Exhibit A

Table 1: Pre-Construction Evaluation of Environmental Issues at the Site

Yes	No	Question
X		Are concentrations of COPCs above the lowest unrestricted Tier 1 EAL1?2
X		Has the release been reported to the HDOH HEER Office?[2]
Unknown, possibly		Are concentrations of COPCs above the construction worker EAL?
X		Has the extent of contamination been fully delineated (both vertically and laterally)?
NA		Have sufficient soil vapor samples been collected in areas where a future building will be present?
	X	Is there an ongoing release at the site that must be mitigated prior to construction?
	X	Does contaminated media need to be removed or remediated prior to construction?
	X	Are COPC concentrations and contaminated media unknown but presumed or suspected to be present at the site at potentially hazardous levels based on historic site activities or other evidence?[1]
	X	Will demolition of structures be conducted at the site prior to redevelopment?
NA		If demolition will occur, has asbestos and lead-paint abatement been completed prior to demolition in accordance with all State and Federal regulations?

EAL= Environmental Action Level

COPC=Chemical of Potential Concern

[1] If no contaminants are present or suspected to be present at the site at concentrations greater than the lowest unrestricted Tier 1 EAL then a C-EHMP is not required. The lowest Tier 1 EAL is defined as the EAL for unrestricted land use where groundwater is a potential drinking water resource and the nearest surface water body is less than 150 meters away.

[2] All releases must be reported to the HEER Office Emergency Preparedness and Response Section (EP&R) by calling (808) 586-4249 and following up with a written Release Notification

Following construction, contact the HEER Office to confirm that all contamination was managed in accordance with the approved C-EHMP. At a minimum, please submit all appropriate manifests, tracking logs, and photos. This Project-Specific Construction Environmental Hazard Management Plan (C-EHMP) is limited to use during construction of the Farrington Highway Drainage Improvements Project.

PROJECT-SPECIFIC CONSTRUCTION ENVIRONMENTAL HAZARD MANAGEMENT PLAN

State of Hawai‘i, Department of Transportation (HDOT) Highways Division,
Farrington Highway Drainage Improvements Project,
Project Number 99D-01-17

LOCATED AT

Pearl City, O‘ahu, Hawai‘i
Near TMK 9-6-003:022 and 9-6-003:024

MAY 2021

SIGNATURES

This document is not finalized until it is signed. A signed copy will be present on-site at all times.

Property Owner: HDOT Highways

I certify that as property owner, I am responsible for ensuring all parties who work or reside at my site are aware of the contamination at my property, and the associated hazards, and that the information in this document is true and accurate to the best of my knowledge. I am responsible for ensuring compliance with all land use controls as well as advance notifications to the Hawai‘i Department of Health (HDOH) of anticipated land use changes or groundbreaking activity at my property.

Property Owner or Representative of Property Owner

Qualified Environmental Professional

I certify that I am a qualified environmental professional, capable of ensuring compliance with the requirements of this Construction Environmental Hazard Management Plan (C-EHMP). It is my duty on this project to understand the requirements of this document and be on site during ground-breaking activities. I will communicate hazards, management protocols, and other C-EHMP requirements to construction professionals at the site. I will document such activities, and communicate with HDOH, as needed.

Qualified Environmental Professional

Construction Manager

As Construction Manager, I am responsible for understanding the requirements of this C-EHMP, effectively communicating the requirements and hazards to my crews and subcontractors and providing the required training and personal protective equipment to site workers. I will work with the Qualified Environmental Professional to ensure compliance with this C-EHMP during work at this property.

Construction Manager

TABLE OF CONTENTS

ACRONYMS

BMP	Best management practices
C-EHMP	Construction Environmental Hazard Management Plan
COPC	Chemical of potential concern
cy	Cubic yard
EAL	Environmental Action Level
EHE	Environmental Hazard Evaluation
EHMP	Environmental Hazard Management Plan
HAR	Hawaii Administrative Rules
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response Standard
HDOH	Hawaii Department of Health
HEER	Hazard Evaluation and Emergency Response
HIOSH	Hawaii Department of Labor and Industrial Relations, Occupational Safety and Health
HRS	Hawaii Revised Statutes
LEL	Lower explosive limit
LEPC	Local Emergency Planning Committee
MI	Multi-increment
NRC	National Response Center
PEL	Permissible exposure limit
PID	Photoionization detector
PPE	Personal protective equipment
PQL	Practical Quantitation Limit
QEP	Qualified environmental professional
SAP	Sampling and Analysis Plan
SHWB	Solid and Hazardous Waste Branch
TGM	Technical Guidance Document
USCG	United States Coast Guard
VOC	Volatile organic compound

CHAPTER 1: INTRODUCTION

This Project-Specific Construction Environmental Hazard Management Plan (C-EHMP) provides guidance to environmental consultants, owners, operator, tenants, and construction/utility workers, who are proposing construction-related and ground-disturbing activities that change building configuration and property use at sites with known or presumed contamination (renovation/redevelopment). Examples of such activities include, but are not limited to demolition, grading, excavation, trenching, or drilling at sites with identified or potential contamination. These guidelines should be used by all who may be hired to assist any of the activities described above to keep workers, site users, the environment, and the general public safe from contact with contamination on site and prevent COPCs from leaving the site without proper management.

This C-EHMP was prepared to address residual petroleum-impacted soil and groundwater beneath the subject project area. The petroleum impact is related to historic releases for a nearby Navy pipeline. The pipeline itself is not in the project area. Based on studies conducted for the Navy, the State of Hawai‘i Department of Transportation, Highways Division (HDOT) understands that contaminants associated with the historic pipeline releases are present in the groundwater beneath the site and in the soil around the water table at approximately 15 to 20 feet below ground surface (bgs). The subject drainage improvement project is not anticipated to encounter the impacted soil because excavation activities will reach a maximum depth of approximately 10 feet bgs. Nevertheless, the potential of encountering and disturbing petroleum-impacted material cannot be ruled out and this C-EHMP has been prepared to describe safety precautions to be taken and the proper handling of materials in the event that they are encountered.

CHAPTER 2: BACKGROUND

The C-EHMP applies to the subject project. The project area is also identified by the following.

TMK #	Highway right-of-way between TMK 9-6-003:022 and 9-6-003:024
Latitude/Longitude	12D23’44.1”N / 157D58’48.7”W

2.1 SITE CONDITIONS

Distance to Nearest Surface Water Body	Waiawa Stream is roughly 200 feet (61 meters) to the northeast
Approximate Depth to Groundwater	15 to 20 feet below ground surface
Is the Property Above or Below UIC Line	Above
Is the first-encountered groundwater classified as a potential source of drinking water in the Mink & Lau Aquifer Identification and Classification Report?	No
Current Property Use Type (Residential, Commercial, Zoning, etc.)	Highway
Proposed/Future Property Use Type (Residential, Commercial, Mixed Use Zoning, etc.)	Highway
Typical Soil Profile from Surface to Groundwater (Include Depth Range, Lithology)	The proposed drain line alignment is generally underlain by alluvial deposits, consisting of stiff to hard clayey silts, extending to depths of approximately 10 to 15 feet below existing ground surface. The alluvial soils in the boring drilled towards the western end of the drain line alignment are underlain by weathered basalt and basalt rock formation extending to a depth of approximately 15 feet below existing ground surface. Marsh deposits consisting of soft clayey silts were encountered below the alluvial deposits in the boring drilled towards the eastern end of the alignment and extend below the groundwater table. Refer to Attachment C – Geotechnical Engineering Report for Boring Logs.
Utilities Serving Site (e.g., Storm Drains, Electrical, Gas, Water, Sewer)	NA

2.2 EXISTING ENVIRONMENTAL CONDITIONS

The project site is the shoulder of east-bound Farrington Highway. It is a landscaped area of the highway.

Other information regarding the existing environmental conditions at the site were obtained from the Naval Facilities Engineering Command Hawai‘i (NAVFAC Hawai‘i), *Eighteenth Quarterly Long-Term Monitoring and Remedial Action Operations Report, Site ST02 Waiawa Booster Pump Station* report, dated September 2020. That report indicates that under Farrington Highway and parcels on the opposite side of Farrington Highway (TMKs 9-6-003:045 and 024) the Hickam Petroleum, Oils, and Lubricants (POL) pipeline was completed in 1943 to provide storage and transmission of petroleum products (e.g., aviation gasoline, motor fuel gasoline, jet propulsion fuel grade 4, and jet propulsion fuel grade 8). In January 1951, a leak occurred in the area (the Waiawa Booster Pump Station) and it was estimated that 10,000 gallons of aviation gasoline were released. A smaller release of an estimated 100 gallons of jet propulsion fuel grade 4 occurred in 1989.

Those releases are considered Site ST02 by NAVFAC. The following sections include information obtained from the report regarding chemicals of potential concern and other information.

2.3 CHEMICALS OF POTENTIAL CONCERN

The following chemicals of potential concern (COPCs) have been detected above the most restrictive unrestricted EAL and may pose a hazard.

2.3.1 Media: Soil

The NAVFAC report states:

> Vadose zone soil contaminants were identified in five soil borings (VP26-B02, VP26-B05, VP26-B07, VP26-B11, and ST02-B38) that exceeded HDOH Tier 1 Environmental Action Levels (EALs) or hydrocarbon fraction screening levels. Contaminants exceeding screening criteria in one or more of the soil borings included benzene, toluene, ethylbenzene, and total xylenes (BTEX), naphthalene, 1- and 2-methylnaphthalenes, C5-C8 aliphatics, C9-C12 aliphatics, C9-C10 aromatics, C11-C22 aromatics, total petroleum hydrocarbons as gasoline (TPH-g), total petroleum hydrocarbons as diesel fuel (TPH-d), and volatile petroleum hydrocarbons.

The investigations conducted by the Navy, including the borings identified in the statement above, have delineated the extent of vadose zone soil contamination around the booster pump where the historic release(s) occurred. As the project site is downgradient of the release site and the release occurred over 30 years ago, residual petroleum-impacted soil has only been identified in the capillary fringe area at the approximate depth of the groundwater table. The planned project excavations will be at least 4 feet above the soil-groundwater interface, per groundwater elevations measured in June 2020.

COPC	**Concentration Range**	**EAL*** (mg/kg)
TPH-g	Unknown where trenching will be done. EALs were exceeded in samples collected nearby, but not in samples collected from borings nearest the planned trench.	100
TPH-d		220
BTEX		0.30, 0.78, 0.90, and 1.4
1,2-DCA		0.023
Naphthalene		3.1
1- and 2-methylnaphthalenes		0.89 and 1.9

* EAL for Unrestricted Use; < 150m from surface water; above drinking water
mg/kg = milligrams per kilogram (aka parts per million)

2.3.2 Media: Groundwater

The NAVFAC report states:

> In shallow aquifer groundwater samples, the most conservative EALs or hydrocarbon fraction screening levels were exceeded for the target analytes except for organic lead, which has no screening level. Concentrations of COPCs near Waiawa Stream exceeded toxicity-based drinking water EALs; however, concentrations of COPCs in wells nearest the stream were below aquatic habitat protection based EALs. Natural attenuation indication parameters including pH,

> oxidation reduction potential (ORP), alkalinity, dissolved oxygen (DO), nitrate/nitrite, manganese, ferrous iron, sulfate, and methane provided limited evidence that anaerobic biodegradation of residual hydrocarbons was occurring in groundwater. Methane data also indicates that biodegradation of fuel hydrocarbons, including TPH-g, was occurring via methanogenesis. There were no exceedances of EALs in deep aquifer groundwater samples collected from a supply well in Waiawa Village and the aquaculture systems at the nearby Former RC Farms property.

Recent (June 2020) groundwater samples collected from wells upgradient of the project site contained COPCs exceeding EALs; groundwater samples collected from wells downgradient of the project site did not contain COPCs exceeding EALs, and the release occurred over 30 years ago. Therefore, groundwater impacted with COPCs near their EAL is likely present beneath the project site. However, impacted groundwater will not be encountered during the planned project because the groundwater level is well below the maximum depth of all project excavations.

COPC	**Concentration Range**	**EAL*** (µg/L)
TPH-g	Exceeding EALs upgradient of site; below EALs downgradient of site; onsite wells not monitored in June 2020	300
TPH-d		400
BTEX		5, 9.8, 7.3, and 13
1,2-DCA		5.0
Naphthalene		12
1- and 2-methylnaphthalenes		2.1 and 4.7

* EAL for Unrestricted Use; < 150m from surface water; above drinking water
µg/L = micrograms per liter (aka parts per billion)

2.3.3 Media: Soil Vapor

The NAVFAC report states:

> Shallow soil vapor sample (5 feet bgs) results were compared to the HDOH EALs for shallow soil vapor intrusion into indoor air while deeper soil vapor sample results were collected for characterization purposes and to serve as a baseline to assess progress of the selected remedy. Shallow soil vapor sampling results indicated that TPH-g exceeded the 2009 EAL (26,000 micrograms per cubic meter [µg/m3]) at two locations; however, these results did not exceed the updated 2012 EAL for TPH-g (130,000 µg/m3). No other EALs were exceeded in shallow soil vapor. Results of soil vapor samples collected from deeper than 5 feet bgs document elevated concentrations of BTEX, 1,2-dichloroethane (1,2-DCA), methane, and TPH-g in the area of VP26. Additionally, soil vapor samples collected from greater than 5 feet bgs were associated with low concentrations of oxygen (O2) and elevated concentrations of carbon dioxide (CO2) in areas with high soil vapor photoionization detector results, total volatile hydrocarbons, and TPH-g concentrations.

Given the soil and groundwater conditions described above and the historic soil vapor information provided immediately above, it is possible that the COPCs are present in soil vapor at concentrations approaching their EAL.

COPC	Concentration Range	EAL*/LEL
TPH-g	Unknown, but likely near the EAL for some of the COPCs	590 mg/m3
TPH-d		260 mg/m3
BTEX		0.72, 2,100, 22, and 42 mg/m3
1,2-DCA		0.22 mg/m3
Naphthalene		1.3 mg/m3
1- and 2-methylnaphthalenes		120 and 6.7 mg/m3
Methane		4.4 % LEL

* EAL for Unrestricted Use; < 150m from surface water; above drinking water
LEL= Lower Explosive Limits
mg/m3 = milligrams per cubic meter
COPC=Chemical of Potential Concern

Soil vapor COPC concentrations at depth may exceed the EALs throughout the project site. However, the subsurface is clay-rich and the petroleum-impacted soil is believed to be deeper than all excavations that will occur as part of the planned project, thus the migration of soil vapor contaminants from the contaminated groundwater source to the excavation depth will likely be limited, reducing the potential for soil vapor contaminant concentrations to exceed EALs.

Methane, listed in the table above, is a byproduct of anaerobic degradation of petroleum which may present an explosive hazard when at concentrations greater than the Lower Explosive Limit (LEL).

2.4 CHEMICALS OF POTENTIAL CONCERN AND CONSTRUCTION MATERIALS

2.4.1 Construction Materials Exposure Assessment

Question	Yes	No
Are storm drains (including interceptors) or will storm drains be present at the site?	X	
Will any portion of a storm drain (including interceptors) be present at an elevation that is potentially in contaminated groundwater?		X
Will any portion of a utility corridor be present at an elevation that is potentially in contaminated groundwater?		X
Will a portion of any other utility or subsurface structure (other than foundations) extend potentially into contaminated groundwater?		X
Are any potentially flammable or explosive COPCs present at the site (e.g., methane, total petroleum hydrocarbons as gasoline, etc.)?	X	
Will any electrical lines/utility corridors be subsurface?		X
Are any COPCs in vapors present at or above 10 % of the LEL?	Unknown, unlikely	
Will any elevator shafts or escalator pits, potentially extend into contaminated groundwater?		X

Soil vapor intrusion into the planned storm drain infrastructure over the long term is not considered a relevant hazard given (a) the depth and degraded nature (petroleum spill occurred over 30 years ago) of the residual petroleum impacted soil believed to be beneath the project area at the soil-groundwater interface, and (b) the silty clay composition of the subsurface soil. Direct contact between the planned storm drain infrastructure and residual petroleum-impacted soil is also considered unlikely given the depth of the planned infrastructure relative to the soil-groundwater interface (at least 4 vertical feet separation); however, it is possible.

2.4.2 Construction Materials Compatibility Assessment

None of the construction materials are expected to be in direct contact with petroleum-impacted soil, but it is possible. It is anticipated that the petroleum-impacted soil will be deeper than the storm drain improvements planned at the site. The following are considered.

Construction Material in Contact with Contaminated Media	**COPC, Concentration and Media**	**Proposed Material to be used**	**Material Safe with COPC**	
			Yes*	**No**
36" drainpipe	TPH-g & TPH-d, unknown, soil	High Density Polyethylene	X	
Storm drain manhole		Pre-cast concrete	X	
Gaskets/sealents		Plastic	X	
Storm drain outlet and ditch		Concrete	X	
Transition and slope protection		Grout-rubble pavement (lava rock and cement)	X	
Bed Course Material		Basalt Aggregate	X	
Stabilization Layer		Basalt Aggregate	X	
Non-woven Filter Fabric		Polypropylene	X	

* Documentation that material is safe to use, and will remain functional, in the presence of the identified contamination should be included as an attachment to the C-EHMP.

COPC=Chemical of Potential Concern

CHAPTER 3: SUMMARY OF POTENTIAL ENVIRONMENTAL HAZARDS

3.1 ENVIRONMENTAL HAZARD TABLE

The primary environmental hazards associated with the residual petroleum contamination beneath the subject site is the direct exposure to impacted soil and impacted soil vapor by construction workers. The soil may be grossly contaminated, meaning it may be saturated with petroleum. Other media, hazards, and receptors are of lesser concern given site conditions and uses. The following table provides greater detail concerning the hazards.

COPC	Media			Hazard					Potential Receptors				
	Soil	Water	Vapor	Direct Exposure	Leaching	Gross Contamination	Ecotoxicity	Vapor Intrusion	Construction Workers	Site Visitors	Site Occupants	General Public	Future Site Users
TPH-g	X	X		X		X			X				
TPH-d	X	X		X		X			X				
BTEX	X	X	X	X				X	X				
1,2-DCA	X	X	X	X				X	X				
Methane	X	X	X	X				X	X				
Naphthalene	X	X		X					X				
1- and 2-methylnaphthalenes	X	X		X					X				

COPC=Chemical of Potential Concern

3.2 CHRONIC AND ACUTE DIRECT EXPOSURE HAZARDS

When exposed to the broad range of petroleum hydrocarbons associated with historic aviation gasoline and jet fuel releases, **construction workers and supervisors should be alert for acute exposure symptoms such as (a) irritated eyes, skin, and mucous membrane; (b) blurred vision; and (c) dizziness and confusion.** The following table provides more detail.

COPC	Direct Exposure Hazard				Acute Exposure	Chronic Exposure
	Ingestion	Inhalation	Absorption	Injection		
TPH-g	X	X	X		Irritation of the eyes, skin, mucous membrane; dermatitis; headache, lassitude (weakness, exhaustion), blurred vision, dizziness, slurred speech, confusion, convulsions;	chemical pneumonitis (aspiration liquid); possible liver, kidney damage; [potential occupational carcinogen]
TPH-d	X		X		irritation of the nose and eyes, lung function changes,	cough, sputum production and lung function decrements

COPC	Direct Exposure Hazard				Acute Exposure	Chronic Exposure
	Ingestion	Inhalation	Absorptio	Injection		
					respiratory changes, headache, fatigue and nausea	
BTEX	X	X	X		Irritation of the eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait	anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; [potential occupational carcinogen]
1,2-DCA	X	X	X		Irritation of the skin	central nervous system depression; liver, kidney, lung damage
Methane		X	X		simple asphyxiant, displaces oxygen in confined spaces causing death	
Naphthalene	X		X		irritation of the eyes; headache, confusion, excitement, malaise (vague feeling of discomfort); nausea, vomiting, abdominal pain; irritation of the bladder; profuse sweating	jaundice; hematuria (blood in the urine), renal shutdown; dermatitis, optical neuritis, corneal damage
1- and 2-methylnaphthalenes	X		X			

COPC=Chemical of Potential Concern

Sources: NIOSH Pocket Guide, National Institute for Health, and World Health Organization

3.3 HAZARD MAP

A Hazard Map is included in the Figures Section, see Figure 3. Most important when considering the hazard posed by the petroleum plume to the construction work is the depth of excavation relative to the soil-groundwater interface. The Hazard Map (Figure 3) shows the drainage plan and profile and illustrates the relationship the soil hazard zone as the capillary fringe, which is the 2- to 3-feet around the groundwater level, and the soil vapor hazard zone that the soil-groundwater interface is always at least eight feet below the proposed storm drain improvements.

Not all contamination is a direct exposure hazard to construction workers and other Site Users; however, all contaminated media must be properly handled and disposed of in accordance with the guidance in this C-EHMP. Mishandling of contaminated media could result in spreading the contamination to uncontaminated areas of the site or to uncontaminated off-site locations, which could result in fines and other penalties.

CHAPTER 4: NOTIFICATION REQUIREMENTS

The effective environmental management of any project requires a coordinated effort from all individuals involved. The following sections outline the need to identify the responsibilities of key personnel involved in project construction.

If the Contractor encounters or exposes any hazardous or contaminated items, material or conditions at the worksite, the Contractor shall immediately notify the State Department of Health – HEER Office at 808-586-4249 and any other appropriate government agencies.

4.1 KEY PROJECT PERSONNEL

The project owner (owner/developer) is expected to maintain a list of project contacts throughout the construction phase of the project.

The key project personnel are as follows. An updated key project personnel list needs to be maintained throughout the project and submitted to HDOH in writing whenever a change in key project personnel occurs.

Table below to be completed when project is awarded.

Role	Company	Name	Phone #	e-mail
Construction Project Manager	HDOT-Highways			
Construction Foreman				
Onsite Qualified Environmental Professional (QEP)				
Qualified Environmental Professional (Project Manager)				
Owner	HDOT-Highways			
Monitoring Well Owner	NAVFAC Hawaii	Clint Zenigami	808-471-4610	Clint.zenigami@navy.mil
NPDES Permit contact	NA			
DPP Building Permit contact	NA			
HDOH HEER Office Project Manager	DOH-HEER Office	Thomas Gilmore	808-586-4353	Thomas.gilmore@doh.hawaii.gov
Landfill Disposal Contact				
Waste Transporter Contact				
Contact Export Site (if exporting soil)				
Contact Import Site (if importing soil)				

In addition, if site conditions or planned building configurations change following submittal and acceptance of this C-EHMP by the HDOH HEER Office, then the following agencies must be notified at least 90 days prior to conducting ground disturbing activities or as soon as the change has been identified. Please note that if HDOH is notified of a change in site conditions or planned building configuration less than 90 days prior to ground disturbing activities, there could be delays in construction if additional assessment work needs to be conducted. The initial notification of construction activities and any changes can be submitted through the HDOH e-permitting portal using the website link below.

Agency	Phone	Link/Website
HDOH HEER Office	808-586-4249	https://eha-cloud.doh.hawaii.gov/epermit/app/#/formversion/ed9ca916-7863-459b-b5dd-e66f881381d5

CHAPTER 5: REQUIREMENTS FOR ONSITE ENVIRONMENTAL OVERSIGHT

On-site monitoring is a key component of ensuring that the procedures documented in this C-EHMP are implemented properly and function as intended (e.g. appropriate installation and location of erosion and sediment control measures, cleanliness of equipment, suitability of secondary containment for fuel storage, screening of potential contaminated material, and stockpile segregation, etc.). **A qualified environmental professional (QEP) will be retained as the environmental monitor to provide guidance on implementing the recommended measures and to develop additional mitigation measures if the need arises**. The onsite QEP will have at least 5 years of experience providing environmental oversight for construction projects and must have completed HAZWOPER 40-hour training with current 8-hour refresher. The QEP shall provide documentation to show completion of the training and refresher course.

Monitoring events will be conducted at an appropriate frequency based on specific work tasks/procedures and the potential for adverse impacts to occur. An appropriate schedule (frequency and duration of site visits) will be established between the QEP and all involved regulatory agencies regarding when the QEP is onsite. In general, the QEP will be familiar with the day-to-day conduct of project activities and the **QEP will be on-site during activities with the potential to impact human health or the environment, when contaminated media will be disturbed, when mitigation measures are implemented, or as determined in discussion with the regulatory agencies**. Monitoring should be conducted with greater frequency during periods of inclement weather (e.g., heavy precipitation, strong winds) and during critical components/tasks of the project, such as working in contaminated groundwater (note, contaminated groundwater is not anticipated to be encountered during subject project). The QEP will be on-site whenever potentially impacted soil or groundwater may be disturbed and when hazardous vapors may be present. If demolition activities include abatement of lead-based paint or asbestos, abatement activities must be completed in accordance with all State and Federal laws and regulation prior to demolition (note, no such activities will be conducted as part of the subject project). This is necessary to ensure the protection of construction workers, the general public, and the environment.

Key monitoring stages when the QEP will be present may include, but are not necessarily limited to:

- **When excavations advance beyond five feet below ground surface**
- Prior to and after heavy rain/storm events while excavations deeper than 5 feet are exposed

The primary responsibility of the QEP is to ensure that the environmental and human health protection measures are implemented and are adhered to and that any movement, transport, and disposal of contaminated material (onsite and to an offsite location) is properly documented.

Typical responsibilities of the QEP include those identified below; however, specific items are expected to be refined and/or expanded as per the needs of the project:

- Conduct field monitoring of soil and soil vapor conditions and direct the segregation of impacted soil, if any is encountered.

- Communicate the requirements of the C-EHMP to project members during pre-job and tailgate meetings.
- Remain onsite as per the schedule established between parties prior to project start. The QEP will remain on-call during non-critical work periods to respond to emerging environmental issues.
- Review the contractor's work procedures to ensure functionality and compliance with the C-EHMP and applicable regulations, standards and best management practices (BMP).
- Provide advice in preparing for work activities in a manner that mitigates adverse environmental or health effects.
- Exercise the authority to modify and/or halt any construction activity at any time if deemed necessary for the protection of human health and the environment.
- Advise project members if project activities have caused or are likely to cause an environmental incident and make recommendations for corrective action.
- Monitor compliance with the C-EHMP and relevant permit conditions.
- Liaise directly with project members and provide technical advice for the purpose of resolving situations that may impact human health and the environment as they arise.
- Maintain complete records of activities related to the implementation of the C-EHMP. This should include any measurements taken (e.g. pH, turbidity, temperature, conductivity, photoionization detector [PID] screening, air monitoring, equipment calibration, manifests, truck receipts, truck counting spreadsheets etc.), photographs and incident reports.
- Complete and submit environmental monitoring reports to the HDOH HEER and report any unanticipated adverse effects to the environment. Such reports must include the nature of the effect, its cause, mitigation and/or remediation implemented, and whether a work stoppage was ordered, as well photographs, analyses, and measurements, if applicable.
- Report unanticipated encounters with contamination at the site in accordance with HRS 128D. Reportable releases include contamination not already identified at the site, as well as tanks, drums, and/or abandoned pipelines that are not identified in advance and are encountered during excavation.

Table of Project Activities when QEP Must be Present

Activity	**Planned at Site?**		**QEP Will Be Present?**		**Monitoring Equipment to be Used by QEP**
	Yes	**No**	**Yes**	**No**	
Environmental Sampling		X			
Geotechnical Sampling	X			Task complete	
Demolition	X			X	
Grading	X			X	
Excavation	X			X	
Pile Installation		X		X	

Activity	**Planned at Site?**		**QEP Will Be Present?**		**Monitoring Equipment to be Used by QEP**
	Yes	**No**	**Yes**	**No**	
UST Removal		X		X	
Dewatering		X		X	
Utility Trenching	X		When trench exceeds 5 feet deep		PID and LEL
Soil Stockpiling	X		If petroleum-impacted soil is encountered		PID
Soil Export/Import	X				PID
Vapor Barrier Installation		X		X	
Vapor Extraction		X		X	
Confined Space Work		X		X	
Work Below High-Water Mark		X		X	
Engineering Control Installation and Testing		X		X	
Pipeline Tapping		X		X	
Installation of Erosion/ Sediment Controls, including compost filter berms	X			X	Not needed because impacted soil will not be encountered during task
Prior to/During Rainstorm Events	X		If PID and/or LEL monitoring conducted during trenching identified impacted soil vapor at elevated concentrations or petroleum-impacted soil was encountered within 50 linear feet of where work is being performed		No monitoring equipment, visual inspection only
Installation of storm drain and manholes	X				PID and LEL
Other:					

PID = Photoionization detector meter
LEL = Lower explosive level meter with LEL, Oxygen, Carbon Monoxide, and Hydrogen Sulfide sensors

Additional details regarding QEP monitoring schedule:

If the QEP establishes that based on the available information and monitoring conducted that there is no longer a chemical exposure risk to construction workers, monitoring can be discontinued. This may arise if the utility trench is excavated and no petroleum impact soil or soil vapor is encountered. At that point the monitoring outlined in this C-EHMP may be discontinued and the remainder of the work (e.g., installation of storm drain infrastructure and backfilling of trenches) may proceed without the QEP being present.

CHAPTER 6: CONSTRUCTION ACTIVITIES

The proposed project is the installation of roughly 315 linear feet of 36-inch diameter storm drain with 5 manholes, an outlet structure and trench that together are roughly 23 linear feet, and a GRP transition and slope protection that is roughly 22 linear feet. Details can be found on the attached construction plans.

It is not anticipated that groundwater will be encountered and no dewatering will be conducted. It is also unlikely that significant quantities of petroleum-impacted soil will be encountered, although there is some chance that impacted soil or soil vapor may be encountered in the deepest parts of the utility trench. No soil vapor barriers or other controls will be employed.

An Erosion Control Plan is included in Attachment A – Figure 4.

Planned Types of Excavations:

Excavation Type	**Maximum Depth**
Trenching for storm drain installation	10 feet below ground surface

The following activities will require workers to enter the trench or otherwise potential be exposed to impacted soil and/or soil vapor:

- Installation of storm drain and manholes

CHAPTER 7: SOIL MANAGEMENT PLAN

The purpose of this section is to ensure that impacted soil is properly handled and managed. The management of potentially impacted soil will be overseen by an onsite QEP.

No soil will be imported to the site as part of the project. Bed course and stabilization layer materials will be imported but are not considered "soil" and will be placed beneath and partially around the 36-inch diameter storm drain being installed.

7.1 SOIL MANAGEMENT

Soil more than five feet below ground surface that is disturbed will be continuously monitored and documented by a QEP. Soil that is not impacted will be temporarily placed next to the trench until it can be reused for backfill or other on-site use. Where known or suspect impacted soil is encountered during excavation, the appropriate response actions must be taken that conform with HDOH and EPA guidance, laws, and regulations. This includes proactive planning to ensure that workers have the appropriate level of PPE and that impacted soil is managed properly when excavated. Tasks associated with properly managing impacted soil include the following:

- Where impacted soil is encountered, a **QEP shall provide field oversight to ensure that**:
    - **known or suspect impacted soil is segregated from non-impacted soil**,
    - **known or suspected impacted soil is properly stored and covered with plastic sheeting**,
    - the impacted soil is managed properly during and following excavation,
    - and health and safety guidance related to potential exposure of workers to COPCs is provided.
- Workers who may come into contact with impacted soil must wear the appropriate level of PPE.
- Workers who may come into contact with impacted soil must have required training (at a minimum, 40-hour HAZWOPER certification and current 8-hour annual refresher training).
- Petroleum-impacted soil trucked offsite should be drained of fluids and the load must be covered with a dust screen during transport. Where and how fluids will be drained from the soil will be provided in the final C-EHMP prepared by the contractor. Water may be re-infiltrated at the site provided free-product is removed prior to re-infiltration.
- If newly encountered soil contamination is discovered at a previously unknown source or location, the HDOH HEER Office must be immediately notified of its discovery by reporting it as a new release.
- Where trenches or excavation pits may constitute confined spaces, particularly where soil or groundwater COPCs include volatile chemicals, confined space entry permits may be required. Refer to Site-Specific Health and Safety Plan (HASP) for more details on requirements for confined space entry restrictions and permits.

7.1.1 Field Identification of Impacted Soil

Some COPC cannot be identified in the field through visual and olfactory observations, especially when present at lower concentrations that may still exceed the EALs. Petroleum impacted soil, such as that potentially encountered at the project site, typically exhibits petroleum staining and/or a petroleum hydrocarbon odor. Free product (petroleum saturation of soil) may or may not be observed. Petroleum impacted soil, particularly when associated with a spill that occurred many years ago such as the subject site, may be also detected indirectly via a rotten egg odor stemming from anaerobic degradation of the product that produces hydrogen sulfide in oxygen starved zones. Previous sampling or historical research has identified COPCs present in soil beneath the project area at concentrations approaching the most restrictive HDOH EALs at depths just below, and potentially within depths, that will be disturbed by the proposed project.

If impacted soil is encountered during construction, it must be managed in a manner protective of site workers, the public, and the environment. There is no evidence that soil from ground surface to a depth of 5 feet bgs is petroleum impacted. Soil excavated from those shallow depths will be managed as “clean” soil. Soil excavated from depths below 5 feet bgs will be screened by the QEP and temporarily segregated from the soil excavated from depths above 5 feet bgs until QEP screening is complete. Once screening is complete, the soil will be segregated into the following possible units:

1. Non-impacted soil, when the soil resembles the soil from the top five feet and has been confirmed to have no indications of petroleum impact (e.g., no odor, no staining, and PID readings less than 50 ppm). It can be combined with the soil from the top five feet.
2. Impacted soil, when the soil is stained or saturated with petroleum or otherwise impacted (e.g., PID readings exceed 50 ppm).

During excavation of soil below 5 feet bgs, the QEP must perform the following activities on a continuous basis:

- Visually screen soils for staining, debris, soil waste, discoloration, or other evidence of contamination as the soils are removed from the excavation.
- Check for petroleum or other unusual chemical odors emanating from the soil.
- Collect soil screening samples in sealable inert bags and test the headspace within each bag for volatile organic compounds (VOCs) using a PID and following the Maine Department of Environmental Protection PID Bag Headspace Test procedure described in detail in Section 8.4.2 of the Technical Guidance Manual (TGM). Prior to testing, PID meters must be calibrated in accordance with device manufacturer instructions. A PID screening sample will be collected at least for every 10 linear feet of utility trench excavated.
- Use the field observations, PID measurements, and any other field screening tests, such as the glove and paper towel tests, to segregate the soil into the categories above properly.

7.1.2 Dust and Erosion Control

Dust and erosion controls at the Site will be continuously monitored and documented by the QEP when excavation is occurring at depths greater than 5 feet bgs. Prior to excavation activities, the Contractor and the QEP must evaluate and establish erosion control and dust control measures. The erosion control and dust control measures must prevent impacted soils from migrating away from the excavation area. Typically, Best Management Practices (BMPs) are employed to control erosion and prevent the spread of contamination via runoff or wind.

Dust control measures should ensure compliance with ambient air quality standards established in the Hawaiʻi Administrative Rules (HAR) 11-59 and should comply with air pollution control requirements specified in HAR 11-60.1. During excavation and handling of impacted soil, the following dust control measures must be implemented to minimize dust generation:

- Compost filter berms: BMPs associated with erosion control measures shall include the installation of compost filter berms in the vicinity of the excavation and along the site perimeter as shown in the Erosion Control Plan.
- Equipment decontamination: BMPs to control the transport of impacted soil from the site and within the site shall be used to limit the tracking of soil away from the excavation area. Decontamination areas should be set up adjacent to excavation areas where contaminated media will be disturbed, adjacent to stockpile areas, and where vehicles and equipment leaves the site. Decontamination protocols are described in Section 14.0.
- Wetting/misting: BMPs associated with dust control measures shall include the use of water to be sprayed on the soil during excavation activities. During excavation, water shall be sprayed on the surface of the soil to prevent dust from being generated. However, the amount of water used for dust control shall be minimized as to not create run-off away from the excavation.

