REGION 9
SAN FRANCISCO, CA 94105

October 29, 2024

Rear Admiral M. F. Williams
Deputy Commander
Navy Closure Task Force – Red Hill
850 Ticonderoga St., Ste. 110
Joint Base Pearl Harbor Hickam, HI 96860-5101
(Sent via Electronic Mail)

Subject: EPA Review of:

- *Draft Final - Technical Memorandum, Phase 2 Holding Tank and Leach Tank Characterization, November 2021 Pipeline Release, Red Hill Bulk Fuel Storage Facility, Navy Facilities and Engineering Command, Hawaii, JBPHH, HI,* dated November 22, 2022
- *Draft – Closure Report, Concrete Tank Removal Red Hill Bulk Fuel Storage Facility, Navy Facilities and Engineering Command, Hawaii, JBPHH, HI,* dated January 2023
- *Technical Memorandum, Revised Phase 2 Holding Tank and Leach Tank Characterization, November 2021 Pipeline Release, Red Hill Bulk Fuel Storage Facility, JBPHH, HI,* dated August 8, 2024
- *Draft – Closure Report, Concrete Tank Removal Red Hill Bulk Fuel Storage Facility, Joint Base Pearl Harbor-Hickam, Oahu, Hawaii, dated July 2024*

Dear Rear Admiral Williams:

Thank you for submitting the *Draft Final - Technical Memorandum, Phase 2 Holding Tank and Leach Tank Characterization, November 2021 Pipeline Release, Red Hill Bulk Fuel Storage Facility, Navy Facilities and Engineering Command, Hawaii, JBPHH, HI,* dated November 22, 2022*. ("Tech. Memo").* and the *Draft – Closure Report, Concrete Tank Removal Red Hill Bulk Fuel Storage Facility, Navy Facilities and Engineering Command, Hawaii, JBPHH, HI,* dated January 2023. ("CRCT"). Although these documents were not submittals under the 2015 AOC, they are important records of work the Navy completed after the 2021 releases. Future deliverables for environmental work for this operable unit should be submitted for EPA approval under the Phase II Closure plan pursuant to Section 7 of the 2023 Consent Order. This operable unit should be considered in the investigation phase of work and should be given a unique name for future reference, such as Holding Tank/Leach Tank Investigation.

EPA engaged our contractor, S.S. Papadopulos & Associates, Inc. (SSPA), to aid in the review of the Tech. Memo and the CRCT. SSPA's enclosed evaluation focused on confidence of field sampling and survey work, representativeness of the data, and completeness of the removal action. We acknowledge that the Navy provided revised reports on August 8, 2024 to address comments made by the Hawaii Department of Health. EPA's initial review of these documents finds that, although the Navy made some updates, the majority of SSPA's comments still apply to the revised documents.

In particular, SSPA identified multiple data gaps, and the Navy will need to delineate the remaining contamination in soil and groundwater at the holding tank and leach tank operable unit. Enclosed please find a marked-up figure from the CRCT with red circles depicting the areas that EPA finds are not delineated. Additional removal and/or remediation of the November 20, 2021, jet fuel propellant 5 (JP-5) release will likely be required. Please incorporate the recommendations from the enclosed memo in the next Holding Tank/Leach Tank Investigation Work Plan.

If you have any questions regarding this letter, please contact me at russi.tonya@epa.gov or 415-972-3706.

Sincerely,

/s/

Tonya Russi
Red Hill Project Coordinator
U.S. Environmental Protection Agency, Region 9

Enclosures:

- Technical Memorandum - Adit 3 Document Review – Tasks 9 & 10
- Figure – Further Investigation Required

cc: Kelly Ann Lee, Hawaii Department of Health
RADM Stephen Barnett, Commander NCTF-RH
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ENCLOSURE 1:
Technical Memorandum
Adit 3 Document Review
Tasks 9 & 10

S.S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

Technical Memorandum

Date:	August 7, 2024
From:	Shelly Griffin (SSP&A) and Benjamin Petersen (SSP&A)
To:	Lynn Brockway (USEPA Region 9)
Cc:	Kenneth Dixon (USEPA Region 9)
Project:	SSPA-1857
Subject:	**Adit 3 Document Review – Tasks 9 & 10**

1 Introduction

On May 15, 2023, the United States Environmental Protection Agency ("USEPA") Region 9 tasked S.S. Papadopulos & Associates, Inc. ("SSP&A") with 14 discrete tasks related to the review of site documents and data from the Red Hill Bulk Fuel Storage Facility, Joint Base Pearl Harbor-Hickam, Oahu, Hawaii ("Facility"). This memorandum summarizes the technical review of site documents performed in support of Tasks 9 and 10.

Tasks 9 and 10 are to review the following documents:

- **Task 9** – *Draft Final - Technical Memorandum, Phase 2 Holding Tank and Leach Tank Characterization, November 2021 Pipeline Release, Red Hill Bulk Fuel Storage Facility*, Navy Facilities and Engineering Command, Hawaii, JBPHH, HI, November 22, 2022. ("Tech. Memo").
- **Task 10** – *Draft – Closure Report, Concrete Tank Removal Red Hill Bulk Fuel Storage Facility,* Navy Facilities and Engineering Command, Hawaii, JBPHH, HI, January 2023. ("CRCT").

These documents summarize site characterization and tank removal activities in the Holding Tank and Leach Tank area between January 2022 and January 2023 in response to a release of Jet Fuel Propellant 5 (JP-5) in the Adit 3 Tunnel of the Facility on November 20, 2021. The Tech. Memo, was reported by AECOM Technical Services Inc ("AECOM") for the Naval Facilities Engineering Systems Command (NAVFAC) and the CRCT report and work was performed for NAVFAC by CAPE Environmental Management Inc ("CAPE").

Specific objectives for the document reviews assigned in Tasks 9 and 10 are to 1) identify data gaps in the Holding Tank and Leach Tank site characterization and 2) assess the methodologies and technologies used in the Holding Tank and Leach Tank Area of Concern site characterization investigations and identify those that may be useful for a Facility-wide Site Assessment.

2 Background

The Facility is a former Navy fuel storage facility located approximately 2-3 miles east of Pearl Harbor in O'ahu, Hawai'i. The Facility was built between 1940 and 1943 to house 20 large-capacity underground storage tanks ("Tank Farm"). Fuel from the Tank Farm, which at various times included Navy Special Fuel Oil ("NFO"), Marine Fuel (e.g. F-76), Aviation Gasoline ("AVGAS"), and Jet Fuel (e.g. JP-5 and JP-8), was conveyed to the Navy Facility at Pearl Harbor through fuel transmission lines that run along the interior of a tunnel system that connect the two facilities. The tunnel from the Tank Farm connects to the "Pearl Harbor Tunnel" via the "Adit 3 Tunnel." A water supply Pump Station is located approximately 147 feet (ft) east of the junction between the Pearl Harbor and Adit 3 tunnels. Drinking water is pumped from the basal aquifer through Navy Well 2254-01 (a.k.a. Red Hill Shaft [RHS]), which consists of a vertical shaft connected to a horizontal "Water Development Tunnel."

