Exhibit D18

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In reply, please refer to:
File:

March 30, 2020

Captain Marc Delao
Commander Navy Region Hawaii
850 Ticonderoga St., Suite 110
Joint Base Pearl Harbor Hickam, Hawaii 96860-5101
[via marc.delao@navy.mil only]

Dear Captain Delao:

**SUBJECT: Department of Health Response to *Conceptual Site Model, Investigation and Remediation of Releases and Groundwater Protection and Evaluation, Red Hill Bulk Fuel Storage Facility, Joint Base Pearl Harbor-Hickam, Oahu, Hawaii***

The Hawaii Department of Health (DOH) has reviewed the ***Conceptual Site Model, Investigation and Remediation of Releases and Groundwater Protection and Evaluation,*** June 30, 2019 Revision 01 *(2019 CSM)*, submitted by the U.S. Department of the Navy (Navy) and Defense Logistics Agency (DLA). The DOH notes that the 2019 CSM is not a formal deliverable under the Red Hill Administrative Order on Consent (AOC) and is providing the following comments in the interest of improving the technical basis for critical upcoming groundwater protection decisions.

The DOH review team includes internal and external subject matter experts (SMEs) recognized for their extensive local experience in the geology and hydrogeology of Hawaii volcanics, groundwater flow and transport, and groundwater chemistry. These include Robert Whittier of the Safe Drinking Water Branch Source Water Protection Program, Dr. Don Thomas, Dr. Scott Rowland and G.D. Beckett.

While our review of the 2019 CSM has been underway for many months, the timing of this response specifically addresses the Navy's March 5, 2020 request for written input on this document in the AOC Parties Technical Working Group webinar. While there remain technical disagreements among the AOC parties, the DOH appreciates the willingness and interest of the Navy to continue working collaboratively on these complex technical issues.

We note that these comments are being delivered just days after the Navy submitted the *Groundwater Flow Model (GWFM) Report, Red Hill Bulk Fuel Storage Facility, Joint Base Pearl Harbor-Hickam (JBPHH)* and the *Investigation and Remediation of Releases Report, Red Hill bulk Fuel Storage Facility, JBPHH,* dated March 25, 2020, with the Section 508-compliant versions to be submitted on April 8, 2020. The comments below do not include or address the content of these recent deliverables.

The role of the 2019 CSM is to form a functional understanding to guide investigations of the geology, hydrogeology, release mechanisms, and fate and transport of contaminants at Red Hill as they impact groundwater and drinking water supplies. The 2019 CSM forms the conceptual basis for the development of the groundwater and fate and transport models, and available field data become key reference points to align the conceptual and numeric models.

The Navy has dramatically increased the amount of high-quality data available about subsurface conditions at the site and the DOH has provided extensive information and localized expertise on the local and regional geology and hydrogeology. Even so, much remains unknown about contaminant occurrence and distribution in the near field of the tank farm. Due to the unique conditions at Red Hill, the DOH acknowledges that the water quality dataset within the confines of the tank farm is sparse and likely to remain so due to the potential risks to groundwater of installing additional wells that could create preferential contaminant pathways.

Given the unique conditions of the tank siting, and the difficulties of characterizing the complex, fractured volcanic rock environment that limit the amount of the information available, the DOH believes interpretations of the data by the Navy must be conservative in nature and evaluate hazards suggested by the data to account for the uncertainty inherent in assessing releases and transport mechanisms from the Red Hill tank farm.

Working in consultation with our SMEs in Hawaiian geology, hydrogeology, and fate and transport, we continue to disagree with fundamental conclusions made in the 2019 CSM that minimize evidence of historic impacts to the aquifer; do not account for fast track pathways for fuel releases to groundwater; emphasize very rapid degradation of releases; and describe groundwater flow behaviors not supported by on- and off-site field data. Together, these assumptions may artificially limit the reader's understanding of potential future risks to nearby drinking water resources; lead to premature conclusions about the effectiveness of proposed treatment remedies; and underestimate existing contamination in the subsurface from historic releases. These concerns have been raised by our SMEs repeatedly in writing, in groundwater modeling working group meetings, and multiple AOC party technical meetings since early 2018.

More detailed comments that outline DOH's specific concerns are in the enclosure.

We share a critical common goal for groundwater protection and believe the Navy is committed to that goal as well. A shift to a more conservative, data-driven assessment of available information to build a more solid, joint foundation for our decision making will build public confidence and increase options for early, effective response strategies to avoid and mitigate reasonably foreseeable release scenarios.

If you have any questions, please contact me at joanna.seto@doh.hawaii.gov or (808) 292-8408(c).

Sincerely,

JOANNA SETO, P.E., ACTING CHIEF
Environmental Management Division

Enclosure: Hawaii Department of Health Technical Review of the Navy's Red Hill Conceptual Site Model (CSM) Report, dated March 30, 2020, with References, based on review of *Conceptual Site Model, Investigation and Remediation of Releases and Groundwater Protection and Evaluation, Red Hill Bulk Fuel Storage Facility, Joint Base Pearl Harbor-Hickam, Oahu, Hawaii, June 30, 2019, Revision 01*

# HAWAII DEPARTMENT OF HEALTH TECHNICAL REVIEW

## Conceptual Site Model, Investigation and Remediation of Releases and Groundwater Protection and Evaluation, Red Hill Bulk Fuel Storage Facility, Joint Base Pearl Harbor-Hickam, Oahu, Hawaii, dated June 30, 2019 Revision 01 (2019 CSM)

March 30, 2020

The Department of Health (DOH) has reviewed the 2019 CSM. The following comments below do not include or address the content of the March 2020 Administrative Order on Consent deliverables including the *Groundwater Flow Model Report (GWFM) Report*. The DOH acknowledges, however, that the Navy's proposed multi-model approach is intended to address the DOH concerns about the groundwater flow direction.

