UNIVERSITY of HAWAIʻI® SYSTEM
ʻŌnaehana Kulanui o Hawaiʻi

Jan S. Gouveia
Vice President for Administration

November 8, 2024

Ms. Mary Alice Evans
Director
State of Hawai`i, Office of Planning and Sustainable Development
Environmental Review Program
235 South Beretania Street, Room 702
Honolulu, Hawaiʻi 96813

SUBJECT: Final Environmental Assessment -Finding of No Significant Impact (FEA-FONSI)
Waikīkī Aquarium Water System Upgrade [TMK(1)3-1-031:006]
Honolulu, Oʻahu, Hawaiʻi

Dear Director Evans:

With this letter, the University of Hawaiʻi (UH) transmits the Final Environmental Assessment and Finding of No Significant Impact (FEA-FONSI) dated November 2024. The Draft Environmental Assessment was published in the February 23, 2024, edition of The Environmental Notice. Comments received during the public comment period and UH's responses are included in the FEA-FONSI.

This transmittal is pursuant to requirements set forth in Hawaii Chapter 343. As the proposing and approving agency, UH finds that the proposed action is not likely to have significant effects; and is therefore, issuing a FONSI.

Please publish notice of this FEA-FONSI in the next edition of The Environmental Notice. We have uploaded an electronic copy of this letter, the publication form, and the FEA-FONSI to your online submittal site. We are also providing the action summary, significance criteria, and other required information via The Environmental Notice online submittal platform.

Please contact our Consultant, Ms. Berna Senelly at (808) 954-4221 or bsenelly@oceanit.com if you have questions.

Sincerely,

Jan S. Gouveia
Vice President for Administration

Enclosure(s) / Attachment(s)

From: webmaster@hawaii.gov
To: DBEDT OPSD Environmental Review Program
Subject: New online submission for The Environmental Notice
Date: Thursday, October 31, 2024 2:18:17 PM

Action Name

Waikīkī Aquarium Upgrades

Type of Document/Determination

Final environmental assessment and finding of no significant impact (FEA-FONSI)

HRS §343-5(a) Trigger(s)

- (1) Propose the use of state or county lands or the use of state or county funds
- (2) Propose any use within any land classified as a conservation district
- (3) Propose any use within a shoreline area

Judicial district

Honolulu, Oʻahu

Tax Map Key(s) (TMK(s))

(1) 3-1-031:006

Action type

Agency

Other required permits and approvals

US Army Corps permits (Section 404 Clean Water Act, Section 10, Work in Navigable Waters), Section 401State Certification of Water Quality, State Site Plan Approval, Coastal Zone Management Consistency, Well Construction/Pump Installation Permit, NPDES Notice of Intent Form C, Community Noise Control Permit, Special Management Area Major Permit; Shoreline Setback Variance

Proposing/determining agency

University of Hawaiʻi at Mānoa

Agency jurisdiction

State of Hawaiʻi

Agency contact name

Brandon Shima

Agency contact email (for info about the action)

bshima@hawaii.edu

Email address for receiving comments

WAq@oceanit.com

Agency contact phone

(808) 956-0282

Agency address

2002 East West Road, Room 102
Honolulu, HI 96822
United States
Map It

Is there a consultant for this action?

Yes

Consultant

Oceanit

Consultant contact name

Berna Senelly

Consultant contact email

bsenelly@oceanit.com

Consultant contact phone

(808) 954-4221

Consultant address

828 Fort Street Mall, Suite 600
Suite 600
Honolulu, HI 96813
United States
Map It

Action summary

The Aquarium uses 3 intake water sources for 60 public exhibits and holding tanks. Three water sources include 1) natural seawater (NSW) via 2 8-inch offshore intake pipes, 2) saltwater derived from a saltwater production well, and 3) freshwater from the CCH water supply system. The antiquated supply water intake system infrastructure needs to be updated to prevent future failures. Project includes the replacement of the 2 existing ocean water intake pipes that extend 160 ft offshore, construction of a new partially below ground NSW and well water pump vault, a new partially below ground aeration tank, reconstruction and extension of the existing pump building, rehabilitation or construction of a new saltwater production well, and the installation of new equipment and piping. Improvements include new expanded Edge of Reef (EOR) Exhibit that will replace the old EOR that is being demolished as part of Discharge System Project and will be located in same location.

Reasons supporting determination

Please see Final EA Section 6: Reasons Supporting Finding of No Significant Impact (FONSI).

Attached documents (signed agency letter & EA/EIS)

- WAq-Upgrades-Final-EA_FONSI.REDUCED.pdf

Shapefile

- The location map for this Final EA is the same as the location map for the associated Draft EA.

Action location map

- Waikiki-Aquarium-Project-Boundary.zip

Authorized individual

Berna Senelly

Authorization

- The above named authorized individual hereby certifies that he/she has the authority to make this submission.

FINAL

ENVIRONMENTAL ASSESSMENT

Waikīkī Aquarium Upgrades

Supply Water Intake System

2777 Kalākaua Avenue

Honolulu, Hawaiʻi, 96815

TMK: (1) 3-1-031:006

Prepared for
University of Hawaiʻi at Manoa
Office of Project Delivery
2002 East-West Road, Room 102
Honolulu, HI 96822

Prepared by
Oceanit
828 Fort Street Mall, Suite 600
Honolulu HI 96813

November 2024

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ACRONYMS AND ABBREVIATIONS

%	Percent
§	Section
°	Degree(s)
ALRFI	Archaeological Literature Review and Field Inspection Report
amps	Amperes
AOC	Administrative Order of Consent
ATS	Automatic Transfer Switches
bgs	Below Ground Surface
BLNR	Board of Land and Natural Resources
BMP	Best Management Practice
BPBM	Bernice Pauahi Bishop Museum
BS	Beaches
BW	Back wash
CCH	City and County of Honolulu
CFR	Code of Federal Regulations
CMU	Concrete Masonry Unit
CWA	Clean Water Act
CWRM	Commission on Water Resource Management
CZM	Coastal Zone Management
DAR	Division of Aquatic Resources, DLNR
dBA	Decibels
DDC	Department of Design and Construction
DLNR	State of Hawai'i Department of Land and Natural Resources
DOCARE	State of Hawai'i Department of Land and Natural Resources Division of Conservation and Resources Enforcement
DOH	State of Hawaiʻi Department of Health
DOH-CWB	State of Hawai'i Department of Health, Clean Water Branch
DPP	City and County of Honolulu Department of Planning and Permitting
DPS	Distinct Population Segment
EA	Environmental Assessment
EFH	Essential Fish Habitat
ENV	Department of Environmental Services
EOR	Edge of Reef
ERP	State of Hawaii, Office of Planning and Sustainable Development Environmental Review Program
ESA	Endangered Species Act

FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FONSI	Finding of No Significant Impacts
FR	Final Rule
ft	Foot or feet
ft/yr	Feet per Year
FWCA	Fish and Wildlife Coordination Act
GMSL	Global Mean Sea Level
GPD	Gallons per Day
GPM	Gallons per Minute
GPS	Global Positioning System
HAR	Hawai'i Administrative Rules
HDOA	Hawaiʻi Department of Agriculture
HDPE	High-density polyethylene
HECO	Hawaiian Electric Company
Hg	Mercury
HRS	Hawaiʻi Revised Statutes
ID	Identification
IPCC	Intergovernmental Panel on Climate Change
IWDP	Industrial Wastewater Discharge Permit
JaC	Jaucas
kW	Kilowatt
kVA	Kilo Volt-Ampere
LBSP	Land Based Source of Pollution
M	Million
m	Meter(s)
MBTA	Migratory Bird Treaty Act
mg/L	milligrams per liter
MLCD	Marine Life Conservation District
NAAQS	National Ambient Air Quality Standards
NMFS	National Marine Fisheries Service
No.	Number
NOAA	National Oceanic and Atmospheric Administration
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NSW	Natural Seawater
NTU	Nephelometric Turbidity Units
O&M	Operation and Maintenance
OCCL	Office of Conservation and Coastal Lands, DLNR

PacIOOS	Pacific Islands Ocean Observing System
PIFWSO	Pacific Islands Fish and Wildlife Service
PIRO	Pacific Islands Regional Office
PM	Particulate Matter
Qty	Quantity
ROH	Revised Ordinances of Honolulu
ROM	Rough Order of Magnitude
RTE	Rare, Threatened, and Endangered
SIHP	State Inventory of Historic Places
SLOPES	Standard Local Operating Procedures for Endangered Species
SLR	Sea Level Rise
SLR-XA	Sea Level Rise Exposure Area
SLUD	State Land Use District
TMK	Tax Map Key
TSS	Total Suspended Solids
UHM	University of Hawaii at Manoa
U.S.	United States
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UV	Ultraviolet
VFD	Variable frequency drive
WQC	Water Quality Certification
WQS	Water Quality Standards
WW	Well Water
ZOM	Zone of Mixing

SUMMARY SHEET

Type of Document	Final Environmental Assessment (FEA)
Project Name	Waikīkī Aquarium Upgrades
Applicant/Approving Agency	University of Hawaiʻi at Mānoa, Office of Project Delivery 2002 East West Road, Room 102 Honolulu, HI 96822 c/o Brandon Shima, Project Manager
Project Location	Waikīkī Aquarium 2777 Kalākaua Ave Honolulu, HI, 96815
Tax Map Key (TMK)	(1) 3-1-031:006
Land Area:	102,210 square feet (2.35 acres)
State Land Use District (SLUD)	Urban (U)
State Land Use Conservation District	Protective Subzone (ocean portion)
Special Management Area	Yes
County Zoning Designation	P-2 General Preservation District
Project Summary	A functional water intake supply system is critical to the operation of the Aquarium and to the life support systems for biota at the Aquarium. The Waikīkī Aquarium (WAq) utilizes three intake water sources for their approximately sixty (60) public exhibits and behind-the-scenes holding tanks that are in operation at any given time. The three (3) water sources include 1) natural seawater (NSW) via two (2) 8-inch offshore intake pipes, 2) saltwater derived from an 80-ft deep saltwater production well, and 3) freshwater from the City and County of Honolulu water supply system. The purpose of the proposed project is to upgrade the Aquarium's antiquated supply water intake system infrastructure to prevent future failures that threaten the life and wellbeing of the biota. The project includes the replacement of the two existing ocean water intake pipes that extend approximately 160-ft offshore, the construction of a new partially below ground NSW and well water pump vault, a new partially below ground aeration tank, the reconstruction and extension of the existing pump building, the rehabilitation or construction

of a new saltwater production well, and the installation of new equipment and piping.

New equipment includes eight (8) new pumps, four (4) new media filters, two (2) ultraviolet sterilizers, heat exchanger and chiller, air compressors and diffusers, flow meters, level sensors, and other appurtenances. The project also includes the mechanical and electrical upgrades associated with the new structures, building and equipment. The existing well will be refurbished to serve as backup for well saltwater supply. A functional water intake supply system is critical to the operation of the Aquarium and to the life support systems for the animals at the Aquarium.

Future improvements include a new expanded Edge of Reef (EOR) Exhibit that will replace the old EOR Exhibit that is being demolished as part of the Discharge System Upgrade project currently in construction. The new EOR Exhibit will increase the footprint of the old exhibit from approximately 1,300 square feet to over 1,800 square feet. The new EOR Exhibit will be in the same general location as the old exhibit.

Regulatory Context: Chapters 343 and 344, Hawaiʻi Revised Statutes (HRS) and Chapter 11-200.1, Hawaiʻi Administrative Rules (HAR)

Triggers for the EA: Use of state or county land or the use of state or county funds
Use within Conservation District
Use within shoreline area

Anticipated Determination: Finding of No Significant Impact (FONSI)

Estimated Cost: $8.00 million

Time Frame: Construction completion anticipated in 2027-2028

Consultant: Oceanit
828 Fort Street Mall, Suite 600
Honolulu, HI, 96813
WAq@oceanit.com

EXECUTIVE SUMMARY

This Environmental Assessment (EA) was conducted to assess potential environmental impacts associated with the proposed Waikīkī Aquarium (WAq) Upgrades Related to the Supply Water Intake System and the future expanded Edge of Reef (EOR) exhibit to replace the original EOR exhibit. Much of WAq's supply water intake system infrastructure was part of the original construction dating back to the 1950s. Some of these original infrastructures are nearly 70 years old, are well beyond their engineering life and are in desperate need of upgrades or replacement. The original EOR exhibit was constructed in 1986.

The WAq currently utilizes three intake water sources for their approximately sixty (60) public exhibits and behind-the-scenes holding tanks that are in operation at any given time. The three (3) water sources include 1) natural seawater (NSW) via two (2) 8-inch offshore intake pipes, 2) saltwater derived from an 80-ft deep saltwater production well, and 3) freshwater from the City and County of Honolulu water supply system.

The Proposed Action is intended to upgrade the Aquarium's outdated and antiquated supply water intake system infrastructure to prevent future failures that threaten the life and wellbeing of biota under WAq care. The Proposed Action includes the replacement of the two existing ocean water intake pipes that extend approximately 160-ft offshore, the construction of a new partially below ground NSW and well water pump vault, a new partially below ground aeration tank, the reconstruction and extension of the existing pump building, the rehabilitation of the existing or construction of a new saltwater production well, and the installation of new equipment and piping. New equipment includes eight (8) new pumps, four (4) new media filters, two (2) ultraviolet sterilizers, heat exchanger and chiller, air compressors and diffusers, flow meters, level sensors, and other appurtenances. The project also includes the mechanical and electrical upgrades associated with the new structures and equipment. The EA includes a discussion of the No Action alternative and the following alternatives:

- Alternative A: Construct a new well and well water aeration/demineralization filters and eliminate the existing NSW supply. This also includes a new pump vault and aeration tank, and repair of the existing pump building.
- Alternative B: Refurbish existing well only (with no new well) and reuse existing ocean intake pipes for NSW supply (filtered only without treatment or cooling). This also includes a new pump vault and aeration tank, and repair and extend existing pump building.

The alternatives analyses evaluated construction cost, operation and maintenance efforts and cost, longevity of new systems, redundance, and compatibility with future expansion. The Proposed Action was selected because the other alternatives would leave part of the existing outdated infrastructure in place that will eventually need to be replaced, with reduced redundancy and no backup systems. By leaving some of the aging infrastructure in place there is a risk of imminent failure that would endanger the Aquarium's biota and end up costing more in future upgrades.

The Proposed Action also includes the future replacement of the original EOR exhibit (approximately 1,300 square feet) with an expanded EOR exhibit (approximately 1,800 square feet) in the same general location. The water supply sources of the future exhibit will be from the ocean intake or the well that is part of the previously described Proposed Action. The discharge of the future EOR exhibit effluent will be directed into injection wells currently in construction as part of the approved Waikiki Aquarium Discharge System Upgrade project. With no future discharge to the ocean or the CCH sewer system, the environmental impact of the future EOR exhibit is anticipated to be negligible.

The following potentially impacted environments were evaluated in Final EA:

- Climate and topography
- Geology and soils
- Hydrogeology and water resources
- Ocean water quality
- Air and noise quality
- Climate change and sea level rise
- Flood, tsunami and hurricane hazards
- Terrestrial biological resources
- Marine biological resources
- Demographics and the economy
- Archaeological and cultural resources
- Public services and facilities

The Proposed Action is anticipated to have long term positive impacts on environmental and ocean water quality by replacing the existing in-water asbestos-containing transite intake pipes with new high-density polyethylene (HDPE) pipes. The Proposed Action will provide the Aquarium with a more reliable system in the future and reduce the need for future infrastructure upgrades. Further, the Proposed Action will provide the WAq exhibits with higher quality water supply and, with added redundancy and backup, allow for maintenance and servicing of equipment with minimum disruptions to operations. It supports the overall operations and viability of the Aquarium that serves as an educational and recreational facility enjoyed by residents and visitors.

Potential negative impacts are limited to short-term effects related to construction. These impacts will be mitigated by employing construction Best Management Practices (BMP) to eliminate or minimize impacts to the maximum extent practicable, limiting activities to daytime hours, curtailing construction activities to avoid impacts on terrestrial and marine biological resources, coordinating with public agencies, and monitoring by qualified professionals.

No negative cumulative and secondary impacts are anticipated.

Hawaiʻi Administrative Rule (HAR) §11-200.1-11.2 establishes procedures for determining if a Finding of No Significant Impact (FONSI) is warranted. In accordance with the provisions set forth in Chapter 343, HRS, and HAR §11-200.1-11.2, this Final EA has determined that the Proposed Action will not have significant adverse impacts on the environment and qualifies for a Finding of No Significant Impact (FONSI).

1. STATEMENT OF PURPOSE AND NEED

1.1 Background

The Waikīkī Aquarium (WAq) is located at the southern end of the world-famous Waikīkī Beach near the center of Kapiolani Park and welcomes more than 250,000 visitors annually. The WAq was established in 1904 and is the second oldest aquarium in the United States. It has been a part of the University of Hawaiʻi (UH) since 1919 and moved to its present location in 1955, at which time the existing infrastructure proposed for replacement was originally installed. The WAq mission is to inspire and promote understanding, appreciation, and conservation of Pacific marine life. Each year, the Aquarium delivers rich educational experiences to over 30,000 local children under 12 years old and to over 20,000 seniors over 65 years old. WAq is an important educational outreach facility with an international reputation for its display quality and was the first aquarium in the world to successfully cultivate and display several marine organisms in captivity. WAq presently displays fish and invertebrates in publicly viewable tanks, has outdoor pool displays, one of which is home to an endangered Hawaiian Monk Seal, and offers research opportunities to University of Hawaiʻi (UH) students and faculty. In addition, various outdoor events, such as summers concerts, are held on its lawn.

Although WAq has been in nearly constant operation since it moved to its current location in 1955, no significant improvements have been made to the supply water intake system in the last 30 years. Much of WAq's aging water system infrastructure system was designed prior to modern Federal Clean Water Act regulations and does not meet current regulatory requirements. This has resulted in State and County regulatory citations relating to water quality issues associated with disposal of WAq effluent either into the ocean or the municipal sewer system. To comply with requirements to rectify citations, UH designed disposal system improvements and prepared an Environmental Assessment (EA) on the WAq Water Discharge System Upgrade that involved construction of two new injection wells (in progress) for the aquarium. When constructed, these wells will eliminate effluent discharge into the ocean and the municipal sewer system. The Final Environmental Assessment with a Findings of No Significant Impact (FONSI) was published on February 23, 2023, in The Environmental Notice issued by the State Office of Planning and Sustainable Development (OPSD).

The Proposed Action for this EA is separate and independent from the UH-designed disposal system improvements in the Final Environmental Assessment published on February 23, 2023.

1.2 Purpose and Project Need

Planning for the upgrades to the effluent discharge system exposed inadequacies of the existing Aquarium intake, filtration, and distribution systems. WAq utilizes three (3) intake water sources for their approximately sixty (60) public exhibits and behind-the-scenes holding tanks that are in operation at any given time. The three (3) intake water sources include:

1. Natural seawater (NSW) via two (2) 8-inch offshore intake pipes,
2. Saltwater derived from an 80-ft deep saltwater production well, and
3. Freshwater from the City and County of Honolulu water supply system.

The freshwater system comprises less than one percent of facility water intake at less than 2,000 gallons per day (GPD). WAq has four (4) freshwater exhibits and up to ten (10) freshwater holding tanks. Freshwater supplies only a small number of exhibits at relatively low water flow rate, whereas the NSW and the salt water well supply most of the exhibits and holding tanks at the WAq at a considerably much higher water flow rates.

A functional water intake supply system is critical to the operation of the Aquarium and to the life support systems for biota at the Aquarium. If any of the three intake water sources fails, the health and wellbeing of biota that depend on these water sources are endangered. The purpose of the proposed project, hereafter referred to as Proposed Action, is to upgrade WAq's outdated and obsolete saltwater intake water system infrastructure that currently comprises two offshore intake pipes, an onsite well, and treatment and filtration systems. These replacements will protect against likely future failures of these very old systems and upgrade the WAq's ability to provide high quality water for existing and future exhibits. to prevent future failures that threaten the life and wellbeing of the biota.

The Proposed Action includes the replacement of the two existing ocean water intake pipes that extend approximately 160 feet offshore, the construction of a new partially below ground NSW and well water pump vault, a new partially below ground aeration tank, the reconstruction and extension of the existing pump building, the refurbishment or construction of a new saltwater production well, and the installation of new equipment and piping. New equipment includes eight (8) new pumps, four (4) new media filters, two (2) ultraviolet sterilizers, heat exchanger and chiller, air compressors and diffusers, flow meters, level sensors, and other appurtenances. The project also includes mechanical and electrical upgrades associated with the new structures, building and equipment. The existing well will be refurbished to serve as backup for well saltwater supply.

The Proposed Action also includes the future replacement of the original EOR exhibit with an expanded EOR exhibit. As part of the Waikiki Aquarium Discharge System Upgrade project (currently in construction) the existing outdoor EOR exhibit is being demolished. The EOR exhibit first opened on Oct. 30, 1986, and showcased a living reef and featured native Hawaiian corals and fishes. The EOR exhibit was visited by countless visitors to the Aquarium over the years and very popular with the keiki. To construct the Discharge System Upgrade project to meet regulatory requirements, it was necessary to demolish the existing EOR exhibit. The EOR exhibit had been deteriorating in recent years with continuous leaks. The Waikiki Aquarium plans to replace the existing EOR exhibit with a future expanded EOR exhibit that will offer an enhanced experience for visitors. The expanded EOR exhibit will increase the size from the existing of approximately 1,300 square feet of area to over 1,800 square feet with shallow depth of two (2) feet on the makai side where visitors can touch the fishes to an eight (8) foot depth on the mauka side with viewing windows. The new expanded EOR exhibit will continue the legacy of the existing EOR exhibit beloved by many.

1.3 Project Site and Surrounding Area

WAq is located in Waikīkī on the south shore of the island of Oʻahu. The property lies at the Diamond Head end of Waikīkī and is surrounded by open space afforded by the Pacific Ocean and Kapiʻolani Park. The 2.35-acre parcel lies within the State Urban Land Use District, the State Conservation District Protective Subzone (ocean portion), the City and County of Honolulu (CCH) P-2 General Preservation District, the Special Management Area (SMA), and the Diamond Head Special District. Further, the Proposed Action is situated near the Marine Life Conservation District (MLCD) just offshore of WAq.

As depicted in Figure 1-1, the makai, or western, boundary of the property is adjacent to a popular public shoreline walkway that connects the Waikīkī Natatorium War Memorial to Queen's Surf Beach and Kalākaua Avenue. WAq is bounded by Kapiʻolani Park to the north and south, and by Kalākaua Avenue along its mauka or eastern boundary. Slightly further north is the Barefoot Beach Cafe, a casual cafe at Queen's Surf Beach. Slightly further south are the Kaimana Beach Hotel and San Souci (Kaimana) Beach. Further mauka, or east, of WAq are the Kapiʻolani Bandstand and Honolulu Zoo.

1.4 Scope and Authority

This Environmental Assessment (EA) was prepared for the proposed WAq's Supply Water Intake System Upgrade and the future EOR exhibit in accordance with Hawaiʻi Revised Statutes (HRS) Chapter 343 relating to Environmental Impacts Statements (EIS), Hawaiʻi Administrative Rules (HAR) Title 13, Chapter 5, which specifies procedures for projects located in the State Conservation District, and Revised Ordinances of Honolulu (ROH) Chapter 25, which specifies procedures for projects conducted within the Special Management Area (SMA).

HRS Chapter 343 is triggered by the use of state or county land or the use of state or county funds, project location within the conservation district, and project location within the shoreline area.

The portion of the proposed project involving the replacement of the two intake pipes is considered an identified land use in the Conservation District Protective pursuant to Section 13-5-22, Hawaii Administrative Rules (HAR), (P-8) STRUCTURES AND LAND USES, EXISTING (B-1), *"Demolition, removal, or minor alteration of existing structures, facilities, land, and equipment,"* which requires a Site Plan Approval that can be processed by the OCCL. This Final EA will be included in the application for a Site Plan Approval.

Pursuant to ROH §25-1.3, the definition of "Development" includes "construction, reconstruction, demolition or alteration of the size of any structure" within the SMA. ROH, §25.3(c) states that any proposed development within the SMA area requiring an SMA permit shall be subject to assessment.

This Final EA will be part of the SMA application. Both a Site Plan approval and an SMA have been identified as required regulatory permits for this project.

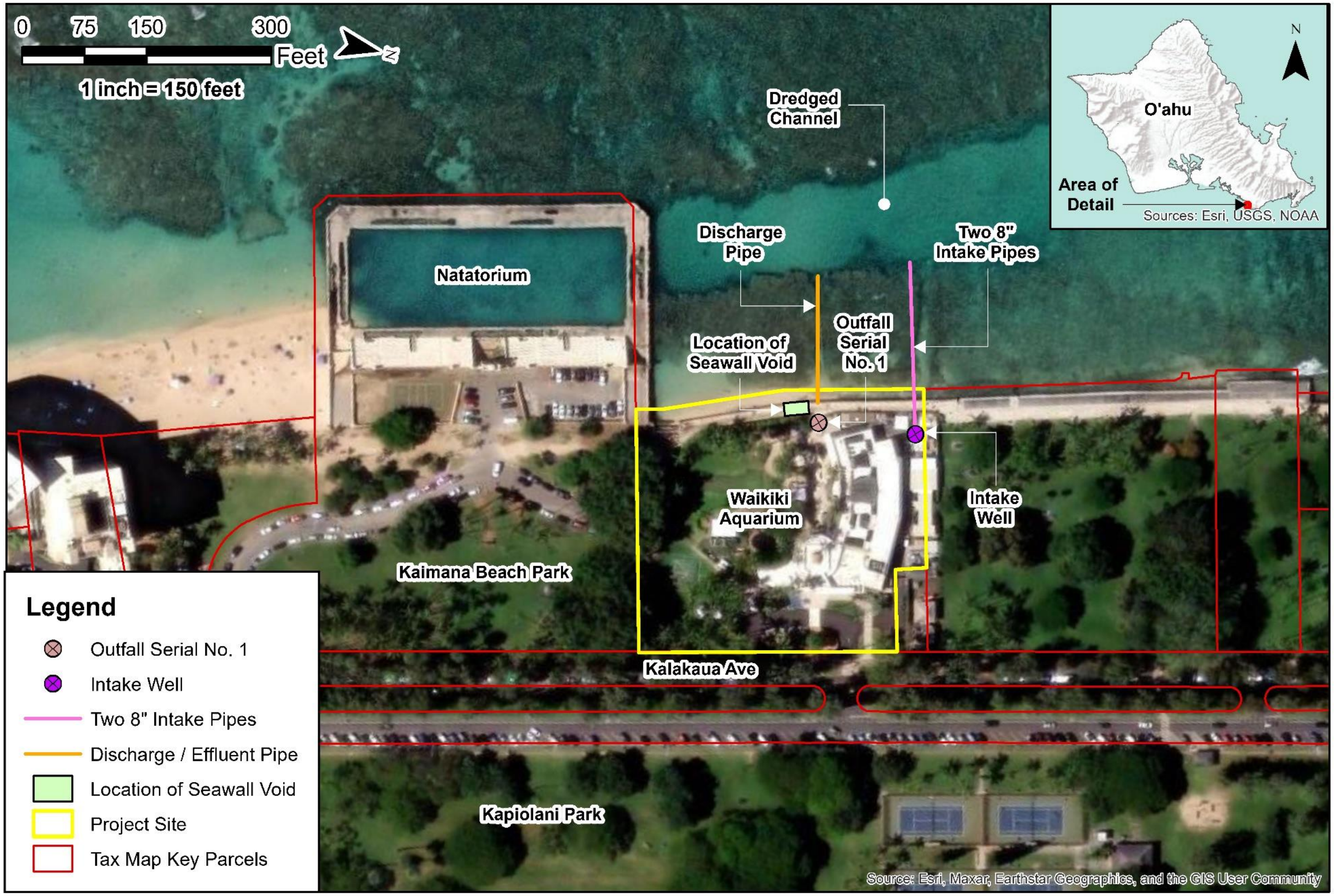

Figure 1-1: Project Site Map

2. PROPOSED ACTION AND PROJECT ALTERNATIVES

2.1 Existing Conditions

WAq houses native and non-native saltwater biota and some freshwater species in approximately 60 public exhibits and behind-the-scenes holding tanks that are in operation at any given time. Tank systems are segregated depending upon the types of animals on display. The largest display is a 70,000-gallon seawater pool designed to house endangered Hawaiian Monk Seals. "Native Tanks" include those that house Native Hawaiian saltwater species and solitary non-breeding, non-native animals. "Non-Native Tanks" include those that house biota from the Pacific Ocean distant from Hawaiʻi or native animals which require any live non-native feed. Hawaiian freshwater biota is housed separately.

Effluent water from native exhibits is currently discharged through a nearshore outfall under a National Pollutant Discharge Elimination System (NPDES) permit issued by the State Department of Health (DOH), while effluent from non-native exhibits is currently discharged into the CCH sanitary sewer system. To comply with federal, state and county requirements, UH is implementing discharge system upgrades intended to eliminate the discharge of wastewater generated by WAq exhibits into the ocean and the CCH wastewater system. The implementation of the discharge system upgrade is underway, with construction anticipated to begin in late 2023 or 2024. Scope of work for that upcoming project includes the installation of a wastewater discharge/transfer sump and pumps, two onsite injection wells and associated appurtenances and equipment for disposal of WAq exhibit effluent and upgrading the plumbing systems within the main building and the property. Three pumps connected to the discharge/transfer sump will pump the wastewater from the sump to a filter house structure on the south side of the property for filtration prior to discharge into the injection wells.

Planned upgrades to the effluent discharge system exposed inadequacies of the existing WAq intake, filtration, and distribution systems. The purpose of the Proposed Action is to replace the outdated and failing saltwater supply systems and upgrade them to provide better water quality for existing and future exhibits. Roughly half of the saltwater for WAq operations is drawn from a pair of 8-inch transite/concrete ocean intake pipes and the balance is drawn from a saltwater well located near the shore within WAq premises. Freshwater from the City's potable water supply accounts for less than one percent of the water requirement for exhibits. A functional supply water intake system is critical to the operation of the life support systems for the Aquarium biota. If any of the three intake water sources fails, the health and wellbeing of the biota that depend on it will be endangered.

The original Edge of Reef (EOR) exhibit needed to be demolished for the construction of the Discharge System Upgrade. Figure 2-1b depicts the footprint of the original EOR exhibit.

2.1.1 Water Intake Sources for Tanks

WAq utilizes three intake water sources totaling approximately 470,000 gallons per day (GPD), or approximately 325 gallons per minute (GPM), for the aquatic exhibits and holding tanks maintained at the facility at the present time. The new system will be designed to obtain a total of 886,000 gallons per day, roughly 396,000 from wellwater and 490,000 natural seawater from the nearshore pipes. Figure 2-1a depicts existing conditions.

2.1.1.1 Well Saltwater

Salt water from an 80-foot deep on-site well provides an average of approximately 225,000 GPD to WAq, or 156 GPM. The upgraded system plans are for a well water capacity of 396,000 GPD. Well salt water has very low turbidity and total suspended solids (TSS) and is considered free of parasites and pathogens. The well saltwater also has a lower temperature of around 24 degrees Celsius that is appropriate for on-site biota. The well water is anoxic and is aerated using two water pumps to raise the oxygen and degas the carbon dioxide before distribution to the indoor and outdoor aquatic exhibits and holding tanks. However, aeration of the water both raises its pH and results in the precipitation of a black precipitate consisting primarily of sodium, manganese, iron, magnesium and calcium oxides (in order of concentrations). Prior to entering each individual exhibit, the aerated well water undergoes phos-ban filtration to remove phosphates, silicates, and the iron oxide precipitate. This process has historically not been very efficient resulting in the black precipitate residues in many of the aquarium pipes and often entering exhibits. The well saltwater supplies most of the exhibits and tanks at the WAq.

2.1.1.2 Natural Seawater

Natural seawater (NSW) is the largest volume of daily water usage for the facility. An average of 247,000 GPD of NSW is pumped into the facility at about 170 GPM. The upgraded system will have a capacity of 496,000 GPD. Natural seawater is obtained through two parallel 8-inch diameter transite pipes that extend approximately 160 feet (ft) from the shoreline to the edge of the nearshore reef. Natural seawater is filtered by ten bag filter canisters in series, each comprised of 3-layer filter bags, that progressively remove particulates 50, 10, and down to one micron in size. This filtration system is inefficient and expensive to maintain. The NSW mainly supplies the outdoor pool that houses the endangered Hawaiian Monk Seal. The NSW contains plankton that may include fish parasites or pathogens, and is often too warm for use in the indoor fish and invertebrate exhibits. NSW is primarily used for the outdoor Monk Seal exhibit which does not require the water to be sterilized or cooled

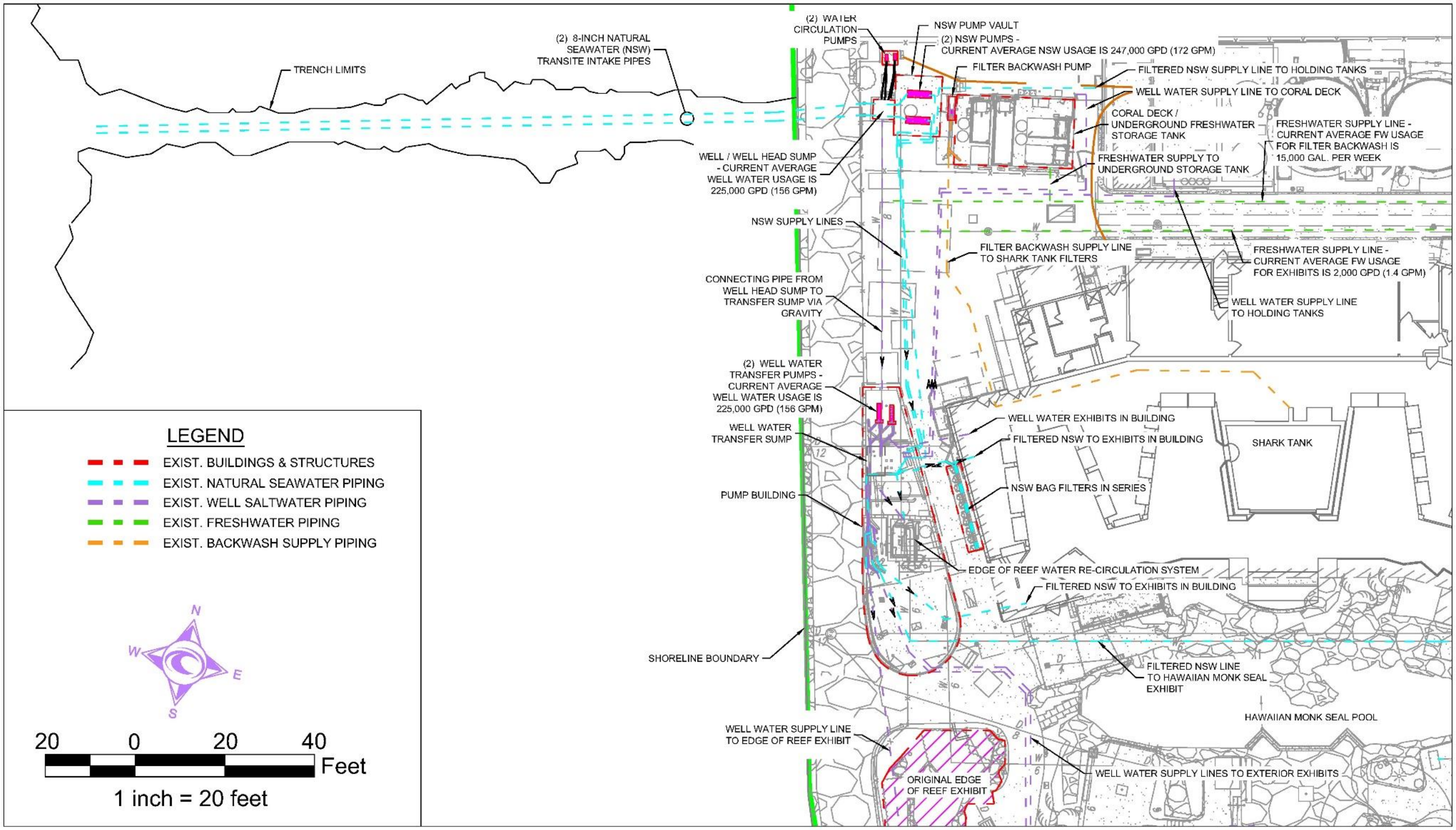

Figure 2-1.a: Water Intake System Existing Conditions

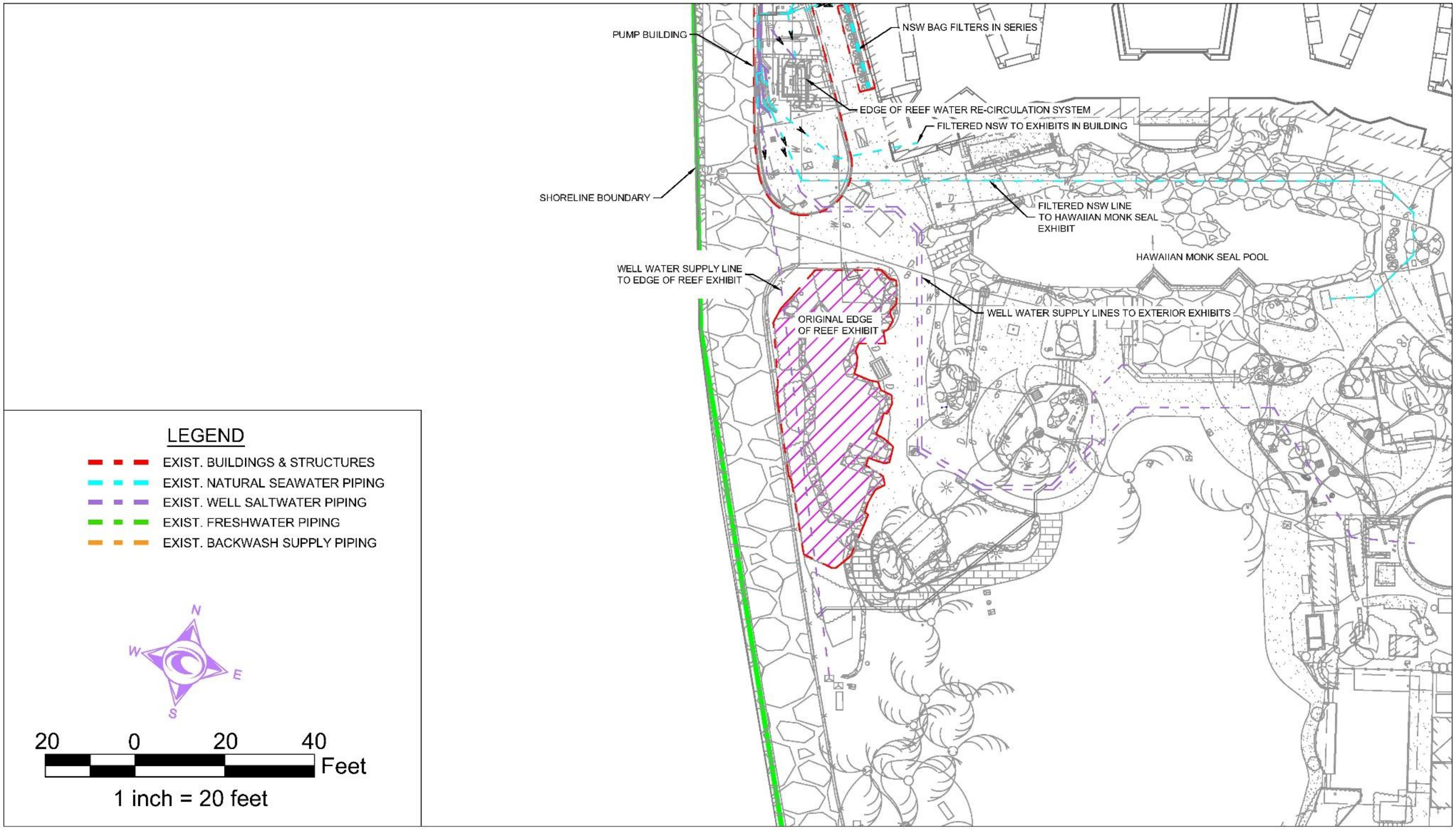

Figure 2-1.b: Original Edge of Reef Exhibit Existing Conditions

2.1.1.3 *Freshwater*

Freshwater from the CCH Board of Water Supply's (BWS) potable water supply comprises the smallest facility water intake at less than 2,000 GPD; and is less than one percent of the overall water intake system. Future freshwater needs for exhibits are not expected to change. Carbon filtration is used to remove chlorine immediately before introducing the water into the exhibits. WAq has four freshwater exhibits and up to ten (10) freshwater holding tanks in operation at a time.

2.1.2 Offshore Marine Environment

The existing ocean intake pipes (two 8-inch transite/concrete) and the existing ocean outfall effluent discharge pipe (12-inch transite/concrete) extend about 160 ft offshore directly from the WAq property and are near the south end of the Waikīkī Beach immediately north of the historical War Memorial Natatorium (Figure 2-2). By the time the new intake water system of the Proposed Action is installed, the present ocean discharge system will have been replaced by the deep injection well discharge system, although the existing effluent pipe will remain in place to serve as an emergency overflow for extreme stormwater runoff events. Because the discharge at the bottom of the injection well (126 to 226 ft below mean sea level) is expected to be of equal or greater density to surrounding groundwater, there should be no tendency for the effluent plume to rise. The effluent plume is expected to disperse and percolate through natural strata.

The active reef crest is located a little more than 1,000 ft offshore of WAq. The undisturbed lagoon flat between the shore and the reef crest averages 4 to 6 ft deep and has limited live coral cover, typical of reef lagoon areas off Waikīkī. In the 1920s, coincident with the construction of the War Memorial Natatorium, a deep channel was dredged through the reef flat roughly 125 ft wide and 700 ft long parallel to and about 150 ft off the present seawall shoreline. In its present condition, the channel is about 8 to 10 ft deep with a sand bottom substrate. Both the water intake and effluent pipes of the Aquarium extend from the shoreline to the edge of this channel. The vertical edges of the channel provide habitat for small fish and a few small corals. Currents in the area are weak and mainly driven by winds and tides with an average drift in the southern (Diamond Head) direction.

The reef flat throughout the Marine Life Conservation District (MLCD) consists mostly of consolidated rubble covered in coralline algae, beds of macro algae, and some small, dispersed patches of live coral. Surveys of the reef flat just north of the Aquarium show a coral coverage of zero to one percent (Franklin et. al., 2013). At the outer edge of the reef, roughly 1,000 feet offshore, coral cover and species diversity increase, and the depth increases to about 15 to 20 ft. At the reef edge there is an increase in the abundance and diversity of coral, fish, and benthic invertebrate species.

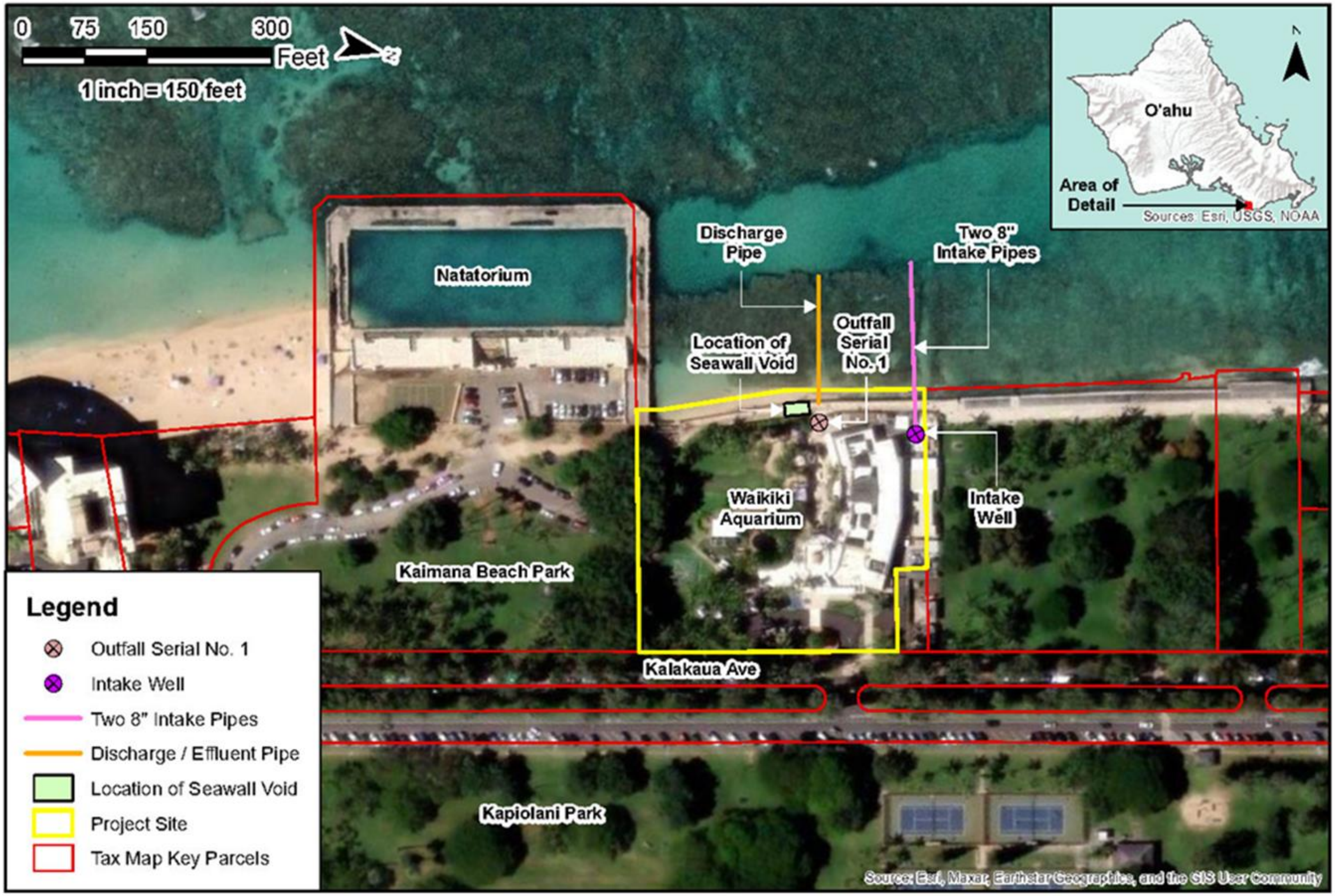

Figure 2-2: Existing Ocean Intake System

Survey information of the seafloor along the existing NSW intake pipes was collected by Oceanit personnel on June 6, 2023 and July 26, 2023. A depth profile along the intake pipes is shown in Figure 2-3.

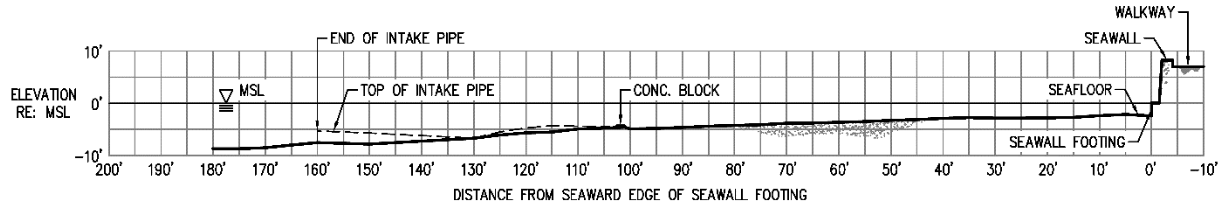

Figure 2-3: Depth Profile of NSW Intake Pipes

2.2 Limitations, Deficiencies and Other Assumptions

This section presents findings that lead to the alternatives analysis and selection of the preferred alternative. Appendix A, Waikīkī Aquarium Supply Water Intake System Upgrade Basis of Design Report, contains descriptions and evaluations of the various components of the WAq water intake system.

2.2.1 Limitations and Deficiencies

Numerous limitations and deficiencies of the existing systems were identified by WAq staff and in field investigations. Limitations and deficiencies are hereafter described and further discussed in appropriate sub-sections of Section 3.

1) Intake flow rates for the NSW are at or near capacity. Installed in the 1950s, the two intake pipes are well beyond their standard 50-year engineering life, although a visual external inspection of these pipes showed no obvious damage. In their present use, both pipes appear to be used simultaneously. Standard practice is to use only one pipe at a time to prevent organisms from growing inside and clogging the pipeline. There's no current mechanism to clear the pipe interior to remove growth. NSW intake needs to be upgraded and addressed with future upgrades.

2) Intake from the onsite saltwater well is limited by the size of existing 12-inch pipe connecting the well head to the pump sump. Any saltwater that comes through an onsite well must be aerated, degassed, and go through phosphorous and dissolved metal flocculation and filtration before use.

3) The two intake water sources (well and NSW) have different water quality challenges, and each requires its own filtration method. This increases complexity and the operation and maintenance (O&M) required to maintain the two intake water sources and associated filtration methods.

4) The quantity of water available from the existing sources is not sufficient to allow expansion of any significant future exhibits at the WAq.

5) Old and outdated infrastructure comprising the majority of existing WAq systems has high potential of failure and needs to be upgraded to ensure safety of exhibit biota.

6) There is limited square footage at WAq to accommodate changes. Sizes and locations of new equipment and facilities need to be carefully considered and planned to avoid conflicting with existing above- and below-ground infrastructure.

7) Existing underground utilities will pose potential conflicts with new lines or piping. Rerouting or relocating existing utilities may be necessary.

8) Electrical wiring/conductor may currently be insufficiently sized to accommodate future upgrades, thereby causing power issues. The electrical systems would need to be upgraded.

9) Existing electrical and mechanical infrastructure is not currently set up to accommodate exhibit upgrades or expansion and would need to be upgraded.

10) Leaks from the existing outdoor "Edge of the Reef" exhibit may have contributed to erosion and partial collapse of the seawall beneath the public sidewalk adjacent to this exhibit.

2.2.2 Other Assumptions

Other assumptions of the existing systems at the WAq considered in the design of recommended improvements include:

1) All existing infrastructure components are currently at capacity.

2) Most existing infrastructure components are beyond their usable engineering lifetime.

3) Staff training and turnover will require maximization of controls automation and minimization of O&M components to simplify transitions and training.

2.3 Proposed Action

2.3.1 Objectives of the Proposed Action

The Proposed Action is designed to achieve the following objectives:

1) Upgrade the existing saltwater supply and distribution systems by replacing the existing intake systems and associated treatment infrastructure; and

2) Maintain public safety and access along the Waikīkī promenade fronting the seawall.

2.3.2 Description of the Proposed Action

The purpose of this project is to upgrade WAq's outdated intake water system infrastructure to prevent the possibility of future failures that have the potential to threaten the life and wellbeing of the biota, and to increase the quality and quantity of water available for future WAq exhibits. To meet design goals and address the deteriorated condition of WAq's aged water system, the existing infrastructure will be replaced with new infrastructure designed to supply water from both the ocean and the well.

NSW from the ocean intake will be filtered and a portion will be routed to the Hawaiian Monk Seal exhibit. The balance of NSW used for fish and invertebrate exhibits will be disinfected with ultraviolet (UV) light and chilled prior to being routed to these exhibits. Saltwater from the well water intake will be pre-treated through aeration, sedimentation, and filtration prior to being routed to the exhibits. The scope of work for Proposed Action includes the following:

Natural Seawater System

1) Replace two existing NSW pumps/motors and reconfigure piping and pump vault;
2) Replace two existing 8-inch transite offshore intake pipes with new 8-inch high-density polyethylene (HDPE) pipes and intake sections; and
3) Remove existing pleated bag filters and install new NSW treatment components, to include media filters, UV sterilizers, heat exchanger and chiller for filtration, disease organism and temperature control. Target flow for NSW new treatment components is 340 GPM through media filters and 75 GPM through UV sterilizers, heat exchanger and chiller.

Saltwater Well System

1) Clean and refurbish existing well.
2) Install new saltwater well if existing well cannot be adequately refurbished;
3) Reconfigure well water distribution plumbing;
4) Replace existing water pump house;
5) Install new 275 GPM well water treatment components for aeration, metals precipitation and filtration, and
6) Refurbish existing well to serve as backup to the new well.

2.3.3 Proposed Action Components

The relationship of the various Proposed Action components is illustrated in Figure 2-4. Figure 2-5 presents the conceptual site plan layout.

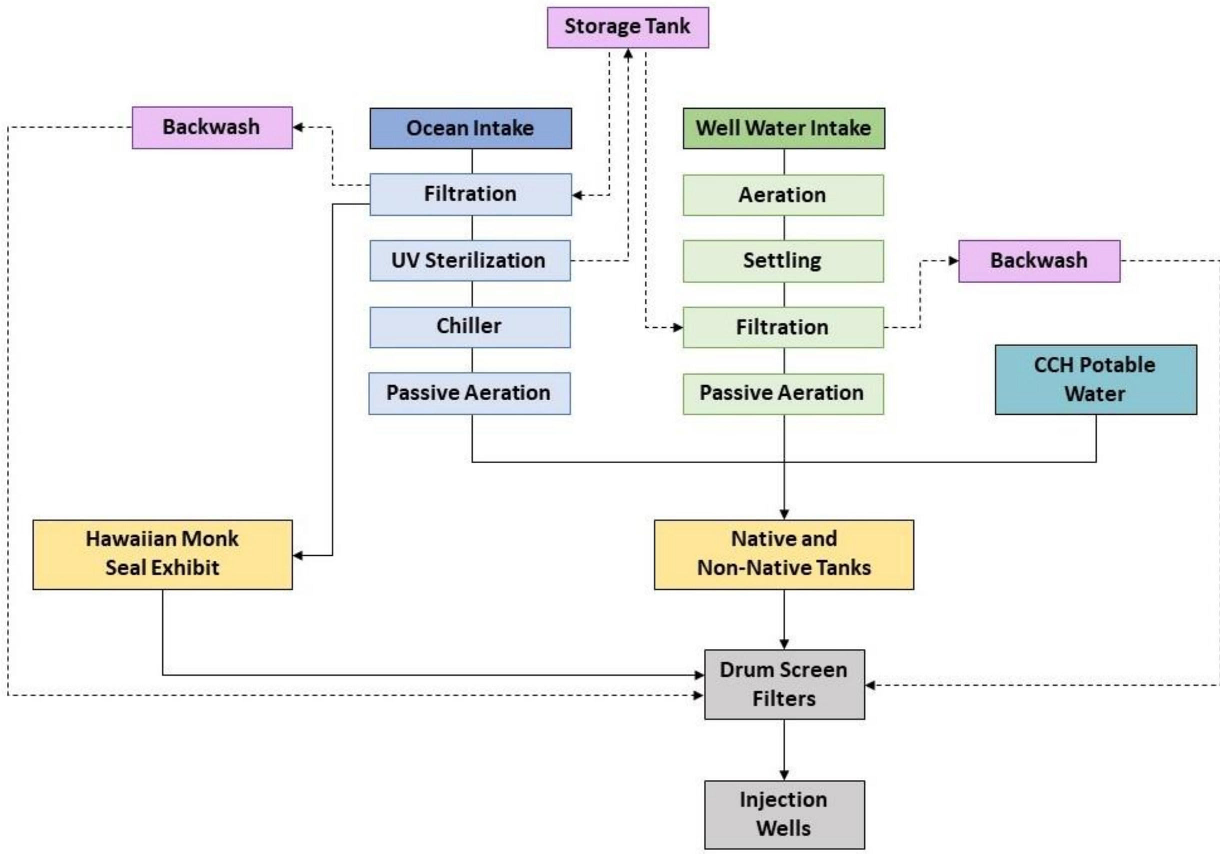

Figure 2-4: Conceptual Flow Diagram of the Proposed Action

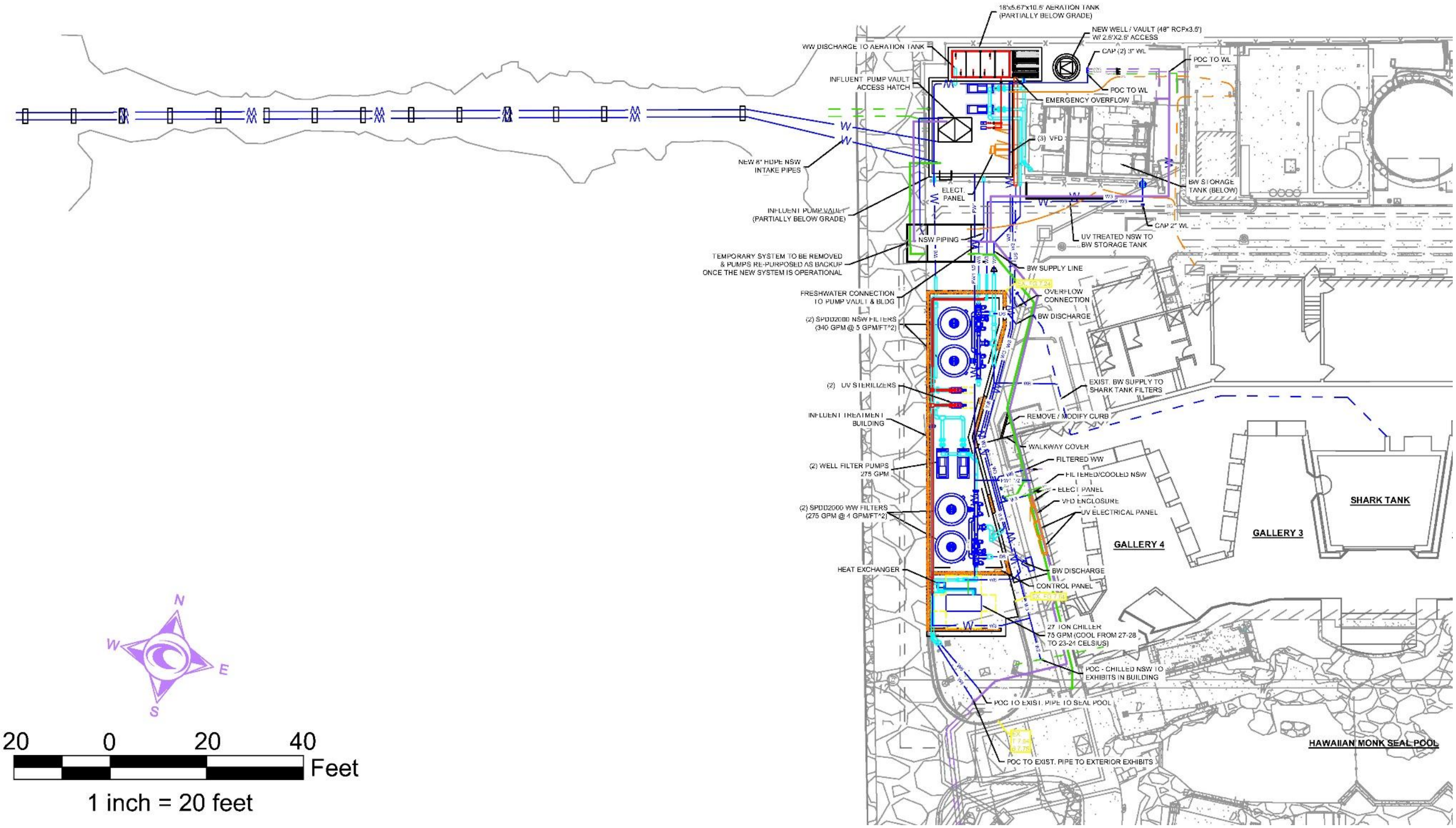

Figure 2-5: Conceptual Site Plan Layout

2.3.3.1 Upgrade of the Well Water Intake

The projected well water intake anticipated for future upgrades and improvements proposes to increase the flow from its existing 225,000 GPD to 396,000 GPD. Currently, the intake volume from the saltwater well is limited by the existing 12-inch gravity pipe that connects the well water sump and the sump beneath the pumps.

A camera was lowered down the well to determine its existing condition. Examination of the video indicates multiple mineral encrusting growths on the sides of the well bore, but an intact (not collapsed) well bore down to a depth of 45 feet. Based on the results of the well investigation it may be possible to rehabilitate the existing well by cleaning the sidewalls, removing accumulated debris from the bottom, and renewing the casing down to a depth of 45-feet. If this effort proves to be ineffective then a new saltwater well will need to be installed located approximately 20-30 feet inland (northwest) of the existing well adjacent to the property boundary. While a flow test of the existing well has not yet been conducted, it is highly probable that capacity is reduced from the original design. Detailed designs will be revised, if necessary, prior to permit and approval applications.

Water will be pumped from the well using two pumps located within a new pump vault partially below grade (Figure 2-6). Well water is low in oxygen, has low pH, and is laden with nutrients and metals, so a new well treatment system is proposed. A well water aeration/settling tank has been conceptualized to raise oxygen and pH, and precipitate dissolved metals (Figure 2-7). New well water treatment components will be installed, conceptualized as two 275 GPM pumps, an aeration/settling tank, and two media filters for filtration. The existing 12-inch transite well water distribution pipe and sump will be plugged and abandoned, and the existing well water pump house will be replaced.

Experiments were conducted to determine the make-up, concentration, and size range of the precipitate formed when the well water is aerated. Based on results from sampling on April 11, 2023 (Attachment A), the average suspended particle size in well water is between 50 to 100 microns, post-aeration. Ninety percent of the particles are greater than 10 microns and 80% are greater than 20 microns in size post-aeration. Based on results from the experiment on July 11, 2023 (Attachment B), an aeration chamber with a residence time of approximately 15 minutes at 275 GPM appears to be adequately sized to optimally treat dissolved solids from Aquarium well water. Fifteen minutes of contact time with air will precipitate manganese and iron hydroxides from well water.

The aeration/setting tank's up-and-down maze is a standard method that assures minimum shortcutting through the system and an even distribution of air bubbles throughout the flow.

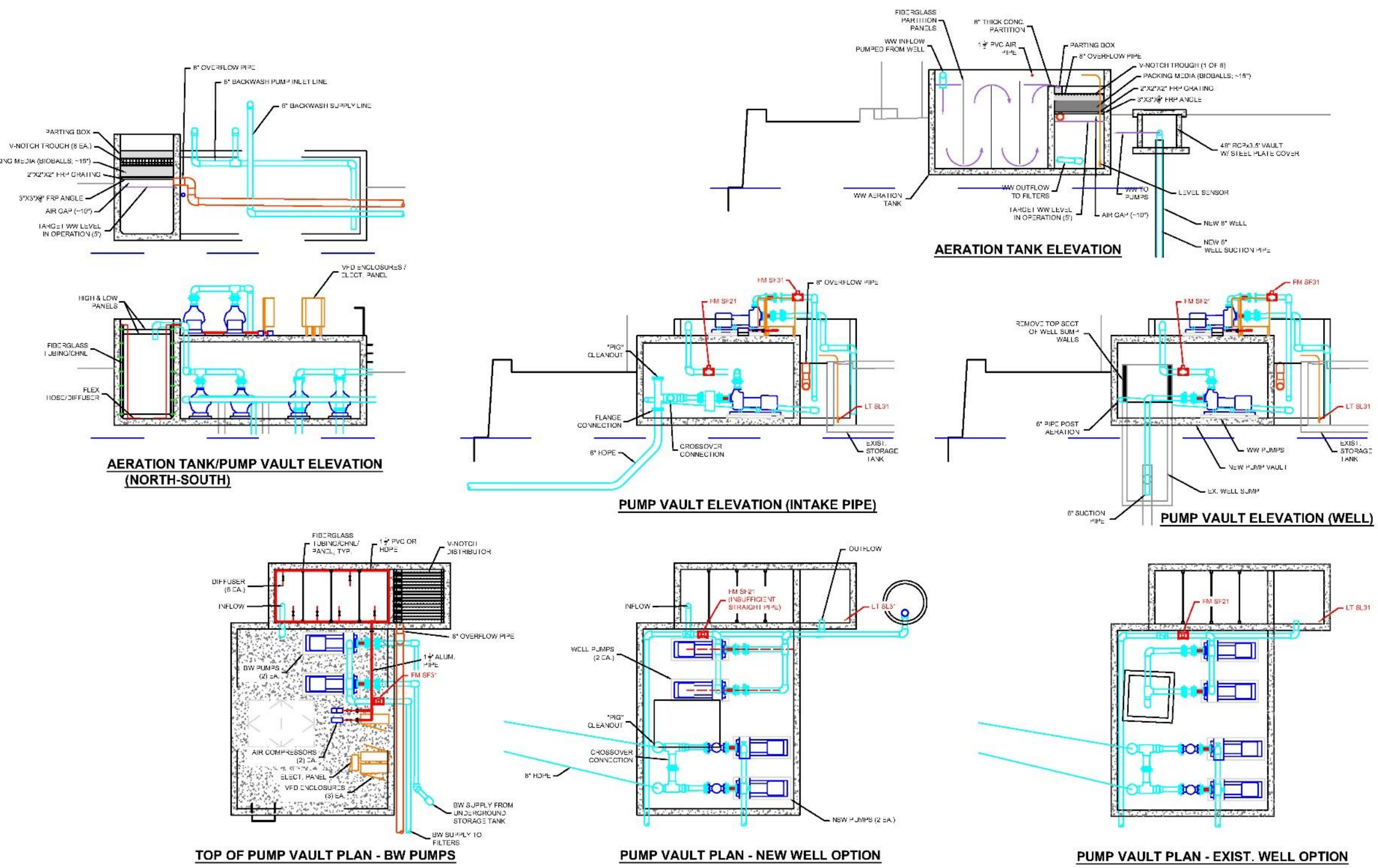

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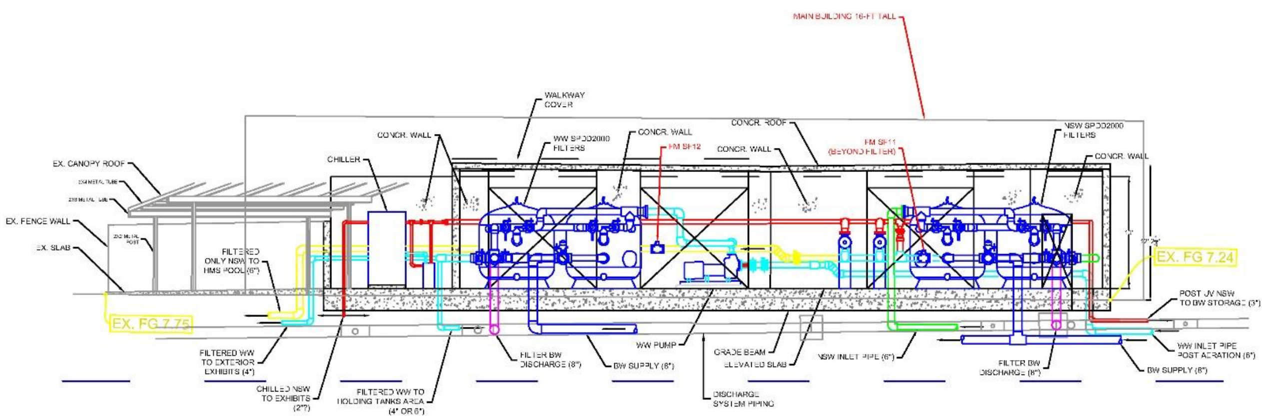
Figure 2-6: Pump Vault / Aeration Tank Plan and Elevation



INFLUENT TREATMENT BLDG. ELEVATION

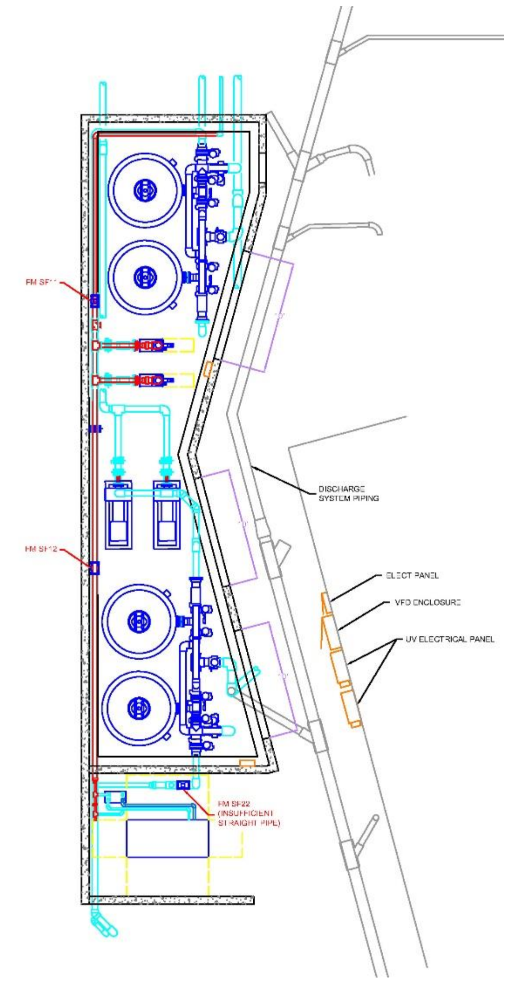


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Figure 2-7: Influent Treatment Building Plan and Elevation

The existing influent treatment building has significant structural issues that have developed over the years requiring replacement of the footings, walls, and roof. The Influent Treatment Building footprint will be expanded into the adjacent walkway that currently exists between the Treatment Building and the main Aquarium building. A minimum 5 ft walkway width is maintained between the main building and the new building structure. Height is intended to match existing with a low-pitched roof sloping towards the ocean. The preference is to rebuild the building structure using concrete, which will provide better durability and reinforcement protection than the existing concrete masonry unit (CMU) structure. The preference is to also have a concrete roof structure for enhanced durability, or a timber roof structure to save slightly on construction costs. Other options for roofing include built-up, ethylene propylene diene terpolymer (EPDM), thermoplastic polyolefin (TPO) and elastomeric roofing. Metal roofing is also an option, although less ideal, as it can easily corrode in such close proximity to the ocean. All new concrete structure will need to sit on micropile foundations.

2.3.3.2 Improvements to Ocean Intake System

The Aquarium cannot run exclusively on well water due to volume and quality limitations. Therefore, the NSW intake flow would double from 247,000 GPD to approximately 490,000 GPD. In perfect working conditions, a single 8-inch NSW intake is sufficient to provide this capacity at a flow speed of about 2 feet per second. Because the two transite intake pipes were installed in the early 1950s and are well beyond their 50-year engineering life, they will be replaced with new 8-inch HDPE pipes (Figure 2-8). Flow will be limited to only one pipe at a time to minimize the potential for marine growth on the inner walls of the intake pipes.

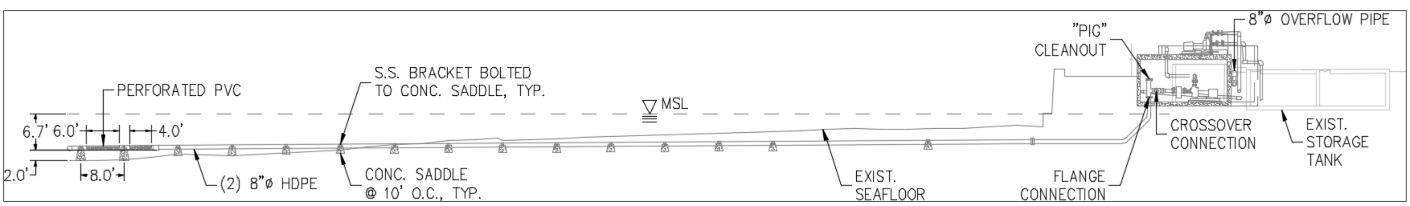


Figure 2-8: Conceptual Profile of New Intake Pipes

The openings to the seawater intakes will be designed to minimize entrainment of small fish and invertebrates. Consideration will be given to anchoring the terminus of the new intake, which presently hangs off the edge of the dredged reef face, 2 feet above the existing elevation of the sand bottom of the channel, to make it a few feet deeper than present and improve water quality during winter storm events. Consideration will also be given to extending the intake pipes by 10 ft, from 160 ft to 170 ft in length measured from the existing seawall. The end of each pipeline will consist of a removable section of pipe with several thousand small (~3/4") holes designed to limit the flow speed to less than 1-inch per second to minimize biota entrapment. The end sections of pipe are designed to be able to be removed for occasional cleaning.

The two existing NSW pumps and motors will be replaced due to their age, and will include a reconfiguration of the pump vault and piping. NSW needs to be treated for TSS, particulates, parasites (including *Cryptocaryon irritans)*, and microbiologics that cause biofouling. New treatment components will be installed to accommodate the 340 GPM NSW flow. These include two media filters for filtration of all the flow, two 170 GPM UV sterilization units, and a water chiller to accommodate 75 GPM flow. The Aquarium expressed preference for medium pressure UV lamps due to space efficiency and lower maintenance.

Filtered and UV-treated NSW will be routed to an existing storage tank for use as backwash water supply for all four well water and NSW filters as well as the two existing shark tank filters. The tank is currently used for freshwater storage but will be converted to saltwater storage. Two 600 GPM backwash pumps will be located atop the new pump vault. Backwash discharge will be routed to the drum screen filters and injection wells to be constructed as part of the upcoming Discharge System Upgrade project.

2.3.3.3 Supply Water Distribution System

The pumps and delivery pipes to the main building will be upgraded to accommodate the new flow. The water distribution system, water treatment facilities and controls also need to be upgraded. A new system of treatment, pumps, controls and delivery lines to accommodate the full flow is designed to direct water to the exhibits. New piping will be kept away from the promenade and fronting seawall. Existing piping located within the promenade are planned to be abandoned in place, filled and capped.

Before distribution to the shark tank or other exhibits containing fish or invertebrates, NSW will need to be cooled to a temperature range of approximately 23 to 24 degrees Celsius, slightly cooler than the NSW intake provides. Note that the Monk Seal is not sensitive to water temperature and uses filtered NSW without UV treatment or cooling.

2.3.3.4 Upgrades to the Existing Electrical System

The existing electrical service, switchboards, and generator will have the capacity to serve all new electrical loads for the Supply Water Intake System Upgrade project.

Eight new variable frequency drives (VFDs) will be needed, one for each of the eight new pumps, including the two backwash pumps. VFDs will be located near the pumps they are controlling. New electrical panels will also be needed to distribute power to pumps, aerators, UV sterilizers, chillers, heat exchangers, and structures. The existing electrical feeders to the areas of the well water pumps, NSW pumps, air injection compressors, filters, UV sterilizers, chiller and heat exchanger will remain and be reused from the existing electrical room. The new electrical panels being provided will replace the local panels in these areas to improve the distribution of the equipment branch circuits. New light fixtures and lighting control system will be provided at the new pump vault and new Influent Treatment Building. Since redundant equipment is not expected to operate simultaneously, interlocking controls will be implemented to prevent redundant electrical supply from operating secondary equipment. Status and control of the new equipment will be monitored and controlled by the existing Aquarium's Sensaphone system.

2.3.3.5 Upgrades to the Existing Mechanical System

The backflush pumps, filter pumps and associated valves will be automated and interfaced to a controls system. However, the backflush and rinse cycle sequences for individual filters will be initiated manually by an Operator; they will not initiate automatically. New flowmeters and instrumentation will be required for monitoring purposes.

The backwash system will involve replacing the existing 25 horsepower (hp) backwash pump/motor, piping and appurtenances, and reconfiguring piping to accommodate new pumps. New 600 GPM backwash components will be installed, to include two backwash pumps, piping, and appurtenances. The new backwash pumps will be installed on top of the new pump vault.

Construction of the new pump vault will also require a new exhaust fan with sufficient capacity to accommodate the heat load from the pumps operating within the pump vault.

2.3.3.6 Edge of Reef Display

As part of the Waikīkī Aquarium Discharge System Upgrade project (currently in construction) the existing outdoor "Edge of Reef" (EOR) exhibit is being demolished. The EOR exhibit first opened on October. 30, 1986. Inspired by the tidepools at Makapuʻu, the EOR exhibit showcased a living reef and featured native Hawaiian corals and fishes. The EOR exhibit was visited by countless visitors to the Aquarium over the years and has been very popular with families.

The Discharge System Upgrade project under construction is required to meet regulatory requirements, and construction of the project entailed the demolition of the existing EOR exhibit. The EOR exhibit had been deteriorating in recent years with continuous leaks. The Waikīkī Aquarium plans to replace the existing EOR exhibit with a future expanded EOR exhibit that will offer an enhanced experience for visitors. Figure 2-9 outlines the location of the future EOR. The expanded EOR exhibit will increase in size from the existing of approximately 1,300 square feet of area to over 1,800 square feet with shallow depth of two (2) feet on the makai side where visitors can touch the fishes to an eight (8)-foot depth on the mauka side with viewing windows. The new expanded EOR exhibit will continue the legacy of the existing EOR exhibit beloved by many. Figure 2-10 depicts a section of the proposed EOR.

Figure 2-9: Future Expanded EOR Exhibit

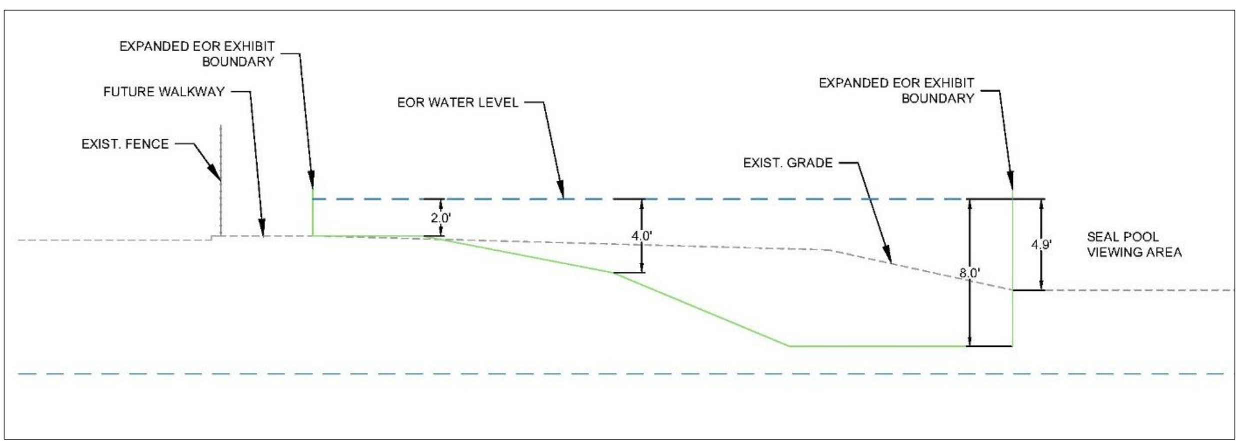


Figure 2-10: EOR Section

2.3.3.7 Emergency Seawall Repairs

As a part of the pre-consultation process, DLNR Office of Conservation of Coastal Lands (OCCL) commented that the current condition the seawall fronting WAq should be addressed. UH is currently undertaking emergency repairs to the seawall to repair voids as pictured in Figure 2-11a. Seawall repairs are part of the Water System Upgrade Plan and therefore included in this EA. However, in discussions with the City and County (CCH) Department of Planning and Permitting (DPP), it was advised that this seawall repair could qualify for an emergency building permit, the application of which was submitted. Repairs have been completed as of this writing. Figure 2-11b shows repaired wall.

Figure 2-11a: Seawall In Need of Repair

Figure 2-11b: Repaired Seawall

2.4 Costs, Operation, and Maintenance

The new intake system will have built-in features to allow for maintenance and be reconfigured to improve accessibility for operations and maintenance. Rather than utilizing disposable membrane filters that require maintenance on an hourly basis, the transition to media filters will provide a much lower maintenance requirements solution for both saltwater sources. The elimination of excess minerals present in well water will result in reduced cleaning requirements for the exhibit water distribution system. Improved water quality across all exhibits may lessen exhibit cleaning requirements over time.

In addition, redundance will be part of the new intake system to allow for equipment failures and maintenance.

2.4.1 Construction Scope of Work

The first phase of construction will be to establish a temporary water supply system to maintain WAq operations during construction. This will involve either using the existing well for temporary water supply or drilling the new well and getting it operational prior to the rest of construction. Temporary water supply should assume the Monk Seal will be back at the Aquarium by the time construction for the Supply Water Intake System Upgrade project starts, therefore, the temporary water supply will also include NSW using one of the existing intake pipes. The shark tank filter backwash pump needs to remain in operation during construction. As part of the temporary water supply system, three new pumps will be installed for the well water supply, NSW supply and for filter backwashing. The pumps and the distribution piping of the temporary system will be located clear of the new construction of the new intake system. The new pumps used for the temporary system will be repurposed at the end of the project to serve as redundant/backup pumps.

The construction Scope of Work for the Proposed Action includes the following.

- All necessary signs, tights, barricades, and other safety equipment will be installed and maintained by the contractor during the construction.
- Mobilize to site and set up Best Management Practices (BMPs).
- Set up and test temporary water supply.
- Construct new well.
- Replace NSW intake pipes. Removal of the existing asbestos containing transite pipes will be done by a licensed C-19 asbestos abatement contractor.
- Demolish existing pump vault. Reconstruct new pump vault and well water aeration/settling tank. Install mechanical components, including two NSW pumps, two well water pumps, and two filter backwash pumps.

- Reconstruct well water pump house (i.e., Influent Treatment Building). Install mechanical components, including four well saltwater pumps, UV sterilizers, NSW filters, two well water filters, a chiller and a heat exchanger.
- Install new supply water plumbing to reconfigure distribution system.
- Install feedback controls and complete electrical work to connect new equipment.
- Test new supply water intake system prior to decommissioning temporary water supply.
- Demobilize from site.

A full set of design plans and specifications will be prepared by licensed engineers and construction will be performed by a licensed contractor.

2.4.2 Other Project Characteristics

Other project characteristics are as follows:

- From an economic standpoint, the Proposed Action will have a positive short-term impact by creating direct and indirect employment related to construction. Further, it will allow WAq to comply with State and CCH environmental requirements while continuing operations and remaining financially viable. These effects will continue to promote Waikīkī as a visitor destination. Section 3.4.2 presents further discussion on the economy.

- The Proposed Action will not have any effects on demographics. In terms of other social - related impacts, the Proposed Action is consistent with and supportive of public policies and plans related to ocean processes, benthic habitats, recreational resources and activities and, the promotion of Waikīkī and Diamond Head as visitor and resident destinations. Section 3.4.1 discusses demographic impacts and public policies and plans are discussed in Section 4.

- An Archaeological and Literature Review and Field Inspection Report (ALRFI) is presented in Appendix F and summarized in Section 3.4.3. Based on the ALRFI and on previous archaeological projects near the project area that have recorded subsurface historic properties including cultural deposits and human burials, there is insufficient information to make a HRS Chapter 6E historic preservation determination of effect of the project's impact on potential subsurface historic properties within the 0.06-acre project area. Therefore, archaeological monitoring for identification purposes, guided by a SHPD-approved archaeological monitoring plan (HAR § 13-279-3), is recommended.

- No significant cultural impacts are anticipated as a result of the Proposed Action. Cultural impacts are discussed in Section 3.4.4 and a Revised Cultural Impact Assessment is contained in Appendix G.

- The Proposed Action is anticipated to have long term positive impacts on ocean water quality, benthic habitats and WAq infrastructure and operations. Impacts on nearshore receiving waters are expected to occur temporarily during in-water construction for the replacement of the two intake pipes. Effective BMPs will avoid and minimize short-term construction-related impacts. Impacts on these topics are discussed throughout Section 3.

2.5 Project Alternatives

The Proposed Action incorporates the combined use of well water and treated/cooled NSW that would be collected by new intake pipes. In the Proposed Action, well water will have a 275 GPM target flow rate, while NSW will have a 340 GPM target flow rate, with roughly 170 GPM filtered only to the Monk Seal pool and roughly 75 GPM UV-treated and cooled prior to being distributed to the remaining exhibits. The Proposed Action has a total flow rate of approximately 615 GPM.

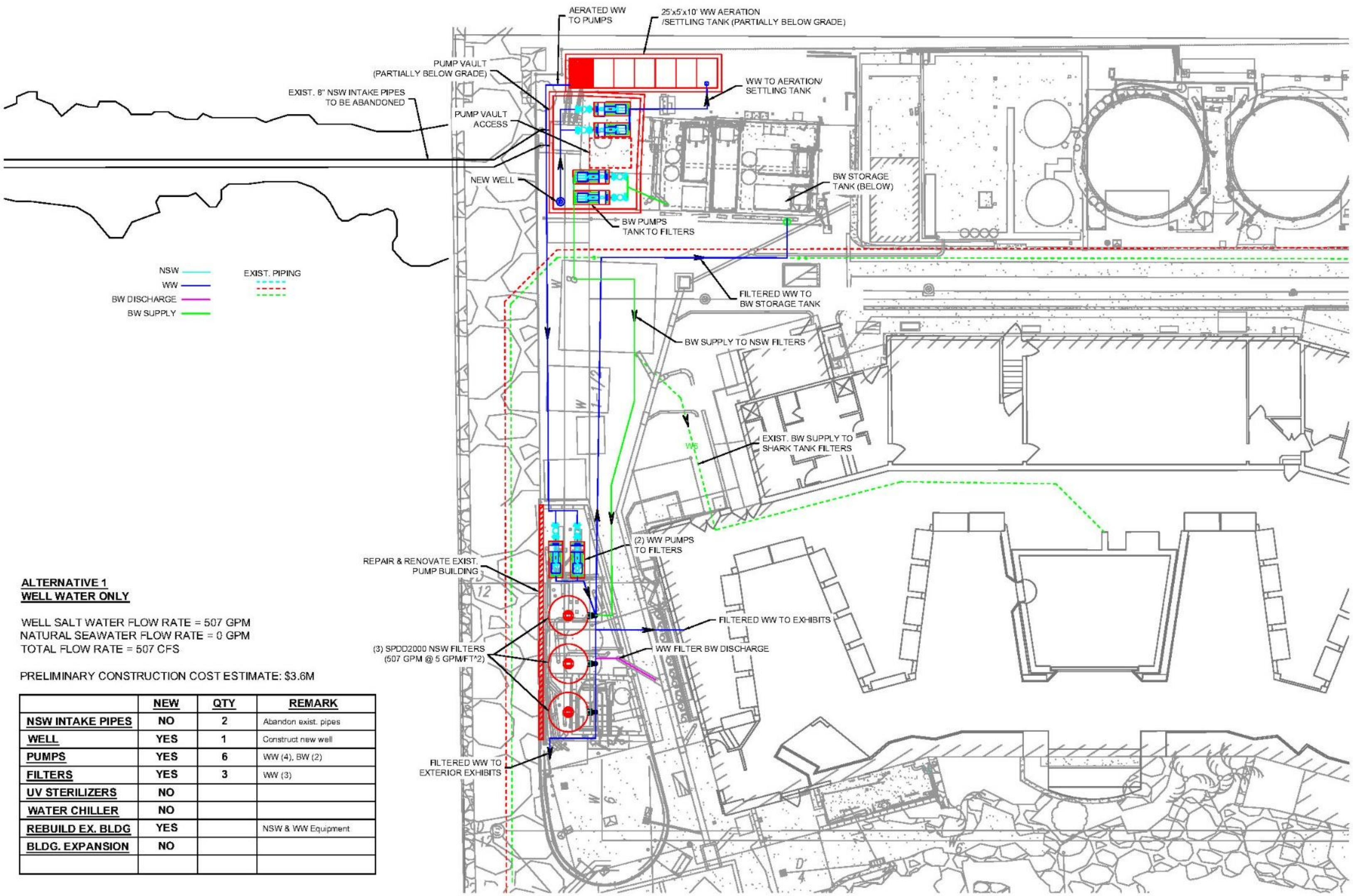
Two alternatives to the Proposed Action were considered and are hereby described.

2.5.1 Alternative 1: Use of Well Water Only

Alternative 1 would supply WAq with well saltwater originating from a new production well. The NSW supply would be eliminated, and the existing ocean intake pipes would be abandoned in place. A new pump vault would be constructed to house well pumps and filter backwash pumps and a new aeration tank to treat the well saltwater prior to filtration. The existing pump building would be repaired and renovated to house new well pumps and well saltwater media filters. See Figure 2-12.

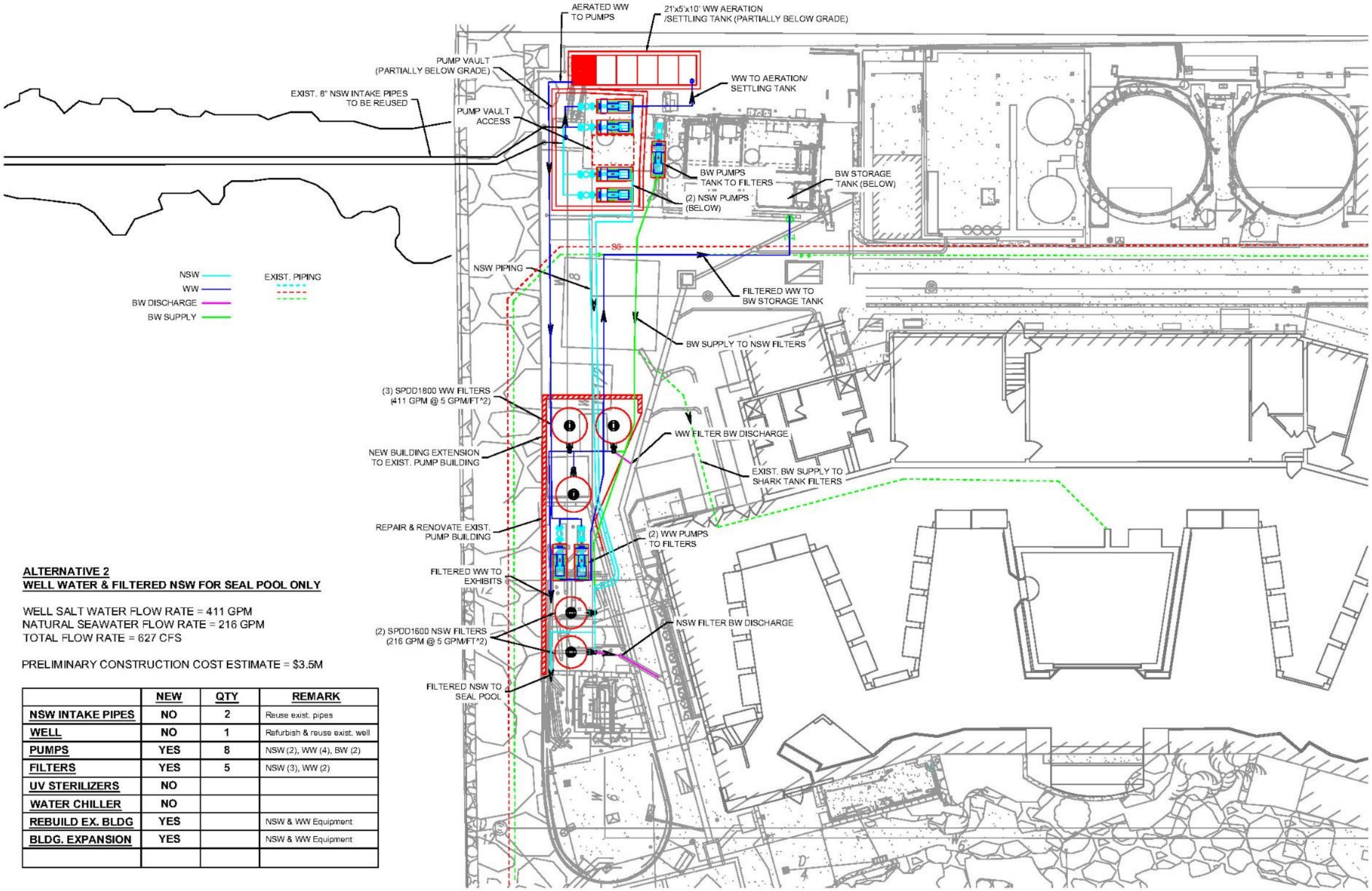
2.5.2 Alternative 2: Combination of Well Water and NSW Using Existing System

Alternative 2 would refurbish the existing well and reuse the existing ocean intake pipes for NSW supply (filtered only without treatment or cooling). No new well would be built. A new pump vault would be constructed to house well pumps and NSW pumps and new aeration tank to treat the well saltwater prior to filtration. The existing pump building would be repaired, renovated and extended to house new well pumps and NSW and well saltwater media filters. See Figure 2-13.



	NEW	QTY	REMARK
NSW INTAKE PIPES	NO	2	Abandon exist. pipes
WELL	YES	1	Construct new well
PUMPS	YES	6	WW (4), BW (2)
FILTERS	YES	3	WW (3)
UV STERILIZERS	NO		
WATER CHILLER	NO		
REBUILD EX. BLDG	YES		NSW & WW Equipment
BLDG. EXPANSION	NO		

Figure 2-12: Alternative 1 – Well Water Only



	NEW	QTY	REMARK
NSW INTAKE PIPES	NO	2	Reuse exist. pipes
WELL	NO	1	Refurbish & reuse exist. well
PUMPS	YES	8	NSW (2), WW (4), BW (2)
FILTERS	YES	5	NSW (3), WW (2)
UV STERILIZERS	NO		
WATER CHILLER	NO		
REBUILD EX. BLDG	YES		NSW & WW Equipment
BLDG. EXPANSION	YES		NSW & WW Equipment

Figure 2-13: Alternative 2 – Well Water and Filtered NSW for Seal Pool Only

2.5.3 No Action Alternative

The No Action Alternative would limit the capacity on NSW inflow to current levels, thereby requiring simultaneous use of both pipes which is inconsistent with the current practice of using one pipe at a time to prevent organisms growing inside and clogging the pipelines. Further, the intake pipes are well beyond their standard 50-year engineering life and could lead to damage that would severely curtail the supply of NSW to support biota at the Aquarium. Old and outdated infrastructure comprising the majority of existing Aquarium systems has high potential of failure and should be upgraded. Intake from the onsite saltwater well is limited by the size of existing pipes and pump. Any saltwater that comes through an onsite well must be aerated, degassed, and go through phosphorous and dissolved metal flocculation and filtration before use. Further, NSW is too warm for many WAq exhibits and requires treatment to eliminate parasites.

2.5.4 Evaluation of Alternatives

Table 2-1 compares Alternatives 1 and 2 with the Proposed Action. Although Alternatives 1 and 2 are estimated to have lower construction costs than the Proposed Action, the latter is preferred due to system flexibility, water quality control and accommodation of future increases and expansion of WAq exhibits. The Proposed Action is also preferrable because the other alternatives will leave part of the existing outdated infrastructure in place and will eventually need to be replaced. Reduced redundance and no backup systems will result in potential disruptions to WAq operations. Leaving some of the aging infrastructure in place poses a risk of imminent failure that would endanger the animals and end up costing more in future upgrades.

Table 2-1: Comparison of Alternatives 1 and 2 and the Proposed Action

	Alternative 1 Well Water Only			Alternative 2 Well Water and NSW with Existing Pipes			Proposed Action New NSW Pipes and New Well		
Element	**New**	**Qty**	**Remark**	**New**	**Qty**	**Remark**	**New**	**Qty**	**Remark**
NSW Intake Pipes	No	2	Abandon existing pipes	No	2	Reuse existing pipes	Yes	2	Replace existing pipes with new
Well	Yes	1	Construct new well	No	1	Refurbish and reuse existing well	Yes	1	Construct new well
Pumps	Yes	6	WW (4), BW (2)	Yes	8	NSW (2), WW (4), BW (2)	Yes	8	NSW (2), WW (4), BW (2)
Filters	Yes	3	WW (3)	Yes	5	NSW (3), WW (2)	Yes	4	NSW (2), WW (2)
UV Sterilizers	No	--	--	No	--	--	Yes	2	NSW (2)

Water Chiller	No	--	--	No	--	--	Yes	1	NSW
Rebuild Existing Building	Yes	--	NSW and WW equipment	Yes	--	NSW and WW equipment	Yes	--	NSW and WW equipment
Building Expansion	No	--	--	Yes	--	NSW and WW equipment	Yes	--	NSW and WW equipment
	OPTION 1			**OPTION 2**			**OPTION 3**		
ROM Cost	$3.6M			$3.5M			$6.0M		

3. AFFECTED ENVIRONMENT, POTENTIAL IMPACTS, AND PROPOSED MITIGATION MEASURES

This section discusses existing conditions, potential impacts and proposed mitigation measures for the physical and natural environment, natural hazards, ecological resources, the human environment, and public services and facilities.

3.1 Physical and Natural Environment

3.1.1 Climate

3.1.1.1 Existing Conditions

The Hawaiian Island chain in the Pacific Ocean is one of the most remote land masses on Earth. A large eastern Pacific semi-permanent high-pressure cell to the north of the islands dictates much of air circulation patterns and climate in the region. This high-pressure cell produces northeasterly winds called trade winds over the Hawaiian Islands.

The average annual rainfall at the project area is approximately 23.5 inches per year with the most rain occurring during the wet season months of November through March. Relative humidity is usually about 70% (Giambelluca et al., 2014). The temperature in Honolulu is 74.7 degrees Fahrenheit (°F) on average, with relatively stable temperatures throughout the year due to its close proximity to the ocean (Giambelluca et al., 2014). Tradewinds dominate throughout the majority of the year and blow toward the northeast. Kona winds and storms bring winds from the southwest and are most prevalent between October and April.

3.1.1.2 Potential Impacts and Proposed Mitigation Measures

The proposed action will not impact climate in the area and no mitigation is required.

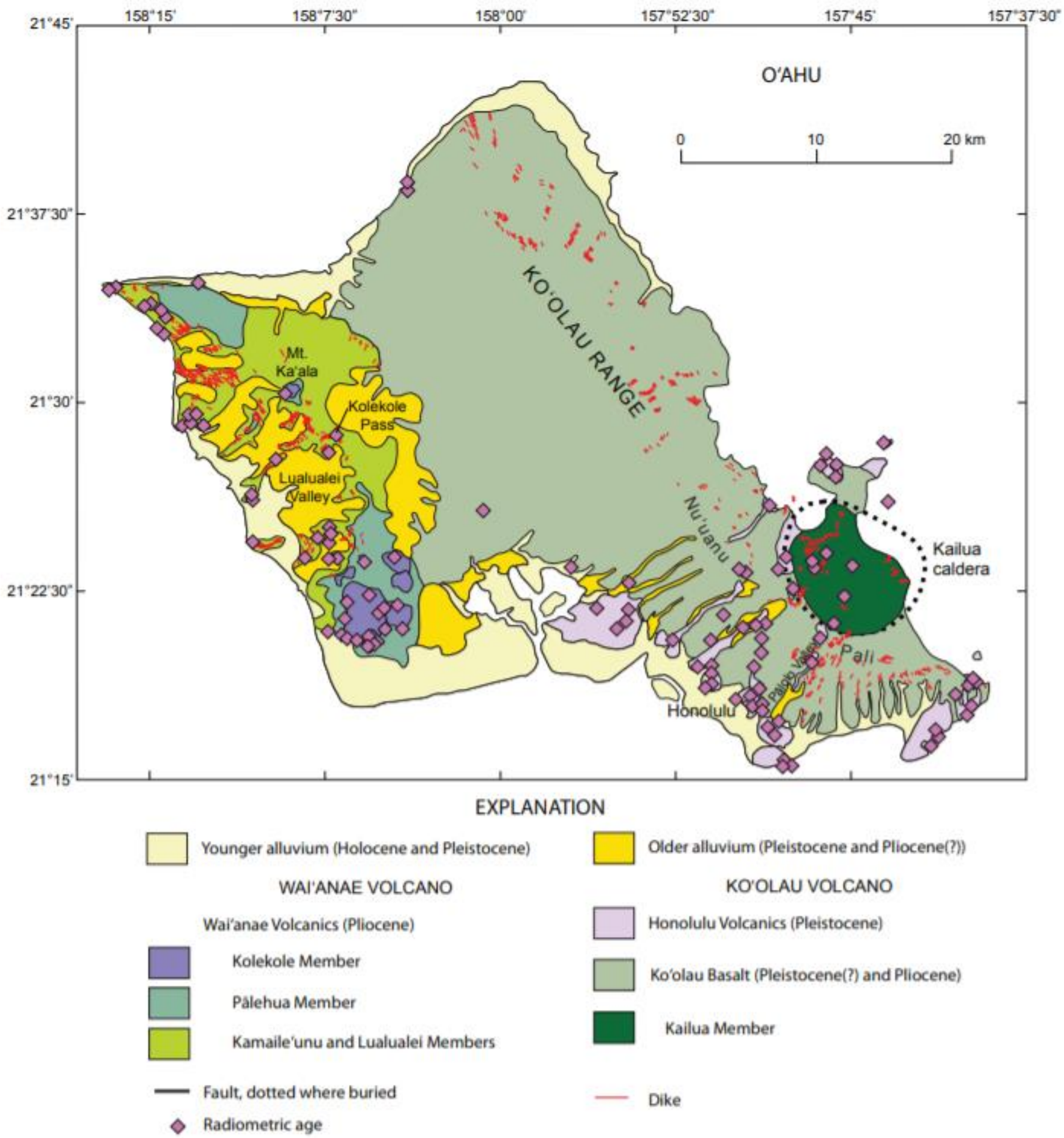
3.1.2 Geology and Soils

3.1.2.1 Existing Conditions

The island of Oʻahu was created by basaltic lava flows from the Waiʻanae and Koʻolau shield volcanoes, which erupted approximately 3.0 to 1.78 million years ago (Sherrod et al., 2007). WAq is located in the caprock on the southern flank of the Koʻolau Volcano. The Koʻolau lavas are divided into Koʻolau Basalt and Honolulu Volcanics. The Koʻolau Basalt primarily consists of Pliocene-aged shield stage tholeiitic basalt. Koʻolau Basalt underlies the project area. Figure 3-1 presents a geologic map of Oʻahu.

WAq is located on the caprock of the coastal plain of southern Oʻahu. Holocene and Pleistocene sedimentary caprock deposits directly underlay the project area and the Koʻolau Basalt lies below the caprock. These deposits are generally called the Honolulu Caprock, which forms a coastal plain along the Waikīkī coast. The caprock is over 900 ft thick in the vicinity of WAq, as shown in Figure 3-2.

The caprock in Honolulu is comprised of marine and terrestrial sediments along with some lava flows and pyroclastic deposits from the Honolulu Volcanics.



Source: Sherrod et al., 2007

Figure 3-1: Geologic Map of O'ahu

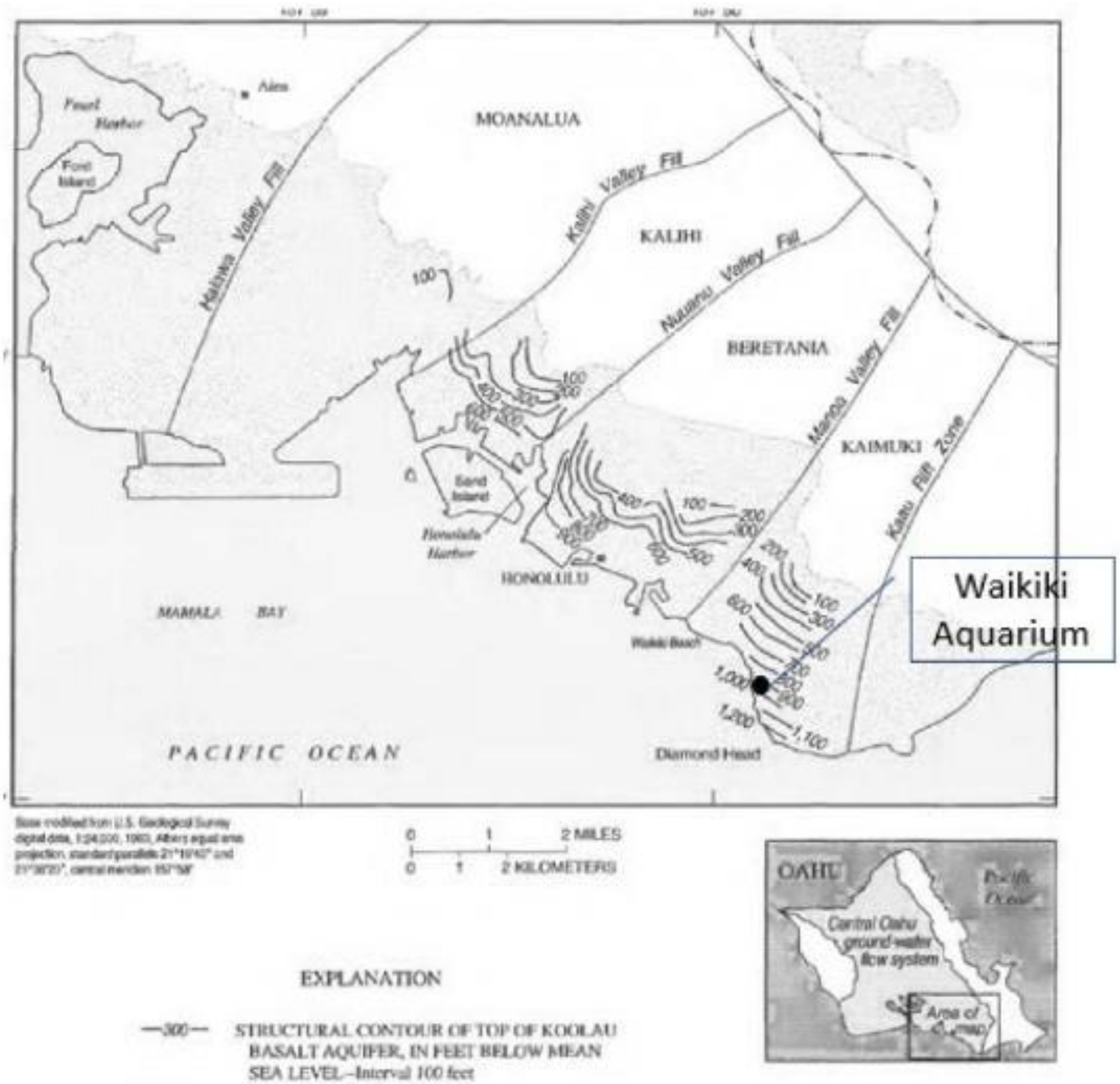


Figure 3-2: Caprock depths in the Honolulu Area (Oki, 1998)

Four subsurface boring cores were taken from the project site during a geotechnical engineering exploration in May 2021 to observe and evaluate subsurface conditions and the suitability of injection wells as part of the Discharge System Upgrade project. In October 2023, three subsurface boring cores were taken from the project site during a geotechnical engineering exploration to observe and evaluate the general subsurface conditions to formulate geotechnical recommendations to assist in the design of the Supply Water Intake System Upgrade project. Bore hole depth ranged between approximately 3-43.5 ft below existing ground surface (bgs). The borings encountered surface fill materials overlying beach deposits, lagoonal deposits, and apparent coral. The surface materials encountered in May 2021 were 1-3 ft thick and were loose to medium dense clayey/silty sand and medium stiff to stiff clayey/sandy silt, while the surface materials encountered in October 2023 were 3-7 ft thick and generally consisted of medium dense to very dense clayey gravel and very loose to loose silty sand. Beach deposits occurred at approximately 6-11 ft bgs and consisted of very loose to medium dense sand with a little silt and gravel. Lagoonal deposits found beneath the beach deposits extended down to 42.5 ft bgs and consisted of very loose to medium dense clayey sand/gravel and very soft sandy clay. Lagoonal deposits are known to be highly compressible. Beneath the lagoonal deposits, medium hard to hard coral formation extended down to the maximum depth tested (approximately 43.5 ft bgs). For more information on moisture, plasticity, and other soil properties, please refer to Appendix B: Geotechnical Engineering Exploration: Waikīkī Aquarium Improvements and Wastewater System Upgrades (2022) and Appendix C: Geotechnical Engineering Exploration: Waikīkī Aquarium Improvements, Phase 2.

According to the United States Geological Survey (USGS) map, the project area consists of Beaches (BS) on the makai half of the property and Jaucus Sand 0-15% (JaC) on the mauka side (Figure 3-3). These soil types are described as:

> *Beaches (BS)* – Excessively drained soils with very low runoff. Frequent flooding and strongly saline.
>
> *Jaucus Sand, 0 t15 2% (JaC)* MLRA 163- excessively drained soils with low runoff. Rare flooding and no ponding.

Figure 3-3: USDA NRCS Soils Map

Beaches soils are light-colored calcium carbonate sands derived from coral and seashells that are washed by ocean waves. Jaucas soils are similar but light brown, excessively drained, calcareous soils deposited from wind and water that occur adjacent to the ocean. Formerly, the Waikīkī area consisted of low elevation marsh wetlands and lagoons that were eventually reclaimed with dredged fill when Waikīkī was developed into an urban hot spot over the last 80 years.

3.1.2.2 Potential Impacts and Proposed Mitigation Measures

The Proposed Action will not affect the geology or soils of the area, which would also remain the same in the No Action Alternative. WAq has an existing 80 ft-deep saltwater production well (State Well No. 3-1649-010) that was constructed in 1954, which is indicative of the suitability for wells in the area. The existing well is beyond its design life and the overall condition is unknown. The new saltwater supply well will be constructed to a 110 ft depth in the same area (northwest corner of the property) as the existing well.

3.1.3 Hydrogeology and Water Resources

3.1.3.1 Existing Conditions

WAq is situated on the sedimentary Honolulu Caprock formation, which forms a coastal plain along the Waikīkī Coast in the Pālolo Aquifer System. The caprock is over 900 ft thick in the vicinity of WAq and comprises marine and terrestrial sediments, some lava flows, and pyroclastic deposits. Koʻolau Basalt lies below the caprock. Hydraulic properties of these sedimentary formations can vary extensively; however, marine deposits (mainly calcareous) are generally more permeable than terrestrial deposits. The hydraulic properties of the sedimentary formations vary extensively. Marine sedimentary rocks are mostly calcareous and include limestone coral reefs, calcareous rubble and sand along with lagoonal sands and marls. The terrestrial deposits are more common in the valleys and the marine deposits are found on the coastal plain.

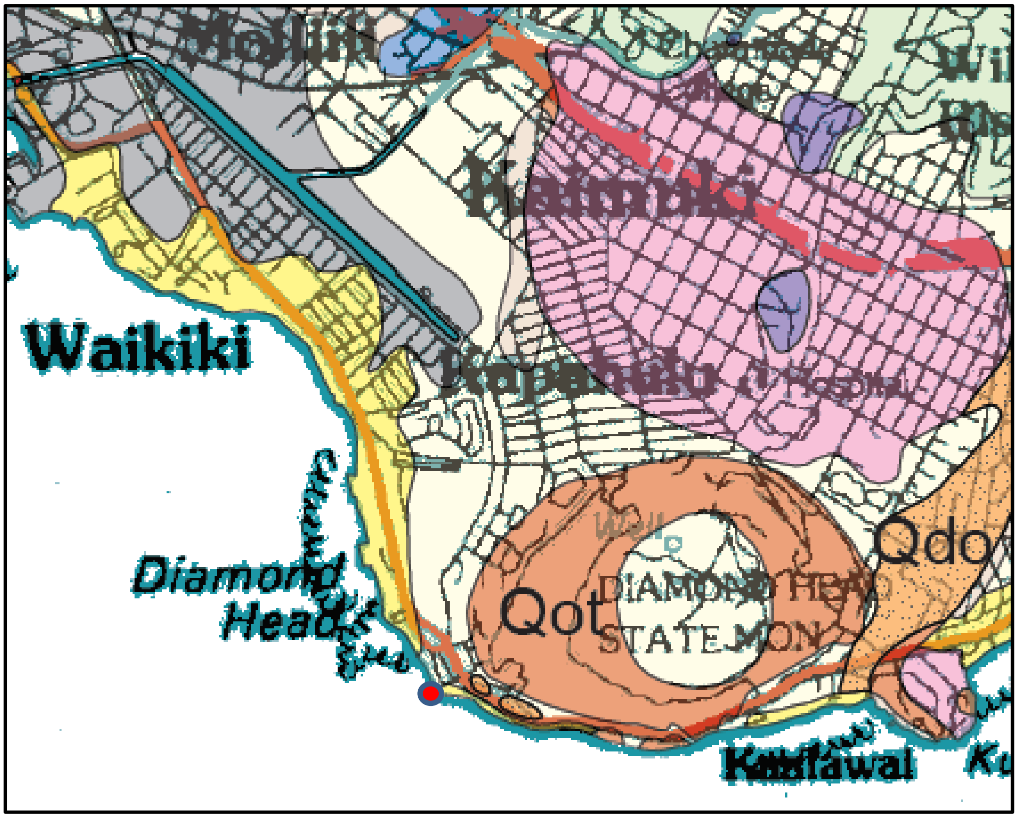
Hydraulic conductivity of in situ reef limestone varies from 100 to 20,000 feet/day and the hydraulic conductivity of lagoonal sands and mud varied from less than 1 to 500 feet/day.

Groundwater was encountered about 5.3 to 8.1 ft bgs during the field exploration conducted for the Proposed Action. Due to the proximity to the Pacific Ocean, groundwater levels likely vary with tidal fluctuation, seasonal precipitation, and other factors.

Figure 3-4 depicts the project site with a red dot. The surficial geology is caprock beach deposits and depicted in yellow. The orange, pink and blue areas are Honolulu Volcanics. The green is Koʻolau Basalt. The yellow and light green is caprock. The grey is artificial fill.

WAq is located within the Ala Wai Watershed, which is designated by the DLNR Division of Aquatic Resources (DAR) as DAR Watershed Code: 33007. The Ala Wai watershed is 19 square miles, with a maximum elevation of 3,051 ft. The watershed land use distribution is 0.9% agricultural, 40% conservation, 0% rural, and 59.1% urban. The Ala Wai watershed is 65.7% privately owned, while 9.5% is owned by the City and County of Honolulu, and the State owns 35% (Parham et al., 2008).

Ala Wai Stream is a perennial stream that occurs in the watershed. The total stream length is 30.4 miles and Ala Wai Stream has a terminal stream order of 3. At its closest point, Ala Wai Canal is approximately 0.6 miles away from the project site.



Source: Sherrod et al., 2007

Figure 3-4: Geologic map of the project site

3.1.3.2 Potential Impacts and Proposed Mitigation Measures

The proposed reconstruction of an existing well is not expected to affect existing hydrogeological or water resources. Mitigation measures to avoid or minimize impacts include the following as recommended by the State Commission on Water Resource Management (CWRM):

- Efficient fixtures will be installed, and water efficient practices implemented throughout the development to reduce the increased demand on the area's freshwater resources. Reducing the water usage of a home or building may earn credit towards Leadership in Energy and Environmental Design (LEED) certification.

- BMPs will be utilized for stormwater management to minimize the impact of the project to the existing area's hydrology while maintaining on-site infiltration and preventing polluted runoff from storm events. Stormwater management BMPs may earn credit toward LEED certification.

- The project's main water sources are natural sea water and saltwater. When practicable, alternative water sources will be used.
- The project team is exploring participation in the Hawai'i Green Business Program, which assists and recognizes businesses that strive to operate in an environmentally and socially responsible manner.
- The contractors will adopt landscape irrigation conservation BMPs endorsed by the Landscape Industry Council of Hawaii.
- It is understood that the potential for ground or surface water degradation/contamination would be reviewed by the State Department of Health. The project proponent is prepared to accept any resulting requirements related to water quality.

Applications for a Well Construction Permit and a Pump Installation Permit will be submitted to the DLNR CWRM.

3.1.4 Ocean Water Quality

3.1.4.1 Existing Conditions

Water quality off WAq in the MLCD is routinely monitored under NPDES Permit No. HI 0020630, which authorizes WAq to discharge wastewater from its saltwater exhibit tanks and pools and treated seal pool to Māmala Bay through Outfall Serial No. 001. The wastewater must be monitored at its outfall as well as within the designated Zone of Mixing (ZOM) pursuant to Water Quality Standards (WQS) (HAR Chapter 11-54) for open coastal waters. The NPDES permit requires water quality monitoring at the intake location, effluent outfall manhole, four ZOM locations, and two control locations (Figure 3-5). Sampling frequency and parameters are specified for each sampling location. Water quality parameters include enterococci, chlorine, total nitrogen (N), total phosphorus (P), ammonia, nitrate + nitrite, biological oxygen demand, total suspended solids (TSS), chlorophyll a, turbidity, pH, dissolved oxygen, and salinity.

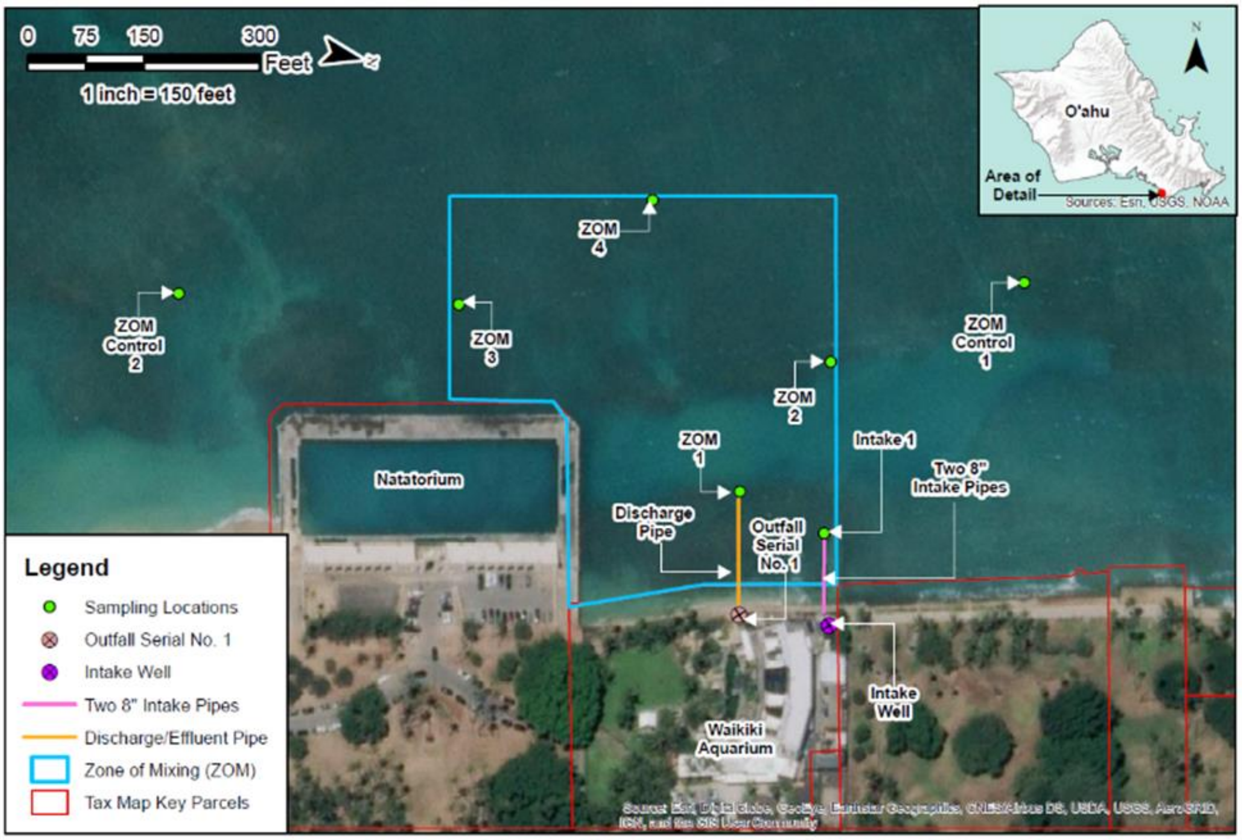


Figure 3-5: ZOM Sampling Locations

Water quality data from 2008-2020 for total N (TN), total P (TP), ammonia nitrogen, and nitrate/nitrate from ZOM and control sites were taken as required by the NPDES permit. When compared to various State Standards, total Nitrogen within the ZOM is indistinguishable from TN as measured at the Control sites, and both fall within the Dry Open Coast standard. Total Phosphorus in the ZOM is slightly lower (particularly in the higher ranges) than within the Control samples, and both are lower than the Dry Open Coast State standard. Ammonia nitrogen is higher in the ZOM than at the Control sites and both are higher than the Dry Open Coast state standard. Control site NH4 is at concentrations equal to the State standard for Embayments and Wet Open Coast, but historically the ZOM samples exceed these values and are closer to the State standard for an Estuary. Nitrate plus nitrite values in the ZOM are slightly higher than the Dry Open Coast State standard. The Control sites are within the Dry Open Coast standards and do not display as much variance as the samples from the ZOM. Of these four parameters, only the Ammonia standard is significantly exceeded within the ZOM. The higher concentrations of ammonia are likely the result of metabolic byproducts generated by the invertebrates, fish, and marine mammals within the WAq.

3.1.4.2 Potential Impacts and Proposed Mitigation Measures

The two existing transite (asbestos-cement) offshore intake pipes were installed in the early 1950s and are well beyond their engineering design life. In the long-term, the Proposed Action will likely protect valuable coastal ecosystems, improve water quality in the MLCD, and help reefs thrive by replacing the deteriorating transite pipes with HDPE pipes. In the short-term, impacts to nearshore receiving waters are expected to occur temporarily during in-water construction for the replacement of the intake pipes. Effective BMPs will prevent and minimize short-term construction-related impacts. BMPs that will be used during construction include a turbidity curtain or sandbag barrier to isolate the construction area from the nearshore environment, work along the shoreline conducted during periods of expected low tide and small or favorable wave conditions, upland measures (e.g., fiber roll, silt fence, stabilized construction access) to control runoff and other pollutants and maintain good housekeeping, etc.

To mitigate wastewater impacts associated with new well drilling activities, well construction specifications will require the driller to have zero discharge and truck off drilling wastewater, thus HAR Chapter 11-55 Form I, NPDES General Permit Authorizing Discharges of Treated Process Wastewater Associated with Well Drilling Activities, is not anticipated.

3.1.5 Topography

3.1.5.1 Existing Conditions

The topography of the project site is relatively flat. Ground surface elevations range from +6 to +9 ft above mean sea level.

3.1.5.2 Potential Impacts and Proposed Mitigation Measures

The proposed action will not alter the topography of the parcel. A new well water pump house will be constructed to house most of the new mechanical equipment, including two well water pumps, two UV sterilizers, two natural seawater filters, two well water filters, a chiller and a heat exchanger. The new pump vault will be located partially below grade.

3.1.6 Air Quality

3.1.6.1 Existing Conditions

The United States Environmental Protection Agency (EPA) has national ambient air quality standards (NAAQS) for ozone (O_3), nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), 2.5-micron and 10-micron particulate matter (PM) ($PM_{2.5}$ and PM_{10}), and airborne lead (Pb). These ambient air quality standards establish the maximum concentrations of pollution considered acceptable for public health and welfare. The State of Hawaiʻi also has ambient air quality standards for five of the six criteria pollutants (excluding $PM_{2.5}$) and hydrogen sulfide (H_2S), which is not included in NAAQS (DOH, 2020).

The project area is in EPA attainment zones for CO, NO_2, O_3, $PM_{2.5}$, PM_{10}, SO_2, and lead (EPA, 2014). In 2020, Hawaiʻi was in attainment with NAAQS annual averages of PM_{10}, $PM_{2.5}$, O_3, CO, and SO_2, based upon the calendar year 2020 average of annual mean values from 20 air quality stations, including six on Oʻahu, two on Maui, eleven on Hawaiʻi Island (four temporary), and one on Kauaʻi.

The Honolulu Station (AQS No. 150031001) is located approximately 3.5 miles northwest of the project site at 20m MSL. The station is located in downtown Honolulu in a busy commercial, business, and government district and measures CO, SO_2, $PM_{2.5}$, and PM_{10}. The tall, dense building structures in downtown Honolulu tend to create city pollution of warmer temperatures and turbulent winds within the city center; however, these are minimized by trade winds. The annual averages from this air quality station during the 2018-2020 calendar years did not exceed attainment, and no sites were in violation of the NAAQS (DOH, 2020).

During winter months when trade winds are absent and "Kona" winds blow from the southeast, vog from Hawaiʻi Island can bring increased levels of SO_2 and $PM_{2.5}$. Hawaiʻi's advisories for volcanic SO_2 and $PM_{2.5}$ have been customized for local conditions. Air monitoring stations in communities near Kīlauea Volcano on Hawaiʻi Island often exceed the NAAQS for SO_2 and occasionally $PM_{2.5}$. The EPA considers activities from the volcano a natural, uncontrollable event, and therefore the state requests exclusion from these NAAQS exceedances for attainment/non-attainment determination. Shorter exposure time intervals have also been adopted due to variable wind conditions, which can cause volcanic gas concentrations to change rapidly. DOH regulates fugitive dust, which can be released during earth-moving activities including removal of earth, excavation and fill, debris clearing, and vegetation grubbing.

3.1.6.2 Potential Impacts and Proposed Mitigation Measures

Construction and earth moving activities have the potential to generate fugitive dust in the short-term time frame. Temporary degradation in air quality [e.g., increased levels of CO, nitrogen oxides, volatile organic compounds (VOCs)], and $PM_{2.5}$ and PM_{10} in the immediate project area may occur from emissions from construction equipment and personal vehicles. To minimize emissions, construction BMPs will be employed throughout the project. Most air quality impacts will occur during the construction and the contractor will comply with the provisions of HAR §11-60.1-33 on Fugitive Dust to keep dust and other air pollutants to the lowest levels practicable.

These include but are not limited to:

- Planning different phases of construction, focusing on minimizing the amount of airborne, visible fugitive dust-generating materials and activities, centralizing on-site vehicular traffic routes, and locating potential dust-generating equipment in areas of the least impact;
- Providing an adequate water source at the site prior to start-up of construction activities;
- Landscaping and providing rapid covering of bare areas, including slopes, starting from the initial grading phase;
- Minimizing airborne, visible fugitive dust from shoulders and access roads;
- Providing reasonable dust control measures during weekends, after hours, and prior to daily start-up of construction activities;
- Controlling airborne, visible fugitive dust from debris being hauled away from the project site;

- Properly tuning and maintaining construction equipment and vehicles;
- Limiting size and extent of exposed areas;
- Covering mounds of soil or fill;
- Watering work areas and unpaved work roads;
- Using wind/dust screens;
- Establishing a routine road cleaning and/or tire washing program; and
- Monitoring dust at the project boundary if significant dust generation is anticipated.

No long-term impacts to air quality are expected.

3.1.7 Noise

3.1.7.1 Existing Conditions

Existing ambient noise levels include vehicle traffic, aircraft, ongoing maintenance, construction equipment, surf, boats, and wind. In proximity of significant construction activity, noise levels can intermittently reach 80 decibels (dBA). The DOH regulates noise per HAR Chapter 11-46, "Community Noise Control," which establishes maximum permissible sound levels shown in Table 3-1. The rules provide for the prevention, control, and abatement of noise pollution from stationary noise sources and from equipment related to agricultural, construction, and industrial activities. The standards are intended to protect public health and welfare and to prevent the significant degradation of the environment and quality of life. DOH establishes acceptable levels of noise based on the ambient conditions (Class A-C) that would be anticipated in differing land uses situations (i.e., Zoning Districts) ranging from residential and business/resort, to industrial conditions.

The project site is in a Class A zoning district, as defined by HAR Chapter 11-46. HAR §11-46-7 that grants the Director of the DOH the authority to issue permits to operate a noise source that emits sound more than the maximum permissible levels specified in Table 3-1 if it is in the public interest and subject to any reasonable conditions. Those conditions can include requirements to employ the best available noise control technology.

Table 3-1: Maximum Permissible Sound Levels in dBA

Zoning Districts	Daytime (7am – 10pm)	Nighttime (10pm-7am)
Class A	55	45
Class B	60	50
Class C	70	70

Notes:

1) Class A zoning districts include all areas equivalent to lands zoned residential, conservation, preservation, public space, open space, or similar type.

2) Class B zoning districts include all areas equivalent to lands zoned for multi-family dwellings, apartment, business, commercial, hotel, resort, or similar type.
3) Class C zoning districts include all areas equivalent to lands zoned agriculture, country, industrial, or similar type.
4) The maximum permissible sound levels apply to any excessive noise source emanating within the specified zoning district, and at any point at or beyond (past) the property line of the premises. Noise levels may exceed the limit up to 10% of the time within any 20-minute period. Higher noise levels are allowed only by permit or variance issued under HAR §11-46-7 and §11-46-8.
5) For mixed zoning districts, the primary land use designation is used to determine the applicable zoning district class and the maximum permissible sound level.
6) The maximum permissible sound level for impulsive noise is 10 dBA (as measured by the "Fast" meter response) above the maximum permissible sound levels shown.

3.1.7.2 Potential Impacts and Proposed Mitigation Measures

Short-term noise impacts associated with construction are anticipated with the Proposed Action. Project activities would involve drilling, moving heavy equipment and materials, and other construction activities. To mitigate noise emissions and community effects of noise emissions from construction activities, BMPs such as the following will be employed:

- Equipment operation on the shoreline will be limited between 7:00 AM and 7:00 PM. Noisier operations, such as truck hauling, could be limited to minimize disruption to beach users and aquarium occupants;
- Equipment substitution will be used to ensure that the quietest locally available equipment is used (e.g., high insertion loss mufflers, fully enclosed engines, and rubber-tired equipment, if possible); and
- The use of horns will be prohibited.

Drilling operations may cause noise levels to exceed the allowable levels for more than 10% of the time within any twenty-minute period, in which case a Community Noise Permit from the DOH should be obtained. All construction activities and mechanical equipment needs to be under the allowable limit at or beyond the property line, if not, a community noise permit should be submitted. No night construction work will be permitted. No long-term noise related impacts from the Proposed Action are anticipated.

3.2 Natural Hazards

3.2.1 Climate Change and Sea Level Rise

3.2.1.1 Existing Conditions

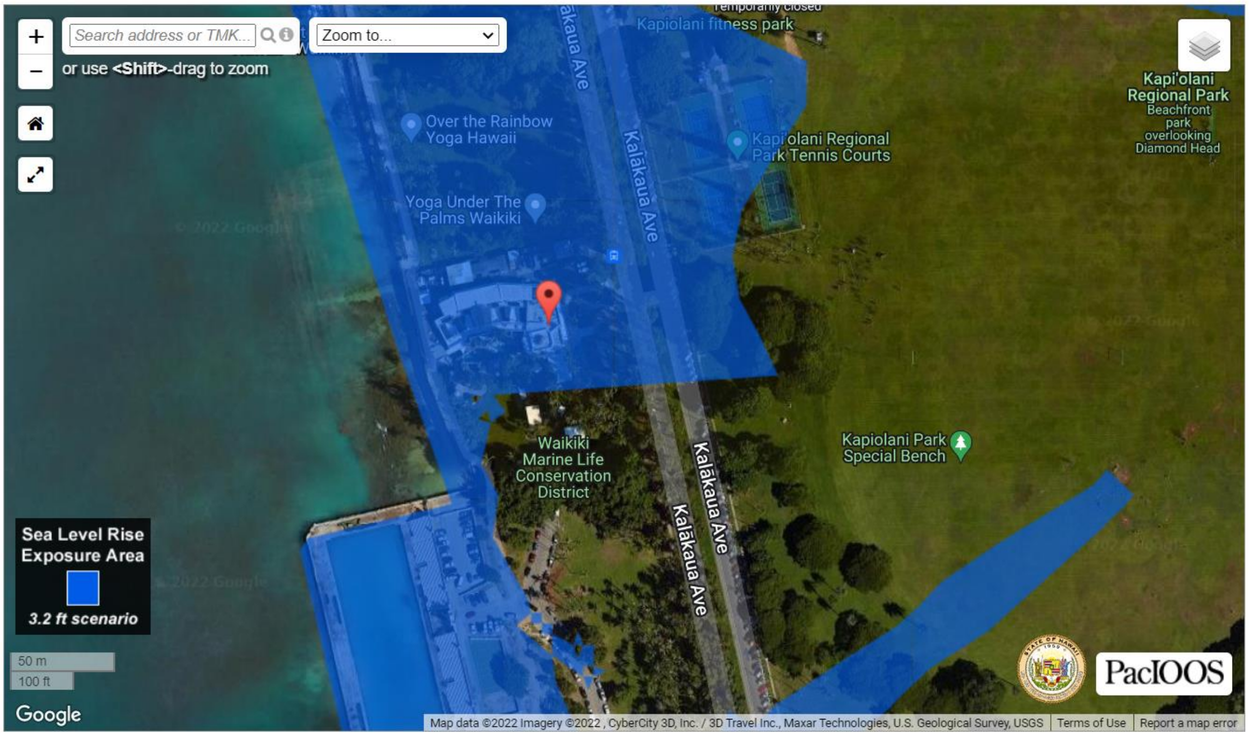
The Sea Level Rise (SLR) Exposure Area (SLR-XA) is a combination of three hazards including passive flooding, annual high wave flooding, and coastal erosion. Passive flooding modeling evaluates low-lying areas susceptible to flooding through elevation of ocean water level or groundwater level by SLR. Annual high wave flooding captures the distance wave runup and over wash will travel across the shoreline under high wave conditions. With SLR and higher water levels, offshore reefs will be less effective at dissipating incoming wave energy, which in turn results in greater wave size and energy impacts on the shoreline. Finally, coastal erosion modeling depicts the areas threatened by landward recession of the shoreline based on historical shoreline data.

According to their fifth assessment report (AR5), the Intergovernmental Panel on Climate Change (IPCC) predicts a worldwide SLR of 0.9 ft to 3.2 ft by the year 2100, depending on future efforts to mitigate for greenhouse gas emissions. The IPCC has outlined numerous impacts from this magnitude of sea level rise on coastal communities including beach erosion, inundation of land, increased flood and storm damage, saltwater intrusion into the freshwater lens aquifer, changes in precipitation, increased levels of land-based pollutants to coastal waters including sediments, nutrients and contaminants, and more frequent, longer, and more powerful El Niño and La Niña events (IPCC, 2014).

More recent studies by National Oceanic and Atmospheric Administration (NOAA) suggest that up to 3.2 ft of SLR could occur as early as the year 2060 under extreme scenarios. Under immediate scenarios, however, NOAA predicts 1.5 ft of rise in as early as the 2060s and 3.3 ft of rise by 2100 (Sweet et al. 2017). With uncertainties on the exact projections of SLR associated with greenhouse gas emission trajectories and the behavior of Earth's cryosphere, the State of Hawai‘i Sea Level Rise Report (Hawai‘i Climate Change Mitigation and Adaptation Commission, 2017) recommends the State to begin planning now for 3.2 ft of SLR.

The majority of WAq parcel is within the 3.2 ft SLR-XA (Figure 3-6); only the southern end of the lawn area remains outside the 3.2 ft SLR-XA. Under the lowest 0.5 ft SLR scenario, both the southern end of the lawn area and the eastern end of the WAq parcel (i.e., the parking lot) are outside the 0.5 ft SLR-XA.