On November 20, 2021, JP-5 fuel, which had been recovered from a release at the Tank Farm in May 2021, was released from an overhead fire suppression recovery drain line in the Adit 3 Tunnel. The November release occurred approximately 425 ft east of the Pump Station ("Release Area"), 135 ft east of the junction with the Pearl Harbor Tunnel, and approximately 80 ft above the location where the Water Development Tunnel crosses under the Adit 3 Tunnel. JP-5 fuel flowed westward along the Adit 3 Tunnel and accumulated in an underground sump ("Adit 3 Sump") and sanitary storage tank, located near the Adit 3 entrance. Automatic overflow pumps in the Adit 3 Sump and sanitary storage tank were activated and pumped JP-5 fuel into underground holding and leach tanks ("Holding Tank and Leach Tank") and an above ground sanitary waste holding tank ("Collection, Holding, and Transfer [CHT] Tank"). The Holding Tank and Leach Tank are connected via a 4-inch cast iron discharge line that extends from the sump to the Holding Tank and were identified on December 18, 2021 as possibly impacted by the JP-5 spill. The tanks are subsurface 6" thick concrete tanks measuring 8 ft in height and 7 ft in diameter. The Leach Tank was open on the bottom to sediment.

On November 28, 2021, Navy Well 2254-01 was shut off and isolated after it was confirmed that fuel had impacted the Navy drinking water distribution system. Light nonaqueous-phase liquid (LNAPL), suspected of being JP-5 from the release, was observed in a groundwater sample collected from the Water Development Tunnel on December 2, 2021.

Site Characterization investigations and tank closure activities related to the removal and closure of the Holding Tank and Leach Tank Area of Concern ("Site") are documented in the Tech. Memo and CRCT, which are the subjects of this review.

3 Document Review

The Tech. Memo and CRCT summarize data collection activities and results from the Site Characterization investigations and tank removal activities conducted at the Site in response to the

November 20, 2021, Adit 3 fuel release. The Tech. Memo and CRCT present data and laboratory reports for field vapor screening, soil, and groundwater samples collected between January 2022 and October 2022. The Tech. Memo also includes the Phase 1 characterization of the Site as an appendix to the Phase 2 report. The CRCT presents data collected during the closure and removal of tanks and impacted materials, soil, and water. The CRCT details site activities associated with the closure and remediation of impacted soils. This Technical Memorandum (TM) is organized into the following sections: a) Summary of Investigation Activities, Results and CSM; b) Appropriateness of Data Collection, Analysis, and Use; c) Evaluation of Data Gaps; d) Evaluation of Technologies Used; and e) Summary.

3.1 Summary of Investigation Activities, Results, and CSM

This section summarizes the investigation activities, results, and CSM described in the Tech. Memo and CRCT.

3.1.1 Overview

The Tech. Memo and CRCT are focused on Holding Tank and Leach Tank Area of Concern characterization and remedial actions. The exact area of investigation and concern is not well defined in the reports reviewed; however, the Holding Tank and Leach Tank Area of Concern are located 200 feet northwest of the Adit 3 tunnel entrance. The soil investigation area covered an irregularly shaped area extending approximately 55 ft in the farthest distance from the tanks. The area of soil contamination was approximately defined in the Tech. Memo as a rectangle 50 ft by 23 ft. The analytical suite focused on middle range distillate petroleum and target “indicator chemicals” as indicated in Hawai’i Department of Health (HDOH) Fall 2017 guidance, Figure 2-4. The principal study questions changed from the Phase 1 Tech. Memo to the Phase 2 Tech. Memo. The Phase 1 Tech. Memo study questions were as follows:

- “Determine whether petroleum or petroleum-impacted water was/is entering the Holding Tank and Leach Tank from the Adit 3 drain line.
- Determine whether petroleum or petroleum-impacted water passed through the Holding Tank and Leach Tank from the Adit 3 drain line into environmental media (subsurface soil, groundwater) in the vicinity of these features.
- If petroleum impacts enter the environment adjacent to these features, evaluate the nature and extent of the contamination.”

The Phase 2 Tech. Memo study data quality objectives were as follows:

- “Vertically delineate contamination in the subsurface soil adjacent to the Holding Tank and Leach Tank in areas where the direct push rig encountered refusal prior to achieving the objective of vertical delineation.

- Horizontally delineate contamination in subsurface soil to provide better resolution for the planning of any removal actions that may be required.
- Investigate perched groundwater directly beneath the release area to determine the nature and extent of COPC contamination in the medium.
- The objectives of semi-quantitative headspace measurement using handheld real-time organic vapor detectors at each 1-foot interval of subsurface soil core located below 5 ft bgs [below ground surface] were to:
    - Assess the potential for petroleum migration in the unsaturated zone as LNAPL based on the relative magnitude of these results compared to that expected for LNAPL; and
    - Identify the location of the hotspot in the soil boring for analytical sampling."
- The CRCT reported the "purpose" of the CRCT was referenced in the August 2022 Final Plan, Concrete Tank Removal Red Hill Bulk Fuel Storage Facility (CRWP). The CRWP states:
    - "The purpose of this project is to provide all services, equipment, labor, and material required to remove a concrete holding tank, a concrete leach tank, connection piping, and surrounding soil at the Red Hill Bul Storage Facility…identified as potentially contaminated."
- The CRCT work was to be performed in two phases.
    - Round 1 of excavation only involves the removal of the two concrete tanks at this location along with the removal of connection piping.
    - Round 2 of excavation involves the removal of approximately 1,444 cubic yards (cy) of petroleum impacted soil to a depth of 30 feet below land surface[…].

3.1.2 Lithologic and Geologic Borings

This section discusses lithology and geologic boring activities in the Tech. Memo and CRCT.

3.1.2.1 Tech. Memo Drilling and Geologic Boring Activities

AECOM used direct-push methodology during the Phase I and hollow-stem augers (HSA) with "California split-spoon sampling techniques." Prior to sampling, all borings were hand-augered to 5 feet bgs. Twenty-one borings were drilled during the Phase I, and an additional 8 borings were drilled during the Phase II. Boring depths ranged from 4 to 45 feet bgs. Generally, standard penetration test (SPT) counts were recorded during Phase II soil sample collection. Each sample was lithologically described and classified based on the Unified Soil Classification System (USCS).

3.1.2.2 CRCT Excavation Details of Geology and the Subsurface

CAPE excavated to a maximum depth of 30 feet bgs. No geologic descriptions of the sidewalls were provided in the CRCT. CAPE noted the excavated materials consisted of soils, stained soils, broken concrete, bricks, and loose debris.

3.1.3 Utility Locating

Each phase of the investigation performed some type of utility locating prior to ground disturbance. The Phase I states that prior to sampling, "toning for utilities was completed." During the Phase II, borings were hand-augered to 5 feet bgs "to identify potential near-surface utilities." Prior to excavation and removal of the Holding Tank and Leach Tank, two utility locates were performed. Hawaii One Call (HWO) "conducted geophysical toning to identify on-site utilities." Hawaii Private Locators (HPL) were subcontracted "for additional third-party utility clearance to ensure that intrusive locations were not positioned over subsurface utilities." Though not explicitly written in the report, HWO likely located public utilities while HPL located private utilities (e.g., the Adit 3 discharge line).

