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JUN - 8 2021

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GOVERNOR OF
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BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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DEPUTY DIRECTOR - WATER

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FORESTRY AND WILDLIFE
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LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

May 3, 2021

MEMORANDUM

TO: Keith Kawaoka, Acting Director
Office of Environmental Quality Control

FROM: Suzanne D. Case, Chairperson Suzanne Q. Case
Board of Land and Natural Resources

SUBJECT: Draft Programmatic Environmental Impact Statement (DPIES)
Waikīkī Beach Improvement and Maintenance Program
Honolulu District, Island of Oʻahu
(seaward of) Tax Map Key Nos. (1) 2-6-001:003, (1) 2-6-004:007, (1) 2-6-005:001, (1) 2-6-008:029, (1) 2-6-002:026, (1) 2-6-001:019, (1) 2-6-004:012, (1) 2-6-002:017, (1) 2-6-001:013, (1) 2-6-001:012, (1) 2-6-001:002, (1) 2-6-001:015, (1) 2-6-001:008, (1) 2-6-004:006, (1) 2-6-004:005, (1) 2-6-001:017, (1) 2-6-004:008, (1) 2-6-004:009, (1) 2-6-004:010, (1) 2-6-001:018, (1) 2-6-005:006, (1) 2-6-001:004, (1) 2-6-002:006, (1) 2-6-002:005

With this memorandum, the State of Hawaiʻi Department of Land and Natural Resources (DLNR) requests the Draft Programmatic Environmental Impact Statement (DPEIS) for the proposed Waikīkī Beach Improvement and Maintenance Program be published in the next issue of the Office of Environmental Quality Control's (OEQC) periodic bulletin, *The Environmental Notice*.

So as to not overlook any potentially significant impacts to the natural and/or human environment, the DLNR has determined at the outset that an environmental impact statement is required for the proposal pursuant to Hawaiʻi Revised Statutes §343-5(e) and Hawaiʻi Administrative Rules (HAR) §11-200.1-14(d)(2).

The required publication forms and files, including an electronic copy of the DPEIS in pdf format, have been provided via the OEQC online submission platform. Concurrently, with the electronic filing, and as required by HAR §11-200.1-5(e)(4)(B), paper copies of the DPEIS have been submitted to the Waikiki-Kapahulu Public Library and with the Hawaiʻi Documents Center.

Pursuant to HAR §11-200.1-23(10)(c), publication of the DPEIS in *The Environmental Notice* initiates a 45-day public comment period for the public to provide comments regarding potential effects of the proposed actions. Public comments should be submitted to Sea Engineering, Inc. with copies to the DLNR Office of Conservation and Coastal Lands.

Should you have any questions, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377 or Sam.J.Lemmo@hawaii.gov.

C:Governor's Office- Accepting Authority

21-172

From: webmaster@hawaii.gov
To: HI Office of Environmental Quality Control
Subject: New online submission for The Environmental Notice
Date: Thursday, May 27, 2021 3:45:29 PM

Action Name

Waikīkī Beach Improvement and Maintenance Program

Type of Document/Determination

Draft environmental impact statement (DEIS)

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
- (5) Propose any use within the Waikīkī area of Oʻahu

Judicial district

Honolulu, Oʻahu

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

(seaward of) (1) 2-6-001:003, 1) 2-6-004:007, (1) 2-6-005:001, (1) 2-6-008:029, (1) 2-6-002:026, (1) 2-6-001:019, (1) 2-6-004:012, (1) 2-6-002:017, (1) 2-6-001:013, (1) 2-6-001:012, (1) 2-6-001:002, (1) 2-6-001:015, (1) 2-6-001:008, (1) 2-6-004:006, (1) 2-6-004:005, (1) 2-6-001:017, (1) 2-6-004:008, (1) 2-6-004:009, (1) 2-6-004:010, (1) 2-6-001:018, (1) 2-6-005:006, (1) 2-6-001:004, (1) 2-6-002:006, (1) 2-6-002:005

Action type

Agency

Other required permits and approvals

Numerous

Proposing/determining agency

Hawaiʻi Department of Land and Natural Resources

Agency contact name

Sam Lemmo

Agency contact email (for info about the action)

sam.j.lemmo@hawaii.gov

Email address or URL for receiving comments

waikiki@seaengineering.com

Agency contact phone

(808) 587-0377

Agency address

P.O. Box 621

Honolulu, Hawaiʻi 96809
United States
Map It

Accepting authority

Governor of the State of Hawaiʻi

Accepting authority contact name

David Ige

Accepting authority contact email or URL

http://governor.hawaii.gov/contact-us/contact-the-governor/

Accepting authority contact phone

(808) 586-0034

Accepting authority address

Executive Chambers, State Capitol
415 South Beretania St.
Honolulu, Hawaiʻi 96813
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Map It

Was this submittal prepared by a consultant?

Yes

Consultant

Sea Engineering, Inc.

Consultant contact name

David Smith

Consultant contact email

dsmith@seaengineering.com

Consultant contact phone

(808) 259-7966

Consultant address

Makai Research Pier
41-305 Kalanianaʻole Hwy
Waimānalo, Hawaiʻi 96795
United States
Map It

Action summary

The Hawaiʻi Department of Land and Natural Resources proposes beach improvement and maintenance projects in the Fort DeRussy, Halekūlani, Royal Hawaiian, and Kūhiō beach sectors of Waikīkī. Projects would include the construction of new beach stabilization structures, and the recovery of offshore sand and its placement on the shoreline. The objectives of the proposed actions are to restore and improve Waikīkī's public beaches, increase beach stability through improvement and maintenance of shoreline structures, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise.

Attached documents (signed agency letter & EA/EIS)

- EISPN-Public-Scoping-Meeting-Audio-Video-Files.pdf
- Waikiki-Beach-Improvement-and-Maintenance-Program-DPEIS-2021-05-26.pdf
- Signed-OEQC-Request-for-publication-2021-05-27.pdf

Shapefile

- The location map for this Draft EIS is the same as the location map for the associated EIS Preparation Notice.

Action location map

- SHP-KMZ.zip

Authorized individual

David A. Smith, PhD, PE

Authorization

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

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

Waikīkī Beach Improvement and Maintenance Program

June 2021

Prepared for:
Hawai‘i Department of Land and Natural Resources
Office of Conservation and Coastal Lands
1151 Punchbowl Street, Suite 131
Honolulu, Hawai‘i 96813

Partnered with:
Waikīkī Special Improvement District Association
2250 Kalākaua Ave. Suite 315
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Prepared by:
Sea Engineering, Inc.
Makai Research Pier
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WAIKĪKĪ BEACH IMPROVEMENT and MAINTENANCE PROGRAM

Draft Programmatic Environmental Impact Statement

Proposing Agency:

DEPARTMENT OF LAND AND NATURAL RESOURCES

This document and all ancillary documents were prepared under my direction and the information submitted, to the best of my knowledge fully addresses document content requirements set forth in the Hawaiʻi Revised Statutes Chapter 343; and the Hawaiʻi Administrative Rules Title 11, Chapter 200.1, Sub-chapter 10.

May 3, 2021

Suzanne D. Case, Director
Department of Land and Natural Resources

Date

Accepting Authority:

GOVERNOR, STATE OF HAWAIʻI

Prepared By:

SEA ENGINEERING, INC.

May 2021

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ACKNOWLEDGEMENTS

Hawaiʻi State Legislature
Appropriating funds to support beach improvement and maintenance actions in Waikīkī.

Hawaiʻi Department of Land and Natural Resources (DLNR)
Providing funding, leadership, and staff resources to support beach improvement and maintenance actions in Waikīkī**.** Special thanks to Sam Lemmo (Administrator), Tiger Mills (Senior Planner), and Dr. Shellie Habel (Coastal Lands Program Coordinator).

Waikīkī Special Improvement District Association (WBSIDA)
Generating tax revenue and project coordination to support beach improvement and maintenance actions in Waikīkī. Establishing the Waikīkī Beach Community Advisory Committee.

Waikīkī Beach Community Advisory Committee (WBCAC)
Establishing the priorities and objectives for each beach sector, establishing planning and design criteria, evaluating conceptual options, and providing feedback on the conceptual designs for the proposed actions.

University of Hawaiʻi Sea Grant Program
Providing staff resources to support beach improvement and maintenance actions in Waikīkī. Special thanks to Dolan Eversole (Waikīkī Beach Management Coordinator), Dr. Bradley Romine (Coastal Processes Specialist), and Dr. Shellie Habel (Coastal Lands Program Coordinator).

University of Hawaiʻi Coastal Geology Group
Providing research and data for historical and projected shoreline change, sea level rise, and beach profile monitoring. Special thanks to Dr. Chip Fletcher and Dr. Tiffany Anderson.

University of Hawaiʻi Coastal Groundwater Research Group
Providing opinions regarding submarine groundwater discharge at Kawehehe. Special thanks to Dr. Henrietta Dulai and Dr. Craig Glenn.

AECOS, Inc.
Conducting the Ocean Recreation Study for the DPEIS.

International Archaeology LLC
Conducting the Cultural Impact Assessment for the DPEIS.

John Clark
Conducting the Ocean Recreation Study for the DPEIS.

Jonathan Quach
Providing conceptual renderings for the DPEIS.

ACRONYMS AND ABBREVIATIONS

AMAP	Applicable Monitoring and Assessment Plan
AIS	Archaeological Inventory Study
AMP	Archeological Monitoring Plan
BLNR	Board of Land and Natural Resources
BMP	Best Management Practices
CDP	Community Development Plan
CDUA	Conservation District Use Application
CDUP	Conservation District Use Permit
cf	Cubic feet
CFR	Code of Federal Regulations
CIA	Cultural Impact Assessment
cm	Centimeters
CWA	Clean Water Act
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act of 1977
DA	Department of the Army
DAGS	Department of Accounting and General Services
DAR	Division of Aquatic Resources
dBA	Decibels
DBEDT	State of Hawaiʻi Department of Business, Economic Development, and Tourism
Deg	Degrees
DEIS	Draft Environmental Impact Statement
DLNR	State of Hawaiʻi Department of Land and Natural Resources
DO	Dissolved Oxygen
DOH	State of Hawaiʻi Department of Health
DOBOR	Division of Boating and Ocean Recreation
DPEIS	Draft Programmatic Environmental Impact Statement
CWB	Clean Water Branch
cy	Cubic yards
E	Existing
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EISPN	Environmental Impact Statement Preparation Notice
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
ft	Feet
ft/yr	Feet Per Year
FWCA	Fish and Wildlife Coordination Act
GMSL	Global Mean Sea Level
GPS	Global Positioning System
HAR	Hawaiʻi Administrative Rules
HDPE	High-Density Polyethylene

HEPA	Hawaiʻi Environmental Policy Act
HRS	Hawaiʻi Revised Statutes
HSBPA	Hawaiʻi Shore and Beach Preservation Association
HST	Hawaiʻi Standard Time
Hz	Hertz
in	Inches
m	Meters
IPCC	Intergovernmental Panel on Climate Change
MBTA	Migratory Bird Treaty Act
mgd	Million Gallons Per Day
MHHW	Mean Higher High Water
mi	Miles
MLLW	Mean Lower Low Water
mm	Millimeters
MMPA	Marine Mammal Protection Act
mph	Miles Per Hour
MSA	Magnuson-Stevens Conservation Act
MSL	Mean Sea Level
MUS	Management Unit Species
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NHPA	National Historic Preservation Act
NO_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NWP	Nationwide Permit
NTU	Nephelometric Turbidity Units
OCCL	Office of Conservation and Coastal Lands
OEQC	Office of Environmental Quality Control
ORMP	Ocean Resources Management Plan
P	Proposed
PacIOOS	Pacific Islands Ocean Observing System
PIRO	Pacific Islands Regional Office
PM	Particulate Matter
ROE	Right-of-Entry
RTE	Rare, Threatened, and Endangered
ROH	Revised Ordinances of Honolulu
SEI	Sea Engineering, Inc.
SLR	Sea Level Rise
SLR-XA	Sea Level Rise Exposure Area
SLUD	State Land Use District
SMA	Special Management Area
SO_2	Sulfur Dioxide
SOEST	School of Ocean Earth Science and Technology
SWAN	Simulating Waves Nearshore

TMDL	Total Maximum Daily Load
TMK	Tax Map Key
TSS	Total Suspended Solids
UH	University of Hawai‘i
UHCGG	University of Hawai‘i Coastal Geology Group
USACE	United States Army Corps of Engineers
USC	United States Code
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
US	United States
UV	Ultraviolet
VOC	Volatile Organic Compound
WBCAC	Waikīkī Beach Community Advisory Committee
WBSIDA	Waikīkī Special Improvement District Association
WIA	Waikīkī Improvement Association
WNB	Waikīkī Neighborhood Board
WQC	Water Quality Certification
WQS	Water Quality Standards
yr	Years

PROJECT SUMMARY

Project: Waikīkī Beach Improvement and Maintenance Program

Proposing Agency
Office of Conservation and Coastal Lands
Department of Land and Natural Resources
State of Hawaiʻi
1151 Punchbowl Street, Room 131
Honolulu, Hawaiʻi 96813
Contact: Sam Lemmo (808) 587-0377
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Approving Authority:
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Contact: David Smith, Ph.D., P.E. (808) 259-7966 ext. 30
Email: waikiki@seaengineering.com

Location: Waikīkī Beach, Honolulu, Oʻahu, Hawaiʻi

State Land Use District: Conservation (Resource Subzone)

Tax Map Keys: (seaward of) (1) 2-6-001:003, 1) 2-6-004:007, (1) 2-6-005:001, (1) 2-6-008:029, (1) 2-6-002:026, (1) 2-6-001:019, (1) 2-6-004:012, (1) 2-6-002:017, (1) 2-6-001:013, (1) 2-6-001:012, (1) 2-6-001:002, (1) 2-6-001:015, (1) 2-6-001:008, (1) 2-6-004:006, (1) 2-6-004:005, (1) 2-6-001:017, (1) 2-6-004:008, (1) 2-6-004:009, (1) 2-6-004:010, (1) 2-6-001:018, (1) 2-6-005:006, (1) 2-6-001:004, (1) 2-6-002:006, (1) 2-6-002:005

County Zoning: Public Precinct (Waikīkī Special District)

Proposed Action:	The Hawaiʻi Department of Land and Natural Resources proposes beach improvement and maintenance projects in the Fort DeRussy, Halekūlani, Royal Hawaiian, and Kūhiō beach sectors of Waikīkī. Projects would include the construction of new beach stabilization structures, and the recovery of offshore sand and its placement on the shoreline. The objectives of the proposed actions are to restore and improve Waikīkī's public beaches, increase beach stability through improvement and maintenance of shoreline structures, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise.
Required Permits And Approvals:	Programmatic Environmental Impact Statement Conservation District Use Permit Small-scale Beach Nourishment Permit Department of the Army Permit (Section 10 and Section 404) Coastal Zone Management Act Consistency Determination Clean Water Act Section 401 Water Quality Certification National Pollutant Discharge Elimination System Permit State of Hawaiʻi, Hawaiʻi Revised Statutes Chapter 6E Review City and County of Honolulu, Special Management Area Permit
Actions Requiring Environmental Assessment:	Work within the Conservation District. Use of State Lands Use of State Funds Work within the Shoreline Area

CONTENT CHECKLIST

The Draft EIS, at a minimum, shall contain the following information required in this section (Hawaiʻi Administrative Rules (HAR) 11-200.1-24)

Section	Requirement	Chapters / Sections
(d)(1)	Brief description of the proposed action.	Executive Summary
(d)(2)	Significant beneficial and adverse impacts.	Executive Summary Chapter 8 Chapter 9 Chapter 10
(d)(3)	Proposed mitigation measures.	Chapter 8 Chapter 9 Chapter 12
(d)(4)	Alternatives considered.	Section 3.4 Section 4.4 Section 5.4 Section 6.4 Section 7.4 Section 7.6
(d)(5)	Unresolved issues.	Executive Summary Chapter 15
(d)(6)	Compatibility with land use plans and policies, and a list of permits or approvals.	Executive Summary Chapter 16 Chapter 17
(d)(7)	A list of relevant EAs and EISs considered in the analysis of the preparation of the EIS.	Executive Summary
(e)	Table of contents.	Table of Contents
(f)	Statement of purpose and need for the proposed action.	Executive Summary Section 2.2
(g)(1)	Detailed maps.	Figure 2-1 Figure 2-2 Figure 8.23 Figure 8.24 Figure 8.25 Figure 8.26
(g)(2)	Objectives of the proposed action.	Section 2.3 Section 4.2 Section 5.2 Section 6.2 Section 7.2
(g)(3)	General description of the action’s technical, economic, social, cultural, and environmental characteristics.	Executive Summary Chapter 2 Chapter 3 Section 4.3 Section 5.3

		Section 6.3 Section 7.3 Section 7.5 Chapter 8 Chapter 9
(g)(4)	Use of state of county funds or lands for the action.	Section 2.2
(g)(5)	Phasing and timing of the action.	Executive Summary Section 3.4 Section 4.3.4 Section 5.3.4 Section 6.3.4 Section 7.3.4 Section 7.5.4 Chapter 10 Chapter 15
(g)(6)	Summary technical data, diagrams, and other information necessary to enable an evaluation of potential environmental impact by commenting agencies and the public.	Section 4.3 Section 5.3 Section 6.3 Section 7.3 Section 7.5 Appendix B Appendix C Appendix D
(g)(7)	Historic perspective	Section 2.1 Section 4.1 Section 5.1 Section 6.1 Section 7.1 Section 9.2 Appendix D
(h)(1)	No action alternative.	Section 3.4.1
(h)(2)	Alternatives requiring actions of a significantly different nature that would provide similar benefits with different environmental impacts.	Section 3.4 Section 4.4 Section 5.4 Section 6.4 Section 7.4 Section 7.6 Chapter 10
(h)(3)	Alternatives related to different designs or details of the proposed action that would present different environmental impacts.	Section 3.4 Section 4.4 Section 5.4 Section 6.4 Section 7.4 Section 7.6 Chapter 10
(h)(4)	Alternative locations for the proposed action.	Section 2.5 Section 2.6

(i)	Description of the environmental setting, including a description of the environment in the vicinity of the action, as it exists before commencement of the action, from both a local and regional perspective.	Section 2.1 Section 4.1 Section 5.1 Section 6.1 Section 7.1 Appendix C Appendix D
(i)	Environmental resources that are rare or unique to the region and the action site.	Section 2.1 Section 4.1 Section 5.1 Section 6.1 Section 7.1 Section 9.2 Section 9.4
(i)	Related projects, public and private, existent or planned in the region.	Section 2.6
(i)	Population and growth characteristics, assumptions, and impacts.	Section 9.1.2 Section 9.1.5
(j)	Description of the relationship of the proposed action to land use and natural or cultural resource plans, policies, and controls for the affected area.	Executive Summary Chapter 16
(k)	List of necessary approvals and status of each.	Executive Summary Section 4.3.5 Section 5.3.5 Section 6.3.5 Section 7.3.5 Section 7.5.5 Chapter 16
(l)	Analysis of the probable impact of the proposed action on the environment and impacts of the natural or human environment on the action.	Chapter 8 Chapter 9 Chapter 10 Chapter 11 Chapter 12 Chapter 13 Chapter 14
(l)	Consideration of all phases of the action.	Section 3.4 Section 4.3.4 Section 5.3.4 Section 6.3.4 Section 7.3.4 Section 7.5.4 Chapter 10 Chapter 15
(l)	Consideration of all consequences on the environment, including direct and indirect effects.	Chapter 8 Chapter 9 Chapter 10 Chapter 11 Chapter 12

		Chapter 13 Chapter 14
(l)	Interrelationships and cumulative environmental impacts of the proposed action and other related actions.	Section 2.6
(l)	Secondary effects.	Chapter 11
(l)	Estimated population impacts.	Section 9.1.2 Section 9.1.5
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(m)	Poses long-terms risks to health and safety	Section 13.4
(n)	Unavoidable impacts.	Chapter 10
(n)	Use of non-renewable resources.	Chapter 10 Section 13.2
(n)	Irreversible curtailment of the range of beneficial uses of the environment.	Section 14.2
(n)	Possibility of environmental accidents.	Section 14.3
(l)	Rationale for proceeding with Proposed Action, notwithstanding adverse effects	Executive Summary Section 2.2 Section 4.2 Section 5.2 Section 6.2 Section 7.2 Chapter 10 Chapter 11 Chapter 12 Chapter 13 Chapter 14
(l)	Other public policies that offset adverse environmental effects of the Proposed Action	Chapter 12 Chapter 16
(l)	Ability of reasonable alternatives to achieve countervailing benefits to avoid adverse effects	Executive Summary Section 3.4 Section 4.4 Section 5.4 Section 6.4 Section 7.4 Section 7.6 Chapter 10
(l)	Description of mitigation measures in action plan to reduce significant, unavoidable, adverse impacts to insignificant levels and basis for considering these levels are acceptable	Chapter 8 Chapter 9 Chapter 10

		Chapter 11
(l)	Timing of each mitigation step to assuring mitigation	Chapter 8 Chapter 9 Chapter 10 Chapter 12
(n)	How unresolved issues will be resolved prior to commencement of Proposed Action	Executive Summary Chapter 15
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(p)	Reproductions of substantive comments and responses made during consultation	Appendix E
(p)	Agencies who were consulted and had no comment	Chapter 19 Chapter 20

1. EXECUTIVE SUMMARY

Waikīkī is a predominantly engineered shoreline. The beaches of Waikīkī are almost entirely composed of imported sand and the current shoreline configuration is largely the result of past efforts to widen and stabilize the beaches. The beaches of Waikīkī are chronically eroding, and the backshore (landward of the beach) is frequently flooded, particularly during high tide and high surf events. Over the past several years, Hawaiʻi has experienced record high tides (referred to as *King Tides*) that have exacerbated erosion and flooding in Waikīkī. These events have highlighted the impacts of sea level rise on the beaches of Waikīkī. As sea levels continue to rise, beach loss will progressively degrade the recreational, social, cultural, environmental, aesthetic, and economic value of Waikīkī.

Almost the entire length of Waikīkī is armored by seawalls, many of which are in various states of disrepair. As the beaches continue to erode and flooding occurs more frequently and extends further landward, processes that are likely to accelerate as sea levels continue to rise, the shoreline will migrate further landward. As the shoreline approaches the existing shoreline armoring, there will be incremental loss of recreational beach area and shoreline habitat, a process that is referred to as *coastal squeeze* (Lester and Matella, 2016). While it is possible that some sand may remain in front of the existing shoreline armoring, what remains of the beaches will be narrow, submerged, unstable, inaccessible, and unusable.

Without beach improvements and maintenance, sea level rise will cause substantial beach loss in Waikīkī. For discussion purposes in this Draft Programmatic Environmental Impact Statement (DPEIS), *beach loss* is defined as the loss of dry recreational beach area and lateral shoreline access during typical wave and tidal conditions.

Beach erosion threatens to diminish the economic viability of Waikīkī. A recent study found that the loss of Waikīkī Beach would result in an annual loss of $2.223 billion in visitor expenditures (Tarui et al. 2018). Beach improvements and maintenance actions are urgently needed to restore and maintain the beaches of Waikīkī to continue to support Hawaiʻi's tourism-based economy and preserve the recreational, social, cultural, environmental, aesthetic, and economic value of Waikīkī for future generations.

For discussion purposes in this DPEIS, *beach maintenance* refers to actions that involve using existing sand or adding sand with no new structures or modifications to existing structures. Beach maintenance options include beach nourishment, sand backpassing, sand pushing, and sand pumping. The proposed beach maintenance actions are intended to be conducted on a periodic basis and may be adapted as sea levels continue to rise. *Beach improvements* refer to actions that involve adding new sand, constructing new structures, and/or modifying existing structures. Beach improvement options include beach nourishment with stabilizing groins, segmented breakwaters, and modifications to existing structures. The proposed beach improvements actions are designed to account for 1.5 ft of sea level rise and may be adapted as sea levels continue to rise.

Beach maintenance actions are proposed in three beach sectors of Waikīkī:

- Fort DeRussy Beach Sector – Sand Backpassing
- Royal Hawaiian Beach Sector – Beach Nourishment without Stabilizing Structures
- Kūhiō Beach Sector: Diamond Head (east) Basin – Sand Pumping

Beach improvement actions are proposed in two beach sectors of Waikīkī:

- Halekūlani Beach Sector – Beach Nourishment with Stabilizing Groins
- Kūhiō Beach Sector: ʻEwa (west) Basin – Beach Nourishment with a Segmented Breakwater

The primary objectives of the proposed actions are to:

- Restore and improve Waikīkī's public beaches.
- Increase beach stability through improvement and maintenance of shoreline structures.
- Provide safe access to and along the shoreline.
- Increase resilience to coastal hazards and sea level rise.

The proposed actions were developed in collaboration with public and private stakeholders with the shared goal and vision of making the beaches of Waikīkī sustainable and resilient for current and future generations. Selection of the proposed beach improvement and maintenance actions was a primarily stakeholder-driven process. The project proponents relied heavily on feedback and direction from local stakeholders to identify issues, needs, priorities, and design criteria for beach sector.

Significant Beneficial Impacts

Improving and maintaining the beaches of Waikīkī will support existing uses and preserve the recreational, social, cultural, environmental, aesthetic, and economic value of Waikīkī. The proposed actions will also decrease vulnerability to coastal hazards, increase resilience to sea level rise, and have a substantial positive impact on the economies of the State of Hawaiʻi and City and County of Honolulu. The proposed actions are consistent with the existing environment and surrounding uses and will not fundamentally alter the character of Waikīkī. The proposed actions will not narrow or curtail the range of beneficial uses in the area.

Potential Adverse Impacts

The proposed actions have the potential to temporarily impact coastal processes, bathymetry, marine habitat and species, water quality, noise, and air quality. The proposed actions also have the potential to temporarily impact commercial operations, shoreline access, ocean recreation, scenic and aesthetic resources, and public services and infrastructure. These impacts are primarily associated with construction activities and are anticipated to be minor and temporary in nature. The potential adverse impacts of the proposed actions are countervailed by the beneficial impacts of preserving and enhancing the recreational, social, cultural, environmental, and aesthetic value of Waikīkī.

Proposed Mitigation Measures

Best Management Practices (BMPs) will be utilized to mitigate or minimize potential impacts to the maximum extent practicable.

Alternatives Considered

A variety of alternatives were evaluated during the project selection and conceptual design process. These alternatives include No Action, Managed Retreat, Repair, Modification, Replacement, or Removal of Existing Structures, Beach Maintenance, and Beach Nourishment With or Without Stabilizing Structures. Selection of the proposed beach improvement and maintenance actions was a primarily stakeholder-driven process. The project proponents relied heavily on feedback and direction from the Waikīkī Beach Community Advisory Committee (WBCAC) to identify issues, needs, priorities, and design criteria for beach sector.

Unresolved Issues

Project Phasing

The proposed beach maintenance actions are intended to be conducted on a periodic basis and may be adapted as sea levels continue to rise. The proposed beach improvement actions are designed to be implemented in phases, with the initial phase being designed for approximately 1.5 ft of sea level rise, thus in 25 to 30 years following construction it may be necessary to raise the project elevations. If then raised by several feet, the projects could be effective until about the year 2080, or 50-years post-construction. Sea level rise projections continue to evolve as new and improved sea level and climate change research becomes available. It is also important to recognize that global sea level rise will not stop within these timeframes but will very likely continue for centuries. As a result, there is uncertainty regarding precisely when and the degree to which the designs will need to be adapted. As sea levels continue to rise, additional beach improvement and maintenance actions may be required in the other beach sectors of Waikīkī. –

Sand Recovery

The offshore sand deposits that will be used to support the proposed beach improvement actions in the Halekūlani beach sector and Kūhiō beach sector ʻEwa (west) basin have yet to be confirmed. The dredging methods to recovery the offshore sand and transport it to the shoreline for placement have also not been confirmed. These determinations will be made based on feedback obtained during the public review of the DPEIS and will be confirmed during the final design and permitting process.

Costs and Funding

The costs for construction for the proposed beach improvement and maintenance actions has yet to be confirmed. Initial construction costs, recurring maintenance costs, and future adaptation costs will depend on a variety of factors including but not limited to the selected offshore sand deposits, sand recovery and transport methodologies, project phasing, maintenance intervals, the timing and scope of structural adaptations, damage due to unpredictable design wave events (e.g., hurricanes, tsunamis), and inflation/deflation over the life of the program.

Monitoring

The monitoring and assessment plans for the proposed actions include beach profile monitoring, water quality monitoring, and marine biological monitoring (see Chapter 12). At this time, it is unclear if any additional monitoring will be required. Monitoring requirements will be confirmed during the final design and permitting process.

Required Permits and Approvals

Due to recent statutory changes and ongoing policy changes, there is uncertainty in terms of the permits and approvals that will be required for the proposed actions. Regulatory requirements will be confirmed during the final design and permitting process.

Existing Structures

The proposed actions were developed as mandated in Governor David Ige's August 2018 directive to include a sea level rise analysis in Environmental Impact Statements. The proposed actions will be located primarily on submerged lands makai (seaward) of the shoreline; however, some aspects of the proposed actions (e.g., laydown and staging areas) may extend mauka (landward) of the shoreline. The existing seawalls that span nearly the entire length of the Waikīkī shoreline are privately-owned structures and are located outside of the Conservation District. During the final design phase, it may be determined that the existing seawalls may need to be modified to accommodate increased beach elevation. The seawalls may also need to be modified or replaced to accommodate a beach walkway in the Halekūlani beach sector. The seawalls are privately-owned structures and are located outside of the Conservation District. The DLNR does not regulate land uses mauka (landward) of the shoreline.

Compatibility with Existing Land Use Plans and Policies

The proposed actions are compatible with the following land use plans and policies:

- Coastal Zone Management Act of 1972 (16 USC §§1451-1464)
- Hawaiʻi Administration Rules §13-5 Conservation District
- Hawaiʻi State Plan (Hawaiʻi Revised Statutes Chapter 226)
- Conservation Lands State Functional Plan (1991)
- Recreation State Functional Plan (1991)
- Hawaiʻi State Tourism Function Plan (1991)
- General Plan for the City and County of Honolulu
- Primary Urban Center Development Plan
- Oʻahu Resilience Strategy
- Chapter 23, Revised Ordinances of Honolulu (Shoreline Setbacks)
- Chapter 25, Revised Ordinances of Honolulu (Special Management Area)

Required Permits and Approvals

The primary Federal approvals required for the proposed actions are:

- Section 10, Rivers and Harbors Act (U.S. Army Corps of Engineers)
- Section 404, Clean Water Act (U.S. Army Corps of Engineers)

Other Federal laws that may affect the proposed actions include:

- Archaeological and Historic Preservation Act (16 USC § 469a-1)
- National Historic Preservation Act of 1966 (16 USC § 470(f))
- Native American Graves Protection and Repatriation Act of 1990 (25 USC § 3001)
- Clean Air Act (42 USC § 7506(C))
- Coastal Zone Management Act (16 USC § 1456(C) (1))
- Endangered Species Act (16 U.S.C. 1536(A) (2) and (4))
- Fish and Wildlife Coordination Act 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 of 1972, as amended (16 USC §§ 1361-1421(H) et seq.)
- EO 13089, Coral Reef Protection (63 FR 32701)
- Migratory Bird Treaty Act of 1918, as amended (16 USC §§ 703-712)

The primary State of Hawaiʻi approvals required for the proposed actions are:

- Conservation District Use Permit – Hawaiʻi Department of Land and Natural Resources
- Small-scale Beach Nourishment Permit – Hawaiʻi Department of Land and Natural Resources
- Small-scale Beach Restoration Permit – Hawaiʻi Department of Land and Natural Resources
- Shoreline Certification – Hawaiʻi Department of Land and Natural Resources
- Right of Entry Permit – Hawaiʻi Department of Land and Natural Resources
- Section 401 Water Quality Certification – Hawaiʻi Department of Health
- National Pollutant Discharge Elimination System – Hawaiʻi Department of Health
- Community Noise Permit – Hawaiʻi Department of Health
- Coastal Zone Management Consistency Review – Hawaiʻi Department of Business, Economic Development, and Tourism, Office of Planning

The primary City and County of Honolulu approvals required for the proposed actions are:

- Special Management Area Permit
- Shoreline Setback Variance
- Grubbing, Grading and Stockpiling Permit
- Building Permit

Relevant EAs and EISs Considered in the Analysis of the Preparation of the DPEIS.

- *Environmental Assessment for Fort DeRussy Beach Restoration*: *Waikīkī, Oʻahu, Hawaiʻi*. Prepared by United States Army Corps of Engineers, Honolulu District. (December 1993).
- *Environmental Assessment/Environmental Impact Statement Preparation Notice for Gray's Beach Restoration Project*: *Waikīkī, Oʻahu, Hawaiʻi*. Prepared by Planning Solutions and Sea Engineering, Inc. (August 2008).
- *Final Environmental Assessment for Waikīkī Beach Maintenance*: *Waikīkī, Oʻahu, Hawaiʻi*. Prepared by Sea Engineering, Inc. (June 2010).
- *Final Environmental Assessment for Iroquois Point Beach Nourishment and Stabilization: ʻEwa Beach, Oʻahu, Hawaiʻi*. Prepared by Sea Engineering, Inc. (January 2012).
- *Final Environmental Assessment for Royal Hawaiian Groin Replacement Project*: *Waikīkī, Oʻahu, Hawaiʻi*. Prepared by Sea Engineering, Inc. (May 2016).
- *Draft Environmental Assessment for Waikīkī (Queen's Surf) Seawall Mitigative Improvements*: *Waikīkī, Oʻahu, Hawaiʻi*. Prepared by Oceanit, Inc. (June 2017).
- *Final Environmental Impact Statement for Ala Moana Regional Park and Magic Island Improvements*: *Honolulu, Oʻahu, Hawaiʻi*. Prepared by Belt Collins. (June 2018).
- *Final Environmental Impact Statement for the Waikīkī War Memorial Complex*: *Waikīkī, Oʻahu, Hawaiʻi*. Prepared by AECOM Technical Services, Inc. (October 2019).
- *Draft Environmental Impact Statement for Kāʻanapali Beach Restoration and Berm Enhancement*. Prepared by Sea Engineering, Inc. (August 2020).

2. INTRODUCTION

2.1 Project Area Description

Waikīkī Beach extends along the shoreline of Mamala Bay on the south shore of the island of Oʻahu, Hawaiʻi (Figure 2-1 and Figure 2-2). The Waikīkī shoreline originally consisted of a narrow barrier beach backed by wetlands, duck ponds, taro farms, and fishponds. In the late 1800s, the first tourist attractions were established in Waikīkī. Development of beachfront hotels such as the Sans Souci, Moana Surfrider, and Honolulu Seaside soon followed.

In 1881, Long Branch Baths bathhouse was built on the beach at the water's edge, near the present-day Moana Surfrider Hotel (Wiegel, 2008). The bathhouse serviced visitors by providing changing rooms, towels, swimsuits, and access to the beach, all for a fee, which caught the attention of Waikīkī businessmen and developers (Miller and Fletcher, 2003).

In 1890, a seawall was constructed to protect Waikīkī Road (now Kalākaua Avenue) at the entrance to Kapiʻolani Park. In 1901, the Moana Hotel (now Moana Surfrider Hotel) opened with a restaurant on piles over the beach and water (Wiegel, 2008; Cohen, 2000). Seawalls rapidly proliferated and their adverse impacts on the sandy shoreline were immediately apparent.

In the early 1900s, the wetland areas were declared a public health hazard, and the government decided to dredge the Ala Wai Canal to drain the wetlands and use the dredge material to fill in the low-lying areas (Miller and Fletcher, 2003). In the early 1900s, much of the beach at Waikīkī disappeared under structures and landscaping, and significant volumes of sand were reportedly removed from the beach and adjacent backshore area (Wiegel, 2008). In later years, sand was imported into Waikīkī to increase beach width, and numerous shore perpendicular and shore parallel channels were dredged in the reef for navigation, ocean recreation, and fill material to increase the width of the historically narrow beaches.

In 1917, the Hawaiʻi Board of Harbor Commissioners prohibited construction of seawalls along the shoreline; however, the prohibition was widely ignored. A total of 37 seawalls were constructed in Waikīkī, and by about 1920 seawalls lined most of Waikīkī Beach (Crane, 1972; Miller and Fletcher, 2003; Wiegel, 2008).

A 1926 investigation of Waikīkī Beach by the Engineering Association of Hawaiʻi concluded that seawalls were the primary cause of beach erosion and that beach nourishment and groins could be used to rebuild the beach (Gerritsen, 1978; Miller and Fletcher, 2003). A total of 42 groins or groin-like structures have been constructed in Waikīkī. Only the larger groins have been effective in stabilizing the beach. Most of the smaller groins are deteriorated or have been removed (Crane, 1972). 8 groins remain functional today. These groins compartmentalize the beaches of Waikīkī into discrete sectors that are similar to littoral cells (see Section 2.5).

In 1928, the Waikīkī Beach Reclamation agreement was established between the Territory of Hawaiʻi and various property owners in Waikīkī. The agreement recognized the need to control and limit seaward development on Waikīkī Beach and established limitations on construction along the beach in response to the proliferation of seawalls and groins in Waikīkī. The agreement provided that the Territory of Hawaiʻi would build a beach seaward from the existing high water mark and that title of the newly created beach would be vested by the abutting landowners. The Territory of Hawaiʻi and private landowners further agreed that no new structures would be built on the beach in Waikīkī. The private landowners agreed to provide a 75-ft-wide public easement along the beach inshore of the new mean high water mark.

The 1928 agreement covers the Waikīkī beach area from the Ala Wai Canal to the Elks Club at Diamond Head. The 1928 agreement consists of a) the October 19, 1928 main agreement between the Territory and Waikīkī landowners, b) the October 19, 1928 main agreement between the Territory and the Estate of Bernice Pauahi Bishop, and c) the July 5, 1929 Supplemental Agreement between the Territory and Waikīkī landowners. The area between the Royal Hawaiian Hotel and the Moana Surfrider Hotel is the subject of a separate agreement between the State of Hawaiʻi and the subject Waikīkī landowners established on May 28, 1965.

From about 1930 until the late 1970s, it is estimated that over 400,000 cy of sand was placed on Waikīkī Beach, from a variety of sources including other beaches on Oʻahu and Molokaʻi, backshore dune deposits, and crushed coralline limestone. Between 1925 and 2001, the Waikīkī shoreline moved about 40 ft seaward, reflecting the extensive human alteration of the shoreline (Miller and Fletcher, 2003). Despite past beach nourishment efforts, Miller and Fletcher (2003) estimate that, between 1951 and 2001, at least 100,000 cy of sand has been lost to erosion.

TOPOGRAPHIC MAP
Waikīkī Beach Improvement and Maintenance Program
Draft Programmatic Environmental Impact Statement
Honolulu, Oʻahu, Hawaiʻi

Figure 2-1 Topographic map of Waikīkī (USGS)

Figure 2-2 Overview map of Waikīkī

2.2 Purpose and Need for the Program

Waikīkī is a predominantly engineered shoreline. Almost the entire length of Waikīkī is armored by seawalls that were constructed in the early 1900s, many of which are in various states of disrepair. The beaches of Waikīkī are primarily man-made and composed almost entirely of sand that has been imported from various terrestrial sources, other beaches, and dredged from offshore deposits. Beach stability is largely dependent on the presence of numerous groins, breakwaters, and other structures that stabilize the sand along the shoreline.

Waikīkī is recognized as Hawaii's primary visitor destination and is home to more than 30,000 visitor accommodation units including resorts, hotels, and condominiums, which accounts for 90% of all units on Oʻahu and nearly half of all units in the State of Hawaiʻi (HTA, 2018). In 2002, tourism-related activities in Waikīkī accounted for an estimated $3.6 billion, which was 8% of Hawaii's Gross State Product. In addition, 12% of all State and County tax revenues and 10% of all civilian jobs statewide can be credited to Waikīkī's attraction of visitors (DBEDT, 2003). In 2015, Waikīkī generated 41% of the state's visitor industry activity and contributed 7% to Hawaii's Gross State Product (State of Hawaiʻi, 2015; Porro, 2020).

The beaches of Waikīkī have tremendous historical, cultural, and recreational value and are the primary amenity that supports the tourism-based economies of Waikīkī, the City and County of Honolulu, and the State of Hawaiʻi. Hospitality Advisors LLC (2008) found that more than 90% of visitors considered beach availability in Waikīkī as very important or somewhat important.

Erosion is a serious threat to beach-related tourism and public shoreline access (USACE, 1994). Beach loss results in a variety of negative economic, social, cultural, environmental, recreational, and aesthetic impacts. These impacts highlight the need for sustained long-term capital improvements and comprehensive beach management to sustain the unique qualities and values of Waikīkī Beach. Many of Hawaii's sandy beaches are suffering from erosion. Fletcher et al. (2012) found that 70% of beaches in Hawaiʻi are undergoing chronic (long-term) erosion and over 10% (13 miles) of Hawaii's beaches have been completely lost to erosion over the past century. The Island of Oʻahu has 66.5 miles of sandy beaches, approximately 60% of which are experiencing erosion (Fletcher et al. 2011).

Sea level rise has emerged as a serious threat to the beaches of Waikīkī. The earth is experiencing climatic changes that are unprecedented in modern history. The earth and oceans are rapidly warming, and one inexorable result of this is an accelerating rise in global mean sea level as seawater expands and as glaciers and ice sheets melt. Vousdoukas et al. (2020) found that a substantial proportion of the world's sandy coastlines are eroding, and that sea level rise could result in the near extinction of 35.7 to 49.5% of the world's sandy beaches by the end of the century. Hawaiʻi is uniquely vulnerable to sea level rise due to a combination of our geography, topography, wave climate, and coastal development patterns. Erosion and beach loss in Hawaiʻi are expected to increase significantly as rates of sea level rise increase. Anderson et al. (2015) found that, due to sea level rise, the average shoreline recession in Hawaiʻi by 2050 is projected to be nearly twice the historical rates, and nearly 2.5 times the historical rates by 2100.

The *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* (2017) found that 3.2 ft of sea level rise will have profound impacts on Oʻahu. $12.9 billion in structures and land could be lost; 3,800 structures could be flooded, including hotels and resorts in Waikīkī; over 13,000 residents could be displaced; and nearly 18 miles of major roads could be flooded. The 2017 report estimates that, due to the density of development and economic assets, Oʻahu will account for an estimated 66% of the total statewide economic losses due to sea level rise. The State of Hawaiʻi recommended that private and public entities in Waikīkī should begin planning for sea level rise adaptation, including beach restoration, to prepare for higher sea levels in the future.

The beaches of Waikīkī are chronically eroding, and the backshore is frequently flooded, particularly during high tides and high surf events. The beaches of Waikīkī are critical infrastructure and the primary amenity that has established Waikīkī as a world-class tourism destination. Complete erosion of Waikīkī Beach would result in an annual loss of $2.223 billion in visitor expenditures (Tarui et al. 2018). Despite being such a critical component of Hawaii's tourism-based economy, relatively little has been spent on improving and maintaining the beaches of Waikīkī. From 2006 to 2021, approximately $10 million dollars has been invested in beach improvement projects in Waikīkī. In 2019, the Hawaiʻi State Legislature appropriated $8.85 million to support beach improvement and maintenance projects in Waikīkī with up to $3 million of this support provided by the Waikīkī Beach Special Improvement Distract Association (WBSIDA).

The Oʻahu Resilience Strategy prepared by the City and County of Honolulu Office of Climate Change, Sustainability and Resiliency (2019) defines resilience as "the ability to survive, adapt and thrive regardless of what shocks or stresses come our way." Healthy, stable beaches provide a first line of defense against coastal flooding and inundation by rising sea levels and hurricane storm waves. Beach improvements are necessary to ensure that the beaches and economy of Waikīkī are sustainable and resilient to sea level rise. The proposed actions directly support the recommendations and goals of the State of Hawaiʻi and City and County of Honolulu to increase resilience to sea level rise.

2.3 Objectives of the Proposed Actions

The beaches of Waikīkī are chronically eroding, and the backshore is frequently flooded, particularly during high tides and high surf events. The loss of Waikīkī Beach would result in a loss of $2.223 billion in in visitor expenditures (Tarui et al. 2018). Improvements and maintenance are necessary to restore and maintain the beaches of Waikīkī to continue to support Hawaii's tourism-based economy and preserve the recreational, social, cultural, environmental, and aesthetic value of Waikīkī for future generations.

For discussion purposes in this DPEIS, *beach maintenance* refers to actions that involve using existing sand or adding sand with no new structures or modifications to existing structures. Beach maintenance options include beach nourishment, sand backpassing, sand pushing, and sand pumping. *Beach improvements* refer to actions that involve adding new sand, constructing new structures, and/or modifying existing structures. Beach improvement options include beach nourishment with stabilizing groins, segmented breakwaters, and modifications to existing structures.

Beach maintenance actions are proposed in three beach sectors of Waikīkī:

- Fort DeRussy Beach Sector – Sand Backpassing
- Royal Hawaiian Beach Sector – Beach Nourishment without Stabilizing Structures
- Kūhiō Beach Sector: Diamond Head (east) Basin – Sand Pumping

The proposed beach maintenance actions are being intended to be implemented periodically on an as-needed basis. Beach maintenance would be conducted when beach conditions reach some pre-defined topographic triggers. Beach monitoring would be required to determine when the triggers have been met. The proposed beach maintenance actions are not designed to account for sea level rise.

Beach improvement actions are proposed in two beach sectors of Waikīkī:

- Halekūlani Beach Sector – Beach Nourishment with Stabilizing Groins
- Kūhiō Beach Sector: ʻEwa (west) Basin – Beach Nourishment with a Segmented Breakwater

The proposed beach improvement actions are designed to be implemented in phases, with the initial phase being designed for approximately 1.5 ft of sea level rise, thus in 25 to 30 years following construction it may be necessary to raise the project elevations. If then raised by several feet, the projects could be effective until about the year 2080, or 50-years post-construction. It is important to note that sea level rise projections continue to evolve as new and improved sea level and climate change research becomes available. It is also important to recognize that global sea level rise will not stop within these timeframes but will very likely continue for centuries.

The primary objectives of the proposed beach improvement and maintenance actions are to:

- Restore and improve the beaches of Waikīkī.
- Increase beach stability through improvement and maintenance of shoreline structures.
- Provide safe access to and along the shoreline.
- Increase resilience to coastal hazards and sea level rise.

2.4 Project Stakeholders and Proponents

The actions proposed for implementation in Waikīkī will be undertaken by the State of Hawaiʻi Department of Land and Natural Resources (DLNR), which is responsible for overseeing beaches and submerged lands out to the seaward extent of the State's jurisdiction. The proposed actions were developed in collaboration with public and private stakeholders with the shared goal and vision of improving the beaches of Waikīkī for current and future generations.

Project coordination and implementation is being done in collaboration with the Waikīkī Beach Special Improvement District Association (WBSIDA), which is a private non-profit organization that was created in 2015 by City ordinance to preserve and restore Waikīkī Beach, and to serve as a cost-share partner in a public-private partnership with the DLNR. The WBSIDA is governed by a Board of Directors that consists of representatives of Waikīkī's major resorts, property owners, State and County government designees, and other stakeholders. The WBSIDA provides a mechanism for coordination of the proposed actions with a broad spectrum of Waikīkī stakeholders and securing private funding to support project implementation.

The proposed actions were developed in close collaboration with the Waikīkī Beach Community Advisory Committee (WBCAC), which was formed in 2017 to provide a forum to engage stakeholders and provide guidance and feedback on design criteria and rationale for beach improvement and maintenance projects in Waikīkī. The WBCAC is composed of various stakeholders representing business (34%), government (30%), hotels and resorts (15%), non-profit organizations (12%), and science and engineering (9%). The WBCAC serves as a representative body to communicate the diversity of perspectives and priorities in the broader Waikīkī community, provide guidance and feedback for beach management and planning activities in Waikīkī, and ensure that future beach management projects address the issues and concerns of the Waikīkī community and local stakeholders.

The WBCAC has and continues to serve a vital role in the planning process that led to the selection of the proposed actions. The WBCAC was directly involved in determining the priorities and objectives for each beach sector, establishing planning and design criteria, evaluating conceptual options, and providing feedback on the conceptual designs for the proposed actions. The function of the WBCAC is further enhanced by the role of the University of Hawaiʻi Sea Grant Program's Waikīkī Beach Management Coordinator, which provides technical support, education and outreach, and project coordination. The WBCAC held six (6) formal meetings from 2017 to 2021. The meeting agendas and outcomes are included as Appendix A. The WBCAC will continue to provide feedback on the proposed actions throughout the environmental review, final design, and permitting processes.

2.5 Waikīkī Beach Sectors

Waikīkī is a predominantly engineered shoreline, and the beach is almost entirely composed of imported sand. Almost the entire length of Waikīkī is armored by seawalls, many of which are in various states of disrepair. The beaches of Waikīkī are primarily man-made and are largely dependent upon the presence of groins that stabilize the sand. The groins compartmentalize the Waikīkī shoreline into discrete units that are semi-contained with limited sediment transport between adjacent sectors. For the purposes of this DPEIS, the Waikīkī shoreline is divided into eight discrete *beach sectors* that have unique physical characteristics.

The *beach sectors* are similar to *littoral cells,* which are defined as coastal compartments that contain a complete cycle of sedimentation including sources, transport paths, and sinks (Inman, 2005). The cell boundaries delineate the geographical area within which the budget of sediment is balanced, providing the framework for the quantitative analysis of coastal erosion and accretion. The sediment sources are commonly streams, sea cliff erosion, onshore migration of sand banks, and material of biological origin such as shells, coral fragments, and skeletons of small marine organisms”.

The natural shoreline of Waikīkī pre-development consisted of combination of pocket beaches, streams, and wetlands. It is possible that Mamala Bay was originally a single littoral cell, bounded on the east by Diamond Head, and on the west by Kalaeloa (Barbers Point). The shoreline of Waikīkī has been engineered and significantly modified over the past century, when streams were diverted, wetlands were filled, shoreline structures (e.g., seawalls, storm drains, groins, and breakwaters) were constructed, and sand beaches were built. The present-day shoreline of Waikīkī is compartmentalized by engineered structures, many of which were constructed with the specific intent of stabilizing the beaches. For the purposes of this DPEIS, these compartments are referred to as *beach sectors*. The beach sectors are shown in Figure 2-3 and summarized below (from west to east).

- ***Duke Kahanamoku (Hilton) Beach*** consists of approximately, 1,100 ft of shoreline extending from a rubblemound breakwater to the Hilton pier/groin.

- ***Fort DeRussy Beach*** consists of approximately, 1,680 ft of shoreline extending from the Hilton pier/groin to the Fort DeRussy outfall/groin.

- ***Halekūlani Beach*** consists of approximately 1,450 ft of shoreline extending from the Fort DeRussy outfall/groin to the Royal Hawaiian groin.

- ***Royal Hawaiian Beach*** consists of approximately 1,730 ft of shoreline extending from the Royal Hawaiian groin to the ʻEwa (west) groin at Kūhiō Beach Park

- ***Kūhiō Beach*** consists of approximately 1,500 ft of shoreline extending from the ʻEwa (west) groin at Kūhiō Beach Park to the Kapahulu storm drain/groin.

- ***Queen’s Beach*** consists of approximately 1,050 ft of shoreline extending from the Kapahulu storm drain/groin to the Queen’s Surf groin.

- ***Kapiʻolani Beach*** consists of approximately 1,250 ft of shoreline extending from the Queen’s Surf groin to the north wall of the Waikīkī Natatorium War Memorial.

- ***Kaimana (Sans Souci) Beach*** consists of approximately 500 ft of shoreline extending from the north wall of the Waikīkī Natatorium War Memorial to the groin fronting the New Otani (Kaimana) Hotel.

The relative independence of the beach sectors allows for improvements to be made incrementally, rather than all at once. This will allow for prioritization, funding, final design, permitting, and construction to be phased over time, while limiting impacts to one sector at a time.

2.6 Sectors Selected for Beach Improvement and Maintenance Actions

Selection of the proposed beach improvement and maintenance actions was a primarily stakeholder-driven process. The project proponents relied heavily on feedback and direction from the WBCAC to identify issues, needs, priorities, and design criteria for beach sector. Four beach sectors were identified as being the highest priorities for beach improvements and maintenance (Figure 2-4): Fort DeRussy, Halekūlani, Royal Hawaiian, and Kūhiō.

While the other beach sectors of Waikīkī – Duke Kahanamoku, Queens, Kapiʻolani, and Kaimana - were not selected for beach improvement and maintenance actions, these areas are clearly important and, as sea levels continue to rise, additional actions may be necessary in these beach sectors in the future. For additional information about the WBCAC and the project selection process, see Appendix A.

The proposed actions are intended to compliment recent efforts to improve the condition and stability of the beaches in Waikīkī including:

- Waikīkī Beach Maintenance I (completed May 2012)
- Waikīkī Beach Management Plan (completed May 2018)
- Kūhiō Sandbag Groin (completed November 2019)
- Royal Hawaiian Groin Replacement (completed August 2020)
- Waikīkī Beach Maintenance II (completed May 2021)

Waikīkī Beach Maintenance I

In 2012, the DLNR conducted the Waikīkī Beach Maintenance I project. Approximately 24,000 cy of sand was dredged from an offshore sand deposit near the *Canoes* and *Queens* surf breaks. Sand recovery was accomplished with the use of a Toyo DB 75B 8-inch pump with ring jet attachment suspended from an 80-ton capacity crawler crane on a barge. The average rate of sand recovery was approximately 500 cy per day. The sand discharge pipeline was an 8-inch high-density polyethylene (HDPE) pipe with a total length of 3,200 ft. Sand was pumped into a dewatering basin that was constructed in the Diamond Head (east) basin of Kūhiō Beach Park. The dewatering basin measured approximately 100 ft wide and 400 ft long. Sand was pushed into large piles with an excavator and bulldozer and then transported by dump trucks to the sand placement area on Royal Hawaiian Beach. The project widened the beach by an average of 37 ft, which aligned with the position of the shoreline in 1985. The project was completed in June 2012 (Figure 2-5 and Figure 2-6). The permits included a second nourishment effort approximately 10 years after the initial nourishment.

Beach monitoring following the 2012 Waikīkī Beach Maintenance I project showed continued erosion and beach recession at the east and west ends of the Royal Hawaiian beach sector. Habel (2016) found that beach recession ranged from 5.2 to 9.5 ft/yr at the east end fronting the beach concessions. This erosion exposed the old concrete foundation of the Waikīkī Tavern, creating a hazardous condition for beach users, and has resulted in damage and flanking of the Kūhiō

Beach ʻEwa (west) groin. In January 2018, the City and County of Honolulu funded construction of a temporary erosion control structure built of sand-filled geotextile mattresses to cover the tavern foundation and prevent erosion of terrigenous sediment from the backshore.

Waikīkī Beach Management Plan

The WBSIDA provides a unique opportunity for public-private partnerships to support policy, planning, research and scientific studies in Waikīkī Beach and the Ala Wai Canal. The WBSIDA has provided leadership, coordination and cost sharing that has improved the ability of State and local stakeholders to secure funding for beach improvement and maintenance projects in Waikīkī. The WBSIDA has also taken a lead role in facilitating, coordinating, and supporting beach improvement projects in Waikīkī.

The WBSIDA, in partnership with the University of Hawaiʻi Sea Grant Program, has developed the Waikīkī Beach Management Plan, which provides a management framework and strategies to ensure that prioritized beach improvement and maintenance projects are consistent with vision, goals, and expectations of the broader Waikīkī community. The primary goal of the plan is to improve the quality, sustainability, and stability of the public beaches and nearshore resources in Waikīkī. The Waikīkī Beach Management Plan is part of a broader environmental initiative, *Hoʻomau ʻO Waikīkī Kahakai*, which serves as a guiding principle for the community visioning process for beach management, improvement, and maintenance projects in Waikīkī.

The Waikīkī Beach Management Plan was completed in May 2018, approved by the WBSIDA Board of Directors and the Association members, and submitted to the Honolulu City Council as part of the 2017-18 Annual Report to the Council. The Waikīkī Beach Management Plan is intended to support and compliment the beach improvement and maintenance actions proposed in this DPEIS.

Kūhiō Sandbag Groin

Beach monitoring following the 2012 Waikīkī Beach Maintenance I project showed continued erosion and beach recession at the east and west ends of the Royal Hawaiian beach sector. Habel (2016) found that beach recession ranged from 5.2 to 9.5 ft/yr at the east end fronting the beach concessions. This erosion exposed the old concrete foundation of the Waikīkī Tavern, creating a hazardous condition for beach users, and has resulted in damage and flanking of the Kūhiō Beach ʻEwa (west) groin.

A sandbag groin was placed 140 ft west of the existing ʻEwa (west) groin of Kūhiō Beach Park. The purpose of the groin is to stabilize the east end of Royal Hawaiian Beach and cover the remnants of the concrete foundation of the Waikīkī Tavern with sand. The designed 95-ft groin length was the minimum length necessary to ensure adequate beach width to keep the concrete rubble covered. At the time of construction, the groin was extended 16 ft on the inshore end to address additional beach erosion.

The Kūhiō Sandbag Groin was completed in November 2019 (Figure 2-7 and Figure 2-8). The groin consists of 83 ElcoRock containers and 275 cy of sand to fill the containers. Each sand container holds 2.5 m^3 of sand and weighs over 10,000 lbs when full. The non-woven geotextile fabric is UV and puncture resistant, has excellent abrasion resistance, and its soft finish is attractive and non-abrasive. Approximately 750 cy of sand was excavated from Kūhiō Beach park and placed to cover the concrete rubble and fill the cell between groins to its design shape.

The University of Hawaiʻi Coastal Geology Group (UHCGG) has and is continuing to conduct periodic monitoring of the Kūhiō Sandbag Groin. Initial findings based on approximately one year of survey data indicate that the groin is functioning as intended. The efficacy of the groin is evident by significant sand accumulation on the Diamond Head (east) side of the structure throughout the year, indicating that longshore sediment transport was altered as intended to mitigate extreme erosion along this section of beach. Sediment capture by the groin has not resulted in significant erosion on the ʻEwa (west) side of the structure, which would be evidenced by sediment depletion and flanking directly adjacent to the structure. Overall, one year following completion, the structural integrity and efficacy of the groin structure has been confirmed. No adverse effects of the project have been observed. No significant deficiencies with the ElcoRock sandbags and/or the overall groin performance have been observed.

Royal Hawaiian Groin Replacement

As of 2020, the original Royal Hawaiian groin was in an extremely deteriorated condition. Its failure could have destabilized 1,730 ft of sandy shoreline east of the groin in the Royal Hawaiian beach sector. The Hawaiʻi Department of Land and Natural Resources (DLNR) initiated design and construction of a new groin to replace the original Royal Hawaiian groin. The objective of the project was to reinforce the existing groin to stabilize the beach on the Diamond Head (east) side of the groin so that it could provide its intended recreational and aesthetic benefits. The new groin was designed to maintain the approximate beach width of the 2012 Waikīkī Beach Maintenance I project.

Replacement of the Royal Hawaiian groin was completed in August 2020 (Figure 2-9 and Figure 2-10). The new groin was constructed along the alignment of the original groin and incorporated a portion of the original groin as a core wall to prevent sand movement through the groin. The new groin is of rock rubblemound construction and incorporates a cast-in-place concrete crown wall. The new groin extends 125 ft from the seawall fronting the Sheraton Waikiki Hotel, and then angles to the southeast to create a 50-ft-long L-head, for a total crest length of 175 ft. The new groin was constructed of a single layer of keyed and fit 3,200 to 5,400 lb armor stone over 300 to 600 lb underlayer stone and 30 to 100 lb core stone.

Following stone placement, a 5-ft wide by 5-ft-thick concrete crown wall was constructed to stabilize the crest and provide a foundation should a future increase in crest elevation be necessary to accommodate sea level rise. The concrete crown wall elevation is +9 ft MSL for its first 40 ft, then transitions down to +6 ft MSL on a 1V:8H (vertical to horizontal) slope, then remains at +6 ft MSL for the remainder of its length. The stone crest elevation is +7 ft MSL for the first 40 ft and then transitions down to +4 ft MSL for the remainder of the groin length. The existing concrete block groin was reduced in elevation to a maximum elevation of +4 to +1 ft MSL to facilitate construction of the new groin. Approximately 40 ft of the original groin, beginning at about 120 ft from shore, was removed to construct the transition to the L-head portion of the new groin. The remainder of the original groin, seaward of the new groin head, was left in place. Initial observations indicate that the groin is performing its primary function to stabilize the beach on the Diamond Head (east) side of the groin. The beach in this area is currently wider than it was pre-construction, and the shoreline has naturally taken the arc-shape anticipated from the groin design.

Waikīkī Beach Maintenance II

The permits for the 2012 Waikīkī Beach Maintenance I project authorized a second nourishment effort to be performed within 10 years. The project consisted of recovery of approximately 20,000 cy of sand from the same offshore sand deposit that was used in the 2012 project. Sand was pumped into a dewatering basin in the Diamond Head (east) basin of Kūhiō Beach Park. The dewatering basin was approximately 100 ft wide and 300 ft long. Sand was pushed into large piles with an excavator and bulldozer and then transported by dump trucks to the sand placement area on Royal Hawaiian Beach. The project was completed in May 2021 (Figure 2-11 and Figure 2-12).

Related Projects in The Area

The City and County of Honolulu (City) is proposing improvements to the deteriorated Waikīkī Natatorium War Memorial Complex (WMMC). The City proposes to rehabilitate the WMMC by demolishing the submerged structures and reconstructing the deck on support piles to allow free flow of water between the ocean and a swim basin. A Final Environmental Impact Statement (FEIS) for the proposed action was approved on November 23, 2019.

The City is also proposing improvements to the deteriorated seawall fronting the Queen’s beach sector. The seawall is deteriorated and has been damaged by wave action. The City proposes to repair or reconstruct the seawall. A Draft Environmental Assessment (DEA) for the proposed action was published on June 8, 2017.

These projects are unrelated to the Waikīkī Beach Improvement and Maintenance Program as they are located outside of the project area and are not intended to improve the condition of the beaches or improve lateral shoreline access. These projects are not anticipated to have any direct or secondary effects on the actions proposed in this DPEIS.

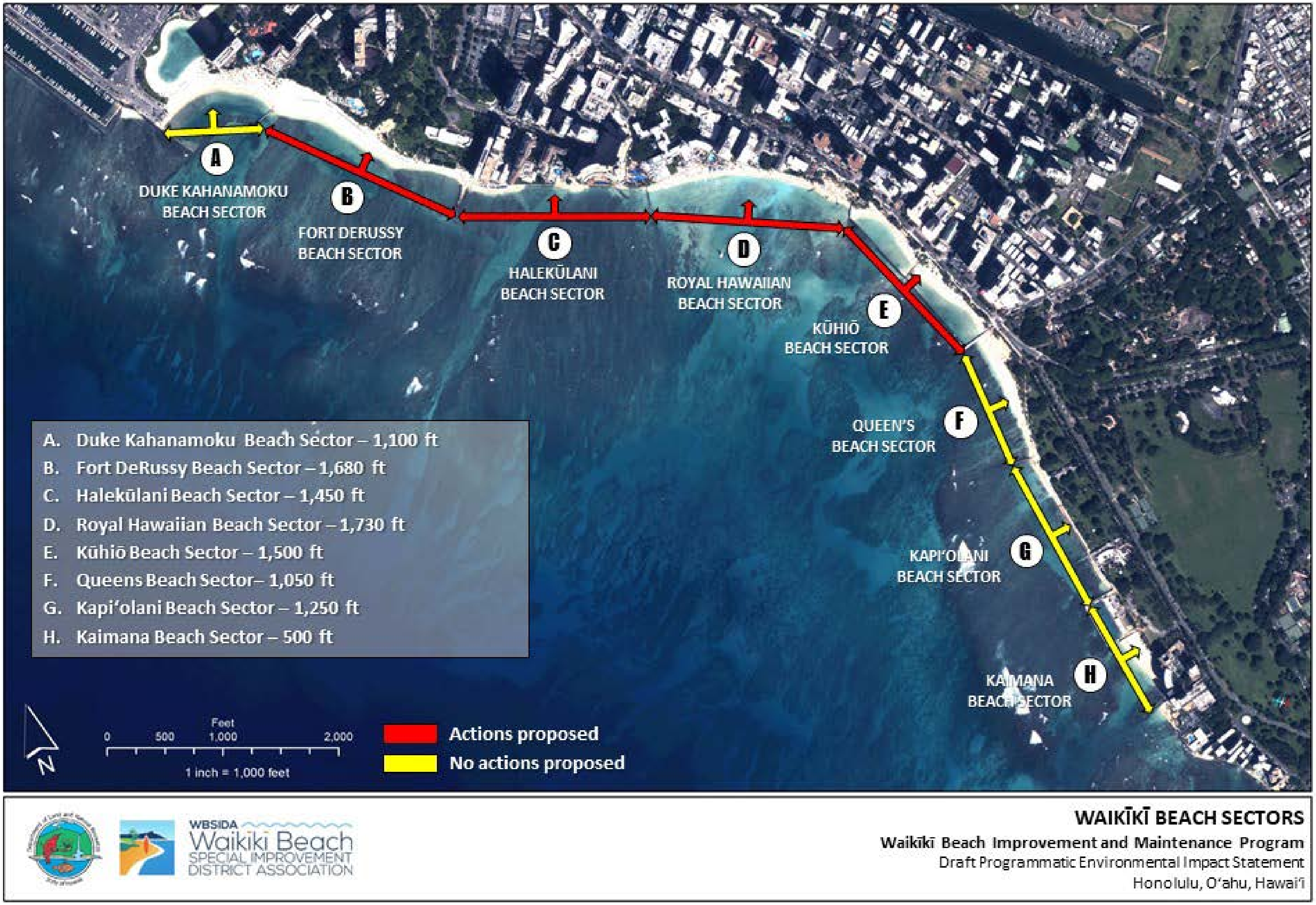
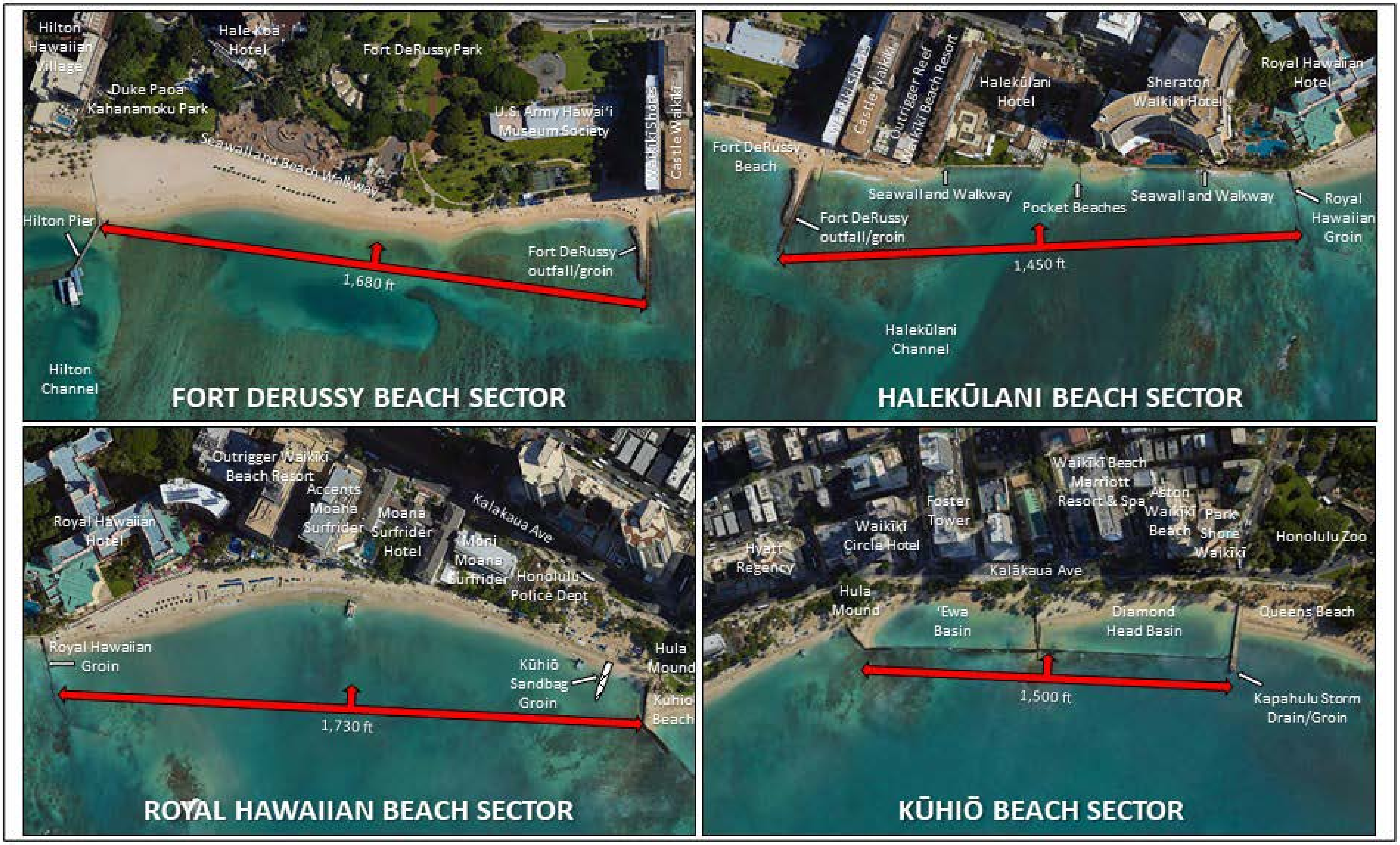


Figure 2-3 Waikīkī beach sectors



WBSIDA
Waikiki Beach
SPECIAL IMPROVEMENT
DISTRICT ASSOCIATION

WAIKĪKĪ BEACH SECTORS SELECTED FOR BEACH IMPROVEMENT AND MAINTENACE ACTIONS
Waikīkī Beach Improvement and Maintenance Program
Draft Programmatic Environmental Impact Statement
Honolulu, Oʻahu, Hawaiʻi

Figure 2-4 Waikīkī beach sectors selected for improvement and maintenance actions

Figure 2-5 Conditions before Waikīkī Beach Maintenance I (Sep 2009)

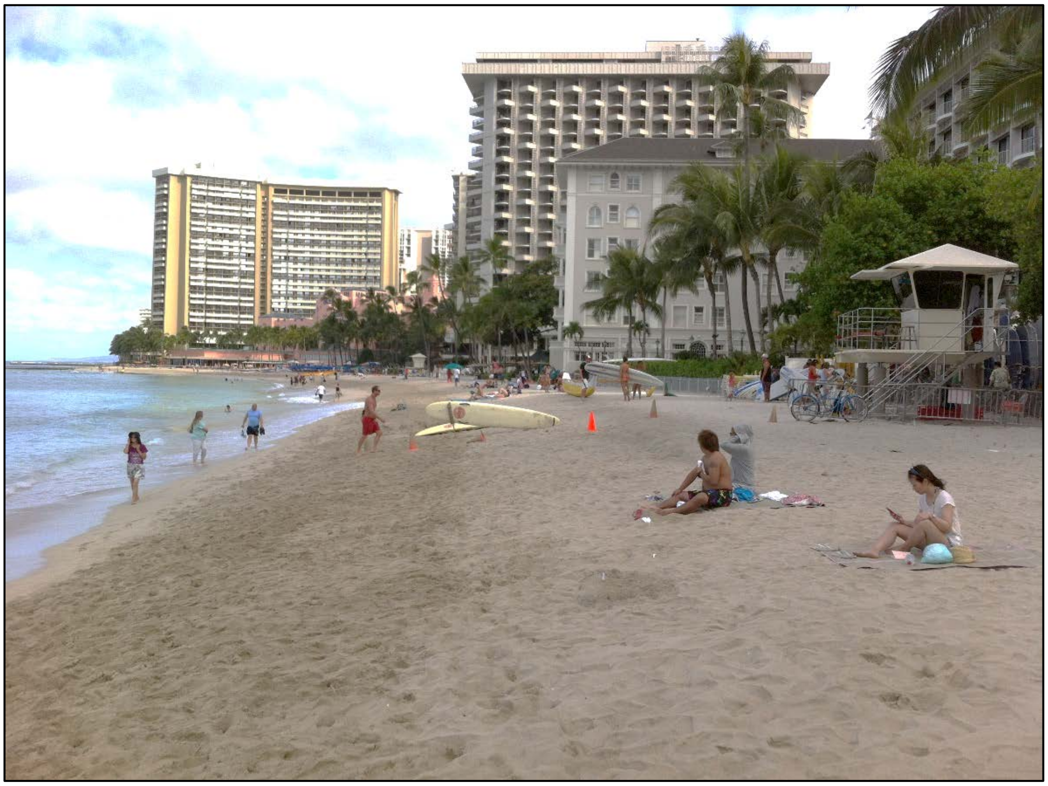


Figure 2-6 Conditions after Waikīkī Beach Maintenance I (Nov 2019)

Figure 2-7 Conditions before construction of Kūhiō Sandbag Groin (Nov 2017)

Figure 2-8 Conditions after construction of Kūhiō Sandbag Groin (Nov 2019)

Figure 2-9 Conditions before reconstruction of Royal Hawaiian groin (May 2020)

Figure 2-10 Conditions after reconstruction of Royal Hawaiian groin (August 2021)

Figure 2-11 Conditions before Waikīkī Beach Maintenance II (May 1, 2021)

Figure 2-12 Conditions after Waikīkī Beach Maintenance II (May 5, 2021)

3. SUMMARY OF PROPOSED ACTIONS

3.1 Introduction

The DLNR is proposing beach improvement and maintenance actions in four beach sectors in Waikīkī – Fort DeRussy Beach, Halekūlani Beach, Royal Hawaiian Beach, and Kūhiō Beach. These beach sectors were selected based on the issues and priorities established by the WBCAC. Beach improvements or maintenance actions are not being proposed at this time for the other beach sectors – Duke Kahanamoku Beach, Queen's Beach, Kapiʻolani Beach, and Kaimana Beach. This chapter provides information on the primary planning and design considerations involved in formulating the proposed actions and summarizes the improvements being proposed.

3.2 Planning and Design Considerations

The following general planning and design considerations for the proposed beach improvement and maintenance actions were developed in collaboration with the DLNR, the WBSIDA, and the WBCAC:

- Actions are designed to increase beach stability and sand retention.
- Actions are designed to increase the resilience and sustainability of the Waikīkī shoreline.
- A primary design consideration is predicted future sea level rise and the associated increasing rates of beach erosion and increasing frequency and severity of coastal flooding.
- Initial design of beach improvements, and stabilizing structures, should consider sea level rise projections through the year 2060, with provisions for extending their functional life until 2080. Assuming improvements are constructed by about 2030 this would give them an approximately 50-year functional life.
- Improvements are programmatic in nature and together form an overall plan to restore and maintain the Waikīkī shoreline for approximately 50 years.
- Improvements may be implemented concurrently or sequentially and be scaled and/or adapted based on changing conditions.
- Improvements must be stakeholder driven and support or improve the widest possible array of existing and future uses.
- Existing beach and ocean-based recreational activities shall be preserved or improved to the maximum extent practicable.

3.3 Anticipated Project Lifespans

Consideration of sea level rise is a key component in the design of coastal structures today. Sea level rise affects nearshore water depths, and the design wave height for rock rubblemound structure stability is a direct function of the water depth (i.e., the deeper the water the larger the possible wave height). Wave runup on the beach is also a direct function of the incident wave height. As sea levels continue to rise, the magnitude and frequency of erosion and flooding will increase with increasing water levels and wave energy at the shoreline, beaches will become narrower and more submerged, and low-lying shoreline areas will be inundated more frequently.

The proposed actions will be designed for a nominal 50-year lifespan, assuming maintenance is conducted when necessary.

For discussion purposes in this DPEIS, *beach maintenance* refers to actions that involve using existing sand or adding sand with no new structures or modifications to existing structures. Beach maintenance options include beach nourishment, sand backpassing, sand pushing, and sand pumping.

This DPEIS proposes beach maintenance actions in two three sectors of Waikīkī:

- Fort DeRussy Beach Sector – Sand Backpassing
- Royal Hawaiian Beach Sector – Beach Nourishment without Stabilizing Structures
- Kūhiō Beach Sector: Diamond Head (east) Basin – Sand Pumping

The proposed beach maintenance actions are intended to be implemented periodically on an as-needed basis. Beach maintenance would be conducted when beach conditions reach some pre-defined topographic triggers. Beach monitoring would be required to determine when the triggers have been met. The proposed beach maintenance actions may be adapted as sea levels continue to rise.

For discussion purposes in this DPEIS, *beach improvements* refer to actions that involve adding new sand, constructing new structures, and/or modifying existing structures. Beach improvement options include beach nourishment with stabilizing groins, segmented breakwaters, and modifications to existing structures.

This DPEIS proposes beach improvement actions in two beach sectors of Waikīkī:

- Halekūlani Beach Sector – Beach Nourishment with Stabilizing Groins
- Kūhiō Beach Sector: 'Ewa (west) Basin – Beach Nourishment with a Segmented Breakwater

The proposed beach improvement actions are designed based on the most recent sea level rise predictions by the National Oceanic and Atmospheric Administration (NOAA, 2017). Assuming construction is completed by 2030, the NOAA sea level rise predictions for Honolulu 30 and 50 years later are shown in Table 3-1.

Table 3-1 NOAA sea level rise projections (in ft) for Honolulu, Hawai'i

Year	Low	Intermediate	High	Extreme
2060	0.8	1.7	3.4	4.0
2080	1.0	2.7	5.8	6.9

The proposed beach improvement actions are designed to be implemented in phases, with the initial phase being designed for approximately 1.5 ft of sea level rise, thus in 25 to 30 years following construction it may be necessary to raise the project elevations. If then raised by several feet, the projects could be effective until about the year 2080, or 50-years post-construction. It is important to note that sea level rise projections continue to evolve as new and improved sea level and climate change research becomes available. It is also important to recognize that global sea level rise will not stop within these timeframes but will very likely continue for centuries.

3.4 Alternatives Considered

The primary objectives of the proposed beach improvement and maintenance actions are to:

- Restore and improve the beaches of Waikīkī
- Increase beach stability through improvement and maintenance of shoreline structures
- Provide safe access to and along the shoreline
- Increase resilience to coastal hazards and sea level rise

To achieve these objectives, the following alternatives were considered:

- No Action
- Managed Retreat
- Beach Maintenance
- Beach Nourishment without Stabilizing Structures
- Beach Nourishment with Stabilizing Structures

3.4.1 No Action

The No Action alternative would consist of not implementing the proposed actions and allowing the beaches to migrate and erode naturally. No Action could occur if 1) the DPEIS is withdrawn by the applicant, 2) the FPEIS is denied by the approving authority, or 3) the FPEIS is accepted by the approving authority but the applicant is unable to obtain the necessary funding and approvals to implement the proposed actions.

Without the proposed actions, existing shoreline processes would continue, and the beaches would continue to erode. This would result in a continued decrease in usable dry beach area and substantial economic losses. Based on historical and projected erosion rates, the narrower portions of the beaches (e.g., the east ends of the Fort DeRussy and Royal Hawaiian beach sectors) can be expected to be completely gone in 15 to 30 years, with total beach loss occurring before the end of the century. The majority of the backshore area (landward of the beach) is completely developed and is protected by old seawalls, many of which are currently buried by sand. As the beaches continue to erode, the erosion can be expected to begin to expose these seawalls, which will exacerbate the erosion problem due to wave impacts and reflection and could result in wall damage and the need for repair, modification, or replacement of the structures to protect backshore land and infrastructure.

The existing beach and offshore sand deposits have a negligible effect on coastal water quality. During periods of high surf there is typically a general increase in nearshore turbidity due to the suspension of fine bottom material by wave action, and this can be expected to continue with or without the proposed actions. Thus, the No Action alternative would be expected to have no significant effect on existing water quality in the project area.

No Action would also have a negligible effect on the nearshore biological environment. Not implementing the proposed actions would simply result in the continued deterioration of the marine biological environment in Waikīkī, and the potential continued growth of invasive algae. In the same way, No Action would have a negligible effect on marine protected species, or historic, cultural, and archaeological resources.

No Action will ultimately have a very significant impact on beach-related recreation. The diminishing beach area will severely limit sunbathing, decrease access for swimming, surfing, paddling and other ocean-based recreation activities, and reduce commercial recreational opportunities for the beach concessions, catamarans, and adjacent hotels and resorts.

The socioeconomic impacts resulting from the loss of Waikīkī Beach would be substantial. In 2008, the Waikīkī Improvement Association commissioned Hospitality Advisors, LLC to conduct an economic impact analysis of the effect of the complete erosion of Waikīkī Beach (Hospitality Advisors, 2008). A summary of the study results are as follows.

Waikīkī Beach is recognized as a major tourism destination in Hawaiʻi, as well as a popular recreational spot for visitors and residents. On average, there are 25,600 hotel rooms available in Waikīkī on a daily basis, 87% of the total hotel supply on Oʻahu. Anthology Group (2019) reported that 48.9% of Oʻahu visitors participate in snorkeling activities, 68% participate in swimming activities, and 84% participate in beach and sunbathing activities. More than one-third of westbound (e.g., mainland) and Japanese visitors cited beach or swimming as their primary reason for staying in Waikīkī. The top four planned activities for both westbound and Japanese visitors were swimming, sunbathing, surfing and snorkeling. An overwhelming majority, 76% to 79%, of all visitors consider beach availability to be very important. When presented with the possibility of the complete erosion of Waikīkī Beach, 58% of all westbound visitors and 14% of Japanese visitors said they would not consider staying in Waikīkī without the beach.

There has been substantial recent capital investment to ensure that Waikīkī remains competitive as a visitor destination; examples include the Outrigger Waikīkī Beach Walk and Starwood property renovations/upgrades (Sheraton Waikiki Hotel, Royal Hawaiian Hotel, and the Moana Surfrider Hotel). The loss of Waikīkī Beach would result in significant socioeconomic losses to the State of Hawaiʻi. Tarui et al. (2018) found that complete erosion of Waikīkī Beach would result in approximately $2.223 billion in annual visitor expenditures.

3.4.2 Managed Retreat

Managed retreat is a coastal management strategy that focuses on strategic relocation of existing and new development away from the shoreline and out of vulnerable areas and is intended to allow the shoreline to naturally move inland rather than fixing the shoreline with engineered shore protection structures. Managed retreat in a heavily developed urban area, like Waikīkī, will likely require a phased approach that may be implemented over the course of several decades. This will require extensive planning and coordination between government agencies, the community, affected landowners, major resorts, and the general public.

The proposed beach improvement and maintenance actions focus on interim solutions to allow sufficient time for long-term sea-level rise adaptation plans to be developed and implemented. These long-term plans may include strategic retreat of Waikīkī's resort infrastructure away from the shoreline or a combination of strategies such as continued beach restoration combined with incremental movement of structures and facilities away from the shoreline triggered by recurring erosion and flooding impacts and/or coinciding with permitting for planned improvements to individual properties.

From the perspective of adapting a densely developed resort community, like Waikīkī, the discussion of alternatives is based on conservation and preservation of the beaches in the near to mid-term while longer-term adaptation plans and supporting government policies and programs are developed to address relocation of vulnerable development landward of the shoreline.

Managed retreat is a long-term process focused on large scale development of the terrestrial area landward the shoreline, whereas the proposed beach improvement and maintenance actions are interim solutions that focus on management of a natural environmental and public resource. Managed retreat in Waikīkī would consist of a long-term planning, legal, financial, political, land use, and regulatory process that should be coordinated and guided by the appropriate agencies, driven by community engagement, and facilitated by landowner participation.

The report, *Assessing the Feasibility and Implications of Managed Retreat Strategies for Vulnerable Coastal Areas in Hawaiʻi* (Hawaiʻi Office of Planning, 2019) presented next steps for the State of Hawaiʻi to develop a managed retreat plan. The report states that "… to have a cogent and comprehensive retreat plan, it requires long-range planning, legal changes, funding, and some level of community agreement, understanding and support for retreat." The report also noted that retreat from chronic coastal hazards (e.g., erosion and sea level rise) can be incremental and may take decades to complete. Based on these findings, the report suggests the following next steps to develop a statewide managed retreat plan:

- Determine the feasibility and implication of additional managed retreat tools.
- Establish criteria for areas to be retreated and priority list(s).
- Identify funding to retreat areas and review tax implications of retreat.
- Review State and County land uses to determine where it may be possible to retreat to.
- Review State and County plans to determine where they may be amended or updated or both to support retreat.
- Review laws and regulations that may have to be amended or adopted or both to facilitate retreat at the State or County or both levels.
- Engage in outreach to the communities to obtain their input and buy-in for retreat strategies to be adopted.

Until managed retreat policies, regulations, tools, and programs are in place to implement Managed retreat in a heavily developed urban community like Waikīkī, other appropriate solutions should be considered. The proposed beach improvement and maintenance actions are as interim solutions and would not preclude the implementation of other sea level rise adaptation strategies in Waikīkī. The proposed beach improvement and maintenance actions will help to maintain the economic, social, cultural, environmental, and recreational value of Waikīkī, while providing a protective buffer to reduce impacts from erosion and flooding. The multi-decadal process of planning for and implementing managed retreat should not preclude the State of Hawaiʻi fulfilling its responsibility for overseeing beaches and submerged lands out to the seaward extent of the State's jurisdiction and, where feasible, conserve and enhance beach resources and shoreline public access.

Managed retreat should be part of the community development planning process.

Managed retreat will likely require substantial redevelopment or relocation of the major resorts that currently operate along Waikīkī Beach. Relocation at this scale would, at a minimum, require substantial redevelopment of approximately 120 acres of land between Kalākaua Avenue and the shoreline, affecting over 65 public and private landowners and resorts, as well as the economies of the City and County of Honolulu and the State of Hawaiʻi. A project of this magnitude would fundamentally alter nearly every aspect of the natural and built environments, and the appearance and character of the Waikīkī community as it exists today.

Managed retreat plans should be developed in coordination and collaboration with State and County agencies, the community, existing landowners, and other stakeholders that would be affected. Ideally, managed retreat would be initially evaluated as part of the Community Development Planning (CDP) process, which is coordinated by the City and County of Honolulu. Waikīkī is part of the Primary Urban Center Development Plan, which is currently in the process of being updated and may provide an opportunity for a more in-depth analysis of managed retreat options for Waikīkī.

The geographic scale of managed retreat is disproportionately larger than the proposed actions.

The beaches of Waikīkī are a Public Trust resource and occupy approximately 12 acres of submerged land seaward of the shoreline, whereas the terrestrial area occupies approximately 120 acres of fast land between Kalākaua Avenue and the shoreline. Thus, the geographic scale of managed retreat at Waikīkī is 10 times greater than the proposed beach improvement and maintenance program, affects over 65 public and private landowners and resorts, and would require substantial redevelopment of a substantial portion of Waikīkī.

Current retreat options within existing regulations.

Managed retreat for individual land uses would involve modification, relocation, or removal of existing structures to reduce hazard exposure and maintain a natural shoreline. Shoreline setbacks are an existing regulation that requires development to be set back a minimum distance from the shoreline, creating a buffer zone that reduces the potential for shorefront development to be exposed to erosion and flooding. The City and County of Honolulu requires shoreline setbacks for new development (and redevelopment) along the shoreline. The purpose of the shoreline setback area is to protect and preserve the natural shoreline, lateral shoreline access, and open space along the shoreline while minimizing exposure of the built environment to coastal hazards.

Setbacks for development in the backshore are calculated and implemented during the County permitting process, prior to construction. These setbacks are calculated based on the location of a certified shoreline. A certified shoreline will be completed as part of the permit process prior to the proposed beach improvement and maintenance actions, establishing a pre-construction baseline for shoreline setback calculations. The proposed beach improvement and maintenance actions will not move the certified shoreline or the shoreline setback area further seaward. Setback requirements based on certified shorelines will continue to be applied in Waikīkī, regardless of implementation of the proposed actions.

The proposed beach improvement and maintenance actions will increase recreational dry beach area and stability, reducing the impacts of erosion for the coming years to decades; however, the certified shoreline location will be based on current conditions. This provides the double benefit of mitigating the negative impacts of erosion while maintaining the existing shoreline location for setback determinations for any potential future development projects in the area.

Managed retreat is not the only option to adapt to sea level rise.

Managed retreat is an example of an adaptation strategy, which is one of three primary strategies for developed coastal areas – along with protection and accommodation – to respond to sea-level rise. It is not the only option, and the other options may be assessed for implementation as stand-alone approaches or as a combination of two or more approaches to address local needs and in consideration of feasibility. Beach nourishment is considered a nature-based adaptation strategy and, like any coastal management strategy, has tradeoffs and limitations. However, beach nourishment has proven to be a cost-effective strategy for maintaining beaches (Porro, 2020). While periodic nourishment efforts may be required, the economic, social, cultural, and environmental impacts of beach restoration are low compared to the impacts and costs associated with continued beach erosion given the economic significance of Waikīkī Beach to the economies of the City and County of Honolulu and the State of Hawaiʻi, and the environmental impacts of materials and structures encroaching and collapsing onto the beach with ongoing, unmitigated shoreline erosion.

The timeline for managed retreat is disproportionately longer than beach restoration. Managed retreat should be evaluated through long-range planning beginning with the community planning process. One suitable venue for assessment, community input, and prioritization of managed retreat could be the Primary Urban Center Development Plan, which is in the process of being updated. It will take decades to envision, plan, fund, and implement a managed retreat plan for Waikīkī and the community planning provides an appropriate multi-decadal planning outlook. Beach restoration can be completed in a matter of years as an iterative, interim mitigation and adaptation measure. Multiple beach restoration efforts, nature-based sea-level rise adaptation measures, could be completed in the time it will take to implement a comprehensive and holistic managed retreat plan at Waikīkī. Moreover, beach restoration can be an integral step in a broader and more inclusive managed retreat plan, providing a nature-based solution and allowing additional time for other sea-level rise adaptation measures on a coastline.

3.4.3 Beach Maintenance

Beach maintenance refers to actions that involve using existing sand or adding sand with no new structures or modifications to existing structures. Beach maintenance options include sand backpassing, sand pushing, sand pumping, and beach nourishment without stabilizing structures.

Sand Pushing

Sand pushing is a beach maintenance strategy that typically involves moving sand from the lower beach face to the upper beach to restore an eroded beach profile and reduce exposure of the backshore to wave action. Sand pushing has been a successful beach maintenance strategy at various beaches throughout Hawaiʻi. An example of a sand pushing project at Sunset Beach, Oʻahu, is shown in Figure 3-1. Agencies are generally supportive of sand pushing as a beach maintenance strategy on a case-by-case basis with conditions and limitations to prevent potential impacts to adjacent shorelines and properties. Authorizations for sand pushing are typically limited to the beach immediately fronting the adjacent property or properties.

Figure 3-1 Sand pushing at Sunset Beach, Oʻahu (2014)

While sand pushing may temporarily restore the beach profile, the pushed sand would be expected to mobilize and move alongshore and offshore. The construction process is relatively timely and efficient and is often the least expensive alternative for beach maintenance. However, sand pushing would be disruptive to beach users and commercial operations, and the cumulative costs for recurring sand pushing efforts could be substantial. Sand pushing could be performed routinely when a sufficient volume of sand is present along the shoreline. Sand pushing may provide a temporary increase in dry beach volume and elevation and may provide some temporary relief from erosion and wave runup; however, the sand is likely to mobilized by natural processes, and ongoing seasonal or chronic erosion and beach loss is likely to continue.

Sand Backpassing

Sand backpassing involves recovering sand from portions of a beach where sand has accreted and placing it in areas that are subject to erosion and beach loss. Sand backpassing counters the natural longshore movement of sand and can be an effective beach maintenance strategy in areas with dominant seasonal or long-term erosion and sand transport in a particular direction along the shoreline and a surplus of sand accumulating in the area of accretion. For sand backpassing to be feasible in Waikīkī, an adequate volume of sand would need to be available from another area within the same beach sector. This is unlikely as the majority of beaches in Waikīkī are experiencing erosion. Similar to sand pushing, the construction process for sand backpassing is relatively straightforward but would be temporarily disruptive to beach users and commercial operations, and the cumulative costs for recurring sand backpassing efforts could be substantial. Sand backpassing may provide a temporary increase in beach volume and width and may provide some temporary relief from erosion; however, without the addition of stabilizing structures, the sand is likely to mobilize, and erosion and beach loss is likely to continue and accelerate as sea levels continue to rise.

Sand Pumping

Sand pumping involves recovering sand from the nearshore waters and placing it on the beach. Sand pumping counters the natural cross-shore (seaward) movement of sand and can be an effective beach maintenance strategy in areas where eroded sand is accumulating in shallow submerged areas adjacent to the dry beach. There are three options for sand pumping in Waikīkī: 1) suction dredge, 2) floating platform dredge, or 3) diver-operated dredge.

A small suction dredge could be used to recover limited volumes of sand from shallow nearshore deposits adjacent to the dry beach. A Piranha PS165-E suction dredge would be capable of recovering about 60 to 100 cubic yards of sand per day. This operation would be conducted on an as-needed basis to restore the beach profile. Sand slurry would be impounded within small dewatering basins trenched into the upper beach face and located entirely above the mean higher high water (mhhw) line. The purpose of the dewatering basins is to allow the water portion of the sand slurry to percolate through the sandy beach substrate, which acts as a natural filter. After the water has percolated from the basins, the dewatered sediment would be distributed across the adjacent beach face. A small Bobcat loader would be used to push sand from the lower beach face (above mhhw) to the upper beach face. A small berm would be created along the back beach to maximize the volume of sand on the upper beach profile. Figure 3-2 shows an example of a small-scale suction dredging operation at Koʻolina, Oʻahu.

Another alternative for sand pumping is a floating platform dredge or submersible diver-operated dredge. An Eddy Pump© diver operated dredge is a mobile system that is fully submersible and designed for pumping production rates of 50 to 100 cy of material per hour. The system can be powered electrically or hydraulically. A single system can allow up to three suction hoses and divers to operate simultaneously. Suction hoses are 200 ft long with a maximum pumping distance of 2,500 ft.

Sand pumping is a maintenance activity that could be performed periodically on an as-needed basis when sand is available, and the dry beach is narrowed beyond a predetermined threshold. The construction process would be more time-consuming than sand pushing or sand backpassing, which would be more disruptive to beach users and commercial operations.

Given the recurring costs for periodic maintenance, sand pumping would likely be the most expensive alternative for beach maintenance in Waikīkī. Sand pumping may provide a temporary increase in beach volume and width and may provide some temporary relief from erosion; however, without the addition of stabilizing structures, the sand is likely to mobilize, and erosion and beach loss is likely to continue and accelerate as sea levels continue to rise.

Figure 3-2 Sand pumping at Koʻolina, Oʻahu (2017)

3.4.4 Beach Nourishment without Stabilizing Structures

Beach nourishment typically involves placement of beach fill to specified design profiles. Beach nourishment is intended to augment the natural morphology of the beach to offset the effects of chronic, seasonal, or episodic erosion. Agencies are generally supportive of beach nourishment because it has minimal environmental impacts and is consistent with City and State policies that seek to preserve and enhance beach resources. An example of a small-scale beach restoration project at Sugar Cove (Pā'ia, Maui, Hawaiʻi), is shown in Figure 3-3.

The Hawaiʻi Department of Land and Natural Resources, Office of Conservation and Coastal Lands (DLNR-OCCL) authorizes beach nourishment projects through the Small Scale Beach Nourishment (SSBN) program, which allows placement of compatible beach quality sand makai (seaward) of the shoreline in the State Conservation District. There are two categories of SSBN permits: Category I (up to 500 cy of sand), and Category II (up to 10,000 cy of sand). A Category I SSBN may provide sufficient volume to temporarily increase beach width over relatively small reaches of the shoreline; however, restoring beach width for an entire beach sector would require a Category II SSBN. Large-scale beach nourishment projects, such as those being proposed in the Halekūlani, Royal Hawaiian, and Kūhiō beach sectors, are beyond the scope of the existing SSBN program. The DLNR is in the process of updating the SSBN program through a statewide Programmatic Environmental Assessment (PEA). The new program will be referred to as the Small Scale Beach Restoration (SSBR) program.

Figure 3-3 Small-scale beach restoration at Pā'ia, Maui (2016)

3.4.5 Beach Nourishment with Stabilizing Structures

Ongoing erosion can limit the effectiveness of beach nourishment projects. Without additional mitigative measures, rates of pre-project beach erosion should be expected to continue following a beach nourishment project. Some areas have natural features such as headlands, embayments, or reefs that disrupt sediment transport and naturally stabilize the sand. In some cases, engineered beach stabilizing structures that mimic these natural features, such as T-head groins, can be constructed to maintain a stable beach. T-head groins decrease and reorient the amount of wave energy reaching the beach and create artificial littoral cells to stabilize the sand. An example of regional beach nourishment with stabilizing T-head groin structures is shown in Figure 3-4.

The knowledge gained from studying natural crenulate-shaped bays provides a design tool for coastal engineers to produce stable sandy shorelines. Silvester and Hsu (1993) present methods for determining the stable beach planform adjacent to rocky headlands, thus facilitating the engineering use of artificial headlands as beach stabilizing structures. Whereas natural beaches obtain a stable shape in response to the wave climate and headland orientation, beaches can also be stabilized by engineering artificial headlands with positions and orientations that produce the desired beach shape.

Figure 3-4 Beach nourishment with T-head groins at Iroquois Point, Oʻahu

Klein et al (2003) proposed methods for using locations of upcoast and downcoast control points, along with incident wave angle, to approximate the stable shoreline position for an embayed beach. Bodge (2003) proposed the use of T-head groins as artificial headlands to produce stable beaches, an approach that has been implemented successfully on numerous beaches in Florida and the Caribbean (Bodge, 1998), and more recently at Iroquois Point on Oʻahu (Figure 3-4).

A schematic of the components of a tuned T-head groin system is presented as Figure 3-5. The heads of the T-groins can be aligned (tuned) according to the prevailing wave crest orientation to produce the desired beach configuration. Rubblemound T-head groins are recommended to reduce rip currents, wave reflection, and the loss of sand via cross-shore transport. The beach should be nourished with sand to achieve the predicted shoreline shape. According to Bodge (1998), tuned structures work well when the erosion is so severe that renourishment would be too frequent to be economical or practical, or when the shoreline is no longer conducive to having beaches, such as along hardened shorelines.

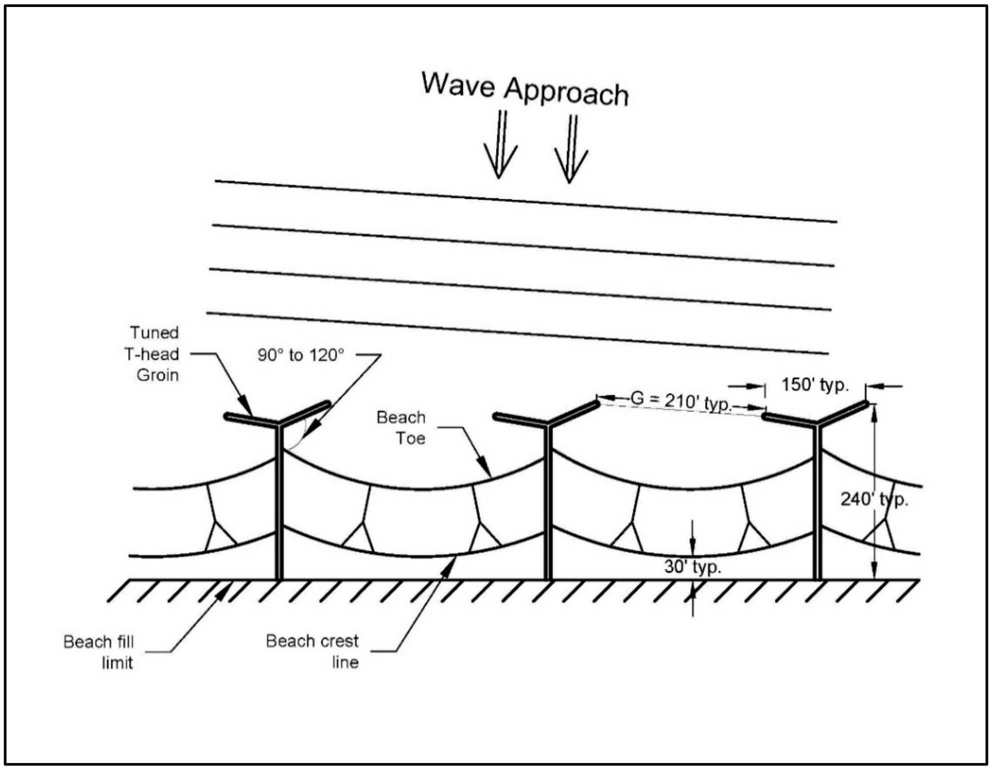


Figure 3-5 Schematic of a typical tuned T-head groin system

Key design parameters for T-head groin design include groin length, head length and orientation, armor stone sizing, and desired beach shape and width. In general, the beach shape responds more to the gap width (opening) between the groin heads than it does to the structure heads themselves. Thus, the stable beach is a function of the length and orientation of the gaps. Orientation of the gaps is primarily dictated by the shape of the shoreline and the prevailing direction of wave approach.

The groin layout and head angles should be oriented such that the gap opening is approximately parallel with the average prevailing wave crest. This “tuning” of the heads helps to ensure the predictability of the beach shape and yields greater shoreline stability within the beach cell. In many cases, it is not possible to achieve a perfect match between gap orientation and incident wave crest, because of the directional variability of waves approaching the shoreline. In practice, this difference should be no more than 25 deg, and differences of up to 15 deg have been consistently shown to produce a stable beach (Bodge, 2012).

The beach design process includes establishing the desired physical characteristics of the beach, and then applying coastal engineering analysis to orient structures to achieve the desired beach planform. Deviation of the gaps from parallel with the wave crests will result in a less uniform beach in the planform view, and wave modeling may be necessary to approximate the stable beach configuration. Physical beach characteristics include crest height, dry beach width, beach slope, and sand grain size. Standard methodology typically involves trying to match adjacent beach characteristics because this indicates what is naturally stable for local conditions and it is aesthetically more pleasing to match the adjacent beach.

The empirical relationships show that the mean low water (low tide) shoreline will be located between one-third and two-thirds of the gap length (G) behind the groin head (i.e., $0.35G$ to $0.65G$). Larger values in this range are appropriate for 1) energetic open coasts that are directly exposed to wave action, 2) larger gap widths, 3) larger angles between the wave approach and the gap orientation, 4) reduced beach fill sand compatibility, and 5) a higher degree of conservatism. The groin head lengths should be long enough so that the mean low water shoreline approaches the groin head, while maintaining a minimum ratio of gap width to head width of about 60:40 for aesthetic reasons so that the groins do not dominate the viewplanes.

The groin stems should extend landward of the design beach crest to mitigate flanking and loss of sand from the cell around the back of the groin. The groin crest elevation should be above the high tide elevation and high enough to prevent significant overtopping during prevailing (non-storm) water levels and wave conditions. Experience at Iroquois Point, Oʻahu suggests that a stable beach crest elevation would be approximately +8 to +9 ft MLLW, and the beach foreshore slope would be approximately 1V:8H (vertical to horizontal).

3.5 Sand Sources

3.5.1 Introduction

A key component to the success of the proposed actions is the availability of a suitable sand source to support beach nourishment. The majority of Hawaii's beaches are composed of calcareous (calcium carbonate) sand, which is primarily composed of skeletal fragments of marine organisms such as corals, coralline algae, mollusks, echinoids, forams, with minor fractions of terrigenous (i.e., volcanic) sediment. The composition of sand is determined by the relative abundance of each contributing materials and varies by location. The density of calcium carbonate is more than 2.7 g/cm^3; however, microscopic pores and hollow grains make the effective density somewhat lower. The density and shape of the individual particles affects the transport characteristics when compared to silica beach sand that is derived from inland sources characteristic of most beaches on continental U.S. coastlines (Smith and Cheung, 2003).

In the past, sand for beach nourishment was typically obtained from other beaches on Oʻahu and Molokaʻi or from inland deposits of relict beach and dune sands that were commercially available. Mokulēʻia sand, previously mined by Hawaiian Cement, was a high-quality relict beach sand deposit located several hundred meters inland of the beach on the North Shore of Oʻahu. Mokulēʻia sand is moderately sorted, and the median grain size (D_{50}) is 0.60 mm. This sand has reportedly been used for beach nourishment projects at the Hilton Hawaiian Village and Kūhiō Beach but is no longer commercially available.

Maui dune sand was previously mined by Hawaiian Cement and HC&D (formerly Ameron). Class A Maui dune sand is a fine-to-medium grain sand with a median grain size (D_{50}) of 0.25 mm. The sand contains a relatively high percentage of fines, contains terrigenous sediment (dirt), and has a medium to dark brown color. Class A Maui dune sand has been used in previous beach nourishment projects on Maui but has never been used on Oʻahu. In 2017, the County of Maui placed a moratorium on mining of inland dune sand, so this sand is no longer commercially available.

Imported sand has been commercially available for many years to support various industries including but not limited to construction, landscaping, and golf courses. These sands are often composed of quartz minerals and can be ordered to desired sand composition, grain size, density, texture, angularity and color specifications. However, the use of imported sand from outside Hawaiʻi that is not composed of calcium carbonate does not comply with State of Hawaiʻi standards and guidelines for beach nourishment projects.

Offshore marine deposits present an alternative source of sand. These deposits have been dredged and transported to shore to support various beach nourishment projects in Hawaiʻi. Offshore sand deposits occurring within the same beach sector or littoral cell can often have grain size characteristics and composition that are similar to the adjacent beach sand. Offshore sands were utilized in the 2006 Kūhiō Beach Nourishment project, and the Waikīkī Beach Maintenance I and II projects in 2012 and 2021, respectively.

3.5.2 Sand Characteristics and Quality

The State of Hawaiʻi Department of Land and Natural Resources (DLNR) established standards and guidelines, which specify that fill sand used for beach nourishment projects must meet several requirements:

- Sand shall contain no more than 6% fine material (grain size < 0.074 mm).
- Sand shall contain no more than 10% coarse material (grain size > 4.76 mm).
- The grain size distribution will fall within 20% of the existing beach sand.
- The overfill ratio of the fill sand to existing sand shall not exceed 1.5.
- Sand will be free of contaminants such as silt, clay, sludge, organic matter, turbidity, grease, pollutants, and others.
- Sand will be primarily composed of naturally occurring carbonate beach or dune sand.

The majority of the current requirements for beach fill sand are related to grain size. To determine the grain size characteristics, a sieve analysis is performed by mechanically shaking a sand sample through a series of sieves of decreasing screen size. The material captured on each sieve is weighed to establish grain size distribution curves. The median grain size (D_{50}), which represents the grain diameter that is finer than 50 percent of the sample, is often used to quantify the grain size of a sample. Other important characteristics of fill sand include color, texture, density, angularity, sphericity, and abrasion resistance.

Color is an important consideration when determining whether sand is suitable for beach nourishment. While natural calcareous sand beaches range in color from light brown to white, sand in offshore deposits is typically grayish in color, primarily as a result of anoxic conditions produced by biologic activity and a lack of wave action and associated mixing. Even though an offshore sand source may be suitable in terms of grain size characteristics, as illustrated in several offshore dredging and beach restoration projects in Waikīkī, a persistent gray color can be undesirable. During the 2012 Waikīkī Beach Maintenance I project, the offshore sand was noticeably grayer than the existing beach sand after initial recovery and placement; however, after several weeks of prolonged exposure to subaerial conditions and ultraviolet radiation from the sun, the gray color faded and is no longer discernable from the existing beach sand.

3.5.3 Representative Waikīkī Offshore Sand Deposits

A number of offshore sand deposits are located along the South Shore of Oʻahu from the Pearl Harbor entrance channel to Diamond Head. Multiple offshore sand investigations have been done over the years to determine if the deposits are suitable to support beach nourishment projects in Waikīkī. The following discussion focuses on six offshore sand deposits that were evaluated as potential sand sources to support the proposed beach improvement and maintenance actions (see Appendix B). The estimated area and volume of each deposit are shown in Table 3-2. The locations of the deposits are shown in Figure 3-6.

Table 3-2 Estimated volume and area of South Shore Oʻahu offshore sand deposits

Offshore Deposit	Estimated Volume (cy)	Estimated Area (acres)
Reef Runway	250,000	79
Ala Moana	190,000	26
Hilton Channel	45,000	11
Halekūlani Channel	580,000	28
Canoes/Queens	50,000	10
Diamond Head	110,000	26
TOTAL	**1,225,000**	**180**

Reef Runway

Two deposits are located approximately 1,500 ft offshore of the west end of the Reef Runway at Daniel K. Inouye International Airport in water depths of 20 to 70 ft. The deposits cover approximately 79 acres and contains an estimated 250,000 cy of sand that varies in thickness from 2 to 8 ft. The typical median grain size (D_{50}) ranged from 0.24 mm to 0.41 mm, and fine material ranged from 2.1% to 6.6%. The deposits were quite thin, with an average thickness of less than 4 ft. Due to the limited sand thickness and higher percentage of fine material, these deposits are not proposed for use in Waikīkī.

Ala Moana

This deposit is located approximately 3,700 ft offshore of Ala Moana Regional Park in water depths of 75 to 120 ft. The deposit covers more than 25 acres and contains an estimated 190,000 cy of sand that varies in thickness from 5 to 15 ft. The typical median grain size (D_{50}) is 0.4 mm. The sand becomes progressively finer in deeper water. The central portion of the deposit contains more than the 70,000 cy of sand that is currently proposed for use by the City and County of Honolulu to nourish the beach at Ala Moana Regional Park. The sand at the *Ala Moana* deposit complies with State of Hawaiʻi requirements and, if not used for beach nourishment at Ala Moana Regional Park, could potentially support beach nourishment in the Halekūlani and Kūhiō beach sectors. However, there may not be an adequate volume of beach quality sand in this deposit to support beach nourishment projects at both Ala Moana and Waikīkī.

Hilton

This deposit is located approximately 2,700 ft offshore of the Hilton Hawaiian Village in water depths of 40 to 60 ft. The deposit covers approximately 11 acres and contains an estimated 45,000 cy of sand that varies in thickness from 4 to 8 ft. The median grain size (D_{50}) is 0.6 mm, which is relatively coarse in comparison to the existing beach sand. The sand at the *Hilton* deposit complies with State of Hawaiʻi requirements and could potentially support beach nourishment in the Fort DeRussy, Halekūlani, and Kūhiō beach sectors.

Halekūlani Channel

This deposit is located in the Halekūlani Channel, which extends approximately 4,000 ft offshore from the Halekūlani Hotel where it widens into a broad sand field in 40 to 80 ft of water. This sand source has been investigated numerous times since the 1970s. The deposit is very large and contains an estimated 580,000 cy of sand. The current study investigated a portion of this larger deposit that covers approximately 28 acres and contains an estimated 200,000 cy of sand that is up to 40 ft thick. The median grain size (D_{50}) ranged from 0.2 mm to 0.4 mm, with coarser sand nearshore in shallower water. The sand quantity and grain size in the Halekūlani Channel varies with distance offshore. The shallower deposits comply with State of Hawaiʻi requirements and could potentially be used to support beach nourishment in the Halekūlani beach sector. The deeper deposits contain a substantial volume of sand; however, the sand is generally finer than the existing beach sand in Waikīkī.

Canoes/Queens

This deposit is located approximately 1,200 ft offshore of Royal Hawaiian Beach in water depths of 10 to 20 ft. The deposit covers approximately 10 acres and contains an estimated 25,000 to 50,000 cy of sand that varies in thickness from 3 to 7 ft. The typical median grain size (D_{50}) is 0.3 mm, which is similar to the existing beach sand in Waikīkī. This sand deposit was used by the DLNR for beach nourishment projects at Kūhiō Beach Park (2006) and Royal Hawaiian Beach (2012, 2021). The sand at the *Canoes/Queens* deposit complies with State of Hawaiʻi requirements and could potentially support beach nourishment in the Kūhiō and Halekūlani beach sectors; however, it is best suited as a “recycled” sand source to support periodic renourishment in the Royal Hawaiian beach sector.

Diamond Head

This deposit is located approximately 1,600 ft offshore of the Diamond Head Lighthouse in water depths of 20 to 40 ft. The deposit covers approximately 26 acres and contains an estimated 110,000 cy of sand that varies in thickness from 3 to 9 ft. The typical median grain size (D_{50}) is 0.4 mm. The sand at the *Diamond Head* deposit complies with State of Hawaiʻi requirements and could potentially support beach nourishment in the Fort DeRussy, Halekūlani, Royal Hawaiian, and Kūhiō beach sectors.

Figure 3-6 Representative Waikīkī offshore sand deposits

3.6 Offshore Sand Recovery and Transport Methodology

Several of the proposed actions will require sand to be recovered from deposits located offshore of the project area. A variety of methods are available to recover the offshore sand. Each method has inherent advantages, disadvantages, and ranges of applicability. The three most common forms of dredging used in Hawaiʻi are 1) submersible slurry pumps, 2) self-contained hydraulic suction dredges, and 3) clamshell buckets.

3.6.1 Submersible Slurry Pumps

Submersible slurry pumps are lowered from a boat or barge and suspended above the seafloor. The pumps can be hydraulically or electrically driven and are available in a range of sizes. The pump is connected to a pipeline that transports the slurry to a dewatering basin onshore. An example of a submersible slurry pump is shown in Figure 3-7. An advantage of a submersible slurry pump is its precise positioning and ability to reach into tight spaces. Using a crane-tip GPS unit to locate the pump, the operator can accurately position the pump to within a few feet of any location to effectively recover sand from near the edge of the reef. Since many of the nearshore sand deposits off Waikīkī are relatively small in area and bordered by hard reef-rock bottom, a smaller, more precise methodology like the submersible pump is advantageous.

A disadvantage of a submersible slurry pump is the significant volume of seawater recovered with the sand (typically, 1-part sand to 10-parts water), and the need to contain and control the dewatering of the sand onshore in accordance with State of Hawaiʻi water quality requirements. A submersible slurry pump was used for the Waikīkī Beach Maintenance I and II projects in 2012 and 2021, respectively. Sand was recovered from the *Canoes/Queens* offshore deposit and pumped to a dewatering basin that was constructed in the Diamond Head (east) basin at Kūhiō Beach Park.

3.6.2 Hydraulic Suction Dredge

A hydraulic section dredge is a more traditional dredging method that has proven to be effective for beach nourishment projects. A hydraulic section dredge functions similarly to a submersible slurry pump, except that the pump is located above water on a surface platform (e.g., boat or barge), and a rigid suction pipe is lowered from the surface platform down to the seafloor. Dredged material is typically discharged as a sand-water slurry through a pipeline to shore. An example of hydraulic section dredging is shown in Figure 3-8.

Hydraulic section dredges come in a wide range of sizes, from large ocean-going dredges for maintaining commercial ports and waterways, to small, trailerable units that are typically used for lake and reservoir clearing or small marina maintenance. A small hydraulic suction dredge (Mud Cat) was used in a small-scale sand pumping demonstration project conducted by the DLNR in February 2000 (Noda, 2000). Approximately 1,400 cy of sand was dredged from a deposit located 1,500 ft offshore of Kūhiō Beach and pumped to a dewatering basin excavated into the dry beach area within the Diamond Head (east) basin of Kūhiō Beach Park. Hydraulic suction dredges are less common in Hawaiʻi in comparison to submersible slurry pumps.

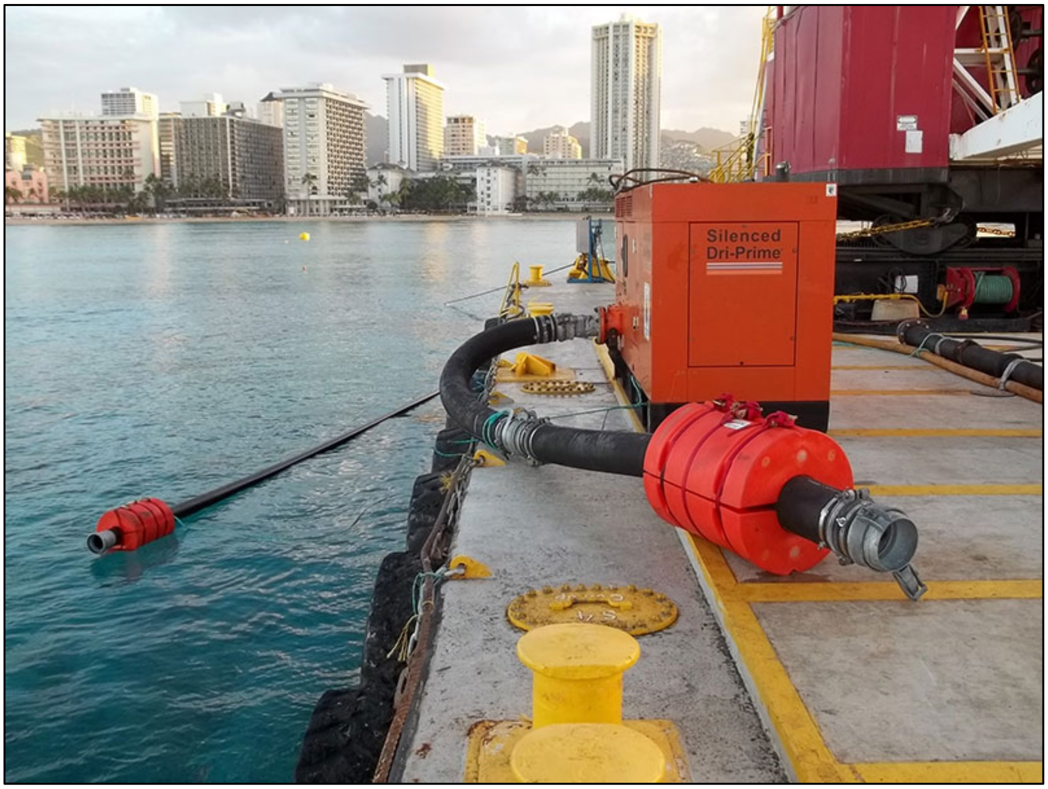


Figure 3-7 Example of a submersible slurry pump (Healy Tibbitts Builders, Inc.)

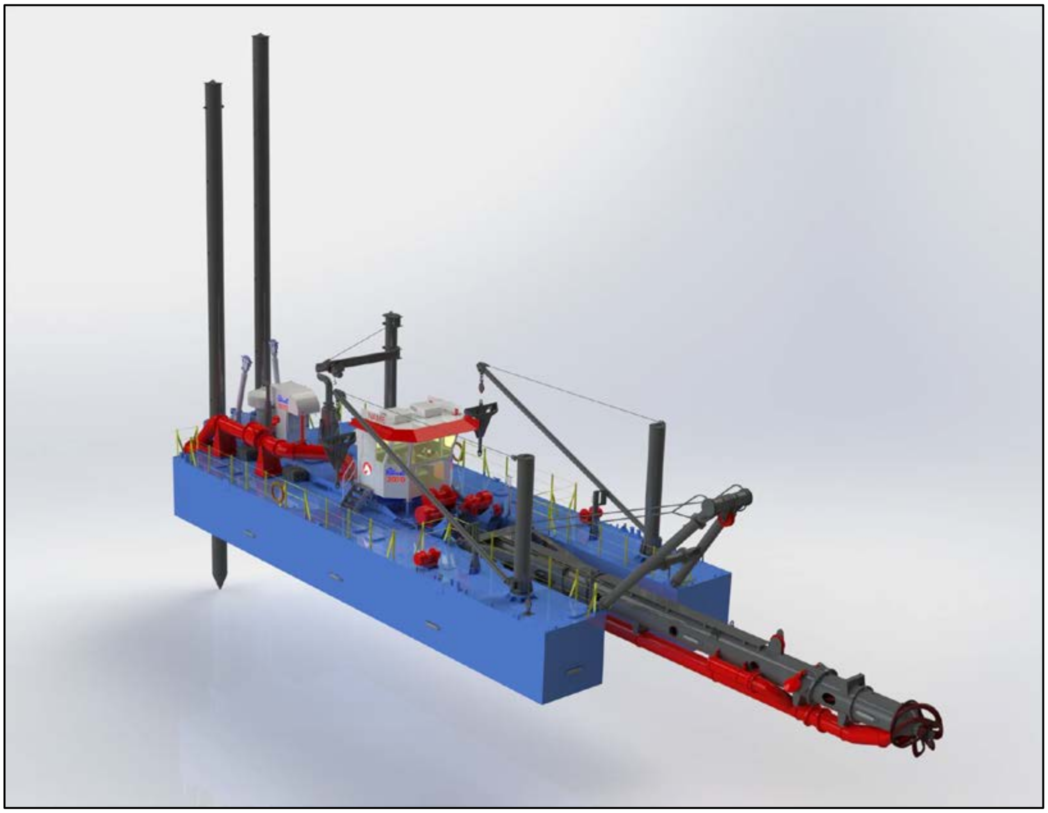


Figure 3-8 Example of a hydraulic suction dredge (Ellicott Dredges, LLC)

3.6.3 Clamshell Dredging

Clamshell dredging involves mechanically scooping and lifting sediment, in this case sand, from the seafloor. Clamshell dredging is often conducted with a large barge upon which the recovered sediment is deposited. A clamshell bucket is lowered with a crane in the open position. Upon reaching the seafloor, the crane operator closes the clamshell jaws, lifts the material out of the water, and opens the bucket over a barge. Once the sand is deposited onto the barge, the barge transits to a dock where the sand can be offloaded and transported to a stockpiling area or dewatering basin. An example of clamshell dredging is shown in Figure 3-9.

Figure 3-9 Example of clamshell dredging (IP Subsea)

The advantages of clamshell dredging are that it is very mobile, it can operate at any depth that the crane cable can reach, it can be used in moderate swell conditions, and it can recover a wide variety of material types. Environmental buckets that seal when closed help to reduce environmental impacts associated with turbidity and increase efficiency in recovering sand, thereby reducing the overall time and cost of the operation. Additionally, the amount of water that is accumulated from the clamshell dredging process is much less than with hydraulic dredging, and the small amount of water can be discharged at an approved location.

The disadvantages of clamshell dredging are that it is less efficient than other dredging systems, such as submersible slurry pumps or hydraulic suction dredges. Clamshell dredging is also less precise in terms of positioning and requires the sand deposits to be thick enough that the clamshell does not encounter hard substrate.

3.6.4 Small-scale Maintenance Dredging

Nearshore sand deposits are typically too far from the coastline to be recovered using land-based equipment, such as cranes and excavators, and too shallow to access via work vessels. Sand deposits located within approximately 1,000 ft of the shoreline may be viable for small scale beach maintenance purposes, as this sand is likely eroded from the beach.

Potential nearshore sand sources in Waikīkī include:

- Fort DeRussy Beach Sector – Hilton Channel
- Halekūlani Beach Sector – Halekūlani Channel
- Royal Hawaiian Beach Sector – Royal Hawaiian Sandbar
- Kūhiō Beach Sector – Diamond Head (east) Basin

Novel dredging approaches must be utilized to recover sand from these nearshore deposits. Two examples of equipment that could potentially be used for nearshore dredging projects are an ROV subdredge and a diver-operated dredge.

3.6.5 Remote Operated Submersible Dredge

A Remote Operated Submersible Dredge (ROV subdredge) is an electrically powered tracked hydraulic pump manufactured by EddyPump© Corporation (Figure 3-10). The pump was developed for the U.S. Army and U.S. Navy for Logistics-Over-the-Shore (LOTS) operations for early entry forces and areas that are too dangerous for human operators. It is fully submersible and capable of being operated remotely from shore. An umbilical runs along the pipeline providing power and control to the ROV subdredge. The pump is powered by an electric power unit located on shore and a small submersible hydraulic power unit mounted on the ROV subdredge. A Real-time Kinematic (RTK) Global Positioning System (GPS) provides precise location data to the landside operator.

An advantage of an ROV subdredge is that it can be operated in shallow water that cannot be accessed by barges. To recover nearshore sand deposits in Waikīkī, an ROV subdredge would be deployed and operated from shore. A pipeline would transport slurry from the ROV subdredge to two dewatering basins on shore. The pipeline would float on the water surface. A small support vessel (e.g., small boat or jet ski) would be used to maintain a safety buffer and assist with maneuvering the dredge pipeline. The operator would move the ROV subdredge through the sand deposit until a sufficient volume of sand was recovered. A camera mounted on the ROV subdredge allows the operator to direct the dredge head to the sand deposit to maximize efficiency. The production rate for the ROV subdredge is expected to be up to 30 to 50 cy of sand per hour.

Additional equipment would be required for proper operation of the ROV subdredge. A 100-kW diesel generator would be located onshore and provide power to the ROV via the umbilical. 1,000 ft of floating pipeline would connect to the ROV subdredge. A bulldozer and skid-steer would be required to excavate the dewatering basins and push sand to the desired grade. The primary disadvantage of an ROV subdredge is the initial cost for the equipment. The ROV subdredge itself would cost approximately $1 million.

Figure 3-10 Remote Operated Submersible Dredge (Eddy Pump©, 2021)

3.6.6 Diver-operated Dredge

A diver-operated dredge is a dredge system that can be manipulated and operated by divers. Diver-operated dredges are typically used in shipyard operations and the mining and fracking industries. Using divers to manipulate the suction hose offers a level of precision that cannot be achieved by lowering a pump over the side of a vessel. Figure 3-11 shows a diver-operated dredge pump manufactured by EddyPump© Corporation. The diver-operated dredge pump is about 6 ft long, 3 ft wide, and 3 ft tall, but dimensions vary depending on the size of the pump. Figure 3-12 shows a diver on surface supplied air (SSA) manipulating a diver-operated dredge nozzle.

Sand recovery would require a 4-person dive team working from shore for Occupational Safety and Health Administration (OSHA) compliance. The dredge pump could be placed on shore on the beach face, or on a small vessel or float. A floating slurry pipeline and power cable would extend from the dredge pump to the sand recovery area. The pump would be powered by a 100kW generator located on shore. A suction hose would be connected to the dredge pump. The suction hose would be controlled by a single diver. The hose would have a length of 100 ft, which would enable the diver to dredge sand within a 100-ft radius of the pump. Once the sand is dredged to the desired depth, the pump would be relocated to another area. The 6-in pump system can accommodate two divers and two hoses for greater efficiency. A bulldozer and/or skid-steer would be required to spread the sand to the design grade. The production rate for one diver is expected to be 20 to 40 cy of sand per hour.

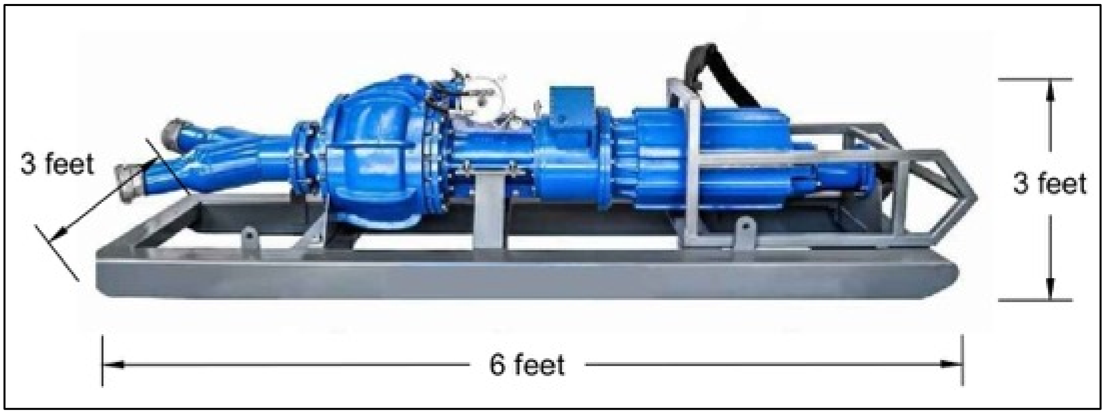


Figure 3-11 Diver-operated dredge pump

Figure 3-12 Surface supplied air (SSA) diver using a diver-operated dredge

3.6.7 Excavator with Dredge Pump Attachment

An excavator with a dredge pump attached to the boom is a direct method of dredging sand from nearshore onto the beach. The system would include an excavator, a submersible pump, a slurry pipeline to shore, and power for the pump. The pump could hang from or be attached to the excavator boom. The pump would be lowered into the water into contact with the sand and moved around by the excavator, as necessary.

This method has been used successfully for ongoing beach maintenance at the KoʻOlina lagoons, where sand regularly migrates (slumps) from the beach face into the water due to the low wave energy within the lagoons. The excavator is positioned near the water line and a Toyo submersible pump is lowered into the water. The sand/water slurry is pumped to shore into dewatering basins that are trenched into the upper beach face. Sand recovery typically extends about 60 ft from the waterline into the lagoon.

An excavator equipped with a cutterhead pump attachment is potentially a more-efficient method for sand recovery. Eddy Pump© makes an excavator attachment that is specifically designed to connect to the excavator bucket linkage. The pump can also be powered by the excavator's hydraulics, eliminating the need for shore-side power. This configuration reduces crew size and allows the excavator operator to dredge sand by sweeping back-and-forth with the excavator arm. The system could extend further from the waterline by placing the excavator on a Flexifloat system or in very shallow water by building a platform that rests on the sand. A minimum 40-ton class excavator is recommended. The coverage area could be extended by using a long-reach excavator, provided that it can remain balanced. An example of an excavator-mounted pump is shown in Figure 3-13.

Advantages of an excavator with a dredge pump are that the equipment is available on-island, is relatively simple to maneuver and operate, and can be powered by the excavator (no additional power required). A disadvantage of an excavator is that it has limited reach. Extending the reach of the excavator would require a platform, such as Flexifloats, or construction of a berm to drive on. Additionally, a dewatering basin on land would be required. Production rates are dependent on the pump size and are expected to be 20 to 40 cy per hour.

Figure 3-13 Excavator with 10-in dredge pump and power pack (EddyPump©, 2021)

4. PROPOSED ACTION: FORT DERUSSY BEACH SECTOR

4.1 General Description

The Fort DeRussy beach sector spans approximately 1,680 ft of shoreline that extends from the Hilton pier/groin east to the Fort DeRussy outfall/groin. Prominent features in this sector include the Fort DeRussy beach walkway, Duke Paoa Kahanamoku Park, Hale Koa Hotel, Fort DeRussy Park, and the U.S. Army Museum of Hawaiʻi. An overview map of the Fort DeRussy beach sector is shown in Figure 4-1.

History
Modifications to the Fort DeRussy beach sector began in the early 1900s with dredging and seawall construction extending to the present location of the Sheraton Waikiki Hotel. The backshore, which was primarily wetlands, was filled with crushed coral material that was dredged from the adjacent reef. In the 1950s, the Hilton pier/groin and Hilton Channel were constructed at the west end of the sector. The beach was constructed in 1969 using approximately 160,000 cy of crushed coral material that was dredged from the nearshore reef (USACE, 1993). In 1976, a 2-ft-thick layer of carbonate sand was placed over the crushed coral base (USACE, 2002). Sand was periodically placed on the beach through the mid-1990s, but no beach improvements or maintenance has been conducted since then. The history of coastal engineering in the Fort DeRussy beach sector is summarized in Figure 4-2. Historical photographs of the Fort DeRussy beach sector are shown in Figure 4-3. Aerial photographs comparing the shoreline conditions in the Fort DeRussy beach sector in 1949 and 2015 are shown in Figure 4-4.

Existing Conditions
The Fort DeRussy beach sector is an entirely engineered shoreline. The west end of the sector is bounded by a concrete rubble masonry (CRM) groin that is buried in the beach and connects to the Hilton pier. The central portion of the sector consists of a man-made beach that is backed by a concrete seawall that was constructed in 1916. The seawall spans the entire length of the Fort DeRussy beach sector. The east end of the sector is bounded by the Fort DeRussy outfall/groin, which consists of a concrete box culvert and a rock rubblemound groin.

The existing shoreline is a man-made sandy beach that is composed of a combination of sand and coral that was dredged from offshore. The beach is widest at the west end and narrowest at the east end. At the west end of the beach, adjacent to the Hilton pier/groin, the sand is compacted and hardened over much of the dry beach area. The eastern portion of the sector consists of a narrow sandy beach with steeper slopes that is subject to chronic erosion. The Fort DeRussy seawall is frequently exposed by erosion along this portion of the shoreline.

The Fort DeRussy beach walkway provides lateral access along the shoreline from Hilton Hawaiian Village to the Castle Waikīkī Shore. Perpendicular access to the shoreline is available through Fort DeRussy Park and a public beach access located at the intersection of Kālia Road and Saratoga Road. There are no lifeguard towers in the Fort DeRussy beach sector. The existing beach walkway has a ground elevation of about +5 ft MSL. Along the Diamond Head (east) end of the beach sector, sand is often pushed landward over the beach walkway by wave action, particularly during high tides and high surf events. The beach fronting the Fort DeRussy tennis courts has been significantly eroded in recent years and appears to be increasingly unstable with the beach being completely eroded along a 200-foot reach and waves frequently overtopping the beach walkway. It appears that what has traditionally been a seasonal erosion pattern has transitioned into a semi-permanent state of erosion. Beach rental concessions, beach pavilions and tennis (pickle ball) courts back this section of the beach walkway. Behind the concessions is Fort DeRussy Park and the U.S. Army Hawaiʻi Museum of History.

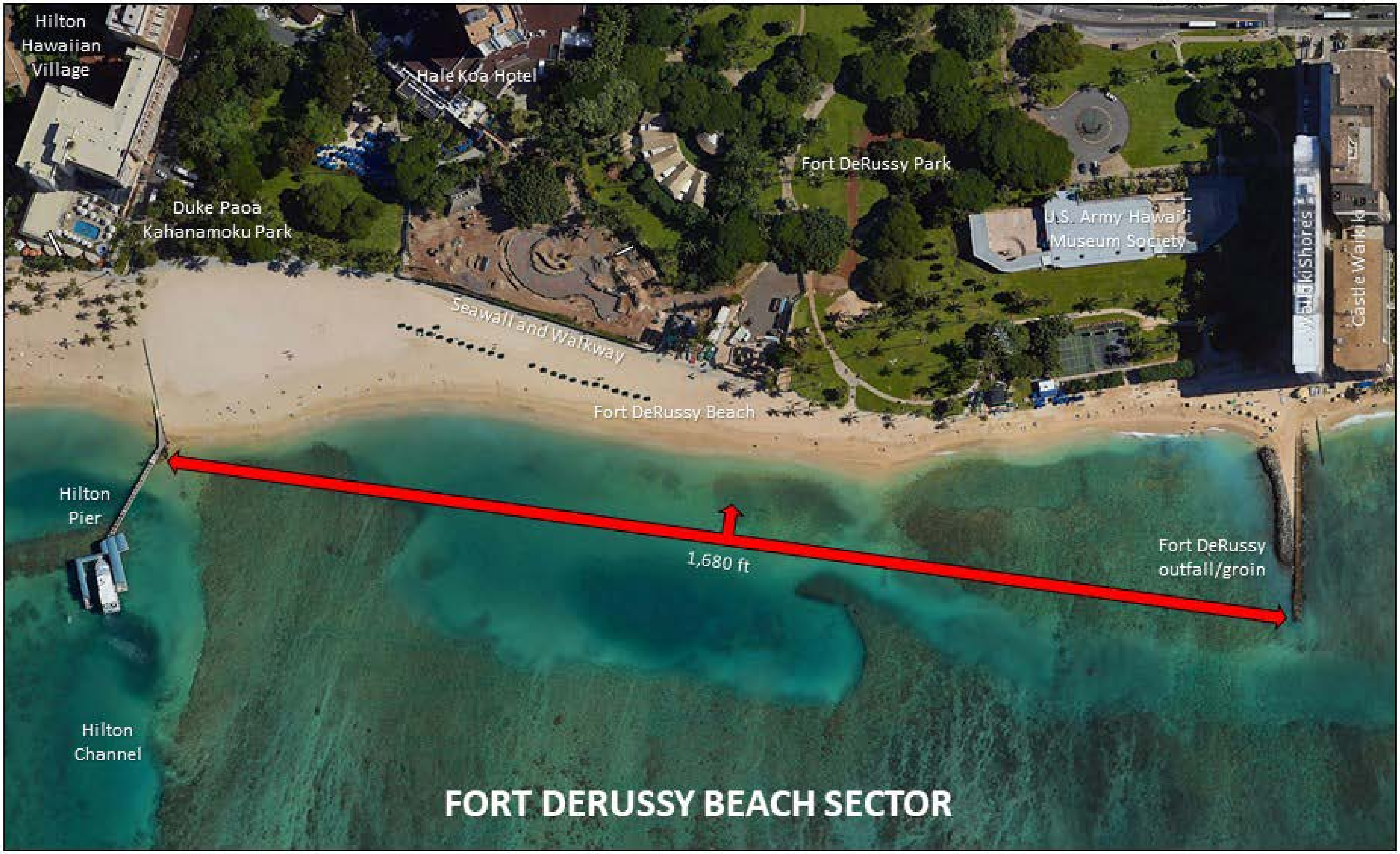
Adjacent to the pier is a wide sand channel (Hilton Channel) with scattered rubble and sandy seafloor. East of the Hilton Channel, rubble covered in macroalgae extends east to the Fort DeRussy outfall/groin. The Hilton pier and Hilton Channel are located within the Waikīkī Ocean Water Restricted Zone B, which is under the jurisdiction of the DLNR Division of Boating and Ocean Recreation (DOBOR). DOBOR rules prohibit vessels from operating within this area except for outrigger canoes, authorized sailing catamarans, and other vessels operating from the Hilton pier. Photographs of existing conditions in the Fort DeRussy beach sector are shown in Figure 4-5.

Historical and Projected Shoreline Change

The University of Hawaiʻi Coastal Geology Group (UHCGG) historical shoreline change trend for the Fort DeRussy beach sector (transects 141 to 169) from 1927 to 2015 has been erosion at an average rate 0.4 ft/yr (UHCGG, 2019). Beach erosion does not occur uniformly throughout the sector. The east end of the beach (transects 141 to 153) has been eroding at an average rate of 1.2 ft/yr, whereas the west end of the beach (transects 154 to 169) has been accreting at an average rate of 0.4 ft/yr. The erosion is more pronounced at the east end of the beach because the predominant direction of sediment transport is from east to west along this portion of the Waikīkī shoreline (Miller and Fletcher, 2003). As sand is transported from east to west along the beach, the east end of the beach narrows and there is no mechanism to transport sand back to the eroding area.

Erosion, coastal flooding, and beach loss in the Fort DeRussy beach sector are projected to increase as sea levels continue to rise. The UHCGG shoreline change projections estimate that the shoreline could erode up to 30.8 ft (9.4 m) by 2050 and up to 81 ft (24.7 meters) by 2100 (UHCGG, 2019). These projections do not account for the presence of the existing seawall that spans the entire length of the Fort DeRussy beach sector. As the shoreline approaches the existing seawall, there is an incremental loss of recreational beach area and shoreline habitat, a process that is referred to as *coastal squeeze* (Lester and Matella, 2016).

There have been no beach improvement or maintenance projects in the Fort DeRussy beach sector since the mid-1990s. Recent observations indicate that beach loss is already accelerating in the eastern portion of the Fort DeRussy beach sector. Without beach improvements and/or maintenance, it is likely that sea level rise will result in total beach loss at the east end of this sector by mid-century or sooner due to the combined effects of increasing erosion and increasing frequency and severity of coastal flooding, particularly in areas where the beach is already narrow and often submerged during high tides and high surf events.



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OVERVIEW MAP – FORT DERUSSY BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
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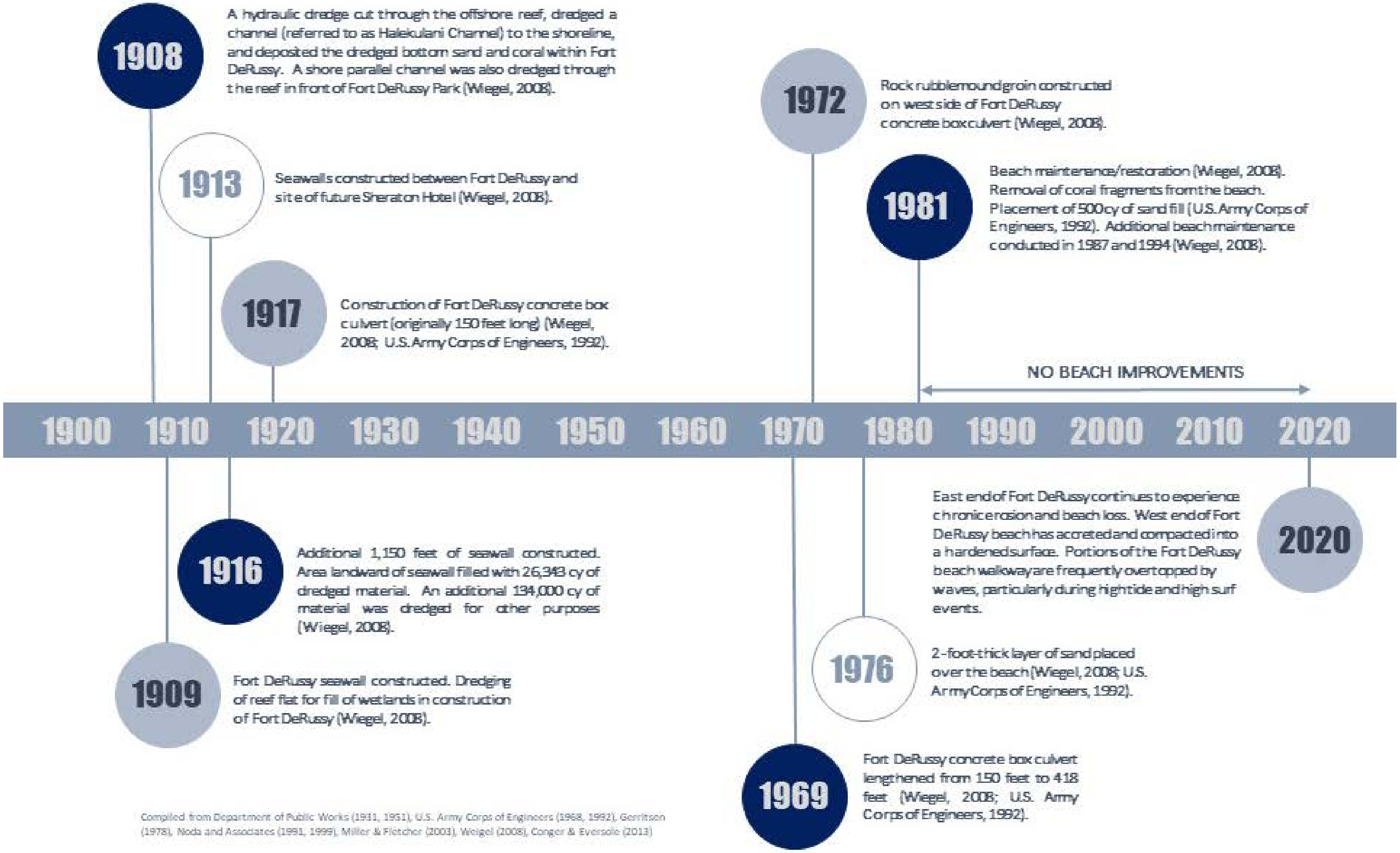
Figure 4-1 Overview map – Fort DeRussy beach sector



1908 A hydraulic dredge cut through the offshore reef, dredged a channel (referred to as Halekulani Channel) to the shoreline, and deposited the dredged bottom sand and coral within Fort DeRussy. A shore parallel channel was also dredged through the reef in front of Fort DeRussy Park (Wiegel, 2008).

1909 Fort DeRussy seawall constructed. Dredging of reef flat for fill of wetlands in construction of Fort DeRussy (Wiegel, 2008).

1913 Seawalls constructed between Fort DeRussy and site of future Sheraton Hotel (Wiegel, 2008).

1916 Additional 1,150 feet of seawall constructed. Area landward of seawall filled with 26,343 cy of dredged material. An additional 134,000 cy of material was dredged for other purposes (Wiegel, 2008).

1917 Construction of Fort DeRussy concrete box culvert (originally 150 feet long) (Wiegel, 2008; U.S. Army Corps of Engineers, 1992).

1969 Fort DeRussy concrete box culvert lengthened from 150 feet to 418 feet (Wiegel, 2008; U.S. Army Corps of Engineers, 1992).

1972 Rock rubblemound groin constructed on west side of Fort DeRussy concrete box culvert (Wiegel, 2008).

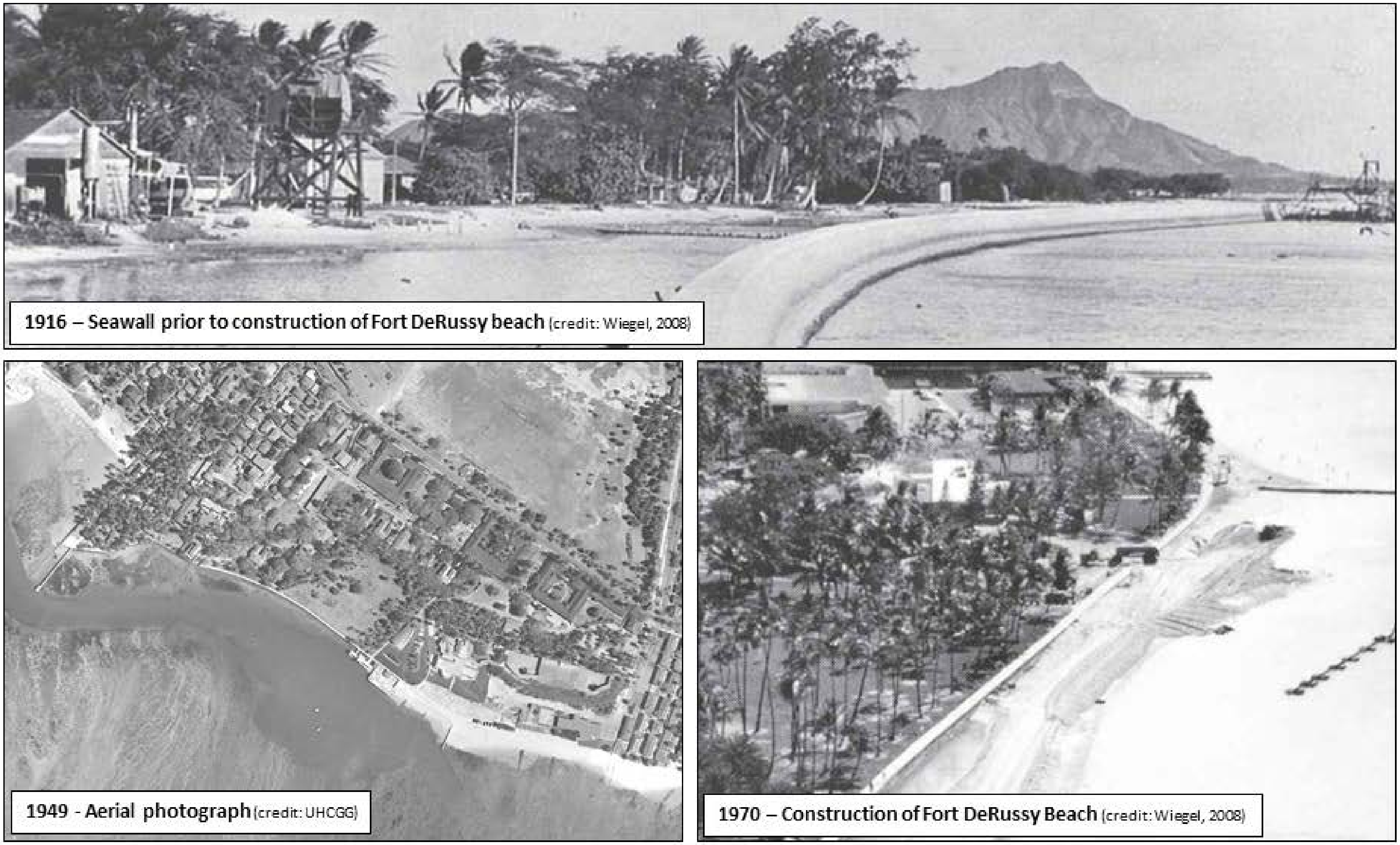
1976 2-foot-thick layer of sand placed over the beach (Wiegel, 2008; U.S. Army Corps of Engineers, 1992).

1981 Beach maintenance/restoration (Wiegel, 2008). Removal of coral fragments from the beach. Placement of 500 cy of sand fill (U.S. Army Corps of Engineers, 1992). Additional beach maintenance conducted in 1987 and 1994 (Wiegel, 2008).

2020 East end of Fort DeRussy continues to experience chronic erosion and beach loss. West end of Fort DeRussy beach has accreted and compacted into a hardened surface. Portions of the Fort DeRussy beach walkway are frequently overtopped by waves, particularly during high tide and high surf events.

Compiled from Department of Public Works (1931, 1951), U.S. Army Corps of Engineers (1968, 1992), Gerritsen (1978), Noda and Associates (1991, 1999), Miller & Fletcher (2003), Weigel (2008), Conger & Eversole (2013)

Figure 4-2 History of coastal engineering – Fort DeRussy beach sector



1916 – Seawall prior to construction of Fort DeRussy beach (credit: Wiegel, 2008)

1949 - Aerial photograph (credit: UHCGG)

1970 – Construction of Fort DeRussy Beach (credit: Wiegel, 2008)

HISTORICAL PHOTOGRAPHS – FORT DERUSSY BEACH SECTOR

Waikīkī Beach Improvement and Maintenance Program

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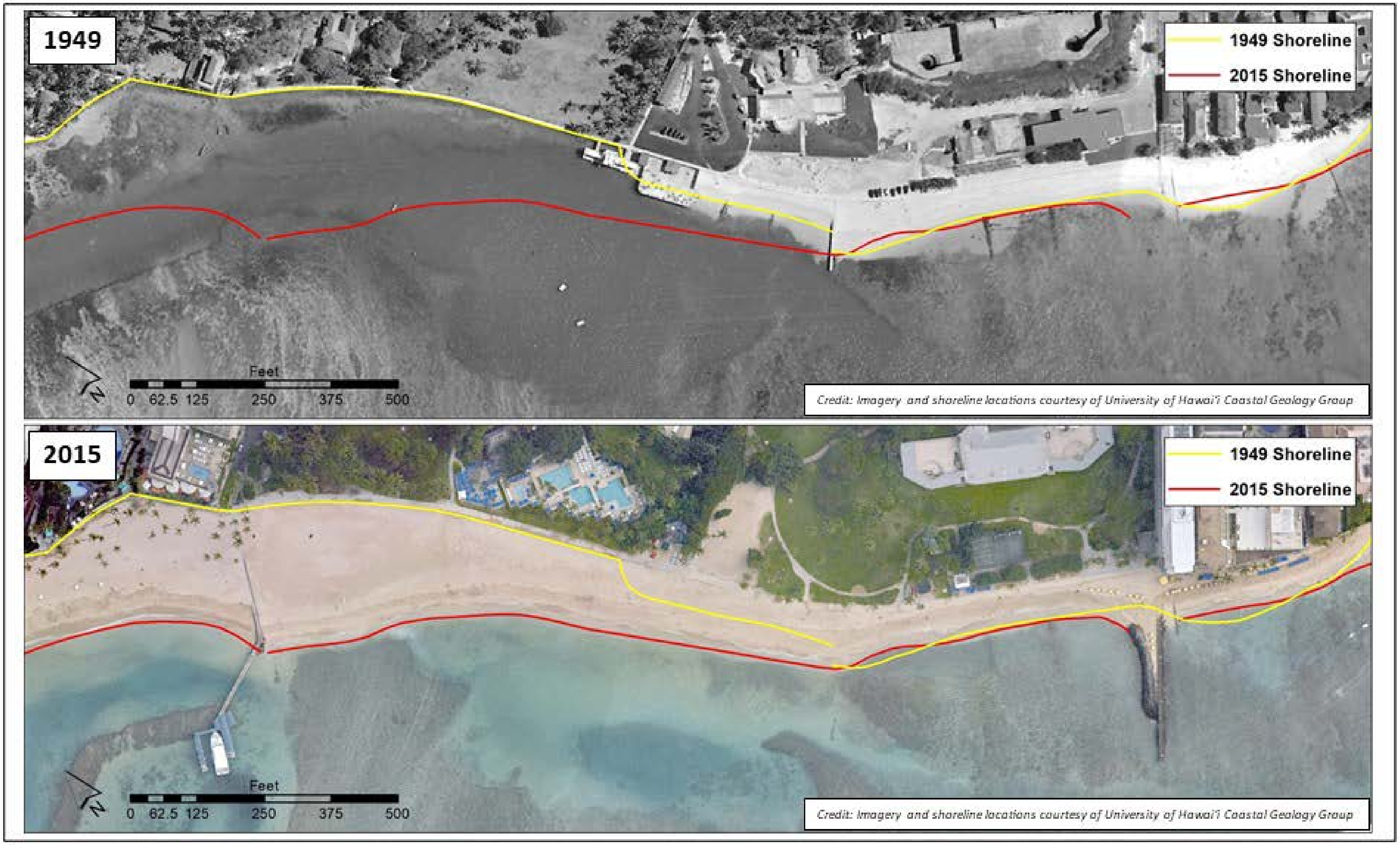
Figure 4-3 Historical photographs – Fort DeRussy beach sector



Credit: Imagery and shoreline locations courtesy of University of Hawaiʻi Coastal Geology Group

HISTORICAL SHORELINE POSITIONS – FORT DERUSSY BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
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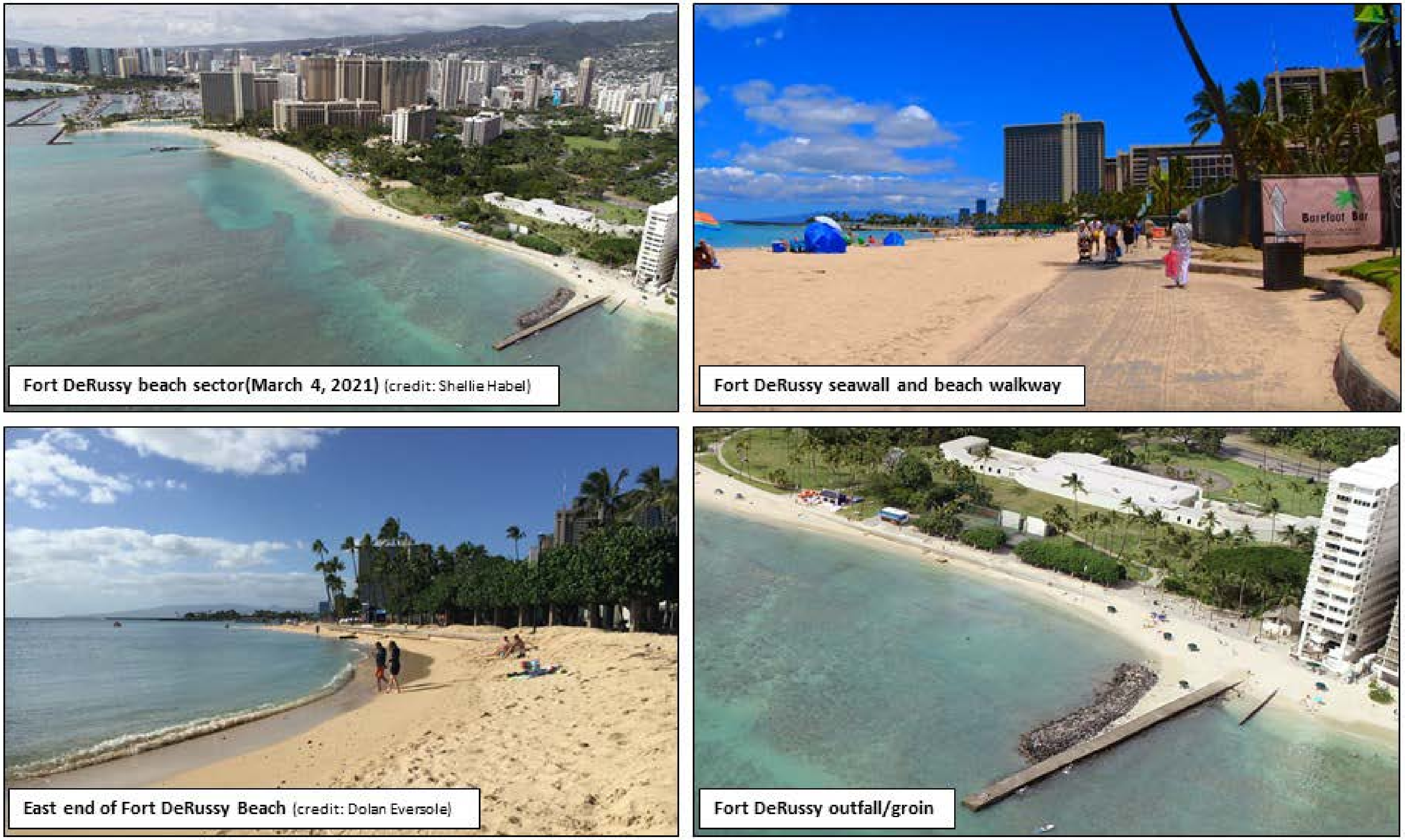
Figure 4-4 Comparison of 1949 and 2015 shoreline positions – Fort DeRussy beach sector



Fort DeRussy beach sector(March 4, 2021) (credit: Shellie Habel)

Fort DeRussy seawall and beach walkway

East end of Fort DeRussy Beach (credit: Dolan Eversole)

Fort DeRussy outfall/groin

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EXISTING CONDITIONS – FORT DERUSSY BEACH SECTOR

Waikīkī Beach Improvement and Maintenance Program

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Figure 4-5 Existing conditions – Fort DeRussy beach sector

4.2 Purpose and Need for the Proposed Action

Waves from the south approach the beach at an oblique angle pushing sand from the east end to the west end, which causes erosion and beach narrowing at the east end of the sector. The Fort DeRussy beach walkway runs along the inshore side of the beach and is fronted by a low crested seawall that was constructed in 1916. The majority of the seawall is buried flush with the beach walkway and provided protection from scour and undermining. However, the elevation of the beach walkway is currently at the wave run-up elevation and waves periodically overtop the beach crest pushing sand over the beach walkway. Without beach improvements or maintenance, the seawall will become more exposed to wave action and the beach walkway will experience more frequent overtopping as sea levels continue to rise.

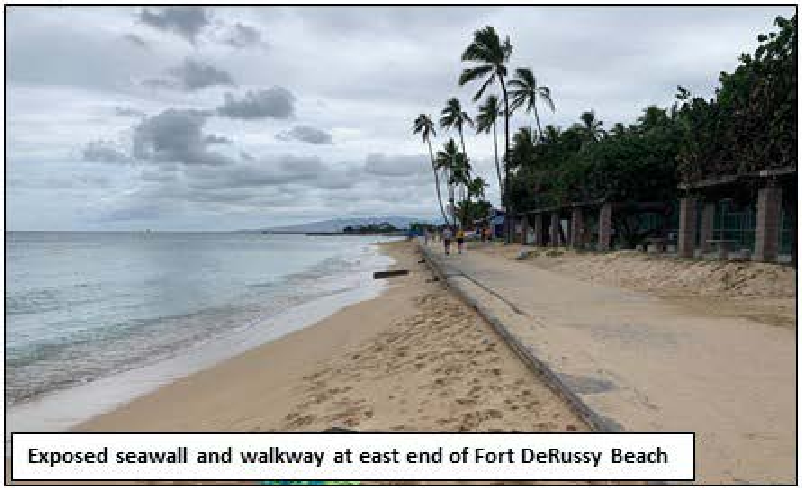
Erosion along the Fort DeRussy shoreline threatens to expose the seawall fronting the beach walkway, which extends along the entire length of the shoreline. Beach widths are narrow (on the order of 30 ft) at the east end of the sector. Wave overwash on the mauka (landward) side of the beach is problematic where beach widths are narrow (USACE, 2009). There is evidence that the Fort DeRussy outfall/groin is also being flanked by erosion, thereby reducing its effectiveness as a beach stabilizing structure. Photographs of existing issues and problems in the Fort DeRussy beach sector are shown in Figure 4-6.

In collaboration with the WBCAC, the project proponents determined that the primary issues and problems in the Fort DeRussy beach sector are:

- Erosion and beach narrowing.
- Wave runup and overtopping of the Fort DeRussy beach walkway.
- Deterioration and failure of the Fort DeRussy seawall.
- Environmental degradation.
- Lack of amenities.

The highest priorities in the Fort DeRussy beach sector are to:

- Address beach loss at the east end of Fort DeRussy Beach.
- Prevent the existing seawall from becoming exposed by erosion.
- Prevent wave overtopping of the Fort DeRussy beach walkway.


Exposed seawall and walkway at east end of Fort DeRussy Beach


King tide flooding over seawall and walkway (credit: Matt Gonser)


Erosion at east end of Fort DeRussy Beach


King tide flooding over seawall and walkway (credit: Derek Bacigal)

ISSUES AND PROBLEMS – FORT DERUSSY BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
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Figure 4-6 Issues and problems – Fort DeRussy beach sector

4.3 Proposed Action

4.3.1 Description of the Proposed Action

The proposed action for the Fort DeRussy beach sector is beach maintenance consisting of sand backpassing with no improvements or modifications to existing structures. Sand will be transported from the accreted area at the west end of the beach to the eroding area at the east end of the beach to increase dry beach width and mitigate wave overtopping. Sand will be obtained from the beach face on the east side of the Hilton pier/groin, where sand has accreted over the years. Sand will be excavated from the beach face extending inshore only as far as necessary to obtain the required volume of sand.

The purpose of the proposed sand backpassing is to widen the east end of Fort DeRussy Beach, which is chronically eroding and in a narrow, deteriorated condition. Sand will be transported from the borrow site to the placement site, where it will be placed along the beach face from the beach toe to the crest, widening the dry beach with an average 15 to 20 ft wide crest and measuring 50 to 60 ft from the seawall and walkway to the waterline. The proposed action is based on a design fill template (footprint and profile) that is based on the historical position of the beach and walkway. The volume of sand required to achieve the design fill template will depend on conditions at the borrow site and placement site at the time of construction. This will provide flexibility in terms of when the backpassing can be performed.

The orientation of sandy shorelines is a function of the wave angle approaching shore. The shoreline is shaped by the incident waves passing over the reef and undergoing the processes of breaking, refraction, and diffraction. Wave modeling for a prevailing south swell was performed. The model results indicate that the waves closest to the shoreline have a slight arc shape, which is consistent with the shape of the historical shoreline. In addition to the waves, the seafloor near the beach can determine the fill footprint. Ideally, the fill sand will be placed on existing sandy substrate rather than reef.

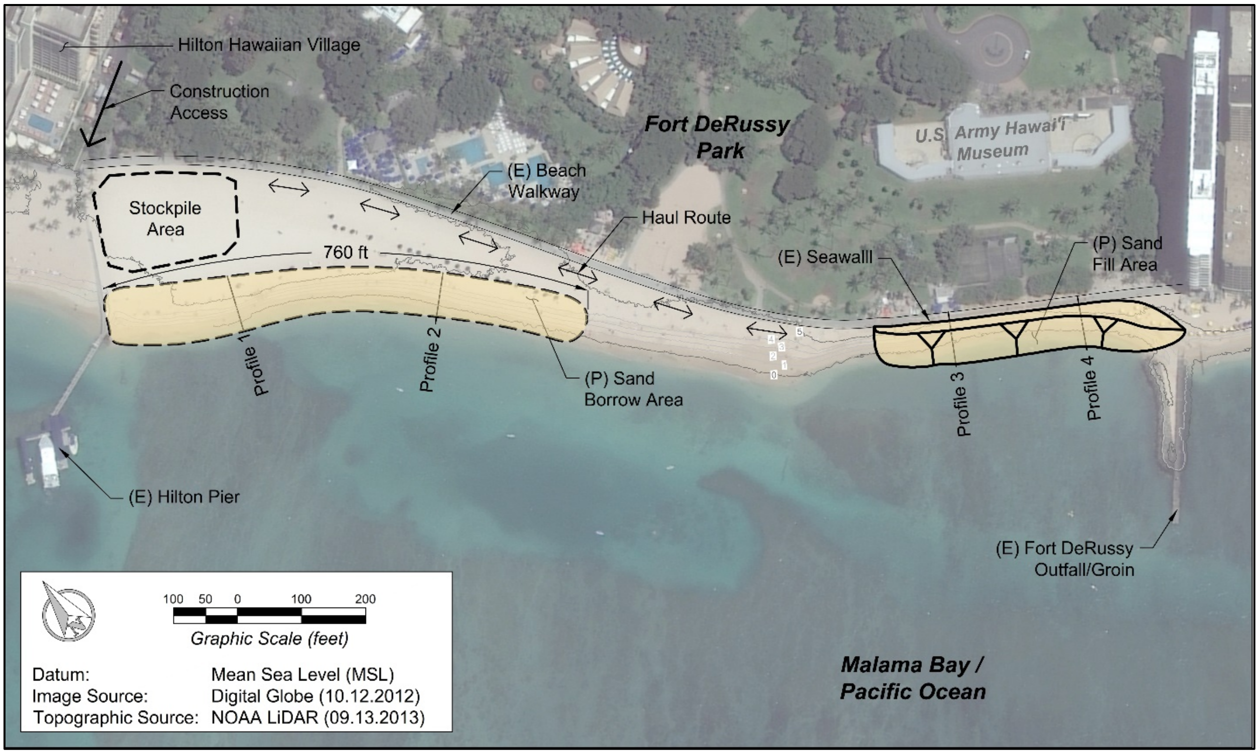
The proposed sand backpassing will include relocating approximately 1,500 cy of sand. The fill sand will be placed inshore of the “offshore fill limit” and the beach crest will be +5 ft MSL to match the elevation of the seawall and beach walkway in the placement site. The volume of sand required is based on a December 2019 topographic survey (Figure 4-7). Recent observations indicate that Profiles 3 and 4 are significantly more eroded now and there is almost no sand fronting the seawall and walkway. An updated topographic survey will be conducted during the final design and permitting phase to confirm the volume of sand required to achieve the design beach profile.

Sand will be obtained from the beach face over an approximate 700-ft reach on the Diamond Head (east) side of the Hilton pier/groin where the beach is currently more than 250 ft wide. A reduction in beach width of 7.5 ft (3%) over the 700 ft will produce approximately 1,500 cy of sand. The sand will be manually transported from the borrow site to the placement site, where it will be placed along the shoreline to produce a beach with a 15 to 20 ft wide crest and measuring 50 to 60 ft from the seawall and walkway to the waterline. The project layout and design beach profiles for the proposed action are shown in Figure 4-7 and Figure 4-8, respectively. Conceptual renderings of the proposed action are shown in Figure 4-9 and Figure 4-10.

The sand backpassing is not anticipated to alter existing sediment transport patterns. The beach at the placement site will continue to be subject to erosion; however, large wave events such as hurricanes could result in significant loss of sand in a short period of time. Due to the narrow width of the existing beach, some sand will need to be placed in the ocean to achieve an initially stable beach profile.

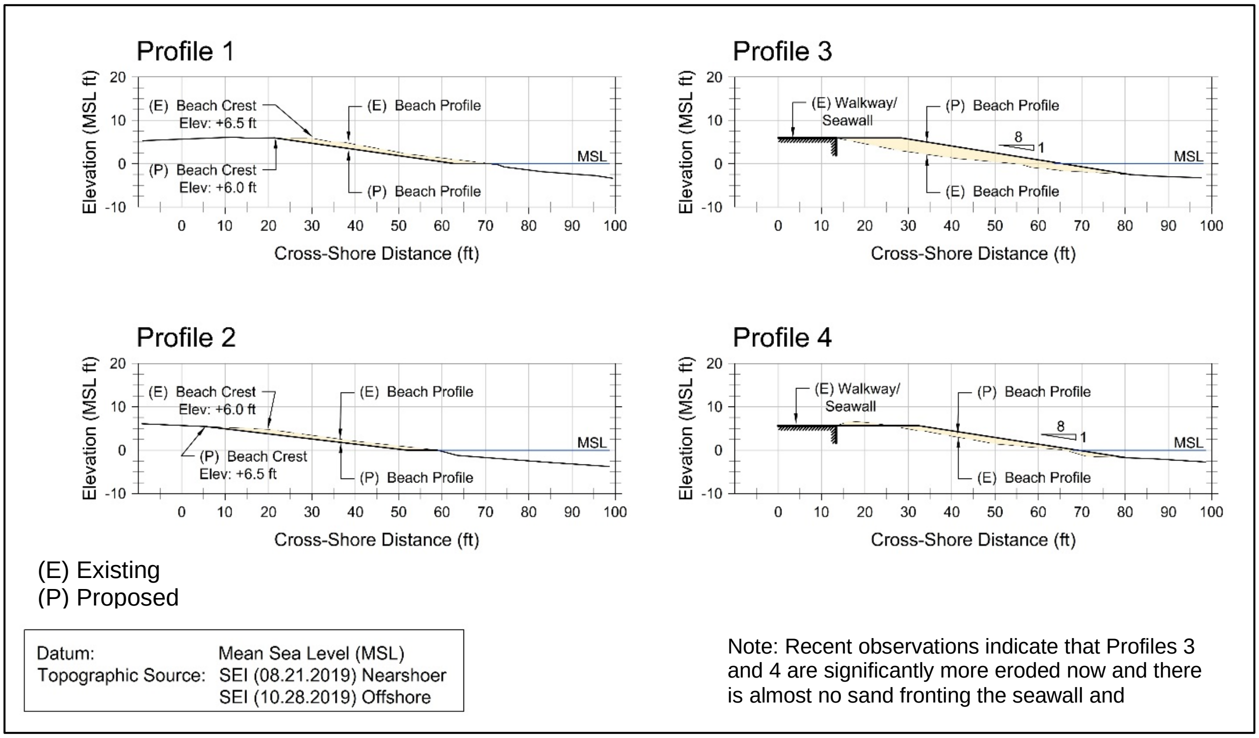
The proposed sand backpassing could be performed as a single project but is intended to be implemented as an ongoing maintenance program. Periodic backpassing would be performed on an as-need basis to maintain adequate beach width at the east end of the beach sector. The maintenance program would allow for sand backpassing to be conducted when beach conditions reach some pre-defined topographic triggers without having to repeat the permit process. Beach monitoring will be required to determine when the triggers have been met.

The UHCGG estimates that the average annual erosion rate at the east end of the Fort DeRussy beach sector with 3.2 ft of sea level rise is 2.7 ft/yr (mid-range, 80% confidence) (UHCGG, 2019). Based on this estimate, sand backpassing will need to be conducted every 3 years. Over a period of 50 yrs, this will result in a total of 17 individual sand backpassing events and a total of 170 days of construction.



Datum: Mean Sea Level (MSL)
Image Source: Digital Globe (10.12.2012)
Topographic Source: NOAA LiDAR (09.13.2013)

Figure 4-7 Project layout for proposed action – Fort DeRussy beach sector



(E) Existing
(P) Proposed

Datum: Mean Sea Level (MSL)
Topographic Source: SEI (08.21.2019) Nearshoer
SEI (10.28.2019) Offshore

Note: Recent observations indicate that Profiles 3 and 4 are significantly more eroded now and there is almost no sand fronting the seawall and

Figure 4-8 Beach profiles for proposed action – Fort DeRussy beach sector

Rendering By Jonathan Quach, Independent Contractor.

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CONCEPTUAL PLAN VIEW OF PROPOSED ACTION – FORT DERUSSY BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
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Figure 4-9 Conceptual plan view of proposed action – Fort DeRussy beach sector

Rendering By Jonathan Quach, Independent Contractor.

CONCEPTUAL OBLIQUE VIEW OF PROPOSED ACTION – FORT DERUSSY BEACH SECTOR
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Figure 4-10 Conceptual oblique view of proposed action – Fort DeRussy beach sector

4.3.2 Sand Source

The proposed action in the Fort DeRussy beach sector involves moving sand from the beach face east of the Hilton pier/groin to the beach fronting the U.S. Army Hawaiʻi Museum. Two sand samples were obtained from the beach face at each end of the beach sector in February 2021. Figure 4-11 shows the composite grain size distribution for the existing sand at the Diamond Head (east) end of the beach sector, which has a median grain size (D_{50}) of 0.35 mm. Figure 4-11 also shows the composite grain size distributions for two samples of the fill sand that will be obtained from the ʻEwa (west) end of the beach sector, which is slightly coarser but would be expected to be more stable on an eroding beach. This is particularly true for the Fort DeRussy beach sector where no additional beach stabilizing structures are proposed.

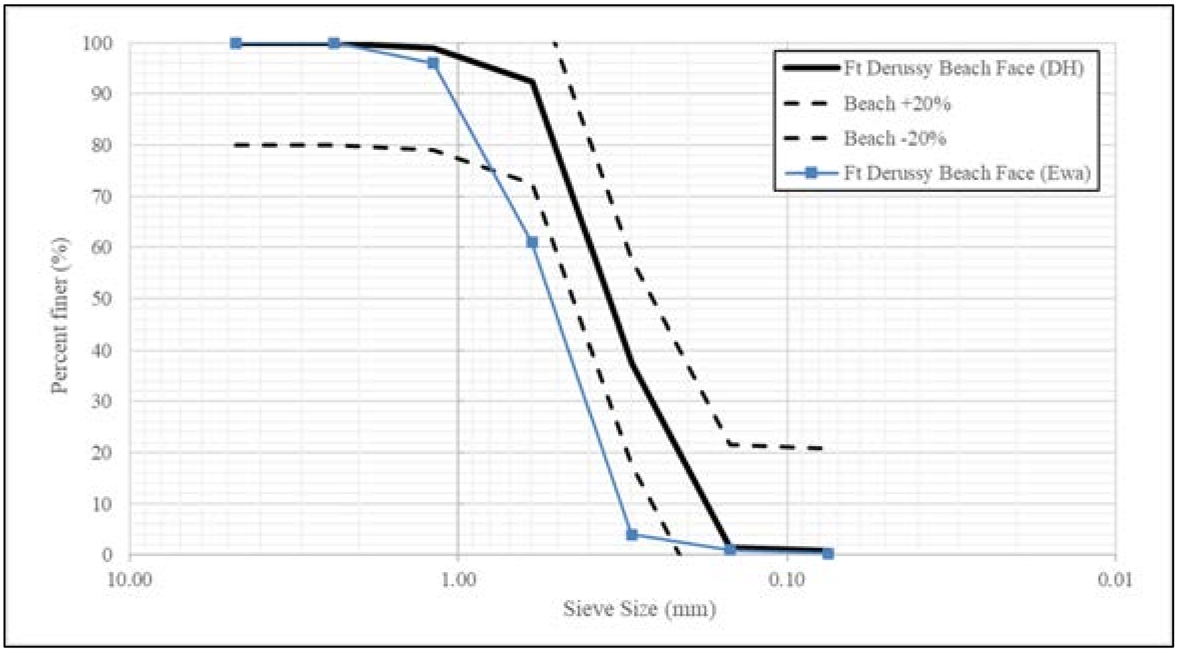


Figure 4-11 Grain size comparison of existing beach sand at borrow site and fill site

4.3.3 Construction Methodology

Heavy equipment such as excavators, front end loaders, and dump trucks will access the site either through the parking lot makai (seaward) of the Duke Kahanamoku Lagoon or through Paoa Lane between Hilton Hawaiian Village and the Hale Koa Hotel. Sand will be excavated from the beach face at the borrow site on the east side of the Hilton pier/groin using an excavator situated on the dry beach. The borrow site is approximately 700 ft long, and removal of sand equating to a 7.5-ft reduction in beach width will produce around 1,500 cy of sand. The sand will be taken from the beach face and will not reduce the beach crest elevation at the borrow site. The proposed project layout is shown in Figure 3-7.

The borrow sand will be obtained by the excavator scooping sand from the beach face, both above and below the waterline, and placing the sand directly into dump trucks or stockpiling it temporarily on the back beach prior to transport. The dump trucks will then transport the sand down the beach along the makai (seaward) side of the seawall and walkway and place the sand in the placement area, where it will be graded by a bulldozer to achieve the design beach profiles. Depending on the size and capacity of the dump trucks, approximately 50 to 100 truckloads will be required to move 1,500 cy of sand. Based on this volume of sand, the construction duration will be approximately 10 days.

Access between the borrow site and placement site may be limited due to beach conditions at the time of construction. If the beach is narrow, sand placement will begin at the west end of the placement site and proceed from west to east, with the newly placed sand providing access for trucking.

Best Management Practices (BMPs) will be employed as required by the permits. BMPs may include turbidity curtains surrounding the borrow and fill sites, silt fencing, and biosocks. Signage and barriers will be used to divert beach users away from active work areas, and the dump trucks will be escorted down the beach to ensure public health and safety.

4.3.4 Estimated Timing, Phasing, and Duration

The proposed sand backpassing is designed to be implemented periodically on an as-needed basis. Sand backpassing will be conducted when beach conditions reach some predetermined topographic triggers. Beach monitoring will be required to determine when the triggers have been met. The estimated construction duration for the proposed sand backpassing is 10 days. The UHCGG estimates that the average annual erosion rate at the east end of the Fort DeRussy beach sector with 3.2 ft of sea level rise is 2.7 ft/yr (mid-range, 80% confidence) (UHCGG, 2019). Based on this estimate, sand backpassing will need to be conducted every 3 years. Over a period of 50 yrs, this will result in a total of 17 individual sand backpassing events and a total of 170 days of construction.

4.3.5 Required Permits and Approvals

The proposed action is anticipated to require the following permits and approvals:

- Department of the Army Permit (Section 10 and Section 404)
- Clean Water Act, Section 401 Water Quality Certification
- Coastal Zone Management Act Consistency Review
- Small Scale Beach Nourishment (SSBN) or Small Scale Beach Restoration (SSBR) Permit
- Right of Entry Permit

4.4 Alternatives to the Proposed Action

The following alternatives were considered for the Fort DeRussy beach sector:

- Beach Nourishment without Stabilizing Structures
- Beach Nourishment with Stabilizing Structures

4.4.1 Beach Nourishment without Stabilizing Structures

An alternative to sand backpassing is beach nourishment without stabilizing structures, which would involve obtaining offshore sand and placing it on the beach at the Diamond Head (east) end of the Fort DeRussy beach sector. Depending on the desired beach width and crest elevation, the project would involve placement of approximately 6,300 to 13,700 cy of offshore sand on the beach. The beach would be widened to approximately 165 ft as measured from the beach walkway to the waterline. A topographic survey would be required to confirm the final design profiles.

Potential sand sources for beach nourishment in the Fort DeRussy beach sector are the *Hilton* and *Ala Moana* offshore deposits (see Section 3.5). Sand recovery would likely be performed using a clamshell dredging system, with the sand loaded onto a barge, transported to shore, and offloaded into dump trucks. Consultations with the Hawaiʻi Department of Transportation determined that pier space at Honolulu Harbor is not available; therefore, the most likely sand offloading site would be the Ala Wai Small Boat Harbor and Magic Island parking lot. This is the same offloading location that is proposed for the Ala Moana Regional Park beach nourishment project. The sand would be trucked into Fort DeRussy through Paoa Lane or through the U.S. Army Hawaiʻi Museum property. The sand would be placed on the beach and spread using bulldozers.

Beach nourishment without stabilizing structures would not alter existing sediment transport patterns and the beach would continue to erode; however, large events such as hurricanes could result in significant loss of sand in a short period of time.

The estimated construction duration for beach nourishment without stabilizing structures is 120 days, and the estimated recurrence interval is 10 yrs. Assuming that renourishment is conducted over a period of 50 yrs, this would result in a total of 5 individual renourishment events and a total of 600 days of construction.

4.4.2 Beach Nourishment with Stabilizing Groins

Another alternative to sand backpassing would be to nourish the beach and construct 2 to 3 groins to stabilize the sand fill. Stabilizing groins are necessary to maintain a stable beach profile and prevent the sand from eroding. Guidance for T-head groin design is provided in Section 3.4.5.

Figure 4-12 presents two conceptual layouts for beach nourishment with stabilizing groins that would produce one or two stable beach cells fronting the U.S. Army Hawaiʻi Museum property. The conceptual layout presented in Figure 4-12 (a) would require construction of one L-head groin and adding an angled head to the existing rock rubblemound groin on the ʻEwa (west) side of the existing Fort DeRussy outfall/groin. This option would create one stable, arc-shaped beach cell that would be approximately 50 ft wide in the center and widen to approximately 83 ft near the groins. The project would place approximately 8,500 cy of offshore sand on the beach.

The conceptual layout presented in Figure 4-12 (b) would require construction of one T-head groins and one L-head groin and adding an angled head to the existing rock rubblemound groin on the ʻEwa (west) side of the existing Fort DeRussy outfall/groin. This option would create two stable, arc-shaped beach cells that would be approximately 38 to 53 ft wide in the center and widen to approximately 92 to 97 ft near the groins. The project would place approximately 14,000 cy of offshore sand on the beach.

The groins would be designed for an initial +8.5 ft MSL beach crest elevation to account for 1.5 ft of sea level rise, with the ability to increase the beach crest elevation to +10 ft MSL to account for additional future sea level rise. The groin stems would be up to about 200 ft long and would be sufficient to stabilize up to a +10-ft MSL beach crest elevation. The minimum beach crest width at its narrowest point midway between the groins would be about 20 to 30 ft, and the beach slope would be 1V:8H (vertical to horizontal).

The proposed sand backpassing is designed to be implemented periodically on an as-needed basis. Sand backpassing will be conducted when beach conditions reach some predetermined topographic triggers. Beach monitoring will be required to determine when the triggers have been met. The proposed sand backpassing will involve moving approximately 1,500 cy of existing beach sand from one end of the beach to the other. No dredging is proposed and the volume of sand in the littoral system will not be altered. The estimated construction duration for the proposed sand backpassing is 10 days.

The UHCGG estimates that the average annual erosion rate at the east end of the Fort DeRussy beach sector with 3.2 ft of sea level rise is 2.7 ft/yr (mid-range, 80% confidence) (UHCGG, 2019). Based on this estimate, sand backpassing will need to be conducted every 3 years. Over a period of 50 yrs, this will result in a total of 17 individual sand backpassing events and a total of 170 days of construction.

When compared to the alternatives of beach nourishment with or without stabilizing structures, the proposed action has less cumulative impacts. The proposed sand backpassing requires fewer individual events, fewer construction days, fewer beach closures, no offshore dredging, and no increase in the volume of sand in the littoral system. While larger-scale beach nourishment is technically feasible, it is not being proposed due to the relatively isolated scope of the erosion problem. Furthermore, beach nourishment may not be a viable long-term solution due to the limited volume of compatible offshore sand to support periodic renourishment efforts in Waikīkī.

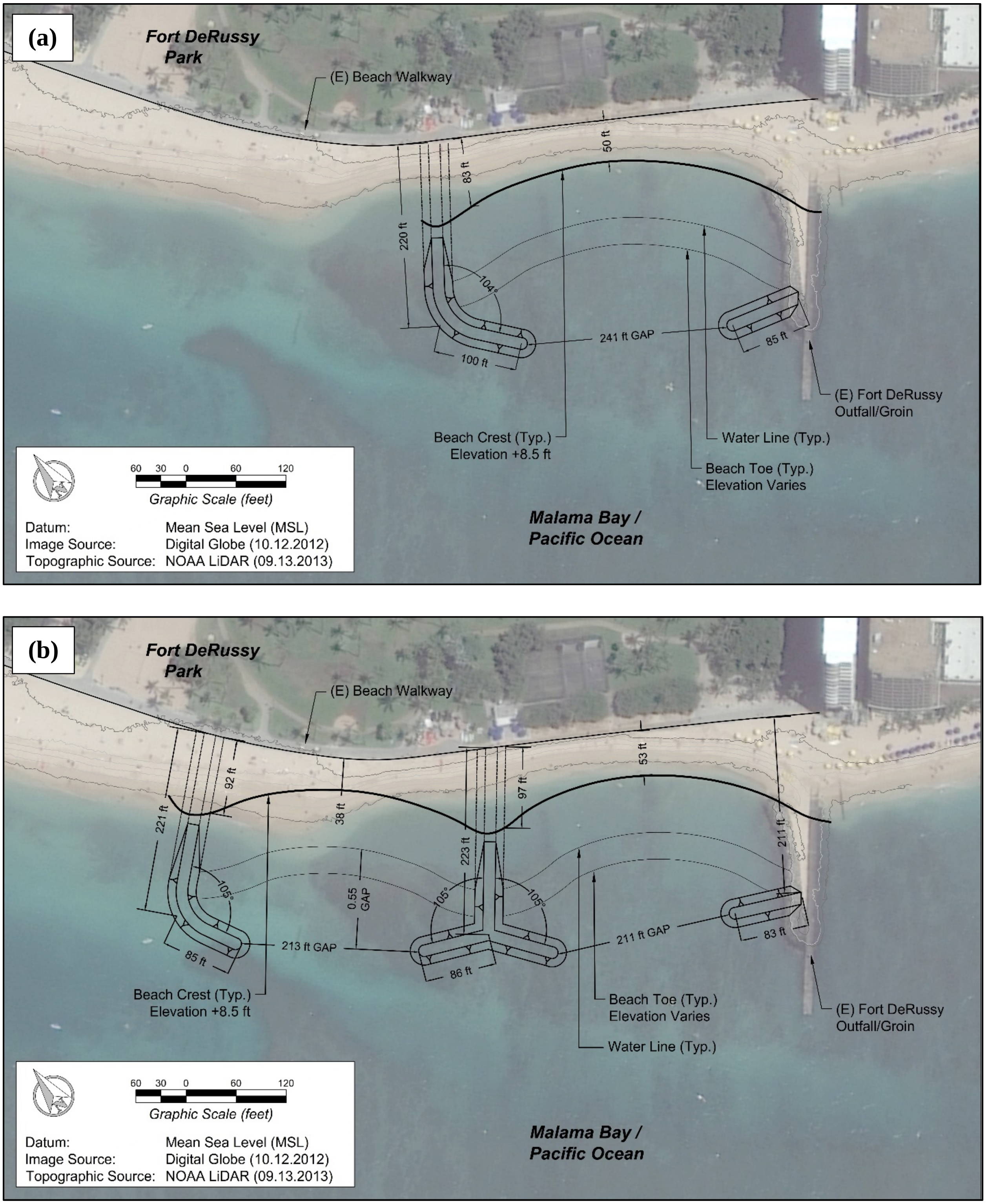


Figure 4-12 Conceptual layouts for beach nourishment with stabilizing groins – Fort DeRussy beach sector

5. PROPOSED ACTION: HALEKŪLANI BEACH SECTOR

5.1 General Description

The Halekūlani beach sector spans approximately 1,450 ft of shoreline extending from the Fort DeRussy outfall/groin east to the Royal Hawaiian groin. Prominent features in this sector include the Castle Waikīkī Shore, Outrigger Reef Waikīkī Beach Resort, Halekūlani Hotel, and the Sheraton Waikiki Hotel. The Halekūlani Channel extends perpendicular from the shoreline fronting the Halekūlani Hotel. An overview map of the Halekūlani beach sector is shown in Figure 5-1.

History

Shoreline modifications in the Halekūlani beach sector occurred generally coincident with modifications in the Fort DeRussy beach sector. In the early 1900's, the Halekūlani Channel was dredged, the material was used as fill for Fort DeRussy, and a series of seawalls were constructed along the shoreline. The Royal Hawaiian groin was constructed in 1927 and, soon after, sand was pumped to the shoreline to construct a beach. Eight small groins were constructed between Fort DeRussy and the Royal Hawaiian groin to stabilize the sand. The history of coastal engineering in the Halekūlani beach sector is summarized in Figure 5-2. Historical photographs of the Halekūlani beach sector are shown in Figure 5-3. Aerial photographs comparing the shoreline conditions in the Halekūlani beach sector in 1949 and 2015 are shown in Figure 5-4.

Existing Conditions

The Halekūlani beach sector is an entirely engineered shoreline. The west end of the sector is bounded by the Fort DeRussy outfall/groin, which consists of a concrete box culvert and a rock rubblemound groin. A narrow beach extends approximately 375 ft east from the Fort DeRussy outfall/groin fronting the Castle Waikīkī Shore and Outrigger Reef Waikīkī Beach Resort. The beach terminates at the west end of a vertical seawall that spans approximately 335 ft of shoreline fronting the Halekūlani Hotel. A concrete sidewalk constructed on top of the seawall provides limited lateral access along the shoreline. The seawall varies in height between +5.2 to +5.6 ft MSL and is frequently overtopped by waves during high tides and high surf events.

Two small pocket beaches, backed by vertical seawalls, are located between the Halekūlani and Sheraton Waikiki hotels. This area is often referred to as "Gray's Beach" in reference to a boardinghouse called "Gray's by the Sea" that existed at this site in the early 1900s. The west pocket beach spans approximately 100 ft of shoreline. The beach has a crest elevation up to approximately +7.5 ft MSL and a crest width of about 5 to 10 ft. The beach crest is regularly overtopped by waves and is frequently flooded, particularly during high tide and high surf events. A relict concrete groin is located near the center of the pocket beaches and extends approximately 125 ft seaward of the shoreline. The groin is almost entirely submerged. Due to the lack of a walkway in this area, lateral shoreline access is discontinuous, and people must traverse the intertidal beach in this area.

The east pocket beach spans approximately 125 ft of shoreline. The beach has a beach crest elevation between +5.5 to +6.5 ft MSL. The crest width varies from 0 to 25 ft. The beach terminates at the west end of a vertical seawall that spans approximately 500 ft of shoreline fronting the Sheraton Waikiki Hotel. The seawall continues east and terminates at the existing Royal Hawaiian groin, which marks the east boundary of the Halekūlani beach sector. A concrete walkway on top of the seawall provides the only lateral shoreline access between the east and west portions of Waikīkī Beach. Stairs are located at the ends of the seawalls east and west of the pocket beaches. An approximately 150-ft-long section of the walkway along the seawall has been closed to the public since 2017 and there is no lateral access along this portion of the shoreline except through the Sheraton Waikiki Hotel pool deck area. Closure of this area inhibits lateral shoreline access between the east and west portions of Waikīkī Beach.

The Royal Hawaiian groin was originally constructed as a concrete wall groin in 1927. The groin was recently replaced with a rock rubblemound L-head groin that was constructed in 2020. There are eight additional (8) relict groins in the Halekūlani beach sector that were constructed in the early 1900s. The groins are deteriorated, largely submerged, and do not appear to perform any significant function. Photographs of existing conditions in the Halekūlani beach sector are shown in Figure 5-5.

Historical and Projected Shoreline Change

The UHCGG historical shoreline change analysis for the Halekūlani beach sector (transects 118 to 140) determined that, from 1927 to 2015, the shoreline has been relatively stable with slightly more pronounced accretion at the east end of the sector fronting the Sheraton Waikiki Hotel (UHCGG, 2019). Miller and Fletcher (2003) found that sediment transport in the Halekūlani beach sector varies according to the seasonal wave regime. The relative stability of the shoreline can be attributed to the limited volume of sand and the presence of the seawalls that artificially fix the shoreline. At the west end of the sector (transects 133 to 140), sand is impounded on the updrift side of the Fort DeRussy outfall/groin. The beach in this area is narrow and beach width fluctuates seasonally.

The pocket beaches in the central portion of the sector (transects 126 to 129), between the Halekūlani and Sheraton Waikiki hotels, are aligned with the Halekūlani Channel and have experienced moderate erosion at a rate of 0.2 ft/yr (UHCGG, 2019). The pocket beaches are dynamic and sand volumes and beach width often fluctuate. The pocket beaches are often completely submerged during high tides and high surf events, and waves frequently overtop the existing walls in this area. The east end of the sector (transects 118 to 125) is dominated by a seawall fronting the Sheraton Waikiki Hotel. Sand occasionally accumulates in front of the seawall where it is impounded by the Royal Hawaiian groin; however, the sand is unstable and there is typically little or no dry beach in this area.

Erosion, coastal flooding, and beach loss in the Halekūlani beach sector are projected to continue and accelerate as sea levels continue to rise. The UHCGG shoreline change projections estimate that the shoreline could erode up to 3.9 ft (1.2 m) by 2050 and up to 14.1 ft (4.3 m) by 2100 (UHCGG, 2019). It is important to note that the long-term historical shoreline change rates for Waikīkī are influenced by efforts over the past century to stabilize and restore the beaches, which influences the future erosion projections. These projections also do not account for the presence of the existing seawalls that span the entire length of the Halekūlani beach sector. As the shoreline approaches the existing seawalls, there is an incremental loss of recreational beach area and shoreline habitat, a process that is referred to as *coastal squeeze* (Lester and Matella, 2016).

Without beach improvements and maintenance, it is likely that sea level rise will result in total beach loss this sector by mid-century or sooner due to the combined effects of increasing erosion and increasing frequency and severity of coastal flooding, particularly in areas where the beaches are already narrow and often submerged during high tide and high surf events. Recent observations indicate that beach loss is already accelerating in the western portion of the Halekūlani beach sector.

Beach Improvements and Maintenance

The most recent beach improvement project in the Halekūlani beach sector was the replacement of the Royal Hawaiian groin, which was completed in August 2020. The original Royal Hawaiian groin was in a severely deteriorated condition. Its failure would have destabilized 1,730 ft of sandy shoreline east of the groin in the Royal Hawaiian beach sector. The DLNR initiated design and construction of a new groin to replace the original Royal Hawaiian groin. The objective of the project was to stabilize Royal Hawaiian Beach to maintain its intended recreational, aesthetic, and economic values, and improve lateral access along the shoreline. The new groin was designed to maintain the approximate beach width of the 2012 Waikīkī Beach Maintenance I project.

The new groin was constructed along the alignment of the original groin and incorporated a portion of the original groin as a core wall to prevent sand movement through the groin. The new groin is of rock rubblemound construction and incorporates a cast-in-place concrete crown wall. The new groin extends 125 ft from the seawall fronting the Sheraton Waikiki Hotel, and then angles to the southeast to create a 50-ft-long L-head, for a total crest length of 175 ft. The new groin was constructed of a single layer of keyed and fit 3,200 to 5,400 lb armor stone over 300 to 600 lb underlayer stone and 30 to 100 lb core stone.

Following stone placement, a 5-ft wide by 5-ft-thick concrete crown wall was constructed to stabilize the crest and provide a foundation should a future increase in crest elevation be necessary to accommodate sea level rise. The concrete crown wall elevation is +9 ft MSL for its first 40 ft, then transitions down to +6 ft MSL on a 1V:8H (vertical to horizontal) slope, then remains at +6 ft MSL for the remainder of its length. The stone crest elevation is +7 ft MSL for the first 40 ft and then transitions down to +4 ft MSL for the remainder of the groin length.

The existing concrete block groin was reduced in elevation to a maximum elevation of +4 ft MSL to +1 ft MSL to facilitate construction of the new groin. Approximately 40 ft of the existing groin, beginning at about 120 ft from shore, was removed as necessary to construct the transition to the L-head portion of the groin. The remaining portion of the existing groin, makai (seaward) of the new groin head, was left in place.

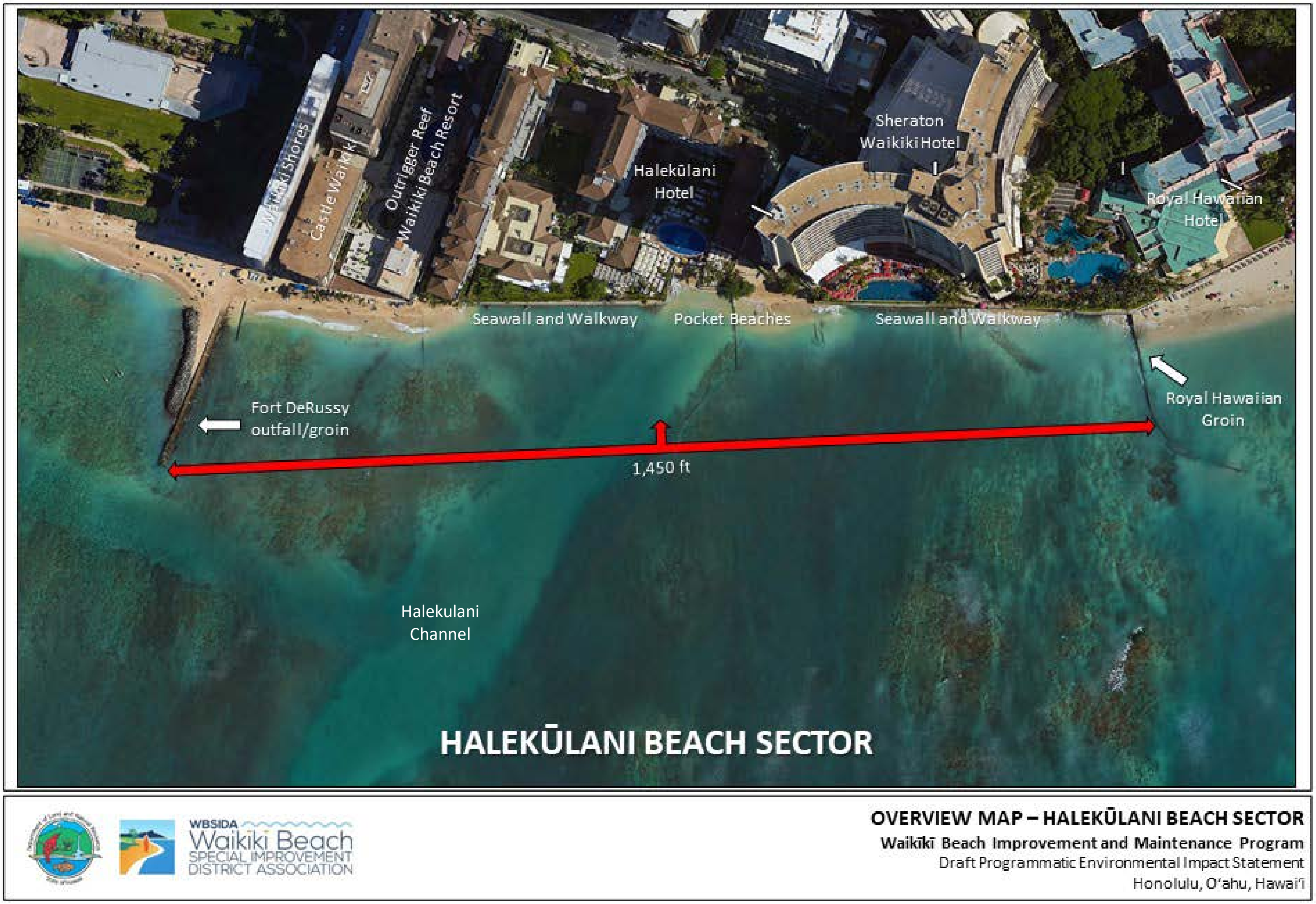
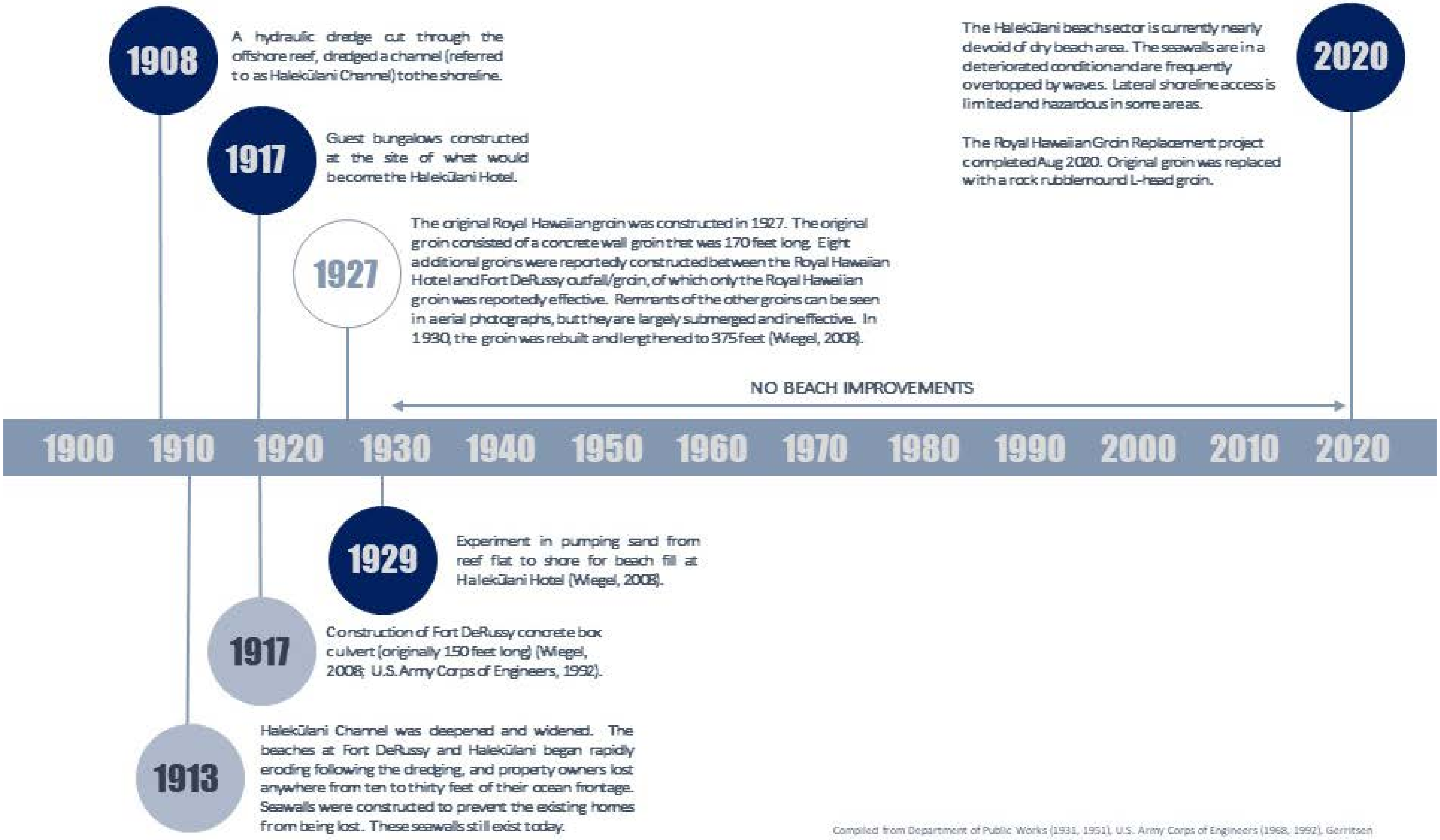


Figure 5-1 Overview map – Halekūlani beach sector



1908 A hydraulic dredge cut through the offshore reef, dredged a channel (referred to as Halekūlani Channel) to the shoreline.

1917 Guest bungalows constructed at the site of what would become the Halekūlani Hotel.

1927 The original Royal Hawaiian groin was constructed in 1927. The original groin consisted of a concrete wall groin that was 170 feet long. Eight additional groins were reportedly constructed between the Royal Hawaiian Hotel and Fort DeRussy outfall/groin, of which only the Royal Hawaiian groin was reportedly effective. Remnants of the other groins can be seen in aerial photographs, but they are largely submerged and ineffective. In 1930, the groin was rebuilt and lengthened to 375 feet (Wiegel, 2008).

2020 The Halekūlani beach sector is currently nearly devoid of dry beach area. The seawalls are in a deteriorated condition and are frequently overtopped by waves. Lateral shoreline access is limited and hazardous in some areas.

The Royal Hawaiian Groin Replacement project completed Aug 2020. Original groin was replaced with a rock rubblemound L-head groin.

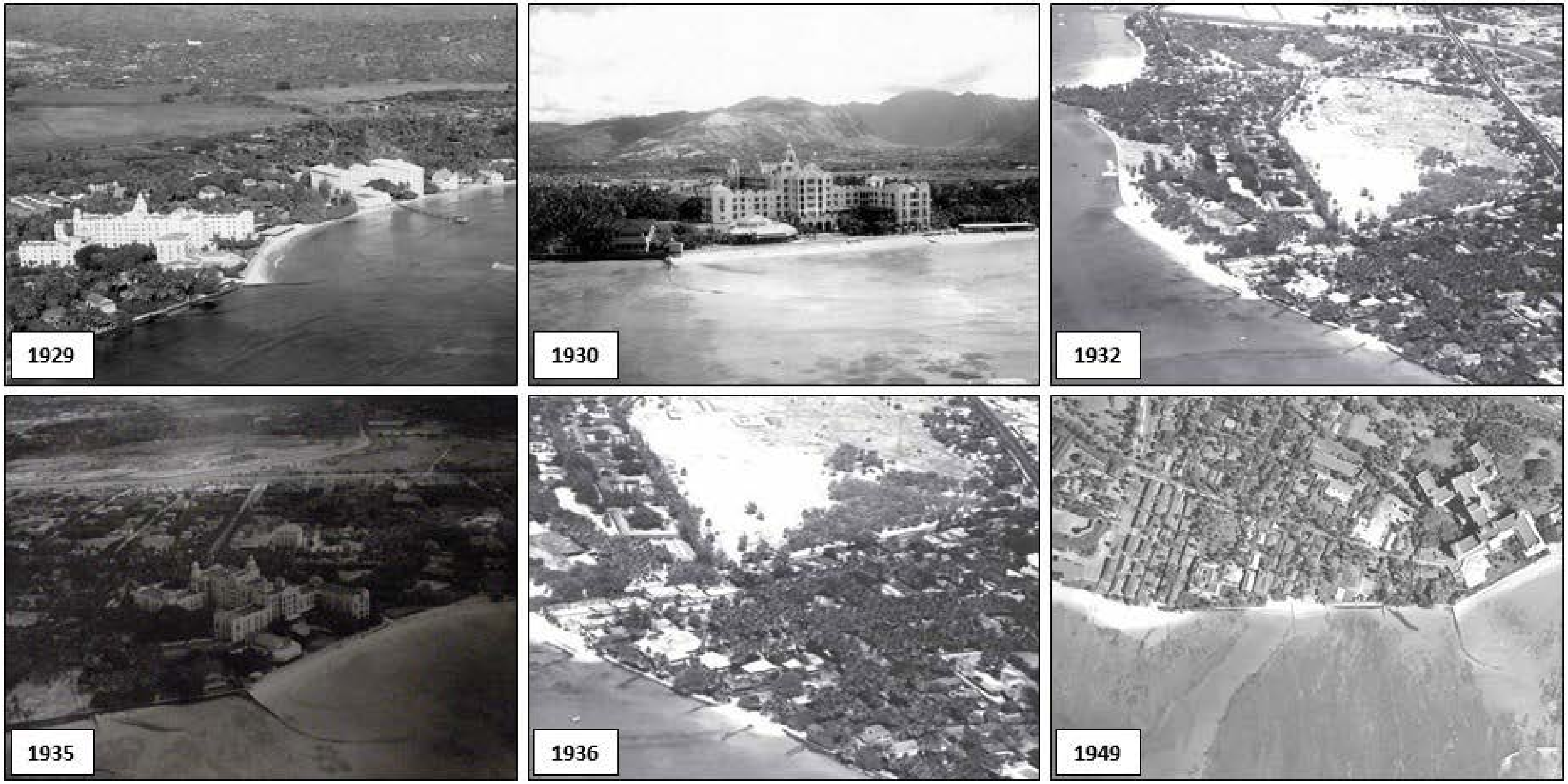
1929 Experiment in pumping sand from reef flat to shore for beach fill at Halekūlani Hotel (Wiegel, 2008).

1917 Construction of Fort DeRussy concrete box culvert (originally 150 feet long) (Wiegel, 2008; U.S. Army Corps of Engineers, 1992).

1913 Halekūlani Channel was deepened and widened. The beaches at Fort DeRussy and Halekūlani began rapidly eroding following the dredging, and property owners lost anywhere from ten to thirty feet of their ocean frontage. Seawalls were constructed to prevent the existing homes from being lost. These seawalls still exist today.

Compiled from Department of Public Works (1931, 1951), U.S. Army Corps of Engineers (1968, 1992), Gerritsen (1978), Noda and Associates (1991, 1999), Miller & Fletcher (2003), Weigel (2008), Conger & Eversole (2013)

Figure 5-2 History of coastal engineering – Halekūlani beach sector



WBSIDA
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DISTRICT ASSOCIATION

HISTORICAL PHOTOGRAPHS – HALEKŪLANI BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Draft Programmatic Environmental Impact Statement
Honolulu, Oʻahu, Hawaiʻi

Figure 5-3 Historical photographs – Halekūlani beach sector

Credit: Imagery and shoreline locations courtesy of University of Hawaiʻi Coastal Geology Group

Credit: Imagery and shoreline locations courtesy of University of Hawaiʻi Coastal Geology Group

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HISTORICAL SHORELINE POSITIONS – HALEKŪLANI BEACH SECTOR
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Figure 5-4 Comparison of 1949 and 2015 shoreline positions – Halekūlani beach sector

Halekūlani beach sector (March 4, 2021) (credit: Shellie Habel)

Seawall and walkway fronting Halekūlani Hotel (credit: Dolan Eversole)

Pocket beaches between hotels (credit: Shellie Habel)

Seawall and walkway fronting Sheraton Waikiki Hotel (credit: Dolan Eversole)

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EXISTING CONDITIONS – HALEKŪLANI BEACH SECTOR
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Figure 5-5 Existing conditions – Halekūlani beach sector

5.2 Purpose and Need for the Proposed Action

The Halekūlani beach sector essentially bifurcates shoreline access and viewplanes between the western portion of Waikīkī Beach (Hilton Hawaiian Village to Fort DeRussy) and the eastern portion of Waikīkī Beach (Royal Hawaiian Beach to Kaimana Beach). Walkways on top of the seawalls fronting the Halekūlani and Sheraton Waikiki hotels provide limited and discontinuous lateral access along the shoreline. The walkways are very narrow, are not ADA-accessible, and are subject to wave overtopping during high tides and high surf events. Structural damage has repeatedly resulted in closure of the walkways, which effectively prohibits lateral shoreline access between the Fort DeRussy and Royal Hawaiian beach sectors. There are no walkways across the small pocket beaches between the Halekūlani and Sheraton Waikiki hotels making access extremely challenging for those with limited mobility. Lateral access is currently accomplished by walking around the landward portion of the intertidal beach which, given its low elevation, is frequently flooded and often submerged during high tides and high surf events.

Perpendicular access to the shoreline is limited due to the density of development in the backshore. The only perpendicular access is a privately owned pathway where access by the public is presently allowed between the Halekūlani and Sheraton Waikiki hotels, extending from Kālia Road to the small pocket beaches between the hotels. There are no lifeguard towers in the Halekūlani beach sector.

There has historically been a limited amount of stable dry beach in the Halekūlani beach sector, with the exception of a 375-ft-long stretch of narrow beach at the west end of the sector, which is stabilized by the Fort DeRussy outfall/groin and wave refraction along the west edge of the Halekūlani Channel, and two small pocket beaches at the head of the channel between the Halekūlani and Sheraton Waikiki hotels. With the exception of the replacement of the Royal Hawaiian groin, which was completed in August 2020, there have been no substantial beach or structural improvements in this sector in nearly a century. Photographs of existing issues and problems in the Halekūlani beach sector are shown in Figure 5-6.

In collaboration with the WBCAC, the project proponents determined that the primary issues and problems in the Halekūlani beach sector are:

- Erosion and beach narrowing.
- Limited lateral access along the shoreline.
- Wave overtopping and wave reflection of existing seawalls.
- Deterioration and potential failure of existing seawalls.

The highest priorities in the Halekūlani beach sector are to:

- Increase dry beach width and stability.
- Improve lateral shoreline access.
- Maintain or improve mixed recreational uses (swimming, surfing, bathing).
- Maintain or improve water quality.
- Preserve submarine groundwater discharge at Halekūlani Channel (Kawehewehe).
- Preserve and protect surf sites (*Populars, Threes, Fours*).