7.1.3 Excavation and Stockpiling

Suspect impacted soil must be stockpiled and segregated from non-impacted soil. The following tasks must be performed with respect to managing impacted soil.

- Clean, suspect, and impacted soil will be segregated from each other.
- Water contained within excavated soils, if any, will be allowed to drain back into the excavation prior to stockpiling the soil.
- Stockpile suspect and impacted soil in a 20-mil plastic-lined, bermed area. The impacted soil must be placed inside the bermed area on top of the plastic sheeting. The stockpiles must be covered with plastic sheeting at the end of each day and during any major wind or rain events. The plastic sheeting must be secured with enough ballast so that it will not be dislodged by strong winds.
- Underlay the edges of the plastic sheeting with non-impacted soil or other material to create a berm around the stockpile.
- Ensure that the height of the berm is sufficient to prevent storm water runoff or run-on from breaching it.

- Soil stockpiles shall be located away from storm drain inlets, surface waters, and storm water drainage pathways/channels.
- Soil stockpiles must remain on-site and cannot be transported or stored off-site without prior authorization or characterization. (Note, off-site storage of soil will likely require a Temporary Storage and Disposal Facility permit and may require other permits as well).
- Confirmation sampling of the underlying soil may be required following stockpile removal to ensure that COPCs did not leach into the ground. Should impacted soil be encountered and stockpiled on-site, the QEP will prepare a plan for confirmation sampling post-stockpiling.

Figures showing where segregated stockpiles will be located and where and how fluids will be drained back into the trench will be provided in the final C-EHMP prepared by the contractor.

7.2 SOIL REUSE AND DISPOSAL

The policies in this section only apply to the soil excavated from depths greater than 5 feet bgs.

The current construction plans do not anticipate contingencies for alternate soil reuse; therefore, if plans change, then this C-EHMP will be revised and re-submitted by the contractor and QEP to the HEER Office for review and approval at least 90 days prior to moving soil off-site. Current construction plans regarding soil use are as follows:

- To the maximum extent practicable, non-impacted soil will be reused on-site to backfill utility excavations. If all the soil excavated is clean, there will be an excess of soil (e.g., not all the soil can be reused to fill the trench). Preferably, the excess soil will be reused on site to regrade or restore the project area.
- Impacted soil will be reused on-site to backfill utility excavations to the degree possible. If there is excess impacted soil, or grossly impacted soil, it will be disposed of at PVT Landfill.

If construction plans change, such that soil will be imported or exported from the site, then this C-EHMP must be revised and re-submitted by the contractor and QEP to the HEER Office for review and approval at least 90 days prior to importing or exporting soil from the site, or as soon as the change has been identified.

Prior to reuse of soil off-site or disposal at a licensed disposal facility (e.g., PVT Landfill), all soil will be sampled to ensure that it is appropriately characterized so the appropriate final disposition of the soil may be determined. Below are the planned location(s) for soil reuse or disposal. If other locations are later planned following approval of this plan, then the HEER Office must be notified and provide approval prior to any material being transported.

Soil Characterization Sampling (to be completed and provided in the final C-EHMP prepared by the contractor)

Chemicals to Analyze	**Analytical Method**	**Sampling Frequency (CY per Sample)**
TPH-g		

TPH-d		
VOCs (BTEX, 1,2-DCA)		
SVOCs (Naphthalene, 1- and 2-methylnaphthalenes)		
Lead		

All soil samples will be collected in accordance with the HEER Office TGM. This requires the collection of multi-increment soil samples to properly characterize the soil.

Off-site Disposal/Re-Use Table

	Re-Use Location	**Disposal Location**
Name of Re-use or Disposal Location	On-site	PVT Landfill
Address of Re-use or Disposal Location	NA	87-2020 Farrington Hwy, Waianae, HI 96792
Land Use (Site Zoning)	NA	AG-2

This information will be communicated to the soil hauler and it will be ensured that the hauler only dispose of soil at locations approved in this plan. The QEP will monitor and review hauling manifests and disposal records to ensure adherence to the plan. Disposal of soil at a location not previously approved could result in fines.

7.2.1 On-site Reuse of Clean and Impacted Soil

Non-impacted soil may be reused on-site without restriction. The non-impacted soil will be reused on-site to backfill the utility trench following the placement of the 36-inch diameter storm drain.

Impacted soil may be re-used on-site unless it is grossly contaminated. Grossly impacted soil is soil that is saturated with free petroleum product. As the project will not disturb soil at the soil-groundwater interface, grossly impacted soil is not anticipated. If grossly contaminated soil is generated as part of the subject project, it will be disposed of at PVT Landfill after characterization described in Section 7.2.2.

Impacted soil will be replaced in the same area and at a similar depth as where the soil was originally excavated. Exceptions may apply based on site-specific hazard situations. HDOH HEER Office guidance should be reviewed to ensure proposed re-use is in line with current guidance. The QEP will ensure that impacted soil is not spread to uncontaminated areas of the site without prior approval from HDOH.

7.2.2 Stockpile Sampling for Disposal at a Disposal Facility

If impacted soil will be disposed of at an appropriate permitted waste disposal facility the MI sampling requirements are as follows:

	Disposal Facility Requirements
Stockpile Volume (cy) per sample	(to be completed and provided in the final C-EHMP prepared by the contractor)
# of increments per MI sample	(to be completed and provided in the final C-EHMP prepared by the contractor)

The soil will be disposed of at the following permitted site:

- PVT Landfill

7.2.3 Record Keeping

A log of all soil that leaves the Site and its final disposition will be maintained by the QEP. All waste manifests, truckload counts at source and receiving site, weigh tickets, and soil profiles will be included in a final report documenting the environmental oversight conducted during construction. The report will be submitted to the HEER Office at the conclusion of the project. In addition, whenever soil is exported from the site, summary reports of the disposal records, including copies of documents, will be submitted to the HEER Office on a weekly or monthly basis, unless waived in writing by the HEER Office project manager. For all soil disposed of at a disposal facility a manifest with all required signatures will be submitted.

CHAPTER 8: GROUNDWATER MANAGEMENT PLAN

Estimated Depth to Groundwater at Site:	8 to 20 feet		
Proposed Maximum Excavation Depth:	10 feet; trenching will always be at least 4 feet above estimated groundwater level (see Attachment A – Figure 3)		
Estimated Direction of Groundwater Flow:	North-Northeast		
Will Contaminated Groundwater be Encountered During this Project?	Yes	No	Unknown
		X	
Will Groundwater from this Site be Dewatered into the Sanitary Sewer System?		X	
Will Groundwater from this Site be Dewatered into the Storm Sewer System?		X	
Does the Contractor have a Dewatering Permit Issued by the County and/or HDOH Clean Water Branch?		X	
Is Free Product Known or Suspected to be Present at the Site?		X	

The current construction plans do not anticipate encountering groundwater at this site; therefore, a groundwater management plan is not needed for this C-EHMP. If plans change or new information indicates that groundwater will be impacted, then this C-EHMP will be revised and re-submitted by the contractor and QEP to the HEER Office for review and approval at least 90 days prior to conducting groundwater disturbing activities or as soon as the change has been identified.

CHAPTER 9: FREE PRODUCT MANAGEMENT PLAN

The purpose of the free product management plan is to ensure proper handling and management of free product that may be encountered. Free product is generally encountered floating on the groundwater or at the capillary fringe, and typically presents as either free-flowing, black or brown, viscous product; a thin layer of black or brown product; a discontinuous layer of product (e.g., spots or globules); or a petroleum hydrocarbon sheen. In areas where groundwater level is tidally influenced there may be an increase in the amount of free product at either high or low tide.

Question	Yes	No	Unknown
Is free product known or suspected to be present at the site?		X	
Is the groundwater at the site tidally influenced?		X	
Is groundwater at the site confined?		X	
Will excavation activities at the site potentially encounter contaminated groundwater and free product?		X	

The current construction plans do not anticipate encountering groundwater at this site; therefore, a free product management plan is not needed for this C-EHMP. If plans change or new information indicates that groundwater will be impacted, then this C-EHMP will be revised and re-submitted by the contractor and QEP to the HEER Office for review and approval at least 90 days prior to conducting groundwater disturbing activities or as soon as the change has been identified.

CHAPTER 10: STORM WATER MANAGEMENT PLAN

Proactive actions must be taken to prevent storm water from coming into contact with contaminated groundwater and soil at the site. The actions listed below will minimize the potential for contaminating storm water.

- Place impacted soil on plastic sheeting in a lined, bermed area to prevent storm water from contacting impacted soil.
- Open excavations should be backfilled as soon as practicable to prevent storm water and direct precipitation from entering the excavation. When possible, open excavations should be bermed to prevent storm water run-off from entering the excavation.
- In the event of heavy rain, ensure that all stockpiles of impacted soil are covered with plastic sheeting and substantially secured.
- Regularly monitor the weather throughout the day for signs of approaching storms and/or heavy rains.

An Erosion Control Plan with additional BMPS is included in *Attachment A – Figure 4*.

CHAPTER 11: VAPOR MANAGEMENT PLAN

The purpose of the Vapor Management Plan is to identify VOC vapors and toxic gases that could adversely affect air quality during construction. Included are procedures to detect and mitigate potential fire and explosion hazards posed by explosive vapors.

Below are the Chemicals of Potential Concern associated with potential vapors that may be encountered at the Site.

- TPH-g
- TPH-d
- BTEX
- Methane (from anaerobic degradation of hydrocarbon contaminants)
- Hydrogen Sulfide (from anaerobic degradation of hydrocarbon contaminants)

Soil vapor hazards are known or suspected to be present through the project area.

The **principal hazards posed by volatized COPCs are direct exposure through inhalation, asphyxiation, flammability, and explosivity**. Where volatile COPCs are found during construction activities, the concentrations of these vapors must be controlled in accordance with HDOH and U.S. Environmental Protection Agency (EPA) regulations and guidelines, and Occupational Safety and Health Administration (OSHA) rules and regulations. This includes proactive planning to ensure workers and the general public are not exposed to hazardous volatized COPC concentrations and that workers have the appropriate level of PPE. Tasks associated with adequate and proper vapor management include the following:

- The QEP must provide field oversight where COPC vapors may be present and/or are detected at concentrations above EALs, LELs and/or PELs. The QEP should provide health and safety guidance related to potential exposure of workers to the vapors.
- The QEP shall establish exclusion areas around the areas of known or suspected COPC vapors and only workers with appropriate PPE and training will be allowed to work within the exclusion areas. Exclusion areas will be established if elevated concentrations of the COPCs are encountered during the work.
- Workers who may come into contact with COPC vapors must wear the appropriate level of PPE.
- Workers who may come into contact with COPC vapors must have required training (at a minimum, 40-hour HAZWOPER certification and current 8-hour annual refresher training).
- **Air monitoring will be conducted by the QEP during excavation beyond 5 feet below ground surface**.
- **Air monitoring will also occur when workers are required to enter excavations**. Where workers will enter excavations or trenches, confined space restrictions may also apply. Confined space requirements are described in detail in the Site-Specific HASP.
- The monitoring will include both workspace and perimeter measurements of COPC vapors.

- If warranted by air monitoring results, the QEP will notify onsite workers to upgrade PPE to include respiratory protection. Requirements for the use of respiratory protection, including medical monitoring, are described in detail in the Site-Specific HASP.
- Air monitoring will be conducted using a PID meter and LEL 4 gas meter.
- Air monitoring associated with confined-space entry will be described in the site-specific HASP for construction.

If the QEP establishes that based on the available information and monitoring conducted that there is no longer a chemical exposure risk to construction workers, monitoring can be discontinued. This may arise if the utility trench is excavated and no petroleum impact soil or soil vapor is encountered. At that point the monitoring outlined in this C-EHMP may be discontinued and the remainder of the work (e.g., installation of storm drain infrastructure and backfilling of trenches) may proceed without the QEP being present.

11.1 ENGINEERING AND INSTITUTIONAL CONTROLS

Methods to prevent vapor exposure are required during construction activities in areas where known or suspected COPC vapors may be present. The following administrative controls shall be established to protect workers and the public from COPC vapor hazards:

- Appropriate worker training (including 40-hour HAZWOPER and current annual 8-hour refresher) required for workers in areas where COPC vapor hazards are encountered, as determined by QEP monitoring.
- Establishment of Exclusion Area(s) should petroleum-impacted soil and/or soil vapor be encountered.

The following engineering controls shall be established to protect workers and the public from COPC vapor hazards:

- Use of plastic sheeting on soil stockpiles

11.2 ADMINISTRATIVE CONTROLS

Administrative Controls for Protecting Workers from COPC Hazards (further detailed in the HASP) include:

- 40-hour HAZWOPER training and current 8-hour refresher required for all workers who may come into contact with contaminated media.
- A discussion of COPC hazards that may be encountered will be discussed during daily tailgate safety meetings.
- The QEP will be present when contaminated media will be moved or disturbed.

CHAPTER 12: SPILL OR RELEASE RESPONSE

Releases, should they occur, must be reported in accordance with HRS 128D and HAR 11-451. In addition to contractor releases, a release may include pre-existing contamination encountered during construction activities. If new contamination is discovered that is different from any known previously reported releases, the release must be reported as described in the above-mentioned regulations.

12.1 RELEASE RESPONSE

If a release occurs, the following actions must be taken:

- Construction workers who observe or find evidence of a release are to immediately inform the Spill Coordinator. The Spill Coordinator is to notify HDOT personnel, DOH-HEER, NAVFAC Hawaii, and all other responsible parties as required per *Attachment B – Emergency Spill Response Plan*.
- Determine the identity of what was spilled, the source of the spill, the volume of the spill, the severity of the spill, and if immediate emergency response actions are necessary.
- Stop work if contaminant releases are extremely large and cannot be contained. If an imminent threat to human health or the environment exists, or if human or environmental receptors are impacted (e.g., human receptors falling ill or suffering sudden illness), notify the Honolulu Fire Department by calling 911.
- If the spill is of a volatile, flammable, or combustible liquid or vapor, possible ignition sources should be eliminated, and workers will be directed to remain upwind. In addition, monitor for explosive vapors using an LEL meter.
- Stop work if an unusually large release or contaminated area is encountered unexpectedly or if there is any release of chemicals or hazards not covered by the plan.
- Stop work and take immediate emergency response actions if a worker or member of the general public is injured.
- Eliminate the source of the spill to the extent practicable (e.g., shutting off a valve, righting an overturned container), if it is safe to do so. Do not attempt to stop a release from an active fuel pipeline.
- Protect sensitive ecological receptors threatened by the spill.

12.2 RELEASE REPORTING

In the event of a release of a hazardous substance that causes imminent threat to human health or the environment, the first call should be to 9-1-1. Example of releases requiring a call to 911 include, but are not limited to fuel or gas leaking from an active pipeline, an ammonia tank leak, or workers and/or the public becoming ill.

All releases must be reported to the HEER Office (808-586-4249 or 808-247-2191 after work hours) and the Local Emergency Planning Committee (LEPC) at 808-723-8960. Both agencies must be contacted by telephone or in person immediately following a release. Note, there is no penalty for reporting a release unnecessarily, but there are large penalties for not reporting a release.

If petroleum is observed on surface water, then notify the U.S. Coast Guard (USCG) through the National Response Center (NRC) at (800) 424-8802. Please note, petroleum observed on groundwater is not reportable to the NRC. For oil and hazardous substance spills that threaten or occur in navigable waters, the USCG is the lead agency.

The on-site personnel responsible for ensuring that the appropriate release notifications are conducted are listed below. Please note, that in the case of an emergency or imminent threat to the environment, any on-site personnel can contact 911.

Personnel Responsible for Release Notifications

Table below to be completed when project is awarded.

Name	**Company**	**Title**	**Phone Number**
[Spill Coordinator]	[Contractor]		
[Construction Project Manager]	HDOT Highways		

CHAPTER 13: WORKER PROTECTION

A site-specific Health and Safety Plan (HASP) must be prepared for the site in accordance with the appropriate occupational health and safety regulations. These regulations and requirements include but are not limited to the use of the appropriate level of PPE and appropriate personal hygiene steps associated with the identified COPCs as the site. A copy of the Site-Specific HASP will be attached to this C-EHMP when the project is awarded.

Administrative Controls for Protecting Workers from COPC Hazards (further detailed in the HASP) include:

- 40-hour HAZWOPER training and current 8-hour refresher required for all workers who may come into contact with contaminated media.
- A discussion of COPC hazards that may be encountered will be discussed during daily tailgate safety meetings.
- The QEP will be present when contaminated media will be moved or disturbed.
- Confined Space Entry Permits are required for workers who will enter trenches or pits deeper than 3 feet.

Engineering Controls for Protecting Workers from COPC Hazards (further detailed in the HASP) include:

- The appropriate level of PPE shall be selected based on the potential hazards and COPCs associated with the individual construction tasks. The level of PPE may be upgraded or downgraded depending upon the tasks being conducted and the level of contact with the soil. At a minimum, Modified Level D PPE consisting of Tyvek suits, chemical-resistant boots, and nitrile gloves is to be required for workers directly exposed to impacted soils within the trenches and excavations.
- Stanchions (delineators) and hazard tape shall be used to delineate exclusion areas where COPCs are present and access is restricted.
- If deemed necessary by the QEP, fans shall be placed around trenches and excavation pits where vapor hazards are present to increase air flow and redirect hazardous vapors away from workers.

CHAPTER 14: DECONTAMINATION

Prior to excavation activities, the Contractor and the QEP must designate areas for decontamination activities. The QEP must also evaluate and establish decontamination procedures for personnel, tools, equipment and vehicles, prior to construction. Decontamination procedures for personnel and BMPs to limit direct exposure to COPCs is also discussed in the Site-Specific HASP that is attached to this C-EHMP.

14.1 DECONTAMINATION OF TOOLS AND PERSONNEL

Appropriate personal hygiene practices shall be adhered to at all times when handling potentially impacted soil. Washing facilities shall be made available on the jobsite to allow workers to wash their hands and avoid cross-contamination before eating, drinking, smoking, and/or heading home for the day.

After contact with the impacted soil, proper decontamination procedures shall be conducted including the removal, segregation, and disposal of PPE. Any used PPE shall be placed in plastic garbage bags, double bagged, and deposited in the site dumpster, or a municipal landfill.

Hand-held and manual tools in direct contact with impacted soil must be decontaminated to remove any impacted soil or water prior to handling non-impacted material that are assumed to be uncontaminated and before they are removed from the work area. The decontamination of tools must include the following:

- At the excavation location, physically remove soil adhering to the surface of the equipment using appropriate hand tools. Soil removed during this step should be placed back into the impacted area, excavation, or the appropriate stockpile following removal.
- Rinse off contaminated groundwater at the excavation location, allowing rinse water to drain back into the excavation or be collected in a container for proper disposal.
- While the tools are located at the excavation, water should be used to wash the surfaces of the tools that were exposed to impacted material. The water used to wash the exposed surfaces should be directed back to the impacted area or excavation and allowed to infiltrate.

During equipment decontamination, proper PPE shall be employed to minimize exposure to COPCs. Proper PPE should include Modified Level D PPE with nitrile gloves, rubber boots, waterproof Tyvek, and an appropriate face shield to protect against splash back during decontamination. The QEP shall designate Decontamination Areas for the donning and doffing of disposable PPE and for the cleaning of materials.

14.2 DECONTAMINATION OF VEHICLES AND EQUIPMENT

Vehicle and equipment decontamination should occur following the use of vehicles and equipment (to include haul trucks and heavy machinery) in direct contact with impacted soil. The equipment decontamination procedures are intended to describe methods for reducing and controlling the spread of site COPCs to non-impacted portions of the site or non-impacted materials, and to off-site locations.

Equipment and vehicles in direct contact with impacted soil must be decontaminated to remove any impacted soil before they leave the work area. The decontamination of vehicles equipment must include the following:

- At the excavation location, physically remove soil adhering to the surface of the equipment using appropriate hand tools. Soil removed during this step should be placed back into the impacted area, excavation, or the appropriate stockpile following removal.
- While the vehicle/equipment is located at the excavation, water should be used to wash the surfaces of the vehicle/equipment that was exposed to impacted material. The water used to wash the exposed surfaces should be directed back to the impacted area or excavation and allowed to infiltrate.

During equipment decontamination, proper PPE shall be employed to minimize exposure to COPCs. Proper PPE may include Modified Level D PPE with nitrile gloves, rubber boots, waterproof Tyvek, and an appropriate face shield to protect against splash back during decontamination. The Contractor and QEP shall designate Decontamination Areas for the decontamination of vehicles and heavy machinery.

CHAPTER 15: RECORDKEEPING AND REPORTING REQUIREMENTS

Detailed records of all environmental activities conducted during construction should be kept. These records may include air monitoring results, stockpile sampling, soil segregation, soil and/or groundwater sampling methodologies and results, dewatering activities, free product recovery, vapor suppression, soil disposal or re-use, and any other environmental activities conducted in association with construction activities.

In addition to maintaining these records, within 30 days of the completion of ground disturbing activities a removal action report summarizing the environmental activities conducted during construction is to be submitted to HDOH for review and comment. Guidance for preparation of a removal action report can be found in Section 18 of the HEER Office Technical Guidance Manual. The report should also include copies of all disposal receipts, truck logs, and laboratory analytical results, as well as a map illustrating the approximate GPS location(s) where any impacted soil was encountered and/or reused onsite.

Any reports will be shared with NAVFAC. NAVFAC will remain responsible for any further requirements related to the petroleum plume under the project site. Their responsibilities extend to the need to complete/update an Environmental Hazard Evaluation (EHE) and prepare/update an Environmental Hazard Management Plan (EHMP) to manage the contamination in the long-term.

CHAPTER 16: REFERENCES

HAR 11-59. Hawai'i Administrative Rules, Department of Health. Title 11, Chapter 59. Ambient Air Quality Standard. September 15, 2001.

HAR 11-60.1. Hawai'i Administrative Rules, Department of Health. Title 11, Chapter 60.1. Air Pollution Control. June 30, 2014.

HAR 11-451. Hawai'i Administrative Rules, Department of Health. Title 11, Chapter 451, State Contingency Plan (SCP). August 2, 1995.

HDOH. State of Hawaii Department of Health (HDOH), Solid and Hazardous Waste Branch. *Use of HEER Office Environmental Action Level Guidance and HEER Office Technical Guidance Manual for Characterization and Remediation of Contaminated Properties Overseen by the Solid and Hazardous Waste Branch.* January 30, 2019.

HDOH. State of Hawaii Department of Health (HDOH), Hazard Evaluation and Emergency Response (HEER) Office. *Guidance for Stockpile Characterization and Evaluation of Imported and Exported Fill Material.* October 2017.

HRS 128D. Hawaii Revised Statutes. Hawaii Environmental Response Law (HERL), Chapter 128D. Website URL: https://www.capitol.hawaii.gov/hrscurrent/Vol03_Ch0121-0200D/HRS0128D/HRS_0128D-0001.htm

TGM. Technical Guidance manual for the Implementation of the Hawai'i State Contingency Plan. Website URL: http://www.hawaiidoh.org/tgm.aspx

Attachment A

Figures

FIGURE 1

FED. ROAD DIST. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAW.	99D-01-17	2018	1	19

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19	TRAFFIC CONTROL PLAN

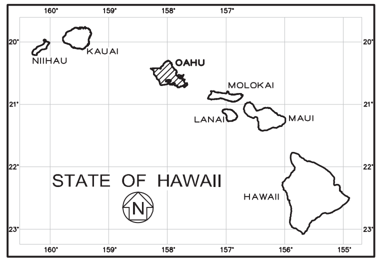
STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
HONOLULU, HAWAII

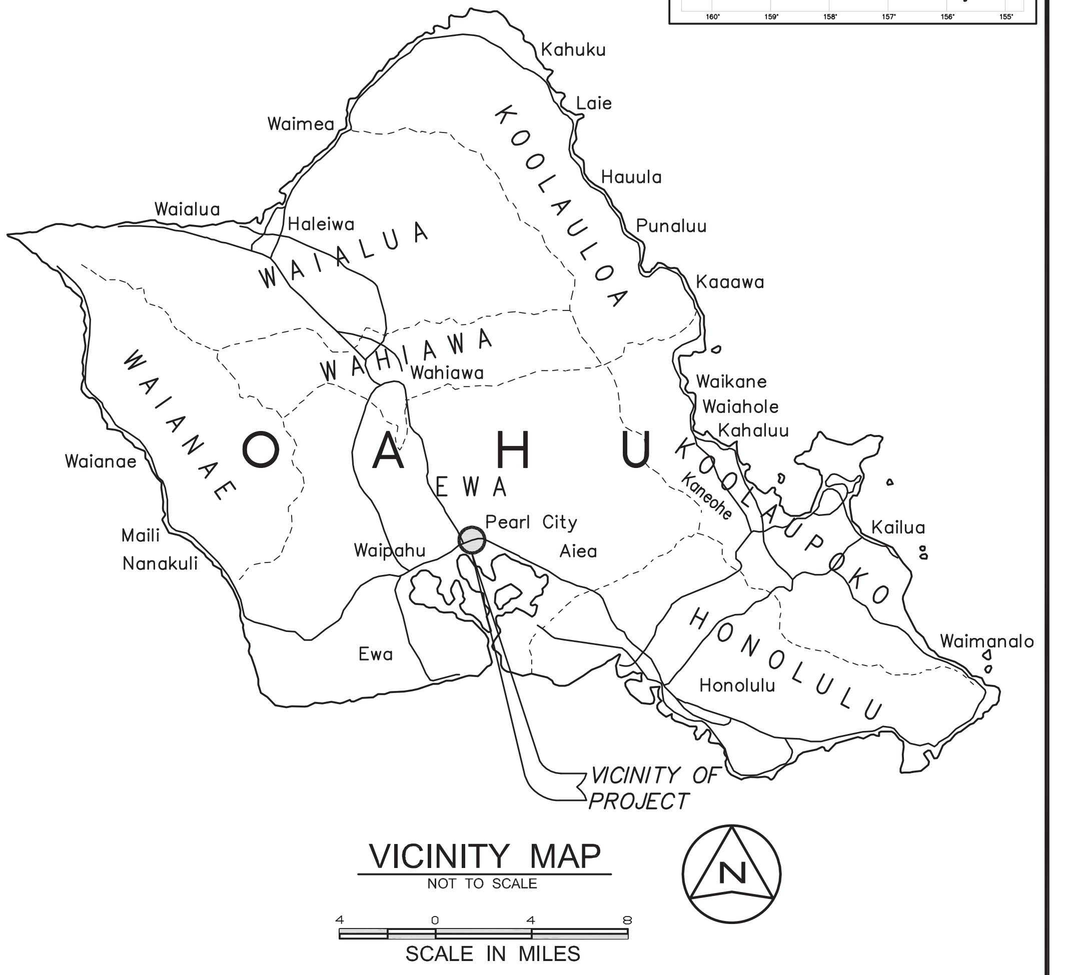
PLANS FOR

FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS

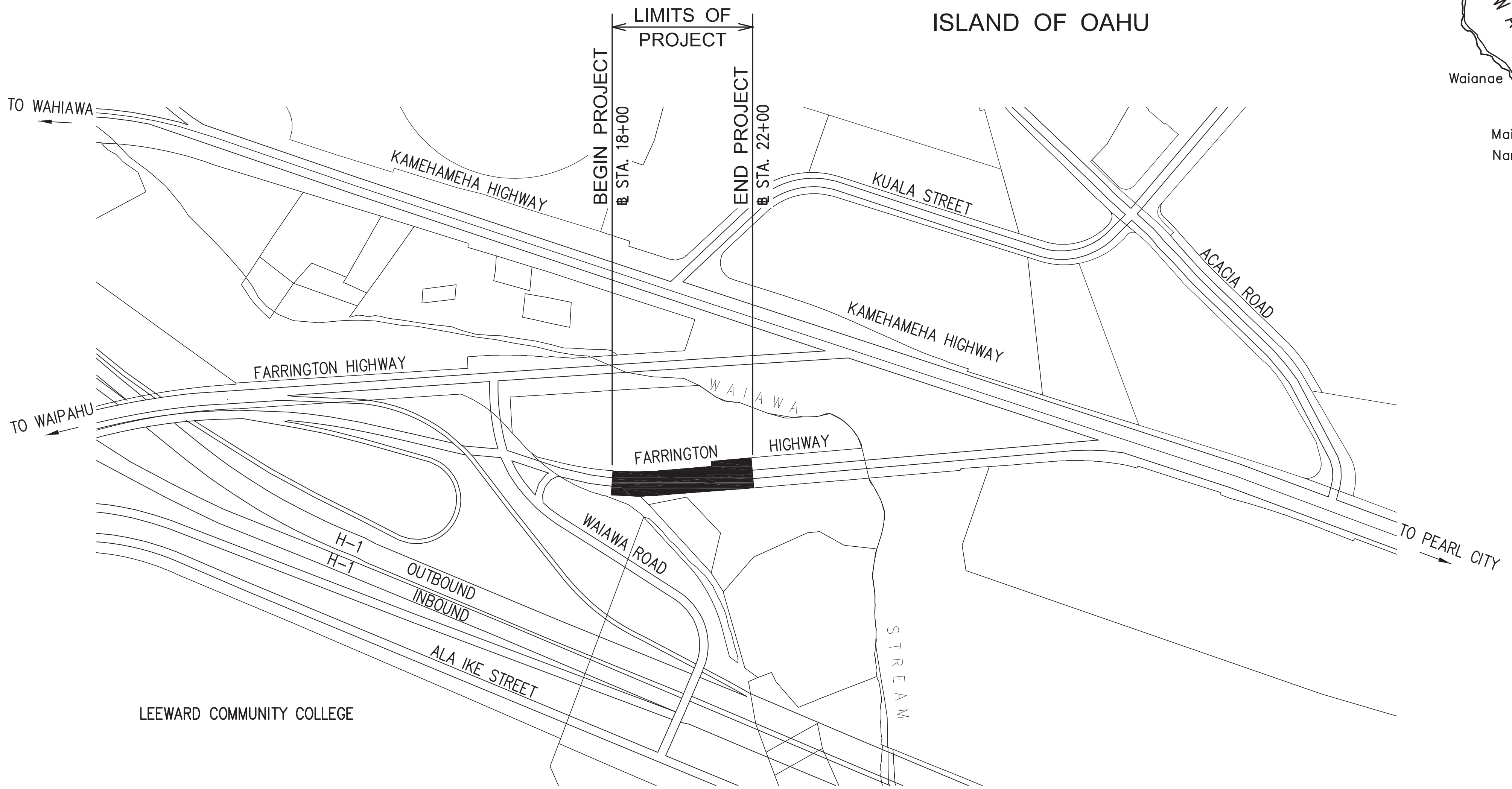
PROJECT NO. 99D-01-17

DISTRICT OF EWA
ISLAND OF OAHU





VICINITY MAP
NOT TO SCALE



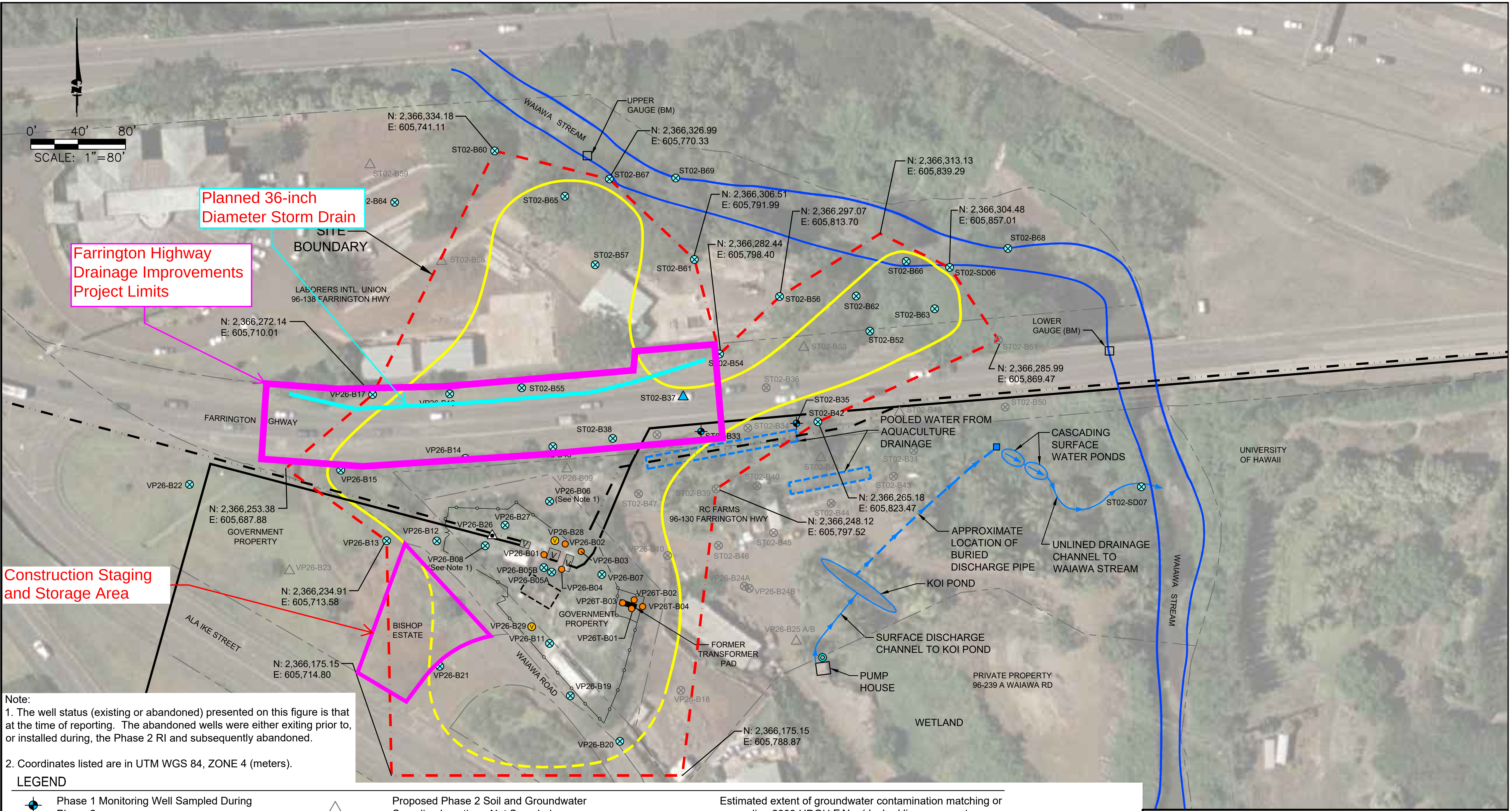
LAYOUT PLAN
NOT TO SCALE

DESIGNED BY	PAREN, INC.
MANAGED BY	HWY-DH
PHONE	692-7563
DATE	APRIL 2018

DEPARTMENT OF TRANSPORTATION
STATE OF HAWAII
APPROVED:

DIR. OF TRANSPORTATION DATE

FIGURE 2



Note:
1. The well status (existing or abandoned) presented on this figure is that at the time of reporting. The abandoned wells were either exiting prior to, or installed during, the Phase 2 RI and subsequently abandoned.