According to NOAA, based on mean sea level data from 1905 to 2022, the relative sea level trend from Honolulu Harbor (Station 1612340) is 1.54 mm/year with a 95% confidence interval of +/- 0.2 mm/year. This is equivalent to about a 0.51 ft-rise in 100 years (NOAA, 2023; Figure 3-7). Currently, a seawall fronts a 12-ft wide bike and pedestrian pathway, which separates WAq from the Pacific Ocean. The seawall is approximately +8.3 ft MSL high, and the elevation of the walkway is +7 ft MSL.



Source: PacIOOS, 2021. https://www.pacioos.Hawai'i.edu/shoreline/slr-Hawai'i/

Figure 3-6: Sea Level Rise Exposure Area (SLR-XA) 3.2 feet

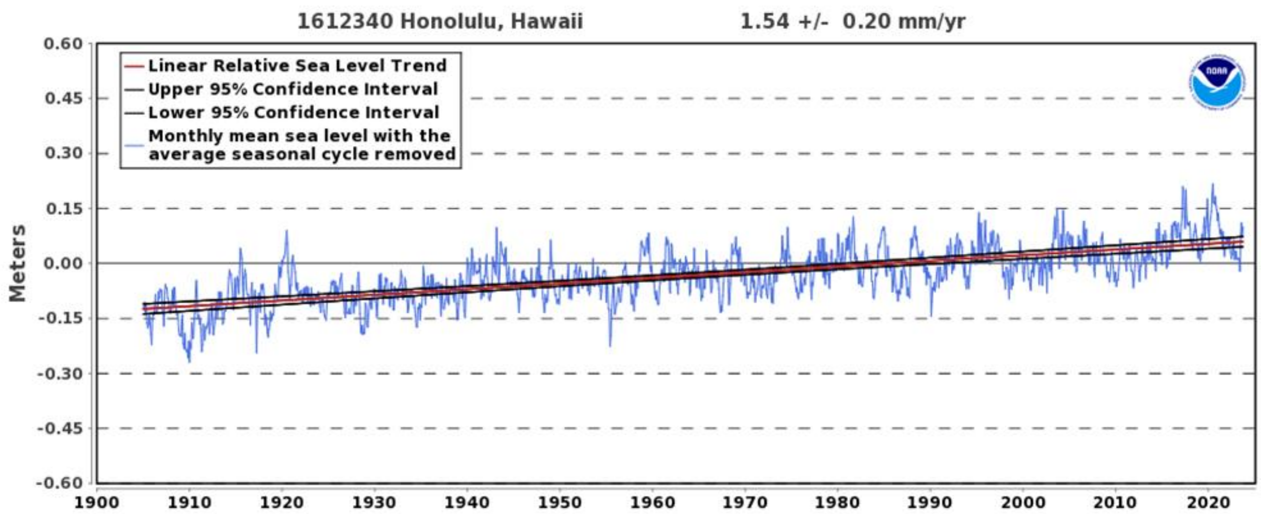


Figure 3-7: Relative Sea Level Trend Station 1612340, Honolulu HI

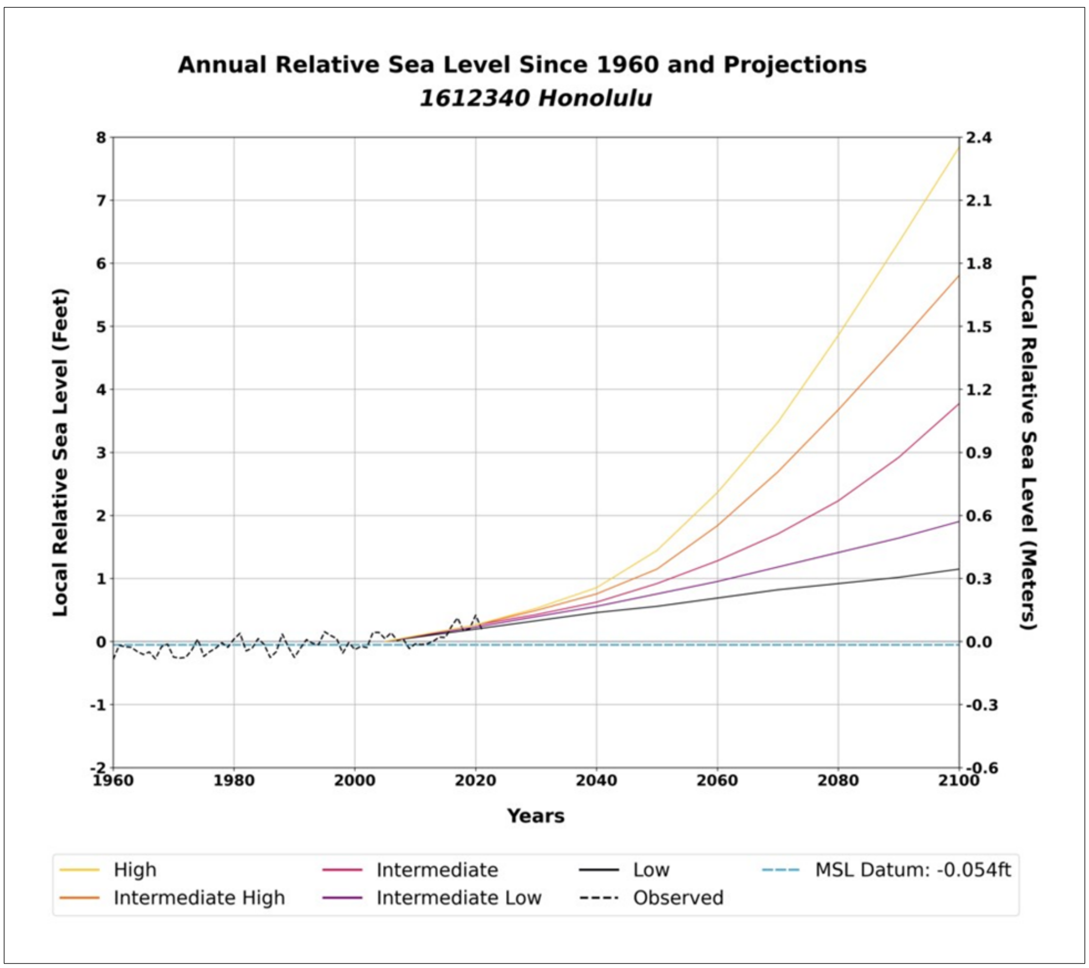


Figure 3-8: Mean local relative SLR projections until 2100 at NOAA tide gauge 1612340 in Honolulu with six SLR scenarios plotted relative to a 1996-2014 baseline period

3.2.1.2 Potential Impacts and Proposed Mitigation Measures

The proposed project will neither impact SLR nor increase WAq's degree of risk and exposure to SLR. Nevertheless, the Waikīkī region is particularly threatened by SLR due to its low elevation and proximity to the rising seas. As the main WAq building complex is entirely in the 3.2 SLR-XA, a long-term plan for adaptation or relocation may need to be developed for WAq.

3.2.2 Flood Hazards

3.2.2.1 Existing Conditions

Flood hazards for the project site are depicted on Flood Insurance Rate Map (FIRM) panel number 15003C0368G (effective date January 19, 2011). WAq is located in *Zone AE* (base flood elevation 8 ft) (Figure 3-9). Flood Zones AE are areas that present a 1% annual chance of flooding, with wave heights less than 3 ft.

3.2.2.2 Potential Impacts and Proposed Mitigation Measures

The Proposed Action will not change or impact flood zones. Site planning for proposed facilities and equipment should take the location of the parcel within the flood zone AE into consideration.

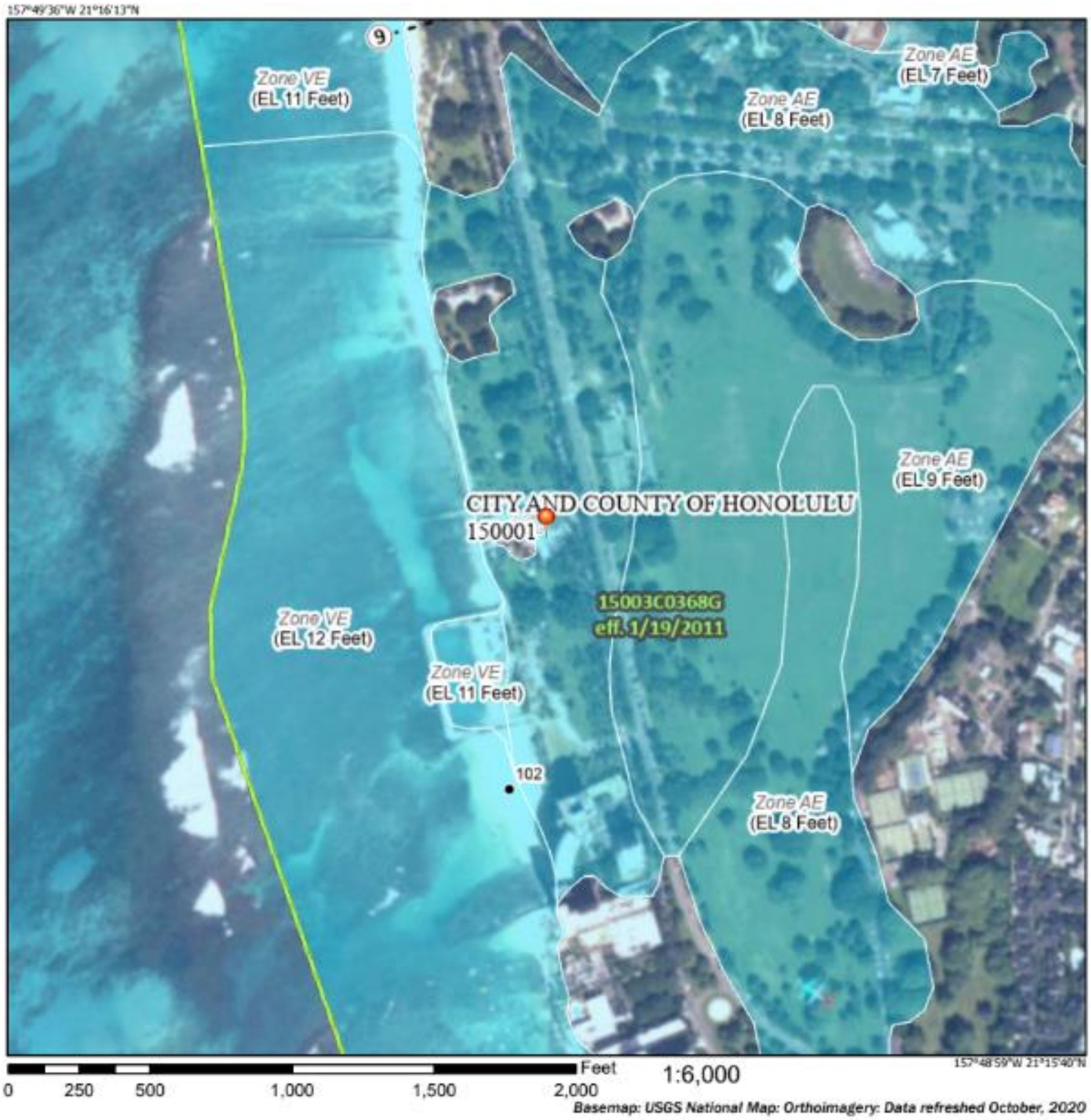
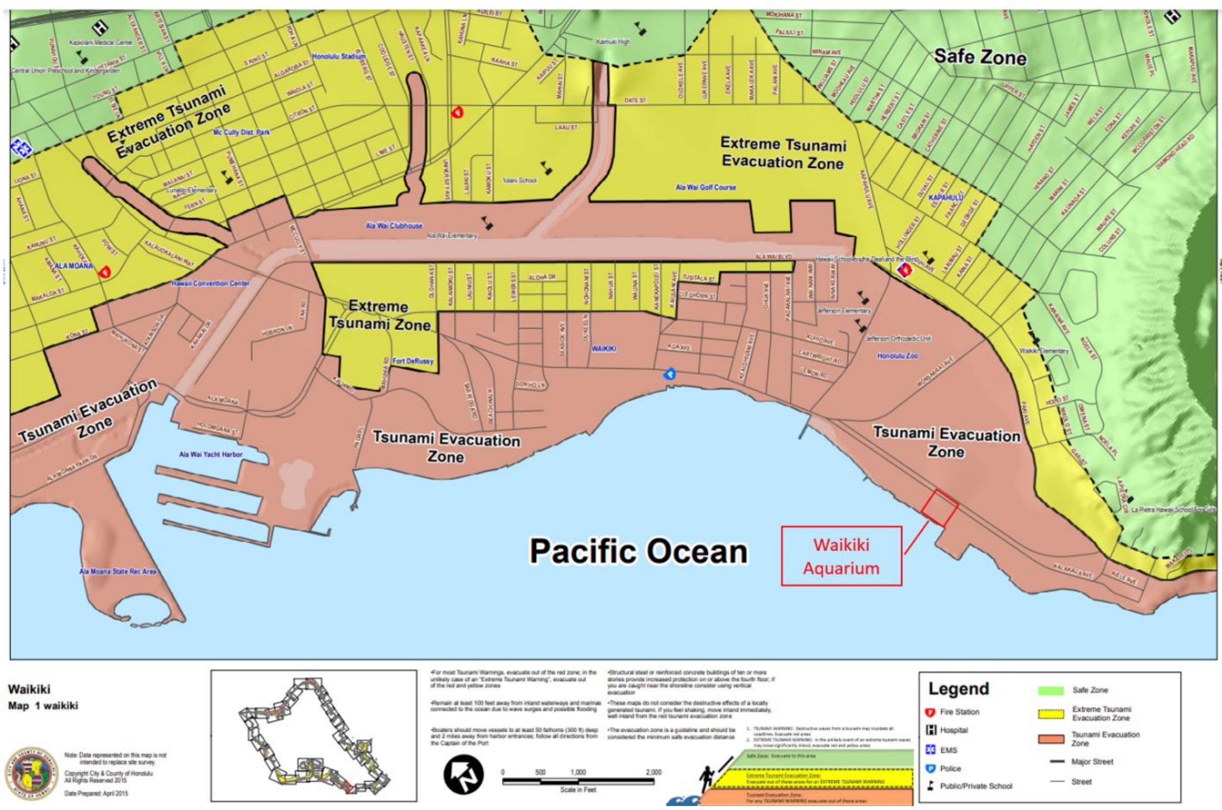


Figure 3-9: FIRM Map around WAq

3.2.3 Tsunami and Hurricane Hazards

3.2.3.1 Existing Conditions

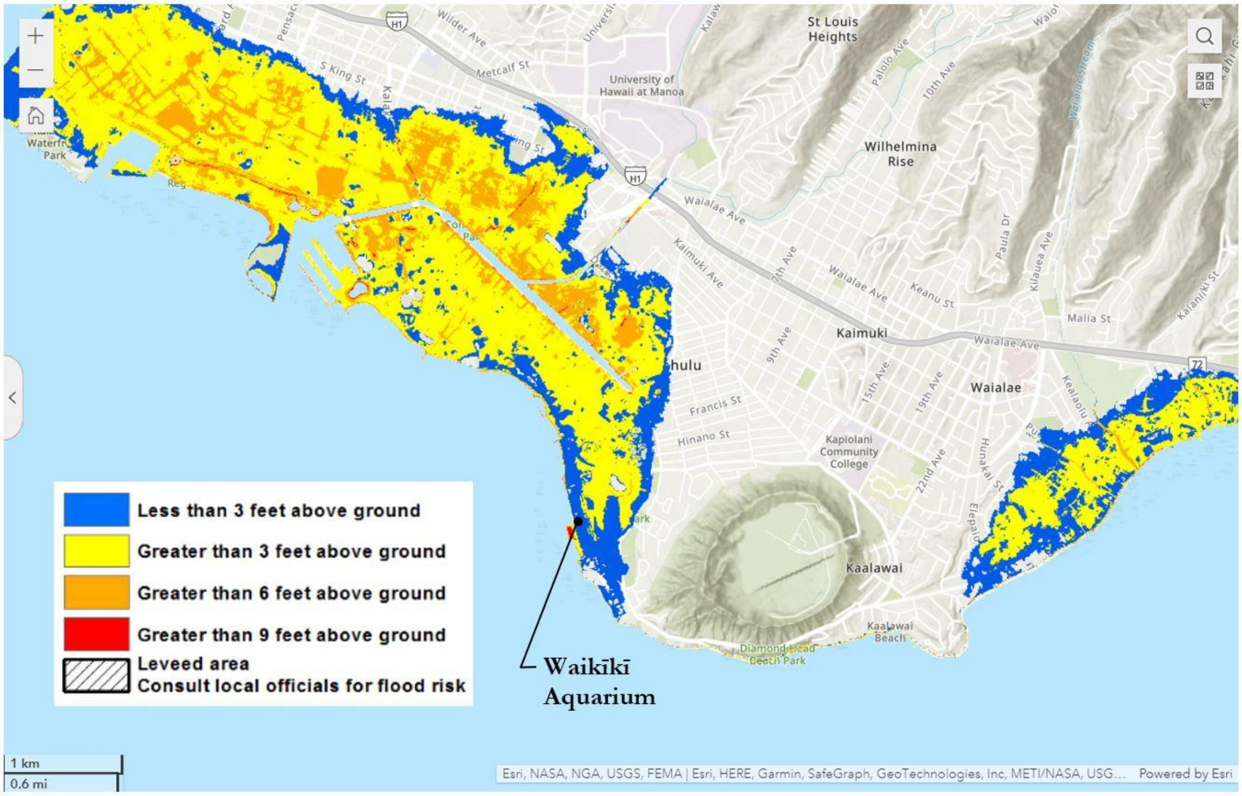
The project is located within the Tsunami Evacuation Zone (TEZ) (Figure 3-10). Occupants within these zones are required to evacuate and move to a safe zone in the event of a tsunami warning. Hurricanes are classified as tropical cyclones with violent winds, heavy rains, and abnormally high waves and storm tides. Hurricane season in Hawaiʻi occurs annually between the months of June through November, although large storms are rare. Hurricanes of note that have directly hit or caused great damage to the Hawaiian Islands include Hurricane Dot in 1959, Hurricane Iwa in 1982, and Hurricane Iniki in 1992. Although the occurrences of hurricanes in the islands are rare, storm surges and coastal flooding are expected to continue to become more severe and frequent with climate change predictions.



Source: City and County of Honolulu, 2015

Figure 3-10: Tsunami Evacuation Zone Map

Storm surge has the potential to extend miles inland from the immediate coastline. Based on review of the NOAA National Hurricane Storm Surge Hazard Maps, the WAq parcel is outside the storm surge flooding vulnerability area given Category 1 hurricanes. However, given Category 4 hurricanes, storm surge flooding will inundate the entire WAq parcel with water levels less than 3 ft above ground (Figure 3-11).



Source: NOAA, 2021. https://www.nhc.noaa.gov/nationalsurge/index.php

Figure 3-11: Storm Surge Risk Map, Category 4 Hurricane

3.2.3.2 Potential Impacts and Proposed Mitigation Measures

Implementation of the proposed project is not expected to alter flooding, tsunami or hurricane hazards to the project site and surrounding areas.

3.3 Ecological Resources

3.3.1 Terrestrial Biological Resources

3.3.1.1 Existing Conditions

The outdoor area at WAq is mainly landscaped to the south and with paved surfaces to the east and north. An approximately 13-ft wide promenade and seawall separate the WAq and the ocean to the west. The outdoor landscaped area is planted with native plants for educational purposes and ornamental landscaped vegetation. The terrestrial biological resources and a bird survey were conducted in the outdoor area of WAq, including the grassed lawn area and front of the building along Kalākaua Avenue. In conjunction with the Waikīkī Aquarium Water System EA on the discharge system upgrade, a Terrestrial Biological Resources Study was conducted in May 2022 and is contained in Appendix D.

All vegetation at WAq is cultivated and landscaped, with numerous native plants on display for educational purposes. The most abundant plant species were naupaka kahakai (*Scaevola taccada*), portia tree (or milo, *Thespesia populnea*), coconut trees (*Cocos nucifera*), ti leaf (*Cordyline fruticose*), and tree heliotrope (*Heliotropium arboretum*). One giant African Snail (*Achatina fulica*) was observed in the lawn area. No mammals or other macro fauna were observed.

A bird survey was conducted during the morning hours before the Aquarium opened in the lawn area. At that time (May 2022), in addition to introduced common bird species to urban Honolulu, two white fairy terns (*Gygis alba*) nests were observed in separate milo trees (*Thesesia populnea*) near to the public restrooms and mullet tank. The milo trees that contained the nests were marked with blue tape on their trunk to designate them as white fairy tern nesting trees and warn tree maintenance crews of their presence. As of this writing, it is reported that these birds are not onsite all year but rather from early spring. They breed in the trees in front of the mullet tank. When they are breeding, WAq ties a blue ribbon around the trees and signs to inform the public to not disturb during breeding.

The nearshore area off the WAq consists of a shallow lagoon . The seafront of the aquarium lies within the Waikīkī MLCD, and is fronted by a public-access seawall that spans from the Natatorium War Memorial Natatorium to the east, to Queen's Beach to the west. Construction of the Natatorium and seawall in the 1920s has greatly impacted the character of the nearshore ecosystem. The seawall appears to rest upon a reef-rock base and this shoreline is typically absent of a sand beach. The flat reef-rock substrate slopes gradually from the base of the seawall (~-1ft MSL) to about -6-ft MSL 45-m offshore at the edge of a dredged channel. Construction of the Natatorium included dredging through the lagoon directly offshore of the WAq creating a channel consisting of a sandy bottom intermixed with rocky rubble substrate. The dredged area extends from 45-m to about 76-m (250-ft) offshore where the substrate then rises to the natural back-reef lagoon depth and slowly deepens to the edge of the active reef at 300-m (1,000-ft) offshore. Turbidity is generally high in the area due to persistent wave action on the shallow reef, particularly during summertime when swells bring high surf to the area.

The two (2) existing seawater intake pipes extend from the seawall at north-east corner of the WAq property out to the landward side of the dredged channel, extending 160 ft from the shoreline, and are buried by sand and rubble in a trench cut through the reef flat. An existing cavity in the seawall is approximately 12 ft long and 5 ft tall, located directly below the public walkway extending along the top of the seawall. The cavity in the seawall is located approximately mid-way along the WAq property boundary and is being repaired at the time of this writing.

In terms of Section 7 of the Endangered Species Act, the following federally listed species may occur or transit through or adjacent to the proposed project area:

- The endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*)
- The endangered Hawaiian petrel (*Pteerodroma sanwichensis*)
- The threatened Newell's shearwater (*Puffinus auricularis newelli*)

- The endangered Hawaii distinct population segment (DPS) of band-rumped storm-petrel (*Oceanodroma castro*)
- The threatened Central North Pacific DPS of green sea turtle (*Chelonia mydas*)
- The endangered Hawaiian Monk Seal (*Neomonachus schauinslandi*) [1]

Hawaiian hoary bats roost in exotic and native woody vegetation over 15 feet in height. Several trees within the project area are greater than 15 feet in height.

Hawaiian seabirds may pass through the project area during the day or night during the breeding, nesting, and fledging seasons that extends from March 1 to December 15. Outdoor and artificial lighting attracts seabirds and can result in seabird disorientation, fallout, and injury or mortality. Fledging birds are particularly vulnerable and would most likely pass through the site between September 15 through December 15.

Green sea turtles may nest on any sandy beach in the Pacific Islands and newly hatched turtles are known to become disoriented by artificial lighting. Although there is no sandy beach at or immediately adjacent to the project site, there are many sandy beaches near the project site. Due to the quantity of people that occupy Waikīkī beaches, sea turtle nesting near the project site is somewhat unlikely in the area.

Hawaiian Monk Seals are known to frequent the Waikīkī shoreline. Because the Natatorium acts as a groin preventing the northern transport of sand along the shoreline, and any available sand becomes trapped in the offshore dredged lagoon, there is typically no sandy beach fronting the WAq. It is highly unlikely that any Monk Seals would select the WAq shoreline as resting habitat.

3.3.1.2 Potential Impacts and Proposed Mitigation Measures

Proposed mitigation measures for the white tern and hoary bat; Hawaiian Monk Seal, sea turtles and seabirds; green sea turtle, and native plants include the following:

- **White Tern and Hoary Bat**

  Trees that have known White Tern (*Gygis alba)* nests should not be trimmed or disturbed during nesting season extending from February through June. Trees with the known White Tern nest will continue to be marked with a blue ribbon. It is recommended that, if tree trimming or removal is planned, a qualified biologist survey for the presence of White Terns prior to any action that could disturb the trees needs to be conducted. It was noted that White Tern pairs lay their single

[1] *Based on May 19, 2022, pre-consultation comments from the U.S Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office regarding the Waikīkī Aquarium Water System EA on the discharge system upgrade. The Final EA / FONSI for that project was published in February 2023.*

egg in a branch fork with no nest, and that eggs and chicks could be dislodged if the trees are nudged during construction.

To avoid and minimize impacts to the Hawaiian hoary bat, woody plants greater than 15 feet tall shall not be disturbed, removed, or trimmed during bat birthing and pupping season, which extends from June 1 through September 15, and barbed wire should not be used for fencing. Construction of the sump and appurtenances will avoid disturbing as many mature trees as possible. In the present design, new infrastructure and equipment will be located within already developed areas such that no mature trees are expected to be disturbed.

- **Hawaiian Monk Seal, Green Sea Turtles and Seabirds**

The State endangered Hawaiian Monk Seal (*Monachus schauinslandi*) and threatened Green Sea Turtle (*Chelonia mydas*) could potentially be present or haul out on shore within the vicinity of the proposed project site. If either species is detected within 100 meters of the project area, all nearby construction operations would cease and not continue until the focal animal has departed the area on its own accord.

Artificial lighting can adversely impact seabirds that may pass through the area at night by causing them to become disoriented. This disorientation can result in their collision with manmade structures or the grounding of birds. For nighttime work that might be required, DOFAW recommends that all lights used be fully shielded to minimize the attraction of seabirds. Nighttime work that requires outdoor lighting should be avoided during the seabird fledging season, from September 15 through December 15, when young seabirds make their maiden voyage to sea.

Nighttime construction is not anticipated or planned. However, if nighttime construction is required during the seabird fledgling season (September 15 to December 15), a qualified biologist will be present at the project site to monitor and assess the risk of seabirds being attracted or grounded due to the lighting. If seabirds are seen circling around the area, lights would then be turned off.

To minimize impacts to seabirds and sea turtles and in consideration for social impacts, construction of the project will avoid outdoor lighting and limit work during daylight hours. Additionally, design measures for the construction or operation of new structures and buildings adjacent to the beach will include tinting or the use of automatic window shades for any exterior windows that face the beach, reducing the height of the exterior lighting to below three feet and pointed downward or away from the beach, and minimizing light intensity to the lowest level feasible.

- **Native Plants**

Native plant species for landscaping that are appropriate for the area, including climate suitable and historically occurring plants on the site, will be used for landscaping. Landscape designers will consult the Hawai'i-Pacific Weed Risk Assessment website to determine the potential invasiveness of plants proposed for use in the project.

- **Protection Against Invasive Species**

  Soil and plant material may contain invasive species that could harm native species and ecosystems, and may include fungal pathogens (e.g., Rapid ʻŌhiʻa Death), vertebrate and invertebrate pests (e.g., Little Fire Ants, Coconut Rhinoceros Beetle), or invasive plant parts. Further, the invasive Coconut Rhinoceros Beetle (CRB) or *Oryctes rhinoceros,* is known to occur on Oʻahu. Host material for the beetle specifically includes a) entire dead trees, b) mulch, compost, trimmings, fruit and vegetative scraps, and c) decaying stumps. CRB host plants include the live palm plants in the following genera: *Washingtonia, Livistona*, and *Pritchardia* (all commonly known as fan palms), *Cocos* (coconut palms), *Phoenix* (date palms), and *Roystonea* (royal palms). When such material or these specific plants are moved there is a risk of spreading CRB because they may contain CRB in any life stage.

  To minimize the presence of invasive species, the movement of plant or soil material between worksites, such as infill, will be minimized. All equipment, materials, and personnel should be cleaned of excess soil and debris to minimize the risk of spreading invasive species. Gear that may contain soil, such as work boots and vehicles, should be thoroughly cleaned with water and sprayed with 70% alcohol solution to prevent the spread of Rapid ʻŌhiʻa Death and other harmful fungal pathogens. A Certified Arborist will observe construction activity near the tree and will coordinate consultation with the Oʻahu Invasive Species Committee (OISC) as appropriate.

If these mitigation measures are followed, impacts to terrestrial resources and federally protected species are anticipated to be minimal.

3.3.2 Marine Biological Resources

3.3.2.1 Existing Conditions

MLCDs are designed to conserve and replenish marine resources and are intended to provide fish and aquatic life with a protected area to grow and reproduce. Specifically, MLCDs are established to protect the coastal waters of the islands including coral reefs and the extensive amount of biodiversity that thrives in these ecosystems. MLCDs are authorized under Chapter 190, HRS.

The ocean offshore of WAq is in the Waikīki MLCD, a 78-acre site established in 1988 that stretches from Waikīkī Natatorium War Memorial on the east to the Kapahulu Groin on the west. The Waikīkī MLCD extends from the high-water mark to 500 yards offshore. Fishing and harassing sea life is prohibited, as well as removing sand, corals, or any geological features. Figure 1-1 shows the locational relationship of the WAq to the Waikīkī MLCD.

Public agencies that manage, steward, monitor and regulate activities in the ocean and benthic environment were included in pre-consultation for this EA. Rare. Threatened, and Endangered

(RTE) species that are protected by the Endangered Species Act (ESA) that may be in the area and are identified in Section 3.3.1.1.

Appendix E contains the benthic survey report: conducted in the vicinity of the intake pipes and seawall cavity. Over several days between July and September 2023, nearshore surveys were conducted to assess the marine assemblages in the vicinity of the seawater intake pipe and the seawall cavity. Point-intercept quadrat and belt transect methodologies were used to inventory corals, invertebrates, algae, and fish assemblages in these areas. Special focus was paid to coral colonies in the direct vicinity (1-2m) of the seawater intake pipe, as they are highly likely to be directly impacted by the project.

The seawall cavity area was found to be fringed by a shallow reef flat covered with mats made up of common species of macroalgae and dotted with sea urchins. No corals were observed in the 10-meter survey radius. The seawater intake pipe was found to be overgrown by cyanobacteria and turf algae, with low presence of encrusting organisms. A moderate diversity of fish species (17) was recorded in a 10-meter belt transect of the intake pipe.

A total of three coral colonies were inventoried in the direct vicinity of the seawater intake pipe, as well as four coral colonies near the proposed pipe extension (seven in total). Out of the seven coral colonies observed, five were found to be in poor/deteriorating condition, exhibiting overgrowth of algae, pale or bleached tissue, and/or infection by "pink spot disease".

3.3.2.2 Potential Impacts and Proposed Mitigation Measures

It is anticipated that the pipe replacement and seawall repair project will have minimal disturbance on critical species in the project vicinity. Though some corals may be impacted, the impact can be minimized through the implementation of coral fragmentation and/or transplantation efforts. Further mitigation will include the installation of silt curtains to minimize impacts to the surrounding area. A monitoring log will be maintained per Standard Local Operating Procedures for Endangered Species (SLOPES) requirements. Should Endangered and protected species be encountered, these incidents will be reported via the SLOPES monitoring form.

The proposed project will involve temporarily removing loose sediment and rock up to 2m to either side of the pipe. There is no intention or need for the project to remove large cobble or small rocks while conducting the dredging to uncover and remove the existing pipes. The objective is to replace all sediments removed back over the new pipelines. The process of sand removal will result in the loss of fines (i.e. mud) from the existing sediment and these fines will be discarded elsewhere and not returned to the marine environment.

Live rock is any natural hard substrate to which marine life is attached or affixed and it is unlawful to take, break, or damage any live rock, including through the introduction of sediment or pollution into state waters (HAR §13-95). Removed substrate will be returned to the site upon installation of the new pipe.

The contractor will use BMPs to eliminate any potential for incidental entanglement of any marine organism... If incidental entanglement of protected species does occur, DAR and the appropriate federal agency will be notified immediately.

Land Based Source of Pollution (LBSP) will be avoided and mitigated with BMPs. During construction BMPs would include any type of barrier (e.g. sediment barriers/bags, petroleum absorption diapers, etc.) that limits the amount of sediment or LBSP to the maximum extent practicable. Weather will be considered, and construction will be scheduled to avoid storm conditions that would cause runoff and erosion. In such events, the land side construction site will be secured so that runoff into the ocean is unlikely.

Seawall repair is being conducted in the dry, protected from ocean waves by a temporary sandbag seawall extending about 12 feet out from the base of the existing seawall. No corals or sensitive marine biota were found within this impact area and no significant damage is expected from this seawall repair work.

In-water work will be required for replacement of the twin 8-inch diameter 45-yard-long seawater intake pipes and for repair of the seawall. Replacement of the twin pipelines will require suction dredging of the sand from around the existing pipes. This sand (estimated at less than 25 cubic yards) will be dewatered and held onshore to be replaced over the new pipelines after they are installed. Water from any dewatering necessary will be pumped to a holding tank on shore, settled, and disposed of in the sanitary sewer. The existing transite pipes will be uncoupled and carried or floated to the shoreline where they will be loaded and transported for disposal. Two new HDPE plastic pipes will be laid within the exposed trench and affixed to the substrate then covered with the sand initially dredged from the site.

During removal and replacement of the pipeline and replacement of the sand over the new pipeline, silt fences will be installed to either side of the section where work is underway. No floating platforms are allowed to anchor above the shallow reef flat but may anchor within the lagoon where the bottom substrate consists of sand. No construction activities will take place during inclement weather to include large waves, strong long-shore currents, or the presence of stormwater runoff.

Physical damage to principle benthic organisms from removal and installation of structures in the water may result in breakage or dislocation (i.e., mortality, or sub-lethal tissue abrasion) in corals. Corals, which are primarily responsible for the structural complexity of coral reefs, are particularly vulnerable to physical damage because their slow-growing carbonate skeleton is relatively brittle, and their polyps are easily damaged. Corals often colonize artificial structures, such as pipes.

It is recommended that the corals located in the impact zone and larger than 15 cm be transplanted to a similar nearby habitat fronting the Aquarium. Since transplantation is inherently stressful and increases risk of tissue disease and coral mortality, candidates for transplantation should be in good health. At the time of the report, a total of one (1) coral appears to be a suitable candidate for transplantation. For the remaining coral colonies, their potential loss may be mitigated by offering these corals to the DLNR for fragmentation and propagation into larger corals. If successful, these colonies can then be transplanted back into the waters fronting the Aquarium. Macroinvertebrates in the area may also be potential candidates for relocation, including sea cucumbers and sea urchins.

To avoid impacts to sea turtles and Monk seals during construction, if these ESA species are observed within 100 meters of the aquarium (i.e. between the Natatorium groin to the east and an equal distance to the west) construction activities that generate significant noise above ambient levels will be discontinued until the animal voluntarily leaves the area. Further, the contractor will notify the NOAA Protective Species Division and the DLNR Division of Conservation and Resources Enforcement (DOCARE).

In-water construction will also expose individual habitat-forming marine organisms to sound and vibratory stressors. Although not likely to kill organisms, chronic noise can mask biologically important sounds and alter the natural soundscape, cause hearing loss, and/or have an adverse effect on an organism's stress levels and immune system. The entire project is expected to take approximately two (2) years to complete. However, the in-water pipe replacement is anticipated to take approximately four (4) months depending on weather conditions. Maximum permissible noise levels have been set in Chapter 46, Public Health Regulations, Department of Health, State of Hawaii, "Community Noise Control." The Contractor shall become familiar with the noise level restrictions and the procedures for obtaining a permit for the construction activities and obtain a permit from the Director of Health as needed. To mitigate noise emissions and community effects of noise emissions from construction activities, BMPs such as the following will be employed:

- Equipment operation on the shoreline will be limited between 7:00 AM and 7:00 PM. Noisier operations, such as truck hauling, could be limited to minimize disruption to beach users and Aquarium occupants.
- Equipment substitution will be used to ensure that the quietest locally available equipment is used (e.g., high insertion loss mufflers, fully enclosed engines, and rubber-tired equipment, if possible).
- The use of horns will be prohibited.

In the long-term time frame, the Proposed Action will likely protect valuable coastal ecosystems, improve water quality in the MLCD, and help reefs thrive by replacing the deteriorating transite pipes with HDPE pipes.

3.3.2.3 Essential Fish Habitat Analysis

Modification to the Federal Magnuson-Stevens Act in 2002 requires analyses of any construction activity in the waters of the US that could adversely impact Federal fisheries. This includes impacts within State waters potentially impacting breeding or spawning grounds, nursery waters, or food production for Federal fisheries.

The shallow reef flat habitat fronting the WAq has sparse (<1%) coral cover, abundant macro-algae cover, and is frequented primarily by juvenile reef fish, with larger reef fish and invertebrates more abundant near the end of the pipeline at the edge of the Natatorium dredge escarpment (see description of habitat, above). The Proposed Action consists of the removal of twin existing 8-inch diameter 45-yard long transite pipes that have been in place for more than 50 years, and the replacement of these pipes with twin 8-inch HDPE plastic pipes.

The vicinity of the project supplies both potential nursery grounds and the production of food for federal fisheries. Given the minimal construction activity to replace existing pipelines in an existing footprint with adequate BMPs to control sediment plumes, there does not appear to be any significant impact to EFH. Nevertheless, it is prudent to follow conservation measures outlined by USACE and NMFS. USACE coordinates EFH with NMFS and has accepted NMFS conservation recommendations intended to conserve EFH by avoiding and minimizing adverse effects to EFH. The following lists conservation measures that are applicable to the Proposed Action.

Conservation Recommendations for Physical Impacts to Benthic Communities

- Equipment, anchors, structures, or fill shall not be deployed in project areas containing live corals, seagrass beds, or visible benthic organisms. Perform pre-deployment reconnaissance (e.g., divers, drop cameras, etc.) to ensure these resources are avoided.
- Minimize direct impact (direct or indirect contact causing damage) by divers and construction related tools, equipment, and materials with benthic organisms, regardless of size, especially corals and seagrass.
- Prevent trash and debris from entering the marine environment during the project.
- Maintain all structures, gear, instrumentation, mooring lines, and equipment to prevent failures.
- All objects lowered to the bottom shall be lowered in a controlled manner. This can be achieved by the use of buoyancy controls such as lift bags, or the use of cranes, winches, or other equipment that affect positive control over the rate of descent. This often requires skilled in- water observation.
- Conduct all work from land or an existing structure. If using a barge, employ auto-positioning systems where thrusters will not cause increased turbidity. Anchor barges to (1) shoreline infrastructure; (2) nearby existing moorings; and, (3) anchors or spuds on sand only.).
- Mooring systems (e.g., buoys, chains, ropes) must be kept taut to the minimum length necessary.
- All temporary structures must be removed at the completion of construction and this timeframe will be defined as aligned with General Condition #30 of the Nationwide Permit Program.

Conservation Recommendations for Increase in Sedimentation and/or Turbidity

- Appropriate silt containment devices must be properly installed, monitored and maintained.
- Debris and sediment that is removed from the water shall be disposed of at an appropriate upland location. Sediment and debris must be contained while in transit or on the shore.

- Project operations must cease under unusual conditions, such as large tidal events, storms, and high surf conditions.
- Conduct intertidal work at low and/or slack tide to the greatest extent feasible.
- To minimize impacts to coral larvae, avoid in-water work during mass-coral spawning times or peak coral spawning seasons. Permittees shall coordinate with local NMFS Habitat Conservation Division representatives to determine the exact period when coral spawning would occur for the given year at the project site.
- Use natural or bio-engineered solutions when feasible.

Conservation Recommendations for Increase in Acoustic Impacts

- Use a vibratory hammer to install piles when possible. Under conditions where impact hammers are required, when possible, drive as deep as possible with a vibratory hammer prior to the use of an impact hammer.
- Implement measures to attenuate the sound or minimize impacts to aquatic resources during pile installation. Methods to mitigate sound impacts include, but are not limited to, the following: surround the pile with a dewatered cofferdam and/or air bubble curtain system.

Conservation Recommendations for Increase in Invasive Species

- Prior to in-water work, sanitize equipment or dive gear that has been previously used in an area known to contain invasive species.
- To minimize loss of EFH due to the planned activity, NMFS recommends that a plan is developed to relocate and/or transplant all corals above 10 cm (as opposed to 15 cm) that will be unavoidably lost under the following conditions:
  1. The receiving location(s) must not have foreseeable and avoidable adverse effects (i.e., adverse effects from any anticipated projects by any proponent).
  2. The receiving location(s) must have similar physicochemical conditions (e.g., temperature, salinity, light penetration, nutrient concentrations, and turbidity).
  3. A coral relocation plan that includes post-relocation success criteria and evaluation methodology is provided to and approved by NMFS and implemented by the proponent.
  4. If coral relocation is impractical, then offsets are proposed and implemented by the proponent.

Actions that enhance EFH can offset loss of EFH, such removal of marine debris covering available EFH or stabilization of habitat. Offset plans are individually tailored to the resource, location, and activity. NMFS has noted that it can provide technical assistance in the development of an offset plan if needed. The project team will conduct an EFH consultation during the application process for a US Army Corps of Engineers permit.

3.4 Human Environment

3.4.1 Demographics

3.4.1.1 Existing Conditions

The project site is located within the Urban Honolulu Census Designated Place (CDP), which encompasses 68.4 square miles. The Urban Honolulu CDP area has a population of 350,964. The median age is 43.9 years, with 6.8% of the population under 5 years old and 23.7% over 65 years old. Most of the population identify with two or more races (38.4%), and Asian and White people each comprise 24% of the population. Approximately 12.5% of the population is Native Hawaiian or Pacific Islander. About 93% of adults have a high school degree or higher. The median household income is $72,454. It is estimated that 10.7% of individuals live in poverty (U.S. Census Bureau, 2021).

3.4.1.2 Potential Impacts and Proposed Mitigation

The Proposed Action will not impact the Honolulu's population, nor would it alter demographics. No mitigation is required.

3.4.2 The Economy

3.4.2.1 Existing Conditions

Waikīkī is bounded on the north and west by the Ala Wai canal from Kapahulu Avenue to the ocean (including the Ala Wai Boat Harbor), on the east by Kapahulu Avenue and on the south by the ocean shoreline. This region features hotels, restaurants, and retail operations that cater to the visitor industry and is recognized by CCH as the Waikīkī Beach Special Improvement District. Waikīkī accounts for 4.1 percent of Hawai'i's total civilian jobs and contributed $345.4 million to Hawai'i State taxes in 2021. [2]).

The area east of Waikīkī complements this economic benefit generated by Waikīkī by providing educational, recreational, and open space resources, including WAq, Waikīkī Zoo, Kapi'olani Park and the iconic Diamond Head. Nestled between the ocean and the regional park, WAq is a popular destination for residents and visitors that showcases Pacific marine life. Much of this area is in the Diamond Head Special District designated by CCH.

[2] ***State of Hawai'i Data Book 2021, Table 7.33 Contribution to the State's Economy by Statewide Visitor Industry and by Waikīkī: 2021***

3.4.2.2 Potential Impacts and Proposed Mitigation

The Proposed Action will have a positive short-term impact on the economy by creating direct and indirect employment related to construction.

The Proposed Action will allow WAq to comply with State and County environmental requirements while continuing operations and remaining financially viable. From an economic perspective, these effects will allow WAq to stay in operation will continue to promote Waikīkī as a visitor destination.

3.4.3 Archeological Resources

3.4.3.1 Existing Conditions

The Archaeological Literature Review and Field Inspection Report (ALRFI) is presented in Appendix F. Background research and previous archaeological findings in the vicinity indicate there is potential for traditional Hawaiian historic properties and human burials in the project environs. Waikīkī was intensively used during the pre-contact and early historic period for habitation, agriculture, and aquaculture, and several heiau were once present. In the late 1900s, Waikīkī's landscape was radically modified and became the home of many wealthy businessmen, such as William G. Irwin from England, whose estate included the project area.

In 1876 a group of prominent businessmen formed the Kapiʻolani Park Association. King David Kalākaua offered a 30-year lease of Kāneloa and Kapua (neighboring ʻili to the east) for the endeavor on the east side of Waikīkī, which was crown land. According to the association's charter, the park would serve the purpose "of adorning and putting in order, a tract of land in the vicinity of Honolulu as a place of public resort, and of promoting Agricultural and Stock Exhibitions, and healthful exercise, recreation and Amusements." Kalakaua dedicated the park in June of 1877 in honor of Queen Kapiʻolani.

The aquarium parcel is a portion of property formerly owned by William G. Irwin. His home was located immediately south of WAq. In 1896 Irwin became the Chair of the Honolulu Park Commission which oversaw Kapiʻolani Park. The Beach Park Memorial Committee negotiated the purchase of the Irwin Estate in 1919 for the construction of the Waikīkī War Memorial and Natatorium. In 1913, management of the park was transferred to the Territory of Hawaii, and it was at this time the first public zoo appeared in the park.

Near the project area are several instances of inadvertently discovered human burials reported on by staff of the Bernice Pauahi Bishop Museum (BPBM) at the Outrigger Canoe Beach Club. Further numerous human remains have been found in Kapiʻolani Park and along Kalākaua Avenue.

In the mid-1990s, several human skeletal remains were inadvertently discovered at WAq during rebuilding and modification of a shark tank. No formal burial site was identified. It was speculated that the skeletal fragments were brought in with sand from Maui for construction work during the project.

Excavations were monitored for subsurface electrical infrastructure for a new sewer pumping station which documented a layer of natural beach sand, but no cultural layer was encountered; however, a trash pit, designated Site 6704, was recorded within Kalākaua Avenue, adjacent to the aquarium. The site consisted of bottles dating between the 1880s to 1920s, broken ceramic pieces, and butchered animal bone.

Archaeological monitoring was conducted in 2008 for electrical system upgrades in the northeast corner of the Waikīkī Aquarium. The soil stratigraphy primarily consisted of two layers of fill over a transitional layer, followed by Jaucus sand.

3.4.3.2 Potential Impacts and Proposed Mitigation

It was found that no historic properties are within the proposed project area, although two historic properties are within the larger TMK parcel, including the Waikīkī Aquarium (no State Inventory of Historic Places [SHIP] site number designated) and SIHP Site 04729, was speculated to be skeletal fragments brought onto the aquarium parcel with sand from Maui for construction. Along the beach to the north and south of the aquarium, numerous traditional Hawaiian human burials have been identified. Previous archaeological investigations in the vicinity have recorded in situ soils under fill layers.

Based on the ALRFI and on previous archaeological projects near the project area that have recorded subsurface historic properties including cultural deposits and human burials, there is insufficient information to make a HRS Chapter 6E historic preservation determination of effect of the project's impact on potential subsurface historic properties within the 0.06-acre project area. Therefore, archaeological monitoring for identification purposes, guided by a SHPD-approved archaeological monitoring plan (HAR § 13-279-3), is recommended.

3.4.4 Cultural Impacts

The Draft EA appended a Cultural Impact Assessment dated December 2023. Table 3 of that report incorrectly reported that no responses had been received concerning historic properties or traditional or customary cultural practices. Consultant PCSI had inadvertently missed a contact opportunity with ʻĀina Momona, a Native Hawaiian Organization. Dr. Trisha Watson-Sproat, a representative from ʻĀina Momona, contacted Oceanit after the 30-day timeframe for EA comments and reported this discrepancy. Oceanit asked her to submit comments nevertheless, and in conversation and correspondence with Oceanit, Dr. Watson graciously provided cultural information concerning historic references, and noted that several traditional practices should be considered during planning and implementing the current project, namely surfing, fishing, and canoe paddling. The Revised Cultural Impact Assessment is contained in Appendix G and the following sections contain follow up research based on consultation with her.

3.4.4.1 Existing Conditions

The project site is located in the Waikīkī Ahupuaʻa, Moku of Kona, and Mokupuni Kakuhihewa. The Waikīkī ahupuaʻa covers the area extending from Kou (the old name for Honolulu) to Maunalua, which is now referred to as Hawaiʻi Kai. On a current city map, this measures roughly from Piʻikoi and Sheridan Streets, crossing near Roosevelt High School to the main ridge at Papakōlea, passing over Tantalus to the peak of Kōnāhuanui, then along the crest of the Koʻolau Range along the ahupuaʻa of Kailua and Waimānalo to Maunalua. .[3]

The Waikīkī Aquarium was formerly located in Kapiʻolani Park, roughly 100 yards north of its current location. Constructed in 1904, it was known as the Honolulu Aquarium and was privately financed by Charles M. Cooke and James B. Castle and operated as part of the Honolulu Rapid Transit and Land Company. In 1919 the land lease expired, and the Cooke Estate ceded the lease to the Territory of Hawai'i. The present day Waikīkī Aquarium was funded by the Territorial Legislature in 1949 and opened in 1955.

Cultural activities that occur near the project area include the following:

- Surfing

  Traditionally, Waikīkī was a land beloved of the Hawaiian chiefs, where board surfing could be indulged. The four major Waikiki surfs sites are Kalehuawehe, currently called "Castleʻs," Aiwohi, currently called "Publics," Mihiwa, currently called "Cunhaʻs," and Kapuni, currently called Canoes.

  Aiwohi, or "Publics," is located approximately 1,200 feet northwest of the Waikiki Aquarium and there is a breakwater that lies 300 feet from the shore. An unnamed surf site is located approximately 2,000 feet southwest of the Waikiki Aquarium. Surf breaks only occur on big West swells and is located inside the reef. [4]

- Fishing

  The Waikīkī MLCD is located at the Diamond Head end of Waikīkī Beach and fronts WAq. The MLCD extends from the groin at the end of Kapahulu Avenue to the ewa (west) wall of the Natatorium, from the highwater mark seaward a distance of 500 yards or to the edge of the fringing reef, whichever is greater. Most fish in this area are found along the channel's shoreline side (which has a number of small caves), along the Natatorium wall, and near the exposed parts of

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[3] George S. Kanahele, *Waikīkī: 100 B.C. to 1900 A.D, An Untold Story* (Hawaiʻi: University of Hawaiʻi Press, 1995), 5-6.

[4] John R. K. Clark, *Hawaiian Surfing: Traditions from the Past (*Hawaiʻi: University of Hawaiʻi, 2011), 128.

the reef on the channel's seaward side. The channel itself is about 8 feet deep, and depths above the reef flat are generally less than 3 to 4 feet. Fishing is strictly forbidden in the Waikīkī MLCD. Specific prohibitions include 1) to fish for, take or injure any marine life (including eggs), or possess in the water any device that may be used for the taking of marine life and 2) to take or alter any sand, coral or other geological feature or specimen, or possess in the water any device that may be used for the taking or altering of a geological feature or specimen.

The project area is also near to the Waikīkī-Diamond Head Shoreline Fisheries Management Area, which extends from the ewa wall of the Waikīkī War Memorial Natatorium to the Diamond Head Lighthouse, from the highwater mark out to a minimum seaward distance of 500 yards, or to the seaward edge of the fringing reef beyond 500 yards. Fishing is allowed in this area from January 1 to December 31 of even-numbered years. During this time, it is permitted to fish for, take or possess any legal-size marine life in season, and allowed methods include only hook-and-line, thrownet, handnet to land hooked fish, and spear fishing and hand harvesting methods. Fishing is not allowed on odd-numbered years.

- Canoe Paddling

Canoe paddling occurs along the entire Waikiki coastline, and prominent Waikiki canoe clubs, include the Kumulokahi Canoe Club at the Elks Lodge and Outrigger Canoe Club to the east of the Waikiki Natatorium War Memorial, and the Waikiki Beach Boys Canoe Club headquartered in the Ala Wai Park.

3.4.4.2 Project Impacts and Proposed Mitigation

The Proposed Action includes the replacement of existing intake pipes with new 8-inch HDPE pipes. Flow will be limited to only one pipe at a time to minimize the potential for marine growth on the inner walls of the intake pipes. The openings to the seawater intakes will be designed to minimize entrainment of small fish and invertebrates.

The Proposed Action will not significantly impact or alter the cultural activities occurring along the shoreline. In terms of major surf sites, the nearest is Aiwohi, or "Publics," is located approximately 1,200 feet northwest of the Waikiki Aquarium. An unnamed surf site is located approximately 2,000 feet southwest of the Waikiki Aquarium.

No fishing is allowed along the shoreline fronting the WAq and the project area. Fishing is allowed from the ewa wall of the Waikīkī War Memorial Natatorium to the Diamond Head Lighthouse. While the project area is outside the Waikīkī-Diamond Head Shoreline Fisheries Management Area, food gathering sources are not expected to be negatively impacted in that safeguards will be taken to minimize biota entrapment.

Canoe padding routes are well beyond 170 feet from the existing seawall and will not be impacted by the Proposed Action.

3.4.4.3 Ka Pa'akai Analysis

A further analytical framework for addressing the preservation and protection of cultural practices specific to Native Hawaiian communities resulted from a 2000 Hawai'i Supreme Court ruling [(in Ka Pa'akai O Ka'Aina vs Land Use Commission. 94 Hawaii 31 (2001)]. In its decision, the court established a three-part analytical approach to identify impacts, assess impacts, and mitigate impacts to traditional and customary native Hawaiian rights associated with a proposed action. The three-part analysis, based on current consultation, past consultations, and archival research, is applied to the Proposed Action as follows.

1) *The identity and scope of valued cultural, historical, or natural resources, including the extent to which traditional and customary native Hawaiian rights are exercised:*

   As discussed in the previous section, the Waikīkī coastline supports long-standing traditional and cultural resources and practices, including surfing, fishing and canoe paddling.

2) *The extent to which those resources—including traditional and customary native Hawaiian rights—will be affected or impaired by the proposed action:*

   It is not expected that traditional and customary native Hawaiian rights will be directly affected or impaired by the proposed action. The nearest surf site is 1,200 feet northwest of the project area, and canoe padding does not occur where the new intake pipes will replace the existing pipes at 170 feet from the shoreline. Further, fishing is not allowed in the Waikīkī MLCD, which includes the project area. In terms of impacts on the benthic environment, no corals or sensitive marine biota were found within this impact area. No significant damage is expected from this seawall repair work and no cultural impacts related to food gathering is anticipated.

3) *The feasible action, if any, to be taken by the agency to reasonably protect native Hawaiian rights if they are found to exist:*

   The far distance between native Hawaiian rights related to cultural or historical resources and construction activities does not require protection of these resources.

For the reasons discussed above, native Hawaiians will be able to continue their customarily and traditionally exercised rights within the project area during and after construction and during operation.

3.5 Public Services and Facilities

3.5.1 Recreational Facilities and Resources

3.5.1.1 Existing Conditions

Kapi'olani Park is located across Kalākaua Avenue and adjacent to WAq on its northern and southern boundaries. Encompassing 300 acres, Kapi'olani Park, managed by the CCH Department of Parks and Recreation (DPR), is the largest public park in Hawaiʻi and contains the Honolulu Zoo, Waikīkī Shell, a bandstand, tennis and basketball courts, soccer fields, and large grassed areas used for active and passive recreational activities. The Waikīkī Natatorium War Memorial is located just southeast of WAq.

3.5.1.2 Potential Impacts and Proposed Mitigation Measures

All construction and operations will be contained on WAq property or in the ocean and will not affect any of the surrounding park. The Proposed Action should not impact DPR's properties. If deemed necessary, however, the project's contractor may need to obtain a DPR Right-of-Entry. No other mitigation measures will be needed.

The Proposed Action will have a long-term positive impact on recreation uses by allowing WAq's operational stability, thereby continuing to enhance recreational features, repairing the public walkway between WAq and the ocean, and improving water quality along the adjacent shoreline, a popular resident and visitor recreational resources. The Proposed Action is not anticipated to have any visual or coastal line-of-sight impacts.

3.5.2 Solid Waste Treatment and Disposal

3.5.2.1 Existing Conditions

Solid waste disposal in the area is provided by CCH.

3.5.2.2 Potential Impacts and Proposed Mitigation Measures

Construction of the Proposed Action will result in drilling solids, cuttings, and fluids, which will be properly contained on-site during construction. Upon completion of construction, all construction waste will be properly disposed at the PVT landfill in Nānākuli, Oʻahu's only construction and demolition waste landfill. Alternative disposal of construction waste must be approved and permitted by the Department of Health.

The Proposed Action will not increase the long-term need for solid waste disposal.

3.5.3 Police and Fire Protection

3.5.3.1 Existing Conditions

The project area is within Honolulu Police Department (HPD) District 6, which encompasses the Waikīkī peninsula. The nearest police station is the Waikīkī substation, located 0.7 miles north of the project site at 2425 Kalākaua Avenue.

The nearest Honolulu Fire Department (HFD) fire station is Fire Station 07 located at 381 Kapahulu Avenue and less than a mile northeast from the project site.

3.5.3.2 Potential Impacts and Proposed Mitigation Measures

The Proposed Action will not impact HPD and HFD services during construction. In addition, a public notice will be issued in the event any road closures are required.

WAq will comply with HFD access to the property in accordance with NFPA 1, 2018 Edition, §18.2.3, and an approved water supply. Civil engineering drawings will be submitted to HFD for review and approval as a part of the building permit process.

3.5.4 Roadways and Public Transportation

3.5.4.1 Existing Conditions

Kalākaua Avenue is a busy thoroughfare, frequently used by residents and visitors traversing Waikīkī, Diamond Head, Kapiʻolani Park, Waikīkī Beach and adjacent areas. The project site is located on the makai side of Kalākaua Avenue, along TheBus route. The nearest bus stop fronts WAq on Kalākaua Avenue.

3.5.4.2 Potential Impacts and Proposed Mitigation Measures

Mobilization and demobilization of construction equipment to and from the site for well drilling will be along the two-lane Kalākaua Avenue. To reduce traffic impacts, mobilization and demobilization will take place during non-peak traffic hours (e.g., 8:30 AM – 3:30 PM). Traffic control devices and/or road closures are not anticipated to be needed except very briefly for mobilization and demobilization. Once the construction equipment vehicles are onsite, they will be contained on WAq property and will not encroach on public roadways.

Adequate notification will be made to the residents, visitors and businesses prior to deliveries or possible road closures. No public parking stalls are anticipated to be impacted by construction activities.

The proposed action will not affect the public bus route or stop.

3.5.5 Water and Wastewater System and Services

3.5.5.1 Existing Conditions

Fresh, potable water is provided to the project site by the CCH Board of Water Supply (BWS).

Wastewater services for WAq are provided by CCH ENV. Sewer gravity mains run to and from WAq and along Kalākaua Avenue, and several force mains are concentrated on the northwest corner of the parcel. Two sewer manholes are located on the east side of the parcel. A CCH Sewage Pump Station is located near the northeast corner of the WAq parcel. Figure 3-12 illustrates the wastewater system in the project environs.

Source: City and County of Honolulu DPP, 2022

Figure 3-12: Honolulu Sewer Utilities Map

3.5.5.2 Potential Impacts and Proposed Mitigation Measures

The existing 80-ft deep saltwater production well (State Well No. 3-1649-010) was constructed in 1954. According to the Commission on Water Resource Management well index, the database on wells in Hawai'i, the saltwater well was tested at 1,150 GPM with 2.7 ft of drawdown and has a high specific capacity. Although, the database does not indicate when the well was tested, it was most likely tested around 1954 after its initial construction. Although the saltwater well has not been tested in recent years, it is anticipated that the well performance has decreased over the years from natural aging processes. Based on the results of the well investigation, it is preferable to install a new saltwater well to meet existing volume and quality needs.

The proposed reconstruction of an existing operating saltwater supply well is not expected to have a significant impact on the water and wastewater systems. An application for a Well Construction/Pump Installation Permit will be submitted to the DLNR Commission on Water Resource Management (CWRM).

No impacts will occur on the stormwater containment system and water conservation efforts. No modifications will be made to the current freshwater drinking supply.

The Proposed Action will have no impact on Public Trust uses related to the maintenance of waters in their natural state, domestic water use of the general public, particularly drinking water, and the exercise of Native Hawaiian traditional and customary (T&C) rights. Native Hawaiian T&C rights deriving from Groundwater Dependent Ecosystems are not anticipated to be adversely affected.

The well is designed with over 600 feet of vertical separation from the underlying basalt aquifer. There are no drinking water or domestic wells in the vicinity.

3.5.6 Electrical, Telephone, and Cable Television Services

3.5.6.1 Existing Conditions

Local electrical service is provided by Hawaiian Electric Company (HECO). Electricity to the facility is provided by underground HECO service cable originating from a handhole off the sidewalk fronting the Aquarium and routed to a HECO transformer within the Aquarium. Power is routed through a metering switchboard to two distribution panels in the electrical room that feed a network of panel boards to provide all power to the Aquarium.

Adjacent to and to the north of the electrical room, an emergency 400-kilowatt (kW) generator is housed in a stainless-steel weatherproof housing. Diesel fuel for the generator is stored in a base tank underneath the generator. Two automatic transfer switches (ATS) within the electrical room allow the Aquarium to automatically draw power from HECO power source or from the emergency generator if the HECO power source becomes unavailable.

Cable, telephone, and internet services in Waikīkī are provided by Spectrum and Hawaiian Telcom.

3.5.6.2 Potential Impacts and Proposed Mitigation Measures

The existing electrical service, switchboards, and generator will have the capacity to serve all new electrical loads for the Supply Water Intake System Upgrade project.

Eight new variable frequency drives (VFDs) will be needed, one for each of the eight new pumps, including the two backwash pumps. VFDs will be located near the pumps they are controlling. New electrical panels will also be needed to distribute power to pumps, aerators, UV sterilizers, chillers, heat exchangers, and structures. The existing electrical feeders to the areas of the well water pumps, NSW pumps, air injection pumps, filters, UV sterilizers, chiller and heat exchanger will remain and be reused from the existing electrical room. The new electrical panels being provided will replace the local panels in these areas to improve the distribution of the equipment branch circuits. New light fixtures and lighting control system will be provided at the new pump vault and new well water pump house.

No impacts to telephone or cable services are expected from the proposed action. Some utility lines within the aquarium property may need to be moved to install the upgraded supply water intake system infrastructure and underground pump vault. To mitigate underground interference with new infrastructure, any subsurface construction activities will be preceded by geophysical clearance, such as ground penetrating radar.

3.6 Potential Cumulative and Secondary Impacts

The Proposed Action is not part of a larger action and would not contribute to cumulative adverse environmental effects on the environment, nor would it generate substantial secondary impacts, such as population changes or effects on public facilities.

4. RELATIONSHIP TO LAND USE PLANS, POLICIES, AND CONTROLS

The project will require various permits and approvals from regulatory agencies at the federal, state, and local levels. Regulatory agencies are tasked with ensuring that the project is compliant with statutes, rules, policies, and plans that they are responsible to uphold. Each permit or approval that may be needed for this project is briefly described in this section followed by a discussion on how the Proposed Action relate and comply with permit/approval policies in a manner that either avoids or minimizes any negative impacts.

4.1 Federal

Construction work within waters of the United States may require a United States Army Corps of Engineers (USACE) permit in accordance with the federal Clean Water Act (CWA) Section 404, the DOH Section 401 Water Quality Certification (WQC), Coastal Zone Management Act (CZMA), the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the Fish and Wildlife Coordination Act, and other applicable laws and regulations. The USACE issues both Nationwide and Individual (i.e., Section 404 and Section 10) Permits. Nationwide Permits (NWPs) are designed to streamline the USACE permitting process of minor projects that will have minimal impact on the nation's aquatic environment (e.g., in-kind and in-place maintenance, survey activities, minor dredging in certain locations). Given the repair objective and scale of this project, the Proposed Action may qualify for an NWP. In pre-consultation for Draft EA, USACE indicated that the Proposed Action may qualify for NWP 3, Maintenance.

The project will not use federal funds and environmental documentation under the National Environmental Policy Act (NEPA) is not applicable.

4.1.1 Clean Water Act Section 404

Section 404 of the CWA establishes a program to regulate the discharge of pollutants (i.e., dredged or fill material) into waters of the United States, which include navigable waters seaward of the high tide line, lakes, ponds, streams, ditches and adjacent wetlands. Regulated activities include fill for water resource projects, infrastructure development and mining projects. Section 404 requires a permit from the USACE before dredged or fill material may be discharged into any waters of the United States, including wetlands.

Relationship to the Proposed Action

The Proposed Action includes repairing structures within the Pacific Ocean. A CWA Section 404 Permit will therefore likely be required. During construction of the Proposed Action, short-term impacts on the nearshore reef environments, water quality, and marine resources will be mitigated by effective BMPs to control areas of impact.

4.1.2 Rivers and Harbors Act of 1899, Section 10

Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C 401 et seq.) requires authorization from the USACE for the construction of any structure in or over navigable waters of the United States, the excavation and dredging or deposition of material, or any obstruction or alteration to a navigable water. Note that the USACE's general definition of navigable water are those "waters subject to the ebb and flow of the tide […] and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce."

Relationship to the Proposed Action and Secondary Alternative

The Proposed Action involves replacing structures within the Pacific Ocean. These waters are tidal and considered navigable, and the Proposed Action therefore requires a permit from the USACE in accordance with Section 10 of the Rivers and Harbors Act. The project is not expected, however, to affect waterbody navigation.

4.1.3 Fish and Wildlife Coordination Act (16 United States Code [U.S.C.] 661-666c)

The Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661-666c) mandates that wildlife, including fish, should receive equal consideration as other aspects of water resource development. This is accomplished through consultation with NMFS, the USFWS, and appropriate state agencies whenever any body of water is proposed to be modified in any way and a federal permit or license is required. These agencies determine the possible harm to fish and wildlife resources, the measures needed to both prevent the damage to, and loss of, these resources, and the measures needed to develop and improve the resources, in connection with water resource development. NMFS, the USFWS, and state agencies submit comments to federal licensing and permitting agencies on the potential harm to living marine resources caused by the proposed water development project, as well as recommendations to prevent harm (NMFS, 2004). The FWCA compliance process includes 1) consultation (notice of initiation); 2) reporting (e.g., field surveys and summary reports) and recommendations to protect, mitigate, and restore natural resources; 3) action agency consideration of recommendations; and 4) action agency implementation of recommendations.

Relationship to the Proposed Action

Construction and implementation of the Proposed Action may impact species identified in Sections 3.3.1 and 3.3.2, which discuss project impacts on terrestrial and marine biology, respectively. Mitigation measures, including those recommended by public agencies, are discussed in those sections. Hence, implementation of the Proposed Action is expected to comply with FWCA.

4.2 State of Hawai‘i

4.2.1 Section 401, State Certification of Water Quality

The purpose of the Section 401 Water Quality Certification (WQC) is to provide states with power to protect the water quality of federally regulated waters. A Section 401 WQC permit is required when the action needs a federal permit, license, certificate, approval, registration, or statutory exemption, and may result in any discharge of a pollutant into navigable waters. In Hawai'i, water quality standards are enforced by the State of Hawai'i Department of Health (DOH) under HAR Title 11, Chapter 54. These water quality standards are reviewed every three years.

Relationship to the Proposed Action

The Proposed Action would affect ocean water quality during construction. Impacts would be temporary and mitigated with appropriate BMPs. Section 401 compliance will be coordinated with USACE and the DOH CWB.

4.2.2 State Land Use

HRS Chapter 205-2 establishes a Land Use Commission (LUC) that classifies all lands in the state into four major State Land Use Districts (SLUD): Urban, Rural, Agriculture, and Conservation. The State LUC is responsible for determining the boundaries of each district and any reclassifications or amendments to districts.

The land portion of the project area lies in the Urban district which contains activities or uses provided by ordinances or regulations of the county where the urban district is situated and are generally areas where there is a "city-like" amount of people, infrastructure, and services. Land uses in urban districts are governed by the county government. The Proposed Action is consistent with the current Urban designation.

The portion of the Proposed Action of the project relating to the replacement of the transite pipes is located seaward of the shoreline and lies within the State's Conservation District Protective Subzone. Pursuant to HAR (P-8) STRUCTURES AND LAND USES, EXISTING (B-1), *Demolition, removal, or minor alteration of existing structures, facilities, land, and equipment,"* requires a Site Plan Approval that will be processed by the DLNR OCCL. An application for a Site Plan Approval will be submitted.

4.2.3 Hawai'i Coastal Zone Management

Coastal Zone Management (CZM), as codified under Chapter 205A, HRS, is a public initiative that integrates resource, ecosystem and place-based management of coastal resources. CZM also balances the needs of economic development and conservation of resources in a sustainable manner. The Federal CZM Program was created through passage of the CZM Act of 1972. The Hawai'i CZM Program was approved by the federal government in 1978 and the state in 1977 and is codified under HRS Chapter 205A.

Hawai'i's CZM Program is the State's resource management policy umbrella and guiding perspective for the design and implementation of allowable land and water uses and activities. The CZM Program focuses its work on the complex resource management problems of coastal areas in the part of the State that are under the highest stress. Within a framework of cooperation among federal, state, and local levels, the Hawai'i CZM Program employs a wide variety of regulatory and non-regulatory techniques to address coastal issues and uphold environmental law. These techniques include stewardship, planning, permitting, education and outreach, technical assistance to local governments and permit applicants, policy development and implementation, and identification of emerging issues and exploration of solutions.

The CZM Program identifies 10 objectives and policies (HRS §205A-2 (b):

(b) Objectives

(1) Recreational Resources
(2) Historic Resources
(3) Scenic and Open Space Resources
(4) Coastal Ecosystems
(5) Economic Uses
(6) Coastal Hazards
(7) Managing Development
(8) Public Participation
(9) Beach Protection
(10) Marine Resources

CZM objective and policies for Special Management Areas are set forth in HRS §205A-26 and are discussed further in Section 4.3.4.

4.3 City and County of Honolulu

4.3.1 Oʻahu General Plan

The Oʻahu General Plan sets forth the City's objectives and broad policies for long-range development of the island. The General Plan was adopted in 1977 and amended several times. The most recent amendment was adopted by the City Council on December 1, 2021, as Resolution 21-23, CD1, and was signed by the CCH mayor on January 14, 2022. As a guide for all levels of government, private enterprise, neighborhood and citizen groups, organizations, and individual citizens, the General Plan delineates strategies for 11 key areas including (1) population, (2) balanced economy, (3) the natural environment and resource stewardship, (4) housing and communities, (5) transportation and utilities, (6) energy systems, (7) physical development and urban design, (8) public safety and community resilience, (9) health and education, (10) culture and recreation, and (11) government operations and fiscal management.

The Proposed Action supports Natural Environment and Resource Stewardship objectives and policies of the Oʻahu General Plan, which aim to protect the island's natural resources and environmental quality, by replacing aged and outdated asbestos-containing transite pipes with new HDPE pipes and intake system. New NSW treatment equipment, including media filters and UV sterilizers, will ensure that the system will distribute water that will meet the needs of WAq biota. These improvements will lessen the risk of system failure that would negatively impact on-site and ocean biota, as well as ocean water quality.

In addition, the Proposed Action supports the Health and Education objective by ensuring the longevity of WAq, an important educational facility that promotes understanding, appreciation, and conservation of Pacific marine life.

4.3.2 Primary Urban Center Development Plan (2004)

The project site is located in the Primary Urban Center Community Plan area. In 2004, the CCH Department of Planning and Permitting published the Primary Urban Center (PUC) Development Plan, which is currently undergoing revision. A draft plan of an updated PUC Development Plan was in a public comment period that ended on January 31, 2023. At the time of this writing, the draft passed first reading in the Honolulu City Council as Bill 24-24 in April 2024.

The PUC is the most populous area in the State of Hawaiʻi and encompasses major economic activity hubs, including Downtown Honolulu and Waikīkī, stretching from Kahala to Pearl City along the southern coastline of Oʻahu. The vision of the PUC through 2035 includes:

- Protect and enhance Honolulu's natural, cultural, and scenic resources;
- Create livable neighborhoods with business centers, parks, plazas, and walkable streets;
- Provide in-town housing choices for people of all ages and incomes;
- Make Honolulu the Pacific's leading city and travel destination; and
- Create a balanced transportation system that provides excellent mobility for residents and visitors (CCH DPP, 2004).

The PUC Development Plan identifies the following panoramic views and vistas:

- The Koʻolau and Waiʻanae mountain ranges and their foothills;
- The Pacific Ocean, Pearl Harbor's East Loch, Ford Island, Honolulu Harbor, Keʻehi Lagoon and Kewalo Basin, and their respective shorelines; and
- The craters of Leahi (Diamond Head), Puowaina (Punchbowl), and Aliamanu.

The Pacific Ocean, the Leahi (Diamond Head) crater, and the Waikīkī shoreline are visible from WAq. The Proposed Action will not affect views to and from the Leahi crater, or along the Waikīkī shoreline.

WAq is a landmark destination east of the famous Waikīkī Beach strip. Improvements to WAq, such as those from the Proposed Action, will help to support Honolulu as the "Pacific's leading city and travel destination".

4.3.3 City and County of Honolulu Zoning

The project area is zoned P-2, General Preservation. The Waikīkī Aquarium is a public use operated by the University of Hawaiʻi. The Proposed Action is consistent with the uses permitted in P-2 and will not require zoning changes and zoning-related permits.

4.3.4 Special Management Area

The Shoreline Management Area (SMA) extends inland from and along the shoreline. SMA in each county shall be as shown on maps filed with the authority as of June 8, 1977, pursuant to HRS § 205A-23. Act 16, Session Laws of Hawaii 2020, which amended HRS Chapter 205A, and was enacted on September 15, 2020. Each county authority is tasked with reviewing developments with the SMA. As established in Chapter 25 of the ROH, "special controls on development within an area along the shoreline are necessary to avoid permanent loss of valuable resources and foreclosure of management options, and to ensure that adequate public access is provided to public owned or used beaches, recreation areas, and natural reserves, by dedication or other means". Figure 4-1 shows the location WAq within the SMA.

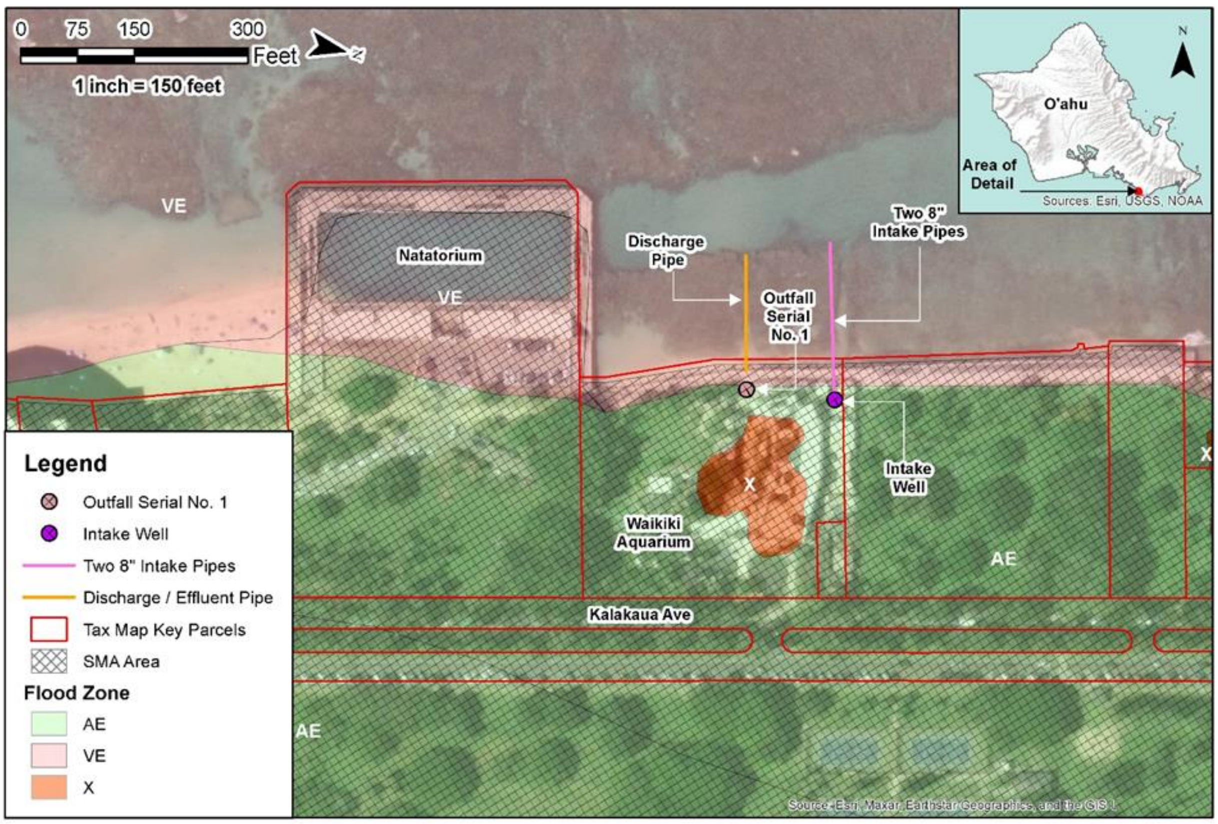

Figure 4-1: Project Relationship to Designated SMA Boundary

4.3.4.1 SMA Objectives and Policies

The objectives and policies hereafter discussed are contained in HRS §205A-2(b) and are the basis for analysis of uses, activities or operations within the SMA.

Recreational Resources

Objective: Provide coastal recreational opportunities accessible to the public.

Relevant policies:

- Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value.

- Ensuring public recreational uses of county, state, and federally owned or controlled shoreline lands and waters having recreational value consistent with public safety standards and conservation of natural resources.

- Adopting water quality standards and regulating point and nonpoint sources of pollution to protect, and where feasible, restore the recreational value of coastal waters.

The proposed action will support coastal recreational opportunities by replacing outdated water transite intake pipes with HDPE pipes. This replacement will lessen the potential for future malfunctions and breakage, thereby preserving the recreational value of the shoreline. The public access walkway between WAq and the shoreline will be repaired and allow the continuation of lateral public access.

Historic Resources

Objective: Protect, preserve, and, where desirable, restore those natural and manmade historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.

Relevant policies:

- Identify and analyze significant archeological resources.
- Maximize information retention through preservation of remains and artifacts or salvage operations.
- Support state goals for protection, restoration, interpretation, and display of historic resources.

An archaeology literature review and field survey study was conducted to determine whether there would be significant impacts to historical or archeological resources under the Proposed Action. The Proposed Action is not anticipated to have significant impacts on existing historic and cultural resources within the project area.

Scenic and Open Space Resources

Objective: Protect, preserve, and, where desirable, restore or improve the quality of coastal scenic and open space resources.

Relevant Policies:

- Identify valued scenic resources in the coastal zone management area.

- Ensure that new developments are compatible with their visual environments by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline.
- Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources.

The Proposed Action will comply with Diamond Head Special District Design Guidelines, which sets forth landscaping and height parameters and is discussed in Section 4.3.6. Further, in-water infrastructure will not alter views in the area.

Coastal Ecosystems

Objective: Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal systems.

Relevant policies:

- Exercise overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources.
- Improve the technical basis for natural resource management.
- Preserve valuable coastal ecosystems of significant biological or economic importance, including reefs, beaches, and dunes.
- Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs.
- Promote water quantity and quality planning and management practices that reflect the tolerance of fresh water and marine ecosystems and maintain and enhance water quality through the development and implementation of point and nonpoint source water pollution control measures.

The Proposed Action supports the objective to protect valuable coastal ecosystems. Implementation of the Proposed Action will eliminate the potential for malfunction and damage of the existing water transite intake pipes and add new HDPE pipes that are durable and environmentally friendly.

Economic Uses

Objective: Provide public or private facilities and improvements important to the State's economy in suitable locations.

Relevant policies:

- Concentrate coastal dependent development in appropriate areas;

- Ensure that coastal development and coastal related development are located, designed, and constructed to minimize exposure to coastal hazards and adverse social, visual, and environmental impacts in the coastal zone management area; and
- Direct the location and expansion of coastal development to areas designated and used for that development and permit reasonable long-term growth at those areas, and permit coastal development outside of designated areas when:
    - Use of designated locations is not feasible;
    - Adverse environmental effects and risks from coastal hazards are minimized; and
    - The development is important to the State's economy.

The Proposed Action is anticipated to have long-term beneficial economic impacts to the community and the State by replacing outdated intake transite pipes with HDPE pipes that are durable and environmentally friendly. WAq is a popular tourist destination, attracting more than 250,000 visitors a year from all around the world. Thus, by prolonging the life of WAq infrastructure and operation, the Proposed Action will have a positive effect on Honolulu's economy. Further, the Proposed Action will occur in an already developed location and construction of the new water treatment building will be designed in compliance with the Diamond Head Special Design District, as discussed in Section 4.3.6.

Coastal Hazards

Objective: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution.

Relevant policies:

- Develop and communicate adequate information about storm wave, tsunami, flood, erosion, subsidence, and point and nonpoint source pollution hazards.
- Control development, including planning and zoning control, in areas subject to coastal hazards.
- Ensure that developments comply with requirements of the National Flood Insurance Program.
- Prevent coastal flooding from inland projects.

A limited amount of ground surface is expected to be exposed temporarily during construction of the treatment building. Further, the removal of existing intake pipes and the installation of new pipes will disturb the ocean floor. Exposed soils are susceptible to erosion, especially if it rains heavily during site work periods. Additionally, increased turbidity resulting from in-water construction may detract from recreational activities occurring along the shoreline.

Adverse impacts would be minimized or avoided due to both temporary and permanent erosion and sedimentation control measures during ground disturbing and trenching activities. Construction wastewater from drilling activities will be hauled off site and will not be discharged on site or offshore. All proposed work shall comply with State and CCH erosion control standards and requirements. The project complies with the requirements of the Federal Flood Insurance Program. Similarly, construction-related impacts related to pipe removal and installation will be minimized and managed by employing stringent BMP measures.

Managing Development

Objective: Improve the development review process, communication, and public participation in the management of coastal resources and hazards.

Relevant policy: Communicate the potential short- and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the public to facilitate public participation in the planning and review process.

In accordance with the public review process established by HRS Chapter 343 and HAR 11-200.1, the Draft EA was distributed to federal, state, and county agencies, utilities, community organizations and leaders for a 30-day response period. Public comments and responses are contained in this Final EA. In addition, the availability of this Final EA will be announced in The Environmental Notice published by OPSD ERP.

Public Participation

Objective: Stimulate public awareness, education, and participation in coastal management.

Relevant policy: Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal related issues, developments, and government activities.

Pre-consultation on the Draft EA and public comments on the Draft EA are discussed in Section 5. In addition to requesting pre-consultation comments from agencies, organizations and individuals, the project team made a presentation to the Diamond Head / Kapahulu / St. Louis Heights Neighborhood Board No. 5. The Contractor will also be required to coordinate with community and stakeholders before and during construction.

Beach Protection

Objective: Protect beaches and coastal dunes for public use and recreation.

Relevant policies:

- Minimize the construction of public shoreline hardening structures, including seawalls and revetments, at sites having sand beaches and at sites where shoreline hardening structures interfere with existing recreational and waterline activities.
- Minimize grading of and damage to coastal dunes.

The Proposed Action does not involve construction of shoreline hardening structures nor will it affect coastal dunes.

Marine and Coastal Resources

Objective: Promote the protection, use, and development of marine and coastal resources to assure their sustainability.

Relevant policies:

- Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial.
- Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency.
- Assert and articulate the interests of the State as a partner with federal agencies in the sound management of ocean resources within the United States exclusive economic zone.
- Promote research, study, and understanding of ocean and coastal processes, impacts of climate changes and sea level rise, marine life, and other ocean resources to acquire and inventory information necessary to understand how coastal development activities relate to and impact ocean and coastal resources.
- Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.

All work in the marine environment will be carefully monitored with stringent BMPs in place. In the long term, the Proposed Action will have a positive effect on marine and coastal resources by replacing outdated asbestos-containing transit water intake pipes with new HDPE pipes that are durable and environmentally friendly.

4.3.4.2 SMA Procedural Guidelines

Pursuant to ROH §25-1.3, the definition of "Development" includes "construction, reconstruction, demolition or alteration of the size of any structure" within the SMA. Thus, the installation of eight (8) new pumps, four (4) new media filters, two (2) ultraviolet sterilizers, heat exchanger and chiller, air compressors and diffusers, flow meters, level sensors, and other appurtenances. constitute "development" within the SMA Area. The Proposed Action also includes the future replacement of the EOR which constitutes "development." Any proposed development within the SMA area requiring an SMA permit shall be subject to an assessment.

The Proposed Action has a total valuation of more than $500,000, and meets the criteria for a major SMA Permit An application for an SMA Major Permit will be submitted to the City and County of Honolulu Department of Planning and Permitting (DPP), accompanied by this Final EA.

4.3.5 Shoreline Setback

According to Chapter 23, ROH, "it is a primary policy of the city to protect and preserve the natural shoreline, especially sandy beaches; to protect and preserve public pedestrian access laterally along the shoreline and to the sea; and to protect and preserve open space along the shoreline. It is also a secondary policy of the city to reduce hazards to property from coastal floods." The shoreline setback line is established at 40 feet inland from the certified shoreline.

Project components within the shoreline setback include a new partially below ground NSW and well water pump vault, a new partially below ground aeration tank, the reconstruction and extension of the existing pump building, a new saltwater production well, and related new equipment and piping Therefore, a Shoreline Setback permit will be required. The Proposed Action meets the criteria for granting a shoreline setback variance according to Public Interest Standard pursuant to ROH § 26-1.8(b)(2), which states "A shoreline setback variance may be granted for a structure or activity that is necessary for or ancillary to facilities or improvements by a public agency or public utility regulated under HRS Chapter 269, or necessary for or ancillary to private facilities or improvements that are clearly in the public interest; provided that the proposal is the practicable alternative that best conforms to the purpose of this chapter and the shoreline setback rules.

Figure 4-2 shows a certified shoreline survey for the property.

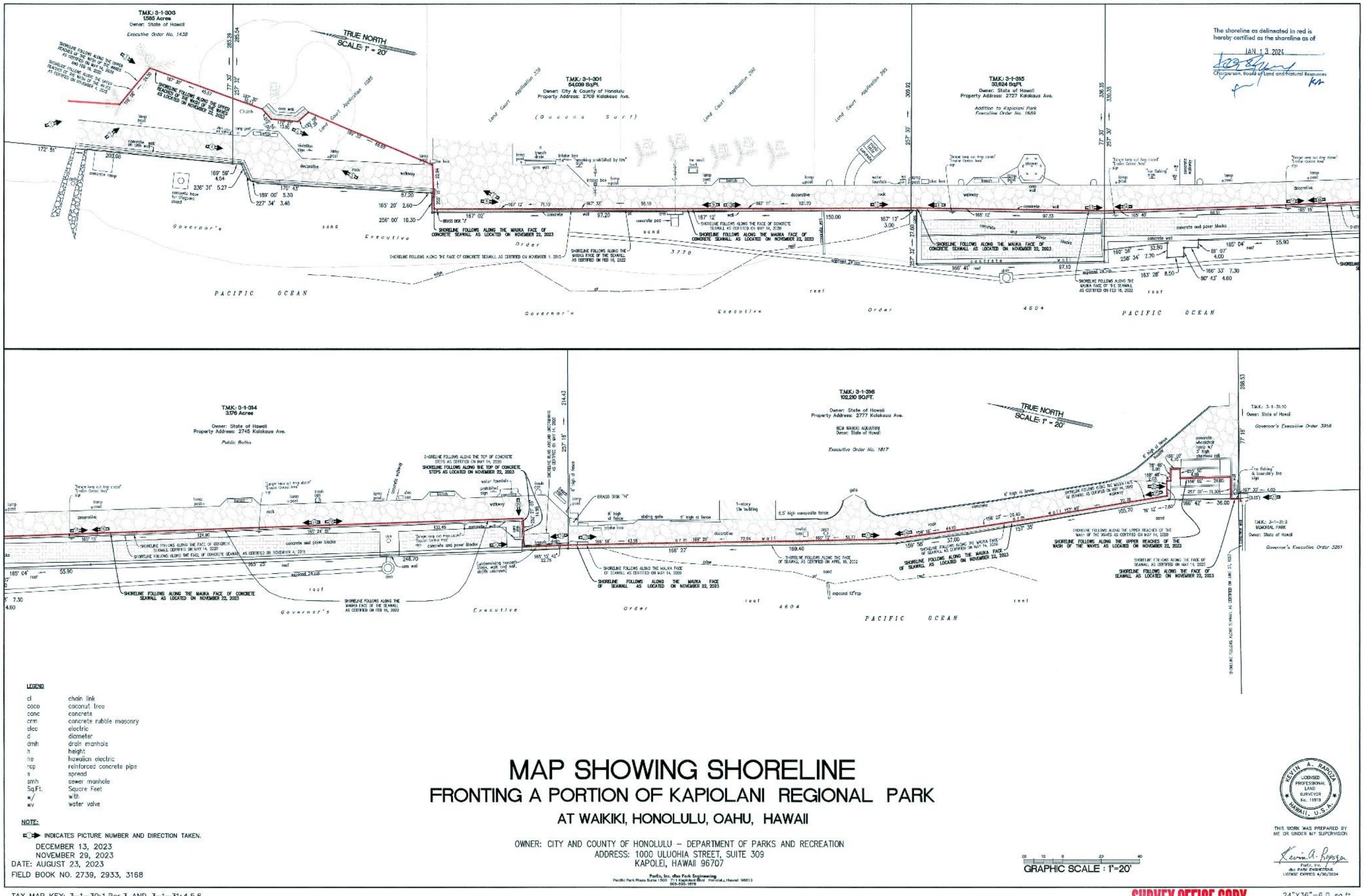

Figure 4-2 Certified Shoreline Map

4.3.6 Diamond Head Special District

WAq lies within the Diamond Head Special District. The objectives of this special district include:

- To preserve existing prominent public views and the natural appearance of Diamond Head by modifying construction projects that would diminish these resources.
- To preserve and enhance the park-like character of the immediate slopes of the Diamond Head monument, which includes Kapiolani Park. (ROH §21-9.40-1)

The project site is located within the core of this special district. Design guidelines relevant to the are related to landscaping and height. An application for a Diamond Head Special District minor permit will be submitted to the CH DPP.

4.3.7 Permits and Approvals

Federal
Section 10, Work in Navigable Waters of the U.S. (USACE)
Section 404, Clean Water Act, for Fill in Waters of the U.S. (USACE)

Other Federal laws may affect the project, including:
Archaeological and Historic Preservation Act (16 United States Code [USC] §469(A) (1))
National Historic Preservation Act (NHPA) of 1966 (Section 106) (16 USC §470(F))
Clean Air Act (42 USC §7506(C))
Clean Water Act (33 USC §1251-1387)
Coastal Zone Management Act (16 USC §1456(C) (1))
Endangered Species Act (16 USC §1536(A) (2) and (4))
EO 13089, Coral Reef Protection (63 FR 32701)
EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds (16 USC §703-711 (66 FR 3853))
Fish and Wildlife Coordination Act (FWCA) of 1934, as amended (16 USC §661-666(C) et seq.)
Magnuson-Stevens Fishery Conservation and Management Act (16 USC §1801 et seq.)
Marine Mammal Protection Act (MMPA) of 1972, as amended (16 USC §1361-1421(H) et seq.)
Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 USC §703-712 et seq.)
Rivers and Harbors Act (33 USC §403)

State of Hawai‘i
Site Plan Approval (DLNR OCCL)
Coastal Zone Management Consistency Determination (State Office of Planning and Sustainable Development)
Well Construction/Pump Installation Permit (DLNR CWRM)
NPDES Notice of Intent Form C (DOH CWB)
Section 401 Water Quality Certification (DOH CWB)
Community Noise Control Permit (DOH Indoor and Radiological Health Branch)
Archaeological Monitoring Plan (DLNR SHPD)

Land Disposition / Right of Entry (DLNR DOBOR)

City and County of Honolulu
Special Management Area Major Permit (CCH DPP)
Shoreline Setback (CCH DPP)
Diamond Head Special Design District Review (CCH DPP)
Site Engineering (Trenching/Stockpile/Grading/Grubbing) Permits (CCH DPP)
Building Permit (CCH DPP)
Right of Entry

5. CONSULTATION

5.1 Pre-Consultation Requests and Comments

Forty-four requests for pre-consultation comments were sent regarding the Draft EA. Twenty-one responses were received. Table 5-1 lists agencies, organizations, and individuals to whom pre-consultation requests were sent, and indicates who submitted comments. Appendix H contains pre-consultation comments and responses.

Table 5-1: List of Consultation Agencies, Organizations and Individuals and Comments Received

Agency / Organization / Individual Included in Pre-Consultation	Submitted Pre-Consultation Comments	Submitted Comments on the DEA
Federal		
U.S. Department of the Interior Fish and Wildlife Service Pacific Islands Office		
U.S. Department of Commerce National Marine Fisheries Services Pacific Islands Regional Office	X (2)	X
U.S. Army Corps of Engineers Honolulu District, Regulatory Office	X	
U.S. Environmental Protection Agency Pacific Southwest, Region 9		
State of Hawai‘i		
Department of Accounting and General Services Office of the Comptroller	X	
Department of Business, and Economic Development and Tourism		
Office of Planning and Sustainable Development Coastal Zone Management Program	X	X
Department of Health Environmental Management Division Clean Water Branch	X	
Department of Health Environmental Management Division Safe Drinking Water Branch		

Agency / Organization / Individual Included in Pre-Consultation	Submitted Pre-Consultation Comments	Submitted Comments on the DEA
Department of Health Environmental Health Administration		
Department of Health Indoor and Radiological Health Branch	X	
Department of Land & Natural Resources Commission on Water Resources Management		X
Department of Land & Natural Resources State Historic Preservation District		
Department of Land & Natural Resources Division of Aquatic Resources	X	
Department of Land & Natural Resources Engineering Division		X
Department of Land & Natural Resources Office of Conservation & Coastal Lands	X	X
Department of Land & Natural Resources Land Division	X	X
Department of Land & Natural Resources Division of Forestry and Wildlife	X	
Department of Transportation		
Office of Hawaiian Affairs		
Department of Agriculture Office of the Chairperson		
City and County of Honolulu		
Board of Water Supply Project Review Section	X	
Emergency Services Department.		
Department of Environmental Services		
Department of Facility Maintenance		
Department of Planning and Permitting	X	X
Department of Parks and Recreation		
Department of Transportation Services		
Honolulu Fire Department	X	

Agency / Organization / Individual Included in Pre-Consultation	Submitted Pre-Consultation Comments	Submitted Comments on the DEA
Honolulu Police Department Division 6 Administrative Office	X	
Diamond Head / Kapahulu / St. Louis Heights Neighborhood Board No. 5	X	
Elected Officials		
U.S. Representative Ed Case		
U.S. Senator Brian Schatz		
U.S. Senator Mazie Hirono		
State Representative Bertrand Kobayashi		
State Senator Stanley Chang		
Councilmember Tommy Waters	X	
Organizations and Individuals		
ʻĀina Momona	X *Responded to initial CIA request but no follow up*	X
Friends of Waikīkī Aquarium		
Kaimana Beach Coalition		
Friends of the Natatorium		
Ka Mokuʻaina ʻO Hawaiʻi Ala Moku O PaeʻAina		X
Kapiʻolani Park Preservation Society		
The Nature Conservancy in Hawaiʻi		
Sierra Club of Hawaiʻi Oʻahu Group		
Surfrider Foundation, Oʻahu Chapter		
Waikīkī Beach Special Improvement District Association		

5.2 Presentation to the Diamond Head/Kapahulu /St. Louis Heights Neighborhood Board No. 5

On August 10, 2023, a presentation on the Proposed Action was made to the Diamond Head / Kapahulu / St. Louis Heights Neighborhood Board No. 5. Questions were related to the effects of construction in this area, including the presence of construction equipment and impacts related to noise and access. In addition, there was a comment of appreciation for the project teamwork and reputation.

6. REASONS SUPPORTING FINDING OF NO SIGNIFICANT IMPACT (FONSI)

6.1 Finding of No Significant Impact

In accordance with the provisions set forth in Chapter 343, HRS, the proposed action was evaluated based on criteria established in HAR §11-200.1-11.2. Based on the analysis discussed hereafter in Section 6.2, the proposed project has been determined to qualify for a Finding of No Significant Impact (FONSI)

6.2 Analysis Supporting FONSI Decision

HAR §11-200.1 establishes procedures for determining if an EIS should be prepared or if a FONSI is warranted and lists the following criteria to be used in making that determination. In most instances, an action shall be determined to have a significant effect on the environment if it:

1) *Involves an irrevocable commitment to loss or destruction of any natural or cultural resource*

   The Proposed Action would not cause the loss or destruction of natural, historic, or cultural resource. Archeological monitoring will be conducted during all dredging and ground disturbing activities. Although unlikely, if human osteological remains or any potential culturally significant features are accidentally unearthed during dredging, site work would cease and SHPD would be contacted in compliance with HRS Chapter 6E. Processes outlined in existing State regulations, specifically HAR Title 13, Chapter 300 (Section 33 and Section 40), would be employed following discovery. Construction BMPs will be in place to monitor and avoid impacts on natural resources.

2) *Curtails the range of beneficial uses of the environment*

   The Proposed Action will replace existing obsolete in-water transite intake pipes with new high-density polyethylene (HDPE) pipes. The Proposed Action will provide the Aquarium with a more reliable system in the future and reduce the need for future infrastructure upgrades. Further, the Proposed Action will provide the WAq exhibits with higher quality water supply and with added redundancy and backup to allow for maintenance and servicing of equipment with minimum disruptions to operations. It will not curtail the range of beneficial uses of the environment.

3) *Conflicts with the State's long-term environmental policies or goals as expressed in Chapter 344, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders*

   The Proposed Action conforms with and is consistent with HRS Chapter 344, State Environmental Policy, to conserve the natural resources and enhance the quality of life. Construction activities proposed under the Proposed Action are not expected to have adverse impacts to the surrounding natural resources and would be planned to minimize any short-term impacts. Long term project impacts will have a beneficial effect on the ocean environment.

4) *Substantially adversely affects the economic or social welfare of the community or State*

No significant impacts on the economic or social welfare of the community or the State are anticipated under the Proposed Action. Rather, the Proposed Action would generate short-term economic vitality for the community by providing temporary construction job opportunities for the duration of project construction. In the long-term time frame, the Proposed Action would help ensure that WAq can continue its public uses and remain economically viable.

5) *Substantially adversely affects public health*

The Proposed Action would have no significant adverse effects on public health.

6) *Involves substantial secondary impacts, such as population changes or effects on public facilities*

The Proposed Action will not induce secondary impacts or negatively impact public facilities.

7) *Involves a substantial degradation of environmental quality*

The Proposed Action is intended to improve environmental quality in the nearshore ocean with the replacement of obsolete supply water transite intake pipes with new high-density polyethylene (HDPE) pipes. The Proposed Action will provide the Aquarium with a more reliable water intake system in the future and reduce the need for future infrastructure upgrades. Further, the Proposed Action will provide the WAq exhibits with higher quality water supply and, with added redundancy and backup, allow for maintenance and servicing of equipment with minimum disruptions to operations. It will not curtail the range of beneficial uses of the environment.

8) *Is individually limited but cumulatively has considerable effect on the environment or involves a commitment for larger actions*

The Proposed Action is not anticipated to result in cumulative effects; therefore, it would not involve a commitment to larger actions.

9) *Substantially adversely affects rare, threatened, or endangered species, or its habitat*

The Proposed Action is not anticipated to have substantial effects on rare, threatened, or endangered species, or any critical habitat. No threatened or endangered plant or animal or marine species nor candidate species were found during the flora, fauna, and marine survey of the project site. Regarding the possibility of proximity to critical habitat, construction BMPs and coordination with public agencies will minimize the possibility of potential impacts to the biological resources within the project site during the construction period.

10) *Substantially adversely affect air or water quality or ambient noise levels*

No significant impacts on the area's long-term air or water quality or ambient noise levels are anticipated to result from the Proposed Action. BMPs will be implemented to minimize temporary impacts during construction activities. Dust abatement measures will be used to reduce potential impact to air quality. In addition, construction noise that exceeds DOH guidelines will be mitigated to reduce the potential of noise levels exceedances.

11) *Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters*

The Proposed Action would not affect environmentally sensitive areas, such as a floodplain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, or fresh water. Every effort will be made through stringent BMPs and agency coordination to prevent damage to coastal waters and benthic habitats. The new HDPE pipes will reduce the likelihood of future intake malfunction and infrastructure damage in this environmentally sensitive area.

12) *Substantially affects scenic vistas and view planes identified in county or state plans or studies*

The Proposed Action would not adversely affect the visual aesthetics of the areas identified in City and County or State plans and studies. The new treatment building will be designed and constructed to comply with the Diamond Head Special District guidelines and in-water infrastructure will not generate visual impacts. Temporary construction-related visual impacts are expected; however, all visual disturbances will be restored to pre-construction condition at the end of the construction phase.

13) *Requires substantial energy consumption*

The Proposed Action will not require substantial energy consumption. The electrical system to serve additional electrical loads required for the water system upgrades is designed for efficient use and distribution.

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Appendix A:

Waikīkī Aquarium Upgrades Basis of Design Report

Basis of Design Report

WAIKIKI AQUARIUM UPGRADES

Supply Water Intake System Upgrade

2777 Kalākaua Avenue

Honolulu, Hawaiʻi, 96815

TMK: (1) 3-1-031:006

Prepared for:

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October 2023

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ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

%	Percent
§	Section
°	Degree(s)
amps	Amperes
AOC	Administrative Order of Consent
ATS	Automatic Transfer Switches
Aquarium	Waikīkī Aquarium
bgs	Below Ground Surface
BMP	Best Management Practice
BOD	Basis of Design
BS	Beaches
CCH	City and County of Honolulu
DOH	State of Hawaiʻi Department of Health
ENV	Department of Environmental Services
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
ft	Foot/Feet
GPD	Gallons per Day
GPM	Gallons per Minute
HECO	Hawaiian Electric Company
ID	Identification
IWDP	Industrial Wastewater Discharge Permit
JaC	Jaucas
kW	Kilowatt
kVA	Kilo Volt-Ampere
m	Meter(s)
mg/L	Milligrams per Liter
mJ/cm^2	Millijoules per Square Centimeter
MLCD	Marine Life Conservation District
NEC	National Electrical Code
No.	Number
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NSW	Natural Seawater
O&M	Operation and Maintenance
SLR	Sea Level Rise
SLR-XA	Sea Level Rise Exposure Area
TMK	Tax Map Key
TSS	Total Suspended Solids
UH	University of Hawaiʻi
UIC	Underground Injection Control
U.S.	United States
UV	Ultraviolet
VFD	Variable Frequency Drive
ZOM	Zone of Mixing

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EXECUTIVE SUMMARY

The Waikīkī Aquarium (Aquarium) is located at the southern end of the world-famous Waikīkī Beach and welcomes more than 250,000 visitors annually. The Aquarium was established in 1904 and moved to its present location in 1955, making it the second oldest aquarium in the United States. Much of the Aquarium's aging water system infrastructure was designed prior to modern Federal Clean Water Act regulations and does not meet current regulatory requirements, which has resulted in Federal, State and City regulatory citations relating to water quality issues associated with disposal of Aquarium effluent either into the ocean or sewer system.

Planned upgrades to the effluent discharge system exposed other inadequacies of the existing Aquarium intake, filtration and distribution systems. The purpose of this Supply Water Intake System Upgrade project is to repair/modify the outdated and failing saltwater supply systems consisting of two offshore intake pipes and an onsite well and the treatment and filtering systems that supply waters to the Aquarium exhibits and research areas. The project also includes repairs to the degraded and partially damaged seawall that protects both the Aquarium and an existing public walkway (i.e., promenade) along the shoreline. This Basis of Design report outlines the investigations, technical, environmental and regulatory evaluations, and design details for the water intake, treatment and distribution systems and repairs to the damaged seawall.

The Aquarium utilizes three intake water sources: natural seawater (NSW) from Mālama Bay, well water from an onsite 80-foot deep saltwater well, and freshwater from the City and County of Honolulu Board of Water Supply (BWS) water system. NSW and well water sources have a theoretical combined capacity of over 1.44 million gallons per day. NSW is obtained through two existing 8-inch diameter intake pipes, originally constructed in 1955 with improvements in 1992, extending approximately 160 feet from the shoreline. Approximately half of the total water currently utilized by the Aquarium comes from the ocean and the balance is supplied by the onsite saltwater well, with less than one percent sourced from the BWS water system. NSW and well saltwater require treatments (e.g., filtration, aeration) prior to use in exhibits. Design concepts to upgrade the Aquarium's water intake system and shoreline infrastructure were developed to meet two key design goals:

1) Upgrade the existing saltwater supply and distribution systems by replacing the existing intake systems and associated treatment infrastructure; and
2) Maintain public safety and access along the Waikīkī promenade fronting the seawall.

The system infrastructure to be addressed for this project include the NSW intake and treatment system, the saltwater well intake and treatment system, and the promenade and fronting seawall. Design alternatives evaluated to improve infrastructure components included "No Action," repairs and rehabilitation of working components, and replacement of non-repairable components. Based on evaluation efforts, the preferred remedial action is replacement of the NSW system, replacement of the saltwater well system, and repair of the seawall.

To meet design goals and address the deteriorated condition of the Aquarium's aged water system, water system infrastructure will be replaced with supply water from both the ocean and the well. NSW from the ocean intake will be filtered and a portion will be routed to the Hawaiian Monk Seal exhibit. Balance seawater will be disinfected with ultraviolet (UV) light and chilled prior to being routed to the rest of the exhibits. Saltwater from the well water intake will be pre-treated through aeration, sedimentation, and filtration prior to being routed to the exhibits. Scope of work for this "Proposed Action" includes the following:

1. **Natural Seawater System:**
    - 1.1. Replace two existing NSW pumps/motors, piping and appurtenances, and reconfigure piping and pump vault;
    - 1.2. Replace two existing 8-inch transite offshore intake pipes with new 8-inch high-density polyethylene (HDPE) pipes and intake screen sections; and
    - 1.3. Remove existing pleated bag filters and install new NSW treatment components, to include media filters, UV sterilizers, heat exchanger and chiller, for filtration, disease organism and temperature control. Target flow for NSW new treatment components is 340 GPM through media filters and 75 GPM through UV sterilizers, heat exchanger and chiller.
2. **Saltwater Well System:**
    - 2.1. Reconfigure well water distribution plumbing;
    - 2.2. Replace existing well water pump house;
    - 2.3. Install new 275 GPM well water treatment components for aeration, metals precipitation and filtration; and
    - 2.4. Install new saltwater well (optional).
3. **Seawall Repairs:**
    - 3.1. Repair approximately 12 linear feet of seawall cavity, to match pre-existing structure footprint;
    - 3.2. Repoint a total of approximately 92 linear feet of seawall façade; and
    - 3.3. Other miscellaneous seawall repairs as called for by structural engineering reports and/or evaluations.

The Aquarium is intending to repair a large seawall cavity, roughly 12 feet long by 5 feet tall, that extends underneath the adjacent public walkway fronting the Waikīkī Aquarium. The seawall both protects the Aquarium grounds and supports the public walkway along the shoreline. The walkway has been cordoned off from public access since the discovery of the large void. An assessment of the condition of the seawall and an investigation into the cause of the seawall damage is underway. Repairs are necessary to prevent the seawall's collapse, protect public safety and property from natural hazards (e.g., erosion, flooding), prevent sediment from being washed out and suspended in nearshore waters, and restore safe connection to the shoreline next to the Aquarium for visitors and residents alike.

1. INTRODUCTION

1.1 Background

The Waikīkī Aquarium (Aquarium), located at the southern end of the world-famous Waikīkī Beach, welcomes more than 250,000 visitors annually. Each year, the Aquarium delivers rich educational experiences to over 30,000 local children under 12 years old and to over 20,000 seniors over 65 years old. The Aquarium is an important educational outreach facility with an international reputation for its display quality and was the first aquarium in the world to successfully cultivate and display a number of marine organisms in captivity. The Aquarium presently displays fish and invertebrates in publicly viewable tanks, has outdoor pool displays, one of which is home to an endangered Hawaiian Monk Seal, and offers research opportunities to University of Hawaiʻi (UH) students and faculty. In addition, various outdoor events (e.g., summers concerts) are held in its lawn. Although the Aquarium has been in nearly constant operation since it moved to its current location in 1955, no significant improvements have been made to the supply water intake system in the last 30 years.

1.2 Purpose

The facility presently takes fresh potable water from the City and County of Honolulu (CCH), ocean water from Mālama Bay and saltwater from an onsite well, and uses all three types of water for display and research tanks. During the recent engineering process of designing the new discharge effluent system, it became obvious that the present seawall protecting the Aquarium and the seawater intake and treatment systems are out-of-date with a potential for failure. The UH contracted Oceanit to develop an improved water system infrastructure design for exhibit operations at the Aquarium and to provide an optimized water intake system process that will allow for continued operation of the Aquarium facility. This Basis of Design report outlines the investigations, technical, environmental and regulatory evaluations, and design details for the water intake, treatment and distribution systems and repairs to the damaged seawall.

1.3 Site Description

The Aquarium is located in the heart of Honolulu on the south shore of the island of Oʻahu next to the War Memorial Natatorium and Kaimana Beach Park (Figure 1-1). The Aquarium abuts the shoreline seawall on its west edge and extends east up to Kalākaua Avenue. A Marine Life Conservation District (MLCD) lies just offshore of the Aquarium. Renown Waikīkī beaches and recreational areas, such as Kapiʻolani and Kaimana Beach Parks, surround the facility.

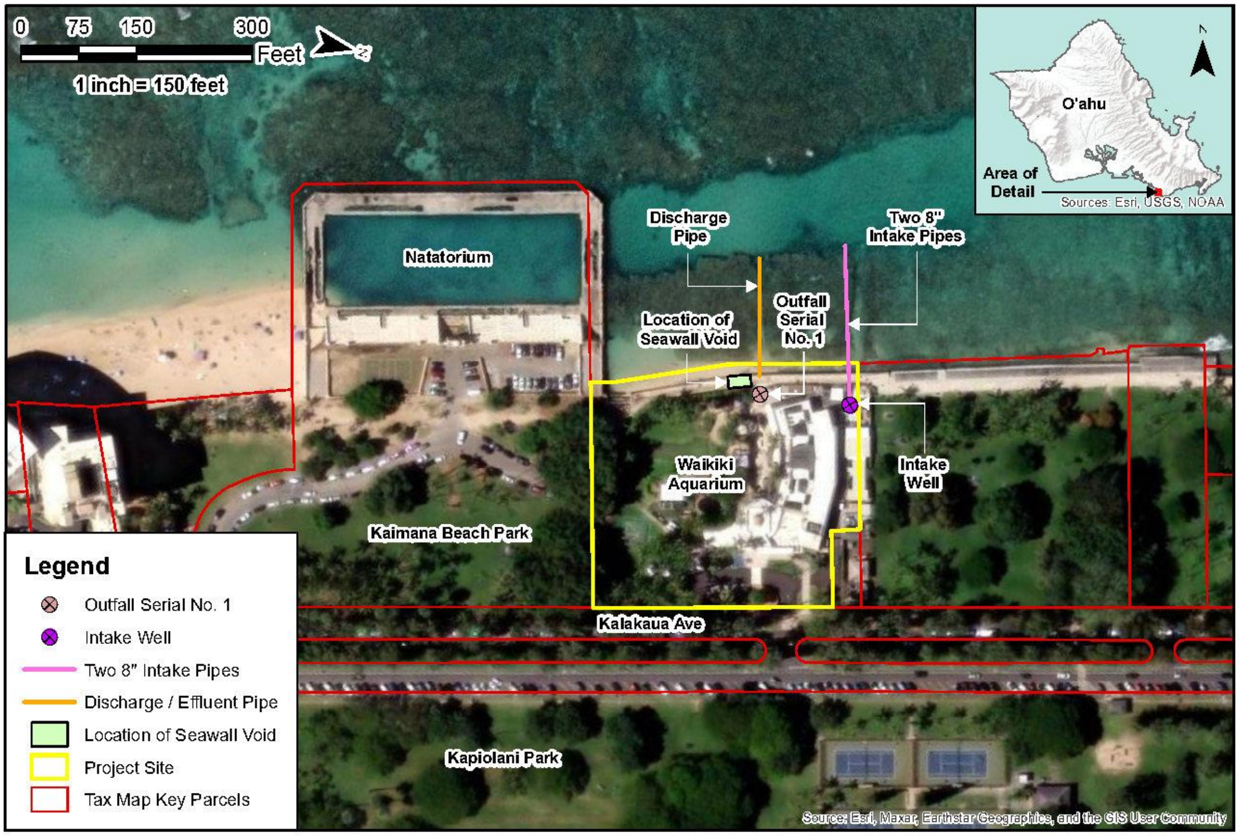

Figure 1-1: Project Site Map

The Aquarium was established in 1904 and is the second oldest aquarium in the United States (U.S.). It has been a part of the UH since 1919 and moved to its present location in 1955. Since its establishment, it has been an important landmark, resident and visitor destination at the southern end of Waikīkī Beach. The area is a highly trafficked area in Waikīkī and is heavily used for recreation, education, tourism, and commerce.

2. CURRENT OPERATIONS

2.1 Existing Exhibits and Operation

The Aquarium houses both native and non-native saltwater animals and some freshwater species in approximately 60 public exhibits and behind-the-scenes holding tanks that are in operation at any given time. Tank systems are segregated depending upon the types of animals on display. The largest display is a 70,000-gallon seawater pool, designed to house endangered Hawaiian Monk Seals. "Native Tanks" include those that house Native Hawaiian saltwater species and solitary non-breeding, non-native animals. "Non-Native Tanks" include those that house non-native animals or native animals which require any live non-native feed. Hawaiian freshwater animals are housed separately.

Roughly half of the water for Aquarium operations is drawn from a nearshore ocean intake and the balance from a saltwater well located near the shore within the Aquarium premises. Freshwater from the City's potable water supply accounts for less than one percent of the water requirement for exhibits. A functional supply water intake system is critical to the operation of the life support systems for the animals at the Aquarium. If any of the three intake water sources is to fail, the health and wellbeing of the animals that depend on it will be endangered.

Effluent water from native exhibits is currently discharged through a nearshore outfall under a National Pollutant Discharge Elimination System (NPDES) permit issued by the State Department of Health (DOH), while effluent from non-native exhibits is currently discharged into the CCH sanitary sewer system. Discharge system upgrades intended to eliminate the discharge of wastewater generated by Aquarium exhibits into the ocean and the CCH wastewater system are underway, with construction anticipated to begin in late 2023 or 2024. Scope of work for that upcoming project includes the installation of a wastewater discharge/transfer sump and pumps, two onsite injection wells and associated appurtenances and equipment for disposal of Aquarium exhibit effluent and upgrading the plumbing systems within the main building and the property. Three pumps connected to the discharge/transfer sump will pump the wastewater from the sump to a filter house structure on the south side of the property for filtration (i.e., post-treatment) prior to discharge into the injection wells.

2.2 Water Intake Sources and Treatment

The Aquarium utilizes three intake water sources to meet its current water demand of about 470,000 gallons per day (GPD) (approximately 325 GPM).

Natural seawater (NSW) is the largest volume of daily water usage for the facility. An average of 247,000 GPD of NSW is pumped into the facility at about 170 GPM. Natural seawater is obtained through two parallel 8-inch diameter transite pipes that extend approximately 160 feet (ft) from the shoreline to the edge of the nearshore reef. Natural seawater is filtered by ten bag filter canisters in series, each comprised of 3-layer filter bags, that progressively remove particulates 50, 10, and down to one micron in size. This filtration system is inefficient and expensive to maintain, according to Aquarium staff. The majority of this flow is used to supply the Monk Seal exhibit.

Saltwater from an 80-ft deep onsite well provides an average of approximately 225,000 GPD (115 GPM) to the Aquarium. Well saltwater has very low initial turbidity and total suspended solids (TSS), is considered free of parasites and pathogens, but carries significant nitrogen and phosphorous concentrations. The well water is anoxic and is aerated using two water pumps to raise the oxygen and degas the carbon dioxide before distribution to the indoor and outdoor aquatic exhibits and holding tanks. However, aeration of the water both raises its pH and results in the precipitation of black metal oxides. Prior to entering each individual exhibit, the aerated well water undergoes phos-ban filtration to remove phosphates, silicates, and the oxide precipitate. See Section 2.5 for more information regarding the well.

Freshwater from the CCH Board of Water Supply's potable water supply comprises the smallest facility water intake (less than one percent) at less than 2,000 GPD. Carbon filtration is used to remove chlorine immediately before introducing the water into the exhibits. The Aquarium has four freshwater exhibits and up to ten freshwater holding tanks.

2.3 Offshore Marine Environment

The present existing ocean discharge point, located about 150 ft offshore, occurs near the east end of the Waikīkī Beach immediately north of the historical War Memorial Natatorium (Figure 1-1). By the time the new intake water system is installed, the present ocean discharge system will have been replaced by the deep injection well discharge system. Because the injected discharge at the bottom (126 to 226 ft below mean sea level) of the well is expected to be of equal or greater density to surrounding groundwater, there should be no tendency for the effluent plume to rise. The effluent plume is expected to disperse and percolate through natural sediments until it reaches the seafloor well beyond the active reef crest area.

The active reef crest is located a little more than 1,000 ft offshore of the Aquarium. The reef flat between the shore and the reef crest averages 4 to 6 ft deep and, typical of reef channel areas off of Waikīkī, has limited live coral cover. A deeper (approximately 10 ft) area was dredged through the shallower reef flat, roughly 150 to 250 ft offshore, during the construction of the adjacent Natatorium in the 1920s. The reef flat throughout the MLCD consists mostly of rubble and coralline algae with some small patches of live coral. Surveys of the reef flat just north of the Aquarium show a coral coverage of zero to one percent (Franklin et. al., 2013). At the outer edge of the reef, coral cover and species diversity increases and the depth increases to about 15 to 20 ft. Numerous arches, crevices and other features are found here, along with an abundance of fish.

In the 1920s, coincident with the construction of the War Memorial Natatorium, a deep channel was dredged through the reef flat roughly 125 ft wide and 700 ft long parallel to and about 150 ft off the present seawall shoreline. In its present condition, the channel is about 8 to 10 ft deep with a sand bottom substrate. Both the water intake and effluent pipes of the Aquarium extend from the shoreline to the edge of this channel. The vertical edges of the channel provide habitat for small fish and a few small corals. Currents in the area are weak and mainly driven by winds and tides.

Survey information of the seafloor along the existing NSW intake pipes was collected by Oceanit personnel on June 6, 2023 and July 26, 2023. A depth profile along the intake pipes is shown in Figure 2-1.

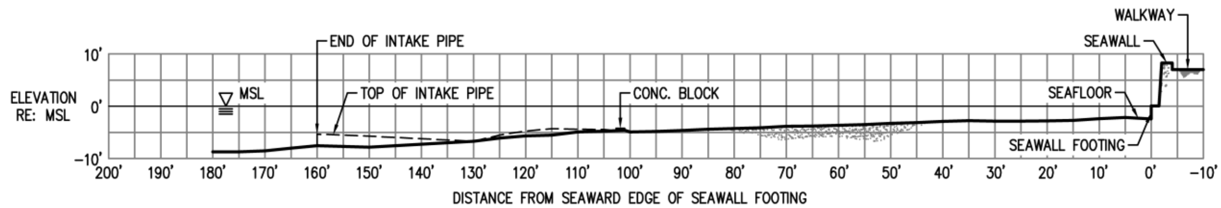

Figure 2-1: Existing Profile Along NSW Intake Pipes

On July 26, July 28, August 25 and September 27, 2023, Oceanit personnel performed marine environmental surveys of the nearshore benthic habitat and fish assemblages at the Waikiki Aquarium. The surveys were conducted to describe the area surrounding the Aquarium's existing natural seawater intake pipes as well as a large cavity in the seawall in support of the Supply Water Intake System Upgrade project. See Attachment B for a summary of findings.

2.4 Geotechnical Environment

The project site is underlain by beach deposits and alluvium (USGS, 2007) and Jaucas (JaC) sand and Beaches (BS) soils (NRCS, 2022). Beaches soils are light-colored calcium carbonate sands derived from coral and seashells that are washed by ocean waves. Jaucas soils are similar but light brown, excessively drained, calcareous soils deposited from wind and water that occur adjacent to the ocean. Formerly, the Waikīkī area consisted of low elevation marsh wetlands and lagoons. These lands were filled with material dredged from the Ala Wai Canal in the 1920s and then developed into the Waikīkī we know today (Kokua, 2021).

Four subsurface boring cores were taken from the project site during a geotechnical engineering exploration to observe and evaluate subsurface conditions. Bore hole depth ranged between approximately 3 to 42 ft below existing ground surface (bgs). The borings encountered surface fill materials overlying beach deposits, lagoonal deposits, and apparent coral. The surface materials were 1 to 3 ft thick and were loose to medium dense clayey/silty sand and medium stiff to stiff clayey/sandy silt. Beach deposits occurred at approximately 8 to 10 ft bgs and consisted of loose to medium dense clayey gravel and very soft sandy clay. Lagoonal deposits found beneath the beach deposits extended down to 40.5 ft bgs and consisted of very loose to medium dense clayey gravel and very soft sandy clay. Lagoonal deposits are known to be highly compressible. Beneath the lagoonal deposits, medium hard to hard coral formation extended down to the maximum depth tested (approximately 42 ft bgs).

The topography of the project site is relatively flat. Ground surface elevations range from +6 to +9 ft relative to mean sea level (MSL). Groundwater was encountered about 7.3 to 8.1 ft bgs during the field exploration; however, due to the close proximity of the site to the Pacific Ocean, groundwater depth is expected to vary with tidal fluctuations (Kokua, 2021).

2.5 Hydrogeological Environment

The Aquarium is located on the sedimentary Honolulu Caprock formation, which forms a coastal plain along the Waikīkī Coast in the Pālolo Aquifer System. The caprock is over 900 ft thick and comprised of marine and terrestrial sediments, some lava flows, and pyroclastic deposits. Koʻolau Basalt lies below the caprock. Hydraulic properties of these sedimentary formations can vary extensively; however, marine deposits (mainly calcareous) are generally more permeable than terrestrial deposits.

A hydrogeological evaluation of the area adjacent to the Aquarium was conducted by a professional geologist to investigate the possibility of using injection wells for the effluent discharges (INTERA, 2021). The Aquarium has an existing 80-ft deep saltwater production well (State Well No. 3-1649-010) that was constructed in 1954 (Section 2.2). The well has 46 ft of 12-inch solid casing. According to the Commission on Water Resource Management well index, the database on wells in Hawaiʻi, the saltwater well was tested at 1,150 GPM with 2.7 ft of drawdown and has a high specific capacity. Although, the database does not indicate when the well was tested, it was most likely tested in around 1954 after its initial construction. Although the saltwater well has not been tested in recent years, it is anticipated that the well performance has decreased over the years from natural aging processes.

2.6 Electrical System

The existing Aquarium electrical system was inspected by a professional electrical engineer, Kraig Otani & Associates, LLC, in March 2020 (Kraig Otani & Associates, LLC, 2020).

Electricity to the facility is provided by underground Hawaiian Electric Company (HECO) service cable originating from a handhole off the sidewalk fronting the Aquarium and routed to a HECO transformer within the Aquarium. Power is routed through a metering switchboard to two distribution panels in the electrical room that feed a network of panel boards to provide all power to the Aquarium.

Per the National Electrical Code (NEC), Section 220.87, 125 percent (%) of the maximum demand over a 12-month period needs to be added to determine if new load can be added to the existing electrical service, which brings the current electrical load to 279.0 kilo volt-Ampere (kVA). The Aquarium's maximum electrical demand load is approximately 223 kVA. The main HECO circuit breaker is rated at 500 kVA, leaving about 221.0 kVA of additional capacity off of the HECO transformer for upgrades.

Adjacent and to the north of the electrical room, an emergency 400 kilowatt (kW) generator is housed in a stainless-steel weatherproof housing. Diesel fuel for the generator is stored in a base tank underneath the generator. Two automatic transfer switches (ATS) within the electrical room allow the Aquarium to automatically draw power from HECO power source or from the emergency generator if the HECO power source becomes unavailable. The emergency generator has the capacity to provide all power to the Aquarium. The existing generator and its fuel tank were originally sized to run at full load for roughly 24 hours. The existing facility load, according to HECO, is running at around 50% of the generator load capacity.

Based on conversation with Aquarium staff, not all power needs are being met, specifically in the seal pool filter room and areas south of the main building. It is suspected that the problems are due to the long runs from the distribution panels in the Electrical Room and undersized electrical wiring/conductors. To address the problems and power needs throughout the Aquarium, the electrical wiring/conductors may need to be upsized to handle the loads at facilities/systems further away from the distribution panels. As part of the upcoming Discharge System Upgrade project, an entirely new run of conductors is routed to the seal pool filter room to mitigate the issues.

2.7 Mechanical System

The existing mechanical system was inspected by a professional engineer on March 6, 2020 (Okahara and Associates, Inc., 2020). Observations and assessments of existing mechanical systems are summarized below:

- The **main electrical room** on the northeast (NE) corner of the property is mechanically cooled by a wall-mounted propeller exhaust fan. The fan is thermostatically controlled. The fan currently is too close to the front of the switchboard and is not code compliant. Any future electrical upgrades would need to address this issue.
- **Coral propagation tanks** are located on the north (N) and northwest (NW) ends of the property, directly on top of the freshwater reservoir. All piping and piping appurtenances are plastic. An outdoor backwash pump (end-suction, 25 horsepower, Fybroc pump) sends water from the freshwater reservoir to the shark tank sand filters.
- **The natural seawater pump house** is located below grade in the NW corner of the property. The pump house contains two end-suction type, 25 horsepower Fybroc pumps which send water to a series of ten canister bag filters via two 6-inch pipes. The pump house is ventilated by a roof-mounted exhaust fan.
- **Aeration pumps** are located in the NW corner of the property, just north of the natural seawater pump house.
- The **well water pump house** is located on the west end of the property and houses two pumps, a well water sump, and three sand filters. The pumps draw water from the well water sump and distribute it throughout the Aquarium. The well water sump receives water from the deep saltwater well via gravity. Sand filters were intended to filter incoming NSW but are not currently in use. The condition of the gravity pipe that connects the well water sump and saltwater well is unknown and may be restricting the water supply from the saltwater well. Record drawings indicate the pipe connecting the well water sump and saltwater well to be 12-inches in diameter. Recently, the Aquarium staff removed a 2-inch pipe from inside the full length of the gravity pipe.
- The **canister bag filter array** is outdoors on the west end of the property, just east of the well water pump house. Ten filter bags are connected in series to filter the natural seawater. All NSW goes through the array before getting distributed throughout the Aquarium. This system is maintenance-intensive and requires frequent filter changes.

- The **Seal Pool pump room** is located just south of the seal pool and lies below grade. The pump house contains two circulation pumps, three sand filters, and an aeration pump. The Monk Seal pool is currently running without a backup pump or redundancy safeguards. New upgrades should incorporate pump redundancy in case a pump breaks or needs to be serviced.
- **Shark tank pumps** are installed in the main Aquarium building behind the shark tanks. Two 15 horsepower and one 3 horsepower pumps are equipped with sand filters that are cleared by the backwash pump. The shark tank is currently running without a backup pump, eliminating the redundancy safeguard. New upgrades should incorporate pump redundancy in case a pump breaks or needs to be serviced.

2.8 Limitations and Deficiencies

Numerous limitations and deficiencies of the existing systems were identified by Aquarium staff and from field investigations. Limitations and deficiencies are described below.

1) Intake flow rates for the NSW are at or near capacity due to intake pump failures and lack of adequate treatment systems. The two intake pipes installed in the 1950s are well beyond their standard 50-year engineering life, although a limited visual external inspection of these pipes showed no obvious damage to unburied pipe sections. In their present use, both pipes appear to be used simultaneously. Standard practice is to only use one pipe at a time to prevent organisms from growing inside and clogging the pipeline. Water intake should be upgraded and addressed with future upgrades.
2) Intake from the onsite saltwater well is limited by the size of existing pipes and pumps. Any saltwater that comes through an onsite well must be aerated, degassed, and go through phosphorous and dissolved metal flocculation and filtration before use.
3) To assure water quality, the two intake water sources (well and NSW) each requires its own filtration methods. This increases complexity and the operation and maintenance (O&M) required to maintain the two intake water sources and associated filtration methods.
4) Old and outdated infrastructure comprising the majority of existing Aquarium systems has potential for failure and should be upgraded.
5) There is limited square footage at the Aquarium to accommodate changes. Sizes and locations of new equipment and facilities need to be carefully considered and planned to avoid conflicting with existing above- and below-ground infrastructure.
6) Existing underground utilities will pose potential conflicts with new lines or piping. Rerouting or relocating existing utilities may be necessary.
7) Electrical wiring/conductor may be insufficiently sized to accommodate future upgrades, causing power issues. The electrical systems would need to be upgraded.
8) Existing electrical and mechanical infrastructure currently not set up to accommodate exhibit upgrades or expansion, would need to be upgraded.

9) Leaks from the existing outdoor "Edge of the Reef" exhibit may have contributed to erosion and partial collapse of the seawall beneath the public sidewalk adjacent to this exhibit.

2.9 Other Assumptions

Other assumptions of the existing systems at the Aquarium considered for this BOD included:

1) All existing infrastructure components are currently at capacity;
2) Most existing infrastructure components are beyond their usable engineering lifetime; and
3) Staff training and turnover will require maximization of controls automation and minimization of O&M components to simplify transitions and trainings.

3. SUPPLY WATER INTAKE SYSTEM UPGRADE

3.1 Design Goals

Design concepts to upgrade the Aquarium's water intake system and shoreline infrastructure were developed to meet two key design goals:

1) Upgrade the existing saltwater supply and distribution systems by replacing the existing intake systems and associated treatment infrastructure; and
2) Maintain public safety and access along the Waikīkī promenade fronting the seawall.

3.1.1 Target Design Flow Rate

The target design flow rate for the upgraded working system is almost 900,000 GPD (approximately 615 GPM), almost double the current water demand of the Aquarium which is about 470,000 GPD. The target flow rate was designed to accommodate potential future improvements, exhibits, and expansions specified by Aquarium management. Based on the existing intake system setup (described in Section 2.2), Oceanit estimated a theoretical maximum flow that the existing intake system could provide by adding the maximum flow rates through the intake system components. NSW and well water sources have the capacity to provide over 1.44 million GPD (approximately 1,000 GPM) combined.

3.1.2 Other Design Considerations

All treatment system equipment should incorporate adequate levels of redundancy to ensure continuation of Aquarium operations during maintenance and repair.

3.2 Proposed Action

The purpose of this project is to upgrade the Aquarium's outdated intake water system infrastructure to prevent the possibility of future failures that have the potential to threaten the life and wellbeing of the animals. To meet design goals and address the deteriorated condition of the Aquarium's aged water system, water system infrastructure will be replaced with supply water from both the ocean and the well. NSW from the ocean intake will be filtered and a portion will be routed to the Hawaiian Monk Seal exhibit. Balance seawater will be disinfected with ultraviolet (UV) light and chilled prior to being routed to the rest of the exhibits. Saltwater from the well water intake will be pre-treated through aeration, sedimentation, and filtration prior to being routed to the exhibits. Scope of work for this "Proposed Action" includes the following:

1. **<u>Natural Seawater System:</u>**

   1.1. Replace two existing NSW pumps/motors, piping and appurtenances, and reconfigure piping and pump vault;

   1.2. Replace two existing 8-inch transite offshore intake pipes with new 8-inch high-density polyethylene (HDPE) pipes and intake screen sections; and

1.3. Remove existing pleated bag filters and install new NSW treatment components, to include media filters, UV sterilizers, heat exchanger and chiller, for filtration, disease organism and temperature control. Target flow for NSW new treatment components is 340 GPM through media filters and 75 GPM through UV sterilizers, heat exchanger and chiller.

2. **<u>Saltwater Well System:</u>**

2.1. Reconfigure well water distribution plumbing;

2.2. Replace existing well water pump house;

2.3. Install new 275 GPM well water treatment components for aeration, metals precipitation and filtration; and

2.4. Install new saltwater well (optional).

3. **<u>Seawall Repairs:</u>**

3.1. Repair approximately 12 linear feet of seawall cavity, to match pre-existing structure footprint;

3.2. Repoint a total of approximately 92 linear feet of seawall façade; and

3.3. Other miscellaneous seawall repairs as called for by structural engineering reports and/or evaluations.

Design development is currently underway, and is based on communication with Aquarium staff, site visits, geotechnical and hydrogeological studies, and inputs from electrical, mechanical, hydrogeological, geotechnical, and aquarium operations specialists. On April 11, 2023, Oceanit personnel collected water samples from four well water locations as well as NSW samples from the intake location to conduct well water and precipitate quality analyses in support of pre-treatment and filtration design (Attachment C). On July 11, 2023, Oceanit personnel conducted a well water aeration and precipitation experiment to collect additional data for the design of treatment and filtration processes (Attachment A). The Proposed Action has a maximum intake flow rate of 615 GPM and was designed to be able to accommodate future planned Aquarium exhibits and expansions.

3.2.1 Alternatives Analysis

Three options were initially considered to upgrade the water intake system. Option 1 considered the use of well water only at a 507 GPM flow rate and eliminated the need for NSW. Option 2 considered the use of well water at a 411 GPM flow rate and filtered NSW for the Monk Seal pool only at a 216 GPM flow rate, for a total flow rate of 627 GPM. Option 3 (Proposed Action) incorporates the combined use of well water and treated/cooled NSW. Well water will have a 275 GPM target flow rate, while NSW will have a 340 GPM target flow rate, with roughly 170 GPM filtered only to the Monk Seal pool and the remaining flow UV-treated and cooled at a 75 GPM capacity prior to being distributed to the remaining exhibits. Option 3 has a total flow rate of approximately 615 GPM.

Though Options 1 and 2 are estimated to have lower construction costs than Option 3 (Table 3-1), Option 3 is preferred by the Aquarium due to the flexibility it provides and because the Aquarium cannot run exclusively on well water due to volume and quality limitations.