Waves overtopping seawall at Halekūlani Hotel (credit: Dolan Eversole)

Flooding at pocket beaches (credit: Dolan Eversole)

Waves reflecting off seawall at Sheraton Waikiki Hotel (credit: Dolan Eversole)

Sinkholes landward of seawall at Halekūlani Hotel (credit: Shellie Habel)

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ISSUES AND PROBLEMS – HALEKŪLANI BEACH SECTOR

Waikīkī Beach Improvement and Maintenance Program

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Figure 5-6 Issues and problems – Halekūlani beach sector

5.3 Proposed Action

5.3.1 Description of the Proposed Action

The proposed action for the Halekūlani beach sector is beach improvements consisting of beach nourishment with stabilizing groins. Constructing a beach by placing suitable sand in an appropriately designed manner along a shoreline can be an effective means of providing additional recreational dry beach area, improving lateral access, and providing a buffer against storm waves and sea level rise. On chronically eroding shorelines, such as Waikīkī, engineered structures can be used to stabilize the beach fill and significantly reduce sand loss and the need for future repair and maintenance. A groin is a shore-perpendicular structure designed to prevent longshore transport of sand and mitigate erosion. A T-head groin system combines a groin with angled heads that can be designed for the existing wave environment to create stable arc-shaped beaches between the groins.

The proposed action will consist of construction of three new sloping rock rubblemound T-head groins, a new L-head groin adjacent to the existing Fort DeRussy outfall/groin, and modification of the recently replaced Royal Hawaiian groin. The groins and beach fill will create four stable beach cells in an area that has previously had limited beach resources. The proposed action will require approximately 60,000 cy of sand fill and will create approximately 3.8 acres of new dry beach area. The project layout for the proposed action is shown in Figure 5-7. The dimensions for the proposed groin heads and stems are shown in Figure 5-8 and Figure 5-9, respectively. Conceptual renderings of the proposed action are shown in Figure 5-10 and Figure 5-11.

The groins are designed for an initial +8.5 ft MSL beach crest elevation (existing Waikīkī beaches are about +7 ft MSL) to account for 1.5 ft of sea level rise, with the ability to increase the beach crest elevation to +10 ft MSL to account for additional sea level rise. The groin stem length (distance seaward from the shoreline) will be up to about 200 ft and will also be sufficient to stabilize a beach crest elevation up to +10 ft MSL. The minimum beach crest width at its narrowest point midway between the groins will be about 20 to 30 ft, and the beach slope will be 1V:8H (vertical to horizontal). The Halekūlani Channel will remain unobstructed for catamaran navigation.

An optional component of the design is the addition of a beach walkway to improve lateral shoreline access between the Royal Hawaiian, Halekūlani, and Fort DeRussy beach sectors. The beach walkway would likely follow the alignment of the existing seawalls, providing continuous lateral access along approximately 4,500 ft (0.85 mi) of shoreline. The beach walkway would need to be wide enough to be ADA-compliant and could include optional features, such as turnouts, to allow users to stop while not affecting pedestrian traffic. The existing seawalls may need to be modified or replaced to accommodate a beach walkway in this sector.

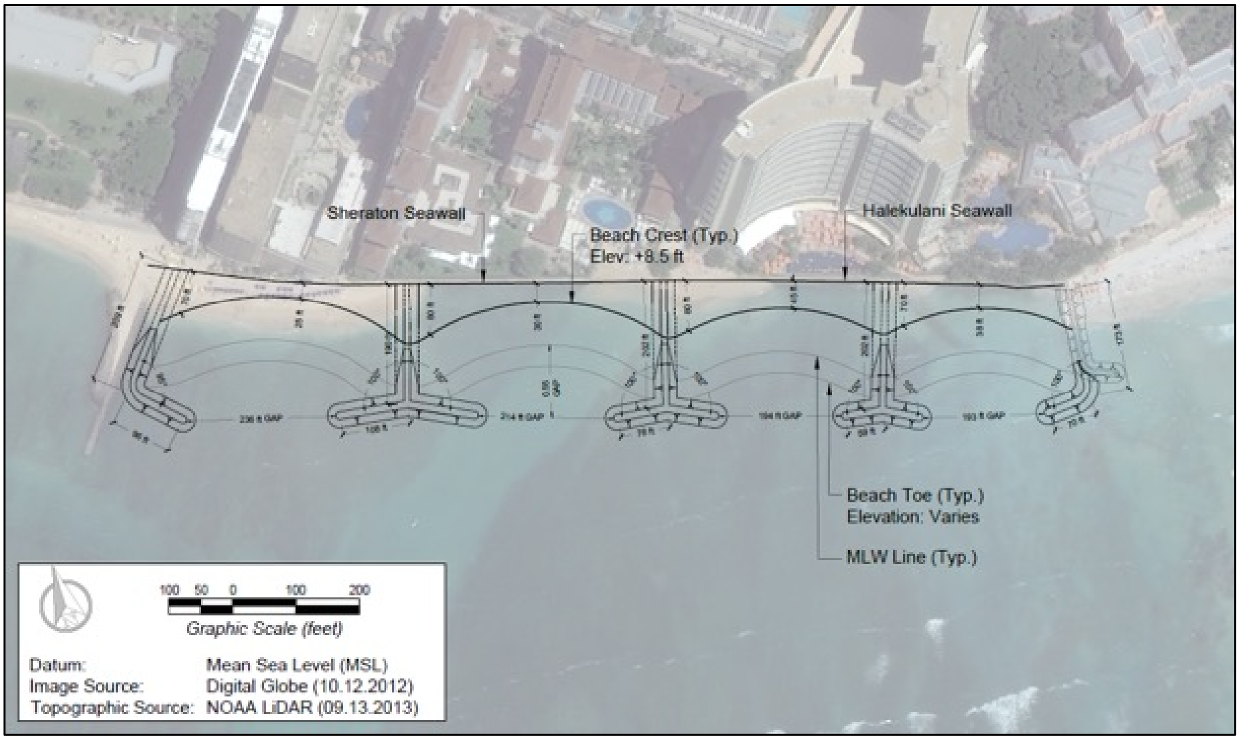

Figure 5-7 Proposed project layout – Halekūlani beach sector

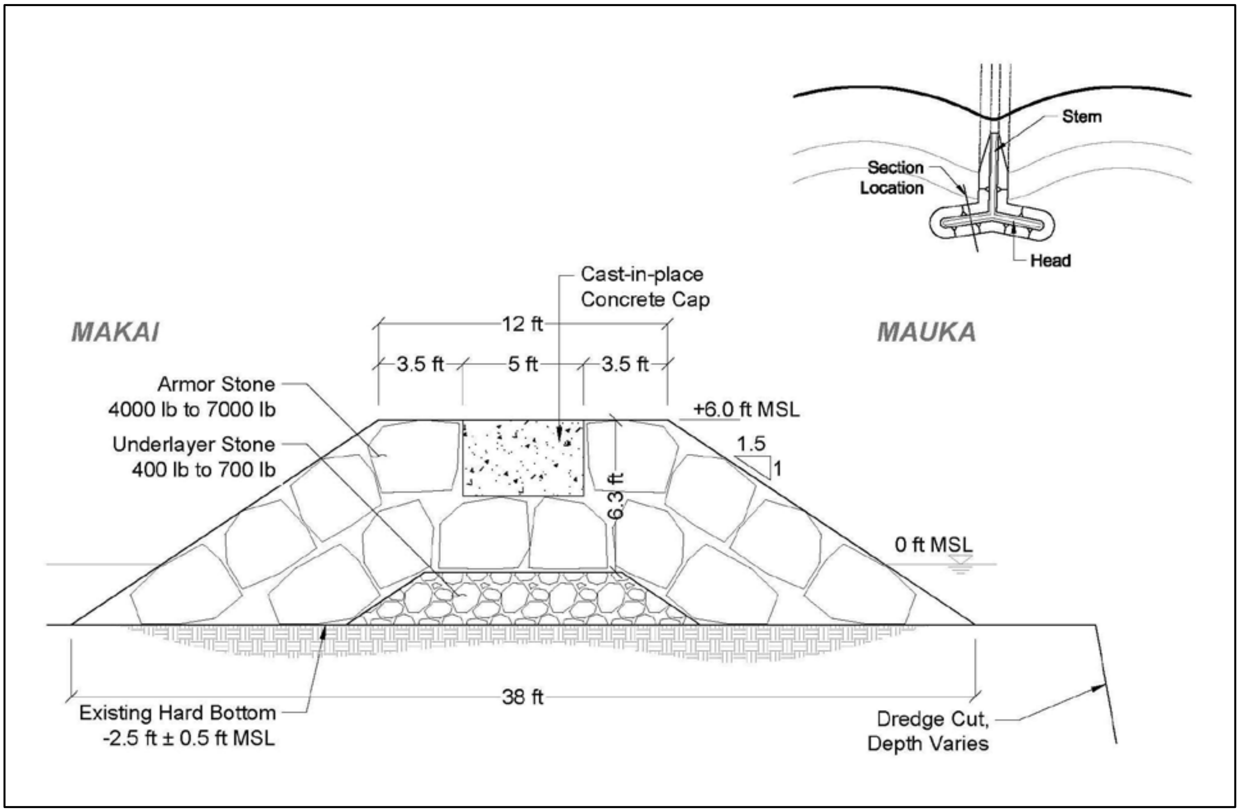

Figure 5-8 Section views of proposed groin heads – Halekūlani beach sector

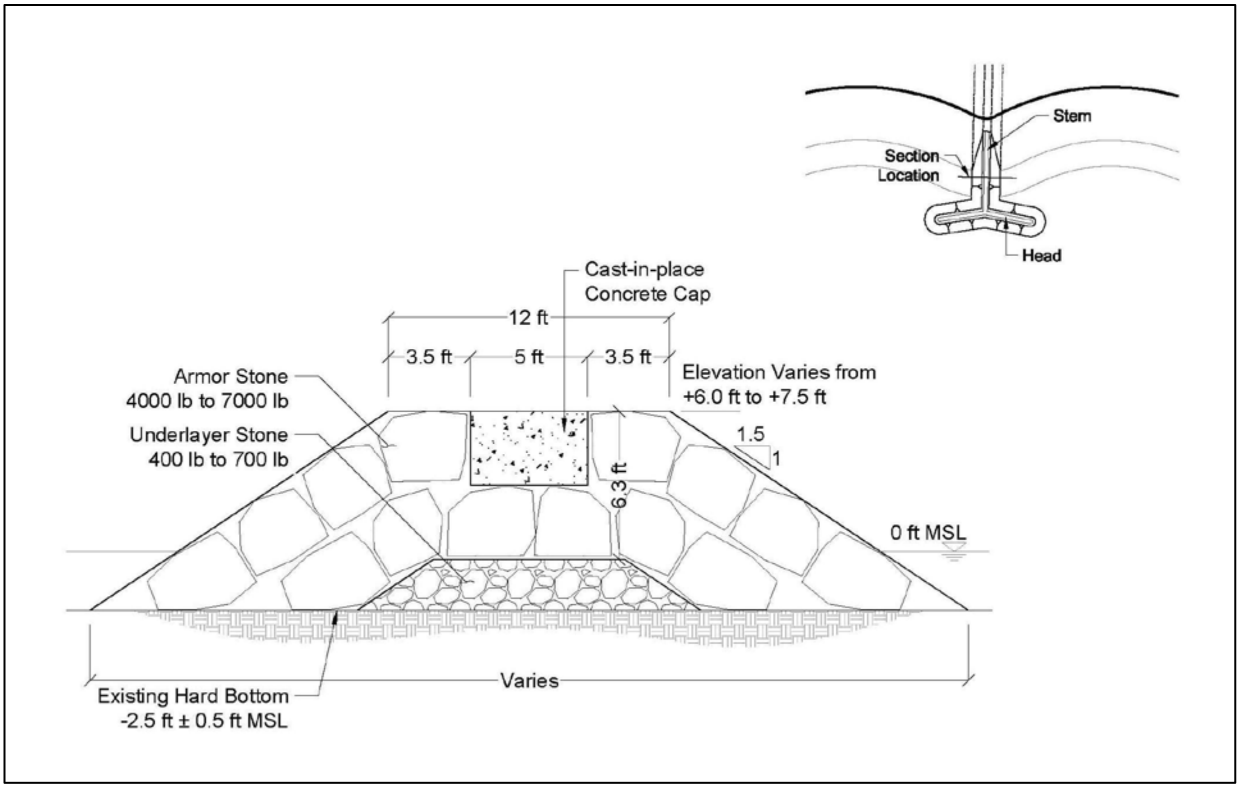

Figure 5-9 Section view of typical groin stems – Halekūlani beach sector

Rendering By Jonathan Quach, Independent Contractor.

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CONCEPTUAL PLAN VIEW OF PROPOSED ACTION – HALEKŪLANI BEACH SECTOR

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Figure 5-10 Conceptual plan view of proposed action – Halekūlani beach sector

Rendering By Jonathan Quach, Independent Contractor.

CONCEPTUAL OBLIQUE VIEW OF PROPOSED ACTION – HALEKŪLANI BEACH SECTOR

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Figure 5-11 Conceptual oblique view of proposed action – Halekūlani beach sector

5.3.2 Sand Source

One sand sample was obtained from the beach face fronting the Halekūlani Hotel in February 2021. Figure 5-12 shows the composite grain size distribution for the existing beach sand, which has a median grain size (D_{50}) of 0.35 mm. Figure 5-12 also shows the composite grain size distributions for the offshore sand deposits investigated in this project. Nearly all the offshore sand falls within ±20% of the Halekūlani beach sand grain size distribution. Sand from the *Hilton* deposit falls on the coarser side; however, slightly coarser sand would be expected to be stable on an eroding beach with stabilizing groins. This would be especially important with sea level rise, at which point waves are expected to be more energetic closer to the shoreline.

Potential sand sources for the Halekūlani beach sector include the *Hilton*, *Ala Moana*, and *Canoes/Queens* offshore deposits. Figure 5-13 and Table 5-1 present the grain size distributions and statistics for the beach and the potential offshore sand sources. Sand from any of the three sources presented (*Ala Moana*, *Hilton*, and *Canoes/Queens*) could be used with no required overfill. Furthermore, given the volume of sand required, a combination of sand from both the *Hilton* and *Ala Moana* sand deposits would be suitable for use in this sector.

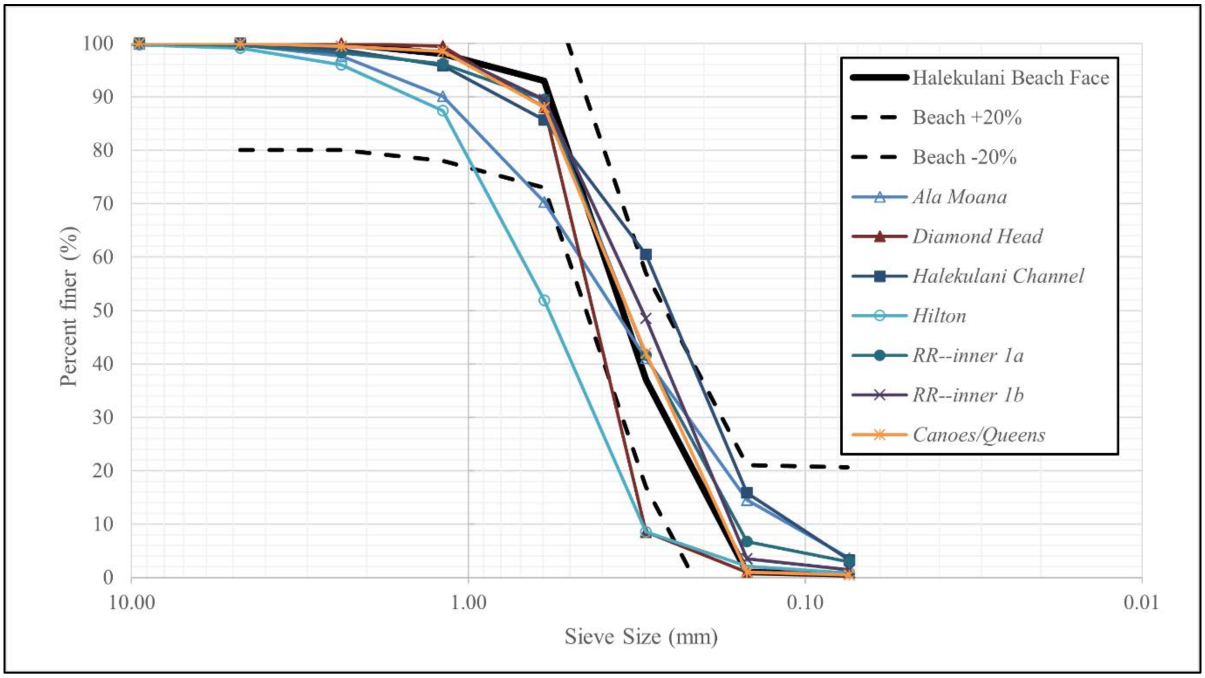


Figure 5-12 Comparison of grain size distributions for existing beach sand and offshore sand – Halekūlani beach sector

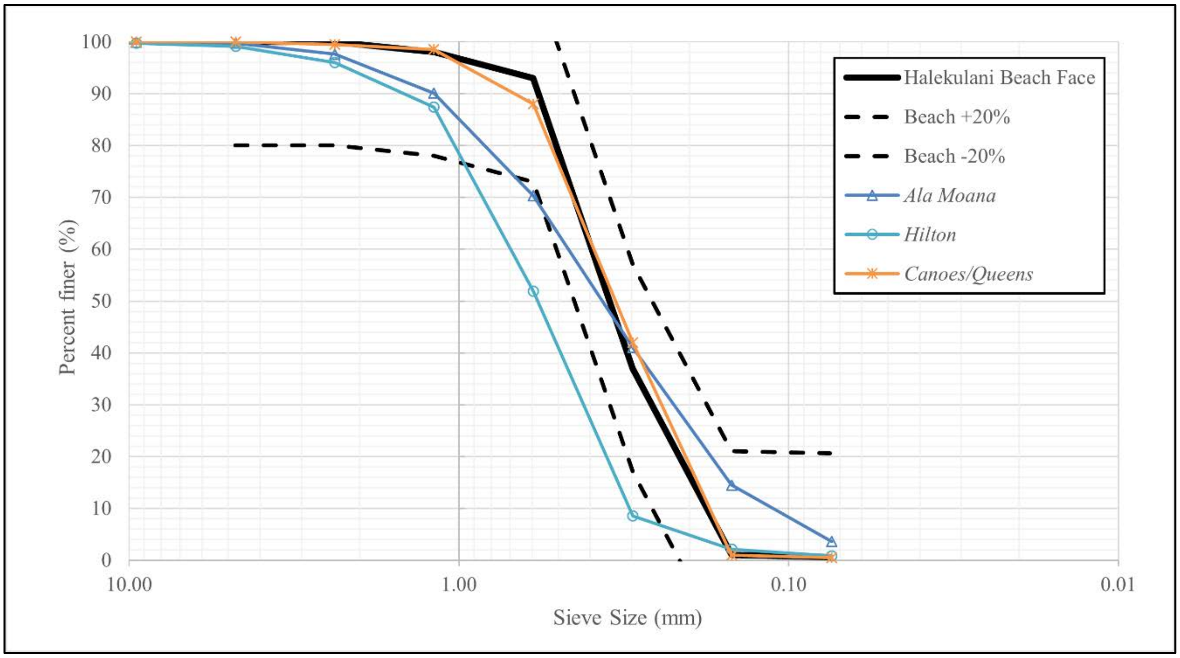


Figure 5-13 Grain size distributions for potential sand sources – Halekūlani beach sector

Table 5-1 Comparison of sand parameters – Halekūlani beach sector

	Existing Beach Sand	*Ala Moana*	*Hilton*	*Canoe/Queens*
Median diameter, D_{50} (mm)	0.35	0.37	0.59	0.34
Sorting	N/A	1.42	1.02	0.82
Overfill factor	N/A	1.10	1.00	1.50
Estimated sand required (cy)	60,000	60,000	60,000	60,000
Estimated sand available (cy)	60,000	86,000	40,000	40,000

5.3.3 Construction Methodology

Hydraulic section dredging is not feasible because the distance between the sand recovery areas is too long to allow the sand to be pumped to shore. A clamshell dredge will be used to recover the sand, which will eliminate the need for a pipeline to shore and a dewatering basin. A crane barge to dredge the sand and a scow and tugboat to transport the sand to an offloading site will be required. Sand will be offloaded at an approved site and trucked to the shoreline. Depending on the size of the dump trucks, approximately 4,000 to 6,000 truckloads of sand will be required.

Access to the shoreline in the Halekūlani beach sector is limited, particularly during high tides and high surf events. Two narrow walkways provide access to the shoreline: one privately owned pathway where access by the public is presently allowed between the Halekūlani Hotel and Sheraton Waikiki Hotel, extending from Kālia Road to the small pocket beaches between the hotels, and another between the Halekūlani Hotel and Outrigger Reef Waikīkī Beach Resort. The only access for construction equipment and materials is across the east end of the Fort DeRussy beach sector, adjacent to the Castle Waikīkī Shore. Construction access from the ocean side via barge will be further evaluated; however, access from the ocean may not be feasible due to the shallow water depths in the nearshore.

A temporary construction access road will be constructed from Kālia Road to the beach, and then a temporary rock rubblemound construction access berm will be constructed along the shoreline from the Fort DeRussy outfall/groin to the Royal Hawaiian groin. The stone used to construct the access berm will be used later to construct the groins. Groin construction will proceed from the head of the Royal Hawaiian groin and progress from east to west, using the stone in the access berm to construct the groins and removing any excess stone. The final groin will be constructed alongside the existing Fort DeRussy outfall/groin. The structures will not be connected and no modifications to the existing Fort DeRussy outfall/groin are proposed. Sand fill will be placed following completion of the groins, moving west to east with the new beach providing access for sequential placement of sand fill.

The groins will be constructed of two-stone-thick rock rubblemound with a median armor stone size of 5,100 lbs. The groin heads will be constructed with a crest elevation of +6 ft MSL, consistent with the existing concrete crown wall of the Royal Hawaiian groin. The groin heads will have a core of concrete at +6 ft MSL that will allow for a vertical extension of up to 1.5 ft in the future to mitigate the effects of sea level rise. The groin stems on the inshore ends will be +8 ft MSL for about 30 ft, slightly below the +8.5 ft MSL beach elevation. The stems will then taper down to meet the heads at +6 ft MSL. All rubblemound structures will have 1V:1.5H (vertical to horizontal) side slopes. Groin construction will require approximately 15,000 cy of rock and 810 cy of concrete to construct the crown walls.

Sand will be placed to the approximate lines and grades shown on Figure 5-7. The beach and groin system is designed to produce a minimum dry beach width of 30 ft with a foreshore slope of 1V:8H (vertical to horizontal). The elevation of the sand in the backshore will be higher than some points of the hotel properties. In these areas, it may be necessary to increase the height of the existing seawalls or construct new walls to retain the sand fill and prevent wave overtopping.

5.3.3.1 Alternative Armor Units

Concrete Armor Units

Man-made concrete armor units have been developed for use when stone of large enough size is not available to meet the design requirements. These concrete units have larger stability coefficients (i.e., greater interlocking and ability to withstand wave attack) than stone. Thus, the concrete units can be smaller than the required stone size for a given wave height. Tribar concrete armor units (Figure 5-14) have been used with considerable success for projects with similar design conditions and are an alternative to stone for this project.

Tribar armor units are implemented as a single layer and, like a rubblemound revetment, the armor units are placed over an underlayer and filter designed to distribute the weight of the armor layer and to prevent loss of fine shoreline material through voids in the Tribars. The underlayer is sized at 1/10 the Tribar weight and is at a minimum two stone diameters thick. Because Tribar units depend on interlocking for stability, the sides, toe, and crest of the structure must be securely tied in and fixed to the surrounding environment. Typically, the toe of the structure is entrenched and grouted into the seafloor. While concrete armor units perform well from an engineering perspective, they can be perceived as having an industrial appearance that may not be desirable in Waikīkī.

Figure 5-14 Tribar concrete armor units in American Samoa

Environmentally Friendly Armor Units

Construction of the proposed actions will cover portions of submerged lands with either sand or rock. The rock rubblemound structures are expected to increase biodiversity of the area based on the monitoring results following the 2013 Iroquois Point Beach Nourishment and Stabilization project. Alternative materials are being considered to further mitigate potential impacts by providing ecologically sensitive solutions, where possible. One option is to add environmentally friendly armor units to the groins where conditions allow. The discussion below focuses on ECOncrete and their products; however, there are other concrete units available that can be considered during the final design phase, including those from Volvo, University of Washington, Reef Design Lab, Intellareef, and others.

ECOncrete

ECOncrete is marketed as an eco-engineered solution for both marine life and humans. Products include ecological armoring units, seawall panels, designed tidepools, and articulated marine mattresses. ECOncrete reportedly achieves their success from a combination of concrete additives and unit design and texture. The concrete armoring units are produced with a proprietary concrete mix with enhancing admixture that complies with marine construction regulations. When compared to standard concrete used in other armor units, ECOncrete reportedly provides higher compressive strength and lower pH levels. The low pH levels reportedly promote better coral growth. Each of the products has unique textured surfaces that reportedly improve marine life and coral structure growth. Production of calcium carbonate from higher levels of marine life provides an additional bond between concrete armoring units, strengthening and stabilizing the structure.

ECOncrete units have been used in multiple locations in the continental U.S. and throughout Europe, and thus far have only been used in calm environments with low wave energy. Intense review of hydraulic stability is currently being performed by ECOncrete through computational modeling and physical testing to determine if their concrete armor units are applicable in high wave energy environments. Costs associated with purchasing ECOncrete units may be similarly priced to standard concrete units if the units can be cast locally. Figure 5-16 through Figure 5-18 show examples of armor units that are marketed as being environmentally friendly.

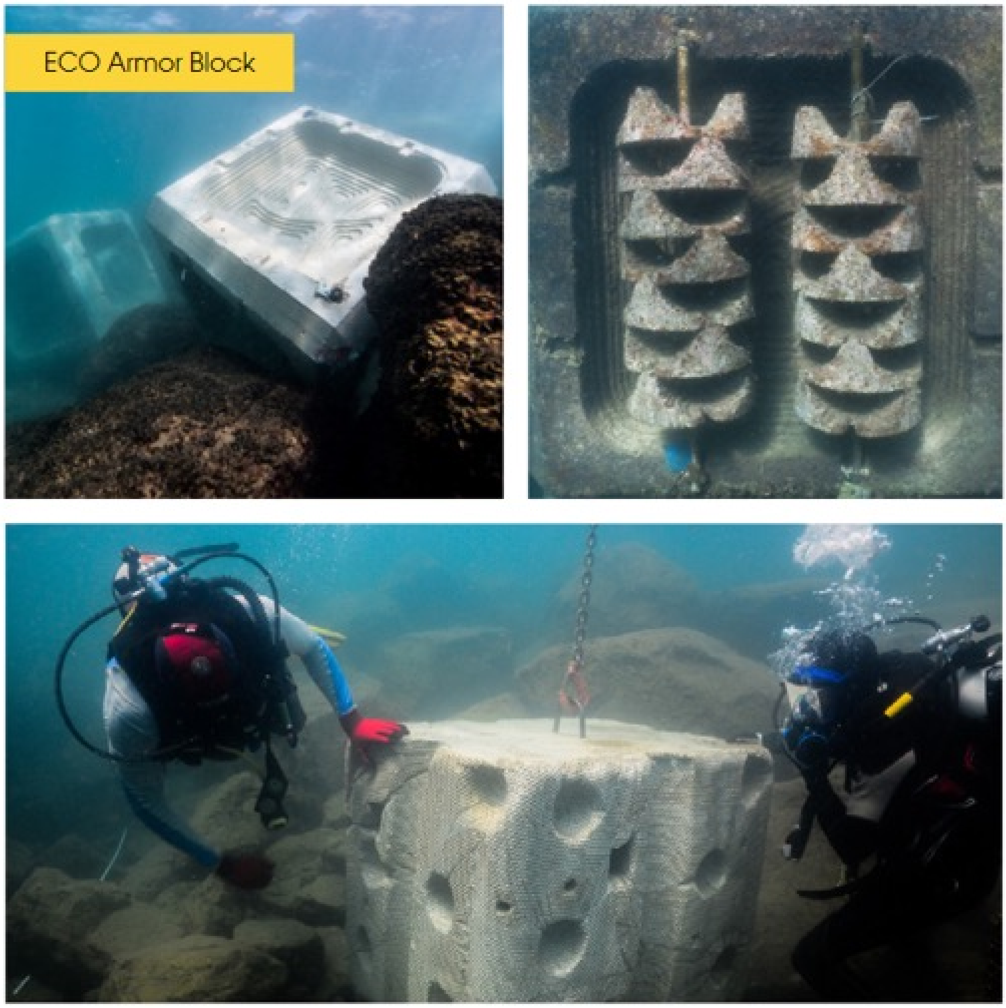


Figure 5-15 ECO Armor Block (www.econcrete.com)

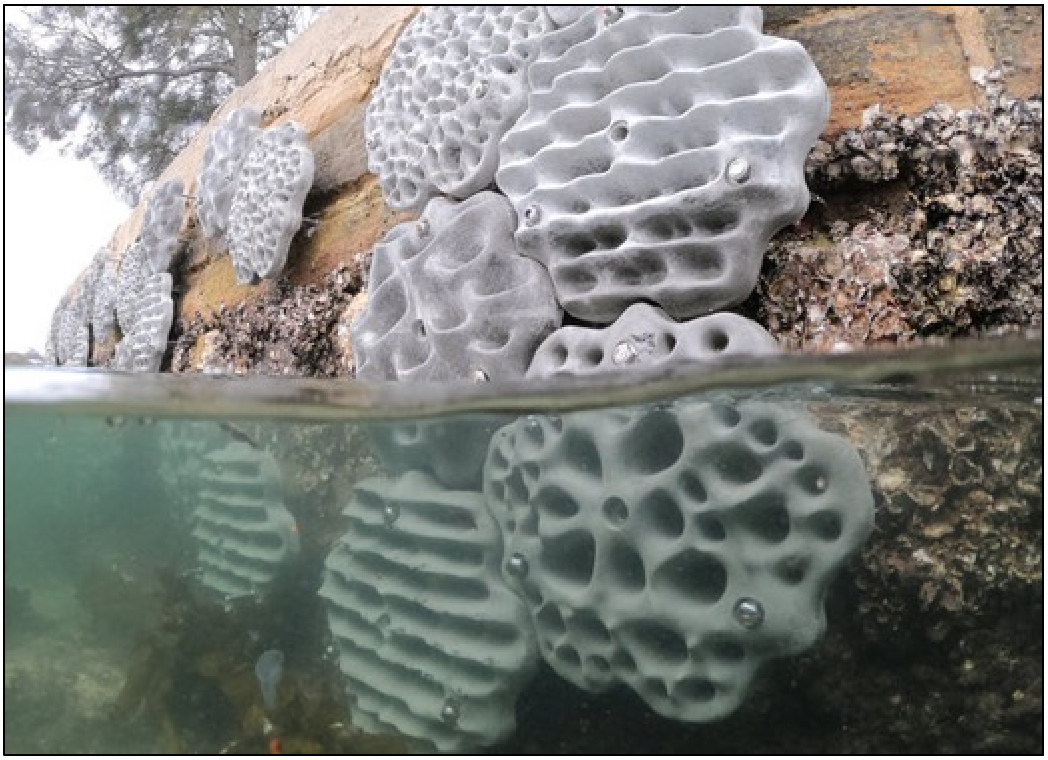


Figure 5-16 "The Living Seawall Project" (www.reefdesignlab.com)

Figure 5-17 ECOncrete Coastalock (www.econcretetech.com)

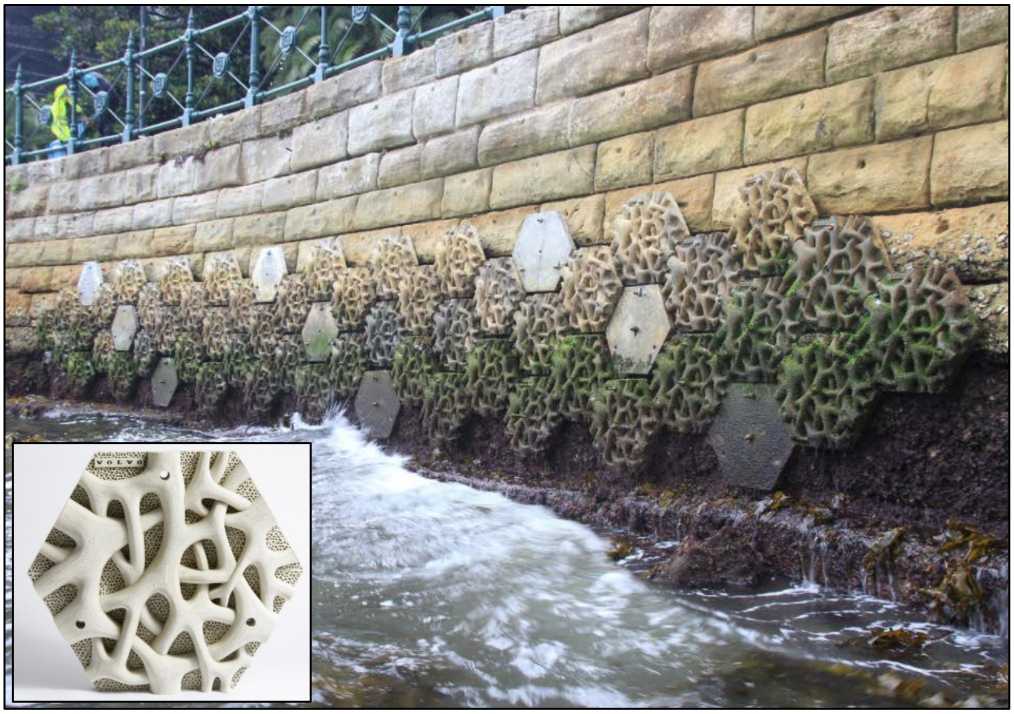


Figure 5-18 Volvo 3D-printed Living Seawall (www.reefdesignlab.com)

5.3.4 Estimated Timing, Phasing, and Duration

The proposed beach improvement action is designed to be implemented in phases, with the initial phase being designed for approximately 1.5 ft of sea level rise, thus in 25 to 30 years following construction it may be necessary to raise the project elevations. If then raised by several feet, the project could be effective until about the year 2080, or 50 yrs post-construction. The estimated construction duration for the proposed action is 500 days.

5.3.5 Required Permits and Approvals

The proposed action is anticipated to require the following permits and approvals:

- Department of the Army Permit (Section 10 and Section 404)
- Clean Water Act Section 401 Water Quality Certification
- Clean Water Act Section 402 National Pollutant Discharge Elimination System
- Coastal Zone Management Act Consistency Review
- Conservation District Use Permit
- Right of Entry Permit

5.4 Alternatives to the Proposed Action

The following alternatives were considered for the Halekūlani beach sector:

- Beach Nourishment without Stabilizing Structures

5.4.1 Beach Nourishment without Stabilizing Structures

This alternative would consist of placing sand directly along the shoreline without any structures to stabilize the sand. The sand would be placed along the entire 1,450-ft length of the beach sector with a beach crest elevation of +8.5 ft MSL and a beach slope of 1V:8H (vertical to horizontal). The Royal Hawaiian groin and the Fort DeRussy outfall/groin would help to stabilize the sand fill at the ends of the beach sector; however, the sand in the central portion of the beach sector would be unstable and subject to erosion. This concept would require approximately 40,000 cy of sand and would create approximately 45,000 sf (1 acre) of new dry beach area. The estimated construction duration for this alternative is 240 days.

Beach nourishment without stabilizing structure would increase dry beach width but would not increase beach stability or prevent erosion. The advantages of this option are that it would require less sand and no groins, which would decrease the overall footprint of the project. This option would be less expensive initially; however, the cumulative costs of periodic renourishment would be substantial.

The UHCGG estimates that the average annual erosion rate in the Halekūlani beach sector with 3.2 ft of sea level rise will be 1.0 ft/yr (mid-range, 80% confidence) (UHCGG, 2019). Based on this estimate, in order to maintain a minimum beach width of 20 ft, the beach would need to be renourished every 5 years. Due to the combination of nearshore wave patterns, seawalls, and the Halekūlani Channel, it is possible that the beach could erode more rapidly, in which case renourishment would need to be conducted more frequently. Assuming that renourishment was conducted every 5 yrs over a period of 50 yrs, this would result in a total of 10 individual renourishment events and a total of 2,400 days of construction.

When compared to the alternative of beach nourishment without stabilizing structures, the proposed action has less cumulative impacts as it will require fewer dredging events, fewer construction events, fewer construction days, and fewer beach closures. While beach nourishment without stabilizing structures is technically feasible, it is not being proposed due to the cumulative impacts associated with periodic dredging and renourishment. Furthermore, beach nourishment without stabilizing structures may not be a viable long-term solution due the limited volume of compatible offshore sand to support periodic renourishment efforts in Waikīkī.

6. PROPOSED ACTION: ROYAL HAWAIIAN BEACH SECTOR

6.1 General Description

The Royal Hawaiian beach sector spans approximately 1,730 ft of shoreline extending from the Royal Hawaiian groin east to the ʻEwa (west) groin at Kūhiō Beach Park. Prominent features in this sector include the Royal Hawaiian Hotel, Outrigger Waikīkī Beach Resort, Moana Surfrider Hotel, Honolulu Police Department substation, and the Duke Kahanamoku statue. An overview map of the Royal Hawaiian beach sector is shown in Figure 6-1.

The Royal Hawaiian beach sector is adjacent to the core of traditional and historical activity in Waikīkī. It falls within portions of the traditional ʻili of Helumoa and Hamohamo. Royal Hawaiian Beach is also an important symbol of the history and lifestyle of Waikīkī with a long history of beach boys and surfing in this reach. ʻĀpuakēhau Stream once flowed into the ocean near the northern edge of the sector (near the present location of the Royal Hawaiian Hotel). When many people think of Waikīkī, they typically envision this stretch of beach with Diamond Head framed in the background.

History

In the early 1900s, Royal Hawaiian Beach was relatively narrow, and portions of the beach were submerged at high tide. Seawalls were constructed along nearly the entire length of the shoreline mauka (landward) of the beach, and most of the walls remain in place today. The Royal Hawaiian groin was built in 1927 to stabilize the beach. In 1971, the vegetation line began shifting mauka (landward) and the beach has been chronically eroding since 1985 (Miller and Fletcher, 2003). The history of coastal engineering in the Royal Hawaiian beach sector is summarized in Figure 6-2. Historical photographs of the Royal Hawaiian beach sector are shown in Figure 6-3. Aerial photographs comparing the existing shoreline conditions in the Royal Hawaiian beach sector in 1949 and 2015 are shown in Figure 6-4.

Existing Conditions

The Royal Hawaiian beach sector is an entirely engineered shoreline. The west end of the sector is bounded by the Royal Hawaiian groin, which was originally constructed as a concrete wall groin in 1927 and replaced with a rock rubblemound L-head groin that was constructed in August 2020. The Royal Hawaiian groin functions as a terminal groin that stabilizes approximately 1,730 ft of sandy beach east of the groin. The east end of the sector is bounded by a rock rubblemound groin at the west end of Kūhiō Beach Park.

Royal Hawaiian Beach provides lateral shoreline access along the entire length of the beach sector. Perpendicular shoreline access to the shoreline is limited due to the density of development in the backshore. Perpendicular access is available from Kalākaua Avenue at two locations: one between the Royal Hawaiian Hotel and the Outrigger Waikīkī Beach Resort, and one between the Moana Surfrider Hotel and the Honolulu Police Department substation. Public access is more abundant east of this sector throughout Kūhiō Beach Park. Two City and County of Honolulu lifeguard towers are located in the Royal Hawaiian beach sector: one fronting the Honolulu Police Department substation, and one fronting the Moana Surfrider Hotel. Photographs of existing conditions in the Royal Hawaiian beach sector are shown in Figure 6-5.

Historical and Projected Shoreline Change

The UHCGG historical shoreline change trend for the Royal Hawaiian beach sector from 1927 to 2015 has been accretion at an average rate 0.19 ft/yr (UHCGG, 2019). The accretion is attributable to the repeated addition of sand from previous beach nourishment projects. Miller and Fletcher (2003) found that sediment transport is predominantly in a northwesterly direction and that a reef channel rip current in the central portion of the beach may contribute to the loss of sand in the Royal Hawaiian beach sector. These currents transport sand offshore, which often results in the formation of a shallow sandbar in this area.

Sea Engineering, Inc. conducted a shoreline change analysis for the Royal Hawaiian beach sector using the UHCGG shoreline positions from 1985 to 2005. The year 1985 was chosen as the initial year since no significant human alterations of the beach had occurred since then. From 1985 to 2005, reflecting the modern history of beach erosion, the dominant trend was shoreline erosion at rates of 1 ft to nearly 3 ft/yr. The highest erosion rates were found in front of the Diamond Head Tower of the Moana Surfrider Hotel and in front of the east wing of the Royal Hawaiian Hotel. The exception to this trend is found at three transects adjacent to the Royal Hawaiian groin, which show accretion of up to 1.5 ft/yr. Thus, it appears likely that some of the eroding sand has been moved west and is impounded by the groin, which is consistent with findings by Miller and Fletcher (2003).

Erosion, coastal flooding, and beach loss in the Royal Hawaiian beach sector are projected to continue and accelerate as sea levels continue to rise. The UHCGG shoreline change projections estimate that the shoreline could erode up to 87.3 ft (26.6 m) by 2050 and up to 216.2 ft (65.9 m) by 2100 (UHCGG, 2019). It is important to note that the long-term historical shoreline change rates for Waikīkī are influenced by efforts over the past century to stabilize and restore the beaches, which influences the future erosion projections. These projections also assume that the backshore is composed of non-cohesive erodible substrate and do not account for the presence of the existing seawalls that span nearly the entire length of the shoreline in the Royal Hawaiian beach sector. As the shoreline approaches the existing seawalls, there is an incremental loss of recreational beach area and shoreline habitat, a process that is referred to as *coastal squeeze* (Lester and Matella, 2016).

Without beach improvements or maintenance, it is likely that sea level rise will result in total beach loss in this sector by mid-century or sooner due to the combined effects of increasing erosion and increasing frequency and severity of coastal flooding, particularly in areas where the beaches are already narrow and often submerged during high tides and high surf events. Loss of recreational dry beach area and lateral shoreline access in the vicinity of the Moana Surfrider Hotel could occur in the next several decades, potentially sooner, as waves currently overtop the seawalls in this area during high tides and high surf events.

Beach Improvements and Maintenance

Recent beach improvements and maintenance projects in the Royal Hawaiian beach sector include Waikīkī Beach Maintenance I (2012), Kūhiō Sandbag Groin (2019), Royal Hawaiian Groin Replacement (2020), and Waikīkī Beach Maintenance II (completed May 2021)

Waikīkī Beach Maintenance I (2012)

In 2012, the DLNR conducted the Waikīkī Beach Maintenance I project. Approximately 24,000 cy of sand was dredged from an offshore sand deposit near the *Canoes* and *Queens* surf breaks. Sand recovery was accomplished with the use of a Toyo DB 75B 8-inch pump with ring jet attachment suspended from an 80-ton capacity crawler crane on a barge. The average rate of sand recovery was approximately 500 cy per day. The sand discharge pipeline was an 8-inch high-density polyethylene (HDPE) pipe with a total length of 3,200 ft. Sand was pumped into a dewatering basin that was constructed in the Diamond Head (east) basin of Kūhiō Beach Park. The dewatering basin measured approximately 100 ft wide and 400 ft long. Sand was pushed into large piles with an excavator and bulldozer and then transported by dump trucks to the sand placement area on Royal Hawaiian Beach. The project widened the beach by an average of 37 ft, which aligned with the position of the shoreline in 1985. The project was completed in June 2012 (see Section 2.6, Figure 2-5 and Figure 2-6). The permits included a second renourishment effort approximately 10 years after the initial nourishment.

Beach monitoring following the 2012 Waikīkī Beach Maintenance I project showed continued erosion and beach recession of the east and west ends of the Royal Hawaiian beach sector. Habel (2016) found that beach recession ranged from 5.2 to 9.5 ft/yr at the east end fronting the beach concessions. This erosion exposed the old concrete foundation of the Waikīkī Tavern, creating a hazardous condition for beach users, and has resulted in damage and flanking of the Kūhiō Beach ʻEwa (west) groin. In January 2018, the City and County of Honolulu funded construction of a temporary erosion control structure built of sand-filled geotextile mattresses to cover the tavern foundation and prevent erosion of terrigenous sediment from the backshore.

Kūhiō Sandbag Groin (2019)

A sandbag groin was placed 140 ft west of the existing ʻEwa (west) groin of Kūhiō Beach Park. The purpose of the groin is to stabilize the east end of Royal Hawaiian Beach and cover the remnants of the concrete foundation of the Waikīkī Tavern with sand. The designed 95-ft groin length was the minimum length necessary to ensure adequate beach width to keep the concrete rubble covered. At the time of construction, the groin was extended 16 ft on the inshore end to address additional beach erosion.

The Kūhiō Sandbag Groin was completed in November 2019 (see Section 2.6, Figure 2-7 and Figure 2-8). The groin consists of 83 ElcoRock sand containers and 275 cy of sand to fill the containers. Each sand container holds 2.5 m^3 of sand and weighs over 10,000 lbs when full. The non-woven geotextile fabric is UV and puncture resistant, has excellent abrasion resistance, and its soft finish is attractive and non-abrasive. Approximately 750 cy of sand was excavated from Kūhiō Beach Park and placed to cover the concrete rubble and achieve the design beach profile.

The University of Hawaiʻi Coastal Geology Group (UHCGG) has and is continuing to conduct periodic monitoring of the Kūhiō Sandbag Groin. Initial findings based on approximately one year of survey data indicate that the groin is functioning as intended. The efficacy of the groin is evident by significant sand accumulation on the Diamond Head (east) side of the structure throughout the year, indicating that longshore sediment transport was altered as intended to mitigate extreme erosion at this section of beach. Sediment capture by the groin has not resulted in significant erosion on the ʻEwa (west) side of the structure, which would be evidenced by sediment depletion and flanking directly adjacent to the structure. Overall, one year following completion the structural integrity and efficacy of the groin structure has been confirmed. No adverse effects of the project have been observed. No significant deficiencies with the ElcoRock sandbags and/or the overall groin performance have been observed.

Royal Hawaiian Groin Replacement (2020)

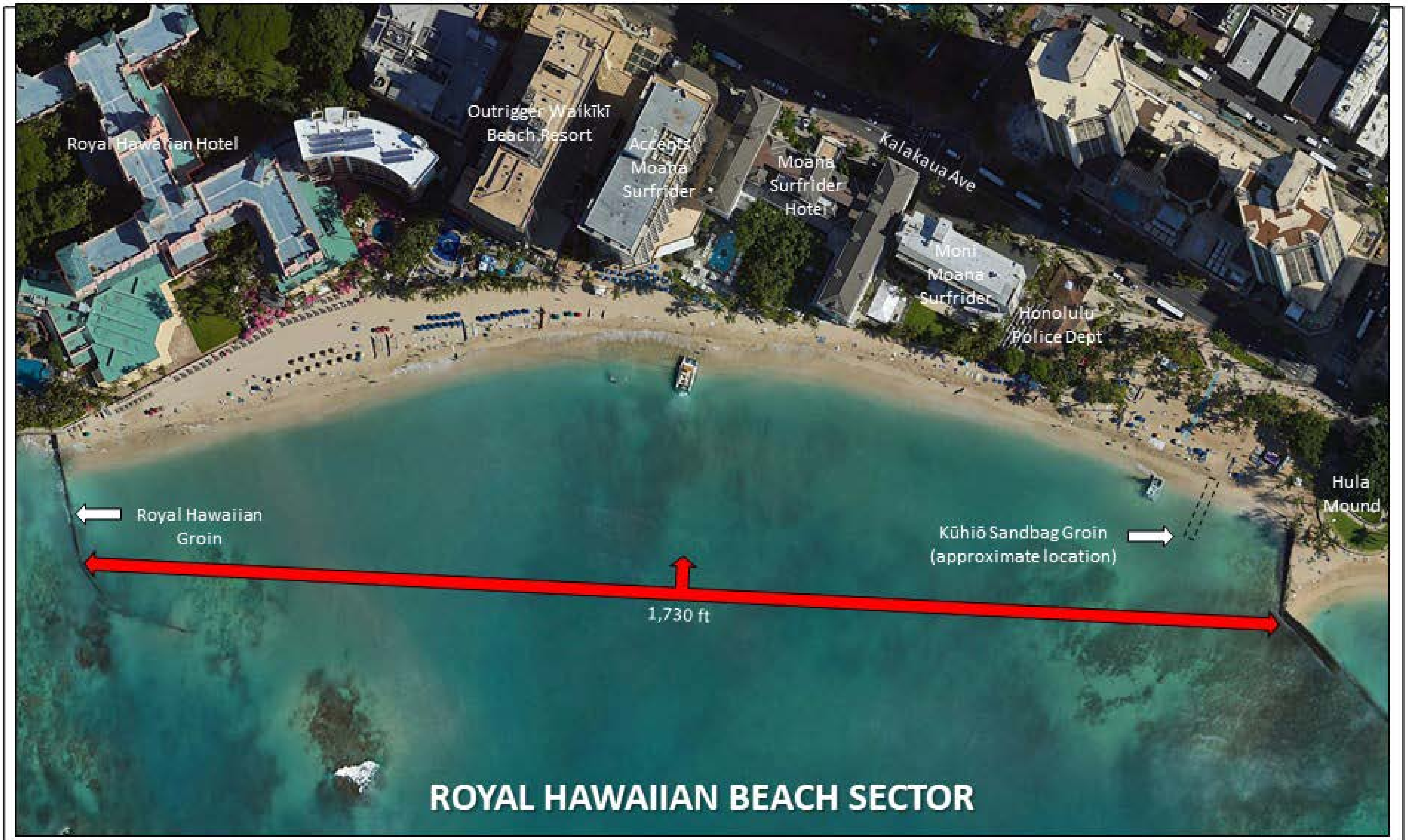
As of 2020, the original Royal Hawaiian groin was in a severely deteriorated condition. Its failure could have destabilized 1,730 ft of sandy shoreline east of the groin in the Royal Hawaiian beach sector. The DLNR initiated design and construction of a new groin to replace the original Royal Hawaiian groin. The objective of the project was to reinforce the existing groin to stabilize the beach on the Diamond Head (east) side of the groin so that it could provide its intended recreational and aesthetic benefits. The new groin was designed to maintain the approximate beach width of the 2012 Waikīkī Beach Maintenance I project.

Replacement of the Royal Hawaiian groin was completed in August 2020 (see Section 2.6, Figure 2-9 and Figure 2-10). The new groin was constructed along the alignment of the original groin and incorporated a portion of the original groin as a core wall to prevent sand movement through the groin. The new groin is of rock rubblemound construction and incorporates a cast-in-place concrete crown wall. The new groin extends 125 ft from the seawall fronting the Sheraton Waikiki Hotel, and then angles to the southeast to create a 50-ft-long L-head, for a total crest length of 175 ft. The new groin was constructed of a single layer of keyed and fit 3,200 to 5,400 lb armor stone over 300 to 600 lb underlayer stone and 30 to 100 lb core stone.

Following stone placement, a 5-ft wide by 5-ft-thick concrete crown wall was constructed to stabilize the crest and provide a foundation should an increase in crest elevation be necessary to accommodate future sea level rise. The concrete crown wall elevation is +9 ft MSL for its first 40 ft, then transitions down to +6 ft MSL on a 1V:8H (vertical to horizontal) slope, then remains at +6 ft MSL for the remainder of its length. The stone crest elevation is +7 ft MSL for the first 40 ft and then transitions down to +4 ft MSL for the remainder of the groin length. The existing concrete block groin was reduced in elevation to a maximum elevation of +4 ft MSL to +1 ft MSL to facilitate construction of the new groin. Approximately 40 ft of the original groin, beginning at about 120 ft from shore, was removed to construct the transition to the L-head portion of the new groin. The remainder of the original groin, makai (seaward) of the new groin head, was left in place. Initial observations indicate that the groin is performing its primary function to stabilize the beach on the Diamond Head (east) side of the groin. The beach in this area is currently wider than it was pre-construction, and the shoreline has naturally taken the arc-shape anticipated from the groin design.

Waikīkī Beach Maintenance II (2021)

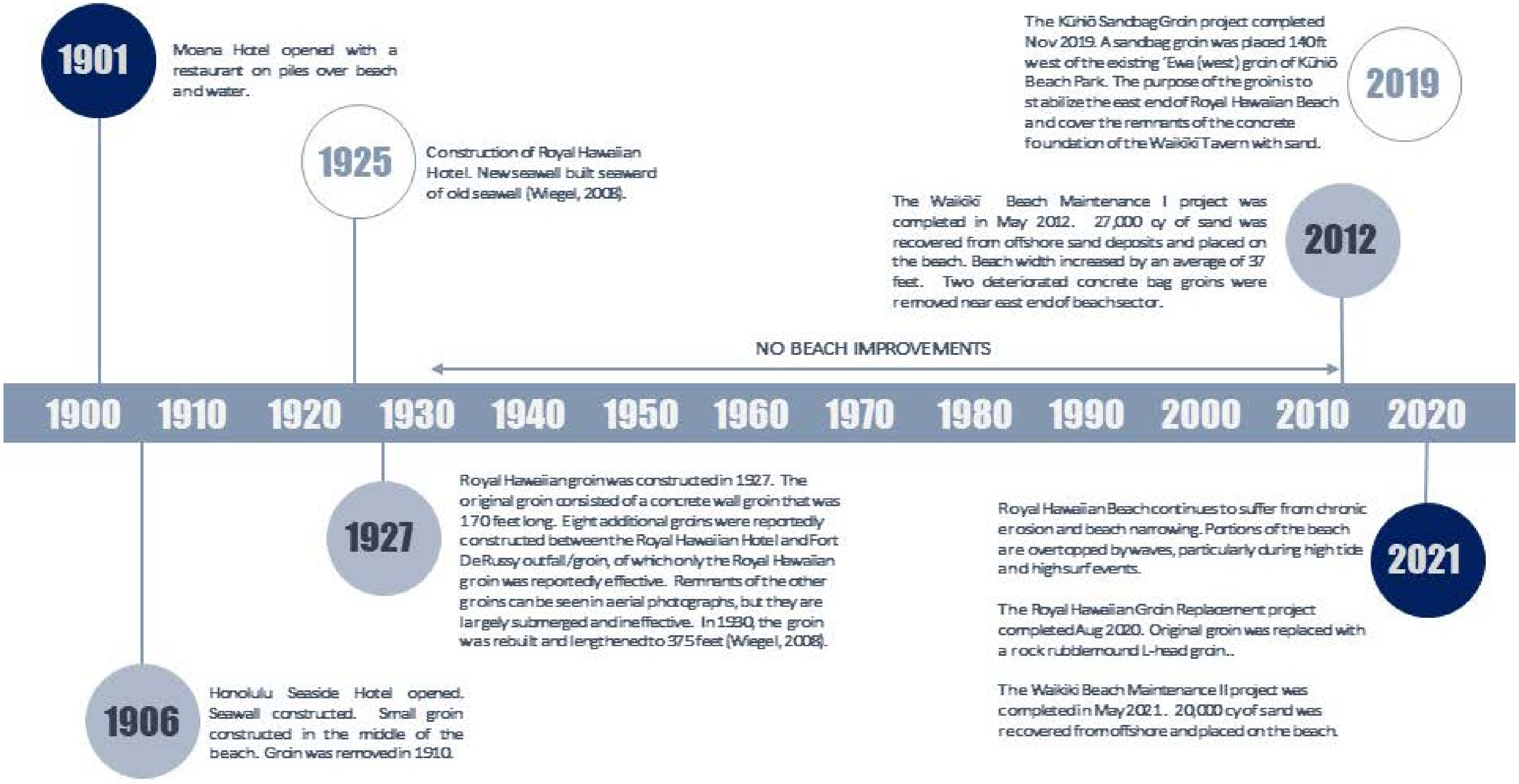
The permits for the 2012 Waikīkī Beach Maintenance I project authorized a second renourishment effort to be performed within 10 years. The project consisted of recovery of approximately 20,000 cy of sand from the same offshore sand deposit (*Canoes/Queens*) that was used in the 2012 project. The project was completed in May 2021 (see Section 2.6, Figure 2-11 and Figure 2-12).



WBSIDA
Waikiki Beach
SPECIAL IMPROVEMENT
DISTRICT ASSOCIATION

OVERVIEW MAP – ROYAL HAWAIIAN BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Draft Programmatic Environmental Impact Statement
Honolulu, Oʻahu, Hawaiʻi

Figure 6-1 Overview map – Royal Hawaiian beach sector



1901 Moana Hotel opened with a restaurant on piles over beach and water.

1906 Honolulu Seaside Hotel opened. Seawall constructed. Small groin constructed in the middle of the beach. Groin was removed in 1910.

1925 Construction of Royal Hawaiian Hotel. New seawall built seaward of old seawall (Wiegel, 2008).

1927 Royal Hawaiian groin was constructed in 1927. The original groin consisted of a concrete wall groin that was 170 feet long. Eight additional groins were reportedly constructed between the Royal Hawaiian Hotel and Fort DeRussy outfall/groin, of which only the Royal Hawaiian groin was reportedly effective. Remnants of the other groins can be seen in aerial photographs, but they are largely submerged and ineffective. In 1930, the groin was rebuilt and lengthened to 375 feet (Wiegel, 2008).

2012 The Waikīkī Beach Maintenance I project was completed in May 2012. 27,000 cy of sand was recovered from offshore sand deposits and placed on the beach. Beach width increased by an average of 37 feet. Two deteriorated concrete bag groins were removed near east end of beach sector.

2019 The Kūhiō Sandbag Groin project completed Nov 2019. A sandbag groin was placed 140ft west of the existing ʻEwa (west) groin of Kūhiō Beach Park. The purpose of the groin is to stabilize the east end of Royal Hawaiian Beach and cover the remnants of the concrete foundation of the Waikīkī Tavern with sand.

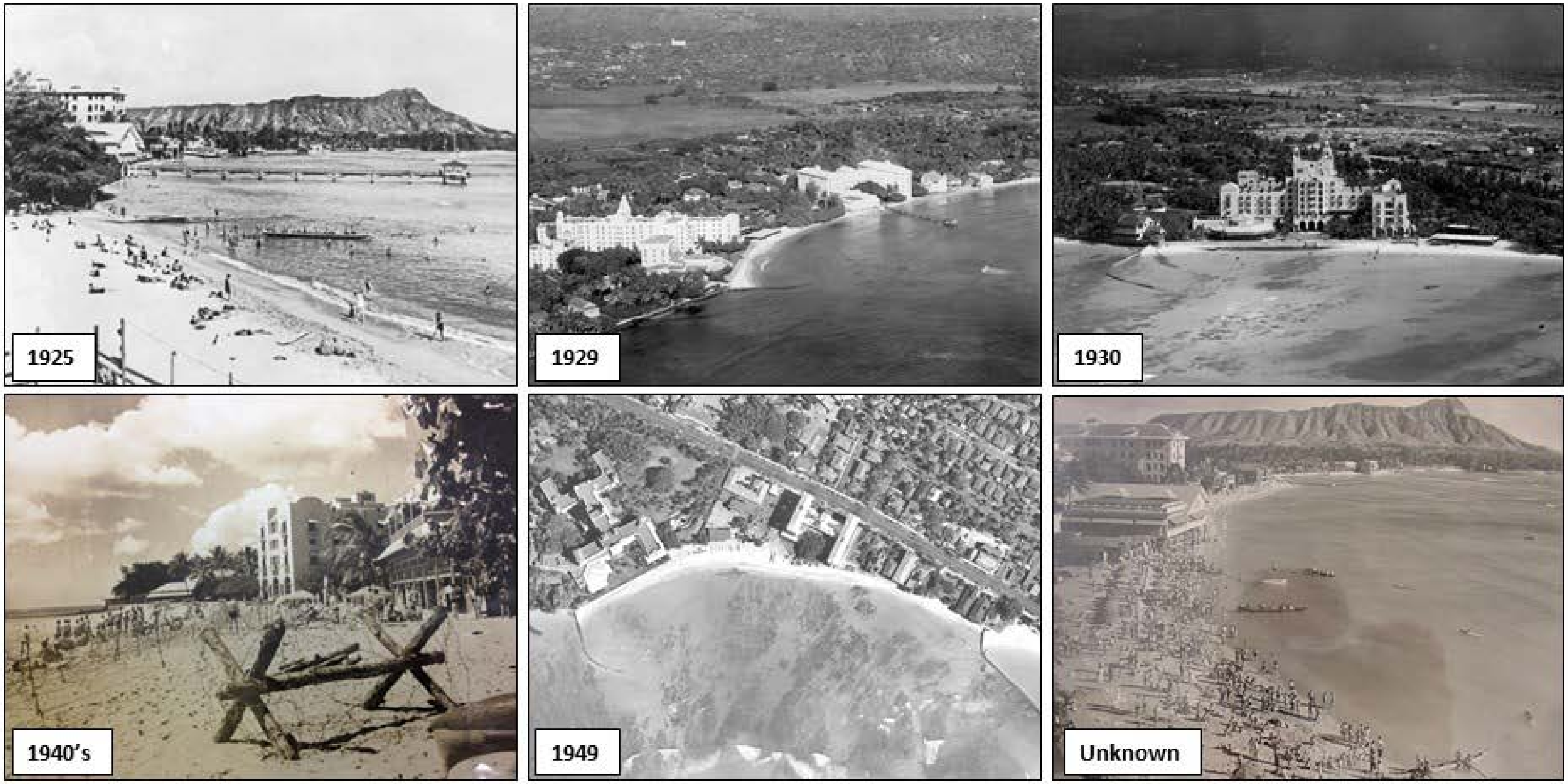
2021 Royal Hawaiian Beach continues to suffer from chronic erosion and beach narrowing. Portions of the beach are overtopped by waves, particularly during high tide and high surf events.

The Royal Hawaiian Groin Replacement project completed Aug 2020. Original groin was replaced with a rock rubblemound L-head groin..

The Waikiki Beach Maintenance II project was completed in May 2021. 20,000 cy of sand was recovered from offshore and placed on the beach.

Compiled from Department of Public Works (1931, 1951), U.S. Army Corps of Engineers (1968, 1992), Gerritsen (1978), Noda and Associates (1991, 1999), Miller & Fletcher (2003), Weigel (2008), Conger & Eversole (2013)

Figure 6-2 History of coastal engineering – Royal Hawaiian beach sector



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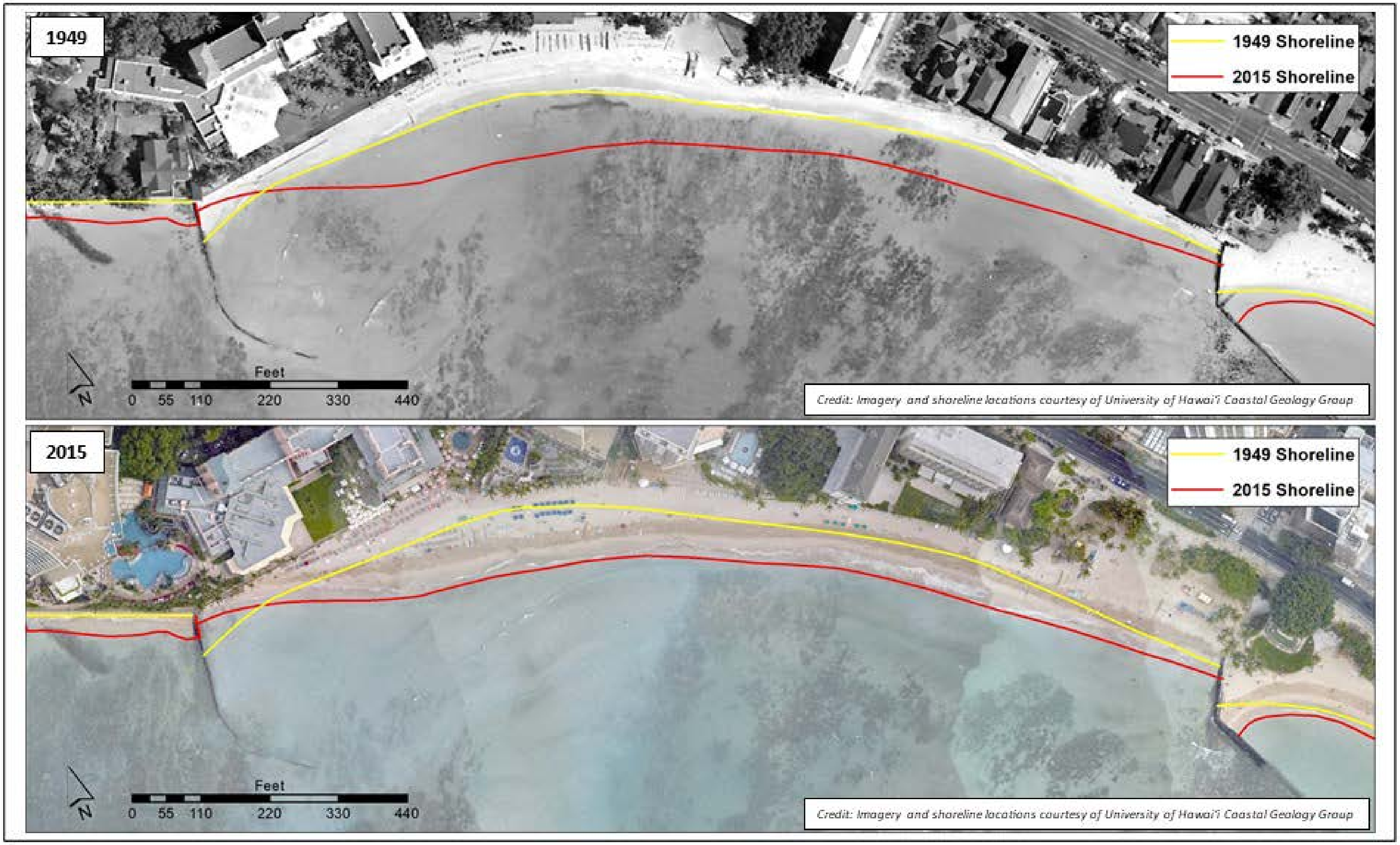
HISTORICAL PHOTOGRAPHS – ROYAL HAWAIIAN BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Draft Programmatic Environmental Impact Statement
Honolulu, Oʻahu, Hawaiʻi

Figure 6-3 Historical photographs – Royal Hawaiian beach sector



Credit: Imagery and shoreline locations courtesy of University of Hawaiʻi Coastal Geology Group

Credit: Imagery and shoreline locations courtesy of University of Hawaiʻi Coastal Geology Group

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HISTORICAL SHORELINE POSITIONS – ROYAL HAWAIIAN BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Draft Programmatic Environmental Impact Statement
Honolulu, Oʻahu, Hawaiʻi

Figure 6-4 Comparison of 1949 and 2015 shoreline positions – Royal Hawaiian beach sector

Royal Hawaiian beach sector (March 4, 2021) (credit: Shellie Habel)

Royal Hawaiian beach sector (looking west)

West end of Royal Hawaiian beach sector (credit: Shellie Habel)

East end of Royal Hawaiian beach sector

EXISTING CONDITIONS – ROYAL HAWAIIAN BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
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Figure 6-5 Existing conditions – Royal Hawaiian beach sector

6.2 Purpose and Need for the Proposed Action

Royal Hawaiian Beach is the most popular beach in Waikīkī. The beach is heavily used for numerous beach and ocean-based recreation activities, so the use of beach stabilizing structures (e.g., groins) is less desirable in this area. Erosion and beach narrowing have reduced the amount of dry beach available, which negatively impacts the recreational value and aesthetic quality of the beach. Photographs of existing issues and problems in the Royal Hawaiian beach sector are shown in Figure 6-6.

The State of Hawaiʻi recognizes that, given the chronic nature of the erosion and the expressed desire to maintain the beach without stabilizing structures, there is a need to develop a strategy for using offshore sand to periodically renourish the beach in this sector. This involves identification, mapping, and analysis of offshore sand deposits, and recovery of this sand and its placement on the beach. This “recycling” strategy provides a sustainable and efficient method of maintaining the recreational beach using existing local sand sources as well as mitigating some of the environmental effects of sand imported to Waikīkī over the past century. Wave-induced currents predominate inside the breaker zone, generating longshore (shore parallel) currents moving sand primarily from east to west. During high wave conditions, cross-shore (rip) currents can transport significant volumes of sand offshore, which causes erosion and beach narrowing. This sand can be periodically recovered and recycled back to the beach.

In collaboration with the WBCAC, the project proponents determined that the primary issues and problems in the Royal Hawaiian beach sector are:

- Chronic erosion and beach narrowing.
- Seasonal beach erosion.
- Deterioration and potential failure of existing structures.
- Limited lateral shoreline access.
- Beach loss at the Diamond Head (east) end of the beach sector.
- Overcrowding and beach use conflicts.

The highest priorities in the Royal Hawaiian beach sector are to:

- Maintain or improve active uses and dynamic beach-ocean interaction.
- Maintain or improve mixed recreational uses (swimming, surfing, bathing).
- Maintain or improve commercial uses (catamarans, canoes, beach concessions).
- Maintain cultural/historical sense of place.
- Maintain or improve vessel ingress/egress through the channel.
- Preserve and protect surf sites (*Canoes*, *Queens*, *Baby Queens*).
- No additional/new shoreline structures in the beach sector.

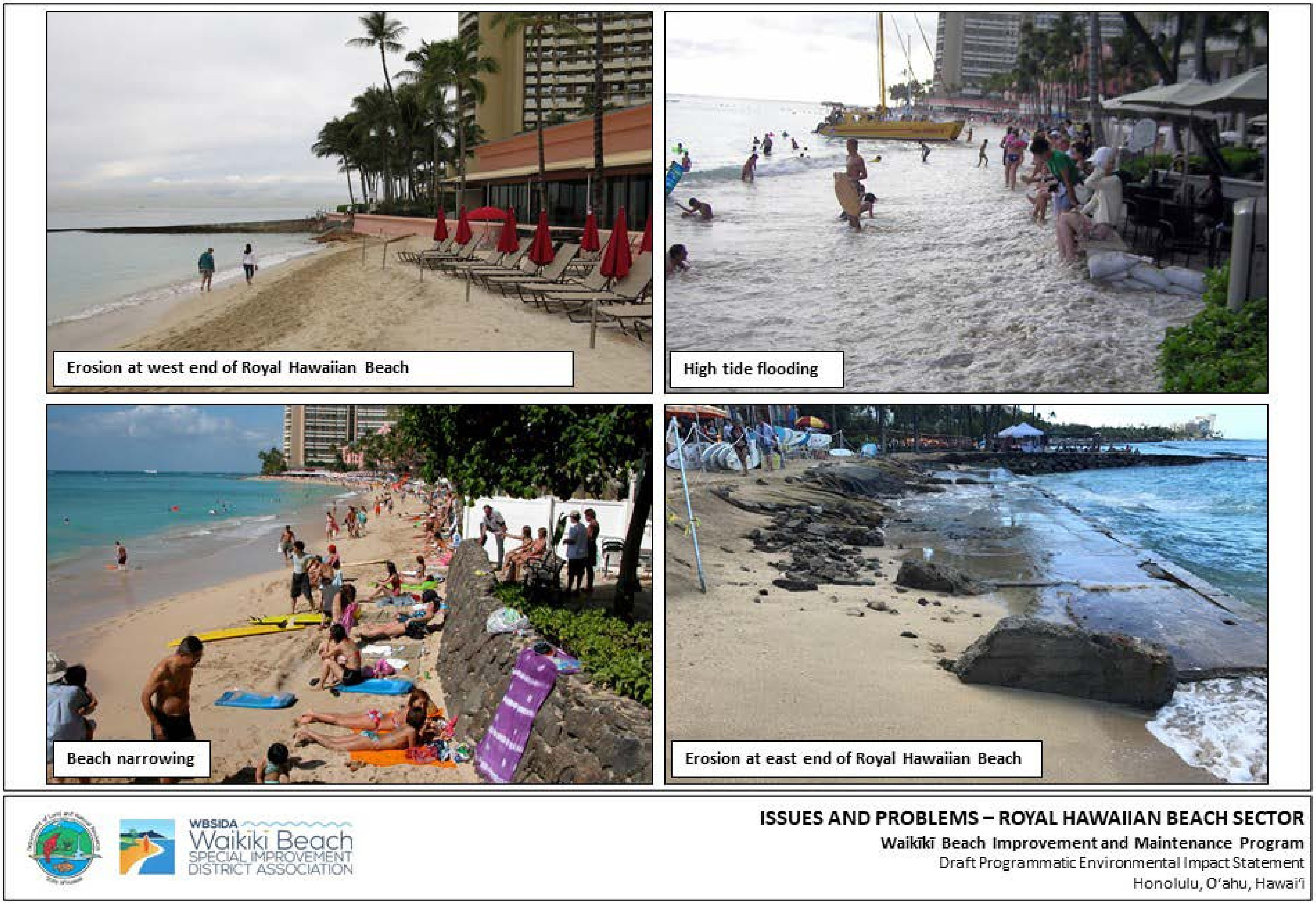

Figure 6-6 Issues and problems – Royal Hawaiian beach sector

6.3 Proposed Action

6.3.1 Description of the Proposed Action

The proposed action for the Royal Hawaiian beach sector is beach maintenance consisting of beach nourishment with no additional improvements or modifications to existing structures. The proposed action will require periodic renourishment to maintain the beach at its 1985 location. Through the permitting process for the 2012 Waikīkī Beach Maintenance I project, the Department of the Army permitted widening the beach to the approximate 1985 position which is the widest natural location of the shoreline in recent history.

The proposed action will involve recovering sand from deposits located directly offshore and placing it on the beach, as was done previously during the Waikīkī Beach Maintenance I and II projects in 2012 and 2021, respectively. The current beach crest is approximately +7 ft MSL. The proposed action will increase the beach crest elevation to +8.5 ft MSL to protect against wave overtopping and flooding. Based on a beach survey conducted in August 2019, approximately 30,000 cy of sand will be required to widen the beach to the historical 1985 and 2012 and 2021 post-nourishment shoreline position, and increase the beach crest elevation by 1.5 ft. The project layout for the proposed action is shown in Figure 6-7. Conceptual renderings of the proposed action are shown in Figure 6-8 and Figure 6-9.

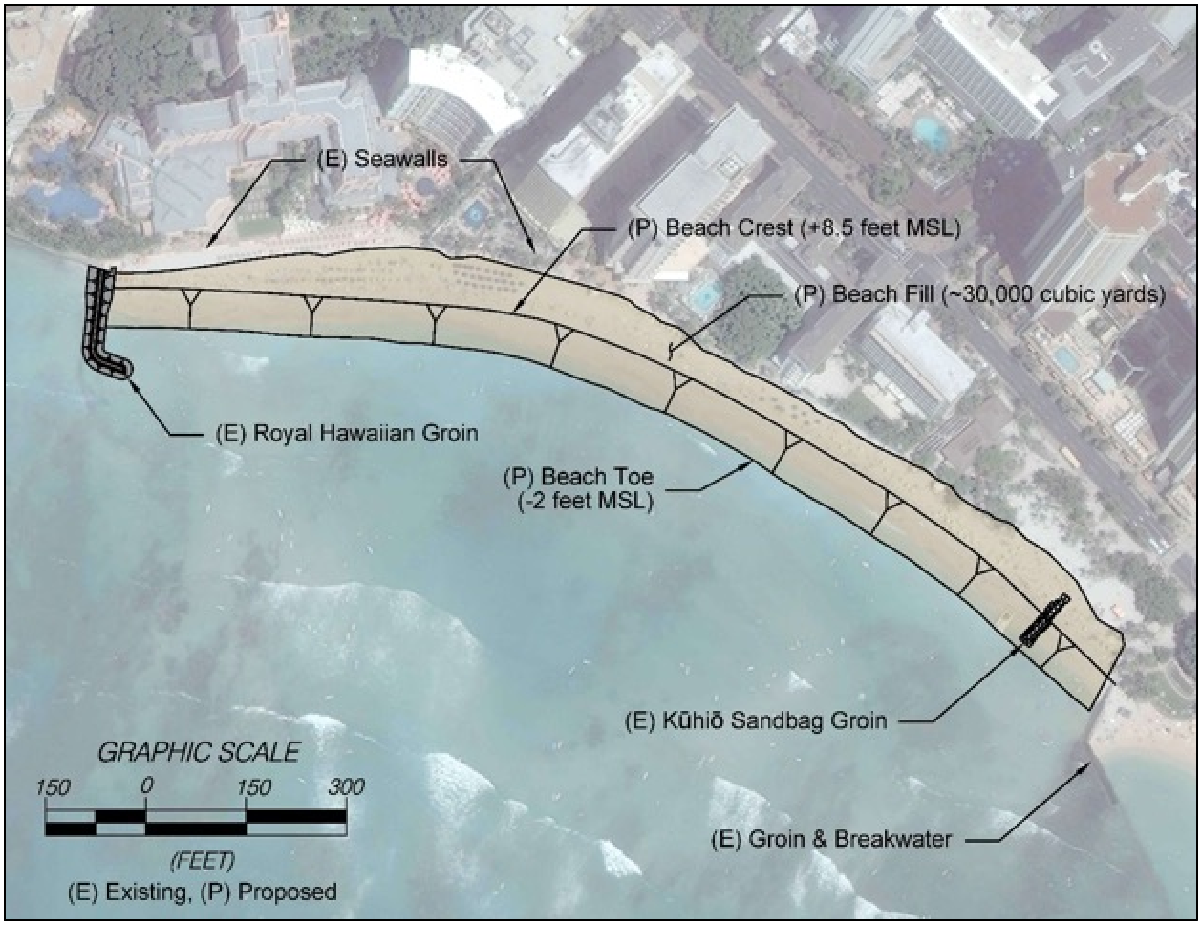

Figure 6-7 Project layout for the proposed action - Royal Hawaiian beach sector

CONCEPTUAL PLAN VIEW OF PROPOSED ACTION – ROYAL HAWAIIAN BEACH SECTOR

Waikīkī Beach Improvement and Maintenance Program
Draft Programmatic Environmental Impact Statement
Honolulu, Oʻahu, Hawaiʻi

Figure 6-8 Conceptual plan view of proposed action - Royal Hawaiian beach sector

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CONCEPTUAL OBLIQUE VIEW OF PROPOSED ACTION – ROYAL HAWAIIAN BEACH SECTOR

Waikīkī Beach Improvement and Maintenance Program

Draft Programmatic Environmental Impact Statement

Honolulu, Oʻahu, Hawaiʻi

Figure 6-9 Conceptual oblique view of proposed action - Royal Hawaiian beach sector

6.3.2 Sand Source

The preferred sand source for the proposed beach nourishment action is the *Canoes/Queens* offshore deposit, which is the same sand source that was used in the Waikīkī Beach Maintenance I and II projects in 2012 and 2021, respectively. The similar sand characteristics to the existing beach, close proximity to the shoreline, and small percentage of fine material in the *Canoes/Queens* offshore sand deposit makes it ideally suited for this beach sector.

Sand from the *Hilton* and *Ala Moana* offshore sand deposits are also viable options. Sand in the *Hilton* deposit is coarser and may be more stable on the beach. Utilizing clamshell dredging to recover sand from either of these deposits and trucking it to the project site may be more economical when compared to hydraulic dredging due to increased production and less projected downtime due to pipe plugging.

6.3.3 Construction Methodology

The construction methodology is expected to be similar to that of the Waikīkī Beach Maintenance I (2012) and II (2021) projects, during which sand was recovered from a deposit located directly offshore near the *Canoes* and *Queens* surf sites. Sand will be dredged using a submersible slurry pump mounted on a crane barge. The recovered sand will be pumped to shore through a bottom-mounted 12-inch diameter high-density polyethylene (HDPE) pipeline. The sand/water slurry will be pumped into a dewatering basin constructed in the Diamond Head (east) basin of Kūhiō Beach Park. The sand will be stockpiled and placed into dump trucks and transported along the beach where bulldozers will level the sand to achieve the design profiles.

Clamshell dredging is an alternative method of recovering offshore sand that will require a crane barge to dredge the sand and a scow and tugboat to transport the sand to an offloading site. Clamshell dredging will eliminate the need for the pipeline to shore and dewatering basin at Kūhiō Beach Park. Sand will be offloaded and trucked to the shoreline where the sand will be placed on the beach.

6.3.4 Estimated Timing, Phasing, and Duration

The estimated construction duration for beach nourishment without stabilizing structures is 120 days, and the estimated recurrence interval is 10 yrs. Assuming that renourishment is conducted over a period of 50 yrs, this will result in a total of 5 individual renourishment events and a total of 600 days of construction.

6.3.5 Required Permits and Approvals

The proposed action is anticipated to require the following permits and approvals:

- Department of the Army Permit (Section 10 and Section 404)
- Clean Water Act Section 401 Water Quality Certification
- Clean Water Act Section 402 National Pollutant Discharge Elimination System
- Coastal Zone Management Act Consistency Review
- Conservation District Use Permit
- Right of Entry Permit

6.4 Alternatives to the Proposed Action

The following alternatives were considered for the Royal Hawaiian beach sector:

- Beach Maintenance
- Beach Nourishment with Stabilizing Structures

6.4.1 Beach Maintenance

Sand backpassing would involve moving sand from wide portions of the beach to areas that are eroded and narrow. Presently, erosion is occurring at the Diamond Head (east) end of the beach adjacent to the ʻEwa (west) groin at Kūhiō Beach Park. A sand backpassing program could periodically add sand to this eroded area. While sand backpassing is technically feasible, it may not be a viable long-term option. The beach adjacent to the Royal Hawaiian groin is the only site in the Royal Hawaiian beach sector where a sufficient volume of sand would be available to support sand backpassing. However, the volume of sand present in this area is not sufficient to support periodic sand backpassing.

Sand pumping would involve recovering sand from the shallow sandbar that occasionally forms fronting the Royal Hawaiian Hotel. The sandbar has formed periodically in the past and is believed to consist of beach sand that has been transported offshore since the 2012 Waikīkī Beach Maintenance I project. As a demonstration project, sand could be recovered from the sandbar and placed back on the beach fronting the Royal Hawaiian Hotel, Outrigger Waikīkī Beach Resort, and Moana Surfrider Hotel.

A topographic survey was performed immediately prior to Hurricane Lane in 2019. Sand volume estimates ranged from 1,500 to more than 5,000 cubic yards. A demonstration project would involve recovery of approximately 2,400 cy of sand (if available), which is the volume required to raise the beach crest by approximately 6 in fronting the Royal Hawaiian Hotel, the Outrigger Waikīkī Beach Resort, and the Moana Surfrider Hotel (Figure 6-10). The concept does not include widening of the beach.

The concept assumes that a pipeline would carry the sand to shore, where the sand/water slurry would enter one of two dewatering basins fronting the Royal Hawaiian Hotel and the Outrigger Waikīkī Beach Resort. As one dewatering basin is being filled, the other would be excavated and sand would be placed on the beach. The dewatering basins would be approximately 120 ft long, 30 ft wide, and 3 ft deep and would provide dewatering capacity for up to 400 cy of sand. Precise dewatering basin size and location would be contingent on additional beach investigations.

The project could be accomplished using a diver-operated dredge (see Section 3.6.6), or another method that could achieve similar results. The project could be refined and potentially expanded when the sand source is better defined. While sand pumping is technically feasible, it may not be a viable long-term option. The sandbar is the only site in the Royal Hawaiian beach sector where sand pumping is feasible. However, the sandbar is an ephemeral feature that contains a limited volume of sand and may not be a sustainable sand source over the lifespan of the Program.

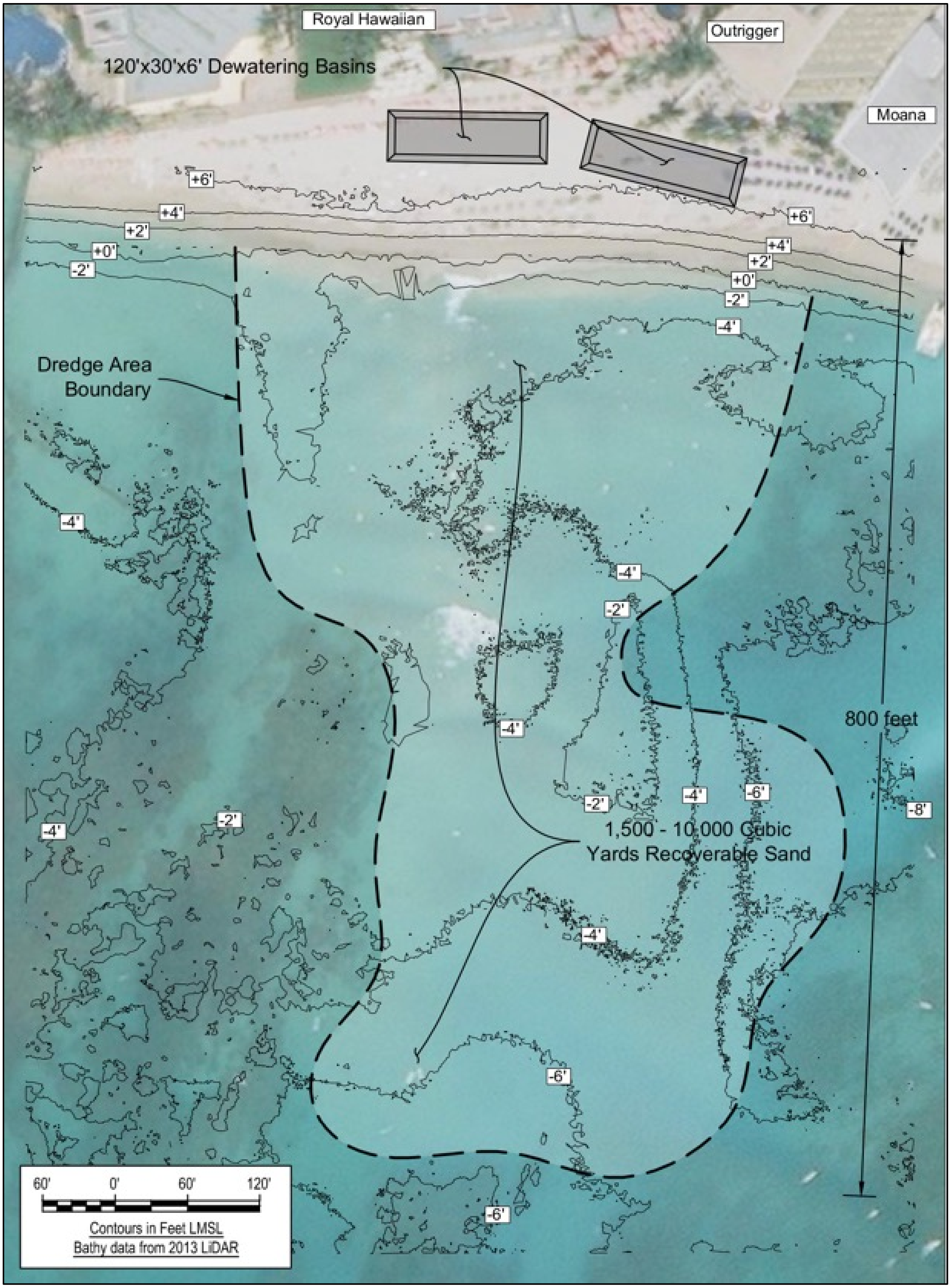


Figure 6-10 Dredge area and dewatering basins for sandbar recovery demonstration project

6.4.2 Beach Nourishment with Stabilizing Structures

This alternative would consist of constructing four new groins and modifying the ʻEwa (west) groin at Kūhiō Beach Park. A combination of T-head groins and beach fill would produce a wide, stable beach in an area where the beach has historically been narrow and subject to chronic erosion. This alternative would require approximately 45,000 cy of sand fill and would create approximately 3.8 acres of new dry beach area.

The groins could be designed for an initial beach crest elevation of +8.5-ft MSL (existing Waikīkī beaches are about +7 ft MSL) to account for 1.5 ft of sea level rise, with the ability to increase the beach crest elevation to +10 ft MSL to account for additional future sea level rise. The groin stem lengths (distance seaward from the shoreline) would be up to about 200 ft and would also be sufficient to stabilize up to a beach crest elevation of +10 ft MSL. The minimum beach crest width at its narrowest point midway between the groins would be about 20 to 30 ft, and the beach slope would be 1V:8H (vertical to horizontal).

This alternative would be implemented in phases, with the initial phase being designed for approximately 1.5 ft of sea level rise, thus in 25 to 30 years following construction it may be necessary to raise the project elevations. If then raised by several feet, the project could be effective until about the year 2080, or 50-years post-construction. The estimated construction duration for beach nourishment with stabilizing structures is 240 days.

Beach nourishment with stabilizing structures would produce a wide, stable beach and eliminate the need for periodic renourishment. However, based on feedback from the WBCAC, the majority of stakeholders prefer that Royal Hawaiian Beach should be maintained without any additional shoreline structures. As a result, beach nourishment with stabilizing structures was ruled out in the early stages of the conceptual design and project selection process.

7. PROPOSED ACTION: KŪHIŌ BEACH SECTOR

7.1 General Description

The Kūhiō beach sector spans approximately 1,500 ft of shoreline extending from the ʻEwa (west) groin at Kūhiō Beach Park east to the Kapahulu storm drain/groin. Prominent features in this sector include Kūhiō Beach Park, the Hula Mound, and the Kūhiō Promenade. The backshore area mauka (landward) of Kalākaua Avenue is densely developed with shops, restaurants, hotels and resorts including the Aston Waikīkī Circle, ʻAlohilani Resort, Waikīkī Beach Marriott, Aston Waikīkī Beach, and Park Shore Waikīkī. An overview map of the Kūhiō beach sector is shown in Figure 7-1.

History
The Kūhiō beach sector has been the subject of numerous modifications attempting to produce stable beach cells. The modifications began in the early 1900s with seawall construction to protect Kalākaua Avenue (Waikīkī Avenue at the time). The ʻEwa (west) breakwater was constructed in 1939, followed in the 1950s by construction of the Kapahulu storm drain/groin and a series of new groins and modifications. No structural improvements have been made since 1975; however, sand has periodically been placed on the beach. The history of coastal engineering in the Kūhiō beach sector is summarized in Figure 7-2. Historical photographs of the Kūhiō beach sector are shown in Figure 7-3. Aerial photographs comparing the shoreline conditions in the Kūhiō beach sector in 1949 and 2015 are shown in Figure 7-4.

Existing Conditions
The Kūhiō beach sector is an entirely engineered shoreline. The west end of the sector is bounded by an old rock rubblemound groin that was constructed in 1939 and separates the Kūhiō and Royal Hawaiian beach sectors. The landward stem of this groin is composed of concrete filled sandbags that are severely deteriorated. The central portion of the sector consists of two basins that are separated by a rock rubblemound groin with a concrete walkway on top. The east end of the sector is bounded by the Kapahulu storm drain/groin, which separates the Kūhiō and Queen's beach sectors. The seaward portion of the sector is bounded by a concrete breakwater (often referred to as "crib walls"). The mauka (landward) portion of the sector is bounded by a series of nearly continuous seawalls that are of concrete rubble masonry (CRM) construction. The beach itself consists of sand fill that was imported from various sources and placed along the shoreline during a series of beach construction and maintenance efforts that began in 1939.

The existing groins and attached offshore breakwaters create two distinct basins, each with different beach configurations that reflect the impact of the different stabilizing structure configurations. The Diamond Head (east) basin is approximately 740 ft long, bounded by the Kapahulu storm drain/groin to the southeast, a rock rubblemound groin that separates the two basins, and a concrete breakwater ((referred to as "slippery wall" due to its slippery covering of algae)) along the makai (seaward) side with a crest elevation of about +3 ft MSL. Narrow offset gaps at either end of the breakwater allow for ocean water to flow in and out of the basin largely due to wave and tidal forcing. The gaps, combined with the low crest elevation of the breakwater, allows wave overtopping that facilitates circulation and water exchange in the basin.

Conditions within the basin are typically shallow and calm, which makes it very popular for sunbathing, wading, floating, and swimming, especially for families with young children. The dry beach is typically 20 to 30 ft wide at the east end, and gradually widens to about 90 ft at the west end. The basin is well protected from incident wave energy and most of the central and east end of the beach is inundated when tide levels exceed +2.0 ft MSL. The beach face is aligned approximately parallel to the incident wave crests along the breakwater. While water circulation is limited, routine water quality testing by the Hawaiʻi Department of Health has not indicated water quality issues except after heavy rain events.

The ʻEwa (west) basin is about 680 ft long, bounded by a rock rubblemound groin at the east end that separates the two basins, a rock rubblemound groin at the west end, and a breakwater along the makai (seaward) side. There is a 220-ft-wide gap in the breakwater, with a concrete sill extending across the gap with an elevation approximately equal to the low tide level. The dry beach width on the east side of the basin is approximately 80 ft, and ranges from 40 to 80 ft on the west side. Opposite the gap in the breakwater, the dry beach is typically very narrow (10 to 20 ft) and is completely inundated during medium to high tides due to the narrow beach width and low elevation. The cuspate beach shape within the basin indicates some wave influence at the beach.

Kūhiō Beach provides lateral shoreline access from the terminal groin at the west end of the ʻEwa (west) basin to the Kapahulu storm drain/groin at the east end of the Diamond Head (east) basin. A concrete sidewalk along Kalākaua Avenue provides ADA-compliant lateral access mauka (landward) of the shoreline along the entire beach sector. Most of Kūhiō Beach Park is backed by a series of seawalls that are of concrete rubble masonry (CRM) construction. A series of openings in the seawalls, most with stairs, provide access from the sidewalk to the beach. Three City and County of Honolulu lifeguard towers are located in the Kūhiō beach sector: one in the ʻEwa (west) basin, and two in the Diamond Head (east) basin.

The Kūhiō beach Sector is heavily utilized by sunbathers and people floating, wading and swimming in the calm, protected waters within the basins. At the west end of the sector, beach concessionaires offer a variety of ocean recreation instruction and equipment rentals. This is also the site of the Hula Mound, which regularly hosts free music and dance shows. The surf site known as *Baby Queens*, a popular break for visitors and beginner surfers, is located makai (seaward) of the west end of the ʻEwa (west) basin. Surfers commonly access the nearby surf sites through this area and paddle through the gaps in the breakwater to shorten the paddle out. At the east end of the beach sector, seaward of the Diamond Head (east) basin breakwater, adjacent to the Kapahulu storm drain/groin, is a very popular body surfing and boogie boarding site known as *Walls*, where intrepid wave riders ride up to (and sometimes over) the breakwater. The area inshore of a series of buoys is a “no surfboard “ zone and only bodyboarding and bodysurfing area allowed in this area.

The nearshore bathymetry makai (seaward) of the breakwater is very irregular, with shallow reef rock bisected by deeper sand bottom channels, which results in considerable wave refraction and a variable wave approach direction along the breakwater. The wave approach varies from nearly parallel to the breakwater to a nearly 45 deg angle to the walls. Even though the breakwater greatly reduces wave energy reaching the shoreline, the beach orientation inside mimics the incident wave crest orientation. In the ʻEwa (west) basin, the beach is very narrow opposite the gap in the breakwater as a result of relatively high wave energy passing through the gap and wave diffraction around the breakwater structures on either side of the gap. Photographs of existing conditions in the Kūhiō beach sector are shown in Figure 7-5.

Historical and Projected Shoreline Change

The UHCGG historical shoreline change trend for the Kūhiō beach sector from 1927 to 2015 has been erosion at an average rate 0.11 ft/yr (UHCGG, 2019). The erosion is more pronounced in the Diamond Head (east) basin with the predominant direction of sediment transport being from east to west (Miller and Fletcher, 2003). As sand is transported from east to west along the beach, the east end of the beach narrows and there is no mechanism to transport sand back to the eroding area. The erosion is less pronounced in the ʻEwa (west) basin where the sand is impounded on the updrift side of the groin at the west end of the sector.

As sea levels continue to rise, the Kūhiō beach sector is projected to erode 33.1 ft (10.1 m) by 2050 and 86.6 ft (26.4 m) by 2100 (UHCGG, 2019). It is important to note that the long-term historical shoreline change rates for Waikīkī are influenced by efforts over the past century to stabilize and restore the beach, which influences the future erosion projections. These projections also assume that the backshore is composed of non-cohesive erodible substrate and do not account for the presence of the existing seawalls that span nearly the entire length of the shoreline in the Kūhiō beach sector. As the shoreline approaches the existing seawalls, there is an incremental loss of recreational beach area and shoreline habitat, a process that is referred to as *coastal squeeze* (Lester and Matella, 2016).

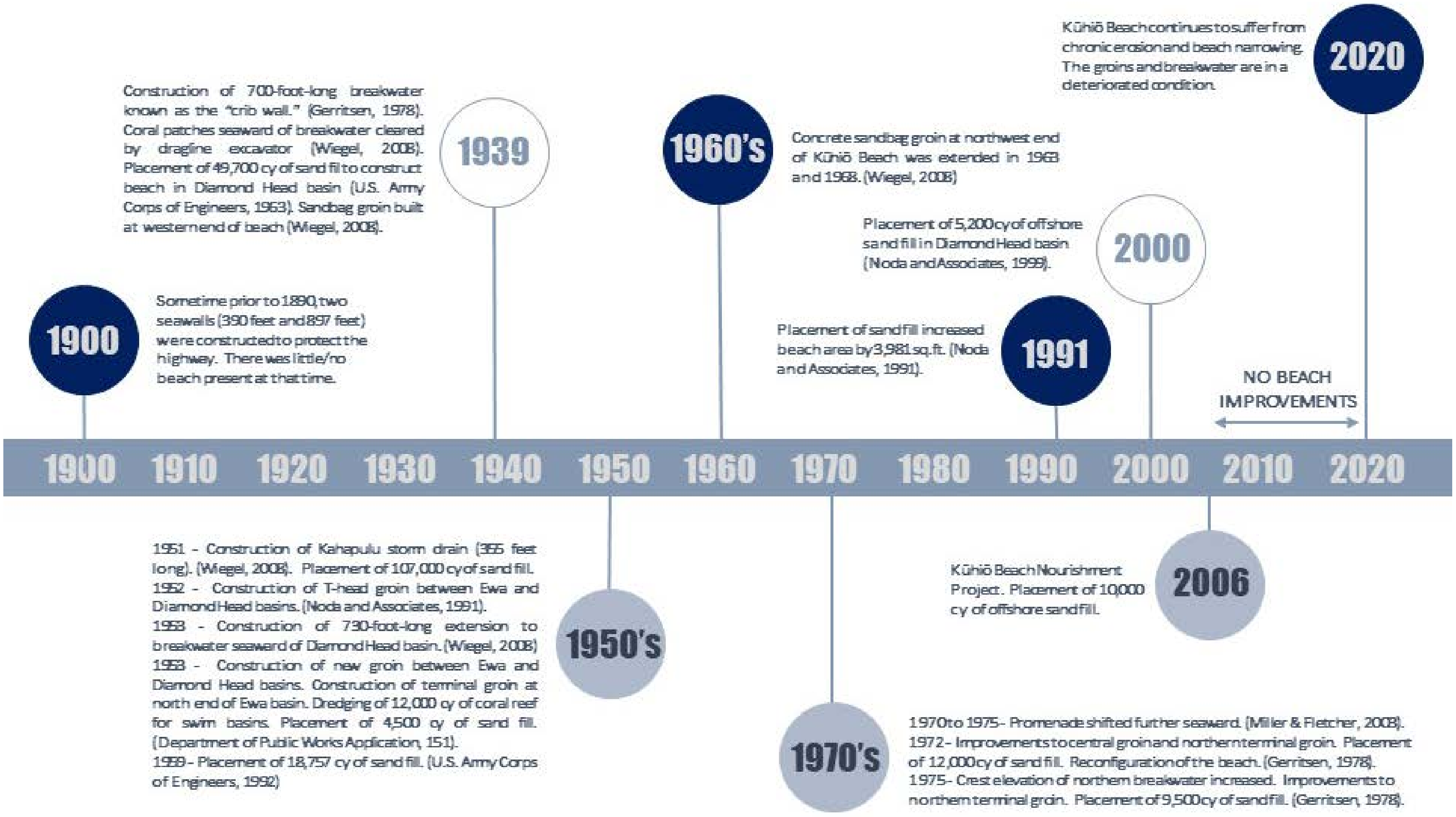
Without beach improvements and/or maintenance, it is likely that increasing erosion and coastal flooding with sea level rise will result in total beach loss in the middle of this sector within several decades. Erosion and flooding may be less severe at the west ends of the basins where the beach is currently widest; however, total beach loss will still likely occur in these areas before the end of the century if erosion continues at historical rates.

Beach Improvements and Maintenance

Over the years, various improvements to Kūhiō Beach have been considered but never implemented (Figure 7-6). In 1999, Edward K. Noda & Associates, Inc. (EKNA) published an Environmental Assessment for Kūhiō Beach Improvements (Noda, 1999), which consisted of replacing the existing breakwater with segmented breakwaters to form a larger and more stable beach configuration (Figure 7-6B). In 2000, Olsen Associates, Inc. (Bodge) proposed an alternative design using a series of T-head groins and beach nourishment (Figure 7-6C).

The most recent beach improvement project in the Kūhiō beach sector was conducted by the DLNR in 2006. The project consisted of the recovery of approximately 10,000 cy of sand from deposits located immediately offshore of Kūhiō Beach, pumping it to shore for dewatering, and placing it on the beach to nourish and widen the beach (USACE, 2006). The sand was primarily placed within the confines of the breakwater; however, approximately 20% of the sand was placed on the beach west of the breakwater, fronting the Duke Kahanamoku statue.

Figure 7-1 Overview map – Kūhiō beach sector



Sometime prior to 1890, two seawalls (390 feet and 897 feet) were constructed to protect the highway. There was little/no beach present at that time.

Construction of 700-foot-long breakwater known as the "crib wall." (Gerritsen, 1978). Coral patches seaward of breakwater cleared by dragline excavator (Wiegel, 2008). Placement of 49,700 cy of sand fill to construct beach in Diamond Head basin (U.S. Army Corps of Engineers, 1963). Sandbag groin built at western end of beach (Wiegel, 2008).

1951 - Construction of Kahapulu storm drain (355 feet long). (Wiegel, 2008). Placement of 107,000 cy of sand fill.
1952 - Construction of T-head groin between Ewa and Diamond Head basins. (Noda and Associates, 1991).
1953 - Construction of 730-foot-long extension to breakwater seaward of Diamond Head basin. (Wiegel, 2008)
1953 - Construction of new groin between Ewa and Diamond Head basins. Construction of terminal groin at north end of Ewa basin. Dredging of 12,000 cy of coral reef for swim basins. Placement of 4,500 cy of sand fill. (Department of Public Works Application, 151).
1959 - Placement of 18,757 cy of sand fill. (U.S. Army Corps of Engineers, 1992)

Concrete sandbag groin at northwest end of Kūhiō Beach was extended in 1963 and 1968. (Wiegel, 2008)

1970 to 1975 - Promenade shifted further seaward. (Miller & Fletcher, 2003).
1972 - Improvements to central groin and northern terminal groin. Placement of 12,000 cy of sand fill. Reconfiguration of the beach. (Gerritsen, 1978).
1975 - Crest elevation of northern breakwater increased. Improvements to northern terminal groin. Placement of 9,500 cy of sand fill. (Gerritsen, 1978).

Placement of sand fill increased beach area by 3,981 sq. ft. (Noda and Associates, 1991).

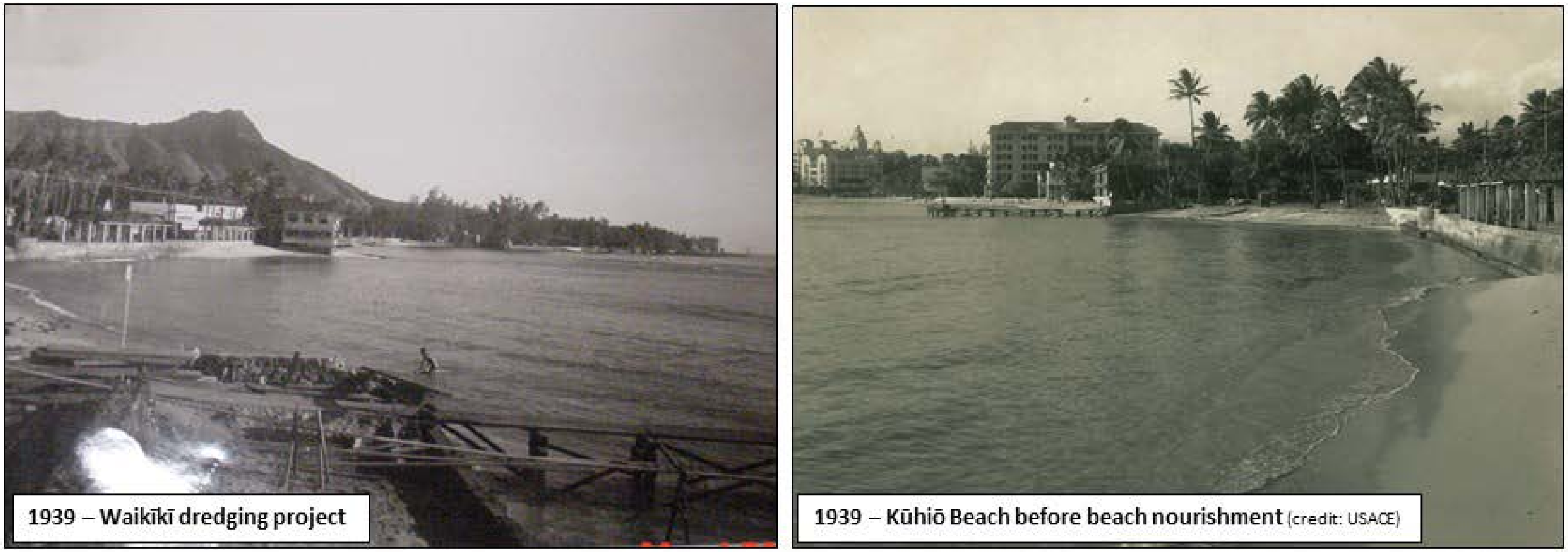
Placement of 5,200 cy of offshore sand fill in Diamond Head basin (Noda and Associates, 1999).

Kūhiō Beach Nourishment Project. Placement of 10,000 cy of offshore sand fill.

Kūhiō Beach continues to suffer from chronic erosion and beach narrowing. The groins and breakwater are in a deteriorated condition.

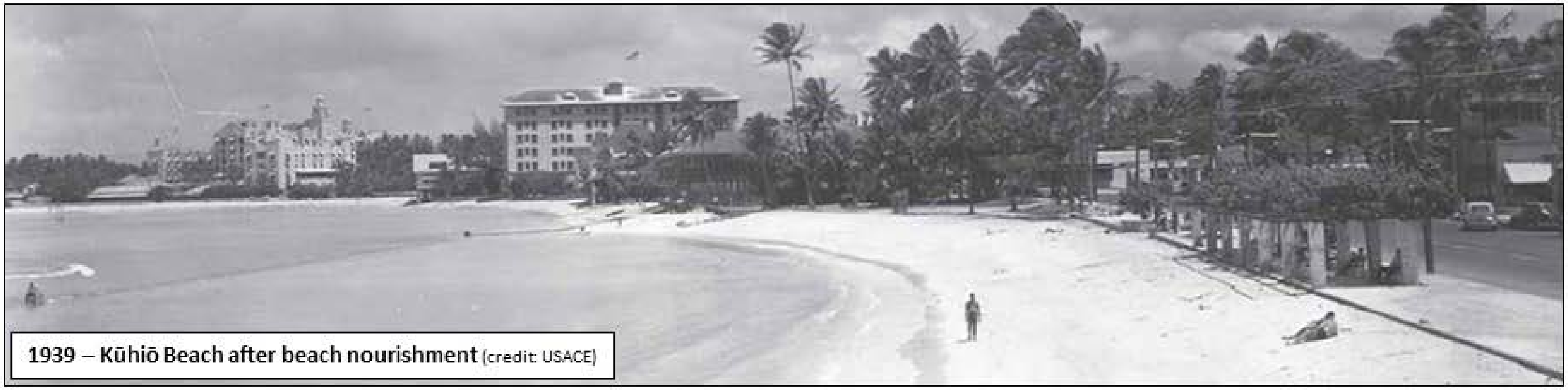
Compiled from Department of Public Works (1931, 1951), U.S. Army Corps of Engineers (1968, 1992), Gerritson (1978), Noda and Associates (1991, 1999), Miller & Fletcher (2003), Weigel (2008), Conger & Eversole (2013)

Figure 7-2 History of coastal engineering – Kūhiō beach sector



1939 – Waikīkī dredging project

1939 – Kūhiō Beach before beach nourishment (credit: USACE)



1939 – Kūhiō Beach after beach nourishment (credit: USACE)

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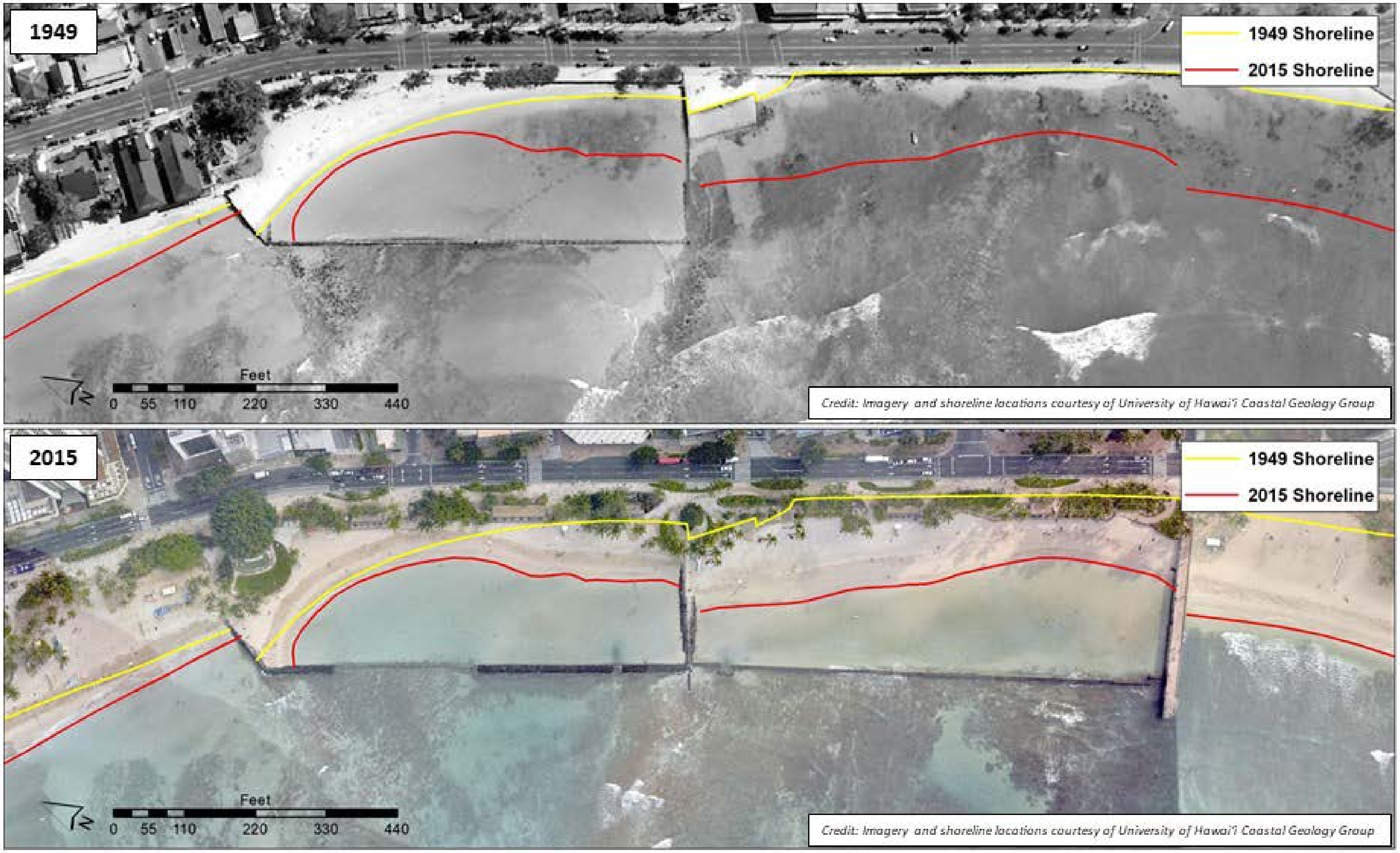
DISTRICT ASSOCIATION

HISTORICAL PHOTOGRAPHS – KŪHIŌ BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Draft Programmatic Environmental Impact Statement
Honolulu, Oʻahu, Hawaiʻi

Figure 7-3 Historical photographs – Kūhiō beach sector



Credit: Imagery and shoreline locations courtesy of University of Hawaiʻi Coastal Geology Group

Credit: Imagery and shoreline locations courtesy of University of Hawaiʻi Coastal Geology Group

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HISTORICAL SHORELINE POSITIONS – KŪHIŌ BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, Oʻahu, Hawaiʻi

Figure 7-4 Comparison of 1949 and 2015 shoreline positions – Kūhiō beach sector

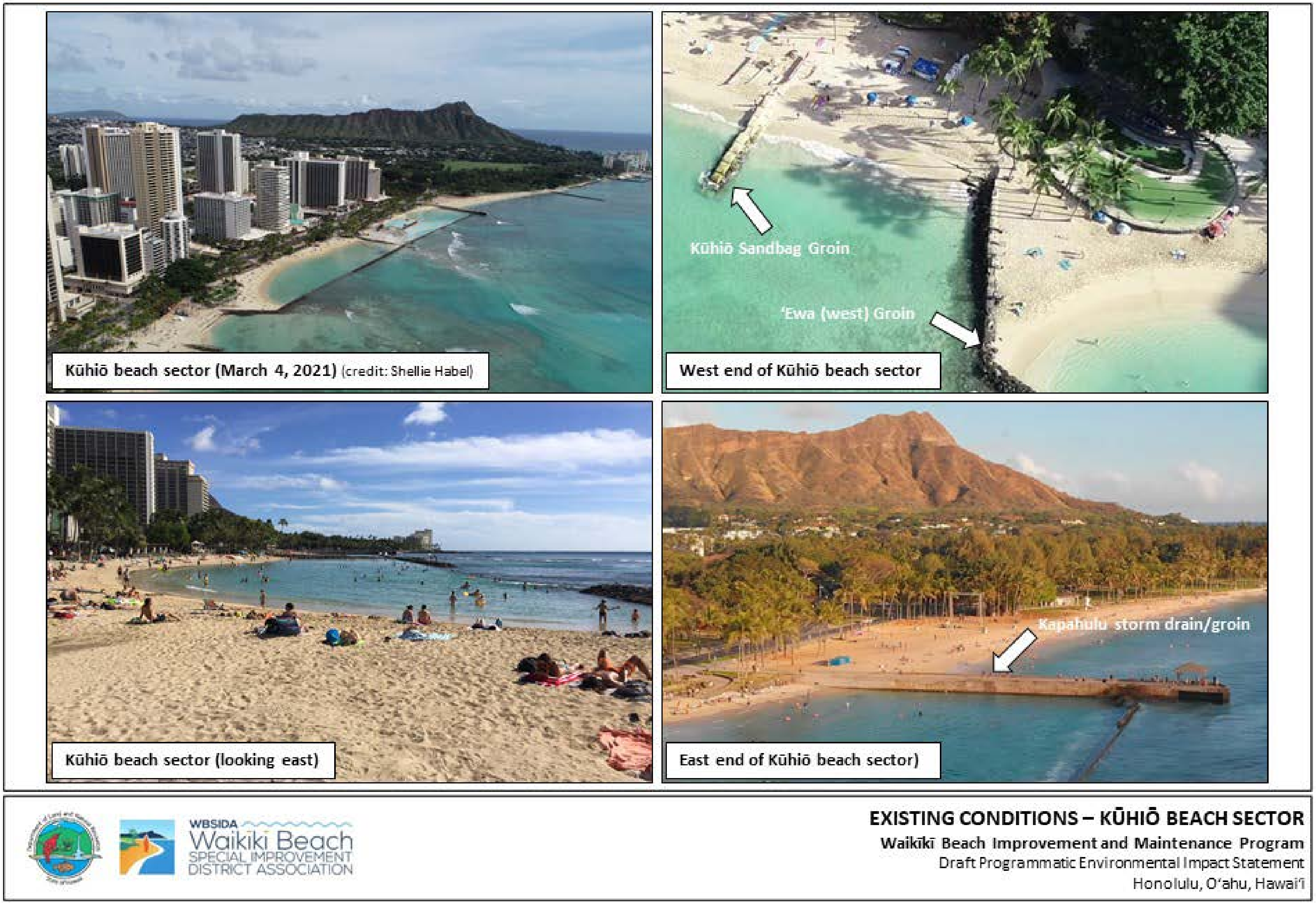

Figure 7-5 Existing shoreline conditions – Kūhiō beach sector

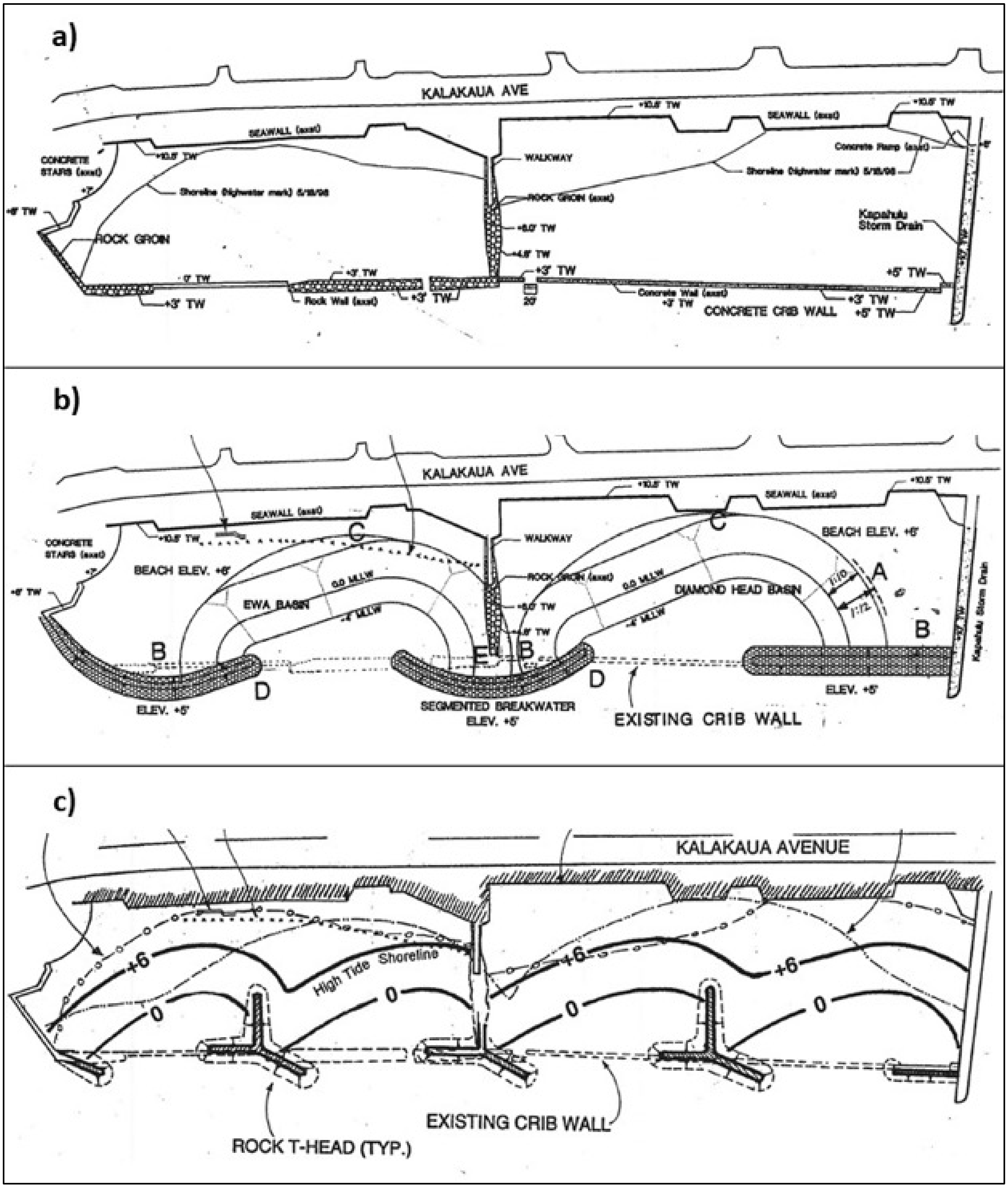

Figure 7-6 (a) existing, b) EKNA proposed (1999), and c) Bodge proposed (2000)

7.2 Purpose and Need for the Proposed Actions

Despite being bounded by offshore breakwaters and groins, the beach in both basins experiences chronic erosion and beach narrowing, some of which can be attributed to water circulation through the wall openings during periods of high surf. In addition, the breakwater significantly reduces wave action on the beach, which causes the sand to migrate (slump) makai (seaward) into the basins, flattening the beach profile, reducing the amount of dry beach area, and decreasing water depths. This was evident following the 2006 Kūhiō Beach Nourishment project. Although the dry beach area rapidly diminished, beach profiles showed that the volume of sand in the basins had not decreased; rather, the sand had migrated into the basins below the waterline.

Other issues with the existing configuration of the basins include safety hazards due to the low, slippery breakwater and narrow gaps for water circulation, and reports of poor water quality due to limited circulation and exchange of ocean water. Strong currents through the gaps in the breakwater produce deep scour trenches that may pose a hazard for unaware waders and swimmers. Despite the extensive breakwater enclosing the basins, there is a slow but chronic loss of sand, and a limited amount of dry beach area. Although the Kūhiō beach sector is nearly 1,500 ft long, the amount of dry beach area at high tide is often very small. Photographs of existing problems in the Kūhiō beach sector are shown in Figure 7-7.

In collaboration with the WBCAC, the project proponents determined that the primary issues and problems in the Kūhiō beach sector are:

- Beach narrowing and makai (seaward) migration (slumping) of the beach profile.
- Seasonal beach erosion.
- Water quality impacts.
- Lack of maintenance of existing infrastructure and amenities.
- Public safety hazard on the existing breakwater and groins.
- Beach narrowing in the Diamond Head (east) basin.

The highest priorities in the Kūhiō beach sector are to:

- Maintain calm and shallow water uses and beach/ocean interaction (swimming, bathing).
- Maintain or improve ocean access at the ʻEwa (west) basin (surfing, paddling).
- Maintain or improve existing commercial uses.
- Maintain cultural/historical sense of place.
- Maintain or improve public access along the Kapahulu storm drain/groin and Esplanade.
- Preserve and protect surf sites (e.g., *Walls*, *Queens*, *Baby Queens*, *Cunha's*).

The highest priorities for the Kūhiō beach sector ʻEwa (west) basin are to maintain a moderately-energetic wave environment, maintain ocean access, reduce sand loss through the breakwater channel, and stabilize seasonal beach dynamics. The highest priority for the Diamond Head (east) basin is to maintain calm and shallow water uses and beach-ocean interaction (e.g., swimming, wading).

Existing breakwater in Diamond Head (east) basin

High tide flooding in ʻEwa (west) basin (credit: Hawaiʻi Sea Grant)

Beach narrowing in Diamond Head (east) basin

High tide flooding in Diamond Head (east) basin (credit: Hawaiʻi Sea Grant)

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ISSUES AND PROBLEMS – KŪHIŌ BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Draft Programmatic Environmental Impact Statement
Honolulu, Oʻahu, Hawaiʻi

Figure 7-7 Issues and problems – Kūhiō beach sector

7.3 Proposed Action - ʻEwa (west) Basin

Kūhiō Beach Park has been considered as a location where beach maintenance could be performed using existing sand from within the basins. Many features of the basins make them a desirable location for experimenting with novel dredging methods. The basins contain a substantial volume of beach quality sand, are subject to minimal wave action, and are almost completely enclosed by existing structures. The proposed actions for the Kūhiō beach sector are divided into actions for the ʻEwa (west) basin, and the Diamond Head (east) basin.

7.3.1 Description of the Proposed Action

The proposed action for the Kūhiō beach sector ʻEwa (west) basin is beach improvements consisting of beach nourishment with a segmented breakwater. The proposed action will involve removing portions of the existing structures, construction of a new groin and segmented breakwater system, and placement of sand fill to increase beach width. The conceptual layout for the proposed action is shown in Figure 7-8. Section views of the groins heads and stems are shown in Figure 7-9 and Figure 7-10, respectively. Conceptual renderings of the proposed action are shown in Figure 7-12 and Figure 7-13.

The groin heads and detached breakwater are designed with crest elevations of +6 ft MSL, which is consistent with the head elevation of the Royal Hawaiian groin. This crest elevation will allow some wave overtopping during high surf events without sacrificing beach stability. The structures are designed to be modified as sea levels continue to rise. The structures will have cast-in-place concrete cores as shown in Figure 7-9, which will serve as bases for groin expansion as sea levels continue to rise. When sea level has risen and vertical extension is required, crown walls can be constructed on top of the concrete cores to effectively raise the height of the structures. Designing the structures in this manner keeps the heights lower and the viewplanes more open initially, as opposed to designing the elevations for 3.2 ft of sea level rise now, as suggested by various agencies, and having the structures with elevations likely exceeding +9 ft msl. Future vertical extension of the structures could be accomplished with manual labor and small equipment. Heavy equipment such as bulldozers and excavators would not be required.

The groin heads and breakwater will have crest elevations of +6 ft MSL, crest widths of 12 ft, base widths of 36 to 38 ft, and side slopes of 1V:1.5H (vertical to horizontal). The ʻEwa (west) groin stem elevations will increase from +6 ft MSL at the heads to +7.5 ft MSL at the inshore end. A concrete crown wall will be constructed on the center groin to contain sand within the ʻEwa (west) basin.

The ʻEwa (west) groin is designed with consideration of the beach on each side of it. The head (seaward portion) of the groin is oriented to stabilize that end of the beach inside the basin. The beach on the ʻEwa (west) side, however, is subject to chronic erosion and the Waikīkī Tavern foundation is frequently exposed. This is occurring because incoming waves approach parallel to the groin stem and wave energy is not dissipated as the waves propagate to shore. This has resulted in erosion of the beach along the ʻEwa (west) side of the groin stem and has also caused undermining of the groin stem.

To mitigate these erosion effects, a recessed head will be constructed on the west side of the ʻEwa (west) groin. This alternative was investigated at a conceptual level during the design phase of the 2019 Kūhiō Sandbag Groin project. The recessed head will be about 50 ft long and is designed to diffract the approaching waves to create a wave approach pattern that will reduce the longshore current and produce a more stable, arc-shaped beach. The recessed head will also help to reduce erosion and flanking of the ʻEwa (west) groin stem. Portions of the old Waikīkī Tavern concrete foundation wall may need to be removed to maintain a stable beach profile in this area as shown in Figure 7-11.

Approximately 4,000 cy of stone and 250 cy of concrete will be required to construct the groins. The median armor stone weight will be approximately 6,300 pounds. A range of ±25% of the median weight is typically utilized, which yields a stone size range of 4,700 to 7,900 pounds. A two-stone thick layer will be about 6.6 ft thick. The armorstone will be keyed and fit to increase stability.

The proposed action will require approximately 28,000 cy of sand fill that will be placed between the groins to create a beach that will be a minimum of 30 ft wide with a crest elevation of +8.5 ft MSL and a slope of 1V:8H (vertical to horizontal) from the beach crest to the beach toe. The total dry beach area inshore of the waterline will be about 44,000 sf (1 acre). The ʻEwa (west) groin stem will be lower than the beach crest elevation, thus approximately half of the groin stem will be covered by sand, with the groins gradually emerging as they progress further makai (seaward). This should help to improve lateral access along this reach of shoreline. The beach elevation will be higher in the ʻEwa (west) basin than in the Diamond Head (east) basin. A concrete crown wall will be constructed along the center groin to contain the sand in the ʻEwa (west) basin.

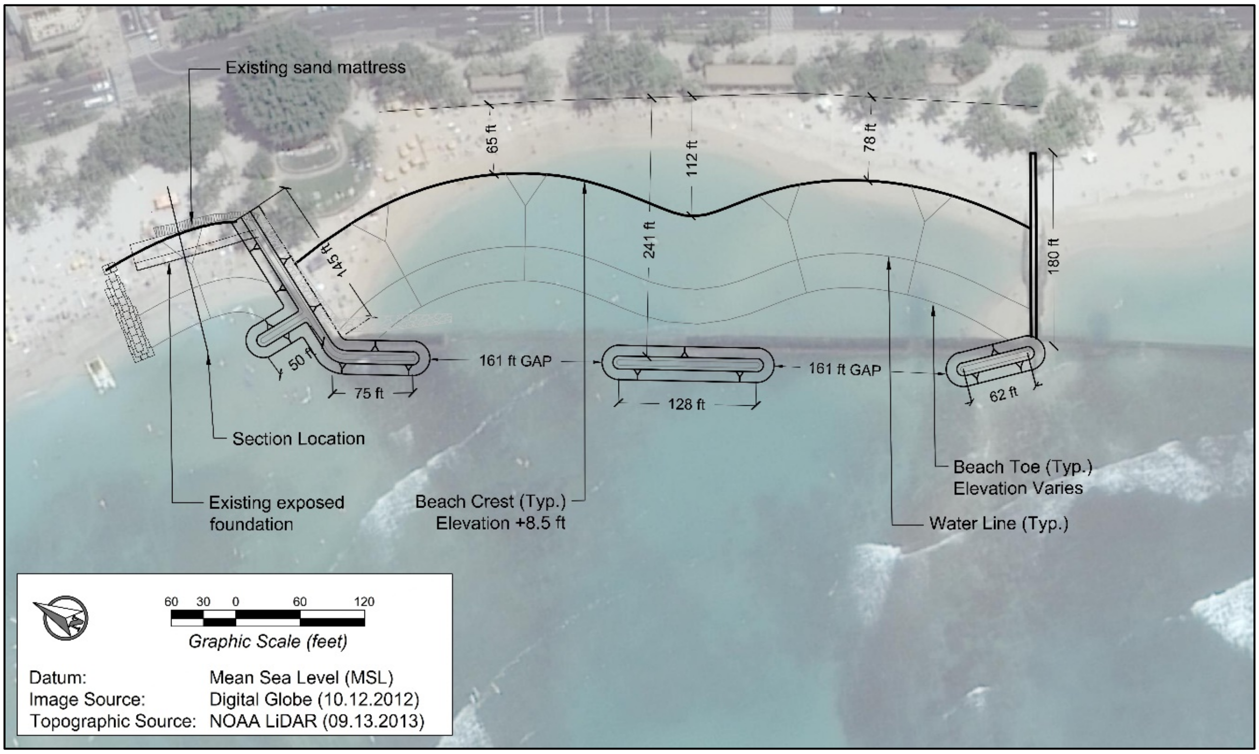


Figure 7-8 Conceptual layout for proposed action - Kūhiō beach sector ʻEwa (west) basin

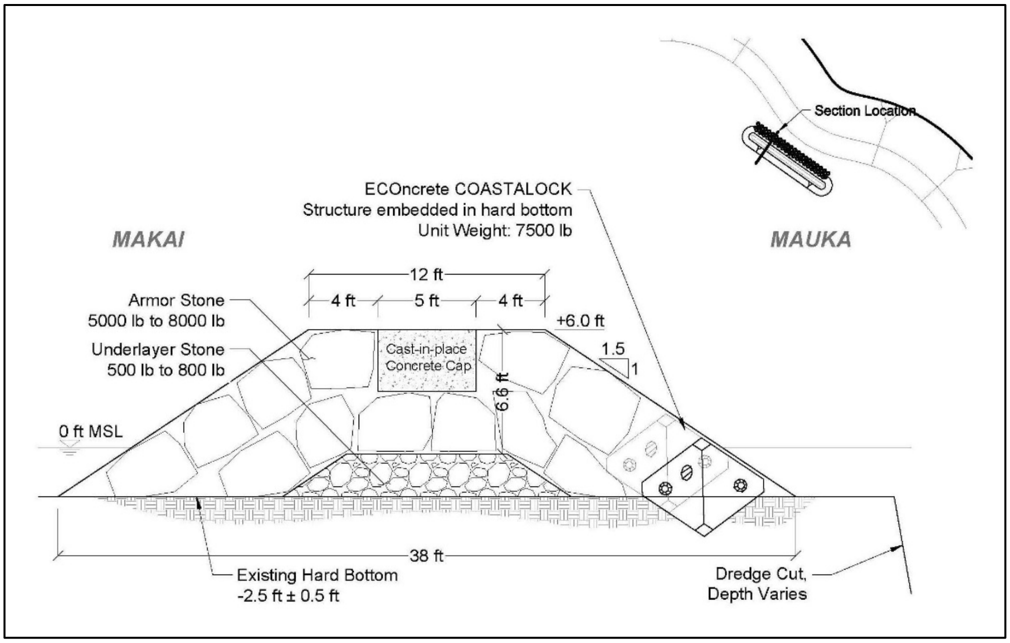


Figure 7-9 Section view of typical groin head

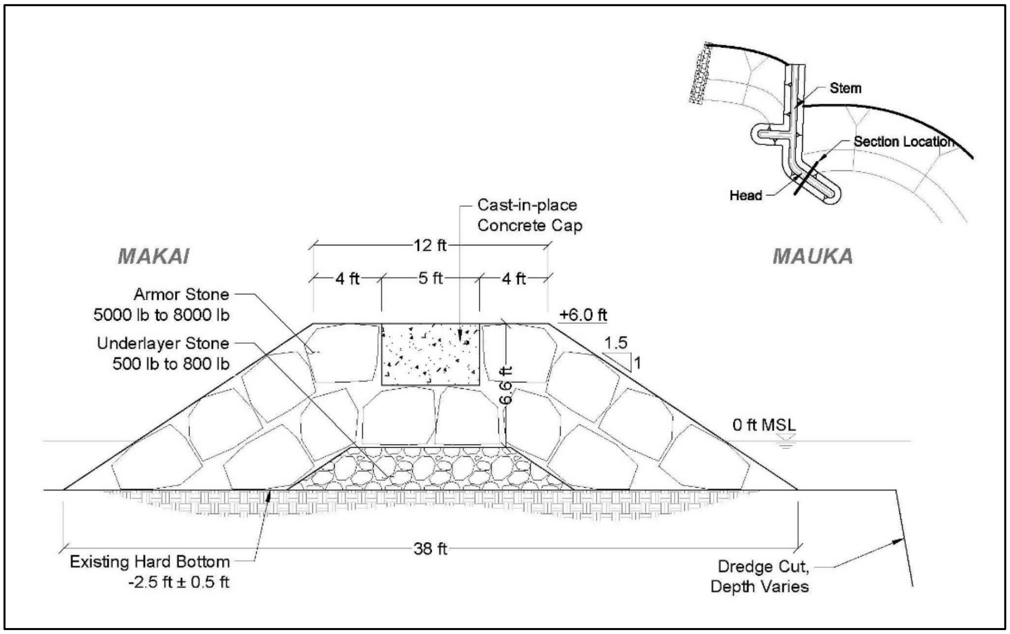


Figure 7-10 Section view of typical groin stem

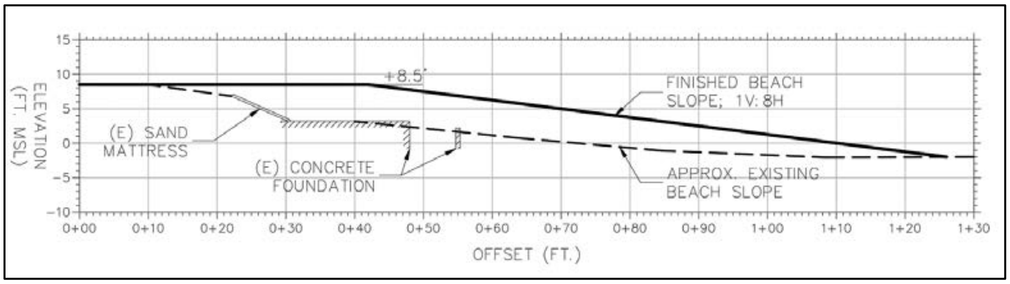


Figure 7-11 Section view of proposed beach fill covering Waikīkī Tavern Foundation

Figure 7-12 Conceptual plan view of proposed action for Kūhiō beach sector (ʻEwa basin)

WBSIDA Waikiki Beach SPECIAL IMPROVEMENT DISTRICT ASSOCIATION

CONCEPTUAL OBLIQUE VIEW OF PROPOSED ACTION – KŪHIŌ BEACH SECTOR

Waikīkī Beach Improvement and Maintenance Program

Draft Programmatic Environmental Impact Statement

Honolulu, Oʻahu, Hawaiʻi

Figure 7-13 Conceptual oblique view of proposed action for Kūhiō beach sector (ʻEwa basin)

7.3.2 Sand Source

Two sand samples were obtained from the beach face in the ʻEwa (west) basin of Kūhiō Beach Park in February 2021. Figure 7-14 shows the composite grain size distribution of those two samples, which have a median grain size (D_{50}) of 0.43 mm. Figure 7-14 also shows the composite grain size distributions for the offshore sand deposits investigated in this project. The best match for the beach is the *Diamond Head* offshore sand deposit. The *Ala Moana* and *Canoes/Queens* offshore sand are reasonable matches for the coarser part of the distribution, before exceeding the ±20% guideline for finer sand. The *Hilton* offshore sand falls on the coarser side; however, slightly coarser sand would be expected to be more stable on an eroding beach.

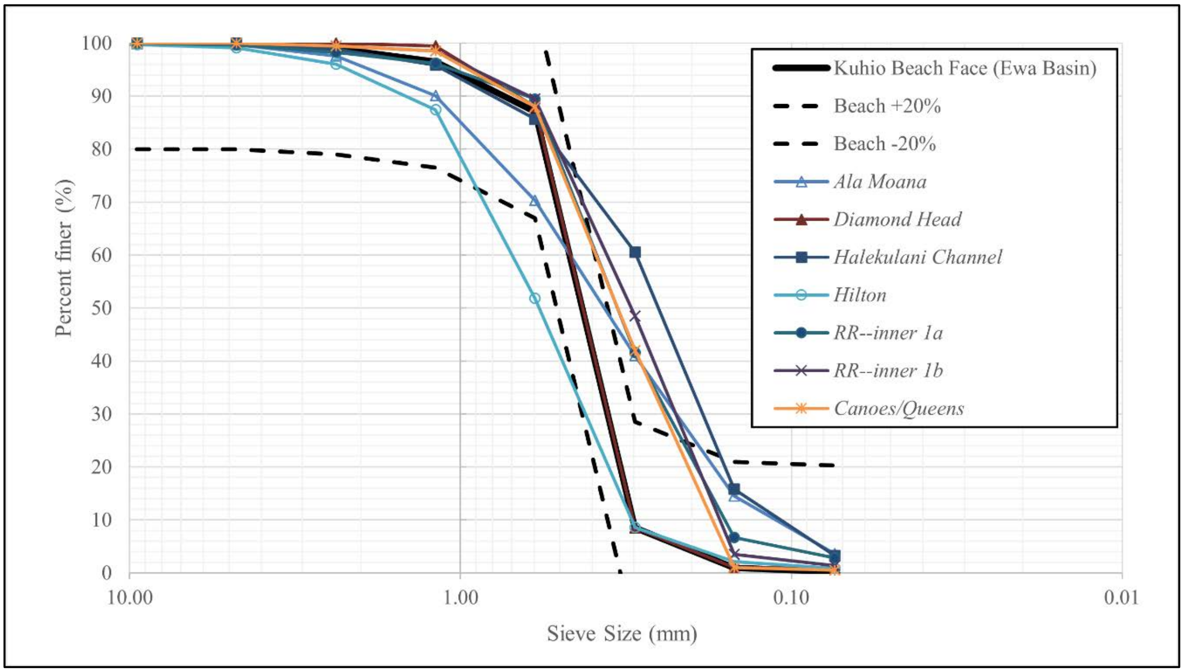


Figure 7-14 Grain size distributions: Kūhiō Beach Park, ʻEwa Basin and offshore sand sources

Given the logistical challenges of obtaining sand from the *Diamond Head* offshore deposit, the preferred sand sources for the Kūhiō beach sector are the *Hilton*, *Ala Moana*, and *Canoes/Queens* offshore deposits. Figure 7-15 and Table 7-1 present the grain size distributions and statistics for the beach and the recommended sources. Sand recovered from the *Ala Moana* and *Hilton* offshore deposits could be used with only minimal overfill, whereas sand from the *Canoes/Queens* offshore deposit would require an additional 12,500 cy sand (total of 40,500 cy) due to the finer sand grain size and increased overfill ratio. Furthermore, the *Canoes/Queens* deposit contains a limited volume of sand, has been dredged multiple times, and is better suited for use in the Royal Hawaiian beach sector. The proposed beach nourishment and structural modifications should result in slightly reduced wave energy in the ʻEwa (west) basin. Additionally, the sand would be contained within the basin by the historical dredge cut in the reef along the makai (seaward) margin of the basin.

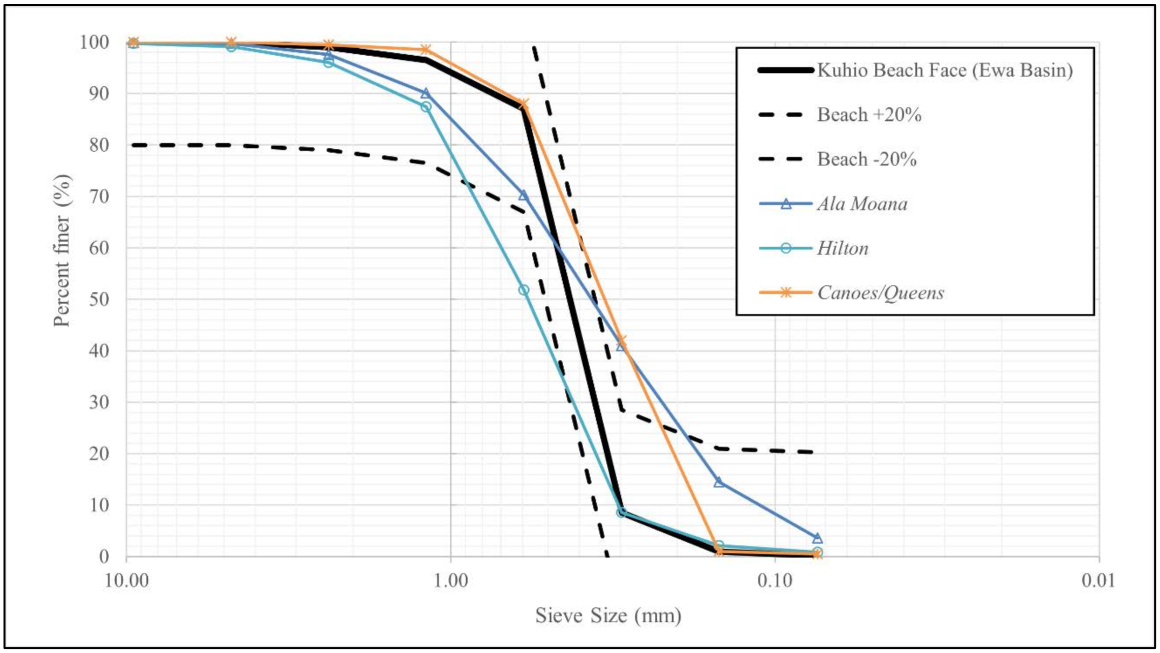


Figure 7-15 Grain size distributions: Kūhiō Beach Park, ʻEwa Basin, Beach Face and recommended sand sources

Table 7-1 Comparison of sand parameters for Kūhiō Beach Park

	ʻEwa Basin	Canoes/Queens	Ala Moana	Hilton
Median diameter, D_{50} (mm)	0.43	0.34	0.37	0.59
Sorting	N/A	0.82	1.42	1.02
Overfill factor	N/A	1.50	1.10	1.00
Estimated sand required (cy)	25,000	37,500	27,500	25,000
Estimated sand available (cy)	N/A	40,000	86,000	40,000

7.3.3 Construction Methodology

The methodology for sand recovery will depend on the sand source. Sand from the *Canoes/Queens* offshore deposit could be pumped into the Diamond Head (east) basin and dewatered as was done for the Waikīkī Beach Maintenance I and II projects in 2012 and 2021, respectively. The sand would then be placed in the ʻEwa (west) basin. Heavy equipment such as excavators, front end loaders, and bulldozers, would be used to spread the sand to achieve the design beach profiles. If the *Ala Moana* or *Hilton* offshore deposits are used, the sand would be trucked from the offloading point to Waikīkī and placed along the shoreline using the equipment mentioned previously.

Access to the shoreline is possible through the central portion of the park near the center groin or along the shoreline past the Duke Kahanamoku statue. Demolition and construction are expected to be performed using an excavator. The existing groins and breakwater will be removed, as necessary, as the excavators progress along the groin alignment. Underlayer and possibly armor stones will be placed on the seafloor to form a work platform to keep the excavator out of the water. The platform will need to be extended to the detached breakwater. Armor stone will be placed beginning at the head and progress mauka (landward). Any excess material will be removed. The sand fill will be placed following completion of the structures.

7.3.3.1 Alternative Armor Units

Alternative armor units were discussed previously in Section 5.3.3.1. The offshore breakwater offers a potential opportunity for inclusion of environmentally friendly armor units into the design. Coastalock armor units have been developed and deployed internationally; however, they have only been deployed in low wave energy environments, such as harbors. The manufacturer (ECOncrete) has reported that they are undergoing hydrodynamic testing and stability analyses for inclusion in high wave energy environments. Until this testing is concluded, the potential applications would be limited to the leeward side of the structures or placement that does not otherwise affect structural integrity and stability.

Placing the armor units on the inshore side of the groin heads, however, would likely result in the blocks being buried in sand, thereby diminishing their ecosystem services. The inshore side of the offshore breakwater is the only protected area where sand accumulation would not be an issue. Figure 7-16 shows a section view through the breakwater with the Coastalock units (Figure 5-17), which would be used along the toe of the structure and would be keyed into the fossil reef for stability, as shown in Figure 5-17. The Coastalock units would be expected to be stable above the sand layer, and would offer the opportunity to attract marine biota and increase biodiversity. An effective use of these units could result in fish aggregation and improved snorkeling in the area.

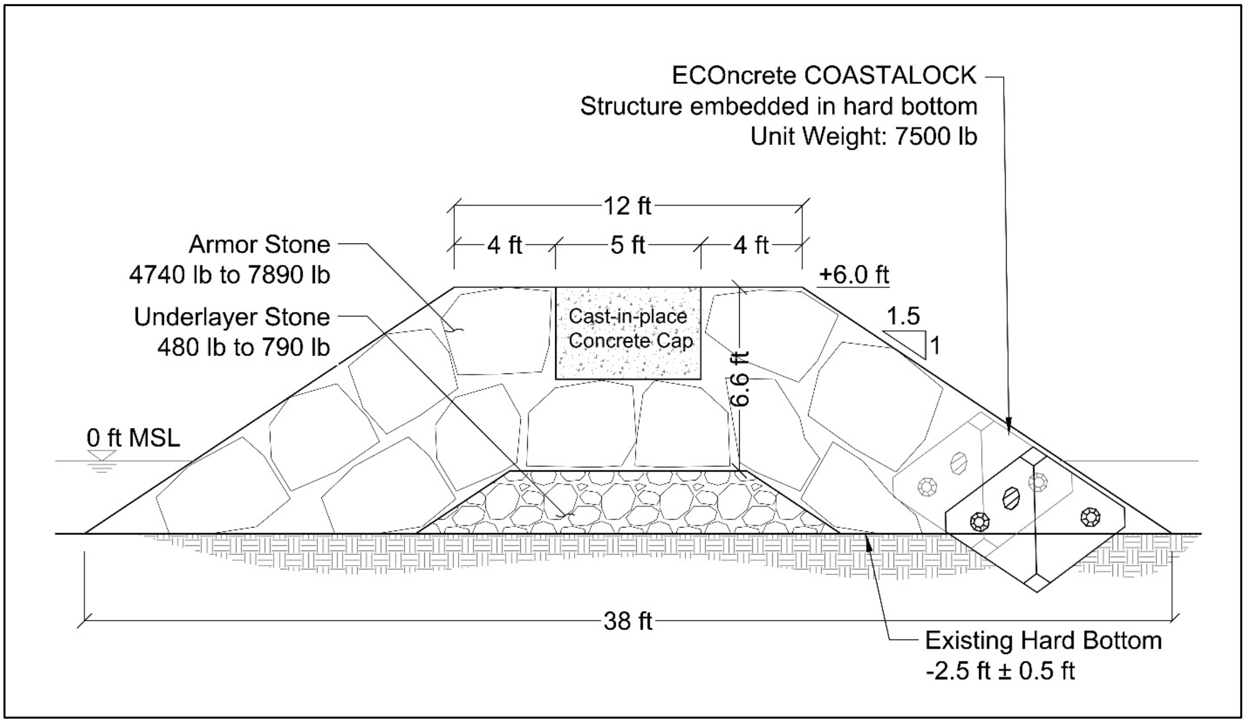


Figure 7-16 Groin head section with ECOncrete modules

7.3.4 Estimated Timing, Phasing, and Duration

The proposed beach improvement action is designed to be implemented in phases, with the initial phase being designed for approximately 1.5 ft of sea level rise, thus in 25 to 30 yrs following construction it may be necessary to raise the project elevations. If then raised by several feet, the project could be effective until about the year 2080, or 50 yrs post-construction. The estimated construction duration for the proposed action is 500 days. There is limited space and depth to accommodate additional sand fill in the ʻEwa (west) basin, so no future renourishment efforts are proposed.

7.3.5 Required Permits and Approvals

The proposed action is anticipated to require the following permits and approvals:

- Department of the Army Permit (Section 10 and Section 404)
- Clean Water Act Section 401 Water Quality Certification
- Clean Water Act Section 402 National Pollutant Discharge Elimination System
- Coastal Zone Management Act Consistency Review
- Conservation District Use Permit
- Right of Entry Permit

7.4 Alternatives to the Proposed Action

The following alternatives were considered for the Kūhiō beach sector ʻEwa (west) basin:

- Beach Maintenance
- Beach Nourishment

7.4.1 Beach Maintenance

The current configuration of the ʻEwa (west) basin has resulted in narrowing of the beach inshore of the gap in the breakwaters, while sand has accreted to some extent at the west end of the beach and below the water surface along the center groin. Beach maintenance could involve recovering sand from along the center groin and placing it along the shoreline at the center of the beach. The estimated construction duration for beach maintenance is 30 days, and the estimated recurrence interval is 5 yrs. Assuming that maintenance is conducted over a period of 50 yrs, this will result in a total of 10 individual maintenance events and a total of 300 days of construction. While beach maintenance is technically feasible, it may not be a viable option. The area adjacent to the center groin in the ʻEwa (west) basin is the only site in the Kūhiō beach sector where a sufficient volume of sand would be available to support beach maintenance. However, the volume of sand present in this area is limited and may not be sufficient to support continued maintenance.

7.4.2 Beach Nourishment without Stabilizing Structures

This alternative would consist of placing sand directly along the shoreline without any structures to stabilize the sand. The sand would be placed along the shoreline in the same approximate footprint as in the proposed action. This concept would require approximately 28,000 cy of sand and would create approximately 40,000 sf (0.92 acres) of dry beach area. An advantage of this option is that it would not require modification of the existing structures. This alternative would increase dry beach width but would not increase beach stability or prevent erosion.

There is limited space and depth to accommodate additional sand fill in the ʻEwa (west) basin, so there would be no future renourishment efforts and periodic maintenance (e.g., sand pumping or sand backpassing) would be required to maintain the desired beach width. Beach nourishment without stabilizing structures would also fundamentally alter the character of the basin. Without the proposed segmented breakwater, the beach would migrate (slump) makai (seaward), the beach profile would flatten, and water depths inside the basin would become very shallow.

The estimated construction duration for beach nourishment without stabilizing structures is 100 days. Assuming that maintenance is conducted every 5 yrs following the initial beach nourishment, over a period of 50 yrs, this would result in a total of 8 individual maintenance events and 240 additional days of construction (total of 340 days).

While this option would be less expensive initially, the cumulative costs of periodic maintenance would be substantial. When compared to beach nourishment without stabilizing structures, the proposed action will have less cumulative impacts as it will require fewer dredging events, fewer construction days, and fewer beach closures.

7.5 Proposed Action - Diamond Head (east) Basin

7.5.1 Description of the Proposed Action

The proposed action in the Kūhiō beach sector Diamond Head (east) basin is beach maintenance consisting of sand pumping with no additional improvements or modifications to existing structures. In collaboration with the WBCAC, the project proponents determined that the Diamond Head (east) basin should remain a safe, calm, and protected area. While the low wave energy produces the calm environment that is enjoyed by many beach users, the wave energy is too low to produce a stable beach profile. Over time, the beach face has migrated (slumped) into the basin below the waterline, with no natural means to transport the sand back onto the beach face. This makai (seaward) migration of sand has flattened the beach profile and decreased water depths in the basin. To increase dry beach width, the sand will need to be manually recovered and placed back onto the beach. The conceptual project layout is shown in Figure 7-17.

In 2018, SEI conducted air jet probing and push core sampling in the Diamond Head (east) basin. Sand thickness in some areas of the basin was measured to be greater than 8 ft (Figure 7-18). The basin was estimated to contain approximately 4,500 cy of sand makai (seaward) of the waterline. The sand within the basin was found to be beige to dark grey, but the color lightened rapidly when exposed to sunlight.

The proposed action will involve recovery of approximately 4,500 cy of submerged sand from within the Diamond Head (east) basin and placement of that sand on the beach. This will lower the depth of the basin to a uniform bottom elevation of -4 ft MSL and widen the dry beach by approximately 18 and 26 ft along the length of the basin. Because the basin is nearly enclosed, turbidity curtains would only be deployed at the offshore breakwater openings on the north and south ends of the basin during sand recovery and placement. This plan replaces sand on the narrow east end of the basin to produce a more linear shoreline configuration. Toward the center groin, the shoreline turns slightly makai (seaward) to account for the existing palm trees and lifeguard tower. The existing and design profiles are shown in Figure 7-19.

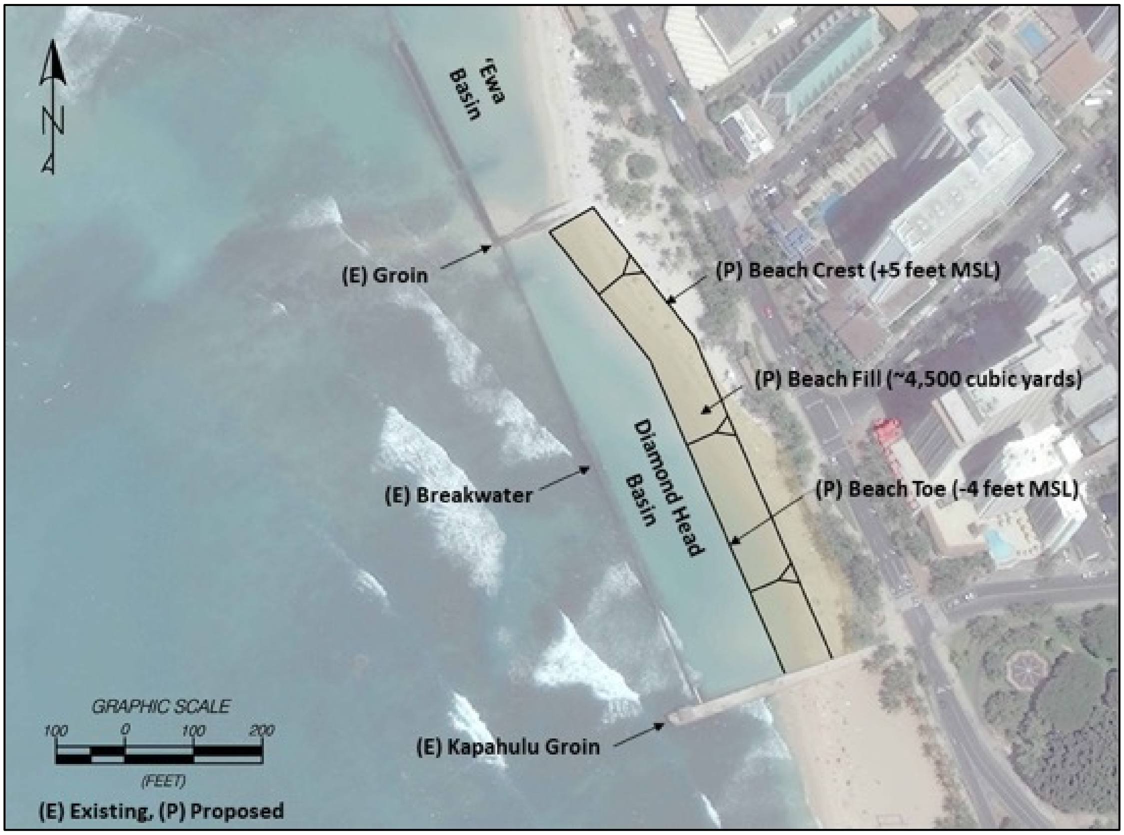


Figure 7-17 Conceptual project layout – Kūhiō Beach sector (Diamond Head (east) basin)

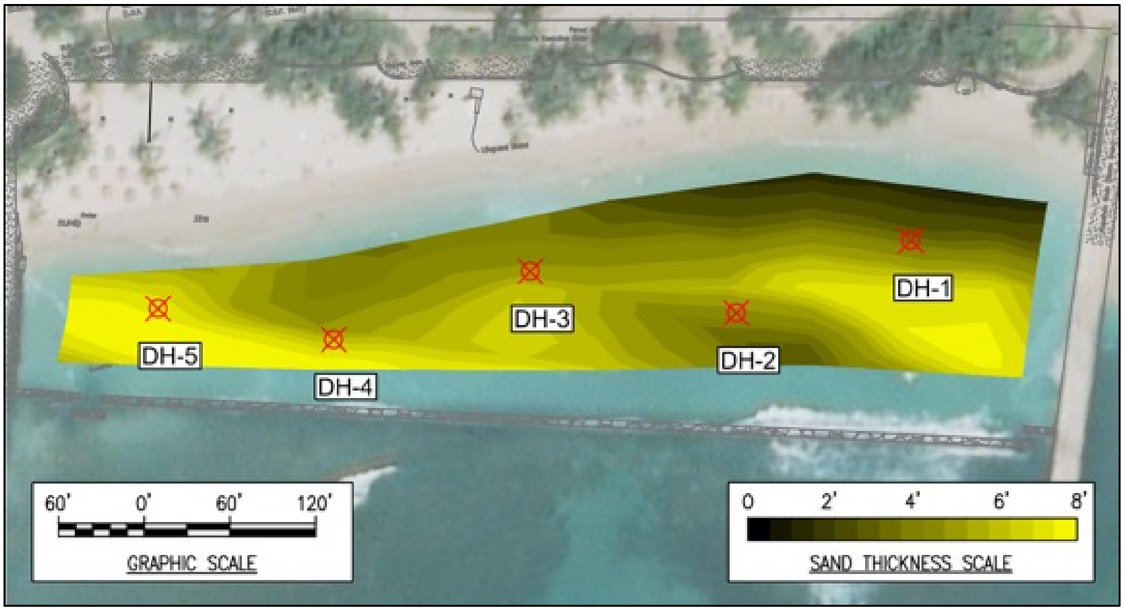


Figure 7-18 Sand thickness – Kūhiō Beach sector (Diamond Head (east) basin)

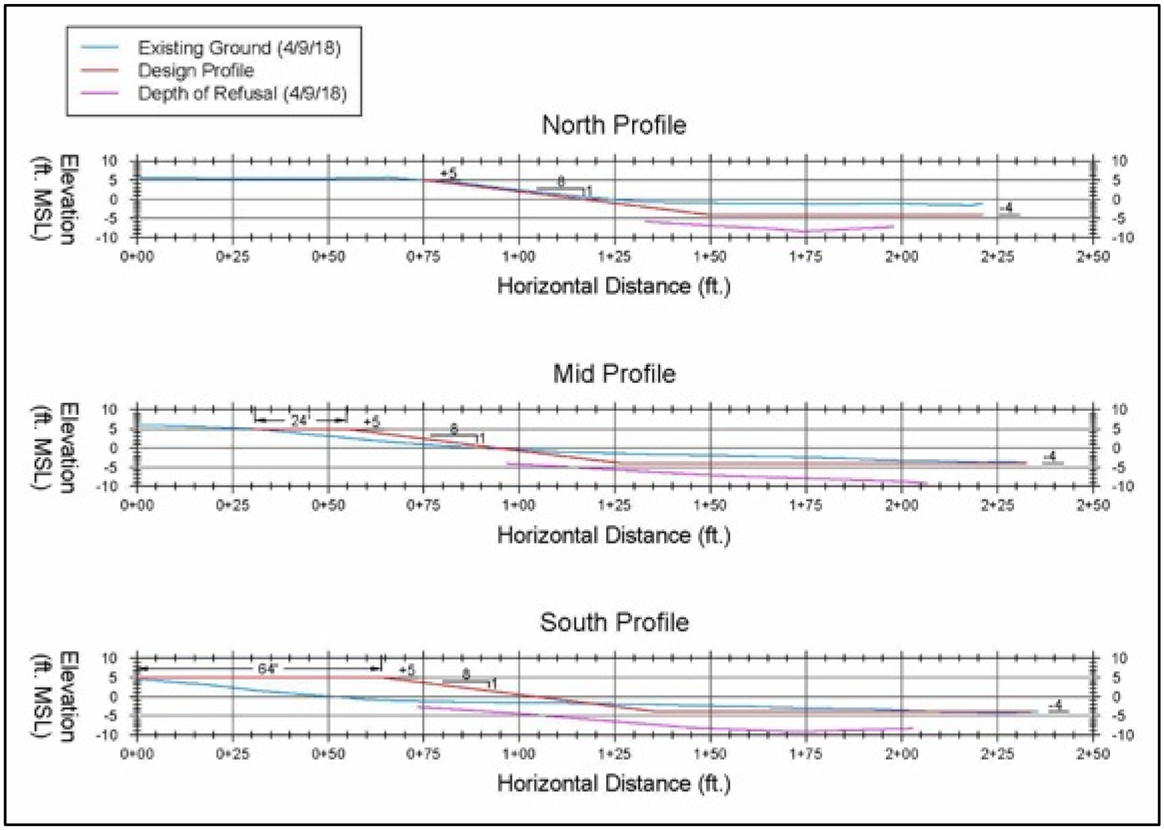


Figure 7-19 Beach nourishment profiles – Kūhiō Beach sector (Diamond Head (east) basin)

7.5.2 Sand Source

Sand will be obtained from within the Diamond Head (east basin). Investigation during the 2019 Kūhiō Sandbag Groin project found an average median grain size of 0.42 mm, and percent fine material (<0.074mm) ranging from 1.2 to 3.2. The sand was considered moderately sorted.

7.5.3 Construction Methodology

Two possible methods are presented to recover sand from within the Diamond Head (east) basin: 1) long-reach excavator or crane, and 2) diver-operated dredge.

Excavator / Crane Method

Recovering sand from within the Diamond Head (east) basin could be accomplished using a long-reach excavator (Figure 7-20), which has a longer arm than a traditional excavator, allowing it to reach further. Long-reach excavators are available for rent on-island and would not require equipment to be shipped in from out of state. To recover sand, the excavator would reach into the basin from the beach face and scoop sand with the bucket. Sand would then be placed directly on the beach face. To reach the offshore limits of the basin, the excavator could build a sand causeway using the recovered sand. A bulldozer and/or skid-steer would be required to spread the sand to the achieve the design beach profiles.

A long-reach excavator is limited by the amount of weight it can lift at distances from the cab to prevent the machine from tipping over. For this reason, the buckets are generally quite small (e.g., 0.3 cy). Due to the limited bucket size, sand recovery operations would be relatively slow, which would increase the duration and costs of construction, as well as disruptions to beach users and shoreline access.

Recovering sand from within the Diamond Head (east) basin could also accomplished using a heavy-duty crane (Figure 6-2). An advantage of a crane is that it has a higher load capacity and can use a larger clamshell bucket to recover sand at a much faster rate. This method could utilize a bucket with capacity of several cubic yards. A crane would recover sand like an excavator, moving through the basin on temporary sand causeways. A disadvantage of a crane is that it is larger in size, which could make access challenging. A crane may need to be disassembled and reassembled to access the shoreline, which would increase the duration and costs of construction.

Figure 7-20 CAT 352F LRE long reach excavator (www.caterpillar.com)

Figure 7-21 Sennebogen 6130 HD duty cycle crawler crane (www.sennebogen.com)

Diver-Operated Dredge Method

An alternative method of sand recovery for the Diamond Head (east) basin would be a diver-operated dredge system. A diver-operated dredge has a suction head that can be manipulated and operated by a diver without assistance from a support vessel or construction equipment. Diver-operated dredges are used in shipyard operations and the mining and fracking industries. Using a diver to manipulate the suction hose offers a level of precision that cannot be achieved by lowering a pump over the side of a vessel (i.e., a Toyo pump).

Figure 7-22 shows a diver-operated dredge pump manufactured by Eddy Pump© Corporation (Eddy Pump). The diver-operated dredge pump is roughly 6 ft long, 3 ft wide, and 3 ft tall, but dimensions vary depending on the output of the selected pump. Sand recovery would require a 4-person dive team working from shore for Occupational Safety and Health Administration (OSHA) compliance. The dredge pump could be placed on shore or on the beach face. A floating slurry pipeline and power cable would extend from the dredge pump to the sand recovery area. The pump would be powered by a 100kW generator located on shore. A suction hose would be connected to the dredge pump. The suction hose would be controlled by a single diver. The hose would have a length of 100 ft, which would enable the diver to dredge sand within a 100-ft radius of the pump. Sand production is estimated to be 20 to 40 cy per hour. Once the sand is dredged to the desired depth, the pump would have to be relocated to another area. A bulldozer and/or skid-steer would be required to spread the sand to the design grade.

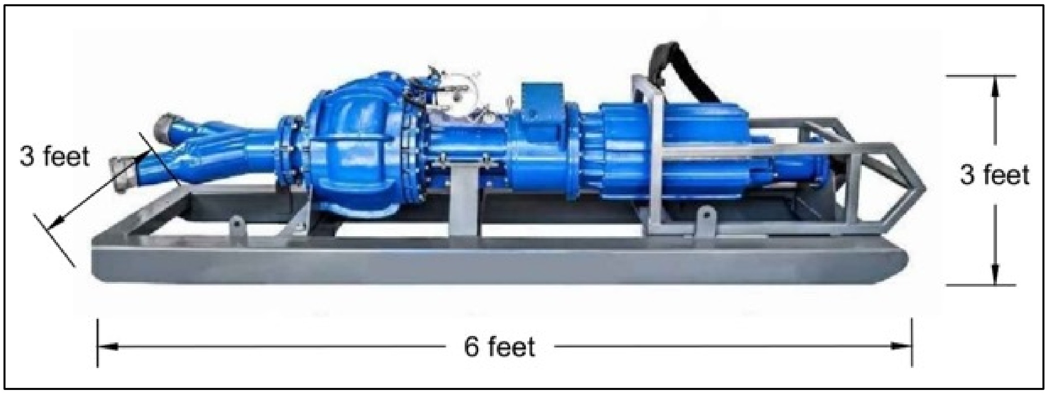


Figure 7-22 Diver-operated dredge pump (Eddy Pump)

7.5.4 Estimated Timing, Phasing, and Duration

The estimated construction duration for the proposed sand pumping is 10 days, and the estimated recurrence interval is 5 yrs. Assuming that maintenance is conducted over a period of 50 yrs, this will result in a total of 10 individual sand pumping events and a total of 100 days of construction.

7.5.5 Required Permits and Approvals

The proposed action is anticipated to require the following permits and approvals:

- Department of the Army Permit (Section 10 and Section 404)
- Clean Water Act Section 401 Water Quality Certification

- Coastal Zone Management Act Consistency Review
- Small Scale Beach Nourishment (SSBN) or Small Scale Beach Restoration (SSBR) Permit
- Right of Entry Permit

7.6 Alternatives to the Proposed Action

The following alternatives were considered for the Kūhiō beach sector Diamond Head (east) basin:

- Beach Nourishment without Stabilizing Structures
- Beach Nourishment with Stabilizing Structures

7.6.1 Beach Nourishment without Stabilizing Structures

Beach nourishment could also be performed, where sand would be imported to the Diamond Head (east) basin and spread on the beach. The same dry beach width and configuration could be accomplished with about 4,500 cy of offshore sand; however, no sand would be recovered from within the basin. Water depths would become progressively shallower over time as the new sand added to the beach would be expected to migrate makai (seaward) into the water. The beach width and elevation could also be expanded by adding more sand. Increasing the dry beach elevation by 1 ft would require about 1,500 cy of sand, while widening the beach by 5 ft would require about 2,000 cy of sand.

7.6.2 Beach Nourishment with Stabilizing Structures

Stabilizing the beach in the Diamond Head (east) basin would require reconfiguring the offshore breakwater to be a series of breakwaters or groins. These alternatives were previously investigated by Noda (1999) and Bodge (2000) shown previously in Figure 7-6. Both plans involved removing the offshore wall. The Noda (1999) plan included adding heads to the Kapahulu storm drain/groin and the center groin to produce a more open swimming area. Bodge (2000) recommended smaller heads and the addition of small T-head groin in the gap between the new groin heads. The Bodge (2000) plan is more consistent with the proposed action for the ʻEwa (west) basin.

Beach nourishment would require dredging to recover approximately 4,500 cy of sand from offshore and placing it on the beach. This would produce the same dry beach width and configuration as the proposed action; however, no sand would be recovered from within the basin. By increasing the volume of sand within the basin, water depths would become progressively shallower over time as the new sand added to the beach would be expected to migrate makai (seaward) into the water. The beach width and elevation could also be expanded by adding more sand. Increasing the dry beach elevation by 1 ft would require about 1,500 cy of sand, while widening the beach by 5 ft would require about 2,000 cy of sand.

The highest priorities for the Diamond Head (east) basin are to maintain the basin as a calm, safe environment for swimming and wading. Reconfiguring the existing breakwater would create a more energetic wave environment, which would fundamentally alter the character of the basin. Without reconfiguring the existing breakwater, the beach would migrate makai (seaward), the beach profile would flatten, and water depths inside the basin would become very shallow. As a result, beach nourishment with or without stabilizing structures was ruled out in the early stages of the conceptual design and project selection process.

When compared to the alternatives of beach nourishment with or without stabilizing structures, the proposed action will have less cumulative impacts as it will require fewer construction days, fewer beach closures, no offshore dredging, and will not increase in the volume of sand in the littoral system.

8. NATURAL ENVIRONMENT

8.1 Climate

The Hawaiian Island chain is situated south of the large eastern Pacific semi-permanent high-pressure cell, the dominant feature affecting air circulation and climate in the region. Over the Hawaiian Islands, this high-pressure cell produces persistent northeasterly winds called *tradewinds*. During the winter months, cold fronts sweep across the north-central Pacific Ocean, bringing rain to the Hawaiian Islands and intermittently modifying the tradewind regime. Thunderstorms, which are rare but most frequent in the mountains, also contribute to annual precipitation.

8.1.1 Temperature and Rainfall

Due to the tempering influence of the Pacific Ocean and their low-latitude location, the Hawaiian Islands experience extremely small diurnal and seasonal variations in ambient temperature. Average temperatures in the coolest and warmest months at Honolulu International Airport are 72.9˚ Fahrenheit (F) (January) and 81.4˚F (July), respectively. These temperature variations are quite modest compared to those that occur at inland continental locations. Temperature data from Honolulu International Airport are summarized in Table 8-1 and Table 8-2.

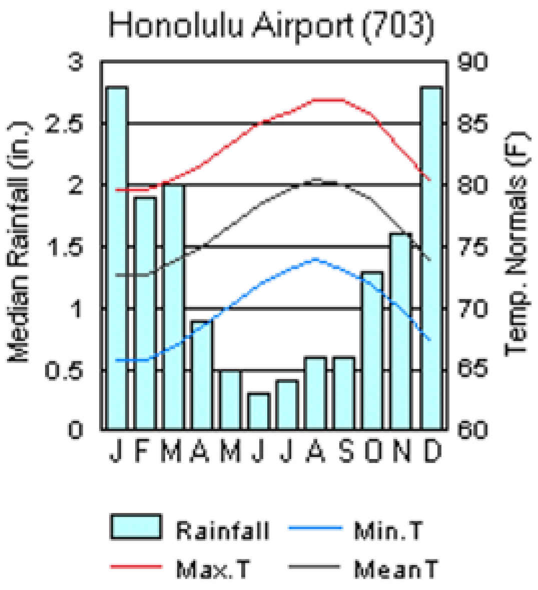
Topography and the dominant northeasterly tradewinds are the two primary factors that influence the amount of rainfall that falls at any given location on Oʻahu. Near the top of the Koʻolau Range on the windward side of Oʻahu that is fully exposed to the tradewinds, rainfall averages nearly 250 in per year. On the leeward side of the island, where the project area is located, the rainfall is much lower. Average annual rainfall in Waikīkī is less than 20 in/yr. Although the project area is on the leeward side of the island, the humidity is still moderately high, ranging from mid-60 to mid-70 percent.

Table 8-1 Average Monthly Temperature, Rainfall, and Humidity

Month	Normal Ambient Temperature, ºFahrenheit		Average Monthly Rainfall (inches)		Average Relative Humidity (%)
	Daily Minimum	***Daily Maximum***	***Monthly Minimum***	***Monthly Maximum***	
January	65.7	80.4	0.18	14.74	71
February	65.4	80.7	0.06	13.68	69
March	66.9	81.7	0.01	20.79	65
April	68.2	83.1	0.01	8.92	62.5
May	69.6	84.9	0.03	7.23	60.5
June	72.1	86.9	T	2.46	59
July	73.8	87.8	0.03	2.33	60
August	74.7	88.9	T	3.08	60
September	74.2	88.9	0.05	2.74	61.5
October	73.2	87.2	0.07	11.15	63.5
November	71.1	84.3	0.03	18.79	67
December	67.8	81.7	0.04	17.29	74.75

Note: "T" signifies a trace amount of rainfall (i.e., less than 0.01 inch).
Source: State of Hawaiʻi Data Book 2003 (Data from Honolulu International Airport)

Table 8-2 Seasonal Rainfall and Temperature Patterns



Station Key: 703 (Honolulu Airport Station)

Coordinates: 21.33138°, 157.91862°

Elevation: 5 feet

Temperature Records: 30 years, 1941 to ______.

Rainfall Records: 29 years

Source: http://hikawa.htohananet.com/climate-oahu/grids/whonolulu.html

8.1.2 Wind

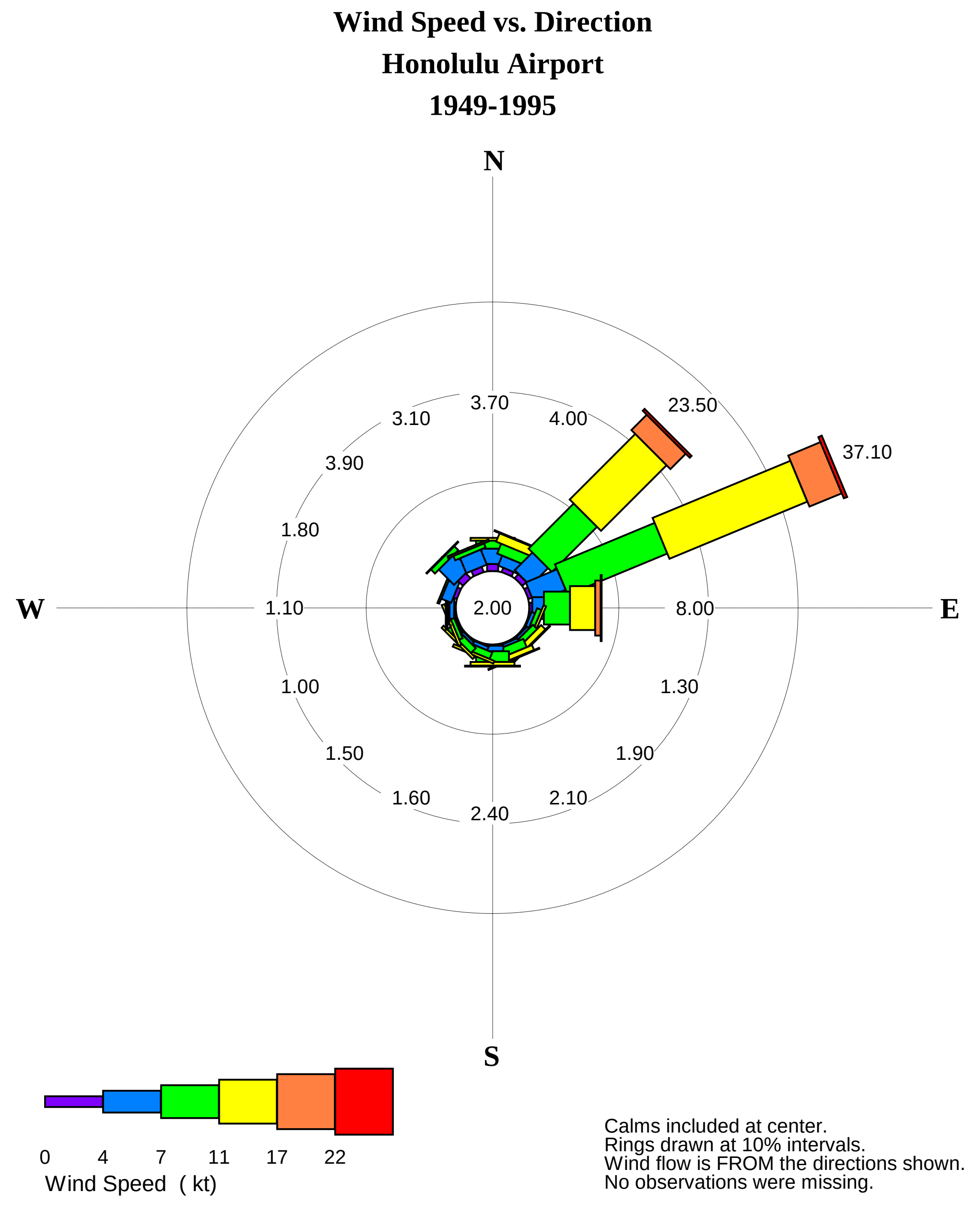
The prevailing winds throughout the year are the northeasterly tradewinds. Average tradewind frequency varies from more than 90% during the summer season to only 50% in January, with an overall annual frequency of 70%. Westerly, or Kona, winds occur primarily during the winter months, generated by low pressure or cold fronts that typically move from west to east past the Hawaiian Islands. Figure 8-1 shows a wind rose diagram applicable to the project area based on wind data recorded at Honolulu International Airport between 1949 and 1995.

Tradewinds are produced by the outflow of air from the Pacific Anticyclone high pressure system, also referred to as the Pacific High. The center of this system is located well north and east of the Hawaiian Islands and moves to the north and south seasonally. In the summer months, the center moves to the north, causing the tradewinds to be at their strongest from May through September. In the winter, the center moves to the south, resulting in decreasing tradewind frequency from October through April. During these months, the tradewinds continue; however, their average monthly frequency decreases to 50%.

During the winter months, wind patterns of a more transient nature increase in prevalence. Winds from extra-tropical storms can be very strong from almost any direction, depending on the strength and position of the storm. The low-pressure systems associated with these storms typically track west to east across the North Pacific north of the Hawaiian Islands. At Honolulu International Airport, wind speeds resulting from these storms have on several occasions exceeded 60 mph. Kona winds are generally from a southerly to southwesterly direction, usually associated with slow-moving low-pressure systems known as Kona lows situated to the west of the Hawaiian Islands. These storms are often accompanied by heavy rains.

8.1.3 Potential Impacts and Mitigation Measures

The proposed actions are anticipated to have a negligible impact on the climate. No mitigation measures are proposed.



PERCENT OCCURRENCE: Wind Speed (kt)
LOWER BOUND OF CATEGORY

DIR	0	4	7	11	17	22
N	0.80	1.70	0.90	0.30	0.00	0.00
NNE	0.50	1.20	1.20	1.00	0.10	0.00
NE	0.60	2.80	7.10	10.30	2.40	0.30
ENE	0.40	3.80	12.00	16.60	3.90	0.40
E	0.30	1.30	2.90	2.80	0.60	0.10
ESE	0.10	0.40	0.50	0.30	0.00	0.00
SE	0.10	0.30	0.70	0.70	0.10	0.00
SSE	0.10	0.30	1.00	0.60	0.10	0.00

TOTAL OBS = 134736 MISSING OBS = 0

PERCENT OCCURRENCE: Wind Speed (kt)
LOWER BOUND OF CATEGORY

DIR	0	4	7	11	17	22
S	0.10	0.60	1.20	0.40	0.10	0.00
SSW	0.10	0.40	0.80	0.30	0.00	0.00
SW	0.10	0.30	0.80	0.30	0.00	0.00
WSW	0.10	0.20	0.40	0.30	0.00	0.00
W	0.20	0.50	0.20	0.20	0.00	0.00
WNW	0.40	1.20	0.20	0.00	0.00	0.00
NW	0.80	2.40	0.60	0.10	0.00	0.00
NNW	0.60	1.80	0.50	0.20	0.00	0.00

CALM OBS = 2695 PERCENT CALM = 2.00

Figure 8-1 Wind rose for Honolulu Airport (1949 to 1995)

8.2 Waves

8.2.1 General Wave Climate

The wave climate in Hawaiʻi is typically characterized by four general wave types. These include tradewind waves, southern swell, North Pacific swell, and Kona wind waves. Tropical storms and hurricanes also generate waves that can approach the islands from virtually any direction. Unlike winds, any and all of these wave conditions may occur at the same time. The dominant swell regimes for Hawaiʻi are shown on Figure 8-2.

Tradewind waves occur throughout the year and are most persistent April through September when they usually dominate the local wave climate. They result from the strong and steady tradewinds blowing from the northeast quadrant over long fetches of open ocean. Tradewind deepwater waves are typically between 3 to 8 ft high with periods of 5 to 10 sec, depending upon the strength of the tradewinds and how far the fetch extends east of the Hawaiian Islands. The direction of approach, like the tradewinds themselves, varies between north-northeast and east-southeast and is centered on the east-northeast direction. The project area is well sheltered from the direct approach of tradewind waves by the island itself, and only a portion of the tradewind wave energy refracting and diffracting around the southeast end of the island reaches Waikīkī.

Southern swell is generated by storms in the southern hemisphere and is most prevalent during the summer months of April through September. Traveling distances of up to 5,000 mi, these waves arrive with relatively low deepwater wave heights of 1 to 4 ft and periods of 14 to 20 sec. Depending on the positions and tracks of the southern hemisphere storms, southern swells approach between the southeasterly and southwesterly directions. The project area is directly exposed to swell from the southerly direction and these waves represent the greatest source of wave energy reaching Waikīkī.

During the winter months in the northern hemisphere, strong storms are frequent in the North Pacific in the mid latitudes and near the Aleutian Islands. These storms generate large North Pacific swells that range in direction from west-northwest to northeast and arrive at the northern Hawaiian shores with little attenuation of wave energy. These are the waves that have made surfing waves on the north shores of the island of Oʻahu so famous. Deepwater wave heights often reach 15 ft and in extreme cases can reach 30 ft. Periods vary between 12 and 20 sec, depending on the location of the storm. The project area is sheltered by the island itself from swell approach from the north and northwest. Refracted waves from large swells with a more westerly angle occasionally affect Waikīkī during the winter months.

Kona storm waves also directly approach the project area; however, these waves are relatively infrequent, occurring only about 10 percent of the time during a typical year. Kona waves typically range in period from 6 to 10 sec with heights of 5 to 10 ft, and approach from the southwest. Deepwater wave heights during the severe Kona storm of January 1980 were about 17 ft. These waves had a significant impact on the south and west shores of Oʻahu.

Severe tropical storms and hurricanes obviously have the potential to generate extremely large waves, which in turn could potentially result in large waves at the project site. Major hurricanes that have impacted the Hawaiian Islands include Hurricane Iwa (1982) and Hurricane Iniki

(1992). Iniki directly hit the island of Kauaʻi and resulted in large waves along the southern shores of all the Hawaiian Islands. Damage from these hurricanes was extensive. Although not a frequent or even likely event, they should be considered in the project design, particularly with regard to shoreline structures, both in the water and on land near the shoreline.

During high wave events, the water level shoreward of the breaker zone may be elevated above the tide level as a result of the wave breaking process. This water level rise, referred to as *wave setup*, may be as much as 10 to 12% of the breaker height. This water level rise results in an increase in the height of the maximum wave that can propagate toward shore. This produces an increase in design wave height, an increase in breaking wave forces, and an increase in stable stone size.

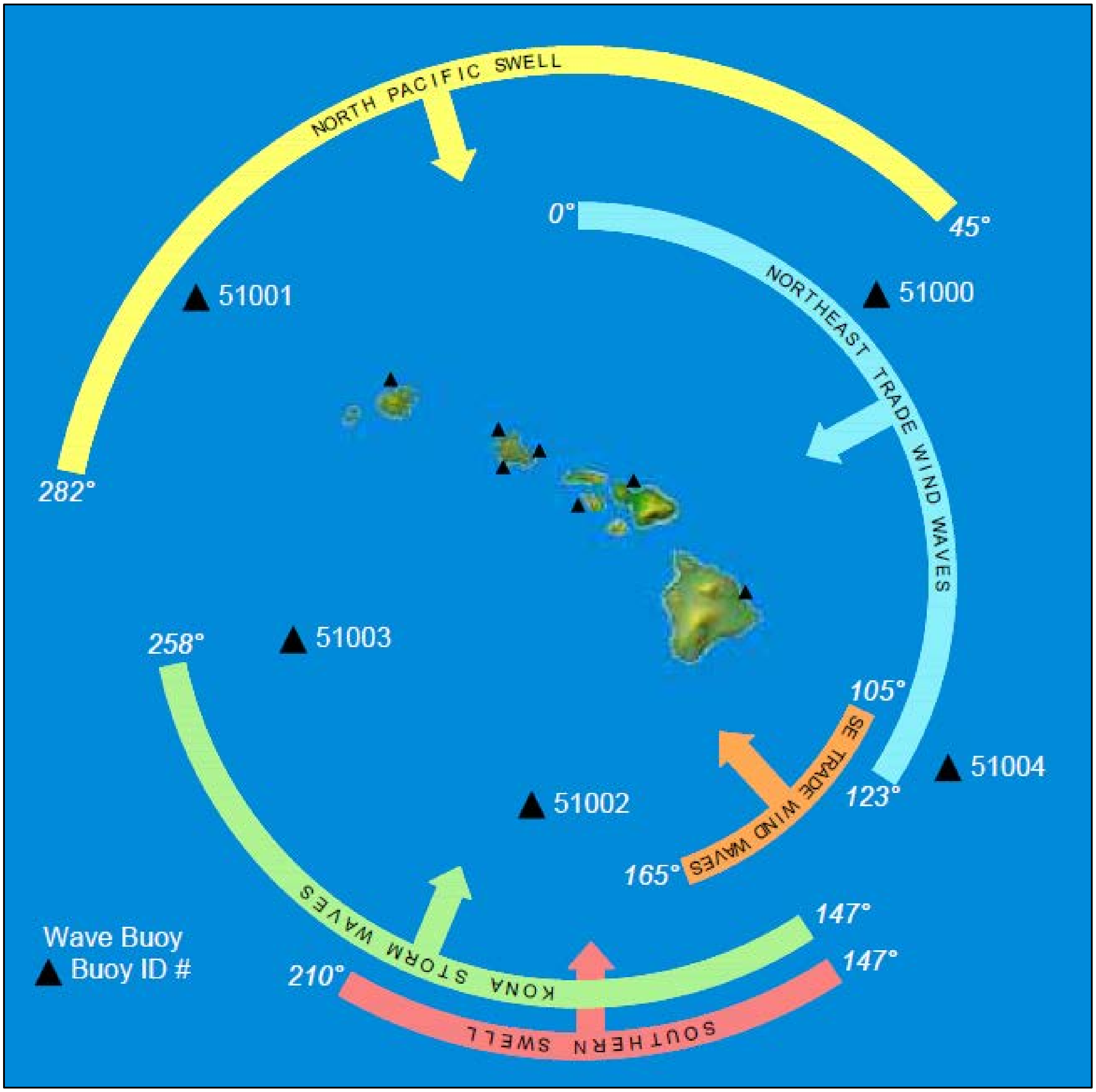


Figure 8-2 Hawaiʻi dominant swell regimes (Vitousek and Fletcher, 2008)

8.2.2 Prevailing Deepwater Waves

Wave conditions for the project area have been measured by the Coastal Data Information Program (CDIP), at two nearby locations, designated as Station 165 (Barbers Point), and Station 238 (Barbers Point, Kalaeloa). Station 165, which was located approximately 19.2 mi west of the project area in a water depth of roughly 990 ft (300 m), recorded data from 2010 to 2017. Station 238 is located approximately 21 mi west-northwest of the project area in a water depth of roughly 920 ft (280 m) and has been recording data since 2018. Buoy locations relative to the project area are shown in Figure 8-3.

Each buoy measures and records its motion due to passing waves. This data is used to compute spectral wave energy and direction at half-hour increments and derives important wave parameters such as significant wave height, peak period, and direction from those measurements. Wave data during the summer months from Station 165 and Station 238 was utilized to generate summer swell wave height and period rose plots, which are a form of histogram that conveys a parameter’s directional dependence (Figure 8-4 and Figure 8-5). In general, the plots show peak values centered on south swell from 180 deg. This indicates that the project area is susceptible to elevated surf during the summer months due to its exposure to southern swell. The wave period rose plot shows that the south swell peaks are primarily of longer period (>16 sec) swell, as would be expected. Based on the summer data, the prevailing summer south swell has a direction from 190 deg and a significant wave height of 2.3 ft with a period of 15 sec and (TN), and the high-prevailing summer south swell has a significant wave height of 3.0 ft with a period of 16 sec.

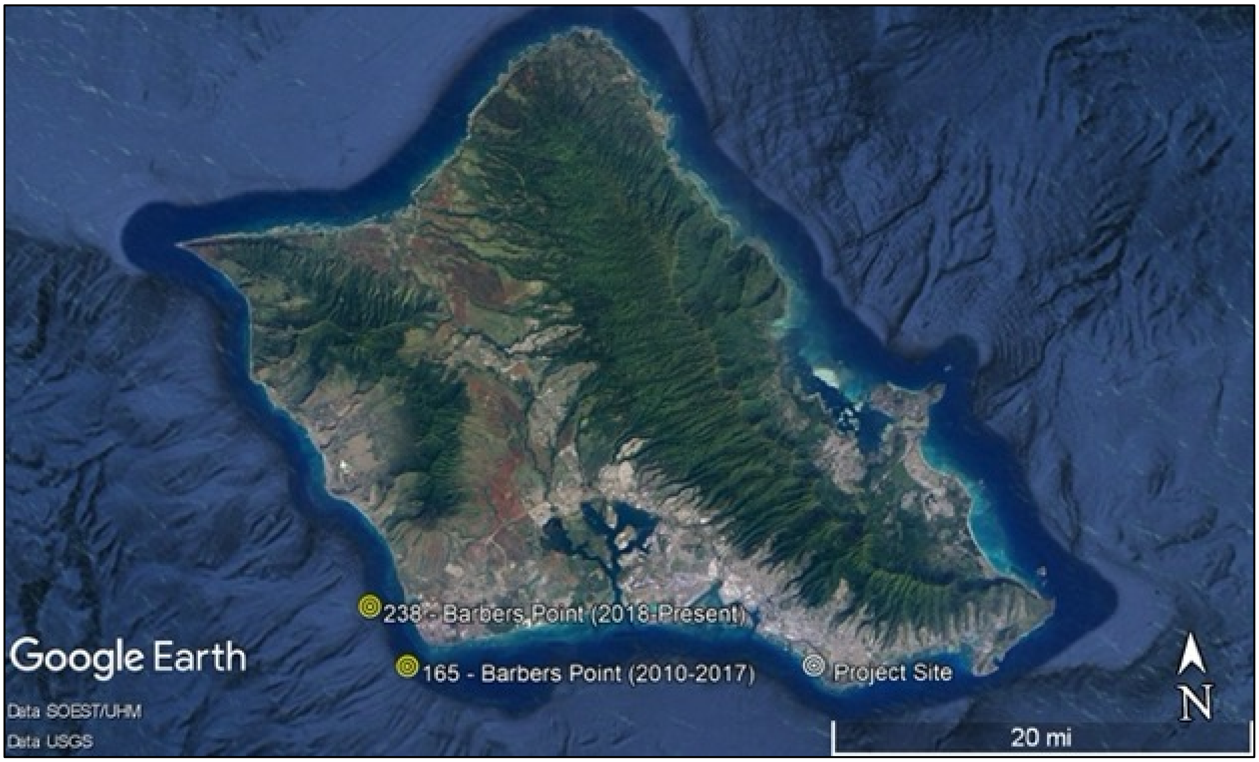


Figure 8-3 Location of CDIP buoys in relation to the project area

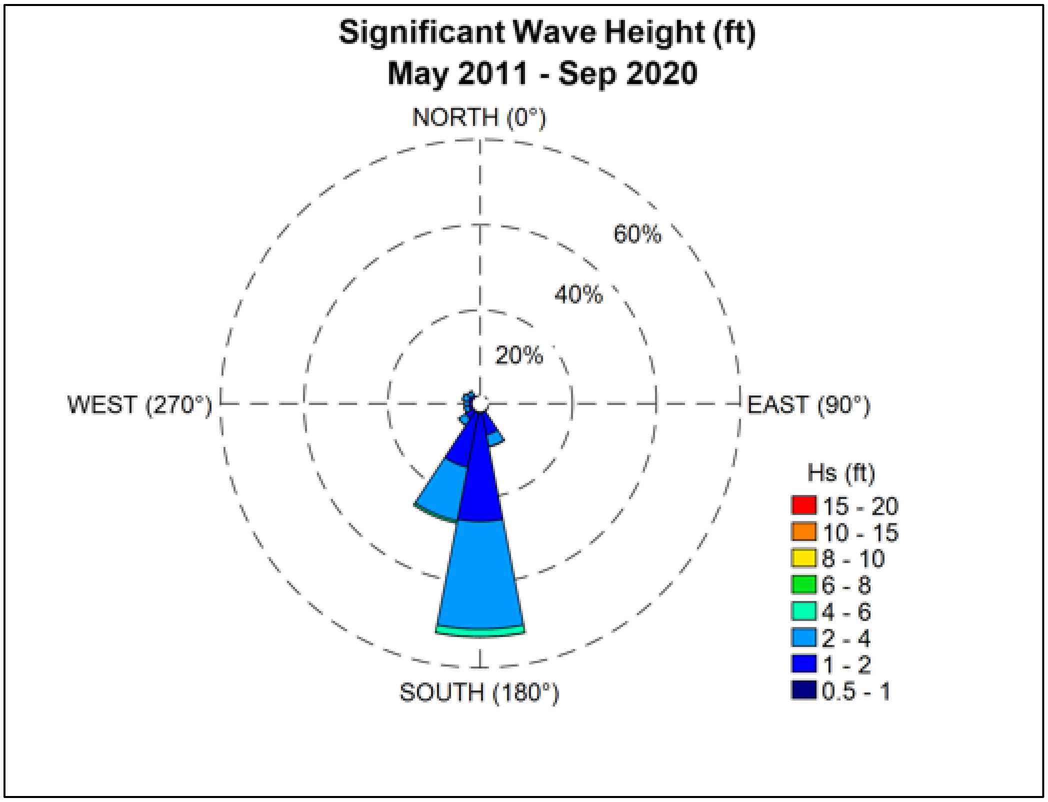


Figure 8-4 CDIP buoy 165 and 238 south swell wave height rose (Oct 2010 to Sep 2020)

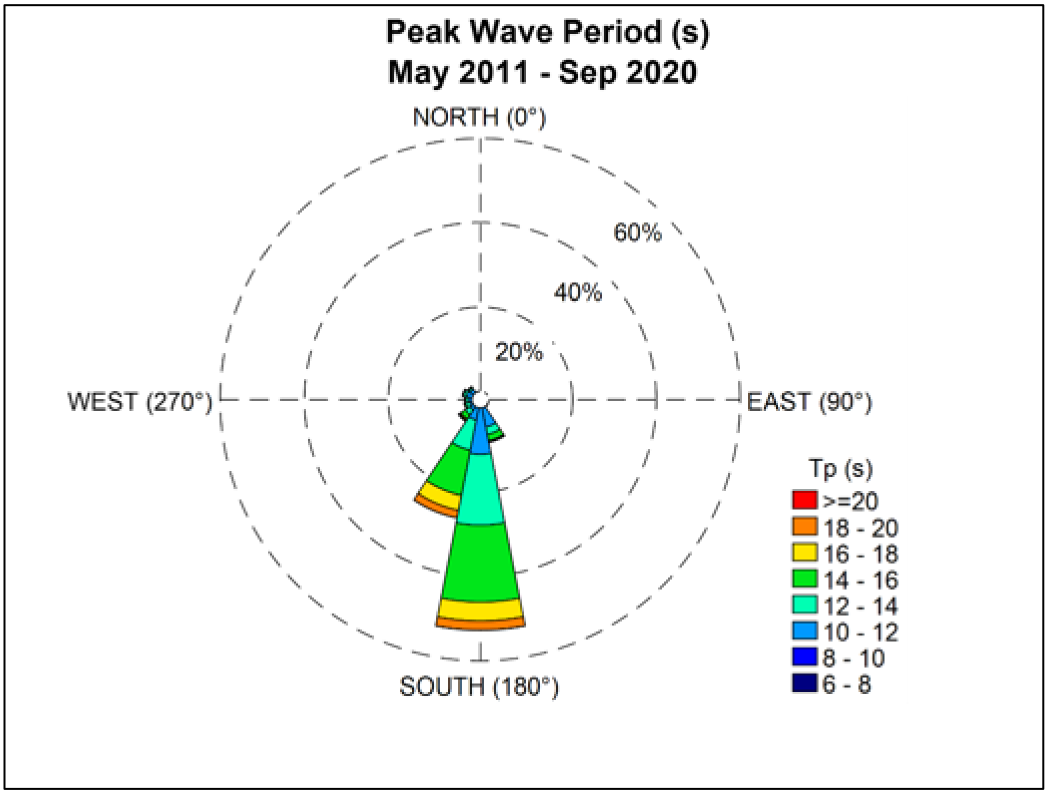


Figure 8-5 CDIP buoy 165 and 238 south swell wave period rose (Oct 2010 to Sep 2020)

As deepwater waves propagate toward shore, they begin to encounter and be transformed by the ocean bottom. In shallow water, the wave speed becomes related to the water depth. As waves slow down with decreasing depth, the process of wave shoaling steepens the wave and increases the wave height. Wave breaking occurs when the wave profile shape becomes too steep to be maintained. This typically occurs when the ratio of wave height to water depth is about 0.78 and is a mechanism for dissipating the wave energy. Wave energy is also dissipated due to bottom friction. The phenomenon of wave refraction is caused by differential wave speed along a wave crest as the wave passes over varying bottom contours and can cause wave crests to converge or diverge and may locally increase or decrease wave heights. Not strictly a shallow water phenomenon, wave diffraction is the lateral transmission of wave energy along the wave crest and would cause the spreading of waves in a shadow zone, such as occurs behind a breakwater or other barrier. Two numerical wave models, SWAN and XBeach-NH were utilized for this study to simulate the wave transformation from deep water to the project area.

Simulating Waves Nearshore (SWAN)

Simulating Waves Nearshore (SWAN) is a third-generation wave model developed by Delft University of Technology that computes random, short-crested wind-generated waves in coastal regions and inland waters (Booij et al, 1999). The SWAN model can be applied as a steady state or non-steady state model and is fully spectral (over the total range of wave frequencies). Wave propagation is based on linear wave theory, including the effect of wave generated currents. SWAN provides many output quantities, including 2-dimensional spectra, significant wave height and mean wave period, and average wave direction and directional spreading. For this project, the SWAN model was used to transform waves from deep water to intermediate water depths just offshore from the project area. SWAN model results were used to provide wave parameter input for a nearshore numerical wave model, XBeach-NH.

XBeach-NH

As waves move into shallow water, bathymetry has a greater influence on wave behavior. Waves interact with the bottom, dissipating more energy through depth-induced breaking and bottom friction. Results of the SWAN model for the prevailing wave, annual wave, and 50-yr wave conditions were modeled from just offshore of the project area into the nearshore region using the XBeach non-hydrostatic (XBeach-NH) numerical model. XBeach is an open-source numerical wave model originally developed to simulate hydrodynamic and morphological processes along sandy shorelines. The XBeach-NH module (Stelling and Zijlema, 2003) computes the depth-averaged flow due to waves and currents using the non-linear shallow water equations and includes a non-hydrostatic pressure term. The governing equations are valid from intermediate to shallow water and can simulate most of the phenomena of interest in the nearshore zone and in harbor basins, including shoaling and refraction over variable bathymetry, reflection and diffraction near structures, energy dissipation due to wave breaking and bottom friction, breaking-induced longshore/cross-shore (rip) currents, and harbor oscillations. XBeach-NH is a phase resolving model, meaning that wave crests and troughs are modeled and propagated in time and space. The result is an accurate representation of wave heights and wave patterns across the domain. The XBeach-NH model was utilized to assess the complex wave pattern along the Waikīkī shoreline. Figure 8-6 shows the XBeach-NH output of wave patterns for a high-prevailing south swell. Figure 8-7 through Figure 8-10 show the XBeach-NH output of wave patterns for a high-prevailing south swell for the four selected beach sectors.

Figure 8-6 XBeach-NH wave pattern output for high-prevailing SSW swell

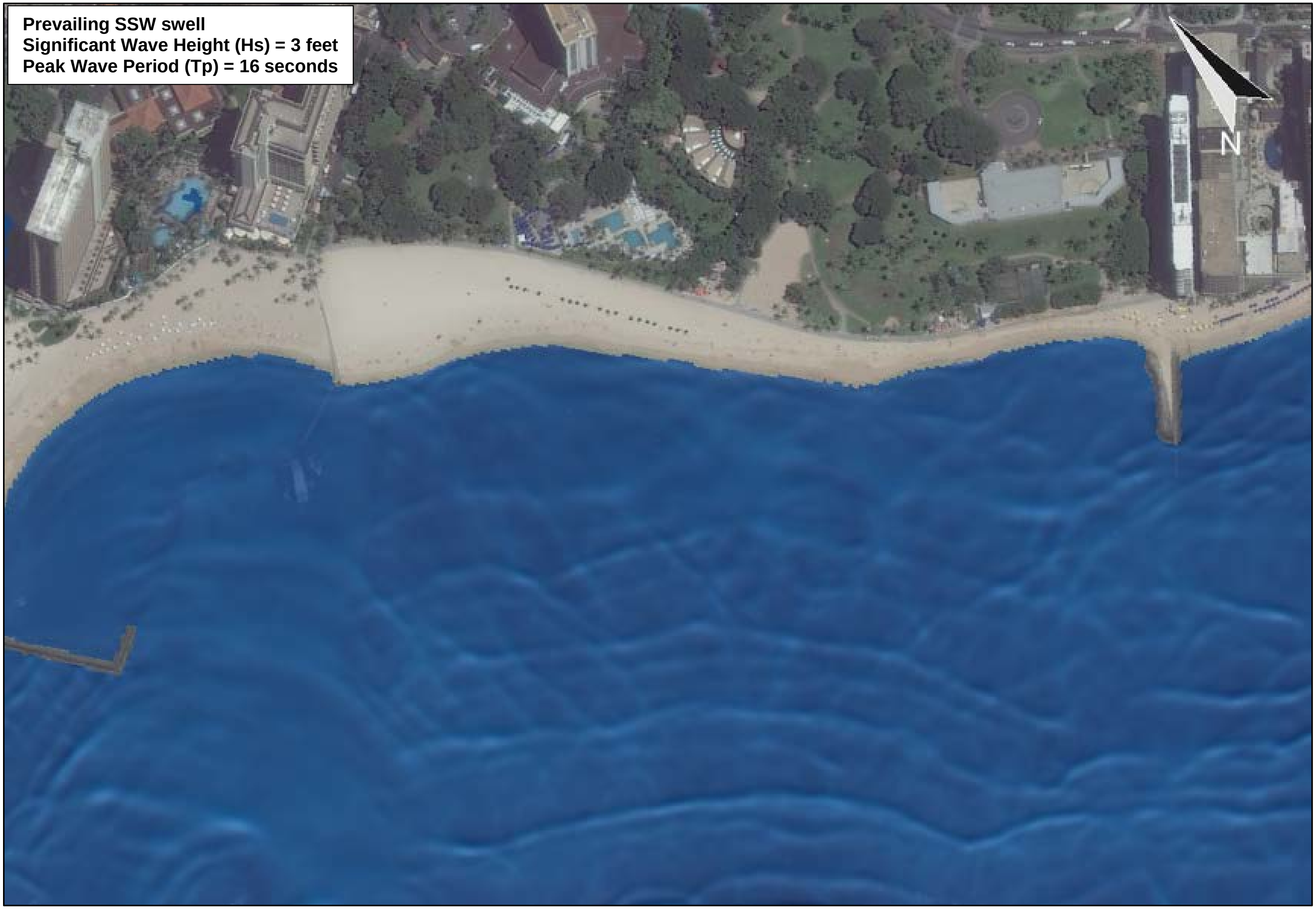


Figure 8-7 XBeach-NH wave pattern for high-prevailing SSW swell – Fort DeRussy beach sector

Figure 8-8 XBeach-NH wave pattern for high-prevailing SSW swell – Halekūlani beach sector

Figure 8-9 XBeach-NH wave pattern for high-prevailing SSW swell – Royal Hawaiian beach sector

Figure 8-10 XBeach-NH wave pattern for high-prevailing SSW swell – Kūhiō beach sector

8.2.3 Extreme Deepwater Waves

The Hawaiian Islands are annually exposed to severe storms and waves generated by tropical cyclonic storms (hurricanes). Hurricanes, the worst-case tropical cyclones, are caused by intense low-pressure vortices that are usually spawned in the eastern tropical Pacific Ocean and travel westward. Along with damaging winds and rains, hurricanes bring the threat of elevated sea level, commonly referred to as *storm surge*.

Storm surge is composed of three elements: wave setup, wind setup, and pressure setup. Wave setup is a phenomenon where the water level shoreward of the breaker zone may be elevated above the tide level due to breaking waves offshore. Wind setup is an increase in water level rise due to wind stress acting on the water surface and will only occur when winds are blowing towards the shore. Typically, wind setup is negligible in Hawaiʻi because it requires a long shallow shelf to help hold water against the shore. Pressure setup is an increase in water level due to reduced atmospheric pressure surrounding the storm. Pressure setup is a function of the center pressure of the storm and the distance from the center of the storm.

While it is not uncommon for hurricanes to pass near Hawaiʻi, they often change course or deteriorate by the time they reach Hawaiian waters. Figure 8-11 shows the historical tracks of tropical storms and hurricanes in the central Pacific from 1949 to 2018. While direct hits to the islands are rare, hurricane tracks to the north or south of the Hawaiian Islands are not infrequent and can generate large, damaging waves that can impact shorelines throughout Hawaiʻi. The historical tracks of hurricanes that have passed near the Hawaiian Islands between 1948 to 2018 are shown in Figure 8-12, and the tracks of tropical storms and tropical depressions that have passed near Hawai'i are shown in Figure 8-13.

Four model hurricane tracks were developed based on similar characteristics of Hurricane Lane in August 2018. Scenario tracks were developed specifically for the west and south facing shores of the island of Oʻahu. The model results for the direct strike scenario track, referred to as *3ab 12kt*, was chosen for this study to assess a worst-case scenario impact to the project area. The modeled wind field and wave height from the previous study are shown in Figure 8-14 and Figure 8-15 respectively. The modeled deepwater significant wave height offshore from the project area at peak conditions is 42 ft with a peak wave period and direction of 14 sec and 215 deg, TN, respectively.