Please refer to Figure 1 for the locations of the wells, valleys, and other features referred to in these review comments.

**Purpose of the CSM**

The purpose of the CSM is to review and analyze available data, then to form a functional understanding of the geology, hydrogeology, and fate and transport of released contaminants at the Red Hill Bulk Fuel Storage Facility (Facility). The 2019 CSM is to provide a critical foundation for the development of the numerical groundwater flow and transport models required by the Administrative Order on Consent (AOC). The conceptual and numerical models should be in alignment and this commonly requires iterative changes of each as differences between the two (conceptual and numerical) emerge. The desired result is to have a numerical model that is technically defensible and backed up by a robust conceptual model. Technically defensible models can then inform critical decisions such as the Groundwater Protection Plan, response actions to be taken in case of a fuel release, and feasibility and design of drinking water treatment systems.

**Putting Review in Perspective**

The 2019 CSM contains a large amount of critical data. The DOH commends the Navy on the extraordinary ongoing field and data collection effort to inform and refine decision making at the Facility. We appreciate the collaborative assistance the Navy is providing to support our ongoing field investigations of outcrops and subsurface features of the lava geometry. This work will shed light on LNAPL transport and mobility to groundwater through fractures and dense aʻa flows.

However, significant technical disagreements remain about interpretation of these data and conclusions drawn by the Navy. Below is a summary of DOH concerns with major conclusions put forth by the Navy regarding groundwater flow in the Red Hill region and the contamination risk that future releases from the Facility pose to groundwater and drinking water sources.

**MAJOR CONCLUSIONS OF THE 2019 CSM**

1. Overall groundwater flow beneath the facility is to the southwest through very permeable pathways and high rates of transport.
2. LNAPL from the 2014 release is held in the unsaturated zone well above the water table resulting in no impact to the groundwater.
3. Dissolved phase contamination is quickly attenuated with a half-life less than 10 days for all COPCs under the field conditions at Red Hill.
4. Distal detections of contamination and electron acceptor indicators of contamination are unreliable due to laboratory issues and drilling fluid impacts.
5. Deep saprolite prevents contaminant migration from Red Hill to Halawa.

The Navy has based these conclusions on the interpretation of available published research literature as well as analysis of more than a decade of prior groundwater monitoring data, and a greatly expanded data set generated by an ongoing post-release investigation of the region around the Facility.

However, the DOH has identified flaws and shortcomings in the analysis as presented in the 2019 CSM. These include, but are not limited to:

***General approach of dismissing or redefining important data sets***

Examples:

- Dismissing petroleum contaminant detections as an artifact of drilling fluids (Appendix I, Section 3); and
- Redefining the background dissolved oxygen concentration to be much lower than the data support with the net effect of reducing the area that is evaluated as being impacted by petroleum contamination (Appendix I, Section 2).

***Presenting blanket assertions to support specific interpretations while providing insufficient supporting data***

Examples:

- Bivariate diagrams show mixing of sodium chloride type water from north of South Halawa Valley with bicarbonate type water from the southeast (Section 6.4, Pages 6-31 and 6-32; and Figure 6-38).
- Residual drilling fluid contaminants render detections of significant levels of TPH-d in samples unreliable for up to 2 years after well installation. (Appendix I, Section 3).

- Thermal profiling shows LNAPL is held within a zone that extends no more than 45 ft beneath the floor of the lower access tunnel (Appendix B.1, Section 2).