2. Coordinates listed are in UTM WGS 84, ZONE 4 (meters).

LEGEND

⌖	Phase 1 Monitoring Well Sampled During Phase 2	△	Proposed Phase 2 Soil and Groundwater Sampling Location - Not Sampled	— - —	Estimated extent of groundwater contamination matching or exceeding 2009 HDOH EALs (dashed line represents undefined extent)
●	Phase 1 Soil and Soil Vapor Sampling Location	▲	Light Non-Aqueous Phase Liquid (LNAPL) Recovery Well	━━	Approximate location of realigned Hickam POL Pipeline (taken out of service March 1993)
⊗	Phase 2 Sampling Location and Groundwater Monitoring Well	Ⓥ	Bioventing Well	— · —	Approximate location of Hickam POL Pipeline (abandoned in-place mid-1950's)
⊗	Abandoned Well (See Note 1)	■	Koi Pond Effluent Transition To Surface Flow	━━	Approximate location of stream bank
V	Valve Pit	— — —	Approximate Property Boundary	— · —	Site Boundary
▲	Phase 2 Soil Sample Location	—o—o—	Chainlink Fence		
□	Stream Gauging Benchmark	┅┅	Former Waiawa Booster Station		
◎	Active Irrigation Well				

FIGURE 3

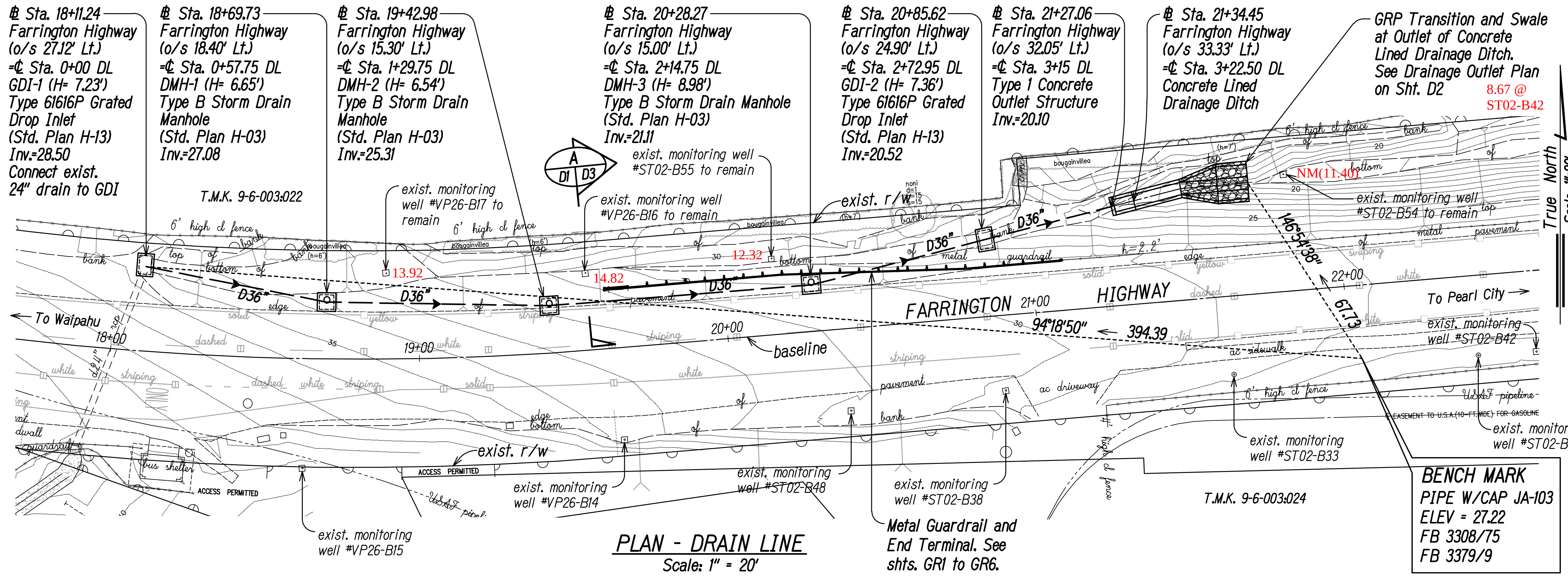
SITE BOUNDARY
SITE ST02

Hickam POL Pipeline
Joint Base Pearl Harbor-Hickam, Hawaii

Honolulu, Hawaii

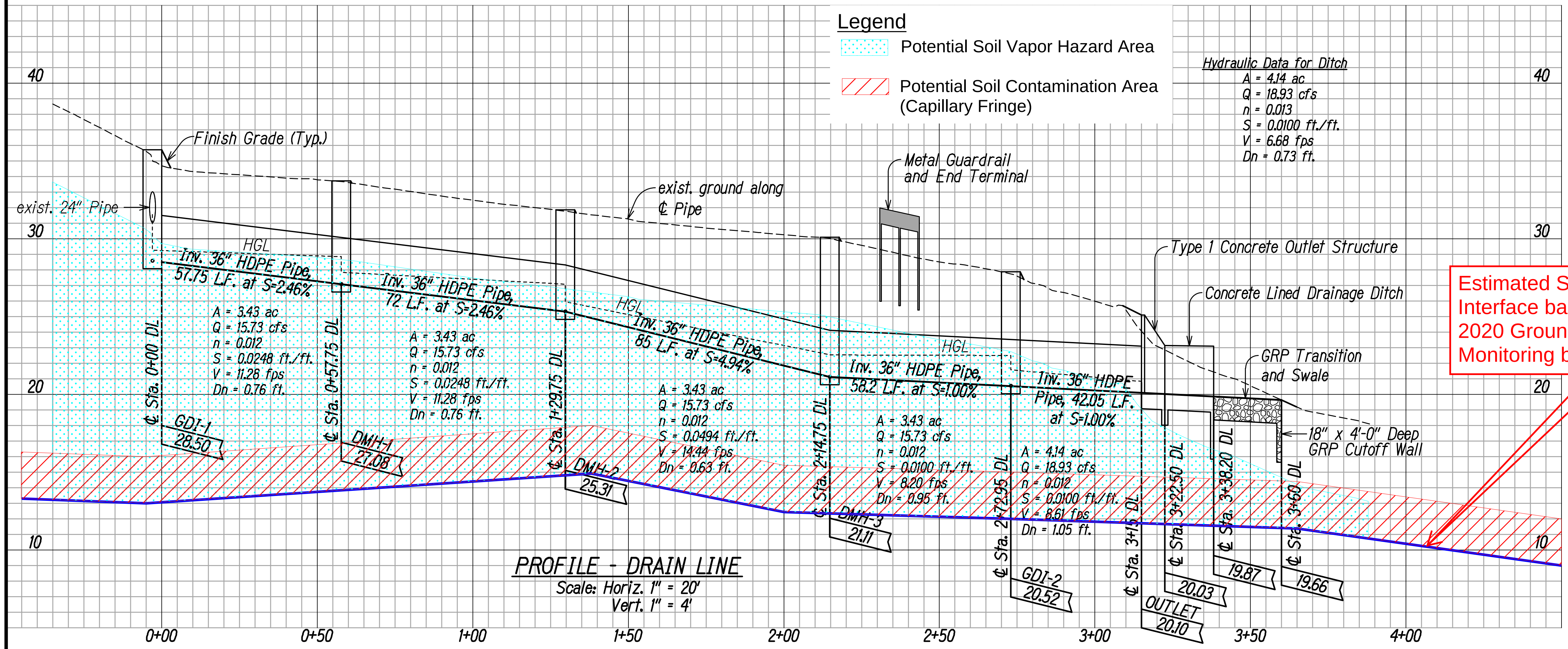
S:\ES\REMED\746859 – HPOL PH 2 RI – 4P08 T048\10000 – RAA\ST02\HAWAII\1. DRAFT\FIGURES\ST02–P2–BOUND_DRAFT.DWG 10/31/12 SDM

FED. ROAD DIST. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAW.	99D-01-17	2019	12	34



PLAN - DRAIN LINE

Scale: 1" = 20'



Legend
- ▨ Potential Soil Vapor Hazard Area
- ▨ Potential Soil Contamination Area (Capillary Fringe)

Estimated Soil-Groundwater Interface based on June 2020 Groundwater Monitoring by NAVFAC

PROFILE - DRAIN LINE

Scale: Horiz. 1" = 20'
Vert. 1" = 4'

Note:

1. The Contractor shall protect all existing monitoring wells to remain.
2. According to the "Eighteenth Quarterly Long-Term Monitoring and Remedial Action Operations Report Site ST02 Waiawa Booster Pump Station" dated September 2020 by NAVFAC Hawaii, petroleum contaminated hazardous groundwater has been found at the following nearby monitoring wells at the elevations listed below:

Monitoring Well No.	Groundwater Elevation
VP26-B17	13.92'
VP26-B16	14.82'
ST02-B55	12.32'

The Contractor shall take proper precaution when excavating. If contaminated or hazardous items or materials are encountered, the Contractor shall handle the material in accordance with Hawaii Standard Specifications for Road and Bridge Construction, 2005, Subsection 107.16 - Contaminated or Hazardous Items and Material; Regulated Items and Materials; Waste and Subsection 219.04 - Determination and Handling of Hazardous Waste.

3. The existing drainage system shall be functional at all times. The Contractor shall furnish materials, equipment, labor, tools, and incidentals necessary to maintain flow. This work shall be considered incidental to the various contract items.
4. Contractor shall perform all work in accordance with Hawaii Standard Specifications for Road and Bridge Construction, 2005, Subsection 105.10 - takes, Lines and Grades.

RUSSELL M. ARAKAKI
LICENSED PROFESSIONAL ENGINEER
No. 8297-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

APRIL 30, 2022
LIC. EXP. DATE

ParEn, Inc.
dba PARK ENGINEERING

STATE OF HAWAI'I
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

DRAINAGE PLAN AND PROFILE

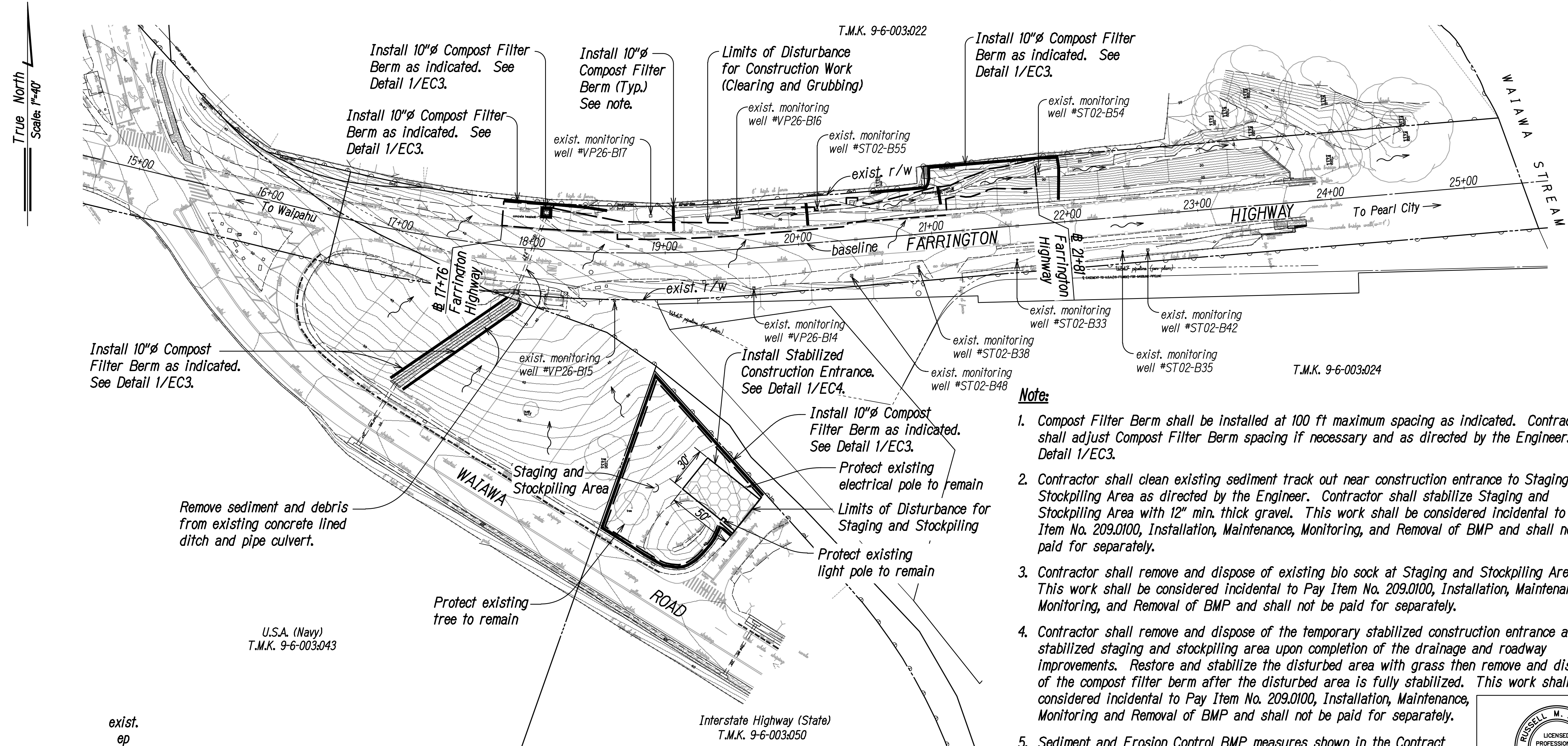
FARRINGTON HIGHWAY
Drainage Improvements
Vicinity of Leeward Community College
PROJECT NO. 99D-01-17

Scale: As Shown
Date: December 2020

SHEET No. D1 OF D4 SHEETS

ORIGINAL PLAN
NOTE BOOK
No.
SURVEY PLOTTED BY
DRAWN BY
TRACED BY
DESIGNED BY
QUANTITIES BY
CHECKED BY
DATE

FED. ROAD DIST. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAW.	99D-01-17	2019	9	34

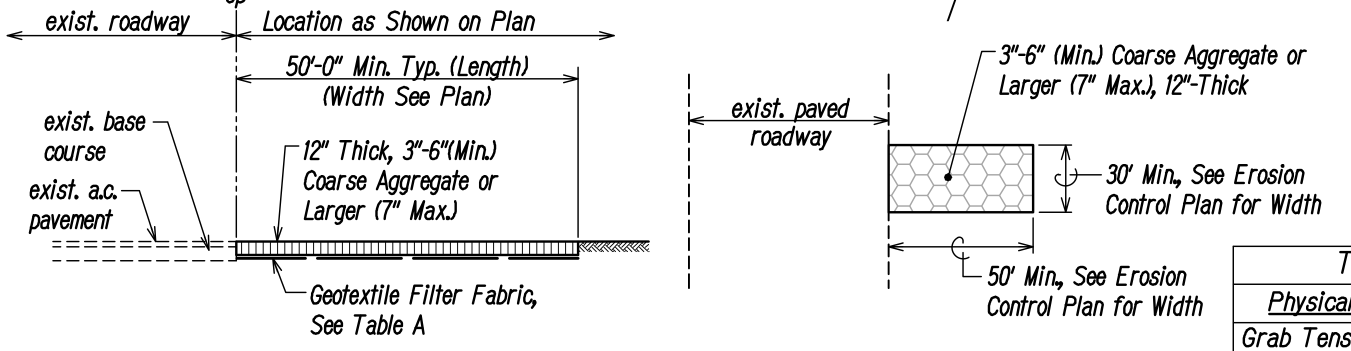


EROSION CONTROL PLAN

Scale: 1" = 40'

Note:

1. Compost Filter Berm shall be installed at 100 ft maximum spacing as indicated. Contractor shall adjust Compost Filter Berm spacing if necessary and as directed by the Engineer. See Detail 1/EC3.
2. Contractor shall clean existing sediment track out near construction entrance to Staging and Stockpiling Area as directed by the Engineer. Contractor shall stabilize Staging and Stockpiling Area with 12" min. thick gravel. This work shall be considered incidental to Pay Item No. 209.0100, Installation, Maintenance, Monitoring, and Removal of BMP and shall not be paid for separately.
3. Contractor shall remove and dispose of existing bio sock at Staging and Stockpiling Area. This work shall be considered incidental to Pay Item No. 209.0100, Installation, Maintenance, Monitoring, and Removal of BMP and shall not be paid for separately.
4. Contractor shall remove and dispose of the temporary stabilized construction entrance and the stabilized staging and stockpiling area upon completion of the drainage and roadway improvements. Restore and stabilize the disturbed area with grass then remove and dispose of the compost filter berm after the disturbed area is fully stabilized. This work shall be considered incidental to Pay Item No. 209.0100, Installation, Maintenance, Monitoring and Removal of BMP and shall not be paid for separately.
5. Sediment and Erosion Control BMP measures shown in the Contract Documents are minimum BMP requirements and do not constitute a complete Sediment and Erosion Control Plan. The Contractor shall incorporate additional BMPs based upon means and methods considering site conditions and construction sequence in accordance with the Contract Documents including applicable permit document requirements. Costs shall be included in lump sum Pay Item No. 209.0100, Installation, Maintenance, Monitoring, and Removal of BMP and shall not be paid for separately.



SECTION

PLAN

STABILIZED CONSTRUCTION ENTRANCE

NOT TO SCALE

1
EC4 EC4

Table A: Geotextile Requirements	
Physical Property	Requirements
Grab Tensile Strength	220 Lb. (ASTM D1682)
Elongation Failure	60% (ASTM D1682)
Mullen Burst Strength	430 Lb. (ASTM D3768)
Puncture Strength	125 Lb. (ASTM D751, Modified)
Equivalent Opening	Size 40-80 (U.S. Std. Sieve, CW-02215)

Construction Disturbance Area:	0.14 acres
Staging and Stockpiling Area:	0.23 acres
Total Ground Disturbance Area:	0.37 acres

RUSSELL M. ARAKAKI
No. 8297-C

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

ParEn, Inc.
dba PARK ENGINEERING

APRIL 30, 2022
LIC. EXP. DATE

STATE OF HAWAI'I
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

EROSION CONTROL PLAN

FARRINGTON HIGHWAY
Drainage Improvements
Vicinity of Leeward Community College
PROJECT NO. 99D-01-17

Scale: As Shown
Date: December 2020

SHEET No. EC4 OF EC4 SHEETS

ORIGINAL PLAN
NOTE BOOK
No.
SURVEY PLOTTED BY
DRAWN BY
TRACED BY
DESIGNED BY
QUANTITIES BY
CHECKED BY
DATE

Attachment B

Emergency Spill Response Plan

Emergency Spill Response Plan

Procedures for expeditiously stopping, containing, and cleaning up spills, leaks, and other releases (7.2.11.1a).

Spill Coordinator

The Contractor shall appoint a Primary and Secondary Emergency Spill Response Coordinator who will be responsible for the reporting of spills, coordinating contractor personnel for spill cleanup, subsequent site investigations, and associated reports. In the event of a spill, the Emergency Spill Response Coordinator will be responsible for determining the extent of the containment/isolation area and cleanup methods. Include Names, positions, and emergency contact information.

The Contractor shall make contact with a Spill Cleanup Emergency Response Contractor prior to start of construction to provide sufficient information for the spill contractor to be prepared should they receive a call in the event of an emergency.

Immediate Response

All spills regardless of size must be reported to the Emergency Spill Response Coordinator and the (HDOT Construction Resident Engineer/Project Engineer/Construction Inspector). The person observing the incident will take the following actions:

- *Assess the safety of the situation (including the risk to the surrounding public).*
- *Alert nearby personnel and secure the immediate area for safety.*

If the person is aware the chemical spilled is not toxic or a known petroleum product do the following:

- *Make every effort to remove potential ignition sources and stop the source of the spill.*
- *Clean the spill using absorbent materials available on-site. Do not hose down or bury spills. Remove and properly dispose of cleanup materials.*
- *Promptly notify the Emergency Spill Response Coordinator. Report name, the spill location, material spilled, and the extent of the incident.*

Upon learning of the spill, the Emergency Spill Response Coordinator will implement the following measures:

- *Assess the safety of the situation (including the risk to the surrounding public).*
- *If the source of the spill is toxic or unknown, immediately notify the Fire Department and ask for assistance from the HAZMAT team.*
- *Secure the area by stopping traffic if necessary and install barricades or safety fencing around the area.*
- *If safe to do so, prevent hazardous material from entering the stormwater or sewer system or any waterbodies by covering/blocking any drains in the spill area, and providing containment BMPs to either prevent stormwater from contacting hazardous material or contain commingled stormwater.*
- *If safe to do so, absorbent materials will be applied to the spill area. Contaminated soils and vegetation will be excavated and temporarily placed on and covered by plastic sheeting or in an appropriate container or surrounded by impermeable lined berms in a containment area a minimum of 100 feet away from any wetland or waterbody, until proper disposal is arranged.*
- *Notify appropriate agencies as required by Federal, State, and local regulations.*
- *For petroleum spills, provide notification if the release meets any of conditions the below:*
    - *a) Greater than 25 gallons*
    - *b) Not cleaned within 72 hours*
    - *c) Enters a storm drainage system or state waters*
- *Arrange for proper disposal (including contaminated personal protective equipment and/or cleanup supplies) in accordance with Federal, State, and local regulations and Manufacturer's instructions if known.*
- *If a spill is beyond the scope of on-site equipment and personnel, contact the Spill Cleanup Emergency Response Contractor to further contain and clean up the spill.*
- *Notify the (HDOT Construction Resident Engineer/Project Engineer/Construction Inspector).*

Contents of the Spill kits shall be determined by the Contractor based on the anticipated type and quantity of hazardous material to be stored/used on-site. The kit should contain at minimum:

•55 gallon drum with lid
•absorbent pads (50)
•absorbent socks (12)
•absorbent pillows (5)
•1 pair goggles or faceshield
•1 pair elbow length gloves
•1 disposable apron
•disposable bags with ties (3)
•Include additional materials such as Absorbent Skimmers or Booms for work adjacent or over State Waters as needed.
•Include additional materials as necessary to secure the spill area.

Procedures for notification of appropriate facility personnel, emergency response agencies, and regulatory agencies where a leak, spill, or other release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity consistent with HAR 11-55 subsection 5.3.4. and established under either 40 CFR Part 110, 40 CFR Part 117, or 40 CFR Part 302, occurs during a 24-hour period (7.2.11.1.b).

• Contact information must be in locations that are readily accessible and available.

• The Contractor shall take all reasonable measures to protect human health and the environment.

• For emergencies or life-threatening situations, call 911 first.

• Notify responsible parties listed below as required and immediately notify DOH Clean Water Branch and the National Response Center of the incident. The notification shall also include the identity of the pollutant sources and the implemented control or mitigation measures. Notify other agencies as required by Federal/State/Local laws. List additional agencies or personnel below as required.

1. Owner Contact/Emergency Contact Number: (HDOT Construction Resident Engineer/Project Engineer/Construction Inspector)

2. Authorized Representative/ Emergency Contact Number: (HDOT District Engineer or designated representative who can contact Authorized Representative)

3. Contractor/ Emergency Contact Number: (Contractor Emergency Contact)

4. Department of Health
Clean Water Branch (During regular working hours): ……………………….808-586-4309
Hawaii State Hospital Operator (After hours):……………………………….. 808-247-2191

AND E-mail Clean Water Branch via email at cleanwaterbranch@doh.hawaii.gov

5. Hawaii Hazard Evaluation and Emergency Response (HEER) …………..808-586-4249
(After Hours) ……………………....808-247-2191
AND

Appropriate Local Emergency Planning Committee (LEPC)

For projects on Oahu
Leland Nakai Department of Emergency Management……808-723-8958
LEPC……………………………………………….…..808-723-8960
(After Hours)…………………………………………..911

6. National Response Center (NRC)…………………………………………..(800)424-8802

7. Coast Guard Operations Center, Honolulu (working hours) …………….. 808-522-8246
(After hours)…………………808-247-2191

8. County Fire Department/Police……………………………………………… 911

9. HDOT Tunnels Emergency Contact Number (After Hours)………………..808-485-6200

10. Contractor's Spill Cleanup Emergency Response Contractor……………..xxx-xxx-xxxx

11. NAVFAC Hawaii……………………………………………(Clint Zenigami) 808-471-4610

Attachment C

Geotechnical Engineering Report

GEOTECHNICAL ENGINEERING EXPLORATION
FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII

W.O. 7754-00   FEBRUARY 11, 2019

Prepared for

PAREN, INC. DBA PARK ENGINEERING

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

GEOTECHNICAL ENGINEERING EXPLORATION
FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII

W.O. 7754-00 FEBRUARY 11, 2019

Prepared for

PAREN, INC. DBA PARK ENGINEERING

TEDDY S. T. KWOK
LICENSED PROFESSIONAL ENGINEER
No. 7951-C

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

Teddy S T Kwok 4-30-20
SIGNATURE EXPIRATION DATE OF THE LICENSE

GEOLABS, INC.
Geotechnical Engineering and Drilling Services
2006 Kalihi Street • Honolulu, HI 96819

Hawaii • California

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

February 11, 2019
W.O. 7754-00

Mr. Russell Arakaki, P.E.
ParEn, Inc. dba Park Engineering
711 Kapiolani Boulevard, Suite 1500
Honolulu, HI 96813

Dear **Mr. Arakaki:**

Geolabs, Inc. is pleased to submit our report entitled "Geotechnical Engineering Exploration, Farrington Highway Drainage Improvements, Pearl City, Oahu, Hawaii" prepared in support of the design of the proposed drainage improvement project.

Our work was performed in general accordance with the scope of services outlined in our revised fee proposal dated January 11, 2017 and the Agreement entered into on July 10, 2018.

Please note that the soil and rock samples recovered during our field exploration (remaining after testing) will be stored for a period of two months from the date of this report. The samples will be discarded after that date unless arrangements are made for a longer sample storage period. Please contact our office for alternative sample storage arrangements, if appropriate.

Detailed discussion and specific design recommendations are contained in the body of this report. If there is any point that is not clear, please contact our office.

Very truly yours,

GEOLABS, INC.

Teddy S.T. Kwok

Teddy S.T. Kwok, P.E.
Vice President

TK:mj

GEOTECHNICAL ENGINEERING EXPLORATION
FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII
W.O. 7754-00 FEBRUARY 11, 2019

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GEOTECHNICAL ENGINEERING EXPLORATION
FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII
W.O. 7754-00 FEBRUARY 11, 2019

SUMMARY OF FINDINGS AND RECOMMENDATIONS

Based on our field exploration, the proposed drain line alignment is generally underlain by alluvial deposits, consisting of stiff to hard clayey silts, extending to depths of approximately 10 to 15 feet below the existing ground surface. The alluvial soils in the boring drilled towards the western end of the drain line alignment are underlain by weathered basalt and basalt rock formation extending to a depth of approximately 15 feet below the existing ground surface. Marsh deposits consisting of soft clayey silts were encountered below the alluvial deposits in the boring drilled towards the eastern end of the alignment and extended to the maximum depth explored of approximately 21.5 feet below the existing ground surface.

We believe that the stiff to hard clayey subsoils generally encountered in the shallow subsurface along the drain line alignment would provide adequate support for the new pipes without the need for special foundation support. Where soft/loose soils are encountered at or near the invert elevations along the new drain line planned, we recommend providing a subgrade stabilization layer consisting of 24 inches of No. 2 Rock (ASTM C33, No. 4 gradation) wrapped in a non-woven filter fabric (Mirafi 180N or equivalent) below the bedding layer for uniform support.

The stiff clayey soils would allow the open-trench excavation to proceed with normal excavation method/equipment and shoring requirements. Based on the generally stiff subsoil conditions encountered and the anticipated depths of excavation, we believe that steel plates with horizontal struts may be considered for temporary shoring for the new drain line planned for the project. For deeper excavations and excavations adjacent to existing buildings and utilities, we recommend considering interlocking steel sheet piling with horizontal bracing for excavation support in order to reduce the potential for appreciable adjacent ground movement. It should be noted that the potential for presence of cobbles and boulders and shallow basalt rock formation in localized areas could pose some difficulties during the trench excavation and shoring installation. A temporary shoring system consisting of soldier pile and lagging may need to be considered for shoring support in these conditions.

The text of this report should be referred to for detailed discussion and recommendations.

END OF SUMMARY OF FINDINGS AND RECOMMENDATIONS

SECTION 1. GENERAL

1.1 Introduction

This report presents the results of our geotechnical engineering exploration performed for the *Farrington Highway Drainage Improvements* project in the Pearl City area on the Island of Oahu, Hawaii. The project location and general vicinity are shown on the Project Location Map, Plate 1.

This report summarizes the findings and geotechnical recommendations derived from our field exploration, laboratory testing, and engineering analyses. The recommendations presented herein are intended for the design of the drain line and appurtenances only. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.2 Project Considerations

The proposed drainage improvement project will involve the installation of a new 36-inch drain line along the portion of Farrington Highway between the Hawaii Laborers' Apprenticeship & Training Center and Waiawa Stream in the Pearl City area on the Island of Oahu, Hawaii. The purpose of the drainage improvement project is to minimize the runoff crossing Farrington Highway and reduce maintenance needs for the existing 24-inch drain line.

Based on the information provided, we understand that the new drain line will run along the north side of Farrington Highway and convey the runoff water from the outlet area to the vicinity of Waiawa Stream. The new drain line will consist of 315 linear feet of 36-inch diameter drain pipes and three new storm drain manholes. In addition, a new concrete outlet structure, concrete ditch, and Grouted Rubble Paving (GRP) transition for slope protection are planned at the eastern end of the new drain line alignment.

Based on the plan and profile drawings provided, the invert elevations of the new drain line will range from about +28.5 to +20 feet Mean Sea Level (MSL) at the western and eastern ends, respectively. Based on the existing topography, we envision excavation depths up to about 10 feet deep below the existing ground surface may be required for the drain line installation.

Since the new drain line will traverse open land to the north of Farrington Highway, we envision the drain pipes will be installed by conventional “cut-and-cover” open-trench method. Our experience indicates that this portion of the Farrington Highway was built on embankment fill placed over soft marsh deposits overlying basalt rock formation at relatively shallow depths. Therefore, the important geotechnical considerations for this project will include excavation difficulty (rock excavation), suitability of material for trench backfill, special pipe bedding requirements for soft ground conditions, and corrosion protection.

1.3 Purpose and Scope

The purpose of our exploration was to obtain an overview of the surface and subsurface conditions to develop an idealized soil and/or rock data set to formulate geotechnical recommendations for the design of the proposed drainage improvement project. The work was performed in general accordance with our revised fee proposal dated January 11, 2017 and the Agreement entered into on July 10, 2018. The scope of work for this exploration included the following tasks and work efforts:

1. Review of available in-house soil and geologic information in the project vicinity.
2. Filing of a permit application for excavation in the public right-of-way and clearance from underground utilities.
3. Provision of traffic control during our field exploration work.
4. Mobilization and demobilization of a truck-mounted drill rig, water truck, and two operators to and from the project site.
5. Drilling and sampling of two borings extending to depths of approximately 15 and 21.5 feet below the existing ground surface for approximately 36.5 lineal feet of exploration.
6. Coordination of the field exploration and logging of the borings by our geologist.
7. Laboratory testing of selected soil and rock samples obtained during the field exploration as an aid in classifying the materials and evaluating their engineering properties.

8. Engineering analyses of the field and laboratory data to develop geotechnical recommendations for design of the proposed drainage improvement project.
9. Preparation of this report summarizing our work on the project and presenting our findings and geotechnical engineering recommendations.
10. Coordination of our overall work on the project by our engineer.
11. Quality assurance of our work and client/design team consultation by our principal engineer.
12. Miscellaneous work efforts such as drafting, word processing, and clerical support.

Detailed descriptions of our field exploration methodology and the Logs of Borings are presented in Appendix A. Results of the laboratory tests performed on selected soil and rock samples obtained from our field exploration are presented in Appendix B. A photograph of the core samples is presented in Appendix C.

END OF GENERAL

SECTION 2. SITE CHARACTERIZATION

2.1 Regional Geology

The Island of Oahu was built by the extrusion of basaltic lavas from the Waianae and Koolau shield volcanoes. The older Waianae Volcano is estimated to be middle to late Pliocene in age and forms the bulk of the western third of the island. The younger Koolau Volcano is estimated to be late Pliocene to early Pleistocene (Ice Age) in age and forms the majority of the eastern two-thirds of the island. Waianae Volcano became extinct while Koolau Volcano was still active, and its eastern flank was partially buried below Koolau lavas banking against its eastern flank. These banked or ponded lavas formed a broad plateau referred to as the Schofield Plateau.

The Schofield Plateau was formed when lavas from the Koolau Volcano ponded against the already eroded slopes of the Waianae Volcano in the late Pleistocene Epoch. The dips of the lava beds are generally near horizontal (between 3 to 5 degrees from horizontal). The lava flows on the plateau have undergone in-situ weathering extending to depths of 50 to 100 feet and are characterized by the red colors of the soil.

The deep narrow canyons, such as Waikakalua, Kipapa, and Kaukonahua, are a result of this weathering. The brown and reddish brown soils generally consist of ancient alluvial deposits overlying the weathered rock. The project site is located on the southern side of the Schofield Plateau, north of the Pearl City Peninsula, which is located between Middle and East Lochs.

2.2 Site Description

The project site is located along Farrington Highway in the Pearl City area on the Island of Oahu, Hawaii. As mentioned above, the proposed drain line alignment will run parallel to the north side of Farrington Highway, adjacent to the Hawaii Laborers' Apprenticeship & Training Center, as shown on the Site Plan, Plate 2.

At the time of our field exploration, the existing ground surface on the western portion of the new alignment was lightly vegetated with multiple exposed bare-earth patches observed. The area appears to receive a fair amount of foot traffic based on the worn footpaths visible in certain areas. Further east, a metal guardrail cuts through the grassy shoulder area as the existing grade descends towards Waiawa Stream. This shoulder area was generally observed to be heavily vegetated with waist to chest-high grasses and medium to large woody trees near Waiawa Stream.

Based on the plan and profile drawings provided, the terrain along the new drain line alignment generally slopes down from west to east with existing ground surface elevations ranging from about +35 feet MSL near the connection to the existing 24-inch drain line to about +20 feet MSL at the end of the proposed concrete outlet structure and GRP transition near Waiawa Stream.

2.3 Subsurface Conditions

Our field exploration program consisted of drilling and sampling two borings, designated as Boring Nos. 1 and 2, extending to depths of about 15 and 21.5 feet below the existing ground surface. The approximate boring locations are shown on the Site Plan, Plate 2.

Based on our field exploration, the proposed drain line alignment is generally underlain by alluvial deposits, consisting of stiff to hard clayey silts, extending to depths of approximately 10 to 15 feet below the existing ground surface. The alluvial soils in the boring drilled towards the western end of the drain line alignment are underlain by weathered basalt consisting of cobbles and boulders and basalt rock formation extending to a depth of approximately 15 feet below the existing ground surface. Marsh deposits consisting of soft clayey silts were encountered below the alluvial deposits in the boring drilled towards the eastern end of the alignment and extended to the maximum depth explored of approximately 21.5 feet below the existing ground surface.

We encountered groundwater level in one of the drilled borings at a depth of about 19.5 feet below the existing pavement surface. The groundwater level measured generally corresponds to about Elevation +8 feet MSL. It should be noted that groundwater levels can vary significantly depending on rainfall, temperature, surface water runoff, groundwater withdrawal, and other factors.

Detailed descriptions of our field exploration methodology and the Logs of Borings are presented in Appendix A. Results of the laboratory tests performed on selected soil and rock samples retrieved from our field exploration are presented in Appendix B. A photograph of the core samples is presented in Appendix C.

END OF SITE CHARACTERIZATION

SECTION 3. DISCUSSION AND RECOMMENDATIONS

Based on our field exploration, the proposed drain line alignment is generally underlain by alluvial deposits, consisting of stiff to hard clayey silts, extending to depths of approximately 10 to 15 feet below the existing ground surface. The alluvial soils in the boring drilled towards the western end of the drain line alignment are underlain by weathered basalt and basalt rock formation extending to a depth of approximately 15 feet below the existing ground surface. Marsh deposits consisting of soft clayey silts were encountered below the alluvial deposits in the boring drilled towards the eastern end of the alignment and extended to the maximum depth explored of approximately 21.5 feet below the existing ground surface.

We believe that the stiff to hard clayey subsoils generally encountered in the shallow subsurface along the drain line alignment would provide adequate support for the new pipes without the need for special foundation support. Where soft/loose soils are encountered at or near the invert elevations along the new drain line planned, we recommend providing a subgrade stabilization layer consisting of 24 inches of No. 2 Rock (ASTM C33, No. 4 gradation) wrapped in a non-woven filter fabric (Mirafi 180N or equivalent) below the bedding layer for uniform support.