Table 3-1: Preliminary Construction Cost Estimates for Options 1 through 3

	OPTION 1			OPTION 2			OPTION 3		
Element	**New**	**Qty**	**Remark**	**New**	**Qty**	**Remark**	**New**	**Qty**	**Remark**
NSW Intake Pipes	No	2	Abandon existing pipes	No	2	Reuse existing pipes	Yes	2	Replace existing pipes with new
Well	Yes	1	Construct new well	No	1	Refurbish and reuse existing well	Yes	1	Construct new well
Pumps	Yes	6	WW (4), BW (2)	Yes	8	NSW (2), WW (4), BW (2)	Yes	8	NSW (2), WW (4), BW (2)
Filters	Yes	3	WW (3)	Yes	5	NSW (3), WW (2)	Yes	4	NSW (2), WW (2)
UV Sterilizers	No	--	--	No	--	--	Yes	2	NSW (2)
Water Chiller	No	--	--	No	--	--	Yes	1	NSW
Rebuild Existing Building	Yes	--	NSW and WW equipment	Yes	--	NSW and WW equipment	Yes	--	NSW and WW equipment
Building Expansion	No	--	--	Yes	--	NSW and WW equipment	Yes	--	NSW and WW equipment
	OPTION 1			**OPTION 2**			**OPTION 3**		
ROM Cost	$3.6M			$3.5M			$5.0M		

Acronyms:
BW = Backwash
M = Million
NSW = Natural Seawater
Qty = Quantity
ROM = Rough Order of Magnitude
UV = Ultraviolet
WW = Well Water

3.2.2 Elements of the Proposed Action

In summary, the Proposed Action will include the replacement of the two existing 8-inch transite NSW pipes with two new 8-inch HDPE pipes, the construction of a new saltwater well (or alternatively, the utilization of the existing well if possible), a new enlarged pump vault, a new aeration/settling tank for well water treatment, as well as reconstruction and extension of the existing well water pump house (i.e., Influent Treatment Building) that has extensive cracks and spalling. New equipment will include eight new pumps (four well water pumps, two NSW pumps, two filter backwash pumps), four new media filters (two well water filters, two NSW filters), two UV sterilizers to treat NSW, and a chiller and heat exchanger to cool warmer NSW to an acceptable temperature prior to supply tanks and exhibits. Also included will be new piping/fittings and mechanical and electrical upgrades.

As part of the NSW system, the new media filters, UV sterilizers, heat exchanger and chiller will be installed in the new Influent Treatment Building, while the NSW pumps will be installed in the new pump vault, similar to existing conditions. As part of the saltwater well system, the new media filters and post-aeration pumps will be installed in the Influent Treatment Building, while the well water pumps will be installed in the new pump vault. For both systems, VFDs will be provided for the new pumps.

Elements of the development of the Proposed Action are shown in Figure 3-1 and described below. See Figure 3-2 for a conceptual site plan layout.

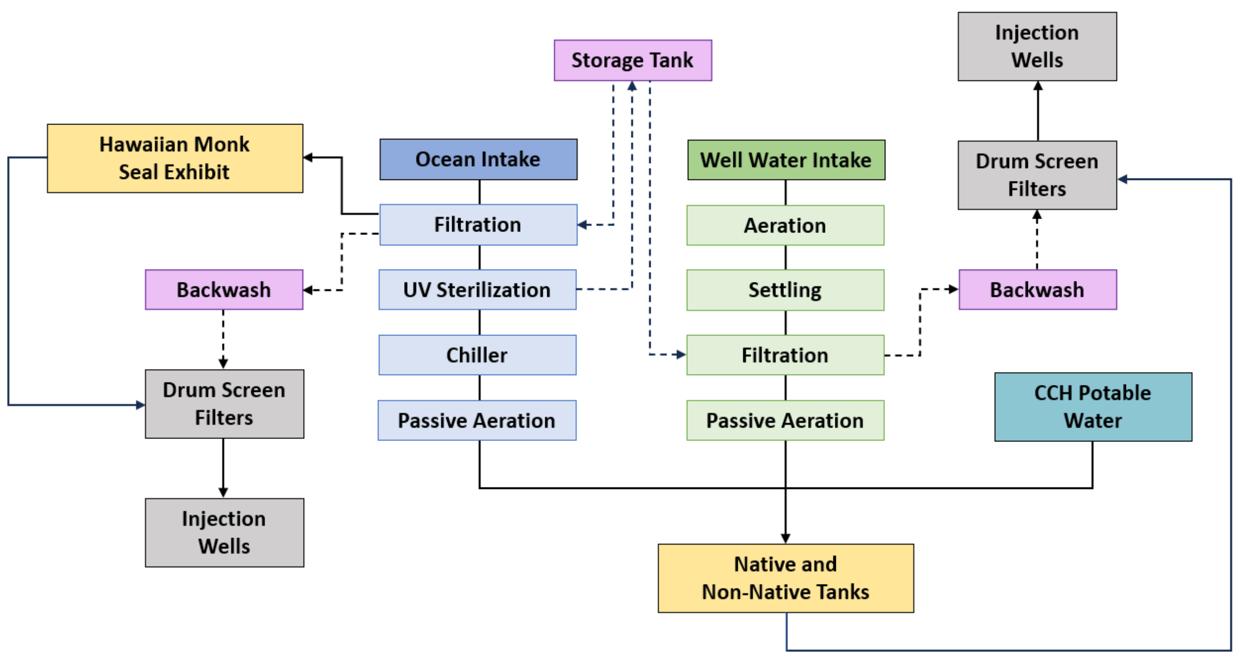

Figure 3-1: Conceptual Flow Diagram of the Proposed Action

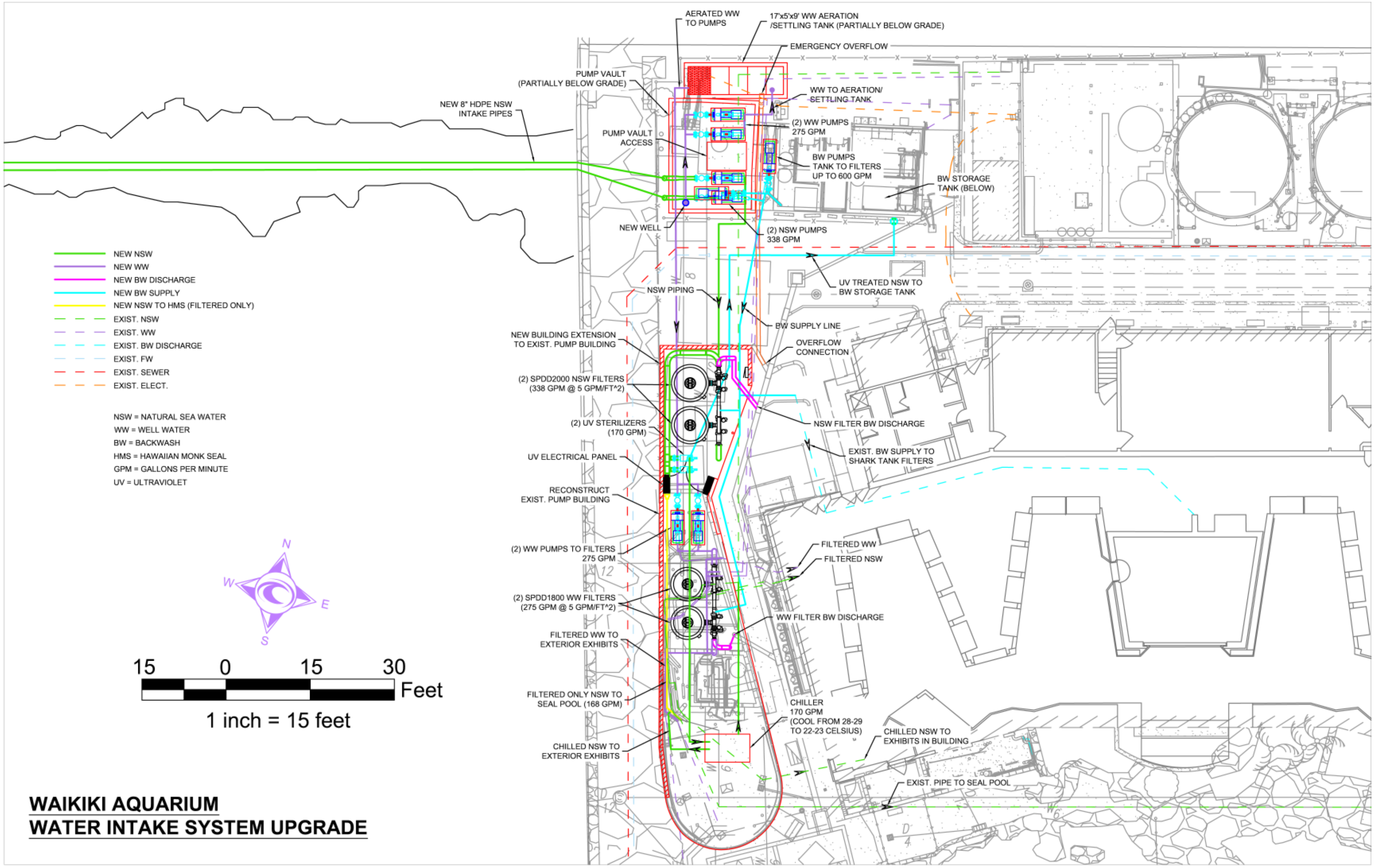

Figure 3-2: Conceptual Site Plan Layout of the Proposed Action

3.2.2.1 Well Water Intake

The projected well water intake anticipated for future upgrades and improvements is more than two and half times the existing amount. Currently, the intake from the saltwater well seems to be limited by the existing gravity pipe that connects the well water sump and saltwater well.

Based on the results of the well investigation, a new saltwater well will likely need to be installed. The existing well is encrusted with heavy growth of unknown composition throughout its depth, with casing confirmed along the upper roughly 45 ft. It will need to be cleaned prior to another inspection in order to determine if the existing well is in good enough condition to rehabilitate and reuse. Since the condition of the existing well remains relatively unknown, design efforts will proceed with new well installation as an option. The new well location being considered is roughly 20 to 30 ft northeast of the existing well, next to the property's north fence line within the Coral Deck/FW Storage area.

Water will be pumped from the well using two pumps located within a new pump vault partially below grade (Figure 3-3). Well water is low in oxygen, has low pH, and is laden with nutrients and metals, so a new well treatment system is proposed. A well water aeration/settling tank has been conceptualized to raise oxygen and pH, and precipitate dissolved metals (Figure 3-4). New well water treatment components will be installed, conceptualized as two 275 GPM pumps, an aeration/settling tank, and two media filters for filtration. The existing 12-inch transite well water distribution pipe and sump will be removed or backfilled, and the existing well water pump house will be replaced.

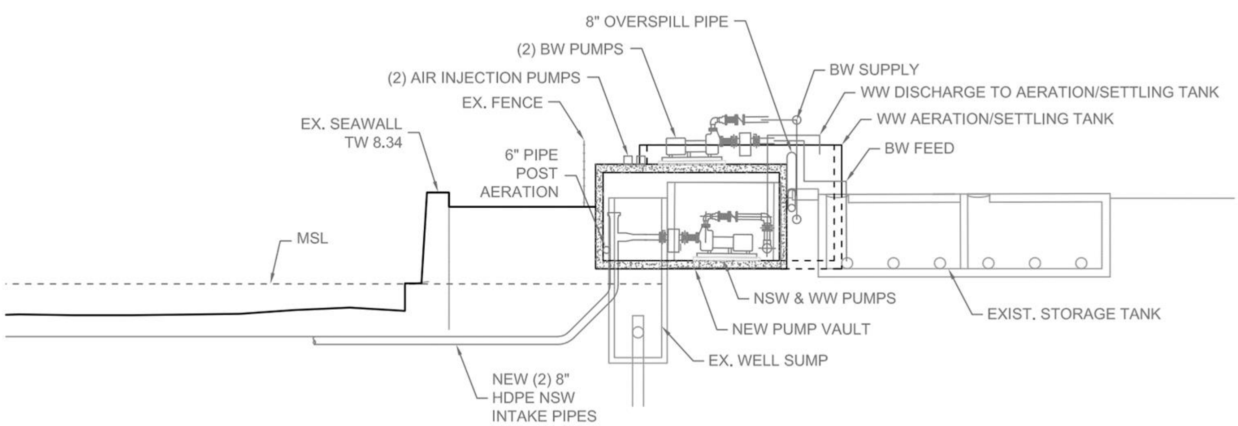

Figure 3-3: Conceptual Cross-Section of Pump Vault

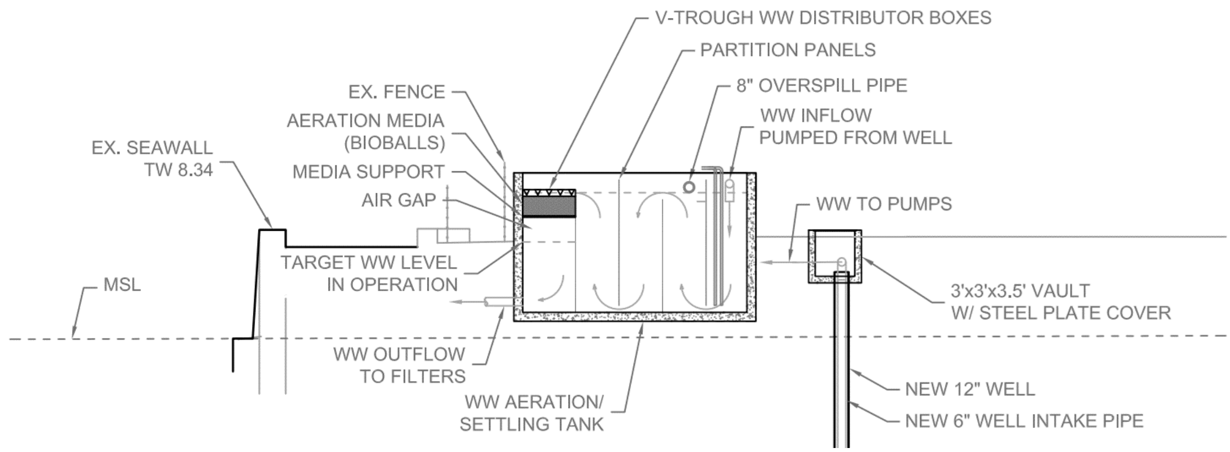

Figure 3-4: Conceptual Cross-Section of Aeration/Settling Tank

Based on results from sampling on April 11, 2023 (Attachment C), the average suspended particle size in well water is between 50 to 100 microns, post-aeration. 90% of the particles are greater than 10 microns and 80% are greater than 20 microns in size post-aeration. Based on results from the experiment on July 11, 2023 (Attachment A), an aeration chamber with a residence time of approximately 15 minutes at 275 GPM appears to be adequately sized to optimally treat dissolved solids from Aquarium well water. 15 minutes of contact time with air will precipitate manganese and iron hydroxides from well water.

The aeration/setting tank's up-and-down maze is a fairly standard method that assures minimum shortcutting through the system and an even distribution of air bubbles throughout the flow.

The Influent Treatment Building footprint may be expanded into the adjacent walkway that currently exists to the west of the main Aquarium building, as long as a minimum 5 ft walkway width is maintained between the main building and the new building structure. Height is intended to match existing or sufficient clearance to accommodate new equipment. The preference is to rebuild the building structure using concrete, which will provide better durability and reinforcement protection than its concrete masonry unit (CMU) counterpart. The preference is to also have a concrete roof structure for enhanced durability, or a timber roof structure to save slightly on construction costs. Other options for roofing include built-up, ethylene propylene diene terpolymer (EPDM), thermoplastic polyolefin (TPO) and elastomeric roofing. Metal roofing is also an option, although less ideal, as it can easily corrode in such close proximity to the ocean. All new concrete structure will need to sit on micropiles.

3.2.2.2 Ocean Intake

The Aquarium cannot run exclusively on well water due to volume and quality limitations. Therefore, the NSW intake flow would double from 246,421 GPD to approximately 500,000 GPD. In perfect working conditions, the existing 8-inch NSW intake is sufficient to provide this capacity. Because the two transite intake pipes were installed in the early 1950s and are well beyond their 50-year engineering life, they will be replaced with new 8-inch HDPE pipes (Figure 3-5).

The openings to the sea water intakes will be designed to minimized entrainment of particulate materials such as microalgae and small fish. Consideration will be given to anchoring the terminus of the new intake, which presently hangs off the edge of the dredged reef face, 2 ft above the existing elevation of the sand bottom of the channel, to make it a few feet deeper than present and improve water quality during winter storm events. Consideration will also be given to extending the intake pipes by 10 ft, from 160 ft to 170 ft in length measured from the existing seawall.

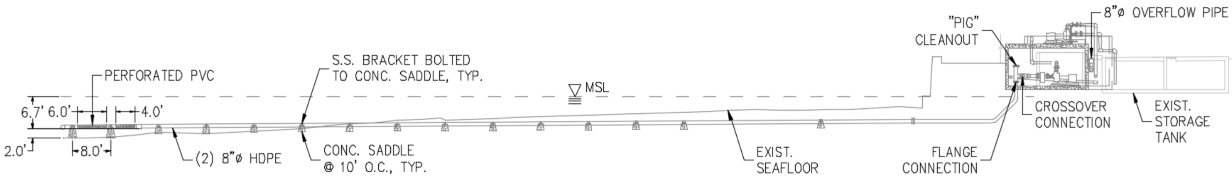

Figure 3-5: Conceptual Profile of New Intake Pipes

In addition, the two existing NSW pumps and motors will be replaced due to their age, which will include a reconfiguration of the pump vault and piping. NSW needs to be treated for TSS, particulates, parasites (including *Cryptocaryon irritans)*, and microbiologics that cause biofouling. For pre-treatment, new 340 GPM NSW treatment components will be installed, conceptualized as two media filters for filtration, two 75 GPM UV treatment units, water chiller and heat exchanger. The Aquarium expressed preference for medium pressure UV lamps due to space efficiency and lower maintenance.

Filtered and UV-treated NSW will be routed to an existing storage tank for use as backwash water supply for all four well water and NSW filters as well as the two existing shark tank filters. The tank is currently used for freshwater storage, but will be converted to saltwater storage. Two 600 GPM backwash pumps will be located atop the new pump vault. Backwash discharge will be routed to the drum screen filters and injection wells to be constructed as part of the upcoming Discharge System Upgrade project.

3.2.2.3 Supply Water Distribution System

The pumps and delivery pipes should be upgraded to accommodate the new flow. The water distribution system, water treatment facilities and controls also need to be also upgraded. A new system of treatment, pumps, controls, and delivery lines to accommodate the full flow must be designed and constructed to direct water to the exhibits. New piping will be kept away from the promenade and fronting seawall. Existing piping located within the promenade and planned to be abandoned in place will be filled and capped.

Before distribution to exhibits, NSW will need to be cooled to a temperature range of approximately 23 to 24 degrees Celsius, slightly cooler than the NSW intake provides. Modern water chillers and heat exchangers could get the temperature down. Note that the Monk Seal is not sensitive to water temperature and currently uses filtered NSW without cooling.

3.2.2.4 Seawall Repairs

In addition to supply water intake system upgrades, the Aquarium is intending to repair a large seawall cavity, roughly 12 feet long by 5 feet tall, that extends underneath the adjacent public walkway fronting the Waikīkī Aquarium (Figure 3-6) as well as repoint a total of approximately 92 linear feet of seawall façade. The seawall both protects the Aquarium grounds and supports the public walkway along the shoreline. The walkway has been cordoned off from public access since the discovery of the large void. An assessment of the condition of the seawall and an investigation into the cause of the seawall damage is underway. Site visits with a professional structural engineer, Coffman Engineers, to evaluate the condition of the existing seawall occurred on July 17, 2023 and August 2, 2023. A brief survey to document existing seawall conditions was performed on August 16, 2023.

Figure 3-6: Location of Damaged Seawall to be Repaired

Historical accounts inform that original segments of the seawall were constructed in the 1920s using concreted rubble, cast-in-place concrete, and cinder blocks (Wiegel, 2002 and Crane, 1972). There have been numerous repairs and modifications over the years. Presently, the seawall is typically comprised of a cast-in-place concrete wall as its base with horizontal layers of mortared stones (concrete rubble masonry [CRM]) on top. Because the existing wall is likely historically significant, similar repair materials should be utilized so as not to alter the exposed wall faces.

According to the topographic survey prepared by Controlpoint Surveying, Inc. in 2021, within the Aquarium's property limits, the top-of-seawall varies in elevation from +8.24 to +8.45 ft relative to MSL. The top-of-walkway on the landward (east) side of the wall lies at an average elevation of +7 ft relative to MSL. The wall is fronted on the seaward (west) side by a sandy beach.

Repairs at the existing cavity location are anticipated to include temporary shoring, demolishing existing concrete remnants within the cavity, reconstructing the seawall using reinforced concrete with a CRM finish at the seaward face (flush with the existing seawall to remain on both sides of the cavity), and replacing a section of walkway required to be demolished to accommodate the cavity repair. Repointing at various deteriorated seawall sections are anticipated to include temporary bracing/shoring and pressure grouting as needed (e.g., to fill larger gaps) as well as installing new rocks and mortar between the existing rocks at the seaward face. Repairs are necessary to prevent the seawall's collapse, protect public safety and property from natural hazards (e.g., erosion, flooding), prevent sediment from being washed out and suspended in nearshore waters, and restore safe connection to the shoreline next to the Aquarium for visitors and residents alike.

3.2.2.5 Upgrades to Existing Electrical System

The existing electrical service, switchboards, and generator will have the capacity to serve all new electrical loads for the Supply Water Intake System Upgrade project.

Eight new variable frequency drives (VFDs) will be needed, one for each of the eight new pumps, including the two backwash pumps. VFDs will be located near the pumps they are controlling. New electrical panels will also be needed to distribute power to pumps, aerators, UV sterilizers, chillers, heat exchangers, and structures. The existing electrical feeders to the areas of the well water pumps, NSW pumps, air injection pumps, filters, UV sterilizers, chiller and heat exchanger will remain and be reused from the existing electrical room. The new electrical panels being provided will replace the local panels in these areas to improve the distribution of the equipment branch circuits. New light fixtures and lighting control system will be provided at the new pump vault and new Influent Treatment Building. Since redundant equipment is not expected to operate simultaneously, interlocking controls will be implemented to prevent redundant electrical supply from operating secondary equipment. Status and control of the new equipment will be monitored and controlled by the existing Aquarium's Sensaphone system.

3.2.2.6 Upgrades to Existing Mechanical System

The backflush pumps, filter pumps and associated valves will be automated and interfaced to a controls system. However, the backflush and rinse cycle sequences for individual filters will be initiated manually by an Operator; they will not initiate automatically. New flowmeters and instrumentation will be required for monitoring purposes.

The backwash system will involve replacing the existing 25 horsepower (hp) backwash pump/motor, piping and appurtenances, and reconfiguring piping to accommodate new pumps. New 600 GPM backwash components will be installed, to include two backwash pumps, piping and appurtenances. The new backwash pumps will be installed on top of the new pump vault.

Construction of the new pump vault will also require a new exhaust fan with sufficient capacity to accommodate the heat load from the pumps operating within the pump vault.

3.2.2.7 Costs, Operation, and Maintenance

The new intake system will have built-in features to allow for maintenance and be reconfigured to improve accessibility for operations and maintenance. Rather than utilizing disposable membrane filters that require maintenance on an hourly basis, the transition to media filters will provide a much lower maintenance requirements solution for both saltwater sources. Elimination of minerals present in well water will result in lesser cleaning requirements for the exhibit water distribution system. Improved water quality across all exhibits may lessen exhibit cleaning requirements over time.

In addition, redundancy will be incorporated into all new systems to allow for equipment failures and maintenance.

3.2.3 Construction Scope of Work

The first phase of construction will be to get a temporary water supply system in place to maintain Aquarium operations during construction. This will involve either using the existing well for temporary water supply or drilling the new well and getting it operational prior to the rest of construction. Temporary water supply should assume the Monk Seal will be back at the Aquarium by the time construction for the Supply Water Intake System Upgrade project starts, therefore, the temporary water supply will also include NSW using one of the existing intake pipes. The shark tank filter backwash pump needs to remain in operation during construction. As part of the temporary water supply system, three new pumps will be installed for the well water supply, NSW supply and for filter backwashing. The pumps and the distribution piping of the temporary system will be located clear of the new construction of the new intake system. The new pumps used for the temporary system will be repurposed at the end of the project to serve as redundant/backup pumps.

The construction Scope of work for the Proposed Action will include:

- Mobilize to site and set up Best Management Practices (BMPs).
- Set up and test temporary water supply.
- Construct new well.
- Replace NSW intake pipes.
- Demolish existing pump vault. Reconstruct new pump vault and well water aeration/settling tank. Install mechanical components, including two NSW pumps, two well water pumps, and two filter backwash pumps.
- Reconstruct well water pump house (i.e., Influent Treatment Building). Install mechanical components, including two well water pumps, two UV sterilizers, two NSW filters, two well water filters, a chiller and a heat exchanger.
- Install new supply water plumbing to reconfigure distribution system.
- Install feedback controls and complete electrical work to connect new equipment.
- Test new supply water intake system prior to decommissioning temporary water supply.
- Demobilize from site.

A full set of design plans and specifications will be prepared by licensed engineers and construction performed by a licensed contractor.

3.2.4 Anticipated Effects

Impacts to nearshore receiving waters are expected to occur temporarily during in-water construction for the replacement of the two intake pipes and repair of the seawall. Effective BMPs will prevent and minimize short-term construction-related impacts. BMPs that will be used during construction will include a turbidity curtain or sandbag barrier to isolate the construction area from the nearshore environment, work along the shoreline conducted during periods of expected low tide and small or favorable wave conditions, upland measures (e.g., fiber roll, silt fence, stabilized construction access) to control runoff and other pollutants, good housekeeping, etc. In the long-term, the Proposed Action will likely protect valuable coastal ecosystems, improve water quality in the MLCD, and help reefs to thrive by replacing the deteriorating transite (asbestos-cement) pipes with HDPE pipes.

The Proposed Action is not anticipated to have negative impacts on existing historic and cultural resources within the project area, nor is it anticipated to have any visual or coastal line-of-sight impacts. The Proposed Action is anticipated to have long-term beneficial economic impacts to the community and the State by providing much needed supply water intake upgrades that will allow the Aquarium to stay in operation.

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Attachment A

Experiment Report: Well Water Aeration and Precipitation (Oceanit)

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Attachment B

Benthic Survey Report: Vicinity of Intake Pipes and Seawall Cavity (Oceanit)

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Attachment C

Waikīkī Aquarium Supply Water Quality Report (Oceanit)

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Basis of Design Report

WAIKIKI AQUARIUM UPGRADES

Supply Water Intake System Upgrade

2777 Kalākaua Avenue
Honolulu, Hawaiʻi, 96815
TMK: (1) 3-1-031:006

Prepared for:

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October 2023

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ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

%	Percent
§	Section
°	Degree(s)
amps	Amperes
AOC	Administrative Order of Consent
ATS	Automatic Transfer Switches
Aquarium	Waikīkī Aquarium
bgs	Below Ground Surface
BMP	Best Management Practice
BOD	Basis of Design
BS	Beaches
CCH	City and County of Honolulu
DOH	State of Hawaiʻi Department of Health
ENV	Department of Environmental Services
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
ft	Foot/Feet
GPD	Gallons per Day
GPM	Gallons per Minute
HECO	Hawaiian Electric Company
ID	Identification
IWDP	Industrial Wastewater Discharge Permit
JaC	Jaucas
kW	Kilowatt
kVA	Kilo Volt-Ampere
m	Meter(s)
mg/L	Milligrams per Liter
mJ/cm^2	Millijoules per Square Centimeter
MLCD	Marine Life Conservation District
NEC	National Electrical Code
No.	Number
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NSW	Natural Seawater
O&M	Operation and Maintenance
SLR	Sea Level Rise
SLR-XA	Sea Level Rise Exposure Area
TMK	Tax Map Key
TSS	Total Suspended Solids
UH	University of Hawaiʻi
UIC	Underground Injection Control
U.S.	United States
UV	Ultraviolet
VFD	Variable Frequency Drive
ZOM	Zone of Mixing

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EXECUTIVE SUMMARY

The Waikīkī Aquarium (Aquarium) is located at the southern end of the world-famous Waikīkī Beach and welcomes more than 250,000 visitors annually. The Aquarium was established in 1904 and moved to its present location in 1955, making it the second oldest aquarium in the United States. Much of the Aquarium's aging water system infrastructure was designed prior to modern Federal Clean Water Act regulations and does not meet current regulatory requirements, which has resulted in Federal, State and City regulatory citations relating to water quality issues associated with disposal of Aquarium effluent either into the ocean or sewer system.

Planned upgrades to the effluent discharge system exposed other inadequacies of the existing Aquarium intake, filtration and distribution systems. The purpose of this Supply Water Intake System Upgrade project is to repair/modify the outdated and failing saltwater supply systems consisting of two offshore intake pipes and an onsite well and the treatment and filtering systems that supply waters to the Aquarium exhibits and research areas. The project also includes repairs to the degraded and partially damaged seawall that protects both the Aquarium and an existing public walkway (i.e., promenade) along the shoreline. This Basis of Design report outlines the investigations, technical, environmental and regulatory evaluations, and design details for the water intake, treatment and distribution systems and repairs to the damaged seawall.

The Aquarium utilizes three intake water sources: natural seawater (NSW) from Mālama Bay, well water from an onsite 80-foot deep saltwater well, and freshwater from the City and County of Honolulu Board of Water Supply (BWS) water system. NSW and well water sources have a theoretical combined capacity of over 1.44 million gallons per day. NSW is obtained through two existing 8-inch diameter intake pipes, originally constructed in 1955 with improvements in 1992, extending approximately 160 feet from the shoreline. Approximately half of the total water currently utilized by the Aquarium comes from the ocean and the balance is supplied by the onsite saltwater well, with less than one percent sourced from the BWS water system. NSW and well saltwater require treatments (e.g., filtration, aeration) prior to use in exhibits. Design concepts to upgrade the Aquarium's water intake system and shoreline infrastructure were developed to meet two key design goals:

1) Upgrade the existing saltwater supply and distribution systems by replacing the existing intake systems and associated treatment infrastructure; and
2) Maintain public safety and access along the Waikīkī promenade fronting the seawall.

The system infrastructure to be addressed for this project include the NSW intake and treatment system, the saltwater well intake and treatment system, and the promenade and fronting seawall. Design alternatives evaluated to improve infrastructure components included "No Action," repairs and rehabilitation of working components, and replacement of non-repairable components. Based on evaluation efforts, the preferred remedial action is replacement of the NSW system, replacement of the saltwater well system, and repair of the seawall.

To meet design goals and address the deteriorated condition of the Aquarium's aged water system, water system infrastructure will be replaced with supply water from both the ocean and the well. NSW from the ocean intake will be filtered and a portion will be routed to the Hawaiian Monk Seal exhibit. Balance seawater will be disinfected with ultraviolet (UV) light and chilled prior to being routed to the rest of the exhibits. Saltwater from the well water intake will be pre-treated through aeration, sedimentation, and filtration prior to being routed to the exhibits. Scope of work for this "Proposed Action" includes the following:

1. **<u>Natural Seawater System:</u>**
    1.1. Replace two existing NSW pumps/motors, piping and appurtenances, and reconfigure piping and pump vault;
    1.2. Replace two existing 8-inch transite offshore intake pipes with new 8-inch high-density polyethylene (HDPE) pipes and intake screen sections; and
    1.3. Remove existing pleated bag filters and install new NSW treatment components, to include media filters, UV sterilizers, heat exchanger and chiller, for filtration, disease organism and temperature control. Target flow for NSW new treatment components is 340 GPM through media filters and 75 GPM through UV sterilizers, heat exchanger and chiller.
2. **<u>Saltwater Well System:</u>**
    2.1. Reconfigure well water distribution plumbing;
    2.2. Replace existing well water pump house;
    2.3. Install new 275 GPM well water treatment components for aeration, metals precipitation and filtration; and
    2.4. Install new saltwater well (optional).
3. **<u>Seawall Repairs:</u>**
    3.1. Repair approximately 12 linear feet of seawall cavity, to match pre-existing structure footprint;
    3.2. Repoint a total of approximately 92 linear feet of seawall façade; and
    3.3. Other miscellaneous seawall repairs as called for by structural engineering reports and/or evaluations.

The Aquarium is intending to repair a large seawall cavity, roughly 12 feet long by 5 feet tall, that extends underneath the adjacent public walkway fronting the Waikīkī Aquarium. The seawall both protects the Aquarium grounds and supports the public walkway along the shoreline. The walkway has been cordoned off from public access since the discovery of the large void. An assessment of the condition of the seawall and an investigation into the cause of the seawall damage is underway. Repairs are necessary to prevent the seawall's collapse, protect public safety and property from natural hazards (e.g., erosion, flooding), prevent sediment from being washed out and suspended in nearshore waters, and restore safe connection to the shoreline next to the Aquarium for visitors and residents alike.

1. INTRODUCTION

1.1 Background

The Waikīkī Aquarium (Aquarium), located at the southern end of the world-famous Waikīkī Beach, welcomes more than 250,000 visitors annually. Each year, the Aquarium delivers rich educational experiences to over 30,000 local children under 12 years old and to over 20,000 seniors over 65 years old. The Aquarium is an important educational outreach facility with an international reputation for its display quality and was the first aquarium in the world to successfully cultivate and display a number of marine organisms in captivity. The Aquarium presently displays fish and invertebrates in publicly viewable tanks, has outdoor pool displays, one of which is home to an endangered Hawaiian Monk Seal, and offers research opportunities to University of Hawaiʻi (UH) students and faculty. In addition, various outdoor events (e.g., summers concerts) are held in its lawn. Although the Aquarium has been in nearly constant operation since it moved to its current location in 1955, no significant improvements have been made to the supply water intake system in the last 30 years.

1.2 Purpose

The facility presently takes fresh potable water from the City and County of Honolulu (CCH), ocean water from Mālama Bay and saltwater from an onsite well, and uses all three types of water for display and research tanks. During the recent engineering process of designing the new discharge effluent system, it became obvious that the present seawall protecting the Aquarium and the seawater intake and treatment systems are out-of-date with a potential for failure. The UH contracted Oceanit to develop an improved water system infrastructure design for exhibit operations at the Aquarium and to provide an optimized water intake system process that will allow for continued operation of the Aquarium facility. This Basis of Design report outlines the investigations, technical, environmental and regulatory evaluations, and design details for the water intake, treatment and distribution systems and repairs to the damaged seawall.

1.3 Site Description

The Aquarium is located in the heart of Honolulu on the south shore of the island of Oʻahu next to the War Memorial Natatorium and Kaimana Beach Park (Figure 1-1). The Aquarium abuts the shoreline seawall on its west edge and extends east up to Kalākaua Avenue. A Marine Life Conservation District (MLCD) lies just offshore of the Aquarium. Renown Waikīkī beaches and recreational areas, such as Kapiʻolani and Kaimana Beach Parks, surround the facility.

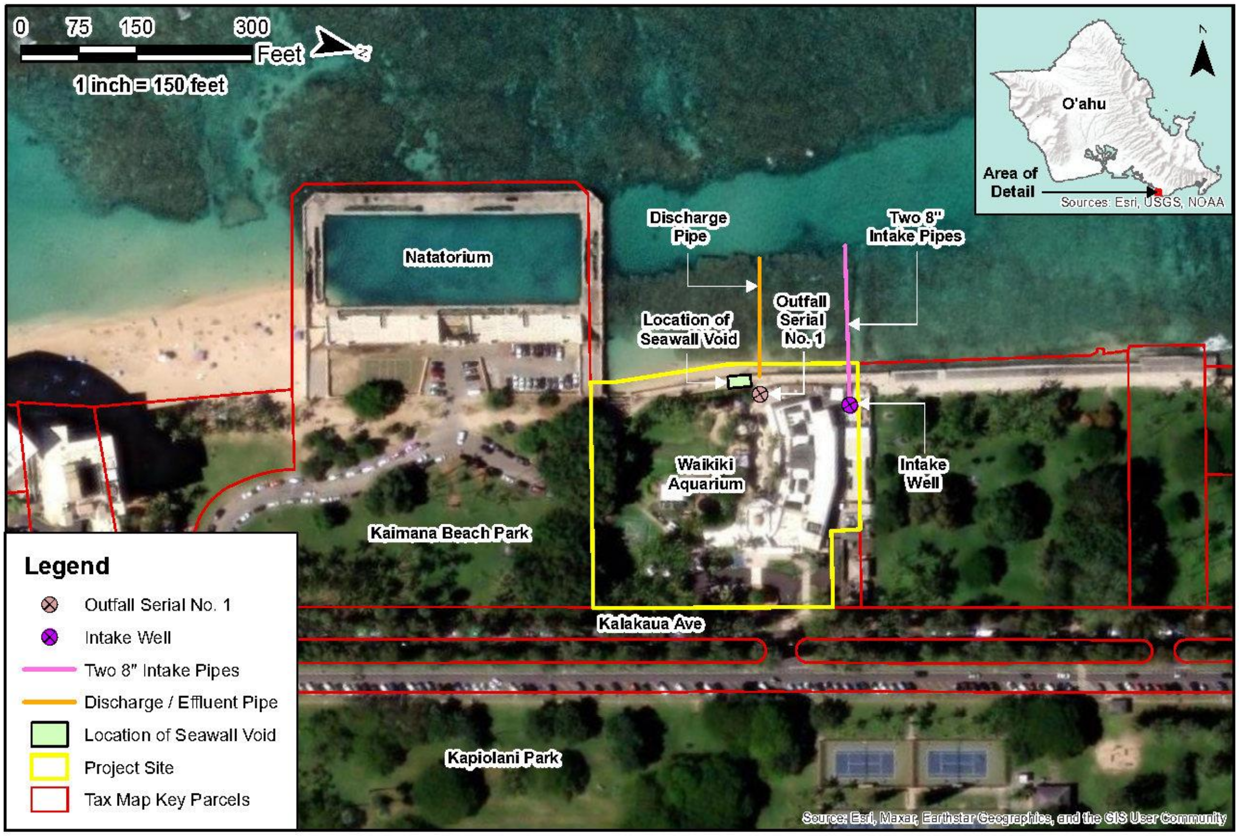

Figure 1-1: Project Site Map

The Aquarium was established in 1904 and is the second oldest aquarium in the United States (U.S.). It has been a part of the UH since 1919 and moved to its present location in 1955. Since its establishment, it has been an important landmark, resident and visitor destination at the southern end of Waikīkī Beach. The area is a highly trafficked area in Waikīkī and is heavily used for recreation, education, tourism, and commerce.

2. CURRENT OPERATIONS

2.1 Existing Exhibits and Operation

The Aquarium houses both native and non-native saltwater animals and some freshwater species in approximately 60 public exhibits and behind-the-scenes holding tanks that are in operation at any given time. Tank systems are segregated depending upon the types of animals on display. The largest display is a 70,000-gallon seawater pool, designed to house endangered Hawaiian Monk Seals. "Native Tanks" include those that house Native Hawaiian saltwater species and solitary non-breeding, non-native animals. "Non-Native Tanks" include those that house non-native animals or native animals which require any live non-native feed. Hawaiian freshwater animals are housed separately.

Roughly half of the water for Aquarium operations is drawn from a nearshore ocean intake and the balance from a saltwater well located near the shore within the Aquarium premises. Freshwater from the City's potable water supply accounts for less than one percent of the water requirement for exhibits. A functional supply water intake system is critical to the operation of the life support systems for the animals at the Aquarium. If any of the three intake water sources is to fail, the health and wellbeing of the animals that depend on it will be endangered.

Effluent water from native exhibits is currently discharged through a nearshore outfall under a National Pollutant Discharge Elimination System (NPDES) permit issued by the State Department of Health (DOH), while effluent from non-native exhibits is currently discharged into the CCH sanitary sewer system. Discharge system upgrades intended to eliminate the discharge of wastewater generated by Aquarium exhibits into the ocean and the CCH wastewater system are underway, with construction anticipated to begin in late 2023 or 2024. Scope of work for that upcoming project includes the installation of a wastewater discharge/transfer sump and pumps, two onsite injection wells and associated appurtenances and equipment for disposal of Aquarium exhibit effluent and upgrading the plumbing systems within the main building and the property. Three pumps connected to the discharge/transfer sump will pump the wastewater from the sump to a filter house structure on the south side of the property for filtration (i.e., post-treatment) prior to discharge into the injection wells.

2.2 Water Intake Sources and Treatment

The Aquarium utilizes three intake water sources to meet its current water demand of about 470,000 gallons per day (GPD) (approximately 325 GPM).

Natural seawater (NSW) is the largest volume of daily water usage for the facility. An average of 247,000 GPD of NSW is pumped into the facility at about 170 GPM. Natural seawater is obtained through two parallel 8-inch diameter transite pipes that extend approximately 160 feet (ft) from the shoreline to the edge of the nearshore reef. Natural seawater is filtered by ten bag filter canisters in series, each comprised of 3-layer filter bags, that progressively remove particulates 50, 10, and down to one micron in size. This filtration system is inefficient and expensive to maintain, according to Aquarium staff. The majority of this flow is used to supply the Monk Seal exhibit.

Saltwater from an 80-ft deep onsite well provides an average of approximately 225,000 GPD (115 GPM) to the Aquarium. Well saltwater has very low initial turbidity and total suspended solids (TSS), is considered free of parasites and pathogens, but carries significant nitrogen and phosphorous concentrations. The well water is anoxic and is aerated using two water pumps to raise the oxygen and degas the carbon dioxide before distribution to the indoor and outdoor aquatic exhibits and holding tanks. However, aeration of the water both raises its pH and results in the precipitation of black metal oxides. Prior to entering each individual exhibit, the aerated well water undergoes phos-ban filtration to remove phosphates, silicates, and the oxide precipitate. See Section 2.5 for more information regarding the well.

Freshwater from the CCH Board of Water Supply's potable water supply comprises the smallest facility water intake (less than one percent) at less than 2,000 GPD. Carbon filtration is used to remove chlorine immediately before introducing the water into the exhibits. The Aquarium has four freshwater exhibits and up to ten freshwater holding tanks.

2.3 Offshore Marine Environment

The present existing ocean discharge point, located about 150 ft offshore, occurs near the east end of the Waikīkī Beach immediately north of the historical War Memorial Natatorium (Figure 1-1). By the time the new intake water system is installed, the present ocean discharge system will have been replaced by the deep injection well discharge system. Because the injected discharge at the bottom (126 to 226 ft below mean sea level) of the well is expected to be of equal or greater density to surrounding groundwater, there should be no tendency for the effluent plume to rise. The effluent plume is expected to disperse and percolate through natural sediments until it reaches the seafloor well beyond the active reef crest area.

The active reef crest is located a little more than 1,000 ft offshore of the Aquarium. The reef flat between the shore and the reef crest averages 4 to 6 ft deep and, typical of reef channel areas off of Waikīkī, has limited live coral cover. A deeper (approximately 10 ft) area was dredged through the shallower reef flat, roughly 150 to 250 ft offshore, during the construction of the adjacent Natatorium in the 1920s. The reef flat throughout the MLCD consists mostly of rubble and coralline algae with some small patches of live coral. Surveys of the reef flat just north of the Aquarium show a coral coverage of zero to one percent (Franklin et. al., 2013). At the outer edge of the reef, coral cover and species diversity increases and the depth increases to about 15 to 20 ft. Numerous arches, crevices and other features are found here, along with an abundance of fish.

In the 1920s, coincident with the construction of the War Memorial Natatorium, a deep channel was dredged through the reef flat roughly 125 ft wide and 700 ft long parallel to and about 150 ft off the present seawall shoreline. In its present condition, the channel is about 8 to 10 ft deep with a sand bottom substrate. Both the water intake and effluent pipes of the Aquarium extend from the shoreline to the edge of this channel. The vertical edges of the channel provide habitat for small fish and a few small corals. Currents in the area are weak and mainly driven by winds and tides.

Survey information of the seafloor along the existing NSW intake pipes was collected by Oceanit personnel on June 6, 2023 and July 26, 2023. A depth profile along the intake pipes is shown in Figure 2-1.

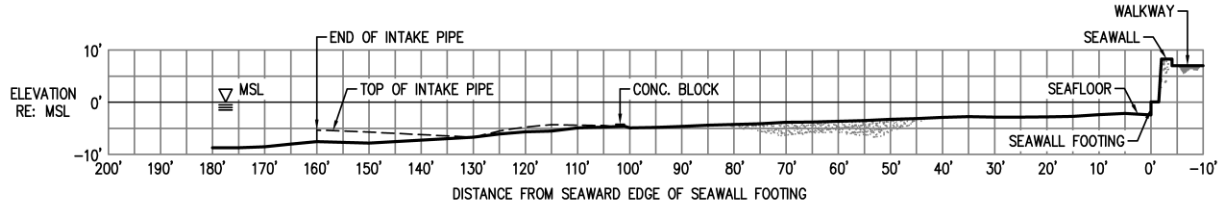

Figure 2-1: Existing Profile Along NSW Intake Pipes

On July 26, July 28, August 25 and September 27, 2023, Oceanit personnel performed marine environmental surveys of the nearshore benthic habitat and fish assemblages at the Waikiki Aquarium. The surveys were conducted to describe the area surrounding the Aquarium's existing natural seawater intake pipes as well as a large cavity in the seawall in support of the Supply Water Intake System Upgrade project. See Attachment B for a summary of findings.

2.4 Geotechnical Environment

The project site is underlain by beach deposits and alluvium (USGS, 2007) and Jaucas (JaC) sand and Beaches (BS) soils (NRCS, 2022). Beaches soils are light-colored calcium carbonate sands derived from coral and seashells that are washed by ocean waves. Jaucas soils are similar but light brown, excessively drained, calcareous soils deposited from wind and water that occur adjacent to the ocean. Formerly, the Waikīkī area consisted of low elevation marsh wetlands and lagoons. These lands were filled with material dredged from the Ala Wai Canal in the 1920s and then developed into the Waikīkī we know today (Kokua, 2021).

Four subsurface boring cores were taken from the project site during a geotechnical engineering exploration to observe and evaluate subsurface conditions. Bore hole depth ranged between approximately 3 to 42 ft below existing ground surface (bgs). The borings encountered surface fill materials overlying beach deposits, lagoonal deposits, and apparent coral. The surface materials were 1 to 3 ft thick and were loose to medium dense clayey/silty sand and medium stiff to stiff clayey/sandy silt. Beach deposits occurred at approximately 8 to 10 ft bgs and consisted of loose to medium dense clayey gravel and very soft sandy clay. Lagoonal deposits found beneath the beach deposits extended down to 40.5 ft bgs and consisted of very loose to medium dense clayey gravel and very soft sandy clay. Lagoonal deposits are known to be highly compressible. Beneath the lagoonal deposits, medium hard to hard coral formation extended down to the maximum depth tested (approximately 42 ft bgs).

The topography of the project site is relatively flat. Ground surface elevations range from +6 to +9 ft relative to mean sea level (MSL). Groundwater was encountered about 7.3 to 8.1 ft bgs during the field exploration; however, due to the close proximity of the site to the Pacific Ocean, groundwater depth is expected to vary with tidal fluctuations (Kokua, 2021).

2.5 Hydrogeological Environment

The Aquarium is located on the sedimentary Honolulu Caprock formation, which forms a coastal plain along the Waikīkī Coast in the Pālolo Aquifer System. The caprock is over 900 ft thick and comprised of marine and terrestrial sediments, some lava flows, and pyroclastic deposits. Koʻolau Basalt lies below the caprock. Hydraulic properties of these sedimentary formations can vary extensively; however, marine deposits (mainly calcareous) are generally more permeable than terrestrial deposits.

A hydrogeological evaluation of the area adjacent to the Aquarium was conducted by a professional geologist to investigate the possibility of using injection wells for the effluent discharges (INTERA, 2021). The Aquarium has an existing 80-ft deep saltwater production well (State Well No. 3-1649-010) that was constructed in 1954 (Section 2.2). The well has 46 ft of 12-inch solid casing. According to the Commission on Water Resource Management well index, the database on wells in Hawaiʻi, the saltwater well was tested at 1,150 GPM with 2.7 ft of drawdown and has a high specific capacity. Although, the database does not indicate when the well was tested, it was most likely tested in around 1954 after its initial construction. Although the saltwater well has not been tested in recent years, it is anticipated that the well performance has decreased over the years from natural aging processes.

2.6 Electrical System

The existing Aquarium electrical system was inspected by a professional electrical engineer, Kraig Otani & Associates, LLC, in March 2020 (Kraig Otani & Associates, LLC, 2020).

Electricity to the facility is provided by underground Hawaiian Electric Company (HECO) service cable originating from a handhole off the sidewalk fronting the Aquarium and routed to a HECO transformer within the Aquarium. Power is routed through a metering switchboard to two distribution panels in the electrical room that feed a network of panel boards to provide all power to the Aquarium.

Per the National Electrical Code (NEC), Section 220.87, 125 percent (%) of the maximum demand over a 12-month period needs to be added to determine if new load can be added to the existing electrical service, which brings the current electrical load to 279.0 kilo volt-Ampere (kVA). The Aquarium's maximum electrical demand load is approximately 223 kVA. The main HECO circuit breaker is rated at 500 kVA, leaving about 221.0 kVA of additional capacity off of the HECO transformer for upgrades.

Adjacent and to the north of the electrical room, an emergency 400 kilowatt (kW) generator is housed in a stainless-steel weatherproof housing. Diesel fuel for the generator is stored in a base tank underneath the generator. Two automatic transfer switches (ATS) within the electrical room allow the Aquarium to automatically draw power from HECO power source or from the emergency generator if the HECO power source becomes unavailable. The emergency generator has the capacity to provide all power to the Aquarium. The existing generator and its fuel tank were originally sized to run at full load for roughly 24 hours. The existing facility load, according to HECO, is running at around 50% of the generator load capacity.

Based on conversation with Aquarium staff, not all power needs are being met, specifically in the seal pool filter room and areas south of the main building. It is suspected that the problems are due to the long runs from the distribution panels in the Electrical Room and undersized electrical wiring/conductors. To address the problems and power needs throughout the Aquarium, the electrical wiring/conductors may need to be upsized to handle the loads at facilities/systems further away from the distribution panels. As part of the upcoming Discharge System Upgrade project, an entirely new run of conductors is routed to the seal pool filter room to mitigate the issues.

2.7 Mechanical System

The existing mechanical system was inspected by a professional engineer on March 6, 2020 (Okahara and Associates, Inc., 2020). Observations and assessments of existing mechanical systems are summarized below:

- The **main electrical room** on the northeast (NE) corner of the property is mechanically cooled by a wall-mounted propeller exhaust fan. The fan is thermostatically controlled. The fan currently is too close to the front of the switchboard and is not code compliant. Any future electrical upgrades would need to address this issue.
- **Coral propagation tanks** are located on the north (N) and northwest (NW) ends of the property, directly on top of the freshwater reservoir. All piping and piping appurtenances are plastic. An outdoor backwash pump (end-suction, 25 horsepower, Fybroc pump) sends water from the freshwater reservoir to the shark tank sand filters.
- **The natural seawater pump house** is located below grade in the NW corner of the property. The pump house contains two end-suction type, 25 horsepower Fybroc pumps which send water to a series of ten canister bag filters via two 6-inch pipes. The pump house is ventilated by a roof-mounted exhaust fan.
- **Aeration pumps** are located in the NW corner of the property, just north of the natural seawater pump house.
- The **well water pump house** is located on the west end of the property and houses two pumps, a well water sump, and three sand filters. The pumps draw water from the well water sump and distribute it throughout the Aquarium. The well water sump receives water from the deep saltwater well via gravity. Sand filters were intended to filter incoming NSW but are not currently in use. The condition of the gravity pipe that connects the well water sump and saltwater well is unknown and may be restricting the water supply from the saltwater well. Record drawings indicate the pipe connecting the well water sump and saltwater well to be 12-inches in diameter. Recently, the Aquarium staff removed a 2-inch pipe from inside the full length of the gravity pipe.
- The **canister bag filter array** is outdoors on the west end of the property, just east of the well water pump house. Ten filter bags are connected in series to filter the natural seawater. All NSW goes through the array before getting distributed throughout the Aquarium. This system is maintenance-intensive and requires frequent filter changes.

- The **Seal Pool pump room** is located just south of the seal pool and lies below grade. The pump house contains two circulation pumps, three sand filters, and an aeration pump. The Monk Seal pool is currently running without a backup pump or redundancy safeguards. New upgrades should incorporate pump redundancy in case a pump breaks or needs to be serviced.
- **Shark tank pumps** are installed in the main Aquarium building behind the shark tanks. Two 15 horsepower and one 3 horsepower pumps are equipped with sand filters that are cleared by the backwash pump. The shark tank is currently running without a backup pump, eliminating the redundancy safeguard. New upgrades should incorporate pump redundancy in case a pump breaks or needs to be serviced.

2.8 Limitations and Deficiencies

Numerous limitations and deficiencies of the existing systems were identified by Aquarium staff and from field investigations. Limitations and deficiencies are described below.

1) Intake flow rates for the NSW are at or near capacity due to intake pump failures and lack of adequate treatment systems. The two intake pipes installed in the 1950s are well beyond their standard 50-year engineering life, although a limited visual external inspection of these pipes showed no obvious damage to unburied pipe sections. In their present use, both pipes appear to be used simultaneously. Standard practice is to only use one pipe at a time to prevent organisms from growing inside and clogging the pipeline. Water intake should be upgraded and addressed with future upgrades.
2) Intake from the onsite saltwater well is limited by the size of existing pipes and pumps. Any saltwater that comes through an onsite well must be aerated, degassed, and go through phosphorous and dissolved metal flocculation and filtration before use.
3) To assure water quality, the two intake water sources (well and NSW) each requires its own filtration methods. This increases complexity and the operation and maintenance (O&M) required to maintain the two intake water sources and associated filtration methods.
4) Old and outdated infrastructure comprising the majority of existing Aquarium systems has potential for failure and should be upgraded.
5) There is limited square footage at the Aquarium to accommodate changes. Sizes and locations of new equipment and facilities need to be carefully considered and planned to avoid conflicting with existing above- and below-ground infrastructure.
6) Existing underground utilities will pose potential conflicts with new lines or piping. Rerouting or relocating existing utilities may be necessary.
7) Electrical wiring/conductor may be insufficiently sized to accommodate future upgrades, causing power issues. The electrical systems would need to be upgraded.
8) Existing electrical and mechanical infrastructure currently not set up to accommodate exhibit upgrades or expansion, would need to be upgraded.

9) Leaks from the existing outdoor "Edge of the Reef" exhibit may have contributed to erosion and partial collapse of the seawall beneath the public sidewalk adjacent to this exhibit.

2.9 Other Assumptions

Other assumptions of the existing systems at the Aquarium considered for this BOD included:

1) All existing infrastructure components are currently at capacity;
2) Most existing infrastructure components are beyond their usable engineering lifetime; and
3) Staff training and turnover will require maximization of controls automation and minimization of O&M components to simplify transitions and trainings.

3. SUPPLY WATER INTAKE SYSTEM UPGRADE

3.1 Design Goals

Design concepts to upgrade the Aquarium's water intake system and shoreline infrastructure were developed to meet two key design goals:

1) Upgrade the existing saltwater supply and distribution systems by replacing the existing intake systems and associated treatment infrastructure; and
2) Maintain public safety and access along the Waikīkī promenade fronting the seawall.

3.1.1 Target Design Flow Rate

The target design flow rate for the upgraded working system is almost 900,000 GPD (approximately 615 GPM), almost double the current water demand of the Aquarium which is about 470,000 GPD. The target flow rate was designed to accommodate potential future improvements, exhibits, and expansions specified by Aquarium management. Based on the existing intake system setup (described in Section 2.2), Oceanit estimated a theoretical maximum flow that the existing intake system could provide by adding the maximum flow rates through the intake system components. NSW and well water sources have the capacity to provide over 1.44 million GPD (approximately 1,000 GPM) combined.

3.1.2 Other Design Considerations

All treatment system equipment should incorporate adequate levels of redundancy to ensure continuation of Aquarium operations during maintenance and repair.

3.2 Proposed Action

The purpose of this project is to upgrade the Aquarium's outdated intake water system infrastructure to prevent the possibility of future failures that have the potential to threaten the life and wellbeing of the animals. To meet design goals and address the deteriorated condition of the Aquarium's aged water system, water system infrastructure will be replaced with supply water from both the ocean and the well. NSW from the ocean intake will be filtered and a portion will be routed to the Hawaiian Monk Seal exhibit. Balance seawater will be disinfected with ultraviolet (UV) light and chilled prior to being routed to the rest of the exhibits. Saltwater from the well water intake will be pre-treated through aeration, sedimentation, and filtration prior to being routed to the exhibits. Scope of work for this "Proposed Action" includes the following:

1. **<u>Natural Seawater System:</u>**
   - 1.1. Replace two existing NSW pumps/motors, piping and appurtenances, and reconfigure piping and pump vault;
   - 1.2. Replace two existing 8-inch transite offshore intake pipes with new 8-inch high-density polyethylene (HDPE) pipes and intake screen sections; and

1.3. Remove existing pleated bag filters and install new NSW treatment components, to include media filters, UV sterilizers, heat exchanger and chiller, for filtration, disease organism and temperature control. Target flow for NSW new treatment components is 340 GPM through media filters and 75 GPM through UV sterilizers, heat exchanger and chiller.

2. **<u>Saltwater Well System:</u>**

2.1. Reconfigure well water distribution plumbing;

2.2. Replace existing well water pump house;

2.3. Install new 275 GPM well water treatment components for aeration, metals precipitation and filtration; and

2.4. Install new saltwater well (optional).

3. **<u>Seawall Repairs:</u>**

3.1. Repair approximately 12 linear feet of seawall cavity, to match pre-existing structure footprint;

3.2. Repoint a total of approximately 92 linear feet of seawall façade; and

3.3. Other miscellaneous seawall repairs as called for by structural engineering reports and/or evaluations.

Design development is currently underway, and is based on communication with Aquarium staff, site visits, geotechnical and hydrogeological studies, and inputs from electrical, mechanical, hydrogeological, geotechnical, and aquarium operations specialists. On April 11, 2023, Oceanit personnel collected water samples from four well water locations as well as NSW samples from the intake location to conduct well water and precipitate quality analyses in support of pre-treatment and filtration design (Attachment C). On July 11, 2023, Oceanit personnel conducted a well water aeration and precipitation experiment to collect additional data for the design of treatment and filtration processes (Attachment A). The Proposed Action has a maximum intake flow rate of 615 GPM and was designed to be able to accommodate future planned Aquarium exhibits and expansions.

3.2.1 Alternatives Analysis

Three options were initially considered to upgrade the water intake system. Option 1 considered the use of well water only at a 507 GPM flow rate and eliminated the need for NSW. Option 2 considered the use of well water at a 411 GPM flow rate and filtered NSW for the Monk Seal pool only at a 216 GPM flow rate, for a total flow rate of 627 GPM. Option 3 (Proposed Action) incorporates the combined use of well water and treated/cooled NSW. Well water will have a 275 GPM target flow rate, while NSW will have a 340 GPM target flow rate, with roughly 170 GPM filtered only to the Monk Seal pool and the remaining flow UV-treated and cooled at a 75 GPM capacity prior to being distributed to the remaining exhibits. Option 3 has a total flow rate of approximately 615 GPM.

Though Options 1 and 2 are estimated to have lower construction costs than Option 3 (Table 3-1), Option 3 is preferred by the Aquarium due to the flexibility it provides and because the Aquarium cannot run exclusively on well water due to volume and quality limitations.

Table 3-1: Preliminary Construction Cost Estimates for Options 1 through 3

	OPTION 1			OPTION 2			OPTION 3		
Element	**New**	**Qty**	**Remark**	**New**	**Qty**	**Remark**	**New**	**Qty**	**Remark**
NSW Intake Pipes	No	2	Abandon existing pipes	No	2	Reuse existing pipes	Yes	2	Replace existing pipes with new
Well	Yes	1	Construct new well	No	1	Refurbish and reuse existing well	Yes	1	Construct new well
Pumps	Yes	6	WW (4), BW (2)	Yes	8	NSW (2), WW (4), BW (2)	Yes	8	NSW (2), WW (4), BW (2)
Filters	Yes	3	WW (3)	Yes	5	NSW (3), WW (2)	Yes	4	NSW (2), WW (2)
UV Sterilizers	No	--	--	No	--	--	Yes	2	NSW (2)
Water Chiller	No	--	--	No	--	--	Yes	1	NSW
Rebuild Existing Building	Yes	--	NSW and WW equipment	Yes	--	NSW and WW equipment	Yes	--	NSW and WW equipment
Building Expansion	No	--	--	Yes	--	NSW and WW equipment	Yes	--	NSW and WW equipment
	OPTION 1			**OPTION 2**			**OPTION 3**		
ROM Cost	$3.6M			$3.5M			$5.0M		

Acronyms:
BW = Backwash
M = Million
NSW = Natural Seawater
Qty = Quantity
ROM = Rough Order of Magnitude
UV = Ultraviolet
WW = Well Water

3.2.2 Elements of the Proposed Action

In summary, the Proposed Action will include the replacement of the two existing 8-inch transite NSW pipes with two new 8-inch HDPE pipes, the construction of a new saltwater well (or alternatively, the utilization of the existing well if possible), a new enlarged pump vault, a new aeration/settling tank for well water treatment, as well as reconstruction and extension of the existing well water pump house (i.e., Influent Treatment Building) that has extensive cracks and spalling. New equipment will include eight new pumps (four well water pumps, two NSW pumps, two filter backwash pumps), four new media filters (two well water filters, two NSW filters), two UV sterilizers to treat NSW, and a chiller and heat exchanger to cool warmer NSW to an acceptable temperature prior to supply tanks and exhibits. Also included will be new piping/fittings and mechanical and electrical upgrades.

As part of the NSW system, the new media filters, UV sterilizers, heat exchanger and chiller will be installed in the new Influent Treatment Building, while the NSW pumps will be installed in the new pump vault, similar to existing conditions. As part of the saltwater well system, the new media filters and post-aeration pumps will be installed in the Influent Treatment Building, while the well water pumps will be installed in the new pump vault. For both systems, VFDs will be provided for the new pumps.

Elements of the development of the Proposed Action are shown in Figure 3-1 and described below. See Figure 3-2 for a conceptual site plan layout.

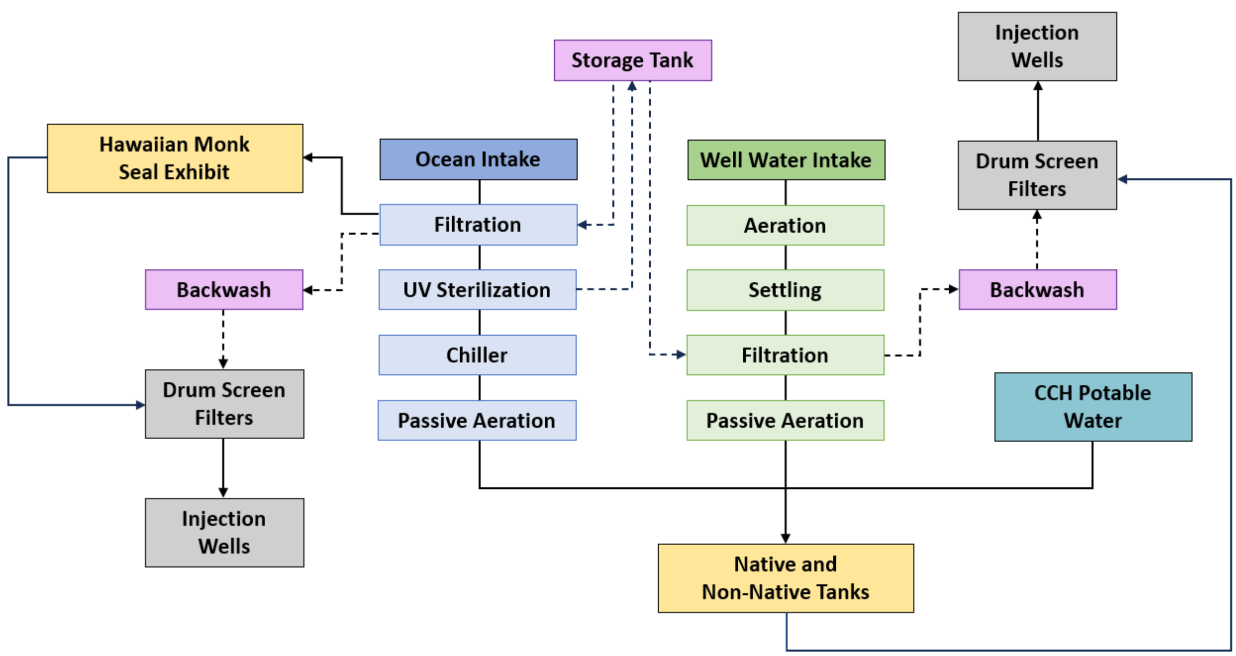

Figure 3-1: Conceptual Flow Diagram of the Proposed Action

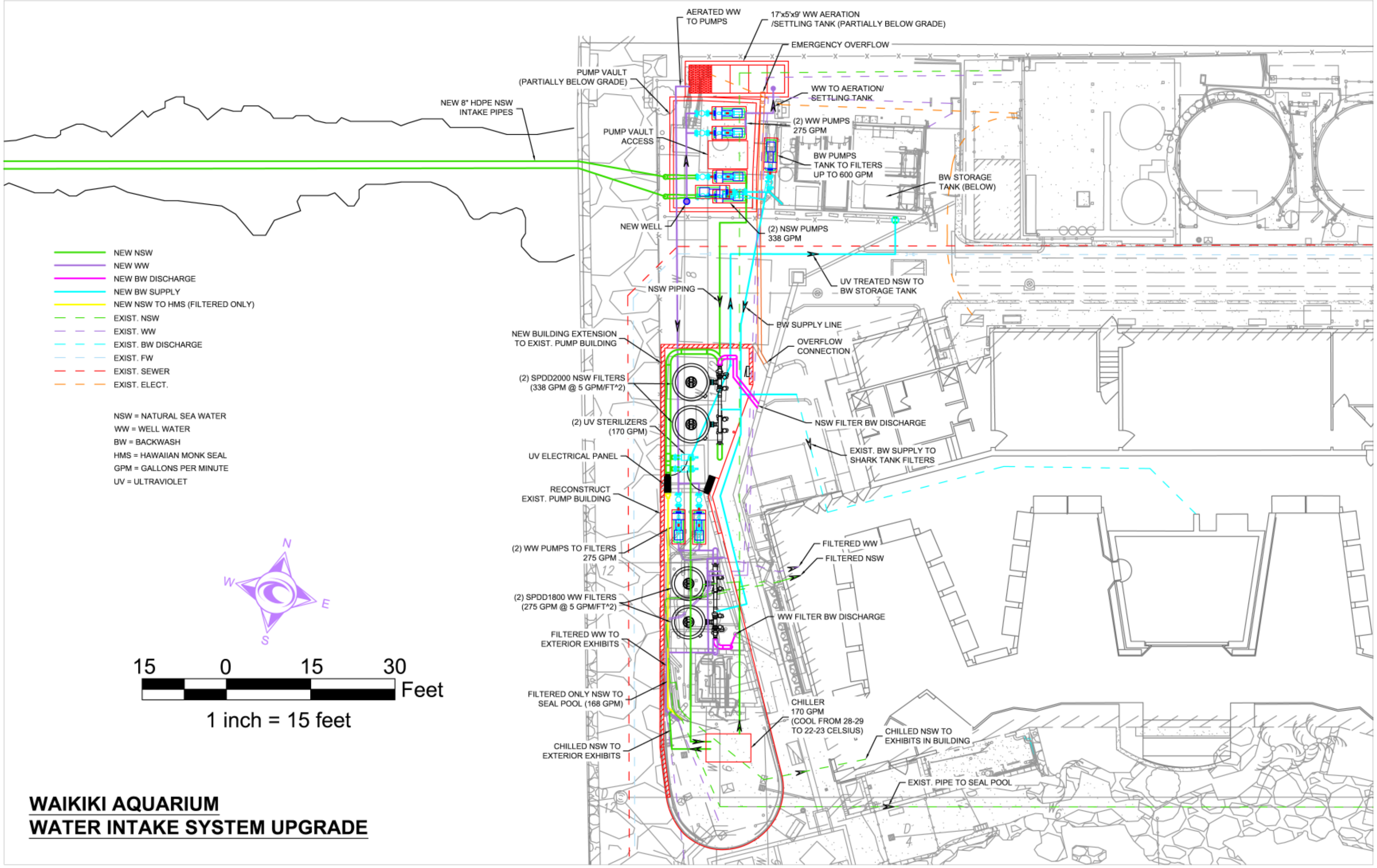

Figure 3-2: Conceptual Site Plan Layout of the Proposed Action

3.2.2.1 Well Water Intake

The projected well water intake anticipated for future upgrades and improvements is more than two and half times the existing amount. Currently, the intake from the saltwater well seems to be limited by the existing gravity pipe that connects the well water sump and saltwater well.

Based on the results of the well investigation, a new saltwater well will likely need to be installed. The existing well is encrusted with heavy growth of unknown composition throughout its depth, with casing confirmed along the upper roughly 45 ft. It will need to be cleaned prior to another inspection in order to determine if the existing well is in good enough condition to rehabilitate and reuse. Since the condition of the existing well remains relatively unknown, design efforts will proceed with new well installation as an option. The new well location being considered is roughly 20 to 30 ft northeast of the existing well, next to the property's north fence line within the Coral Deck/FW Storage area.

Water will be pumped from the well using two pumps located within a new pump vault partially below grade (Figure 3-3). Well water is low in oxygen, has low pH, and is laden with nutrients and metals, so a new well treatment system is proposed. A well water aeration/settling tank has been conceptualized to raise oxygen and pH, and precipitate dissolved metals (Figure 3-4). New well water treatment components will be installed, conceptualized as two 275 GPM pumps, an aeration/settling tank, and two media filters for filtration. The existing 12-inch transite well water distribution pipe and sump will be removed or backfilled, and the existing well water pump house will be replaced.

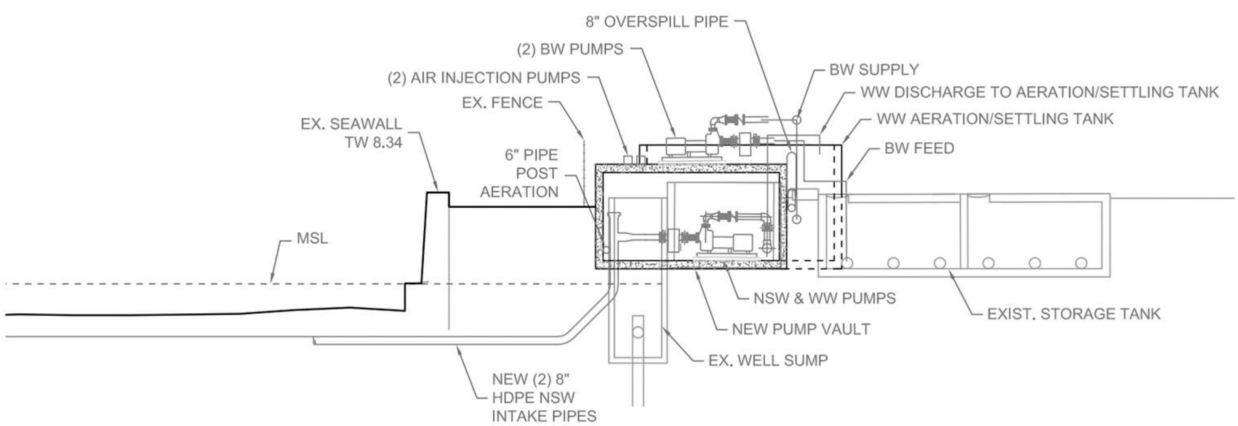

Figure 3-3: Conceptual Cross-Section of Pump Vault

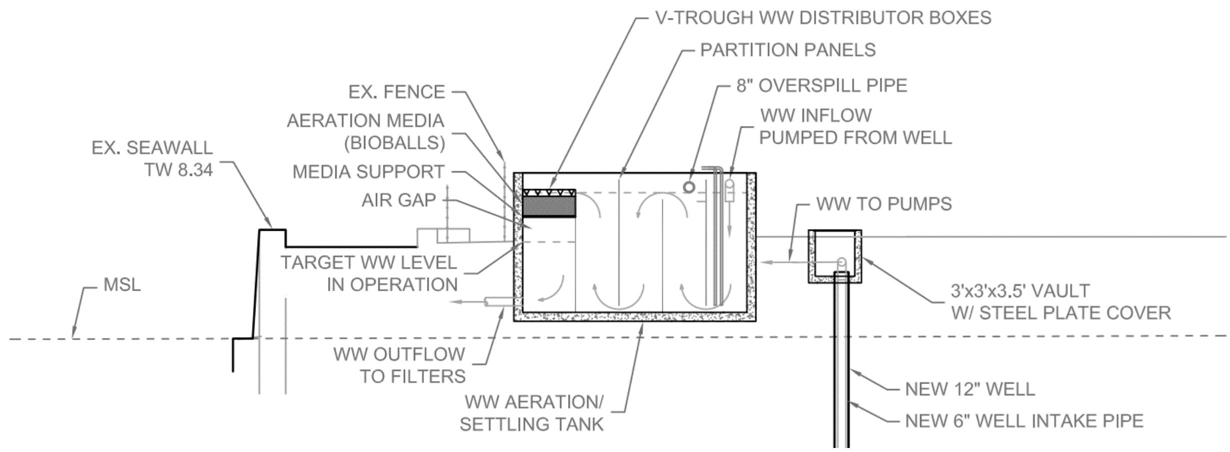

Figure 3-4: Conceptual Cross-Section of Aeration/Settling Tank

Based on results from sampling on April 11, 2023 (Attachment C), the average suspended particle size in well water is between 50 to 100 microns, post-aeration. 90% of the particles are greater than 10 microns and 80% are greater than 20 microns in size post-aeration. Based on results from the experiment on July 11, 2023 (Attachment A), an aeration chamber with a residence time of approximately 15 minutes at 275 GPM appears to be adequately sized to optimally treat dissolved solids from Aquarium well water. 15 minutes of contact time with air will precipitate manganese and iron hydroxides from well water.

The aeration/setting tank's up-and-down maze is a fairly standard method that assures minimum shortcutting through the system and an even distribution of air bubbles throughout the flow.

The Influent Treatment Building footprint may be expanded into the adjacent walkway that currently exists to the west of the main Aquarium building, as long as a minimum 5 ft walkway width is maintained between the main building and the new building structure. Height is intended to match existing or sufficient clearance to accommodate new equipment. The preference is to rebuild the building structure using concrete, which will provide better durability and reinforcement protection than its concrete masonry unit (CMU) counterpart. The preference is to also have a concrete roof structure for enhanced durability, or a timber roof structure to save slightly on construction costs. Other options for roofing include built-up, ethylene propylene diene terpolymer (EPDM), thermoplastic polyolefin (TPO) and elastomeric roofing. Metal roofing is also an option, although less ideal, as it can easily corrode in such close proximity to the ocean. All new concrete structure will need to sit on micropiles.

3.2.2.2 Ocean Intake

The Aquarium cannot run exclusively on well water due to volume and quality limitations. Therefore, the NSW intake flow would double from 246,421 GPD to approximately 500,000 GPD. In perfect working conditions, the existing 8-inch NSW intake is sufficient to provide this capacity. Because the two transite intake pipes were installed in the early 1950s and are well beyond their 50-year engineering life, they will be replaced with new 8-inch HDPE pipes (Figure 3-5).

The openings to the sea water intakes will be designed to minimized entrainment of particulate materials such as microalgae and small fish. Consideration will be given to anchoring the terminus of the new intake, which presently hangs off the edge of the dredged reef face, 2 ft above the existing elevation of the sand bottom of the channel, to make it a few feet deeper than present and improve water quality during winter storm events. Consideration will also be given to extending the intake pipes by 10 ft, from 160 ft to 170 ft in length measured from the existing seawall.

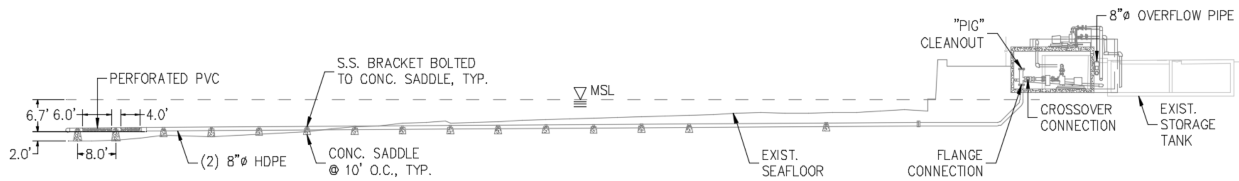

Figure 3-5: Conceptual Profile of New Intake Pipes

In addition, the two existing NSW pumps and motors will be replaced due to their age, which will include a reconfiguration of the pump vault and piping. NSW needs to be treated for TSS, particulates, parasites (including *Cryptocaryon irritans)*, and microbiologics that cause biofouling. For pre-treatment, new 340 GPM NSW treatment components will be installed, conceptualized as two media filters for filtration, two 75 GPM UV treatment units, water chiller and heat exchanger. The Aquarium expressed preference for medium pressure UV lamps due to space efficiency and lower maintenance.

Filtered and UV-treated NSW will be routed to an existing storage tank for use as backwash water supply for all four well water and NSW filters as well as the two existing shark tank filters. The tank is currently used for freshwater storage, but will be converted to saltwater storage. Two 600 GPM backwash pumps will be located atop the new pump vault. Backwash discharge will be routed to the drum screen filters and injection wells to be constructed as part of the upcoming Discharge System Upgrade project.

3.2.2.3 Supply Water Distribution System

The pumps and delivery pipes should be upgraded to accommodate the new flow. The water distribution system, water treatment facilities and controls also need to be also upgraded. A new system of treatment, pumps, controls, and delivery lines to accommodate the full flow must be designed and constructed to direct water to the exhibits. New piping will be kept away from the promenade and fronting seawall. Existing piping located within the promenade and planned to be abandoned in place will be filled and capped.

Before distribution to exhibits, NSW will need to be cooled to a temperature range of approximately 23 to 24 degrees Celsius, slightly cooler than the NSW intake provides. Modern water chillers and heat exchangers could get the temperature down. Note that the Monk Seal is not sensitive to water temperature and currently uses filtered NSW without cooling.

3.2.2.4 Seawall Repairs

In addition to supply water intake system upgrades, the Aquarium is intending to repair a large seawall cavity, roughly 12 feet long by 5 feet tall, that extends underneath the adjacent public walkway fronting the Waikīkī Aquarium (Figure 3-6) as well as repoint a total of approximately 92 linear feet of seawall façade. The seawall both protects the Aquarium grounds and supports the public walkway along the shoreline. The walkway has been cordoned off from public access since the discovery of the large void. An assessment of the condition of the seawall and an investigation into the cause of the seawall damage is underway. Site visits with a professional structural engineer, Coffman Engineers, to evaluate the condition of the existing seawall occurred on July 17, 2023 and August 2, 2023. A brief survey to document existing seawall conditions was performed on August 16, 2023.

Figure 3-6: Location of Damaged Seawall to be Repaired

Historical accounts inform that original segments of the seawall were constructed in the 1920s using concreted rubble, cast-in-place concrete, and cinder blocks (Wiegel, 2002 and Crane, 1972). There have been numerous repairs and modifications over the years. Presently, the seawall is typically comprised of a cast-in-place concrete wall as its base with horizontal layers of mortared stones (concrete rubble masonry [CRM]) on top. Because the existing wall is likely historically significant, similar repair materials should be utilized so as not to alter the exposed wall faces.

According to the topographic survey prepared by Controlpoint Surveying, Inc. in 2021, within the Aquarium's property limits, the top-of-seawall varies in elevation from +8.24 to +8.45 ft relative to MSL. The top-of-walkway on the landward (east) side of the wall lies at an average elevation of +7 ft relative to MSL. The wall is fronted on the seaward (west) side by a sandy beach.

Repairs at the existing cavity location are anticipated to include temporary shoring, demolishing existing concrete remnants within the cavity, reconstructing the seawall using reinforced concrete with a CRM finish at the seaward face (flush with the existing seawall to remain on both sides of the cavity), and replacing a section of walkway required to be demolished to accommodate the cavity repair. Repointing at various deteriorated seawall sections are anticipated to include temporary bracing/shoring and pressure grouting as needed (e.g., to fill larger gaps) as well as installing new rocks and mortar between the existing rocks at the seaward face. Repairs are necessary to prevent the seawall's collapse, protect public safety and property from natural hazards (e.g., erosion, flooding), prevent sediment from being washed out and suspended in nearshore waters, and restore safe connection to the shoreline next to the Aquarium for visitors and residents alike.

3.2.2.5 Upgrades to Existing Electrical System

The existing electrical service, switchboards, and generator will have the capacity to serve all new electrical loads for the Supply Water Intake System Upgrade project.

Eight new variable frequency drives (VFDs) will be needed, one for each of the eight new pumps, including the two backwash pumps. VFDs will be located near the pumps they are controlling. New electrical panels will also be needed to distribute power to pumps, aerators, UV sterilizers, chillers, heat exchangers, and structures. The existing electrical feeders to the areas of the well water pumps, NSW pumps, air injection pumps, filters, UV sterilizers, chiller and heat exchanger will remain and be reused from the existing electrical room. The new electrical panels being provided will replace the local panels in these areas to improve the distribution of the equipment branch circuits. New light fixtures and lighting control system will be provided at the new pump vault and new Influent Treatment Building. Since redundant equipment is not expected to operate simultaneously, interlocking controls will be implemented to prevent redundant electrical supply from operating secondary equipment. Status and control of the new equipment will be monitored and controlled by the existing Aquarium's Sensaphone system.

3.2.2.6 Upgrades to Existing Mechanical System

The backflush pumps, filter pumps and associated valves will be automated and interfaced to a controls system. However, the backflush and rinse cycle sequences for individual filters will be initiated manually by an Operator; they will not initiate automatically. New flowmeters and instrumentation will be required for monitoring purposes.

The backwash system will involve replacing the existing 25 horsepower (hp) backwash pump/motor, piping and appurtenances, and reconfiguring piping to accommodate new pumps. New 600 GPM backwash components will be installed, to include two backwash pumps, piping and appurtenances. The new backwash pumps will be installed on top of the new pump vault.

Construction of the new pump vault will also require a new exhaust fan with sufficient capacity to accommodate the heat load from the pumps operating within the pump vault.

3.2.2.7 Costs, Operation, and Maintenance

The new intake system will have built-in features to allow for maintenance and be reconfigured to improve accessibility for operations and maintenance. Rather than utilizing disposable membrane filters that require maintenance on an hourly basis, the transition to media filters will provide a much lower maintenance requirements solution for both saltwater sources. Elimination of minerals present in well water will result in lesser cleaning requirements for the exhibit water distribution system. Improved water quality across all exhibits may lessen exhibit cleaning requirements over time.

In addition, redundancy will be incorporated into all new systems to allow for equipment failures and maintenance.

3.2.3 Construction Scope of Work

The first phase of construction will be to get a temporary water supply system in place to maintain Aquarium operations during construction. This will involve either using the existing well for temporary water supply or drilling the new well and getting it operational prior to the rest of construction. Temporary water supply should assume the Monk Seal will be back at the Aquarium by the time construction for the Supply Water Intake System Upgrade project starts, therefore, the temporary water supply will also include NSW using one of the existing intake pipes. The shark tank filter backwash pump needs to remain in operation during construction. As part of the temporary water supply system, three new pumps will be installed for the well water supply, NSW supply and for filter backwashing. The pumps and the distribution piping of the temporary system will be located clear of the new construction of the new intake system. The new pumps used for the temporary system will be repurposed at the end of the project to serve as redundant/backup pumps.

The construction Scope of work for the Proposed Action will include:

- Mobilize to site and set up Best Management Practices (BMPs).
- Set up and test temporary water supply.
- Construct new well.
- Replace NSW intake pipes.
- Demolish existing pump vault. Reconstruct new pump vault and well water aeration/settling tank. Install mechanical components, including two NSW pumps, two well water pumps, and two filter backwash pumps.
- Reconstruct well water pump house (i.e., Influent Treatment Building). Install mechanical components, including two well water pumps, two UV sterilizers, two NSW filters, two well water filters, a chiller and a heat exchanger.
- Install new supply water plumbing to reconfigure distribution system.
- Install feedback controls and complete electrical work to connect new equipment.
- Test new supply water intake system prior to decommissioning temporary water supply.
- Demobilize from site.

A full set of design plans and specifications will be prepared by licensed engineers and construction performed by a licensed contractor.

3.2.4 Anticipated Effects

Impacts to nearshore receiving waters are expected to occur temporarily during in-water construction for the replacement of the two intake pipes and repair of the seawall. Effective BMPs will prevent and minimize short-term construction-related impacts. BMPs that will be used during construction will include a turbidity curtain or sandbag barrier to isolate the construction area from the nearshore environment, work along the shoreline conducted during periods of expected low tide and small or favorable wave conditions, upland measures (e.g., fiber roll, silt fence, stabilized construction access) to control runoff and other pollutants, good housekeeping, etc. In the long-term, the Proposed Action will likely protect valuable coastal ecosystems, improve water quality in the MLCD, and help reefs to thrive by replacing the deteriorating transite (asbestos-cement) pipes with HDPE pipes.

The Proposed Action is not anticipated to have negative impacts on existing historic and cultural resources within the project area, nor is it anticipated to have any visual or coastal line-of-sight impacts. The Proposed Action is anticipated to have long-term beneficial economic impacts to the community and the State by providing much needed supply water intake upgrades that will allow the Aquarium to stay in operation.

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Attachment A

Experiment Report: Well Water Aeration and Precipitation (Oceanit)

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Attachment B

Benthic Survey Report: Vicinity of Intake Pipes and Seawall Cavity (Oceanit)

Attachment C

Waikīkī Aquarium Supply Water Quality Report (Oceanit)

Appendix B:

Geotechnical Engineering Exploration: Waikīkī Aquarium Improvements and Wastewater System Upgrades (2021)

GEOTECHNICAL ENGINEERING EXPLORATION

WAIKIKI AQUARIUM IMPROVEMENTS AND WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
TMK: 3-1-031: 006
HONOLULU, OAHU, HAWAII

JUNE 24, 2021

Prepared for:
OCEANIT

PROJECT NO. 030421-00

Kokua Geotech LLC
Soil and Foundation Engineering

June 24, 2021
Project No. 030421-00

Oceanit
828 Fort Street Mall, Suite 600
Honolulu, Hawaii 96813

Attention: Mr. Jordan Moniuszko

Subject: **Geotechnical Engineering Exploration**
Waikiki Aquarium Improvements and Wastewater System Upgrades
2777 Kalakaua Avenue
TMK: 3-1-031: 006
Honolulu, Oahu, Hawaii

Dear **Mr. Moniuszko**:

We are pleased to submit this report entitled "Geotechnical Engineering Exploration, Waikiki Aquarium Improvements and Wastewater System Upgrades, 2777 Kalakaua Avenue, TMK: 3-1-031: 006, Honolulu, Oahu, Hawaii" prepared for the design of the project.

The purpose of our field exploration and this report was to observe and evaluate the general subsurface conditions at accessible locations at the project site to formulate geotechnical recommendations to assist in the design of the project. Our work was performed in general accordance with the scope of services outlined in our fee proposal dated March 9, 2021.

Our findings and recommendations are summarized as follows:

1. Our field exploration at the project site generally encountered surface fill materials overlying beach deposits, lagoonal deposits, and apparent coral formation extending down to the maximum depth explored of about 42 feet below the existing ground surface. The surface fill materials encountered generally consisted of loose to medium dense clayey/silty sand and medium stiff to stiff clayey/sandy silt and were estimated to be about 1 to 3 feet thick.

   Beach deposits were encountered underlying the surface fill materials to depths ranging from about 8 to 10 feet below the existing ground surface and generally consisted of loose to medium dense sand with a little silt and gravel. Lagoonal deposits generally consisting of very loose to medium dense clayey gravel and very soft sandy clay were encountered underlying the beach deposits to a depth of about 40.5 feet below the existing ground surface.

It should be noted that the lagoonal deposits encountered at the project site are highly compressible when subjected to new loads. Below the highly compressible lagoonal deposits, our field exploration generally encountered apparent medium hard to hard coral formation extending down to the maximum depth explored of about 42 feet below the existing ground surface.

2. We encountered groundwater in our borings at depths ranging from about 7.3 to 8.1 feet below the existing ground surface at the time of our field exploration. Due to the proximity of the project site to the Pacific Ocean, groundwater levels are expected to vary with tidal fluctuations. In addition, groundwater levels may change due to seasonal precipitation, surface water runoff, and other factors.

3. We anticipate that installation of the new pumping station and piping will generally consist of trench excavation, pipe bedding and placement, and trench backfill. Based on an anticipated excavation depth of about 12 feet below the existing ground surface, we believe that dewatering may be needed.

4. Based on the results of our field exploration, we believe the near-surface soils would not provide adequate foundation support for the proposed pumping station without appreciable settlements and differential settlements under the anticipated loads. Therefore, we recommend utilizing a deep foundation system consisting of micropiles to support the proposed pumping station.

5. Based on availability of local equipment, we envision a micropile system with a minimum grout bulb diameter of 5.5 inches (minimum drill bit size) may be used for foundation support of the new pumping station structure. We recommend designing each micropile based on an allowable compressive load capacity of 30 kips for the 5.5-inch diameter micropiles.

6. We anticipate the load supporting capacity of the micropile foundation would be derived primarily from skin friction between the micropile shaft and the coralline materials anticipated underlying the project site. We also recommend using permanent steel casing for the micropiles that extend through the loose/soft, compressible beach and lagoonal deposits to the top of the coralline materials.

7. To achieve the allowable compressive load capacity of 30 kips with a factor of safety of 2, we believe the 5.5-inch diameter micropiles would need a minimum bonded zone of 20 feet below the permanent casing and extend a minimum of about 10 feet into the underlying coralline materials encountered in our boring at a depth of about 41 feet below the existing ground surface.

8. Based on our borings at the project site, excavations for the project may encounter loose to medium dense sandy soils with little to no cohesion. In general, we believe the sides of open excavations will generally be unstable unless properly sloped or shored and that temporary cut slopes for open cut excavations may not be practical. Therefore, it appears the trench walls would have to be cut near vertical necessitating the use of shoring during construction.

9. In general, the excavated on-site soils may be re-used as a source of general fill, provided they are free of vegetation, deleterious materials, and rock fragments greater than 3 inches in maximum dimension.

10. The construction plans and specifications for the project should be forwarded to us for review to determine whether the recommendations contained in this report are adequately reflected in those documents. If this review is not made, Kokua Geotech LLC cannot assume responsibility for misinterpretation of our recommendations.

11. Kokua Geotech LLC should also be retained to monitor the micropile installation, site grading, utility line installation and backfill, and other aspects of earthwork construction to determine whether the recommendations of this report are followed. The recommendations presented herein are contingent upon such observations.

    If the actual exposed subsurface soil conditions encountered during construction differ from those assumed or considered in this report, Kokua Geotech LLC should be contacted to review and/or revise the geotechnical recommendations presented herein.

Detailed discussion of our findings and geotechnical engineering recommendations are contained in the body of this report. We appreciate the opportunity to be of service for this project. Should you have any questions concerning this report, please contact our office.

Very truly yours,

Kokua Geotech LLC

____

Xiaobin (Tim) Lin, P.E.
President

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GEOTECHNICAL ENGINEERING EXPLORATION
WAIKIKI AQUARIUM IMPROVEMENTS AND WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
TMK: 3-1-031: 006
HONOLULU, OAHU, HAWAII

SECTION 1.0 INTRODUCTION

We have performed a geotechnical engineering exploration for the *Waikiki Aquarium Improvements and Wastewater System Upgrades* project in Honolulu on the Island of Oahu, Hawaii. The location of the project and general vicinity are shown on the Project Location Map, Plate 1.

The purpose of our exploration was to observe and evaluate the general subsurface conditions at accessible locations at the project site to formulate geotechnical recommendations to assist in the design of the project. This report summarizes the findings and presents our geotechnical recommendations resulting from our site reconnaissance, field exploration, laboratory testing, and engineering analyses for the project. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.1 PROJECT CONSIDERATIONS

The project generally involves improvements and wastewater system upgrades at the existing Waikiki Aquarium at 2777 Kalakaua Avenue in the Waikiki area of Honolulu on the Island of Oahu, Hawaii. Based on the information provided, we understand the improvements and upgrades will generally include a new pumping station, discharge sump, IW pre-filtration equipment pad, 10-inch piping, new seawater discharge piping, and three new injection wells. A layout of the project site is shown on the Site Plan, Plate 2.

Based on the information provided, we understand the new pumping station will have an invert depth of approximately 12 feet below the existing ground surface. In addition, we anticipate excavation depths on the order of about 5 to 12 feet may be required for installation of the new 10-inch piping and new seawater discharge piping. It should be noted that permeability testing to assist in the design of the new injection wells were not included in our scope of work for the project.

1.2 PURPOSE AND SCOPE OF WORK

The purpose of our geotechnical engineering exploration was to generally explore and evaluate the subsurface soil conditions at accessible locations at the project site to provide geotechnical recommendations to assist in the design of the project. Our work was performed in general accordance with our fee proposal dated March 9, 2021. The scope of work for this exploration included the following items:

1. Coordination of boring stake-out and utility clearances by our engineer.
2. Mobilization and demobilization of a truck-mounted drill rig and two operators to and from the project site.
3. Drilling, hand augering, and sampling of four boreholes extending to depths ranging from about 3 to 42 feet below the existing ground surface.
4. Performance of Dynamic Cone Penetrometer (DCP) testing at the hand auger location to evaluate the relative consistency of the subsurface materials encountered.
5. Coordination of the field exploration and logging of the boreholes by our field engineer.
6. Laboratory testing of selected samples obtained during the field exploration as an aid in classifying the materials and evaluating their engineering properties.
7. Analyses of the field and laboratory data to formulate geotechnical recommendations for design of the project.
8. Preparation of this report summarizing our work on the project and presenting our findings and recommendations.

Detailed descriptions of our field exploration methodology are presented in the following section and the Log of the Boring in Appendix A. Results of the laboratory tests performed are presented in Appendix B. Results of the DCP tests performed are presented in Appendix C.

END OF INTRODUCTION

SECTION 2.0 SITE CHARACTERIZATION AND FINDINGS

2.1 GENERAL SITE GEOLOGY

The project site is generally located on the southeastern flank of the Koolau Volcano on the Island of Oahu. Based on the geologic maps of the Island of Oahu (Stearns, 1939 and Sherrod and others, 2007), the general area of the project sites is underlain by Beach Deposits (Qbd) and Alluvium (Qa).

During the Pleistocene Epoch, a time period that began about 2.6 million years ago and lasted until about 11,700 years ago, sea levels fluctuated in response to the cycles of continental glaciation. As the glaciers grew and advanced, less water was available to fill the oceanic basins such that sea levels fell below the present stands of the sea. When the glaciers melted and receded, an excess of water became available such that the sea levels rose to above the present sea level.

The higher sea level stands caused the formation of deltas and fans of accumulated terrigenous sediments in the heads of old bays, accumulated reef deposits at correspondingly higher elevations, and deposited lagoonal/marine sediments in the quiet waters protected by fringing reefs. The processes of landform erosion, sediment deposition, and reef development were affected by these glacio-eustatic sea level fluctuations.

When the sea level was relatively lower, the erosional base level was correspondingly lower and stream valleys were carved deeper into the Island’s basaltic rock, the fringing coastal sediments, and the offshore reef deposits. Also, during periods of relatively lower sea level, the sub-aerial exposure of calcareous marine sediments caused consolidation and cementation of the deposits to form hardened calcareous deposits.

Placement of near-surface man-made fills associated with the development of urban areas within the last 80 years has brought the Honolulu Coastal Plain to its present form. In the early part of this century, much of the Waikiki area consisted of low elevation marsh wetlands. As the City of Honolulu grew and the Waikiki area was urbanized, man-made fills were placed to

reclaim the marshy areas and lagoons for development. It should be noted that much of the resulting fill materials placed are of poor quality in terms of supporting heavy structural loads.

The surface soils underlying the project sites are classified as Beaches (BS) and Jaucas Sand (JaC) by the U.S. Soil Conservation Service in their publication "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii" (1972). The Beaches (BS) soil type is described as light-colored sands derived from coral and seashells that are washed and rewashed by ocean waves. Similarly, the Jaucas Sand soil type is described as light brown, excessively drained, calcareous soils that occur in narrow strips on coastal plains adjacent to the ocean that developed in wind and water deposited sand from coral and seashells.

2.2 SITE DESCRIPTION

The project site is at the existing Waikiki Aquarium located at 2777 Kalakaua Avenue in the Waikiki area of Honolulu on the Island of Oahu, Hawaii. This facility is generally bordered by Sans Souci State Recreational Park to the north, Waikiki War Memorial Natatorium to the south, Kalakaua Avenue to the east, and the Pacific Ocean to the west. In general, this facility includes aquarium and lobby building structures, numerous aquatic tank structures, water features, comfort station, and access driveway and parking areas.

In general, the topography of the project site appears to be relatively flat. Based on topographic survey information provided, we anticipate existing ground surface elevations to range from roughly +6 to +9 feet Mean Sea Level (MSL).

At the time of our field exploration, the existing building and tank structures were generally surrounded by concrete walkways, mown lawn grass, and various landscaping plants. Exposed surface soils at the site were observed to generally consist of brownish tan beach sand.

2.3 FIELD EXPLORATION

We explored the subsurface conditions at the project site by drilling, hand augering, and sampling four borings, designated as Boring Nos. 1 through 4, extending to depths ranging from approximately 3 to 42 feet below the existing ground surface. Boring Nos. 1 through 3 were drilled utilizing a truck-mounted drill rig equipped with continuous flight augers, while Boring No. 4 was advanced using hand auger and Dynamic Cone Penetrometer (DCP) testing equipment due to an abundance of underground utility lines in the area. The approximate boring and DCP test locations are shown on the Site Plan, Plate 2.

Our engineer classified the materials encountered in the boring 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). Graphic representations of the materials encountered are presented on the Log of Borings, Appendix A.

Soil samples were obtained in general accordance with ASTM D1586 by driving a 2-inch OD standard penetration sampler with a 140-pound hammer falling 30 inches. In addition, relatively undisturbed soil samples were obtained in general accordance with ASTM D3550 by driving a 3-inch OD Modified California 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 “Sampling Resistance” on the Log of Boring at the appropriate sample depths. The blow counts may need to be factored to obtain the Standard Penetration Test (SPT) blow counts.

It should be noted that hollow stem augers were used to advance Boring No. 1 to the maximum auger depth of about 30 feet below the existing ground surface. Since very soft/loose soil conditions were encountered at this depth, probing operations were implemented within the borehole to determine the approximate depth to stiff/dense soil conditions. Probing operations generally consisted of driving a pointed steel probing tip with a 140-pound hammer falling 30 inches. The blow counts needed to drive the probing tip 12 inches are shown on the Logs of Borings at the appropriate sample depths.

In addition, a 2-inch diameter PVC water pipe was encountered and damaged during our drilling operations at Boring No. 3 at a depth of about 1.5 feet below the existing ground surface. This pipe was subsequently repaired, and the water system chlorinated.

The DCP tests were performed at the hand auger locations by driving a 1.5-inch diameter 45-degree steel cone tip with a 15-pound hammer falling 20 inches in vertical height. The blow counts were recorded per every or near 1-inch of penetration and converted to standard penetration resistance (SPT) using correlation between Penetration Index (PI) and SPT, developed by Sowers and Hedges. Results of the DCP tests performed are presented in Appendix C.

2.4 LABORATORY TESTING

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 Log of the Boring at the appropriate sample depths.

Two Atterberg Limits tests (ASTM D4318) were performed on selected soil samples to evaluate the liquid and plastic limits. The samples tested had Plasticity Indices (PIs) of 26 and 16 and plotted as low plasticity clay (CL) on a Standard Plasticity Chart. The test results are summarized on the Logs of Borings at the appropriate sample depths. Graphic presentations of the Atterberg Limits test results are provided on Plate B-1.

Three Sieve Analysis tests (ASTM C117 and C136) were performed on selected soil samples to evaluate the gradation characteristics of the soil and to aid in soil classification. Graphic presentations of the grain size distributions are provided on Plate B-2.

One, one-inch Ring Swell test was performed on a relatively undisturbed (natural) sample to evaluate the swelling potential of the on-site soils. A swell test result of 0.5 percent was observed for the sample under a surcharge pressure of 60 pounds per square foot (psf). These test results indicate the on-site soils have low swelling potential when subjected to moisture fluctuations. The Ring Swell test results are summarized on Plate B-2.

2.5 SUBSURFACE CONDITIONS

Our borings generally encountered surface fill materials overlying beach deposits, lagoonal deposits, and apparent coral formation extending down to the maximum depth explored of about 42 feet below the existing ground surface. In addition, Boring No. 3 was located on an existing pavement surface and generally encountered an approximate 3-inch thick layer of asphaltic concrete overlying the surface fill materials. The surface fill materials encountered generally consisted of loose to medium dense clayey/silty sand and medium stiff to stiff clayey/sandy silt and were estimated to be about 1 to 3 feet thick.

Beach deposits were encountered underlying the surface fill materials to depths ranging from about 8 to 10 feet below the existing ground surface and generally consisted of loose to medium dense sand with a little silt and gravel. Lagoonal deposits generally consisting of very loose to medium dense clayey gravel and very soft sandy clay were encountered underlying the beach deposits to a depth of about 40.5 feet below the existing ground surface.

It should be noted that the lagoonal deposits encountered at the project site are highly compressible when subjected to new loads. Below the highly compressible lagoonal deposits, our field exploration generally encountered apparent medium hard to hard coral formation extending down to the maximum depth explored of about 42 feet below the existing ground surface.

We encountered groundwater in our borings at depths ranging from about 7.3 to 8.1 feet below the existing ground surface at the time of our field exploration. Due to the proximity of the project site to the Pacific Ocean, groundwater levels are expected to vary with tidal fluctuations. In addition, groundwater levels may change due to seasonal precipitation, surface water runoff, and other factors.

2.6 SEISMIC DESIGN CONSIDERATIONS

Based on the International Building Code, 2012 Edition (IBC 2012) and American Society of Civil Engineers Standard ASCE/SEI 7-10 (ASCE 7-10), the project site may be subject to seismic activity, and seismic design considerations will need to be addressed. Based on the subsurface materials encountered at the project site and the geologic setting of the area, we anticipate the project site may be classified from a seismic analysis standpoint as being a “Soft Soil Profile” site corresponding to a Site Class E soil profile type based on Chapter 20 of ASCE 7-10.

Based on Site Class E, the following seismic design parameters were estimated and may be used for seismic analysis of the project.

SUMMARY OF SEISMIC DESIGN PARAMETERS	
Mapped MCE Spectral Response Acceleration, S_S	0.579g
Mapped MCE Spectral Response Acceleration, S_1	0.170g
Site Class	E
Site Coefficient, F_a	1.542
Site Coefficient, F_v	3.291
Design Spectral Response Acceleration, S_{DS}	0.595g
Design Spectral Response Acceleration, S_{D1}	0.372g
Peak Ground Acceleration, PGA	0.266g
Site Modified Peak Ground Acceleration, PGA_M	0.364g

Based on the IBC 2012, the project site may be subjected to seismic activity and should be evaluated for soil liquefaction potential. In general, the subsurface information from our field exploration indicates that the site is underlain by surface fill materials and overlying beach deposits generally consisting of loose to medium dense sand with a little silt and gravel and lagoonal deposits consisting of very loose to loose clayey gravel and very soft sandy clay to a depth of about 41 feet below the existing ground surface. In general, these loose sandy soils can be considered potentially liquefiable during a seismic event.

Based on the Atterberg Limits conducted on some of these soils, the liquid limits of the soils are in excess of 35, which is the maximum number for the soils to be considered potentially liquefiable (Youd, et. al, 2001). In addition, soils with a Plasticity Index (PI) greater than 7 are considered to have a clay-like behavior and are generally not susceptible to liquefaction (AASHTO LRFD Bridge Design Specifications, 2017 and Boulanger, Idriss, 2006).

Based on the results of our laboratory testing program, we believe that the loose to very loose lagoonal deposits encountered in our borings are not susceptible to liquefaction because of the clayey nature (more cohesive soil properties) of the granular soils encountered, especially the clayey gravel (GC) and sandy clay (CL) soil classifications. In general, we anticipate very loose sandy soils with little to no cohesion may be present underlying the project site; however, we believe that these materials occur in isolated pockets and are not continuous across the entire site.

END OF SITE CHARACTERIZATION AND FINDINGS

SECTION 3.0 DISCUSSION AND RECOMMENDATIONS

Based on the results from our field exploration, the project site is generally underlain by surface fill materials overlying beach deposits, lagoonal deposits, and apparent coral formation extending down to the maximum depth explored of about 42 feet below the existing ground surface. The surface fill materials encountered generally consisted of loose to medium dense clayey/silty sand and medium stiff to stiff clayey/sandy silt and were estimated to be about 1 to 3 feet thick.

Beach deposits were encountered underlying the surface fill materials to depths ranging from about 8 to 10 feet below the existing ground surface and generally consisted of loose to medium dense sand with a little silt and gravel. Lagoonal deposits generally consisting of very loose to medium dense clayey gravel and very soft sandy clay were encountered underlying the beach deposits to a depth of about 40.5 feet below the existing ground surface.

It should be noted that the lagoonal deposits encountered at the project site are highly compressible when subjected to new loads. Below the highly compressible lagoonal deposits, our field exploration generally encountered apparent medium hard to hard coral formation extending down to the maximum depth explored of about 42 feet below the existing ground surface.

We encountered groundwater in our borings at depths ranging from about 7.3 to 8.1 feet below the existing ground surface at the time of our field exploration. Due to the proximity of the project site to the Pacific Ocean, groundwater levels are expected to vary with tidal fluctuations. In addition, groundwater levels may change due to seasonal precipitation, surface water runoff, and other factors.

Based on the information provided, we understand the planned improvements and upgrades to the aquarium facility will generally include a new pumping station, discharge sump, IW pre-filtration equipment pad, 10-inch piping, new seawater discharge piping, and three new injection wells. we understand the new pumping station will have an invert depth of approximately 12 feet below the existing ground surface. In addition, we anticipate excavation depths on the order of about 5 to 12 feet may be required for installation of the new 10-inch piping and new seawater discharge piping.

We anticipate that installation of the new pumping station and piping will generally consist of trench excavation, pipe bedding and placement, and trench backfill. Based on an anticipated excavation depth of about 12 feet below the existing ground surface, we believe that dewatering may be needed.

Based on the results of our field exploration, highly compressible recent lagoonal deposits are anticipated at depths of about 8 to 10 feet below the existing ground surface. Therefore, we anticipate relatively significant ground settlements may occur when new fills and structures are placed over these highly compressible soils, with resulting distress to the structures.

Based on the above, we believe the near-surface soils would not provide adequate foundation support for the proposed pumping station without appreciable settlements and differential settlements under the anticipated loads. Therefore, we recommend utilizing a deep foundation system to support the proposed pumping station. Based on our evaluation, we recommend the deep foundation support system consist of micropiles extending through the loose/soft, compressible beach and lagoonal deposits and deriving load bearing support from the underlying coralline materials anticipated at greater depths.

In general, the excavated on-site soils may be re-used as a source of general fill, provided they are free of vegetation, deleterious materials, and rock fragments greater than 3 inches in maximum dimension. Imported fill materials, if required, should consist of non-expansive structural fill material, such as crushed coral or basalt.

Detailed discussion of these items and our geotechnical recommendations for design of the new pumping station, slabs-on-grade, trench excavation, backfilling, dewatering, and other geotechnical aspects of the project are presented in the following sections.

3.1 NEW PUMPING STATION

Based on the information provided, we understand the new pumping station will have an invert depth of approximately 12 feet below the existing ground surface. As discussed above, we believe the near-surface soils would not provide adequate foundation support for the proposed pumping station without appreciable settlements and differential settlements under the anticipated loads. Therefore, we recommend utilizing a deep foundation system to support the proposed underground pumping station.

Based on our evaluation, we recommend the deep foundation support system consist of micropiles extending through the loose/soft, compressible beach and lagoonal deposits and deriving load bearing support from the underlying coralline materials anticipated at greater depths.

3.1.1 NEW PUMPING STATION FOUNDATIONS

In general, a micropile consists of a small diameter (usually less than 12 inches) drilled and grouted pile with steel reinforcing. The micropile foundation typically is constructed by drilling a borehole, placing reinforcing steel in the hole, and grouting the borehole. Micropiles are desirable because they can be installed readily in access restrictive environments and in numerous soil types and ground conditions. In addition, installation of the micropiles generally causes minimal disturbance to the adjacent structures, the adjacent soils, and the environment.

Based on availability of local equipment, we envision a micropile system with a minimum grout bulb diameter of 5.5 inches (minimum drill bit size) may be used for foundation support of the new pumping station structure. We recommend designing each micropile based on an allowable compressive load capacity of 30 kips for the 5.5-inch diameter micropiles. The allowable compressive load capacity for the micropiles is for supporting dead-plus-live loads and may be increased by one-third (1/3) for transient loads, such as wind or seismic forces.

Based on the anticipated subsurface conditions at the project site, we anticipate the load supporting capacity of the micropile foundation would be derived primarily from skin friction between the micropile shaft and the coralline materials anticipated underlying the project site. We also recommend using permanent steel casing for the micropiles that extend through the loose/soft, compressible beach and lagoonal deposits to the top of the coralline materials. The permanent steel casing should have an outside diameter (OD) of about 5.5 inches (same as the grout bulb size) and should provide confinement to the micropile in the area where moment demand on the micropile is greatest.

To achieve the allowable compressive load capacity of 30 kips with a factor of safety of 2, we believe the 5.5-inch diameter micropiles would need a minimum bonded zone of 20 feet below the permanent casing and extend a minimum of about 10 feet into the underlying coralline materials encountered in our boring at a depth of about 41 feet below the existing ground surface.

Based on topographic survey information provided, we anticipate existing ground surface elevations to range from roughly +6 to +9 feet Mean Sea Level (MSL). Therefore, we recommend a minimum micropile tip elevation of about -44 feet MSL based on a total micropile length of about 51 feet installed on an assumed working grade of about +7 feet MSL. Based on these assumptions, our recommendations pertaining to the preliminary micropile allowable load capacities and lengths are presented in the following table:

SUMMARY OF MICROPILE FOUNDATIONS

Micropile Diameter (inch)	**Allowable Compressive Load Capacity** (kips)	**Minimum Micropile Tip Elevation** (feet MSL)	**Minimum Bonded Zone Length** (feet)	**Total Estimated Micropile Length** (feet)
5.5	30	-44	20 feet and 10 feet min. into hard coralline materials	51

Notes:
1. Min. Tip Elevation and Total Estimated Micropile Length assumes working grade of +7 feet MSL
2. Permanent casing should be used below the pumping station invert to the top of bonded zone
3. Minimum Bonded Zone Length is the length of micropile below the bottom of permanent casing

To facilitate the micropile drilling and ensure the quality of the grouting, we recommend advancing the steel casing to the bottom of the micropile during the drilling operation. The steel casing may be withdrawn during the grouting operation while a minimum of 5 feet of grout head is maintained above the bottom of the casing at all times. The steel casing should be withdrawn above the design casing depth and plunged back to the design casing depth.

Lateral loads imposed on the foundations should be resisted by the passive earth pressure acting against the near-vertical faces of the foundation caps. Lateral load resistance contribution from the micropile should be discounted due to the relatively small diameter of the foundation element. Passive earth pressure against the near-vertical faces of the foundation caps may be estimated using an equivalent fluid pressure of 350 and 150 pounds per cubic foot (pcf) for above and below groundwater conditions, respectively.

Settlements of the micropiles will result primarily from elastic compression of the micropile member and subgrade response. We estimate the total settlement of the micropile-supported foundations to be 0.5 inches or less with differential settlements between micropiles not exceeding about one-half of the total settlement. We believe these settlements are essentially elastic and should occur as the loads are applied.

In order to determine whether the contractor’s methods of micropile installation are adequate and to determine the ultimate compressive load capacity, we recommend performing one pre-production compressive load test on a sacrificial micropile.

In general, the purpose of the pre-production load test on a micropile is to fulfill the following objectives:

- To examine the adequacy of the methods and equipment proposed by the contractor to install the micropiles to the depths required.

- To confirm or modify the estimated minimum depth of the micropiles by determining the ultimate grout-to-soil bond stress.
- To assess the contractor's method of drilling and grouting.

In general, the pre-production load test should be performed in accordance with ASTM D1143. Based on experience, we believe the load test should be conducted no earlier than 7 days after completion of the micropile installation to allow the grout adequate time to cure. Two (or four) additional micropiles may be used for reaction during the compressive load testing of the pre-production load test micropile. The reaction micropiles may be installed to depths as deep as the load test micropile to provide adequate reaction in uplift (to be determined by the contractor).

The load test micropile should be loaded gradually to at least 200 percent of the allowable design load in compression. We recommend holding the maximum test load (200 percent of the design load) for a minimum of 4 hours depending on the recorded movements of the load test micropile. The pre-production load test is an integral part of the design of the micropile foundation system. Therefore, we recommend a Kokua Geotech LLC representative observe the pre-production load test.

In addition to the pre-production load test, we also recommend performing pullout tests (proof tests) on selected micropiles during construction to confirm the load carrying capacity of the installed micropiles. We recommend testing a minimum 10 percent of the total number of micropiles for pullout. The pullout tests should consist of subjecting the micropile to at least 133 percent of the design load. The micropile should be loaded in 12.5% design load increments, and each load should be held for at least 5 minutes. The maximum test load should be held for a minimum of 10 or 60 minutes. Pullout test on the selected micropiles is an integral part of the design of the micropile foundation system. Therefore, we recommend conducting the pullout tests under the observation of a Kokua Geotech LLC representative.

A specialty contractor experienced in the construction of a micropile foundation system (minimum five projects) should perform the installation of the micropiles. Due to the specialized nature of the micropile foundation construction, observation and testing of the micropile foundation system should be designated as a "Special Inspection" item. Therefore, a Kokua Geotech LLC representative (Special Inspector) should be present to observe the geotechnical aspects of the micropile foundation construction and testing.

3.1.2 NEW PUMPING STATION LATERAL EARTH PRESSURES

The new pumping station should be designed to resist lateral earth pressures due to the adjacent soils and surcharge effects caused by loads adjacent to the walls. The recommended lateral earth pressures for the design of the new pumping station, expressed in equivalent fluid pressures of pounds per square foot per foot of depth (pcf), are presented in the following table.

LATERAL EARTH PRESSURES FOR DESIGN OF RETAINING STRUCTURES			
Level Backfill Condition	**Earth Pressure Component**	**Active** (pcf)	**At-Rest** (pcf)
Above Groundwater	Without Hydrostatic Pressure	40	60
Below Groundwater	With Hydrostatic Pressure	82	91
	Without Hydrostatic Pressure	19	29

The values provided in the table above assume that on-site soils and/or structural fill materials will be used to backfill around the new pumping station. It is assumed that the backfill around the new pumping station will be compacted to between 90 and 95 percent relative compaction per ASTM D1557. Over compaction of the retaining structure backfill should be avoided.

In general, an active condition may be used only for walls that are free to deflect by as much as 0.5 percent of the structure height. If the top of the structure is not free to deflect beyond this degree, the structure 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 structures.

Surcharge stresses due to areal surcharges, 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 structure, a rectangular distribution with a uniform pressure equal to 33 percent of the vertical surcharge pressure acting over the entire height of the structure, which is free to deflect (cantilever), may be used in the design.

For structure walls that are restrained, a rectangular distribution equal to 50 percent of the vertical surcharge pressure acting over the entire height of the structure may be used for design. Additional analyses during design may be needed to evaluate the surcharge effects of point loads and line loads.

Dynamic lateral earth forces due to seismic loading will need to be considered in the design of the retaining structures. Seismic loading is used to estimate the dynamic lateral earth pressure based on a peak ground acceleration (PGA or a_{max}) of 0.364g. The table below summarizes the dynamic lateral earth forces acting on the structure walls in the event of an earthquake versus the estimated wall displacements.

Please note that the values provided in the table only apply to level backfill conditions, where H is the height of the wall in feet. The resultant force should be assumed to act through the mid-height of the wall. The dynamic lateral earth forces are in addition to the static lateral earth pressures provided previously.

DYNAMIC LATERAL EARTH FORCES FOR RETAINING STRUCTURES	
Lateral Movement (inches)	Dynamic Lateral Earth Forces (H^2 pounds per linear foot)
0.5	32.8

DYNAMIC LATERAL EARTH FORCES FOR RETAINING STRUCTURES	
Lateral Movement (inches)	Dynamic Lateral Earth Forces (H^2 pounds per linear foot)
1.0	26.4
1.5	21.5
2.0	17.4
Note: H is the height of the retaining structure in feet.	

3.2 SLABS-ON-GRADE

We anticipate that concrete slabs-on-grade will be utilized for the new equipment pads at the project site. Our laboratory test results indicate the on-site clayey soils have low expansion potential when subjected to moisture fluctuations. To provide uniform bearing conditions and reduce the potential for changes in the moisture content of the slab subgrade clayey soils, we recommend capping the slab subgrade with a minimum 6-inch thick layer of non-expansive structural fill material. The structural fill should be compacted to a minimum of 90 percent relative compaction.

Structural fill should be imported, non-expansive granular material, such as crushed coral or basalt. The structural fill should be well-graded from coarse to fine with particles no larger than 3 inches in largest dimension. The material should have a CBR value of 20 or higher and a swell potential of 1 percent or less when tested in accordance with ASTM D1883. The material should also contain between 10 and 30 percent particles passing the No. 200 sieve.

Prior to placing the non-expansive structural fill, we recommend scarifying the subgrade soils to a depth of about 10 inches, moisture-conditioning the soils to above the optimum moisture content, and compacting to a minimum of 90 percent relative compaction. The underlying subgrade soils and structural fill should be wetted and kept moist until the final placement of slab concrete. Saturation and subsequent yielding of the exposed subgrade due to inclement weather and poor drainage may require over excavation of the soft areas and replacement with structural fill.

The thickened edges of slabs adjacent to unpaved areas should be embedded at least 12 inches below the lowest adjacent grade. It should be emphasized that the areas adjacent to the slab edges should be backfilled tightly against the edges of the slabs with relatively impervious soils. These areas should also be graded to divert water away from the slabs and to reduce the potential for water ponding around the slabs.

3.3 OPEN TRENCH (CUT-AND-COVER) METHOD FOR PIPING

We envision the new underground piping planned for the project would likely be installed using conventional open trench (cut-and-cover) methods. Based on the information provided, we understand the new pumping station will have an invert depth of approximately 12 feet below the existing ground surface. In addition, we anticipate excavation depths on the order of about 5 to 12 feet will be required for installation of the new 10-inch piping and new seawater discharge piping.

3.3.1 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 friction resistance between the backfill material and the trench walls. To calculate the vertical loads on the buried utility pipe, we recommend that an average unit weight of 110 pounds per cubic feet (pcf) for the backfill material and a coefficient of friction of 0.3 be used. Earth forces acting upon the pipe generally 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.

3.3.2 TRENCH EXCAVATION

All excavations should be made in accordance with applicable Occupational Safety and Health Administration (OSHA) and state regulations. The contractor should determine the method and equipment to be used for the excavations, subject to practical limits and safety considerations. In addition, the excavations should comply with the applicable federal, state, and local safety requirements. The contractor should be responsible for trench shoring design and installation.

As mentioned above, we anticipate excavation depths up to about 12 feet deep may be required for installation of the new pumping station and piping. Based on our borings, trench excavations will likely encounter beach deposits generally consisting of loose to medium dense sand with a little silt and gravel. In addition, these excavation may encounter lagoonal deposits generally consisting of very loose to medium dense clayey gravel and very soft sandy clay.

It is anticipated that most of the material may be excavated with normal heavy excavation equipment. However, deep excavations and excavations encountering boulders and hard coral formation may require the use of hoerams. It should be noted that coral formations typically contain localized hard and crystallized zones. Therefore, we anticipate that some difficult excavation conditions may arise in localized areas during construction when the coral formation is encountered.

The contractor must exercise care to avoid over-ripping, which would disrupt the structure of the coral formation, resulting in a potential loss of bearing strength for improvements in the vicinity. Contractors should be encouraged to examine the site conditions and the subsurface data to make their own reasonable and prudent interpretation.

3.3.3 TRENCH EXCAVATION SUPPORT

We anticipate excavation depths up to about 12 feet below the existing ground surface will be required for the installation of the new pumping station and piping. Where excavations greater than 5 feet in depth are planned, temporary shoring or sloping and benching should be used. Based on our borings at the project site, these excavations may encounter loose to medium dense sandy soils with little to no cohesion. Therefore, the sides of open excavations will generally be unstable unless properly sloped or shored.

Based on our site observations, we believe that temporary cut slopes for open cut excavations may not be practical. Therefore, it appears the trench walls would have to be cut near vertical necessitating the use of shoring during construction.

The excavation support and shoring system used must comply with applicable safety requirements. The contractor should be solely responsible for the adequacy and safety of the shoring installation. The contractor's representative should be on-site at all times during excavation and construction work for the opportunity to promptly observe changing or unforeseen conditions, such as, high groundwater, inappropriate construction sequence or techniques, etc., which may affect the shoring stability.

Excavated soils should not be stockpiled closer than a horizontal distance equal to the depth of the excavation from the edge of the excavation to reduce the potential for excessive ground movement.

It is important to install adequate shoring and to maintain it tight against the excavation walls with proper bracing during construction. The properly braced shoring is essential to reduce the potential for appreciable lateral movements of the adjacent ground into the excavation, which may result in potential settlement or distress to adjacent structures or other improvements.

It must be noted that some minor movements 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 movement. The magnitude also depends greatly upon workmanship, such as how quickly and tightly the shoring and bracing supports are installed, the subsurface conditions, the size of the excavation, and the rate of excavation.

Therefore, it is important to realize that the excavation shoring should be installed properly and as early as practical. The adjacent ground should be continuously monitored for cracks, dips and/or other indications of movements with instruments until the trench excavations are finally backfilled.

3.3.4 PIPE BEDDING

The stress distribution against the bottom of a pipe has a significant effect on the load supporting capacity of the pipe. Therefore, the pipe bedding is an important design consideration. In general, we recommend providing granular bedding consisting of 6 inches of open-graded gravel, such as No. 3 Fine gravel (ASTM C33, No. 67 gradation), under the pipes for uniform support.

In addition, open-graded gravel (ASTM C33, No. 67 gradation) should also be used for the initial trench backfill up to about 12 inches above the pipes (or groundwater level) to provide adequate support around the pipes. It is critical to use a free-draining material, such as open-graded gravel, to reduce the potential for formation of voids below the haunches of pipes and to provide adequate support for the sides of the pipes. Improper trench backfill could result in backfill settlement and pipe damage. Where groundwater is encountered, the bedding should be wrapped on all sides by non-woven filter fabric (Mirafi 180N or equivalent).

We envision soft and/or loose soils may be encountered at or near the invert elevations along portions of the new utility lines. Therefore, we recommend providing a subgrade stabilization layer consisting of 18 inches of No. 2 Rock (ASTM C 33, No. 4 gradation) wrapped in a non-woven filter fabric (Mirafi 180N or equivalent) below the bedding layer for uniform support, if soft and/or loose soils are encountered. The stabilization layer should extend beyond the sides of the pipe a minimum width of one-fourth the outside diameter of the pipe or 12 inches, whichever is greater.

Before the placement of bedding material, a Kokua Geotech LLC representative should observe the excavated trench bottom to confirm that firm materials are exposed at the bottom of the trench or whether the installation of a stabilization layer is needed.

3.3.5 TRENCH BACKFILL

As discussed above, the first zone of backfill extending from the bedding material to at least 12 inches above the top of the pipes (or groundwater level) should consist of open-graded gravel, such as No. 3 Fine gravel (ASTM C33, No. 67 gradation) to reduce the compaction effort required and resulting stresses on the pipe.

The trench backfill from 12 inches above the top of the pipes (or groundwater level) to the finished subgrade may consist of the excavated on-site soils provided that they are free of deleterious materials (vegetation) and are screened of particles greater than 3 inches in largest dimension.

Imported fill materials, if required, should consist of non-expansive structural fill material, such as crushed coral or basalt. The structural fill should be well-graded from coarse to fine with particles no larger than 3 inches in largest dimension. The material should have a CBR value of 20 or higher and a swell potential of 1 percent or less when tested in accordance with ASTM D1883. The material should also contain between 10 and 30 percent particles passing the No. 200 sieve.

3.3.6 TRENCH BACKFILL PLACEMENT AND COMPACTION REQUIREMENTS

The backfill materials consisting of the on-site soils 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 below the finished pavement grade in areas subjected to vehicular traffic should be compacted to a minimum of 95 percent relative compaction.

The backfill materials consisting of open-graded gravel, such as No. 3 Fine gravel (ASTM C33, No. 67 gradation), should generally be placed in level lifts not exceeding 8 inches in loose thickness and compacted to a firm surface.

Imported non-expansive structural fill materials, if required, should be moisture-conditioned to above the optimum moisture, placed in level lifts of about

8 inches in loose thickness, and compacted to a minimum of 90 percent relative compaction. Aggregate base course materials, if required, 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 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 determined in accordance with ASTM D1557. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

3.3.7 SETTLEMENTS

Primary settlement of new utility lines are normally caused by the difference in the unit weight of the lighter excavated original earth and the heavier compacted backfill material placed over the pipes. The net increase in loading will cause settlement of the underlying subsoils below the trench invert. Based on our calculations, primary settlement on the order of less than 0.5 inches is anticipated for the project.

The above estimate assumes that proper construction procedures and good workmanship will be engaged during construction. Additional settlement could occur if improper trench support is used.

3.4 DEWATERING

During our field exploration, we encountered groundwater at depths ranging from about 7.3 to 8.1 feet below the existing ground surface. Due to the relatively shallow groundwater levels encountered at the project site, we anticipate that the pumping station and piping to be installed may extend below the groundwater level. Therefore, dewatering of the excavation may be necessary for this installation.

In general, dewatering operations should be conducted in such a manner that dewatering will not cause areal ground subsidence, which may cause potential damage to the nearby existing structures. Therefore, consideration should be given to a dewatering system that includes a cut-off wall to reduce the volume of water to be removed within the excavation and to reduce the areal extent of groundwater drawdown outside of the excavation.

Because the excavation dewatering may involve the discharge of groundwater from the dewatering operation into adjacent drainage systems, a National Pollutant Discharge Elimination System (NPDES) permit may be necessary. The contractor should consult their independent consultant or the State of Hawaii, Department of Health for the latest regulations and information pertaining to the NPDES permit application.

Based on our borings, we anticipate the project site is generally underlain by loose to dense beach deposits and very loose to loose lagoonal deposits to a depth of about 40.5 feet below the existing ground surface. Due to the heterogeneous nature of these materials, the actual subsurface soil permeability may range broadly and also vary locally in terms of orders of magnitude. The permeability of the subsurface materials at the sites may be considered moderately to highly permeable based on the materials encountered. Therefore, the contractor should pay special attention to the site-specific dewatering plan for the proposed excavations.

3.5 PRECONSTRUCTION DISTRESS SURVEY AND MONITORING

Due to the close proximity of the planned excavations to existing structures at the project site and the anticipated dewatering operations, we recommend performing a preconstruction distress survey to document the existing conditions prior to the start of construction. The survey should include photographs and detailed descriptions of pre-existing distresses.

In addition, implementation of a monitoring program for building movement is recommended for the project. The monitoring program should consist of the installation of structure monitoring points on the existing building footing columns that are in close proximity to the planned excavations to measure changes in the vertical and horizontal position during the monitoring period.

Prior to the start of construction, the monitoring points should be surveyed to establish initial readings for the monitoring points. Benchmarks should be established for the survey work. Surveyed readings of the monitoring points should be taken daily during construction and weekly subsequent to construction until the contract completion date. The survey readings should be submitted promptly for review.

3.6 DESIGN REVIEW AND CONSTRUCTION OBSERVATION SERVICES

The construction plans and specifications for the project should be forwarded to us for review to determine whether the recommendations contained in this report are adequately reflected in those documents. If this review is not made, Kokua Geotech LLC cannot assume responsibility for misinterpretation of our recommendations.

Kokua Geotech LLC should also be retained to monitor the micropile installation, site grading, utility line installation and backfill, and other aspects of earthwork construction to determine whether the recommendations of this report are followed. The recommendations presented herein are contingent upon such observations. If the actual exposed subsurface soil conditions encountered during construction differ from those assumed or considered in this report, Kokua Geotech LLC should be contacted to review and/or revise the geotechnical recommendations presented herein.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4.0 LIMITATIONS

This report has been prepared for the exclusive use of Oceanit and their project consultants for specific application to the design of the *Waikiki Aquarium Improvements and Wastewater System Upgrades* project in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied. If any part of the project concept is altered or if subsurface conditions differ from those described in this report, then the information presented herein shall be considered invalid, unless the changes are reviewed, and any supplemental or revised recommendations issued in writing by Kokua Geotech LLC.

The analyses and report recommendations are based in part upon information obtained from the field boring and the assumption that subsurface conditions do not vary significantly from those observed in the boring. Variations of the subsurface conditions beyond the field boring may occur, and the nature and extent of these variations may not become evident until construction is underway. If variations then appear evident, Kokua Geotech LLC should be notified so that we can re-evaluate the recommendations presented herein.

The owner/client should be aware that unanticipated soil conditions are commonly encountered. 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.

The field boring locations indicated herein is approximate, having been estimated by taping from visible features shown on the Site Plan transmitted by Oceanit on March 4, 2021. Elevations of the borings were estimated from spot elevations shown on topographic survey plans transmitted by Oceanit on June 11, 2021. The field boring locations and elevation should be considered accurate only to the degree implied by the methods used.

The stratification breaks shown on the graphic representations of the boring depict the approximate boundaries between soil types and, as such, may denote a gradual transition. Water level data from the boring was measured at the time of drilling. However, groundwater levels may change due to seasonal precipitation, tidal fluctuation, surface water runoff, and other factors. These data have been reviewed and interpretations made in the formulation of this report.

This report has been prepared solely for the purpose of assisting the design engineers in the design of the project. Therefore, this report may not contain sufficient data, or the proper information, to serve as a basis for detailed construction cost estimates.

This geotechnical engineering exploration conducted at the project site was not intended to investigate the potential presence of hazardous materials existing at the project site. It should be noted that 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

Log of Boring .... Appendix A

Laboratory Test Results .... Appendix B

Dynamic Cone Penetrometer (DCP) Test Results .... Appendix C

This report concludes our scope of work outlined in our fee revised proposal dated March 9, 2021. If you have any questions regarding this report or if any part of the report is not clear, please contact our office.