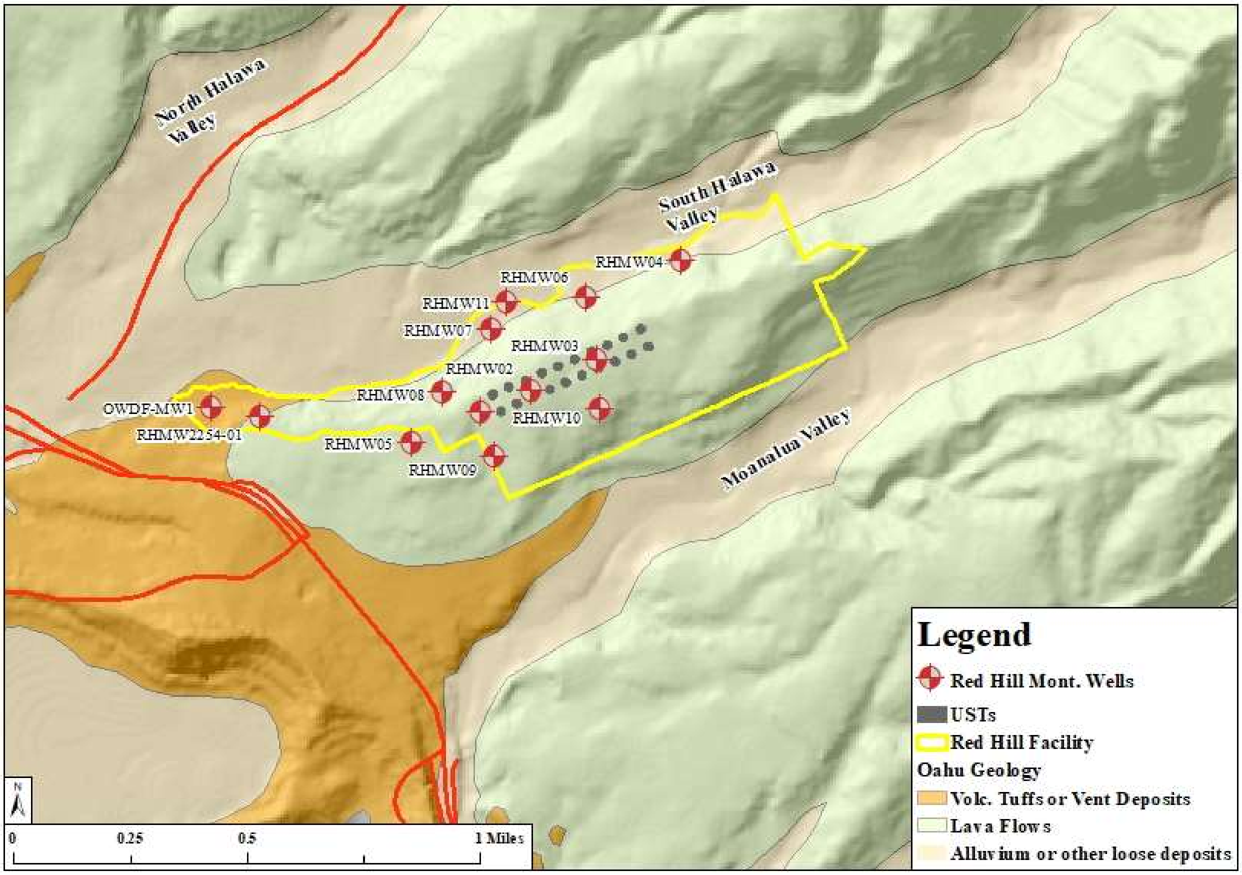


*Figure 1 The Red Hill investigation area showing major features and the generalized geology.*

### ***Drawing conclusions from inappropriate or inconclusive tests***

Examples:

- Source Zone Depletion Mass Rates Using $CO_2$ Flux Measurements –The surface coverage was insufficient to allow reliable upscaling. Existing knowledge of vadose zone airflow at the site is inadequate to support the calculated contamination mass that the 2019 CSM states is being degraded (Appendix B.2). Given the variability of carbon trap results as well as that among the bulk tunnel evaluations, the degradation rates per year have large uncertainty, as does the subsurface volume to which these values are applied.
- Petrographic Analysis –The centrifuge testing method used produces unreliably high residual saturations, overestimating the holding capacity of the vadose zone (API, 2006). Further, the scale and character of core samples selected for

testing are not representative of the characteristics of favorable migration pathways. The forced saturation and de-saturation of the core samples bears little resemblance to the conditions that affect fluid (water and LNAPL) retention in the zone between the USTs and the water table. (Section 5.1.11 and Appendix F). There are several issues in the petrographic testing program, as were conveyed by the DOH communications to the Navy in early 2018, that limit their applicability in groundwater protection decisions. The primary issues are: a) core sample size and vertical testing orientation limit conclusions that can be drawn for field-scale applicability; b) related, specific features such as near-horizontal clinker zones (transport features) are not adequately captured by core sampling; c) the centrifuge testing method (where applied) has been shown to over-estimate residual saturations (API, 2006, OU1-C, Honolulu Harbor, 2009 and other sites); d) in-situ initial fuel saturation conditions are unknown and represent a reduction of the formation retention capacity; e) the artificial emplacement of fuel into core likely does not represent field conditions and the residual capacity is a function of that initial saturation; and f) the scale and conditions of lab-testing needs to match those expected under field release conditions, and at the present time are unknown.

- The double ring infiltrometer test, conducted to evaluate the likelihood that the saprolite cap above the tanks can prevent vertical infiltration is inconclusive as the test was conducted on the infiltration characteristics of the very shallow soil and not of the deeper saprolite (Section 5.1.12 and Appendix G).
- The use of Dissolved oxygen (DO) concentrations measured in groundwater beneath a landfill, located in a former sugar cane field to define background DO concentration (Appendix I, Section 2) is inappropriate since the groundwater presumed to be flowing below the tanks is derived from pristine mountain recharge having no anthropogenic inputs.

A more detailed evaluation of these shortcomings is as follows:

***Overall groundwater flow beneath the facility is to the southwest***

The primary lines of evidence provided in the 2019 CSM include:

- Groundwater levels measured throughout the Facility are consistent with previous studies (Oki, 2005; and Dept. of the Navy, 2007 and 2010).
- Groundwater gradients in the Red Hill area generally show a gradient to the southwest beneath facility.
- Trends in major chemical components in the groundwater indicate mixing of sodium-chloride type water from north of South Halawa Valley and sodium-bicarbonate type water from the southeast.

These lines of evidence do not align with hydrologic conditions at Red Hill.