The stiff clayey soils would allow the open-trench excavation to proceed with normal excavation method/equipment and shoring requirements. Based on the generally stiff subsoil conditions encountered and the anticipated depths of excavation, we believe that steel plates with horizontal struts may be considered for temporary shoring for the new drain line planned for the project. For deeper excavations and excavations adjacent to existing buildings and utilities, we recommend considering interlocking steel sheet piling with horizontal bracing for excavation support in order to reduce the potential for appreciable adjacent ground movement. It should be noted that the potential for presence of cobbles and boulders and shallow basalt rock formation in localized areas could pose some difficulties during the trench excavation and shoring installation. A temporary shoring system consisting of soldier pile and lagging may need to be considered for shoring support in these conditions. Detailed discussions and recommendations for planning design of the project are presented in the following sections.

3.1 Open-Trench Construction

We understand that the invert depths of the new drain line will range from about 5 to 10 feet below the existing ground surface. In addition, we envision that the new drain line will be installed using the conventional open-trench method.

3.1.1 Earth Pressure Loads on Pipes

Loads on buried pipes are influenced by the width of the trench, the size of the pipes, the unit weight of backfill material, and the frictional resistance between the backfill material and the trench walls. To calculate the vertical loads acting on the buried pipes, an average unit weight of 110 pounds per cubic foot (pcf) may be used for compacted backfill material within the trench excavation and above the pipes. In addition, a coefficient of friction of 0.25 may be used to calculate the frictional resistance between the compacted backfill and the sidewalls of the excavated trench. For the underground pipes, earth forces upon the pipe increase rapidly with the width of the trench. Therefore, the width of the trench should be kept to a minimum. Traffic loads on the buried pipes should also be considered for the portion of the pipes located in roadway areas.

3.1.2 Pipe Bedding

The stress distribution against the bottom of a pipe has a great effect upon the load supporting capacity of the pipe. Therefore, pipe bedding is an important design consideration. In general, a granular bedding consisting of 6 inches of No. 3B gravel (ASTM C33, No. 67 gradation) is recommended under the pipes. The granular bedding should extend beyond the sides of the pipe a minimum width of one-fourth (¼) the outside pipe diameter. Before the placement of bedding material, the excavated trench bottom should be observed by a Geolabs representative to confirm whether firm materials are exposed at the bottom of the trench or if a stabilization layer should be provided as discussed below.

Where soft/loose soils are encountered at or near the invert elevations along the new drain line planned, we recommend providing a subgrade stabilization layer consisting of 24 inches of No. 2 Rock (ASTM C33, No. 4 gradation) wrapped in a non-woven filter fabric (Mirafi 180N or equivalent) below the bedding layer for uniform support. The stabilization layer should extend beyond the sides of the pipe a minimum width of one-fourth (¼) the outside diameter of the pipe or 12 inches, whichever is greater. A typical trench detail is provided on Plate 3.

3.1.3 Backfill

In general, trench backfill should be performed in accordance with the Hawaii Standard Specifications for Road and Bridge Construction, 2005 (HSS). Free-draining granular materials, such as No. 3B Fine gravel (ASTM C33, No. 67 gradation) should be used for the trench backfill up to about 12 inches above the pipes to provide adequate support around the pipes and to reduce compaction of the backfill, thus reducing the possibility of damaging the pipes.

The upper portion of the trench backfill from the level 12 inches above the pipes to the top of the subgrade or finished grade may consist of on-site soils with particles less than 6 inches in maximum dimension or select fill material. If required, imported select granular fill should consist of crushed coral or basaltic gravel. Imported materials should be well-graded from coarse to fine with particles no larger than 3 inches in largest dimension and should contain between 10 and 30 percent particles passing the No. 200 sieve. The imported fill material should have a laboratory California Bearing Ratio (CBR) value of 20 or more and should have a maximum swell of 1 percent or less when tested in accordance with ASTM D1883. Imported materials should be tested for conformance with these recommendations prior to delivery to the project site for the intended use.

The backfill should be moisture-conditioned to above the optimum moisture content, placed in maximum 8-inch horizontal loose lifts, and mechanically compacted to a minimum of 90 percent relative compaction to reduce the potential for appreciable future ground subsidence.

Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil established in accordance with ASTM D1557. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density. The upper 3 feet of the trench backfill below the pavement grade should be compacted to a minimum of 95 percent relative compaction. In addition, compaction by water ponding or jetting should not be allowed for this project.

As mentioned above, weathered basalt consisting of cobbles and boulders may be encountered in localized areas along the new drain line alignment. Therefore, boulder size materials may be generated during trench excavation. It should be noted that boulder-size materials generated during the trench excavations should not be used for trench backfill.

3.1.4 Pipe Settlement

Primary settlement of the new pipe installation is generally caused by the difference in the unit weight of the excavated original earth and the compacted backfill material placed over the pipeline. The net increase in loading may cause settlement of the underlying subsoils below the trench invert. Based on our exploration and analyses, primary settlements on the order of about less than one inch may be anticipated for the new drain line alignment.

3.2 Storm Drain Manhole Structures

Based on the results from our field exploration, we anticipate that the storm drain manhole structures planned for the project will be constructed in the stiff alluvial soils encountered in the shallow subsurface along the drain line alignment.

3.2.1 Manhole Structures

The soils encountered at the bottom of the excavations should be compacted to provide a firm and unyielding base. Soft and/or loose soils encountered at the bottom of the manhole structure excavations should be removed to expose the underlying firm materials. The resulting over-excavation should be backfilled with engineered fill. Where thick deposit of soft/loose soils are encountered at the bottom of the manhole excavations, a subgrade stabilization layer consisting of 24 inches of No. 2 Rock (ASTM C33, No. 4 gradation) wrapped in a non-woven filter fabric (Mirafi 180N or equivalent) may be provided below the cushion layer for uniform support.

In general, we recommend the bottom of the manhole structure bear on 6 inches of No. 3B Fine gravel (ASTM C33, No. 67 gradation) over the stiff clayey soils encountered in our drilled borings. Based on our engineering analyses, we believe that the net increase in bearing pressure on the underlying soil deposits resulting from the manhole construction would be minimal. Settlements on the order of less than one inch are anticipated for the manhole structures.

The lateral earth pressures acting on the proposed underground manhole structures will depend on the type of backfill used, the extent of backfill, and the compactive effort on the backfill material around the structures. We recommend designing the new manhole structures to resist the following lateral earth pressures (at-rest condition) from the adjacent soils.

LATERAL EARTH PRESSURES		
Subsoil Conditions	**At-Rest** (pcf)	**Passive** (pcf)
Above Groundwater	60	300

Surcharge stresses due to areal surcharges, traffic loads, line loads, and point loads within a horizontal distance equal to the depth of the structure should be considered in the design. For uniform surcharge stresses imposed on the loaded side of the manhole, a rectangular distribution with uniform pressure equal to 50 percent of the vertical surcharge pressure acting over the entire depth of the structure may be used in design. Additional analyses during design may be needed to evaluate the surcharge effects of point loads and line loads.

Lateral loads acting on the structures may be resisted by friction developed between the bottom of the foundation and the supporting subgrade soils and passive earth pressure developed against the embedded near-vertical faces of the foundation system. A coefficient of friction of 0.45 may be used between the base of the structure and the granular bedding material to resist lateral loads. Based on our field exploration data and laboratory test results, the recommended passive earth pressure shown in the above table may be used in the design.

3.2.2 Backfilling of Manhole Excavations

The manhole excavations will need to be properly backfilled. The excavated on-site clayey soils may be used as backfill above the cushion layer up to the finish grades. The backfill materials should have a maximum particle size of 3 inches.

The soil backfill above the No. 3B Fine gravel should be placed in thin lifts (normally 8 inches in loose lift thickness) with each lift mechanically compacted to a minimum of 90 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil determined in accordance with ASTM D1557. Within the roadway area, the top 3 feet below the finished subgrade should be compacted to a minimum of 95 percent relative compaction. Should the manhole excavation to be backfilled be too small for a compactor, the excavation should be backfilled with lean concrete or Controlled Low Strength Material (CLSM).

3.3 Retaining Structures

We understand that retaining structures, such as the concrete outlet structure and concrete ditch, are planned at the eastern end of the new drain line alignment. Based on the anticipated subsurface conditions, the following general guidelines may be used for design of the retaining structures planned.

3.3.1 Retaining Structure Foundations

An allowable bearing pressure of up to 3,000 pounds per square foot (psf) may be used for design of the retaining structure foundations bearing on the recompacted on-site soils. This bearing value is for dead-plus-live loads and may be increased by one-third (⅓) for transient loads such as those caused by wind or seismic forces.

In general, retaining wall footings should have a minimum width of 18 inches and the bottom should be embedded a minimum of 24 inches below the lowest adjacent grade. For sloping ground conditions, the footing should extend deeper to obtain a minimum 6-foot setback distance measured horizontally from the outside edge of the footing to the face of the slope. Wall footings oriented parallel to the direction of the slope should be constructed in stepped footings.

If foundations are located next to utility trenches or easements, the footing should be embedded below a 45-degree imaginary plane extending upward from the bottom edge of the utility trench, or the footing should be extended to a depth as deep as the inverts of the utility lines. This requirement is necessary to avoid surcharging adjacent below-grade structures with additional structural loads and to reduce the potential for appreciable foundation settlement.

Lateral loads acting on the structures may be resisted by friction developed between the bottom of the foundation and the bearing soil and by passive earth pressure acting against the near-vertical faces of the foundation system. A coefficient of friction of 0.30 may be used for footings bearing on the recompacted on-site soils. Resistance due to passive earth pressure may be estimated using an equivalent fluid pressure of 300 pounds per square foot per foot of depth (pcf). This assumes that the soils around the footings are well compacted (minimum of 90 percent relative compaction). Unless covered by pavements or slabs, the passive pressure resistance in the upper 12 inches of soil should be neglected.

It is important to compact the bottom of foundation excavations to a firm and unyielding condition prior to placement of reinforcing steel and concrete. A Geolabs representative should observe foundation excavations prior to placement of reinforcing steel and concrete to confirm the foundation bearing conditions and the required over-excavation depths, if applicable.

3.3.2 Static Lateral Earth Pressures

Retaining structures should be designed to resist lateral earth pressures due to the adjacent soils and surcharge effects caused by loads adjacent to the retaining structures. The recommended lateral earth pressures for design of retaining structures, expressed in equivalent fluid pressures, are presented in the following table.

LATERAL EARTH PRESSURES
FOR DESIGN OF DRAINAGE STRUCTURES

Backfill Condition	**Earth Pressure Component**	**Active** (pcf)	**At-Rest** (pcf)
Level Backfill	Horizontal	40	60
	Vertical	None	None
2H:1V	Horizontal	58	76
	Vertical	29	38

Type A Structure Backfill Material conforming to Section 703.20 of the Hawaii Standard Specifications for Road and Bridge Construction, 2005 (HSS) should be used to backfill behind the retaining structures. A backfill unit weight of 120 pcf may be used in the design. Backfill behind retaining structures should be compacted to between 90 and 95 percent relative compaction. Over-compaction of the retaining structure backfill should be avoided. These lateral earth pressures do not include hydrostatic pressures that might be caused by groundwater trapped behind the walls.

In general, an active condition may be used for gravity walls or walls that are free to deflect by as much as 0.5 percent of the wall height. If the tops of walls are not free to deflect beyond this degree or are restrained, the walls should be designed for the at-rest condition. These lateral earth pressures do not include hydrostatic pressures that might be caused by groundwater trapped behind the walls.

Surcharge stresses due to areal surcharges, line loads, and point loads within a horizontal distance equal to the depth of the wall should be considered in the design. For uniform surcharge stresses imposed on the loaded side of the wall, a rectangular distribution with a uniform pressure equal to 33 percent of the vertical surcharge pressure acting over the entire height of the wall, which is free to deflect (cantilever), may be used in the design. For walls that are restrained, a rectangular distribution equal to 50 percent of the vertical surcharge pressure acting over the entire height of the wall may be used for the design. Additional analyses during design may be needed to evaluate the surcharge effects of point loads and line loads.

3.3.3 Drainage

For wing walls, a typical drainage system may consist of a sack of permeable material placed at each weep hole location. The sack of permeable material should consist of about 1 to 2 cubic feet of No. 3B Fine gravel (ASTM C33, No. 67 gradation) material wrapped with non-woven filter fabric (Mirafi 180N or equivalent). The weep holes should consist of a minimum 4-inch diameter Polyvinyl Chloride (PVC) pipe spaced no more than 6 feet apart.

Backfill placed immediately behind permeable drainage materials should consist of select granular fill material with a maximum particle size of 3 inches. Unless covered by concrete slabs, the upper 12 inches of backfill should consist of relatively impervious material to reduce the potential for significant water infiltration behind the walls.

3.4 Excavation

Based on the planned drain line inverts, we envision that temporary shoring of the excavations will be required for the utility line installation.

3.4.1 Excavation Method

In general, the contractor should determine the method and equipment to be used for excavation, subject to practical limits and safety considerations. Based on our field exploration and the available information, we envision that conventional excavation techniques using a backhoe excavator may be used for the drain line excavations. However, it is anticipated that hoe-ramming and/or chipping will be required within the dense weathered basalt and hard basalt rock formation during the drain line and manhole installation. The excavated soils should be stockpiled no closer than a horizontal distance equal to the depth of the excavation measured from the outside edge of the excavation in order to reduce the potential for appreciable ground movement.

3.4.2 Excavation Support

Based on the generally stiff subsoil conditions encountered and the anticipated depths of excavation, we believe that steel plates with horizontal struts may be considered for temporary shoring for the new drain line planned for the project. For deeper excavations and excavations adjacent to existing buildings and utilities, we recommend considering interlocking steel sheet piling with horizontal bracing for excavation support in order to reduce the potential for appreciable adjacent ground movement. It should be noted that the potential for presence of cobbles and boulders and shallow basalt rock formation in localized areas could pose some difficulties during the trench excavation and shoring installation. A temporary shoring system consisting of soldier pile and lagging may need to be considered for shoring support in these conditions.

The excavation support and shoring system used must comply with all applicable safety requirements. The contractor should retain a qualified geotechnical engineer to design and evaluate the shoring system used. The contractor should be made solely responsible for the adequacy and safety of the shoring installation. The contractors' representative, who should be required to be continuously present on site during excavation and construction work, will have the best opportunity to promptly observe changing conditions during construction, such as unforeseen subsurface soil conditions, groundwater table, inappropriate construction sequence or techniques, etc., which may adversely affect shoring stability.

Even if good construction procedures are followed, some movement of the shoring system and the adjacent ground may still occur due to changes in earth stresses during excavation. Due to the complexity of the stress changes, it is difficult to accurately estimate the magnitude of ground movement. The magnitude of ground movement also greatly depends upon workmanship, such as how quickly and tightly the shoring supports are installed, the subsoil conditions, the size of the excavation, and the rate of excavation. Therefore, it is important to realize that the shoring should be installed properly and as early as practical, and if necessary, the adjacent ground should be monitored continuously for cracks, dips and/or other indications of movements.

3.5 Site Grading

We anticipate that the earthwork for the project will generally consist of excavations and backfilling up to about 10 feet thick along the new drain line alignment. At the on-set of earthwork, the area within the contract grading limits should be thoroughly cleared and grubbed. Construction debris, deleterious materials, and other unsuitable materials should be removed and disposed of properly off-site or in a designated area to reduce the potential for contamination of the excavated materials with the spoils.

Soft and yielding areas encountered during clearing and grubbing should be over-excavated to expose firm natural ground, and the resulting excavation should be backfilled with well-compacted fill. The excavated soft and/or organic soils should be properly disposed of off-site. Contract documents should include additive and deductive unit prices for over-excavation and engineered fill placement to account for variations in the over-excavation quantities.

Imported fill and backfill materials, if required, should consist of non-expansive select granular material, such as crushed coral or basalt. The material should be well-graded from coarse to fine with particles no larger than 3 inches in largest dimension. In addition, the material should contain between 10 and 30 percent particles passing the No. 200 sieve. The material should have a laboratory California Bearing Ratio (CBR) value of 20 or more and should have a maximum swell of 1 percent or less when tested in accordance with ASTM D1883.

General fill and backfill materials should be moisture-conditioned to above the optimum moisture content, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to a minimum of 90 percent relative compaction. Select granular fill and backfill materials should be moisture-conditioned to above the optimum moisture content, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to a minimum of 90 percent relative compaction. The upper 3 feet of the trench backfill below the pavement grade should be compacted to a minimum of 95 percent relative compaction Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil established in accordance with ASTM D1557. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

A Geolabs representative should monitor site grading operations to observe whether undesirable materials are encountered during the excavation process and to confirm whether the exposed soil/rock conditions are similar to those encountered in our field exploration.

3.6 Pavement Restoration

It is anticipated that asphaltic concrete pavements will be used to repave the trenches along the drain line alignment within paved areas. In general, we anticipate the vehicle loading for the pavements will be typical of the highway traffic. Based on the anticipated traffic loading and subsurface soil conditions encountered, the new pavements along the drain line trenches should match the existing pavement sections or the following flexible pavement section may be used, whichever is greater.

Flexible Pavement Restoration

4.0-Inch Asphaltic Concrete
6.0-Inch Asphalt Concrete Base
6.0-Inch Aggregate Subbase (Minimum 95 Percent Relative Compaction)
16.0-Inch Minimum Total Pavement Thickness on Compacted Subgrade

The pavement subgrade soils should be scarified to a minimum depth of about 8 inches, moisture-conditioned to at least 2 percent above the optimum moisture content and compacted to no less than 95 percent relative compaction. Aggregate subbase material required for the project should consist of crushed basaltic aggregates and should conform to Subsection 703.17 of the State of Hawaii, Standard Specifications for Road and Bridge Construction (2005). Aggregate subbase should be moisture-conditioned to above the optimum moisture content and compacted to no less than 95 percent relative compaction. CBR and field density tests should be performed on the actual subgrade soils encountered during construction to confirm the adequacy of the above section.

3.7 Design Review

Preliminary and final drawings and specifications for the proposed project should be forwarded to Geolabs for review and written comments prior to advertisement for bidding. This review is necessary to evaluate conformance of the plans and specifications with the intent of the geotechnical engineering recommendations provided herein. If this review is not made, Geolabs cannot be responsible for misinterpretation of our recommendations.

3.8 Construction Monitoring

Geolabs should be retained to provide geotechnical services during construction of the proposed project. The items of construction monitoring that are critical requiring "Special Inspection" include the following:

- Observation of fill and backfill placement and compaction
- Observation of shallow foundation excavation and construction

Other aspects of the earthwork construction should also be monitored by a Geolabs representative. This is to observe compliance with the intent of the design concepts, specifications, or recommendations and to expedite suggestions for design changes that may be required in the event that subsurface conditions differ from those anticipated at the time this report was prepared. The recommendations provided in this report are contingent upon such observations.

If the actual exposed subsurface conditions encountered during construction are different from those assumed or considered in this report, then appropriate modifications to the design should be made.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4. LIMITATIONS

The analyses and recommendations submitted herein are based, in part, upon information obtained from the field borings. Variations of the subsurface conditions between and beyond the field borings may occur, and the nature and extent of these variations may not become evident until construction is underway. If variations then appear evident, it will be necessary to re-evaluate the recommendations provided herein.

The boring locations are approximate, having been estimated by taping from reference points and visible features shown on the Roadway Plan transmitted by ParEn, Inc. dba Park Engineering on January 29, 2019. Elevations of the borings were interpolated from the contour lines shown on the same plans. The physical locations and elevations of the field borings should be considered accurate only to the degree implied by the methods used.

The stratification lines shown on the graphic representations of the borings depict the approximate boundaries between soil and/or rock types and, as such, may denote a gradual transition. Water level data from the borings were measured at the times shown on the graphic representations and/or presented in the text of this report. These data have been reviewed and interpretations made in the formulation of this report. However, it must be noted that fluctuation may occur due to variation in tides, rainfall, perched groundwater conditions, groundwater withdrawal, and other factors.

This report has been prepared for the exclusive use of ParEn, Inc. dba Park Engineering and their project consultant for specific application to the design of the proposed *Farrington Highway Drainage Improvements* project in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied.

This report has been prepared solely for the purpose of assisting the engineer in the project design. Therefore, this report may not contain sufficient data, or the proper information, to serve as a basis for construction cost estimates. A contractor wishing to bid on this project is urged to retain a competent geotechnical engineer to assist in the interpretation of this report and/or in the performance of additional site-specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil and/or rock conditions are commonly encountered during construction. Unforeseen subsurface conditions, such as perched groundwater, soft deposits, hard layers, or cavities, may occur in localized areas and may require additional probing or corrections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, a sufficient contingency fund is recommended to accommodate these possible extra costs.

In addition, this geotechnical exploration conducted at the project site was not intended to investigate the potential presence of hazardous materials existing at the site. The equipment, techniques, and personnel used to conduct a geo-environmental exploration differ substantially from those applied in geotechnical engineering.

END OF LIMITATIONS

CLOSURE

The following plates and appendices are attached and complete this report:

Project Location Map	Plate 1
Site Plan	Plate 2
Typical Trench Detail	Plate 3
Field Exploration	Appendix A
Laboratory Tests	Appendix B
Photograph of Core Samples	Appendix C

-ΩΩΩΩΩΩΩΩΩ-

Respectfully submitted,

GEOLABS, INC.

By Teddy S T Kwok

Teddy S.T. Kwok, P.E.
Vice President

TK:mj

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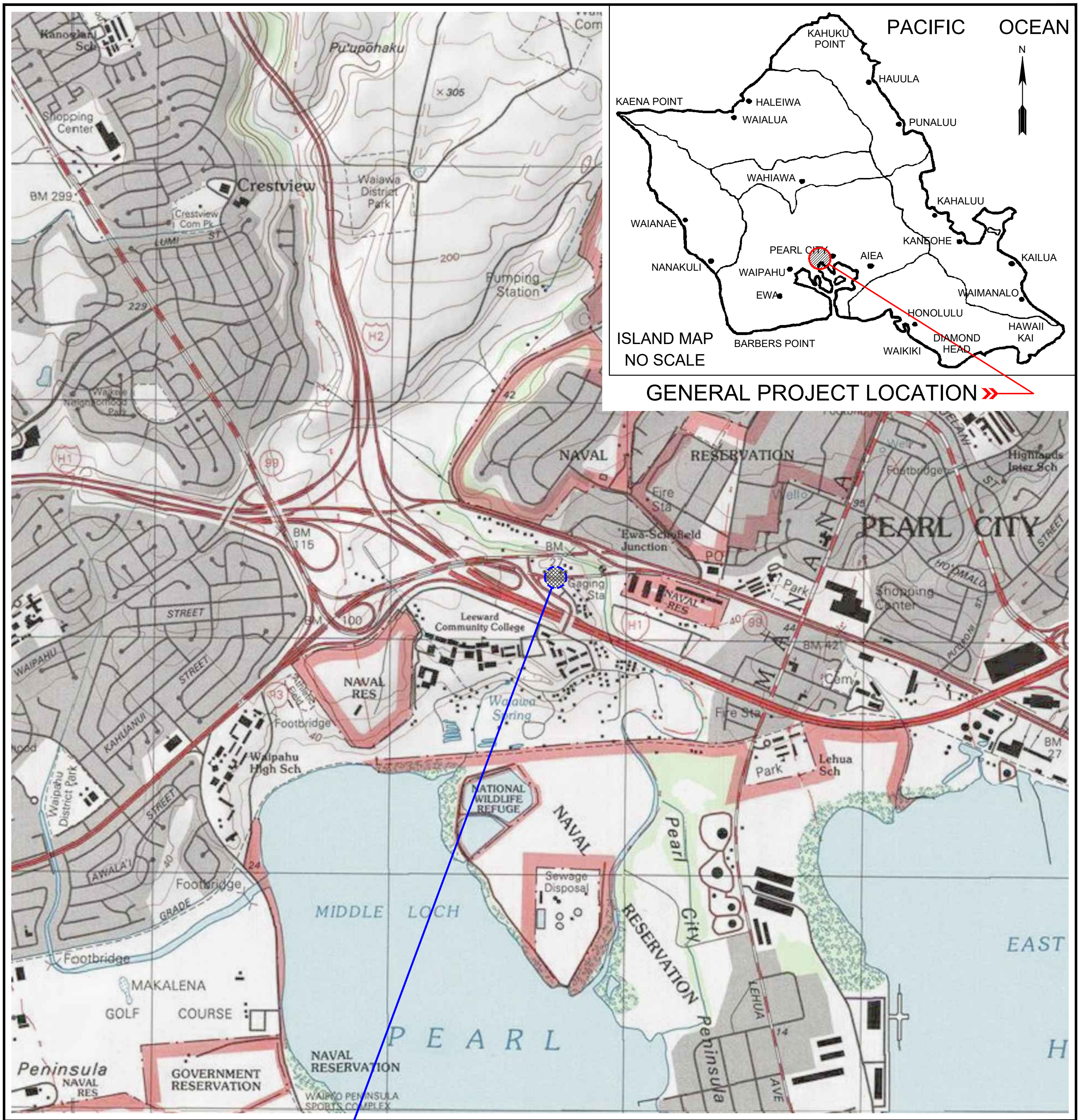
PLATES



PROJECT LOCATION »

2000 1000 0 2000 FT.

GRAPHIC SCALE

N

REFERENCE: MAP CREATED WITH TOPO!® ©2010 NATIONAL GEOGRAPHIC; ©2007 TELE ATLAS, REL. 1/2007.

PROJECT LOCATION MAP

FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII

GEOLABS, INC.

Geotechnical Engineering

DATE JANUARY 2019	DRAWN BY ASP	PLATE
SCALE 1" = 2,000'	W.O. 7754-00	1

CAD User: ASPASIONJR File Last Updated: January 28, 2019 12:29:05pm Plot Date: January 28, 2019 - 12:30:18pm
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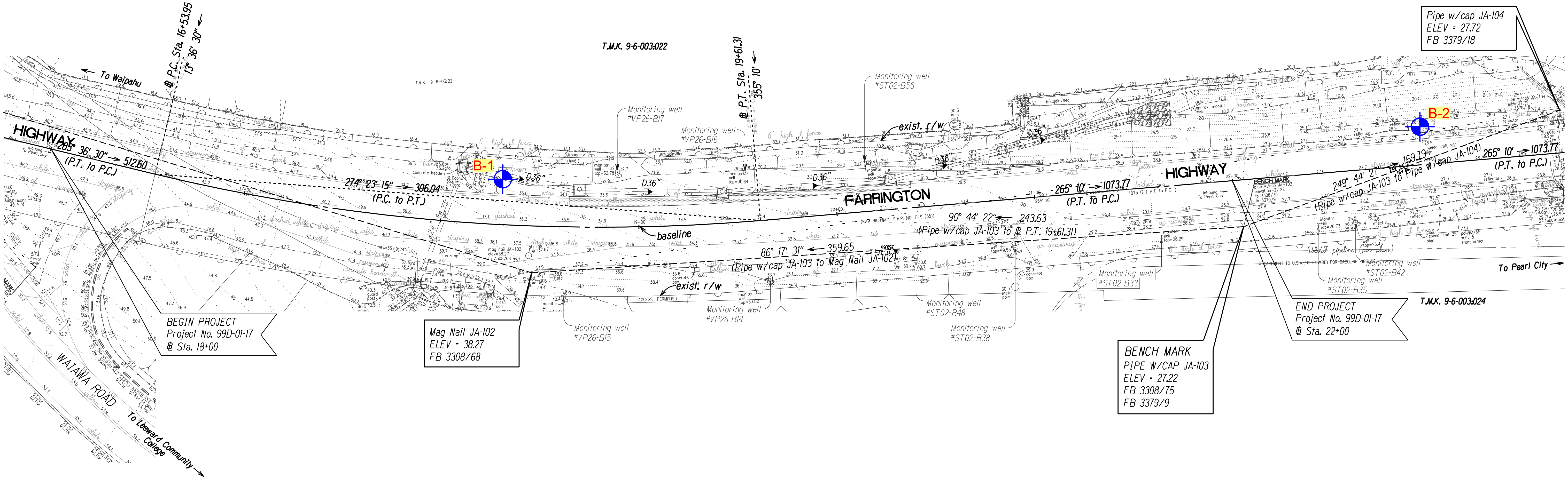

LEGEND:

⊕ APPROXIMATE BORING LOCATION

0 10 20 30 40 50 100 150 FT.

GRAPHIC SCALE

N

REFERENCE: ROADWAY PLAN TRANSMITTED BY PAREN, INC. dba PARK ENGINEERING ON JANUARY 29, 2019.

SITE PLAN

FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JANUARY 2019	ASP	
SCALE	W.O.	2
1" = 50'	7754-00	

CAD User: ASPASIONJR File Last Updated: February 11, 2019 10:43:10am Plot Date: February 11, 2019 - 10:43:42am
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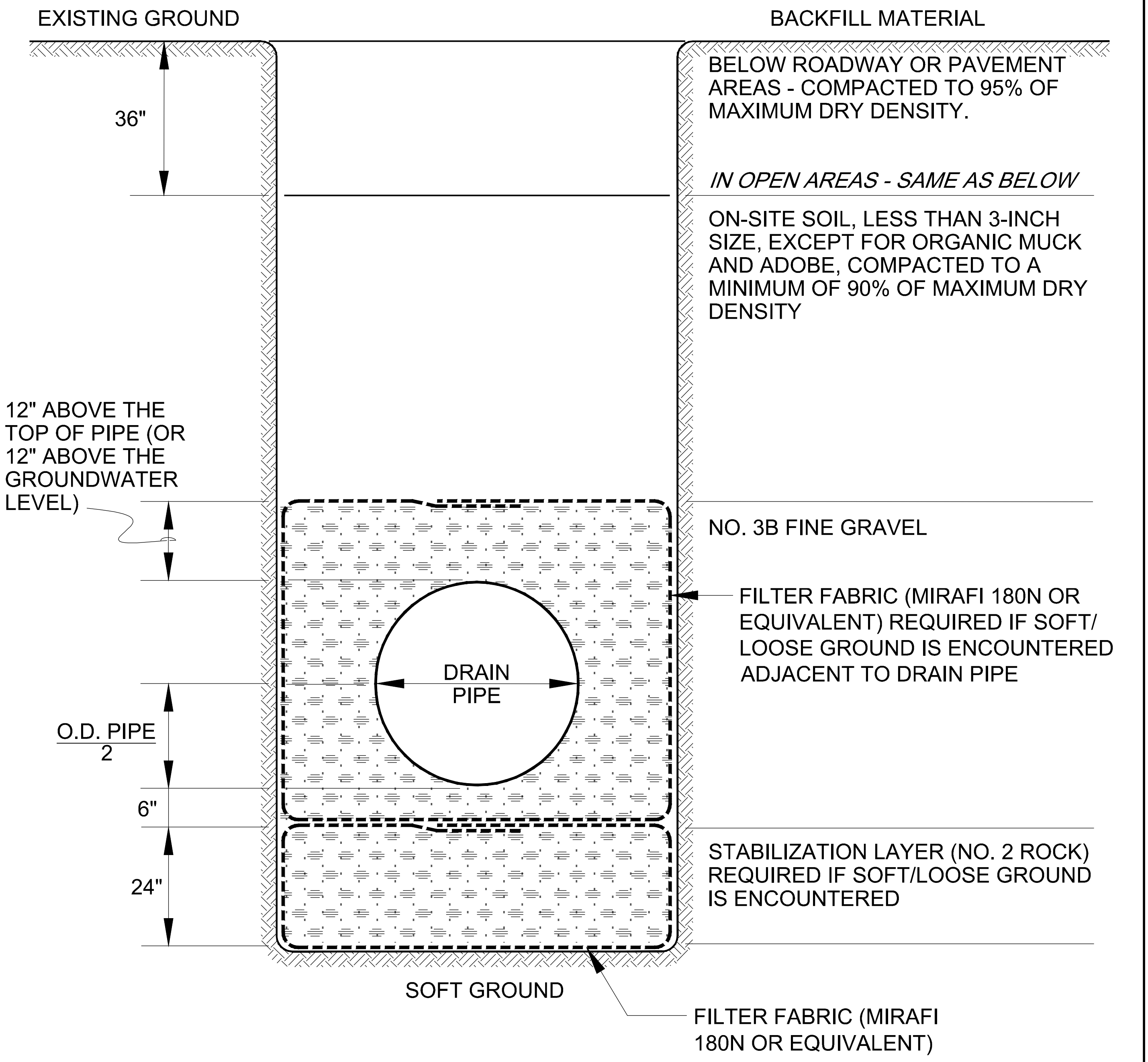
Plotter: DWG To PDF.pc3 Plotstyle: GEO-No-Dithering-Blue-Boring.ctb



TYPICAL TRENCH DETAIL

FARRINGTON HIGHWAY DRAINAGE IMPROVMENTS
PEARL CITY, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
FEBRUARY 2019	ASP	
SCALE	W.O.	3
NOT TO SCALE	7754-00	

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APPENDIX A

APPENDIX A

Field Exploration

We explored the subsurface conditions along the new drain line alignment by drilling and sampling two borings, designated as Boring Nos. 1 and 2, extending to depths of approximately 15 and 21.5 feet below the existing ground surface. The approximate boring locations are shown on the Site Plan, Plate 2. The borings were drilled using a truck-mounted drill rig equipped with continuous flight augers and coring tools.

Our geologist classified the materials encountered in the borings by visual and textural examination in the field in general accordance with ASTM D2488, Standard Practice for Description and Identification of Soils, and monitored the drilling operations on a near-continuous (full-time) basis. These classifications were further reviewed visually and by testing in the laboratory. Soils were classified in general accordance with ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), as shown on the Soil Log Legend, Plate A-0.1. Deviations made to the soil classification in accordance with ASTM D2487 are described on the Soil Classification Log Key, Plate A-0.2. Graphic representations of the materials encountered are presented on the Logs of Borings, Plates A-1 and A-2.

Relatively “undisturbed” soil samples were obtained in general accordance with ASTM D3550, Ring-Lined Barrel Sampling of Soils, by driving a 3-inch OD Modified California sampler with a 140-pound hammer falling 30 inches. In addition, some samples were obtained from the drilled borings in general accordance with ASTM D1586, Penetration Test and Split-Barrel Sampling of Soils, by driving a 2-inch OD standard penetration sampler using the same hammer and drop. The blow counts needed to drive the sampler the second and third 6 inches of an 18-inch drive are shown as the “Penetration Resistance” on the Logs of Borings at the appropriate sample depths. The penetration resistance shown on the logs of borings indicates the number of blows required for the specific sampler type used. The blow counts may need to be factored to obtain the Standard Penetration Test (SPT) blow counts.

Pocket penetrometer tests were performed on selected cohesive soil samples in the field. The pocket penetrometer test provides an indication of the unconfined compressive strength of the sample. Results of the pocket penetrometer tests are summarized on the Logs of Borings at the appropriate sample depths.

Core samples of the rock materials encountered at the project site were obtained by using diamond core drilling techniques in general accordance with ASTM D2113, Diamond Core Drilling for Site Investigation. Core drilling is a rotary drilling method that uses a hollow bit to cut into the rock formation. The rock material left in the hollow core of the bit is mechanically recovered for examination and description. Rock cores were described in general accordance with the Rock Description System, as shown on the

Rock Log Legend, Plate A-0.3. The Rock Description System is based on the publication "Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses" by the International Society for Rock Mechanics (March 1977).

Recovery (REC) may be used as a subjective guide to the interpretation of the relative quality of rock masses, where appropriate. Recovery is defined as the actual length of material recovered from a coring attempt versus the length of the core attempt. For example, if 3.7 feet of material is recovered from a 5.0-foot core run, the recovery would be 74 percent and would be shown on the Logs of Borings as REC = 74%.