Figure 8-11 Central Pacific historical hurricane tracks (1949 to 2018)

Source: https://coast.noaa.gov/hurricanes/

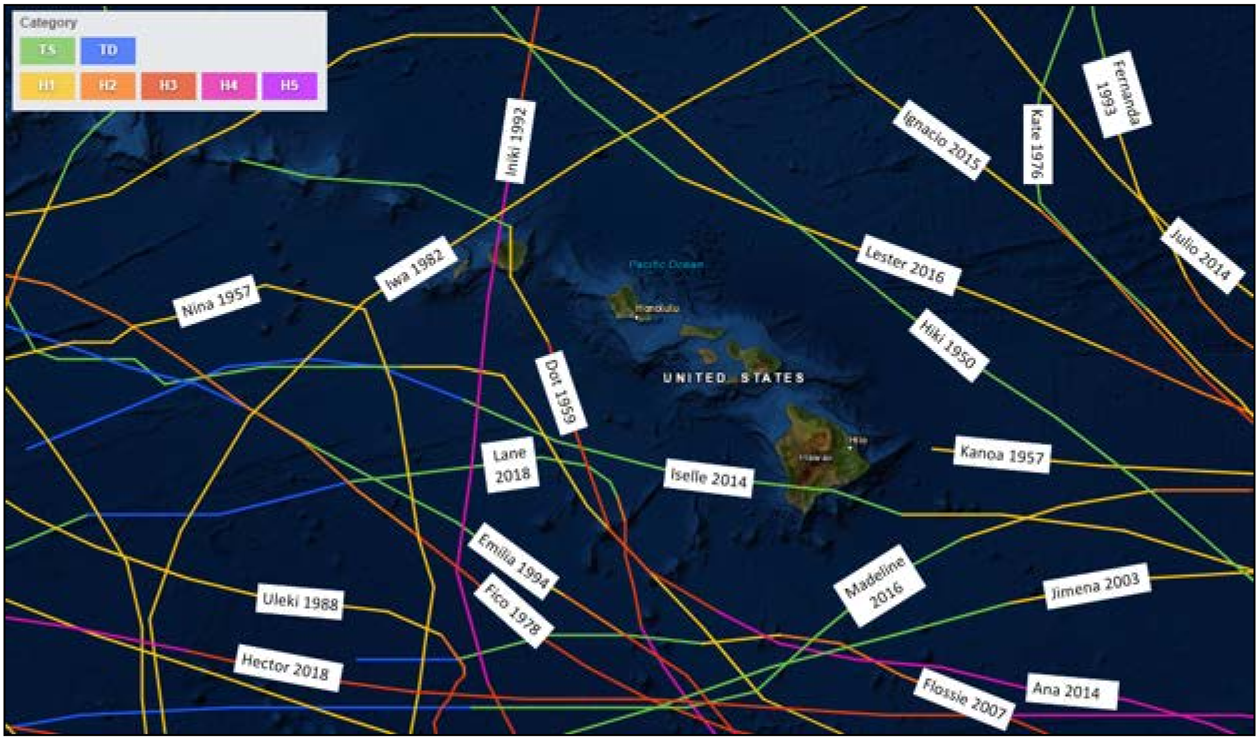


Figure 8-12 Hawaiʻi historical hurricane tracks (1949 to 2018)

Source: https://coast.noaa.gov/hurricanes/

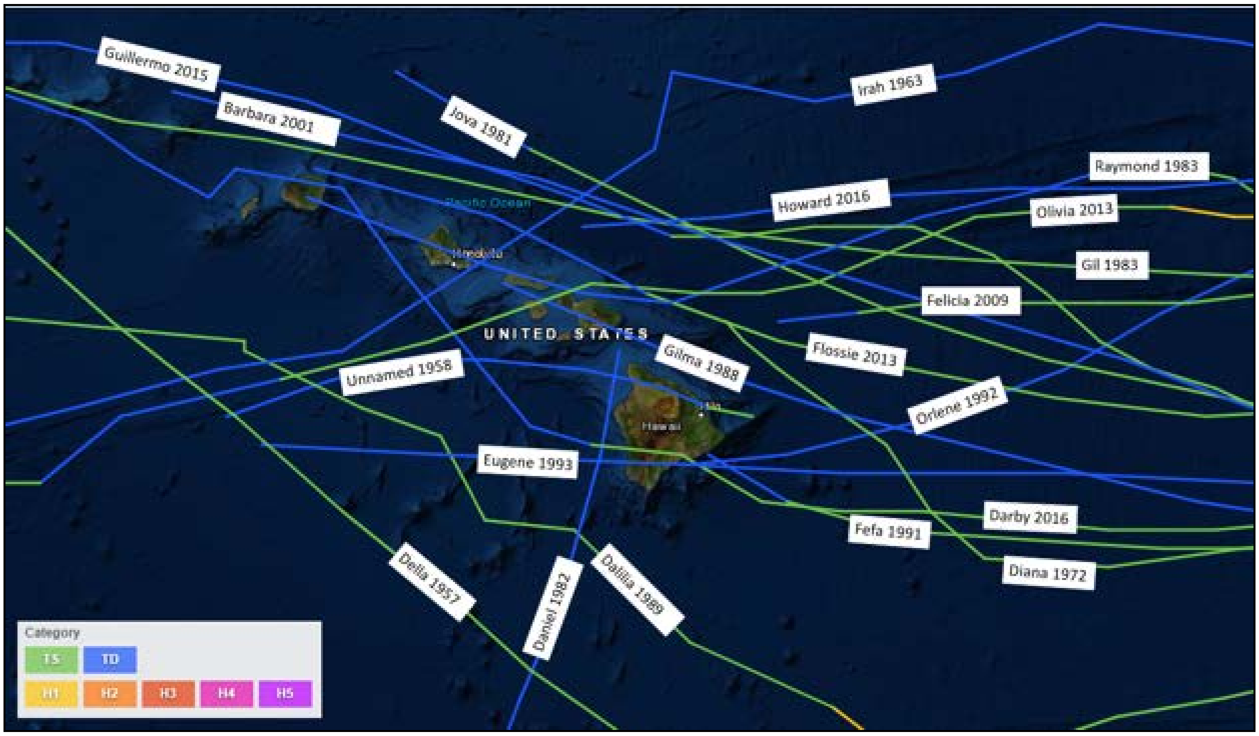


Figure 8-13 Hawai‘i historical tropical storms and depressions (1949 to 2018)

Source: https://coast.noaa.gov/hurricanes/

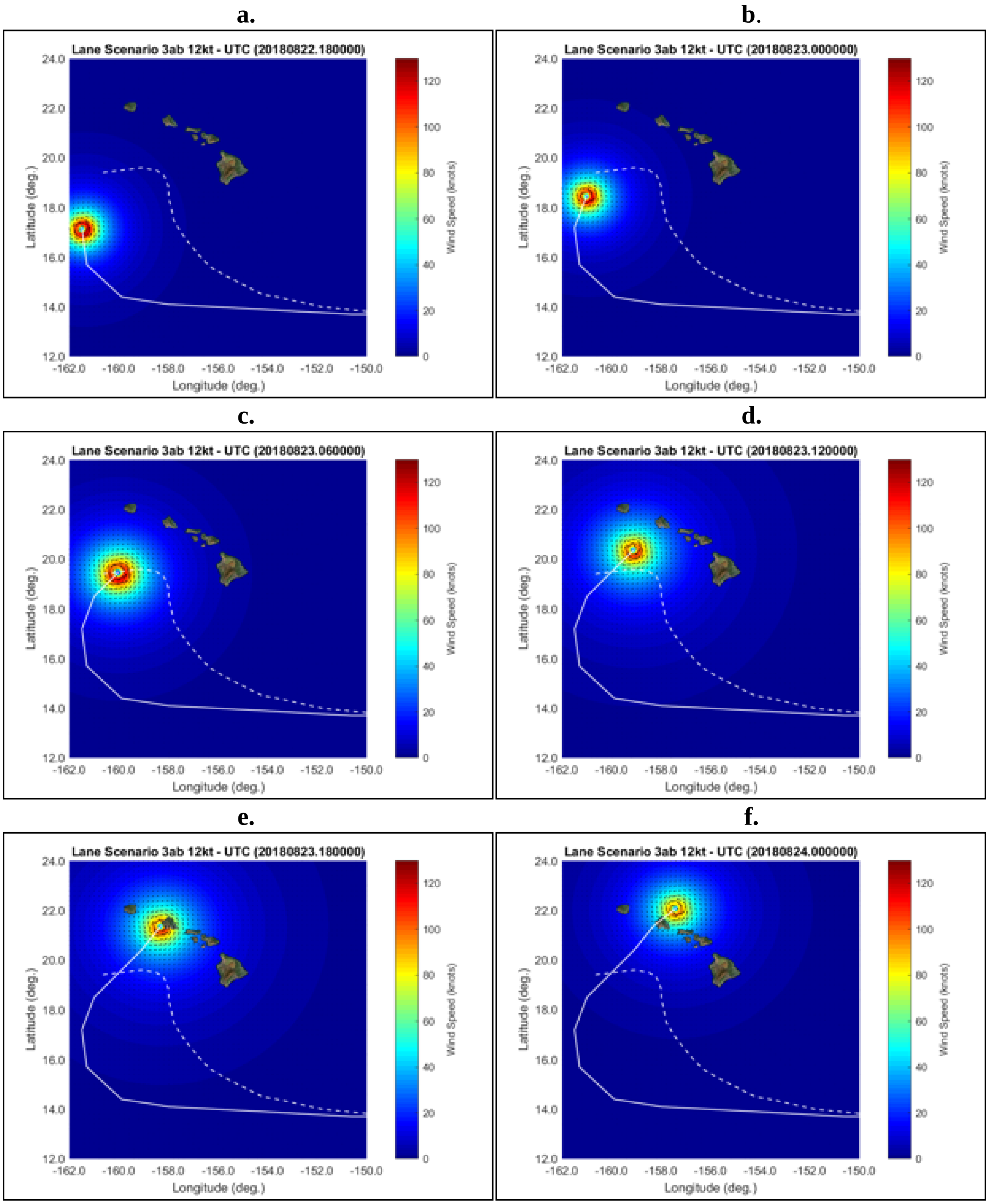


Figure 8-14 Hurricane scenario 3ab_12kt modeled wind field through the Hawaiʻi domain (solid line indicates hurricane scenario track; dashed line indicates original hurricane Lane track)

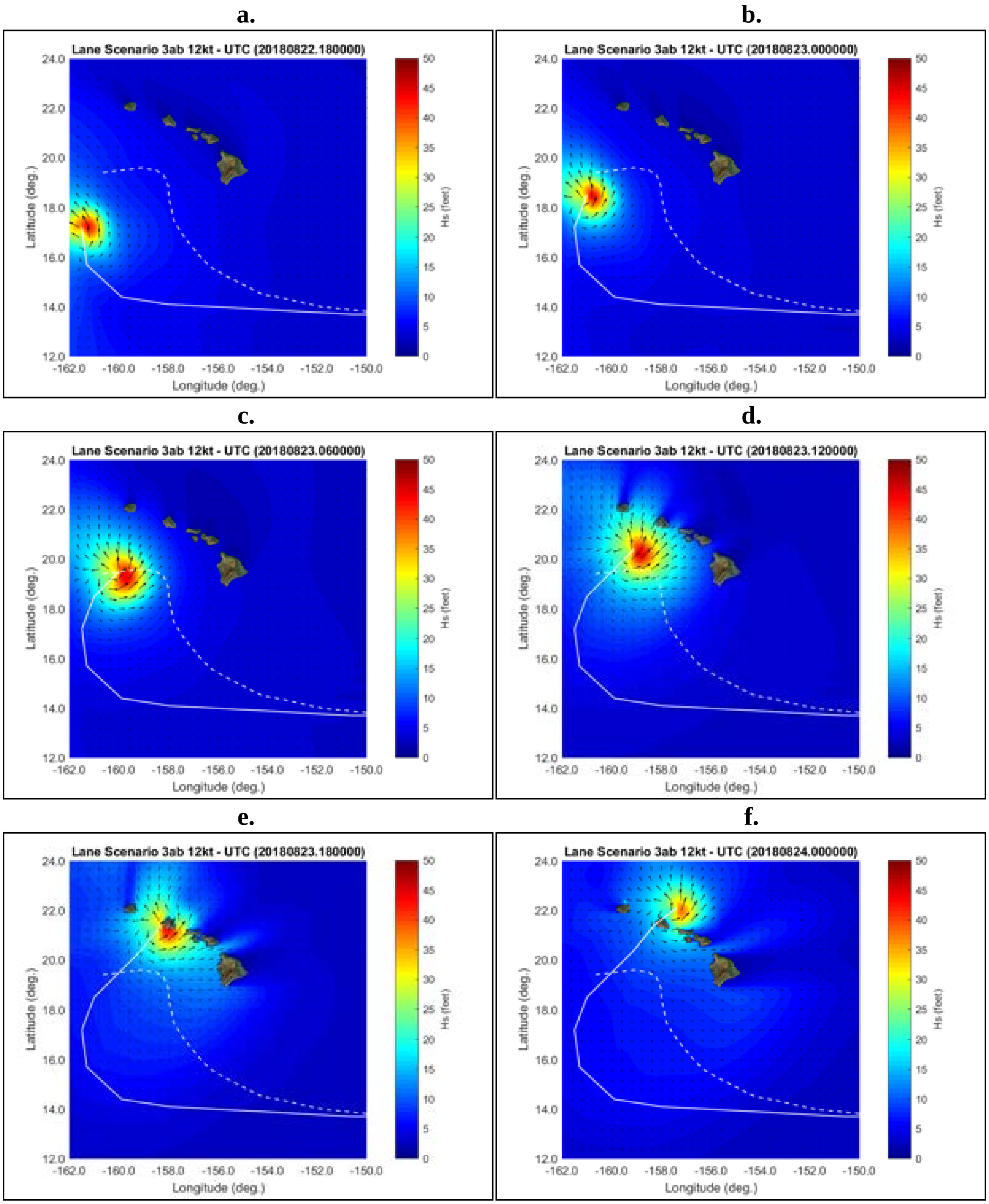

a. b. c. d. e. f.

Figure 8-15 Hurricane Lane Scenario 3ab 12kt modeled significant wave height through the Hawaiʻi domain (solid line indicates hurricane scenario track; dashed line indicates original Hurricane Lane track

Historical wave buoy and hindcast data allows the prediction of extreme wave events. These are infrequent, large, powerful, low probability wave events that are typically used for design purposes. For example, a 50-yr return period wave event is an extreme event with a 1/50 (i.e., 2%) chance of occurring in any given year. Because the project area shoreline is vulnerable to multiple wave regimes (southern swell, Kona storm waves, refracted westerly waves, hurricane waves) extreme deep water wave heights for each event were determined based on available buoy data (seasonal waves) or previous model study results (hurricane waves).

The available buoy wave height data was used to generate a Weibull extreme value distribution for return period wave heights. The Weibull Distribution is a tool for relating the size of wave to the frequency of occurrence at a given location. The analysis requires a long-term dataset with well-documented wave events. These events are then sorted by size and frequency of occurrence and can be assessed by how often these events occur in the historical record. The relationship is logarithmic, and a linear fit can be established with a best fit linear regression of the data. Though not all wave events will be co-located on the line, its general trend represents the nature of the size and frequency relationship of wave events at a specific location. An extreme wave return period analysis using the Weibull Distribution was performed for waves associated with southern swell, and Kona storm waves.

Southern Swell

For extreme deepwater waves associated with southern swell, wave buoy data was compiled from CDIP buoy stations 165 and 238 located offshore from Barbers Point approximately 19.2 to 21 mi to the west-northwest of the project area (shown previously in Figure 8-3). Wave data for these buoys spans a 10-yr period between October 2010 and March 2021. Extreme wave heights were investigated by filtering the buoy data by direction and period for waves approaching from the south to southwest directions, with periods of 12 sec or greater. Wave height versus return period is shown on Figure 8-16 and Table 8-3. The ten largest wave events associated with south swell during the period of record are shown in Table 8-4.

Kona Storm Waves

For extreme deepwater waves associated with Kona storm waves (seas), wave buoy data was compiled from CDIP buoy stations 165 and 238 located offshore from Barbers Pt. approximately 19.2 to 21 mi to the west-northwest of the project area (shown previously in Figure 8-3). Wave data for these buoys spans a 10-yr period between October 2010 and March 2021. Extreme wave heights were investigated by filtering the buoy data by direction and period for waves approaching from the west to south directions, with periods of 10 sec or less. Wave height versus return period is shown on Figure 8-17 and Table 8-5. The ten largest wave events associated with Kona seas during the period of record are shown in Table 8-6.

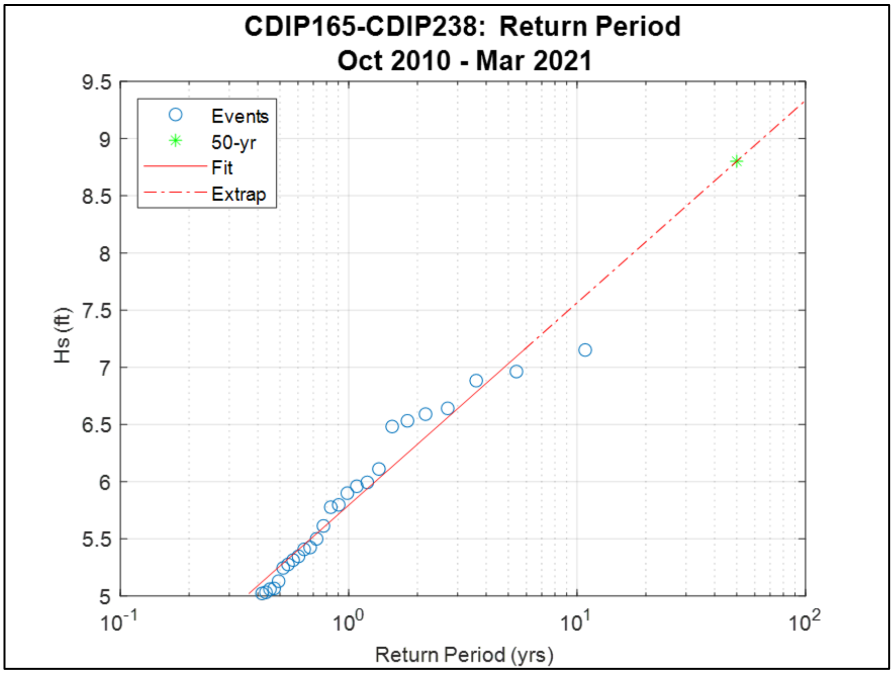


Figure 8-16. Significant wave height vs. return period, CDIP 165/238 (Barbers Point buoy), filtered for south swell, October 2010 to March 2021

Table 8-3. Significant wave height vs. return period, CDIP 165/238 (Barbers Point buoy), filtered for south swell, October 2010 to March 2021

Return Period	Hs (ft)
1	5.8
2	6.3
5	7.0
10	7.6
25	8.3
50	8.8

Table 8-4. Top 10 south swell events recorded at CDIP 165/238 (Barbers Point buoy)

Date	Hs (ft)	Tp (sec)	Dp (deg. TN)
2013-06-06	7.2	17	186
2018-08-23	7.0	13	167
2020-03-24	6.9	15	188
2013-05-19	6.6	15	175
2015-07-26	6.6	17	193
2011-08-31	6.5	18	181
2018-10-04	6.5	14	219
2020-06-03	6.1	17	188
2011-09-11	6.0	17	192
2018-06-10	6.0	15	178

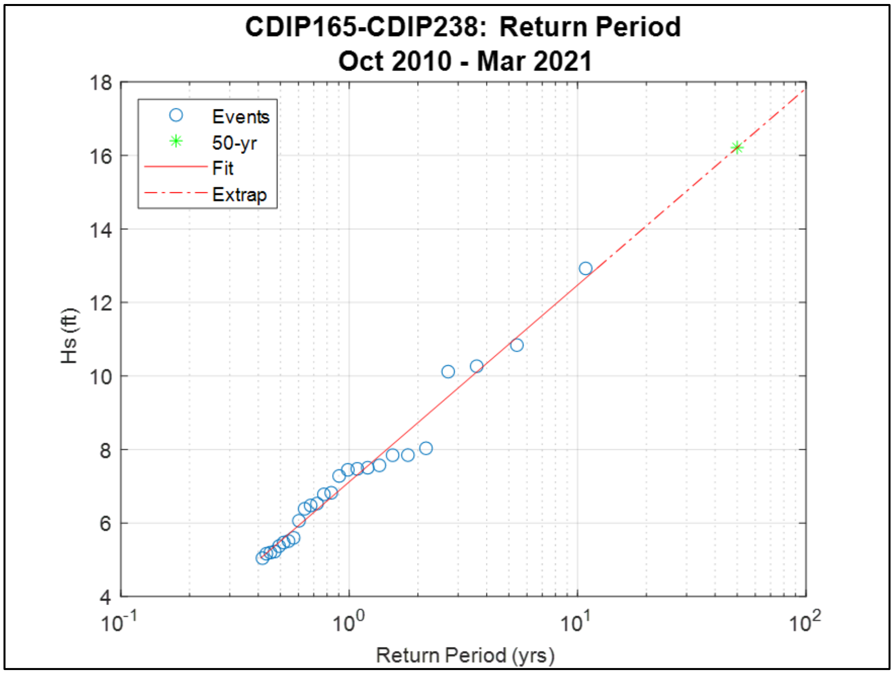


Figure 8-17. Significant wave height vs. return period, CDIP 165/238 (Barbers Point buoy), filtered for Kona storm waves, October 2010 to March 2021

Table 8-5. Significant wave height vs. return period, CDIP 165/238 (Barbers Point buoy), filtered for Kona storm waves, October 2010 to March 2021

Return Period	Hs (ft)
1	7.1
2	8.7
5	10.9
10	12.5
25	14.6
50	16.2

Table 8-6. Top 10 Kona storm waves events recorded at CDIP 165/238 (Barbers Point buoy)

Date	Hs (ft)	Tp (sec)	Dp (deg. TN)
2019-02-11	12.9	10	276
2015-01-03	10.8	8	245
2015-02-14	10.3	8	247
2014-01-22	10.1	8	269
2015-02-03	8.0	7	249
2020-02-10	7.8	6	279
2021-02-04	7.8	7	276
2014-01-03	7.6	6	231
2011-03-04	7.5	6	200
2014-10-19	7.5	8	202

8.2.4 Potential Impacts and Mitigation Measures

Detailed wave modeling was conducted to evaluate the potential for the proposed actions to impact waves in Waikīkī (see Sections 8.2.2 and 9.4.6). Dredging of offshore sand deposits involves removing sand from the deposits, resulting in a lowering of the bottom elevation or altering the bathymetry. Dredging could occur at the *Ala Moana*, *Canoes/Queens*, or *Hilton* offshore sand deposits. Wave modeling was used to assess the potential impacts of dredging on nearby surf sites. A wave reflection analysis was also conducted to evaluate the potential for the proposed structures in the Halekūlani and Kūhiō beach sectors to reflect waves that could negatively impact surf sites. To evaluate potential impacts, wave modeling of the existing conditions and with the proposed structures was performed. Based on the results of the wave modeling, the dredge analysis, and the wave reflection analysis, no significant impacts to waves of surf sites in Waikīkī are anticipated.

8.3 Sea Level

8.3.1 Still Water Level

The total water depth at a particular location is composed of the depth below the nearshore bottom relative to sea level datum, plus factors that add to the still water level (SWL) such as the astronomical tide, mesoscale eddies and other oceanographic phenomena, wave setup, storm surge (pressure setup and wind setup), and potential sea level change over the life of a project. The sea level datum used for this project is mean sea level (MSL)

8.3.2 Tides

Hawaiʻi tides are semi-diurnal with pronounced diurnal inequalities (i.e., two high and low tides each 24-hr period with different elevations). Variation of the tidal range results from the relative position of the moon and sun. During full moon and new moon phases, the moon and sun act together to produce larger *spring tides*, where the difference between high and low tide is the greatest. When the moon is in its first or last quarter, smaller *neap tides* occur, where the difference between high and low tide is the least. The cycle of spring to neap tides and back is half the 27-day period of the moon's revolution around the earth and is known as the *fortnightly cycle*. The combination of diurnal, semi-diurnal and fortnightly cycles dominate variations in sea level throughout the Hawaiian Islands.

King Tides is a non-scientific term that has become increasing common in recent years. Often associated with coastal flooding, *King Tides*, or perigean spring tides, are strictly an astronomical phenomenon. *King Tides* generally refers to the highest tide levels of the year that are a result of the alignment of the earth, sun, and moon during the winter and summer months. During these times, high tide can reach an elevation of as much as +2.7 ft MLLW in Honolulu.

Tidal predictions and historical extreme water levels are provided by the National Ocean and Atmospheric Administration (NOAA), NOS (National Ocean Service), Center for Operational Oceanographic Products and Services (CO-OPS). The nearest NOAA tide station is located at Honolulu Harbor (Station ID: 1612340). Water level data from Station 1612340, based on the 1983 to 2001 tidal epoch, is shown in Table 8-7.

Table 8-7 Water level data for Honolulu Harbor (NOAA Station 1612340)

Datum	Elevation (ft MLLW)	Elevation (ft MSL)
Highest Astronomical Tide	+2.71	+1.89
Mean Higher High Water	+1.90	+1.08
Mean High Water	+1.44	+0.62
Mean Sea Level	+0.82	0.00
Mean Low Water	+0.16	-0.66
Mean Lower Low Water	0.00	-0.82
Lowest Astronomical Tide	-0.43	-1.25

8.3.3 Sea Level Anomalies

The ocean surface does not have a consistent elevation. Sea level anomalies (SLA) are defined as the difference between the measured and predicted tides recorded. SLA are caused by climatic and oceanographic processes such as global warming, the El Niño-Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO), geostrophic currents due to the rotation of the earth, and mesoscale eddies that propagate across the ocean.

Hawaiʻi is subject to periodic extreme tide levels due to large oceanic eddies and other oceanographic phenomena that have recently been recognized and that sometimes propagate through the islands. Mesoscale eddies produce tide levels that can be up to 0.5 ft higher than normal for periods up to several weeks (Firing and Merrifield, 2004). An additional temporary sea level rise on the order of 0.5 ft has also been associated with phenomena related to the El Niño-Southern Oscillation.

In 2017, Hawaiʻi experienced anomalous sea levels which caused significant inundation of low-lying urban areas such as Waikīkī, Ala Wai Boulevard, and Mapunapuna. The daily maximum recorded tides at Honolulu Harbor from February through October 2017 are show in Figure 8-18. The plot also shows the corresponding predicted tide and SLA for the daily maximum recorded tide. Table 8-8 extends this data, presenting the recorded and predicted tides at Honolulu Harbor from February 2017 to present.

The media widely reported that the flooding was the result of *king tides*; however, sea level anomalies during the high-water events ranged from approximately 0.5 ft to 1 ft above the astronomical tide. The occurrence of summer swells during this period of elevated water levels further exacerbated the inundation. The end of 2019 also marked an extended period of pronounced SLA. Figure 8-19 shows the extreme water levels from December 24 to 27, 2019. During this time period, SLA of +0.6 to +1.1 ft added to the winter *King Tides* resulting in the highest recorded water level at Honolulu Harbor of +3.4 ft MLLW.

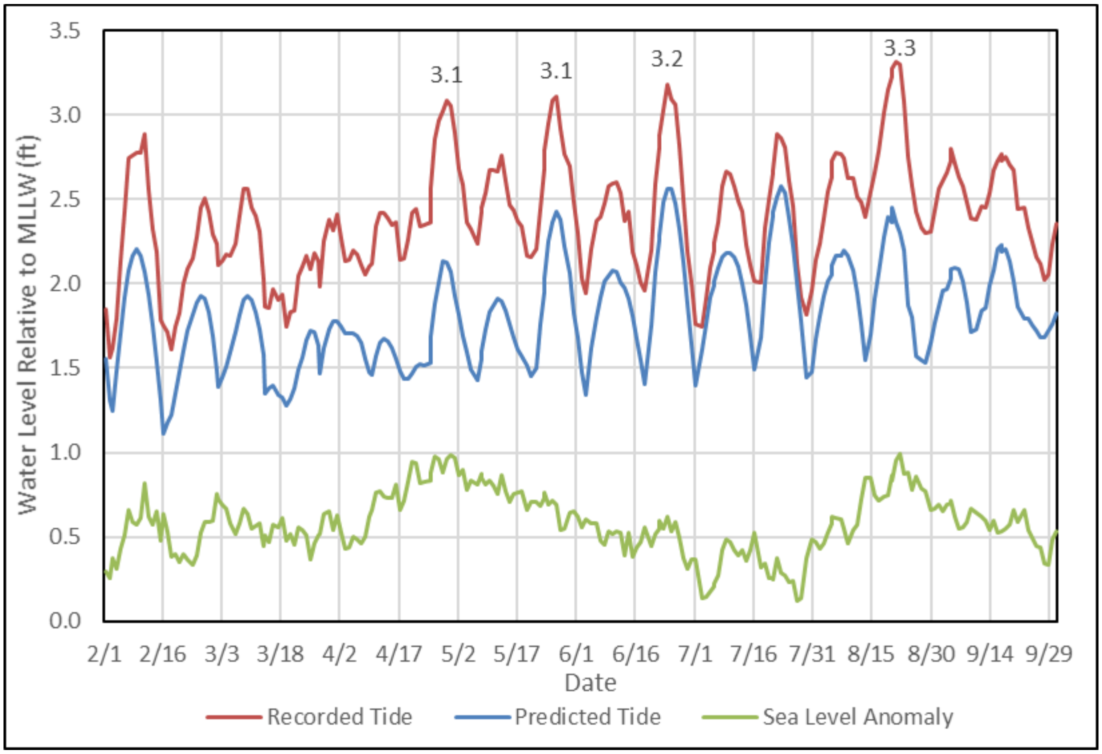


Figure 8-18 Daily maximum measured tides at Honolulu Harbor and corresponding predicted tides and sea level anomaly (February 1-October 1, 2017)

Table 8-8 Peak recorded tide levels at Honolulu Harbor from 2017 to present

Date	Recorded Tide (ft MLLW)	Predicted Tide (ft MLLW)	SLA (ft)
12/25/2019	3.4	2.4	1.0
08/20/2017	3.3	2.4	0.9
08/21/2017	3.3	2.3	1.0
08/19/2017	3.3	2.4	0.9
07/19/2020	3.3	2.4	0.9
07/20/2020	3.3	2.5	0.8
12/26/2019	3.3	2.4	0.9
07/21/2020	3.2	2.4	0.8
07/04/2020	3.2	2.5	0.7
11/15/2020	3.2	2.5	0.7

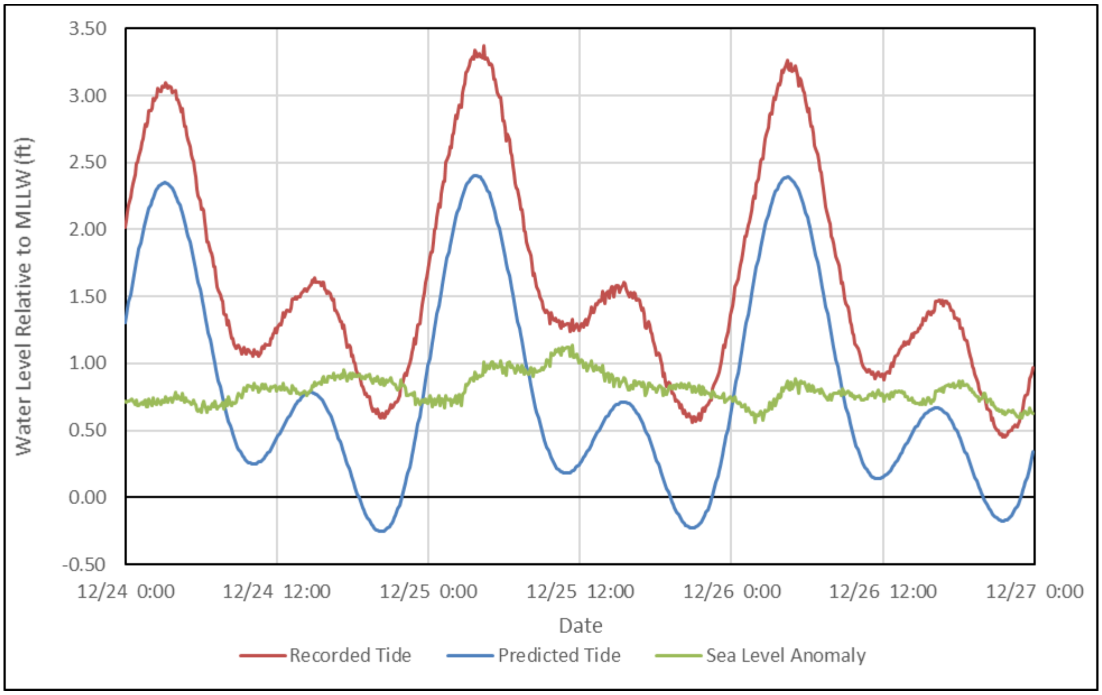


Figure 8-19 Predicted and measured tides at Honolulu Harbor (Dec 24-26, 2019)

8.3.4 Combined Stillwater Level

The aforementioned water level rise phenomena are additive and may occur at a given time. The total still water level, *S*, at a given time, therefore, can be a linear combination of:

- Astronomical tide and other oceanographic phenomena (S_a)
- Sea level rise due to atmospheric pressure reduction (S_p)
- Wind tide caused by wind stress component perpendicular (S_x) to the coastline and parallel to the coastline (S_y)
- Wave set-up in the breaker zone (S_w)
- Sea level rise (S_{SLR})

or,

$$S = S_a + S_p + S_x + S_y + S_w + S_{SLR}$$

The linear superposition of water level components is an empirical method of determining total still water during a model event. As it does not consider the joint probability of components included, it is a conservative method and can be used to estimate a “worst-case” scenario for water levels.

8.3.5 Sea Level Rise

The present rate of global mean sea level change is +3.3 ± 0.4 mm/yr (NASA, 2020), where a positive number represents a rising sea level. Global mean sea level rise has accelerated over preceding decades compared to the mean of the 20th century. Factors contributing to the rise in sea level include melting of land-based glaciers and ice sheets and thermal expansion of the ocean water column.

The relative sea level trend for Honolulu Harbor for the period of 1905 to present is shown in Figure 8-20 (NOAA, 2020). The rate of sea level change is +1.51 ± 0.21 mm/yr based on monthly data from 1905 to present. Figure 8-20 also shows interannual anomalies exceeding 0.5 ft (15 cm) in magnitude due to natural oceanic variability from processes such as the El Niño-Southern Oscillation (ENSO).

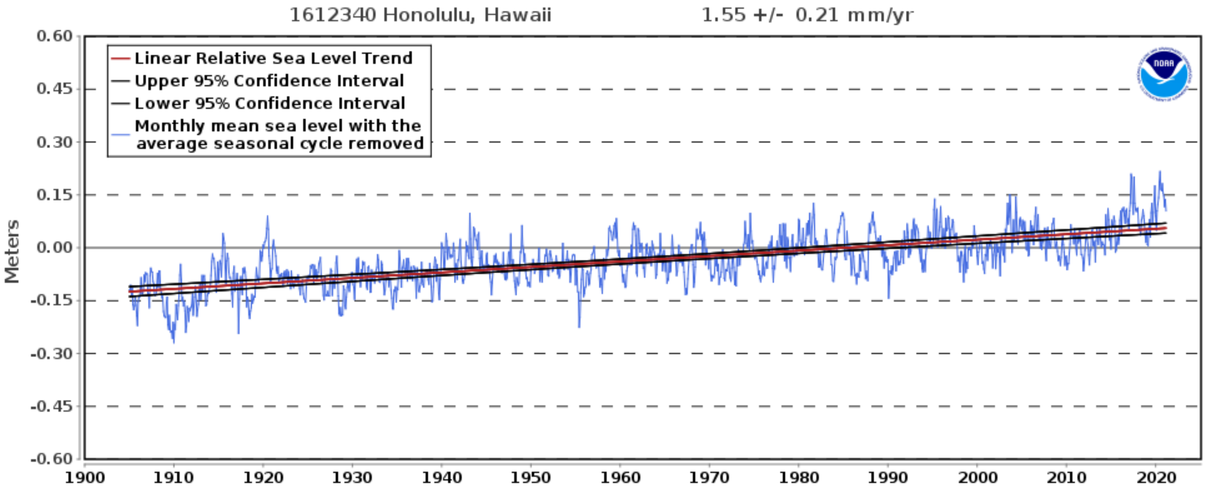


Figure 8-20 Relative sea level trend, Honolulu Harbor, 1905 to present (NOAA, 2021)

NOAA recently revised their sea level change projections through 2100 taking into account up-to-date scientific research and measurements (Sweet et al. 2017). The NOAA *Intermediate* scenario represents approximately 3.3 ft of sea level rise by 2100 and their *Extreme* scenario represents more than 8 ft of sea level rise by 2100 (Table 8-9). NOAA (2017) describes the *Extreme* scenario as “physically plausible” and corresponds to a “business as usual” trajectory for increasing greenhouse gas emissions (i.e., no reductions in the increasing rate of emissions) and worst case for glacier and polar ice loss in this century.

Hawaiʻi thus far has seen a rate of sea level rise that is less than the global average; however, this is expected to change as Hawaiʻi is in the “far field” of the effects of melting land ice. This means that those effects have been significantly less in Hawaiʻi compared to areas closer to the ice melt. Over the next few decades, this effect will spread to Hawaiʻi, which is projected to experience sea level rise greater than the global average due to global-scale gravitational effects related to the shrinking of polar sheets. Table 8-9 shows NOAA’s most recent global mean sea level rise scenarios. Table 8-10 and Figure 8-21 present mean sea level rise scenarios for Hawaiʻi based on the revised NOAA (2017) projections, taking into account the far field effects.

Table 8-9 Global mean sea level rise scenarios (NOAA, 2017)

Scenario (ft)	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
Low	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Intermediate-Low	0.1	0.3	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.6
Intermediate	0.1	0.3	0.5	0.8	1.1	1.5	1.9	2.3	2.8	3.3
Intermediate-High	0.2	0.3	0.6	1.0	1.4	2.0	2.6	3.3	3.9	4.9
High	0.2	0.4	0.7	1.2	1.8	2.5	3.3	4.3	5.6	6.6
Extreme	0.2	0.4	0.8	1.3	2.1	3.0	3.9	5.2	6.6	8.2

Table 8-10 Hawaiʻi local mean sea level rise scenarios (adapted from NOAA, 2017)

Scenario (ft)	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
Low	0.1	0.2	0.3	0.5	0.6	0.7	0.9	1.0	1.2	1.3
Intermediate-Low	0.1	0.3	0.5	0.7	0.9	1.1	1.4	1.6	1.9	2.1
Intermediate	0.1	0.4	0.6	1.0	1.3	1.8	2.3	2.9	3.5	4.2
Intermediate-High	0.2	0.4	0.7	1.1	1.7	2.4	3.2	4.1	5.0	6.3
High	0.2	0.4	0.8	1.4	2.1	3.0	4.0	5.3	7.0	8.4
Extreme	0.2	0.4	0.9	1.6	2.4	3.5	4.8	6.5	8.3	10.5

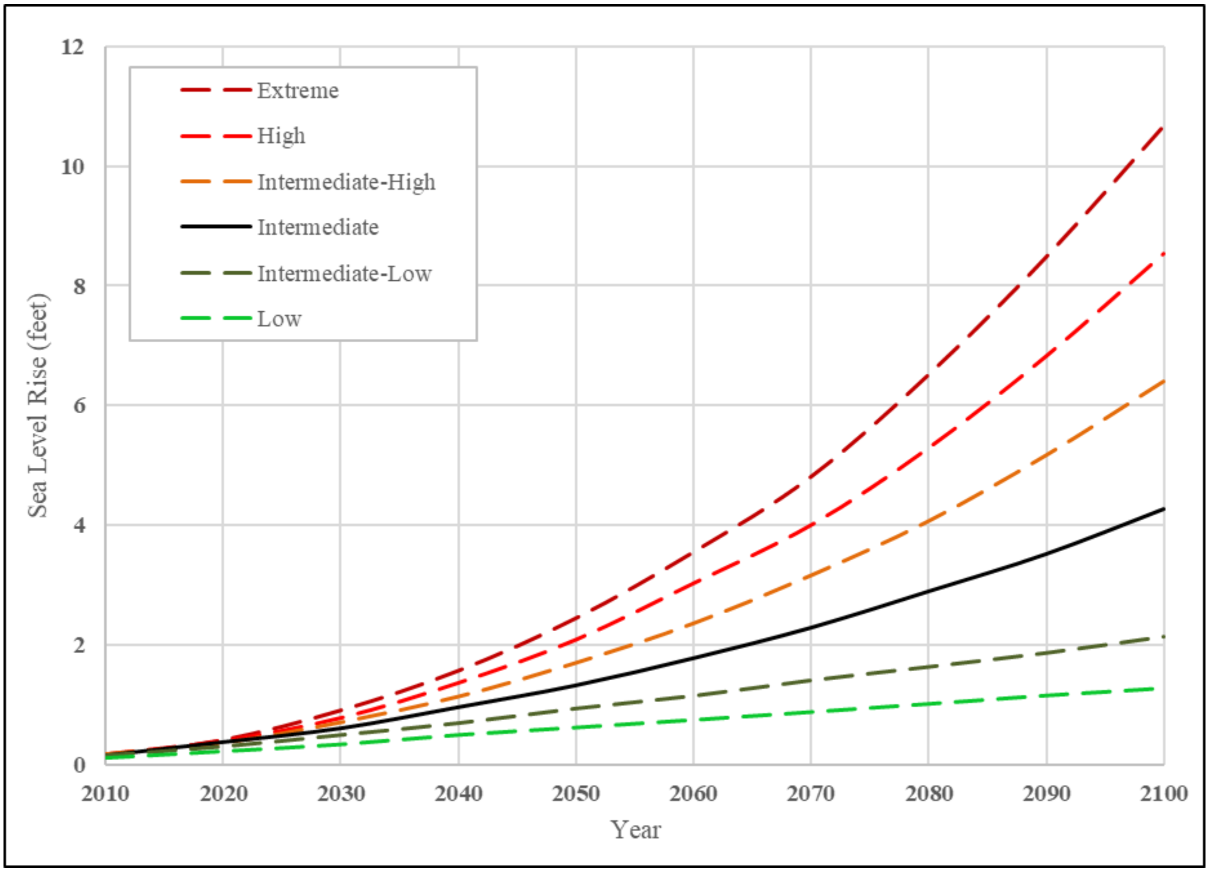


Figure 8-21 Hawaiʻi local mean sea level rise projections (adapted from NOAA, 2017)

Sea level rise is negatively impacting beaches and shorelines in Hawaiʻi. Impacts include beach narrowing and beach loss, permanent loss of terrestrial land due to erosion, and infrastructure damage due to wave inundation and flooding. Anderson et al. (2015) found that, due to sea level rise, the average shoreline recession in Hawaiʻi is projected to be nearly twice the historical rates by 2050, and nearly 2.5 times the historical rates by 2100. The impacts from anomalous sea level events (e.g., El Niño, king tides, mesoscale eddies, storm surge) are also likely to increase.

The *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* (2017) discusses the anticipated impacts of projected future sea level rise on coastal hazards, and the potential physical, economic, social, environmental, and cultural impacts of sea level rise in Hawaiʻi. The report concluded that the potential impacts of 3.2 ft of sea level rise on Oʻahu include the loss of $12.9 billion in structures and land; 3,800 structures, including hotels and resorts in Waikīkī; the displacement of 13,300 residents; and the loss of 17.7 miles of major roads. (State of Hawaiʻi, 2017). The report estimates that, due to the density of development and economic assets, Honolulu will account for an estimated 66% of the total statewide economic losses due to sea level rise. Public and private facilities and infrastructure in Waikīkī are particularly vulnerable to sea level rise given their relatively low elevation and close proximity to the shoreline.

A key component of the report was a numerical modeling effort by the University of Hawaiʻi Coastal Geology Group (UHCGG) to estimate the potential impacts of a 3.2-ft rise in sea level. UHCGG used the most current available information on climate change and sea level rise from the Intergovernmental Panel on Climate Change (IPCC) Assessment Report 5 (AR5). The UHCGG numerical modeling is based on the upper end of the IPCC AR5 representative concentration pathway (RCP) 8.5 sea level rise scenario, which predicts up to 3.2 ft of global sea level rise by the year 2100. However, based on recent peer-reviewed publications, it is possible that sea level rise could be significantly greater than the RCP 8.5 sea level rise scenario by the end of this century. Sweet et al. (2017) suggest that global mean sea level rise in the range of 6.4 ft to 8.8 ft is physically plausible by the end of this century, which is significantly higher than the worst-case IPCC AR5 projections.

UHCGG modeled the potential impacts that a 3.2-ft rise in sea level will have on coastal hazards including passive flooding, annual high wave flooding, and coastal erosion. The footprint of these three hazards were combined to map the projected extent of chronic flooding due to sea level rise, referred to as the *sea level rise exposure area (SLR-XA)*. Flooding in the SLR-XA is associated with long-term, chronic hazards punctuated by annual or more frequent flooding events.

The SLR-XA study used the X-Beach wave model, which is commonly used to assess wave inundation in coastal areas because it captures the contribution of waves to water levels. Figure 8-22 shows a diagram of the elements of wave runup and inundation as modeled in the SLR-XA study. The UHCGG modeling results can be explored in the Hawaiʻi Sea Level Rise Viewer (hawaiisealevelriseviewer.org) and are shown in Figure 8-23 through Figure 8-26.

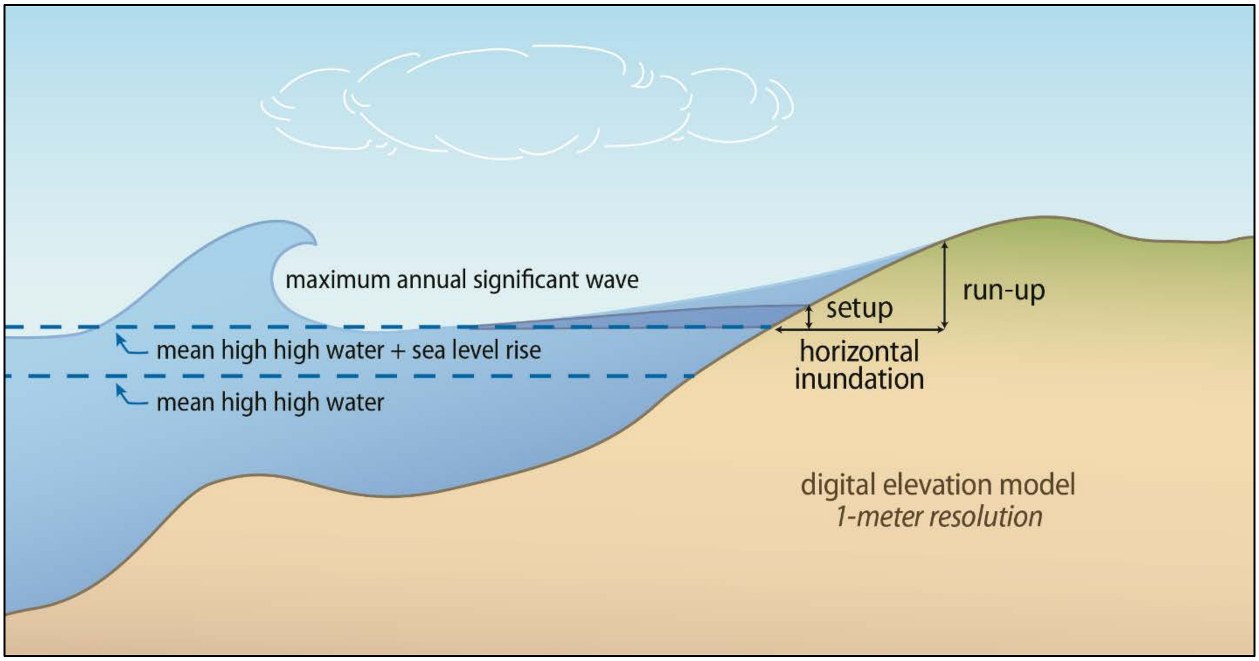


Figure 8-22 Diagram of wave runup (Hawai‘i Climate Change Commission, 2017)

Figure 8-23 depicts the potential for passive flooding with 3.2 ft of sea level rise. Passive flooding includes areas that are hydrologically connected to the ocean (marine flooding) and low-lying areas that are not hydrologically connected to the ocean (groundwater flooding). The model projects minimal passive flooding in Waikīkī with 3.2 ft of sea level rise.

Figure 8-24 depicts the potential for annual high wave flooding with 3.2 ft of sea level rise. The annual high wave flooding model propagates the maximum annually recurring wave, calculated from historical wave buoy data, over the reef and to the shore along 1-dimensional cross-shore profiles extracted from a 1-m digital elevation model (DEM). The model results depict the spatial extent of inundation that is greater than 10 cm in depth from that annually recurring high wave event with 3.2 ft of sea level rise. The model projects extensive annual high wave flooding in Waikīkī with 3.2 ft of sea level rise.

Figure 8-25 depicts the estimated area that could be exposed to erosion with 0.5 to 3.2 ft of sea level rise. The results of the erosion model represent the combined results of measured historical erosion rates and a model of beach profile response to sea level rise. The projected erosion hazard lines for Waikīkī are derived, in part, from historical erosion rates that are based on shoreline locations that are digitized (mapped) from aerial photographs and earlier coastal survey charts dating back to the early 1900s and measured at individual transects located 20 meters apart along the coastline. The model projects extensive erosion in Waikīkī with 3.2 ft of sea level rise.

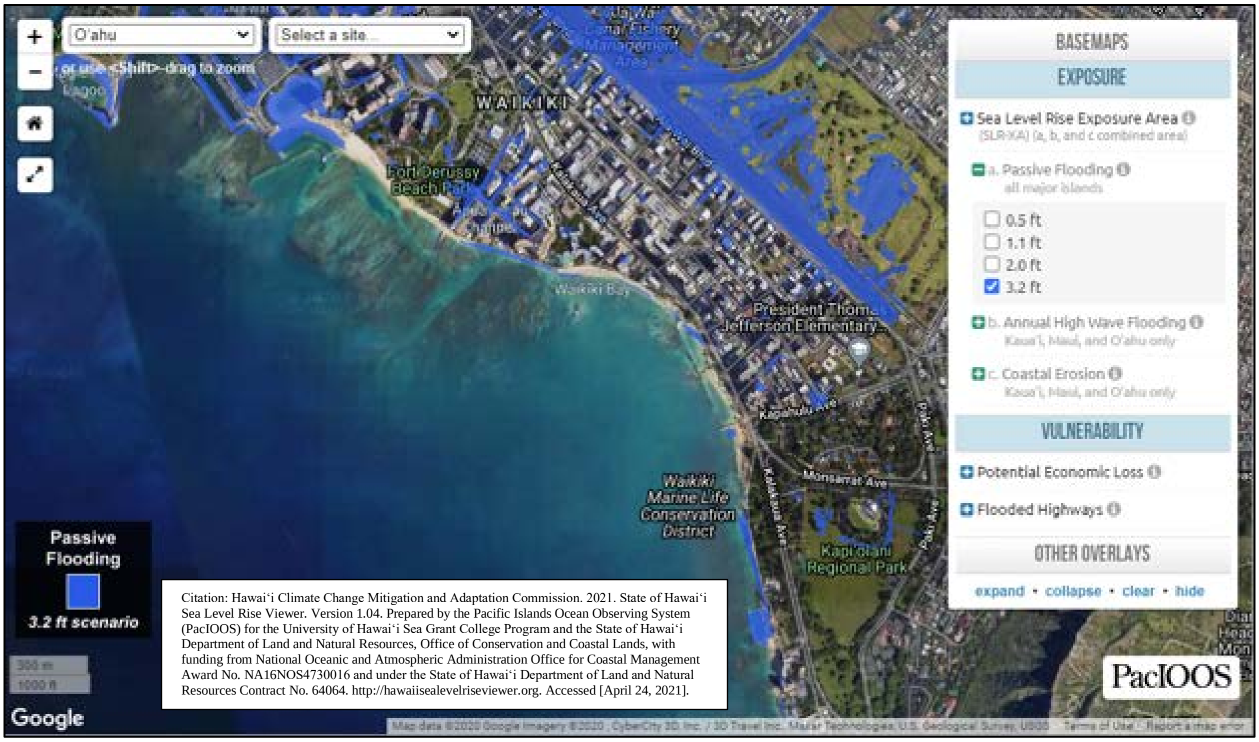
It is important to note that the long-term historical shoreline change rates for Waikīkī are influenced by human efforts over the past century to engineer and stabilize the beaches, which influences the projected rates of future erosion. These projections also assume that the terrestrial area is composed of non-cohesive erodible substrate and do not account for the presence of the existing seawalls that span nearly the entire length of the Waikīkī shoreline. While it is unlikely that erosion would extend significantly mauka (landward) of the existing seawalls, the potential for structural damage and wall failure will increase as the structures become more exposed to wave action. There is evidence of this occurring in the Halekūlani beach sector where undermining and scour have caused sinkholes to form mauka (landward) of the exposed portions of the seawalls. Without beach improvements and/or maintenance, it is likely that sea level rise will result in total beach loss in many areas of Waikīkī within this century as the beaches are "squeezed" between rising water levels and seawalls in the backshore.

Figure 8-26 depicts the projected extent of chronic flooding with 3.2 ft of sea level rise, referred to as the sea level rise exposure area (SLR-XA). The SLR-XA represents the combined footprint of the three individual hazards that were modeled - passive flooding, annual high wave flooding, and coastal erosion. The model results indicate that coastal flooding in Waikīkī, particularly annual high wave flooding, will increase significantly as sea levels continue to rise.

Sea level rise also has the potential to significantly alter the wave climate in Waikīkī. As water depths increase, the fringing reef will be less effective in dissipating wave energy. As a result, waves will break further inland and swells will have to be larger to break in the deeper water (Honolulu Civil Beat, 2019). This could potentially eliminate some of the surfable waves at certain locations in Hawaiʻi, including those in Waikīkī. A recent study found that 16% of surf sites in California would be eliminated with 3 ft of sea level rise and 18% would be threatened (Reineman et al., 2017).

8.3.6 Potential Impacts and Mitigation Measures

The proposed actions are anticipated to have a negligible impact on global, regional, or local sea level. Rather, the proposed actions are anticipated to have a positive impact by improving beach stability, improving lateral shoreline access, and providing a natural buffer to reduce the potential for wave overtopping and marine flooding.



Citation: Hawaiʻi Climate Change Mitigation and Adaptation Commission. 2021. State of Hawaiʻi Sea Level Rise Viewer. Version 1.04. Prepared by the Pacific Islands Ocean Observing System (PacIOOS) for the University of Hawaiʻi Sea Grant College Program and the State of Hawaiʻi Department of Land and Natural Resources, Office of Conservation and Coastal Lands, with funding from National Oceanic and Atmospheric Administration Office for Coastal Management Award No. NA16NOS4730016 and under the State of Hawaiʻi Department of Land and Natural Resources Contract No. 64064. http://hawaiisealevelriseviewer.org. Accessed [April 24, 2021].

Figure 8-23 Projected passive flooding with 3.2 ft of sea level rise

Citation: Hawaiʻi Climate Change Mitigation and Adaptation Commission. 2021. State of Hawaiʻi Sea Level Rise Viewer. Version 1.04. Prepared by the Pacific Islands Ocean Observing System (PacIOOS) for the University of Hawaiʻi Sea Grant College Program and the State of Hawaiʻi Department of Land and Natural Resources, Office of Conservation and Coastal Lands, with funding from National Oceanic and Atmospheric Administration Office for Coastal Management Award No. NA16NOS4730016 and under the State of Hawaiʻi Department of Land and Natural Resources Contract No. 64064. http://hawaiisealevelriseviewer.org. Accessed [April 24, 2021].

Figure 8-24 Projected annual high wave flooding with 3.2 ft of sea level rise

Citation: Hawaiʻi Climate Change Mitigation and Adaptation Commission. 2021. State of Hawaiʻi Sea Level Rise Viewer. Version 1.04. Prepared by the Pacific Islands Ocean Observing System (PacIOOS) for the University of Hawaiʻi Sea Grant College Program and the State of Hawaiʻi Department of Land and Natural Resources, Office of Conservation and Coastal Lands, with funding from National Oceanic and Atmospheric Administration Office for Coastal Management Award No. NA16NOS4730016 and under the State of Hawaiʻi Department of Land and Natural Resources Contract No. 64064. http://hawaiisealevelriseviewer.org. Accessed [April 24, 2021].

Figure 8-25 Projected coastal erosion with 3.2 ft of sea level rise

Citation: Hawaiʻi Climate Change Mitigation and Adaptation Commission. 2021. State of Hawaiʻi Sea Level Rise Viewer. Version 1.04. Prepared by the Pacific Islands Ocean Observing System (PacIOOS) for the University of Hawaiʻi Sea Grant College Program and the State of Hawaiʻi Department of Land and Natural Resources, Office of Conservation and Coastal Lands, with funding from National Oceanic and Atmospheric Administration Office for Coastal Management Award No. NA16NOS4730016 and under the State of Hawaiʻi Department of Land and Natural Resources Contract No. 64064. http://hawaiisealevelriseviewer.org. Accessed [April

Figure 8-26 Projected Sea Level Rise Exposure Area (SLR-XA) with 3.2 ft of sea level rise

8.4 Coastal Hazards

8.4.1 Coastal Flooding

Flood hazards for the project area are depicted on Flood Insurance Rate Map (FIRM) 15003C0370F. That map indicates that there are moderate threats of flooding from streams, but that the shoreline is exposed to flooding caused by storm waves and tsunami. The area makai (seaward) of the shoreline is the VE Zone with a Base Flood Elevation (BFE) of +11 to +12 ft MSL. The area immediately mauka (landward) of the shoreline is in Zone AE with a BFE of +7 to +8 ft MSL.

During extreme high tides (often referred to as *king tides*), the still water level can exceed an elevation of as much as +3 ft MLLW in Honolulu. Some of the highest tides of the year overlap with the prevailing occurrence of south swell during the summer months, which leaves shoreline property in Waikīkī vulnerable to flooding. Elevated water levels associated with El Niño, king tides, and sea level rise allow more wave energy to pass over the reef and reach the shoreline. This results in higher wave runup and overtopping of the beaches that can result in flooding of the backshore. Previous studies of the Waikīkī area have examined wave runup and inundation for annual return period waves and for a worst-case direct hit hurricane scenario.

8.4.2 Storm Waves

The wave regime along the project area shoreline is discussed in considerable detail in Section 8.2. Fletcher et al. 2002 rates the threat from high waves along the Waikīkī shoreline as moderate to high because this region regularly receives nearshore breaking wave heights on the order of 6 ft from south swell. Severe tropical storms and hurricanes have the potential to generate extremally large waves, which in turn can generate large waves and high water levels in Waikīkī. Recent hurricanes that impacted the south shore of Oʻahu include Hurricane Iwa (1982) and Hurricane Iniki (1992). Although not frequent events, they should be considered in coastal management and engineering design. Climate change and ocean warming may increase the likelihood of hurricane events in the Hawaiian Islands (Murakami et.al., 2017).

8.4.3 Tsunami

Tsunamis are sea waves that result from large-scale displacements of the seafloor. They are most commonly caused by earthquakes (magnitude 7.0 or greater) that occur adjacent to or under the ocean. If the earthquake involves a large segment of land that displaces a large volume of water, the water will travel outwards in a series of waves, each of which extends from the ocean surface to the seafloor where the earthquake originated. Tsunami waves are only a foot or so high at sea but can have wavelengths of hundreds of miles and travel at 500 mph. As they approach shore, the waves slow down as they begin to feel bottom, increase significantly in height, and push inland at considerable speed. The water then recedes, also at considerable speed, and the recession often causes as much damage as the original wave front itself.

Most tsunamis in Hawaiʻi originate from the tectonically active areas located around the Pacific Rim (e.g., Japan, Alaska, and Chile). Waves originating from earthquakes in these areas take hours to reach Hawaiʻi, and the network of sensors that is part of the U.S. Tsunami Warning System in the Pacific can give Hawaiʻi several hours advance warning of tsunami from these locations. Less commonly, tsunamis originate from seismic activity in the Hawaiian Islands. These events occur with little or no advance warning. For example, the 1975 Halapē earthquake (magnitude 7.2) produced a wave that reached Oʻahu in less than 30 min.

Fletcher et al. (2002) reported that 10 of the 26 tsunamis with flood elevations greater than 3.3 ft that have made landfall in the Hawaiian Islands during recorded history have had “significant damaging effects on Oʻahu”. This means that, on average, one damaging tsunami reaches Oʻahu every 19 years. The recent record (1946 to the present) has seen four tsunami cause damage on Oʻahu, a rate that is very close to the longer-term average. Fletcher et al. (2002) also noted that, while observations of tsunami flooding have not exceeded 8 ft along the south shore of Oʻahu, much of the Waikīkī shoreline is below that elevation.

8.4.4 Potential Impacts and Mitigation Measures

The proposed beach improvement and maintenance actions are intended to reduce exposure to wave overtopping and flooding by increasing dry beach width and volume, which will provide a protective buffer between the ocean and the existing backshore infrastructure. This will increase the wave energy dissipating properties of the beaches and decrease the landward extent of wave runup, reducing the vulnerability of the backshore flooding to marine flooding. The proposed actions are anticipated to have a negligible impact on hurricane and tsunami hazards for the Waikīkī area. Damage from hurricanes and tsunamis depends on the height of the water level rise relative to the backshore elevation, neither of which will be affected by the proposed actions.

8.5 Coastal Processes

Waikīkī is a predominantly engineered shoreline, and the beach is composed almost entirely of imported sand. Almost the entire length of Waikīkī is armored by seawalls, many of which are in various states of disrepair. The beaches of Waikīkī are primarily man-made and are largely dependent upon the presence of groins that stabilize the sand. The groins compartmentalize the Waikīkī shoreline into discrete units that are semi-contained with limited sediment transport between adjacent sectors. For the purposes of this DPEIS, the Waikīkī shoreline is divided into eight discrete *beach sectors* that have unique physical characteristics.

The *beach sectors* are similar to *littoral cells*, which are defined as “a coastal compartment that contains a complete cycle of sedimentation including sources, transport paths, and sinks” (Inman, 2005). The cell boundaries delineate the geographical area within which the budget of sediment is balanced, providing the framework for the quantitative analysis of coastal erosion and accretion. The sediment sources are commonly streams, sea cliff erosion, onshore migration of sand banks, and material of biological origin such as shells, coral fragments, and skeletons of small marine organisms”.

The natural shoreline of Waikīkī pre-development consisted of a combination of pocket beaches, streams, and wetlands. It is possible that Mamala Bay was originally a single littoral cell, bounded on the east by Diamond Head, and on the west by Kalaeloa (Barbers Point). The shoreline of Waikīkī has been engineered and modified over the course of the past century, when streams were diverted, wetlands were filled, shoreline structures (e.g., seawalls, storm drains, groins, and breakwaters) were constructed, and sand beaches were built. The present-day shoreline of Waikīkī is compartmentalized by engineered structures, many of which were constructed with the specific intent of stabilizing the beaches. For the purposes of this DPEIS, these compartments are referred to as *beach sectors*.

The primary coastal processes that affect beaches in Waikīkī are waves, tides, and currents. As deepwater waves approach the shoreline, they begin to transform due to the effects of shoaling, bottom friction, refraction, and diffraction. As waves shoal, heights increase and the wave crests steepen to the point that the waves become unstable, leading to breaking and dissipation of wave energy. Wave energy is also attenuated due to bottom friction. The approach direction can change as the wave front refracts or becomes oriented parallel to the existing bathymetric contours. Diffraction, the lateral spreading of wave energy, can occur behind natural or man-made barriers.

Offshore tidal driven currents in Waikīkī generally flow toward the north-northwest during rising tides and south-southwest during falling tides, generally flowing parallel with the bottom contours (Noda, 1991). Currents inshore of the 30-ft bottom contour are weaker than the currents further offshore with typical velocities of 0.15 to 0.50 ft/sec (0.1 to 0.3 knots). Wind speed and direction influences the surface currents (upper 3 ft), creating eddies when opposed to the tidal flow and enhancing it when blowing in the same direction.

Wave-induced currents predominate inside the breaker zone, generating both longshore (shore parallel) and cross-shore (rip) currents, which are a primary driver of sediment transport, along with suspension and transport from the swash zone and beach face. From Gerritsen (1978): “In agreement with the dominant directions of the incoming waves, the longshore currents inside the surf zone flow from southeast to northwest most of the time. The wave-induced longshore current is a major cause for the direction and magnitude of the littoral sediment transport. Along Waikīkī Beach the littoral drift is therefore mostly in the westerly direction”.

Accumulations of sand on the updrift (east) side of the existing structures (i.e., Queen’s surf groin, Kapahulu storm drain/groin, Royal Hawaiian groin, Fort DeRussy outfall/groin, Hilton pier/groin) are indications of a predominantly westerly littoral drift. Occasionally waves from opposite directions cause a reversal of the littoral drift pattern. During high wave conditions a cross-shore (rip) current typically forms fronting the Royal Hawaiian Hotel, with current speeds sufficient to transport sand offshore. The result of this can be seen as a shoal or sandbar forms immediately offshore, which is popular with beach users. This sandbar appears to be most pronounced during the Spring when a bimodal swell direction is most dominant (Habel et al. 2016). A cross-shore (rip) current is also typical in the deeper channel fronting the Outrigger Waikīkī Beach Resort and the Moana Surfrider Hotel, which is used by beach catamarans.

8.5.1 Fort DeRussy Beach Sector

The Fort DeRussy beach sector spans approximately 1,680 ft of shoreline that extends from the Hilton pier/groin east to the Fort DeRussy outfall/groin. Modifications to the Fort DeRussy beach sector began in the early 1900s with dredging and seawall construction extending to the present location of the Sheraton Waikiki Hotel.

The Fort DeRussy beach sector is an entirely engineered shoreline. The west end of the beach sector is bounded by a rock rubblemound groin that is buried in the beach and connects to the Hilton pier. The central portion of the beach sector consists of a man-made beach that is backed by a concrete seawall that was constructed in 1916 and spans the entire length of the shoreline. The east end of the beach sector is bounded by the Fort DeRussy outfall/groin, which consists of a concrete box culvert and a rock rubblemound groin.

The existing shoreline is a man-made sandy beach that is composed of a combination of sand and coral that was dredged from offshore. The beach is widest at the west end and narrowest at the east end. At the west end of the beach, adjacent to the Hilton pier/groin, the sand is compacted and hardened over much of the dry beach area. On the eastern portion of the sector is a narrow sandy beach with steeper slopes.

The nearshore reef extends up to about 1,300 ft from the shoreline. Several popular surf sites, including *Kaisers* and *Fours*, are located along the outer edge of the reef. The waves patterns produced as waves propagate over the reef are shown in Figure 8-27. The waves from the *Kaisers* surf site have an arc shape that is maintained to the shoreline. The waves passing through the rest of the sector are slightly concave, while some waves also propagate from the Halekūlani beach sector to Fort DeRussy beach. These waves interact to produce the convergence and divergence patterns shown in Figure 8-27. The most significant area of divergence is on the west side of the Fort DeRussy outfall/groin where the beach has eroded back to the seawall and walkway in front of the U.S. Army Museum of Hawaiʻi.

White arrows show wave direction
Black arrows show direction of sand transport

Image Date: May 24, 2019
Image Source: Google Earth

Figure 8-27 Wave model output for prevailing SSW swell – Fort DeRussy beach sector

8.5.2 Halekūlani Beach Sector

The Halekūlani beach sector spans approximately 1,450 ft of shoreline extending from the Fort DeRussy outfall/groin east to the Royal Hawaiian groin. The shoreline consists of a combination of seawalls and pocket beaches. A narrow beach extends approximately 375 ft east from the Fort DeRussy outfall/groin and terminates at the west end of a vertical seawall that span approximately 335 ft of shoreline fronting the Halekūlani Hotel. Two small pocket beaches, backed by vertical seawalls, are located between the Halekūlani and Sheraton Waikiki hotels. The adjacent pocket beaches span approximately 225 ft of shoreline. The pocket beaches terminate at the west end of a vertical seawall that spans approximately 500 ft of shoreline fronting the Sheraton Waikiki Hotel. The seawall continues east and terminates at the Royal Hawaiian groin, which marks the east boundary of the Halekūlani beach sector.

The nearshore is characterized by a wide and shallow reef containing a relict stream bed, referred to as the Halekūlani Channel. The nearshore reef is more than 1,500 ft wide with typical water depths of 5 ft or less over the reef. Waves break on the reef at several notable surf sites including *Threes*, *Populars*, and *Fours*, then propagate to shore, producing wave patterns with low energy waves crossing throughout the sector. These complex wave patterns are shown in Figure 8-28. The reef edges and channel also cause wave refraction. The pocket beaches are produced by wave convergence, while eroded areas fronting the seawalls are areas of wave divergence. Wave modeling and aerial imagery indicate that the eroded areas fronting the Halekūlani and Sheraton Waikiki hotels are a byproduct of the nearshore bathymetry and subsequent wave patterns. The seawalls were built in response to the erosion, rather than being the cause of the erosion.

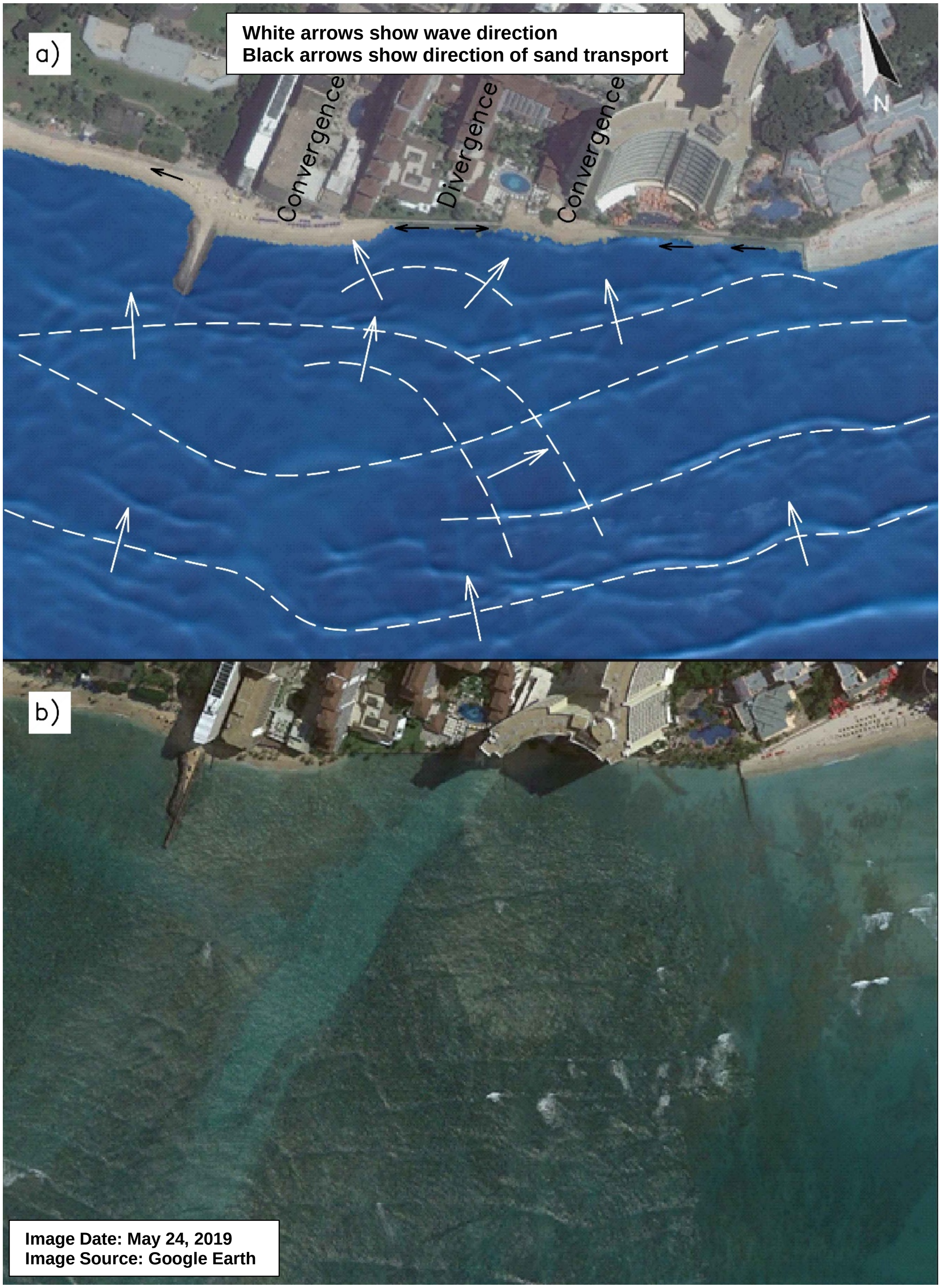


Figure 8-28 Wave model output for prevailing SSW swell - Halekūlani Beach Sector

8.5.3 Royal Hawaiian Beach Sector

The Royal Hawaiian beach sector contains a 1,730-foot-long beach between Kūhiō Beach Park and the Royal Hawaiian groin. This sector is exposed to waves that are transformed as they pass over the nearshore reef, and these waves shape the shoreline. The Kūhiō Sandbag Groin was constructed in November 2019, approximately 140 ft west of the ʻEwa (west) groin at Kūhiō Beach Park, to stabilize the east end of Royal Hawaiian Beach. The Royal Hawaiian groin was replaced in 2020 and stabilizes the west end of Royal Hawaiian Beach.

Royal Hawaiian Beach is highly dynamic as a result of the complex wave field. Waves approaching the central part of the sector propagate to shore, passing between the *Canoes* surf site and the Royal Hawaiian sandbar. The waves are slightly arc shaped, creating a concave beach shape and somewhat of a divergence point fronting the Outrigger Waikīkī Beach Resort. From here, sand moves east and west in reaction to the wave crest shape.

The west end of the beach is stabilized by the Royal Hawaiian groin, which supports sand that is transported from east to west. The groin also blocks waves approaching from the west that would otherwise move sand away from the groin in the easterly direction. This situation was more prevalent in the past prior to reconstruction of the groin in 2020. Waves from the *Populars* surf site approach obliquely from the southwest and impact the beach.

The west end of the beach and the Royal Hawaiian sandbar are shaped by the central waves and the waves that propagate into the Royal Hawaiian beach sector from the Halekūlani beach sector. These waves work in conjunction to form the Royal Hawaiian sandbar and produce a slight bulge along the shoreline inshore of the sandbar. A bimodal wave direction spectrum (e.g., waves approaching from the southwest and southeast at the same time) can produce the same results.

The east end of the beach bordering Kūhiō Beach Park has been highly dynamic following the 2012 Waikīkī Maintenance I project (Habel et al., 2016). Waves approaching from the *Queens* and *Baby Queens* surf site propagate to shore at an angle toward the west, moving sand away from the ʻEwa (west) groin at Kūhiō Beach Park. This has resulted in chronic erosion, beach narrowing, and damage to the groin. The waves from the central part of the beach sector refract and diffract toward Kūhiō Beach where they interact with the waves from *Queens* and *Baby Queens*. The wave from *Canoes* transports sand toward Kūhiō Beach, while the wave from *Queens*, which has a distinct arc shape, travels along the ʻEwa (west) groin stem and transports sand to the east, exposing the foundation wall of the old Waikīkī Tavern.

Each of these waves that intersect near the Kūhiō Sandbag Groin begins with the same offshore wave and, depending on the offshore wave direction, the inshore waves can have different relative effects. These two waves converge in the area shown on Figure 8-29 and Figure 8-30. The location of this convergence shifts slightly to the east or west, depending on the wave conditions at the time. The relative wave energy compared to the *Queens* wave dictates if sand moves toward the Ewa (west) groin or away from it.

The optimal location for the Kūhiō Sandbag Groin is in the zone where these two waves converge. There is no single correct location for the groin, as the wave convergence point varies. With this in mind, the Kūhiō Sandbag Groin was designed and constructed within that convergence zone. Habel et al. (2016) observed the seasonality of the sand movement in this area. During periods of strong westerly waves, sand moves east toward the ʻEwa (west) groin. During periods of south or southeast waves, or when tradewind wrap dominates, sand is transported to the west, away from the ʻEwa (west) groin (Figure 8-31). While the Kūhiō Sandbag Groin helped to retain sand, the wave angle propagating along the ʻEwa (west) groin was unchanged. A recessed head on the ʻEwa (west) groin to diffract the incident waves and accrete sand against the groin is discussed in Section 7.3.

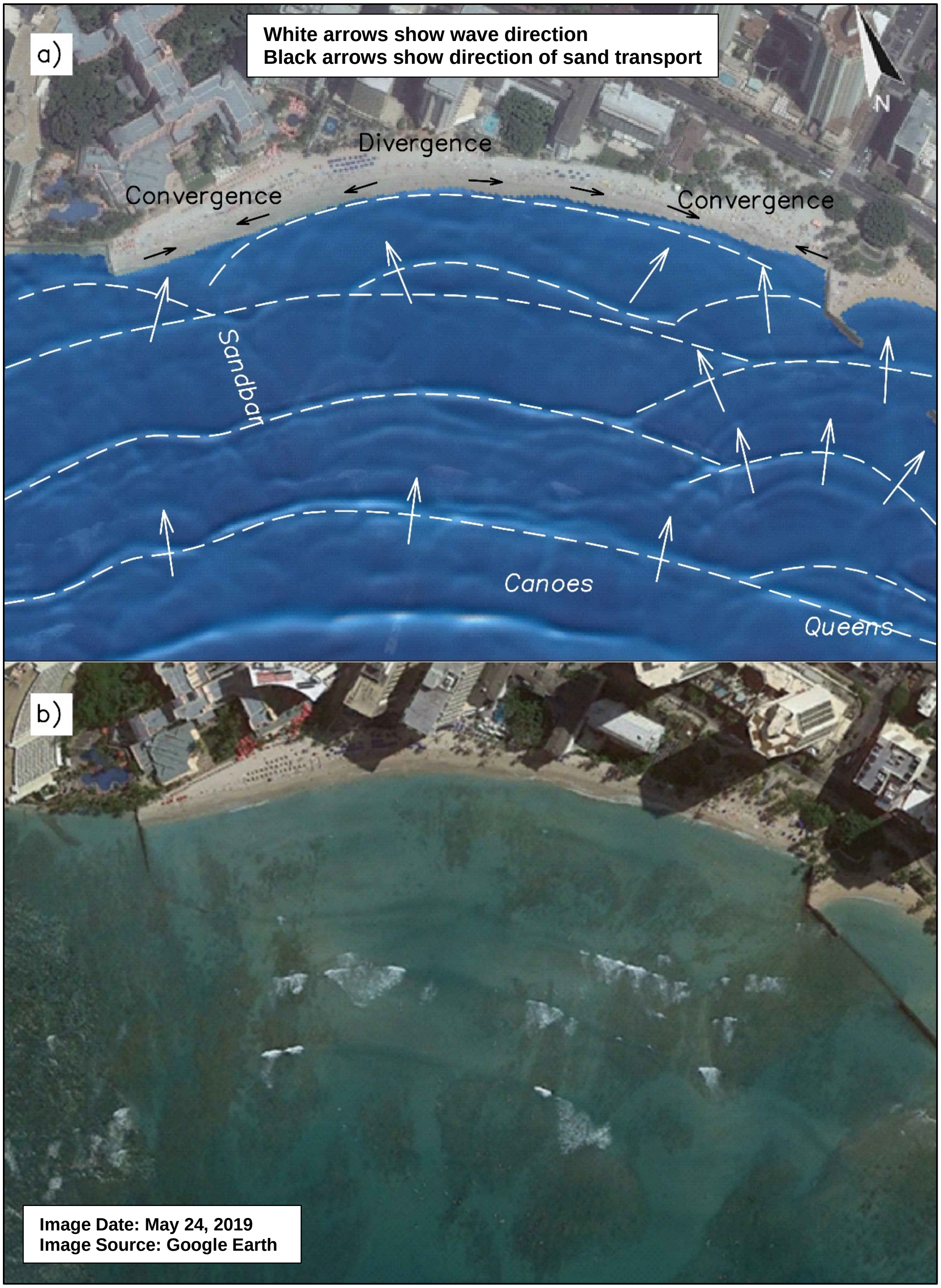


Figure 8-29 Wave model output for prevailing SSW swell - Royal Hawaiian beach sector


Image Date: August 9, 2014
Image Source: Google Earth

Figure 8-30 Converging wave patterns at east end of Royal Hawaiian beach sector


Image Date: March 12, 2014
Image Source: Google Earth

Figure 8-31 Wave patterns during strong tradewinds in the Royal Hawaiian beach sector

8.5.4 Kūhiō Beach Sector

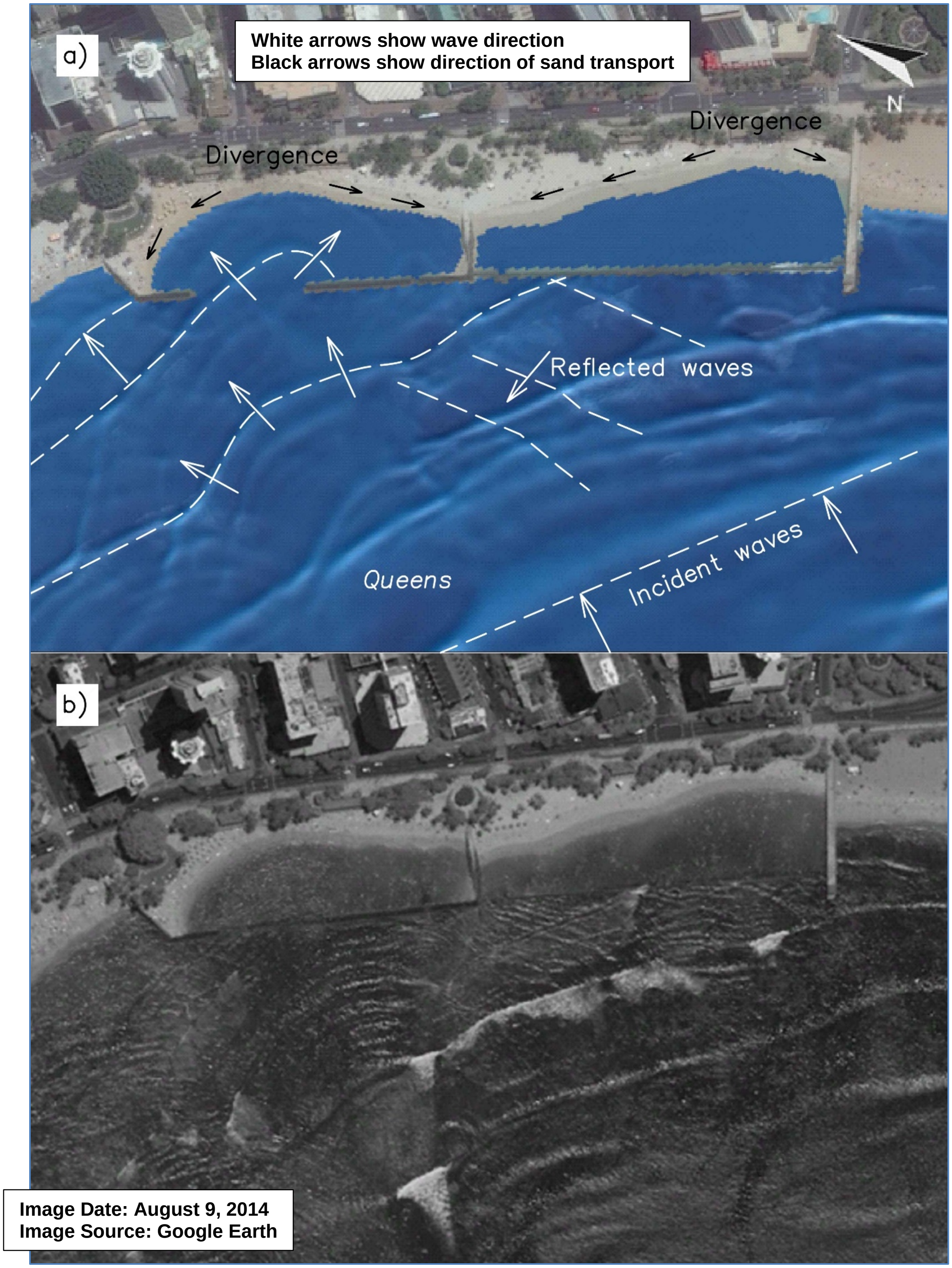
The Kūhiō beach sector is divided into two sub-sectors: the ʻEwa (west) basin and the Diamond Head (east) basin of Kūhiō Beach Park. The natural shoreline through this area was once a narrow beach with a stream mouth near the center of the park (Clark, 2021). Construction of Kalākaua Avenue (originally Waikīkī Avenue) prompted a series of attempts to stabilize the shoreline and provide a recreational amenity.

The ʻEwa (west) basin is bounded by two offshore breakwaters with a gap in between to allow some wave energy into the basin. Waves passing through the gap diffract, producing an arc-shaped shoreline. The incident wave angle increases progressively from east to west along the breakwaters and is as much as about 35 deg at the center of the basin. Additionally, the *Queens* surf site produces arc-shaped waves that propagate through slightly deeper water leading to the gap in the breakwaters. These waves enter the basin with enough energy to erode the shoreline opposite the gap. This area often has little or no dry beach at high tide.

The Diamond Head (east) basin is enclosed by a low, straight breakwater along the makai (seaward) edge of the basin. Two small openings in the breakwater allow some exchange of ocean water but the basin is otherwise enclosed. The breakwaters are aligned parallel to Kalākaua Avenue, rather than the incident waves; thus, waves approach the basin with angles of up to about 20 deg as shown in Figure 8-32. Enough wave energy is transmitted over the breakwater at higher water levels that waves can propagate to shore with enough energy to transport sand to the northwest. While this is a relatively slow process, the incremental movement of sand results in beach narrowing along the eastern portion of the basin.

Gravity also moves sand from the beach face into the basin waters due to the lack of sufficient energy to support a stable beach profile. The transmitted waves lack sufficient energy to transport sand back up the beach face. As the beach migrates makai (seaward), the beach profile flattens, and water depths inside the basin become shallower. This process has resulted in the accumulation of a significant volume of sand within the basin and a noticeable shallowing of the water depths.

Compared to the other beach sectors, the Kūhiō beach sector is less susceptible to variations in the wave climate that can alter sediment transport patterns. The existing structures limit the effect of winter wave conditions, including large westerly swells and southwesterly (Kona) wind swells, which can result in significant easterly transport of sand in the other sectors.



White arrows show wave direction
Black arrows show direction of sand transport

Image Date: August 9, 2014
Image Source: Google Earth

Figure 8-32 Wave model output for prevailing SSW swell - Kūhiō beach sector

8.5.5 Potential Impacts and Mitigation Measures

The proposed beach maintenance actions in the Fort DeRussy and Royal Hawaiian beach sectors, and the Diamond Head (east) basin of the Kūhiō beach sector, are not anticipated to significantly alter or affect presently ongoing sediment transport, wave-driven currents, circulation patterns, or offshore wave breaking. The proposed actions are intended to increase dry beach width and produce a more linear beach planform. Sediment (sand) within these beach sectors will be subject to the same coastal processes that exist under the current conditions.

The proposed beach improvement action in the Halekūlani beach sector is anticipated to alter or affect presently existing sediment transport, wave-driven currents, and circulation patterns. The proposed groins will inhibit longshore sediment transport and alter wave-driven currents and circulation patterns within the beach cells between the groins. Existing current velocities within the project footprint are relatively weak, therefore the proposed action is not anticipated to significantly alter wave-driven currents and circulation patterns in the vicinity of the groins. The proposed groins will provide superior stability for the beach, and the sand fill will mitigate the reflection of wave energy from the existing seawalls. The groins heads will help prevent the formation of cross-shore (rip) currents along the groin stems, minimizing the loss of sand due to cross-shore sediment transport. The groins will terminate well inshore of the offshore surf breaks and are not anticipated to alter the bathymetry or wave formation characteristics of the surrounding seafloor.

The proposed beach improvement action in the ʻEwa (west) basin of the Kūhiō beach sector is anticipated to alter or affect existing sediment transport and wave-driven currents. The proposed groin and breakwater system is designed to alter existing wave patterns within the basin to maintain a more stable, arc-shaped beach profile. Existing current velocities within the basin are relatively weak, therefore the proposed action is not anticipated to significantly alter wave-driven currents and circulation patterns within the basin. The groins and breakwater system will not alter the bathymetry or wave formation characteristics of the seafloor outside of the basin.

8.6 Bathymetry

Waikīkī is located on the south shore of Oʻahu, west of Diamond Head, along a pronounced embayment in the shoreline (Māmala Bay). This embayment is evident in the 18-ft depth contour, located approximately 0.5 mi offshore (Figure 8-33). Seaward of this, contours become straighter and bottom slope increases. A fringing fossil reef intersected by several relict stream channels extends approximately 1 mi offshore. The shoreline is fronted by a shallow fossil limestone reef including channels and pockets filled with sand. This extends approximately 1,500 ft offshore, with depths generally 5 ft or less. Seaward of the surf zone (approximate 10-ft depth), to a depth of 40 ft, the average bottom slope is very gradual, 1V:100H (vertical to horizontal). Between the 40 and 60-ft depth contours, bottom slopes increase to 1V:50H and further increase seaward of the 60-ft contour to 1V:15H. The nearshore bathymetry in Waikīkī is very complicated, with shallow fossil reef bisected by paleo stream channels. This results in complex nearshore wave patterns. Bathymetric maps for the four selected beach sectors are shown in Figure 8-34 through Figure 8-37.

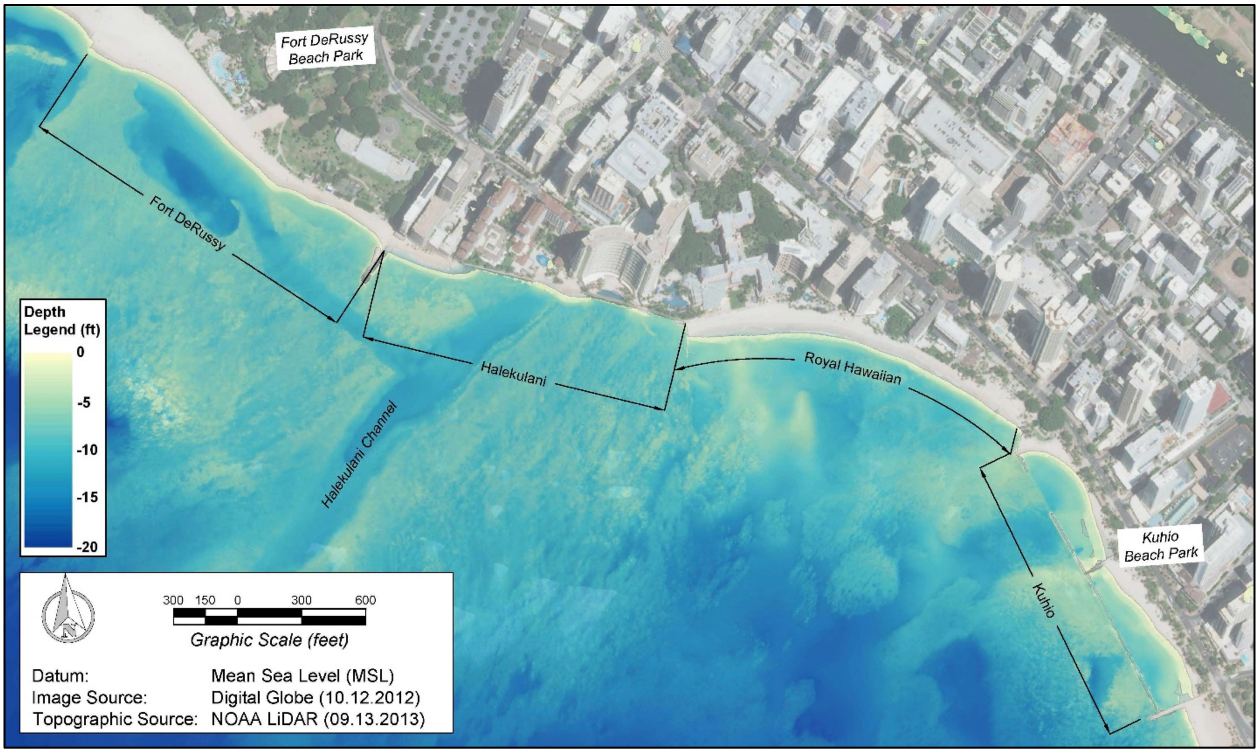


Figure 8-33 Bathymetric map of the project area

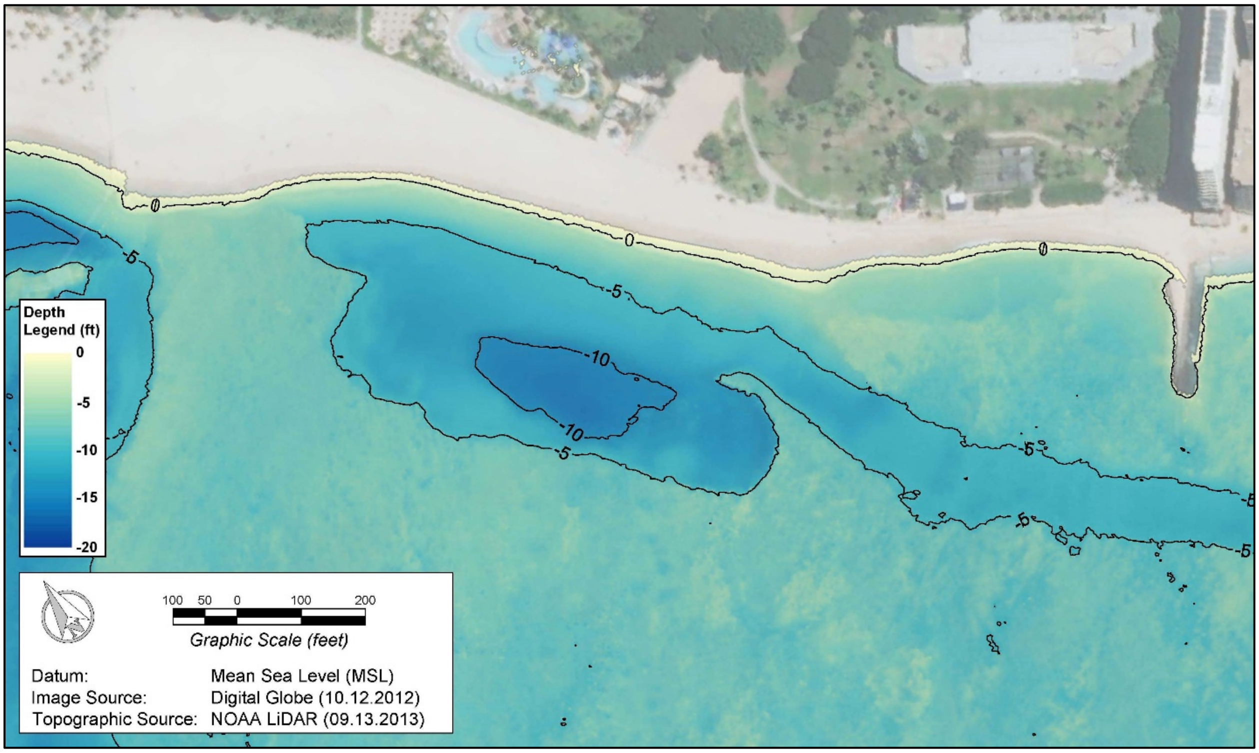


Figure 8-34 Bathymetric map – Fort DeRussy beach sector

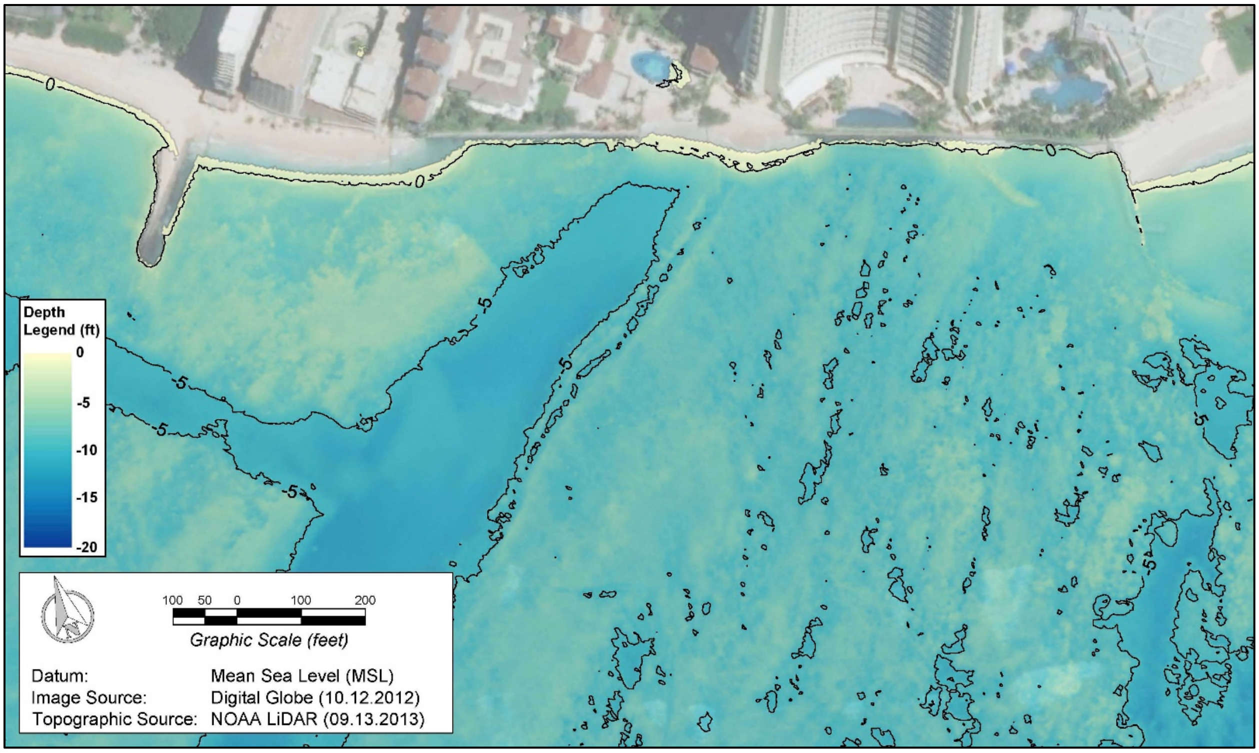


Figure 8-35 Bathymetric map – Halekūlani beach sector

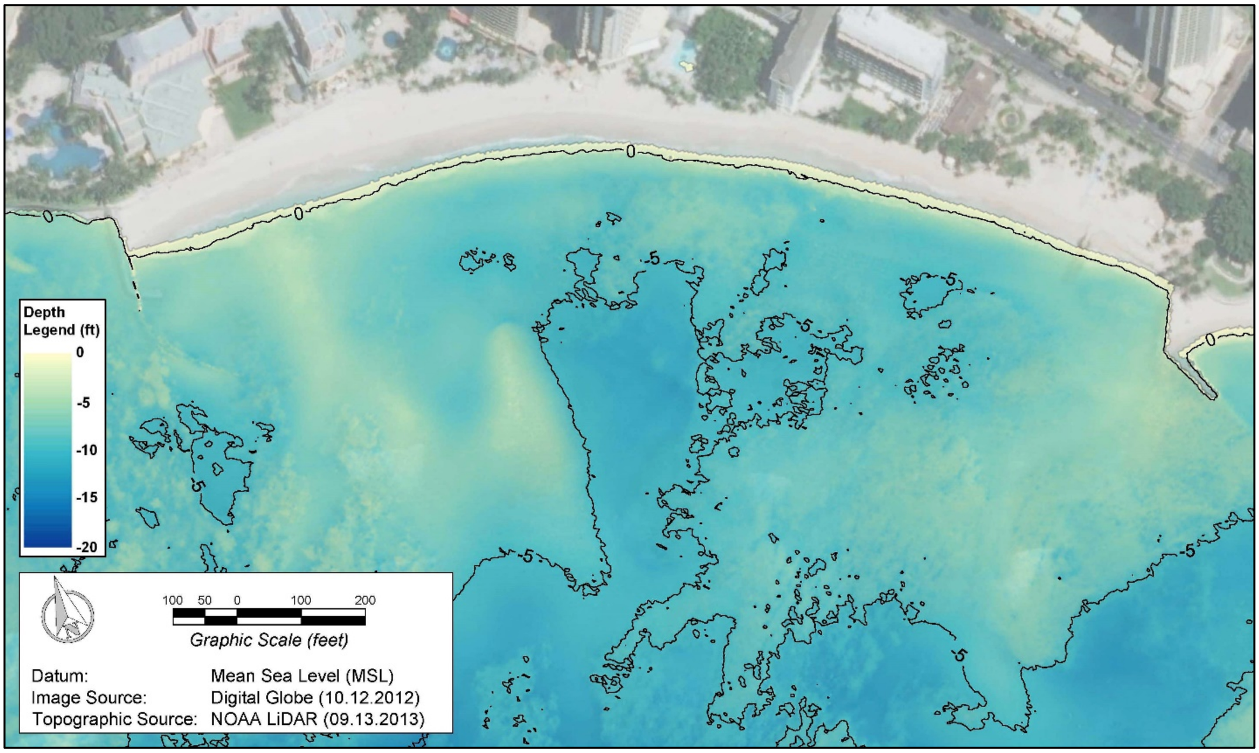


Figure 8-36 Bathymetric map – Royal Hawaiian beach sector

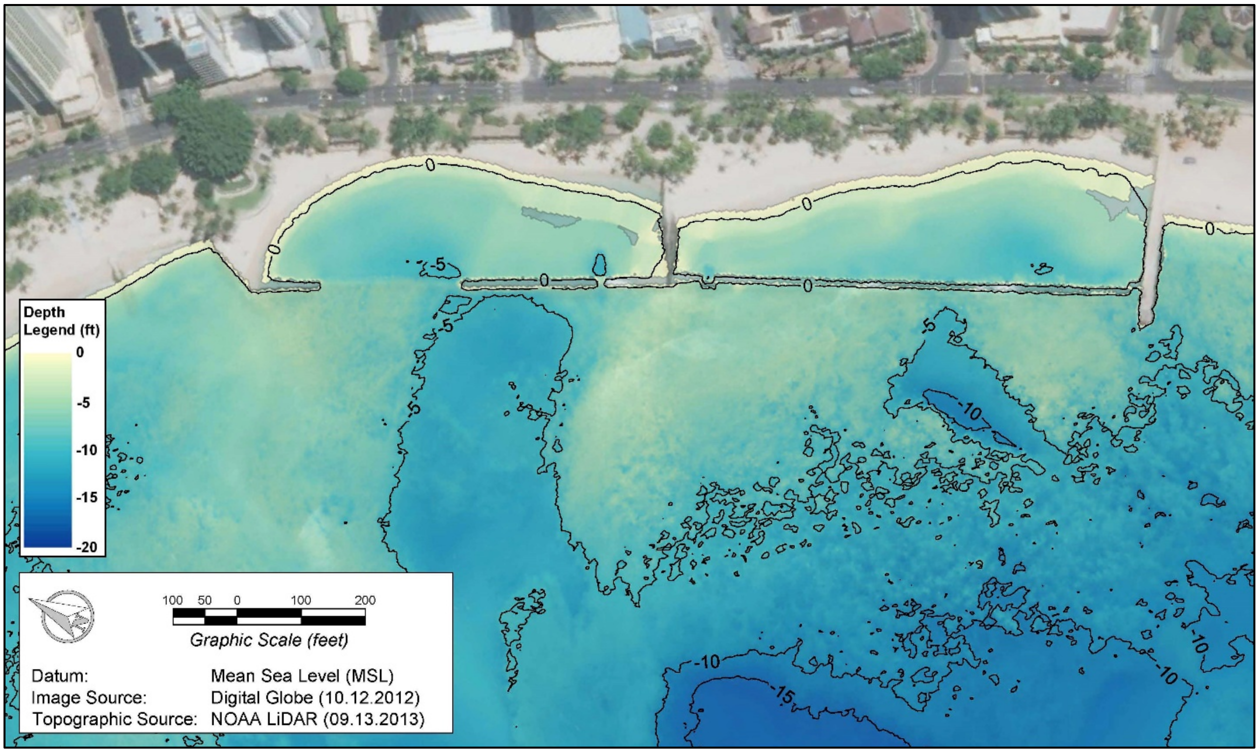


Figure 8-37 Bathymetric map – Kūhiō beach sector

8.6.1 Potential Impacts and Mitigation Measures

The proposed actions are anticipated to have a temporary impact on bathymetry and seafloor conditions and will alter the foreshore topography along Waikīkī Beach by increasing dry beach width and elevation compared to the existing shoreline configuration.

Nearshore sandbars, sand waves, and sand ripples are currently present in the natural beach system in Waikīkī. These sandy features develop, move across, and disappear on both sandy and hard seafloor substrates in the Waikīkī nearshore environment. Following sand placement, there will be a period of beach equilibration, during which the beach profile and nearshore water depths can be expected to vary as the beach adjusts to the prevailing wave conditions and the beach assumes its stable configuration. Chronic erosion would continue to affect the shoreline along portions of Waikīkī Beach, as would seasonal and episodic erosion and beach adjustment events due to natural variability.

Short-term Impacts

In-water construction impacts will be limited to the immediate areas of groin and breakwater construction. The new structural footprints will be carefully delineated, and no construction activities or in-water material storage will be permitted outside of these areas. Construction of the proposed groins and segmented breakwater will alter the bathymetry of the areas they cover. Construction will be in accordance with all necessary permits and approvals required for the proposed actions. Short-term changes in nearshore bathymetry and coastal processes are anticipated as the beaches equilibrate after sand placement.

Dredging of offshore sand deposits involves removing sand from the deposits, resulting in a lowering of the bottom elevation or alteration of the bathymetry. Dredging could occur at the *Ala Moana*, *Canoes/Queens*, or *Hilton* offshore sand deposits. Detailed wave modeling was conducted to evaluate potential impacts to bathymetry and wave formation at the offshore sand recovery areas (see Sections 8.2.2 and 9.4.6). Based on the results of the wave modeling and dredge analysis, no significant impacts to bathymetry are anticipated.

The modeling results show that the sand borrow pit at the *Ala Moana* offshore sand deposit causes decreases in wave heights of less than 1 in at the *Courts* surf site. For the BOUSS-2D model, the breaking wave height at *Courts* decreased by 0.8 in, or 1.1%, due to the dredge pit, and for the SWAN model, the breaking wave height at *Courts* decreased by 0.5 in, or 1.0%, due to the sand borrow pit. Conversely, model output shows that the wave heights at the *Concessions* and *Baby Haleʻiwa* surf sites would be expected to increase by up to 1 in.

The modeling results show that the sand borrow pit at the *Hilton* offshore sand deposit causes an increase in significant wave heights of less than 2 in at the *Bowls* and *Kaisers* surf sites. Inspection of the wave patterns reveals no noticeable change in the structure of the wave. Other surf sites, including *Threes*, *Fours*, and *Populars*, are more than 1,000 ft to the southeast of the *Hilton* offshore sand deposit, therefore dredging is not anticipated to have any impacts to bathymetry or surfing waves at these locations.

The modeling results show that the sand borrow pit at the *Canoes/Queens* offshore sand deposit causes an increase in significant wave heights of about 1.8 in at the *Canoes* surf site and a decrease in significant wave heights of about 1.6 in at the *Queens* surf site. As a result, the proposed actions are not anticipated to have any significant impacts on surfing waves in these areas.

Long Term Impacts

The new beach stabilizing structures proposed in the Halekūlani and Kūhiō beach sectors are anticipated to significantly reduce chronic beach erosion rates in these areas. In addition to these natural phenomena, the beach sectors may also be impacted by large magnitude events such as strong Kona storms, hurricanes, tsunamis, extreme water level changes, sea level anomalies, and other oceanographic and atmospheric events. Any and all of these natural phenomena can alter the beach configuration, as the project area is located on an open ocean coastline that is exposed to a wide range of wave and water level events and coastal hazards.

Long term impacts to bathymetry and seafloor conditions will be limited to the actual footprints of the structures. The Halekūlani beach sector is bounded by the Royal Hawaiian groin and the Fort DeRussy outfall/groin. These structures form hard boundaries that limit interaction between the Halekūlani beach sector and the adjacent beach sectors. Constructing rock rubblemound groins will provide superior stability for the beach, and the sand fill will mitigate reflected wave energy from the existing seawalls. The groins heads will help prevent the formation of cross-shore (rip) currents along the groin stems, minimizing the loss of sand due to cross-shore sediment transport. The groins will terminate well inshore of the offshore surf breaks and are not anticipated to alter the bathymetry or wave formation characteristics of the surrounding seafloor.

8.7 Water Quality

The waters offshore of Waikīkī are classified in the Hawaiʻi Water Quality Standards as (a) marine waters, (b) open coastal, (c) reef flat, (d) Class A, and (e) Class II marine bottom ecosystem (DOH, 2012). It is the objective of Class A waters that their use for recreational purposes and aesthetic enjoyment be protected. Other uses are permitted as long as they are compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. Class A waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control.

State water quality criteria for open coastal marine waters incorporate “wet” and “dry” criteria values based on average percent of freshwater inflow, where terrestrial freshwater input exceeds three million gallons per day, wet criteria are applied, where freshwater input is less than three million gallons per day, dry criteria apply. In this case, dry criteria apply, based upon the salinity results that show no significant dilution from oceanic salinity (35.2 PSU) for this region of the Pacific (SOEST, 1996).

The Hawaiʻi Department of Health, Clean Water Branch (DOH-CWB), monitors nearshore water quality in Waikīkī, including Waikīkī Beach Center and Kūhiō Beach. These two areas have been listed as impaired water bodies, meaning they do not meet State of Hawaiʻi water quality standards, particularly during the wet season. Applicable State of Hawaiʻi water quality criteria for the proposed beach improvement and maintenance actions are shown in Table 8-11.

Table 8-11 State of Hawaiʻi water quality criteria (dry season) for open coastal marine waters

Parameter	Geometric Mean value not to exceed this value	Value not to be exceeded more than 10% of the time	Value not to be exceeded more than 2% of the time
Total Nitrogen (µg N/L)	110.0	180.0	350.0
Ammonia (µg N/L)	2.0	5.0	9.0
Nitrate+Nitrite (µg N/L)	3.5	10.0	20.0
Total Phosphorus (µg/L)	16.0	30.0	45.0
Chlorophyll α (µg/L)	0.15	0.50	1.00
Turbidity (NTU)	0.20	0.50	1.00

Other "standards":

- pH units shall not deviate more than 0.5 units from ambient and not lower than 7.0 nor
- higher than 8.6.
- Dissolved oxygen shall not decrease below 75% of saturation.
- Temperature shall not vary more than 1Co from ambient conditions.
- Salinity shall not vary more than 10% from ambient.

8.7.1 Potential Impacts and Mitigation Measures

The proposed actions are anticipated to have a temporary impact on water quality. Sand recovered from the ocean, though highly compatible with the existing dry beach sand, would still have some naturally occurring fine carbonate content that would be winnowed from the beach system and moved offshore during the initial equilibration process and beach erosion events.

Dredging, transport, and placement of carbonate sand can also increase the percent of fines through mechanical abrasion of the friable sand grains. Turbidity, or a reduction in water transparency, occurs when fine sediment particles are suspended in the water column. Turbidity can occur at the offshore sand dredging sites or along the beach where the offshore sand is placed.

Turbidity at Offshore Dredging Sites

Increased turbidity is anticipated at the offshore dredging sites during sand recovery operations. As the clamshell bucket recovers sand from the seafloor, it will disturb fine particles adjacent to the bucket. As the bucket is raised through the water column, minor volumes of sand containing fine particles would be released into the water column. Turbidity at the dredging sites will be reduced by using an environmental clamshell bucket, which is an industry-standard Best Management Practice that has been used to minimize turbidity during dredging of harbor channels in Hawaiʻi. Environmental clamshell buckets typically have tighter seals and overlapping sides. These buckets are designed to minimize sediment loss from within the bucket, resuspension at the dredging sites, and water entrainment with each grab. A conservative estimate of the amount of material that leaks from an environmental clamshell bucket is only 0.5% (Palermo et al., 2008). This material is expected to fall out of suspension rapidly near the dredging sites.

The use of a hydraulic suction dredge would result in the majority of bottom material disturbed being drawn into the dredge pipeline, with only a small amount of disturbed material escaping the dredge to potentially affect adjacent areas or water quality. Loss rates for hydraulic suction dredges have been estimated to be less than 0.1% (Hayes and Wu, 2001). Careful placement of anchors and cables would ensure that they do not move or disturb/suspend bottom material.

Turbidity generated from dredging operations is expected to be transported by currents moving parallel to shore. Wave action has the potential to transport turbidity inshore. These water quality impacts are expected to be temporary, occurring only during dredging operations, and are expected to be localized to the immediate vicinity of the dredging sites. Best Management Practices (BMPs) will be followed throughout the sand recovery operations, consistent with the requirements of the Hawaiʻi Department of Health Section 401 Water Quality Certification.

Turbidity at Sand Placement Sites

Beach nourishment projects can generate turbidity plumes that can be unsightly and affect water clarity. Although sand fill placed on a beach must closely match the existing beach sand with respect to grain size, offshore sand will typically have a higher percentage of fines than dry beach sand. Additionally, fines may be generated during dredging and placement of offshore sand onto the beach. After placement, wave action can suspend the fines creating milky-white turbidity plumes immediately offshore of the nourished beach. The turbidity decreases over time as fine material is winnowed out of the active beach face.

Turbidity containment barriers will be deployed along the shoreline during sand placement operations. Following placement of sand on the beach, there will likely be periodic turbidity associated with equilibration of the beach profile and planform and during large wave events, as sand moves alongshore and cross-shore.

Turbidity is a complex phenomenon that is dependent on both the optical and physical properties of suspended particles. To evaluate potential impacts, pre- and post-project conditions in Waikīkī were examined using available high elevation photographs, and laboratory turbidity analyses were conducted to compare the borrow sand and existing beach sand.

Laboratory Turbidity Analysis Results

Turbidity test results for sand samples obtained from *Ala Moana*, *Halekūlani Channel*, *Hilton*, *Reef Runway* (*RR Inner-1a*, *RR Inner-1b)*, and *Canoes/Queens* offshore deposits are plotted in Figure 8-38 through Figure 8-43. Data are plotted as turbidity versus time. The average value for each deposit is plotted in Figure 8-44 for comparison amongst the sand deposits. The turbidity results should not be considered indicative of turbidity levels that are to be expected during the actual beach nourishment because they result from artificial experiments in a small sample bottle. Rather, they are useful to evaluate differences between the existing beach sand and the potential borrow sand sources.

All samples tested showed initial turbidity that decreased exponentially with time. Samples from the *Canoes/Queens* offshore deposit had the lowest initial turbidity, which should be expected, since this is likely sand that had been recently transported and some of the fine material had already been winnowed out. The *Halekūlani Channel* offshore deposit had the second lowest turbidity; however, that was due to a very low value for one of the samples. That sample was obtained from the top of a core, so much of the fines may have been washed out. Sand from the other samples had significantly higher turbidity. The *Hilton* and *Ala Moana* offshore deposits had the highest initial turbidity values; however, the values decreased rapidly over the first 2 hrs. Even though the *Hilton* samples were the coarsest of the sites, three of the five samples had initial turbidity in excess of 1,000 NTU, while the other two were in excess of 850 NTU.

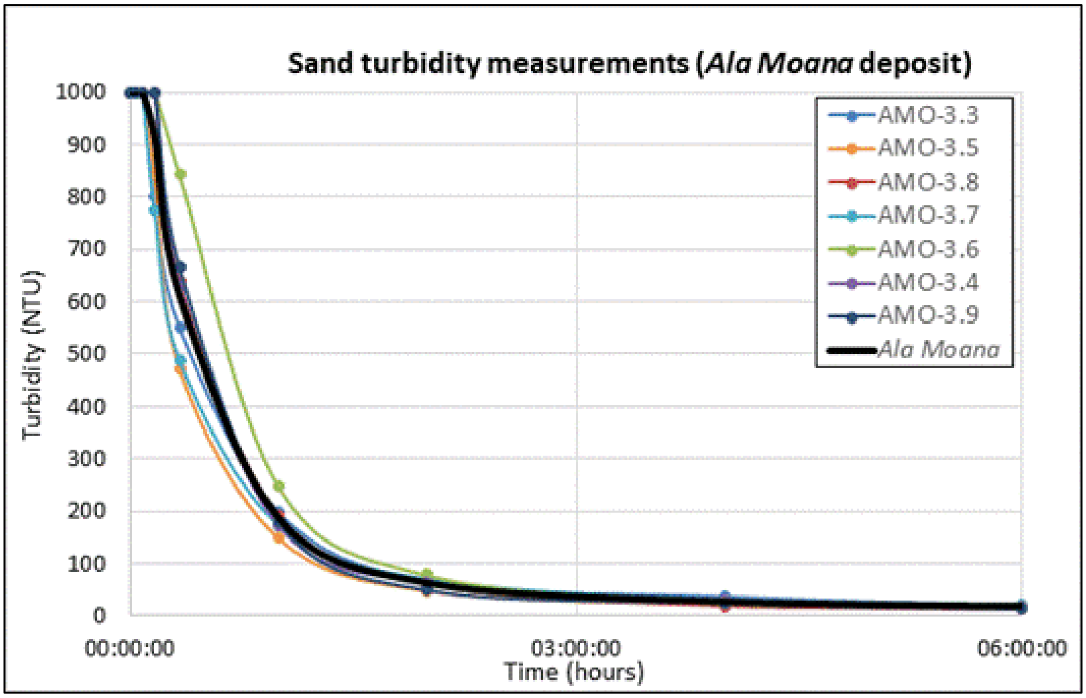


Figure 8-38 Turbidity results for *Ala Moana* offshore sand deposit

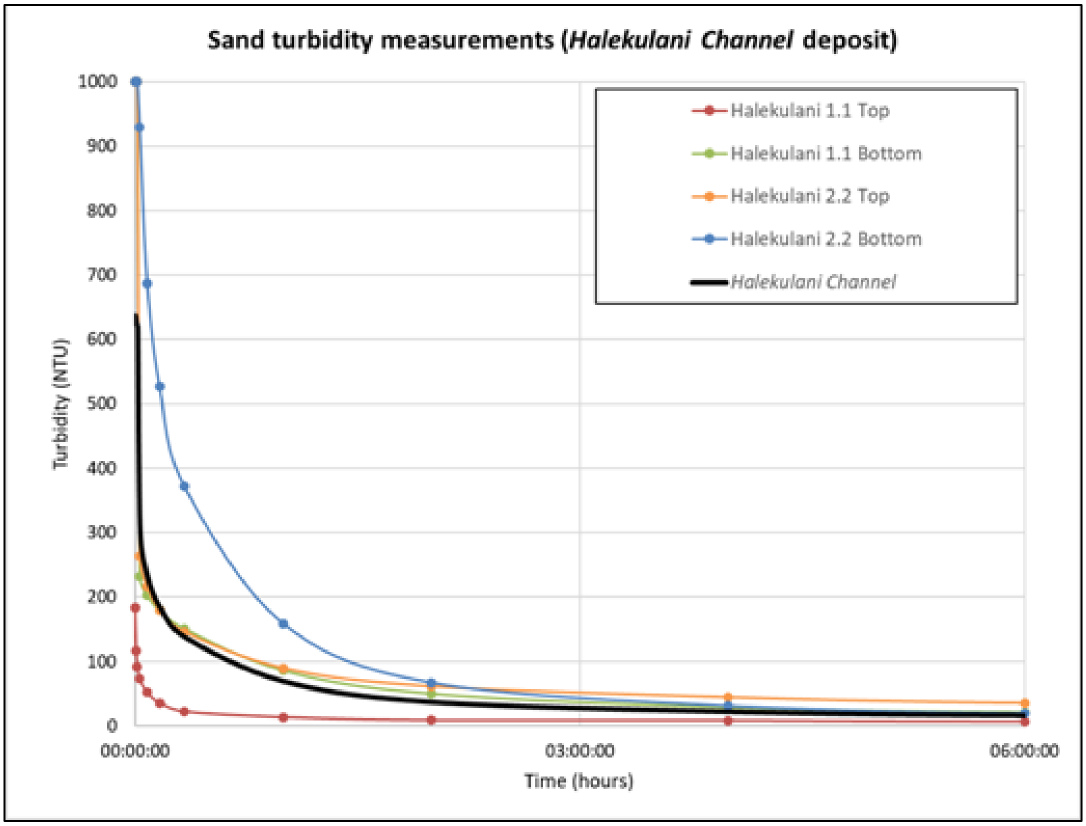


Figure 8-39 Turbidity results for *Halekūlani Channel* offshore sand deposit

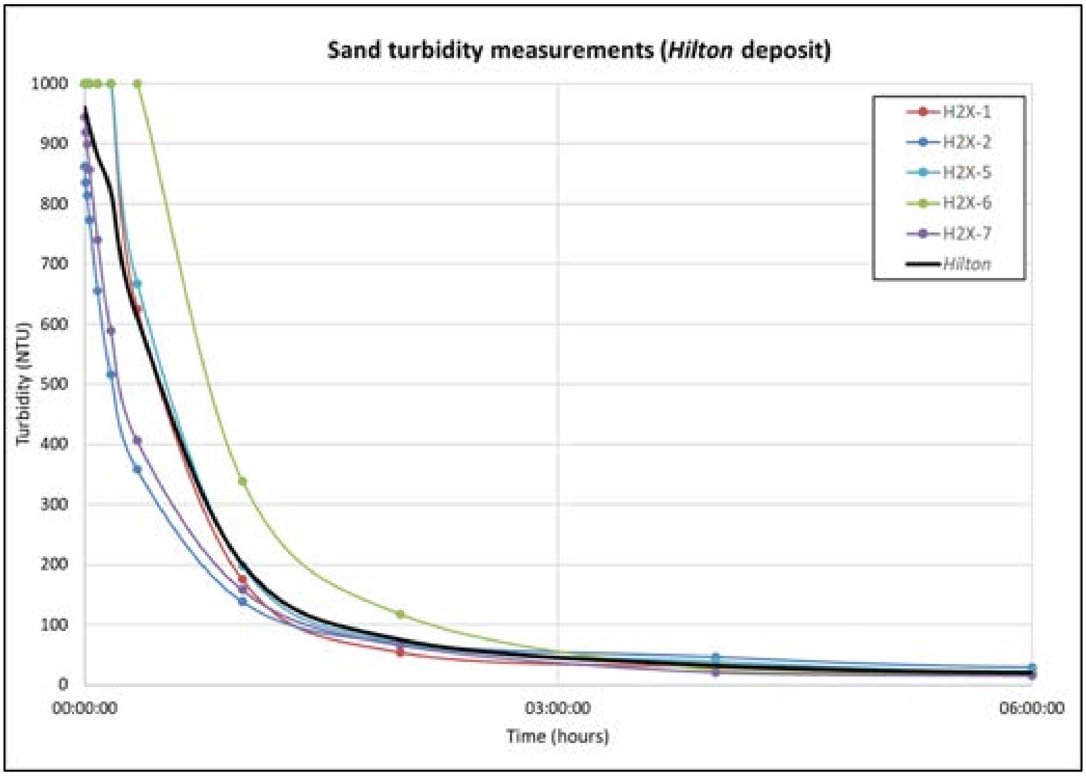


Figure 8-40 Turbidity results for *Hilton* offshore sand deposit

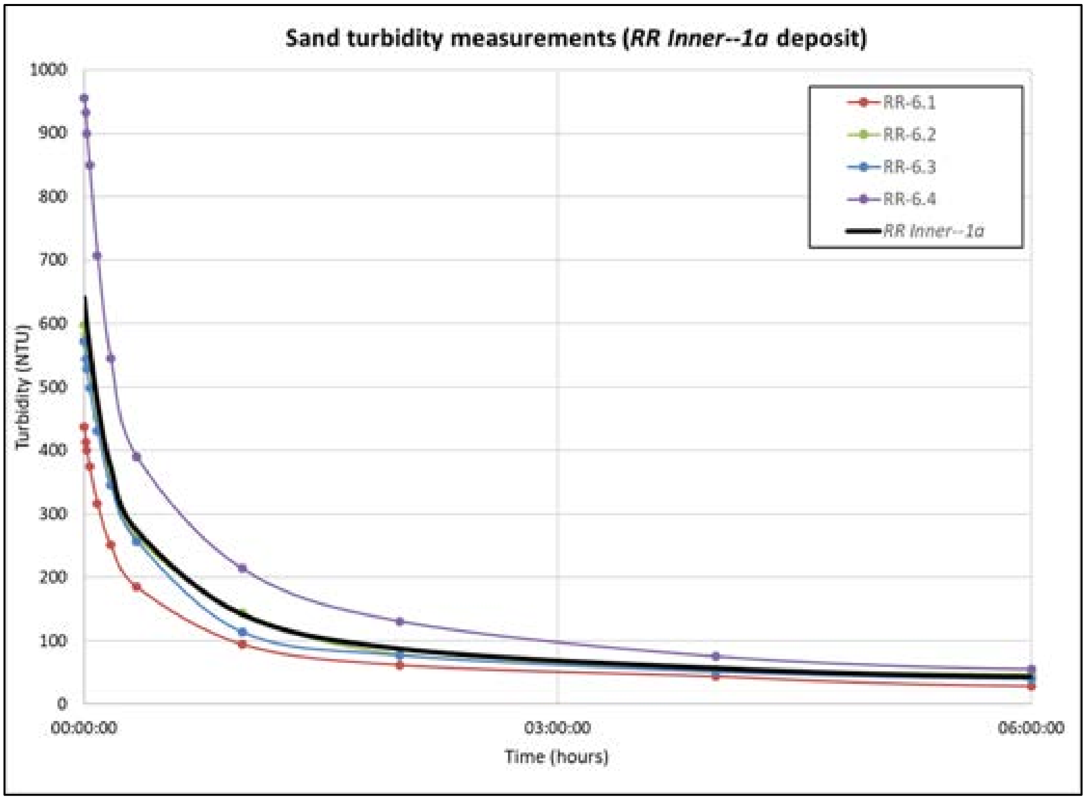


Figure 8-41 Turbidity results for *Reef Runway Inner 1a* offshore sand deposit

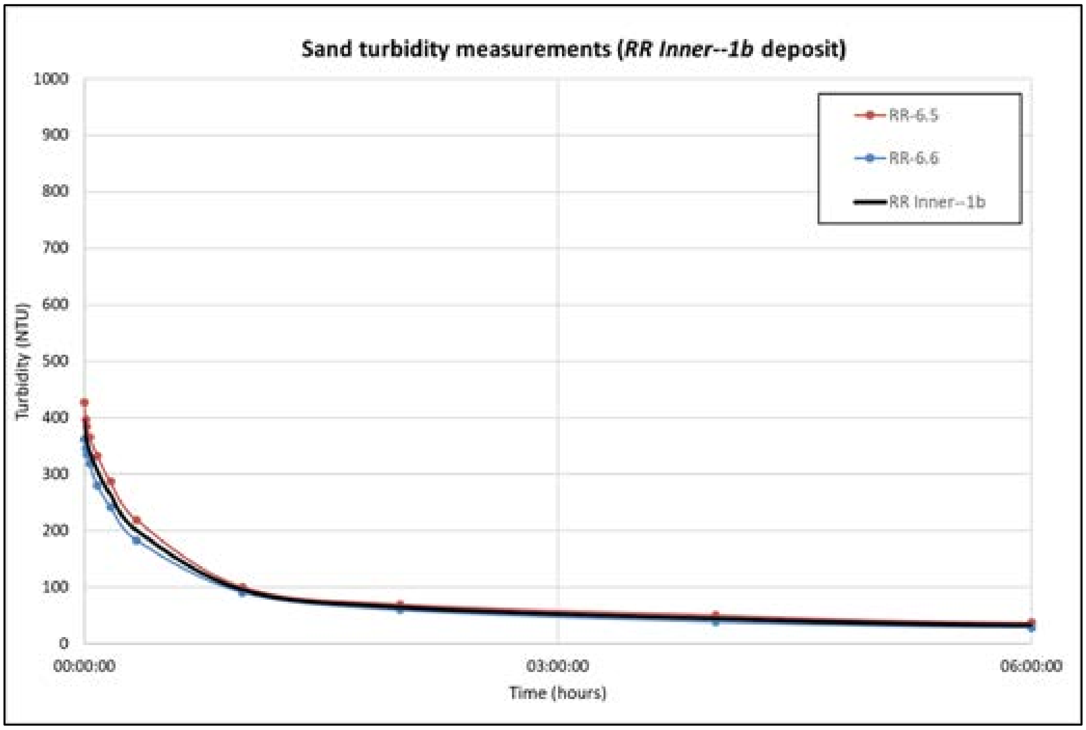


Figure 8-42 Turbidity results for Reef Runway Inner 1b offshore sand deposit

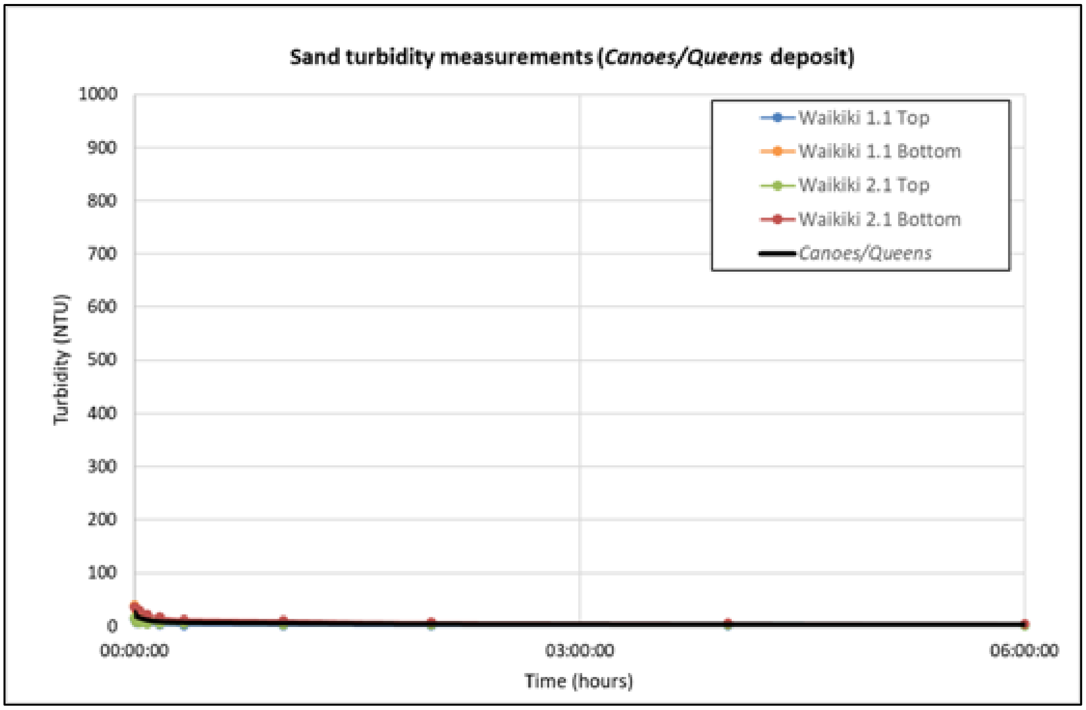


Figure 8-43 Turbidity results for *Canoes/Queens* offshore sand deposit

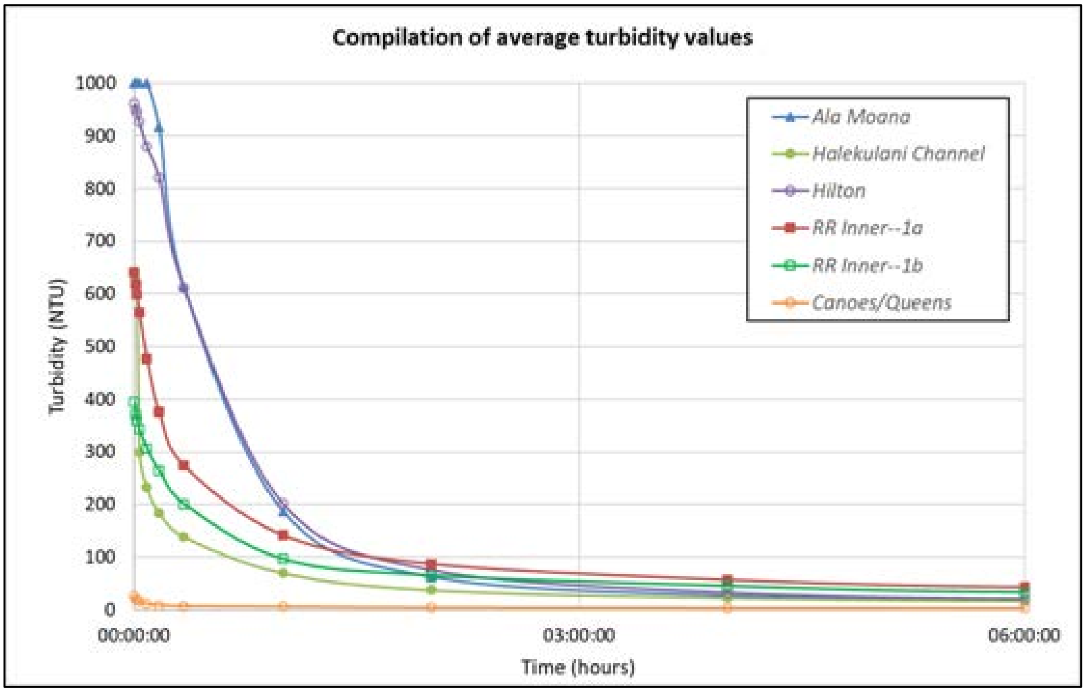


Figure 8-44 Compilation of average turbidity measurements for offshore sand sources

Turbidity During the 2012 Waikīkī Beach Maintenance I Project

The Waikīkī Beach Maintenance I project was completed in June 2012, when about 24,000 cy of sand was recovered from the *Canoes/Queens* offshore deposit, pumped to shore, dewatered, and placed on Royal Hawaiian Beach. The placement of the sand produced elevated levels of turbidity and, immediately following the completion of sand placement, the project area experienced a series of summer south swell events that further exacerbated the turbidity.

Turbidity was assessed visually from photographs obtained via a University of Hawaiʻi webcam mounted on the Sheraton Waikiki Hotel. Turbidity levels appeared to decrease in general following completion of sand placement on April 25, 2012. By November 2012, turbidity on calm days appeared to have decreased to pre-project levels, though turbidity was still elevated during higher wave conditions which are responsible for washing fine material from the beach and resuspending sediment. A June 24, 2019 view from the Sheraton Waikiki Hotel shows the nearshore water clarity to be comparable to pre-project levels.

Turbidity During the 2021 Waikīkī Beach Maintenance II Project

The Waikīkī Beach Maintenance II project was completed May 7, 2021, when about 20,000 cy of sand was recovered from the *Canoes/Queens* offshore deposit, pumped to shore, dewatered, and placed on Royal Hawaiian Beach. The placement of the sand again produced elevated levels of turbidity. Turbidity plumes were observed on May 10, 2021 originating from the ʻEwa (west) basin of the Kūhiō beach sector and the central channel in the Royal Hawaiian beach sector. The plumes were observed using surf cameras located on top of the Sheraton Waikiki Hotel. The plume originating from the ʻEwa (west) basin consisted of a narrow band of suspended fine sediment that slowly moved offshore from the beach. Once it reached the submerged breakwater that separates the ʻEwa (west) basin from the offshore waters, the plume accelerated makai (seaward) between the *Canoes* and *Queens* surf sites. The plume then curved slightly north before turning south in a circular pattern just outside of the *Queens* surf site.

The numerical wave model (SWASH) was used to simulate the exact wave and tide conditions occurring at the time of the plume observations. The full development of the plume shape occurred at approximately 4:30pm HST where the tide measured +1.28 feet MSL at the Honolulu Harbor tide station. Wave conditions during this time were measured at the offshore wave buoy station 238 located approximately 2 mi west of Barbers Point. The primary wave component measured at station 238 was a south swell with a significant wave height of 1.9 ft and peak period of 14 sec. There was also a small northwest swell measured at the buoy; however, this specific swell was expected to have little to no impact to the nearshore waves at Waikīkī at the time. The measured oceanographic parameters were used as input to the SWASH model which simulated nearshore wave transformation and wave generated currents along the Waikīkī shoreline.

The modeled current vectors closely matched the observed plume shape at the time of the observation (Figure 8-45). The modeled currents also closely matched the path of the turbidity plumes to the north along Royal Hawaiian Beach. The model results confirmed that, when beach erosion occurs, the fine sediment contained in the offshore borrow sand follows distinct and relatively narrow sediment pathways before being deposited in the sediment sink between the *Canoes* and *Queens* surf breaks.

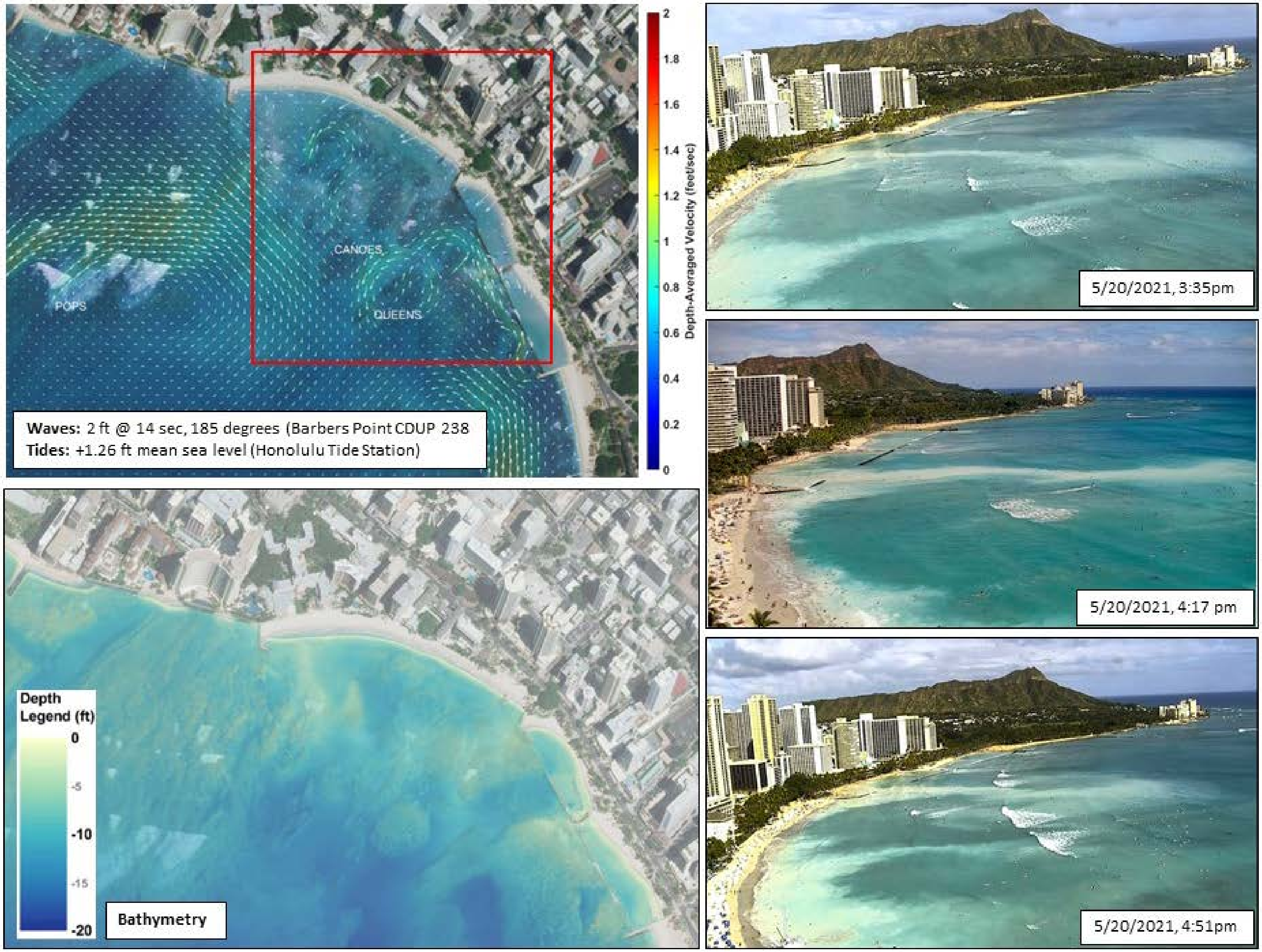


Figure 8-45 Comparison of sediment plume observations and SWASH model results (5/10/2021)

Turbidity Impacts Analysis

Sand from within the offshore sand deposits is expected to become well mixed during recovery, transport, and placement on the beach. Average turbidity values for the targeted areas in the deposits are important, as they are representative of the material that will eventually be placed on the beach. Initial elevated turbidity levels are expected during sand placement and periodically during larger wave events. The laboratory turbidity analyses indicated that the turbidity should return to typical existing levels after a short period of adjustment. Observations from the Waikīkī Beach Maintenance I and II projects, and results of the turbidity experiments described above suggest that elevated turbidity following sand placement should be expected.

A temporary increase in turbidity levels is anticipated in the immediate areas of construction; however, these impacts will be mitigated by the employment of Best Management Practices (BMPs). The proposed actions will require a Clean Water Act Section 401 Water Quality Certification (WQC), which will include an Applicable Monitoring and Assessment Program (AMAP) and Data Quality Objectives (DQO). The AMAP and DQO will be reviewed and approved by the Hawaiʻi Department of Health, Clean Water Branch (DOH-CWB). The contractor will utilize appropriate BMPs to minimize potential impacts to water quality during construction including but not limited to sand dewatering, silt fencing, and turbidity curtains.

Water quality protection measures will include the following general requirements:

- Turbidity containment barriers shall be installed and maintained to completely surround the work area so as to control and contain construction generated turbidity.
- The water area affected by construction shall be monitored, and if monitoring indicates that the turbidity standards are being exceeded, construction shall be suspended until the condition is corrected.
- The construction contractor shall be required to employ standard BMPs for construction in coastal waters, such as daily inspection of equipment for conditions that could cause spills or leaks; cleaning of equipment prior to operation near the water; proper location of storage, refueling, and servicing sites away from the water; implementation of adequate on site spill response procedures; and stormy weather preparation plans.
- All construction activities shall be confined to the immediate area of construction, and no excess construction material shall be stockpiled in the water.
- Construction materials (e.g., sand, stone, concrete) shall be inert and free of earthen and any other deleterious substances.
- Water quality monitoring will be performed before, during, and after construction.

8.8 Shoreline Change

The University of Hawaiʻi Coastal Geology Group (UHCGG) conducted a historical analysis of sandy shorelines on Oʻahu and produced shoreline change maps based on survey data and aerial imagery from 1927 to 2015. Their analysis used the beach toe as the reference feature to measure changes in the position of the shoreline over time. The results of the UHCGG historical shoreline change analysis for Waikīkī are shown in Figure 8-46 and Table 8-12. The rates presented in Table 8-12 represent the average shoreline change rates from 1927 to 2015 for the selected beach sectors; however, rates can be substantially higher in smaller areas that are more susceptible to erosion. Since 2015 (the most recent data point in the analysis), most beaches throughout Waikīkī appear to be experiencing an increase in erosion that appears to well exceed the historical rates.

Erosion, coastal flooding, and beach loss are expected to continue and accelerate in Waikīkī in the coming decades as rates of sea levels continue to increase. Recent record high water levels and severe erosion events indicate that this acceleration may already be occurring. Anderson et al. (2015) projected future shoreline change in Hawaiʻi by combining historical shoreline trends with projected sea level rise using the Davidson-Arnott profile model. The analysis found that, due to sea level rise, average shoreline recession in Hawaiʻi is projected to be nearly double the historical rates by 2050, and nearly 2.5 times the historical rates by 2100 (Anderson et al. 2015).

The UHCGG calculated projected future exposure to erosion and annual high wave flooding to account for sea level rise (UHCGG, 2019). All of the beach sectors in Waikīkī are projected to experience erosion and increased coastal flooding as sea levels continue to rise (State of Hawaiʻi , 2017, Anderson et al. 2015). The erosion projections for the Fort DeRussy, Halekūlani, Royal Hawaiian, and Kūhiō beach sectors are shown in Table 8-13. These projections do not account for the presence of shoreline armoring, which spans nearly the entire length of the Waikīkī shoreline. Based on the erosion projections, without mitigative actions, sea level rise will likely result in total beach loss in Waikīkī by mid-century or sooner due to the combined effects of increasing erosion and increasing frequency and severity of coastal flooding, particularly in areas where the beaches are already narrow and often submerged, particularly during high tides and high surf events.

8.8.1 Fort DeRussy Beach Sector

The historical shoreline change trend for the Fort DeRussy beach sector (transects 141 to 169) from 1927 to 2015 has been erosion at an average rate 0.4 ft/yr (UHCGG, 2019). Beach erosion does not occur uniformly throughout the sector. The east end of the beach (transects 141 to 153) has been eroding at an average rate of 1.2 ft/yr, whereas the west end of the beach (transects 154 to 169) has been accreting at an average rate of 0.4 ft/yr. The erosion is more pronounced at the east end of the beach because the predominant direction of sediment transport is from east to west along this portion of the Waikīkī shoreline (Miller and Fletcher, 2003). As sand is transported from east to west along the beach, the east end of the beach narrows and there is no mechanism to transport sand back to the eroding area. Waves currently overwash the beach walkway at the east end of this sector during the highest tides.

Erosion, coastal flooding, and beach loss in the Fort DeRussy beach sector are projected to increase as sea levels continue to rise. The UHCGG shoreline change projections estimate that the shoreline could erode up to 30.8 ft (9.4 m) by 2050 and up to 81 ft (24.7 m) by 2100 (UHCGG, 2019). The entire length of the shoreline in the Fort DeRussy beach sector is armored by a seawall that was constructed in 1916. As the shoreline approaches the existing seawall, there is an incremental loss of recreational beach area and shoreline habitat, a process that is referred to as *coastal squeeze* (Lester and Matella, 2016). Without beach improvements and/or maintenance, it is likely that sea level rise will result in total beach loss in the east end of this sector by mid-century or sooner due to the combined effects of increasing erosion and increasing frequency and severity of coastal flooding, particularly in areas where the beaches are already narrow and often submerged during high tides and high surf events.

8.8.2 Halekūlani Beach Sector

The historical shoreline change analysis for the Halekūlani beach sector (transects 118 to 140) determined that, from 1927 to 2015, the shoreline has been relatively stable with slightly more pronounced accretion at the east end of the sector fronting the Sheraton Waikiki Hotel (UHCGG, 2019). Miller and Fletcher (2003) found that sediment transport in the Halekūlani beach sector varies according to the seasonal wave regime. The relative stability of the shoreline can be attributed to the limited volume of sand in the narrow sections of beach that are stabilized by groins, and the presence of the seawalls that artificially fix the shoreline where no beach is present.

At the west end of the sector (transects 133 to 140), sand is impounded on the updrift side of the Fort DeRussy outfall/groin. The beach in this area is narrow and fluctuates seasonally but has been relatively stable over the long-term. The pocket beaches in the central portion of the sector (transects 126 to 129), between the Halekūlani Hotel and the Sheraton Waikiki Hotel, are aligned with the Halekūlani Channel and have experienced moderate erosion at a rate of 0.2 ft/yr (UHCGG, 2019). The pocket beaches are dynamic and sand volumes and beach width often fluctuate. The pocket beaches are often completely submerged during high tides and high surf events, and waves frequently overtop the existing walls in this area. The east end of the sector (transects 118 to 125) is dominated by a seawall fronting the Sheraton Waikiki Hotel. Sand occasionally accumulates in front of the seawall where it is impounded by the Royal Hawaiian groin; however, the sand is unstable and there is typically no dry beach in this area.

Erosion, coastal flooding, and beach loss in the Halekūlani beach sector are projected to continue and accelerate as sea levels continue to rise. The UHCGG shoreline change projections estimate that the shoreline could erode up to 3.9 ft (1.2 m) by 2050 and up to 14.1 ft (4.3 m) by 2100 (UHCGG, 2019). These projections do not account for the presence of the existing seawalls that span the entire length of the Halekūlani beach sector. As the shoreline approaches the existing seawalls, there is an incremental loss of recreational beach area and shoreline habitat, a process that is referred to as *coastal squeeze* (Lester and Matella, 2016). Without beach improvements and/or maintenance, it is likely that sea level rise will result in total beach loss in this sector by mid-century or sooner due to the combined effects of increasing erosion and increasing frequency and severity of coastal flooding, particularly in areas where the beaches are already narrow and often submerged during high tides and high surf events.

8.8.3 Royal Hawaiian Beach Sector

The historical shoreline change trend for the Royal Hawaiian beach sector from 1927 to 2015 has been accretion at an average rate 0.19 ft/yr (UHCGG, 2019). This long-term accretion rate is likely attributable to the addition of beach sand during previous beach nourishment efforts over the past century. Miller and Fletcher (2003) found that sediment transport is predominantly in a northwesterly direction and that a cross-shore (rip) current in the eastern portion of the beach may contribute to the loss of sand in the in the Royal Hawaiian beach sector. These currents transport sand offshore, which often results in the formation of a shallow sandbar in this area. Habel et.al. (2016) also confirmed predominant westerly sediment transport and noted that cross-shore sediment transport occurs through an offshore channel that acts as both a sediment source and sink depending on seasonal wave conditions: a source during seasonal and storm-related swell events, and a sink otherwise.

Beach profile monitoring following the 2012 Waikīkī Beach Maintenance I project found that the beach volume decreased at a rate of 760 ± 450 m^3/yr over the 2.7 yr monitoring period, consistent with the design rate of 1,070 m^3/yr. Seasonal cycles caused beach volume to fluctuate between 2,000 m^3 to 4,000 m^3, i.e., 15% to 30% of total nourishment volume (Habel et al. 2016).

Erosion, coastal flooding, and beach loss in the Royal Hawaiian beach sector are projected to continue and accelerate as sea levels continue to rise. The UHCGG shoreline change projections estimate that the shoreline could erode up to 87.3 ft (26.6 m) by 2050 and up to 216.2 ft (65.9 m) by 2100 (UHCGG, 2019). These projections do not account for the presence of the existing seawalls that span the nearly the entire length of the shoreline in the Royal Hawaiian beach sector or the compounding effects of erosion and increasing coastal flooding. Without beach improvements and/or maintenance, it is likely that sea level rise will result in total beach loss in this sector by mid-century or sooner due to the combined effects of increasing erosion and increasing frequency and severity of coastal flooding, particularly in areas where the beaches are already narrow and often submerged during high tides and high surf events. Loss of the recreational dry beach and lateral shoreline access in the vicinity of the Moana Surfrider Hotel could occur in the next several decades as waves currently overtop the seawalls in this area during extreme high tides and high surf events.

8.8.4 Kūhiō Beach Sector

The historical shoreline change trend for the Kūhiō beach sector from 1927 to 2015 has been erosion at an average rate 0.11 ft/yr (UHCGG, 2019). The erosion is more pronounced in the Diamond Head (east) basin with the predominant direction of sediment transport being east to west (Miller and Fletcher, 2003). As sand is transported from east to west along the beach, the east end of the beach narrows and there is no mechanism to transport sand back to the eroding area. The erosion is less pronounced in the ʻEwa (west) basin where the sand is impounded on the updrift side of the groin at the west end of the sector.

As sea levels continue to rise, the Kūhiō beach sector is projected to erode 33.1 ft (10.1 m) by 2050 and 86.6 ft (26.4 m) by 2100 (UHCGG, 2019). The majority of the shoreline in the Kūhiō beach sector is armored by seawalls and the middle of the beach is often completely submerged during high tides and high surf events. Without beach improvements and/or maintenance, it is likely that increasing erosion and coastal flooding with sea level rise will result in total beach loss in the middle of this sector within several decades. Erosion and flooding may be less severe at the west and east ends of the sector where the beach is currently widest; however, total beach loss will still likely occur in these areas before the end of the century.

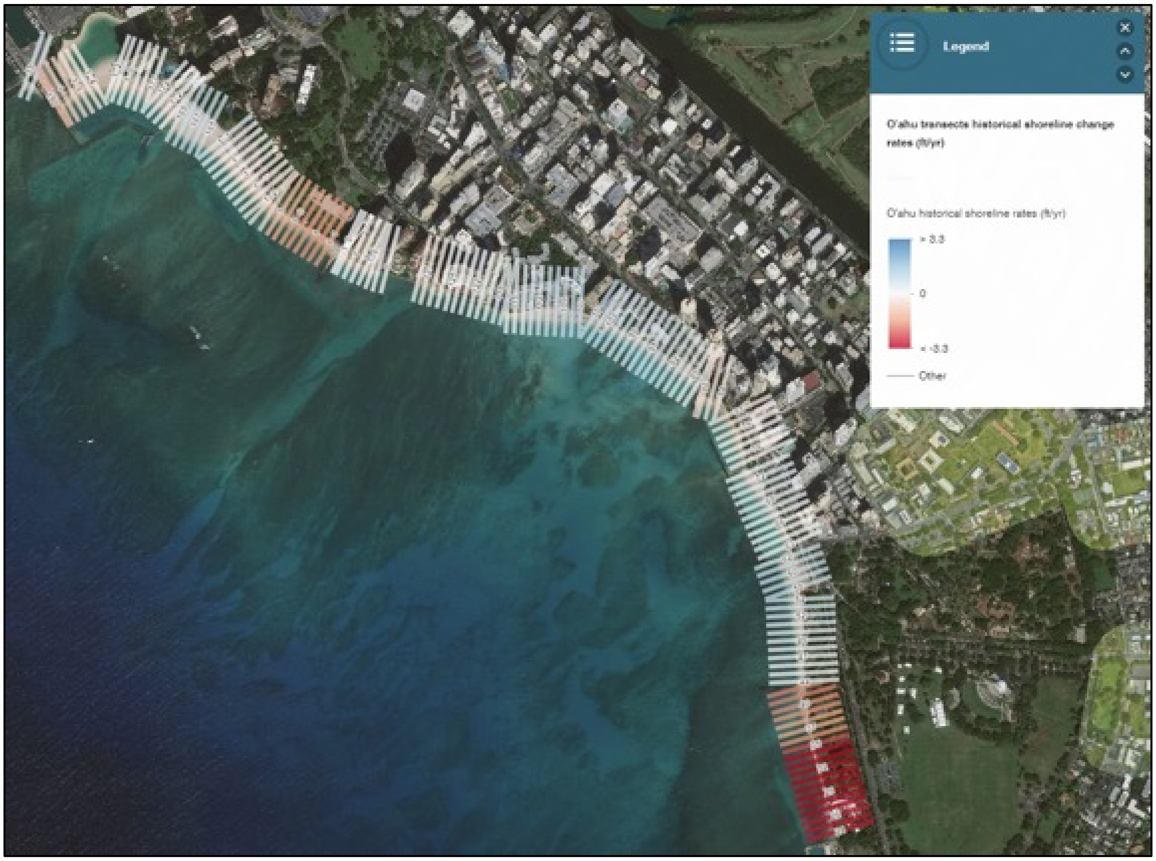


Figure 8-46 Waikīkī historical shoreline change rates,1927 to 2015 (UHCGG, 2019)

Table 8-12 Waikīkī historical shoreline change rates,1927 to 2015 (UHCGG, 2019)

Beach Sector	Historical Trend	Historical Rate (ft/yr)
Fort DeRussy	Erosion	0.4
Halekūlani	Erosion	0.0
Royal Hawaiian *	Accretion	0.6
Kūhiō	Erosion	0.0

* Long-term accretion rate is likely influenced by previous beach nourishment efforts.

Table 8-13 Waikīkī projected shoreline change with sea level rise (UHCGG, 2019)

Beach Sector	Projected Erosion by 2050 (ft)	Projected Erosion by 2100 (ft) *
Fort DeRussy	30.8	81.0
Halekūlani	3.9	14.1
Royal Hawaiian	87.3	216.2
Kūhiō	33.1	86.6

* Erosion projections do not account for existing shoreline armoring (i.e., seawalls).

8.8.5 Potential Impacts and Mitigation Measures

The proposed action in the Fort DeRussy beach sector is beach maintenance (sand backpassing). Periodic sand backpassing will improve lateral shoreline access and reduce the potential for the seawall and beach walkway to become exposed by erosion and overwashed by wave runup. While sand backpassing will not prevent future beach erosion, it will balance the sediment budget within the beach sector, which will help to maintain a more linear beach planform.

The proposed action in the Halekūlani beach sector is beach nourishment with stabilizing groins. The project will produce four stable beach cells in an area that has historically been largely devoid of sand. The groins will stabilize the sand so long-term erosion rates will decrease when compared to historical rates.

The proposed action in the Royal Hawaiian beach sector is beach nourishment without stabilizing structures. The project will be similar in size and scope to the Waikīkī Beach Maintenance I and II projects in 2012 and 2021, respectively. While beach nourishment will not prevent future beach erosion, it will balance the sediment budget within the beach sector, which will help to maintain a wider, more linear beach planform.

The proposed action in the Kūhiō beach sector ʻEwa (west) basin is beach nourishment with a segmented breakwater. The segmented breakwater will alter wave patterns to produce a more stable beach profile, which will reduce long-term erosion rates when compared to historical rates.

The proposed action in the Kūhiō beach sector Diamond Head (west) basin is beach maintenance. While beach maintenance will not prevent future beach erosion, it will balance the sediment budget within the basin, which will help to maintain a wider, more linear beach planform.

Beach profile monitoring will be conducted before and after construction. The monitoring plan will be reviewed and approved by the Hawaiʻi Department of Land and Natural Resources, Office of Conservation and Coastal Lands (DLNR-OCCL). Requirements for post-construction beach profile monitoring will be confirmed during the final design and permitting process.

8.9 Sand Characteristics

The beaches of Waikīkī are composed primarily of calcareous (calcium carbonate) sand with minimal fine material. Carbonate sand is the most common type of beach sand along shorelines of the Hawaiian Islands and is the product of bioerosion and biological production on offshore reefs and marine waters. Carbonate sand is primarily composed of skeletal fragments of marine organisms such as corals, coralline algae, mollusks, echinoids, forams, with minor fractions of terrigenous (i.e., volcanic) sediment. The composition of sand is determined by the relative abundance of each contributing materials and varies by location.

Carbonate sands range in color from pure white to yellow, brown, and dark grey. Beyond the aesthetic value, color also affects temperature, as darker sands achieve higher temperatures under the bright tropical sunlight than a lighter shade of sand. Native beach sand in Waikīkī is typically gold or tan in color.

Both density and grain size play an important role in how sand behaves on a beach. Grain size in beaches within the Hawaiian Islands can range from a very fine silt to large coral cobbles. The density of calcium carbonate crystals is roughly a constant 2.72 g/cm^3; however, microscopic pores and hollow grains make the effective density of individual grains somewhat lower. Smith and Cheung (2002) found the effective density of carbonate sand grains to be 2.4 g/cm^3.

The grain size characteristics of sand are typically determined by passing or shaking a sand sample through a series of sieves with progressively smaller openings. The amount of sand remaining on each sieve is weighed, and the corresponding percentage that this weight represents of the entire sample weight is computed. The results are presented graphically by plotting the percentage of the sample that is collected at each particular grain size on a logarithmic graph, with grain size plotted on a log base 10 x-axis.

The median diameter (diameter at which 50% of the sample's mass is composed of particles less than this value), or D_{50}, is often used by engineers to represent the grain size of a sample. D_{16} (diameter at which 16% of the sample's mass is composed of particles less than this value) and D_{84} (diameter at which 84% of the sample's mass is composed of particles less than this value) are used to quantify the range of grain sizes present in a sample known as sorting, σ, defined by:

$$\sigma = \frac{\varphi_{84} - \varphi_{16}}{2}$$

where $\varphi = \log_2(D)$, where D is diameter in millimeters. Descriptive sorting values are presented in Table 8-14.

Table 8-14 Sorting value descriptions

Sorting Range (Φ)	Description
0.00 – 0.35	very well sorted
0.35 – 0.50	well sorted
0.50 – 0.71	moderately well sorted
0.71 – 1.00	moderately sorted
1.00 – 2.00	poorly sorted
2.00 – 4.00	very poorly sorted
> 4.00	Extremely poorly sorted

Composite beach samples containing sand from the beach berm, beach crest, beach face, and beach toe were taken at various locations along the Waikīkī shoreline. Grain size analysis of representative sand samples indicates that the average median grain size is approximately 0.35 mm to 0.60 mm. Both of these average sizes are considered medium-grained sand according to the Wentworth Grain Size Classification.

Beaches typically have a higher degree of sorting (i.e., a narrower distribution of grain size) than other environments due to predominant waves, currents, and wind that naturally sort the sediment. In addition, open ocean beaches tend to have a relatively low percentage, by mass, of fines, as wave energy and currents mobilize these smaller grains and transport them away from the beach face into deeper water. Wind can also deliver finer grains across the backshore to dune systems. The existing beach sand in Waikīkī is well to moderately-well sorted with a very low percentage of fines (0 to 5%).

8.9.1 Potential Impacts and Mitigation Measures

A critical component of successful beach nourishment projects is the availability of suitable sand fill that is compatible with the existing beach sand. Sand fill should closely match the grain size distribution, color, composition, and density of the existing beach sand. Deviation from these characteristics may result in unpredictable behavior of the beach. The State of Hawaiʻi Department of Land and Natural Resources (DLNR) established standards and guidelines, which specify that fill sand used for beach nourishment projects must meet several requirements:

- Sand shall contain no more than 6% fine material (grain size < 0.074 mm).
- Sand shall contain no more than 10% coarse material (grain size > 4.76 mm).
- The grain size distribution will fall within 20% of the existing beach sand.
- The overfill ratio of the fill sand to existing sand shall not exceed 1.5.
- Sand will be free of contaminants such as silt, clay, sludge, organic matter, turbidity, grease, pollutants, and others.
- Sand will be primarily composed of naturally occurring carbonate beach or dune sand.

Sand sources that have been determined to be suitable for placement can have undesirable characteristics that are difficult to fully identify prior to sand recovery or mitigate during sand placement. Potential problems include compaction and lithification of placed sand; coral cobbles in the placed sand; anoxic conditions in the recovered sand; change in beach color; and other issues dependent on the site and conditions.

Compaction occurs when grains are pressed together, reducing pore space between them. Heavily compacted sand can become partially or wholly lithified (solidified), having a consistency ranging from compact but friable (able to be easily broken down into sand grains), to more rock-like. Indurated (hardened) beach rock cannot be easily broken up into individual sand grains.

Sand compaction was observed following the 2012 Waikīkī Beach Maintenance I project along the truck haul route between the dewatering basin and the sand placement area. A 1- to 3-ft tall, hardened berm formed along the seaward edge of the truck haul route. This compaction is likely the result of heavy loaded dump trucks repeatedly traveling over the sand fill. Additionally, chemical processes in the form of carbonate dissolution and precipitation likely contributed to the hardening of the sand fill.

The sand fill for the proposed actions will be transported along the beach using equipment similar to that used in the Waikīkī Beach Maintenance I and II projects in 2012 and 2021, respectively. The combination of pressure, dissolution of calcium carbonate material from freshwater, and the presence of fines could increase the chances of induration (hardening) of the placed sand. Compaction from trucks will be minimized by mechanically loosening or turning the sand along the truck haul route at regular intervals. Moreover, truck haul routes can be monitored and plowed after project completion, if necessary.

Coral cobbles and rubble, which occur naturally in offshore sand deposits, were an issue during the 2012 Waikīkī Beach Maintenance I project. These larger cobbles accumulated along the beach toe and were uncomfortable for beach users. The potential for coral rubble was addressed during the design process, and efforts were made to reduce the recovery of large pieces of rubble from the offshore sand deposits. However, the amount of rubble reaching the beach still exceeded construction specifications, specifically for long and narrow pieces of rubble that were able to fit through a screen on the hydraulic sand pump. After placement, the rubble became concentrated along the beach toe, just below the waterline. The contractor removed coral rubble by hand, and the Hawaiʻi Department of Land and Natural Resources (DLNR) organized volunteer rubble removal efforts after construction was completed.

Though the grain size distribution of the offshore sand proposed for use in the proposed actions has been thoroughly investigated, coral rubble, or sediment grains that are cobble-sized or larger, may exist sporadically within the sand deposits. During offshore sand sample recovery, no coral rubble larger than 1 inch in diameter was encountered at the offshore sand deposits. Additionally, air-jet probing encountered no layers of coral rubble between the sand surface and up to 8 ft below the seafloor. However, rubble may exist in discreet pockets within the sand deposits.

One of the disadvantages of clamshell dredging is that there is no method to screen coral rubble from the recovered sand at the dredge site. The contractor, therefore, should monitor the sand for coral rubble as the clamshell bucket empties the sand onto the barges, transfers the sand to the shore, and then places the sand on the beach. If excessive coral rubble is encountered in an area within the offshore sand deposits, sand recovery operations will move to a different location within the deposits.

The dewatered sand in the current 2021 Waikīkī Beach Maintenance II project was passed through a screen to remove particles larger than 1 in diameter prior to transport to the beach (Figure 8-47). Additionally, sieve testing was performed periodically on the deck barge as sand was being recovered. A relatively small volume of cobble was effectively screened and removed prior to sand placement. No cobble was placed on the beach.

Figure 8-47 Screening process to remove cobble from offshore sand

Borrow sand from offshore deposits would preferably match the color of the existing beach sand. While natural calcareous beaches can range in color, sand in offshore deposits usually turns a gray color as a result of anoxic conditions that occur due to a lack of wave action and associated mixing and aeration of the sand, or with depth within the deposits. Sand samples were taken from various layers in the offshore sand deposits and dried under direct sunlight. The color of the offshore samples, after several days of drying, closely matched the existing beach sand, though some samples had a slightly grayer color. Color comparison tests and drying, and experience with past projects in Waikīkī and elsewhere, indicate that the gray will fade over time due when exposed to direct sunlight. In addition, the mixing of offshore sand and existing beach sand is expected to produce a final color that should be closer to that of the existing beach. Sand recovered from anoxic environments can also have an unpleasant odor. Based on previous sand recovery efforts in the Hawaiian Islands, any odor from recovered sand is anticipated to diminish with exposure to sun and air.

Borrow sand from offshore deposits is not anticipated to contain hazardous materials or contaminants. There have been no significant environmental contamination events in close proximity to the offshore deposits, and there are no known point sources of pollution that could potentially contaminate the sand. Thus, there is no reason to anticipate that sand recovered from the offshore deposits will contain contaminants.

Proposed Mitigation Measures

The contractor will monitor and screen the sand for coral rubble during sand recovery operations. If excessive coral rubble is encountered in an area within the offshore sand deposits, sand recovery operations will move to a different location within the deposits. The contractor will also monitor and screen the sand for coral rubble prior to and during sand placement operations.

8.10 Marine Biota

The U.S. Fish and Wildlife Service classifies the marine environment in Waikīkī as estuarine and marine deepwater habitat. The nearshore area along the shoreline is classified as marine, intertidal, unconsolidated shore that is regularly flooded. The offshore area is classified as marine, subtidal, coral reef (Figure 8-48).

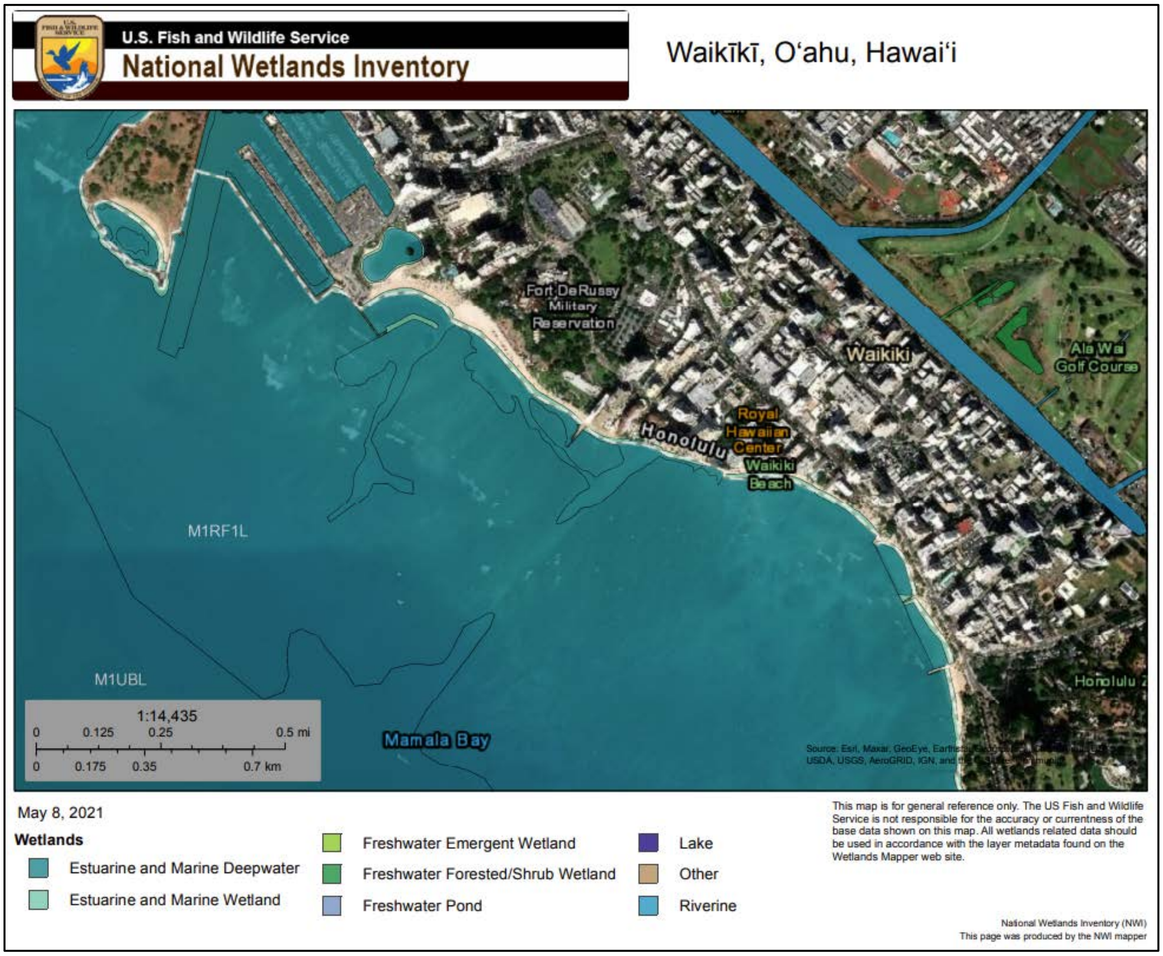


Figure 8-48 National Wetlands Inventory water classifications (USFWS)

The National Oceanographic and Atmospheric Administration (NOAA) defines the benthic habitat geomorphology offshore of Waikīkī as pavement, sand, and reef rubble (Figure 8-49). Benthic habitat biology is characterized by a combination of coralline algae, turf algae, and uncolonized seafloor (Figure 8-50).

Figure 8-49 Benthic habitat geomorphology (PacIOOS)

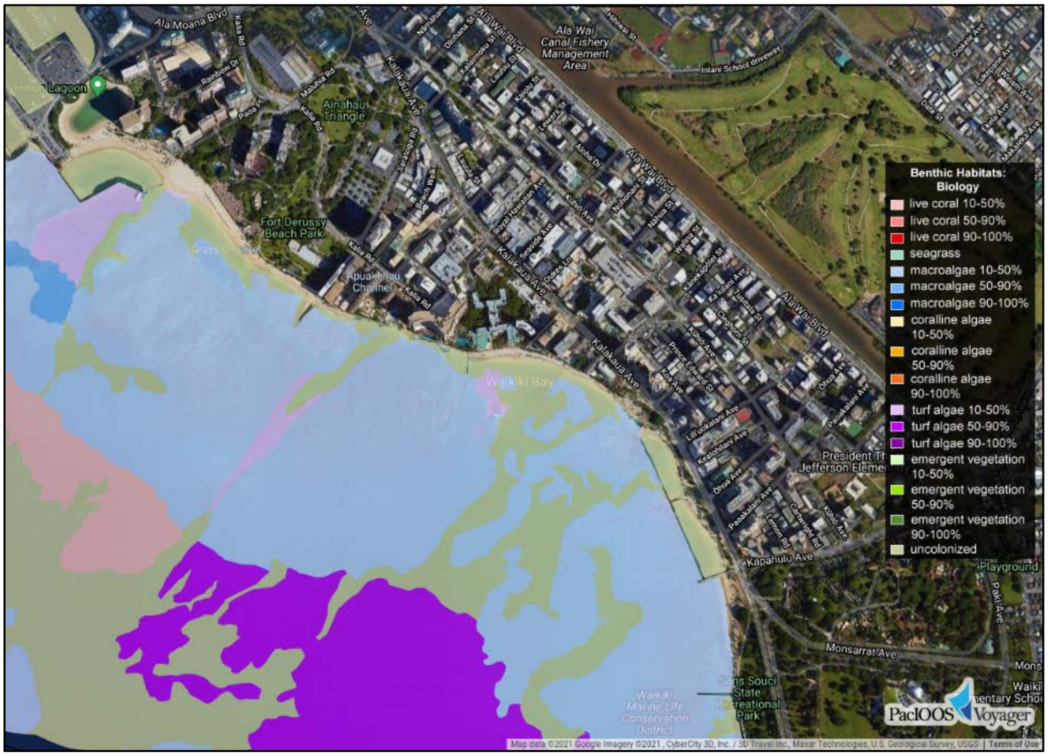


Figure 8-50 Benthic habitat biology (PacIOOS)

A Baseline Assessment of the Marine Biological Environment was prepared by AECOS, Inc. in April 2021 (see Appendix C). Biologists conducted surveys to inventory marine assemblages in the nearshore waters off the Project. Biologists used snorkel gear to collect data on bottom type, coral colony size-frequency (size, diversity, new recruits, large colonies, health); diversity, dentification and categorization (common vs. uncommon) of algae (including crustose coralline algae) and seagrass; and non-coral macro-invertebrates greater than 3 cm.

The point intercept method (also termed a line-point intercept method) was used to assess benthic composition on each transect. This protocol uses meter marks on the transect line as sample points. At 0.5-m intervals, the nature of the bottom under each "point" is identified and assigned to one of the following categories: sand, rubble, limestone (rock or pavement), turf algae, crustose coralline algae (CCA), live coral, or macroinvertebrate. Benthic percent cover was calculated by dividing the total number of points for each category by the total number of points sampled times 100.

A two-meter belt survey of coral colonies was conducted on each transect. All corals 1 m to either side of the transect line were counted. Coral abundance was determined as the number of individuals observed for each transect normalized to number of individuals per m^2. Coral heads were identified to species and assigned to a size class (1- to 5-cm; 6- to 10-cm; 11- to 20-cm; 21- to 40-cm; 41- to 80-cm; 81- to 160-cm; or >160-cm) based on the largest horizontal dimension of the colony. Coral size-class distribution was determined for each coral species recorded. Percent morbidity (amount of coral colony not alive) and any signs of disease were also recorded.

General Conditions

The dominant benthic organisms on the reef platform off Waikīkī Beach are marine macro-algae or *limu*, which cover most exposed hard surfaces not scoured or buried by shifting sand. Nearshore algal cover is 75 to 100% (based on visual estimates), except in areas exposed to sand scour (such as channel margins and limestone outcrops in sand fields) where algae coverage is less than 25% of the hard bottom. The growth form of these algae is typically low-growing or turf-like.

Up to 87 different species of algae have been reported from the Waikīkī reef since 1969 (Doty, 1969; Chave et al., 1973; OI, 1991; Huisman et al., 2007; MRC, 2007; and AECOS, 2007, 2008, 2009, 2010). Although the flora of Waikīkī reef remains relatively diverse today, two invasive red algae (*Rhodophyta*): *Acanthophora spicifera* and *Gracilaria salicornia*, dominate the benthic flora (Smith et al., 2004; Huisman et al., 2007; MRC, 2007; AECOS, 2007a, 2008, 2009a).

Common macro-invertebrates observed in various surveys on the reef flat off Waikīkī include *Holothuria atra*, *H. nobilis*, *Echinothrix diadema*, *Tripneustes gratilla*, *Echinometra mathaei*, *Echinostrephus aciculatus*, and various sponges (OI, 1991); *E. matheai*, *E. aciculatus*, and *H. atra* (MRC, 2007, AECOS, 2007a, 2008, 2009a).

The most common (although total cover comprising less than one percent of the bottom) hermatypic corals found on the reef flat off Waikīkī Beach are *Pocillopora meandrina* and *Porites lobata* (OI, 1991; MRC, 2007; and AECOS, 2007, 2008, 2009). In addition, *Cyphastrea* *ocellina* (MRC, 2007; AECOS, 2007, 2008, 2009), *Montipora capitata*, *M. patula*, *P. evermanni*, *Psammocora stellata*, *Leptastrea purpurea* (AECOS, 2007, 2008, 2009), and *L. bewickensis* (2009 and 2010 surveys) have been recorded.

Distribution of fishes on the reef flat off Waikīkī is largely determined by local topography and bottom composition. Fishes are generally uncommon in keeping with the mostly low topography on this inner reef flat. Surveys off Waikīkī (MRC, 2007; AECOS, 2009) found the most common species to be wrasses (*Thalassoma duperrey*, *T. trilobatum*, *Stethojulis balteata*), *Acanthurus triostegus* (manini), and *Rhinecanthus rectangulus* (reef triggerfish). These surveys also found several species of small juvenile fishes inhabiting small holes and spaces in the reef structure.

Fort DeRussy Beach Sector

Biologists surveyed the sand placement area of the Fort DeRussy beach sector. The survey consisted of a qualitative, reconnaissance snorkeling survey between the Fort DeRussy outfall/groin and the west end of the sand placement area, and out to approximately 25 m from the shoreline. The dominant substrate here is sand, with patches of rubble and limestone outcrops. Algal growth on the hard bottom was primarily *Padina* sp. and *A. spicifera*. One *Porites* sp. coral colony in the 6-10 cm size class was observed in this beach sector. Fishes were rare here and included threadfin butterflyfish (*Chaetodon Auriga*), Hawaiian sergeant (*Abudefduf abnominalis*), and spotted boxfish (*Ostracion meleagris*). One coral colony was observed in the Fort DeRussy beach sector.

Halekūlani Beach Sector

Six (6) survey stations were established at the each of the potential groins and groin heads. One additional station was placed directly in front of the Halekūlani Hotel, traversing the sand channel. At the groin stations and Halekūlani station, a 60-m transect was run perpendicular to the shore from the beach crest and terminating near the end of the future groin footprint. At the proposed head stations, a 20-m transect was run parallel to the beach. A survey of benthic composition and coral size class and abundance (as described below) was undertaken along each 60-m “groin” transect and 20-m “head” transect.

Two invasive red algae, *Acanthophora spicifera* and *Gracilaria salicornia* are abundant on the reef flat off the Halekūlani sector of Waikīkī Beach. In addition to these two invasive algal species, other common species include: *Dictyota* spp., *Neomeris* sp., *Codium edule*, *Padina australis*, *Tubinaria ornata*, and *Asparagopsos taxifolia*. Another invasive species, *Avrainvillea amadelpha*, is present. Sea urchins are the most conspicuous invertebrates on the reef flat, particularly *Echinometra mathaei*, which burrows into the limestone, and *Tripneustes gratilla*, which grazes open hard bottom areas. *Holothuria atra*, the black sea cucumber or *loli*, is the most common sea cucumber here. Scattered coral colonies (*Porites* spp. and *Pocillopora damicornis*) occur on the reef flat in the Halekūlani beach sector.

Thalassoma duperrey (saddle wrasse) is the most common species on the reef flat in the project area. *Acanthurus triostegus sandvicensis* (manini) is also commonly seen in small schools feeding on benthic algae, and *Thalassoma trilobatum* (Christmas wrasse), *Stethojulis balteata* (belted wrasse), and *Rhinecanthus rectangulus* (reef triggerfish) are commonly seen solitarily scavenging for algae and benthic invertebrates. *Naso unicornis* (kala) and *Arothron hispidus* (ʻoʻopu hue) are encountered occasionally farther offshore.

Four 60-m transects and two 25-m transects were used to assess the benthic community of the seafloor in the Halekūlani beach sector. The dominant bottom type is rubble, at 24%, closely followed by sand and macroalgae, with similar covers at 23% and 19%, respectively. Live coral is low across the transects, at less than 1% of the total.

A total of 28 colonies were counted on the six transects. Density of corals in the proposed groin and T-head footprints of the Halekūlani beach sector is low, with an average of 0.1 colony/m^2. A total of 28 coral colonies, representing at least three coral taxa (*Pocillopora damicornis*, *Porites compressa* and *Porites* sp.) were recorded. The most common species was *Porites* sp. at 57% of the total. The most common colony size was the 1- to 5-cm class (39% of the total). Large (41- to 80- cm) colonies were rare (one *Porites* sp. colony). No colonies greater than 80 cm were recorded.

Overall coral cover at the proposed groin locations is very low (mean of 0.1 colony/m^2). In general, coral colonies here are small, with 64% being less than 10 cm in diameter. The lack of large coral heads is evidence that the Waikīkī marine environment is not particularly favorable to coral growth. Coral settlement and growth are limited by impinging waves, scour by rubble and sand, reduced light conditions associated with turbid water events, and burial with fine sediment. The proposed rock rubblemound groins and sand fill will bury a portion of the existing subtidal environment of primarily low relief sand, rubble, and limestone. This limestone provides substrate for macroalgae and coralline algae growth, as well as habitat for macroinvertebrates. Placement of boulders and sand will result in loss of some benthic organisms, including corals. These corals provide ecological services to the coral reef ecosystem: shelter, reef consolidation, food for corallivores, or coral gametes.

Impacts to corals could be avoided by relocating the few scattered corals that occur in the footprint of the placed sand and groins. Benthic invertebrates will repopulate from surrounding habitat after construction is completed and sessile organisms will colonize new hard surfaces (*AECOS*, 2014-2020). Additionally, the proposed groins and sand fill will provide stable, hard bottom for coral settlement and possibly calmer waters for coral development, but coral assemblage development may be compromised by competition for space, freshwater influence, sediment transport, and heavy utilization of the nearshore by the human population.

Fish abundance and diversity are directly correlated with topographical structure and complexity (Friedlander and Parrish, 1998; Ménard et al., 2012). Fish species richness, biomass, and diversity tend to be highest in environments with considerable spatial relief such as along limestone outcrop/sand bottom interfaces; fish biomass is lowest on shallow reef flats (Friedlander and Brown, 2006) of the sort in the project area. Although most of project area reef has low topographic relief, where vertical structure does occur, fishes are present and sometimes in high numbers. The distribution of topographical relief on this reef is highly patchy and weakly captured by our transect locations and survey areas. Stations with visibly greater relief, in the form of limestone outcrops, existing breakwaters and groins had greater fish abundance than the reef flat. The substantial structural complexity and topographical relief offered by the groins is expected to provide habitat for fishes and an increase in fish species richness, biomass, and abundance can be anticipated (AECOS, 2020).

Two common algae species found in Waikīkī are non-native and invasive: *A. spicifera* and *G. salicornia*. These species are widespread off the shores of the Hawaiian Islands and *A. spicifera* is a food favored by green sea turtles. The groin structures are not anticipated to affect species introductions to Hawaiʻi but may serve as habitat for existing introduced species. Future monitoring events should note any changes in the distribution of *A. spicifera* and other invasive species in Waikīkī.

The proposed action is not anticipated to result in any significant long-term degradation of the environment or loss of habitat. Rather, by the construction of the proposed groins, the proposed action will improve the shoreline conditions, restore the beach, and increase potential biological habitat in a relatively barren reef flat area. Ecological services of reef flat habitat will be lost under the project footprints (sand and groins) but are anticipated to recover over time as the benthic community re-establishes. A biological and water quality monitoring program will be implemented to enhance control over construction impacts.

Royal Hawaiian Beach Sector
Biologists surveyed the Royal Hawaiian beach sector, conducting qualitative surveys of the seafloor. The qualitative survey extended east from the Royal Hawaiian groin to the Kūhiō crib wall, and approximately 20 m out from the shoreline. The Royal Hawaiian beach sector is sand with occasional limestone outcrops with algae (*Acanthophora spicifera*, *Padina* sp., and patches of *Gracilaria salicornia*). Corals are absent in this beach sector. Much of this area is intertidal or shallow subtidal marked by small, breaking waves most days of the year.

Kūhiō Beach Sector
Biologists surveyed the entire existing breakwater structures and immediate surrounding basin floor for corals and other marine biota. A census of corals was made along the entirety of the existing groin. The intertidal zone of the existing structures is covered with small numbers of nerite snail (*Nerita picea*), thin shelled rock crab (*Grapsus tenuicrustatus*), and macroalgae (*Cladophora* sp. *Hydrolithon onkodes*, *Dictyota acutiloba*, *Laurencia nidifica*, *Acanthophora spicifera*, and *Gracilaria salicornia*). Invertebrates common here include urchins (*E. mathaei* and *Diadema paucispinum*) and sea cucumbers (*Holothuria atra* and *H. cinerascens*).

A census of corals was made along the entirety of the existing crib wall. No corals were observed on the existing structure. Several coral colonies (*Pocillopora damicornis*) in the <5 cm size class were observed on the outside of the seafloor beyond the crib wall, approximately 10 ft (3 m) seaward from the structure.

A total of 17 species of fishes were identified in and around the basin. Fishes closely associated with the structures included: trumpetfish (*Alustomus chinensis*), Hawaiian gregory (*Stegastes marginatus*), yellowfin goatfish (*Mulloidichthys vanicolensis*), and tobies (*Canthigaster amboinensis*, and *C. jacator*). Other fishes observed included: surgeonfishes (*Acanthurus triostegus*, *Acanthurus blochii*, juvenile *Naso unicornis*), wrasses (*Stethojulis balteata*, *Thalassoma duperrey* and *T. purpurem*), schools of flagtail (*āholehole* or *Kuhlia xenura*), schools of goatfishes (*Parupeneuss multifasciatus* and *P. porphyreus*).

8.10.1 Potential Impacts and Mitigation Measures

Mitigating for impacts to marine resources is a sequential process of avoiding impacts, minimizing impacts, and then compensating for unavoidable adverse impacts. The first step is to avoid impacts through project design. The second step, after avoidance measures have been incorporated, is to minimize remaining impacts. If unavoidable impacts still exist after avoidance and minimization, then replacement of lost ecosystem functions and values is appropriate. This last step is called compensatory mitigation (Bentivoglio, 2003). Project design decisions should incorporate measures to avoid and minimize impacts to marine communities associated with beach stabilization to the extent possible. In particular, impacts to corals in the footprint of the proposed sand borrow margins should be avoided by excluding those areas from the dredging limits.

The United States Coral Reef Task Force (USCRTF) has identified a portfolio of compensatory mitigation and restoration options (USCRTF, 2016) and a list of Best Management Practices (BMPs) that could be implemented to offset adverse impacts on coral reef communities from development projects. The USCRTF list was reviewed and screened for appropriateness to anticipated project-related impacts, ability to successfully implement, and impacts already minimized by project specific BMPs.

The proposed actions have the potential to affect marine biota. Potential impacts include:

- Direct physical disturbance of the seafloor and water column during construction.
- Indirect effects associated with project related changes in water quality.
- Indirect effects related to re-colonization patterns as biota re-establishes itself in areas that were disturbed by temporary construction activities following the completion of construction.

Potential biological effects are considered to be significant to the extent that they exceed the following criteria:

- Change environmental conditions (e.g., water quality, ambient noise level, wave energy, etc.) within a substantial part of the range of an important marine community.
- Involve work in a habitat believed to be used by known sensitive species (Federal or State listed endangered, essential fish habitat, etc.) or in a conservation district.
- Substantially affect the spawning area available to a marine species.

<u>Sand Recovery Effects on Benthic Habitat</u>

Dredging operations have the potential to impact benthic habitat in the vicinity of the sand recovery areas. Analytical modeling was conducted to evaluate the potential impacts of sedimentation on benthic habitat resulting from clamshell dredging for the *Ala Moana* and *Hilton* offshore sand deposits. (see Figure 1 and Figure 2). The modeling results indicate that there would be no anticipated impacts to benthic habitat in the vicinity of the sand recovery areas.

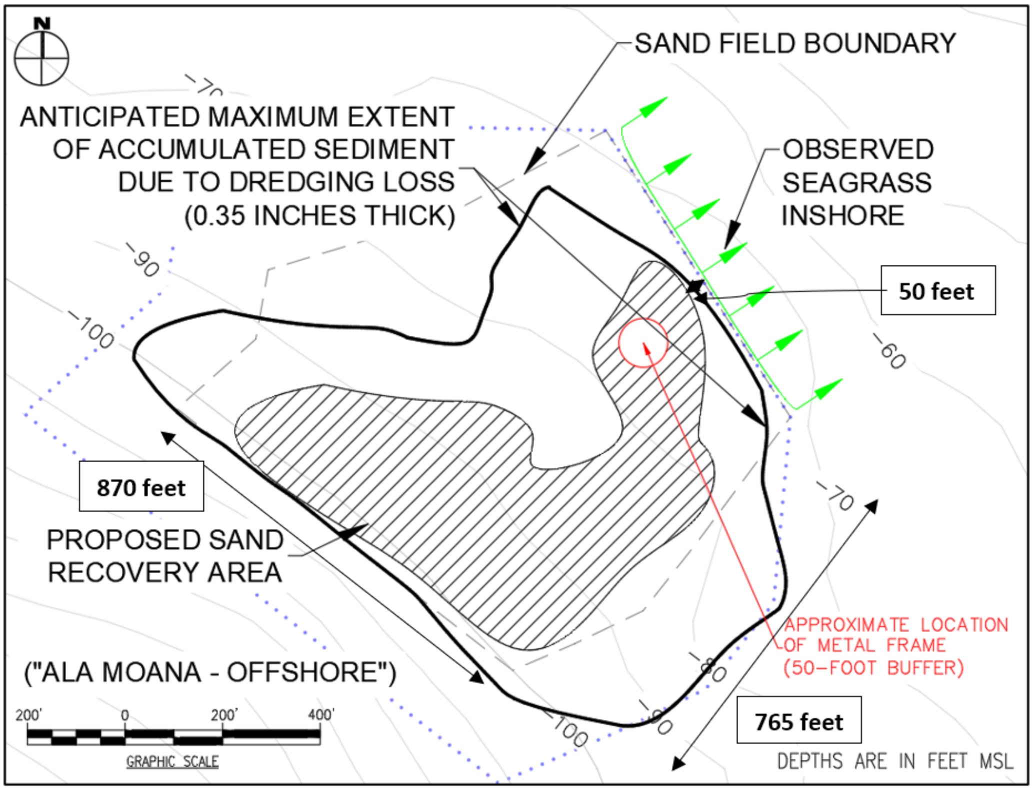


Figure 8-51 Sediment plume modeling results for *Ala Moana* offshore sand deposit

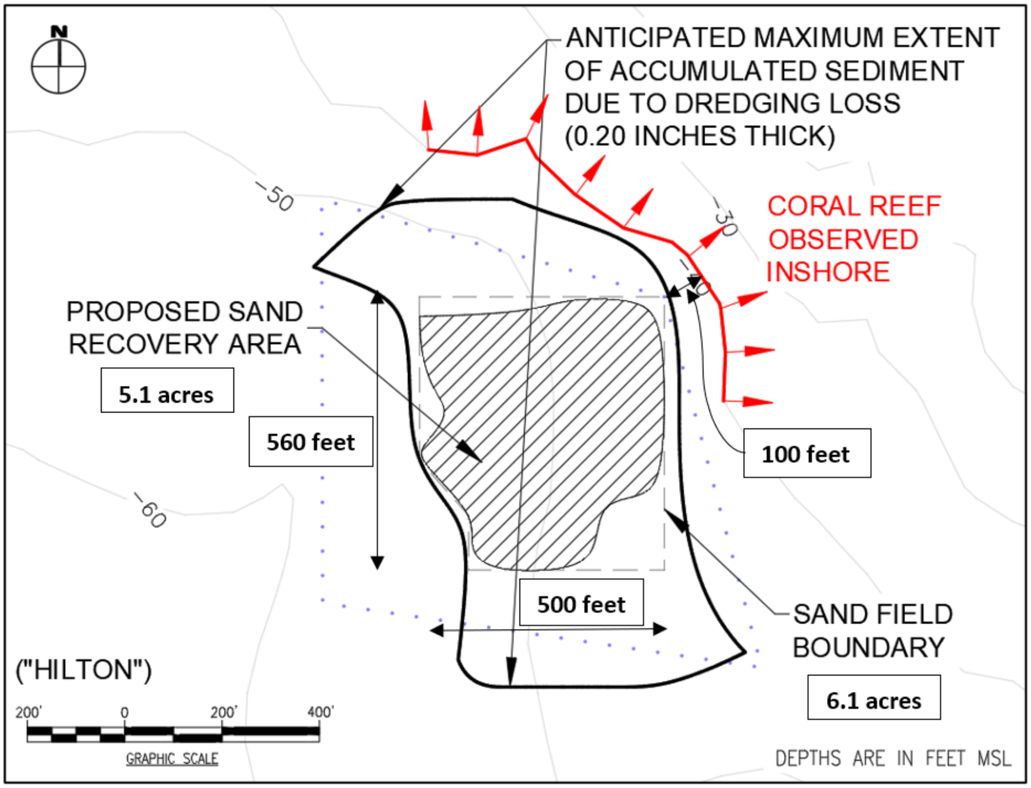


Figure 8-52 Sediment plume modeling results for *Hilton* offshore sand deposit

Analytical modeling was not conducted to evaluate the potential impacts of sedimentation on benthic habitat resulting from dredging activities for the *Canoes/Queens* and *Diamond Head* offshore sand deposits. The *Canoes/Queens* deposit has been used in previous beach nourishment projects in 2012 and 2021. Sand recovery for those projects was accomplished using a hydraulic suction dredge and pumping the sand through a high-density polyethylene (HDPE) pipe to a dewatering basin in the Diamond Head (east) basin of Kūhiō Beach Park. When compared to clamshell dredging, hydraulic suction dredging significantly reduces the potential for sedimentation that could impact benthic habitat.

Sand Recovery Effects on Infauna

Investigation of infauna in the Halekūlani Channel sand deposits identified 31 species of infauna (Bailey-Brock and Krause, 2008). The most abundant taxa observed are the nematodes (round worms, phylum *Nematoda*; 62 percent), followed by oligochaete worms (earth worm relatives, phylum *Annelida*, subclass *Oligochaeta*, 12 percent) and copepods (tiny crustaceans, phylum *Arthropoda*; 8 percent). While the sand deposits may contain a diverse assemblage of infaunal invertebrates, none have been listed as threatened or endangered by Federal or State agencies and none of the infaunal species found are known to be preyed on by typical reef fish. Moreover, the types of organisms that are present have a relatively fast reproductive cycle and those organisms that survive the dredging typically repopulate areas within a relatively short period of time. Dredging will remove sand from the recovery sites, and thus disturbance to infauna in the respective sand deposits will be significant. However, based on the recent 2006 Kūhiō Beach Restoration project, the sand deposits can be expected to fill back up with sand over time, and possibly quite rapidly, and infauna can be expected to rapidly repopulate the deposits.

Sand Recovery Effects on Corals

Studies conducted for the State's 2006 Kūhiō Beach Restoration project provide an excellent model for evaluating potential effects on coral and other marine biota (AECOS, 2007, 2008). The sand recovery sites are bordered by fossil limestone reef rock with less than 1 percent live coral cover. A survey conducted soon after the sand recovery work was completed identified some damage to individual coral colonies, with the condition of individual coral colonies varying greatly. Some corals were in pristine condition, others were mildly damaged (some branches broken, but colony mostly intact), and some were severely damaged or missing entirely. The majority of damage to corals appeared to be the result of equipment movement (pipeline, anchor lines), and much of this appeared to have occurred during an unseasonable south swell event that occurred during the dredging operations.

Biologists re-surveyed the sand recovery area approximately one year following the completion of the work and prepared a final post-construction survey report (Laing, February 22, 2008). Two divers snorkeled the area to inspect individual coral colonies for signs of previously existing damage and for signs of new damage. No recent coral damage was observed during the one-year survey. Previously damaged coral colonies and their cast off fragments experienced varying degrees of recovery success. They found that some coral colonies had succumbed to mechanical damage and died while others had responded with copious growth leading to a more robust growth form. A few previously damaged coral colonies with branches missing were revisited several times. The observations indicated illustrate that there was mixed success in coral fragment survival. Cast-off fragments either fell from the parent colony into a location that promoted growth or into a location that did not. Fragments that landed on sand died without having a stable place to become established. Fragments that landed on hard substrate sometimes survived initially, but later became overgrown with turf algae and died. Other live fragments observed in the 1-year survey were located in small shallow depressions in the reef that are protected during periods of elevated wave energy allowing them continued growth.

Measures proposed to be exercised to protect corals during construction activities include:

- Locating and marking significant corals in the vicinity of the sand recovery areas;
- Identifying pipeline route corridors to minimize the potential for damage to coral and other benthic fauna; and
- Transplanting corals, as necessary and where practicable, to relocate them from the construction site, particularly along the pipeline route.

Sand Recovery Effects on Fishes

The sand deposits are typically home to a relatively small and depauperate resident fish population. None of the fish species that have been observed are listed as rare or endangered. Neither are they considered particularly desirable by fishermen nor by those who conduct subsistence fishing along the shoreline. The Hawaiʻi Coral Reef Assessment & Monitoring Program (CRAMP, 2008) ranked Waikīkī low in mean number of species (55th) and fish biomass (51st) when compared to 56 other CRAMP sites throughout the main Hawaiian Islands. These fish are mobile, as evidenced by the fact that fish ingestion during sand pumping operations was not reported during the State's 2006 Kūhiō Beach Restoration project. The vast majority of fishes are capable of avoiding the equipment used to recover and transport sand from offshore to the shoreline. Sand recovery operations will temporarily displace fish in the vicinity of the operations but are unlikely to injure or kill a substantial number of fish. Furthermore, because the resident fish population is small, the number of affected individuals will be small as well. Consequently, no significant effects to fish are anticipated.

Sand Placement Effects

Sand placement to widen the beaches will take place almost completely on existing sand bottom or barren reef flat. Site investigations show that only about 5 percent of the project footprint may cover exposed limestone reef rock bottom, and even this nearshore hard bottom is regularly scoured and sometimes covered by sand. The new beach will replace in kind the sand bottom to be covered by the beach widening.

Short-term Impacts

The proposed action in the Halekūlani beach sector is not anticipated to result in any significant long-term degradation of the environment or loss of habitat. Rather, by the construction of the proposed groins, the proposed action will improve the shoreline conditions, restore the beach, and increase potential biological habitat in a relatively barren reef flat area. Ecological services of reef flat habitat will be lost under the project footprints (sand and groins) but are anticipated to recover over time as the benthic community re-establishes. Most adult fish in the project vicinity are mobile and will actively avoid direct impacts from project activities. There is potential for demersal fish eggs to be buried; however, new hard substrata created by the groins will provide greater surface area for these species to lay eggs in the future. Some impairment of ability of EFH managed species to find prey items could occur, but this effect should be temporary and spatially limited to the immediate vicinity of construction activities. Turbidity containment barriers will effectively isolate the construction activities from the adjacent seafloor and water column; thus, impacts to marine biota will be limited to the immediate construction area. A biological and water quality monitoring program will be implemented to enhance control over construction impacts.

Long-term Impacts

The proposed action in the Halekūlani beach sector will create approximately 3.8 acres of new dry beach area. Marine habitat in this area consists of a relatively barren reef flat. The groins will provide bare, stable surfaces for recruitment of corals, algae, and other invertebrates. The groins will be porous, permeable, with approximately 37 percent interstitial void space between stones. Obligate reef dwellers are often limited by the availability of suitable shelter, especially juveniles. Reef fishes prefer reef holes and crevices commensurate with the size of the fish. The interstitial spaces between stones will also provide habitat for benthic (crabs, shrimps, worms, etc.) and sessile organisms (sponges and tunicates) which will provide additional foraging resources for fishes. The boulders also provide a hard, stable surface for coral colonization, and elevates them above the shifting sand and rubble bottom.

The Iroquois Point Beach Nourishment and Stabilization project, which was completed in 2013, involved the construction of nine rock rubblemound groins very similar in size and construction to the proposed groins in the Halekūlani beach sector. Extensive marine ecosystem monitoring is being accomplished for that project (AECOS, 2014). The 1-year post-construction marine ecosystem monitoring shows that the project has resulted in a significant increase in marine species diversity and density. In the vicinity of the groins there has been a 25-fold increase in fish abundance, not counting small baitfish, and a tripling of species richness (number of species). Fish biomass is more than six times greater than prior to construction. Prior to construction of the groins, fish biomass at Iroquois Point was considered low compared to island averages around the state, roughly on par with the shallow reef flats off Waikīkī (AECOS, 2009b, 2011, 2014). After construction, the biomass at the groins is on par with maximum values observed around the state (AECOS, 2014). Other changes in the vicinity of the groins includes an increase in crustose coralline algae cover from 1% to 60%, coral cover increase from 0 to 0.6% and macroinvertebrate cover from 1.4% to 6.3%. Coral abundance in the groin vicinity increased from 0 to 16 colonies per 10 m^2, with the most common coral species being *Pocillopora damicornis*. These changes are attributable to the creation of hard, stable habitat for colonization.

The proposed actions have the potential to increase the spread of invasive species, particularly *A. erecta*. Areas where *A. erecta* have been observed will be identified and avoided during sand recovery operations. Two common algae species found in Waikīkī are non-native and invasive: A. *spicifera* and *G. salicornia*. These species are widespread off the shores of the Hawaiian Islands and *A. spicifera* is a food favored by green sea turtle. The proposed groins in the Halekūlani beach sector are not anticipated to affect species introductions to Hawaiʻi but may serve as habitat for existing introduced species. Future monitoring events will note any changes in the distribution of *A. spicifera* and other invasive species in Waikīkī.

8.11 Essential Fish Habitat

The 1996 Sustainable Fishery Act amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and subsequent Essential Fish Habitat (EFH) Regulatory Guidelines (NOAA, 2002) describe provisions to identify and protect habitats of federally-managed marine and anadromous fish species. Under the various provisions, federal agencies that fund, permit, or undertake activities that may adversely affect EFH are required to consult with the National Marine Fisheries Service (NMFS).

EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." EFH is further defined by existing regulations as (MSFCMA, 1996; NOAA, 2002). "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" is defined as required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' life cycle.

The proposed actions are located within waters designated as EFH (including water column and all bottom areas) for coral reef ecosystem, bottomfish, pelagic, and crustacean MUS. Of the thousands of species which are federally managed under the coral reef FMP, at least 58 (juvenile and adult life stages) are known to occur in the general vicinity of Waikīkī Beach (MRC, 2007; AECOS, 2009, 2010, 2012).

The Western Pacific Regional Fishery Management Council (WPRFMC) has restructured its management framework from species-based fishery management plans (FMPs) to place-based fishery ecosystem plans (FEPs). The Hawaiian Archipelago FEP establishes the framework under which the WPRFMC will manage fishery resources and begin the integration and implementation of ecosystem approaches to management in the Hawaiian Archipelago. This FEP does not establish any new fishery management regulations, but rather consolidates existing fishery regulations for demersal species. Specifically, this FEP identifies as MUS those species known to be present in waters around the Hawaiian Archipelago and incorporates all of the management provisions of the Bottomfish and Seamount Groundfish FMP, the Crustaceans FMP, the Precious Corals FMP, and the Coral Reef Ecosystems FMP that are applicable to the area.

In addition to EFH, the WPRFMC identifies Habitat Areas of Particular Concern (HAPC) within EFH for all FEPs. Specific subsets of EFH, HAPCs are areas within EFH that are essential to the life cycle of federally managed coral reef species. In determining whether a type or area of EFH should be designated as a HAPC, one or more of the following criteria established by NMFS should be met: (a) the ecological function provided by the habitat is important; (b) the habitat is sensitive to human-induced environmental degradation; (c) development activities are, or will be, stressing the habitat type; or (d) the habitat type is rare.

8.11.1 Potential Impacts and Mitigation Measures

The proposed actions have the potential to affect EFH. Potential impacts include:

- Direct physical disturbance of the bottom during sand dredging and pumping, and sand placement on the beach.
- Direct physical disturbance of biota in the water column and the disturbed sand substrate as a result of project-related construction activities.
- Indirect effects associated with project related changes in water quality.
- Indirect effects related to re-colonization patterns as biota re-establishes itself in areas that were disturbed by temporary construction activities following the completion of construction.

This section of the DPEIS describes those potential biological effects. Effects are considered to be significant to the extent that they exceed the following criteria:

- Change environmental conditions (e.g., water quality, ambient noise level, wave energy, etc.) within a substantial part of the range of an important marine community.
- Involve work in a habitat believed to be used by known sensitive species (Federal or State listed endangered, essential fish habitat, etc.) or in a conservation district.
- Substantially affect the spawning area available to a marine species.

Sand Recovery Effects on Infauna

Investigation of infauna in the nearby Halekūlani Channel sand deposits identified 31 species of infauna (Bailey-Brock and Krause, 2008). The most abundant taxa observed are the nematodes (round worms, phylum Nematoda; 62 percent), followed by oligochaete worms (earth worm relatives, phylum Annelida, subclass Oligochaeta, 12 percent) and copepods (tiny crustaceans, phylum Arthropoda; 8 percent). While the sand deposits may contain a diverse assemblage of infaunal invertebrates, none have been listed as threatened or endangered by Federal or State agencies and none of the infaunal species found are known to be preyed on by typical reef fish. Moreover, the types of organisms that are present have a relatively fast reproductive cycle and those organisms that survive the dredging typically repopulate areas within a relatively short period of time. Dredging will remove about 35 percent of the total estimated sand available from the recovery sites, and thus disturbance to infauna in the respective sand deposits will be substantial and significant. However, based on the recent Kūhiō Beach experience, the sand deposits can be expected to fill back up with sand over time, and possibly quite rapidly, and infauna can be expected to rapidly repopulate the deposits.

Sand Recovery Effects on Corals

Studies conducted for the State's 2006 Kūhiō Beach Restoration Project, which involved nearly identical activity in the same area, provide an excellent model understanding possible effects on coral and other marine biota (AECOS, 2007, 2008). The sand recovery sites are bordered by fossil limestone reef rock with less than one percent live coral cover. A survey conducted soon after the sand recovery work was completed identified some damage to individual coral colonies, with the condition of individual coral colonies varying greatly. Some corals were in pristine condition, others were mildly damaged (some branches broken, but colony mostly intact), and some were severely damaged or missing entirely. The majority of damage to corals appeared to be the result of equipment movement (pipeline, anchor lines), and much of this appeared to have occurred during an unseasonable south swell event mid-way during the dredging operations.

Biologists re-surveyed the sand extraction area approximately one year following the completion of the work and prepared a final post-construction survey report (Laing, February 22, 2008). Two divers snorkeled the area to inspect individual coral colonies for signs of previously existing damage and for signs of new damage. No recent coral damage was observed during the one-year survey. Previously damaged coral colonies and their cast off fragments experienced varying degrees of recovery success. They found that some coral colonies had succumbed to mechanical damage and died while others had responded with copious growth leading to a more robust growth form. A few previously damaged coral colonies with branches missing were revisited several times. The observations indicated illustrate that there was mixed success in coral fragment survival. Cast-off fragments either fell from the parent colony into a location that promoted growth or into a location that did not. Fragments that landed on sand died without having a stable place to become established. Fragments that landed on hard substrate sometimes survived initially, but later became overgrown with turf algae and died. Other live fragments observed in the 1-year survey were located in small shallow depressions in the reef that are protected during periods of elevated wave energy allowing them continued growth.

Measures proposed to be exercised to protect corals during construction activities include:

- Locating and marking significant corals in the vicinity of the areas to be dredged;
- Identifying a specific pipeline route corridor which minimizes the potential for damage to coral and other benthic fauna; and
- Transplanting corals as necessary and where practicable to relocate them from the construction site, particularly along the pipeline route.

Sand Recovery Effects on Fish and Essential Fish Habitat

The sand deposits are typically home to a relatively small and depauperate resident fish population. None of the fish species that have been observed is listed as rare or endangered. Neither are they considered particularly desirable by fishermen nor by those who conduct subsistence fishing along the shoreline. The Hawaiʻi Coral Reef Assessment & Monitoring Program (CRAMP, 2008) ranked Waikīkī low in mean number of species (55th) and fish biomass (51st) when compared to 56 other CRAMP sites throughout the Main Hawaiian Islands. These fish are mobile. As evidenced by the fact that fish ingestion by a similar pump was not reported during the 2006 Kūhiō Beach Nourishment project, the vast majority of fishes are capable of avoiding the suction intake. Thus, the sand recovery operation will temporarily displace fish in the vicinity but is unlikely to injure or kill a substantial portion of the population. Furthermore, because the resident fish population is small, the number of affected individuals will be small as well. Consequently, no significant effect is anticipated.

Long-term Effects

The bottom composition in the nearshore environment of Waikīkī and the project vicinity consists of a highly bioeroded fossil limestone reef platform with sand channels and deposits. The benthic community structure is heavily influenced by the scouring action of wave driven sand. The dominant taxa of benthic organisms are algae; corals and other macroinvertebrates are relatively rare. The greatest density and diversity of biota is found in areas where high vertical relief provides protection from sand scour. The Waikīkī sea bottom is dominated by two introduced and invasive algal species: *Acanthophora spicifera* and *Gracileria salicornia*. Another invasive algal species, *Avrainvillea amadelha*, is also becoming more common.

AECOS (2007, 2008) conducted post-project marine monitoring for the 2006 Kūhiō Beach Nourishment project at intervals of 3, 6, 12 and 15 months. Four "impact" monitoring sites were located offshore of the Kūhiō Beach crib walls, one site was located midway along the proposed project reach (offshore of the Moana Surfrider Hotel), and control sites were located to the east in the Waikīkī Marine Life Conservation District and to the west offshore of the Sheraton Waikiki Hotel. The post-construction monitoring showed a significant increase in the percent coverage of algae over the 15-month period, and other changes throughout the study area, however the changes were also evident at the control sites outside of the presumed influence of the project, thus it was concluded that the observed changes are due to factors other than the beach nourishment project. Based on this past experience, no significant long-term impacts are anticipated from the proposed action.

8.12 Protected Species

The nearshore area off Waikīkī is frequented by the threatened green sea turtle (*Chelonia mydas*), which feeds on the algae covered bottom. Hawaiian monk seals (*Monachus schauinslandi*) have been seen in Waikīkī on rare occasions, but this is exceptional, and they have not been reported in the vicinity of the proposed actions. No other listed species have been observed.

Biologists have noted the regular presence of sea turtles in the project area. No obvious congregation or resting areas have been seen, but the turtles clearly forage on the algae that grows in the nearshore area. Turtle surveys in the general area indicate that turtle abundance is not negatively affected by the number of people in the water or all the ocean recreation activities which occur in Waikīkī.

<u>Green Sea Turtles</u>

The distinct population segment (DPS) of green sea turtle that occurs in Hawaiʻi is federally-listed as a threatened species (USFWS and NOAA-NMFS, 2016; UFWS, 2018) and as a threatened subspecies (*Chelonia mydas agassizi*) under Hawaiʻi regulations (DLNR, 2014).

Threats to the green sea turtle in Hawaiʻi include: disease and parasites, accidental fishing take, boat collisions, entanglement in marine debris, loss of foraging habitat to development, and ingestion of marine debris. Throughout the global range of green sea turtle, nesting and foraging habitats are being altered and destroyed by coastal development, beach armoring, beachfront lighting, vehicular/pedestrian traffic, invasive species, and pollution from discharges and runoff (NOAA & USFWS, 2007a, 2007b). Adult green sea turtles forage in shallow nearshore areas and on coral reefs. Contamination from effluent discharges and runoff has degraded these environments, and invasive species may reduce native algae species preferred by green sea turtles or could exacerbate susceptibility to, or development of disease (NOAA-NMFS and USFWS, 2007a). Fibropapillomatosis, a disease characterized by the presence of internal and/or external tumors that may grow large enough to hamper swimming, vision, feeding, and potential escape from predators continues to be a major threat to green sea turtles. Extremely high incidence has been reported in Hawaiʻi, where affliction rates peaked at 47-69% in some turtle foraging areas (Murakawa et al., 2000).

Hawksbill Sea Turtles

The Hawksbill sea turtle is distributed across the Pacific, Indian, and Atlantic oceans. Hawksbill sea turtle is much less common in the Hawaiian Islands than green sea turtle and is known to nest only in the southern reaches of the state (NOAA-PIFSC, 2010). Hawksbill sea turtle is federally-listed as endangered and is also listed as an endangered subspecies (*Eretmochelys imbricata bissa*) under Hawaiʻi regulations (HDLNR, 2014). Hawksbill sea turtle faces many of the same threats affecting green sea turtle (see above section; NOAA & USFWS, 2007b).

Hawaiian Monk Seals

The endangered Hawaiian monk seal (*Monachus schauinslandi*) is known to occur in the project vicinity. The Hawaiian monk seal was first listed as an endangered species pursuant to the ESA on November 23, 1976 (41 FR 51612) and remains listed as endangered. In that same year, the Hawaiian monk seal population was designated as "depleted" under the Marine Mammal Protection Act (MMPA).

The majority of monk seal sighting information collected in the main Hawaiian Islands is reported by the general public and is highly biased by location and reporting effort. Systematic monk seal count data come from aerial surveys conducted by the Pacific Islands Fisheries Science Center (PIFSC). Aerial surveys of all the main Hawaiian Islands were conducted in 2000-2001 and in 2008 (Baker and Johanos, 2004, PIFSC unpublished data). One complete survey of Oʻahu was conducted for each of these years. The 2000 survey was conducted from an airplane and the 2001 and 2008 surveys were conducted by helicopter. No Hawaiian monk seals were sighted off Waikīkī during any of the three surveys.

Reports by the general public, which are non-systematic and not representative of overall seal use of main Hawaiian Islands shorelines, have been collected in the main Hawaiian Islands since the early 1980s. In total, seventy-six Hawaiian monk seal sightings have been reported off Waikīkī, east of the project vicinity between Queen's Beach and Sans Souci Beach, between 2002 and 2011. A sighting is defined as a calendar day during which an individual seal was documented as present at a given location. It should be noted that the majority of monk seal sightings are reported when seals are sighted onshore. No births have been documented for the area.

Critical habitat for Hawaiian monk seals has been designated (NOAA-NMFS, 2015) and includes the seafloor and marine environment to 10 m above the seafloor from the 200 m depth contour, through the shoreline and extending onto the land 5 m inland from the shoreline between identified boundary points. These terrestrial boundary points define preferred pupping areas and significant haul-out areas. Waikīkī is excluded from terrestrial critical habitat designation (NOAA-NMFS, 2015).

Humpback Whales

The humpback whale or *koholā* (*Megaptera novaeangliae*) was listed as endangered in 1970 under the ESA. In 1993 it was estimated that there were 6,000 humpback whales in the North Pacific Ocean, and that 4,000 of these regularly came to the Hawaiian Islands. The population is estimated to be growing at between 4 and 7% per year. Today, as many as 10,000 humpback whales may visit Hawaiʻi each year (HIHWNMS, 2014).