3.1.4 Sub-Surface Investigations and Confirmatory

This section discusses sampling performed during the Phase 1, Phase 2, waste characterization, and excavation confirmation sampling.

3.1.4.1 Subsurface Soil Samples

During the Phase 1 characterization field work performed January 11-13, 2022, twenty-one (21) soil borings were drilled surrounding the Adit 3 Holding Tank and Leach Tank. Thirty-five (35) subsurface soil samples, three (3) field duplicates, and one (1) sediment sample from the bottom of the leach tank were collected from these borings. Samples for Volatile Organic Compound (VOC) analysis were collected using terracore soil plugs and preserved in methanol. Discussion of laboratory concerns follow in Section 3.2.4 The samples were analyzed for:

- Gasoline Range Organics (C6-C12) TPH-g by 8260/CALUFT DOD
- Diesel Range Organics (C10-C24) TPH-d by 8015D
- Oil Range Organics (C24-C40) TPH-o by 8015D
- Volatile Organics (Benzene, Toluene, Ethylbenzene, Xylenes [m-, p-, and o-]) by 8260D
- Semi-Volatile Organics (Naphthalene, 1-Methylnapththalene and 2-Methylnapththalene N) by 8270E SIM

During the Phase 2 characterization field work performed March 9-17, 2022, eight (8) soil borings were drilled in the areas surrounding the Site. Sixteen (16) samples and three (3) field duplicates were collected and analyzed for:

- Gasoline Range Organics (C6-C10) TPH-g by 8260/CALUFT DOD
- Diesel Range Organics (C10-C24) TPH-d by 8015D
- Oil Range Organics (C24-C40) TPH-o by 8015D
- Volatile Organics (Benzene, Toluene, Ethylbenzene, Xylenes [m-, p-, and o-]) by 8260D
- Semi-Volatile Organics (Naphthalene, 1-Methylnapththalene and 2-Methylnapththalene N) by 8270E SIM

Additional borings and soil samples were collected by CAPE as part of waste characterization for offsite disposal.

3.1.4.2 Groundwater Samples

Groundwater samples were collected from four (4) locations: OWDFMW06B, HT-E00; LT-E00, and LT-W35. Table 11 in the Tech. Memo details the groundwater collection summary, dates of collection, analyses, and laboratory utilized for the groundwater samples. The method for sample collection (e.g., low flow submersible pump, bailer, etc.) is not specified in the report or included in the field notes in associated appendices. All of the wells were positioned in the perched water zone and the temporary wells were set with screens set between 33 to 36 ft bgs (Figure 10, Tech. Memo). Boring elevations presented in the Tech. Memo are estimates based on LiDAR (Table 3, Tech. Memo).

One permanent monitoring well was sampled once and included in the Tech. Memo.

- OWDFMW06B, an existing groundwater monitoring well prior to the November 20, 2021, JP-5 release, was sampled on January 26, 2022. The samples were sent to four different laboratories (Eurofins Seattle, APPL, Alpha, FQ Labs). Table 11 only indicates the analyses performed at Eurofins Seattle. Records and laboratory reports from the other three laboratory reports are not readily apparent in the included appendices.

Temporary wells were sampled twice, first on March 16, 2022 and then on April 1, 2022 prior to the abandonment on April 1, 2022.

- HT-E00 a temporary 5 ft screened well positioned under the Holding Tank
- LT-E00 a temporary 5 ft screened well positioned under the Leach Tank
- LT-W35 a temporary 5 ft screened well positioned 45 feet west of the Leach Tank

A total of seven (7) unique groundwater samples were collected with two (2) field duplicates and analyzed for:

- Gasoline Range Organics (C6-C10) TPH-g by 8260/CALUFT DOD
- Diesel Range Organics (C10-C24) TPH-d by 8015D

- Oil Range Organics (C24-C40) TPH-o by 8015D
- Volatile Organics (Benzene, Toluene, Ethylbenzene, Xylenes [m-, p-, and o-]) by 8260D
- Semi-Volatile Organics (Naphthalene, 1-Methylnapththalene and 2-Methylnapththalene N) by 8270E SIM

3.1.4.3 Waste Characterization Sampling

CAPE details waste characterization for offsite disposal of soils surrounding the tanks in the CRCT. The waste characterization sample consisted of 20 aliquots collected from May 4-5, 2022, from four borings. Each boring was advanced to 12-ft for the collection of five aliquots per boring. The samples were analyzed for the following:

- Toxicity Characteristic Leaching Procedure for RCRA metals (cadmium, chromium, and lead) by U.S. Environmental Protection Agency (USEPA) Methods 1311/6010B
- TPH (-d [C10-C28], -o [C28-C40]) by USEPA Methods 8015
- TPH (GC/FID) Low Fraction by Method 8015D-GRO
- Volatile Organics (Benzene, Toluene, Ethylbenzene, Xylenes [m-, p-, and o-]) by USEPA method 8260B

Six (6) building material samples were collected on May 19, August 31, September 15 and 19, 2022 and tested for asbestos by USEPA Method 600.

Liquid from the tanks was removed and disposed of at PCS Kapolei Dewatering Facility on May 23, 2022. The CRCT does not provide information on sample collection or analyses performed on the tank contents or wash water.

3.1.4.4 Excavation Confirmation Samples

On May 26, 2022, the first round of confirmation samples was collected from post-excavation floor and sidewall locations. Confirmation sampling was performed using multi-increment sampling (MIS) techniques. Two decision units (DUs), consisting of the floor and sidewall, were sampled from each excavated tank area and the excavated connecting pipe (i.e. six DUs in total). Each MIS sample consisted of a composite of "30 aliquots" of "both floor increments and sidewall increment locations" for a total mass of approximately two kilograms (CRCT, pg. 3-9). One sample was collected in triplicate.

The second round of confirmation samples was collected September 21 through October 21, 2022. MIS confirmation samples were collected "directly from the excavator bucket, which was used to scrape soil from the excavation floor and sidewalls…" as the excavation was performed (CRCT, pg. 3-10). A total of 15 DUs were sampled and two DUs were sampled in triplicate.

The first and second rounds of samples were analyzed for:

- TPH (-d [C10-C28], -o [C28-C40]) by USEPA method 8015
- TPH (GC/FID) Low Fraction by USEPA method 8015D-GRO
- Volatile Organics (Benzene, Toluene, Ethylbenzene, Xylenes [m-, p-, and o-]) by USEPA method 8260B
- Semi-Volatile Organics (Naphthalene, 1-Methylnapththalene and 2-Methylnapththalene N) by USEPA method 8270C SIM

3.1.5 Conceptual Site Model

The Site conceptual model describes the materials under the concrete tanks area as “unconsolidated soil and saprolite,” with a “perched water zone” at approximately 30 feet bgs. South Hālawa Stream, which largely remains dry except “during periods of high precipitation,” lies at approximately 10 feet lower elevation and 70 feet northwest of the leach tank. The stream was reported as having drain holes that allow infiltrating groundwater to flow in the stream channel during periods of high precipitation. The basal aquifer exists at approximately 75 ft below mean sea level (msl) in the tank area; monitoring well OWDFMW06A indicates the basal aquifer has an upward hydraulic gradient.

The following receptors of potential contamination associated with the JP-5 release were identified:

- Construction workers via direct contact
- Human and ecological receptors – through direct contact with soils and perched water or ingestion of drinking water.