The Rock Quality Designation (RQD) is also a subjective guide to the relative quality of rock masses. RQD is defined as the percentage of the total core run in rock that is sound material in excess of 4 inches in length without any discontinuities, discounting any drilling, mechanical, and handling induced fractures or breaks. If 2.5 feet of sound material is recovered from a 5.0-foot core run in rock, the RQD would be 50 percent and would be shown on the Logs of Borings as RQD = 50%. Generally, the following is used to describe the relative quality of the rock based on the "Practical Handbook of Physical Properties of Rocks and Minerals" by Robert S. Carmichael (1989).

Rock Quality	**RQD** (%)
Very Poor	0 – 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 – 100

The excavation characteristic of a rock mass is a function of the relative hardness of the rock, its relative quality, brittleness, and fissile characteristics. A dense rock formation with a high RQD value would be very difficult to excavate and probably would require more arduous methods of excavation.

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Soil Log Legend

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS MORE THAN 50% OF MATERIAL RETAINED ON NO. 200 SIEVE	GRAVELS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS LESS THAN 5% FINES	**GW**	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES MORE THAN 12% FINES	**GM**	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS 50% OR MORE OF COARSE FRACTION PASSING THROUGH NO. 4 SIEVE	CLEAN SANDS LESS THAN 5% FINES	**SW**	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES MORE THAN 12% FINES	**SM**	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE-GRAINED SOILS 50% OR MORE OF MATERIAL PASSING THROUGH NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	**ML**	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT 50 OR MORE	**MH**	INORGANIC SILT, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			**PT**	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

LEGEND

◩	(2-INCH) O.D. STANDARD PENETRATION TEST
⧗	(3-INCH) O.D. MODIFIED CALIFORNIA SAMPLE
S	SHELBY TUBE SAMPLE
G	GRAB SAMPLE
▮	CORE SAMPLE
∇	WATER LEVEL OBSERVED IN BORING AT TIME OF DRILLING
▼	WATER LEVEL OBSERVED IN BORING AFTER DRILLING
▼	WATER LEVEL OBSERVED IN BORING OVERNIGHT

LL	LIQUID LIMIT (NP=NON-PLASTIC)
PI	PLASTICITY INDEX (NP=NON-PLASTIC)
TV	TORVANE SHEAR (tsf)
UC	UNCONFINED COMPRESSION OR UNIAXIAL COMPRESSIVE STRENGTH
TXUU	UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (ksf)

Plate

A-0.1

LOG LEGEND FOR SOIL 7754-00.GPJ GEOLABS.GDT 1/30/19

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Soil Classification Log Key

(with deviations from ASTM D2488)

GEOLABS, INC. CLASSIFICATION*

GRANULAR SOIL (- #200 <50%)

- **PRIMARY** constituents are composed of the largest percent of the soil mass. Primary constituents are capitalized and bold (i.e., **GRAVEL, SAND**)
- **SECONDARY** constituents are composed of a percentage less than the primary constituent. If the soil mass consists of 12 percent or more fines content, a cohesive constituent is used (**SILTY** or **CLAYEY**); otherwise, a granular constituent is used (**GRAVELLY** or **SANDY**) provided that the secondary constituent consists of 20 percent or more of the soil mass. Secondary constituents are capitalized and bold (i.e., **SANDY** GRAVEL, **CLAYEY** SAND) and precede the primary constituent.
- **accessory descriptions** compose of the following:
  with some: >12%
  with a little: 5 - 12%
  with traces of: <5%
  accessory descriptions are lower cased and follow the Primary and Secondary Constituents
  (i.e., SILTY GRAVEL **with a little sand**)

COHESIVE SOIL (- #200 ≥50%)

- **PRIMARY** constituents are based on plasticity. Primary constituents are capitalized and bold (i.e., **CLAY, SILT**)
- **SECONDARY** constituents are composed of a percentage less than the primary constituent, but more than 20 percent of the soil mass. Secondary constituents are capitalized and bold (i.e., **SANDY** CLAY, **SILTY** CLAY, **CLAYEY** SILT) and precede the primary constituent.
- **accessory descriptions** compose of the following:
  with some: >12%
  with a little: 5 - 12%
  with traces of: <5%
  accessory descriptions are lower cased and follow the Primary and Secondary Constituents
  (i.e., SILTY CLAY **with some sand**)

EXAMPLE: Soil Containing 60% Gravel, 25% Sand, 15% Fines. Described as: **SILTY GRAVEL** with some sand

RELATIVE DENSITY / CONSISTENCY

Granular Soils			Cohesive Soils			
N-Value (Blows/Foot)		Relative Density	N-Value (Blows/Foot)		PP Readings (tsf)	Consistency
SPT	MCS		SPT	MCS		
0 - 4	0 - 7	Very Loose	0 - 2	0 - 4		Very Soft
4 - 10	7 - 18	Loose	2 - 4	4 - 7	< 0.5	Soft
10 - 30	18 - 55	Medium Dense	4 - 8	7 - 15	0.5 - 1.0	Medium Stiff
30 - 50	55 - 91	Dense	8 - 15	15 - 27	1.0 - 2.0	Stiff
> 50	> 91	Very Dense	15 - 30	27 - 55	2.0 - 4.0	Very Stiff
			> 30	> 55	> 4.0	Hard

MOISTURE CONTENT DEFINITIONS

Dry:	Absence of moisture, dry to the touch
Moist:	Damp but no visible water
Wet:	Visible free water, usually soil is below water table

ABBREVIATIONS

WOH:	Weight of Hammer
WOR:	Weight of Drill Rods
SPT:	Standard Penetration Test Split-Spoon Sampler
MCS:	Modified California Sampler
PP:	Pocket Penetrometer

GRAIN SIZE DEFINITION

Description	Sieve Number and / or Size
Boulders	> 12 inches (305-mm)
Cobbles	3 to 12 inches (75-mm to 305-mm)
Gravel	3-inch to #4 (75-mm to 4.75-mm)
Coarse Gravel	3-inch to 3/4-inch (75-mm to 19-mm)
Fine Gravel	3/4-inch to #4 (19-mm to 4.75-mm)
Sand	#4 to #200 (4.75-mm to 0.075-mm)
Coarse Sand	#4 to #10 (4.75-mm to 2-mm)
Medium Sand	#10 to #40 (2-mm to 0.425-mm)
Fine Sand	#40 to #200 (0.425-mm to 0.075-mm)

**Soil descriptions are based on ASTM D2488-09a, Visual-Manual Procedure, with the above modifications by Geolabs, Inc. to the Unified Soil Classification System (USCS).*

Plate

A-0.2

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Rock Log Legend

ROCK DESCRIPTIONS

╱	**BASALT**	∘	**CONGLOMERATE**
○	**BOULDERS**	▦	**LIMESTONE**
△	**BRECCIA**	⋯	**SANDSTONE**
×	**CLINKER**	×	**SILTSTONE**
⬠	**COBBLES**	▩	**TUFF**
☼	**CORAL**		**VOID/CAVITY**

ROCK DESCRIPTION SYSTEM

ROCK FRACTURE CHARACTERISTICS

The following terms describe general fracture spacing of a rock:

Massive:	Greater than 24 inches apart
Slightly Fractured:	12 to 24 inches apart
Moderately Fractured:	6 to 12 inches apart
Closely Fractured:	3 to 6 inches apart
Severely Fractured:	Less than 3 inches apart

DEGREE OF WEATHERING

The following terms describe the chemical weathering of a rock:

Unweathered:	Rock shows no sign of discoloration or loss of strength.
Slightly Weathered:	Slight discoloration inwards from open fractures.
Moderately Weathered:	Discoloration throughout and noticeably weakened though not able to break by hand.
Highly Weathered:	Most minerals decomposed with some corestones present in residual soil mass. Can be broken by hand.
Extremely Weathered:	Saprolite. Mineral residue completely decomposed to soil but fabric and structure preserved.

HARDNESS

The following terms describe the resistance of a rock to indentation or scratching:

Very Hard:	Specimen breaks with difficulty after several "pinging" hammer blows. Example: Dense, fine grain volcanic rock
Hard:	Specimen breaks with some difficulty after several hammer blows. Example: Vesicular, vugular, coarse-grained rock
Medium Hard:	Specimen can be broked by one hammer blow. Cannot be scraped by knife. SPT may penetrate by ~25 blows per inch with bounce. Example: Porous rock such as clinker, cinder, and coral reef
Soft:	Can be indented by one hammer blow. Can be scraped or peeled by knife. SPT can penetrate by ~100 blows per foot. Example: Weathered rock, chalk-like coral reef
Very Soft:	Crumbles under hammer blow. Can be peeled and carved by knife. Can be indented by finger pressure. Example: Saprolite

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FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII

Log of Boring
1

Latitude: 21.3955991° N
Longitude: 157.9800165° W
Approximate Ground Surface
Elevation(feet MSL): 34.5 *

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	27	91			122					MH	Orangish brown with multi-color mottling **CLAYEY SILT** with some gravel and sand, hard, dry (older alluvium)
LL=62 PI=28	39				54					MH	Reddish brown with black mottling **CLAYEY SILT** with some gravel (basaltic), hard, moist (older alluvium)
	43	80			52	4.0	5			MH	Orangish brown with multi-color mottling **CLAYEY SILT** with some gravel and sand, hard, dry (older alluvium)
	17		47		50/3"		10				Gray **COBBLES (BASALTIC)** with some silt, very dense, moist (weathered basalt)
UC= 5230 psi			95	17							Gray **BASALT**, closely fractured, moderately weathered, hard (a'a basalt)
							15				Boring terminated at 15 feet * Elevations estimated from Roadway Plan transmitted by ParEn Inc. dba Park Engineering on January 29, 2019.
							20				
							25				
							30				
							35				

Date Started:	September 25, 2018	Water Level: ▼	Not Encountered 09/25/2018 1126 HRS	Plate
Date Completed:	September 25, 2018			
Logged By:	N. Vaiana	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 78%)*	A - 1
Total Depth:	15 feet	Drilling Method:	4" Solid Stem Auger & PQ Coring	
Work Order:	7754-00	Driving Energy:	140 lb. wt., 30 in. drop	

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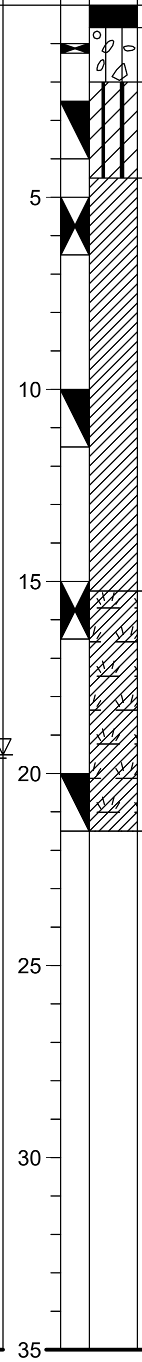
FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII

Log of Boring
2

Latitude: 21.3956241° N
Longitude: 157.9790918° W
Approximate Ground Surface
Elevation(feet MSL): 27.5 *

Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									ASPHALTIC CONCRETE
	5	72			50/3"			GM	Brownish gray **SILTY GRAVEL (BASALTIC)** with some sand (basaltic), very dense, moist (base course)
	24				12			MH	Grayish brown **CLAYEY SILT** with some gravel (basaltic), stiff, moist (fill)
Direct Shear	30	92			32	2.5	5	CH	Brown with orange mottling **SILTY CLAY** with a little sand (basaltic), very stiff, moist (older alluvium)
LL=59 PI=32	26				28		10		
Consol.	35	80			17		15	MH	Dark grayish brown **CLAYEY SILT** with a little gravel (basaltic) and traces of shells, stiff, moist (marsh deposit) grades with hydrocarbon odor
							⊻		
					6		20		grades to soft
									Boring terminated at 21.5 feet
							25		
							30		
							35		



Date Started: September 25, 2018
Date Completed: September 25, 2018
Logged By: N. Vaiana
Total Depth: 21.5 feet
Work Order: 7754-00

Water Level: ⊻ 19.5 ft. 09/25/2018 1253 HRS
Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 78%)*
Drilling Method: 4" Solid Stem Auger
Driving Energy: 140 lb. wt., 30 in. drop

Plate
A - 2

APPENDIX B

APPENDIX B

Laboratory Tests

Moisture Content (ASTM D2216) and Unit Weight (ASTM D2937) determinations were performed on selected samples as an aid in the classification and evaluation of soil properties. The test results are presented on the Logs of Borings at the appropriate sample depths.

Two Atterberg Limits tests (ASTM D4318) were performed on selected soil samples to evaluate the liquid and plastic limits and to aid in soil classification. The test results are summarized on the Logs of Borings at the appropriate sample depths. Graphic presentation of the test results is provided on Plate B-1.

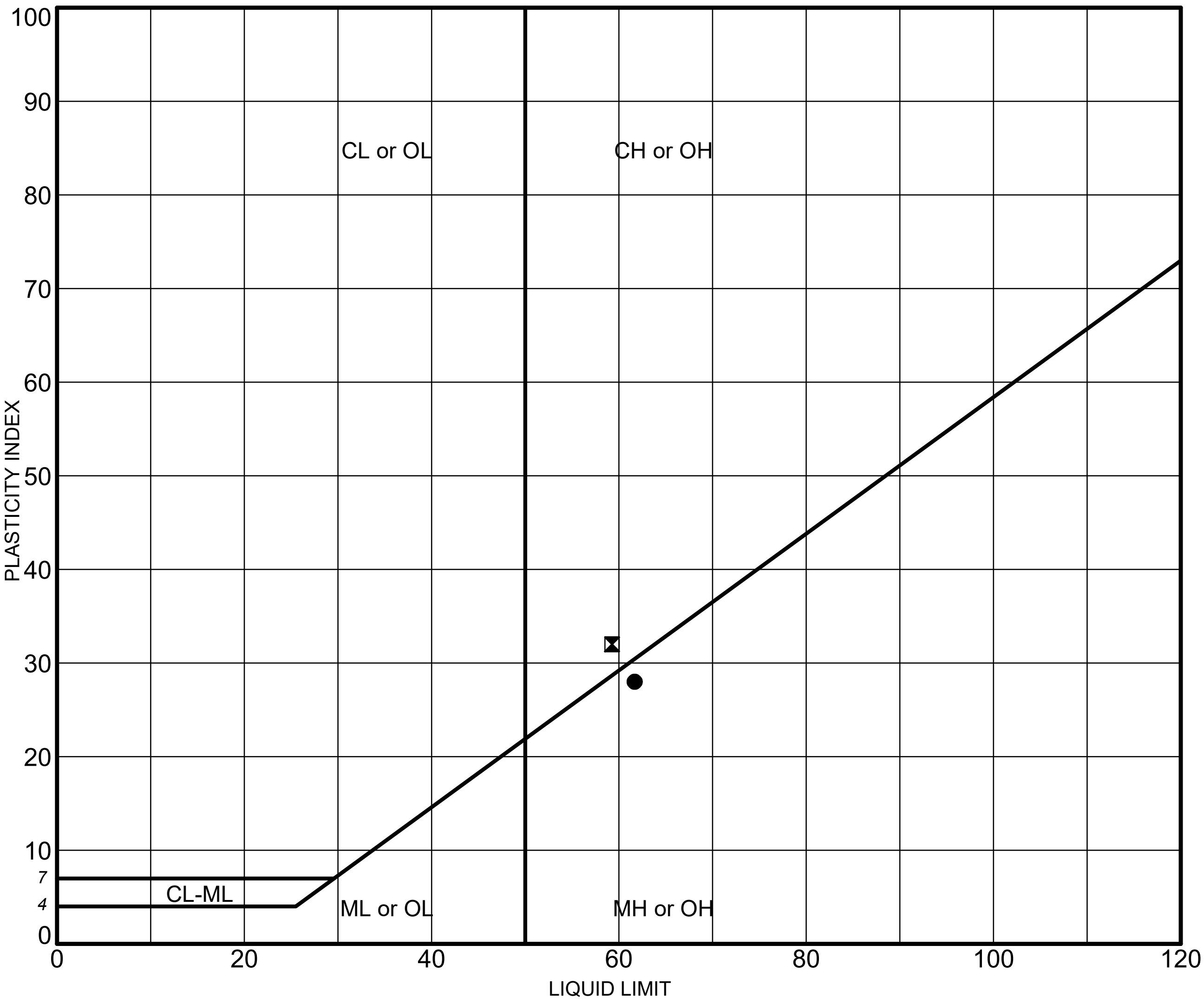
One Uniaxial Compression test (ASTM D7012, Method C) was performed on a selected core sample to evaluate the unconfined compressive strength of the basalt formation encountered. The test results are presented on Plate B-2.

One Direct Shear test (ASTM D3080) was performed on a selected sample to evaluate the shear strength characteristics of the material tested. The test results are presented on Plate B-3.

One consolidation test with time rates (ASTM D2435) was performed on a sample of the potentially compressible soils to evaluate the compressibility characteristics of the materials encountered. Results of the consolidation test are presented on Plate B-4.

One laboratory California Bearing Ratio test (ASTM D1883) was performed on a bulk sample of the near-surface soils to evaluate the pavement support characteristics of the soils. The test results are presented on Plate B-5.

One set of Corrosivity tests, including pH (ASTM G51), Minimum Resistivity (ASTM G57), Chloride Content (EPA 300.0), and Sulfate Content (EPA 300.0), were performed by our office and TestAmerica Laboratories, Inc. on a selected soil sample obtained from our field exploration. The test results are summarized on Plate B-6.



	Sample	Depth (ft)	LL	PL	PI	Description
●	B-1	2.5-4.0	62	34	28	Reddish brown clayey silt (MH) with some gravel
☒	B-2	10.0-11.5	59	27	32	Brown silty clay (CH) with a little sand

NP = NON-PLASTIC

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W.O. 7754-00

ATTERBERG LIMITS TEST RESULTS - ASTM D4318

FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII

Plate
B - 1

Location	Depth	Length	Diameter	Length/ Diameter Ratio	Density	Load	Compressive Strength
	(feet)	(inches)	(inches)		(pcf)	(lbs)	(psi)
B-1	11.5 - 15	6.130	3.250	1.89	167.0	43,390	5,230

ASTM D7012 (METHOD C)

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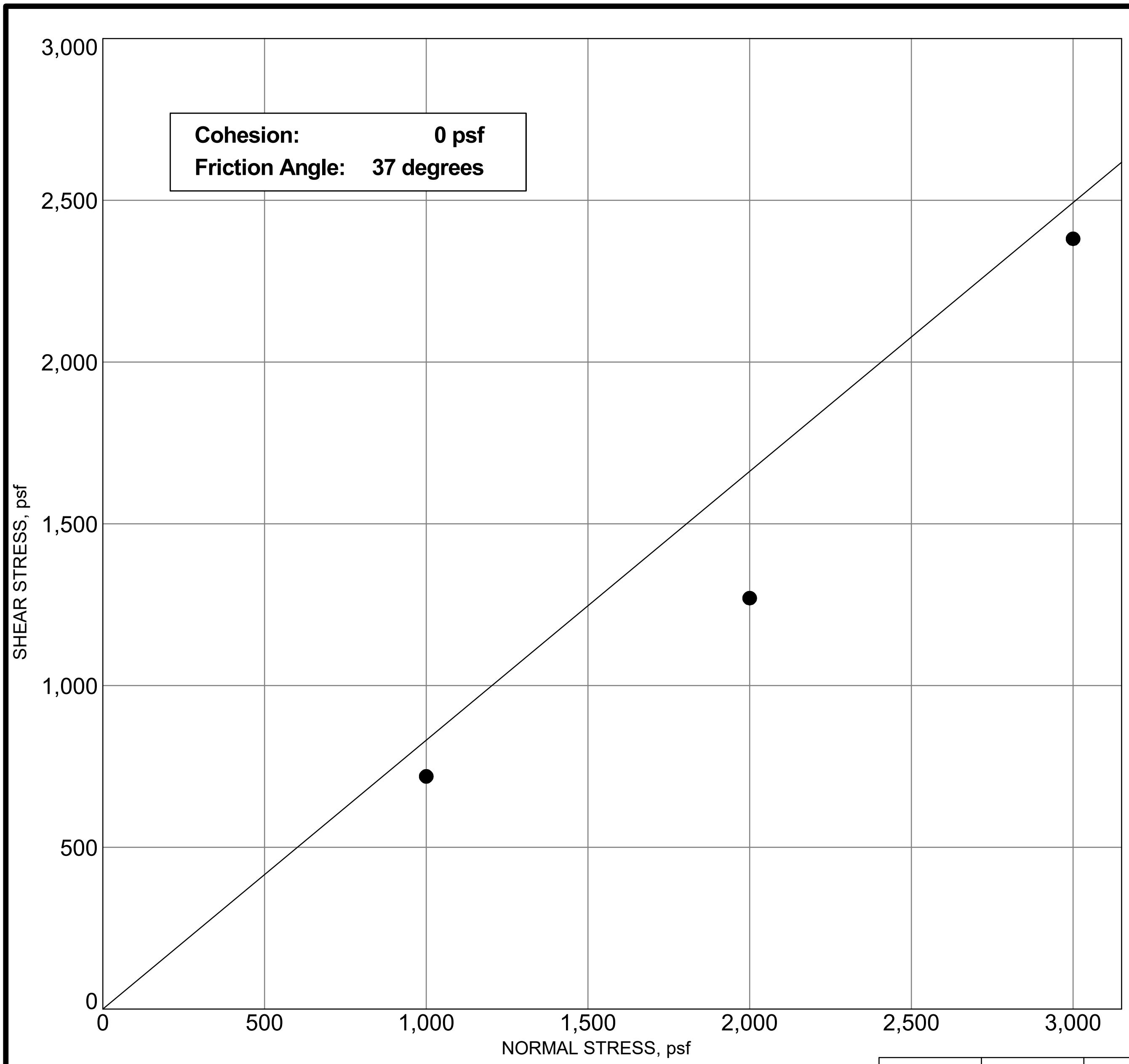
UNIAXIAL COMPRESSIVE STRENGTH TEST

FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII

Plate
B - 2

G ROCK UC TEST PORTRAIT 7754-00.GPJ GEOLABS.GDT 1/30/19



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	29.9	29.8	30.3
	Dry Density, pcf	91.4	94.9	94.7
	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	38.5	33.7	31.5
	Dry Density, pcf	89.5	96.6	98.5
	Height, inches	1.020	0.982	0.961
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0025	0.0019	0.0019
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**719**	**1270**	**2381**
	Shear Displacement, inches	0.43	0.41	0.39

Sample: B-2
Depth: 5.0 - 6.5 feet
Description: Brown with orange mottling silty clay with a little sand

G_DIRECT_SHEAR 7754-00.GPJ GEOLABS.GDT 1/30/19

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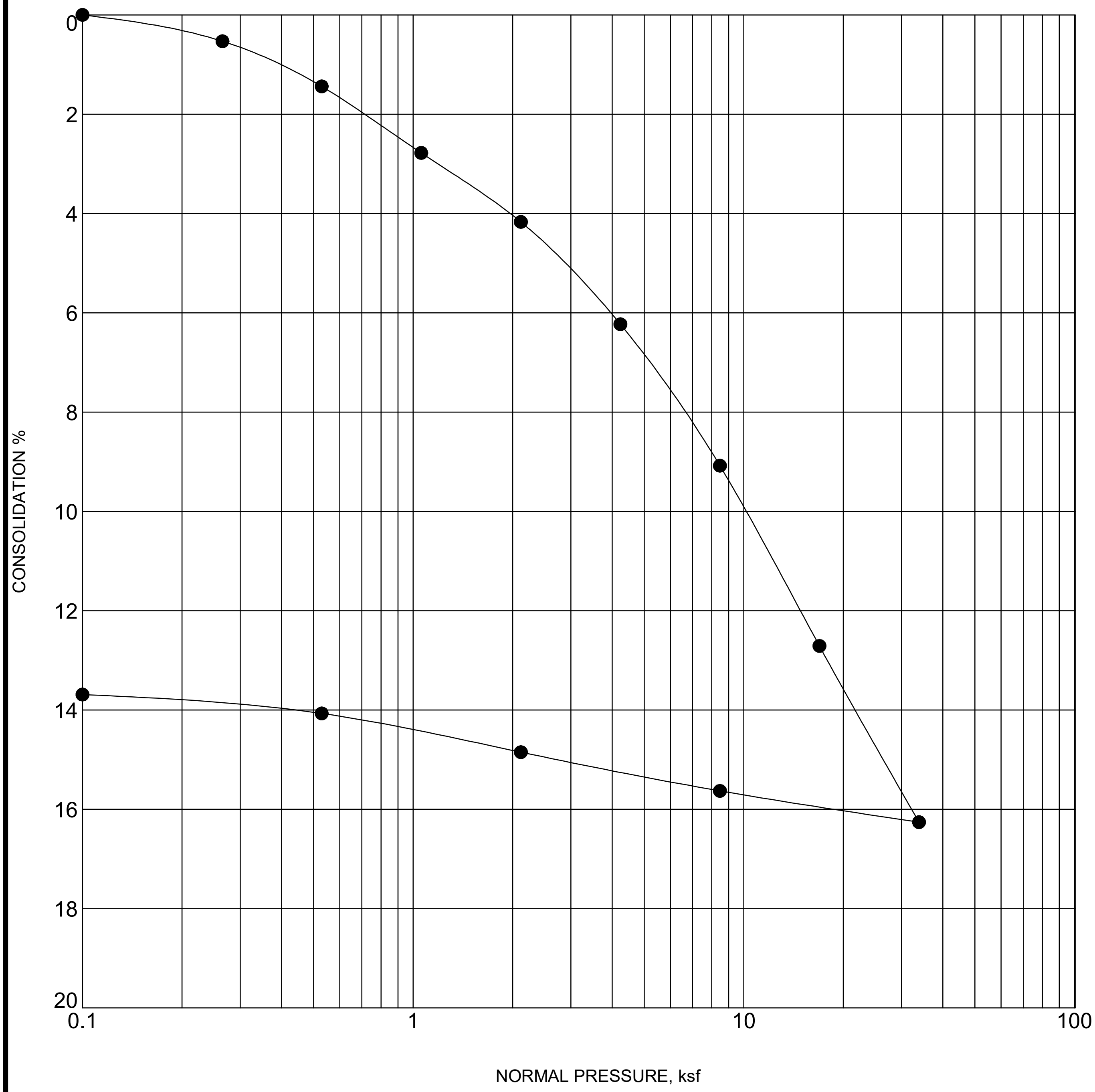
W.O. 7754-00

DIRECT SHEAR TEST - ASTM D3080

FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII

Plate
B - 3



Sample: B-2
Depth: 15.0 - 16.5 feet
Description: Dark grayish brown clayey silt with a little gravel

Liquid Limit = N/A Plasticity Index = N/A

	Initial	Final
Water Content, %	34.5	35.7
Dry Density, pcf:	78.8	91.3
Void Ratio	1.428	1.096
Degree of Saturation, %	74.0	100.0
Sample Height, inches	1.0000	0.8588

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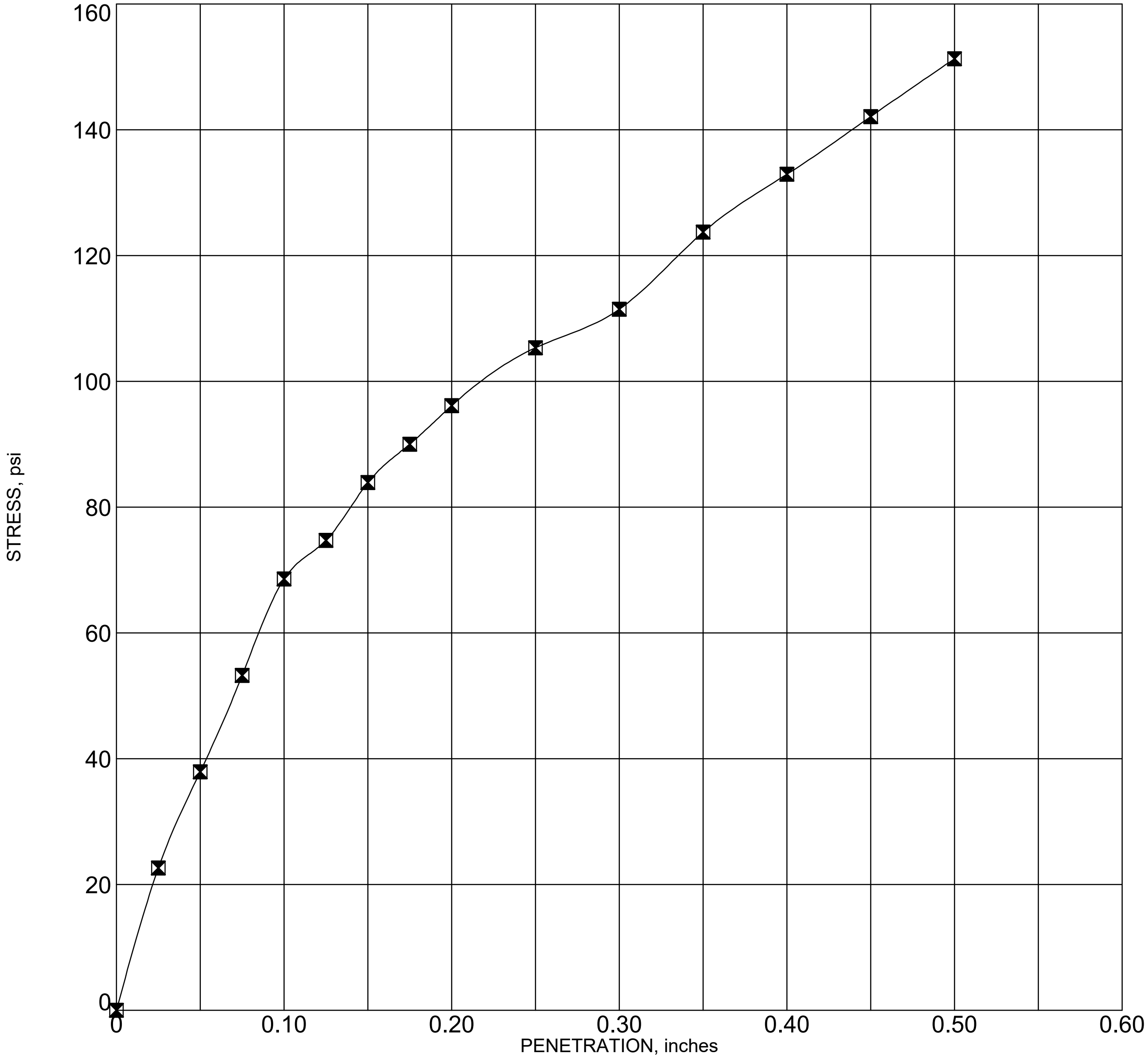
CONSOLIDATION TEST - ASTM D2435

FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII

Plate
B - 4

G CONSOL 7754-00.GPJ GEOLABS.GDT 1/30/19



Corr. CBR @ 0.1"	6.9
Corr. CBR @ 0.2"	6.4
Swell (%)	2.29

Sample: BULK-1
Depth: 0.0 - 1.0 feet
Description: Brown silty clay with some gravel

Molding Dry Density (pcf)	95.2	Hammer Wt. (lbs)	10
Molding Moisture (%)	26.3	Hammer Drop (inches)	18
Days Soaked	5	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

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CALIFORNIA BEARING RATIO - ASTM D1883

FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII

Plate
B - 5

G_CBR 7754-00.GPJ GEOLABS.GDT 1/30/19

Location	Depth (feet)	pH Value	Minimum Resistivity (ohm-cm)	Chloride Content (mg/kg)	Sulfate Content (mg/kg)
B-1	5.0 - 6.5	6.69*	1000*	29	18

TEST METHODS (by TestAmerica Laboratories, Inc.)

pH Value	Method 9045C
Minimum Resistivity	SM 2510B
Chloride Content	EPA 300.0
Sulfate Content	EPA 300.0

TEST METHODS (by Geolabs, Inc.)*

pH Value	ASTM G51
Minimum Resistivity	ASTM G57
Chloride Content	N/A
Sulfate Content	N/A

ND: Not Detected Within Reporting Limits

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GEOTECHNICAL ENGINEERING
W.O. 7754-00

SUMMARY OF CORROSIVITY TESTS

FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII

Plate
B - 6

APPENDIX C

FARRINGTON HIGHWAY DRAINAGE IMPROVEMENTS
PEARL CITY, OAHU, HAWAII

B-1 10.25’ TO 15.0’

10.25’

15.0’

Attachment D

Eighteenth Quarterly Long-Term Monitoring and Remedial Action Operations Report Site ST02 Waiawa Booster Pump Station, dated September 2020, prepared by NAVFAC Hawaii

Naval Facilities Engineering Command Hawaii
JBPHH HI

Eighteenth Quarterly Long-Term Monitoring and Remedial Action Operations Report
Site ST02 Waiawa Booster Pump Station

JOINT BASE PEARL HARBOR-HICKAM OAHU HI

JBPHH PEARL HARBOR HI SITE HP6

September 2020

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Naval Facilities Engineering Command Hawaii
JBPHH HI

Eighteenth Quarterly Long-Term Monitoring and Remedial Action Operations Report
Site ST02 Waiawa Booster Pump Station

JOINT BASE PEARL HARBOR-HICKAM OAHU HI

JBPHH PEARL HARBOR HI SITE HP6

September 2020

Prepared for NAVFAC Hawaii by

EATC Joint Venture
615 Piikoi Street, Suite 515
Honolulu, Hawaii 96814-3503

N62742-16-D-1810
CTO N6274219F0122

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ACRONYMS AND ABBREVIATIONS

µg/L	microgram(s) per liter
µg/m^3	micrograms per cubic meter
AAF	Army Airfield
amsl	above mean sea level
AVGAS	aviation gasoline
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CO_2	carbon dioxide
COC	contaminant of concern
COPC	contaminant of potential concern
CRI	Comprehensive Remedial Investigation
CTO	Contract Task Order
DCA	dichloroethane
DO	dissolved oxygen
DoN	Department of the Navy
EAL	Environmental Action Level
EDB	ethylene dibromide
ERP	Environmental Restoration Program
HDOH	State of Hawaii Department of Health
JBPHH	Joint Base Pearl Harbor-Hickam
JP-4	jet propulsion fuel grade 4
JP-8	jet propulsion fuel grade 8
LNAPL	light nonaqueous phase liquid
LTM	long-term monitoring
LUC	land use control
mg/L	milligram(s) per liter
MNA	monitored natural attenuation
MOGAS	automobile/motor fuel gasoline
MPX	multi-phase extraction
NAVFAC	Naval Facilities Engineering Command
O_2	oxygen
ORP	oxidation reduction potential
PAH	polycyclic aromatic compound
POL	Petroleum, Oils, and Lubricants
QA	quality assurance
QC	quality control
RAA	Remedial Action Alternatives
RACG	Remedial Action Cleanup Goal
RAM	Response Action Memorandum for Site ST02
RAO	remedial action objective
RAO-WP	Remedial Action Operation Work Plan
RD	Remedial Design for Site ST02
RI	remedial investigation

ACRONYMS AND ABBREVIATIONS (continued)

TPH-d	total petroleum hydrocarbons as diesel fuel
TPH-g	total petroleum hydrocarbons as gasoline
U.S.	United States
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
VP26	Valve Pit 26

Executive Summary

This Eighteenth Quarterly Long-Term Monitoring (LTM) Report documents the results of the 18th quarterly LTM event performed in June/July 2020 in support of the selected remedy at Site ST02 at the former Waiawa Booster Pump Station in Pearl City, Hawaii (herein referred to as the site or Site ST02). The wells sampled during this event included those designated for quarterly and semiannual monitoring. The work described in this report was performed under Contract Number N62742-16-D-1810, Contract Task Order N6274219F0122, in accordance with the Revised Remedial Action Operations Work Plan (RAO-WP) (Department of the Navy [DoN], 2019).