Respectfully submitted,

Kokua Geotech LLC

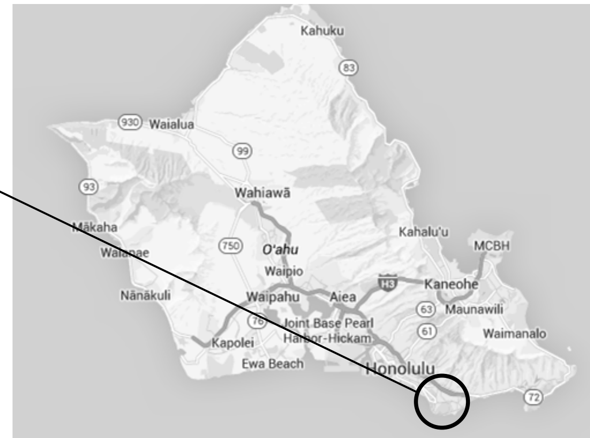
Xiaobin (Tim) Lin, P.E.
President

XIAOBIN (TIM) LIN
LICENSED PROFESSIONAL ENGINEER
No. 13982-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.
(MY LICENSE EXPIRES 4/30/2022)

PLATES

GENERAL PROJECT LOCATION



Mercator Projection
WGS84
USNG Zone 4QFJ
CALTOPO

1 2 3 4 5 km
1 2 3 mi

Scale **1:28148** 1 inch = 2346 feet

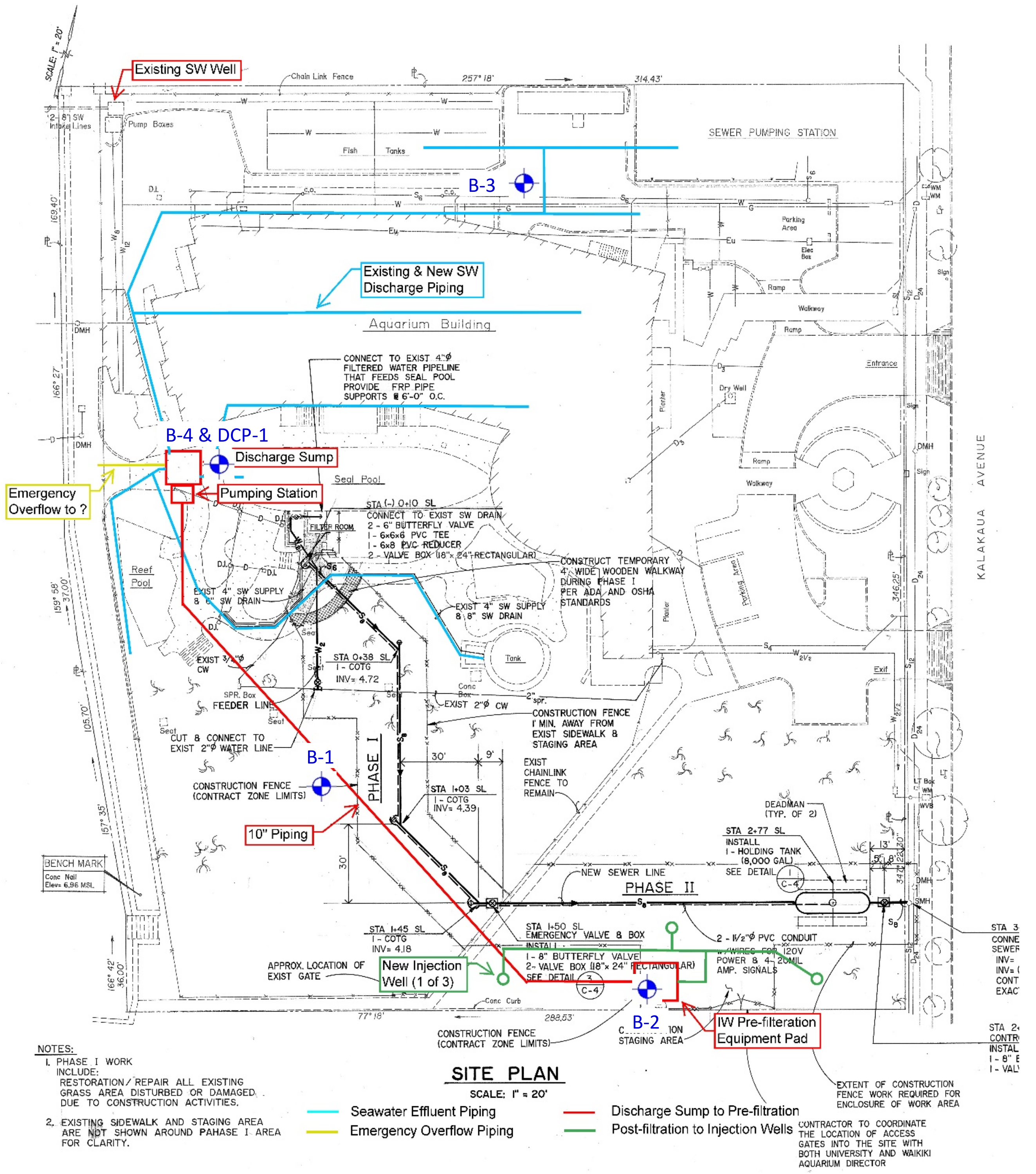
N MN 9°

PROJECT LOCATION MAP

WAIKIKI AQUARIUM IMPROVEMENTS AND
WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
HONOLULU, OAHU, HAWAII

PROJECT NO.: 030421-00	**PLATE**
DATE: JUNE 2021	**1**

Kokua Geotech LLC
Soil and Foundation Engineering



REFERENCE: SITE PLAN TRANSMITTED BY OCEANIT ON MARCH 4, 2021

APPROXIMATE BORING & DCP TEST LOCATION

SITE PLAN

WAIKIKI AQUARIUM IMPROVEMENTS AND WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
HONOLULU, OAHU, HAWAII

Kokua Geotech LLC
Soil and Foundation Engineering

PROJECT NO.: 030421-00	**PLATE**
DATE: JUNE 2021	**2**

APPENDIX A

Project: **Waikiki Aquarium** Project Location: **2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii** Project Number: **030421-00**	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Key to Logs of Borings Sheet 1 of 1

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
1	2	3	4	5	6	7	8	9	10	11	12

COLUMN DESCRIPTIONS

1 Elevation (feet): Elevation (MSL, feet).
2 Depth (feet): Depth in feet below the ground surface.
3 Sample Type: Type of soil sample collected at the depth interval shown.
4 Sample Number: Sample identification number.
5 Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
6 U.S.C.S: Type of material encountered.
7 Graphic Log: Graphic depiction of the subsurface material encountered.
8 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
9 Pocket Pen./Torvane, tsf: the reading from Poecket Penetrometer or Torvane.
10 Water Content, %: Water content of the soil sample, expressed as percentage of dry weight of sample.
11 Dry Unit Weight, pcf: Dry weight per unit volume of soil sample measured in laboratory, in pounds per cubic foot.
12 Remarks and Other Tests: Other Tests

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Asphaltic Concrete (AC)
Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)
Coral Formation
Clayey GRAVEL (GC)
SILT, SILT w/SAND, CLAYEY SILT (MH)
SILT, SILT w/SAND, SANDY SILT (ML)
Clayey SAND (SC)
Silty SAND (SM)
Poorly graded SAND (SP)
Poorly graded SAND with Silt (SP-SM)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Grab Sample
3-inch OD Modified California w/ brass liners
PQ Coring
Probing w/ Pointed Tip
2-inch OD unlined split spoon (SPT)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
? Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

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Project: **Waikiki Aquarium** Project Location: **2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii** Project Number: **030421-00**	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 1 Sheet 1 of 2

Date(s) Drilled **5/13/21**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **6-inch Hollow Stem Auger**	Total Depth of Borehole **42.0 feet**
Drill Rig Type **Yellow Acker II**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+7 feet MSL***
Groundwater Level and Date Measured **7.3 feet @ 16:33 5/13/21**	Sampling Method(s) **SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings and Gravel**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
7	0				SC		Brown CLAYEY SAND, loose to medium dense, moist (fill)				
					SP		Tan SAND with traces of silt and gravel (coralline), loose, moist (fill/beach deposit)				
			1	9					12		
			2	13			grades to medium dense		8		Sieve -#200= 1.9%
2	5		3	13					8		
					GP-GC		Light gray SANDY GRAVEL (coralline) with a little clay, medium dense, wet (lagoonal deposit)				
-3	10		4	15					29		
					GC		Gray CLAYEY GRAVEL (coralline) with some sand, very loose (lagoonal deposit)				
-8	15		5	3					39		
-13	20		6	2			grades to light gray		48		LL=49, PI=26
					CL		Light gray SANDY CLAY with a little gravel (coralline), very soft (lagoonal deposit)				
-18	25										

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Project: **Waikiki Aquarium** Project Location: **2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii** Project Number: **030421-00**	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 1 Sheet 2 of 2

Date(s) Drilled **5/13/21**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **6-inch Hollow Stem Auger**	Total Depth of Borehole **42.0 feet**
Drill Rig Type **Yellow Acker II**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+7 feet MSL***
Groundwater Level and Date Measured **7.3 feet @ 16:33 5/13/21**	Sampling Method(s) **SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings and Gravel**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
-18	25		7	WOH/18"	CL		Light gray SANDY CLAY with a little gravel (coralline), very soft (lagoonal deposit)		45		LL=35, PI=16
					GC		Light gray CLAYEY GRAVEL (coralline) with some sand, very loose (lagoonal deposit)				
-23	30		8	2					42		
				5							
				4							
				3							
-28	35			5							
				4							
				14							
				4							
				5							
-33	40			20			Light tan CORAL, moderately weathered, medium hard to hard (coral formation)				
				50							
							Boring terminated at approximately 42.0 feet below the existing ground surface *Elevations of borings estimated from Topographic Survey information provided by Oceanit on June 11, 2021				
-38	45										
-43	50										

Project: **Waikiki Aquarium** Project Location: **2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii** Project Number: **030421-00**	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 2 Sheet 1 of 1

Date(s) Drilled **5/13/21**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **4-inch Solid Stem Auger**	Total Depth of Borehole **11.5 feet**
Drill Rig Type **Yellow Acker II**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+7 feet MSL***
Groundwater Level and Date Measured **7.5 feet @ 18:45 5/13/21**	Sampling Method(s) **SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings and Gravel**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
7	0				ML		Brown SANDY SILT, medium stiff to stiff, dry to moist (fill)				
			1	11					12		
					SP-SM		Tan SAND with a little silt and gravel (coralline), loose to medium dense, moist (beach deposit)				
			2	10					20		Sieve -#200= 6.4%
2	5										
			3	11					31		
					GC		Gray CLAYEY GRAVEL (coralline) with some sand, very loose, wet (lagoonal deposit)				
-3	10										
			4	3					40		
							Boring terminated at approximately 11.5 feet below the existing ground surface				
-8	15										
-13	20										
-18	25										

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Project: **Waikiki Aquarium** Project Location: **2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii** Project Number: **030421-00**	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 3 Sheet 1 of 1

Date(s) Drilled **5/13/21**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **4-inch Solid Stem Auger**	Total Depth of Borehole **3.0 feet**
Drill Rig Type **Yellow Acker II**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+6.5 feet MSL***
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Gravel and AC Patch**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
6.5	0						3-inch ASPHALTIC CONCRETE				
					MH		Brown CLAYEY SILT with some sand and gravel (coralline), medium stiff, moist (fill)				
			1	13			(2-inch PVC pipe encountered)		13		Sw.= 0.5%
					SP-SM		Tan SAND with a little silt and gravel (coralline), medium dense, moist (beach deposit)				
							Boring terminated at approximately 3 feet below the existing ground surface				
1.5	5										
-3.5	10										
-8.5	15										
-13.5	20										
-18.5	25										

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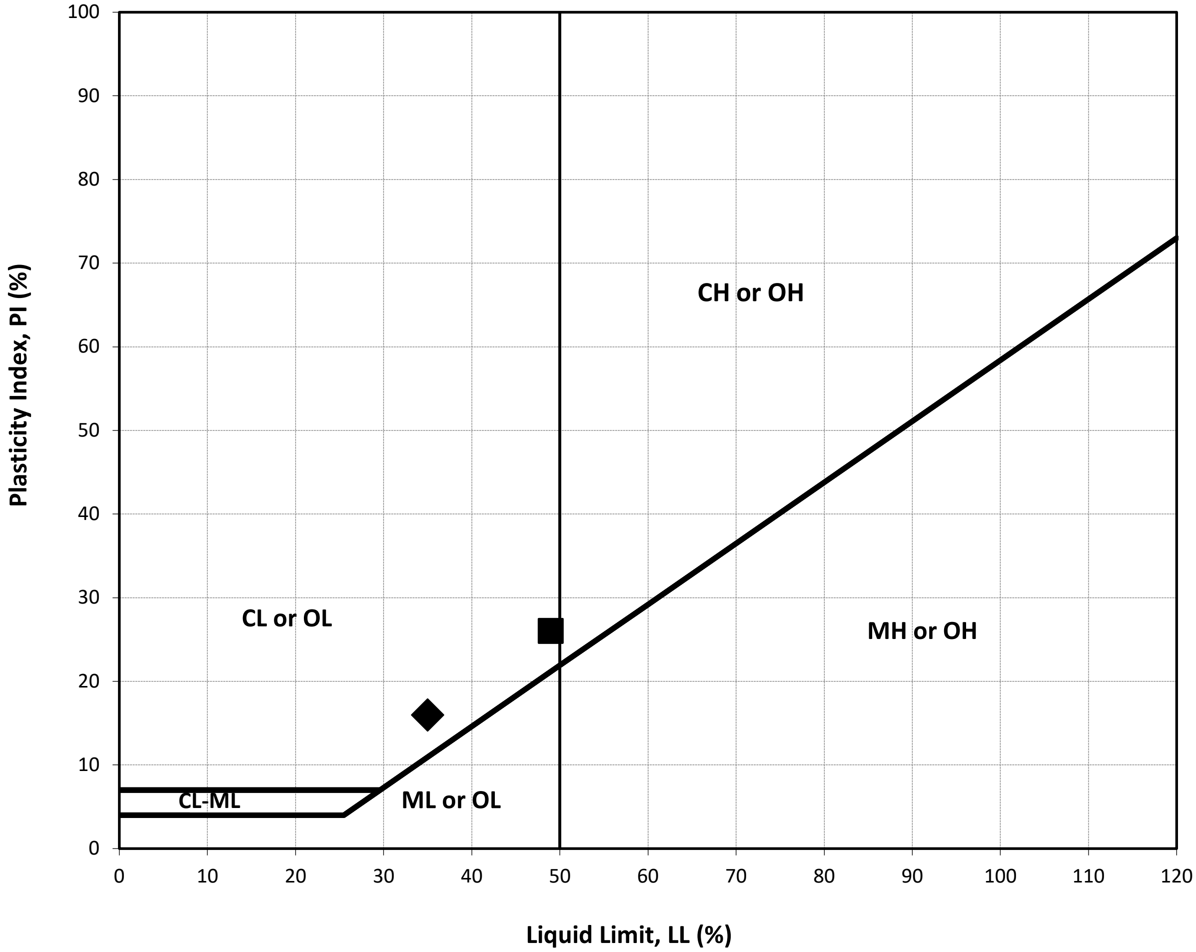
Project: **Waikiki Aquarium** Project Location: **2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii** Project Number: **030421-00**	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 4 Sheet 1 of 1

Date(s) Drilled **5/17/21**	Logged By **JL**	Checked By **AJF**
Drilling Method **Hand Auger**	Drill Bit Size/Type **4-inch Solid Stem Auger**	Total Depth of Borehole **12.5 feet**
Drill Rig Type **N/A**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+8 feet MSL***
Groundwater Level and Date Measured **8.1 feet @ 15:45 5/17/21**	Sampling Method(s) **SPT**	Hammer Data **DCP - 15 lbs. with 20-inch drop**
Borehole Backfill **Soil Cutting and Gravel**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
8	0				SM		Tan SILTY SAND with some gravel (coralline), medium dense, moist (fill)				
		X	1						8		Sieve -#200= 15.2%
		X	2		SP		Tan SAND with traces of silt and gravel (coralline), loose to medium dense, moist (beach deposit)		8		
3	5	X	3						9		
				DCP							
							grades medium dense to dense, wet				
-2	10	X	4		GC		Gray CLAYEY GRAVEL (coralline) with some sand, loose (lagoonal deposit)		19		
							Boring terminated at approximately 12.5 feet below the existing ground surface				
-7	15										
-12	20										
-17	25										

APPENDIX B

PLASTICITY CHART



Symbol	Sample	Depth (feet)	Material Description	USCS	LL	PL	PI
■	B-1	20.0 to 21.5	Light gray CLAYEY GRAVEL with some sand	GC	49	23	26
◆	B-1	25.0 to 26.5	Light gray SANDY CLAY with a little gravel	CL	35	19	16

SUMMARY OF ATTERBERG LIMITS (ASTM D4318) TEST RESULTS

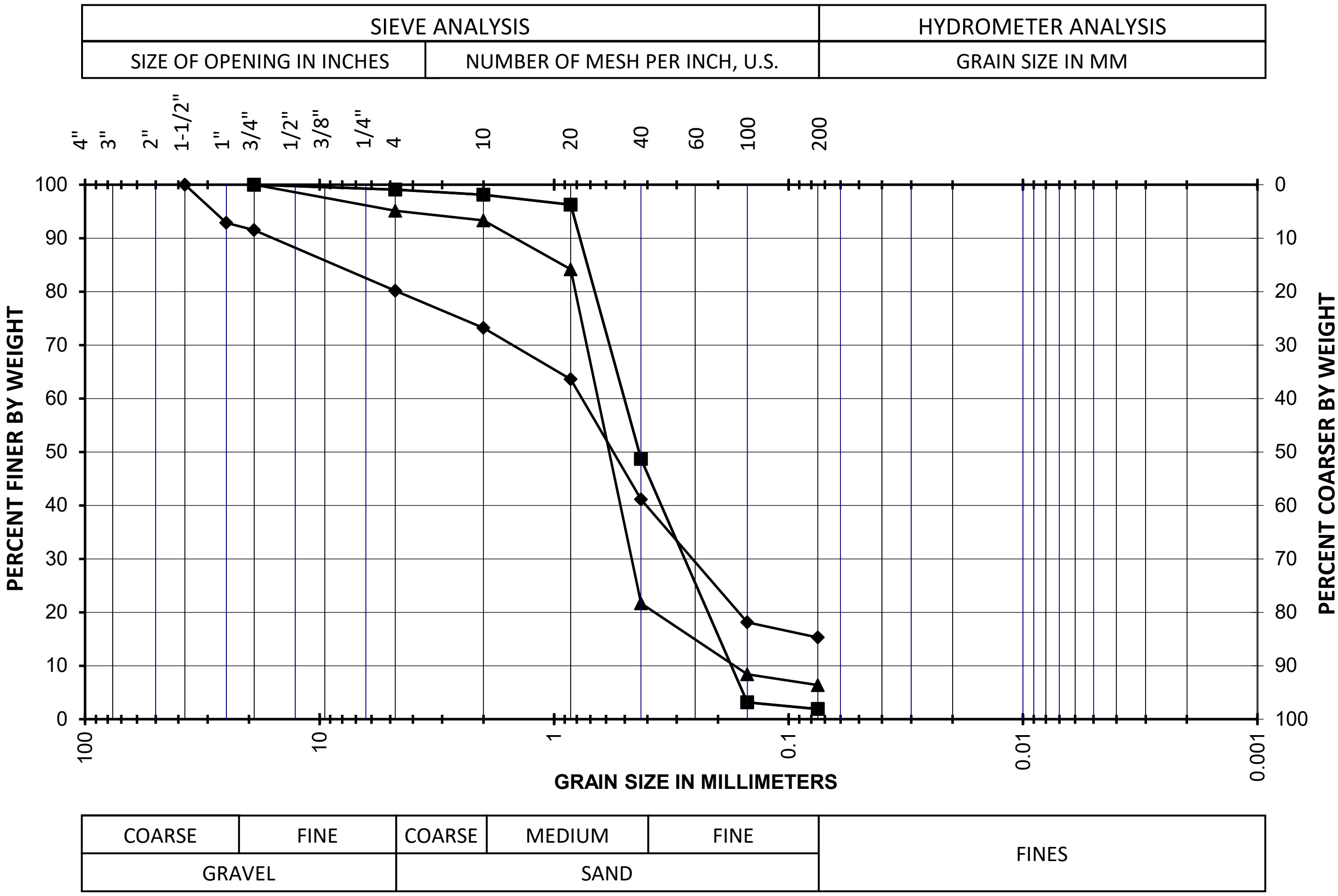
Kokua Geotech LLC
Soil and Foundation Engineering

WAIKIKI AQUARIUM IMPROVEMENTS AND
WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
HONOLULU, OAHU, HAWAII

PROJECT NO.: 030421-00

DATE: JUNE 2021

PLATE
B-1



Symbol	Sample	Depth (feet)	USCS	Description
■	B-1	3.0 to 4.5	SP	Tan SAND with traces of silt and gravel
▲	B-2	3.0 to 4.5	SP-SM	Tan SAND with a little silt and gravel
◆	B-4	1.0 to 2.0	SM	Tan SILTY SAND with some gravel

SUMMARY OF GRAIN SIZE DISTRIBUTION (ASTM C117 & C136) TEST RESULTS

WAIKIKI AQUARIUM IMPROVEMENTS AND
WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
HONOLULU, OAHU, HAWAII

Kokua Geotech LLC
Soil and Foundation Engineering

PROJECT NO.: 030421-00

DATE: JUNE 2021

PLATE
B-2

Location	Depth (feet)	Test Type	Soil Description	Dry Density (pcf)	Moisture Contents Initial (%)	Moisture Contents Air-Dried (%)	Moisture Contents Final (%)	Ring Swell (%)
B-3	1.0 to 2.5	Natural	Brown CLAYEY SILT with some sand and gravel	108.6	18.0	7.0	20.0	0.5

Note: Sample tested was relatively undisturbed (natural) in a 2.4-inch diameter by 1-inch high ring. Sample was then air-dried overnight followed by saturating for a minimum of 24 hours under a surcharge pressure of 60 psf.

SUMMARY OF RING SWELL TEST RESULTS

Kokua Geotech LLC
Soil and Foundation Engineering

WAIKIKI AQUARIUM IMPROVEMENTS AND
WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
HONOLULU, OAHU, HAWAII

PROJECT NO.: 030421-00

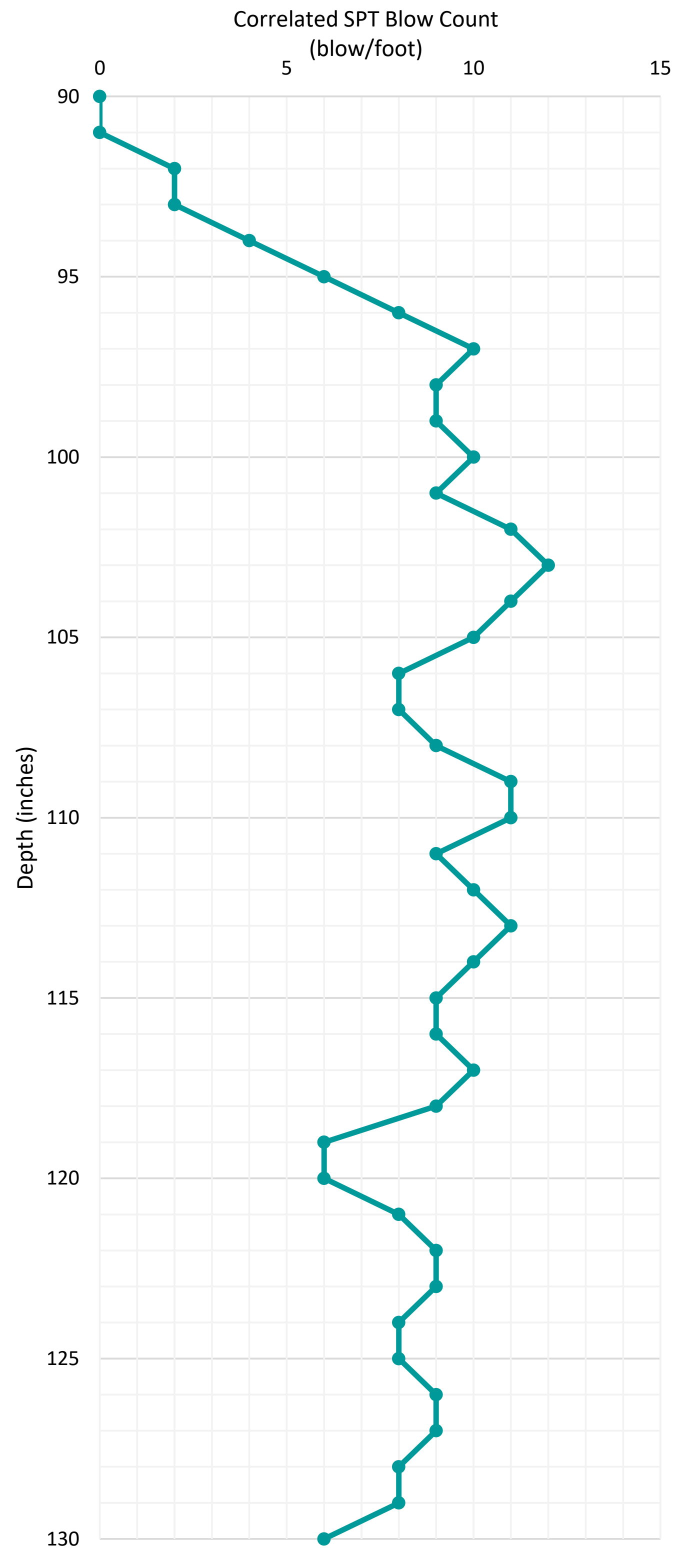
DATE: JUNE 2021

PLATE
B-3

APPENDIX C

Kokua Geotech LLC Soil and Foundation Engineering	WAIKIKI AQUARIUM IMPROVEMENTS AND WASTEWATER SYSTEM UPGRADES 2777 KALAKAUA AVENUE HONOLULU, OAHU, HAWAII	LOG OF DCP **1**

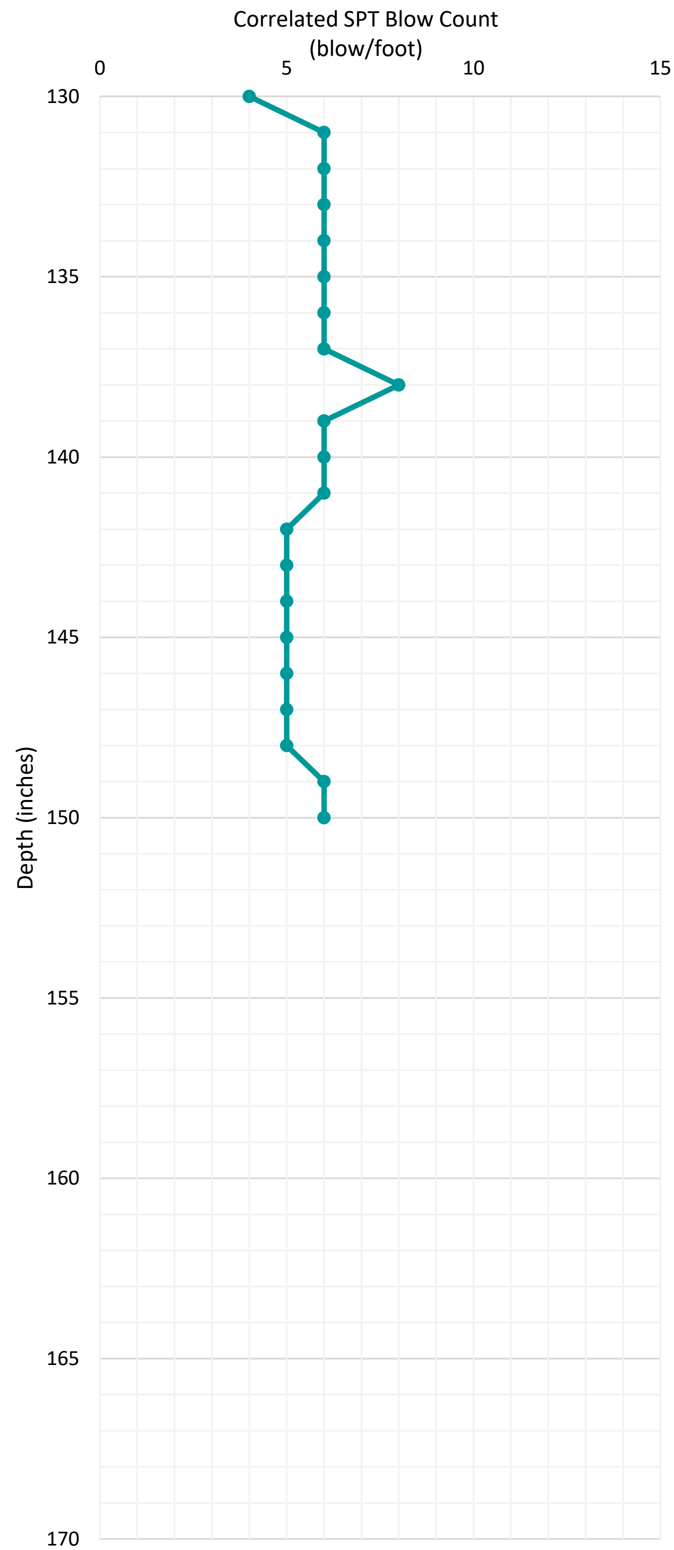
No. of Blows	Depth of Penetration (inches)	Correlated CBR	Correlated SPT Blow Count (blow/foot)
0	90	0.0	0
1	91	0.0	0
1	92	1.3	2
1	93	1.3	2
4	94	2.5	4
5	95	3.7	6
9	96	4.9	8
10	97	6.2	10
5	98	5.5	9
10	99	5.5	9
7	100	6.2	10
9	101	5.5	9
11	102	6.9	11
12	103	7.6	12
10	104	6.9	11
7	105	6.2	10
6	106	4.9	8
7	107	4.9	8
9	108	5.5	9
11	109	6.9	11
8	110	6.9	11
9	111	5.5	9
10	112	6.2	10
11	113	6.9	11
7	114	6.2	10
8	115	5.5	9
8	116	5.5	9
10	117	6.2	10
6	118	5.5	9
5	119	3.7	6
6	120	3.7	6
7	121	4.9	8
8	122	5.5	9
7	123	5.5	9
6	124	4.9	8
7	125	4.9	8
8	126	5.5	9
6	127	5.5	9
7	128	4.9	8
5	129	4.9	8
5	130	3.7	6



Project No.:	030421-00	Total Depth:	7.5 to 12.5 feet	**PLATE**
Date Started:	5/17/2021	Probing Equipment:	DCP H-4202SX	**C-1**
Date Completed:	5/17/2021	Size of Cone Tip:	1.5 inch diameter with 45° cone	
Logged By:	ZYH	Driving Energy:	15 lb. steel mass falling 20 inches	

Kokua Geotech LLC Soil and Foundation Engineering	WAIKIKI AQUARIUM IMPROVEMENTS AND WASTEWATER SYSTEM UPGRADES 2777 KALAKAUA AVENUE HONOLULU, OAHU, HAWAII	LOG OF DCP **1**

No. of Blows	Depth of Penetration (inches)	Correlated CBR	Correlated SPT Blow Count (blow/foot)
5	130	2.5	4
4	131	3.7	6
5	132	3.7	6
5	133	3.7	6
4	134	3.7	6
5	135	3.7	6
4	136	3.7	6
6	137	3.7	6
6	138	4.9	8
5	139	3.7	6
5	140	3.7	6
3	141	3.7	6
3	142	3.1	5
3	143	3.1	5
4	144	3.1	5
3	145	3.1	5
3	146	3.1	5
3	147	3.1	5
4	148	3.1	5
4	149	3.7	6
5	150	3.7	6



Project No.:	030421-00	Total Depth:	7.5 to 12.5 feet	PLATE
Date Started:	5/17/2021	Probing Equipment:	DCP H-4202SX	**C-2**
Date Completed:	5/17/2021	Size of Cone Tip:	1.5 inch diameter with 45° cone	
Logged By:	ZYH	Driving Energy:	15 lb. steel mass falling 20 inches	

GEOTECHNICAL ENGINEERING EXPLORATION

WAIKIKI AQUARIUM IMPROVEMENTS AND WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
TMK: 3-1-031: 006
HONOLULU, OAHU, HAWAII

JUNE 24, 2021

Prepared for:
OCEANIT

PROJECT NO. 030421-00

Kokua Geotech LLC
Soil and Foundation Engineering

June 24, 2021
Project No. 030421-00

Oceanit
828 Fort Street Mall, Suite 600
Honolulu, Hawaii 96813

Attention: Mr. Jordan Moniuszko

Subject: **Geotechnical Engineering Exploration**
Waikiki Aquarium Improvements and Wastewater System Upgrades
2777 Kalakaua Avenue
TMK: 3-1-031: 006
Honolulu, Oahu, Hawaii

Dear **Mr. Moniuszko**:

We are pleased to submit this report entitled "Geotechnical Engineering Exploration, Waikiki Aquarium Improvements and Wastewater System Upgrades, 2777 Kalakaua Avenue, TMK: 3-1-031: 006, Honolulu, Oahu, Hawaii" prepared for the design of the project.

The purpose of our field exploration and this report was to observe and evaluate the general subsurface conditions at accessible locations at the project site to formulate geotechnical recommendations to assist in the design of the project. Our work was performed in general accordance with the scope of services outlined in our fee proposal dated March 9, 2021.

Our findings and recommendations are summarized as follows:

1. Our field exploration at the project site generally encountered surface fill materials overlying beach deposits, lagoonal deposits, and apparent coral formation extending down to the maximum depth explored of about 42 feet below the existing ground surface. The surface fill materials encountered generally consisted of loose to medium dense clayey/silty sand and medium stiff to stiff clayey/sandy silt and were estimated to be about 1 to 3 feet thick.

   Beach deposits were encountered underlying the surface fill materials to depths ranging from about 8 to 10 feet below the existing ground surface and generally consisted of loose to medium dense sand with a little silt and gravel. Lagoonal deposits generally consisting of very loose to medium dense clayey gravel and very soft sandy clay were encountered underlying the beach deposits to a depth of about 40.5 feet below the existing ground surface.

It should be noted that the lagoonal deposits encountered at the project site are highly compressible when subjected to new loads. Below the highly compressible lagoonal deposits, our field exploration generally encountered apparent medium hard to hard coral formation extending down to the maximum depth explored of about 42 feet below the existing ground surface.

2. We encountered groundwater in our borings at depths ranging from about 7.3 to 8.1 feet below the existing ground surface at the time of our field exploration. Due to the proximity of the project site to the Pacific Ocean, groundwater levels are expected to vary with tidal fluctuations. In addition, groundwater levels may change due to seasonal precipitation, surface water runoff, and other factors.

3. We anticipate that installation of the new pumping station and piping will generally consist of trench excavation, pipe bedding and placement, and trench backfill. Based on an anticipated excavation depth of about 12 feet below the existing ground surface, we believe that dewatering may be needed.

4. Based on the results of our field exploration, we believe the near-surface soils would not provide adequate foundation support for the proposed pumping station without appreciable settlements and differential settlements under the anticipated loads. Therefore, we recommend utilizing a deep foundation system consisting of micropiles to support the proposed pumping station.

5. Based on availability of local equipment, we envision a micropile system with a minimum grout bulb diameter of 5.5 inches (minimum drill bit size) may be used for foundation support of the new pumping station structure. We recommend designing each micropile based on an allowable compressive load capacity of 30 kips for the 5.5-inch diameter micropiles.

6. We anticipate the load supporting capacity of the micropile foundation would be derived primarily from skin friction between the micropile shaft and the coralline materials anticipated underlying the project site. We also recommend using permanent steel casing for the micropiles that extend through the loose/soft, compressible beach and lagoonal deposits to the top of the coralline materials.

7. To achieve the allowable compressive load capacity of 30 kips with a factor of safety of 2, we believe the 5.5-inch diameter micropiles would need a minimum bonded zone of 20 feet below the permanent casing and extend a minimum of about 10 feet into the underlying coralline materials encountered in our boring at a depth of about 41 feet below the existing ground surface.

8. Based on our borings at the project site, excavations for the project may encounter loose to medium dense sandy soils with little to no cohesion. In general, we believe the sides of open excavations will generally be unstable unless properly sloped or shored and that temporary cut slopes for open cut excavations may not be practical. Therefore, it appears the trench walls would have to be cut near vertical necessitating the use of shoring during construction.

9. In general, the excavated on-site soils may be re-used as a source of general fill, provided they are free of vegetation, deleterious materials, and rock fragments greater than 3 inches in maximum dimension.

10. The construction plans and specifications for the project should be forwarded to us for review to determine whether the recommendations contained in this report are adequately reflected in those documents. If this review is not made, Kokua Geotech LLC cannot assume responsibility for misinterpretation of our recommendations.

11. Kokua Geotech LLC should also be retained to monitor the micropile installation, site grading, utility line installation and backfill, and other aspects of earthwork construction to determine whether the recommendations of this report are followed. The recommendations presented herein are contingent upon such observations.

    If the actual exposed subsurface soil conditions encountered during construction differ from those assumed or considered in this report, Kokua Geotech LLC should be contacted to review and/or revise the geotechnical recommendations presented herein.

Detailed discussion of our findings and geotechnical engineering recommendations are contained in the body of this report. We appreciate the opportunity to be of service for this project. Should you have any questions concerning this report, please contact our office.

Very truly yours,

Kokua Geotech LLC

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Xiaobin (Tim) Lin, P.E.
President

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GEOTECHNICAL ENGINEERING EXPLORATION
WAIKIKI AQUARIUM IMPROVEMENTS AND WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
TMK: 3-1-031: 006
HONOLULU, OAHU, HAWAII

SECTION 1.0 INTRODUCTION

We have performed a geotechnical engineering exploration for the *Waikiki Aquarium Improvements and Wastewater System Upgrades* project in Honolulu on the Island of Oahu, Hawaii. The location of the project and general vicinity are shown on the Project Location Map, Plate 1.

The purpose of our exploration was to observe and evaluate the general subsurface conditions at accessible locations at the project site to formulate geotechnical recommendations to assist in the design of the project. This report summarizes the findings and presents our geotechnical recommendations resulting from our site reconnaissance, field exploration, laboratory testing, and engineering analyses for the project. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.1 PROJECT CONSIDERATIONS

The project generally involves improvements and wastewater system upgrades at the existing Waikiki Aquarium at 2777 Kalakaua Avenue in the Waikiki area of Honolulu on the Island of Oahu, Hawaii. Based on the information provided, we understand the improvements and upgrades will generally include a new pumping station, discharge sump, IW pre-filtration equipment pad, 10-inch piping, new seawater discharge piping, and three new injection wells. A layout of the project site is shown on the Site Plan, Plate 2.

Based on the information provided, we understand the new pumping station will have an invert depth of approximately 12 feet below the existing ground surface. In addition, we anticipate excavation depths on the order of about 5 to 12 feet may be required for installation of the new 10-inch piping and new seawater discharge piping. It should be noted that permeability testing to assist in the design of the new injection wells were not included in our scope of work for the project.

1.2 PURPOSE AND SCOPE OF WORK

The purpose of our geotechnical engineering exploration was to generally explore and evaluate the subsurface soil conditions at accessible locations at the project site to provide geotechnical recommendations to assist in the design of the project. Our work was performed in general accordance with our fee proposal dated March 9, 2021. The scope of work for this exploration included the following items:

1. Coordination of boring stake-out and utility clearances by our engineer.
2. Mobilization and demobilization of a truck-mounted drill rig and two operators to and from the project site.
3. Drilling, hand augering, and sampling of four boreholes extending to depths ranging from about 3 to 42 feet below the existing ground surface.
4. Performance of Dynamic Cone Penetrometer (DCP) testing at the hand auger location to evaluate the relative consistency of the subsurface materials encountered.
5. Coordination of the field exploration and logging of the boreholes by our field engineer.
6. Laboratory testing of selected samples obtained during the field exploration as an aid in classifying the materials and evaluating their engineering properties.
7. Analyses of the field and laboratory data to formulate geotechnical recommendations for design of the project.
8. Preparation of this report summarizing our work on the project and presenting our findings and recommendations.

Detailed descriptions of our field exploration methodology are presented in the following section and the Log of the Boring in Appendix A. Results of the laboratory tests performed are presented in Appendix B. Results of the DCP tests performed are presented in Appendix C.

END OF INTRODUCTION

SECTION 2.0 SITE CHARACTERIZATION AND FINDINGS

2.1 GENERAL SITE GEOLOGY

The project site is generally located on the southeastern flank of the Koolau Volcano on the Island of Oahu. Based on the geologic maps of the Island of Oahu (Stearns, 1939 and Sherrod and others, 2007), the general area of the project sites is underlain by Beach Deposits (Qbd) and Alluvium (Qa).

During the Pleistocene Epoch, a time period that began about 2.6 million years ago and lasted until about 11,700 years ago, sea levels fluctuated in response to the cycles of continental glaciation. As the glaciers grew and advanced, less water was available to fill the oceanic basins such that sea levels fell below the present stands of the sea. When the glaciers melted and receded, an excess of water became available such that the sea levels rose to above the present sea level.

The higher sea level stands caused the formation of deltas and fans of accumulated terrigenous sediments in the heads of old bays, accumulated reef deposits at correspondingly higher elevations, and deposited lagoonal/marine sediments in the quiet waters protected by fringing reefs. The processes of landform erosion, sediment deposition, and reef development were affected by these glacio-eustatic sea level fluctuations.

When the sea level was relatively lower, the erosional base level was correspondingly lower and stream valleys were carved deeper into the Island's basaltic rock, the fringing coastal sediments, and the offshore reef deposits. Also, during periods of relatively lower sea level, the sub-aerial exposure of calcareous marine sediments caused consolidation and cementation of the deposits to form hardened calcareous deposits.

Placement of near-surface man-made fills associated with the development of urban areas within the last 80 years has brought the Honolulu Coastal Plain to its present form. In the early part of this century, much of the Waikiki area consisted of low elevation marsh wetlands. As the City of Honolulu grew and the Waikiki area was urbanized, man-made fills were placed to

reclaim the marshy areas and lagoons for development. It should be noted that much of the resulting fill materials placed are of poor quality in terms of supporting heavy structural loads.

The surface soils underlying the project sites are classified as Beaches (BS) and Jaucas Sand (JaC) by the U.S. Soil Conservation Service in their publication "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii" (1972). The Beaches (BS) soil type is described as light-colored sands derived from coral and seashells that are washed and rewashed by ocean waves. Similarly, the Jaucas Sand soil type is described as light brown, excessively drained, calcareous soils that occur in narrow strips on coastal plains adjacent to the ocean that developed in wind and water deposited sand from coral and seashells.

2.2 SITE DESCRIPTION

The project site is at the existing Waikiki Aquarium located at 2777 Kalakaua Avenue in the Waikiki area of Honolulu on the Island of Oahu, Hawaii. This facility is generally bordered by Sans Souci State Recreational Park to the north, Waikiki War Memorial Natatorium to the south, Kalakaua Avenue to the east, and the Pacific Ocean to the west. In general, this facility includes aquarium and lobby building structures, numerous aquatic tank structures, water features, comfort station, and access driveway and parking areas.

In general, the topography of the project site appears to be relatively flat. Based on topographic survey information provided, we anticipate existing ground surface elevations to range from roughly +6 to +9 feet Mean Sea Level (MSL).

At the time of our field exploration, the existing building and tank structures were generally surrounded by concrete walkways, mown lawn grass, and various landscaping plants. Exposed surface soils at the site were observed to generally consist of brownish tan beach sand.

2.3 FIELD EXPLORATION

We explored the subsurface conditions at the project site by drilling, hand augering, and sampling four borings, designated as Boring Nos. 1 through 4, extending to depths ranging from approximately 3 to 42 feet below the existing ground surface. Boring Nos. 1 through 3 were drilled utilizing a truck-mounted drill rig equipped with continuous flight augers, while Boring No. 4 was advanced using hand auger and Dynamic Cone Penetrometer (DCP) testing equipment due to an abundance of underground utility lines in the area. The approximate boring and DCP test locations are shown on the Site Plan, Plate 2.

Our engineer classified the materials encountered in the boring 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). Graphic representations of the materials encountered are presented on the Log of Borings, Appendix A.

Soil samples were obtained in general accordance with ASTM D1586 by driving a 2-inch OD standard penetration sampler with a 140-pound hammer falling 30 inches. In addition, relatively undisturbed soil samples were obtained in general accordance with ASTM D3550 by driving a 3-inch OD Modified California 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 "Sampling Resistance" on the Log of Boring at the appropriate sample depths. The blow counts may need to be factored to obtain the Standard Penetration Test (SPT) blow counts.

It should be noted that hollow stem augers were used to advance Boring No. 1 to the maximum auger depth of about 30 feet below the existing ground surface. Since very soft/loose soil conditions were encountered at this depth, probing operations were implemented within the borehole to determine the approximate depth to stiff/dense soil conditions. Probing operations generally consisted of driving a pointed steel probing tip with a 140-pound hammer falling 30 inches. The blow counts needed to drive the probing tip 12 inches are shown on the Logs of Borings at the appropriate sample depths.

In addition, a 2-inch diameter PVC water pipe was encountered and damaged during our drilling operations at Boring No. 3 at a depth of about 1.5 feet below the existing ground surface. This pipe was subsequently repaired, and the water system chlorinated.

The DCP tests were performed at the hand auger locations by driving a 1.5-inch diameter 45-degree steel cone tip with a 15-pound hammer falling 20 inches in vertical height. The blow counts were recorded per every or near 1-inch of penetration and converted to standard penetration resistance (SPT) using correlation between Penetration Index (PI) and SPT, developed by Sowers and Hedges. Results of the DCP tests performed are presented in Appendix C.

2.4 LABORATORY TESTING

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 Log of the Boring at the appropriate sample depths.

Two Atterberg Limits tests (ASTM D4318) were performed on selected soil samples to evaluate the liquid and plastic limits. The samples tested had Plasticity Indices (PIs) of 26 and 16 and plotted as low plasticity clay (CL) on a Standard Plasticity Chart. The test results are summarized on the Logs of Borings at the appropriate sample depths. Graphic presentations of the Atterberg Limits test results are provided on Plate B-1.

Three Sieve Analysis tests (ASTM C117 and C136) were performed on selected soil samples to evaluate the gradation characteristics of the soil and to aid in soil classification. Graphic presentations of the grain size distributions are provided on Plate B-2.

One, one-inch Ring Swell test was performed on a relatively undisturbed (natural) sample to evaluate the swelling potential of the on-site soils. A swell test result of 0.5 percent was observed for the sample under a surcharge pressure of 60 pounds per square foot (psf). These test results indicate the on-site soils have low swelling potential when subjected to moisture fluctuations. The Ring Swell test results are summarized on Plate B-2.

2.5 SUBSURFACE CONDITIONS

Our borings generally encountered surface fill materials overlying beach deposits, lagoonal deposits, and apparent coral formation extending down to the maximum depth explored of about 42 feet below the existing ground surface. In addition, Boring No. 3 was located on an existing pavement surface and generally encountered an approximate 3-inch thick layer of asphaltic concrete overlying the surface fill materials. The surface fill materials encountered generally consisted of loose to medium dense clayey/silty sand and medium stiff to stiff clayey/sandy silt and were estimated to be about 1 to 3 feet thick.

Beach deposits were encountered underlying the surface fill materials to depths ranging from about 8 to 10 feet below the existing ground surface and generally consisted of loose to medium dense sand with a little silt and gravel. Lagoonal deposits generally consisting of very loose to medium dense clayey gravel and very soft sandy clay were encountered underlying the beach deposits to a depth of about 40.5 feet below the existing ground surface.

It should be noted that the lagoonal deposits encountered at the project site are highly compressible when subjected to new loads. Below the highly compressible lagoonal deposits, our field exploration generally encountered apparent medium hard to hard coral formation extending down to the maximum depth explored of about 42 feet below the existing ground surface.

We encountered groundwater in our borings at depths ranging from about 7.3 to 8.1 feet below the existing ground surface at the time of our field exploration. Due to the proximity of the project site to the Pacific Ocean, groundwater levels are expected to vary with tidal fluctuations. In addition, groundwater levels may change due to seasonal precipitation, surface water runoff, and other factors.

2.6 SEISMIC DESIGN CONSIDERATIONS

Based on the International Building Code, 2012 Edition (IBC 2012) and American Society of Civil Engineers Standard ASCE/SEI 7-10 (ASCE 7-10), the project site may be subject to seismic activity, and seismic design considerations will need to be addressed. Based on the subsurface materials encountered at the project site and the geologic setting of the area, we anticipate the project site may be classified from a seismic analysis standpoint as being a “Soft Soil Profile” site corresponding to a Site Class E soil profile type based on Chapter 20 of ASCE 7-10.

Based on Site Class E, the following seismic design parameters were estimated and may be used for seismic analysis of the project.

SUMMARY OF SEISMIC DESIGN PARAMETERS	
Mapped MCE Spectral Response Acceleration, S_S	0.579g
Mapped MCE Spectral Response Acceleration, S_1	0.170g
Site Class	E
Site Coefficient, F_a	1.542
Site Coefficient, F_v	3.291
Design Spectral Response Acceleration, S_{DS}	0.595g
Design Spectral Response Acceleration, S_{D1}	0.372g
Peak Ground Acceleration, PGA	0.266g
Site Modified Peak Ground Acceleration, PGA_M	0.364g

Based on the IBC 2012, the project site may be subjected to seismic activity and should be evaluated for soil liquefaction potential. In general, the subsurface information from our field exploration indicates that the site is underlain by surface fill materials and overlying beach deposits generally consisting of loose to medium dense sand with a little silt and gravel and lagoonal deposits consisting of very loose to loose clayey gravel and very soft sandy clay to a depth of about 41 feet below the existing ground surface. In general, these loose sandy soils can be considered potentially liquefiable during a seismic event.

Based on the Atterberg Limits conducted on some of these soils, the liquid limits of the soils are in excess of 35, which is the maximum number for the soils to be considered potentially liquefiable (Youd, et. al, 2001). In addition, soils with a Plasticity Index (PI) greater than 7 are considered to have a clay-like behavior and are generally not susceptible to liquefaction (AASHTO LRFD Bridge Design Specifications, 2017 and Boulanger, Idriss, 2006).

Based on the results of our laboratory testing program, we believe that the loose to very loose lagoonal deposits encountered in our borings are not susceptible to liquefaction because of the clayey nature (more cohesive soil properties) of the granular soils encountered, especially the clayey gravel (GC) and sandy clay (CL) soil classifications. In general, we anticipate very loose sandy soils with little to no cohesion may be present underlying the project site; however, we believe that these materials occur in isolated pockets and are not continuous across the entire site.

END OF SITE CHARACTERIZATION AND FINDINGS

SECTION 3.0 DISCUSSION AND RECOMMENDATIONS

Based on the results from our field exploration, the project site is generally underlain by surface fill materials overlying beach deposits, lagoonal deposits, and apparent coral formation extending down to the maximum depth explored of about 42 feet below the existing ground surface. The surface fill materials encountered generally consisted of loose to medium dense clayey/silty sand and medium stiff to stiff clayey/sandy silt and were estimated to be about 1 to 3 feet thick.

Beach deposits were encountered underlying the surface fill materials to depths ranging from about 8 to 10 feet below the existing ground surface and generally consisted of loose to medium dense sand with a little silt and gravel. Lagoonal deposits generally consisting of very loose to medium dense clayey gravel and very soft sandy clay were encountered underlying the beach deposits to a depth of about 40.5 feet below the existing ground surface.

It should be noted that the lagoonal deposits encountered at the project site are highly compressible when subjected to new loads. Below the highly compressible lagoonal deposits, our field exploration generally encountered apparent medium hard to hard coral formation extending down to the maximum depth explored of about 42 feet below the existing ground surface.

We encountered groundwater in our borings at depths ranging from about 7.3 to 8.1 feet below the existing ground surface at the time of our field exploration. Due to the proximity of the project site to the Pacific Ocean, groundwater levels are expected to vary with tidal fluctuations. In addition, groundwater levels may change due to seasonal precipitation, surface water runoff, and other factors.

Based on the information provided, we understand the planned improvements and upgrades to the aquarium facility will generally include a new pumping station, discharge sump, IW pre-filtration equipment pad, 10-inch piping, new seawater discharge piping, and three new injection wells. we understand the new pumping station will have an invert depth of approximately 12 feet below the existing ground surface. In addition, we anticipate excavation depths on the order of about 5 to 12 feet may be required for installation of the new 10-inch piping and new seawater discharge piping.

We anticipate that installation of the new pumping station and piping will generally consist of trench excavation, pipe bedding and placement, and trench backfill. Based on an anticipated excavation depth of about 12 feet below the existing ground surface, we believe that dewatering may be needed.

Based on the results of our field exploration, highly compressible recent lagoonal deposits are anticipated at depths of about 8 to 10 feet below the existing ground surface. Therefore, we anticipate relatively significant ground settlements may occur when new fills and structures are placed over these highly compressible soils, with resulting distress to the structures.

Based on the above, we believe the near-surface soils would not provide adequate foundation support for the proposed pumping station without appreciable settlements and differential settlements under the anticipated loads. Therefore, we recommend utilizing a deep foundation system to support the proposed pumping station. Based on our evaluation, we recommend the deep foundation support system consist of micropiles extending through the loose/soft, compressible beach and lagoonal deposits and deriving load bearing support from the underlying coralline materials anticipated at greater depths.

In general, the excavated on-site soils may be re-used as a source of general fill, provided they are free of vegetation, deleterious materials, and rock fragments greater than 3 inches in maximum dimension. Imported fill materials, if required, should consist of non-expansive structural fill material, such as crushed coral or basalt.

Detailed discussion of these items and our geotechnical recommendations for design of the new pumping station, slabs-on-grade, trench excavation, backfilling, dewatering, and other geotechnical aspects of the project are presented in the following sections.

3.1 NEW PUMPING STATION

Based on the information provided, we understand the new pumping station will have an invert depth of approximately 12 feet below the existing ground surface. As discussed above, we believe the near-surface soils would not provide adequate foundation support for the proposed pumping station without appreciable settlements and differential settlements under the anticipated loads. Therefore, we recommend utilizing a deep foundation system to support the proposed underground pumping station.

Based on our evaluation, we recommend the deep foundation support system consist of micropiles extending through the loose/soft, compressible beach and lagoonal deposits and deriving load bearing support from the underlying coralline materials anticipated at greater depths.

3.1.1 NEW PUMPING STATION FOUNDATIONS

In general, a micropile consists of a small diameter (usually less than 12 inches) drilled and grouted pile with steel reinforcing. The micropile foundation typically is constructed by drilling a borehole, placing reinforcing steel in the hole, and grouting the borehole. Micropiles are desirable because they can be installed readily in access restrictive environments and in numerous soil types and ground conditions. In addition, installation of the micropiles generally causes minimal disturbance to the adjacent structures, the adjacent soils, and the environment.

Based on availability of local equipment, we envision a micropile system with a minimum grout bulb diameter of 5.5 inches (minimum drill bit size) may be used for foundation support of the new pumping station structure. We recommend designing each micropile based on an allowable compressive load capacity of 30 kips for the 5.5-inch diameter micropiles. The allowable compressive load capacity for the micropiles is for supporting dead-plus-live loads and may be increased by one-third (1/3) for transient loads, such as wind or seismic forces.

Based on the anticipated subsurface conditions at the project site, we anticipate the load supporting capacity of the micropile foundation would be derived primarily from skin friction between the micropile shaft and the coralline materials anticipated underlying the project site. We also recommend using permanent steel casing for the micropiles that extend through the loose/soft, compressible beach and lagoonal deposits to the top of the coralline materials. The permanent steel casing should have an outside diameter (OD) of about 5.5 inches (same as the grout bulb size) and should provide confinement to the micropile in the area where moment demand on the micropile is greatest.

To achieve the allowable compressive load capacity of 30 kips with a factor of safety of 2, we believe the 5.5-inch diameter micropiles would need a minimum bonded zone of 20 feet below the permanent casing and extend a minimum of about 10 feet into the underlying coralline materials encountered in our boring at a depth of about 41 feet below the existing ground surface.

Based on topographic survey information provided, we anticipate existing ground surface elevations to range from roughly +6 to +9 feet Mean Sea Level (MSL). Therefore, we recommend a minimum micropile tip elevation of about -44 feet MSL based on a total micropile length of about 51 feet installed on an assumed working grade of about +7 feet MSL. Based on these assumptions, our recommendations pertaining to the preliminary micropile allowable load capacities and lengths are presented in the following table:

SUMMARY OF MICROPILE FOUNDATIONS				
Micropile <u>Diameter</u> (inch)	**Allowable Compressive <u>Load Capacity</u>** (kips)	**Minimum Micropile <u>Tip Elevation</u>** (feet MSL)	**Minimum Bonded Zone <u>Length</u>** (feet)	**Total Estimated Micropile <u>Length</u>** (feet)
5.5	30	-44	20 feet and 10 feet min. into hard coralline materials	51

Notes:
1. Min. Tip Elevation and Total Estimated Micropile Length assumes working grade of +7 feet MSL
2. Permanent casing should be used below the pumping station invert to the top of bonded zone
3. Minimum Bonded Zone Length is the length of micropile below the bottom of permanent casing

To facilitate the micropile drilling and ensure the quality of the grouting, we recommend advancing the steel casing to the bottom of the micropile during the drilling operation. The steel casing may be withdrawn during the grouting operation while a minimum of 5 feet of grout head is maintained above the bottom of the casing at all times. The steel casing should be withdrawn above the design casing depth and plunged back to the design casing depth.

Lateral loads imposed on the foundations should be resisted by the passive earth pressure acting against the near-vertical faces of the foundation caps. Lateral load resistance contribution from the micropile should be discounted due to the relatively small diameter of the foundation element. Passive earth pressure against the near-vertical faces of the foundation caps may be estimated using an equivalent fluid pressure of 350 and 150 pounds per cubic foot (pcf) for above and below groundwater conditions, respectively.

Settlements of the micropiles will result primarily from elastic compression of the micropile member and subgrade response. We estimate the total settlement of the micropile-supported foundations to be 0.5 inches or less with differential settlements between micropiles not exceeding about one-half of the total settlement. We believe these settlements are essentially elastic and should occur as the loads are applied.

In order to determine whether the contractor's methods of micropile installation are adequate and to determine the ultimate compressive load capacity, we recommend performing one pre-production compressive load test on a sacrificial micropile.

In general, the purpose of the pre-production load test on a micropile is to fulfill the following objectives:

- To examine the adequacy of the methods and equipment proposed by the contractor to install the micropiles to the depths required.

- To confirm or modify the estimated minimum depth of the micropiles by determining the ultimate grout-to-soil bond stress.
- To assess the contractor's method of drilling and grouting.

In general, the pre-production load test should be performed in accordance with ASTM D1143. Based on experience, we believe the load test should be conducted no earlier than 7 days after completion of the micropile installation to allow the grout adequate time to cure. Two (or four) additional micropiles may be used for reaction during the compressive load testing of the pre-production load test micropile. The reaction micropiles may be installed to depths as deep as the load test micropile to provide adequate reaction in uplift (to be determined by the contractor).

The load test micropile should be loaded gradually to at least 200 percent of the allowable design load in compression. We recommend holding the maximum test load (200 percent of the design load) for a minimum of 4 hours depending on the recorded movements of the load test micropile. The pre-production load test is an integral part of the design of the micropile foundation system. Therefore, we recommend a Kokua Geotech LLC representative observe the pre-production load test.

In addition to the pre-production load test, we also recommend performing pullout tests (proof tests) on selected micropiles during construction to confirm the load carrying capacity of the installed micropiles. We recommend testing a minimum 10 percent of the total number of micropiles for pullout. The pullout tests should consist of subjecting the micropile to at least 133 percent of the design load. The micropile should be loaded in 12.5% design load increments, and each load should be held for at least 5 minutes. The maximum test load should be held for a minimum of 10 or 60 minutes. Pullout test on the selected micropiles is an integral part of the design of the micropile foundation system. Therefore, we recommend conducting the pullout tests under the observation of a Kokua Geotech LLC representative.

A specialty contractor experienced in the construction of a micropile foundation system (minimum five projects) should perform the installation of the micropiles. Due to the specialized nature of the micropile foundation construction, observation and testing of the micropile foundation system should be designated as a "Special Inspection" item. Therefore, a Kokua Geotech LLC representative (Special Inspector) should be present to observe the geotechnical aspects of the micropile foundation construction and testing.

3.1.2 NEW PUMPING STATION LATERAL EARTH PRESSURES

The new pumping station should be designed to resist lateral earth pressures due to the adjacent soils and surcharge effects caused by loads adjacent to the walls. The recommended lateral earth pressures for the design of the new pumping station, expressed in equivalent fluid pressures of pounds per square foot per foot of depth (pcf), are presented in the following table.

LATERAL EARTH PRESSURES FOR DESIGN OF RETAINING STRUCTURES			
Level Backfill Condition	**Earth Pressure Component**	**Active** (pcf)	**At-Rest** (pcf)
Above Groundwater	Without Hydrostatic Pressure	40	60
Below Groundwater	With Hydrostatic Pressure	82	91
	Without Hydrostatic Pressure	19	29

The values provided in the table above assume that on-site soils and/or structural fill materials will be used to backfill around the new pumping station. It is assumed that the backfill around the new pumping station will be compacted to between 90 and 95 percent relative compaction per ASTM D1557. Over compaction of the retaining structure backfill should be avoided.

In general, an active condition may be used only for walls that are free to deflect by as much as 0.5 percent of the structure height. If the top of the structure is not free to deflect beyond this degree, the structure 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 structures.

Surcharge stresses due to areal surcharges, 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 structure, a rectangular distribution with a uniform pressure equal to 33 percent of the vertical surcharge pressure acting over the entire height of the structure, which is free to deflect (cantilever), may be used in the design.

For structure walls that are restrained, a rectangular distribution equal to 50 percent of the vertical surcharge pressure acting over the entire height of the structure may be used for design. Additional analyses during design may be needed to evaluate the surcharge effects of point loads and line loads.

Dynamic lateral earth forces due to seismic loading will need to be considered in the design of the retaining structures. Seismic loading is used to estimate the dynamic lateral earth pressure based on a peak ground acceleration (PGA or a_{max}) of 0.364g. The table below summarizes the dynamic lateral earth forces acting on the structure walls in the event of an earthquake versus the estimated wall displacements.

Please note that the values provided in the table only apply to level backfill conditions, where H is the height of the wall in feet. The resultant force should be assumed to act through the mid-height of the wall. The dynamic lateral earth forces are in addition to the static lateral earth pressures provided previously.

DYNAMIC LATERAL EARTH FORCES FOR RETAINING STRUCTURES	
Lateral Movement (inches)	Dynamic Lateral Earth Forces (H^2 pounds per linear foot)
0.5	32.8

DYNAMIC LATERAL EARTH FORCES FOR RETAINING STRUCTURES	
Lateral Movement (inches)	Dynamic Lateral Earth Forces (H^2 pounds per linear foot)
1.0	26.4
1.5	21.5
2.0	17.4
Note: H is the height of the retaining structure in feet.	

3.2 SLABS-ON-GRADE

We anticipate that concrete slabs-on-grade will be utilized for the new equipment pads at the project site. Our laboratory test results indicate the on-site clayey soils have low expansion potential when subjected to moisture fluctuations. To provide uniform bearing conditions and reduce the potential for changes in the moisture content of the slab subgrade clayey soils, we recommend capping the slab subgrade with a minimum 6-inch thick layer of non-expansive structural fill material. The structural fill should be compacted to a minimum of 90 percent relative compaction.

Structural fill should be imported, non-expansive granular material, such as crushed coral or basalt. The structural fill should be well-graded from coarse to fine with particles no larger than 3 inches in largest dimension. The material should have a CBR value of 20 or higher and a swell potential of 1 percent or less when tested in accordance with ASTM D1883. The material should also contain between 10 and 30 percent particles passing the No. 200 sieve.

Prior to placing the non-expansive structural fill, we recommend scarifying the subgrade soils to a depth of about 10 inches, moisture-conditioning the soils to above the optimum moisture content, and compacting to a minimum of 90 percent relative compaction. The underlying subgrade soils and structural fill should be wetted and kept moist until the final placement of slab concrete. Saturation and subsequent yielding of the exposed subgrade due to inclement weather and poor drainage may require over excavation of the soft areas and replacement with structural fill.

The thickened edges of slabs adjacent to unpaved areas should be embedded at least 12 inches below the lowest adjacent grade. It should be emphasized that the areas adjacent to the slab edges should be backfilled tightly against the edges of the slabs with relatively impervious soils. These areas should also be graded to divert water away from the slabs and to reduce the potential for water ponding around the slabs.

3.3 OPEN TRENCH (CUT-AND-COVER) METHOD FOR PIPING

We envision the new underground piping planned for the project would likely be installed using conventional open trench (cut-and-cover) methods. Based on the information provided, we understand the new pumping station will have an invert depth of approximately 12 feet below the existing ground surface. In addition, we anticipate excavation depths on the order of about 5 to 12 feet will be required for installation of the new 10-inch piping and new seawater discharge piping.

3.3.1 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 friction resistance between the backfill material and the trench walls. To calculate the vertical loads on the buried utility pipe, we recommend that an average unit weight of 110 pounds per cubic feet (pcf) for the backfill material and a coefficient of friction of 0.3 be used. Earth forces acting upon the pipe generally 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.

3.3.2 TRENCH EXCAVATION

All excavations should be made in accordance with applicable Occupational Safety and Health Administration (OSHA) and state regulations. The contractor should determine the method and equipment to be used for the excavations, subject to practical limits and safety considerations. In addition, the excavations should comply with the applicable federal, state, and local safety requirements. The contractor should be responsible for trench shoring design and installation.

As mentioned above, we anticipate excavation depths up to about 12 feet deep may be required for installation of the new pumping station and piping. Based on our borings, trench excavations will likely encounter beach deposits generally consisting of loose to medium dense sand with a little silt and gravel. In addition, these excavation may encounter lagoonal deposits generally consisting of very loose to medium dense clayey gravel and very soft sandy clay.

It is anticipated that most of the material may be excavated with normal heavy excavation equipment. However, deep excavations and excavations encountering boulders and hard coral formation may require the use of hoerams. It should be noted that coral formations typically contain localized hard and crystallized zones. Therefore, we anticipate that some difficult excavation conditions may arise in localized areas during construction when the coral formation is encountered.

The contractor must exercise care to avoid over-ripping, which would disrupt the structure of the coral formation, resulting in a potential loss of bearing strength for improvements in the vicinity. Contractors should be encouraged to examine the site conditions and the subsurface data to make their own reasonable and prudent interpretation.

3.3.3 TRENCH EXCAVATION SUPPORT

We anticipate excavation depths up to about 12 feet below the existing ground surface will be required for the installation of the new pumping station and piping. Where excavations greater than 5 feet in depth are planned, temporary shoring or sloping and benching should be used. Based on our borings at the project site, these excavations may encounter loose to medium dense sandy soils with little to no cohesion. Therefore, the sides of open excavations will generally be unstable unless properly sloped or shored.

Based on our site observations, we believe that temporary cut slopes for open cut excavations may not be practical. Therefore, it appears the trench walls would have to be cut near vertical necessitating the use of shoring during construction.

The excavation support and shoring system used must comply with applicable safety requirements. The contractor should be solely responsible for the adequacy and safety of the shoring installation. The contractor's representative should be on-site at all times during excavation and construction work for the opportunity to promptly observe changing or unforeseen conditions, such as, high groundwater, inappropriate construction sequence or techniques, etc., which may affect the shoring stability.

Excavated soils should not be stockpiled closer than a horizontal distance equal to the depth of the excavation from the edge of the excavation to reduce the potential for excessive ground movement.

It is important to install adequate shoring and to maintain it tight against the excavation walls with proper bracing during construction. The properly braced shoring is essential to reduce the potential for appreciable lateral movements of the adjacent ground into the excavation, which may result in potential settlement or distress to adjacent structures or other improvements.

It must be noted that some minor movements 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 movement. The magnitude also depends greatly upon workmanship, such as how quickly and tightly the shoring and bracing supports are installed, the subsurface conditions, the size of the excavation, and the rate of excavation.

Therefore, it is important to realize that the excavation shoring should be installed properly and as early as practical. The adjacent ground should be continuously monitored for cracks, dips and/or other indications of movements with instruments until the trench excavations are finally backfilled.

3.3.4 PIPE BEDDING

The stress distribution against the bottom of a pipe has a significant effect on the load supporting capacity of the pipe. Therefore, the pipe bedding is an important design consideration. In general, we recommend providing granular bedding consisting of 6 inches of open-graded gravel, such as No. 3 Fine gravel (ASTM C33, No. 67 gradation), under the pipes for uniform support.

In addition, open-graded gravel (ASTM C33, No. 67 gradation) should also be used for the initial trench backfill up to about 12 inches above the pipes (or groundwater level) to provide adequate support around the pipes. It is critical to use a free-draining material, such as open-graded gravel, to reduce the potential for formation of voids below the haunches of pipes and to provide adequate support for the sides of the pipes. Improper trench backfill could result in backfill settlement and pipe damage. Where groundwater is encountered, the bedding should be wrapped on all sides by non-woven filter fabric (Mirafi 180N or equivalent).

We envision soft and/or loose soils may be encountered at or near the invert elevations along portions of the new utility lines. Therefore, we recommend providing a subgrade stabilization layer consisting of 18 inches of No. 2 Rock (ASTM C 33, No. 4 gradation) wrapped in a non-woven filter fabric (Mirafi 180N or equivalent) below the bedding layer for uniform support, if soft and/or loose soils are encountered. The stabilization layer should extend beyond the sides of the pipe a minimum width of one-fourth the outside diameter of the pipe or 12 inches, whichever is greater.

Before the placement of bedding material, a Kokua Geotech LLC representative should observe the excavated trench bottom to confirm that firm materials are exposed at the bottom of the trench or whether the installation of a stabilization layer is needed.

3.3.5 TRENCH BACKFILL

As discussed above, the first zone of backfill extending from the bedding material to at least 12 inches above the top of the pipes (or groundwater level) should consist of open-graded gravel, such as No. 3 Fine gravel (ASTM C33, No. 67 gradation) to reduce the compaction effort required and resulting stresses on the pipe.

The trench backfill from 12 inches above the top of the pipes (or groundwater level) to the finished subgrade may consist of the excavated on-site soils provided that they are free of deleterious materials (vegetation) and are screened of particles greater than 3 inches in largest dimension.

Imported fill materials, if required, should consist of non-expansive structural fill material, such as crushed coral or basalt. The structural fill should be well-graded from coarse to fine with particles no larger than 3 inches in largest dimension. The material should have a CBR value of 20 or higher and a swell potential of 1 percent or less when tested in accordance with ASTM D1883. The material should also contain between 10 and 30 percent particles passing the No. 200 sieve.

3.3.6 TRENCH BACKFILL PLACEMENT AND COMPACTION REQUIREMENTS

The backfill materials consisting of the on-site soils 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 below the finished pavement grade in areas subjected to vehicular traffic should be compacted to a minimum of 95 percent relative compaction.

The backfill materials consisting of open-graded gravel, such as No. 3 Fine gravel (ASTM C33, No. 67 gradation), should generally be placed in level lifts not exceeding 8 inches in loose thickness and compacted to a firm surface.

Imported non-expansive structural fill materials, if required, should be moisture-conditioned to above the optimum moisture, placed in level lifts of about

8 inches in loose thickness, and compacted to a minimum of 90 percent relative compaction. Aggregate base course materials, if required, 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 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 determined in accordance with ASTM D1557. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

3.3.7 SETTLEMENTS

Primary settlement of new utility lines are normally caused by the difference in the unit weight of the lighter excavated original earth and the heavier compacted backfill material placed over the pipes. The net increase in loading will cause settlement of the underlying subsoils below the trench invert. Based on our calculations, primary settlement on the order of less than 0.5 inches is anticipated for the project.

The above estimate assumes that proper construction procedures and good workmanship will be engaged during construction. Additional settlement could occur if improper trench support is used.

3.4 DEWATERING

During our field exploration, we encountered groundwater at depths ranging from about 7.3 to 8.1 feet below the existing ground surface. Due to the relatively shallow groundwater levels encountered at the project site, we anticipate that the pumping station and piping to be installed may extend below the groundwater level. Therefore, dewatering of the excavation may be necessary for this installation.

In general, dewatering operations should be conducted in such a manner that dewatering will not cause areal ground subsidence, which may cause potential damage to the nearby existing structures. Therefore, consideration should be given to a dewatering system that includes a cut-off wall to reduce the volume of water to be removed within the excavation and to reduce the areal extent of groundwater drawdown outside of the excavation.

Because the excavation dewatering may involve the discharge of groundwater from the dewatering operation into adjacent drainage systems, a National Pollutant Discharge Elimination System (NPDES) permit may be necessary. The contractor should consult their independent consultant or the State of Hawaii, Department of Health for the latest regulations and information pertaining to the NPDES permit application.

Based on our borings, we anticipate the project site is generally underlain by loose to dense beach deposits and very loose to loose lagoonal deposits to a depth of about 40.5 feet below the existing ground surface. Due to the heterogeneous nature of these materials, the actual subsurface soil permeability may range broadly and also vary locally in terms of orders of magnitude. The permeability of the subsurface materials at the sites may be considered moderately to highly permeable based on the materials encountered. Therefore, the contractor should pay special attention to the site-specific dewatering plan for the proposed excavations.

3.5 PRECONSTRUCTION DISTRESS SURVEY AND MONITORING

Due to the close proximity of the planned excavations to existing structures at the project site and the anticipated dewatering operations, we recommend performing a preconstruction distress survey to document the existing conditions prior to the start of construction. The survey should include photographs and detailed descriptions of pre-existing distresses.

In addition, implementation of a monitoring program for building movement is recommended for the project. The monitoring program should consist of the installation of structure monitoring points on the existing building footing columns that are in close proximity to the planned excavations to measure changes in the vertical and horizontal position during the monitoring period.

Prior to the start of construction, the monitoring points should be surveyed to establish initial readings for the monitoring points. Benchmarks should be established for the survey work. Surveyed readings of the monitoring points should be taken daily during construction and weekly subsequent to construction until the contract completion date. The survey readings should be submitted promptly for review.

3.6 DESIGN REVIEW AND CONSTRUCTION OBSERVATION SERVICES

The construction plans and specifications for the project should be forwarded to us for review to determine whether the recommendations contained in this report are adequately reflected in those documents. If this review is not made, Kokua Geotech LLC cannot assume responsibility for misinterpretation of our recommendations.

Kokua Geotech LLC should also be retained to monitor the micropile installation, site grading, utility line installation and backfill, and other aspects of earthwork construction to determine whether the recommendations of this report are followed. The recommendations presented herein are contingent upon such observations. If the actual exposed subsurface soil conditions encountered during construction differ from those assumed or considered in this report, Kokua Geotech LLC should be contacted to review and/or revise the geotechnical recommendations presented herein.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4.0 LIMITATIONS

This report has been prepared for the exclusive use of Oceanit and their project consultants for specific application to the design of the *Waikiki Aquarium Improvements and Wastewater System Upgrades* project in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied. If any part of the project concept is altered or if subsurface conditions differ from those described in this report, then the information presented herein shall be considered invalid, unless the changes are reviewed, and any supplemental or revised recommendations issued in writing by Kokua Geotech LLC.

The analyses and report recommendations are based in part upon information obtained from the field boring and the assumption that subsurface conditions do not vary significantly from those observed in the boring. Variations of the subsurface conditions beyond the field boring may occur, and the nature and extent of these variations may not become evident until construction is underway. If variations then appear evident, Kokua Geotech LLC should be notified so that we can re-evaluate the recommendations presented herein.

The owner/client should be aware that unanticipated soil conditions are commonly encountered. 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.

The field boring locations indicated herein is approximate, having been estimated by taping from visible features shown on the Site Plan transmitted by Oceanit on March 4, 2021. Elevations of the borings were estimated from spot elevations shown on topographic survey plans transmitted by Oceanit on June 11, 2021. The field boring locations and elevation should be considered accurate only to the degree implied by the methods used.

The stratification breaks shown on the graphic representations of the boring depict the approximate boundaries between soil types and, as such, may denote a gradual transition. Water level data from the boring was measured at the time of drilling. However, groundwater levels may change due to seasonal precipitation, tidal fluctuation, surface water runoff, and other factors. These data have been reviewed and interpretations made in the formulation of this report.

This report has been prepared solely for the purpose of assisting the design engineers in the design of the project. Therefore, this report may not contain sufficient data, or the proper information, to serve as a basis for detailed construction cost estimates.

This geotechnical engineering exploration conducted at the project site was not intended to investigate the potential presence of hazardous materials existing at the project site. It should be noted that 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
Log of Boring	Appendix A
Laboratory Test Results	Appendix B
Dynamic Cone Penetrometer (DCP) Test Results	Appendix C

This report concludes our scope of work outlined in our fee revised proposal dated March 9, 2021. If you have any questions regarding this report or if any part of the report is not clear, please contact our office.

Respectfully submitted,

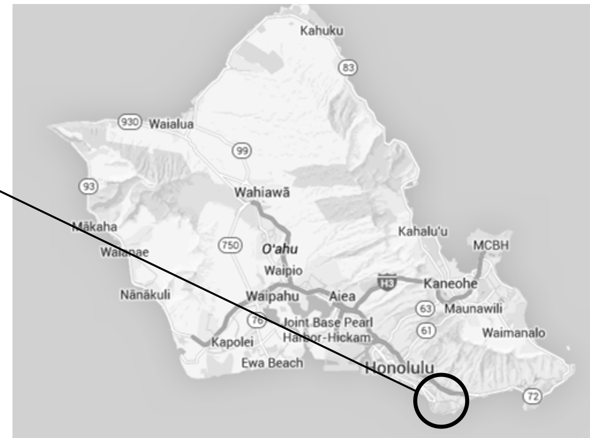
Kokua Geotech LLC

Xiaobin (Tim) Lin, P.E.
President

XIAOBIN (TIM) LIN
LICENSED PROFESSIONAL ENGINEER
No. 13982-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.
(MY LICENSE EXPIRES 4/30/2022)

PLATES

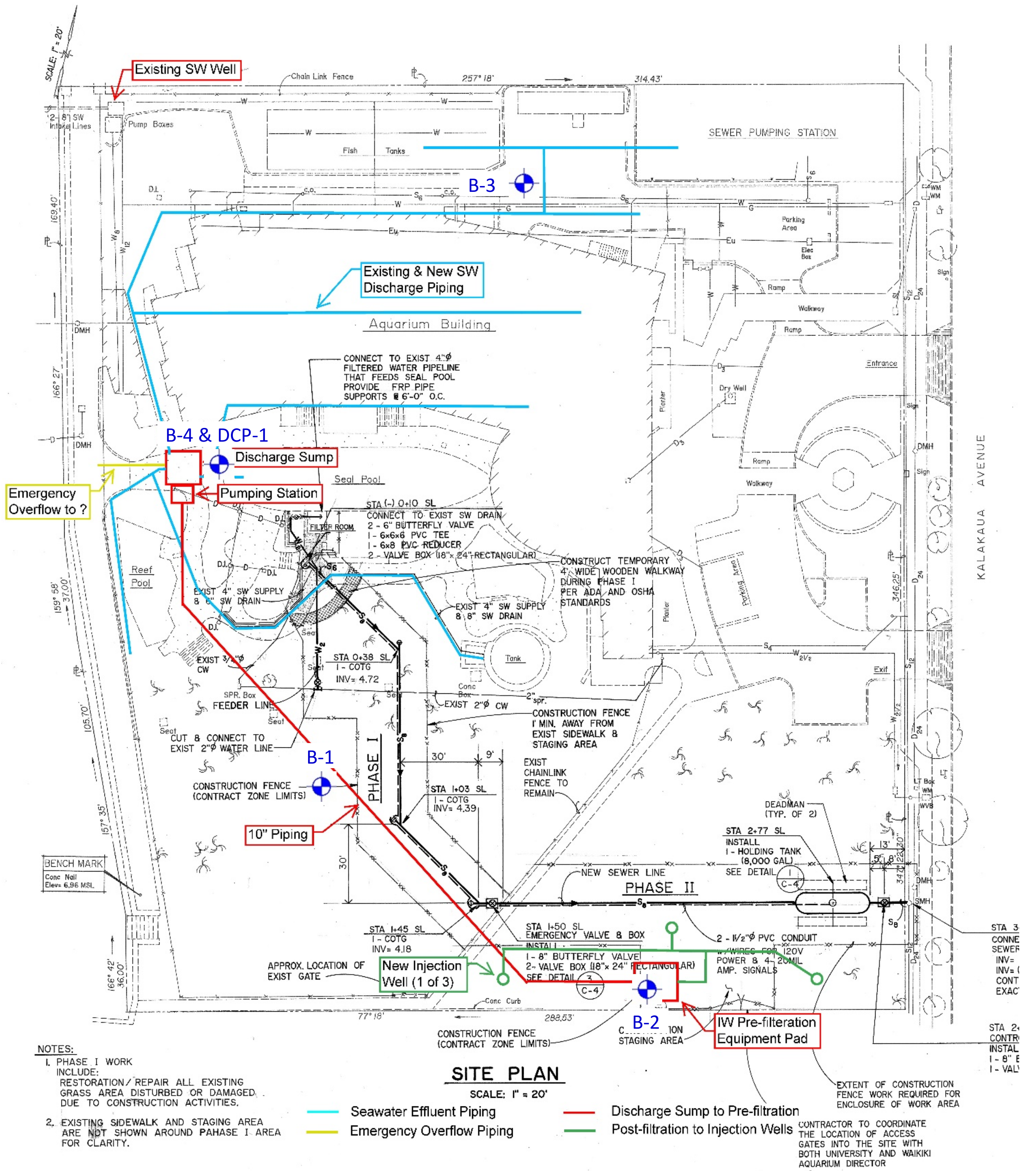


PROJECT LOCATION MAP

WAIKIKI AQUARIUM IMPROVEMENTS AND
WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
HONOLULU, OAHU, HAWAII

PROJECT NO.: 030421-00	**PLATE**
DATE: JUNE 2021	**1**

Kokua Geotech LLC
Soil and Foundation Engineering



REFERENCE: SITE PLAN TRANSMITTED BY OCEANIT ON MARCH 4, 2021

APPROXIMATE BORING & DCP TEST LOCATION

SITE PLAN

WAIKIKI AQUARIUM IMPROVEMENTS AND WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
HONOLULU, OAHU, HAWAII

Kokua Geotech LLC
Soil and Foundation Engineering

PROJECT NO.: 030421-00	**PLATE**
DATE: JUNE 2021	**2**

APPENDIX A

Project: **Waikiki Aquarium**	**Kokua Geotech LLC**	Key to Logs of Borings
Project Location: **2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii**	94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Sheet 1 of 1
Project Number: **030421-00**		

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
1	2	3	4	5	6	7	8	9	10	11	12

COLUMN DESCRIPTIONS

1 Elevation (feet): Elevation (MSL, feet).
2 Depth (feet): Depth in feet below the ground surface.
3 Sample Type: Type of soil sample collected at the depth interval shown.
4 Sample Number: Sample identification number.
5 Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
6 U.S.C.S: Type of material encountered.
7 Graphic Log: Graphic depiction of the subsurface material encountered.
8 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
9 Pocket Pen./Torvane, tsf: the reading from Poecket Penetrometer or Torvane.
10 Water Content, %: Water content of the soil sample, expressed as percentage of dry weight of sample.
11 Dry Unit Weight, pcf: Dry weight per unit volume of soil sample measured in laboratory, in pounds per cubic foot.
12 Remarks and Other Tests: Other Tests

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Asphaltic Concrete (AC)
Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)
Coral Formation
Clayey GRAVEL (GC)
SILT, SILT w/SAND, CLAYEY SILT (MH)
SILT, SILT w/SAND, SANDY SILT (ML)
Clayey SAND (SC)
Silty SAND (SM)
Poorly graded SAND (SP)
Poorly graded SAND with Silt (SP-SM)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Grab Sample
3-inch OD Modified California w/ brass liners
PQ Coring
Probing w/ Pointed Tip
2-inch OD unlined split spoon (SPT)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
? Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

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Project: **Waikiki Aquarium** Project Location: **2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii** Project Number: **030421-00**	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 1 Sheet 1 of 2

Date(s) Drilled **5/13/21**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **6-inch Hollow Stem Auger**	Total Depth of Borehole **42.0 feet**
Drill Rig Type **Yellow Acker II**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+7 feet MSL***
Groundwater Level and Date Measured **7.3 feet @ 16:33 5/13/21**	Sampling Method(s) **SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings and Gravel**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
7	0				SC		Brown CLAYEY SAND, loose to medium dense, moist (fill)				
					SP		Tan SAND with traces of silt and gravel (coralline), loose, moist (fill/beach deposit)				
			1	9					12		
			2	13			grades to medium dense		8		Sieve -#200= 1.9%
2	5										
			3	13					8		
					GP-GC		Light gray SANDY GRAVEL (coralline) with a little clay, medium dense, wet (lagoonal deposit)				
-3	10										
			4	15					29		
					GC		Gray CLAYEY GRAVEL (coralline) with some sand, very loose (lagoonal deposit)				
-8	15										
			5	3					39		
-13	20						grades to light gray				
			6	2					48		LL=49, PI=26
					CL		Light gray SANDY CLAY with a little gravel (coralline), very soft (lagoonal deposit)				
-18	25										

Project: **Waikiki Aquarium**	**Kokua Geotech LLC**	Log of Boring No. 1
Project Location: **2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii**	94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Sheet 2 of 2
Project Number: **030421-00**		

Date(s) Drilled **5/13/21**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **6-inch Hollow Stem Auger**	Total Depth of Borehole **42.0 feet**
Drill Rig Type **Yellow Acker II**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+7 feet MSL***
Groundwater Level and Date Measured **7.3 feet @ 16:33 5/13/21**	Sampling Method(s) **SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings and Gravel**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
-18	25		7	WOH/18"	CL		Light gray SANDY CLAY with a little gravel (coralline), very soft (lagoonal deposit)		45		LL=35, PI=16
					GC		Light gray CLAYEY GRAVEL (coralline) with some sand, very loose (lagoonal deposit)				
-23	30		8	2					42		
				5							
				4							
				3							
-28	35			5							
				4							
				14							
				4							
				5							
-33	40			20			Light tan CORAL, moderately weathered, medium hard to hard (coral formation)				
				50							
							Boring terminated at approximately 42.0 feet below the existing ground surface *Elevations of borings estimated from Topographic Survey information provided by Oceanit on June 11, 2021				
-38	45										
-43	50										

Project: **Waikiki Aquarium** Project Location: **2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii** Project Number: **030421-00**	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 2 Sheet 1 of 1

Date(s) Drilled **5/13/21**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **4-inch Solid Stem Auger**	Total Depth of Borehole **11.5 feet**
Drill Rig Type **Yellow Acker II**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+7 feet MSL***
Groundwater Level and Date Measured **7.5 feet @ 18:45 5/13/21**	Sampling Method(s) **SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings and Gravel**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
7	0				ML		Brown SANDY SILT, medium stiff to stiff, dry to moist (fill)				
			1	11					12		
					SP-SM		Tan SAND with a little silt and gravel (coralline), loose to medium dense, moist (beach deposit)				
			2	10					20		Sieve -#200= 6.4%
2	5										
			3	11					31		
					GC		Gray CLAYEY GRAVEL (coralline) with some sand, very loose, wet (lagoonal deposit)				
-3	10										
			4	3					40		
							Boring terminated at approximately 11.5 feet below the existing ground surface				
-8	15										
-13	20										
-18	25										

Project: **Waikiki Aquarium** Project Location: **2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii** Project Number: **030421-00**	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 3 Sheet 1 of 1

Date(s) Drilled **5/13/21**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **4-inch Solid Stem Auger**	Total Depth of Borehole **3.0 feet**
Drill Rig Type **Yellow Acker II**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+6.5 feet MSL***
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Gravel and AC Patch**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
6.5	0						3-inch ASPHALTIC CONCRETE				
					MH		Brown CLAYEY SILT with some sand and gravel (coralline), medium stiff, moist (fill)				
			1	13			(2-inch PVC pipe encountered)		13		Sw.= 0.5%
					SP-SM		Tan SAND with a little silt and gravel (coralline), medium dense, moist (beach deposit)				
							Boring terminated at approximately 3 feet below the existing ground surface				
1.5	5										
-3.5	10										
-8.5	15										
-13.5	20										
-18.5	25										

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PLATE A-3

Project: **Waikiki Aquarium** Project Location: **2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii** Project Number: **030421-00**	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 4 Sheet 1 of 1

Date(s) Drilled **5/17/21**	Logged By **JL**	Checked By **AJF**
Drilling Method **Hand Auger**	Drill Bit Size/Type **4-inch Solid Stem Auger**	Total Depth of Borehole **12.5 feet**
Drill Rig Type **N/A**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+8 feet MSL***
Groundwater Level and Date Measured **8.1 feet @ 15:45 5/17/21**	Sampling Method(s) **SPT**	Hammer Data **DCP - 15 lbs. with 20-inch drop**
Borehole Backfill **Soil Cutting and Gravel**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
8	0				SM		Tan SILTY SAND with some gravel (coralline), medium dense, moist (fill)				
		X	1						8		Sieve -#200= 15.2%
		X	2		SP		Tan SAND with traces of silt and gravel (coralline), loose to medium dense, moist (beach deposit)		8		
3	5	X	3						9		
				DCP							
							▼ grades medium dense to dense, wet				
-2	10	X	4		GC		Gray CLAYEY GRAVEL (coralline) with some sand, loose (lagoonal deposit)		19		
							Boring terminated at approximately 12.5 feet below the existing ground surface				
-7	15										
-12	20										
-17	25										

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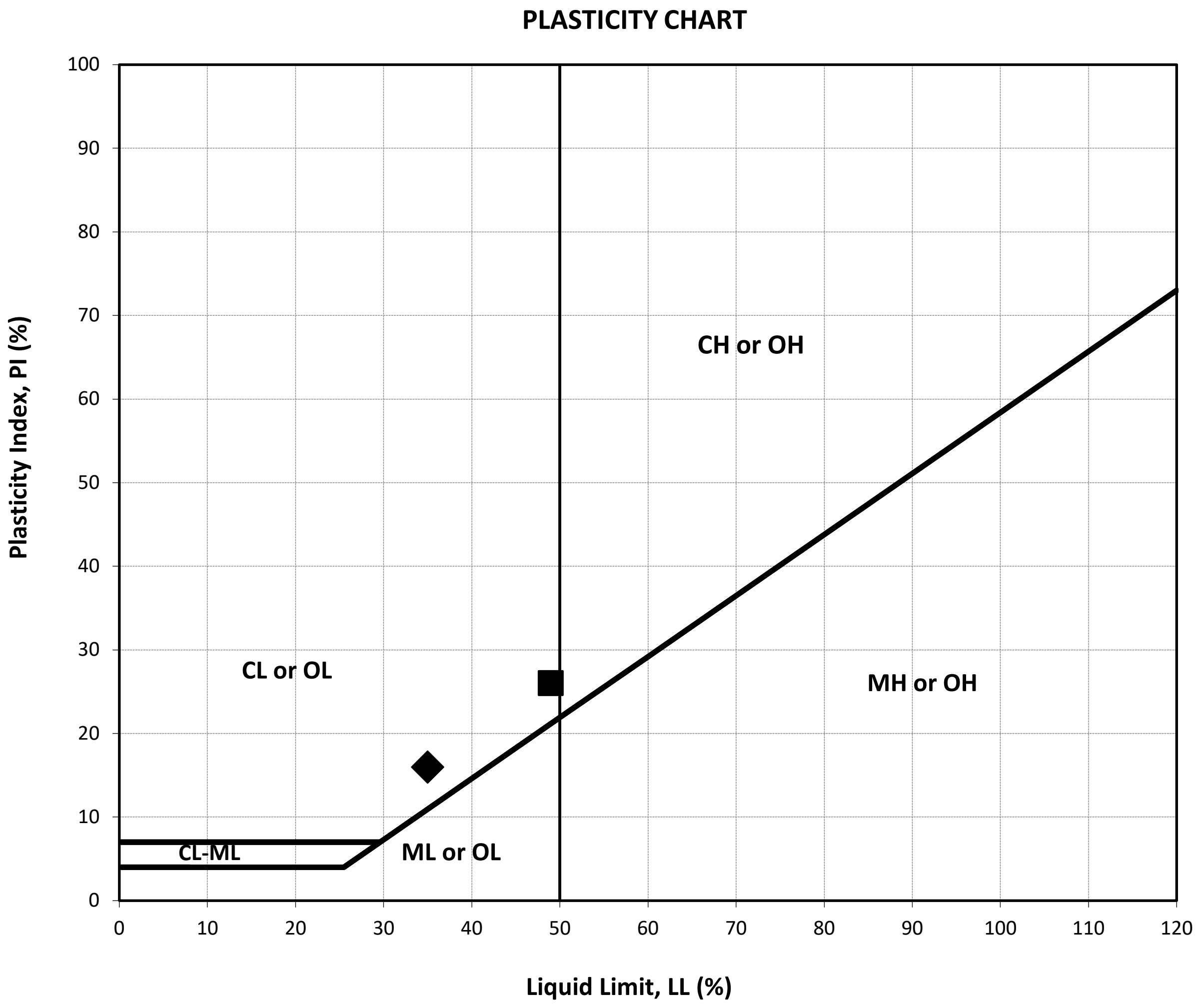
APPENDIX B



Symbol	Sample	Depth (feet)	Material Description	USCS	LL	PL	PI
■	B-1	20.0 to 21.5	Light gray CLAYEY GRAVEL with some sand	GC	49	23	26
◆	B-1	25.0 to 26.5	Light gray SANDY CLAY with a little gravel	CL	35	19	16

SUMMARY OF ATTERBERG LIMITS (ASTM D4318) TEST RESULTS

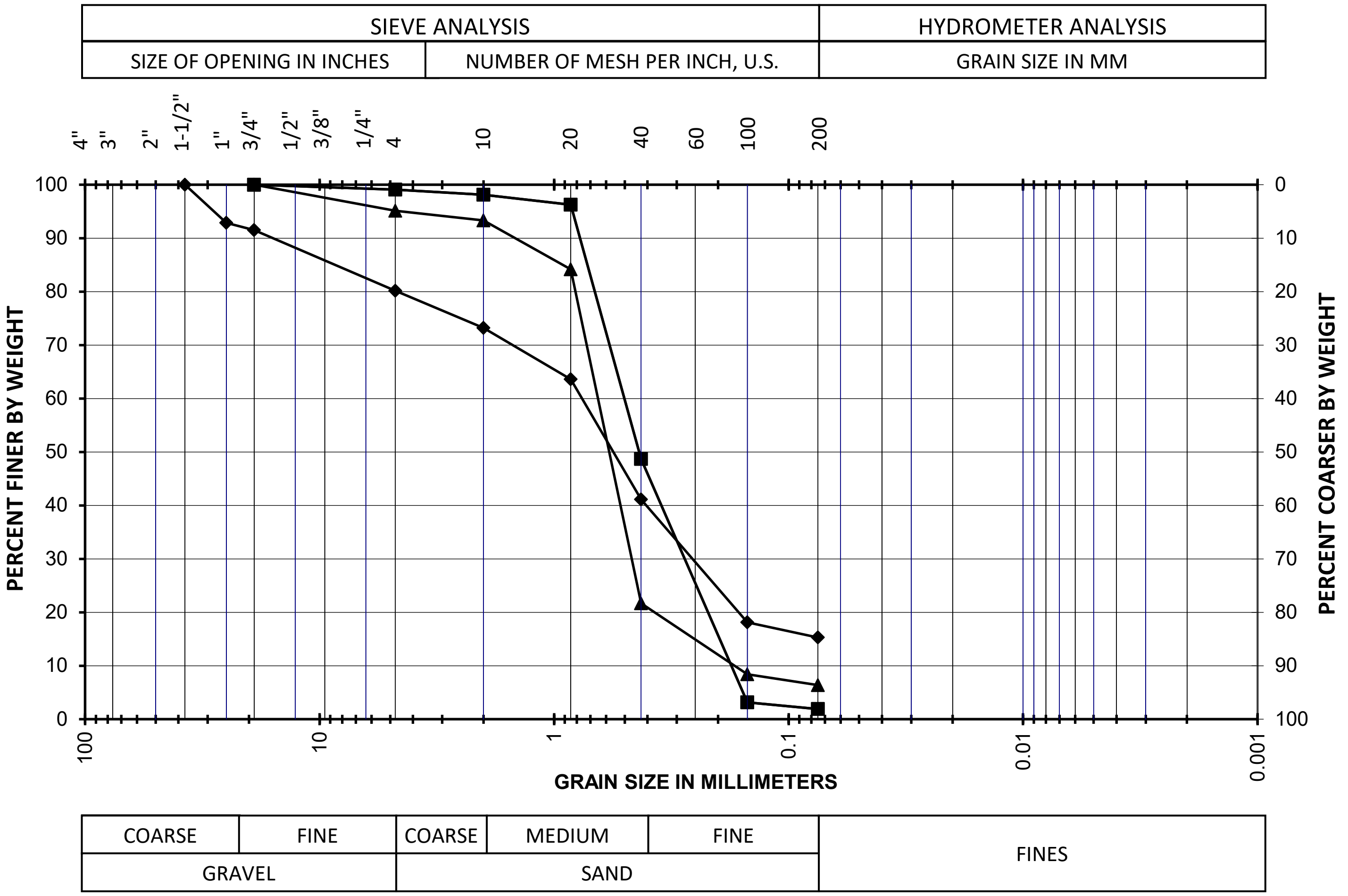
Kokua Geotech LLC
Soil and Foundation Engineering

WAIKIKI AQUARIUM IMPROVEMENTS AND
WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
HONOLULU, OAHU, HAWAII

PROJECT NO.: 030421-00

DATE: JUNE 2021

PLATE
B-1



Symbol	Sample	Depth (feet)	USCS	Description
■	B-1	3.0 to 4.5	SP	Tan SAND with traces of silt and gravel
▲	B-2	3.0 to 4.5	SP-SM	Tan SAND with a little silt and gravel
◆	B-4	1.0 to 2.0	SM	Tan SILTY SAND with some gravel

SUMMARY OF GRAIN SIZE DISTRIBUTION (ASTM C117 & C136) TEST RESULTS

Kokua Geotech LLC
Soil and Foundation Engineering

WAIKIKI AQUARIUM IMPROVEMENTS AND
WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
HONOLULU, OAHU, HAWAII

PROJECT NO.: 030421-00

DATE: JUNE 2021

PLATE
B-2

Location	Depth (feet)	Test Type	Soil Description	Dry Density (pcf)	Moisture Contents Initial (%)	Moisture Contents Air-Dried (%)	Moisture Contents Final (%)	Ring Swell (%)
B-3	1.0 to 2.5	Natural	Brown CLAYEY SILT with some sand and gravel	108.6	18.0	7.0	20.0	0.5

Note: Sample tested was relatively undisturbed (natural) in a 2.4-inch diameter by 1-inch high ring. Sample was then air-dried overnight followed by saturating for a minimum of 24 hours under a surcharge pressure of 60 psf.

SUMMARY OF RING SWELL TEST RESULTS

WAIKIKI AQUARIUM IMPROVEMENTS AND WASTEWATER SYSTEM UPGRADES
2777 KALAKAUA AVENUE
HONOLULU, OAHU, HAWAII

Kokua Geotech LLC
Soil and Foundation Engineering

PROJECT NO.: 030421-00

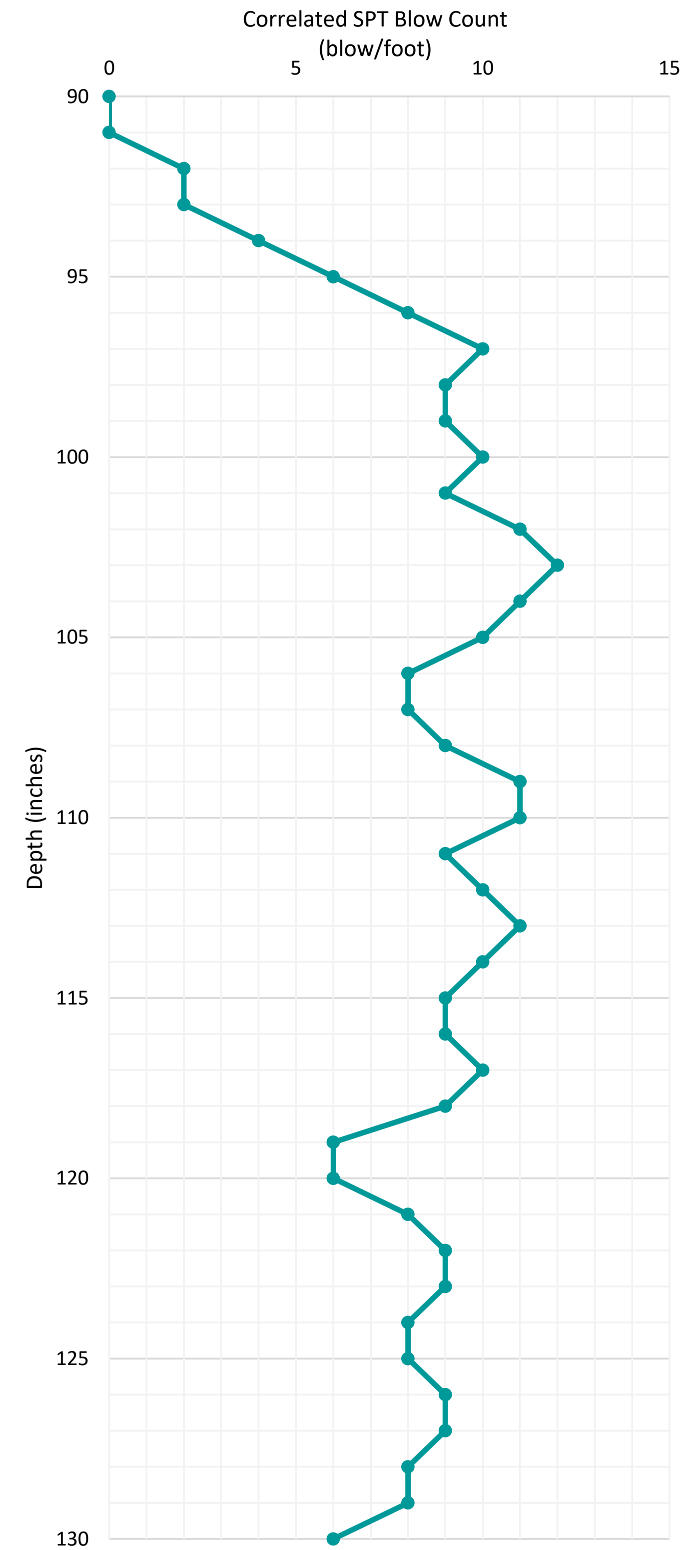
DATE: JUNE 2021

PLATE
B-3

APPENDIX C

Kokua Geotech LLC Soil and Foundation Engineering	WAIKIKI AQUARIUM IMPROVEMENTS AND WASTEWATER SYSTEM UPGRADES 2777 KALAKAUA AVENUE HONOLULU, OAHU, HAWAII	LOG OF DCP **1**

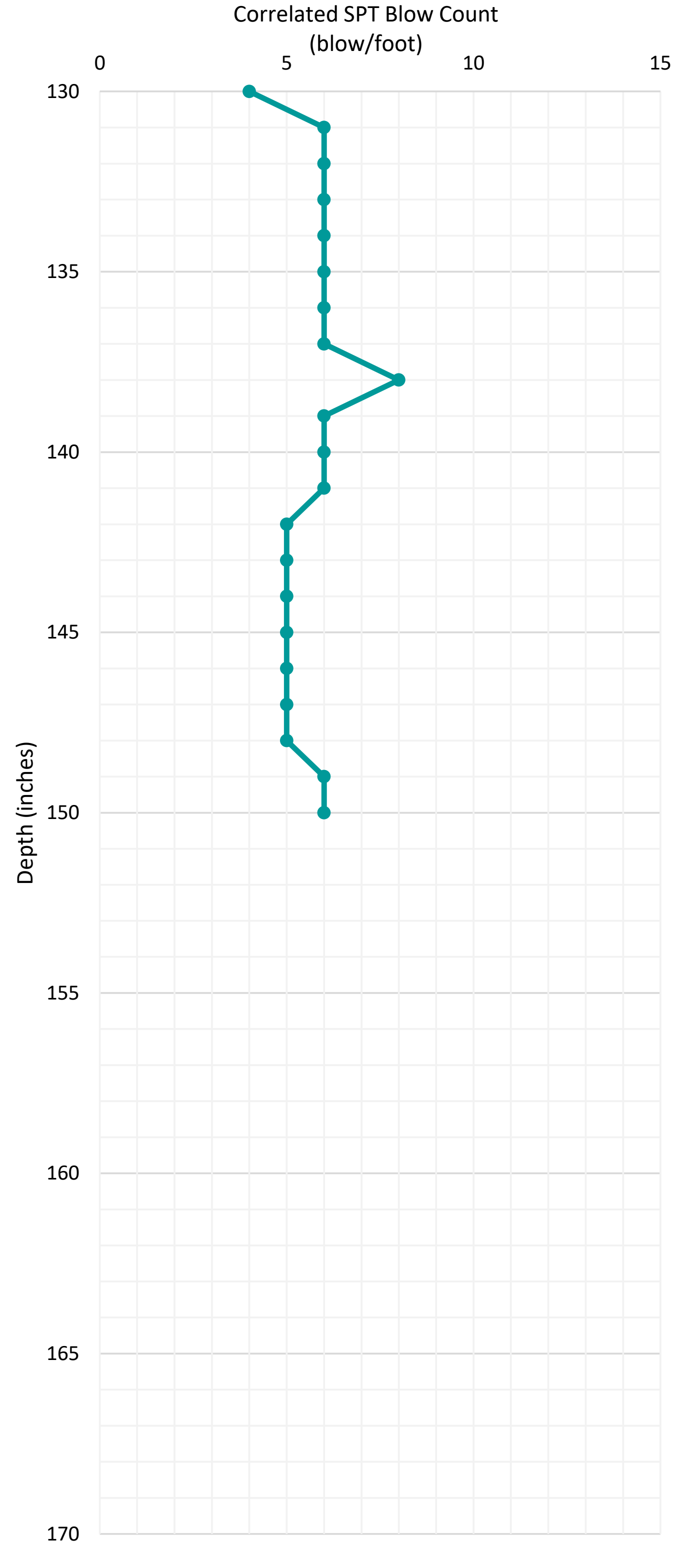
No. of Blows	Depth of Penetration (inches)	Correlated CBR	Correlated SPT Blow Count (blow/foot)
0	90	0.0	0
1	91	0.0	0
1	92	1.3	2
1	93	1.3	2
4	94	2.5	4
5	95	3.7	6
9	96	4.9	8
10	97	6.2	10
5	98	5.5	9
10	99	5.5	9
7	100	6.2	10
9	101	5.5	9
11	102	6.9	11
12	103	7.6	12
10	104	6.9	11
7	105	6.2	10
6	106	4.9	8
7	107	4.9	8
9	108	5.5	9
11	109	6.9	11
8	110	6.9	11
9	111	5.5	9
10	112	6.2	10
11	113	6.9	11
7	114	6.2	10
8	115	5.5	9
8	116	5.5	9
10	117	6.2	10
6	118	5.5	9
5	119	3.7	6
6	120	3.7	6
7	121	4.9	8
8	122	5.5	9
7	123	5.5	9
6	124	4.9	8
7	125	4.9	8
8	126	5.5	9
6	127	5.5	9
7	128	4.9	8
5	129	4.9	8
5	130	3.7	6



Project No.:	030421-00	Total Depth:	7.5 to 12.5 feet	PLATE **C-1**
Date Started:	5/17/2021	Probing Equipment:	DCP H-4202SX	
Date Completed:	5/17/2021	Size of Cone Tip:	1.5 inch diameter with 45^{o} cone	
Logged By:	ZYH	Driving Energy:	15 lb. steel mass falling 20 inches	

Kokua Geotech LLC Soil and Foundation Engineering	WAIKIKI AQUARIUM IMPROVEMENTS AND WASTEWATER SYSTEM UPGRADES 2777 KALAKAUA AVENUE HONOLULU, OAHU, HAWAII	LOG OF DCP **1**

No. of Blows	**Depth of Penetration**	**Correlated CBR**	**Correlated SPT Blow Count**
	(inches)		(blow/foot)
5	130	2.5	4
4	131	3.7	6
5	132	3.7	6
5	133	3.7	6
4	134	3.7	6
5	135	3.7	6
4	136	3.7	6
6	137	3.7	6
6	138	4.9	8
5	139	3.7	6
5	140	3.7	6
3	141	3.7	6
3	142	3.1	5
3	143	3.1	5
4	144	3.1	5
3	145	3.1	5
3	146	3.1	5
3	147	3.1	5
4	148	3.1	5
4	149	3.7	6
5	150	3.7	6



Project No.:	030421-00	Total Depth:	7.5 to 12.5 feet
Date Started:	5/17/2021	Probing Equipment:	DCP H-4202SX
Date Completed:	5/17/2021	Size of Cone Tip:	1.5 inch diameter with 45º cone
Logged By:	ZYH	Driving Energy:	15 lb. steel mass falling 20 inches

PLATE
C-2

Appendix C:

Geotechnical Engineering Exploration: Waikīkī Aquarium Improvements, Phase 2

GEOTECHNICAL ENGINEERING EXPLORATION

WAIKIKI AQUARIUM IMPROVEMENTS, PHASE 2
2777 KALAKAUA AVENUE
TMK: 3-1-031: 006
HONOLULU, OAHU, HAWAII

NOVEMBER 11, 2023

Prepared for:
OCEANIT

PROJECT NO. 021523-00

Kokua Geotech LLC
Soil and Foundation Engineering

November 11, 2023
Project No. 021523-00

Oceanit
828 Fort Street Mall, Suite 600
Honolulu, Hawaii 96813

Attention: Mr. Jason Lee

Subject: **Geotechnical Engineering Exploration**
Waikiki Aquarium Improvements, Phase 2
2777 Kalakaua Avenue
TMK: 3-1-031: 006
Honolulu, Oahu, Hawaii

Dear **Mr. Lee**:

We are pleased to submit this report entitled "Geotechnical Engineering Exploration, Waikiki Aquarium Improvements, Phase 2, 2777 Kalakaua Avenue, TMK: 3-1-031: 006, Honolulu, Oahu, Hawaii" prepared for the design of the project.

The purpose of our field exploration and this report was to observe and evaluate the general subsurface conditions at accessible locations at the project site to formulate geotechnical recommendations to assist in the design of the project. Our work was performed in general accordance with the scope of services outlined in our fee proposal dated February 27, 2023.

Our findings and recommendations are summarized as follows:

1. Our field exploration at the project site generally encountered surface fill materials overlying beach deposits, lagoonal deposits, and apparent coral formation extending down to the maximum depth explored of about 43.5 feet below the existing ground surface. In addition, Boring No. 101 was located on an existing tiled surface and generally encountered an approximate 12-inch thick layer of concrete overlying the surface fill materials, while Boring Nos. 102 and 103 were located on an existing asphaltic concrete surface and encountered about 1 to 3 inches of asphaltic concrete overlying about 4 to 5 inches of base material.

   The surface fill materials encountered generally consisted of medium dense to very dense clayey gravel and very loose to loose silty sand and were estimated to be about 3 to 7 feet thick. Beach deposits were encountered underlying the surface fill materials to depths ranging from about 6 to 11 feet below the existing ground surface and generally consisted of very loose to medium dense sand with a little silt and gravel. Lagoonal deposits generally consisting of very loose to medium dense clayey sand/gravel and very soft sandy clay were encountered underlying the beach deposits to a depth of about 42.5 feet below the existing ground surface.

It should be noted that the lagoonal deposits encountered at the project site are highly compressible when subjected to new loads. Below the highly compressible lagoonal deposits, our field exploration generally encountered apparent medium hard to hard coral formation extending down to the maximum depth explored of about 43.5 feet below the existing ground surface.

2. We encountered groundwater in our borings at depths ranging from about 5.3 to 6.5 feet below the existing ground surface at the time of our field exploration. Due to the proximity of the project site to the Pacific Ocean, groundwater levels are expected to vary with tidal fluctuations. In addition, groundwater levels may change due to seasonal precipitation, surface water runoff, and other factors.

3. Based on the subsurface conditions anticipated at the project site and our engineering analyses, we believe the near-surface soils would not provide adequate foundation support for the proposed pump vault, well water aeration/settling tank, and influent treatment building structures without appreciable settlements and differential settlements under the anticipated loads. Therefore, we recommend utilizing a deep foundation system to support these structures.

   Based on our evaluation, we recommend the deep foundation support system for the proposed pump vault, well water aeration/settling tank, and influent treatment building structures consist of micropiles extending through the loose/soft, compressible beach and lagoonal deposits and deriving load bearing support from the underlying coralline materials anticipated at greater depths.

4. Based on availability of local equipment, we envision a micropile system with a minimum grout bulb diameter of 5.5 inches (minimum drill bit size) may be used for foundation support of the new pumping station structure. We recommend designing each micropile based on an allowable compressive load capacity of 30 kips for the 5.5-inch diameter micropiles.

5. We anticipate the load supporting capacity of the micropile foundation would be derived primarily from skin friction between the micropile shaft and the coralline materials anticipated underlying the project site. We also recommend using

permanent steel casing for the micropiles that extend through the loose/soft, compressible beach and lagoonal deposits to the top of the coralline materials.

6. To achieve the allowable compressive load capacity of 30 kips with a factor of safety of 2, we believe the 5.5-inch diameter micropiles would need a minimum bonded zone of 20 feet below the permanent casing and extend a minimum of about 10 feet into the underlying coralline materials encountered in our boring at a depth of about 43 feet below the existing ground surface.

7. We anticipate that installation of the new landside piping for the natural sea water system, well water system, and pump building will generally consist of trench excavation, pipe bedding and placement, and trench backfill. Based on the anticipated excavation depths for the new piping and structures, we believe that dewatering may be needed.

8. In general, the excavated on-site soils may be re-used as a source of general fill, provided they are free of vegetation, deleterious materials, and rock fragments greater than 3 inches in maximum dimension. Imported fill materials, if required, should consist of non-expansive structural fill material, such as crushed coral or basalt.

9. Based on the information provided, we understand an interim repair concept being considered generally consists of reconstructing the CRM seawall and backfilling the existing void area behind the wall with lean concrete through injection ports. In general, we believe this reconstruction and concrete injection concept may be used for interim repairs of the existing distressed seawall. However, we believe consideration should be given to utilizing Controlled Low Strength Material (CLSM) as an alternative to lean concrete.

10. The construction plans and specifications for the project should be forwarded to us for review to determine whether the recommendations contained in this report are adequately reflected in those documents. If this review is not made, Kokua Geotech LLC cannot assume responsibility for misinterpretation of our recommendations.

11. Kokua Geotech LLC should also be retained to monitor the micropile installation, site grading, utility line installation and backfill, and other aspects of earthwork construction to determine whether the recommendations of this report are followed. The recommendations presented herein are contingent upon such observations.

    If the actual exposed subsurface soil conditions encountered during construction differ from those assumed or considered in this report, Kokua Geotech LLC should be contacted to review and/or revise the geotechnical recommendations presented herein.

Detailed discussion of our findings and geotechnical engineering recommendations are contained in the body of this report. We appreciate the opportunity to be of service for this project. Should you have any questions concerning this report, please contact our office.

Very truly yours,

Kokua Geotech LLC

____

Xiaobin (Tim) Lin, P.E.
President

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GEOTECHNICAL ENGINEERING EXPLORATION
WAIKIKI AQUARIUM IMPROVEMENTS, PHASE 2
2777 KALAKAUA AVENUE
TMK: 3-1-031: 006
HONOLULU, OAHU, HAWAII

SECTION 1.0 INTRODUCTION

We have performed a geotechnical engineering exploration for the *Waikiki Aquarium Improvements, Phase 2* project in Honolulu on the Island of Oahu, Hawaii. The location of the project and general vicinity are shown on the Project Location Map, Plate 1.

The purpose of our exploration was to observe and evaluate the general subsurface conditions at accessible locations at the project site to formulate geotechnical recommendations to assist in the design of the project. This report summarizes the findings and presents our geotechnical recommendations resulting from our site reconnaissance, field exploration, laboratory testing, and engineering analyses for the project. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.1 PROJECT CONSIDERATIONS

The project generally involves Phase 2 improvements and upgrades at the existing Waikiki Aquarium in the Waikiki area of Honolulu on the Island of Oahu, Hawaii. Based on the information provided, we understand improvements and upgrades are planned for the natural sea water system, well water system, and pump building. In addition, we understand repairs are planned for a portion of an existing distressed seawall along the public walkway on the makai of the aquarium facility. A layout of the project site is shown on the Site Plan, Plate 2.

In general, it is our understanding that geotechnical engineering recommendations are desired for new partially below grade new natural sea water pump vault and well water aeration/settling tank structures. Based on conceptual design plans provided, we anticipate the new pump vault and well water aeration/settling tank will generally consist of partially below grade concrete structures. In addition, we understand a new influent treatment building structure containing four 25,000 lb. filtration tanks, filter pumps, and a 27-ton chiller is planned for the project.

We understand interim repair recommendations are also desired for the existing distressed seawall along the public walkway on the makai of the aquarium facility. In general, it is our understanding that a portion of the existing seawall has apparently collapsed, resulting in a loss of the CRM materials and seawall backfill materials.

1.2 PURPOSE AND SCOPE OF WORK

The purpose of our services was to generally explore and evaluate the subsurface soil conditions at accessible locations at the project site to provide geotechnical recommendations to assist in the design of the project. Our work was performed in general accordance with our fee proposal dated February 27, 2023. The scope of work for this exploration included the following items:

1. Coordination of boring stake-out and utility clearances by our engineer.
2. Mobilization and demobilization of a track-mounted drill rig and two operators to and from the project site.
3. Drilling, hand augering, and sampling of three boreholes extending to depths ranging from about 7 to 43.5 feet below the existing ground surface.
4. Performance of Dynamic Cone Penetrometer (DCP) testing at the hand auger locations to evaluate the relative consistency of the subsurface materials encountered.
5. Coordination of the field exploration and logging of the boreholes and DCP testing by our field engineer.
6. Laboratory testing of selected samples obtained during the field exploration as an aid in classifying the materials and evaluating their engineering properties.
7. Analyses of the field and laboratory data to formulate geotechnical recommendations for design of the project.

8. Preparation of this report summarizing our work on the project and presenting our findings and recommendations.

9. Coordination of our overall work on the project by our project engineer.

10. Quality assurance and client/design team consultation by our principal engineer.

11. Miscellaneous work efforts such as drafting, word processing, and clerical support.

Detailed descriptions of our field exploration methodology are presented in the following section and the Log of the Boring in Appendix A. Results of the laboratory tests performed are presented in Appendix B. Results of the DCP tests performed are presented in Appendix C.

END OF INTRODUCTION

SECTION 2.0 SITE CHARACTERIZATION AND FINDINGS

2.1 GENERAL SITE GEOLOGY

The project site is generally located on the southeastern flank of the Koolau Volcano on the Island of Oahu. Based on the geologic maps of the Island of Oahu (Stearns, 1939 and Sherrod and others, 2007), the general area of the project site is underlain by Beach Deposits (Qbd) and Alluvium (Qa).

During the Pleistocene Epoch, a time period that began about 2.6 million years ago and lasted until about 11,700 years ago, sea levels fluctuated in response to the cycles of continental glaciation. As the glaciers grew and advanced, less water was available to fill the oceanic basins such that sea levels fell below the present stands of the sea. When the glaciers melted and receded, an excess of water became available such that the sea levels rose to above the present sea level.

The higher sea level stands caused the formation of deltas and fans of accumulated terrigenous sediments in the heads of old bays, accumulated reef deposits at correspondingly higher elevations, and deposited lagoonal/marine sediments in the quiet waters protected by fringing reefs. The processes of landform erosion, sediment deposition, and reef development were affected by these glacio-eustatic sea level fluctuations.

When the sea level was relatively lower, the erosional base level was correspondingly lower and stream valleys were carved deeper into the Island's basaltic rock, the fringing coastal sediments, and the offshore reef deposits. Also, during periods of relatively lower sea level, the sub-aerial exposure of calcareous marine sediments caused consolidation and cementation of the deposits to form hardened calcareous deposits.

Placement of near-surface man-made fills associated with the development of urban areas within the last 80 years has brought the Honolulu Coastal Plain to its present form. In the early part of this century, much of the Waikiki area consisted of low elevation marsh wetlands. As the City of Honolulu grew and the Waikiki area was urbanized, man-made fills were placed to

reclaim the marshy areas and lagoons for development. It should be noted that much of the resulting fill materials placed are of poor quality in terms of supporting heavy structural loads.

The surface soils underlying the project sites are classified as Beaches (BS) and Jaucas Sand (JaC) by the U.S. Soil Conservation Service in their publication “Soil Survey of Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii” (1972). The Beaches (BS) soil type is described as light-colored sands derived from coral and seashells that are washed and rewashed by ocean waves. Similarly, the Jaucas Sand soil type is described as light brown, excessively drained, calcareous soils that occur in narrow strips on coastal plains adjacent to the ocean that developed in wind and water deposited sand from coral and seashells.

2.2 SITE DESCRIPTION

The project site is at the existing Waikiki Aquarium located at 2777 Kalakaua Avenue in the Waikiki area of Honolulu on the Island of Oahu, Hawaii. This facility is generally bordered by Sans Souci State Recreational Park to the north, Waikiki War Memorial Natatorium to the south, Kalakaua Avenue to the east, and the Pacific Ocean to the west. In general, this facility includes aquarium and lobby building structures, numerous aquatic tank structures, water features, comfort station, and access driveway and parking areas.

In general, the topography of the project site appears to be relatively flat. Based on topographic survey information provided, we anticipate existing ground surface elevations to range from roughly +6 to +9 feet Mean Sea Level (MSL). At the time of our field exploration, the existing building and tank structures were generally surrounded by concrete walkways, mown lawn grass, and various landscaping plants. Exposed surface soils at the site were observed to generally consist of brownish tan beach sand.

In addition, a portion of the existing seawall along the public walkway on the makai of the aquarium facility was observed to have apparently collapsed at the time of our field exploration, resulting in a loss of the CRM materials and seawall backfill materials. Signs of foundation undermining were also observed along portions of the existing distressed seawall.

2.3 FIELD EXPLORATION

We explored the subsurface conditions at the project site by drilling, hand augering, and sampling three borings, designated as Boring Nos. 101 through 103, extending to depths ranging from approximately 7 to 43.5 feet below the existing ground surface. Boring No. 101 was drilled utilizing a track-mounted drill rig equipped with continuous flight hollow stem augers, while Boring Nos. 102 and 103 were advanced using hand auger and Dynamic Cone Penetrometer (DCP) testing equipment due to accessibility constraints and an abundance of underground utility lines in the area. The approximate boring and DCP test locations are shown on the Site Plan, Plate 2.

Our engineer classified the materials encountered in the boring 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). Graphic representations of the materials encountered are presented on the Log of Borings, Appendix A.

Soil samples were obtained in general accordance with ASTM D1586 by driving a 2-inch OD standard penetration sampler with a 140-pound hammer falling 30 inches. In addition, relatively undisturbed soil samples were obtained in general accordance with ASTM D3550 by driving a 3-inch OD Modified California 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 "Sampling Resistance" on the Log of Boring at the appropriate sample depths. The blow counts may need to be factored to obtain the Standard Penetration Test (SPT) blow counts.

It should be noted that hollow stem augers were used to advance Boring No. 1 to the maximum auger depth of about 7 feet below the existing ground surface. Since very soft/loose soil conditions were encountered at this depth, probing operations were implemented within the borehole to determine the approximate depth to stiff/dense soil conditions. Probing operations generally consisted of driving a pointed steel probing tip with a 140-pound hammer falling

30 inches. The blow counts needed to drive the probing tip 12 inches are shown on the Logs of Borings at the appropriate sample depths.

The DCP tests were performed at the hand auger locations by driving a 1.5-inch diameter 45-degree steel cone tip with a 15-pound hammer falling 20 inches in vertical height. The blow counts were recorded per every or near 1-inch of penetration and converted to standard penetration resistance (SPT) using correlation between Penetration Index (PI) and SPT, developed by Sowers and Hedges. Results of the DCP tests performed are presented in Appendix C.

2.4 LABORATORY TESTING

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

One Atterberg Limits test (ASTM D4318) was performed on a selected soil sample to evaluate the liquid and plastic limits. The sample tested was determined to be essentially Non-Plastic (NP). The test results are summarized on the Logs of Borings at the appropriate sample depths. Graphic presentations of the Atterberg Limits test results are provided on Plate B-1.

Two Sieve Analysis tests (ASTM C117 and C136) were performed on selected soil samples to evaluate the gradation characteristics of the soil and to aid in soil classification. Graphic presentations of the grain size distributions are provided on Plate B-2.

2.5 SUBSURFACE CONDITIONS

Our borings generally encountered surface fill materials overlying beach deposits, lagoonal deposits, and apparent coral formation extending down to the maximum depth explored of about 43.5 feet below the existing ground surface. In addition, Boring No. 101 was located on an existing tiled surface and generally encountered an approximate 12-inch thick layer of concrete overlying the surface fill materials, while Boring Nos. 102 and 103 were located on an existing asphaltic concrete surface and encountered about 1 to 3 inches of asphaltic concrete overlying about 4 to 5 inches of base material.

The surface fill materials encountered generally consisted of medium dense to very dense clayey gravel and very loose to loose silty sand and were estimated to be about 3 to 7 feet thick. Beach deposits were encountered underlying the surface fill materials to depths ranging from about 6 to 11 feet below the existing ground surface and generally consisted of very loose to medium dense sand with a little silt and gravel. Lagoonal deposits generally consisting of very loose to medium dense clayey sand/gravel and very soft sandy clay were encountered underlying the beach deposits to a depth of about 42.5 feet below the existing ground surface.

It should be noted that the lagoonal deposits encountered at the project site are highly compressible when subjected to new loads. Below the highly compressible lagoonal deposits, our field exploration generally encountered apparent medium hard to hard coral formation extending down to the maximum depth explored of about 43.5 feet below the existing ground surface.

We encountered groundwater in the drilled borings at depths ranging from about 5.3 to 6.5 feet below the existing ground surface at the time of our field exploration. Due to the proximity of the project site to the Pacific Ocean, groundwater levels are expected to vary with tidal fluctuations. In addition, groundwater levels may change due to seasonal precipitation, surface water runoff, and other factors.

2.6 SEISMIC DESIGN CONSIDERATIONS

Based on the International Building Code, 2018 Edition (IBC 2018) and American Society of Civil Engineers Standard ASCE/SEI 7-16 (ASCE 7-16), the project site may be subject to seismic activity, and seismic design considerations will need to be addressed. The following sections provide discussions on the seismicity, the potential for liquefaction, and soil profile for seismic design at the project site.

2.6.1 EARTHQUAKES AND SEISMICITY

In general, earthquakes that occur throughout the world are caused by shifts in the tectonic plates. In contrast, earthquake activity in Hawaii is linked primarily to volcanic activity. Therefore, earthquake activity in Hawaii generally occurs before or during volcanic eruptions. In addition, earthquakes may result from the underground movement of magma that comes close to the surface but does not erupt. The Island of Hawaii experiences thousands of earthquakes each year, but most are so small that they can only be detected by sensitive instruments. However, some of the earthquakes are strong enough to be felt, and a few cause minor to moderate damage.

In general, earthquakes associated with volcanic activity are most common on the Island of Hawaii. Earthquakes directly associated with the movement of magma are concentrated beneath the active Kilauea and Mauna Loa Volcanoes on the Island of Hawaii. Because the majority of the earthquakes in Hawaii (over 90 percent) are related to volcanic activity, the risk of seismic activity and degree of ground shaking diminishes with increased distance from the Island of Hawaii.

The Island of Hawaii has experienced numerous earthquakes greater than Magnitude 5 (M5+); however, earthquakes are not confined only to the Island of Hawaii. To a lesser degree, the Island of Maui also has experienced earthquakes greater than M5+. Therefore, moderate to strong earthquakes have occurred in the County of Maui. The effects of earthquakes occurring on the Islands of Hawaii and Maui may be felt on the Island of Oahu. For example, small landslides occurred on the Island of Oahu as a result of the Maui Earthquake of 1938 (M6.8). Some houses on the Island of Oahu were reportedly damaged as a result of the Lanai Earthquake of 1871 (M7+).

In the last 150 years of recorded history, we are not aware of earthquakes greater than Magnitude 6 that have occurred on the Island of Oahu. An earthquake of Magnitude 4.8 to 5.0 occurred along the Diamond Head Fault in 1948 on the Island of Oahu. The moderate tremor resulted in broken store windows, ruptured building walls, and broken underground water mains.

2.6.2 LIQUEFACTION POTENTIAL

Based on the IBC 2018 and ASCE 7-16, the project site should be evaluated for the potential for soil liquefaction. Soil liquefaction is a condition where saturated cohesionless soils located near the ground surface undergo a substantial loss of strength due to the build-up of excess pore water pressures resulting from cyclic stress applications induced by earthquakes. In this process, when the loose saturated sand deposit is subjected to vibration (such as during an earthquake), the soil tends to densify and decrease in volume causing an increase in pore water pressure.

If drainage is unable to occur rapidly enough to dissipate the build-up of pore water pressure, the effective stress (internal strength) of the soil is reduced. Under sustained vibrations, the pore water pressure build-up could equal the overburden pressure, essentially reducing the soil shear strength to zero and causing it to behave as a viscous fluid. During liquefaction, the soil acquires sufficient mobility to permit both horizontal and vertical movements, and if not confined, will result in significant deformations.

Soils most susceptible to liquefaction are loose, uniformly graded, fine-grained sands and loose silts with little cohesion. The major factors affecting the liquefaction characteristics of a soil deposit are as follows:

FACTORS	LIQUEFACTION SUSCEPTIBILITY
Grain Size Distribution	Fine and uniform sands and silts are more susceptible to liquefaction than coarse or well-graded sands.
Initial Relative Density	Loose sands and silts are most susceptible to liquefaction. Liquefaction potential is inversely proportional to relative density.
Magnitude and Duration of Vibration	Liquefaction potential is directly proportional to the magnitude and duration of the earthquake.

Our borings encountered surface fill materials overlying beach deposits generally consisting of loose to medium dense sand with a little silt and gravel and lagoonal deposits consisting of very loose to loose clayey gravel and very soft sandy clay to a depth of about 43.5 feet below the existing ground surface. In general, these loose sandy soils can be considered potentially liquefiable during a seismic event.

We evaluated the liquefaction potential of the saturated granular soils at the site using the computer software program LiquefyPro (Version 5) by CivilTech Software and the procedures outlined by Youd, et. al. (2001). Our analyses were performed on the drilled borings based on a seismic event of Magnitude 6 with an associated preliminary peak ground acceleration of 0.266g.

Based on our analyses, it appears that portions of the very loose to loose beach and lagoonal deposits below the surface fill materials have a factor of safety of 0.5 to 1.0 against liquefaction. Therefore, we believe the project site could be subjected to appreciable seismically induced ground settlements (on the order of about 3 to 7 inches) in the event of liquefaction during a moderate earthquake (M6+). However, we believe lateral spreading associated with liquefaction would not be a significant design consideration based on the relatively flat site topography.

2.6.3 SOIL PROFILE

In accordance with Chapter 20, Site Classification Procedure for Seismic Design contained in ASCE 7-16, a site-response analysis is not required to determine the spectral accelerations for liquefiable soils for structures having fundamental periods of vibration equal to or less than 0.5 seconds. Rather, a site class is permitted to be determined in accordance with Section 20.3 and the corresponding values of F_a and F_v determined from Tables 11.4-1 and 11.4-2.

Based on our evaluation, we believe the fundamental period of vibration should be less than 0.5 seconds for the structures planned for the project. Therefore, a site class is permitted to be determined in accordance with Section 20.3. The project structural engineer should be consulted to confirm our assumption on the fundamental period of vibration for the planned structures.

Based on the subsurface materials encountered at the project site, the average penetration resistance (N-values) of the subsurface materials, and the geologic setting of the area, we anticipate that the project site may be classified from a seismic analysis standpoint as being a "Soft Soil Profile" site corresponding to a Site Class E soil profile type based on Chapter 20 of ASCE 7-16.

Based on Site Class E, the following seismic design parameters were estimated and may be used for seismic analysis of the project.

SUMMARY OF SEISMIC DESIGN PARAMETERS	
Mapped MCE Spectral Response Acceleration, S_S	0.579g
Mapped MCE Spectral Response Acceleration, S_1	0.169g
Site Class	E
Site Coefficient, F_a	1.574
Site Coefficient, F_v	4.200
Design Spectral Response Acceleration, S_{DS}	0.607g
Design Spectral Response Acceleration, S_{D1}	0.475g
Peak Ground Acceleration, PGA	0.266g
Site Modified Peak Ground Acceleration, PGA_M	0.453g

END OF SITE CHARACTERIZATION AND FINDINGS

SECTION 3.0 DISCUSSION AND RECOMMENDATIONS

Based on the results from our field exploration, the project site is generally underlain by surface fill materials overlying beach deposits, lagoonal deposits, and apparent coral formation extending down to the maximum depth explored of about 43.5 feet below the existing ground surface. In addition, Boring No. 101 was located on an existing tiled surface and generally encountered an approximate 12-inch thick layer of concrete overlying the surface fill materials, while Boring Nos. 102 and 103 were located on an existing asphaltic concrete surface and encountered about 1 to 3 inches of asphaltic concrete overlying about 4 to 5 inches of base material.

The surface fill materials encountered generally consisted of medium dense to very dense clayey gravel and very loose to loose silty sand and were estimated to be about 3 to 7 feet thick. Beach deposits were encountered underlying the surface fill materials to depths ranging from about 6 to 11 feet below the existing ground surface and generally consisted of very loose to medium dense sand with a little silt and gravel. Lagoonal deposits generally consisting of very loose to medium dense clayey sand/gravel and very soft sandy clay were encountered underlying the beach deposits to a depth of about 42.5 feet below the existing ground surface.

It should be noted that the lagoonal deposits encountered at the project site are highly compressible when subjected to new loads. Below the highly compressible lagoonal deposits, our field exploration generally encountered apparent medium hard to hard coral formation extending down to the maximum depth explored of about 43.5 feet below the existing ground surface.

We encountered groundwater in the drilled borings at depths ranging from about 5.3 to 6.5 feet below the existing ground surface at the time of our field exploration. Due to the proximity of the project site to the Pacific Ocean, groundwater levels are expected to vary with tidal fluctuations. In addition, groundwater levels may change due to seasonal precipitation, surface water runoff, and other factors.

Based on the subsurface conditions anticipated at the project site and our engineering analyses, we believe the near-surface soils would not provide adequate foundation support for the proposed pump vault, well water aeration/settling tank, and influent treatment building structures without appreciable settlements and differential settlements under the anticipated loads. Therefore, we recommend utilizing a deep foundation system to support these structures.

Based on our evaluation, we recommend the deep foundation support system for the proposed pump vault, well water aeration/settling tank, and influent treatment building structures consist of micropiles extending through the loose/soft, compressible beach and lagoonal deposits and deriving load bearing support from the underlying coralline materials anticipated at greater depths.

We anticipate that installation of the new landside piping for the natural sea water system, well water system, and pump building will generally consist of trench excavation, pipe bedding and placement, and trench backfill. Based on the anticipated excavation depths for the new piping and structures, we believe that dewatering may be needed.

In general, the excavated on-site soils may be re-used as a source of general fill, provided they are free of vegetation, deleterious materials, and rock fragments greater than 3 inches in maximum dimension. Imported fill materials, if required, should consist of non-expansive structural fill material, such as crushed coral or basalt.

Detailed discussion of these items and our geotechnical recommendations for design of the new pump vault, well water aeration/settling tank, and influent treatment building structures, utility trenches, interim seawall repairs, and other geotechnical aspects of the project are presented in the following sections.

3.1 PUMP VAULT, AERATION/SETTLING TANK, AND INFLUENT TREATMENT BUILDING STRUCTURE FOUNDATIONS

Based on the subsurface conditions anticipated at the project site and our engineering analyses, we believe the near-surface soils would not provide adequate foundation support for the proposed pump vault, well water aeration/settling tank, and influent treatment building structures without appreciable settlements and differential settlements under the anticipated loads. Therefore, we recommend utilizing a deep foundation system to support these structures.

Based on our evaluation, we recommend the deep foundation support system for the proposed pump vault, well water aeration/settling tank, and influent treatment building structures consist of micropiles extending through the loose/soft, compressible beach and lagoonal deposits and deriving load bearing support from the underlying coralline materials anticipated at greater depths.

In general, a micropile consists of a small diameter (usually less than 12 inches) drilled and grouted pile with steel reinforcing. The micropile foundation typically is constructed by drilling a borehole, placing reinforcing steel in the hole, and grouting the borehole. Micropiles are desirable because they can be installed readily in access restrictive environments and in numerous soil types and ground conditions. In addition, installation of the micropiles generally causes minimal disturbance to the adjacent structures, the adjacent soils, and the environment.

Based on availability of local equipment, we envision a micropile system with a minimum grout bulb diameter of 5.5 inches (minimum drill bit size) may be used for foundation support of the new pump vault, well water aeration/settling tank, and influent treatment building structures. We recommend designing each micropile based on an allowable compressive load capacity of 30 kips for the 5.5-inch diameter micropiles. The allowable compressive load capacity for the micropiles is for supporting dead-plus-live loads and may be increased by one-third (1/3) for transient loads, such as wind or seismic forces.

Based on the anticipated subsurface conditions at the project site, we anticipate the load supporting capacity of the micropile foundation would be derived primarily from skin friction between the micropile shaft and the coralline materials anticipated underlying the project site. We also recommend using permanent steel casing for the micropiles that extend through the loose/soft, compressible beach and lagoonal deposits to the top of the coralline materials. The permanent steel casing should have an outside diameter (OD) of about 5.5 inches (same as the grout bulb size) and should provide confinement to the micropile in the area where moment demand on the micropile is greatest.

To achieve the allowable compressive load capacity of 30 kips with a factor of safety of 2, we believe the 5.5-inch diameter micropiles would need a minimum bonded zone of 20 feet below the permanent casing and extend a minimum of about 10 feet into the underlying coralline materials encountered in our boring at a depth of about 43 feet below the existing ground surface.