3.2 Appropriateness of Data Collection, Analysis, and Use

This section discusses SSP&A’s assessment of the appropriateness of data collection, analysis, and use for Site Characterization investigations conducted in response to the release of JP-5 in the Holding Tank and Leach Tank area. SSP&A identified the following limitations regarding the Site Characterization activities and use of data.

3.2.1 Field Sample Collection Issues

Field operations with a large quantity of samples being sampled and shipped often come with a risk of samples being broken, lost, or otherwise invalidated. Several items were noted in the laboratory receiving documents, laboratory narratives, and within emails included in laboratory reports between AECOM (i.e., Navy consultants) and Eurofins regarding sample condition, sample container label completeness, and chain of custody completeness. Some of these items may have been a result of shipping or site conditions; however, others indicate uncertain field sampling practices. Each item on its own is not particularly concerning but when viewed together, these items indicate a need for field quality control procedures to be reviewed or implemented among staff collecting samples. The need for oversight of field sampling activities may be warranted to determine the level of compliance between approved workplans or standard operating procedures (SOPs) and field activities.

3.2.1.1 VOCs and TPH-g Insufficient Sample Weight

Multiple VOC and TPH-g samples were below the nominal sample weight of 10 grams specified in the method by more than 20%. This can affect reporting limits and potentially method performance. A Data Validation Report, in the Tech. Memo Appendix, noted the sample weight deviation but stated that "No actions were taken on this basis" (Tech. Memo, pdf pg. 737). Therefore, the associated samples are not qualified based on the low sample volume and potential biases are not indicated.

3.2.1.2 VOCs Insufficient Sample Preservative

Four samples collected on March 16 and 17, 2022 under Eurofins laboratory job 580-111720-1 were received with insufficient sample preservative needed to complete VOC by 8260D and 8260 CALUFT GRO analyses. No reasons for the lack of sample preservative were indicated. In general, a lack of sample preservative can occur in a few ways, 1) lab error in sample container preparation, 2) field accident in spilling preservative, 3) field error in not getting a good seal between container and lid, 4) shipping damage, or 5) accident at the lab after receipt. AECOM did confirm cancelation of analyses with the following statement in an email, "Good news is BTEX and GRO has been nondetect or very low in these samples and the TPH-d and PAHs are the drivers. Please complete those analyses on schedule." (AECOM email March 29, 2022 to Eurofins, Appendix C pdf pg. 601, Tech. Memo). The samples canceled included four samples from two borings, one along the B-B' transect (HT-W35) and a boring 15 feet north of the holding tank (HT-N15) along the D-D' transect. Near the HT-N15 location, in the 19-20 ft bgs sample from HT-N10, TPH-g was reported at 1200 mg/kg (Figure 9, pg. 37 Tech. Memo), which exceeds EALs in Table A-2 Soil Leaching to Groundwater standard. Based on the proximity of other high concentration TPH-g which exceed appropriate Environmental Action Levels (EALs) in samples in this Area of Concern, TPH-g should be considered a driver of importance to the investigation.

3.2.1.3 Air in Water Sample VOA

Air was noted on sample receiving forms as present in some water sample containers for volatile organic analysis (VOA). The number of VOA samples impacted and whether these were used for analysis is not detailed in the Tech. Memo narrative. Air in VOA sample containers will bias sample results low if used and may indicate post collection modifications from sample preservative interactions or improper sampling and sample handling.

3.2.1.4 *Incomplete sample labels*

Sample labels were noted as not having collection time and date. AECOM corrected this by submitting a table of samples with time and date to the laboratory after Eurofins contacted them. However, the accidental exclusion of critical sample collection information 1) contradicts Section 6.0 Sample Control Procedures which states “Sampling and sample handling procedures were designed to ensure that samples were consistently collected, labeled, preserved, […]”, and 2) indicates poor field documentation and sampling practices.

3.2.2 PID and Soil COPC Correlations

Photoionization detectors (PIDs) were used to indicate “hot-spots” in soil cores and assisted with the locating of samples to be collected for analysis. When used properly, PID screening can provide useful qualitative information on the summed total amount of ionized VOCs. However, the amplitude of a PID reading does not directly correspond to LNAPL or VOC mass. PIDs in general are not as sensitive to aliphatic hydrocarbons (see ASTM, 2006 and HDOH, 2012) which compositionally dominate JP-5. Displayed values on PIDs are dependent on the lamp used, the correction factor (if applied), the calibration gas used, the presence or absence and distribution of compounds, and the specific ionization potential of each compound, among other factors. PIDs are limited to screening for compounds ionized by the internal lamp and therefore highly dependent on the lamp used. In soil screening the value is highly dependent on the material of the sediment and the volatile compounds present. Field documentation of equipment used with lamp types is critical for the interpretation of screening results and any apparent trends. For example, a compound may comprise a high percentage of the total VOCs present in a material but may not be ionized by the PID in equilibrium with concentrations present in the vapor, thus making the PID measurement biased low. A change in the composition of VOCs present (not total VOC concentrations) may bias a PID reading low or high, depending on the lamp used.

In the Tech. Memo, the location of the sample was determined by a combination of PID reading and professional judgement, which is an important and favorable addition to the decision-making process. However, the laboratory analytical results when compared to the PID screening results in Figures 6, 7, 8, and 9 do not appear to have a high degree of correlation. For example, at core LT-W17.5 the highest PID reading is shown as 247 ppmv with corresponding analytical results substantially greater than nearby location LT-W10 where the PID was 440 ppmv. See the table on the next page.

Location ID	LT-W17.5	LT-W10
PID (ppmv)	247	440
TPH-g (mg/kg)	3300	250
TPH-d (mg/kg)	4700	370
N (mg/kg)	4.1 J	0.61
1-MN (mg/kg)	9.1	1.7
2-MN (mg/kg)	13	2.5

The PID may be responding to elevated levels of other constituents in the soil at location LT-W10 which are not being measured quantitatively by laboratory analysis (see Section 3.3.4 for analyte selection). It may also be the case that previously mentioned data quality notes may have biased sample results (see Section 3.2.1). PID headspace screening for JP-5 contamination during these investigations has not been demonstrated as a viable method to characterize media, including soil; the utility to identify hotspots has not been demonstratively illustrated.

In the Phase I Tech. Memo, organic vapor headspace readings are provided with interpretation of potential or likely EAL exceedance based on magnitude of the PID reading (Section 7.0 Phase 1 Tech. Memo). In order to fully understand and utilize a PID for the determination of the likely concentration of JP-5 constituents in soil or water, the technology needs to be accessed for utility and a correlative study including all soil VOC and semi-volatile organic compound (SVOC) constituents that contribute to PID reading values needs to be conducted on the variety of media, soil types, and conditions from the site. If this has not been completed, the reliance of the Navy and their contractors to make decisions based on this technology is inappropriate.