Site ST02 is located in Pearl City, Hawaii, approximately 0.6 miles north of the Middle Loch of Pearl Harbor, south of the Farrington Highway, and northeast of Leeward Community College. Site ST02 is the site of historical documented fuel releases from the Hickam Petroleum, Oils, and Lubricants (POL) Pipeline. Site ST02 includes the Waiawa Booster Pump Station as well as Valve Pit 26 (VP26), which are part of the overall Hickam POL Pipeline.

The monitoring of groundwater and soil vapor was conducted at Site ST02 during the LTM event to satisfy the requirements of the selected remedy for Site ST02, presented in the Response Action Memorandum for Site ST02 (DoN, 2013a). The selected remedy includes monitored natural attenuation using LTM to verify that the plume is stable or decreasing, to document and track natural degradation of hydrocarbons in soil and groundwater before, during, and after the completion of multi-phase extraction and bioventing treatment, and to evaluate potential impacts to Waiawa Stream related to discharge of shallow groundwater into the stream. The chemicals of concern at Site ST02 include selected volatile organic compounds, polycyclic aromatic compounds, total petroleum hydrocarbons, and lead. The multiphase extraction and bioventing systems are no longer operating at the site.

During the 18th quarterly LTM event, 12 monitoring wells in the groundwater LTM network for quarterly and semiannual sampling were located and found to be in good condition. Groundwater samples could not be collected during this LTM event at ST02-B67 (sentinel well) and VP26-B13 (cross gradient) because not enough water was in the wells at the time of sampling.

The groundwater data generated from wells included in the monitoring well network were compared to the site-specific Remedial Action Cleanup Goals (RACGs). Chemicals of concern were detected at concentrations at or exceeding the RACGs in 3 of the 10 wells sampled. Exceedances were reported for three in-plume monitoring wells.

Soil vapor monitoring of four wells (VP26-B05A/B, VP26-B07, VP26-B08, and VP26-B11) at multiple depth intervals was performed on 10 June 2020. Vapor points at each well were purged of at least one well volume and monitored for percent oxygen, carbon dioxide, and methane. Field screening results show that the oxygen level was above 10 percent in the 20 feet below grade interval in VP26-B07. The oxygen readings indicate higher COC concentrations remain at the deeper monitoring points in wells VP26-B05A/B, VP26-B07, and VP26-B11 (source area).

Based on the LTM results, the monitored natural attenuation remedy appears to be effective and biodegradation appears to be occurring and contaminant concentration data from monitoring performed between 2014 and 2020 provide ample supporting evidence. The LTM program at Site ST02 will continue in accordance with the Remedial Design for Site ST02 and the RAO-WP (DoN, 2019).

1 INTRODUCTION

This Eighteenth Quarterly Long-Term Monitoring (LTM) Report documents the results of the 18th quarterly LTM event that was performed in June/July 2020 in support of the selected remedy at Site ST02 at the former Waiawa Booster Pump Station in Pearl City, Hawaii (herein referred to as the site or Site ST02). The selected remedy for Site ST02 is presented in Section 1.5 and in greater detail in the Response Action Memorandum (RAM) (Department of the Navy [DoN], 2013a). The field activities performed during the 18th quarterly LTM event at Site ST02 included vegetation clearance and groundwater and soil vapor monitoring. The wells sampled during this event included those designated for quarterly and semiannual monitoring.

EATC Joint Venture performed the work described herein for the Naval Facilities Engineering Command (NAVFAC) Hawaii under Contract No. N62742-16-D-1810, Contract Task Order (CTO) N6274219F0122, in accordance with the Revised Remedial Action Operations Work Plan (RAO-WP) (DoN, 2019a).

1.1 Site Background

The following sections present the site background, including location, description, geology, hydrogeology, and history, as well as a summary of previous investigations.

1.1.1 Site Location and Description

Site ST02 is located in Pearl City, Hawaii (Figure 1) approximately 0.6 miles north of the Middle Loch of Pearl Harbor, south of the Farrington Highway, and northeast of Leeward Community College (Figure 2). The 5-acre site may be accessed by the Farrington Highway on-ramp, to the west of the Pearl City Home Depot. Site ST02 includes the former Waiawa Booster Pump Station as well as Valve Pit 26 (VP26).

At present, no buildings are located at the site except for the former Waiawa Booster Pump Station, which is located underground. The valve pits and pipeline remain in place but have been closed. The booster station is a concrete structure built into the hillside that housed pumps and provided the pressure head needed to pump fuel to higher elevations at Wheeler Army Airfield (AAF).

The ground surface elevation at Site ST02 ranges from approximately 23 feet above mean sea level (amsl) on the east near the bank of Waiawa Stream to 64 feet amsl along Waiawa Road south of VP26. The Waiawa Stream channel and adjacent floodplain are located along the eastern and northern portions of Site ST02. South of

Farrington Highway and west of the privately owned property known as RC Farms, the ground surface rises steeply up to VP26.

The United States (U.S.) Government property has two tiers that are separated by approximately 12 feet in elevation. VP26 and the entrance to the former Waiawa Booster Pump Station are located on the lower tier. The upper tier is located to the south and a portion of it overlies the former booster station. Most of the ground around VP26 and the upper tier are covered with gravel. The far eastern and northern peripheries of the U.S. Government property are covered with natural vegetation.

1.1.2 Geology and Hydrogeology

The Waiawa Stream borders Site ST02 to the north and south of the site. The perennial stream originates in Koolau Mountain range on the windward coast of Oahu. The stream discharges into the Middle Loch of Pearl Harbor. There are several manmade ponds on the privately-owned property to the south of Site ST02. A wetland is present south of a man-made koi pond on RC Farms and east of Waiawa Village. The groundwater well providing water to the aquaculture systems at RC Farms is located at the north edge of the wetland.

Site ST02 is located above an upper sedimentary caprock aquifer and lower basal aquifer that are part of the Waiawa Aquifer system in the Pearl Harbor Aquifer Sector. Groundwater in the upper sedimentary caprock is considered ecologically important, and the lower basal aquifer is considered an irreplaceable drinking water resource that is highly vulnerable to contamination (Mink and Lau, 1990). Depths to groundwater range from less than 1 foot below ground surface (bgs) near the banks of Waiawa Stream to approximately 50.5 feet bgs located along Waiawa Drive. Shallow groundwater (4.6 feet bgs) was also encountered near an area of ponded aquaculture discharge water.

Regional groundwater flow is likely southeast towards Pearl Harbor; however, the groundwater flow direction at Site ST02 is north towards the Waiawa Stream and is likely influenced by local hydrogeologic conditions in the fractured basalt and local potentiometric mounding caused by discharge from the aquaculture systems in the vicinity of the site.

1.1.3 Site History

The Hickam Petroleum, Oils, and Lubricants (POL) Pipeline was designed in 1939 and completed in 1943 to provide long-term storage and transmission capability of wartime fuel to military facilities located on Oahu during World War II, including the Hickam and

Wheeler Airfields, now respectively the former Hickam Air Force Base (now part of Joint Base Pearl Harbor Hickam [JBPHH]) and Wheeler AAF. The Hickam POL Pipeline consists of two parallel 10-inch diameter steel pipes that originated on the south end of the Pearl City Peninsula, traversed the Pearl City Peninsula and central Oahu, and terminated at both the Waikakalaua Fuel Storage Annex, adjacent to Wheeler AAF, and the Kipapa Fuel Storage Annex, located in Kipapa Gulch.

Originally, aviation gasoline (AVGAS) and automobile/motor fuel gasoline (MOGAS) were both distributed through the pipelines. In the 1960s, MOGAS was phased out of the pipeline distribution system and jet propulsion fuel grade 4 (JP-4) gradually replaced AVGAS, with complete conversion occurring in 1971. In 1992, jet propulsion fuel grade 8 (JP-8) was included in the system. The pipeline was taken out of service in March 1993, except for the segment that extends from VP30 on the Pearl City Peninsula to the former Hickam Air Force Base.

1.1.4 Historical Releases

There have been two documented fuel releases at Site ST02. In January 1951, a leak occurred in the vicinity of the Waiawa Booster Pump Station. During repair of the leak it was discovered that the pipeline was badly corroded (U.S. Geological Survey, 1990). One account of the 1951 leak reports that an estimated 10,000 gallons of AVGAS “drained through nearby agriculture to Waiawa Stream” (Engineering Science, Inc., 1984). This description of the VP26 fuel leak drainage pattern is presumed to refer to the property and low-lying drainage area located east of VP26 and historically referred to as LA1 or Spill Site ST02.

The second reported leak occurred in 1989 during repairs to the pipeline. This leak was east of VP26 and an estimated 100 gallons of JP-4 were released.

1.2 Summary of Previous Investigations

Previous investigations at Site ST02 have included a Stage 2/Phase 2 Remedial Investigation (RI) (Harding Lawson Associates, 1992), a Preliminary Assessment/Site Inspection (EA Engineering, Science, and Technology, Inc., 1997), and the Phase 1 and Phase 2 RIs (DoN, 2009 and 2012a). The investigations conducted during the 1990s were limited in scope and did not include the former booster station or VP26. The Phase 1 and Phase 2 RIs addressed Site ST02 in its entirety, including the previously investigated areas. The results of the Phase 1 and Phase 2 RIs served as the basis of the Remedial Action Alternatives (RAA) and Remedial Design (RD) (DoN, 2012b and 2013b) and are summarized below.

During the Phase 1 and Phase 2 RIs (DoN, 2009 and 2012a), contaminants of potential concern (COPCs) were selected based on State of Hawaii Department of Health (HDOH) guidance and the type of products conveyed by the Hickam POL Pipeline (e.g. AVGAS, MOGAS, JP-4, and JP-8). The following sections present a summary of the magnitude and extent of COPCs found in the identified matrices (soil, soil vapor, groundwater, and stream sediment), based on the RIs:

Soil - Vadose zone soil contaminants were identified in five soil borings (VP26-B02, VP26-B05, VP26-B07, VP26-B11, and ST02-B38) that exceeded HDOH Tier 1 Environmental Action Levels (EALs) or hydrocarbon fraction screening levels. Contaminants exceeding screening criteria in one or more of the soil borings included benzene, toluene, ethylbenzene, and total xylenes (BTEX), naphthalene, 1- and 2-methylnaphthalenes, C5-C8 aliphatics, C9-C12 aliphatics, C9-C10 aromatics, C11-C22 aromatics, total petroleum hydrocarbons as gasoline (TPH-g), total petroleum hydrocarbons as diesel fuel (TPH-d), and volatile petroleum hydrocarbons.

Soil Vapor - Shallow soil vapor sample (5 feet bgs) results were compared to the HDOH EALs for shallow soil vapor intrusion into indoor air while deeper soil vapor sample results were collected for characterization purposes and to serve as a baseline to assess progress of the selected remedy. Shallow soil vapor sampling results indicated that TPH-g exceeded the 2009 EAL (26,000 micrograms per cubic meter [$\mu g/m^3$]) at two locations; however, these results did not exceed the updated 2012 EAL for TPH-g (130,000 $\mu g/m^3$). No other EALs were exceeded in shallow soil vapor. Results of soil vapor samples collected from deeper than 5 feet bgs document elevated concentrations of BTEX, 1,2-dichloroethane (1,2-DCA), methane, and TPH-g in the area of VP26. Additionally, soil vapor samples collected from greater than 5 feet bgs were associated with low concentrations of oxygen (O_2) and elevated concentrations of carbon dioxide (CO_2) in areas with high soil vapor photoionization detector results, total volatile hydrocarbons, and TPH-g concentrations.

Groundwater - In shallow aquifer groundwater samples, the most conservative EALs or hydrocarbon fraction screening levels were exceeded for the target analytes except for organic lead, which has no screening level. Concentrations of COPCs near Waiawa Stream exceeded toxicity-based drinking water EALs; however, concentrations of COPCs in wells nearest the stream were below aquatic habitat protection based EALs. Natural attenuation indication parameters including pH, oxidation reduction potential (ORP), alkalinity, dissolved oxygen (DO), nitrate/nitrite, manganese, ferrous iron, sulfate, and methane provided limited evidence that anaerobic biodegradation of residual hydrocarbons was occurring in groundwater. Methane data also indicates that biodegradation of fuel hydrocarbons, including TPH-g, was occurring via methanogenesis. There were no exceedances of EALs in deep aquifer groundwater samples collected from a supply well in Waiawa Village and the aquaculture systems at the nearby Former RC Farms property.

Stream Sediment - Although the groundwater plume extends to Waiawa Stream, based on sediment sampling results during the Phase 2 RI it was concluded that plume-related impacts to the stream were minimal. No COPCs were detected above sediment screening levels (DoN, 2012a).

The results of the Phase 1 and Phase 2 RIs (DoN, 2009 and 2012a) indicated that measurable light nonaqueous phase liquid (LNAPL) was primarily confined to eight wells located on the U.S. Government property. Apparent LNAPL thickness ranged from 0.01 to 2.86 feet. LNAPL had limited mobility and was unlikely to migrate within the aquifer.

An Environmental Hazard Evaluation was conducted as part of the RAA (DoN, 2012b). The Environmental Hazard Evaluation concluded that fuel contamination at Site ST02 presented potentially unacceptable risks to human and ecological receptors (DoN, 2013c).

The RAA evaluated various remedial alternatives for the site against evaluation criteria contained within the National Contingency Plan. The selected alternative specified land use controls (LUCs) with monitored natural attenuation (MNA), bioventing, dual phase extraction, and sulfate injection. Sulfate injection was also included in this alternative to address the dissolved-phase contaminant plume in groundwater down gradient of the source area. This alternative was recommended to reduce contaminant concentrations and to mitigate potential exposure risks until such a time that the site is considered suitable for unrestricted use and unlimited exposure. The findings of the RAA were presented in the RAM (DoN, 2013a) and used to develop the RD (DoN, 2013b).

Based upon the data collected during the previous investigations and the results presented in the Comprehensive Remedial Investigation (CRI) Report, RAA Report, and the RAM (DoN, 2012a, 2012b, and 2013a), the media of concern at Site ST02 were identified as soil, soil vapor, and groundwater.

1.3 Remedial Action Objectives

The remedial action objectives (RAOs) describe how potential risks to residential, commercial/industrial, and ecological receptors will be mitigated. RAOs may be accomplished by ensuring exposure pathways are not completed, or by reducing concentrations of contaminants of concern (COCs) at exposure points to protective concentrations. The planned remedial alternative (DoN, 2013a) was designed to meet these specific RAOs:

- RAO 1: Prevent current intrusive workers, commercial/industrial workers, and hypothetical future residents and recreational site users from being exposed to contaminants in air, soil, and groundwater via inhalation, incidental ingestion, and dermal contact at concentrations that could pose a hazard.
- RAO 2: Mitigate leaching of contaminants from unsaturated soil and basalt to groundwater.
- RAO 3: Prevent human receptors from being exposed to contaminants in soil vapor via volatilization into indoor air at concentrations that could present a hazard.
- RAO 4: Prevent human receptors from being exposed to contaminants in shallow groundwater at concentrations that could present a hazard due to development of the shallow aquifer as a potable water source.
- RAO 5: Mitigate potential explosion hazards associated with accumulation of explosive vapors in a trench, excavation, or enclosed building space (e.g., crawl space or basement).
- RAO 6: Prevent human and ecological receptors from being exposed to LNAPL in the bed of Waiawa Stream, residual contaminants in Waiawa Stream sediments at concentrations that could present a hazard, and dissolved contaminants in shallow groundwater in the bed of Waiawa Stream at concentrations that could present a hazard.

1.4 Contaminants of Concern and Remedial Action Cleanup Goals

The COCs at Site ST02 include:

- Volatile organic compounds (VOCs) including BTEX, ethylene dibromide (EDB), and 1,2-DCA
- Polycyclic aromatic compounds (PAHs) including 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene
- TPH-g and TPH-d
- Lead.

The site-specific Remedial Action Cleanup Goals (RACGs) developed from the 2012 CRI (DoN, 2012a) data and presented in the RAA Report (DoN, 2012b) and the Environmental Hazard Management Plan for Sites Associated with the Hickam Petroleum, Oils, and Lubricants System (DoN, 2013c), are included in Table 3.

The HDOH EALs appropriate for Site ST02 (Groundwater Category A-2) are based on the classification of the uppermost underlying aquifer as a freshwater aquifer (i.e., potential drinking water source; Mink and Lau, 1990) and the fact that the site is located within 150 meters of a surface water body (HDOH, 2012) that is hydraulically connected to the shallow aquifer. The 2012 HDOH Tier 1 EALs were presented in the 2012 CRI as they were current at the time of document publication.

1.5 Description and Status of Selected Remedy

The selected remedy for Site ST02, presented in the RAM (DoN, 2013a), consisted of the following elements:

- Multi-phase extraction (MPX) to treat contaminated materials near the soil-water interface including the capillary zone and smear zone.
- Bioventing to treat vadose zone materials in the source area.
- MNA using LTM to verify that the plume is stable or decreasing, to document and track natural degradation of hydrocarbons in soil and groundwater before, during, and after completion of multi-phase extraction and bioventing treatment, and to evaluate potential impacts to Waiawa Stream related to discharge of shallow groundwater into the stream.
- LUCs to mitigate potential exposures.

The status of the selected remedy is discussed further below.

The remedial systems were installed at the site in 2015 in accordance with the RD (DoN, 2013a) as described in the Remedial Construction Verification Report (DoN, 2017a). Based on approximately two years of MPX operation (Years 1 and 2 of RAO), the monitoring data indicated that the operation of this portion of the selected remedy was at completion. No free phase LNAPL has been observed in the site wells for more than two years, and vapor extraction monitoring data illustrate an approaching asymptotic condition for removal of volatile hydrocarbon fractions. Therefore, fuel recovery using the MPX system is likely no longer efficient or cost effective (DoN, 2016 and 2017b) and has been discontinued.

The wells included in the LTM program for Site ST02 and the rationale for their inclusion were presented in the RAM (DoN, 2012a). The selected wells that were not found to contain LNAPL were to be sampled quarterly for the first two years of monitoring; this work was completed in April 2017. A summary of the quarterly LTM events performed during the first and second years of monitoring (Year 1 and Year 2) is presented in the Second Annual and Eighth Quarterly Long-Term Monitoring Report (DoN, 2017c). A summary of the quarterly LTM events performed during the third year of monitoring (Year 3) is presented in the Annual and Twelfth Quarterly Long-Term Monitoring Report (DoN, 2018a). The documentation of the 13th, 14th, and 15th quarterly events performed during Year 4 are presented in the respective reports (DoN, 2018b, 2019b, and 2019c).

The monitoring network and COCs for the LTM program was revised before the 13th quarterly event based on the evaluation of the historical groundwater data, plume stability, and the performance of the remedial systems (DoN, 2018b), in accordance with the RD (DoN, 2013a). The currently implemented monitoring network is presented Table 1. The wells that were included in the LTM program for the sole purpose of monitoring the performance of the remedial systems have been removed.

1.6 Scope of Work

The scope of work for this project consists of the following tasks:

- Clearing and controlling vegetation at the project site.
- Conducting an annual site review and inspections (to be performed in Fall 2020) to monitor the effectiveness of LUCs.
- Performing long-term groundwater and soil vapor monitoring.
- Implementing, maintaining, reporting, and enforcing LUCs, including replacement of broken sections of chain-link fence.
- Characterizing and disposing of project generated wastes.

1.7 Report Purpose and Organization

This report describes activities performed for the 18th quarterly LTM event for Site ST02 and is organized as follows:

- Section 1 presents the background of Site ST02 and an overview of the project.
- Section 2 describes the LTM field activities.
- Section 3 presents and interprets the groundwater monitoring results and evaluates natural attenuation.
- Section 4 presents a summary and the conclusions.
- Section 5 contains the references cited in the report.

The following appendices are also included in this document:

- Appendix A includes groundwater and soil vapor sampling forms.

- Appendix B includes the data reports from the offsite laboratory.
- Appendix C includes the data quality assessment report.

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2 FIELD ACTIVITIES

The field activities in support of the 18th quarterly LTM event at Site ST02 were conducted in June/July 2020. These activities, which included well inspections, water level measurements, and groundwater and soil vapor sampling, are discussed in this section. The locations of the monitoring wells at the site and in the vicinity are shown in Figure 3. The wells sampled during this event included those designated for quarterly and semiannual monitoring.

2.1 Monitoring Well Inspections

During the 18th quarterly LTM event, the 12 wells included in the groundwater LTM network for quarterly and semiannual monitoring were located and found to be in good condition. Groundwater samples could not be collected during this LTM event at ST02-B67 (sentinel well) and VP26-B13 (cross gradient) because not enough water was in the wells at the time of sampling.

2.2 Vegetation Maintenance

Vegetation maintenance was performed at the site as necessary to safely access monitoring locations and around security features such as the fence.

2.3 Sampling Procedures

Between 10 June and 10 July 2020, groundwater samples were collected from 10 monitoring wells in accordance with NAVFAC Pacific Environmental Restoration Program (ERP), Procedure No. I-C-3, “Monitoring Well Sampling” (DoN, 2015). Note that wells ST02-B67 and VP26-B13 did not have enough water to sample at the time of sampling. Groundwater sampling was performed by field samplers with specific training in low-flow groundwater sampling methods, records documentation, chain-of-custody procedures, and sample handling procedures described in the RAO-WP (DoN, 2019a).

Prior to removing the water from a monitoring well and before groundwater sampling, each monitoring well was gauged with an oil/water interface probe to measure the depth of the static water level and total well depth to the nearest 0.01 foot from a datum of known elevation (i.e., top of well casing) and to evaluate the presence of LNAPL. No LNAPL was detected in wells sampled. This procedure also checked the well for obstructions prior to insertion of the pump. The well gauging data are presented on the groundwater sampling logs in Appendix A.

The wells were purged with a submersible low-flow bladder pump. The purging was conducted at a flow rate sufficiently low to minimize drawdown in the well. For low-flow/minimal draw-down sampling of the wells, each monitoring well was purged with a bladder pump through a flow-through cell before sampling to establish stable groundwater parameters. The stability of the groundwater parameters (pH, specific conductance, DO, ORP, and turbidity) was measured using a water quality meter. Once purging was complete and field parameter stabilization was achieved, the discharge tubing was disconnected from the flow-through cell and directed into laboratory-supplied containers for the collection of groundwater samples.

Pertinent observations and measurements were recorded on the groundwater sampling logs which are included in Appendix A.

2.4 Soil Vapor Sampling

Vapor points at each well and several depths were purged of at least one well volume and monitored for %O_2, %CO_2, and %methane, using direct read instruments in the field (LandTec Gem™ 2000+ landfill gas meter calibrated with methane), and for VOCs using a MiniRAE 3000™ photoionization detector.

Quarterly soil vapor monitoring was performed on 10 June 2020 at four wells (VP26-B05A/B, VP26 B07, VP26-B08, and VP26-B11) and multiple depths using a portable gas meter and photo-ionization detector. Field screening was performed for the following:

- Percent O_2
- Percent CO_2
- Total VOCs
- Methane.

2.5 Sample Management and Chain of Custody

Groundwater samples collected during this field effort were immediately labeled and placed in a cooler containing ice following collection. Prior to shipment, the sample coolers were repacked with fresh ice and custody seals were affixed. Sample labeling and record keeping was conducted in accordance with NAVFAC Pacific ERP Procedure No. III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody Procedures* (DoN 2015). Chain-of-custody documentation is presented in Appendix B.

2.6 Laboratory Sample Analysis

The groundwater samples were submitted to Pace Analytical Services in Mt. Juliet, Tennessee for the scope of testing outlined in Section 3. Pace Analytical Services is accredited in accordance with the Department of Defense Environmental Laboratory Accreditation Program for the target analytes and methods. Quality assurance/quality control (QA/QC) procedures were followed routinely during the groundwater sampling and analysis task. Trip blanks, field duplicates, and aliquots for matrix spike/matrix spike duplicates were collected. The QA/QC procedures performed were consistent with those specified in the RAO-WP (DoN, 2019a). The data quality assessment report for the data collected during the 18th quarterly LTM sampling event is provided in Appendix C.

The groundwater samples were analyzed for:

- VOCs (BTEX, EDB, and 1,2-DCA) by United States Environmental Protection Agency (USEPA) Method SW8260B
- PAHs (naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene) by USEPA Method SW8270C using selected ion monitoring mode
- TPH-g and TPH-d by USEPA Method SW8015D
- Dissolved lead by USEPA Method SW6020

MNA parameters included the following:

- Alkalinity by USEPA Method SM2320B
- Dissolved oxygen, ferrous iron, ORP, and pH by field test
- Methane by Method RSK-175
- Nitrate/nitrite by USEPA Method 353.2
- Sulfate by USEPA Method E300.0
- Total dissolved solids by Method SM2540D
- Total organic carbon by Method SM5310C.

MNA parameters were included for analysis at in-plume wells with historical elevated TPH contamination (ST02-B57 and ST02-B62).

2.7 Investigation-Derived Waste Management

The investigation-derived waste was primarily generated during the purging and sampling of the wells at the site. Specifically, the types of waste generated during the field activities included the following:

- Purge water from groundwater sampling activities
- Fluids generated during decontamination of non-consumable sampling equipment (i.e., water quality probe and decontamination of the pump)
- Miscellaneous non-operational derived waste comprised primarily of spent disposable personal protective equipment and groundwater sampling tubing.

The purge and decontamination water is currently stored in a drum on secondary containment onsite. Miscellaneous non-operational derived waste was double-bagged and disposed as municipal solid waste.

3 ANALYTICAL RESULTS

The analytical results for groundwater and soil vapor samples collected during the 18th quarterly LTM event at Site ST02 are presented below.

3.1 Groundwater Monitoring Results

The analytical results for the groundwater samples collected during the 18th quarterly LTM event performed in June/July 2020 are summarized in Table 3 and Figure 5. Table 3 also lists the RACG for each contaminant.

The complete laboratory reports, including chain-of-custody records and case narratives are presented in Appendix B. The data validation reports are presented in Appendix C.

3.1.1 Total Petroleum Hydrocarbons

During the 18th quarterly LTM event, TPH-g and/or TPH-d were detected at concentrations exceeding the RACGs in groundwater samples collected at three wells. The highest TPH-g of 5.14 milligrams per liter (mg/L) was detected in the sample collected from ST02-B38. The TPH results detected above RACGs, concentrations, and associated sample locations are as follows:

- TPH-g was detected above the RACG of 0.10 mg/L at three in-plume wells (ST02-B38, ST02-B57, and ST02-B62) at concentrations ranging from 0.441 to 5.14 mg/L.
- TPH-d was detected above the RACG of 0.10 mg/L at three in-plume wells (ST02-B38, ST02-B57, and ST02-B62) at concentrations ranging from 0.254 to 0.708 mg/L. TPH-d was detected at the RACG of 0.10 mg/L in one sentinel well (VP26-B21).

3.1.2 Volatile Organic Compounds

During the 18th quarterly LTM event, VOCs were detected at concentrations exceeding the RACGs in groundwater samples collected at one well. The compounds detected above RACGs, concentrations, and associated sample locations are as follows:

- Benzene was detected above the RACG of 5.0 micrograms per liter (µg/L) at one in-plume well (ST02-B38) at a concentration of 198 µg/L.
- Ethylbenzene was detected above the RACG of 30 µg/L at one in-plume well (ST02-B38) at a concentration of 37.6 µg/L.
- Xylenes (total) were detected above the RACG of 20 µg/L at one in-plume well (ST02-B38) at a concentration of 92.1 µg/L.

3.1.3 Polycyclic Aromatic Hydrocarbons

During the 18th quarterly LTM event, no PAHs were detected above their respective RACGs.

3.1.4 Dissolved Lead

During the 18th quarterly LTM event, dissolved lead was not detected above the RACG of 5.6 µg/L.

3.2 Soil Vapor Monitoring

Field screening results show that the O_2 level was above 10 percent in the 20 feet below grade interval in VP26-B07. Depleted oxygen readings indicate higher COC concentrations remain at the deeper monitoring points in wells VP26-B05A/B and VP26-B11 (source area). The shallower well depths are able to sustain O_2 concentrations above 10 percent for extended periods. VOCs are above 100 parts per million by volume in the 24 feet below grade interval in VP26-B05A/B and the 31 feet below grade interval in VP26-B11 (Table 4).

3.3 Evaluation of Natural Attenuation

In accordance with the requirements of the RAO-WP (DoN, 2019), the natural attenuation of petroleum hydrocarbons in groundwater was evaluated. Natural attenuation indication parameters including alkalinity, pH, nitrate/nitrite, ORP, sulfate, and total organic carbon provided limited evidence that biodegradation of residual hydrocarbons was occurring in groundwater collected from ST02-B57 (anaerobic) and ST02-B62 (aerobic). Methane data also indicate that the biodegradation of fuel hydrocarbons, including TPH-g, was occurring via methanogenesis in well ST02-B38. The results for MNA parameters for groundwater samples collected during the 18th quarterly LTM event are reported in Table 3.

In general, high dissolved methane concentrations were observed in wells with high TPH concentrations, indicating that anaerobic biodegradation of petroleum hydrocarbons is occurring at the site. Nitrate/nitrite concentrations are generally depleted, suggesting it may have acted as a primary electron acceptor.

3.4 Data Quality Evaluation and Management

Groundwater analytical data were evaluated following guidelines outlined in the project-specific Sampling and Analysis Plan presented in Appendix B of the RAO-WP (DoN, 2019a). The data collected met the quality objectives of the project and can be used as qualified. No data were qualified with the “R” flag, which indicates that the data should be considered unusable. Data qualified with the “UJ” (nondetectable results) or “J” (detectable results) flags should be considered estimated minimum concentrations. A summary of data validation findings, including additional qualification of data and flagging criteria used is presented in further detail in Appendix C.

The laboratory reports and the data validation reports are included as Appendices B and C, respectively. The analytical data from the groundwater monitoring activities has been uploaded into the Navy Installation Restoration Information Solutions System.

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4 SUMMARY AND CONCLUSIONS

The groundwater monitoring activities conducted during the 18th quarterly LTM event at Site ST02 included well gauging, inspections and maintenance of wells and LUCs (e.g., fencing, signage), soil gas and groundwater sampling, field testing, and laboratory analysis.

During the 18th quarterly LTM event, 12 monitoring wells (in-plume, plume edge, and sentinel) included in the groundwater monitoring network for quarterly and semiannual sampling were located, inspected, gauged, and found to be in good condition: wells ST02-B33, ST02-B38, ST02-B57, ST02-B60, ST02-B61, ST02-B62, ST02-B63, ST02-B65, ST02-B67, ST02-SD06, VP26-B13, and VP26-B17. Wells ST02-B67 and VP26-B13 (sentinel wells) did not have enough water and could not be sampled during the 18th quarterly LTM event. Groundwater samples were collected from 10 monitoring wells and analyzed for the following COCs:

- VOCs (BTEX, EDB, 1,2-DCA)
- PAHs (naphthalene, 1-methylnapthalene, 2-methylnapthalene)
- TPH-g
- TPH-d
- Dissolved lead.

The data generated from wells included in the monitoring well network was compared to the site-specific RACGs. COCs (TPH-g, TPH-d, benzene, ethylbenzene, and xylenes) were detected at concentrations exceeding the RACGs in 3 of the 10 wells sampled. Exceedances were reported at three in-plume monitoring wells (ST02-B38, ST02-B57, and ST02-B62).

Groundwater samples were collected from two in-plume wells (ST02-B57 and ST02-B62) and analyzed for the following natural attenuation parameters:

- Alkalinity
- Dissolved oxygen
- Ferrous iron
- Methane
- Nitrate/nitrite
- ORP
- pH
- Sulfate
- Total organic carbon
- Total dissolved solids.

The natural attenuation of petroleum hydrocarbons in groundwater was evaluated using the results of MNA parameters. There is evidence that biodegradation of petroleum hydrocarbons is occurring at this site based on the results of MNA parameters in wells with high concentrations of petroleum hydrocarbons.

Soil vapor monitoring of four wells (VP26-B05A/B, VP26-B07, VP26-B08, and VP26-B11) was performed on 10 June 2020. Vapor points at each well were purged of at least one well volume and monitored for %O_2, %CO_2, and %methane.

In summary, no LNAPL recovery has occurred since operation of the remedial systems ceased, but dissolved phase and vapor phase concentrations continue to exceed the RACGs within the plume. Based on the LTM results, the MNA remedy appears to be effective and biodegradation appears to be occurring and contaminant concentration data from monitoring performed between 2014 and 2020 provide supporting evidence (DoN, 2017c, 2018a, 2018b, 2019b, and 2019c). The LTM program at Site ST02 will continue in accordance with the RD (DoN, 2013b) and the RAO-WP (DoN, 2019a).