Based on topographic survey information provided, we anticipate existing ground surface elevations to range from roughly +6 to +8 feet Mean Sea Level (MSL). Therefore, we recommend a minimum micropile tip elevation of about -46 feet MSL based on a total micropile length of about 53 feet installed on an assumed working grade of about +7 feet MSL. Based on these assumptions, our recommendations pertaining to the preliminary micropile allowable load capacities and lengths are presented in the following table:

SUMMARY OF MICROPILE FOUNDATIONS				
Micropile Diameter (inch)	**Allowable Compressive Load Capacity** (kips)	**Minimum Micropile Tip Elevation** (feet MSL)	**Minimum Bonded Zone Length** (feet)	**Total Estimated Micropile Length** (feet)
5.5	30	-46	20 feet and 10 feet min. into hard coralline materials	53

Notes:
1. Min. Tip Elevation and Total Estimated Micropile Length assumes working grade of +7 feet MSL
2. Permanent casing should be used below the bottom of foundation to the top of bonded zone
3. Minimum Bonded Zone Length is the length of micropile below the bottom of permanent casing

To facilitate the micropile drilling and ensure the quality of the grouting, we recommend advancing the steel casing to the bottom of the micropile during the drilling operation. The steel casing may be withdrawn during the grouting operation while a minimum of 5 feet of grout head is maintained above the bottom of the casing at all times. The steel casing should be withdrawn above the design casing depth and plunged back to the design casing depth.

Lateral loads imposed on the foundations should be resisted by the passive earth pressure acting against the near-vertical faces of the foundation caps. Lateral load resistance contribution from the micropile should be discounted due to the relatively small diameter of the foundation element. Passive earth pressure against the near-vertical faces of the foundation caps may be estimated using an equivalent fluid pressure of 350 and 150 pounds per cubic foot (pcf) for above and below groundwater conditions, respectively.

Settlements of the micropiles will result primarily from elastic compression of the micropile member and subgrade response. We estimate the total settlement of the micropile-supported foundations to be 0.5 inches or less with differential settlements between micropiles not exceeding about one-half of the total settlement. We believe these settlements are essentially elastic and should occur as the loads are applied.

In order to determine whether the contractor's methods of micropile installation are adequate and to determine the ultimate compressive load capacity, we recommend performing one pre-production compressive load test on a sacrificial micropile.

In general, the purpose of the pre-production load test on a micropile is to fulfill the following objectives:

- To examine the adequacy of the methods and equipment proposed by the contractor to install the micropiles to the depths required.
- To confirm or modify the estimated minimum depth of the micropiles by determining the ultimate grout-to-soil bond stress.
- To assess the contractor's method of drilling and grouting.

In general, the pre-production load test should be performed in accordance with ASTM D1143. Based on experience, we believe the load test should be conducted no earlier than 7 days after completion of the micropile installation to allow the grout adequate time to cure. Two (or four) additional micropiles may be used for reaction during the compressive load testing of the pre-production load test micropile. The reaction micropiles may be installed to depths as deep as the load test micropile to provide adequate reaction in uplift (to be determined by the contractor).

The load test micropile should be loaded gradually to at least 200 percent of the allowable design load in compression. We recommend holding the maximum test load (200 percent of the design load) for a minimum of 4 hours depending on the recorded movements of the load test micropile. The pre-production load test is an integral part of the design of the micropile foundation system. Therefore, we recommend a Kokua Geotech LLC representative observe the pre-production load test.

In addition to the pre-production load test, we also recommend performing pullout tests (proof tests) on selected micropiles during construction to confirm the load carrying capacity of the installed micropiles. We recommend testing a minimum 10 percent of the total number of micropiles for pullout. The pullout tests should consist of subjecting the micropile to at least 133 percent of the design load. The micropile should be loaded in 12.5 percent design load increments, and each load should be held for at least 5 minutes. The maximum test load should be held for a minimum of 10 or 60 minutes. Pullout test on the selected micropiles is an integral part of the design of the micropile foundation system. Therefore, we recommend conducting the pullout tests under the observation of a Kokua Geotech LLC representative.

A specialty contractor experienced in the construction of a micropile foundation system (minimum five projects) should perform the installation of the micropiles. Due to the specialized nature of the micropile foundation construction, observation and testing of the micropile foundation system should be designated as a "Special Inspection" item. Therefore, a Kokua Geotech LLC representative (Special Inspector) should be present to observe the geotechnical aspects of the micropile foundation construction and testing.

The new partially below-grade pump vault and well water aeration/settling tank structures should also be designed to resist lateral earth pressures due to the adjacent soils and surcharge effects caused by loads adjacent to the walls. The recommended lateral earth pressures for the design of the new below-grade structures, expressed in equivalent fluid pressures of pounds per square foot per foot of depth (pcf), are presented in the following table:

LATERAL EARTH PRESSURES FOR DESIGN OF RETAINING STRUCTURES			
Level Backfill Condition	**Earth Pressure Component**	**Active** (pcf)	**At-Rest** (pcf)
Above Groundwater	Without Hydrostatic Pressure	40	60
Below Groundwater	With Hydrostatic Pressure	82	91
	Without Hydrostatic Pressure	19	29

The values provided in the table above assume that on-site soils and/or structural fill materials will be used to backfill around the new pumping station. It is assumed that the backfill around the new pumping station will be compacted to between 90 and 95 percent relative compaction per ASTM D1557. Over compaction of the retaining structure backfill should be avoided.

In general, an active condition may be used only for walls that are free to deflect by as much as 0.5 percent of the structure height. If the top of the structure is not free to deflect beyond this degree, the structure 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 structures.

Surcharge stresses due to areal surcharges, 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 structure, a rectangular distribution with a uniform pressure equal to 33 percent of the vertical surcharge pressure acting over the entire height of the structure, which is free to deflect (cantilever), may be used in the design.

For structure walls that are restrained, a rectangular distribution equal to 50 percent of the vertical surcharge pressure acting over the entire height of the structure may be used for design. Additional analyses during design may be needed to evaluate the surcharge effects of point loads and line loads.

3.2 SLABS-ON-GRADE

We anticipate that concrete slabs-on-grade will be utilized for the new equipment pads planned at the project site. To provide uniform bearing conditions and reduce the potential for changes in the moisture content of the slab subgrade soils, we recommend capping the slab subgrade with a minimum 6-inch thick layer of non-expansive structural fill material. The structural fill should be compacted to a minimum of 90 percent relative compaction.

Structural fill should be imported, non-expansive granular material, such as crushed coral or basalt. The structural fill should be well-graded from coarse to fine with particles no larger than 3 inches in largest dimension. The material should have a CBR value of 20 or higher and a swell potential of 1 percent or less when tested in accordance with ASTM D1883. The material should also contain between 10 and 30 percent particles passing the No. 200 sieve.

Prior to placing the non-expansive structural fill, we recommend scarifying the subgrade soils to a depth of about 8 inches, moisture-conditioning the soils to above the optimum moisture content, and compacting to a minimum of 90 percent relative compaction. The underlying subgrade soils and structural fill should be wetted and kept moist until the final placement of slab concrete. Saturation and subsequent yielding of the exposed subgrade due to inclement weather and poor drainage may require over excavation of the soft areas and replacement with structural fill.

The thickened edges of slabs adjacent to unpaved areas should be embedded at least 12 inches below the lowest adjacent grade. It should be emphasized that the areas adjacent to the slab edges should be backfilled tightly against the edges of the slabs with relatively impervious soils. These areas should also be graded to divert water away from the slabs and to reduce the potential for water ponding around the slabs.

3.3 UTILITY TRENCHES

We envision that installation of the new landside piping for the natural sea water system, well water system, and pump building will generally consist of trench excavation, pipe bedding and placement, and trench backfill. All excavations should be made in accordance with applicable Occupational Safety and Health Administration (OSHA) and state regulations. The contractor should determine the method and equipment to be used for utility trench excavation, subject to practical limits and safety considerations. In addition, the trench excavations should comply with the applicable federal, state, and local safety requirements. The contractor should be responsible for trench shoring design and installation.

Based on our borings, trench excavations will likely encounter surface fills and beach deposits generally consisting of medium dense to very dense clayey gravel and very loose to medium dense silty sand and sand with a little silt and gravel. In addition, these excavation may encounter lagoonal deposits generally consisting of very loose to medium dense clayey sand/gravel and very soft sandy clay.

It is anticipated that most of the material may be excavated with normal heavy excavation equipment. However, deep excavations and excavations encountering boulders and hard coral formation may require the use of hoerams. It should be noted that coral formations typically contain localized hard and crystallized zones. Therefore, we anticipate that some difficult excavation conditions may arise in localized areas during construction when the coral formation is encountered.

In general, we recommend providing granular bedding consisting of 6 inches of open-graded gravel, such as No. 3 Fine gravel (ASTM C33, No. 67 gradation), under the pipes for uniform support. Open-graded gravel (ASTM C33, No. 67 gradation) should also be used for the initial trench backfill up to about 12 inches above the pipes (or groundwater level) to provide adequate support around the pipes.

It is critical to use a free-draining material, such as open-graded gravel, to reduce the potential for formation of voids below the haunches of pipes and to provide adequate support for the sides of the pipes. Improper trench backfill could result in backfill settlement and pipe damage. Where groundwater is encountered, the bedding should be wrapped on all sides by non-woven filter fabric (Mirafi 180N or equivalent).

We envision soft and/or loose soils may be encountered at or near the invert elevations along portions of the new utility lines. Therefore, we recommend providing a subgrade stabilization layer consisting of 18 inches of No. 2 Rock (ASTM C 33, No. 4 gradation) wrapped in a non-woven filter fabric (Mirafi 180N or equivalent) below the bedding layer for uniform support, if soft and/or loose soils are encountered. The stabilization layer should extend beyond the sides of the pipe a minimum width of one-fourth the outside diameter of the pipe or 12 inches, whichever is greater.

Trench backfill material above the open-graded gravel may consist of general fill materials or structural fill material. In general, the excavated on-site soils may be re-used as a source of general fill, provided they are free of vegetation, deleterious materials, and rock fragments greater than 3 inches in maximum dimension. The backfill materials should be placed in maximum 8-inch level loose lifts and mechanically compacted to no less than 90 percent relative compaction to reduce the potential for appreciable future ground subsidence. The upper 2 feet below the finished grade in areas subjected to vehicular traffic should be compacted to a minimum of 95 percent relative compaction.

3.4 DEWATERING

During our field exploration, we encountered groundwater at depths ranging from about 5.3 to 6.5 feet below the existing ground surface. Due to the relatively shallow groundwater levels encountered at the project site, we anticipate that the below-grade structures and piping to be installed may extend below the groundwater level. Therefore, dewatering of the excavation may be necessary for this installation.

In general, dewatering operations should be conducted in such a manner that dewatering will not cause areal ground subsidence, which may cause potential damage to the nearby existing structures. Therefore, consideration should be given to a dewatering system that includes a cut-off wall to reduce the volume of water to be removed within the excavation and to reduce the areal extent of groundwater drawdown outside of the excavation.

Because the excavation dewatering may involve the discharge of groundwater from the dewatering operation into adjacent drainage systems, a National Pollutant Discharge Elimination System (NPDES) permit may be necessary. The contractor should consult their independent consultant or the State of Hawaii, Department of Health for the latest regulations and information pertaining to the NPDES permit application.

Based on our borings, we anticipate the project site is generally underlain by loose to dense beach deposits and very loose to loose lagoonal deposits to a depth of about 43.5 feet below the existing ground surface. Due to the heterogeneous nature of these materials, the actual subsurface soil permeability may range broadly and also vary locally in terms of orders of magnitude. The permeability of the subsurface materials at the sites may be considered moderately to highly permeable based on the materials encountered. Therefore, the contractor should pay special attention to the site-specific dewatering plan for the proposed excavations.

3.5 INTERIM SEAWALL REPAIRS

As discussed above, we understand interim repair recommendations are desired for the existing distressed seawall along the public walkway on the makai of the aquarium facility. Based on our field observations, a portion of the existing seawall has apparently collapsed, resulting in a loss of the CRM materials and seawall backfill materials. In addition, signs of foundation undermining were observed along portions of the existing distressed seawall.

Based on the information provided, we understand an interim repair concept being considered generally consists of reconstructing the CRM seawall and backfilling the existing void area behind the wall with lean concrete through injection ports. In general, we believe this reconstruction and concrete injection concept may be used for interim repairs of the existing distressed seawall. However, we believe consideration should be given to utilizing Controlled Low Strength Material (CLSM) as an alternative to lean concrete.

Based on the results of our field exploration, we generally believe an underpinning system consisting of micropiles with a supplemental footing should be used for foundation support for long-term repairs to the existing distressed CRM seawall. In general, the micropile foundations would extend through the loose/soft, compressible beach and lagoonal deposits anticipated underlying the project site and derive load bearing support from the underlying coralline materials anticipated at greater depths.

3.6 PRECONSTRUCTION DISTRESS SURVEY AND MONITORING

Due to the close proximity of the planned excavations to existing structures at the project site and the anticipated dewatering operations, we recommend performing a preconstruction distress survey to document the existing conditions prior to the start of construction. The survey should include photographs and detailed descriptions of pre-existing distresses.

In addition, implementation of a monitoring program for building movement is recommended for the project. The monitoring program should consist of the installation of structure monitoring points on the existing building footing columns that are in close proximity to the planned excavations to measure changes in the vertical and horizontal position during the monitoring period.

Prior to the start of construction, the monitoring points should be surveyed to establish initial readings for the monitoring points. Benchmarks should be established for the survey work. Surveyed readings of the monitoring points should be taken daily during construction and weekly subsequent to construction until the contract completion date. The survey readings should be submitted promptly for review.

3.7 DESIGN REVIEW AND CONSTRUCTION OBSERVATION SERVICES

The construction plans and specifications for the project should be forwarded to us for review to determine whether the recommendations contained in this report are adequately reflected in those documents. If this review is not made, Kokua Geotech LLC cannot assume responsibility for misinterpretation of our recommendations.

Kokua Geotech LLC should also be retained to monitor the micropile installation, site grading, utility line installation and backfill, and other aspects of earthwork construction to determine whether the recommendations of this report are followed. The recommendations presented herein are contingent upon such observations. If the actual exposed subsurface soil conditions encountered during construction differ from those assumed or considered in this report, Kokua Geotech LLC should be contacted to review and/or revise the geotechnical recommendations presented herein.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4.0 LIMITATIONS

This report has been prepared for the exclusive use of Oceanit and their project consultants for specific application to the design of the *Waikiki Aquarium Improvements, Phase 2* project in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied. If any part of the project concept is altered or if subsurface conditions differ from those described in this report, then the information presented herein shall be considered invalid, unless the changes are reviewed, and any supplemental or revised recommendations issued in writing by Kokua Geotech LLC.

The analyses and report recommendations are based in part upon information obtained from the field boring and the assumption that subsurface conditions do not vary significantly from those observed in the boring. Variations of the subsurface conditions beyond the field boring may occur, and the nature and extent of these variations may not become evident until construction is underway. If variations then appear evident, Kokua Geotech LLC should be notified so that we can re-evaluate the recommendations presented herein.

The owner/client should be aware that unanticipated soil conditions are commonly encountered. 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.

The field boring locations indicated herein is approximate, having been estimated by taping from visible features shown on the Water Intake System Upgrade Plan transmitted by Oceanit on November 10, 2023. Elevations of the borings were estimated from spot elevations shown on topographic survey plans transmitted by Oceanit on June 11, 2021. The field boring locations and elevations should be considered accurate only to the degree implied by the methods used.

SECTION 4.0 LIMITATIONS

The stratification breaks shown on the graphic representations of the boring depict the approximate boundaries between soil types and, as such, may denote a gradual transition. Water level data from the boring was measured at the time of drilling. However, groundwater levels may change due to seasonal precipitation, tidal fluctuation, surface water runoff, and other factors. These data have been reviewed and interpretations made in the formulation of this report.

This report has been prepared solely for the purpose of assisting the design engineers in the design of the project. Therefore, this report may not contain sufficient data, or the proper information, to serve as a basis for detailed construction cost estimates.

This geotechnical engineering exploration conducted at the project site was not intended to investigate the potential presence of hazardous materials existing at the project site. It should be noted that 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

Log of Boring .... Appendix A

Laboratory Test Results .... Appendix B

Dynamic Cone Penetrometer (DCP) Test Results .... Appendix C

This report concludes our scope of work outlined in our fee proposal dated February 27, 2023. If you have any questions regarding this report or if any part of the report is not clear, please contact our office.

Respectfully submitted,

Kokua Geotech LLC

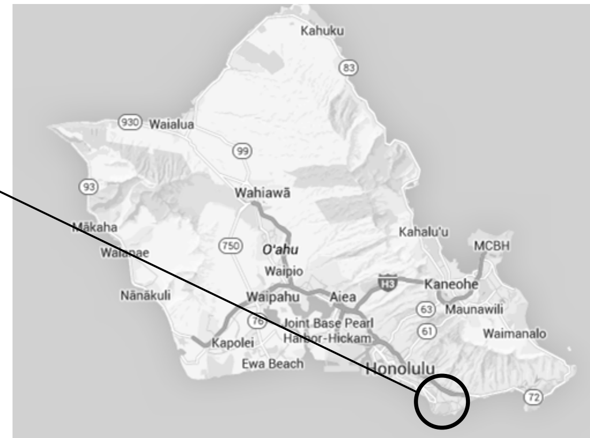
Xiaobin (Tim) Lin, P.E.
President

XIAOBIN (TIM) LIN
LICENSED PROFESSIONAL ENGINEER
No. 13982-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.
(MY LICENSE EXPIRES 4/30/2024)

PLATES

GENERAL PROJECT LOCATION



Mercator Projection
WGS84
USNG Zone 4QFJ
CALTOPO

1 2 3 4 5 km
1 2 3 mi
Scale **1:28148** 1 inch = 2346 feet

N MN 9°

PROJECT LOCATION MAP

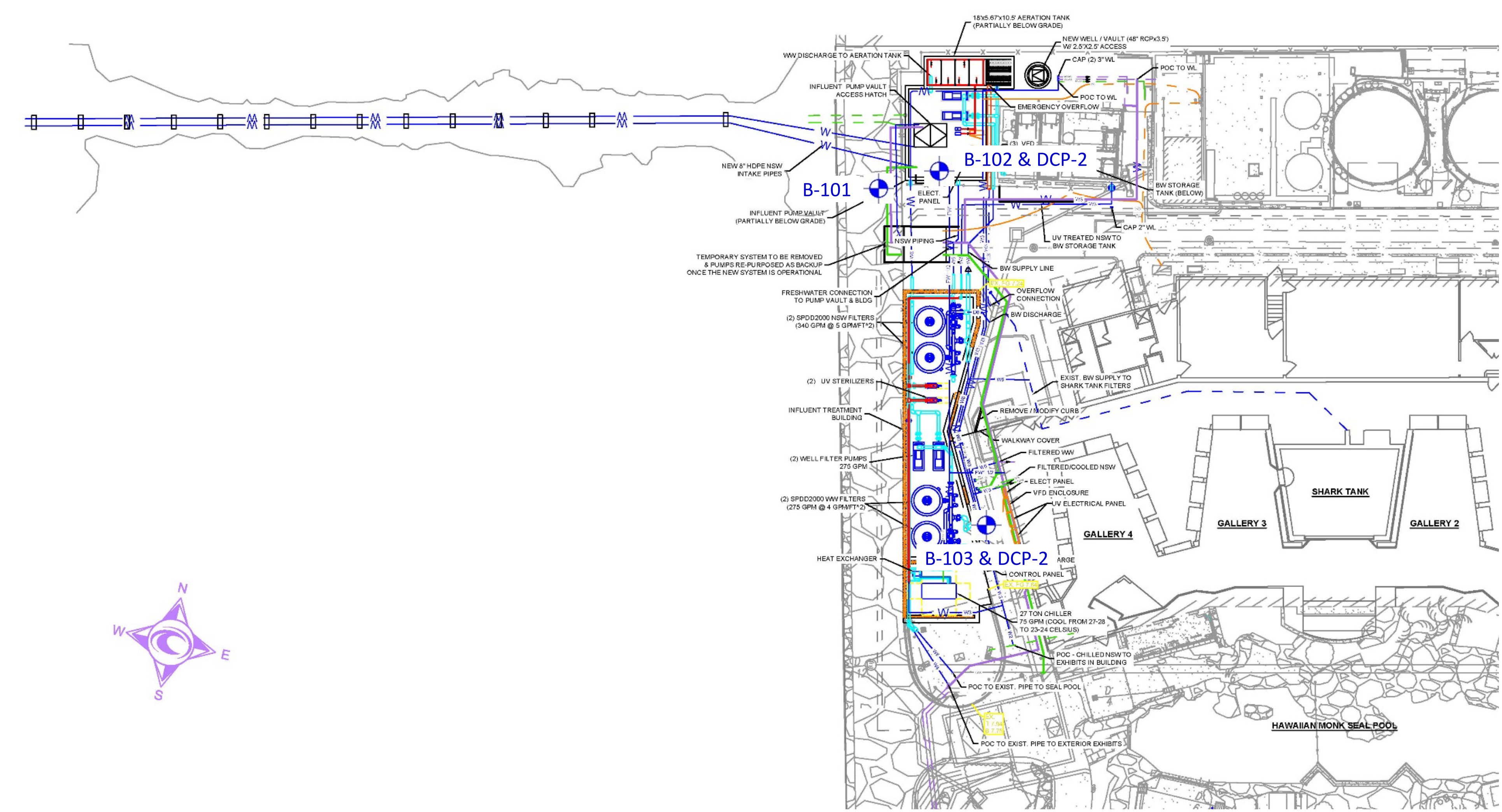
WAIKIKI AQUARIUM IMPROVEMENTS, PHASE 2
2777 KALAKAUA AVENUE
TMK: 3-1-031: 006
HONOLULU, OAHU, HAWAII

PROJECT NO.: 021523-00

DATE: NOVEMBER 2023

PLATE
1

Kokua Geotech LLC
Soil and Foundation Engineering



REFERENCE: WATER INTAKE SYSTEM UPGRADE PLAN TRANSMITTED BY OCEANIT ON NOVEMBER 8, 2023

APPROXIMATE BORING AND DCP TEST LOCATION

Kokua Geotech LLC
Soil and Foundation Engineering

SITE PLAN

WAIKIKI AQUARIUM IMPROVEMENTS, PHASE 2
2777 KALAKAUA AVENUE
TMK: 3-1-031: 006
HONOLULU, OAHU, HAWAII

PROJECT NO.: 021523-00	**PLATE**
DATE: NOVEMBER 2023	2

APPENDIX A

Project: Waikiki Aquarium Improvements, Phase 2 Project Location: 2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii Project Number: 021523-00	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Key to Logs of Borings Sheet 1 of 1

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
1	2	3	4	5	6	7	8	9	10	11	12

COLUMN DESCRIPTIONS

1 Elevation (feet): Elevation (MSL, feet).
2 Depth (feet): Depth in feet below the ground surface.
3 Sample Type: Type of soil sample collected at the depth interval shown.
4 Sample Number: Sample identification number.
5 Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
6 U.S.C.S: Type of material encountered.
7 Graphic Log: Graphic depiction of the subsurface material encountered.
8 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
9 Pocket Pen./Torvane, tsf: the reading from Poecket Penetrometer or Torvane.
10 Water Content, %: Water content of the soil sample, expressed as percentage of dry weight of sample.
11 Dry Unit Weight, pcf: Dry weight per unit volume of soil sample measured in laboratory, in pounds per cubic foot.
12 Remarks and Other Tests: Other Tests

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Asphaltic Concrete (AC)
Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)
Portland Cement Concrete
Coral Formation
Clayey GRAVEL (GC)
Silty GRAVEL (GM)
Clayey SAND (SC)
Silty SAND (SM)
Poorly graded SAND (SP)
Poorly graded SAND with Silt (SP-SM)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
Grab Sample
HQ Coring
3-inch OD Modified California w/ brass liners
PQ Coring
Probing w/Pointed Tip
2-inch OD unlined split spoon (SPT)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
? Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

Project: Waikiki Aquarium Improvements, Phase 2 Project Location: 2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii Project Number: 021523-00	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 101 Sheet 1 of 2

Date(s) Drilled **10/4 to 10/7/23**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **6-inch Hollow Stem Auger**	Total Depth of Borehole **43.5 feet**
Drill Rig Type **Lone Star Track Drill**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+7 feet MSL***
Groundwater Level and Date Measured **5.3 feet @ 8:51 10/5/23**	Sampling Method(s) **SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings, Gravel, Concrete Patch**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
7	0						12-inch CONCRETE with double rebar mat				
			1	20	GC		Gray CLAYEY GRAVEL (coralline and basaltic) with some sand, medium dense, moist (fill)		11		
							grades to very dense				
			2	57					13		
2	5						grades with boulders, dense				
			3	38					20		LL=NP, PI=NP
				14	SP-SM		Tan SAND with a little silt, medium dense, wet (beach deposit)				
				8			grades to loose				
				3							
-3	10										
				3							
				3	GC		Light gray CLAYEY GRAVEL (coralline) with some sand, very loose, wet (lagoonal deposit)				
				4							
				2							
				1							
-8	15										
				1							
				1							
				3							
				2							
				1	CL		Light gray SANDY CLAY with a little gravel (coralline), very soft, wet (lagoonal deposit)				
-13	20										
				1							
				1							
				1							
				4	GC		Light gray CLAYEY GRAVEL (coralline) with some sand, loose, wet (lagoonal deposit)				
				4							
-18	25										

Project: Waikiki Aquarium Improvements, Phase 2 Project Location: 2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii Project Number: 021523-00	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 101 Sheet 2 of 2

Date(s) Drilled **10/4 to 10/7/23**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **6-inch Hollow Stem Auger**	Total Depth of Borehole **43.5 feet**
Drill Rig Type **Lone Star Track Drill**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+7 feet MSL***
Groundwater Level and Date Measured **5.3 feet @ 8:51 10/5/23**	Sampling Method(s) **SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings, Gravel, Concrete Patch**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
-18	25			5	GC		Light gray CLAYEY GRAVEL (coralline) with some sand, loose, wet (lagoonal deposit)				
				8							
				2							
				6			grades loose to medium dense				
				19							
-23	30			16							
				12							
				5			grades to loose				
				4							
				3							
-28	35			3							
				5							
				4							
				4							
				5							
-33	40			5							
				3							
				4							
				32/6" +20/0" Ref.			Light tan CORAL, moderately weathered, medium hard to hard (coral formation)				
							Boring terminated at approximately 43.5 feet below the existing ground surface				
-38	45						*Elevations of borings estimated from Topographic Survey information provided by Oceanit on June 11, 2021				
-43	50										

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Project: Waikiki Aquarium Improvements, Phase 2 Project Location: 2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii Project Number: 021523-00	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 102 Sheet 1 of 1

Date(s) Drilled **10/5/23**	Logged By **JL**	Checked By **AJF**
Drilling Method **Hand Auger**	Drill Bit Size/Type **4-inch Hand Auger**	Total Depth of Borehole **7.0 feet**
Drill Rig Type **N/A**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+7 feet MSL***
Groundwater Level and Date Measured **5.6 feet @ 10:45 10/5/23**	Sampling Method(s) **Grab Samples**	Hammer Data **DCP - 15 lbs. with 20-inch drop**
Borehole Backfill **Soil Cutting and Gravel**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
7	0						3-inch ASPHALTIC CONCRETE				
					GM		Brown SILTY GRAVEL with some sand, medium dense, moist (base material)				
		X	1	DCP	SP-SM		Brownish tan SAND with a little silt and gravel (coralline), loose, moist (fill/beach deposit)		9		Sieve -#200= 8.8%
		X	2				grades with cobbles (coralline)		9		
2	5				SP		Tan SAND with traces of silt and gravel (coralline), very loose to loose, moist (beach deposit)				
							grades to medium dense				
		X	3		SC		Gray CLAYEY SAND with a little gravel (coralline), loose (lagoonal deposit)		9		
							Boring terminated at approximately 7.0 feet below the existing ground surface				
-3	10										
-8	15										
-13	20										
-18	25										

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Project: Waikiki Aquarium Improvements, Phase 2 Project Location: 2777 Kalakaua Avenue, Honolulu, Oahu, Hawaii Project Number: 021523-00	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 103 Sheet 1 of 1

Date(s) Drilled **10/5/23**	Logged By **JL**	Checked By **AJF**
Drilling Method **Hand Auger**	Drill Bit Size/Type **4-inch Hand Auger**	Total Depth of Borehole **8.4 feet**
Drill Rig Type **N/A**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+7.5 feet MSL***
Groundwater Level and Date Measured **6.5 feet @ 13:45 10/5/23**	Sampling Method(s) **Grab Samples**	Hammer Data **DCP - 15 lbs. with 20-inch drop**
Borehole Backfill **Soil Cutting and Gravel**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
7.5	0						1-inch ASPHALTIC CONCRETE				
					GM		Light tan SILTY GRAVEL (coralline) with some sand, medium dense, moist (base material)				
			1	DCP					10		
					SM		Brownish tan SILTY SAND with some gravel (coralline), very loose to loose, moist (fill)				
			2		SP		Tan SAND with traces of silt and gravel (coralline), very loose to loose, moist (beach deposit)		10		Sieve -#200= 4.7%
2.5	5						grades to medium dense, wet				
			3						10		
					GC		Gray CLAYEY GRAVEL (coralline) with some sand, loose to medium dense, wet (lagoonal deposit)				
							Boring terminated at approximately 8.4 feet below the existing ground surface				
-2.5	10										
-7.5	15										
-12.5	20										
-17.5	25										

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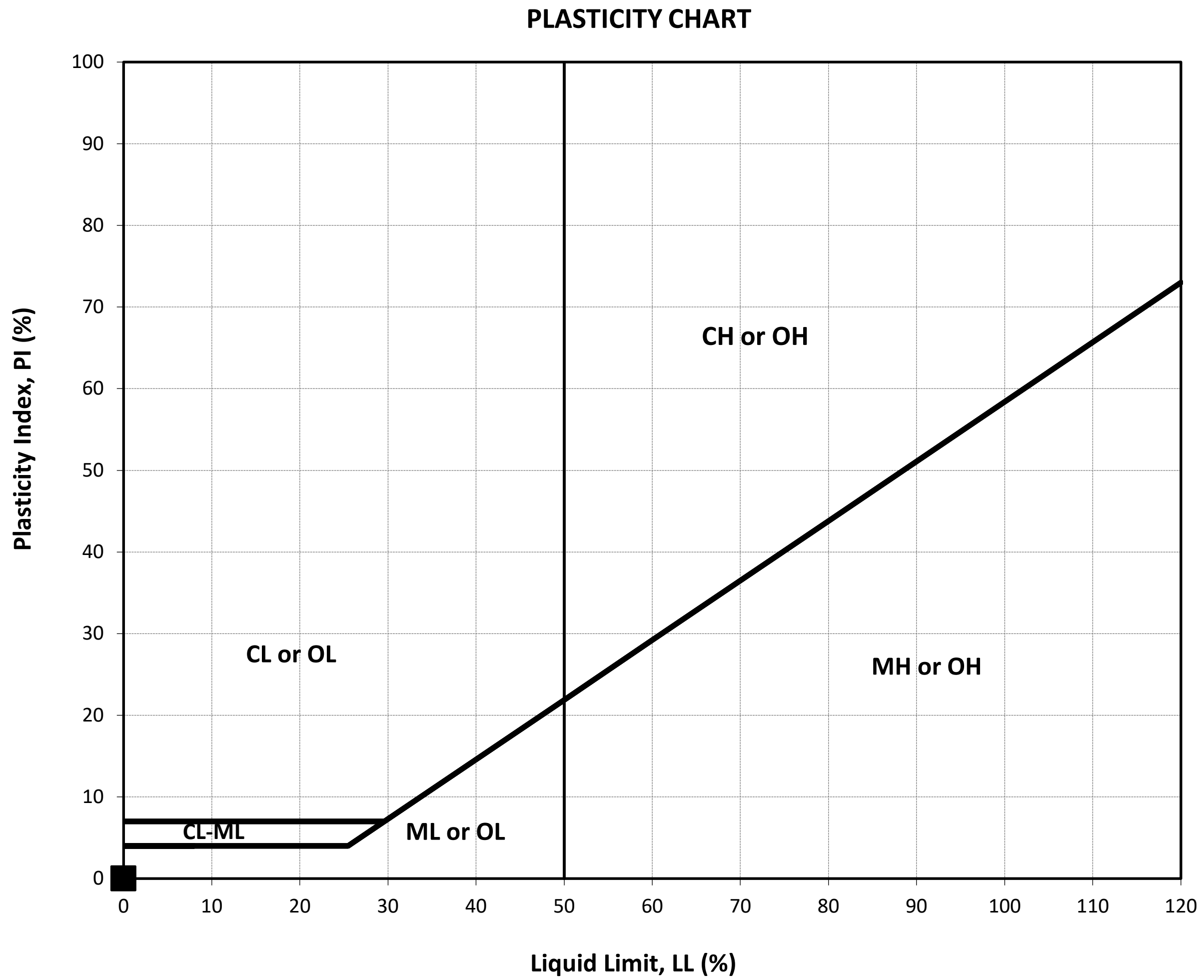
APPENDIX B



Symbol	Sample	Depth (feet)	Material Description	USCS	LL	PL	PI
■	B-101	5.0 to 6.5	Gray CLAYEY GRAVEL with some sand	GC	NP*	NP*	NP*
			*NP = Non-Plastic				

SUMMARY OF ATTERBERG LIMITS (ASTM D4318) TEST RESULTS

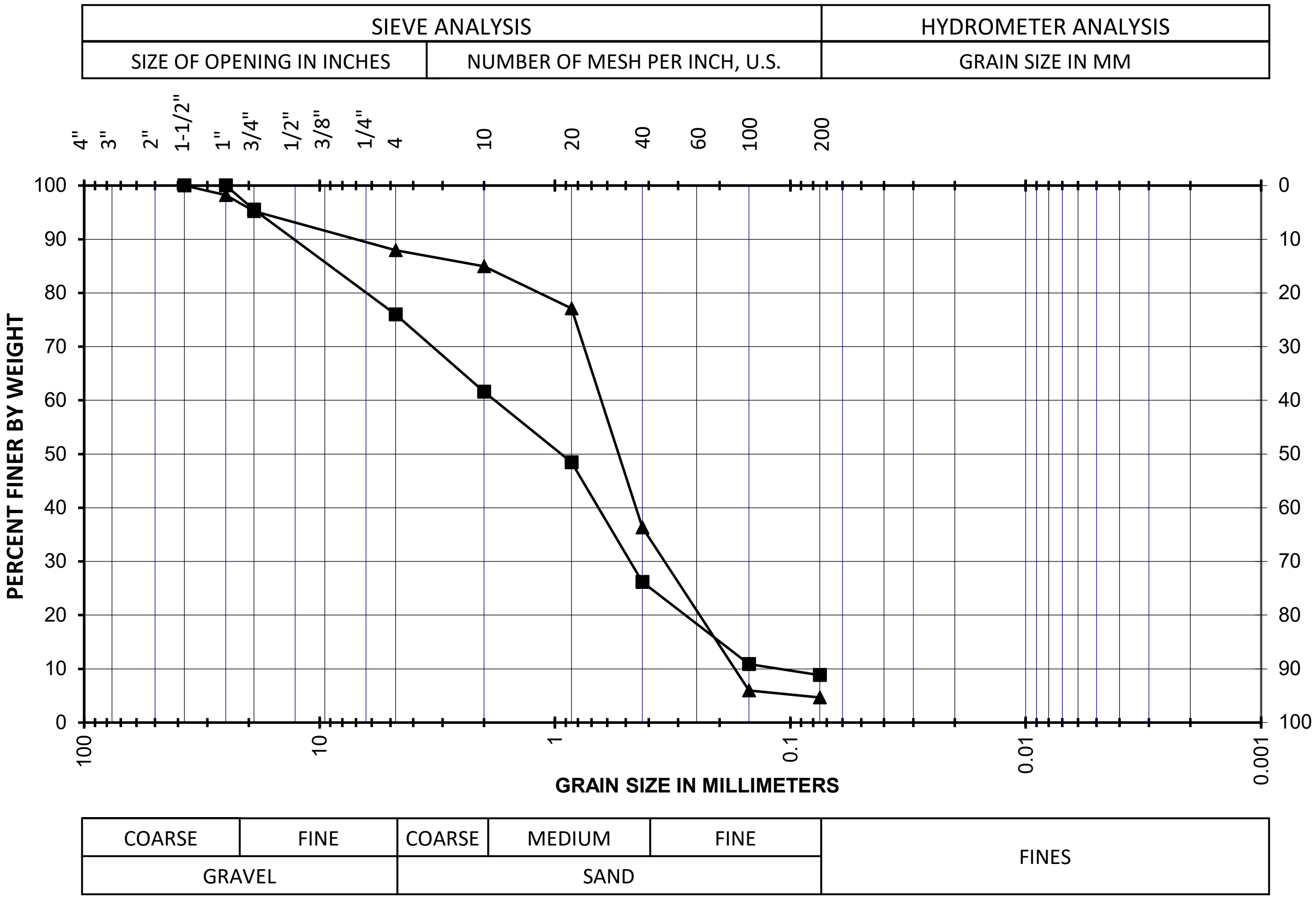
Kokua Geotech LLC
Soil and Foundation Engineering

WAIKIKI AQUARIUM IMPROVEMENTS, PHASE 2
2777 KALAKAUA AVENUE
TMK: 3-1-031: 006
HONOLULU, OAHU, HAWAII

PROJECT NO.: 021523-00

DATE: NOVEMBER 2023

PLATE
B-1



Symbol	Sample	Depth (feet)	USCS	Description
■	B-102	1.0 to 2.0	SP-SM	Brownish tan SAND with a little silt and gravel
▲	B-103	3.0 to 4.0	SP	Tan SAND with traces of silt and gravel

SUMMARY OF GRAIN SIZE DISTRIBUTION (ASTM C117 & C136) TEST RESULTS

WAIKIKI AQUARIUM IMPROVEMENTS, PHASE 2
2777 KALAKAUA AVENUE
TMK: 3-1-031: 006
HONOLULU, OAHU, HAWAII

Kokua Geotech LLC
Soil and Foundation Engineering

PROJECT NO.: 021523-00

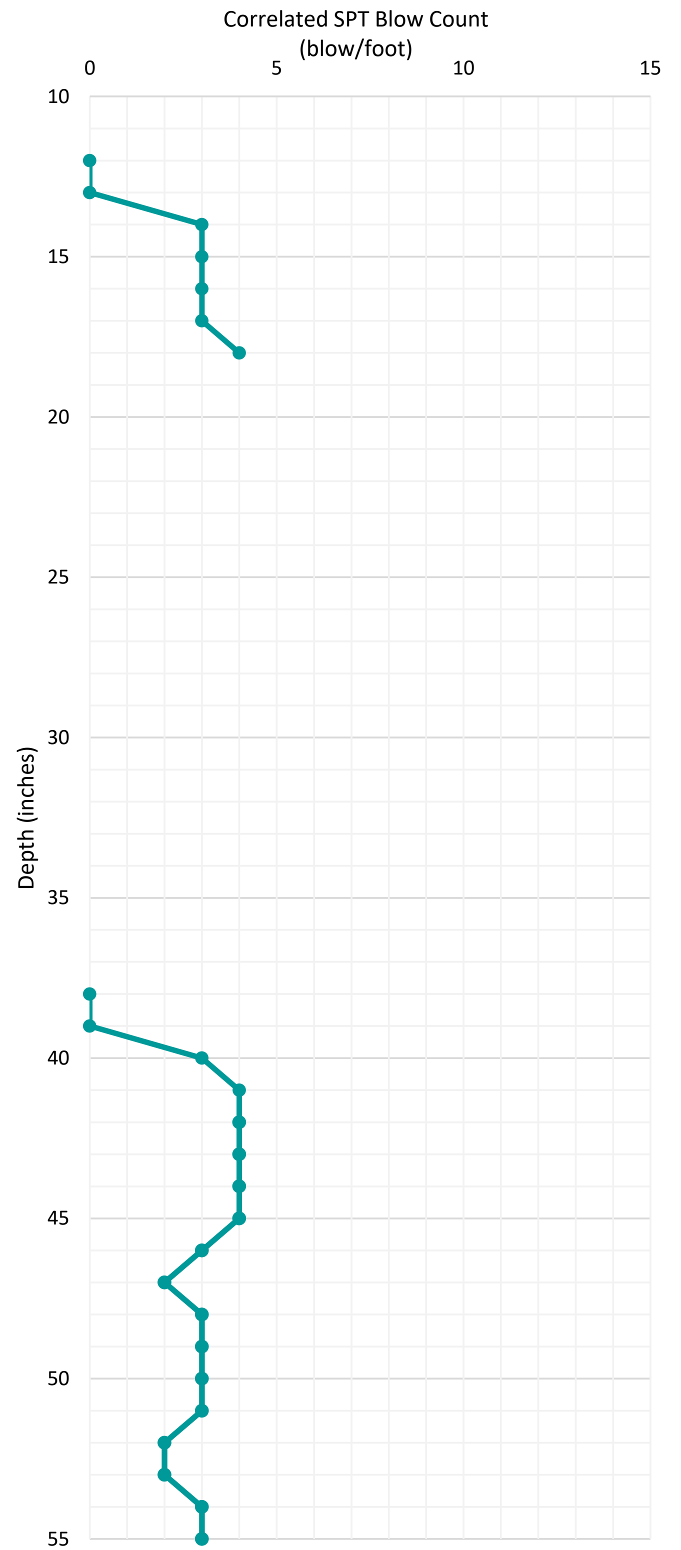
DATE: NOVEMBER 2023

PLATE B-2

APPENDIX C

Kokua Geotech LLC Soil and Foundation Engineering	WAIKIKI AQUARIUM IMPROVEMENTS, PHASE 2 2777 KALAKAUA AVENUE TMK: 3-1-0361: 006 HONOLULU, OAHU, HAWAII	LOG OF DCP **1**

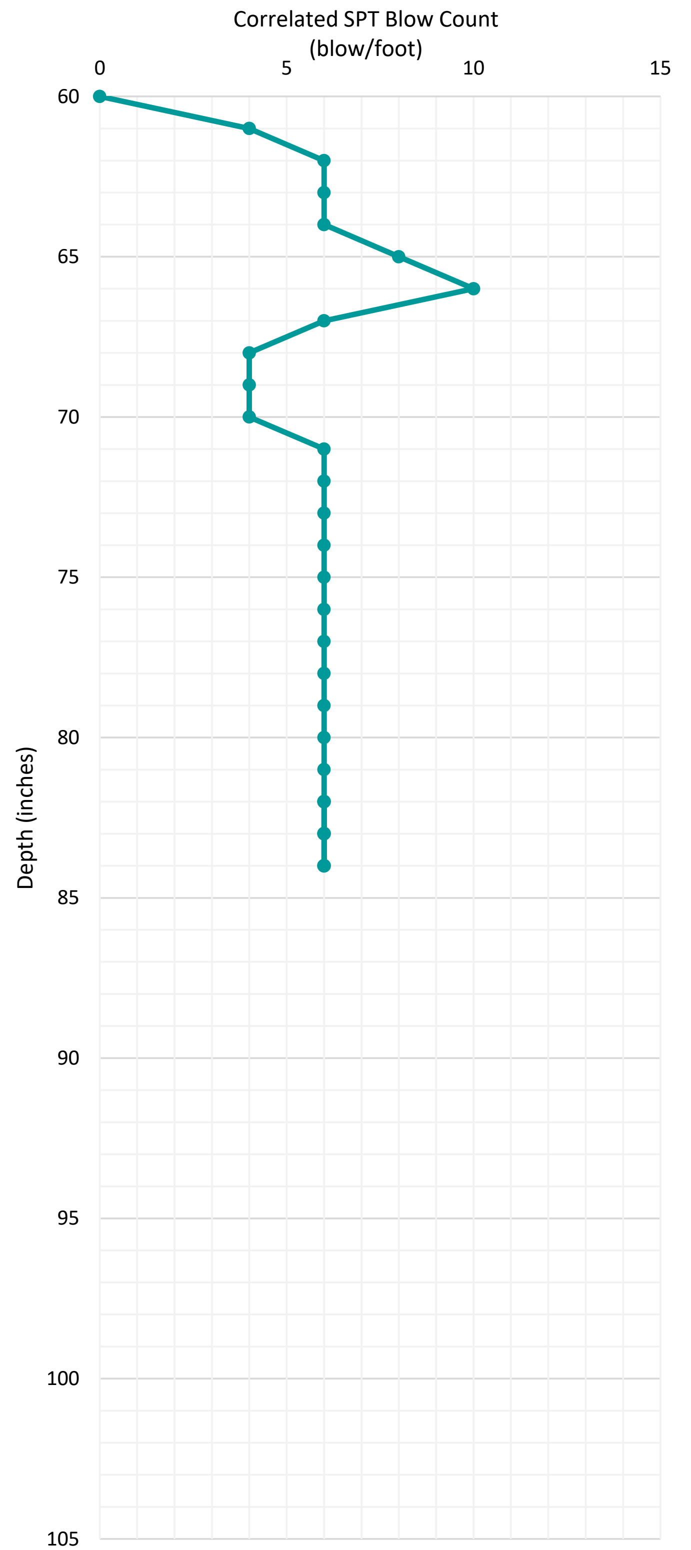
No. of Blows	**Depth of Penetration** (inches)	**Correlated CBR**	**Correlated SPT Blow Count** (blow/foot)
0	12	0.0	0
1	13	0.0	0
2	14	1.9	3
1	15	1.9	3
2	16	1.9	3
1	17	1.9	3
3	18	2.5	4
20/0"			
Ref.			
0	38	0.0	0
1	39	0.0	0
2	40	1.9	3
2	41	2.5	4
2	42	2.5	4
2	43	2.5	4
2	44	2.5	4
2	45	2.5	4
1	46	1.9	3
1	47	1.3	2
2	48	1.9	3
1	49	1.9	3
2	50	1.9	3
1	51	1.9	3
1	52	1.3	2
1	53	1.3	2
2	54	1.9	3
1	55	1.9	3
2	56	1.9	3
2	57	2.5	4
2	58	2.5	4
2	59	2.5	4
2	60	2.5	4



Project No.:	021523-00	Total Depth:	1.0 to 1.5 and 3.2 to 5.0 feet	**PLATE**
Date Started:	10/5/2023	Probing Equipment:	DCP H-4202SX	**C-1.1**
Date Completed:	10/5/2023	Size of Cone Tip:	1.5 inch diameter with 45° cone	
Logged By:	JFL	Driving Energy:	15 lb. steel mass falling 20 inches	

Kokua Geotech LLC Soil and Foundation Engineering	WAIKIKI AQUARIUM IMPROVEMENTS, PHASE 2 2777 KALAKAUA AVENUE TMK: 3-1-0361: 006 HONOLULU, OAHU, HAWAII	LOG OF DCP **1**

No. of Blows	**Depth of Penetration**	**Correlated CBR**	**Correlated SPT Blow Count**
	(inches)		(blow/foot)
0	60	0.0	0
4	61	0.0	4
5	62	3.7	6
5	63	3.7	6
3	64	3.7	6
11	65	4.9	8
7	66	6.2	10
2	67	3.7	6
3	68	2.5	4
2	69	2.5	4
3	70	2.5	4
6	71	3.7	6
4	72	3.7	6
5	73	3.7	6
5	74	3.7	6
5	75	3.7	6
4	76	3.7	6
5	77	3.7	6
5	78	3.7	6
4	79	3.7	6
6	80	3.7	6
5	81	3.7	6
4	82	3.7	6
5	83	3.7	6
6	84	3.7	6



Project No.:	021523-00	Total Depth:	5.0 to 7.0 feet
Date Started:	10/5/2023	Probing Equipment:	DCP H-4202SX
Date Completed:	10/5/2023	Size of Cone Tip:	1.5 inch diameter with 45° cone
Logged By:	JFL	Driving Energy:	15 lb. steel mass falling 20 inches

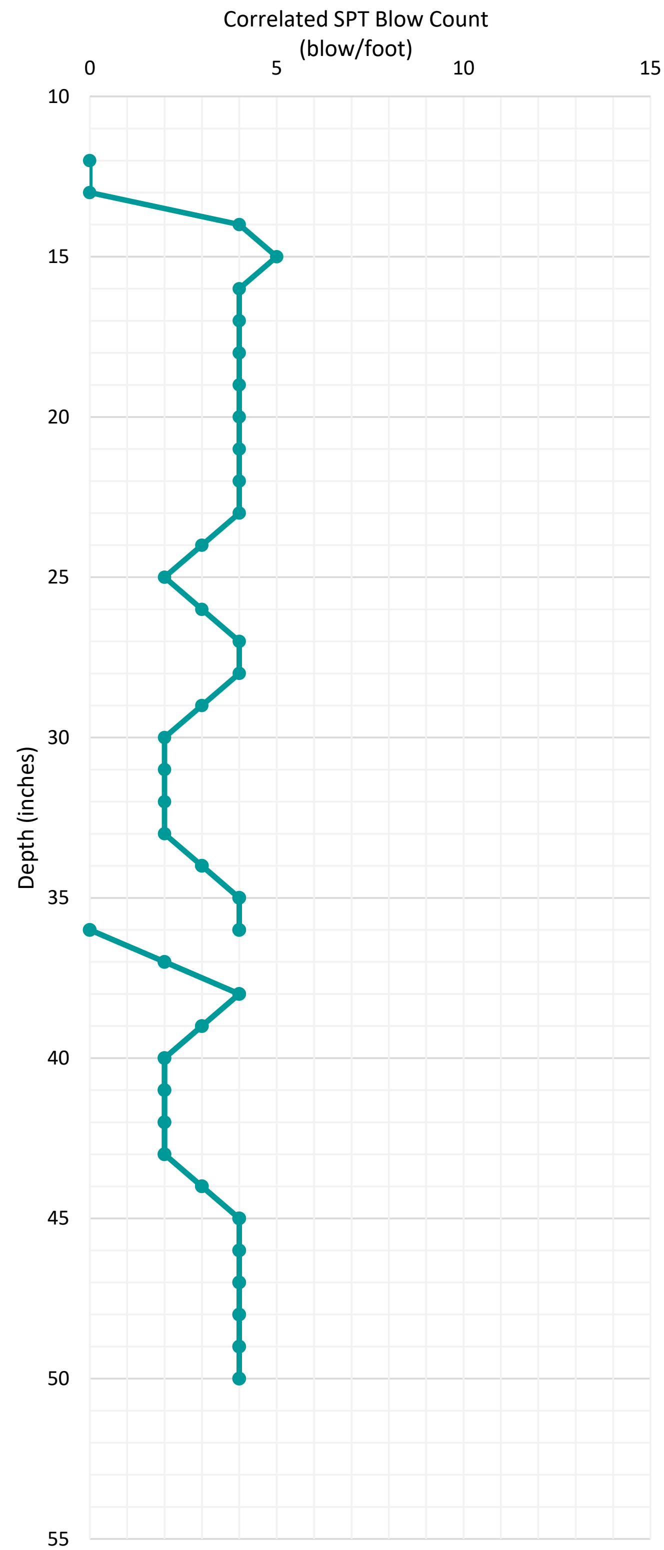
PLATE
C-1.2

Kokua Geotech LLC
Soil and Foundation Engineering

WAIKIKI AQUARIUM IMPROVEMENTS, PHASE 2
2777 KALAKAUA AVENUE
TMK: 3-1-0361: 006
HONOLULU, OAHU, HAWAII

LOG OF DCP **2**

No. of Blows	Depth of Penetration (inches)	Correlated CBR	Correlated SPT Blow Count (blow/foot)
0	12	0.0	0
1	13	0.0	0
3	14	2.5	4
3	15	3.1	5
2	16	2.5	4
2	17	2.5	4
2	18	2.5	4
2	19	2.5	4
2	20	2.5	4
2	21	2.5	4
2	22	2.5	4
2	23	2.5	4
1	24	1.9	3
1	25	1.3	2
2	26	1.9	3
2	27	2.5	4
2	28	2.5	4
1	29	1.9	3
1	30	1.3	2
1	31	1.3	2
1	32	1.3	2
1	33	1.3	2
2	34	1.9	3
2	35	2.5	4
2	36	2.5	4
0	36	0.0	0
2	37	1.3	2
2	38	2.5	4
1	39	1.9	3
1	40	1.3	2
1	41	1.3	2
1	42	1.3	2
1	43	1.3	2
2	44	1.9	3
2	45	2.5	4
2	46	2.5	4
2	47	2.5	4
2	48	2.5	4
2	49	2.5	4
2	50	2.5	4

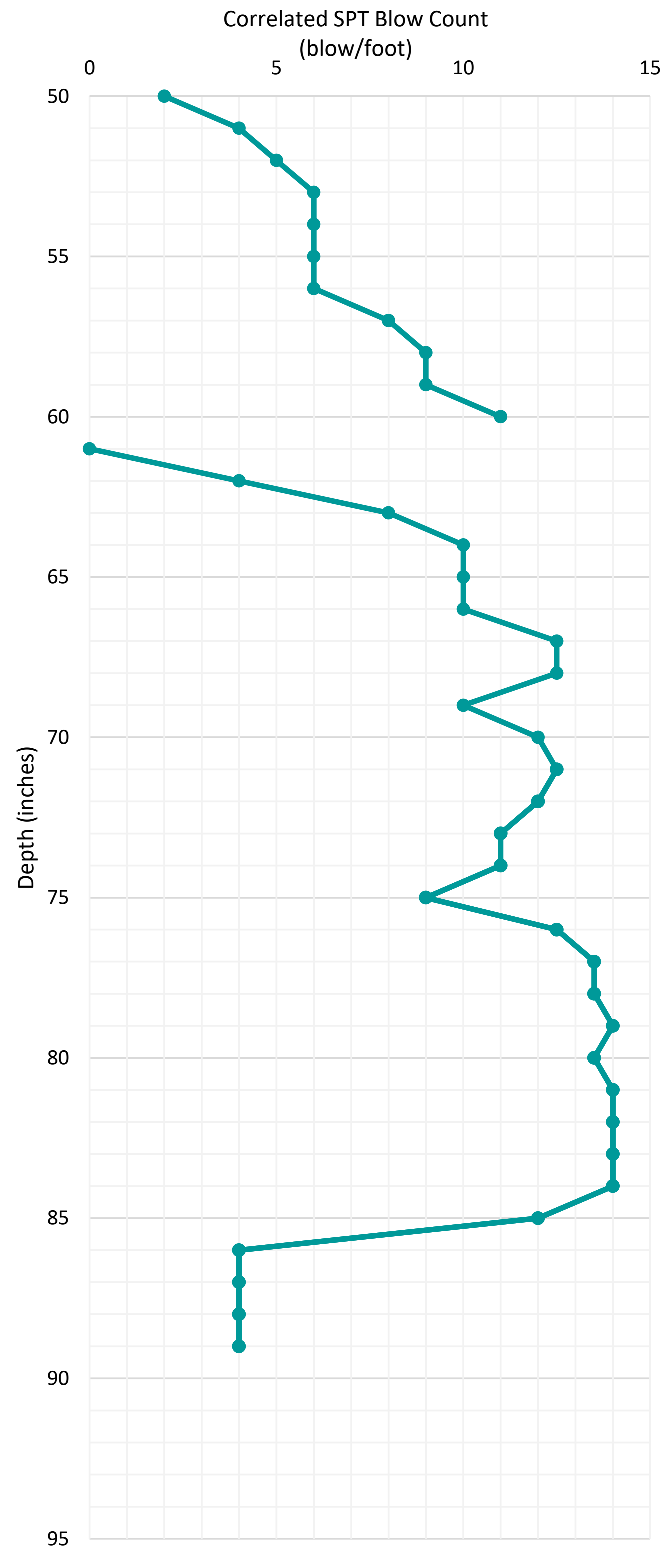


Project No.:	021523-00	Total Depth:	1.0 to 3.0 and 3.0 to 4.2 feet
Date Started:	10/5/2023	Probing Equipment:	DCP H-4202SX
Date Completed:	10/5/2023	Size of Cone Tip:	1.5 inch diameter with 45° cone
Logged By:	JFL	Driving Energy:	15 lb. steel mass falling 20 inches

PLATE
C-2.1

Kokua Geotech LLC Soil and Foundation Engineering	WAIKIKI AQUARIUM IMPROVEMENTS, PHASE 2 2777 KALAKAUA AVENUE TMK: 3-1-0361: 006 HONOLULU, OAHU, HAWAII	LOG OF DCP **2**

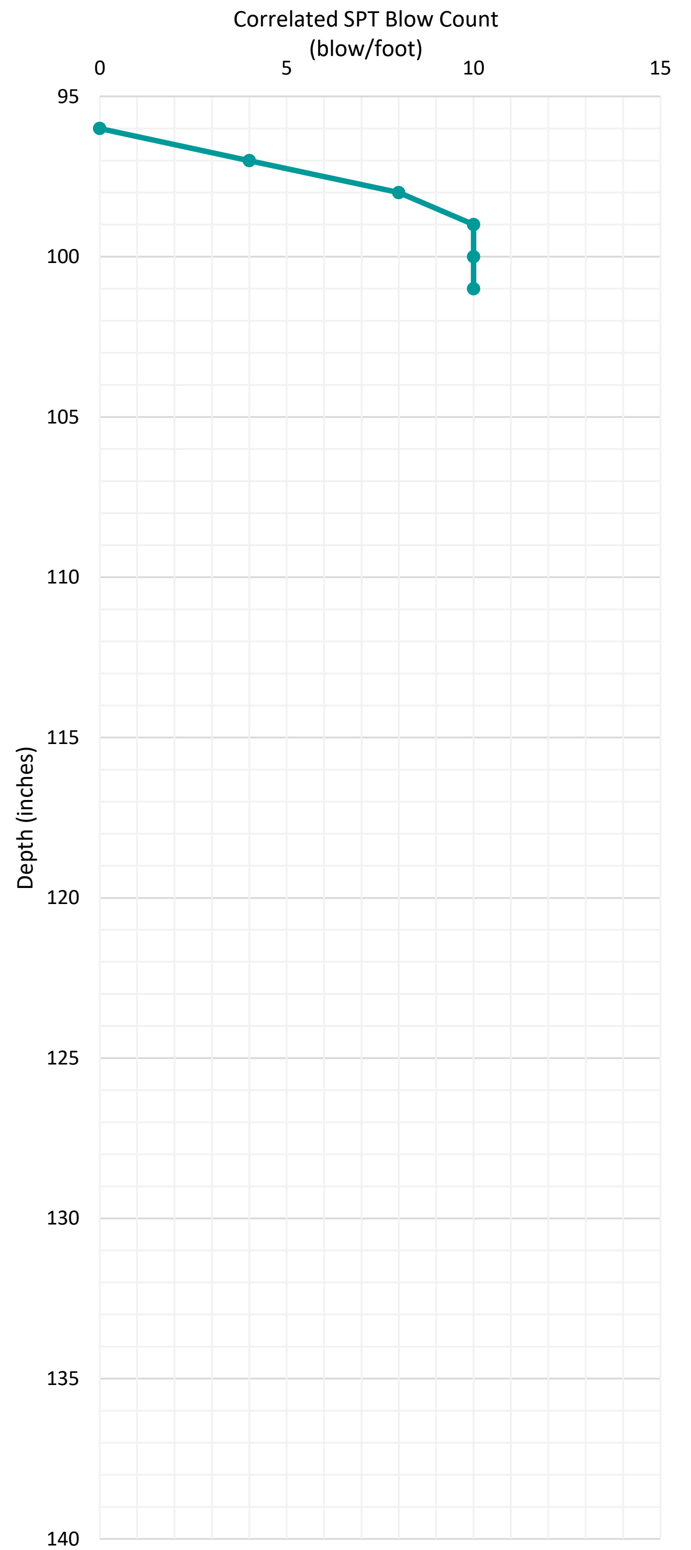
No. of Blows	**Depth of Penetration**	**Correlated CBR**	**Correlated SPT Blow Count**
	(inches)		(blow/foot)
2	50	0.0	2
2	51	0.0	4
4	52	3.1	5
4	53	3.7	6
4	54	3.7	6
4	55	3.7	6
5	56	3.7	6
7	57	4.9	8
7	58	5.5	9
10	59	5.5	9
11	60	6.9	11
0	61	0.0	0
5	62	2.5	4
8	63	4.9	8
10	64	6.2	10
7	65	6.2	10
11	66	6.2	10
18	67	7.9	12.5
8	68	7.9	12.5
11	69	6.2	10
13	70	7.6	12
13	71	7.9	12.5
10	72	7.6	12
12	73	6.9	11
7	74	6.9	11
10	75	5.5	9
19	76	7.9	12.5
12	77	8.6	13.5
23	78	8.6	13.5
14	79	9.0	14
20	80	8.6	13.5
17	81	9.0	14
25	82	9.0	14
17	83	9.0	14
20	84	9.0	14
2	85	7.6	12
2	86	2.5	4
2	87	2.5	4
2	88	2.5	4
2	89	2.5	4



Project No.:	021523-00	Total Depth:	4.2 to 5.0 and 5.0 to 7.4 feet	**PLATE**
Date Started:	10/5/2023	Probing Equipment:	DCP H-4202SX	**C-2.2**
Date Completed:	10/5/2023	Size of Cone Tip:	1.5 inch diameter with 45^{o} cone	
Logged By:	JFL	Driving Energy:	15 lb. steel mass falling 20 inches	

Kokua Geotech LLC Soil and Foundation Engineering	WAIKIKI AQUARIUM IMPROVEMENTS, PHASE 2 2777 KALAKAUA AVENUE TMK: 3-1-0361: 006 HONOLULU, OAHU, HAWAII	LOG OF DCP **2**

No. of Blows	Depth of Penetration	Correlated CBR	Correlated SPT Blow Count
	(inches)		(blow/foot)
0	96	0.0	0
5	97	0.0	4
8	98	4.9	8
10	99	6.2	10
7	100	6.2	10
11	101	6.2	10



Project No.:	021523-00	Total Depth:	8.0 to 8.4 feet
Date Started:	10/5/2023	Probing Equipment:	DCP H-4202SX
Date Completed:	10/5/2023	Size of Cone Tip:	1.5 inch diameter with 45° cone
Logged By:	JFL	Driving Energy:	15 lb. steel mass falling 20 inches

PLATE C-2.3

Appendix D:

Terrestrial Biological Resources Study (2022)

ATTACHMENT D

Terrestrial Biological Resources Study

Waikīkī Aquarium Water System Upgrade

2777 Kalakaua Avenue
Honolulu, Hawaiʻi, 96815
TMK: (1) 3-1-031:006

Prepared for:

University of Hawaiʻi at Mānoa
Office of Project Delivery
2002 East-West Road
Honolulu, HI 96822

Prepared by:

Oceanit Laboratories, Inc.
828 Fort Street Mall, Suite 600
Honolulu, HI 96813

May 2022

TABLE OF CONTENTS

LIST OF FIGURES

APPENDIX

EXECUTIVE SUMMARY

The outdoor area of the Waikīkī Aquarium (WAq) is entirely landscaped, with planted native plants for educational purposes and ornamental landscaped vegetation. On May 18, 2022, a terrestrial biological resources and a bird survey were conducted at WAq. The survey took place in the outdoor area of WAq, including the grassed lawn area and front of the building along Kalakaua Avenue. They survey spanned from the fence boundary line along beach walkway to the property line along Kalakaua Avenue on the southern side of the property.

All vegetation at WAq is cultivated and landscaped, with numerous native plants on display for educational purposes. The most abundant plant species were *naupaka kahakai* (*Scaevola taccada)*, portia tree (or milo, *Thespesia populnea),* coconut trees (*Cocos nucifera*), ti leaf (*Cordyline fruticose*), and tree heliotrope (*Heliotropium arboretum*). One giant African Snail (*Achatina fulica*) was observed in the lawn area. No mammals or other macro fauna were observed.

A bird survey was conducted during the morning hours before the Aquarium opened in the lawn area. In addition to introduced common bird species to urban Honolulu, two (2) white fairy tern (*Gygis alba*) nests were observed in separate milo trees (*Thesesia populnea*) near to the public restrooms and mullet tank. The milo trees that contained the nests were marked with blue tape on their trunk to designate them as white fairy tern nesting trees and warn tree maintenance crews of their presence. According to WAq staff, at the time of the site visit on May 18, 2022, one nest had a recently fledged offspring (only one adult was observed), and the other nest had a 2-day old chick and an adult. The parent white fairy tern was observed feeding the chick during the site survey.

There were no protected flora or fauna species within the surveyed project area; however, pre-consultation with the PIFWO identified the following federally listed species that may occur or transit through the proposed project area:

- The endangered Hawaiian hoary bat (*Lasiurus cinereus semotus)*
- The endangered Hawaiian petrel (*Pteerodroma sanwichensis)*
- The threatened Newell's shearwater (*Puffinus auricularis newelli)*
- The endangered Hawaii distinct population segment (DPS) of band-rumped storm-petrel (*Oceanodroma castro)*
- The threatened Central North Pacific DPS of green sea turtle (*Chelonia mydas*).

Green sea turtles (*Chelonia mydas*) and Hawaiian monk seals (*Neomonachus schauinslandi*) are known to visit nearby beaches in Waikīkī and nearshore waters in Mamala Bay. Construction of the proposed project will be conducted entirely on the WAq parcel and there will not be any in water work. Construction best management practices (BMPs) plan should be enforced to avoid impacts to marine species.

Impacts from project operations on terrestrial flora and fauna will be minimal, as the entire parcel is heavily landscaped and all vegetation on site is cultivated. There will be excavation work needed to install the underground utilities and pipes and the sump, but disturbance of large mature trees will be minimized as much as possible. In particular, the milo trees with active *Gygis alba* nests should be properly flagged and not be disturbed until the chicks have fledged and the nesting season has passed. To avoid and minimize impacts to the Hawaiian hoary bat, woody plants greater than 15 feet tall shall not be disturbed, removed, or trimmed during bat birthing and pupping season (June 1 through September 15). Construction of the sump and appurtenances will avoid disturbing as many mature trees as possible, and no night work or artificial lighting should be done to avoid confusing sea birds and turtles.

1. INTRODUCTION

The Waikīkī Aquarium (the Aquarium) is located at the southern end of the world-famous Waikīkī Beach and welcomes more than 250,000 visitors annually. The Aquarium was established in 1904 and has been a part of University of Hawaiʻi (UH) since 1919. The Aquarium moved to its present location in 1955, making it the second oldest aquarium in the United States (U.S.). Much of the Aquarium's aging water system infrastructure was designed prior to modern Federal Clean Water Act regulations and does not meet current regulatory requirements, which has resulted in State, Federal and City regulatory citations.

Much of WAq's aging infrastructure is original since 1955, well beyond its engineering life and outdated, resulting in effluent which fails to meet current regulatory requirements. In August 2019, the Aquarium was notified by the City and County of Honolulu (CCH) Department of Health (DOH) Clean Water Branch (CWB) that it was violating applicable laws by discharging saltwater that did not meet environmental quality thresholds directly into the ocean. The DOH issued an Administrative Order on Consent (AOC) pursuant to its authority to regulate water pollution under Hawaiʻi Revised Statutes (HRS) Chapter 342D and Federal Environmental Protection Agency authorization to issue National Pollutant Discharge Elimination System (NPDES) permits in Hawaiʻi under Section 402 of the Clean Water Act. The University of Hawaiʻi (UH) contracted Oceanit to develop an improved Water System Infrastructure Design for exhibit operations at the Aquarium and to provide an optimized effluent discharge process that will comply with Federal, State, and CCH regulatory requirements.

This Draft Environmental Assessment (EA) is being prepared for WAq's Water System Upgrade in accordance with Hawai'i Revised Statutes (HRS) Chapter 343. According to Hawai ʻi Revised Statutes (HRS) Chapter 343-5, an environmental assessment is required as the proposed action (1) Propose[s] the use of state or county land or the use of state or county funds.

To evaluate environmental impacts that may arise from the proposed action, the intent of this survey report is to identify terrestrial biological resources present within the WAq property. Data collected from this survey will identify and mitigate potential impacts to these resources from short-term construction activities or long-term impacts related to the proposed action.

1.1 Site Description

The Waikīkī Aquarium is located in Honolulu on the south shore of the island of Oʻahu next to the Waikīkī Natatorium War Memorial and Kapiʻolani Park (Figure 1-1). The Aquarium abuts the shoreline seawall on its south edge and extends north up to Kalākaua Avenue. The majority of the major infrastructure from 1955 remains in use today, including the salt water well which was constructed to supply the display tanks. A Marine Life Conservation District (MLCD) lies just offshore of Waikīkī Aquarium. Renown Waikīkī beaches and recreational areas surround the facility. Figure 1-1 presents the Project Location Map.

The Aquarium houses both native and nonnative saltwater animals and some freshwater species in approximately 60 public exhibits and behind the scenes holding tanks that are in operation at any given time. The largest display is a 70,000-gallon seawater pool, which houses an endangered Hawaiian Monk Seal. "Native Tanks" include tanks that house Native Hawaiian saltwater species and solitary non-breeding, non-native animals. Tanks that house native animals may also include one or two nonnative animals that are unable to reproduce and therefore would not cause invasive species introduction when discharged to the ocean.

Figure 1-1: Project Location Map

"Non-Native Tanks" include those that house non-native animals or native animals which require any live non-native feed. Hawaiian freshwater animals are housed separately. Effluent water from native exhibits is discharged through a nearshore outfall under a NPDES permit issued by the DOH. Effluent from non-native exhibits is discharged into the CCH sanitary sewer system.

The Aquarium parcel extends from Kalākaua Avenue to the fence line along the pedestrian promenade above the seawall on the makai side. The Aquarium and associated buildings occupy the about half the parcel on the northern end, while an outdoor grassed courtyard area occupies the south side of the property. This area is a manicured lawn area lined by coconut trees used for events and for visitor gatherings. Landscaped ornamental plants also are present on the east side of the property, along the façade of the Aquarium entrance. Figure 1-2 depicts existing conditions.

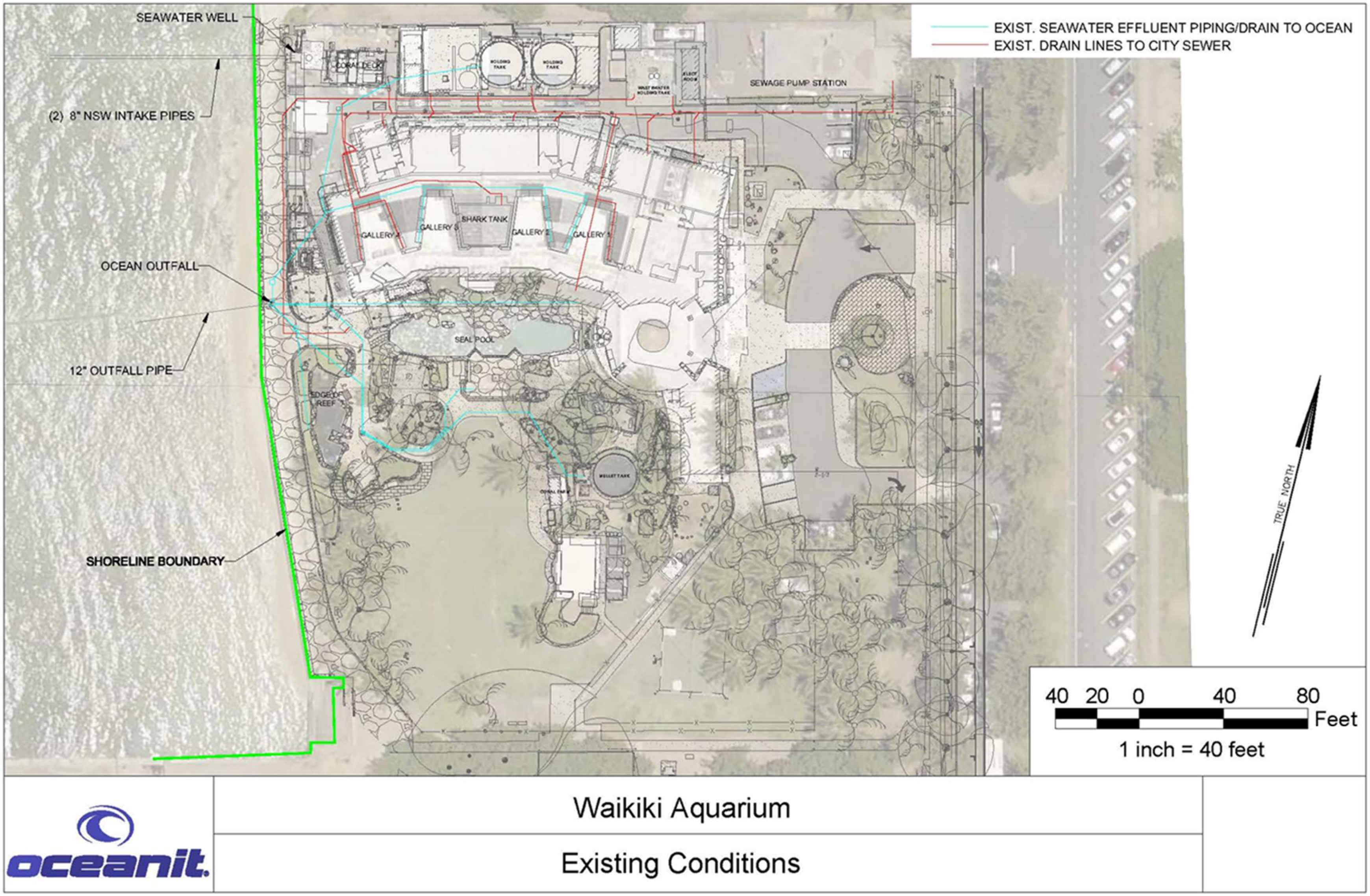


Figure 1-2: WAq Existing Conditions

1.1.1 Aquarium Plant Guide

The Aquarium has various native plants that serve as landscape plants on their property and are used , which they use for educational purposes. These landscaped plants are identified on their *Hawaiian Plant Guide* Brochure (Aquarium, 2022) (Figures 1-3 and 1-4). All native plants specified in the plant guide below were verified at their locations during the May 18, 2022 site visit.

Source: Waikīkī Aquarium (https://www.waikikiaquarium.org/experience/plants-seaweeds/hawaiian-plant-guide/)

Figure 1-3: Aquarium Native Plant Location Guide Map

Source: Waikīkī Aquarium (https://www.waikikiaquarium.org/experience/plants-seaweeds/hawaiian-plant-guide/)

Figure 1-4: Aquarium Native Plant Guide

1.2 Proposed Action

The Proposed Action is to dispose of all effluent into two on-site injection wells, eliminating direct effluent discharge into ocean and into the city sewer system. Effluent from native and non-native tanks will flow by gravity to an underground discharge/transfer sump, where it will be pumped by three sump pumps through two drum screen filters housed in a built above ground structure. The drum screen filters will filter the effluent down to 20 microns prior to being discharged into the injection wells. A conceptual schematic is shown in Figure 1-5 and the Water System Upgrade Plan is presented in Figure 1-6. The construction Scope of Work for the Proposed Action will include:

- Construct and test two injection wells;
- Install drum screen filters and backwash station at the injection well head;
- Construct a drum screen filter house;
- Install a discharge sump, pumps, and feedback controls;
- Install new wastewater plumbing to reconfigure exhibit & filter backwash discharges to the discharge sump, drum screen filter backwash to sewer;
- Install freshwater plumbing to supply drum screen filter backwash station; and

- Complete electrical work to connect new pumps and drum screen filters.

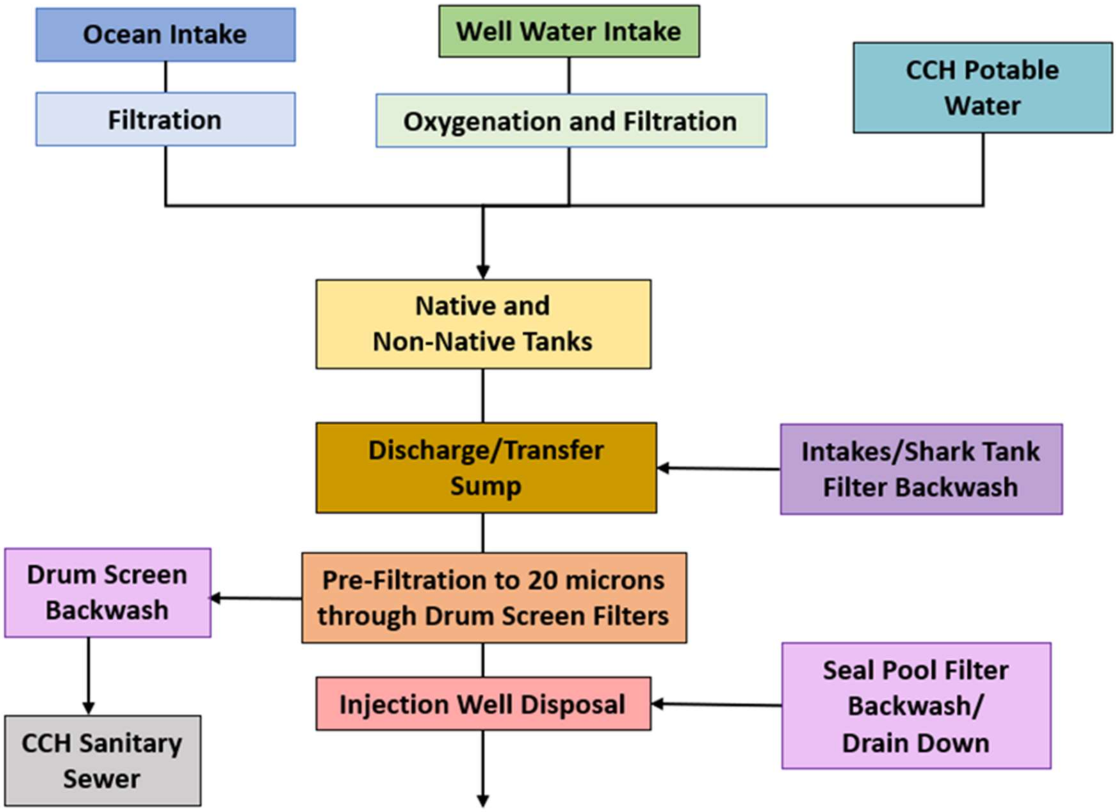


Figure 1-5: Conceptual Schematic of the Proposed Action

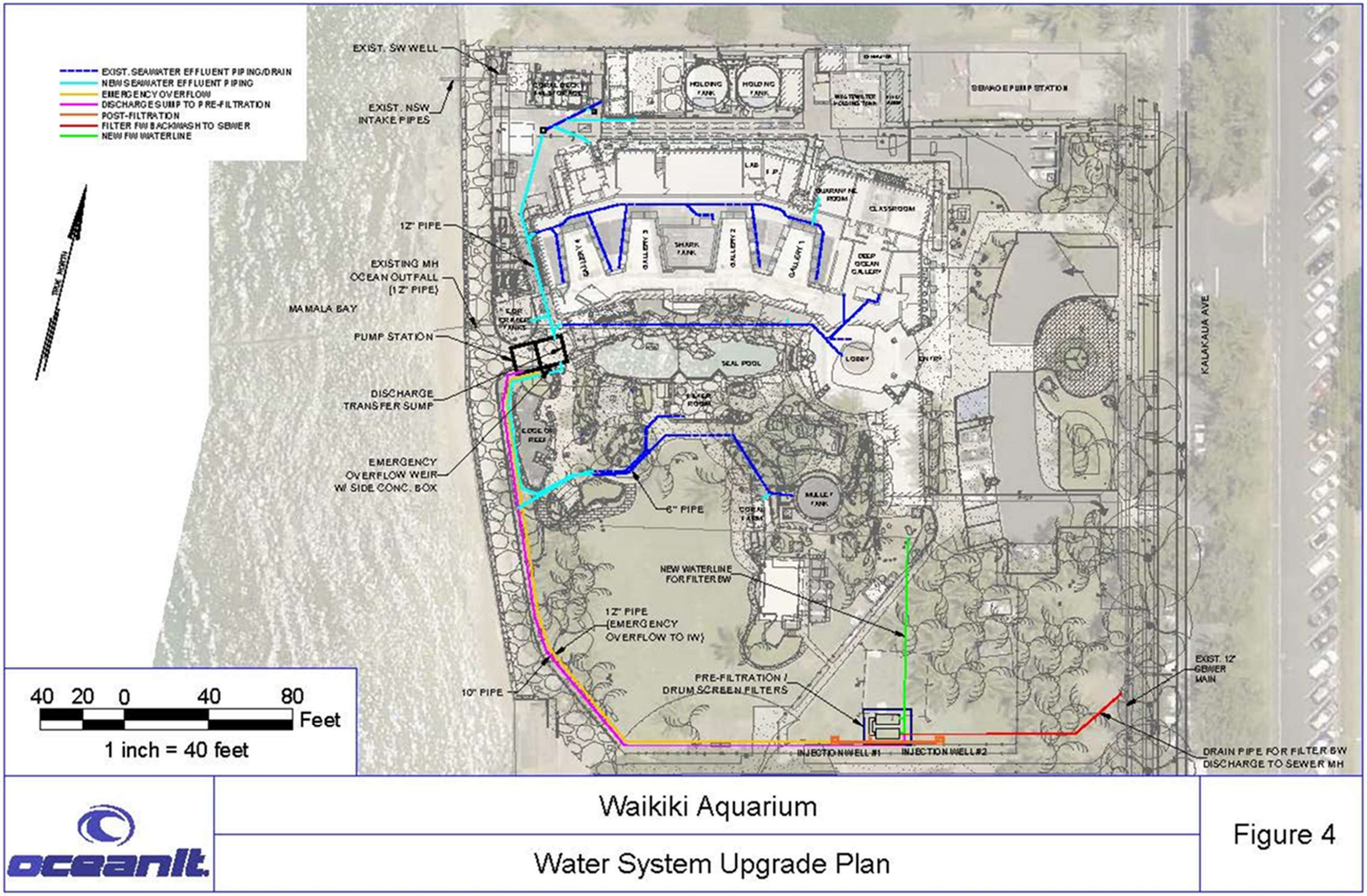


Figure 1-6: Proposed Layout for the Proposed Action - All Effluent Discharge Through Two Injection Wells

2. SURVEY METHODS

A biologist conducted a walking survey for terrestrial flora (i.e., vegetation) and fauna in the outdoor area at the Aquarium on May 18, 2022. The survey area included the lawn gathering area, landscaped native plant live displays, and the front of the WAq to Kalākaua Avenue. All observed plant, invertebrate, and bird species encountered were recorded.

The bird survey was conducted in the morning on May 18, 2022 and included a stationary point count on the south end/fenceline of the property. The survey included a 10-minute viewing period where all birds observed during were recorded within a visible radius of the observer and by listening for vocalizations (Figure 1-2; Attachment A; Photo 1). Other incidental observations of birds during the walking survey were also recorded.

3. SURVEY RESULTS

3.1 Terrestrial Flora

The WAq site is heavily developed and there are WAq staff, volunteers, and visitors in and around the area. The outdoor area of WAq including the grassed courtyard area, is heavily manicured with ornamental plants and native plantings used for educational purposes (see Section 1.1.1).

A total of 25 plant species were identified during the survey on May 18, 2022. Terrestrial plants were all ornamental, landscaped introduced plants or native plants. The vegetation line along the coastline is either not existent due to the presence of seawalls and sand bag erosion control structures, landscaped by the condominiums, or highly disturbed by wave erosion events and anthropogenic use. The soil inland of the seawall and sandbags is mainly fill material vegetated with landscaped grass. There were no plants of concern that were identified as protected, threatened, or endangered (USFWS, 2015; DLNR, 2019).

The most abundant plant species along the shoreline are *naupaka kahakai* (*Scaevola taccada)*, portia tree (or milo, *Thespesia populnea),* and false Kamani (*Terminalia catappa*). A few native plants were observed, including *naupaka kahakai, milo, Pritchardia spp.* palm, *aki'aki (Sporobolus virginicus),* and the seaside morning glory (pohuehue, *Ipomoea pes-caprae subp. brasilensis*). However, the *naupaka, Pritchardia spp.* palm, and *milo* appeared to be landscaped. A detailed plant list is included in shown in Table 3-1.

Figure 3-1: Flora observed in the project area

Family	*Genus species*	Common Name	Status*	Abundance**
Aizoceae	*Sesuvium portulacastrum*	Sea Purslane / ʻĀkulikuli	N	U
Araceae	*Colocasia esculenta*	Taro / Kalo	P	R
Arecaceae	*Cocos nucifera*	Coconut Tree	P	A
Arecaceae	*Pritchardia spp.*	Fan Palm / Loulu	N	R
Asparagaceae	*Cordyline fruticosa*	Ti Leaf / Kī	N	A
Boraginaceae	*Heliotropium arboreum*	Tree heliotrope	I	A
Boranginaceae	*Cordia subcordata*	Hawaiian Kou	N	R
Casuarinaceae	*Casuarina equisetifolia*	Ironwood	I	C
Convulvulaceae	*Ipomoea pes-caprae*	Beach Morning Glory / Pohuehue	N	O
Euphobiaceae	*Aleurites moluccana*	Candle nut tree / Kukui	P	C
Fabaceae	*Vigna mariana*	Beach Pea / Nanea	N	U
Goodeniaceae	*Scaevola taccada*	Beach Naupaka / Naupaka Kahakai	N	A
Lamiaceae	*Vitex rotundifolia*	Beach Vitex / Pōhinahina	N	O
Malvaceae	*Hibiscus arnottianus*	White Hibiscus	N	U
Malvaceae	*Thespesia populnea*	Portia Tree / Pacific Rosewood / Milo	N	C
Myrtaceae	*Metrosideros polymorpha*	Red and Yellow Ohia / ʻŌhia Lehua	N	O
Pandanaceae	*Pandanus tectorius*	Screw Pine / Hala	N	O
Poaceae	*Sporobolus virginicus*	Aki'aki / Seashore Rushgrass	N	U
Poaceae	*Cynodon dactylon*	Manicured Grass / Bermuda grass	I	A
Polypodiaceae	*Phymatosorus scolopendria*	Maile-scented fern / Lauaʻe	I	C
Rosaceae	*Osteomeles anthylliifolia*	Hawaiian Rose / Ūlei	N	O
Rubiaceae	*Gardenia taitensis*	Tahitian gardenia	I	C
Scrophulariaceae	*Myoporum sandwicense*	False Sandalwoond / Naio	N	R
Thymelaeaceae	*Wikstroemia oahuensis*	Oʻahu false ohelo / ʻĀkia	N	U
Xanthorrhoeaceae	*Dianella sandwicensis*	Hawaiian lily / ʻUki ʻuki	N	C

** Abundance R - Rare (1-2 observations)
U - Uncommon (3-5 observations)
O - Occasional (5-10 observations)
C- Common (11-20 observations)
A - Abundant (>20 observations)

* Status: N - Native to Hawaii, indigenous
I - Introduced, exotic
P - Polynesian introduction before 1778

3.2 Terrestrial Fauna

All bird species observed during the bird survey and the walking survey were introduced species commonly seen in populated areas across the Hawaiian Islands. Only one native bird species was observed, the white fairy tern (*Gygis alba)*. Two (2) fairy tern (*Gygis alba*) nests were observed in separate milo trees (*Thesesia populnea*) near to the public restrooms and mullet tank. The milo trees that contained the nests were marked with blue tape on their trunk to designate them as fairy tern nesting trees and warn tree maintenance crews of their presence. According to WAq staff, at the time of the site visit on May 18, 2022, one nest had a recently fledged offspring (only one adult was observed), and the other nest had a 2-day old chick and an adult. The parent fairy tern was observed feeding the chick fish during the site survey. The white fairy tern is protected under the Migratory Bird Treaty Act (MBTA). A total of 10 species of birds were recorded (Table 3-2).

Table 3-1: Birds Observed in and Near the Survey Area

Common Name	Scientific Name	Status
Common Myna	*Acridotheres tristis*	Non-native
House Finch	*Passer domesticus*	Non-native
House Sparrow	*Haemorhous mexicanus*	Non-native
Red-crested Cardinal	*Paroaria coronata*	Non-native
Red-vented Bulbul	*Pycnonotus cafer*	Non-native
Rock Pigeon	*Columba livia*	Non-native
Rose-Ringed Parakeet	*Psittacula krameria*	Non-native
Spotted Dove	*Streptopelia chinensis*	Non-native
White Fairy Tern	*Gygis alba*	Native
Zebra Dove	*Geopelia striata*	Non-native

Two large banyan trees reside on Kaimana Beach Park / Natatorium parcel just south of the WAq property. Many of the rose-winged parakeets (*Psittacula krameria*) and rock pigeons (*Columba livia*) that passed through the project area were enroute to the two banyan trees.

One Giant African Snail (*Achatina fulica*) was observed in the lawn area. No large mammals were observed. There were no protected species of mammals, birds, reptiles, or insects observed. Although not observed during the time of the survey, rats (*Rattus spp.*), house mice (*Mus musculus*), feral cats (*Felis catus*), and the small Indian mongoose (*Herpestes javanicus*) are likely to occur in the survey area.

Pre-consultation with the PIFWO identified the following federally listed species that may occur or transit through the proposed project area:

- The endangered Hawaiian hoary bat (*Lasiurus cinereus semotus)*
- The endangered Hawaiian petrel (*Pteerodroma sanwichensis)*
- The threatened Newell's shearwater (*Puffinus auricularis newelli)*
- The endangered Hawaii distinct population segment (DPS) of band-rumped storm-petrel (*Oceanodroma castro)*
- The threatened Central North Pacific DPS of green sea turtle (*Chelonia mydas*).

Hawaiian hoary bats roost in exotic and native woody vegetation over 15 feet in height. Several trees within the project area that are greater than 15 feet in height.

Hawaiian seabirds may pass through the project area at night during the breeding, nesting, and fledging seasons (March 1 to December 15). Outdoor and artificial lighting attracts seabirds and can result in seabird disorientation, fallout, and injury or mortality. Fledging birds are particularly vulnerable and would most likely pass through the site between September 15 through December 15.

Green sea turtles may next on any sandy beach in the Pacific Islands and may become disoriented by artificial lighting. Although there is no sandy beach at the project site, there are many sandy beaches adjacent to the project site. Due to the sheer amount of people and tourists that occupy Waikīkī beaches, sea turtle nesting is not common in the area.

4. CONCLUSIONS

Impacts from project operations on terrestrial flora and fauna will be minimal, as the entire parcel is heavily landscaped and all vegetation on site is cultivated. There will be excavation work needed to install the underground utilities and pipes and the sump, but disturbance of large mature trees will be minimized as much as possible. In particular, the milo trees with active *Gygis alba* nests should are properly flagged and should not be disturbed until the chicks have fledged and the nesting season has passed.

No sensitive, protected, rare, threatened, or endangered species were observed within the project area. A wide variety of native plants are cultivated and planted on display for public educational purposes. Any impacts to extant terrestrial species will be localized and temporary, especially if proper BMPs and control plans are implemented. Construction routes and equipment areas should be staged along existing roads, walkways, and open lawn areas to minimize impacts to planted vegetation.

During the pre-consultation process, the Pacific Islands Fish and Wildlife Office (PIFWO) was contacted for their input on the proposed project. Mitigation measures for the Hawaiian hoary bat, seabirds, and green sea turtle suggested by the PIFWO are summarized below.

- To avoid and minimize impacts to the Hawaiian hoary bat, woody plants greater than 15 feet tall shall not be disturbed, removed, or trimmed during bat birthing and pupping season (June 1 through September 15), and barbed wire should not be used for fencing. Construction of the sump and appurtenances will avoid disturbing as many mature trees as possible.
- To minimize impacts to seabirds and sea turtles, the project should avoid outdoor lighting and only limit work during daylight hours, so that it does not attract shearwaters to the construction site. Should nighttime work need to be conducted, nighttime construction should be avoided during the seabird fledging period (September 15 through December 15) and during sea turtle nesting and hatching season (May through December). Additionally, design measures that can be incorporated into the construction or operation of buildings adjacent to the beach include tinting or using automatic window shades for exterior windows that face the beach, reducing the height of the exterior lighting to below three feet and pointed downward or away from the beach, and minimize light intensity to the lowest level feasible. If these mitigation measures are followed, impacts to terrestrial resources and federally protected species will be minimal (PIFWO, 2022).

5. REFERENCES

Aquarium, 2022. Waikīkī Aquarium Hawaiian Plant Guide. Accessed 5 April 2022. Accessible at: https://www.waikikiaquarium.org/experience/plants-seaweeds/hawaiian-plant-guide/.

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PIFWO, 2022. 2022-0043962-S7-001 Species List for the Waikīkī Aquarium Water System Upgrade, Oʻahu. Correspondence in pre-consultation for the DEA. Received 19 May.

USFWS, 2015. List of species believed to or known to occur in Hawaii. Environmental Conservation Online System. Accessed June 2019. Available at < https://ecos.fws.gov/ecp0/reports/species-listed-by-state-report?state=HI&status=listed>

Attachment A:

Photograph Log

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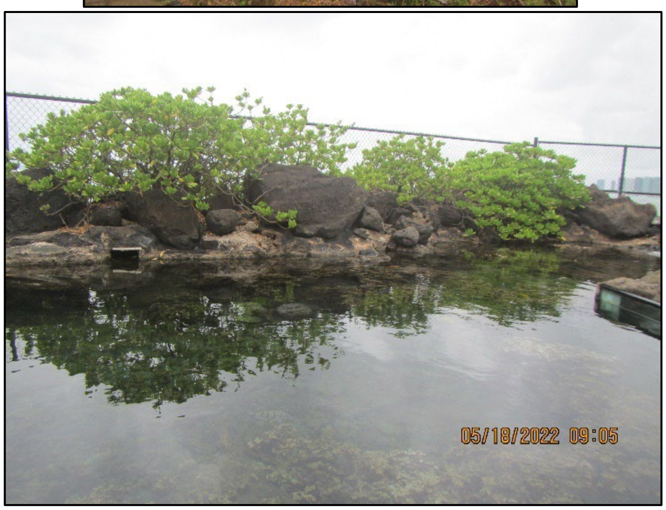
No.	Photograph	Description
1		Photograph open lawn area with mix of grass and turf, taken from bird survey post on the south end of the property line facing north. The Pacific Ocean is to the left, Kalākaua Avenue to the right.
2		Photograph of the northeast corner of the property, facing east toward Kalākaua Avenue. The proposed injection wells will be located in this area.
3		Stage area with potted palms and ornamental plants decorating the stage. The entire area is heavily landscaped.

No.	Photograph	Description
4		Cultivated native white hibiscus plant (*Hibiscus arnottianus*) is an educational live display.
5		Landscaped areas contain native plants that are for public viewing and education.
6		Yellow ʻōhia lehua (*Metrosideros polymorpha*) and red ʻōhia lehua are planted on the WAq site but are not naturally occurring.

No.	Photograph	Description
7		Several planted Hawaiian lily (*Dianella sandwicensis)* plants are on educational display.
8		Two milo (*Thespesia populnea*) trees have active white fairy tern (*Gygis alba)* nests during the May 18, 2022 site visit and are labeled with blue tape.
9		During the site visit on May 18, 2022, a parent white fairy tern (*Gygis alba)* was observed feeding live fish to its offspring.

No.	Photograph	Description
10		Landscaped plants are cultivated in the groundskeeper's area and then planted in the publicly viewed areas of the Aquarium.
11		Beach vitex/ Pōhinahina (*Vitex rotundifolia*) is planted in several locations for public education viewing.

No.	Photograph	Description
12		Several decorative fan palm (*Pritchardia spp.*) trees are present in landscaped areas.
13		Beach naupaka (*Scaevola taccada*) is commonly present, here shown lining the Edge of Reef exhibit.
14		Tahitian gardenia (*Gardenia taitensis*) line the front of the Aquarium.

No.	Photograph	Description
15		Coconut trees (*Cocos nucifera*) trees along are present along the perimeter of the open lawn area.
16		Ironwood *(Casuarina equisetifolia*) trees line Kalākaua Avenue and the sidewalk.

No.	Photograph	Description
17		A large single Hawaiian Kou Tree (*Cordia subcordata*) greets visitors at the front of the Aquarium.

Appendix E:

Benthic Survey Report: Vicinity of Intake Pipes and Seawall Cavity, July – September, 2023

BENTHIC SURVEY REPORT

Vicinity of Intake Pipes and Seawall Cavity

July – September, 2023

Waikīkī Aqarium
Supply Water Intake System Upgrade

Prepared for:

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November 2023

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List of Acronyms and Abbreviations

BMP	Best Management Practices
BWS	City and County of Honolulu Board of Water Supply
CCA	Crustose Coralline Algae
CCH	City and County of Honolulu
cm	centimeter
DLNR	State of Hawai‘i Department of Land and Natural Resources
DAR	State of Hawai‘i Department of Land and Natural ResourcesDivision of Aquatic Resources
ESA	Endangered Species Act
ft	foot or feet
GPM	Gallons per minute
HDPE	High-Density Polyethylene
m	meter
m^2	square meter
MLCD	Marine Life Conservation District
NSW	Natural seawater
UH	University of Hawai‘i
UV	Ultraviolet
WAq	Waikīkī Aquarium

1. PURPOSE OF THE PROPOSED ACTION

The Waikīkī Aquarium first opened in 1904, making it the second oldest public aquarium in the United States. It became an institution of the University of Hawai'i (UH) in 1919 and its location was moved to its present site in 1955. WAq will celebrate its 120th anniversary in 2024. The Aquarium has won many national awards for its exhibits and aquatic culture methods. It is visited by over 330,000 people per year and is currently home to more than 3,500 organisms of 490 species of marine plants and animals.

The University of Hawai'i (UH) is proposing to replace two existing offshore intake pipes supplying natural seawater to the Waikīkī Aquarium (WAq) located on the south shore of the island of O'ahu. These pipes are part of the water intake system designed to supply seawater to the WAq biota exhibits. The existing 8-inch transite intake pipes were installed in the 1950s and are well past their engineering life of 50 years, thereby resulting in moderate deterioration of the pipe material and a subsequent effect on the quality and quantity of seawater used by the Aquarium.

The Waikīkī Aquarium Supply Water Intake System Upgrade Project, hereafter referred to as the Proposed Action, is intended to fully replace the intake pipes to restore the quality and quantity of intake water, as well as to update pipe material to ensure a longer lifespan. UH proposes to replace these pipes with two new 8-inch high-density polyethylene (HDPE) pipes to prevent the possibility of future failures that have the potential to threaten the life and wellbeing of the biota and to increase the quality and quantity of water available for future WAq exhibits. Further, by replacing the deteriorating transite (asbestos-cement) pipes with HDPE pipes, the Project will likely protect valuable coastal ecosystems, improve water quality and help reefs to thrive within the vicinity of the Aquarium.

As part of the Proposed Action, UH is also proposing to repair a large cavity located in the seawall fronting the Aquarium. As this section of seawall is currently considered hazardous to the public due to potential collapse, the Proposed Action is planned to prevent the seawall's failure, protect public safety and property, prevent sediment from being washed out and suspended in nearshore waters, and restore safe connection to the shoreline next to the Aquarium for visitors and residents alike.

2. DESCRIPTION OF THE PROPOSED ACTION

2.1 Project Location and Existing Conditions

The Aquarium is located on the southeast corner of Waikīkī, adjacent to Kapi'olani Regional Park on the south shore of the island of O'ahu (Figure 2-1). The Aquarium abuts the shoreline seawall on its west edge and extends east up to Kalākaua Avenue.

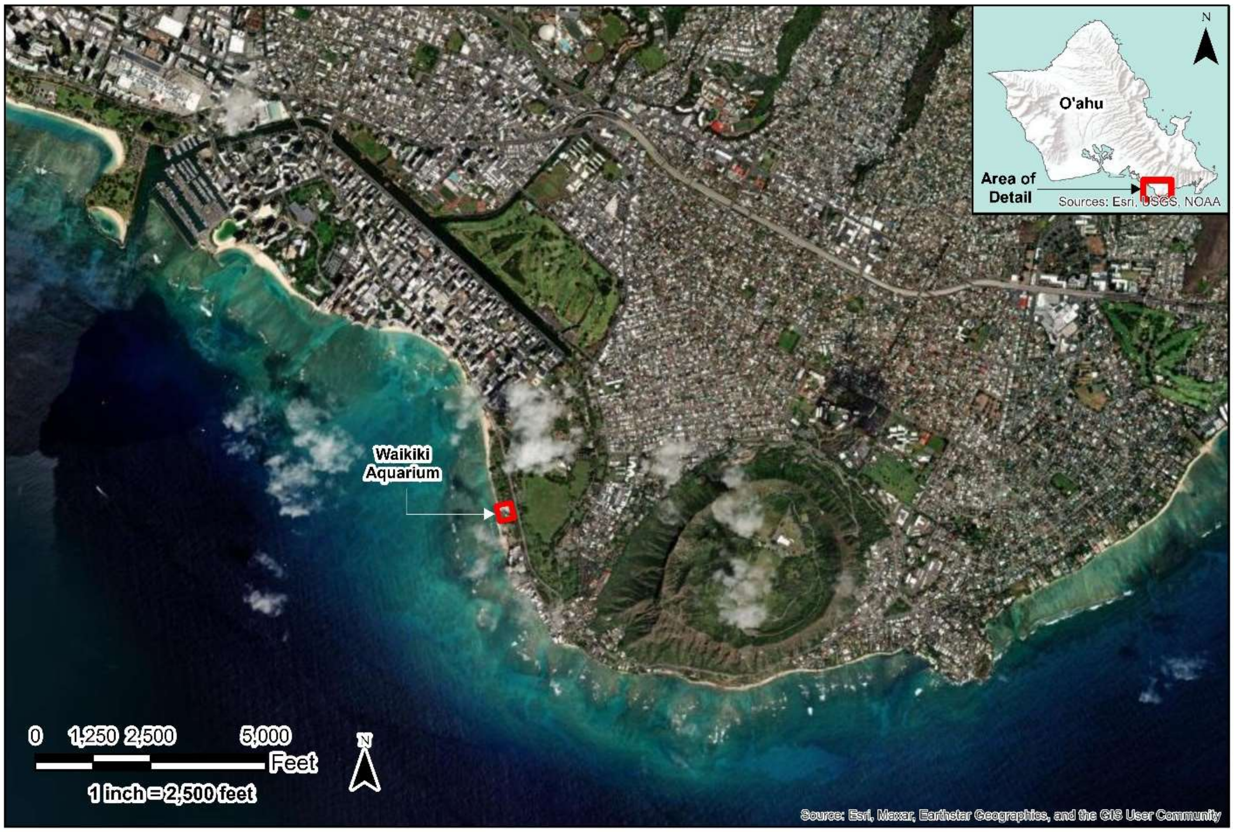

Figure 2-1: Location Map

The seafront of the Aquarium lies within the Waikīkī Marine Life Conservation District (MLCD) and is fronted by a public-access seawall that spans from the War Memorial Natatorium to the south to Queen's Beach to the north. In the subtidal zone past the seawall, a shallow reef flat (4-6 feet deep) extends about 150 feet (45 meters) before dropping off to a dredged channel (8-10 feet deep) consisting of a sandy bottom intermixed with rocky rubble substrate. The channel was dredged in the 1920s, coincident with the construction of the War Memorial Natatorium. The dredged area extends to about 250 feet (76 meters) offshore where the substrate then rises to the natural back-reef lagoon depth and slowly deepens to the edge of the active reef (15-20 feet deep) at 1,000 feet (300 meters) offshore. Turbidity is generally high in the area due to persistent wave action on the shallow reef, particularly during summertime when swells bring high surf to the area.

As depicted in Figure 2, the two existing intake pipes are located at the landward side of the dredged channel, extending 160 feet (ft) from the shoreline, and are buried by sand and rubble in a trench cut through the reef flat in the northwestern section of the Aquarium oceanfront. The existing cavity in the seawall is approximately 12 ft long and 5 ft tall, located directly below the public walkway extending along the top of the seawall. The cavity is located approximately mid-way between the Natatorium and the intake pipes.

2.2 Description of the Proposed Action

WAq utilizes three intake water sources totaling approximately 470,000 gallons per day (GPD), or approximately 325 gallons per minute (GPM), for the aquatic exhibits and holding tanks maintained at the facility at the present time. The new overall system will be designed to obtain a total of 886,000 gallons per day, roughly 396,000 from wellwater and 490,000 natural seawater (NSW) from the nearshore pipes.

NSW is the largest volume of daily water usage for the facility. An average of 247,000 GPD of NSW is pumped into the facility at about 170 GPM. The upgraded system will have a capacity of 496,000 GPD. Natural seawater is obtained through two parallel 8-inch diameter transite pipes that extend approximately 160 feet (ft) from the shoreline to the edge of the nearshore reef. Natural seawater is filtered by ten bag filter canisters in series, each comprised of 3-layer filter bags, that progressively remove particulates 50, 10, and down to one micron in size. This filtration system is inefficient and expensive to maintain. The NSW mainly supplies the outdoor pool that houses the endangered Hawaiian Monk Seal. The NSW contains plankton that may include fish parasites or pathogens, and is often too warm for use in the indoor fish and invertebrate exhibits. NSW is primarily used for the outdoor Monk Seal exhibit which does not require the water to be sterilized or cooled.

In terms of seawall repairs, the Proposed Action includes repairing the seawall cavity within the footprint of the existing seawall, as well as other miscellaneous seawall repairs as called for by structural engineering reports and/or evaluations.

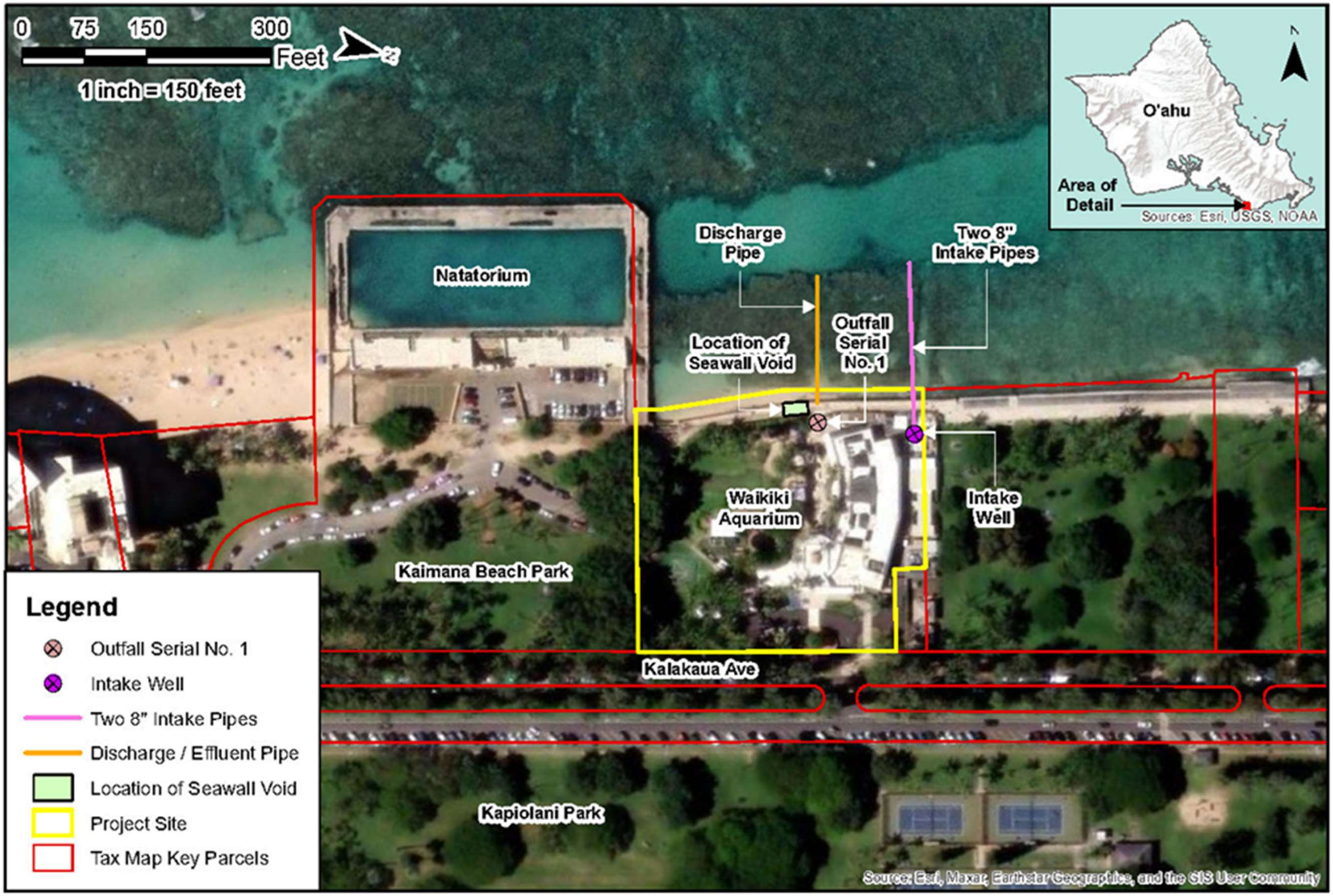

Figure 2-2: Existing Natural Seawater Intake System

3. STUDY METHODOLOGY

3.1 Survey Areas: Transect and Quadrat Placement

On July 26, July 28, August 25, and September 27, 2023, Oceanit personnel used a combination of snorkel gear and dive gear to inventory benthic substrate and marine assemblages at the project site. Depicted in Figure 3-1, a total of 32 random points were assessed with a point quadrat methodology; including 24 at the intake pipes and 8 at the seawall cavity. Using a 1-meter quadrat with 25 marked string intersection points, each quadrat location was inventoried for benthos type and marine life to the lowest taxonomic class possible. Two divers also conducted surveys of fish assemblages and coral colonies along two end-to-end 30-meter (98-feet) transects set along the intake pipe centerline. Due to the shallow (<2 feet deep), turbid nature of the seawall cavity site, fish assemblages were not surveyed at that location. Figure 3-1 shows the transect and quadrat locations. Field notes from the surveys are documented in Appendix C.

3.1.1 Intake Pipes

Twenty-four (24) quadrat points were randomized in 5-meter increments along the intake pipe transects. Twelve (12) points were assigned within 1 meter from the pipe centerline, and twelve (12) points were assigned 1-5 meters away on either side, covering the benthos adjacent to the pipe centerline.

3.1.2 Seawall Cavity

Eight (8) quadrat points were randomized within a 10-meter radius of the center of the seawall cavity.

3.2 Coral Abundance and Size Class Distribution

A 10-meter-wide belt survey of coral colonies was conducted along each 30-meter transect. All corals larger than 2 centimeters (cm) and located within 5 meters (m) on either side of the transect line were counted. Coral heads were identified to species and assigned to a size class (2-5 cm, 6-10 cm, 11-14 cm, 15-20 cm, and 21-40 cm) based on the largest horizontal direction of the colony. Percent morbidity (amount of colony pale/bleached or covered in macroalgae) and any signs of disease were also recorded. Coral abundance was calculated as the number of individuals per square meter (m^2).

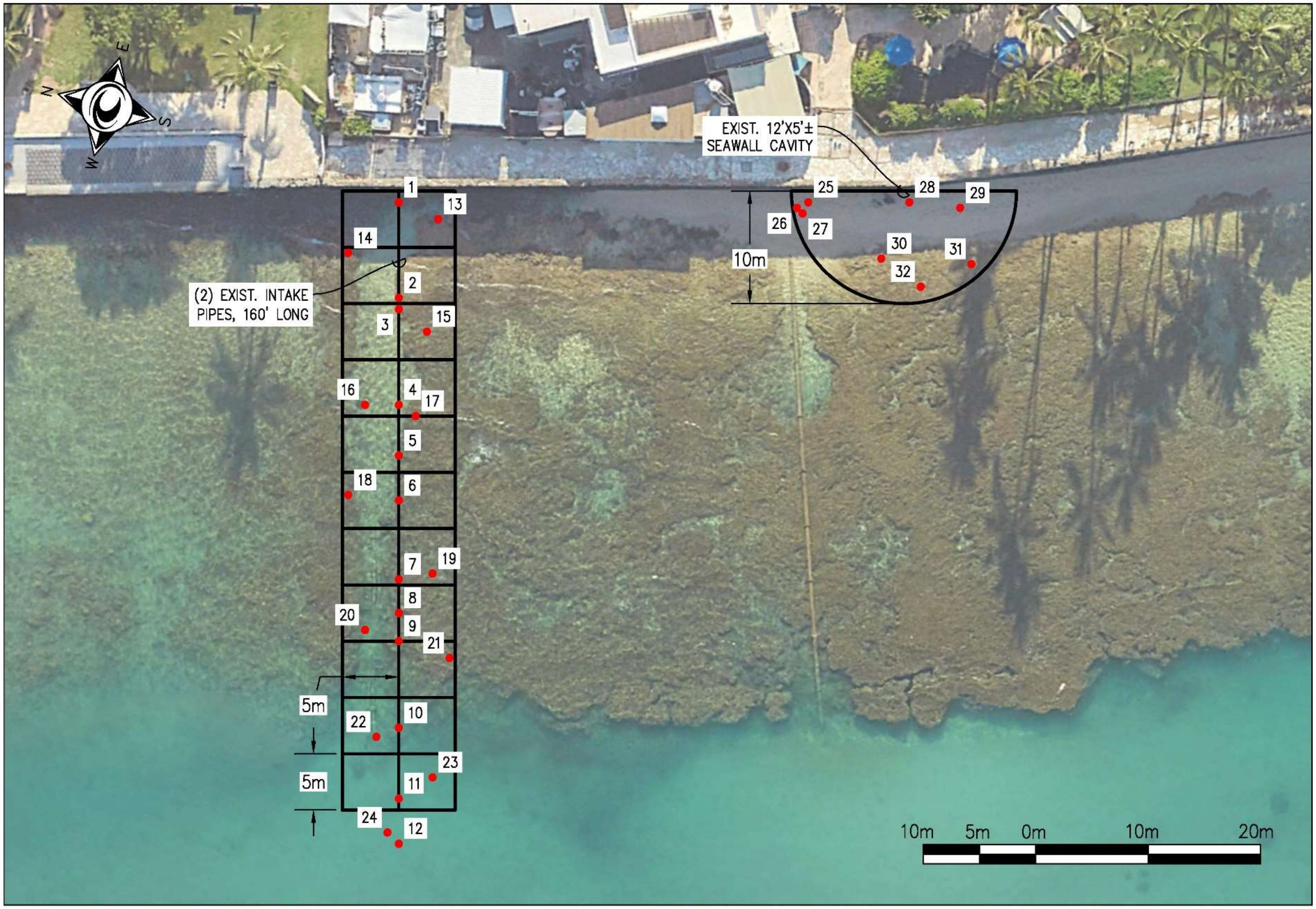

Figure 3-1: Random Survey Point Locations Along the Intake Pipes and at the Seawall Cavity

4. FINDINGS

4.1 General Observations

4.1.1 Intake Pipe Dredged Channel and Surrounding Reef Flat

4.1.1.1 Benthic Survey

Soft sand and gravel substrate extend 1-5 ft to either side of the dual pipe, likely due to the original trenching for the pipe when it was installed roughly 70 years ago. Adjacent to the sand channel, a shallow reef flat runs parallel to each side. The intake pipe channel substrate is characterized by a predominantly rocky and rubble bottom with coarse sand intermixed, and relatively low presence of algae and invertebrates. During the survey, it was observed that approximately the first 100 ft of pipe was buried, and the pipe gradually emerged from the seafloor until it was fully exposed at its terminus over the dredge escarpment.

The shallow reef flat section is dominated by mats of macroalgae, mostly made up of *Padina sp.* and various cyanobacteria and turf algae, as well as *Acanthophora spicifera*, *Dictyota sanvicensis*, *Codium edule*, *Turbinaria ornata*, *Avrainvillea lacerata* (formerly *Avrainvillea amadelpha*) and *Neomeris* spp., in rough order of prevalence. Over the intake pipe channel (primarily loose sand and gravel), macroalgae was significantly sparser and made up primarily of cyanobacteria and turf algae. The pipe surface, where it was exposed, was thickly covered with soft mats of cyanobacteria and turf algae, but demonstrated low presence of encrusting organisms. One *Tripneustes gratilla* was observed on the pipe. Along the edge of the surrounding reef, occasional *Holothuria atra* were observed.

4.1.1.2 Coral Survey

The area surveyed extended 5 m (15 ft) to either side of the pipe, over the soft sand and gravel substrate of the pipe trench as well as the surrounding reef flat. The survey also extended to the dredge edge/dropoff zone beyond the existing pipe, where the substrate became dominated by rubble with coarse sand intermixed. A higher density of coral was observed associated with the solid substrate in the dropoff zone. To better estimate the potential impact to coral colonies in the immediate area of proposed construction activities, the observed corals were also split by location – on the raised reef flat (lesser chance of impact), within the current intake pipe trench (higher chance of impact), and within 5 m on either side of the proposed pipe extension (higher chance of impact).

The raised reef flat on either side of the intake pipe channel was found to be dotted with eight colonies of *Porites evermanni* and *Pocillopora damicornis*, as well as *Pocillopora meandrina* in rough order of prevalence. These ranged in size from less than 5 cm (2 inches) up to about 14 cm (5.5 inches). In total, percent cover of coral on the reef flat within 5 m (15 ft) of the pipe was found to be less than 1%. The corals on this reef flat were observed to be in relatively healthy condition, showing some pale tissue, but little bleaching or overgrowth.

Within the intake pipe trench and pipe extension area, seven coral colonies were observed. Of these, six coral colonies larger than 15 cm were documented to include location specifics. Five out of six of these corals showed signs of stress, including pale or bleached tissue, overgrowth by algae, and/or signs of "pink spot disease", believed to be caused by an infection of trematode larvae (Aeby, 1993). The coral colonies 15 cm and larger are described below:

1. Approximately 20 m (65 ft) from the seawall and 3.5 m (11.5 ft) from the intake pipes, a 30-cm (12.5-in) colony of *Porites evermanni* was recorded. This colony was observed to be in poor condition, appearing flipped upside down and 80% pale/bleached/overgrown by algae (Appendix A. Photo 4).

2. Around 28 m (92 ft) from the seawall and 20 cm (8 in) from the intake pipes, a 17-cm (7-in) colony of *Porites evermanni* was recorded. This colony also appeared to be in deteriorating health, estimated to be 70% pale, 20% bleached, and showing signs of the pink spot disease (Appendix A, Photo 5).

3. At 172 ft from the seawall, past the end of the existing pipe, a 20-cm (8.5-in) colony of *Porites evermanni* was found near the proposed extension of the pipe (Appendix A, Photo 7). The colony appeared relatively healthy, with no reported signs of stress.

4. At 172 ft from the seawall, past the end of the existing pipe, another 20-cm (8.5-in) colony of *Porites evermanni* was found near the proposed extension of the pipe. The colony appeared 40% pale/bleached, and 10% covered in algae.

5. Past the end of the existing pipe, just beyond the large concrete block, an approximately 17-cm (7-inch) colony of *Porites evermanni* exhibiting signs of stress was observed (Appendix A, Photo 8). The top portion of the colony, approximately 30%, was observed to be covered in algal overgrowth.

6. A few feet further, a 15-cm (6-in) colony of *Porites evermanni* with signs of the pink spot disease was recorded (Appendix A, Photo 9).

4.1.1.3 Fish Survey

The fish survey was conducted using a belt transect method, with two observers each recording species encountered within a 5 m (15 ft) distance on either side of the existing pipes. The visibility at the time of the survey was 6 m (20 ft).

The intake pipe channel, characterized by substrate of small gravel and sand, was found to exhibit low rugosity and correspondingly hosted few assemblages of fish species. However, the reef area surrounding the intake pipe channel was observed to support a moderate assemblage of species (17 total) and low abundance (total count = 184). Where the intake pipe emerged from the sand, a larger number of fish were seen to congregate in comparison to where it was buried. The most common species, occurring in large schools, was *Acanthurus triostegus*. Other species observed in rough order of prevalence included *Acanthurus nigrofuscus*, *Thalassoma duperrey*, *Naso unicornis*, *Thalassoma purpureum*, *Acanthurus xanthopterus*, *Canthigaster jactator*, *Zanclus cornutus*, *Acanthurus leucopareius*, *Abudefduf sordidus*, *Rhinecanthus rectangulus, Caranx melampygus*, *Mulloidichthys flavolineatus, Chaetodon auriga*, *Cymolutes lecluse* and *Gomphus varius*. The nearshore half of the survey area was dominated by small juveniles, and the second half of the survey, towards the dredged dropoff zone, hosted larger juveniles as well as small adults. Two (2) moray eels (*Gymnothorax meleagris* and *Gymnothorax eurostus*) were also observed in the reef flat crevices. Total counts of all fish species observed are displayed in Table 1.

Table 1: Total Number of Each Fish Species

Fish Species	Common Name	Number Counted *(see note)*
Abudefduf sordidus	Blackspot damselfish	4
Acanthurus leucopareius	Whitebar surgeonfish	4
Acanthurus nigrofuscus	Brown surgeonfish	20
Acanthurus triostegus	Convict tang	78
Acanthurus xanthopterus	Yellowfin surgeonfish	8
Canthigaster jactator	Hawaiian whitespotted toby	7
Caranx melampygus	Bluefin trevally	3
Chaetodon auriga	Threadfin butterflyfish	1
Cymolutes lecluse	Hawaiian Razorfish	2
Gomphus varius	Bird wrasse	1
Mulloidichthys flavolineatus	Yellowstripe goatfish	1
Naso unicornis	Bluespine unicorn	15
Rhinecanthus rectangulus	Reef triggerfish	6
Thalassoma duperrey	Saddle wrasse	18
Thalassoma purpureum	Surge wrasse	8
Zanclus cornutus	Moorish idol	7
Zebrasoma flavescens	Yellow sailfin tang	1
Total	**17 species**	**184**

Note: The combined count is likely to include duplicate counts on individuals that crossed through the parallel transect areas during the survey conducted by two Oceanit personnel.

4.1.2 Seawall Cavity

4.1.2.1 Benthic Survey

The cavity in the seawall is approximately 12 ft long and 5 ft tall, with rocks from the failure area scattered on the substrate within 8 ft of the cavity. The frontage of the collapsed wall is fringed by a 15-20 ft patch of intertidal coarse sand, which then gives way to a shallow reef flat just below mean lower low water elevation. This area is subject to frequent surge and the reef is mostly covered in algae mats. The algae mats were diverse and covered at least 75% of the substrate, and made up predominantly of *Padina* spp., *Dictyota sandvicensis*, *Avrainvillea lacerata*, *Codium edule*, and *Turbinaria ornata*. Turf algae covered the bulk of the remaining substrate in this area, with about 25% of the substrate either uncolonized sand or abraded rubble. The reef was dotted with *Echinometra mathaei* and *Echinometra oblonga*. No corals were seen within an arc extending 10-m (30-ft) out across the reef flat from the center of the cavity.

4.2 Results: Coral Abundance and Size Class Distribution

Data on coral abundance and size-class distribution were collected during the survey. Table 2 presents the total number of coral colonies larger than 2cm and the coral abundance determined within each of the transects. The average overall density of corals along the intake pipes and within approximately 5 meters of the pipes on both sides is measured as 0.025 colonies per m^2. Table 3 further splits coral density calculations by location in relation to the intake pipe trench and proposed pipe elongation area. Coral abundance is measured as 0.41 colonies per m^2 in the reef flat over transect 2, and 0.40 colonies per m^2 in the dredged area past the end of the current intake pipe. As discussed in the General Observations section, no corals were seen during the seawall cavity survey.

Results of the coral size class survey are presented in Table 4. A total of fifteen (15) coral colonies, representing at least four (4) coral taxa (*Pocillopora damicornis, Pocillopora meandrina, Porites evermanni, and Porites* spp.), were recorded. The most common species was *Porites evermanni* at 53.3% of the total. The most common colony size was the 15-to-20-centimeter class (33.3% of the total). Large (21 to 40 centimeter) colonies were rare. No colonies greater than 40 centimeters were recorded.

Table 2: Total Number of Coral Colonies and Coral Colony Abundance Over Each Transect

Transect	Survey Area (m^2)	Coral count (colonies)	Coral abundance (mean number of colonies per m^2)
1	300	4	0.013
2	300	11	0.036
Total	600	15	0.025

Table 3: Total Number of Coral Colonies and Coral Colony Abundance by Location, in Relation to the Intake Pipe Trench and Proposed Pipe Extension Area

Location	Survey Area (m2)	Coral count (colonies)	Coral abundance (mean number of colonies per m^2)
Transect 1, within the intake pipe trench	120	1	0.0083
Transect 1, over the adjacent reef flat	180	3	0.0167
Transect 2, within the intake pipe trench	80	2	0.025
Transect 2, over the adjacent reef flat	120	5	0.041

Location	Survey Area (m2)	Coral count (colonies)	Coral abundance (mean number of colonies per m²)
Transect 2, within 5m of the proposed pipe extension on either side	100	4	0.04
Total	600	15	0.025

Table 4: Number of Coral Colonies Recorded in Each Size Class by Species

Taxa	**Size Class (cm)**						**Percent of total**
	2 to 5	**6 to 10**	**11 to 14**	**15 to 20**	**21 to 40**	**Total**	
Pocillopora damicornis	3		1			4	26.7%
Pocillopora meandrina	2					2	13.3%
Porites evermannii			2	5	1	8	53.3%
Porites spp.			1			1	6.7%
Total	5		4	5	1	15	
Percent of Total	33.3%		26.7%	33.3%	6.7%		

4.3 State- and Federally-Listed Marine Species

Some state- and federally-listed marine species, such as Hawaiian monk seals (*Neomonachus schauinslandi*) and green sea turtles (*Chelonia mydas*) are known to occur in the general vicinity of the proposed Supply Water Intake System Upgrade project. On July 28, 2023, a Hawaiian monk seal was observed swimming through the site area. No other sightings occurred on other survey days, and no sea turtles were seen during any surveys. Some living corals were seen in the project area, described in this report with accompanying images.

5. RECOMMENDED MITIGATION MEASURES

5.1 Impact Assessment

The proposed replacement of the water intake pipe will likely include removal of the sand covering the existing pipeline, removal of the existing pipes, installation of the new twin HDPE plastic intake pipes, and replacement of the dredged sand back on top of the new pipeline. Other than the removal of the loose sand and gravel within the existing trench, no removal or damage to the hard substrate to either side of the pipeline is anticipated.

It is anticipated that all corals occurring within two meters of the intake pipe or planned pipe extension (a total of 7) will be directly impacted. Impacts to corals outside of this range will be minimized by the use of silt curtains to either side of the alignment during active construction. To the extent possible, corals larger than 15 cm diameter within the impact zone will be removed and reattached in a similar nearby habitat fronting the Aquarium.

5.2 Recommended Mitigation Measures

Prior to the start of the project, a coral response and rescue team will be formed to remove corals, as practicable, from the directly impacted (2m to either side of the pipeline) project area and transplant them to another site. Based on the survey data, due to apparent signs of tissue damage or disease in corals located near the intake pipe, approximately one out of seven, or 14% of the coral colonies would be suitable candidates for relocation. The *Porites evermanni* candidate for relocation is located just beyond the end of the current intake pipe (Appendix A, photo 7). Relocation could be attempted for additional coral colonies, although their survival may have a lower chance of success. Additionally, various macroinvertebrates are potential candidates for relocation, including urchins and sea cucumbers. The project will likely result in damage to the corals that do not meet criteria for relocation. For the corals that are not suitable candidates for relocation, their loss may be mitigated by offering these corals to the State of Hawaiʻi Department of Land and Natural Resources (DLNR) Division of Aquatic Resources' (DAR) Coral Nursery, propagating them into larger corals, and transplanting them back into the waters fronting the Aquarium.

It is anticipated, however, that the replacement pipes and the seawall repair will provide better habitat for corals to grow. The two (2) existing offshore intake pipes are made of transite (asbestos-cement). Because they were installed in the early 1950s and are now well beyond their 50-year engineering design life, they are deteriorating. As part of the proposed Supply Water Intake System Upgrade project, the transite pipes will be replaced with high density polyethylene (HDPE) pipes. Additionally, as part of the proposed project, the Aquarium is intending to repair the large seawall cavity to prevent the seawall's collapse, protect public safety and property from natural hazards (e.g., erosion, flooding), prevent sediment from being washed out and suspended in nearshore waters, and restore safe connection to the shoreline next to the Aquarium for visitors and residents alike. Therefore, in the long-term, the proposed project will likely protect valuable coastal ecosystems, improve water quality in the MLCD, and help reefs to thrive by replacing the deteriorating transite pipes with HDPE pipes.

Potential indirect impacts to coral reef ecosystems from construction activity of the project may occur due to degradation of water quality. Project construction may temporarily increase the amount of suspended sediment in the water column. Appropriate construction Best Management Practices (BMPs), such as the use of silt fences, will be designed and implemented to minimize the impacts of water quality associated with project activities.

The project includes work in marine waters where Endangered Species Act (ESA) listed species, such as sea turtles, may be directly exposed to project activities. Because sea turtles and marine mammals typically avoid human activity, the expected effect of this interaction would be an avoidance behavior leading to an exposed animal leaving the project area without injury. The likelihood of interaction will be reduced through a BMP of watching for and avoiding protected marine life before commencing work and by postponing certain activities when protected species are within 50 yards of that activity. The project is expected to have no long-term effect on the foraging characteristics or upon the quality or quantity of monk seal prey.

BMPs that will be implemented during project construction include the following

- Prevent trash and debris material from entering the marine environment during the project. Any foreign material that falls onto the beach or into nearshore waters during construction will be immediately contained and removed.

- Appropriate silt containment devices (e.g., silt curtain) will be properly installed, monitored and maintained.

- Project operations will cease under unusual conditions, such as large tidal events, storms, and high surf conditions.

- Work will be conducted during periods of expected low tide to the greatest extend feasible.

- Construction will be stopped immediately if a sea turtle, monk seal or any other endangered or protected marine species enters the construction site or nearby vicinity. Construction may continue when the animal(s) leaves the site on its own accord. There shall be no attempt to remove or force the animal to leave the site.

Other standard BMPs that will be used during construction include solid waste management, stockpiles surrounded by sediment barriers or silt fences, dampening any graded areas with water, and daily inspections of filter socks and geotextile fabrics to identify and repair breaches in construction stage work zones. Inspections of BMPs will be performed regularly. The contractor is required to have available materials (e.g., oil absorbent pads, spill kits) to immediately contain and clean up any accidental spills of fuel or lubricants from heavy construction equipment. Construction phases will be sequenced to minimize in-water construction time. Following the end of construction, any dirt or disturbed grass areas will be re-grassed. The contractor will utilize good housekeeping procedures at all times.

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APPENDIX A: SURVEY PHOTOGRAPHS

Representative pictures of transects surveyed in the Waikiki Aquarium Supply Water Intake System Upgrade Project area and vicinity. The intake pipe vicinity was photographed July 26, July 28, August 25 and September 27, 2023. Due to shallow (<1m) water and turbidity, quadrats surrounding the seawall cavity were not photographed.

Photo 1. Typical representation of the macroalgae-dominant reef flat to either side of the dredged pipe intake channel

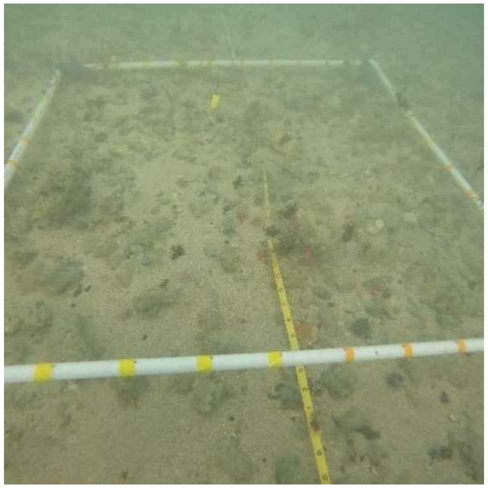

Photo 2. Typical benthos over the pipe intake channel, where pipe is buried

Photo 3. Typical view over the pipe intake channel, where pipe is exposed

The substrate within 1-2m of the dual intake pipe was largely composed of sand, rocks, gravel, and rubble. A macroalgae-dominant reef flat extended to either side of the intake pipe trench. Coral colonies were found scattered along both the trench and the reef.

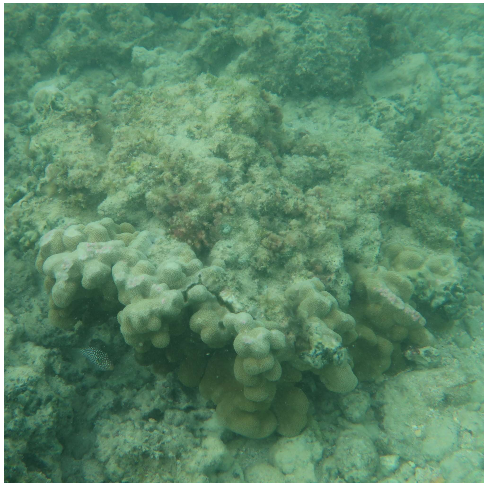

Photo 4. *Porites evermanni* at 62 feet from the seawall

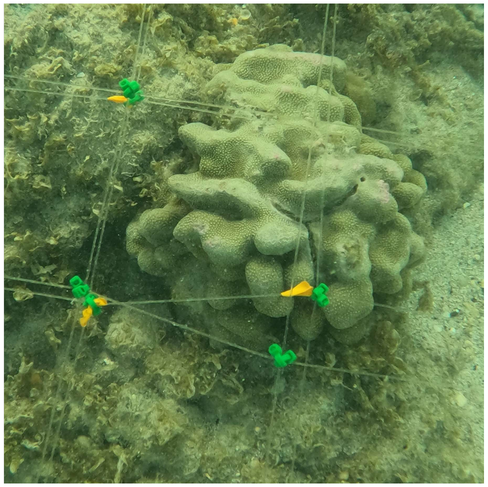

Photo 5. *Porites evermanni* at 92 feet from the seawall

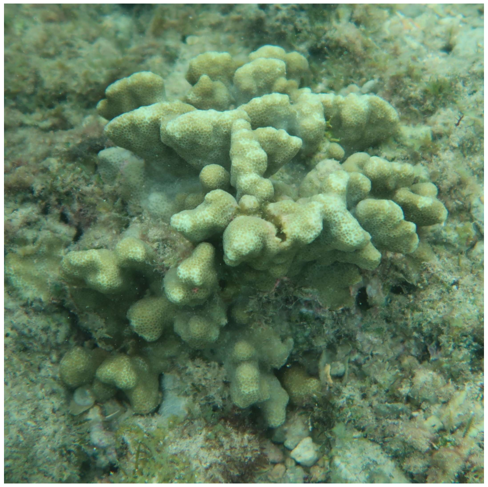

Photo 6. *Porites* spp. at 100 feet from the seawall

Within 5-m (15-ft) of the intake pipe centerline, several coral colonies were observed.

