.5%	7.9%
RHMW2254-01	610	16.2%	6.1%
NMW25	73	8.2%	5.5%
RHMW17	278	15.5%	4.7%
RHMW21	45	17.8%	4.4%
RHMW04	392	16.8%	4.3%
RHMW19	260	16.5%	4.2%
RHMW08	353	27.5%	3.1%
RHP05	142	5.6%	2.8%
RHMW05	352	26.7%	2.6%
RHMW10	162	6.2%	2.5%
RHMW06	301	11.0%	1.7%
NMW26	62	16.1%	1.6%
RHSF-PUMP	200	8.5%	1.5%
RHMW20	92	3.3%	1.1%
NMW32	100	2.0%	1.0%
NMW24	138	11.6%	0.7%
RHP04B	143	37.8%	0.7%
RHMW09	300	16.7%	0.7%
RHP04A	156	4.5%	0.6%
RHP02	185	2.2%	0.5%
RHMW12A	244	11.9%	0.4%
RHMW16	266	8.3%	0.4%
RHMW15	280	9.6%	0.4%
RHMW13	288	8.3%	0.3%
RHMW11	308	12.7%	0.3%
HDMW2253-03	134	3.0%	0.0%
NMW27	28	0.0%	0.0%
NMW30	65	6.2%	0.0%
NMW33	64	3.1%	0.0%
NMW33A	8	0.0%	0.0%
NMW34	80	2.5%	0.0%
OWDFMW03A	46	0.0%	0.0%
OWDFMW08A	308	6.8%	0.0%
RHMW14	284	6.0%	0.0%
RHP01	174	3.4%	0.0%
RHP03	156	1.9%	0.0%
RHP04C	121	5.0%	0.0%
RHP06	115	0.9%	0.0%
RHP07	108	0.9%	0.0%
RHP08B	33	9.1%	0.0%
RHP08C	36	0.0%	0.0%

Attachment 6:
PAH Detection Frequencies Over Time

Attachment 6: PAH Detection Frequencies Over Time

Location ID	Pre-NOI	NOI	Consolidated
RHMW02	82.0%	40.5%	18.1%
RHMW01R	0.0%	15.1%	2.3%
RHMW04	0.0%	0.3%	0.6%
RHMW16	0.00%	1.02%	0.6%
RHMW03	0.0%	3.4%	0.4%
RHMW17	0.0%	0.2%	0.1%
NMW32	0.0%	0.0%	0.1%
RHP02	0.0%	0.9%	0.1%
RHP05	0.0%	0.0%	0.1%
RHP08	0.0%	0.0%	0.1%
OWDFMW08A	0.0%	0.8%	0.0%
RHMW05	0.0%	6.8%	0.0%
RHMW06	0.0%	1.2%	0.0%
RHMW08	0.0%	1.5%	0.0%
RHMW09	0.0%	2.2%	0.0%
RHMW12A	0.0%	0.9%	0.0%
RHMW13	0.0%	0.2%	0.0%
RHMW14	0.0%	0.2%	0.0%
RHMW15	0.0%	0.1%	0.0%
RHMW2254-01	0.0%	1.4%	0.0%
RHP01	0.0%	0.9%	0.0%
RHP03	0.0%	5.4%	0.0%
RHP04A	0.0%	8.1%	0.0%
RHSF-PUMP	0.0%	4.1%	0.0%

Note: Sampling locations without PAH detections are not shown.