The waters of Maunalua Bay are within the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS). Humpback whales normally occur in Hawaiian waters annually from November to May with the peak between January and March (HIHWNMS, 2014). The proposed actions will not directly affect humpback whales, and sounds generated from groin improvement activities are not anticipated to be substantial enough to cause an acoustic disturbance to protected species in nearshore waters. The effects thresholds currently used by NMFS are marine mammal specific and based on levels of harassment as defined by the Marine Mammal Protection Act (MMPA). For exposure to sounds in water, >180 dB and >190 dB are the thresholds for Level A harassment (i.e., injury and/or PTS) for cetaceans and pinnipeds, respectively. The thresholds for Level B harassment for all marine mammals in the form of TTS and other behavioral impacts are >160 dB for impulsive noises and >120 dB for continuous noises (NOAA, 2013).

Invertebrates

Hawaiʻi Department of Land and Natural Resources (HDLNR) regulates shellfishes such as pearl oysters (HDLNR, 1987) and ʻopihi (HDLNR, 1989). No ʻopihi species or pearl oyster (*Pinctada margaritifera*) were observed in our survey of the Project area.

Coral species are protected under Hawaiʻi State law, which prohibits "breaking or damaging, with any implement, any stony coral from the waters of Hawaiʻi, including any reef or mushroom coral" (HAR §13-95-70, DLNR, 2010). It is also unlawful to take, break or damage with any implement, any rock or coral to which marine life of any type is visibly attached (HAR §13-95-71, DLNR, 2002).

In February 2010, 83 species of corals world-wide were petitioned for listing as threatened or endangered under ESA (NOAA-NMFS, 2010). In response to the petition, the National Oceanic and Atmospheric Administration (NOAA) completed a status review report (Brainard et al., 2011) in March 2011 and a management report of the candidate species (PIRO-NOAA, 2012) in November 2012. A proposed rule was published in December 2012 (NOAA-NMFS, 2012) with public comment extended through April 6, 2013 (NOAA-NMFS, 2013). On August 27, 2014, NOAA issued a final rule for listing 20 coral species as threatened under the Endangered Species Act (ESA; NOAA-NMFS, 2014), but none of these listed coral species occurs in Hawaiʻi. On September 20, 2018, NOAA issued a proposed rule for listing the cauliflower coral (*Pocillopora meandrina*) as an endangered or threatened species under ESA (NOAA-NMFS, 2018). A global status review has been initiated by NOAA to determine whether listing throughout the species range is warranted.

8.12.1 Potential Impacts and Mitigation Measures

The proposed actions have the potential to affect protected species. Dredging activities will produce an underwater sound that can be perceived by marine creatures. The ears of marine mammals and sea turtles are sensitive to changes in sound pressure which is produced by the amplitude, wavelength, and frequency of a sound wave. While audiograms are not available for whales and sea turtles, it is generally accepted that 120 dB causes disturbance to these sea creatures.

The underwater sound intensity level of a pump has not presently been determined; however, the level can be inferred based on the sound intensity level of the pump in air. The following relationship can be used to convert the source in-air sound level intensity to the source underwater sound level intensity:

$$\text{dB (water)} = \text{dB(air)} + 62$$

Pumps with power ratings of 75 Hp like the one used for the 2006 Kūhiō Beach project are reported to generally produce in-air sound levels of about 90 dB; the corresponding source underwater sound level will be 152 dB. Propagation losses are primarily caused by spherical spreading and can be calculated using the following relationship:

$$\text{Propagation Losses} = 20\log(r)$$

where

r = radial distance from the source in meters

Using 152 dB as the source underwater sound level and using a threshold level of 120 dB for continuous noise for marine creature disturbance, the resulting operational clearance distance is found from:

$$20\log(r) = 152-120$$

which gives

$$r = 40 \text{ m (131 ft)}.$$

Thus, sea turtle disturbance will be limited to within about a 130-ft radius of the sand recovery operations. Turtles would be expected to move away from the disturbance, and as the impact area is relatively small and primarily in sandy bottom, it is not anticipated to affect turtle foraging.

The following Best Management Practices (BMPs) as typically recommended by the National Marine Fisheries Service (NMFS) will be adhered to during construction of the proposed actions to avoid impacts to protected species:

1. Conduct a survey for marine protected species before any work in the water starts, and if a marine protected species is in the area, a 150-ft buffer must be observed between the protected species and the work zone.
2. Establish a safety zone around the project area whereby observers will visually monitor this zone for marine protected species 30 minutes prior to, during, and 30 minutes post project in-water activity. Record information on the species, numbers, behavior, time of observation, location, start and end times of project activity, sex or age class (when possible) and any other disturbances (visual or acoustic).
3. Conduct activities only if the safety zone is clear of turtles.
4. Upon sighting of a turtle within the safety zone during project activity, immediately halt the activity until the animal has left the zone. In the event a marine protected species enters the safety zone and the project activity cannot be halted, conduct observations and immediately contact NMFS staff in Honolulu to facilitate agency assessment of collected data.
5. For on-site project personnel that may interact with a protected species potentially present in the project area, provide education on the status of any listed species and the protections afforded to those species under Federal laws.

Potential effects on protected species will be mitigated as follows:

- By using the above BMPs noise/physical disturbance to green sea turtles is expected to be temporary and insignificant and not result in adverse behavioral changes.
- Based on the in-water work being conducted in relatively shallow water with silt curtains confining the sediment, any exposure of marine protected species to turbidity and sedimentation will be temporary and not significant.
- The sand recovery site is not frequented by turtles or used as a foraging area due to a lack of algae on the sand bottom, the sand recovery equipment will be fitted with fences/barriers to prevent turtle entanglement or entrapment, and the above discussed BMPs will be implemented, thus physical disturbance to turtles is anticipated to be temporary and not significant during the sand recovery operations.

Given the extensive turtle foraging area in Waikīkī, and the relatively small percent loss which will result from the proposed actions, the change in turtle foraging habits and habitats is not anticipated to be significant.

9. BUILT ENVIRONMENT

9.1 Socioeconomic Setting

9.1.1 General Overview

Waikīkī is a densely developed urban area that supports a wide variety of commercial, recreational, and residential uses. Waikīkī Beach is recognized as the State's primary tourist destination, attracting millions of visitors yearly. The Waikīkī shoreline is dominated by a series of major hotels and resorts that extend from Ala Wai Boat Harbor to Kapiʻolani Park.

9.1.2 Population and Growth

In 2016, the resident population of the City and County of Honolulu was 992,605. The de facto population, which accounts for the number of residents and visitors present at a given time, was 12.1 percent higher at that time (DBEDT, 2019). The number of annual visitors to Hawaiʻi has steadily increased since the 1970s. The total number of Oʻahu visitors increased by 18.5% between 2007 and 2016, and the State of Hawaiʻi set a new record in 2019 with 10.4 million visitors. The resident and de facto populations of the City and County of Honolulu are projected to grow at an annual rate of 0.3 and 0.1 percent, respectively, through 2045 (DBEDT, 2019).

The proposed actions are intended to restore and improve the beaches of Waikīkī. The proposed actions are intended to increase beach width and stability and improve lateral shoreline access and support ongoing recreational and commercial uses in Waikīkī. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational and economic uses in Waikīkī. The proposed actions are not anticipated to increase the resident or de facto populations of the City and County of Honolulu.

9.1.3 Land Ownership

Waikīkī is a densely developed urban, commercial area. The Waikīkī shoreline is dominated by a series of major hotels and resorts that extend from Ala Wai Boat Harbor to Kapiʻolani Park. There are 21 individual public and privately-owned parcels within the project area. A summary of the major landowners in the project area is shown in

Table 9-1.

Table 9-1 Summary of land ownership in the project area

Beach Sector	Tax Map Key	Address	Owner
Fort DeRussy	(1) 2-6-005:001	2066 Kālia Road	United States of America
Fort DeRussy	(1) 2-6-005:006	192 Paoa Place	State of Hawaiʻi
Halekūlani	(1) 2-6-004:012	2161 Kālia Road	Waikīkī Shore
Halekūlani	(1) 2-6-004:010	2169 Kālia Road	ORTG ORF LLC
Halekūlani	(1) 2-6-004:008	2199 Kālia Road	Halekūlani Corporation
Halekūlani	(1) 2-6-004:007	2199 Kālia Road	Halekūlani Corporation
Halekūlani	(1) 2-6-004:006	2199 Kālia Road	Halekūlani Corporation
Halekūlani	(1) 2-6-004:005	2199 Kālia Road	Multiple Owners
Halekūlani	(1) 2-6-002:026	Undefined	Multiple Owners
Halekūlani	(1) 2-6-002:006	2255 Kalākaua Ave.	Kyo-ya Resorts & Hotels LP
Royal Hawaiian	(1) 2-6-002:005	2255 Kalākaua Ave	Bishop Estate Trust
Royal Hawaiian	(1) 2-6-002:017	2325 Kalākaua Ave	Queen Emma Land Company
Royal Hawaiian	(1) 2-6-001:013	2353 Kalākaua Ave	Kyo-ya Resorts & Hotels LP
Royal Hawaiian	(1) 2-6-001:012	2371 Kalākaua Ave	Kyo-ya Resorts & Hotels LP
Royal Hawaiian	(1) 2-6-001:015	Undefined	State of Hawaiʻi
Royal Hawaiian	(1) 2-6-001:018	2403 Kalākaua Ave	City and County of Honolulu
Royal Hawaiian	(1) 2-6-001:008	2401 Kalākaua Ave	City and County of Honolulu
Kūhiō	(1) 2-6-001:017	Undefined	City and County of Honolulu
Kūhiō	(1) 2-6-001:004	2479 Kālia Ave	City and County of Honolulu
Kūhiō	(1) 2-6-001:003	2501 Kālia Ave	City and County of Honolulu
Kūhiō	(1) 3-1-030:005	Undefined	State of Hawaiʻi

Shorelines, beaches, and nearshore waters in Hawaiʻi are considered part of the Public Trust, with access and use available to all people. As a result, Hawaii's shorelines are heavily regulated. The current definition of the "shoreline" in Hawaiʻi is as follows:

> "*Shoreline* means the upper reaches of the wash of the waves, other than storm or seismic waves, at high tide during the season of the year in which the highest wash of the waves occurs, usually evidenced by the edge of vegetation growth, or the upper limit of debris left by the wash of the waves (Hawaiʻi Administrative Rules (HAR) §13-222)."

Generally, County jurisdiction begins at the shoreline and extends mauka (landward). State jurisdiction begins at the shoreline and extends makai (seaward). Federal jurisdiction begins at the mean higher high water (MHHW) line and extends out to the 200 nautical mile limit of the U.S. exclusive economic zone (EEZ); this area is also defined as "navigable waters of the United States". The relevant jurisdictional boundaries for coastal construction in Hawaiʻi are shown in Figure 9-1.

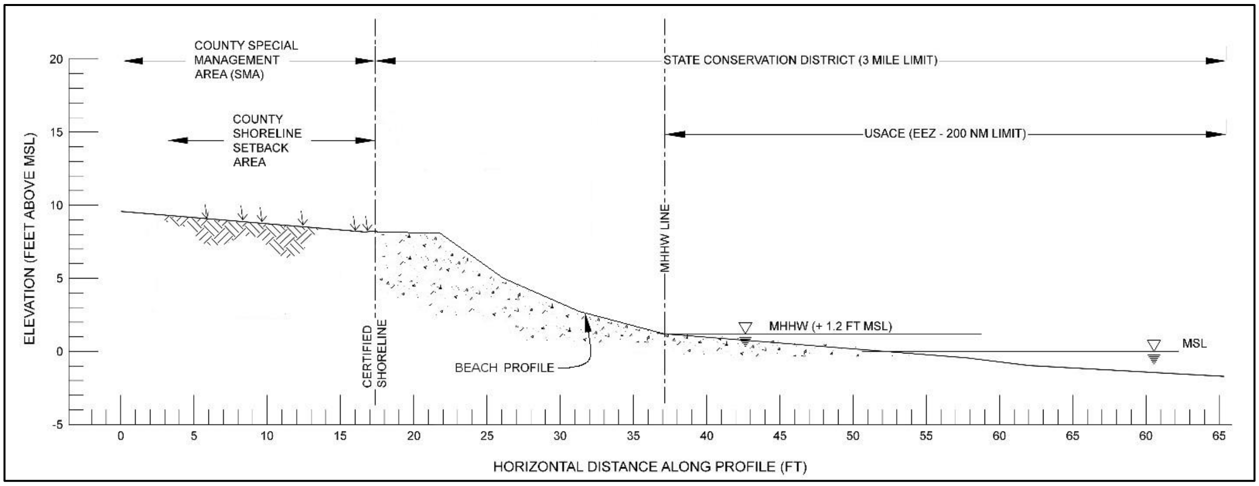


Figure 9-1 Jurisdictional boundaries for coastal construction in Hawai‘i

The Federal, State, and County governments all have different objectives and rules regulating what activities are permissible along the shoreline. Therefore, the definition and location of the “shoreline” is critical for the planning and permitting of coastal construction projects. The certified shoreline is a line established by a licensed land surveyor and certified by the State of Hawai‘i, which reflects the shoreline definition stated above. The certified shoreline is valid for 12 months from the date of issuance and is used to establish State and County jurisdiction and shoreline setbacks.

Fort DeRussy Beach Sector

Fort DeRussy is a U.S. military reservation that is under the jurisdiction of the United States Army. Most the backshore area between the shoreline and Kālia Road is owned and maintained by the Federal government. Notable features include the Fort DeRussy beach walkway, Duke Paoa Kahanamoku Park, Hale Koa Hotel, Fort DeRussy Park, the Daniel K. Inouye Asia-Pacific Center for Security Studies, and the U.S. Army Museum of Hawai‘i.

Halekūlani Beach Sector

The backshore area between the shoreline and Kālia Road is privately owned and densely developed with hotels, resorts, shops, and restaurants. Major resorts in this sector includes the Castle Waikīkī Shore, Outrigger Reef Waikīkī Beach Resort, Halekūlani Hotel, and the Sheraton Waikiki Hotel.

Royal Hawaiian Beach Sector

The backshore area between the shoreline and Kalākaua Avenue is almost entirely privately owned and densely developed with hotels, resorts, shops, and restaurants. Major development in this sector includes the Royal Hawaiian Hotel, Outrigger Waikīkī Beach Resort, and Moana Surfrider Hotel. The Honolulu Police Department is located east of the Moana Surfrider Hotel. At the east end of the sector, there is an open area of public beach park seaward of Kalākaua Avenue that is managed by the City and County of Honolulu Department of Enterprise Services. The area is leased to beach concessionaires that conduct commercial ocean recreation activities and equipment rentals (e.g., surfboards, paddleboards, snorkeling, outrigger canoe rides, and beach catamaran rides).

Kūhiō Beach Sector

The backshore area immediately landward of the shoreline consists of a sidewalk that provides lateral access along Kalākaua Avenue. The area mauka (landward) of Kalākaua Avenue is privately owned and densely developed with hotels, resorts, shops, and restaurants. Major development in this sector includes the Aston Waikīkī Circle, ʻAlohilani Resort, Waikīkī Beach Marriott, Aston Waikīkī Beach Resort, and the Park Shore Hotel.

Waikīkī Beach Reclamation Agreement

In 1928, the Waikīkī Beach Reclamation agreement was established between the Territory of Hawaiʻi property owners in Waikīkī. The agreement recognized the need to control and limit seaward development on Waikīkī Beach and established limitations on construction along the beach in response to the proliferation of seawalls in Waikīkī. The agreement provided that the Territory of Hawaiʻi would build a beach seaward from the existing high water mark and that title of the newly created beach would be vested by the abutting landowners. The Territory of Hawaiʻi and the private landowners further agreed that they would not build any new structures on the beach in Waikīkī. The private landowners agreed to allow a 75-ft-wide public easement along the beach measured from the new mean high water mark.

The Waikīkī Beach Reclamation agreement covers the beach area including the area from the Ala Wai Canal to the Elks Club at Diamond Head. The agreement consists of a) the October 19, 1928 main agreement between the Territory and Waikīkī landowners, b) the October 19, 1928 main agreement between the Territory and the Estate of Bernice Pauahi Bishop, and c) the July 5, 1929 Supplemental Agreement between the Territory and Waikīkī landowners. The shoreline area between the Royal Hawaiian Hotel and the Moana Surfrider Hotel is the subject of a separate agreement between the Territory and the subject Waikīkī landowners entered into on May 28, 1965.

9.1.4 Economy

Waikīkī Beach is recognized as the State's primary tourist destination, attracting millions of visitors yearly. Waikīkī contains approximately 44 percent of the rooms/lodging units available in the State. The Waikīkī Beach Erosion Control Reevaluation Report prepared by the U.S. Army Corps of Engineers contains an extensive economic analysis of the costs and benefits of beach restoration and erosion control along all of Waikīkī Beach (Lent, 2002, and USACE, 2002). Some of the findings of this analysis include the following.

Visitor surveys indicate that 12.6 percent of tourists cited crowding and congestion (considered to be of the beach) as the primary reasons for not revisiting Waikīkī. This is equivalent to about 250,000 visitors, or 3.6 percent of the total visitors to the State in a year. These visitors, were they to revisit Waikīkī, would spend an estimated $181 million/yr.

A benefit to cost ratio analysis was completed to determine Federal interest in restoring and improving Waikīkī Beach, with a ratio greater than one indicating that benefits exceeded costs. The overall benefit to cost ratio for all of Waikīkī was about 6. The total Waikīkī Gross National Product (GNP) contribution to the annual Federal economy is an estimated $3.3 billion. This estimate excludes spending by mainland west coast visitors (USACE, 2002).

An economic analysis of the importance of Waikīkī Beach conducted by Hospitality Advisors LLC (2008) showed that an overwhelming majority of all visitors consider beach availability to be very important. When presented with the possibility of the complete erosion of Waikīkī, 58% of all westbound visitors said they would not consider staying in Waikīkī without the beach.

9.1.5 Potential Impacts and Mitigation Measures

The proposed actions will restore and stabilize existing public beaches in Waikīkī. The economic value of the beaches to the commercial success of Waikīkī is extremely significant. A study by Hospitality Advisors, LLC (2008) determined that if Waikīkī Beach is not maintained and allowed to erode away it could result in a $150 million annual loss in State tax revenue, and a loss of 6,350 jobs in the hotel industry alone. A more recent study by Tarui et al. (2018) determined that complete erosion of Waikīkī Beach would result in an annual loss of $2.223 billion in visitor expenditures.

The proposed actions will not alter existing land use patterns seaward of the shoreline and no changes in beach use patterns are anticipated. Some negative economic impact on commercial activities may occur during construction; however, every effort will be made to minimize adverse economic impacts, particularly during the prime daytime beach use hours.

The direct socio-economic effects of the proposed actions are limited primarily to construction employment and related business activity. The direct construction employment and business expenditures are not large enough to affect the larger socio-economic context of the Waikīkī area. Overall, the economic effect on existing land uses is anticipated to be positive. The No Action alternative would have a significant negative impact on the economies of the State of Hawaiʻi and City and County of Honolulu. Waikīkī has 87% of the total hotel rooms on Oʻahu, and approximately 69% of all Oʻahu visitors participate in swimming/sunbathing/beach activities (Hospitality Advisors, LLC, 2008).

The resident and de facto populations of the City and County of Honolulu are projected to grow at an annual rate of 0.3 and 0.1 percent, respectively, through 2045 (DBEDT, 2019). Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational and economic uses in Waikīkī. The proposed actions are not anticipated to increase the resident or de facto populations of the City and County of Honolulu.

9.2 Historical, Cultural and Archaeological Resources

A Cultural Impact Assessment (CIA) was prepared by International Archeology, LLC. (IA, 2021) for the proposed beach improvement and maintenance actions to comply with the State of Hawaii's environmental review process under HRS Chapter 343 and HAR §11-200.1. The CIA is included as Appendix D. In addition, a Ka Paʻakai Cultural Impact Analysis was prepared by SEI. The results of these assessments are summarized below.

9.2.1 Cultural Geography

This section provides an overview of the cultural geography of the Waikīkī area and the Waikīkī beach sectors that will be affected by the proposed beach improvement and maintenance program. Components of this section are 1) place names that indicate connections between physical locations in Waikīkī and traditional Hawaiian cultural practices, notable people, and important events; 2) the traditional history of Waikīkī, reflecting its political, economic, and spiritual significance in Hawaiian society before European contact; and 3) the history of Waikīkī following European contact in 1778, and its subsequent transformations in the approximately 200-year span through the mid-20th century.

This section has largely been adapted from Tomonari-Tuggle (2017) and Lauer et al. (2019). Both reports relied on primary references from Bishop (1881)1, Kamakau (1976, 1991, 1992), Pukui et al. (1974), and Sterling and Summers (1978). Historical information was also obtained from books and reports held in the IA library, the State Historic Preservation Division (SHPD) Kapolei Library, and the State Office of Environmental Quality Control online library of environmental assessments and impact statements (archaeological reports and CIAs are generally included as appendices).

Place Names

The project area falls within the *ahupuaʻa* of Waikīkī in the traditional district of Kona. Waikīkī includes the seven valleys from Mānoa on the west to Kuliʻouʻou on the east; in contrast, the eastern half of Kona district consists of smaller *ahupuaʻa* whose boundaries are generally coterminous with valley areas (e.g., Nuʻuanu, Kalihi, Kahauiki, and Moanalua). The reasoning behind this difference in *ahupuaʻa* size is unknown, although the political prominence of Waikīkī and the concentration of chiefs who came to live and play in this area may have been a factor (Tomonari-Tuggle and Blankfein 1998).

Waikīkī translates as "spouting water" (Pukui and Elbert 1986:223), in reference to the wetlands and abundant water sources of this region. Many traditional place names in Waikīkī relate to agriculture or the requirements for successful agriculture. Three place names (Waiʻaʻala, Waiaka, and Waikīkī) reference water (*wai*), one (ʻĀpuakēhau) may be the name of a rain, two refer to soil or sand (Kapahulu and Keʻokea), and three relate to food plants, *niu* (*Cocos nucifera*) (Niukūkahi and Uluniu) and *ʻuala* (*Ipomoea batatas*) (Kalauʻuala). The sea (ʻAuʻaukai and Hamohamo) is another theme; the place name Kanukuāʻula refers to a very fine-meshed fishing net. A single place name, Kaluaʻolohe, relates to a historical event and person.

Other Waikīkī place names refer to locations where events recounted in Hawaiian traditions occurred, or places that are related to Hawaiians of historical note. An example of the former is

ʻĀpuakēhau (in the Royal Hawaiian sector, roughly where the Royal Hawaiian Hotel sits), which is said to be where the Maui king Kahekili landed his invasion force in his successful conquest of Oʻahu (Fornander 1919:VI-2:289; Kanahele 1995:79); the general area was called Helumoa and was the site of royal residences, a heiau, athletic grounds, and a royal coconut grove. Another example is Kawehewehe (at the boundary between Halekūlani and Fort DeRussy sectors), which was the residence of the Luluka family of noted Hawaiian historian, John Papa ʻĪʻī. The family moved to Oʻahu in the early 1800s, in the company of Kamehameha who was preparing for the invasion of Kauaʻi (ʻĪʻī 1959:15); Papa ʻĪʻī's uncle was a member of the royal court, and members of the Luluka family were responsible for the royal residence of Kamehameha at Puaʻaliʻiliʻi at Helumoa.

Traditional place names are associated with each of the Waikīkī Beach sectors included in the proposed project area. In the Fort DeRussy beach sector, the two place names are Kālia, which is the traditional Hawaiian name for this general area, and Kawehewehe, which is the name of the former drainage that marks the east side of the beach sector (roughly the alignment of Saratoga Road).

Prior to modern development, the Halekūlani beach sector lay between two drainages, ʻĀpuakēhau to the east (in the Royal Hawaiian sector) and Kawehewehe to the west (along the boundary with the Fort DeRussy sector). Kawehewehe was the outflow from the large fishpond complex of Kālia, the inland area of present Fort DeRussy. As markers of a former landscape, ʻĀpuakēhau and Kuʻekaunahi are important as the names of two of the three major drainages that once cut through the Waikīkī coastal plain. The single place name in the Halekūlani beach sector is Kawehewehe, which refers to the land and sea area at the west end of the sector, as well as to the mouth of a drainage that emptied the fishponds of inner Kālia (roughly along the present alignment of Saratoga Road). It might also be the name of the channel through the reef in front of the present Halekūlani Hotel (Pukui et al. 1974:99).

Place names in the Royal Hawaiian beach sector reflect the *aliʻi* connections to the area: Helumoa as the royal center, Helumoa Heiau and Kahuamokomoko as adjuncts to the royal center, Hamohamo along the coast as part of Liliʻuokalani's birthright, and Pualeilani as the first beach home of Prince Kūhiō. Another historical place is Muliwai ʻĀpuakēhau, which was the mouth of ʻĀpuakēhau Stream, which was one of three major drainages that flowed into Waikīkī waters.

The Kūhiō beach sector contained Liliʻuokalani's beachside residence, Kealohilani (Kanahele 1928b), which was subsequently the Pualeilani home of Prince Jonah Kūhiō Kalanianaʻole. In the midcentury Māhele, the *ʻili* of Hamohamo was awarded to the high chief Keohokālole. In 1859, Keohokālole transferred the land to her daughter Liliʻuokalani (future queen of Hawaiʻi), who established a residence at Paoakalani (makai of the present Ala Wai Canal) and a beachside cottage that she called Kealohilani. In 1918, Prince Kūhiō acquired Kealohilani through an out-of-court settlement of his challenge to Liliʻuokalani's establishment of a trust (Hibbard and Franzen 1986:37), and built a new home called Pualeilani on the property. Until the late 1800s, Kuʻekaunahi Stream flowed as a wide and slow-moving estuary into the ocean in the southern portion of the Kūhiō beach sector (the Diamond Head (east) basin, around the present alignment of Paoakalani Avenue). Another historical place in the Kūhiō beach sector is Muliwai

Kuʻekaunahi, which was the mouth of Kuʻekaunahi Stream. This stream was one of three major drainages that flowed into Waikīkī waters.

Traditions

The chronology of pre-Contact occupation along the Waikīkī shoreline is based on a suite of 16 radiocarbon determinations obtained from previous archaeological investigations in the area. The radiocarbon determinations are problematic in that most samples were run on unidentified charcoal which has potential to produce dates with inbuilt age (i.e., dates that are older than the target event). Considering this limitation, the use of Bayesian modeling provides the best current estimate for occupation along the Waikīkī shoreline of no later than AD 1350–1610 (95.4%), and likely AD 1379–1600 (68.2%) (Tomonari-Tuggle 2017).

The earliest Hawaiian settlers probably made their homes on the windward shores of the islands and visited the drier southern and western areas only for selected resources like fish and birds. As time passed and settlers eventually migrated to other parts of Oʻahu, coastal Waikīkī was probably one of the earliest areas occupied as it offered easy access to rich ocean resources, a ready freshwater supply from springs and streams, level and easily developed lands for cultivation and aquaculture, and a bounty of game foods like ducks and other wildfowl. Some cultivation probably followed the stream courses into valleys like Mānoa, which were also sources for items like hardwood (for tools, weapons, and building materials) and birds (for feathers) (Tomonari-Tuggle and Blankfein 1998).

The traditions of Waikīkī indicate its significance as a nexus of interconnected *aliʻi* histories and as a highly productive agricultural region. In ancient times, Waikīkī was a center of *aliʻi* power, “a land beloved of the chiefs” who resided there because the lands were rich and the surfing was excellent (Kamakau 1991:44).

Chiefly Associations

It is said that Māʻilikūkāhi, the ruling chief of Oʻahu in the mid-14th century (based on genealogical reckoning), made Waikīkī the royal seat of chiefs (Beckwith 1970:383). From that time, it was the residence, either permanently or part-time, of the high *aliʻi*. In the 16th century, the Maui chief Kiha-a-Piʻilani was born at ʻĀpuakēhau (Kamakau 1991:50). In the 18th century, after his conquest of the island, Maui king Kahekili made his home at Waikīkī, as did Kamehameha after he succeeded in wresting control of the island from Kahekili’s successor. Kamakau (1992:394) writes that Kamehameha made Kekāuluohi his wife at ʻĀpuakēhau; she later became one of Liholiho’s five wives and through a later husband, Kanaʻina, she bore Lunalilo, who would become the first elected Hawaiian king after the death of Kamehameha V in 1872.

Helumoa and Ulukou, areas at the mouth of ʻĀpuakēhau Stream, were the focal points of chiefly residence. The stream emptied into a protected curve of the shoreline that created a “famous surfing spot called Kalehuawehe” (Nāpōkā 1986:2). Rich fishponds lay to the west, and the expansive inland wetlands produced a bounty of *kalo* and other crops. The ocean provided an array of fish. A visitor in the 1850s described a typical catch (Nāpōkā 1986:3, quoting Harriet Newell Foster Deming):

> *Sometimes four canoes would be drawn up on the beach at once, filled with shining beauties in nets … the wealth of color fascinated us as we hung over the sides of the canoes watching the bronzed fishermen who, naked except for a loincloth, scooped up the fish in their hands and laid them in piles on the sand.*

Agriculture and Fishpond

Waikīkī was famous for its extensive irrigated pondfields and fishponds that covered the coastal plain "from the inland side to the coconut grove beside the sea" (Kamakau 1991:45). Fed by the waters of Mānoa and Pālolo Valleys and by the numerous springs that gave Waikīkī its name, the wetland system of expansive *loʻi* is credited to the 15th century ruling chief Kalamakua-a-Kaipūhōlua (Kamakau 1991:45):

> *He was noted for cultivating, and it was he who constructed the large pond fields Keʻokea, Kūalulua, Kalāmanamana, and the other loʻi in Waikīkī. He traveled about his chiefdom with his chiefs and household companions to cultivate the land and gave the produce to the commoners, the makaʻāinana.*

Kamakau (1992:192) also credits Kamehameha with the creation of the extensive pondfield system, including the pondfields attributed to Kalamakua-a-Kaipūhōlua, but this likely reflects Kamehameha's modification or expansion of extant *loʻi*.

Heiau

The significance of Waikīkī Ahupuaʻa is also emphasized by the number and kinds of *heiau* distributed across this area, particularly along the coast (Kamakau 1976:144; Thrum 1907:44-45). Three of the eight *heiau* identified by Thrum (1907) (Table 2) are of the *poʻo kanaka* class, i.e., sacrificial *heiau* that were "only for the paramount chief, the *aliʻi nui,* of an island or district (*moku*)" (Kamakau 1976:129).

Battles

In the late 1700s, warfare in the islands raged. High chiefs amassed huge armies and sailed flotillas of war canoes between islands in a quest for territorial expansion. At least two assaults on Oʻahu took place on the beaches of Waikīkī. From Maui in 1779 came the warrior-chief Kahekili, who conquered Oʻahu after three years of fighting. With victory, the high chief made Waikīkī his home, specifically at Helumoa near the mouth of ʻĀpuakēhau Stream (the location of Helumoa Heiau). After some time on Maui and Hawaiʻi, Kahekili returned to Waikīkī, where he died in 1794. He was succeeded by his son, Kalanikūpule.

A year later, in 1795, Kahekili's chief rival for power, Kamehameha, staged an attack on Oʻahu. It is said that his armada, which included 1,200 double canoes and 10,000 warriors, landed at Waikīkī, a beachhead of relatively calm waters and sandy beaches that offered abundant water, *kalo,* and other supplies for his vast army (Kanahele 1995:87). Unlike Kahekili's three-year battle, Kamehameha was quickly successful in defeating his adversary, Kalanikūpule, and taking control of Oʻahu. Like the Maui chief, Kamehameha settled in Waikīkī near the mouth of ʻĀpuakēhau Stream. Along with Kona on Hawaiʻi Island and Lāhaina on Maui, this served as one of the capitals of his unified (except for Kauaʻi) kingdom.

9.2.2 Historical Background

In 1778, British Captain James Cook made first Western landfall in Hawaiʻi, and other European and American explorers, traders, and missionaries followed. Many wrote accounts and journals that provide an image of the wetland agricultural landscape of Waikīkī. For example, Archibald Menzies (1920:23-24), an early Western visitor who was naturalist and surgeon on board the *HMS Discovery* captained by George Vancouver (in Hawaiʻi in 1792-1793), described a visit to Waikīkī:

> *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.… We pursued a pleasing path back to 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 luxuriance of its productions. Here and there we met with ponds of considerable size, and besides being well stocked with fish, they swarmed with waterfowl of various kinds such as ducks, coots, water hens, bitterns, plovers and curlews.*

Although Waikīkī was the initial capital and residence of Kamehameha on Oʻahu, the growing number of American and European traders looked to the harbor at Kou (present Honolulu) as a safer and therefore favored berth for their deeper draft ships. In the first decade of the 19th century, Kamehameha gradually shifted his capital to that once rural village, and by 1809, he had an established residence near the Honolulu harbor frontage. His family and members of court and government also made the move, leaving Waikīkī in the care of lesser chiefs and land managers (Kanahele 1995:104-105).

Waikīkī, however, remained an attraction for the *aliʻi*. Only three or so miles from Honolulu, it was the only place near the city with beaches and surf and provided an easy escape from the increasingly Western atmosphere of the new capital (Hibbard and Franzen 1986:10). *Aliʻi*, particularly members of the Kamehameha extended family, built beach cottages on the ocean front. As the 19th century progressed, they replaced their grass roofed, wooden buildings with more elaborate and modern homes. Hawaiian chiefs and royalty were joined by *haole* residents and visitors to form a relaxed community. By the late 19th century, the homes of *aliʻi* like Emma (wife of Kamehameha IV), Kapiʻolani (wife of Kalākaua), and Liliʻuokalani (Queen of Hawaiʻi) were located between ʻĀpuakēhau and the present Kapiʻolani Park, and residences of *haole* businessmen like Davies, Robinson, Brown, and Damon were on the beachfront west of ʻĀpuakēhau (Wall 1893). The beginnings of the Waikīkī tourist trade were also represented at this time by the presence of the Long Branch, the earliest known bathing establishment at which visitors were provided “a towel, bathing suit, dressing rooms and a stretch of beach and ocean to enjoy” (Hibbard and Franzen 1986:52), and the W.C. Peacock property (“Peacock’s”), which would become the site of the first major hotel in Waikīkī, the Moana Hotel, in 1901.

Mid-19th Century Land Parcels

In the mid-19th century, major structural changes were made to the ways land was held in Hawaiʻi. In 1848, the traditional system of land tenure was replaced with a Western system of fee-simple land ownership. This radical restructuring, called the Māhele, divided all lands between the king and 245 high ranking *aliʻi*; the king later divided his lands between himself (called Crown Lands) and the government (Kameʻeleihiwa 1992). Subsequently, commoners were offered the opportunity to claim fee-simple title to the land on which they lived or improved; these became known as *kuleana* lands and were awarded in the form of Land Commission awards (LCAs; often referred to as *kuleana* lands).

Unlike most *aliʻi* land awards that were for entire *ahupuaʻa*, *aliʻi* awards in the ahupuaʻa of Waikīkī were for *ʻili*. As Kameʻeleihiwa (1992:232) explains, land on Oʻahu was desirable and therefore *ʻili* on Oʻahu were as valuable as *ahupuaʻa* on the other islands:

> *On Oʻahu, the moku of Kona (especially in Honolulu and Waikīkī), ʻEwa, and Koʻolaupoko were defined predominantly by ʻili. This division of ʻĀina into a great number of rather small areas indicates that Oʻahu was not only more populated, but its ʻĀina were more desired by the Aliʻi and konohiki.… Although an ʻili was almost always smaller in size than an ahupuaʻa, an ʻili on Oʻahu was considered as desirable as an ahupuaʻa on the outer islands.*

About 250 Land Commission awards (to six *aliʻi* and the remaining to local land managers and commoners) were made in Waikīkī (Kanahele 1995:115). The *aliʻi* awardees included Kauikeauoli (Kamehameha III) (62 acres), high chiefs William Lunalilo (2,229 acres) and Ana Keohokālole (100 acres), and three lesser-ranked chiefs, Mataio Kekūanaōʻa (133 acres), Keoni Ana (11 acres), and Kaisara Kapaʻakea (9 acres). As noted by Kanahele (1995:116), “Their properties all included choice spots located near the beach, streams or fishponds.” It is notable that the heirs of these *aliʻi* awardees include the monarchs Kamehameha V, David Kalākaua, and Liliʻuokalani; queen consorts Emma Rooke and Kapiʻolani; Princesses Ruth Keʻelikōlani, Likelike, and Kaʻiulani; and Prince Jonah Kūhiō Kalanianaʻole.

Kuleana awards, most of which were generally less than an acre, lined the Waikīkī shore, with associated inland pieces that provided land for farming. Of the shoreline *ʻāpana*, two fall in the Fort DeRussy beach sector, ten in the Halekūlani beach sector, three in the Royal Hawaiian beach sector, and one in the Kūhiō beach sector. There were no LCAs awarded south of Kuʻekaunaha Stream (roughly the alignment of present Paoakalani Avenue).

Late-19th Century

In the second half of the 19th century, changes to the Waikīkī landscape entailed improvements to transportation connections between Waikīkī and Honolulu, including construction of a tram line between the two areas, and the development of Kapiʻolani Park and an associated residential neighborhood on June 11, 1877 (Brown and Monsarrat 1883).

In the 1860s, rice cultivation experienced a boom across the islands, directed at two markets: export to California for Chinese emigrants who had settled there after the mid-century Gold Rush and local consumption by a growing number of Chinese contract laborers who had come to Hawaiʻi to work on the sugarcane plantations (by 1884, there were 18,254 Chinese in the islands;

see Coulter and Chun 1937:13). Rice was second only to sugar in the economic hierarchy in the islands (Haraguchi 1987:xiii). Like sugar, Hawai‘i's rice production filled the void created by the U.S. Civil War, when rice farming in the southern United States was severely curtailed (Coulter and Chun 1937:13). During negotiations for the Reciprocity Treaty between the U.S. and Hawaiian governments, efforts were made to ensure that rice shared the same protection as sugar.

Land speculators purchased *kalo* fields, and in some cases, pulled up young *kalo* plants to replace them with rice seedlings (Haraguchi 1987:viv). Many *kuleana* owners leased their former *kalo* fields to rice entrepreneurs, although in some cases, they retained land for the Hawaiian staple food. By 1892, there were 542 acres in Waikīkī planted in rice, representing almost 12 percent of the total 4,659 acres in rice cultivation on O‘ahu (Hammatt and Shideler 2007:17). Nakamura (1979:20, quoting Iwai 1933:80, brackets added) notes that Waikīkī was one of "the most important [rice] growing districts on O‘ahu."

At the end of the 19th century, Waikīkī Road (roughly the alignment of the present Kalākaua Avenue) marked the boundary between fishponds and beach lots to the makai, and rice fields to the mauka (Monsarrat 1897). Kapahulu Avenue was the southeastern boundary of the rice fields, with the gridded Kapahulu house lots and Kapi‘olani Park extending toward the base of Diamond Head (the Kapahulu lands to the east of the present Kapahulu Avenue appear to have been planned for subdivision in 1899, see Monsarrat 1899).

20th Century Landscape Changes

The 20th century saw the definitive transformation of Waikīkī from quiet retreat and agricultural breadbasket to a bustling tourist destination. As the popularity of Waikīkī among residents—particularly the foreign/haole population—and visitors grew, the region was eyed for development. Kapi‘olani Park in 1877 was originally developed as a private recreational/open space amenity for high-end residences at the base of Diamond Head and along the coast (Brown and Monsarrat 1883). In the early 20th century, the extensive wetlands complex on the coastal plain was valuable for rice cultivation and raising ducks but was described as "swamp lands" by those who had visions of development. As noted by Steele (1992:8-3), "in the eyes of many in Honolulu, [it could] be put to better use … but only if the land could be 'reclaimed' (filled in)." The first effort in Waikīkī reclamation was by the U.S. Department of War in its development of Fort DeRussy at the western end of Waikīkī, which required filling in a large portion of the fishponds. The agricultural landscape of Waikīkī was nearing its end, victim to the allure of Waikīkī as a resort destination. Nakamura (1979:34) writes:

> *A conflict was developing at Waikīkī between wet agriculture and aquaculture, on the one hand, and urbanization on the other. Urbanization was adversely affecting the good and proper drainage of surface water flowing from the mountains to the sea. This restricted water, in turn, was labeled unsightly and unsanitary by those who wished to see wet agriculture and aquaculture at Waikīkī destroyed.*

By the end of the first decade of the 20th century, the rice fields and duck ponds that once covered the entire coastal plain inland of Kalākaua Avenue appear to have been contracted to the northwest, leaving the eastern portion of the wetlands complex as pasture or open fields, with scattered buildings and a network of dirt roads (U.S. Army 1909-1913).

Ala Wai Canal

The primary impetus for landscape change was construction of the Ala Wai Canal in the 1920s. The canal effectively cut off Waikīkī from the rest of the Honolulu urban and suburban landscape and created developable lands where before there were the expansive wetland agricultural fields. In addition, the canal was seen as remedying a perceived impact of outflow from the wetlands on the growing bathing industry: "the proposed drainage canal would carry the runoff away from the Waikīkī beaches" (Steele 1992:8-4).

Using so-called unsanitary conditions as a justification, the government (first the post-overthrow Hawaiian Republic and then the Territorial Government) enacted legislation that forced landowners to fill in the wetlands, and if they did not, the government would do so and put a lien on the property to pay for the "improvements." The end result was the destruction of the agricultural system and in many cases, the loss of land (Nakamura 1979:67-68).

> *The Sanitary Commission of 1912 estimated that, of the total amount of land in the district of Honolulu located below the foothills, one third was wet land. This wet land, which was used for agriculture and aquaculture, represented, then, a considerable amount of urban real estate if filled in.*
>
> *Such laws as Chapter 83, R.L. 1905 already existed to deal with filling in wet land. The justification for such actions would be sanitation, that is, if wet lands were allowed to exist within the district of Honolulu, the public health would be endangered, for mosquitoes, carriers of dangerous diseases, would continue to breed.... Thus, sanitation was presented as the primary motive in the destruction of wet agriculture and aquaculture while the profitability of reclaimed was hardly mentioned at all.*

Land acquisition for the two-mile long canal began in 1918, either through voluntary purchase or condemnation (Steele 1992:8-5). Construction began in 1921, with Walter F. Dillingham's Hawaiian Dredging Company contracted by the Territory of Hawaiʻi to carry out the work (Nakamura 1979:90). By 1924, the entire length of the canal from its outflow at the west end of Waikīkī to its head at Kapahulu Road was excavated; a proposed outflow from Kapahulu Road to the eastern end of Waikīkī was never completed, aborted by a concern that the onshore current would take canal runoff west onto the pristine beaches (Cocke, 2013). Although the canal was dredged as planned, additional fill was needed to "reclaim" adjacent lands and additional funds were authorized to widen the canal from 150 to 250 ft. In 1928, the canal was completed. Steele (1992:8-7) describes the resultant changes in land values and tourism:

> *… land values had gone from $500 an acre for a piece of agricultural property prior to the construction of the canal to up to $4 a square foot for business property in 1928. With a great increase in available property, numerous residential development projects were undertaken in Waikīkī. The number of visitors was also on the rise since the beginning of the reclamation project. Between 1921 and 1927, the number of visitors to Waikīkī doubled from 8,000 to 17,451 according to the Hawaiʻi Visitors Bureau.*

In addition to the dredge and fill operations related to the Ala Wai Canal, the Waikīkī portions of natural drainages, like ʻĀpuakēhau and Kuʻekaunahi Streams, were also filled.

Beach Control Infrastructure

In the mid- to late 19th century, Waikīkī became a retreat for town dwellers in Honolulu who wearied of dry, dusty urban life. Royalty escaped to their beachfront estates. Families began to frequent the beach on weekend bathing trips. In 1881, James Dodd opened the first commercial hospitality operation, the Long Branch, which was a small cottage where visitors could change their clothes for a small fee (Kanahele 1995:152). Modest residences were common, and it was not until the 1890s that sumptuous homes began to appear along the beachfront (Hibbard and Franzen 1986:27).

As more visitors frequented Waikīkī and more properties developed along the coast, shoreline improvements were made to enhance the visitors' beach experience (the chronology of shore improvements is primarily from Wiegel 2008:26-27). One of the first infrastructure projects was construction of a bridge/causeway at the entrance to the new Kapiʻolani Park around 1880, a portion of which was replaced in 1890 by a seawall to protect Waikīkī Road (now Kalākaua Avenue near Kapahulu Avenue). Also in 1890, picturesque piers were built at Queen Liliʻuokalani's Kealohilani beach home and at W.C. Peacock's residence; both structures graced the Waikīkī shoreline for over 40 years. When the Moana Hotel was constructed on Peacock's property in 1901, the pier became known as Moana Pier.

In the first three decades of the 20th century, seawalls were constructed at various locations, but with no apparent overall design or strategy. The earliest record of a constructed retaining wall at a specific property is an 1897 map showing a wall fronting Liliʻuokalani's property at Kealohilani, adjoining the inland end of her pier (Kanakanui 1897). As hotels began to develop, each protected its shorefront with a seawall: the Moana Hotel in 1901, the Seaside in 1906, Gray's Hotel (now the Halekūlani) in 1916, and the Royal Hawaiian Hotel in 1925-1926. When the U.S. War Department acquired lands at Kālia for Fort DeRussy, it too protected its beachfront with walls built in 1909 and 1916. By 1920, almost the entire shorefront of Kapiʻolani Park was lined in seawalls.

Groins were also built to protect and enhance the beach, and many have come and gone, leaving only the present five groins in the project area. The first was a concrete wall projecting into the shallows at the mouth of ʻĀpuakēhau Stream, built sometime between 1906 and 1910, presumably by Moana Hotel; it was removed in 1927. Between 1917 and 1930, nine groins were built along the shore between the Royal Hawaiian Hotel and Fort DeRussy, and experimental sandbag groins were installed between the Royal Hawaiian Hotel and Gray's Hotel. Groins were also constructed at the original Honolulu Aquarium; they appear on a 1928 map of the Waikīkī shoreline (Kanahele 1928c).

9.2.3 Archaeological Resources

9.2.3.1 General Overview

The archaeological record of the Waikīkī shoreline is fragmented, disturbed, and damaged by over a century of urbanization. Nonetheless, archaeological investigations have shown that remnants of the former landscape lie beneath the asphalt and concrete of the modern resort area. This record can be characterized as an extensive but discontinuous buried A-horizon, with high-density clusters of archaeological material and burials representing the most intensive pre-Contact and historical-period occupations.

There are 15 sites that contain human skeletal remains, including at least 97 identifiable individuals. The largest burial clusters include Sites 50-80-14-1974 and 50-80-14-5860, each of which contained 24 discrete burials. Site 50-80-14-1974 is on the grounds of the Moana Surfrider Hotel, while Site 50-80-14-5860 is at the intersection of Kalākaua Avenue and Kealohilani Avenue. Also, along Kalākaua Avenue are Sites 50-80-14-5858 and 50-80-14-5859, which include eight burials each. Site 50-80-14-5861 at the intersection of Kalākaua and ʻŌhua Avenues includes seven burials. There are also 10 sites that are buried archaeological deposits or discrete features (Table 6). Of particular note is Site 50-80-14-5940, which is described as a discontinuous deposit of very dark-stained sand containing diffuse charcoal flecks, traditional Hawaiian artifacts, midden, firepits, hearths, and other pits. It is a linear site that runs along Kalākaua Avenue between Kaʻiulani and Liliʻuokalani Avenues. This delineation of a site boundary is deceptive in two respects: (1) burial Sites 50-80-14-5857 through 50-80-14-5859, as well as the inland edge of Site 50-80-14-5863, fall within same area and thus could be included as clusters within the site; and (2) archaeological deposits have been identified with burial associations at the not-distant Sites 50-80-14-5860 and 50-80-14-5861 to the south and Sites 50-80-14- 1974, 50-80-14-3705, 50-80-14-4570, and 50-80-14-9975 to the north and northwest. Thus, in actuality, it could be argued that the pre-Contact and historical-era occupation of Waikīkī beach encompasses the entire length of the shoreline adjacent to the project area, with probable concentrations of occupation at advantageous locations near stream mouths, fishing grounds, or easy canoe access to the open ocean.

Ten radiocarbon dates have been obtained from archaeological sites near the Waikīkī Beach Improvement and Maintenance Program area. The earliest radiocarbon determination for the shoreward area is 410±50 BP (Davis 1989), obtained on a piece of unidentified charcoal from a hearth, which produces a bi-modal calibrated date of AD 1422-1529 and AD 1546-1635. Most dates indicate that the shoreline was occupied by the 15th or 17th centuries AD. It reasonable to assume, however, given the lack of extensive archaeological investigations in this area and the presence of earlier dates elsewhere on the Fort DeRussy property, that the immediate area was settled even earlier.

9.2.3.2 Fort DeRussy Beach Sector

The Fort DeRussy beach sector consists of approximately 510 m (1,680 ft.) of shoreline extending from the Hilton pier/groin to the Fort DeRussy outfall/groin. The southwest-facing shoreline is a continuous sand beach that fronts a landscaped open space of tended lawn and coconut trees in the Fort DeRussy Armed Forces Recreation Center. Until the early 20th century, Kawehewehe Stream, the outlet for the Kālia fishponds, ran into the sea along the southern edge of this sector. Piʻinaio Stream entered the sea at a broad delta or estuary approximately 350 m north of the sector, near the southern end of the Ala Wai Boat Harbor. This beach sector is within the traditional ʻili of Kālia. Today, the Hale Koa Hotel is just inland of the western portion of the sector and the U.S. Army Museum of Hawaiʻi, housed in the historic 1914 Battery Randolph, is at the eastern end of the sector. A wide concrete promenade runs along the inland edge of the beach.

The shoreline within the Fort DeRussy sector was further removed from the Waikīkī chiefly center at the mouth of ʻĀpuakēhau Stream; nevertheless, this land near Piʻinaio Stream and the Kālia fishponds was likely associated with noble families.

Like the Halekūlani beach sector, the Fort DeRussy beach sector includes portions of Kawehewehe. As noted above, Kawehewehe was known as the residence of the Luluka family, which moved to Oʻahu from Lāhainā with Kamehameha around 1803. The family maintained the royal residence at Puaʻaliʻiliʻi as retainers of Kamehameha (ʻĪʻī 1959:17).

During the mid-19th century land division, Kālia, including the large complex of six fishponds inland of the Fort DeRussy beach sector, was awarded to the high chief Mataio Kekūanaōʻa as LCA 104 FL:6 (Davis 1989:14). Five *kuleana* awards (Table 20) and five land grants were made along the coast. LCA 867:1 to Nihopuu, located at the middle of the sector, was a small house lot at the shore, with separate inland taro patches and an ʻauwai; the house lot contained one house surrounded by a wooden fence (Davis 1989:83). LCA 1515:2 to Kaihoolua, seaward of Battery Randolph, was also a fenced house lot (Davis 1989:87). The five land grants were also awarded in the mid-19th century. Grant 2880 to H.J.K. Holdsworth, which is at the southern edge of the sector, overlaps slightly with the project area.

The U.S. Army began to acquire land in the Kālia area in 1904. Extensive dredging of the reef off Fort DeRussy was conducted between 1908 and 1910, with the dredged coral used to infill the Kālia fishponds (Wiegel 2008:10). In 1913, a “deep channel was dredged through the reef in front of Fort DeRussy” to facilitate the arrival of a bargeload of 69-ton guns (Thompson 1985:37). The dredging is said to have contributed significantly to the erosion of beach sand long the Waikīkī shoreline by altering the currents (see discussion in Halekūlani sector section, below).

Battery Randolph was completed and armed by 1914. Battery Dudley, which was adjacent to and northwest of Randolph, was armed in 1916. To protect the remaining beach in front of Fort DeRussy, a 1,150-ft-long seawall was built on the reef in 1916; the area behind the seawall was later infilled with dredged coral to significantly expand the active beach (Wiegel 2008:12). A 70-ft-long box culvert and groin at the Diamond Head edge of the Fort DeRussy sector, originally built in 1917, was lengthened to 300 ft in 1969 and supplemented by a rubble mound groin ca. 1971 (Wiegel 2008:22). Both batteries were decommissioned in 1944, and Battery Dudley was demolished in 1970 (Davis 1989:21). Battery Randolph has housed the U.S. Army Museum of Hawaiʻi since 1976. The Artillery District of Honolulu (Site 50-80-14-1382), which includes Battery Randolph, was listed on the NRHP in 1984.

The Fort DeRussy shoreline is an almost completely constructed beach. A narrow strip of coastal land formerly separated a large complex of fishponds from the ocean; immediately inland of the Fort DeRussy beach sector was one of the larger ponds, Loko Kaʻihikapu. Bishop’s (1881) map of Waikīkī shows that the shoreline at the western boundary of the sector was over 150 m inland of its present location. The outlet of a small waterway identified on Bishop’s (1882) map as Kawehewehe was on the Diamond Head boundary of the beach sector. Known shoreline structures in the Fort DeRussy beach sector include a seawall built in 1916 and a box culvert and groin built in 1917 (subsequently extended in 1969 and supplemented by a rubble-mound groin in 1971).

No archaeological sites have been identified within the Fort DeRussy beach sector. Site 50-80-14-4570, a multi-component deposit with traditional Hawaiian and historical-period layers (Davis 1989, 1992; Denham and Pantaleo 1997a, 1997b, 1998), is along the inland boundary of the eastern portion of the sector. This site is within LCA 1515:2, awarded to Kaihuoloa, and Grant 2880, purchased by H.J.H. Holdsworth. Davis' (1989) trenches revealed two distinct archaeological layers, the uppermost of which (Layer II) contained an *imu* and other pit features, as well as historical artifacts. Subsequent data recovery documented 40 features, including 24 hearths, 12 pits of unknown function, three post molds, and a historical-period burial pit. Unidentified charcoal from Layer III, the earliest archaeological deposit, produced a radiocarbon determination of 410±50 BP (Beta-31310), which provides a calibrated date of AD 1422-1529 and AD 1546-1635.

BioSystems Analysis, Inc., conducted monitoring and data recovery at Fort DeRussy in association with the realignment of Kālia Road and construction at the Hale Koa Hotel (Denham and Pantaleo 1997a, 1997b, 1998). Site 50-80-14-4570 was assigned to "all non-spatially contiguous features on the former spit" and encompasses numerous pre-Contact-era to historical-era subsurface features dispersed across the Fort DeRussy property (Denham and Pantaleo 1998:I), along with Davis' (1989, 1992) previous finds.

BioSystems' Feature 23, a group of five burials, was near the Fort DeRussy sector. The burials appeared to have been previously disturbed by landscaping activities and were associated with both traditional Hawaiian and historical-period artifacts (Denham and Pantaleo 1998:28).

Site 50-80-14-9500 falls outside of the Fort DeRussy beach sector but is worthy of mention based on its proximity and its ability to inform on the potential for human burials along the Fort DeRussy coastline. This site designation was assigned to six burials encountered during construction of the Hale Koa Hotel in 1976. Five of the burials were identified as pre-Contact or early post-Contact, and one burial immediately beneath a 20th century pavement was thought possibly to represent a homicide victim (Kimble 1976, cited in Armstrong and Spear 2009:6-7).

9.2.3.3 Halekūlani Beach Sector

The Halekūlani beach sector consists of approximately 440 m (1,450 ft.) of shoreline extending from the Fort DeRussy outfall/groin to the Royal Hawaiian groin. This sector includes Halekūlani Beach, formerly known as Gray's Beach. The south-facing shoreline is a mix of seawalls and discontinuous, small, narrow sand beaches that front a fully developed urban landscape. Prior to modern development, the Halekūlani sector lay between two drainages, ʻĀpuakēhau to the east (in the Royal Hawaiian beach sector) and Kawehewehe to the west (along the boundary with the Fort DeRussy sector). Kawehewehe was the outflow from the large fishpond complex of Kālia, the inland area of present Fort DeRussy. This beach sector comprises portions of the traditional ʻili of Helumoa and Keōmuku. Like the Royal Hawaiian beach sector, the Halekūlani beach sector contains the beachfronts of major Waikīkī hotels. From south to north, the hotels are the Sheraton Waikiki Hotel, the Halekūlani Hotel, and the Outrigger Reef Waikīkī Beach Resort.

The Halekūlani beach sector was immediately ʻEwa of the mouth of ʻĀpuakēhau Stream (within the Royal Hawaiian sector), which served as the seat of the Waikīkī chiefs as early as the mid-1400s. ʻĪʻī (1959:15) records that the area near the mouth of Kawehewehe Stream became the residence of the Luluka family, of which he was a member, when they moved to Oʻahu in the company of Kamehameha who was preparing for the invasion of Kauaʻi around 1803. ʻĪʻī's uncle was a member of the royal court, and members of the Luluka family were responsible for the royal residence at Puaʻaliʻiliʻi at Helumoa (in the Royal Hawaiian beach sector).

Twelve LCAs were awarded along the shoreline of the Halekūlani sector (Table 16). An *aliʻi* award of Keōmuku was made to Samuel Kuluwailehua (LCA 1281:1). Unlike the other beach sectors, the shoreline within the Halekūlani beach sector is almost completely encompassed by *kuleana* awards. These awards are primarily house lots, although the Māhele claims indicate farming was also undertaken.

In 1907, a small hotel called the Hau Tree opened in the former home of Robert Lewers. The Hau Tree, which became the Halekūlani in 1917, continued to grow in size and eventually incorporated the neighboring resort property Gray's-By-the-Sea. The Gray's-By-the-Sea boarding house was established by La Vancha Maria Chapin Gray in a two-story house built by Minnie Gilman (Mrs. Joseph A. Gilman) in 1903 and is the source of the name "Gray's Beach" sometimes used for this area (Clark 1977:56). A new Halekūlani Hotel was opened in 1932; the hotel was completely rebuilt in the 1980s to accommodate over 600 rooms.

The first seawalls in this vicinity were built in front of the S.C. Wilder home and Gray's By-the-Sea in 1913-1914, and in 1916 a 1,150-ft-long seawall was built along the shoreline in front of Fort DeRussy (Wiegel 2008: 26). The seawalls were constructed after offshore dredging in front of Fort DeRussy reportedly destabilized the coastline (Wiegel 2008:11). Kīnaʻu Wilder (quoted in Wiegel 2008:11) describes the drastic changes of that period to the shoreline:

> *After the dredging, the] beach at Waikīkī was never the same. Instead of the reef holding the sands of the beach and preventing them from being carried out by the changing tides, the sand was swept through the hole in the reef, never to return. What had been a glorious beach – which no other beach on earth could touch – was nothing. Property owners lost anywhere from ten to thirty feet of their frontage. Everyone was forced to put up seawalls to keep from losing their houses as well. Instead of running from the grass right out to the ocean, we had to go down slippery steps to a miserable little strip of sand which, during certain months, was non-existent. At times I could jump from our seawall right into the water…*

According to Wiegel (2008:26), eight groins were built "between [the] Royal Hawaiian Hotel and Fort DeRussy" between 1926 and 1929. Four groins are said to have been removed from this area in 1970 (Wiegel 2008:22). An aerial photograph taken in 1932 shows five groins in the vicinity. The ʻEwa groin may be the original Fort DeRussy outfall/groin at the boundary of the Halekūlani and Fort DeRussy beach sectors; the original Fort DeRussy outfall, built in 1917, was 70 ft long (Wiegel 2008:22).

The Halekūlani beach sector contains minimal beach, with sections in front of the Sheraton Waikiki Hotel and the Halekūlani Hotel fronted by seawalls. Several shoreline structures were built during the early 20th century and the small beach in front of the Outrigger Reef Waikīkī Beach Resort developed after ca. 1881. This is the former location of the outlet of a small waterway identified on Bishop's (1882) map as Kawehewehe (Bishop 1882), which may have drained the Kālia fishponds. This waterway, which may have been a small stream or artificial watercourse, may have been filled along with the Kālia fishponds in conjunction with the construction of Fort DeRussy. Seawalls were built as early as 1914 after dredging offshore of Fort DeRussy initiated nearby beach erosion. Eight groins were built in this vicinity in the 1920s, four of which were removed in 1970.

No archaeological sites are known to be within the Halekūlani beach sector, with one site abutting a portion of the inland sector boundary. Site 50-80-14-9957 was mapped and excavated in 1981-1982 during renovations to the Halekūlani Hotel (Davis 1984). A major portion of the site lies just inland of the seawall at the southwest corner of the hotel property (now occupied by the ʻEwa hotel tower). Murabayashi and Dye (2014:10-11) summarize the results:

> *While most of the property was disturbed by recent construction, an area along the beach and an isolated area in the center of the property remained relatively intact. Excavations uncovered 32 features, including human skeletal remains, a dog burial, postholes, trash pits, privies, and several pits. Most of the trash pits contained bottles, ceramics, and metal. Although the area had been heavily disturbed by the recent construction, significant cultural materials dating to the late 1800s remained intact.*

Additional archaeological finds include human skeletal remains recovered on the grounds of the Sheraton Waikiki Hotel. The skeletal remains of eight individuals were collected in 1970 (NPS 1998:4282), and a single female "forearm bone" was collected in 1993 (Hammatt and Shideler 2007c:59).

9.2.3.4 Royal Hawaiian Beach Sector

The Royal Hawaiian beach sector is approximately 530 m (1,730 ft.) of shoreline extending from the ʻEwa (west) basin of the Kūhiō groin complex to the Royal Hawaiian groin. It lies at an inward curve in the Waikīkī coastline that allows the development of a wide sand beach and sits between two of the three former major stream outlets (Kuʻekaunahi and ʻĀpuakēhau) that once flowed into the ocean. ʻĀpuakēhau Stream once flowed into the ocean near the northern edge of the sector (near the present location of the Royal Hawaiian Hotel). The Royal Hawaiian beach sector is adjacent to the core of traditional and historical activity in Waikīkī. It falls within portions of the traditional ʻili of Helumoa and Hamohamo.

The Royal Hawaiian beach sector contains the beachfront of several prominent hotels and resorts, including the Royal Hawaiian Hotel, the Outigger Waikīkī Beach Resort, and the Moana Surfrider Hotel. The southern end of the sector is the Kūhiō Beach Park and the Waikīkī Beach Center, which contains the Honolulu Police Department's Waikīkī Substation, and the Duke Paoa Kahanamoku Statue.

ʻĀpuakēhau Stream was the major outlet of drainages originating in Mānoa and Pālolo Valleys and was the focus of *aliʻi* activity along the Waikīkī shoreline. Waikīkī was the home of Oʻahu ruling chiefs from at least the 1400s, during which Maʻilikūkahi moved the political center of Oʻahu to Waikīkī (Nāpōkā 1986:2; Beckwith 1970:383). From that time, it was the residence, either permanently or part-time, of the high *aliʻi*; the mouth of ʻĀpuakēhau Stream was the focal point of chiefly residence.

Around 1783, Maui king Kahekili landed an invasion force at Waikīkī and encamped at ʻĀpuakēhau. After successfully conquering the island, Kahekili established his residence on the bank of ʻĀpuakēhau Stream (Fornander 1919:VI-2:289; Kanahele 1995:79). After some time on Maui and Hawaiʻi, Kahekili returned to Waikīkī, where he died in 1794.

In 1795, following the death of Kahekili, Waikīkī was the landing for an invading force led by Kamehameha. Although the invasion was successful, it was not until 1803 that Kamehameha moved permanently to Oʻahu (ʻĪʻī 1959:16). He established his capital at Waikīkī and set up a residence, named Kūihelani, at Puaʻaliʻiliʻi on the northwest side of ʻĀpuakēhau Stream just inland of the shore (ʻĪʻī1959:17; Kanahele 1995:91, 92). The residence would have been between the present-day locations of the Moana Surfrider Hotel and the Royal Hawaiian Hotel on the west side of ʻĀpuakēhau Stream just inland of the shore (ʻĪʻī 1959:17; Kanahele 1995:91, 92). ʻĪʻī (1959:17) describes the compound, which was surrounded by the houses of his wife Kaʻahumanu and his retainers:

> *Kamehameha's houses were at Puaaliilii, makai of the old road, and extended as far as the west side of the sands of Apuakehau. Within it was Helumoa, where Kaʻahumanu ma went to while away the time. The king built a stone house there, enclosed by a fence; and Kamalo, Wawae, and their relatives [the Luluka family of John Papa ʻĪʻī] were in charge of the royal residence.*

During the Māhele, four LCAs were recorded in or adjacent to the shoreline within the Royal Hawaiian sector (Table 12). An *aliʻi* land award for the coastal portion of Hamohamo was made to Keohokālole (LCA 8452:1). Three *kuleana* awards on the shoreline include LCAs 6616:4 and 7597:3 at the east end of the sector, and LCA 1445:1 at the west end; all three are described as house lots in land claims and testimonies. The mauka portion of the Royal Hawaiian sector overlaps slightly with the makai edge of these awards.

In the 19th century, this area became the beachside retreat for the *aliʻi*. Liliʻuokalani received the land of Hamohamo from her mother, Keohokālole, in 1859. Kamehameha V purchased property, including the former LCA 1445:1 at Helumoa, in 1866 on the northwest side of ʻĀpuakēhau Stream. This land was subsequently bequeathed to Bernice Pauahi Bishop, who built a house on the property. Land was purchased at Uluniu (at the southern end of the Hamohamo coastal strip) by Kalākaua and his wife Kapiʻolani, which was later inherited by Prince Kūhiō. Kūhiō built a home he called Pualeilani.

The ʻĀpuakēhau Stream outlet to the ocean transitioned from the focus of Waikīkī's *aliʻi* residences to the heart of the region's hospitality. The Long Branch Bathhouse, where bathers could change their clothes for a small charge, was established in 1881 at Ulukou (Hibbard and Franzen 1986:53). The first building at the location of the present Waikīkī Beach Center, the Ilaniwai Baths, was built in 1884 (Clark 1977:54; Hibbard and Franzen 1986:53).

In 1901, the first major hotel, the Moana, opened on the grounds of W.C. Peacock's home on the south side of the river. The hotel was originally outfitted with a 300-ft-long pier, originally called Peacock Pier, that was a landmark of the Waikīkī shoreline until it was demolished in 1931 (Wiegel 2008:21). Two concrete five-story wings were added to the original four-story wooden structure in 1918, doubling the hotel's capacity (Hibbard and Franzen 1986:77). Five years after the establishment of the Moana Hotel, the cottage-style Seaside Hotel opened on Bernice Pauahi's property in Helumoa.

One of the earliest known seawalls in Waikīkī was a 230-ft-long seawall that was built ca. 1901 in front of the Moana Hotel (Hibbard and Franzen 1986:58-59; Wiegel 2008:21, 26). A concrete groin reportedly built between the Moana Hotel and Royal Hawaiian Hotel at an unknown date had been removed by 1927 (Wiegel 2008:26). The Moana Groin was a concrete wall built into the ocean on the Diamond Head side of ʻĀpuakēhau Stream sometime between 1906 and 1907; it was removed in 1927 (Kanahele 1928c; Wiegel 2008:26).

The 21-story Surfrider Hotel opened on the western side of the Moana Hotel in 1969 (Wiegel 2008:21); the original Moana Hotel has been replaced by a newer building, and the Moana and Surfrider today operate as a single establishment called the Moana Surfrider Hotel.

Construction of the Royal Hawaiian Hotel on the grounds of the former Seaside Hotel began in 1925 and the hotel opened in 1927. The distinctive six-story building, with its pink-colored stucco concrete façade, contributed to the coastline's growing allure as a glamorous tourist destination. The hotel continues to operate in its original building. According to Hibbard and Franzen (1986:95):

> *The 'pink palace' towered over its neighbors and had a majestic aura new to Waikīkī. Sheer massiveness, capped by a central tower that soared 150 feet above the street, enabled the Royal Hawaiian to join the Moana in dominating the beach's palm-filled skyline. Furthermore, its four hundred rooms, each with a bath, balcony, and view of either mountains or ocean, almost doubled the guest capacity of Waikīkī.*

A second seawall was built shoreward of the old seawall during the construction of the Royal Hawaiian Hotel ca. 1925-1927, and the 170-ft-long Royal Hawaiian groin was added west of the hotel in 1927. The groin was extended to a length of 368 ft in 1930 and was substantially rebuilt in 2020 (Morrison 2020; Wiegel 2008:21, 26).

The Waikīkī Tavern was operating on the Diamond Head-end of the Royal Hawaiian sector by the 1920s, at which time it was known as the "only place other than hotel dining rooms [along Kalākaua Avenue] where a person could obtain a meal" (Hibbard and Franzen 1986:117). The Waikīkī Tavern was demolished in 1960 (Clark 1977:54). Kūhiō Beach Park, which occupies the southern portion of the sector, was dedicated in 1940 (Clark 1977:52).

A comparison of the historical and contemporary shorelines within the Royal Hawaiian sector shows that several shoreline structures were built during the early 20th century and that the beach has expanded considerably since ca. 1880s, especially on the ʻEwa side in front of the Royal Hawaiian Hotel. This beach sector was the location of the mouth (*muliwai*) of ʻĀpuakēhau Stream. Based on historical photographs, the stream mouth was nearly blocked by sand by the end of the 19th century (Wiegel, 2008); the stream was made obsolete by the construction of the Ala Wai Canal in the 1920s.

The earliest shoreline structure was a seawall built in front of the Moana Hotel in 1901; it was followed by a second seawall in front of the Royal Hawaiian Hotel in 1925-1926. A groin between the Moana Hotel and Royal Hawaiian Hotel was demolished in 1927. The Royal Hawaiian groin, built in 1927, was substantially rebuilt in 2020 but remains a prominent feature of the Waikīkī shoreline.

One archaeological site overlaps with the Royal Hawaiian sector with two sites and one burial adjacent to the inland margin. At least 33 burials have been identified within approximately 50 m of the project area. Twenty-four burials (Site 50-80-14-1974) were identified on the grounds of the Moana Hotel, along with a possible pre-Contact archaeological deposit extending under both wings of the hotel. Site 50-80-14-5863, which contains two burials, overlaps with the beach sector boundary. This site is within LCA 6616:4, which later became the residence of Kalākaua and Kapiʻolani and which was eventually developed by Prince Kūhiō as his beachside home Pualeilani. Non-burial sites include Site 50-80-14-5940 (an extensive archaeological deposit), Site 50-80-14-7068 (a historical-period archaeological layer), and Site 50-80-14-7069 (a historical-period trash pit). Site 50-80-14-9980 was assigned to numerous *ʻulu maika* collected during the construction of the Royal Hawaiian Hotel (see Kanahele 1995:99).

Investigations by Simons et al. (1991) on the grounds of the Moana Hotel revealed layers of historical-era fill overlying discrete archaeological deposits dating to the post-Contact and pre-Contact periods. Two radiocarbon dates were obtained from the unidentified charcoal recovered from the pre-Contact layer. One sample from an ash lens produced a determination of 350±90 BP, which calibrates to AD 1408-1684, AD 1735-1803, and AD 1930-1950. Another charcoal specimen from an unspecified context produced a determination of 300±130 BP, which calibrates to AD 1424-1895 and AD 1903-1950. Because the Moana Hotel has occupied the site since 1901, the post-1900 probability ranges can be discarded for both dates. Archaeological features included firepits, post molds, unidentified pit features, animal burials (cat), and planting pits. The cat burials were thought to be associated with the Peabody family residence, and the planting pits were associated with early 20th century use of the property.

Burial 3 of Site 50-80-14-5863 was found at the mauka edge of the Royal Hawaiian sector, near the Waikīkī Police Station. Burial 3 is a modified human femur fragment moved by grading activities. The femur fragment was found to have been “deeply scored and snapped by a sawing or cutting instrument just below the lesser trochanter at the pectineal line” and thought to have been used in the manufacture of fish hooks (Winieski, Perzinski, and Souza et al. 2002:25). The original location of the femur fragment (prior to disturbance by grading) could not be identified and it was recovered for reburial at a dedicated off-site interment location.

The Moana Hotel, which opened in 1901 on the site of the former W.C. Peabody home as the first major hotel in Waikīkī, has been designated as Site 50-80-14-9901. The Moana Hotel was placed on the National Register of Historic Places (NRHP) in 1972.

Also within this sector is a portion of a buried seawall its Diamond Head end, immediately west of the hula mound. The buried seawall was observed by SHPD staff 9 (Nick Belluzzo, personal communication 2016) and is likely associated with a structure illustrated on Kanahele's (1928c) map of Waikīkī. A recent news article (Davis 2017) identifies the exposed concrete structure as part of the foundation of the Waikīkī Tavern.

Helumoa Heiau was placed by Thrum (1906:44) at ʻĀpuakēhau. Based on a field inspection, Hammatt and Shideler (2007c:33) suggest its likely location as "the prominent point just on the Sheraton side of the Royal Hawaiian Hotel."

9.2.3.5 Kūhiō Beach Sector

The Kūhiō beach sector is immediately south-southeast of the former mouth of ʻĀpuakēhau Stream, which served as the royal center of Hawaiian rulers in Waikīkī since the mid-1400s based on oral traditions. Lands within and near the sector were transferred during the Māhele via three *aliʻi* land awards and seven *kuleana* awards. The *aliʻi* awards included Kapuni/Uluniu in the north to Mataio Kekūanaōʻa (LCA 104FL:5); Hamohamo in the center (on the north side of Kuʻekaunahi Stream) to Keohokālole (LCA 8452:1), and Kekio in the south (on the south side of the stream) to Pehu for his wife Keʻekapu (LCA 5931:2). Hamohamo, which encompassed extensive inland lands, also included the coastal strip between Kuʻekaunahi and ʻĀpuakēhau Stream—nearly all of the Kūhiō Beach and Royal Hawaiian beach sectors—and as a result, Kapuni/Uluniu did not have any coastal access in this area.

No *kuleana* awards were made within the Kūhiō Beach sector, though several were nearby. These clustered in two locations along the coast, one along the north side of Kuʻekaunahi Stream and the other about 80 m farther to the north. The southern cluster falls at the present intersection of Kalākaua and ʻŌhua Avenues. The northern cluster is at the intersection of Kalākaua and Liliʻuokalani Avenues. All are described in claims and testimonies as house lots.

LCA 1433:1, originally awarded to Kaluhi, is particularly notable because it is just inland of the location of Liliʻuokalani's beachside residence Kealohilani, which was subsequently the second Pualeilani home of Prince Jonah Kūhiō Kalanianaʻole. In the mid-century Mahele, the ʻili of Hamohamo was awarded to the high chief Keohokālole. In 1859, Keohokālole transferred the land to her daughter Liliʻuokalani (future queen of Hawaiʻi), who established Waikīkī residences at Paoakalani (makai of the present Ala Wai Canal) and a beachside cottage on the former LCA 1433:1 that she called Kealohilani.

One of the earliest structures to modify the shoreline was a bridge and causeway built across the mouth of Kuʻekaunahi Stream at the entrance to Kapiʻolani Park, which opened in 1877 (Photo 4). In 1890, a 390-ft-long retaining wall was built to protect Waikīkī Road (now Kalākaua Avenue), replacing part of the original bridge and causeway. The 1890 retaining wall is said to have been removed in 1972 (Wiegel 2008: 27); as discussed below, an existing portion of the wall may have been discovered during construction along Kalākaua Avenue.

An approximately 130-ft-long timber pier on piles was built sometime prior to 1890 off of Liliʻuokalani's Kealohilani residence. Known as Queen Liliʻuokalani or Kūhiō Pier, it was demolished in 1934 (Kanahele 1995:136; Wiegel 2008:17).

Prince Kūhiō acquired Kealohilani in 1918 through an out-of-court settlement from his challenge to Liliʻuokalani's establishment of a trust (Hibbard and Franzen 1986:37). He built a new home called Pualeilani on the property. This Pualeilani was the second home of this name owned by Kūhiō; his former Pualeilani home was approximately 300 m to the north (in the Royal Hawaiian sector). In 1922, the Paradise of the Pacific magazine noted that it was the last space in Waikīkī that was retained by a member of the royal family (Hibbard and Franzen 1986:38). The property was acquired by the City and County of Honolulu in 1934-1935 and the house was demolished for beach improvements (Hibbard and Franzen 1986:38).

Preparations for the opening of Kūhiō Beach Park in 1940 included the construction of a 650-ft-long crib wall built in 1939 200 ft from shore (parallel to shore) off the ʻEwa end of Kūhiō Beach, with shore return structures at each end of the seawall (Wiegel 2008:17). The 355-ft-long Kapahulu storm drain/groin was built in 1951 at the end of Kapahulu Avenue. The structure is an extension of the storm drain running under Kapahulu Avenue; the storm drain and groin, which is still a prominent feature of the Waikīkī Beach shoreline, is commonly referred to as "The Wall" (Clark 1977:53). Other improvements included construction of a retaining wall on the Diamond Head side of the groin and importing sand.

In 1953, a 750-ft-long retaining wall was built between the 1939 crib wall and the Kapahulu storm drain/groin to keep sand from eroding. This wall, also still extant, is called "Slippery Wall" because of its very slick surface when wet due to the growth of fine seaweed (Clark 1977:53; Wiegel 2008:17, 27). It forms the boundary of Kūhiō Beach's Diamond Head (east) basin. The beach sand has been further supplemented several times, including through off-shore dredging ca. 2000 (Wiegel 2008:19).

The Kūhiō beach sector has seen extensive modification over the past century and a half. A comparison of the historical and contemporary coastlines shows that the present project area is entirely within beach that has been added since ca. 1880s (Figure 20). 19th century maps of the Waikīkī coastline show that this sector contained the mouth (*muliwai*) of Kuʻekaunahi Stream. Kuʻekaunahi Stream ceased to flow in the 1920s after it was cut off from the upland waterways by the Ala Wai Canal.

Over the years, various structures have been built along the shoreline in the Kūhiō beach sector. The earliest of these was a bridge or causeway built along Kalākaua Avenue at the entrance to Kapiʻolani Park. Subsequent structures include Liliʻuokalani Pier (removed in 1934), a retaining wall along Kalākaua Avenue (possibly removed in 1972), and the structures of the Kūhiō groin complex, which include two shore-parallel seawalls enclosing a protected swimming area supplemented by groins. The most prominent of these groins is the Kapahulu storm drain/groin at the Diamond Head end of the complex.

No known archaeological sites are within the Kūhiō beach sector. Eleven sites, inclusive of 52 burials, have been recorded within 50 m of the project area. Site 50-80-14-5859 is a cluster of eight burials near the intersection of Kalākaua and Lili‘uokalani Avenues, which is the location of LCA 1433:1 and a group of nearby *kuleana* awards (LCAs 5FL:1, 1437:1, 1459, and 1468); it is also the location of Lili‘uokalani’s beach residence, Kealohilani. Non-burial sites include Site 50-80- 14-5940 (an extensive but discontinuous archaeological deposit along Kalākaua Avenue between Ka‘iulani and Lili‘uokalani Avenues), Site 50-80-14-5941 (historical trash pit), Site 50-80-14-5942 (remnant of light-gauge rail), Site 50-80-14-5943 (low-energy alluvial deposits related to Ku‘ekaunahi Stream), and Site 50-80-14-5948 (an exposed seawall that might date to around 1890).

9.2.4 Architectural Resources

9.2.4.1 General Overview

Architectural resources within and adjacent to the Waikīkī shoreline project area consist of beach infrastructure (groins and seawalls) and adjacent buildings. The groins (including storm drains) form the boundaries between each of the sectors: Kapahulu storm drain/groin, ‘Ewa Kūhiō groin, Royal Hawaiian groin, and Fort DeRussy outfall/groin. They were built at different times, with dates of origin from 1917 (Fort DeRussy) to 1951 (Kapahulu storm drain/groin). A complex of shore-parallel seawalls in the Kūhiō Beach sector was built in 1939 and extended in 1953. Estimates of construction dates have been made using historical maps and photographs, as well as references in Waikīkī historical sources (e.g., Clark 1977; Wiegel 2008).

With one exception (Site 50-80-14-5948), these beach infrastructure features have not been recorded in detail nor assigned State Inventory of Historic Places (SIHP) numbers. However, based on age (at least 50 years old) and their relevance to Waikīkī’s history they may be considered historic properties. Inland of the shoreline maintenance program areas are three important historic buildings, which will not be physically affected by beach improvement activities but warrant mention: Battery Randolph (Site 50-80-14-1382), the Moana Hotel (Site 50-80-14-9901), and the Royal Hawaiian Hotel (no SIHP number). Both Battery Randolph and the Moana Hotel are listed on the NRHP.

9.2.4.2 Fort DeRussy Beach Sector

The Fort DeRussy sector contains the Fort DeRussy Groin beach control structure with Battery Randolph just inland of the sector’s northeastern boundary, and the Fort DeRussy seawall.

<u>Fort DeRussy Outfall/Groin</u>
A 70-ft-long box culvert at the Diamond Head end of the sector was built in 1917. The box culvert was lengthened to 300 ft in 1969 and supplemented by a rubble mound groin ca. 1971 (Wiegel 2008:22). It is unclear whether the existing groin immediately south of the Fort DeRussy Groin is the original 1917 groin, or if the 1917 groin was destroyed or covered during the 1969 extension of the structure.

Fort DeRussy Seawall

In 1916, a 1,150-ft-long seawall was built along the entire Fort DeRussy shoreline. The seawall was built on the coral reef where there was no sand, and the area behind it was filled with coral rock and rubble dredged from the reef (Wiegel 2008:11). The batteries and seawall are estimated to lie just seaward of the present promenade.

Battery Randolph (Site 50-80-14-1382)

Construction of Battery Randolph was begun in 1910 by the U.S. Army as part of the Artillery District of Honolulu (later renamed the Headquarters Coast Defense of Oʻahu) intended to protect the coast of Oʻahu, including Honolulu Harbor. The Artillery District included Forts Armstrong, DeRussy, Kamehameha, and Ruger. Battery Randolph was completed and armed by 1914. Battery Dudley, which was adjacent to and northwest of Battery Randolph, was armed in 1916. A deep channel was cut into the reef to facilitate the installation of two 14-inch guns. Battery Randolph is built of reinforced concrete, with its design intended to camouflage it from military attack. The appearance of the building is described in its NRHP nomination:

> *In contrast to the stark, vertical walls of older forts, the new works of reinforced concrete [at Fort DeRussy, including Battery Randolph, and Fort Kamehameha] were designed to blend, so far as possible, into the surrounding landscape. The low profile, massive emplacements all possess concrete frontal walls as much as twenty feet thick behind 30 or more additional feet of earth. The batteries were (and still are) all but invisible and invulnerable from the seaward direction. The permanency of construction is also evident by their present condition (Char 1983:4).*

Battery Randolph was deactivated in 1944, and its guns and mounts were removed. Since 1976, the building has housed the U.S. Army Museum of Hawaiʻi. It was entered on the NRHP in 1984 as part of the Artillery District of Honolulu (Site 50-80-14-1382) along with Batteries Selfridge, Jackson, Hawkins, Hawkins Annex, and Hasbrouck at Fort Kamehameha.

9.2.4.3 Halekūlani Beach Sector

In addition to the Royal Hawaiian groin (at the east end), five concrete block groins are visible in aerial photographs of the Halekūlani beach sector and may be historical structures. Similar groins can be seen in a 1932 aerial photograph. Eight groins were built between the Royal Hawaiian Hotel and Fort DeRussy from 1926 to 1929 (Wiegel 2008:26). Four groins in this area were removed in 1970 (Crane 1972, cited in Wiegel 2008:22).

9.2.4.4 Royal Hawaiian Beach Sector

The Royal Hawaiian beach sector contains two beach stabilization structures and has two historic buildings, the Moana Hotel and the Royal Hawaiian Hotel, immediately inland of the sector’s northern margin. The beach infrastructure consists of the Royal Hawaiian groin (built in 1927), which marks the boundary with the Halekūlani sector, and a buried seawall at the southern end of the sector.

Royal Hawaiian Groin

The 170-ft-long Royal Hawaiian groin, which marks the boundary of the Royal Hawaiian and Halekūlani sectors, was built to the west of the Royal Hawaiian Hotel in 1927. The groin was extended to a length of 368 ft in 1930 (Wiegel 2008:21, 26) and substantially rebuilt in 2020. The recent groin expansion included the construction of a 125-ft-long boulder rubble-mound groin overlying a portion of the existing Royal Hawaiian groin and a 50-ft-long dogleg to the east. Archaeological monitoring conducted during the groin expansion yielded no significant finds (Morrison 2020).

Buried Seawall

A buried concrete slab was examined by SHPD staff in 2013 at the Diamond Head end of the sector, immediately west of the Kūhiō Beach Hula Mound (Nick Belluzzo, personal communication 2017). Subsequent beach erosion has exposed a larger portion of the concrete slab, which is in the same location as the Waikīkī Inn (part of the Waikīkī Tavern) as shown on a 1950 Sanborn Fire Insurance map. The buildings of the Waikīkī Tavern were built in the 1920s and demolished ca. 1960 for the development of Kūhiō Beach Park. The buried seawall may be associated with a structure illustrated on Kanahele's (1928c) map of Waikīkī.

Moana Surfrider Hotel (Site 50-80-14-9901)

In 1901, Waikīkī's first major hotel, the Moana, opened on the grounds of W.C. Peacock's former home on the south side of the ʻĀpuakēhau Stream mouth (Photo 6). The Moana Hotel, which was designed by O.G. Traphagen, "features an elaborately designed lobby which extends to open lanais and is open to the Banyan Court and the sea" (Riconda 1972:3). The hotel was outfitted with a 300-ft-long pier, originally called Peacock Pier, that was a landmark of the Waikīkī shoreline until it was demolished in 1931 (Wiegel 2008:21). The Moana Groin was a concrete wall built into the ocean on the Diamond Head side of ʻĀpuakēhau Stream sometime between 1906 and 1907; it was removed in 1927 (Kanahele 1928c; Wiegel 2008:26). During the early 20th century, the hotel's dining room was built on piles and extended nearly to the water; this dining room has since been removed. Two concrete five-story wings were added onto the original four-story wooden structure in 1918, doubling the hotel's capacity (Hibbard and Franzen 1986:77). The 21-story Surfrider Hotel opened on the western side of the Moana Hotel in 1969 (Wiegel 2008:21); the Moana and Surfrider today operate as a single establishment known as the Moana Surfrider Hotel. The Moana Hotel, which has been designated as Site 50-80-14- 9901, was listed on the NRHP in 1972. According to the NRHP nomination form (Riconda 1972:3):

> *The original wooden center structure of the Moana Hotel, built in 1901, is the oldest existing hotel in Waikīkī. As such, it deserves recognition as a landmark in Hawaii's tourist industry. The Moana was one of the earliest "high-rise" buildings in Hawaiʻi and was the costliest and most elaborate hotel in the islands. In spite of numerous renovations and changes, it has retained its tropical openness and is a welcome change from the more modern highrises [sic] that surround it. The Moana represents an important architectural link in the development of Waikīkī.*

Royal Hawaiian Hotel

In 1925-1926, the iconic Royal Hawaiian Hotel was built on the grounds of the former Seaside Hotel, and it opened in 1927 (Photo 8). The distinctive six-story building, with its pink stucco concrete façade, contributed to the coastline's growing allure as a glamorous tourist destination. According to Hibbard and Franzen (1986:95):

> *The 'pink palace' towered over its neighbors and had a majestic aura new to Waikīkī. Sheer massiveness, capped by a central tower that soared 150 feet above the street, enabled the Royal Hawaiian to join the Moana in dominating the beach's palm-filled skyline. Furthermore, its four hundred rooms, each with a bath, balcony, and view of either mountains or ocean, almost doubled the guest capacity of Waikīkī.*

The Royal Hawaiian Hotel continues to operate in its original building. Although undoubtedly a historically significant structure, it has not been assigned an SIHP number or evaluated in terms of its eligibility for the NRHP.

9.2.4.5 Kūhiō Beach Sector

There are four known historical architectural structures within the Kūhiō beach sector, all of which are beach stabilization structures: 1) Site 50-80-14-5948 is a buried remnant of the seawall constructed in 1890, 2) the ʻEwa (west) basin of the Kūhiō groin complex constructed in 1939, 3) "Slippery Wall" (forming the Diamond Head (east) Basin of the Kūhiō groin complex) constructed in 1951-1953, and 4) the Kapahulu storm drain/groin constructed in 1951.

Site 50-80-14-5948

The site consists of remnants of a buried historical seawall approximately 4 m seaward of the Kalākaua Avenue curb near the intersection of Kalākaua and Kapahulu Avenues (Winieski et al. 2002:55). The top of the 15 m long wall, which is built of mortared large basalt boulders, was exposed by construction excavation at about 1 m below the surface and the base of the wall, extended below the base of excavation at 2.2 m below surface. The wall is also shown on Kanahele's (1928d) map of Waikīkī beach. The seawall was evaluated as significant under the State of Hawaii's Criterion d1.

ʻEwa (west) basin of the Kūhiō Groin Complex

In 1939, preparations for the opening of Kūhiō Beach Park in 1940 included the construction of a 650-ft-long breakwater built 200 ft from shore (parallel to shore) along the ʻEwa end of Kūhiō Beach, with shore return structures at each end of the seawall. The breakwater is known as the "crib wall." At least 7,000 cy of sand were also placed on the beach around the same time (Wiegel 2008:17).

Kapahulu Storm Drain/Groin

The 355-ft-long Kapahulu storm drain/groin was built in 1951 at the end of Kapahulu Avenue. Other improvements included construction of a retaining wall on the Diamond Head side of the Kapahulu storm drain/groin and importing sand. The structure is an extension of the storm drain running under Kapahulu Avenue, which discharges storm water at its seaward end. The Kapahulu storm drain/groin, which is still a prominent feature of the Waikīkī Beach shoreline, is commonly referred to as "The Wall" (Clark 1977:53).

“Slippery Wall”
In 1953, a 750-ft-long retaining wall was built between the 1939 crib wall and the Kapahulu storm drain/groin to keep sand from eroding away. This wall is called “Slippery Wall” because of its slick surface when wet due to the growth of fine seaweed (Clark 1977:53; Wiegel 2008:17, 27). It forms the boundary of the Diamond Head (east) basin of the Kūhiō groin complex. The beach sand along Kūhiō Beach has been supplemented several times, including through offshore dredging ca. 2000 (Wiegel 2008:19).

9.2.5 Ka Paʻakai Cultural Impact Analysis

The State of Hawaiʻi has a responsibility to promote and preserve cultural beliefs, practices, and resources of Native Hawaiians and other ethnic groups. This includes ensuring that legitimate customary and traditional practices of Native Hawaiians be protected to the extent feasible.

The Hawaiʻi Supreme Court in *Ka Paʻakai O Ka `Aina v. Land Use Commission* (2000) suggested three tests for agencies to protect traditional and customary Native Hawaiian practices to the extent feasible. The tests include assessment of the following:

A. The identity and scope of valued cultural and historical or natural resources in the petition area including the extent to which traditional and customary Native Hawaiian rights are exercised in the petition area;
B. The extent to which those resources including traditional and customary Native Hawaiian rights will be affected or impaired by the proposed action; and
C. The feasible action, if any, to be taken by the state to reasonably protect Native Hawaiian rights if they are found to exist.

Waikīkī is a predominantly engineered shoreline. The current shoreline configuration is largely the result of past efforts to widen and stabilize the beaches. The project area consists of eight littoral cells (beach sectors), four of which have been selected for beach improvement and maintenance actions. The boundaries of the beach sectors are primarily defined by engineered structures (e.g., groins, breakwaters, seawalls) that influence coastal processes. Beach width and stability vary by sector.

The project area falls within the *ahupuaʻa* of Waikīkī in the traditional *moku* (district) of Kona. The traditions of Waikīkī indicate its significance as a nexus of interconnected *aliʻi* histories and as a highly productive agricultural region. In ancient times, Waikīkī was a center of *aliʻi* power, “a land beloved of the chiefs” who resided there because the lands were rich, and the surfing was excellent (Kamakau 1991:44). The significance of Waikīkī *ahupuaʻa* is also emphasized by the number and kinds of heiau distributed across this area, particularly along the coast (Kamakau 1976:144; Thrum 1907:44-45).

During the past 130 years, the Waikīkī shoreline has been substantially engineered to create larger sandy beaches for recreation and tourism. As such, most of the proposed beach improvement and maintenance program will occur within modern beach deposits seaward of the 19th century and early 20th century shorelines.

A. The identity and scope of valued cultural and historical or natural resources in the petition area including the extent to which traditional and customary Native Hawaiian rights are exercised in the petition area.

Traditional cultural practices in the Waikīkī area include gathering, fishing, diving, contemplation, spiritual and physical healing, canoe paddling, surfing, and other ocean activities. There have been numerous Cultural Impact Assessments (CIA) for previous projects in Waikīkī, some of which address the shoreline and areas immediately inshore of the active beach system, including portions of the four Waikīkī beach sectors selected for improvement and maintenance actions (Fort DeRussy, Halekūlani, Royal Hawaiian, and Kūhiō Beach). The CIA for the Waikīkī Beach Improvement and Maintenance Program was completed by International Archaeology, LLC in March 2021, and is included as Appendix D.

The most frequently mentioned concern in the previous and current CIA studies was the inadvertent exposure of cultural material, particularly iwi kūpuna (ancestral remains or bones), during ground-disturbing construction work along the shoreline or in the offshore sand deposits that will be dredged to expand and replenish the beaches.

The second most frequently mentioned concern in the previous and current CIA studies involved past and present ocean and shoreline cultural-natural resources, particularly fishing, gathering, and potential impacts to marine habitat. Kawehewehe (at the boundary between the Fort DeRussy and Halekūlani beach sectors) was also frequently mentioned as both a historical and ongoing place of spiritual and physical healing, where the sick undergo ritual bathing. Traditional Native Hawaiian healing and purification rituals are still practiced in the waters of Kawehewehe, and *limu kālā*—a plant used in healing and *hoʻoponopono* ceremonies—may still grow in the area.

The third most frequently mentioned concern was the ongoing development of Waikīkī, particularly obstruction of mauka-to-makai view corridors by tall buildings/hotels, harm to associated cultural features on the landscape, increasing demands on infrastructure in Waikīkī, including traffic, noise and waste management problems, and most critically, the loss of a "Hawaiian sense of place" and the feel of "old Waikīkī."

A. The extent to which those resources including traditional and customary Native Hawaiian rights will be affected or impaired by the proposed action.

Iwi Kūpuna

The proposed actions have the potential to encounter or disturb iwi kūpuna at three potential locations: 1) backshore (mauka of the shoreline), 2) foreshore (active beach system), and 3) offshore (sand deposits).

Backshore (Terrestrial Area)

Surface and subsurface cultural resources have been identified in the backshore (terrestrial) area inshore of the project area (active beach system). Resources in the backshore (terrestrial) area have been heavily impacted by previous and ongoing development activities. The most predominant resource in the backshore, based on previous investigations, are in situ and disturbed iwi kūpuna. The resources are located mauka (landward) of the proposed actions, and no excavation or ground-disturbing activities are proposed in the backshore (terrestrial) portion of the project area. The proposed beach improvement and maintenance actions will widen and stabilize the existing beaches, thereby providing a protective buffer for any burials or cultural materials that may exist inshore of the active beach system.

Foreshore (Beach)

While the beaches of Waikīkī are almost entirely composed of imported sand and unlikely to contain primary burials, there are concerns regarding the history and sources of the sand used to build and replenish the beaches during the 20th century.

From about 1930 until the late 1970s, it is estimated that over 400,000 cy of sand has been placed on Waikīkī Beach, from a variety of sources including other beaches on Oʻahu and Molokaʻi, inland dune deposits, and even crushed coralline limestone. It is not known whether sand containing iwi kūpuna has ever been redeposited in the project area or has eroded into offshore deposits. Much of the information regarding historical beach nourishment efforts is anecdotal and based on oral accounts. Given the lack of historical data, it would be difficult to ascertain where and when the sand was acquired and imported into Waikīkī.

While no cultural or archaeological resources (including iwi kūpuna) have currently been discovered within the project area, the applicant is aware that cultural or archaeological resources may be identified during public notices and community meetings. If iwi kūpuna were encountered in the foreshore (active beach system), it would be difficult or impossible to confirm the ancestry of the remains or identify lineal descendants. In summary, the proposed actions are not anticipated to encounter or affect iwi kūpuna in the foreshore (active beach system).

Offshore (Sand Deposits)

The sand required for the proposed beach nourishment and maintenance actions would be almost exclusively recovered from submerged deposits located offshore of Waikīkī. Sand would be recovered using submersible slurry pumps, self-contained hydraulic suction dredges, and/or clamshell buckets. There are concerns regarding the potential disturbance of modern human remains in the submerged sand deposits immediately offshore of Waikīkī where cremated human remains are frequently spread.

The applicant acknowledges and appreciates the history and practice of spreading cremated human remains in the offshore waters of Waikīkī. However, the likelihood of encountering iwi kūpuna in these areas is considered to be relatively low and it would be very difficult to differentiate cremated remains from marine carbonate sand. The cremation process applies extreme temperature to the body, completely incinerating everything and reducing the body to bone fragments, which are mechanically pulverized down to a coarse, sand-like material. The cremated remains (commonly referred to as "ashes") consist of inorganic material largely composed of Calcium Phosphate, which is typically a pale to dark gray powder that is similar in texture and appearance to coarse sand. Given the similarities between cremated remains and marine carbonate sand in terms of particle size and color, it would be difficult or impossible to identify or differentiate cremated remains from marine carbonate sand.

The proposed sand recovery areas located offshore of Waikīkī are dynamic and mobile. The *Ala Moana* and *Hilton* sand deposits are reef-generated deposits, so the potential for these deposits to contain iwi kūpuna is considered to be relatively low. The *Canoes/Queens* sand deposit is closer to the shoreline; however, this deposit is very mobile and has dredged multiple times during previous beach nourishment projects.

It is likely that any cremated remains spread within the vicinity of the proposed sand recovery areas would be immediately dispersed within the water column. The non-uniform dispersion of the cremated remains reduces the likelihood of encountering in situ deposits. If iwi kūpuna were encountered in the offshore sand deposits, it would be difficult or impossible to confirm the ancestry of the remains or identify lineal descendants. In summary, the proposed actions are not anticipated to encounter or affect iwi kūpuna in the offshore sand recovery areas.

Traditional and Cultural Practices

The applicant recognizes and appreciates the various Native Hawaiian traditional and cultural activities that are practiced in Waikīkī, particularly surfing, fishing, gathering, and spiritual and physical healing. The proposed actions may temporarily curtail these activities. During construction, the use of some portions of the shoreline and offshore sand recovery areas may be prevented for public health and safety reasons. In addition, dredging operations will be visible from the shoreline. These impacts will be short-term in nature. Upon completion, the proposed actions will not curtail these activities. In summary, valued Native Hawaiian traditional and cultural practices are not anticipated to be adversely affected should the proposed actions be approved and implemented.

Natural Resources

The applicant recognizes and appreciates the quality and value of marine resources in Waikīkī. The proposed actions have the potential to temporarily affect marine species and habitat. *Honu* (green sea turtles) are regularly observed swimming and foraging in the nearshore waters within the project area; however, no obvious *honu* congregation or nesting areas have been observed. Hawaiian monk seals (*Monachus Schauinslandi*) have also been observed in Waikīkī. The seafloor and all subsurface waters and marine habitat within 10 m of the seafloor, through the water's edge 5 m into the terrestrial environment from the shoreline are considered critical habitat for Hawaiian monk seals.

The proposed actions may temporarily inhibit foraging opportunities for marine species. In-water construction work (e.g., dredging, groin construction) may result in significant underwater sound that could potentially affect marine species. The following Best Management Practices (BMPs) and avoidance and minimization measures will be implemented to mitigate potential effects on marine species and habitat to the maximum extent practicable.

1. Turbidity containment devices (e.g., silt fencing, turbidity curtains) shall be installed around the areas of groin construction and sand placement.
2. Visual monitoring for turbidity outside the confines of the turbidity curtains shall be conducted. In the event that turbidity is observed outside of the turbidity curtains, work shall stop, and the turbidity curtains shall remain in place until the turbidity dissipates.

turbidity curtains shall be inspected after dissipation and prior to returning to project operations.

3. All construction personnel on site shall be informed of the potential for federally protected marine species that may occur within or transit through the project area. It shall be made clear that any intentional physical interactions with any identified federally protected marine species is explicitly prohibited.
4. A competent observer shall be designated to observe the construction work areas and areas immediately adjacent to the work for the presence of federally protected marine species, including but not limited to, green sea turtles, hawksbill sea turtles, and Hawaiian monk seals. Visual surveys for these species shall be made prior to the start of work each day, and prior to resumption of work following any break of more than one half hour, to ensure that no federally protected marine species are within 150 ft of the work area.
5. A 150-ft safety zone shall be established around the project areas where a competent observer shall visually monitor the zone for the presence of federally protected marine species 30 minutes prior to, and 30 minutes post project in-water activity. The observer shall record information on the species, numbers, behavior, time of observation, location, start and end time of project activity, characteristics of the marine species, and any observed disturbances of the work on the species (visual or acoustic).
6. Activity shall be conducted only if the safety zone is clear of all marine federally protected species.
7. Upon sighting of a federally protected marine species within the safety zone during project activity the activity shall immediately halt until the animal has left the zone. In the event that a federally protected marine species enters the safety zone and the project activity cannot be halted, observations shall be made and NOAA-NMFS staff in Honolulu shall be immediately contacted to facilitate agency assessment of collected data. Work may continue only if there is no possibility for the activity to adversely affect the animal.
8. All equipment and material shall be free of contaminants of any kind including but not limited to excessive silt, sludge, anoxic or decaying organic matter, clay, dirt, oil, floating debris, grease or foam or any other pollutant that would produce an undesirable condition to the shoreline or water quality.
9. Cease construction work if unusual conditions, such as large tidal events or high surf conditions affect the project site, except for efforts to avoid or minimize damage to natural resources, such as the temporary removal of turbidity curtains.
10. Construction site inspections and debris sweeps will be made at the end of each workday, and all project related debris and trash shall be removed and disposed of. Equipment that is not actively being used shall be properly stored and secured so as not to cause unintended damage to the beach or adversely affect any federally protected marine species. A full inspection of the project site shall be conducted at the end of the project to ensure that no visible debris or project waste is present upon completion of the project.
11. Nighttime work and/or work requiring artificial light sources is prohibited. No new permanent lighting shall result from the proposed actions.
12. Any incidental injuries or take of green or hawksbill sea turtles on land shall be immediately reported to the U.S. Fish and Wildlife Service.

13. Any incidental injury or take of green or hawksbill sea turtle or Hawaiian monk seal in the water shall be immediately reported to NOAA-NMFS and the Pacific Island Protected Species Program Manager, Southwest Region.

By using the above BMPs, noise/physical disturbance to *honu* and Hawaiian monk seals is anticipated to be temporary and unlikely to result in adverse behavioral changes. Based on the in-water work being conducted in very shallow water with turbidity containment barriers surrounding the work areas, any exposure of federally protected marine species to turbidity is expected to be temporary and not significant. No significant loss of foraging area is anticipated.

The structures proposed in the Halekūlani and Kūhiō beach sectors have the potential to improve biodiversity and habitat for marine species. The interstitial spaces between the armor stones provide additional habitat for cryptic benthic (crabs, shrimps, worms, etc.) and sessile organisms (sponges and tunicates) that provide additional foraging resources for fishes. The Iroquois Point Beach Nourishment and Stabilization project, which was completed in 2013, utilized groins that are similar to those being proposed in Waikīkī. Post-construction monitoring from 2013-present found a 25-fold increase in fish abundance, not counting small baitfish, and a doubling of species richness (number of species). Fish biomass is more than 6 times greater than prior to construction. The greatest change occurred in the vicinity of the new habitat created by the groin structures. Other changes in the vicinity of the groins include an increase in crustose coralline algae cover from 1% to 60%, coral cover increase from 0 to 0.6% and macroinvertebrate cover from 1.4% to 6.3%. Coral abundance in the groin vicinity increased from 0 to 16 colonies per $10m^2$. These changes are attributable to the creation of hard, stable habitat for colonization. In summary, the proposed actions are not anticipated to adversely affect federally protected marine species or habitat.

Kawehewehe

The applicant recognizes and appreciates the cultural significance of Kawehewehe as a historical and ongoing place of spiritual and physical healing. Kawehewehe was the residence of the Luluka family of noted Hawaiian historian, John Papa ʻĪʻī. The family moved to Oʻahu in the early 1800s, in the company of Kamehameha who was preparing for the invasion of Kauaʻi (ʻĪʻī 1959:15); Papa ʻĪʻī's uncle was a member of the royal court, and members of the Luluka family were responsible for the royal residence of Kamehameha at Puaʻaliʻiliʻi at Helumoa. Kawehewehe was the outflow from the large fishpond complex of Kālia and marks the ʻEwa (west) end of the Halekūlani beach sector (roughly the alignment of Saratoga Road).

The proposed action in the Halekūlani beach sector may temporarily curtail these uses. During construction, access and use of some portions of the shoreline and offshore areas may be prevented for public health and safety reasons. In addition, dredging operations will be visible from the shoreline. These impacts will be short-term in nature. Upon completion, the proposed action will not curtail these activities. In summary, valued Native Hawaiian traditional and cultural practices at Kawehewehe are not anticipated to be adversely affected should the proposed actions be approved and implemented.

Development

The applicant understands and appreciates concerns that have been expressed in regard to the intensity of past and ongoing development in Waikīkī. Impacts to viewplanes, increasing demands on infrastructure, and the loss of a "Hawaiian sense of place" and the feel of "old Waikīkī" are recognized issues in Waikīkī. The applicant also acknowledges that the beaches are intrinsically linked to the development of Waikīkī. Without the beaches, it is unlikely that Waikīkī would have evolved into the world-class tourism destination that it is today.

The proposed actions are limited to the foreshore (active beach system) makai of the shoreline and are consistent with historical and ongoing uses in this area. The proposed actions will improve the condition of the Waikīkī shoreline by increasing recreational dry beach area, increasing beach stability, improving lateral shoreline access, and enhancing existing viewplanes. The proposed structures (i.e., groins, segmented breakwater) will be similar in size and appearance to the structures that currently exist in Waikīkī. While the proposed actions are unlikely to restore a "Hawaiian sense of place" or the feel of "old Waikīkī", they will not negatively affect the intrinsic value of Waikīkī. In summary, the proposed actions are not anticipated to affect or intensify existing or future development patterns in Waikīkī.

B. The feasible action, if any, to be taken by the state to reasonably protect Native Hawaiian rights if they are found to exist.

To address these concerns, the applicant will take the following actions:

1. *Carefully evaluate new sources of replenishment sand to confirm they do not contain iwi kūpuna or other cultural material.*

   The applicant will develop and implement an archaeological monitoring plan. An archaeological monitor will be present during implementation of the proposed actions. While no excavation is proposed, the applicant acknowledges that the installation of certain environmental Best Management Practices (e.g., silt fencing, turbidity curtains) may constitute "ground alteration", and that an archaeological monitor should be present. Should any iwi kūpuna or cultural materials be discovered, the proper authority shall be notified. The proposed beach improvement and maintenance actions will widen and stabilize the existing beaches, thereby providing a protective buffer for any burials or cultural materials that may exist inshore of the active beach system.

2. *Monitor all ground-disturbing project work within the historical (pre-20th century) shoreline areas for exposed or disturbed cultural material and develop a plan to protect these resources in consultation with cultural stakeholders/organizations and appropriate government agencies.*

   The applicant will develop and implement an archaeological monitoring plan. An archaeological monitor will be present during implementation of the proposed actions. While no excavation is proposed, the applicant acknowledges that the installation of certain environmental Best Management Practices (e.g., silt fencing, turbidity curtains) may constitute "ground alteration", and that an archaeological monitor should be present. Should any iwi kūpuna or cultural assets be discovered, the proper authority shall be notified.

3. *Reasonably address concerns from community members about the disposition of cremated remains.*

   The applicant will continue to engage the community and local stakeholders to address the concerns related to the disposition of cremated remains. A public scoping meeting will be held during the 45-day public comment period for the Draft Programmatic Environmental Impact Statement (DPEIS).

4. *Protect Kawehewehe from damage and allow cultural practitioners reasonable access to the area during construction work.*

   The applicant will seek to minimize potential impacts to Kawehewehe to the maximum extent practicable. The project was designed to avoid contact with any portion of Kawehewehe, and to minimize impacts to Native Hawaiian practitioners at the site. The Kawehewehe area will be clearly delineated in project plans, and efforts will be made to avoid burying or damaging the area during construction. The applicant will make a good faith effort to accommodate the needs of Native Hawaiian practitioners in the region during construction. Native Hawaiian practitioners will be provided regular and reasonable access to the waters throughout the duration of the project; however, access to certain areas will be temporarily restricted in order to ensure public health and safety. Upon completion, the proposed action will not curtail any of these important cultural activities and practices.

5. *Regularly engage cultural stakeholders and the local community in future project planning.*

   The applicant has conducted extensive outreach and stakeholder engagement in development of the Waikīkī Beach Improvement and Maintenance Program. A critical component of the project was the establishment of the Waikīkī Beach Community Advisory Committee (WBCAC), which was formed in 2017 to provide a forum to engage stakeholders and provide guidance and feedback on design criteria and rationale for beach improvement and maintenance projects in Waikīkī. The WBCAC is composed of various stakeholders representing business (34%), government (30%), hotels (15%), non-profit organizations (12%), and science and engineering (9%).

   The WBCAC serves as a representative body to communicate the diversity of perspectives and priorities in the broader Waikīkī community, provide guidance and feedback for beach management and planning activities in Waikīkī, and ensure that future beach management projects address the issues and concerns of the Waikīkī community and local stakeholders. The WBCAC was directly involved in determining the priorities and objectives for each beach sector, establishing planning and design criteria, evaluating conceptual options, and providing feedback on the conceptual designs for the proposed actions. The WBCAC held six (6) formal meetings from Nov 2017 to Jan 2021. The WBCAC meeting agendas and outcomes are included as Appendix A of the DPEIS.

In addition, the applicant has held two (2) public scoping meetings and will continue to solicit guidance and feedback from the community regarding the potential impacts of the proposed actions. A public scoping meeting will be held during the 45-day public comment period for the Draft Programmatic Environmental Impact Statement (DPEIS). The applicant will also engage in a formal consultation with the Hawaiʻi Department of Land and Natural Resources, State Historic Preservation Division (SHPD) to determine if any additional cultural Best Management Practices are recommended or required. If cultural assets are discovered, all work will cease and SHPD will be notified.

9.2.6 Potential Impacts and Mitigation Measures

Waikīkī has a rich historical and cultural legacy. There do not appear to be any known traditional Hawaiian cultural practices that would be adversely affected by the proposed actions, nor does it appear that the activities associated with the proposed actions will conflict with traditional cultural practices as expressed in legend. The proposed actions will be implemented in an area that has been substantially altered over more than a century and is entirely makai (seaward) of the shoreline where the existence of any cultural artifacts or remains is unlikely.

Four aspects of the program make it unlikely that the proposed beach improvement and maintenance actions will have a significant adverse effect on historical, cultural, archaeological, or architectural resources, or any on rights customarily and traditionally exercised for subsistence, cultural and religious purposes:

1. Implementation of the proposed actions does not involve construction on or excavation of backshore land areas that might contain physical remains. Work on land will take place only on the beach and submerged lands. Care will be taken when working on the beach to avoid disturbing previously undisturbed sandy sediments that might hide subsurface deposits.

2. Construction of the new structures (groins and segmented breakwater) will take place completely on submerged lands, seaward of the shoreline, and will not involve modification of soft deposits which could reasonably be expected to have the potential to hide archaeological materials or burials.

3. The likelihood of encountering iwi kūpuna in the offshore deposits is considered to be relatively low. The cremation process applies extreme temperature to the body, completely incinerating everything and reducing the body to bone fragments, which are mechanically pulverized down to a coarse, sand-like material. The cremated remains (commonly referred to as "ashes") consist of inorganic material largely composed of Calcium Phosphate, which is typically a pale to dark gray powder that is similar in texture and appearance to coarse sand. Given the similarities between cremated remains and marine carbonate sand in terms of particle size and color, it would be difficult or impossible to identify or differentiate cremated remains from marine carbonate sand. It is not known whether sand containing iwi kūpuna has ever been redeposited in the project area or has eroded into offshore deposits. Much of the information regarding historical beach nourishment efforts is anecdotal and based on oral accounts. Given the lack of historical data, it would be difficult to ascertain where and when the sand was acquired

and imported into Waikīkī. If human remains were encountered, it would be very difficult to confirm the identity of the deceased or lineal descendancy.

4. Construction of the new groins and beach fill in the Halekūlani beach sector is not anticipated to affect submarine groundwater discharge at Kawehewehe. The proposed action does not include shore parallel structures penetrating to depths that would prevent submarine groundwater discharge, including tidal pumping. Sand would not be a barrier to flow, it would just make the seepage more diffuse, so submarine groundwater discharge would be significantly altered (H. Dulai, personal communication, April 19, 2021). If there is submarine groundwater discharge coming out of this sector, the ocean current-dampening action of adding groins (as is its function) would pond (decrease oceanic mixing) and thus increase the residence time of any groundwater that has been discharged (C. Glenn, personal communication, April 19, 2021). As a result, the proposed action is not anticipated to affect submarine groundwater discharge or any ongoing Native Hawaiian cultural practices at Kawehewehe.

9.2.6.1 Fort DeRussy Beach Sector

The proposed action for the Fort DeRussy beach sector includes the addition of approximately 1,500 cy of sand fill near the Diamond Head edge. A sand borrow area is proposed at the ʻEwa end of the sector adjacent to the Hilton pier/groin. The proposed action will be confined to the area makai of the Fort DeRussy seawall, which consists of beach constructed during the 20th century. Any ground disturbance makai of the ca. 1881 and ca. 1928 shorelines has the potential to encounter archaeological deposits; Site 50-80-14-4570 at the Diamond Head end of the sector is inland of the present promenade.

The addition of sand fill is unlikely to result in significant ground disturbance. However, due to the proximity of previously recorded buried deposits and burials, archaeological monitoring will be conducted during all work within the historical shorelines. Monitoring will not be conducted for work at the sand borrow area since this is an area of relatively recent sand accretion. Prior to commencement of the proposed action, the applicant will prepare a Historic American Engineering Record (HAER) for the Fort DeRussy outfall/groin.

9.2.6.2 Halekūlani Beach Sector

The proposed action for the Halekūlani beach sector will include the addition of approximately 60,000 cy of sand fill between +8.5 ft and -3 ft MSL, and construction of five groins between the Royal Hawaiian groin and the Fort DeRussy outfall/groin. Because the proposed work is expected to occur makai of the existing seawalls, shown in a 1932 photograph with no beach on its seaward side, there is a negligible likelihood of archaeological materials in the present active beach.

Given the proximity of cultural deposits and burials associated with Sites 4570 and 9957, ground disturbance mauka of the ca. 1881/ca. 1928 shorelines has the potential to encounter cultural deposits or burials. Because the area makai of the existing seawall is unlikely to contain beach sand or natural sediments pre-dating the 1930s, project work in this location has little potential to encounter archaeological resources or burials.

The addition of sand fill is unlikely to result in significant ground disturbance. However, due to the proximity of previously recorded buried deposits and burials, significant traditional places, and multiple LCA lots, archaeological monitoring will be conducted during all work within the historical shorelines. Prior to commencement of the proposed action, the applicant will prepare a Historic American Engineering Record (HAER) for the existing groins.

9.2.6.3 Royal Hawaiian Beach Sector

The proposed beach nourishment action for the Royal Hawaiian beach sector will include the addition of approximately 25,000 cy of sand fill between +8.5 and -2 ft MSL. The proposed action will partially overlap the ca. 1881 and ca. 1928 shorelines as illustrated by Bishop (1881) and Kanahele (1928c). Any ground disturbance makai of the ca. 1881/ca. 1928 shorelines in the Royal Hawaiian beach sector has the potential encounter cultural deposits or burials. The presence of a partially buried seawall and possible Waikīkī Tavern foundation at the Diamond Head end of the Royal Hawaiian sector suggests that intact beach sediments may extend into the mauka portion of the project area; as a result, cultural deposits and burials such as those found along Kalākaua Avenue may occur within the beach nourishment area.

The addition of sand fill is unlikely to result in significant ground disturbance. However, due to the proximity of previously recorded buried deposits and burials, significant traditional places, and chiefly residences, archaeological monitoring will be conducted during all work within the historical shorelines. Prior to commencement of the proposed action, the applicant will conduct a historic preservation documentation and review of the remaining portions of the original Royal Hawaiian groin, the exposed seawall, and the Waikīkī Inn/Tavern foundation.

9.2.6.4 Kūhiō Beach Sector

Beach improvement and maintenance actions are proposed at both basins of the Kūhiō groin complex. In the Diamond Head (east) basin, the proposed action includes the addition of approximately 4,500 cy of sand between +5 and -4 ft MSL. No alterations to the existing structures are proposed. In the ʻEwa (west) basin, the proposed action includes the addition of approximately 26,000 cy of sand between +8 and -3 ft MSL, along with the construction of a segmented breakwater partially overlapping the existing 1939 “crib wall” and adjacent shore return structures.

The proposed work in the Diamond Head (east) basin, which consists of sand fill only, will occur makai of the ca. 1881 and ca. 1928 coastlines as depicted by Bishop (1881) and Kanahele (1928c), respectively. The location of Site 50-80-14-5948, a retaining wall thought to be the 1890 wall replacing the ca. 1880 bridge/causeway to Kapiʻolani Park, is approximately 27 m mauka of the Kūhiō Beach sector. The buried wall is beneath the seaward sidewalk of Kalākaua Avenue, so any intact archaeological deposits would lie inland of this wall and thus, under the roadway. While several archaeological sites, including burials, have been identified along Kalākaua Avenue near the Diamond Head (east) basin, the proposed action will be limited to an area of imported beach sand that likely post-dates the 1950s.

The proposed action in the ʻEwa (west) basin, which includes beach nourishment and construction of a segmented breakwater, will also occur makai of the ca. 1881 coastline and primarily seaward of the ca. 1928 coastline, although the sand fill area extends mauka of a "masonry wall" depicted on Kanahele's (1928c) map on the north side of the ʻEwa (west) basin.

The applicant will conduct periodic spot-check monitoring for the proposed beach maintenance action within the Diamond Head (east) basin since all work is within the post-late-19th century shoreline. The applicant will also conduct scheduled monitoring during ground-disturbing activities within the historical shorelines within the ʻEwa (west) basin. Given the presence of potentially significant existing beach infrastructure, including the Kapahulu storm drain/groin ("The Wall"), "Slippery Wall," the "crib wall," and the shore return structures on either side of the crib wall, the applicant will conduct historic preservation documentation and evaluations of the existing beach infrastructure prior to commencement of the proposed action. The applicant will also conduct formal consultations with the State Historic Preservation Division (SHPD) to further evaluate potential impacts of the proposed actions on historical, cultural, architectural, and archaeological resources, and possible measures to mitigate any potential adverse impacts.

9.3 Scenic and Aesthetic Resources

The gentle curve of the Waikīkī shoreline, the wide expanse of turquoise waters with multiple world-famous surf breaks, the changing colors resulting from the varying water depths and bottom types, and the picturesque backdrop of Diamond Head make the seaward and alongshore views from the shoreline spectacular. At the same time, the tall buildings that have been developed relatively close to the ocean along portions of the shoreline disrupt viewplanes from various perspectives. As a result, views inland from the shoreline are not one of the "significant panoramic views" identified in the City and County of Honolulu's Primary Urban Center Development Plan. The appearance of the beach is of significant interest to the resorts and commercial enterprises that operate in the project area, as their guests represent the most numerous and closest viewers. However, it is also of considerable interest to those who own and/or use adjacent areas and the walkway along Kalākaua Avenue.

Both residents and the tourist industry depend on Waikīkī's scenic resources. The beauty of its coastline draws millions of tourists to its sights and beaches each year. Map A-1 of the City and County of Honolulu's *Primary Urban Center Development Plan* identifies all of Waikīkī as being within a "Significant Panoramic View" zone. The *Waikīkī Special Design Guideline*'s Urban Design Control Map also identifies the area within which the access right-of-way and construction staging area are located as being within the Waikīkī Special Design district "Major View Corridor".

The City and County of Honolulu Land Use Ordinance (LUO) §9.80-3(a) designates some of the visual landmarks and significant vistas to be protected in the Waikīkī area, as:

- Views of Diamond Head from many vantage points,
- Continuous views of the ocean along Kalākaua Avenue from Kūhiō Beach to Kapahulu Avenue,

- Intermittent ocean views from Kālia Road across Fort DeRussy Park, Ala Wai Yacht Harbor, and the Ala Wai Bridge on Ala Moana Boulevard,
- Mauka views from streets mauka of Kūhiō Avenue, and
- Views towards Ala Wai Yacht Harbor from Magic Island Park.

9.3.1 Potential Impacts and Mitigation Measures

The proposed actions are anticipated to have short-term negative impacts and positive long-term impacts on scenic and aesthetic resources. Due to its low elevation and profile, the proposed actions are not anticipated to adversely affect existing viewplanes. Construction equipment, material stockpiles, and construction activities will be present within the project area during construction. Additionally, the dredging equipment will be visible from the shoreline during sand recovery options. These impacts are temporary in nature and will not be present once the construction phase of the project is completed. The proposed actions are anticipated to have a long-term positive impact on scenic and aesthetic resources. While the offshore sand is slightly greyer than the existing beach sand, the color difference is anticipated to be negligible after a season of mixing and fading due to UV exposure.

9.4 Recreation

An Ocean Recreation Study (Clark, 2021) was conducted by John Clark, a locally recognized expert on ocean recreation and cultural activities in Hawaiʻi. Mr. Clark has completed several assessments of ocean recreation activities in the Waikīkī Beach vicinity for recent beach improvement projects (FEA, Waikīkī Beach Maintenance, 2010 and FEA Royal Hawaiian Groin Improvement Project, 2016).

Mr. Clark conducted an Ocean Recreation Study for this DPEIS. Site visits and interviews were conducted during February, March and April 2021. The purpose of the current study was to identify potential recreational impacts associated with the proposed beach improvement and maintenance actions. The study consisted of: 1) observing ocean activities and ocean conditions during field trips to the four beach sectors, 2) interviewing shoreline users, including surfers, swimmers, snorkelers, fishers, staff of the catamaran concessions, staff of the beach concessions, and City and County of Honolulu lifeguards, 3) identifying cultural practices in the project area and determining whether the proposed action affects cultural resources or practices, and 4) describing possible impacts of the project that were reported by the ocean recreation users in the four beach sectors. The findings of the study are presented below.

9.4.1 General Overview

Waikīkī Beach, including the waters offshore, is the most heavily used shoreline area in Hawaiʻi and supports a diverse array of ocean recreation activities. These include sunbathing, swimming, surfing, standup paddling, bodyboarding, sand skimming, snorkeling, spear fishing, pole fishing, walking, wading and metal detecting. Annual recreation events such as canoe regattas and surf contests are held in the project area. Numerous beach concessions are located along the shoreline, providing beach umbrella and surfboard and paddleboard rentals, surfing lessons, and canoe rides. Commercial sailing catamarans are permitted to operate on Waikīkī Beach. Beach concessions in the Fort DeRussy and Duke Kahanamoku beach sectors contract their leases through the State of Hawaiʻi, while those along the Royal Hawaiian beach sector lease through the adjacent hotels, and those in the Kūhiō beach sector lease through the City and County of Honolulu. Sailing catamarans are permitted by the Hawaiʻi Department of Land and Natural Resources, Division of Boating and Ocean Recreation (DLNR-DOBOR).

Sunbathing

Sunbathing in the project area is possible from one end to the other. The best time for sunbathing is at low tide during periods of little or no surf. At high tide the dry beach area is significantly reduced along much of the shoreline, and if high surf combines with a high tide, waves may overrun the entire beach, precluding all opportunities for sunbathing.

Swimming

Swimming occurs in all four beach sectors. The greatest concentration of swimmers tends to be in Kūhiō Beach Park, Royal Hawaiian Beach, and Fort DeRussy Beach.

Snorkeling

The Waikīkī shoreline is not known as a good site for snorkeling. The inner portions of the reef are largely covered with sand and do not attract the volume or variety of fish that other reefs do. During periods of low or no surf, there is some snorkeling for lost valuables such as rings, watches, and coins occurs, an extension of the treasure hunting with metal detectors that takes place on the beach. Snorkeling in Waikīkī can be hazardous due to the number of surfers, paddlers, and vessels present in the water. In addition, during periods of high surf, visibility over the reef is poor due to wave agitation of the ocean bottom. Recognizing these hazards, beach concessions do not rent snorkel gear. Snorkeling is much better suited to the fringing reef areas in the Kapiʻolani beach sector and areas surrounding the Waikīkī Natatorium War Memorial.

Surfing

In pre- and early post-contact Waikīkī, surfing was popular to both chiefs (*aliʻi*) and commoners (*makaʻāinana*). So important was surfing that there is a major heiau dedicated to the *nalu* (surf) and its riders. Papaʻenaʻena, a terraced structure built at the ft of Diamond Head, is where surfers came to offer their sacrifices in order to obtain *mana* (supernatural and divine power) and knowledge of the surf. The site overlooked what is today referred to as First Break, which marks the start of the Kalehuawehe surfing course which extended to Kawewehi (the deep, dark surf) at Kālia.

Although everyone, including women and children, surfed, it was the chiefs who dominated the sport. One of the best among Waikīkī's chiefs was Kalamakua; he came from a long ancestry of champion surfers whose knowledge, skill, and *mana* were handed down and passed on from generation to generation. The story of his romantic meeting with Keleanuinohoanaapiapi has been preserved as a reminder of the role that surfing played in the history of Waikīkī (Kanahele 1995:56-58).

Surf historians agree that, among the documented forms of surfing that existed independently in pre-contact times, the highest development of the sport was in Hawaiʻi, where surfing was a national pastime. Native Hawaiians surfed at hundreds of surf spots on all eight of the Main

Hawaiian Islands, but Waikīkī stood out above the rest as a hub for surfing. Waikīkī is often referred to as the birthplace of modern surfing, and Hawaiian surfers like Duke Kahanamoku helped spread the sport to locations around the world. However, surfing was beyond just a sport for Native Hawaiians. Wave-riding and surfboard-crafting were both ceremonious and skillful arts that demonstrated the important connection between Native Hawaiians and their environment, which served as a foundation for their traditional land stewardship model and lifestyle.

There are over 30 recognized surfing sites in Waikīkī (Figure 9-2). Notable surfing sites offshore of the project area include:

- Fort DeRussy Beach Sector – *Kaiser Bowls, Fours, Threes*
- Halekūlani Beach Sector – *Wanas, Paradise, Cornucopia, Populars, Zeros, First Break*
- Royal Hawaiian Beach Sector – *Canoes, Baby Canoes, Queens, Baby Queens*
- Kūhiō Beach Sector – *Cunha's, Baby Cunha's, The Wall*

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES

Figure 9-2 Approximate locations of surfing sites in Waikīkī

There are numerous popular surf sites in the vicinity of Waikīkī Beach. Surfers have reported concerns that a change to the bathymetry might affect the characteristics of the surfing waves. A surfing wave is the result of complex interactions between wind, water, seafloor, other waves, and currents. Waves at a particular site may change many times over the course of a day, either subtly or dramatically due to changes in the tide level, wind, swell direction, and wave period. Waves entering shallow water are transformed by shoaling, refraction, breaking, and energy dissipation. All of these factors would have to be considered to assess possible impacts on surfing waves.

Wave modeling can be performed to try to understand the effect, if any, sand dredging will have on waves passing over the dredge site and propagating toward shore. To approximate the sand borrow pit, the bathymetry of the sand deposit can be reduced depending on the amount of sand needed. The boundary of the sand borrow pit sloped by 1V:3H (vertical to horizontal) to represent the stable slope of sand. Wave models were run using the same input wave conditions over the pre- and post-dredge bathymetry. Input wave conditions were a high-prevailing south swell with deepwater significant wave height H_s = 3 ft, period T = 16 s, and direction south-southwest. The model output in the form of wave energy at each grid point throughout the model domain were produced. This energy was converted into wave height for comparison of the effects of the sand borrow pit. In each of the scenarios presented in Section 9.4.6, the change in wave height at the surf sites was found to be less than 2 inches. Small differences in wave height due to dredging are considered to be significantly less than the change from wave to wave, and the results indicate that these dredging scenarios are not expected to result in a noticeable change to the surf.

It is anticipated that the actual dredging would be slightly different than the scenario presented, likely covering a larger area with a shallower depth of pit. That scenario would be expected to have even less impact on the wave heights. Over time, the dredge pit is expected to gradually fill in, further diminishing any differences with the pre-dredge condition.

Canoe Surfing

Catching waves with an outrigger canoe in Waikīkī primarily takes place at *Canoes* (originally known as *Kapuni*), and *Populars* (originally known as *Kawehewehe*), seaward of the Royal Hawaiian Hotel. The waves on the west edge of *Canoes* are ideal for canoe surfing and often have enough momentum to carry the canoes all the way to shore.

Most of the beach concessions offer outrigger canoe rides. Use of the commercial canoes is controlled by the Division of Boating and Ocean Recreation (DOBOR), Department of Land and Natural Resources (DLNR), State of Hawaiʻi. DOBOR controls boating in Waikīkī shore waters and their administrative rules regarding commercial outrigger canoe operations may be accessed through their homepage under Title 13, Subtitle 11, Parts 2 and 3.

Canoe surfing is a feature in the Outrigger Canoe Club's annual Fourth of July canoe races in Waikīkī. Known as the Walter J. MacFarlane Regatta, the racecourse begins on the beach fronting the Moana Surfrider Hotel and then turns around a buoy offshore which brings the canoes back to the beach through the waves of *Canoes*.

Catamaran Rides

Catamaran rides are a popular activity on Waikīkī Beach. The catamarans park on the beach, where they load and unload passengers. They motor in and out of the beach and sail up and down the Waikīkī coast for specified periods of time. The Division of Boating and Ocean Recreation (DOBOR), Department of Land and Natural Resources (DLNR), State of Hawaiʻi, controls boating in Waikīkī shore waters. Administration of the beach landing areas for the catamarans in the project site comes under DOBOR's Oʻahu District Manager. DOBOR's administrative rules regarding commercial catamaran operations may be accessed through their homepage under Title 13, Subtitle 11, Parts 2 and 3.

Ocean Recreation Events

In addition to the annual Walter J. MacFarlane Regatta, which is held every July 4, a number of other ocean recreation events are held in the project site. These are primarily surf contests, which are run at the surf spot *Queens* during the spring and summer months. Contest organizers set up their staging area on the beach at the east end of the project site between the Hula Mound and the Duke Kahanamoku Statue. The staging area includes judging towers and a number of tents for t-shirt concessions, food concessions, and competitors.

Fishing and Gathering

Two types of fishing occur in the project site, spear fishing and pole fishing, but both are infrequent. During the field trips for this report, no spear fishers or pole fishers were observed, but one respondent said that he goes spearing perhaps once a month for fish and octopus. The intensive use of the beach and the ocean in the project site by all of the other ocean users is a major deterrent to activities involving spears and fishhooks. Waikīkī was once known as a good place to gather edible *limu* (seaweeds), especially *limu lipoa*, but little if any edible seaweed seems to remain in Waikīkī today. No gathering activities of seaweed, shellfish, or other marine species were observed during the field trips or noted by the respondents.

Marine Managed Areas

There are two designated Waikīkī Marine Managed Areas (MMA): the Waikīkī Marine Life Conservation District (MLCD) and the Waikīkī-Diamond Head Fisheries Management Area (FMA). The project area is not included in the Waikīkī MMA.

Boating

The Division of Boating and Ocean Recreation (DOBOR), Department of Land and Natural Resources (DLNR), State of Hawaiʻi, controls boating in Waikīkī shore waters. DOBOR's administrative rules regarding commercial catamaran operations may be accessed through their homepage under Title 13, Subtitle 11, Parts 2 and 3. DOBOR's administrative rules also regulate power boating in Waikīkī shore waters. The authorized commercial catamarans and personal watercrafts operated by the lifeguards are the only vessels under power that are permitted in the project site. Non-motorized boats such as surf skis (racing kayaks) and ocean kayaks (recreational kayaks) are permitted. A large pocket of sand outside of the *Queens* surf site is called the *Sand Spit*. It is a popular anchorage for boats, especially in the evening and at night. On weekends and holidays, sometimes as many as 30 boats may be anchored there.

9.4.2 Fort DeRussy Beach Sector

The Fort DeRussy beach sector consists of approximately 1,680 ft of shoreline extending from the Fort DeRussy outfall/groin to the Hilton pier/groin. There are no lifeguard towers in this sector. There are two beach concessions, both operated by Dive Oahu and Surf.

Ocean Activities in the Fort DeRussy Beach Sector

Sunbathing, Swimming, and Snorkeling

Sunbathing, swimming, and snorkeling are all activities that take place in this beach sector. Some beach goers call an area outside the reef *Turtle Canyons* for its abundance of sea turtles. Dive Oʻahu and Surf offers this description of the site:

> “*Turtle Canyons* is a finger reef system divided by sandy bottoms between each of the reefs. One of the canyons in particular is known for the Hawaiian green sea turtles (*honu*) that consistently frequent the reef to get their shells cleaned. Commonly, the endemic gold ring surgeon fish can be seen snacking on/cleaning the algae off of their shells and bodies. This site also offers a range of reef fish”.

Surfing
Two surf breaks are located in this beach sector: *Threes* at its east end and *Fours* at its west end. *Threes* is the third surf site from east to west on the reef that begins off the Sheraton Waikiki Hotel and ends at the Hilton Channel. The two surf breaks that precede it are *Populars* and *Paradise*. On big south swells many surfers consider *Threes* to be the best right in Waikīkī. They access the site from the Royal Hawaiian beach sector or by parking on Saratoga Road and walking through Fort DeRussy Park.

Fours is the fourth surf site from east to west on the reef that begins off the Sheraton Waikiki Hotel and ends at the Hilton Channel. It is located outside the reef just east of the channel, where the depth of the ocean is deeper than the other surf sites along this reef. For this reason, *Fours* only breaks on big south swells. Otherwise, it is generally flat. Surfers access *Fours* from the Duke Kahanamoku Beach area fronting the Hilton Hawaiian Village.

Fishing
One respondent, who has been fishing the shoreline of Waikīkī since the early 1970s, noted that fishing for *omilu* and *awaawa* from his kayak around the *Threes* surf site was productive when he fished there in the 1990s.

Catamarans
The Spirit of Aloha, a 65-foot catamaran, operates from the Hilton pier. It docks at the pier to load and land its passengers. It does not park on the beach in the Fort DeRussy beach sector. The Spirit of Aloha offers snorkel tours, fireworks dinner cruises, turtle and whale watching excursions, and sailing trips off Waikīkī.

Survey Results
Respondents for this beach sector were in favor of the proposed action. No concerns or potential impacts were identified.

9.4.3 Halekūlani Beach Sector

The Halekūlani beach sector consists of approximately 1,450 ft of shoreline extending from the Royal Hawaiian groin to the Fort DeRussy outfall/groin. There are no lifeguard towers in this beach sector. There are two beach concessions, one for the *Maita'i* catamaran at Gray’s Beach in the Sheraton Waikiki Hotel and one at the Castle Waikīkī Shore Hotel, the Waikīkī Shore Beach Service. Due to the severe deterioration of the seawall fronting the Sheraton Waikiki Hotel, the general public’s former lateral access through this section of the shoreline, which was across the top of the seawall, is permanently closed. The only way to transit this area now is to walk through the Sheraton Waikiki Hotel property.

A small pocket sand beach, commonly known as Gray's Beach, fronts both the Sheraton Waikiki Hotel Hotel and the Halekūlani Hotel at their common boundary. Another small sand beach fronts the Outrigger Reef Waikīkī Beach Resort and the Castle Waikīkī Shore Hotel at the west end of the sector. Another smaller pocket of sand is at the east end of the sector, where the Royal Hawaiian groin meets the seawall fronting the Sheraton Waikiki Hotel. The pocket beach accreted in January during an extended period of strong westerly winds.

Ocean Recreation Activities in the Halekūlani Beach Sector

Sunbathing, Swimming, and Snorkeling

Sunbathing in this sector is possible at the three small beaches. The best time for sunbathing is at low tide during periods of little or no surf. High tides cover at least half of the beaches. The Halekūlani Channel fronting Gray's Beach is a long, wide, sand-filled channel that passes through the shallow reef flat fronting the beach and ends in deep water offshore. It is the best area in this sector for swimming. The reef flat on either side of the channel attracts snorkelers looking for sea turtles and other marine life. Green sea turtles (*honu*) are seen at all times of the day, often close to shore, foraging on seaweed and algae that grows on the reef.

Surfing

There are two surf sites in the Halekūlani beach sector: *Populars* and *Paradise*. *Populars* is located directly offshore of the Sheraton Waikiki Hotel. The break was named in the early 1900s when it became a "popular" spot with Waikīkī surfers. Today, *Populars,* or "*Pops*", is heavily used. Its popularity is due to its long, rolling waves that accommodate all levels of surfing ability from beginners to experts. *Paradise* is a secondary break between *Populars* and the Halekūlani Channel. Commercial surfing instructors who give surfing lessons bring their students to the inside sections of *Populars*. The instructors are from the beach concessions or nearby surf shops in Waikīkī.

Fishing

At certain times of the year, schools of *nehu*, small anchovy-sized fish, congregate near shore in the Halekūlani Channel fronting Gray's Beach. The *nehu* attract larger predators like *papio* and *ulua,* which are prized eating fish. The *papio* and *ulua* in turn attract pole fishermen. Pole fishermen whip for *papio* and cast for *ulua*.

Many areas of Waikīkī, including this sector, were once known as good places to gather edible seaweeds (*limu)*, but little if any edible seaweed seems to remain in Waikīkī today. No gathering activities of seaweed, shellfish, or other marine species were observed during the field trips for this study, and none were noted by respondents.

The Waikīkī Marine Managed Areas (MMA) consists of two parts: the Waikīkī Marine Life Conservation District (MLCD) and the Waikīkī-Diamond Head Fisheries Management Area (FMA). The project area is not included in the Waikīkī MMA.

Catamarans

Catamaran rides are a popular activity on Waikīkī Beach. Two catamarans operate out of the Halekūlani beach sector: the *Maitaʻi* and the *Holokai*. These two catamarans park on the beach, where they load and unload passengers. They motor in and out of the beach to sail up and down the Waikīkī coast for specified periods of time. The *Maitaʻi* operates at Gray's Beach, the pocket of sand between the Sheraton Waikiki Hotel and the Halekūlani Hotel. The *Holokai* operates from the beach fronting the Outrigger Reef Waikīkī Beach Resort. At the time of the current study, the *Maitaʻi* was available for daily sails, but the *Holokai* was available for private charters only.

The Division of Boating and Ocean Recreation (DOBOR), Department of Land and Natural Resources (DLNR), State of Hawaiʻi, controls boating in Waikīkī shore waters. DOBOR's administrative rules regarding commercial catamaran operations may be accessed through their homepage under Title 13, Subtitle 11, Parts 2 and 3. DOBOR's administrative rules also regulate power boating in Waikīkī shore waters. The catamarans and personal watercrafts operated by the lifeguards are the only vessels under power that are permitted in the project site. Non-motorized boats such as surf skis (racing kayaks) and ocean kayaks (recreational kayaks) are permitted.

The proposed action for the Halekūlani beach sector is beach improvements consisting of beach nourishment with stabilizing groins. The Halekūlani Channel will remain unobstructed for beach catamaran navigation. An optional component of the design is the addition of a beach walkway to provide ADA-accessible lateral shoreline access between the Royal Hawaiian and the Fort DeRussy beach sectors, a distance of approximately 0.85 miles.

Survey Results

Most respondents for this sector liked the proposed actions, noting that they will create a new beach for Waikīkī where one does not exist now.

One respondent is completely opposed to the proposed T-groin system for this sector. The respondent stated that "each T-groin is designed with two arms to hold sand and when incoming waves strike these arms, their impact against the boulders may generate reflected waves. These waves will travel seaward into the surf breaks at *Populars*, *Paradise*, and *Threes*, disrupting the wave faces for surfers". The respondent also stated that "the original beaches here were seasonal, forming only during the winter and disappearing during the summer and suggested that "the proposed T-groin system will block the natural lateral movement of sand in this sector".

Other respondents believe that the T-groins are far enough away from the surf breaks that reflected waves are not an issue. One respondent noted that similar concerns regarding reflected waves were raised about the construction of the Royal Hawaiian groin, but that those concerns have not materialized with the new groin.

A common concern shared by all respondents is the lateral shoreline access from one end of this sector to the other. Shoreline access is currently marginal fronting the Halekūlani Hotel and non-existent fronting the Sheraton Waikiki Hotel. They would like to see this issue addressed in the proposed actions for this sector.

One respondent noted that "the new beach and groins will cover sections of the existing reef, a known foraging area for green sea turtles (*honu*). Episodes of high surf may also erode sand from the new beach and deposit it on the adjoining reef".

The one cultural activity associated with the ocean in this study, a traditional Hawaiian cleansing ceremony in the Halekūlani Channel fronting Gray's beach, was discontinued by the woman who performed it. In the event that someone wanted to resume the practice, the introduction of a new beach would not prevent it.

The new beach will provide sunbathing, swimming, and snorkeling opportunities for large numbers of beach goers. If the proposed actions are implemented, the City and County of Honolulu Ocean Safety Division is requesting its presence on the new beach, which would include personnel, a lifeguard tower and beach access for their mobile beach vehicles. The Ocean Safety Division would need additional funding in their annual budget for the new personnel, a tower, and equipment, including mobile vehicles. They noted that seven lifeguards are needed to meet the staffing requirements for each two-person tower.

One respondent, a catamaran crew member, noted that sometimes during the summer months, the sand in this sector, including at Gray's beach, experiences severe seasonal erosion. When this occurs, the *Maitaʻi* and the *Holokai* relocate their landing and departing operations to the Fort DeRussy beach sector, specifically on the ʻEwa (west) side of the Fort DeRussy outfall/groin. The catamarans access this site via a small channel that joins the west side of the Halekūlani Channel and leads to Fort DeRussy Beach. This respondent noted that "the new beach and groins should eliminate the seasonal erosion in this sector and their occasional need to relocate their operations".

One respondent noted that pole fishermen after *ulua* come to the beach late in the afternoon to cast, when most sunbathers and swimmers have left. Pole and occasionally spear fishermen usually access the area from the public right-of-way to Gray's Beach between the Sheraton Waikiki Hotel and the Halekūlani Hotel. Another respondent noted that for many years he fished the Halekūlani Channel in the early evenings and almost always caught white *papio* and *oio*. He also caught *pualu* and *enenue* there.

Opportunities for gathering shellfish and seaweed are minimal to non-existent in this sector. No gathering activities were observed or reported by respondents.

9.4.4 Royal Hawaiian Beach Sector

The Royal Hawaiian beach sector consists of approximately 1,730 ft of shoreline extending from the ʻEwa (west) groin at Kūhiō Beach Park to the Royal Hawaiian groin, which was completed in 2020. It includes the Kūhiō Sandbag groin, which is 140 ft west of the ʻEwa (west) groin and consists of 83 sandbags that weigh approximately 10,000 pounds each. It was completed in November 2019 when erosion in this area of the beach exposed the concrete remnants of the former Waikīkī Tavern. Lifeguard tower 2B is situated on the shoreline fronting the Waikīkī Beach Center, and lifeguard tower 2A is situated on the shoreline fronting the Moana Surfrider Hotel. When the field trips for this study were conducted, a beach nourishment project for the Royal Hawaiian beach sector was underway.

Ocean Activities in the Royal Hawaiian Beach Sector

The shoreline in the Royal Hawaiian beach sector is the most heavily used portion of Waikīkī Beach. Ocean recreation activities include sunbathing, swimming, snorkeling, surfing, outrigger canoe rides, and catamaran rides. This beach sector also includes the largest concentration of commercial beach concessions, which offer surfboard rentals, surfing instructions, and canoe rides. Four catamaran concessions also operate in this beach sector.

During the course of this study, Dive Oʻahu and Surf, the main beach concession near the Duke Kahanamoku statue, was closed until further notice due to the COVID-19 pandemic. However, in the interim, they have relocated to the Fort DeRussy beach sector, where they opened two beach concessions on federal property. The catamaran concessions remain operational in the Royal Hawaiian beach sector, along with two beach concessions at the west end of the beach: Aloha Beach Services and Waikīkī Beach Services. Surfboard rentals are also available at nearby surf shops in Waikīkī, such as those located on Koa Avenue.

The COVID-19 pandemic with its devastating impact on Hawaii's visitor industry has resulted in a dramatic reduction of tourists on local beaches and in local surf breaks. The lack of visitors, however, has not reduced the numbers of surfers in local breaks, but rather has increased them. Local surfers have returned in force to many Waikīkī surf site, such as *Canoes* and *Queens*, often creating what some local surfers call "COVID crowds."

Sunbathing, Swimming and Snorkeling

Sunbathing and swimming are the main near shore activities in this sector. Some snorkeling occurs here, too. Daily beach counts here were much lower than they were prior to the COVID-19 pandemic. Prior to the pandemic the heaviest concentration of sunbathers in Waikīkī was at the west end of this sector, near the Royal Hawaiian groin. This is where the beach is widest, fronting the Outrigger Waikīkī Beach Resort and the Royal Hawaiian Hotel. The section of beach was and continues to be most crowded with sunbathers at low tide during periods of little or no surf.

Swimming occurs from one end of the beach to the other, but the greatest concentration of swimmers tends to be in the middle of the beach, fronting the Moana Surfrider Hotel. With surfboard rental, canoe ride, and catamaran ride concessions concentrated at the ends of the sector, the least amount of traffic that might interfere with or endanger swimmers is in the center of the beach.

Snorkeling is an infrequent activity in this sector. With its predominance of sand on the ocean bottom rather than reefs that would attract marine life and the heavy traffic from surfboards, outrigger canoes and catamarans, most snorkelers prefer the conditions on the west side of the Royal Hawaiian groin.

Surfing

The main surf sites in the Royal Hawaiian beach sector are *Canoes* and *Queens*. Secondary surf sites include *Baby Queens*, *Baby Canoes*, and *Sandbars*, which is also known as *Baby Royals*. During the course of the current study, the absence of tourists in the surf breaks was evident, but the surf breaks were still crowded with local surfers.

Canoes is the name of the surf site located directly off the Moana Surfrider Hotel. *Canoes* is the most heavily used surf spot in Waikīkī for commercial surfing activities, including surfboard rentals, surfing lessons, and outrigger canoe rides. Beginning surfers and surf instructors with beginners receiving lessons are concentrated on the smaller inside waves, which is known as *Baby Canoes*, while intermediate and advanced surfers ride the bigger waves outside.

Queens is the name of the surf site located directly off the Duke Kahanamoku statue. The waves at *Queens* are steeper than those at *Canoes* and are concentrated in a much smaller area, so beginning surfers and surf instructors with beginners receiving lessons generally do not surf here. Outrigger canoes usually do not surf here either. When waves at *Queens* die out, they reform near shore on the shallow reef at the east end of the sector. This surf site is known as *Baby Queens* and attracts beginning surfers and surf instructors with beginners receiving lessons.

Sandbars is the name of the surf site located directly off the Royal Hawaiian hotel. It is also known as *Baby Royals*. As the size of the sandbar has increased in recent years, this break has evolved into a popular spot for beginning surfers and surf instructors with beginners receiving lessons.

Canoes, *Queens* and *Sandbars* are located on the south shore of O‘ahu, which generally receives its biggest surf during the spring and summer months. However, there is almost always enough surf at each of these spots in the fall and winter to sustain commercial and non-commercial surfing activities throughout the year.

Canoe Surfing

Catching waves with an outrigger canoe in Waikīkī takes place at *Canoes*, the famous surf site off the Moana Surfrider Hotel that was named for this activity. The waves on the west side of *Canoes* are ideal for canoe surfing and often have enough momentum to carry the canoes all the way to shore.

During the course of the current study, only two beach concessions, Aloha Beach Services at the Moana Surfrider Hotel and Waikīkī Beach Services at the Royal Hawaiian Hotel, were offering canoe rides, a normally popular activity in this sector. Due to the COVID-19 pandemic restrictions, the concessionaires were limited to two unrelated passengers or small groups of related passengers or traveling companions. With these restrictions and the small numbers of visitors on the beach, there was little demand for canoe rides.

Catamarans

Catamaran rides are normally a popular activity on Waikīkī Beach. The catamarans park on the beach, where they load and unload passengers. They motor in and out of the beach, then sail up and down the Waikīkī coast for specified periods of time. Four catamaran concessions offer rides in the Royal Hawaiian beach sector: the *Mana Kai* at the east end of the beach and the *Manu Kai*, *Na Hoku II*, and the *Kepoikai II* at the west end of the beach. When the current study was conducted, the COVID-19 pandemic restrictions only allowed catamarans to carry ¼ of their permitted capacity. Catamarans that are permitted to carry 49 passengers, for example, are only allowed to carry 12.

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Fishing

One respondent, who has been fishing the shoreline of Waikīkī since the early 1970s, noted that "fishing for *oʻio* from the beach was productive in the Royal Hawaiian channel at the end of the old groin". The respondent stated that "he would wade out and stand on the submerged portions of the old groin and caught several 10-pounders there".

Several respondents believe that sand deposited from the 2012 Waikīkī Beach Maintenance I project resulted in too much sand being placed on the beach in this sector. When two old sandbag groins were removed from the east end of the sector, beach recession was severe, which exposed the old concrete foundation of the Waikīkī Tavern. The eroded sand traveled laterally along the beach and created a large, shallow sandbar at the west end of this sector.

The objectives of the Kūhiō Sandbag Groin project were to stabilize the east end of the Royal Hawaiian beach sector and to ensure that the Waikīkī Tavern concrete foundation remnants remained covered with sand. All respondents commenting on this sector agree that the sandbag groin has stabilized the east end of the beach, but the ocean has again eroded the sand covering the concrete foundation remnant, leaving it exposed. Some respondents are concerned that placing additional sand in the cove between the Kūhiō Beach sector's ʻEwa groin and the Kūhiō sandbag groin will simply add to the sand that has already eroded and drifted west. One respondent recommended replacing the sandbag groin with a boulder groin and redesigning the angle of the new groin to contain sand in this cove.

Some respondents question the advisability of designing proposed actions, such as the addition of additional sand, for a 50-year lifespan in anticipation of sea level rise. They point out that so much sand has already been added to the beach that normal wave runup from the present level of the sea is no longer effective in reaching the crest of the beach, which they believe is necessary to maintain a gradual slope and the width of the beach. This has resulted in a steeper foreshore, a narrower beach crest, and a sloping backshore.

The additional sand has buried a sidewalk and steps that front the Moana Surfrider Hotel Beach Bar with approximately 4 ft of sand and has buried the lower steps of lifeguard tower 2A, along with reducing the storage area under the tower. It has also increased the level of sand fronting the seawall fronting the Royal Hawaiian Hotel, raising it almost to the top of the wall, which is approximately 6 ft above its former level. In response, the Royal Hawaiian Hotel installed an iron railing on top of the wall to deter beach users from climbing over it.

The high crest of the beach with its sloping backshore has contributed to flooding in properties behind the beach. During periods of extreme inundation from the ocean, such as high surf during king tides and severe storm surf, wave surges overtop the crest and spill through the backshore into adjoining properties.

Given the conditions that exist now, several respondents do not see the value of placing additional sand on the beach crest. They see it as exacerbating an existing problem. They recommend that bulldozers or graders be used to push the sand on top of the crest seaward to widen the beach and restore it to its former lower level. They believe that additional sand may result in an even narrower crest. This would reduce the area for sunbathing and result in a steeper foreshore, which will make accessing the ocean more difficult for all beach users and for launching and landing outrigger canoes.

One respondent pointed out that a proposed action for the Fort DeRussy beach sector is "backpassing," or moving sand from one area of the beach to another. He recommended the same action for the Royal Hawaiian beach sector, but instead of moving the sand laterally from one end of the beach to the other, moving it seaward.

Several respondents believe that sand from past beach nourishment projects has drifted into the surf zone and settled in and around *Canoes*, impacting the entire surf break. The right at *Canoes*, which was once a fast, steep wave, no longer breaks the same. The same is true for the left at *Canoes*. It no longer breaks the same. One respondent said, "now the left is more like a windward Oʻahu beach break".

Several respondents noted that drifting sand also occasionally creates a shallow sandbar in *Baby Royals*, the surf site at the west end of the Royal Hawaiian beach sector, which is also known as *Sandbars*. When this occurs, the sandbar is so shallow at low tide beach goers can walk out on it into the surf zone.

The predominantly westerly littoral drift of eroding sand has also settled in the channel between *Canoes* and *Baby Royals*, the channel that catamarans in this sector use to access the beach. Catamaran crew members reported that the channel and adjoining sandbar are sometimes difficult to negotiate at low tide, especially with a full load of passengers. Occasionally, they have hit bottom. When the current study was conducted, this problem was of less concern. Due to the COVID-19 pandemic restrictions, catamarans are only allowed to carry ¼ of their permitted capacity. Catamarans that are permitted to carry 49 passengers, for example, are only allowed to carry 12. This means the catamarans are carrying considerably less weight than a full load, making it easier for the boats to travel over shallow areas.

In January 2021, during an extended period of strong westerly winds, wave-induced currents reversed the normal westerly longshore current flow. Several respondents noted that these easterly currents coming around the Royal Hawaiian groin created a strong eddy on its east side that eroded the beach, creating a vertical sandbank in the foreshore approximately 4-ft high. With the return of the trade winds, however, the normal longshore currents eventually restored the beach. This episode also created a small pocket beach on the west side of the Royal Hawaiian groin in the Halekūlani beach sector.

9.4.5 Kūhiō Beach Sector

The Kūhiō Beach Sector consists of approximately 1,500 ft of shoreline extending from the Kapahulu groin to the ʻEwa (west) groin at Kūhiō Beach Park. This beach sector consists of two enclosed basins. The Diamond Head (east) basin begins at the Kapahulu groin and is defined by a 740-ft-long breakwater, or crib wall. The ʻEwa (west) basin begins at the west end of the Diamond Head (east) basin and is defined by a 700-ft-long breakwater. A 185-ft-long rubblemound groin separates the two basins. Lifeguard tower 2D is situated on the shoreline inland of the rubblemound groin and lifeguard tower 2C is situated on the shoreline of the ʻEwa basin.

When the field trips for the current study were conducted (February and March 2021), a beach nourishment project for the Royal Hawaiian beach sector was underway. The west half of the Diamond Head (east) basin was secured as a construction site for dewatering sand that was being delivered from a dredge anchored offshore. Lifeguard tower 2D was closed and unmanned. The ʻEwa basin was open for ocean recreation. Lifeguard tower 2C was manned.

Ocean Activities in the Diamond Head (East)Basin

Sunbathing, Swimming, and Snorkeling

The shoreline in the Diamond Head Basin is used mainly by sunbathers and swimmers. Some snorkeling occurs here. With a shallow sand bottom, this protected basin is popular for families with young children.

Surfing

The surf breaks around the Kapahulu storm drain/groin comprise the most popular bodyboarding area in Waikīkī. These breaks are limited to bodysurfers and bodyboarders and are off limits to anyone using a surfboard. The State of Hawaiʻi placed a line of white buoys offshore the Kapahulu storm drain/groin from approximately Lifeguard Tower 2D to 2E to delineate this restricted area.

Two surf sites are located outside the breakwater that defines the Diamond Head (east) basin. The first is *Graveyards*, which is just to the west of the Kapahulu storm drain/groin. It is the most popular and the most heavily used of the different breaks around the groin. A shallow reef separates *Graveyards* from the second break, which is called *Ins-and-Outs*.

Ins-and-Outs, which is also known as *Baby Cunha's*, is off the west end of the Diamond Head (east) basin's breakwater. The name *Ins-and-Outs* refers to the reflected waves that form when incoming waves strike the breakwater and are reflected seaward into the surf zone. Reflected waves occur frequently here and travel out far enough to disrupt the faces of incoming waves. *Ins-and-Outs* also lays within the restricted area delineated by the white buoys. Bodyboarders do not surf this break often.

Ocean Activities in the ʻEwa Basin

Sunbathing, Swimming, and Snorkeling

The shoreline in the ʻEwa (west) basin is used mainly by sunbathers and swimmers. Some snorkeling occurs here. With a shallow sand bottom, this basin is more heavily used now than the Diamond Head (east) basin because of the active sand nourishment project. The breakwater that defines this basin has two gaps: a short gap at the east end of the basin and a long segment of submerged breakwater at the west end.

Surfing

The famous *Queens* surf site is located directly offshore of the ʻEwa (west) basin. The right at *Queens* ends at a shallow reef just seaward of the breakwater. Some surfers use the long gap in the breakwater to access *Queens*, one of the most popular surf breaks in Waikīkī. A shallow sandbar seaward of the gap and near the edge of shallow the reef inside of *Queens* forms a surf site called *Pockets*, a left. This is a new break that forms on sand that may have eroded seaward from the Kūhiō beach sector. Surfers also report that there are other new small unnamed sandbars in the *Queens* and *Canoes* area that were not there historically.

Fishing

Several fishers noted that *papio* (juvenile jack fish) congregate around the sandbar at *Pockets*.

Survey Results

Several respondents recommended that the proposed beach maintenance for the Diamond Head (east) basin include adding sand to the east section of the basin that is currently in use by the public. They noted that this basin has lost a lot of sand and that at high tide there are only two small pocket beaches for sunbathers at either end of the vertical seawall supporting Kūhiō Beach Park. At medium to high tides the ocean overruns the center of the beach, washing against the seawall, and this wave action is beginning to undermine the seawall. They suggest that the active beach nourishment project be amended to include adding sand to the center of the beach.

Several respondents noted that the small sandbars that have formed in the area of the *Queens* and *Canoes* surf sites seem to have formed from sand eroded from the ʻEwa (west) basin. They are concerned that additional sand from the proposed beach nourishment will also end up in the surf zone.

9.4.6 Potential Impacts and Mitigation Measures

The proposed action is anticipated to have a positive impact on recreation in the Royal Hawaiian beach sector. Providing a wider, more stable beach will support or enhance continued recreational and commercial uses (present and future) in uses in Waikīkī.

Potential Impacts on Sunbathing
Active construction areas will not be available for sunbathing for the duration of construction operations. To the extent practicable, beach closure areas will be confined to the immediate vicinity of construction operations to maximize the available dry beach area. Turbidity containment barriers will surround the in-water construction activities to prevent the work from people in the water, impacting swimming in the immediate vicinity of the construction areas. These impacts to recreation will be temporary.

Potential Impacts to Catamarans
A total of six catamans operate on Waikīkī Beach. Four catamaran concessions offer rides in the Royal Hawaiian beach sector: the *Mana Kai* at the east end of the beach and the *Manu Kai*, *Na Hoku II*, and the *Kepoikai II* at the west end of the beach. Two catamarans operate out of the Halekūlani beach sector: the *Maitaʻi* and the *Holokai*. The *Maitaʻi* operates at Gray's Beach, the pocket of sand between the Sheraton Waikiki Hotel and the Halekūlani Hotel. The *Holokai* operates from the beach fronting the Outrigger Reef Waikīkī Beach Resort.

The proposed beach maintenance in the Royal Hawaiian beach sector is anticipated to have a positive impact on catamaran operations. There are no structures being proposed that will inhibit safe navigation, and maintaining a wide, stable beach profile will provide additional space for the catamarans to tie up and safely load and offload guests.

The proposed beach improvements in the Halekūlani beach sector are also anticipated to have a positive impact on catamaran operations. The minimum beach crest width at its narrowest point midway between the groins will be about 20 to 30 ft, and the beach slope will be 1V:8H (vertical to horizontal). Maintaining a stable beach with a gentler slope will provide additional space for the catamarans to tie up and safely load and offload guests. The Halekūlani Channel will remain unobstructed to allow for safe navigation. The groin stem length (distance seaward from the shoreline) will be up to about 200 ft and the gaps between the groin heads will be approximately 200 ft wide.

The catamarans are approximately 45 ft long and 25ft wide, so the gaps between the groin heads should be sufficiently wide to provide safe ingress and egress for catamaran access to/from the shoreline (Figure 9-3). The current travel path for the catamarans would shift slightly to the west to align with the gap between the groins on either side of the Halekūlani Channel (Figure 9-4). The new beach and groins will also eliminate the seasonal erosion that forces the catamarans to relocate their operations to the Fort DeRussy beach sector. Thus, no negative impacts to navigation or catamaran operations are anticipated.

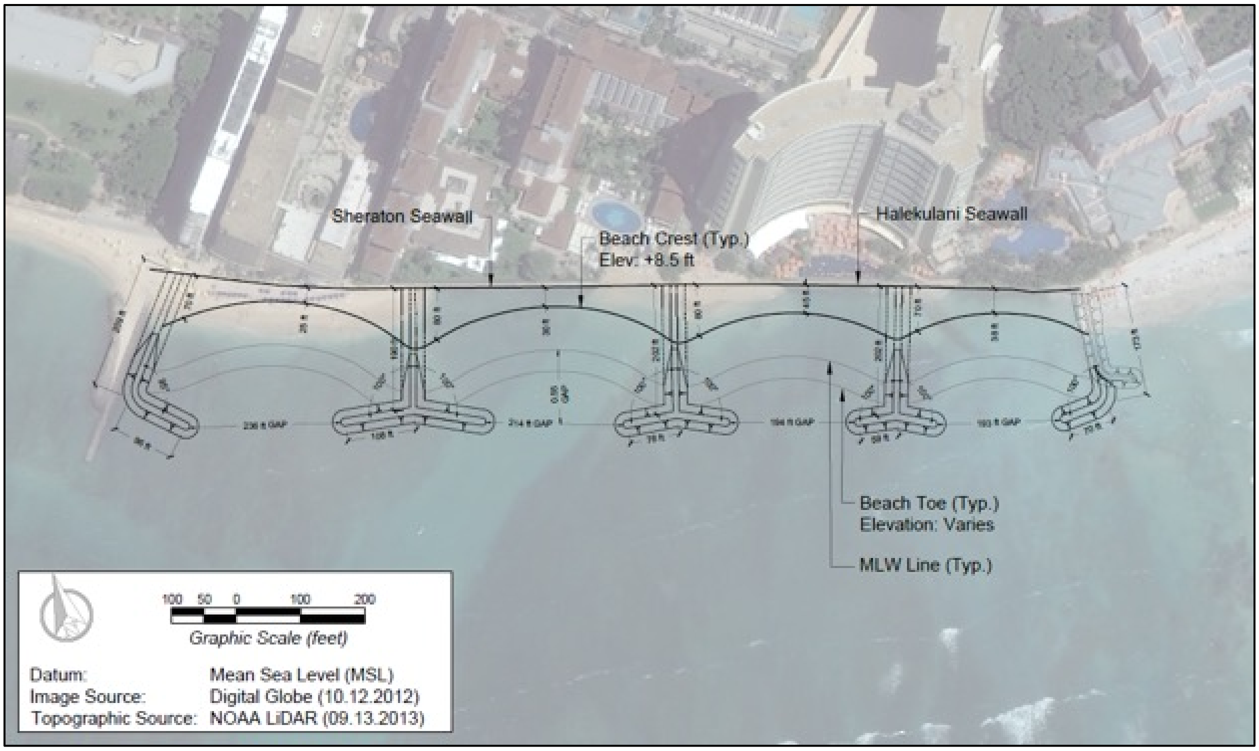

Figure 9-3 Proposed project layout - Halekūlani beach sector

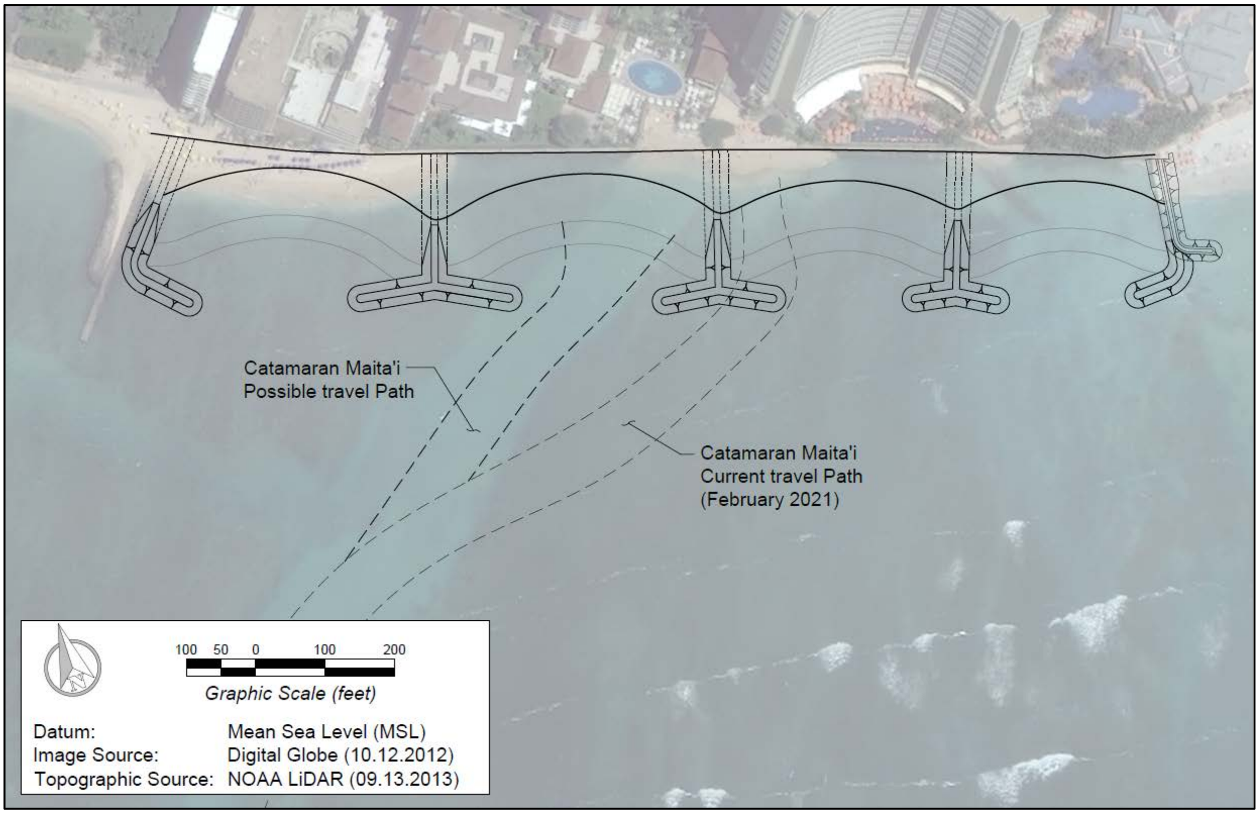

Figure 9-4 Navigation routes for *Maitaʻi* and the *Holokai* catamarans

Potential Impacts to Beach Concessions

Beach concessions currently operate in the Fort DeRussy and Royal Hawaiian beach sectors. The proposed action will temporarily impact the beach concessions during construction, as a portion of these areas will be utilized for access and equipment/material storage. These impacts will cease immediately following completion of construction, and every effort will be made to minimize potential impacts to beach concessions.

Potential Impacts to Snorkeling

The shallow reef in the project area is not known as a particularly good site for snorkeling, and the surfing, canoes, catamarans, and other recreational craft make snorkeling somewhat risky. The reef does not seem to attract the volume or variety of fish that other reefs in Hawaiʻi do, and for this reason snorkeling is an infrequent activity in Waikīkī. In addition, during periods of high surf, visibility over the reef is poor due to wave agitation of the ocean bottom. Turbidity containment barriers will surround the in-water construction activities and effectively cordon off the work from people in the water. Hence, the proposed actions are not anticipated to have any negative impacts on snorkeling activities.

Potential Impacts to Kayaking

Touring kayaks are not common in Waikīkī. However, they are available for rent from the ocean activity desk in the Fort DeRussy beach sector and are occasionally seen in the project area. However, as with snorkeling, the construction area will be cordoned off and easy to avoid.

Potential Impacts to Fishing and Gathering

Two types of fishing occur in the project area, spear fishing and pole fishing, but both are infrequent. The offshore hard bottom was once noted octopus grounds, but they do not have that reputation today. Nonetheless, some spear fishermen still try their luck in these areas. The reef fronting the project area is not known as a productive fishing area, so pole fishing is an infrequent activity. However, at certain times of the year, schools of *nehu*, small anchovy-sized fish, may congregate near shore. The *nehu* attract larger predators like *papio*, which are prized eating fish, which in turn attract pole fishermen. Pole fishermen whip for *papio*, which has the potential to create conflicts between them and swimmers. The proposed actions are not anticipated to significantly affect fishing during construction.

Many areas of Waikīkī were once known as good places to gather edible seaweeds, or *limu*, but little if any edible seaweed seems to remain in Waikīkī today. No gathering activities of seaweed, shellfish, or other marine species were observed during the field trips or noted by the respondents. The recovered sand will be placed on the existing beaches and submerged areas that consist of relatively barren reef flats, where *limu* does not grow. Hence, no significant adverse effects on *limu* are anticipated.

Potential Impacts to Marine Managed Areas

The Waikīkī Marine Managed Areas (MMA) consists of two parts: the Waikīkī Marine Life Conservation District (MLCD) and the Waikīkī -Diamond Head Fisheries Management Area (FMA). As the project area is not included in the Waikīkī MMA, no effects are anticipated.

Potential Impacts to Surf Sites

Detailed wave modeling was conducted to evaluate the potential for the proposed beach improvement and maintenance actions to impact surf sites in Waikīkī (see Section 8.2.2). Dredging of offshore sand deposits involves removing sand from the deposits, resulting in a lowering of the bottom elevation or changing the bathymetry. Dredging could occur at the *Ala Moana*, *Canoes/Queens*, or *Hilton* deposits. Wave modeling was used to assess the impact of dredging on nearby surf sites. A wave reflection analysis was also conducted to evaluate the potential for the proposed structures in the Halekūlani and Kūhiō beach sectors to reflect waves that could negatively impact surf sites, primarily in the Halekūlani beach sector. To evaluate potential impacts, wave modeling of the existing conditions and with the proposed structures was performed. Based on the results of the wave modeling, the dredge analysis, and the wave reflection analysis, no significant impacts to surf sites in Waikīkī are anticipated.

Concerns regarding impacts to surfing waves in Waikīkī extend well beyond the proposed beach improvement and maintenance actions. The qualify of surfing waves in Waikīkī as they exist today is expected to change as sea levels continue to rise. As water depths increase, the fringing reef will be less effective in dissipating wave energy. As a result, waves will break further inland and swells will have to be larger to break in the deeper water (Honolulu Civil Beat, 2019). This could potentially eliminate some of the surfable waves at certain locations in Hawaiʻi, including those in Waikīkī. A recent study found that 16% of surf sites in California would be eliminated with 3 ft of sea level rise and 18% would be threatened (Reineman et al., 2017).

Dredge Analysis

Ala Moana

The *Courts* surf site is located about 2,000 ft directly inshore of the *Ala Moana* offshore sand deposit (see Section 3.5). Additional nearby surf sites include *Concessions* and *Baby Haleʻiwa*. Surfers have expressed concerns that changes in bathymetry associated with sand recovery operations may affect the characteristics of the surfing waves, particularly at *Courts*.

To approximate the sand borrow area, the bathymetry of the central portion of the sand deposit was reduced by 4 ft, which is considered to be a reasonable scenario. This would produce approximately 52,000 cy of sand. The boundary of the sand borrow pit sloped by 1V:3H (vertical to horizontal) to represent the stable slope of sand.

Wave models BOUSS-2D and SWAN were run independently, using the same input wave conditions over the pre- and post-dredge bathymetry. The two models agree well in spatial pattern and in magnitude. The results show that the sand borrow pit causes decreases in wave heights of less than 1 in at *Courts*. For the BOUSS-2D model, the breaking wave height at *Courts* decreased by 0.8 in, or 1.1%, due to the dredge pit, and for the SWAN model, the breaking wave height at *Courts* decreased by 0.5 in, or 1.0%, due to the sand borrow pit. Conversely, model output shows that the wave heights at *Concessions* and *Baby Haleʻiwa* would be expected to increase by up to 1 in.

Hilton

The *Ala Moana Bowls* surf site is located about 1,500 ft north of the *Hilton* offshore sand deposit (see Section 3.5). Additional nearby surf sites include *Rock Piles*, *In Betweens*, and *Kaisers*. To approximate the sand recovery area, the LiDAR bathymetry in the region of the sand deposit was reduced by 4 ft to represent the anticipated change to the seafloor, which is considered to be a practical dredging scenario. This scenario would produce approximately 40,000 cy of sand. The boundary of the sand borrow pit was sloped by 1V:3H (vertical to horizontal) in the bathymetry set to represent the stable slope of sand.

The phase-resolving wave model SWASH was used to simulate wave transformation over both the existing bathymetry and imposed dredge pit bathymetry using the south swell conditions presented earlier. The results show that the sand borrow pit causes an increase in significant wave heights of less than 2 in at the *Bowls* and *Kaisers* surf sites. Inspection of the wave patterns reveals no noticeable change in the structure of the wave. Other surf sites, including *Threes*, *Fours*, and *Populars* are more than 1,000 ft to the southeast of the *Hilton* offshore sand deposit, therefore dredging is not anticipated to have any impacts to surfing waves at these locations.

Canoes and Queens

The *Canoes* and *Queens* surf sites are located about 200 ft east and 150 ft north, respectively, of the sand recovery area used for the Waikīkī Maintenance I and II projects in 2012 and 2021, respectively (see Section 3.5). To approximate the sand recovery area, the LiDAR bathymetry in the area of the sand deposit was reduced by 4 ft to represent the anticipated change to the seafloor, which is considered to be a reasonable scenario. This would produce approximately 20,000 cy of sand. The boundary of the sand borrow area sloped by 1V:3H (vertical to horizontal) to represent the stable slope of sand.

The phase-resolving wave model SWASH was used to simulate wave transformation over both the existing bathymetry and imposed dredge pit bathymetry using the south swell conditions presented earlier. The results show that the sand borrow pit causes an increase in significant wave heights of about 1.8 in at the *Canoes* surf site and a decrease in significant wave heights of about 1.6 in at the *Queens* surf site. As a result, the proposed actions are not anticipated to have any significant impacts on surfing waves in these areas.

Wave Reflection Analysis

Concerns were expressed regarding the potential for the proposed structures in the Halekūlani and Kūhiō beach sectors to reflect waves that could negatively impact surf sites, primarily in the Halekūlani beach sector. To evaluate potential impacts, wave modeling of the existing conditions and with the proposed structures was performed.

The numerical model SWASH was utilized for this study. SWASH is a phase-resolving non-hydrostatic wave model that computes the depth-averaged flow due to waves and currents using the non-linear shallow water equations. The governing equations are valid from intermediate to shallow water and can simulate most of the phenomena of interest in the nearshore zone and in harbor basins, including shoaling and refraction over variable bathymetry, reflection and diffraction near structures, energy dissipation due to wave breaking and bottom friction, breaking-induced longshore/cross-shore (rip) currents, and harbor oscillations. Various types of structures can be included in the model from porous rock structures to impermeable vertical walls. A key strength of this model is the ability to adjust porosity of different types of structures being imposed into the model.

Model bathymetry was adapted from the USACE SHOALS LiDAR dataset and modified to include the most recent beach survey along Waikīkī Beach and the newly constructed Royal Hawaiian Groin. Existing wall structures were incorporated into the model with low porosities (<0.1) as recommended in the SWASH user manual (The SWASH Team, 2020). Existing rubblemound structures were incorporated with porosities ranging from 0.4 to 0.45, typical for these types of structures (The SWASH Team, 2020). The model was validated against measured wave buoy data collected by Sea Engineering in 2009 at four locations along the Waikīkī shoreline where the shoreline contained rubblemound structures, vertical walls, or sandy beaches.

The validated SWASH model was used to simulate a prevailing summer south-southwest swell during mid-tide for the existing and proposed shoreline configurations. Observation points were included in the model and were positioned at four popular surf sites *Threes*, *Populars*, *Canoes*, and *Queens*. These sites were chosen based on their popularity and their location relative to the proposed shoreline structures. Other nearby surf sites were expected to have similar impacts.

Halekūlani Beach Sector

The *Threes* and *Populars* surf sites are located more than 1,000 ft offshore of the proposed structures in the Halekūlani beach sector. The shoreline in this sector consists of a combination of seawalls and narrow beaches. The wave modeling showed that there is presently some wave reflection originating from the shoreline in the Halekūlani beach sector. The modeling showed this reflected wave energy to be about 0.4 ft (5 in) at *Threes* and *Populars*.

The wave modeling for the proposed beach improvements shows that no change in wave energy is anticipated at *Threes* and a minor decrease in wave energy is anticipated at *Populars*. The similar or decreased wave energy indicates that, while the proposed beach improvements would shift the shoreline further seaward, the effect of the structures is negligible when compared to the existing conditions.

Kūhiō Beach Sector

The model results for the Kūhiō beach sector show that there would currently be a reflected wave of 0.4 ft (5 in) at *Queens* and 0.6 ft (7 in) at *Canoes* under the model conditions. The water surface animation shows that the reflected waves affecting *Canoes* and *Queens* come from the Kūhiō Beach Park offshore breakwaters. The incident wave angle at those structures indicates that *Queens* would be affected by the reflection from the breakwater in the Diamond Head (east) basin, while *Canoes* could be affected by reflection off the breakwater in both basins.

The model results for the proposed beach improvements indicates that there would be no change in the amount of reflected wave energy at *Queens*, likely because the origin of the reflection, the Diamond Head (east) basin breakwater, would not be altered. The reflected wave energy at *Canoes* increases by 0.2 ft (2.5 in) due to the improvements to the ʻEwa (west) basin. Based on the results of the wave modeling, the dredge analysis, and the wave reflection analysis, no significant impacts to surf sites in Waikīkī are anticipated.

9.5 Shoreline Access

The shorelines of Hawaiʻi are a public resource that provides significant economic, social, recreational, and environmental benefits. The public’s right to access the shoreline is rooted in common law and the Public Trust Doctrine. Public access to and along the shorelines of Hawaiʻi is an indisputable right of every citizen and is regarded by the courts and State law as inviolable. The Hawaiʻi Supreme Court has consistently ruled in support of the important public policy of “extending to public use and ownership as much of Hawaii’s shoreline as is reasonably possible” and the long-recognized common law principle, now enshrined in the Hawaiʻi Constitution, that the lands below the shoreline are held by the state as a public trust for the people of Hawaiʻi.

State and local governments have the duty to maintain both perpendicular and lateral access to the shoreline to ensure that the public has adequate access to this valuable public resource. While the counties have the primary authority and duty to develop and maintain public access to and along the shorelines, primarily via shore-perpendicular public rights-of-way (HRS §46-6.5), the State of Hawaiʻi has the primary authority and responsibility to maintain lateral shoreline access within *beach transit corridors* (HRS §115-5 & 115-7), which is the area seaward of the *shoreline* (HRS §205-A, HAR §113-22). The DLNR is the lead agency with regulatory authority for maintaining access within *beach transit corridors*.

The Waikīkī shoreline is relatively accessible. The east and west ends of the project area consist of public parks with more open space and a wider buffer between the existing development and the shoreline. Perpendicular and lateral shoreline access are more limited in the central portion of the project area, particularly in the Halekūlani beach sector. The following discussion summarizes existing shoreline access in each beach sector.

9.5.1 Fort DeRussy Beach Sector

The Fort DeRussy beach sector spans approximately 1,680 ft of shoreline that extends from the Hilton pier/groin east to the Fort DeRussy outfall/groin. Perpendicular access to the shoreline is available through Fort DeRussy Park. The Fort DeRussy beach walkway provides lateral access along the shoreline from Hilton Hawaiian Village to the Castle Waikīkī Shores. Sand often gets pushed landward over the beach walkway by wave action, particularly during high tides and high surf events.

9.5.2 Halekūlani Beach Sector

The Halekūlani beach sector spans approximately 1,450 ft of shoreline extending from the Fort DeRussy outfall/groin east to the Royal Hawaiian groin. Perpendicular access to the shoreline is available at three locations: Fort DeRussy Park at the ʻEwa (west) end of the sector, a public right-of-way between the Outrigger Reef Waikīkī Beach Resort and the Halekūlani Hotel, and a privately-owned perpendicular access between the Halekūlani Hotel and the Sheraton Waikiki Hotel.

Lateral shoreline access throughout the Halekūlani beach sector is more limited than the rest of Waikīkī due to the lack of dry beach area and the density of development immediately adjacent to the shoreline. Lateral access is available along the beach at the ʻEwa (west) end of the sector. Access past the Halekūlani Hotel is available via a discontinuous, narrow walkway on top of the low elevation seawall, which is constantly wet due to wave splash and overtopping. There is no walkway across the small pocket beaches between the Halekūlani Hotel and the Sheraton Waikiki Hotel. Lateral access is accomplished by walking around the back of the beach which, given its low elevation, is often submerged during high tides and high surf events. A narrow walkway on the top of the seawall fronting the Sheraton Waikiki Hotel had provided a small measure of wave-splashed lateral access but has been closed since 2017 due to hazardous conditions, forcing people to walk through the hotel grounds. Closure of this area inhibits lateral shoreline access between the east and west portions of Waikīkī Beach.

9.5.3 Royal Hawaiian Beach Sector

The Royal Hawaiian beach sector spans approximately 1,730 ft of shoreline extending from the Royal Hawaiian groin east to the ʻEwa (west) groin at Kūhiō Beach Park. Perpendicular access to the shoreline is limited due to the density of development in the backshore. Perpendicular shoreline access is available from Kalākaua Avenue at two locations: one between the Royal Hawaiian Hotel and Outrigger Waikīkī Beach Resort, and one between the Moana Surfrider Hotel and the Honolulu Police Department substation. Royal Hawaiian Beach provides continuous lateral shoreline access along the entire sector but has no walkway to provide ADA-compliant lateral access. Lateral non-beach access between the Sheraton Waikiki Hotel and Kuhio Beach Park requires utilizing the ADA-compliant public sidewalks along Kalākaua Ave.

9.5.4 Kūhiō Beach Sector

The Kūhiō beach sector spans approximately 1,500 ft of shoreline extending from the ʻEwa (west) groin at Kūhiō Beach Park east to the Kapahulu storm drain/groin. A wide concrete sidewalk and esplanade along Kalākaua Avenue provides perpendicular access to the shoreline at multiple locations, as well ADA-compliant lateral access landward of the shoreline along the entire beach sector. The Kūhiō beach sector offers the most abundant access to and along the Waikīkī shoreline since it is entirely a public beach park.

9.5.5 Potential Impacts and Mitigation Measures

Construction is anticipated to have short-term impacts on shoreline access. During construction, the use of some portions of the shoreline and offshore sand recovery areas may be prevented for public health and safety reasons. The proposed actions are anticipated to have a long-term positive impact on lateral shoreline access by increasing beach width and stability. The applicant will notify adjacent landowners and the public prior to commencement of construction activities. Beach closures will be minimized to the extent practicable. Crossing guards will be on-site to divert beach goers away from active work areas.

9.6 Air Quality

The U.S. Environmental Protection Agency (EPA) has established national ambient air quality standards (NAAQS) for ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, 2.5-micron and 10-micron particulate matter ($PM_{2.5}$ and PM_{10}), and airborne lead. These ambient air quality standards establish the maximum concentrations of pollution considered acceptable, with an adequate margin of safety, to protect the public health and welfare. The State of Hawaiʻi has also adopted ambient air quality standards for some pollutants. In some cases, these are more stringent than the Federal standards. The State of Hawaiʻi has established standards for five of the six criteria pollutants (excluding $PM_{2.5}$), in addition to hydrogen sulfide (DOH, 2003).

In general, air quality in the Waikīkī area is excellent. The State of Hawaiʻi Department of Health (DOH) monitors ambient air quality on Oʻahu using a system of nine monitoring sites. The primary purpose of the monitoring network is to measure ambient air concentrations of the six criteria NAAQS pollutants. DOH monitoring data for 2008 shows that air quality in the Waikīkī area during that year never exceeded the short-term or long-term State or National standards for the six pollutants measured [particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen dioxide (NO_2) sulfur dioxide (SO_2), carbon monoxide, and hydrogen sulfide]. The only ozone monitoring station on Oʻahu is located on Sand Island, west of Waikīkī. Existing ozone concentrations at that location also meet State and Federal ambient air quality standards.

9.6.1 Potential Impacts and Mitigation Measures

The proposed actions are anticipated to have short-term impacts on air quality. Because most of the work that will take place in the water, or on the sandy shoreline, the proposed actions differ from many construction projects in that they involve little or no soil disturbance that could result in particulate emissions. Potential sources of air pollution as a result of the proposed actions are related to the construction phase.

During the actual construction process beach nourishment activities will create temporary degradation in air quality in the immediate vicinity of the project areas. This negative impact to air quality will be limited to typical work hours and will end once the sand is in place. The emissions from these internal combustion engines are far too small to have a significant or lasting effect on air quality. As part of the construction process, the contractor will observe all BMPs to keep construction related emissions to the lowest practicable levels.

Short-term degradation of air quality may occur due to emissions from construction equipment and would include carbon monoxide (CO), nitrogen oxides (NO_2), volatile organic compounds (VOCs), directly emitted particulate matter (PM_{10} and $PM_{2.5}$), and toxic air contaminants such as diesel exhaust particulate matter. Sulfur dioxide (SO_2) is generated by oxidation during combustion of organic sulfur compounds contained in diesel fuel. Off-road diesel fuel meeting Federal standards can contain up to 5,000 parts per million (ppm) of sulfur, whereas on-road diesel is restricted to less than 15 ppm of sulfur. These construction impacts to air quality are short-term in duration and, therefore, will not result in adverse or long-term conditions.

Implementation of the following measures will reduce any air quality impacts resulting from construction activities:

- Apply water or dust palliative to the site and equipment as frequently as necessary to control fugitive dust emissions.
- Properly tune and maintain construction equipment and vehicles.
- Locate equipment and materials storage sites as far away from hotels and commercial uses as practical. Keep construction areas clean and orderly.

During the previous 2012 Waikīkī Nourishment I Project it was noted that the sand dewatering site emitted an unpleasant odor as the sand dried. It is likely that this odor will be present during construction; however, it ends quickly once the sand is exposed to the air. The sand to be recovered has a very low percentage of material smaller than sand size, and it will be wet, thus fugitive dust susceptible to airborne dispersion is expected to not be significant. Once construction is completed the beach will have no long-term air emissions or impact on air quality.

9.7 Noise

The proposed actions are anticipated to have short-term impacts on noise associated with construction. Hawaiʻi Administrative Rules §11-46, “Community Noise Control” establishes maximum permissible sound levels (

Table 9-2) and provides for the prevention, control, and abatement of noise pollution in the State from stationary noise sources and from equipment related to agricultural, construction, and industrial activities. The standards are also intended to protect public health and welfare, and to prevent the significant degradation of the environment and quality of life. The limits are applicable at the property line rather than at some predetermined distance from the sound source.

The project area is in the Conservation District, but there are no noise-sensitive uses at the present time. Because of that, the Class B limits applicable to land zoned for resort use appears the most applicable for the proposed actions. HAR §11-46-7 grants the Director of the Department of Health the authority to issue permits to operate a noise source which emits sound in excess of the maximum permissible levels specified in

Table 9-2 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.

Existing ambient noise levels vary considerably within the project area both spatially (i.e., from place to place) and temporally (i.e., from one time to another). In general, existing background sound levels along Waikīkī Beach are relatively high, 55 to 60 dBA, due to surf, traffic, aircraft, and on-going maintenance and construction equipment. In the vicinity of significant construction activity noise levels can intermittently reach 80 dBA.

Table 9-2 Maximum Permissible Sound Levels in dBA

Zoning Districts	Daytime (7 a.m. to 10 p.m.)	Nighttime (10 p.m. to 7 a.m.)
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 sections 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.

Source: Hawaiʻi Administrative Rules §11-46, “Community Noise Control”

9.7.1 Potential Impacts and Mitigation Measures

The proposed actions are anticipated to have short-term negative impacts on noise levels. Noise from diesel powered equipment operating on the sand recovery vessel offshore can be expected to attenuate with distance such that it will be less than background levels along the shoreline. Equipment operation in the vicinity of the dewatering site and being used in the sand placement operations along the shoreline, however, will be audible and may exceed current background noise levels. As the separation distance from the operating equipment decreases, very high noise levels (80+ dBA) can be expected to occur. Back up alarms which use beeping high frequency signals near 1,000 Hz can be relatively loud and tend to be intrusive because they occur in the high frequency band where the background ambient noise level tends to be lower.

It is not feasible to mitigate construction noise to the extent that it does not at times exceed existing background noise levels or is inaudible to beach users, hotel guests, etc. Some reduction is practical, however, and the following measures will be implemented.

- Equipment operation on the shoreline will be limited to the hours between 7am and 10pm.
- Broadband noise backup alarms in lieu of higher frequency beepers will be required for construction vehicles and equipment. Broadband noise alarms tend to be less audible and intrusive with distance as they blend in with other background noise sources.

- The project will specify use of the quietest locally available equipment, e.g. high insertion loss mufflers, fully enclosed engines, and rubber tired equipment when possible.
- The use of horns for signaling will be prohibited.
- Worker training on ways to minimize impact noise and banging will be required.
- A noise complaint hot line will be provided at the job site to allow for feedback from the hotel operators, which can be used to help develop modifications to construction operations whenever feasible.
- Construction operations will cease in the vicinity of scheduled performances, such as the nightly hula show at the west end of Kūhiō Beach.

9.8 Public Services

9.8.1 Solid Waste

The City and County of Honolulu, Department of Environmental Services manages Honolulu's municipal solid waste system, including the H-POWER resource recovery facility and one sanitary landfill. A private company operates a construction debris landfill in Nānākuli, and private companies are responsible for solid waste collection from virtually all of the island's commercial organization.

9.8.2 Water Supply

The Honolulu Board of Water Supply (BWS) is responsible for the management, control and operation of Oʻahu's municipal water system that serves the entire Primary Urban Center Development Plan area. The BWS system is an integrated, island-wide system with interconnections between water sources and service areas. Water is exported from areas of available supply to areas of municipal demand. None of the BWS facilities are present seaward of the shoreline where the proposed beach improvement and maintenance actions will occur. Neither does it maintain nor operate any pipelines or other water supply facilities within the area that will be used by construction equipment.

9.8.3 Police, Fire and Emergency Medical Services

Police Protection

The Hawaiʻi Department of Land and Natural Resources Division of Conservation and Resources Enforcement (DLNR-DOCARE) is responsible for enforcement activities in areas controlled by the DLNR, which includes the area seaward of the certified shoreline where the proposed actions will take place. In addition, Honolulu Police Department officers patrol accessible areas of the beach on all-terrain vehicles. Presently, officers only patrol as far as the Royal Hawaiian due to the limited shoreline access. The proposed actions will improve lateral access and thus facilitate police patrolling along the beach. The nearest police station is located at the Waikīkī Beach Center (Police Sub-Station) on Kalākaua Avenue adjacent to the Moana Surfrider Hotel. Police headquarters is located on Beretania Street near its intersection with Ward Avenue.

Fire Protection
The three nearest Fire Stations are on Makaloa Street, at the intersection of University and Date Streets, and at the intersection of Kapahulu Avenue and Ala Wai Boulevard. All are roughly 1.5 miles by road from the project site.

Emergency Medical Services
The three hospitals nearest to the project site are Kapiʻolani Women's and Children's Hospital on Punahou Street, Straub Hospital on King Street, and Queen's Hospital on Punchbowl Street. All three hospitals provide emergency medical services (EMS) to the area, as do the Fire Stations mentioned above.

9.8.4 Potential Impacts and Mitigation Measures

The proposed actions are anticipated to have a negligible impact on public services. Increasing dry beach area could potentially increase the number of beach users in Waikīkī, which could increase the volume of trash and require more frequent solid waste collection and disposal. If the number of beach users in Waikīkī were to increase, this could also result in an increased number of incidents that would require police, fire, and medical services. Prior to commencement of construction activities, the Honolulu Police Department, Honolulu Fire Department, and Emergency Medical Services will be informed of the project construction schedule and apprised of the emergency vehicle access routes to be used during construction. The contractor will be required to provide ample clearance for emergency vehicles at all times. The proposed actions do not involve any activities that will permanently alter the need for, or ability to provide, emergency services.

9.9 Public Infrastructure

9.9.1 Transportation

Vehicular and Pedestrian Access
Pedestrian access to the beach is available from Kalākaua Avenue is available through public rights-of-way, and the large open spaces located at intervals along the shoreline. A shoreline sidewalk extends from the Waikīkī Natatorium War Memorial to the Queen's Surf groin, and then merges into the sidewalk along Kalākaua Avenue up to the Moana Surfrider Hotel. Lateral pedestrian shoreline access is then only available by walking along Royal Hawaiian Beach makai (seaward) of the hotels. During high tides and periods of high surf, this beach is narrow and lateral access is difficult. From the Royal Hawaiian Hotel to Fort DeRussy there is a narrow walkway on top of the existing seawalls, however wave splash often makes this very wet, and the walkway is frequently closed due to safety concerns. The beach walkway resumes at the east end of the Fort DeRussy beach sector and extends west to the Hilton Hawaiian Village.

Harbors
The nearest harbor is the Ala Wai Harbor, which is owned and operated by the State of Hawaiʻi. Commercial cargo arrives and departs through Honolulu Harbor.

Airports
Honolulu International Airport is approximately six miles west of the project area.

9.9.2 Water System

The Honolulu Board of Water Supply (BWS) is responsible for the management, control and operation of Oahu's municipal water system that serves the entire Primary Urban Center Development Plan area. The BWS system is an integrated, island-wide system with interconnections between water sources and service areas. Water is exported from areas of available supply to areas of municipal demand. None of the BWS facilities are present makai of the shoreline where the proposed actions will occur. Neither does it maintain nor operate any pipelines or other water supply facilities within the area that will be used by construction equipment.

9.9.3 Sanitary Wastewater Collection and Treatment Facilities

The City and County of Honolulu Department of Environmental Services manages the municipal wastewater collection, treatment, and disposal system that serves the hotels surrounding the project site. The project site lies within the East Mamala Bay service area, with outflows processed through the Sand Island Wastewater Treatment Plant. The nearest City and County of Honolulu sanitary sewer line is located inland from the project area.

9.9.4 Solid Waste Collection and Disposal

The City and County of Honolulu Department of Environmental Services manages Honolulu's municipal solid waste system, including the H-POWER resource recovery facility and one sanitary landfill. A private company operates a construction debris landfill in Nānākuli, and private companies are responsible for solid waste collection from virtually all of the island's commercial organization.

9.9.5 Electrical and Telecommunications System

Telecommunication Facilities
There are no telecommunication lines within the shoreline area or in the area which will be used by construction equipment.

Electric Power
The Hawaiian Electric Company (HECO) provides electrical service to the project area. Most of the electrical power that is consumed in Waikīkī comes from fossil fuel-fired generating units located at Waiau, Campbell Industrial Park, and Kahe. Power is delivered to customers by a system of underground and overhead transmission and distribution lines, none of which are in the project area.

9.9.6 Potential Impacts and Mitigation Measures

The proposed actions are anticipated to have a negligible impact on public infrastructure. The proposed actions will not require water or electrical power and will not generate a need for additional sanitary wastewater collection and treatment facilities. There are no anticipated to stormwater runoff that will affect the City and County of Honolulu stormwater drainage system. Most people visiting Waikīkī Beach travel by foot rather than in vehicles, and the proposed actions are not anticipated to increase the resident or visitor population of the island.

During construction, workers can park either in a construction staging area or existing public parking facilities. Mobilization and demobilization of the on-shore equipment and materials will involve some heavy vehicle traffic through Waikīkī; however, this will be of limited duration. Equipment and materials will be transported along Waikīkī Beach to the project sites, which will require secure trucking lanes on the beach. Equipment will be escorted to ensure public health and safety, and the delivery of materials and equipment will be timed to minimize impacts to beach users to the maximum extent practicable. Upon completion of the projects, the number of trips along the beach will be less, as only the equipment and a fraction of the materials will need to be removed. Because of the small number of vehicle-trips involved, construction worker and equipment/material delivery trips do not have the potential to substantially affect traffic volumes and/or the level of service on area roadways.

10. UNAVOIDABLE AND CUMULATIVE IMPACTS

Cumulative impacts, as defined in HAR §11-200.1-2:

> *"the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."*

Cumulative impacts can be viewed as sum product of actions, past and present, on the project site and resources within the project site. Past beach improvement and maintenance projects in Hawaiʻi and domestically have generated data on potential project-related impacts. This section discusses potential adverse impacts which likely cannot be avoided.

10.1 Fort DeRussy Beach Sector

The proposed action for the Fort DeRussy beach sector is beach maintenance consisting of sand backpassing with no additional improvements or modifications to existing structures. Sand will be transported from the accreted area at the west end of the beach to the eroding area at the east end of the beach to increase dry beach width and mitigate wave overtopping. Sand will be obtained from the beach face on the east side of the Hilton pier/groin, where sand eroded has accreted over the years. Sand will be excavated from the beach face extending inshore only as far as necessary to obtain the required volume of sand.

10.1.1 Unavoidable Impacts

- The proposed action will use a non-renewable resource (sand).
- 1,500 cubic yards of sand will be recovered from the borrow area at the west end of the Fort DeRussy beach sector, which will alter the existing beach profile in this area.
- Sand compaction can occur in high traffic areas during sand transport and placement operations.
- Machinery operating on the beach will generate noise and may temporarily impact air quality.
- Sand transportation and placement operations on the beach will require portions of the shoreline to be cordoned off to ensure public health and safety. Access across the cordoned off areas will be limited to specific crossing points with crossing guards.
- Bathymetry at and adjacent to the nourishment efforts will be temporarily perturbated while the beach equilibrates to the new sand volume.

10.1.2 Cumulative Impacts

The proposed sand backpassing is designed to be implemented periodically on an as-needed basis. Sand backpassing will be conducted when beach conditions reach some pre-defined topographic triggers. Beach monitoring will be required to determine when the triggers have been met. The proposed sand backpassing will involve moving approximately 1,500 cy of existing beach sand from one end of the beach to the other. No dredging is proposed and the volume of sand in the littoral system will not be altered. The estimated construction duration for the proposed sand backpassing is 5 days.

The UHCGG estimates that the average annual erosion rate at the east end of the Fort DeRussy beach sector with 3.2 ft of sea level rise is 2.7 ft/yr (mid-range, 80% confidence) (UHCGG, 2019). Based on this estimate, sand backpassing will need to be conducted every 3 years. Over a period of 50 yrs, this will result in a total of 17 individual sand backpassing events and a total of 85 days of construction.

Alternatives to sand backpassing consist of beach nourishment with or without stabilizing structures (see Section 4.4). Beach nourishment would involve recovering approximately 20,000 cy of sand from offshore and placing it on the beach. This alternative would require dredging to recover sand from offshore and would increase the volume of sand in the littoral system; however, no sand would be removed from the ʻEwa (west) end of the beach sector. Like the sand backpassing plan, beach nourishment would widen the beach to a prescribed width and profile. The beach would be widened to approximately 70 ft as measured from the beach walkway to the waterline.

The estimated construction duration for beach nourishment without stabilizing structures is 120 days, and the estimated recurrence interval is 10 yrs. Assuming that renourishment is conducted over a period of 50 yrs, this would result in a total of 5 individual renourishment events and a total of 600 days of construction. The estimated construction duration for beach nourishment with stabilizing structures is 240 days.

When compared to the alternatives of beach nourishment with or without stabilizing structures, the proposed action has less cumulative impacts. The proposed sand backpassing requires fewer construction days, fewer beach closures, no offshore dredging, and no increase in the volume of sand in the littoral system. While larger-scale beach nourishment is technically feasible, it is not being proposed due to the relatively isolated scope of the erosion problem. Furthermore, beach nourishment may not be a viable long-term solution due to the limited volume of compatible offshore sand to support periodic renourishment efforts.

10.2 Halekūlani Beach Sector

The proposed action for the Halekūlani beach sector is beach improvements consisting of beach nourishment with stabilizing groins. The proposed action will consist of construction of three new sloping rock rubblemound T-head groins, a new L-head groin adjacent to the existing Fort DeRussy outfall/groin, and modification of the recently replaced Royal Hawaiian groin. The groins and beach fill will create four stable beach cells in an area that has previously had limited beach resources. The proposed action will require approximately 60,000 cy of sand fill and will create approximately 3.8 acres of new dry beach area.

10.2.1 Unavoidable Impacts

- The proposed action will use non-renewable resources (sand, stone, concrete). The estimated volume of sand required to nourish the beach is 60,000 cy. The estimated volume of stone required to construct the groins is 15,000 cy. The estimated volume of concrete required to construct the crown walls is 810 cy.
- 60,000 cubic yards of sand will be recovered from an offshore deposit, temporarily altering the bathymetry and temporarily disrupting the ecology in the dredge extents.
- Sand recovered from the ocean, though highly compatible with the dry beach sand, may still have some fine content that will be winnowed from the beach system and moved offshore during the initial equilibration process and consequent beach erosion events.
- Dredging, transportation, and placement of carbonate sand can increase the percentage of fine sediment through mechanical abrasion of friable grains.
- Particles greater than one inch in diameter may be present in the recovered and placed sand.
- Sand compaction can occur in high traffic areas during sand transportation and placement operations.
- When sand is recovered from anoxic environments, such as offshore deposits, it will typically have a grey color and unpleasant scent immediately after recovery.
- During sand recovery operations, minor turbidity is anticipated as sand is brought from the seafloor to the barge.
- Anchor lines around the sand recovery area will be in place for the duration of sand recovery operations.
- Dredging and sand transportation operations will temporarily disrupt marine ecology and ocean recreation in the area during construction.
- Machinery operating on the barge will generate noise and may temporarily impact air quality.
- Any construction activities taking place in the nearshore waters are anticipated to temporarily impact marine ecology, ocean recreation and access in the area.
- Sand placement operations on the beach will require portions of the shoreline to be cordoned off to ensure public health and safety. Access across the cordoned off areas will be limited to specific crossing points with crossing guards.
- Ecological services of reef flat habitat will be lost within the project footprints (sand fill and groins) but are anticipated to recover over time as the benthic community re-establishes.
- Bathymetry within the project footprints (sand fill and groins) will be permanently altered.
- The current travel path for the catamarans would shift slightly to the west to align with the gap between the groins on either side of the Halekūlani Channel.

10.2.2 Cumulative Impacts

The proposed beach improvement action is designed to be implemented in phases, with the initial phase being designed for approximately 1.5 ft of sea level rise, thus in 25 to 30 years following construction it may be necessary to raise the project elevations. If then raised by several feet, the project could be effective until about the year 2080, or 50-years post-construction. The estimated construction duration for the proposed action is 500 days.

An alternative to the proposed action is beach nourishment without stabilizing structures (see Section 5.4). Beach nourishment would involve recovering approximately 60,000 cy of sand from offshore and placing it on the beach. The estimated construction duration for beach nourishment without stabilizing structures is 240 days.

The UHCGG estimates that the average annual erosion rate in the Halekūlani beach sector with 3.2 ft of sea level rise will be 1.0 ft/yr (mid-range, 80% confidence) (UHCGG, 2019). Based on this estimate, in order to maintain a minimum beach width of 20 ft, the beach would need to be renourished every 5 years. Due to the combination of nearshore wave patterns, seawalls, and the Halekūlani Channel, it is possible that the beach could erode more rapidly, in which case renourishment would need to be conducted more frequently. Assuming that renourishment was conducted every 5 yrs over a period of 50 yrs, this would result in a total of 10 individual renourishment events and a total of 2,400 days of construction.

When compared to the alternative of beach nourishment without stabilizing structures, the proposed action has less cumulative impacts. The proposed action will require fewer individual dredging events, fewer construction days, and fewer beach closures. While beach nourishment without stabilizing structures is technically feasible, it is not being proposed due to the cumulative impacts associated with periodic dredging and renourishment. Furthermore, beach nourishment may not be a viable long-term solution due the limited volume of compatible offshore sand to support periodic renourishment efforts.

10.3 Royal Hawaiian Beach Sector

The proposed action for the Royal Hawaiian beach sector is beach maintenance consisting of beach nourishment with no additional improvements or modifications to existing structures. The proposed action will require periodic renourishment to maintain the beach at its 1985 location.

10.3.1 Unavoidable Impacts

- The proposed action will use a non-renewable resource (sand).
- 25,000 cy of sand will be dredged from the *Canoes/Queens* offshore deposit, temporarily altering the bathymetry and temporarily disrupting the ecology in the dredge extents.
- Sand recovered from the ocean, though highly compatible with the dry beach sand, will still have some fine content that will be winnowed from the beach system and moved offshore during the initial equilibration process and consequent beach erosion events.
- Dredging, transportation, and placement of carbonate sand can increase the percentage of fine sediment through mechanical abrasion of friable grains.
- Particles greater than one inch in diameter may be present in the recovered and placed sand.
- Sand compaction can occur in high traffic areas during sand transportation and placement operations.

- When sand is recovered from anoxic environments, such as the *Canoes/Queens* offshore deposit, it will typically have a grey color and unpleasant scent immediately after recovery.
- During sand recovery operations, minor turbidity is anticipated as sand is brought from the seafloor to the barge.
- Anchor lines around the sand recovery area will be in place for the duration of sand recovery operations.
- Dredging and sand transportation operations will likely disrupt marine ecology and ocean recreation in the area during construction.
- Machinery operating on the barge and the beach will generate noise and may temporarily impact air quality.
- Any construction activities taking place in the nearshore waters are anticipated to temporarily impact marine ecology, ocean recreation and access in the area.
- Sand placement operations on the beach will require portions of the shoreline to be cordoned off to ensure public health and safety. Access across the cordoned off areas will be limited to specific crossing points with crossing guards.
- Bathymetry at the sand recovery area and along the beach toe will be temporarily altered while the beach equilibrates to the new sand volume.

10.3.2 Cumulative Impacts

The proposed action is designed to be implemented periodically on an as-needed basis. Beach nourishment will be conducted when beach conditions reach some pre-defined topographic triggers. Beach monitoring will be required to determine when the triggers have been met. The proposed action will involve recovering approximately 25,000 cy of sand from the *Canoes/Queens* offshore sand deposit and placing it on the beach. The volume of sand in the littoral system would not be altered.

The estimated construction duration for beach nourishment without stabilizing structures is 120 days, and the estimated recurrence interval is 10 yrs. Assuming that renourishment is conducted over a period of 50 yrs, this will result in a total of 5 individual renourishment events and a total of 600 days of construction.

Alternatives to the proposed action include beach maintenance (sand backpassing or sand pumping) and beach nourishment with stabilizing structures (see Section 6.4). Sand backpassing would involve moving sand from wide portions of the beach to areas that are eroded and narrow. Presently, erosion is occurring at the Diamond Head (east) end of the beach along the Kūhiō Beach Park ʻEwa (west) groin. A backpassing program could periodically add sand to this eroded area. While sand backpassing is technically feasible, it may not be a viable option. The beach adjacent to the Royal Hawaiian groin is the only site in the Royal Hawaiian beach sector where a sufficient volume of sand would be available to support sand backpassing. However, the volume of sand present in this area is not sufficient to support continued sand backpassing.

Sand pumping would involve recovering sand from the shallow sandbar that occasionally forms fronting the Royal Hawaiian Hotel, adjacent to the *Canoes* surf site. The sandbar has formed periodically in the past and is believed to consist of beach sand that has been transported offshore since the 2012 Waikīkī Beach Maintenance I project. As a demonstration project, sand could be recovered from the sandbar and placed back on the beach fronting the Royal Hawaiian Hotel, Outrigger Waikīkī Beach Resort, and Moana Surfrider Hotel. This would involve recovery of approximately 2,400 cy of sand, if available, which is the volume required to raise the beach crest by approximately 6 in fronting the Royal Hawaiian Hotel, Outrigger Waikīkī Beach Resort, and Moana Surfrider Hotel. While sand pumping is technically feasible, it may not be a viable option. The sandbar is the only site in the Royal Hawaiian beach sector where sand pumping is feasible. However, the sandbar is an ephemeral feature that contains a limited volume of sand and may not be a sustainable sand source over the lifespan of the program.

Another alternative for the Royal Hawaiian beach sector is beach nourishment with stabilizing structures. This alternative would consist of constructing four new groins and modifying the ʻEwa (west) groin at Kūhiō Beach Park. A combination of T-head groins and beach fill would produce a wide, stable beach in an area where the beach has historically been narrow and subject to chronic erosion. This alternative would require approximately 45,000 cubic yards of sand fill and would create approximately 3.8 acres of new dry beach area. The *Canoes/Queens* offshore sand deposit contains an estimated 25,000 to 50,000 cy of sand, so this alternative would require removal of nearly the entire sand deposit. This would increase the potential for environmental impacts and may not be technically feasible. This alternative would be implemented in phases, with the initial phase being designed for approximately 1.5 ft of sea level rise, thus in 25 to 30 yrs following construction it may be necessary to raise the project elevations. If then raised by several feet, the project could be effective until about the year 2080, or 50 yrs post-construction.

Beach nourishment with stabilizing structures would produce a wide, stable beach and eliminate the need for periodic renourishment. However, based on feedback from the WBCAC, the majority of stakeholders prefer that Royal Hawaiian Beach should be maintained without any additional shoreline structures. Furthermore, this alternative may not be feasible due to the limited volume of sand in the *Canoes/Queens* offshore sand deposit. As a result, beach nourishment with stabilizing structures was ruled out in the early stages of the conceptual design and project selection process.

10.4 Kūhiō Beach Sector - ʻEwa (west) Basin

The proposed action for the Kūhiō beach sector ʻEwa (west) basin is beach improvements consisting of beach nourishment with a segmented breakwater. The proposed action will involve removing portions of the existing structures, construction of a new groin and segmented breakwater system, and placement of sand fill to increase beach width.

10.4.1 Unavoidable Impacts

- The proposed action will use non-renewable resources (sand, stone, concrete). The estimated volume of sand required to nourish the beach is 28,000 cy. The estimated volume of stone required to construct the groin and breakwater system is 4,000 cy. The estimated volume of concrete required is 250 cy.
- 28,000 cubic yards of sand will be recovered from an offshore deposit, temporarily altering the bathymetry and temporarily disrupting the ecology in the dredge extents.

- While these non-renewable resources will be moved from their current locations, the sand and rocks will continue to serve as environmental resources. The sand will expand beach resources and form the foundation of a shoreline berm vegetated with native plants. The rocks will help to control the effects of beach erosion and provide additional benthic habitat.
- Sand recovered from the ocean, though highly compatible with the dry beach sand, will still have some fine content that will be winnowed from the beach system and moved offshore during the initial equilibration process and consequent beach erosion events.
- Dredging, transport, and placement of carbonate sand can increase the percentage of fine sediment through mechanical abrasion of friable grains.
- Particles greater than one inch in diameter may be present in the recovered and placed sand.
- Sand compaction can occur in high traffic areas during sand transportation and placement operations.
- When sand is recovered from anoxic environments, such as offshore deposits, it will typically have a grey color and unpleasant scent immediately after recovery.
- During sand recovery operations, minor turbidity is anticipated as sand is brought from the seafloor to the barge.
- Anchor lines around the offshore deposit will be in place for the duration of sand recovery operations. Anchor lines will be in place at the active sand offloading site.
- Dredging and sand transportation operations may temporarily disrupt marine ecology and ocean recreation in the area during construction.
- Machinery operating on the barge and the beach will generate noise and may temporarily impact air quality.
- Delivery to shore will require the emplacement of bridge structures, floats, or pipelines from the shoreline to at least 15 feet of water depth. Bridge structures could disrupt marine ecology and ocean recreation in the area during construction.
- Any construction activities taking place in the nearshore waters are expected to directly impact marine ecology, ocean recreation and access in the area.
- Placement operations on the beach will require lengths of the coast to be cordoned off during trucking operations. Access across the cordoned off area will be limited to specific crossing points with crossing guards.
- Bathymetry within the existing basin will be temporarily altered while the beach equilibrates to the new sand volume.