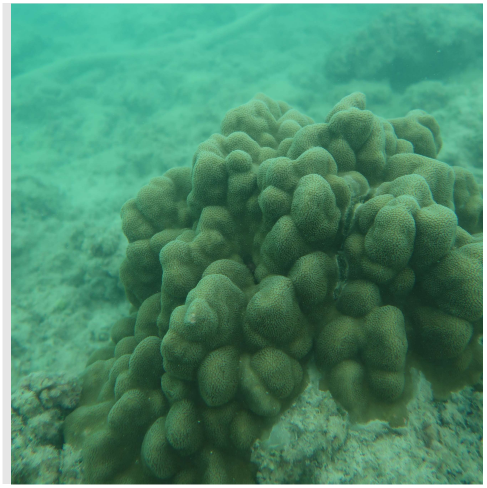	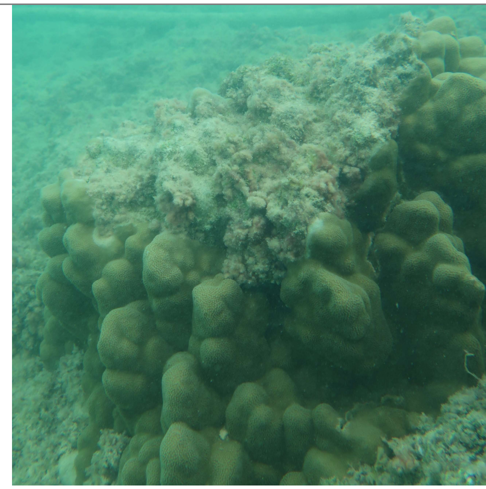	
Photo 7. *P. evermanni* past the existing pipe	**Photo 8.** A second *P. evermanni* past the existing pipe	**Photo 9.** A third *P. evermanni* past the existing pipe

Past the existing pipe, the dredge edge zone was composed of a largely sandy bottom. Several coral colonies occurred in this area, largely comprising of *Porites evermannii.*

APPENDIX B: INVENTORY OF OBSERVED BIOTA

Inventory of marine biota observed in the Waikiki Aquarium Supply Water Intake System Upgrade Project area and vicinity, Waikiki, Hawai'i, July 26, July 28, August 25 and September 27, 2023.

FLORA

Scientific Name	Common Name	Hawaiian Name
Acanthophora spicifera	Spiny seaweed	n/a
Avrainvillea lacerata	Leather mudweed	n/a
Codium edule	Creeping antler seaweed	limu wawaeʻiole
Dictyosphaeria versluysii	Hard bubble seaweed	limu
Dictyota sandvicensis	Hawaiian Dictyota	limu alani
Gracilaria salicornia	Gorilla seaweed	limu manauea
Neomeris sp.	Neomeris	n/a
Padina sp.	Brown macroalgae of the Padina genus	limu pepeiao
Turbinaria ornata	Ornate seaweed	limu kahili

FAUNA

Scientific Name	Common Name	Hawaiian Name
Abudefduf sordidus	Blackspot damselfish	kūpīpī
Acanthurus leucopareius	Whitebar surgeonfish	maiko
Acanthurus nigrofuscus	Brown surgeonfish	maʻiʻi
Acanthurus triostegus	Convict tang	manini
Acanthurus xanthopterus	Yellowfin surgeonfish	pualu
Canthigaster jactator	Hawaiian whitespotted toby	kōkala
Caranx melampygus	Bluefin trevally	ʻomilu
Chaetodon auriga	Threadfin butterflyfish	kapuhili
Chaetodon lunula	Racoon butterflyfish	kīkākapu
Chelonia mydas	Green sea turtle	honu
Echinometra mathaei	Pale rock-boring urchin	ʻina ula or ʻine kea
Echinometra oblonga	Black rock-boring urchin	ʻina ʻeleʻele
Gomphus varius	Bird wrasse	hīnālea ʻakilolo
Gymnothorax eurostus	Stout moray eel	puhi
Gymnothorax meleagris	Whitemouth moray eel	puhiʻōniʻo
Holothuria atra	Black sea cucumber	loli
Mulloidichthys flavolineatus	Yellowstripe goatfish	weke ʻa
Naso unicornis	Bluespine unicorn	kala
Neomonachus schauinslandi	Hawaiian monk seals	ʻīlio holo i ka uaua

Pocillopora damicornis	Lace coral	koʻa
Pocillopora meandrina	Cauliflower coral	koʻa
Porites compressa	Finger coral	ʻakoʻakoʻa
Porites evermanni	Brown lobe coral	ʻakoʻakoʻa
Thalassoma duperrey	Saddle wrasse	hīnālea lauwili
Thalassoma purpureum	Surge wrasse	hou
Tripneustes gratilla	Collector urchin	hawaʻe maoli
Zanclus cornutus	Moorish idol	kihikihi

APPENDIX C: FIELD NOTES AT BENTHIC SURVEY POINTS

Along Pipe Centerline (Nearshore to Offshore)		
Point	**Coral Present**	**Notes**
1 (0,1)		Very shallow, turbid and wave action. Algae mats on top of rough shoreline rock. *Padina*, cyanobacteria, turf algae, CCA, *Codium*, *Avrainvillea*.
2 (0,9.5)		Mixture of coarse sand, small rocks and rubble. No algae in this spot. Pipe still buried here.
3 (0,10.5)		Rock of various sizes, broken down to gravel size. Some coarse sand. Light algae: *Padina* and cyanobacteria. *Dictyota sandvicensis* present.
4 (0,19)		Rock of various sizes, down to gravel. Some coarse sand. Light algae: turf and CCA, cyanobacteria, *A. spicifera* present.
5 (0,23.5)		Rock of various sizes, broken down to gravel and coarse sand. Sparse algae: turf, *A. spicifera* present. *Neomeris* present.
6 (0,27.5)	*Porites evermanni*, 0.3m from pipe. 18x15x5cm. 70% pale/20% bleached. Has pink tissue disease.	Cobble-sized rock, coarse sand with parallel-running calcium carbonate reef coming in close to the (still buried) pipe here. Cyanobacteria mats.
7 (0,34.5)		Mostly rock with some broken-down pieces of cobble size and sand/gravel interspersed. Cyanobacteria, CCA, *Neomeris* present. Pipe exposed; quadrat placed under.
8 (0,37.5)		Pipe flush with benthos. Reef/rock with some smaller pieces of cobble size. Reef comes in close to pipe here (within 1m). All turf algae/cyanobacteria.
9 (0,40)		Calcium carbonate rock starts giving way to coarse sandy bottom here. Low algae: cyanobacteria.
10 (0,47.7)		Mostly coarse sand with some rocks interspersed. Light cyanobacteria and CCA. *Neomeris* present. One (1) *Tripneustes gratilla* in area (not in sampling location).
11 (0,54)		Even mixture of coarse sand and rock. Low algae: some light cyanobacteria and CCA. *Neomeris* present.
12 (0,58)	1: *Porites evermanni* within 5m of transect. 13x12x5cm.	Mostly sand, light rock presence. Very low cyanobacteria, *Dictyosphaeria versluysii* present.

1-5 Meters from Pipe Centerline (Nearshore to Offshore)		
Point	**Coral Present**	**Notes**
13 (-3.5,2.5)		Very shallow, mostly chunks of rock with coarse sandy patches. *Padina*, cyanobacteria, turf, *Codium*.
14 (4.5,5.5)		Mostly chunks of rock with gravel interspersed. Algae mat of *Padina*, cyanobacteria, turf algae, and CCA.
15 (-2.5,12.5)		Majority calcium carbonate reef, with a little sand or rock. Thick mat of algae on top of reef: *Acanthophora spicifera*, *Padina*, cyanobacteria, turf algae, *D. sandvicensis*.
16 (3,19)	*Porites evermanni*, 30cm in length, 3.5m from pipe. 80% bleached. Grown over by algae, has a pink tissue disease.	Calcium carbonate reef covered almost entirely with algae mat. Cyanobacteria, *D. sandvicensis*, *Padina*, CCA.
17 (-1.5,20)	Two (2) *Porites evermanni* within 5m of pipe. 1: 33x30x10cm and appears flipped upside down. 80% covered in algae. Of other 20%, 50% pale or bleached, has pink tissue disease. 2: 14x5x3cm. 40% pale, 5% bleached, has pink tissue disease.	Rock broken down to cobble, interspersed with larger rock and smaller gravel. Medium algae coverage, mostly turf and CCA with some *Neomeris*.
18 (4.5,27)		Mostly reef, some broken pieces of rock. Cyanobacteria, turf algae, *A. spicifera* mats. *Neomeris* present. *Holothuria atra* on quadrat.
19 (-3,34)		Fully reef covered with thick algae mat. Cyanobacteria, turf, some *Padina* and *Dictyota*. CCA present.
20 (3,39)		All reef with *D. sandvicensis*-dominant algae mat. Some *Padina*, *A. spicifera*, cyanobacteria.
21 (-4.5,41.5)	1: *Pocillopora damicornis*, just off of quadrat location. 14x11x4cm. 10% pale. 2: *Pocillopora meandrina*, *Pocillopora damicornis*. A few small individuals,	All reef, covered thickly by cyanobacteria. Topped with *A. spicifera* and *Padina* mat with *D. sandvicensis* and *Turbinaria* present.

	5cm or less dispersed in the area.	
22 (2,48.5)	1: *Pocillopora damicornis*, within 5m of pipe. 5x3x3cm.	Reef gives way to large calcium carbonate rock chunks. Some coarse sand. Cyanobacterial coverage, some CCA.
23 (-3,52.5)	1: *Porites evermanni*, on the transect line. 22x10x5cm. 2: *Porites evermanni*, 1m from the transect line. 23x15x10cm.	Mixture of rock with coarse sand and gravel. Cyanobacteria-dominant.
24 (1,57)		All sand. Very light cyanobacteria, presence of *G. salicornia*.

Within 10-m Radius of Seawall Cavity		
Point	**Coral Present**	**Notes**
25 (8.5,1)		Only sand here. Submerged during high tide, exposed at low tide.
26 (9.5,1.5)		Only sand here. Submerged during high tide, exposed at low tide.
27 (9,2)		Only sand here. Submerged during high tide, exposed at low tide.
28 (-0.5,1)		Only sand here. Submerged during high tide, exposed at low tide.
29 (-5,1.5)		Only sand here. Submerged during high tide, exposed at low tide.
30 (2,6)		Reef covered by a thick mat of algae. *Padina* dominant, *Avrainvillea lacerata*, cyanobacteria, turf, and *Dictyota*. Reef with boring urchins, however none in the random point sample.
31 (-6,6.5)		Reef covered by a thick sandy mat, topped with algae. Some bare spots. Cyanobacteria, turf, *Padina*, *A. lacerata*, *D. sandvicensis*. There is a shelf in the reef here of about 3-5" running parallel to shore.
32 (-1.5,8.5)		Reef covered by a thick sandy mat, topped with algae. *Padina*-heavy, cyanobacteria, *A. lacerata*, *Codium edule*. *Turbinaria* present.

Appendix F:

Archaeological Literature Review and Field Inspection Report in Support of Supply Water Intake System Upgrades at Waikīkī Aquarium in Waikīkī Ahupuaʻa, Honolulu (Kona) District, Island of Oʻahu, Hawaiʻi

PRELIMINARY DRAFT REPORT

Archaeological Literature Review and Field Inspection Report in Support of Upgrade of the Waikīkī Aquarium Water Intake System in Waikīkī Ahupua‘a, Honolulu (Kona) District, Island of O‘ahu, Hawaii

TMK: (1) 3-1-031:006 (por.)

Prepared for:
Oceanit Laboratories, Inc.
828 Fort Street, Suite 600
Honolulu, Hawaii
96813

On behalf of:
University of Hawai‘i
Spalding Hall, 2540 Maile Way
Honolulu, Hawaii 96822

November 2023

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PRELIMINARY DRAFT REPORT

Archaeological Literature Review and Field Inspection Report in Support of Upgrade of the Waikīkī Aquarium Water Intake System in Waikīkī Ahupuaʻa, Honolulu (Kona) District, Island of Oʻahu, Hawaii

TMK: (1) 3-1-031:006 (por.)

By
Nicole I. Vernon, M.A.
Principal Investigator

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November 2023

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MANAGEMENT SUMMARY

Document Title:	Archaeological Literature Review and Field Inspection Report in Support of Upgrade of the Waikīkī Aquarium Water Intake System in Waikīkī Ahupua‘a, Honolulu (Kona) District, Island of O‘ahu, Hawaii
Date/Revised Date:	Preliminary Draft: August 2023
SHPD HICRIS Project No.:	-
SHPD Reference Document:	-
Archaeological Permit #:	SHPD Permit No. 23-08
Project Location:	2777 Kalākaua Ave, Honolulu, HI 96815
Project TMK:	(1) 3-1-031:006 (por.)
Land Owner:	State of Hawaii
Project Proponents:	University of Hawai‘i
Project Tasks:	Archaeological Literature Review and Field Inspection
Parcel Acreage:	2.35 acres (.95 hectares)
Project Area	Approx. 0.06 acres (230.3 sq m)
Principal Investigator:	Dennis Gosser, M.A.
Regulatory Oversight:	Chapter 6E-7 and 6E-8, Hawaii Revised Statutes (HRS) and Hawaii Administrative Rules (HAR) Chapter 275
Project Background:	The University of Hawai‘i is proposing to upgrade Waikīkī Aquarium’s outdated intake water system infrastructure to prevent future failures that threaten the life and wellbeing of the animals. Ground disturbing work will include replacement of the two existing 8-inch Transite NSW intake pipes that extend 160-ft offshore with two new 8-inch HDPE pipes; construction of a new saltwater production well and decommissioning of the existing well; construction of a new pump vault; construction of a new aeration/settling tank for well water treatment; and reconstruction and extension of the existing pump building that has extensive cracks and spalling.
SIHP #:	Waikīkī Aquarium is over 50 years old (no SIHP site number designated); See Human Skeletal Remains below
Findings:	Background research and previous archaeological findings in the vicinity indicate there is potential for traditional Hawaiian historic properties and human burials in the project area. Waikīkī was intensively used during the pre-Contact and early historic period for habitation, agriculture, and aquaculture, and several *heiau* were once present. In the late 1900s, Waikīkī’s landscape was radically modified and became the home of many wealthy businessmen, such as William G. Irwin from England, whose estate included the current project area.
Human Skeletal Remains:	50-80-14-04729, secondarily deposited human skeletal remains
Recommended Effect Determination:	Based on the results of this ALR and on previous archaeological projects near the project area that have recorded subsurface historic properties including cultural deposits and human burials, there is insufficient information to make a Chapter 6E historic preservation determination of effect of the project’s impact on potential subsurface historic properties within the 0.16-acre project area. Therefore, archaeological monitoring for identification purposes, guided by a SHPD-approved archaeological monitoring plan (HAR 13-13-279), is recommended. A list of SHPD-permitted consultants to conduct the archaeological monitoring can be found at: https://dlnr.hawaii.gov/shpd/about/branches/archaeology/

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INTRODUCTION

Under contract to Oceanit Laboratories, Inc., Pacific Consulting Services, Inc. (PCSI) has prepared this Archaeological Literature Review and Field Inspection (ALRFI) report in support Upgrade of the Waikīkī Aquarium Water Intake System at Waikīkī Aquarium in Waikīkī Ahupuaʻa, Honolulu (Kona) District, Island of Oʻahu, Hawaii. The project proponent is the University of Hawaiʻi, and the landowner is the State of Hawaii. The location of the proposed project is shown in Figure 1. The project scope of work proposes upgrading Waikīkī Aquarium's outdated intake water system infrastructure to prevent future failures that threaten the life and wellbeing of the animals. A historical, cultural, and archaeological background study was conducted in order to evaluate any potential effect on historic properties and to recommend appropriate historic preservation actions, if warranted. This work was carried out in accordance with Hawaii Revised Statutes (HRS) Chapter 6E, and Title 13 of the Hawaii Administrative Rules (HAR), Subtitle 13 (State Historic Preservation Division Rules), Chapter 275 (*Rules Governing Procedures for Historic Preservation Review for Governmental Projects Covered Under Sections 6E-7 and 6E-8, HRS*).

PROJECT AREA LOCATION AND DESCRIPTION

The proposed project is located at the Waikīkī Aquarium at 2777 Kalākaua Avenue. The entire project parcel measures 2.35 acres (.95 hectares) and the proposed 0.06-acre (approximate) project area excavations will be conducted primarily in the western and southern portions of the parcel. The Tax Map Key (TMK) parcel for the project area is (1) 3-1-031:006, as shown in Figure 2. Table 1 summarizes the proposed ground disturbing activities, which are described in detail in this section. The project site plan is shown in Figure 3.

The purpose of the proposed project is to upgrade the Aquarium's outdated intake water system infrastructure to prevent future failures that threaten the life and wellbeing of the animals. Anticipated ground disturbing work includes replacement of the two existing 8-inch Transite NSW intake pipes that extend 160-ft offshore with two new 8-inch HDPE pipes; construction of a new saltwater production well and decommissioning of the existing well; construction of a new pump vault; construction of a new aeration/settling tank for well water treatment; and reconstruction and extension of the existing pump building that has extensive cracks and spalling. These activities are summarized in Table 1 with anticipated excavation measurements.

ENVIRONMENTAL SETTING

Waikīkī Ahupuaʻa is located on the leeward side of Oʻahu and extends from the Koʻolau mountain range through the coastal plain to the shoreline. The project area is situated within the beach portion of Kapiʻolani Park, between the shoreline and Kalākaua Avenue.

Table 1. Anticipated Construction Activities.

Task	Work Description	Anticipated Size (M) (Length x Width x Depth)
Trenching	New 8” HDPE Natural Saltwater Intake Pipes	48.8 x 0.3 (n=2)
Trenching	New Natural Saltwater Supply UV Treated Natural Saltwater to Brackish Water Storage Tank Piping	44.0 x 0.3
Trenching	New Natural Saltwater Piping	15.0 x 0.3
Trenching	New Chilled Natural Saltwater to Exterior Exhibits Piping	5.0 x 0.3
Trenching	New Well Water Piping	34.0 x 0.3 7.0 x 0.3
Trenching	New Natural Saltwater piping to Hawaiian Monk Seal	14.0 x 0.3
Trenching	New Natural Saltwater Filter Brackish Water Discharge Piping	5.0 x 0.3
Trenching	New Well Water Filter Brackish Water Discharge Piping	1.5 x 0.3
Excavation	New Aeriation Settling Tank	5.1 x 1.5 x 3.2
Excavation	New Air Injection Pumps	1.0 x 1.0
Excavation	New Well Water Pumps	2.0 x 7.0 (below grade)
Excavation	New Natural Saltwater Pumps	2.0 x 7.0 (partially below grade)
Excavation	New Pump Vault	6.5 x 6.0 (partially below grade)
Excavation	New Saltwater Production Well/Vault	0.9 x 0.9 x 0.9
Excavation	Reconstruction and Extension of the Existing Pump Building	35.0 x 0.3

Figure 1. Waikīkī Aquarium Parcel and Project Area Location on 7.5-Minute Series USGS Honolulu Topographical Quadrangle (2017).

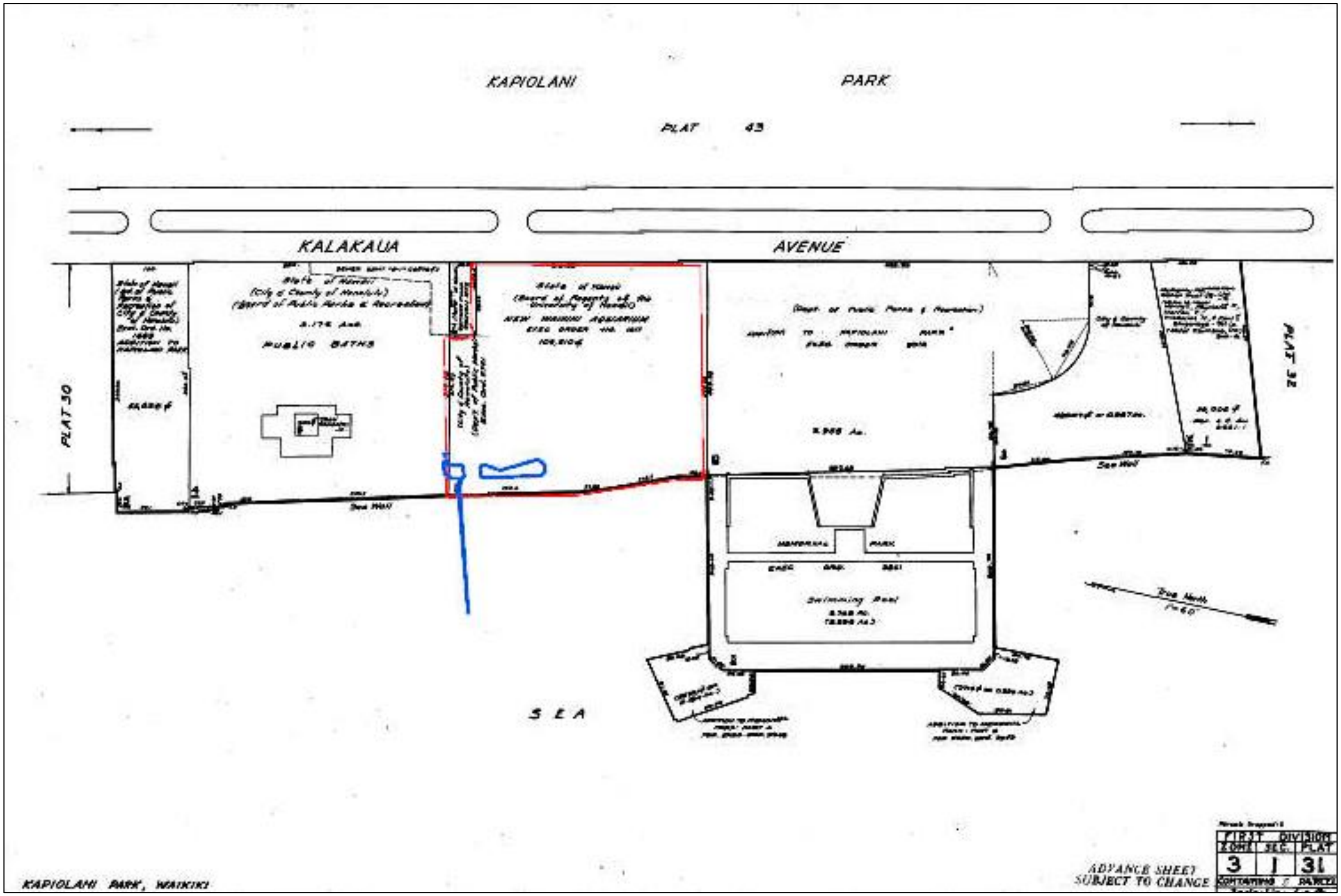

Figure 2. Waikīkī Aquarium Parcel and Project Area Shown on Tax Map Key (TMK) Plat Map (1) 3-1-031:006 (Tax Maps Bureau 1932).

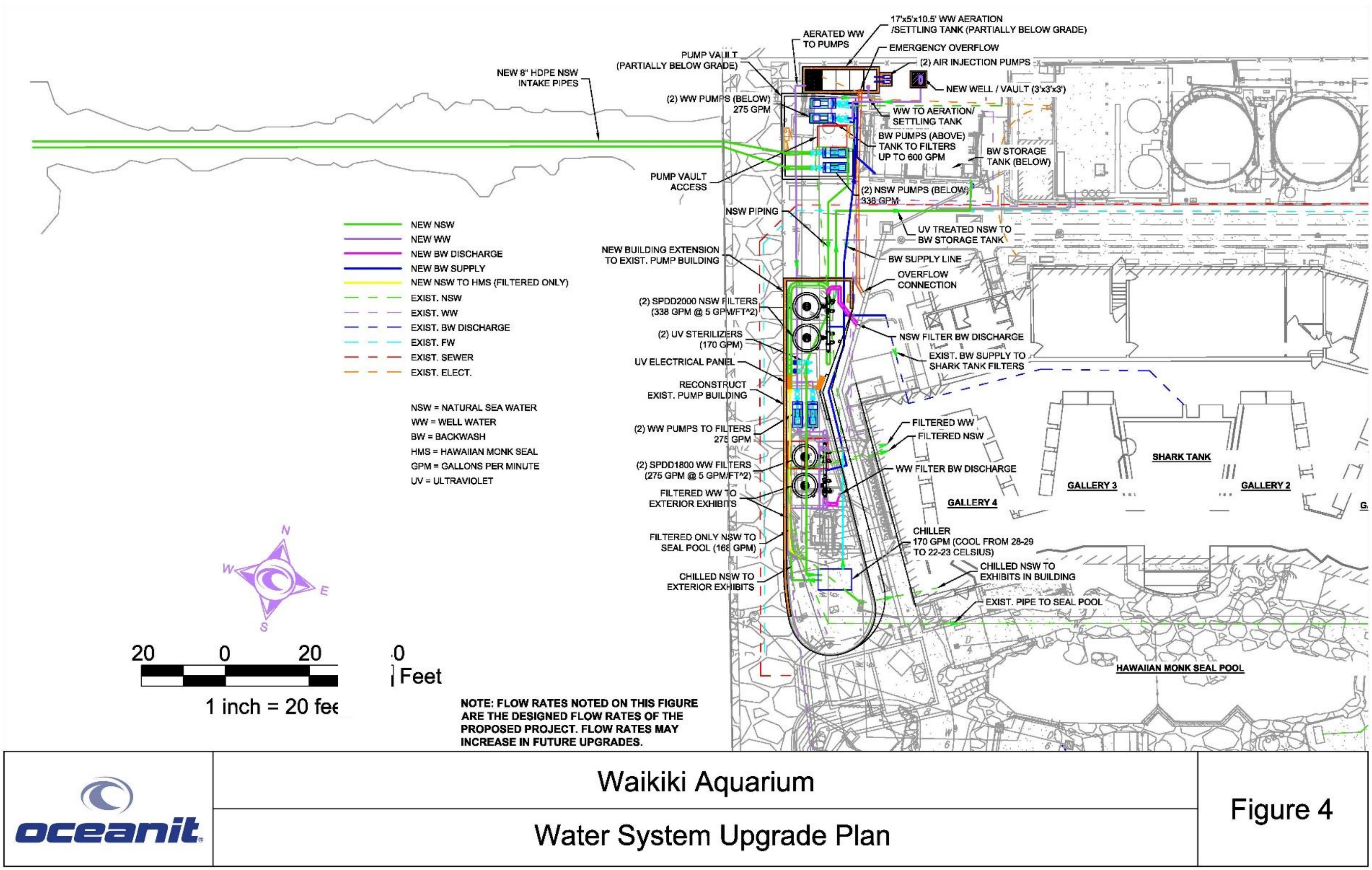

Figure 3. Design Plan for the Waikīkī Aquarium Intake System Upgrade.

1

Topography and Soils

The project area is in a low-lying coastal zone, approximately 3.0 m (9.8 feet [ft]) above mean sea level (amsl). Two major soil series are present, as shown in Figure 4. Most of the project area contains beaches (BS), while the remainder is classified as Jaucas sands (JaC). Areas classified as beaches consist of either sand derived from coral and seashell, or in some cases basalt and andesite (Foote et al 1972:28).

The Jaucas sands series are found on vegetated beach and sand dune areas along the shore. These soils formed in calcareous sand deposits. They are very deep, excessively drained, and have very rapidly permeability (Foot et al. 1972:48). Areas containing these soils are typically used for recreation and as marine wildlife refuges. Vegetation consists of sea grape (*Coccoloba uvifera*), coconut (*Cocos nucifera*), and other xerophytic and salt-tolerant plants. From a historic preservation perspective, deposits of Jaucas Sands are often associated with the presence of traditional Hawaiian burials and subsurface cultural deposits.

Prior to the 1900s, Waikīkī had a long history of productive wetland agriculture and aquaculture (Nakamura 1979). These activities came to a halt in the first part of the twentieth century with the dredging of the Ala Wai Canal and the filling of land. Consequently, it is typical to find substantial historic fill deposits, which consist of either calcareous marine sediments originating from the dredging of the Ala Wai Canal, imported terrigenous fill, or a combination of both, overlying in situ soils in the lowlands of Waikīkī.

Rainfall, Hydrology, and Vegetation

Annual rainfall in the project area averages 596.3 millimeters (mm) (23.48 in) per year with a majority of the rain falling between October and March (Giambelluca et al. 2013). The vegetation in the project area consists of modern landscaping associated with the aquarium grounds and includes both indigenous and introduced species.

HISTORICAL BACKGROUND

Archival background research and literature review examined maps, historical and archival documents, and previous archaeological studies in the vicinity of the project area. Relevant historical maps were georeferenced to determine where traditional Hawaiian or historic features may fall within the project area. The information obtained from these sources was synthesized to present data findings and to evaluate the potential for archaeological and cultural resources in the project area.

The Hawaiian cultural landscape can be described through *mo‘ōlelo* and *wahi pana* (significant Hawaiian place names). *Mo‘ōlelo* may be myths, legends, proverbs, and events surrounding well-known individuals in Hawaiian history (Pukui and Elbert 1986:254). The project area is situated in the *‘ili* (land division of an *ahupua‘a*) of Kāneloa in Waikīkī Ahupua‘a. Kāneloa can be translated as “tall Kāne” (Pukui et al. 1974:84). Waikīkī, which can be translated as “spouting water” (Pukui et al. 1974:223), is named for its former wetlands fed by numerous streams from the valleys of Makiki, Mānoa, and Pālolo.

Several *heiau* (traditional Hawaiian temple) were once located in Waikīkī Ahupua‘a, which were described in Thrum’s Hawaiian Annual for 1907. These included Papa‘ena‘ena Heiau, Kapua Heiau, Kūpalaha Heiau, Helumoa or Āpuakēhau Heiau, Makahuna Heiau, Kamauakapu Heiau, Kulanihakoi Heiau, and Pahu-a-Maui Heiau (Thrum 1906a:44–45; Thrum 1906b: 49–69). Also mentioned in the Annual are four large *pohaku* —also of religious significance—commonly called the Wizard Stones of Kapeimāhū, which are extant to today at Waīkikī Beach (Boyd 1906:139–141). Not noted by Thrum are two other *heiau* formerly present in Waikīkī: Hale Kumuka‘aha Heiau, which was mentioned by Hawaiian historian Samuel Kamakau in the Hawaiian newspaper *Kuakoa* (McAllister 1933:78), and “Altar Opunaha,” which appears

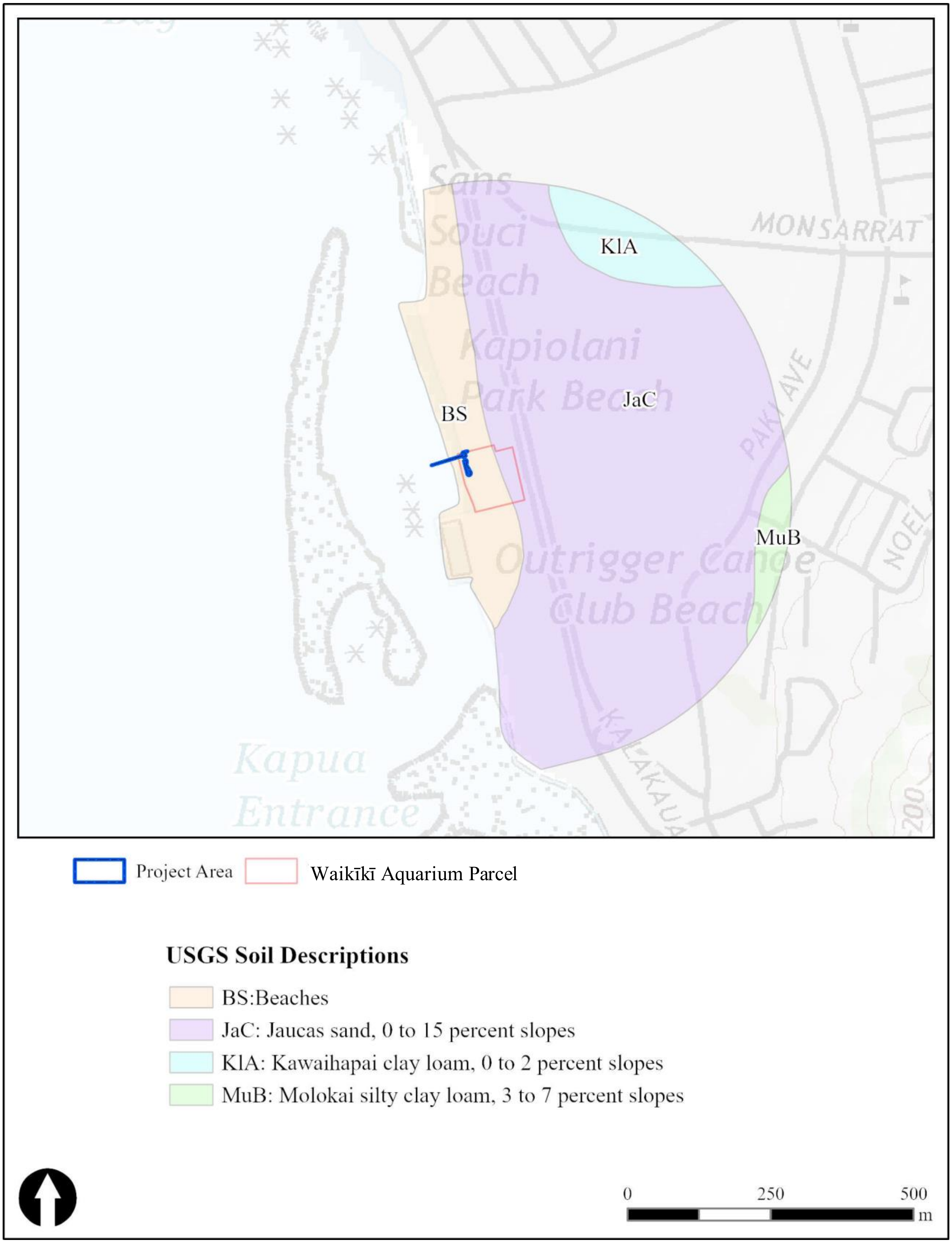

Figure 4. Soil Units in the Vicinity of the Waikīkī Aquarium Parcel (Soil Survey Staff, NRCS, USDA 2022).

on a ca 1876 historic map by C.J. Lyons of the south coast of O‘ahu (Register Map [RM] RM 727). It is unclear if latter site was something other than a *heiau*. Another undated but contemporaneous map by Lyons of Kāneloa does not label the site as an altar. These two maps are shown in Figures 5 and 6. During background research, the only historical sources identified mentioning Opunaha[1] are death notices dating to the 1860s in *Kuakoa* that cite Opunaha, Waikīkī or Waikīkī Kai as the place of death.

The most well-known *heiau* of those listed above is Papa‘ena‘ena Heiau. Numerous accounts of this *heiau* from early voyagers were compiled by McAllister (1933:71–74). This *heiau* was located on the west side of Diamond Head and visible from Waikīkī, as shown in Figures 5 and 6 (McAllister 1933:71). Thrum further offers that it was “at the foot of Diamond Head slope, rear of Douglas’ premises” (Thrum 1906a:44). It was a *heiau po‘okanaka* (*heiau* where human sacrifices were made) and known for the number of sacrifices carried out by Kamehameha I. A description of Papa‘ena‘ena Heiau during this early period is from the journal of Tyerman and Bennet (1832:48–49).

> In the year 1804, when the late king, Tamehameha, was on his way from Hawaii, to invade Tauai, he halted with an army of eight thousand men at Oahu. The yellow fever broke out among the troops, and in the course of a few days swept away more than two-thirds of them. During the plague, the king repaired to the great marae at Wytiti, to conciliate the god, whom he supposed to be angry. The priests recommended a ten days' tabu, the sacrifice of three human victims, four hundred hogs, as many cocoanuts, and an equal number of branches of plantains. Three men, who had been guilty of the enormous turpitude of eating cocoa-nuts with the old queen (the present king's mother), were accordingly seized and led to the marae. But there being yet three days before the offerings could be duly presented, the eyes of the victims were scooped out, the bones of their arms and legs were broken, and they were then deposited in a house, to await the coup de grace on the day of sacrifice. While these maimed and miserable creatures were in the height of their suffering, some persons, moved by curiosity, visited' them in prison, and found them neither raving nor desponding. But sullenly singing the national *huru*---dull as the drone of a bagpipe, and hardly more variable-as though they were insensible of the past, and indifferent to the future. When the slaughtering time arrived, one of them was placed under the legs of the idol, and the other two were laid, with the hogs and fruit, upon the altar-frame. They were then beaten with clubs upon the shoulders till they died of the blows.-This was told us by an eye-witness of the murderous spectacle [Tyerman and Bennet 1832:48–49].

A chief named Kaolohaka is also said to have been sacrificed at this *heiau*: “Fragments of its walls, torn down in 1860, show it to have been about 240 feet square; said to be the place of sacrifice of Kaolohaka, a chief of Hawaii, on suspicion of being a spy” (Thrum 1906a:44).

Based on various accounts, McAllister determined that the *heiau* was “a quadrangular paved terrace, with walls on three sides, but open on the west side, which faced the village of Waikīkī and the sea” (McAllister 1933:74). Multiple step-like terraces led to the open side of the *heiau*. Averaging measurements, given by first-hand accounts, McAllister estimated that the *heiau* was approximately 128 feet by 68 feet with walls 6.2 feet high and 3 feet wide. According to Thrum (1906a:44) the *heiau* was destroyed by Kanaina in 1856 and the stones were used to enclose Queen Emma’s premises and for road work.

Kapua Heiau was located somewhere in or near Kapi‘olani Park and is mentioned in the *Legend of Pumaia* (Fornander 1918-1919). Pumaia was a pig farmer who lived in Pukaola in the Kona District of O‘ahu. The king of O‘ahu, Kūali‘i, was building Kapua Heiau, “east of Leahi Hill overlooking Māmala Bay” (Fornander 1918-1919: 470). When the *heiau* was complete, Kūali‘i repeatedly ordered pigs from

[1] Kumu Hula Samuel M. ‘Ohukani‘ōhi‘a Gon III, a scientist, Hawaiian cultural practitioner, paleobiologist, and teacher has held a changing of the seasons event on the north side of the aquarium: “We gathered at the water’s edge at the site of the heiau Kūpalaha, the sibling heiau of Papa‘ena‘ena (that still graces the base of Leahi) where, from its kuahu (altar), named Opunaha, the setting sun would be observed by the kahuna kilolani, and on a certain day, the sun would set into the bowl of Pu‘u o Kapolei, when seen from Opunaha, marking the end of the Ho‘oilo [Hawaiian Cool Wet Season] and the start of the Kauwela [Hawaiian Hot Dry Season], and the reactivation of the luakini heiau of Kū.” (https://www.facebook.com/events/1751387621819771/?acontext=%7B%22ref%22%3A%223%22%2C%22ref_newsfeed_story_type%22%3A%22regular%22%2C%22action_history%22%3A%22null%22%7D).

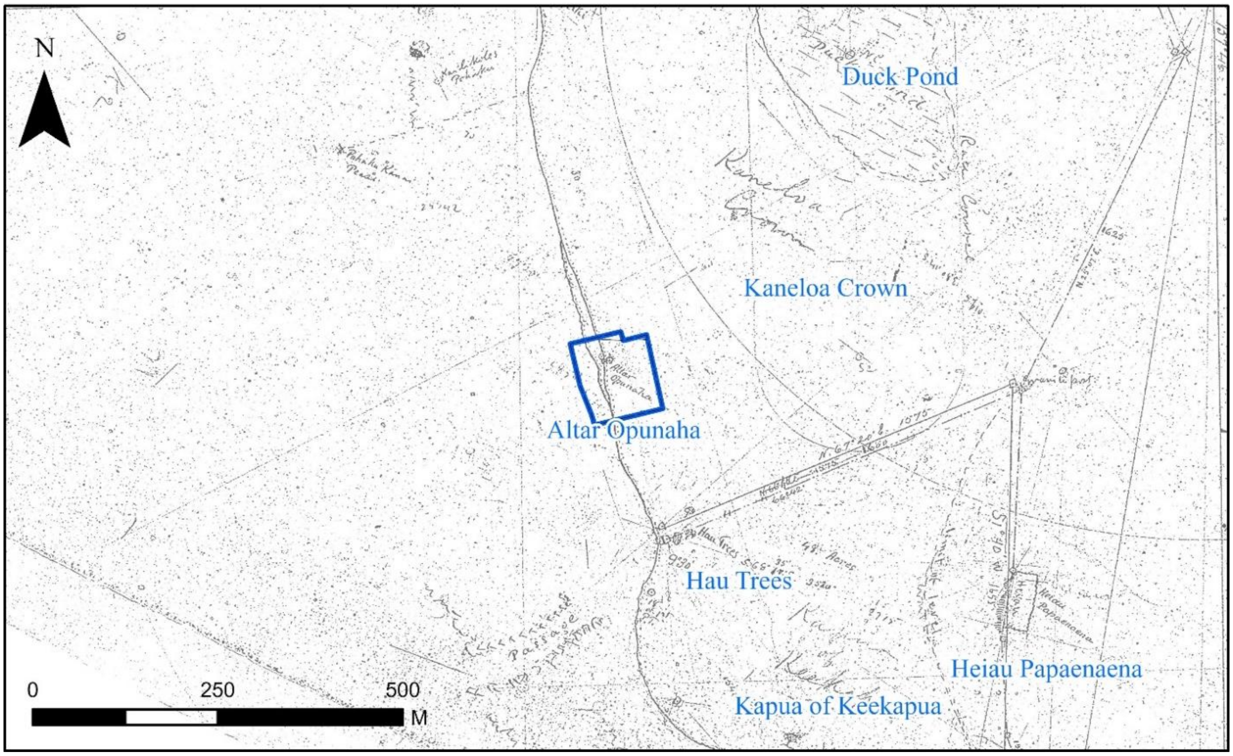

Figure 5. Portion of ca 1876 Map of the South Coast of Oʻahu by C.J. Lyons Showing “Altar Opunaha” and “Heiau Papaenaena” in Relation to the Project Parcel (Reg. 727). Blue Text Added for Clarity.

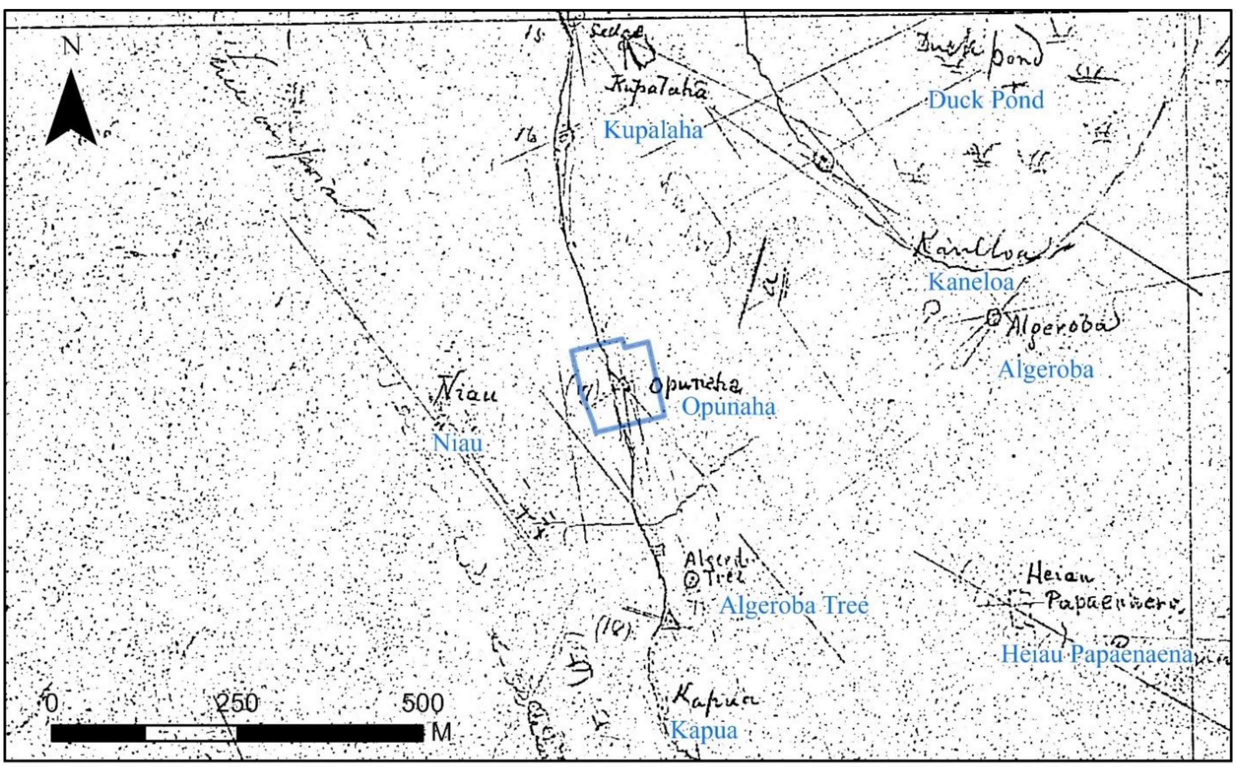

Figure 6. Portion of ca 1876 Map of Kāneloa by C.J. Lyons Showing “Opunaha,” Kupulaha,” and “Heiau Papaenaena” in Relation to the Project Parcel. Blue Text Added for Clarity.

Pumaia until one day Pumaia refused to oblige him. The king's men fought Pumaia over one of the pigs and all the men were killed by Pumaia but one. Kūali‘i then declared war on Pumaia. Pumaia won multiple battles against the king's soldiers until finally Kūali‘i prayed to his god to capture Pumaia. Only then was he caught and bound: "Kualii was so incensed at Pumaia that he was immediately killed and was dragged to Kapua where his dead body was thrown into the pit with the men he had killed. During the ill treatment given his body, the jaws were crushed and cut up into fragments" (Fornander 1918-1919:474).

Makahuna Heiau was once located on the south side of Diamond Head, overlooking "Aqua Marine" and near the former residence of Honorable Sanford B. Dole (McAllister 1933:196). According to a historic map by Wall (1893), this places the *heiau* west of Diamond Head Lighthouse. McAllister offers the following accounts:

> Thrum writes: "A large heiau enclosure dedicated to Kane and Kanaloa, of Kuula character, so said." Tucker reports: "Opposite the residence of the Honorable Sanford B. Dole. The ruins of a heiau of the Pookanaka class. Was located at this place in order to propitiate, by human sacrifice, the departure of the Aliis to foreign shores, and Black Point, between that and Kahala, was called Keala o Kahiki. These ruins are mostly all overgrown and have been used probably to make fences or for road purposes. A dense growth of lantana and kiawe, scrub kiawe, covers the ruins" [McAllister 1933:196].

According to Thrum (1906a), Kūpalaha Heiau was located at Kapi‘olani Park near Cunha's, which is a surfing area named for the Emmanuel S. Cunha estate near Kapahulu and Kalākaua Avenues (Pukui et al. 1974). The location of this estate is shown in Figure 7. In his description Thrum wrote: "Entirely obliterated. Class unknown, but said to have had connection in its workings with Papaenaena" (Thrum 1906a:44). Hammatt and Chiogioji (2002:9) locate Kūpalaha Heiau "on or adjacent to Kalākakua Ave., just southeast of the intersection with Monsarrat Ave." This *heiau* was associated with a legend involving Kākuhihewa, *mō‘i* (king) of O‘ahu circa 1540–1634, and Pueo Ali‘i (king of the owls). In the legend, a man named Kapoi went to gather pili grass at a marsh near the beach. He found seven owl eggs that he collected with the intention of later eating (Thrum 1907:200–202; Westervelt 1915:133–136). After returning home, an owl arrived at his fence and cried out "O Kapoi, give me my eggs!" Hearing the repeated pleas, Kapoi returned the eggs. The owl became his *‘aumakua* (family god) and instructed him to build Manua Heiau (situated on the southwest side of Pūowaina [Punchbowl Crater]). After building the *heiau* he made an offering of bananas and set the *kapu* (taboo) days for its dedication. At the same time, Kākuhihewa was building a *heiau* in Waikīkī and he made a law that if any person built a *heiau* and set the *kapu* before him, that person would be put to death. Kapoi was arrested and taken to the Kūpalaha Heiau in Waikīkī. Kapoi's *‘aumakua* owl tried to help him by calling on all of the owls in the islands to gather and fly to Kūpalaha Heiau to battle the king's men. The king's men surrendered, and the owls won the battle. Since that day, the owl was considered a powerful *akua* (god) and the location of the battle was known as Kukaeunahio-ka-pueo, which means "the confused noise of owls rising in masses" (Thrum 1907:200–202; Westervelt 1915:133–136).

TRADITIONAL HISTORY AND LAND USE

Paleoenvironmental and archaeological data indicate that the Hawaiian Archipelago was settled between A.D. 1000 and 1100 (Athens et al. 2014), with some of the earliest evidence coming from O‘ahu Island. In the 1400s, Mā‘ilikūkahi, *ali‘i nui* of O‘ahu, went with his chiefs to the south side of the island and Waikīkī became the seat of royal power. Kamakau wrote of Waikīkī as a home to chiefs:

> Waikīkī sits proudly in the calm of the Ka‘ao breeze… Waikīkī was a land beloved of the chiefs and there many of them lived from remote times to the time of board surfing could be indulged in there, and for this reason the chiefs liked the place very much. At Waikīkī are the surfs of Ka-lehua-wehe, ‘Aiwohi, Maihiwa, and Kapuna [Kamakau 1991:44].

Mā‘ilikūkahi was born at Kūkaniloko and was chosen to be *mō‘i* at age 29 (Kamakau 1991:53). According to Kamakau, "Soon after he became *mō‘i* the chiefs took Mā‘ili-kūkahi to Waikīkī to live; he

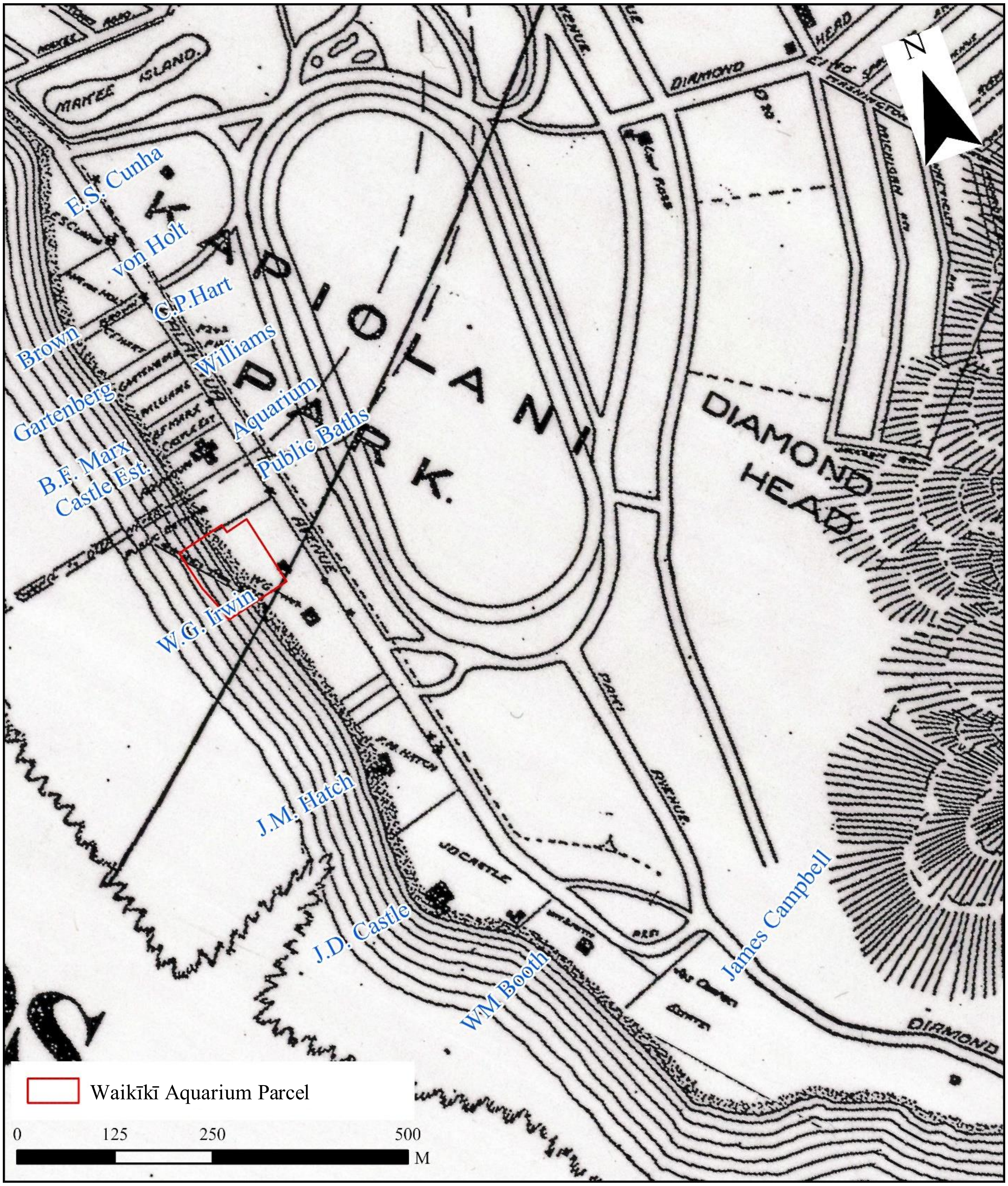

Figure 7. Portion of 1912 Map of Honolulu Old Aquarium Location and Estates of Prominent Individuals Along the Coast (Dove 1912).

was perhaps the first of the ruling chiefs to live there. Until then the chiefs had lived in Wai‘alua and ‘Ewa” (Kamakau1991:53). Mā‘ilikūkahi is also attributed with creating the land division system, enacting just laws, and bringing peace and prosperity to the island (Kamakau 1991:54–56). According to Kamakau (1991):

> When the kingdom passed to Mā‘ili-kūkahi, the land divisions were in a state of confusion; the *ahupua‘a*, the *kū* [‘ili kūpono], the *‘ili ‘āina*, the *mo‘o ‘āina*, the *paukū ‘āina*, and the *kīhāpai* were not clearly defined. Therefore Mā‘ili-kūkahi ordered the chiefs, *ali‘i*, the lesser chiefs, *kaukau ali‘i*, the warrior chiefs, *pū‘ali ali‘i*, and the overseers, *luna* to divide all of O‘ahu into *moku* and *ahupua‘a*, *‘ili kūpono*, *‘ili ‘āina*, and *mo‘o ‘āina*. There were six districts, *moku*, and six district chiefs, *ali‘i nui ‘ai moku*. Chiefs were assigned to the *ahupua‘a*—if it was a large *ahupua‘a*, a high chief, an *ali‘i nui*, was assigned to it. Lesser chiefs, *kaukau ali‘i*, were placed over the *kūpono* lands, and warrior chiefs over *‘ili ‘āina*. Lands were given to the *maka‘āinana* all over O‘ahu [Kamakau 1991:54–55].

Another O‘ahu chief known for ruling during a time of prosperity on O‘ahu was Chief Kalamakua-a-Kaipūhōlua. He ruled around the sixteenth century (based on Stokes’ [1933] 20 year-count; Kelly 1989) and was the first to build an extensive irrigation system of *loko ‘ai* (fishpond) and *lo‘i* (irrigated taro field) in Waikīkī. Kamakau wrote:

> Kalamakua-a-Kaipūhōlua was a good chief. He was noted for cultivating, and it was he who constructed the large pond fields Ke‘okea, Kūalulua, Kalāmanamana, and other *lo‘i* in Waikiki. He traveled about his chiefdom with his chiefs and household companions to cultivate the land and gave the produce to the commoners, the *maka‘āinana* [Kamakau 1991:45].

In 1780, the army of Maui chief Kahekili landed at Waikīkī “carpeting the beaches from Ka‘alawai (near Diamond Head) to Kawehewehe (next to the Halekulani Hotel)” (Kanahele 1995:79). At the time, his nephew Kahahana was *ali‘i nui* of the island. Kahahana, along with his wife Kekuapo‘i‘ula and his retainer Alapa‘i, fled to the mountains where they were cared for by sympathetic *maka‘āinana* (commoner) (Kamakau 1992:136). They hid successfully for two and a half years but were then found out. Kahekili had Kahahana and Alapa‘i killed at Waikele and their bodies taken to him in Waikīkī.

According to Thrum (1925:109), Kahekili dedicated Papa‘ena‘ena Heiau, formerly located in the vicinity of Diamond Head, following his victory. In 1794, Kahekili died and was succeeded by Kalanikupule. The next year, Kamehameha invaded O‘ahu at Waikīkī, possibly with 10,000 warriors. The army made their base on the sandy beaches from Wai‘alae to Diamond Head to Kālia (Kanahele 1995:87). The final battle ended at Nu‘uanu when O‘ahu warriors became trapped between Kamehameha’s warriors and the *pali* (cliff) and chose to leap to their deaths (Tomonari-Tuggle and Blankfein 1998:13). After the battle of Nu‘uanu, Kalanikūpule fled but was later captured and then scarified.

Kamehameha made his capital at Waikīkī and the area became the chiefly center of the south coast where the ruling chief and subordinate *ali‘i* (chiefly class) resided (Cordy 1996; Nāpōkā 1986; Tomonari-Tuggle 1994). Hawaiian historian John Papa ‘Ī‘ī (1959) describes Kamehameha’s residence in Waikīkī:

> Kamehameha’s houses were at Puaaliilii, makai of the old road, and extended as far as the west side of the sands of Apuakehau [vicinity of Moana Surfrider Hotel]. Within it was Helumoa [vicinity of Royal Hawaiian Hotel], where Kaahumanu ma went to while away the time. The king built a stone house there, enclosed by a fence; and Kamalo, Wawae, and their relatives were in charge of the royal residence. Kamalo and Wawae were the children of Luluka and Keaka, the childhood guardians of Kamehameha.
>
> This place has long been a residence of chiefs. It is said that it had been Kekuapoi’s home, through her husband Kahahana, since the time of Kahekili. Haalou, a makuahine of Kamehameha, lived there with her younger daughter Kekuapoi while en route from Hawaii to Kauai to consult Kapoukahi, a seer of Kauai, for means whereby Kamehameha would gain victory over Keoua Kuahuula [‘Ī’ī 1959:17].

Early Historic Land Use

Waikīkī is described as a richly productive area in accounts by early European explorers. An early map by Lieutenant C. R. Malden of the Royal Navy, shown in Figure 8, shows cultivated land, freshwater ponds, “Ruins of a Morai”, “Fresh Water Ponds”, and a coconut grove in the vicinity of the project area. In 1792, Captain George Vancouver of the H.M.S. Discovery arrived at “Whyteete” and noted the field systems:

> On the shores, the villages appeared numerous, large, and in good repair; and the surrounding country pleasingly interspersed with deep, though not extensive valleys; which, with the plains near the sea-side, presented a high degree of cultivation and fertility
>
> This opened to our view a spacious plain, which, in the immediate vicinity of the village, had the appearance of the open common fields in England; but, on advancing, the major part appeared divided into fields of irregular shape and figure, which were separated from each other by low stone walls, and were in a very high state of cultivation. These several portions of land were planted with the eddo or taro root, in different stages of inundation; none being perfectly dry, and some from three to six or seven inches under water. The causeway led us near a mile from the beach, at the end of which was the water we were in quest of. It was a rivulet five or six feet wide, and about two or three feet deep, well banked up, and nearly motionless; some small rills only, finding a passage through the dams that checked the sluggish stream, by which a constant supply was afforded to the taro plantations.

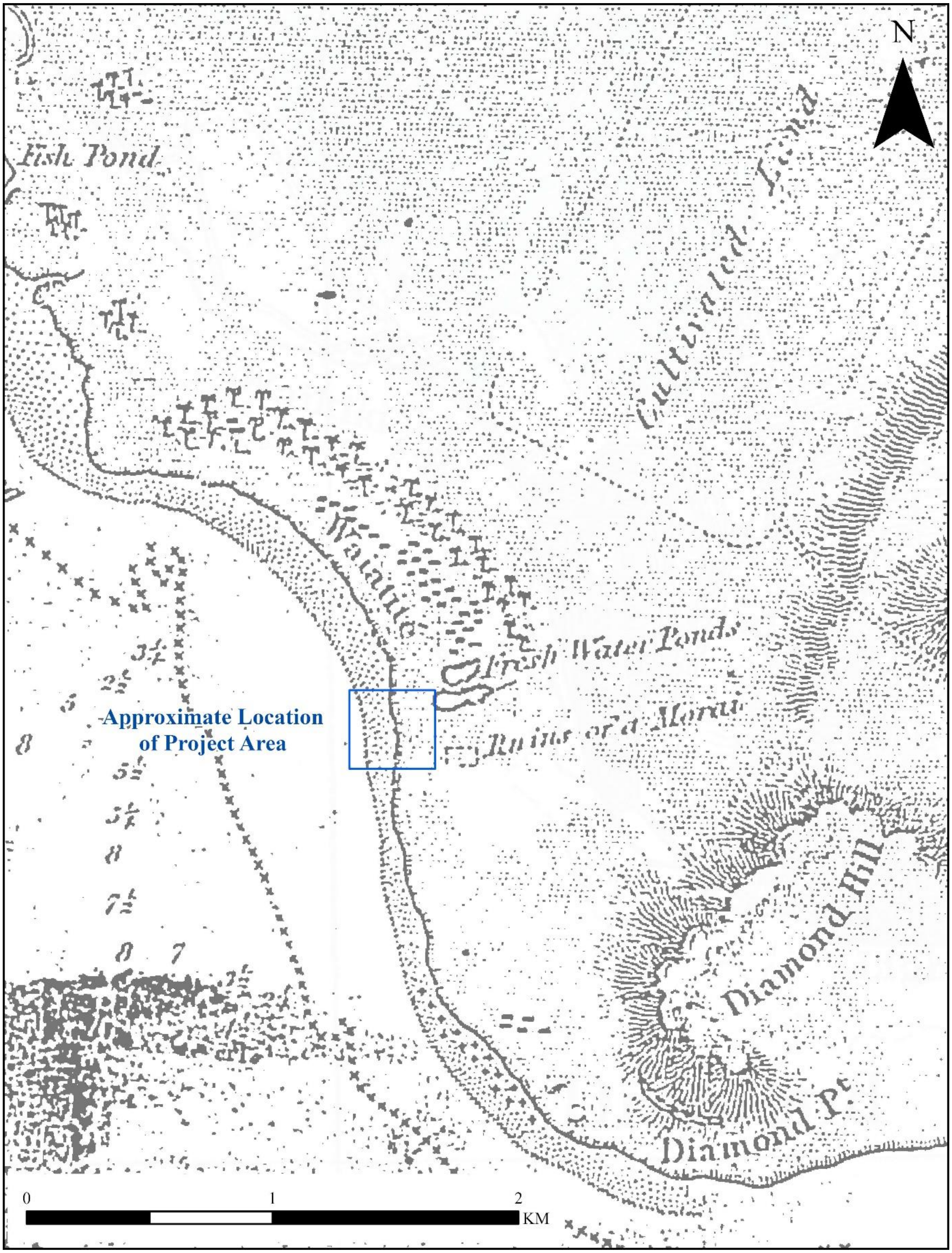

Figure 8. Portion of Historical Map by Malden (1825) Showing the Approximate Location of the Project Area.

> In this excursion we found the land in a high state of cultivation, mostly under immediate crops of taro; and abounding with a variety of wild fowl, chiefly of the duck kind, some of which our sportsmen shot, and they were very fine eating. The sides of the hills, which were at some distance, seemed rocky and barren; the intermediate vallies, which were all inhabited, produced some large trees, and made a pleasing appearance. The plains, however, if we may judge from the labour bestowed on their cultivation, seem to afford the principal proportion of the different vegetable productions on which the inhabitants depend for the subsistence [Vancouver 1798:161–164].

Also aboard the H.M.S. Discovery was surgeon and naturalist Archibald Menzies. He echoed Vancouver's description of a bountiful land:

> The verge of the shore was planted with a large grove of coconut palms, affording a delightful shade to the scattered habitations of the natives. Some of those near the beach were raised a few feet from the ground upon a kind of stage, so as to admit the surf to wash underneath them. We pursued a pleasing path back into the plantation, which was nearly level and very extensive, and laid out with great neatness into little fields planted with taro, yams, sweet potatoes and the cloth plant. These, in many cases, were divided by little banks on which grew the sugar cane and a species of Draecena without the aid of much cultivation, and the whole was watered in a most ingenious manner by dividing the general stream into little aqueducts leading in various directions so as to be able to supply the most distant fields at pleasure, and the soil seemed to repay the labor and industry of these people by the luxuriancy of its productions. Here and there we met with ponds of considerable size, and besides being well stocked with fish, they swarmed with water fowl of various kinds such as ducks, coots, water hens, bitterns, plovers, and curlews [Menzies 1920:23–24].

Several others followed Vancouver and Menzies in describing Waikīkī over the next few decades. Peter Corney wrote of Waikīkī between 1813 and 1818:

> On rounding Diamond hill the village of Wyteetee (Waikiki) appears through large groves of cocoanut and bread-fruit trees; it has a most beautiful appearance, the land all round in the highest state of cultivation, and the hills covered with wood; a beautiful plain extending as far as the eye can reach. A reef of coral runs along the whole course of this shore, within a quarter of a mile of the beach, on which the sea breaks high; inside this reef there is a passage for canoes [Corney 1965:193].

Otto von Kotzebue commander of the Russian ship Rurick viewed Waikīkī from the sea in 1816. His description of the land follows:

> but you have scarcely sailed round the Yellow Diamond Hill, when you are surprised by the most beautiful landscape. Close to the shore you see verdant valleys adorned with palm and banana-trees, under which the habitations of the savages lie scattered; behind this, the land gradually rises, all the hills are covered with a smiling verdure, and bear the stamp of industry [von Kotzebue 1821:320].

Finally, the naturalist Andrew Bloxam was ashore from the H.M.S. Blonde in 1824–1825 when he noted the abundance of Waikīkī:

> I walked along shore towards the bay of Whyteete to see if I could procure any shells, but I found none worth picking up. The whole distance to the village of Whyteete is taken up with innumerable artificial fishponds extending a mile inland from the shore, in these the fish taken by nets in the sea are put, and though most of the ponds are fresh water, yet the fish seem to thrive and fatten. Most of these fish belong to the chiefs, and are caught as wanted. The ponds are several hundred in number and are the resort of wild ducks and other water fowl. I found it very difficult to get out of the labyrinth of paths which lead among them. Whyteete is about four miles east of Honoruru [Honolulu]. It is pleasantly situated and built along the shore among numerous groves of coconut and other trees, and in this respect far better than Honoruru, as scarcely any trees are to be found there [Bloxam 1925:35–36].

This period of political importance ended for Waikīkī in 1809, when Kamehameha moved his capital to Honolulu, which was more accessible to Western visitors (Tomonari-Tuggle and Blankfein 1998:13). Following this move, traditional agriculture in Waikīkī waned. The population in the area had drastically decreased due to economic changes and the devastation caused by Western diseases. The missionary Levi Chamberlain noted these changes when writing in 1828:

> Our path led us along the borders of extensive plats of marshy ground, having raised banks on one or more sides, and which were once filled with water, and replenished abundantly with esculent fish; but now overgrown with tall rushes waving in the wind. The land all around for several miles has the appearance of having once been under cultivation. I entered into conversation with the natives respecting this present neglected state. They ascribed it to the decrease of population [Chamberlain 1957:26].

THE MĀHELE

Traditional land divisions of the fifteenth and sixteenth centuries persisted until the 1848 Mahele, which introduced private property into Hawaiian society (Kamakau 1991:54). During the Mahele, the Land Commission required the Hawaiian chiefs and *konohiki* (land agent for the *ali'i*) to present their claims to the Land Commission. In return they were granted Land Commission Awards (LCAs) for the land quit-claimed to them by Kamehameha III. Land was divided into Crown Lands, Government Lands, and Konohiki Lands. The remaining unclaimed land was then sold publicly, "subject to the rights of the native tenants" (Chinen 1958:29).

In the case of land claims made for Konohiki lands, approval by the Land Commissioners was required before the award was made. If approved, then the awardee obtained a Royal Patent (RP) from the Minister of the Interior, which indicated that the government's interest in the land had been settled with a commutation fee. This fee was typically no more than one-third of the value of the unimproved land. This fee was paid either in cash, or, more commonly, the return of one-third of the awardee's lands (or total value of the lands awarded) (King 1945).

Following the Mahele of 1848, two acts were passed in 1850 that changed land ownership in Hawaii. On 10 July 1850, the Alien Land Ownership Act was adopted, which allowed foreigners to own land. On 6 August 1850, the Kuleana Act of 1850 was adopted, which allowed *hoa'āina* (common people of the land, native tenants) to make claims to the Land Commission. The new western system of ownership resulted in many losing their land. Often *kuleana* (property) claims would be made for discontiguous cultivated plots with varying crops, but only one parcel would be awarded.

The Crown Lands became Government Lands when the Hawaiian Government was overthrown in 1895, making them public domain for sale by fee simple (Alexander 1920). Patents were the certificates issued for the sale of such lands. Beginning in 1900, when Hawaii became a U.S. territory, the certificates were called Land Patents, or Land Patent Grants (Alexander 1920).

Records indicate that the *'ili of* Kāneloa was returned by Aaron Keali'iahonui at the Māhele and retained by Crown. LCAs in the '*ili* were limited to a 20.85-acre square lot northwest of the project area (today's southwest corner of Paki and Kapahulu avenues). Within the lot, 4.35 acres were *kuleana* parcels and 15.0 acres were Crown *lo'i*. Other land within the lot included a pond and grassland. The remainder of the '*ili* (171.0 acres) consisted of level open plain—referred to on historic maps Kāneloa Plain—and a seasonal pond.

LATE HISTORIC LAND USE

In 1876 a group of prominent businessmen, which included Archibald Cleghorn, John O. Dominis, and James Makee, formed the Kapi'olani Park Association. King David Kalākaua offered a 30-year lease of Kāneloa and Kapua (neighboring *'ili* to the east) for the endeavor on the east side of Waikīkī, which was at the time crown land. According to the association's charter, the park would serve the purpose "of adorning and putting in order, a tract of land in the vicinity of Honolulu as a place of public resort, and of promoting Agricultural and Stock Exhibitions, and healthful exercise, recreation and Amusements" (Abel 1992:3–4). Kalakaua dedicated the park in June of 1877 in honor of Queen Kapi'olani. At this time, the east portion of the park was sparsely vegetated and sandy, while the western portion contained wetlands and streams. Consequently, the park's development entailed road building, drainage, and extensive plantings of ironwood, banyan, date palm, and other trees (Abel 1992:4).

Up until 1913, the park was managed by the Honolulu Park Commission whose mission was to operate the park as a public space (Abel 1992:5). During this nascent period, the oceanfront parcels were lost to private individuals in an effort to raise money for the Association through subleasing beachfront lots for residences (see Figure 7). Some of these lots were reacquired in 1905, though others became private property with the overthrow of the monarchy in 1893 (Hibbard and Franzen 1986:43). In 1898, the year Hawaiʻi was annexed to the United States, a temporary U.S. military camp was established at the park, which cause damage to the roads and a horse racing track at the park's center. In 1900, horse racing was banned and subsequently the track was used as an auto raceway and a polo field. Elements of the park that date to the early period (1896 to 1913), include the original aquarium, athletic fields, the bandstand, food concessions, and the beach park and bathhouse.

The aquarium parcel is a portion of property formerly owned by William G. Irwin, a very wealthy businessman in the sugar industry. He formed William G. Irwin and Company, which lasted from the mid-1870s to 1880 (Adler 1958:9). In 1881 he partnered with Claus Spreckels in sugar, banking, and ship building (Nellist 1925:123). In 1896 he became the Chair of the Honolulu Park Commission which oversaw Kapiʻolani Park, as was mentioned above. The Irwin residence was designed by architect Charles Dickey in 1899. It is cited as "[t]he most expensive and impressive of Dickey's early use of the Mission style" (Neil 1975:102). Dickey also designed the Irwin Stable (Neil 1975:105). Photographs of the Irwin home are shown in Figures 9–11. The historical map in Figure 12 shows the project area parcel in relation to the home and stable. In the 1920s, well after Irwin moved to San Francisco, the house was torn down. The Beach Park Memorial Committee had negotiated the purchase of the Irwin Estate in 1919 (Ireland 2005:58) for the construction of the Waikīkī War Memorial and Natatorium (a saltwater pool). In 1913, management of the park was transferred to the Territory of Hawaii (Abel 1992:5). It was at this time the first public zoo appeared in the park:

> During 1915 and 1916, acquisition of animals and the construction of cages and bird houses established a "zoological garden." So delighted were officials that they filled the park report for 1916 with photographs of animals and added a detailed list of new park acquisitions that included two lions, twelve monkeys, two bears, one tortoise, four elk, four deer, twelve horses, seven donkeys, forty-six ducks, ten geese, four swans, two cranes two emus, assorted Australian doves, and an African elephant [Weyeneth 1991:28].

In 1919, additional coastal parcels were acquired by the Territory of Hawaii and the Waikīkī War Memorial and Natatorium were built, which opened in 1927. The memorial commemorates World War I servicemen. The competitions at the Natatorium included participation by Duke Kahanamoku, Buster Crabbe, and Johnny Weissmuller in the 1920s. The Waikīkī War Memorial and Natatorium are listed on the Hawaiʻi Register of Historic Places (HRHP) as SIHP Site 50-80-14-09758. Other notable features of Kapiʻolani Park include the Waikīkī Shell (an outdoor amphitheater built in 1953) and the Waikīkī Aquarium. The Waikīkī Aquarium was formerly located roughly 100 yards north of its current location[2]. Constructed in 1904, it was known as the Honolulu Aquarium and was privately financed by Charles M. Cooke and James B. Castle and operated as part of the Honolulu Rapid Transit and Land Company. In 1919 the land lease expired, and the Cooke Estate ceded the lease to the Territory of Hawaii. The present day Waikīkī Aquarium was funded by the Territorial Legislature in 1949 and opened in 1955.

During World War II (WWII), the park again housed the U.S. military. By the end of the war the park had deteriorated, and it entered a period of redevelopment. In 1948, the Honolulu Zoo was established at its current 42.0-acre parcel, the site of a former waterscape. The entrance to the Zoo is listed on the HRHP as SIHP Site 50-80-14-08023.

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[2] Waikīkī Aquarium history is summarized from https://www.waikikiaquarium.org/about/history/.

Figure 9. Photograph of the William G. Irwin Residence (Bishop Museum in Hibbard and Franzen (1986:29).

Figure 10. William G. Irwin (Right) at His Waikīkī Property (Hawaii State Archives 2021).

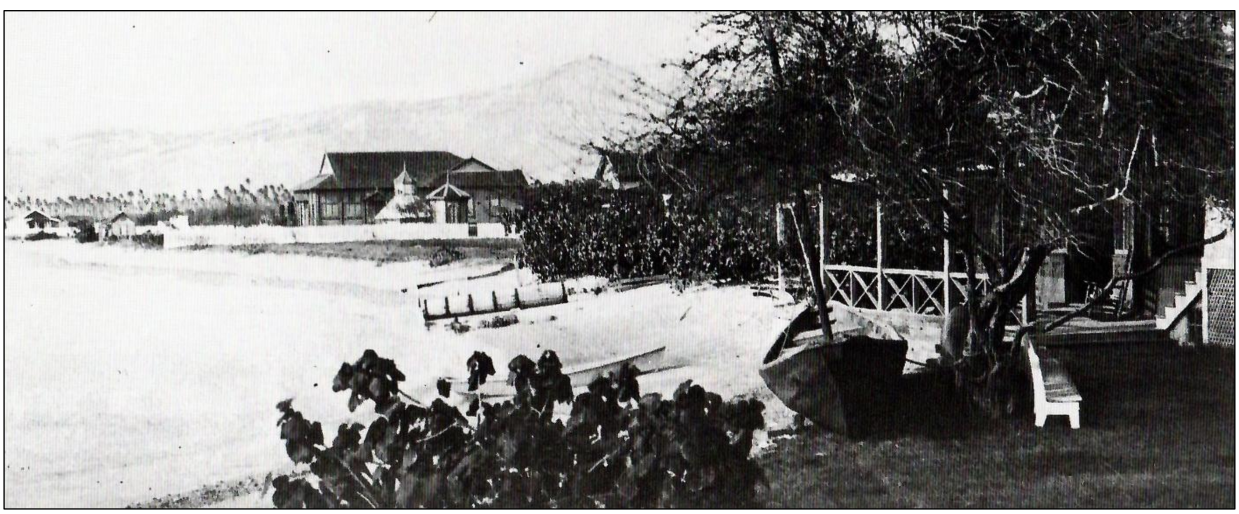

Figure 11. View of Irwin Residence From the Alfred Mitchell House (Bishop Museum in Hibbard and Franzen (1986:22)[3].

[3] This photograph is erroneously dated 1886 in Hibbard and Franzen (1986).

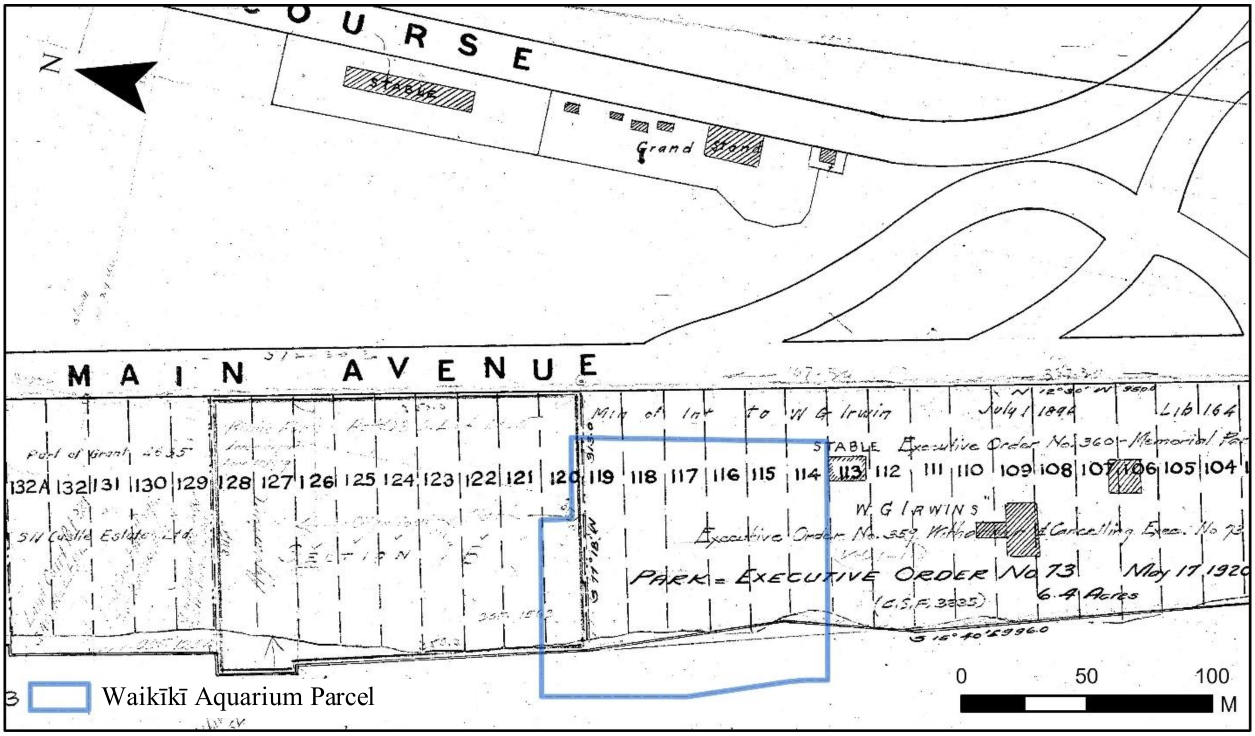

Figure 12. Portion of 1883 Map by Monserrat With Twentieth Century Mark-Ups. Note the Loction of the Irwin House and Stable East of the Project Parcel.

Kapi‘olani Park is listed on the HRHP as SIHP Site 50-80-14-09758, and is eligible for placement on the National Register of Historic Places (NRHP). However, to date this property has not been added to the NRHP. The significance statement for Kapi‘olani Park as summarized in the NRHP nomination form is listed below:

> Kapiolani Park is historically significant for its past association with indigenous Hawaiian culture and royalty. Hawaiian King Kalakaua envisioned the park as a place of recreation for all and named it after his famous Queen, Kapiolani. Since its dedication in 1877 it has been in continuous use as a location for recreational activities valued by local residents and visitors alike. It provides a sense of place to a special part of Honolulu and is identified with the world famous image of Hawaii as a recreational resort. Over the years it has been the scene of a variety of sports and leisure time activities that reflects the recreational development of Honolulu and Hawaii into the modern world [Abel 1992:3].

PREVIOUS ARCHAEOLOGY

Many archaeological investigations have been conducted in Waikīkī and there have been numerous instances of the inadvertent discovery of human remains, despite the filling of land. Pockets of undisturbed beach sands (i.e., Jaucas Sands) have been observed below the historic fill layers (Bush et al. 2004:37–38), making the possibility of discovering human burials and other cultural materials in this area relatively high. For a detailed summary of previous archaeological investigations and inadvertent discoveries the reader is referred to Shideler and Hammatt (2021) and Vernon (2022). The following section focuses on human burial finds and previous archaeological investigations near the Waikīkī Aquarium. Table 2 summarizes all previous work and the locations of previous projects and previously identified historic properties and human burials are presented in Figure 13.

Previous Archaeological Investigations Near the Waikīkī Aquarium

Since the early 1900s, human skeletal remains have been encountered inadvertently during construction projects throughout Waikīkī. In 1901, human skeletal remains of four individuals were encountered during trenching for sewer pipes on the James B. Castle property (see Figure 7), which is location of today’s Elk’s Club. Associated artifacts included whale bone and glass beads, indicating the burials dated to the late pre-Contact to early post-Contact periods (Emerson 1902).

The site of human skeletal remains designated “OA0633” attributed to “Hartwell 1927” is placed south of the Natatorium in an archaeological monitoring report by Bush et al. (2002b:Figure 7). According to a notice in the Federal Register: “In 1927, human remains representing one individual from Waikiki, Oahu were collected by C.C. Hartwell and acquired by the Bishop Museum. No known individual was identified. No associated funerary objects are present.”[4]

Near the current project area are several instances of inadvertently discovered human burials reported on by staff of the Bernice Pauahi Bishop Museum (BPBM). Human burials recorded at the Outrigger Canoe Beach Club were designated BPBM Sites 50-Oa-A5-64 and 50-Oa-A6-25 to 55. The sites are not known to have a SIHP designation. A total of 27 burials were encountered (Yost 1971); no formal archaeological report was prepared (Moser et al. 2012). The following is an excerpt from a newspaper article:

> Robert Bowen of the Bishop Museum has been working closely with Ernest Souza, Hawaiian Dredging superintendent, on the removal of skeletons unearthed on the site, between the Colony Surf and the Elks Club...
>
> Most of the bodies were buried in the traditional hoolewa position, with the legs bound tightly against the chest.

[4] Federal Register Volume 63, Number 18 (Wednesday, January 28, 1998). Notices. Pages 4277–4284. From the Federal Register Online via the Government Publishing Office (www.gpo.gov). FR Doc No: 98-1993.

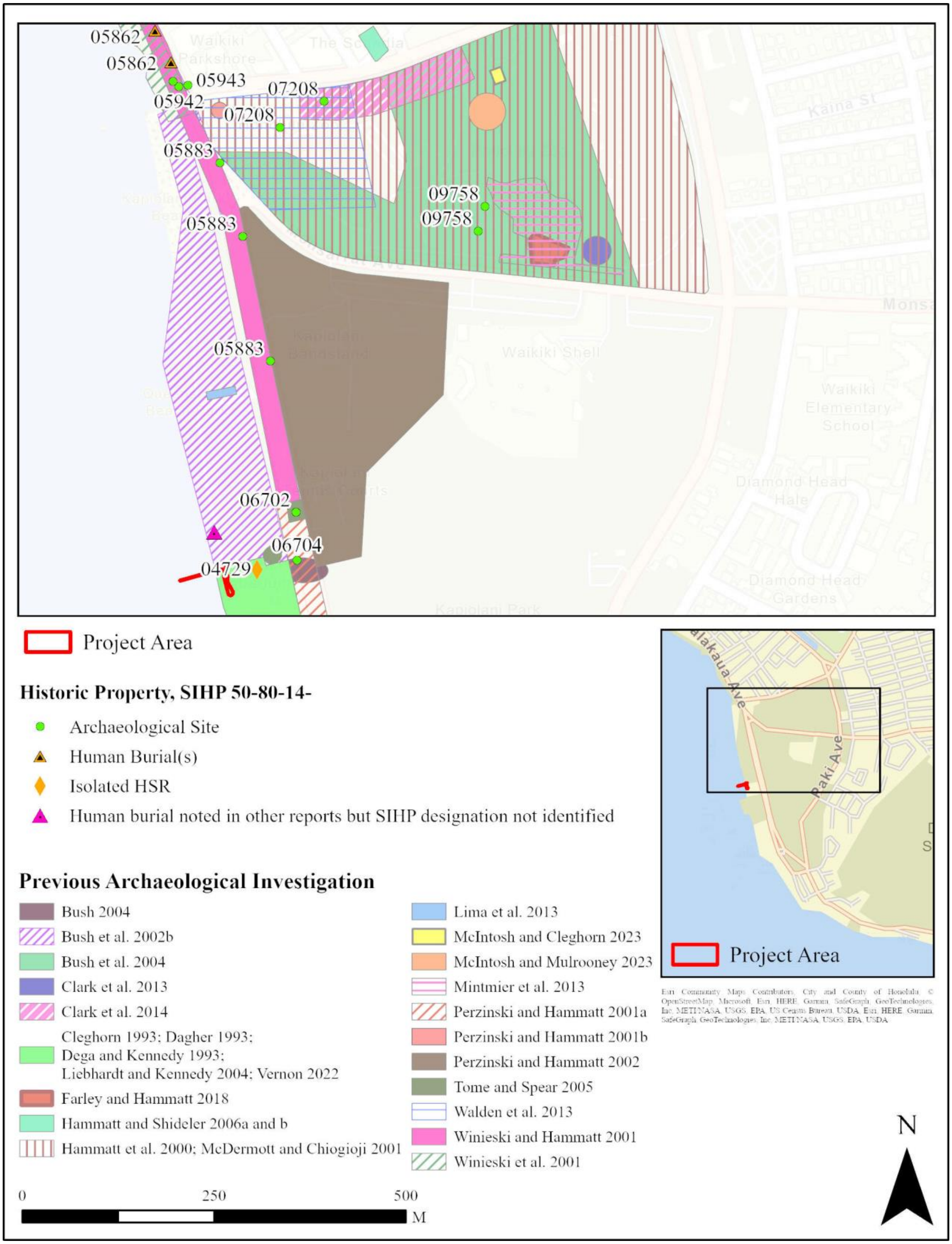

Figure 13. Previous Archaeological Investigations and Historic Properties, Including Human Burials, North of the Project Area.

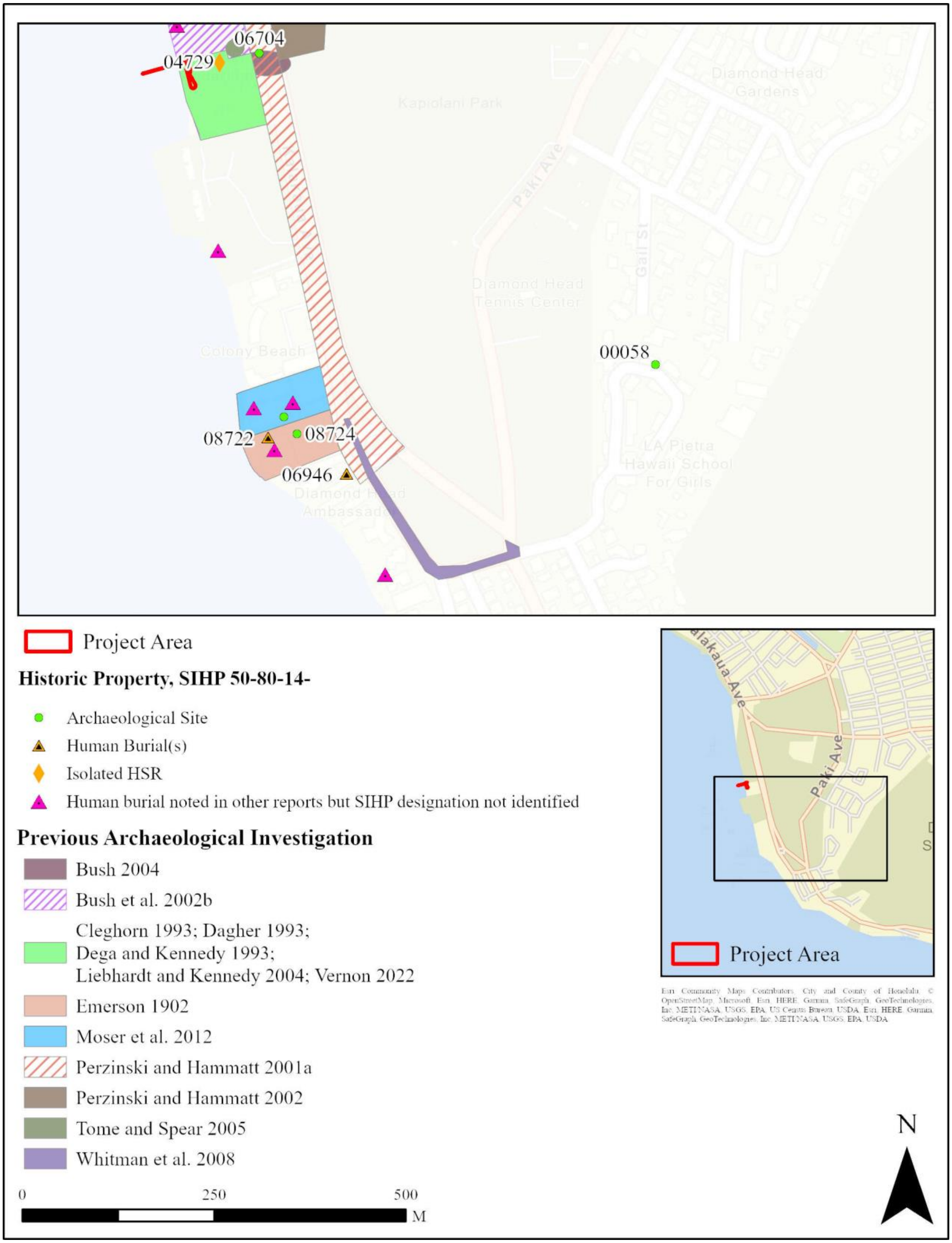

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Figure 14. Previous Archaeological Investigations and Historic Properties, Including Human Burials, South of the Project Area.

Table 2. List of Previous Archaeological Studies and Burial Finds Near the Project Area.

Author Year	TMK(s) (1) or Location	Nature of Study	SIHP[1] Site 50-80-14-	Description
Emerson 1902	3-1-032:006/ Today's Elks Club	Inadvertent discovery	No site number	Human skeletal remains of at least four individuals
Hartwell 1927[3]	3-1-031:009/San Souci Beach	Inadvertent discovery	[50-OA-006-33][2]	Human burial
McAllister 1933	Waikīkī (general)	Archaeological Survey	[Site #60]	Waikīkī
BPBM 1957[3]	3-1-032:004(?)/ Diamond Head Apartments (?)	Inadvertent discovery	[50-OA-0391–402][2]	Human burial
Soehren and Sinoto 1964[3] in BPBM 2018	3-1-032:031/ Outrigger Canoe Club	Inadvertent discovery	03705	One humerus (50-Oa-A04-024)
BPBM 1963[3] (Yost 1971)	3-1-032:031/ Outrigger Canoe Club	Inadvertent discovery	[50-OA-A4-25–55]	27 traditional Hawaiian burials
Han and Sinoto 1986[3] in Tulchin and Hammatt 2007:Figure 19	3-1-031:004/ Kapi'olani Beach Park	Inadvertent discovery?	[Bishop Museum 50-Oa-A5-84]	Human burial
Cleghorn 1993; Dagher 1993; Dega and Kennedy 1993	3-1-031:006/ Waikīkī Aquarium	Inadvertent discovery	04729	Human remains (scattered)
Hammatt et al. 2000	3-1-043/ Honolulu Zoo	Archaeological Assessment	-	No significant historic properties identified
McDermott and Chiogioji 2001	3-1-043/ Honolulu Zoo	Archaeological Inventory Survey with Subsurface Testing	-	No significant historic properties identified
Perzinski and Hammatt 2001	3-1-043:999/ Kalākaua Ave	Archaeological Monitoring	-	No historic properties identified
Winieski and Hammatt 2001	2-6-025–027, 3-1-031 and 043:999/ Kalākaua Ave	Archaeological Monitoring	05883	Discontinuous A horizon
Bush et al. 2002b	3-1-030 and 031/ Queen's Surf Promenade	Archaeological Monitoring	-	No significant historic properties identified
Perzinski and Hammatt 2002	3-1-043:001/ Kapi'olani Park (bandstand)	Archaeological Monitoring	-	Basalt lamp fragment; charcoal concentration

Author Year	TMK(s) (1) or Location	Nature of Study	SIHP[1] Site 50-80-14-	Description
Bush 2004	3-1-031:999/ Kalākaua Ave	Archaeological Monitoring	06704	Historic trash deposit
Bush et al. 2004	3-1-043:001/ Honolulu Zoo	Archaeological Monitoring	-	No significant historic properties identified
Tome and Spear 2005	3-1-031:007/ Kapiʻolani Beach Park	Archaeological Monitoring	06702	Historic debris/trash deposit
Liebhardt and Kennedy 2008	3-1-031:006/ Waikīkī Aquarium	Archaeological Monitoring	-	No historic properties identified
Whitman et al. 2008	3-1-032:999 and 042:999/ Kalākaua Avenue and Poni Mōʻī Road	Archaeological Monitoring	06946	Human burial
Moser et al. 2012	3-1-032:031/ Outrigger Canoe Club	Archaeological Monitoring	-	No historic properties identified
Mintmier et al. 2013	3-1-043:001 por./ Elephant Enclosure	Archaeological Monitoring	-	Recent and historic features associated with Zoo and Kapiʻolani Regional Park
Walden et al. 2013	3-1-043:001 por./ Front Entrance Area	Archaeological Monitoring	07208	Subsurface features in dune sand layer; possibly on Makee Island
Clark et al. 2014	3-1-043:001 por./ Parking Lot	Archaeological Monitoring	07208	Subsurface pit feature
Farley and Hammatt 2018	3-1-043:001 por./ Reptile House	Archaeological Monitoring	09758	Kapiʻolani Park; identified two additional contributing components
McIntosh and Cleghorn 2023	3-1-043:001 por./ Food Concession Building	Archaeological Monitoring	-	No significant historic properties identified
McIntosh and Mulrooney 2023	3-1-043:001 por./ Tiger Exhibit	Archaeological Monitoring	-	No significant historic properties identified

[1] SIHP (State Inventory of Historic Places)

[2]Bernice Pauahi Bishop Museum Hawaiian Archaeological Database

[3]No report citation available; see Bush et al. (2002:Figure 7).

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> One of the skeletons, Bowen said, shows evidence of a successful amputation of the lower forearm, indicating that the Hawaiians knew this kind of operation before the arrival of Europeans.
>
> The ages of the skeletons ranged from children to 40-year-old men and women.
>
> The average life span of the Hawaiians at the time was about 32 years [Honolulu Star-Bulletin; Jan. 24, 1963:1A in Yost 1971:28].

In 1986, human skeletal remains, designated BPBM Site 50-Oa-A5-84, were documented just north of the Waikīkī Aquarium at Kapiʻolani Beach Park (Han and Sinoto 1986[5] in Bush et al. 2002b:Figure 7). Additional burials were recorded south of the aquarium and designated BPBM Site 50-Oa-A5-64. The sites are not known to have a SIHP designation.

In the late 1990s and early 2000s, numerous human burials were found along Kalākaua Avenue in Waikīkī (Bush et al. 2002a; Perzinski et al. 2001; Winieski and Hammatt 2001; Winieski et al. 2001; Winieski et al. 2002); however, all of these burial finds were over 500 meters north of the Waikīkī Aquarium. Relevant results of soil stratigraphy encountered during archaeological monitoring near the current project area are discussed in this section.

In 2000, archaeological monitoring was conducted for the Kapiʻolani Park Bandstand Redevelopment Project (Perzinski and Hammatt 2002). In situ beach sand deposits (20.0+ cm in thickness) were recorded on the northeast side of the bandstand at roughly 30 cmbs, along with a traditional Hawaiian basalt lamp at approximately 40 to 75 cm below the surface. No significant cultural deposits were found west of the bandstand area.

Along Kalākaua Avenue from Poni Mōʻi Road to the Natatorium, archaeological monitoring was conducted for street lighting improvements (Perzinski and Hammatt 2001). Two traditional Hawaiian artifacts were recovered from a backdirt pile, which included a modified Hump-back cowrie and a dense basalt, chisel-shaped adze preform (Perzinski and Hammatt 2001:14). Diagnostic historic period artifacts recovered included ten glass bottles and two ceramic vessels dating from the mid-nineteenth to the early twentieth century. Jaucas sand deposits were encountered at 45 to 50 cmbs below a discontinuous and thin (less than 5 cm thick) A horizon, which was overlain by fill.

During monitoring for the Waikīkī Force Main Replacement project (Winieski and Hammatt 2001). A pit feature and a discontinuous buried "A" horizon, which were designated SIHP 05883, were recorded on Kalākaua Avenue, roughly 300 to 400 meters north of the aquarium. To the south of the aquarium, archaeological monitoring was conducted for 12-inch water main installation along Kalākaua Avenue and Poni Mōʻī Road (Whitman et al. 2008). A single in situ pre-Contact traditional Hawaiian burial was inadvertently discovered during excavations, which was designated SIHP 06946. Other finds included a pit feature in Jaucas sand. The feature contained burnt layers of charcoal and a burnt basalt cobble.

In 2009 and 2010, archaeological monitoring was conducted during the Outrigger Canoe Club Sewer and Storm Drain Repair and Women's and Girl's Locker Room Renovation Projects (Moser et al. 2012). Soil stratigraphy recorded consisted of multiple layers of fill over disturbed Jaucas sand. No historic properties or human burials were encountered. Finds were limited to a small stone awl or cutting tool, a cut pig bone, and charcoal flecking, all in a disturbed context.

The SHPD HICRIS notes three locations of disturbed human burials at the Elk's Club are designated SIHP Site 08722[6]. The file reads: "Three areas of disarticulated skeletal finds, consisting of three skeletal elements each. Presumably of Hawaiian descent. Found within a highly disturbed deposit located immediately beneath the interior ground surface of the Elks Lodge, Honolulu." A cultural deposit designated SIHP 08723 is also present based on HICRIS data: "Partially intact, subsurface A horizon ranging from 50–82 cmbs. Deposit is lacking material debris but is rich in charcoal and includes two

[5] A full reference was not provided in Bush et al. 2002b:Figure 7 and could not be located.

[6] It is possible these burials correlated to the BPBM Sites 50-Oa-A5-64 and 50-Oa-A6-25 to 55.

indeterminate pit features and one combustion feature." Finally, "Kainalu", the former Castle family home, was located on the Elk's Club property, which is designated SIHP 08724.

Previous Archaeological Investigations at the Honolulu Zoo

Over the last 25 years, several archaeological investigations have been conducted within the Honolulu Zoo parcel (Bush et al. 2004; Clark et al. 2014; Farley et al. 2018; Hammatt et al. 2000; McDermott and Chiogioji 2001; McIntosh and Cleghorn 2023; McIntosh and Mulrooney 2023; Mintmier et al. 2013; Walden et al. 2012). To date, no pre-Contact historic properties have been encountered. McDermott and Chiogioji (2001) noted the following on soil stratigraphy in the Zoo parcel:

> Documented stratigraphy consisted predominantly of various types of fill layers, including terrigenous landscaping fill, dredge sediments from the Ala Wai Canal, construction fill layers, and calcareous "beach sand" layers. These results were not altogether surprising based on the background research, which indicated that prior to development in the 1870s, the area that would become the Zoo was a low-land area of "swamps", ponds, and sand dunes. Background research indicated that substantial fill layers were brought in to elevate the formerly low-lying Zoo area for development [McDermott and Chiogioji 2001:94].

Between 2009 and 2011, archaeological monitoring was conducted during improvements to the zoo entrance area (Walden et al. 2012), which resulted in the recording of SIHP Site 07208. This site consists of 12 subsurface features that may be associated with historical activities on Makee Island. Makee Island was an early waterscape feature in Kapiʻolani Park and pre-dated the Ala Wai Canal and Waikīkī Land Reclamation Project.

Between 2010 and 2011, archaeological monitoring was carried out during construction of a new elephant habitat (Mintmier et al. 2013). Recent and possibly historic concrete foundations and infrastructure were encountered, which may be associated with development of Kapiʻolani Park and the zoo. A total of 45 historic artifacts were recovered, including hand-made, mold-blown, bottles, bottles and jars manufactured by automatic bottle machine, English porcelaneous-stoneware, fragmentary examples of English earthenware plates and platters, a fragment of an earthenware jar, and a fragment of a porcelaneous stoneware bowl of Asian, possibly Chinese origin. No pre-Contact or traditional Hawaiian artifacts were encountered. A majority of the assemblage dates from the 1900s to the 1920s (Mintmier et al. 2013).

In 2013, archaeological monitoring was conducted in the northern half of the Honolulu Zoo parking lot (Clark et al. 2014). A single post-Contact subsurface pit feature associated the former Makee Island was recorded. The feature was assigned to the previously designated SIHP Site 07208.

In 2015 and 2016, archaeological monitoring was conducted in the reptile house area of Honolulu Zoo (Farley et al. 2018). Two archaeological features were identified as components of existing SIHP Site 09758, Kapiʻolani Park. Feature 1 is a manhole containing a U.S. military communication line, which is likely associated with military activity during WWII. Construction plans were altered to preserve the manhole during the project. Feature 2 is a historic period concrete box culvert.

Two archaeological monitoring projects were conducted in the zoo in the early 2020s, both of which had negative findings (McIntosh and Cleghorn 2023; McIntosh and Mulrooney 2023). These projects were at the Food Concession Building and the Tiger Exhibit. Only fill material was encountered during subsurface excavations.

Previous Archaeological Investigations at Waikīkī Aquarium

In the mid-1990s, several human skeletal remains were inadvertently discovered at the Waikīkī Aquarium during rebuilding and modification of a shark tank (Cleghorn 1993; Dagher 1993; Dega and Kennedy 1993). The human skeletal remains were found during backhoe excavation of six inches of sand from the tank area and in backfill brought into the project area for ground support. The fragmented human skeletal remains were scattered, and no formal burial site was identified. It was speculated that the skeletal fragments were brought in with sand from Maui for construction work during the project. The find was designated SIHP Site 04729.

Excavations were monitored for subsurface electrical infrastructure for a new sewer pumping station (Bush 2004), which documented a layer of natural beach sand between 15.0 to 100.0 cmbs (5.9 to 40.0 in). No cultural layer was encountered; however, a trash pit, designated SIHP Site 06704, was recorded within Kalākaua Avenue, adjacent to the aquarium. The site consisted of bottles dating between the 1880s to 1920s, broken ceramic pieces, and butchered animal bone.

Archaeological monitoring was conducted for the Public Baths Pump Station Modification Improvements Project (Tome and Spear 2005). A single archaeological site was identified which consisted of a subsurface feature containing glass bottles manufactured from the 1870s to the 1920s. The site was designated SIHP Site 06702. It was situated in a layer of undisturbed beach sand at 100 to 170 cmbs, which was overlain by multiple layers of fill. No further archaeological work was recommended in the project area footprint due to extensive previous disturbance.

Archaeological monitoring was conducted in 2008 for electrical system upgrades in the northeast corner of the Waikīkī Aquarium (Liebhardt and Kennedy 2008). The soil stratigraphy primarily consisted of two layers of fill over a transitional layer, followed by Jaucus sand (Liebhardt and Kennedy 2008:12).

Archaeological Literature Review and Field Inspection (ALRFI) was conducted for Waikīkī Aquarium Wastewater Discharge System Upgrades (Vernon 2022). Based on the results of this ALRFI and on previous archaeological projects near the project area that recorded subsurface historic properties including cultural deposits and human burials, there was insufficient information to make a Chapter 6E historic preservation determination of effect of the project’s impact on potential subsurface historic properties within the.16-acre project area. Therefore, archaeological monitoring for identification purposes, guided by a SHPD-approved archaeological monitoring plan (HAR 13-13-279), was recommended.

ANTICIPATED FINDS

Based on archival research and the results of previous archaeological studies in and near the Aquarium, there is potential for encountering subsurface historic properties, including human burials. Dune sands, which may contain human burials, are known to underlie historic fill deposits at approximately 15.0 to 100.0 cm (5.9 to 40.0 in) below ground surface in the northeast corner of the aquarium (Bush 2004; Liebhardt and Kennedy 2008). Evidence of early twentieth century habitation may be encountered on the south side of the aquarium, which is near the former location of the Irwin family’s stable. In addition to human burials, anticipated archaeological finds include traditional Hawaiian subsurface cultural deposits or artifacts, and historic features or artifacts associated with the Irwin residence. Finally, the Waikīkī Aquarium is over 50 years old and is a historic property; no SIHP site number has been assigned.

FIELD INSPECTION

An archaeological field inspection was conducted by a PCSI archaeologist, Kylen Chang, B.A., on 10 October 2023. Nicole Vernon, M.A., served as Principal Investigator for the project. Field inspection consisted of walking the property where the ground disturbance is proposed and photographing existing conditions in the project footprint.

FIELD INSPECTION RESULTS

As previously noted, the Waikīkī Aquarium is over 50 years old and is a historic property; no SIHP site number has been assigned. No newly identified historic properties were identified in the project area during the field inspection. General photographs of the offshore intake area are shown in Figure 15, while Figure 16 shows the general locations where trenching will occur as well as the placement of required infrastructure such as the p**ump station, emergency overflow box, and discharge and transfer sump.**

SUMMARY AND ASSESSMENT

The proposed project is at the Waikīkī Aquarium at 2777 Kalākaua Avenue. The project proponent is the University of Hawai'i, and the landowner is the State of Hawaii. The parcel, TMK (1) 3-1-031:006 (por.), measures 2.35 acres (.95 hectares). Excavations in the approximately 0.06-acre (approximate) project area will be conducted in the western portion of the parcel for replacement of the two existing 8-inch Transite NSW intake pipes that extend 160-ft offshore with two new 8-inch HDPE pipes; construction of a new saltwater production well and decommissioning of the existing well; construction of a new pump vault; construction of a new aeration/settling tank for well water treatment; and reconstruction and extension of the existing pump building that has extensive cracks and spalling. The purpose of the proposed project is to upgrade the Aquarium's outdated intake water system infrastructure to prevent future failures that threaten the life and wellbeing of the animals. This ALR and FI was carried out in accordance with Hawaii Revised Statutes (HRS) Chapter 6E, and Title 13 of the Hawaii Administrative Rules (HAR), Subtitle 13 (State Historic Preservation Division Rules), Chapter 275 (*Rules Governing Procedures for Historic Preservation Review for Governmental Projects Covered Under Sections 6E-7 and 6E-8, HRS*).

The Waikīkī Aquarium property falls within the traditional land division of Kāneloa ʻIli. The area was intensively used for habitation, aquaculture, and agriculture from the pre–Contact period into the mid- to late 1800s, when the landscape was transformed by wealthy businessmen. One such businessman was William G. Irwin, whose large home, designed by Charles Dickey, was immediately south of today's aquarium.

Based on background research and previous archaeological findings in the vicinity, there is potential for traditional Hawaiian historic properties and human burials in the project area. It is also possible that historic period artifacts of cultural deposits may be present based on the proximity of the Irwin home site.

RECOMMENDATIONS

As a result of this ALR and FI, it was found that no historic properties are within the proposed project area, although two historic properties are within the larger TMK parcel: the Waikīkī Aquarium building (no SIHP site number designated) and SIHP Site 04729, which was speculated to be skeletal fragments brought onto the aquarium parcel with sand from Maui for construction. Along the beach to the

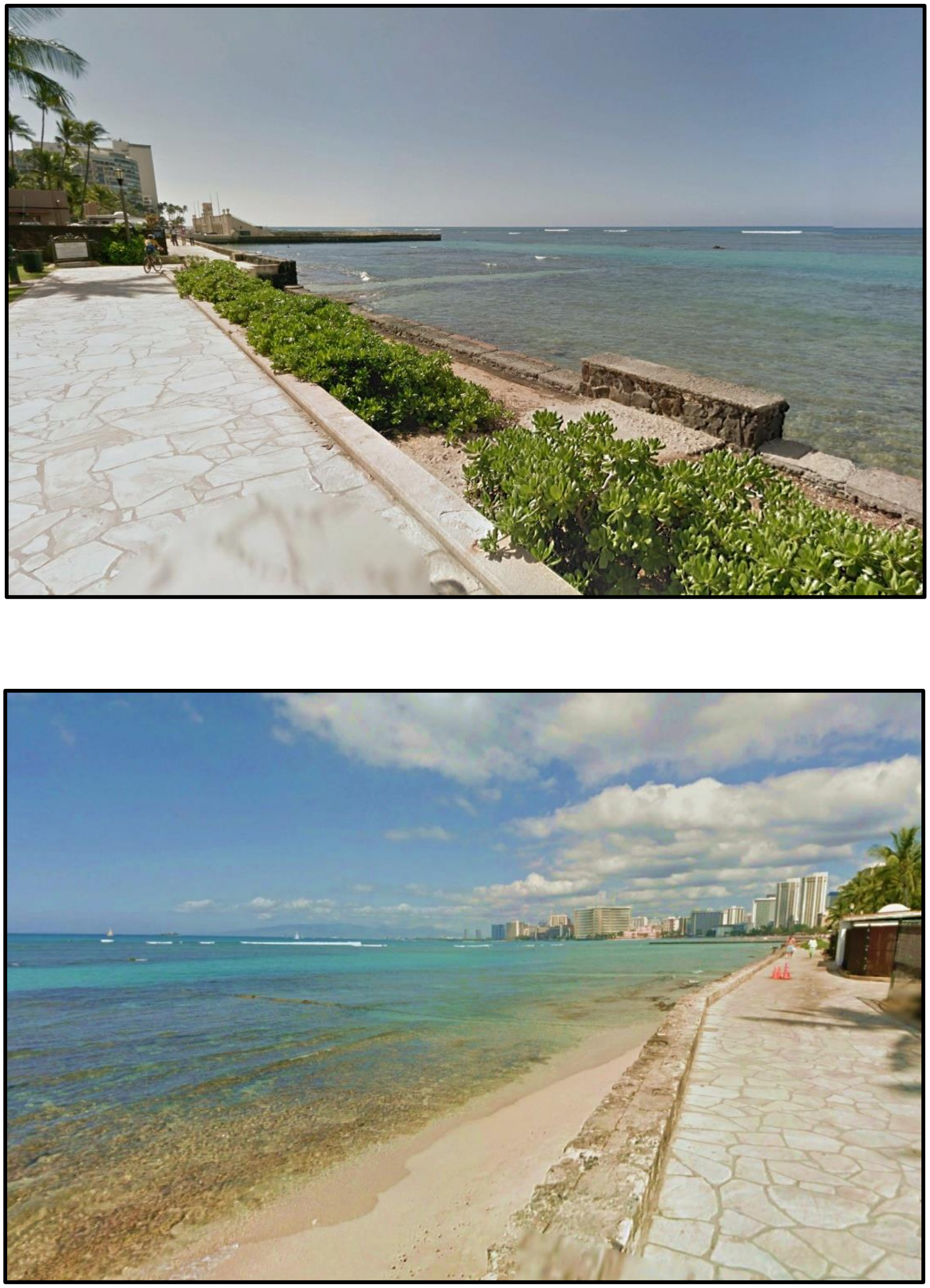

Figure 15. General Photographs Showing the Offshore Intake Area. Top: View to the South. Bottom: View to the Northwest.

Figure 16. General Photographs Showing the locations of proposed project trenching and infrastructure. Left: View to Northwest. Middle: View to West. Right: View to Northwest.

north and south of the aquarium, numerous traditional Hawaiian human burials have been identified. Previous archaeological investigations in the vicinity have recorded in situ soils under fill layers.

Based on the ALR and FI and on previous archaeological projects near the project area that have recorded subsurface historic properties including cultural deposits and human burials, there is insufficient information to make a Chapter 6E historic preservation determination of effect of the project's impact on potential subsurface historic properties within the 0.06-acre project area. Therefore, archaeological monitoring for identification purposes, guided by a SHPD-approved archaeological monitoring plan (HAR 13-13-279), is recommended. A list of SHPD-permitted consultants to conduct the archaeological monitoring can be found at: https://dlnr.hawaii.gov/shpd/about/branches/archaeology/

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GLOSSARY OF HAWAIIAN TERMS

ahupuaʻa—land division and community

Land division usually extending from the uplands to the sea, so called because the boundary was marked by a heap (*ahu*) of stones surmounted by an image of pig (*puaʻa*) or because a pig or other tribute was laid on the altar as tax to the chief. The landlord or owner of an *ahupuaʻa* might be a *konohiki* (Pukui and Elbert 1986:9)

aliʻi—chief or chiefess

Chief, chiefess, officer, ruler, monarch, peer, headman, noble, aristocrat, king, queen, commander (Pukui and Elbert 1986:20); implies hereditary rank

akua—a god or goddess

God, goddess, spirit, ghost, devil, image, idol, corpse; divine, supernatural; godly (Pukui and Elbert 1986:15)

ʻaumakua—family god

Family or personal gods, deified ancestors who might assume the shape of sharks (all islands except Kauaʻi), owls (as at Mānoa, Oʻahu and Kaʻu and Puna, Hawaiʻi) hawks (Hawai'i), *ʻelepaio*, *ʻiwi*, mudhens, octopuses, eels, mice, rats, dogs, caterpillars, rocks, cowries, clouds, or plants. A symbiotic relationship existed; mortals did not harm or eat *ʻaumakua* (they fed sharks), and *'aumakua* warned and reprimanded mortals in dreams, visions, and calls (Pukui and Elbert 1986:32)

heiau—ceremonial structure or place

Pre-Christian place of worship, shrine (Pukui and Elbert 1986:64)

heiau poʻokanaka— a class of *heiau* where human sacrifices were made

A heiau where human sacrifices were offered (Pukui and Elbert 1986:64)

ʻili—division of land smaller than an ahupuaʻa

Land section, next in importance to *ahupuaʻa* an usually a subdivision of an *ahupuaʻa* (Pukui and Elbert 1986:97)

kapu—taboo

Taboo, prohibition; special privilege or exemption from ordinary taboo; sacredness; prohibited, forbidden; sacred, holy, consecrated; no trespassing, keep out. (Pukui and Elbert 1986:132)

konohiki—land managers

Headman of an ahupuaʻa land division undert the chief; land or fishing rights under the control of the konohiki (Pukui and Elbert 1986:166)

kula—dryland field

Plain, field, open country, pasture. An act of 1884 distinguished dry or *kula* land from wet or taro land (Pukui and Elbert 1986:179)

kuleana—small piece of land under the responsibility of a tenant

Right, privilege, concern, responsibility, title, business, property, estate, portion, jurisdiction, authority, liability, interest, claim, ownership, tenure, affair, province (Pukui and Elbert 1986:179)

loʻi—wetland taro field

Irrigated terrace, especially for taro, but also for rice (Pukui and Elbert 1986:209)

loko iʻa—fishpond

makaʻāinana—commoner

Commoner, populace, people in general (Pukui and Elbert 1986:224)

moʻōlelo–legend

Story, tale, myth, history tradition, legend, journal, log, yarn, fable, essay, chronicle, record, article (Pukui and Elbert 1986:254) *pali* —cliff

Cliff, precipice, steep hill or slope suitable for *olonā* and *wauke*; full of cliffs; to be a cliff (Pukui and Elbert 1986:321)

pōhaku—stone

Rock, stone, mineral, tablet (Pukui and Elbert 1986:334)

wahi pana—legendary place

Legendary place (Pukui and Elbert 1986:377)

Appendix G:

<u>REVISED</u> Cultural Impact Assessment in Support of Supply Water Intake System Upgrades at Waikīkī Aquarium in Waikīkī Ahupuaʻa, Honolulu (Kona) District, Island of Oʻahu, Hawaiʻi

REVISED DRAFT

Cultural Impact Assessment in Support of Upgrade of the Waikīkī Aquarium Water Intake System in Waikīkī Ahupua‘a, Honolulu (Kona) District, Island of O‘ahu, Hawai‘i

TMK: (1) 3-1-031:006 (por.)

Prepared for:
Oceanit Laboratories, Inc.
828 Fort Street, Suite 600
Honolulu, Hawaii
96813

On behalf of:
University of Hawai‘i
Spalding Hall, 2540 Maile Way
Honolulu, Hawaii 96822

October 2024

PACIFIC CONSULTING SERVICES, INCORPORATED
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REVISED DRAFT
Cultural Impact Assessment in Support of Upgrade of the Waikīkī Aquarium Water Intake System in Waikīkī Ahupuaʻa, Honolulu (Kona) District, Island of Oʻahu, Hawaii
TMK: (1) 3-1-031:006 (por.)

By
Nicole I. Vernon, M.A.
Principal Investigator

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October 2024

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MANAGEMENT SUMMARY

Document Title:	Cultural Impact Assessment in Support of Upgrade of the Waikīkī Aquarium Water Intake System in Waikīkī Ahupuaʻa, Honolulu (Kona) District, Island of Oʻahu, Hawaii
Date/Revised Date:	Draft: December 2023
SHPD HICRIS Project No.:	-
SHPD Reference Document:	-
Archaeological Permit #:	SHPD Permit No. 23-08; 24-14
Project Location:	2777 Kalākaua Ave, Honolulu, HI 96815
Project TMK:	(1) 3-1-031:006 (por.)
Land Owner:	State of Hawaii
Project Proponents:	University of Hawaiʻi
Project Tasks:	Cultural Impact Assessment
Parcel Acreage:	2.35 acres (.95 hectares)
Project Area	Approx. 0.06 acres (230.3 sq m)
Principal Investigator:	Dennis Gosser, M.A.
Regulatory Oversight:	Chapter 6E-7 and 6E-8, Hawaii Revised Statutes (HRS) and Hawaii Administrative Rules (HAR) Chapter 275
Project Background:	The University of Hawaiʻi is proposing to upgrade Waikīkī Aquarium's outdated intake water system infrastructure to prevent future failures that threaten the life and wellbeing of the animals. Ground disturbing work will include replacement of the two existing 8-inch Transite NSW intake pipes that extend 160-ft offshore with two new 8-inch HDPE pipes; construction of a new saltwater production well and decommissioning of the existing well; construction of a new pump vault; construction of a new aeration/settling tank for well water treatment; and reconstruction and extension of the existing pump building that has extensive cracks and spalling.
SIHP #:	Waikīkī Aquarium is over 50 years old (no SIHP site number designated); See Human Skeletal Remains below
Findings:	Background research and previous archaeological findings in the vicinity indicate there is potential for traditional Hawaiian historic properties and human burials in the project area. Waikīkī was intensively used during the pre-Contact and early historic period for habitation, agriculture, and aquaculture, and several *heiau* were once present. In the late 1900s, Waikīkī's landscape was radically modified and became the home of many wealthy businessmen, such as William G. Irwin from England, whose estate included the current project area. No additional information was provided via cultural consultation.
Human Skeletal Remains:	50-80-14-04729, secondarily deposited human skeletal remains

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INTRODUCTION

Under contract to Oceanit Laboratories, Inc., Pacific Consulting Services, Inc. (PCSI) is preparing a Cultural Impact Assessment (CIA) in support of the Upgrade of the Waikīkī Aquarium Water Intake System project at Waikīkī Aquarium in Waikīkī Ahupuaʻa, Honolulu (Kona) District, Island of Oʻahu, Hawaii[1]. The project proponent is the University of Hawaiʻi, and the landowner is the State of Hawaii. The location of the proposed project is shown in Figure 1.

The project scope of work proposes upgrading Waikīkī Aquarium's outdated intake water system infrastructure to prevent future failures that threaten the life and wellbeing of the animals. A historical, cultural, and archaeological background study was conducted in order to evaluate any potential effect on historic properties and to recommend appropriate historic preservation actions, if warranted. The historical, cultural, and archaeological background study was carried out in accordance with Hawaii Revised Statutes (HRS) Chapter 6E, and Title 13 of the Hawaii Administrative Rules (HAR), Subtitle 13 (State Historic Preservation Division Rules), Chapter 275 (*Rules Governing Procedures for Historic Preservation Review for Governmental Projects Covered Under Sections 6E-7 and 6E-8, HRS*).

REGULATORY CONTEXT

In accordance with the provisions of Hawaii Revised Statutes (HRS), Chapter 343 and its implementing regulations contained in Hawaii Administrative Rules (HAR), Title 11, Chapter 200.1, the CIA provides a detailed analysis of how the Proposed Action could impact cultural practices, resources, and beliefs. The disclosure of this information is intended to promote transparent and responsible decision-making in accordance with Articles IX and XII of the *Constitution of the State of Hawaii*, other state laws, and the courts of the state, which all mandate government agencies to endeavor to promote and preserve the cultural practices and resources of Native Hawaiians and other ethnicities.

In addition to the content requirements of HRS §343 and HAR §11-200.1, on November 19, 1997, the State of Hawaii's Environmental Council issued its *Guidelines for Assessing Cultural Impacts*. The Guidelines provide methodological and content protocol for projects/actions that may have the potential to affect cultural resources, stipulating specific matters that should be addressed in all CIAs.

An alternative analytical framework—the Ka Paʻakai assessment—that can be used for addressing the preservation and protection of cultural practices specific to Native Hawaiian communities resulted from a 2000 Hawaii Supreme Court ruling (*Ka Paʻakai O KaʻAina versus Land Use Commission*). In its decision, the court established the following three-part analytical approach:

- Part 1, identify whether any valued cultural, historical, or natural resources are present; and identify the extent to which any traditional and customary Native Hawaiian rights are exercised;
- Part 2, identify the extent to which those resources and rights will be affected or impaired; and
- Part 3, specify any measures to be taken to reasonably protect Native Hawaiian rights if they are found to exist.

PROJECT AREA LOCATION AND DESCRIPTION

The proposed project is located at the Waikīkī Aquarium at 2777 Kalākaua Avenue. The entire project parcel measures 2.35 acres (.95 hectares) and the proposed 0.06-acre (approximate) project area

[1] PCSI follows the latest edition of the Society for American Archaeology (SAA) Style Guide (2021) regarding textual elements (e.g., numbers, dates, statistical copy, italicization, capitalization, hyphenation, and accents and diacritical marks). The authority for English spelling is the most recent edition of Merriam-Webster's Collegiate Dictionary. Unless noted, the authorities for Hawaiian spelling and geographic place names are the Hawaiian Dictionary (Pukui and Elbert 1986), the most recent listing of the Hawaiʻi Board on Geographic Names (HBGN), and Place Names of Hawaii (Pukui et al. 1976).

Figure 1. Waikīkī Aquarium Parcel and Project Area Location on 7.5-Minute Series USGS Honolulu Topographical Quadrangle (2017)

excavations will be conducted primarily in the western and southern portions of the parcel. The Tax Map Key (TMK) parcel for the project area is (1) 3-1-031:006, as shown in Figure 2. Table 1 summarizes the proposed ground disturbing activities, which are described in detail in this section. The project site plan is shown in Figure 3.

The purpose of the proposed project is to upgrade the Aquarium's outdated intake water system infrastructure to prevent future failures that threaten the life and wellbeing of the animals. Anticipated ground disturbing work includes replacement of the two existing 8-inch Transite NSW intake pipes that extend 160-ft offshore with two new 8-inch HDPE pipes; construction of a new saltwater production well and decommissioning of the existing well; construction of a new pump vault; construction of a new aeration/settling tank for well water treatment; and reconstruction and extension of the existing pump building that has extensive cracks and spalling. These activities are summarized in Table 1 with anticipated excavation measurements.

Table 1. Anticipated Construction Activities.

Task	Work Description	Anticipated Size (M) (Length x Width x Depth)
Trenching	New 8" HDPE Natural Saltwater Intake Pipes	48.8 x 0.3 (n=2)
Trenching	New Natural Saltwater Supply UV Treated Natural Saltwater to Brackish Water Storage Tank Piping	44.0 x 0.3
Trenching	New Natural Saltwater Piping	15.0 x 0.3
Trenching	New Chilled Natural Saltwater to Exterior Exhibits Piping	5.0 x 0.3
Trenching	New Well Water Piping	34.0 x 0.3 7.0 x 0.3
Trenching	New Natural Saltwater piping to Hawaiian Monk Seal	14.0 x 0.3
Trenching	New Natural Saltwater Filter Brackish Water Discharge Piping	5.0 x 0.3
Trenching	New Well Water Filter Brackish Water Discharge Piping	1.5 x 0.3
Excavation	New Aeriation Settling Tank	5.1 x 1.5 x 3.2
Excavation	New Air Injection Pumps	1.0 x 1.0
Excavation	New Well Water Pumps	2.0 x 7.0 (below grade)
Excavation	New Natural Saltwater Pumps	2.0 x 7.0 (partially below grade)
Excavation	New Pump Vault	6.5 x 6.0 (partially below grade)
Excavation	New Saltwater Production Well/Vault	0.9 x 0.9 x 0.9
Excavation	Reconstruction and Extension of the Existing Pump Building	35.0 x 0.3

ENVIRONMENTAL SETTING

Waikīkī Ahupuaʻa is located on the leeward side of Oʻahu and extends from the Koʻolau mountain range through the coastal plain to the shoreline. The project area is situated within the beach portion of Kapiʻolani Park, between the shoreline and Kalākaua Avenue.

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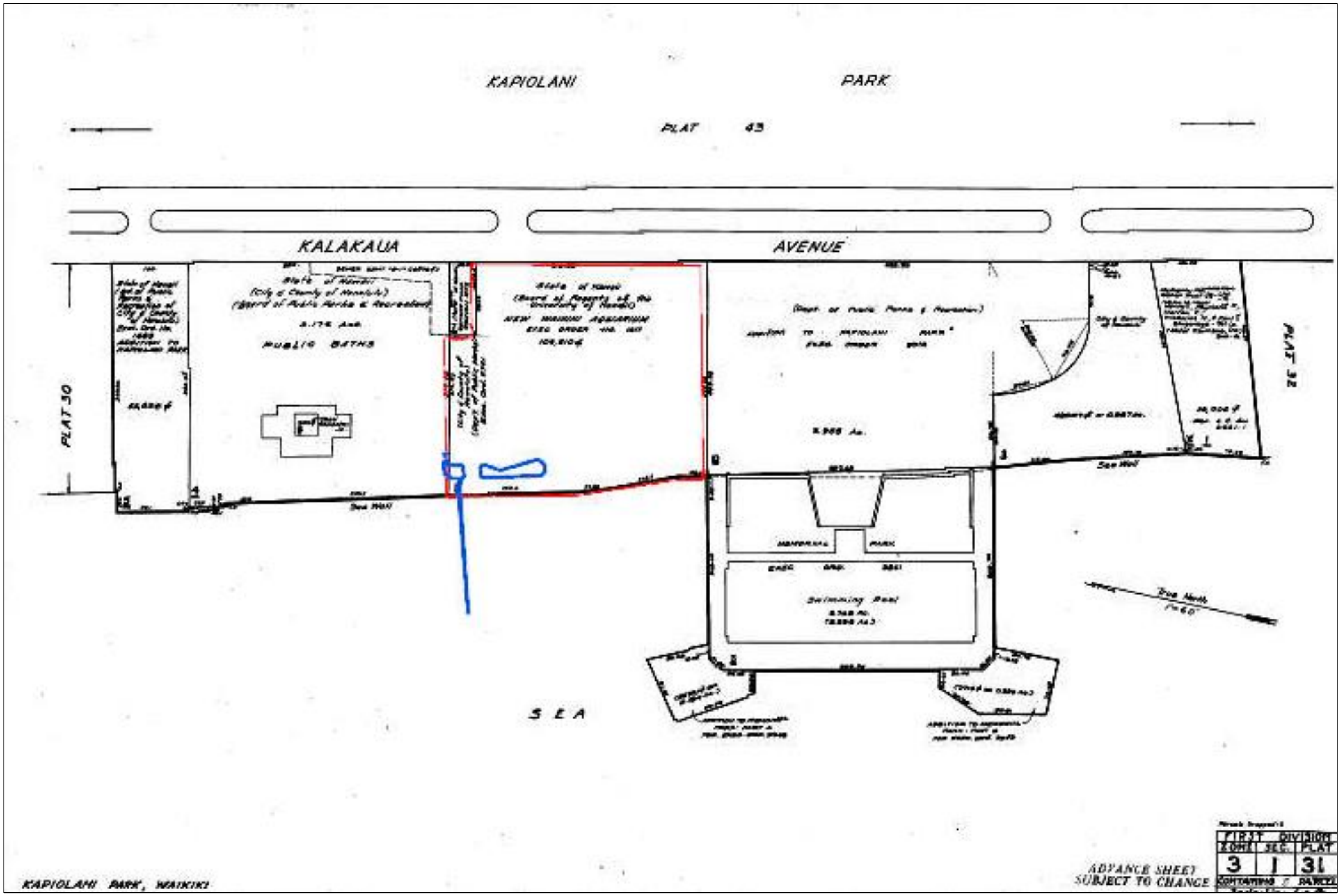


Figure 2. Waikīkī Aquarium Parcel and Project Area Shown on Tax Map Key (TMK) Plat Map (1) 3-1-031:006 (Tax Maps Bureau 1932).

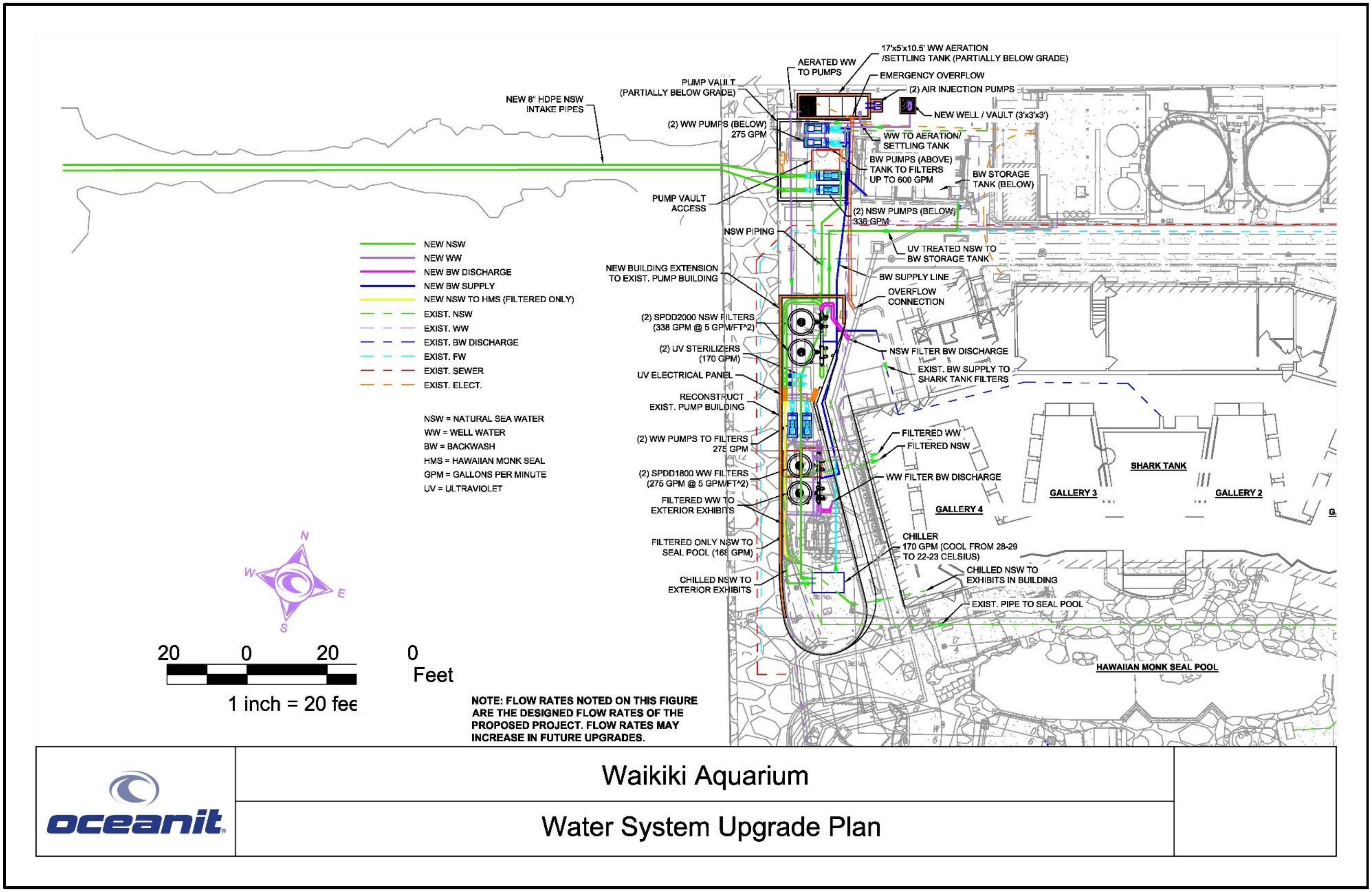


Figure 3. Design Plan for the Waikīkī Aquarium Intake System Upgrade.

1

TOPOGRAPHY AND SOILS

The project area is in a low-lying coastal zone, approximately 3.0 m (9.8 feet [ft]) above mean sea level (amsl). Two major soil series are present, as shown in Figure 4. Most of the project area contains beaches (BS), while the remainder is classified as Jaucas sands (JaC). Areas classified as beaches consist of either sand derived from coral and seashell, or in some cases basalt and andesite (Foote et al 1972:28).

The Jaucas sands series are found on vegetated beach and sand dune areas along the shore. These soils formed in calcareous sand deposits. They are very deep, excessively drained, and have very rapidly permeability (Foot et al. 1972:48). Areas containing these soils are typically used for recreation and as marine wildlife refuges. Vegetation consists of sea grape (*Coccoloba uvifera*), coconut (*Cocos nucifera*), and other xerophytic and salt-tolerant plants. From a historic preservation perspective, deposits of Jaucas Sands are often associated with the presence of traditional Hawaiian burials and subsurface cultural deposits.

Prior to the 1900s, Waikīkī had a long history of productive wetland agriculture and aquaculture (Nakamura 1979). These activities came to a halt in the first part of the twentieth century with the dredging of the Ala Wai Canal and the filling of land. Consequently, it is typical to find substantial historic fill deposits, which consist of either calcareous marine sediments originating from the dredging of the Ala Wai Canal, imported terrigenous fill, or a combination of both, overlying in situ soils in the lowlands of Waikīkī.