3.2.3 Temporary Well Construction

The three temporary monitoring wells installed during Phase II were similarly constructed, using designs typical for monitoring dissolved-phase contamination. Detailed construction diagrams are found on page 38 of the Phase II report. Constructing monitoring wells with the intention to detect the potential presence for LNAPL in the subsurface may require modifying the design to ensure LNAPL is not excluded from the well due to its tendency to reside near the top of the water table and within the smear zone. If the top of the well screen and/or filter pack is constructed below the top of the water table and/or smear zone, LNAPL may not be sampled. To avoid this, monitoring well screens and filter packs should fully span the minimum and maximum water levels, as well as the top of the smear zone. When these variables are unknown, longer screens and filter packs should be installed.

The tops of the filter packs in the temporary wells installed during the Phase II were all within 3 feet or less of the static water-level measurements. It is, therefore, possible that the top of the filter packs were installed below the top of the smear zone, which may have limited the detection of LNAPL. Should future monitoring wells be installed in the vicinity of the concrete tank area, well design should take into consideration smear zone thickness and water-level variations throughout the year.

3.2.4 Utility and Subsurface Infrastructure Locating

Locating utilities and subsurface infrastructure prior to subsurface ground disturbance reduces the risk of utility strikes and helps limit project delays and costs. Additionally, the ability to determine all contributing sources and potential conduits for contaminated liquids to travel is critical in the determination of locations of contamination and migration. Only "geophysical toning," interpreted by SSP&A to describe radiofrequency (RF) locating equipment, is described in both the Tech. Memo and CRCT. Using only RF methods increases the risks of not identifying all subsurface utilities and infrastructure.

Numerous geophysical techniques are commonly employed to detect potential subsurface utilities and infrastructure because geophysical techniques are sensitive to different parameters. For example, ground penetrating radar (GPR) may be used to identify a near-surface PVC pipe while an RF line locator will not succeed without the addition of a "transmitter sonde" or similar. Based on the unidentified utilities and infrastructure found during the concrete tank removal (Section 3.3.1.1), modifications to the techniques and methodologies are recommended (Section 3.4.4).

3.2.5 Comparability and Representativeness of Groundwater and Soil Samples

3.2.5.1 Unknown Sample Collection Methodology

The three temporary wells were sampled two times each from March 16, 2022 to April 1, 2022. However, the groundwater sampling methodology was not clearly stated in the Tech. Memo or included field notes. Based on the method of collection (e.g. bailer, submersible pump, external low flow pump, etc.), the sample results may be biased high or low. For example, samples collected using bailer sampling methods are more likely to capture a higher proportion of LNAPL components near the groundwater surface in a stratified water column. Low-flow methods sample from deeper in the water column and are more representative of the fully dissolved LNAPL components.

Additionally, what can be gleaned from the Tech. Memo indicates that the groundwater samples were collected differently. The first set of samples were collected on March 16, 2022 as grab samples; it is unclear in the reports and in the field notes if these locations were developed prior to sampling, and if development occurred, how soon after development the samples were collected. The second round of samples were collected on April 1, 2022, prior to temporary well abandonment. These samples were collected after attempting to remove three well volumes; only two locations were successful, and the third location went dry after one volume (Table 6, Tech. Memo). It is unclear in the Tech. Memo if parameter stabilization criteria were required for the sampling, and if so, what criteria were required. The March groundwater samples were collected as grabs, and the April groundwater sampling occurred after purging. The different sampling techniques could bias the analytical results. Additionally, a grab sample of water from a well without purging or development would likely not be as representative of surrounding groundwater conditions.

3.2.5.2 Carbon Range Corrections

The Navy identified and corrected carbon range overlaps between the Phase I and Phase II reports to comply with DOH's January 27, 2022 Technical Memorandum, *Recommended Risk-Based Drinking Water Action Levels for Total Petroleum Hydrocarbons (TPH) Associated with Releases of JP-5 Jet Fuel.* This made the data collected in Phase I and Phase II comparable for TPH-g and TPH-d samples. However, previous versions of the Phase I data should be noted as potentially having a different value than the corrected versions.

Additionally, it is unclear if the TPH-g carbon range reported for soil samples from the Tech. Memo and CRCT are comparable. As discussed above, soil samples collected during the Phase I and Phase II investigations were analyzed by USEPA method 8260 for TPH-g and reported for the C_6-C_{10} carbon range. Post-tank excavation confirmation samples, however, were analyzed by USEPA method 8015 for "Low Fraction" TPH. It is unclear what carbon range is covered by the "Low Fraction" TPH and if it is comparable to the previously reported TPH-g (C_6-C_{10}) carbon range.

3.2.5.3 Comparison of Groundwater Values to Soil EALs

Table 13 in the Tech. Memo presents COPC Groundwater Analytical Results Compared to Table D-1a EALs and does not correspond to the groundwater data presented in the Tech. Memo reports. The table indicates that between 51 and 55 samples were analyzed and details Leaching Exceedances, Direct Exposure Exceedances, and Odors Exceedances. The table appears to match the EALs present for soils in Table 9 of the Tech. Memo.

3.2.5.4 Duplicates Included in Statistics

COPC exceedance tables (Tables 9, 10) are provided in the Tech. Memo. It appears that AECOM included duplicate measurements as individual detections in the summary of statistical information. This may bias statistical interpretations to both over and underestimate site conditions. Additionally, the sediment sample collected from the bottom of the Leach Tank was included in Table 8 of the Tech. Memo but was not included in the statistical reporting of detections. The sediment sample was reported to be from the sediment at the bottom of the open leach tank as 0 ft bgs. The bottom of the tank was approximately 8 feet below surface, and for completeness, may be considered in the statistical reporting of maximum and percent detections for the various constituents.

3.2.6 Project Action Limits – CAPE

Project action limits (PALs) are presented in the CRCT in Tables 2-2, 3-2, and 3-3. The PALs given in the table and used for comparison to decision unit confirmation samples are based on the 2017 HDOH EALs for Groundwater Protection of a Drinking Water Resource and Direct Exposure EALs, Table A-2, Soil Action Levels (Potentially impacted groundwater is a current or potential drinking water resource; surface water body is located within 150 meters of the release site). PALs do not appear to be site-specific derived, but rather equivalent to EALs based on the table notes. In the table below, the most recent EALs from the Spring 2024 Surfer Table from HDOH were compared. Shaded boxes indicate a difference between the values. For the Direct exposure EAL, the table also displays a comparison to the Current Final EALs as there was more agreement with the CAPE Direct Exposure values. While the PALs have changed from the values used in the CRCT, the total exceedances have not. It is recommended that future phases of investigation screen against the most current USEPA regional screening level, in addition to following the most current HDOH guidance.