10.4.2 Cumulative Impacts

The proposed action beach improvement action in the Kūhiō beach sector ʻEwa (west) basin will involve removing portions of the existing structures, construction of a new groin and segmented breakwater system, and placement of 28,000 cy of sand fill to increase beach width. The groin heads will have cast-in-place concrete cores that will serve as a base for groin expansion as sea levels continue to rise. Approximately 4,000 cy of stone and 250 cy of concrete will be required to construct the groins. The proposed action will create a beach that will be a minimum of 30 ft wide. The total dry beach area inshore of the waterline will be about 44,000 sf (1 acre). The estimated construction duration for beach nourishment with a segmented breakwater is 240 days.

Alternatives to the proposed beach improvement action include beach maintenance (sand backpassing or sand pumping) and beach nourishment with stabilizing structures (see Section 7.4). The current configuration of the ʻEwa (west) basin has resulted in narrowing of the beach inshore of the gap in the breakwaters, while sand has accreted to some extent at the ʻEwa (west) end of the beach and below the water surface along the center groin. Beach maintenance could involve recovering sand from along the center groin and placing it along the shoreline at the center of the beach.

The estimated construction duration for beach maintenance is 30 days, and the estimated recurrence interval is 5 yrs. Assuming that maintenance is conducted over a period of 50 yrs, this would result in a total of 10 individual maintenance events and a total of 300 days of construction. While beach maintenance is technically feasible, it may not be a viable option. The area adjacent to the center groin in the ʻEwa (west) basin is the only site in the Kūhiō beach sector where a sufficient volume of sand would be available to support beach maintenance. However, the volume of sand present in this area is limited and may not be sufficient to support continued maintenance.

Another alternative for the Kūhiō beach sector ʻEwa (west) basin is beach nourishment without stabilizing structures. This alternative would consist of placing sand directly along the shoreline without any structures to stabilize the sand. This concept would require approximately 28,000 cy of sand and would create approximately 40,000 sf of dry beach area. This alternative would increase dry beach width but would not increase beach stability or prevent erosion. An advantage of this option is that it would not require modification of the existing structures. However, the sand would be unstable and subject to continued erosion.

There is limited space and depth to accommodate additional sand fill in the ʻEwa (west) basin, so there would be no future renourishment efforts. Periodic maintenance (e.g., sand pumping or sand backpassing) would be required to maintain a stable beach profile. The estimated construction duration for beach nourishment without stabilizing structures is 100 days. Assuming that maintenance is conducted every 5 yrs following the initial beach nourishment, over a period of 50 yrs, this would result in a total of 8 individual maintenance events and 240 additional days of construction (total of 340 days). While this option would be less expensive initially, the cumulative costs of periodic maintenance would be substantial. When compared to beach nourishment without stabilizing structures, the proposed action will have less cumulative impacts. The proposed action will require fewer dredging events, fewer construction days, and fewer beach closures.

Beach nourishment without stabilizing structures would also fundamentally alter the character of the basin. Without the proposed segmented breakwater, the beach would migrate (slump) makai (seaward) into the basin, the beach profile would flatten, and water depths inside the basin would become very shallow. In collaboration with the WBCAC, the project proponents determined that the highest priorities for the ʻEwa (west) basin are to maintain the basin as a moderately energetic wave environment with direct access to the ocean, while minimizing the amount of structural and visual change.

10.5 Kūhiō Beach Sector – Diamond Head (east) Basin

The proposed action in the Kūhiō beach sector Diamond Head (east) basin is beach maintenance consisting of sand pumping with no additional improvements or modifications to existing structures. In collaboration with the WBCAC, the project proponents determined that the Diamond Head (east) basin should remain a safe, calm, and protected area. While the low wave energy produces the calm environment that is enjoyed by many, the wave energy is too low to produce a stable beach profile. Over time, the beach face has migrated (slumped) makai (seaward) into the basin, with no natural means to return sand to the beach face. This seaward migration of sand has flattened the beach profile and decreased water depths in the basin. To increase dry beach width, the sand will need to be manually recovered and placed back on the beach.

10.5.1 Unavoidable Impacts

- The proposed action will use a non-renewable resource (sand).
- 4,500 cubic yards of sand will be pumped from within the existing basin, altering the bathymetry and temporarily disrupting the ecology in the vicinity of the dredge area.
- Sand recovered from within the basin may still have some fine content that will be winnowed from the beach system during the initial equilibration process and consequent beach erosion events.
- When sand is recovered from anoxic environments, such as within the existing basin, it will typically have a grey color and unpleasant scent immediately after recovery.
- During sand recovery operations, minor turbidity is anticipated as sand is brought from the basin floor to the beach.
- Machinery operating on the beach will generate noise and may temporarily impact air quality.
- Any construction activities taking place in the nearshore waters are anticipated to directly impact marine ecology, ocean recreation and access in the existing basin.
- Sand pumping operations will require portions of the shoreline to be cordoned off during sand pumping and placement operations. Access across the cordoned off areas will be limited to specific crossing points with crossing guards.
- Bathymetry within the existing basin will be temporarily altered while the beach equilibrates to the new sand volume.

10.5.2 Cumulative Impacts

The proposed sand pumping is designed to be conducted periodically on an as-needed basis. Sand pumping will be conducted when beach conditions reach some pre-defined topographic triggers. Beach monitoring will be required to determine when the triggers have been met. Sand pumping will involve recovering approximately 4,500 cy of existing sand from within the basin onto the dry beach. The volume of sand in the littoral system will not be altered.

The estimated construction duration for the proposed sand pumping is 10 days, and the estimated recurrence interval is 5 yrs. Assuming that maintenance is conducted over a period of 50 yrs, this will result in a total of 10 individual sand pumping events and a total of 100 days of construction.

Alternatives to the proposed sand pumping consist of beach nourishment with or without stabilizing structures (see Section 7.6). Beach nourishment would require dredging to recover approximately 4,500 cy of sand from offshore and placing it on the beach. This would produce the same dry beach width and configuration as the proposed action; however, no sand would be recovered from within the basin. By increasing the volume of sand within the basin, water depths would become progressively shallower over time as the new sand added to the beach would be expected to migrate makai (seaward) into the basin. The beach width and elevation could also be expanded by adding more sand. Increasing the dry beach elevation by 1 ft would require about 1,500 cy of sand, while widening the beach by 5 ft would require about 2,000 cy of sand.

The beach in the Diamond Head (east) basin could be stabilized by reconfiguring the offshore breakwater to be a series of breakwaters or groins. These alternatives were previously investigated by Noda (1999) and Bodge (2000). Both plans involved removing the offshore breakwater. The Noda (1999) plan included adding heads to the Kapahulu storm drain/groin and the center groin to produce a more open swimming area. Bodge (2000) recommended smaller heads and the addition of small T-head groin in the gap between the new groin heads. The Bodge (2000) plan is more consistent with the proposed action for the ʻEwa (west) basin.

The highest priorities for the Diamond Head (east) basin are to maintain the basin as a calm, safe environment for swimming and wading. Reconfiguring the existing breakwater would create a more energetic wave environment, which would fundamentally alter the character of the basin. Without reconfiguring the existing breakwater, the beach would migrate makai (seaward), the beach profile would flatten, and water depths inside the basin would become very shallow. As a result, beach nourishment with or without stabilizing structures was ruled out in the early stages of the conceptual design and project selection process.

When compared to the alternatives of beach nourishment with or without stabilizing structures, the proposed action will have less cumulative impacts. The proposed sand pumping will require fewer construction days, fewer beach closures, no offshore dredging, and will not increase in the volume of sand in the littoral system.

11. SECONDARY IMPACTS

Secondary impact, as defined in HAR §11-200.1-2:

> *"means an effect that is caused by the action and is later in time or farther removed in distance, but is still reasonably foreseeable. An indirect effect may include a growth-inducing effect and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air, water, and other natural systems, including ecosystems."*

Secondary impacts can be viewed as actions of others that are taken because of the presence of the project. Secondary impacts from highway projects, for example, can occur because they can induce development by removing one of the impediments to growth.

11.1 Fort DeRussy Beach Sector

The proposed action in the Fort DeRussy beach sector is beach maintenance consisting of sand backpassing with no additional improvements or modifications to existing structures. Sand will be transported from the accreted area at the west end of the beach to the eroding area at the east end of the beach to increase dry beach width and mitigate wave overtopping. Sand will be obtained from the beach face on the east side of the Hilton pier/groin, where sand eroded has accreted over the years. Sand will be excavated from the beach face extending inshore only as far as necessary to obtain the required volume of sand. The anticipated secondary impacts of the proposed action in the Fort DeRussy beach sector are summarized in Table 11-1.

Table 11-1 Anticipated secondary impacts - Fort DeRussy beach sector

Resource	Secondary Impacts
8.4 Coastal Hazards	The proposed action is intended to mitigate the impacts of wave overtopping and flooding by increasing dry beach width and volume, which will provide a protective buffer between the ocean and the existing backshore infrastructure. This will increase the wave energy dissipating properties of the beaches and decrease the landward extent of wave runup, reducing the vulnerability of the backshore flooding to marine flooding. The proposed action is anticipated to have a negligible impact on hurricane and tsunami hazards for the Waikīkī area. Damage from hurricanes and tsunamis depends on the height of the water level rise relative to the backshore elevation, neither of which will be affected by the proposed actions.
8.5 Coastal Processes	The proposed action is not anticipated to significantly alter or affect presently ongoing sediment transport and shoreline processes, wave-driven currents, circulation patterns, or offshore wave breaking. The proposed action is intended to increase dry beach width and produce a more linear beach planform. Sediment (sand) will be subject to the same coastal processes that exist under the current conditions.
8.7 Water Quality	The proposed action is anticipated to have a temporary impact on water quality during sand placement operations. However, the proposed action

	does not involve using offshore sand, so the percentage of fine carbonate content in the sand will be lower, which will decrease the potential to generate turbidity. Industry-standard Best Management Practices (BMPs) will be utilized to minimize the potential for turbidity during sand recovery and placement operations.
8.8 Shoreline Change	The proposed action is anticipated to have a positive impact on shoreline change. Conducting periodic beach maintenance will improve lateral shoreline access and reduce the potential for the seawall and beach walkway to become exposed by erosion and overwashed by wave runup. While beach maintenance will not prevent future beach erosion, it will balance the sediment budget within the beach sector, which will help to maintain a more linear beach planform.
9.1 Socioeconomic Setting	The proposed action is anticipated to have a positive impact on the economies of the State of Hawaiʻi and City and County of Honolulu. The proposed action will restore an existing public beach in Waikīkī. The economic value of the beaches to the commercial success of Waikīkī is extremely significant. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational and economic uses in Waikīkī. The proposed action may temporarily disrupt commercial activities (e.g., beach concessions) during construction; however, every effort will be made to minimize adverse economic impacts, particularly during the prime daytime beach use hours.
9.3 Scenic and Aesthetic Resources	The proposed action is anticipated to have a positive impact on view planes in the Fort DeRussy beach sector. The beach at the east end of the sector is severely eroded and the existing seawall is exposed, which has degraded the aesthetics of the area. Increasing dry beach width will improve view planes along the shoreline.
9.4 Recreation	The proposed action is anticipated to have a positive impact on recreation. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational uses in Waikīkī. Shoreline access may be temporarily disrupted during construction; however, the duration of construction is very short (estimated 10 days) and every effort will be made to maintain shoreline access, particularly during the prime daytime beach use hours.
9.5 Shoreline Access	The proposed action is anticipated to have a positive impact on shoreline access. The beach at the east end of the sector is severely eroded and the existing seawall is exposed, which limits lateral shoreline access in this area. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users in Waikīkī. Shoreline access may be temporarily disrupted during construction; however, the duration of construction is very short (estimated 10 days) and every effort will be made to maintain shoreline access, particularly during the prime daytime beach use hours.
9.6 Air Quality	The proposed action is anticipated to have a short-term impact on air quality. Because most of the work will take place on the sandy shoreline, the proposed action will involve little or no soil disturbance that could result in particulate emissions. During construction, sand recovery and placement operations may result in a temporary degradation in air quality

	in the immediate vicinity of the project area. This negative impact to air quality will be limited to typical work hours and will end once the sand is in place. Short-term degradation of air quality may occur due to emissions from construction equipment. However, emissions from internal combustion engines are far too small to have a significant or lasting effect on air quality.
9.7 Noise	The proposed action is anticipated to have a short-term impact on noise. The equipment used during sand recovery and placement operations along the shoreline will be audible and may exceed current background noise levels. It is not feasible to mitigate construction noise to the extent that it does not at times exceed existing background noise levels or is inaudible to beach users, hotel guests, etc. Appropriate measures will be taken to minimize noise levels to the extent practicable.
9.8 Public Services	The proposed action is anticipated to have a negligible impact on public services. Increasing dry beach area could potentially increase the number of beach users in Waikīkī, which may increase the volume of trash and require more frequent solid waste collection and disposal. If the number of beach users in Waikīkī were to increase, this may also result in an increased number of incidents that would require police, fire, and medical services. Prior to commencement of construction activities, the Honolulu Police Department, Honolulu Fire Department, and Emergency Medical Services will be informed of the project construction schedule and apprised of the emergency vehicle access routes to be used during construction. The contractor will be required to provide ample clearance for emergency vehicles at all times. The proposed action does not involve any activities that would permanently alter the need for, or ability to provide, emergency services.
9.9 Public Infrastructure	The proposed action is anticipated to have a negligible impact on public infrastructure. The proposed action will not require water or electrical power and will not generate a need for additional sanitary wastewater collection and treatment facilities. There are no anticipated to stormwater runoff that would affect the City and County of Honolulu stormwater drainage system. During construction, workers can park either in a construction staging area or existing public parking facilities. Mobilization and demobilization of equipment and materials will involve some heavy vehicle traffic through Waikīkī; however, this would be of limited duration. Equipment and materials will be transported along Fort DeRussy Beach, which will require secure trucking lanes on the beach. Equipment will be escorted to ensure public health and safety, and the delivery of materials and equipment will be timed to minimize impacts to beach users to the maximum extent practicable. Because of the small number of vehicle-trips involved, construction worker and equipment/material delivery trips do not have the potential to substantially affect traffic volumes and/or the level of service on area roadways.

11.2 Halekūlani Beach Sector

The proposed action for the Halekūlani beach sector is beach improvements consisting of beach nourishment with stabilizing groins. The proposed action will consist of construction of three new sloping rock rubblemound T-head groins, a new L-head groin adjacent to the existing Fort DeRussy outfall/groin, and modification of the recently replaced Royal Hawaiian groin. The groins and beach fill will create four stable beach cells in an area that has previously had limited beach resources. The proposed action will require approximately 60,000 cy of sand fill and will create approximately 3.8 acres of new dry beach area. The anticipated secondary impacts of the proposed action in the Halekūlani beach sector are summarized in Table 11-2

Table 11-2 Anticipated secondary impacts - Halekūlani beach sector

Resource	Secondary Impacts
8.4 Coastal Hazards	The proposed action is intended to mitigate the impacts of wave overtopping and flooding by increasing dry beach width and volume, which will provide a protective buffer between the ocean and the existing backshore infrastructure. This will increase the wave energy dissipating properties of the beaches and decrease the landward extent of wave runup, reducing the vulnerability of the backshore flooding to marine flooding. The proposed action is anticipated to have a negligible impact on hurricane and tsunami hazards for the Waikīkī area. Damage from hurricanes and tsunamis depends on the height of the water level rise relative to the backshore elevation, neither of which will be affected by the proposed actions.
8.5 Coastal Processes	The proposed action is anticipated to alter or affect presently existing sediment transport and shoreline processes, wave-driven currents, and circulation patterns. The proposed groins will prevent longshore sediment transport and alter wave-driven currents and circulation patterns within the beach cells between the groins. Existing current velocities within the project footprint are relatively weak, therefore the proposed action is not anticipated to significantly alter wave-driven currents and circulation patterns in the vicinity of the groins. The proposed groins will provide superior stability for the beach, and the sand fill will mitigate wave energy reflection from the existing seawalls. The heads of the new groins will help prevent the formation of offshore rip currents along the groin stems, and thus reduce cross-shore sediment transport. The groins will terminate well inshore of the offshore surf breaks and are not anticipated to alter the bathymetry or wave formation characteristics of the surrounding seafloor.
8.6 Bathymetry	In-water construction impacts will be limited to the immediate areas of groins. The new structural footprints will be carefully delineated, and no construction activities or in-water material storage will be permitted outside of these areas. Construction of the proposed new groins will alter the bathymetry of the areas they cover. Short-term changes in nearshore bathymetry and coastal processes are anticipated as the beach equilibrates after sand placement.

	Dredging of offshore sand deposits involves removing sand from the deposits, resulting in a lowering of the bottom elevation or changing the bathymetry. Dredging could occur at the *Ala Moana* or *Hilton* offshore sand deposits. Detailed wave modeling was conducted to evaluate the potential impacts to bathymetry and wave formation at the offshore sand recovery areas (see Section 8.2.2). Based on the results of the wave modeling and dredge analysis, no significant impacts to bathymetry are anticipated.
8.7 Water Quality	The proposed action is anticipated to have a temporary impact on water quality. Sand recovered from the ocean, though highly compatible with the existing dry beach sand, would still have some naturally occurring fine carbonate content that would be winnowed from the beach system and moved offshore during the initial equilibration process and beach erosion events. Dredging, transport, and placement of carbonate sand can also increase the percent of fines through mechanical abrasion of the friable grains. Turbidity, or a reduction in water transparency, occurs when fine sediment particles are suspended in the water column. Turbidity can occur at the offshore sand dredging site or along the beach where sand is placed. Industry-standard Best Management Practices (BMPs) will be utilized to minimize the potential for turbidity during sand recovery and placement operations. Water quality monitoring will also be conducted before, during, and after construction.
8.8 Shoreline Change	The proposed action is anticipated to have a positive impact on shoreline change. The project will produce four stable beach cells in an area that has historically been devoid of sand. The groins will stabilize the sand so long-term erosion rates will decrease when compared to historical rates. Beach profile monitoring will be conducted before and after construction.
8.10 Marine Biota	The proposed action is not anticipated to result in any significant long-term degradation of the environment or loss of marine habitat. Construction of the proposed groins will improve the shoreline conditions and increase potential biological habitat in a relatively barren reef flat area. Ecological services of reef flat habitat will be lost under the project footprints (sand and groins) but are anticipated to recover over time as the benthic community re-establishes. Most adult fish in the project vicinity are mobile and will actively avoid direct impacts from project activities. There is potential for demersal fish eggs to be buried; however, new hard substrata created by the groins would provide greater surface area for these species to lay eggs in the future. Some impairment of ability of EFH managed species to find prey items could occur, but this effect should be temporary and spatially limited to the immediate vicinity of construction activities. The groins will provide bare, stable surfaces for recruitment of corals, algae, and other invertebrates. The groins will be porous, permeable, with approximately 37 percent interstitial void space between stones. Obligate reef dwellers are often limited by the availability of suitable shelter, especially juveniles. Reef fishes prefer reef holes and crevices commensurate with the size of the fish. The interstitial spaces between stones will also provide habitat for benthic (crabs, shrimps, worms, etc.) and sessile organisms (sponges and tunicates) which would provide

	additional foraging resources for fishes. The boulders will also provide a hard, stable surface for coral colonization, and elevates them above the shifting sand and rubble bottom. Turbidity containment barriers will effectively isolate the construction activities from the adjacent seafloor and water column; thus, impacts to marine biota will be limited to the immediate construction area. A marine biological and water quality monitoring program will be implemented to enhance control over construction impacts.
9.1 Socioeconomic Setting	The proposed action is anticipated to have a positive impact on the economies of the State of Hawaiʻi and City and County of Honolulu. The proposed action will restore an existing public beach in Waikīkī. The economic value of the beaches to the commercial success of Waikīkī is extremely significant. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational and economic uses in Waikīkī. The proposed action may temporarily disrupt commercial activities during construction; however, every effort will be made to minimize adverse economic impacts, particularly during the prime daytime beach use hours.
9.3 Scenic and Aesthetic Resources	The proposed action is anticipated to have short-term negative impacts and positive long-term impacts on scenic and aesthetic resources. Due to its low elevation and profile, the proposed action is not anticipated to adversely affect existing viewplanes. Construction equipment, material stockpiles, and construction activities will be present within the project area during construction. Additionally, the dredging equipment will be visible from the shoreline during sand recovery options. These impacts are temporary in nature and will not be present once the construction phase of the project is completed. The proposed action is anticipated to have a long-term positive impact on scenic and aesthetic resources. While the offshore sand is slightly greyer than the existing beach sand, the color difference is anticipated to be negligible after a season of mixing and fading due to UV exposure. The groins and beach fill would create four stable beach cells, which will improve view planes along the shoreline.
9.4 Recreation	The proposed action is anticipated to have a positive impact on recreation. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational uses in Waikīkī.
9.5 Shoreline Access	The proposed action is anticipated to have short-term negative impacts and positive long-term impacts on shoreline access. The Halekūlani beach sector essentially bifurcates shoreline access between the east and west portions of Waikīkī Beach. Walkways on top of the seawalls fronting the Halekūlani and Sheraton Waikiki hotels provide limited and discontinuous lateral access along the shoreline. The walkways are very narrow, are not ADA-accessible, and are subject to wave overtopping during high tide and high surf events. Structural damage has repeatedly resulted in closure of the walkways, which effectively prohibits lateral

	shoreline access between the Fort DeRussy Beach and Royal Hawaiian beach sectors. Shoreline access will be temporarily disrupted during construction. However, shoreline access will be permanently improved after construction is completed. Increasing dry beach area will significantly improve lateral shoreline access and provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational uses in Waikīkī.
9.6 Air Quality	The proposed action is anticipated to have a short-term impact on air quality. Because most of the work will take place on the sandy shoreline, the proposed action will involve little or no soil disturbance that could result in particulate emissions. During construction, sand recovery and placement operations may result in a temporary degradation in air quality in the immediate vicinity of the project area. This negative impact to air quality will be limited to typical work hours and will end once the sand is in place. Short-term degradation of air quality may occur due to emissions from construction equipment. However, emissions from internal combustion engines are far too small to have a significant or lasting effect on air quality.
9.7 Noise	The proposed action is anticipated to have a short-term impact on noise. The equipment used during sand recovery and placement operations along the shoreline will be audible and may exceed current background noise levels. It is not feasible to mitigate construction noise to the extent that it does not at times exceed existing background noise levels or is inaudible to beach users, hotel guests, etc. Appropriate measures will be taken to minimize noise levels to the extent practicable.
9.8 Public Services	The proposed action is anticipated to have a negligible impact on public services. Increasing dry beach area could potentially increase the number of beach users in Waikīkī, which may increase the volume of trash and require more frequent solid waste collection and disposal. If the number of beach users in Waikīkī were to increase, this may also result in an increased number of incidents that would require police, fire, and medical services. Prior to commencement of construction activities, the Honolulu Police Department, Honolulu Fire Department, and Emergency Medical Services will be informed of the project construction schedule and apprised of the emergency vehicle access routes to be used during construction. The contractor will be required to provide ample clearance for emergency vehicles at all times. The proposed action does not involve any activities that would permanently alter the need for, or ability to provide, emergency services.
9.9 Public Infrastructure	The proposed action is anticipated to have a negligible impact on public infrastructure. The proposed action will not require water or electrical power and will not generate a need for additional sanitary wastewater collection and treatment facilities. There are no anticipated to stormwater runoff that would affect the City and County of Honolulu stormwater drainage system. During construction, workers can park either in a construction staging area or existing public parking facilities. Mobilization and demobilization of equipment and materials will involve some heavy vehicle traffic through Waikīkī. Equipment and materials

	will be transported through Waikīkī and along the shoreline, which will require secure trucking lanes. Equipment will be escorted to ensure public health and safety, and the delivery of materials and equipment will be timed to minimize impacts to beach users to the maximum extent practicable. Because of the large number of vehicle-trips involved, construction worker and equipment/material delivery trips will have the potential to affect traffic volumes and/or the level of service on area roadways.

11.3 Royal Hawaiian Beach Sector

The proposed action for the Royal Hawaiian beach sector is beach maintenance consisting of beach nourishment with no additional improvements or modifications to existing structures. The proposed action will require periodic renourishment to maintain the beach at its 1985 location. The anticipated secondary impacts of the proposed action in the Royal Hawaiian beach sector are summarized in Table 11-3.

Table 11-3 Anticipated secondary impacts - Royal Hawaiian beach sector

Resource	Secondary Impacts
8.4 Coastal Hazards	The proposed action is intended to mitigate the impacts of wave overtopping and flooding by increasing dry beach width and volume, which will provide a protective buffer between the ocean and the existing backshore infrastructure. This will increase the wave energy dissipating properties of the beaches and decrease the landward extent of wave runup, reducing the vulnerability of the backshore flooding to marine flooding. The proposed action is anticipated to have a negligible impact on hurricane and tsunami hazards for the Waikīkī area. Damage from hurricanes and tsunamis depends on the height of the water level rise relative to the backshore elevation, neither of which will be affected by the proposed actions.
8.5 Coastal Processes	The proposed action is not anticipated to significantly alter or affect presently ongoing sediment transport and shoreline processes, wave-driven currents, circulation patterns, or offshore wave breaking. The proposed actions are intended to increase dry beach width and produce a more linear beach planform. Sediment (sand) will be subject to the same coastal processes that exist under the current conditions.
8.6 Bathymetry	The proposed action is anticipated to temporarily alter bathymetry at the offshore sand recovery areas. Dredging of offshore sand deposits involves removing sand from the deposits, resulting in a lowering of the bottom elevation or changing the bathymetry. Dredging will occur at the *Canoes/Queens* offshore sand deposit. Detailed wave modeling was conducted to evaluate the potential impacts to bathymetry and wave formation at the offshore sand recovery areas (see Section 8.2.2). Based on the results of the wave modeling and dredge analysis, no significant impacts to bathymetry are anticipated. Bathymetry along the beach toe will also be temporarily altered while the beach equilibrates to the new sand volume.

8.7 Water Quality	The proposed action is anticipated to have a temporary impact on water quality. Sand recovered from the ocean, though highly compatible with the existing dry beach sand, would still have some naturally occurring fine carbonate content that would be winnowed from the beach system and moved offshore during the initial equilibration process and beach erosion events. Dredging, transport, and placement of carbonate sand can also increase the percent of fines through mechanical abrasion of the friable grains. Turbidity, or a reduction in water transparency, occurs when fine sediment particles are suspended in the water column. Turbidity can occur at the offshore sand dredging site or along the beach where sand is placed. Industry-standard Best Management Practices (BMPs) will be utilized to minimize the potential for turbidity during sand recovery and placement operations. Water quality monitoring will also be conducted before, during, and after construction.
8.8 Shoreline Change	The proposed action is anticipated to have a positive impact on shoreline change. Conducting periodic beach nourishment will improve lateral shoreline access and countervail the long-term effects of erosion. While beach nourishment will not prevent future beach erosion, it will balance the sediment budget within the beach sector, which will help to maintain a more linear beach planform.
9.1 Socioeconomic Setting	The proposed action is anticipated to have a positive impact on the economies of the State of Hawaiʻi and City and County of Honolulu. The proposed action will restore an existing public beach in Waikīkī. The economic value of the beaches to the commercial success of Waikīkī is extremely significant. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational and economic uses in Waikīkī. The proposed action may temporarily disrupt commercial activities (e.g., beach concessions) during construction; however, every effort will be made to minimize adverse economic impacts, particularly during the prime daytime beach use hours.
9.3 Scenic and Aesthetic Resources	The proposed action is anticipated to have a positive impact on view planes in the Royal Hawaiian beach sector. The beach at the east end of the sector is severely eroded and the old foundation wall of the Waikīkī Tavern is frequently exposed by erosion. Beach narrowing along the remainder of Royal Hawaiian Beach reduces dry beach area and degrades the aesthetics of the area. Increasing dry beach area will improve view planes along the shoreline.
9.4 Recreation	The proposed action is anticipated to have a positive impact on recreation. Royal Hawaiian Beach is the most popular beach in Waikīkī. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational uses in Waikīkī. Beach use and ocean recreation may be temporarily disrupted during sand recovery and placement operations; however, every effort will be made to limit disruptions, particularly during the prime daytime beach use hours.
9.5 Shoreline Access	The proposed action is anticipated to have a positive impact on shoreline access. The beach at the east end of the sector is severely eroded, which limits lateral shoreline access in this area. Increasing dry beach area will provide additional space to accommodate the ever-growing number of

	beach users in Waikīkī. Shoreline access will be temporarily disrupted during construction; however, every effort will be made to maintain shoreline access, particularly during the prime daytime beach use hours.
9.6 Air Quality	The proposed action is anticipated to have a short-term impact on air quality. Because most of the work will take place on the sandy shoreline, the proposed action will involve little or no soil disturbance that could result in particulate emissions. During construction, sand recovery and placement operations may result in a temporary degradation in air quality in the immediate vicinity of the project area. This negative impact to air quality will be limited to typical work hours and will end once the sand is in place. Short-term degradation of air quality may occur due to emissions from construction equipment. However, emissions from internal combustion engines are far too small to have a significant or lasting effect on air quality.
9.7 Noise	The proposed action is anticipated to have a short-term impact on noise. The equipment used during sand recovery and placement operations along the shoreline will be audible and may exceed current background noise levels. It is not feasible to mitigate construction noise to the extent that it does not at times exceed existing background noise levels or is inaudible to beach users, hotel guests, etc. Appropriate measures will be taken to minimize noise levels to the extent practicable.
9.8 Public Services	The proposed action is anticipated to have a negligible impact on public services. Increasing dry beach area could potentially increase the number of beach users in Waikīkī, which may increase the volume of trash and require more frequent solid waste collection and disposal. If the number of beach users in Waikīkī were to increase, this may also result in an increased number of incidents that would require police, fire, and medical services. Prior to commencement of construction activities, the Honolulu Police Department, Honolulu Fire Department, and Emergency Medical Services will be informed of the project construction schedule and apprised of the emergency vehicle access routes to be used during construction. The contractor will be required to provide ample clearance for emergency vehicles at all times. The proposed action does not involve any activities that would permanently alter the need for, or ability to provide, emergency services.
9.9 Public Infrastructure	The proposed action is anticipated to have a negligible impact on public infrastructure. The proposed action will not require water or electrical power and will not generate a need for additional sanitary wastewater collection and treatment facilities. There are no anticipated to stormwater runoff that would affect the City and County of Honolulu stormwater drainage system. During construction, workers can park either in a construction staging area or existing public parking facilities. Mobilization and demobilization of equipment and materials will involve some heavy vehicle traffic through Waikīkī. Equipment and materials will be transported through Waikīkī and along the shoreline, which will require secure trucking lanes. Equipment will be escorted to ensure public health and safety, and the delivery of materials and equipment will be timed to minimize impacts to beach users to the maximum extent practicable.

11.4 Kūhiō Beach Sector – ʻEwa (west) Basin

The proposed action in the Kūhiō beach sector ʻEwa (west) basin is beach improvements consisting of beach nourishment with a segmented breakwater. The proposed action will involve removing portions of the existing structures, construction of a new groin and segmented breakwater system, and placement of sand fill to increase beach width. The anticipated secondary impacts of the proposed action in the Kūhiō beach sector ʻEwa (west) basin are summarized in Table 11-4.

Table 11-4 Anticipated secondary impacts - Kūhiō beach sector ʻEwa (west) basin

Resource	Secondary Impacts
8.4 Coastal Hazards	The proposed action is intended to increase dry beach width and volume and create a stable beach that will provide a protective buffer between the ocean and the existing backshore infrastructure. This will increase the wave energy dissipating properties of the beaches and decrease the landward extent of wave runup, reducing the vulnerability of the backshore flooding to marine flooding. The proposed action is anticipated to have a negligible impact on hurricane and tsunami hazards for the Waikīkī area. Damage from hurricanes and tsunamis depends on the height of the water level rise relative to the backshore elevation, neither of which will be affected by the proposed actions.
8.5 Coastal Processes	The proposed action is anticipated to alter or affect existing sediment transport and shoreline processes, and wave-driven currents. The proposed groin and segmented breakwater are designed to alter existing wave patterns within the basin to maintain a more stable beach profile. Existing current velocities within the basin are relatively weak, therefore the proposed action is not anticipated to significantly alter wave-driven currents and circulation patterns in the basin. The groins and breakwater system will not alter the bathymetry or wave formation characteristics of the seafloor outside of the basin.
8.6 Bathymetry	In-water construction impacts will be limited to the immediate areas of groins and segmented breakwater. The new structural footprints will be carefully delineated, and no construction activities or in-water material storage will be permitted outside of these areas. Construction of the proposed groin and segmented breakwater will not significantly alter the bathymetry of the areas they cover. Short-term changes in nearshore bathymetry and coastal processes are anticipated as the beach equilibrates after sand placement. Dredging of offshore sand deposits involves removing sand from the deposits, resulting in a lowering of the bottom elevation or changing the bathymetry. Dredging could occur at the *Ala Moana*, *Canoes/Queens* or *Hilton* offshore sand deposits. Detailed wave modeling was conducted to evaluate the potential impacts to bathymetry and wave formation at the offshore sand recovery areas (see Section 8.2.2). Based on the results of the wave modeling and dredge analysis, no significant impacts to bathymetry are anticipated. The groins and breakwater system will not alter the bathymetry of the seafloor outside of the basin.

8.7 Water Quality	The proposed action is anticipated to have a temporary impact on water quality. Sand recovered from the ocean, though highly compatible with the existing dry beach sand, would still have some naturally occurring fine carbonate content that would be winnowed from the beach system and moved offshore during the initial equilibration process and beach erosion events. Dredging, transport, and placement of carbonate sand can also increase the percent of fines through mechanical abrasion of the friable grains. Turbidity, or a reduction in water transparency, occurs when fine sediment particles are suspended in the water column. Turbidity can occur at the offshore sand dredging site or along the beach where sand is placed. Industry-standard Best Management Practices (BMPs) will be utilized to minimize the potential for turbidity during sand recovery and placement operations. Water quality monitoring will also be conducted before, during, and after construction.
8.8 Shoreline Change	The proposed action is anticipated to have a positive impact on shoreline change. The project will produce four stable beach cells in an area that has historically been devoid of sand. The groins will stabilize the sand so long-term erosion rates will decrease when compared to historical rates. Beach profile monitoring will be conducted before and after construction.
8.10 Marine Biota	The proposed action is not anticipated to result in any significant long-term degradation of the environment or loss of marine habitat. Construction of the proposed groin and segmented breakwater will improve the shoreline conditions and increase potential biological habitat in a relatively barren reef flat area. Ecological services of reef flat habitat will be lost under the project footprints but are anticipated to recover over time as the benthic community re-establishes. Most adult fish in the project vicinity are mobile and will actively avoid direct impacts from project activities. There is potential for demersal fish eggs to be buried; however, new hard substrata created by the groins and segmented breakwater will provide greater surface area for these species to lay eggs in the future. Some impairment of ability of EFH managed species to find prey items could occur, but this effect should be temporary and spatially limited to the immediate vicinity of construction activities. The groin and segmented breakwater will provide bare, stable surfaces for recruitment of corals, algae, and other invertebrates. The structures will be porous, permeable, with approximately 37 percent interstitial void space between stones. Obligate reef dwellers are often limited by the availability of suitable shelter, especially juveniles. Reef fishes prefer reef holes and crevices commensurate with the size of the fish. The interstitial spaces between stones will also provide habitat for benthic (crabs, shrimps, worms, etc.) and sessile organisms (sponges and tunicates) which would provide additional foraging resources for fishes. The boulders will also provide a hard, stable surface for coral colonization, and elevates them above the shifting sand and rubble bottom. Turbidity containment barriers will effectively isolate the construction activities from the adjacent seafloor and water column; thus, impacts to marine biota will be limited to the immediate construction area. A marine

	biological and water quality monitoring program will be implemented to enhance control over construction impacts.
9.1 Socioeconomic Setting	The proposed action is anticipated to have a positive impact on the economies of the State of Hawaiʻi and City and County of Honolulu. The proposed action will restore an existing public beach in Waikīkī. The economic value of the beaches to the commercial success of Waikīkī is extremely significant. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational and economic uses in Waikīkī.
9.3 Scenic and Aesthetic Resources	The proposed action is anticipated to have short-term negative impacts and positive long-term impacts on scenic and aesthetic resources. Due to its low elevation and profile, the proposed action is not anticipated to adversely affect existing viewplanes. Construction equipment, material stockpiles, and construction activities will be present within the project area during construction. Additionally, the dredging equipment will be visible from the shoreline during sand recovery options. These impacts are temporary in nature and will not be present once the construction phase of the project is completed. The proposed action is anticipated to have a long-term positive impact on scenic and aesthetic resources. While the offshore sand is slightly greyer than the existing beach sand, the color difference is anticipated to be negligible after a season of mixing and fading due to UV exposure. The groins and segmented will create a wide, stable beach, which will improve view planes along the shoreline.
9.4 Recreation	The proposed action is anticipated to have a positive impact on recreation. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational uses in Waikīkī.
9.5 Shoreline Access	The proposed action is anticipated to have short-term negative impacts and positive long-term impacts on shoreline access. Shoreline access will be temporarily disrupted during construction. Increasing dry beach area will improve lateral shoreline access and provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational uses in Waikīkī.
9.6 Air Quality	The proposed action is anticipated to have a short-term impact on air quality. Because most of the work will take place on the sandy shoreline, the proposed action will involve little or no soil disturbance that could result in particulate emissions. During construction, sand recovery and placement operations may result in a temporary degradation in air quality in the immediate vicinity of the project area. This negative impact to air quality will be limited to typical work hours and will end once the sand is in place. Short-term degradation of air quality may occur due to emissions from construction equipment. However, emissions from internal combustion engines are far too small to have a significant or lasting effect on air quality.
9.7 Noise	The proposed action is anticipated to have a short-term impact on noise. The equipment used during sand recovery and placement operations along the shoreline will be audible and may exceed current background

	noise levels. It is not feasible to mitigate construction noise to the extent that it does not at times exceed existing background noise levels or is inaudible to beach users, hotel guests, etc. Appropriate measures will be taken to minimize noise levels to the extent practicable.
9.8 Public Services	The proposed action is anticipated to have a negligible impact on public services. Increasing dry beach area could potentially increase the number of beach users in Waikīkī, which may increase the volume of trash and require more frequent solid waste collection and disposal. If the number of beach users in Waikīkī were to increase, this may also result in an increased number of incidents that would require police, fire, and medical services. Prior to commencement of construction activities, the Honolulu Police Department, Honolulu Fire Department, and Emergency Medical Services will be informed of the project construction schedule and apprised of the emergency vehicle access routes to be used during construction. The contractor will be required to provide ample clearance for emergency vehicles at all times. The proposed action does not involve any activities that would permanently alter the need for, or ability to provide, emergency services.
9.9 Public Infrastructure	The proposed action is anticipated to have a negligible impact on public infrastructure. The proposed action will not require water or electrical power and will not generate a need for additional sanitary wastewater collection and treatment facilities. There are no anticipated to stormwater runoff that would affect the City and County of Honolulu stormwater drainage system. During construction, workers can park either in a construction staging area or existing public parking facilities. Mobilization and demobilization of equipment and materials will involve some heavy vehicle traffic through Waikīkī. Equipment and materials will be transported through Waikīkī and along the shoreline, which will require secure trucking lanes. Equipment will be escorted to ensure public health and safety, and the delivery of materials and equipment will be timed to minimize impacts to beach users to the maximum extent practicable. Because of the large number of vehicle-trips involved, construction worker and equipment/material delivery trips will have the potential to affect traffic volumes and/or the level of service on area roadways.

11.5 Kūhiō Beach Sector – Diamond Head (east) Basin

The proposed action in the Kūhiō beach sector Diamond Head (east) basin is beach maintenance consisting of sand pumping with no additional improvements or modifications to existing structures. In collaboration with the WBCAC, the project proponents determined that the Diamond Head (east) basin should remain a safe, calm, and protected area. While the low wave energy produces the calm environment that is enjoyed by many, the wave energy is too low to produce a stable beach profile. Over time, the beach face has migrated (slumped) into the water, with no natural means to return sand to the beach face. This seaward migration of sand has flattened the beach profile and decreased water depths in the basin. To increase dry beach width, the sand will need to be manually recovered and placed back onto the beach. The anticipated secondary impacts of the proposed action in the Kūhiō beach sector Diamond Head (east) basin are summarized in Table 11-5.

Table 11-5 Anticipated secondary impacts - Kūhiō beach sector Diamond Head (east) basin

Resource	Secondary Impacts
8.5 Coastal Processes	The proposed action is not anticipated to significantly alter or affect presently ongoing sediment transport and shoreline processes, wave-driven currents, circulation patterns, or offshore wave breaking. The proposed action is intended to increase dry beach width and produce a more linear beach planform. Sediment (sand) will be subject to the same coastal processes that exist under the current conditions.
8.7 Water Quality	The proposed action is anticipated to have a temporary impact on water quality. Sand recovered from the ocean, though highly compatible with the existing dry beach sand, would still have some naturally occurring fine carbonate content that would be winnowed from the beach system and moved offshore during the initial equilibration process and beach erosion events. Dredging and placement of carbonate sand can also increase the percent of fines through mechanical abrasion of the friable grains. Turbidity, or a reduction in water transparency, occurs when fine sediment particles are suspended in the water column. Turbidity can occur at the offshore sand dredging site or along the beach where sand is placed. Industry-standard Best Management Practices (BMPs) will be utilized to minimize the potential for turbidity during sand recovery and placement operations. Water quality monitoring will also be conducted before, during, and after construction.
8.8 Shoreline Change	The proposed action is anticipated to have a positive impact on shoreline change. Conducting periodic beach maintenance will improve lateral shoreline access. While beach maintenance will not prevent future beach erosion, it will balance the sediment budget within the beach sector, which will help to maintain a more linear beach planform.
9.1 Socioeconomic Setting	The proposed action is anticipated to have a positive impact on the economies of the State of Hawaiʻi and City and County of Honolulu. The proposed action will restore an existing public beach in Waikīkī. The economic value of the beaches to the commercial success of Waikīkī is extremely significant. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational and economic uses in Waikīkī. The proposed action may temporarily disrupt commercial activities (e.g., beach concessions) during construction; however, every effort will be made to minimize adverse economic impacts, particularly during the prime daytime beach use hours.
9.3 Scenic and Aesthetic Resources	The proposed action is anticipated to have a positive impact on view planes in the Kūhiō beach sector. The beach is severely eroded, which has degraded the aesthetics of the area. Increasing dry beach width will improve view planes along the shoreline.
9.4 Recreation	The proposed action is anticipated to have a positive impact on recreation. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users and support ongoing recreational uses in Waikīkī. Shoreline access may be temporarily disrupted during construction; however, the duration of construction is very short (estimated

	10 days) and every effort will be made to maintain shoreline access, particularly during the prime daytime beach use hours.
9.5 Shoreline Access	The proposed action is anticipated to have a positive impact on shoreline access. The beach is severely eroded, which limits lateral shoreline access in this area. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users in Waikīkī. Shoreline access may be temporarily disrupted during construction; however, the duration of construction is very short (estimated 10 days), and every effort will be made to maintain shoreline access, particularly during the prime daytime beach use hours.
9.6 Air Quality	The proposed action is anticipated to have a short-term impact on air quality. Because most of the work will take place on the sandy shoreline, the proposed action will involve little or no soil disturbance that could result in particulate emissions. During construction, sand recovery and placement operations may result in a temporary degradation in air quality in the immediate vicinity of the project area. This negative impact to air quality will be limited to typical work hours and will end once the sand is in place. Short-term degradation of air quality may occur due to emissions from construction equipment. However, emissions from internal combustion engines are far too small to have a significant or lasting effect on air quality.
9.7 Noise	The proposed action is anticipated to have a short-term impact on noise. The equipment used during sand recovery and placement operations along the shoreline will be audible and may exceed current background noise levels. It is not feasible to mitigate construction noise to the extent that it does not at times exceed existing background noise levels or is inaudible to beach users, hotel guests, etc. Appropriate measures will be taken to minimize noise levels to the extent practicable.
9.8 Public Services	The proposed action is anticipated to have a negligible impact on public services. Increasing dry beach area could potentially increase the number of beach users in Waikīkī, which may increase the volume of trash and require more frequent solid waste collection and disposal. If the number of beach users in Waikīkī were to increase, this may also result in an increased number of incidents that would require police, fire, and medical services. Prior to commencement of construction activities, the Honolulu Police Department, Honolulu Fire Department, and Emergency Medical Services will be informed of the project construction schedule and apprised of the emergency vehicle access routes to be used during construction. The contractor will be required to provide ample clearance for emergency vehicles at all times. The proposed action does not involve any activities that would permanently alter the need for, or ability to provide, emergency services.
9.9 Public Infrastructure	The proposed action is anticipated to have a negligible impact on public infrastructure. The proposed action will not require water or electrical power and will not generate a need for additional sanitary wastewater collection and treatment facilities. There are no anticipated to stormwater runoff that would affect the City and County of Honolulu stormwater drainage system. During construction, workers can park either in a construction staging area or existing public parking facilities. Mobilization and demobilization of equipment and materials will involve

	some heavy vehicle traffic through Waikīkī; however, this would be of limited duration. Equipment will be escorted to ensure public health and safety, and the delivery of materials and equipment will be timed to minimize impacts to beach users to the maximum extent practicable. Because of the small number of vehicle-trips involved, construction worker and equipment/material delivery trips do not have the potential to substantially affect traffic volumes and/or the level of service on area roadways.

12. MONITORING AND ASSESSMENT PLANS

Monitoring programs are proposed for beach conditions, water quality, and marine biology. These proposed monitoring programs are presented below. Details for each of these monitoring efforts will be expanded upon and may be modified during the permit process, as directed by the regulatory and resource agencies at the Federal and State levels.

12.1 Beach Profile Monitoring

Beach profiles and topographic features will be measured and mapped during the final design and permitting processes. Beach monitoring has previously been conducted for the 2012 Waikīkī Beach Maintenance I project and is currently being conducted for the recently completed 2021 Waikīkī Beach Maintenance II project. These monitoring efforts including detailed and frequent topographic mapping of the beach to monitor shoreline change before and after beach nourishment. The cumulative volume of elevation data for the beach provides a strong foundation for future, pre- and post-construction monitoring efforts.

Beach profiles will be collected prior to construction to establish a baseline for monitoring beach width and volume after placement. These measurements are vital for both ensuring correct placement of sand on the beach and documenting pre-construction beach conditions.

Post-construction monitoring of the beach will also be conducted to evaluate project performance. Post-construction project performance and beach stability will be monitored by periodically surveying beach profiles and documenting the characteristics of the shoreline with photographs. Beach profiles are a common measurement technique used to investigate coastal processes and shoreline change. The profiles will be performed by measuring the beach along a transect perpendicular to the shoreline and will extend as far mauka (landward) or makai (seaward) as necessary to capture specific beach features (e.g., toe, berm, crest).

Recoverable benchmarks will be established at each profile location to ensure that all profiles are measured at the same location, azimuth, and with the same elevation controls. These profiles will be collocated with the profile locations established during the final design and permitting process. The profiles will be measured using standard survey equipment and techniques. The profiles will be plotted, and a summary and discussion of the results will be prepared following each survey event. The schedule for beach monitoring profiles will be as follows.

1. Immediately (within 72 hours) after placement of the sand fill to the design beach shape at each profile location.
2. A complete set of profiles at all locations will be accomplished 30 days, 6 months and 12 months post-construction.
3. After the first year, post-construction profiles will be measured quarterly for 3 years, and may be collected, annually or quarterly, for up to 10 years.

Additional profile locations or measurement times may be added as deemed warranted by the project engineer in order to fully evaluate the performance of the project (e.g., should an atypical or unusual shoreline formation or change occur or should changes occur more rapidly than anticipated). The beach monitoring program will provide information to determine the performance and impacts of the project and establish a timeframe for potential future beach improvement or maintenance actions.

12.2 Water Quality Monitoring

Water quality monitoring will be conducted before, during, and after construction. The monitoring methodology and frequency will be reviewed and approved by the Hawaiʻi Department of Health, Clean Water Branch (DOH-CWB), pursuant to the Clean Water Act, Section 401 Water Quality Certification (WQC) process. The WQC defines the Applicable Monitoring and Assessment Plan (AMAP) and Data Quality Objectives (DQO) for the monitoring program. The AMAP will define the water quality sample sites, parameters, frequency, and thresholds for evaluation of test results.

The intent of the AMAP is to conduct water quality sampling and analysis to effectively monitor potential impacts caused by in-water work, including sand recovery, transport, and placement. The AMAP will include baseline (pre-construction), during construction, and post-construction monitoring. Data collected as part of the AMAP will be used to assess the adequacy of Best Management Practices (BMPs) utilized during construction and quantify the impacts of the proposed actions on water quality. If shown to be necessary by the monitoring data, the BMPs will be modified during construction to better protect water quality. The water quality monitoring program will largely follow the *General Monitoring Guidelines for Section 401 Water Quality Certification Projects* (HDOH, 2000). Water quality parameters to be tested as part of the AMAP are pH, turbidity, dissolved oxygen (DO), salinity, and temperature.

<u>During Construction Monitoring</u>

- The Contractor shall follow the accepted Water Quality Monitoring Plan and Applicable Monitoring and Assessment Plan.
- Monitoring locations move through the project area as placement activities progress along the shoreline.
- The Contractor shall incorporate all erosion control measures shown in the drawings and the Best Management Practices Plan (BMPP). The BMPP may be modified as necessary to adjust to conditions that develop during construction. Any changes to the BMPP must be submitted immediately to the DOH-CWB for review. The project may only proceed after the DOH-CWB issues a written acceptance of the modified BMPP.
- Turbidity outside the active project site shall not exceed the baseline turbidity geometric value, as defined in the AMAP. The Contractor shall cease all work if unusual turbidity is observed and take the necessary remedial action to correct the problem.
- The monitoring will be conducted by trained professionals with advanced degrees in the marine sciences. Monitoring and sample testing shall comply with the DOH-CWB *General Monitoring Guideline for Section 401 Water Quality Certification Projects* (HDOH, 2000).

<u>Post-Construction Monitoring</u>

Long-term water quality monitoring efforts will be tied to the beach monitoring program schedule and will sample the parameters identified in the AMAP.

12.3 Marine Biological Monitoring

A comprehensive marine environmental assessment will be completed for the final design of the proposed actions. The assessment will provide the basis for evaluating marine biological monitoring results for the project areas and control areas.

During Construction Monitoring

- Monitoring will be conducted at the during and after construction.
- Monitoring stations will be established at selected sites to allow for a comprehensive assessment or pre- and post-construction conditions.
- Monitoring will consist of mapping the seafloor at the monitoring sites with photomosaics of the seafloor.
- Visual comparison and analysis of the photomosaics will be conducted to identify any changes or impacts associated with the projects.

Post-Construction Monitoring

Long-term monitoring for the project area will be completed, using the methodology presented above, at the following intervals:

- Photomosaics will be collected and analyzed at 6 months and 12 months post-construction.
- After the first year, post-construction marine biological monitoring will be conducted annually for 3 years and may be collected for up to 10 years.

12.4 During Construction Mitigation and Monitoring

12.4.1 Protection of Endangered Species (NOAA-NFMS)

The following endangered species BMPs, as recommended by the National Marine Fisheries Service, shall be adhered to during construction of the Proposed Action:

- Project footprints shall be limited to the minimum area necessary to complete the authorized work.
- The project area shall be flagged to identify sensitive resource areas, such as seagrass beds, ESA-listed terrestrial plants, and turtle nests.
- The authorized work shall be timed to minimize effects on ESA-listed species and their habitats.
- The authorized work shall cease under unusual conditions, such as large tidal events and high surf conditions, except for efforts to avoid or minimize damage to aquatic resources.
- Constant vigilance shall be kept for the presence of ESA-listed species during all phases of the authorized work.
- A responsible party, i.e., permittee/site manager/project supervisor, shall designate a competent observer to survey work sites and the areas adjacent to the authorized work area for ESA-listed species.
- The contractor shall establish a safety zone around the project area whereby observers shall visually monitor for marine protected species 30 minutes prior to, during, and 30

minutes post daily project activity. Record information on the species, numbers, behavior, time of observation, location, start and end times of project activity, sex or age class (when possible), and any other disturbances (visual or acoustic).

- If a marine protected species is in the area, either hauled out onshore or in the nearshore waters, a 150-foot buffer must be observed with no humans approaching it. If a monk seal/pup pair is seen, a minimum 300-foot buffer must be observed.
- In the event that a marine protected species enters the safety zone and the project activity cannot be halted, conduct observations and immediately contact NMFS staff in Honolulu to facilitate agency assessment of collected data. For monk seals contact the Marine Mammal Response Coordinator, at (808) 944-2269, as well as the monk seal hotline at (808) 220-7802. For turtles, contact the turtle hotline at (808) 983-5730.
- No one shall attempt to feed, touch, ride, or otherwise intentionally interact with any ESA-listed species.
- For on-site project personnel that may interact with a listed species potentially present in the action area, provide education on the status of any listed species and the protections afforded to those species under Federal laws. NMFS may be contacted for scheduling educational briefings to convey information on marine mammal behavior and explain why and when to call NMFS and other resource agencies.
- A pollution and erosion control plan for the authorized work site and adjacent areas shall be prepared and carried out. At a minimum, this plan shall include and require:
  - Proper installation and maintenance of silt fences, sausages, equipment diapers, and/or drip pans;
  - A contingency plan to control and clean spilled petroleum products and other toxic materials;
  - Appropriate materials to contain and clean potential spills will be stored at the work site, and be readily available;
  - All project-related materials and equipment placed in the water will be free of pollutants;
  - Daily pre-work inspections of heavy equipment for cleanliness and leaks, with all heavy equipment operations postponed or halted until leaks are repaired and equipment is cleaned;
  - Fueling of project-related vehicles and equipment will take place at least 50 feet away from the water, preferably over an impervious surface;
  - A plan to prevent trash and debris from entering the marine environment during the project; and
  - All construction discharge water (e.g., vehicle wash water) must be treated before discharge.
  - Any necessary and appropriate erosion controls shall be properly installed before undertaking the authorized work.
- Temporary access roads and drilling pads shall avoid steep slopes, where grade, soil types, or other features suggest a likelihood of excessive erosion or failure; existing access routes shall be utilized or improved whenever possible, in lieu of construction of new access routes.
- All disturbed areas must be immediately stabilized following cessation of activities for any break in work longer than 4 days.

- The authorized work shall comply with all applicable NWP General and Regional Conditions.
- With the exception of the actual dredging apparatus (e.g. clamshell buckets, or the scoop and articulated arm of a backhoe, etc.), heavy equipment will be operated from above and out of the water.
- The portions of the equipment that enter the water will be clean and free of pollutants.
- Any form of blasting is not authorized.

12.4.2 Protection of Endangered Species (USFWS)

The following endangered and threatened species BMPs, as recommended by the US Fish and Wildlife Service, shall be adhered to during construction of the Proposed Action:

<u>Hawaiian Hoary Bat</u>

- Do not disturb, remove, or trim woody plants greater than 15 feet tall during the bat birthing and pup rearing season (June 1 through September 15).
- Do not use barbed wire for fencing.

<u>Hawaiian Goose</u>

- Do not approach, feed, or disturb Hawaiian geese.
- If Hawaiian geese are observed loafing or foraging within the project area during the breeding season (September through April), have a biologist familiar with the nesting behavior of Nene survey for nests in and around the project area prior to the resumption of any work. Repeat surveys after any subsequent delay of work of 3 or more days (during which the birds may attempt to nest).
- Cease all work immediately and contact the Service for further guidance if a nest is discovered within a radius of 150 feet of proposed work, or a previously undiscovered nest is found within said radius after work begins.
- In areas where Hawaiian geese are known to be present, post and implement reduced speed limits, and inform project personnel and contractors about the presence of endangered species on-site.

<u>Green and Hawksbill Sea Turtles</u>

- We recommend you consult with the Service prior to project commencement to obtain the latest information on sea turtle activity in the area. Should there be any sea turtle activity occurring in the area, we recommend monitoring timeline and plan be discussed with the Service.
- Incorporate applicable Best Management Practices regarding Work in Aquatic Environments into the project design.
- Have a project team member familiar with sea turtles conduct a visual survey of the project site to ensure no basking sea turtles are present.
    - If a basking sea turtle is found within the project area, cease all mechanical or construction activities within 100 feet until the animal voluntarily leaves the area.
    - Cease all activities between the basking turtle and the ocean.
- Remove any project-related debris, trash, or equipment from the beach if not actively being used.

- Do not stockpile project-related materials in the intertidal zone, reef flats, or stream channels.
- Create a designated staging area for land equipment off of the sand/beach at the end of each work day.
- Minimize the use of lighting and shield all project-related lights so the light is not visible from any beach.
    - If lights can't be fully shielded or if headlights must be used, fully enclose the light source with light filtering tape or filters.
- Incorporate design measures into the construction or operation of buildings adjacent to the beach to reduce ambient outdoor lighting such as:
    - Tinting or using automatic window shades for exterior windows that face the beach;
    - Reducing the height of exterior lighting to below 3 feet and pointed downward or away from the beach; and
    - Minimize light intensity to the lowest level feasible and, when possible, include timers and motion sensors.

<u>Wedge-Tailed Shearwater</u>

- Conduct surveys throughout the project area during the species' breeding season (March through November) to determine the presence and location of nesting areas.
- If wedge-tailed shearwaters nest within the proposed project area and ground disturbance is expected to occur, time project construction outside of the breeding season.
- Install automatic motion sensor switches and controls on all outdoor lights or turn off lights when human activity is not occurring in the lighted area.

<u>Hawaiian Petrel, Newell's Shearwater, and Band-Rumped Storm Petrel</u>

- Fully shield all outdoor lights so the bulb can only be seen from below bulb height and only use when necessary.
- Install automatic motion sensor switches and controls on all outdoor lights or turn off lights when human activity is not occurring in the lighted area.

<u>Hawaiian Yellow-Faced Bee</u>

- If an action will occur in or adjacent to known occupied habitat, a buffer area around the habitat may be required and can be worked out on a site-specific basis through consultation with the Service.
- For coastal species, protect all coastal strand habitat from human disturbance, including:
    - No fires or wood collecting
    - Leave woody debris in place
    - Post educational signs to inform people of the presence of sensitive species.

12.4.3 Monitoring of Dredged Sand for Impurities

Operational controls will include monitoring dredge sand for impurities and grains larger than 1 in diameter. Monitoring will be conducted during all phases of the operation (sand recovery, transport, stockpiling, and placement) to identify any impurities or excessive content of larger grains at the earliest possible opportunity. If impurities or excessive content of larger grains are observed, then the sand recovery operation will be relocated to a new site. The recovery area where the material was dredged will be marked and will not be utilized again for the remainder of the project.

13. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF HUMANITY'S ENVIRONMENT AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

This section discusses the relationship between the short-term uses of humanity's environment and how those uses may compromise or enhance the long-term productivity of that environment.

13.1 Trade-Offs Among Short-Term and Long-Term Gains and Losses

Short-term losses resulting from the proposed actions are primarily associated with construction operations. Sand recovery, sand transport, sand placement, and groin and breakwater construction have the potential to impact benthic habit and water quality. Best Management Practices (BMPs) will be utilized to minimize or mitigate potential impacts to the maximum extent practicable. Construction activities may also temporarily disrupt beach use, shoreline access, commercial activities, and ocean recreation activities. Construction activities may also temporarily impact noise, air quality, and view planes.

These short-term losses are anticipated to be minor and will only occur during construction and are significantly outweighed by the economic, social, recreational and aesthetic benefits of increasing recreational dry beach width and improving lateral shoreline access. The proposed actions will also decrease vulnerability to coastal hazards, increase resilience to sea level rise, and have a substantial positive impact on the economies of the State of Hawai‘i and City and County of Honolulu. These long-term benefits far outweigh the short-term losses associated with construction.

13.2 Extent to Which Proposed Action Forecloses Future Options

Selection of the proposed beach improvement and maintenance actions was a primarily stakeholder-driven process. The project proponents relied heavily on feedback and direction from the WBCAC to identify issues, needs, priorities, and design criteria for beach sector. The proposed actions will be located almost entirely on submerged lands makai (seaward) of the shoreline in the State Conservation District. With the exception of the Halekūlani beach sector, the proposed actions are consistent with the existing environment and surrounding uses in Waikīkī and will not fundamentally alter the existing conditions along the shoreline. Increasing recreational dry beach area will not inhibit or prevent implementation of other potential alternative solutions in the future.

13.3 Narrows the Range of Beneficial Uses

The proposed actions are consistent with the existing environment and surrounding uses and will not fundamentally alter the character of Waikīkī. Increasing recreational dry beach area will not narrow the range of beneficial uses in the area. Improving and maintaining the beaches of Waikīkī will support existing uses and preserve the recreational, social, cultural, environmental, and aesthetic value of Waikīkī for future generations.

13.4 Long-term Risks to Public Health and Safety

The proposed beach improvement and maintenance actions are intended to mitigate the impacts of wave overtopping and flooding by increasing dry beach width and volume, which will provide a protective buffer between the ocean and the existing backshore infrastructure. This will increase the wave energy dissipating properties of the beaches and decrease the landward extent of wave runup, reducing the vulnerability of the backshore flooding to marine flooding. The proposed actions will decrease vulnerability to coastal hazards, increase resilience to sea level rise, and have a substantial positive impact on the economies of the State of Hawaiʻi and City and County of Honolulu.

14. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

An irreversible or irretrievable commitment of resources refers to impacts on or losses to resources that cannot be recovered or reversed. “Irreversible” refers to the loss of future options and applies primarily to the impacts of use of nonrenewable resources, such as minerals or cultural resources. “Irretrievable” refers to the loss of a resource that is not renewable and cannot be recovered for future use. This section discusses the use of non-renewable resources, potential for irreversible curtailment of the range of beneficial environmental uses, and the possibility of environmental accidents.

14.1 Use of Non-Renewable Resources

The proposed actions will involve the use of non-renewable resources. Construction equipment will include barges, dredging equipment, cranes, excavators, dump trucks, and bulldozers. This equipment will require the use of carbon-based fossil fuels. The proposed actions will also require sand, stone, and concrete. The non-renewable resources required for the proposed actions are summarized in .

Table 14-1 Non-renewable resources required for the proposed actions

Beach Sector	Non-renewable Resources
Fort DeRussy	1,500 cy of beach fill sand.
Halekūlani	60,000 cy of offshore sand fill. 5,000 cy of stone for groin construction. 810 cy of concrete for crown wall construction.
Royal Hawaiian	25,000 cy of offshore sand fill.
Kūhiō	28,000 cy of offshore sand fill (‘Ewa (west) basin). 4,500 cy of offshore sand fill (Diamond Head (east) basin). 4,000 cy of stone for groin and breakwater construction. 250 cy of concrete for groin and breakwater construction.

14.2 Irreversible Curtailment of the Range of Beneficial Uses of the Environment

The Waikīkī shoreline is primarily used for recreational and commercial purposes. The proposed actions will increase recreational dry beach width and improve lateral shoreline access, which will support the continuation of existing uses and expand opportunities for recreational enjoyment in Waikīkī. The proposed groins and segmented breakwater in the Kūhiō beach sector ‘Ewa (west) basin are largely within the footprint of the existing structures and will not fundamentally alter the character or environment within and adjacent to the existing basin. The proposed groins and beach in the Halekūlani beach sector will fundamentally alter the environment in this area but is not anticipated to result in any significant long-term degradation of the environment or loss of habitat. Rather, construction of the proposed groins will improve the shoreline conditions, restore the beach, and increase potential biological habitat in a relatively barren reef flat area. Ecological services of reef flat habitat will be lost under the project footprints (sand and groins) but are anticipated to recover over time as the benthic community re-establishes.

The Iroquois Point Beach Nourishment and Stabilization project, which was completed in 2013, involved the construction of nine rock rubblemound groins very similar in size and construction to the proposed groins in the Halekūlani beach sector. Extensive marine ecosystem monitoring is being accomplished for that project (AECOS, 2014). The 1-year post-construction marine ecosystem monitoring shows that the project has resulted in a significant increase in marine species diversity and density. In the vicinity of the groins there has been a 25-fold increase in fish abundance, not counting small baitfish, and a tripling of species richness (number of species). Fish biomass is more than six times greater than prior to construction. Prior to construction of the groins, fish biomass at Iroquois Point was considered low compared to island averages around the state, roughly on par with the shallow reef flats off Waikīkī (AECOS, 2009b, 2011, 2014). After construction, the biomass at the groins is on par with maximum values observed around the state (AECOS, 2014). Other changes in the vicinity of the groins includes an increase in crustose coralline algae cover from 1% to 60%, coral cover increase from 0 to 0.6% and macroinvertebrate cover from 1.4% to 6.3%. Coral abundance in the groin vicinity increased from 0 to 16 colonies per 10 m^2, with the most common coral species being *Pocillopora damicornis*. These changes are attributable to the creation of hard, stable habitat for colonization.

14.3 Possibility of Environmental Accidents

Best Management Practices (BMPs) will be implemented to ensure that adequate protective measures are in place to prevent, if possible, or minimize adverse impacts on the environment and public health, safety, and welfare. The BMPP will include the following:

- Vehicle, Equipment, and Materials Management
- Waste Management
- Monitoring Procedures and Protocols
- Turbidity Containment
- Erosion and Sediment Control
- Oil and Spill Containment
- Noise Control
- Dust Control
- Air Pollution Control
- Operational Controls
- Structure, Authority, and Responsibilities
- Training
- Health and Safety
- Inspection and Monitoring
- Emergency Procedures, Spill Response Plan, and Contacts
- Contingency Plan
- Suspension of Work
- Record Keeping and Documentation

15. UNRESOLVED ISSUES

Project Phasing

This DPEIS proposed five (5) beach improvement and maintenance actions in four (4) beach sectors of Waikīkī. *Beach maintenance* refers to actions that involve using existing sand or adding sand with no new structures or modifications to existing structures. The proposed beach maintenance actions are intended to be conducted on a periodic basis and may be adapted as sea levels continue to rise. *Beach improvements* refers to actions that involve adding new sand, constructing new structures, and/or modifying existing structures. The proposed beach improvement actions are designed to be implemented in phases, with the initial phase being designed for approximately 1.5 ft of sea level rise, thus in 25 to 30 years following construction it may be necessary to raise the project elevations. If then raised by several feet, the projects could be effective until about the year 2080, or 50-years post-construction.

Sea level rise projections continue to evolve as new and improved sea level and climate change research becomes available. It is also important to recognize that global sea level rise will not stop within these timeframes but will very likely continue for centuries. As a result, there is uncertainty regarding precisely when and the degree to which the structures will need to be adapted.

While the other beach sectors of Waikīkī – Duke Kahanamoku, Queens, Kapiʻolani, and Kaimana - were not selected for beach improvement and maintenance actions, these areas are clearly important and, as sea levels continue to rise, additional actions may be necessary in these beach sectors in the future.

Sand Recovery

The offshore sand deposits that will be used to support the beach improvement actions in the Halekūlani beach sector and Kūhiō beach sector ʻEwa (west) basin have yet to be confirmed. The dredging methods to recovery the offshore sand and transport it to the shoreline for placement have also not been confirmed. Additional quantitative resource surveys may also be required to further evaluate potential impacts to benthic habitat at the offshore sand deposits. These aspects of the projects will be confirmed during the final design and permitting process.

Costs and Funding

The estimated costs for construction for the proposed beach improvement and maintenance actions has yet to be confirmed. Initial construction costs will depend on a variety of factors including but not limited to the selected offshore sand deposits, sand recovery and transport methodologies, and project timing. Recurring construction costs will depend on the frequency of beach maintenance activities and unforeseen maintenance costs. For example, a design event (e.g., hurricane or tsunami) could result in unpredicted costs for repair and maintenance. Adaptation costs are similarly difficult to project. As sea levels continue to rise, there is uncertainty regarding precisely when and the degree to which the structures will need to be adapted.

Funding for proposed beach improvement and maintenance actions is currently being provided by an appropriation from the Hawaiʻi State Legislature, and tax revenues generated by the

Waikīkī Special Improvement District Association (WBSIDA). At this time, it is uncertain whether additional funds will be appropriated or provided to support ongoing maintenance efforts and/or additional future projects. The cumulative costs over the 50 yr life of the program will continue to be adjusted to account for inflation/deflation.

Monitoring
The monitoring and assessment plans for the proposed actions include beach profile monitoring, water quality monitoring, and marine biological monitoring (see Chapter 12). At this time, it is unclear if any additional monitoring will be required. Monitoring requirements will be confirmed during the final design and permitting process.

Required Permits and Approvals
Due to recent statutory changes and ongoing policy changes, there is uncertainty in terms of the permits and approvals that will be required for the proposed actions. For example, depending on the location of laydown and staging areas for equipment and materials, and the position of the proposed structures in relation to the shoreline, a Special Management Area (SMA) permit and/or Shoreline Setback Variance (SSV) may be required. The Hawaiʻi Department of Land and Natural Resources is also in the process of finalizing the permitting process for the new Small Scale Beach Restoration (SSBR) Program, which may affect the permits required from the Department of the Army and Hawaiʻi Department of Health.

Existing Structures
The proposed actions were developed as mandated in Governor David Ige's August 2018 directive to include a sea level rise analysis in Environmental Impact Statements. The proposed actions will be located primarily on submerged lands makai (seaward) of the shoreline in the State Conservation District. However, some aspects of the proposed actions may extend mauka (landward) of the shoreline in the Special Management Area (SMA). The DLNR does not regulate land uses mauka (landward) of the shoreline in Waikīkī. Responsibility for regulation and permitting rests with the City and County of Honolulu.

The existing seawalls that span nearly the entire length of the Waikīkī shoreline are privately-owned structures and are located outside of the Conservation District. The DLNR does not have the authority to alter these structures to accommodate the proposed actions. The typical beach crest elevation in the Royal Hawaiian beach sector is +7 ft MSL. The proposed actions have a beach crest elevation of +8.5 ft MSL to account for 1.5 ft of sea level rise. While this can be accomplished in the design and construction of groins and beach fill, it should be noted that the backshore elevations are generally less than +8.5 ft MSL in the Halekūlani and Kūhiō beach sectors. For reference, the seawall fronting the Sheraton Waikiki Hotel has a crest elevation of about +7.4 ft MSL and the seawalls in the Kūhiō beach sector have crest elevations ranging from +7 ft to +10 ft MSL. Nourishing the beach with sand to elevation +8.5 ft MSL would result in sand spilling over these walls and extending into private property. Additionally, sea level rise is projected to rise by 3 ft or more by 2100, which will likely require an additional increase in beach elevation. In these cases, a backstop may be required to support the inshore limit of the beach. The 2013 Iroquois Point Beach Nourishment and Stabilization had a similar challenge. A keystone landscaping wall was constructed along much of the shoreline to support the beach.

During the final design phase, it may be determined that the existing seawalls may need to be modified to accommodate the increased beach elevation. This response to sea level rise may be warranted regardless of the proposed actions, as some shoreline property owners have already begun moving infrastructure to higher floors and renovating the lower floors to be adaptable to coastal flooding. Property owners may find that increasing wall elevations may be a desirable option regardless of the proposed actions.

The proposed actions are intended to provide safe access to and along the shoreline. The proposed action in the Halekūlani beach sector includes an option to incorporate a beach walkway to improve lateral shoreline access between the Royal Hawaiian, Halekūlani, and Fort DeRussy beach sectors. The beach walkway would follow the alignment of the existing walkways that run from Hilton Hawaiian Village past the U.S. Army Hawaiʻi Museum, providing continuous lateral access along approximately 4,500 ft (0.85 mi) of shoreline. The beach walkway would need to be wide enough to be ADA-compliant and could include optional features, such as turnouts, to allow users to stop while not affecting pedestrian traffic. The existing seawalls may need to be modified or replaced to accommodate a beach walkway in the Halekūlani beach sector. The existing seawalls are privately-owned structures and are located outside of the Conservation District. The DLNR does not have the authority to modify or replace these structures to accommodate the proposed actions. At this time, it is unclear whether incorporating a beach walkway into the design for the Halekūlani beach sector is feasible.

16. RELATIONSHIP TO EXISTING PLANS, POLICIES, AND CONTROLS

Shorelines, beaches, and nearshore waters in Hawaiʻi are considered part of the Public Trust, with access and use available to all people. As a result, Hawaii's shorelines are heavily regulated. The current definition of the "shoreline" in Hawaiʻi is as follows:

> "*Shoreline* means the upper reaches of the wash of the waves, other than storm or seismic waves, at high tide during the season of the year in which the highest wash of the waves occurs, usually evidenced by the edge of vegetation growth, or the upper limit of debris left by the wash of the waves (Hawaiʻi Administrative Rules (HAR) §13-222)."

Generally, County jurisdiction begins at the shoreline and extends landward. State jurisdiction begins at the shoreline and extends seaward. Federal jurisdiction begins at the mean higher high water (MHHW) line and extends out to the 200 nautical mile limit of the U.S. exclusive economic zone (EEZ); this area is also defined as the "navigable waters of the United States". Figure 16-1 shows relevant permit jurisdiction lines for shoreline construction in Hawaiʻi.

The Federal, State, and County governments all have different objectives and rules regulating what can and cannot be done along the shoreline. Therefore, the definition and location of the "shoreline" is critical for the planning and permitting of any coastal construction. The *Certified Shoreline* is a line established by a licensed land surveyor and certified by the State, which reflects the shoreline definition stated above. The Certified Shoreline is valid for one year and is used to establish jurisdiction and Shoreline Setback boundaries.

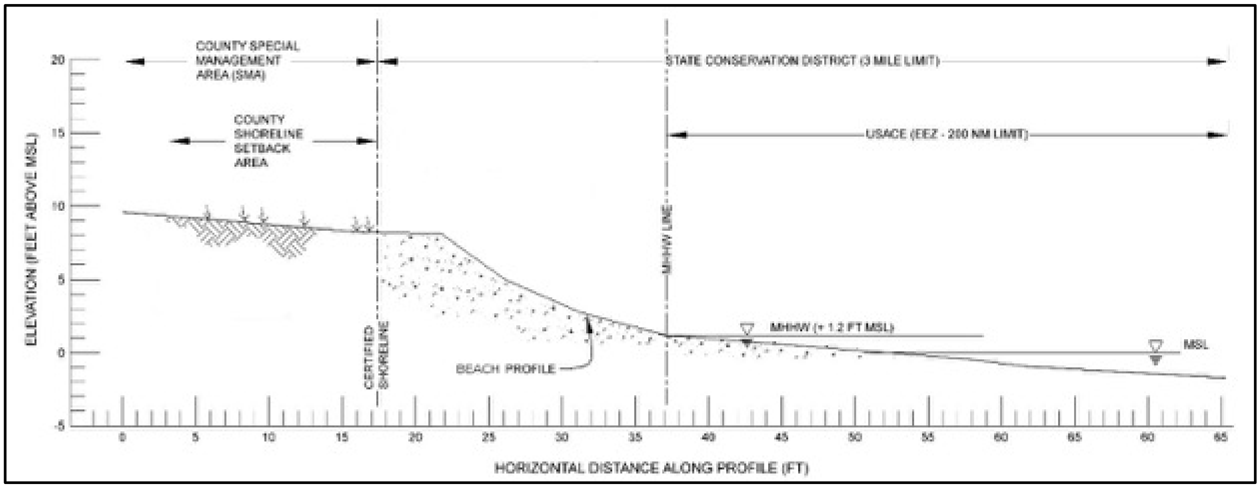

Figure 16-1. Relevant jurisdiction boundaries for shoreline in Hawaiʻi

16.1 Federal

Federal jurisdiction begins at the mean higher high water (MHHW) line and extends out to the boundary of the United States EEZ, 200 nautical miles offshore. This area is defined as the navigable waters of the United States.

16.1.1 Section 10 of the Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act of 1899 (33 USC §403) requires a Department of the Army (DA) permit for any activity that obstructs or alters navigable waters of the U.S., or the course, location, condition, or capacity of any port, harbor, refuge, or enclosure within the limits of any breakwater, or of the channel of any navigable water. DA permits are issued by the U.S. Army Corps of Engineers (USACE). As the proposed actions will involve placing sand in the navigable waters of the U.S, a DA permit will be required pursuant to Section 10.

16.1.2 Clean Water Act

The Clean Water Act (CWA) of 1972 (33 USC §1344) is the key legislation governing surface water quality protection in the United States. The Clean Water Act (CWA) of 1977, as amended (33 USC §1251 et seq.), is the major federal legislation concerning the improvement of the nation's water resources. The CWA amended the Federal Water Pollution Control Act and requires federal agency consistency with state nonpoint source pollution abatement plans. Amended again in 1987, the CWA strengthens enforcement mechanisms and regulations for stormwater runoff, providing for the development of industrial and municipal wastewater treatment standard, and a permitting system to control wastewater discharges to surface waters. Sections 401, 402, and 404 of the Act require permits for actions that involve wastewater discharges or discharge of dredged or fill material into waters of the United States.

16.1.2.1 Section 404 and 401

CWA Section 404 defines requirements for discharges in navigable waters of the U.S. and sets limits on the discharge of dredged or fill material into navigable waters. Permit approval is through the U.S. Army Corps of Engineers (USACE). Dredging activities and placement of fill trigger the need for a Section 404 permit.

For projects which require a Section 404 permit, a Section 401 Water Quality Certification (WQC) is also required. In Hawaiʻi, the U.S. Environmental Protection Agency has delegated responsibility for implementing Section 401 of the Act to the Hawaiʻi Department of Health, Clean Water Branch (DOH-CWB). See Section 3.2.4 for more information regarding the WQC.

16.1.2.2 Section 402

Discharges of point sources of pollutants into surface waters of the U.S. are controlled under the National Pollutant Discharge Elimination System (NPDES) program, pursuant to Section 402 of the CWA. Pursuant to the CWA and amendments, states may be authorized to administer permit programs. The Hawaiʻi Department of Health (DOH), Clean Water Branch, under Hawaiʻi Administrative Rules (HAR) 11-55, administers the NPDES program in Hawaiʻi.

16.1.3 Coastal Zone Management Act

The Federal Coastal Zone Management Act of 1972 (16 USC §§1451-1464) was established as a United States National policy to preserve, protect, develop, and where possible, restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations. The Act encourages coastal states to develop and implement coastal zone management plans (CZMPs). The State of Hawaiʻi developed Chapter 205A, HRS (the Hawaiʻi CZM Program) in 1977, which was later approved as a CZMP under the Act in 1978. A CZM Consistency Determination will be coordinated by the Hawaiʻi Office of Planning, Coastal Zone Management Program, and is described in Section 16.2.5.

16.1.4 Archaeological and Historic Preservation Acts

The National Historic Preservation Act (NHPA) of 1966 (16 U.S.C. § 470 et seq.) established a program for the preservation of historic places throughout the United States. The NHPA requires Federal agencies having direct or indirect jurisdiction to take into account effects on any district, site, building, structure, or object that is included or is eligible for inclusion in the National Register of Historic Places (NRHP) prior to the approval of expenditure of any funds or issuance of any license or permit. Consultation with the State Historic Preservation Division (SHPD) will be accomplished to ensure that the proposed actions comply with the provisions of the NHPA. A NHPA Section 106 review will be accomplished during the Department of the Army permit processing for work in the water.

16.1.5 Clean Air Act

The Clean Air Act (CAA) and amendments (42 USC §7401 et seq.) comprise the comprehensive federal law that regulates air emissions from area, stationary and mobile sources. This law authorizes the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment. Pursuant to the CAA and amendments, State-operated permit programs serve to control emissions. In Hawaiʻi, the State operating permit program is implemented by the DOH, and emissions of regulated air pollutants within the state may be subject to permitting as required under HAR 11-60.1.

16.1.6 Endangered Species Act

The Federal Endangered Species Act (ESA) of 1973 (16 USC §1531 et seq.) establishes a process for identifying and listing threatened and endangered species. It requires federal agencies to carry out programs for the conservation of federally listed endangered and threatened plants and wildlife and designated critical habitats for such species and prohibits actions by federal agencies that would likely jeopardize the continued existence of those species or result in the destruction or adverse modification of designated critical habitat. Section 7 of the ESA requires consultations with federal wildlife management agencies on actions that may affect listed species or designated critical habitat. Section 9 of the ESA prohibits the “taking” (through harm or harassment) of endangered species without an agency-issued permit. Section 7 consultation is accomplished during the Department of the Army permit processing for work in the water.

16.1.7 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (16 USC §1801 et seq.), as amended by the Sustainable Fisheries Act, PL 104-297, calls for action to stop or reverse the loss of marine fish habitat. The waters out to 200 nautical miles around the Hawaiian Islands are under the jurisdiction of the Western Pacific Regional Fishery Management Council (WPRFMC). The WPRFMC has approved a Fisheries Management Plans (FMP) for Hawaiʻi that designates all the ocean waters surrounding Oʻahu, from the shore to depths of over 100 ft, including the area that would be affected by the proposed actions as “Essential Fish Habitat” (EFH). The proposed actions are located within waters designated as EFH (including water column and all bottom areas) for coral reef ecosystem, bottomfish, pelagic and crustacean Management Unit Species (MUS).

The WPRFMC has also defined “Habitat Areas of Particular Concern” (HAPC). As defined in the 1996 amendments to the Act, these habitats are a subset of EFH that are “rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area”. The area that would be affected by the proposed actions is not within a HAPC. A formal EFH consultation will be conducted during the Department of the Army permit processing for work in the water.

16.1.8 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 (16 USC §31), as amended, prohibits (with exceptions) the taking (i.e., harassment, hunting, capture or killing, or attempting to harass, hunt, capture or kill) of marine mammals in waters of the U.S. The implementing regulations at 50 CFR 216 identify definitions, prohibitions, exceptions, permit restrictions, and conditions associated with the MMPA.

16.1.9 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 USC §703 et seq.), establishes protections for migratory birds and prohibitions including those related to activities which “pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export…” unless permitted by regulations. The MBTA prohibits the relocation of listed species without a permit from the U.S. Fish and Wildlife Service. In the event a listed migratory bird enters the construction zone, the contractor must stop work in the immediate area so as not to disturb the bird.

16.1.10 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act of 1934, as amended (16 USC §§ 661-666[C] et seq.) mandates that wildlife, including fish, receive equal consideration and be coordinated with other aspects of water resource development. This is accomplished through consultation with NMFS, the U.S. Fish and Wildlife Service (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, and recommendations to prevent harm (NMFS 2004). In all, the FWCA compliance process includes the following four steps: consultation (notice of initiation); reporting (e.g., field surveys and summary reports) and recommendations to protect, mitigate, and restore natural resources; Action agency consideration of recommendations, and Action agency implementation of recommendations.

16.2 State of Hawaiʻi

Beaches and nearshore submerged lands seaward of the certified shoreline are administered by the DLNR Office of Conservation and Coastal Lands (DLNR-OCCL). Furthermore, permitting and enforcement of some Federal regulations have been delegated to State agencies.

16.2.1 Chapter 343, Hawaiʻi Revised Statutes

Chapter 343 HRS establishes the system of environmental review for proposed projects which ensures that environmental concerns are given appropriate consideration in decision making, along with economic and technical considerations. Chapter 343 HRS also establishes various circumstances that would necessitate the preparation of an Environmental Assessment or an Environmental Impact Statement.

<u>Discussion:</u>
State-funded projects and work within the State Conservation District are actions that require preparation and processing of an Environmental Assessment or Environmental Impact Statement (EIS) per Hawaiʻi Revised Statutes (HRS) Chapter 343. The proposed actions involve work within the State Conservation District. Furthermore, the project is receiving State funding through an MOU between the DLNR and WBSIDA. As the proposed actions could potentially have local and vicinity-related impacts along a broad reach of shoreline, an EIS is being prepared. Under Act 172 (12), the DLNR determined that the proposed actions constitute a "program"; therefore, a Programmatic EIS is required.

16.2.2 State Land Use Districts

Pursuant to Chapter 205A, Hawaiʻi Revised Statutes, all lands in the State have been divided and placed into one of four land use districts by the State Land Use Commission. These land use districts have been designated "Urban", "Rural", "Agricultural", and "Conservation". Conservation District lands are further broken down into four (4) subzones that dictate what types of development can and cannot take place. These subzones, from most restrictive to least restrictive, are (1) Protective, (2) Limited, (3) Resource, and (4) General. The Conservation District has an additional subzone – Special, which is unique for each location it is applied to.

Coastal Lands include beaches, dunes, and rocky shorelines that are seaward of County jurisdictions. The Coastal Lands in the location of the proposed actions are considered part of the Conservation District, Resource Subzone. The DLNR Office of Conservation and Coastal Lands (DLNR-OCCL) is responsible for the management of these coastal resources. The Hawaiʻi Board of Land and Natural Resources (BLNR) regulates uses of the State Conservation District by issuing Conservation District Use Permits (CDUP) for approved activities. Statutes governing use administration procedures of the Conservation District are written in Hawaiʻi Revised Statutes, Chapter 183C (HRS Chapter 183C Conservation District). The administration is further clarified by the Hawaiʻi Administration Rules, Title 13, Chapter 5 (HAR §13-5 Conservation District).

The identified land use for the proposed actions is P-16 Beach Restoration §13-5-22. As specified in HAR §13-5-24(a), the proposed use is permitted in the Resource Subzone with the issuance of a BLNR-approved "D-1" (Board) Conservation District Use Permit for sand placement in excess of 10,000 cy:

"Sand placement in excess of 10,000 cy including structures necessary to retain sand, extraction of sand from submerged lands, and transportation or transmission of sand from an offshore extraction site to the replenishment site."

The criteria that the DLNR-OCCL will use in evaluating proposed actions within the State Conservation District are outlined in Hawaiʻi Administrative Rules §13-5-30. Each criterion is listed below, followed by a discussion of how the Proposed Action complies with it.

The proposed land use is consistent with the purpose of the Conservation District.

<u>Discussion:</u>
The purpose of the Conservation District is "…to regulate land-use in the conservation district for the purpose of conserving, protecting, and preserving the important natural and cultural resources of the State through appropriate management and use to promote their long-term sustainability and the public health, safety, and welfare." (Hawaiʻi Administrative Rules (HAR) §13-5-1). The proposed actions are anticipated to protect and improve Waikīkī Beach, which is an important and valuable Public Trust resource. The proposed actions are an adaptive management strategy to promote the long-term sustainability of beach resources in Waikīkī, while also not materially impacting public health, safety, and welfare. The proposed actions are anticipated to restore the public beach, improve recreational resources, improve lateral shoreline access, and increase resilience to coastal hazards and sea level rise. These objectives are consistent with the purpose of the State of Hawaiʻi Conservation District.

The proposed actions are consistent with the objectives of the subzone of the land on which the use will occur.

<u>Discussion:</u>
The objective of the Resource (R) subzone is "…to ensure, with proper management, the sustainable use of the natural resources of those areas." (Hawaiʻi Administrative Rules (HAR) §13-5-13). The proposed actions are an identified land use within the Resource subzone of the Conservation District, according to Chapter 13-5, Hawai'i Administrative Rules (HAR) § 13-5-22, P-16, BEACH RESTORATION (D-1) Sand placement in excess of 10,000 cy including

structures necessary to retain sand, extraction of sand from submerged lands, and transportation or transmission of sand from an offshore extraction site to the replenishment site.

As stated above, the proposed actions are an adaptive management strategy to promote the long-term sustainability of beach resources in Waikīkī, while also not materially impacting public health, safety, and welfare. The proposed actions involve the recovery of sand from deposits located offshore of Waikīkī Beach, transporting the sand to shore, and placement of the sand along the shore to the achieve the design beach profiles.

The proposed actions are anticipated to restore the public beach, improve recreational resources, improve lateral shoreline access, and increase resilience to coastal hazards and sea level rise. This is consistent with the purpose of the Resource (R) subzone.

The proposed actions comply with provisions and guidelines contained in chapter 205A, HRS, entitled "Coastal Zone Management," where applicable;

<u>Discussion:</u>
Detailed discussion of the proposed actions and their relationship to the Hawaiʻi Coastal Zone Management Program is presented in Section 16.2.5 of this DPEIS.

The proposed actions will not cause substantial adverse impact to existing natural resources within the surrounding area, community, or region;

<u>Discussion:</u>
Improving and maintaining the sandy beaches of Waikīkī will contribute to the preservation and continuation of an important and valuable Public Trust resource. The offshore sand proposed for use in Waikīkī is essentially a sustainable resource in the context of the scope and scale of the proposed actions. Other than temporary, short-term environmental impacts during construction, the proposed actions are not anticipated to result in impacts which can be expected to degrade the environmental quality in Waikīkī.

The proposed actions, including buildings, structures, and facilities, shall be compatible with the locality and surrounding areas, appropriate to the physical conditions and capabilities of the specific parcel or parcels;

<u>Discussion:</u>
The proposed actions will improve existing public beaches and are intended to preserve an important and valuable Public Trust resource along the coastline. The proposed beach improvement and maintenance actions will use offshore sand that is compatible with the existing physical conditions of the beaches in Waikīkī. The proposed structures (groins and segmented breakwater) will be consistent in size and appearance to structures that already exist in Waikīkī, so existing view planes will not be significantly altered.

The existing physical and environmental aspects of the land, such as natural beauty and open space characteristics, will be preserved or improved upon, whichever is applicable;

Discussion:
The scenic and aesthetic beauty of the Waikīkī coastline draws millions of tourists to its sights and beaches each year. Due to its low elevation and profile, the proposed actions are not anticipated to significantly affect existing viewplanes. Construction equipment, material stockpiles, and construction activities will be present within the project area during construction. Additionally, the dredging equipment will be visible from the shoreline. All of these impacts are temporary and will not be present once construction is completed.

The proposed actions are anticipated to have a positive long-term impact on the scenic and aesthetic resources of Waikīkī, as they will increase recreational dry beach area and prevent the existing seawalls from becoming exposed by erosion. The color of sand from the offshore sand deposits is slightly grayer than the existing beach sand; however, after a season of mixing and fading in the sun, the color difference is anticipated to be negligible. This will be an improvement of the open space characteristics for the public trust resource along this section of the coast.

Subdivision of land will not be utilized to increase the intensity of land uses in the Conservation District;

Discussion:
The proposed actions do not include the subdivision of land.

The proposed land use will not be materially detrimental to the public health, safety, and welfare.

Discussion:
Beaches and shorelines are inherently dangerous in Hawaiʻi. Strong waves and currents can cause injuries that range from non-life-threatening scrapes and bruises, broken limbs, soft tissue tears, and joint dislocations to life-threatening spinal and brain injuries and drowning. There are several lifeguard towers in the project area. The proposed actions are not anticipated to change the hazard from breaking waves along the shoreline.

Heavy equipment including barges, dump trucks, excavators, and boats could pose a hazard to the public during construction. Public safety during construction will be of utmost importance. With the implementation of proper precautions, safety notices, markings, and outreach, no changes to public health hazards along the shoreline are anticipated as a result of the proposed actions.

The proposed actions will have some impact on air, noise, and water quality during construction; however, these impacts will be mitigated to the maximum extent practicable by using Best Management Practices (BMPs) and monitoring protocols. The proposed actions will not result in any post-construction or long-term effects on public health, safety, and welfare.

The proposed actions will not alter existing land use patterns makai (seaward) of the beach. The improved beaches will likely attract beach users who do not presently use these areas; however, this increase will be consistent with the current recreational use of the Waikīkī area. The proposed actions could result in an increase in the general level of commercial activity in the Waikīkī area, and thus will have a long-term benefit. The proposed actions are anticipated to have a negligible effect on public infrastructure and services. Once completed, they will require no water, power, sanitary wastewater collection, or additional emergency services.

16.2.3 Hawaiʻi State Plan

The Hawaiʻi State Plan (HRS Chapter 226) is a long-range comprehensive plan that establishes the overall theme, goals, objectives, policies, and priority guidelines for statewide planning. The Hawaiʻi State Plan provides a framework for determining priorities, allocating public resources, and improving coordination between State and County plans, policies, programs, projects, and regulatory activities.

The objectives of the proposed beach improvement and maintenance actions are to:

- Restore and improve the beaches of Waikīkī.
- Increase beach stability through improvement and maintenance of shoreline structures.
- Provide safe access to and along the shoreline.
- Increase resilience to coastal hazards and sea level rise.

Review and analysis of HRS Chapter 226 indicates that the proposed actions are consistent with the Hawaiʻi State Plan objectives and policies listed below.

§226-8 Objective and policies for the economy--visitor industry

(b) (1) Support and assist in the promotion of Hawaii's visitor attractions and facilities.

(b) (2) Ensure that visitor industry activities are in keeping with the social, economic, and physical needs and aspirations of Hawaii's people.

(b) (3) Improve the quality of existing visitor destination areas by utilizing Hawaii's strengths in science and technology.

(b) (4) Encourage cooperation and coordination between the government and private sectors in developing and maintaining well-designed, adequately serviced visitor industry and related developments which are sensitive to neighboring communities and activities.

(b) (5) Develop the industry in a manner that will continue to provide new job opportunities and steady employment for Hawaii's people.

Discussion:

The proposed beach improvement and maintenance actions will improve the quality of an existing visitor destination area by restoring the beaches of Waikīkī and preserving the economic value of the beaches as the primary driver of Hawaii's tourism-based economy. The public and private sectors are working together to develop and implement a program that will maintain an environmentally sound, ecologically beneficial, well-designed, adequately serviced beach resource and the visitor industry that depends on it.

§226-11 Objectives and policies for the physical environment--land-based, shoreline, and marine resources

(1) Prudent use of Hawaii's land-based, shoreline, and marine resources.

(2) Effective protection of Hawaii's unique and fragile environmental resources.

> (2) (b)To achieve the land-based, shoreline, and marine resources objectives, it shall be the policy of this State to:
>
> (2) (b) (1) Exercise an overall conservation ethic in the use of Hawaii's natural resources.
>
> (2) (b) (2) Ensure compatibility between land-based and water-based activities and natural resources and ecological systems.
>
> (2) (b) (3) Take into account the physical attributes of areas when planning and designing activities and facilities.
>
> (2) (b) (4) Manage natural resources and environs to encourage their beneficial and multiple use without generating costly or irreparable environmental damage.
>
> (2) (b) (5) Consider multiple uses in watershed areas, provided such uses do not detrimentally affect water quality and recharge functions.
>
> (2) (b) (7) Provide public incentives that encourage private actions to protect significant natural resources from degradation or unnecessary depletion.
>
> (2) (b) (8) Pursue compatible relationships among activities, facilities, and natural resources.
>
> (2) (b) (9) Promote increased accessibility and prudent use of inland and shoreline areas for public recreational, educational, and scientific purposes.

Discussion:
The proposed beach improvement and maintenance actions will be conducted with a suite of environmental Best Management Practices (BMPs) that are designed to protect and preserve natural resources while not causing any costly or irreparable damage. Preserving the beach resource increases the accessibility of the shoreline area for public, recreational, educational, and scientific purposes.

§226-12 Objective and policies for the physical environment--scenic, natural beauty, and historic resources

> (b) (1) Promote the preservation and restoration of significant natural and historic resources.
>
> (b) (3) Promote the preservation of views and vistas to enhance the visual and aesthetic enjoyment of mountains, ocean, scenic landscapes, and other natural features.
>
> (b) (4) Protect those special areas, structures, and elements that are an integral and functional part of Hawaii's ethnic and cultural heritage.
>
> (b) (5) Encourage the design of developments and activities that complement the natural beauty of the islands.

Discussion:
The proposed beach improvement and maintenance actions will increase recreational dry beach area, which will benefit the preservation and enhancement of viewplanes along the Waikīkī shoreline.

§226-13 Objectives and policies for the physical environment--land, air, and water quality

> (b) (2) Promote the proper management of Hawaii's land and water resources.
>
> (b) (5) Reduce the threat to life and property from erosion, flooding, tsunamis, hurricanes, earthquakes, volcanic eruptions, and other natural or man-induced hazards and disasters.
>
> (b) (6) Encourage design and construction practices that enhance the physical qualities of Hawaii's communities.
>
> (b) (8) Foster recognition of the importance and value of the land, air, and water resources to Hawaii's people, their cultures and visitors.

Discussion:
The proposed beach improvement and maintenance actions will be undertaken by the State of Hawaiʻi Department of Land and Natural Resources (DLNR), which is responsible for overseeing beaches and submerged lands out to the seaward extent of the State's jurisdiction. The proposed actions were developed in collaboration with public and private stakeholders with the shared goal and vision of improving and preserving the beaches of Waikīkī for current and future generations. The proposed actions will enhance the physical quality of the beaches.

The proposed beach improvement and maintenance actions are intended to mitigate the impacts of wave overtopping and flooding by increasing dry beach width and volume, which will provide a protective buffer between the ocean and the existing backshore infrastructure. This will increase the wave energy dissipating properties of the beaches and decrease the landward extent of wave runup, reducing the vulnerability of the backshore to marine flooding.

The proposed actions are anticipated to have a negligible impact on hurricane and tsunami hazards for the Waikīkī area. Damage from hurricanes and tsunamis depends on the height of the water level rise relative to the backshore elevation, neither of which will be affected by the proposed actions.

16.2.4 State of Hawaiʻi Functional Plans

Functional plans set forth the policies, statewide guidelines, and priorities within a specific field of activity, when such activity or program is proposed, administered, or funded by any agency of the state. Functional plans are developed by the state agency primarily responsible for a given functional area, which includes agriculture, conservation lands, education, energy, higher education, health, historic preservation, housing, recreation, tourism, and transportation. The Conservation Lands, Recreation, and Tourism State Functional Plans are relevant to the Proposed Action.

16.2.4.1 Conservation Lands State Functional Plan (1991)

Objective IIA v establishment of plans for natural resources and land management.
To achieve that objective, Policy IIA(1) says to formulate and maintain a management plan for resources and lands having significant conservation value. Waikīkī Beach is a resource that has significant conservation value. The proposed actions will support this objective by ensuring sustained use of the natural resource by increasing dry beach width.

Objective IIC: Enhancement of natural resources.
In accordance with Policy IIC(2), the proposed action will expand and enhance outdoor recreation opportunities. By increasing the sand volume, the dry beach will widen, and more space will be available to the public for outdoor recreational activities and the scenic value of the natural resource will be enhanced. Moreover, the restored littoral system will improve the sandy ecosystem value and services.

Objective IID: Appropriate development of natural resources.
Following Policy IID(3), the proposed actions will develop recreational resources on the shoreline and mauka areas. If the shoreline becomes too narrow, the recreational resources along the beach will decrease. By performing the proposed actions, the beach width will increase and the number of recreational opportunities on the natural resource will increase accordingly.

16.2.4.2 Recreation State Functional Plan (1991)

Objective II-B of the Recreation State Functional Plan is to meet the special recreation needs of the elderly, the disabled, women, single-parent families, immigrants, and other groups. Policy II-B(2) says to give higher priority to providing physical access to the disabled. The proposed action will increase dry beach area in Waikīkī and improve lateral shoreline access.

16.2.4.3 Hawaiʻi State Tourism Function Plan (1991)

Objective II.A. of the Hawaiʻi State Tourism Function Plan is to develop and maintain well-designed visitor facilities and related developments that are sensitive to the environment, sensitive to neighboring communities and activities, and adequately serviced by infrastructure and support services. Policy II.A.8. calls for encouraging the development of hotels and related facilities within designated visitor destination areas with adequate infrastructure and support services before development of other possible visitor destinations. The Action II.A.8.a guidelines for tourism development list that effort should be made to minimize loss of public recreational opportunities. While the existing hotels and resorts along Waikīkī Beach are not new tourism development, the Waikīkī Special Improvement District Association (WBSIDA) is making an effort financially and through operations to minimize loss of the public recreational resource by proposing to restore and maintain the beaches of Waikīkī.

16.2.5 Coastal Zone Management Program

Enacted as Chapter 205A, HRS, the Hawai‘i Coastal Zone Management (CZM) Program was promulgated in 1977 in response to the Federal Coastal Zone Management Act of 1972. The CZM area encompasses all lands throughout the entire state and all marine waters extending seaward from the shoreline to the extent of the state’s police power and management authority, including the United States territorial sea. The U.S. territorial sea extends 12 miles from the shoreline. The proposed actions will require an application to be made to the State Office of Planning, CZM Program, for a CZM Consistency Determination. The proposed actions will be measured against the objectives and policies of the CZM program listed in 205A-2, HRS. These objectives and policies, and their relationship to the Proposed Action are as follows:

(1) Recreational Resources
(A) Provide coastal recreational opportunities accessible to the public.

Policies:

A. Improve coordination and funding of coastal recreational planning and management; and
B. Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:
    i. Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas;
    ii. Requiring restoration of coastal resources that have significant recreational and ecosystem value, including but not limited to coral reefs, surfing sites, fishponds, sand beaches, and coastal dunes, when these resources will be unavoidably damaged by development; or requiring monetary compensation to the State for recreation when restoration is not feasible or desirable;
    iii. Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;
    iv. Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;
    v. 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;
    vi. Adopting water quality standards and regulating point and nonpoint sources of pollution to protect, and where feasible, restore the recreational value of coastal waters;
    vii. Developing new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, and artificial reefs for surfing and fishing; and

viii. Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the land use commission, board of land and natural resources, and county authorities; and crediting that dedication against the requirements of section 46-6;

Discussion:
The proposed beach improvement and maintenance actions will stabilize the recreational beach resource allowing for continued recreational use of the shoreline. Most recreational activities along the Waikīkī shoreline are dependent on the existence of the beaches. During and after the proposed actions, all public access will be managed to promote the health, safety, and welfare of the public, as well as to maintain ample public access consistent with the conservation of the natural resource.

To meet water quality standards for the project area, appropriate Best Management Practices (BMPs) will be used to prevent the release of pollutants into the marine environment. The proposed actions will be an improvement of the existing beach recreational opportunities as the restored beaches are entirely for public use. Some impacts will be imposed on vessel and recreational ocean transit during sand recovery, transport, and placement operations. Efforts will be made to notify potentially affected members of the local and visiting community prior to construction.

(2) Historic Resources

(A) 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.

Policies:

A. Identify and analyze significant archaeological resources;
B. Maximize information retention through preservation of remains and artifacts or salvage operations; and
C. Support state goals for protection, restoration, interpretation, and display of historic resources;

Discussion:
The proposed actions do not include excavation of the dry beach in Waikīkī. The offshore sand deposits are not anticipated to have the potential to contain cultural or archaeological materials. The proposed sand placement areas are on actively mobile beaches. If any cultural or archaeological artifacts are discovered during project operations, work will cease, and the State Historic Preservation Division will be contacted. Public meetings will be held, and the local community will be regularly consulted during project development to solicit community feedback concerning the potential cultural impacts of the proposed beach restoration and berm enhancement activity.

(3) Scenic and Open Space Resources

(A) Protect, preserve, and, where desirable, restore or improve the quality of coastal scenic and open space resources.

Policies:

A. Identify valued scenic resources in the coastal zone management area;
B. Ensure that new developments are compatible with their visual environment by designing and locating those developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;
C. Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources; and
D. Encourage those developments that are not coastal dependent to locate in inland areas;

Discussion:
The Waikīkī shoreline is a globally recognized visitor destination. The wide expanse of water with typically calm conditions, the deep blue colors of the ocean, and an unobstructed view of Diamond Head make the seaward and alongshore views from the shoreline spectacular. Waikīkī Beach itself is a scenic landmark, with millions of tourists each year traveling to see it. At the same time, the tall buildings that have been developed relatively close to the ocean along portions of the shoreline in the project area disrupt view planes along the Waikīkī shoreline.

The appearance of the beach is of significant interest to the Waikīkī resort community, as their guests represent the most numerous and closest viewers. However, it is also of considerable interest to the public and those who own and/or use adjacent areas. Waikīkī Beach, like all sandy shorelines in Hawaiʻi, is available to any member of the public and can be visited and enjoyed at any time. Thus, the project area is also of equal value to members of the public who visit the area. The ongoing erosion within the project area is having deleterious effects on the scenic and aesthetic value of the Waikīkī shoreline.

Impacts to scenic and open space resources will largely be confined to the sand recovery and transportation, and placement phases of the proposed actions. Visible turbidity during operations may impact the deep-blue colors of the ocean offshore of the Waikīkī shoreline. A detailed discussion of turbidity is provided in Section 8.7.

Construction equipment including barges, tugboats, cranes, temporary piers or trestles or pipelines, dump trucks, off-road capable vehicles, loaders, etc., will be present both on the beach and offshore during construction. The dredge barge will be visible from the shoreline for the duration of sand recovery efforts.

The proposed actions, over the long-term, are anticipated to be compatible with the visual environment and will improve the scenic and aesthetic resources of the Waikīkī area. The color of sand from the offshore sand deposits is slightly grayer than the existing beach sand; however, after a season of mixing and fading in the sun, the color difference is anticipated to be negligible.

(4) Coastal Ecosystems

(A) Protect valuable coastal ecosystems, including reefs, beaches, and coastal dunes, from disruption and minimize adverse impacts on all coastal ecosystems.

Policies:

A. Exercise an overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources;
B. Improve the technical basis for natural resource management;
C. Preserve valuable coastal ecosystems of significant biological or economic importance, including reefs, beaches, and dunes;
D. 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; and
E. 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;

<u>Discussion:</u>
The proposed actions are designed to minimize potential impacts to the marine environment. Turbidity containment barriers will surround the active work areas during sand recovery, transport, and placement operations. Impacts on water quality are anticipated to be minor, temporary, and localized to the immediate vicinity of the work activities. No long-term impacts to water quality are anticipated.

The beach resource and its consequent ecological value has been severely degraded by erosion. The proposed actions will restore the beach resource, supporting all manner of organisms that rely on the coastal sandy substrate, including *honu* (green sea turtles) and Hawaiian monk seals. Best Management Practices (BMPs) as typically recommended by the NOAA National Marine Fisheries Service will be adhered to during construction to avoid impacts to marine biota, protected species, and Essential Fish Habitat (EFH).

(5) Economic Uses

(A) Provide public or private facilities and improvements important to the State's economy in suitable locations.

Policies:
A. Concentrate coastal dependent development in appropriate areas;
B. Ensure that coastal dependent 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
C. 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:
    i. Utilization of presently designated locations is not feasible;
    ii. Adverse environmental effects are minimized; and
    iii. Important to the State’s economy.

<u>Discussion:</u>
Much of Hawaii’s economy is based on tourism, following the exodus of island youth during the economic decline of the 1950’s. At that time there was a conscious decision to focus on tourism

to rebuild the economy and create stable, local jobs. The proposed actions and consequent improvement of beach related tourism is anticipated to have a positive corresponding effect on the City and County of Honolulu and State of Hawaiʻi economies through tax revenue generated by sustained or increased visitor populations. The proposed actions are also anticipated to create temporary construction and construction-related jobs. While the proposed actions will not create any permanent positions, a restored beach does improve the longevity and security of jobs related to beach use and coastal-dependent industries. The infrastructure mauka (landward) of and dependent on the beaches are visitor industry facilities. The proposed actions will minimize or reverse the existing natural social, visual, and environmental coastal impacts currently hindering these visitor industry facilities. The proposed actions will restore a major economic resource in an area currently zoned as Resort. The proposed actions are anticipated to have no impact on the density of coastal development or result in any proposed new coastal development in Waikīkī.

(6) Coastal Hazards

(A) Reduce hazard to life and property from coastal hazards.

Policies:

A. Develop and communicate adequate information about the risks of coastal hazards;
B. Control development, including planning and zoning control, in areas subject to coastal hazards;
C. Ensure that developments comply with requirements of the National Flood Insurance Program; and
D. Prevent coastal flooding from inland projects;

Discussion:
Flood Insurance Rate Maps indicate that the Waikīkī coastline is exposed to flooding caused by storm waves and tsunami. The proposed actions are intended to mitigate the impacts of wave overtopping and flooding by increasing dry beach width and volume, which will provide a protective buffer between the ocean and the existing backshore infrastructure. This will increase the wave energy dissipating properties of the beaches and decrease the landward extent of wave runup, reducing the vulnerability of the backshore to marine flooding. The proposed actions are anticipated to have a negligible impact on hurricane and tsunami hazards for the Waikīkī area. Damage from hurricanes and tsunamis depends on the height of the water level rise relative to the backshore elevation, neither of which will be affected by the proposed actions.

(7) Managing Development

(A) Improve the development review process, communication, and public participation in the management of coastal resources and hazards.

Policies:

A. Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development;
B. Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and

C. 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;

Discussion:
This proposed beach improvement and maintenance actions meet the definition of development pursuant to Chapter 205A, HRS, as defined in 205A-22:

"*Development*" means any of the uses, activities, or operations on land or in or under water within a special management area that are included below:

1) Placement or erection of any solid material or any gaseous, liquid, solid, or thermal waste;
2) Grading, removing, dredging, mining, or extraction of any materials;
3) Change in the density or intensity of use of land, including but not limited to the division or subdivision of land;
4) Change in the intensity of use of water, ecology related thereto, or of access thereto; and
5) Construction, reconstruction, or alteration of the size of any structure.

The proposed actions will be reviewed by Federal, State, and County agencies as well as the general and affected public through the DPEIS and permitting processes. All required permits will be obtained prior to project implementation. Additional consultation opportunities will be provided the DPEIS review and the final design and permitting process. Both potential short-term and potential long-term impacts are presented in this DPEIS and will be presented in future permit applications.

(8) Public Participation

(A) Stimulate public awareness, education, and participation in coastal management.

Policies:

A. Promote public involvement in coastal zone management processes;
B. 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 issues, developments, and government activities; and
C. Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts;

Discussion:
Selection of the proposed actions was a primarily stakeholder-driven process. The proposed actions are the result of consultations that were conducted with the State of Hawaiʻi, Department of Land and Natural Resources, Office of Conservation and Coastal Lands (DLNR-OCCL), the Waikīkī Beach Special Improvement District Association (WBSIDA), and the Waikīkī Beach Community Advisory Committee (WBCAC). The purpose of these consultations was to establish priorities and design criteria for beach improvement and maintenance projects that will achieve State of Hawaiʻi and City and County of Honolulu objectives to improve the resilience and sustainability of Waikīkī's beaches, while minimizing disruption to existing commercial

operations. A total of six (6) WBCAC meetings were conducted between November 7, 2017 and January 19, 2021. For additional information about the WBCAC, please see Section 2.4 and Appendix A.

The public was initially informed of the proposed Waikīkī Beach Improvement Maintenance Program during a public meeting that was held at the Waikīkī Community Center on December 5, 2017. The public was formally engaged through the publication of the Environmental Impact Statement Preparation Notice (EISPN), which was published in the OEQC *The Environmental Notice* on December 23, 2020. For additional information about the early consultation process, please see Chapter 19 and Appendix A.

The DLNR also created a project website as a knowledge resource for members of the community who are interested in learning more about the proposed actions and to provide a convenient means for the public to communicate questions to the applicant.
https://dlnr.hawaii.gov/occl/waikiki/

(9) Beach and coastal dune protection
- ***(A) Protect beaches and coastal dunes for:***
  - ***(i) Public use and recreation;***
  - ***(ii) The benefit of coastal ecosystems; and***
  - ***(iii) Use as a natural buffer against coastal hazards; and***
- ***(B) Coordinate and fund beach management and protection.***

Policies:

A. Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion;
B. Prohibit construction of private 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;
C. 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;
D. Minimize grading of and damage to coastal dunes;
E. Prohibit private property owners from creating a public nuisance by inducing or cultivating the private property owner's vegetation in a beach transit corridor; and
F. Prohibit private property owners from creating a public nuisance by allowing the private property owner's unmaintained vegetation to interfere or encroach upon a beach transit corridor; and

<u>Discussion:</u>
The objectives of the proposed beach improvement and maintenance actions are to:

- Restore and improve the beaches of Waikīkī.
- Increase beach stability through improvement and maintenance of shoreline structures.
- Provide safe access to and along the shoreline.
- Increase resilience to coastal hazards and sea level rise.

The improved beaches will enhance recreational opportunities, improve public access to and use of the shoreline, and provide a natural buffer against coastal hazards. The proposed actions are designed to restore and maintain the beaches in a manner that works with natural coastal processes while also mitigating existing erosion pressure along the Waikīkī coastline. The proposed actions are consistent with the objective of HRS §205-A to protect beaches and coastal dunes and coordinate and fund beach management and protection.

(10) Marine and coastal resources

(A) Promote the protection, use, and development of marine and coastal resources to assure their sustainability.

Policies:

A. Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial;
B. Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency;
C. 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;
D. Promote research, study, and understanding of ocean and coastal processes, impacts of climate change 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; and
E. Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.

Discussion:

The proposed actions are anticipated to have no significant long-term negative impacts to marine resources. Minor short-term impacts associated with sand recovery, transport, and placement are anticipated. Environmental construction specifications and Best Management Practices (BMPs) will be implemented to protect marine resources, including water quality, benthic flora and fauna, corals, fishes, and protected species. Formal consultations will be conducted with marine resource agencies, including the NOAA National Marine Fisheries Service, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and the DLNR Division of Aquatic Resources to ensure that all potential environmental impacts are mitigated to the maximum extent practicable. The proposed actions are anticipated to have a long-term positive impact on the sandy coastal resource and ecology, providing both an environmental and economic benefit.

16.2.6 Water Quality Certification

The Clean Water Act (CWA) of 1972 (33 USC §1344) is the key legislation governing surface water quality protection in the United States. In Hawaiʻi, the U.S. Environmental Protection Agency (EPA) has delegated responsibility for implementing the Section 401 of the Act to the State Department of Health, Clean Water Branch (DOH-CWB). Actions that may constitute fill into Waters of the United States include:

- Placement of mooring blocks around the sand recovery areas.

- Placement of temporary piers and mooring blocks at the sand offloading locations.
- Removal of sand from the sand recovery areas.
- Placement of sand below the MHHW line

Discussion:
The proposed actions are subject to review under the Clean Water Act. The DOH-CWB issues Water Quality Certifications (WQC) for projects that involve fill into the Waters of the United States. The WQC will require submission of an Applicable Monitoring and Assessment Plan (AMAP) and Data Quality Objectives (DQO) to the DOH-CWB. The AMAP and DQO will specify the water quality sampling and testing that will be conducted before, during, and after construction to quantitatively confirm the effectiveness of the Best Management Practices (BMPs) that will be implemented to isolate and minimize potential contamination of coastal waters.

16.2.7 HAR 11-55 – Water Pollution Control

Section 402 of the Clean Water Act requires a National Pollutant Discharge Elimination System (NPDES) authorization any time construction activity (including staging and laydown areas) covers an area one (1) acre in size or greater and is intended to prevent pollutants from reaching coastal waters as a result of storm water runoff. The Hawaiʻi Department of Health, Clean Water Branch (DOH-CWB), under HAR 11-55, administers the NPDES program in Hawaiʻi.

Discussion:
The proposed actions may require an NPDES. Information required to obtain an NDPES permit include project specific details and construction drawings, storm and non-storm water discharge, a Stormwater Management Plan, a Best Management Practices Plan (BMPP), and Post-Construction Pollutant Control Measures. The NPDES permit application process requires the applicant to demonstrate that the necessary BMPs will be in place during the construction phase, and the BMPs will be sufficient to prevent potential pollution during conditions identified for a 10-year rain event.

16.3 City and County of Honolulu

Coastal lands in Waikīkī mauka (landward) of the shoreline are located in the Special Management Areas (SMA), and City and County of Honolulu rules and regulations apply.

16.3.1 General Plan

The General Plan for the City and County of Honolulu was first adopted in 1977 and has been subsequently amended (most recently in 2002). The Plan is a comprehensive statement of the long-range social, economic, environmental and design objectives for the general welfare and prosperity of the people of Oʻahu, including broad policy statements that facilitate the attainment of the Plan's objectives.

The General Plan is organized into 11 subject areas:

I. Population

II. Economic Activity
III. The Natural Environment
IV. Housing
V. Transportation and Utilities
VI. Energy
VII. Physical Development and Urban Design
VIII. Public Safety
IX. Health and Education
X. Culture and Recreation
XI. Government Operations and Fiscal Management

Discussion:
The proposed beach improvement and maintenance actions are relevant to four key objectives outlined in the General Plan. Each of these objectives and the relevant policies are listed below, followed by a discussion of the program's relationship to each:

II. Economic Activity, Objective B: To maintain the viability of Oahu's visitor industry.

- *Policy 2*: Provide for a high quality and safe environment for visitors and residents in Waikīkī.
- *Policy 3*: Encourage private participation in improvements to facilities in Waikīkī.
- *Policy 8*: Preserve the well-known and widely publicized beauty of Oahu for visitors as well as residents.

Discussion:
Waikīkī is recognized as Hawaii's primary visitor destination and is home to more than 30,000 visitor accommodation units including resorts, hotels, and condominiums, which accounts for 90% of all units on Oʻahu and nearly half of all units in the State of Hawaiʻi (HTA, 2018). The beaches of Waikīkī have tremendous historical, cultural, and recreational value and are the primary amenity that supports the tourism-based economies of Waikīkī and the State of Hawaiʻi. Hospitality Advisors LLC (2008) found that more than 90% of visitors considered beach availability in Waikīkī as very important or somewhat important.

The beaches of Waikīkī are chronically eroding, and the backshore is frequently flooded, particularly during high tides and high surf events. The beaches of Waikīkī are critical infrastructure and the primary amenity that has established Waikīkī as a world-class tourism destination. Complete erosion of Waikīkī Beach would result in an annual loss of $2.223 billion in visitor expenditures (Tarui et al. 2018).

The primary objectives of the proposed actions are as to:

- Restore and improve the beaches of Waikīkī.
- Increase beach stability through improvement and maintenance of shoreline structures.
- Provide safe access to and along the shoreline.
- Increase resilience to coastal hazards and sea level rise.

The proposed actions are consistent with the objectives set forth in *Policy 2* to "provide for a high quality and safe environment for visitors and residents in Waikīkī", and *Policy 8* to "preserve the well-known and widely publicized beauty of Oʻahu for visitors as well as residents". The proposed actions will improve lateral access along the shoreline for both tourists and residents, thereby improving access to ocean-based recreational activities along the beach. Increasing the viability of Waikīkī Beach, Hawaii's top visitor destination, will directly support the economies of the State of Hawaiʻi and City and County of Honolulu.

In 2019, the Hawaiʻi State Legislature appropriated $8.85 million to support beach improvement and maintenance projects in Waikīkī with up to $3 million of this support provided by the Waikīkī Beach Special Improvement Distract Association (WBSIDA). The funds contributed by the WBSIDA are consistent with the objective set forth in *Policy 3* to "encourage private participation in improvements to facilities in Waikīkī".

III. Natural Environment, Objective A: To protect and preserve the natural environment.

- *Policy 1*: Protect Oahu's natural environment, especially the shoreline, valleys, and ridges, from incompatible development.
- *Policy 2*: Seek the restoration of environmentally damaged areas and natural resources.
- *Policy 3*: Retain the Island's streams as scenic, aquatic, and recreation resources.
- *Policy 4*: Require development projects to give due consideration to natural features such as slope, flood and erosion hazards, water-recharge areas, distinctive land forms, and existing vegetation.
- *Policy 5*: Require sufficient setbacks of improvements in unstable shoreline areas to avoid the future need for protective structures.

III. Natural Environment, Objective B: To preserve and enhance the natural monuments and scenic views of Oahu for the benefit of both residents and visitors.

- *Policy 1*: Protect the Island's well-known resources: its mountains and craters; forests and watershed areas; marshes, rivers, and streams; shoreline, fishponds, and bays; and reefs and offshore islands.

Discussion:

The beaches of Waikīkī are chronically eroding, and the backshore is frequently flooded, particularly during high tides and high surf events. The proposed beach improvement and maintenance actions will help to protect and preserve the beaches of Waikīkī, which are a valuable Public Trust resource.

X. Culture and Recreation

Objective D: To provide a wide range of recreational facilities and services that are readily available to all residents of Oahu.

- *Policy 5*: Encourage the State to develop and maintain a system of natural resource-based parks, such as beach, shoreline, and mountain parks.
- *Policy 6*: Provide convenient access to all beaches and inland recreation areas.
- *Policy 8*: Encourage ocean and water-oriented recreation activities that do not adversely impact on the natural environment.
- *Policy 10*: Encourage the private provision of recreation and leisure-time facilities and services.

- *Policy 12*: Provide for safe and secure use of public parks, beaches, and recreation facilities.

Discussion:
The beaches of Waikīkī are chronically eroding and lateral shoreline access is limited in many areas. As sea levels continue to rise and the beaches continue to erode, the shoreline will become increasingly less accessible. The proposed beach improvement and maintenance actions will help to improve lateral shoreline access which will help to support the various beach and ocean-based recreation activities that are currently practiced in Waikīkī.

16.3.2 Primary Urban Center Development Plan

The City and County of Honolulu's Development Plan (DP) program provides a conceptual framework for implementing the objectives and policies of the General Plan on a regional basis. Eight geographical DP and Sustainable Communities Plan (SCP) areas have been established on Oʻahu. Waikīkī is included in the Primary Urban Center Development Plan, which includes the coastal plain that extends along Oʻahu's southern shore from Waiʻalae -Kahala in the east to Pearl City in the west, and from the shoreline to the westerly slopes of the Koʻolau mountain range.

The Primary Urban Center Development Plan reaffirms the region's role in Oʻahu's development pattern through the establishment of policies in the following areas:

- Natural, historic, cultural and scenic resources
- Parks and recreation areas
- Lower- and higher-density residential neighborhoods
- Commercial and visitor industry facilities
- Military installations, transportation centers and industrial areas
- Design of streets and buildings
- Neighborhood planning
- Transportation networks and systems

Discussion:
The proposed beach improvement and maintenance actions comply with the following policies and guidelines in the Primary Urban Center Development Plan:

- Protect scenic beauty and scenic views and provide recreation (Section 3.1.1 Open Space Preservation).
- Promote access to shoreline and mountain areas (Section 3.1.1 Open Space Preservation).
- Modify shoreline setbacks as needed to protect the natural shoreline, lessen the impact to coastal processes, and address sea level rise (Section 3.1.3.2 Shoreline Areas).
- Analyze the possible impact of sea level rise for new public and private projects in shoreline areas and incorporate, where appropriate and feasible, measures to reduce risks and increase resiliency to impacts of sea level rise (Section 3.1.3.2 Shoreline Areas).

16.3.3 Oʻahu Resilience Strategy

The Oʻahu Resilience Strategy is a clear vision for a thriving island community—even in the face of challenge and change. The Strategy includes four pillars, 12 goals, and 44 actions for the City, partners, and our community to implement in order to directly address the challenge of long-term affordability and the impacts of the climate crisis.

The Oʻahu Resilience Strategy, developed by the City and County of Honolulu, Office of Climate Change, Sustainability and Resiliency, was formally adopted by the Honolulu City Council in September 2019 (Resolution 19-233). The Strategy serves as a guiding policy document to improve Oahu's resilience to social, economic and environmental stresses, with an emphasis on preparing for climate change impacts. To inform climate resilient planning while balancing economic and environmental goals for sustainability, the Strategy identifies 44 actions across four focal areas or resilience "pillars":

- *Pillar I*: Remaining Rooted
- *Pillar II*: Bouncing Forward
- *Pillar III*: Climate Security
- *Pillar IV*: Community Cohesion

<u>Discussion:</u>
The proposed beach improvement and maintenance actions are consistent with the following goals and actions items of the Oʻahu Resilience Strategy:

Pillar II. Bouncing Forward

- *Goal 1*: Pre-Disaster Preparation
  - <u>Action 14</u>. Establish Future Conditions Climate Resilience Design Guidelines
- *Goal 2*: Effective Disaster Response
  - <u>Action 18</u>. Increase Oahu's Preparedness Utilizing Scenario Modeling and Artificial Intelligence

Pillar III. Climate Security

- *Goal 3*: Climate Resilient Future
  - <u>Action 28</u>. Chart a Climate Resilient Future by Creating and Implementing a Climate Adaptation Strategy
  - <u>Action 29</u>. Protect Beaches and Public Safety with Revised Shoreline Management Rules
  - <u>Action 30</u>. Protect Coastal Property and Beaches Through Innovation and Partnerships
  - <u>Action 34</u>: Minimize Economic and Property Risk within the Ala Wai Canal Watershed

Waikīkī is directly exposed to natural hazards such as tsunami, storm surge and hurricane. The beaches of Waikīkī are chronically eroding, and the backshore (landward side of the beach) is frequently flooded, particularly during high tides and high surf events. Over the past several years, Hawaiʻi has experienced record high tides (referred to as King Tides) that have exacerbated erosion and flooding in Waikīkī. These events have highlighted the impacts of sea level rise on the beaches of Waikīkī. As sea levels continue to rise, beach loss will progressively degrade the recreational, social, cultural, environmental, aesthetic, and economic value of Waikīkī.

As the beaches continue to erode and flooding occurs more frequently and extends further landward, processes that are likely to accelerate as sea levels continue to rise, the shoreline will migrate further landward. As the shoreline approaches the existing shoreline armoring, there will be incremental loss of recreational beach area and shoreline habitat, a process that is referred to as *coastal squeeze* (Lester and Matella, 2016). While it is possible that some sand may remain in front of the existing shoreline armoring, what remains of the beaches will be narrow, submerged, unstable, inaccessible, and unusable. Without beach improvements and maintenance, sea level rise will likely result in substantial beach loss in Waikīkī.

The Oʻahu Resilience Strategy defines resilience as “the ability to survive, adapt and thrive regardless of what shocks or stresses come our way.” Healthy, stable beaches provide a first line of defense against coastal flooding and inundation by rising sea levels and hurricane storm waves. Beach improvements are necessary to ensure that the beaches and economy of Waikīkī are sustainable and resilient to sea level rise.

16.3.4 Special Management Area (SMA)

The Hawaiʻi Coastal Zone Management (CZM) Program (HRS Chapter 205A) regulates all types of land uses and activities (“development”) in the Special Management Area (SMA). The City and County of Honolulu has adopted: (1) boundaries which identify the SMA; and (2) rules and regulations which are consistent with HRS Chapter 205A that control development within the SMA (Chapter 25, Revised Ordinances of Honolulu). The proposed actions should, therefore, comply with the objectives and policies contained in 205A-2, HRS and the review guidelines contained in 205A-26, HRS.

<u>Discussion:</u>
The proposed beach improvement and maintenance actions will be located primarily makai (seaward) of the shoreline in the Conservation District. However, some aspects of the projects including but not limited to project laydown/staging areas and ingress/egress routes may be located within the SMA. As a result, one or more of the proposed actions may require an SMA permit from the City and County of Honolulu, Department of Planning and Permitting.

16.3.5 Shoreline Setbacks

It is a primary policy of the City and County of Honolulu 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 (Chapter 23, Sec. 23.1.2, Revised Ordinances of Honolulu).

Pursuant to HRS Chapter 205A, the City and County of Honolulu has established standards and procedures that “generally prohibit within the shoreline area any construction or activity which may adversely affect beach processes, public access along the shoreline, or shoreline open space” (ROH Chapter 23). The shoreline area regulated by the City and County of Honolulu, Department of Planning and Permitting encompasses the land between the certified shoreline and the shoreline setback line, which is typically 40 feet inland from the certified shoreline with exceptions that allow for adjustments. Structures and activities are expressly prohibited within the shoreline setback area. A Shoreline Setback Variance (SSV) is required for all proposed structures, facilities, construction or any such activities which are prohibited within the shoreline setback area.

Discussion:
The proposed actions will be located primarily makai (seaward) of the shoreline in the Conservation District. However, some construction activities may take place mauka (landward) of the shoreline. As a result, one or more of the proposed actions may require a SSV from the City and County of Honolulu, Department of Planning and Permitting.

17. SUMMARY OF REQUIRED PERMITS AND APPROVALS

17.1 Federal

The primary Federal approvals required for the proposed actions are:

- Section 10, Rivers and Harbors Act (U.S. Army Corps of Engineers)
- Section 404, Clean Water Act (U.S. Army Corps of Engineers)

Other Federal laws that may affect the proposed actions include:

- Archaeological and Historic Preservation Act (16 USC § 469a-1)
- National Historic Preservation Act of 1966 (16 USC § 470(f))
- Native American Graves Protection and Repatriation Act of 1990 (25 USC § 3001)
- Clean Air Act (42 USC § 7506(C))
- Coastal Zone Management Act (16 USC § 1456(C) (1))
- Endangered Species Act (16 U.S.C. 1536(A) (2) and (4))
- Fish and Wildlife Coordination Act 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 of 1972, as amended (16 USC §§ 1361-1421(H) et seq.)
- EO 13089, Coral Reef Protection (63 FR 32701)
- Migratory Bird Treaty Act of 1918, as amended (16 USC §§ 703-712)

17.2 State of Hawaiʻi

The primary State of Hawaiʻi approvals required for the proposed actions are:

- Conservation District Use Permit – Hawaiʻi Department of Land and Natural Resources
- Small-scale Beach Nourishment Permit – Hawaiʻi Department of Land and Natural Resources
- Small-scale Beach Restoration Permit – Hawaiʻi Department of Land and Natural Resources
- Shoreline Certification – Hawaiʻi Department of Land and Natural Resources
- Right of Entry Permit – Hawaiʻi Department of Land and Natural Resources
- Section 401 Water Quality Certification – Hawaiʻi Department of Health
- National Pollutant Discharge Elimination System – Hawaiʻi Department of Health
- Coastal Zone Management Consistency Review – Hawaiʻi Department of Business, Economic Development, and Tourism, Office of Planning

17.3 City and County of Honolulu

The primary City and County of Honolulu approvals required for the proposed actions are:

- Special Management Area Permit
- Shoreline Setback Variance
- Grubbing, Grading and Stockpiling Permit
- Building Permit

A summary of the regulatory approvals required for the proposed actions is shown in Table 17-1.

Table 17-1 Summary of Required Regulatory Approvals	**Fort DeRussy Beach Sector**	**Halekūlani Beach Sector**	**Royal Hawaiian Beach Sector**	**Kūhiō Beach Sector: ʻEwa Basin**	**Kūhiō Beach Sector: Diamond Head Basin**
FEDERAL					
Department of the Army Nationwide Permit (NWP)	TBD	N	N	N	TBD
Department of the Army Individual Permit (IP)	N	R	R	TBD	N
STATE OF HAWAIʻI					
Small Scale Beach Nourishment Permit (SSBN)	TBD	N	N	N	TBD
Small Scale Beach Restoration Permit (SSBR)	TBD	N	TBD	TBD	TBD
Shoreline Certification	N	TBD	TBD	TBD	N
Conservation District Use Permit (CDUP)	TBD	R	R	R	N
Right of Entry Permit (ROE)	R	R	R	R	R
Coastal Zone Management Federal Consistency (CZM)	N	R	R	R	N
National Pollutant Discharge Elimination System (NPDES)	N	R	R	R	N
Section 401 Water Quality Certification (WQC)	TBD	R	R	R	TBD
CITY AND COUNTY OF HONOLULU					
Shoreline Setback Variance	N	TBD	N	N	N
Special Management Area Permit	N	TBD	TBD	TBD	N
Grubbing, Grading and Stockpiling Permit	N	R	N	N	N
Building Permit	N	TBD	N	TBD	N

R = REQUIRED
N = NOT REQUIRED
TBD= TO BE DETERMINED

18. EIS DETERMINATION

Hawaiʻi Administrative Rules (HAR) §11-200 Environmental Impact Statement Rules establishes procedures for determining if an action may potentially have a significant effect on the environment and thus require an EIS. An EIS is required if the proposed actions may:

1. Irrevocably commit a natural, cultural, or historic resource;
2. Curtail the range of beneficial uses of the environment;
3. Conflict with the State's environmental policies or long-term environmental goals established by law;
4. Have a substantial adverse effect on the economic welfare, social welfare, or cultural practices of the community or State;
5. Have a substantial adverse effect on public health;
6. Involve adverse secondary impacts, such as population changes or effects on public facilities;
7. Involve a substantial degradation of environmental quality;
8. Be individually limited but cumulatively have substantial adverse effect upon the environment or involves a commitment for larger actions;
9. Have a substantial adverse effect on a rare, threatened, or endangered species, or its habitat;
10. Have a substantial adverse effect on air or water quality or ambient noise levels;
11. Have a substantial adverse effect on or be likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, sea level rise exposure area, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal water;
12. Have a substantial adverse effect on scenic vistas and viewplanes, during day or night, identified in County or State plans or studies; or
13. Require substantial energy consumption or emit substantial greenhouse gases.

The Hawaiʻi Department of Land and Natural Resources, Office of Conservation and Coastal Lands (DLNR-OCCL) determined that the proposed actions could have potentially significant impacts that should be evaluated and discussed by preparing an Environmental Impact Statement (EIS) in accordance with Chapter 343 Hawaiʻi Revised Statutes (HRS) and Hawaiʻi Administrative Rules (HAR) §11-200.1. Pursuant to Act 172 (12), the DLNR determined that the proposed actions constitute a "program"; therefore, a "programmatic" EIS is required.

19. EARLY CONSULTATIONS

The proposed actions presented in this DPEIS are the result of consultations that were conducted with the State of Hawaiʻi, Department of Land and Natural Resources, Office of Conservation and Coastal Lands (DLNR-OCCL), the Waikīkī Beach Special Improvement District Association (WBSIDA), and the Waikīkī Beach Community Advisory Committee (WBCAC). The purpose of these consultations was to establish priorities and design criteria for beach improvement and maintenance projects that will achieve State of Hawaiʻi and City and County of Honolulu objectives to improve the resilience and sustainability of Waikīkī's beaches, while minimizing disruption to existing commercial operations.

Summary of Early Consultations

12/16/2016	Waikīkī Beach Special Improvement District Association coordination meeting
11/07/2017	Waikīkī Beach Community Advisory Committee meeting
12/05/2017	Public scoping meeting at Waikīkī Community Center
01/28/2018	Waikīkī Beach Special Improvement District Association coordination meeting
03/20/2018	Waikīkī Beach Community Advisory Committee meeting
07/13/2018	Waikīkī Beach Special Improvement District Association coordination meeting
02/13/2019	Waikīkī Beach Community Advisory Committee meeting
06/19/2019	Waikīkī Beach Special Improvement District Association coordination meeting
07/02/2019	Waikīkī Beach Special Improvement District Association coordination meeting
10/30/2019	Waikīkī Beach Community Advisory Committee meeting
10/30/2019	Waikīkī Beach Special Improvement District Association coordination meeting
12/06/2019	Waikīkī Beach Special Improvement District Association coordination meeting
12/23/2020	EISPN publication in the OEQC *The Environmental Notice*
01/07/2021	EISPN public scoping meeting
01/19/2021	Waikīkī Beach Community Advisory Committee meeting

EISPN Public Scoping Meeting

Pursuant to Hawaiʻi Administrative Rules (HAR) Chapter 11-200.1-4(b)(4), a public scoping meeting was held during the EISPN 30-day public comment period. The purpose of the public scoping meeting was to provide agencies, citizen groups, and the public with an opportunity to assist the proposing agency in determining the range of actions, alternatives, impacts, and proposed mitigation measures to be considered in the DPEIS and the significant issues to be analyzed in depth in the DPEIS. The public scoping meeting included a separate portion reserved for oral comments and that portion of the public scoping meeting was audio recorded.

A video recording of the EISPN public scoping meeting is available at:
https://www.youtube.com/watch?v=1hd0iLCCqp4&t=2348s

For additional information, please visit the project website at:
https://dlnr.hawaii.gov/occl/waikiki/

Comments may also be submitted to David Smith, Ph.D., P.E at:
waikiki@seaengineering.com.

20. EIS DISTRIBUTION

The following agencies, organizations, and individuals will be directly notified of publication of the Waikīkī Beach Improvement and Maintenance Program Draft Programmatic Environmental Impact Statement (DPEIS). The distribution matrix for the Environmental Impact Statement Preparation Notice (EISPN) and DPEIS is presented in Table 20-1. A total of twenty-nine (29) agencies, organizations, and individuals provided written comments on the EISPN (Table 20-2). The written comments and corresponding response letters are presented in Appendix G.

FEDERAL AGENCIES
Department of the Interior, U.S. Geological Survey, Pacific Islands Water Science Center
Department of the Interior, U.S. Fish and Wildlife Service
Department of Commerce, National Marine Fisheries Service
Department of the Interior, National Parks Service
Department of Agriculture, National Resources Conservation Service
Department of the Army, U.S. Army Corps of Engineers
Department of Transportation, Federal Aviation Administration
Department of Transportation, Federal Transit Administration
Department of Homeland Security, U.S. Coast Guard 14th District
Environmental Protection Agency, Pacific Islands Office

STATE OF HAWAIʻI
Governor's Office (Accepting Authority)
Department of Agriculture
Department of Accounting and General Services
Department of Business, Economic Development and Tourism, Office of Planning
Department of Defense
Department of Education
Department of Hawaiian Homelands
Department of Health, Clean Water Branch
Department of Health, Environmental Health Administration
Department of Land and Natural Resources, Division of Aquatic Resources
Department of Land and Natural Resources, Division of Forestry and Wildlife
Department of Land and Natural Resources, Division of Boating and Ocean Recreation
Department of Land and Natural Resources, Land Division
Department of Land and Natural Resources, Office of Conservation and Coastal Lands
Department of Land and Natural Resources, State Historic Preservation Division
Department of Transportation
Legislative Reference Bureau Library
Office of Environmental Quality Control
Office of Hawaiian Affairs
University of Hawaiʻi, Sea Grant Program
University of Hawaiʻi, Water Resources Research Center
University of Hawaiʻi, Thomas H. Hamilton Library
University of Hawaiʻi at Hilo Edwin H. Moʻokini Library
University of Hawaiʻi, Maui College Library

University of Hawaiʻi, Kauaʻi Community College Library

CITY AND COUNTY OF HONOLULU
City and County of Honolulu, Department of Planning and Permitting
City and County of Honolulu, Department of Design and Construction
City and County of Honolulu, Department of Enterprise Services
City and County of Honolulu, Department of Parks and Recreation
City and County of Honolulu, Office of Climate Change, Sustainability and Resilience

STATE LIBRARIES
Department of Education, Hawaiʻi State Library
Department of Education, Kaimuki Regional Library
Department of Education, Waikīkī-Kapahulu Library

MEDIA
Honolulu Star Advertiser
Hawaiʻi Tribune Herald
West Hawaiʻi Today
The Garden Island
Maui News
Molokaʻi Dispatch
Honolulu Civil Beat

OTHER
U.S. Senator Mazie Hirono
U.S. Senator Brian Schatz
U.S. Representative Ed Case
State Senator Sharon Moriwaki
State Representative Adrian Tam
Honolulu County Council Representative Tommy Waters
Hawaiʻi Tourism Authority
Waikīkī Special Improvement District Association
Waikīkī Improvement Association
Waikīkī Neighborhood Board
Diamond Head/Kapahulu/St. Louis Neighborhood Board
Hawaiʻi Shore and Beach Preservation Association
Surfrider Foundation, Oʻahu Chapter
Save Our Surf Hawaiʻi

Table 20-1 EIS Distribution Matrix	**EISPN Notification**	**EISPN Comments Received**	**EISPN Responses Provided**	**DPEIS Notification**
FEDERAL AGENCIES				
Department of the Interior, U.S. Geological Survey, Pacific Islands Water Science Center	✓			✓
Department of the Interior, U.S. Fish and Wildlife Service	✓			✓
Department of Commerce, National Marine Fisheries Service	✓	✓	✓	✓
Department of the Interior, National Parks Service	✓			✓
Department of Agriculture, National Resources Conservation Service	✓			✓
Department of the Army, U.S. Army Corps of Engineers	✓			✓
Department of Transportation, Federal Aviation Administration	✓			✓
Department of Transportation, Federal Transit Administration	✓			✓
Department of Homeland Security, U.S. Coast Guard 14th District	✓			✓
Environmental Protection Agency, Pacific Islands Office	✓			✓
STATE OF HAWAIʻI				
Governor’s Office (Accepting Authority)				✓
Department of Agriculture	✓			✓
Department of Accounting and General Services	✓	✓	✓	✓
Department of Business, Economic Development and Tourism	✓			✓
Department of Business, Economic Development and Tourism, Office of Planning	✓	✓	✓	✓
Department of Defense	✓			✓
Department of Hawaiian Homelands	✓			✓
Department of Health, Clean Water Branch	✓			✓
Department of Land and Natural Resources, Division of Forestry and Wildlife	✓			✓
Department of Land and Natural Resources, Division of Boating and Ocean Recreation	✓			✓
Department of Land and Natural Resources, Office of Conservation and Coastal Lands	✓			✓
Department of Land and Natural Resources, Land Division	✓			✓
Department of Land and Natural Resources, State Historic Preservation Division	✓			✓

EIS Distribution Matrix (continued)	EISPN Notification	EISPN Comments Received	EISPN Comments Received	DPEIS Notification
STATE OF HAWAIʻI				
Department of Land and Natural Resources, Division of Aquatic Resources	✓			✓
Department of Transportation	✓			✓
Department of Health, Environmental Health Administration	✓			✓
Legislative Reference Bureau Library	✓			✓
Office of Environmental Quality Control	✓			✓
Office of Hawaiian Affairs	✓			✓
University of Hawaiʻi, Sea Grant Program	✓			✓
University of Hawaiʻi, Water Resources Research Center	✓			✓
University of Hawaiʻi, Thomas H. Hamilton Library	✓			✓
University of Hawaiʻi at Hilo Edwin H. Moʻokini Library	✓			✓
University of Hawaiʻi, Maui College Library	✓			✓
University of Hawaiʻi, Kauaʻi Community College Library	✓			✓
CITY AND COUNTY OF HONOLULU				
City and County of Honolulu, Department of Planning and Permitting	✓	✓	✓	✓
City and County of Honolulu, Department of Enterprise Services	✓			✓
City and County of Honolulu, Department of Design and Construction	✓	✓	✓	✓
City and County of Honolulu, Department of Parks and Recreation	✓			✓
City and County of Honolulu, Office of Climate Change, Sustainability and Resilience	✓			✓
STATE LIBRARIES				
Department of Education, Hawaiʻi State Library	✓			✓
Department of Education, Kaimuki Regional Library	✓			✓
Department of Education, Waikīkī-Kapahulu Library	✓			✓

EIS Distribution Matrix (continued)	EISPN Notification	EISPN Comments Received	EISPN Responses Provided	DPEIS Notification
MEDIA				
Honolulu Star Advertiser	✓			✓
Hawaiʻi Tribune Herald	✓			✓
West Hawaiʻi Today	✓			✓
The Garden Island	✓			✓
Maui News	✓			✓
Molokaʻi Dispatch	✓			✓
Honolulu Civil Beat	✓			✓
OTHER				
U.S. Senator Mazie Hirono	✓			✓
U.S. Senator Brian Schatz	✓			✓
U.S. Representative Ed Case	✓			✓
State Senator Sharon Moriwaki	✓			✓
State Representative Adrian Tam	✓			✓
Honolulu County Council Representative Tommy Waters	✓			✓
Hawaiʻi Tourism Authority	✓			✓
Waikīkī Special Improvement District Association	✓	✓	✓	✓
Waikīkī Improvement Association	✓			✓
Waikīkī Neighborhood Board	✓	✓	✓	✓
Diamond Head/Kapahulu/St. Louis Neighborhood Board	✓			✓
Hawaiʻi Shore and Beach Preservation Association	✓	✓	✓	✓
Surfrider Foundation, Oʻahu Chapter	✓	✓	✓	✓
Save Our Surf Hawaiʻi	✓	✓	✓	✓

Table 20-2 Public Comments and Responses	**EISPN Comments Received**	**EISPN Responses Provided**
ABC Stores	✓	✓
Aqualani Beach & Ocean Recreation	✓	✓
Dennis Furukawa	✓	✓
Douglas Meller	✓	✓
John Clark	✓	✓
Joseph Little	✓	✓
Kyo-ya Hotels and Resorts LP	✓	✓
Maitaʻi and Holokai Catamaran, Inc.	✓	✓
Mandy Blake Bower	✓	✓
Mark Robinson Trusts and J.L.P. Robinson LLC	✓	✓
Outrigger Hotels	✓	✓
Park Hotels & Resorts, Inc. and Hilton Hawaiian Village LLC	✓	✓
Richard Criley	✓	✓
Robert Fowler	✓	✓
Russell Leong	✓	✓
Sidney Sealine	✓	✓
Queen Emma Land Company	✓	✓
Waikīkī Beach Services, Ltd.	✓	✓
Waikīkī Shore AOAO	✓	✓

21. GLOSSARY

Accretion: The gradual addition of new beach to old by the deposition of sediment carried by the ocean

Beach Berm: A low shelf or narrow terrace on the backshore of a beach, formed of material thrown up and deposited by storm waves or seasonal changes in wave climate.

Beach Face: The section of beach normally exposed to the action of the wave uprush; the foreshore of the beach

Beach Nourishment: The practice of adding large quantities of sand or sediment to beaches to mitigate erosion and increase beach width.

Beach Profile: The trace of a beach surface on a vertical plane normal to the shoreline. It is commonly concave upward, as the slope is steeper above the water and more gentle seaward.

Beach Improvements: Actions that involve adding new sand, constructing new structures, and/or modifying existing structures. Beach improvement options include beach nourishment with stabilizing groins, segmented breakwaters, and modifications to existing structures.

Beach Maintenance: Actions that involve using existing sand or adding sand with no new structures or modifications to existing structures. Beach maintenance options include beach nourishment, sand backpassing, sand pushing, and sand pumping.

Beach Sector: Discrete coastal units that are semi-contained with limited sediment exchange. Beach sectors are similar to *littoral cells*, which are defined as coastal compartments that contain a complete cycle of sedimentation including sources, transport paths, and sinks (Inman, 2005).

Breakwater: A man-made structure that is designed is to protect the shoreline from waves. Breakwaters are typically parallel to shore and can be attached to shore or detached.

Certified Shoreline: Is a line established by a licensed land surveyor and certified by the State, which reflects the shoreline definition stated in Chapter 13-222 (HAR) and Chapter 205A (HRS).

Depth of Closure*:* The depth of closure is typically the deepest depth at which sediment transport connected to the beach system occurs.

Dredging: In this context - To bring up sand from an area of water.

Erosion: The wearing away of soil and rock by weathering, mass wasting, and the action of streams, glaciers, waves, wind, and underground water.

Environmental Restoration: Defined in 1987 by John J. Berger as “A process in which a damaged resource is renewed. Biologically. Structurally. Functionally.”

Groin: A man-made structure that is designed to block the longshore transport of sediment. Groins are typically constructed perpendicular to the shoreline.

Littoral Cell: A coastal compartment that contains a complete cycle of sedimentation including sources, transport paths, and sinks.

Makai: seaward or toward the sea

Mauka: landward or toward the mountains

Rip Current: A relatively strong, narrow current flowing outward from the beach through the surf zone and presenting a hazard to swimmers.

Sea Level Rise: The average long-term global rise of the ocean surface. Regional sea level rise refers to the long-term average sea level rise relative to the local land level, as derived from coastal tide gauges.

Seawall: A man-made structure built along the shoreline that is designed to protect the backshore from waves and erosion. Seawalls are typically steep or vertical and constructed of rock, concrete, or sheet pile.

Turbidity: The quality of being cloudy, opaque, or thick with suspended matter.

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23. APPENDIX A: WAIKĪKĪ BEACH COMMUNITY ADVISORY COMMITTEE

WAIKĪKĪ BEACH COMMUNITY ADVISORY COMMITTEE EXECUTIVE SUMMARY

BACKGROUND

Waikīkī Beach is a globally recognized icon of Hawaiʻi and is the state's largest tourist destination. Waikīkī Beach also has tremendous cultural significance and is the birthplace of the sport and culture of surfing. The beaches, reef ecosystems, and myriad world-renowned surf breaks are valuable natural resources that support the culture and lifestyle of Hawaiʻi, and the idyllic image of Waikīkī.

Waikīkī Beach is a highly engineered urban shoreline with the modern configuration largely the result of past management efforts (e.g., groins, seawall, and sand fill) intended to widen the beach.

Many sections of Waikīkī Beach are substantially narrowed or completely lost due to chronic beach erosion, lack of coordinated management, and insufficient capital investment. Beach loss results in a variety of negative economic, social, cultural, and environmental impacts. Therefore, it is important to fully understand the cumulative effects of shoreline development, recreational activities, and coastal processes (natural and human-induced) that control the movement of sand within the littoral system.

The Waikīkī Beach Community Advisory Committee will help to address the complex issues associated with beach sustainability by building consensus and identifying and resolving conflicts relating to Waikīkī Beach management. The committee will provide important guidance for planning and prioritizing future beach management projects at Waikīkī.

The State Department of Land and Natural Resources (DLNR) and the Waikīkī Beach Special Improvement District Association (WBSIDA), in partnership with the University of Hawaiʻi Sea Grant College Program (UH Sea Grant), seek to assemble a small group key stakeholders to advise the State and County on future beach management and maintenance projects in Waikīkī. For the purposes of this project, we define Waikīkī Beach as the beaches and nearshore coastal zone extending from Kaimana Beach (Natatorium) to Fort DeRussy Beach (Hilton Hawaiian Village). The primary purpose of the advisory committee is to identify and prioritize beach management projects in Waikīkī and to help inform these projects.

Waikīkī Beach Advisory Committee Goals

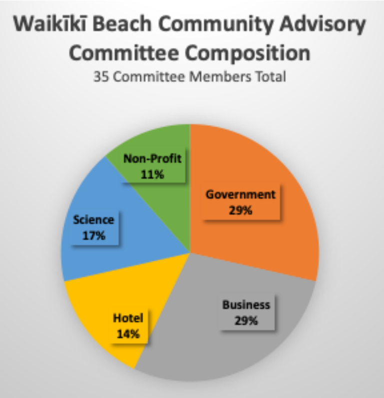
1. Advise the WBSIDA, the DLNR and UH Sea Grant on the development and implementation of a Waikīkī Beach Management Plan.
2. Ensure that future beach management projects address the issues and concerns of the Waikīkī community and local stakeholders.
3. Advise the State, County and stakeholders on beach management projects in Waikīkī.
4. Provide community coordination, education, and outreach efforts about beach management issues and projects in Waikīkī.
5. Provide diverse perspectives and guidance for future beach management and planning activities in Waikīkī.
6. Identify and evaluate alternatives for beach management and maintenance in Waikīkī.

Specific Committee Activities

1. **Meet** semi-annually for updates or more frequently as needed during projects.
2. **Serve as a sounding board** for proposed projects in Waikīkī Beach.
3. **Provide local knowledge and expertise** about important social, cultural, economic and environmental issues related to Waikīkī Beach.
4. **Provide strategic insights** on Waikīkī Beach management and ideas to overcome obstacles, capitalize on opportunities, and support long-term planning.
5. **Facilitate partnerships** with relevant agencies, organizations and individuals.
6. **Serve as community representatives** for specific beach management issues and concerns.

Committee Benefits

Members of the Waikīkī Beach Advisory Committee will benefit from hearing about and collaborating on state-of-the-art research and other project plans being conducted by university researchers and government agencies. Members will also benefit from being part of a network of partners with diverse knowledge and perspectives. All stakeholders will benefit from the external perspectives and strategic thinking provided by diverse individuals. The success of the Advisory Committee would be of mutual benefit to Advisory Committee members by serving as an example of effective early coordination and education for all members and facilitate the early identification of project concerns.



Coordinator Contact Info:

Dolan Eversole
University of Hawaiʻi Sea Grant College Program
Waikiki Beach Management Coordinator
808-956-9780 eversole@hawaii.edu

Waikīkī Beach Community Advisory Committee (April, 2020)
https://www.wbsida.org/waikiki-beach-community-advisory-committee

The Waikīkī Beach Advisory Committee is composed of approximately 35 people from a cross-section of local government, community groups and businesses.

Name	Organization/Business
Agencies & Organizations	
Lauren Blickley	Surfrider Foundation- Regional Manager
Keone Downing	Save our Surf
Rick Egged	Waikīkī Beach Special Improvement District Association
Dolan Eversole	UH Sea Grant (WBSIDA)
Bob Finley	Waikīkī Neighborhood Board
Chip Fletcher	University of Hawaii
Jim Fulton	Duke's Oceanfest/WBSIDA
Shellie Habel	University of Hawaiʻi Sea Grant/DLNR
Jim Howe	C&C Dept of Emergency Services
Kalani Kaanaana	Hawaiʻi Tourism Authority
Guy H. Kaulukukui	C&C of Honolulu Department of Enterprise Services
Sam Lemmo	Department of Land and Natural Resources-OCCL
Michelle Nekota	C&C Parks Department
Rob Porro	University of Hawaiʻi/ NDPTC
Josh Stanbro	C&C Office of Climate Change, Sustainability & Resiliency
Meghan Statts	Oahu District Manager, DLNR/DOBOR
John Tichen	C&C Ocean Safety- Chief
Ed Underwood	Department of Land and Natural Resources-DOBOR
Individuals & Operators	
Brian Benton	Dive and Surf O'ahu
Ted Bush	Waikiki Beach Services
John Clark	Ocean and Beach Expert/Historian
Bob Hampton	Waikīkī Beach Activities
George Kam	HTA/Quiksilver
Mike Kelley	Aqualani Beach and Ocean Recreation
Rus Murakami	Waikiki Beachside Bistro
George Parsons	Maitai Catamaran
Didi Robello	Aloha Beach Services
Soo/Richard Stover	Holokai Catamaran
John Savio	Na Hoku and Manu Kai Catamarans
Hotels	
Connie Deguair	Hilton Hotels
Kelly Hoen	Outrigger Hotels
Corbett Kalama	Weinberg Foundation
Lee Nakahara	Kyo-ya
Fred Orr	Sheraton Hotels
Patty Tam (Neal Sklodowski)	Halekulani

WAIKĪKĪ BEACH COMMUNITY ADVISORY COMMITTEE

Tuesday, November 7, 2017 4:00pm to 5:30pm
Sheraton Princess Kaiulani

Meeting Summary

1. **Meeting Called to Order- Rick Egged (4:07)**

2. **Introductions- Rick Egged (4:10)**
   - Committee structure, framework and geographic extent of the projects.
   - Ground rules and meeting expectations
   - Geographic scope for Waikīkī Beach Improvement projects.

3. **Community Advisory Committee- Dolan Eversole (4:15)**
   - Project Outreach Plan and Composition
   - Public Informational meeting Dec 5th 5pm.
   - Website development

4. **Waikīkī Beach Management Plan- Dolan Eversole (4:20)**
   - Project Background, Goals and Scope
   - Focus is on the “Why” for Waikīkī, the “What” and “How” will come later.
   - Phases of Waikīkī beach Management Plan
   - Goals and scope of the Waikīkī ESI/FS.

5. **Waikīkī EIS & Feasibility Study- Sam Lemmo (4:30)**
   - Project Background- COP 21 Climate Accord meeting in Bonn, Germany
   - Hawaiʻi Climate Change Commission conducting Risk and Vulnerability Assessment for Sea-Level Rise using 3.2 ft of sea-level.
   - Next generation mapping using Sea-Level Rise Exposure area.
   - Mapping indicates beach erosion will accelerate in the future.
   - Waikīkī requires engineering to mitigate the effects of Sea-level rise.
   - Project partnerships are very important to legislative funding requests.
   - Sea Engineering on contract with the State DLNR for the Waikīkī Technical feasibility study/ EIS.
   - WBSIDA is handling the Waikīkī beach Management Plan and public outreach for this project.

6. **Group Discussion top priority for beach issues. (4:40)**
   (See Summary Table and Chart below)

7. **6:10 Meeting Adjourned**

8. **Next Meeting planned for February, 2018.**

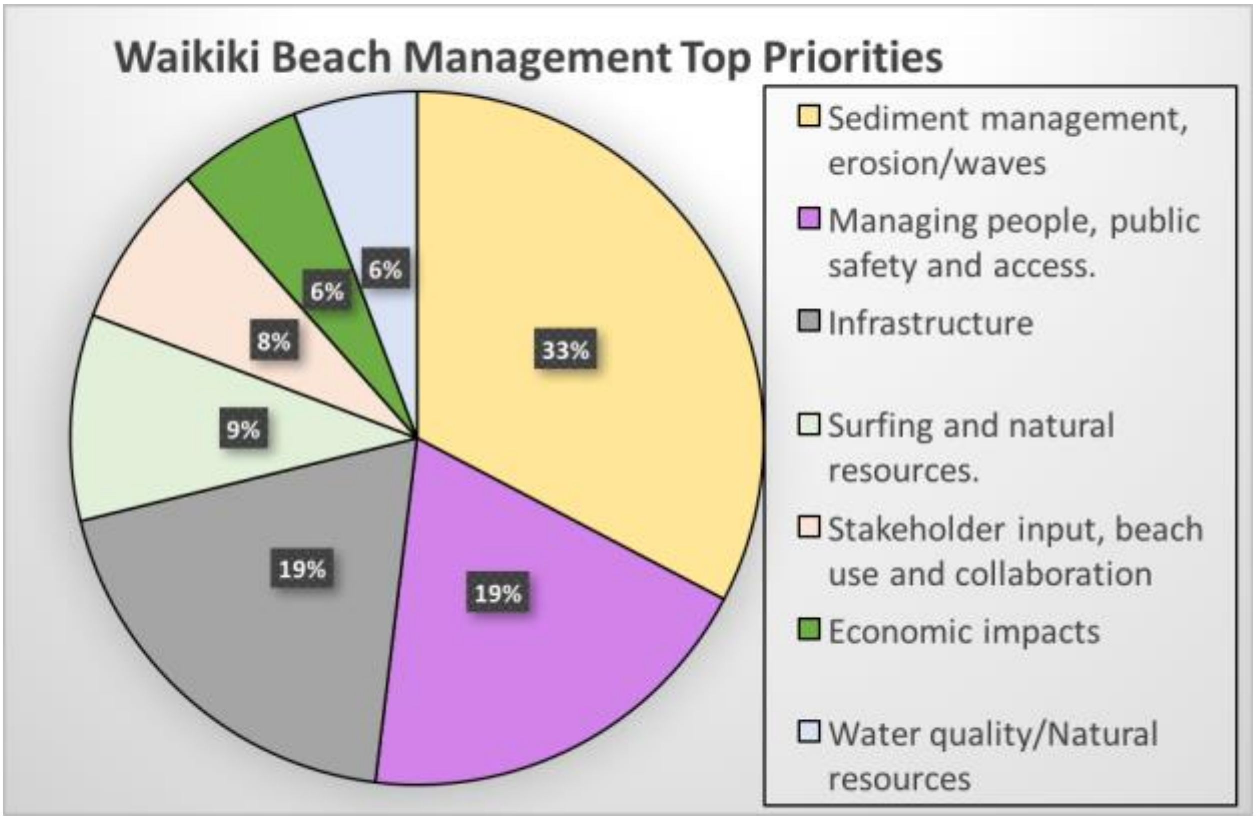
Summary of Priority Issue/Projects

Name	Comments	1st Priority	2nd Priority
Bob Finley *(Waikīkī Neighborhood Board)*	Would like to see more input on projects, interested to see who is using the beaches and how homeless are dealt with.	Stakeholder input, beach use and collaboration	Managing people and experience, public safety and access.
Michelle Nekota *(C&C Parks)*	Excited to collaborate, City needs technical support on beach projects. Beach erosion a major problem, ADA access is a problem in Waikīkī.	Sediment management, erosion/waves	Managing people and experience, public safety and access.
Chip Fletcher *(University of Hawai'i, SOEST)*	Would like to see the productive exchange of information to support the shared management of the beach resources. Waikīkī is a man-made beach. Offered idea to back-pass sand from the Royal Hawaiian side seasonally. Need to avoid fracturing the sand grains during hydraulic pumping.	Sediment management, erosion/waves	Stakeholder input, beach use and collaboration
Soo Stover *(Holokai Catamaran)*	Top issue is beach loss and wave run up affecting their catamaran operations. High tides make loading/unloading unsafe. Outrigger Reef had to close main beach access during king tides.	Sediment management, erosion/waves	Infrastructure and access
Brett Greenberg *(Aqualani Beach and Ocean Recreation)*	King Tides causing beach flooding. Even moderate tides causing flooding now. Beach loss is hurting business. Importance of surfing to Waikīkī.	Sediment management, erosion/waves	Economic impacts
George Parsons *(Maitai Catamaran)*	King Tides causing beach flooding. Beach loss is hurting business. Had to temporarily relocate during high tides. Historical beach at Sheraton, public access stairs need to reopen.	Sediment management, erosion/waves	Managing people, public safety and access.
George Kam *(HTA/Save Our Surf)*	Protection of surf sites and local access. The host culture of surfing needs to be protected and preserved. Public infrastructure is lacking and needs to be upgraded and maintained.	Surfing and natural resources.	Infrastructure and access
Keone Downing *(Save Our Surf)*	Sand volume limitations "how much sand is too much?" Concern over technical study with only one engineering firm. Would like to see distribution of tasks in the EIS.	Surfing and natural resources.	Sediment management, erosion/waves

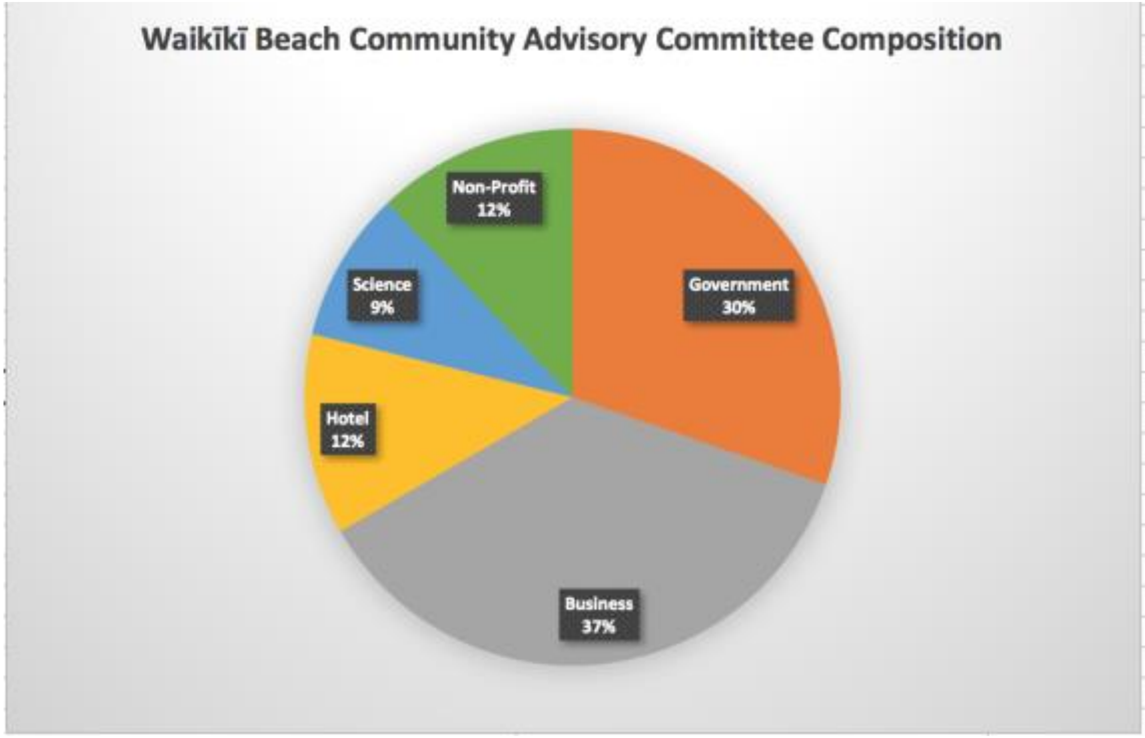
Name	Comments	Primary Focus	Additional Focus
Dolan Eversole *(UH Sea Grant/WBSIDA)*	Water quality, beach access alongshore, Reef health, Infrastructure maintenance. Economic studies will help justify maintenance projects in Waikīkī.	Water quality/Natural Resources	Infrastructure and access
Rus Murikami *(Waikīkī Beachside Bistro)*	Better balance between visitors and locals. Should strive for better experience and excellence. Improved experience/infrastructure	Managing people, public safety and access.	Infrastructure and access
Sam Lemmo *(DLNR-OCCL)*	Maintain modest nature of Waikīkī Beach. Recycle sand don't add more. Committee input important for the management approach.	Sediment management, erosion/waves	Stakeholder input, beach use and collaboration
Kevin Allen *(C&C Ocean Safety)*	Public safety as it pertains to staffing needs for beach changes. Public safety, risk management	Managing people, public safety and access.	Infrastructure
Bob Hampton *(Waikīkī Beach Activities)*	Value of Waikīkī Beach. Water quality and stigma of unknown water quality. PR issues long after the event has past.	Water quality/Natural resources	Economic impacts
Ted Bush *(Waikīkī Beach Services)*	Storm Mitigation benefits, erosion leading to seawall failure. General condition of Waikīkī is terrible.	Sediment management, erosion/waves	Infrastructure
Rick Egged *(WIA/WBSIDA)*	Storm mitigation benefits of beaches, climate change impacts	Sediment management, erosion/waves	Infrastructure
Fred Orr *(WBSIDA/Sheraton PK)*	Public access for Halekulani and Sheraton seawall. Kuhio Beach foundation erosion, Need to stabilize beach, Water quality	Sediment management, erosion/waves	Managing people, public safety and access.
John Clark *(Waikīkī Beach Expert and Historian)*	Need to plan for a high-quality beach. Protect "canoes" surf, surfing as a prime resource	Surfing and natural resources.	Sediment management, erosion/waves
Jim Howe *(C&C DES)*	Risk Management is multi-disciplinary. Need to better understand/manage people to mitigate risk. Act 170 will change the way the City operates relative to liability and risk. Public safety, risk management 6-point risk management approach. 1.Legal risk, 2.Financial risk, 3.Environmental risk, 4.Cultural, 5. Social 6. Physical	Managing people, public safety and access.	Infrastructure
Hubert Chang *(Hawaiian Oceans*	Happy for the WBSIDA and management planning is showing	Sediment management,	Stakeholder input, beach

Waikiki)	progress. Look to the past for examples of what worked.	erosion/waves	use and collaboration
Aaron Rutledge *(Star Beachboys)*	Beach erosion, bringing more sand needs to be thought out. Urgent need to erosion control now.	Sediment management, erosion/waves	Managing people, Public safety and access.
Jim Fulton *(Dukes Oceanfest/WBSIDA)*	Legacy of Duke, tradition and safe beach conditions.	Managing people, Public safety and access.	Sediment management, erosion/waves
Didi Robello *(Aloha Beach Services)*	Waikīkī canoe rides a unique opportunity. Sand loss due to Hurricanes Iniki and Ewa, removal of Kuhio groins accelerated erosion, sand has migrated to Baby Royals channel, need to stabilize the cell, suggestion to have marine special events help fund beach projects, need action now, waiting too long for management to catch up with erosion. Suggest move sand seaward to lower elevation of beach to mitigate wave run up.	Sediment management, erosion/waves	Surfing and natural resources.
Megan Statts *(DLNR-DOBOR)*	Public access to and along the shoreline.	Managing people, public safety and access.	Sediment management, erosion/waves
Brad Romine *(UH Sea Grant/DLNR)*	Support for efforts underway and happy to offer assistance	Sediment management, erosion/waves	Surfing and natural resources.
Matt Gonser *(C&C OCCSR)*	Concern about impacts to City facilities, need to preserve economic activities in Waikīkī.	Infrastructure	Economic impacts
Marvin Heskett *(Surfrider Foundation)*	Water quality impacts, SLR and septic tanks due to ground water table, storm water run off	Water quality/Natural resources	Infrastructure

🟨	Sediment management, erosion/waves
🟦	Water quality/Natural resources
🟪	Managing people, public safety and access.
🟧	Stakeholder input, beach use and collaboration
🟩	Economic impacts
🟩	Surfing and natural resources.
⬜	Infrastructure



Summary of Waikīkī Beach Community Advisory Committee Meeting November 7, 2017



Summary of Waikīkī Beach Community Advisory Committee Composition by Sector

WAIKĪKĪ BEACH COMMUNITY ADVISORY COMMITTEE

HO'OMAU 'O WAIKĪKĪ KAHAKAI

"WAIKĪKĪ BEACH RENEWS ITSELF"

March 20, 2018 Meeting Summary

MEETING AGENDA

Date: **March 20, 2018 1:00pm to 4:00pm**
Location: Waikiki Beach Marriott Resort & Spa
Kaimuki 1 Rm (2nd floor of the Kealohilani Tower)
2552 Kalakaua Ave, Honolulu, HI 96815, USA
Host: Waikīkī Beach Special Improvement District Association (WBSIDA)
Organizer: Dolan Eversole, University of Hawai'i Sea Grant/WBSIDA
Cell (808) 282-2273 email: eversole@hawaii.edu

MEETING AGENDA

1. **Introductions- Facilitator** (10 mins)
   - Project Background, Goals and Scope
   - Ground Rules, Committee structure, framework and role.

2. **Community Advisory Committee Updates** (10 mins)
   a. First meeting and public meeting summary
   b. Advisory Committee Composition (New Members)
   c. WBSIDA Website Updates

3. **Waikīkī Beach Problem Mapping and Response Exercise** (90 mins)
   Goal: Identify highest priority beach management issues and list potential solutions.
   Group Exercise- Maps of Waikīkī
   Identify top beach management priority and potential solutions
   Group Discussion: Waikīkī Beach mapping overview and outcome

4. **Kuhio Beach Sandbag Groin Project** (Concept engineering design feedback) (60 mins)
   Goal: Assess designs for Kuhio groin. Provide feedback on design elements.
   - Project Background, Goals and Scope
   - Design: Design rational and approach and various design alternatives.
   - Group Discussion: Summary and outcome

Pau Hana Social gathering and talk story- Moana Terrace Bar

3-20-2018 Meeting Summary

Committee composition, past meeting summaries and information can be accessed online at: **https://www.wbsida.org/waikiki-beach-community-advisory-committee/**

Background Information

The Waikīkī Beach Community Advisory Committee (WBCAC) is intended to help to identify and address Waikīkī Beach management issues. The committee provides important guidance for planning and prioritizing future beach management projects in Waikīkī.

Waikīkī Beach Advisory Committee Goals

1. Advise the WBSIDA, the DLNR, the City and County of Honolulu and UH Sea Grant on the development and implementation of a Waikīkī Beach Management Plan.
2. Ensure that future beach management projects address the issues and concerns of the Waikīkī community and local stakeholders.
3. Advise/recommend on specific beach management projects in Waikīkī.
4. Provide community coordination, education, and outreach efforts about beach management issues and projects in Waikīkī.
5. Identify and evaluate alternatives for beach management and maintenance in Waikīkī.

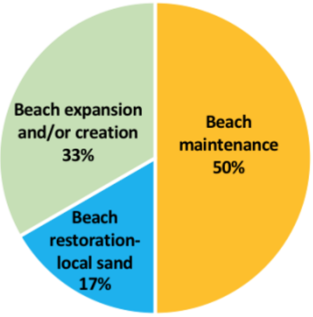
General Summary:

- 19 of the 31-member committee (61%) were present for the 3-20-18 meeting.
- The meeting consisted of 3 group exercises designed to obtain feedback on priorities for future beach management plans.

PRIORITY AREAS

- The Royal Hawaiian Cell was considered the #1 choice for beach management planning and maintenance (50%), followed by Kuhio Beach (25%) and Halekulani (19%)

Overall Top Solution for Waikiki Beach



PRIORITY ASSET

- The top asset identified for Waikīkī included the economic value of the beach but it is recognized how closely connected and inter-related each value is to each other.

PRIORITY PROBLEM

- The top problem identified for Waikīkī varied greatly by cell but tended included Erosion/wave run-up and Structural Damage.

PRIORITY SOLUTION

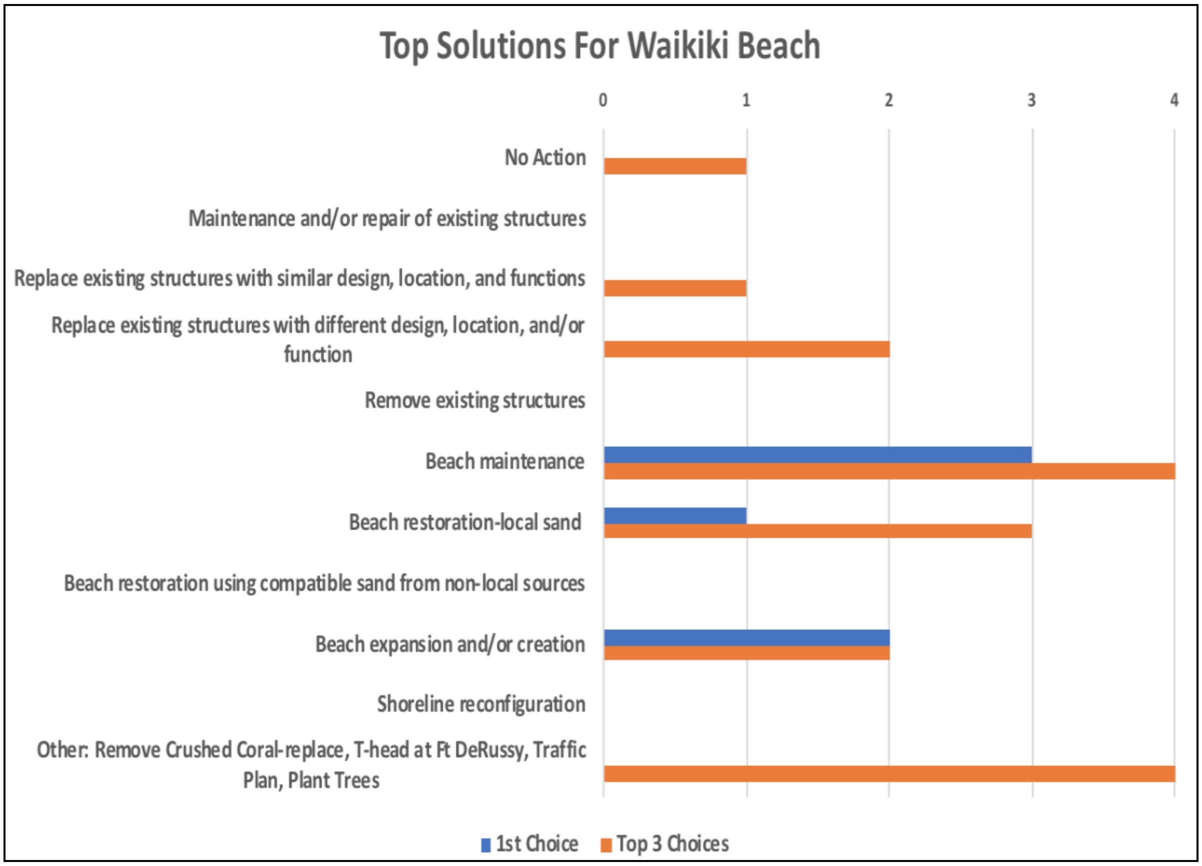
- The top solution identified for Waikīkī varied by cell but included beach maintenance and beach restoration using local sand sources with specific "other" options.

Exercise #1
Waikīkī Beach Problem Mapping and Response Exercise (60 mins)
Goal: Identify highest priority beach management issues and rank potential solutions.

This exercise started with each committee member being assigned to a group and a rotation sequence for 6 separate breakouts by geographic beach area. Each breakout asked the participants to rank the top 3 assets, problems and potential solutions. The results for each cell are summarized in Appendix A and more generally below.

General Summary: Overall the results suggest the following:

1. Preferred solutions vary by each beach cell but tend to generally favor the softer maintenance-oriented solutions.
2. Looking just at the 1st choice solutions, we see that beach maintenance is favored followed by beach expansion and beach restoration.
3. Generally, the *most favored overall* solutions included beach maintenance and beach restoration using local sand sources with specific “other” options that vary by cell.
4. While there are exceptions in some beach cells, the *least favored* solutions included; shoreline reconfiguration, beach restoration using non-local sand sources, removal of existing structures and maintenance and repair of existing structures.



Exercise #2- Kuhio Beach Sandbag Groin Project

This portion of the meeting consisted of a general introduction of the problem area at Kuhio Beach fronting the Duke Kahanamoku Statue and recent erosion responses from the City. This was followed by a briefing from Sam Lemmo of the DLNR on potential mitigation strategies and the DLNR's progress on developing a response to the erosion. There was general discussion and questions from the Committee regarding various options to address the erosion here.

General Summary:

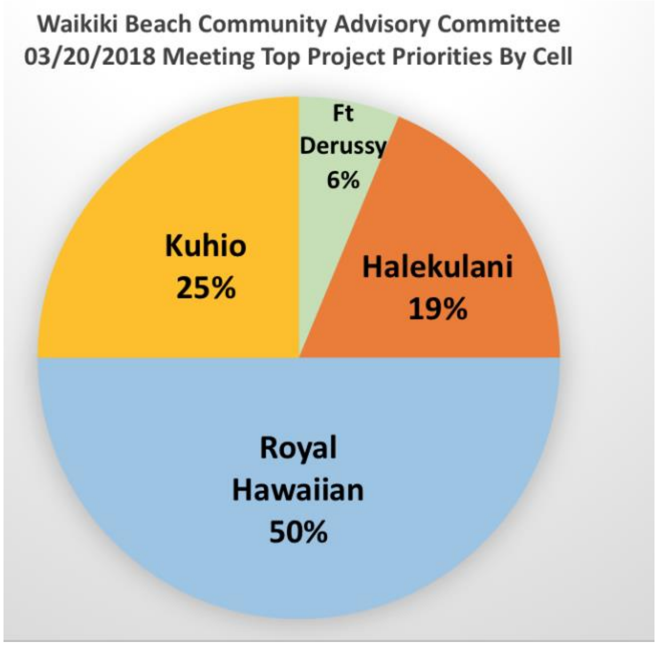
1. Committee members are supportive of a rapid response to the erosion problem here. A possible solution of sandbag groin(s) possibly 2 or 3 was discussed and seemed to be agreeable to the Committee. Although no vote was taken, there were no objections to the project moving forward into a design phase.
2. Sand sources for a project in this area are estimated at ~1000 cubic yards and are recognized as important component of this project. Concern was raised about public safety if the Kuhio swim basin is significantly deepened.

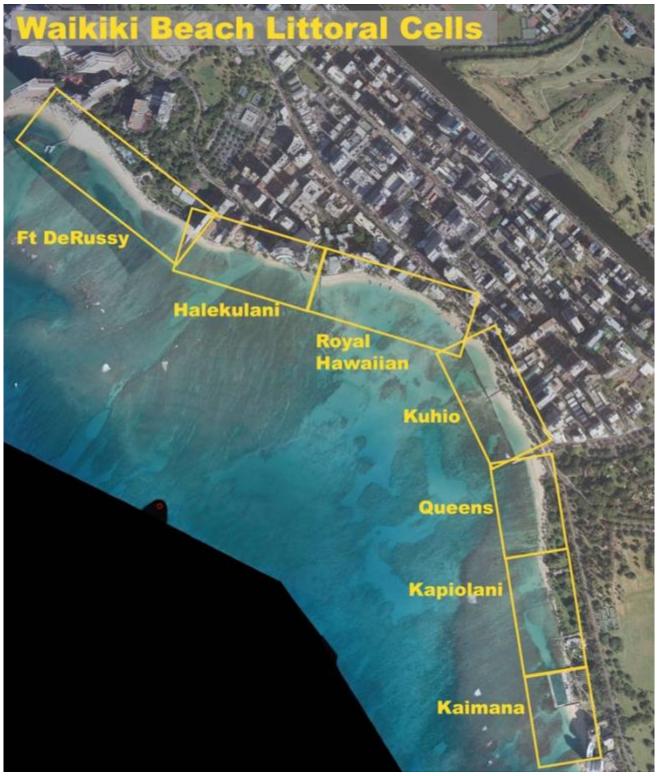
Discussion:

1. Sam Lemmo introduced the DLNR's plan to address the erosion at Kuhio in part based on the Committee's input and prior stakeholder meetings on this subject.
2. The project design goal is to stabilize the area with something that can be permitted and built quickly, possibly as a temporary structure.
3. A potential design may include a short sandbag groin to replicate the effect of the older concrete groins that were removed in 2012.
4. Dolan Eversole described a potential sand source of 1000 cy for this project from the Diamond Head basin of Kuhio Beach as part of a beach maintenance project to reshape the beach profile and utilize excess sand remaining from the 2012 beach maintenance project. This would be in partnership with the City and County Parks Department.
5. Funding sources are not confirmed but the estimated cost of $400,000 would likely be a cost share between the State and the Waikīkī Beach Special Improvement District.
6. Permitting can be complex for this type of project. Sam and Dolan met with the Army Corps of Engineers in September, 2017 about this project to see if it could be considered under the existing 2012 Beach Maintenance project. The initial response was negative from the Army Corps.
7. Permitting could take 1 year or more but there is strong interest in finding a faster expedited (possibly emergency) permitting route.
8. Concern was raised about deepening the Kuhio swim basin water depth as part of the sand bypassing and beach maintenance project.
9. Question if the beach slope is steepened will it erode if the sand is removed from the basin? This was addressed by several staff that the slope will not be steep enough to create an erosion problem in the basin.
10. The City and County used to do this type of beach maintenance annually with long-arm excavators and back hoes to re-shape the beach here but has stopped in recent years.
11. Will the concrete foundation be removed? Dolan Eversole responded that the project goal for now is to stabilize the area with structures and sand and bury the foundation. Removal would be very intrusive and may expose even more dirt fill.

Exercise #3- Beach Project Priority Exercise

This exercise included a simple vote for what beach areas are the highest priority for each committee member. Each committee member was given two votes and allowed to vote by show of hands for which beach cell has the highest priority for developing plans for beach management, maintenance and/or improvements. The Royal Hawaiian Beach cell was the favored beach area for priority by the Committee followed by Kuhio Beach and Halekulani.





Appendix A: Summary of Priority Solutions by Beach Cell

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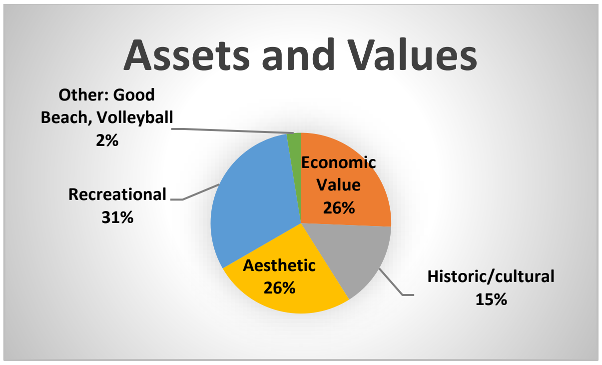
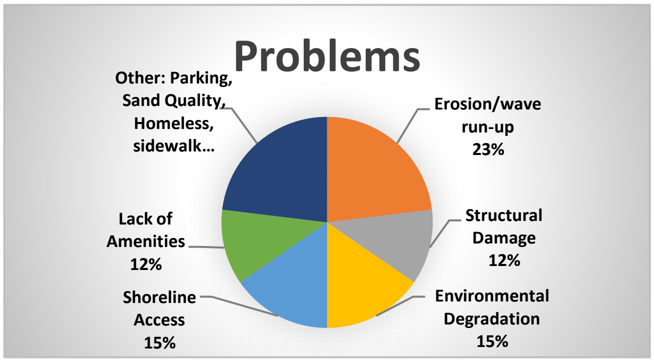
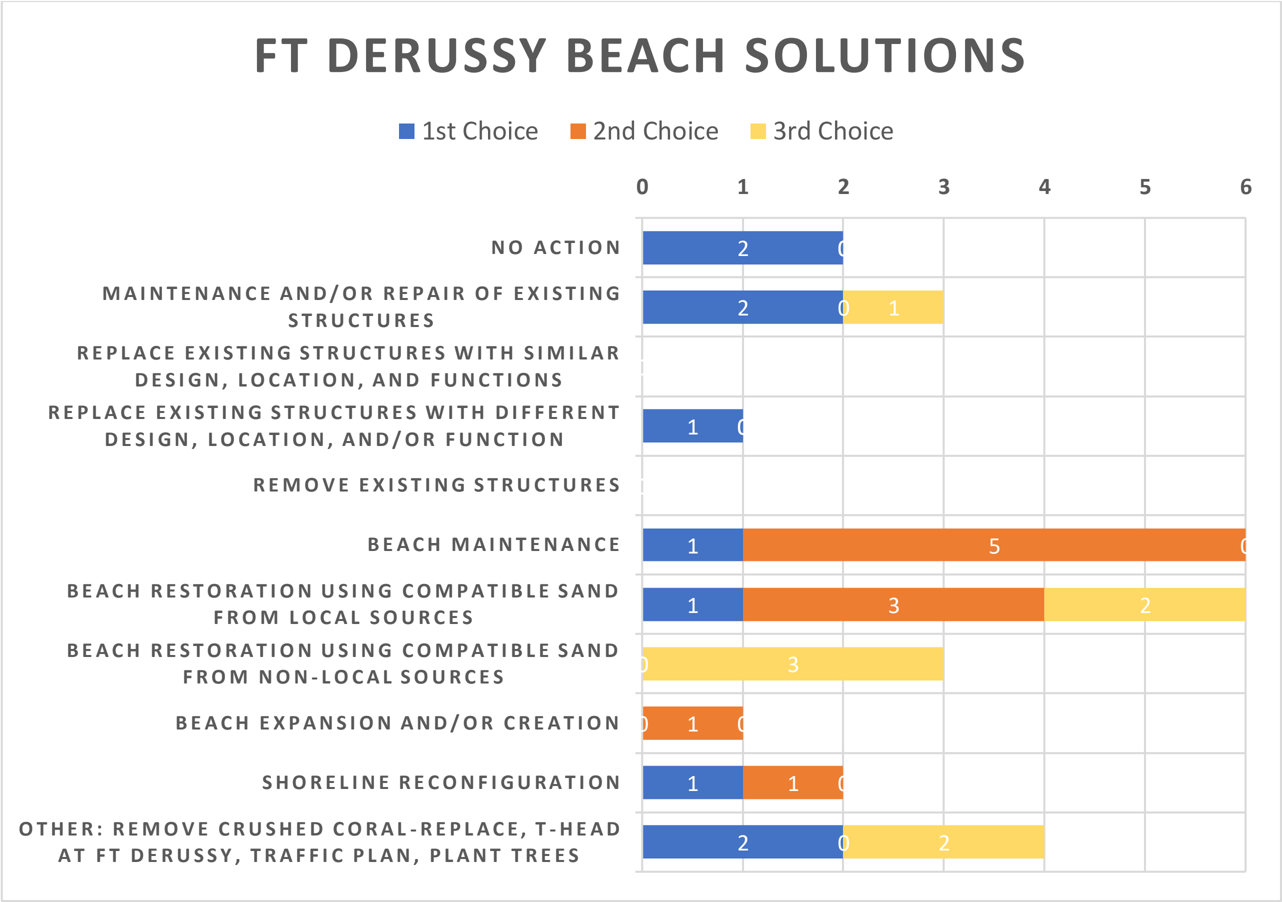
FT. DERUSSY BEACH, WAIKIKI

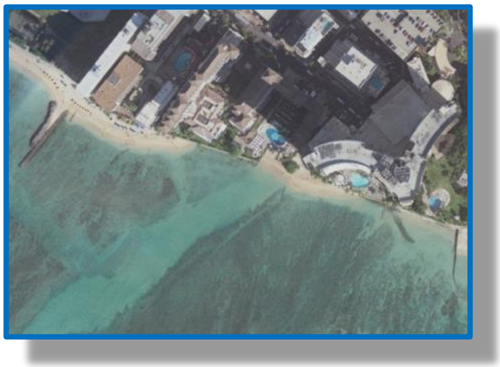
ASSETS & VALUES



ISSUES & PROBLEMS

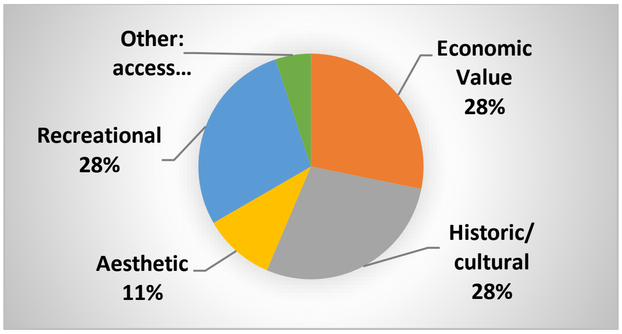




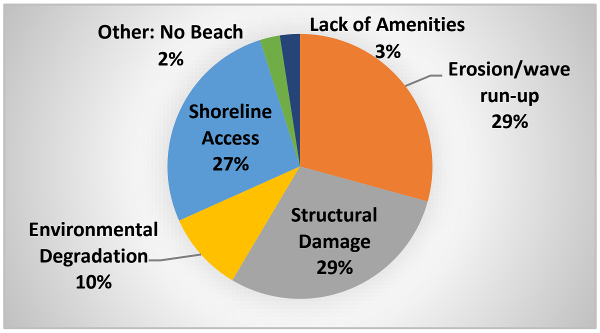


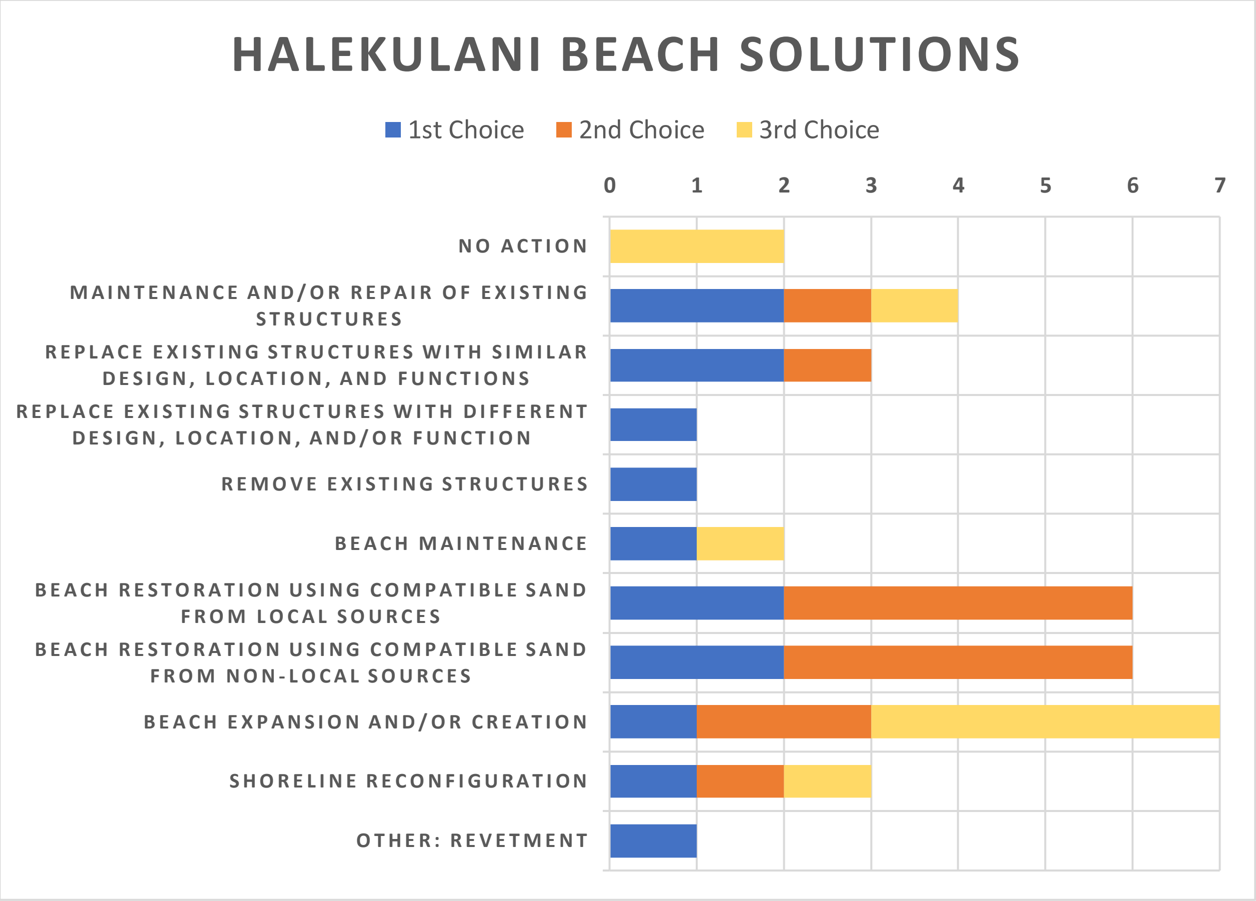
HALEKULANI BEACH, WAIKIKI

ASSETS & VALUES



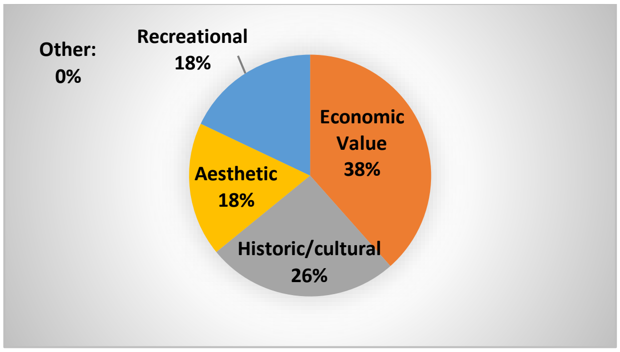
ISSUES & PROBLEMS



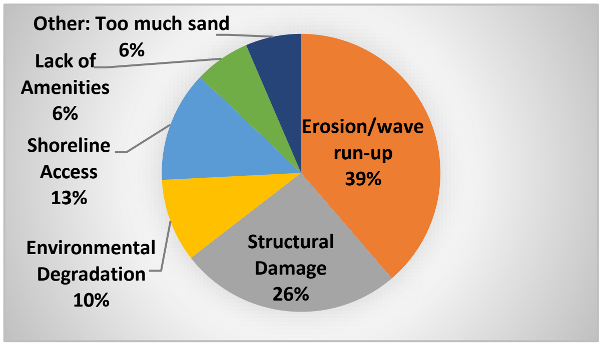

HALEKULANI BEACH SOLUTIONS

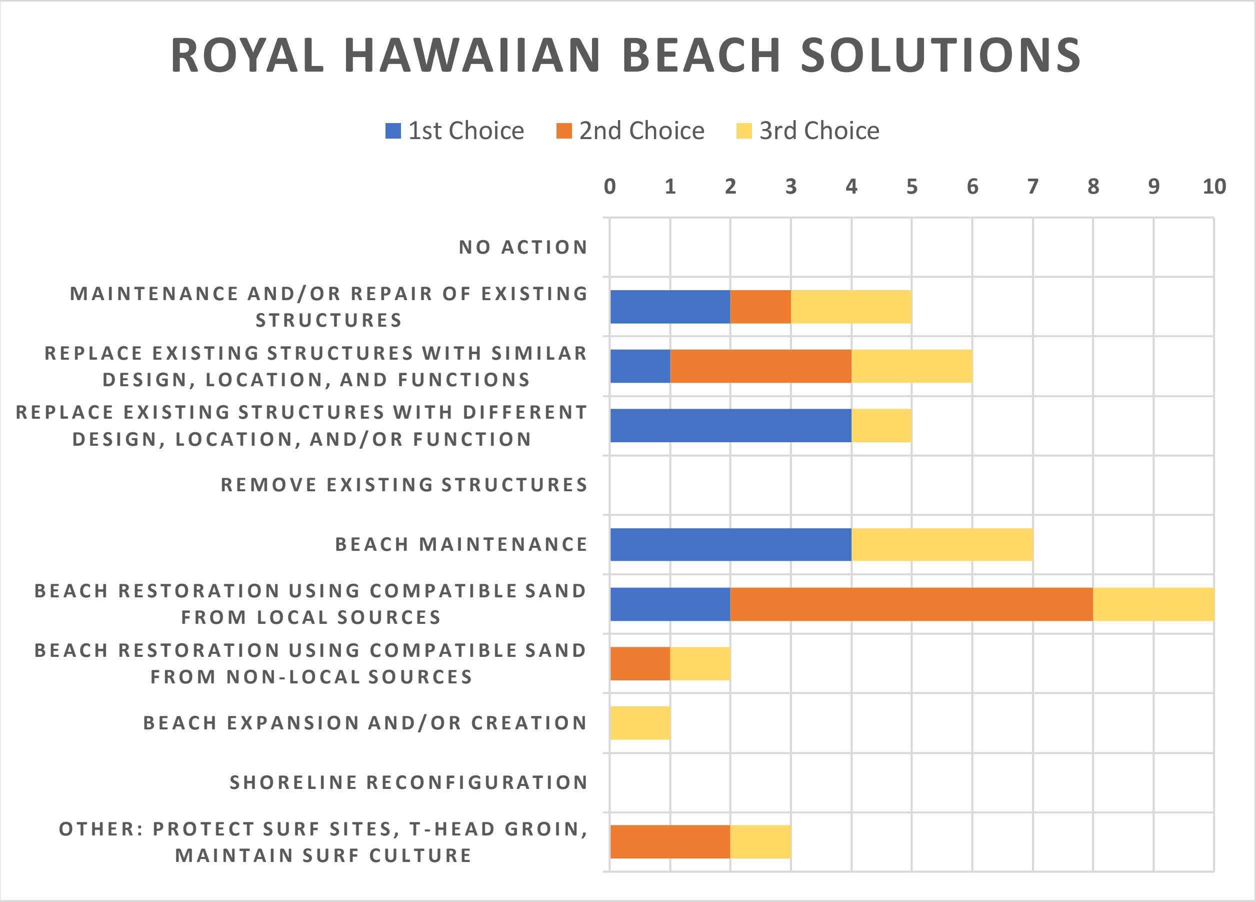
ROYAL HAWAIIAN BEACH, WAIKIKI

ASSETS & VALUES



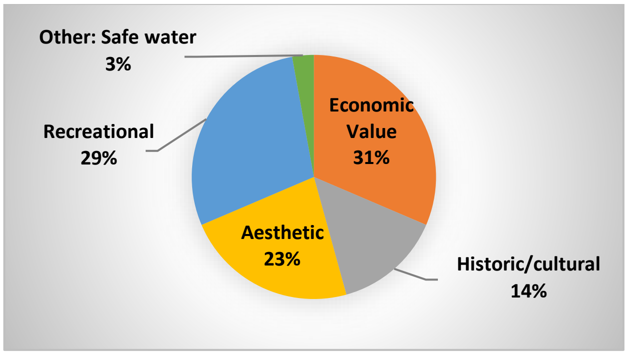
ISSUES & PROBLEMS



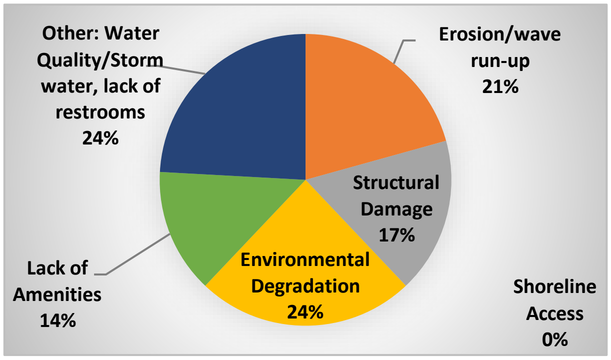


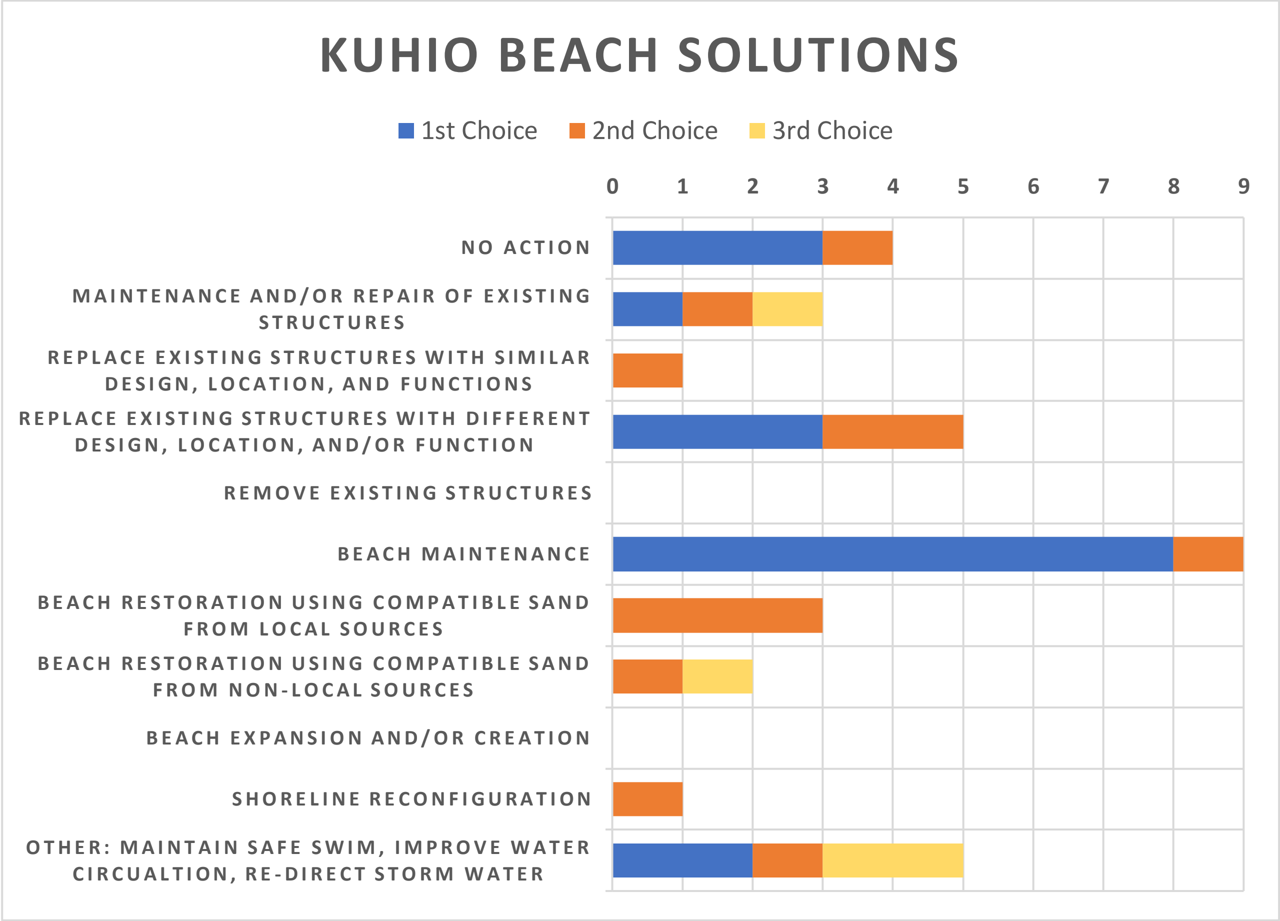
KUHIO BEACH WAIKIKI

ASSETS & VALUES



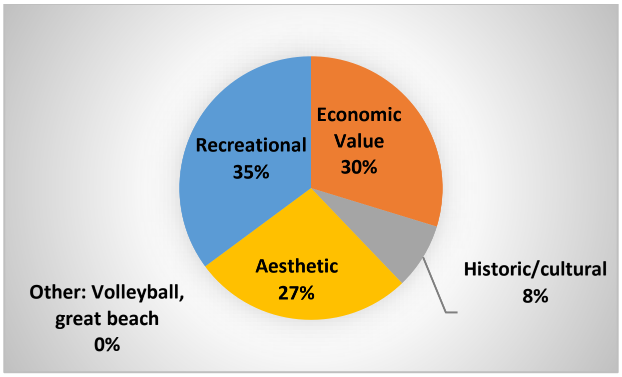
ISSUES & PROBLEMS



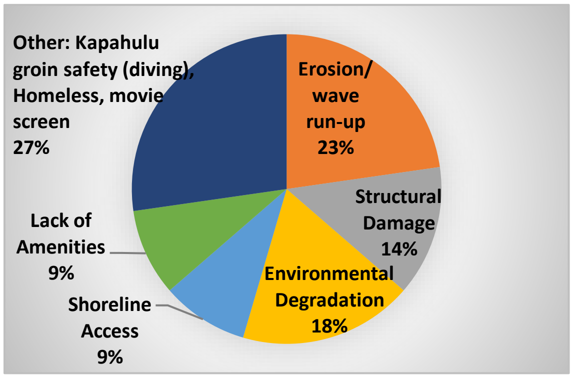


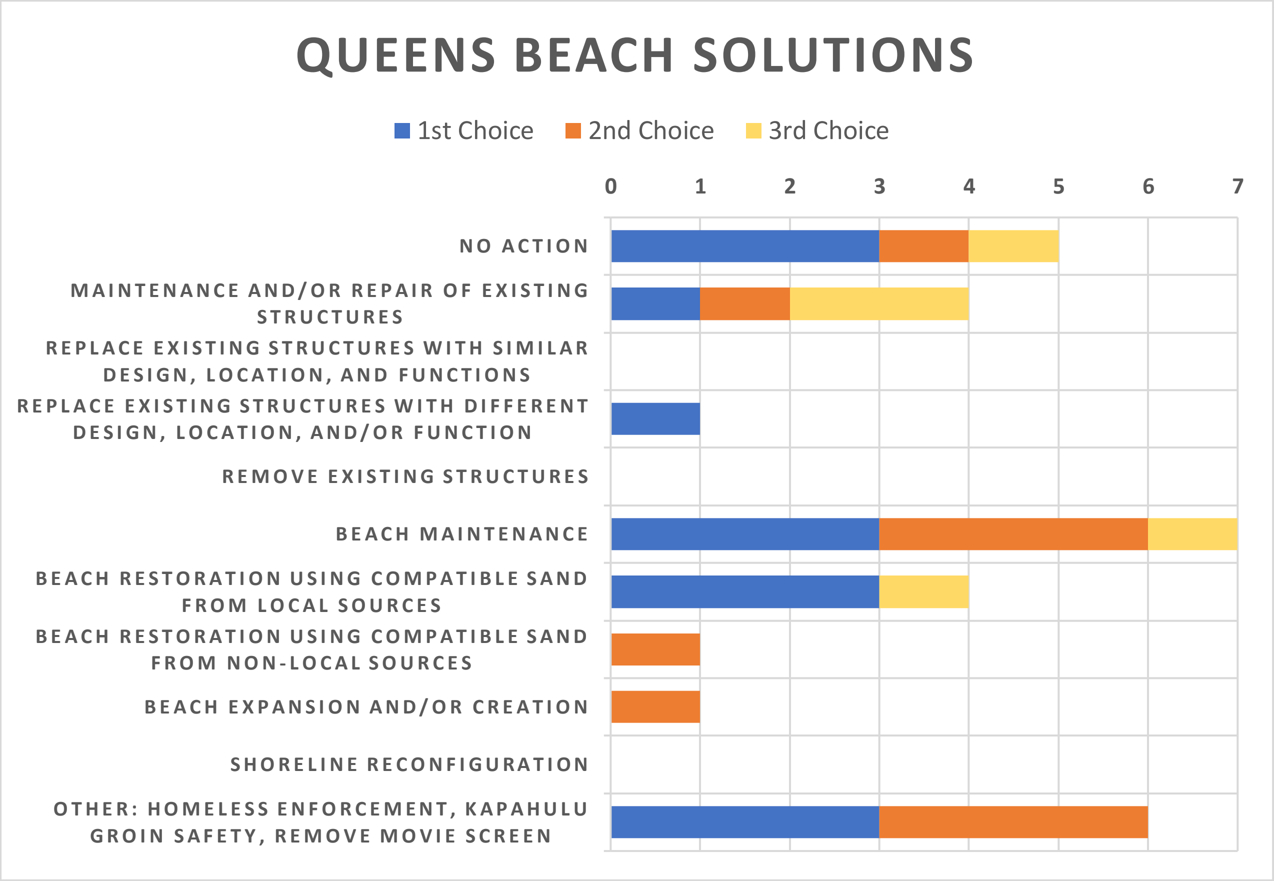
QUEENS BEACH WAIKIKI

ASSETS & VALUES



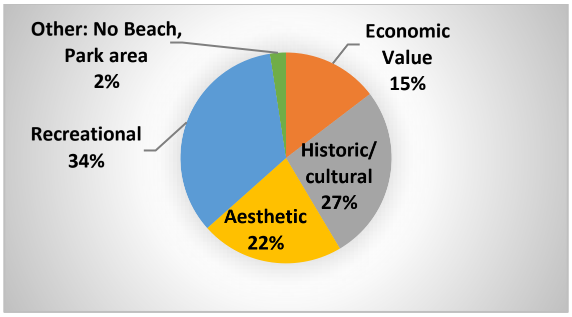
ISSUES & PROBLEMS



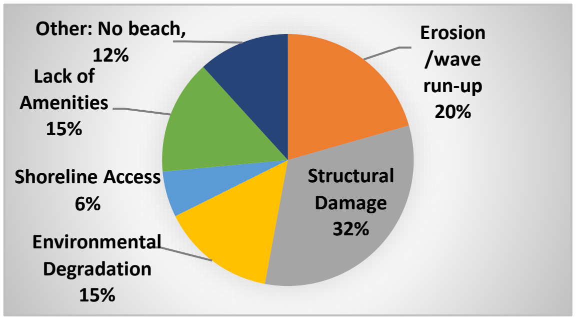


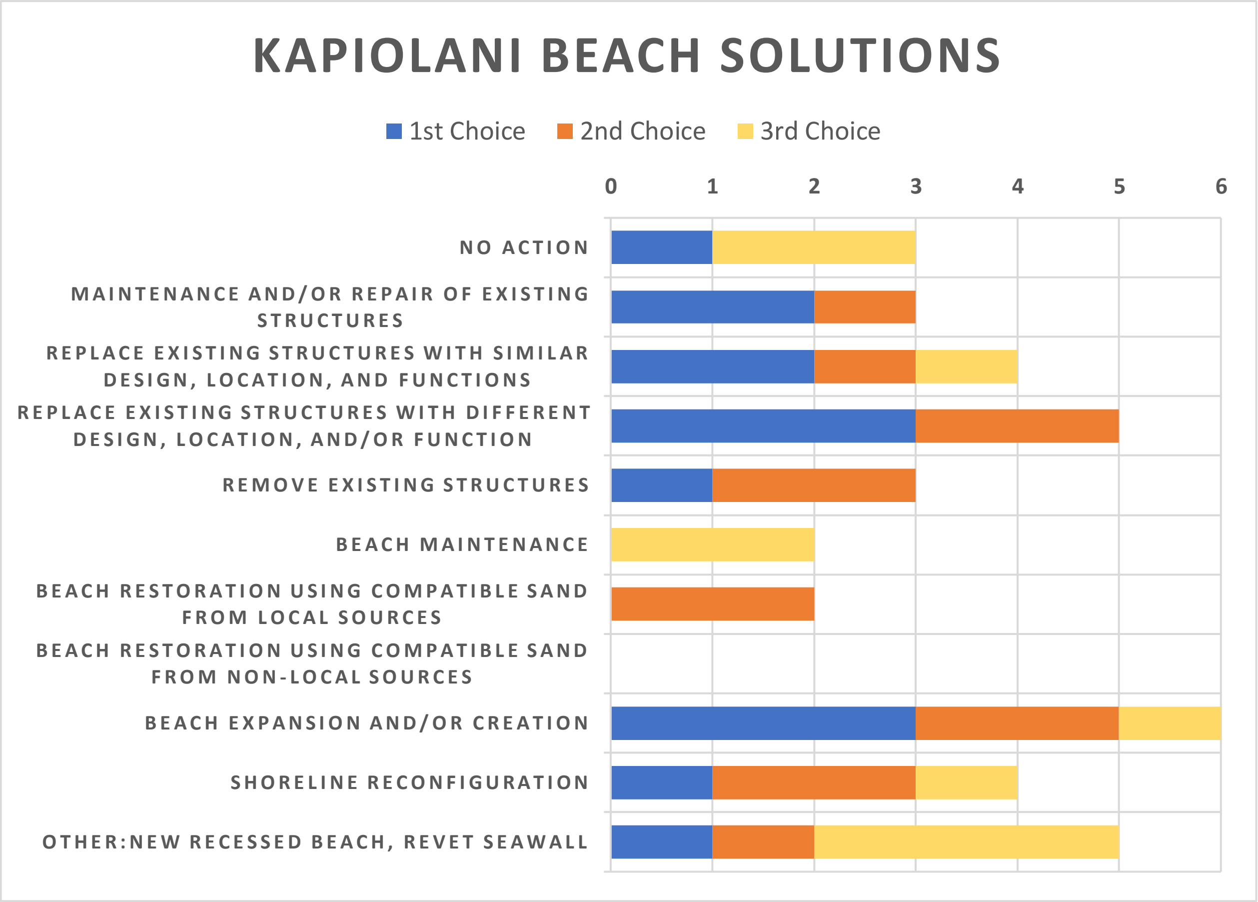
KAPIOLANI BEACH WAIKIKI

ASSETS & VALUES

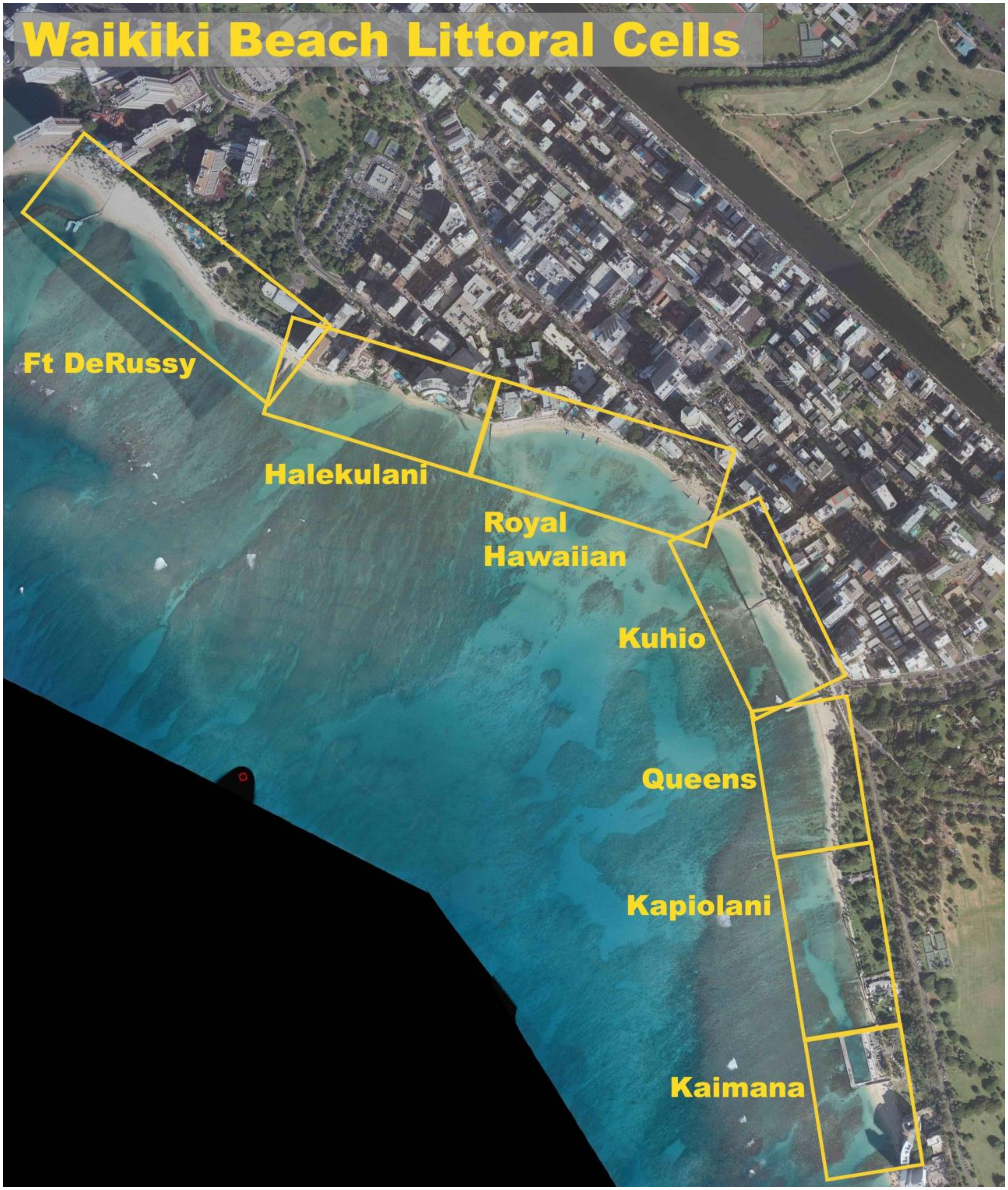


ISSUES & PROBLEMS




KAPIOLANI BEACH SOLUTIONS

Waikiki Beach Littoral Cells



WAIKĪKĪ BEACH COMMUNITY ADVISORY COMMITTEE

HO'OMAU 'O WAIKĪKĪ KAHAKAI

"WAIKĪKĪ BEACH RENEWS ITSELF"

MEETING AGENDA

Date: **September 27, 2018* 1:30pm to 4:00pm**
**Rescheduled August 23, 2018 meeting due to Hurricane Lane*

Location: Royal Hawaiian Hotel
Regency I Room
2559 Kalakaua Ave, Honolulu, HI 96815

Host: Waikīkī Beach Special Improvement District Association (WBSIDA)
Contact: Dolan Eversole, University of Hawai'i Sea Grant/WBSIDA
Cell (808) 282-2273 email: eversole@hawaii.edu

MEETING AGENDA

1. **Waikīkī Beach Community Advisory Committee Updates** (15 mins)
   a. Advisory Committee composition. (New members)
   b. March meeting issue mapping summary. (Handout)

2. **Royal Hawaiian Groin Design Update (**15 mins) (Handout)
   a) sea-level rise (SLR) consideration and new "L-spur" design.
   b) Timing and application status.