- While it is true that previous studies did indicate a southwesterly flow direction, these studies did not benefit from the wealth of new, more precise and accurate groundwater elevation data that are currently available showing a dominant groundwater gradient to the northwest. It is the standard scientific process to revise findings as new data becomes available. Also, the prior USGS studies that are cited in the 2019 CSM were focused on the groundwater amounts and sustainability rather than the groundwater flow trajectory in the very upper part of the aquifer where the petroleum contamination migration will occur.
- As described in a report generated by the DOH Source Water Protection Program (SWPP) (DOH, 2019), the recent, more precise, groundwater elevation data shows that the dominant hydraulic gradient beneath the facility in the vicinity of the USTs is to the northwest except when the Red Hill Shaft is pumping at a high rate for an extended period.
- The 2019 CSM proposed source of sodium chloride water from north of South Halawa Valley is up-flow from the brackish water zone of HDMW2253-03 (Section 6.5 second to the last bullet; Section 6.4, page 6-31, Lines 36 through 44; and page 6-32, Lines 1 through 6). This assertion needs much more justification than is provided because:
    - The upward intra-borehole flow of brackish water starts at -690 ft msl and equilibrates with the formation water at -100 ft. msl. Hence, for brackish water from HDMW2253-03 to be considered a viable source for salinity observed in the much shallower Facility monitoring well network, a mechanism needs to be described by which the denser (cooler and more saline) deep groundwater rises hundreds of feet and mixes with the less dense, fresh shallow groundwater.
    - The bivariate diagrams provided to show the mixing fail to define a coherent mixing line. If binary mixing is occurring, as the 2019 CSM suggests, there should be a linear mixing line from one end-member (Halawa Deep monitoring well at a depth of -624 ft msl) to the other end-member (RHMW02 or RHMW03) with RHMW04, RHMW06, RHMW07, and RHMW2254-01 falling on that line as intermediate mixtures of the two water types. Figure 2 adapted from Figure 6-38 of the 2019 CSM shows that a mixing line from HDMW2253-03 (-624 ft) to the RHMW02 or RHMW03 end members does not pass through the intermediate wells located between the presumed source water and the end- member wells. Figure 3, below, from Hunt (2014) is an example of bivariate mixing where most wells fall close to the mixing line from “MW401 deep” to the

Honokohau Well. The wells that fall off this line (e.g. KAHO 2 and KAHO 3), show chemical enrichment from sources other than the two end members. What the bivariate diagrams presented in the 2019 CSM shows is a more complex mixing system where there is potentially sluggish groundwater movement.

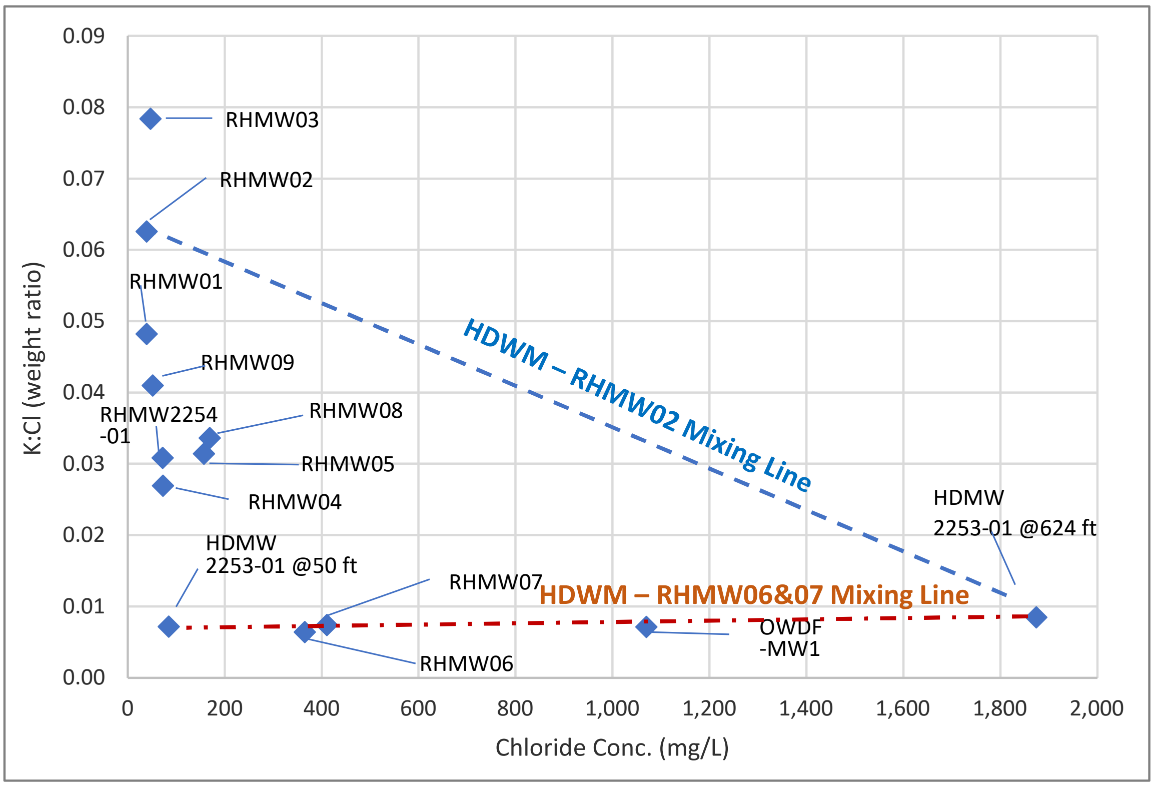


*Figure 2. Bivariate diagram of the chloride concentration versus ratio of potassium to chloride.*