Soil Protective Standards for Groundwater as a Drinking Water Resource and Surface Waters within 150 ft

Analyte	CAPE - 2017 HDOH Leaching and Groundwater Protection Action Level (mg/kg)	Current - Spring 2024 Table A-2 Leaching and Groundwater Protection Action Level (mg/kg)	CAPE - 2017 HDOH Direct Exposure Environmental Action Level (mg/kg)	Current - Spring 2024 Table A-2 Direct Exposure (mg/kg)	Current-Spring 2024 Table A-2 Final EAL (mg/kg)
TPH-d (middle distillates)	940	213.7	220	183.4	183.4
TPH-o (residual fuels)	1000	1000.0	500	1251.4	500.0
TPH-g (gasoline)	700	173.4	100	195.0	100.0
Benzene	0.3	0.3	0.3	1.2	0.3
Ethylbenzene	0.9	0.9	0.9	62.5	0.9
Toluene	0.78	0.8	0.78	817.7	0.78
Total Xylenes	1.4	1.4	1.4	129.2	1.4
Naphthalene	3.1	3.1	3.1	20.6	3.1
1-Methynaphthalene	0.89	0.9	0.89	169.0	0.89
2-Methylnaphthalene	1.9	1.9	1.9	38.0	1.9

3.2.7 Soil in Exceedance of EALs

Soils have been left in place that exceed screening thresholds after the Round 2 excavation completed by CAPE. Final EALs (and the values CAPE presents as Direct Exposure) are exceeded for Decision Unit 10 and 11 at 5 - 12 feet below ground surface. Both location composite samples exceeded TPH-o and at Decision Unit 10 exceeded TPH-d and TPH-o. CAPE concluded that based on the depth of the exceedances direct exposure was not a risk pathway of concern. It should be noted that because these were composite samples across a decision unit higher levels of soil contamination may be present in pockets across the unit than the values presented.

In addition to there being confirmed exceedances in 2 Decision Units, it is unclear which of the soil borings presented in AECOMs Tech. Memos were within or outside of the excavation bounds. A visual representation of this should be produced and analysis performed in order to evaluate remaining soil above EALs.

3.2.8 Conceptual Site Model Discussion

3.2.8.1 Geology

The Phase I and II boring logs in the tank area were limited to 35 feet bgs or less. Materials encountered included mostly gravels, sands, and silts; CL soils (clayey, moderate to low plasticity) defined by the USCS were encountered sporadically and with limited extents in the Phase I and II borings; and CH soils (clayey, high plasticity) were not encountered. Additionally, drillers interpreted voids in boring HT-W35. Overall, the boring logs describe a heterogeneous, potentially hydraulically conductive subsurface with potentially complex pathways for NAPL and dissolved phase contaminants to move through the subsurface.

3.2.8.2 Perched Water Zone

AECOM describes a "perched water zone" present at an elevation of approximately 95 feet above msl. Three temporary monitoring wells (LT-W35, LT-E0, and HT-E0) were installed within the perched water zone and sampled in March and April 2022. A permanent monitoring well, OWDFMW06B, was previously installed and screened within the perched zone. The only boring log in the area to fully penetrate to the basal aquifer, OWDFMW06A, contained sections of no recovery at depths critical to defining the thickness and lithology of a potential low permeability zone beneath the perched water.

3.3 Evaluation of Data Gaps

This section describes the data gaps and limitations that were identified during this review. Data gaps and limitations are organized into the following categories: 1) Unidentified Utilities and Holding Tank Water Sources, 2) Spatial and Temporal Limitations of Impact to Groundwater, 3) Analytes, and 4) Scope Limitations.

3.3.1 Unidentified Utilities and Holding Tank Water Sources

3.3.1.1 Utilities

During the excavation and removal of the tanks, CAPE uncovered previously unidentified infrastructure:

- An 18-inch corrugated HDPE stormwater line
- A 5-foot diameter manhole and associated 8-inch vitrified clay pipe (VCP)
- Electrical line and signal cabling
- A large concrete wall structure, i.e., the "tunnel"
- 16-inch steel aviation gas (AVGAS) line

These utilities, which were not discovered prior to sampling or tank removal activities, present a data gap that may have affected all aspects of the workplan, including tank removal, disposal, additional sampling, excavation and disposal costs, worker safety, and potentially Department of the Navy site operations. In addition, identification of utilities prior to sampling can inform the conceptual site model and sampling location selection by identifying potential preferential flow pathways. Further discussion of utilities and unknown infrastructure detection is described in Section 3.4.4.

3.3.1.2 Holding Tank Water Sources

The Phase II reported the purpose of the Navy's investigation and tank removals was "to implement soil removal actions to protect human health and the environment from the impact of the fuel release from the Adit 3 Sump drain line mixed with infiltrating groundwater and pump cooling water." The investigation focuses solely on characterizing and removing JP-5 related contaminated soil. By limiting the investigation to JP-5 impacts, the investigation leaves data gaps related to potential sources, such as:

- Pump cooling water,
- Fuel or other site-related potential contaminants related to utilities and transportation activities,
- Per- and polyfluoroalkyl substances (PFAS) originating from the fire suppression recovery drain line, and
- Potential chemical cleaning products historically used in the tunnel that may have been introduced to the Adit 3 sump.

JP-5 fuel released during the November 2021 event was stored in a fire suppression drain line prior to release and may have encountered residual PFAS-containing fire suppression materials while stored. PFAS should be considered a contaminant of potential concern related to the Holding and Leach tank area. As a result, the Navy should ensure that investigations and characterization of PFAS at the site, including the PFAS Remedial Investigation, should include the Holding and Leach Tank area as well as any source or discharge areas as Part B.

The November 2021 JP-5 Release in Adit 3 Site Characterization Report states the Hume drain "conveys stormwater and RHS pump cooling water to the Adit 3 Sump." The Adit 3 sump potentially receives water from numerous sources via the Hume drain, all of which may contain unknown potential contaminants. A comprehensive evaluation of all potential sources of contamination to the Holding Tank, Leach Tank, and Adit 3 sump were not presented in the Phase I or Phase II Investigations. To adequately protect human health and the environment, all potential sources, historical and current, should be reviewed and presented to ensure appropriate investigation, sampling, monitoring, and remediation.

3.3.2 Spatial and Temporal Limitations of Impact to Groundwater

Characterization of the perched water zone and below is limited. Only four monitoring wells (3 temporary) were installed and all within 45 feet or less of the concrete tanks. The one permanent monitoring well, OWDFMW06B, is located upgradient of the "estimated perched water flow direction" (Figure 4, Phase II). The boring log lithologies (Section 3.2.6.1) describe a subsurface consistent with high hydraulic conductivities and complicated flow paths. The limited groundwater monitoring of the perched water zone does not provide sufficient characterization of impacted groundwater given the subsurface geology. The limited depth of the Phase II borings is also inconsistent with Phase I recommendations from the Navy: "Following the process laid out in the Preliminary Site Characterization Plan (DON 2022a), the Navy recommends conducting additional characterization to refine the lateral and vertical extent of contamination using a drill rig capable of coring through rock." The recommendation suggests deeper borings and/or wells were planned following the Phase I.

To better understand the fate and transport of contamination as it relates to the tanks area, the following should be investigated:

- Thickness and lateral extents of the perched water
- Extents of JP-5 and other contaminants within the perched water
- Potential water sources to the perched water zone
- Potential presence, material type, thickness, and lateral extents of a low permeable layer (e.g. aquitard) beneath the perched water zone
- Permeability of low permeable layer (if present)

- Potential contamination within the low permeable layer (if present) extending down to the basal aquifer

The groundwater sampling location LT-W35, positioned in the estimated down gradient location of the tanks, has the highest concentrations of COPCs of all four locations (C10-C24 TPH: 3700 ug/L; Naphthalene: 24.0 ug/L; 1-MN: 75.0 ug/L, see Table 12 in the Tech. Memo). This indicates that the contribution and extent of contamination to the perched aquifer is not laterally delineated in the Holding and Leach Tank Area of Concern.