3. **Kuhio Beach Sandbag Groin Project** (30 mins) (Handout)
   - Final sandbag groin design update.
   - Design rationale and construction plan.
   - Access plan, timing and application status.
   - Group discussion, questions and comments.

4. **Waikīkī Conceptual Designs - Halekulani, Royal and Kuhio** (90 mins) (Handout)
   a) DLNR Waikīkī EIS project background, goals and scope.
   b) Review conceptual designs for Kuhio, Royal and Halekulani cells.
   c) Pedestrian access, SLR, public safety and aesthetic considerations for designs.
   d) Timing and application status.
   e) Group discussion, questions and comments.

4pm Pau

9-27-2018 Meeting Summary

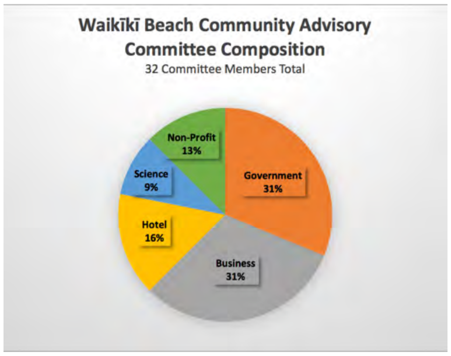
Committee composition, past meeting summaries and information can be accessed online at: https://www.wbsida.org/waikiki-beach-community-advisory-committee/

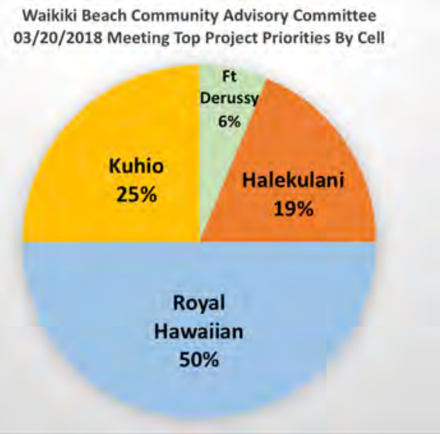
Background Information

The 32-member Waikīkī Beach Community Advisory Committee (WBCAC) is intended to help to identify and address Waikīkī Beach management issues. The committee provides important guidance for planning and prioritizing future beach management projects in Waikīkī.

Waikīkī Beach Advisory Committee Goals

1. Advise the WBSIDA, the DLNR, the City and County of Honolulu and UH Sea Grant on the development and implementation of a Waikīkī Beach Management Plan.
2. Ensure that future beach management projects address the issues and concerns of the Waikīkī community and local stakeholders.
3. Advise/recommend on specific beach management projects in Waikīkī.
4. Provide community coordination, education, and outreach efforts about beach management issues and projects in Waikīkī.
5. Identify and evaluate alternatives for beach management and maintenance in Waikīkī.





General Meeting Summary:

- 21 of the 32-member committee (66%) were present for the 9-27-18 meeting.
- The meeting consisted of several project updates and a ranking sheet exercise for six different conceptual engineering designs for the three priority beach cells (Royal, Kuhio and Halekulani).
- Follow up discussion with several committee members and stakeholders on the overall outreach and communication strategy for the conceptual designs has resulted in the development of an overall project goals, objectives and strategies.
- Based on the above input, the WBSIDA is in the process of developing specific criteria for the identification of the desired recreational use, design rational and outcome objectives for each design cell. This is thought to assist in the committee assessment and ranking of various conceptual designs.

Project Updates

- Royal Hawaiian Groin (RHG)- A project update was provided to the committee on the various design changes planned for the RHG including the change in the shoreward portion to "L-head" and an overall increase in the overall crest elevation by 1.5ft to account for future projections of sea-level rise.
- Discussion of the RHG centered on public safety measures that can be built into the design to prevent and/or mitigate public access along the top of the groin.
- A suggestion of possibly adding a lifeguard station to the base of the RGH was brought up. There was acknowledgement this may serve to improve observational coverage and emergency response time from the RHG to the Ft. DeRussy groin which is currently unguarded.
- Kuhio Beach Groin (KBG)- A project update was provided to the committee on the various design changes planned for the KBG.
- Discussion included the KBG function, dimensions, orientation, sand source and installation methodology.
- Concern raised by several committee members about the use of the proposed sand barrow area in the Diamond head basin for the beach fill next to the KBG as it may increase the slope of the beach and cause a deepening of the shallow wading area leading to a safety concern. Other safety concerns were raised regarding slip/fall hazards on the groin as well as novice surfers hitting the groin.
- A suggestion was made for the planned KBH be oriented similar to the pre-existing groin in order to orient the groin into the prevailing waves, as opposed to shore-perpendicular.

Conceptual Design Ranking Exercise (60 mins)
Goal: Evaluate and rank potential conceptual designs.

This exercise started with a presentation and discussion on six different conceptual designs for the three priority beach cells. Committee members were asked to rank the various designs on a 1-5 scale (1= no support, 5 = full support) (Appendix A). The ranking sheet was also emailed out to all committee members as part of a briefing packet before the meeting and a form-fillable version was sent after the meeting. The results for this exercise are summarized below.

a.

b.

c.

d.

e.

f.

General Summary: Considering the limited sample size[1], the overall the results suggest:

1. Preferred designs vary by each beach cell but tend to favor Options E and F (Halekulani T-heads and T-heads + SLR) as the top ranking for the first choice (Figure 1).
2. Similar ranking is observed if we look at the 1st choice PLUS the 2nd choice with Option F Halekulani T-heads + SLR as the overall preferred design (Figure 2).
3. Option C (Royal Hawaiian Beach) was an equal 2nd to Option E when considering the 1st choice PLUS the 2nd choice (Figure 2).
4. While there are exceptions in some beach cells, the *least favored* designs include Option B (Kuhio w/ breakwaters and C Royal Hawaiian.
5. Note Option C ranked an equal 3rd with 3 other designs when looking at 1st choices only an equal 2nd when looking at 1st Plus 2nd choices and an equal least preferred for the 5th choice. This seems to indicate a bi-modal distribution of ranking results or in other words the committee is largely split on this option with the same number of results as the 5th choice as there are for 1st plus 2nd (Figure 3). This might indicate more information and discussion is needed in order resolve this difference of opinion with this option if there is an interest in pursuing this option.

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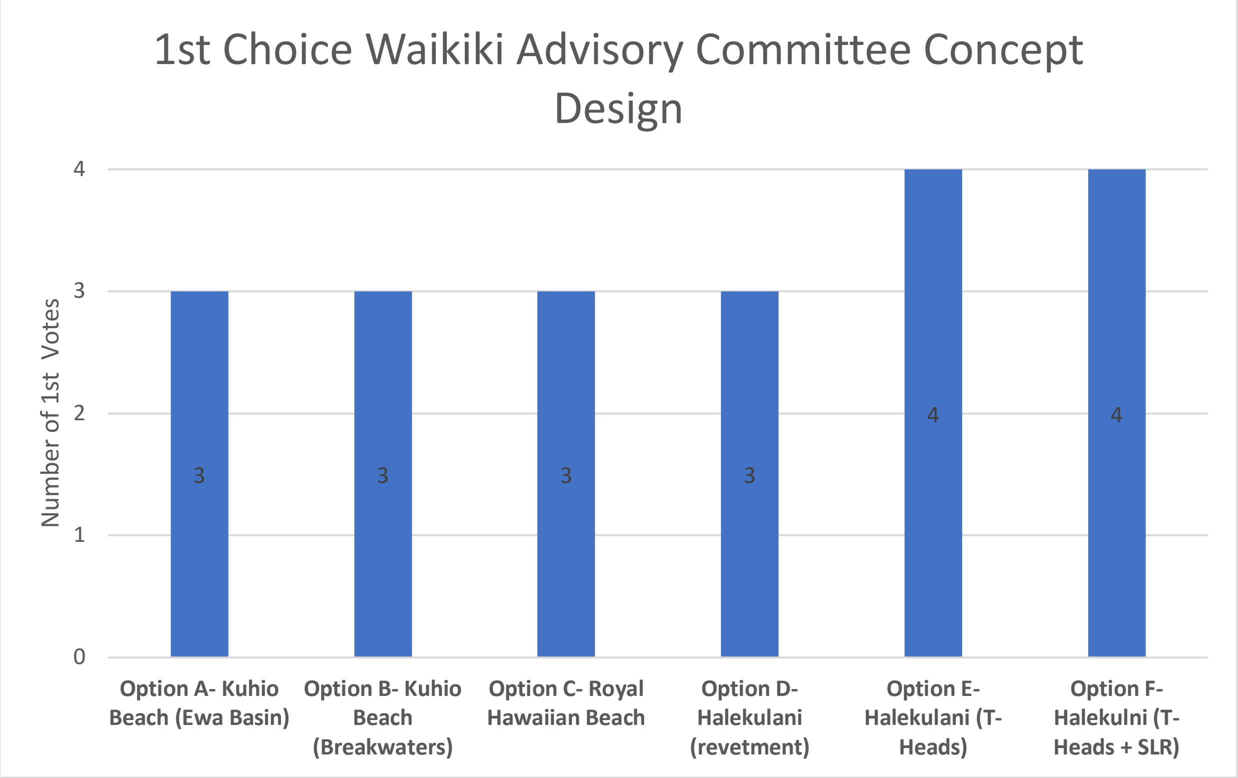
[1] A larger sample size will result in more statistically relevant and representative results. This could be done as an online survey to a wider stakeholder group and/or as public survey. Ideally future surveys will evaluate and rank various options for each cell rather than rank overall for all cells.

Conceptual Design Ranking Exercise – Results

Figure 1.



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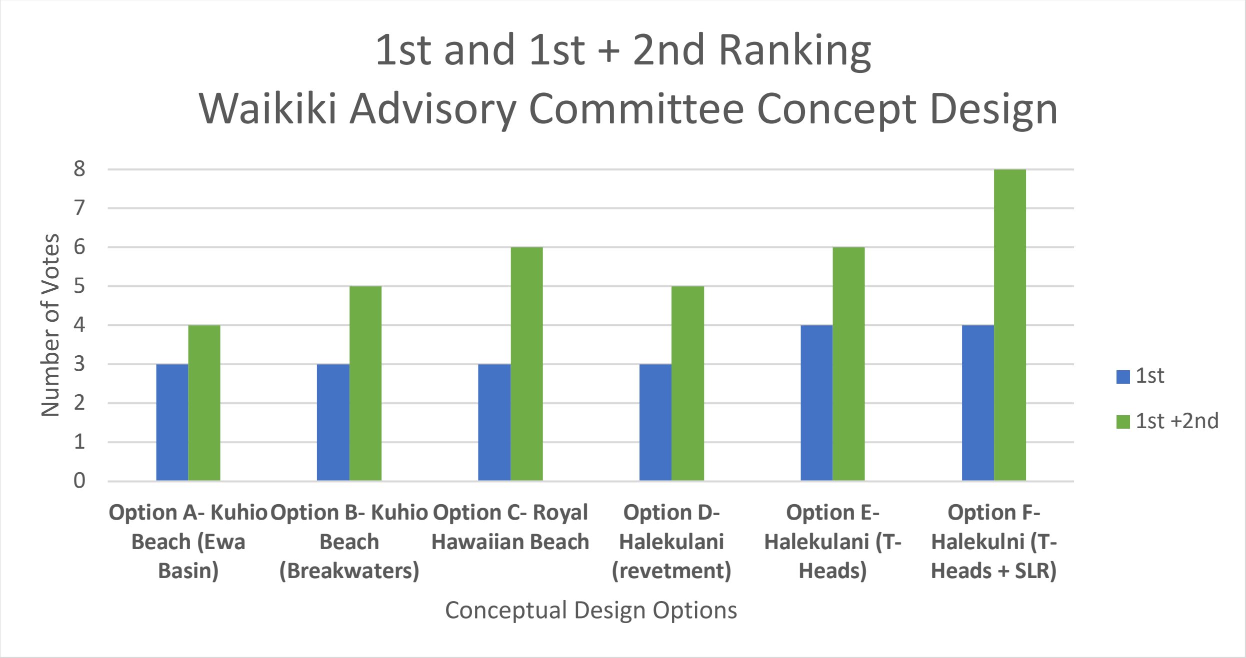
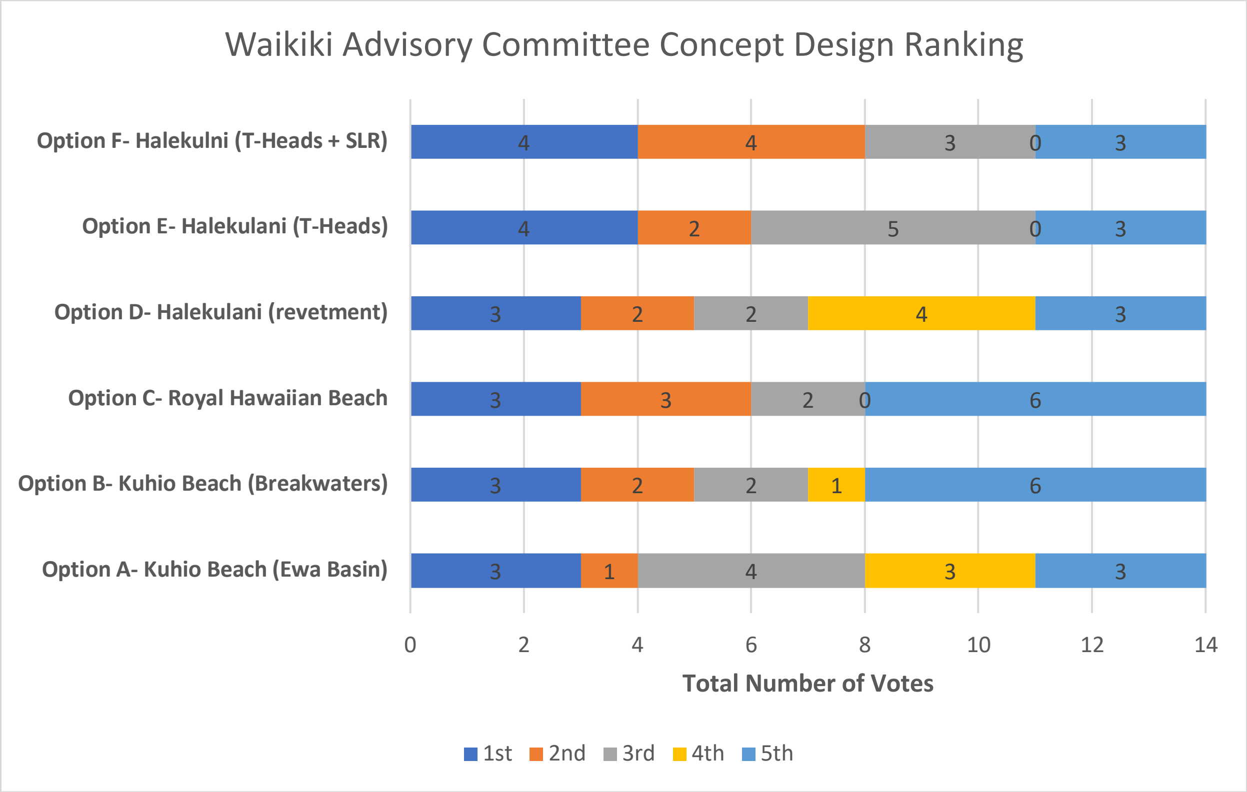
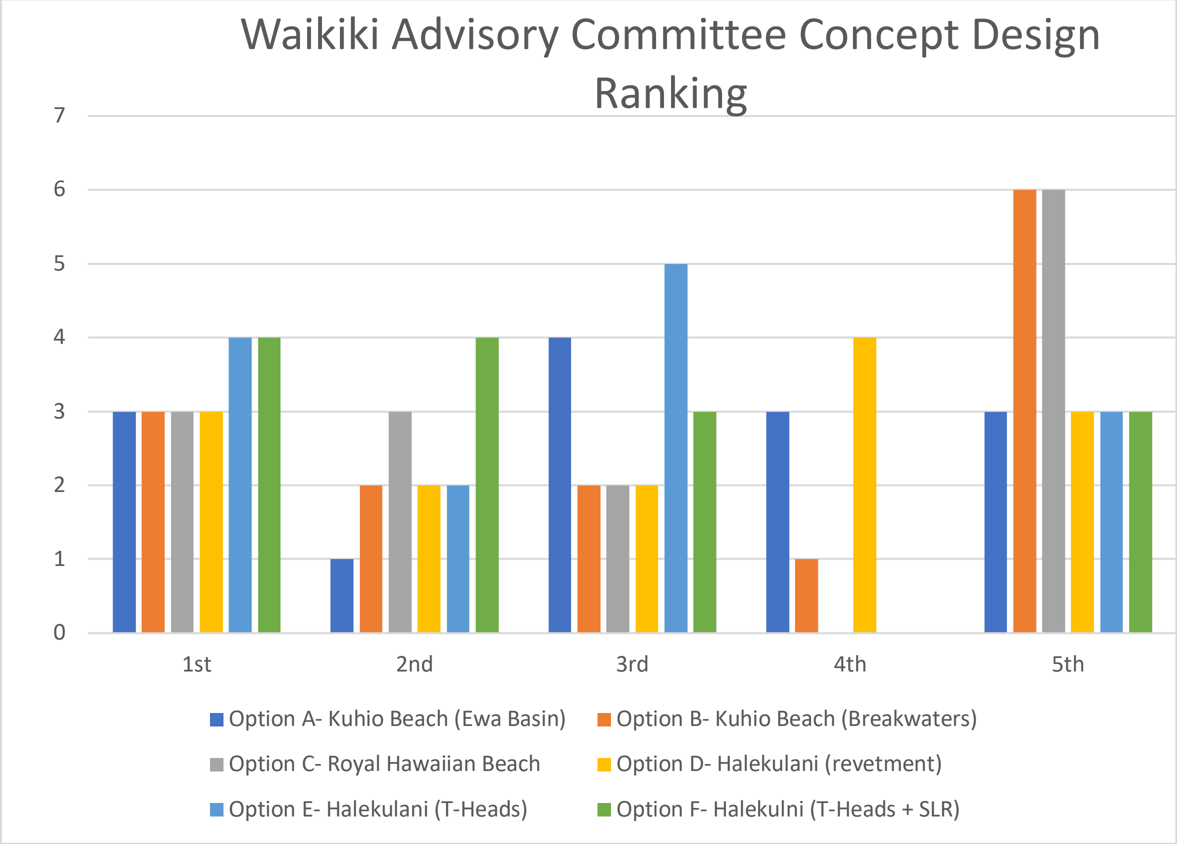


Figure 3.


Waikiki Advisory Committee Concept Design Ranking
Option F- Halekulni (T-Heads + SLR) 4 4 3 0 3
Option E- Halekulani (T-Heads) 4 2 5 0 3
Option D- Halekulani (revetment) 3 2 2 4 3
Option C- Royal Hawaiian Beach 3 3 2 0 6
Option B- Kuhio Beach (Breakwaters) 3 2 2 1 6
Option A- Kuhio Beach (Ewa Basin) 3 1 4 3 3
0
2
4
6
8
10
12
14
Total Number of Votes
1st
2nd
3rd
4th
5th


Waikiki Advisory Committee Concept Design Ranking
7
6
5
4
3
2
1
0
1st
2nd
3rd
4th
5th
Option A- Kuhio Beach (Ewa Basin)
Option B- Kuhio Beach (Breakwaters)
Option C- Royal Hawaiian Beach
Option D- Halekulani (revetment)
Option E- Halekulani (T-Heads)
Option F- Halekulni (T-Heads + SLR)

Conceptual Design Ranking Exercise – Additional Committee Written Comments Received (In no particular order)

1. No T-Heads
2. Safety critical for locals and visitors
3. Surf and recreation important
4. In favor of T-Heads but not the groins leading from shore to the heads.
5. Favor Breakwaters over groins
6. All structures are temporary, plan accordingly
7. Fully support T-Groins just need more details
8. Option A is good but B is better but need 3 more groins towards Kapahulu groin
9. Option C is good but need to take out T-Groin inshore of Canoes
10. Option E is good but need to move western most groin out of Halekulani channel
11. Option B- need to add replacement for Slippery Wall (Kuhio Breakwall)
12. Consider Multi-modal groins for safety, designed for safe access.
13. Design safe water entry areas and signage
14. Allow more mauka room for a beach to form and elevate beach
15. Design multi-use recreational access (stairs) rather than restrict access.
16. Safety concern for eddie formation and current flows (Koolina lagoon example)
17. Possible impacts of sand movement Ewa side of T-head

Appendix A: Sample of Conceptual Design Ranking Sheet

NAME: ______________________________

Waikīkī Beach Conceptual Designs- Comment Sheet

1= no support, 5 = fully support

What is your level of your support for the following conceptual designs?

1-5 Scale

a) Kuhio Beach Option A (Ewa Basin only) __________
b) Kuhio Beach Option B (A +Breakwaters) __________
c) Royal Hawaiian Beach (L-spur and T-head) __________
d) Halekulani Option A (Revetments) __________
e) Halekulani Option B (T-Heads) __________
f) Halekulani Option A (T-Heads + SLR) __________

a.

b.

c.

d.

e.

f.

Other comments you want to add?

WAIKĪKĪ BEACH COMMUNITY ADVISORY COMMITTEE

HO'OMAU 'O WAIKĪKĪ KAHAKAI

"WAIKĪKĪ BEACH RENEWS ITSELF"

MEETING AGENDA

Date: **Wednesday, February 13, 2019 2:00pm to 4:00pm**

Location: **Queen Kapiolani Hotel- *Leahi Room* 3rd floor**
150 Kapahulu Ave. Honolulu, HI 96815
(Parking located across Kapahulu at the Zoo parking lot)

Host: Waikīkī Beach Special Improvement District Association (WBSIDA)

Contact: Dolan Eversole, University of Hawai'i Sea Grant/WBSIDA
Cell (808) 282-2273 email: eversole@hawaii.edu

MEETING AGENDA

1. **Waikīkī Beach Community Advisory Committee Updates** (10 mins)
    a) Advisory committee composition. (Introduce new members)

2. **Waikīkī Priority Project Areas – DLNR EIS Project Scope** (60 mins) (Handout)
    a) DLNR Waikīkī EIS project background, goals and scope.
    b) September 27, 2018 meeting conceptual designs ranking summary. (Handout)
    c) Review beach maintenance techniques for Waikīkī.
        i. Ft DeRussy sand back-passing
        ii. Waikīkī Beach maintenance (Royal Hawaiian Cell)
        iii. Small-scale dredging systems
        iv. Kuhio Beach basin improvements
    d) Group discussion, questions and comments.

3. **Waikīkī Beach Improvement Project Status Update (**30 mins)
    a) Royal Hawaiian groin.
    b) Kuhio Beach sandbag groin.
    c) Repair of Kuhio Sand-filled Mattress
    d) Post-storm assessment

4pm Pau

WBSIDA
Waikiki Beach
SPECIAL IMPROVEMENT
DISTRICT ASSOCIATION

WAIKĪKĪ BEACH COMMUNITY ADVISORY COMMITTEE

Tuesday, February 13, 2019 2:00pm to 4:00pm

SIGN IN SHEET

	Name	Organization	Email
1	Robert Finley	WNR #9	bob2222@hawaii.rr.com
2	Debi Bishop	Hilton	debi.bishop@hilton.com
3	Connie DeGuair	Hilton/WBCA	connie.deguair@hilton.com
4	~~John Clark~~	FWB	jclark@hawaii.rr.com
5	DAVID SMITH	SEA ENGINEERING	DSMITH@SEAENGINEERING.COM
6	ANDY BOHLANDER	SEA ENGINEERING	abohlander@seaengineering.com
7	JASON WOLL	DPR - C+C of Hon	jwoll@honolulu.gov
8	Katie Guye	DIVE OAHU	katie@diveoahu.com
9	Revell Newton	Outrigger Waikiki	revell.newton@outrigger.com
10	BRETT GREENBERG	AQUALANI BEACH + OCEAN REC	bgreenberg@aqualani.com
11	[illegible] Kwon	Quiksilver	[illegible]
12	Jim Fulton	WBSIDA	jimfulton1010@gmail.com
13	Chip Fletcher	UH	fletcher@soest.hawaii.edu
14	Melissa Agbayani	DLNR ENG	melissa.m.agbayani@hawaii.gov
15	JOHN DATILES	DLNR ENG	JOHN.M.DATILES@HAWAII.GOV
16	Dolan Eversole	UH Sea Grant	


Waikiki Beach Littoral Cells
Ft DeRussy
Halekulani
Royal Hawaiian
Kuhio
Queens
Kapiolani
Kaimana

WAIKĪKĪ BEACH COMMUNITY ADVISORY COMMITTEE MEETING MINUTES

Date: Wednesday, February 13, 2019 2:00pm to 4:00pm
Location: Queen Kapiolani Hotel- Leahi Room 3rd floor
150 Kapahulu Ave. Honolulu, HI 96815
Contact: Dolan Eversole, University of Hawai‘i Sea Grant/WBSIDA
email: eversole@hawaii.edu

MEETING SUMMARY

I. Waikīkī Beach Community Advisory Committee Updates

a) Advisory committee composition. (Introduce new members)
b) September 27, 2018 meeting conceptual designs ranking summary. (Handout)

II. Waikīkī Priority Project Areas – DLNR EIS Project Scope (Handout)

a) DLNR Waikīkī EIS project background, goals and scope.

- Presenter: Dolan Eversole (Hawaii Sea Grant / WBSIDA)
- Introductions (# of attendees = 18)

Review of last WBCAC meeting

- Review summary results of 9/27/2018 WBCAC meeting (Eversole)
- Primary goal of WBCAC is to obtain feedback from key stakeholders to inform conceptual planning for beach improvement projects.
- Review of past WBCAC assessments and how this information is being used to direct the next design phase of the EIS project.
- WBCAC identified priority project cells (Kuhio, Royal Hawaiian, Halekulani)
- WBCAC ranked conceptual project designs for each cell.
  - Halekulani beach cell groin field
  - Royal Hawaiian beach maintenance
  - Kuhio swim basins improvements
- WBCAC informed selection of engineering design criteria for each cell. Feedback included assets & values, issues & problems, and potential solutions.
- WBCAC preferred solutions for priority cells:
  - *Kuhio* – beach maintenance (concerns re: ocean safety and water quality)
  - *Royal Hawaiian* – beach restoration/maintenance using locally sourced sand, no new structures
  - *Halekulani* – beach expansion or creation
- Offered Committee the opportunity to share comments or concerns as a critical juncture in the EIS process.
- *Questions and discussion.*

Project-Specific updates

- Presenter: David Smith, PhD (Sea Engineering, Inc.)
- Sand is a critical component of any beach restoration project.
- Concerns re: sand, color, odor, fines (turbidity), coarse material (cobble), fracturing.
- Sand recovery methods:
  - Pneumatic sand conveyance system (unsuccessful in 2012).
  - Hydraulic dredge & pump from offshore sand deposits (successful in 2006, 2012).
  - Clamshell dredge & barge from offshore sand deposits.
  - "Eddy Pump" small-scale diver-operated dredge.
- Sand conveyance methods:
  - Pumping and back-passing
  - Conveyor belts can transport sand from barge to truck and truck to beach.
- Group discussion, questions and comments.
  - Committee discussion on the merits of sand quality and how to sort or filter undesirable components.
  - Discussion regarding small-scale pumping systems and the possibility of utilizing a system in Waikīkī.

Questions and discussion.

III. Waikīkī Beach Improvement Project Status Update

a) Royal Hawaiian Groin Replacement

- Presenter: Dolan Eversole (Hawaii Sea Grant / WBSIDA)
- Nearing the end of the regulatory permitting process.
- Anticipate construction commencing Winter 2019 to Spring 2020.
- Project duration 2-3 months.
- Project will require partial beach closure (likely in the mornings) during construction.
- Staging and construction area at the Royal Hawaiian beach fronting the Royal Hawaiian hotel likely to be significant and ongoing during construction.

b) Kuhio Beach Sandbag Groin

- Presenter: Dolan Eversole (Hawaii Sea Grant / WBSIDA)
- Short-term project (5-10yrs) to allow us to develop/implement a long-term solution.
- All permit applications have been submitted and are under review.
- Anticipate construction commencing Fall, 2019 (Sep-Nov).
- Project duration 2-3 weeks and will require partial beach closure at Kuhio Beach park.

c) Post-storm assessment (Feb 10 high wind/surf event)

- Presenter: Dolan Eversole (Hawaii Sea Grant / WBSIDA)
- Kona Low event transported a substantial volume of sand to the Diamond Head end of Royal Hawaiian Beach, adjacent to the Kuhio swim basin.
- Overall the event was beneficial to Waikīkī by increasing beach sand volumes.
- Sand-filled mattress was damaged in summer of 2018 and repairs are being planned.
- Diamond Head side of Royal Hawaiian Groin experienced seasonal erosion.
- No other storm impacts were observed or discussed.

WAIKĪKĪ BEACH COMMUNITY ADVISORY COMMITTEE

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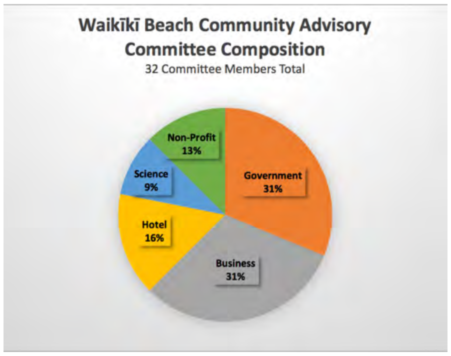

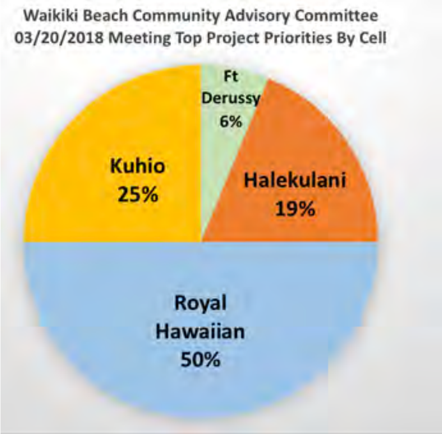

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Goal: Evaluate and rank potential conceptual designs.

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Conceptual Design Ranking Exercise – Results

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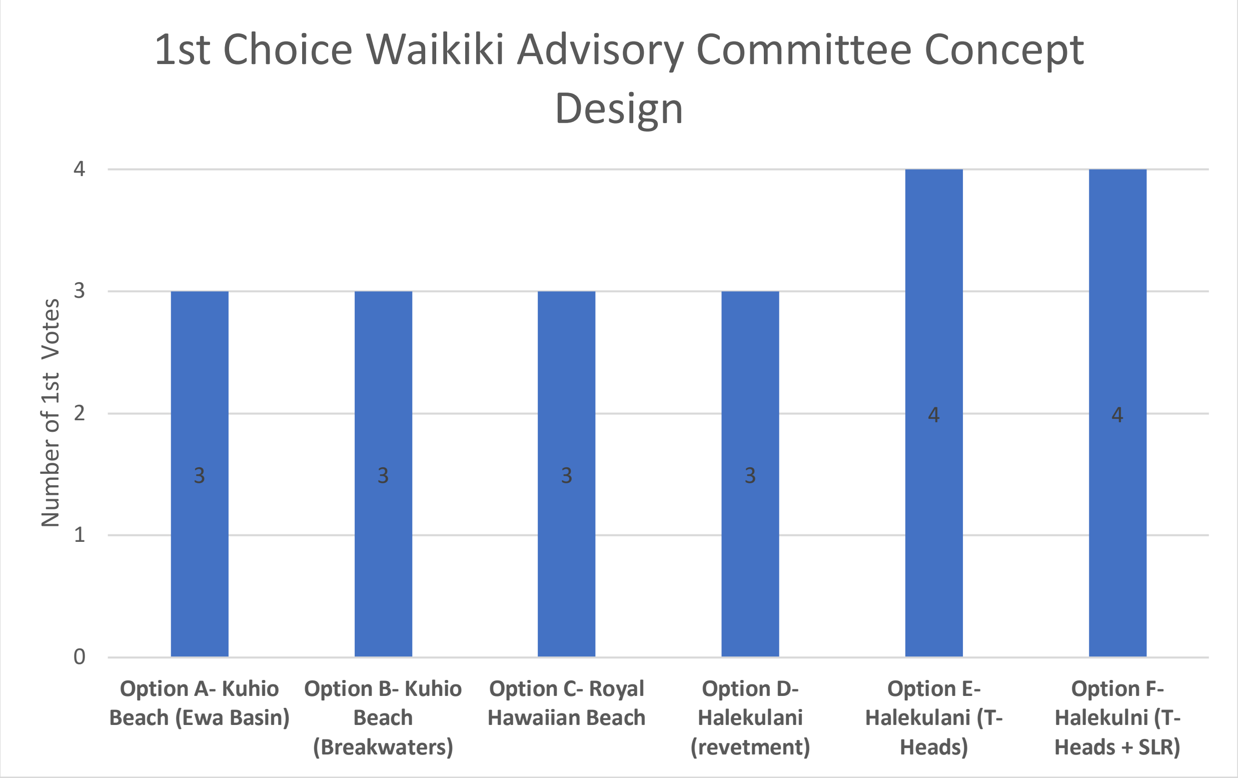

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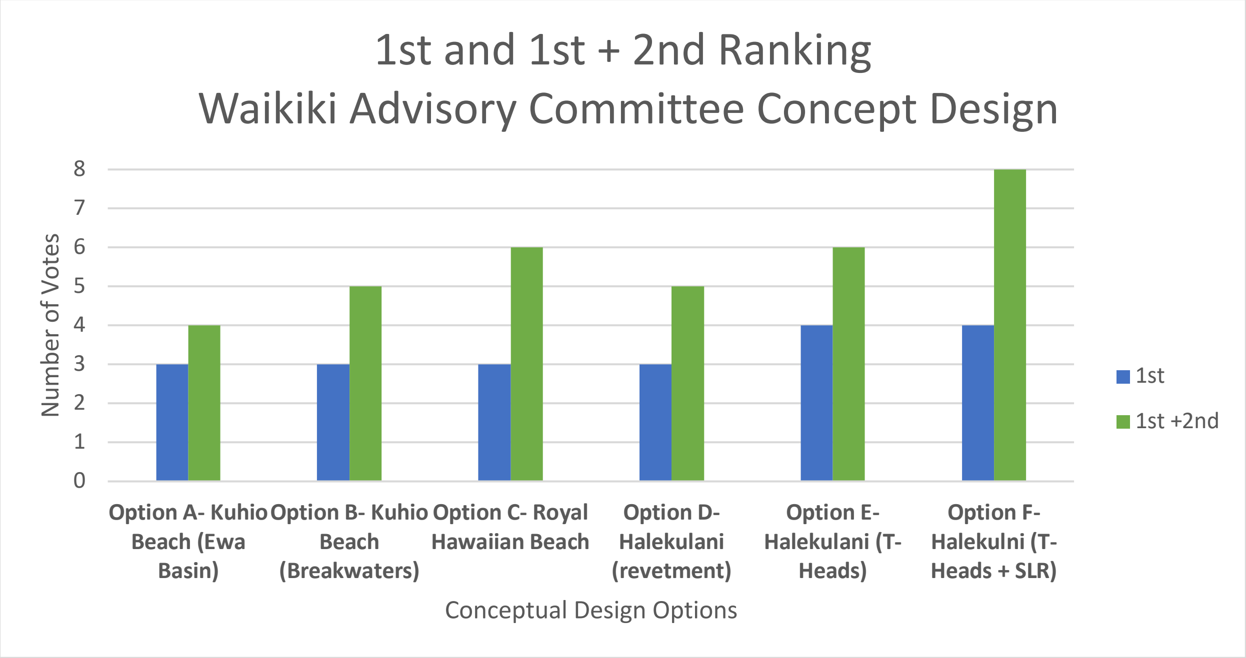

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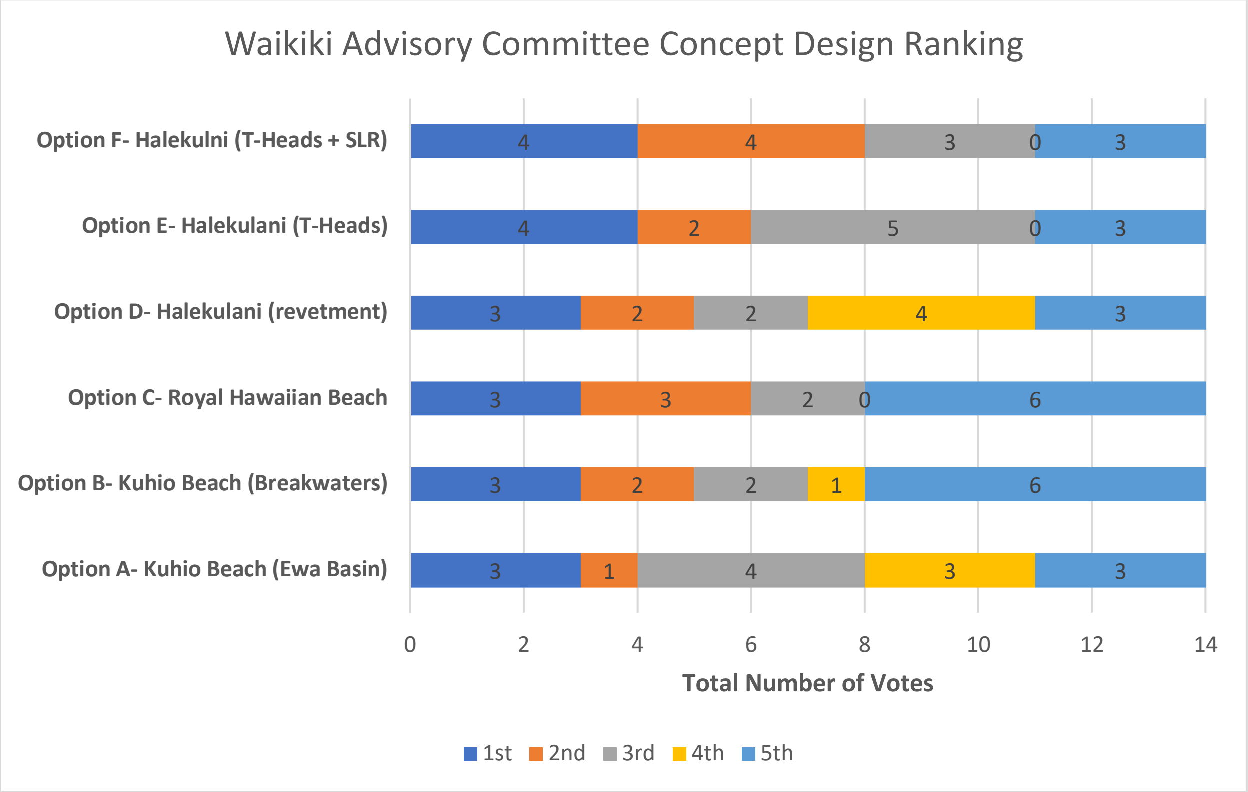
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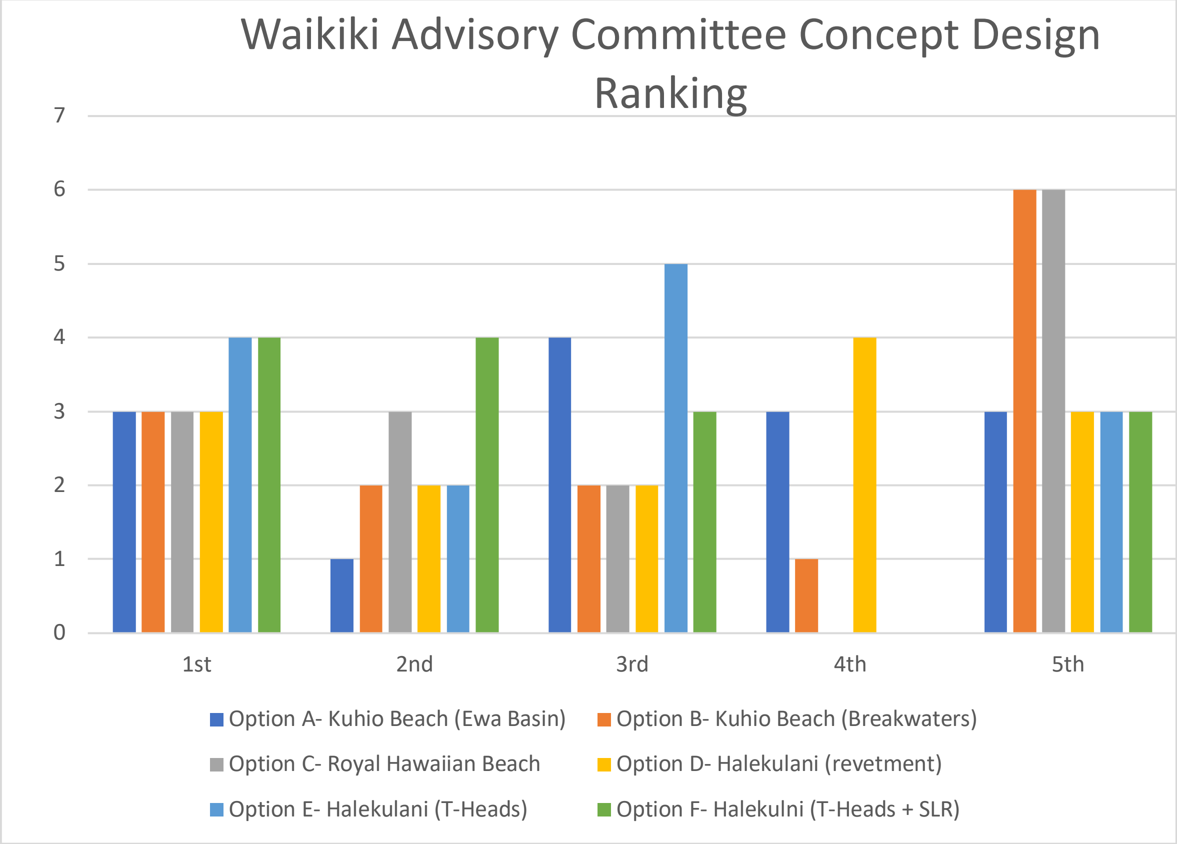
Option B- Kuhio Beach (Breakwaters) 3 2 2 1 6
Option A- Kuhio Beach (Ewa Basin) 3 1 4 3 3
0
2
4
6
8
10
12
14
Total Number of Votes
1st
2nd
3rd
4th
5th


Waikiki Advisory Committee Concept Design Ranking
7
6
5
4
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5th
Option A- Kuhio Beach (Ewa Basin)
Option B- Kuhio Beach (Breakwaters)
Option C- Royal Hawaiian Beach
Option D- Halekulani (revetment)
Option E- Halekulani (T-Heads)
Option F- Halekulni (T-Heads + SLR)

Conceptual Design Ranking Exercise – Additional Committee Written Comments Received (In no particular order)

1. No T-Heads
2. Safety critical for locals and visitors
3. Surf and recreation important
4. In favor of T-Heads but not the groins leading from shore to the heads.
5. Favor Breakwaters over groins
6. All structures are temporary, plan accordingly
7. Fully support T-Groins just need more details
8. Option A is good but B is better but need 3 more groins towards Kapahulu groin
9. Option C is good but need to take out T-Groin inshore of Canoes
10. Option E is good but need to move western most groin out of Halekulani channel
11. Option B- need to add replacement for Slippery Wall (Kuhio Breakwall)
12. Consider Multi-modal groins for safety, designed for safe access.
13. Design safe water entry areas and signage
14. Allow more mauka room for a beach to form and elevate beach
15. Design multi-use recreational access (stairs) rather than restrict access.
16. Safety concern for eddie formation and current flows (Koolina lagoon example)
17. Possible impacts of sand movement Ewa side of T-head

Appendix A: Sample of Conceptual Design Ranking Sheet

NAME: ______________________________________

Waikīkī Beach Conceptual Designs- Comment Sheet

1= no support, 5 = fully support

What is your level of your support for the following conceptual designs?

1-5 Scale

a) Kuhio Beach Option A (Ewa Basin only) __________
b) Kuhio Beach Option B (A +Breakwaters) __________
c) Royal Hawaiian Beach (L-spur and T-head) __________
d) Halekulani Option A (Revetments) __________
e) Halekulani Option B (T-Heads) __________
f) Halekulani Option A (T-Heads + SLR) __________

a.

b.

c.

d.

e.

f.

Other comments you want to add?

____

____

____

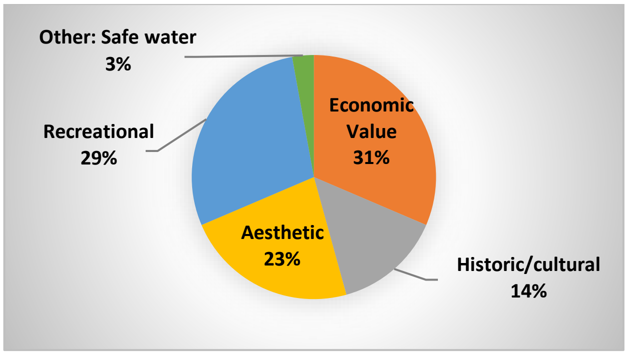
____

____

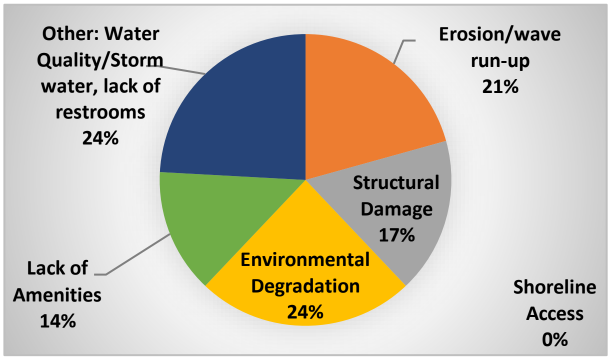
Waikīkī Beach Engineering Design Criteria

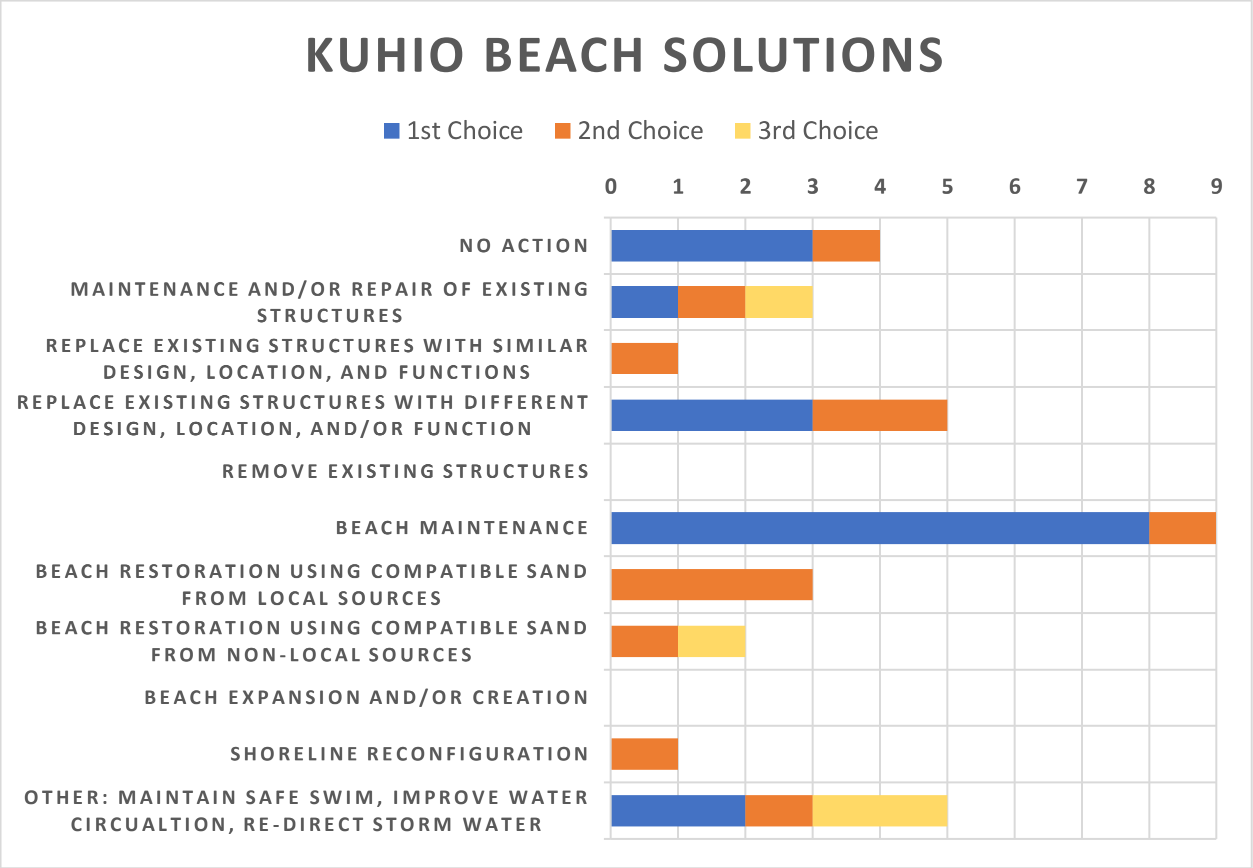
KUHIO BEACH
WAIKIKI

ASSETS & VALUES



ISSUES & PROBLEMS





Waikīkī Beach Engineering Design Criteria

DESIRED ASSETS & USES

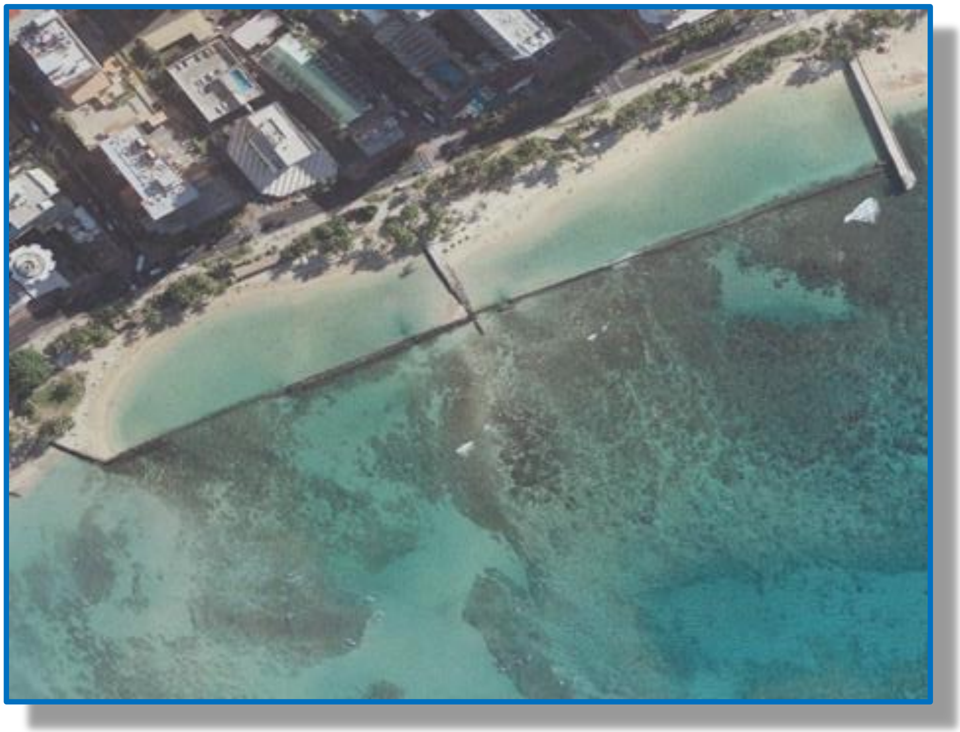
- Maintain calm and shallow water uses and beach-ocean interaction (swimming, bathing)
- Maintain ocean access at Ewa basin (Surfing access)
- Maintain existing commercial uses
- Maintain cultural/historical sense of place
- Maintain public access along Kapahulu groin and esplanade
- Preserve/protect surf sites (Walls, Queens, Baby Queens)

EXISTING ISSUES & PROBLEMS

- Beach Erosion and seaward slumping
- Water quality impacts
- Infrastructure and amenities lack of maintenance
- Seasonal beach erosion
- Public safety hazard on breakwater
- Beach loss at Diamond Head end of beach cell

DESIGN STRATEGIES & OPTIONS

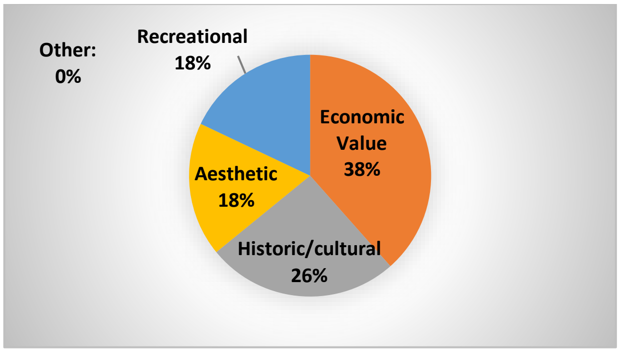
- Beach maintenance and restoration using locally sourced sand
- Small-scale beach maintenance (use existing basin sand for beach profile shaping)
- Replace existing structures with a different design function
- Improve water quality within basin (additional testing)
- Reduce sand loss through the breakwater channel
- Stabilize/manage seasonal beach dynamics



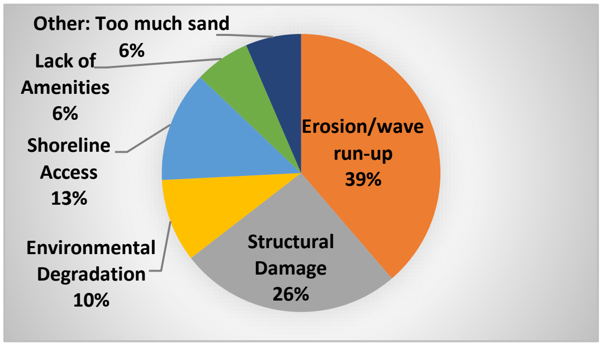
Waikīkī Beach Engineering Design Criteria

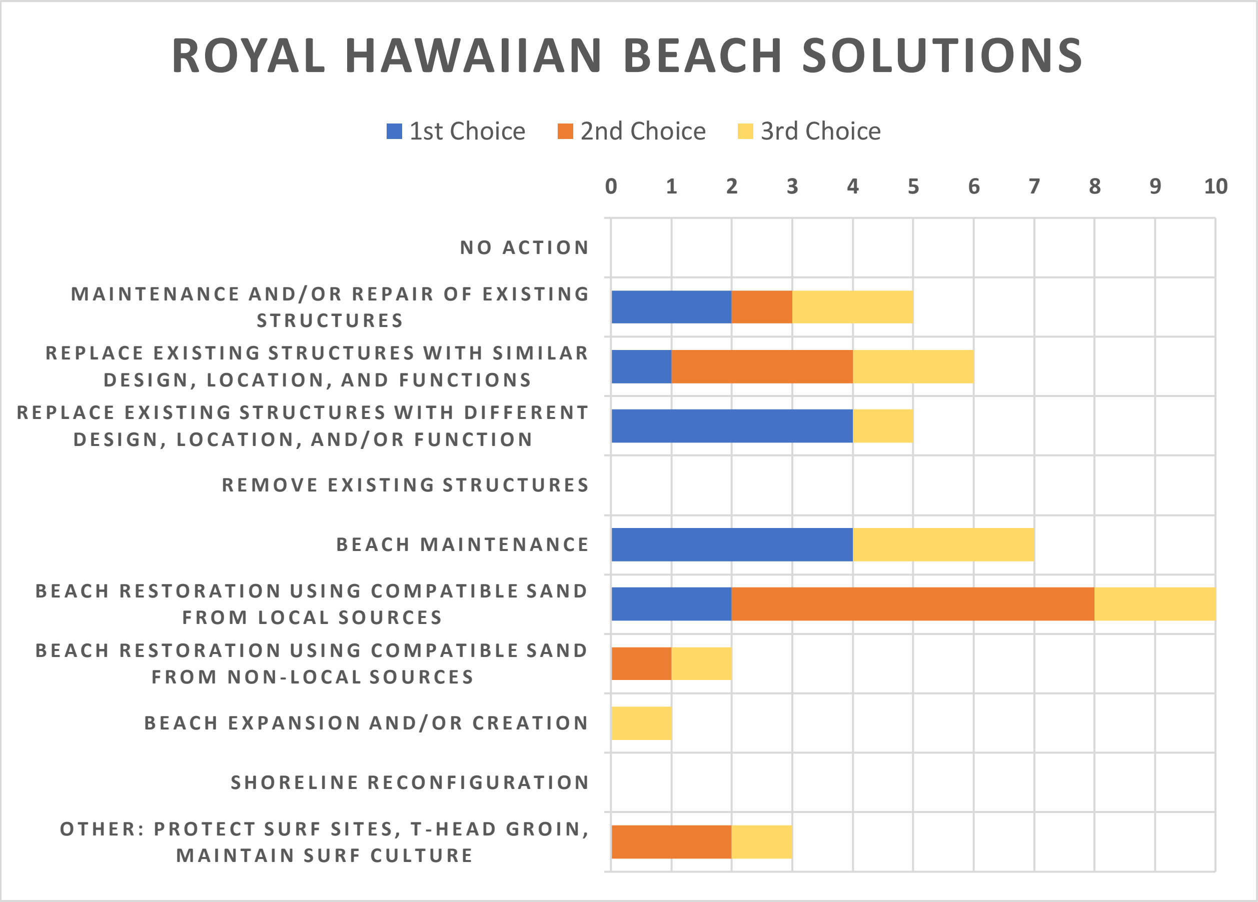
ROYAL HAWAIIAN BEACH, WAIKIKI

ASSETS & VALUES



ISSUES & PROBLEMS





Waikīkī Beach Engineering Design Criteria

DESIRED ASSETS & USES

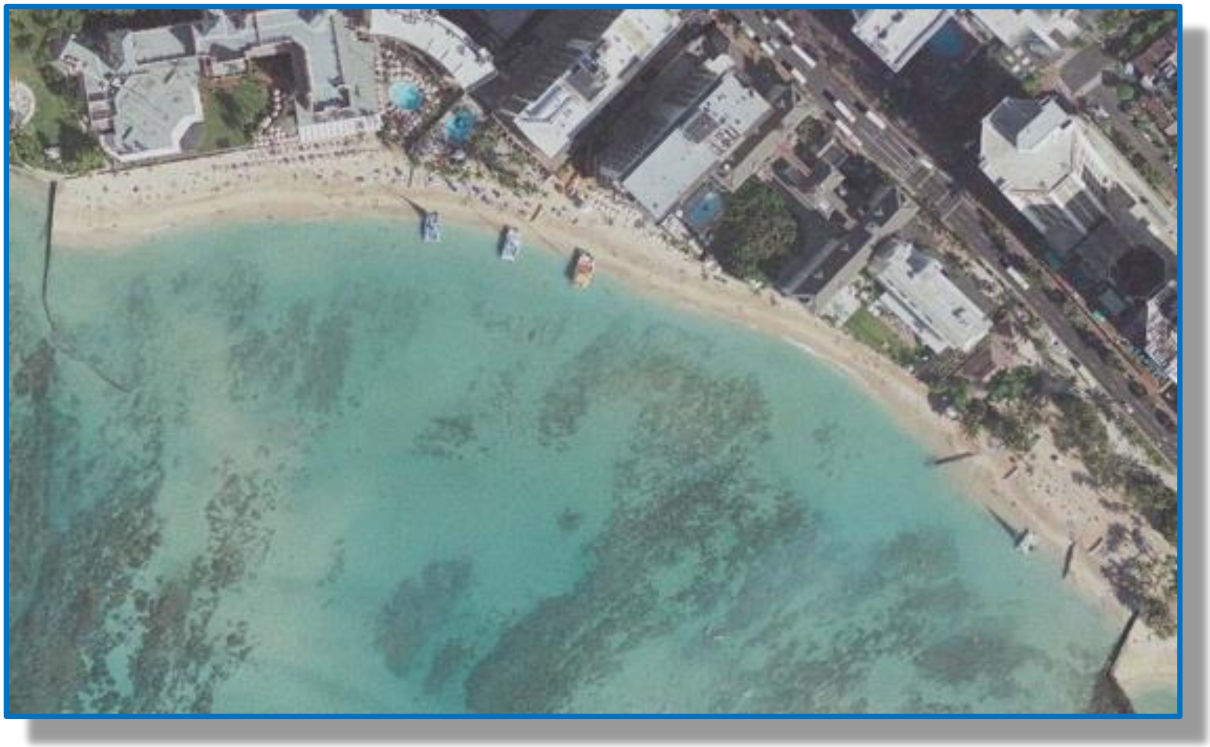
- Active uses and dynamic beach-ocean interaction
- Maintain mixed recreational use (swimming, surfing, bathing)
- Maintain economic/commercial use (catamarans, canoes, surf lessons/beach rentals)
- Maintain cultural/historical sense of place
- Maintain vessel ingress/egress through channel
- Preserve/protect surf sites (Canoes, Queens, Baby Queens)

EXISTING ISSUES & PROBLEMS

- Beach Erosion/Wave Run-up
- Seasonal beach erosion
- Structural failure of structures
- Limited seasonal lateral access
- Beach loss at Diamond Head end of beach cell

DESIGN STRATEGIES & OPTIONS

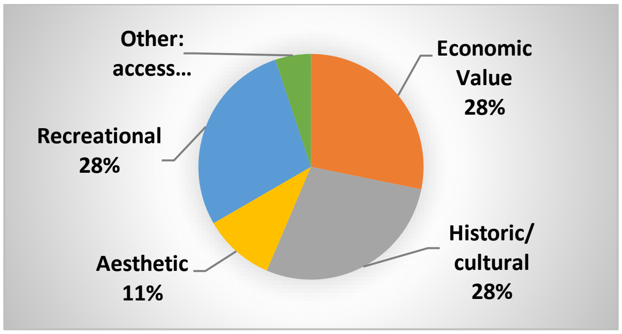
- Beach restoration using locally sourced sand
- Small-scale beach maintenance (use nearshore sandbar for sand back-passing)
- Replace existing structures with similar design
- Limited new shoreline structures-preserve open beach and view planes
- Improve lateral access alongshore (Pinch point at Moana)
- Reduce sand loss through the sand channel
- Stabilize/manage seasonal beach dynamics



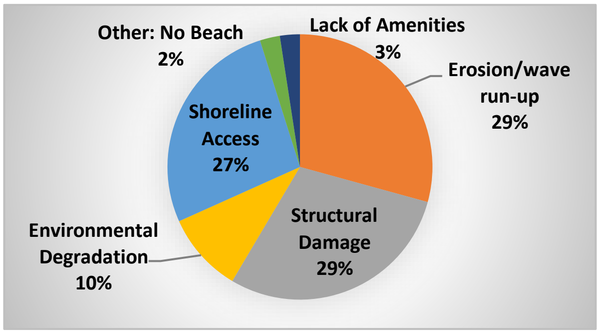
Waikīkī Beach Engineering Design Criteria

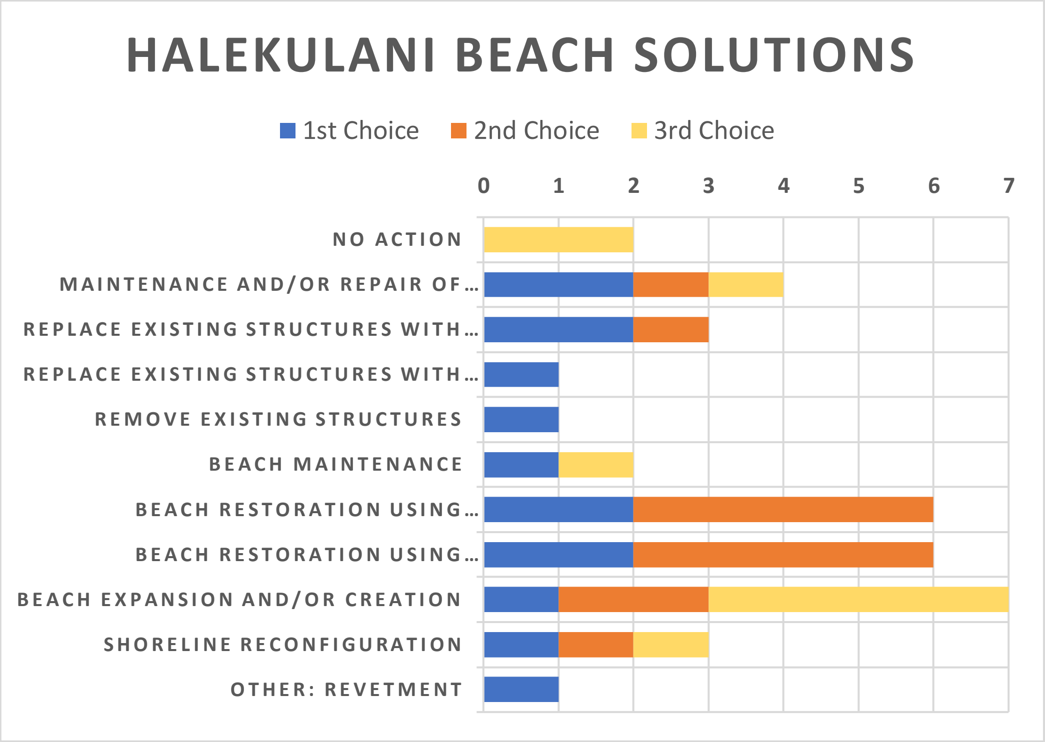
HALEKULANI BEACH, WAIKIKI

ASSETS & VALUES



ISSUES & PROBLEMS





Waikīkī Beach Engineering Design Criteria

DESIRED ASSETS & USES

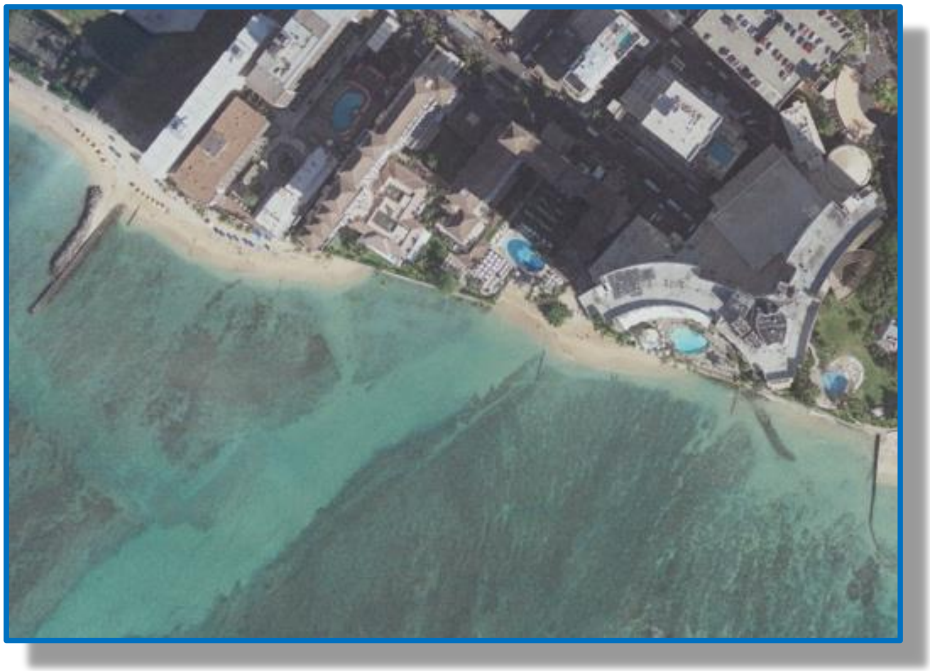
- Maintain mixed recreational use (swimming, surfing, bathing).
- Maintain high level of water quality
- Preserve submarine groundwater discharge at Halekulani Channel (Kawehewehe)
- Maintain vessel ingress/egress through Halekulani channel
- Preserve/protect surf sites (Populars, Threes, Fours)

EXISTING ISSUES & PROBLEMS

- Beach Erosion/Wave Run-up
- Overtopping of seawalls
- Structural failure of seawalls
- Limited lateral access
- Wave reflection off seawalls

DESIGN STRATEGIES & OPTIONS

- Beach Expansion and/or restoration
- Maintain and/or replace existing structures with similar design
- Improve lateral access alongshore (Boardwalk, walkway and/or beach)
- Reduce wave reflection off structures
- Reduce sand loss through the Halekulani sand channel
- Improve health and resilience of reef ecosystem



WAIKĪKĪ BEACH COMMUNITY ADVISORY COMMITTEE

HO'OMAU 'O WAIKĪKĪ KAHAKAI

"WAIKĪKĪ BEACH RENEWS ITSELF"

MEETING AGENDA

Date: **Wednesday, October 30th, 2019 2:00pm to 4:30pm**

Location: **Waikiki Beach Marriott Resort & Spa**
Kaimuki 1 Room 2nd floor Kealohilani tower (makai tower)
2552 Kalakaua Avenue (Parking is validated- Kealohilani tower)

Host: Waikīkī Beach Special Improvement District Association (WBSIDA)
Contact: Dolan Eversole, University of Hawai'i Sea Grant/WBSIDA
Cell (808) 282-2273 email: eversole@hawaii.edu

MEETING AGENDA

1. **Waikīkī Beach Community Advisory Committee** (10 mins)
    a) Introductions and advisory committee composition. (Introduce new members)
    b) Review of past meeting summaries and outcomes

2. **Waikīkī Beach Improvement Project Updates (**20 mins)
    a) Kuhio Beach sandbag groin.
    b) Royal Hawaiian groin.
    c) Waikīkī Beach Perception Surveys Update
    d) World Surfing Reserve Application

3. **Waikīkī Priority Project Areas – DLNR EIS Project Scope** (60 mins) (Handout)
    a) DLNR Waikīkī EIS project background, goals and scope.
    b) DLNR Sea-Level Rise R&V Assessment Update
    c) September 27, 2018 meeting conceptual designs ranking summary. (Handout)
    d) Review beach improvement conceptual designs for Waikīkī.
        i. Ft DeRussy sand back-passing
        ii. Halekulani cell concepts
        iii. Waikīkī Beach maintenance (Royal Hawaiian Cell)
        iv. Small-scale dredging systems
        v. Kuhio Beach basin concepts
    e) Group discussion, questions and comments. (60 mins)

4:30pm Pau Optional social 5-6pm at the pool bar.

WAIKIKI BEACH COMMUNITY ADVISORY COMMITTEE
Marriott Resort Waikiki Beach
October 30, 2019
Meeting Minutes

2:00pm Opening remarks and introductions (Rick Egged, WBSIDA)

2:15pm Review of past meeting outcomes (Dolan Eversole, Hawaii Sea Grant / WBSIDA)

2:25pm Waikiki Beach improvement project updates (Sam Lemmo, DLNR OCCL)

Kuhio Beach Sandbag Groin

Press release 10/30
Construction begins 11/04
Will be doing daily monitoring
K. Downing – is sand fill for bags compatible with the existing beach? Is it sand or crushed coral? What is plan when groin fails; how long will bags remain in place?
S. Lemmo – if it fails, we will adapt it or remove it; sand fill would be disposed of off-site; sandbags are larger than those used at Royal Hawaiian Groin;
C. Fletcher – what is failure and what is success? Will beach cell be more stable than what is currently there? Flanking will lead to proliferation of groins. Is the beach in this area an erosional or depositional feature?
S. Lemmo – failure is if sand does not remain stable in the beach cell or significant flanking occurs on the downdrift side;
K. Downing – does it make sense to spend money to repair this area temporarily or just focus on a larger, more permanent solution.

Royal Hawaiian Groin Replacement

Construction planned for Jan-Mar 2020
Construction duration will be approximately 3 months
Staging materials at Kuhio Beach
Structure is an L-head rubblemound groin with a concrete cap
Crest elevation was lowered to reduce the structural footprint
K. Downing – is a rubblemound groin stronger or weaker with the concrete spine;
D. Smith – ideally, we would have removed the existing groin; maintaining the existing groin was a condition of the permit; the armor layer is designed for the crown wall to be cast-in-place;
C. Fletcher – K. Downing raised a valid point; recommend further detailed analysis be conducted prior to final design and construction.

3:15pm Discussion of Waikiki as a *World Surfing Reserve* (Dolan Eversole)
K. Downing – what has this organization done to help any of the beaches that have been designated as world surfing reserves?
D. Eversole – one example where land was purchased to create a conservation easement.

3:30pm BREAK

3:40pm Waikiki EIS Update (Sam Lemmo) Strong emphasis on climate resilience

4:00pm Beach Improvement Conceptual Designs (David Smith)
S. Lemmo – does Kuhio design take into consideration the erosion hot spot at the Waikiki Tavern?
R. Porro – any adaptable features in the design so the structures can be modified for higher sea level?
D. Smith – designed to be equipment-accessible with the idea that future modifications will be necessary.
D. Eversole – are there other materials (other than rock), such as modular structures?
D. Smith – could use coral, concrete armor units, etc.; other options that would need to be evaluated.
C. Fletcher – Fort DeRussy sand in borrow v' placement areas is different; borrow area is crushed coral that is easily cemented; what is origin of sand in the placement area?
C. Fletcher – Royal Hawaiian Beach compaction, cementation, fracturing caused by trucking; also turbidity
R. Porro – projects seem to be discrete; are they are plans for recurring maintenance; if there is an approved maintenance plan, FEMA funding could be available after a disaster.

ADDITIONAL NOTES

- Questions are generally technical and focused on engineering challenges.
- Why are we encasing the existing RHG? Who made this requirement and why?
- Need to show model conditions on slides (wave height, direction, period).
- Need 3D renderings in addition to 2D plan views.
- For EIS, need to explain that shoreline has been consistently re-engineered over the past century (show examples of 3-4 photos showing evolution of each area); projects are relatively small in the context of the history of Waikiki.
- Investigate including a "maintenance program" to qualify for FEMA post-disaster funds.

WBSIDA
Waikiki Beach
SPECIAL IMPROVEMENT
DISTRICT ASSOCIATION

Sea Grant
University of Hawai'i

WAIKĪKĪ BEACH COMMUNITY ADVISORY COMMITTEE

Wednesday, October 30, 201~~8~~9 2:00pm to 4:30pm

SIGN IN SHEET

Name	Organization	Email
Dolan Eversole	WBSIDA	eversole@hawaii.edu
Ted Bush	"	tedb@waikikibeachservices.com
RUS MURAKAMI	SSA	RUSMURAKAMI@KMSSA.COM
Melissa Agbayani	DLNR ENG	melissa.m.agbayani@hawaii.gov
JOHN DATILES	" "	JOHN.M.DATILES@HAWAII.GOV
ANDY BOHLANDER	SEA ENGINEERING	abohlander@seaengineering.com
John Clark	FWB	jclark@hawaii.rr.com
BRETT GREENBERG	AQUALANI	Bgreenberg@AQUALANI.COM
Katie Gruye	Dive Oahu	Katie@diveoahu.com
Neal Sklodowski	Halekulani	neal.sklodowski@halekulani.com
Bob [illegible]	WUA	
Rob Porro	UH NDPTC	rjporro@hawaii.edu
SAM LEMMO	DLNR	sam.j.lemmo@hawaii.gov
Chip Fletcher	UH	
Kristian McDonald		
Chryssaldo thomas	outrigger	chryssaldo.thomas@outrigger.com
JASON WOLL	C&C Hon DPR	jwoll@honolulu.gov
Jim [illegible]	WBSIDA	
Michele Nekota	DPR	
Revell Newton	Outrigger Waikiki	revell.newton@outrigger.com
JACOB VANDOR	DIVE OAHU	JACOBVANDOR@GMAIL.COM
DiDi [illegible]	ABS	✓

Waikīkī Beach Community Advisory Committee
Ho'omau 'O Waikīkī Kahakai
"Waikīkī Beach Renews itself"

MEETING AGENDA

Date: **Tuesday, January 19th, 2020 2:00pm to 3:30pm**

Location: **Zoom Meeting**
https://us02web.zoom.us/j/82555500228?pwd=SzJWbTJycWtvUkFzeW5yN282Q243QT09
Meeting ID: 825 5550 0228 Passcode: 889179
One tap mobile +12532158782,,82555500228#,,,,*889179# US

Host: Waikīkī Beach Special Improvement District Association (WBSIDA)
Contact: Dolan Eversole, University of Hawai'i Sea Grant/WBSIDA
Cell (808) 282-2273 email: eversole@hawaii.edu

MEETING AGENDA

1. **Waikīkī Beach Community Advisory Committee** (10 mins)
   a) Welcoming, introductions and committee background.

2. **Waikīkī Beach Maintenance Project Updates (**20 mins)
   a) Royal Hawaiian groin
   b) Waikīkī Beach Maintenance Project

3. **Waikīkī Beach Improvements –EIS Project Scope** (30 mins) (Handout)
   a) Waikīkī EIS project background, goals and scope.
   b) Review beach improvement and maintenance conceptual designs for Waikīkī.
      i. Fort DeRussy Beach Sector – Beach Maintenance (sand back passing)
      ii. Halekūlani Beach Sector – Beach Construction with Stabilizing Groins
      iii. Royal Hawaiian Beach Sector - Beach Nourishment
      iv. Kūhiō Beach Sector ('Ewa Basin) – Beach Nourishment & Segmented Breakwater
      v. Kūhiō Beach Sector (Diamond Head Basin) – Beach Maintenance
   c) Group discussion, questions and comments. (30 mins)

3:30pm Pau

WAIKIKI BEACH COMMUNITY ADVISORY COMMITTEE
January 19, 2021
Meeting Minutes

2:00pm Opening remarks and introductions (Rick Egged, WBSIDA - Dolan Eversole, Hawaii Sea Grant/ WBSIDA)
Dolan added links to chat regarding the advisory committee and future beach maintenance project:
https://www.wbsida.org/waikiki-beach-community-advisory-committee
https://www.wbsida.org/waikiki-beach-maintenance

2:10pm Waikīkī Beach Community Advisory Committee (Dolan Eversole)
Review of last year's meeting minutes, review of criteria used in the Waikīkī master planning and how they were established. Review of executive summary regarding WBSIDA and goals. Review of documents attached in meeting invitation email.
No questions asked.

2:20pm Waikīkī Beach Maintenance Project Updates (Dolan Eversole, Hawaii Sea Grant WBSIDA)
Waikīkī Beach Maintenance Project 2021
Provided brief intro regarding Royal Hawaiian Groin and Kūhiō Sandbag Groin. 2021 Waikīkī beach maintenance project similar in scope to 2012 maintenance project. Mobilization will begin in late January and expected to take 2 weeks. Sand recovery/dewatering/transport/placement to begin in February and expected to take 3-4 months. Expect to be demobilized sometime in May and completely finished by June. Outreach material provided to public including FAQ webpage.
Questions (asked via chat window):

- Mike Foley - Cost of the renourishment project?
  Answer: Between $3-4 million
- Chip Fletcher – How long from start to stop?
  Answer: Up to 4 months

2:40pm Waikīkī Beach Improvements –EISPN Project Scope
Waikīkī EIS project background, goals and scope (Sam Lemmo, DLNR OCCL)
Hope to be finished with EIS process by end of 2021.
Dolan shared the following project link:
https://dlnr.hawaii.gov/occl/waikiki/

Review beach improvement conceptual designs for Waikīkī (Andy Bohlander – SEI)
OEQC Process: Environmental Impact Statement Preparation Notice (EISPN)
EISPN published 12/23/20
Public scoping meeting 1/7/21
Draft PEIS expected to be published Spring 2021
Intro on early consultation process. Background – Economically important to state through tourism, beach is heavily engineered and in deteriorated state.

Offshore Sand Resources/Deposits – Reef Runway, Ala Moana, Hilton, Halekulani, Canoes/Queens, Diamond Head
Overview of Waikīkī beach sectors and erosion/flooding issues experienced in each
Reviewed concept designs for each of the four identified projects in the EISPN including:

1. Fort DeRussy Beach Sector
   - Proposed Action: Beach Maintenance (Sand Back passing)
   - Requires ~1,200 cubic yards of sand

2. Halekūlani Beach Sector
   - Proposed Action: Beach Construction with three Stabilizing Groins, potential for ADA access
   - Requires ~60,000 cubic yards of sand

3. Royal Hawaiian Beach Sector
   - Proposed Action: Beach Nourishment, no new structures proposed
   - Requires ~25,000 cubic yards of sand

4. Kūhiō Beach Sector
   - Proposed Action: Beach Nourishment, Segmented Breakwater (ʻEwa Basin)
   - Proposed Action: Beach Maintenance (Diamond Head Basin)
   - Requires ~28,500 cubic yards

3:35pm Group discussion, questions and comments.

- Mike Murray - (via chat box) - Dolan, Great presentation!! Trying to indoctrinate myself with the overall projects. The sites, you shared, past meeting minutes helped a lot! I do apologize as I need to leave the meeting just after 3! Mahalo, mm
- Chip Fletcher (via chat box) - Gotta leave for another meeting. Thanks Sam, Andy and Dolan!
- Dolan – Asked to expand on function and use of small scale dredge systems
  Answer (Andy B) – These are diver operated systems that transport sand from nearshore areas (~60 cubic yards of sand per hour, or 360 cubic yards per day.). Fort DeRussy, Hilton channel, Hilton lagoon, sandbar off of Royal Hawaiian, Kūhiō swim basins are potential candidates.
- Dolan (follow up) – How do these systems compare to truck hauling regarding production rate?
  Answer (Andy B) - Unclear but something they would love to test. Exploring options to conduct a demonstration project.
- Rob Porro – (via chat box) - Great presentation, Andy. Question regarding SLR - what SLR projection was used for the projects? Is there any modularity/flexibility built in to the designs if SLR is higher than expected?
  Answer (Andy B) – 50 year design life based on Sweet et. al. (2017) NOAA SLR projections.

(Dolan added) – Royal Hawaiian Groin modified the design to account for SLR.

Dolan shared website: https://dlnr.hawaii.gov/occl/files/2021/01/2020-12-23-OA-EISPN-Waikiki-Beach-Improvement-and-Maintenance-Program.pdf

- Darren Lerner – (via chat box) Thanks everyone. Gotta run!

3:45pm Pau

1-19-21-Waikiki Beach Community Advisory Committee Registration Report

First Name	Last Name	Registration Time	Approval Status	
Kalani	Kaanaana	2021-01-16 12:56:46	approved	
Scott	Sullivan	2021-01-07 14:52:33	approved	
Neal	Sklodowski	2021-01-07 12:04:47	approved	
Andy	Bohlander	2021-01-07 07:50:53	approved	
soostover		2021-01-11 10:43:23	approved	
Mike	Shaff	2021-01-07 05:08:27	approved	
Meghan	statts	2021-01-07 06:57:56	approved	
Shellie	Habel	2021-01-16 13:15:37	approved	
Doorae	Shin	2021-01-07 13:32:50	approved	
Roberto	Porro	2021-01-07 15:28:19	approved	
Lee	Nakahara	2021-01-07 08:32:44	approved	
Darren	Lerner	2021-01-19 11:57:35	approved	
Jason	Woll	2021-01-19 13:51:48	approved	
David	Smith	2021-01-12 13:44:41	approved	
George	Parsons	2021-01-07 09:53:25	approved	
Mindy	Sanford	2021-01-07 09:44:38	approved	
Bob	Hampton	2021-01-07 10:45:47	approved	
John	Clark	2021-01-16 11:28:10	approved	
harry	robello	2021-01-07 19:53:27	approved	
Ted	Bush	2021-01-08 09:33:21	approved	
rus	murakami	2021-01-19 10:01:40	approved	
Robert	Finley	2021-01-07 10:12:50	approved	
Richard	Stover	2021-01-11 10:34:32	approved	
Dolan	Eversole	2021-01-16 10:38:25	approved	
Jim	Fulton	2021-01-17 12:59:41	approved	
Rick	Egged	2021-01-19 11:08:45	approved	
Matthew	Gonser	2021-01-19 13:18:53	approved	
Mike	Foley	2021-01-19 13:58:48	approved	
brett greenberg		2021-01-07 10:48:07	approved	

sam	lemmo	2021-01-19 11:20:12	approved	
Chip	Fletcher	2021-01-07 12:07:37	approved	
KEVIN	ALLEN	2021-01-19 14:14:56	approved	
Mike	Murray	2021-01-18 11:31:06	approved	
Giannicola	Tumino	2021-01-19 11:57:30	approved	

24. APPENDIX B: SAND INVESTIGATION REPORT

DRAFT

Sand Source Investigation Report
Waikiki Beach Improvement and Maintenance Program

Waikiki, Oahu, Hawaii

May 2021

Prepared for:
State of Hawaii
Department of Land and Natural Resources
P.O. Box 621
Honolulu, HI 96813

Prepared by:
Sea Engineering, Inc.
Makai Research Pier
41-305 Kalanianaole Hwy
Waimanalo, HI 96795

Job No. 25548

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APPENDIX A. VIBRACORE LOG SHEETS

LIST OF FIGURES

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1. INTRODUCTION

1.1 Background

The State of Hawaii Department of Land and Natural Resources (DLNR) has initiated the Waikiki Beach Restoration project, which consists of development of shoreline maintenance and improvement projects. The project area extends from the Natatorium west to the Hilton Hawaiian Village. Waikiki Beach is a highly modified urban shoreline, and the shoreline configuration today is largely the result of past efforts to widen and maintain the beach. Waikiki Beach is, at least in part, in a deteriorating state and requires regular maintenance and strategic improvements in order to continue to meet present and future beach needs to serve the growing Waikiki tourism economy. Many sections of Waikiki Beach are substantially narrowed or have been completely lost to erosion due to a long history shoreline modification, chronic and episodic sand loss, a lack of coordinated beach management, and minimal capital investment.

Sea Engineering, Inc. (SEI) has been contracted to accomplish three project objectives; 1) development of a Feasibility Study for beach maintenance/improvement, 2) preparation of an Environmental Impact Statement (EIS) for selected beach improvements, and 3) conceptual design and permitting for selected beach improvements. This work is being accomplished for the Department of Land and Natural Resources (DLNR), Office of Conservation and Coastal Lands (OCCL). Project coordination is also being assisted by the Waikiki Beach Special Improvement District Association (WBSIDA).

A primary objective of the Feasibility Study is to investigate potential sand sources. The potential sources of sand must be carefully evaluated in terms of quality, quantity, recovery cost, and general feasibility. Initial investigations for this project concluded that there was no readily available terrestrial source of suitable sand and that local offshore sand resources should be evaluated.

The following are objectives of this Sand Source Investigation:

1. Collect and review existing information regarding previous South Shore sand investigations
2. Delineate identified sand sources and estimate volumes
3. Delineate other potential sand sources
4. Investigate (map and sample) the potentially viable offshore deposits
5. Analyze the investigation data
6. Produce a report summarizing the findings and applicability of the sand for beach projects

1.2 Data sources in this report

Sea Engineering, Inc. (SEI) has performed offshore sand source investigations for several decades. SEI has worked in both lead and support roles, and company employees have performed sand investigations as employees of other organizations. SEI's knowledge base of offshore sand sources around Oahu is extensive. For the present study, one of the goals was to investigate both new and existing sand sources, in particular, those known to exist but that have not been well sampled. Sources of historical data included the U.S. Geological Survey (USGS) and the University of Hawaii Coastal Geology Group, as well as previous SEI projects. SEI collected historical data and performed sand source investigations on specific sites for the present project.

As this project was progressing, Sea Engineering undertook a project with the City and County of Honolulu to nourish the beach at Ala Moana Regional Park. Sand source investigations were performed as part of that study, and the results are included in this sand report. That project identified a sand source directly offshore of the park extending from 70 feet of water offshore to depths beyond 120 feet. That project also investigated a new deposit off Diamond Head Beach Park, as well as further investigation of certain sites around Waikiki.

2. SAND SOURCE INVESTIGATIONS

2.1 Introduction

A key component to the success of the proposed actions is the availability of a suitable sand source for beach nourishment. The majority of Hawaiʻi beaches are composed of calcareous (calcium carbonate) sand, which is composed of skeletal fragments of marine organisms such as corals, coralline algae, mollusks, echinoids, forams, and minor fractions of terrigenous (i.e., volcanic) sediment. The composition of sand is determined by the relative abundance of each contributing species and varies with location. The density of calcium carbonate is more than 2.7 g/cm^3; however, microscopic pores and hollow grains make the effective density somewhat lower. The density and shape of the individual particles affects the transport characteristics when compared to silica beach sand that is derived from inland sources characteristic of most beaches on continental U.S. coastlines (Smith and Cheung, 2003).

In the past, sand for beach nourishment was typically obtained from other beaches on Oʻahu and Molokaʻi or from inland deposits of relict beach and dune sands that were commercially available. Mokulēʻia sand, mined by Hawaiian Cement, was a high-quality relict beach sand deposit found several hundred meters inland of the existing beach on the North Shore of Oʻahu. The Mokulēʻia sand is moderately sorted, and the median grain size (D_{50}) is 0.60 mm. This sand has reportedly been used for beach nourishment projects at the Hilton Hawaiian Village and Kūhiō Beach. However, this sand source is no longer commercially available.

Maui dune sand was previously mined by Hawaiian Cement and HC&D (formerly Ameron). It is a fine to medium grain sand with a median grain size (D_{50}) of 0.25 mm. The sand contains a relatively high percentage of fines, contains terrigenous sediment (dirt), and has a medium to dark brown color. It has not been used for beach nourishment projects on Oʻahu. In 2017, the County of Maui placed a moratorium on mining of inland dune sand, so this sand is no longer available.

Imported sand has been commercially available for many years to support various industries including but not limited to construction, landscaping, and golf courses. These sands are often composed of quartz minerals and can be ordered to desired sand composition, grain size, density, texture, angularity and color specifications. However, the use of imported sand from outside Hawaiʻi that is not composed of calcium carbonate does not align with State of Hawaiʻi standards and guidelines for beach nourishment.

Offshore marine deposits present an alternative source of sand. These deposits can and have been dredged and transported to shore to support various beach nourishment projects. Offshore sand deposits can provide a suitable source of sand for beach fill and nourishment, particularly when considering the limited availability of suitable, natural sand from inland sources. Offshore sand deposits occurring within the same littoral cell can have grain size characteristics and composition that are similar to the adjacent beach sand. Offshore sands were utilized in the 2006 Kūhiō Beach Nourishment project, and the Waikīkī Beach Maintenance I and II projects in 2012 and 2021, respectively.

2.2 Sand Characteristics and Quality

The State of Hawaiʻi Department of Land and Natural Resources (DLNR) established beach nourishment guidelines, which specify that fill sand used to nourish a beach must meet several specific requirements:

- Sand shall contain no more than 6% fine material (grain size smaller than 0.074 mm).
- Sand shall contain no more than 10% coarse material (grain size greater than 4.76 mm).
- The grain size distribution will fall within 20% of the existing beach sand.
- The overfill ratio of the fill sand to existing sand shall not exceed 1.5.
- Sand will be free of contaminants such as silt, clay, sludge, organic matter, turbidity, grease, pollutants, and others.
- Sand will be primarily composed of naturally occurring carbonate beach or dune sand.

The majority of the current fill sand requirements are related to grain size. In order to ascertain the grain size characteristics, a sieve analysis is performed, which is done by mechanically shaking a sand sample through a series of sieves of decreasing screen size. The material captured on each sieve is weighed, and this establishes the grain size distribution curves. The median diameter (grain diameter that is finer than 50% of the sample), or D_{50}, is often used by engineers to quantify the grain size of a sample. Similarly, D_{16} and D_{84} are obtained, and they are used to quantify the range of grain sizes present in a sample known as sorting, σ, defined by:

$$\sigma = \frac{\phi_{84} - \phi_{16}}{4} - \frac{\phi_{95} - \phi_{5}}{6.6}$$

where $\phi = -\log_2(D)$ where D is given in millimeters. Descriptive sorting values are presented in Table 1-1.

Table 1-1 Sorting value descriptions

Sorting Range (ϕ units)	Description
0.00 – 0.35	very well sorted
0.35 – 0.50	well sorted
0.50 – 0.71	moderately well sorted
0.71 – 1.00	moderately sorted
1.00 – 2.00	poorly sorted
2.00 – 4.00	very poorly sorted
4.00 – ∞	extremely poorly sorted

Color is also an important consideration when determining whether sand is suitable for beach nourishment. While natural calcareous beaches range in color from light brown to white, sand in offshore deposits is typically grayish in color as a result of anaerobic conditions produced by biologic activity and a lack of wave action and associated mixing. Even though an offshore sand source may be suitable in terms of grain size characteristics, as illustrated in several offshore dredging and beach restoration projects in Waikīkī, a persistent gray color can be undesirable. During the 2012 Waikīkī Beach Maintenance I project, the offshore sand was noticeably grayer than the existing beach sand after initial recovery and placement; however, after several weeks of prolonged exposure to subaerial conditions and ultraviolet radiation from the sun, the gray color faded and is no longer discernable from the existing beach sand.

2.3 Methodology

Sea Engineering conducts seafloor investigations from their boats *Huki Pau* and *Huki Pono* (Figure 1-1 and Figure 1-2). The *Huki Pau* is a 74-foot twin-screw workboat set up to support diving and marine construction operations. The vessel has a large open well-deck, knuckleboom crane, and built-in diving stations. The four-point mooring system allows for stable placement of the boat for vibracore operations.

The *Huki Pono* is a 43-foot twin screw workboat set up to support diving and marine survey operations in the Hawaiian islands. The vessel has three steering stations and a large, air-conditioned deckhouse ideal for use as a support center for survey or ROV operations.

Figure 1-1 Sea Engineering's work vessel *Huki Pau*

Figure 1-2 Sea Engineering's research vessel *Huki Pono*

Sea Engineering's offshore sand investigations typically employ the following: sub-bottom profiling, side scan sonar surveys, towed camera surveys, diver reconnaissance and sampling, jet probing, and vibracoring.

Geophysical sub-bottom profiling systems are essentially echo-sounders that use lower acoustic frequencies to penetrate into the substrate. Where common echo-sounders may use an acoustic frequency in the vicinity of 200 kHz, sub-bottom system frequencies are typically between 0.5 kHz and 20 kHz. The term sub-bottom refers to a generally hard layer of sediment or rock that underlies recent soft sediment deposition. The lower the acoustic frequency, the deeper into the bottom the system can penetrate.

Sea Engineering uses an EdgeTech 0512i "chirp" sub-bottom profiler with an EdgeTech 3200XS processing system. The chirp processors use signal processing to shape the acoustic wavelets used to image the substrate, providing significantly greater image resolution than traditional impulsive systems such as boomers and sparkers. Different wavelets are available with the system for use in different terrains. After on-site system deployment, trial survey lines are typically conducted using various pulse configurations. The optimal pulse for the substrate in Waikiki was found to be a 20 ms pulse with a frequency range of 0.5 kHz to 7 kHz. This relatively low frequency range is necessary for penetration into the coralline limestone sands and gravels found in Hawaii. The EdgeTech 0512i system is in fact a specialty system for use in coarse sand environments.

The sub-bottom data is reviewed with EdgeTech software, sub-bottom horizons are digitized for processing, and sand thicknesses are measured at discrete locations along the tracklines. Text files containing position and either bottom or sub-bottom elevations can be outputted for analysis and presentation. Surfaces representing the bottom and sub-bottom can be created and the difference is the volume of sand in the deposit.

Side-scan sonar transmits acoustic signals with wide vertical beam widths out to either side of the sonar towfish. A receiver then records the signals that are reflected back from the seafloor to the towfish. Hard bottom areas and features produce more intense reflections than sediments. The result is a plan view acoustic image of seafloor characteristics, allowing mapping of bottom type across a swath of seafloor.

Jet probing is conducted to determine the thickness of sediments overlying consolidated or hard bottom substrate, and is therefore an important means of testing and verifying sub-bottom profiling accomplished by remote sensing equipment. A jet probe consists of a length of pipe connected to a water pump by flexible hose. A diver jets the pipe and hose vertically into the sediment deposit until “refusal” is encountered. The refusal can be described as hard, crunchy, or soft; hard indicates a solid bottom, crunchy indicates a gravel layer, and soft indicates that the hole is collapsing and seizing the pipe or that there is insufficient hose to penetrate further.

Vibracoring is a method of pushing a thin-walled tube into the sand deposit and extracting a core of sediment up to about 8 ft long. The sand characteristics over the full core can be analyzed and the results interpolated and extrapolated to better characterize the deposit as a whole. Based on the findings, certain areas within the deposit can then be targeted or avoided, as necessary. Sea Engineering’s vibracore is shown on the deck of the *Huki Pau* in Figure 1-3.

Figure 1-3 Vibracore on the deck of the *R/V Huki Pau*

2.4 Data Analysis Techniques

Sand cores obtained from the 2017 sand investigations were analyzed by coastal geologists by dividing the cores into representative layers and assessing overall appearance, including grain type, shell fragments, color, and grain size. Sand samples were obtained from the cores and processed for grain size distribution. These logs are presented in Appendix A of this report for the 2017 field work. The samples were also tested for turbidity. Grain size distribution and turbidity results for other projects are also included in this report.

2.5 Turbidity methodology

Laboratory turbidity tests were performed on numerous sand samples from offshore sites and beaches to evaluate the relative differences in turbidity generation between beach sand and offshore sand and assess possible impacts of turbidity along the beach. Turbidity was determined by measuring the scattering of the light through sample cells that contained distilled water and sand in suspension. A total of 28 offshore samples were analyzed for turbidity as follows:

- *Ala Moana* (7)
- *Halekulani* (6)
- *Hilton* (5)
- *RR—Inner 1a* (6)
- *RR—Inner 1b* (2)
- *Canoes/Queens* (2)

Turbidity was measured using a Hach 2100Q Portable Turbidimeter (Figure 1-4). The instrument has an optical laser configuration that measures the scattering of the light passing through the sample cell (Figure 1-5). Turbidity is measured in Nephelometric Turbidity Units (NTUs), a standard turbidity unit for United States environmental monitoring. The instrument was calibrated once before the first experiment using the manufacturer's 20, 100, and 800 NTU StablCal primary calibration standards and the 10 NTU primary verification standard. The cells used for the turbidity readings were glass Hach Lab Turbidimeter Sample Cells.

All sample bottles and sample cells were meticulously cleaned. The sample bottles were vigorously cleaned with tap water. The sample cells were cleaned with tap water and filled with distilled water, then left filled for a minimum of 24 hours. The sample cells remained filled with distilled water until use to avoid contamination from air. Before each turbidity test, the cells were emptied, cleaned with tap water, and filled once more with distilled water until overflowing. The outside walls were treated with a thin coating of Hach silicone oil to cover imperfections and scratches and to minimize stray light.

Test samples were prepared with one tablespoon of dry sand placed in a 120 mL Polystyrene sample bottle. The bottle was then filled with 100 mL of distilled water. Preceding each turbidity test run, the sample bottle was shaken vigorously to emulate turbulence. The suspension was immediately poured into a cleaned Hach cell, which was then inverted three times following the manufacturer's guidelines and placed in the machine. The turbidity runs began immediately upon cell insertion within the analyzer.

A reading was taken for each sample at the following time intervals:

- 30 seconds
- 1 minute
- 2 minutes
- 5 minutes
- 10 minutes
- 20 minutes
- 1 hour
- 2 hours
- 4 hours
- 6 hours
- 24 hours

Results were stored on the device's internal memory, then uploaded to a computer for further analysis.

Figure 1-4 2100Q Portable Turbidimeter

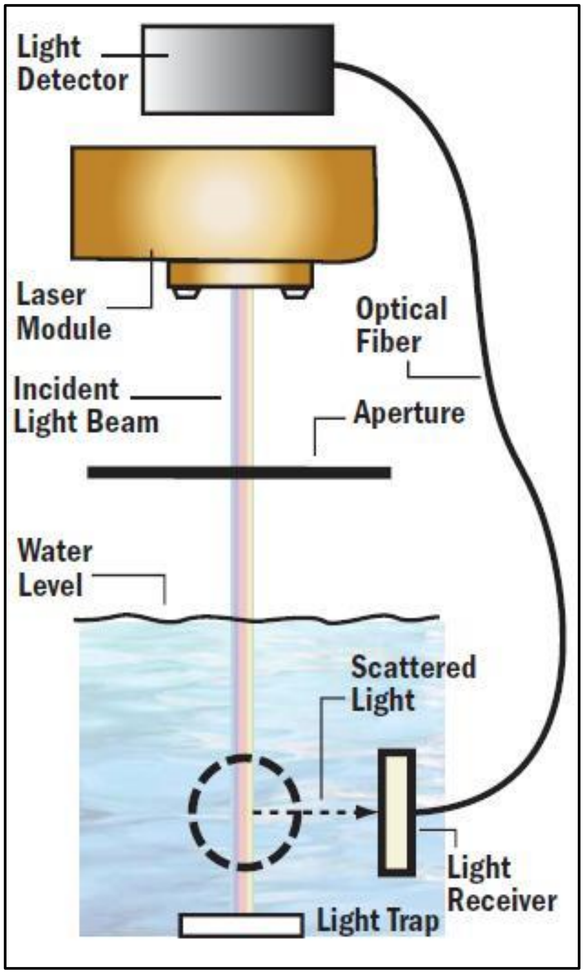


Figure 1-5 Laser Nephelometer Optical Configuration (Sadar, Cason, and Engelhardt; 2009)

2.6 Overfill Factor

A beach undergoes an adjustment period following nourishment. The beach equilibrium profile is achieved as sand moves cross shore and alongshore and there may be an accompanying decrease in beach volume. This loss of sand is compensated for through an overfill ratio, which describes the compatibility of the native beach and borrow sands and is dependent on the size distributions of the native and nourishment (borrow) sand.

The overfill ratio is determined based on the sand size characteristics of the two sands and represents the volume of fill necessary to yield the desired beach volumes calculated previously. Bodge (2004) compared overfill ratio methods and developed an expression that is believed to produce more accurate results than the previous methods.

The mean grain size, M, and sorting, σ, for the native and borrow sands are calculated as presented in the Coastal Engineering Manual (2006) as

$$M = \frac{(\phi_{16} + \phi_{50} + \phi_{84})}{3}$$

$$\sigma = \frac{(\phi_{84} - \phi_{16})}{4} + \frac{(\phi_{95} - \phi_{5})}{6}$$

where $\phi = -\log_2(D)$ where D is given in millimeters.

The dimensionless grain size difference is calculated as

$$M'_b - M'_n = \frac{M_b - M_n}{\sigma_b}$$

where subscripts n and b refer to the native (i.e., beach) and borrow (i.e., offshore) sand, and the overfill ratio is read from Figure 1-6.

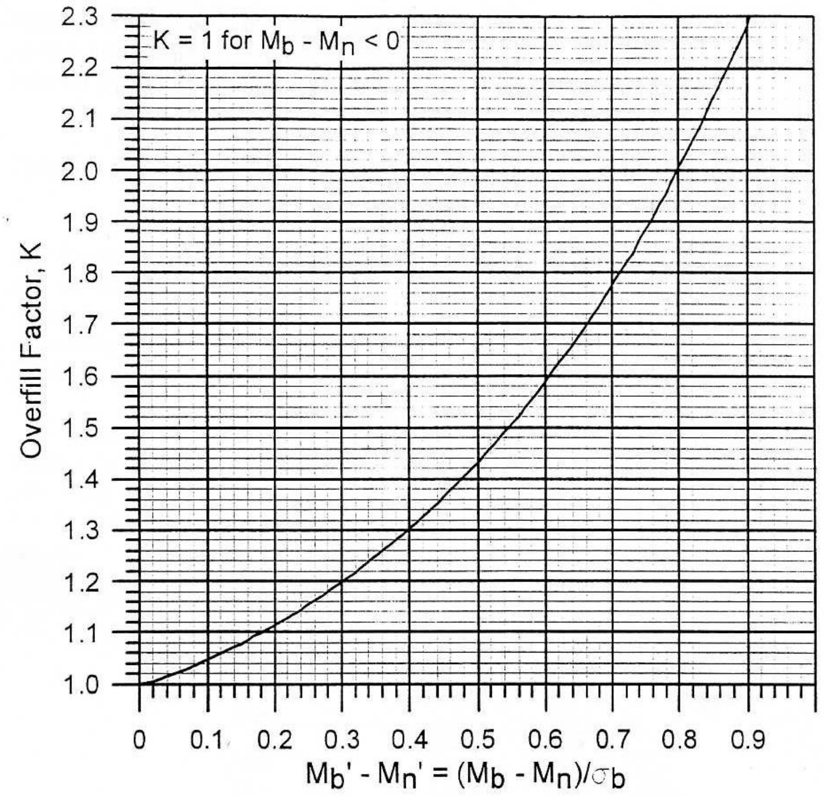


Figure 1-6 Dean's overfill ratio expressed as a single curve (Bodge, 2004).

3. POTENTIAL SAND SOURCES

Sand investigations around Oahu have been performed for several decades, including specific studies pertaining to the characterization and quantification of sand deposits along the south shore of Oahu. These studies have identified sand sources of varying quantities, including small patches or thin deposits. The following discussion presents findings from the previous studies as well as results of the investigations conducted for present projects.

3.1 *Canoes/Queens* Offshore Sand Deposit

3.1.1 Historical data

The University of Hawaii Coastal Geology Group (CGG) performed extensive jet probing of sand deposits offshore of Waikiki Beach in 2005. The 406 probe locations are shown in Figure 3-1 indicated by white markers. Sand thicknesses were measured to the depth where the probe encountered hard refusal or rubble. Sand thicknesses as great as 9 feet, though unusual, were measured. The probe data was used to produce estimates of sand volume for three sand deposits shown by the white lines in the figure. Based on the jet probe data, the CGG estimated these three sand deposits to contain 86,000 cubic yards of sand.

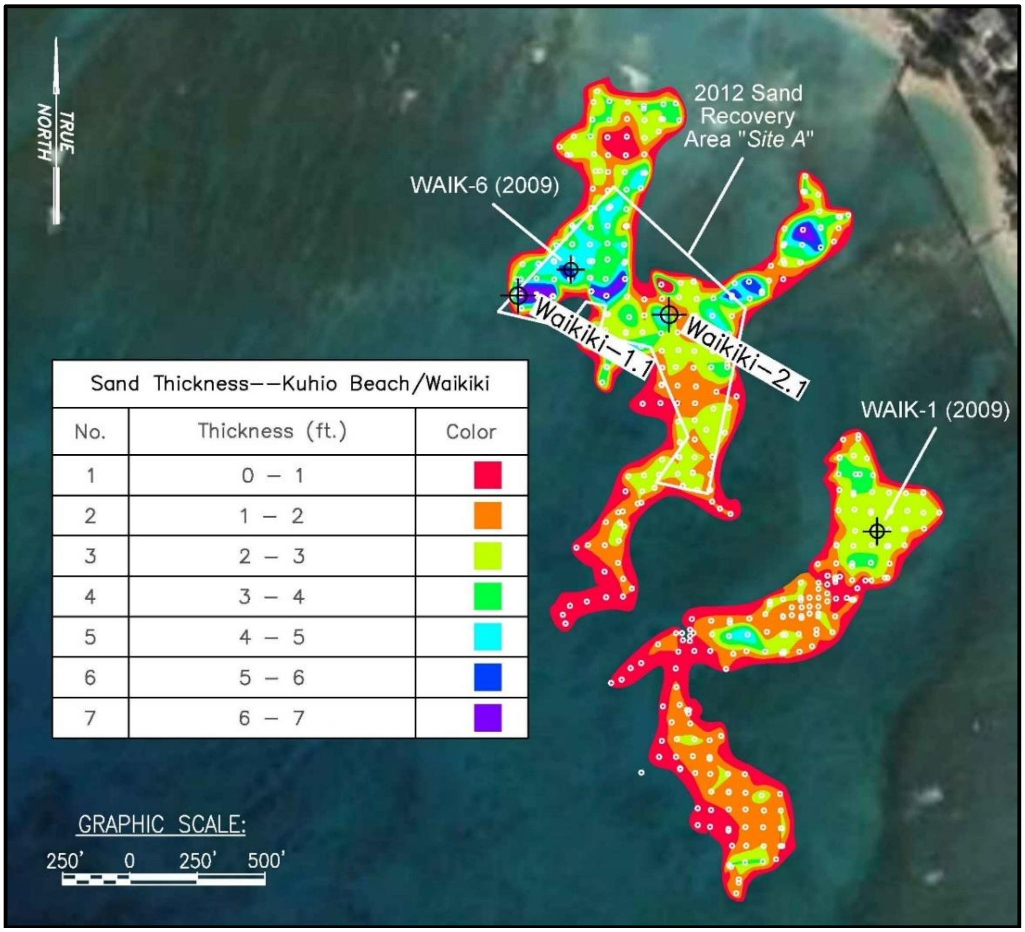
DLNR sponsored nourishment of Kuhio Beach Park during the winter of 2006-2007, utilizing these sand deposit findings of the CGG. Approximately 10,000 cu. yd. of sand was pumped to the beach from the site identified immediately offshore of the Canoes surf break. The project was completed in January of 2007 after a work period of one month. The sand reportedly was well-sorted with medium grain size of 0.35 mm to 0.40 mm. The sand exhibited a light grey color which became lighter upon exposure to sunlight and mixing with existing beach sand.

A field program was conducted by Sea Engineering in August and September of 2009 to verify the findings of the CGG data and estimate the amount of sand that is presently available in offshore deposits. Using aerial photography and a side-scan survey performed by the CGG as guides, geophysical investigations were performed on the offshore deposits using sub-bottom profiling and jet probes. The surveys were performed within practical limits for sand recovery, including water depth and proximity to shore.

For this survey, an EdgeTech 0512i “chirp” sub-bottom profiler was used with an EdgeTech 3200XS processing system. Sub-bottom tracklines from the August 2009 sub-bottom survey are shown as the white and red lines in Figure 3-2. More than 10 miles of sub-bottom tracklines were surveyed. The sub-bottom data was reviewed with EdgeTech software, sub-bottom horizons were digitized for processing, and sand thicknesses were measured at discrete locations along the tracklines. The red lines shown in the figure are portions of four tracklines where sand was identified. These are not the only locations where sand was found; rather, these are examples shown to illustrate findings of the sub-bottom profiling. The sand thicknesses along the four red tracks, referred to as W-1 through W-4, are shown in Figure 3-3. For ease of visual comparison, the figures have the same vertical scale. In August and September of 2009, Sea Engineering revisited the sites, jet probing in 46 locations to verify the sand thicknesses identified by the sub-bottom profiling. Those investigations, shown as red markers in Figure 3-2, found sand thicknesses as great as 7 ft. Sand thicknesses measured using jet probing along tracklines W-3 and W-4 were compared with the results of the sub-bottom profiling. Table 3-1 shows a comparison of the findings; the jet probe data is also shown in Figure 3-3 where the jet probes were coincident with the sub-bottom tracklines.

Figure 3-3 shows lines W-2, W-3, and W-4 to have consistent deposits of sand greater than three feet thick and more than 300 feet wide. Portions of profiles W-1 and W-3 show great variability along the line, indicating that there is an irregular limestone layer beneath the sand. The jet probes show good correlation with the results of the sub-bottom profiling.

Based on the geophysical investigations, “Site A” (immediately offshore of the Canoes and Queens surf sites) was estimated to contain 46,000 cu. yd. of sand. An 18-inch thick sand sample from this site, *WAIK-6*, had a median diameter of 0.31 mm and was classified as moderately well sorted. Approximately 24,000 cu. yd. of sand was dredged from “Site A” and the beach widening was performed from January to May 2012. Site A is also referred to as *Canoes/Queens* in this report.



Sand Thickness––Kuhio Beach/Waikiki

No.	Thickness (ft.)	Color
1	0 – 1	🟥
2	1 – 2	🟧
3	2 – 3	🟨
4	3 – 4	🟩
5	4 – 5	🟦
6	5 – 6	🟦
7	6 – 7	🟪

Figure 3-1 *Canoes/Queens* sand deposit thicknesses.

(Univ. of Hawaii Coastal Geology Group jet probe locations [white circles]
Sea Engineering core locations [black cross / circle])

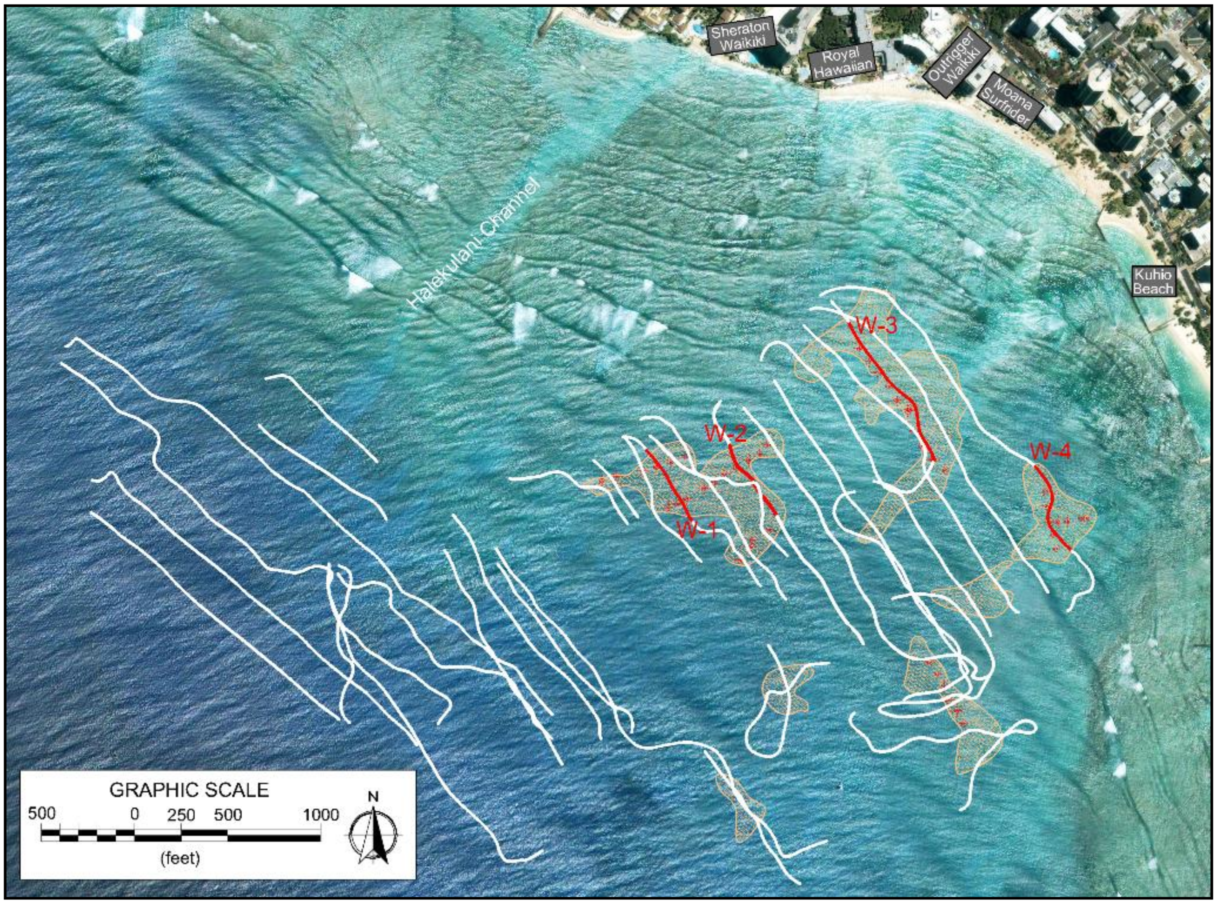


Figure 3-2 Sub-bottom tracklines (white and red lines), jet probe locations (red points), and visible sand deposits (tan outline and fill). Sea Engineering, 2010.

Table 3-1 Comparison of sand thicknesses (feet), Sea Engineering, 2010.

Trackline W-3		Trackline W-4	
Sub-bottom	Jet probe	Sub-bottom	Jet probe
5.2	6.5	4.6	5.5
5.9	7.5	3.6	4.0
6.2	7.0	3.0	4.0
2.0	3.0	4.3	5.0
2.3	2.0	3.9	4.0
2.6	2.0		

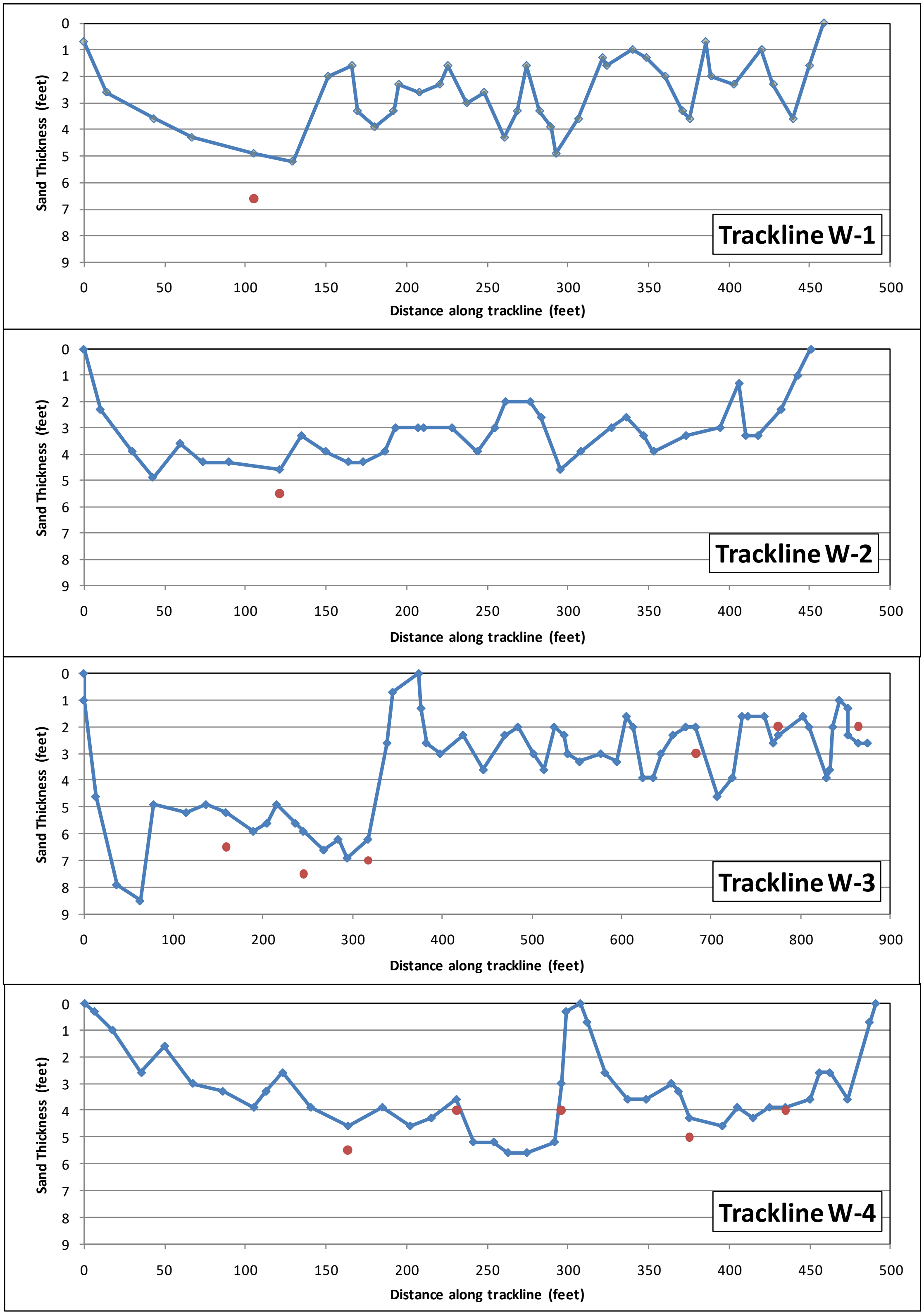


Figure 3-3 Sand thicknesses measured by sub-bottom profiler (blue) and jet probes (red).

(Note: tracklines begin in the northwest and progress toward the southeast).
Sea Engineering 2010.

3.1.2 2017 Sand investigations (Canoes/Queens)

Sea Engineering obtained two vibracore samples from Site A of the 2012 Waikiki Maintenance Project. The locations of those samples are shown on Figure 3-1. Vibracore "Waikiki 1.1" was obtained along the western edge of Site A in the location of the 2008 sand recovery, while Waikiki 2.1 was obtained from a more central location within the site. Grain size analysis shows the two samples to be quite similar, and generally consistent with the 18-in push-core sand sample "WAIK-6" obtained in 2009 as part of the 2012 maintenance project. The sand samples shown in the table have median diameter D_{50} of 0.29 to 0.33 mm and are considered to be moderately to moderately well sorted. The percentage of fine material was 0.6% or less. Grain size distributions for Waikiki 1.1 and Waikiki 2.1 are presented in Table 3-2 and Figure 3-4.

Table 3-2 *Canoes/Queens* offshore sand deposit summary

Location	D_{50} (mm)	Sorting σ	% Fines	Core length (inches)	Water depth (feet)	Source	Year
WAIK-4 (top)	0.26	0.7	0.0	18	~10	SEI	2009
WAIK-4 (bottom)	0.34	1.2	0.4	18	~10	SEI	2009
WAIK-6 (top)	0.29	0.6	0.0	18	~10	SEI	2009
WAIK-6 (bottom)	0.33	0.5	0.0	18	~10	SEI	2009
Waikiki 1.1	0.33	0.7	0.4	85	9	SEI	2017
Waikiki 2.1	0.33	0.8	0.6	85	13	SEI	2017

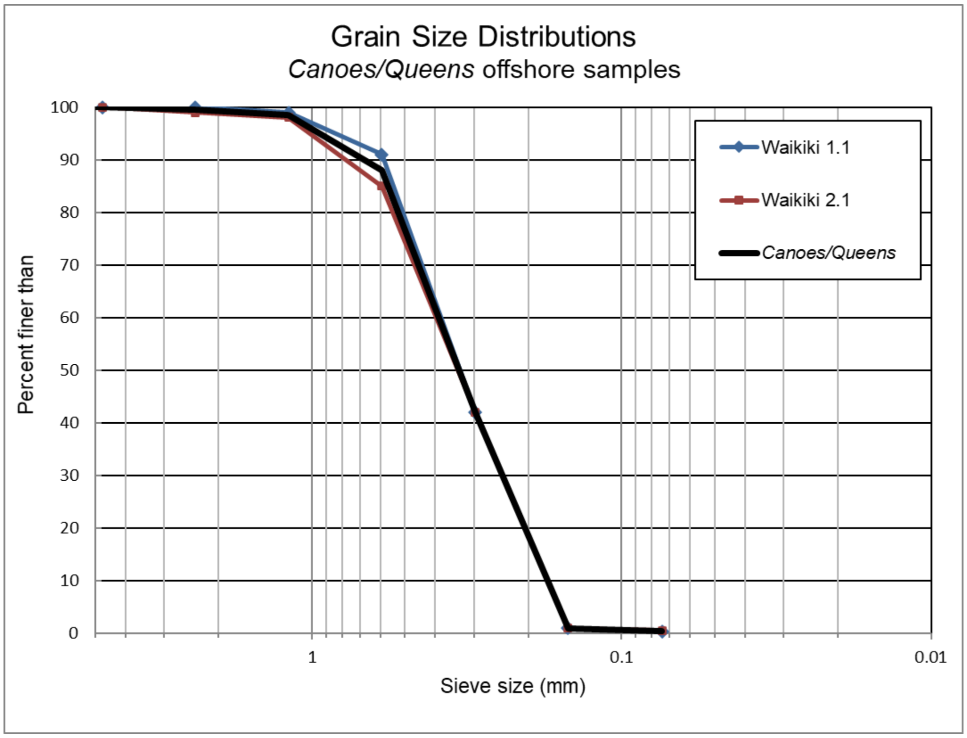


Figure 3-4 Grain size distribution for *Canoes/Queens* offshore sand deposit

3.1.3 Constraints (Canoes/Queens)

The sand deposit has been used three times in the last 15 years for beach nourishment. DLNR representatives reported that the dredge pit produced during the 2006-2007 project filled in quickly when south swells arrived. The offshore sand deposits have limited volume, and continued use of this deposit could result in a decline in available sand. This would be particularly true sand from this deposit were used to nourish other beach sectors, in which case the sand would be removed from the system and would not be expected to return to the deposit.

3.2 ***Halekulani Channel*** **Offshore Sand Deposit**

3.2.1 Historical sand data

The shoreward terminus of the Halekulani Channel is located at the Halekulani Hotel adjacent to the Sheraton Waikiki. The sand channel extends approximately 4,000 feet offshore where it widens into a broad sand field in approximately 120 feet of water. Noda (1991) estimated that approximately 500,000 cu. yd. of sand is contained between the 40-foot and 100-foot depth contours and 80,000 cu. yd. contained shoreward of the 40-foot depth contour. During the Noda study, median grain size, D_{50}, in this deposit was found to vary from 0.20 mm to 0.39 mm with the coarser samples found in depths of less than 10 feet. The average sorting parameter, σ, was 1.1, indicating a moderate to poorly sorted sand. The samples exhibited a gray color.

The University of Hawaii Marine Minerals Technology Center (MMTC) produced a report on the sand deposits in and around the Halekulani Channel (Barry, 1995). They reported sand deposits as much as 40 feet thick over a 75-acre area between the 70 and 100-foot depth contours.

More recently, the U.S. Geological Survey (Hampton et al., 2003) investigated the resource potential of deposits around Oahu, particularly as a source of sand for beach replenishment. The Halekulani Channel was included in this study. Numerous vibracore samples up to 6 meters long were obtained between 2,500 and 5,000 ft offshore, in water depths from 10 to 120 ft. The Halekulani Channel is divided into two sections. The inshore section is about 900 ft long and up to about 160 ft wide. Water depths in this area range from 10 to 40 ft, and the sand deposit is flanked by shallow reef. The USGS obtained four vibracores in this area, and median diameters of the bulk samples ranged from 0.28 mm to 0.38 mm. The USGS also obtained several samples in a broader offshore part of the channel; samples in this area were obtained in water depths between 52 and 72 ft. Median diameters of the bulk samples ranged from 0.23 mm to 0.53 mm.

In February of 2011, Sea Engineering performed sub-bottom profiling along several tracklines across the Halekulani Sand Channel. The data showed thicknesses of as much as 40 feet in water depths of 75 to 100 feet. Although only a small portion (<6 acres) of the sand deposit was investigated, the estimated sand volume was calculated to be nearly 200,000 cy. The sand thickness measurements by Sea Engineering are less than those of MMTC; however, the trend is consistent.

In October of 2011, divers from Sea Engineering, Inc., obtained two sand cores in water depths of 52 and 67 feet. Each core penetrated about 18 in into the sand. Median grain size from the

52-ft depth sample measured to be 0.20 mm and the sand was well to moderately well sorted, while also containing 1.2% fine material (<0.075 mm). The sample from the 67-ft depth had a median diameter of 0.30 mm, was classified as moderately sorted, and contained 1.6% fine material. The sand samples were gray colored, which is typical of offshore sand deposits.

3.2.2 2017 sand investigations (Halekulani Channel)

Sea Engineering returned to the Halekulani Channel in March of 2017. Guided by the sub-bottom profiling performed previously by MMTC and SEI, two vibracore samples were obtained. Sand thicknesses from the MMTC and SEI investigations, along with the vibracore locations, are shown as Figure 3-5. Vibracore "Halekulani 1.1" was obtained in a water depth of 55 ft. The sample was measured to have a median diameter (D_{50}) of 0.23 mm with a sorting parameter of 0.8, which falls in the moderately sorted category. The grain size data is consistent with the 2011 SEI findings. The sample had 1.8% material classified as "fine" (i.e., passing through the #200 sieve. "Halekulani 2.2" was obtained in a water depth of 86 feet and had a D_{50} of 0.25 mm with sorting parameter of 1.6 (poorly sorted) with 5.5% fine material.

Four additional vibracores were obtained in May of 2018 ("HK 3.1" through "HK 3.4"). The characteristics of Halekulani Channel offshore sand deposits are summarized in Table 3-3 and Figure 3-7. Overall, the sand in this part of the channel was considered to be too fine for use on Waikiki's beaches.

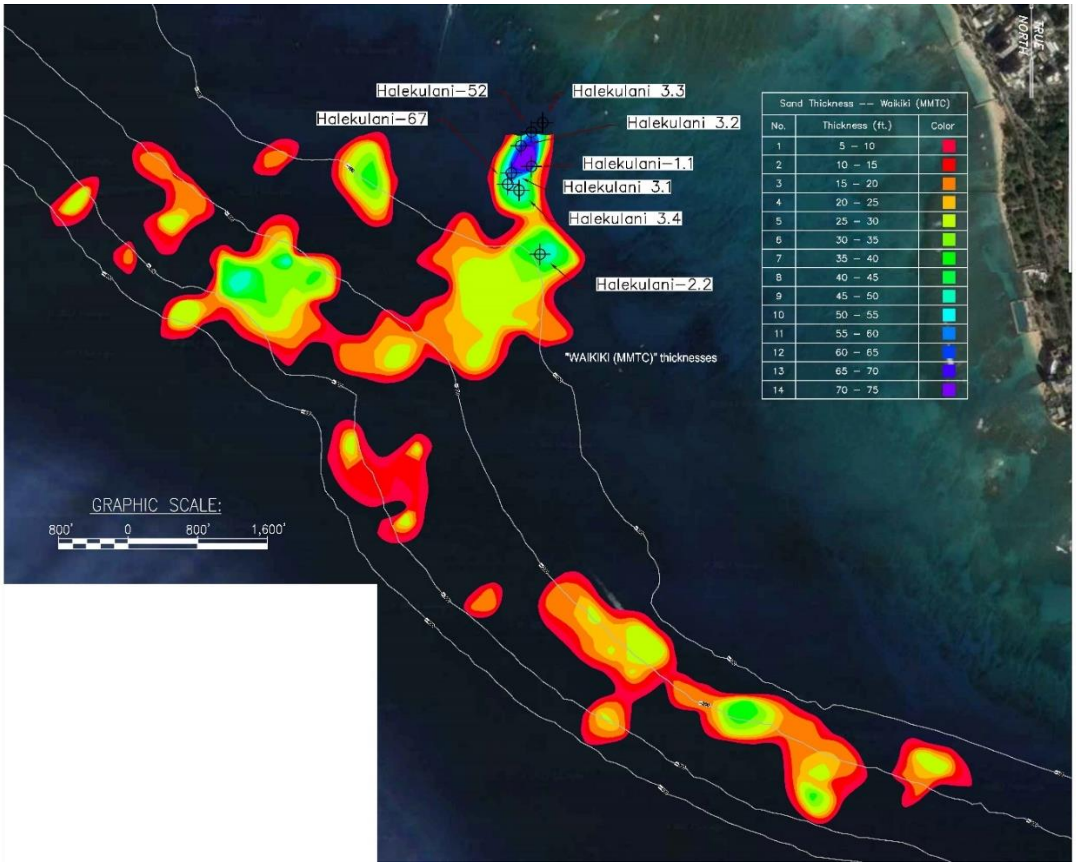


Figure 3-5 *Halekulani Channel* offshore sand deposit and core locations (black "+")

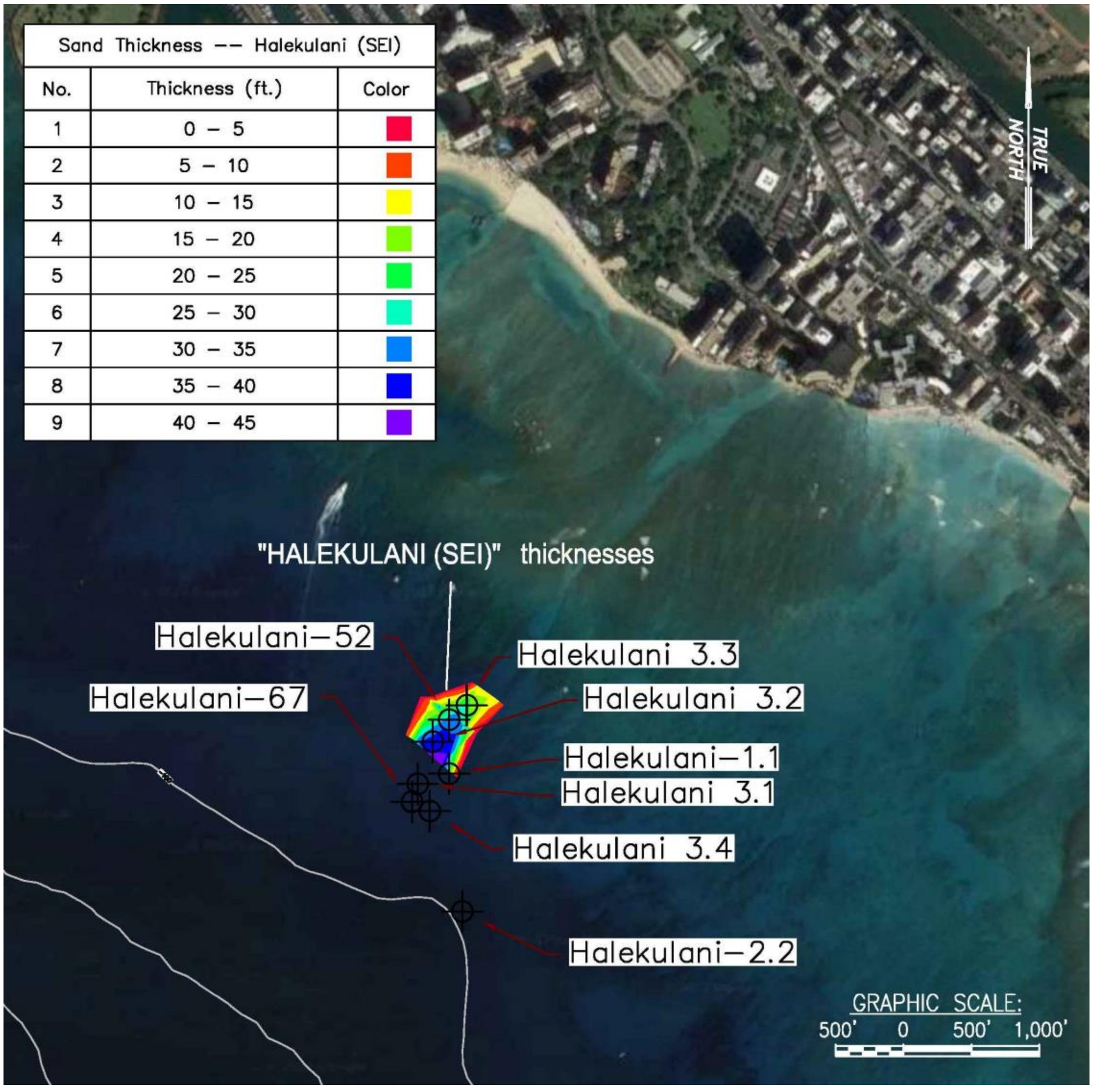


Figure 3-6 ***Halekulani Channel*** **offshore sand deposit and core locations (black "+")**

Table 3-3 ***Halekulani Channel*** **offshore sand deposit summary**

Location	D_{50} (mm)	Sorting σ	% Fines	Core length (inches)	Water depth (feet)	Source	Year
Halekulani 1	0.28–0.38	0.9–1.9	---	n/a	10-40	USGS	2003
Halekulani 2	0.23–0.53	0.9–1.2	---	n/a	52-72	USGS	2003
Halekulani-52	0.20	0.5	1.2	18	52	SEI	2011
Halekulani-67	0.30	0.9	1.6	18	67	SEI	2011
Halekulani 1.1	0.23	0.8	1.8	68	55	SEI	2017
Halekulani 2.2	0.25	1.6	5.5	84	86	SEI	2017
Halekulani HK 3.1	0.29	0.89	2.3	26	---	SEI	2018
Halekulani HK3.2	0.37	0.91	2.8	42	---	SEI	2018
Halekulani HK 3.3	0.20	0.81	3.9	25	---	SEI	2018
Halekulani HK 3.4	0.27	0.90	3.3	39	---	SEI	2018

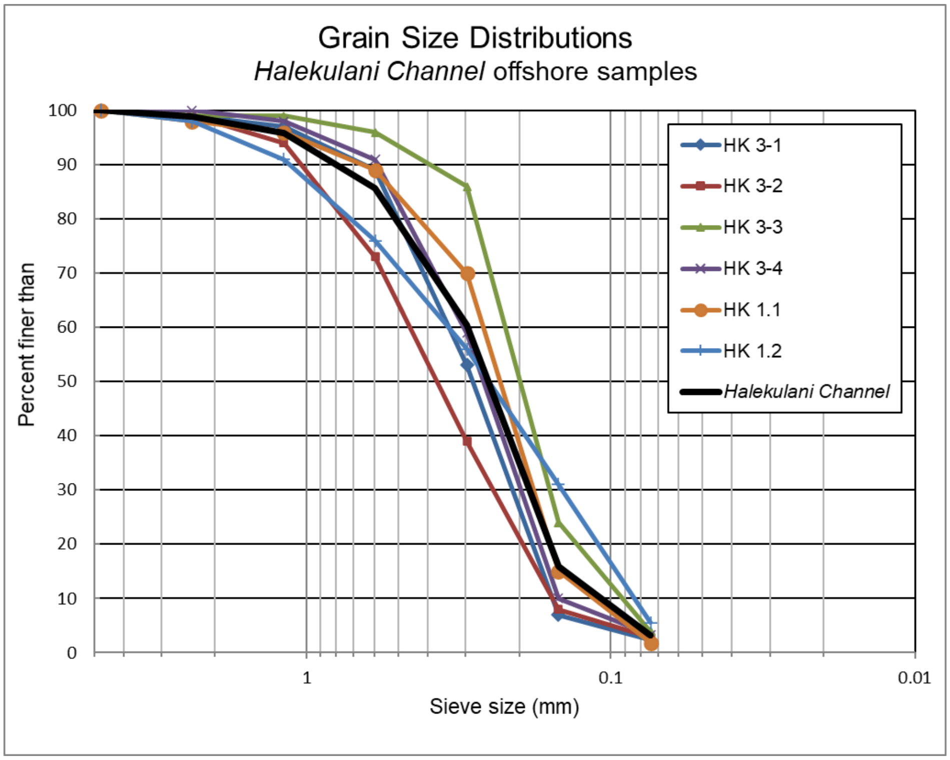


Figure 3-7 Grain size distribution for *Halekulani Channel* offshore sand deposit

3.3 *Hilton* Offshore Sand Deposit

3.3.1 Historical sand data

Sea Engineering (SEI) was contracted in 2004 to investigate possible inland and offshore sand sources for a project to improve the Hilton Hawaiian Village lagoon. In search of offshore sand, a survey was conducted offshore of the Hilton Hawaiian Village to identify and map possible marine sand sources for the lagoon restoration project.

The survey was conducted with differential GPS and divers swimming transects and probing sand thicknesses. Sand probes were accomplished using a combination of water jet, air jet, and manual probes. Sand samples were collected using a push corer and hand trowels. Representative samples were submitted for laboratory grain size analyses.

The primary deposit investigated was approximately 850 ft by 620 ft in dimension, located in water depths of 40 to 55 feet to the southwest of the Hilton Hawaiian Village beach. The maximum sand thickness probed was 5 feet, and the average sand thicknesses in the center of the deposit were about 4 feet. The total estimated volume of sand in the deposit was determined to be approximately 40,000 cubic yards. The size characteristics of a representative sample showed the sand to be very similar to the beach sand. The median grain size, D_{50}, was 0.55 mm and the sorting was considered moderate. The deposit was characterized by a gray color with visible shell fragments, giving the appearance of coarser, poorly sorted sand.

The offshore sand was not used for the lagoon improvement project.

3.3.1.1 2017-2018 sand investigations

SEI returned in 2017 to further investigate the *Hilton* sand deposit. During initial reconnaissance, vibracoring directed at the center of the deposit was noted to penetrate more than 6 feet into the sand deposit; 2004 jet probing had only estimated the thickness to be about 4 feet. Initial analyses of these cores, *Hilton 1.1* and *Hilton 1.2*, were favorable, so SEI followed with a dive team that systematically jet probed a total of 34 locations in the deposit along defined transects to better characterize the size of the deposit. The sampling locations and measured thicknesses are shown on Figure 3-8. The results of the jet probing showed an estimated sand volume of 45,000 cy of sand.

Five additional vibracore samples were obtained from the *Hilton* sand deposit following the jet probing. The vibracore locations are shown on Figure 3-8 and the grain size analysis data from those vibracores is presented in Figure 3-9 and Table 3-4. Median grain size ranges from 0.47 to 0.83 mm, with a minimal percentage of fines.

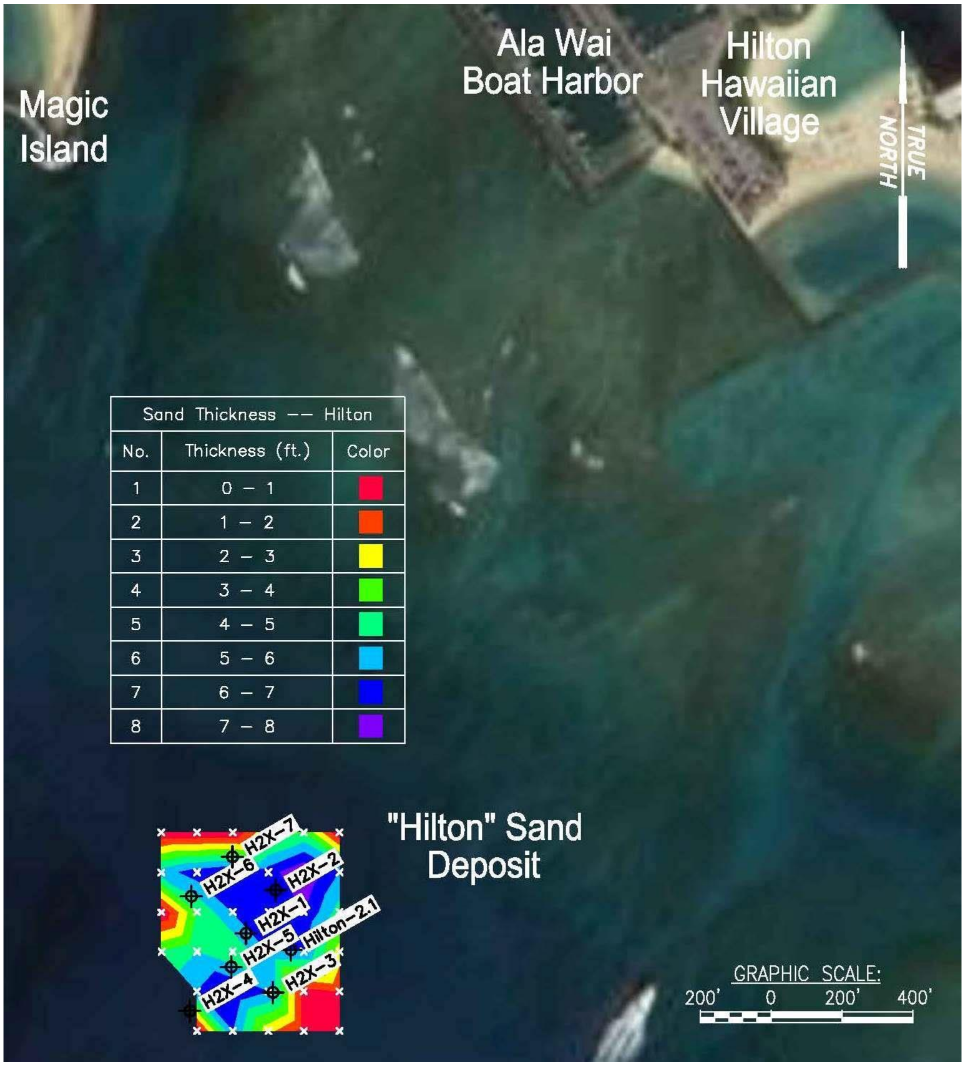


Figure 3-8 *Hilton* offshore sand deposit thickness.

Jet probes (white “x”) and vibracore locations (black “+”)

Table 3-4 *Hilton* offshore sand deposit summary

Location	D_{50} (mm)	Sorting σ	% fines	Core length (inches)	Water depth (feet)	Source	Year
Hilton 1.1	0.47	0.7	0.7	85	47	SEI	2017
Hilton 1.2	0.48	0.6	0.6	85	47	SEI	2017
H-2X.1	0.54	0.8	1.4	67	50	SEI	2017
H-2X.2	0.66	0.7	0.7	79	48	SEI	2017
H-2X.5	0.50	0.7	0.7	80	51	SEI	2017
H-2X.6	0.77	1.1	1.4	79	53	SEI	2017
H-2X.7	0.83	1.7	0.4	86	50	SEI	2017

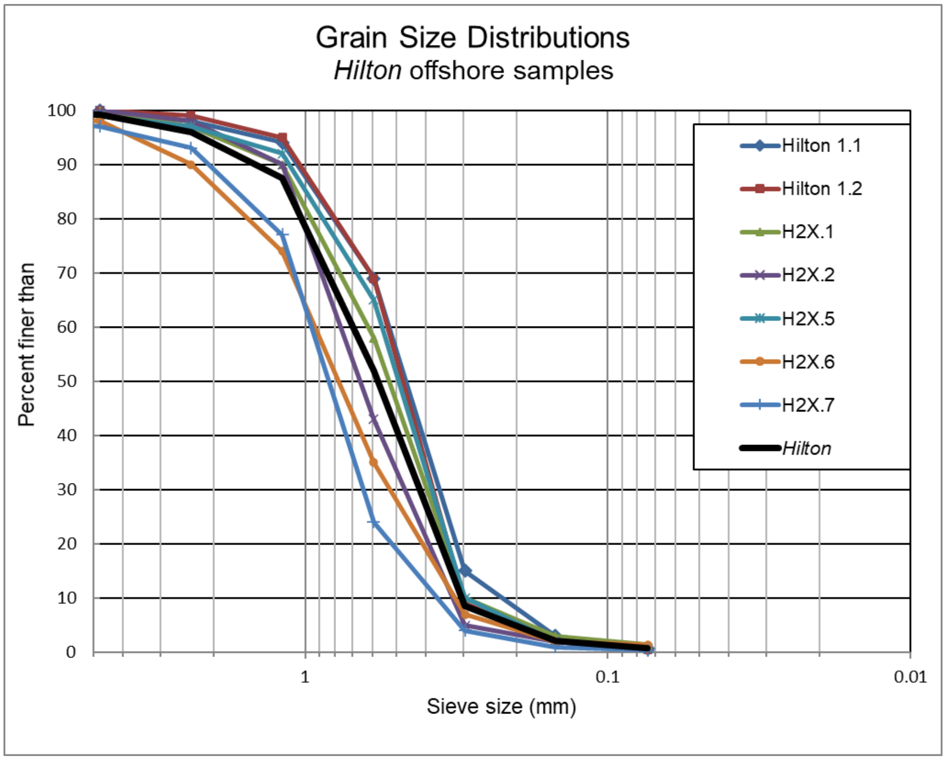


Figure 3-9 Grain size distribution for *Hilton* offshore sand deposit

3.4 *Diamond Head* Offshore Sand Deposit

3.4.1 Historical sand data

A field program was conducted in December 2010, February 2011, and March 2011 to investigate offshore sand deposits in the vicinity of Diamond Head. Using aerial photography and a University of Hawaii Coastal Geology Group (CGG) side-scan survey as guides, geophysical investigations were performed on specific offshore deposits using side-scan sonar and sub-bottom profiling. The surveys were performed within practical limits for sand recovery, including water depth and space for operations.

On December 17, 2010, Sea Engineering personnel conducted a survey utilizing a C-MAX CM2 side-scan sonar (SSS) system. The planned side-scan sonar coverage area was determined based on bathymetry, aerial photographs, and proximity to the project site. The University of Hawaii Coastal Geology Group previously performed a side-scan sonar survey offshore of Waikiki between Diamond Head and the Ala Wai boat harbor in water depths as shallow as 12 feet and as deep as 300 feet. The December 2010 SEI survey covered an area inshore of the CGG survey where potential sand deposits were identified using aerial photographs. The sonar results combined with an aerial view of the targeted offshore deposits are shown in Figure 3-10 and the full coverage is shown in Figure 3-11.

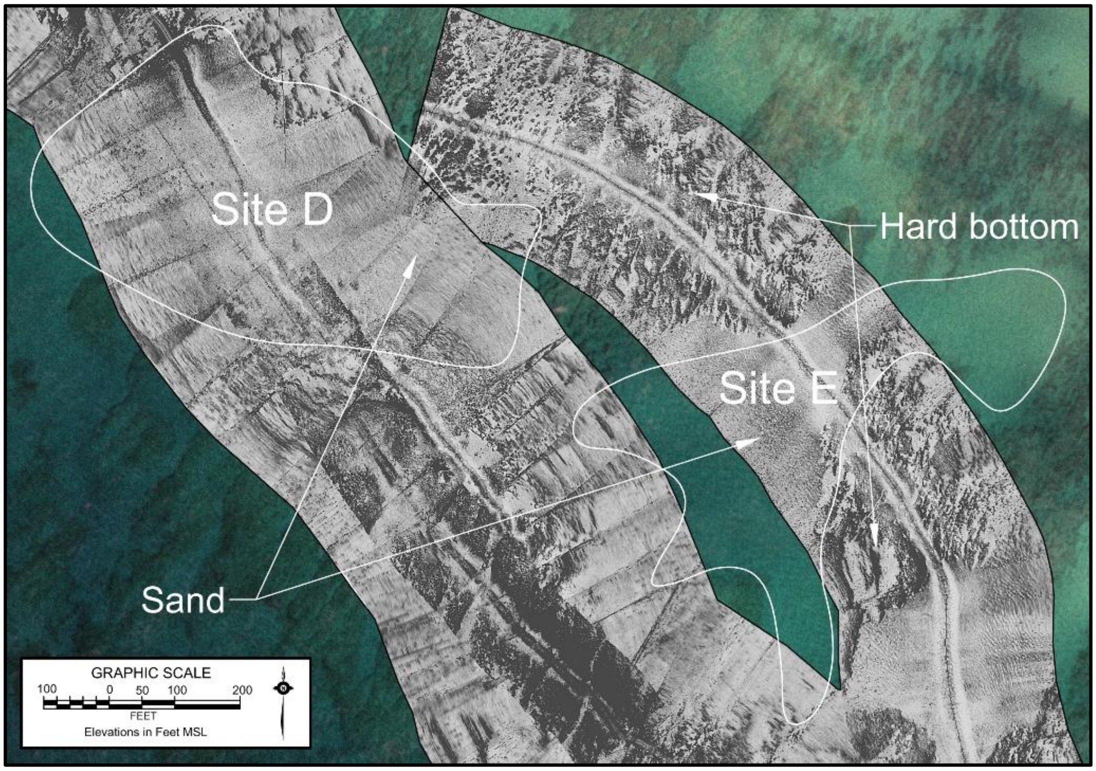


Figure 3-10 Side scan sonar mosaic for offshore sand deposits "D" and "E"

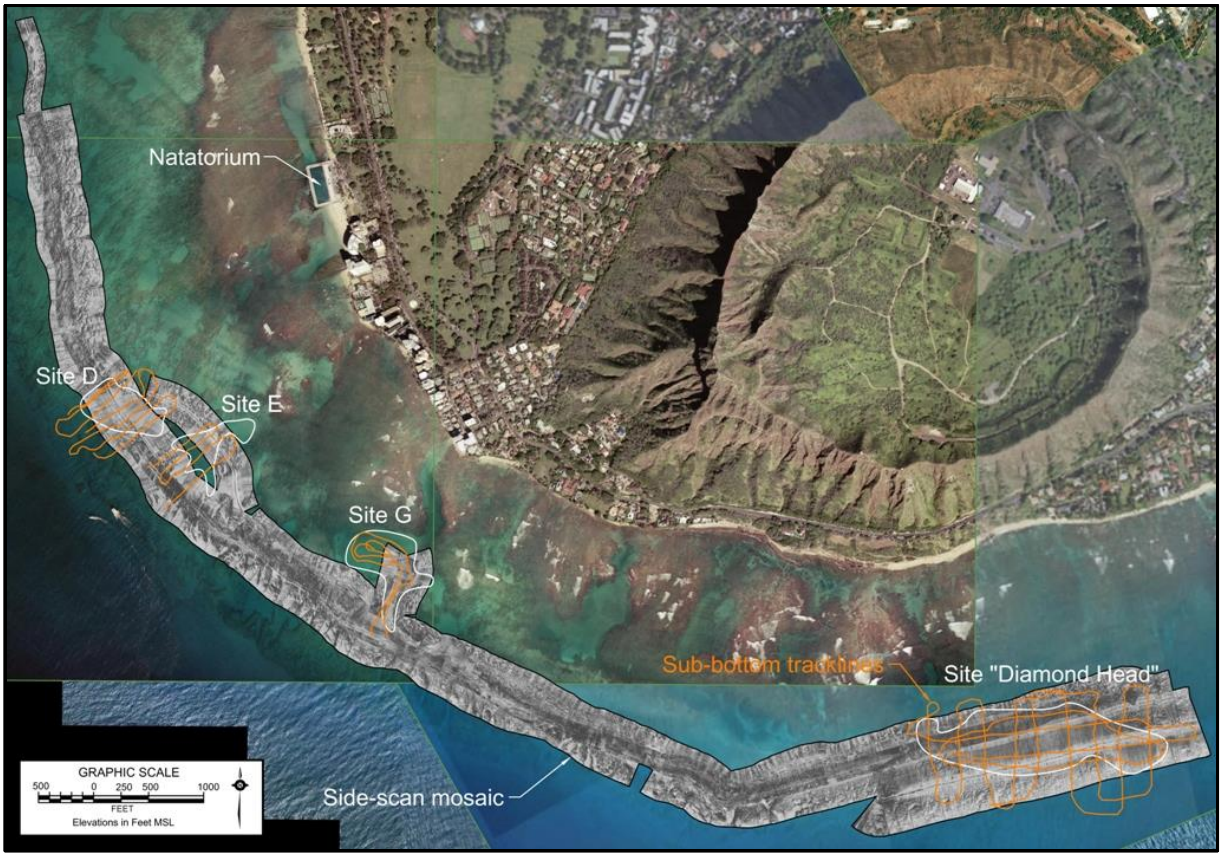


Figure 3-11 Side-scan sonar mosaic and sub-bottom profiler tracklines

On February 24, 2011, SEI conducted a sub-bottom survey utilizing an EdgeTech 0512i Subbottom Profiler. Tracklines from that sub-bottom survey were shown previously on Figure 3-11. The sub-bottom data was reviewed with EdgeTech software, sub-bottom horizons were digitized for processing, and sand thicknesses were measured at discrete locations along the survey tracklines. This geo-referenced data was imported into AutoCAD and surfaces of the bottom and sub-bottom were produced. These two surfaces were compared to produce an estimate the volume of sand in each deposit.

Several passes from west of the Waikiki Aquarium to offshore of Diamond Head Beach Park were performed with the side-scan sonar system. The tracklines were chosen to supplement the CGG survey, and to specifically investigate the sand deposits identified from aerial imagery. The survey data was combined into a single mosaic that covered 2.7 miles parallel to shore with average cross-shore coverage of 670 feet. The subsequent sub-bottom profiling targeted the sand deposits identified from aerial imagery and the side-scan sonar mosaic, covering 2.7 miles offshore of the Natatorium and 4.1 miles offshore of Diamond Head Beach Park.

Sand deposits identified in the side-scan and sub-bottom surveys were also shown previously on Figure 3-11, labeled as sites “D”, “E”, “G”, and “Diamond Head”. These potential deposits were outlined and the areas were calculated, and following the sub-bottom survey, estimates of the sand volumes were calculated. These values are shown in Table 3-5.

Table 3-5 Offshore sand deposit characteristics

Location	Water depth (ft)	D_{50} (mm)	Area (sq. ft.)	Volume (cu. yd.)
Site D	20-38	0.20	252,100	4,000
Site E	12-28	0.23	174,400	5,000
Site G	10-22	0.39	319,700	13,000
Diamond Head	20-30	0.40-0.45	1,019,800	110,000

Sites D and E were initially viewed as a favorable sand sources based on the large surface area; however, the sub-bottom profiling showed that much of the deposits were merely thin veneers of sand. Site G was found to contain a significant amount of sand—slightly more than 13,000 cu. yd. The deposit is situated in a gap in the reef that measures 600 ft long by 380 ft wide. Access to the site would be through a 100-ft wide gap in the reef on the offshore side of the deposit. The shallow water (typically between seven and 11 ft deep over the sand deposit), the nearby reef, and limited access could make recovery a challenge.

Table 3-5 also shows the findings of the surveys for a sand deposit identified off Diamond Head Beach Park (see Figure 3-11). The estimated volume of sand in that deposit based on geophysical investigations is more than 110,000 cu. yd. This sand deposit is further detailed in Section 3.4.2.

3.4.2 2018 sand deposit investigations

SEI performed jet probing and sand sampling on February 23, 2018, to further quantify the *Diamond Head* sand deposit identified in 2011. Jet probes penetrated between 3 and 6 feet within the sand deposit, encountering hard refusal at each location. The probe depths generally confirmed the sub-bottom results.

The sand was found to be light brown at the sand surface, becoming mixed brown and gray below. Push cores are typically limited to about 24 inches in sand, and samples at *Diamond Head* were no different. The sand samples had median grain size in the range of 0.40 to 0.45 mm, the samples were well sorted, and they had less than 1.0% fine material. Grain size distributions are presented in Table 3-6 and Figure 3-13. Vibracoring and turbidity analyses were not performed, though initial qualitative tests indicated that the deposit might have low turbidity.

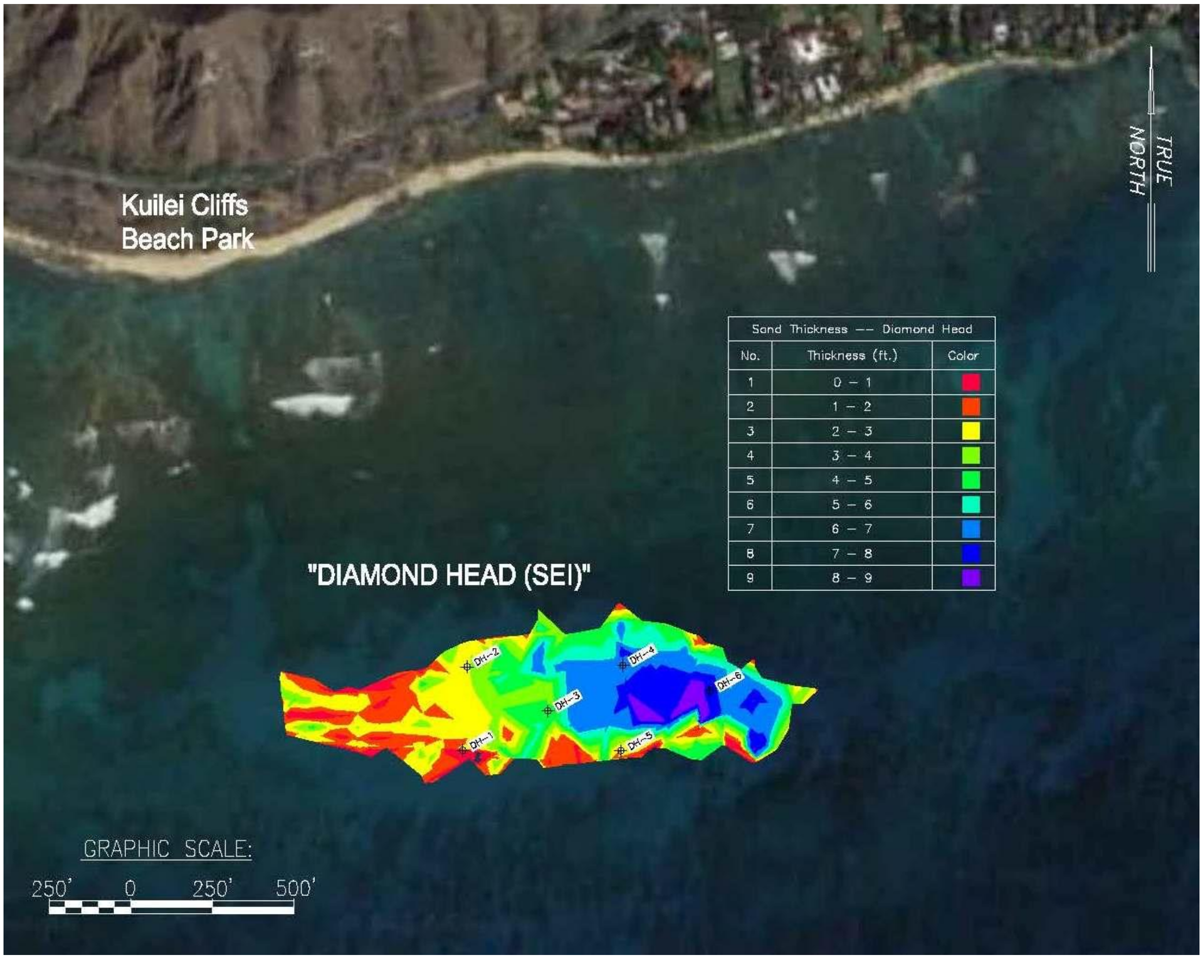


Figure 3-12 *Diamond Head* offshore sand deposit thickness and core locations (black "+")

Table 3-6 *Diamond Head* offshore sand source summary

Location	D_{50} (mm)	Sorting σ	% fines	Jet probe (feet)	Water depth (feet)	Source	Year
DH-1	0.45	0.5	0.8	4	25	SEI	2018
DH-2	0.40	0.6	1.0	6	30	SEI	2018
DH-3	0.43	0.5	1.0	6	30	SEI	2018
DH-4	0.45	0.5	1.0	6	30	SEI	2018
DH-5	n/a	n/a	n/a	6	35	SEI	2018
DH-6	n/a	n/a	n/a	3	35	SEI	2018

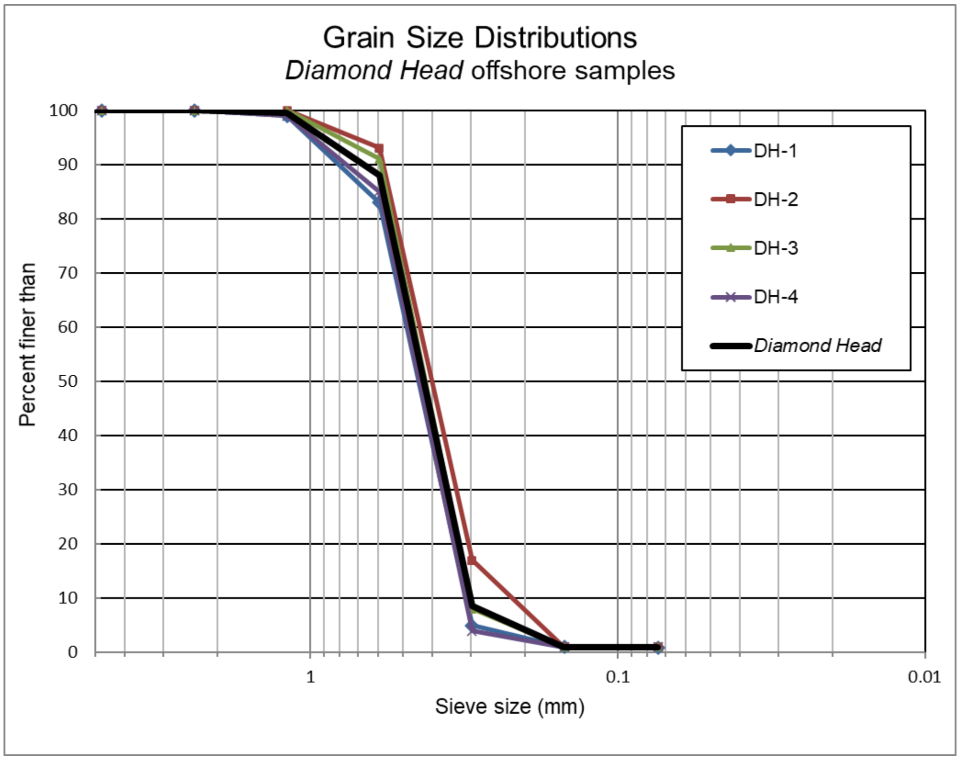


Figure 3-13 Grain size distribution for *Diamond Head* offshore sand deposit

3.4.3 Constraints (Diamond Head)

The *Diamond Head* sand deposit is estimated to contains about 60,000 cy of high-quality sand. The deposit is located near surf breaks and is exposed to wind and waves. The site rarely experiences extended periods of calm weather that the other shores do. Recovery attempts could result in frequent work stoppages.

Further, the sand would be used on a beach outside of the region, and there could be community opposition and regulatory requirements that prevent use of this sand in Waikiki.

3.5 *Reef Runway* Offshore Sand Deposit

3.5.1 Historical sand deposit data

Offshore sand resources at the Reef Runway have been investigated for the past three decades by a variety of organizations. The University of Hawaii Marine Minerals Technology Center (MMTC) produced a report on the sand deposits off the Diamond Head half of the Reef Runway. They reported sand deposits as much as 25 feet thick, though much of the sampling was performed in 100 to 300 feet of water.

Sea Engineering (1994) performed geophysical testing on a 100-acre site off the west end of the Reef Runway near the Pearl Harbor entrance channel. The testing was funded by CEROS for the development of a sub-bottom imaging instrument. Penetration of more than 150 feet into the sand deposit was achieved, along with 12 inches of vertical resolution of geological features. Nine sand samples were obtained along a north-south transect through the middle of the survey area. Two samples toward the north boundary of the study site showed median grain sizes of 0.44 mm and 0.55 mm, while the other samples were in the range of 0.15 mm to 0.31 mm. All samples were moderately to poorly sorted.

Sea Engineering (2001) performed single-beam and multi-beam bathymetric surveys and sub-bottom profiling offshore of the Reef Runway in support of the recovery of the *Ehime Maru*. The survey area covered about 500 acres in front of the Ewa half of the runway. The sub-bottom profiling showed that sand thickness within much of the survey area was up to about 20 feet thick, while two areas that overlapped the CEROS survey area were found to exceed 30 feet in thickness.

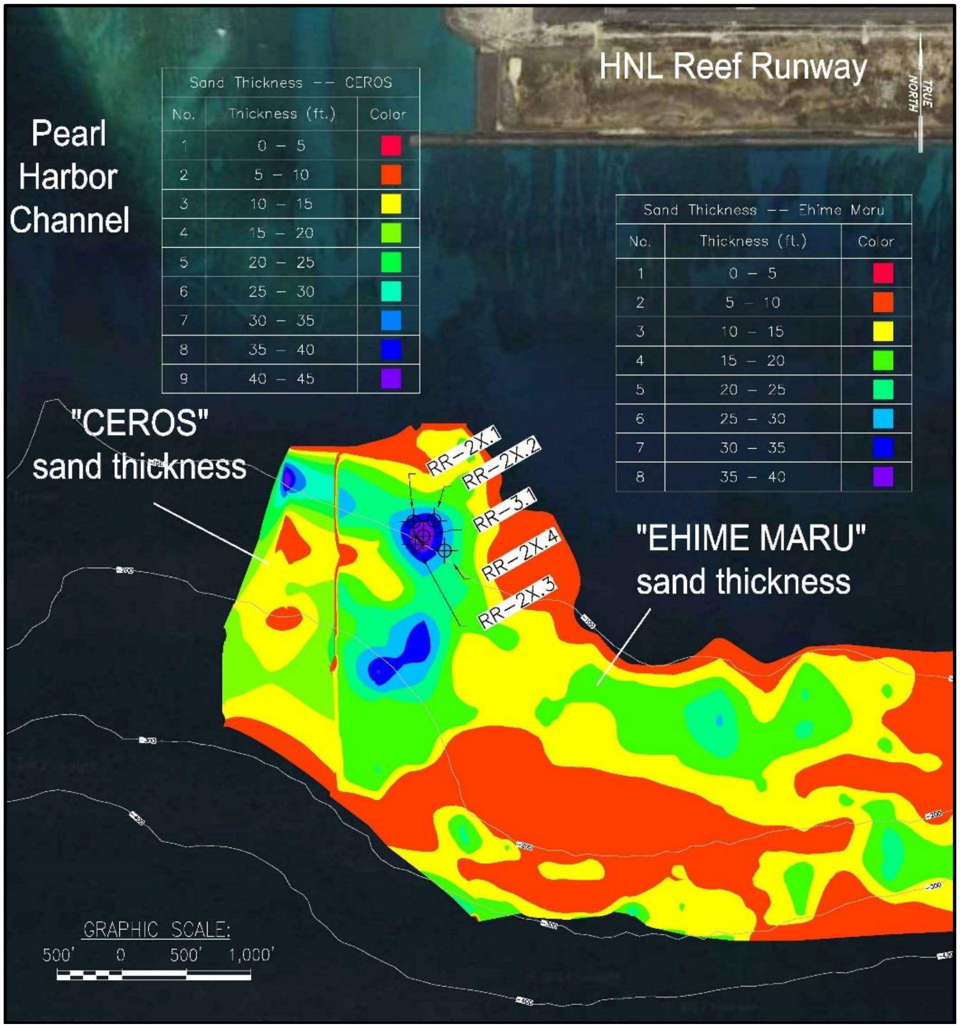


Figure 3-14 Reef Runway sand deposits and vibracore locations

3.5.2 2017-2018 sand investigations (Reef Runway—Outer)

Sea Engineering conducted investigations on the Reef Runway sand deposits in March and May of 2017. Initial investigations found patch reefs within the larger survey area, so divers and underwater video cameras were deployed to ground-truth the sub-bottom data and direct the vibracore toward larger patches of sand.

The subsequent vibracore deployments targeted a patch of sand identified from the sub-bottom profiling as being as much as 40 feet thick. Five vibracore samples were obtained at locations shown previously on Figure 3-14, and the grain statistics are presented in Table 3-7 and Figure 3-15

Table 3-7 *Reef Runway—Outer* offshore sand source summary

Location	D_{50} (mm)	Sorting σ	% fines	Core length (inches)	Water depth (feet)	Source	Year
RR-2X.1	0.21	0.9	2.7	50	87	SEI	2017
RR-2X.2	0.21	0.9	3.7	38	83	SEI	2017
RR-2X.3	0.15	0.9	5.6	65	105	SEI	2017
RR-2X.4	0.18	0.9	3.9	87	94	SEI	2017
RR 3.1	0.17	1.0	3.9	96	93	SEI	2017

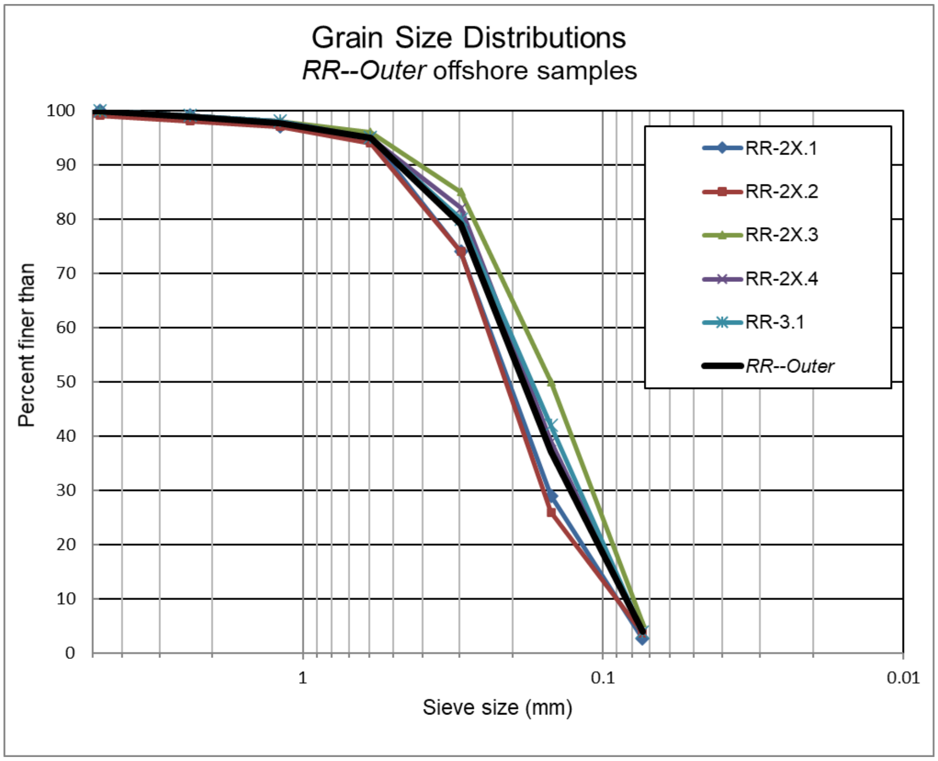


Figure 3-15 Grain size distribution for *Reef Runway—Outer* offshore sand deposit

3.5.3 2018 sand investigations (RR—Inner)

Investigation in the vicinity of the Reef Runway found a sand deposit located in about 60 feet of water approximately 1,500 to 3,000 feet from the runway (Figure 3-16). The patch of sand, referred to as *RR—Inner 1a* is roughly 1,000 ft by 2,000 feet in dimension and was initially investigated with a sub-bottom profiler to determine deposit thickness. Divers later investigated the site with a jet probe to verify deposit thickness, and later with a vibracore to determine the grain size through the deposit. Jet probes penetrated 2 to 4 ft into the sand. The grain size, jet probe, and vibracore information are presented in Table 3-8. The deposit contains an estimated 200,000 cy of sand based on the sub-bottom profiling data.

A smaller sand field located nearby to the northwest of the *RR—Inner 1a* site was also investigated by the field team. This sand field, labeled *RR Inner – 1b*, is shown in Figure 3-16 and covers approximately 450,000 sf. Divers performed jet probes in 10 locations and push core sediment sampling at 2 locations shown on that figure. Jet probes penetrated 2.5 feet to 5 feet with an average of 3.8 feet. This would indicate around 60,000 cy of sand is possible from this deposit.

The sand sample data from the two sites is presented in Table 3-8. Samples “RR-6.5” and “RR-6.6” are in *RR—Inner 1b*; all the rest are from *RR—Inner 1a*.

The median grain size for the samples was in the range of 0.24 to 0.41 mm. The fine material in the samples ranged from 2.1% to 6.6%, which on average is within DLNR’s range of acceptability, but notably higher than beach sand, which is typically less than 1% fines. *RR Inner-1a* was estimated to have a significant volume of sand, because of the expanse of the deposit. The deposit is quite thin—jet probes extended only 15 to 30 inches into the sand. Sand is much less efficiently dredged from thin deposits. The dredging operation would recover only a small amount each cycle and would be required to move frequently. This is expected to become relatively expensive compared to other sites investigated.

State Department of Transportation Airports Division also expressed strong concern over cranes operating near the airport runway. Given the logistical constraints and the marginal sand quality, these two deposits were not considered for Waikiki.

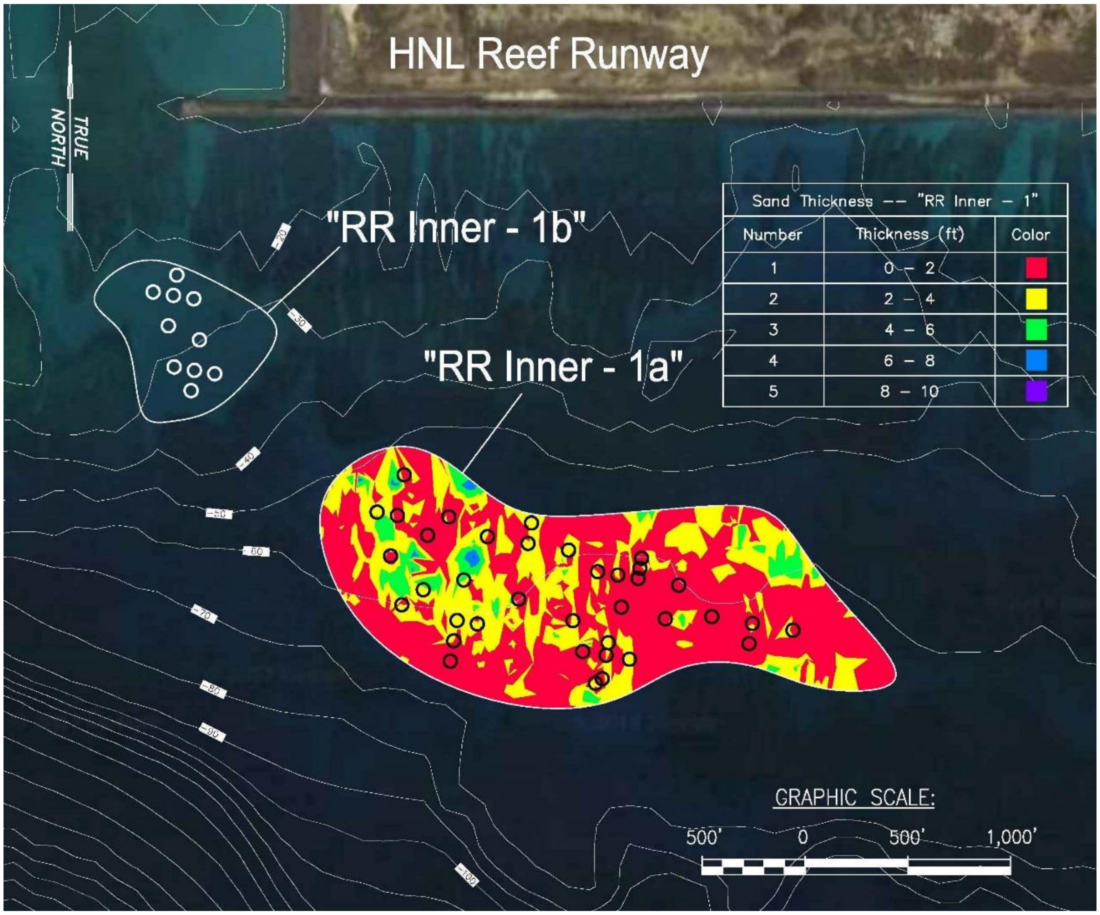


Figure 3-16 *RR—Inner* location map and sand deposit thickness. Jet probe locations shown by black and white circles.

Table 3-8 *RR—Inner* offshore sand source summary

Location	D_{50} (mm)	Sorting σ	% fines	Probe length (inches)	Source	Year
RR 3.1 (1a)	0.27	0.8	2.1	n/a	SEI	2018
RR 3.2 (1a)	0.34	0.8	2.2	n/a	SEI	2018
RR-3.3 (1a)	0.33	0.9	2.7	30	SEI	2018
RR 4.1 (1a)	0.36	0.7	2.9	19	SEI	2018
RR 4.2 (1a)	0.41	0.9	5.1	21	SEI	2018
RR 4.3 (1a)	0.34	1.1	6.6	15	SEI	2018
RR 4.4 (1a)	0.24	0.8	3.8	21	SEI	2018
RR-6.1 (1a)	0.41	1.1	1.4	n/a	SEI	2018
RR-6.2 (1a)	0.42	0.7	1.3	n/a	SEI	2018
RR-6.3 (1a)	0.27	0.8	1.8	n/a	SEI	2018
RR-6.4 (1a)	0.34	0.7	1.7	n/a	SEI	2018
RR-6.5 (1b)	0.36	0.8	1.4	n/a	SEI	2018
RR-6.6 (1b)	0.26	0.7	1.4	n/a	SEI	2018

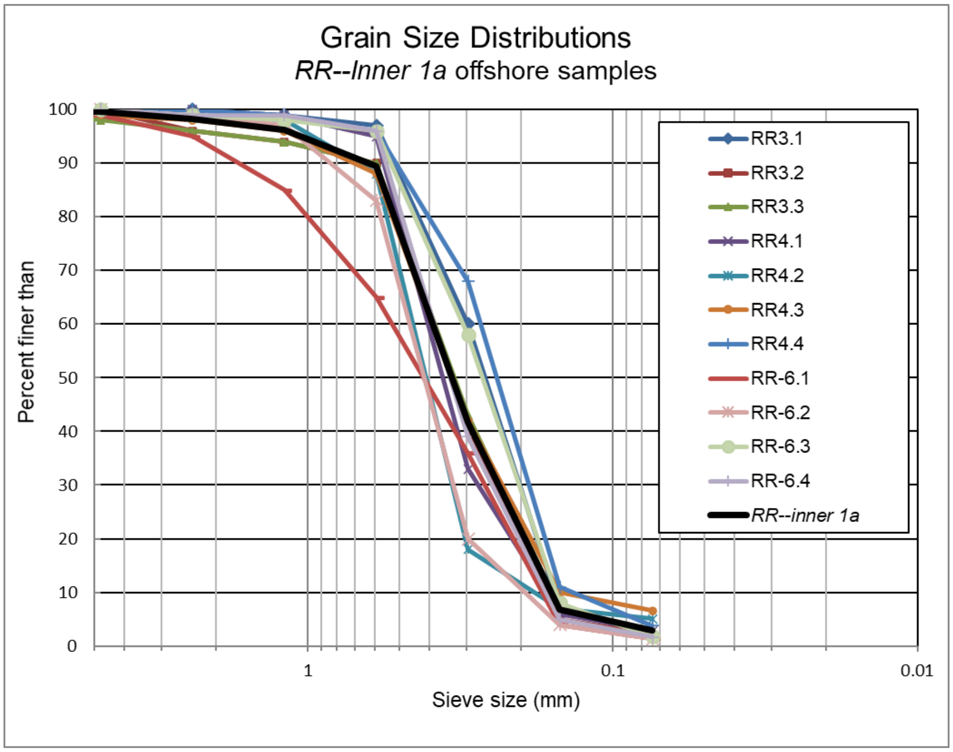


Figure 3-17 Grain size distributions for *RR—Inner 1a*.

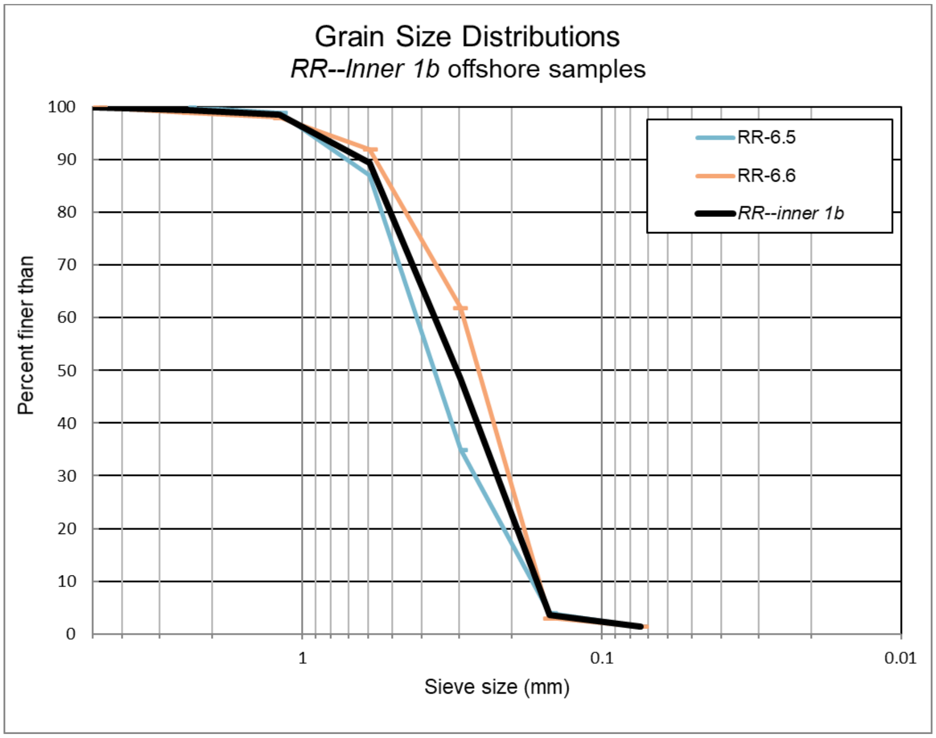


Figure 3-18 Grain size distributions for *RR—Inner 1b*.

3.5.4 Constraints (RR—Inner)

The *RR—Inner* sand deposits are located near the Ewa end of the Daniel K. Inouye Honolulu International Airport Reef Runway. The deposits are in 30 to 100 feet of water and are believed to contain more than 250,000 cy of sand. The measured median grain size ranged from 0.24 mm to 0.42 mm, which is generally similar to Waikiki beach sand. The offshore sand, however, contains a significant amount of fine material—2.1% to 6.1%—which is expected to produce noticeable turbidity, even though the fines are less than the limit set forth by DLNR.

Oceanographic conditions are not expected to be a concern during recovery, though waves and weather will have to be monitored. The site is not located significantly close to any surf sites or other recreational activities. The site is, however, located close to the Pearl Harbor channel. Operations are likely to require coordination with the military base and possible the airport. Our crew was interrogated by a military security boat during field work.

RR Inner—1b contains an estimated 200,000 cy of sand; however, the deposit is thin and dredging would be inefficient. Extraction of sand from this deposit is expected to have no effect of the airport's Reef Runway or any other structure; however, the Department of Transportation Airports Division has expressed concern over cranes operating near the runway. Coordination would be necessary for mining of that deposit.

3.6 *Ala Moana* Offshore Sand Deposit

3.6.1 2018 sand deposit investigations

The University of Hawaii Coastal Geology Group (CGG) produced a report entitled "South Oahu Reeftop Sand Bodies" as part of the U.S. Army Corps of Engineers' Regional Sediment Management program (2010). The study used aerial images to identify ephemeral and non-ephemeral sand deposits along the south shore of Oahu. The use of aerial images, however, limits the findings to visible deposits in shallow water. The sand deposits identified by the CGG were generally found at water depths less than 60 feet, and most at depths less than about 40 feet.

Sea Engineering performed additional investigations between Ala Wai Small Boat Harbor channel and Kewalo Basin channel, specifically focusing on water depths of 40 to 100 feet. Approximately 4.5 miles of drop camera footage and side-scan sonar were obtained. Analysis of the data revealed a sand deposit extending offshore of Ala Moana Beach Park. Diver jet probes and sand samples were obtained in 8 locations (Figure 3-19), and the data is presented in Table 3-9. Sand size characteristics and sand thickness were found to be variable across the deposit.

The diver investigations were later followed by a sub-bottom profiler survey of the deposit thickness (Figure 3-19). The sub-bottom survey found that the deposit had thickness of up to about 16 feet. The mapped part of the deposit, shown in Figure 3-19, is estimated to contain about 190,000 cy of sand; the central portion of the deposit, identified by the white polygon and having the greatest thickness, was estimated to contain 86,000 cy of sand based on sub-bottom profiling results. Additional jet probing was performed in 2020 to validate the subbottom data. The sand samples from vibracores of the *Ala Moana* deposit had median diameters in the range of 0.18 mm to 0.51 mm with an average of 0.39 mm and contained up to 1.7% to 5.4% fine material with an average of 3.6% fines.

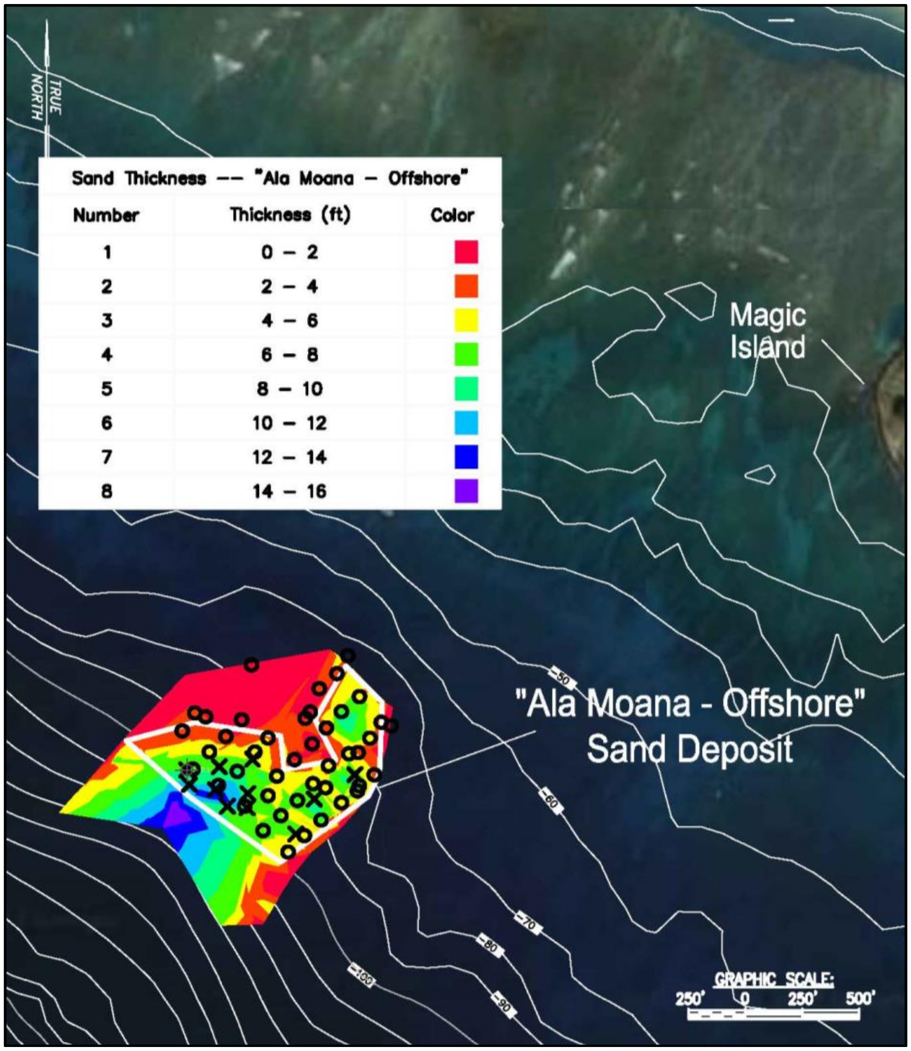


Figure 3-19 ***Ala Moana*** **location map and sand deposit thickness. Jet probe locations shown as "o" and vibracore locations shown as "x".**

Table 3-9 *Ala Moana* sand source summary (vibracores)

Location	D_{50} (mm)	Sorting σ	% fines	Source	Year
AMO-3.3	0.44	1.3	3.5	SEI	2018
AMO-3.4	0.49	1.3	3.0	SEI	2018
AMO-3.5	0.38	1.1	3.6	SEI	2018
AMO-3.6	0.46	1.2	3.1	SEI	2018
AMO-3.7	0.49	1.2	1.7	SEI	2018
AMO-3.8	0.23	1.1	3.4	SEI	2018
AMO-3.9	0.42	1.2	2.5	SEI	2018
AMO-4.1	0.34	1.2	5.1	SEI	2018
AMO-4.2	0.18	1.1	5.4	SEI	2018
AMO-4.4	0.51	1.3	4.7	SEI	2018

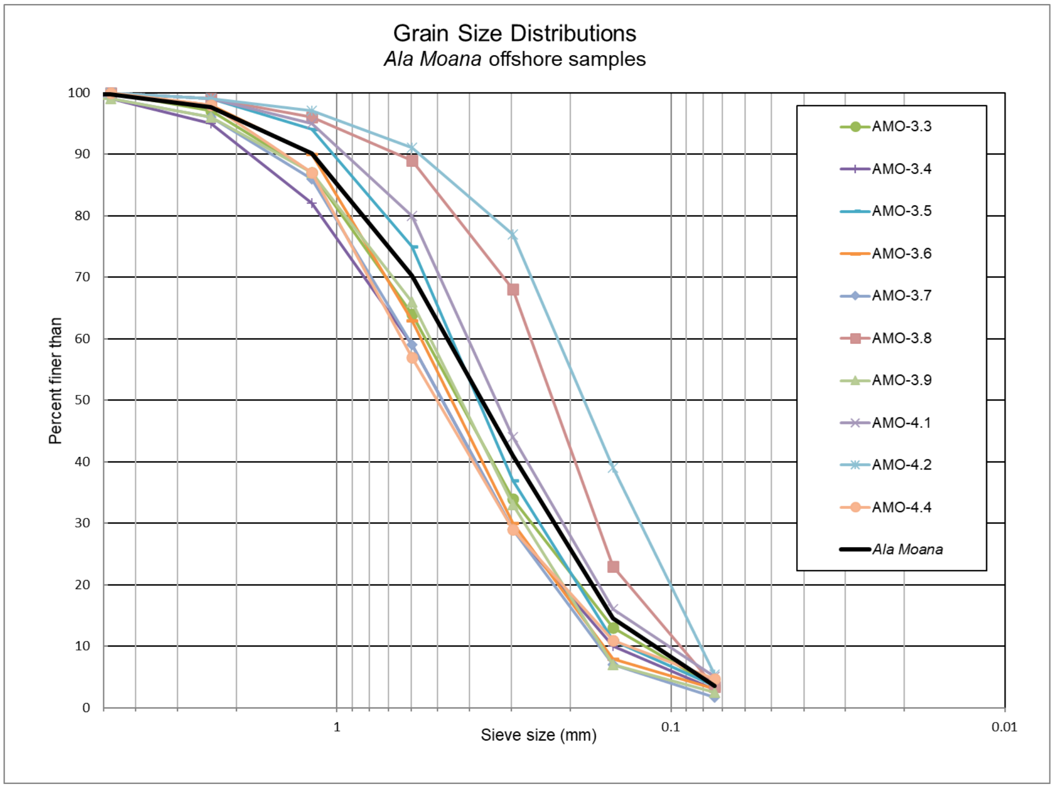


Figure ~~3-20~~ 3-21 Grain size distribution for *Ala Moana* sand deposit

3.6.2 Constraints (Ala Moana)

The *Ala Moana* deposit is located in nearshore waters off Ala Moana Regional Park. The sand deposit is directly offshore of the popular *Courts* surf sites, approximately 2,300 feet offshore of the reef break. The sand deposit is in 70 to more than 100 feet of water, and the central part of the deposit contains the thickest sand.

Oceanographic conditions are not expected to be a concern, particularly in the favorable winter months. The City and County of Honolulu has thoroughly investigated this deposit and has proposed to use sand from the deposit for their Ala Moana Regional Park Beach Nourishment project. Use of this sand deposit for Waikiki projects could meet community and City opposition, as well as regulatory requirements for using sand outside of its native region.

3.7 Pacific Aggregate Inland Sand

Pacific Aggregate has a quarry and processing operation in Waianae that specializes in the production of coral base aggregate. The property covers 200 acres and the quarry that produces a wide variety of coral aggregates, primarily for the concrete industry.

During operations they found remnants of an inland beach from a higher sea level stand, now buried under roughly 30 feet of overburden. The deposit is referred to as "Natural" or "Inland" sand. This layer is up to about 10 feet thick and the spatial extent is not presently known. A boring elsewhere on their property showed sand, but no more detail is known at this point.

The quarry mines the “Natural” sand and stockpiles it separately from the crushed limestone sand. The quarry also produces a "Blended" sample, which is composed of sediment that they recover from the ground at the base of the “Natural” excavation. This is not actually a controlled blend, but rather a combination of the “Natural” sand and any surrounding material that crumbled through the excavation process. The owner reported that the “Blended” sample might be ~50% “Natural”, though identifying the relative percentages may be difficult.

Sand samples of the “Natural” sand had an observably high quantity of fine material, and in general, the sand was poorly sorted. At our request, the quarry performed additional processing, which involved reducing the speed of the rinsing augers and increasing the water flow. This reduced the percentage of material passing through the #200 sieve to 0.5%. The grain size characteristics of the four sand samples are presented in Table 3-10 and Figure 3-22.

Table 3-10 “Pacific Aggregate” sand source summary

Sample ID	D_{50} (mm)	Sorting (σ)	% fines	Source	Year
“Natural Inland”	0.51	1.4	2.8	Pac Agg	2018
“Natural Washed”	0.61	1.0	0.5	SEI	2018
“Blended”	0.93	1.3	n/a	Pac Agg	2018
“Blended Washed”	0.70	1.2	1.1	SEI	2018

The median diameter of the “Blended Washed” sample Table 3-10 is smaller than for the “Blended” sample, although the grain size of the washed sample should have been larger. This is likely because grain size analyses were performed at different times and probably from different locations in the quarry, highlighting the variability in the Blended sand.

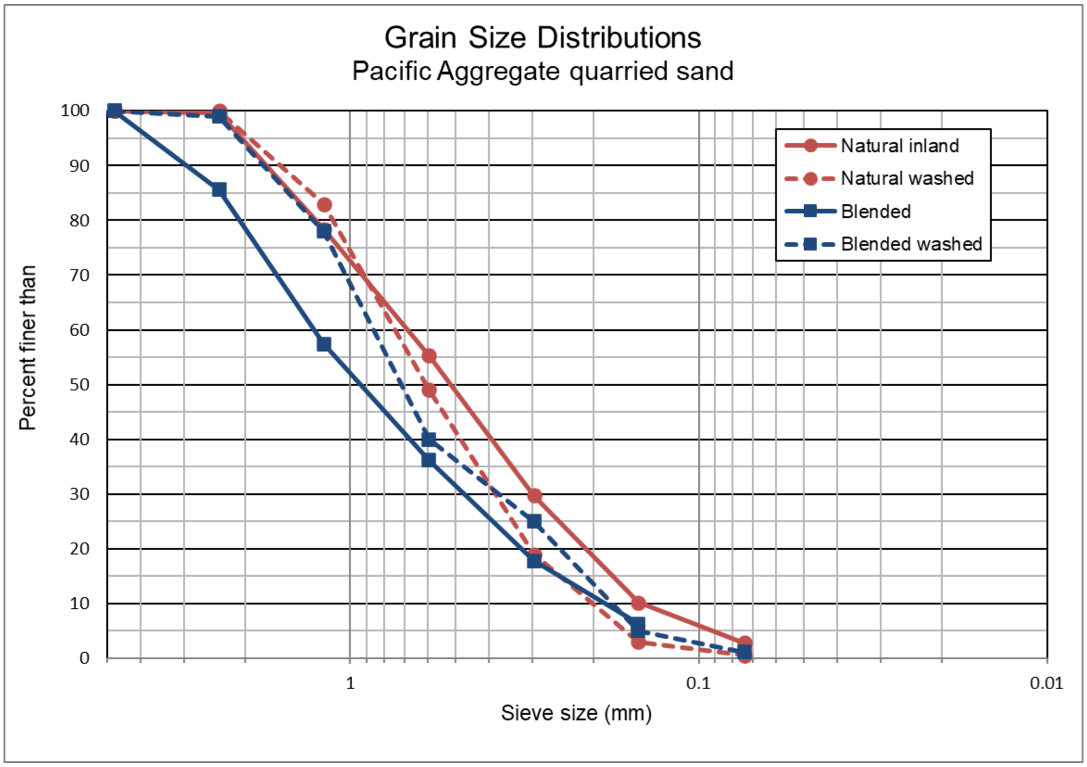


Figure 3-22 Grain size distribution for *Pacific Aggregate* washed quarry sand

3.7.1 Constraints (Pacific Aggregate)

The "Inland Sand" is a layer of relithified calcareous beach sand in an area where fossil reef is mined and processed. The Inland Sand is stockpiled and sold as it is mined. The quarry does not have an estimate of future available or sand quality in other parts of the property.

Trucking from the quarry in Waianae to Waikiki would be needed to use the sand in this project.

The sand has a high amount of fines that can be washed out by the quarry. The extra handling adds to the cost. Additionally, the sand has not been approved for use on the beach by DLNR.

3.8 Summary

Nine offshore sand deposits were considered for this project. The sand statistics are presented in Table 3-11 and turbidity test results are presented in Figure 3-23. A representative photograph of offshore sand samples is presented in Figure 3-24.

Of the sand sources presented in this report, three have direct applicability to the Waikiki EIS project: *Ala Moana*, *Hilton*, and *Canoes/Queens*. Sand from the *Canoes/Queens* deposit was used in the 2006-2007 Kuhio Beach nourishment project and the 2012 and 2021 Waikiki Beach Maintenance projects. Sand from that deposit is best used as a somewhat perpetual source of sand for the Royal Hawaiian Beach Sector. A Conservation District User Permit was granted to the City in February of 2021 to use *Ala Moana* to nourish Ala Moana beach. The other sand deposits have never been mined.

Table 3-11 Offshore sand source data summary.

Deposit	Depth (ft)	D_{50} (mm)	Sorting	% fines	Volume (cy)	Vibra-cored	Jet probed	Turbidity test?
Ala Moana	70-120	0.37	1.3	3.6	>86,000	Y	Y	Y
Diamond Head	20-30	0.43	0.6	1.0	110,000	N	Y	N
Halekulani	70-120	0.27	1.0	3.3	>200,000	Y	N	Y
Hilton	40-60	0.59	0.9	0.8	45,000	Y	Y	Y
RR-inner 1a	50-65	0.33	0.9	2.9	200,000	N	Y	Y
RR-inner 1b	25-35	0.33	0.9	1.4	50,000	Y	Y	Y
RR-outer	100-300	0.18	0.9	4.0	n/a	Y	Y	N
Canoes/Queens	10-20	0.33	0.8	0.5	>30,000	Y	Y	Y

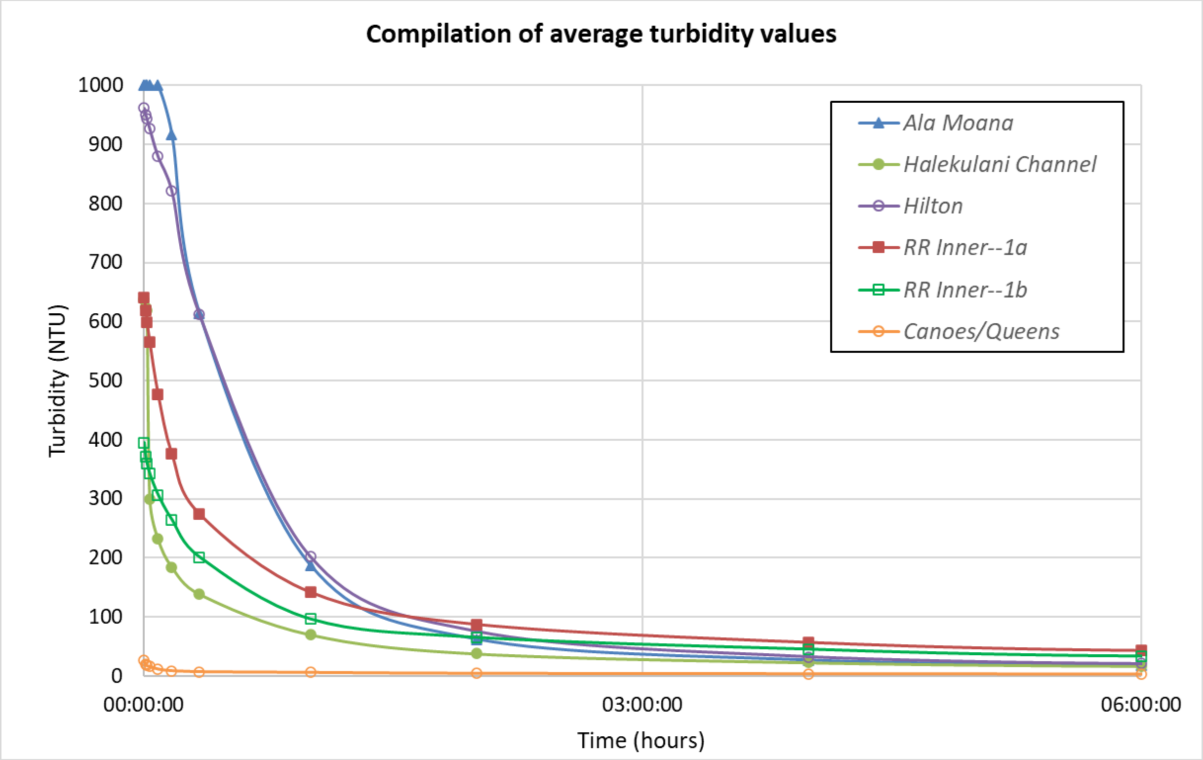


Figure 3-23 Turbidity analysis results for 6 offshore sand deposits

Reef Runway (Inner-1b)		Diamond Head
Hilton		Canoes/ Queens

Figure 3-24 Four representative sand samples from offshore deposits

4. BEACH SECTORS AND POTENTIAL OFFSHORE SAND SOURCES

The following sections present comparisons of sand from the offshore sand sources in relation to the four beach sectors for the Waikiki EIS. Recommendations based on the findings of the sand source investigations are presented. The recommendations are based on the physical characteristics of the sand deposit and the existing shoreline conditions and proposed project.

Beach nourishment at Waikiki and Ala Moana during the 20th century was accomplished by mining sand from distant beaches (e.g., Molokai, Waimea Bay, Yokohama Beach) and placing it directly on the beaches. While this practice is no longer allowed, there is still concern voiced over transporting sand from one region for use in another.

Beach nourishment using an offshore sand deposit has been performed a total of 4 times in Hawaii: Kuhio Beach (2006-2007), Waikiki Maintenance (2012 and 2021), and Iroquois Point (2013). In each of those projects, the sand source was directly offshore or otherwise connected to the project. The use of sand from an offshore source that is outside of the project area has not been done previously in Hawaii, and it is possible that proposed use could encounter community opposition and regulatory constraints that prohibitive the use of sand in other shoreline regions.

4.1 Kuhio Sector

Two sand samples were obtained from the beach face in the Kūhiō Beach Park ‘Ewa (west) basin in February 2021. Figure 4-1**Error! Reference source not found.** shows the composite grain size distribution of those two samples, which have a median grain size (D_{50}) of 0.43 mm. Figure 4-1 **Error! Reference source not found.** also shows the composite grain size distributions for the offshore sand deposits investigated in this project. The best match for the beach is the *Diamond Head* offshore sand deposit. The *Ala Moana* and *Canoes/Queens* offshore sand are reasonable matches for the coarser part of the distribution, before passing outside the ±20% guideline for finer sand. The *Hilton* offshore sand falls on the coarser side; however, slightly coarser sand would be expected to be more stable on an eroding beach.