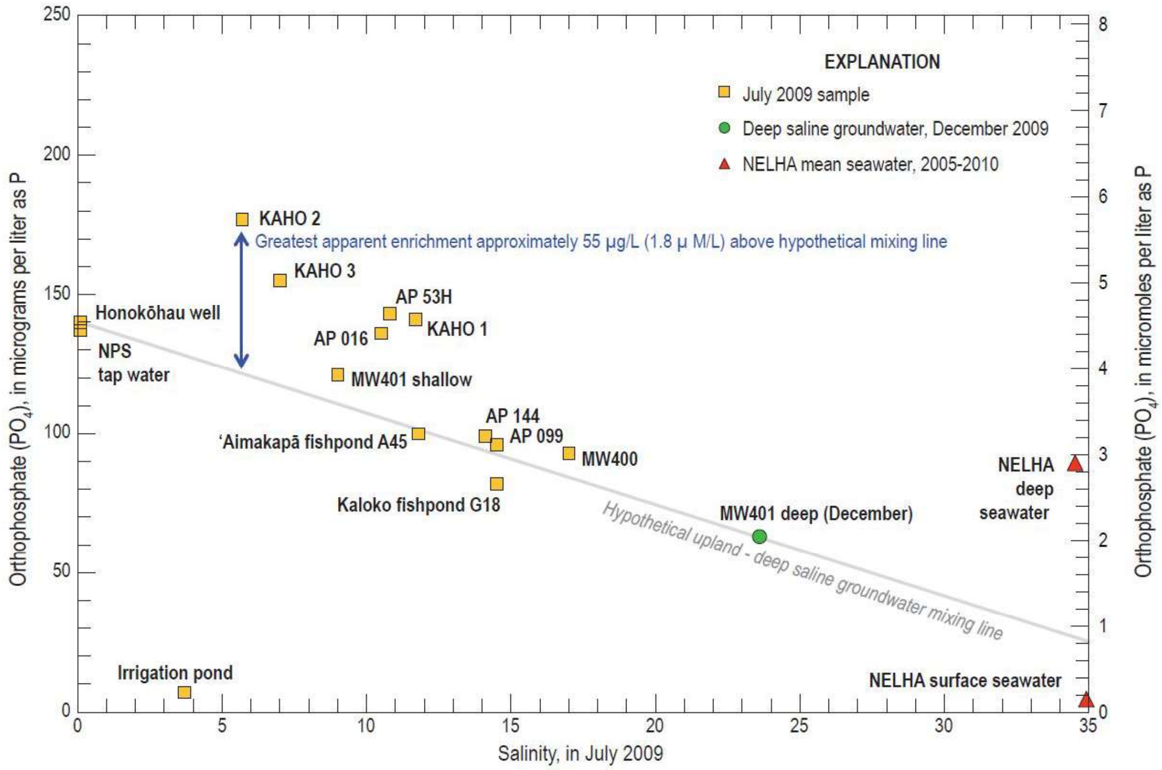


**Figure 24.** Graph showing orthophosphate versus salinity for July 2009 water samples at Kaloko-Honokōhau National Historical Park, Island of Hawai'i. Sites showing greatest enrichment (KAHO 1, KAHO 2, KAHO 3, AP 016, AP 53H) lie near and downslope from Kaloko Light Industrial Park and the KAHO visitor center. NELHA, Natural Energy Laboratory of Hawai'i Authority.

*Figure 3. Bivariate diagram from Hunt (2014) showing a binary mixing line of two water types and apparent enrichment from a third water type results in data points separated from the mixing line.*

***There was no impact to the groundwater from the 2014 release since the LNAPL was held in the vadose zone***

The 2019 CSM supports this conclusion with:

- Temperature versus depth profiles of the monitoring wells in the lower access tunnel that show thermal anomalies apparently ending 45 ft below the floor of the tunnel
- Ratios of key petroleum compounds are consistent with significant weathering indicating the detected petroleum contamination pre-dates the 2014 release.

We believe these arguments are inconclusive and unsubstantiated because:

- Thermal profile:

  a. First, it is important to note that there is no way to discern whether the thermal profile is related to the 2014 release or to prior releases at Tank 5 or other nearby tanks, or by thermal convection from elsewhere through a preferential pathway.

  b. As shown by Dr. Bekins of the USGS at the Red Hill Groundwater Modeling Working Group Meeting Number 15 on August 1, 2019 (Bekins, 2019); the thermal profile data presented in the 2019 CSM are insufficient to draw conclusions about the downward extent of the LNAPL migration.

  c. RHMW03, which would not be affected by the 2014 release, has a thermal anomaly like that at RHMW02. No evidence of LNAPL was found on rock cores from RHMW03 nor have any releases been reported near RHMW03 since this well was drilled so there is no clear evidence to link the thermal anomalies to nearby LNAPL.

- Degree of weathering indicates contamination predates the 2014 release:

  a. In Section 7.3.2.4, Table 7-6 of the 2019 CSM states that the half-lives for the compounds of potential concern are very short (less than 5 days). If true, this indicates that rapid weathering out of COPCs negates the diagnostic power of this line of evidence.

  b. To accept the assertion that chemical indicators of weathering date the contamination to prior than the 2014 release, site relevant data that the lighter fraction of the JP-8 fuel would not be lost during transit from the tank and through the oxygen-rich vadose zone before it reaches the saturated zone below the tank should be provided.

  c. Hawaii's subsurface geology has much higher vapor transport and oxygen enrichment rates than are found in North American geologic environments. Particularly in the vadose zone, this will result in more rapid rates of vapor phase loss and degradation through oxidation than are found elsewhere.

  d. Inspection of RHMW01 TPH-d trends strongly suggest that the contaminant chemistry at this well is impacted by the 2014 release. Figure 4 shows the TPH-d history for RHMW01. Prior to the 2014 release there is a well-defined decreasing trend in TPH-d as indicated by a high correlation coefficient of 0.75. From 2014 onward this decreasing trend ceases being replaced by systematically increasing, then decreasing

TPH-d concentrations that have the appearance of a breakthrough curve. The logical conclusion is that the 2014 release did indeed appear in RHMW01 as a TPH-d break through curve.