Temporal monitoring of perched groundwater conditions in the area is exceedingly limited. The permanent upgradient monitoring well was sampled once for this event in January 2022 and the remaining three temporary monitoring wells were only sampled twice, 17 days apart. Conclusions as to trends in concentrations, migration of contaminants, and the responses to events, such as precipitation, cannot be made with such limited information.

3.3.3 Analytes

The analytes reported and discussed in the CRCT and Tech. Memo were limited to the target analytes for middle-distillates described in the HDOH regulatory guidance document: *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater* (HDOH, 2017). These include TPH, BTEX, and naphthalene for soil and groundwater samples, as well as methylnaphthalenes in soil and groundwater and methane in soil vapor. Other indicators of JP-5 contamination or degradation were not assessed. These include the following:

- Additives – HDOH guidance specifies that known or suspected additives should be evaluated. Examples of known or suspected fuel additives, which are included in the long term monitoring (LTM) sampling program for the tank farm at the Red Hill facility, include 2-(2-Methoxyethoxy)Ethanol (2-MEE), Phenol, and 1,2-Dibromoethane. Additionally, 2-MEE was detected at concentrations ranging from 1200 to 2000 mg/L in JP-5 product sampled during de-fueling (see DLA Fuels, Laboratory Reports SDGs 23G0041 and 23G0043, Revision 2, available in the facility database[1]).
- Additional indicator compounds – Trimethylbenzenes (TMB) are a common component of middle distillates and the 1,2,4-TMB isomer was detected at 18,000 µm/m^3 in vapor analysis from Adit 3 soil vapor samples collected in February 2022 (NAVFAC, 2023). TMBs have also been detected in JP-5 fuel samples collected during de-fueling activities at the Red Hill tank farm. The highest concentrations were detected for the 1,2,4-TMB isomer and ranged from 3,510 to 6,370 mg/kg (see DLA Fuels, Alpha Analytical SDGs L2338337 and L2338338, available in the facility database). Although TMBs elute in the

[1] https://synectics.net

TPH analysis and therefore contribute to the measured TPH value, the selective analysis of individual TMB compounds may serve as a tracer for the transport of JP-5 contamination.

- TPH with silica gel cleanup (SGC) – Polar compounds are produced as petroleum degrades, through both biologic and weathering processes (ITRC, 2018). SGC removes the polar degradation products so that the hydrocarbon fraction can be isolated and quantified. The difference between the TPH and TPH with SGC measurements provides an estimate for the amount of polar compounds in the sample. Fresh fuels consist primarily of hydrocarbons so the TPH and TPH with SGC values will be similar. However, the more degraded the fuel is, the higher the percent polar fraction will be. Degradation, and therefore the percent polar fraction, typically increases with time and distance from the source (ITRC, 2018). Polar compounds have different properties than hydrocarbons; for example, they are typically more soluble and more likely to partition into groundwater. Therefore, TPH with SGC can provide important qualitative information about the composition, age, and mobility of contamination. SGC was requested to not occur by AECOM in chain of custody (COC) documents.

Additional analytes that are not related to JP-5 contamination but should nonetheless be assessed are per- and polyfluoroalkyl substances (PFAS). This is recommended because the JP-5 fuel was stored in a fire suppression drain line when it was released into the Adit 3 tunnel. If the fuel encountered residual PFAS-containing fire suppression materials while in the drain line, then it is possible that PFAS were released along with the fuel.

3.3.4 Scope Limitations

The scope of the reviewed documents in this TM can be found in Section 3.1.1. This scope does not investigate how JP-5 and contaminated water may have migrated, both vertically and laterally, with time. Specific examples of data gaps related to the limited scope are as follows:

- The scope of the investigations conducted thus far is focused exclusively on JP-5 contamination from the November 20, 2021 release. Potential contamination from previous releases or sources has not been considered or investigated.
- Lack of sub-surface investigation along the Adit 3 drain line to the Holding Tank. The potential for the presence of contamination along the Adit 3 sump drain line has not been thoroughly investigated. The drain line should have been assessed for potential leaks and additional utility connections. The drain line has not been thoroughly investigated.
- Limited investigation into perched water zone. Only three Phase II borings are shown to have reached the perched water and document the location and level of contamination. Inferences as to the magnitude and direction of flow and the level of contamination including dissolved and free product are exceptionally limited.

- Evaluation of vertical and lateral migration of contamination. Questions about the extent and magnitude of JP-5 that remains in the environment cannot be sufficiently addressed based on the limited scope of this study. The potential for vertical and/or lateral migration of JP-5 contamination in the sub-surface has not been fully evaluated. Vertical transport of JP-5 through the vadose zone to the basal aquifer did occur as evidenced by LNAPL reaching the basal aquifer within eight (8) days of the release. Furthermore, as LNAPL moves down through the vadose zone it may intersect fractures or zones of low or high permeability that would cause the LNAPL to spread laterally. The occurrence of perched groundwater may limit the vertical migration of LNAPL in areas where it is present, but substantial LNAPL mass could reside below the perched groundwater due to lateral migration from areas where the perched groundwater is absent.
- Downstream receptors and under the South Hālawa Stream. The South Hālawa stream is constructed of concrete but contains perforations in the bottom which allow infiltration of groundwater during periods of high precipitation. The impact to the stream and potential for contaminated groundwater from the Holding Tank and Leach Tank Area of Concern is not included in this scope; however, the limited groundwater monitoring indicates the potential for greater concentrations nearing the stream.
- The two phases of investigation detailed in the Phase I and Phase II of the Tech. Memo left room for improvement in delineation of impacted areas. Even the most thorough investigations encounter unknown or unexpected field conditions that may require additional unplanned levels of effort. The repeated excavations and sidewall confirmatory sampling may have been reduced if a higher density of samples were collected near known sources (i.e., the Holding Tank and Leach Tank).

Future sub-surface investigation areas should include additional 1) borings that extend to the basal aquifer, 2) borings that transect the perched groundwater, 3) borings along the length of the Adit 3 drain line, 4) borings along the stream channel, and 5) full review and field investigation into utilities in the area and potential connections to the Holding or Leach Tanks lines.

3.4 Evaluation of Technologies Used

This section describes the pros and cons of the various technologies used in the Holding Tank and Leach Tank investigations and tank removals.

3.4.1 Sampling: Drilling

AECOM utilized Geoprobe drill rigs with a 3-inch macro-core. Samples were collected using "direct-push methodology" during the Phase I, and HSA and "California split-spoon sampling techniques" during Phase II. Macro-core samplers provide soil cores of large diameter, which can be advantageous when sampling granular materials such as gravel. The use of HSA and split-spoon sampling techniques (using a hammer drop to advance the macro-core) can allow for deeper sampling by preventing the borehole from collapsing and allowing drilling through harder materials that direct push methods alone cannot. Even when using HSA techniques, a number of borings were terminated due to refusal. Should deeper characterization be required, Phase I Navy recommendations of using a rock coring capable drill rig should be implemented.