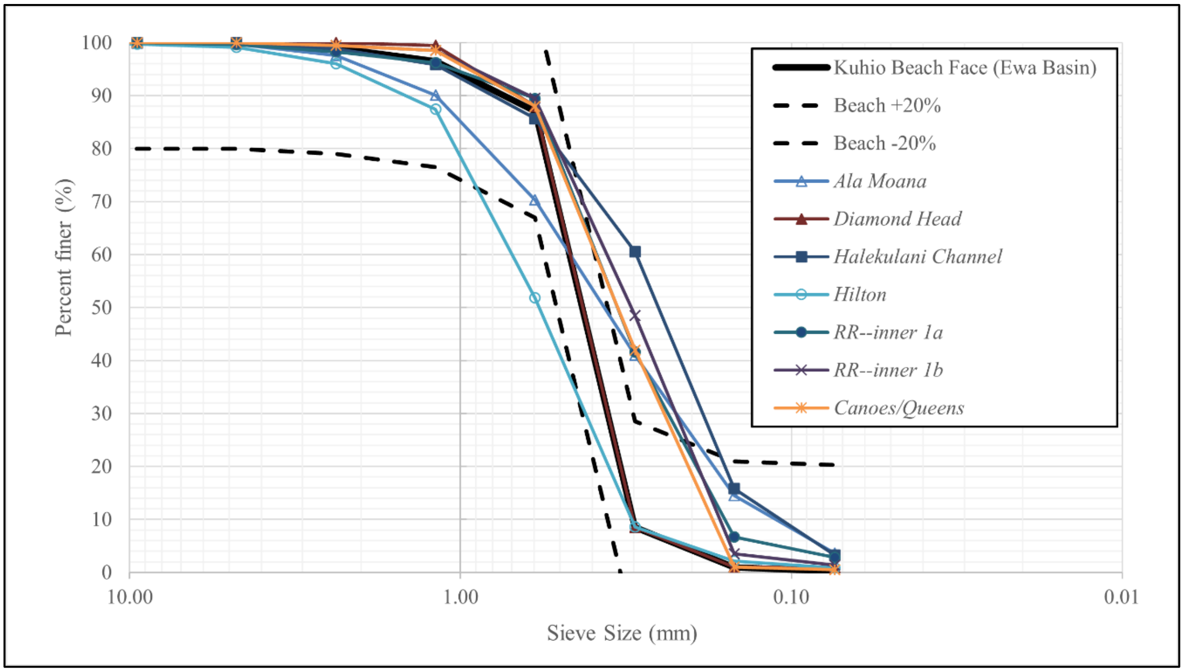


Figure 4-1 Grain size distributions: Kūhiō Beach Park, ‘Ewa Basin and offshore sand sources

Given the logistical challenges of obtaining sand from the *Diamond Head* offshore deposit, the preferred sand sources for the Kūhiō beach sector are the *Hilton*, *Ala Moana*, and *Canoes/Queens* offshore deposits. Figure 4-2**Error! Reference source not found.** and Table 4-1**Error! Reference source not found.** present the grain size distributions and statistics for the beach and the recommended sources. Sand recovered from the *Ala Moana* and *Hilton* offshore deposits could be used with only minimal overfill, whereas sand from the *Canoes/Queens* offshore deposit would require an additional 12,500 cy sand (total of 40,500 cy) due to the finer sand grain size and increased overfill ratio. Furthermore, the *Canoes/Queens* deposit contains a limited volume of sand, has been dredged multiple times, and is better suited for use in the Royal Hawaiian beach sector. The proposed beach nourishment and structural modifications should result in slightly reduced wave energy in the ‘Ewa (west) basin. Additionally, the sand would be contained within the basin by the historical dredge cut in the reef along the offshore margin of the basin.

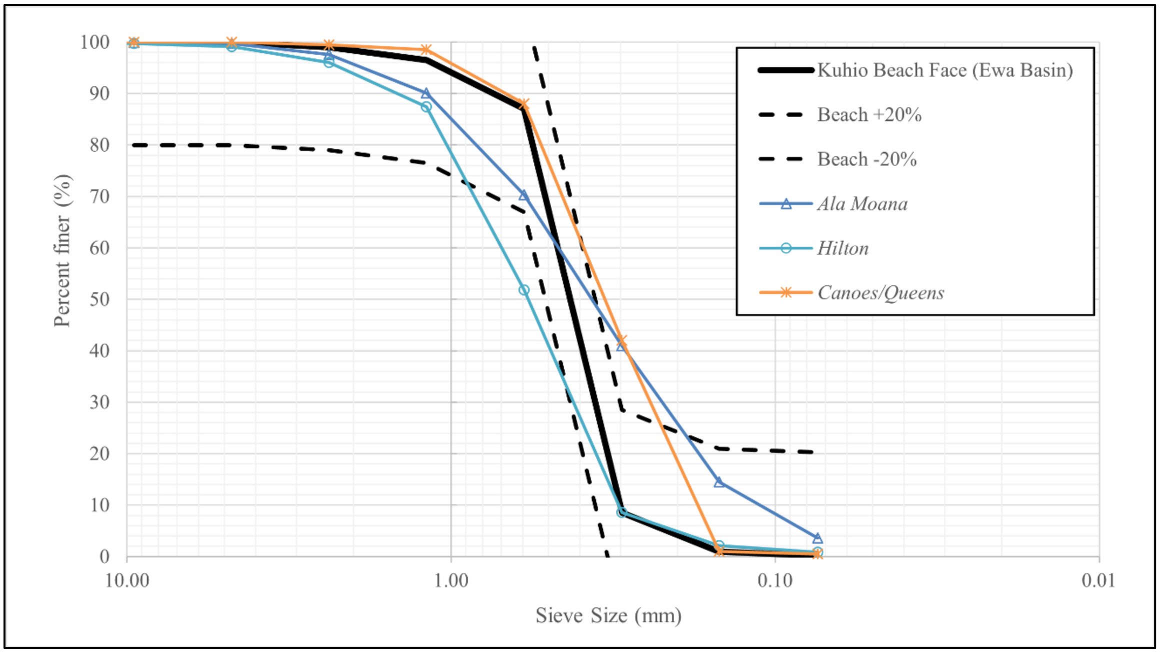


Figure 4-2 Grain size distributions: Kūhiō Beach Park, ‘Ewa Basin, Beach Face and recommended sand sources

Table 4-1 Comparison of sand parameters for Kūhiō Beach Park

	‘Ewa Basin	**Canoes/Queens**	**Ala Moana**	**Hilton**
Median diameter, D_{50} (mm)	0.43	0.34	0.37	0.59
Sorting	N/A	0.82	1.42	1.02
Overfill factor	N/A	1.50	1.10	1.00
Estimated sand required (cy)	25,000	37,500	27,500	25,000
Estimated sand available (cy)	N/A	40,000	86,000	40,000

4.2 Royal Hawaiian Sector

The preferred sand source for the proposed beach nourishment action is the *Canoes/Queens* offshore deposit, which is the same sand source that was used in the Waikīkī Beach Maintenance I and II projects in 2012 and 2021, respectively. The similar sand characteristics to the existing beach, close proximity to the shoreline, and small percentage of fine material in the *Canoes/Queens* offshore sand deposit makes it preferable for this beach sector.

Sand from the *Hilton* and *Ala Moana* offshore sand deposits are also viable options. Sand in the *Hilton* deposit is coarser and may be more stable on the beach. Utilizing clamshell dredging to recover sand from either of these deposits and trucking it to the project site may be more economical when compared to hydraulic dredging due to increased production and less projected downtime due to pipe plugging.

4.3 Halekulani Sector

One sand sample was obtained from the beach face fronting the Halekūlani Hotel in February 2021. Figure 4-3 shows the composite grain size distribution for the existing beach sand, which has a median grain size (D_{50}) of 0.35 mm. Figure 4-3 also shows the composite grain size distributions for the offshore sand deposits investigated in this project. Nearly all of the offshore sand falls within ±20% of the Halekūlani beach sand grain size distribution. Sand from the *Hilton* deposit falls on the coarser side; however, slightly coarser sand would be expected to stable on an eroding beach. This would be especially important with sea level rise, at which point the waves are expected to be more energetic.

The recommended potential sand sources for the Halekūlani beach sector are the *Hilton*, *Ala Moana*, and *Canoes/Queens* offshore deposits. Figure 4-4 and Table 4-2 present the grain size distributions and statistics for the beach and the recommended sources. Sand from any of the three sources presented (*Ala Moana*, *Hilton*, and *Waikīkī*) could be used with no required overfill. Furthermore, given the volume of sand required, sand combined from both the *Hilton* and *Ala Moana* sand deposits would be suitable for use in this sector.

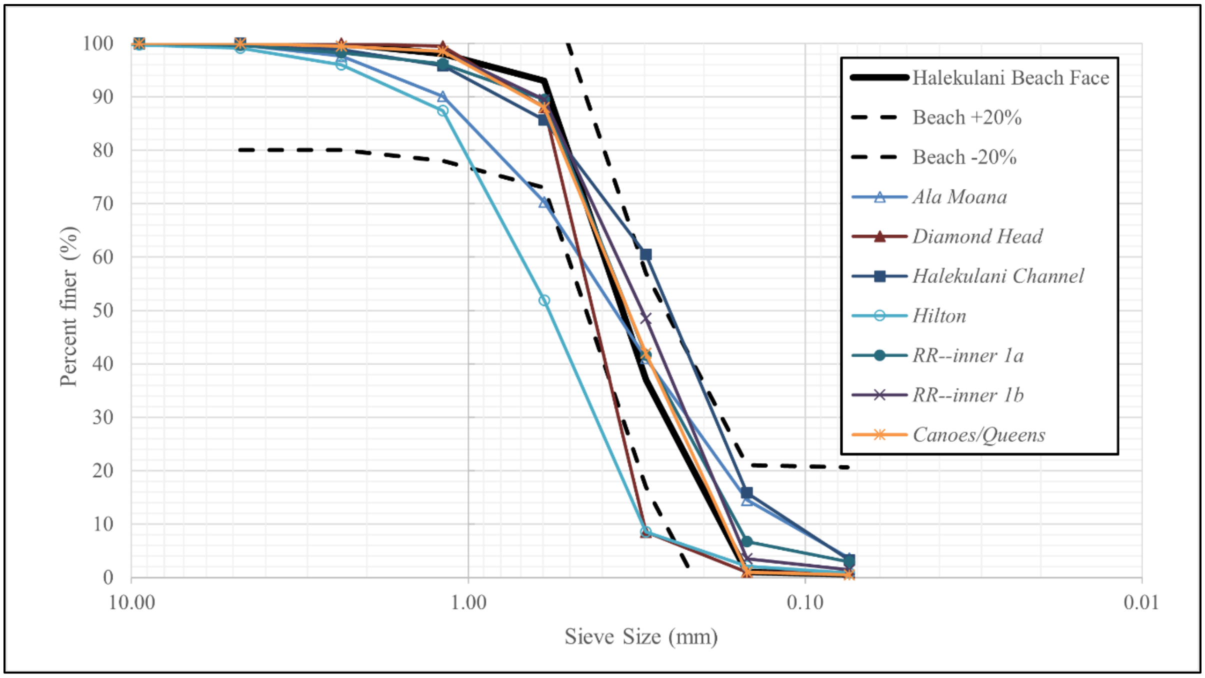


Figure 4-3 Comparison of grain size distributions for existing beach sand and offshore sand

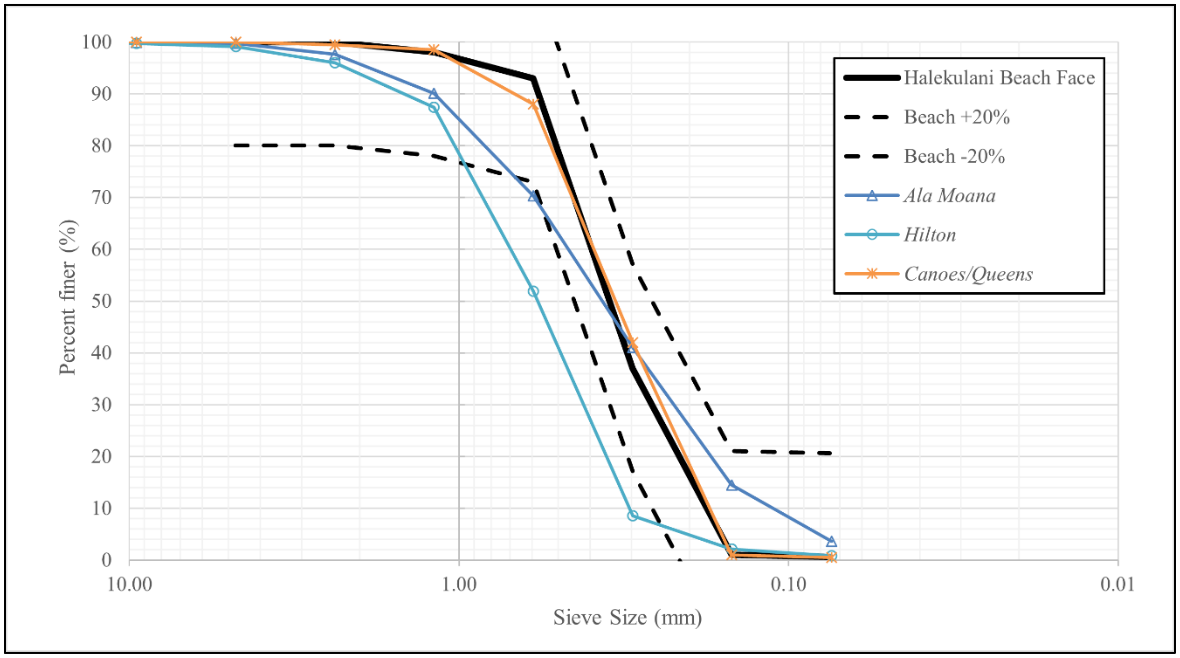


Figure 4-4 Grain size distributions for recommended sand sources - Halekūlani beach sector

Table 4-2 Comparison of sand parameters - Halekūlani beach sector

	Existing Beach Sand	Canoe/Queens	Ala Moana	Hilton
Median diameter, D_{50} (mm)	0.35	0.34	0.37	0.59
Sorting	N/A	0.82	1.42	1.02
Overfill factor	N/A	1.50	1.10	1.00
Estimated sand required (cy)	60,000	60,000	60,000	60,000
Estimated sand available (cy)	60,000	40,000	86,000	40,000

4.4 Ft. Derussy Sector

The proposed action in the Fort DeRussy beach sector involves moving sand from the beach face fronting the Hale Koa hotel to the beach fronting the U.S. Army Hawaiʻi Museum. Two sand samples were obtained from the beach face on each end of the beach sector in February 2021. Figure 4-5 shows the composite grain size distribution for the existing sand at the Diamond Head (east) end of the beach sector, which has a median grain size (D_{50}) of 0.35 mm. Figure 4-5 also shows the composite grain size distributions for two samples of the fill sand that will be obtained from the ʻEwa (west) end of the beach sector, which is slightly coarser but would be expected to be more stable on an eroding beach. This is particularly true for the Fort DeRussy beach sector where no additional sand stabilizing structures are proposed.

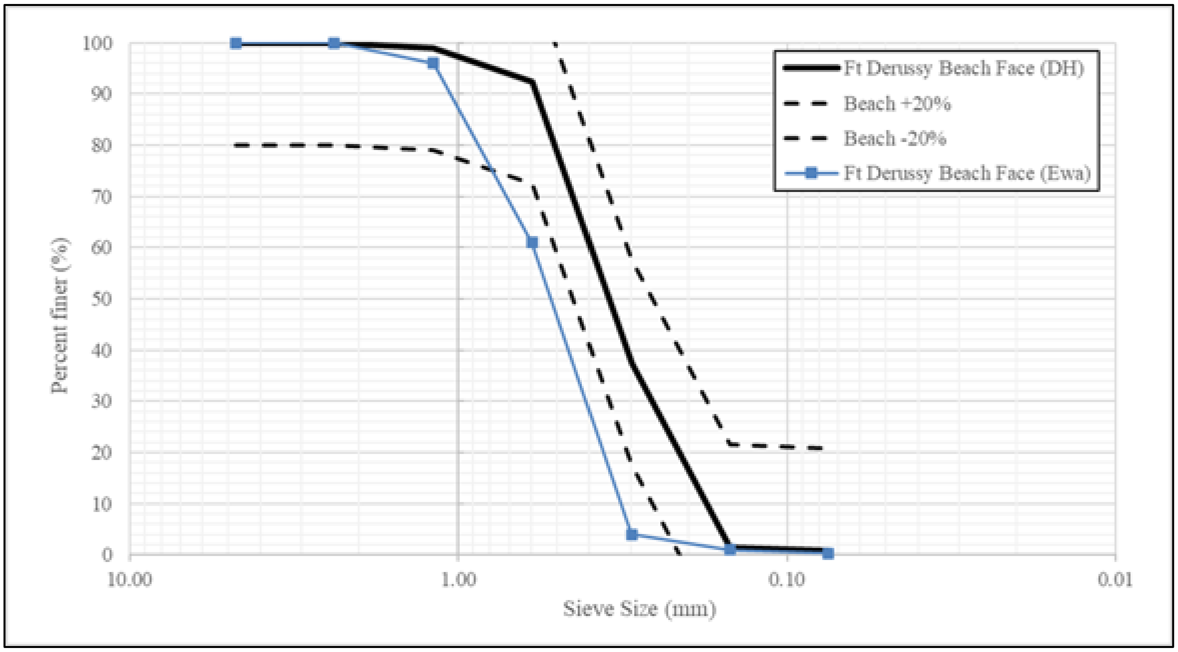


Figure 4-5 Grain size comparison of existing beach sand at borrow site and fill site

4.5 Summary

Comparison of native beach sand with the available offshore sand sources indicates that there are limited sand sources available that have sand that adequately meets DLNR's guidelines for beach nourishment in Waikiki. These deposits are *Ala Moana*, *Diamond Head*, *Hilton*, and *Canoes/Queens*. Within Waikiki, only *Hilton* and *Canoes/Queens* have suitable sand, and their volume is limited. *Ala Moana and Diamond Head* contain suitable sand; however, they are located outside of the project area. Use of offshore sand from deposits outside the project area has not been done to-date in Hawaii. Given heightened awareness on beach erosion, it is possible that community opposition to sand extraction from their beach area for use somewhere else could prove prohibitive. Sand availability for future projects in Waikiki could become increasingly difficult.

5. OFFSHORE SAND RECOVERY AND TRANSPORT METHODOLOGY

A variety of methods are available to recover the offshore sand. Each method has inherent advantages, disadvantages, and ranges of applicability. The three most common forms of dredging used in Hawai‘i are clamshell buckets; 2) submersible slurry pumps; and 3) self-contained hydraulic suction dredges.

5.1 Dredging System

Dredging systems for beach nourishment purposes are designed to recover sand from the seafloor and deliver it to an alternate site. There are various ways to accomplish these operations, some of which store the sand onboard the dredging vessel or deliver it to nearby barges or ships, while others transport the sand directly through a pipeline to the shore. Storing the sand on the dredging vessel requires that the vessel return to a commercial harbor on a regular basis to discharge recovered materials, requiring considerable time, energy, and harbor space. If the sand is pumped to shore, booster pumps and additional barges may be necessary if the distance to the project beach is excessive. The third strategy would be placement of the dredged sand in ships or barges that could be cycled through the recovery and delivery process close to the project site to increase dredging efficiency. This would allow for simultaneous loading and offloading of pairs of these barges and would allow the dredge barge to remain in place for the duration of the recovery effort.

All of these techniques require that the dredge barge be anchored with a stable, minimum four-point mooring in the recovery area. Anchors would be placed within the sand field and marked with floats or buoys, as depicted in Figure 5-1. A four-point mooring would allow the barge to change locations within the recovery area and remain securely anchored without having to adjust anchor placement.

There are several potential dredging techniques that might be employed for the project, all of which are discussed in the following sections.

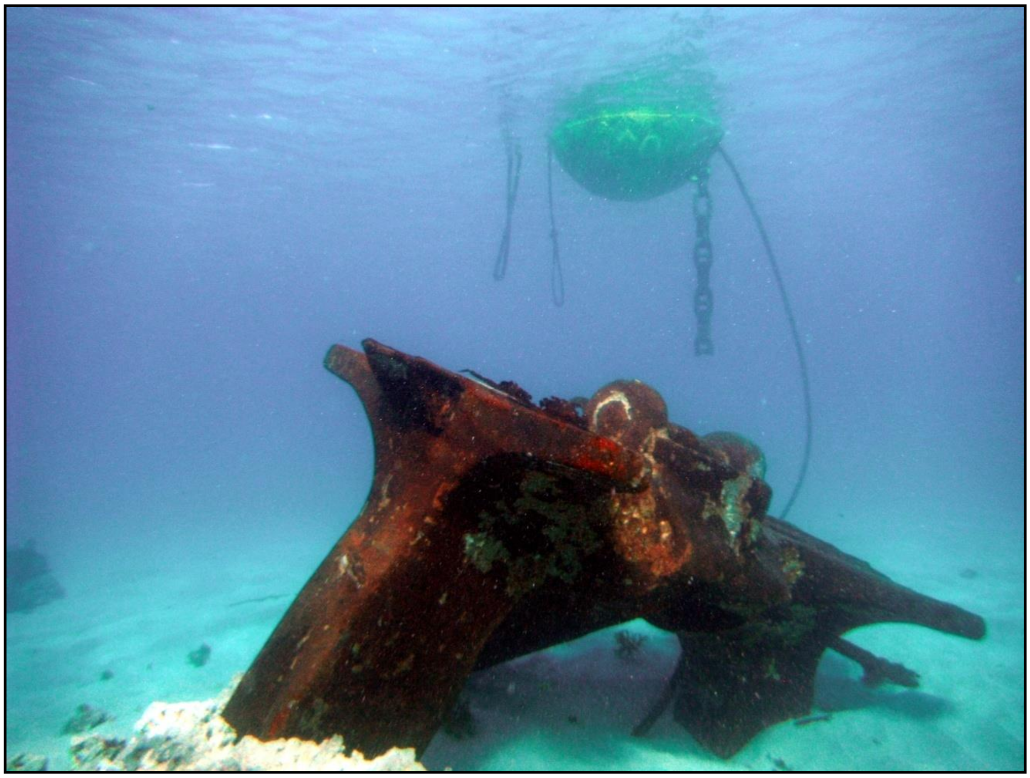


Figure 5-1 Example: Anchor and Anchor Float used in the 2012 Waikiki Beach Maintenance Project.

5.1.1 Clamshell Dredging

Clamshell dredging, shown in Figure 5-2, describes the process of mechanically scooping and lifting the sediment, in this case sand, from the seafloor. An environmental clamshell bucket, such as the one shown in Figure 5-3, is lowered from a crane in the open position, and upon the clamshell reaching the bottom, the crane operator closes the clamshell jaws and lifts the material out of the water. The operator then rotates the crane and opens the bucket to dispense the material into a waiting barge, such as a hopper barge (Figure 5-4).

A 15 cy rated bucket for example would have an open footprint of 13 ft by 13 feet, and would penetrate approximately 2 feet into the bottom, recovering about 12 cy of sand.

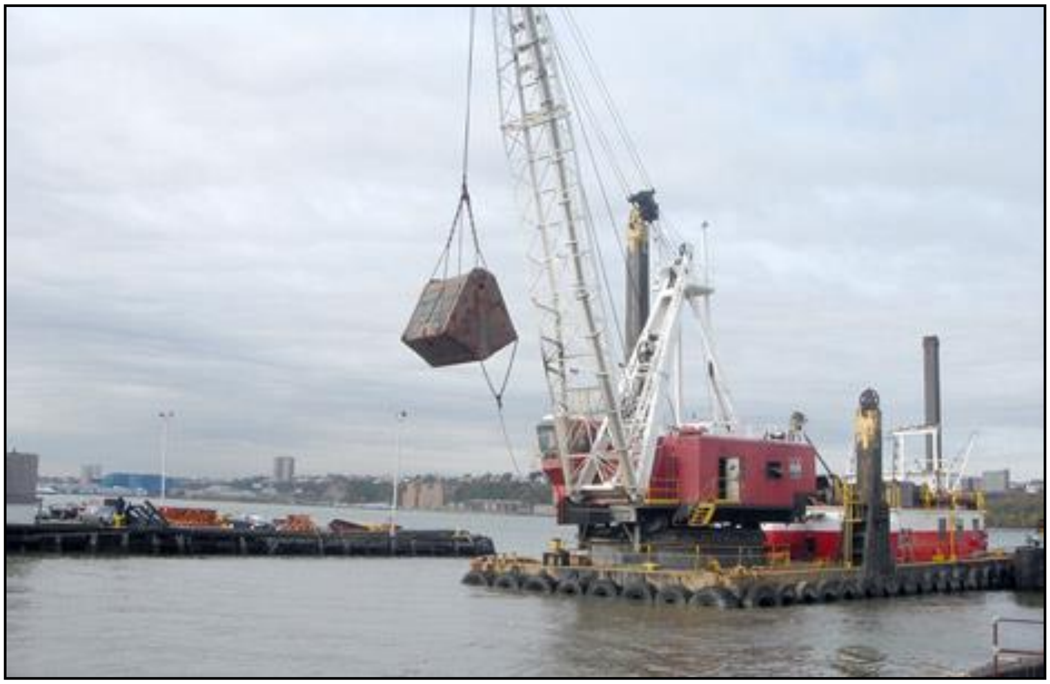


Figure 5-2 Example: Clamshell Dredge with Environmental Bucket
(http://www.conedison.com/ehs/2009annualreport/environmental_stewardship)

Figure 5-3 Example: Environmental Clamshell Bucket
(http://www.alibaba.com/product-free/107658423/Environmental_clamshell_grab.html)

Figure 5-4 Hopper Barge
(http://www.thecargogroup.net/)

Environmental clamshell buckets, also called level-cut buckets, are designed to be able to remove as little as 6 inches of sediment from the seafloor surface if necessary, while leaving the lower sediment undisturbed. Figure 5-5 shows a schematic of the level-cut process. The bucket is lowered to the seafloor with the jaws open. Upon reaching bottom, the jaws are closed, skimming off the upper portion of sediment. Although the bucket does not penetrate deeply into the seafloor, the jaw width is great enough that a 6-inch layer of sediment recovered would still amount to 3 cy of sand.

While recovering a thin surface layer is valuable when dealing with contaminated sediments, in the case of offshore sand recovery, this process allows for recovery of sand from thin deposits. Positioning software allows the operator to precisely place the bucket to recover sediment from the proper location.

Clamshell bucket sizes vary from as small as one cy to over 20 cy, and can be either sealed or open. Newer technology allows removal of material with only slightly more water content than in the *in situ* sediment. The end plates of the buckets overlap and rubber seals help to prevent loss of water and sediment as the bucket is raised.

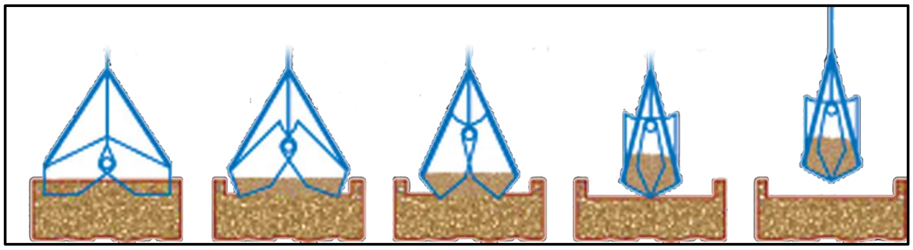


Figure 5-5 Level-cut dredging schematic (www.cablearm.com)

Clamshell dredging is often used in association with a large barge, such as the hopper barge shown in Figure 5-4, on which the sediment is deposited. Once the sediment is onboard the barge, transport is accomplished by either moving the barge to a dock and offloading or using a waterborne sand delivery system to deliver the sand to the shoreline.

The benefits of using clamshell dredging are that it is very mobile, it can operate at any depth that the crane cable can reach, it can be used in moderate swell conditions, and it can recover a wide variety of material types. Additionally, little specialized equipment beyond the clamshell is needed for dredging operations. The technology of the environmental buckets helps to reduce environmental impacts due to turbidity and increase efficiency in recovering sand, reducing time and cost of the operation. Additionally, the amount of water that is accumulated from the clamshell dredging process is much less than with hydraulic dredging presented in the next section, and the small amount of water can be discharged at an approved location.

The drawbacks are that it is less efficient than other dredging systems, such as those utilizing hydraulic or slurry pumps, and it requires the sand deposits to be thick enough that the clamshell does not reach hard substrate.

5.1.2 Submersible Slurry Pump

Submersible slurry pumps, referred to as “Toyo Pumps” after the largest supplier of such, are distinguishable by the way that they are lowered from overhead and suspended above the sediment they are pumping. The pumps can be hydraulically or electrically driven, and are available in a range of sizes. Models are available with up to 400 hp. Toyo DP75B (75hp) hydraulic pumps were used successfully for dredging both the 2006-2007 Kuhio Beach restoration project and 2012 Waikiki Beach Maintenance Project. Respectively, the projects pumped approximately 10,000 and 24,000 cy of sand from offshore onto the beach within the Kuhio Beach crib walls.

Several equipment elements are required to successfully recover sand utilizing a submersible pump. A barge and crane are necessary to position a hydraulic or electric powered pump over the sand bottom. The crane can move the pump across a small area, dependent on the crane size and length of its boom. Accessing different portions within the recovery area is achieved by repositioning of the pump barge using a minimum four-point mooring array. Additionally, depending on the size of the slurry pump, a booster pump may be required if the distance to the shoreline is excessive. An additional piece of equipment called a “jet ring” can be mounted on the pump to aid in entraining sand to increase the percent of sand in the slurry. This jet ring requires a water pump on deck and an additional 4-inch water hose connected to the submersible pump. An illustration of this dredge system is shown on Figure 5-6, taken from the Kuhio Beach project after-action report (American Marine, 2007). Figure 5-7 shows the Healy Tibbitts dredge barge used in the 2012 Waikiki Beach Maintenance Project.

The benefit of the submersible pump is its precise positioning and ability to reach into tight spaces. Using a crane-tip GPS unit to locate the pump, the operator can accurately position the pump to within a few feet of any location to effectively remove the sand from near the edges and corners of the recovery area. In addition, sand recovery with a slurry pump can be more efficient than mechanical recovery when a high sand to water ratio can be achieved.

The primary drawbacks to the submersible pump are that the operation is labor intensive and it requires dewatering. Operation requires a crane operator, a rigger, and several people to handle the pumps, generators, and pipelines on deck. Additionally, the pump must be held at a relatively constant height above the sand. If the pump is lifted too high it will not entrain the sand, and if it is too low the slurry will become too concentrated and the pipeline may clog. Maintaining this balance is especially difficult for the crane operator in the presence of swells greater than one to two feet; however, the dredge equipment can be operated from an ocean-going barge, which provides reasonable seaworthiness. Submersible pumping requires that the slurry be properly dewatered, which increases on-land space requirements. For example, the 2012 Waikiki Maintenance project utilized a one-acre dewatering basin within Kuhio Beach Park, requiring the Diamond Head basin to be completely closed to the public.

Production records for the 2012 Waikiki Maintenance project showed that the contractor recovered 400 to 800 cy of sand in a 10-hour day, and placed sand on the beach at a rate of 1,500 to 2,000 cy in a 5-hour day.

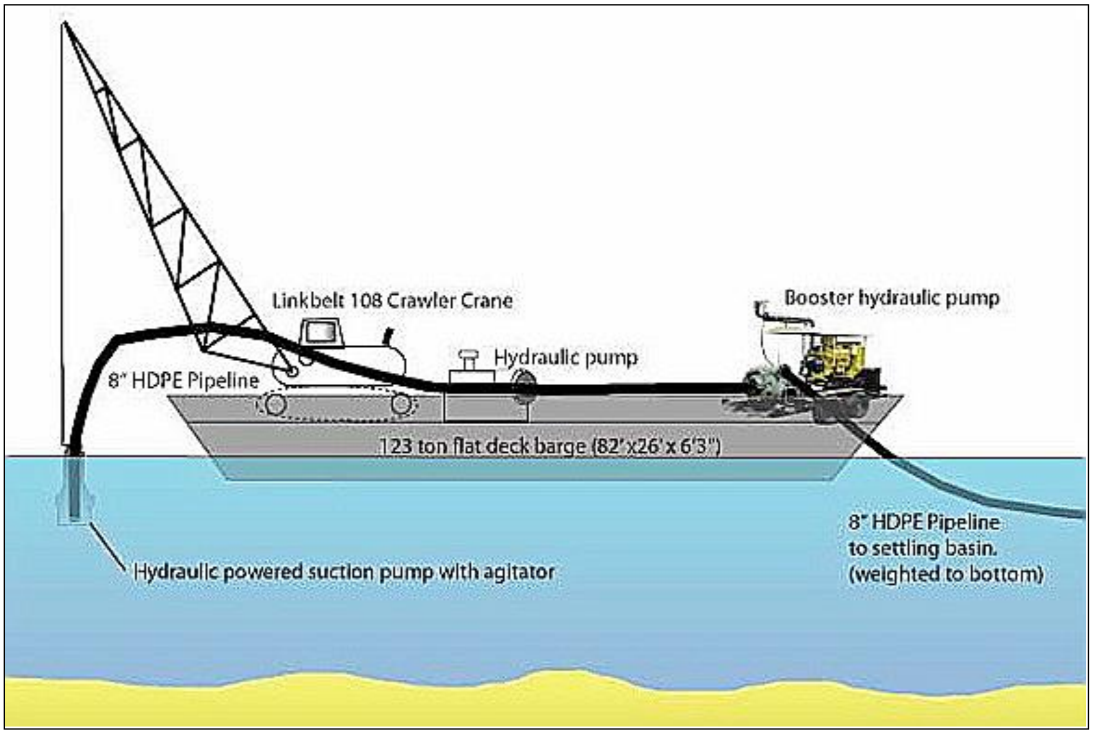


Figure 5-6 Schematic of sand pumping arrangement (American Marine, 2007)

Figure 5-7 Healy Tibbitts Crane Barge used in the 2012 Waikiki Beach Maintenance Project

5.1.3 Hydraulic Suction Dredge

A hydraulic dredge is a more traditional dredging technology that has proven to be effective for beach nourishment projects. A hydraulic dredge functions similarly to a submersible pump, except that the pump is above water on a surface platform (e.g., boat or barge), and a rigid suction pipe is lowered from the surface platform down to the seafloor. Dredged material is typically discharged as a sand-water slurry through a pipeline to shore. An example of hydraulic section dredging is shown in **Figure** 5-8.

Hydraulic dredges come in a wide range of sizes, from large ocean-going dredges for maintaining commercial ports and waterways, to small, trailerable units that are typically used for lake and reservoir clearing or small marina maintenance. A small hydraulic suction dredge (Mud Cat) was used in a small-scale sand pumping demonstration project conducted by the State of Hawaiʻi Department of Land and Natural Resources in February 2000 (Noda, 2000). Approximately 1,400 cy of sand was dredged from a deposit located 1,500 ft offshore of Kūhiō Beach and pumped to a dewatering basin excavated into the dry beach area within the Diamond Head (east) basin of Kūhiō Beach Park. Hydraulic suction dredges are otherwise less common in Hawaiʻi in comparison to submersible slurry pumps.

Figure 5-8 Example of hydraulic suction dredge (Ellicott Dredges)

5.2 Small-scale Maintenance Dredging

Nearshore sand deposits are typically too far from the coastline for land-based equipment such as excavators to reach, and too shallow to access via work vessels. Sand deposits located within approximately 1,000 ft of the shoreline may be viable for small-scale beach maintenance purposes, as this sand is likely eroded from the beach.

Novel dredging approaches must be utilized to recover sand from nearshore deposits. Two examples of equipment that could potentially be used for nearshore dredging projects are an ROV subdredge and a diver-operated dredge.

5.2.1 Remote Operated Submersible Dredge

A Remote Operated Submersible Dredge (ROV subdredge) is an electrically powered tracked hydraulic pump manufactured by EddyPump© Corporation (**Figure** 5-9). The pump was developed for the U.S. Army and U.S. Navy for Logistics-Over-the-Shore (LOTS) operations for early entry forces and areas that are too dangerous for human operators. It is fully submersible and capable of being operated remotely from shore. An umbilical would run along the pipeline providing power and control to the ROV subdredge. The pump would be powered by an electric power unit located on shore and a small submersible hydraulic power unit mounted on the ROV subdredge. A Real-time Kinematic (RTK) Global Positioning System (GPS) provides location data to the landside operator.

An advantage of an ROV subdredge is that it can be operated in shallow water that us inaccessible by barges. To recover nearshore sand deposits in Waikīkī, an ROV subdredge would be deployed and operated from shore. A pipeline would transport slurry from the ROV subdredge to two dewatering basins on shore. The pipeline would float on the water surface. A small support vessel (e.g., small boat or jet ski) would be used to maintain a safety buffer and assist with maneuvering the dredge pipeline. The operator would move the ROV subdredge through the sand deposit until a sufficient volume of sand was recovered. A camera mounted on the ROV subdredge allows the operator to direct the dredge head to the sand deposit for maximum efficiency. The production rate for the ROV subdredge is expected to be up to 30 to 50 cy of sand per hour.

Additional equipment would be required for proper operation of the ROV subdredge. A 100-kW diesel generator would be located onshore and provide power to the ROV via the umbilical. One thousand feet of floating pipeline would connect to the ROV. A bulldozer and skid-steer would be required to excavate the dewatering basins and push sand to the desired grade.

The primary disadvantage of an ROV subdredge is the initial cost for the equipment. The ROV subdredge itself would cost approximately $1 million.

Figure 5-9 Remote Operated Submersible Dredge (Eddy Pump, 2021)

5.2.2 Diver-operated Dredge

A diver-operated dredge is a dredge system that can be manipulated and operated by divers. Diver-operated dredges are typically used in shipyard operations and the mining and fracking industries. Using a diver to manipulate the suction hose offers a level of precision that cannot be achieved by lowering a pump over the side of a vessel. **Figure** 5-10 shows a diver-operated dredge pump manufactured by EddyPump© Corporation. The diver-operated dredge pump is roughly 6 ft long, 3 ft wide, and 3 ft tall, but dimensions vary depending on the size of the pump chosen. **Figure** 5-11 shows a diver on surface supplied area manipulating a diver-operated dredge nozzle.

Sand recovery would require a four-person dive team working from shore for Occupational Safety and Health Administration (OSHA) compliance. The dredge pump could be placed on shore on the beach face, or on a small vessel or float. A floating slurry pipeline and power cable would extend from the dredge pump to the sand recovery area. The pump would be powered by a 100kW generator located on shore. A suction hose would be connected to the dredge pump. The suction hose would be controlled by a single diver. The hose would have a length of 100 ft, which would enable the diver to dredge sand within a 100-ft radius of the pump. Once the sand is dredged to the desired depth, the pump would have to be relocated to another area. The 6-inch pump system can accommodate two divers and two hoses for greater efficiency. A bulldozer and/or skid-steer would be required to spread the sand to the design grade. The production rate for one diver is expected to be 20 to 40 cy of sand per hour.

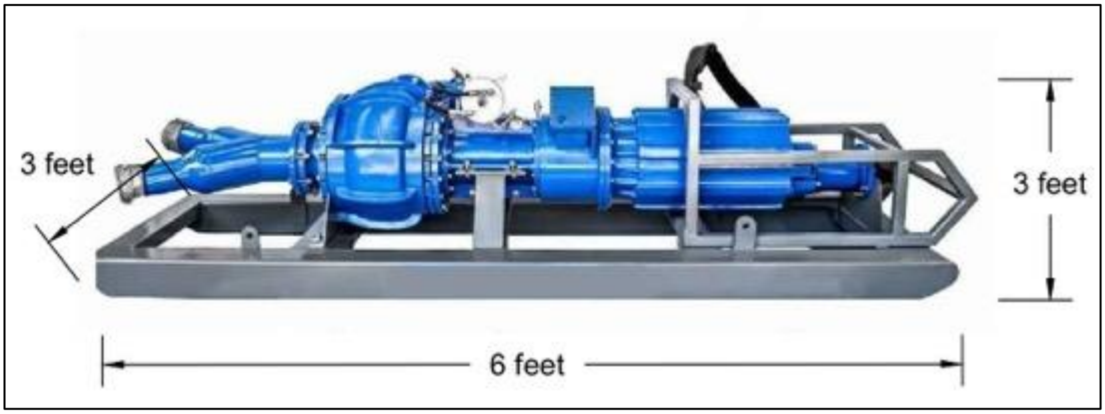


Figure 5-10 Diver-operated dredge pump

Figure 5-11 Surface supplied air (SSA) diver using a diver-operated dredge

5.2.3 Excavator with Dredge Pump Attachment

An excavator with a dredge pump attached to the boom is a direct method of dredging sand from nearshore onto the beach. The system would include an excavator, a submersible pump, a slurry pipeline to shore, and power for the pump. The pump could hang from or be attached to the excavator boom. The pump would be lowered into the water into contact with the sand and moved around by the excavator as necessary.

This method has been successfully used for ongoing beach maintenance at the Ko‘Olina lagoons, where sand regularly migrates (slumps) from the beach face into the water as a result of low wave energy. The excavator is positioned near the water line and a Toyo submersible pump is lowered into the water. The sand/water slurry is pumped to shore into dewatering basins. Sand recovery typically extends about 60 ft from waterline into the lagoon.

An excavator outfitted with a cutterhead pump attachment is potentially a more-efficient method for recovery sand. Eddy Pump makes an excavator attachment that is specifically designed to connect to the excavator's existing bucket linkage. The pump can also be powered by the excavator's hydraulics, eliminating the need for shore-based power. This configuration reduces crew size and allows the excavator operator to dredge sand by sweeping back-and-forth with the excavator arm.

The system could extend further from the waterline by placing the excavator on a Flexifloat system or in very shallow water by building a platform that rests on the sand. Minimum 40-ton class excavator is recommended. The coverage area could be extended by using a long-reach excavator, as long as it can remain balanced. Examples of excavator-mounted pumping are shown in **Figure** 5-12.

Advantages of an excavator with a dredge pump are that the equipment is available on-island, is relatively simple to maneuver and operate, and can be powered by the excavator (no additional power required). A disadvantage of an excavator is that it has limited reach. Extending the reach of the excavator would require a platform, such as Flexifloats, or construction of a berm to drive on. Additionally, a dewatering basin on land would be required. Production rates are dependent on the pump size and are expected to be 20 to 40 cy per hour.

Figure 5-12 Excavator dredge pump attachment with 10-in pump and power pack (EddyPump© Corporation, 2021)

5.3 Delivery to a Nearby Harbor

Sand sources identified in Section 1 that are too far from the project site to consider pumping the sand to shore would require dredging of the sand and loading it into a barge, either through clamshell dredging or hydraulic dredging. After the barge is loaded with sand, it could be transported to an offloading site such as a commercial harbor, where the sand would be offloaded, possibly stockpiled, and transported to the Waikiki project sire. Barging can require extensive time and energy between towing the barge to a commercial harbor, such as Honolulu Harbor or Kalaeloa (Barber's Point) Harbor. Barge travel distances are presented in Table 5-1.

Table 5-1 Barge distances from offshore sand sources to commercial harbors on Oahu

	Barge distance (miles, roundtrip)		
	RR—Inner	***Ala Moana***	***Hilton***
to Honolulu Harbor	13	7	8
to Kalaeloa Harbor	30	40	42
to Ala Wai Boat Harbor	14	3	2

The most efficient method would be to deliver the sand through the Ala Wai Small Boat Harbor and offload it at the Magic Island parking lot, where the barge would be moored alongside the parking lot. The barge would be moored with two lines on shore and two anchors within the harbor. This mooring configuration has recently been used in the Ala Wai canal maintenance dredging project (R.M. Towill Corporation, 2017). A subsequent biological assessment of the mooring site for that project reportedly found no concern regarding impacts to EFH.

The sand would be offloaded onto a conveyor belt or similar system and transported into waiting dumptrucks which would then move the sand systematically to the Waikiki project site. Most of the Magic Island parking lot would stay open during the day, with the area adjacent to the barge closed for equipment. This method would have the shortest barge and truck routes, and it would likely be the fastest and least expensive of the delivery options. Production rates of around 1,000 cy per day could be anticipated with this method.

Alternatives initially considered include delivery to Honolulu and Kalaeloa Harbors. Pier space at Honolulu Harbor is limited, and personnel at Hawaii Department of Transportation, Harbors Division, reported that the harbor does not accept bulk product delivery such as sand. Kalaeloa Harbor would be the nearest commercial facility for offloading sand. Barging to Kalaeloa, however, would entail an ocean transit of as much as 25 miles to the harbor, offloading of the barge into dump trucks, and the 25-mile truck route back to the sand recovery site. This method would result in an involved and circuitous delivery to the project site, which is only a few miles from the sand deposits presented Section 1. In addition to the distance traveled to deliver the sand at pier side, additional travel may be required to dewater the barge at an acceptable offshore location prior to offloading.

If offloading alongside Magic Island is not possible, then discussions within State agencies are recommended to determine if a short-term offloading site at Honolulu Harbor could be developed for use during the projects. It is possible that a temporary offloading site could be accommodated on the west side of Sand Island. There is some presently unutilized land, and a barge could access the shoreline via the Kalihi channel and the seaplane runway adjacent to the shore.

Figure 5-13 Example of barge offloading at Ala Wai and Magic Island

5.3.1 Offloading and trucking to project site

Pier side delivery of sand from a barge requires adequate space to offload sand into dump trucks. The sand could be loaded onto trucks with an excavator or similar equipment, or a conveyor system could be deployed for more efficient handling. Examples of sand conveyance from barge to shore are shown as Figure 5-14 and Figure 5-15. Conveyor belt systems can move an estimated 150 cy of sand per hour.

Mid-size (15 cu. yd.) or larger (20 cu. yd.) dump trucks could be used to haul the sand to Waikiki. For reference, 1,000 cy of sand per day would require 50 to 70 truckloads of sand per day. Careful coordination amongst stakeholders would be necessary to deliver the sand to the project site.

The advantage of truck hauling is that it minimizes impacts to the seafloor by eliminating delivery pipes to the shoreline. The disadvantages would include the increased cost due to time, equipment, and energy to move the sand by trucks rather than pipe it directly to the shoreline, and additional traffic impacts from moving dump trucks into and out of the project area on a regular basis.

Figure 5-14 Barge-mounted conveyor system

Figure 5-15 Barge-mounted conveyor system

5.3.2 Sand Placement

Sand placement would be determined by the individual project needs. As sand is trucked to the project site, the sand would be moved directly to the beach and placed to the design lines and grades. There is no dewatering associated with the truck hauling method. Sand movement and placement during the 2012 Waikiki Beach nourishment project was accomplished using standard mechanical equipment, including a front-end bucket loader, dump trucks, and bulldozers. This method is proposed for use with the present project. Sand movement and placement during the 2006-2007 Kuhio Beach project was accomplished using standard mechanical equipment, a front-end bucket loader, bulldozers, and trucks (Figure 5-16 and Figure 5-17). Some noise and smell from the equipment, and possibly some additional short-lived odor from the sand, will be unavoidable.

For any project, the beach width will be increased from onshore to offshore, thus building dry substrate for machinery to operate on as it is built seaward. Construction to the design profile would be verified during construction with surveys and by placing survey stakes with final beach height markings as references. Design beach profiles and volume calculations would be part of the construction drawings.

A containment system will be required in the area of active sand placement to reduce the potential for turbidity impacts to coastal waters during sand placement in the water. Silt curtains and fences will be required, consistent with previous requirements of the DOH. Schematics of these containment devices are shown as Figure 5-18 through Figure 5-20.

Figure 5-16 Sand placement, 2012 Waikiki Beach Maintenance Project.

Figure 5-17 Example: floating silt curtain and small bulldozer used for sand placement in the 2012 Waikiki Beach Maintenance project.

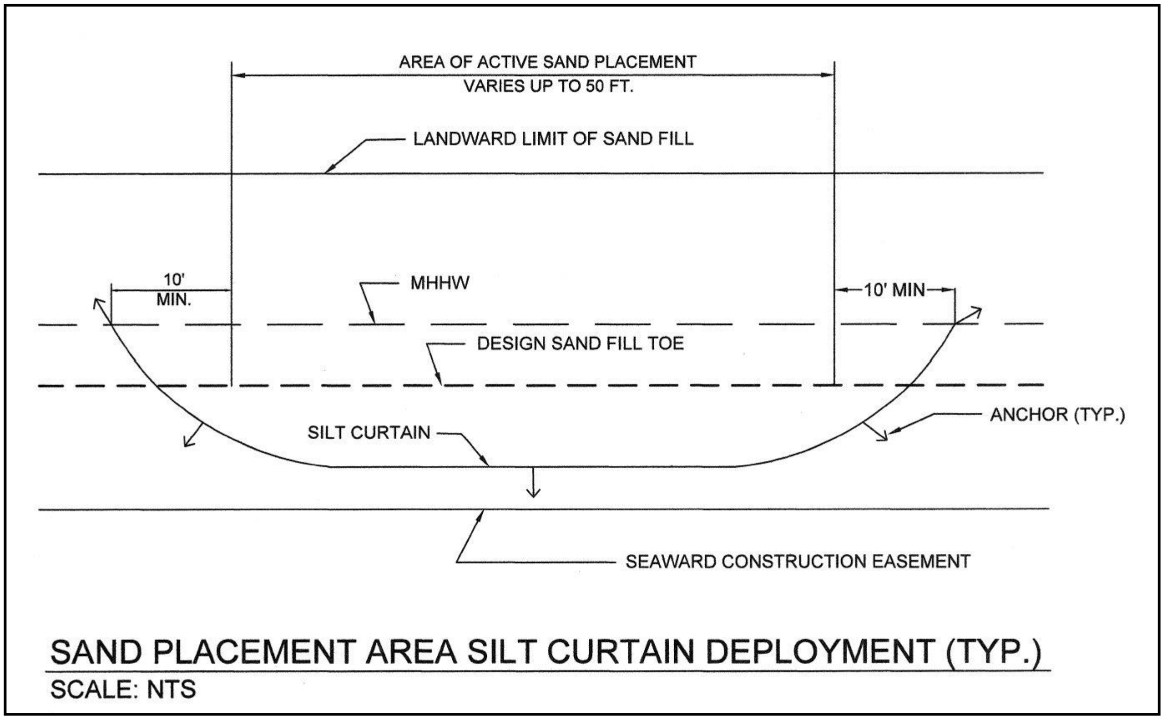


Figure 5-18 Silt curtain layout for sand placement

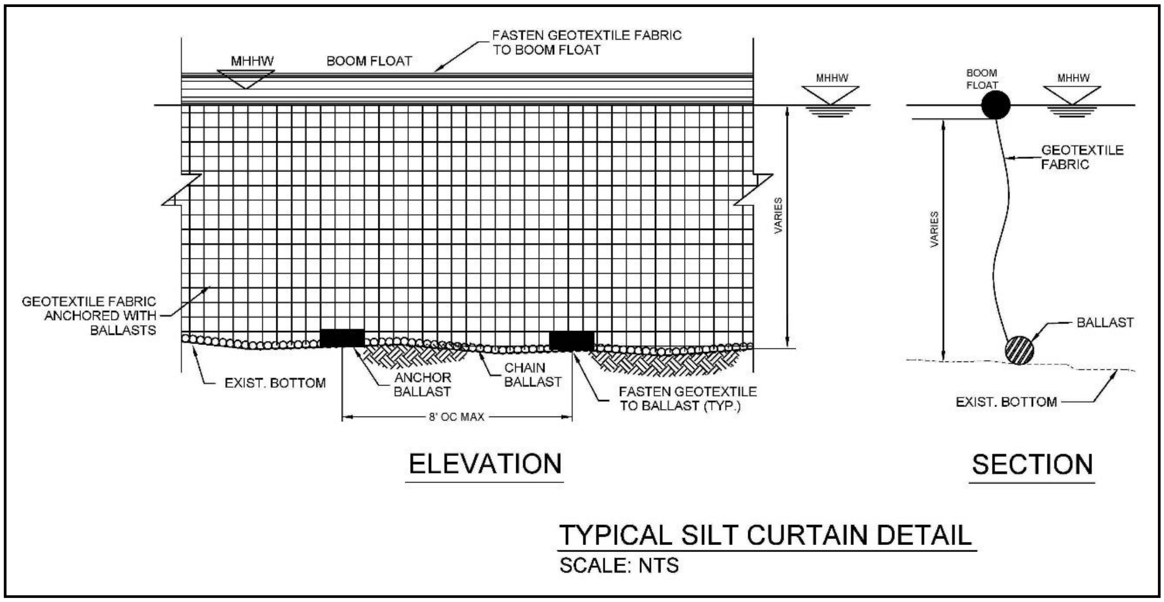


Figure 5-19 Typical silt curtain detail

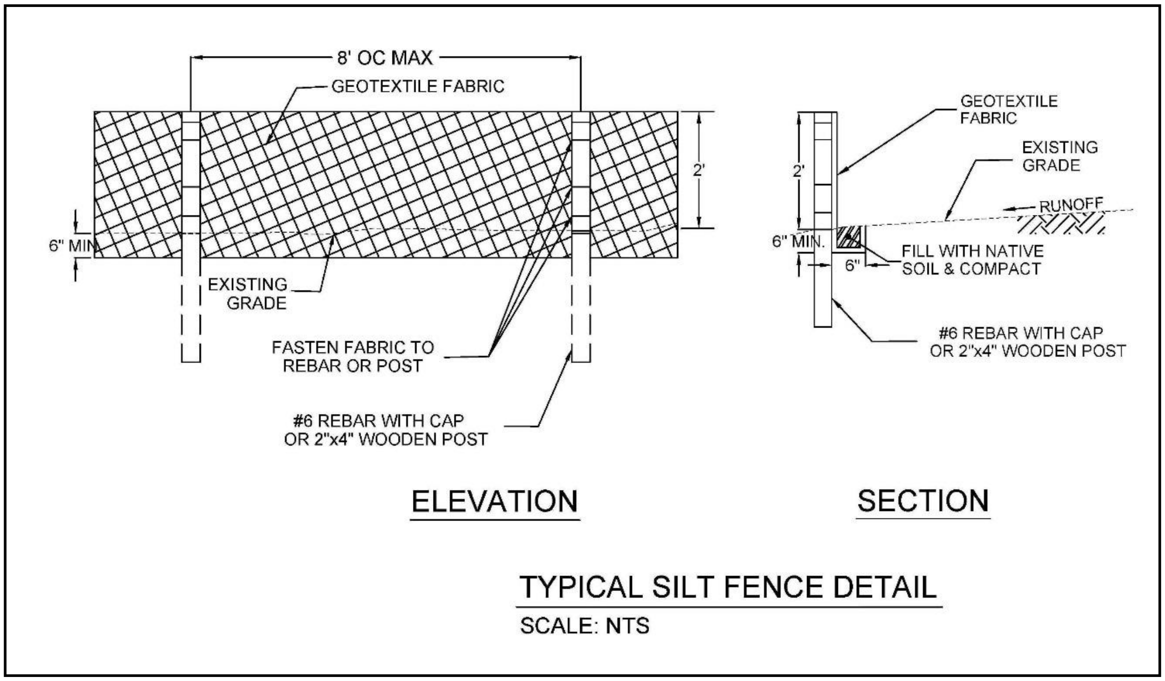


Figure 5-20 Typical silt fence detail

5.3.3 Dewatering

State of Hawaii Department of Health and U.S. Clean Water Act regulations require that the water accumulated on the barge during the dredging process be discharged in a way that reduces the occurrence of turbidity in the ocean water. Ideally, the discharge should be accomplished with no direct dredge water flow back to coastal waters. A direct and effective way to dewater a barge is to discharge the water into an enclosed basin on the beach, above the high water line, and let the water percolate into the ground.

Dewatering for the Waikiki Maintenance projects in 2012 and 2021 was performed in the Diamond Head basin of Kuhio Beach Park. A sand containment berm was constructed and weirs were installed to allow fine particles to settle before the water exited the basin.

5.3.4 Operational Considerations

The wave and wind environment at the sand recovery site presents a challenge for the dredging contractor. Dangerous conditions can occur from both south Pacific swell and tradewinds, and can be reasonably expected to occur at any point during project construction. The most advantageous work period is fall to early winter, when southern swell and tradewinds can be expected to be the least intense. Strong tradewinds can also create seas and currents that would make it difficult to hold the dredge barge and scows in relatively stable positions. For this reason, the operation is proposed to occur during low wave and wind conditions in the fall months.

There are no oceanographic constraints to offloading in a commercial harbor, which would be expected to be sheltered from wave energy. Placement of sand in Waikiki is generally preferred in the winter months, when waves are typically lower and low tides occur in the mornings.

5.4 Fines and Turbidity

Sand recovered from the ocean, though highly compatible with the dry beach sand, would still have some fine content that would be winnowed from the beach system and moved offshore during the initial equilibration process and beach erosion events. Dredging, transport, and placement of carbonate sand can also increase the percent of fines through mechanical abrasion of the friable grains. Turbidity, or a reduction in water transparency, occurs when fine sediment particles are suspended in the water column. Turbidity can occur at the offshore sand dredging site or along the beach where sand is placed.

5.4.1 Turbidity at Dredge Sites

Offshore turbidity is to be expected at the dredge site. As the clamshell bucket grabs sand from the seafloor, it would disturb fine particles adjacent to the bucket. As the bucket is raised through the water column, minor volumes of sand containing fine particles would be released into the water column. Turbidity at the dredge site will be reduced by using an environmental clamshell bucket, which is an industry best practice and has been used to minimize turbidity during dredging of harbor channels in Hawaii. Environmental clamshell buckets typically have tighter seals and overlapping sides. These buckets are designed to minimize sediment loss from within the bucket, resuspension at the dredge site, and water entrainment with each grab. A conservative estimate of the amount of material that leaks from an environmental bucket is only 0.5% (Palermo et al., 2008). This material is expected to fall out of suspension rapidly near the dredge location.

The use of a suction dredge would result in the majority of bottom material disturbed being drawn into the dredge pipeline, with only a small amount of disturbed material escaping the dredge to affect adjacent areas or water quality. Loss rates for suction dredges have been estimated to be less than 0.1% (Hayes and Wu, 2001). Careful placement of anchors and cables would insure that they do not move about and disturb/suspend bottom material.

Turbidity generated from dredging operations is expected to be transported with the currents moving parallel to shore. Wave action has the potential to transport turbidity inshore. These water quality impacts are expected to be temporary, lasting only during the actual dredging operations, and are expected to be localized to the immediate vicinity of the dredging. Best Management Practices (BMPs) will be followed throughout the sand recovery work, consistent with the State Department of Health Water Quality Certification that will be required for the project.

5.4.2 Turbidity at Placement Site

Beach restoration projects can generate turbidity plumes that can be unsightly and affect water clarity for days. Although sand fill placed on a beach must closely match the existing beach sand with respect to grain size, offshore sand will typically have a higher percentage of fines than native beach sand. Additionally, fines may be generated during dredging and placement of offshore sand onto the beach. After placement, wave action can suspend the fines creating turbidity plumes immediately offshore of the nourished beach.

Silt curtains and containment barriers would be deployed along the shoreline where sand placement is occurring. Following placement of sand on the beach, there will likely be periodic turbidity associated with equilibration of the beach profile and planform and during large wave events, as sand moves along the beach and cross-shore.

Turbidity is a complex phenomenon that is dependent on both the optical and physical properties of suspended particles, and is difficult to model or predict. To help evaluate possible impacts, pre- and post-project conditions in Waikiki were examined using available high elevation photographs, and laboratory turbidity analyses were conducted to compare the borrow and existing beach sand for this project.

5.4.2.1 Laboratory Turbidity Analysis Results

Turbidity test results for sand samples obtained from *Ala Moana*, *Halekulani Channel*, *Hilton*, *RR Inner-1a*, *RR Inner-1b*, and *Canoes/Queens* are plotted on Figure 5-21 through Figure 5-26. Data are plotted as turbidity versus time. The average value for each deposit is plotted on Figure 5-27 for comparison amongst the sand deposits. The turbidity results should not be considered indicative of turbidity levels that are to be expected during the actual beach nourishment because they result from artificial experiments in a small sample bottle. Rather, they are useful to evaluate differences between the existing beach sand and the possible nourishment sand.

All samples tested showed initial turbidity that decreased exponentially with time. *Canoes/Queens* samples had the lowest initial turbidity, which should be expected, since this is likely sand that had been recently transported and had the fine material worked out of it. *Halekulani Channel* had the next lowest turbidity; however, that was due to a very low value for one of the samples. That sample was obtained from the top of a core and may have had fines washed out. Sand from the other samples had significantly higher turbidity. *Hilton* and *Ala Moana* had the highest initial turbidity readings; however, the values decreased rapidly over the first 2 hours. Even though the *Hilton* samples were the coarsest of the sites, three of the five samples had initial turbidity in excess of 1,000 NTU, while the other two were in excess of 850 NTU.

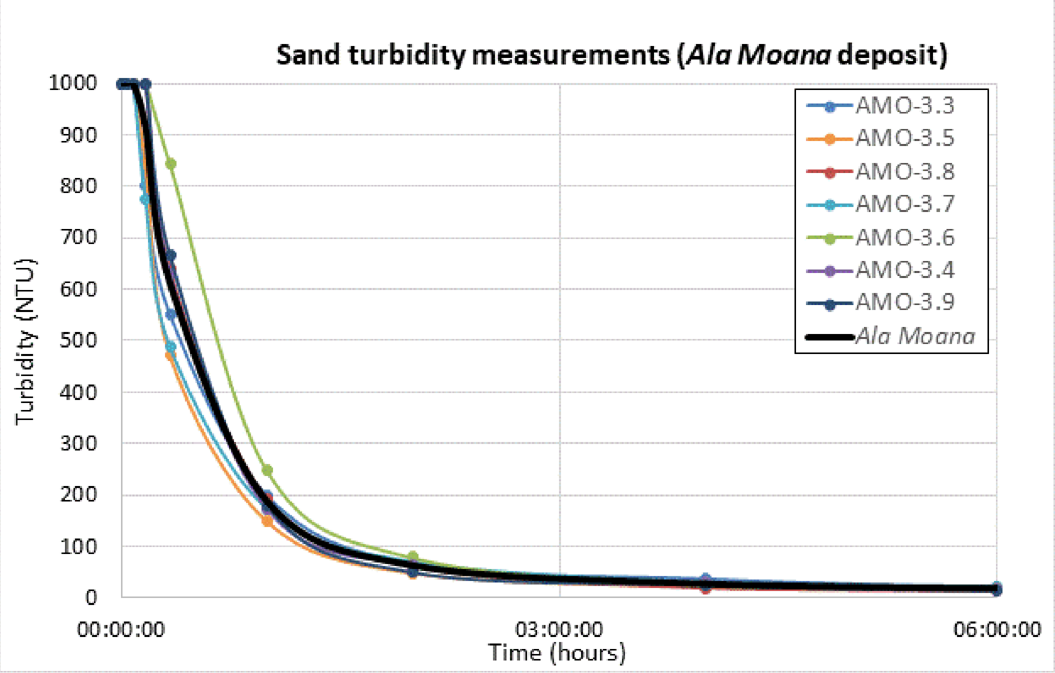


Figure 5-21 Turbidity results for *Ala Moana* sand deposit

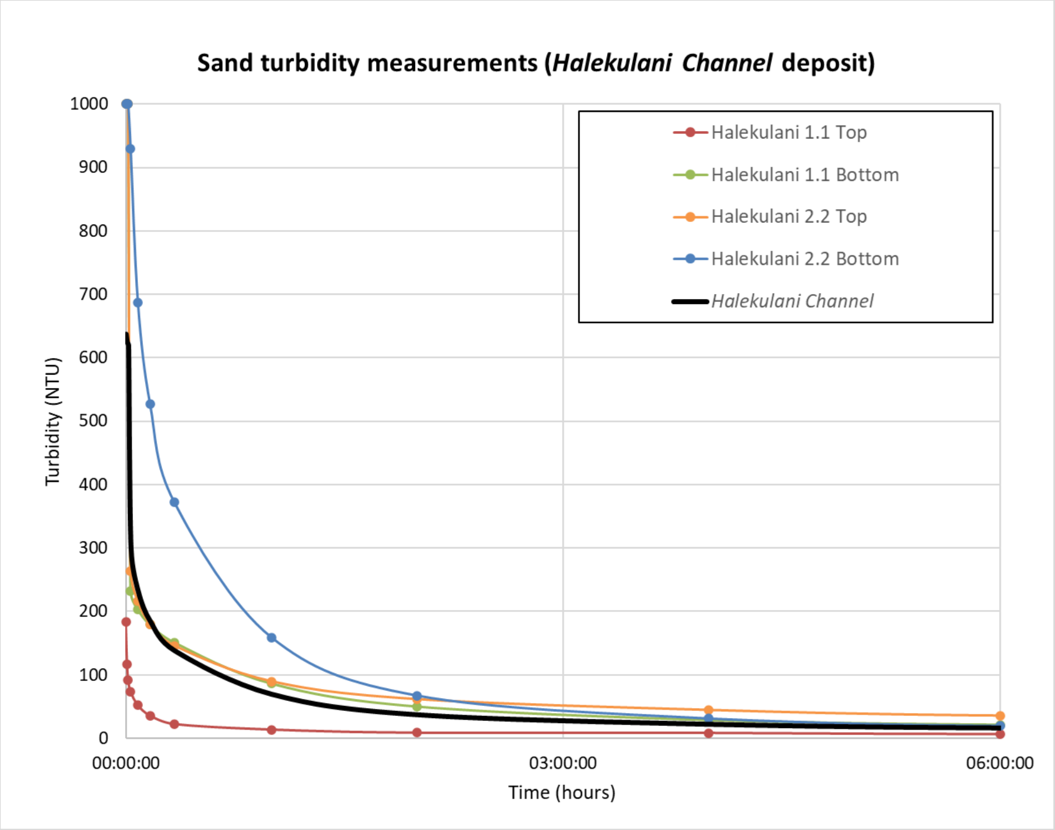


Figure 5-22 Turbidity results for *Halekulani Channel* sand deposit

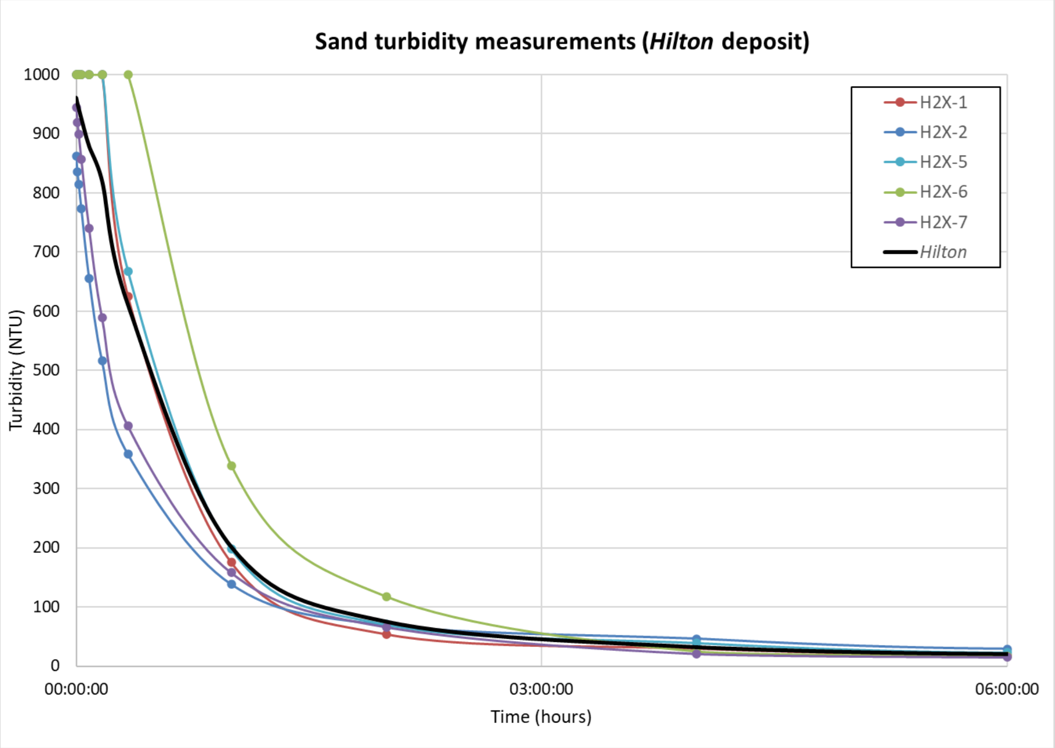


Figure 5-23 Turbidity results for *Hilton* sand deposit

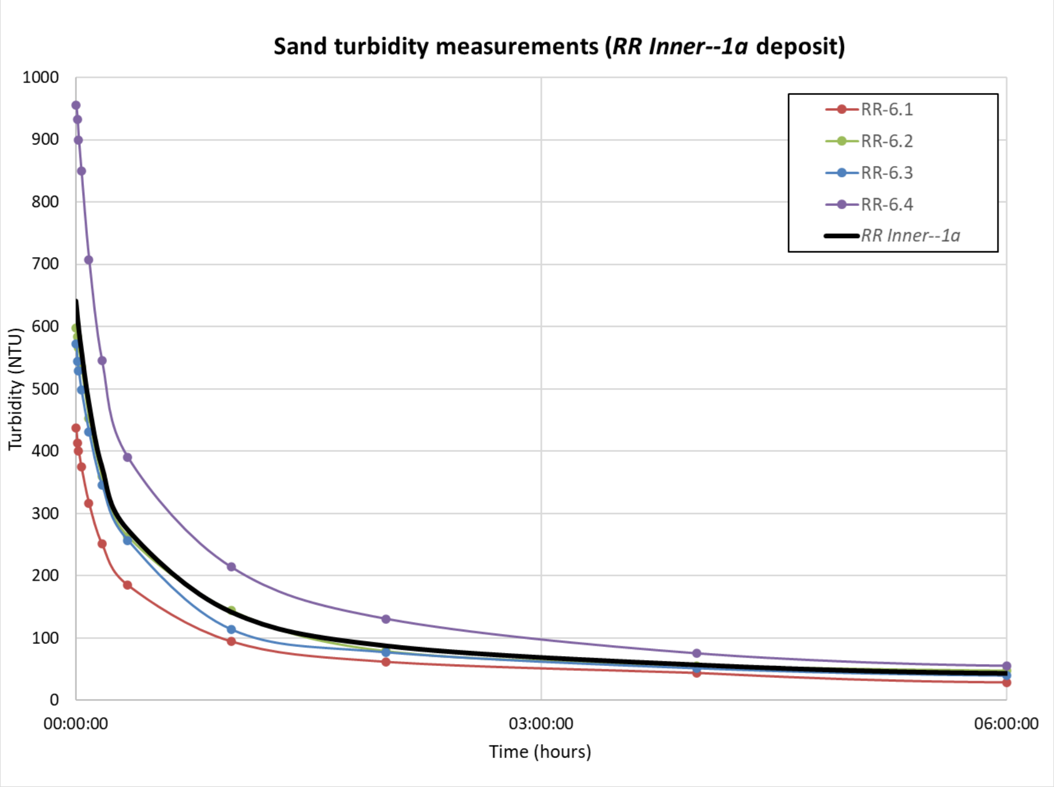


Figure 5-24 Turbidity results for *RR Inner – 1a* sand deposit

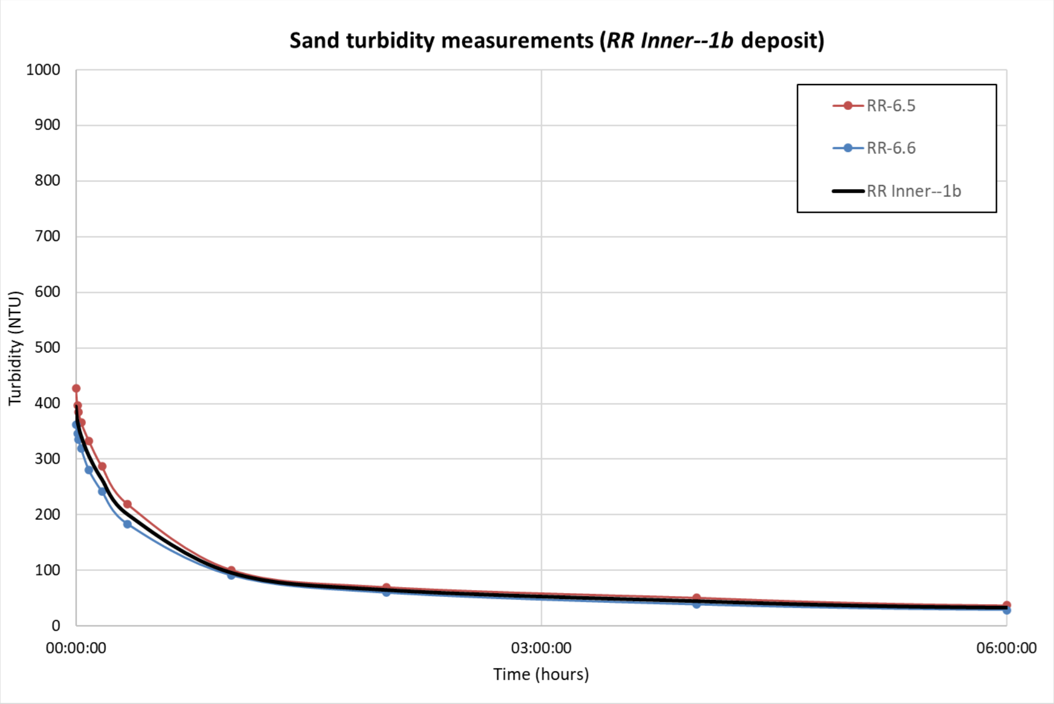


Figure 5-25 Turbidity results for *RR Inner - 1b* sand deposit

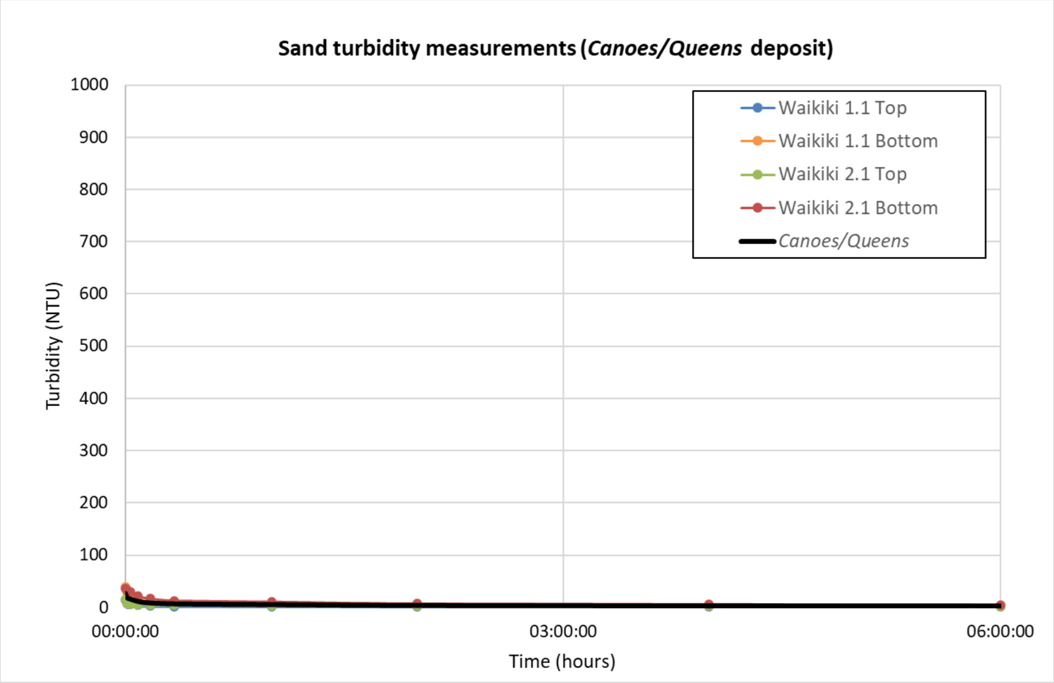


Figure 5-26 Turbidity results for *Canoes/Queens* sand deposit

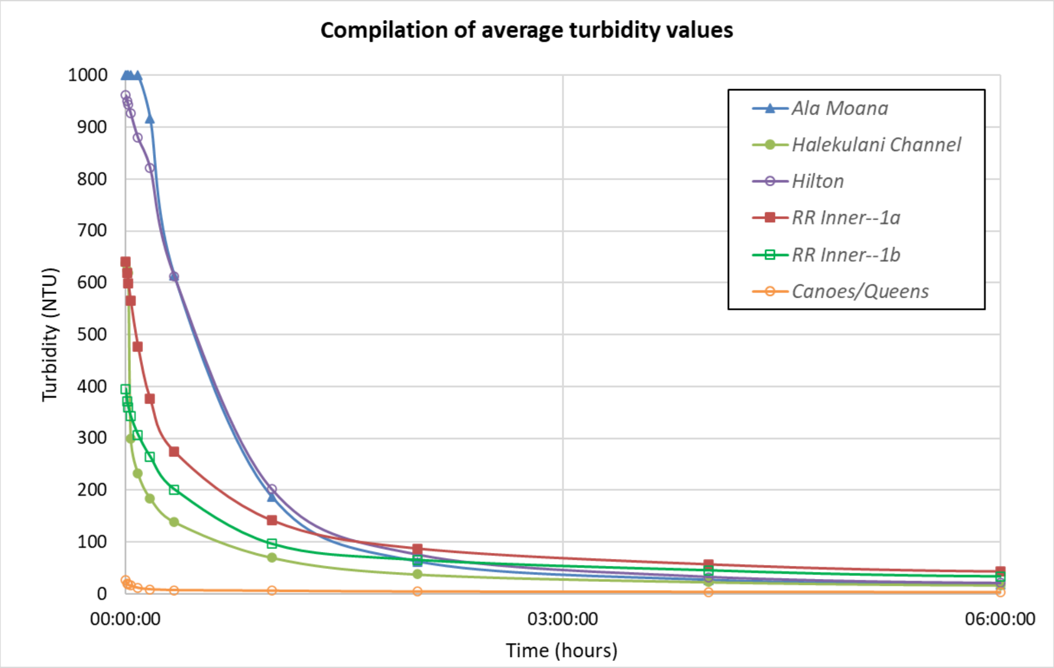


Figure 5-27 Compilation of average turbidity measurements for offshore sand sources

5.4.3 Waikiki Beach Maintenance Turbidity

The Waikiki Beach Maintenance project was performed in late winter and spring of 2012, when about 24,000 cy of sand was borrowed from an offshore deposit, pumped to shore, dewatered, and placed on the beach. The placement of the sand produced high levels of turbidity, and immediately following the completion of sand placement, the project experienced a series summer swell events.

Turbidity was assessed visually from photographs obtained via a University of Hawaii webcam mounted on the Sheraton Waikiki hotel. Turbidity levels appeared to decrease in general following completion of sand placement on April 25, 2012. By November of 2012, turbidity on calm days appeared to have decreased to pre-project levels, though turbidity was still high during higher wave conditions which are responsible for washing fine material from the beach and resuspending sediment. A June 24, 2019 view from the Sheraton Waikiki shows the nearshore water clarity to be comparable to pre-project levels.

5.4.4 Turbidity Impacts Evaluation

Sand from within the offshore sand deposits is expected to become well mixed during excavation, transport, and placement on the beach. Average turbidity values for the targeted area in the deposit are important, as they are representative of the material that will eventually be placed on the beach. Initial elevated turbidity is expected during sand placement and periodically during larger wave events. The laboratory turbidity analyses indicated that overall the turbidity should return to typical existing levels after a short period of adjustment.

The Waikiki Beach Nourishment project and results of the turbidity experiments described above suggest that elevated turbidity following sand placement should be expected.

5.5 Offshore Sand Deposit Chemical Quality

Offshore sand deposits are generally considered to be free of contaminants because they are typically distant from land runoff sources, are located in oceanic waters characterized by good mixing and flushing, and sand size particles do not absorb contaminants. The South Shore marine environment experiences currents driven by the tides, winds, and waves that approach from the south. The currents offshore of the reef are dominated by the tides. Due to the exposure to the numerous physical mixing forces, the residence time of the water is short (Tomlinson, 2011), resulting in high dilution.

Sand is not known to adsorb contaminants and is therefore not typically considered as a risk for contaminants by the regulatory agencies. The State of Hawaii Department of Health ecological risk assessment guidance for coastal marine environments in Hawaii states that “many chemicals that cause ecological effects are known to be associated most strongly with fine-grained sediment”. Furthermore, CFR Title 40 Section 227.13 used by the EPA to regulate dredge material disposal states that dredge material is considered to be environmentally acceptable for ocean dumping if it is composed of sand or to be used for beach nourishment, without the need for testing.

The offshore sand deposits investigated in this project are not expected to contain contaminants of concern. Deposit sampling and analysis, however, can be completed during the permitting phase of the project if deemed necessary by the regulatory agencies.

5.6 Sand Compaction

Compaction occurs when grains are pressed together, reducing pore space between them. Heavily compacted sand can become partially or wholly lithified (solidified), having consistency ranging from compact but friable (able to be easily broken down into sand grains), to more rock-like. Indurated (well compacted) beach rock cannot be easily broken up into individual sand grains.

Sand compaction was observed after the 2012 Waikiki Beach Maintenance project along the truck haul route between the dewatering basin and the sand placement area. A 1- to 3-foot tall hardened berm formed along the seaward edge of the haul route (Figure 5-28). SEI engineers attributed this sand compaction to loaded dump trucks traveling over the beach fill.

Additionally, chemical processes in the form of carbonate dissolution likely contributed to the hardening of the beach fill. The combination of pressure, dissolution of calcium carbonate material from fresh water, and the presence of fines could increase the chances of induration (hardening) of the placed sand. Compaction can be minimized by mechanically loosening or turning the sand along the truck haul route every few days. Moreover, haul routes can be monitored and plowed after project completion, if needed.

Figure 5-28 Sand compaction and induration along Waikiki Beach

5.7 Initial Sand Placement

The slope and shape of a beach face (i.e., beach profile) is a function of grain size and wave energy. Low energy beaches with finer sand tend to have flatter slopes than high-energy beaches composed of coarse sand. When sand is first placed on a beach, the sand will generally be loose and uncompacted. Wave action will help the beach adjust toward an “equilibrium profile” based on the characteristics of the nourishment sand. During this period, the sand can be expected to be loosely compacted and users might sink into the sand somewhat. Over a period of time, the sand is expected to become compacted and resemble the present condition of the beach. The length of time that compaction would take is a function of wave energy, and therefore, the exact time compaction would take is unknown.

Users should be alerted of potential changed conditions until the equilibrium profile has been achieved. The State should consider consulting a signage expert regarding the need to alert the public of such conditions.

5.8 Coral Rubble

Coral cobbles and rubble were an issue during the 2012 Waikiki Beach Maintenance project. These larger grains were uncomfortable for beach users, as they tended to accumulate in the nearshore at the toe of the beach. The potential for coral rubble should be addressed by engineers during the design process, and efforts should be made to reduce recovery of large pieces of rubble from the offshore sand deposit. After placement, the rubble may become concentrated at the beach toe, just offshore of the waterline. This coral rubble could be removed by hand.

Though the grain size distributions of the offshore sand areas have been documented, coral rubble, or sediment grains that are much larger than the median grain size, may exist sporadically within the sand deposit. During offshore sand sampling, limited coral rubble was encountered in the offshore sand deposits. Rubble, however, may exist in discreet pockets within the sand deposits.

One of the disadvantages of clamshell dredging is that there is no method to screen coral rubble from the recovered sand at the dredge site. The contractor, therefore, should monitor the sand for coral rubble as the clamshell bucket empties the sand onto the scow. If excessive coral rubble is encountered in an area within an offshore sand deposit, sand recovery operations should move to a different location within the deposit.

Screening the sand as it is offloaded from the scow is possible, but would drastically slow production and could still allow cobbles to enter the beach system. Use of a screen or a separator such as an Trommel screen (Figure 5-29) or a “grizzly” rock screen (Figure 5-30) could be used to remove coarse material at the placement site.

Figure 5-29 Anaconda TD620 Trommel Screen used to separate coarse material

Figure 5-30 Grizzly rock screen used to separate coarse material

5.9 Sand Dynamics

Chronic erosion will continue to affect the non-stabilized shoreline reaches in Waikiki. Seasonal and episodic erosion and beach adjustment events will continue to occur. In addition to these natural phenomena, Waikiki may also be impacted by large magnitude events such as strong Kona storms, hurricanes, tsunamis, extreme water level changes, and other oceanographic and atmospheric catastrophes. Any and all of these can cause a large-scale change in the beach. As a result of one or more of these events, all placed sand and more could be lost from the beach.

5.10 Anoxic Content

There are some portions of the offshore sand areas that have anoxic conditions beneath the surface of the sand. When sand is recovered from anoxic environments, it would typically have a gray color and an odor. Both of these issues would be expected as part of the restoration and enhancement phases. Both the color and odor have been documented to fade with exposure to sun and air, based on previous sand recovery efforts in Hawaii.

5.11 Marine Activities

The anchor lines at the offshore sand site would be in place for the duration of sand recovery operations, and floating sections or anchor lines would be marked with floats and lights as needed. The machinery operating on the barge would be run from the early morning until later in the afternoon each day. Some lighting would be needed on the barge to conduct operations during the morning hours.

Dredging and barging would be taking place in the nearshore waters, and are expected to directly impact ocean recreation and access in the area. Careful planning will be necessary to minimize these impacts, resulting in a recommendation for longer work days, and working seven days a week, to significantly reduce the overall duration of the project.

Public safety during construction is of utmost importance. A Notice to Mariners detailing construction activities and locations should be publicly issued through the United States Coast Guard prior to mobilization of construction equipment on site. A public awareness campaign is recommended to be initiated through DLNR to help spread awareness about construction activities. All onshore and offshore hazards will be clearly marked with signage and/or marker floats. Transit corridors, both on the beach and in the water, will be clearly labeled. Flag persons will be provided as needed.

5.12 Beach Activities

Placement operations on the beach would require lengths of the coast to be cordoned off during trucking operations. Crossing guards would be placed intermittently along the shoreline to assist the public in transiting across the access route. While operating, the heavy machinery would emit noise and exhaust. Again, working longer days, seven days a week, will limit the overall impact by reducing overall project duration. The 2012 Waikiki Beach Maintenance project moved sand to be beach only in the morning, reopening the beach around noon each day.

5.13 Recreational Hazards

Users experience certain recreational hazards in Waikiki. These hazards include swimming accidents such as drowning, collisions between users, trips and falls, sharp objects, and poor water quality. These hazards exist at times and will continue to exist after the improvement projects.

Users should be forewarned that bottom conditions have changed and may continue to change, and that hard material still lies below the sand. The State should consider consulting a signage expert to implement proper signage noting such conditions.

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APPENDIX A

VIBRACORE LOGS AND GRAIN SIZE ANALYSIS

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Makai Research Pier • 41-305 Kalanianaole Hwy • Waimanalo, Hawaii 96795-1820
Phone: (808) 259-7966 • FAX (808) 259-8143 • E-mail: sei@seaengineering.com • Website: www.seaengineering.com

APPENDIX X

VIBRACORE LOGS AND GRAIN SIZE ANALYSIS

WAIKIKI BEACH RESTORATION
WAIKIKI, OAHU, HAWAII

LOCATION: **HILTON AREA, WAIKIKI, OAHU, HAWAII**
CORE: **H-2X.1**

EASTING:	1693294.6
NORTHING:	39587.3
RECOVERED:	5/19/2017
LENGTH:	67 inches
DEPTH:	50 feet

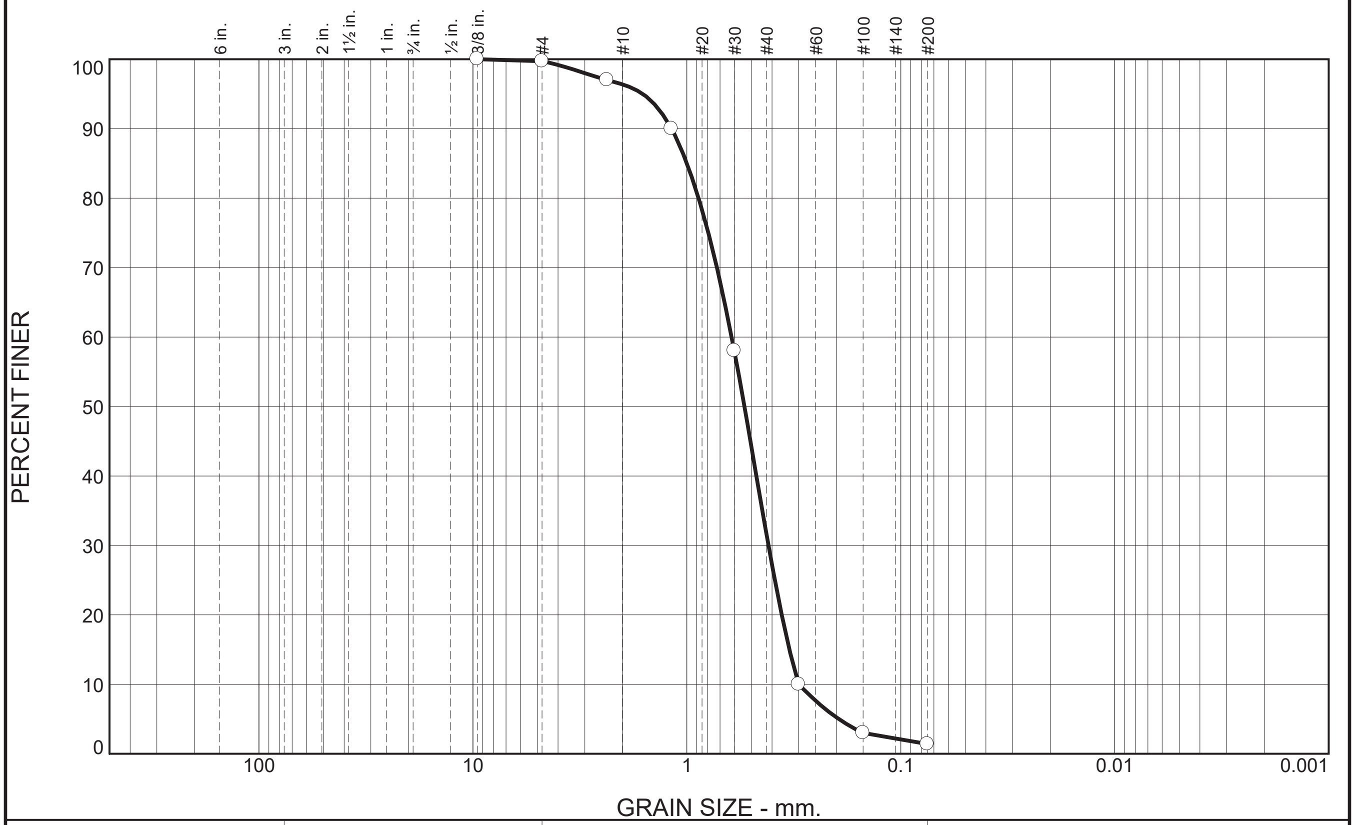
LITHOLOGIC DESCRIPTION

SAND; calcareous; medium-coarse; unconsolidated; no compaction; moderate to poorly sorted; heterogeneous; trace amounts of terrigenous material; 5-10% shell hash, Halimeda, and coralline algae; downward darkening; downward coarsening.

- **0 – 20 in:** SAND; calcareous; medium-coarse; tan color; moderate to poorly sorted; poorly rounded; low sphericity; 0.75” coral cobble at 13”.
- **20 – 43 in:** SAND; calcareous; medium-coarse; grayish-tan color; moderate to poorly sorted; poorly rounded; low sphericity.
- **43 – 62 in:** SAND; calcareous; coarse-medium; light gray color; moderate to poorly sorted; poorly rounded to subangular; low sphericity.

REPRESENTATIVE APPEARANCE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	4	64	31	1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#8	97		
#16	90		
#30	58		
#50	10		
#100	3		
#200	1.4		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.1800 D_{85}= 0.9995 D_{60}= 0.6175
D_{50}= 0.5382 D_{30}= 0.4155 D_{15}= 0.3318
D_{10}= 0.3000 C_u= 2.06 C_c= 0.93

Classification

USCS= SP AASHTO=

Remarks

Location: H2X.1
Sample Number: 83756 5
Date: 6/15/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification
Project No: SEAENG030 **Figure**

LOCATION: HILTON AREA, WAIKIKI, OAHU, HAWAII
CORE: H-2X.2
EASTING: 1693378
NORTHING: 39709.2
RECOVERED: 05/19/2017
LENGTH: 79 inches
DEPTH: 48 feet

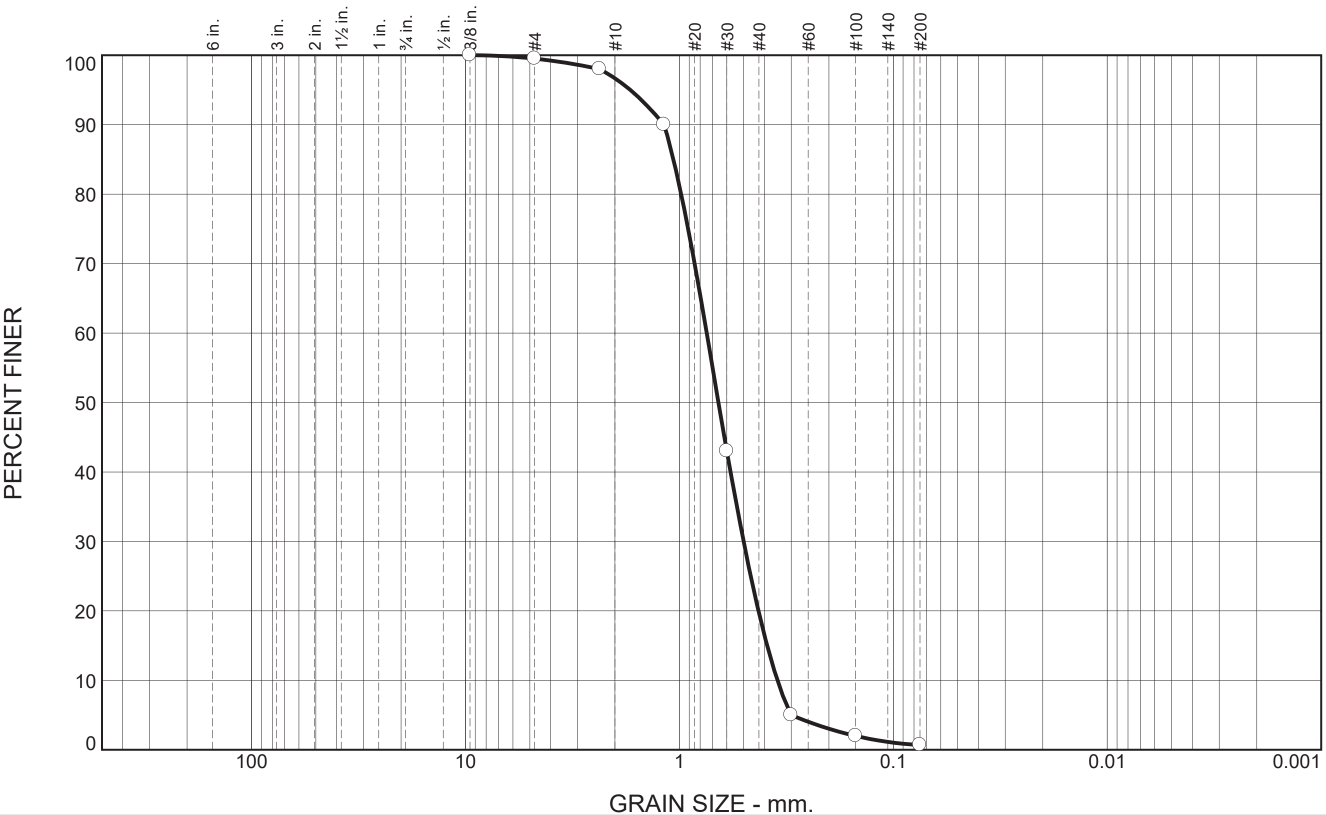
LITHOLOGIC DESCRIPTION
SAND; calcareous; medium grain; unconsolidated; no compaction; moderate to poorly sorted; heterogeneous; trace amounts of terrigenous material; 0-5% coralline algae; 5-10% shell hash and subangular coral fragments; downward darkening; no downward coarsening.

- **0 – 12 in:** SAND; calcareous; medium grain; tan color; moderate to poorly sorted; poorly rounded; low sphericity.

- **12 – 70 in:** SAND; calcareous; medium grain; grayish-tan color; moderate to poorly sorted; poorly rounded; low sphericity; 2” diameter coral cobble at 26”.

REPRESENTATIVE APPEARANCE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	3	77	19	0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#8	98		
#16	90		
#30	43		
#50	5		
#100	2		
#200	0.7		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.1800 D_{85}= 1.0655 D_{60}= 0.7450

D_{50}= 0.6565 D_{30}= 0.5010 D_{15}= 0.3889

D_{10}= 0.3483 C_u= 2.14 C_c= 0.97

Classification

USCS= SP AASHTO=

Remarks

Location: H2X.2
Sample Number: 83756 6

Date: 6/15/17

CONSTRUCTION
ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification

Project No: SEAENG030 **Figure**

LOCATION:	**HILTON AREA, WAIKIKI, OAHU, HAWAII**
CORE:	**H-2X.5**
EASTING:	1693252.3
NORTHING:	39492.9
RECOVERED:	05/19/2017
LENGTH:	80 inches
DEPTH:	51 feet

LITHOLOGIC DESCRIPTION

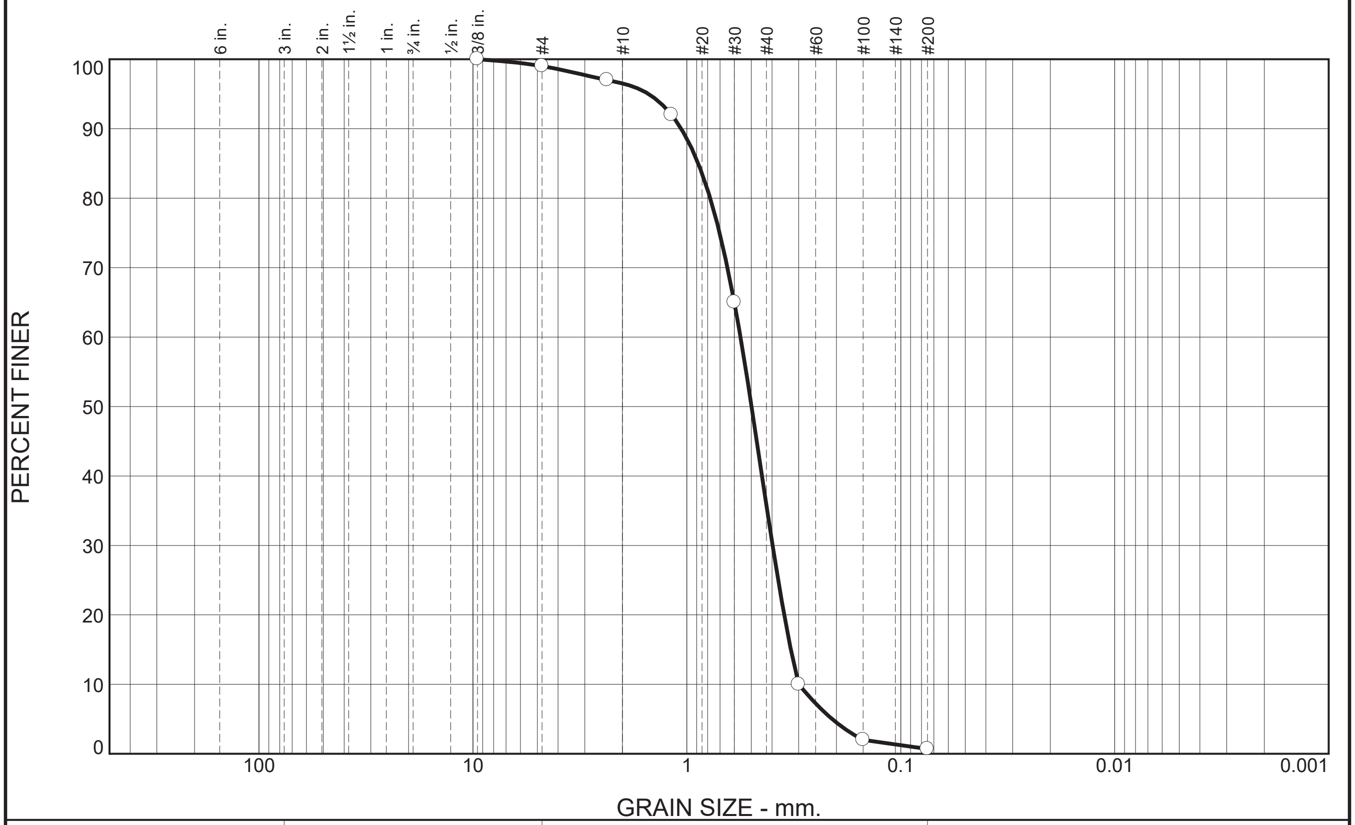
SAND; calcareous; heterogeneous; medium to coarse grain; unconsolidated; no compaction; moderate to poorly sorted; trace amounts of terrigenous material; 10-15% Halimeda and subangular coral fragments; 5-10% coralline algae; downward darkening; no downward coarsening.

- **0 – 8 in:** SAND; calcareous; medium to coarse grain; tan color; poorly sorted; poorly rounded; low sphericity; diffuse boundary between upper and lower sections; 3” coral cobble at 2”.

- **8 – 55 in:** SAND; calcareous; medium grain; grayish tan color; moderately to poorly sorted; poorly rounded; low sphericity; diffuse boundary between upper and lower sections; intact Echinoderm spines, shells, and subangular coral fragments; 4” coral cobble layer at 53”.

REPRESENTATIVE APPEARANCE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	1	2	61	35	1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	99		
#8	97		
#16	92		
#30	65		
#50	10		
#100	2		
#200	0.7		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.0626 D_{85}= 0.8850 D_{60}= 0.5618
D_{50}= 0.4987 D_{30}= 0.3975 D_{15}= 0.3268
D_{10}= 0.3000 C_u= 1.87 C_c= 0.94

Classification

USCS= SP AASHTO=

Remarks

Location: H2X.5
Sample Number: 83756 7
Date: 6/15/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification
Project No: SEAENG030
Figure

LOCATION:	**HILTON AREA, WAIKIKI, OAHU, HAWAII**
CORE:	**H-2X.6**
EASTING:	1693140.2
NORTHING:	39692.3
RECOVERED:	05/19/2017
LENGTH:	79 inches
DEPTH:	53 feet

LITHOLOGIC DESCRIPTION

SAND; calcareous; heterogeneous; medium to coarse grain; unconsolidated; no compaction; moderate to poorly sorted; trace amounts of terrigenous material; 10-15% shell hash, Halimeda, and subangular coral fragments; downward darkening; downward coarsening.

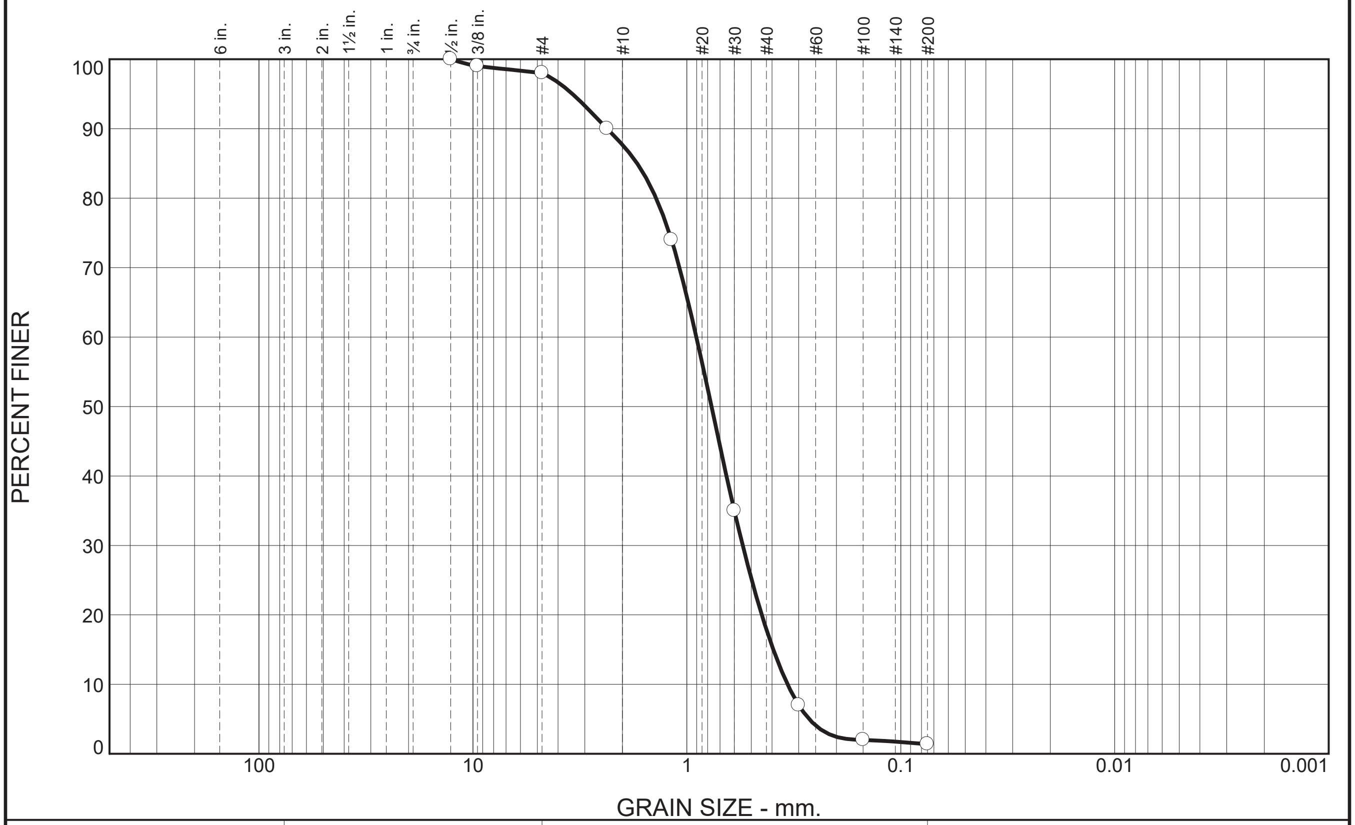
- **0 – 22 in:** SAND; calcareous; medium grain; tan color; moderately to poorly sorted; poorly rounded; low sphericity; dark 2” diameter contact at 8-10”; sharp boundary between upper and middle sections.

- **22 – 51 in:** SAND; calcareous; medium to coarse grain; gray color; moderately-well sorted; poorly rounded; low sphericity. Diffuse boundary between middle and lower sections.

- **51 – 79 in:** SAND; calcareous; coarse to medium grain; gray color; very poorly sorted; angular to subangular; low sphericity; 1” coral cobble at 60-65”; 5” coral cobble at 72”; 2” coral cobble at 79”.

REPRESENTATIVE APPEARANCE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	2	10	70	17	1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100		
3/8"	99		
#4	98		
#8	90		
#16	74		
#30	35		
#50	7		
#100	2		
#200	1.4		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 2.3600 D_{85}= 1.7087 D_{60}= 0.9028
D_{50}= 0.7671 D_{30}= 0.5484 D_{15}= 0.3944
D_{10}= 0.3385 C_u= 2.67 C_c= 0.98

Classification

USCS= SP AASHTO=

Remarks

Location: H2X.6
Sample Number: 83756 8

Date: 6/15/17

**CONSTRUCTION
ENGINEERING LABS, INC.
Pearl City, Hawaii**

Client: Sea Engineering, Inc.
Project: Material Qualification

Project No: SEAENG030 **Figure**

LOCATION:	**HILTON AREA, WAIKIKI, OAHU, HAWAII**
CORE:	**H-2X.7**
EASTING:	1693255.6
NORTHING:	39803.4
RECOVERED:	05/19/2017
LENGTH:	86 inches
DEPTH:	50 feet

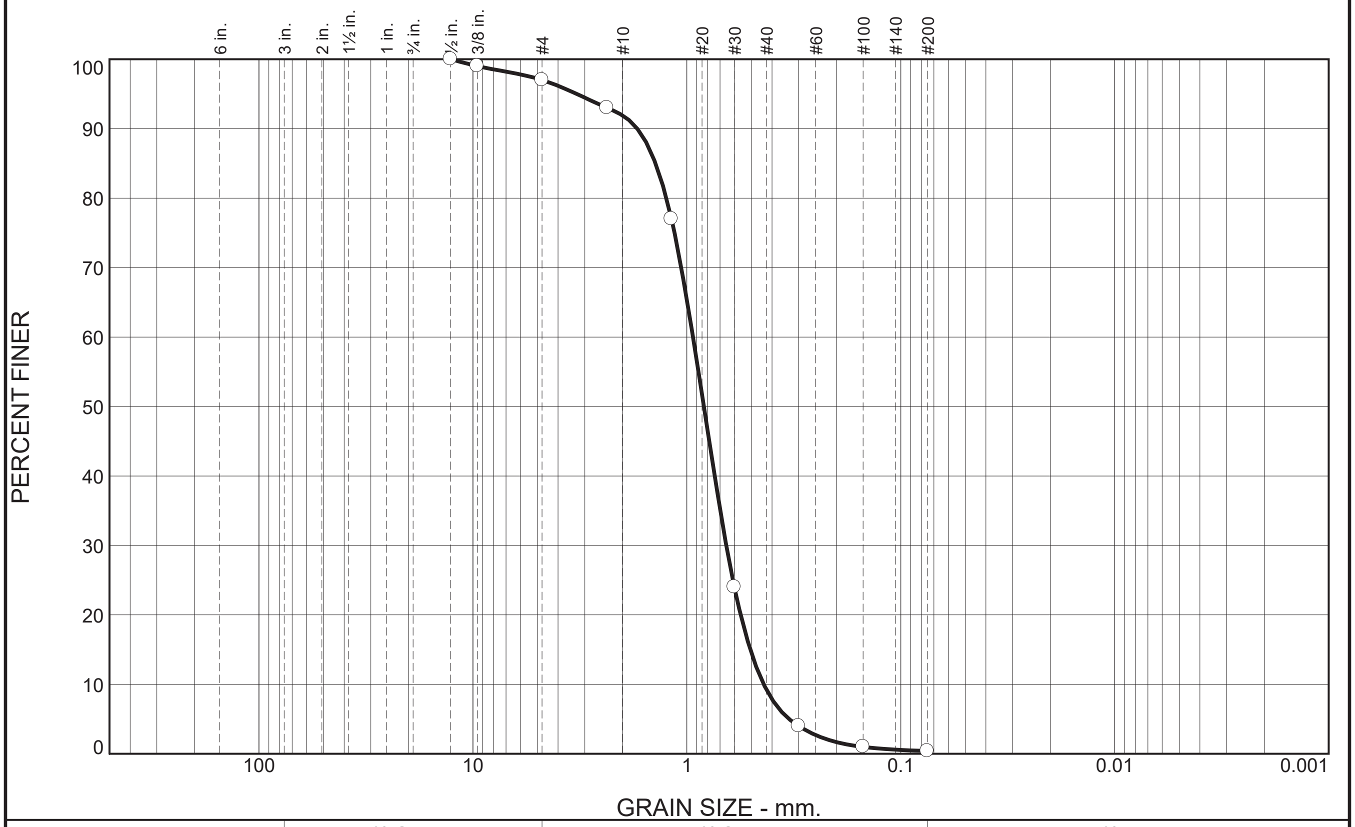
LITHOLOGIC DESCRIPTION

SAND; calcareous; heterogeneous; medium grain; unconsolidated; no compaction; moderate to poorly sorted; trace amounts of terrigenous material; 10-15% shell hash, Halimeda, and subangular coral fragments; no downward darkening; no downward coarsening; composition and color was nearly uniform throughout entire core. large-diameter coral fragments throughout.

0 – 83 in: SAND; calcareous; medium grain; light gray color; moderately sorted; moderately to poorly rounded; moderate to low sphericity; intact shell material; large diameter (1” to 3”) coral cobbles at 10”, 20”, 23”, 37”, 42”, 62”, and 82”.

REPRESENTATIVE APPEARANCE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	3	5	83	9	0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100		
3/8"	99		
#4	97		
#8	93		
#16	77		
#30	24		
#50	4		
#100	1		
#200	0.4		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.7060	D_{85}= 1.4007	D_{60}= 0.9357
D_{50}= 0.8327	D_{30}= 0.6541	D_{15}= 0.5054
D_{10}= 0.4372	C_u= 2.14	C_c= 1.05

Classification

USCS= SP AASHTO=

Remarks

Location: H2X.7
Sample Number: 83756 9
Date: 6/15/17

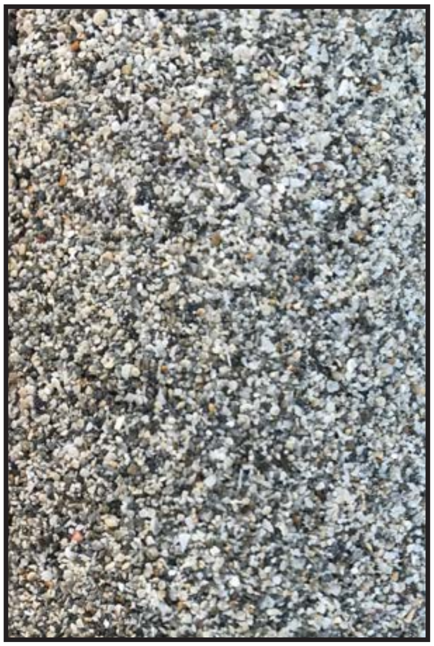
CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification
Project No: SEAENG030 **Figure**

LOCATION:	**HILTON AREA, WAIKIKI, OAHU, HAWAII**
CORE:	**Hilton 1.1**
EASTING:	1693421.2
NORTHING:	39541.4
RECOVERED:	3/20/2017
LENGTH:	85 inches
DEPTH:	47 feet

LITHOLOGIC DESCRIPTION

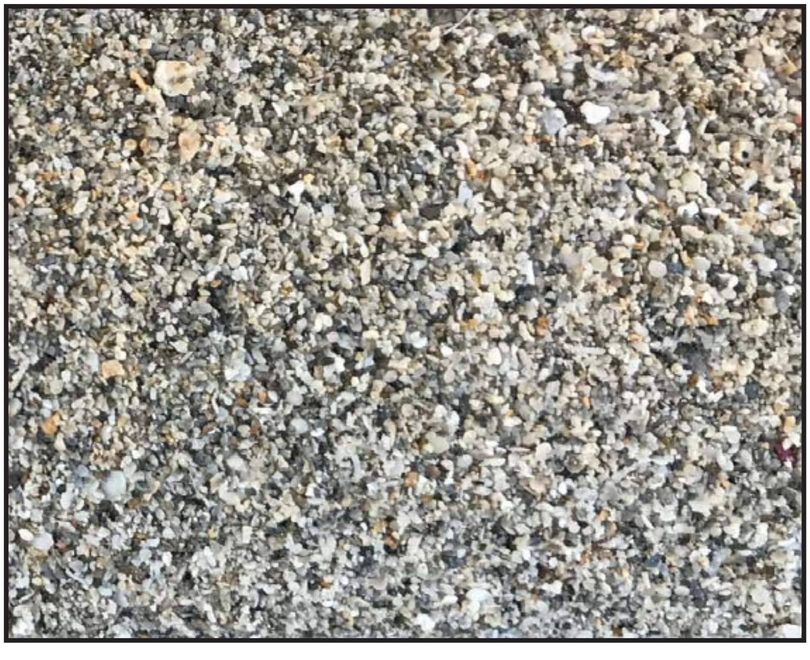
SAND; calcareous; heterogeneous; medium to coarse grain; unconsolidated; no compaction; moderately well-sorted; no terrigenous material; 10-15% shell hash, Halimeda, and coralline algae; no downward darkening; no downward coarsening; composition and color was nearly uniform throughout entire core.



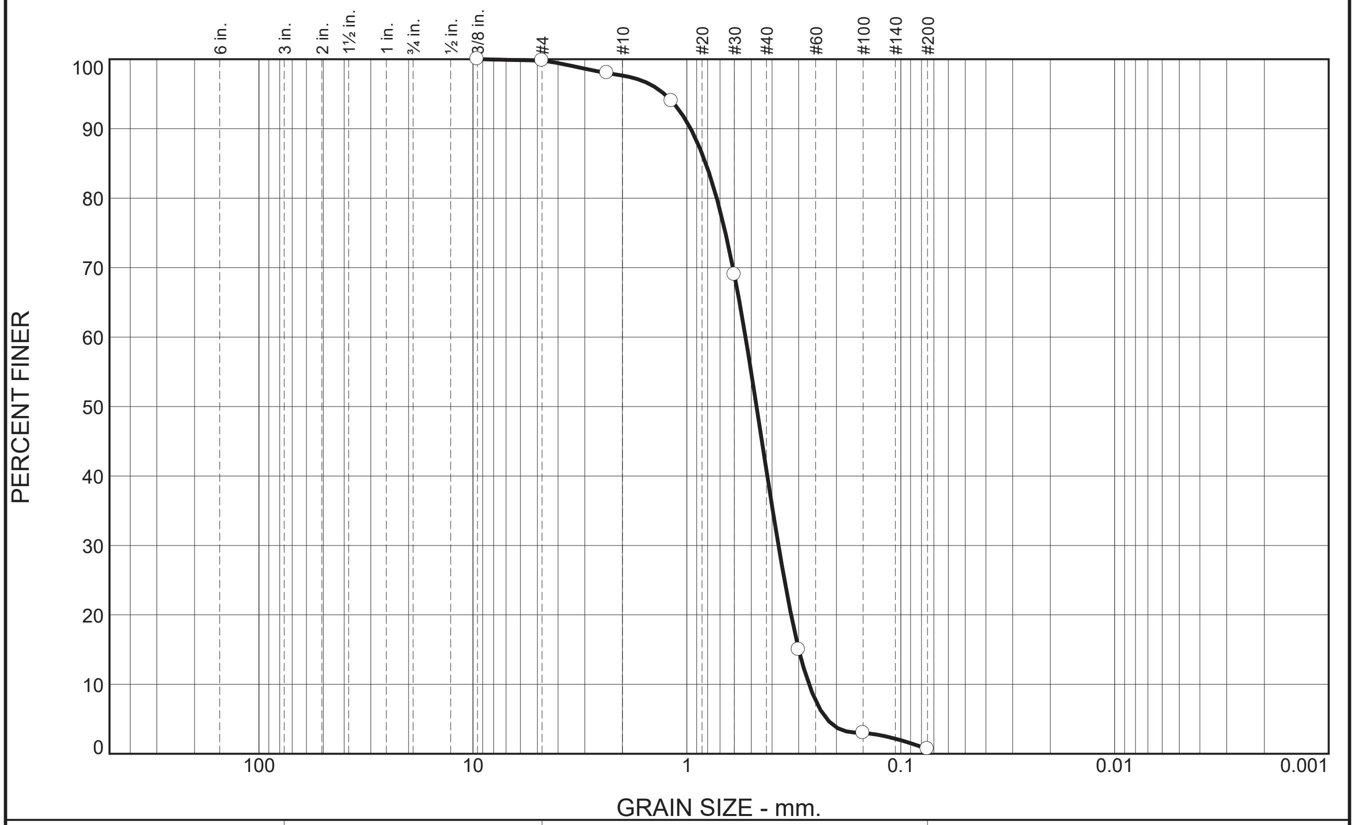
- **0 – 34 in:** SAND; calcareous; medium; grayish-tan color (lightest at top); moderately well-sorted; poorly rounded; low sphericity; appears to beach quality sand.

- **34 – 48 in:** SAND; calcareous; medium-coarse; tannish-gray color (darkest at bottom); moderately well-sorted; poorly rounded; low sphericity; 5% Halimeda in bottom 1”; appears to beach quality sand.

REPRESENTATIVE APPEARANCE



Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	2	57	40	1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#8	98		
#16	94		
#30	69		
#50	15		
#100	3		
#200	0.7		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.9594 D_{85}= 0.8160 D_{60}= 0.5322

D_{50}= 0.4723 D_{30}= 0.3732 D_{15}= 0.3000

D_{10}= 0.2688 C_u= 1.98 C_c= 0.97

Classification

USCS= SP AASHTO=

Remarks

Location: Hilton PP
Sample Number: 83756 3

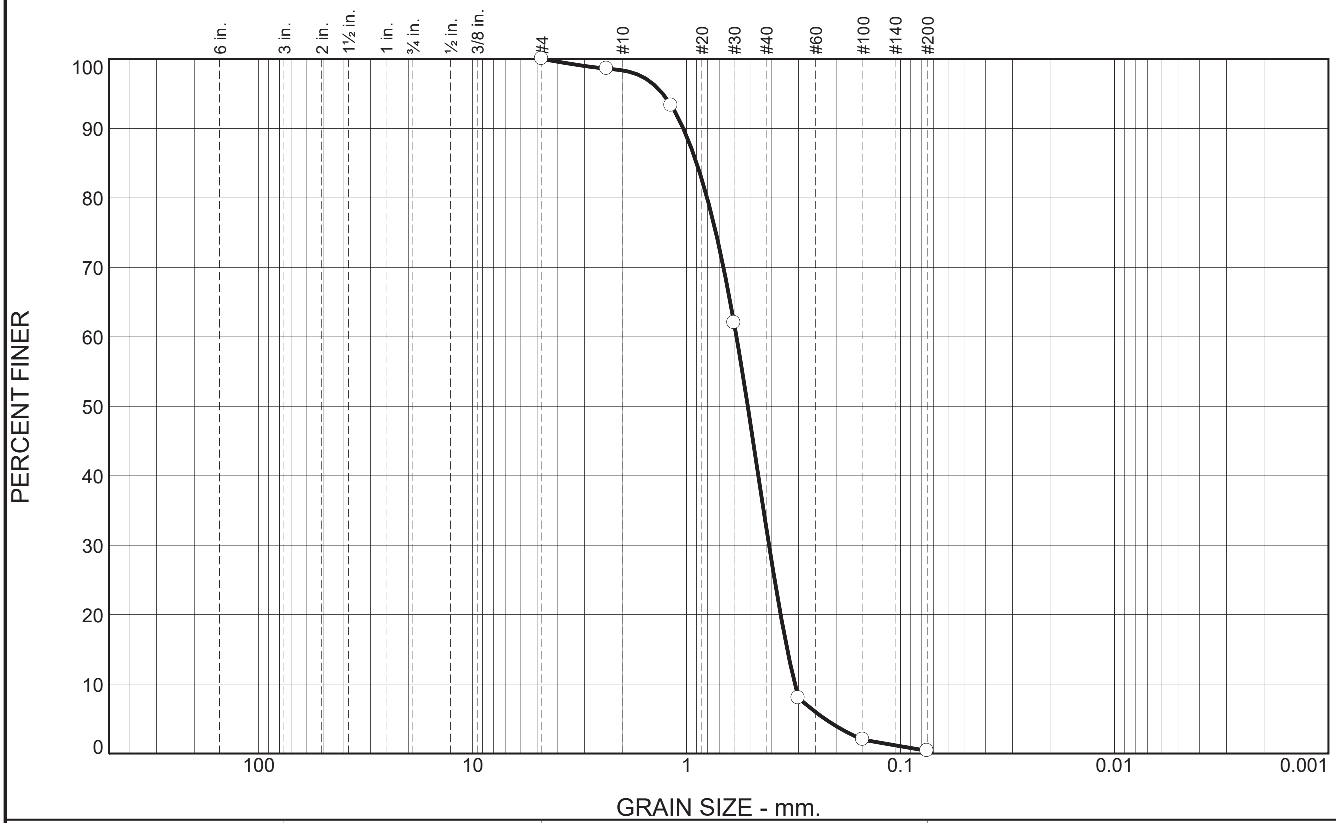
Date: 6/15/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification

Project No: SEAENG030 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.6	65.7	32.3	0.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	98.6		
#16	93.3		
#30	62.0		
#50	8.0		
#100	2.0		
#200	0.4		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.0362	D_{85}= 0.8974	D_{60}= 0.5846
D_{50}= 0.5181	D_{30}= 0.4119	D_{15}= 0.3389
D_{10}= 0.3121	C_u= 1.87	C_c= 0.93

Classification

USCS= SP AASHTO=

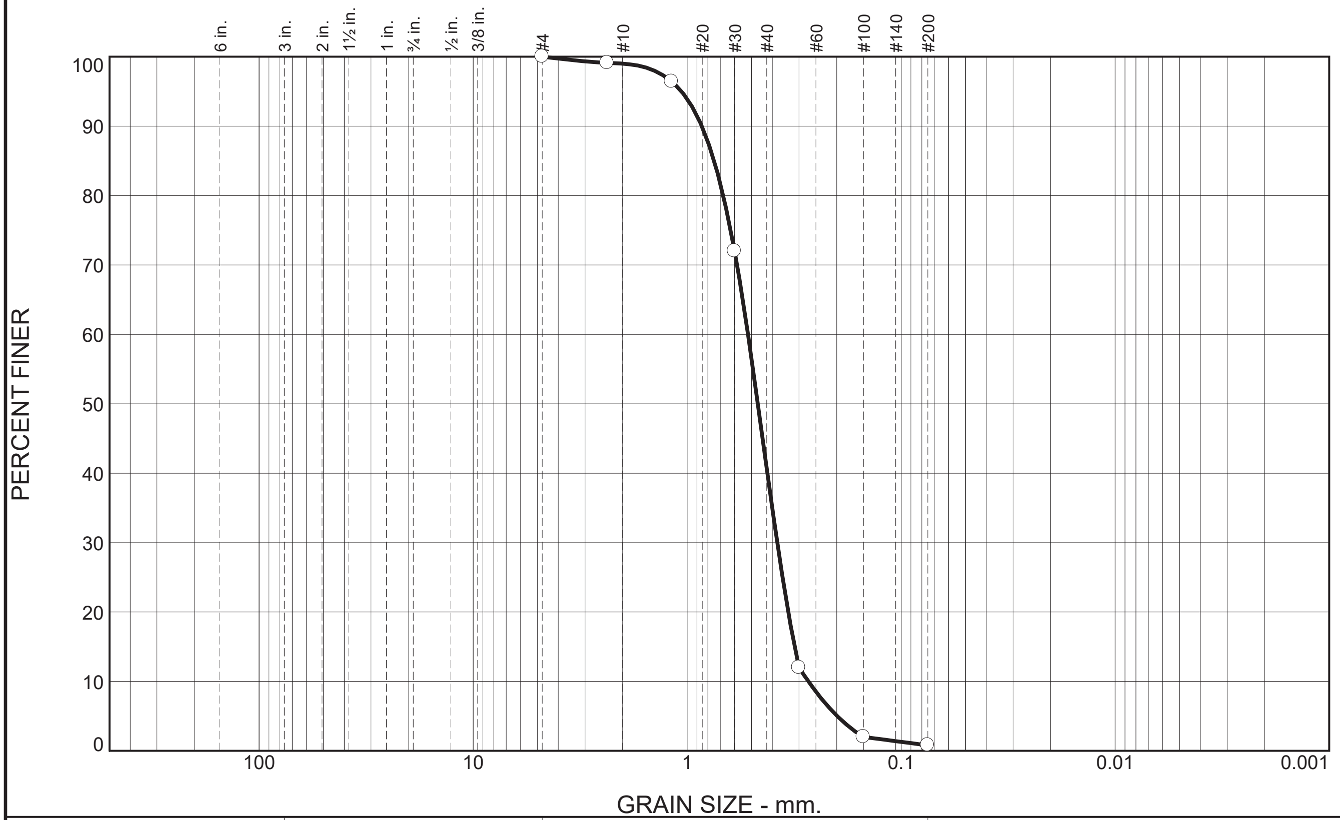
Remarks

Location: Hilton PP Top
Sample Number: 83037 5
Date: 5/10/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing
Project No: SEAENG031 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.0	58.2	40.0	0.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.1		
#16	96.4		
#30	72.0		
#50	12.0		
#100	2.0		
#200	0.8		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.8539 D_{85}= 0.7483 D_{60}= 0.5197
D_{50}= 0.4674 D_{30}= 0.3792 D_{15}= 0.3147
D_{10}= 0.2712 C_u= 1.92 C_c= 1.02

Classification

USCS= SP AASHTO=

Remarks

Location: Hilton PP Bottom
Sample Number: 83037 6
Date: 5/10/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing
Project No: SEAENG031 **Figure**

LOCATION:	**HILTON AREA, WAIKIKI, OAHU, HAWAII**
CORE:	**Hilton 1.2**
EASTING:	1693421.2
NORTHING:	39541.4
RECOVERED:	3/20/2017
LENGTH:	85 inches
DEPTH:	47 feet

LITHOLOGIC DESCRIPTION

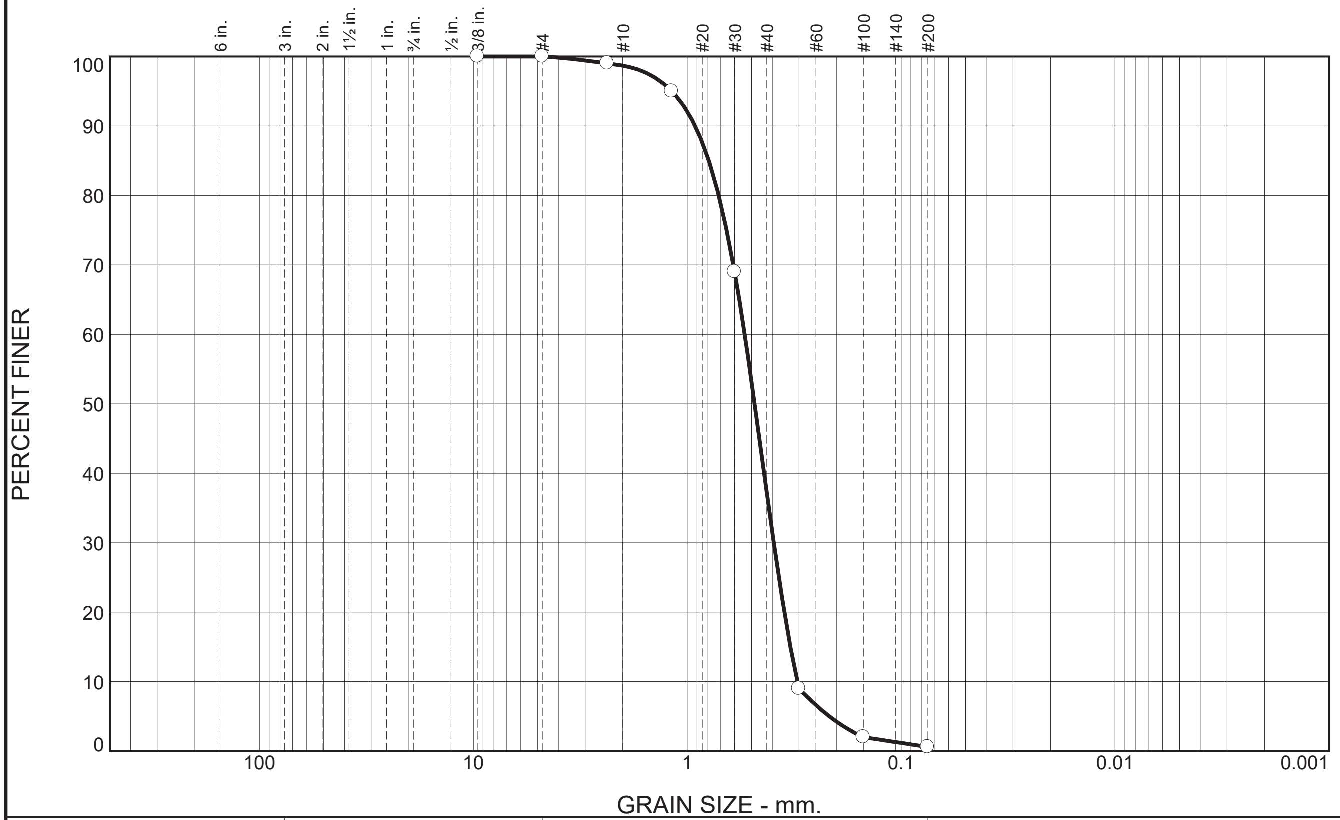
SAND; calcareous; heterogeneous; medium grain; unconsolidated; no compaction; moderately well-sorted; no terrigenous material; 10-15% shell hash, Halimeda, and coralline algae; downward darkening; no downward coarsening; composition and color was nearly uniform throughout entire core.

- **0 – 27 in:** SAND; calcareous; medium grain; tan color; moderately well-sorted; poorly rounded; low sphericity; 10-15% shell hash, Halimeda, and coralline algae; appears to be beach quality sand.

- **27 – 85 in:** SAND; calcareous; medium grain; dark tan-grayish color; moderately-well sorted; poorly rounded; low sphericity; 10-15% shell hash, Halimeda, and coralline algae; appears to be beach quality sand.

REPRESENTATIVE APPEARANCE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	62	36	1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#8	99		
#16	95		
#30	69		
#50	9		
#100	2		
#200	0.6		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.9174 D_{85}= 0.7923 D_{60}= 0.5386
D_{50}= 0.4840 D_{30}= 0.3936 D_{15}= 0.3294
D_{10}= 0.3053 C_u= 1.76 C_c= 0.94

Classification

USCS= SP AASHTO=

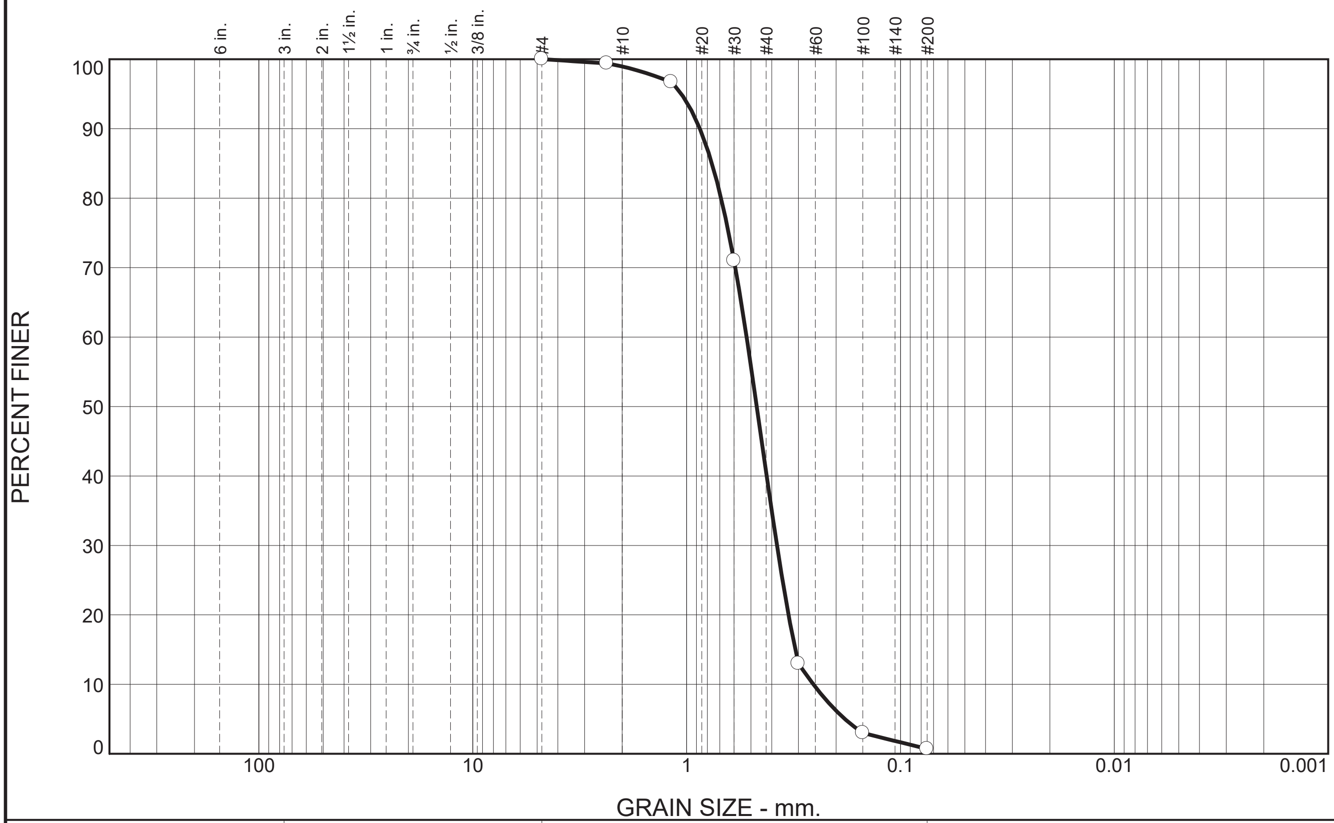
Remarks

Location: Hilton 2.1
Sample Number: 83756 4
Date: 6/15/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification
Project No: SEAENG030 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.1	58.3	39.9	0.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.4		
#16	96.7		
#30	71.0		
#50	13.0		
#100	3.0		
#200	0.7		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.8670 D_{85}= 0.7617 D_{60}= 0.5244
D_{50}= 0.4699 D_{30}= 0.3781 D_{15}= 0.3104
D_{10}= 0.2555 C_u= 2.05 C_c= 1.07

Classification

USCS= SP AASHTO=

Remarks

Location: Hilton 1.2 Top
Sample Number: 83037 7

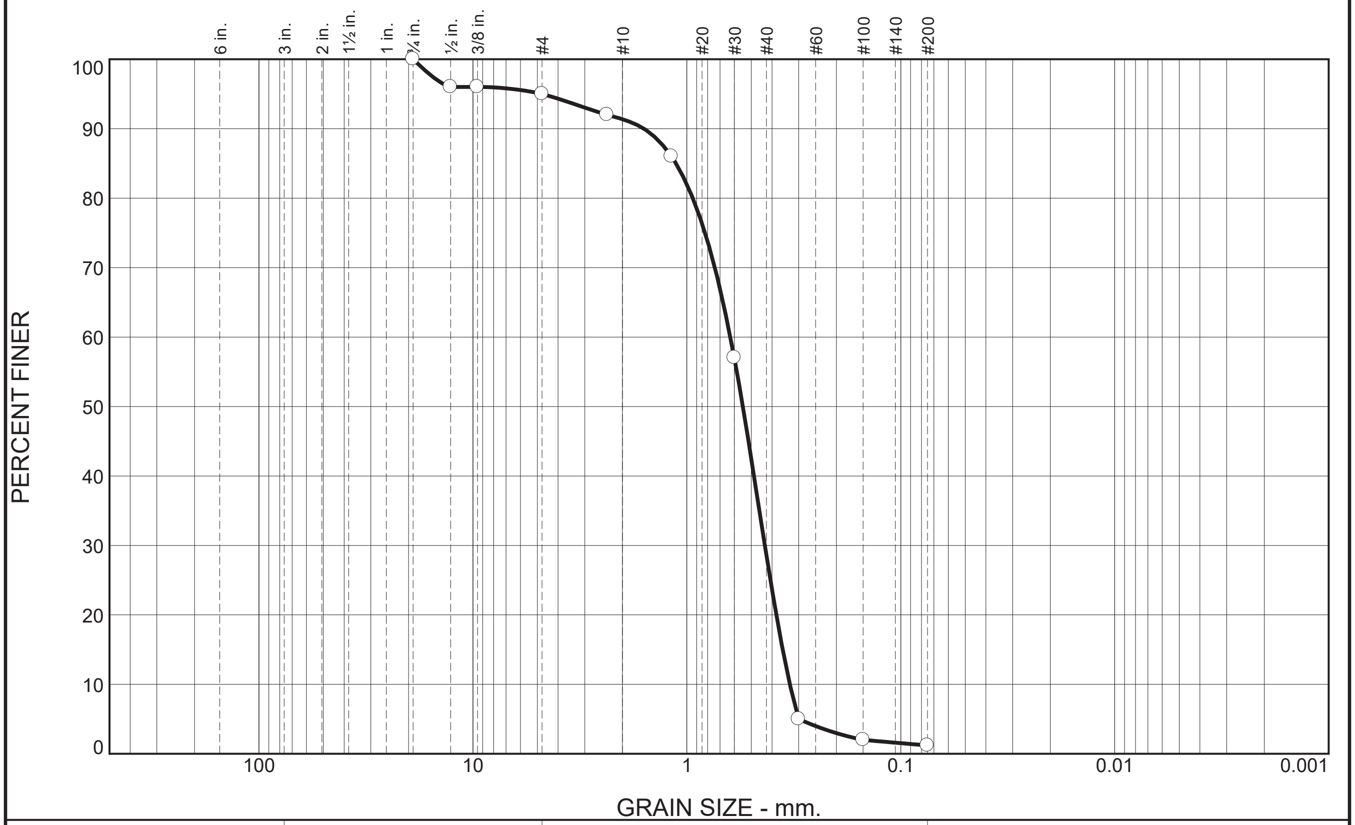
Date: 5/10/17

CONSTRUCTION
ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing

Project No: SEAENG031 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.0	3.6	62.8	27.4	1.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	96.0		
3/8"	96.0		
#4	95.0		
#8	92.0		
#16	86.0		
#30	57.0		
#50	5.0		
#100	2.0		
#200	1.2		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.5903 D_{85}= 1.1249 D_{60}= 0.6262
D_{50}= 0.5476 D_{30}= 0.4320 D_{15}= 0.3567
D_{10}= 0.3303 C_u= 1.90 C_c= 0.90

Classification

USCS= SP AASHTO=

Remarks

Location: Hilton 1.2 Bottom
Sample Number: 83037 8

Date: 5/10/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing

Project No: SEAENG031 **Figure**

LOCATION: **REEF RUNWAY, HONOLULU, OAHU, HAWAII**
CORE: **RR-2X.1**
EASTING: 1693294.6
NORTHING: 39587.3
COLLECTED: 05/19/2017
LENGTH: 50 inches
DEPTH: 87 feet

LITHOLOGIC DESCRIPTION

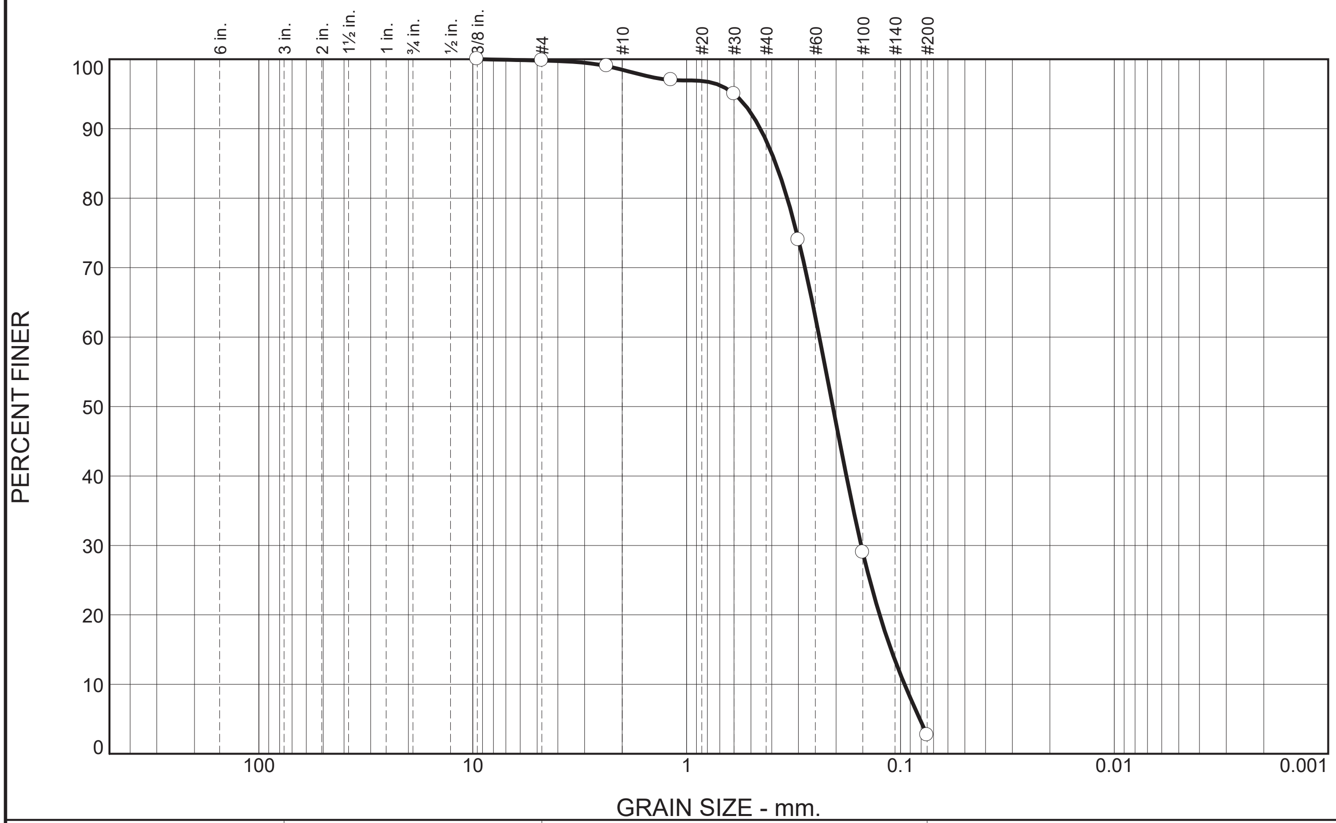
SAND; calcareous; heterogeneous; fine to very-fine grain; moderately-well sorted; moderately-compacted; trace amounts of terrigenous material; 5-10% Halimeda and coralline algae; traces of shell hash; downward darkening; minor downward coarsening.

- **0 – 6 in:** SAND; calcareous; fine to very-fine grain; light tan color; moderately-well sorted; rounded; low sphericity; sharp boundary between upper and lower sections.

- **6 – 29 in:** SAND; calcareous; fine grain; light-gray color; moderately-well sorted; poorly rounded; low sphericity.

REPRESENTATIVE PHOTO

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	2	10	85	3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#8	99		
#16	97		
#30	95		
#50	74		
#100	29		
#200	2.7		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4521 D_{85}= 0.3834 D_{60}= 0.2395
D_{50}= 0.2072 D_{30}= 0.1527 D_{15}= 0.1106
D_{10}= 0.0957 C_u= 2.50 C_c= 1.02

Classification

USCS= SP AASHTO=

Remarks

Location: RR-2X.1
Sample Number: 83756 13

Date: 6/15/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification

Project No: SEAENG030 **Figure**

LOCATION: **REEF RUNWAY, HONOLULU, OAHU, HAWAII**
CORE: **RR-2X.2**
EASTING: 1657473.5
NORTHING: 46894.6
COLLECTED: 05/18/2017
LENGTH: 38 inches
DEPTH: 83 feet

LITHOLOGIC DESCRIPTION

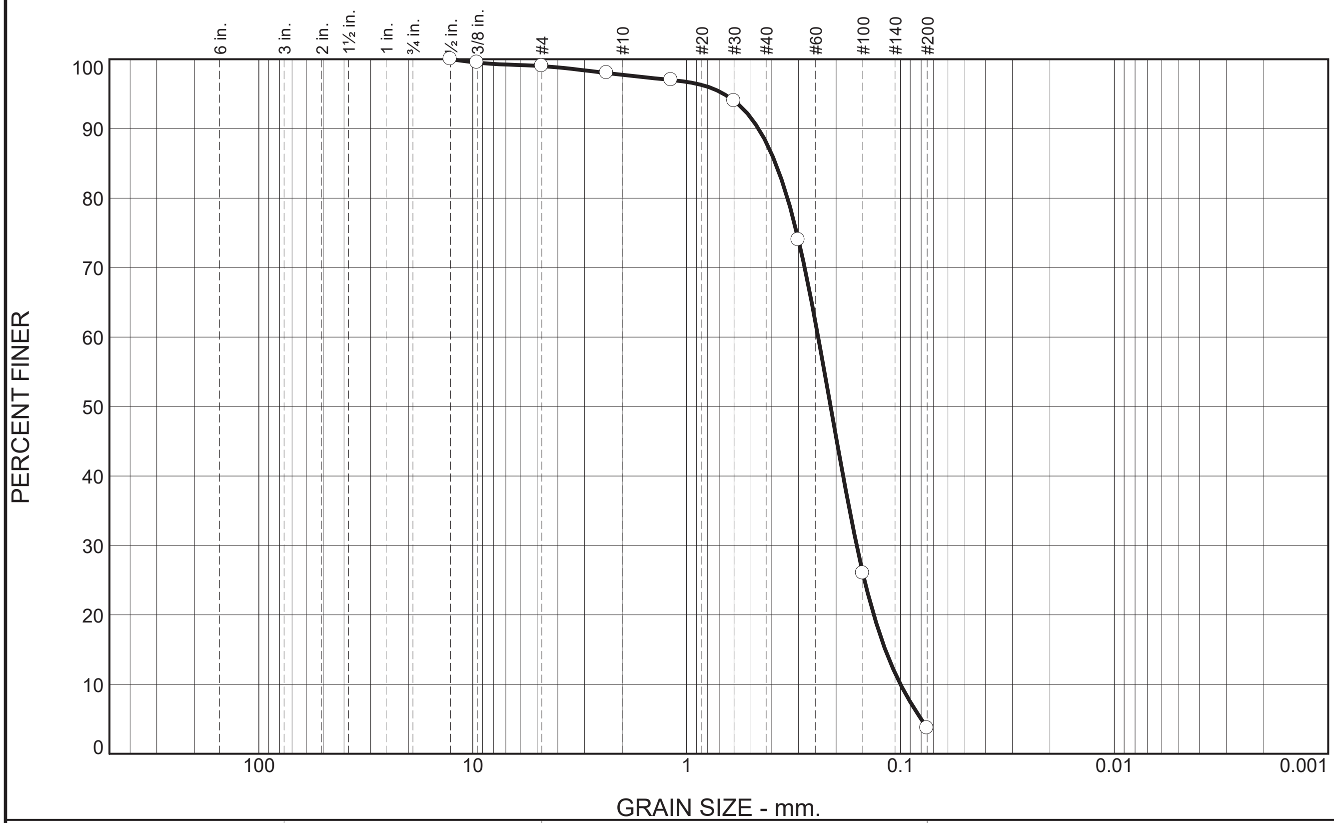
SAND; calcareous; heterogeneous; fine to very-fine; moderately-well sorted; consolidated; moderately-compacted; trace amounts of terrigenous material; 5-15% Halimeda and coralline algae; traces of shell hash; uniform appearance; minor downward darkening; no downward coarsening; sulfurous odor.

- **0 – 5 in:** SAND; calcareous; fine to very-fine; light tan color; moderately sorted; poorly rounded; low sphericity; sharp boundary between upper and lower sections.

- **5 – 20 in:** SAND; calcareous; fine grain; grayish-tan color; moderately sorted; poorly rounded; low sphericity; multiple 2-3” coral cobbles at 14-18”.

REPRESENTATIVE GRAIN SIZE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	1	1	10	84	4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100		
3/8"	100		
#4	99		
#8	98		
#16	97		
#30	94		
#50	74		
#100	26		
#200	3.7		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4610 D_{85}= 0.3837 D_{60}= 0.2426
D_{50}= 0.2121 D_{30}= 0.1603 D_{15}= 0.1178
D_{10}= 0.1000 C_u= 2.43 C_c= 1.06

Classification

USCS= SP AASHTO=

Remarks

Location: RR-2X.2
Sample Number: 83756 14
Date: 6/15/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification
Project No: SEAENG030 **Figure**

LOCATION:	**REEF RUNWAY, HONOLULU, OAHU, HAWAII**
CORE:	**RR-2X.3**
EASTING:	1657329.9
NORTHING:	46710.3
COLLECTED:	05/18/2017
LENGTH:	65 inches
DEPTH:	105 feet

LITHOLOGIC DESCRIPTION

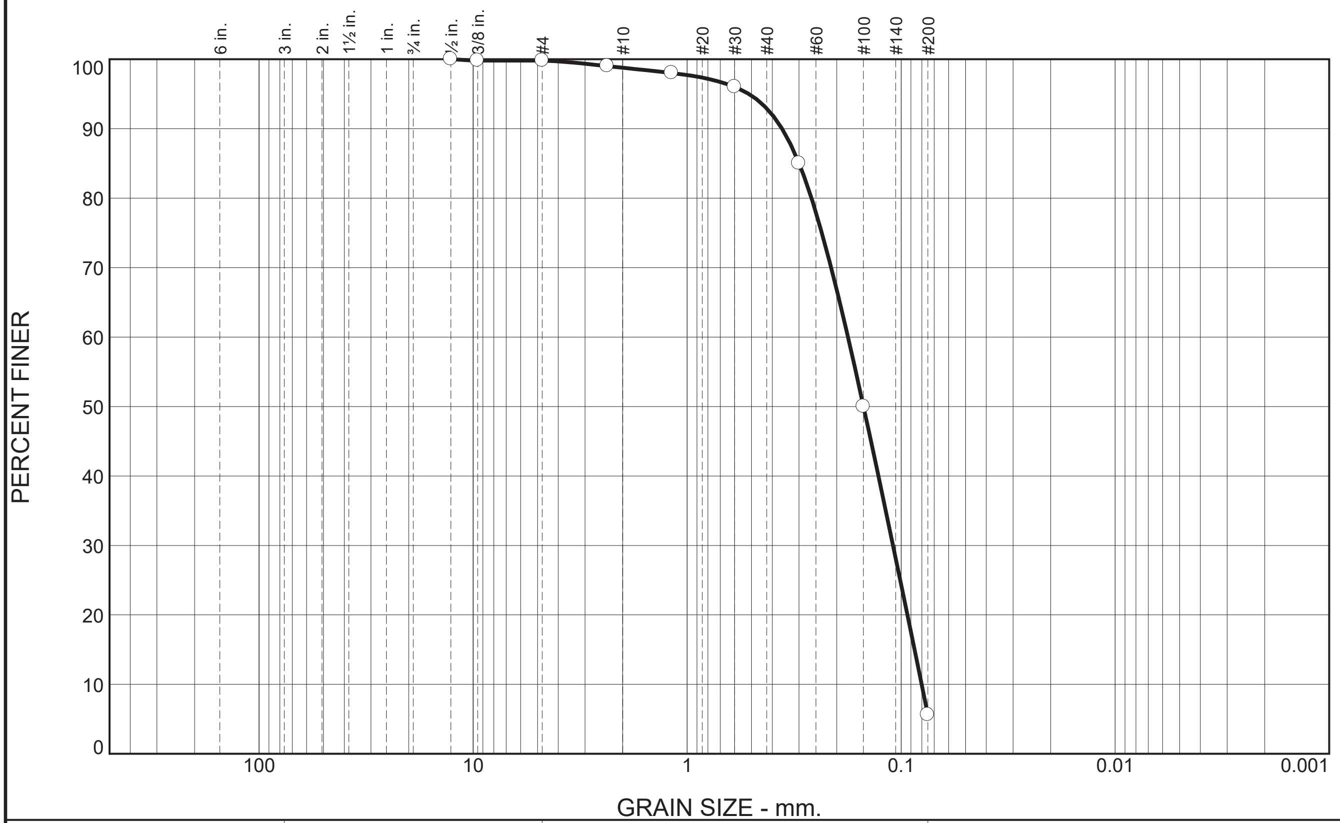
SAND; calcareous; heterogeneous; fine grain; well-sorted; consolidated; moderately-compacted; 0-5% shell hash, Halimeda, and coralline algae; mixed appearance in upper 10”; uniform appearance from 10-44”; minor downward darkening; no downward coarsening; sulfurous odor throughout.

- **0 – 10 in:** SAND; calcareous; fine grain; tan color; well-sorted; poorly rounded; low sphericity; mottled appearance with dark gray intrusions with sulfurous odor (possibly organic material).

- **10 – 44 in:** SAND; calcareous; fine grain; grayish-tan color; moderately sorted; poorly rounded; low sphericity; mottled appearance with dark gray intrusions with sulfurous odor (possibly organic material).

REPRESENTATIVE GRAIN SIZE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	6	87	6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100		
3/8"	100		
#4	100		
#8	99		
#16	98		
#30	96		
#50	85		
#100	50		
#200	5.6		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.3605 D_{85}= 0.3000 D_{60}= 0.1773
D_{50}= 0.1500 D_{30}= 0.1091 D_{15}= 0.0866
D_{10}= 0.0802 C_u= 2.21 C_c= 0.84

Classification

USCS= SP-SM AASHTO= A-3

Remarks

Location: RR-2X.3
Sample Number: 83756 15
Date: 6/15/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification
Project No: SEAENG030 **Figure**

LOCATION:	**REEF RUNWAY, HONOLULU, OAHU, HAWAII**
CORE:	**RR-2X.4**
EASTING:	1657555.2
NORTHING:	46661.4
COLLECTED:	05/18/2017
LENGTH:	87 inches
DEPTH:	94 feet

LITHOLOGIC DESCRIPTION

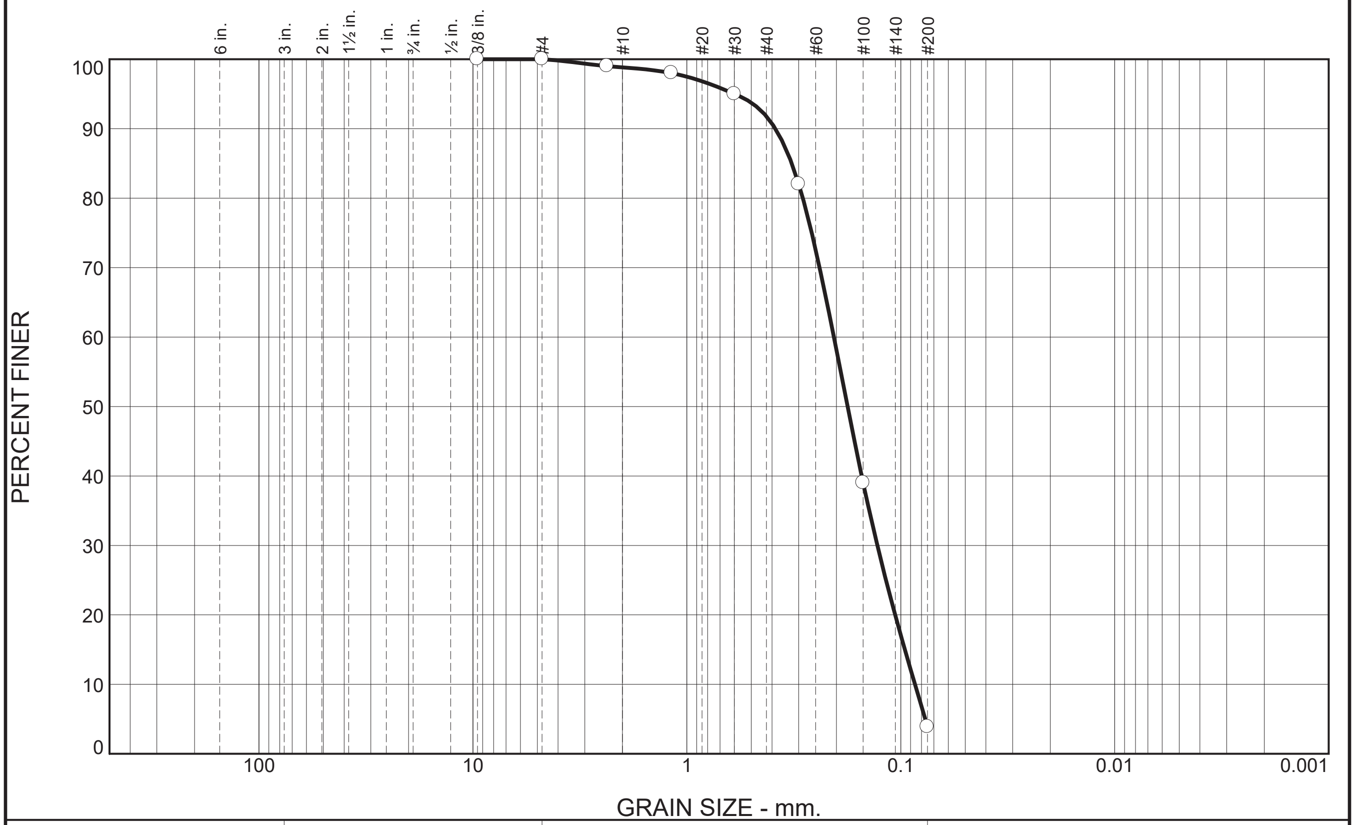
SAND; calcareous; heterogeneous; fine grain; well-sorted; consolidated; compacted; 0-5% shell hash, Halimeda, and coralline algae; no coral fragments or cobbles; minor downward darkening; no downward coarsening.

- **0 – 7 in:** SAND; calcareous; fine grain; light tan color; moderately sorted; poorly rounded; low sphericity; mottled appearance with dark gray intrusions with sulfurous odor (possibly organic material).

- **7 – 57 in:** SAND; calcareous; fine grain; light grayish-tan color; moderately sorted; poorly rounded; low sphericity; mottled appearance with dark gray intrusions with sulfurous odor (possibly organic material); 1” dark gray intrusion at 45”.

REPRESENTATIVE GRAIN SIZE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	7	88	4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#8	99		
#16	98		
#30	95		
#50	82		
#100	39		
#200	3.9		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3859 D_{85}= 0.3236 D_{60}= 0.2055
D_{50}= 0.1774 D_{30}= 0.1287 D_{15}= 0.0957
D_{10}= 0.0859 C_u= 2.39 C_c= 0.94

Classification

USCS= SP AASHTO=

Remarks

Location: RR-2X.4
Sample Number: 83756 16

Date: 6/15/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification
Project No: SEAENG030 **Figure**

LOCATION:	**REEF RUNWAY, HONOLULU, OAHU, HAWAII**
CORE:	**RR-3.1**
EASTING:	1657390.3
NORTHING:	46771.7
COLLECTED:	3/21/2017
LENGTH:	96 inches
DEPTH:	93 feet

LITHOLOGIC DESCRIPTION

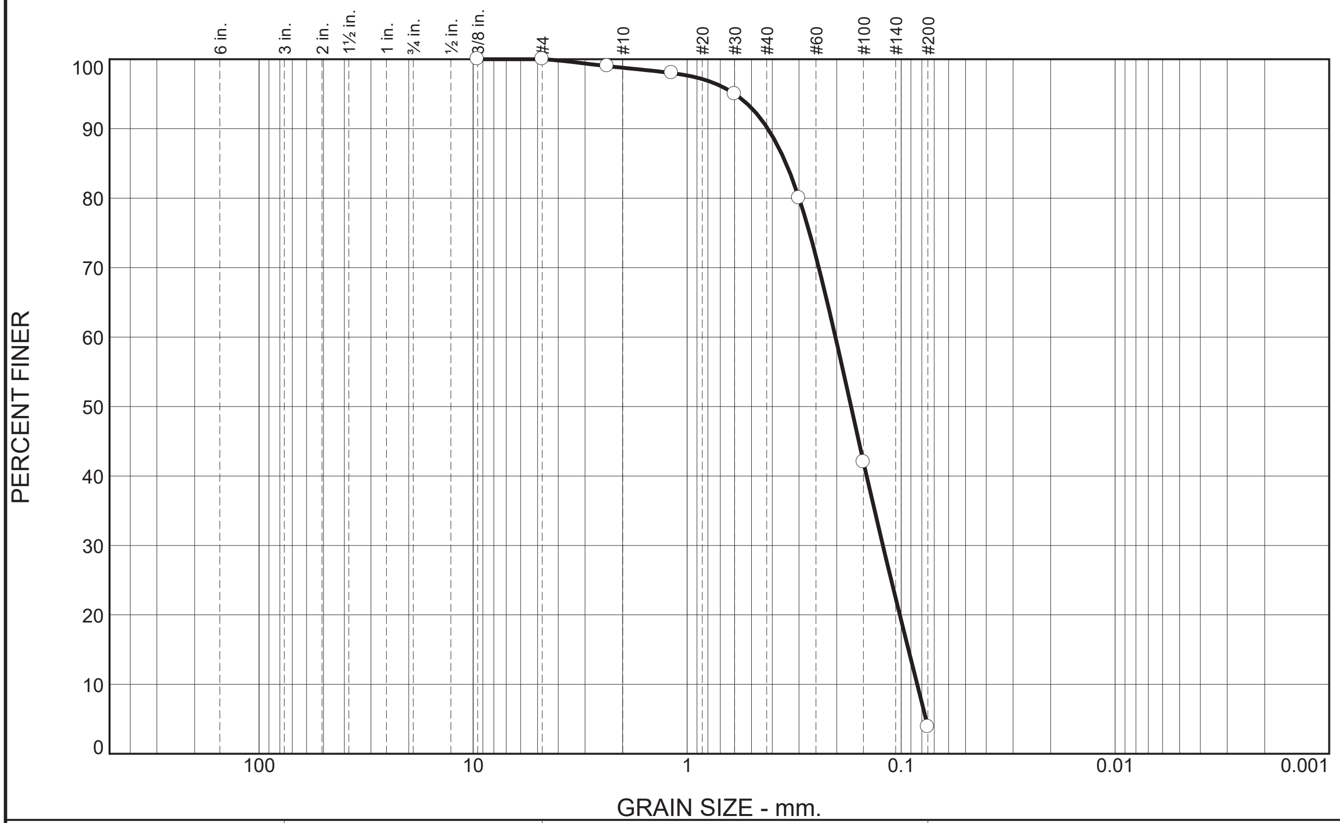
SAND; calcareous; heterogeneous; fine grain; moderately sorted; consolidated; moderately-compacted; trace amounts of terrigenous material; 0-5% Halimeda, coralline algae, and shell hash; minor downward darkening; no downward coarsening.

- **0 – 66 in:** SAND; calcareous; fine to very fine grain; light tannish-gray color; moderately sorted; poorly rounded; low sphericity; 2” diameter cobbles at 28”, 52”, and 56”.

- **66 – 82 in:** SAND; calcareous; fine to very fine grain; light gray color; moderately sorted; poorly rounded; low sphericity; mottled appearance with dark gray intrusions.

REPRESENTATIVE GRAIN SIZE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	9	86	4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#8	99		
#16	98		
#30	95		
#50	80		
#100	42		
#200	3.9		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4198 D_{85}= 0.3453 D_{60}= 0.2028
D_{50}= 0.1715 D_{30}= 0.1217 D_{15}= 0.0924
D_{10}= 0.0841 C_u= 2.41 C_c= 0.87

Classification

USCS= SP AASHTO=

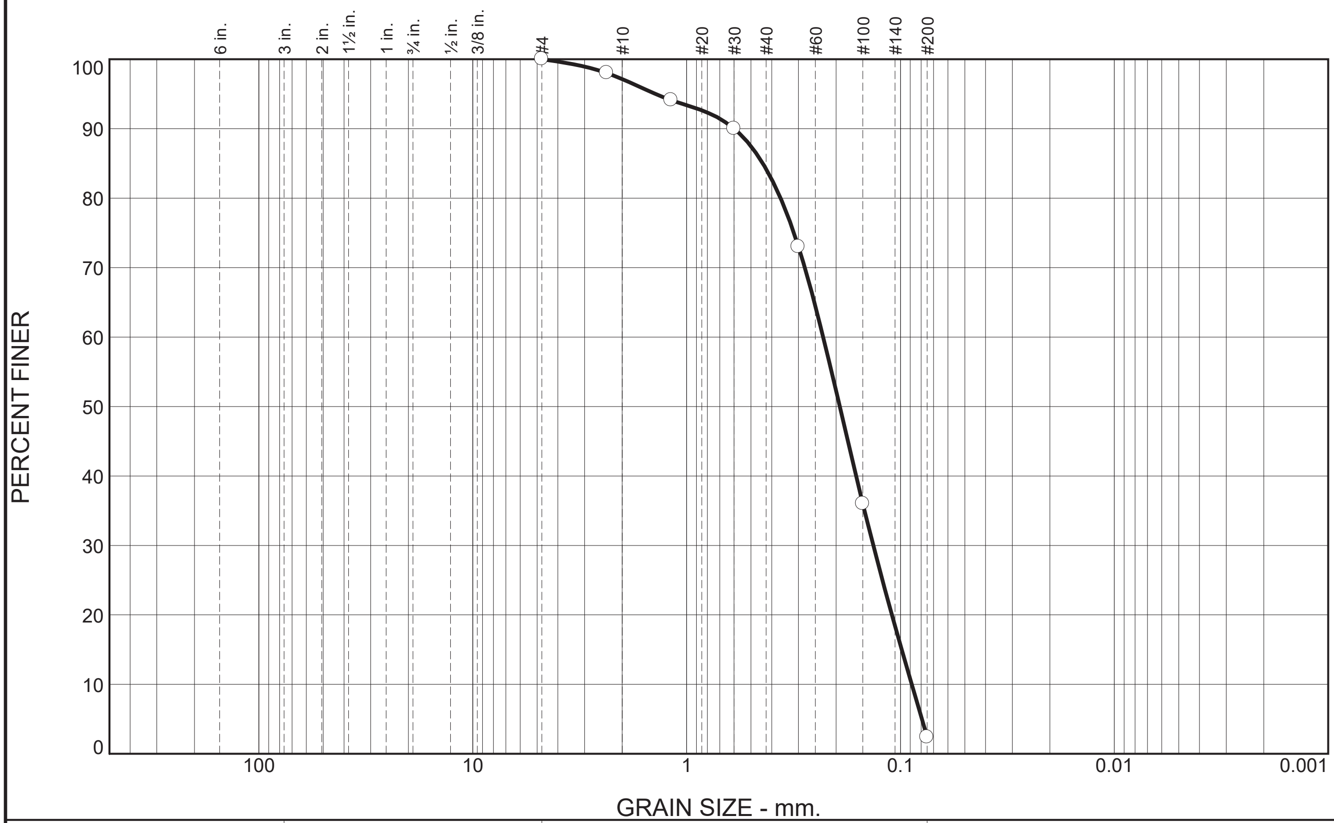
Remarks

Location: RR 3.1
Sample Number: 83756 12
Date: 6/15/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification
Project No: SEAENG030
Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	2.9	12.9	81.8	2.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	98.0		
#16	94.1		
#30	90.0		
#50	73.0		
#100	36.0		
#200	2.4		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6000 D_{85}= 0.4401 D_{60}= 0.2298
D_{50}= 0.1922 D_{30}= 0.1340 D_{15}= 0.0987
D_{10}= 0.0886 C_u= 2.59 C_c= 0.88

Classification

USCS= SP AASHTO=

Remarks

Location: RR 3.1 Top
Sample Number: 83037 13

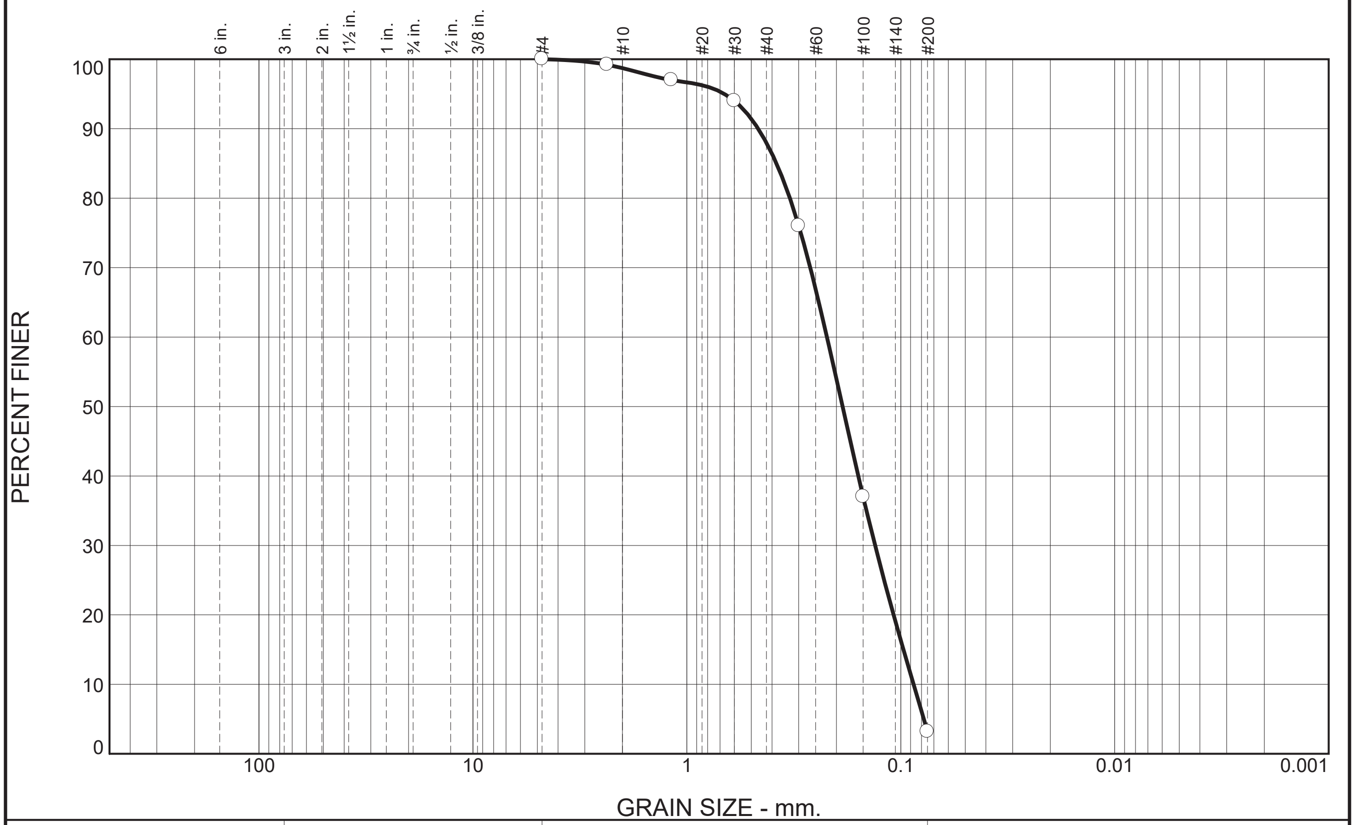
Date: 5/12/17

CONSTRUCTION
ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing

Project No: SEAENG031 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.3	10.7	84.8	3.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.2		
#16	97.0		
#30	94.0		
#50	76.0		
#100	37.0		
#200	3.2		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4643	D_{85}= 0.3815	D_{60}= 0.2214
D_{50}= 0.1871	D_{30}= 0.1319	D_{15}= 0.0972
D_{10}= 0.0872	C_u= 2.54	C_c= 0.90

Classification

USCS= SP AASHTO=

Remarks

Location: RR 3.1 Bottom
Sample Number: 83037 14

Date: 5/12/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing

Project No: SEAENG031 **Figure**

LOCATION: HALEKULANI CHANNEL, OAHU, HAWAII
CORE: Halekulani 1.1
EASTING: 1695202.5
NORTHING: 37297.1
RECOVERED: 3/20/2017
LENGTH: 68 inches
DEPTH: 55 feet

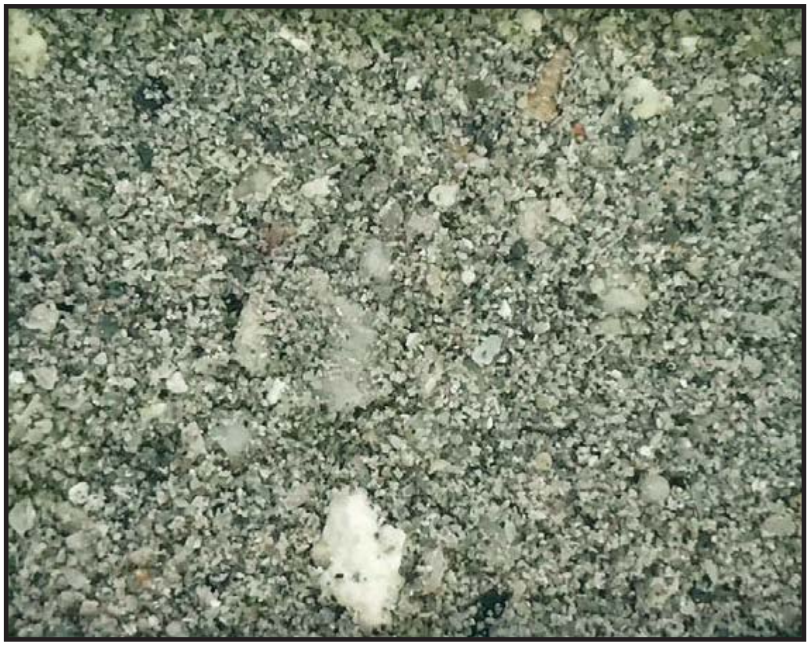
LITHOLOGIC DESCRIPTION

SAND; calcareous; heterogeneous; fine to medium grain; moderately consolidated; well-sorted; trace amounts of terrigenous material; 5-10% shell hash, Halimeda, and coralline algae; downward darkening; downward coarsening; downward darkening.

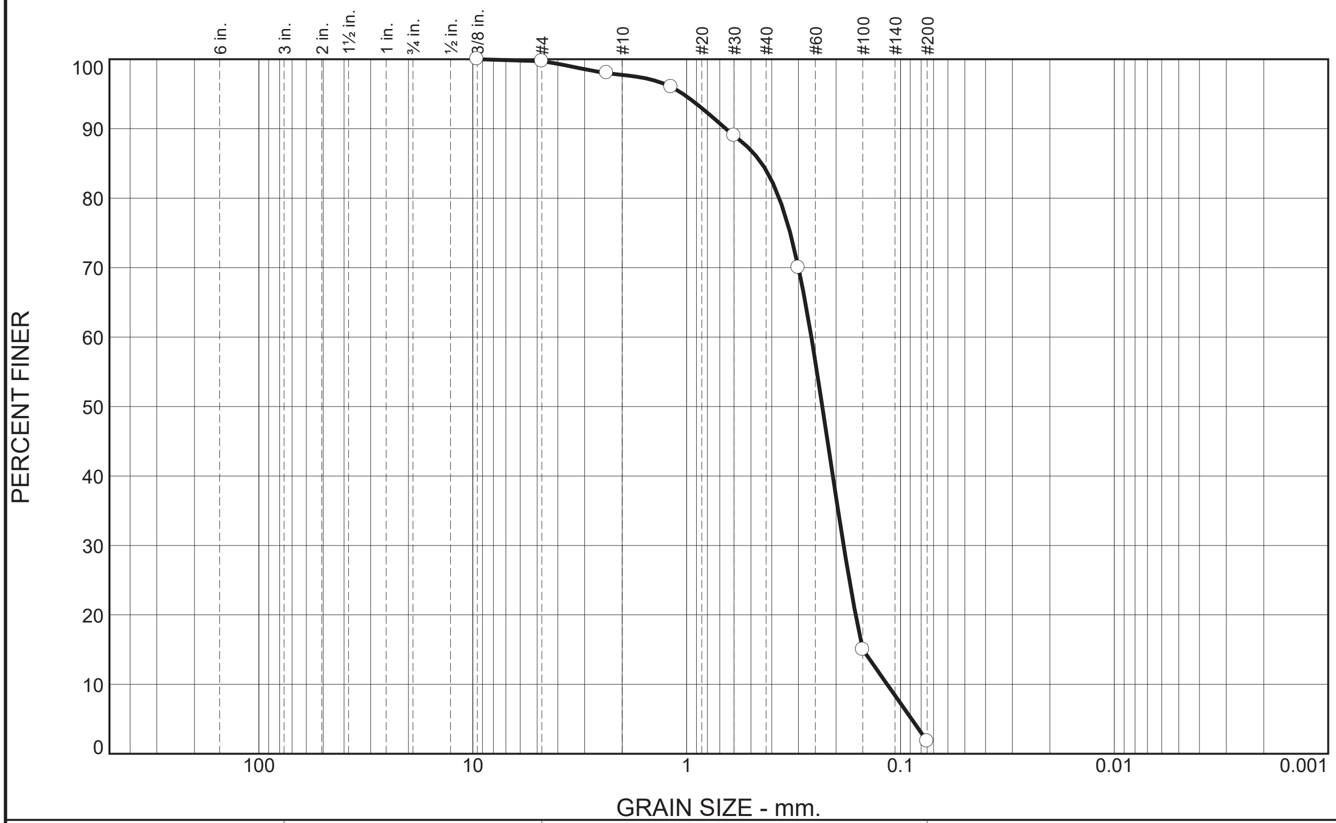
- **0 – 52 in:** SAND; calcareous; fine grain; grayish-tan color (lightest near top of section); well-sorted; rounded; moderate sphericity; no downward coarsening or darkening; 5-10 % shell hash, Halimeda, and coralline algae; diffuse boundary between upper and lower sections.

- **52 – 68 in:** SAND; calcareous; medium grain; darker grayish tan color; downward darkening; moderately-well sorted; rounded; moderate sphericity.

REPRESENTATIVE APPEARANCE



Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	2	14	82	2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#8	98		
#16	96		
#30	89		
#50	70		
#100	15		
#200	1.8		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6560 D_{85}= 0.4452 D_{60}= 0.2612
D_{50}= 0.2319 D_{30}= 0.1845 D_{15}= 0.1500
D_{10}= 0.1154 C_u= 2.26 C_c= 1.13

Classification

USCS= SP AASHTO=

Remarks

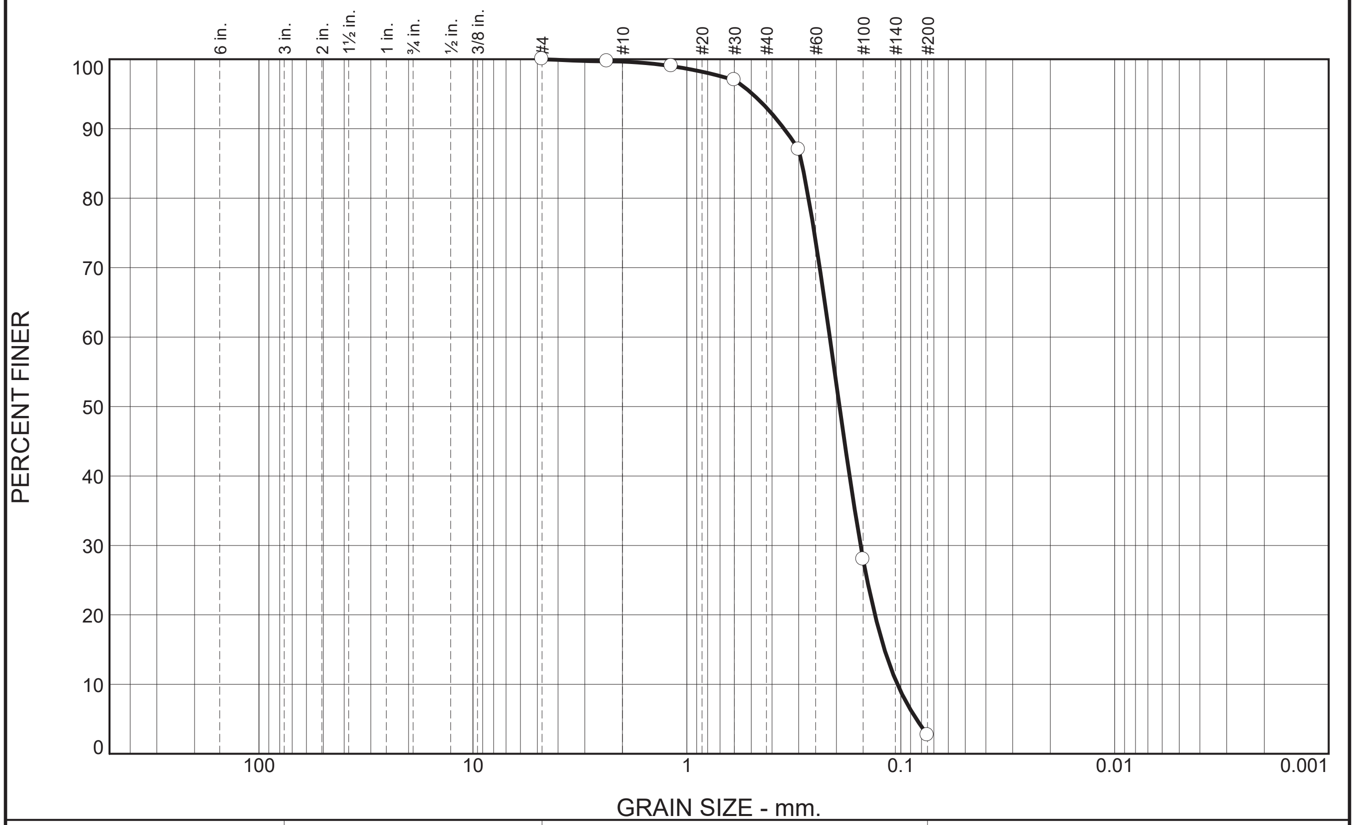
Location: Halekulani 1.1
Sample Number: 83756 10

Date: 6/15/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification
Project No: SEAENG030 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.3	6.7	90.3	2.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.7		
#16	99.0		
#30	97.0		
#50	87.0		
#100	28.0		
#200	2.7		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3516 D_{85}= 0.2902 D_{60}= 0.2148
D_{50}= 0.1934 D_{30}= 0.1541 D_{15}= 0.1191
D_{10}= 0.1037 C_u= 2.07 C_c= 1.07

Classification

USCS= SP AASHTO=

Remarks

Location: Halekulani 1.1 Top
Sample Number: 83037 9

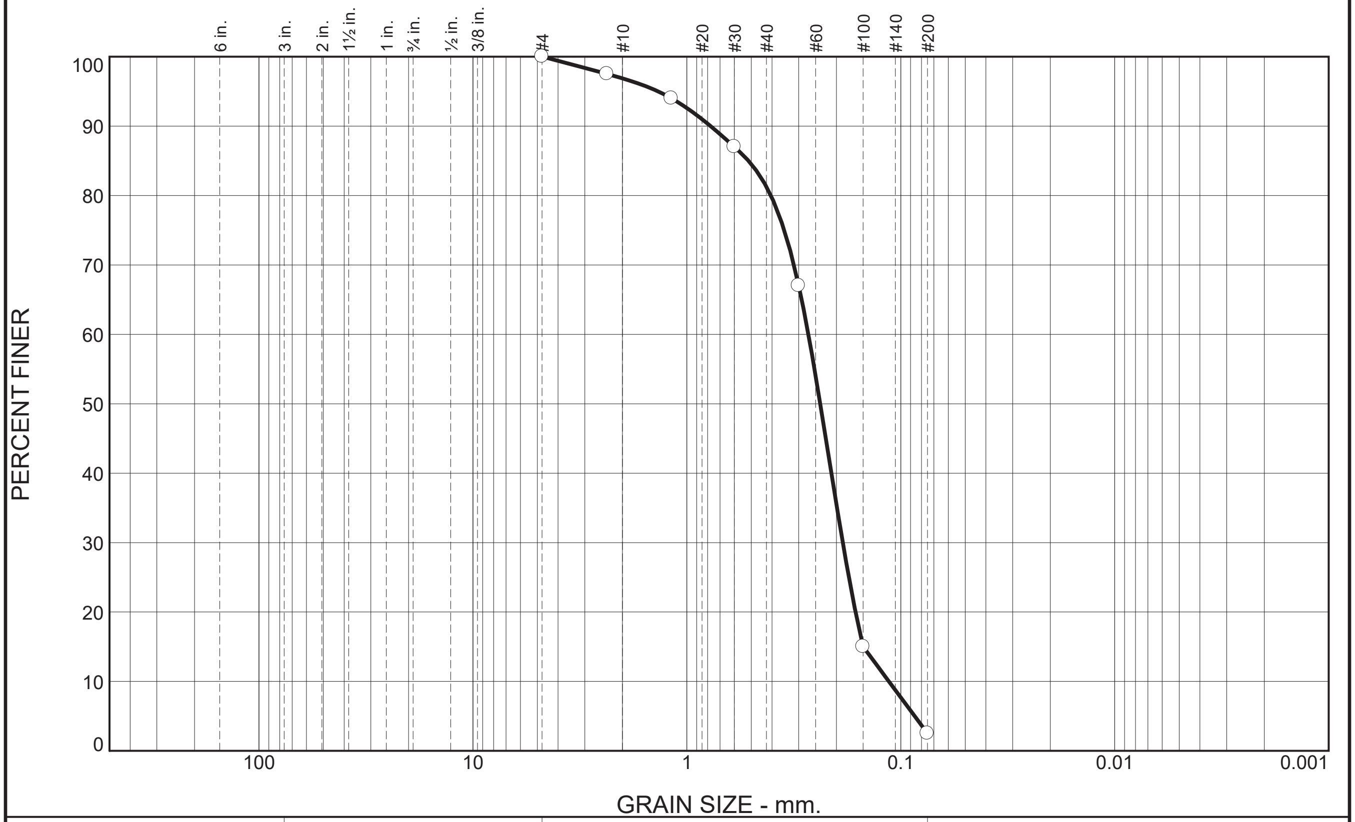
Date: 5/11/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing

Project No: SEAENG031 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	3.1	15.6	78.8	2.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	97.5		
#16	94.0		
#30	87.0		
#50	67.0		
#100	15.0		
#200	2.5		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.7753 D_{85}= 0.5154 D_{60}= 0.2705
D_{50}= 0.2380 D_{30}= 0.1868 D_{15}= 0.1500
D_{10}= 0.1137 C_u= 2.38 C_c= 1.13

Classification

USCS= SP AASHTO=

Remarks

Location: Halekulani 1.1 Bottom
Sample Number: 83037 10

Date: 5/11/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing
Project No: SEAENG031 **Figure**

LOCATION: **HALEKULANI CHANNEL, OAHU, HAWAII**
CORE: **Halekulani 2.2**
EASTING: 1695299.2
NORTHING: 36284.4
RECOVERED: 3/20/2017
LENGTH: 84 inches
DEPTH: 86 feet

LITHOLOGIC DESCRIPTION

SAND; calcareous; heterogeneous; fine to medium grain; consolidated; high compaction; well-sorted; trace amounts of terrigenous material; 5-10% shell hash, Halimeda, and coralline algae; downward darkening; downward coarsening.

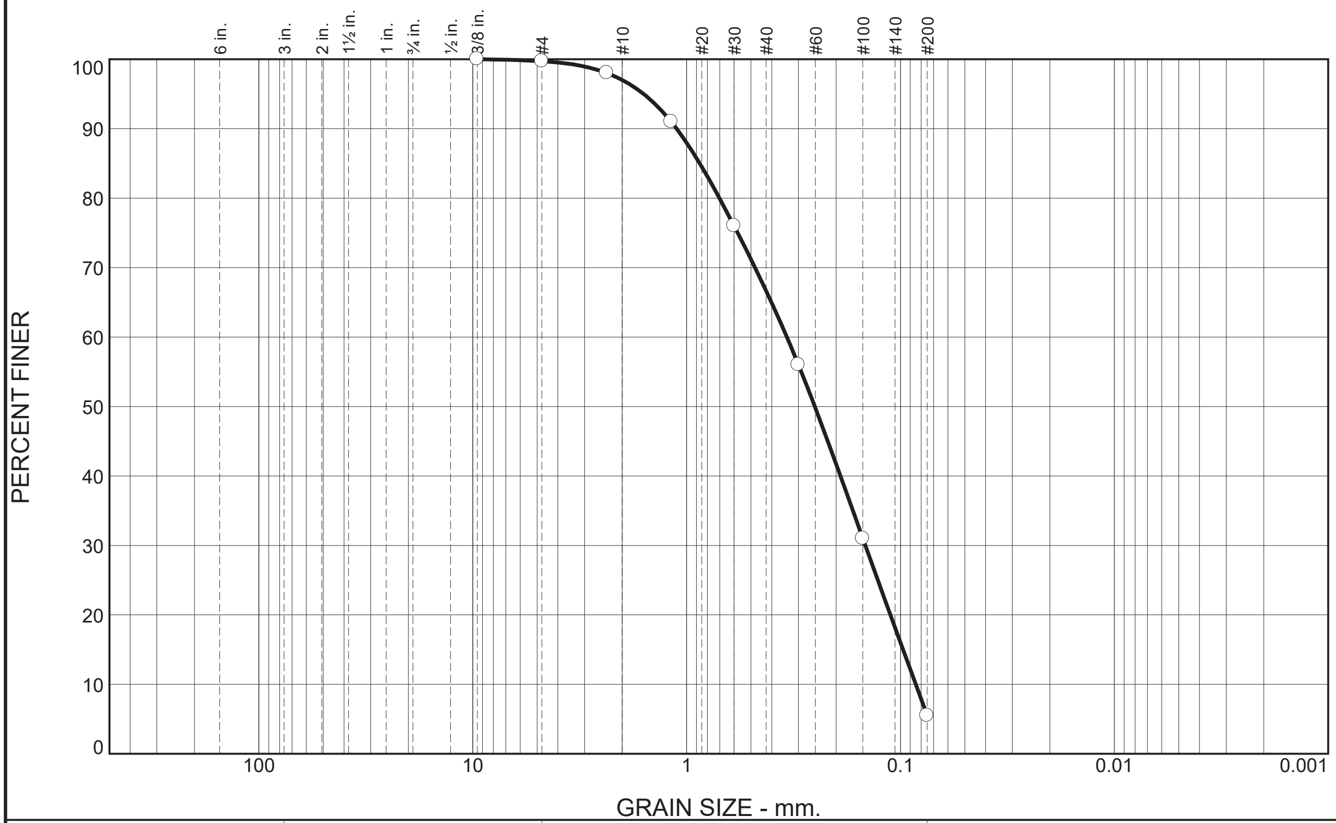
- **0 – 5 in:** SAND; calcareous; fine grain; very light tan color; well-sorted; subangular; low sphericity; 5-10% shell hash and coralline algae.

- **5 – 56 in:** SAND; calcareous; fine to medium grain; light tan to grayish color; well-sorted; subangular; low sphericity; 5-10% shell hash and coralline algae; 3” diameter coral cobble at 29”.

- **56 – 74 in:** SAND; calcareous; medium grain; medium-gray color; moderately well-sorted; subangular; low sphericity; mottled appearance with irregular seams of darker-gray material.

REPRESENTATIVE APPEARANCE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	3	30	61	6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#8	98		
#16	91		
#30	76		
#50	56		
#100	31		
#200	5.5		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 1.1132 D_{85}= 0.8683 D_{60}= 0.3399
D_{50}= 0.2516 D_{30}= 0.1460 D_{15}= 0.0972
D_{10}= 0.0848 C_u= 4.01 C_c= 0.74

Classification

USCS= SP-SM AASHTO= A-3

Remarks

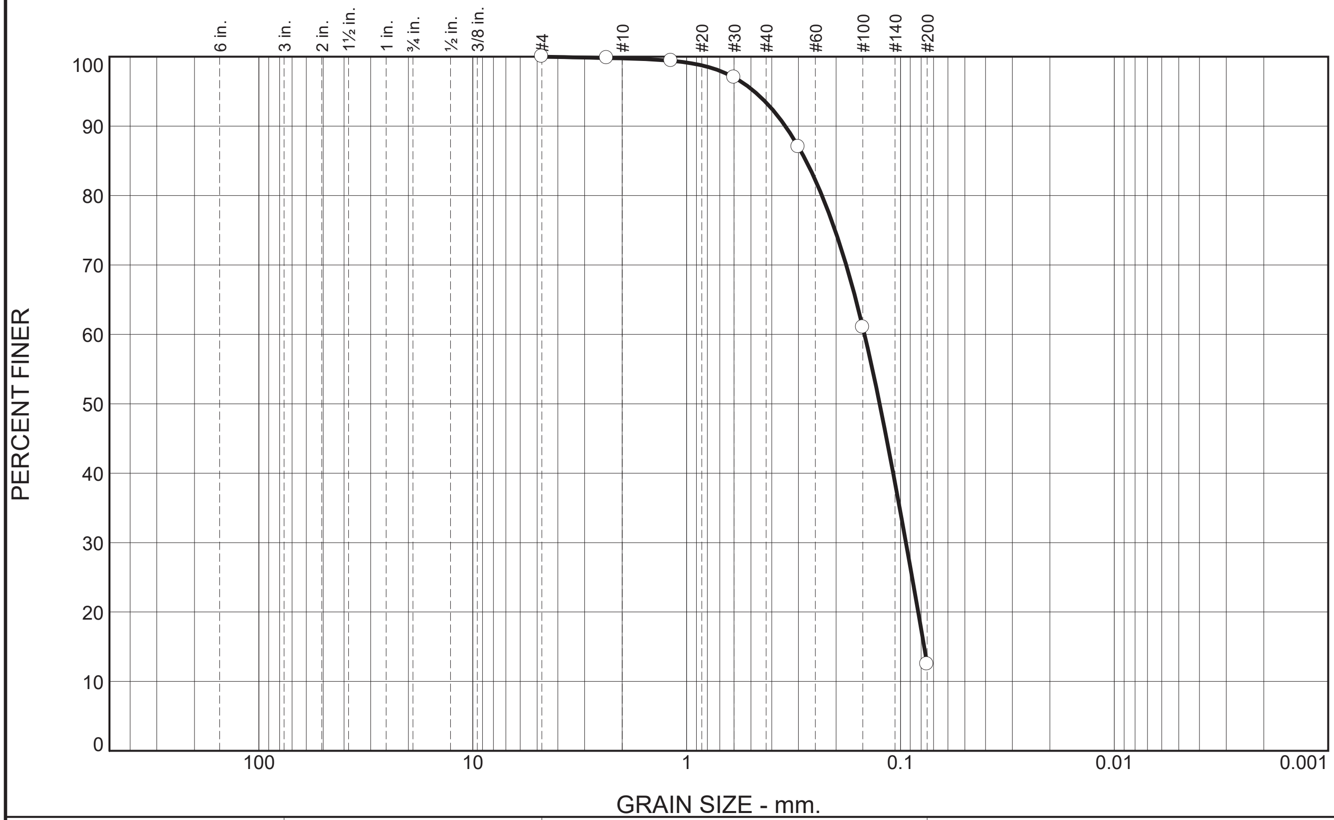
Location: Halekulani 1.2
Sample Number: 83756 11

Date: 6/15/17

CONSTRUCTION
ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification
Project No: SEAENG030 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	6.4	80.9	12.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.8		
#16	99.4		
#30	97.0		
#50	87.0		
#100	61.0		
#200	12.5		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3457 D_{85}= 0.2765 D_{60}= 0.1473
D_{50}= 0.1251 D_{30}= 0.0943 D_{15}= 0.0775
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

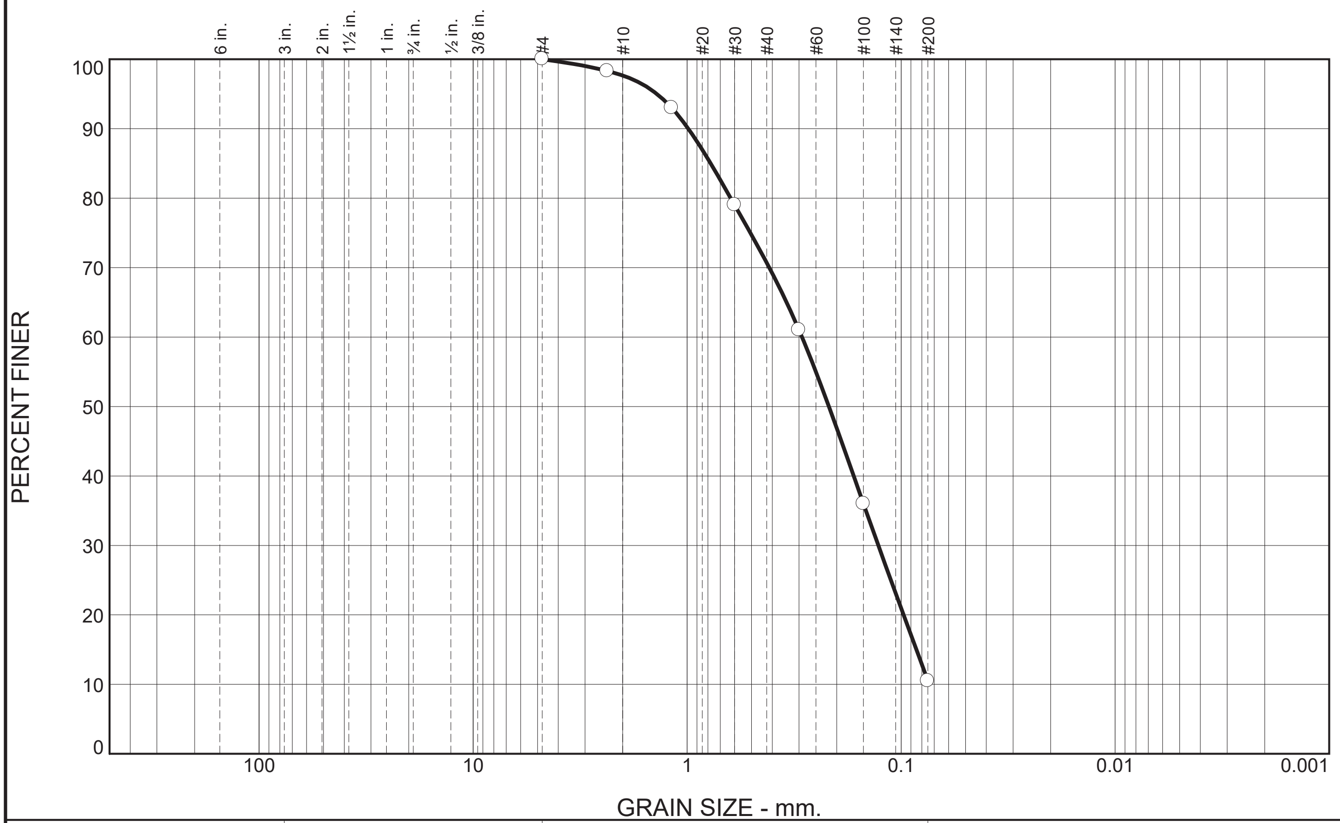
Location: Halekulani 2.2 Top
Sample Number: 83037 11

Date: 5/11/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing
Project No: SEAENG031 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	2.4	26.9	60.2	10.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	98.3		
#16	93.0		
#30	79.0		
#50	61.0		
#100	36.0		
#200	10.5		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.9872 D_{85}= 0.7767 D_{60}= 0.2906
D_{50}= 0.2176 D_{30}= 0.1278 D_{15}= 0.0849
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: Halekulani 2.2 Bottom
Sample Number: 83037 12
Date: 5/11/17

CONSTRUCTION
ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing

Project No: SEAENG031 **Figure**

LOCATION:	**WAIKIKI, OAHU, HAWAII**
CORE:	**Waikiki 1.1**
EASTING:	1698355.9
NORTHING:	38492.7
RECOVERED:	3/20/2017
LENGTH:	64 inches
DEPTH:	9 feet

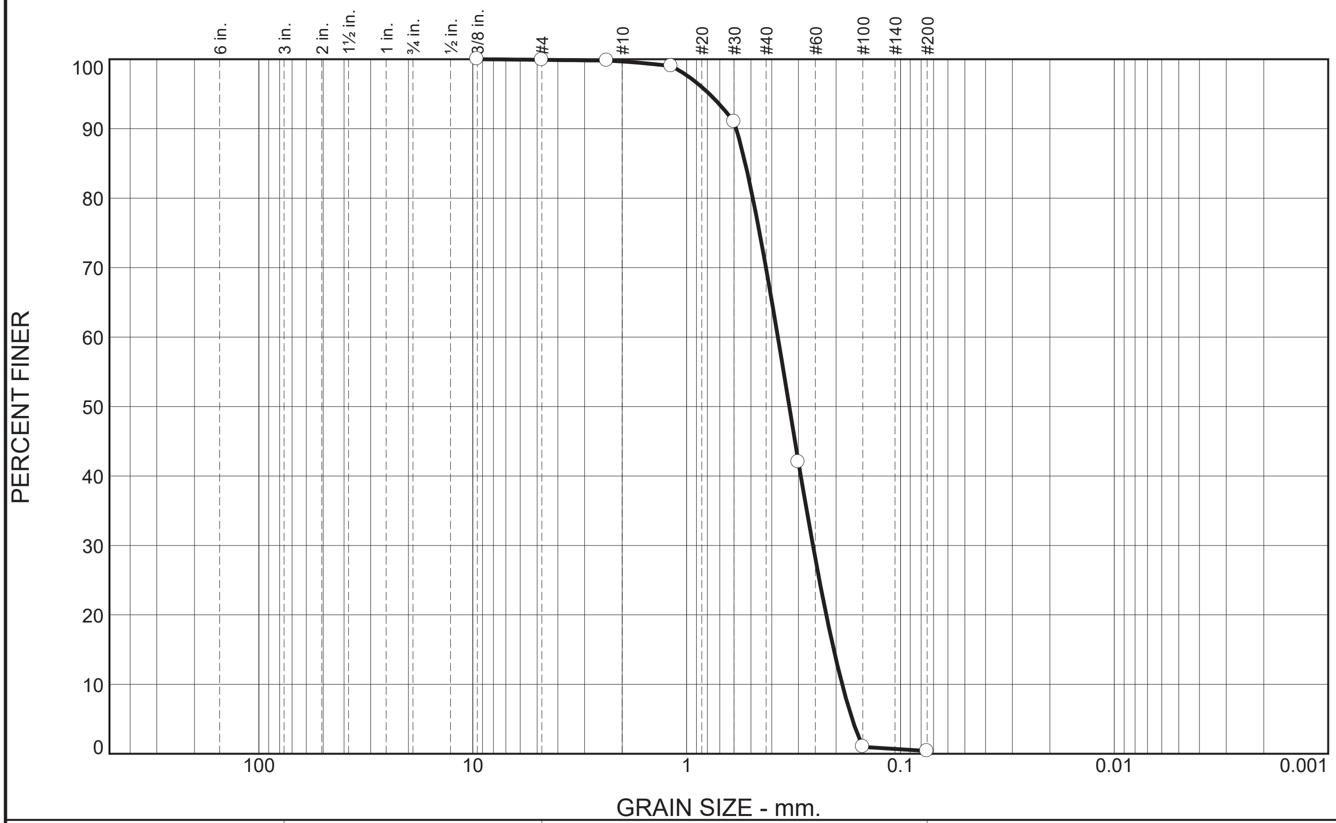
LITHOLOGIC DESCRIPTION

SAND; calcareous; heterogeneous; fine to medium grain; unconsolidated; well-sorted; trace amounts of terrigenous material; uniform composition/color throughout entire core; downward darkening; no downward coarsening; appears to be beach quality sand.

- **0 – 6 in:** SAND; calcareous; fine to medium grain; tan color; well-sorted; rounded; low sphericity; 0-5% Halimeda; lighter-tan sand in upper 6”.
- **6 – 51 in:** SAND; calcareous; fine to medium grain; medium-gray color; well-sorted; rounded; low sphericity; 0-5% Halimeda; 1” diameter coral cobbles at 19”.
- **51 – 62 in:** SAND; calcareous; fine-medium; darkish-gray color; well-sorted; rounded; low sphericity; darkest in bottom 12”.

REPRESENTATIVE APPEARANCE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	30	70	0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#8	100		
#16	99		
#30	91		
#50	42		
#100	1		
#200	0.4		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.5864 D_{85}= 0.5318 D_{60}= 0.3745
D_{50}= 0.3312 D_{30}= 0.2567 D_{15}= 0.2051
D_{10}= 0.1874 C_u= 2.00 C_c= 0.94

Classification

USCS= SP AASHTO=

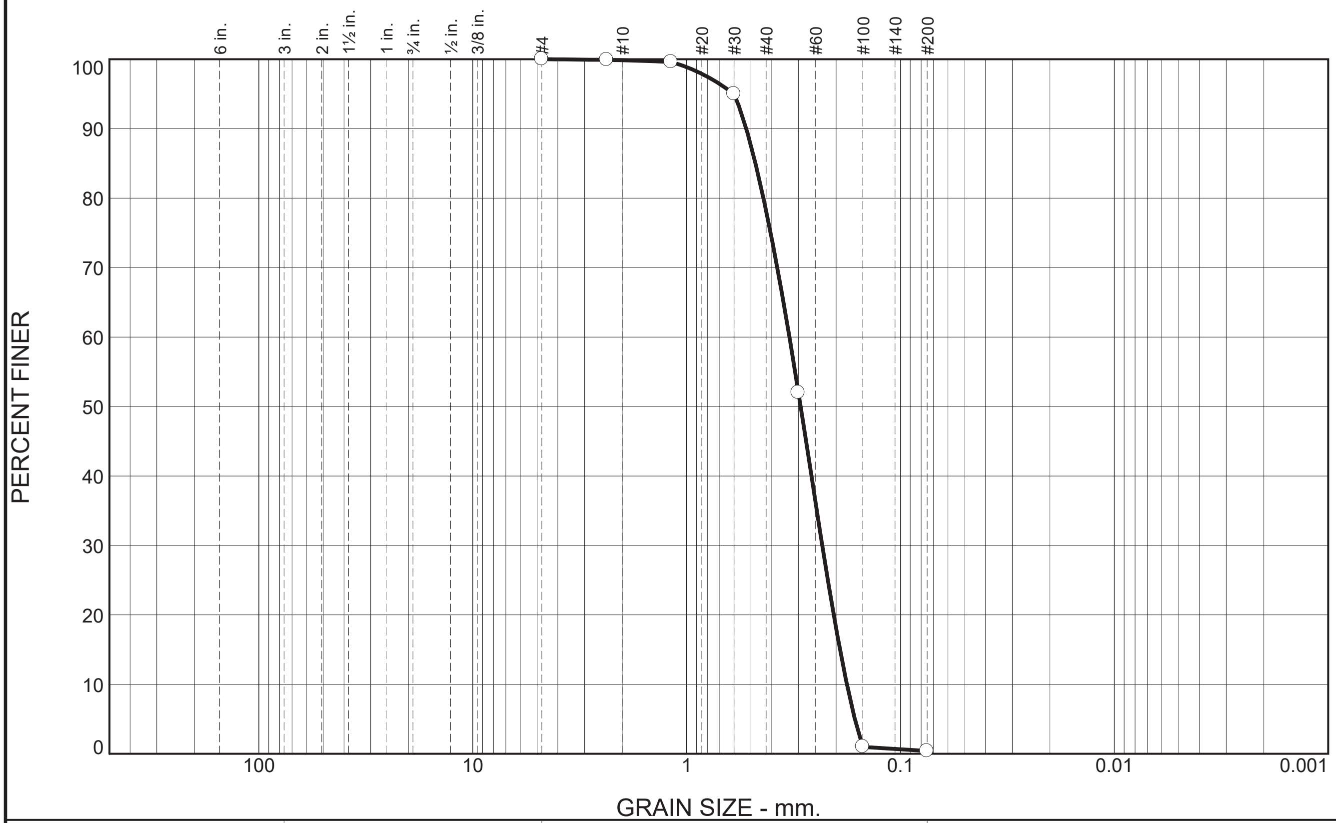
Remarks

Location: Waikiki 1.1
Sample Number: 83756 1
Date: 6/15/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification
Project No: SEAENG030 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	21.6	77.8	0.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.9		
#16	99.6		
#30	95.0		
#50	52.0		
#100	1.0		
#200	0.4		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.5265 D_{85}= 0.4764 D_{60}= 0.3307
D_{50}= 0.2930 D_{30}= 0.2321 D_{15}= 0.1918
D_{10}= 0.1782 C_u= 1.86 C_c= 0.91

Classification

USCS= SP AASHTO=

Remarks

Location: Waikiki 1.1 Top
Sample Number: 83037 1

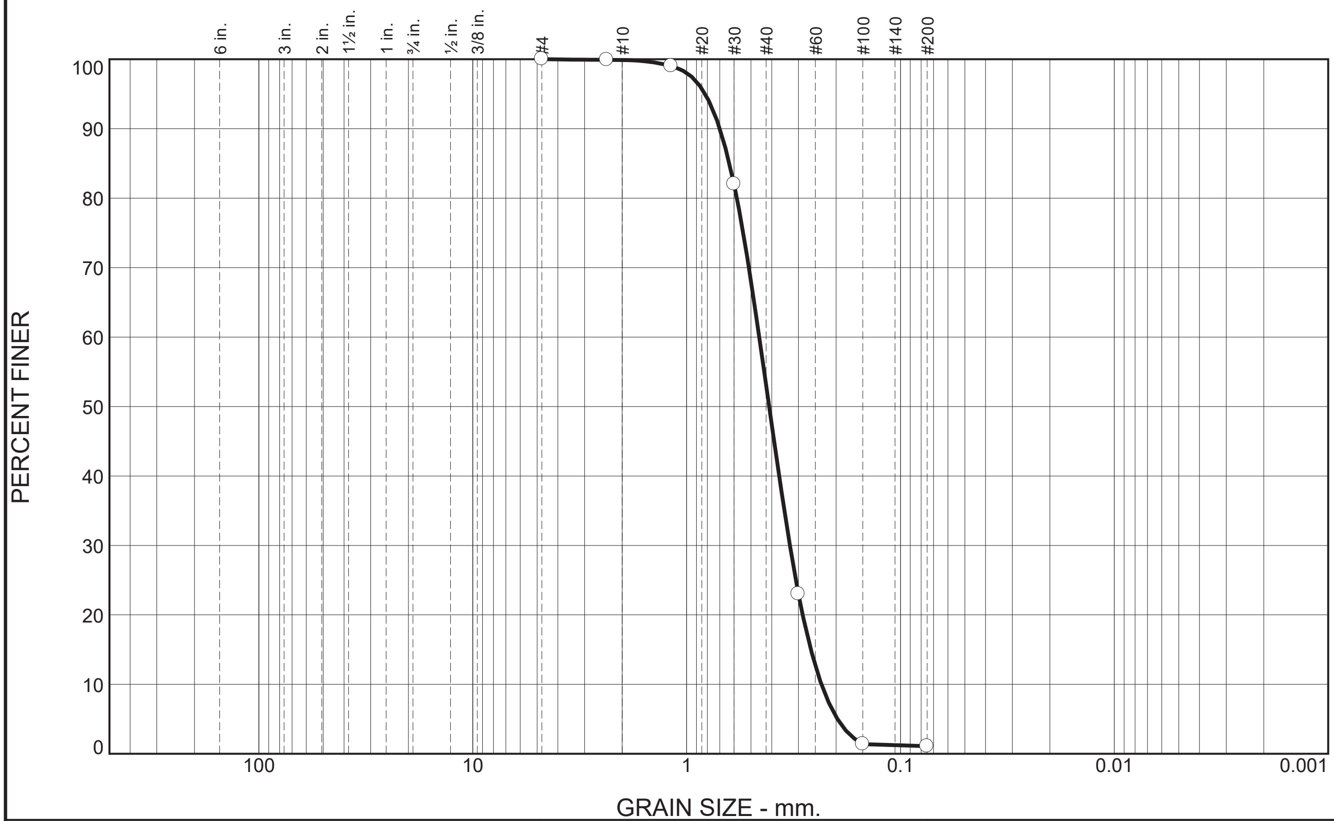
Date: 5/9/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing

Project No: SEAENG031 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	46.8	52.0	1.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.9		
#16	99.0		
#30	82.0		
#50	23.0		
#100	1.4		
#200	1.1		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6996 D_{85}= 0.6308 D_{60}= 0.4574
D_{50}= 0.4111 D_{30}= 0.3290 D_{15}= 0.2625
D_{10}= 0.2342 C_u= 1.95 C_c= 1.01

Classification

USCS= SP AASHTO=

Remarks

Location: Waikiki 1.1 Bottom
Sample Number: 83037 2
Date: 5/9/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing
Project No: SEAENG031 **Figure**

LOCATION: WAIKIKI, OAHU, HAWAII
CORE: Waikiki 2.1
EASTING: 1698916.4
NORTHING: 38422.1
RECOVERED: 3/20/2017
LENGTH: 52 inches
DEPTH: 13 feet

LITHOLOGIC DESCRIPTION

SAND; calcareous; heterogeneous; fine to medium grain; unconsolidated; well-sorted; trace amounts of terrigenous material; uniform composition/color throughout entire core; downward darkening; downward coarsening; appears to be beach quality sand.