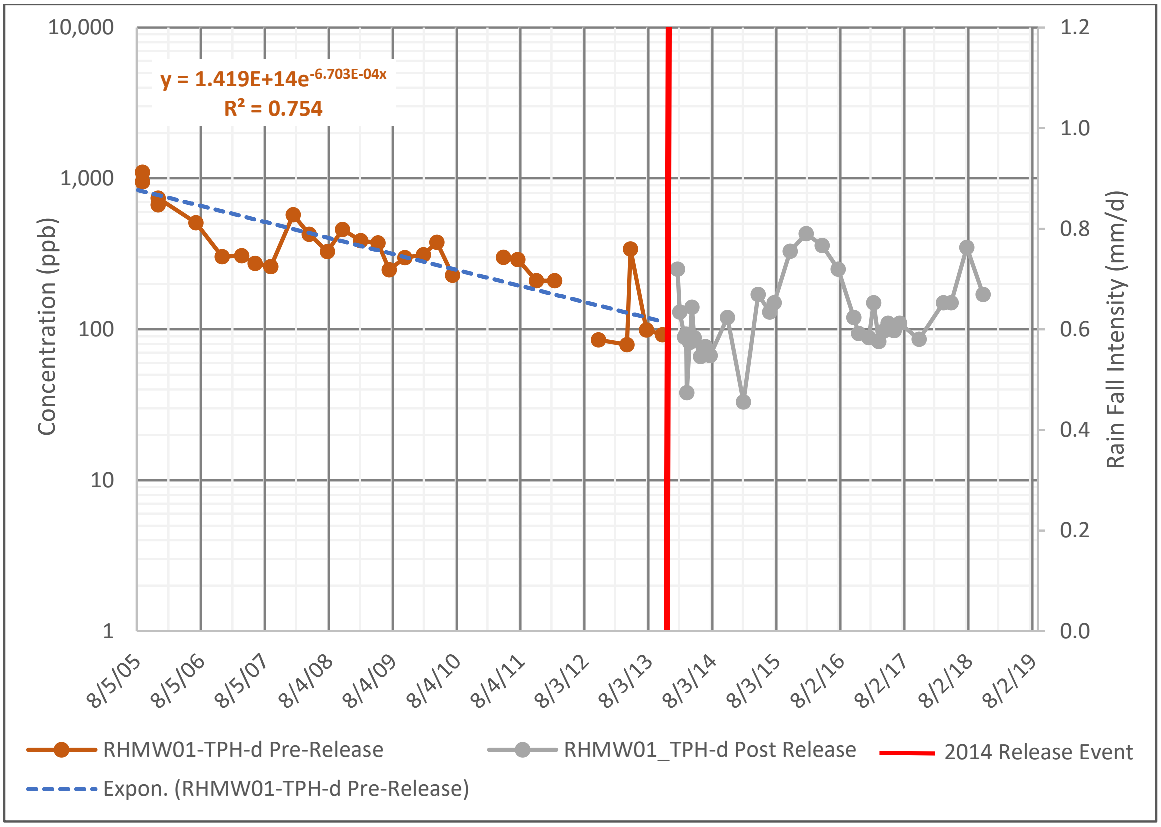


*Figure 4. The TPH-d trends at RHMW01 prior to and after the 2014 release.*

***Dissolved phase contamination is quickly remediated with half-life less than 10 days for all COPCs under all field conditions at Red Hill.***

The 2019 CSM presented the rates of natural attenuation between RHMW02 and RHMW01 in Section 7.3.2.4 and Appendix B.4. The half-lives computed are presented in Table 7-6 and no half-life presented is greater than 4.6 days. These rates are presented as consistent with the results of microbial investigations described in Section 7.3.2.2.

We challenge these assertions for the following reasons:

- The conceptual model assumes that RHMW02 and RHMW01 fall on approximately the same flow path, and that the travel time between the two wells is from 15 to 21 days. Neither of these assertions have been independently validated with field data. The half-lives of 1 to 25 days presented in the 2019 CSM are consistent with aerobic degradation rates (Section 7.3.2.2, Table 7-4). However, both wells show nitrate and sulfate reduction are occurring, thus indicating that anaerobic conditions exist at both wells. If RHMW02 and RHMW01 are in the same flow path, anaerobic conditions are present between the two wells. The anaerobic microcosm half-lives of 101 to 10,000 days are the more likely choice for the electron acceptor conditions between RHMW02 and RHMW01. There are multiple alternative explanations for the sharp reduction in contaminant concentrations between RHMW02 and RHMW01 including that they are not in the same flow path, making them inappropriate choices for plume attenuation calculations, the travel velocity between the two wells is much slower than estimated, or dilution as the plume migrates away from the source area. Attributing the contaminant concentration reduction solely to natural attenuation is inappropriate.

- The independent reference cited to support the rapid natural attenuation rates was Kao et al., (2006). The conditions for the Kao et al. (2006) study bear very little resemblance to Red Hill: it was done in a porous medium in Taiwan where the depth to groundwater was very shallow, and the primary electron acceptor (nitrate and sulfate) concentrations were much higher than at Red Hill. This study explicitly stated that the calculated natural attenuation rates were much faster than those found in other studies. Due to drastic differences in setting and the unusually high estimated natural attenuation rates reported in the Kao et al. (2006) study, it should not be used to support the stated natural attenuation rates for Red Hill. A more rigorous literature search should be done to find sites more like Red Hill to test the stated natural attenuation rates.