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Figures

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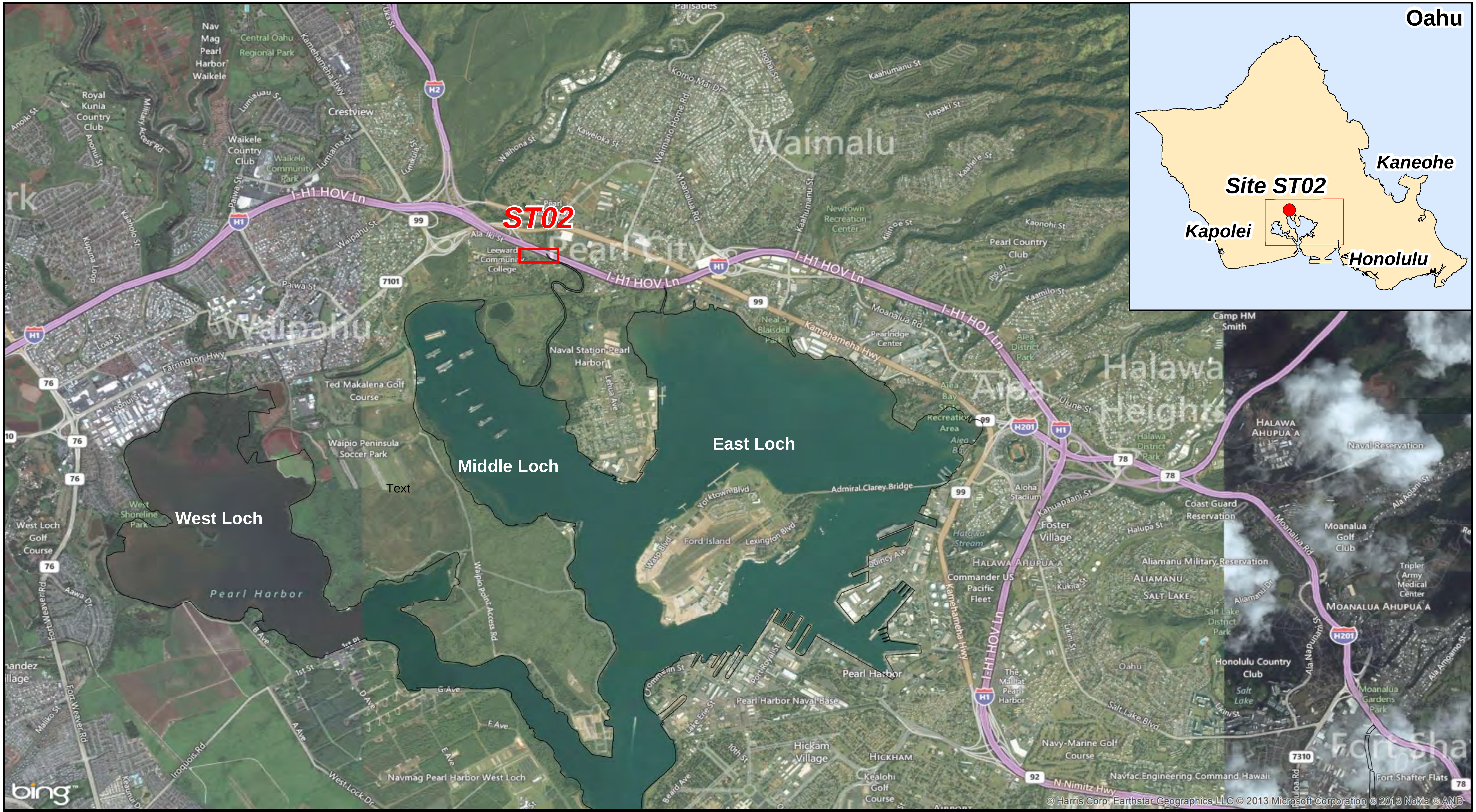
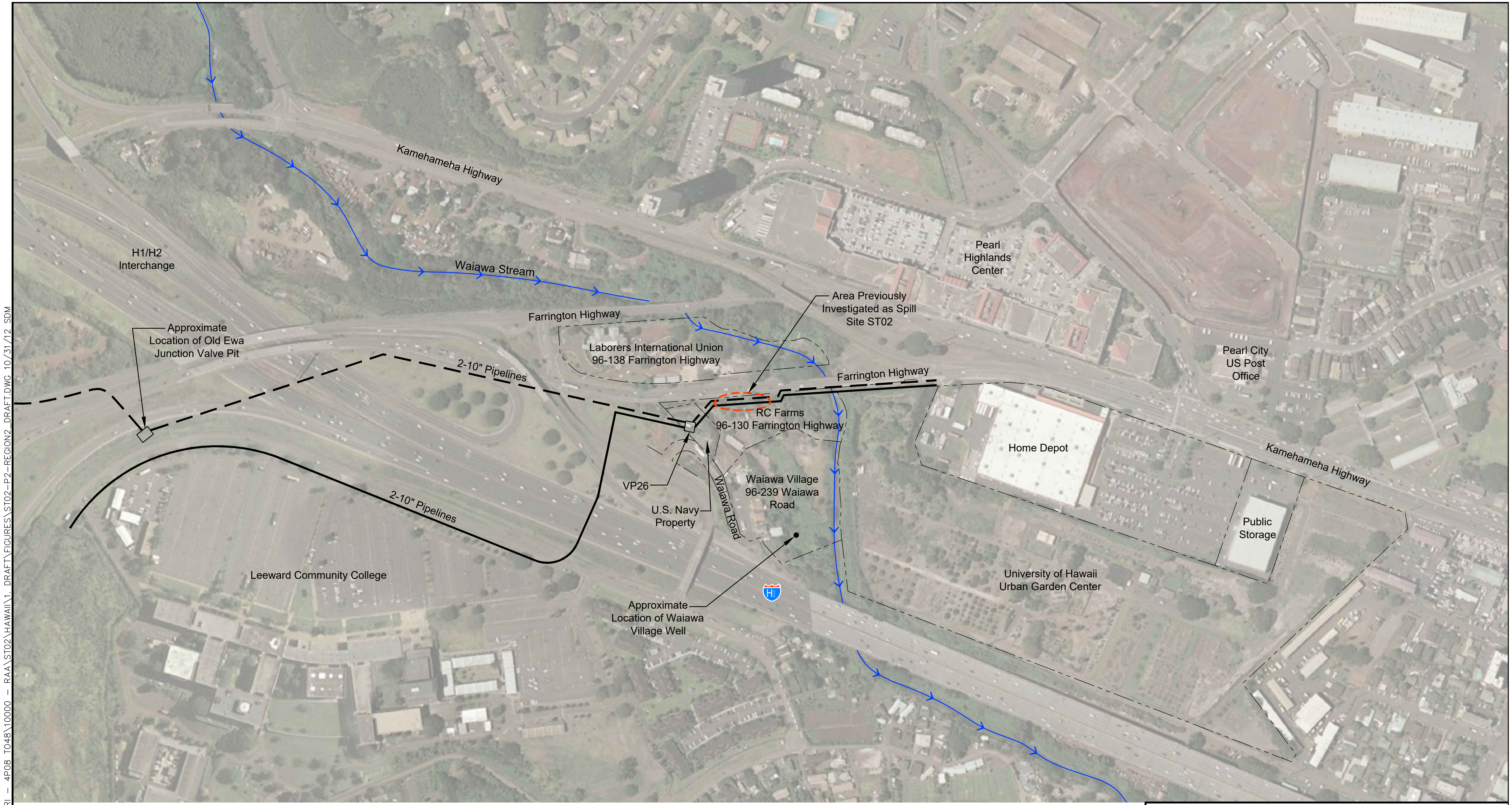


FIGURE 1

SITE LOCATION
SITE ST02

Hickam POL Pipeline
Joint Base Pearl Harbor-Hickam



LEGEND

→	Waiawa Stream and Direction of Flow
– – –	Approximate Location of Original Fuel Lines, Abandoned in Place 1953 to 1955
──	Approximate Location of Relocated Fuel Lines, Abandoned in Place
- - -	Property Boundary

0' 350'

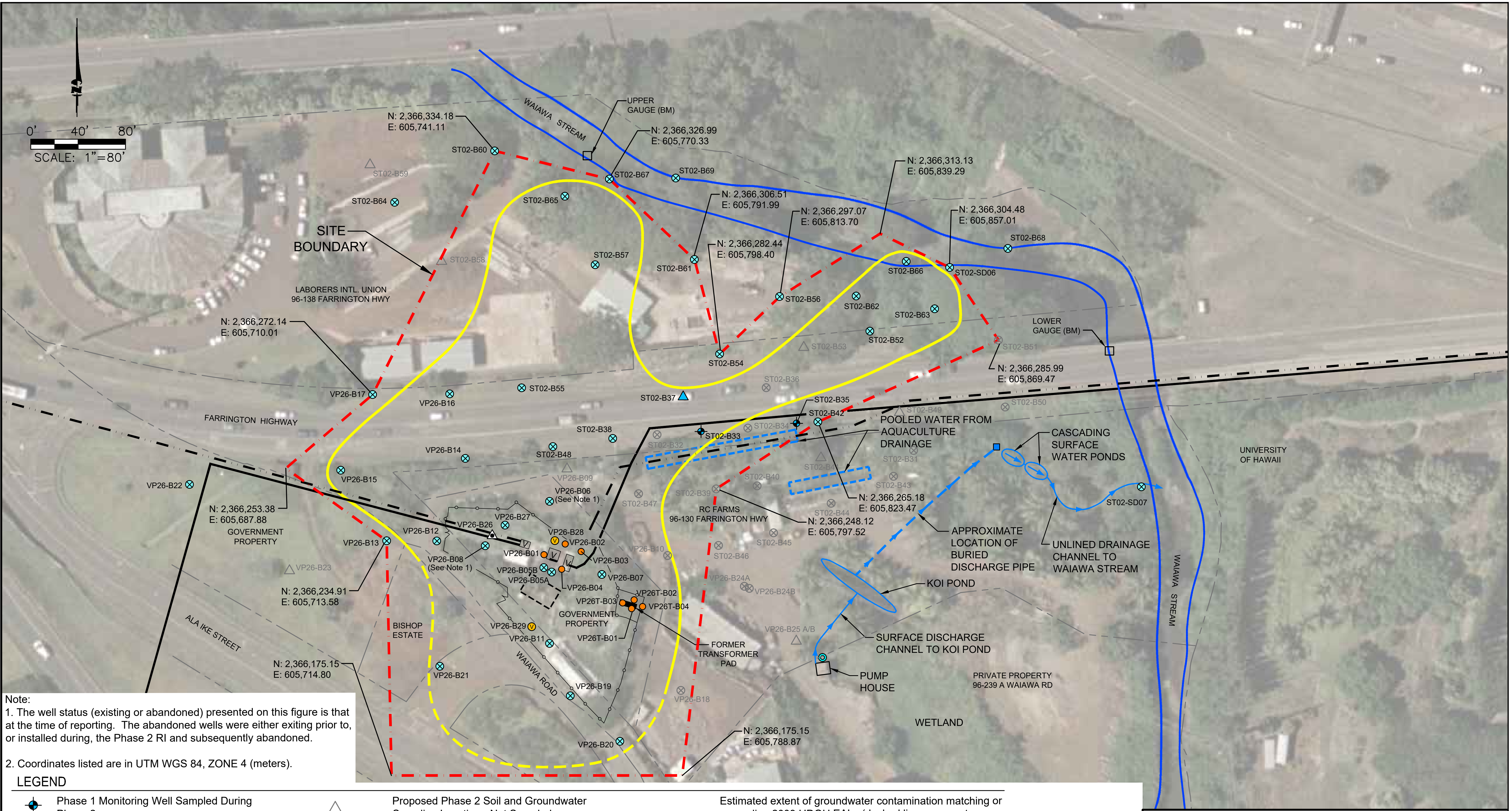
SCALE: 1"=350'

FIGURE 2

REGIONAL LAYOUT
SITE ST02

Hickam POL Pipeline
Joint Base Pearl Harbor-Hickam, Hawaii

S:\ES\REMED\746859 – HPOL_PH_2_RI – 4P08_T048\10000 – RAA\ST02\HAWAII\1._DRAFT\FIGURES\ST02–P2–REGION2_DRAFT.DWG 10/31/12 SDM



Note:
1. The well status (existing or abandoned) presented on this figure is that at the time of reporting. The abandoned wells were either exiting prior to, or installed during, the Phase 2 RI and subsequently abandoned.

2. Coordinates listed are in UTM WGS 84, ZONE 4 (meters).

LEGEND

⯐ Phase 1 Monitoring Well Sampled During Phase 2
● Phase 1 Soil and Soil Vapor Sampling Location
⊗ Phase 2 Sampling Location and Groundwater Monitoring Well
⊗ Abandoned Well (See Note 1)
V Valve Pit
▲ Phase 2 Soil Sample Location
□ Stream Gauging Benchmark
◎ Active Irrigation Well

△ Proposed Phase 2 Soil and Groundwater Sampling Location - Not Sampled
▲ Light Non-Aqueous Phase Liquid (LNAPL) Recovery Well
V Bioventing Well
■ Koi Pond Effluent Transition To Surface Flow
— — — Approximate Property Boundary
—o—o— Chainlink Fence
▭ Former Waiawa Booster Station

— · — Estimated extent of groundwater contamination matching or exceeding 2009 HDOH EALs (dashed line represents undefined extent)
—— Approximate location of realigned Hickam POL Pipeline (taken out of service March 1993)
— · — Approximate location of Hickam POL Pipeline (abandoned in-place mid-1950's)
—— Approximate location of stream bank
— · — Site Boundary

FIGURE 3

SITE BOUNDARY
SITE ST02

Hickam POL Pipeline
Joint Base Pearl Harbor-Hickam, Hawaii

Honolulu, Hawaii

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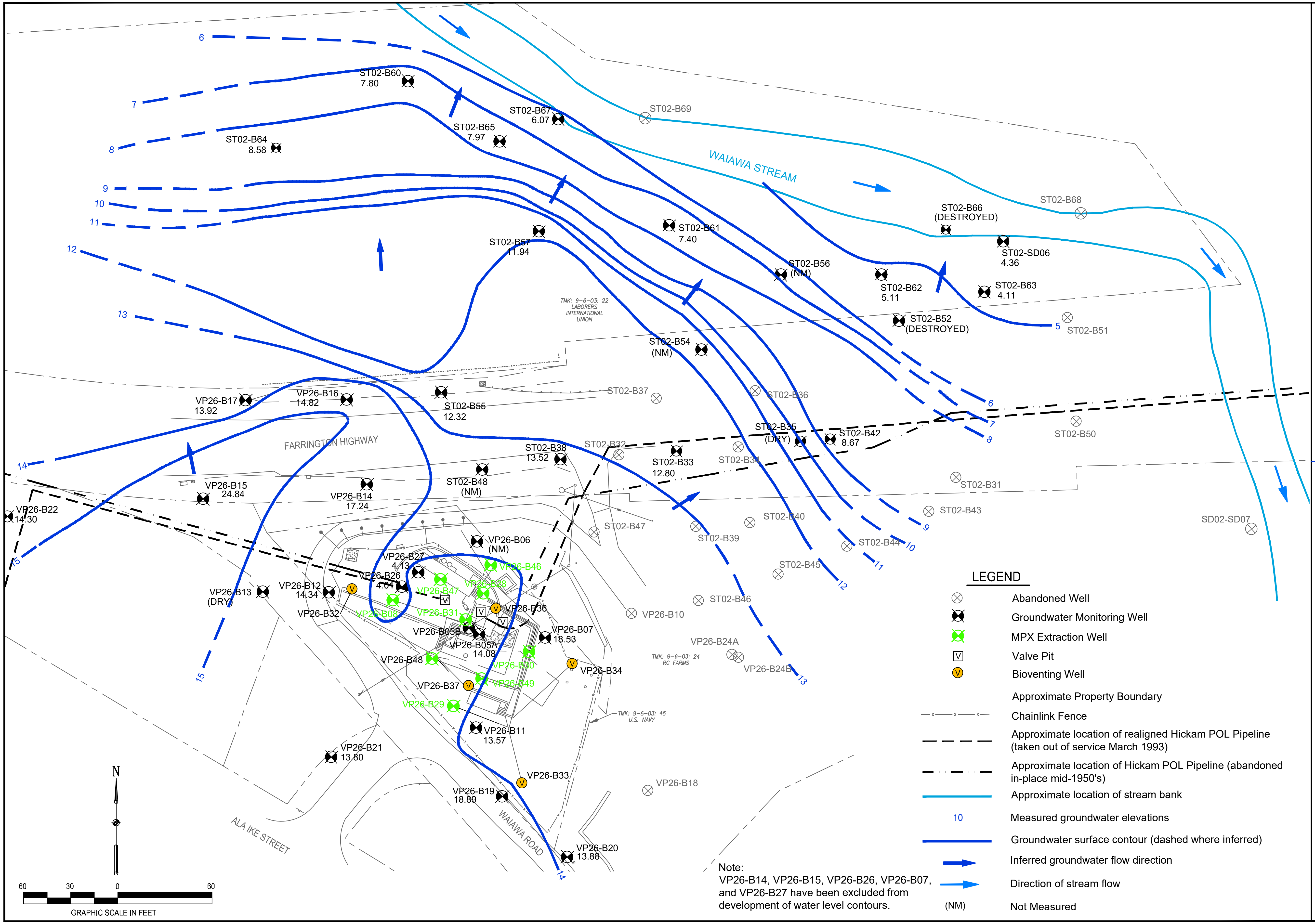

LEGEND

⊗	Abandoned Well
⊗	Groundwater Monitoring Well
⊗	MPX Extraction Well
V	Valve Pit
V	Bioventing Well
— - —	Approximate Property Boundary
—x—x—	Chainlink Fence
— — —	Approximate location of realigned Hickam POL Pipeline (taken out of service March 1993)
— · —	Approximate location of Hickam POL Pipeline (abandoned in-place mid-1950's)
——	Approximate location of stream bank
10	Measured groundwater elevations
——	Groundwater surface contour (dashed where inferred)
➡	Inferred groundwater flow direction
➡	Direction of stream flow
(NM)	Not Measured

Note:
VP26-B14, VP26-B15, VP26-B26, VP26-B07, and VP26-B27 have been excluded from development of water level contours.

GROUNDWATER SURFACE CONTOURS
JUNE 17, 2020
SITE ST02

SITE ST02 WAIAWA BOOSTER PUMP STATION AT
JOINT BASE PEARL HARBOR-HICKAM
OAHU, HAWAII

FIGURE	4
DRAWING NO.	-
FILE NAME	-
PROJECT NO.	6308717
SCALE	AS SHOWN
DATE	AUG 2020
CHECKED BY	JH
DRAWN BY	CNS
DESIGNED BY	JH
PROJECT MGR.	BN

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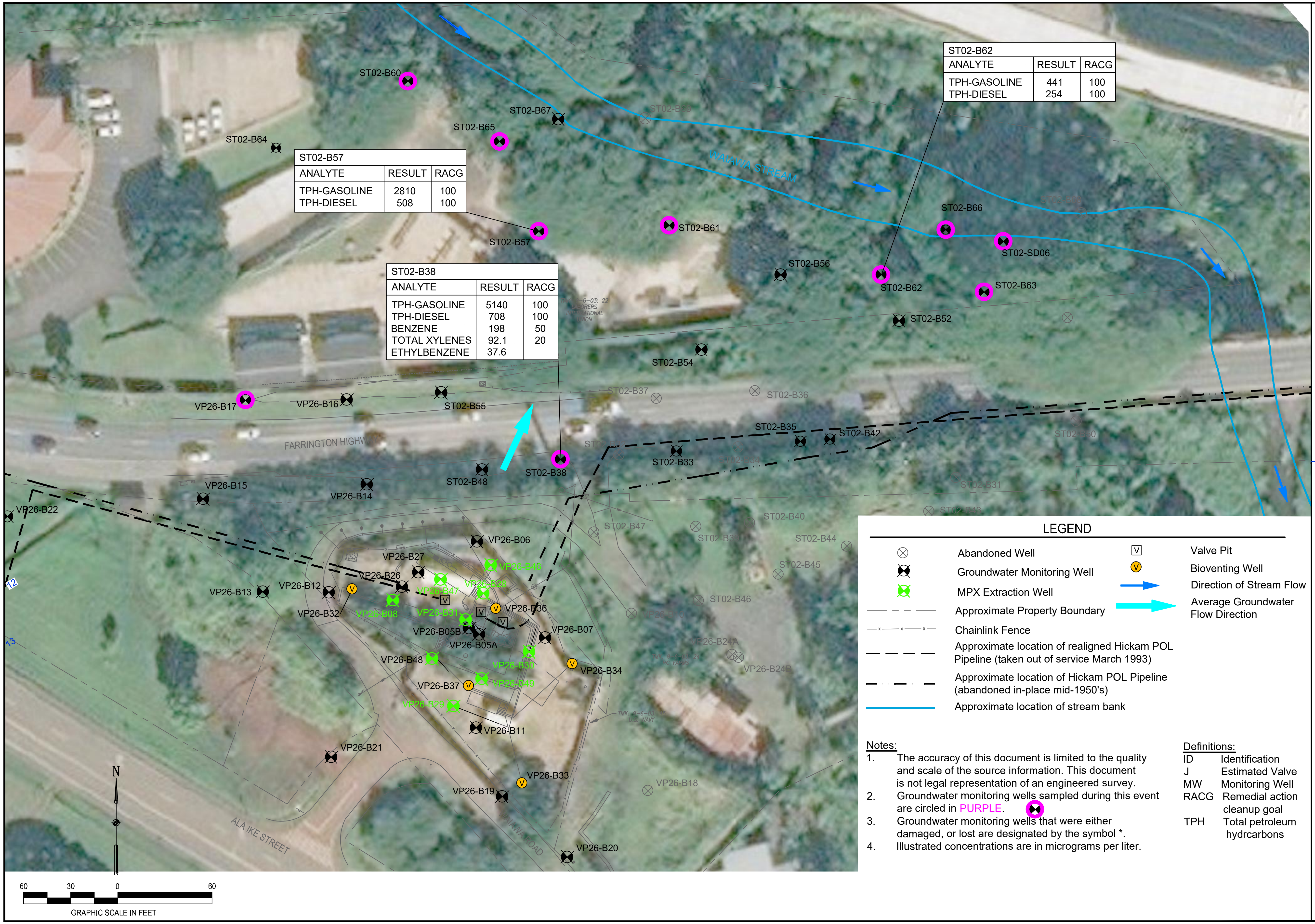

ST02-B62

ANALYTE	RESULT	RACG
TPH-GASOLINE	441	100
TPH-DIESEL	254	100

ST02-B57

ANALYTE	RESULT	RACG
TPH-GASOLINE	2810	100
TPH-DIESEL	508	100

ST02-B38

ANALYTE	RESULT	RACG
TPH-GASOLINE	5140	100
TPH-DIESEL	708	100
BENZENE	198	50
TOTAL XYLENES	92.1	20
ETHYLBENZENE	37.6	

LEGEND

⊗	Abandoned Well	V	Valve Pit
⊗	Groundwater Monitoring Well	Ⓥ	Bioventing Well
⊗	MPX Extraction Well	→	Direction of Stream Flow
— – – —	Approximate Property Boundary	→	Average Groundwater Flow Direction
—x—x—x—	Chainlink Fence		
— — — —	Approximate location of realigned Hickam POL Pipeline (taken out of service March 1993)		
— · · — · · —	Approximate location of Hickam POL Pipeline (abandoned in-place mid-1950's)		
——	Approximate location of stream bank		

Notes:
1. The accuracy of this document is limited to the quality and scale of the source information. This document is not legal representation of an engineered survey.
2. Groundwater monitoring wells sampled during this event are circled in PURPLE. ⊗
3. Groundwater monitoring wells that were either damaged, or lost are designated by the symbol *.
4. Illustrated concentrations are in micrograms per liter.

Definitions:

ID	Identification
J	Estimated Valve
MW	Monitoring Well
RACG	Remedial action cleanup goal
TPH	Total petroleum hydrcarbons

GROUNDWATER SAMPLE EXCEEDANCES
JUNE/ JLUY 2020
QUARTERLY LTM REPORT
SITE ST02

SITE ST02 WAIAWA BOOSTER PUMP STATION AT
JOINT BASE PEARL HARBOR-HICKAM
OAHU, HAWAII

FIGURE	5
DRAWING NO.	-
FILE NAME	-
PROJECT NO.	6308717
SCALE	AS SHOWN
DATE	AUG 2020
CHECKED BY	JH
DRAWN BY	CNS
DESIGNED BY	JH
PROJECT MGR.	BN

Tables

Table 1.

Groundwater Long-Term Monitoring Plan

Well ID	UTM Coord (WGS 84, Zone 4)		Surface Elev.	Top of Casing Elev.	Screened Interval	Casing Diam.	Well Type	Sample Status /	Monitoring Objectives			Rationale
	Northing	Easting	(ft amsl)	(ft amsl)	(ft bgs)	(inches)		Frequency	Waiawa Stream Protection	Track Plume Shape/Size	Remedial System Performance	
ST02-B33	2366262.711	605793.6850	28.47	28.12	10-20	1	In-Plume	Quarterly	--	X	--	Along with well ST02-B38, finer definition of movement of plume off site.
ST02-B38	2366260.968	605771.2070	29.69	29.16	17.5-22.5	0.75	In-Plume	Quarterly	--	X	--	Along with well ST02-B33, finer definition of movement of plume off site.
ST02-B48	2366258.885	605755.9530	30.88	30.59	16-26	1	In-Plume	Exclude	--	--	--	Monitor impacts of treated groundwater injection on plume.
ST02-B55	2366273.847	605747.9760	29.63	29.36	16-31	1	In-Plume	Exclude	--	--	--	Monitor impacts of treated groundwater injection on plume.
ST02-B57	2366305.191	605766.7070	24.13	23.67	11-21	1	In-Plume	Quarterly	X	X	--	Track elevated COC concentrations in N plume lobe upgradient of Waiawa Stream
ST02-B60	2366334.175	605741.1100	19.18	18.97	8-18	1	Plume-edge	Quarterly	--	X	--	Continue monitoring cross-gradient plume stability near Waiawa Stream to determine if trend exists
ST02-B61	2366306.513	605791.9890	20.94	20.62	10-20	1	Plume-edge	Quarterly	--	X	--	Confirm stability of plume edge between lobes of the plume.
ST02-B62	2366297.211	605833.2090	19.11	18.77	11-21	1	In-Plume	Quarterly	X	X	--	Track elevated COC concentrations in north plume lobe upgradient of Waiawa Stream.
ST02-B63	2366293.973	605853.1950	16.14	15.85	8.5-18.5	1	In-Plume	Quarterly	X	X	--	Track COC concentrations at plum edge (eastern) near Waiawa Stream.
ST02-B65	2366322.594	605758.9890	23.02	22.68	10-20	1	In-Plume	Quarterly	X	X	--	Track COC concentrations at northern edge of north plume lobe just upgradient of Waiawa Stream.
ST02-SD06	2366303.787	605856.8430	6	6.53	0-2.9	0.75	Sentinel	Quarterly	X	X	--	Track COC concentrations downgradient of east plume lobe where plume discharges to Waiawa Stream. Shallow well on stream bank; not accessible during high water
ST02-B67	2366326.992	605770.3260	7.46	8.23	0.2.66	0.75	Sentinel	Quarterly	X	X	--	Track COC concentrations downgradient of north plume lobe where plume approaches Waiawa Stream. Shallow well on stream bank; not accessible during high water. ST02-B65 & ST02-B61 will provide data to monitor stability of north plume lobe.
VP26-B16	2366272.279	605729.6520	30.84	30.44	15-30	1	In-Plume	Exclude	--	--	--	Monitor impacts of treated groundwater injection on plume.
VP26-B26	2366235.997	605740.5793	44.9	43.6	10-20	4	In-Plume Source Area	Exclude	--	--	--	Assess impacts of remediation on source area well with highly elevated COC concentrations.
ST02-B56	2366297.066	605813.6990	19.70	19.52	8-18	1	Plume-edge	Exclude	--	--	--	Wells ST02-B61 and ST02-B62 will provide data to monitor stability of the western edge of the north plume lobe.
ST02-B66	2366306.018	605845.6590	5.29	6.33	0-2.39	0.75	Sentinel In- Plume	Exclude	--	--	--	Wells ST02-SD06 and ST02-B62 will provide data to monitor stability of the north plume lobe.
VP26-B05	2366228.082	605753.6200	44.88	44.53	28-38	1	In-Plume Source Area	Exclude	--	--	--	Assess impacts of remediation on source area well with highly elevated COC concentrations.
VP26-B06	2366244.915	605755.0780	39.62	39.31	0.2.9	1	In-Plume Source Area	Exclude	--	--	--	Assess impacts of remediation on source area well with highly elevated COC concentrations.
VP26-B11	2366208.77	605755.0900	56.03	55.69	37.5-52.5	1	In-Plume Source Area	Exclude	--	--	--	Assess impacts of remediation on source area well with highly elevated COC concentrations.
VP26-B13	2366234.906	605713.5810	49.81	49.43	33.75-48.75	1	Cross Gradient Plume-edge	Semi-Ann.	--	X	--	Monitor cross-gradient plume stability on west side.
VP26-B14	2366255.871	605733.6310	33.96	33.76	15-30	1	In-Plume	Exclude	--	--	--	Monitor impacts of treated groundwater injection on western edge of plume.
VP26-B17	2366272.139	605710.0080	32.97	32.59	16-31	1	Plume-edge	Semi-Ann.	--	X	--	Monitor cross-gradient plume stability on west side.
VP26-B20	2366183.854	605773.0016	63.52	63.16	46-56	1	In-Plume Upgradient	Annual	--	X	--	Monitor upgradient plume stability on south side.
VP26-B21	2366202.909	605727.0740	58.55	58.11	42-57	1	In-Plume Upgradient	Annual	--	X	--	Monitor up- to cross-gradient plume stability on west side.
VP26-B28	2366234.951	605756.4290	43.48	43.11	16-36	2	In-Plume Source Area	Exclude	--	--	--	Used as MPX well.
ST02-B35	2366264.766	605817.7280	26.87	26.55	10-20	1	Plume-edge	Replace	--	--	--	Monitoring of well ST02-B33 will track limits of east lobe of plume.
ST02-B52	2366288.285	605836.7130	14.54	14.36	3.3-13.3	1	In-Plume	Exclude	--	--	--	Monitoring of wells ST02-B62 and ST02-B63 will track impacts to plume in this area.
ST02-B54	2366282.443	605798.3980	19.12	18.82	9-24	1	Plume-edge	Exclude	--	--	--	Monitoring of well ST02-B61 will track stability of plume edges between the north and east lobes.
ST02-B42	2366265.184	605823.4660	29.69	26.28	9.6-19.6	1	Plume-edge	Exclude	--	--	--	Dry. Well ST02-B33 will monitor plume stability along southern edge of east lobe.
ST02-B64	2366321.061	605715.6310	19.18	18.96	9-19	1	Plume-edge Crossgradient	Exclude	--	--	--	Well ST02-B60 will provide data to monitor stability of the western edge of the north plume lobe.
VP26-B07	2366226.332	605768.4290	46.34	46.05	30-45	1	In-Plume Source Area	Exclude	--	--	--	Assess impacts of remediation on source area well with highly elevated COC concentrations.
VP26-B08	2366233.631	605738.6990	45.74	45.36	27-42	1	In-Plume Source Area	Exclude	--	--	--	Used as MPX well; Other source area wells will be used to assess performance of remedial system.

Table 1.

Groundwater Long-Term Monitoring Plan

Well ID	UTM Coord (WGS 84, Zone 4)		Surface Elev.	Top of Casing Elev.	Screened Interval	Casing Diam.	Well Type	Sample Status /	Monitoring Objectives			Rationale
	Northing	Easting	(ft amsl)	(ft amsl)	(ft bgs)	(inches)		Frequency	Waiawa Stream Protection	Track Plume Shape/Size	Remedial System Performance	
VP26-B12	2366234.846	605726.3810	49.6	49.21	30-45	1	In-Plume	Exclude	--	--	--	Other source area wells with higher COC concentrations will be monitored
VP26-B15	2366252.863	605701.8850	40.61	40.18	23-33	1	In-Plume	Exclude	--	--	--	Monitor impacts of treated groundwater injection on plume.
VP26-B19	2366195.438	605760.3850	59.89	59.56	43-53	1	In-Plume	Exclude	--	--	--	Plume magnitude and stability are adequately assessed with continued monitoring of VP26-B21 and VP26-B20.
VP26-B22	2366249.225	605663.3600	43.3	42.93	25-40	1	Cross-gradient	Exclude	--	--	--	Distant from plume; other wells closer to plume boundary adequtely monitor cross-gradient plume stability.
VP26-B27	2366238.864	605743.7560	43.57	43.30	23-38	2	In-Plume Source Area	Exclude	--	--	--	Other source area wells will be used to assess performance of remedial system.
VP26-B29	2366213.028	605750.5420	55.08	54.76	27-47	2	In-Plume Source Area	Exclude	--	--	--	Used as MPX well

Table 2
Groundwater Elevations in Monitoring Wells at Site ST02 - 17 June 2020

Monitoring Well ID	Date of Measurement	Top of Well Casing Elevation (feet above MSL)	Static Water Level (feet below TOC)	Water Level Elevation (feet above MSL)	Notes
ST02-B33	17-Jun-2020	28.12	15.32	12.80	No cap/lid
ST02-B35	17-Jun-2020	26.55	--	--	Well is dry.
ST02-B38	17-Jun-2020	29.16	15.64	13.52	Odor
ST02-B42	17-Jun-2020	26.28	17.61	8.67	
ST02-B55	17-Jun-2020	29.36	17.04	12.32	
ST02-B57	17-Jun-2020	26.67	14.73	11.94	
ST02-B60	17-Jun-2020	18.97	11.18	7.79	
ST02-B61	17-Jun-2020	20.62	13.22	7.40	
ST02-B62	17-Jun-2020	18.77	13.66	5.11	
ST02-B63	17-Jun-2020	15.85	11.74	4.11	Missing lid
ST02-B64	17-Jun-2020	18.96	10.62	8.34	
ST02-B65	17-Jun-2020	22.68	15.10	7.58	
ST02-B67	17-Jun-2020	8.23	2.04	6.19	
ST02-SD06	17-Jun-2020	6.53	2.17	4.36	
VP26-B05	17-Jun-2020	44.53	30.45	14.08	Mild Odor
VP26-B07	17-Jun-2020	46.05	27.52	18.53	
VP26-B11	17-Jun-2020	55.69	42.12	13.57	
VP26-B12	17-Jun-2020	49.21	34.87	14.34	
VP26-B13	17-Jun-2020	49.43	--	--	Well is dry.
VP26-B14	17-Jun-2020	33.76	16.52	17.24	
VP26-B15	17-Jun-2020	40.18	15.34	24.84	
VP26-B16	17-Jun-2020	30.44	15.62	14.82	
VP26-B17	17-Jun-2020	32.59	18.67	13.92	
VP26-B19	17-Jun-2020	59.56	40.67	18.89	
VP26-B20	17-Jun-2020	63.16	49.28	13.88	
VP26-B21	17-Jun-2020	58.11	44.31	13.80	
VP26-B22	17-Jun-2020	42.93	28.63	14.30	
VP26-B26	17-Jun-2020	43.63	39.62	4.01	Slight odor
VP26-B27	17-Jun-2020	43.30	39.17	4.13	

Notes :
MSL denotes mean sea level.
TOC denotes top of well casing.

TABLE 3. SUMMARY OF GROUNDWATER MONITORING ANALYTICAL RESULTS - 18TH QUARTER
Site ST02, Waiawa Booster Pump Station, Hickam POL Pipeline RAO, Joint Base Pearl Harbor-Hickam, Hawaii

Monitoring Well ID					**ST02-B33**		**ST02-B38**		**ST02-B57**		**ST02-B60**				**ST02-B61**		**ST02-B62**	
Well Type					**In-Plume**		**In-Plume**		**In-Plume**		**Plume-Edge**				**Plume-Edge**		**In-Plume**	
Sample Identifier					**ST02-B33-0620**		**ST02-B38-0720**		**ST02-B57-0620**		**ST02-B60-0620**		**ST02-J650-0620**		**ST02-B61-0720**		**ST02-B62-0620**	
Sampling Frequency					**Quarterly**		**Quarterly**		**Quarterly**		**Quarterly**		**Quarterly**		**Quarterly**		**Quarterly**	
Sample Type					**Primary**		**Primary**		**Primary**		**Primary**		**Field duplicate of ST02-B60-0620**		**Primary**		**Primary**	
Laboratory Report ID					**L1229238**		**L1239961**		**L1231281**		**L1231281**		**L1231281**		**L1239961**		**L1231047**	
Sample Date					9-Jun-2020		10-Jul-2020		15-Jun-2020		15-Jun-2020		15-Jun-2020		10-Jul-2020		16-Jun-2020	
Analyte	**Analytical Method**	**CASRN**	**Units**	**RACG [1]**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Total Petroleum Hydrocarbons (TPH)																		
TPH as Gasoline (C_6 to C_{10})	SW8015D	8006-61-9	mg/L	0.10	0.049	UJ	**5.14**		**2.81**		0.0368	J	0.055	U	0.055	U	**0.441**	
TPH as Diesel (C_{10} to C_{28})	SW8015D	68334-30-5	mg/L	0.10	0.068	J	**0.708**		**0.508**		0.050	U	0.050	U	0.043	J	**0.254**	
Volatile Organic Compounds																		
Benzene	SW8260B	71-43-2	µg/L	5.0	0.36	J	**198**		4.32	J	0.50	U	0.50	U	0.50	U	0.50	U
1,2-Dibromoethane (EDB)	SW8260B	106-93-4	µg/L	0.040	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
1,2-Dichloroethane	SW8260B	107-06-2	µg/L	0.15	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Ethylbenzene	SW8260B	100-41-4	µg/L	30	0.31	J	**37.6**		6.47	J	0.50	U	0.50	U	0.50	U	0.50	U
Toluene	SW8260B	108-88-3	µg/L	40	0.50	U	17.2		5.49	J	0.50	U	0.50	U	0.50	U	0.50	U
Xylenes (total)	SW8260B	1330-20-7	µg/L	20	1.01	J	**92.1**		6.87	J	1.5	U	1.5	U	1.5	U	0.23	J
Polycyclic Aromatic Hydrocarbons																		
1-Methylnaphthalene	SW8270C SIM	90-12-0	µg/L	2.1	0.20	J	1.21		0.97		0.13	U	0.13	U	0.13	U	0.12	J
2-Methylnaphthalene	SW8270C SIM	91-57-6	µg/L	2.1	0.13	U	2.05		0.78		0.13	U	0.13	U	0.13	U	0.13	U
Naphthalene	SW8270C SIM	91-20-3	µg/L	17	0.13	U	7.97		1.14		0.13	U	0.13	U	0.13	U	0.23	J
Dissolved Metals																		
Lead (dissolved)	SW6020	7439-92-1	µg/L	5.6	0.50	U	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
Monitored Natural Attenuation Parameters																		
Alkalinity (total)	SM2320B	NS	mg/L	NA	NA		NA		306		NA		NA		NA		303	
Dissolved oxygen	field	NS	mg/L	NA	1.75		1.06		0.40		1.97		NA		0.57		1.21	
Ferrous iron	field	15438-31-0	mg/L	NA	NA		NA		>10		NA		NA		NA		>10	
Methane	RSK-175	74-82-8	mg/L	NA	NA		NA		8.09		NA		NA		NA		13.1	
Nitrate and nitrite	E353.2	NS	mg/L	NA	NA		NA		0.050	U	NA		NA		NA		0.050	U
Oxidation reduction potential	field	NS	mV	NA	29		-19		-109		-82		NA		72		-100	
pH	field	NS	s.u.	NA	6.25		7.18		6.87		6.53		NA		6.62		6.69	
Solids, total dissolved	SM2540C	NS	mg/L	NA	NA		NA		478		NA		NA		NA		904	
Sulfate	E300.0	18785-72-3	mg/L	NA	NA		NA		3.51	J	NA		NA		NA		0.92	J
Total organic carbon	SM5310C	NS	mg/L	NA	NA		NA		6.39		NA		NA		NA		4.47	

Notes:

Results shown in bold and highlighted blue equal or exceed the project action levels.