3.4.2 Field Screening: PID

In both the Tech. Memo and CRCT, headspace measurements data taken from PIDs were presented. PIDs are useful screening tools for real time data; however, they are limited in the selectivity of chemicals and in the response to individual chemicals. PIDs tend to target (have higher relative responses to) aromatic hydrocarbons and are not good indicators of total TPH levels in soil vapors without inclusion of an appropriate correction factor for mixtures with high percentages of aliphatic hydrocarbons. This is an especially important consideration for middle range distillates like JP-5. PIDs are useful tools for monitoring breathing and ambient air and can assist with determining placement of analytical measurement samples; however, all the chemicals present that impact a PID need to be established and each chemical's specific response known prior to use for directing sampling.

One set of field notes indicates the use of a miniRae (PID) and multiRae (PID and 4 Gas Meter) to screen headspace vapor at OWDF6B RHSF on January 28, 2022. The miniRae measured 158.7 ppmv and the multiRae measured 38.8 ppmv. The devices had vastly different headspace readings in part due to lack of tubing for the multiRae; however, each lamp's ionization energy and associated correction factors were not listed in the fieldnotes, which may have been a factor contributing to the difference in ppmv values. Field notes should list the complete information for all devices used.

3.4.3 Sampling

Soil samples for VOC and TPH-g analyses were collected with terracore sampling devices and placed into methanol preserved containers. This is a commonly used method for sampling high level soils. The method is straight forward but experience is needed in adverse conditions and care should be taken to make sure a clean seal is formed between the lid and container to prevent preservative leaks. Commonly too much or too little soil is added to the container making the results biased.

Groundwater sampling technologies could not be evaluated, the sampling techniques were not disclosed.

3.4.4 Utility and Unknown Infrastructure Identification

Encountering unknown utilities poses safety risks to onsite personnel, may impact site operations, and leads to deviations from the work plan, including additional costs for excavation, disposal, and sampling. Changes to the locating procedures should be made to improve the detection and identification of not only utilities but also infrastructure so potential hazards, delays, and costs can be incorporated into the work plan prior to implementation. Some additional steps that can improve identification of utilities include:

1) Request and thoroughly review all utility drawings and/or maps from the Department of Navy (DON) or other applicable agencies.
2) Survey an area for utilities much larger than the work zone. This improves the chances of identifying utilities potentially passing through the work zone, as utilities may only "daylight" in a few areas outside of the work area.
3) Use a minimum of the following geophysical methods: RF line locators, GPR, and electromagnetic (EM) equipment (EM, e.g. EM-31 or EM-61). Additionally, magnetometers and RF sondes can provide additional information.
4) Implement the "4-Way Sweep" methodology using the RF line locators to help identify buried metal piping that does not daylight in the work zone.
5) Depending on the site conditions, air and/or water knifing can be used to daylight utilities in congested areas or trench the entire work area perimeter to potentially identify any intersecting utilities.

4 Summary

In summary, the Site Characterization investigations and remedial work performed at the Holding Tank and Leach Tank in response to the November 20, 2021 JP-5 fuel release suffer from 1) limited confidence in field sampling and survey work, 2) incomplete spatial and temporal investigation meant to characterize the extent of subsurface contamination in the Holding and Leach Tank Area of Concern, 3) limited analytical suite for the determination of impact to environment, and 4) soils at approximately 5-12 ft bgs left in place that exceed direct contact for TPH-g and TPH-oEALs.

5 References

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ENCLOSURE 2:

Figure

Further Investigation Required

Enclosure 2: Further Investigation Required

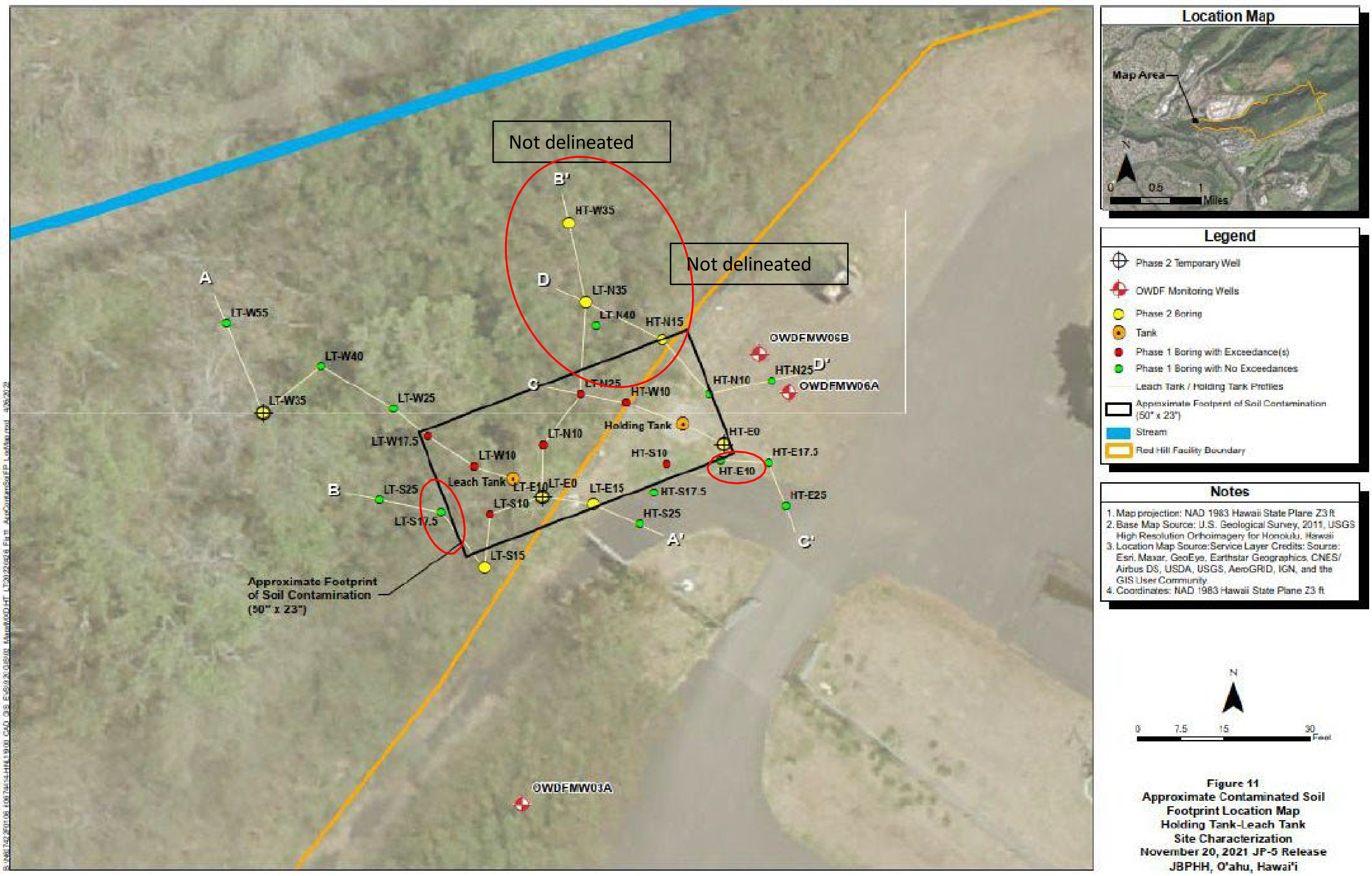

Figure 11: Approximate Contaminated Soil Footprint Location Map

Note: = needs further investigation