***Distal detections of contamination and electron acceptor indicators of contamination are unreliable due to drilling impacts.***

The 2019 CSM characterizes the petroleum contaminant detections and depletion of DO during the first two years following well installation as unreliable due to potential drilling contamination. This is the basis used to discount nearly all the TPH distal well detections.

We reject this assertion because:

- The argument that drilling fluid contamination could persist up to two years directly contradicts the the rapid attenuation rates as well as rapid groundwater flow rates presented in the 2019 CSM.
- The average TPH concentration in drilling fluids presented in Appendix I, Table I-1 was 165 μg/L. The detection limit for TPH-d is 25 μg/L so it takes much

less than one-order of magnitude reduction in concentration to bring the TPH-d below the laboratory detection limit. Because there is no LNAPL source zone associated with drilling fluids, the rapid groundwater flow rate assumed in the 2019 CSM would quickly move the drilling fluids and associated contaminants down gradient from the well reducing the concentration to less than the detection limit.

- To demonstrate that this is more than just speculation, we present the results of a tracer test. In 2001, as part of the Hickam Petroleum, Oil, and Lubrication investigation of the decommissioned Waikakalaua Fuel Storage Annex at Wheeler Army Airfield a tracer test was conducted (United States Air Force, 2007). A large tracer plume was created by adding 12,000 gallons of fluorescent dye tagged water into a monitoring well over a period of 5.5 days. Due to the large plume generated, this tracer test is a good surrogate for the impact of drilling fluids on the chemistry of monitoring wells. Upon termination of dye injection, the concentration immediately started decreasing. Normal advection and dispersion processes showed an order of magnitude reduction in tracer-dye concentration within the first month. This tracer test demonstrates that the concentration of introduced solutes quickly attenuates due to advection, dilution, and dispersion when there is rapid groundwater flow. It is unreasonable to assume that drilling fluids could account for detected petroleum contamination except for possibly immediately after the well was installed.
- The 2019 CSM states that drilling operations make DO measurements unreliable for a prolonged period after well installation. We make the further argument that, in the absence of depletion due to the natural attenuation of fuel hydrocarbons, the DO concentrations within the Red Hill monitoring well network will be near saturation. As was presented to the AOC parties during the July 2019 face to face meetings, the selection of wells (from outside of the monitoring network) that the Navy used to justify depleted DO in shallow monitoring wells are all influenced by large scale agriculture and the biological processes in the soil associated with this land use. The Navy's own data shows that a DO concentration of more than 8 mg/L is a more appropriate reference level for Red Hill than the stated 6.7 mg/L (refer to Appendix I Table 2-5).

***Distal detections of contamination are unreliable due to variability induced by changing laboratories and the non-specific nature of TPH-d analysis.***

This conclusion was arrived at without adequately investigating the various factors that will result in COPC variability.

- Much of the variability in COPC concentrations, particularly TPH-d and naphthalene, are attributed to differences in procedures and capabilities of the various analyzing laboratories during the history of the Red Hill monitoring. This conclusion does not consider other likely sources of variability. Figure 5 shows that the naphthalene concentrations at RHMW02 significantly decreased following periods of intense rainfall in 2008 and 2010. This correlation was also found to be true for TPH-d.

- The 2019 CSM cites CalScience/Eurofins and Columbia Analytical Services as laboratories that produced analytical results that were likely elevated compared to the other laboratories. The DOH contends that since the EPA/Navy split sampling found that the TPH-d results from APPL (the Navy's current laboratory) were low compared to the EPA analysis, it is the lower historical results from APPL that should be viewed as unrepresentative.
    - Since APPL revised their extraction process following review of the split sample results it seems that they agree that the representative TPH-d values are higher.
- The 2019 CSM states that TPH-d is a poor indicator of petroleum contamination due to the non-specific analysis that includes petroleum compounds as well as metabolites. However, the primary purpose of the current Red Hill investigation is to assess the contaminant migration risk from future releases. Unlike the BTEX compounds that the Navy prefers as indicators, the compounds making up TPH-d are persistent and mobile, making TPH-d a good indicator of where past contamination has migrated and a reasonable predictor of where contamination from future releases may migrate.
- The DOH assumes all contaminant detections are valid unless strong evidence to the contrary is presented. As discussed in the DOH guidance and numerous, referenced documents, non-specific, aliphatic and aromatic compounds, along with their degradation compounds that collectively make up the "TPH" component of contaminated groundwater, typically drive health risk over individual, aromatic compounds at sites contaminated with middle distillate fuels (Hawaii Dept. of Health 2016, 2017, 2018). Toxicity factors have been available for the individual, carbon range fractions that make up TPH-d since the 1990s.
- The DOH action levels for TPH-d are based on an assumed, carbon range makeup of the fuel in soil, water and air (laboratory study of dissolved-hydrocarbons in water currently underway). This can be re-assessed on a case-by-case basis. The toxicity of parent, petroleum hydrocarbon compounds and related degradants is assumed to be similar for initial screening purposes and must be included in the data. While imperfect, TPH-d analysis and data are critical for assessment of health risk posed by contaminated groundwater and cannot be ignored. Proposals for more accurate testing of TPH in contaminated media are permitted on a case-by-case basis.