RAINFALL, HYDROLOGY, AND VEGETATION

Annual rainfall in the project area averages 596.3 millimeters (mm) (23.48 in) per year with a majority of the rain falling between October and March (Giambelluca et al. 2013). The vegetation in the project area consists of modern landscaping associated with the aquarium grounds and includes both indigenous and introduced species.

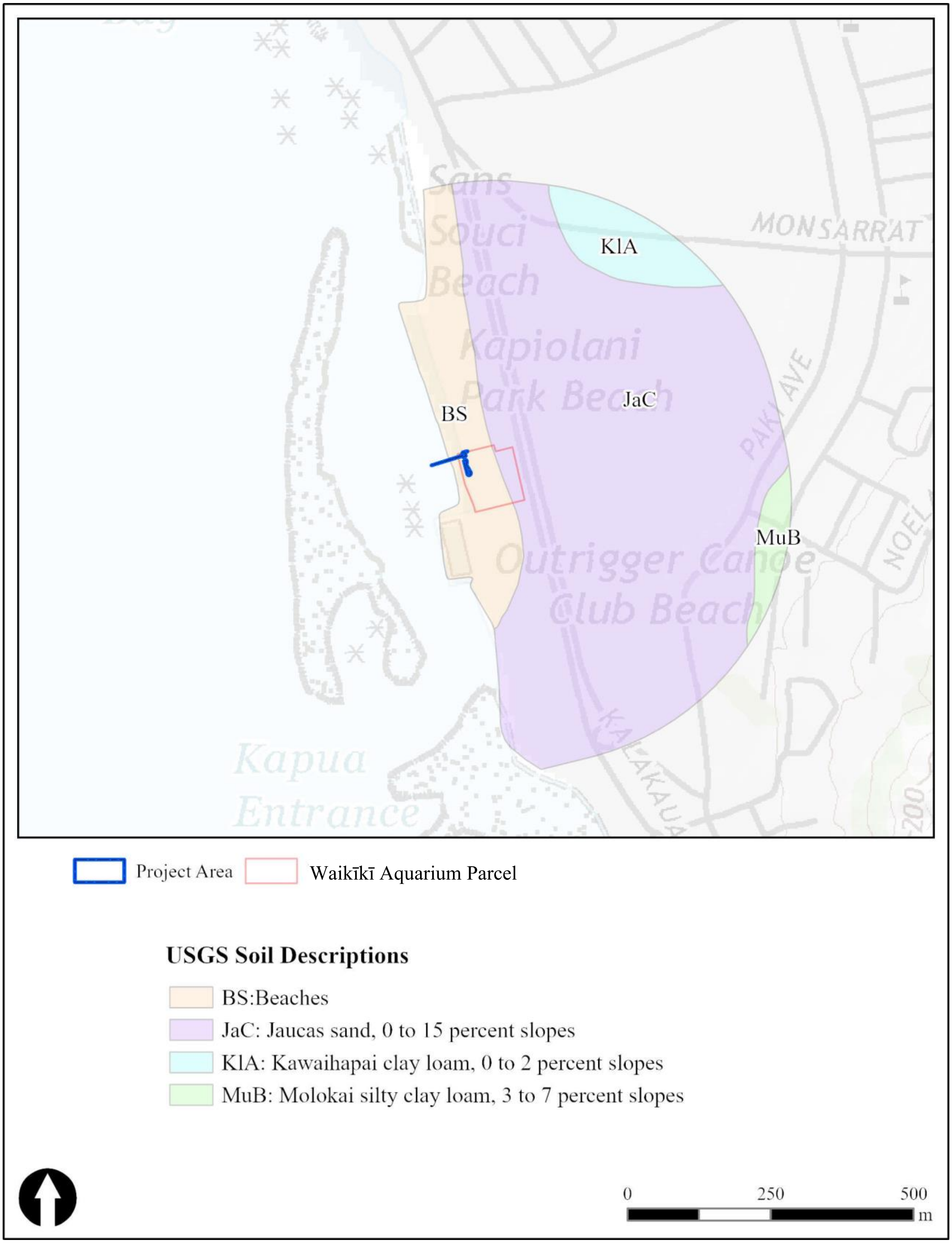
HISTORICAL BACKGROUND

Archival background research and literature review examined maps, historical and archival documents, and previous archaeological studies in the vicinity of the project area. Relevant historical maps were georeferenced to determine where traditional Hawaiian or historic features may fall within the project area. The information obtained from these sources was synthesized to present data findings and to evaluate the potential for archaeological and cultural resources in the project area.

The Hawaiian cultural landscape can be described through *moʻōlelo* and *wahi pana* (significant Hawaiian place names). *Moʻōlelo* may be myths, legends, proverbs, and events surrounding well-known individuals in Hawaiian history (Pukui and Elbert 1986:254). The project area is situated in the *ʻili* (land division of an *ahupuaʻa*) of Kāneloa in Waikīkī Ahupuaʻa. Kāneloa can be translated as "tall Kāne" (Pukui et al. 1974:84). Waikīkī, which can be translated as "spouting water" (Pukui et al. 1974:223), is named for its former wetlands fed by numerous streams from the valleys of Makiki, Mānoa, and Pālolo.

Several *heiau* (traditional Hawaiian temple) were once located in Waikīkī Ahupuaʻa, which were described in Thrum's Hawaiian Annual for 1907. These included Papaʻenaʻena Heiau, Kapua Heiau, Kūpalaha Heiau, Helumoa or Āpuakēhau Heiau, Makahuna Heiau, Kamauakapu Heiau, Kulanihakoi Heiau, and Pahu-a-Maui Heiau (Thrum 1906a:44–45; Thrum 1906b: 49–69). Also mentioned in the Annual are four large *pohaku* —also of religious significance—commonly called the Wizard Stones of Kapeimāhū, which are extant to today at Waīkikī Beach (Boyd 1906:139–141). Not noted by Thrum are two other *heiau* formerly present in Waikīkī: Hale Kumukaʻaha Heiau, which was mentioned by Hawaiian historian Samuel Kamakau in the Hawaiian newspaper *Kuakoa* (McAllister 1933:78), and "Altar Opunaha," which appears

Figure 4. Soil Units in the Vicinity of the Waikīkī Aquarium Parcel (Soil Survey Staff, NRCS, USDA 2022).



on a ca 1876 historic map by C.J. Lyons of the south coast of Oʻahu (Register Map [RM] RM 727). It is unclear if latter site was something other than a *heiau.* Another undated but contemporaneous map by Lyons of Kāneloa does not label the site as an altar. These two maps are shown in Figures 5 and 6. During background research, the only historical sources identified mentioning Opunaha[2] are death notices dating to the 1860s in *Kuakoa* that cite Opunaha, Waikīkī or Waikīkī Kai as the place of death.

The most well-known *heiau* of those listed above is Papaʻenaʻena Heiau. Numerous accounts of this *heiau* from early voyagers were compiled by McAllister (1933:71–74). This *heiau* was located on the west side of Diamond Head and visible from Waikīkī, as shown in Figures 5 and 6 (McAllister 1933:71). Thrum further offers that it was "at the foot of Diamond Head slope, rear of Douglas' premises" (Thrum 1906a:44). It was a *heiau poʻokanaka* (*heiau* where human sacrifices were made) and known for the number of sacrifices carried out by Kamehameha I. A description of Papaʻenaʻena Heiau during this early period is from the journal of Tyerman and Bennet (1832:48–49).

> In the year 1804, when the late king, Tamehameha, was on his way from Hawaii, to invade Tauai, he halted with an army of eight thousand men at Oahu. The yellow fever broke out among the troops, and in the course of a few days swept away more than two-thirds of them. During the plague, the king repaired to the great marae at Wytiti, to conciliate the god, whom he supposed to be angry. The priests recommended a ten days' tabu, the sacrifice of three human victims, four hundred hogs, as many cocoanuts, and an equal number of branches of plantains. Three men, who had been guilty of the enormous turpitude of eating cocoa-nuts with the old queen (the present king's mother), were accordingly seized and led to the marae. But there being yet three days before the offerings could be duly presented, the eyes of the victims were scooped out, the bones of their arms and legs were broken, and they were then deposited in a house, to await the coup de grace on the day of sacrifice. While these maimed and miserable creatures were in the height of their suffering, some persons, moved by curiosity, visited' them in prison, and found them neither raving nor desponding. But sullenly singing the national *huru*---dull as the drone of a bagpipe, and hardly more variable-as though they were insensible of the past, and indifferent to the future. When the slaughtering time arrived, one of them was placed under the legs of the idol, and the other two were laid, with the hogs and fruit, upon the altar-frame. They were then beaten with clubs upon the shoulders till they died of the blows.-This was told us by an eye-witness of the murderous spectacle [Tyerman and Bennet 1832:48–49].

A chief named Kaolohaka is also said to have been sacrificed at this *heiau*: "Fragments of its walls, torn down in 1860, show it to have been about 240 feet square; said to be the place of sacrifice of Kaolohaka, a chief of Hawaii, on suspicion of being a spy" (Thrum 1906a:44).

Based on various accounts, McAllister determined that the *heiau* was "a quadrangular paved terrace, with walls on three sides, but open on the west side, which faced the village of Waikīkī and the sea" (McAllister 1933:74). Multiple step-like terraces led to the open side of the *heiau*. Averaging measurements, given by first-hand accounts, McAllister estimated that the *heiau* was approximately 128 feet by 68 feet with walls 6.2 feet high and 3 feet wide. According to Thrum (1906a:44) the *heiau* was destroyed by Kanaina in 1856 and the stones were used to enclose Queen Emma's premises and for road work.

Kapua Heiau was located somewhere in or near Kapiʻolani Park and is mentioned in the *Legend of Pumaia* (Fornander 1918-1919). Pumaia was a pig farmer who lived in Pukaola in the Kona District of Oʻahu. The king of Oʻahu, Kūaliʻi, was building Kapua Heiau, "east of Leahi Hill overlooking Māmala Bay" (Fornander 1918-1919: 470). When the *heiau* was complete, Kūaliʻi repeatedly ordered pigs from

[2] Kumu Hula Samuel M. ʻOhukaniʻōhiʻa Gon III, a scientist, Hawaiian cultural practitioner, paleobiologist, and teacher has held a changing of the seasons event on the north side of the aquarium: "We gathered at the water's edge at the site of the heiau Kūpalaha, the sibling heiau of Papaʻenaʻena (that still graces the base of Leahi) where, from its kuahu (altar), named Opunaha, the setting sun would be observed by the kahuna kilolani, and on a certain day, the sun would set into the bowl of Puʻu o Kapolei, when seen from Opunaha, marking the end of the Hoʻoilo [Hawaiian Cool Wet Season] and the start of the Kauwela [Hawaiian Hot Dry Season], and the reactivation of the luakini heiau of Kū." (https://www.facebook.com/events/1751387621819771/?acontext=%7B%22ref%22%3A%223%22%2C%22ref_newsfeed_story_type%22%3A%22regular%22%2C%22action_history%22%3A%22null%22%7D).

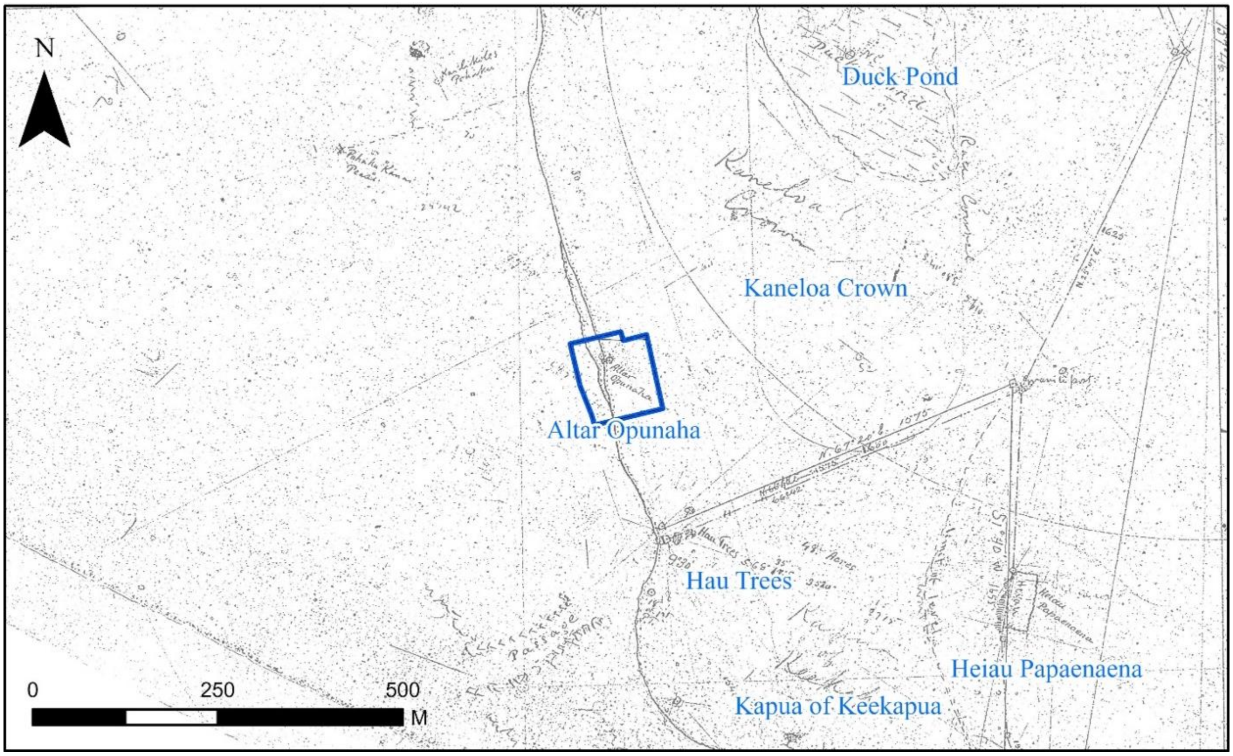


Figure 5. Portion of ca 1876 Map of the South Coast of Oʻahu by C.J. Lyons Showing "Altar Opunaha" and "Heiau Papaenaena" in Relation to the Project Parcel (Reg. 727). Blue Text Added for Clarity.

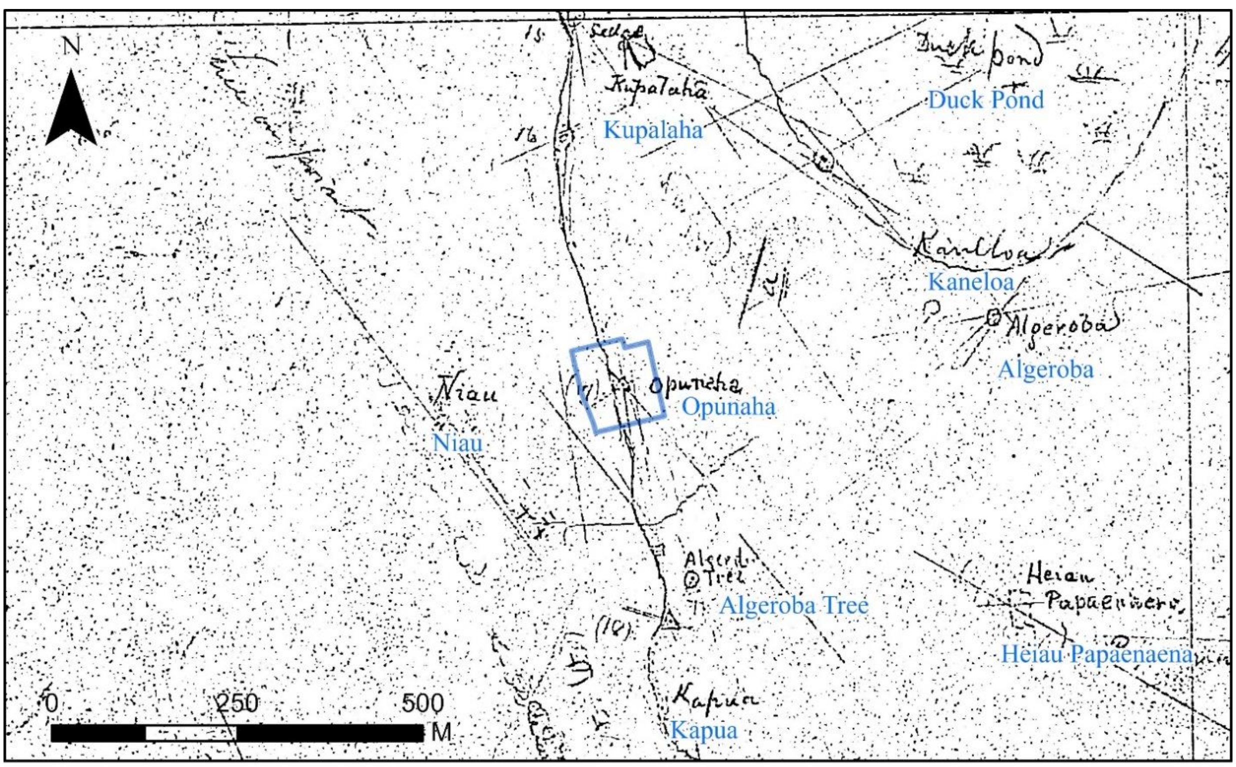


Figure 6. Portion of ca 1876 Map of Kāneloa by C.J. Lyons Showing "Opunaha," Kupulaha," and "Heiau Papaenaena" in Relation to the Project Parcel. Blue Text Added for Clarity.

Pumaia until one day Pumaia refused to oblige him. The king's men fought Pumaia over one of the pigs and all the men were killed by Pumaia but one. Kūali‘i then declared war on Pumaia. Pumaia won multiple battles against the king's soldiers until finally Kūali‘i prayed to his god to capture Pumaia. Only then was he caught and bound: "Kualii was so incensed at Pumaia that he was immediately killed and was dragged to Kapua where his dead body was thrown into the pit with the men he had killed. During the ill treatment given his body, the jaws were crushed and cut up into fragments" (Fornander 1918-1919:474).

Makahuna Heiau was once located on the south side of Diamond Head, overlooking "Aqua Marine" and near the former residence of Honorable Sanford B. Dole (McAllister 1933:196). According to a historic map by Wall (1893), this places the *heiau* west of Diamond Head Lighthouse. McAllister offers the following accounts:

> Thrum writes: "A large heiau enclosure dedicated to Kane and Kanaloa, of Kuula character, so said." Tucker reports: "Opposite the residence of the Honorable Sanford B. Dole. The ruins of a heiau of the Pookanaka class. Was located at this place in order to propitiate, by human sacrifice, the departure of the Aliis to foreign shores, and Black Point, between that and Kahala, was called Keala o Kahiki. These ruins are mostly all overgrown and have been used probably to make fences or for road purposes. A dense growth of lantana and kiawe, scrub kiawe, covers the ruins" [McAllister 1933:196].

According to Thrum (1906a), Kūpalaha Heiau was located at Kapi‘olani Park near Cunha's, which is a surfing area named for the Emmanuel S. Cunha estate near Kapahulu and Kalākaua Avenues (Pukui et al. 1974). The location of this estate is shown in Figure 7. In his description Thrum wrote: "Entirely obliterated. Class unknown, but said to have had connection in its workings with Papaenaena" (Thrum 1906a:44). Hammatt and Chiogioji (2002:9) locate Kūpalaha Heiau "on or adjacent to Kalākakua Ave., just southeast of the intersection with Monsarrat Ave." This *heiau* was associated with a legend involving Kākuhihewa, *mō‘i* (king) of O‘ahu circa 1540–1634, and Pueo Ali‘i (king of the owls). In the legend, a man named Kapoi went to gather pili grass at a marsh near the beach. He found seven owl eggs that he collected with the intention of later eating (Thrum 1907:200–202; Westervelt 1915:133–136). After returning home, an owl arrived at his fence and cried out "O Kapoi, give me my eggs!" Hearing the repeated pleas, Kapoi returned the eggs. The owl became his *‘aumakua* (family god) and instructed him to build Manua Heiau (situated on the southwest side of Pūowaina [Punchbowl Crater]). After building the *heiau* he made an offering of bananas and set the *kapu* (taboo) days for its dedication. At the same time, Kākuhihewa was building a *heiau* in Waikīkī and he made a law that if any person built a *heiau* and set the *kapu* before him, that person would be put to death. Kapoi was arrested and taken to the Kūpalaha Heiau in Waikīkī. Kapoi's *‘aumakua* owl tried to help him by calling on all of the owls in the islands to gather and fly to Kūpalaha Heiau to battle the king's men. The king's men surrendered, and the owls won the battle. Since that day, the owl was considered a powerful *akua* (god) and the location of the battle was known as Kukaeunahio-ka-pueo, which means "the confused noise of owls rising in masses" (Thrum 1907:200–202; Westervelt 1915:133–136).

TRADITIONAL HISTORY AND LAND USE

Paleoenvironmental and archaeological data indicate that the Hawaiian Archipelago was settled between A.D. 1000 and 1100 (Athens et al. 2014), with some of the earliest evidence coming from O‘ahu Island. In the 1400s, Mā‘ilikūkahi, *ali‘i nui* of O‘ahu, went with his chiefs to the south side of the island and Waikīkī became the seat of royal power. Kamakau wrote of Waikīkī as a home to chiefs:

> Waikīkī sits proudly in the calm of the Ka‘ao breeze… Waikīkī was a land beloved of the chiefs and there many of them lived from remote times to the time of board surfing could be indulged in there, and for this reason the chiefs liked the place very much. At Waikīkī are the surfs of Ka-lehua-wehe, ‘Aiwohi, Maihiwa, and Kapuna [Kamakau 1991:44].

Mā‘ilikūkahi was born at Kūkaniloko and was chosen to be *mō‘i* at age 29 (Kamakau 1991:53). According to Kamakau, "Soon after he became *mō‘i* the chiefs took Mā‘ili-kūkahi to Waikīkī to live; he

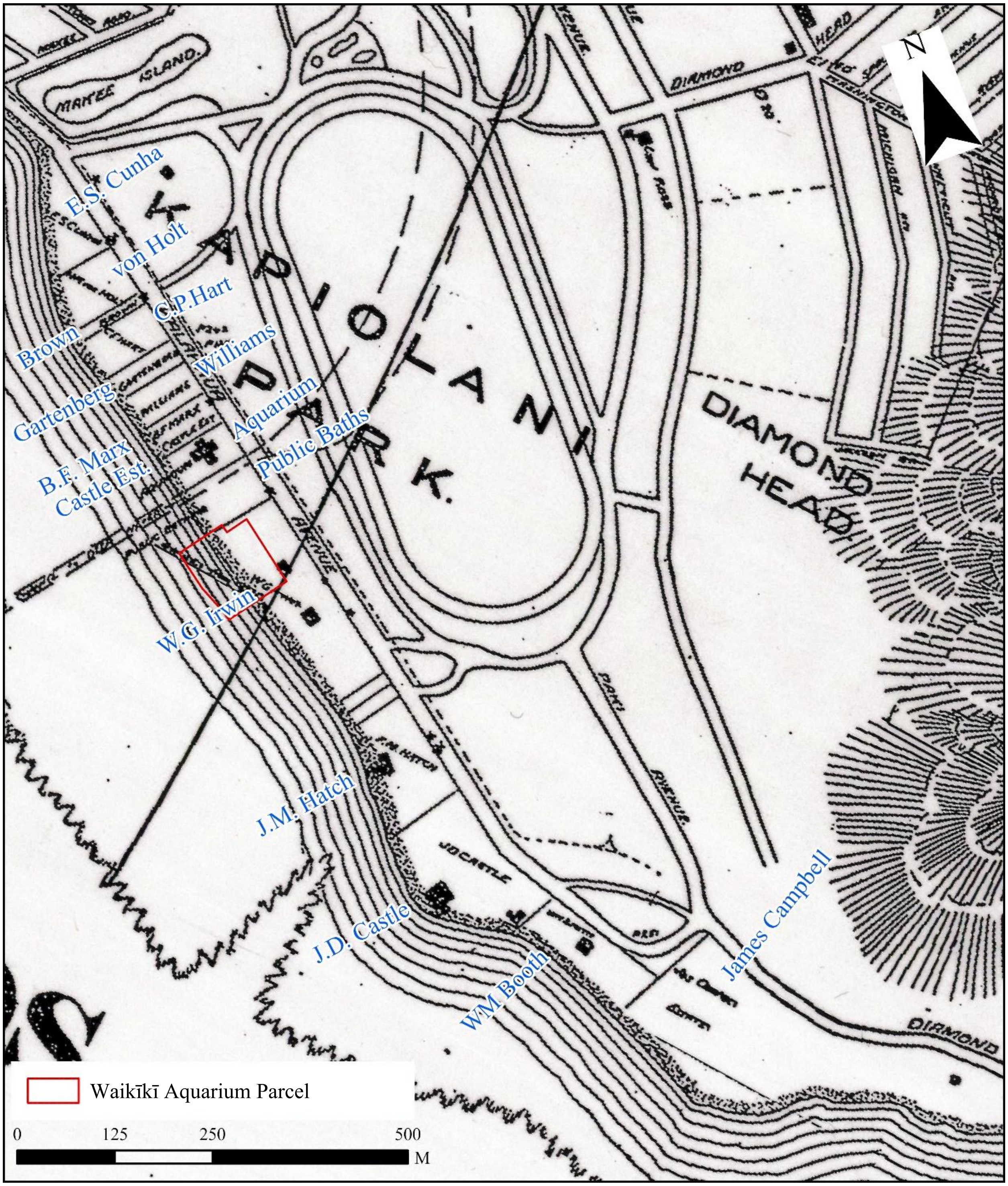


Figure 7. Portion of 1912 Map of Honolulu Old Aquarium Location and Estates of Prominent Individuals Along the Coast (Dove 1912).

was perhaps the first of the ruling chiefs to live there. Until then the chiefs had lived in Wai‘alua and ‘Ewa" (Kamakau1991:53). Mā‘ilikūkahi is also attributed with creating the land division system, enacting just laws, and bringing peace and prosperity to the island (Kamakau 1991:54–56). According to Kamakau (1991):

> When the kingdom passed to Mā‘ili-kūkahi, the land divisions were in a state of confusion; the *ahupua‘a*, the *kū* [‘ili kūpono], the *‘ili ‘āina*, the *mo‘o ‘āina*, the *paukū ‘āina*, and the *kīhāpai* were not clearly defined. Therefore Mā‘ili-kūkahi ordered the chiefs, *ali‘i*, the lesser chiefs, *kaukau ali‘i*, the warrior chiefs, *pū‘ali ali‘i*, and the overseers, *luna* to divide all of O‘ahu into *moku* and *ahupua‘a*, *‘ili kūpono*, *‘ili ‘āina*, and *mo‘o ‘āina*. There were six districts, *moku*, and six district chiefs, *ali‘i nui ‘ai moku*. Chiefs were assigned to the *ahupua‘a*—if it was a large *ahupua‘a*, a high chief, an *ali‘i nui*, was assigned to it. Lesser chiefs, *kaukau ali‘i*, were placed over the *kūpono* lands, and warrior chiefs over *‘ili ‘āina*. Lands were given to the *maka‘āinana* all over O‘ahu [Kamakau 1991:54–55].

Another O‘ahu chief known for ruling during a time of prosperity on O‘ahu was Chief Kalamakua-a-Kaipūhōlua. He ruled around the sixteenth century (based on Stokes' [1933] 20 year-count; Kelly 1989) and was the first to build an extensive irrigation system of *loko ‘ai* (fishpond) and *lo‘i* (irrigated taro field) in Waikīkī. Kamakau wrote:

> Kalamakua-a-Kaipūhōlua was a good chief. He was noted for cultivating, and it was he who constructed the large pond fields Ke‘okea, Kūalulua, Kalāmanamana, and other *lo‘i* in Waikiki. He traveled about his chiefdom with his chiefs and household companions to cultivate the land and gave the produce to the commoners, the *maka‘āinana* [Kamakau 1991:45].

In 1780, the army of Maui chief Kahekili landed at Waikīkī "carpeting the beaches from Ka‘alawai (near Diamond Head) to Kawehewehe (next to the Halekulani Hotel)" (Kanahele 1995:79). At the time, his nephew Kahahana was *ali‘i nui* of the island. Kahahana, along with his wife Kekuapo‘i‘ula and his retainer Alapa‘i, fled to the mountains where they were cared for by sympathetic *maka‘āinana* (commoner) (Kamakau 1992:136). They hid successfully for two and a half years but were then found out. Kahekili had Kahahana and Alapa‘i killed at Waikele and their bodies taken to him in Waikīkī.

According to Thrum (1925:109), Kahekili dedicated Papa‘ena‘ena Heiau, formerly located in the vicinity of Diamond Head, following his victory. In 1794, Kahekili died and was succeeded by Kalanikupule. The next year, Kamehameha invaded O‘ahu at Waikīkī, possibly with 10,000 warriors. The army made their base on the sandy beaches from Wai‘alae to Diamond Head to Kālia (Kanahele 1995:87). The final battle ended at Nu‘uanu when O‘ahu warriors became trapped between Kamehameha's warriors and the *pali* (cliff) and chose to leap to their deaths (Tomonari-Tuggle and Blankfein 1998:13). After the battle of Nu‘uanu, Kalanikūpule fled but was later captured and then scarified.

Kamehameha made his capital at Waikīkī and the area became the chiefly center of the south coast where the ruling chief and subordinate *ali‘i* (chiefly class) resided (Cordy 1996; Nāpōkā 1986; Tomonari-Tuggle 1994). Hawaiian historian John Papa ‘Ī‘ī (1959) describes Kamehameha's residence in Waikīkī:

> Kamehameha's houses were at Puaaliilii, makai of the old road, and extended as far as the west side of the sands of Apuakehau [vicinity of Moana Surfrider Hotel]. Within it was Helumoa [vicinity of Royal Hawaiian Hotel], where Kaahumanu ma went to while away the time. The king built a stone house there, enclosed by a fence; and Kamalo, Wawae, and their relatives were in charge of the royal residence. Kamalo and Wawae were the children of Luluka and Keaka, the childhood guardians of Kamehameha.
>
> This place has long been a residence of chiefs. It is said that it had been Kekuapoi's home, through her husband Kahahana, since the time of Kahekili. Haalou, a makuahine of Kamehameha, lived there with her younger daughter Kekuapoi while en route from Hawaii to Kauai to consult Kapoukahi, a seer of Kauai, for means whereby Kamehameha would gain victory over Keoua Kuahuula [‘Ī'ī 1959:17].

EARLY HISTORIC LAND USE

Waikīkī is described as a richly productive area in accounts by early European explorers. An early map by Lieutenant C. R. Malden of the Royal Navy, shown in Figure 8, shows cultivated land, freshwater ponds, “Ruins of a Morai”, “Fresh Water Ponds”, and a coconut grove in the vicinity of the project area. In 1792, Captain George Vancouver of the H.M.S. Discovery arrived at “Whyteete” and noted the field systems:

> On the shores, the villages appeared numerous, large, and in good repair; and the surrounding country pleasingly interspersed with deep, though not extensive valleys; which, with the plains near the sea-side, presented a high degree of cultivation and fertility.
>
> This opened to our view a spacious plain, which, in the immediate vicinity of the village, had the appearance of the open common fields in England; but, on advancing, the major part appeared divided into fields of irregular shape and figure, which were separated from each other by low stone walls, and were in a very high state of cultivation. These several portions of land were planted with the eddo or taro root, in different stages of inundation; none being perfectly dry, and some from three to six or seven inches under water. The causeway led us near a mile from the beach, at the end of which was the water we were in quest of. It was a rivulet five or six feet wide, and about two or three feet deep, well banked up, and nearly motionless; some small rills only, finding a passage through the dams that checked the sluggish stream, by which a constant supply was afforded to the taro plantations.
>
> In this excursion we found the land in a high state of cultivation, mostly under immediate crops of taro; and abounding with a variety of wild fowl, chiefly of the duck kind, some of which our sportsmen shot, and they were very fine eating. The sides of the hills, which were at some distance, seemed rocky and barren; the intermediate vallies, which were all inhabited, produced some large trees, and made a pleasing appearance. The plains, however, if we may judge from the labour bestowed on their cultivation, seem to afford the principal proportion of the different vegetable productions on which the inhabitants depend for the subsistence [Vancouver 1798:161–164].

Also aboard the H.M.S. Discovery was surgeon and naturalist Archibald Menzies. He echoed Vancouver’s description of a bountiful land:

> The verge of the shore was planted with a large grove of coconut palms, affording a delightful shade to the scattered habitations of the natives. Some of those near the beach were raised a few feet from the ground upon a kind of stage, so as to admit the surf to wash underneath them. We pursued a pleasing path back into the plantation, which was nearly level and very extensive, and laid out with great neatness into little fields planted with taro, yams, sweet potatoes and the cloth plant. These, in many cases, were divided by little banks on which grew the sugar cane and a species of Draecena without the aid of much cultivation, and the whole was watered in a most ingenious manner by dividing the general stream into little aqueducts leading in various directions so as to be able to supply the most distant fields at pleasure, and the soil seemed to repay the labor and industry of these people by the luxuriancy of its productions. Here and there we met with ponds of considerable size, and besides being well stocked with fish, they swarmed with water fowl of various kinds such as ducks, coots, water hens, bitterns, plovers, and curlews [Menzies 1920:23–24].

Several others followed Vancouver and Menzies in describing Waikīkī over the next few decades. Peter Corney wrote of Waikīkī between 1813 and 1818:

> On rounding Diamond hill the village of Wyteetee (Waikiki) appears through large groves of cocoanut and bread-fruit trees; it has a most beautiful appearance, the land all round in the highest state of cultivation, and the hills covered with wood; a beautiful plain extending as far as the eye can reach. A reef of coral runs along the whole course of this shore, within a quarter of a mile of the beach, on which the sea breaks high; inside this reef there is a passage for canoes [Corney 1965:193].

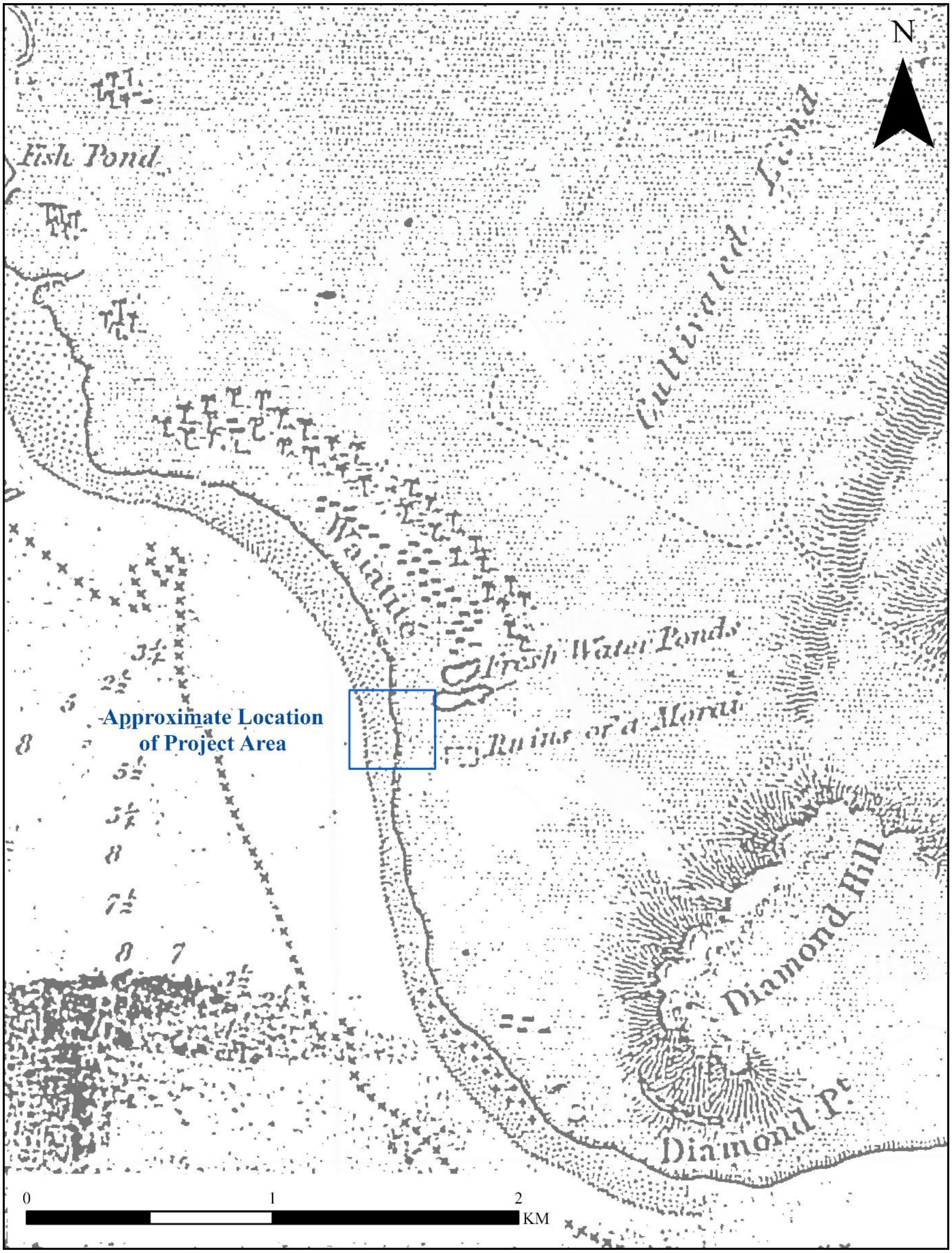


Figure 8. Portion of Historical Map by Malden (1825) Showing the Approximate Location of the Project Area.

Otto von Kotzebue commander of the Russian ship Rurick viewed Waikīkī from the sea in 1816. His description of the land follows:

> but you have scarcely sailed round the Yellow Diamond Hill, when you are surprised by the most beautiful landscape. Close to the shore you see verdant valleys adorned with palm and banana-trees, under which the habitations of the savages lie scattered; behind this, the land gradually rises, all the hills are covered with a smiling verdure, and bear the stamp of industry [von Kotzebue 1821:320].

Finally, the naturalist Andrew Bloxam was ashore from the H.M.S. Blonde in 1824–1825 when he noted the abundance of Waikīkī:

> I walked along shore towards the bay of Whyteete to see if I could procure any shells, but I found none worth picking up. The whole distance to the village of Whyteete is taken up with innumerable artificial fishponds extending a mile inland from the shore, in these the fish taken by nets in the sea are put, and though most of the ponds are fresh water, yet the fish seem to thrive and fatten. Most of these fish belong to the chiefs, and are caught as wanted. The ponds are several hundred in number and are the resort of wild ducks and other water fowl. I found it very difficult to get out of the labyrinth of paths which lead among them. Whyteete is about four miles east of Honoruru [Honolulu]. It is pleasantly situated and built along the shore among numerous groves of coconut and other trees, and in this respect far better than Honoruru, as scarcely any trees are to be found there [Bloxam 1925:35–36].

This period of political importance ended for Waikīkī in 1809, when Kamehameha moved his capital to Honolulu, which was more accessible to Western visitors (Tomonari-Tuggle and Blankfein 1998:13). Following this move, traditional agriculture in Waikīkī waned. The population in the area had drastically decreased due to economic changes and the devastation caused by Western diseases. The missionary Levi Chamberlain noted these changes when writing in 1828:

> Our path led us along the borders of extensive plats of marshy ground, having raised banks on one or more sides, and which were once filled with water, and replenished abundantly with esculent fish; but now overgrown with tall rushes waving in the wind. The land all around for several miles has the appearance of having once been under cultivation. I entered into conversation with the natives respecting this present neglected state. They ascribed it to the decrease of population [Chamberlain 1957:26].

The Māhele

Traditional land divisions of the fifteenth and sixteenth centuries persisted until the 1848 Mahele, which introduced private property into Hawaiian society (Kamakau 1991:54). During the Mahele, the Land Commission required the Hawaiian chiefs and *konohiki* (land agent for the *ali‘i*) to present their claims to the Land Commission. In return they were granted Land Commission Awards (LCAs) for the land quit-claimed to them by Kamehameha III. Land was divided into Crown Lands, Government Lands, and Konohiki Lands. The remaining unclaimed land was then sold publicly, “subject to the rights of the native tenants” (Chinen 1958:29).

In the case of land claims made for Konohiki lands, approval by the Land Commissioners was required before the award was made. If approved, then the awardee obtained a Royal Patent (RP) from the Minister of the Interior, which indicated that the government’s interest in the land had been settled with a commutation fee. This fee was typically no more than one-third of the value of the unimproved land. This fee was paid either in cash, or, more commonly, the return of one-third of the awardee’s lands (or total value of the lands awarded) (King 1945).

Following the Mahele of 1848, two acts were passed in 1850 that changed land ownership in Hawaii. On 10 July 1850, the Alien Land Ownership Act was adopted, which allowed foreigners to own land. On 6 August 1850, the Kuleana Act of 1850 was adopted, which allowed *hoa‘āina* (common people of the land, native tenants) to make claims to the Land Commission. The new western system of ownership resulted in many losing their land. Often *kuleana* (property) claims would be made for discontiguous cultivated plots with varying crops, but only one parcel would be awarded.

The Crown Lands became Government Lands when the Hawaiian Government was overthrown in 1895, making them public domain for sale by fee simple (Alexander 1920). Patents were the certificates issued for the sale of such lands. Beginning in 1900, when Hawaii became a U.S. territory, the certificates were called Land Patents, or Land Patent Grants (Alexander 1920).

Records indicate that the *ʻili of* Kāneloa was returned by Aaron Kealiʻiahonui at the Māhele and retained by Crown. LCAs in the ʻ*ili* were limited to a 20.85-acre square lot northwest of the project area (today's southwest corner of Paki and Kapahulu avenues). Within the lot, 4.35 acres were *kuleana* parcels and 15.0 acres were Crown *loʻi*. Other land within the lot included a pond and grassland. The remainder of the ʻ*ili* (171.0 acres) consisted of level open plain—referred to on historic maps Kāneloa Plain—and a seasonal pond.

LATE HISTORIC LAND USE

In 1876 a group of prominent businessmen, which included Archibald Cleghorn, John O. Dominis, and James Makee, formed the Kapiʻolani Park Association. King David Kalākaua offered a 30-year lease of Kāneloa and Kapua (neighboring *ʻili* to the east) for the endeavor on the east side of Waikīkī, which was at the time crown land. According to the association's charter, the park would serve the purpose "of adorning and putting in order, a tract of land in the vicinity of Honolulu as a place of public resort, and of promoting Agricultural and Stock Exhibitions, and healthful exercise, recreation and Amusements" (Abel 1992:3–4). Kalakaua dedicated the park in June of 1877 in honor of Queen Kapiʻolani. At this time, the east portion of the park was sparsely vegetated and sandy, while the western portion contained wetlands and streams. Consequently, the park's development entailed road building, drainage, and extensive plantings of ironwood, banyan, date palm, and other trees (Abel 1992:4).

Up until 1913, the park was managed by the Honolulu Park Commission whose mission was to operate the park as a public space (Abel 1992:5). During this nascent period, the oceanfront parcels were lost to private individuals in an effort to raise money for the Association through subleasing beachfront lots for residences (see Figure 7). Some of these lots were reacquired in 1905, though others became private property with the overthrow of the monarchy in 1893 (Hibbard and Franzen 1986:43). In 1898, the year Hawaiʻi was annexed to the United States, a temporary U.S. military camp was established at the park, which cause damage to the roads and a horse racing track at the park's center. In 1900, horse racing was banned and subsequently the track was used as an auto raceway and a polo field. Elements of the park that date to the early period (1896 to 1913), include the original aquarium, athletic fields, the bandstand, food concessions, and the beach park and bathhouse.

The aquarium parcel is a portion of property formerly owned by William G. Irwin, a very wealthy businessman in the sugar industry. He formed William G. Irwin and Company, which lasted from the mid-1870s to 1880 (Adler 1958:9). In 1881 he partnered with Claus Spreckels in sugar, banking, and ship building (Nellist 1925:123). In 1896 he became the Chair of the Honolulu Park Commission which oversaw Kapiʻolani Park, as was mentioned above. The Irwin residence was designed by architect Charles Dickey in 1899. It is cited as "[t]he most expensive and impressive of Dickey's early use of the Mission style" (Neil 1975:102). Dickey also designed the Irwin Stable (Neil 1975:105). Photographs of the Irwin home are shown in Figures 9–11. The historical map in Figure 12 shows the project area parcel in relation to the home and stable. In the 1920s, well after Irwin moved to San Francisco, the house was torn down. The Beach Park Memorial Committee had negotiated the purchase of the Irwin Estate in 1919 (Ireland 2005:58) for the construction of the Waikīkī War Memorial and Natatorium (a saltwater pool). In 1913, management of the park was transferred to the Territory of Hawaii (Abel 1992:5). It was at this time the first public zoo appeared in the park:

Figure 9. Photograph of the William G. Irwin Residence (Bishop Museum in Hibbard and Franzen (1986:29).

Figure 10. William G. Irwin (Right) at His Waikīkī Property (Hawaii State Archives 2021).

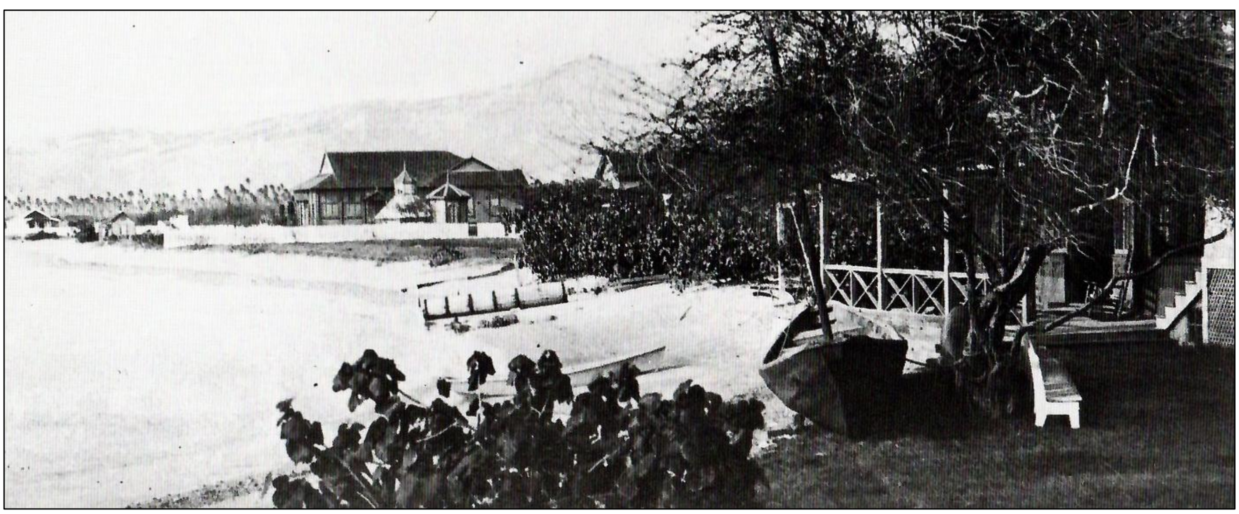


Figure 11. View of Irwin Residence From the Alfred Mitchell House (Bishop Museum in Hibbard and Franzen (1986:22)[3].

[3] This photograph is erroneously dated 1886 in Hibbard and Franzen (1986).

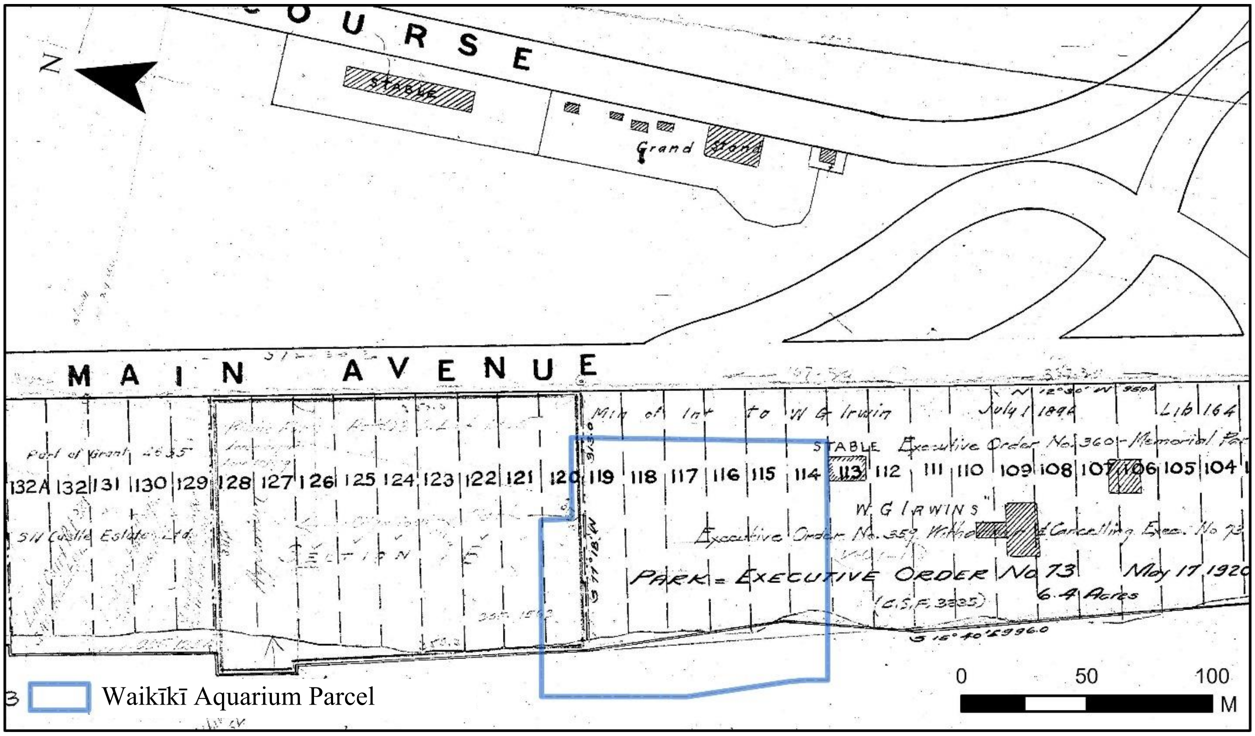


Figure 12. Portion of 1883 Map by Monserrat With Twentieth Century Mark-Ups. Note the Loction of the Irwin House and Stable East of the Project Parcel.

> During 1915 and 1916, acquisition of animals and the construction of cages and bird houses established a "zoological garden." So delighted were officials that they filled the park report for 1916 with photographs of animals and added a detailed list of new park acquisitions that included two lions, twelve monkeys, two bears, one tortoise, four elk, four deer, twelve horses, seven donkeys, forty-six ducks, ten geese, four swans, two cranes two emus, assorted Australian doves, and an African elephant [Weyeneth 1991:28].

In 1919, additional coastal parcels were acquired by the Territory of Hawaii and the Waikīkī War Memorial and Natatorium were built, which opened in 1927. The memorial commemorates World War I servicemen. The competitions at the Natatorium included participation by Duke Kahanamoku, Buster Crabbe, and Johnny Weissmuller in the 1920s. The Waikīkī War Memorial and Natatorium are listed on the Hawaiʻi Register of Historic Places (HRHP) as SIHP Site 50-80-14-09758. Other notable features of Kapiʻolani Park include the Waikīkī Shell (an outdoor amphitheater built in 1953) and the Waikīkī Aquarium. The Waikīkī Aquarium was formerly located roughly 100 yards north of its current location[4]. Constructed in 1904, it was known as the Honolulu Aquarium and was privately financed by Charles M. Cooke and James B. Castle and operated as part of the Honolulu Rapid Transit and Land Company. In 1919 the land lease expired, and the Cooke Estate ceded the lease to the Territory of Hawaii. The present day Waikīkī Aquarium was funded by the Territorial Legislature in 1949 and opened in 1955.

During World War II (WWII), the park again housed the U.S. military. By the end of the war the park had deteriorated, and it entered a period of redevelopment. In 1948, the Honolulu Zoo was established at its current 42.0-acre parcel, the site of a former waterscape. The entrance to the Zoo is listed on the HRHP as SIHP Site 50-80-14-08023.

Kapiʻolani Park is listed on the HRHP as SIHP Site 50-80-14-09758, and is eligible for placement on the National Register of Historic Places (NRHP). However, to date this property has not been added to the NRHP. The significance statement for Kapiʻolani Park as summarized in the NRHP nomination form is listed below:

> Kapiolani Park is historically significant for its past association with indigenous Hawaiian culture and royalty. Hawaiian King Kalakaua envisioned the park as a place of recreation for all and named it after his famous Queen, Kapiolani. Since its dedication in 1877 it has been in continuous use as a location for recreational activities valued by local residents and visitors alike. It provides a sense of place to a special part of Honolulu and is identified with the world famous image of Hawaii as a recreational resort. Over the years it has been the scene of a variety of sports and leisure time activities that reflects the recreational development of Honolulu and Hawaii into the modern world [Abel 1992:3].

PREVIOUS ARCHAEOLOGY

Many archaeological investigations have been conducted in Waikīkī and there have been numerous instances of the inadvertent discovery of human remains, despite the filling of land. Pockets of undisturbed beach sands (i.e., Jaucas Sands) have been observed below the historic fill layers (Bush et al. 2004:37–38), making the possibility of discovering human burials and other cultural materials in this area relatively high. For a detailed summary of previous archaeological investigations and inadvertent discoveries the reader is referred to Shideler and Hammatt (2021) and Vernon (2022). The following section focuses on human burial finds and previous archaeological investigations near the Waikīkī Aquarium. Table 2 summarizes all previous work and the locations of previous projects and previously identified historic properties and human burials are presented in Figures 13 and 14.

[4] Waikīkī Aquarium history is summarized from https://www.waikikiaquarium.org/about/history/.

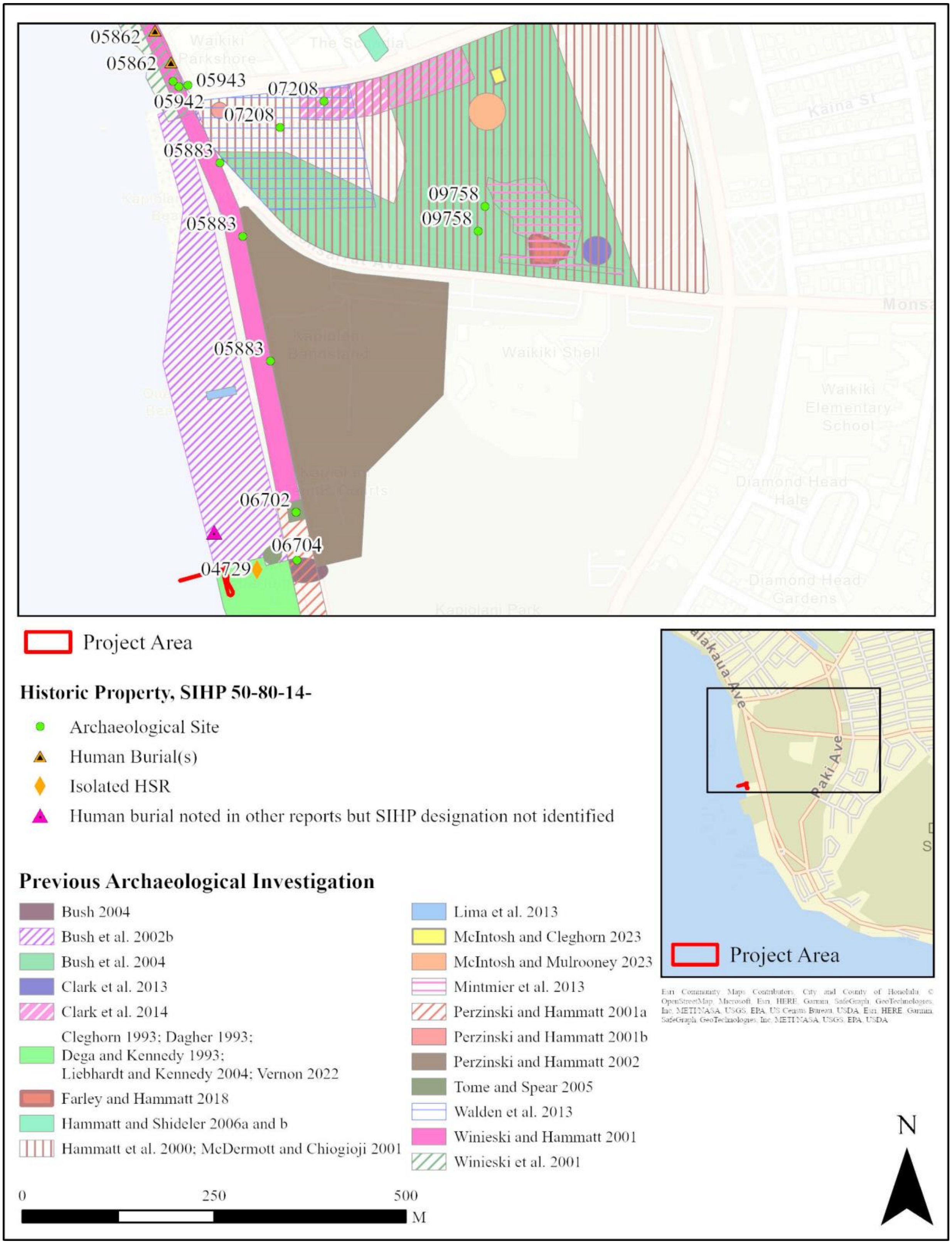


Figure 13. Previous Archaeological Investigations and Historic Properties, Including Human Burials, North of the Project Area.

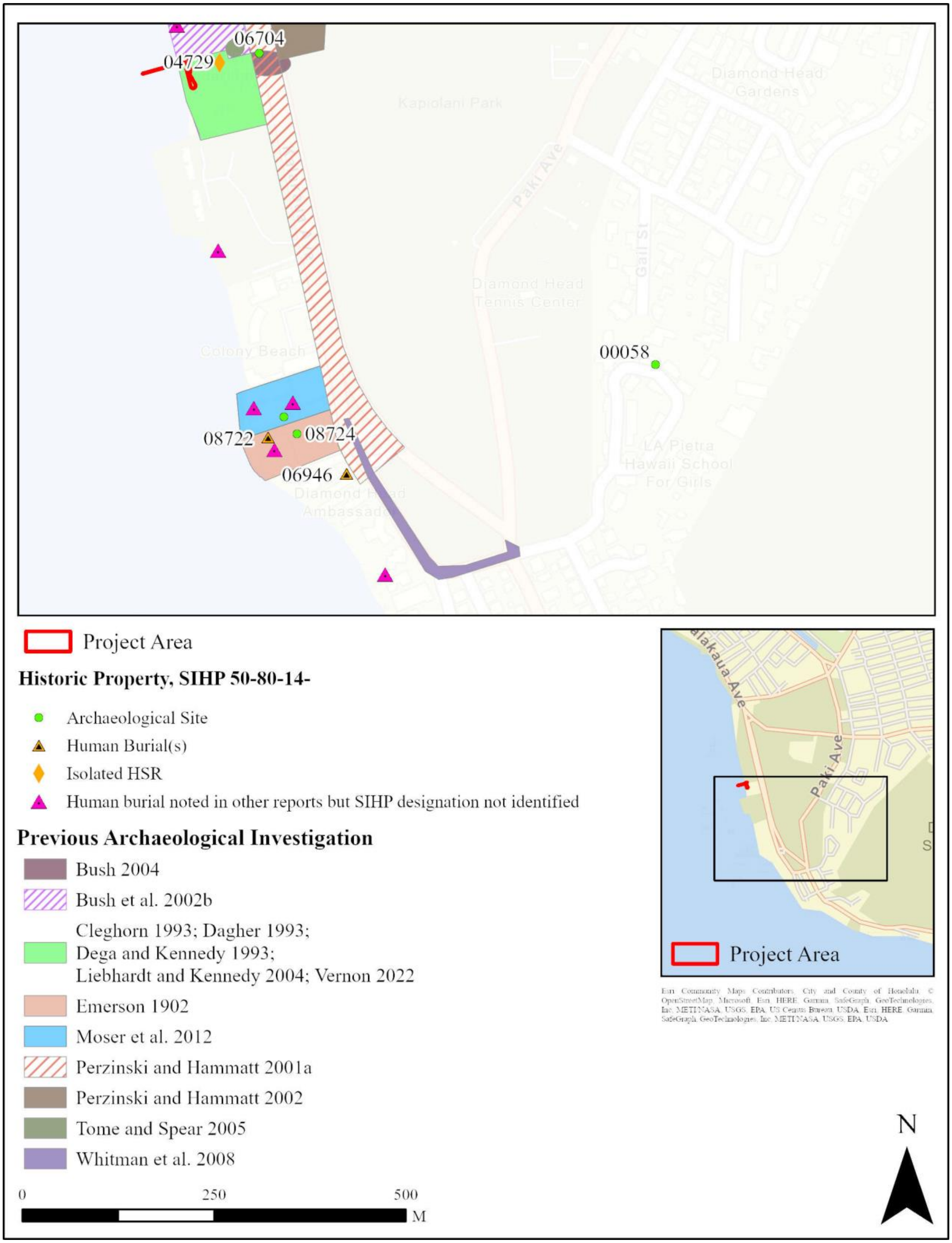


Figure 14. Previous Archaeological Investigations and Historic Properties, Including Human Burials, South of the Project Area.

Table 2. List of Previous Archaeological Studies and Burial Finds Near the Project Area.

Author Year	TMK(s) (1) or Location	Nature of Study	SIHP[1] Site 50-80-14-	Description
Emerson 1902	3-1-032:006/ Today's Elks Club	Inadvertent discovery	No site number	Human skeletal remains of at least four individuals
Hartwell 1927[3]	3-1-031:009/San Souci Beach	Inadvertent discovery	[50-OA-006-33][2]	Human burial
McAllister 1933	Waikīkī (general)	Archaeological Survey	[Site #60]	Waikīkī
BPBM 1957[3]	3-1-032:004(?)/ Diamond Head Apartments (?)	Inadvertent discovery	[50-OA-0391–402][2]	Human burial
Soehren and Sinoto 1964[3] in BPBM 2018	3-1-032:031/ Outrigger Canoe Club	Inadvertent discovery	03705	One humerus (50-Oa-A04-024)
BPBM 1963[3] (Yost 1971)	3-1-032:031/ Outrigger Canoe Club	Inadvertent discovery	[50-OA-A4-25–55]	27 traditional Hawaiian burials
Han and Sinoto 1986[3] in Tulchin and Hammatt 2007:Figure 19	3-1-031:004/ Kapiʻolani Beach Park	Inadvertent discovery?	[Bishop Museum 50-Oa-A5-84]	Human burial
Cleghorn 1993; Dagher 1993; Dega and Kennedy 1993	3-1-031:006/ Waikīkī Aquarium	Inadvertent discovery	04729	Human remains (scattered)
Hammatt et al. 2000	3-1-043/ Honolulu Zoo	Archaeological Assessment	-	No significant historic properties identified
McDermott and Chiogioji 2001	3-1-043/ Honolulu Zoo	Archaeological Inventory Survey with Subsurface Testing	-	No significant historic properties identified
Perzinski and Hammatt 2001	3-1-043:999/ Kalākaua Ave	Archaeological Monitoring	-	No historic properties identified
Winieski and Hammatt 2001	2-6-025–027, 3-1-031 and 043:999/ Kalākaua Ave	Archaeological Monitoring	05883	Discontinuous A horizon
Bush et al. 2002b	3-1-030 and 031/ Queen's Surf Promenade	Archaeological Monitoring	-	No significant historic properties identified
Perzinski and Hammatt 2002	3-1-043:001/ Kapiʻolani Park (bandstand)	Archaeological Monitoring	-	Basalt lamp fragment; charcoal concentration

Author Year	TMK(s) (1) or Location	Nature of Study	SIHP[1] Site 50-80-14-	Description
Bush 2004	3-1-031:999/ Kalākaua Ave	Archaeological Monitoring	06704	Historic trash deposit
Bush et al. 2004	3-1-043:001/ Honolulu Zoo	Archaeological Monitoring	-	No significant historic properties identified
Tome and Spear 2005	3-1-031:007/ Kapiʻolani Beach Park	Archaeological Monitoring	06702	Historic debris/trash deposit
Liebhardt and Kennedy 2008	3-1-031:006/ Waikīkī Aquarium	Archaeological Monitoring	-	No historic properties identified
Whitman et al. 2008	3-1-032:999 and 042:999/ Kalākaua Avenue and Poni Mōʻī Road	Archaeological Monitoring	06946	Human burial
Moser et al. 2012	3-1-032:031/ Outrigger Canoe Club	Archaeological Monitoring	-	No historic properties identified
Mintmier et al. 2013	3-1-043:001 por./ Elephant Enclosure	Archaeological Monitoring	-	Recent and historic features associated with Zoo and Kapiʻolani Regional Park
Walden et al. 2013	3-1-043:001 por./ Front Entrance Area	Archaeological Monitoring	07208	Subsurface features in dune sand layer; possibly on Makee Island
Clark et al. 2014	3-1-043:001 por./ Parking Lot	Archaeological Monitoring	07208	Subsurface pit feature
Farley and Hammatt 2018	3-1-043:001 por./ Reptile House	Archaeological Monitoring	09758	Kapiʻolani Park; identified two additional contributing components
McIntosh and Cleghorn 2023	3-1-043:001 por./ Food Concession Building	Archaeological Monitoring	-	No significant historic properties identified
McIntosh and Mulrooney 2023	3-1-043:001 por./ Tiger Exhibit	Archaeological Monitoring	-	No significant historic properties identified

[1] SIHP (State Inventory of Historic Places)

[2]Bernice Pauahi Bishop Museum Hawaiian Archaeological Database

[3]No report citation available; see Bush et al. (2002:Figure 7).

Previous Archaeological Investigations Near the Waikīkī Aquarium

Since the early 1900s, human skeletal remains have been encountered inadvertently during construction projects throughout Waikīkī. In 1901, human skeletal remains of four individuals were encountered during trenching for sewer pipes on the James B. Castle property (see Figure 7), which is location of today's Elk's Club. Associated artifacts included whale bone and glass beads, indicating the burials dated to the late pre-Contact to early post-Contact periods (Emerson 1902).

The site of human skeletal remains designated "OA0633" attributed to "Hartwell 1927" is placed south of the Natatorium in an archaeological monitoring report by Bush et al. (2002b:Figure 7). According to a notice in the Federal Register: "In 1927, human remains representing one individual from Waikiki, Oahu were collected by C.C. Hartwell and acquired by the Bishop Museum. No known individual was identified. No associated funerary objects are present."[5]

Near the current project area are several instances of inadvertently discovered human burials reported on by staff of the Bernice Pauahi Bishop Museum (BPBM). Human burials recorded at the Outrigger Canoe Beach Club were designated BPBM Sites 50-Oa-A5-64 and 50-Oa-A6-25 to 55. The sites are not known to have a SIHP designation. A total of 27 burials were encountered (Yost 1971); no formal archaeological report was prepared (Moser et al. 2012). The following is an excerpt from a newspaper article:

> Robert Bowen of the Bishop Museum has been working closely with Ernest Souza, Hawaiian Dredging superintendent, on the removal of skeletons unearthed on the site, between the Colony Surf and the Elks Club...
>
> Most of the bodies were buried in the traditional hoolewa position, with the legs bound tightly against the chest.
>
> One of the skeletons, Bowen said, shows evidence of a successful amputation of the lower forearm, indicating that the Hawaiians knew this kind of operation before the arrival of Europeans.
>
> The ages of the skeletons ranged from children to 40-year-old men and women.
>
> The average life span of the Hawaiians at the time was about 32 years [Honolulu Star-Bulletin; Jan. 24, 1963:1A in Yost 1971:28].

In 1986, human skeletal remains, designated BPBM Site 50-Oa-A5-84, were documented just north of the Waikīkī Aquarium at Kapiʻolani Beach Park (Han and Sinoto 1986[6] in Bush et al. 2002b:Figure 7). Additional burials were recorded south of the aquarium and designated BPBM Site 50-Oa-A5-64. The sites are not known to have a SIHP designation.

In the late 1990s and early 2000s, numerous human burials were found along Kalākaua Avenue in Waikīkī (Bush et al. 2002a; Perzinski et al. 2001; Winieski and Hammatt 2001; Winieski et al. 2001; Winieski et al. 2002); however, all of these burial finds were over 500 meters north of the Waikīkī Aquarium. Relevant results of soil stratigraphy encountered during archaeological monitoring near the current project area are discussed in this section.

In 2000, archaeological monitoring was conducted for the Kapiʻolani Park Bandstand Redevelopment Project (Perzinski and Hammatt 2002). In situ beach sand deposits (20.0+ cm in thickness) were recorded on the northeast side of the bandstand at roughly 30 cmbs, along with a traditional Hawaiian basalt lamp at approximately 40 to 75 cm below the surface. No significant cultural deposits were found west of the bandstand area.

Along Kalākaua Avenue from Poni Mōʻi Road to the Natatorium, archaeological monitoring was conducted for street lighting improvements (Perzinski and Hammatt 2001). Two traditional Hawaiian

[5] Federal Register Volume 63, Number 18 (Wednesday, January 28, 1998). Notices. Pages 4277–4284. From the Federal Register Online via the Government Publishing Office (www.gpo.gov). FR Doc No: 98-1993.

[6] A full reference was not provided in Bush et al. 2002b:Figure 7 and could not be located.

artifacts were recovered from a backdirt pile, which included a modified Hump-back cowrie and a dense basalt, chisel-shaped adze preform (Perzinski and Hammatt 2001:14). Diagnostic historic period artifacts recovered included ten glass bottles and two ceramic vessels dating from the mid-nineteenth to the early twentieth century. Jaucas sand deposits were encountered at 45 to 50 cmbs below a discontinuous and thin (less than 5 cm thick) A horizon, which was overlain by fill.

During monitoring for the Waikīkī Force Main Replacement project (Winieski and Hammatt 2001). A pit feature and a discontinuous buried "A" horizon, which were designated SIHP 05883, were recorded on Kalākaua Avenue, roughly 300 to 400 meters north of the aquarium. To the south of the aquarium, archaeological monitoring was conducted for 12-inch water main installation along Kalākaua Avenue and Poni Mōʻī Road (Whitman et al. 2008). A single in situ pre-Contact traditional Hawaiian burial was inadvertently discovered during excavations, which was designated SIHP 06946. Other finds included a pit feature in Jaucas sand. The feature contained burnt layers of charcoal and a burnt basalt cobble.

In 2009 and 2010, archaeological monitoring was conducted during the Outrigger Canoe Club Sewer and Storm Drain Repair and Women's and Girl's Locker Room Renovation Projects (Moser et al. 2012). Soil stratigraphy recorded consisted of multiple layers of fill over disturbed Jaucas sand. No historic properties or human burials were encountered. Finds were limited to a small stone awl or cutting tool, a cut pig bone, and charcoal flecking, all in a disturbed context.

The SHPD HICRIS notes three locations of disturbed human burials at the Elk's Club are designated SIHP Site 08722[7]. The file reads: "Three areas of disarticulated skeletal finds, consisting of three skeletal elements each. Presumably of Hawaiian descent. Found within a highly disturbed deposit located immediately beneath the interior ground surface of the Elks Lodge, Honolulu." A cultural deposit designated SIHP 08723 is also present based on HICRIS data: "Partially intact, subsurface A horizon ranging from 50–82 cmbs. Deposit is lacking material debris but is rich in charcoal and includes two indeterminate pit features and one combustion feature." Finally, "Kainalu", the former Castle family home, was located on the Elk's Club property, which is designated SIHP 08724.

Previous Archaeological Investigations at the Honolulu Zoo

Over the last 25 years, several archaeological investigations have been conducted within the Honolulu Zoo parcel (Bush et al. 2004; Clark et al. 2014; Farley et al. 2018; Hammatt et al. 2000; McDermott and Chiogioji 2001; McIntosh and Cleghorn 2023; McIntosh and Mulrooney 2023; Mintmier et al. 2013; Walden et al. 2012). To date, no pre-Contact historic properties have been encountered. McDermott and Chiogioji (2001) noted the following on soil stratigraphy in the Zoo parcel:

> Documented stratigraphy consisted predominantly of various types of fill layers, including terrigenous landscaping fill, dredge sediments from the Ala Wai Canal, construction fill layers, and calcareous "beach sand" layers. These results were not altogether surprising based on the background research, which indicated that prior to development in the 1870s, the area that would become the Zoo was a low-land area of "swamps", ponds, and sand dunes. Background research indicated that substantial fill layers were brought in to elevate the formerly low-lying Zoo area for development [McDermott and Chiogioji 2001:94].

Between 2009 and 2011, archaeological monitoring was conducted during improvements to the zoo entrance area (Walden et al. 2012), which resulted in the recording of SIHP Site 07208. This site consists of 12 subsurface features that may be associated with historical activities on Makee Island. Makee Island was an early waterscape feature in Kapiʻolani Park and pre-dated the Ala Wai Canal and Waikīkī Land Reclamation Project.

Between 2010 and 2011, archaeological monitoring was carried out during construction of a new elephant habitat (Mintmier et al. 2013). Recent and possibly historic concrete foundations and infrastructure

[7] It is possible these burials correlated to the BPBM Sites 50-Oa-A5-64 and 50-Oa-A6-25 to 55.

were encountered, which may be associated with development of Kapiʻolani Park and the zoo. A total of 45 historic artifacts were recovered, including hand-made, mold-blown, bottles, bottles and jars manufactured by automatic bottle machine, English porcelaneous-stoneware, fragmentary examples of English earthenware plates and platters, a fragment of an earthenware jar, and a fragment of a porcelaneous stoneware bowl of Asian, possibly Chinese origin. No pre-Contact or traditional Hawaiian artifacts were encountered. A majority of the assemblage dates from the 1900s to the 1920s (Mintmier et al. 2013).

In 2013, archaeological monitoring was conducted in the northern half of the Honolulu Zoo parking lot (Clark et al. 2014). A single post-Contact subsurface pit feature associated the former Makee Island was recorded. The feature was assigned to the previously designated SIHP Site 07208.

In 2015 and 2016, archaeological monitoring was conducted in the reptile house area of Honolulu Zoo (Farley et al. 2018). Two archaeological features were identified as components of existing SIHP Site 09758, Kapiʻolani Park. Feature 1 is a manhole containing a U.S. military communication line, which is likely associated with military activity during WWII. Construction plans were altered to preserve the manhole during the project. Feature 2 is a historic period concrete box culvert.

Two archaeological monitoring projects were conducted in the zoo in the early 2020s, both of which had negative findings (McIntosh and Cleghorn 2023; McIntosh and Mulrooney 2023). These projects were at the Food Concession Building and the Tiger Exhibit. Only fill material was encountered during subsurface excavations.

Previous Archaeological Investigations at Waikīkī Aquarium

In the mid-1990s, several human skeletal remains were inadvertently discovered at the Waikīkī Aquarium during rebuilding and modification of a shark tank (Cleghorn 1993; Dagher 1993; Dega and Kennedy 1993). The human skeletal remains were found during backhoe excavation of six inches of sand from the tank area and in backfill brought into the project area for ground support. The fragmented human skeletal remains were scattered, and no formal burial site was identified. It was speculated that the skeletal fragments were brought in with sand from Maui for construction work during the project. The find was designated SIHP Site 04729.

Excavations were monitored for subsurface electrical infrastructure for a new sewer pumping station (Bush 2004), which documented a layer of natural beach sand between 15.0 to 100.0 cmbs (5.9 to 40.0 in). No cultural layer was encountered; however, a trash pit, designated SIHP Site 06704, was recorded within Kalākaua Avenue, adjacent to the aquarium. The site consisted of bottles dating between the 1880s to 1920s, broken ceramic pieces, and butchered animal bone.

Archaeological monitoring was conducted for the Public Baths Pump Station Modification Improvements Project (Tome and Spear 2005). A single archaeological site was identified which consisted of a subsurface feature containing glass bottles manufactured from the 1870s to the 1920s. The site was designated SIHP Site 06702. It was situated in a layer of undisturbed beach sand at 100 to 170 cmbs, which was overlain by multiple layers of fill. No further archaeological work was recommended in the project area footprint due to extensive previous disturbance.

Archaeological monitoring was conducted in 2008 for electrical system upgrades in the northeast corner of the Waikīkī Aquarium (Liebhardt and Kennedy 2008). The soil stratigraphy primarily consisted of two layers of fill over a transitional layer, followed by Jaucus sand (Liebhardt and Kennedy 2008:12).

Archaeological Literature Review and Field Inspection (ALRFI) was conducted for Waikīkī Aquarium Wastewater Discharge System Upgrades (Vernon 2022). Based on the results of this ALRFI and on previous archaeological projects near the project area that recorded subsurface historic properties including cultural deposits and human burials, there was insufficient information to make a Chapter 6E historic preservation determination of effect of the project's impact on potential subsurface historic properties within the.16-acre project area. Therefore, archaeological monitoring for identification purposes, guided by a SHPD-approved archaeological monitoring plan (HAR 13-13-279), was recommended.

ANTICIPATED FINDS

Based on archival research and the results of previous archaeological studies in and near the Aquarium, there is potential for encountering subsurface historic properties, including human burials. Dune sands, which may contain human burials, are known to underlie historic fill deposits at approximately 15.0 to 100.0 cm (5.9 to 40.0 in) below ground surface in the northeast corner of the aquarium (Bush 2004; Liebhardt and Kennedy 2008). Evidence of early twentieth century habitation may be encountered on the south side of the aquarium, which is near the former location of the Irwin family's stable. In addition to human burials, anticipated archaeological finds include traditional Hawaiian subsurface cultural deposits or artifacts, and historic features or artifacts associated with the Irwin residence. Finally, the Waikīkī Aquarium is over 50 years old and is a historic property; no SIHP site number has been assigned.

FIELD INSPECTION

An archaeological field inspection was conducted by a PCSI archaeologist, Kylen Chang, B.A., on 10 October 2023. Nicole Vernon, M.A., served as Principal Investigator for the project. Field inspection consisted of walking the property where the ground disturbance is proposed and photographing existing conditions in the project footprint.

FIELD INSPECTION RESULTS

As previously noted, the Waikīkī Aquarium is over 50 years old and is a historic property; no SIHP site number has been assigned. No newly identified historic properties were identified in the project area during the field inspection. General photographs of the offshore intake area are shown in Figure 15, while Figure 16 shows the general locations where trenching will occur as well as the placement of required infrastructure such as the pump station, emergency overflow box, and discharge and transfer sump.

CULTURAL CONSULTATION

As part of the CIA, PCSI contacted entities and individuals to solicit information about historic properties, cultural resources, traditional cultural properties, and traditional and customary practices potentially within the current project area (Table 1); a sample letter is provided in Appendix A. Responses regarding cultural resources, historic properties, or traditional cultural practices within or near the project area are provided below.

SUMMARY AND ASSESSMENT

The proposed project is at the Waikīkī Aquarium at 2777 Kalākaua Avenue. The project proponent is the University of Hawai‘i, and the landowner is the State of Hawaii. The parcel, TMK (1) 3-1-031:006 (por.), measures 2.35 acres (.95 hectares). Excavations in the approximately 0.06-acre (approximate) project area will be conducted in the western portion of the parcel for replacement of the two existing 8-inch Transite NSW intake pipes that extend 160-ft offshore with two new 8-inch HDPE pipes; construction of a new saltwater production well and decommissioning of the existing well; construction of a new pump vault; construction of a new aeration/settling tank for well water treatment; and reconstruction and extension of the existing pump building that has extensive cracks and spalling. The purpose of the proposed project is to upgrade the Aquarium's outdated intake water system infrastructure to prevent future failures that threaten the life and wellbeing of the animals. An Archaeological Literature Review with Field Inspection was carried out in accordance with Hawaii Revised Statutes (HRS) Chapter 6E, and Title 13 of the Hawaii Administrative Rules (HAR), Subtitle 13 (State Historic Preservation Division Rules), Chapter 275 (*Rules Governing Procedures for Historic Preservation Review for Governmental Projects Covered Under Sections 6E-7 and 6E-8, HRS*).

Table 3: List of Entities/Individuals

Name/Affiliation	Sent Via	Response	Summary Comment
Dawn N. S. Chang SHPO and Chairperson, DLNR	email	None to Date (NTD)	
Alan Downer Administrator, SHPD; Deputy State Historic Preservation Officer	email	NTD	
Hailama Farden, President Association of Hawaiian Civic Clubs	email	NTD	
Curt Cottrell, Administrator, Division of State Parks, DLNR	email	NTD	
Dennis Ragsdale, Advocate General, Order of Kamehameha I	email	NTD	
Kamakana C. Ferreira, Lead Compliance Specialist, OHA	email	NTD	
Vincent Hinano Rodrigues, JD, Branch Chief History and Culture, SHPD	email	NTD	
Regina Hilo, Burial Sites Specialist (Oʻahu) SHPD	email	NTD	
Megan Alvarez, Oʻahu Lead Archaeologist, SHPD	email	NTD	
Walter Ritte, Executive Director ʻĀina Momoa	email	2 Apr 24	See section below for consultation with Dr. Trisha Watson
ʻĀnela Jackson , President, ʻAha Mālama, Corp.	email	NTD	
Ms. Kauʻi N. Burgess, Director of Community & Government Relations, Kamehameha Schools	email	NTD	
Ms. Taffi Wise, Executive Director, Kanu o ka ʻĀina Learning ʻOhana	email	NTD	
Mr. Kaleo Patterson, President, Native Hawaiian Church	email	NTD	
Carolyn Keala Norman, ʻOhana Keaweamahi	email	NTD	
Emma Emalia Keohokalole , Secretary-Treasurer, ʻOhana Keohokālole	email	NTD	
Ms. Victoria Holt Takamine, Executive Director, PAʻI Foundation	email	NTD	
Mr. L. Laʻakea Suganuma, President, Royal Hawaiian Academy of Traditional Arts	email	NTD	

The Waikīkī Aquarium property falls within the traditional land division of Kāneloa ʻIli. The area was intensively used for habitation, aquaculture, and agriculture from the pre–Contact period into the mid- to late 1800s, when the landscape was transformed by wealthy businessmen. One such businessman was William G. Irwin, whose large home, designed by Charles Dickey, was immediately south of today's aquarium.

Based on archival research and the results of previous archaeological studies in and near the Aquarium, there is potential for encountering subsurface historic properties, including human burials. Dune sands, which may contain human burials, are known to underlie historic fill deposits at approximately 15.0 to 100.0 cm (5.9 to 40.0 in) below ground surface in the northeast corner of the aquarium (Bush 2004; Liebhardt and Kennedy 2008). Evidence of early twentieth century habitation may be encountered on the south side of the aquarium, which is near the former location of the Irwin family's stable. In addition to human burials, anticipated archaeological finds include traditional Hawaiian subsurface cultural deposits or artifacts, and historic features or artifacts associated with the Irwin residence. Finally, the Waikīkī Aquarium is over 50 years old and is a historic property; no SIHP site number has been assigned.

As part of the CIA, PCSI contacted the SHPD requesting contact information for individuals who might be interested in participating in the consultation process to determine if traditional cultural practices were being undertaken within the project area as well as contacting entities and individuals listed in the U.S. Department of Interior's *Native Hawaiian Organization Notification List*. Furthermore, recent CIAs undertaken immediately adjacent to the Aquarium (Walden et al. 2013; Walden and Collins 2017) were

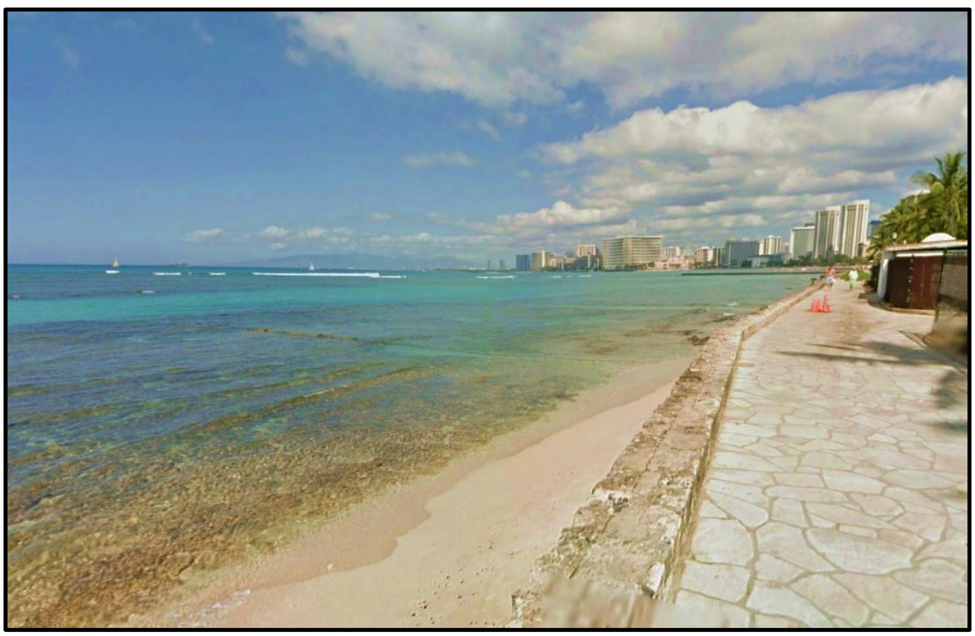


Figure 15. General Photographs Showing the Offshore Intake Area. Top: View to the South. Bottom: View to the Northwest.

Figure 16. General Photographs Showing the locations of proposed project trenching and infrastructure. Left: View to Northwest. Middle: View to West. Right: View to Northwest.

reviewed to determine if traditional or customary cultural practices had been identified in the immediate vicinity of the project area.

In an earlier draft of this document PCSI incorrectly reported that no responses had been received concerning historic properties or traditional or customary cultural practices. PCSI inadvertently missed a contact opportunity with ʻĀina Momona, a Native Hawaiian Organization. Dr. Trisha Watson from ʻĀina Momona contacted Ms. Berna Senelly (Senior Regulatory and Community Lead with Oceanit) on 2 April 2024 to report the discrepancy. In conversation and correspondence with Ms. Senelly, Dr. Watson graciously provided cultural information concerning several traditional practices that should be considered during planning and implementing the current project: surfing, fishing, and canoe paddling; her information is included in this report and the Final Environmental Assessment.

SURFING

Traditionally, Waikīkī was a land beloved of the Hawaiian chiefs, where board surfing could be indulged. The four major Waikiki surfing sites are Kalehuawehe, currently called "Castle‘s," Aiwohi, currently called "Publics," Mihiwa, currently called "Cunha‘s," and Kapuni, currently called Canoes.

Aiwohi, or "Publics," is located approximately 1,200 feet northwest of the Waikiki Aquarium and there is a breakwater that lies 300 feet from the shore. An unnamed surf site is located approximately 2,000 feet southwest of the Waikiki Aquarium. Surf breaks only occur on big West swells and is located inside the reef.

FISHING

The Waikīkī Marine Life Conservation District (Waikīkī MLCD) is located at the Diamond Head end of Waikīkī Beach and fronts the Waikīkī Aquarium. The MLCD extends from the groin at the end of Kapahulu Avenue to the ewa (west) wall of the Natatorium, from the highwater mark seaward a distance of 500 yards or to the edge of the fringing reef, whichever is greater. Most fish in this area are found along the channel's shoreline side (which has a number of small caves), along the Natatorium wall, and near the exposed parts of the reef on the channel's seaward side. The channel itself is about 8 feet deep, and depths above the reef flat are generally less than 3 to 4 feet.

Fishing is strictly forbidden in the Waikīkī MLCD. Specific prohibitions include 1) to fish for, take or injure any marine life (including eggs), or possess in the water any device that may be used for the taking of marine life and 2) to take or alter any sand, coral or other geological feature or specimen, or possess in the water any device that may be used for the taking or altering of a geological feature or specimen.

The project area is also near to the Waikīkī-Diamond Head Shoreline Fisheries Management Area, which extends from the ewa wall of the Waikīkī War Memorial Natatorium to the Diamond Head Lighthouse, from the highwater mark out to a minimum seaward distance of 500 yards, or to the seaward edge of the fringing reef beyond 500 yards.

Fishing is allowed in this area from January 1 to December 31 of even-numbered years. During this time, it is permitted to fish for, take or possess any legal-size marine life in season, and allowed methods include only hook-and-line, thrownet, handnet to land hooked fish, and spear fishing and hand harvesting methods. Fishing is not allowed on odd-numbered years.

CANOE PADDLING

Canoe paddling occurs along the entire Waikīkī coastline, and prominent Waikīkī canoe clubs, include the Kumulokahi Canoe Club at the Elks Lodge and Outrigger Canoe Club to the east of the Waikīkī Natatorium War Memorial, and the Waikīkī Beach Boys Canoe Club headquartered in the Ala Wai Park.

With regards to recent CIAs conducted adjacent to the current project area (one in association with a project to repair the Queen's Seawall [Walden and Collins 2017], the other in association with a project to construct a new Ocean Safety Substation [Walden et al. 2013]), all responses indicated that there was no knowledge of traditional or cultural practices for the area. One respondent did question the ownership legality of the project proponent; however, that response has no bearing on traditional or customary cultural practices within the current project.

Kumu Hula Samuel M. ʻOhukaniʻōhiʻa Gon III, a scientist, Hawaiian cultural practitioner, paleobiologist, and teacher has held a changing of the seasons event to the north of the aquarium at the site of the heiau Kūpalaha. According to a Facebook page for the event:

> We gathered at the water's edge at the site of the heiau Kūpalaha, the sibling heiau of Papaʻenaʻena (that still graces the base of Leahi) where, from its kuahu (altar), named Opunaha, the setting sun would be observed by the kahuna kilolani, and on a certain day, the sun would set into the bowl of Puʻu o Kapolei, when seen from Opunaha, marking the end of the Hoʻoilo [Hawaiian Cool Wet Season] and the start of the Kauwela [Hawaiian Hot Dry Season] , and the reactivation of the luakini heiau of Kū

It appears that the event last occurred in 2017 and it is unclear if future events are planned.

KA PAʻAKAI O KAʻAINA ANALYSIS

A further analytical framework for addressing the preservation and protection of cultural practices specific to Native Hawaiian communities resulted from a 2000 Hawaii Supreme Court ruling (in Ka Paʻakai O KaʻAina vs Land Use Com'n. 94 Hawaii 31 (2001). In its decision, the court established a three-part analytical approach to identify, assess impacts, and mitigate impacts to traditional and customary native Hawaiian rights associated with a proposed action. The three-part analysis, based on current consultation, past consultations, and archival research is summarized below:

1. *The identity and scope of valued cultural, historical, or natural resources, including the extent to which traditional and customary native Hawaiian rights are exercised* As discussed in the previous section, the Waikīkī coastline supports long-standing traditional and cultural resources and practices, including surfing, fishing and canoe paddling.
2. *The extent to which those resources—including traditional and customary native Hawaiian rights—will be affected or impaired by the proposed action.* It is not expected that traditional and customary native Hawaiian rights will be directly affected or impaired by the proposed action. The nearest surf site is 1,200 feet northwest of the project area, and canoe padding does not occur where the new intake pipes will replace the existing pipes at 170 feet from the shoreline. Further, fishing is not allowed in the Waikīkī MLCD, which includes the project area.
3. *The feasible action, if any, to be taken by the agency to reasonably protect native Hawaiian rights if they are found to exist.* The far distance between native Hawaiian rights and practices related to cultural or historical resources and construction activities does not require protection of these resources. However, if historic properties are discovered during the proposed project, they will be evaluated in accordance with HRS 6E and its associated Administrative Rules; if additional traditional and customary native Hawaiian resources or practices are identified, appropriate mitigation or preservation measures will be implemented.

RECOMMENDATIONS

As a result of the background study and cultural consultation, it was found that no historic properties are within the proposed project area, although two historic properties are within the larger TMK parcel: the Waikīkī Aquarium building (no SIHP site number designated) and SIHP Site 04729, which was speculated to be skeletal fragments brought onto the aquarium parcel with sand from Maui for construction. Along the beach to the north and south of the aquarium, numerous traditional Hawaiian human burials have been identified. Previous archaeological investigations in the vicinity have recorded in situ soils under fill layers.

Several traditional practices, including surfing, fishing, and canoe paddling have been identified associated with the shore and near shore environment fronting the Waikīkī Aquarium. Given the anticipated project design, it is unlikely that the proposed project will impact surfing or canoeing activities; currently, fishing is prohibited within the Waikīkī MLCD, which includes the area fronting the Waikīkī Aquarium.

Based on previous archaeological projects near the project area that have recorded subsurface historic properties including cultural deposits and human burials, there is insufficient information to make a Chapter 6E historic preservation determination of effect of the project's impact on potential subsurface historic properties within the 0.06-acre project area. Therefore, archaeological monitoring for identification purposes, guided by a SHPD-approved archaeological monitoring plan (HAR 13-13-279), is recommended. A list of SHPD-permitted consultants to conduct the archaeological monitoring can be found at: https://dlnr.hawaii.gov/shpd/about/branches/archaeology/

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GLOSSARY OF HAWAIIAN TERMS

ahupuaʻa—land division and community

> Land division usually extending from the uplands to the sea, so called because the boundary was marked by a heap (*ahu*) of stones surmounted by an image of pig (*puaʻa*) or because a pig or other tribute was laid on the altar as tax to the chief. The landlord or owner of an *ahupuaʻa* might be a *konohiki* (Pukui and Elbert 1986:9)

aliʻi—chief or chiefess

> Chief, chiefess, officer, ruler, monarch, peer, headman, noble, aristocrat, king, queen, commander (Pukui and Elbert 1986:20); implies hereditary rank

akua—a god or goddess

> God, goddess, spirit, ghost, devil, image, idol, corpse; divine, supernatural; godly (Pukui and Elbert 1986:15)

ʻaumakua—family god

> Family or personal gods, deified ancestors who might assume the shape of sharks (all islands except Kauaʻi), owls (as at Mānoa, Oʻahu and Kaʻu and Puna, Hawaiʻi) hawks (Hawai'i), *ʻelepaio*, *ʻiwi*, mudhens, octopuses, eels, mice, rats, dogs, caterpillars, rocks, cowries, clouds, or plants. A symbiotic relationship existed; mortals did not harm or eat *ʻaumakua* (they fed sharks), and *'aumakua* warned and reprimanded mortals in dreams, visions, and calls (Pukui and Elbert 1986:32)

heiau—ceremonial structure or place

> Pre-Christian place of worship, shrine (Pukui and Elbert 1986:64)

heiau poʻokanaka— a class of *heiau* where human sacrifices were made

> A heiau where human sacrifices were offered (Pukui and Elbert 1986:64)

ʻili—division of land smaller than an ahupuaʻa

> Land section, next in importance to *ahupuaʻa* an usually a subdivision of an *ahupuaʻa* (Pukui and Elbert 1986:97)

kapu—taboo

> Taboo, prohibition; special privilege or exemption from ordinary taboo; sacredness; prohibited, forbidden; sacred, holy, consecrated; no trespassing, keep out. (Pukui and Elbert 1986:132)

konohiki—land managers

> Headman of an ahupuaʻa land division undert the chief; land or fishing rights under the control of the konohiki (Pukui and Elbert 1986:166)

kula—dryland field

> Plain, field, open country, pasture. An act of 1884 distinguished dry or *kula* land from wet or taro land (Pukui and Elbert 1986:179)

kuleana—small piece of land under the responsibility of a tenant

> Right, privilege, concern, responsibility, title, business, property, estate, portion, jurisdiction, authority, liability, interest, claim, ownership, tenure, affair, province (Pukui and Elbert 1986:179)

loʻi—wetland taro field

> Irrigated terrace, especially for taro, but also for rice (Pukui and Elbert 1986:209)

loko iʻa—fishpond

makaʻāinana—commoner

> Commoner, populace, people in general (Pukui and Elbert 1986:224)

moʻōlelo–legend

> Story, tale, myth, history tradition, legend, journal, log, yarn, fable, essay, chronicle, record, article (Pukui and Elbert 1986:254)

pali —cliff

> Cliff, precipice, steep hill or slope suitable for *olonā* and *wauke*; full of cliffs; to be a cliff (Pukui and Elbert 1986:321)

pōhaku—stone

> Rock, stone, mineral, tablet (Pukui and Elbert 1986:334)

wahi pana—legendary place

> Legendary place (Pukui and Elbert 1986:377)

APPENDIX A:

Consultation Letter Template

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PACIFIC CONSULTING SERVICES, INCORPORATED

DATE

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SUBJECT: Community Consultation regarding historical and cultural information related to the University of Hawai'i Project to Upgrade the Waikīkī Aquarium Water Intake System in Waikīkī Ahupua'a, Honolulu (Kona) District, Island of O'ahu, Hawaii (TMK: [1] 3-1-031:006 [(por.])

Dear *****:

On behalf of Oceanit Laboratories, Inc. and the University of Hawai'i, Pacific Consulting Services, Inc. (PCSI) is compiling a Cultural Impact Assessment (CIA) and Ka Pa'akai assessment in support of the Waikīkī Aquarium Supply Water Intake System Upgrade at the Waikīkī Aquarium in Waikīkī Ahupua'a, Honolulu (Kona) District, Island of O'ahu, Hawaii. Oceanit is preparing an Environmental Assessment on behalf of University of Hawai'i. **PCSI is seeking community input concerning historic properties, and cultural, traditional, and customary practices within or near the proposed project area. Any assistance you can provide would be greatly appreciated.** A map is attached showing the proposed project area.

REGULATORY CONTEXT

In accordance with the provisions of Hawaii Revised Statutes (HRS), Chapter 343 and its implementing regulations contained in Hawaii Administrative Rules (HAR), Title 11, Chapter 200.1, the CIA provides a detailed analysis of how the Proposed Action could impact cultural practices, resources, and beliefs. The disclosure of this information is intended to promote transparent and responsible decision-making in accordance with Articles IX and XII of the *Constitution of the State of Hawaii*, other state laws, and the courts of the state, which all mandate government agencies to endeavor to promote and preserve the cultural practices and resources of Native Hawaiians and other ethnicities.

In addition to the content requirements of HRS §343 and HAR §11-200.1, on November 19, 1997, the State of Hawaii's Environmental Council issued its *Guidelines for Assessing Cultural Impacts*. The Guidelines provide methodological and content protocol for projects/actions that may have the potential to affect cultural resources, stipulating specific matters that should be addressed in all CIAs.

An alternative analytical framework—the Ka Pa'akai assessment—can can be used for addressing the preservation and protection of cultural practices specific to Native Hawaiian communities. The Ka Pa'akai assessment structure resulted from a 2000 Hawaii Supreme Court ruling (*Ka Pa'akai O Ka'Aina versus Land Use Commission*). In its decision, the court established the following three-part analytical approach:

- Part 1, identify whether any valued cultural, historical, or natural resources are present; and identify the extent to which any traditional and customary Native Hawaiian rights are exercised;
- Part 2, identify the extent to which those resources and rights will be affected or impaired; and
- Part 3, specify any measures to be taken to reasonably protect Native Hawaiian rights if they are found to exist.

PROPOSED PROJECT BACKGROUND AND ACTION

The proposed project is located at the Waikīkī Aquarium at 2777 Kalākaua Avenue. The entire project parcel measures 2.35 acres (.95 hectares) and the proposed 0.06-acre (approximate) project area excavations will be conducted primarily in the western and southern portions of the parcel. The Tax Map Key (TMK) parcel for the project area is (1) 3-1-031:006.

The purpose of the proposed project is to upgrade the Aquarium's outdated intake water system infrastructure to prevent future failures that threaten the life and wellbeing of on-site biota. Anticipated ground disturbing work includes replacement of the two existing 8-inch Transite Natural Sea Water (NSW) intake pipes that extend 160-ft offshore with two new 8-inch high-density polyethylene (HDPE) pipes; construction of a new partially below NSW and well water pump vault, a new partially below ground aeration tank, the reconstruction and extension of the existing pump building, the construction of a new saltwater production well, and the installation of new equipment and piping.

HISTORIC PROPERTIES WITHIN THE PROJECT AREA

PCSI has prepared an archaeological literature review (ALR) that details the legendary, historical, and archaeological history near the project area. There are no known significant historic properties within the proposed project area; the Waikīkī Aquarium is over 50 years old, although no SIHP site number has been assigned.

REQUEST FOR INFORMATION

In an effort to more completely understand the cultural and historical background within and around the project area and bring as much information as possible on the decision-making process for this project, PCSI is seeking community input. We are especially interested in any information you may be willing to provide about historic sites located in or near the project area, as well as cultural traditions, legends, and traditional cultural places and practices pertaining to this area. If we can provide you with more information concerning our research, please feel free to contact us. If you would like to share information with us, you can contact us in several ways:

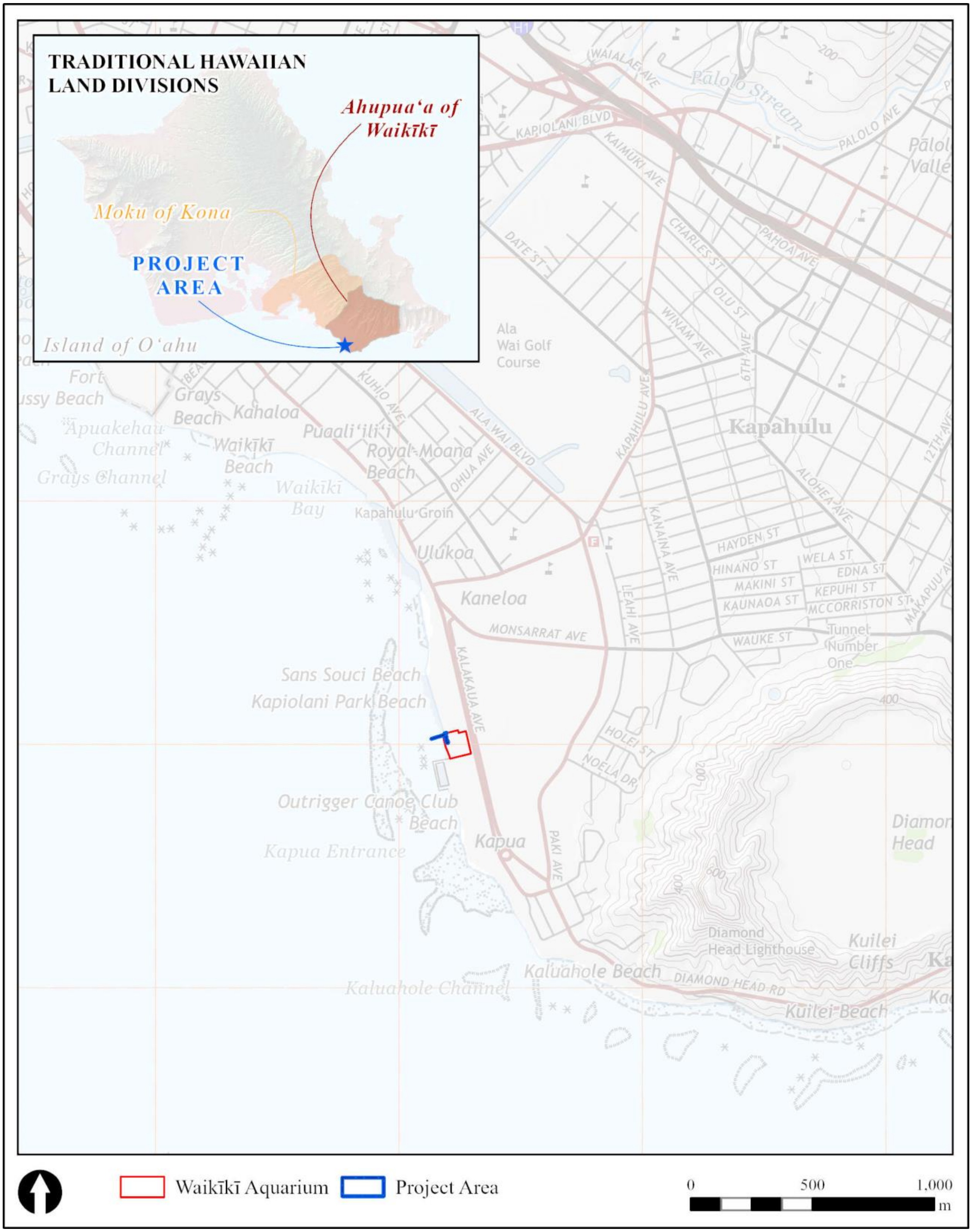
Pacific Consulting Services, Inc.
1130 North Nimitz Hwy, Suite C-300
Honolulu, HI 96817

- Email: info@pcsihawaii.com
- Phone: 808.546.5557, ext. 212

PCSI would greatly appreciate your response within 30 days of receiving this request. Thank you very much in advance for your timely response, and we look forward to hearing from you.

Sincerely,

Dennis Gosser
Pacific Consulting Services, Inc



Map Showing the Location of the Proposed Waikīkī Aquarium Project

Appendix H:

Pre-Consultation Comments and Responses

Berna Senelly

From: CleanWaterBranch <cleanwaterbranch@doh.hawaii.gov>
Sent: Friday, July 21, 2023 3:23 PM
To: WAq
Cc: Dale Uno; Jason Y. Lee
Subject: [External] RE: Pre-Consultation Regarding Waikiki Aquarium Water Intake System

Some people who received this message don't often get email from cleanwaterbranch@doh.hawaii.gov. Learn why this is important

Hello,

Please see the Department of Health, Clean Water Branch's (CWB) standard comments regarding water pollution control at: https://health.hawaii.gov/cwb/clean-water-branch-home-page/cwb-standard-comments/. These standard comments specify your project's responsibilities to maintain water quality and to obtain any necessary permitting issued by the Clean Water Branch.

Thank you,

The Clean Water Branch

From: WAq <WAq@oceanit.com>
Sent: Thursday, July 20, 2023 3:14 PM
To: CleanWaterBranch <cleanwaterbranch@doh.hawaii.gov>
Cc: Dale Uno <duno@oceanit.com>; Jason Y. Lee <jylee@oceanit.com>
Subject: [EXTERNAL] Pre-Consultation Regarding Waikiki Aquarium Water Intake System

Aloha

On behalf of the University of Hawaiʻi (UH), Oceanit is preparing a Draft Environmental Assessment (EA) regarding the Upgrade of the Waikīkī Aquarium (WAq) Water Intake System. WAq utilizes three (3) intake water sources for their approximately sixty (60) public exhibits and behind-the-scenes holding tanks that are in operation at any given time. The three (3) intake water sources include 1) natural seawater (NSW) via two (2) 8-inch offshore intake pipes, 2) saltwater derived from an 80-ft deep saltwater production well, and 3) freshwater from the City and County of Honolulu water supply system. The freshwater supplies only a small number of exhibits, whereas the NSW and the salt water well supply most of the exhibits and holding tanks at the WAq.

A functional water intake supply system is critical to the operation of the WAq and to the life support systems for the animals at WAq. If any of the three intake water sources fails, the health and wellbeing of the animals that depend on it are endangered. The purpose of the proposed project is to upgrade the Aquarium's outdated intake water system infrastructure to prevent future failures that threaten the life and wellbeing of the animals.

We invite you to submit pre-consultation comments on this project. We are attaching a pre-consultation letter that describes the proposed improvements to the WAq Water Intake System, as well as figures depicting the project site and location, existing conditions of the Water Intake System, an aerial view of proposed Water Intake System improvements, the proposed Upgrade Plan.

Please transmit your comments by August 9, 2023. Your comments and our responses will be included in the Draft Environmental Assessment that will be published in *The Environmental Notice* issued by the Hawai'i State Office of Planning and Sustainable Development Environmental Review Program. Please email me if you have questions.

We look forward to your comments!

Sincerely,

Berna Cabacungan Senelly

Berna Cabacungan Senelly | **Senior Regulatory and Community Lead**
828 Fort Street Mall Suite 600 | Honolulu, HI 96813
Email: bsenelly@oceanit.com
Office: 808.531.3017 ext. 221
Direct: 808.954.4221
Mobile: 817.422.1372
Fax: 808.531.3177

▸ **Website** | **Facebook** | **Twitter** | **LinkedIn**

Berna Senelly

From:	Migita, Reef A <reef.migita@doh.hawaii.gov>
Sent:	Wednesday, July 26, 2023 7:43 PM
To:	WAq
Cc:	Lum, Darryl C
Subject:	[External] Request for Pre-Consultation for an Environmental Assessment Regarding the Upgrade of the Waikiki Aquarium Water Intake System

You don't often get email from reef.migita@doh.hawaii.gov. Learn why this is important

Aloha Berna Senelly,

Thank you for reaching out to the State of Hawaii, Department of Health (DOH), Environmental Management Division's (EMD) Clean Water Branch (CWB) requesting comments on the **Environmental Assessment Regarding the Upgrade of the Waikiki Aquarium Water Intake System**. CWB offers standard comments on Environmental Assessments, Environmental Impact Statements, and other documents on our website at: Clean Water Branch | CWB Standard Comments (hawaii.gov). Please click on the link CWB-Standard-Project-Comments-20221007.pdf (hawaii.gov) for CWB's standard project comments.

Please let us know if you have any further questions.

Mahalo,
Reef Migita
Clean Water Branch
State of Hawaii Department of Health
Phone: (808) 586-4309

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January 12, 2024

Reef Migita
Clean Water Branch
State of Hawaii – Department of Health

TRANSMITTED VIA EMAIL: CleanWaterBranch cleanwaterbranch@doh.hawaii.gov; reef.migita@doh.hawaii.gov

Dear Mr. Migata:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comment dated July 26, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades.

Per your comment, we incorporated information in https://health.hawaii.gov/cwb/files/2022/10/CWB-Standard-Project-Comments-20221007.pdf,

Impacts related to the Proposed Action on State waters are discussed in Section 3.1.4, Ocean Water Quality, in the Draft Environmental Assessment. As noted in the discussion, the two existing transite (asbestos-cement) offshore intake pipes were installed in the early 1950s and are well beyond their engineering design life. In the long-term, the Proposed Action will likely protect valuable coastal ecosystems, improve water quality in the MLCD, and help reefs thrive by replacing the deteriorating transite pipes with HDPE pipes. In the short-term, impacts to nearshore receiving waters are expected to occur temporarily during in-water construction for the replacement of the intake pipes. Effective BMPs will prevent and minimize short-term construction-related impacts.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawaiʻi, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawaiʻi
Tavia Oshiro, Environmental Compliance Program Manager, University Hawaiʻi

Oceanit Center 828 Fort Street Mall, Suite 600 Honolulu, Hawaii 96813 Phone: 808.531.3017 Fax: 808.531.3177
www.oceanit.com

Berna Senelly

From: Evelyn Wight <ewight@TNC.ORG>
Sent: Tuesday, July 25, 2023 10:58 PM
To: WAq; @Info
Subject: [External] Please take me off your mailing list

You don't often get email from ewight@tnc.org. Learn why this is important

Hi, I just received your hard copy letter asking for comments on the Waikiki intake system. This is important but I cannot comment on TNC's behalf. Please remove me from your mailing list.
Thanks,
Evelyn

Evelyn Wight
Senior Communications Manager
The Nature Conservancy, Hawai'i and Palmyra
923 Nuuanu Ave
Honolulu, HI 96817
808-537-3570 (cell)

innovation through engineering & scientific excellence

January 12, 2024

Evelyn Wight
Senior Communications Manager
The Nature Conservancy

TRANSMITTED VIA EMAIL: ewight@TNC.ORG

Dear Ms. Wight:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comment dated July 25, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades. Per your request, we will remove you from our mailing list.

We are including a copy of your comments and our response in the Draft EA.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai'i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai'i

HONOLULU CITY COUNCIL

Ke Kanihela o ke Kalana o Honolulu

530 South King Street, Room 202 • Honolulu, Hawai'i 96813-3065
Phone: (808) 768-5010 • Fax: (808) 768-5011

TOMMY WATERS
CHAIR & PRESIDING OFFICER
HONOLULU CITY COUNCIL
DISTRICT IV
PHONE: (808) 768-5004
FAX: (808) 768-1220
EMAIL: tommy.waters@honolulu.gov

July 25, 2023

To Whom It May Concern:

I am expressing my support for the proposed upgrade of the Waikīkī Aquarium's intake water system infrastructure which is in Council District IV.

The Waikīkī Aquarium was founded in 1904 and is located near the Waikīkī Natatorium War Memorial and Kapi'olani Park. It is the second oldest public aquarium in the United States and is known for its diverse collection of marine life, including Hawaiian monk seals, jellyfish, and coral reefs. The aquarium is also notable for its conservation efforts, such as the Hawaiian green sea turtle breeding program and the Hawaiian Monk Seal Rehabilitation Program.

The proposed improvements to the Waikīkī Aquarium Water Intake System project aim to prevent future failures that could harm the animals. The proposed upgrades include replacing the existing 8-inch transit natural seawater (NSW) intake pipes with new 8-inch high-density polyethylene pipes, constructing a new saltwater production well, and building a new pump vault, among other improvements. New equipment includes eight new pumps, four new media filters, two ultraviolet sterilizers, and a chiller to cool warmer NSW to an acceptable temperature. The new system will have redundancy to mitigate the impacts of equipment failures or necessary maintenance activities.

It is imperative to upgrade the outdated water intake supply system to prevent future failures that threaten the life and well-being of the animals. I am confident that the proposed project will benefit the overall well-being of the aquarium's inhabitants and the surrounding ecosystem. By ensuring a reliable water supply, the aquarium can continue to provide visitors with an unforgettable experience while maintaining high animal care standards.

Thank you for considering my support for this important project.

Mahalo,

Tommy Waters

Council Chair Tommy Waters

District IV (*Hawai'i Kai, Kuli'ou'ou, Niu Valley, 'Āina Haina, Wailupe, Wai'alae-Iki, Kalani Valley, Kāhala, Wilhelmina Rise, Kaimukī, portions of Kapahulu, Diamond Head, Black Point, and Waikīkī*)

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January 12, 2024

Chair Tommy Waters
Honolulu City Council

TRANSMITTED VIA EMAIL: tommy.waters@honolulu.gov

Dear Chair Waters:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comment dated July 25, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades.

We note your background on the Waikīkī Aquarium need to upgrade the outdated water intake supply system to prevent future failures that threaten the life and well-being of biota at the aquarium. We also appreciate your confidence that the Proposed Action will ensure a reliable water supply and benefit the overall well-being of the aquarium's inhabitants and the surrounding ecosystem.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai'i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai'i

JOSH GREEN, M.D.
GOVERNOR
KE KIAʻĀINA

KEITH A. REGAN
COMPTROLLER
KA LUNA HOʻOMALU HANA LAULĀ

MEOH-LENG SILLIMAN
DEPUTY COMPTROLLER
KA HOPE LUNA HOʻOMALU HANA LAULĀ

STATE OF HAWAIʻI | KA MOKUʻĀINA O HAWAIʻI
DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES | KA ʻOIHANA LOIHELU A LAWELAWE LAULĀ
P.O. BOX 119, HONOLULU, HAWAII 96810-0119

(P)23.120

JUL 28 2023

Ms. Berna Senelly, Regulatory Lead
Oceanit
828 Fort Street Mall, Suite 600
Honolulu, Hawaii 96813

Dear Ms. Senelly:

Subject: Pre-Consultation for an Environmental Assessment
Upgrade of the Waikiki Aquarium Water Intake System
2777 Kalakaua Avenue, Honolulu, Hawaii 96815
TMK: (1)3-1-031-006

Thank you for the opportunity to comment on the subject project. We have no comments to offer at this time as the proposed project does not impact any of the Department of Accounting and General Services' projects or existing facilities.

If you have any questions, your staff may call Dora Choy of the Public Works Division at (808) 586-0488.

Sincerely,

CHRISTINE L. KINIMAKA
Public Works Administrator

DC:mo

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January 12, 2024

Ms. Christine L. Kinimaka
Public Works Administrator
State Department of Accounting and General Services
P. O. Box 119
Honolulu, Hawaii 96810-0119

TRANSMITTED VIA EMAIL: dags@hawaii.gov

Dear Ms. Kinimaka:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comment dated July 28, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades.

We note that you have no comments at this time.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawaiʻi, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawaiʻi
Tavia Oshiro, Environmental Compliance Program Manager, University Hawaiʻi

HONOLULU FIRE DEPARTMENT
KA ʻOIHANA KINAI AHI O HONOLULU
CITY AND COUNTY OF HONOLULU

636 SOUTH STREET • HONOLULU, HAWAIʻI 96813
PHONE: (808) 723-7139 • FAX: (808) 723-7111 • WEB: www.honolulu.gov

RICK BLANGIARDI
MAYOR
MEIA

SHELDON K. HAO
FIRE CHIEF
LUNA NUI KINAI AHI

JASON SAMALA
DEPUTY FIRE CHIEF
HOPE LUNA NUI KINAI AHI

July 31, 2023

Ms. Berna Senelly
Regulatory Lead
Oceanit
828 Fort Street Mall Suite 600
Honolulu, Hawaii 96813

Dear Ms. Senelly:

Subject: Preconsultation for an Environmental Assessment Request
Upgrade of the Waikiki Aquarium Water Intake System
Waikiki Aquarium
2777 Kalakaua Avenue
Honolulu, Hawaii 96815

In response to your letter received on July 24, 2023, regarding the abovementioned subject, the Honolulu Fire Department (HFD) reviewed the submitted information and is unable to render a determination or offer comments as this proposed project resides outside of the HFD's scope.

Should you have questions, please contact Battalion Chief Jean-Claude Bisch of our Fire Prevention Bureau at 808-723-7151 or jcbisch@honolulu.gov.

Sincerely,

CRAIG UCHIMURA
Assistant Chief

CU/JR:bh

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January 12, 2024

Mr. Craig Uchimura
Assistant Chief
Honolulu Fire Department
636 South Street
Honolulu, Hawaii 96813

TRANSMITTED VIA EMAIL: hfdrfi@honolulu.gov

Dear Assistant Chief Uchimura:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comment dated July 31, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades.

We note your comment that the proposed project resides outside of the HFD's scope.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai'i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai'i

Berna Senelly

From:	Joshua Rudolph - NOAA Federal <joshua.rudolph@noaa.gov>
Sent:	Monday, July 31, 2023 11:13 AM
To:	WAq
Cc:	David Delaney - NOAA Federal; Dale Uno; Jason Y. Lee
Subject:	[External] Re: Pre-Consultation Regarding Waikiki Aquarium Water Intake System

You don't often get email from joshua.rudolph@noaa.gov. Learn why this is important

Aloha Berna,

Thank you for your inquiry. We also received your letter dated the 27th to Mr.Tosatto. Per our previous conversation on previous activities related to a similar project(s), do you know whether a federal nexus exists for this proposed project? That is, are any Federal agencies funding, authorizing, or carrying out the proposed action? Are there any federal permitting requirements for your activities? Endangered Species Act (ESA) and Essential Fish Habitat (EFH) consultations are only completed with federal agencies when a federal nexus exists (50 CFR 402.02). Otherwise, consultation is not required.

As we only complete ESA and EFH consultations with Federal agencies, they would be the ones responsible to consult with our offices if they believe effects may occur to our trust resources.

Reviewing this information, I would assume you may need a U.S. Army Corps of Engineers permit, do you know if that's the case? You may want to reach out to the U.S. Army Corps of Engineers, Honolulu District to be safe.

Thanks,
Josh

On Fri, Jul 21, 2023 at 3:19 PM Kate Taylor <kate.taylor@noaa.gov> wrote:

> Aloha EFH/ESA folks,
>
> Forwarding in case of in-water construction consultation requirement.
>
> Kate
>
> ---------- Forwarded message ---------
> From: **WAq** <WAq@oceanit.com>
> Date: Thu, Jul 20, 2023 at 3:15 PM
> Subject: Pre-Consultation Regarding Waikiki Aquarium Water Intake System
> To: piro.info@noaa.gov <piro.info@noaa.gov>
> Cc: Dale Uno <duno@oceanit.com>, Jason Y. Lee <jylee@oceanit.com>
>
> Aloha
>
> On behalf of the University of Hawaiʻi (UH), Oceanit is preparing a Draft Environmental Assessment (EA) regarding the Upgrade of the Waikīkī Aquarium (WAq) Water Intake System. WAq utilizes three (3) intake water sources for their approximately sixty (60) public exhibits and behind-the-scenes holding tanks that are in operation at any given time. The three (3) intake water sources include 1) natural seawater (NSW) via two (2) 8-inch offshore intake pipes, 2) saltwater derived from an 80-ft deep saltwater production well, and 3) freshwater from the City and County of Honolulu water supply system. The freshwater supplies only a small number of exhibits, whereas the NSW and the salt water well supply most of the exhibits and holding tanks at the WAq.

A functional water intake supply system is critical to the operation of the WAq and to the life support systems for the animals at WAq. If any of the three intake water sources fails, the health and wellbeing of the animals that depend on it are endangered. The purpose of the proposed project is to upgrade the Aquarium's outdated intake water system infrastructure to prevent future failures that threaten the life and wellbeing of the animals.

We invite you to submit pre-consultation comments on this project. We are attaching a pre-consultation letter that describes the proposed improvements to the WAq Water Intake System, as well as figures depicting the project site and location, existing conditions of the Water Intake System, an aerial view of proposed Water Intake System improvements, the proposed Upgrade Plan.

Please transmit your comments by August 9, 2023. Your comments and our responses will be included in the Draft Environmental Assessment that will be published in *The Environmental Notice* issued by the Hawaiʻi State Office of Planning and Sustainable Development Environmental Review Program. Please email me if you have questions.

We look forward to your comments!

Sincerely,

Berna Cabacungan Senelly

Berna Cabacungan Senelly | **Senior Regulatory and Community Lead**

828 Fort Street Mall Suite 600 | Honolulu, HI 96813

Email: bsenelly@oceanit.com

Office: 808.531.3017 ext. 221

Direct: 808.954.4221

Mobile: 817.422.1372

Fax: 808.531.3177

▸ **Website** | **Facebook** | **Twitter** | **LinkedIn**

--

Joshua Rudolph, M.Sc.

Endangered Species Biologist
Protected Resources
Pacific Island Regional Office
NOAA Fisheries | U.S. Department of Commerce
Office: (808) 725-5147
www.fisheries.noaa.gov

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January 12, 2024

Mr. Josh Rudolph
National Marine Fisheries Service
U.S. Department of Commerce

TRANSMITTED VIA EMAIL: joshua.rudolph@noaa.gov

Dear Mr. Rudplph:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comment dated July 31, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades.

Please be advised that we are in consultation with the U.S. Army Corps of Engineers regarding necessary permits and approvals. We note your comment that your agency only completes Endangered Species Act (ESA) and Essential Fish Habitat (EFH) analysis with Federal Agencies.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai‘i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai‘i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai‘i

Berna Senelly

From:	Alexandria Barkman - NOAA Federal <alexandria.barkman@noaa.gov>
Sent:	Tuesday, August 1, 2023 4:57 PM
To:	Berna Senelly; WAq
Cc:	Dale Uno; Jason Y. Lee; David Delaney - NOAA Federal; Malia Chow - NOAA Federal
Subject:	[External] EFH Pre-Consultation Regarding Waikiki Aquarium Water Intake System

You don't often get email from alexandria.barkman@noaa.gov. Learn why this is important

Aloha Berna,

The National Marine Fisheries Service, Pacific Islands Regional Office (PIRO) received a request from Oceanit, on the behalf University of Hawaiʻi, for comments on potential adverse effects to the marine environment from proposed activities to upgrade the Waikīkī Aquarium (WAq) water intake system. Our technical assistance is provided below and is intended to help you avoid and minimize potential adverse effects to NOAA trust resources, including essential fish habitat (EFH). This technical assistance does not fulfill any federal responsibilities and does not constitute an EFH consultation, which requires a federal nexus. In addition to being the federal regulatory agency responsible for implementing the Magnuson-Stevens Fishery Conservation and Management Act (MSA; Section 305(b)(2) as described by 50 CFR 600.920), PIRO oversees consultations for compliance with the Endangered Species Act (ESA) and other statutory mandates. For all questions related to consultations with us in the future, please contact us through the email address EFHESAconsult@noaa.gov.

Given the information that you have provided, there currently is no federal nexus for consultation on EFH. If a permit is required from the U.S Army Corps of Engineers for construction, however, that permit would require the lead Federal agency to consult with NMFS on EFH if the activities may adversely affect EFH. Therefore, we recommend that you confirm whether such a permit(s) may be required and refer that agency to NMFS via the email address provided above. Irrespective, and because there could be potential impacts to NOAA trust resources, including EFH, below is our technical assistance intended to help you avoid and minimize potential adverse effects to the marine environment.

In the main Hawaiian Islands, EFH has been designated in the marine water column from the surface to a depth of 1,000 meters (m), from the shoreline to the outer boundary of the Exclusive Economic Zone (200 nautical miles), and the seafloor from the shoreline out to a depth of 400 m. These waters and submerged lands are designated as EFH because they support various life stages for the management unit species (MUS) identified under the Western Pacific Fishery Management Council's Pelagic and Hawaiʻi Archipelago Fishery Ecosystem Plan (Hawaiʻi FEP). The MUS and life stages found in these waters include: eggs, larvae, juveniles, and adults of Bottomfish MUS; eggs, larvae, juveniles, and adults of Crustacean MUS; and eggs, larvae, juveniles, and adults of Pelagic MUS. Specific types of habitat considered as EFH include coral reefs, patch reefs, hard substrate, seagrass beds, soft substrate, artificial or man-made structures, lagoon, estuarine, surge zone, deep-slope terraces and pelagic/open ocean.

NMFS is concerned that certain aspects of the proposed project may adversely affect EFH through the proposed activities due to in-water construction on the intake pipes. Specifically, NMFS is concerned that: 1) seawater intake will result in mortality to eggs, larvae, and juvenile life stages of federally managed fish species (e.g., Bottomfish, Pelagic, and Crustacean management unit species (MUS)), 2) Increased turbidity due to activities in the water may increase mortality of eggs, larvae, and juvenile life stages of federally managed fish species (e.g., Bottomfish, Pelagic, and Crustacean species MUS, 3) Physical damage to the benthos from removal and installation of pipes including corals and seagrass in the area that will results in loss of resources (corals) that provide habitat to early life stages of Bottomfish, Pelagic, and Crustacean MUS.

<u>Adverse Effect of Replacement of Water Intake Pipe below mean high-water mark:</u>

i. Physical Damage/Removal: Physical damage to principle benthic organisms from removal and installation of structures in the water may result in breakage or dislocation (i.e., mortality, or sub-lethal tissue abrasion) in corals. Corals, which are primarily responsible for the structural complexity of coral reefs, are particularly vulnerable to physical damage because their slow-growing carbonate skeleton is relatively brittle and their polyps are easily damaged. Corals often colonize artificial structures, such as pipes. Literature reviews (Newell et al., 1998; ICES 2016) suggest that the successional marine community requires at least six to eight months to recover back to initial levels after removal, although broken coral will take many years to regrow if significant biomass is removed (Minton 2013).

ii. Sedimentation and Turbidity: Sedimentation may smother nearby corals and seagrass. Elevated turbidity levels reduce light penetration and photosynthesis in corals and seagrass. These adverse effects may cause short-term, long-term to permanent and cumulative adverse effects to habitat forming EFH such as corals and seagrass. Consider developing measures to avoid and minimize these adverse effects such as the installation of silt curtains and planning operation activities around the low tide

iii. Nutrient, Disease, and Chemical Contamination: Elevated macronutrient concentrations may cause algal overgrowth in coral reef ecosystems. Introduction of pathogens, including bacteria and viruses, can cause various types of coral disease resulting in degradation of coral condition. Chemical contaminants, including petroleum products and metal (e.g., copper in anti-fouling paints) can cause mortality and reduced reproductive success, respectively. In all, discharge of high concentrations of nutrients, pathogens, and chemical contaminants could reduce water quality and negatively affect marine life in the marine environment. We recommend that you consider these concerns and develop any potential avoidance and minimization measures.

iv. Noise (environmental stressor): In-water construction will expose individual habitat-forming marine organisms to sound and vibratory stressors. Behavioral changes can occur, resulting in animals leaving feeding or reproduction grounds (Cox et al., 2018) or becoming more susceptible to mortality through decreased predator-avoidance responses (Simpson et al., 2016). Less intense but chronic noise, such as that produced by continuous boating, can cause a general increase in background noise over a large area. Although not likely to kill organisms, chronic noise can mask biologically important sounds and alter the natural soundscape, cause hearing loss, and/or have an adverse effect on an organism's stress levels and immune system.

We greatly appreciate the opportunity to provide comments. For all additional questions related to this, please contact us through the email address: efhesaconsult@noaa.gov

Best,
Alexandria

References

Cox, K., Brennan, L.P., Gerwing, T.G., Dudas, S.E. and Juanes, F., 2018. Sound the alarm: A meta-analysis on the effect of aquatic noise on fish behavior and physiology. *Global Change Biology*, *24*(7), pp.3105-3116.

ICES. 2016. Effects of extraction of marine sediments on the marine environment 2005–2011. ICES Cooperative Research Report No. 330. 206 pp.

Minton, D. 2013. Review of growth rates for indo-pacific corals final report. National Oceanic and Atmospheric Administration Pacific Islands Regional Office.

Newell, R.C., Seiderer, L.J. and Hitchcock, D.R., 1998. The impact of dredging works in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. *Oceanography and Marine Biology: An Annual Review*, 36, pp.127-178.

Simpson, S.D., Radford, A.N., Nedelec, S.L., Ferrari, M.C., Chivers, D.P., McCormick, M.I. and Meekan, M.G., 2016. Anthropogenic noise increases fish mortality by predation. *Nature communications*, *7*(1), p.10544.

--
Alexandria Barkman, PhD.
EFH Consulting Biologist, PIRO Habitat Conservation Division
National Marine Fisheries Service | U.S. Department of Commerce

Office: (808) 725-5150

www.fisheries.noaa.gov

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January 12, 2024

Dr. Alexandria Barkman
EFH Consulting Biologist
PIRO Habitat Conservation Division
National Marine Fisheries Service
U.S. Department of Commerce

TRANSMITTED VIA EMAIL: EFHESAconsult@noaa.gov alexandria.barkman@noaa.gov

Dear Dr Barkman:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comment dated August 1, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades.

Please note that we are in consultation with the U.S. Army Corps of Engineers regarding necessary Department of the Army permits and approvals.

We note your concern that the Proposed Action may adversely affect Essential Fish Habitat (EFH) due to in-water construction. We appreciate your technical assistance intended to help us avoid and minimize potential adverse effects to the marine environment. In the Draft EA, Section 3.3.2, Marine Biological Resources, and Appendix E, Benthic Survey Report: Vicinity of Intake Pipes and Seawall Cavity, contain discussions regarding EFH.

The following includes your comments and our responses:

1. *Physical Damage/Removal: Physical damage to principle benthic organisms from removal and installation of structures in the water may result in breakage or dislocation (i.e., mortality, or sub-lethal tissue abrasion) in corals. Corals, which are primarily responsible for the structural complexity of coral reefs, are particularly vulnerable to physical damage because their slow-growing carbonate skeleton is relatively brittle and their polyps are easily damaged. Corals often colonize artificial structures, such as pipes. Literature reviews (Newell et al., 1998; ICES 2016) suggest that the successional marine community requires at least six to eight months to recover back to initial levels after removal, although broken coral will take many years to regrow if significant biomass is removed (Minton 2013).*

   Response: Dredging of loose material for the removal and replacement of the pipes is expected to physically disturb the benthic habitat up to 2m to either side of the pipes. This benthic habitat is primarily composed of various sizes of sand, sediment and rock, and up to seven (7) small to medium (5 – 30 cm) coral colonies. The pipe itself has not been colonized by corals – it is dominated by mats of turf algae and cyanobacteria. To the extent possible, corals at risk of physical damage will be relocated to a similar site fronting the Waikiki Aquarium but outside of the project impact zone. The shallow reef flat to either side of the pipes is not expected to be physically damaged during the proposed project activities.

2. *Sedimentation and Turbidity: Sedimentation may smother nearby corals and seagrass. Elevated turbidity levels reduce light penetration and photosynthesis in corals and seagrass. These adverse effects may cause short-term, long-term to permanent and cumulative adverse effects to habitat forming EFH such as corals and seagrass. Consider developing measures to avoid and minimize these adverse effects such as the installation of silt curtains and planning operation activities around the low tide.*

   Response: The dredging and replacement of sand and gravel during pipe replacement is expected to temporarily elevate turbidity levels in the project area, although this level of turbidity is not expected to exceed that typically experienced over this reef flat during seasonal large wave storm events. This has the potential to impact corals on the shallow reef flat to either side, as well as fish and algae in the vicinity of the project. To mitigate this effect, silt curtains will be installed on either side of the alignment in sections where work is presently under way during construction, and activities will be scheduled around low tide. As the site is exposed to tidal flushing and wave energy, impacts to water quality are expected to be temporary and short-term.

3. *Nutrient, Disease, and Chemical Contamination: Elevated macronutrient concentrations may cause algal overgrowth in coral reef ecosystems. Introduction of pathogens, including bacteria and viruses, can cause various types of coral disease resulting in degradation of coral condition. Chemical contaminants, including petroleum products and metal (e.g., copper in anti-fouling paints) can cause mortality and reduced reproductive success, respectively. In all, discharge of high concentrations of nutrients, pathogens, and chemical contaminants could reduce water quality and negatively affect marine life in the marine environment. We recommend that you consider these concerns and develop any potential avoidance and minimization measures.*

   Response*:* The in-water pipe replacement scope of work consists of materials that are commonly used in coastal construction in areas throughout Hawaiʻi. No chemical leeching is anticipated. The work will be completed using the heavy equipment available to the Contractor. This may include excavators, backhoes, loaders, boom trucks, etc. BMPs to address the risks of heavy equipment at project site will be provided in the construction documents, including the following:

   - Measures to control runoff and other pollutants (e.g., fiber roll, silt curtain) shall be in place before any work is initiated. These measures shall be properly constructed and maintained throughout the construction period.
   - At all times, the Contractor shall keep public areas (including the shoreline) in the vicinity of the project site clear of trash, debris and any other unnecessary materials related to construction.
   - The Contractor shall ensure that all tires of construction vehicles are sufficiently cleaned off so that dirt or debris is not tracked off the construction site. Washing off tires will not be acceptable unless the runoff is contained and does not enter the storm drain system, the roadway, or ocean. The Contractor shall remove all sediment deposited on paved surfaces within twenty-four (24) hours.
   - Material management practices shall be used to reduce the risk of spills or other accidental exposure of materials and substances. Only sufficient product as is required to do the job will be stored. All materials stored on-site shall be stored in a neat, orderly manner in their appropriate containers and under a roof and/or within a secondary containment enclosure.

- All onsite vehicles shall be monitored for leaks and receive regular maintenance to reduce the chance of leakage. Petroleum products shall be stored in tightly sealed containers which are clearly labeled.

- Concrete trucks shall not be allowed to wash out or discharge drum wash water at the site.