[1] Remedial Action Cleanup Goals (RACGs) are from the *Response Action Memorandum for Site ST02, Hickam Petroleum Oils, and Lubricants Pipeline, Joint Base Pearl Harbor-Hickam, Hawaii* (2013).

CASRN = Chemical Abstracts Service Registry Number

µg/L = microgram(s) per liter	Q = qualifier
mg/L = milligram(s) per liter	s.u. = pH standard units
mV = millivolt(s)	SIM = selected ion monitoring
NA = not analyzed	SM = Standard Methods for the Examination of Water and Wastewater
NS = not specified	

Data Qualifiers:

J = The analyte was positively identified; the quantitation is estimated.

U = The analyte was analyzed for, but not detected. The associated numerical value is at or below the limit of detection.

UJ = The analyte was not detected; however, the quantitation limit is estimated due to discrepancies in the associated quality control criteria.

TABLE 3. SUMMARY OF GROUNDWATER MONITORING ANALYTICAL RESULTS - 18TH QUARTER
Site ST02, Waiawa Booster Pump Station, Hickam POL Pipeline RAO, Joint Base Pearl Harbor-Hickam, Hawaii

Monitoring Well ID					ST02-B63		ST02-B65		ST02-B67		ST02-SD06		VP26-B13		VP26-B17			
Well Type					In-Plume		In-Plume		Sentinel		Sentinel		Sentinel		Plume-Edge			
Sample Identifier					ST02-B63-0620		ST02-B65-0620		no sample collected		ST02-SD06-0620		no sample collected		ST02-B17-0620		ST02-J600-0620	
Sampling Frequency					Quarterly		Quarterly		Quarterly		Quarterly		Semiannual		Semiannual		Semiannual	
Sample Type					Primary		Primary		Dry		Primary		Dry		Primary		Field duplicate of ST02-B17-0620	
Laboratory Report ID					L1231047		L1231047		--		L1239961		--		L1229238		L1229238	
Sample Date					16-Jun-2020		16-Jun-2020		--		10-Jul-2020		--		9-Jun-2020		9-Jun-2020	
Analyte	**Analytical Method**	**CASRN**	**Units**	**RACG [1]**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Total Petroleum Hydrocarbons (TPH)																		
TPH as Gasoline (C_6 to C_{10})	SW8015D	8006-61-9	mg/L	0.10	0.0736	J	0.033	J	--		0.055	U	--		0.055	U	0.055	U
TPH as Diesel (C_{10} to C_{28})	SW8015D	68334-30-5	mg/L	0.10	0.074	J	0.097	J	--		0.051	J	--		0.060	J	0.050	J
Volatile Organic Compounds																		
Benzene	SW8260B	71-43-2	µg/L	5.0	0.50	U	0.50	U	--		0.50	U	--		0.50	U	0.50	U
1,2-Dibromoethane (EDB)	SW8260B	106-93-4	µg/L	0.040	0.50	U	0.50	U	--		0.50	U	--		0.50	U	0.50	U
1,2-Dichloroethane	SW8260B	107-06-2	µg/L	0.15	0.50	U	0.50	U	--		0.50	U	--		0.50	U	0.50	U
Ethylbenzene	SW8260B	100-41-4	µg/L	30	0.50	U	0.50	U	--		0.50	U	--		0.50	U	0.50	U
Toluene	SW8260B	108-88-3	µg/L	40	0.50	U	0.50	U	--		0.50	U	--		0.50	U	0.50	U
Xylenes (total)	SW8260B	1330-20-7	µg/L	20	1.5	U	1.5	U	--		1.5	U	--		0.45	J	0.39	J
Polycyclic Aromatic Hydrocarbons																		
1-Methylnaphthalene	SW8270C SIM	90-12-0	µg/L	2.1	0.13	U	0.13	U	--		0.13	U	--		0.13	U	0.13	U
2-Methylnaphthalene	SW8270C SIM	91-57-6	µg/L	2.1	0.13	U	0.13	U	--		0.13	U	--		0.13	U	0.13	U
Naphthalene	SW8270C SIM	91-20-3	µg/L	17	0.13	U	0.13	U	--		0.13	U	--		0.13	U	0.13	U
Dissolved Metals																		
Lead (dissolved)	SW6020	7439-92-1	µg/L	5.6	3.0	U	3.0	U	--		3.0	U	--		0.50	U	0.50	U
Monitored Natural Attenuation Parameters																		
Alkalinity (total)	SM2320B	NS	mg/L	NA	NA		NA		--		NA		--		NA		NA	
Dissolved oxygen	field	NS	mg/L	NA	0.53		1.80		--		0.78		--		4.58		NA	
Ferrous iron	field	15438-31-0	mg/L	NA	NA		NA		--		NA		--		NA		NA	
Methane	RSK-175	74-82-8	mg/L	NA	NA		NA		--		NA		--		NA		NA	
Nitrate and nitrite	E353.2	NS	mg/L	NA	NA		NA		--		NA		--		NA		NA	
Oxidation reduction potential	field	NS	mV	NA	-72		48		--		-40		--		-25		NA	
pH	field	NS	s.u.	NA	6.61		6.69		--		7.21		--		6.51		NA	
Solids, total dissolved	SM2540C	NS	mg/L	NA	NA		NA		--		NA		--		NA		NA	
Sulfate	E300.0	18785-72-3	mg/L	NA	NA		NA		--		NA		--		NA		NA	
Total organic carbon	SM5310C	NS	mg/L	NA	NA		NA		--		NA		--		NA		NA	

Notes:

Results shown in bold and highlighted blue equal or exceed the project action levels.

[1] Remedial Action Cleanup Goals (RACGs) are from the *Response Action Memorandum for Site ST02, Hickam Petroleum Oils, and Lubricants Pipeline, Joint Base Pearl Harbor-Hickam, Hawaii* (2013).

CASRN = Chemical Abstracts Service Registry Number

µg/L = microgram(s) per liter	Q = qualifier
mg/L = milligram(s) per liter	s.u. = pH standard units
mV = millivolt(s)	SIM = selected ion monitoring
NA = not analyzed	SM = Standard Methods for the Examination of Water and Wastewater
NS = not specified	

Data Qualifiers:

J = The analyte was positively identified; the quantitation is estimated.

U = The analyte was analyzed for, but not detected. The associated numerical value is at or below the limit of detection.

UJ = The analyte was not detected; however, the quantitation limit is estimated due to discrepancies in the associated quality control criteria.

Table 4: Static Soil Vapor Monitoring
ST02 Waiawa Booster Pump Station

Location	Depth (ft bgs)	Date	Oxygen (%)	Carbon dioxide (%)	VOCs (ppm)	Methane (%)
VP26-B05A/B	18	10-Jun-2020	2.4	14.2	<0.2	0.1
	24		<0.1	5.1	160.7	>99
VP26-B07	20	10-Jun-2020	12.7	4	0.5	<0.1
	25		2.4	14.2	<0.2	0.1
VP26-B08	21	10-Jun-2020	3.6	13.3	<0.2	<0.1
VP26-B11	26	10-Jun-2020	0.2	0.2	<0.2	<0.1
	31		<0.1	3	331	34.3

Notes:
% - percent
ft bgs - feet below ground surface
ppm - parts per million
VOCs - volatile organic compounds

Appendix A
Sampling Logs

S102 Soil Vapor
10 June 2020

Well	VMP26-B05A/B		VP26-B07		VP26-B08 ✓	VP26-B11	
Depth	18' sample	24'	20'	25' sample	21' sample	26'	31' sample
Tube Color	BLUE	RED	GREEN	BLUE	RED	GREEN	RED
Time	1441	1415	1447	1445	1409	c1450	1453
CH4	0.1	>>>	0.1	0.0	0.0	0.0	34.3
CO2	14.2	5.1	4.0	11.7	13.3	0.2	3.0
O2	2.4	0.0	12.7	~~0.1~~ 1.5	3.6	18.9	0.0
Bal	83.4	>>>	83.2	86.8	83.6	80.9	62.7
LEL	2%	>>>	1%	1%	0%	1%	>>>
VOCs	0.0	160.7	0.5	0.0	0.0	0.0	~~304.8~~ CM

331.0

GROUNDWATER SAMPLING LOG

WELL NO. B33 LOCATION: STD2 PROJECT NO. 16-7178

DATE: 06/09/20 TIME: 1250 CLIMATIC CONDITIONS: CLOUDY / RAINING @ 1320

TIDAL CONDITIONS: Rising ☐ Falling ☐ HIGH TIDE: LOW TIDE: CURRENT TIDE:

STATIC WATER LEVEL (FT.) and TIME: 16.10' TOTAL DEPTH (FT.): 19.67'

WELL PURGING: LENGTH OF SATURATED ZONE: 3.57' LINEAR FT.

a VOLUME OF WATER TO BE EVACUATED: ______ GALS. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)

METHOD OF REMOVAL: LOW FLOW PUMP PUMPING RATE: 100 mL/min

WELL PURGE DATA:

DATE/ TIME	(ft) DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (mS/cm)	D.O. (mg/L)	TURB. (NTU)	°F TEMP. ~~(°C)~~	ORP (mV)	SAL (ppt)
1315	16.10	0.25	.713	6.10	1.11	1.59	174	85.9	24	0.5
1318		0.30	.712	6.14	1.11	1.58	148	85.8	24	0.5
1321		0.35	.712	6.17	1.11	1.67	126	85.6	25	0.5
1324		0.40	.710	6.22	1.11	1.75	89.7	85.0	26	0.5
1327		0.45	.710	6.32	1.11	1.74	75	84.9	32	0.5
1330		0.50	.710	6.30	1.11	1.67	68.4	85.2	30	0.5
1333		0.55	.714	6.25	1.12	1.75	104	85.8	29	0.6

SAMPLE WITHDRAWAL METHOD: Low Flow

APPEARANCE OF SAMPLE: COLOR: LIGHT BROWN → CLEAR

SEDIMENT: MODERATE

OTHER: NO ODOR / BEGAN RAINING @ 1320, STOPPED @ 1337

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES DISSOLVED METALS, TPH D/O, VOLATILES, TPH LOW FRAC, PAH

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: (8)-40 ML HCL VOAS, (3) 40 ML VOAS (NO PRES) (1)-250 ML HDPE HNO$_3$ PRES. (Field Filt)

SAMPLE IDENTIFICATION NUMBER(S) STD2-B33-0620

DECONTAMINATION PROCEDURES: DI + SIMPLE GREEN

NOTES: Pump @ ~ 18'.

SAMPLED BY: J. SAHIB / P. Liwis

SAMPLES DELIVERED TO: Fedex TRANSPORTER: EATC JV

DATE: TIME:

CAPACITY OF CASING (GALLONS/LINEAR FOOT)

2"-0.16•4"-0.65•6"-1.47•8"-2.61•10"-4.08•12"-5.87

Figure I-C-3-1: Groundwater Sampling Log

GROUNDWATER SAMPLING LOG

WELL NO. B-17 LOCATION: ST02 PROJECT NO. 16-7178

DATE: 06/09/20 TIME: 0925 CLIMATIC CONDITIONS: CLOUDY

TIDAL CONDITIONS: Rising ☐ Falling ☐ HIGH TIDE: LOW TIDE: CURRENT TIDE:

STATIC WATER LEVEL (FT.) and TIME: 18.56' TOTAL DEPTH (FT.): 29.97'

WELL PURGING: LENGTH OF SATURATED ZONE: 11.41' LINEAR FT.

a VOLUME OF WATER TO BE EVACUATED: ______ GALS. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)

METHOD OF REMOVAL: LOW FLOW PUMP PUMPING RATE: 100 mL/min

WELL PURGE DATA:

DATE/ 06/09/2020 TIME	(ft) DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (mS/cm)	D.O. (mg/L)	TURB. (NTU)	°F TEMP. ~~(°C)~~	ORP (mV)	SAL (ppt)
0928	18.56	0.25	.966	6.24	1.51	4.67	21.2	81.9	-139	0.8
0931	↓	0.30	.970	6.38	1.52	4.70	19.3	82.4	-120	0.8
0934		0.35	.970	6.40	1.52	4.64	19.5	82.5	-114	0.8
0937		0.40	.973	6.39	1.52	4.77	18.7	83.1	-95	0.8
0940		0.45	.975	6.40	1.52	4.73	18.8	83.2	-56	0.8
0943		0.50	.979	6.55	1.53	4.71	19.0	83.7	-28	0.8
0946		0.55	.987	6.51	1.54	4.58	19.1	84.3	-25	0.8

SAMPLE WITHDRAWAL METHOD: Low Flow

APPEARANCE OF SAMPLE: COLOR: CLEAR; NO SHEEN/ODOR

SEDIMENT: VERY MINIMAL

OTHER:

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES DISSOLVED METALS, TPH D/O, VOLATILES, TPH LOW FRAC, PAH

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: (1) - 250 ML HDPE HNO3 ~~[illegible]~~ PRES, (Field Filt). (32) ~~(8)~~ - 40 ML HCL VOA, (12) 40 ML VOA, 1

SAMPLE IDENTIFICATION NUMBER(S) ST02-B17-0620, ST02-J000-0620 (Field Dup.) ST02-B17-0620 MS, ST02-B17-0620 MSD.

DECONTAMINATION PROCEDURES: DI & SIMPLE GREEN

NOTES: PUMP @ ~25', MS/MSD Collected Here

SAMPLED BY: J. SAHIB / P. LIWIS

SAMPLES DELIVERED TO: Fedex TRANSPORTER: EATC JV

DATE: TIME:

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16•4"-0.65•6"-1.47•8"-2.61•10"-4.08•12"-5.87

Figure I-C-3-1: Groundwater Sampling Log

GROUNDWATER SAMPLING LOG

WELL NO. B60

LOCATION: ST02

PROJECT NO. ~~16 7178~~

DATE: 06/15/2020 TIME: 0915

CLIMATIC CONDITIONS: CLOUDY / SPRINKLES

TIDAL CONDITIONS: Rising ☐ Falling ☐

HIGH TIDE:

LOW TIDE:

CURRENT TIDE:

STATIC WATER LEVEL (FT.) and TIME: 11.85'

TOTAL DEPTH (FT.): 17.65'

WELL PURGING: LENGTH OF SATURATED ZONE: 5.80' LINEAR FT.

a VOLUME OF WATER TO BE EVACUATED: ______ GALS. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)

METHOD OF REMOVAL: LOW FLOW PUMP

PUMPING RATE: 50 mL/min

WELL PURGE DATA:

DATE/ TIME	(ft) DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (mS/cm)	D.O. (mg/L)	TURB. (NTU)	TEMP. °F ~~(°C)~~	ORP (mV)	SAL (ppt)
1005	11.85	0.20	.488	6.29	.763	2.17	50.8	81.0	-49	0.4
1010		0.25	.490	6.33	.765	2.14	38.0	81.4	-53	0.4
1015		0.30	.489	6.65	.764	2.10	35.8	81.8	-66	0.4
1020		0.35	.489	6.47	.763	2.07	34.9	82.0	-65	0.4
1025		0.40	.488	6.49	.762	2.04	34.2	82.3	-68	0.4
1030		0.45	.488	6.51	.762	2.00	33.9	82.5	-73	0.4
1035		0.50	.487	6.53	.765	1.97	31.3	82.9	-82	0.4

SAMPLE WITHDRAWAL METHOD: LOW FLOW PUMP

APPEARANCE OF SAMPLE: COLOR: LIGHT OPAQUE

SEDIMENT: VERY MINIMAL

OTHER:

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES VOC'S, DISS. LEAD, PAH'S, TPH, D/O

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: (4)-250 ML HDPE; (44)-40 ML VOA

SAMPLE IDENTIFICATION NUMBER(S) ST02-B60-0620, ST02-B60-0620 MS, ST02-B60-0620 MSD, ~~ST02-B60~~ ST02-J650-0620

DECONTAMINATION PROCEDURES: SIMPLE GREEN & DI WATER

NOTES: PUMP @ ~ 15'

SAMPLED BY: J. SAHIB

SAMPLES DELIVERED TO: Fedex

TRANSPORTER: EATC JV

DATE: TIME:

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16•4"-0.65•6"-1.47•8"-2.61•10"-4.08•12"-5.87

Figure I-C-3-1: Groundwater Sampling Log

1040 START

FD: 1140

1155 END

FINAL DTW: 12.43'

MNA PARAMETERS

GROUNDWATER SAMPLING LOG

WELL NO. B57 LOCATION: ST02 PROJECT NO. ~~16-7178~~

DATE: 06/15/20 TIME: 1315 CLIMATIC CONDITIONS: CLOUDY/DRIZZLE/SUNNY

TIDAL CONDITIONS: Rising ☐ Falling ☐ HIGH TIDE: LOW TIDE: CURRENT TIDE:

STATIC WATER LEVEL (FT.) and TIME: 14.74' TOTAL DEPTH (FT.): 20.21'

WELL PURGING: LENGTH OF SATURATED ZONE: 5.47' LINEAR FT.

a VOLUME OF WATER TO BE EVACUATED: ______ GALS. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)

METHOD OF REMOVAL: LOW FLOW PUMP PUMPING RATE: 100 mL/min

WELL PURGE DATA:

DATE/ TIME	(ft) DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (mS/cm)	D.O. (mg/L)	TURB. (NTU)	TEMP. °F ~~(°C)~~	ORP (mV)	SAL (ppt)
1348	14.74	0.20	.878	6.89	1.35	0.47	78.1	86.1	-103	0.7
1351	↓	0.25	.857	6.90	1.34	0.46	71.7	86.2	-103	0.7
1354		0.30	.855	6.89	1.33	0.46	68.3	86.3	-104	0.7
1357		0.35	.840	6.89	1.31	0.44	59.9	86.5	-105	0.7
1400		0.40	.837	6.88	1.28	0.43	48.6	87.1	-107	0.7
1403		0.45	.833	6.88	1.25	0.41	47.3	87.1	-108	0.6
1406		0.50	.830	6.87	1.24	0.40	46.7	87.2	-109	0.6

SAMPLE WITHDRAWAL METHOD: LOW FLOW PUMP

APPEARANCE OF SAMPLE: COLOR: LIGHT SHEEN; YELLOW TINT

SEDIMENT: VERY MINIMAL

OTHER: MILD PETRO ODOR; ~~ND FER~~

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES: ~~VOC'S~~ DISSOLVED METALS, TPH D/O, VOLATILES, TPH LOW FRAC, PAH, MNA (SEE SAP)

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: (2) - 125 ML HDPE, (~~3~~4) - 250 ML HDPE (13) - 40 ML VOA'S

SAMPLE IDENTIFICATION NUMBER(S) ST02-B57-0620

DECONTAMINATION PROCEDURES: SIMPLE GREEN + DISTILLED WATER

NOTES: FERROUS IRON - 10+ MG/L, PUMP @ ~17'

SAMPLED BY: J. SAHB

SAMPLES DELIVERED TO: Fedex TRANSPORTER: EATC JV

DATE: TIME:

CAPACITY OF CASING (GALLONS/LINEAR FOOT)

2"-0.16•4"-0.65•6"-1.47•8"-2.61•10"-4.08•12"-5.87

Figure I-C-3-1: Groundwater Sampling Log

SAMPLE START: 1410
END 1520 FINAL: 14.86

GROUNDWATER SAMPLING LOG

WELL NO. ST62-B62 LOCATION: ST02 PROJECT NO. 16-7178

DATE: 6.16.20 TIME: 11:50 CLIMATIC CONDITIONS: Cloudy

TIDAL CONDITIONS: Rising ☐ Falling ☐ HIGH TIDE: LOW TIDE: CURRENT TIDE:

STATIC WATER LEVEL (FT.) and TIME: ~~1143~~ 13.73' TOTAL DEPTH (FT.): 20.83'

WELL PURGING: LENGTH OF SATURATED ZONE: 7.10' LINEAR FT.

a VOLUME OF WATER TO BE EVACUATED: ______ GALS. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)

METHOD OF REMOVAL: Low Flow PUMPING RATE: 150 mL/min

WELL PURGE DATA:

DATE/ TIME	(ft) DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (mS/cm)	D.O. (mg/L)	TURB. (NTU)	°F TEMP. ~~(°C)~~	ORP (mV)	SAL (ppt)
1210	13.73	0.2	0.962	6.63	1.50	1.22	230	78.1	-103	0.8
1215		0.3	0.952	6.62	1.49	1.19	177	78.	-101	0.7
1220		0.4	0.946	6.61	1.48	1.22	138	77.9	-100	0.7
1225		0.5	0.947	6.64	1.48	1.24	127	77.9	-103	0.7
1230		0.6	0.947	6.66	1.48	1.26	120	77.9	-102	0.7
1235		0.7	0.940	6.68	1.47	1.23	118	77.8	-100	0.7
1240		0.8	0.939	6.69	1.47	1.21	115	77.8		0.7

SAMPLE WITHDRAWAL METHOD: Low Flow

APPEARANCE OF SAMPLE: COLOR: Cloudy

SEDIMENT: NONE

OTHER: Petroleum odoR

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES VOCs, diss. metals / PAHs, TPH d/mo | Nitrate.nitrite | methane \ SO4, Alkalinity, TDS, TOC

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: Two 125 ml HDPE ⊖ pres / one 250 ml HDPE ⊖ pres one 250 ml HDPE SO4, 1-250 ml HDPE HCl, 8-AMB VOA HCl, 3-AMB ⊖ pres 1-250 ml HDPE HNO_3

SAMPLE IDENTIFICATION NUMBER(S) ST02-B62-0620

DECONTAMINATION PROCEDURES: Simple green soln + DI H_2O x3 rinse

NOTES: Pump @ 17.5'

SAMPLED BY: Doug Neund / Ty Lewis

SAMPLES DELIVERED TO: TRANSPORTER:

DATE: 6 TIME:

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16•4"-0.65•6"-1.47•8"-2.61•10"-4.08•12"-5.87

Figure I-C-3-1: Groundwater Sampling Log

w/ MNA

Final DTW 16.10

@ 1316

Ferrous Fe > 10 mg/l
very dark

GROUNDWATER SAMPLING LOG

WELL NO. ST02-B63 LOCATION: ST02 PROJECT NO. 16-7178

DATE: 6-16-20 TIME: ______ CLIMATIC CONDITIONS: Cloudy - Light rain

TIDAL CONDITIONS: Rising ☐ Falling ☐ HIGH TIDE: LOW TIDE: CURRENT TIDE:

STATIC WATER LEVEL (FT.) and TIME: 10.73' (1040) TOTAL DEPTH (FT.): 18.47'

WELL PURGING: LENGTH OF SATURATED ZONE: 7.74' LINEAR FT.

a VOLUME OF WATER TO BE EVACUATED: ______ GALS. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)

METHOD OF REMOVAL: Low Flow PUMPING RATE: 200 mL/min

WELL PURGE DATA:

DATE/ TIME	(ft) DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (mS/cm)	D.O. (mg/L)	TURB. (NTU)	°F TEMP. ~~(°C)~~	ORP (mV)	SAL (ppt)
10:50	10.73	0.2	.885	7.32	1.32	0.47	233	78.6	-77	0.7
10:55	↓	0.35	.986	6.67	1.53	0.49	203	78.1	-66	0.8
11:00		0.5	1.62	6.59	1.57	0.51	125	77.8	-68	0.8
11:05		0.65	1.62	6.59	1.59	0.52	113	77.7	-70	0.8
11:10		0.75	1.01	6.58	1.58	0.55	101	77.7	-71	0.8
11:15		0.95	0.99	6.60	1.58	0.54	98	77.7	-71	0.8
11:20		1.15	0.98	6.61	1.57	0.53	97	77.7	-72	0.8

SAMPLE WITHDRAWAL METHOD: Low flow

APPEARANCE OF SAMPLE: COLOR: Clear

SEDIMENT: None

OTHER: No odor

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES TPH D/O / VOCs / metals / PAHs

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: 8-40ml amb - HCl
3-40ml Amb-o preserv / 1-250 ml HDPE HNO3 (filtered in field)

SAMPLE IDENTIFICATION NUMBER(S) ST02-B63-0620

DECONTAMINATION PROCEDURES: Simple green soln & DI WATER

NOTES: Pump @ 14'

SAMPLED BY: Ty Lewis / Doug Heat

SAMPLES DELIVERED TO: ______ TRANSPORTER: ______

DATE: ~~6-16-20~~ DH TIME: ~~11:25~~ DH

CAPACITY OF CASING (GALLONS/LINEAR FOOT)

DTW 10.87 @ 1140

2"-0.16•4"-0.65•6"-1.47•8"-2.61•10"-4.08•12"-5.87

Figure I-C-3-1: Groundwater Sampling Log

GROUNDWATER SAMPLING LOG

WELL NO. ST02-B65 LOCATION: ST02 PROJECT NO. 16-7178

DATE: 6·16·20 TIME: CLIMATIC CONDITIONS:

TIDAL CONDITIONS: Rising ☐ Falling ☐ HIGH TIDE: LOW TIDE: CURRENT TIDE:

STATIC WATER LEVEL (FT.) and TIME: 15.45' TOTAL DEPTH (FT.): 19.71'

WELL PURGING: LENGTH OF SATURATED ZONE: 4.26' LINEAR FT.

a VOLUME OF WATER TO BE EVACUATED: GALS. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)

METHOD OF REMOVAL: Low Flow PUMPING RATE: 200 mL/min

WELL PURGE DATA:

DATE/ TIME	(ft) DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (mS/cm)	D.O. (mg/L)	TURB. (NTU)	TEMP. ~~(°C)~~ °F	ORP (mV)	SAL (ppt)
0845	15.45	0.2	.423	6.48	.659	4.27	654	80.7	49	0.3
0850	↓	0.3	.424	6.55	.658	3.33	95	80.5	30	0.3
0855		0.4	.422	6.64	.659	3.70	87	80.4	44	0.3
0900		0.5	.421	6.67	.658	1.80	86	80.5	45	0.3
0905		0.6	.421	6.66	.659	1.78	77	80.5	47	0.3
0910		0.7	.421	6.67	.658	1.77	75	80.4	46	0.3
0915		0.8	.419	6.69	.656	1.80	73	80.4	48	0.3

SAMPLE WITHDRAWAL METHOD: Low Flow

APPEARANCE OF SAMPLE: COLOR: Lt Brown –

SEDIMENT: none

OTHER: no odor

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES Metals, TPH D/O VOCs, TPH-Low Fract, PAH

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: 8-40ml amb-HCl, 3-40ml Amb -∅ pres. 1-250 ml HDPE-HNO3

SAMPLE IDENTIFICATION NUMBER(S) ST02-B65-0620

DECONTAMINATION PROCEDURES: ~~Liqo~~ Simple green sol'n + DI H2O

NOTES: pump @ 17.5'

SAMPLED BY: Doug Heard / Ty Lewis

SAMPLES DELIVERED TO: TRANSPORTER:

DATE: 6.16.20 DH TIME: 0920 DH

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16•4"-0.65•6"-1.47•8"-2.61•10"-4.08•12"-5.87

end DTW 16.40

Figure I-C-3-1: Groundwater Sampling Log

GROUNDWATER SAMPLING LOG

WELL NO. STO2-SD06
LOCATION: STO2
PROJECT NO.
DATE: 7/10/20
TIME:
CLIMATIC CONDITIONS: Clear
TIDAL CONDITIONS: Rising ☐ Falling ☐
HIGH TIDE:
LOW TIDE:
CURRENT TIDE:

STATIC WATER LEVEL (FT.) and TIME: 11:36 am 2.25'
TOTAL DEPTH (FT.): 3.70'
WELL PURGING:
LENGTH OF SATURATED ZONE: 1.45' LINEAR FT.
a VOLUME OF WATER TO BE EVACUATED: GALS. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)
METHOD OF REMOVAL: BAILER ~~Low Flow~~
PUMPING RATE: 100 mL/min

WELL PURGE DATA:

DATE/ TIME	DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (mS/cm)	D.O. (mg/L)	TURB. (NTU)	TEMP. (°C)	ORP (mV)	SAL (ppt)
12:30	2.25		0.421	7.36	0.657	1.13	>450	27.4	-44	0.3
12:35			0.420	7.36	0.657	1.13		26.9	-54	0.3
12:39			0.418	7.24	0.654	0.99		26.06	-45	0.3
12:45			0.417	7.22	0.652	0.76		26.13	-48	0.3
12:49			0.418	7.21	0.653	0.78		26.04	-40	0.3

SAmple time 1345 - delay continuing sampling w/ bailer

SAMPLE WITHDRAWAL METHOD: BAILER
APPEARANCE OF SAMPLE: COLOR: Brown - Turbid
SEDIMENT: Yes
OTHER: No odor
LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES VOCs, diss. Pb, PAH, TPH g/d/o
NUMBER AND TYPES OF SAMPLE CONTAINERS USED: 8-40ml VOAs Amber, 1-250 HDPE - 0 preserv, 3-40ml VOA Amber - 0 preserv,
SAMPLE IDENTIFICATION NUMBER(S) STO2-SD06-0720
DECONTAMINATION PROCEDURES:
NOTES: Diss Pb not Field Filtered, triple rinsed, no pres for diss. Pb - Lab to filter.
SAMPLED BY: Doug Heard / Brian Carroll
SAMPLES DELIVERED TO: Fedex
TRANSPORTER: EATC JV
DATE: 7/13/20
TIME: 1000

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16•4"-0.65•6"-1.47•8"-2.61•10"-4.08•12"-5.87

Figure I-C-3-1: Groundwater Sampling Log

GROUNDWATER SAMPLING LOG

WELL NO. ST02-B38 LOCATION: ST02 PROJECT NO.

DATE: 7/10/20 TIME: 1500 CLIMATIC CONDITIONS: Clear

TIDAL CONDITIONS: Rising ☐ Falling ☐ HIGH TIDE: LOW TIDE: CURRENT TIDE:

STATIC WATER LEVEL (FT.) and TIME: 1500 15.61' TOTAL DEPTH (FT.): 22.12'

WELL PURGING: LENGTH OF SATURATED ZONE: 6.51' LINEAR FT.

a VOLUME OF WATER TO BE EVACUATED: ______ GALS. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)

METHOD OF REMOVAL: Low-flow PUMPING RATE: 100 mL/min

WELL PURGE DATA:

4

DATE/ 7.10.20 TIME	DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (mS/cm)	D.O. (mg/L)	TURB. (NTU)	TEMP. (°C)	ORP (mV)	SAL (ppt)
1522	15.61	0.2	0.62	7.78	0.969	1.64	136	32.89	-16	0.5
1527	↓	0.25	0.63	7.73	0.978	1.07	133	32.71	-20	0.5
1532		0.3	0.62	7.74	0.974	0.13	115	32.31	-25	0.5
1537		0.28	0.64	7.29	0.959	0.92	78	32.52	-22	0.5
1542		0.44	0.63	7.50	0.964	1.01	91	32.67	-20	0.5
1546		0.5	0.63	7.18	0.943	1.06	112	32.97	-19	0.5
~~1550~~	SAMPLE BEGIN 1555									

SAMPLE WITHDRAWAL METHOD: Low-Flow Bladder

APPEARANCE OF SAMPLE: COLOR: Clear

SEDIMENT: NO

OTHER: NO - Moderate Petroleum odor

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: 8-40ml VOA Amber-HCl, 3-40ml VOA amber Ø preserv 1-250 HDPE w HNO_3 preserv

SAMPLE IDENTIFICATION NUMBER(S) ST02-B38-0720

DECONTAMINATION PROCEDURES: Simple green, distilled H2O rinse X3

NOTES: Pump @20'

SAMPLED BY: Doug Beard/ Brian Carroll

SAMPLES DELIVERED TO: Fedex TRANSPORTER: EATC JV

DATE: 7/13/20 TIME: 1000

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16•4"-0.65•6"-1.47•8"-2.61•10"-4.08•12"-5.87

Figure I-C-3-1: Groundwater Sampling Log

GROUNDWATER SAMPLING LOG

WELL NO. ST02-B61 LOCATION: ST02 PROJECT NO.

DATE: 7/16/20 TIME: 8:41 am CLIMATIC CONDITIONS: Clear

TIDAL CONDITIONS: Rising ☐ Falling ☐ HIGH TIDE: LOW TIDE: CURRENT TIDE:

STATIC WATER LEVEL (FT.) and TIME: 8:47 am 13.37' TOTAL DEPTH (FT.): 19.60'

WELL PURGING: LENGTH OF SATURATED ZONE: 5.23' LINEAR FT.

a VOLUME OF WATER TO BE EVACUATED: ______ GALS. (Gals/Linear ft. X linear feet of saturation X 3-casing volumes)

METHOD OF REMOVAL: Low flow PUMPING RATE: <100 mL/min

WELL PURGE DATA:

DATE/ TIME	DTW	GALLONS REMOVED	TDS (g/L)	pH	SP. COND. (mS/cm)	D.O. ~~(%)~~ (mg/L)	TURB. (NTU)	TEMP. (°C)	ORP (mV)	SAL (ppt)
10:~~09:55~~	13.37	0.1	0.322	6.88	0.495	~~30.9~~ 1.32	42	30.33	61	0.2
10:07	↓	0.15	0.303	6.36	0.466	~~29.0~~ 1.25	22.0	30.41	88	0.2
10:12		~~0.24~~	0.30	6.35	0.458	1.23	6.8	30.25	78	0.2
10:17			0.29	6.41	0.453	0.97	3.0	30.40	70	0.2
10:22			0.29	6.51	0.451	0.68	2.1	30.90	61	0.2
10:27			0.29	6.58	0.450	0.50	4.3	30.61	66	0.2
10:32			0.29	6.62	0.451	0.57	7.9	30.25	72	0.2

SAMPLE WITHDRAWAL METHOD: Low flow

APPEARANCE OF SAMPLE: COLOR: CLEAR

SEDIMENT: none

OTHER: none

LABORATORY ANALYSIS PARAMETERS AND PRESERVATIVES ~~8-40ml Amb VOAs~~ PAHs
Diss. Pb / TPH g/d/o

NUMBER AND TYPES OF SAMPLE CONTAINERS USED: 8-40 ml VOAs (HCl), 3-40ml VOA 0 pres

SAMPLE IDENTIFICATION NUMBER(S) ST02-B61-0720

DECONTAMINATION PROCEDURES: 1 Simple Grn wash / DI Rinse

NOTES: Pump @ ~ 18.5

SAMPLED BY: Doug Heard / Brian Carroll

SAMPLES DELIVERED TO: ______ TRANSPORTER: ______

DATE: ______ TIME: ______

CAPACITY OF CASING (GALLONS/LINEAR FOOT)
2"-0.16•4"-0.65•6"-1.47•8"-2.61•10"-4.08•12"-5.87

Figure I-C-3-1: Groundwater Sampling Log