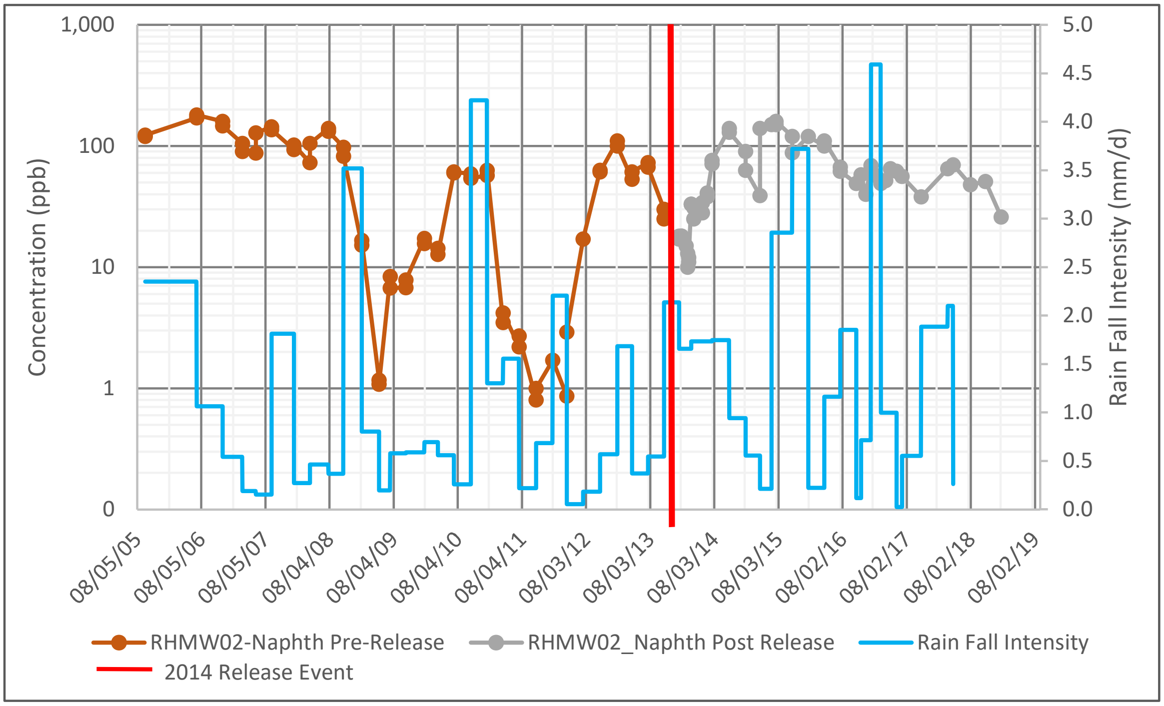


*Figure 5. Naphthalene concentrations at RHMW02 and the influence of intense rainfall on the naphthalene concentrations prior to the 2014 release.*

***Deep saprolite prevents contaminant migration from Red Hill to Halawa.***

The DOH agrees that saprolite may affect and limit migration of LNAPL and dissolved petroleum contamination; however, the field-scale properties with regard to LNAPL migration are unknown. The major point of disagreement is how far upslope that saprolite acts as a potential barrier to contaminant transport. The main points of contention are:

- The valley cross-sections (Appendix E, Cross-Section K-K' (South Halawa Valley) and Cross-Section O-O' (North Halawa Valley)) of the saprolite/basalt interface are predominantly based on literature values and most cases do not reflect the seismic data that the Navy collected for the purpose of characterizing the saprolite barrier.
- The consequence of not adequately considering the seismic field data for this purpose is that:
  - the up-valley portions of the cross-sections in the 2019 CSM are much deeper than those indicated by the seismic survey and boreholes,

significantly over-estimating the protection afforded to the Halawa Shaft by the saprolite, and

- o the down-valley portions of the cross-sections in the 2019 CSM are shallower than those indicated by the seismic survey, underestimating the resistance that the valley fill and saprolite pose to groundwater migration to Pearl Harbor.

- The cumulative effect of these two discrepancies is a non-conservative conceptual model that over-estimates the protection afforded the Halawa Shaft by the valley fill and saprolite.
- The geologic logs for RHTB01 and RHMW13 confirm that the saprolite/basalt interface is much shallower than any estimation displayed in the 2019 CSM.

## SUMMARY AND RECOMMENDATIONS

A CSM is an important document as it provides the technical and scientific basis for the numerical groundwater flow model, and more importantly, the basis for understanding and making critical decisions to minimize the risk the Facility poses to vital drinking water assets. The conclusions of the 2019 CSM need to be conservative from a risk perspective to ensure proper risk mitigation measures are taken. The 2019 CSM does not meet this standard in many respects, asserting interpretations and conclusions that lack scientific defensibility, are uncertain and non-conservative. Foremost among the conclusions is the insistence that the evidence shows the dominant groundwater flow direction is to the southwest. An examination of the lines of evidence presented in Section 6.5 show that none adequately support this conclusion. This is also true for the 2019 CSM's conclusions regarding rates of natural attenuation, LNAPL transport and retentivity in vadose zone, distal detections of petroleum contamination, and background concentrations of electron acceptors.

The DOH remains committed to working with the Navy, providing Hawaii geologic expertise and welcoming opportunities for multi-agency collaboration on additional field testing to more conclusively evaluate the groundwater flow dynamics in the vicinity of the Facility and that will better characterize the LNAPL transport properties of the east Oahu basalts underlying the Red Hill facility.

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