- A spill prevention plan shall be posted and adjusted to include a description and cause of each spill and measures to prevent and clean up each spill. Materials and equipment necessary for spill cleanup shall be kept in the material storage area onsite. All spills shall be cleaned up immediately. The Contracting Officer will be notified immediately of all spills. Spills of toxic hazardous material shall be reported to the appropriate State or local government agency, regardless of the size.

- Any hydraulic equipment used in or over the water will use environmentally safe hydraulic fluid.

- No in-water work will be conducted during periods of large waves or significant stormwater runoff from adjacent City drainages.

4. *Noise (environmental stressor): In-water construction will expose individual habitat-forming marine organisms to sound and vibratory stressors. Behavioral changes can occur, resulting in animals leaving feeding or reproduction grounds (Cox et al., 2018) or becoming more susceptible to mortality through decreased predator-avoidance responses (Simpson et al., 2016). Less intense but chronic noise, such as that produced by continuous boating, can cause a general increase in background noise over a large area. Although not likely to kill organisms, chronic noise can mask biologically important sounds and alter the natural soundscape, cause hearing loss, and/or have an adverse effect on an organism's stress levels and immune system.*

   Response: The entire project is expected to take approximately two (2) years to complete. However, the in-water pipe replacement is anticipated to take approximately four (4) months depending on weather conditions. Maximum permissible noise levels have been set in Chapter 46, Public Health Regulations, Department of Health, State of Hawaii, “Community Noise Control.” The Contractor shall become familiar with the noise level restrictions and the procedures for obtaining a permit for the construction activities and obtain a permit from the Director of Health as needed. To mitigate noise emissions and community effects of noise emissions from construction activities, BMPs such as the following will be employed:

   - Equipment operation on the shoreline will be limited between 7:00 AM and 7:00 PM. Noisier operations, such as truck hauling, could be limited to minimize disruption to beach users and Aquarium occupants.

   - Equipment substitution will be used to ensure that the quietest locally available equipment is used (e.g., high insertion loss mufflers, fully enclosed engines, and rubber-tired equipment, if possible).

   - The use of horns will be prohibited.

Underwater sound from in-water construction is expected to be below regulatory thresholds [1] (NMFS, 2018), as no in-water activities that generate high-intensity noise (e.g., drilling, pile-driving, the use of explosives) will occur. We will also refer to the BMP of "watching for and avoiding protected marine life before commencing work and postponing certain activities when protected species are within 50 yards of that activity."

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai'i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai'i

---

[1] *National Marine Fisheries Service. 2018. 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p*

DEPARTMENT OF THE ARMY
HONOLULU DISTRICT, U.S. ARMY CORPS OF ENGINEERS
FORT SHAFTER, HAWAII 96858-5440

August 1, 2023

SUBJECT: Proposed Upgrade of the Waikiki Aquarium Water Intake System, Honolulu, Island of Oahu, Hawaii; Department of the Army File No. POH-2022-00081

Berna Senelly
Oceanit
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Ms. Senelly:

The U.S. Army Corps of Engineers – Honolulu District, Regulatory Office (Corps) received your letter dated July 20, 2023, requesting consultation comments for the proposed Upgrade of the Waikiki Aquarium Water Intake System at Honolulu, Island of Oahu, Hawai'i. Your request has been assigned Department of the Army (DA) file number POH-2022-00081. Please reference this number in all future correspondence with our office relating to this action.

Based on the information provided in regard to your proposed project, the Corps provides the following comments.

The Corps authorities are based on two laws: Section 404 of the Clean Water Act (33 U.S.C. 1344; "Section 404") and Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403; "Section 10").

Section 404 of the Clean Water Act requires that a DA permit be obtained for the placement or discharge of dredged and/or fill material into waters of the U.S., including jurisdictional wetlands (33 U.S.C. 1344). The Corps defines wetlands as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Section 10 of the Rivers and Harbors Act of 1899 requires that a DA permit be obtained for structures or work in or affecting navigable waters of the U.S. (33 U.S.C. 403). Section 10 waters are those waters subject to the ebb and flow of the tide shoreward to the mean high water mark, and/or other waters identified by the Honolulu District.

Based on the proposed scope of work as described in your letter, DA authorization would be required for the replacement of the two 8-inch natural seawater intake pipes as it would involve work in navigable waters of the U.S. and may involve the placement of dredged and/or fill material into waters of the U.S. The proposed activity may qualify for verification under Nationwide Permit (NWP) 3, Maintenance. For more information regarding the NWP Program please visit: https://www.poh.usace.army.mil/Missions/Regulatory/Permits/Nationwide-Permits/.

Thank you for your cooperation with the Honolulu District Regulatory Program. Should you have any questions related to this determination or would like to schedule a pre-application consultation meeting, please contact me via e-mail at Cristian.J.Cayanan@usace.army.mil or via phone at 808-835-4107. You are encouraged to provide comments on your experience with the Honolulu District Regulatory Office by accessing our web-based customer survey form at https://regulatory.ops.usace.army.mil/ords/f?p=136:4.

Sincerely,

CJ Cayanan
Biologist/Regulatory Specialist

oceanit®
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January 12, 2024

Honolulu District
U.S. Army Corps of Engineers
Fort Shafter, Hawaii 96858-5440

TRANSMITTED VIA EMAIL: CEPOH-RO@usace.army.mil; Vera.B.Koskelo@usace.army.mil

Aloha:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments
Department of the Army File No. POH-2022-00081

We received pre-consultation comments dated August 1, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades.

We note your comments that a Department of Army (DA) permit must be obtained for Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899. You also indicated that the proposed activity may qualify for verification under Nationwide Permit (NWP) 3, Maintenance.

We discuss these Federal permits and approvals in Section 4.1, Federal, as part of Section 4, Relationship to Land Use Plans, Policies and Controls, and , RELATIONSHIP TO LAND USE PLANS, POLICIES, AND CONTROLS. Further, we identify Federal permits and approvals in Section 4.4, Permits and Approvals.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai‘i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai‘i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai‘i

JOSH GREEN, M.D.
GOVERNOR | KE KIAʻĀINA

SYLVIA LUKE
LIEUTENANT GOVERNOR | KA HOPE KIAʻĀINA

DAWN N. S. CHANG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAIʻI | KA MOKUʻĀINA ʻO HAWAIʻI
DEPARTMENT OF LAND AND NATURAL RESOURCES
KA ʻOIHANA KUMUWAIWAI ʻĀINA
LAND DIVISION

P.O. BOX 621
HONOLULU, HAWAII 96809

August 7, 2023

LD 0054

Berna Cabacungan Senelly
Senior Regulatory and Community Lead
828 Fort Street Mall Suite 600
Honolulu, Hawaii 96813

Via email:bsenelly@oceanit.com

Dear Ms. Senelly:

SUBJECT: **Request for Comments Regarding Pre-Consultation on DEA for Waikiki Aquarium Water Intake System, TMK (1) 3-1-031: 006**

Thank you for the opportunity to review and comment on the subject project. The Land Division of the Department of Land and Natural Resources (DLNR) distributed copies of your request to DLNR's various divisions for their review and comment.

Enclosed are responses/comments received from our Land Division, Engineering Division and Division of Boating and Ocean Recreation. Should you have any questions, please feel free to contact Timothy Chee via email at *timothy.chee@hawaii.gov*. Thank you.

Sincerely,

Russell Tsuji

Russell Y. Tsuji
Land Administrator

Attachments
cc: Central Files

JOSH GREEN, M.D.
GOVERNOR | KE KIAʻĀINA

SYLVIA LUKE
LIEUTENANT GOVERNOR | KA HOPE KIAʻĀINA

DAWN N. S. CHANG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAIʻI | KA MOKUʻĀINA ʻO HAWAIʻI
DEPARTMENT OF LAND AND NATURAL RESOURCES
KA ʻOIHANA KUMUWAIWAI ʻĀINA
LAND DIVISION

P.O. BOX 621
HONOLULU, HAWAII 96809

July 21, 2023

LD 0054

MEMORANDUM

TO: **DLNR Agencies:**
_X_ Div. of Aquatic Resources *(via email: kendall.l.tucker@hawaii.gov)*
_X_ Div. of Boating & Ocean Recreation (*richard.t.howard@hawaii.gov*)
_X_ Engineering Division *(via email: DLNR.Engr@hawaii.gov)*
_X_ Div. of Forestry & Wildlife *(via email: Rubyrosa.T.Terrago@hawaii.gov)*
__ Div. of State Parks
_X_ Commission on Water Resource Management *(via email: DLNR.CWRM@hawaii.gov)*
_X_ Office of Conservation & Coastal Lands *(via email: sharleen.k.kuba@hawaii.gov)*
_X_ Land Division – Oahu District *(via email: barry.w.cheung@hawaii.gov)*
__ Aha Moku *(via email: leimana.k.damate@hawaii.gov)*

FROM: Russell Y. Tsuji, Land Administrator Russell Tsuji
SUBJECT: **Request for Comments Regarding Pre-Consultation for Waikiki Aquarium Water Intake System**
LOCATION: 2777 Kalakaua Avenue, Honolulu, Island of Oahu, Hawaii
TMK: (1) 3-1-031:006
APPLICANT: **Oceanit**

Transmitted for your review and comment is information on the above-referenced project. Please review the attached information and submit any comments by the Internal deadline of August 7, 2023 to timothy.chee@hawaii.gov at the Land Division.

If no response is received by the above due date, we will assume your agency has no comments at this time. Should you have any questions about this request, please contact Timothy Chee at the above email address. Thank you.

BRIEF COMMENTS:
Please include background information and any prior approvals for the existing 160ft. offshore seawater intake pipes as noted in project map. Any new improvements placed seaward on lands under Land Board jurisdiction will need an approved land disposition from the Board, and approvals from Legislation and the Governor before the easement can be executed.

( ) We have no objections.
( ) We have no comments.
( ) We have no additional comments.
(X) Comments are included/attached.

Signed: Darlene Bryant-Takamatsu BC
Print Name: Darlene Bryant-Takamatsu
Division: Land Division
Date: 7/24/2023

Attachments
Cc: Central Files

January 12, 2024

Mr. Russell Tsuji
Land Administrator
State Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

TRANSMITTED VIA EMAIL: dlnr.land@hawaii.gov

Aloha:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

We received pre-consultation comments dated August 7, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades. Thank you for distributing copies to various divisions within the Department of Land and Natural Resources (DLNR). We will respond to the individual agencies directly.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai'i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai'i

DEPARTMENT OF LAND AND NATURAL RESOURCES
ENGINEERING DIVISION

LD/Russell Y. Tsuji
Ref: Request for Comments Regarding Pre-Consultation for Waikiki Aquarium Water Intake System
Location: 2777 Kalakaua Avenue, Honolulu, Island of Oahu, Hawaii
TMK(s): (1) 3-1-031:006
Applicant: Oceanit on behalf of the University of Hawaii for the Waikiki Aquarium

COMMENTS

The rules and regulations of the National Flood Insurance Program (NFIP), Title 44 of the Code of Federal Regulations (44CFR), are in effect when development falls within a Special Flood Hazard Area (high-risk areas). State projects are required to comply with 44CFR regulations as stipulated in Section 60.12. Be advised that 44CFR, Chapter 1, Subchapter B, part 60 reflects the minimum standards as set forth by the NFIP. Local community flood ordinances may stipulate higher standards that can be more restrictive and would take precedence over the minimum NFIP standards.

The owner of the project property and/or their representative is responsible to research the Flood Hazard Zone designation for the project. Flood Hazard Zones are designated on FEMA's Flood Insurance Rate Maps (FIRM). The official FIRMs can be accessed through FEMA's Map Service Center (msc.fema.gov). Our Flood Hazard Assessment Tool (FHAT) (fhat.hawaii.gov) could also be used to research flood hazard information.

If there are questions regarding the local flood ordinances, please contact the applicable County NFIP coordinating agency below:

- Oahu: City and County of Honolulu, Department of Planning and Permitting (808) 768-8098.
- Hawaii Island: County of Hawaii, Department of Public Works (808) 961-8327.
- Maui/Molokai/Lanai County of Maui, Department of Planning (808) 270-7139.
- Kauai: County of Kauai, Department of Public Works (808) 241-4896.

Signed: ______________________
CARTY S. CHANG, CHIEF ENGINEER

Date: Aug 2, 2023

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January 12, 2024

Mr. Carty Chang, Chief Engineer
Engineering Division
State Department of Land and Natural Resources

TRANSMITTED VIA EMAIL dlnr.engr@hawaii.gov

Dear Mr. Chang:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comments dated August 2, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades.

We note your comment regarding the Flood Hazard Zone designation for the project. The Draft EA contains a full discussion of this in Section 3.2.2, Flood Hazards and includes a map showing FIRM in the vicinity of Waikīkī Aquarium in Figure 3-8.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai‘i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai‘i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai‘i

JOSH GREEN, M.D.
GOVERNOR | KE KIAʻĀINA

SYLVIA LUKE
LIEUTENANT GOVERNOR | KA HOPE KIAʻĀINA

RECEIVED
LAND DIVISION

2023 JUL 26 PM 2:22

DEPT. OF LAND & NATURAL RESOURCES
STATE OF HAWAII

DAWN N. S. CHANG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAIʻI | KA MOKUʻĀINA ʻO HAWAIʻI
DEPARTMENT OF LAND AND NATURAL RESOURCES
KA ʻOIHANA KUMUWAIWAI ʻĀINA
LAND DIVISION

P.O. BOX 621
HONOLULU, HAWAII 96809

July 21, 2023

LD 0054

MEMORANDUM

TO: **DLNR Agencies:**
X Div. of Aquatic Resources *(via email: kendall.l.tucker@hawaii.gov)*
X Div. of Boating & Ocean Recreation (*richard.t.howard@hawaii.gov*)
X Engineering Division *(via email: DLNR.Engr@hawaii.gov)*
X Div. of Forestry & Wildlife *(via email: Rubyrosa.T.Terrago@hawaii.gov)*
__Div. of State Parks
X Commission on Water Resource Management *(via email: DLNR.CWRM@hawaii.gov)*
X Office of Conservation & Coastal Lands *(via email: sharleen.k.kuba@hawaii.gov)*
X Land Division – Oahu District *(via email: barry.w.cheung@hawaii.gov)*
__Aha Moku *(via email: leimana.k.damate@hawaii.gov)*

FROM: Russell Y. Tsuji, Land Administrator Russell Tsuji
SUBJECT: **Request for Comments Regarding Pre-Consultation for Waikiki Aquarium Water Intake System**
LOCATION: 2777 Kalakaua Avenue, Honolulu, Island of Oahu, Hawaii
TMK: (1) 3-1-031:006
APPLICANT: **Oceanit**

Transmitted for your review and comment is information on the above-referenced project. Please review the attached information and submit any comments by the Internal deadline of August 7, 2023 to timothy.chee@hawaii.gov at the Land Division.

If no response is received by the above due date, we will assume your agency has no comments at this time. Should you have any questions about this request, please contact Timothy Chee at the above email address. Thank you.

BRIEF COMMENTS:

(X) We have no objections.
( ) We have no comments.
( ) We have no additional comments.
( ) Comments are included/attached.

Signed: Rich Howard
Print Name: Richard Howard
Division: DOBOR
Date: 7/25/2023

Attachments
Cc: Central Files

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January 12, 2024

Mr. Richard Howard
Division of Boating and Ocean Recreation
State Department of Land and Natural Resources

TRANSMITTED VIA EMAIL richard.t.howard@hawaii.gov

Dear Mr. Howard:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comments dated July 25, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades.

We note your comment of no objections.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawaiʻi, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawaiʻi
Tavia Oshiro, Environmental Compliance Program Manager, University Hawaiʻi

POLICE DEPARTMENT
KA 'OIHANA MĀKA'I O HONOLULU
CITY AND COUNTY OF HONOLULU

801 SOUTH BERETANIA STREET · HONOLULU, HAWAI'I 96813
TELEPHONE: (808) 529-3111 · INTERNET: www.honolulupd.org

RICK BLANGIARDI
MAYOR
MEIA

ARTHUR J. LOGAN
CHIEF
KAHU MĀKA'I

KEITH K. HORIKAWA
RADE K. VANIC
DEPUTY CHIEFS
HOPE LUNA NUI MĀKA'I

OUR REFERENCE EO-LS

August 7, 2023

SENT VIA EMAIL

Ms. Berna Senelly
WAq@oceanit.com

Dear Ms. Senelly:

This is in response to your letter dated July 20, 2023, requesting input on the Pre-Consultation, Environmental Assessment for the proposed upgrades to the Waikīkī Aquarium Water Intake System at 2777 Kalākaua Avenue.

The Honolulu Police Department (HPD) has reviewed the information provided and has some concerns. We recommend that all necessary signs, lights, barricades, and other safety equipment be installed and maintained by the contractor during the construction phase of the project, as Kalākaua Avenue is a heavily traversed roadway by both pedestrians and vehicles.

The HPD also recommends that adequate notification be made to residents and visitors in the area prior to deliveries or possible road closures, as any impacts to pedestrian and/or vehicular traffic may cause issues and disruptions that could lead to complaints.

If there are any questions, please call Major Randall Platt of District 6 (Waikīkī) at (808) 723-8639.

Sincerely,

GLENN HAYASHI
Assistant Chief of Police
Support Services Bureau

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January 12, 2024

Mr. Glenn Hayashi, Assistant Chief of Police
Honolulu Police Department
801 South Beretania Street
Honolulu, Hawaii 96813

TRANSMITTED VIA EMAIL: hpdchiefsoffice@honolulu.gov

Dear Assistant Chief Hayashi:

SUBJECT: Environmental Assessment (EA) Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comments dated August 7,2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades.

We note your concern regarding the installation and maintenance of all necessary signs, lights, barricades, and other safety equipment during the construction phase of the project. We include your recommendation in Section 2.4.1, Construction Scope of Work of the Draft EA.

Further, regarding your recommendation of adequate notification prior to deliveries and possible road closures, we discuss this in Draft EA Section 3.5.4, Roadways and Public Transportation.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawaiʻi, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawaiʻi
Tavia Oshiro, Environmental Compliance Program Manager, University Hawaiʻi

JOSH GREEN, M.D.
GOVERNOR OF HAWAI'I
KE KIA'ĀINA O KA MOKU'ĀINA 'O HAWAI'I

KENNETH S. FINK, MD, MGA, MPH
DIRECTOR OF HEALTH
KA LUNA HO'OKELE

STATE OF HAWAI'I
DEPARTMENT OF HEALTH
KA 'OIHANA OLAKINO
P. O. BOX 3378
HONOLULU, HI 96801-3378

In reply, please refer to:
File:

August 1, 2023

Ms. Berna Senelly
Oceanit Center
828 Fort Street Mall, Suite 600
Honolulu, Hawaii 96813

Dear Ms. Senelly:

Thank you for your submittal requesting comments for the Upgrade of the Waikiki Aquarium Water Intake System project. We have reviewed the request and recommend that the project comply with the following Department of Health Administrative Rules:

- Chapter 11-39 Air Conditioning and Ventilating
- Chapter 11-46 Community Noise Control
- Chapter 11-501 Asbestos Requirements
- Chapter 11-503 Fees for Asbestos Removal and Certification
- Chapter 11-504 Asbestos Abatement Certification Program

According to the request's description of the project, replacement of two 8-inch transite asbestos NSW intake pipes that extend 160 feet offshore from the Aquarium is planned. Since the project involves the removal of the asbestos containing pipes from a "regulated facility" as defined under Hawaii Administrative Rules Title 11 Chapter 501 "Asbestos Requirements", it therefore must be performed by a licensed C-19 asbestos abatement contractor.

Should you have any questions, please contact me at (808) 586-4700.

Sincerely,

Gabrielle Fenix Grange
Program Manager
Indoor and Radiological Health Branch

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January 12, 2024

Ms. Gabrielle Fenix Grange
Program Manager
Indoor and Radiological Health Branch
Hawaii Department of Health

TRANSMITTED VIA EMAIL: shawn.haruno@doh.hawaii.gov

Dear Ms. Grange:

SUBJECT: Environmental Assessment (EA) Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comments dated August 1, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades.

We appreciate your citing of relevant Department of Health Administrative Rules. Regarding noise, Section 3.1.7, Noise, of the Draft EA discusses existing conditions, potential impacts and recommended mitigation, and Section 4.4, Permits and Approvals, includes a Community Noise Control Permit. Regarding asbestos, the Proposed Action will have a positive impact by replacing the existing asbestos-containing transite pipes with new HDPE pipes. The Draft EA Section 2.4.1, Construction Scope of Work, notes that the removal of the existing asbestos containing transite pipes will be done by a licensed C-19 asbestos abatement contractor.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawaiʻi, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawaiʻi
Tavia Oshiro, Environmental Compliance Program Manager, University Hawaiʻi

JOSH GREEN, M.D.
GOVERNOR | KE KIAʻĀINA

SYLVIA LUKE
LIEUTENANT GOVERNOR | KA HOPE KIAʻĀINA

STATE OF HAWAIʻI | KA MOKUʻĀINA ʻO HAWAIʻI
DEPARTMENT OF LAND AND NATURAL RESOURCES DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

DAWN N.S. CHANG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

LAURA H.E. KAAKUA
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

Date: 8/9/2023
DAR # AR6442

MEMORANDUM

TO: Brian J. Neilson
DAR Administrator

FROM: Kimberly Fuller, Aquatic Biologist

SUBJECT: Request for Pre-Consultation for an Environmental Assessment Regarding the Upgrade of the Waikīkī Aquarium Water Intake System

Request Submitted by: Oceanit on behalf of the University of Hawaiʻi (UH)

Location of Project: 2777 Kalākaua Avenue, Honolulu, HI 96815,TMK (1) 3-1-031:006

Brief Description of Project:

This project plans to upgrade the existing seawater intakes at the Waikiki Aquarium (WAq). Currently, WAq utilizes three (3) intake water sources for their approximately sixty (60) public exhibits and behind-the-scenes holding tanks that are in operation at any given time. The three water sources include 1) natural seawater (NSW) via two (2) 8-inch offshore intake pipes, 2) saltwater derived from an 80-ft deep saltwater production well, and 3) freshwater from the City and County of Honolulu water supply system. The freshwater only supplies a small number of exhibits, whereas the NSW and the salt water well supply most of the exhibits and holding tanks at the WAq.

Comments:

☐ No Comments ☒ Comments Attached

Thank you for providing DAR the opportunity to review and comment on the proposed project. Should there be any changes to the project plan, DAR requests the opportunity to review and comment on those changes.

Comments Approved: ____________________ Date: Aug 9, 2023
Brian J. Neilson
DAR Administrator

DAR# AR6442

<u>Brief Description of Project</u>

Upgrades planned include: Replacement of the two existing 8-inch transite NSW intake pipes that extend 160-ft offshore with two new 8-inch HDPE pipes. Construction of a new saltwater production well and decommissioning of the existing well. Construction of a new pump vault, construction of a new aeration / settling tank for well water treatment, and reconstruction and extension of the existing pump building that has extensive cracks and spalling.

New equipment includes but not limited to the following:

-Eight (8) new pumps: four (4) well water pumps, two (2) NSW pumps, two (2) filter backwash pumps; two (2) air injection pumps

- Four (4) new media filters, including two (2) well water filters, two (2) NSW filters,

-Two (2) ultraviolet (UV) sterilizers to treat NSW, and a chiller to cool warmer NSW to an
acceptable temperature prior to supply to tanks and exhibits

Also included are new piping/fittings, and mechanical and electrical upgrades. Redundance
will be part of the new system to mitigate the impacts of equipment failures or necessary
maintenance activities. See attached Figure 4 - Waikiki Aquarium Water Intake System Upgrade Plan.

DAR# AR6442

Comments

Aquatic Resources:
All negative impacts to marine resources should be avoided or minimized to the maximum extent possible. Construction and design of water intake system upgrade should consider long term impacts as well as immediate impacts.

Coral:
If live coral resources are expected to be impacted with this activity please notify the State of Hawaii Department of Land and Natural Resources Division of Aquatic Resources. Any live coral expected to be impacted should be attempted to be moved prior to impact. Options include coordinating with DLNR DAR to remove coral that may be affected so that they can be transplanted in the surrounding vicinity or moved to their Anuenue Fisheries Research Station for research or educational use. Alternatively, coordination with DLNR DAR could be made to house the coral at the Waikiki Aquarium if proper permitting such as a Special Activity Permit can be put in place.

Live Rock:
Impacts to live rock with the proposed activities should be considered.

Protected Marine Species:
In the event that protected species such as the Hawaiian monk seal, other marine mammal or sea-turtle is observed in close proximity to the construction/repair site, and the activities being conducted may be considered as a "negligent or intentional act which results in disturbing or molesting a marine mammal". Contractors should take appropriate action to modify activities in order to avoid disturbance to the regular behavior and activities of the animal. Appropriate action would include but is not limited to ceasing construction activity until the animal leaves the area.

Any interaction between a protected species and the construction and repair activity proposed should be reported to the NOAA Protected Species Division and State of Hawaii DOCARE:

NOAA Marine Mammal Response Coordinators (Oahu): 808-220-7802

NOAA Sea Turtles (Oahu): Monday-Friday, 7:30am-4pm NOAA National Marine Fisheries Service - PIFSC Marine Turtle Biology and Assessment Program: (808) 725-5730

DAR# AR6442

Comments

State of Hawaii Department of Land and Natural Resources (DLNR) Division of Conservation and Resources Enforcement (DOCARE): 808-643-3567

Entanglement Prevention:
DAR recommends that applicant utilize best management practices to eliminate any potential for incidental entanglement of any marine organism. Entanglement prevention practices will include but are not limited to: minimizing the amount of in-water structures or components that may potentially cause entanglement during research operations (loops, holes, slack lines). If incidental entanglement of protected species occurs DAR and the appropriate federal agency should be notified immediately.

Construction:
Erosion and Land Based Source of Pollution (LBSP) Mitigation:

DAR recommends that best management practices for mitigation of erosion and LBSP be followed. The close proximity to aquatic resources should be considered during design and construction. Landscape design and leveling should be such that long term erosion and LBSP are minimized.

During construction these measures would include any type of barrier (e.g. sediment barriers/bags, petroleum absorption diapers, etc.) that limits the amount of sediment or LBSP (e.g. petroleum products, chemicals, debris, etc.) to the maximum extent practicable. DAR recommends that all construction materials be composed of environmentally inert materials to the extent practicable. The Contractor shall consider the weather while performing construction. Some work may be performed during low rain conditions, but all construction would be halted during storm conditions or when storm conditions threaten the watershed. The site should be secured during storm conditions so that runoff into nearby natural waterbodies is unlikely.

DAR should be notified to assess impact should any event occur during construction that could negatively impact marine resources. Examples of this type of event include but are not limited to excess turbidity from construction, release of liquids such as oil or gas into the water, and live rock or coral damage.

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innovation through engineering & scientific excellence

January 12, 2024

Mr. Brian J. Neilson, Administrator
Division of Aquatic Resources
Hawaii State Department of Land and Natural Resources

TRANSMITTED VIA EMAIL: dlnr.aquatics@hawaii.gov; brian.j.neilson@hawaii.gov

Dear Mr. Neilson:

SUBJECT: Environmental Assessment (EA) Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comments dated August 9, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades. We received comments from both the Division of Aquatic Resources and the Division of Conservation and Resource Enforcement. The following includes your comments and our responses to both agencies.

Division of Aquatic Resources

All negative impacts to marine resources should be avoided or minimized to the maximum extent possible. Construction and design of water intake system upgrade should consider long term impacts as well as immediate impacts.

> Response: Draft EA Section 3.3.2, Marine Biological Resources, provides a thorough discussion of existing conditions, particularly in light of location within the Waikīkī Marine Life Conservation District (MLCD), potential impacts and recommended mitigation measures for the Proposed Action. In addition, the Draft EA Appendix E, Benthic Survey Report: Vicinity of Intake Pipes and Seawall Cavity, contains the findings and recommendations of a survey conducted for the Proposed action.

Coral: If live coral resources are expected to be impacted with this activity, please notify the State of Hawaii Department of Land and Natural Resources Division of Aquatic Resources. Any live coral expected to be impacted should be attempted to be moved prior to impact. Options include coordinating with DLNR DAR to remove coral that may be affected so that they can be transplanted in the surrounding vicinity or moved to their Anuenue Fisheries Research Station for research or educational use. Alternatively, coordination with DLNR DAR could be made to house the coral at the Waikiki Aquarium if proper permitting such as a Special Activity Permit can be put in place.

> Response: A total of three coral colonies were inventoried in the direct vicinity of the seawater intake pipe, as well as four coral colonies near the proposed pipe extension (seven in total). Out of the seven coral colonies observed, five were found to be in poor/deteriorating condition, exhibiting overgrowth of algae, pale or bleached tissue, and/or infection by "pink spot disease". It is anticipated that the pipe replacement and seawall repair project will have minimal disturbance on critical species in the project vicinity. Though some corals may be impacted, the impact can be minimized through the implementation of coral fragmentation and/or transplantation efforts. Further mitigation will include the installation of silt curtains to minimize impacts to the surrounding area.

Live Rock: Impacts to live rock with the proposed activities should be considered.

> Response: Draft EA Section 3.3.2.2, Potential Impacts and Proposed Mitigation Measures, notes that the project will involve removing loose sediment and rock up to 2m to either side of the pipe. All removed substrate will be returned to the site upon installation of the new pipe.

Protected Marine Species: In the event that protected species such as the Hawaiian monk seal, other marine mammal or sea-turtle is observed in close proximity to the construction/repair site, and the activities being conducted may be considered as a "negligent or intentional act which results in disturbing or molesting a marine mammal". Contractors should take appropriate action to modify activities in order to avoid disturbance to the regular behavior and activities of the animal. Appropriate action would include but is not limited to ceasing construction activity until the animal leaves the area.

Any interaction between a protected species and the construction and repair activity proposed should be reported to the NOAA Protected Species Division and State of Hawaii DOCARE.

> Response: Draft EA Section 3.3, Ecological Resources, discusses that that Federal and State agencies will be notified of any interaction between protected species and construction and repair activities related to the Proposed Action.

Division of Conservation and Resource Enforcement

Entanglement Prevention: DAR recommends that applicant utilize best management practices to eliminate any potential for incidental entanglement of any marine organism. Entanglement prevention practices will include but are not limited to: minimizing the amount of in-water structures or components that may potentially cause entanglement during research operations (loops, holes, slack lines). If incidental entanglement of protected species occurs DAR and the appropriate federal agency should be notified immediately.

> Response: Draft EA Section 3.3.2, Marine Biological Resources, includes avoidance of incidental entanglment of protected species.

Construction - Erosion and Land Based Source of Pollution (LBSP) Mitigation: DAR recommends that best management practices for mitigation of erosion and LBSP be followed. The close proximity to aquatic resources should be considered during design and construction. Landscape design and leveling should be such that long term erosion and LBSP are minimized.

During construction these measures would include any type of barrier (e.g. sediment barriers/bags, petroleum absorption diapers, etc.) that limits the amount of sediment or LBSP (e.g. petroleum products, chemicals, debris, etc.) to the maximum extent practicable. DAR recommends that all construction materials be composed of environmentally inert materials to the extent practicable. The Contractor shall consider the weather while performing construction. Some work may be performed during low rain conditions, but all construction would be halted during storm conditions or when storm conditions threaten the watershed. The site should be secured during storm conditions so that runoff into nearby natural waterbodies is unlikely.

DAR should be notified to assess impact should any event occur during construction that could negatively impact marine resources. Examples of this type of event include but are not limited to excess turbidity from construction, release of liquids such as oil or gas into the water, and live rock or coral damage.

> Response: : Draft EA Section 3.3.2, Marine Biological Resources, identifies BMP measures to avoid LBSP. DAR shall be notified of construction-related events that could negatively impact marine resources.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai‘i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai‘i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai‘i

STATE OF HAWAII
OFFICE OF PLANNING
& SUSTAINABLE DEVELOPMENT

JOSH GREEN, M.D.
GOVERNOR

SYLVIA LUKE
LT. GOVERNOR

MARY ALICE EVANS
INTERIM DIRECTOR

235 South Beretania Street, 6th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

Telephone: (808) 587-2846
Fax: (808) 587-2824
Web: https://planning.hawaii.gov/

Coastal Zone Management Program

Environmental Review Program

Land Use Commission

Land Use Division

Special Plans Branch

State Transit-Oriented Development

Statewide Geographic Information System

Statewide Sustainability Program

DTS 202307210815NA

August 10, 2023

Ms. Berna Cabacungan Senelly
Senior Regulatory and Community Lead
Oceanit Laboratories, Inc.
828 Fort Street Mall, Suite 600
Honolulu, Hawaiʻi 96813

Subject: Request for Pre-Consultation for an Environmental Assessment, Upgrade of the Waikīkī Aquarium Water Intake System; 2777 Kalākaua Ave., Honolulu, Oʻahu TMK: (1) 3-1-031:006

Dear Ms. Senelly:

Thank you for the opportunity to provide comments on your Pre-consultation request for the proposed upgrades to the Waikīkī, Aquarium Water Intake System. The notification request was received by our office via memo dated July 20, 2023.

It is our understanding that the proposed action seeks to upgrade the Aquarium's outdated intake water system infrastructure to prevent future failures that threaten the life and wellbeing of the animals. The upgrades will include replacement of the two existing 8-inch transit intake pipes that extend 160-ft offshore with two new 8-inch pipes; construction of a new saltwater production well and decommissioning of the existing well; as well as the construction of a new pump vault.

The Office of Planning and Sustainable Development (OPSD) has reviewed the submitted materials and has the following comments to offer:

1. Coastal Zone Management Act (CZMA), Federal Consistency
   We note that the proposed water intake upgrade action may be subject to federal permitting, such as a Department of the Army Nationwide Permit, as activity may occur within the offshore waters of Waikīkī Beach. Please consult with the appropriate federal authorities, such as the U.S. Army Corps of Engineers, on applicable federal approvals and authorization. If it is deemed that federal permits are needed, then this project may be subject to CZMA federal consistency.

OPSD is the lead state agency with the authority to conduct CZMA federal consistency reviews. Please consult with our office on the applicability of CZMA federal consistency if federal permits are needed.

2. Hawaiʻi Coastal Zone Management (CZM) Program
The CZM area is defined as "all lands of the State and the area extending seaward from the shoreline to the limit of the State's police power and management authority, including the U.S. territorial sea" (Hawaiʻi Revised Statutes (HRS) § 205A-1).

Pursuant to HRS § 205A-4, in implementing the objectives of the CZM program, agencies shall consider ecological, cultural, historic, esthetic, recreational, scenic, open space values, coastal hazards, and economic development. As this project is being proposed by the University of Hawaiʻi, the Draft EA should include analysis on the applicability of the provisions of HRS § 205A to this proposed action.

The objectives and supporting policies of the Hawaiʻi CZM Program serve as the foundation of the enforceable policies of the State of Hawaiʻi, as listed in HRS § 205A-2. Disclosure of impacts on CZM objectives and supporting policies, as it relates to HRS Chapter 343 requirements, will aid the State in determining impacts to the resources of the coastal zone, and can be cited in a CZMA federal consistency submittal if one is warranted.

3. Special Management Area (SMA) / Shoreline Setbacks
The Draft EA should provide a regional location map and include the project site's proximity and relation to the designated SMA boundary and the shoreline. Additionally, given that the subject Environmental Assessment (EA) may serve as a supporting document for a SMA Use Permit application, we recommend that the EA specifically discuss the compliance with the requirements of SMA use and any applicable shoreline setbacks requirements by consulting with the City and County of Honolulu, Department of Planning and Permitting.

4. Climate Change Adaptation / Sea Level Rise (SLR)
The Waikīkī Aquarium and its support facilities are in close proximity to the nearshore waters of Māmala Bay and the Pacific Ocean. Thus, the aquarium may be vulnerable to the natural threats associated with coastal areas such as shoreline flooding, erosion, storm surges, saltwater intrusion, and related natural disasters associated with climate change.
To assess potential impacts of SLR and assess the viability of the Waikīkī Aquarium's proposed water intake system, we suggest the Draft EA refer to the findings of the Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report 2017, accepted by the Hawaiʻi Climate Change Mitigation and Adaptation Commission.

The Report, and Hawaii Sea Level Rise Viewer at https://www.pacioos.hawaii.edu /shoreline/slr-hawaii/ particularly identifies a 3.2-foot sea level rise exposure area across the main Hawaiian Islands, which may occur in the mid to latter half of the 21st century. The Draft EA should provide a map of 3.2-foot sea level rise exposure area in relation to the project area, and consider site-specific mitigation measures, including setbacks from the shoreline erosion during the life of the proposed structure, to respond to the potential impacts of 3.2-foot SLR.

5. <u>Stormwater Runoff, Erosion, and Surface Water Resources</u>
   Pursuant to Hawaii Administrative Rules (HAR) § 11-200.1-18(d)(7) – identification and analysis of impacts and alternatives considered; to ensure that nearshore marine resources along the coastal regions within Māmala Bay remain protected, the negative effects of stormwater inundation and sediment loading surrounding the proposed project site, ensuing from the construction and operation of the upgraded water intake system should be evaluated.

   Issues that may be examined include, but are not limited to, project site characteristics in relation to flood and erosion prone areas, vulnerability of the nearshore environment, and any increase of permeable surfaces that may lead to an increased volume or rate of stormwater runoff. Developing mitigation measures for the protection for surface water resources and the coastal ecosystem should take this into account, pursuant to HAR § 11-200.1-18(d)(8).

If you have any questions, please contact Joshua Hekekia on Environmental Assessment concerns as they relate to this OPSD response letter at (808) 587-2845; or Debra Mendes on CZMA federal consistency at (808) 587-2840.

Sincerely,

Mary Alice Evans

Mary Alice Evans,
Interim Director

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January 12, 2024

Ms. Mary Alice Evans, Interim Director
State Office of Planning and Sustainable Development
235 South Beretania Street, 6th Floor
Honolulu, Hawaii 96804

TRANSMITTED VIA EMAIL: joshua.k.hekekia@hawaii.gov; dbedt.op.czm@hawaii.gov

Dear Ms. Evans:

SUBJECT: Environmental Assessment (EA) Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comments dated August 10, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades. The following provides our responses to your comments.

1. *Coastal Zone Management Act (CZMA), Federal Consistency: We note that the proposed water intake upgrade action may be subject to federal permitting, such as a Department of the Army Nationwide Permit, as activity may occur within the offshore waters of Waikīkī Beach. Please consult with the appropriate federal authorities, such as the U.S. Army Corps of Engineers, on applicable federal approvals and authorization. If it is deemed that federal permits are needed, then this project may be subject to CZMA federal consistency.*

   OPSD is the lead state agency with the authority to conduct CZMA federal consistency reviews. Please consult with our office on the applicability of CZMA federal consistency if federal permits are needed.

   Response: The Proposed Action will require a Department of the Army permit, and we are in consultation with the U.S. Corps of Engineers for applicable permits and approvals. We anticipate a review regarding CZMA. Draft EA Section 4.4, Permits and Approvals lists permits and approvals related to the Proposed Action.

2. *Hawaiʻi Coastal Zone Management (CZM) Program: The CZM area is defined as "all lands of the State and the area extending seaward from the shoreline to the limit of the State's police power and management authority, including the U.S. territorial sea" (Hawaiʻi Revised Statutes (HRS) § 205A-1).*

   Pursuant to HRS § 205A-4, in implementing the objectives of the CZM program, agencies shall consider ecological, cultural, historic, esthetic, recreational, scenic, open space values, coastal hazards, and economic development. As this project is being proposed by the University of Hawaiʻi, the Draft EA should include analysis on the applicability of the provisions of HRS § 205A to this proposed action.

   The objectives and supporting policies of the Hawaiʻi CZM Program serve as the foundation of the enforceable policies of the State of Hawaiʻi, as listed in HRS § 205A-2. Disclosure of impacts on CZM objectives and supporting policies, as it relates to HRS Chapter 343 *requirements, will aid the State in determining impacts to the resources of the coastal zone, and can be cited in a CZMA federal consistency submittal if one is warranted.*

Response: Draft EA Section 4.2.3, Hawai‘i Coastal Zone Management, identifies the regulatory context and objectives of CZM, and Section 4.3.4.1, SMA Objectives and Policies, discusses relevant objectives and policies contained in HRS § 205A-4.

3. *Special Management Area (SMA) / Shoreline Setbacks: The Draft EA should provide a regional location map and include the project site’s proximity and relation to the designated SMA boundary and the shoreline. Additionally, given that the subject Environmental Assessment (EA) may serve as a supporting document for a SMA Use Permit application, we recommend that the EA specifically discuss the compliance with the requirements of SMA use and any applicable shoreline setbacks requirements by consulting with the City and County of Honolulu, Department of Planning and Permitting.*

   Response: The Draft EA Figure 4-1 depicts the project area‘s relationship to the SMA boundary. Draft EA Section 4.3.4.1, SMA Objectives and Policies discusses Proposed Action compliance with SMA requirements. Draft EA Section 4.3.5, Shoreline Setback, discusses the requirement for a Shoreline Setback Variance.

4. *Climate Change Adaptation / Sea Level Rise (SLR): The Waikīkī Aquarium and its support facilities are in close proximity to the nearshore waters of Māmala Bay and the Pacific Ocean. Thus, the aquarium may be vulnerable to the natural threats associated with coastal areas such as shoreline flooding, erosion, storm surges, saltwater intrusion, and related natural disasters associated with climate change. To assess potential impacts of SLR and assess the viability of the Waikīkī Aquarium’s proposed water intake system, we suggest the Draft EA refer to the findings of the Hawai‘i Sea Level Rise Vulnerability and Adaptation Report 2017, accepted by the Hawai‘i Climate Change Mitigation and Adaptation Commission.*

   The Draft EA should provide a map of 3.2-foot sea level rise exposure area in relation to the project area, and consider site-specific mitigation measures, including setbacks from the shoreline erosion during the life of the proposed structure, to respond to the potential impacts of 3.2-foot SLR.

   Response: Please refer to Draft EA Section 3.2.1, Climate Change and Sea Level Rise. Figure 3-6 depicts Seal Level Rise Exposure at 3.2 feet.

5. *Stormwater Runoff, Erosion, and Surface Water Resources: Pursuant to Hawaii Administrative Rules (HAR) § 11-200.1-18(d)(7) – identification and analysis of impacts and alternatives considered; to ensure that nearshore marine resources along the coastal regions within Māmala Bay remain protected, the negative effects of stormwater inundation and sediment loading surrounding the proposed project site, ensuing from the construction and operation of the upgraded water intake system should be evaluated.*

   Issues that may be examined include, but are not limited to, project site characteristics in relation to flood and erosion prone areas, vulnerability of the nearshore environment, and any increase of permeable surfaces that may lead to an increased volume or rate of stormwater runoff. Developing mitigation measures for the protection for surface water resources and the coastal ecosystem should take this into account, pursuant to HAR § 11-200.1-18(d)(8).

   Response: Flood hazards are discussed in Section 3.2.2 of the Draft EA. As noted the project area is located in Zone AE. Flood Zones AE are areas that present a 1% annual chance of flooding, with wave heights less than 3 ft. The Proposed Aroject will not change or impact flood zones. Site planning for proposed facilities and equipment will take the location of the parcel within the flood zone AE into consideration.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai‘i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai‘i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai‘i

JOSH GREEN, M.D.
GOVERNOR | KE KIAʻĀINA

SYLVIA LUKE
LIEUTENANT GOVERNOR | KA HOPE KIAʻĀINA

STATE OF HAWAIʻI | KA MOKUʻĀINA ʻO HAWAIʻI
DEPARTMENT OF LAND AND NATURAL RESOURCES
KA ʻOIHANA KUMUWAIWAI ʻĀINA

DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET, ROOM 325
HONOLULU, HAWAII 96813

DAWN N.S. CHANG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

LAURA H.E. KAAKUA
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
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CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

August 10, 2023

MEMORANDUM *Log no. 4195*

TO: RUSSELL Y. TSUJI, Administrator
Land Division

FROM: LAINIE BERRY, Wildlife Program Manager
Division of Forestry and Wildlife

SUBJECT: Pre-Consultation for Waikiki Aquarium (WAq) Water Intake System Project in Honolulu on O'ahu Island

The Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW) has received your request for comments for Pre-Consultation for the Waikiki Aquarium (WAq) Water Intake System Project at 2777 Kalakaua Avenue in Honolulu, on the Island of Oahu; TMK: (1) 3-1-031:006. The purpose of the proposed project is to upgrade the aquarium's outdated intake water system infrastructure to prevent future failures that threaten the life and wellbeing of the animals. WAq utilizes three (3) intake water sources for their approximately sixty (60) public exhibits and behind-the-scenes holding tanks that are in operation at any given time. The three (3) intake water sources include 1) natural seawater (NSW) via two (2) 8-inch offshore intake pipes, 2) saltwater derived from an 80-ft deep saltwater production well, and 3) freshwater from the City and County of Honolulu water supply system. The proposed project comprises replacement of the two existing 8-inch transite NSW intake pipes that extend 160-ft offshore with two new 8-inch HDPE pipes, construction of a new saltwater production well and decommissioning of the existing well, construction of a new pump vault, construction of a new aeration / settling tank for well water treatment, and reconstruction and extension of the existing pump building that has extensive cracks and spalling.

The State listed ʻŌpeʻapeʻa or Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) could potentially occur at or in the vicinity of the project and may roost in nearby trees. Any required site clearing should be timed to avoid disturbance to bats during their birthing and pup rearing season (June 1 through September 15). During this period woody plants greater than 15 feet (4.6 meters) tall should not be disturbed, removed, or trimmed. Barbed wire should also be avoided for any construction because bats can become ensnared and killed by such fencing material during flight.

Artificial lighting can adversely impact seabirds that may pass through the area at night by causing them to become disoriented. This disorientation can result in their collision with manmade structures or the grounding of birds. For nighttime work that might be required, DOFAW recommends that all lights used be fully shielded to minimize the attraction of seabirds. Nighttime work that requires outdoor lighting should be avoided during the seabird fledging season, from September 15 through December 15, when young seabirds make their maiden voyage to sea.

If nighttime construction is required during the seabird fledgling season (September 15 to December 15), we recommend that a qualified biologist be present at the project site to monitor and assess the risk of seabirds being attracted or grounded due to the lighting. If seabirds are seen circling around the area, lights should then be turned off. If a downed seabird is detected, please follow DOFAW's recommended response protocol by visiting https://dlnr.hawaii.gov/wildlife/seabird-fallout-season/#response.

Permanent lighting also poses a risk of seabird attraction, and as such should be minimized or eliminated to protect seabird flyways and preserve the night sky. For illustrations and guidance related to seabird-friendly light styles that also protect seabirds and the dark starry skies of Hawaiʻi please visit https://dlnr.hawaii.gov/wildlife/files/2016/03/DOC439.pdf.

The State threatened Manu o Kū or White Tern (*Gygis alba*) is known to nest in the vicinity of the proposed project. If tree trimming or removal is planned, DOFAW strongly recommends a qualified biologist survey for the presence of White Terns prior to any action that could disturb the trees. White Tern pairs typically lay their single egg on a tree branch with no nest. Eggs and chicks can be dislodged by construction equipment or workers that contact trees in which White Terns are nesting. As such, a tree protection program should be in place for any mature trees with nesting or roosting White Terns. If a nest is discovered, please notify DOFAW staff for assistance.

The State endangered ʻʻīlio holo i ka uaua or Hawaiian Monk Seal (*Monachus schauinslandi*) and the threatened honu or Green Sea Turtle (*Chelonia mydas*) could potentially occur or haul out onshore within the vicinity of the proposed project site. Nesting season for the honu is April through December and the ʻʻīlio holo i ka uaua can give birth to pups all year round. If either species is detected within 33 feet (100 meters) of the project area all nearby construction operations should cease and not continue until the focal animal has departed the area on its own accord.

State-listed waterbirds such as the Ae'o or Hawaiian stilt (*Himantopus mexicanus knudseni*), 'Alae ke'oke'o or Hawaiian coot (*Fulica alai*), and 'Alae 'Ula or Hawaiian gallinule (*Gallinula chloropus sandvicensis*) could potentially occur at or in the vicinity of the proposed project site. It is against State law to harm or harass these species. If any of these species are present during construction, all activities within 100 feet (30 meters) should cease and the bird or birds should not be approached. Work may continue after the bird or birds leave the area of their own accord. If a nest is discovered at any point, please contact the Oʻahu Branch DOFAW Office at (808) 973-9778.

The State endangered pueo or Hawaiian Short-eared owl (*Asio flammeus sandwichensis*) could potentially occur in the project vicinity. Pueo are most active during dawn and dusk twilights. Remove and exclude non-native mammals such as mongoose, cats, dogs, and ungulates from the nesting area. Minimize habitat alterations and disturbance during pueo breeding season. Before any potentially disturbing activity like clearing vegetation, especially ground-based disturbance DOFAW recommends a qualified biologist conduct surveys during crepuscular hours and walk line transects through the area to detect any active pueo nests. If a pueo nest is discovered, notify DOFAW staff, minimize time spent at the nest, and establish a minimum buffer distance of 200 meters from the nest until chicks are capable of flight.

DOFAW recommends using native plant species for landscaping that are appropriate for the area; i.e., plants for which climate conditions are suitable for them to thrive, plants that historically occurred there, etc. Please do not plant invasive species. DOFAW also recommends referring to www.plantpono.org for guidance on the selection and evaluation of landscaping plants and to determine the potential invasiveness of plants proposed for use in the project.

DOFAW recommends minimizing the movement of plant or soil material between worksites. Soil and plant material may contain detrimental fungal pathogens (e.g., Rapid ʻŌhiʻa Death), vertebrate and invertebrate pests (e.g., Little Fire Ants, Coconut Rhinoceros Beetles, etc.), or invasive plant parts (e.g., Miconia, Pampas Grass, etc.) that could harm our native species and ecosystems. We recommend consulting the Oʻahu Invasive Species Committee (OISC) at (808) 266-7994 to help plan, design, and construct the project, learn of any high-risk invasive species in the area, and ways to mitigate their spread. All equipment, materials, and personnel should be cleaned of excess soil and debris to minimize the risk of spreading invasive species.

The invasive Coconut Rhinoceros Beetle (CRB) or *Oryctes rhinoceros* is known to occur on the island of Oʻahu. On July 1, 2022, the Hawaiʻi Department of Agriculture (HDOA) approved Plant Quarantine Interim Rule 22-1. This rule restricts the movement of CRB-host material within or to and from the island of Oʻahu, which is defined as the Quarantine Area. Regulated material (host material or host plants) is considered a risk for potential CRB infestation. Host material for the beetle specifically includes a) entire dead trees, b) mulch, compost, trimmings, fruit and vegetative scraps, and c) decaying stumps. CRB host plants include the live palm plants in the following genera: *Washingtonia*, *Livistona*, and *Pritchardia* (all commonly known as fan palms), *Cocos* (coconut palms), *Phoenix* (date palms), and *Roystonea* (royal palms). When such material or these specific plants are moved there is a risk of spreading CRB because they may contain CRB in any life stage. For more information regarding CRB, please visit https://dlnr.hawaii.gov/hisc/info/invasive-species-profiles/coconut-rhinoceros-beetle/.

We recommend that Best Management Practices are employed during and after construction to contain any soils and sediment with the purpose of preventing damage to near-shore waters and marine ecosystems.

We appreciate your efforts to work with our office for the conservation of our native species. These comments are general guidelines and should not be considered comprehensive for this site or project. It is the responsibility of the applicant to do their own due diligence to avoid any negative environmental impacts. Should the scope of the project change significantly, or should it become apparent that threatened or endangered species may be impacted, please contact our staff as soon as possible.

If you have any questions, please contact Myrna N. Girald Pérez, Protected Species Habitat Conservation Planning Coordinator at (808) 265-3276 or myrna.girald-perez@hawaii.gov.

Sincerely,

Lainie Berry

LAINIE BERRY
Wildlife Program Manager

innovation through engineering & scientific excellence

January 12, 2024

Mr. Laine Berry, Wildlife Program Manager
Division of Forestry and Wildlife Management
State Department of Land and Natural Resources

TRANSMITTED VIA EMAIL: timothy.chee@hawaii.gov

Dear Mr. Berry:

SUBJECT: Environmental Assessment (EA) Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comments dated August 9, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades. .

Please refer to Draft EA Section 3.3.1, Terrestrial Biological Resources, which analyzes impacts on terrestrial species to which you refer and recommends both general and specie-specific mitigation measures to avoid or minimize impacts.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai‘i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai‘i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai‘i

BOARD OF WATER SUPPLY
KA 'OIHANA WAI
CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET • HONOLULU, HAWAII 96843
Phone: (808) 748-5000 • www.boardofwatersupply.com

August 9, 2023

Ms. Berna Senelly
Oceanit
828 Fort Street Mall, Suite 600
Honolulu, Hawaii 96813

Dear Ms. Senelly:

Subject: Your Letter Dated July 20, 2023 Requesting Comments on the Environmental Assessment Pre-Consultation for the Upgrade of the Waikiki Aquarium Water Intake System Project off Kalakaua Avenue – Tax Map Key: 3-1-031: 006

Thank you for the opportunity to comment on the proposed water intake improvements project.

The existing water system is currently adequate to accommodate the proposed redevelopment. However, please be advised that the existing Honolulu water system capacity has been reduced due to the shut-down of the Halawa Shaft pumping station as a proactive measure to prevent fuel contamination from the Navy's Red Hill Bulk Storage Tank fuel releases. The final decision on the availability of water will be confirmed when the building permit application is submitted for approval, pending evaluation of the water system conditions at that time on a first-come, first-served basis. The Board of Water Supply (BWS) reserves the right to change any position or information stated herein up until the final approval of the building permit application.

We continue to request 10% voluntary water conservation of all customers until new sources are completed and require water conservation measures in all new developments. If water consumption significantly increases, progressively restrictive conservation measures may be required to avoid low water pressures and disruptions of water service.

Presently, there is no moratorium on the issuance of new and additional water services. Water distributed via the BWS water systems remains safe for consumption. The BWS is closely monitoring water usage and will keep the public informed with the latest findings. Please visit our website at www.boardofwatersupply.com and www.protectoahuwater.org for the latest updates and water conservation tips.

When water is made available, the applicant will be required to pay our Water System Facilities Charges for resource development, transmission, and daily storage.

Water conservation measures are required for all proposed developments. These measures include utilization of nonpotable water for irrigation using rain catchment, drought tolerant plants, xeriscape landscaping, efficient irrigation systems, such as a drip system and moisture sensors, and the use of Water Sense labeled ultra-low flow water fixtures and toilets.

The proposed project is subject to BWS Cross-Connection Control and Backflow Prevention requirements prior to the issuance of the Building Permit Applications.

The construction drawings should be submitted for our review and the construction schedule should be coordinated to minimize impact to the water system.

The on-site fire protection requirements should be coordinated with the Fire Prevention Bureau of the Honolulu Fire Department.

If you have any questions, please contact Barry Usagawa, Water Resources Division at (808) 748-5900.

Very truly yours,

ERNEST Y. W. LAU, P.E.
Manager and Chief Engineer

ky

oceanit
innovation through engineering & scientific excellence

January 12, 2024

Mr. Ernest Lau, Manager and Chief Engineer
Honolulu Board of Water Supply

TRANSMITTED VIA EMAIL: contactus@hbws.org

Dear Mr. Lau:

SUBJECT: Environmental Assessment (EA) Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comments dated August 9, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades.

We note your comment that the existing water system is currently adequate to accommodate the Proposed Action.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai‘i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai‘i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai‘i

JOSH GREEN, M.D.
GOVERNOR | KE KIA'ĀINA

SYLVIA LUKE
LIEUTENANT GOVERNOR | KA HOPE KIA'ĀINA

RECEIVED
AUG 18 2023
By

DAWN N.S. CHANG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

LAURA H.E. KAAKUA
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

KA MOKU'ĀINA 'O HAWAI'I
DEPARTMENT OF LAND AND NATURAL RESOURCES
KA 'OIHANA KUMUWAIWAI 'ĀINA
OFFICE OF CONSERVATION AND COASTAL LANDS
P.O. BOX 621
HONOLULU, HAWAII 96809

REF:OCCL:CM

Correspondence: OA 24-15

Aug 11, 2023

Berna Senelly
Oceanit
828 Fort Street Mall, Suite 600
Honolulu, HI 96813

SUBJECT: Pre-Assessment Consultation for Environmental Assessment (EA) Regarding the Upgrade of the Waikiki Aquarium Water Intake System Located at 2777 Kalakaua Avenue; Kapiolani Park, Waikiki, Oahu; Tax Map Key (TMK): (1) 3-1-031:006

Dear Ms. Senelly,

The Office of Conservation and Coastal Lands (OCCL) has reviewed your correspondence regarding the proposed upgrade of the Waikiki Aquarium's water intake system at the subject location. Accordingly to your information, the proposed project will include; (1) the replacement of the two existing 8-inch concrete transite natural seawater intake pipes that extend 160 feet offshore with two new 8-inch high density polyethylene pipes; (2) the construction of a new saltwater production well and decommissioning of the existing well; (3) construction of a new pump vault; (4) construction of a new aeration/settling tank for well water treatment; and (5) reconstruction and extension of the existing pump building that has extensive cracks and spalling. You are requesting a pre-consult for an EA to determine possible environmental, social and economic impacts associated with the project.

Staff's research identified that most of the project site is in the State of Hawaii Urban Land Use District, and the City and County of Honolulu's P-2 Preservation District. However, the portion of the project relating to the replacement of the transite pipes appear to be located seaward of the shoreline, within the State's Conservation District Protective Subzone. The OCCL regulates land uses in the State Land Use Conservation District.

OCCL was not able to locate any permit or authorization for the two existing intake pipes. Please include any permits or authorization which allowed for the construction of the intake pipes. Alternatively, please provide evidence that the intake pipes are non-conforming structures that predate the establishment of the Conservation District rules.

The parcel abuts the shoreline area and may likely be impacted by future climate changes and sea level rise. A review of the Hawai'i State Sea Level Rise Viewer (https://www.pacioos.hawaii.edu/shoreline/slr-hawaii/) indicates that the subject parcel lies within the sea level rise exposure area (SLR-XA). The OCCL has attached **Exhibit 1** regarding the SLRXA for your information.

We suggest that you include a thorough discussion of coastal hazards, climate change, sea level rise, and associated impacts in the EA. As the landowner's agent, you may want to consider reviewing the Hawaii Sea Level Rise Vulnerability and Adaptation Report (2017). A copy of the report can be obtained at https://climateadaptation.hawaii.gov/wp-content/uploads/2017/12/SLR-Report_Dec2017.pdf.

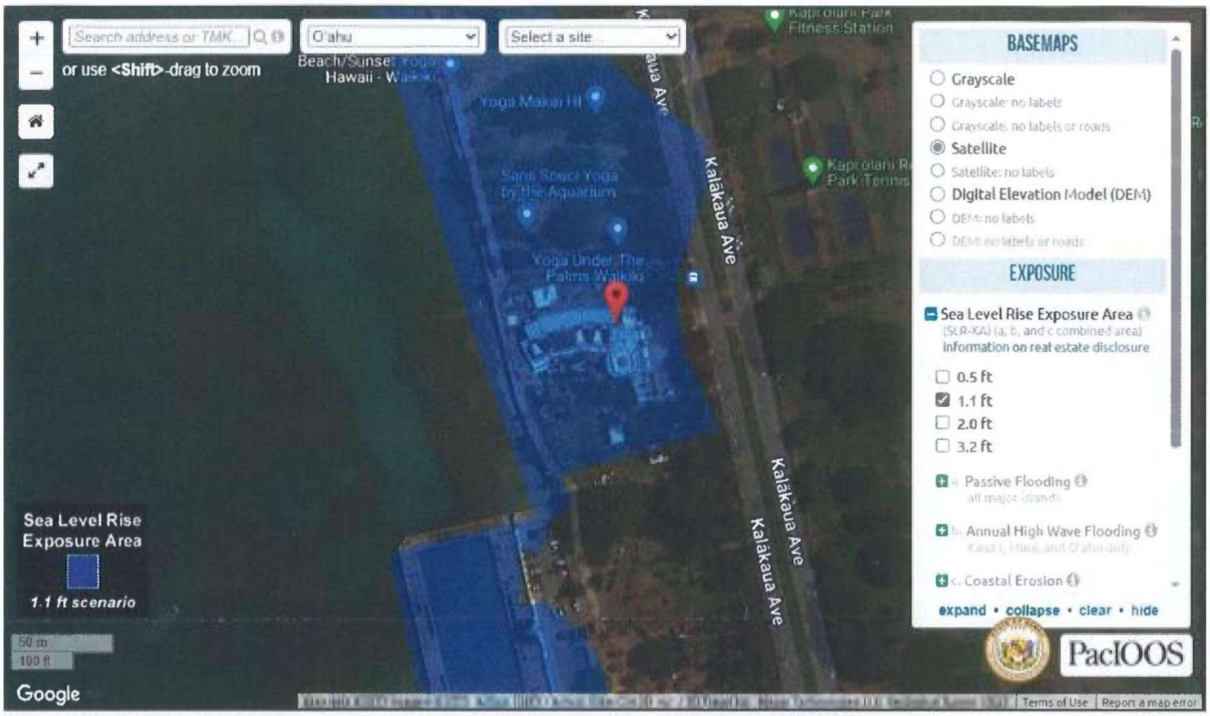
Should you have any questions regarding this correspondence, contact Cal Miyahara of the Office of Conservation and Coastal Lands at (808) 798-6147 or calen.miyahara@hawaii.gov.

Sincerely,

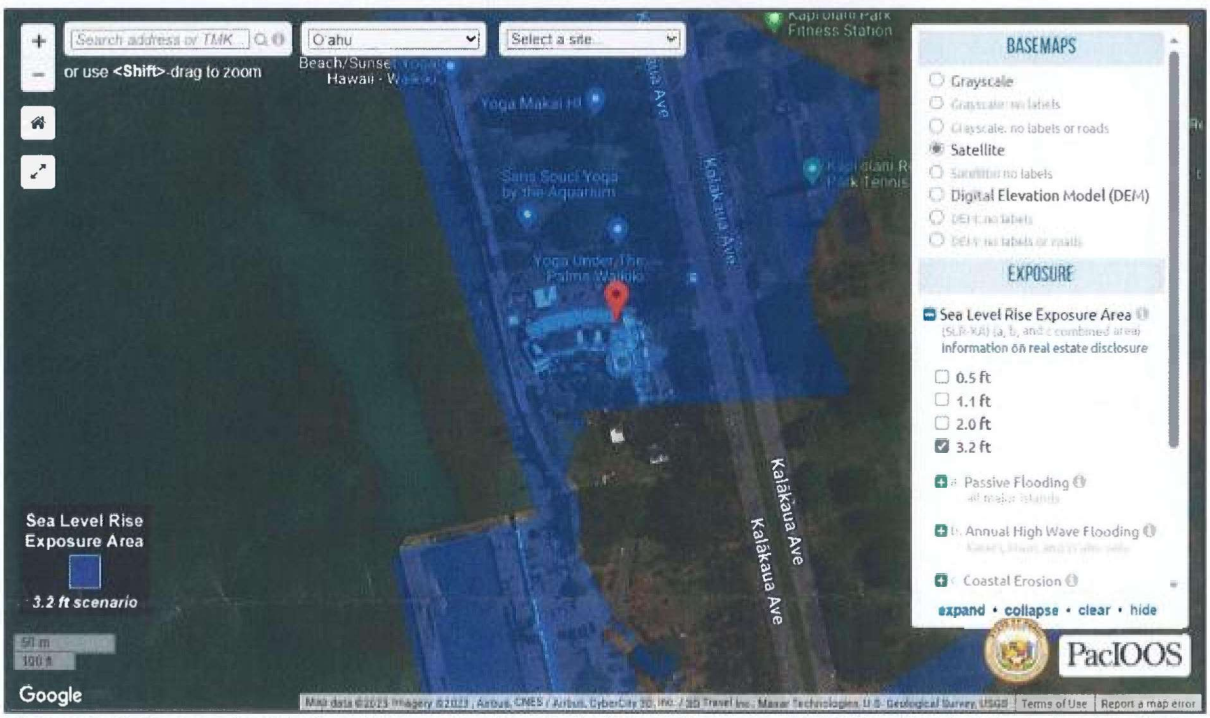
S Michael Cain

Michael Cain, Administrator
Office of Conservation and Coastal Lands

C: ODLO
City-Department of Planning and Permitting



Note: 1.1-ft. sea level rise forecast shown in blue (approx. 2050). TMK: (1) 3-1-031:006.



Note: 3.2-ft. sea level rise forecast shown in blue (approx. 2100). TMK: (1) 3-1-031:006.

Exhibit 1

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January 12, 2024

Mr. Michael Cain, Administrator
Office of Conservation and Coastal Lands
State Department of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Cain:

SUBJECT: Environmental Assessment (EA) Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comments dated August 11, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades.

We agree with your comment that the portion of the Proposed Action is within the State Conservation District Protective Zone and intend to submit an application for a Conservation District Use Permit (CDUP).

Regarding your request for evidence that the intake pipes predate the Board of Land and Natural Resources 1964 adoption of the land use regulations for the Conservation District pursuant to the State Land Use Law (Act 187) of 1961, we are attaching plans developed in 1952 to install the seawater intake pipes that are proposed for replacement. The pipes were installed around 1954.

Regarding your comment suggesting a thorougd discussion of coastal hazards, climate change, sea level rise and associated impacts, please refer to Draft EA Section 3.2.1, Climate Change and Sea Level Rise.

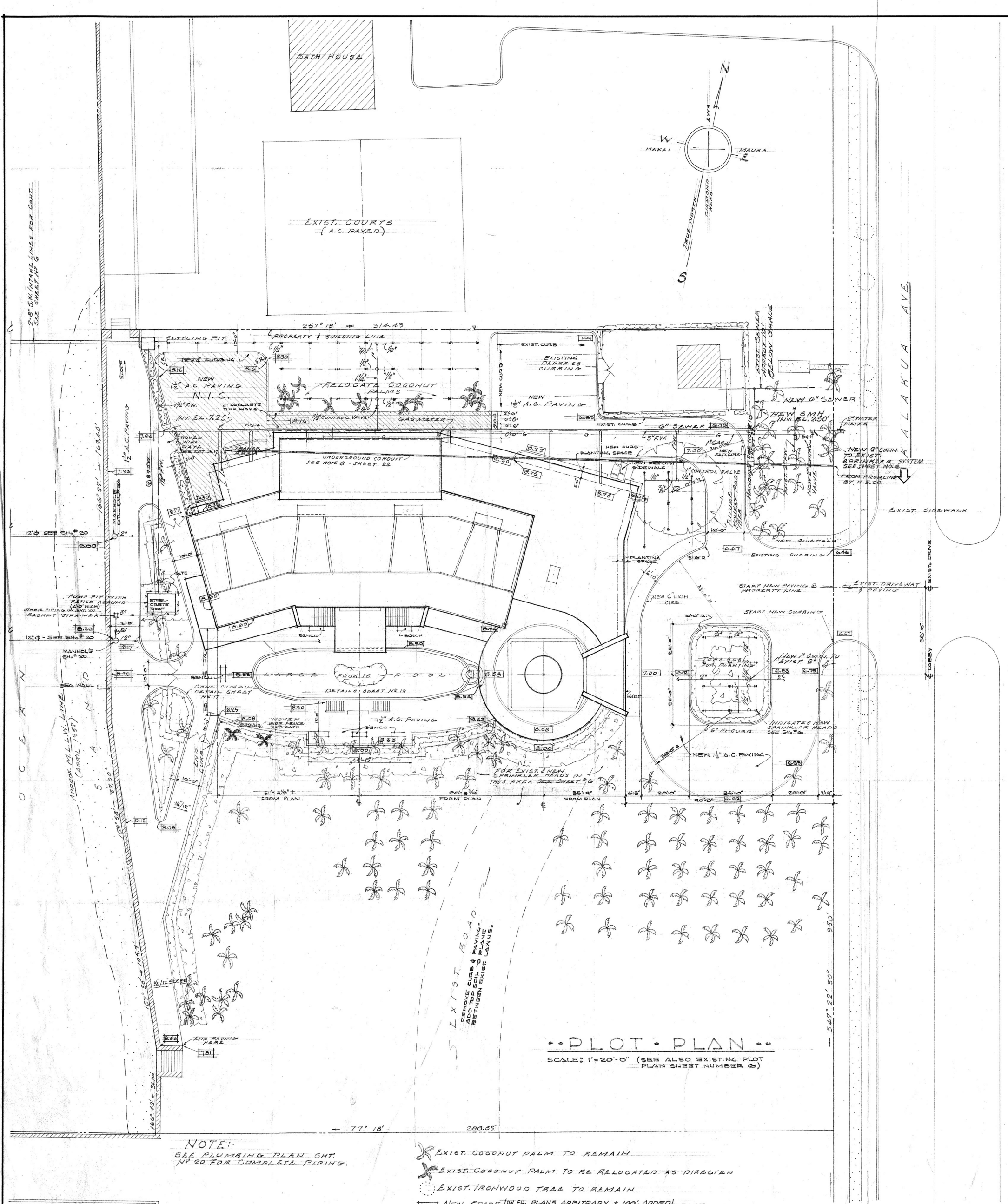
We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai‘i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Attachment: 1952 Plans for Existing Intake Pipes

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai‘i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai‘i



AQUARIUM
TERRITORY OF HAWAII · UNIVERSITY OF HAWAII · MARINE LABORATORY

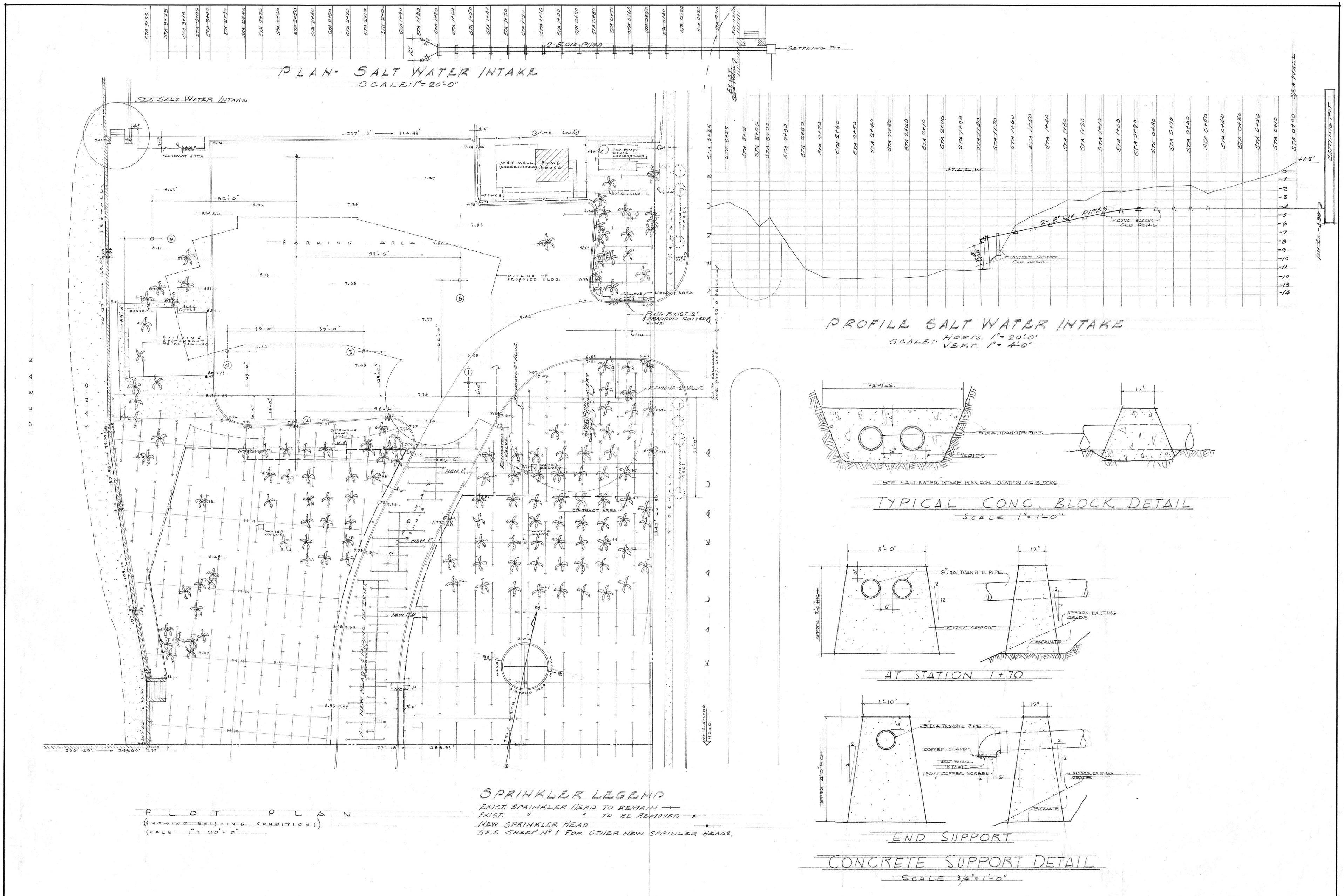
HART WOOD - F.A.I.A.
EDWIN A. WEED
ARCHITECTS

D.P.W. JOB NO. 5600

TITLE & PLOT PLAN

APPROVED:	DATE	APPROVED:	DATE	APPROVED:	DATE	APPROVED:	DATE	APPROVED:	DATE	APPROVED:	DATE
[signature]	10/30/52	[signature]	8-6-52	B.J. McMorrow	Aug. 6, 1952	[signature]	Sept. 10, 1952	[signature], Exec. Officer	7/25/52	B.F. Rush	Oct. 26, 1952
SUPT. OF PUBLIC WORKS	DATE	TERRITORIAL FIRE MARSHAL	DATE	DEPARTMENT OF HEALTH	DATE	CITY & COUNTY BOARD OF PUBLIC PARKS & RECREATION	DATE	BOARD OF REGENTS, UNIV. OF HAWAII	DATE	TERRITORIAL HARBOR BOARD	DATE

54-3



EXISTING PLOT PLAN

TERRITORY OF HAWAII **AQUARIUM** & U. OF H. MARINE LABORATORY KALAKAUA AVENUE	ARCHITECTS HART WOOD F.A.I.A. EDWIN A. WEED 2512 MANOA RD, HONOLULU 91054	COMM. 4909 / DATE / REV. DATE / DRAWN / CHECK	SHEET NO. 6 OF 22

5443

DEPARTMENT OF PLANNING AND PERMITTING
KA ʻOIHANA HOʻOLĀLĀ A ME NĀ PALAPALA ʻAE
CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAIʻI 96813
PHONE: (808) 768-8000 • FAX: (808) 768-6041 • WEB: www.honolulu.gov/dpp

RICK BLANGIARDI
MAYOR
MEIA

DAWN TAKEUCHI APUNA
DIRECTOR
PO'O

JIRO A. SUMADA
DEPUTY DIRECTOR
HOPE PO'O

August 17, 2023

2023/ELOG-1358 (LM)

Ms. Berna Senelly
828 Fort Street Mall, Suite 600
Honolulu, Hawaiʻi 96813

Dear Ms. Senelly:

SUBJECT: Request for Pre-Consultation Comments
Environmental Assessment (EA) for the Upgrade of the Waikīkī Aquarium Water Intake System
2777 Kalākaua Avenue – Waikīkī
Tax Map Key 3-1-031: 006

This is in response to your letter, received July 21, 2023, requesting comments on the scope and content to be addressed in a Draft Environmental Assessment (DEA), as required under Chapter 343, Hawaiʻi Revised Statutes (HRS), for the upgrade of the Waikīkī Aquarium water intake system, which is separate from the upgrade of the water system as addressed in the Final EA published in the February 23, 2023 *The Environmental Notice*. While we understand that the scope of the Project now proposed was not covered in the previous Final EA, it is for the same Project site and is similar to the type of improvements that are necessary for the site to function. Please consider combining projects under one review. Phased projects can be submitted under one EA rather than having multiple EAs for the same site. Similarly, for Special Management Area (SMA) Permits, phased project improvements should be submitted under one SMA Application.

The Waikikīkī Aquarium is located on a shoreline lot and the Project involves work in the pacific ocean, which is outside of the City and County of Honolulu (CCH) jurisdiction. For work within CCH jurisdiction, the following items should be addressed in the DEA:

1. Long-term Planning Policies and Objectives: The DEA should address the proposed Project's consistency with the relevant policies of the General Plan and the Primary Urban Center Development Plan.

2. Land Use Ordinance (LUO; Chapter 21, Revised Ordinances of Honolulu [ROH]): Based on a review of our records, the Project site consists of a 102,210 square-foot (approximately 2.35 acres) shoreline zoning lot located in the P-2 General Preservation District. Therefore, proposed development activities must comply with the development standards applicable to the P-2 General Preservation District. Project compliance with

these standards should be presented and evaluated in the DEA. The LUO is available on our website at:

https://www.honolulu.gov/rep/site/dpp/dpp_docs/land-use-ordinance.pdf

3. Onsite Structures: The DEA should describe all existing structures on the site, including storage buildings, tanks, shoreline hardening structures, etc. If any existing structures are proposed to remain in place, the DEA should describe what and where they are located, whether they were lawfully established (permitted), and whether they are located within any required setback areas. Such structures should be included in the DEA's analysis of compliance with the applicable development standards in the LUO.

4. SMA: The DEA should include in its analysis all of the required components for an SMA Use Permit under both Chapter 205A, HRS, as revised, and Chapter 25, ROH. The revised text of Chapter 205A, HRS, as amended by Act 16 (2020) is available online at:

https://www.capitol.hawaii.gov/session2020/bills/SB2060_HD2_.htm

On July 6, 2023, Chapter 205A, HRS was revised by Act 229, Session Laws of Hawaii 2023, to expand exclusions to the definition of "development" and is available online at:

https://www.capitol.hawaii.gov/sessions/session2023/bills/GM1332_.PDF

Chapter 25, ROH, is available online at:

https://hnldoc.ehawaii.gov/hnldoc/document-download?id=16460

5. Shoreline Setback: All development must be located outside of the shoreline setback area, which currently extends 40 feet mauka of the Certified Shoreline for most residential properties. After July 1, 2024, the shoreline setback line will be established at 60 feet for sites located within the Primary Urban Center Development Plan area.

This setback distance from the shoreline must be confirmed on a current shoreline survey certified by the State of Hawaiʻi, and must also be reflected in the plans submitted for the SMA Use Permit to confirm compliance with the Shoreline Setback Ordinance (Chapter 26, ROH). A draft shoreline survey should be included and evaluated in the DEA. A certified shoreline survey should be included in the Final EA.

Alternatively, if the Applicant seeks to waive the requirement for a certified shoreline survey and locate all development more than 55 feet from an uncertified (presumed) shoreline, the DEA should include a shoreline survey and plans that identify and label the proposed distance from the presumed shoreline. Under this approach, the Applicant must provide evidence documenting the location of the presumed shoreline. Such information may include, but is not limited to, a previously certified shoreline survey, erosion and/or accretion information, historic versus current photographs, and physical or geographic markers such as survey pins or trees that document the level of change in the shoreline since the most recent certified shoreline survey. Please note that a waiver of the requirement for a certified shoreline survey is subject to the discretion of the Director of the Department of Planning and Permitting (DPP).

Chapter 26, ROH, is available online at:

https://hnldoc.ehawaii.gov/hnldoc/document-download?id=16456

The DPP Rules Relating to Shoreline Setbacks and the SMA are available online at:

https://www.honolulu.gov/rep/site/dpp/dpp_docs/rules-shoreline-setbacks-and-the-SMA.pdf

6. Flood Zone: The DEA should identify the subject property's Flood Zone, as mapped by the Federal Emergency Management Agency and evaluate the proposed Project's compliance with the City's Flood Hazard Areas Ordinance (Chapter 21A, ROH), which is available online at:

   https://www.honolulu.gov/rep/site/ocs/roh/ROH_Chapter_21A_.pdf

7. Coastal Hazards: The Project site, as a shoreline lot, is susceptible to Sea Level Rise (SLR), tsunamis, and storm surge. Mayor's Directive 18-2, issued on July 16, 2018, requires all City departments and agencies to use the Hawai'i *Sea Level Rise Vulnerability and Adaptation Report*, the *Sea Level Rise Guidance* and the *Climate Change Brief* in planning decisions. As a result, proposed development activities within the SMA must be evaluated not only for potential impacts to sensitive SMA resources, but also for current and future susceptibility to coastal hazards such as flooding, SLR, wave action, tsunamis, and storm surge.

   The recent amendments to Chapter 205A, HRS, under Act 16 (2020), further reiterate the need to evaluate potential impacts related to coastal hazards and SLR. As such, the following items need to be evaluated in a site-specific coastal hazards analysis and evaluated in both the DEA and SMA Use Permit application prepared for the Project. This analysis should evaluate the site's **existing topographic, geologic, and shoreline environment, and show whether and how a proposed development can safely be located outside of the 3.2-foot SLR Exposure Area (SLR-XA) and avoid impacts associated with other coastal hazards**. This study should include analysis of potential impacts and mitigation measures associated with implementation of the Project related to, but not limited to, the following:

   - SLR - Potential impacts relating to SLR at the subject property, based on review of the State's SLR-XA Mapping Tool of 3.2 feet of SLR by mid-century.

   - Storm Surge - Potential impacts and hurricane storm surge inundation levels at the subject property during Category 1 through 4 hurricane events, based on review of the National Oceanic and Atmospheric Administration's (NOAA) National Hurricane Storm Surge Hazard Maps.

- Potential cumulative impacts of coastal hazards and property inundation should SLR exacerbate existing flooding, wave-action, coastal erosion, or other coastal hazards that may occur at the subject property.

The DEA should also explore project alternatives, site design (siting and configuring the proposed dwelling as far from the shoreline as possible), project design features (elevated structures, alternative foundations, etc.), Best Management Practices, and appropriate mitigation measures to reduce, to the extent possible, potential impacts related to hazards. Relevant sources of information are available online at the following links:

- Mayor's Directive No. 18-2 (2018) regarding climate change and sea level rise:

  www.honolulu.gov/rep/site/dpptod/climate_docs/MAYORS_DIRECTIVE_18-2.pdf

- SLR Vulnerability and Adaptation Report:

  http://climate.hawaii.gov/wp-content/uploads/2019/02/SLR-Report_Dec2017-with-updated-disclaimer.pdf

- State SLR-XA Mapping Tool:

  www.pacioos.hawaii.edu/shoreline/slr-hawaii/

- Guidance for Using the SLR-XA:

  https://climate.hawaii.gov/wp-content/uploads/2020/12/Guidance-for-Using-the-Sea-Level-Rise-Exposure-Area.pdf

- Honolulu Office of Climate Change, Sustainability and Resiliency Climate Ready Oahu Web Explorer:

  www.resilientoahu.org/water

- NOAA Storm Surge Mapping tool:

  https://www.nhc.noaa.gov/nationalsurge/

8. Wetlands and Sensitive Species: The DEA should identify the presence or potential presence of any protected wetlands, sensitive habitat, flora species, and fauna species. A **Biological Survey** should be conducted and the report included. The DPP recommends utilizing the U.S. Fish and Wildlife Service (USFWS) *Information for*

Planning and Consultation (IPAC) website to obtain a list of species that are known to occur, or may potentially occur, in the Project vicinity. IPAC is available online at:

https://ipac.ecosphere.fws.gov/

Known mapped wetlands can be viewed on the USFWS National Wetlands Inventory *Wetlands Mapper*. The DEA must evaluate potential impacts to each identified sensitive species and provide standard agency-required mitigation measures, as well as any applicable site-specific mitigation measures to avoid or minimize potential impacts to each identified species, critical habitat, and habitat applicable to the site. The Wetlands Mapper is available online at:

https://www.fws.gov/wetlands/data/mapper.html

9. <u>Historic and Cultural Resources:</u> The DEA should identify whether any archaeological sites are within or nearby the Project site. Please be advised that in December of 2020, the State Historic Preservation Division (SHPD) began using a new online system to better track consultation requests:

https://shpd.hawaii.gov/hicris/landing

Because the new tracking system requires agency-to-agency requests, the DPP has created a generic request letter that consultants and/or property owners may use for projects that will eventually require DPP approval. This letter may be completed by a consultant and/or property owner and submitted to SHPD directly via their online system to initiate requests before permit applications are submitted to the DPP. The letter includes a general DPP contact number and email, as well as blank fields where the consultant and/or property owner can enter their contact information. The generic request letter is available online at:

https://www.honolulu.gov/rep/site/dpp/dpp_docs/SHPD-Comment-Request.pdf

Finally, please contact the appropriate Neighborhood Board and any relevant neighborhood associations or commissions to request an opportunity to present the Project proposal at the next available Neighborhood Board meeting and/or association meeting(s).

Thank you for the opportunity to comment on this proposal. Should you have any questions, please contact Laura Mo, of our Urban Design Branch, at (808) 768-8025, or via email at laura.mo@honolulu.gov.

Very truly yours,

Alex D. Beatty
for Dawn Takeuchi Apuna
Director

January 12, 2024

Ms Dawn Takeuchi Apuna, Director
Department of Planning and Permtting
City and County of Honolulu
650 South King Street, 7th Floor
Honolulu, Hawaii 96813

TRANSMITED VIA USPS AND EMAIL: abeatty@honolulu.gov

Dear Ms. Apuna:

SUBJECT: Environmental Assessment (EA) Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Pre-Consultation Comments

Thank you for your pre-consultation comments dated August 17, 2023, regarding the Waikīkī Aquarium Supply Water Intake System Upgrades. Our responses to your comments are as follows:

1. *Long-term Planning Policies and Objectives: The DEA should address the proposed Project's consistency with the relevant policies of the General Plan and the Primary Urban Center Development Plan.*

   Response: Please refer to Section 4.3.1, O'ahu General Plan and Section 4.3.2, Primary Urban Center Development Plan, for discussion of consistency.

2. *Land Use Ordinance(LUO; Chapter 21, Revised Ordinances of Honolulu [ROH]: Based on a review of our records, the Project site consists of a 102,210 square-foot (approximately 2.35 acres)shoreline zoning lot located in the P-2 General Preservation District. Therefore, proposed development activities must comply with the development standards applicable to the P-2. Project compliance with these standards should be presented and evaluated in the DEA.*

   Response: As discussed in Section 4.3.3, City and County of Honolulu Zoning, the Proposed Action is consistent with uses permitted in P-2 and will not require zoning changes.

3. *Onsite Structures: The DEA should describe all existing structures on the site, including storage buildings, tanks, shoreline hardening structures, etc. If any existing structures are proposed to remain in place, the DEA should describe what and where they are located, whether they were lawfully established (permitted), and whether they are located within any required setback areas. Such structures should be included in the DEA's analysis of compliarce with the applicable development standards in the LUO.*

   Response: Draft EA Section 2.1, Existing Conditions, discusses the existing on-site structures that support the WAq water intake system, and Figure 2-1, Water Intake System Existing Conditions, depicts the structures and their locations. Section 2.3.2, Description of the Proposed Action, provides details of structural changes, and Figure 2-5 presents the upgrade plan and structures involved in the improvements. Figure 2-7 depicts the proposed influent treatment building plan and elevation. All structural changes are designed to comply with applicable LUO development standards.

4. *SMA: The DEA should include in its analysis all of the required components for an SMA Use Permit under both Chapter 205A, HRS, as revised, and Chapter 25, ROH.*

   Response: Draft EA Section 4.3.2, Special Management Area, discusses how the Proposed Action is consistent with SMA objectives and policies contained in HRS §205A-2(b).

5. *Shoreline Setback: All development must be located outside of the shoreline setback area, which currently extends 40 feet mauka of the Certified Shoreline for most residential properties. After July 1, 2024, the shoreline setback line will be established at 60 feet for sites located within the Primary Urban Center Development Plan area.*

   This setback distance from the shoreline must be confirmed on a current shoreline survey certified by the State of Hawaii, and must also be reflected in the plans submitted for the SMA Use Permit to confirm compliance with the Shoreline Setback Ordinance (Chapter 26, ROH). A draft shoreline survey should be included and evaluated in the DEA. A certified shoreline survey should be included in the Final EA.

   Alternatively, if the Applicant seeks to waive the requirement for a certified shoreline survey and locate all development more than 55 feetfrom an uncertified (presumed) shoreline, the DEA should include a shoreline survey and plans that identify and label the proposed distance from the presumed shoreline. Under this approach, the Applicant must provide evidence documenting the location of the presumed shoreline. Such information may include, but is not limited to, a previously certified shoreline survey, erosion and/or accretion information, historic versus current photographs, and physical or geographic markers such as survey pins or trees that document the level of change in the shoreline since the most recent certified shoreline survey. Please note that a waiver of the requirement for a certified shoreline survey is subject to the discretion of the Director of the Department of Planning and Permitting(DPP).

   Response: As discussed in the Draft EA Section 4.3.5, Shoreline Setback, the Proposed Action will require a Shoreline Setback Variance. As discussed in that section, the Proposed Action meets the criteria for granting a shoreline setback variance according to Public Interest Standard pursuant to ROH § 26-1.8(b)(2), which states "A shoreline setback variance may be granted for a structure or activity that is necessary for or ancillary to facilities or improvements by a public agency or public utility regulated under HRS Chapter 269, or necessary for or ancillary to private facilities or improvements that are clearly in the public interest. . ." Figure 4-2 provides a certified shoreline map.

6. *Flood Zone: The DEA should identify the subject property's Flood Zone,as mapped by the Federal Emergency Management Agency and evaluate the proposed Project's compliance with the City's Flood Hazard Areas Ordinance(Chapter 21A, ROH).*

   Response: Please refer to Draft EA Section 3.2.2, Flood Hazards, which notes that the Proposed Action will not change or impact flood zones and provides a map showing the FIRM map in the WAq vicinity.

7. *Coastal Hazards: The Project site, as a shoreline lot, is susceptible to Sea Level Rise (SLR),tsunamis, and storm surge. Mayor's Directive 18-2, issued on July 16, 2018, requires all City departments and agencies to use the Hawaii Sea Level Rise Vulnerability and Adaptation Report, the Sea Level Rise Guidance and the Climate Change Brief in planning decisions. As a result, proposed development activities within the SMA must be evaluated not only for potential impacts to sensitive SMA resources, but also for current and future susceptibility to coastal hazards such as flooding, SLR, wave action, tsunamis, and storm surge.*

The recent amendments to Chapter 205A, HRS, under Act 16(2020),further reiterate the need to evaluate potential impacts related to coastal hazards and SLR. As such, the following items need to be evaluated in a site-specific coastal hazards analysis and evaluated in both the DEA and SMA Use Permit application prepared for the Project. This analysis should evaluate the site's existing topographic, geologic, and shoreline environment, and show whether and how a proposed development can safely be located outside of the 3.2-foot SLR Exposure Area(SLR-XA)and avoid impacts associated with other coastal hazards.

Response: Draft EA Section 3.2, Natural Hazards, contains a full discussion of the Proposed Action's relationship to Climate Change and Sea Level Rise (Section 3.2.1), Flood Hazards (Section 3.2.2) and Tsunami and Hurricane Hazards (Section 3.2.3). References you cite in your comments were employed in the analysis of potential impacts and recommended mitigation measures.

8. *Wetlands and Sensitive Species: The DEA should identify the presence or potential presence of any protected wetlands, sensitive habitat, flora species, and fauna species. A Biological Survey should be conducted and the report included. The DPP recommends utilizing the U.S. Fish and Wildlife Service(USFWS)Information for Planning and Consultation(IPAC)website to obtain a list of species that are known to occur, or may potentially occur, in the Project vicinity. IPAC is available online at: https://ipac.ecosphere.fws.gov/*

   Response: Protected and sensitive habitat for flora and fauna species are discussed in Draft EA Section 3.3.1, Terrestrial Biological Species. Existing conditions are described and federally listed species that may occur or transit through or adjacent project area are identified. General mitigation measures, as well as those specific to protected species you cited, were proposed. Further, Appendix D contains a Terrestrial Biological Study.

9. *Historic and Cultural Resources: The DEA should identify whether any archaeological sites are within or nearby the Project site. Please be advised that in December of 2020, the State Historic Preservation Division(SHPD) began using a new online system to better track consultation requests:https://shpd.hawaii.gov/hicris/landing.*

   Because the new tracking system requires agency-to-agency requests,the DPP has a generic request letter that consultants and/or property owners may use for projects that will eventually require DPP approval. This letter may be completed by a consultant and/or property owner and submitted to SHPD directly via their online system to initiate requests before permit applications are submitted to the DPP. The letter includes a general DPP contact number and email, as well as blank fields where the consultant and/or property owner can enter their contact information. The generic request letter is available online at: https://www.honolulu.gov/rep/site/dpp/dpp_docs/SHPD-Comment-Request.pdf

   Response: Draft EA Section 3.4.3, Archaeological Resources, summarizes findings and recommendation contained in Appendix F: Archaeological Literature Review and Field Inspection Report in Support of Supply Water Intake System Upgrades at Waikīkī Aquarium in Waikīkī Ahupua'a, Honolulu (Kona) District, Island of O'ahu, Hawai'i. We are familiar with HICRIS and will contact DPP when SHDP is consulted.

Finally, please contact the appropriate Neighborhood Board and any relevant neighborhood associations or commissions to request an opportunity to present the Project proposal at the next available Neighborhood Board meeting and/or association meeting(s).

Response: Draft EA Section 5.2 reports that, on August 10, 2023, a presentation on the Proposed Action was made to the Diamond Head / Kapahulu / St. Louis Heights Neighborhood Board No. 5. Questions were related to the effects of construction in this area, including the presence of construction equipment and impacts related to noise and access.

We are including a copy of your comments and our response in the Draft EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai‘i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Attachment: 1952 Plans for Existing Intake Pipes

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai‘i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai‘i

Appendix I:

Draft EA Comments and Responses

STATE OF HAWAIʻI
OFFICE OF PLANNING
& SUSTAINABLE DEVELOPMENT

JOSH GREEN, M.D.
GOVERNOR

SYLVIA LUKE
LT. GOVERNOR

MARY ALICE EVANS
INTERIM DIRECTOR

235 South Beretania Street, 6th Floor, Honolulu, Hawaiʻi 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaiʻi 96804

Telephone: (808) 587-2846
Fax: (808) 587-2824
Web: https://planning.hawaii.gov/

Coastal Zone Management Program
Environmental Review Program
Land Use Commission
Land Use Division
Special Plans Branch
State Transit-Oriented Development
Statewide Geographic Information System
Statewide Sustainability Program

DTS202402231207NA

March 15, 2024

To: Ms. Jan S. Gouveia, Vice President for Administration
University of Hawaiʻi System

From: Mary Alice Evans, Interim Director
Office of Planning and Sustainable Development

Mary Alice Evans

Subject: Draft Environmental Assessment, HRS Chapter 343
Waikīkī Aquarium Upgrades
Honolulu, Oʻahu
Tax Map Key: (1) 3-1-031: 006

Thank you for the opportunity to provide comments on the Draft Environmental Assessment (Draft EA) on the proposed Waikīkī Aquarium Upgrades Project. The notification request was received by our office via memo dated February 14, 2024.

It is our understanding that this project seeks to upgrade the Waikīkī Aquarium's aging sea water supply intake system infrastructure to prevent potential failures of the aquarium facilities that could threaten the life and wellbeing of the marine biota. The project includes the replacement of two existing ocean water intake pipes that extend approximately 160-ft offshore; construction of a new below ground natural seawater and well water pump vault; a ground aeration tank; extension of the existing pump building; rehabilitation of the saltwater production well; and the installation of new equipment and piping.

The Office of Planning and Sustainable Development (OPSD) has reviewed the submitted materials and has the following comments to offer:

1. <u>Early Consultation Comments</u>
We note that the Draft EA sufficiently addresses our comments from our Pre-Consultation Response letter, DTS 202307210815NA, dated August 10, 2023. The Draft contains an accurate analysis on the objectives and supporting policies of the Hawaii Coastal Zone Management Program, HRS § 205A-2; 2) assesses project alignment with HRS § 205 – State Land Use Law; 3) includes an evaluation on Special Management Area Use (major) permitting and notes the need for Shoreline Setback approval; 4) incorporates a Sea Level Rise vulnerability assessment of the Aquarium and its support facilities; and 5) contains an examination

on stormwater runoff as it pertains to hydrology, ocean water quality, geology/soils, National Pollutant Discharge Elimination System (NPDES) permitting, and erosion control measures.

2. Coastal Zone Management Act (CZMA) federal consistency
We recognize that Draft EA correctly notes that this action is subject to Coastal Zone Management Act (CZMA) federal consistency and that OPSD has jurisdictional authority on that matter. At your earliest convenience, please contact our office regarding the applicable rules and procedures for CZMA federal consistency reviews.

For any questions regarding HRS Chapter 343 Environmental Assessment matters as they pertain to this comment letter, please contact Joshua Hekekia at (808) 587-2845 or by email to Joshua.K.Hekekia@hawaii.gov. Inquiries on CZMA federal consistency should be directed to Debra Mendes at (808) 587-2840 or by email to Debra.L.Mendes@Hawaii.gov.

If you wish to respond to this comment letter, please include DTS 202402231207NA in the subject line.

c: Ms. Berna Senelly, Oceanit

oceanit
innovation through engineering & scientific excellence

November 8, 2024

Ms. Mary Alice Evans, Director
State of Hawai‘i Office of Planning and Sustainable Development
P.O. Box 2359
Honolulu, Hawai‘i 96804

TRANSMITTED VIA EMAIL: email to Joshua.K.Hekekia@hawaii.gov

ATTENTION: Joshua K. Hekekia

Dear Director Evans:

SUBJECT: DTS 202402231207NA
Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Comments on the Draft Environmental Assessment (EA)

Thank you for your Draft EA comments dated March 15, 2024, regarding the Waikīkī Aquarium Upgrades to the Supply Water Intake System.

We appreciate your guidance in the your Pre-Consultation Response letter dated August 10, 2023, and incorporated an accurate analysis of the project‘s relationship to the Hawai‘i Coastal Zone Management (CZM) Program, Special Management Area, Shoreline Setback and Sea Level Rise vulnerability. Further, we will consult with OPSD on the CZM Act regarding federal consistency.

Please note that the Proposed Action also includes the future replacement of the original Edge of Reef (EOR) exhibit with an expanded EOR exhibit. As part of the Waikiki Aquarium Discharge System Upgrade project (currently in construction) the existing outdoor EOR exhibit is being demolished. To construct the Discharge System Upgrade project to meet regulatory requirements, it was necessary to demolish the existing EOR exhibit, which had been deteriorating in recent years with continuous leaks. The expanded EOR exhibit will increase the size from the existing of approximately 1,300 square feet of area to over 1,800 square feet with shallow depth of two (2) feet on the makai side where visitors can touch the fishes to an eight (8) foot depth on the mauka side with viewing windows. The location will be generally the same as the current EOR. The EOR will be included in applications for all permits required for this project.

We are including a copy of your comments and our response in the Final EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai‘i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai‘i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai‘i

JOSH GREEN, M.D.
GOVERNOR | KE KIA'ĀINA

SYLVIA LUKE
LIEUTENANT GOVERNOR | KA HOPE KIA'ĀINA

KA MOKU'ĀINA 'O HAWAI'I
DEPARTMENT OF LAND AND NATURAL RESOURCES
KA 'OIHANA KUMUWAIWAI 'ĀINA
OFFICE OF CONSERVATION AND COASTAL LANDS
P.O. BOX 621
HONOLULU, HAWAII 96809

DAWN N.S. CHANG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RYAN K.P. KANAKA'OLE
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

REF:OCCL:CM

RE Correspondence: OA 24-15
Mar 14, 2024

Berna Senelly
Oceanit
828 Fort Street Mall, Suite 600
Honolulu, HI 96813

SUBJECT: Draft Environmental Assessment (DEA) Regarding the Waikiki Aquarium Upgrades to the Supply Water Intake System Located at 2777 Kalakaua Avenue; Kapiolani Park, Waikiki, Oahu; Tax Map Key (TMK): (1) 3-1-031:006

Dear Ms. Senelly,

The Office of Conservation and Coastal Lands (OCCL) has reviewed your Draft Environmental Assessment (DEA) regarding the proposed upgrade of the Waikiki Aquarium's water intake system at the subject location. According to the DEA, the proposed project will include; (1) the replacement of the two existing 8-inch concrete transite natural seawater intake pipes that extend 160 feet offshore with two new 8-inch high density polyethylene pipes; (2) the construction of a new saltwater production well and decommissioning of the existing well; (3) construction of a new pump vault; (4) construction of a new aeration/settling tank for well water treatment; and (5) reconstruction and extension of the existing pump building that has extensive cracks and spalling.

New equipment will include eight new pumps, four new media filters, two ultraviolet sterilizers, heat exchanger and chiller, air compressors and diffusers, flow meters, level sensors, and other appurtenances. The project will also include mechanical and electrical upgrades.

The DEA states the two existing offshore concrete intake pipes were installed at the time of the aquarium's construction in the mid-1950s. These structures are deemed to be non-conforming. The original pipeline would be abandoned in place and the new pipeline would be placed in the same corridor.

The portion of the proposed project involving the replacement of the two intake pipes is considered an identified land use in the Conservation District Protective Subzone pursuant to Section 13-5-22, Hawaii Administrative Rules (HAR), (P-8) STRUCTURES AND LAND USES, EXISTING (B-1), *Demolition, removal, or minor alteration of existing structures, facilities, land, and equipment*, which requires a Site Plan Approval that can be processed by the OCCL.

Should you have any questions regarding this correspondence, contact Cal Miyahara of the Office of Conservation and Coastal Lands at (808) 798-6147 or calen.miyahara@hawaii.gov.

Sincerely,

S Michael Cain

Michael Cain, Administrator
Office of Conservation and Coastal Lands

C: ODLO
City-Department of Planning and Permitting

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November 8, 2024

Mr. Michael Cain, Administrator
Office of Conservation and Coastal Lands
State of Hawaiʻi Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaiʻi 96804

TRANSMITTED VIA EMAIL TO calen.miyahara@hawaii.gov and VIA USPS

ATTENTION: Cal Miyahara

Dear Mr. Cain:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Comments on the Draft Environmental Assessment (EA)

Thank you for your Draft EA comments dated March 14, 2024, regarding the Waikīkī Aquarium Upgrades to the Supply Water Intake System.

Please note that the two existing intake pipes will be replaced and removed. On the other hand, the existing outfall pipes will remain in place. To comply with requirements to rectify citations, UH designed disposal system improvements and prepared an Environmental Assessment (EA) on the WAq Water Discharge System Upgrade that involved construction of two new injection wells (in progress) for the aquarium. When constructed, these wells will eliminate effluent discharge into the ocean and the municipal sewer system. The Final Environmental Assessment with a Findings of No Significant Impact (FONSI) for that project was published on February 23, 2023, in The Environmental Notice issued by the State Office of Planning and Sustainable Development (OPSD).

We appreciate your clarification that the portion of the proposed project involving the replacement of the two intake pipes is considered an identified land use in the Conservation District Protective Subzone pursuant to Section 13-5-22, Hawaii Administrative Rules (HAR), (P-8) STRUCTURES AND LAND USES, EXISTING (B-1), Demolition, removal, or minor alteration of structures, facilities, land, and equipment, which requires a Site Plan Approval. We will submit a Site Plan Approval application and required information to OCCL.

Please note that the Proposed Action also includes the future replacement of the original Edge of Reef (EOR) exhibit with an expanded EOR exhibit. As part of the Waikiki Aquarium Discharge System Upgrade project (currently in construction) the existing outdoor EOR exhibit is being demolished. To construct the Discharge System Upgrade project to meet regulatory requirements, it was necessary to demolish the existing EOR exhibit, which had been deteriorating in recent years with continuous leaks. The expanded EOR exhibit will increase the size from the existing of approximately 1,300 square feet of area to over 1,800 square feet with shallow depth of two (2) feet on the makai side where visitors can touch the fishes to an eight (8) foot depth on the mauka side with viewing windows. The location will be generally the same as the current EOR. The EOR will be included in applications for permits noted above.

We are including a copy of your comments and our response in the Final EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai‘i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai‘i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai‘i

Berna Senelly

From:	Mo, Laura L Y <laura.mo@honolulu.gov>
Sent:	Friday, March 22, 2024 8:46 PM
To:	Waq
Cc:	Beatty, Alexander D
Subject:	[External] Waikiki Aquarium Water Intake System Upgrades DEA Comment
Follow Up Flag:	Follow up
Flag Status:	Flagged

You don't often get email from laura.mo@honolulu.gov. Learn why this is important

Hi Berna,

Thank you for the opportunity to comment on the DEA. We have one comment, which is the FEA should state that a minor Special District Permit will be required for accessory structures, and for any tree removal over six inches in diameter. The Project is within the Diamond Head Special District Core Area, and pursuant to Table 21-9.2, new accessory structures in the Core Area require a minor permit. One minor Special District Permit may cover the filter housing structure proposed for the Wastewater Discharge System Upgrades, as well as for the proposed influent treatment building and any other new structures aboveground as discussed in this EA.

Aloha,
Laura

HONOLULU
Planning & Permitting

Laura Mo
Planner | Land Use Permits Division
Department of Planning & Permitting
650 South King Street, 7th Floor
laura.mo@honolulu.gov | (808)768-8025

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November 8, 2024

Ms. Laura Mo
Land Use Permits Division
City and County of Honolulu Department of Planning and Permitting
650 South King Street, 7th Floor
Honolulu, Hawaii 96813

TRANSMITTED VIA EMAIL: laura.mo@honolulu.gov; abeatty@honolulu.gov

Dear Ms. Mo:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Comments on the Draft Environmental Assessment (EA)

Thank you for your Draft EA comments dated March 22, 2024, regarding the Waikīkī Aquarium Upgrades to the Supply Water Intake System.

We appreciate your clarification that a Diamond Head Special District Minor Permit will be required for accessory structures and any tree removal. We further understand that one minor Special District permit may cover the filter housing structure proposed for the Wastewater Discharge System Upgrades, as well as for the proposed influent treatment building and any other new structures aboveground as discussed in this EA.

Please note that, while this process would certainly be efficient in terms of permit processing, the time frame and funding for these two efforts are completely separate and it is preferable to keep the two efforts separate. We appreciate your patience and diligence in processing two separate permits.

We are including a copy of your comments and our response in the Final EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai‘i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai‘i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai‘i

Berna Senelly

From: Alexandria Barkman - NOAA Federal <alexandria.barkman@noaa.gov>
Sent: Monday, March 25, 2024 7:00 PM
To: Waq
Subject: [External] NMFS HCD Comments on Draft Environmental Assessment for the Waikīkī Aquarium Upgrades (TMK: (1) 3-1-031:006)

Follow Up Flag: Follow up
Flag Status: Flagged

You don't often get email from alexandria.barkman@noaa.gov. Learn why this is important

Aloha Berna,

Thank you for sharing the Draft Environmental Assessment (DEA) and your responses to our previous comments on the Waikiki Aquarium Water Intake Upgrades Project with the National Marine Fisheries Service (NMFS), Habitat Conservation Division (HCD). We appreciate the inclusion of a benthic survey in the DEA.

To minimize loss of EFH due to the planned activity, NMFS recommends that a plan is developed to relocate and/or transplant all corals above 10 cm (as opposed to 15 cm) that will be unavoidably lost under the following conditions:

1. The receiving location(s) must not have foreseeable and avoidable adverse effects (i.e., adverse effects from any anticipated projects by any proponent).
2. The receiving location(s) must have similar physicochemical conditions (e.g., temperature, salinity, light penetration, nutrient concentrations, and turbidity).
3. A coral relocation plan that includes post-relocation success criteria and evaluation methodology is provided to and approved by NMFS, and implemented by the proponent.
4. If coral relocation is impractical, then offsets are proposed and implemented by the proponent.

Actions that enhance EFH can offset loss of EFH, such removal of marine debris covering available EFH or stabilization of habitat. Offset plans are individually tailored to the resource, location, and activity. NMFS is ready and willing to provide technical assistance in the development of an offset plan if needed.

Since a US Army Corps of Engineers permit will be required for this project, we look forward to conducting an EFH consultation in the future.

Regards,
Alex

--
Alexandria Barkman, PhD.
EFH Consulting Biologist, PIRO Habitat Conservation Division
National Marine Fisheries Service | U.S. Department of Commerce
Office: (808) 725-5150

www.fisheries.noaa.gov

NOAA FISHERIES

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November 8, 2024

Ms. Alexandria Barkman
PIRO Habitat Conservation Division
National Marine Fisheries Service
U.S. Department of Commerce

TRANSMITTED VIA EMAIL: alexandria.barkman@noaa.gov

Dear Ms. Barkman:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Comments on the Draft Environmental Assessment (EA)

Thank you for your Draft EA comments dated March 25, 2024, regarding the Waikīkī Aquarium Upgrades to the Supply Water Intake System.

We appreciate your recommedations regarding the development of a plan to relocate and / or transplant corals above 10 cm that will be unavoidably lost. Your recommendations have been incorporated in the Final EA Section 3.3.2.3, Essential Fish Habitat Analysis. We further appreciate your offer to provide technical assistance in the development of an offset plan if needed. In our application process for a US Army Corps of Engineers permit, we look forward to Essential Fish Habitat consultation with you.

We are including a copy of your comments and our response in the Final EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai‘i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai‘i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai‘i

JOSH GREEN, M.D.
GOVERNOR | KE KIAʻĀINA

SYLVIA LUKE
LIEUTENANT GOVERNOR | KA HOPE KIAʻĀINA

DAWN N. S. CHANG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAIʻI | KA MOKUʻĀINA ʻO HAWAIʻI
DEPARTMENT OF LAND AND NATURAL RESOURCES
KA ʻOIHANA KUMUWAIWAI ʻĀINA
LAND DIVISION

P.O. BOX 621
HONOLULU, HAWAII 96809

March 25, 2024

LD 0249

Berna Cabacungan Senelly
Senior Regulatory and Community Lead
828 Fort Street Mall Suite 600
Honolulu, HI 96813

*Via email:*bsenelly@oceanit.com

SUBJECT: **Waikiki Aquarium Upgrades to Improve the Water Supply Intake System**
2777 Kalakaua Avenue, Honolulu District, Island of Oahu, Hawaii
TMK: (1) 3-1-031:006

Thank you for the opportunity to review and comment on the subject project. The Land Division of the Department of Land and Natural Resources (DLNR) distributed copies of your request to DLNR's various divisions for their review and comment.

Enclosed are comments received from our Engineering Division, Office of Conservation and Coastal Lands and Land Division. Should you have any questions, please feel free to contact Timothy Chee via email at *timothy.chee@hawaii.gov*. Thank you.

Sincerely,

Russell Tsuji

Russell Y. Tsuji
Land Administrator

Attachments
cc: Central Files

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November 8, 2024

Mr. Russell Tsuji
Land Administrator
State Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

TRANSMITTED VIA EMAIL: dlnr.land@hawaii.gov; timothy.chee@hawaii.gov

Aloha Mr. Tsuji:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades

Response to Comments on the Draft Environmental Assessment (EA)

Thank you for your Draft EA comments dated March 25, 2024, regarding the Waikīkī Aquarium Upgrades to the Supply Water Intake System. Thank you for distributing copies to various divisions within the Department of Land and Natural Resources (DLNR) and appreciate comments from the Land Division, Engineering Division and Office of Conservation and Coastal Lands. We will respond to the individual agencies directly.

We are including a copy of your comments and our response in the Final EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawaiʻi, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawaiʻi
Tavia Oshiro, Environmental Compliance Program Manager, University Hawaiʻi

JOSH GREEN, M.D.
GOVERNOR | KE KIAʻĀINA

SYLVIA LUKE
LIEUTENANT GOVERNOR | KA HOPE KIAʻĀINA

DAWN N. S. CHANG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAIʻI | KA MOKUʻĀINA ʻO HAWAIʻI
DEPARTMENT OF LAND AND NATURAL RESOURCES
KA ʻOIHANA KUMUWAIWAI ʻĀINA
LAND DIVISION

P.O. BOX 621
HONOLULU, HAWAII 96809

February 23, 2024

LD 0249

MEMORANDUM

FROM: ~~TO:~~ **DLNR Agencies:**
X Div. of Aquatic Resources *(via email: kendall.l.tucker@hawaii.gov)*
X Div. of Boating & Ocean Recreation *(via email: richard.t.howard@hawaii.gov)*
X Engineering Division *(via email: DLNR.Engr@hawaii.gov)*
X Div. of Forestry & Wildlife *(via email: rubyrosa.t.terrago@hawaii.gov)*
X Div. of State Parks *(via email: curt.a.cottrell@hawaii.gov)*
X Commission on Water Resource Management *(via email: DLNR.CWRM@hawaii.gov)*
X Office of Conservation & Coastal Lands *(via email: sharleen.k.kuba@hawaii.gov)*
X Land Division – Oahu District *(via email: barry.w.cheung@hawaii.gov)*
X Aha Moku *(via email: leimana.k.damate@hawaii.gov)*

TO: ~~FROM:~~ **Russell Y. Tsuji, Land Administrator** Russell Tsuji
SUBJECT: **Draft Environmental Assessment (DEA)**
Waikiki Aquarium Upgrades to Improve the Water Supply Intake System
LOCATION: **2777 Kalakaua Avenue, Honolulu District, Island of Oahu, Hawaii**
TMK: (1) 3-1-031:006
APPLICANT: **Oceanit**

Transmitted for your review and comment is information on the above-referenced subject. You can access the document here:

https://files.hawaii.gov/dbedt/erp/Doc_Library/2024-02-23-OA-DEA-Waikiki-Aquarium-Upgrades.pdf

Please submit any comments to *timothy.chee@hawaii.gov* at the Land Division by the internal deadline of **March 22, 2024**. If no response is received by this date, we will assume your agency has no comments. If you have any questions, please contact Timothy Chee at the above email address. Thank you.

BRIEF COMMENTS:

( ) We have no objections.
( ) We have no comments.
(✓) We have no additional comments.
( ) Comments are included/attached.

Signed: [signature]
Print Name: Carty S. Chang, Chief Engineer
Division: Engineering Division
Date: Mar 19, 2024

Attachments
Cc: Central Files

oceanit

innovation through engineering & scientific excellence

November 8, 2024

Mr. Carty Chang, Chief Engineer
Engineering Division
State of Hawaii Department of Land and Natural Resources
Kalanimoku Building
1151 Punchbowl Street, Room 221
Honolulu, Hawaii 96813

TRANSMITTED VIA EMAIL: dlnr.engr@hawaii.gov

Aloha Mr. Chang:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Comments on the Draft Environmental Assessment (EA)

Thank you for your Draft EA comments dated March 19, 2024, regarding the Waikīkī Aquarium Upgrades to the Supply Water Intake System. We note that you have no additional comments.

We are including a copy of your comments and our response in the Final EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawai'i
Tavia Oshiro, Environmental Compliance Program Manager, University Hawai'i

JOSH GREEN, M.D.
GOVERNOR | KE KIAʻĀINA

SYLVIA LUKE
LIEUTENANT GOVERNOR | KA HOPE KIAʻĀINA

DAWN N. S. CHANG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAIʻI | KA MOKUʻĀINA ʻO HAWAIʻI
DEPARTMENT OF LAND AND NATURAL RESOURCES
KA ʻOIHANA KUMUWAIWAI ʻĀINA
LAND DIVISION

P.O. BOX 621
HONOLULU, HAWAII 96809

February 23, 2024

LD 0249

MEMORANDUM

TO: **DLNR Agencies:**
X Div. of Aquatic Resources *(via email: kendall.l.tucker@hawaii.gov)*
X Div. of Boating & Ocean Recreation *(via email: richard.t.howard@hawaii.gov)*
X Engineering Division *(via email: DLNR.Engr@hawaii.gov)*
X Div. of Forestry & Wildlife *(via email: rubyrosa.t.terrago@hawaii.gov)*
X Div. of State Parks *(via email: curt.a.cottrell@hawaii.gov)*
X Commission on Water Resource Management *(via email: DLNR.CWRM@hawaii.gov)*
X Office of Conservation & Coastal Lands *(via email: sharleen.k.kuba@hawaii.gov)*
X Land Division – Oahu District *(via email: barry.w.cheung@hawaii.gov)*
X Aha Moku *(via email: leimana.k.damate@hawaii.gov)*

FROM: **Russell Y. Tsuji, Land Administrator** Russell Tsuji
SUBJECT: **Draft Environmental Assessment (DEA)**
Waikiki Aquarium Upgrades to Improve the Water Supply Intake System
LOCATION: **2777 Kalakaua Avenue, Honolulu District, Island of Oahu, Hawaii**
TMK: (1) 3-1-031:006
APPLICANT: **Oceanit**

Transmitted for your review and comment is information on the above-referenced subject. You can access the document here:

https://files.hawaii.gov/dbedt/erp/Doc_Library/2024-02-23-OA-DEA-Waikiki-Aquarium-Upgrades.pdf

Please submit any comments to *timothy.chee@hawaii.gov* at the Land Division by the internal deadline of **March 22, 2024**. If no response is received by this date, we will assume your agency has no comments. If you have any questions, please contact Timothy Chee at the above email address. Thank you.

BRIEF COMMENTS:

Any existing or planned pipes outside of the Executive Order boundary on lands under the jurisdiction of the Board of Land and Natural Resources needs an approved land disposition from the Board and approvals from the Legislature and the Governor before any easements can be executed.

( ) We have no objections.
( ) We have no comments.
( ) We have no additional comments.
(X) Comments are included/attached.

Signed: Darlene Bryant-Takamatsu BC
Print Name: Darlene Bryant-Takamatsu
Division: Land Division
Date: March 13, 2024

Attachments
Cc: Central Files

November 8, 2024

Ms. Darlene Bryant-Takamatsu
Land Division
State of Hawaii Department of Land and Natural Resources
Kalanimoku Building
1151 Punchbowl Street, Room 221
Honolulu, Hawaii 96813

TRANSMITTED VIA EMAIL: barry.w.cheung@hawaii.gov)

Aloha Ms. Bryant-Takamatsu:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Comments on the Draft Environmental Assessment (EA)

Thank you for your Draft EA comments dated February 23, 2024, regarding the Waikīkī Aquarium Upgrades to the Supply Water Intake System.

We note that your comment that any existing or planned pipes outside of the Executive Order boundary on lands under the jurisdiction of the Board of Land and Natural Resources needs an approved land disposition from the Board and approvals from the Legislature and the Governor before any easements can be executed. Please note that the subject area is falls under the jurisdiction of the Division of Boating and Ocean Recreation pursuant to Governor's Executive Order 4604.

We are including a copy of your comments and our response in the Final EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawaiʻi, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawaiʻi
Tavia Oshiro, Environmental Compliance Program Manager, University Hawaiʻi

STATE OF HAWAIʻI | KA MOKUʻĀINA ʻO HAWAIʻI
DEPARTMENT OF LAND AND NATURAL RESOURCES | KA ʻOIHANA KUMUWAIWAI ʻĀINA
COMMISSION ON WATER RESOURCE MANAGEMENT | KE KAHUWAI PONO
P.O. BOX 621
HONOLULU, HAWAII 96809

Mar 25, 2024

REF: RFD.6246.3

TO: Berna Senelly, Senior Regulatory and Community Lead
, Oceanit

FROM: Dean D. Uyeno, Acting Deputy Director
Commission on Water Resource Management

SUBJECT: Waikiki Aquarium Upgrades to Improve the Water Supply Intake System

FILE NO.: RFD.6246.3
TMK NO.: (1) 3-1-031:006

Thank you for the opportunity to review the subject document. The Commission on Water Resource Management (CWRM) is the agency responsible for administering the State Water Code (Code). Under the Code, all waters of the State are held in trust for the benefit of the citizens of the State, therefore all water use is subject to legally protected water rights. CWRM strongly promotes the efficient use of Hawaii's water resources through conservation measures and appropriate resource management. For more information, please refer to the State Water Code, Chapter 174C, Hawaii Revised Statutes, and Hawaii Administrative Rules, Chapters 13-167 to 13-171. These documents are available via the Internet at http://dlnr.hawaii.gov/cwrm.

Our comments related to water resources are checked off below.

☐ 1. We recommend coordination with the county to incorporate this project into the county's Water Use and Development Plan. Please contact the respective Planning Department and/or Department of Water Supply for further information.

☐ 2. We recommend coordination with the Engineering Division of the State Department of Land and Natural Resources to incorporate this project into the State Water Projects Plan.

☐ 3. We recommend coordination with the Hawaii Department of Agriculture (HDOA) to incorporate the reclassification of agricultural zoned land and the redistribution of agricultural resources into the State's Agricultural Water Use and Development Plan (AWUDP). Please contact the HDOA for more information.

X 4. We recommend that water efficient fixtures be installed and water efficient practices implemented throughout the development to reduce the increased demand on the area's freshwater resources. Reducing the water usage of a home or building may earn credit towards Leadership in Energy and Environmental Design (LEED) certification. More information on LEED certification is available at http://www.usgbc.org/leed. A listing of fixtures certified by the EAP as having high water efficiency can be found at http://www.epa.gov/watersense.

X 5. We recommend the use of best management practices (BMP) for stormwater management to minimize the impact of the project to the existing area's hydrology while maintaining on-site infiltration and preventing polluted runoff from storm events. Stormwater management BMPs may earn credit toward LEED certification. More information on stormwater BMPs can be found at http://planning.hawaii.gov/czm/initiatives/low-impact-development/

X 6. We recommend the use of alternative water sources, wherever practicable.

X 7. We recommend participating in the Hawaii Green Business Program, that assists and recognizes businesses that strive to operate in an environmentally and socially responsible manner. The program description can be found online at http://energy.hawaii.gov/green-business-program.

X 8. We recommend adopting landscape irrigation conservation best management practices endorsed by the Landscape Industry Council of Hawaii. These practices can be found online at http://www.hawaiiscape.com/wp-content/uploads/2013/04/LICH_Irrigation_Conservation_BMPs.pdf.

- [X] 9. There may be the potential for ground or surface water degradation/contamination and recommend that approvals for this project be conditioned upon a review by the State Department of Health and the developer's acceptance of any resulting requirements related to water quality.
- [ ] 10. The proposed water supply source for the project is located in a designated water management area, and a Water Use Permit is required prior to use of water. The Water Use Permit may be conditioned on the requirement to use dual line water supply systems for new industrial and commercial developments.
- [ ] 11. The Hawaii Water Plan is directed toward the achievement of the utilization of reclaimed water for uses other than drinking and for potable water needs in one hundred per cent of State and County facilities by December 31, 2045 (§174C-31(g)(6), Hawaii Revised Statutes). We strongly recommend that this project consider using reclaimed water for its non-potable water needs, such as irrigation. Reclaimed water may include, but is not limited to, recycled wastewater, gray water, and captured rainwater/stormwater. Please contact the Hawaiʻi Department of Health, Wastewater Branch, for more information on their reuse guidelines and the availability of reclaimed water in the project area.
- [X] 12. A Well Construction Permit(s) is (are) are required before the commencement of any well construction work.
- [X] 13. A Pump Installation Permit(s) is (are) required before ground water is developed as a source of supply for the project.
- [ ] 14. There is (are) well(s) located on or adjacent to this project. If wells are not planned to be used and will be affected by any new construction, they must be properly abandoned and sealed. A permit for well abandonment must be obtained.
- [ ] 15. Ground-water withdrawals from this project may affect streamflows, which may require an instream flow standard amendment.
- [ ] 16. A Stream Channel Alteration Permit(s) is (are) required before any alteration can be made to the bed and/or banks of a steam channel.
- [ ] 17. A Stream Diversion Works Permit(s) is (are) required before any stream diversion works is constructed or altered.
- [ ] 18. A Petition to Amend the Interim Instream Flow Standard is required for any new or expanded diversion(s) of surface water.
- [ ] 19. The planned source of water for this project has not been identified in this report. Therefore, we cannot determine what permits or petitions are required from our office, or whether there are potential impacts to water resources.

- [ ] OTHER:

If you have any questions, please contact Ryan Imata of the Regulation Branch at (808) 587-0225 or Katie Roth of the Planning Branch (808) 587-0216.
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November 8, 2024

Mr. Dean D. Uyeno, Acting Deputy Director
Hawaiʻi State Commission on Water Resource Management
State of Hawaiʻi Department of Land and Natural Resources

TRANSMITTED VIA EMAIL: Lu, Bonnie bonnie.lu@hawaii.gov

Aloha Mr. Uyeno:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Comments on the Draft Environmental Assessment (EA)

Thank you for your Draft EA comments dated March 25, 2024, regarding the Waikīkī Aquarium Upgrades to the Supply Water Intake System.

We note your checklist of eight (8) comments pertinent to this project. We incorporated these comments in Section 3.1.3, Hydrogeology and Water Resources, in the Final EA.

We are including a copy of your comments and our response in the Final EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawaiʻi, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawaiʻi
Tavia Oshiro, Environmental Compliance Program Manager, University Hawaiʻi

Ka Moku'aina 'O Hawai'i Aha Moku O Pae'Aina

State of Hawai'i Aha Moku

P. O. Box 621

Honolulu, Hawaii 96809

May 1, 2024

Berna Senelly

Oceanit

828 Fort Street Mall, Suite 600

Honolulu, HI 96813

Aloha Ms. Senelly,

The Hawaii State Aha Moku is comprised of traditional cultural native Hawaiian practitioners from the eight main Hawaiian Islands. Its mission is to bring the voices of the indigenous people of Hawaii forward on issues pertaining to traditional cultural practices of specific ahupua'a and moku of an island. Legally, it is Act 288 SLH 2012.

On behalf of some of the generational and lineal descendants of the Waikiki Ahupua'a, Moku of Kona, Mokupuni Kakuhihewa, we offer our comments.

We strongly support Kehaulani (Trisha) Watson-Sproat's comments on the draft EA (DEA) for the Waikiki Aquarium. We also agree that the Cultural Impact Assessment (CIA) could not be based on the contacting of the groups mentioned. We note that many lineal and generational individuals who continue their traditional practices were not mentioned.

I must reiterate that the Hawaii State Aha Moku in the case of Kakuhihewa (O'ahu) is comprised of five (5) Moku – Kona, Waianae, Wailua, Ko'olauloa, and Ko'olaupoko. Each Moku has a representative who works with specific ahupua'a in their Moku. The Moku Representative has the deep respect of their ahupua'a as they have the kuleana to protect and perpetuate the traditional practices of their people.

Kehaulani (Trisha) Watson-Sproat is the Hawaii State Aha Moku Representative of the Kona Moku and the Ahupua'a of Waikiki. Her family is well-known for their *Lawai'a* practices in Waikiki.

On a personal note, my family also were born, lived and died in Waikiki. Along with my brothers and cousins, my grandmother taught us to surf in Waikiki as toddlers. We were taught all of the breaks, and currents of Waikiki.

My great-grandmother, Augusta Lihuenuiahanakalani Holt was with Queen Liliuokalani during the overthrow, and my great-grandfather, Edward Holt was the High Sheriff of the areas from Kakaako to Waikiki during that time. Our family home was where the zoo is today, and my father was the last one born in that house in 1929. My parents, two brothers, grandparents and many cousins who passed away are in their final resting place in the sacred waters of Waikiki. I will join them when my time comes.

I tell you this, so you understand that I also find the current CIA deeply painful and insulting. My family is so deeply connected to Waikiki, as is Dr. Watson-Sproat, but we also are being erased in this document. Do you realize that if our two family's genealogy and cultural practices are erased, how many other histories connected to Waikiki cannot be protected because of a flawed CIA?

The Aha Moku fully supports the *Ka Pa'akai* Analysis which calls for 1) the identification and scope of valued cultural, historical, or natural resources in the petition or impacted area, including the extent to which traditional and customary Native Hawaiian rights are exercised in the petition area; 2) The extent to which those resources, including traditional and customary native Hawaiian rights, will be affected or impaired by the proposed action; and 3) The feasible action, if any, to be taken to reasonably protect Hawaiian rights if they are found to exist.

We believe that the current CIA does not comply with *Ka Pa'akai* and strongly recommend that you work with Dr. Kehaulani (Trisha) Watson-Sproat to amend it. Professionally, Dr. Watson-Sproat has the background and knowledge to help you. Culturally, she is the Hawaii State Aha Moku Representative of Waikiki.

Respectfully,

Leimana DaMate, Luna Alaka'i/Executive Director
Hawaii State Aha Moku
808-640-1214
Leimana.k.damate@hawaii.gov

oceanit

innovation through engineering & scientific excellence

November 8, 2023

Ms. Leimana DaMate, Luna Alakaʻi
Hawaiʻi State Aha Moku

TRANSMITTED VIA EMAIL: Leimana.k.damate@hawaii.gov

Aloha Ms. DaMate,

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Comments on the Draft Environmental Assessment (EA)

Mahalo for your Draft EA comments dated May 1, 2024, regarding the Waikīkī Aquarium Upgrades to the Supply Water Intake System. I am humbled by your information about your personal history and the legacy left by your ʻohana in Waikīkī. Thank you.

We note your strong support for comments from Dr. Kehaulani (Trisha) Watson-Sproat's comments on the draft EA (DEA) for the Waikiki Aquarium and that you agree that lineal and generational individuals who continue their traditional practices were not mentioned. The Cultural Impact Assessment has been revised to 1) acknowledge that there was no follow up to ʻĀina Momona's November 21, 2023, stated interest in participating in the Cultural Impact Assessment on this project, and 2) to follow up on suggestions provided by Dr. Trisha Watson-Sproat. Section 3.4.4, Cultural Impacts, of the Final EA includes both an acknowledgement of the initial lack of consultation and follow up information based on her suggestions. In addition, the Ka Paʻakai analysis has been revised accordingly.

Again, thank you for your comments. We are including a copy of your comments and our response in the Final EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawaiʻi, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawaiʻi
Tavia Oshiro, Environmental Compliance Program Manager, University Hawaiʻi

‘ĀINA MOMONA

P.O. Box 367 | Ho‘olehua, HI 96729

www.kaainamomona.org

May 1, 2024

Berna Senelly
Oceanit
828 Fort Street Mall, Suite 600
Honolulu, HI 96813

Dear Ms. Senelly,

Mahalo for the opportunity to provide comments on the draft EA (DEA) for the Waikiki Aquarium.

We have numerous concerns about the context of the DEA. We have detailed them below.

1. The CIA Erroneously Claims that Aina Momona Did Not Respond to Its Request for an Interview

‘Āina Momona was contacted by PCSI on November 21, 2023, seeking information about Waikīkī. ‘Āina Momona responded on November 24, 2023, expressing interest in participating. No response or follow up was received from PCSI. On page 29 of the CIA, it is written that ‘Āina Momona did not respond. This is not true and should be corrected.

2. The CIA Lacks Ethnographic Data

We note that most of the groups contacted for the CIA are not from Waikīkī. Many are not even from O‘ahu. The CIA says that it utilized the Office of Native Hawaiian Relations NHO List, but it does not seem to be the case. A cursory review of the list shows many organizations that interest interest in O‘ahu were not contacted. The list, which was updated in September 2023, prior to when PCSI reached out, is available here https://www.doi.gov/media/document/nhol-complete-list-pdf For example, *the first organization on the list* is the ‘Aha Kāne. We can tell you, as an organization with ties to this ahupua‘a, that the listed contact for the ‘Aha Kāne is master practitioner Umi Kai, who lives in the Waikīkī ahupua‘a and would have been an excellent subject for interview.

As a result of this problematic outreach, there are no interviews in the CIA. At the core of a CIA is the ethnographic data, we do not believe this CIA meets the guidelines without interviews.

3. The CIA Inadequately Researches Cultural Practices

The CIA guidelines read: “A cultural impact assessment includes information relating to the practices and beliefs of a particular cultural or ethnic group or groups.” This CIA makes next to no effort to identify practices in the area and erroneously concludes there are none. The practices that have occur and continue to take place in the area are numerous. Surfing, fishing, paddling, and ceremonial practices. Currently take place. Waikīkī has a long history of farming. When you look at adjacent areas, you have hula and mele. When you apply the geographic extent recommended by the CIA guidelines, you have even more practices. To say there are no practices is truly insulting. There are numerous texts documenting these practices as well.

As a result of the inadequate information in the CIA, the *Ka Pa‘akai* analysis is also wrong. The DEA language is wrong as well.

As someone born and raised in this ahupua‘a, this CIA was deeply painful and insulting to read. My family has fished and surfed these waters their whole lives and this CIA effectively erases them. My nieces are literally named for these surf breaks. That’s how closely tied we are to these places. As a professional in this field, I’m baffled as to how something of this poor quality was utilized and published. I’m very happy to work with Oceanit on finding a solution, but the conclusions in the CIA and *Ka Pa‘akai* analysis are so grossly erroneous that we would like them removed entirely from the final EA and the cultural section of the Final EA rewritten to accurately convey the cultural practices that take place in the project area and the adjacent area in Waikīkī. The *Ka Pa‘akai* analysis should also be fully rewritten to identify the cultural practices in the area, potential impacts, and the feasible action the project will take to avoid impacts to those practices.

Me ka ha‘aha‘a,

Trisha Kehaulani Watson-Sproat, J.D., Ph.D.
Vice President, ‘Āina Momona

November 8, 2024

Dr. Trisha Kehaulani Watson-Sproat, Vice President
ʻĀina Momona

TRANSMITTED VIA EMAIL: watson@honuaconsulting.com

Aloha Dr. Watson-Sproat:

SUBJECT: Environmental Assessment Regarding Waikīkī Aquarium Supply Water Intake System Upgrades
Response to Comments on the Draft Environmental Assessment (EA)

Mahalo for your Draft EA comments dated May 1, 2024, regarding the Waikīkī Aquarium Upgrades to the Supply Water Intake System. First, I apologize that there was no follow up to ʻĀina Momona's November 21, 2023, interest in participating in the Cultural Impact Assessment on this project. I did not know about this until I received your email dated April 2, 2024. Please accept my apology for this lack of follow up.

Second, I greatly appreciate your time and guidance in our phone conversation on May 1, 2024 and in your written comments provided on the same date. You clearly explained your concerns and were very generous in recommending resources that would be helpful in identifying cultural practices in this area. Based on your consultation via our conversation and your subsequent letter, the Cultural Impact Assessment has been revised to acknowledge that there was no follow up to your response to be consulted. Further, the Revised Cultural Impact Assessment incorporates your suggestions, and Section 3.4.4, Cultural Impacts, of the Final EA includes both an acknowledgement of the initial lack of follow up and findings based on your consultation. Please note that the Ka Paʻakai analysis has been revised accordingly.

Again, many thanks for your manaʻo, time and guidance. We are including a copy of your comments and our response in the Final EA. Further, we will notify you of its publication in The Environmental Notice published by the State of Hawaiʻi, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Copies to
Lise Ditzel-Ma, Project Manager, Office of Project Delivery, University of Hawaiʻi
Tavia Oshiro, Environmental Compliance Program Manager, University Hawaiʻi