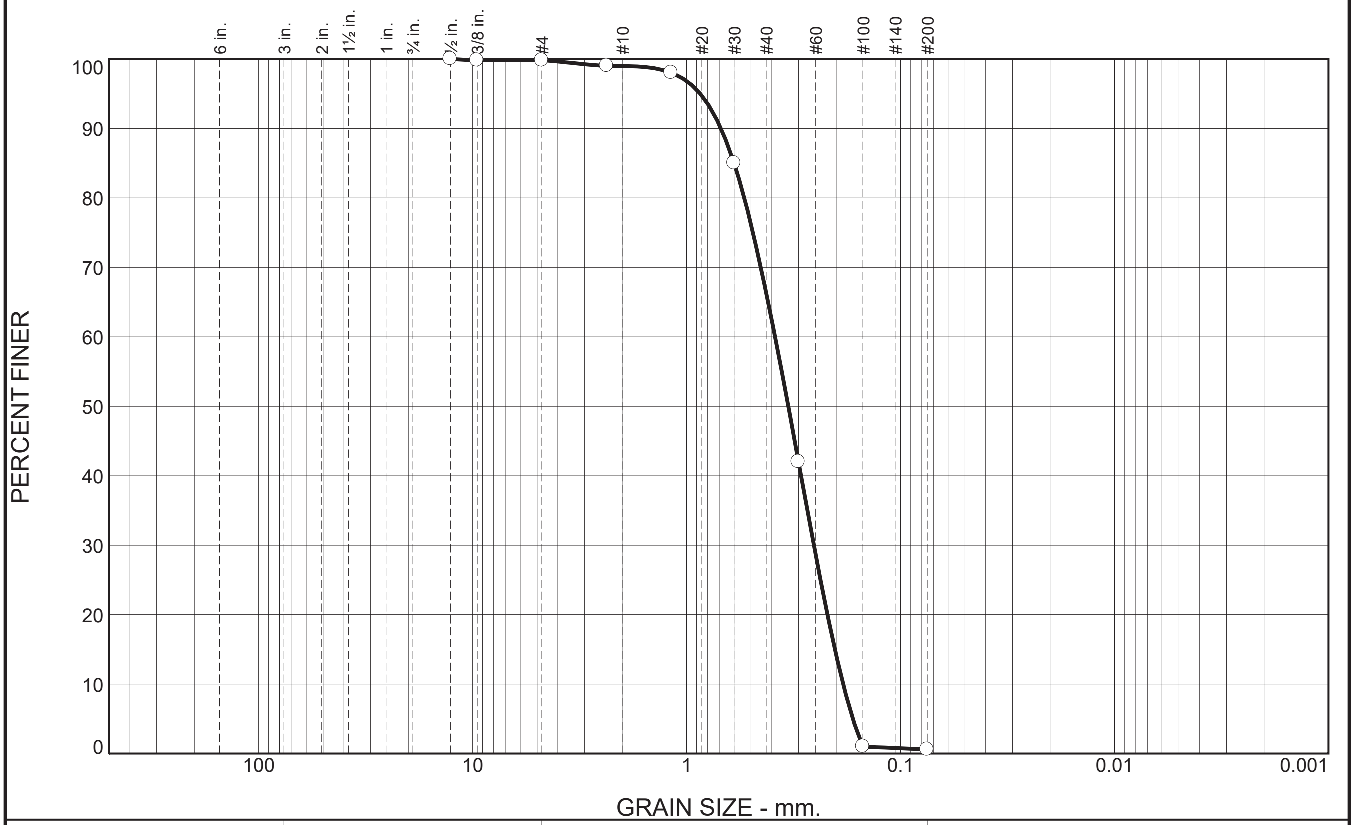
- **0 – 7 in:** SAND; calcareous; fine to medium grain; light-tan color; well-sorted; rounded; low sphericity; 0-5% shell hash, Halimeda, and coralline algae; lighter-tan sand in upper 7”.

- **7 – 37 in:** SAND; calcareous; fine to medium grain; light tannish-gray color; well-sorted; moderately rounded; low sphericity; 0-5% Halimeda; 1” diameter coral cobbles at 19”.

- **37 – 52 in:** SAND; calcareous; medium grain; darkish-gray color; well-sorted; angular; low sphericity; intact shell material; 10-15% coralline algae.

REPRESENTATIVE APPEARANCE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	33	65	1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100		
3/8"	100		
#4	100		
#8	99		
#16	98		
#30	85		
#50	42		
#100	1		
#200	0.6		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL=
LL=
PI=

Coefficients

D_{90}= 0.6913
D_{85}= 0.6000
D_{60}= 0.3861
D_{50}= 0.3349
D_{30}= 0.2542
D_{15}= 0.2028
D_{10}= 0.1856
C_u= 2.08
C_c= 0.90

Classification

USCS= SP
AASHTO=

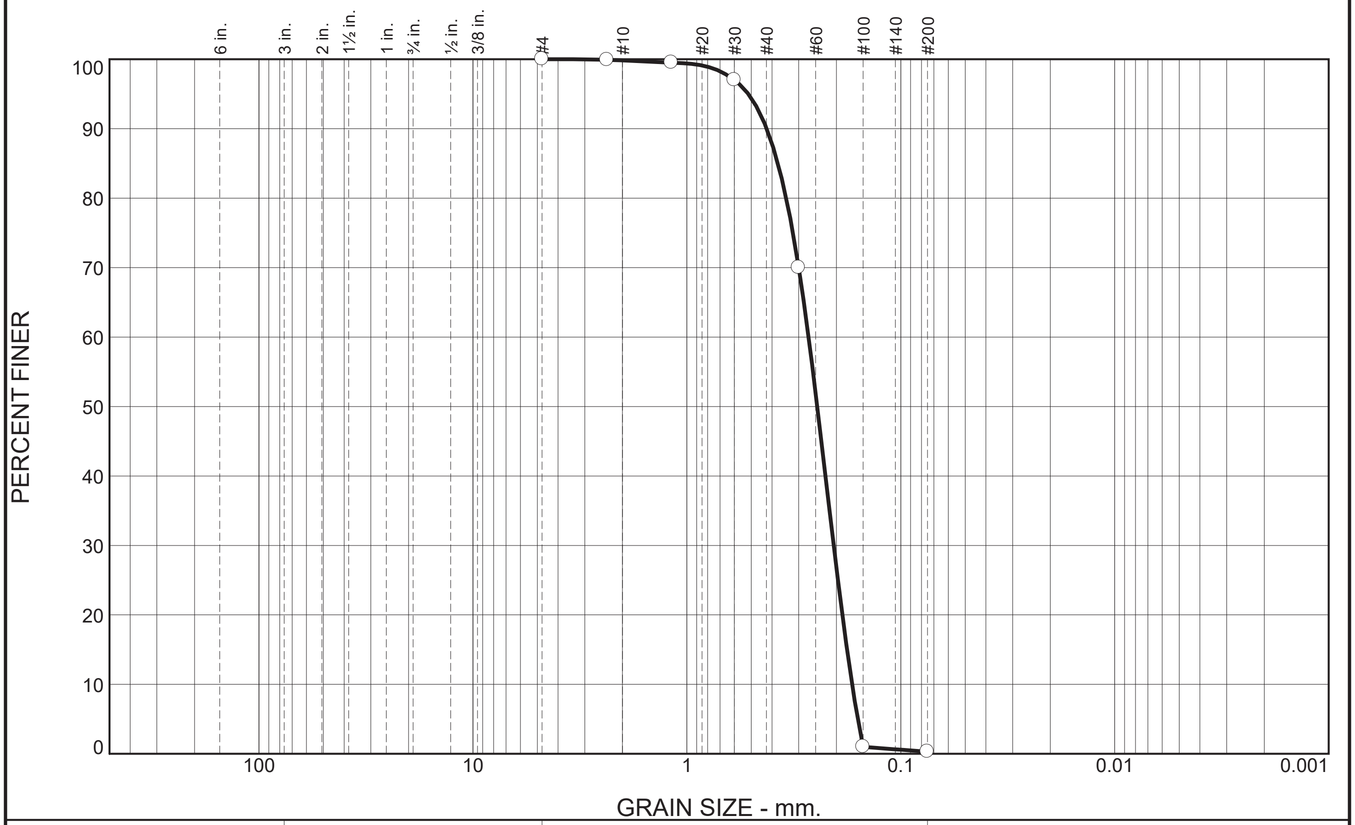
Remarks

Location: Waikiki 2.1
Sample Number: 83756 2
Date: 6/15/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: Material Qualification
Project No: SEAENG030
Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	9.7	89.8	0.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.9		
#16	99.5		
#30	97.0		
#50	70.0		
#100	1.0		
#200	0.3		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4235 D_{85}= 0.3756 D_{60}= 0.2700
D_{50}= 0.2459 D_{30}= 0.2059 D_{15}= 0.1785
D_{10}= 0.1691 C_u= 1.60 C_c= 0.93

Classification

USCS= SP AASHTO=

Remarks

Location: Waikiki 2.1 Top
Sample Number: 83037 3

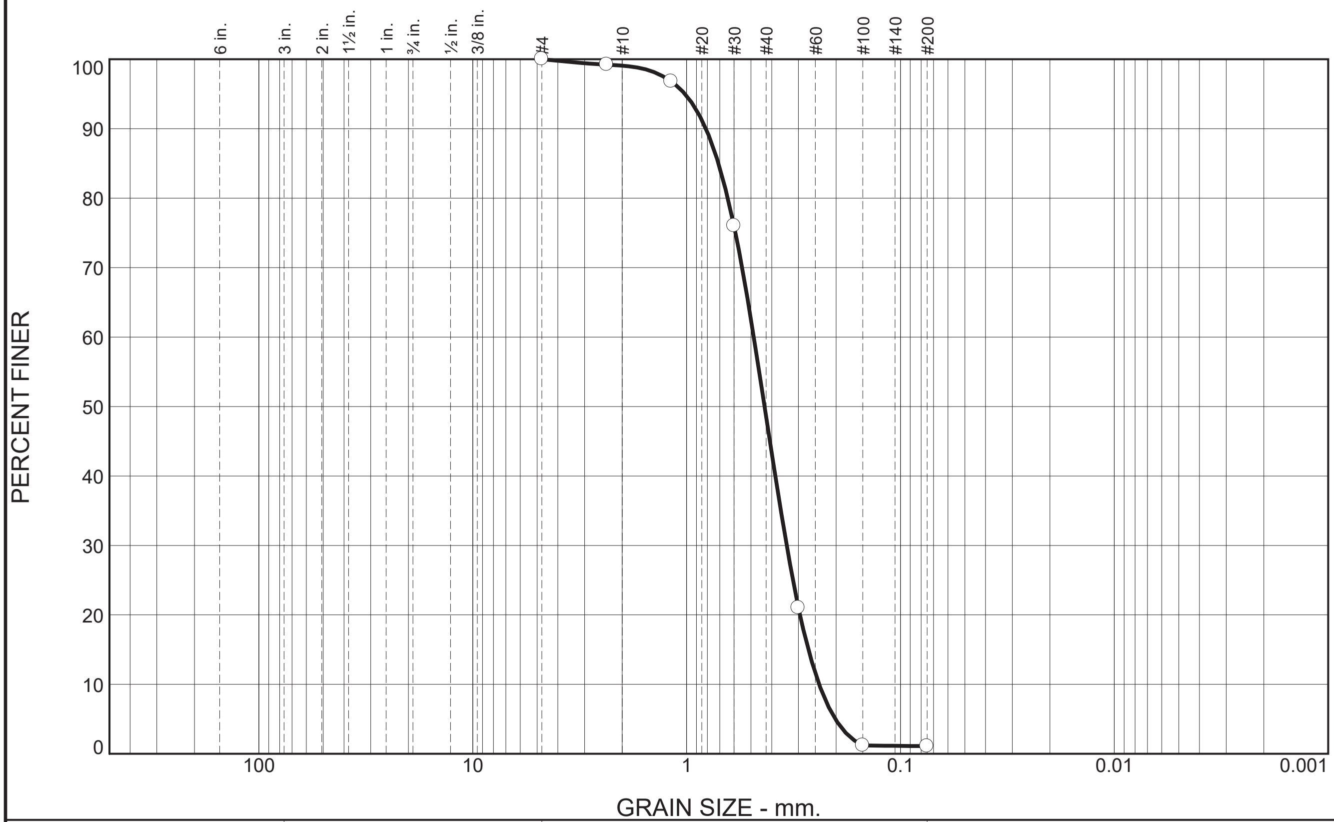
Date: 5/9/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing

Project No: SEAENG031 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.9	50.5	47.5	1.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.2		
#16	96.8		
#30	76.0		
#50	21.0		
#100	1.2		
#200	1.1		

* (no specification provided)

Material Description

Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.8127 D_{85}= 0.7098 D_{60}= 0.4853
D_{50}= 0.4320 D_{30}= 0.3406 D_{15}= 0.2697
D_{10}= 0.2401 C_u= 2.02 C_c= 1.00

Classification

USCS= SP AASHTO=

Remarks

Location: Waikiki 2.1 Bottom
Sample Number: 83037 4

Date: 5/9/17

CONSTRUCTION ENGINEERING LABS, INC.
Pearl City, Hawaii

Client: Sea Engineering, Inc.
Project: 25548 Sand Testing
Project No: SEAENG031 **Figure**

25. APPENDIX C: BASELINE MARINE BIOLOGICAL ASSESSMENT

AECOS No. 1662B

Marine biological resources off Waikīkī Beach, Oʻahu

Prepared by:

AECOS, Inc.
45-939 Kamehameha Hwy, Suite 104
Kāneʻohe, Hawaiʻi 96744-3221

April 8, 2021
Revised May 18, 2021

Marine biological resources off Waikīkī Beach, Oʻahu[1]

April 8, 2021
Revised May 18, 2021

DRAFT

AECOS No. 1662B

Stacey Kilarski
AECOS, Inc.
45-939 Kamehameha Hwy, Suite 104
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[1] Report prepared for Sea Engineering, Inc. to become part of the public record.

Introduction

Waikīkī Beach extends along the shoreline of Māmala Bay on the south shore of the island of Oʻahu, Hawaiʻi (Figure 1). The beaches of Waikīkī are chronically eroding, and the backshore is frequently flooded, particularly during high tides and high surf events. As the beaches continue to erode, a process that will accelerate as sea level continues to rise, the shoreline will migrate further landward. The Hawaiʻi Department of Land and Natural Resources (HDLNR) proposes beach improvement and maintenance projects in the Fort DeRussy, Halekūlani, Royal Hawaiian, and Kūhiō Beach sectors of Waikīkī ("Project"). Included is the construction of new beach stabilization structures and the recovery of offshore sand for placement on the shore. Objectives of the proposed actions are to restore and improve Waikīkī's public beaches, increase beach stability through improvement and maintenance of shoreline structures, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise. An Environmental Impact Statement (EIS) is being prepared for the Project, and *AECOS* was contracted to conduct marine surveys of the waters adjacent to the Project location to support the EIS development. Our surveys were undertaken in February and March, 2021. In March, 2021, we prepared an interim summary report. This full report supplements that summary report and presents details of our findings.

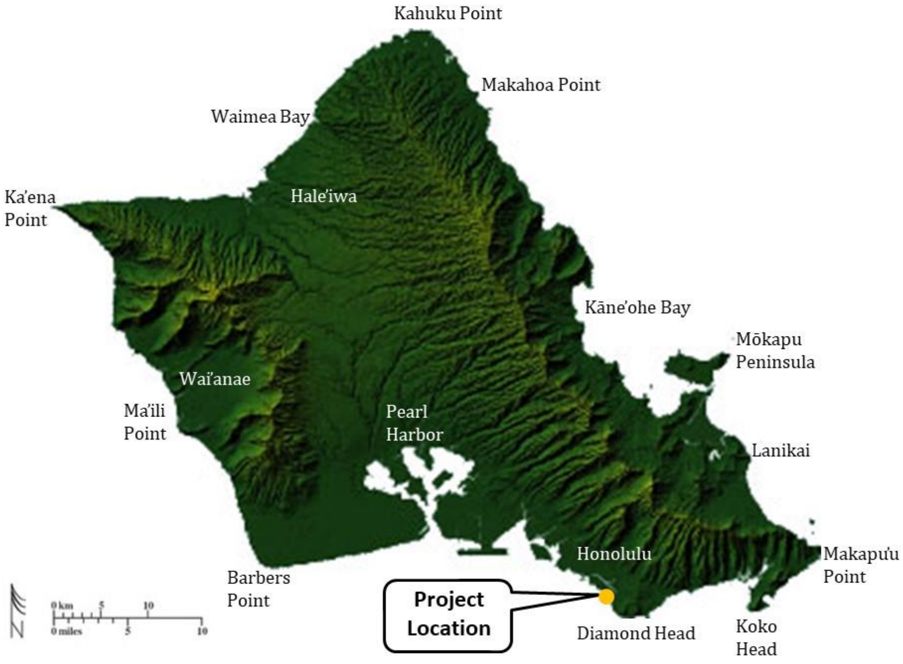

Figure 1. Waikīkī Project area.

Project description

The beaches of Waikīkī are composed primarily of imported sand and the existing shoreline configuration is mostly the result of previous projects to widen and stabilize the beach. Almost the entire length of Waikīkī is armored by seawalls, many of which are in various states of disrepair. In recent years, exceptional spring tides (now referred to as king tides) have exacerbated erosion and flooding in Waikīkī. Project improvement and maintenance actions encompass four beach sectors in Waikīkī' (Figures 2 through 6):

1. *Fort DeRussy Beach – beach maintenance*
   The proposed action for the Fort DeRussy Beach sector is to move sand from an accretion area at the west end of the beach to an eroding area at the east end, relocating approximately 917 cubic meters (1,200 cubic yards) of sand and widening the beach by an average of 3 m (10 ft).

2. *Halekūlani Beach – beach nourishment with stabilizing groins*
   The Halekulani Beach sector spans approximately 442 m (1,450 ft) of shoreline extending from the Fort DeRussy outfall groin east to the Royal Hawaiian groin. The proposed action for the Halekulani Beach sector is to construct a new beach with new stabilizing groins and produce a wide, stable beach with approximately 46,000 cubic meters (60,000 cubic yards) of sand fill.

3. *Royal Hawaiian Beach – beach nourishment and maintenance*
   The Royal Hawaiian Beach sector spans approximately 527 m (1,730 ft) of shoreline extending from the Royal Hawaiian groin east to the ʻEwa groin at Kūhiō Beach Park. The proposed action for the Royal Hawaiian Beach sector is to conduct periodic beach nourishment to maintain the beach by recovering sand from deposits located directly offshore and placing it on the beach.

4. *Kūhiō Beach – beach nourishment, breakwater and beach maintenance*
   The Kūhiō Beach sector spans approximately 457 m (1,500 ft) of shoreline extending from the ʻEwa groin at Kūhiō Beach Park east to the Kapahulu storm drain. The proposed actions for the Kūhiō Beach sector are divided into actions for the ʻEwa basin and the Diamond Head basin. The improvements to the ʻEwa basin would involve removing portions of the existing breakwater, construction of a new groin and segmented breakwater system, and placement of sand fill to increase beach width. The proposed action in the Diamond Head basin would consist of beach maintenance with no modifications to existing structures.

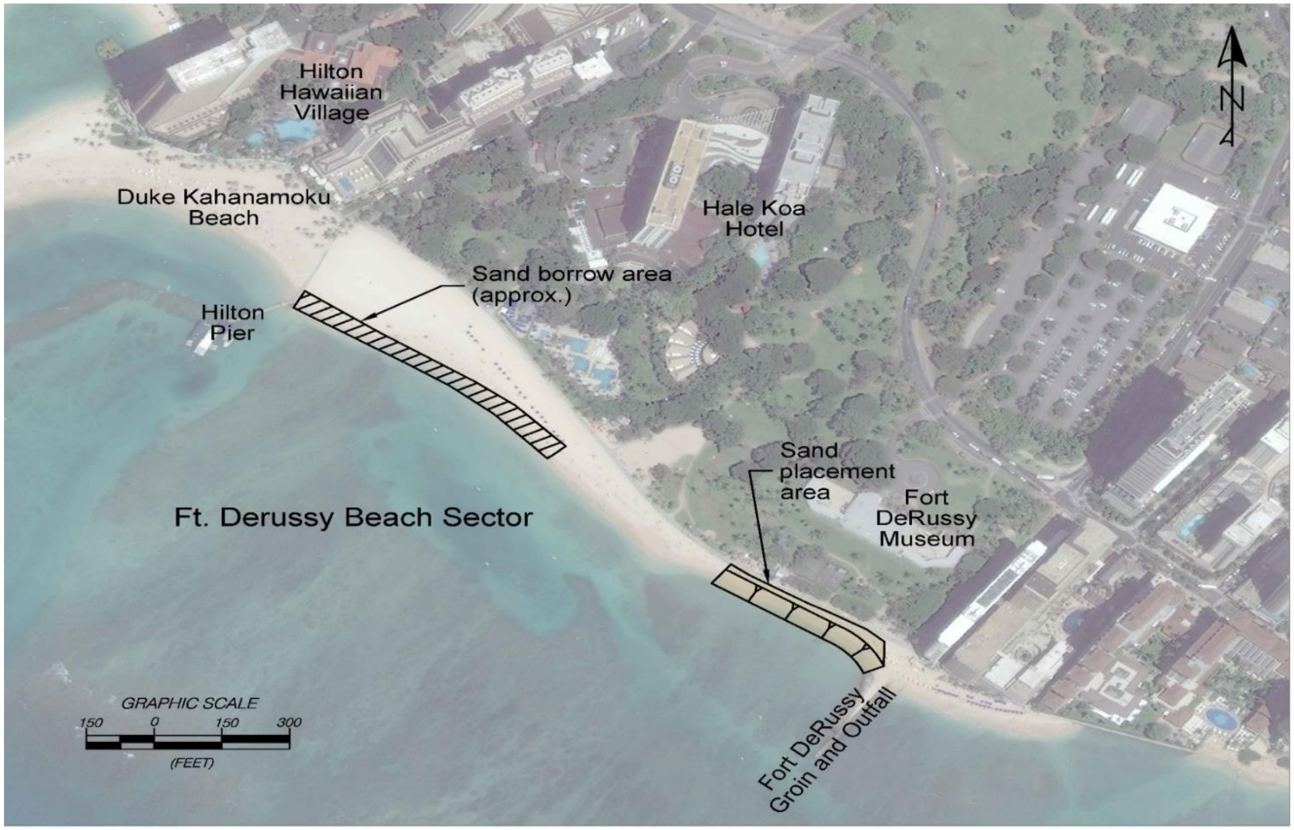

Figure 2. Ft. DeRussy Beach Sector conceptual design (SEI, 2021).

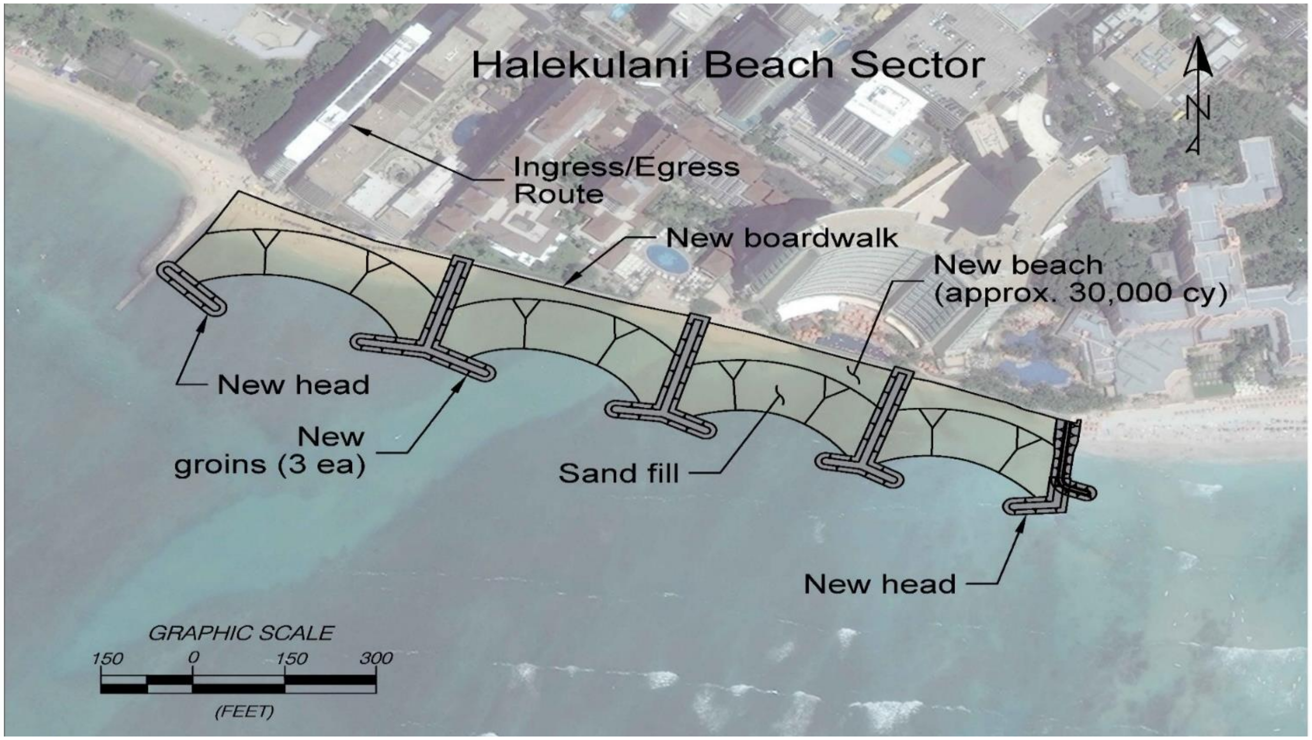

Figure 3. Halekūlani Sector conceptual design (SEI, 2021).

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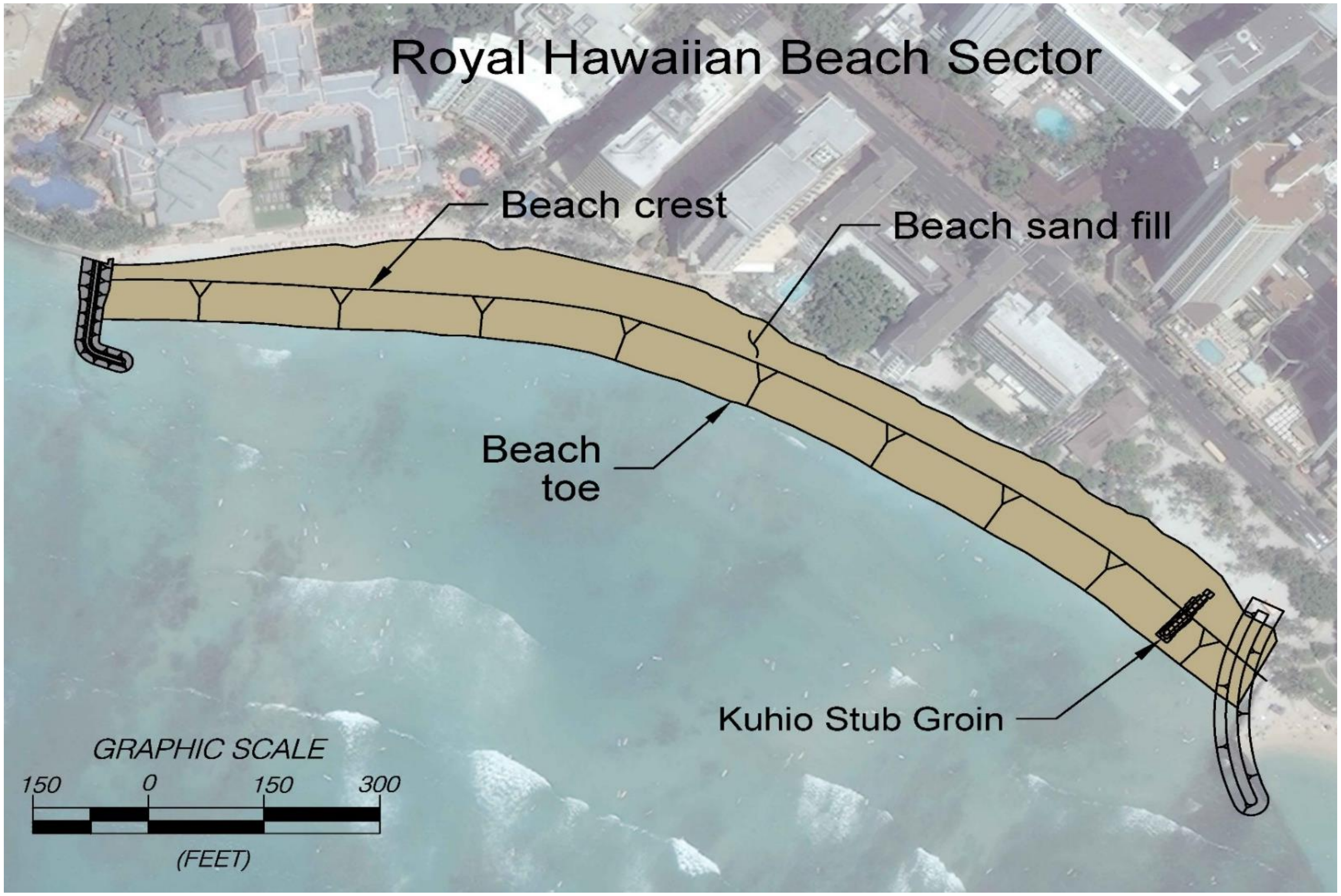

Figure 4. Royal Hawaiian Beach Sector conceptual design (SEI, 2021).

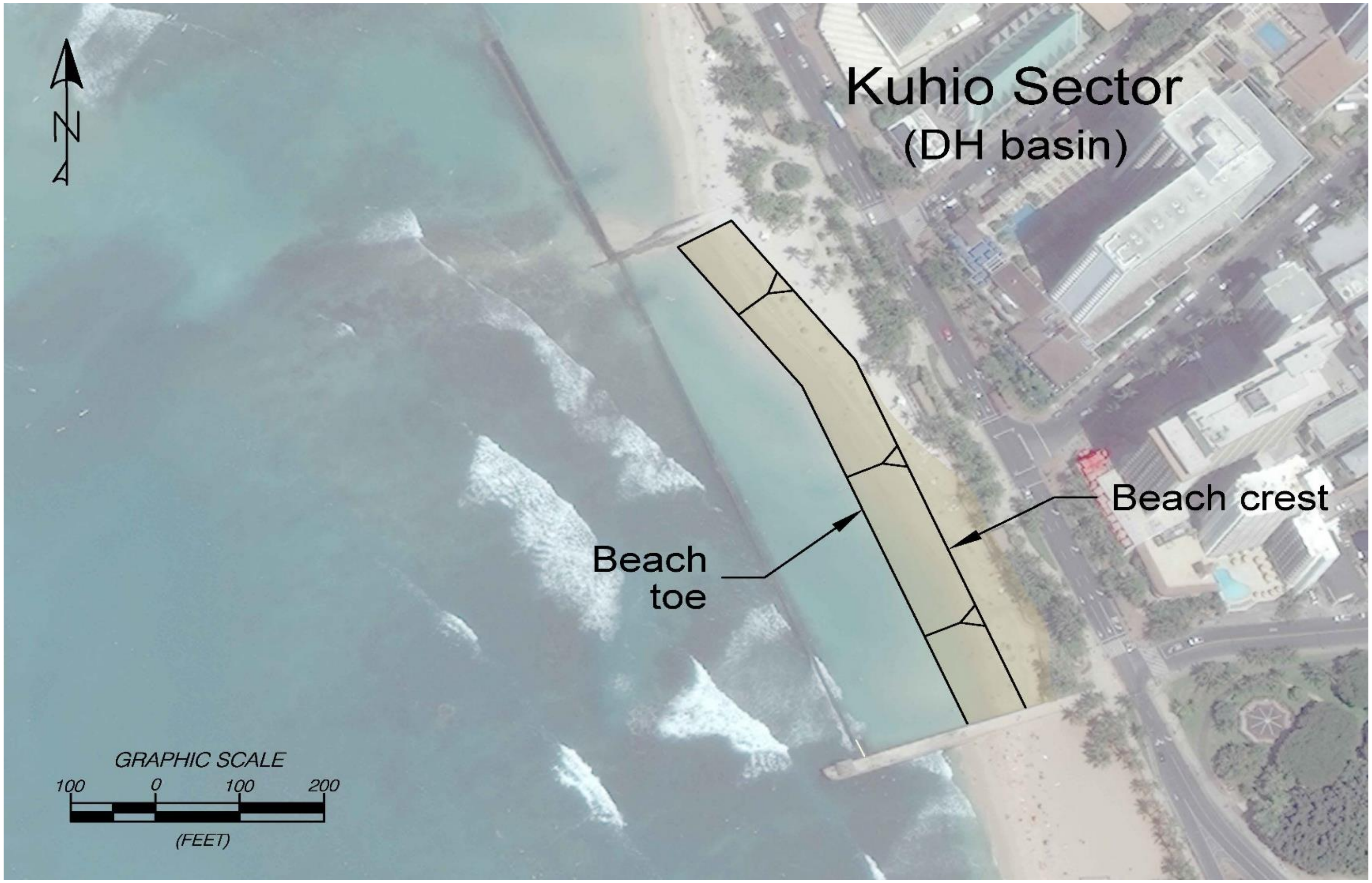

Figure 5. Kūhiō Sector (Diamond Head Basin) conceptual design (SEI, 2021).

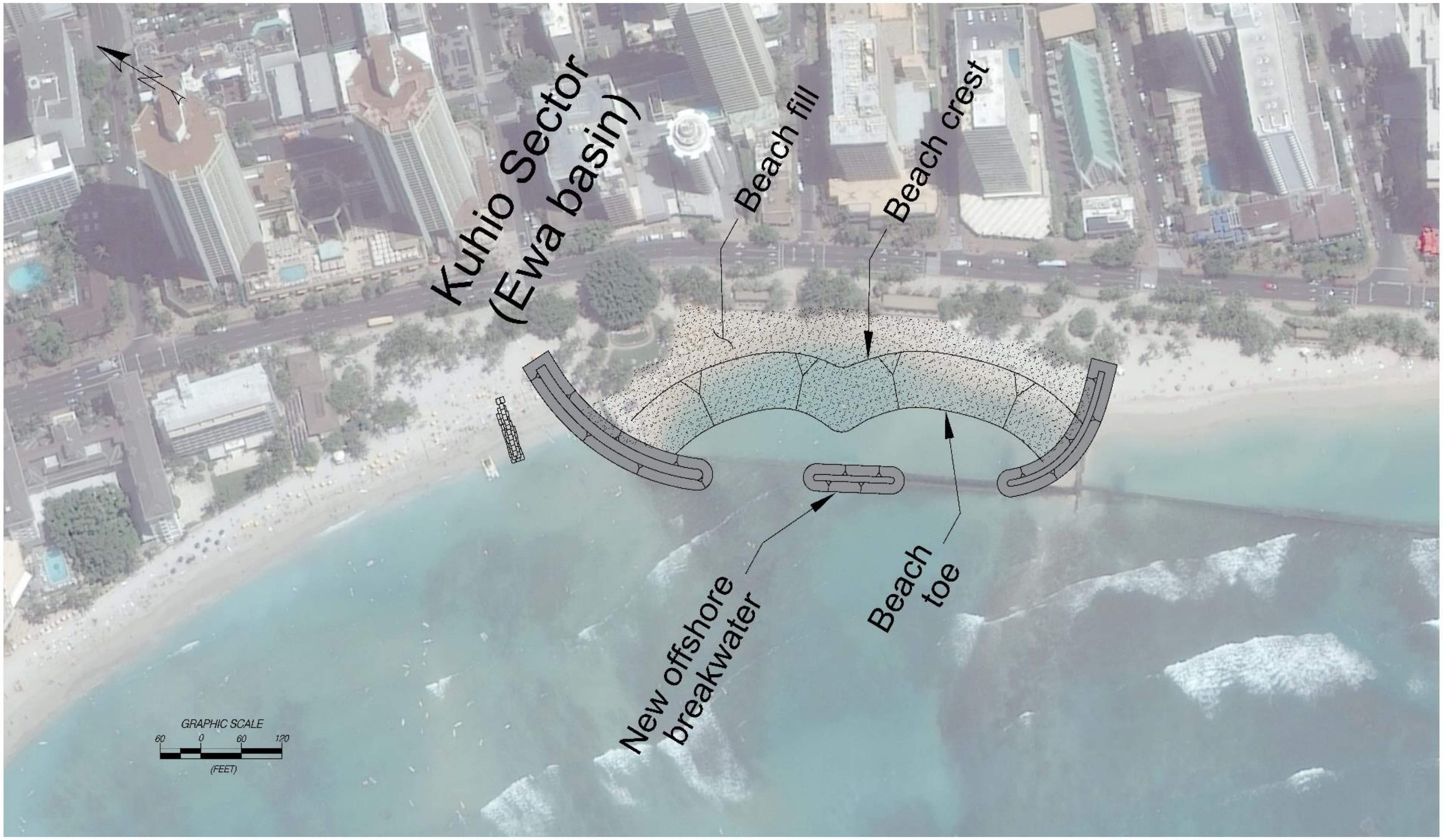

Figure 6. Kūhiō Sector (‘Ewa Basin) conceptual design (SEI, 2021).

Site Description

The fringing reef off Waikīkī is an eroded limestone platform influenced by sand suspension and scour caused by impinging waves. The areas of hard bottom are generally slightly raised above the sand plains and consist of heavily eroded biogenic limestone. Numerous dead and weathered coral colonies are attached to the limestone surfaces. Live coral colonies also occurred sporadically on the limestone platforms (MRC, 2021). The dominant benthic organisms on the reef platform off Waikīkī Beach are marine macro-algae or *limu*, which cover most exposed hard surfaces not scoured or buried by shifting sand. Nearshore algal cover is 75 to 100% (based on visual estimates), except in areas exposed to sand scour (such as channel margins and limestone outcrops in sand fields) where algae coverage is less than 25% of the hard bottom. The growth form of these algae is typically low-growing or turf-like.

Up to 87 different species of algae have been reported from the Waikīkī reef since 1969 (Doty, 1969; Chave et al., 1973; OI, 1991; Huisman et al., 2007; MRC, 2007; and *AECOS*, 2007, 2008, 2009, 2010). Table A is a checklist of algae observed on the reef off Waikīkī Beach from the most recent surveys (February and March 2021), and those observed previously in surveys off Waikīkī Beach (July 2009, May and June 2010) and Kūhiō Beach and Gray's Beach (*AECOS*, 2007, 2008, and 2009a). Although the flora of Waikīkī reef remains relatively diverse today, two invasive red algae (Rhodophyta): *Acanthophora spicifera* and *Gracilaria salicornia*, dominate the benthic flora (Smith et al., 2004; Huisman et al., 2007; MRC, 2007, 2021; *AECOS*, 2007a, 2008, 2009a).

Common macro-invertebrates observed in various surveys on the reef flat off Waikīkī include *Holothuria atra*, *H. nobilis*, *Echinothrix diadema*, *Tripneustes gratilla*, *Echinometra mathaei*, *Echinostrephus aciculatus*, and various sponges (OI, 1991); *E. matheai*, *E. aciculatus*, and *H. atra* (MRC, 2007, *AECOS*, 2007a, 2008, 2009a). Table B is a checklist of macro-invertebrates (other than coral) observed on the reef off Waikīkī Beach from the most recent survey (February and March 2021), and observed previously off Waikīkī Beach, Kūhiō Beach, and Gray's Beach (*AECOS*, 2007, 2008, 2009).

The most common (although total cover comprising less than one percent of the bottom) hermatypic corals found on the reef flat off Waikīkī Beach are *Pocillopora meandrina* and *Porites lobata* (OI, 1991; MRC, 2007, 2021; and *AECOS*, 2007, 2008, 2009). In addition, *Cyphastrea ocellina* (MRC, 2007, 2021; *AECOS,* 2007, 2008, 2009), *Montipora capitata*, *M. patula*, *P. evermanni*, *Psammocora stellata*, *Leptastrea purpurea* (*AECOS,* 2007, 2008, 2009), and *L. bewickensis* (2009 and 2010 surveys) have been recorded. Table C is a checklist of corals observed on the reef off Waikīkī Beach from the most recent survey and as observed previously (*AECOS*, 2007, 2008, 2009).

Distribution of fishes on the reef flat off Waikīkī is largely determined by local topography and bottom composition, Fishes are generally uncommon in keeping with the mostly low topography on this inner reef flat. Surveys off Waikīkī (MRC, 2007; *AECOS*, 2009) found the most common species to be wrasses (*Thalassoma duperrey*, *T. trilobatum*, *Stethojulis balteata*), *Acanthurus triostegus* (*manini*), and *Rhinecanthus rectangulus* (reef triggerfish). These surveys also found several species of small juvenile fishes inhabiting small holes and spaces in the reef structure. Table D is a check list of the 58 species observed on the reef off Waikīkī Beach from the most recent survey and as observed previously in surveys off Waikīkī Beach, Kūhiō Beach, and Gray's Beach (*AECOS*, 2007, 2008, 2009).

The nearshore waters of Māmala Bay off Waikīkī are designated as Class A coastal, marine waters in Hawaiʻi water quality standards (HDOH, 2014). It is the objective of Class A waters that their use for recreational purposes and aesthetic enjoyment be protected. Other uses are permitted so long as they are compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation. Class A waters are not to act as receiving waters for any discharge which has not received the best treatment or control practicable.

Waters in the Project area are included on the HDOH 2020 list of impaired waters in Hawaiʻi—prepared under Clean Water Act §303(d) (HDOH, 2020)—for nitrate+nitrite, ammonia, turbidity, and chlorophyll α. These nearshore waters are listed as a "Category 2" water body, meaning some uses are attained; in this case, total nitrogen, total phosphorus, and *Entercocci* bacteria. The Project area is also listed as a "Category 5" water body, meaning that "[a]vailable data and/or information indicate that at least one or more designated use is not being supported or is threatened, and a Total Maximum Daily Load Study (TMDL) is needed. The TMDL has been assigned a priority of low.

Methods

On February 18, 19 and March 4, 2021, *AECOS* biologists conducted surveys to inventory marine assemblages in the nearshore waters off the Project. Biologists used snorkel gear to collect data on bottom type, coral colony size-frequency (size, diversity, new recruits, large colonies, health); diversity, dentification and categorization (common vs. uncommon) of algae (including crustose coralline algae) and seagrass; and non-coral macro-invertebrates greater than 3 cm.

Survey Areas and Transect Placement

The baseline biological survey collected data in each of the Project sectors[2]: (1) Fort DeRussy; (2) Halekūlani; (3) Royal Hawaiian; and (4) Kūhiō Sector (ʻEwa Basin), shown in Figure 7.

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[2] At the time of our surveys, sand renourishment was occurring in the Kūhiō Sector (Diamond Head basin), and biologists could not enter the sector due to construction.

<u>Fort DeRussy Sector</u> — Biologists surveyed the sand placement area of the Fort DeRussy Beach Sector. The survey consisted of a qualitative, reconnaissance snorkeling survey between the Fort DeRussy groin and the west end of the sand placement area, and out to approximately 25 m from the shoreline.

<u>Halekūlani Sector</u> — Six survey stations were established at the each of the potential groins and groin heads. One additional station was placed directly in front of the Halekūlani Hotel, traversing the sand channel. At the groin stations and Halekūlani station, a 60-m transect was run perpendicular to the shore from the beach crest and terminating near the end of the future groin footprint. At the proposed head stations, a 20-m transect was run parallel to the beach. A survey of benthic composition and coral size class and abundance (as described below) was undertaken along each 60-m "groin" transect and 20-m "head" transect.

<u>Royal Hawaiian Beach Sector</u> — Biologists surveyed the Royal Hawaiian Beach Sector, conducting qualitative surveys of the seafloor. The qualitative survey extended east from the Royal Hawaiian groin to the Kūhiō crib wall, and approximately 20 m out from the shoreline.

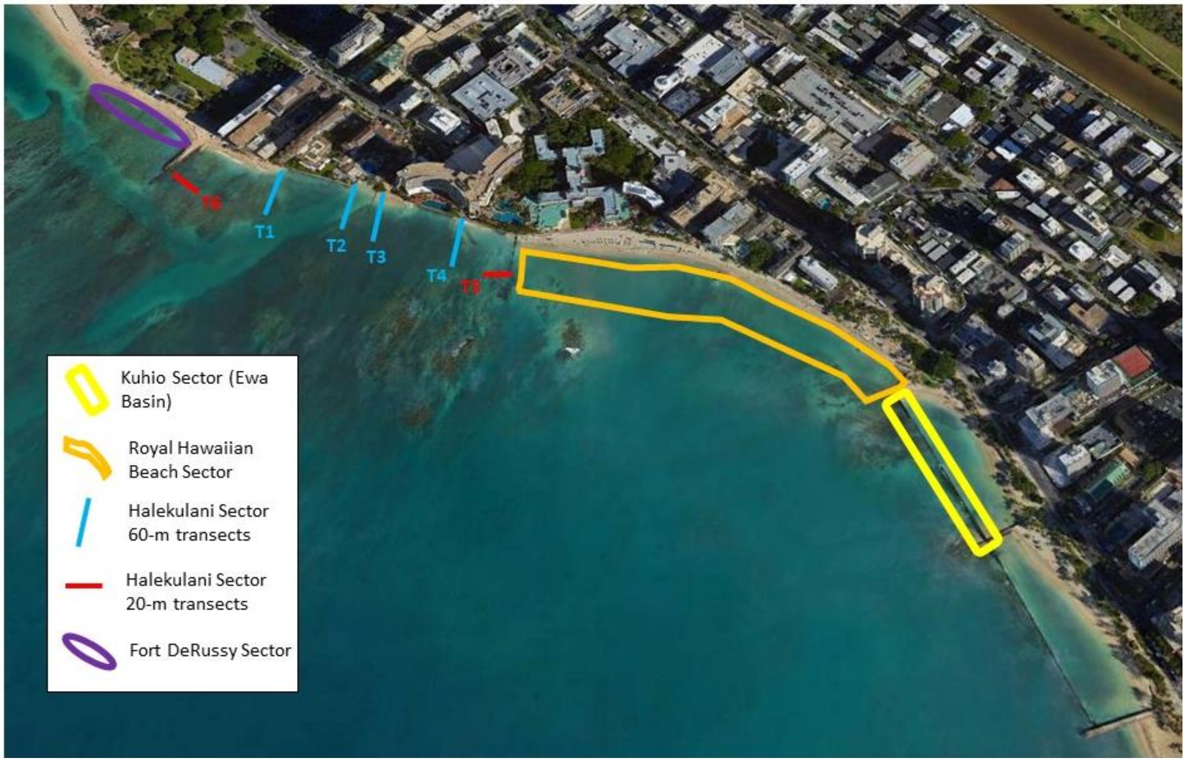

Figure 7. Location of survey areas.

<u>Kūhiō Sector (ʻEwa Basin)</u> — Biologists surveyed the entire existing breakwater structures and immediate surrounding basin floor for corals and other marine biota. A census of corals was made along the entirety of the existing groin.

Benthic Composition

The point intercept method (also termed a line-point intercept method) was used to assess benthic composition on each transect. This protocol uses meter marks on the transect line as sample points. At 0.5-m intervals, the nature of the bottom under each "point" is identified and assigned to one of the following categories: sand, rubble, limestone (rock or pavement), turf algae, crustose coralline algae (CCA), live coral, or macroinvertebrate. Benthic percent cover was calculated by dividing the total number of points for each category by the total number of points sampled times 100.

Coral Abundance and Size Class Distribution

A two-meter belt survey of coral colonies was conducted on each transect. All corals 1 m to either side of the transect line were counted. Coral abundance was determined as the number of individuals observed for each transect normalized to number of individuals per m^2. Coral heads were identified to species and assigned to a size class (1- to 5-cm; 6- to 10-cm; 11- to 20-cm; 21- to 40-cm; 41- to 80-cm; 81- to 160-cm; or >160-cm) based on the largest horizontal dimension of the colony. Coral size-class distribution was determined for each coral species recorded. Percent morbidity (amount of coral colony not alive) and any signs of disease were also recorded.

Results

Fort DeRussy Sector

The dominant substrate here is sand, with patches of rubble and limestone outcrops (Figure 8). Algal growth on the hard bottom was primarily *Padina* sp. and *A. spicifera*. One *Porites* sp. coral colony in the 6-10 cm size class was observed in this sector. Fishes were rare here and included threadfin butterflyfish (*Chaetodon Auriga*), Hawaiian sergeant (*Abudefduf abnominalis*), and spotted boxfish (*Ostracion meleagris*). Sand resuspension and shifting was visible.

Figure 8. At the Fort DeRussy Sector, sand and rubble make up the majority of the bottom type. Hardbottom areas host algal growth (*Padina* sp. and *A. spicifera*).

Halekūlani Sector

Figure 9 (above) displays representative photos of the Halekūlani Sector survey area. Two invasive red algae, *Acanthophora spicifera* and *Gracilaria salicornia* are abundant on the reef flat off the Halekūlani sector of Waikīkī Beach. In addition to these two invasive algal species, other common species include: *Dictyota* spp., *Neomeris* sp., *Codium edule*, *Padina australis*, *Tubinaria ornata*, and *Asparagopsos taxifolia*. Another invasive species, *Avrainvillea amadelpha*, is present. Sea urchins are the most conspicuous invertebrates on the reef flat, particularly *Echinometra mathaei*, which burrows into the limestone, and *Tripneustes gratilla*, which grazes open hard bottom areas. *Holothuria atra*, the black sea cucumber or *loli*, is the most common sea cucumber here. Scattered coral colonies (*Porites* spp. and *Pocillopora damicornis*) occur on the reef flat in the Halekūlani Sector.

Thalassoma duperrey (saddle wrasse) is the most common species on the reef flat in the Project area. *Acanthurus triostegus sandvicensis* (m*anini*) is also commonly seen in small schools feeding on benthic algae, and *Thalassoma trilobatum* (Christmas wrasse), *Stethojulis balteata* (belted wrasse), and *Rhinecanthus rectangulus* (reef triggerfish) are commonly seen solitarily scavenging for algae and benthic invertebrates. *Naso unicornis* (*kala*) and *Arothron hispidus* (*ʻoʻopu hue*) are encountered occasionally farther offshore

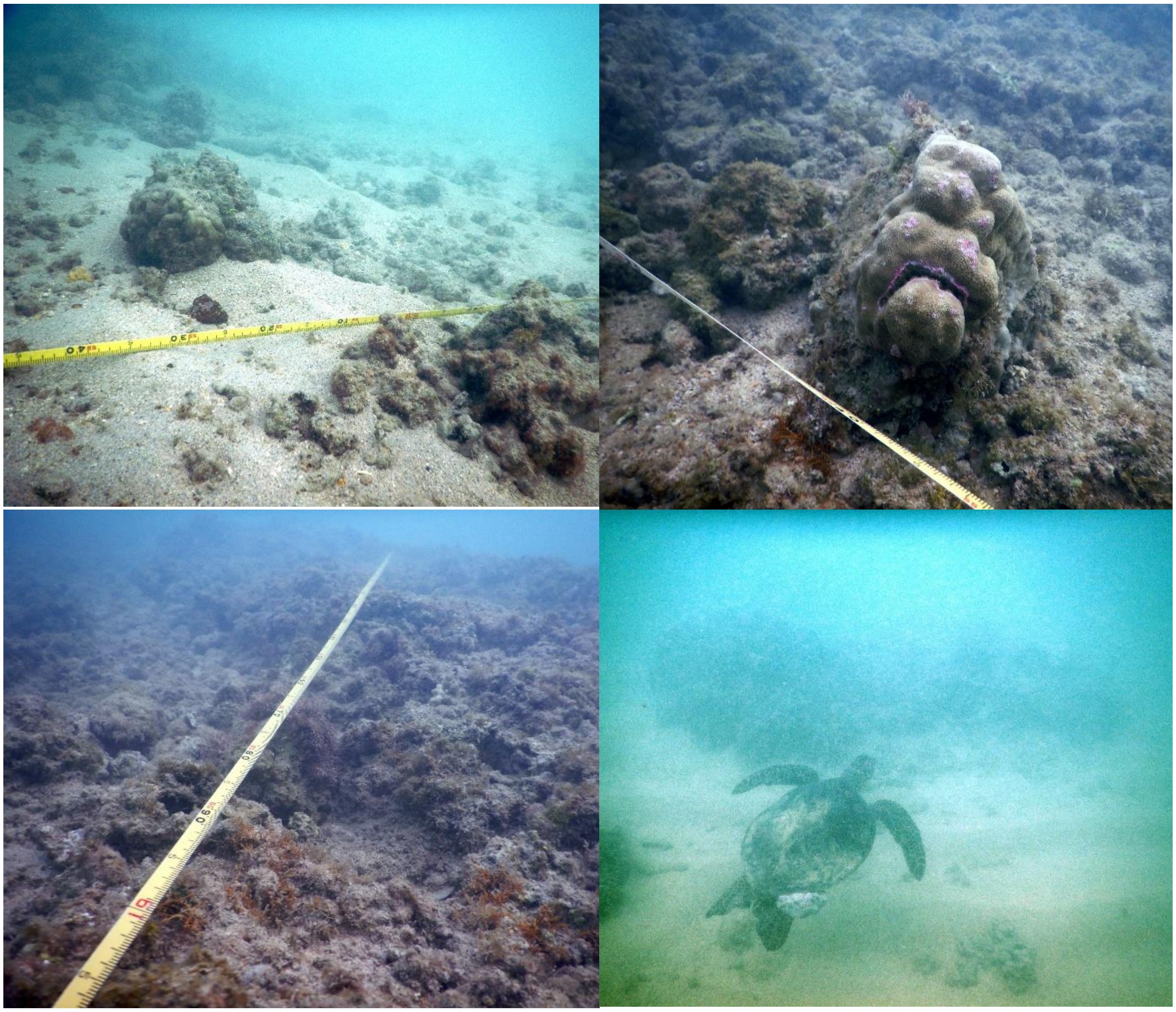

Figure 9. The dominant bottom types in the Halekulani Sector are sand and rubble (top left). Coral abundance is very low and coral distribution patchy; *Porites* sp. (top right) are uncommon. *Acanthophora spicifera* and *Gracilaria salicornia* are abundant on the reef flat (bottom left). One state- and federally-listed green sea turtle (*Chelonia mydas*) was observed (bottom right).

<u>Benthic Composition</u> - Four 60-m transects and two 25-m transects were used to assess the benthic community of the seafloor in the Halekūlani Sector area. The results of the point-intercept survey are presented in Figures 10 and 11. The dominant bottom type is rubble, at 24%, closely followed by sand and macroalgae, with similar covers at

23% and 19%, respectively. Live coral is low across the transects, at less than 1% of the total. The category "Other" accounts for basalt rock (boulders and seawall).

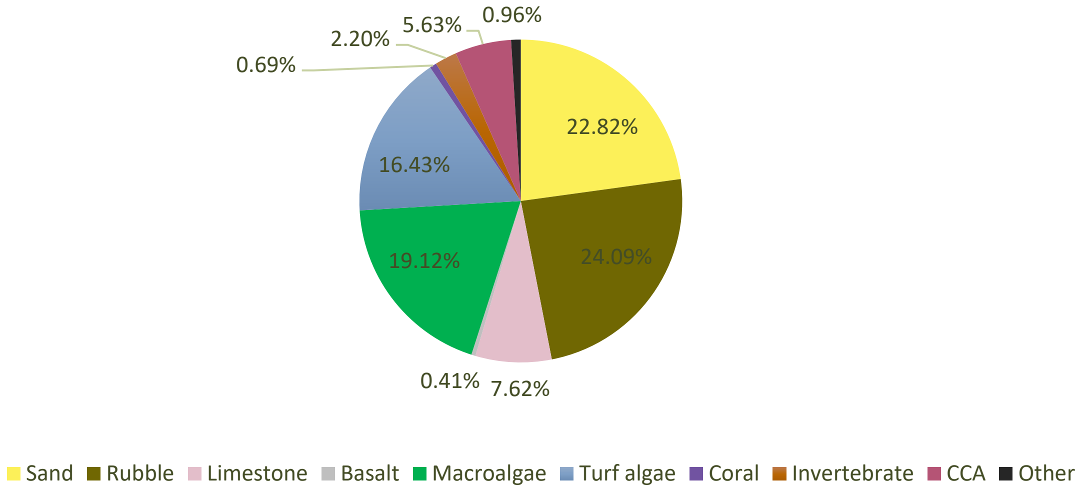

Figure 10. Percent benthic cover as measured using point-intercept along four 60-m transects and two 25-m transects in the Halekūlani Sector.

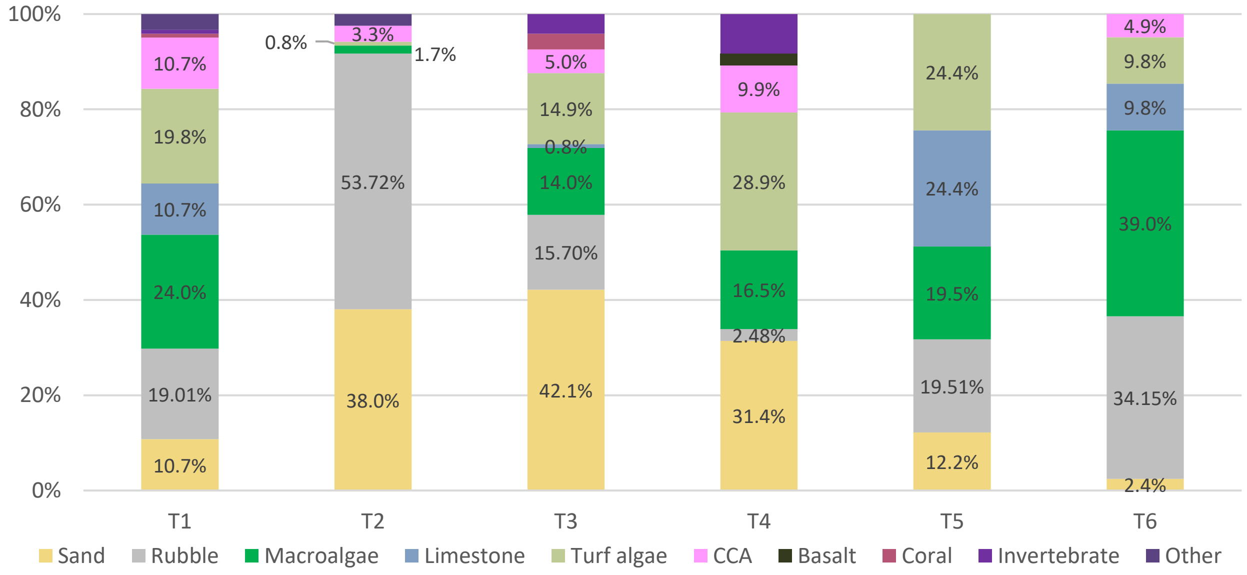

Figure 11. Percent benthic cover as measured using point-intercept along four 60-m transects (T1-T4) and two 25-m transects (T5 and T6).

Coral Abundance and Size Class Distribution - Coral abundance determined on each transect is presented in Table 1. A total of 28 colonies were counted on the six transects. Density of corals in the proposed groin and T-head footprints of the Halekūlani sector is low, with an average of 0.1 colony/m^2. Results of the coral size class survey are presented in Table 2 and Figure 12. A total of 28 coral colonies, representing at least three coral taxa (*Pocillopora damicornis*, *Porites compressa* and *Porites* sp.) were recorded. The most common species was *Porites* sp. at 57% of the total. The most common colony size was the 1- to 5-cm class (39% of the total). Large (41- to 80- cm) colonies were rare (one *Porites* sp. colony). No colonies greater than 80 cm was recorded.

Royal Hawaiian Beach Sector

The Royal Hawaiian Beach Sector is sand with occasional limestone outcrops with algae (*Acanthophora spicifera, Padina* sp., and patches of *Gracilaria salicornia*). Corals and seagrass are absent. Much of this area is intertidal or shallow subtidal marked by small, breaking waves most days of the year. Constant resuspension of sediments and sand scour is observed (MRC, 2021, *AECOS*, 2009). As such, biotic communities inhabiting this area are subjected to the effects of shifting sand. Because of these stresses, as well as limited solid substrate required for settlement, coral communities and seagrass do not occur in this sector, and are not expected to occur between the Royal Hawaiian Beach and the dredge site.

Table 1. Total number of coral colonies and coral colony abundance (mean colonies per m^2) counted on six transects.

Transect	**Survey area (m^2)**	**Coral count (colonies)**	**Coral abundance (no./m^2)**
1	60	4	0.1
2	60	2	0.0
3	60	14	0.2
4	60	2	0.0
5	20	1	0.1
6	20	5	0.3
Total	**280**	**28**	**0.1**

Table 2. Number of coral colonies in each size class by species from two nearshore transects (100 m^2 survey area).

	Size class (cm)							
Taxa	**1 to 5**	**6 to 10**	**11 to 20**	**21 to 40**	**41 to 80**	**81 to 160**	**Total**	***Percent of total***
Poc. damicornis	8	3	--	--	--	--	11	***39.3%***
P. compressa	--	--	1	--	--	--	1	***3.6%***
Porites sp.	3	4	3	5	1	--	16	***57.1%***
Total count	**11**	**7**	**4**	**5**	**1**	--	28	
Percent of total	*39.3%*	*25.0%*	*14.3%*	*17.9%*	*3.6%*	*0%*		

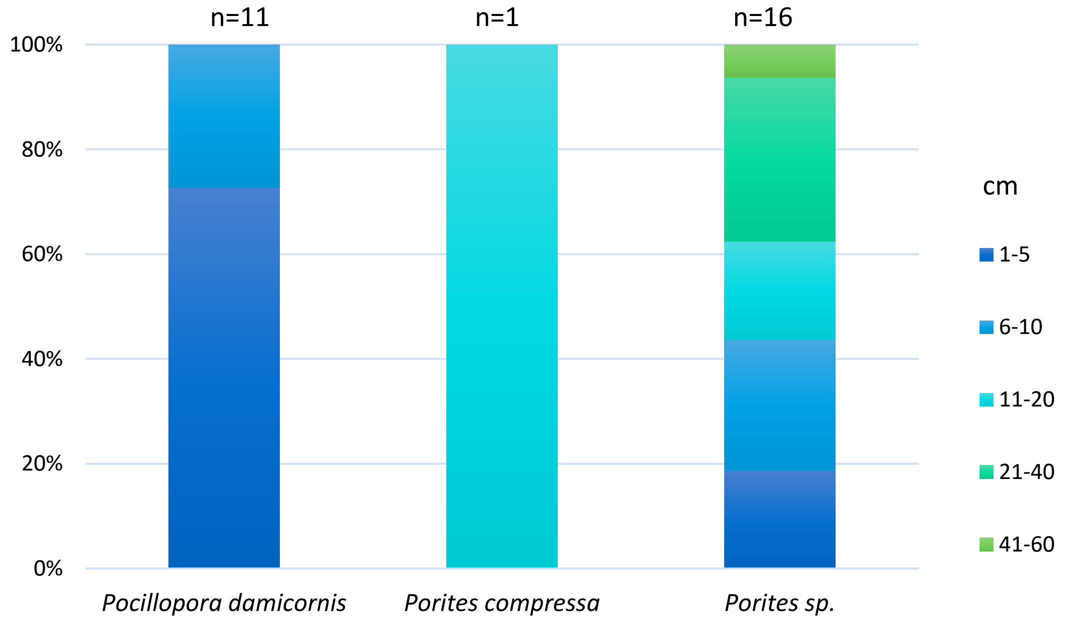

Figure 12. Coral colony sizes (cm) for transects in the Halekūlani Sector survey area. n = total number of colonies measured in size class.

Kūhiō (ʻEwa Basin) Sector

Figure 13 displays representative photos of the Kūhiō (ʻEwa Basin) Sector survey area. Biologists surveyed the entire existing Kūhiō crib wall structures and immediate surrounding basin floor for corals and other marine biota. The bottom substrate in the basin is sand. No corals or seagrass were observed on the sea floor of the basin. The intertidal zone of the existing structures is covered with small numbers of nerite snail (*Nerita picea*), thin shelled rock crab (*Grapsus tenuicrustatus*), and macroalgae (*Cladophora* sp. *Hydrolithon onkodes*, *Dictyota acutiloba*, *Laurencia nidifica*, *Acanthophora spicifera,* and *Gracilaria salicornia*). Invertebrates common here include urchins (*E. mathaei* and *Diadema paucispinum*) and sea cucumbers (*Holothuria atra* and *H. cinerascens*).

A census of corals was made along the entirety of the existing crib wall. No corals were observed on the existing structure. Several coral colonies (*Pocillopora damicornis*) in the <5 cm size class were observed on the outside of the seafloor beyond the crib wall, approximately 10 ft (3 m) seaward from the structure.

A total of 17 species of fishes were identified in and around the basin. Fishes closely associated with the structures included: trumpetfish (*Alustomus chinensis*), Hawaiian gregory (*Stegastes marginatus*), yellowfin goatfish (*Mulloidichthys vanicolensis*), and tobies (*Canthigaster amboinensis*, and *C. jacator*). Other fishes observed included: surgeonfishes (*Acanthurus triostegus*, *Acanthurus blochii*, juvenile *Naso unicornis*), wrasses (*Stethojulis balteata*, *Thalassoma duperrey* and *T. purpurem*), schools of flagtail (*āholehole* or *Kuhlia xenura*), schools of goatfishes (*Parupeneuss multifasciatus* and *P. porphyreus*).

Kūhiō (Diamond Head Basin) Sector

At the time of our February and March 2021 surveys, the Kūhiō Sector (Diamond Head basin) was an active de-watering basin and biologists could not enter the water However, conclusions about this basin can be made about this sector based on visual observations and comparisons to the ʻEwa Basin. The Diamond Head basin is a highly disturbed area, with visible turbidity plumes. As observed in and around the ʻEwa Basin, the Diamond Head basin is assumed to be sand bottom. Due to elevated turbidity, no seagrass or corals would be expected on the seafloor. Because no corals were observed on the crib wall of the ʻEwa Basin, we conclude a similar composition would be found on the Diamond Head basin wall structures.

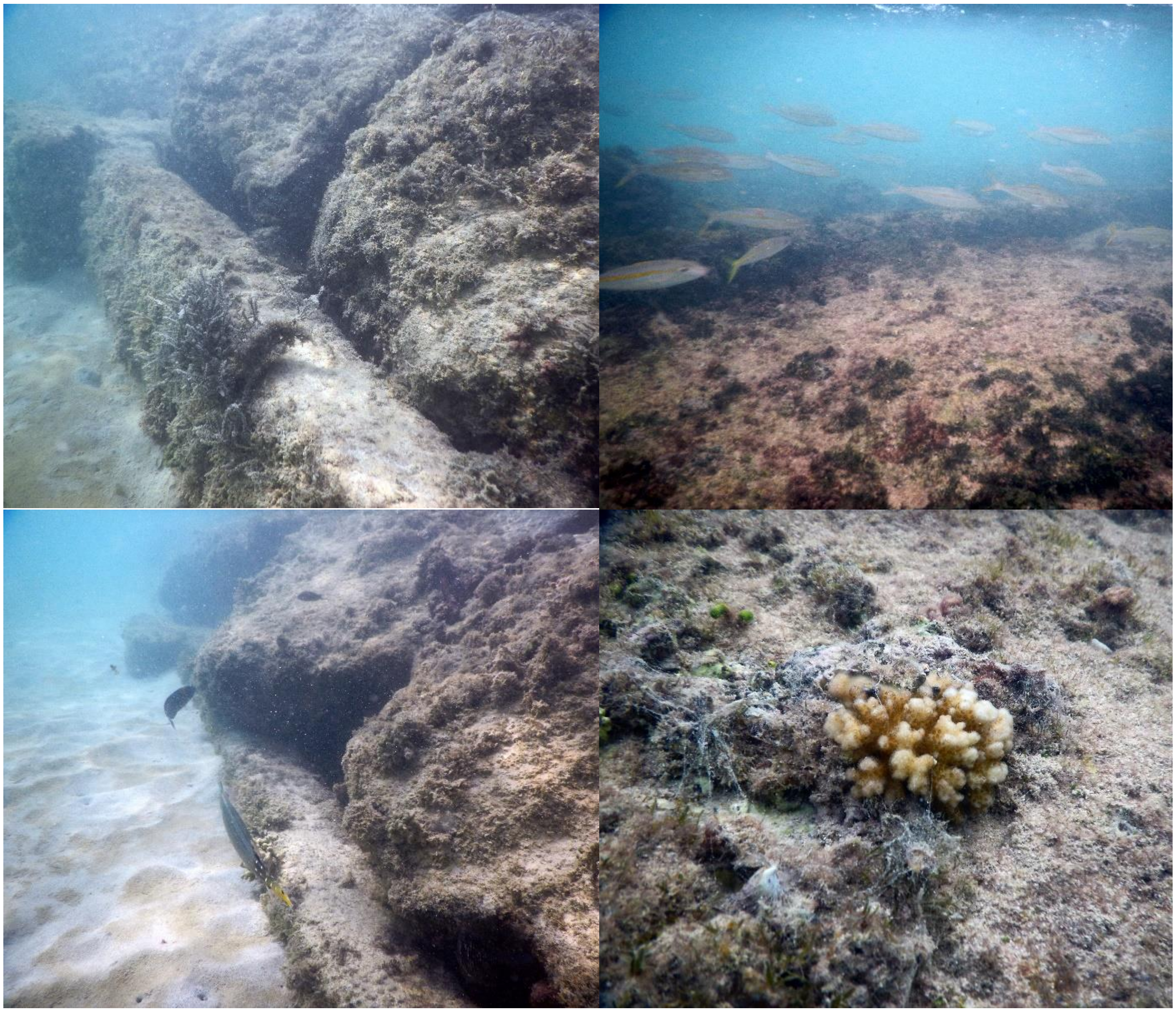

Figure 13. *Acanthophora spicifera* and *Gracilaria salicornia* are abundant on the structure of the Kuhio Sector (top left). Fishes associated with the Kuhio basin structures include schools of yellowfin goatfish (*Mulloidichthys vanicolensis*; top right), trumpetfish (*Alustomus chinensis*) and wrasses (*Thalassoma duperrey*; bottom left). Several coral colonies (*Pocillopora damicornis*) in the <5 cm size class were observed on the outside of the seafloor beyond the crib wall (bottom right).

Discussion

Listed and Protected Species

One state- and federally-listed (endangered or threatened; USFWS and NOAA-NMFS, 2016; HDLNR, 2015; USFWS, undated) marine species was encountered in our survey: green sea turtle (*Chelonia mydas*). Other state- and federally-listed marine species—hawksbill sea turtle (*Eretmochelys imbricata*) and monk seal (*Neomonachus schauinslandi*)—may occur in the general vicinity of the Project, considering the distribution of these species and their occurrences throughout the Islands as discussed below.

<u>Invertebrates</u> — Coral species are protected by Hawaiʻi State regulations that prohibit damage to "any stony coral by any intentional or negligent activity causing the introduction of sediment, biological contaminants, or pollution into state waters" (HDLNR, 2014). On August 27, 2014, NOAA issued a final rule for listing 20 coral species as threatened under the Endangered Species Act (ESA; NOAA-NMFS, 2014), but none of these listed coral species occurs in Hawaiʻi. On September 20, 2018, NOAA issued a proposed rule for listing the cauliflower coral (*Pocillopora meandrina*) as an endangered or threatened species under ESA (NOAA-NMFS, 2018). A global status review has been initiated by NOAA to determine whether listing throughout the species range is warranted.

Hawaiʻi Department of Land and Natural Resources (HDLNR) regulates shellfishes such as pearl oysters (HDLNR, 1987) and ʻ*opihi* (HDLNR, 1989). No ʻ*opihi* species or pearl oyster (*Pinctada margaritifera*) were observed in our survey of the Project area.

<u>Sea turtles</u> — The distinct population segment (DPS) of green sea turtle that occurs in Hawaiʻi is federally-listed as a threatened species (USFWS and NOAA-NMFS, 2016; UFWS, 2018) and as a threatened subspecies (*Chelonia mydas agassizi*) under Hawaiʻi regulations (DLNR, 2014).

Threats to the green sea turtle in Hawaiʻi include: disease and parasites, accidental fishing take, boat collisions, entanglement in marine debris, loss of foraging habitat to development, and ingestion of marine debris. Throughout the global range of green sea turtle, nesting and foraging habitats are being altered and destroyed by coastal development, beach armoring, beachfront lighting, vehicular/pedestrian traffic, invasive species, and pollution from discharges and runoff (NOAA & USFWS, 2007a, 2007b). Adult green sea turtles forage in shallow nearshore areas and on coral reefs. Contamination from effluent discharges and runoff has degraded these environments, and invasive species may reduce native algae species preferred by green sea turtles or could exacerbate susceptibility to, or development of disease (NOAA-NMFS and USFWS, 2007a). Fibropapillomatosis, a disease characterized by the presence of internal and/or external tumors that may grow large enough to hamper swimming, vision, feeding, and potential escape from predators continues to be a major threat to green sea turtles. Extremely high incidence has been reported in Hawaiʻi, where affliction rates peaked at 47-69% in some turtle foraging areas (Murakawa et al., 2000).

Hawksbill sea turtle is distributed across the Pacific, Indian, and Atlantic oceans. Hawksbill sea turtle is much less common in the Hawaiian Islands than green sea turtle and is known to nest only in the southern reaches of the state (NOAA-PIFSC, 2010). Hawksbill sea turtle is federally-listed as endangered (USFWS, nd) and is also listed as an endangered subspecies (*Eretmochelys imbricata bissa*) under Hawaiʻi regulations (HDLNR, 2014). Hawksbill sea turtle faces many of the same threats affecting green sea turtle (see above section; NOAA & USFWS, 2007b).

<u>Monk Seal</u> — The endangered Hawaiian monk seal (*Monachus schauinslandi*) is known to occur in the Project vicinity. The Hawaiian monk seal was first listed as an endangered species pursuant to the ESA on November 23, 1976 (41 FR 51612) and remains listed as endangered. In that same year, the Hawaiian monk seal population was designated as "depleted" under the Marine Mammal Protection Act (MMPA). Critical habitat for Hawaiian monk seals has been designated (NOAA-NMFS, 2015) and includes the seafloor and marine environment to 10 m above the seafloor from the 200 m depth contour, through the shoreline and extending onto the land 5 m inland from the shoreline between identified boundary points. These terrestrial boundary points define preferred pupping areas and significant haul-out areas. Waikīkī is excluded from terrestrial critical habitat designation (NOAA-NMFS, 2015).

Essential Fish Habitat

The 1996 Sustainable Fishery Act amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and subsequent Essential Fish Habitat (EFH) Regulatory Guidelines (NOAA, 2002) describe provisions to identify and protect habitats of federally-managed marine and anadromous fish species. Under the various provisions, federal agencies that fund, permit, or undertake activities that may adversely affect EFH are required to consult with the National Marine Fisheries Service (NMFS).

Congress defines EFH as "those waters and substrate necessary to fish[es] for spawning, breeding, feeding, or growth to maturity" (MSFCMA, 1996; NOAA, 2002). EFH provisions in MSFCMA designate that species harvested in sufficient quantities to require fisheries management are to be subdivided into similar Management Unit Species (MUS). Five MUS groups are currently managed in Hawaiian waters: bottomfishes, pelagics, precious corals, crustaceans, and coral reef ecosystem (Table 3). In the waters surrounding the Hawaiian Islands, EFH for coral reef ecosystem MUS as defined by the Final Coral Reef Ecosystem Fishery Management Plan (WPRFMC, 2001) and subsequent Fishery Ecosystem Plan for the Hawaiian Archipelago (WPRFMC, 2009a, 2009b, 2016) "includes all waters and habitat at depths from the sea surface to 50 fathoms extending from the shoreline (including state and territorial land and waters) to the outer boundary of the Exclusive Economic Zone (EEZ)."

Table 3. EFH Designations for Hawaiian Archipelago FEP Management Unit

Management Unit	Species Complex	EFH
Pelagic	Temperate species, Tropical species, Sharks, Squid	**Eggs and larvae:** the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 650 ft (200 m). **Juvenile/adults:** the water column extending from the shoreline to a depth of 3,280 ft (1,000 m).
Bottomfish and Seamount Groundfish	Shallow-water species (0 to 50 fm)	**Eggs and larvae:** the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 1,310 ft (400 m). **Juvenile/adults:** the water column and all bottom habitat extending from the shoreline to a depth of 1,310 ft (400 m).
Bottomfish and Seamount Groundfish	Deep-water species (50 to 200 fm)	**Eggs and larvae:** the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 1,310 ft (400 m). **Juvenile/adults:** the water column and all bottom habitat extending from the shoreline to a depth of 1,310 ft (400 m).
Crustacean	Spiny and slipper lobster complex, Kona crab	**Eggs and larvae:** the water column from the shoreline to the outer limit of the EEZ down to a depth of 490 ft (150 m). **Juvenile/adults:** all of the bottom habitat from the shoreline to a depth of 330 ft (100 m).
Coral Reef Ecosystem	All Currently Harvested Coral Reef Taxa All Potentially Harvested Coral Reef Taxa	EFH for the Coral Reef Ecosystem MUS includes the water column and all benthic substrate to a depth of 330 ft (100 m) from the shoreline to the outer limit of the EEZ for eggs, larvae, juveniles and adults.

The Western Pacific Regional Fishery Management Council (WPRFMC) has restructured its management framework from species-based fishery management plans (FMPs) to place-based fishery ecosystem plans (FEPs). The Hawaiian Archipelago FEP establishes the framework under which the WPRFMC will manage fishery resources and begin the integration and implementation of ecosystem approaches to management in the Hawaiian Archipelago. This FEP does not establish any new fishery management regulations, but rather consolidates existing fishery regulations for demersal species. Specifically, this FEP identifies as MUS those species known to be present in waters around the Hawaiian Archipelago and incorporates all of the management provisions of the Bottomfish and Seamount Groundfish FMP, the Crustaceans FMP, the Precious Corals FMP, and the Coral Reef Ecosystems FMP that are applicable to the area.

In addition to EFH, the WPRFMC identifies Habitat Areas of Particular Concern (HAPC) within EFH for all FEPs. Specific subsets of EFH, HAPCs are areas within EFH that are essential to the life cycle of federally managed coral reef species. In determining whether a type or area of EFH should be designated as a HAPC, one or more of the following criteria established by NMFS should be met: (a) the ecological function provided by the habitat is important; (b) the habitat is sensitive to human-induced environmental degradation; (c) development activities are, or will be, stressing the habitat type; or (d) the habitat type is rare.

The waters off Waikīkī are designated as EFH (including water column and all bottom areas) for coral reef ecosystem, bottomfish, pelagic and crustacean MUS. Of the thousands of species which are federally managed under the coral reef FMP, at least 40 (juvenile and adult life stages) are known to occur in waters in the vicinity.

Impact Assessment

Marine Resources

The Waikīkī Beach Improvement and Maintenance Project is taking place on an engineered beach and shallow reef flat. Overall, the proposed groin project area is 24% rubble and 23% sand, offering limited topographical relief and structural complexity. The Project area supports a low abundance of fishes with low species richness and a marginal coral community. The daily use by large numbers of waders, fishers, paddlers, and swimmers influences negatively the biotic community. Areas with little or no vertical relief are affected by the continually shifting sand and tend to have little algal and macro-invertebrate diversity, with few or no coral colonies present. These hard bottom areas may be regularly covered and uncovered by shifting sand.

Coral assemblages in Waikīkī are limited by availability of stable hard bottom, silt cover, competition with algae, and freshwater influence among other factors. No corals were observed in the Royal Hawaiian Beach Sector, and one colony was observed in the Fort DeRussy Sector. At the Kuhio (ʻEwa Basin) Sector, no colonies were observed on the breakwater structures.

At the Halekulani Sector, overall coral cover at the proposed groin locations is very low (mean of 0.1 colony/m^2). In general, coral colonies here are small, with 64% being less than 10 cm in diameter. Coral settlement and growth in Waikīkī are limited by impinging waves, scour by rubble and sand, reduced light conditions associated with turbid water events, and burial with fine sediment. Project-placed boulders and sand fill will bury a portion of the existing subtidal environment of primarily low relief sand, rubble, and limestone. This limestone provides substrate for macroalgae and coralline algae growth, as well as habitat for macroinvertebrates. Placement of boulders and sand will result in loss of some benthic organisms, including corals. These corals provide ecological services to the coral reef ecosystem: shelter, reef consolidation, food for corallivores, or coral gametes. Impacts to corals could be avoided by relocating the few scattered corals that occur in the footprint of the placed sand and groins. Benthic invertebrates will repopulate from surrounding habitat after construction is completed and sessile organisms will colonize new hard surfaces (*AECOS*, 2014-2020). Additionally, the Project will provide stable, hard bottom for coral settlement and possibly calmer waters for coral development, but coral assemblage development may be compromised by competition for space, freshwater influence, sediment transport, and heavy utilization of the nearshore by the human population.

Fish abundance and diversity are directly correlated with topographical structure and complexity (Friedlander and Parrish, 1998; Ménard et al., 2012). Fish species richness, biomass, and diversity tend to be highest in environments with considerable spatial relief such as along limestone outcrop/sand bottom interfaces; fish biomass is lowest on shallow reef flats (Friedlander and Brown, 2006) of the sort in the Project area. Although most of the Project area reef has low topographic relief, where vertical structure does occur, fishes are present and sometimes in high numbers. The distribution of topographical relief on this reef is highly patchy and weakly captured by our transect locations and survey areas. Stations with visibly greater relief, in the form of limestone outcrops, existing breakwaters and groins had greater fish abundance than the reef flat. The substantial structural complexity and topographical relief offered by the groins is expected to provide habitat for fishes and an increase in fish species richness, biomass, and abundance can be anticipated, which has been observed at T-head groins placed at Iroquois Point, Oʻahu (*AECOS*, 2020).

Two common algae species found in Waikīkī are non-native and invasive: *A. spicifera* and *G. salicornia*. These species are widespread off the shores of the Islands, and *A. spicifera* is a food favored by green sea turtle. While some turtle foraging resources may be lost due to sand and groin placement, benthic resources for grazing occur throughout Waikīkī Beach. As such, we expect minimal impacts to turtle foraging. The groin structures are not expected to affect species introductions to Hawaiʻi but may serve as habitat for existing introduced species. Future monitoring events should note any changes in the distribution of *A. spicifera* and other invasive species in Waikīkī.

The proposed Project is not expected to result in any significant long-term degradation of the environment or loss of habitat. Rather, by the construction of the proposed T-head groins, the Project will improve the shoreline conditions, restore beaches and increase potential biological habitat in a relatively barren reef flat area. Ecological services of reef flat habitat will be lost under the project footprints (sand and groin) but these services are expected to recover over time as the benthic community (including hard corals) re-establishes. The boulders of the groins are expected to offer a substratum for sessile organisms, such as corals, and provide increased habitat complexity for motile fauna (*AECOS*, 2020). A biological and water quality monitoring program should be implemented to enhance control over Project construction impacts.

Mitigation

Mitigating for impacts to marine resources is a sequential process of avoiding impacts, minimizing impacts, and then compensating for unavoidable adverse impacts. The first step is to avoid impacts through project design. The second step, after avoidance measures have been incorporated, is to minimize remaining impacts. If unavoidable impacts still exist after avoidance and minimization, then replacement of lost ecosystem functions and values is appropriate. This last step is called compensatory mitigation (Bentivoglio, 2003). Project design decisions should incorporate measures to avoid and minimize impacts to marine communities associated with beach stabilization to the extent possible. In particular, impacts to corals in the footprint of the proposed sand borrow margins should be avoided by excluding those areas from the dredging limits.

The United States Coral Reef Task Force (USCRTF) has identified a portfolio of compensatory mitigation and restoration options (USCRTF, 2016) and a list of Best Management Practices (BMPs) that could be implemented to offset adverse impacts on coral reef communities from development projects. The USCRTF list was reviewed and screened for appropriateness to anticipated Project impacts, ability to successfully implement, and impacts already minimized by project specific BMPs. Possible avoidance and minimization measures that could be taken to offset adverse impacts are provided below.

Water quality improvements:
  - Storm water BMPs

Coral response and rescue team:
  - Movement of at-risk corals from a project area

Offsite placement of structures to enhance substrate:

- Placement of material that mimics natural coral reef structure
- Deposition of boulders or other artificial material
- Placement of artificial reef modules

Nuisance species removal:

- Removal of nuisance or invasive algae species
- Super sucker removal of invasive algae

Coral and Macroinvertebrate Relocation - To avoid and minimize impacts to selected marine resources that occur in the Project area, any coral colonies and other macroinvertebrates (e.g., sea urchins, sea cucumbers) that occur within the direct footprint of the Project could be relocated, as practicable. Removing corals from the Project area and transplanting them to another site could avoid and minimize impacts to the coral assemblage. Additionally, different macroinvertebrates are potential candidates for relocation, including primarily urchins and sea cucumbers.

Placement of Structures - The Project contains an inherent mitigation in that the proposed groins are hard substratum additions with substantial vertical relief that would be suitable for attraction of reef fishes and provide substratum for a wide variety of algae and invertebrates (including corals). The improvements are intended to increase beach stability and sand retention, increase resilience and sustainability of the Waikīkī shoreline to sea level rise projections.

Nuisance Species Removal and urchin out-planting - To offset loss of biological assemblages associated with the loss of hard substrate beneath the enhanced beach, invasive algae elsewhere could be removed as part of a reef restoration effort. This effort could allow for an increase in diversity as native algae and invertebrates recolonize the reef. The key to maintaining low levels of invasive algae is the presence of native herbivores and native collector urchins (*Tripneustes gratilla*) are spawned and raised in captivity at the DLNR-DAR's Anuenue Fisheries Research Center (Oʻahu) for use as a biological tool to fight invasive alien seaweeds on reef areas throughout Hawaiʻi. Echinoderms rescued from the Project footprint could be used in such an effort, but only if a location can be identified where increasing the urchin population would provide the desired benefit.

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TABLE A
List of algae observed on the reef flat in the Project area off Waikīkī Beach (2007-2021).

PHYLUM, CLASS, ORDER, FAMILY		**Location of reef**			**QC Code**
Species	**Common name**	**Gray's**	**Kūhiō**	**Waikīkī**	
CYANOPHYTA	BLUE-GREEN ALGAE				
Leptolyngbya crosbyana		R			05
Lyngbya sp.		P			07
Lyngbya majuscule			R	R	05, 10
Symploca hydnoides		R	R	O	05, 10
CHLOROPHYTA	GREEN ALGAE				
indet.		R	R		05
Avrainvillea amadelpha		C, C	U	R, O	05, 07, 21
Bornetella sp.		P			07
Bornetella sphaerica			R		05
Bryopsis sp.		O	R	R	05, 21
Caulerpa racemosa			R	O	05, 21
Caulerpa sertularioides			U	O	05, 10, 21
Chaetomorpha antennina			R		05
Cladophoropsis luxurians		R			05
Cladophora sp.		R		O	07, 21
Cladophora fascicularis			R		05
Cladophora luxurians			R		05
Cladophora sericea				R	10
Cladophoropsis luxurians		R			05
Codium arabicum		O	R	R, U, O	05, 10, 21
Codium edule		C	O	R, R, O	05, 10, 21
Dictyosphaeria cavernosa			U	U	05, 21
Dictyosphaeria versluysii		P	R	R	07, 05, 10
Dictyosphaeria sp.			U	U	05, 21
Enteromorpha sp.		U	R		05
Halimeda sp.				U, U	10, 21
Halimeda opuntia		R	O	O	05, 21
Halimeda discoidea		O		O	07, 21
Microdictyon setchellianum			R		05
Microdictyon umbilicatum			U		05
Neomeris annulata		R	R	R	07, 05, 10
Neomeris sp.				U	21
Ulva fasciata	sea lettuce	U	O	C, O	07, 05, 10, 21
Ulva reticulata			U	R	05, 21
PHAEOPHYTA	BROWN ALGAE				
Asteronema breviarticulatum			U	U	05, 21
Chnoospora sp.			R		05
Colpomenia sinuosa			R		05
Colpomenia tuberculata			R		05

PHYLUM, CLASS, ORDER, FAMILY ***Species***	**Common name**	**Location of reef**			**QC Code**
		Gray's	**Kūhiō**	**Waikīkī**	
PHAEOPHYTA (cont.)					
Dictyopteris australis			R	R	05, 10
Dictyopteris plagiogramma			R		05
Dictyota sp.				C, O	10, 21
Dictyota acutiloba		O	O	O	05, 10, 21
Dictyota bartayresiana	*alani*	R	O		05
Dictyota ceylanica		P		O	07, 21
Dictyota friabilis		R	R	O	05, 21
Dictyota sandvicensis			R	O	05, 21
Dictyota spp.		A, C, A	U		05, 06, 07
Distromium flabellatum			R		05
Lobophora variegata		R	R	O	05, 21
Padina spp.		C, P	U	A, U	06, 07, 05, 10, 21
Padina australis		O	O	O	05, 21
Padina japonica		O	O		05
Padina sanctae-cruis				O	21
Sargassum spp.		C			06
Sargassum echinocarpum		C, C	C	A	05, 07, 10
Sargassum obtusifolium				A	10
Sargassum polyphyllum				R	10
Sphacelaria furcigera			R		05
Stypopodium hawaiiensis			U		05
Turbinaria ornata		U, C, A	R	R	05, 06, 07, 10, 21
RHODOPHYTA	RED ALGAE				
indet.		R	R		05
Acanthophora spicifera	spiny seaweed	A, A, A	C	A, C	05, 06, 07, 10, 21
Asparagopsis taxiformis		R, C, P	U	U, C	05, 06, 07, 10, 21
Botryocladia skottsbergii		R			05
Centroceras clavulatum		C	R		05
Coelothrix irregularis			R		05
Dasya sp.		P	R		07, 05
Dasya iridescens				R	21
Dichotomaria marginata			R		05
Dichotomaria obtusata			O		05
Galaxaura spp.		O, C, O	R	R, U	05, 06, 07, 21
Galaxaura fastigiata		O	R		05
Galaxaura rugosa			R		05
Gelidium pusillum			R	O	05, 21
Gelidiopsis scoparia			R		045
Gracilaria sp.			R		05
Gracilaria bursa-pastoris			R		05
Gracilaria coronopifolia		O	R	R	05, 10
Gracilaria salicornia		A, A, O	C	C, C	05, 06, 07, 10, 21
Hydrolithon breviclavium			O		05
Hydrolithon gardineri		R	C		05
Hydrolithon onkodes		R	C	C	05, 21

PHYLUM, CLASS, ORDER, FAMILY *Species*	**Common name**	**Location of reef** Gray's	Kūhiō	Waikīkī	**QC Code**
RHODOPHYTA (cont.)					
Hydrolithon reinboldii			O	O, C	05, 10, 21
Hypnea sp.			R	R	05, 10, 21
Hypnea cervicornis			U		05
Hypnea chordacea			R		05
Jania sp.		C	C	O, O	05, 10, 21
Laurencia sp.		R	O	O	05, 21
Laurencia mcdermidiae		R	R		05
Laurencia nidifica		R	U		05
Liagora sp.		P	R	R, R	07, 05, 10, 21
Liagora ceranoides			U	R	05, 21
Martensia fragilis		U	O		05
Martensia sp.		P			07
Melanamansia glomerata		U	C		05
Peyssonnelia rubra		R	R	R	05, 21
Plocamium sandvicense		R, P	R		05, 07
Pneophyllum conicum			R		05
Portieria hornemannii		R	R	R, R	05, 10, 21
Pterocladiella sp.		C			06
Pterocladiella caerulescens		R	R		05
Sporolithon sp.		P	R	O	07, 05, 21
Spyridia filamentosa			R		05
Tricleocarpa cylindrica		R	R	R	05, 21
Trichogloea sp.		C			06
Trichogloea lubrica		R			05
Wrangelia sp.		R			05
Wrangelia elegantissima			O		05

KEY TO SYMBOLS USED IN TABLE:

Abundance categories:

R - Rare - Only one or two individuals or specimens observed in area.
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C - Common – Seen regularly, although generally in small numbers.
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QC Code:

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06 - Reported previously by aquatic biologists from reef offshore Gray's Beach in March 2007 (MRC, 2007).
07 - Reported previously by aquatic biologists from reef offshore Gray's Beach on November 30, 2007, December 10 - 11, 2007, December 13, 2007, December 17, 2007, December 29, 2007, January 18, 2008, and April 21, 2008 (*AECOS*, 2009a).
10 – Reported previously by aquatic biologists on July 29, 2009, May 27, 2010, June 4, 2010, and June 8, 2010 (*AECOS*, 2010).
21 – Observed in the field by aquatic biologists on February 18, 2021, February 19, 2021 and March 4, 2021 or collected for identification in the laboratory. None was saved as voucher specimens.

Table B
List of macro-invertebrates (other than coral) observed on the reef flat
in the Project area off Waikīkī Beach (2007-2021).

PHYLUM, CLASS, ORDER, FAMILY ***Species***	**Common name**	**Location of reef**			**QC Code**
		Gray's	**Kūhiō**	**Waikīkī**	
PORIFERA, CALCAREA	SPONGES				
LEUCETTIDAE					
Leucetta solida	white leucetta			R	10
PORIFERA, DEMOSPONGIAE	SPONGES				
unid.	red, orange sponge			U	10
unid.	black sponge			R	21
ANCHINOIDAE					
Hamigera sp.	red boring sponge			R	10
CHONDRILLIDAE					
Chondrosia chucalla	meandering sponge			R	10
SPIRASTRELLIDAE					
Spirastrella vagabunda	vagabond boring sponge			R	10
SPONGIIDAE					
Spongia oceania	black reef sponge			R	10
CNIDARIA, ANTHOZOA ACTINIARIA	SEA ANEMONE				
AIPTASIIDAE					
Aiptasia pulchella	glass anemone			R	10, 21
ANNELIDA, POLYCHAETA	WORMS				
unid.				R	10
MOLLUSCA, GASTROPODA	MOLLUSKS				
PATELLIDAE					
Cellana sp.	ʻopihi			R	21
SIPHONARIIDAE					
Siphonaria normalis	false ʻopihi, *ʻopihi-ʻawa*			O	21
NERITIDAE					
Nerita pacea	black nerite, *pipipi*			O	21
LITTORINIDAE					
Littoraria pintado	dotted periwinkle, *pipipi kōlea*			O	21
VERMETIDAE					
Serpulorbis variabilis	variable worm snail, *kauna'oa*			O	21
Dendropoma sp.	worm snail			O	21
CONIDAE					
Conus imperialis	imperial cone			R	10
Conus lividus	spiteful cone			R	10
Conus marmoreus	marble cone			R	10
Conus pulicarius	flea-bite cone			R	10
Conus (Vigiconus) flavidus	golden-yellow cone			R	21

PHYLUM, CLASS, ORDER, FAMILY *Species*	**Common name**	**Location of reef** Gray's	Kūhiō	Waikīkī	**QC Code**
CYPRAEIDAE					
Cypraea sp.	unid. cowry			R	10
Cypraea caputserpentis	serpent's-head cowry			R	10
Cypraea tigris†	tiger cowry			R	10
MURICIDAE					
Morula granulata	drupe			U	10
Morula uva	grape drupe	P		U, O	07, 10, 21
Drupa ricina	spotted drupe			R	21
RANELLIDAE					
Cymatium pileare	hairy triton			R	10
TURBINIDAE					
Turbo sandwicensis	Hawaiian turban, *ʻalīlea, pūpū mahina*			R	10
TURRIDAE					
unid.	unid. turrid			R	10
MOLLUSCA, ANASIPIDAE					
APLYSIDAE					
Aplysia parvula	small sea hare, *kualakai*			R	10
MOLLUSCA, SACOGLOSSA					
ELYSIIDAE					
Plakobranchus ocellatus	ringed sap-sucking slug			R	21
MOLLUSCA, NUDIBRANCHIA					
CHROMODORIDAE					
Chromodoris decora	decorated nudibranch			R	10
DENDRODORIDAE					
Dendrodoris nigra	black dendrodoris			R	10
MOLLUSCA, AEOLIDACEA					
FLABELLINIDAE					
Flabellina exoptata	desirable nudibranch			R	10
MOLLUSCA, BIVALVIA					
MYTILIDAE					
Brachidontes crebricostatus	Hawaiian mussel			R	10
PINNIDAE					
Streptopinna saccata	baggy pen shell			R	10
ISOGNOMONIDAE					
Isignomon perna	brown purse shell, *nahawele pāpaua*			O	21
MOLLUSCA, CEPHALOPODA, OCTOPODA					
OCTOPODIDAE					
Octopus cyanea	day octopus, *heʻe mauli*			R, R	10, 21
MOLLUSCA, CEPHALOPODA, TEUTHOIDEA					
SEPIOLIDAE					
Sepioteuthis lessoniana	big fin squid, *muheʻe*	R			05

PHYLUM, CLASS, ORDER, FAMILY		**Location of reef**			**QC Code**
Species	**Common name**	**Gray's**	**Kūhiō**	**Waikīkī**	
ARTHOPODA, CRUSTACEA, CIRRIPEDIA					
BALANIDAE					
Amphibalanus amphitrite	amphitrite's rock barnacle			O	21
CHTHAMALIDAE					
Chthamalus proteus	proteus' rock barnacle			O	21
ARTHOPODA, CRUSTACEA, STOMATOPODA					
unid.	mantis shrimp	R			05
Pseudoquilla ciliata	ciliated mantis shrimp			R	21
ARTHOPODA, CRUSTACEA, DECAPODA					
STENOPODIDAE					
Stenopus hispidus	banded coral shrimp			R, R	10, 21
ALPHEIDAE					
Alpheus deuteropus	petroglyph shrimp	P			07
CORALLIANASSIDAE					
Corallianassa borradailei	Borradaile's ghost shrimp			R, R	10, 21
ARTHOPODA, CRUSTACEA, DECAPODA, ANOMURA					
DIOGENIDAE					
unid.	hermit crab			O	10
Calcinus c.f. elegans	elegant hermit crab			R	21
ARTHOPODA, CRUSTACEA, DECAPODA, BRACHYURA					
XANTHIDAE					
unid.	pebble crab			R	10
GRAPSIDAE					
Grapsus tenuicrustheus	thin-shelled rock crab, *ʻaʻama*			O	21
Percnon planissimum	flat rock crab, *pāpā*			O	21
Plagusia squamosa	scaly rock crab			O	21
ECHINODERMATA, OPHIUROIDEA	BRITTLE STARS				
OPHIOCOMIDAE					
Ophiocoma erinaceus	spiny brittle star	P		U, O	07, 10, 21
ECHINODERMATA, ECHINOIDAE	SEA URCHINS				
CIDARIDAE					
Eucidaris metularia	ten-lined urchin, *haʻueʻue*			R	10

PHYLUM, CLASS, ORDER, FAMILY *Species*	**Common name**	**Location of reef** Gray's	Kūhiō	Waikīkī	**QC Code**
DIADEMATIDAE					
Diadema paucispinum	long-spined urchin	O, U			06, 07
Echinothrix diadema	blue-black urchin, *wana*	O, R	R	U	05, 06, 01
Echinothrix calamaris	banded urchin, *wana*	C	R	O, O	07, 05, 10, 21
ECHINOMETRIDAE					
Echinometra mathaei	rock-boring urchin, *ʻina*	O, P, C	C	C, C	05, 06, 07, 10, 21
Echinometra oblonga	oblong urchin, *ʻina*		R	R, C	05, 10, 21
Echinostrephus aciculatus	needle-spined urchin	P		R	06, 10
Heterocentrotus mammillatus	red-pencil urchin	U	O	R, O	07, 05, 10, 21
TOXOPNEUSTIDAE					
Tripneustes gratilla	collector urchin, *hāwaʻe*	R, O	U	C, R	05, 07, 10, 21
ECHINODERMATA, HOLOTHUROIDAE	SEA CUCUMBERS				
HOLOTHURIIDAE					
Actinopyga mauritiana	white-spotted sea cucumber, *loli*	R, P	R	O	05, 07, 21
Holothuria atra	black sea cucumber, *loli okuhi kuhi*	C, O, C	U	R, O	05, 06, 07, 10, 21
Holothuria cinerascens	ashy sea cucumber, *loli pua*	U	U	C	05, 21
Holothuria whitmaei	teated sea cucumber, *loli*			R, R	10, 21
CHORDATA, TUNICATA	TUNICATES				
unid. spp.	unid. blue, gray, white colonial tunicates			U	10
Palythoa tuberculosa	Blue-gray/ rubbery/pillow zoanthid			R	21
Zoanthus pacificus	Striped zooanthid			R	21
Zoanthus spp.	Mat zoanthid			O	21

KEY TO SYMBOLS USED IN TABLE:

Abundance categories:

- R - Rare - Only one or two individuals or specimens observed in area.
- U - Uncommon - Three to no more than a dozen individuals or specimens observed in area.
- O - Occasional – Seen irregularly and always in small numbers;
- C - Common – Seen regularly, although generally in small numbers.
- A - Abundant - Found in large numbers and widely distributed.

Other symbols and categories:

- † - identified by shell or carapace only.

QC Code:

Table B (continued).

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06 - Reported previously by aquatic biologists from reef offshore Gray's Beach in March 2007 (MRC, 2007).
07 - Reported previously by aquatic biologists from reef offshore Gray's Beach on November 30, 2007, December 10 - 11, 2007, December 13, 2007, December 17, 2007, December 29, 2007, January 18, 2008, and April 21, 2008 (*AECOS*, 2009a).
10 – Reported previously by aquatic biologists on July 29, 2009, May 27, 2010, June 4, 2010, and June 8, 2010 (*AECOS*, 2010).
21 – Observed in the field by aquatic biologists on February 18, 2021, February 19, 2021 and March 4, 2021 or collected for identification in the laboratory. None was saved as voucher specimens.

Table C
List of corals observed on the reef flat in the Project area off Waikīkī Beach (2007-2021).

PHYLUM, CLASS, ORDER, FAMILY		**Location**			**QC Code**
Genus species	**Common name**	**Gray's**	**Kūhiō**	**Waikīkī**	
CNIDARIA, ANTHOZOA					
ALCYONACEA					
ALCYONIIDAE					
Sarcothelia edmondsoni	blue soft coral, *ʻokole*	<1%	<1%		07, 21
TELESTACEA, ZOANTHINARIA, ZOANTHIDAE					
SCLERACTINIA,					
ACROPORIDAE					
Montipora capitata	rice coral	<1%		<1%	05, 06, 07, 10
Montipora patula	spreading coral	<1%		<1%	05, 06, 07, 10
FAVIIDAE					
Leptastrea bewickensis	Bewick coral			<1%	10
Leptastrea purpurea	crust coral	<1%			05
Cyphastrea ocellina	ocellated coral	<1%			05, 06, 21
POCILLOPORIDAE					
Pocillopora damicornis	lace coral	<1%			10, 21
Pocillopora meandrina	cauliflower coral, *koʻa*	<1%		<1%	05, 06, 07, 10
PORITIDAE					
Porites evermanni		<1%			05, 21
Porites lobata	lobe coral, *puna*	<1%		<1%	05, 06, 07, 10
Porites lutea	mound coral				07
Porites sp.			<1%		21
SIDERASTREADAE					
Psammocora sp.		<1%			05
Psammocora stellata	stellar coral	<1%		<1%	07, 10, 21

Coral abundances are given in percent coverage.

KEY TO SYMBOLS USED IN TABLE:

QC Code:

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- 06 - Reported previously by aquatic biologists from reef offshore Gray's Beach in March 2007 (MRC, 2007).
- 07 - Reported previously by aquatic biologists from reef offshore Gray's Beach on November 30, 2007, December 10 - 11, 2007, December 13, 2007, December 17, 2007, December 29, 2007, January 18, 2008, and April 21, 2008 (*AECOS*, 2009a).
- 10 – Reported previously by aquatic biologists on July 29, 2009, May 27, 2010, June 4, 2010, and June 8, 2010 (*AECOS*, 2010).
- 21 – Observed in the field by aquatic biologists on February 18, 2021, February 19, 2021 and March 4, 2021 or collected for identification in the laboratory. None was saved as voucher specimens.

Table D.
List of fishes observed on the reef flat in the Project area off Waikīkī Beach (2007-2021).

PHYLUM, CLASS, ORDER, FAMILY		**Location**			**QC Code**
Genus species	**Common name, *Hawaiian***	**Gray's**	**Kūhiō**	**Waikīkī**	
CNIDARIA, ANTHOZOA					
ALCYONACEA					
ALCYONIIDAE					
Sarcothelia edmondsoni	blue soft coral, *ʻokole*	<1%	<1%		07, 21
TELESTACEA, ZOANTHINARIA, ZOANTHIDAE					
SCLERACTINIA,					
ACROPORIDAE					
Montipora capitata	rice coral	<1%		<1%	05, 06, 07, 10
Montipora patula	spreading coral	<1%		<1%	05, 06, 07, 10
FAVIIDAE					
Leptastrea bewickensis	Bewick coral			<1%	10
Leptastrea purpurea	crust coral	<1%			05
Cyphastrea ocellina	ocellated coral	<1%			05, 06, 21
POCILLOPORIDAE					
Pocillopora damicornis	lace coral	<1%			10, 21
Pocillopora meandrina	cauliflower coral, *koʻa*	<1%		<1%	05, 06, 07, 10
PORITIDAE					
Porites evermanni		<1%	<1%		05, 21
Porites lobata	lobe coral, *puna*	<1%		<1%	05, 06, 07, 10
Porites lutea	mound coral				07
Porites sp.					21
SIDERASTREADAE					
Psammocora sp.		<1%			05
Psammocora stellata	stellar coral	<1%		<1%	07, 10, 21

KEY TO SYMBOLS USED IN TABLE D:

Abundance categories:
- R - Rare - Only one or two individuals or specimens observed in area.
- U - Uncommon - Three to no more than a dozen individuals or specimens observed in area.
- O - Occasional – Seen irregularly and always in small numbers;
- C - Common – Seen regularly, although generally in small numbers.
- A - Abundant - Found in large numbers and widely distributed.

Other symbols and categories:
- E – Endemic – Found in Hawaiʻi and nowhere else.

QC Code:
- 06 - Reported previously by aquatic biologists from reef offshore Gray's Beach in March 2007 (MRC, 2007).

Table D (continued).

07 - Reported previously by aquatic biologists from reef offshore Gray's Beach on November 30, 2007, December 10 - 11, 2007, December 13, 2007, December 17, 2007, December 29, 2007, January 18, 2008, and April 21, 2008 (*AECOS*, 2009a).

10 – Reported previously by aquatic biologists on July 29, 2009, May 27, 2010, June 4, 2010, and June 8, 2010 (*AECOS*, 2010).

21 – Observed in the field by aquatic biologists on February 18, 2021, February 19, 2021 and March 4, 2021 or collected for identification in the laboratory. None was saved as voucher specimens.

26. APPENDIX D: CULTURAL IMPACT ASSESSMENT

— Draft —

A Cultural Impact Assessment for the Proposed Waikīkī Beach Improvement and Maintenance Program, Waikīkī Ahupua‘a, Kona District, Island of O‘ahu, Hawai‘i

TMK (1) 2-6-001:002, 003, 004, 008, 012, 013, 015, 017, 018, 019; 2-6-002:005, 006, 017, 026; 2-6-004:005, 006, 007, 008, 009, 010, 012; 2-6-005:001, 006; 2-6-008:029

Prepared by:
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Hannah Kaumakamanōkalanipō Anae

Prepared for:
Sea Engineering, Inc.
41-305 Kalanianaole Hwy.
Makai Research Pier
Waimānalo, Hawai‘i 96795

INTERNATIONAL ARCHAEOLOGY, LLC

MAY 2021

— DRAFT —

A CULTURAL IMPACT ASSESSMENT FOR THE PROPOSED WAIKĪKĪ BEACH IMPROVEMENT AND MAINTENANCE PROGRAM, WAIKĪKĪ AHUPUA‘A, KONA DISTRICT, ISLAND OF O‘AHU, HAWAI‘I

TMK (1) 2-6-001:002, 003, 004, 008, 012, 013, 015, 017, 018, 019; 2-6-002:005, 006, 017, 026; 2-6-004:005, 006, 007, 008, 009, 010, 012; 2-6-005:001, 006; 2-6-008:029

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May 2021

ABSTRACT

At the request of Sea Engineering, Inc. (SEI), and on behalf of the Department of Land and Natural Resources (DLNR), Office of Conservation and Coastal Lands, International Archaeology, LLC prepared a cultural impact assessment (CIA) in support of the proposed Waikīkī Beach Improvement and Maintenance Program. The beach improvement and maintenance program encompasses four areas of Waikīkī Beach—the Kūhiō Beach sector, the Royal Hawaiian sector, the Halekūlani sector, and the Fort DeRussy sector—along the shoreline of Māmala Bay in the Kona District of the Island of O‘ahu, seaward of TMKs (1) 2-6-001:002, 003, 004, 008, 012, 013, 015, 017, 018, 019; 2-6-002:005, 006, 017, 026; 2-6-004:005, 006, 007, 008, 009, 010, 012; 2-6-005:001, 006; and 2-6-008:029. These sectors include portions of the active beach and nearshore marine areas and extend to a maximum of approximately 70 m offshore. The CIA is a component of the program's Environmental Impact Statement prepared by SEI for the DLNR. The proposed project includes the construction of new beach stabilization structures and shoreline replenishment primarily using sand recovered from offshore areas.

The Waikīkī region was an important traditional location, noted for its chiefly associations as well as the wealth of its agricultural and aquacultural development. It has historical associations as the beachside retreat for the 19th century Hawaiian royalty and wealthy Honolulu residents, and has more recently become the center of the modern Hawaiian hospitality economy. During the past 130 years, the Waikīkī shoreline has been substantially engineered to create larger sandy beaches for recreation. As such, most of the maintenance program will occur within modern beach deposits seaward of the 19th century and early 20th century shorelines.

The intent of the CIA is to present information about past and present practices and resources for coastal Waikīkī to identify issues and concerns relating to the proposed beach improvement and maintenance program. Over 200 potential cultural consultants were contacted to provide information about cultural activities and resources within the maintenance program area and to identify any potential affects to these activities and resources by the proposed program. Seven individuals responded to the consultation request and provided written consent to include their information in the CIA. In addition, several O‘ahu Island Burial Council members and meeting participants provided verbal comments following an informatory presentation about the maintenance program during the February 2021 meeting.

The primary concern for most of the cultural consultants who commented on the project is the inadvertent disturbance of *iwi kūpuna* (ancestral human skeletal remains) along the beach or in the offshore sand deposits that will be dredged to expand and replenish the beach. Although the current Waikīkī Beach shoreline is almost entirely engineered and unlikely to contain primary burials, the history and sources of the sand used to build and replenish the beach during the 20th century remain a concern to some individuals. Several consultants also expressed concern about the potential disturbance of modern cremated human remains in the submerged sand deposits immediately offshore from Waikīkī Beach where cremated remains are frequently spread. Alternatively, some consultants feel that the replenishment and stabilization of Waikīkī Beach will protect the burials and cultural deposits inland of the active beach (some of which are recorded as archaeological sites) from erosion damage.

Several consultants emphasized that the waters of Kawehewehe (also known as Gray's Beach or the Halekūlani Channel) in the Halekūlani sector are still actively used by *kūpuna* for healing and to *pikai* (purify). One consultant remembers that *limu kālā* (*Sargassum echinocarpum*) grew in Kawehewehe, and does not want the area to be disturbed. Two consultants from the City and County of Honolulu's Department

of Design and Construction cited the danger that coastal erosion poses to the existing causeway structures and lifeguard stations on the beach.

To address these concerns, IA recommends that project proponents take the following actions: [1] carefully evaluate new sources of replenishment sand to confirm they do not contain *iwi kūpuna* or other cultural material, [2] monitor all ground-disturbing project work within the historical (pre-20th century) shoreline areas for exposed or disturbed cultural material and develop a plan to protect these resources in consultation with cultural stakeholders/organizations and appropriate government agencies, [3] reasonably address concerns from community members about the disposition of cremated remains, [4] protect Kawehewehe from damage and allow cultural practitioners reasonable access to the area during construction work, and [5] regularly engage cultural stakeholders and the local community in future project planning.

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I. INTRODUCTION

At the request of Sea Engineering, Inc. (SEI), and on behalf of the Department of Land and Natural Resources (DLNR), Office of Conservation and Coastal Lands, International Archaeology, LLC (IA) prepared a cultural impact assessment (CIA) in support of the proposed Waikīkī Beach Improvement and Maintenance Program (Figure 1 and Figure 2). The beach improvement and maintenance program encompasses four sectors of Waikīkī Beach—Fort DeRussy, Halekūlani, Royal Hawaiian, and Kūhiō Beach—along the shoreline of Māmala Bay in the Kona District of the Island of O‘ahu, seaward of TMKs (1) 2-6-001:002, 003, 004, 008, 012, 013, 015, 017, 018, 019; 2-6-002:005, 006, 017, 026; 2-6-004:005, 006, 007, 008, 009, 010, 012; 2-6-005:001, 006; and 2-6-008:029. The CIA is a component of the program's Environmental Impact Statement (EIS) prepared by SEI for the DLNR. The proposed project includes the construction of new beach stabilization structures and shoreline replenishment primarily using sand recovered from offshore areas.

The purpose of the CIA is to collect information about the past and present cultural resources and practices associated with Waikīkī Beach in order to identify any issues and concerns that may arise from the proposed beach improvements and future maintenance activities. Individuals and organizations with historical and cultural knowledge of the project area were contacted by email or letter and invited to review and comment on the planned project work; the project was also introduced at a meeting of the O‘ahu Island Burial Council (OIBC) to elicit further comments. The results of these consultations are presented in this report, along with a summary of the traditional and historical background of the Waikīkī area and recommendations from previous CIAs for Waikīkī.

PROJECT AREA DESCRIPTION

Waikīkī Beach is an approximately 3,130-m (10,260-ft.) ocean shoreline along the southwest edge of the Waikīkī neighborhood of Honolulu, extending from a breakwater fronting the Hilton Hawaiian Village Waikīkī Beach Resort to the west to a groin fronting the New Otani (Kaimana) Hotel to the east. Almost the entire length of the beach is armored by seawalls and stabilized by groins that compartmentalize the shoreline into eight individual "littoral cells" or sectors. The Waikīkī Beach Improvement and Maintenance Program will affect four of these sectors (Figure 3 through Figure 7), which are described individually.

1. The Kūhiō Beach sector consists of approximately 460 m (1,500 ft.) of shoreline extending from the ‘Ewa (west) groin at Kūhiō Beach Park to the Kapahulu storm drain. The northwestern half of the sector (called the ‘Ewa basin here) was created in 1939 (Figure 3); the southeastern half of the sector (called the Diamond Head basin here) was built between 1951 and 1953 (Figure 4). The sector is essentially an enclosed body of water within a set of constructed crib walls and groins. It is at the southern end of the curving and protected portion of the Waikīkī coastline, between two of the three major stream outlets (Ku‘ekaunahi and ‘Āpuakēhau) that once flowed into the ocean.

2. The Royal Hawaiian sector consists of approximately 530 m (1,730 ft.) of shoreline extending from the Royal Hawaiian groin to the ‘Ewa (west) groin at Kūhiō Beach Park (Figure 5). It lies at an inward curve in the Waikīkī coastline that allows the development of a wide sand beach, and sits between two of the three major stream outlets (Ku‘ekaunahi and ‘Āpuakēhau) that once flowed into the ocean. This sector is the core of traditional and historical activity in Waikīkī.

3. The Halekūlani sector consists of approximately 440 m (1,450 ft.) of shoreline extending from the Fort DeRussy outfall groin to the Royal Hawaiian groin (Figure 6). The south-facing shoreline is a mix of seawalls and discontinuous, small, and narrow sand beaches that front a fully developed urban landscape. The Royal Hawaiian groin was constructed in 1925-1926; the Fort DeRussy groin was built in 1917 and was extended in 1969. The remains of at least five, 10- to 20-m concrete block groins are spaced along the length of the sector.

4. The Fort DeRussy sector consists of approximately 510 m (1,680 ft.) of shoreline extending from the Hilton Hawaiian Village pier to the Fort DeRussy outfall groin (Figure 7). The southwest-facing shoreline is a continuous sand beach that fronts a landscaped open space of tended lawn and coconut trees in the Fort DeRussy Armed Forces Recreation Center. The Hale Koa Hotel is just inland of the western portion of the sector, and the U.S. Army Museum of Hawai‘i, housed in the historic 1914 Battery Randolph, is at the eastern end of the sector. A wide concrete promenade runs along the inland edge of the beach.

THE WAIKĪKĪ BEACH IMPROVEMENT AND MAINTENANCE PROGRAM

The proposed Waikīkī Beach Improvement and Maintenance Program is intended to address the ongoing erosion of the shoreline and frequent flooding of the backshore. Without improvements and follow-up maintenance, sand erosion and rising sea level will likely result in the total loss of Waikīkī Beach by the end of the 21st century. The project's immediate goals are to restore and improve Waikīkī's public beaches, increase beach stability, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise.

The planned actions and construction methods for each beach sector in the project area are summarized below.

1. For the Kūhiō Beach sector, separate plans are proposed for the ‘Ewa basin (west) and the Diamond Head basin (east):

    a. For the ‘Ewa basin, the existing groins on the east and west ends will be removed and reconstructed to accommodate sea level rise (see Figure 3). The west groin will be approximately 150 feet long with a crest elevation of +7.5 feet mean sea level (msl), and the east groin will be approximately 125 feet long and vary in elevation from +7.5 feet msl at the shoreline to +6 feet msl at the head. A 125-foot-long detached breakwater will be built in the gap between the groins and will be approximately +6 feet mslto match the heads of the groins. Construction equipment and material would be transported to the work area through either the central portion of the park or along the shoreline past the Duke Kahanamoku statue. Demolition and construction will be conducted with an excavator that is supported by a temporary work platform extending from the shore to the breakwater. Sand fill from offshore deposits will be added to the beach after the new structures are completed.

    b. For the Diamond Head basin, existing structures will not be modified, but the beach will be replenished using eroded sand that has settled in a submerged deposit just offshore (see Figure 4). Approximately 4,500 cubic yards will be recovered and spread across the beach, widening the existing shoreline by approximately 18 to 26 feet and reducing the offshore depth of the basin to a uniform bottom elevation of -4 feet msl. The sand will be recovered and redeposited using either a long-reach excavator operating on an excavated sand causeway, or a diver-operated dredge that will pump the sand to an onshore recovery area. A bulldozer and/or skid-steer will spread the sand across the beach.

2. For the Royal Hawaiian sector, sand recovered from deposits directly offshore will be used to widen and replenish the beach (see Figure 5). The beach crest elevation will be increased from about +7 feet above mean sea level (msl) to +8.5 feet msl. Approximately 30,000 cubic yards of recovered sand will be required to complete the work. To counter ongoing erosion and shoreline recession, beach nourishment will need to be repeated every eight to 10 years or more frequently if required. The recovered sand will probably be dredged with a submersible pump mounted on a crane barge and pumped through a bottom-mounted pipeline to a dewatering basin in the Diamond Head basin of Kūhiō Beach Park. After drying, the sand will be stockpiled and transported to Royal Hawaiian, where it will be distributed using bulldozers.

3. For the Halekūlani sector, a new beach with stabilizing groins will be constructed (see Figure 6). Three new sloping rock rubble mound T-head groins will be combined with the existing Fort DeRussy and Royal Hawaiian groins to create four stable beach cells. The groin stems will extend approximately 200 feet seaward from the shoreline and will be of sufficient size to stabilize a +10-foot beach crest elevation. The groin stem crests could also be wide enough (approximately 10 feet) to accommodate construction equipment or a pedestrian walkway. The Halekūlani Channel will be left unobstructed for beach catamaran navigation. In addition, approximately 60,000 cubic yards of sand fill recovered from offshore deposits will be used to create approximately 3.8 acres of new dry beach area. Construction equipment and materials will likely be transported into the area across the east end of the Fort DeRussy sector, which may require construction of a temporary access road from Kalia Road to the beach and a temporary rock rubble mound access berm along the shoreline from Fort DeRussy to the Royal Hawaiian groin.

4. For the Fort DeRussy sector, sand will be transported from an accretion area at the west end of the beach (near the Hilton Pier) to an eroding area at the east end (see Figure 7). The sand will be excavated from the existing beach face extending inshore only as far as necessary to obtain the required amount, estimated to be approximately 1,200 cubic yards. Dump trucks will transport the sand across the beach, and a bulldozer will distribute it across the eroding area. This process will need to be repeated periodically in the future to maintain a stable beach profile.

Construction work will be confined to the active sand portion of Waikīkī Beach and nearshore marine areas up to approximately 200 feet offshore. The work will not extend outside the inland boundary of the active beach, which is defined by any buildings, roads, seawalls, or other types of construction that constrain the sand beach.

The sand required for beach nourishment will be almost exclusively recovered from submerged offshore deposits. In addition to the near-offshore areas mentioned in the descriptions above, sand will be dredged from one or more known deposits further offshore of the south coast of Oʻahu, using submersible slurry pumps, self-contained hydraulic suction dredges, and/or clamshell buckets.

ORGANIZATION OF THE REPORT

The CIA is organized as followings. Section I is the introduction, and contains a description of the project area and a summary of the proposed project work. Section II summarizes the cultural geography of the general Waikīkī area and the Waikīkī Beach sectors that will be affected by the proposed project work. It includes a discussion of local place names, the traditional history of Waikīkī before European contact, and the post-Contact history of Waikīkī through the mid-20th century. Section III presents the results of consultation with Waikīkī cultural stakeholders and community members who evaluated the project for potential cultural impacts. It also contains a summary of responses received following the presentation of the project at the February 2021 OIBC meeting. The section concludes with a summary of cultural recommendations for the Waikīkī Beach area compiled from previous Waikīkī CIAs (Gollin 2017). Section IV summarizes the major cultural issues that consultants identified after reviewing the proposed project work, and contains recommendations for addressing these concerns. References cited and a glossary of Hawaiian words used in the report follows Section IV. Appendix A is the consultation letter. Appendix B is a list of all individuals approached to provide cultural consultation for this CIA. Appendix C contains emails from consultants giving permission for their responses to be included in the CIA.

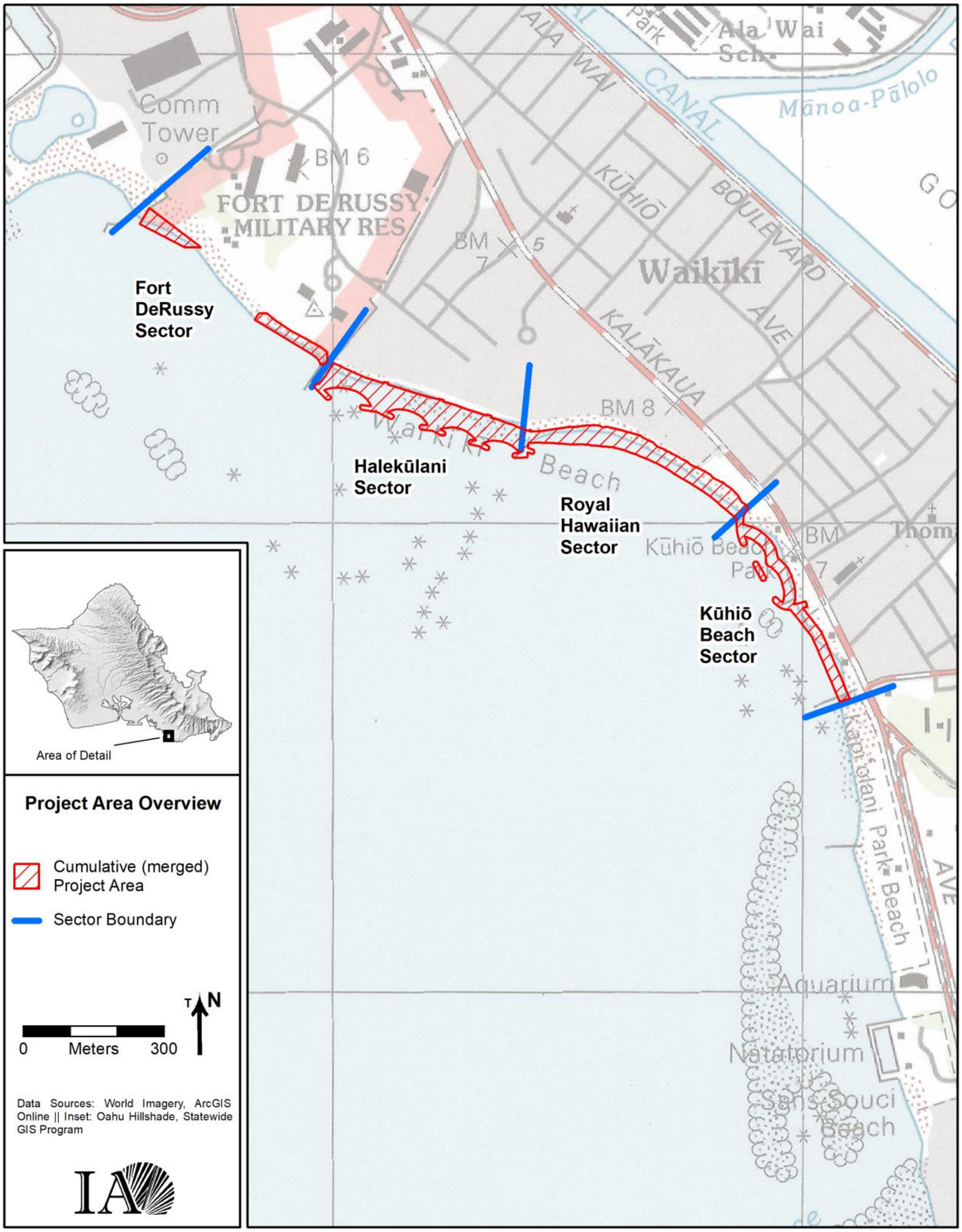

Figure 1. The Waikīkī Beach Improvement and Maintenance Program project area overlaid onto the Honolulu 1998 topographic quadrangle map.

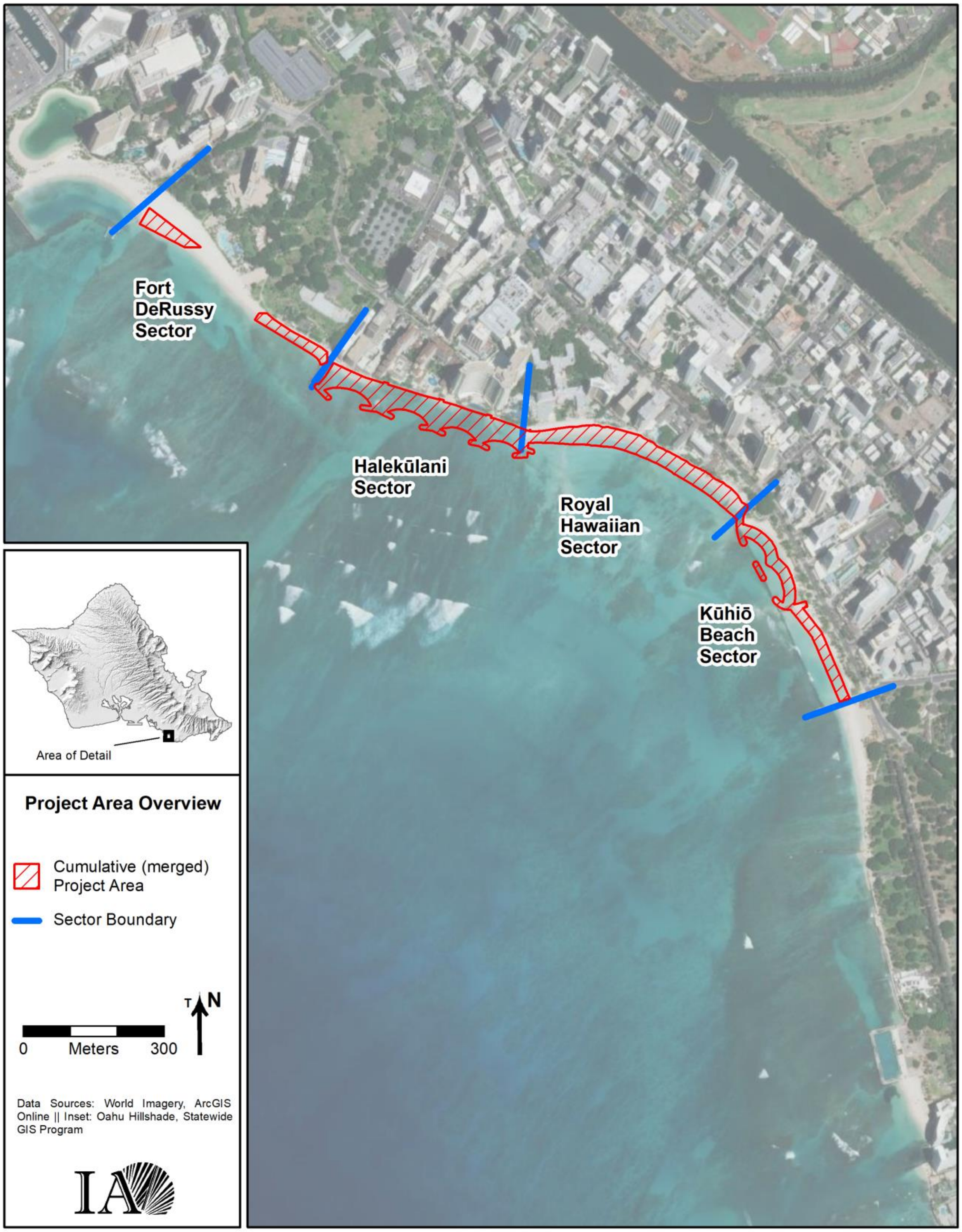

Figure 2. The Waikīkī Beach Improvement and Maintenance Program project area overlaid onto aerial imagery.

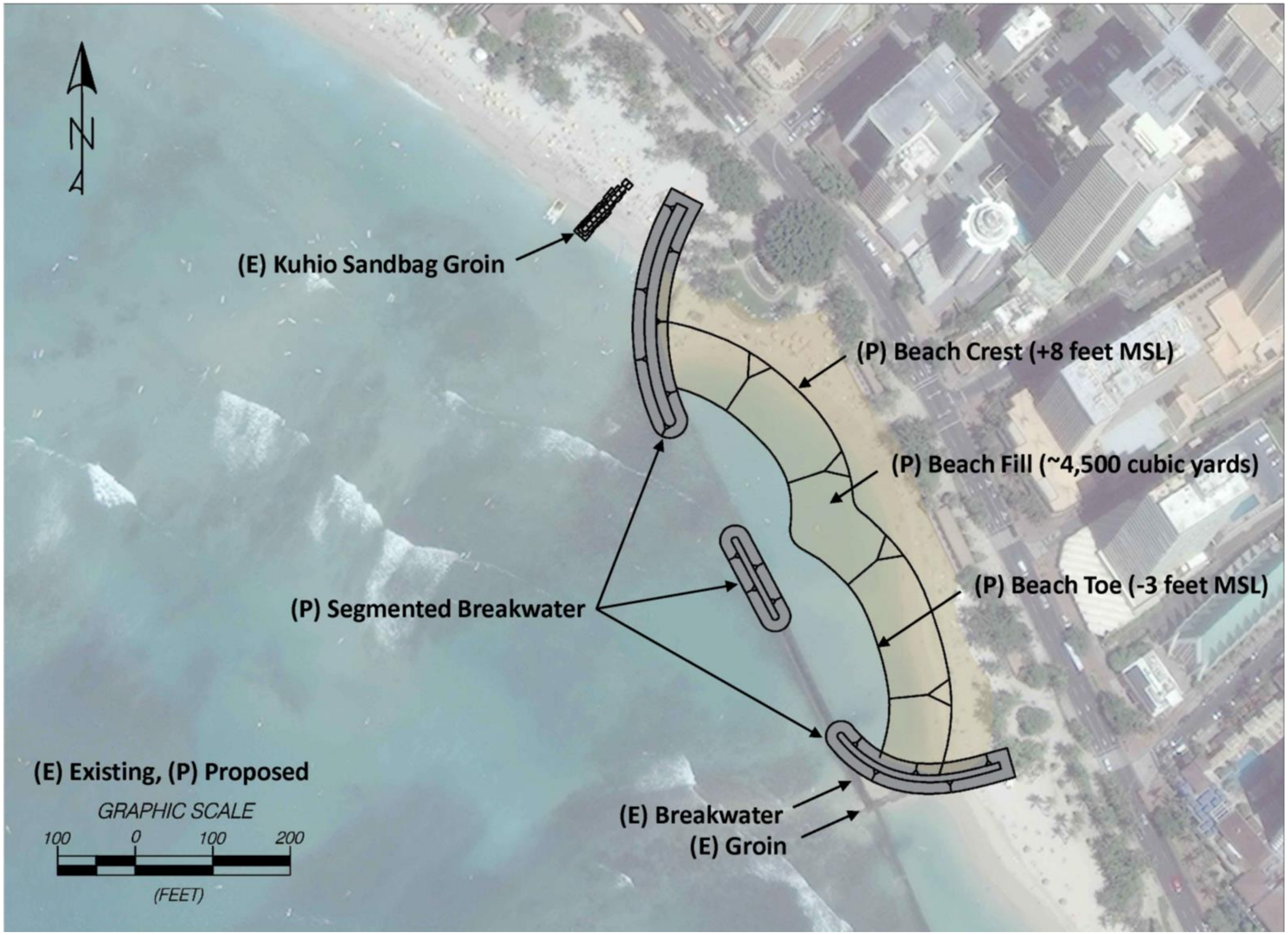

Figure 3. Planned beach improvement activates within the Kūhiō Beach sector, ‘Ewa Basin. Image provided by Sea Engineering, Inc.

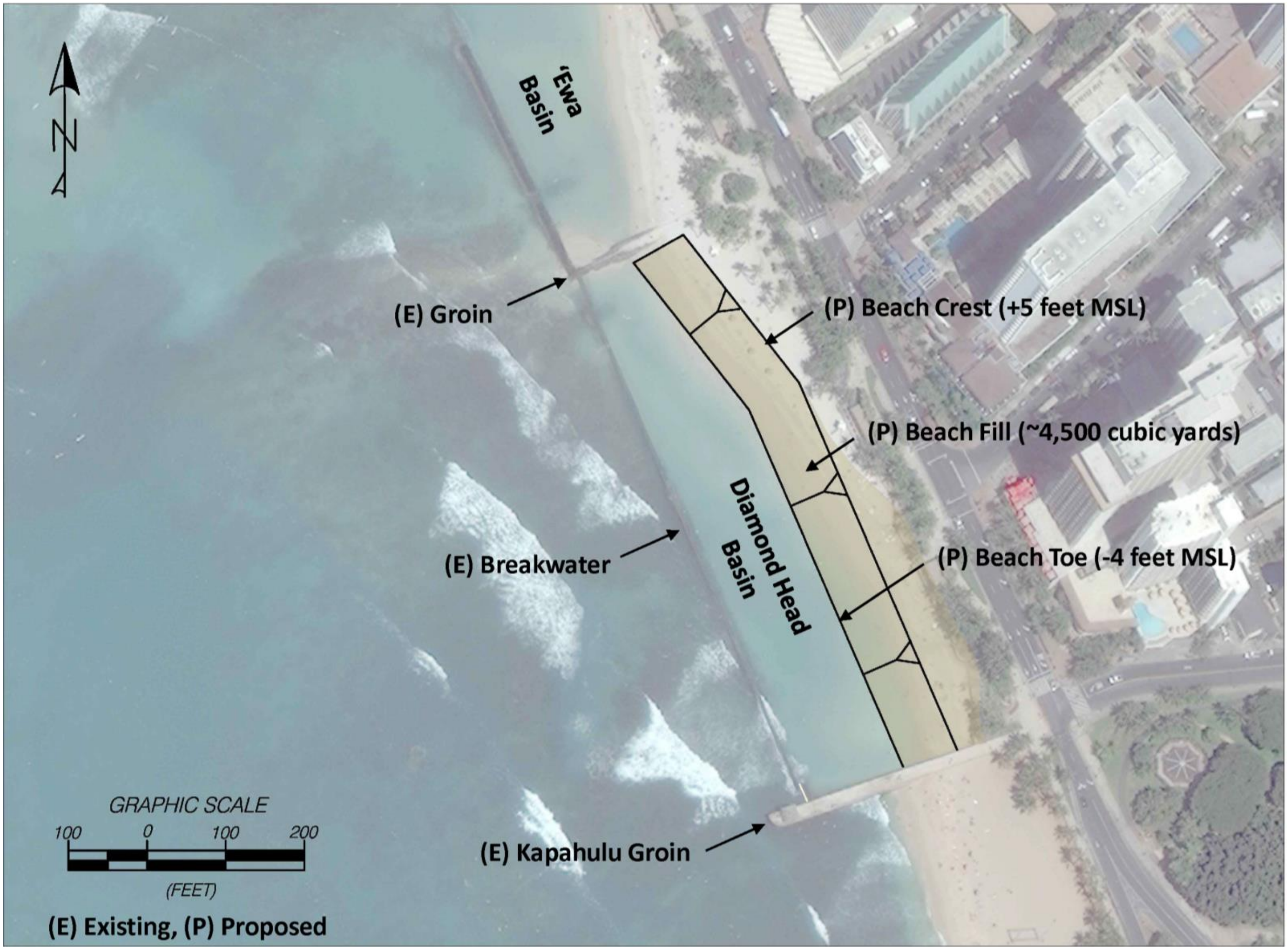

Figure 4. Planned beach improvement activities within the Kūhiō Beach sector, Diamond Head Basin. Image provided by Sea Engineering, Inc.

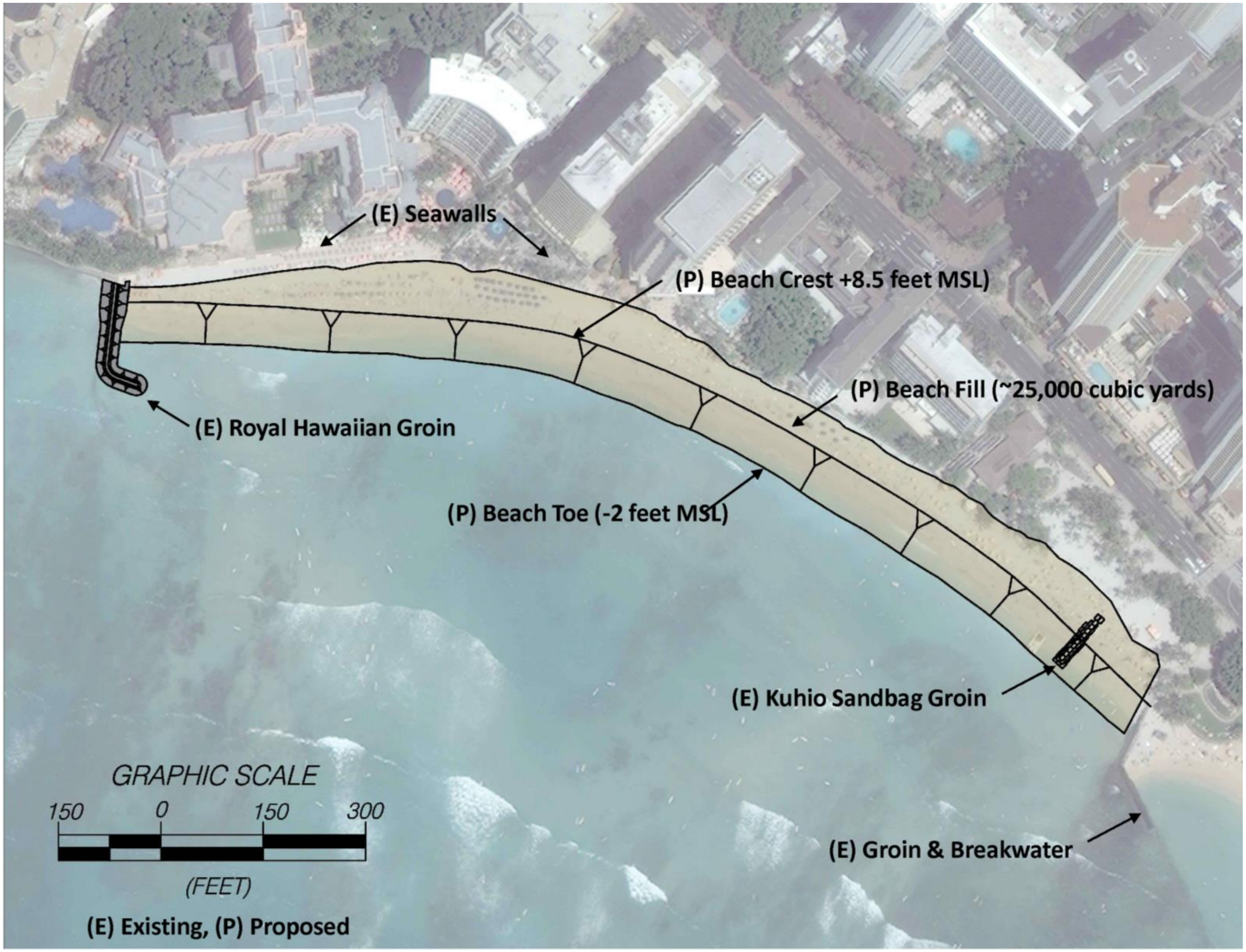

Figure 5. Planned beach improvement activities within the Royal Hawaiian sector. Image provided by Sea Engineering, Inc.

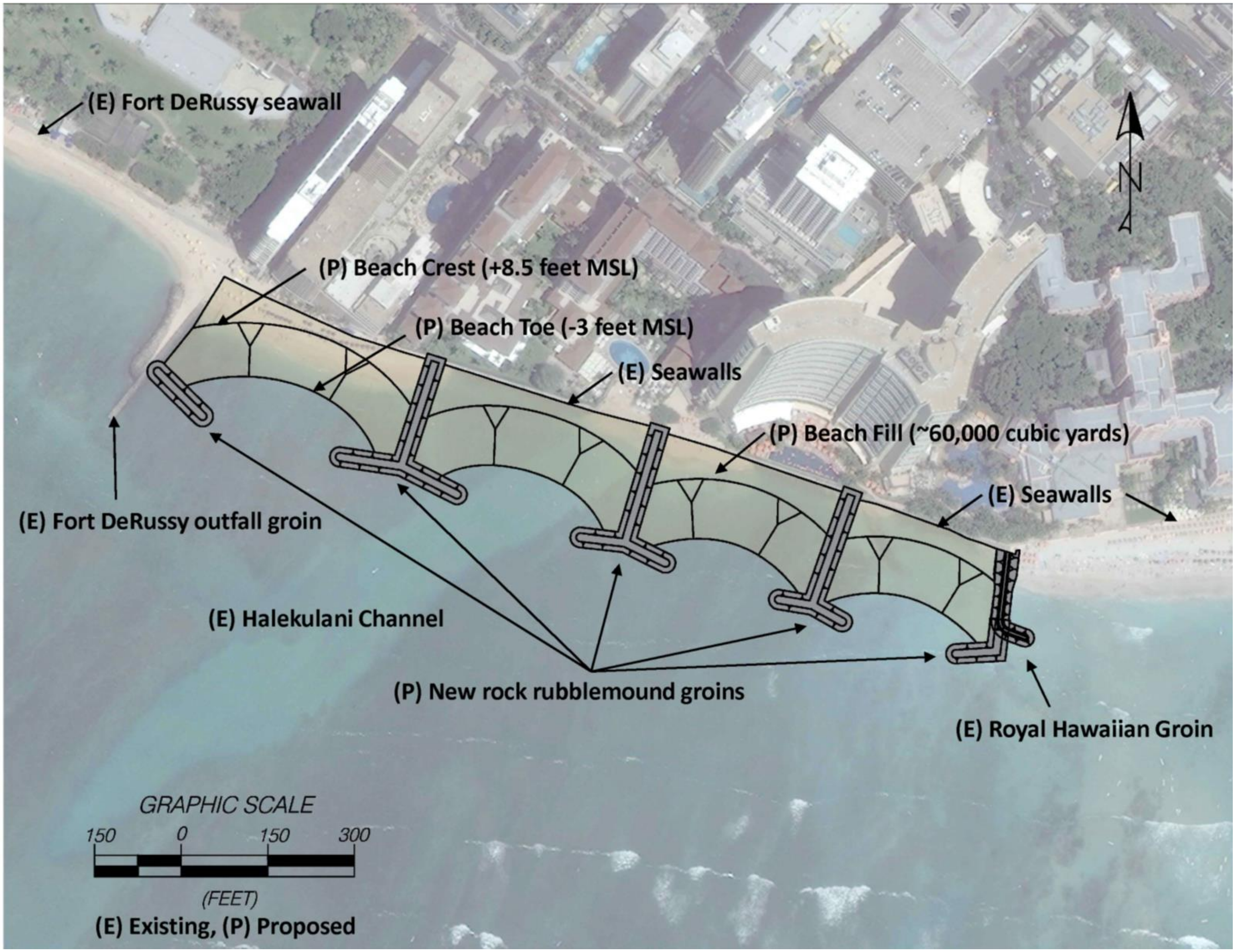

Figure 6. Planned beach improvement activities within the Halekūlani sector. Image provided by Sea Engineering, Inc.

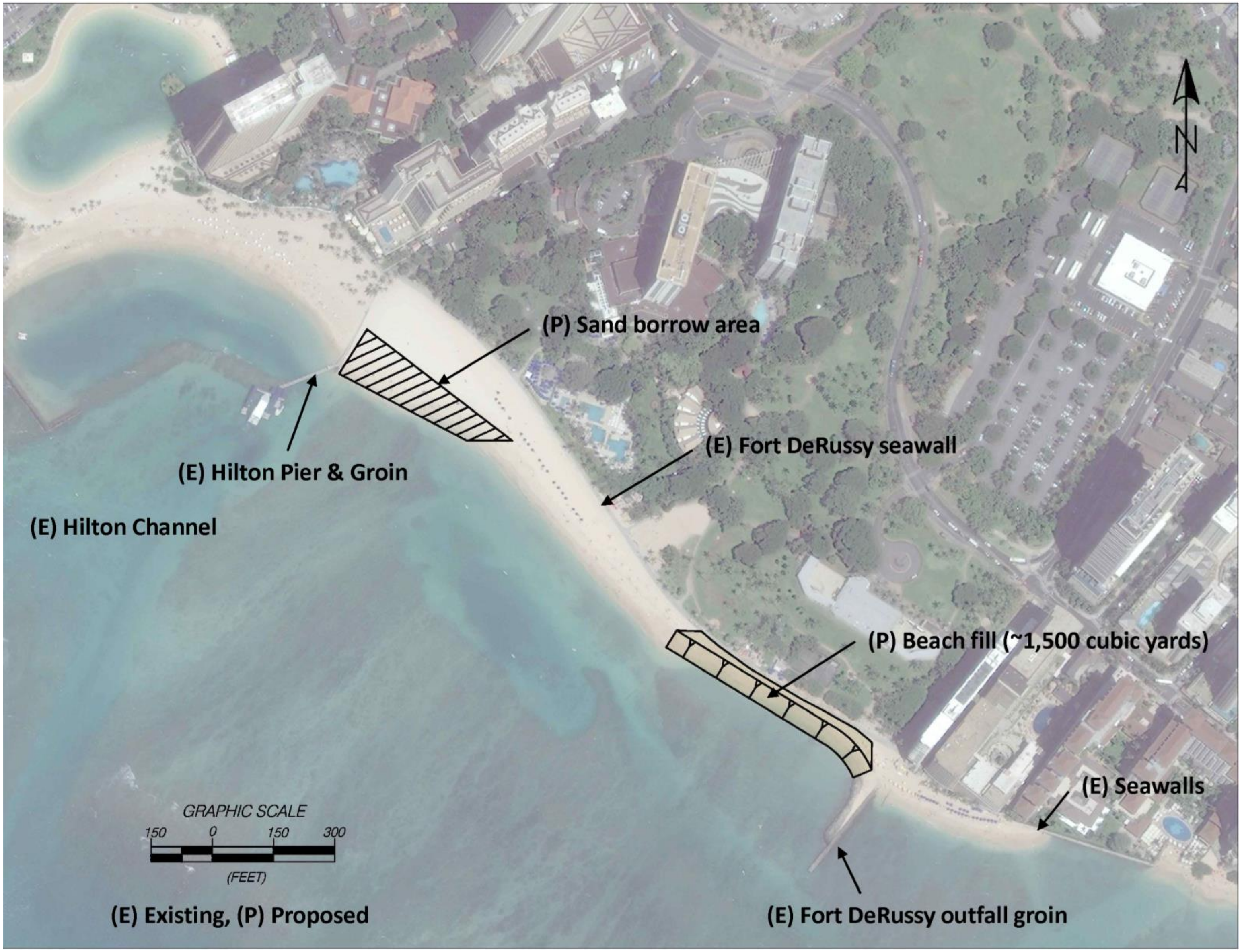

Figure 7. Planned beach improvement activities within the Fort DeRussy sector. Image provided by Sea Engineering, Inc.

II. CULTURAL GEOGRAPHY

This section provides an overview of the cultural geography of the Waikīkī area and the Waikīkī Beach sectors that will be affected by the planned improvement and maintenance program. Components of this section are [1] place names that indicate connections between physical locations in Waikīkī and traditional Hawaiian cultural practices, notable people, and important events; [2] the traditional history of Waikīkī, reflecting its political, economic, and spiritual significance in Hawaiian society before European contact; and [3] the history of Waikīkī following European contact in 1778, and its subsequent transformations in the approximately 200-year span through the mid-20th century.

This section has largely been adapted from Tomonari-Tuggle (2017) and Lauer et al. (2019). Both reports relied on primary references from Bishop (1881)[1], Kamakau (1976, 1991, 1992), Pukui et al. (1974), and Sterling and Summers (1978). Historical inform ation was also obtained from books and reports held in the IA library, the State Historic Preservation Division (SHPD) Kapolei Library, and the State Office of Environmental Quality Control online library of environmental assessments and impact statements (archaeological reports and CIAs are generally included as appendices).

PLACE NAMES

The project area falls within the *ahupua'a* of Waikīkī in the traditional district of Kona. Waikīkī includes the seven valleys from Mānoa on the west to Kuliʻouʻou on the east; in contrast, the western half of Kona district consists of smaller *ahupua'a* whose boundaries are generally coterminous with valley areas (e.g., Nuʻuanu, Kalihi, Kahauiki, and Moanalua). The reasoning behind this difference in *ahupua'a* size is unknown, although the political prominence of Waikīkī and the concentration of chiefs who came to live and play in this area may have been a factor (Tomonari-Tuggle and Blankfein 1998).

Waikīkī translates as "spouting water" (Pukui and Elbert 1986:223), in reference to the wetlands and abundant water sources of this region. Many traditional place names in Waikīkī relate to agriculture or the requirements for successful agriculture. Three place names (Waiʻaʻala, Waiaka, and Waikīkī) reference water (*wai*), one (ʻĀpuakēhau) may be the name of a rain, two refer to soil or sand (Kapahulu and Keʻokea), and three relate to food plants, *niu* (*Cocos nucifera*) (Niukūkahi and Uluniu) and *'uala* (*Ipomoea batatas*) (Kalauʻuala). The sea (ʻAuʻaukai and Hamohamo) is another theme; the place name Kanukuāʻula refers to a very fine-meshed fishing net. A single place name, Kaluaʻolohe, relates to a historical event and person.

Other Waikīkī place names refer to locations where events recounted in Hawaiian traditions occurred, or places that are related to Hawaiians of historical note (Table 1; Figure 8). An example of the former is ʻĀpuakēhau (in the Royal Hawaiian sector, roughly where the Royal Hawaiian Hotel sits), which is said to be where the Maui king Kahekili landed his invasion force in his successful conquest of Oʻahu (Fornander 1919:VI-2:289; Kanahele 1995:79); the general area was called Helumoa and was the site of royal residences, a *heiau*, athletic grounds, and a royal coconut grove. Another example is Kawehewehe (at the boundary between Halekūlani and Fort DeRussy sectors), which was the residence of the Luluka family of noted Hawaiian historian, John Papa ʻĪʻī. The family moved to Oʻahu in the early 1800s, in the company of Kamehameha who was preparing for the invasion of Kauaʻi (ʻĪʻī 1959:15); Papa ʻĪʻī's uncle was a member of

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[1] S.E. Bishop completed a survey and map in 1881. He reconstructed the map with a different datum in 1888, and in 1922, Joseph Iao copied the map "with additions and alterations from Government Survey Records."

the royal court, and members of the Luluka family were responsible for the royal residence of Kamehameha at Pua‘ali‘ili‘i at Helumoa.

Traditional place names are associated with each of the Waikīkī Beach sectors included in the proposed project area. In the Fort DeRussy sector, the two place names are Kālia, which is the traditional Hawaiian name for this general area, and Kawehewehe, which is the name of the former drainage that marks the east side of the sector (roughly the alignment of Saratoga Road).

Prior to modern development, the Halekūlani sector lay between two drainages, ‘Āpuakēhau to the east (in the Royal Hawaiian sector) and Kawehewehe to the west (along the boundary with the Fort DeRussy sector). Kawehewehe was the outflow from the large fishpond complex of Kālia, the inland area of present Fort DeRussy. As markers of a former landscape, ‘Āpuakēhau and Ku‘ekaunahi are important as the names of two of the three major drainages that once cut through the Waikīkī coastal plain (see above).

The single place name in the Halekūlani sector is Kawehewehe, which refers to the land and sea area at the west end of the sector, as well as to the mouth of a drainage that emptied the fishponds of inner Kālia (roughly along the present alignment of Saratoga Road). It might also be the name of the channel through the reef in front of the present Halekūlani Hotel (Pukui et al. 1974:99).

Place names in the Royal Hawaiian sector reflect the *ali‘i* connections to the area: Helumoa as the royal center, Helumoa Heiau and Kahuamokomoko as adjuncts to the royal center, Hamohamo along the coast as part of Lili‘uokalani’s birthright, and Pualeilani as the first beach home of Prince Kūhiō. Another historical place is Muliwai ‘Āpuakēhau, which was the mouth of ‘Āpuakēhau Stream, which was one of three major drainages that flowed into Waikīkī waters.

The Kūhiō Beach sector contained Lili‘uokalani’s beachside residence, Kealohilani (Kanahele 1928b), which was subsequently the Pualeilani home of Prince Jonah Kūhiō Kalaniana‘ole. In the mid-century Māhele, the *‘ili* of Hamohamo was awarded to the high chief Keohokālole. In 1859, Keohokālole transferred the land to her daughter Lili‘uokalani (future queen of Hawai‘i), who established a residence at Paoakalani (*makai* of the present Ala Wai Canal) and a beachside cottage that she called Kealohilani. In 1918, Prince Kūhiō acquired Kealohilani through an out-of-court settlement of his challenge to Lili‘uokalani’s establishment of a trust (Hibbard and Franzen 1986:37), and built a new home called Pualeilani on the property.

Until the late 1800s, Ku‘ekaunahi Stream flowed as a wide and slow-moving estuary into the ocean in the southern portion of the Kūhiō Beach sector (the Diamond Head basin, around the present alignment of Paoakalani Avenue). Another historical place in the Kūhiō Beach sector is Muliwai Ku‘ekaunahi, which was the mouth of Ku‘ekaunahi Stream. This stream was one of three major drainages that flowed into Waikīkī waters.

Table 1. Place Names of Waikīkī Within or Near the Project Area.

Name	Description	Translation	Reference
ʻĀpuakēhau	stream, *muliwai*; site of present-day Moana Hotel	basket [of] dew, probably named for a rain	Bishop (1881, 1882) Kamakau (1991:50, 1992)
ʻAuʻaukai	land area; designated Fort Land	to bathe in the sea	Bishop (1882); Pukui and Elbert (1986)
Halemauʻuola (Loko Halemauʻuola)	fishpond	--	Bishop (1881)
Hamohamo	land area *(ʻili lele*?)	rub gently (as the sea on the beach)	Bishop (1881, 1882)
Helumoa	name of *ʻili* that was a royal center from at least the 15th century; site of present-day Royal Hawaiian Hotel	chicken scratch (chickens scratched to find maggots in the victim's body, possibly a reference to a sacrificial *heiau* formerly at that location)	Bishop (1881); Nāpōkā (1986); Kanahele (1995); Pukui et al. (1974:44)
Kaʻihikapu (Loko Kaʻihikapu)	fishpond	the taboo sacredness	Bishop (1881); Pukui et al. (1974)
Kawehewehe	stream, *muliwai*; outlet for fishpond complex in inland Kālia (Fort DeRussy); shown as "Muliwai Kawehewehe" on GRM 1720 (n.d.) but not on other historical maps	the removal	Reg. Map 1720; Pukui et al. (1974:99)
Kawehewehe	location of the residence of John Papa ʻĪʻī, an advisor to Kamehameha, from around 1803 when Kamehameha moved to Oʻahu; also the "reef entrance and channel off Gray's Beach, just east of the Hale-kū-lani Hotel, Waikīkī, Honolulu"; the sea water of Kawehewehe is said to have had healing qualities and was known for its fragrant *līpoa* seaweed	the removal	ʻĪʻī (1959:17); Pukui et al. (1974:99); Kanahele (1995:98); McGuire et al. (2001:69-70); Pukui (1983:246)

Name	Description	Translation	Reference
Kahuamokomoko	athletic field, including *ʻulu maika* field, said to be on grounds of Royal Hawaiian Hotel; see Site 9980	*kahua mokomoko*, “a place where people assembled to wrestle”(Andrews 1922:239)	McAllister (1933:77); Kanahele (1995:99)
Kālia	name of *ʻili* and general area of Fort DeRussy	waited for	Bishop (1881); Pukui et al. (1974:77)
Kapuni	land area, surf break	the surrounding (perhaps named for the spreading banyan tree on the Cleghorn ʻĀina-hau estate)	Bishop (1881); Kamakau (1991:44, 1992b:290)
Kapuʻuiki (Loko Kapuʻuiki)	fishpond	the small hill	Bishop (1881); Thrum (1922:646)
Kaohai (Loko Kaohai)	fishpond	the ʻ*ōhai* shrub (*Sesbania tomentosa*)	Bishop (1881); Thrum (1922:644)
Kealohilani	beachside home of Queen Liliʻuokalani; later site of Prince Kūhiō’s second Pualeilani home; this is just seaward of Site 5859	heavenly brightness	Pukui et al. (1974:102)
Kekio	land area	pool	Bishop (1881, 1882); Thrum (1922:650)
Keōmuku Kamoku Kamaku	land area	the shortened sand	Bishop (1881, 1882); Pukui et al. (1974:108)
Kuʻekaunahi Kukaunahi Kukaʻiunahi	stream, *muliwai*; see Site 5943	--	Bishop (1881, 1882); Kamakau (1964:74); Winieski et al. (2002)
Kūihelani	Kamehameha’s residence at Puaʻaliʻiliʻi near the mouth of ʻĀpuakēhau Stream	standing at Helani (a mythical land), name of one of Kamehameha’s chiefs	Kanahele (1995:136); Pukui et al. (1974:120)
ʻŌʻō (Loko ʻŌʻō)	fishpond	black honeyeater, *Moho nobilis*	Bishop (1881); Pukui et al. (1974:171)

Name	Description	Translation	Reference
Paweo (Loko Paweo I/Loko Paweo II)	fishpond	turn aside	Bishop (1881); Pukui et al. (1974:182)
Pi‘inaio	stream, *muliwai*, *kahawai*	ascend for (go upstream in search of?) *naio*, *Myoporum sandwicense*	Bishop (1881, 1882); Thrum (1922:666)
Pua‘ali‘ili‘i	place of Kamehameha’s residence Kūihelani near the mouth of ‘Āpuakēhau Stream	little pig	Kanahele (1995:91); Pukui et al. (1974:190)
Pualeilani	name of two residences of Prince Kūhiō; see Site 5859 and Site 5863	royal garland of flowers	Hibbard and Franzen (1986:37-39)
Uluniu	land area	coconut grove	Pukui et al. (1974:215)

Figure 8. Place names plotted along the late 19th century Waikīkī coastline.

TRADITIONS

The chronology of pre-Contact occupation along the Waikīkī shoreline is based on a suite of 16 radiocarbon determinations obtained from previous archaeological investigations in the area. The radiocarbon determinations are problematic in that most samples were run on unidentified charcoal which has potential to produce dates with inbuilt age (i.e., dates that are older than the target event). Considering this limitation, the use of Bayesian modeling provides the best current estimate for occupation along the Waikīkī shoreline of no later than *AD 1350–1610 (95.4%),* and likely *AD 1379–1600 (68.2%)* (Tomonari-Tuggle 2017).

The earliest Hawaiian settlers probably made their homes on the windward shores of the islands, and visited the drier southern and western areas only for selected resources like fish and birds. As time passed and settlers eventually migrated to other parts of O‘ahu, coastal Waikīkī was probably one of the earliest areas occupied as it offered easy access to rich ocean resources, a ready freshwater supply from springs and streams, level and easily developed lands for cultivation and aquaculture, and a bounty of game foods like ducks and other wildfowl. Some cultivation probably followed the stream courses into valleys like Mānoa, which were also sources for items like hardwood (for tools, weapons, and building materials) and birds (for feathers) (Tomonari-Tuggle and Blankfein 1998).

The traditions of Waikīkī indicate its significance as a nexus of interconnected *ali‘i* histories and as a highly productive agricultural region. In ancient times, Waikīkī was a center of *ali‘i* power, “a land beloved of the chiefs” who resided there because the lands were rich and the surfing was excellent (Kamakau 1991:44).

CHIEFLY ASSOCIATIONS

It is said that Mā‘ilikūkāhi, the ruling chief of O‘ahu in the mid-14th century (based on genealogical reckoning), made Waikīkī the royal seat of chiefs (Beckwith 1970:383). From that time, it was the residence, either permanently or part-time, of the high *ali‘i*. In the 16th century, the Maui chief Kiha-a-Pi‘ilani was born at ‘Āpuakēhau (Kamakau 1991:50). In the 18th century, after his conquest of the island, Maui king Kahekili made his home at Waikīkī, as did Kamehameha after he succeeded in wresting control of the island from Kahekili’s successor. Kamakau (1992:394) writes that Kamehameha made Kekāuluohi his wife at ‘Āpuakēhau; she later became one of Liholiho’s five wives and through a later husband, Kana‘ina, she bore Lunalilo, who would become the first elected Hawaiian king after the death of Kamehameha V in 1872.

Helumoa and Ulukou, areas at the mouth of ‘Āpuakēhau Stream, were the focal points of chiefly residence. The stream emptied into a protected curve of the shoreline that created a “famous surfing spot called Kalehuawehe” (Nāpōkā 1986:2). Rich fishponds lay to the west, and the expansive inland wetlands produced a bounty of *kalo* and other crops. The ocean provided an array of fish. A visitor in the 1850s described a typical catch (Nāpōkā 1986:3, quoting Harriet Newell Foster Deming):

> Sometimes four canoes would be drawn up on the beach at once, filled with shining beauties in nets … the wealth of color fascinated us as we hung over the sides of the canoes watching the bronzed fishermen who, naked except for a loincloth, scooped up the fish in their hands and laid them in piles on the sand.

AGRICULTURE AND FISHPONDS

Waikīkī was famous for its extensive irrigated pondfields and fishponds that covered the coastal plain “from the inland side to the coconut grove beside the sea” (Kamakau 1991:45). Fed by the waters of Mānoa and Pālolo Valleys and by the numerous springs that gave Waikīkī its name, the wetland system of expansive *lo‘i* is credited to the 15th century ruling chief Kalamakua-a-Kaipūhōlua (Kamakau 1991:45):

> He was noted for cultivating, and it was he who constructed the large pond fields Ke‘okea, Kūalulua, Kalāmanamana, and the other *lo‘i* in Waikīkī. 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 (1992:192) also credits Kamehameha with the creation of the extensive pondfield system, including the pondfields attributed to Kalamakua-a-Kaipūhōlua, but this likely reflects Kamehameha's modification or expansion of extant *lo‘i*.

HEIAU

The significance of Waikīkī Ahupua‘a is also emphasized by the number and kinds of *heiau* distributed across this area, particularly along the coast (Kamakau 1976:144; Thrum 1907:44-45). Three of the eight *heiau* identified by Thrum (1907) (Table 2) are of the *po‘o kanaka* class, i.e., sacrificial *heiau* that were "only for the paramount chief, the *ali‘i nui*, of an island or district (*moku*)" (Kamakau 1976:129).

Table 2. Heiau in Waikīkī, Based on Thrum (1907).

Name	Location	Type	Description from Thrum (1907)
Helumoa	‘Āpuakēhau	*Heiau po‘o kanaka*	place of sacrifice of Kauhi-a-Kama, defeated *mō‘ī* of Maui, after his failed raid on O‘ahu in early 1600s; during the reign of O‘ahu chief, Ka‘ihikapu
Papa‘ena‘ena	at foot of Diamond Head slope	*Heiau po‘o kanaka*	walled and paved structure of open terraced front; destroyed by Kana‘ina about 1856, and the stones used to enclose Queen Emma's premises and for road work; said to be the place of a number of sacrifices by Kamehameha I in early 1800s
Kupalaha	Kapi‘olani Park	unknown	said to be associated with working of Papa‘ena‘ena; entirely obliterated by 1906
Kapua	Kapi‘olani Park	*Heiau po‘o kanaka*	torn down in 1860; said to be the place of sacrifice of Kaolohaka, a chief from Hawai‘i, on suspicion of being a spy
Kamauakapu	Kapahulu, Diamond Head	husbandry class	erected by Kalākaua in 1888 for his Naua Society; in partial ruins in 1906
Kulanihakoi	Waikīkī	unknown	site of grass house on Kalākaua's premises; in ruins in 1862 (walls torn down much earlier)
Makahuna	Diamond Head	Ku‘ula class	large enclosure dedicated to Kāne and Kanaloa
Pahu-a-Maui	Diamond Head (site of lighthouse station)	unknown	destroyed by 1906

BATTLES

In the late 1700s, warfare in the islands raged. High chiefs amassed huge armies and sailed flotillas of war canoes between islands in a quest for territorial expansion. At least two assaults on Oʻahu took place on the beaches of Waikīkī. From Maui in 1779 came the warrior-chief Kahekili, who conquered Oʻahu after three years of fighting. With victory, the high chief made Waikīkī his home, specifically at Helumoa near the mouth of ʻĀpuakēhau Stream (the location of Helumoa Heiau). After some time on Maui and Hawaiʻi, Kahekili returned to Waikīkī, where he died in 1794. He was succeeded by his son, Kalanikūpule.

A year later, in 1795, Kahekili's chief rival for power, Kamehameha, staged an attack on Oʻahu. It is said that his armada, which included 1,200 double canoes and 10,000 warriors, landed at Waikīkī, a beachhead of relatively calm waters and sandy beaches that offered abundant water, *kalo*, and other supplies for his vast army (Kanahele 1995:87). Unlike Kahekili's three-year battle, Kamehameha was quickly successful in defeating his adversary, Kalanikūpule, and taking control of Oʻahu. Like the Maui chief, Kamehameha settled in Waikīkī near the mouth of ʻĀpuakēhau Stream. Along with Kona on Hawaiʻi Island and Lāhaina on Maui, this served as one of the capitals of his unified (except for Kauaʻi) kingdom.

HISTORICAL BACKGROUND

In 1778, British Captain James Cook made first Western landfall in Hawaiʻi, and other European and American explorers, traders, and missionaries followed. Many wrote accounts and journals that provide an image of the wetland agricultural landscape of Waikīkī. For example, Archibald Menzies (1920:23-24), an early Western visitor who was naturalist and surgeon on board the *HMS Discovery* captained by George Vancouver (in Hawaiʻi in 1792-1793), described a visit to Waikīkī:

> 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.… We pursued a pleasing path back to 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 luxuriance of its productions. Here and there we met with ponds of considerable size, and besides being well stocked with fish, they swarmed with waterfowl of various kinds such as ducks, coots, water hens, bitterns, plovers and curlews.

Although Waikīkī was the initial capital and residence of Kamehameha on Oʻahu, the growing number of American and European traders looked to the harbor at Kou (present Honolulu) as a safer and therefore favored berth for their deeper draft ships. In the first decade of the 19th century, Kamehameha gradually shifted his capital to that once rural village, and by 1809, he had an established residence near the Honolulu harbor frontage. His family and members of court and government also made the move, leaving Waikīkī in the care of lesser chiefs and land managers (Kanahele 1995:104-105).

Waikīkī, however, remained an attraction for the *aliʻi*. Only three or so miles from Honolulu, it was the only place near the city with beaches and surf, and provided an easy escape from the increasingly Western atmosphere of the new capital (Hibbard and Franzen 1986:10). *Aliʻi*, particularly members of the Kamehameha extended family, built beach cottages on the ocean front. As the 19th century progressed, they replaced their grass roofed, wooden buildings with more elaborate and modern homes. Hawaiian chiefs and royalty were joined by *haole* residents and visitors to form a relaxed community. By the late 19th century, the homes of *aliʻi* like Emma (wife of Kamehameha IV), Kapiʻolani (wife of Kalākaua), and Liliʻuokalani (Queen of Hawaiʻi) were located between ʻĀpuakēhau and the present Kapiʻolani Park, and residences of *haole* businessmen like Davies, Robinson, Brown, and Damon were on the beachfront west of ʻĀpuakēhau (Wall 1893). The beginnings of the Waikīkī tourist trade were also represented at this time by the presence of the Long Branch, the earliest known bathing establishment at which visitors were provided "a towel, bathing suit, dressing rooms and a stretch of beach and ocean to enjoy" (Hibbard and Franzen 1986:52), and the W.C. Peacock property ("Peacock's"), which would become the site of the first major hotel in Waikīkī, the Moana Hotel, in 1901.

MID-19TH CENTURY LAND PARCELS

In the mid-19th century, major structural changes were made to the ways land was held in Hawaiʻi. In 1848, the traditional system of land tenure was replaced with a Western system of fee-simple land ownership. This radical restructuring, called the Māhele, divided all lands between the king and 245 high-ranking *aliʻi*; the king later divided his lands between himself (called Crown Lands) and the government (Kameʻeleihiwa 1992). Subsequently, commoners were offered the opportunity to claim fee-simple title to the land on which they lived or improved; these became known as *kuleana* lands and were awarded in the form of Land Commission awards (LCAs; often referred to as *kuleana* lands).

Unlike most *aliʻi* land awards that were for entire *ahupuaʻa*, *aliʻi* awards in the *ahupuaʻa* of Waikīkī were for *ʻili*. As Kameʻeleihiwa (1992:232) explains, land on Oʻahu was desirable and therefore *ʻili* on Oʻahu were as valuable as *ahupuaʻa* on the other islands:

> On Oʻahu, the moku of Kona (especially in Honolulu and Waikīkī), ʻEwa, and Koʻolaupoko were defined predominantly by ʻili. This division of ʻĀina into a great number of rather small areas indicates that Oʻahu was not only more populated, but its ʻĀina were more desired by the Aliʻi and konohiki.… Although an ʻili was almost always smaller in size than an ahupuaʻa, an ʻili on Oʻahu was considered as desirable as an ahupuaʻa on the outer islands.

About 250 Land Commission awards (to six *aliʻi* and the remaining to local land managers and commoners) were made in Waikīkī (Kanahele 1995:115). The *aliʻi* awardees included Kauikeauoli (Kamehameha III) (62 acres), high chiefs William Lunalilo (2,229 acres) and Ana Keohokālole (100 acres), and three lesser-ranked chiefs, Mataio Kekūanaōʻa (133 acres), Keoni Ana (11 acres), and Kaisara Kapaʻakea (9 acres). As noted by Kanahele (1995:116), "Their properties all included choice spots located near the beach, streams or fish ponds." It is notable that the heirs of these *aliʻi* awardees include the monarchs Kamehameha V, David Kalākaua, and Liliʻuokalani; queen consorts Emma Rooke and Kapiʻolani; Princesses Ruth Keʻelikōlani, Likelike, and Kaʻiulani; and Prince Jonah Kūhiō Kalanianaʻole.

Kuleana awards, most of which were generally less than an acre, lined the Waikīkī shore, with associated inland pieces that provided land for farming. Of the shoreline *ʻāpana*,[2] two fall in the Fort DeRussy sector, ten in the Halekūlani sector, three in the Royal Hawaiian sector, and one in the Kūhiō Beach sector. There were no LCAs awarded south of Kuʻekaunaha Stream (roughly the alignment of present Paoakalani Avenue).

THE LATE 19TH CENTURY

In the second half of the 19th century, changes to the Waikīkī landscape entailed improvements to transportation connections between Waikīkī and Honolulu, including construction of a tram line between the

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[2] Only those LCAs that fall in or adjacent to the Waikīkī beach improvements project area are counted.

two areas, and the development of Kapiʻolani Park and an associated residential neighborhood on June 11, 1877 (Brown and Monsarrat 1883).

In the 1860s, rice cultivation experienced a boom across the islands, directed at two markets: export to California for Chinese emigrants who had settled there after the mid-century Gold Rush and local consumption by a growing number of Chinese contract laborers who had come to Hawaiʻi to work on the sugarcane plantations (by 1884, there were 18,254 Chinese in the islands; see Coulter and Chun 1937:13). Rice was second only to sugar in the economic hierarchy in the islands (Haraguchi 1987:xiii). Like sugar, Hawaiʻi's rice production filled the void created by the U.S. Civil War, when rice farming in the southern United States was severely curtailed (Coulter and Chun 1937:13). During negotiations for the Reciprocity Treaty between the U.S. and Hawaiian governments, efforts were made to ensure that rice shared the same protection as sugar.

Land speculators purchased *kalo* fields, and in some cases, pulled up young *kalo* plants to replace them with rice seedlings (Haraguchi 1987:viv). Many *kuleana* owners leased their former *kalo* fields to rice entrepreneurs, although in some cases, they retained land for the Hawaiian staple food. By 1892, there were 542 acres in Waikīkī planted in rice, representing almost 12 percent of the total 4,659 acres in rice cultivation on Oʻahu (Hammatt and Shideler 2007:17). Nakamura (1979:20, quoting Iwai 1933:80, brackets added) notes that Waikīkī was one of "the most important [rice] growing districts on Oahu."

At the end of the 19th century, Waikīkī Road (roughly the alignment of the present Kalākaua Avenue) marked the boundary between fishponds and beach lots to the *makai*, and rice fields to the *mauka* (Monsarrat 1897). Kapahulu Avenue was the southeastern boundary of the rice fields, with the gridded Kapahulu house lots and Kapiʻolani Park extending toward the base of Diamond Head (the Kapahulu lands to the east of the present Kapahulu Avenue appear to have been planned for subdivision in 1899, see Monsarrat 1899).

20TH CENTURY LANDSCAPE CHANGES

The 20th century saw the definitive transformation of Waikīkī from quiet retreat and agricultural breadbasket to a bustling tourist destination. As the popularity of Waikīkī among residents—particularly the foreign/*haole* population—and visitors grew, the region was eyed for development. Kapiʻolani Park in 1877 was originally developed as a private recreational/open space amenity for high-end residences at the base of Diamond Head and along the coast (Brown and Monsarrat 1883). In the early 20th century, the extensive wetlands complex on the coastal plain was valuable for rice cultivation and raising ducks, but was described as "swamp lands" by those who had visions of development. As noted by Steele (1992:8-3), "in the eyes of many in Honolulu, [it could] be put to better use … but only if the land could be 'reclaimed' (filled in)." The first effort in Waikīkī reclamation was by the U.S. Department of War in its development of Fort DeRussy at the western end of Waikīkī, which required filling in a large portion of the fishponds.

The agricultural landscape of Waikīkī was nearing its end, victim to the allure of Waikīkī as a resort destination. Nakamura (1979:34) writes:

> A conflict was developing at Waikiki between wet agriculture and aquaculture, on the one hand, and urbanization on the other. Urbanization was adversely affecting the good and proper drainage of surface water flowing from the mountains to the sea. This restricted water, in turn, was labeled unsightly and unsanitary by those who wished to see wet agriculture and aquaculture at Waikiki destroyed.

By the end of the first decade of the 20th century, the rice fields and duck ponds that once covered the entire coastal plain inland of Kalākaua Avenue appear to have been contracted to the northwest, leaving the eastern portion of the wetlands complex as pasture or open fields, with scattered buildings and a network of dirt roads (U.S. Army 1909-1913).

ALA WAI CANAL

The primary impetus for landscape change was construction of the Ala Wai Canal in the 1920s. The canal effectively cut off Waikīkī from the rest of the Honolulu urban and suburban landscape, and created developable lands where before there were the expansive wetland agricultural fields. In addition, the canal was seen as remedying a perceived impact of outflow from the wetlands on the growing bathing industry: "the proposed drainage canal would carry the runoff away from the Waikīkī beaches" (Steele 1992:8-4).

Using so-called unsanitary conditions as a justification, the government (first the post-overthrow Hawaiian Republic and then the Territorial Government) enacted legislation that forced landowners to fill in the wetlands, and if they did not, the government would do so and put a lien on the property to pay for the "improvements." The end result was the destruction of the agricultural system and in many cases, the loss of land (Nakamura 1979:67-68):

> The Sanitary Commission of 1912 estimated that, of the total amount of land in the district of Honolulu located below the foothills, one third was wet land. This wet land, which was used for agriculture and aquaculture, represented, then, a considerable amount of urban real estate if filled in.
>
> Such laws as Chapter 83, R.L. 1905 already existed to deal with filling in wet land. The justification for such actions would be sanitation, that is, if wet lands were allowed to exist within the district of Honolulu, the public health would be endangered, for mosquitoes, carriers of dangerous diseases, would continue to breed.... Thus sanitation was presented as the primary motive in the destruction of wet agriculture and aquaculture while the profitability of reclaimed was hardly mentioned at all.

Land acquisition for the two-mile long canal began in 1918, either through voluntary purchase or condemnation (Steele 1992:8-5). Construction began in 1921, with Walter F. Dillingham's Hawaiian Dredging Company contracted by the Territory of Hawaii to carry out the work (Nakamura 1979:90). By 1924, the entire length of the canal from its outflow at the west end of Waikīkī to its head at Kapahulu Road was excavated; a proposed outflow from Kapahulu Road to the eastern end of Waikīkī was never completed, aborted by a concern that the on-shore current would take canal runoff west onto the pristine beaches (Cocke 2013). Although the canal was dredged as planned, additional fill was needed to "reclaim" adjacent lands and additional funds were authorized to widen the canal from 150 to 250 feet. In 1928, the canal was completed. Steele (1992:8-7) describes the resultant changes in land values and tourism:

> … land values had gone from $500 an acre for a piece of agricultural property prior to the construction of the canal to up to $4 a square foot for business property in 1928. With a great increase in available property, numerous residential development projects were undertaken in Waikīkī. The number of visitors was also on the rise since the beginning of the reclamation project. Between 1921 and 1927, the number of visitors to Waikīki doubled from 8,000 to 17,451 according to the Hawaii Visitors Bureau.

In addition to the dredge and fill operations related to the Ala Wai Canal, the Waikīkī portions of natural drainages, like ʻĀpuakēhau and Ku'ekaunahi Streams, were also filled.

BEACH CONTROL INFRASTRUCTURE

In the mid- to late 19th century, Waikīkī became a retreat for town dwellers in Honolulu who wearied of dry, dusty urban life. Royalty escaped to their beachfront estates. Families began to frequent the beach on weekend bathing trips. In 1881, James Dodd opened the first commercial hospitality operation, the Long Branch, which was a small cottage where visitors could change their clothes for a small fee (Kanahele 1995:152). Modest residences were common, and it was not until the 1890s that sumptuous homes began to appear along the beachfront (Hibbard and Franzen 1986:27).

As more visitors frequented Waikīkī and more properties developed along the coast, shoreline improvements were made to enhance the visitors' beach experience (the chronology of shore improvements is primarily from Wiegel 2008:26-27). One of the first infrastructure projects was construction of a bridge/causeway at the entrance to the new Kapiʻolani Park around 1880, a portion of which was replaced in 1890 by a seawall to protect Waikīkī Road (now Kalākaua Avenue near Kapahulu Avenue). Also in 1890, picturesque piers were built at Queen Liliʻuokalani's Kealohilani beach home and at W.C. Peacock's residence; both structures graced the Waikīkī shoreline for over 40 years. When the Moana Hotel was constructed on Peacock's property in 1901, the pier became known as Moana Pier.

In the first three decades of the 20th century, seawalls were constructed at various locations, but with no apparent overall design or strategy. The earliest record of a constructed retaining wall at a specific property is an 1897 map showing a wall fronting Liliʻuokalani's property at Kealohilani, adjoining the inland end of her pier (Kanakanui 1897). As hotels began to develop, each protected its shorefront with a seawall: the Moana Hotel in 1901, the Seaside in 1906, Gray's Hotel (now the Halekūlani) in 1916, and the Royal Hawaiian Hotel in 1925-1926. When the U.S. War Department acquired lands at Kālia for Fort DeRussy, it too protected its beachfront with walls built in 1909 and 1916. By 1920, almost the entire shorefront of Kapiʻolani Park was lined in seawalls.

Groins were also built to protect and enhance the beach, and many have come and gone, leaving only the present five groins in the project area. The first was a concrete wall projecting into the shallows at the mouth of ʻĀpuakēhau Stream, built sometime between 1906 and 1910, presumably by Moana Hotel; it was removed in 1927. Between 1917 and 1930, nine groins were built along the shore between the Royal Hawaiian Hotel and Fort DeRussy, and experimental sand bag groins were installed between the Royal Hawaiian Hotel and Gray's Hotel. Groins were also constructed at the original Honolulu Aquarium; they appear on a 1928 map of the Waikīkī shoreline (Kanahele 1928c).

HISTORICAL EVENTS IN THE PROJECT AREA

Table 3 to Table 6 contain summaries of historical events pertaining to shoreline changes in the four Waikīkī Beach sectors (Fort DeRussy, Halekūlani, Royal Hawaiian, and Kūhiō Beach) within the project area.

Table 3. Fort DeRussy Sector: Historical Events.

Year	Event	Reference
1803-1804	Luluka family established residence at Kawehewehe, when they moved to Oʻahu with Kamehameha; members of family were in charge of the royal residence at Puaʻaliʻiliʻi.	ʻĪʻī (1959:17)
1904-1910	U.S. War Department acquired 73 acres of Kalia through purchase, condemnation, and Executive Order.	Hibbard and Franzen (1986:79)
1909	Fort DeRussy established; over next two years, Kalia fishponds filled by dredging off-shore reefs and pumping into ponds.	Hibbard and Franzen (1986:79), Clark (1977:58)
1910-1914	Batteries Randolph and Dudley constructed as part of Artillery District of Honolulu.	Davis (1989:7)
1916	1,150-foot long seawall built along the Fort DeRussy shoreline.	Wiegel (2008:Figure 18, 26)

Year	Event	Reference
1917	70-foot long groin built at east boundary of Fort DeRussy sector.	Wiegel (2008:22)
1941	Fort DeRussy shoreline closed to the public for duration of WWII.	Clark (1977:58)
1945	Fort DeRussy beach reopened to public.	Clark (1977:58)
1969	Box culvert/groin at east boundary lengthened from 70 to 300 feet.	Wiegel (2008:22)

Table 4. Halekūlani Sector: Historical Events.

Year	Event	Reference
1600s	First dated occupation of Halekūlani area.	Davis (1984)
1803-1804	Kawehewehe became residence of the Luluka family when they moved to Oʻahu as part of Kamehameha's entourage (Kamehameha was preparing for the invasion of Kauaʻi); members of family were in charge of the royal residence at Puaʻaliʻiliʻi.	ʻĪʻī (1959:17)
1912	Gray's by the Sea boarding house established by La Vancha Maria Chapin Gray in a two-story house built by Minnie Gilman (Mrs. Joseph A. Gilman) in 1903; source of the name Gray's Beach for the area.	Clark (1977:56)
1913-1914	Seawalls built in front of S.C. Wilder home and Gray's by the Sea.	Wiegel (2008:26)
1917	70-foot long Fort DeRussy box culvert/groin built at west boundary of Halekūlani sector.	Wiegel (2008:22)
1926-1929	Eight groins built between Royal Hawaiian Hotel and Fort DeRussy.	Wiegel (2008:26)
1928	Stone groin built off of Minnie Gilman's property (incorporated into future Halekūlani Hotel).	Kanahele (1928a)
1929	Charles Kimball acquired Gray's by the Sea and adjacent land and established Halekūlani Hotel.	Clark (1977:56)
1931	New Halekūlani Hotel opened.	Hibbard and Franzen (1986:103)
1932	Aerial photograph shows five piers or groins in Halekūlani sector.	Wiegel (2008:Figure 19)
1969	Fort DeRussy box culvert/groin at west boundary lengthened from 70 to 300 feet.	Wiegel (2008:22)

Table 5. Royal Hawaiian Sector: Historical Events.

Year	Event	Reference
1500s	Ruling chief of Oʻahu Kakūhihewa lived at Ulukou; during his reign, legend of Kalehuawehe and Pīkoi (surfing at what is now called Populars).	Pukui (1983:161-162), Nāpōkā (1986:2), Kanahele (1995:73)
1600s	Maui chief Kauhi-a-Kama attacked Oʻahu; landed at Waikīkī but was defeated and killed by Oʻahu chief Kaʻihikapu, and then sacrificed at Helumoa Heiau.	McAllister (1933:76), Nāpōkā (1986:5), Kanahele (1995:74)

Year	Event	Reference
1783	Maui king Kahekili conquered O‘ahu, after which he established a residence at ‘Āpuakēhau.	Fornander (1919:VI-2:289), Kanahele (1995:79)
1794	Kahekili died at his home at Ulukou.	--
1803	Kamehameha established his residence at Pua‘ali‘ili‘i between the mouth of ‘Āpuakēhau Stream and “the old road” (Royal Hawaiian Hotel); built a stone house enclosed by a fence; Kaahumanu and her family lived at Helumoa (within Pua‘ali‘ili‘i); members of Luluka family (family of Papa Ii) were in charge of the royal residence.	‘Ī‘ī (1959:17), Kanahele (1995:91, 92)
1859	Lili‘uokalani received the land of Hamohamo from her mother, Keohokālole (who was awarded the land in the Māhele); a section of Hamohamo covers almost the entire beach in the Royal Hawaiian sector and a large section of the Kūhiō Beach sector.	Hibbard and Franzen (1986:8)
1866	Kamehameha V purchased property at Helumoa (LCA 1445:1).	Kanahele (1995:132)
1868	Kamehameha V purchased additional property (LCA 228) at Helumoa (inland of LCA 1445:1).	Kanahele (1995:132)
1880	Kalākaua purchased beachfront land at Uluniu and built a house (LCA 6616:4).	Kanahele (1995:133)
1881	James Dodd established the first bathhouse in Waikīkī at Ulukou; called the Long Branch, it was a cottage where bathers could change their clothes for a small charge.	Hibbard and Franzen (1986:53), Kanahele (1995:152)
1883	Bernice Pauahi Bishop inherited the lands of Ruth Ke‘elikōlani, which included the estate of Kamehameha V (who died in 1872); this included Helumoa, where Bishop and her husband built a house on the former LCA 1445:1.	Kanahele (1995:132)
1884	first building constructed at location of present Waikiki Beach Center; known over the years as Ilaniwai Baths, Wright’s Villa, Waikiki Inn, Heinie’s Tavern, and Waikiki Tavern.	Clark (1977:54), Hibbard and Franzen (1986:51)
1890	240-foot long timber pier on piles constructed off the W.C. Peacock home (which preceded the Moana Hotel); originally called Peacock Pier and subsequently renamed Moana Pier.	Wiegel (2008:21)
1899	Prince Kūhiō inherited his beachside property at Uluniu called Pualeilani from his *hānai* mother Kapi‘olani, who had inherited it from her husband Kalākaua when he died in 1891; this was the location of LCA 6616:4.	Kanahele (1995:134)
1901	Moana Hotel opened, Waikīkī’s first major hotel; 230-foot long seawall built in front of hotel.	Hibbard and Franzen (1986:58-59), Wiegel (2008:21, 26)
1906	Cottage-style Seaside Hotel opened; property included the royal coconut grove of Helumoa.	Hibbard and Franzen (1986:62)
1915	Thatched houses of original Outrigger Canoe Club replaced with two-story, pavilion-like clubhouse.	Hibbard and Franzen (1986:77)
1918	Concrete wings added to Moana Hotel, doubling hotel’s capacity.	Hibbard and Franzen (1986:61)

Year	Event	Reference
1918	Prince Kūhiō removed the high board fence around his property and opened it to the public (he moved to Liliʻuokalani's Kealohilani property about 1,000 feet to the southeast and built a new Pualeilani home).	Clark (1977:52), Hibbard and Franzen (1986:37)
1925-1926	Royal Hawaiian Hotel built on the site of the former Seaside Hotel; groin built at same time; new seawall built shoreward of old seawall.	Wiegel (2008:21, 26)
1926	Ala Wai Canal completed; water supply to ʻĀpuakēhau Stream cut off.	--
1927	Concrete groin between Moana Hotel and Royal Hawaiian Hotel removed.	Wiegel (2008:26)
1930	Royal Hawaiian Groin extended to 368 feet.	Wiegel (2008:26)
1931	Moana Pier demolished.	Wiegel (2008:21, 26)
1937	Territory acquired Dean's Hotel and Luella Emman's properties to be used for park (present Kūhiō Park).	SSRI (1985:A-15)
1969	21-story Surfrider Hotel opened on the west side of the Moana Hotel.	Wiegel (2008:21)

Table 6. Kūhiō Beach Sector: Historical Events.

Year	Event	Reference
1859	Liliʻuokalani received the land of Hamohamo from her mother, Keohokālole (who was awarded the land in the Māhele; a section of Hamohamo covers almost the entire beach in Royal Hawaiian sector and a large section of Kūhiō Beach sector.	Hibbard and Franzen (1986:8)
1877	Kapiʻolani Park opened.	Hibbard and Franzen (1986:43)
1880	Around this time, a bridge/causeway was built across mouth of Kuʻekaunahi Stream at entrance to Kapiʻolani Park; the bridge ran from around the present ʻŌhua Avenue to Monsarrat Avenue.	Wiegel (2008:26)
1890	390-foot long retaining wall built to protect Waikīkī Road (now Kalākaua Avenue), replacing part of bridge and causeway near entrance to Kapiʻolani Park.	Wiegel (2008:26)
1890	Ca. 130-foot long wooden timber pier on piles built sometime prior to 1890 off of Liliʻuokalani's Kealohilani residence; known as Queen Liliʻuokalani Pier or Kūhiō Pier.	Kanahele (1995:136), Wiegel (2008:17)
1918	Prince Kūhiō acquired Liliʻuokalani's beach residence Kealohilani through an out-of-court settlement of his challenge to Liliʻuokalani's establishment of a trust; he built a new home called Pualeilani on the property.	Clark (1977:52), Hibbard and Franzen (1986:37)
1922	The original Pualeilani was given to the City when Prince Kūhiō died.	Clark (1977:52)
1934-1935	City and County purchased the second Pualeilani house, including Liliʻuokalani Pier, and demolished both for beach improvements; this was the last residence of an *aliʻi* in Waikīkī.	Hibbard and Franzen (1986:38), Wiegel (2008:17, 26)

Year	Event	Reference
1939	650-foot long crib wall built about 200 feet from shore (parallel to shore), with shore return structures at each end of seawall; this is the ‘Ewa portion of the Kūhiō Beach sector; concrete seawall built along Kalākaua Avenue to protect road.	Wiegel (2008:17)
1940	Kūhiō Park was officially dedicated.	Clark (1977:52)
1951	355-foot long Kapahulu Storm Drain/Groin built as part of Waikīkī Beach Improvement Project; it is an extension of the storm drain running under Kapahulu Avenue; project also included building a retaining wall on the Diamond Head side of the groin and importing sand; the Storm Drain/Groin is commonly referred to as “The Wall.”	Clark (1977:53), Wiegel (2008:17)
1953	750-foot long retaining wall built on ‘Ewa side of Kapahulu Groin to keep sand from eroding away; called “Slippery Wall” because of very slick surface when wet due to growth of fine seaweed; connected to 1939 crib wall.	Clark (1977:53), Wiegel (2008:17, 27)
1960	Waikiki Tavern demolished to make way for Waikiki Beach Center.	Clark (1977:54)
1972	Retaining wall to protect Kalākaua Avenue removed.	Wiegel (2008:27)

III. CULTURAL CONSULTATION

This section contains the results of the cultural consultation solicited as part of the preparation of this CIA. It also summarizes Gollin's (2017) overview of previous CIAs and consultations for Waikīkī, which contain additional cultural concerns and recommendations applicable to the current project.

Between January 5 and January 7, 2021, IA distributed consultation letters (using email and conventional mail) to 213 Waikīkī cultural stakeholders and community members, including cultural descendants, government officials at the federal, state, and county levels, and leaders of local businesses and civic organizations. Most of the prospective consultants were identified through previous Waikīkī CIAs and archaeological reports, public websites, or referrals from SHPD staff and other consultants. The letter contained a description of the project area, a summary of the planned improvement and maintenance work, a discussion of relevant cultural concerns for the project area identified in a feasibility study for the project (Tomonari-Tuggle 2017), and a review of CIA studies for previous Waikīkī projects (Gollin 2017). The letter concluded with a request for the consultant to share any personal knowledge about the cultural impacts the proposed project might have on the Waikīkī shoreline and associated areas. It further stated that all responses would be summarized or reproduced in the CIA report, made no requirements about the amount or type of information shared, and made clear that consultants could request anonymity or ask that certain information not be made publically available. IA requested that all responses be received by February 12, 2021. The full letter is reproduced in Appendix A. A list of all individuals approached to provide cultural consultation for the project is in Appendix B.

Ten consultants provided IA with written or verbal responses to the request letter. On March 6 and March 8, 2021, IA sent follow-up email messages to these consultants asking them to review their comments, edit them if desired, and to consent that their responses could be reproduced in the CIA. IA also restated the nature and function of the CIA and emphasized that participation was voluntary. Seven consultants provided written or verbal agreement that their original or revised responses could be included. The consent letters are reproduced in Appendix C. The remarks of consultants who did not respond to the consent letter are not included in the CIA.

Table 7 presents the consultant responses (with minor revisions for clarity). Bracketed comments were inserted by the report authors.

O‘AHU ISLAND BURIAL COUNCIL MEETING

On February 10, 2021, Hannah Kaumakamanōkalanipō Anae, M.A., and Robert Pacheco, M.A., of IA presented a summary of the project to the OIBC during its monthly public meeting (via videoconference) to request additional cultural consultation. Several council members and participants provided comments during and immediately after the meeting. These comments (as recorded in IA's meeting notes) are summarized below.

Council Chair Hinaleimoana Wong-Kalu is concerned about any sand replenishment project due to the potential disturbance of *iwi kūpuna*, due in large part to previous cases (e.g., Mōkapu and Maui) where sand dunes containing *iwi* were mined. She views the Waikīkī Beach Improvement Project as primarily serving the interests of the tourism industry, and as a "band-aid" approach to global warming and sea level rise.

Table 7. Responses from Cultural Consultants Concerning the Proposed Waikīkī Beach Improvement and Maintenance Program.

Name	Title and/or Affiliation	Response
Apo, Peter	Office of Hawaiian Affairs (OHA)	I am familiar with the Waikiki shoreline erosion situation particularly with respect to iwi. If there is any specific aspect of your quest to be inclusive in your reach out to the community I'd be happy to opine. But, there's too many land mines in navigating iwi issues along the Waikiki corridor so I can't give you a general response. Also, Rob Iopa, a person with whom I shared your email of the project is head of WCIT Architecture whose company has a long history of Waikiki development projects.
Cáceres, Norman "Mana"	Waikīkī cultural descendant; Ohana Kūpono Consulting, Inc.	After reading the information sent to us, my ʻohana and I support the project. As State Recognized Cultural Descendants to native Hawaiian Human Remains documented in Waikīkī as well as being trained burial practitioners, we have both extensive knowledge as well as a responsibility to ensure the proper care and protection of the iwi kūpuna of that area. Beach erosion is a serious concern to us because the more the beach erodes the more potential impacts there are to burials along the coast. Just a few weeks ago we were assisting the community and descendants of the Kaʻaʻawa area in protecting two burials that were exposed due to erosion.
Clark, John	Author and *kūpuna* who frequented Waikīkī	If you have a copy of *Hawaiian Surfing: Traditions from the Past*, I included a section at the end called "Waikiki Place Names Related to Surfing." There's material in it that addresses some of the information that you're after. Several years ago the Department of Education asked me if I would narrate a surfing history of Waikīkī. We finished it in 2017 and premiered it at my alma mater in Waikīkī, Jefferson Elementary School. If you haven't seen it, this is the link: https://www.youtube.com/watch?v=NbFigfXH5Yg. FYI, it's 48 minutes long. Please feel free to share it.

Name	Title and/or Affiliation	Response
Kozlov, Alex	Director, Department. of Design and Construction, City and County of Honolulu	Thank you for the opportunity to review and comment. The Department of Design and Construction's Facilities Division has the following comments. 1. The proposed project along the Halekulani Beach Sector will restore a severely eroded section of beach in an area which tourists and local residents historically could access and utilize our valuable beach resource for recreational and cultural practices. The erosion is resulting in the closure of Brow 141A to protect the public from a hazardous condition. This project will insure that free access can be restored and protect against future sea level rise and coastal erosion. 2. Along the C, D, and E areas the City provides valuable lifeguard services which insures the safety of both tourists and locals who enjoy the various water activities that this shoreline has been and will continue to be intensively used for. To undertake this service the City has in place lifeguard towers which are key to enable the lifeguards to perform their duties. The severe erosion has endangered those structures which make it more difficult for the City to provide this service. The restoration of those shorelines will protect these structures ensuring that the City lifeguards will be able to continue to provide their service. 3. All around the island we see severe erosion of the shoreline at beach parks. When this occurs we see burials in the sand deposits being exposed. We see this project providing protection of sensitive cultural deposits which exist inland from the immediate beach area. If this kind of project is not undertaken we fully expect that the coastal erosion will progress mauka and will expose burial which we know to exist in this coastal area. With sea level rise taking no action to restore the beach and raise the elevation will leave the sensitive cultural areas exposed. Sincerely, Alex Kozlov, P.E. Director Designate

Name	Title and/or Affiliation	Response
Lau, Clifford	Facilities Branch Chief, Department of Design and Consultation, City and County of Honolulu	[The following paragraph is a summary of a phone conversation with Mr. Lau.] Mr. Lau says that the Department of Design and Construction supports the proposed project as it will restore shoreline access and protect lifeguard stations along Waikiki Beach which [are] being endangered by the beach erosion.
Lemmo, Sam	Administrator, DLNR-Office of Conservation and Coastal Lands	[Mr. Lemmo requested a copy of a 2008 report by Robert Wiegel (Waikīkī Beach, O‘ahu, Hawai‘i: History of Its Transformation from a Natural to an Urban Shore), but provided no further comment.]
Norman, Carolyn (Keli‘ipa‘akaua)	Waikīkī cultural descendant	Mahalo for including my ohana and I in the consultation process. This is how we connect to Waikiki. My Great grandfather William Nehemiah Keaweamahi, my grandmother Alice Kekahiliokamoku Keaweamahi-Kawainui and my mother Eileen Kekahiliokamoku "Kahili" Kawainui-Norman, who is still with us, were all born and raised in Kalia, Waikiki. 2 of my siblings were born at the old Kaiser Hospital that was once on my Kupuna Moehonua's aina in Kalia, Waikiki. My mother Kahili Norman remembers as a child going to the beach where Hilton Hawaiian Village is currently located with her mother and grand Aunts to pick limu for lunch and dinner." You mentioned in your letter that shoreline replenishment using sand recovered from offshore to help stabilize the shoreline. I have concerns about that and would like to know where and how the sand will be recovered because my great grandfather and his brother, who both were original Waikiki Beach Boys, have their ashes scattered offshore in Waikiki. When a person's body is cremated, not all the bones are burned down to ashes. It would be very disturbing if iwi is found on the shore because of this project. Iwi kūpuna were found in multiple areas spanning from Hilton Hawaiian Village down towards the Royal Hawaiian Hotel. They were found more inland but, that doesn't mean they won't be found near the shore. Iwi kūpuna have been found in some areas at Fort DeRussy in depths as shallow as 12 inches below the surface. Kawehewehe also known as Gray's Beach between Outrigger Reef Hotel and Halekulani,

Name	Title and/or Affiliation	Response
		was a place where kupuna would go for healing and to pikai. My Aunty Ka'anohi, my son Kepo'o and I went there to pikai after we had kanu iwi kūpuna from the Outrigger Reef Hotel. I remember seeing limu kala growing there. I haven't been to Kawehewehe for a while, but I wouldn't want that area to be disturbed because it is a place for kanaka to go for healing.

Council member Kai Markell of the Office of Hawaiian Affairs (OHA) expressed concerns about whether sand previously used to replenish Waikīkī Beach contained *iwi kūpuna*, and if the proposed offshore sand sources contained remains from recent burials, such as scattered ashes.

Participant Carolyn Norman also expressed concerns about human remains in offshore sand, and about the potential disturbance of the Kawehewehe healing waters, which are still actively used. She later provided a written response (see Table 7).

Participant Edward Halealoha Ayau requested more information about the sources of the current Waikīkī Beach sand, and asked if any processes were followed to ensure that *iwi* were not impacted during previous replenishment. He has no concerns about *iwi* if the sand was manufactured. He mentioned a historical case where sand was taken from Papohaku, Moloka‘i on behalf of the State Department of Transportation to build the Honolulu Airport reef runway. He said that Hawaiian truck drivers observed the disturbed *iwi* in the sand as it was driven to Haleolono for loading onto barges sailing to O‘ahu.

Due to concerns about the disturbance of *iwi kūpuna* potentially present in the existing beach sand and the replenishment sand, several council members, including Hinaleimoana Wong-Kalu, Kai Markell, and Chuck Ehrhorn, believe it is OIBC’s mandate to formally evaluate the project. Council Chair Wong-Kalu informally requested that SEI and IA participate in the next OIBC meeting to address several engineering questions, including the history and sources of the current Waikīkī sand, and the distances of proposed offshore sand deposits from the shoreline. SEI subsequently responded to this request in a letter sent to the OIBC prior to the council’s March meeting.

After the meeting, council member Kamana‘o Mills of Kamehameha Schools forwarded an ethnohistoric study of Waikīkī (Cruz and Hammatt 2011) with an emphasis on the lands of Helumoa, which is now the site of the Hilton Hawaiian Shopping Center. Council member Auli‘i Mitchell also provided information about the “Ka Pa‘akai Analysis,” a legal process by which the reasonable exercise of customarily and traditionally exercised rights of native Hawaiians must be protected to the extent feasible when the State Land Use Commission grants a petition for reclassification of district boundaries.

SUMMARY OF CULTURAL CONSULTATION

The primary concern for most of the cultural consultants who commented on the project is the inadvertent disturbance of *iwi kūpuna* along the beach or in the offshore sand deposits that will be dredged to expand and replenish the beach. Although the current Waikīkī Beach shoreline is almost entirely engineered and unlikely to contain primary burials, the history and sources of the sand used to build and replenish the beach during the 20th century remain a concern to some individuals. A few consultants cited historical examples of sand mining from beaches on O‘ahu, Maui, and Moloka‘i, which contained *iwi kūpuna*. However, it is not known whether sand containing *iwi kūpuna* has ever been redeposited in the project area, or has eroded into offshore deposits.

Several consultants also expressed concern about the potential disturbance of modern human remains in the submerged sand deposits immediately offshore from Waikīkī Beach where cremated remains are frequently spread. Some consultants reported that their own relatives’ remains have been scattered in the area.

Alternatively, some consultants feel that the replenishment and stabilization of Waikīkī Beach will protect the burials and cultural deposits inland of the active beach (some of which are recorded as archaeological sites) from erosion damage. Two consultants noted that shoreline burials in beach parks around O‘ahu and in Ka‘a‘awa along Kamehameha Highway have already been disturbed by coastal erosion.

Two consultants from the City and County of Honolulu's Department of Design and Construction cited the danger that coastal erosion poses to the existing causeway structures and lifeguard stations on the beach. One of them noted that the project would also restore an eroded portion of the Halekūlani sector that has historically been accessible to beach users.

Finally, several consultants emphasized that the waters of Kawehewehe (also known as Gray's Beach or the Halekūlani Channel) in the Halekūlani sector are still actively used by *kūpuna* for healing and to *pikai* (purify). One consultant remembers that *limu kālā* (*Sargassum echinocarpum*) grew in Kawehewehe, and does not want the area to be disturbed.

REVIEW OF PREVIOUS WAIKĪKĪ CIA STUDIES

There have been numerous CIA studies for previous projects in Waikīkī, some of which address the shoreline and areas immediately inland of the active beach, including portions of the four Waikīkī Beach sectors (Fort DeRussy, Halekūlani, Royal Hawaiian, and Kūhiō Beach) within the current project area. In 2016, IA reviewed 10 of these previous studies to evaluate and highlight the cultural uses and issues for Waikīkī Beach up to that time (Gollin 2017). The CIA review enumerates several cultural concerns and recommendations that are relevant to the proposed beach improvement and maintenance project, and are summarized below.

The most frequently mentioned concern in the CIAs reviewed (mentioned in eight of the 10 studies) was the inadvertent exposure of cultural material, particularly *iwi kūpuna* (ancestral remains or bones), during ground-disturbing construction work or sand replenishment activity. To mitigate potential disturbance of this material, one study (McGuire et al. 2001) recommended that [1] cultural monitoring be conducted during all ground-disturbing project work; [2] in the event that *iwi* are encountered, all ground disturbance activity must stop, and lineal and/or cultural descendants and relevant agencies and groups (e.g. SHPD, the OIBC, OHA) be contacted; and [3] a Burial Treatment Plan be developed in consultation with the previously-mentioned parties and agencies.

The second most-mentioned concern in the CIA studies, raised by consultants in six of the 10 CIAs, involved past and present ocean and shoreline cultural-natural resources (Groza et al. 2009; Spearing et al. 2009; Cruz et al. 2010; Genz and Hammatt 2011; Dagher and Spear 2013; Duhaylonsod and McElroy 2015). Consultants emphasized the significance of *honu* in Hawaiian culture (e.g., as ancestral spirits, ʻaumakua), and recalled that the makai areas of Waikīkī Beach were formerly a rich place for gathering seaweed (e.g., limu kohu, limuʻeleʻele, limu līpeʻepeʻe [sic]) and sea urchins (wana, hāʻukeʻuke), and for fishing (e.g., upāpalu). They emphasized ongoing threats to these resources, particularly sea turtle habitats. Kawehewehe (at the boundary between the Fort DeRussy and Halekūlani sectors) was also frequently mentioned as both a historical and ongoing place of spiritual and physical healing, where the sick still underwent ritual bathing.

The third most frequently mentioned concern was the ongoing development of Waikīkī in general. Several respondents cited cumulative impacts resulting from rampant construction in Waikīkī, including and obstruction of *mauka-makai* view corridors by tall buildings/hotels, harm to associated cultural features on the landscape, the "overtaxed infrastructure" in Waikīkī, including traffic, noise and waste management problems, and most critically, the loss of a "Hawaiian sense of place" and the feel of "old Waikīkī."

All 10 of the CIA studies reviewed advised proactive planning for inadvertent burial and cultural finds, and often recommended burial treatment planning. Four of the CIA studies recommended that project proponents engage regularly with cultural consultants and, in some cases, the "wider Waikīkī community" (Groza et al. 2009:i) to address concerns raised by consultants and to incorporate design ideas into the planning of proposed developments. One CIA advised that project proponents landscape using plant species native to the project area (especially drought-resistant plants), utilize "Hawaiian themes" in design elements, and strive to perpetuate the "feeling of old Waikīkī." Two CIA studies recommended that project proponents find a way to give back to the community via donations, cultural programs, etc., and that project proponents seek design ideas from the community (Groza et al. 2009; Spearing et al. 2009).

The CIA review concludes by providing a list of recommendations and mitigation measures that should be incorporated into all future project work planned for Waikīkī Beach. These recommendations, which are listed below, were informed by the CIA literature review and the author's knowledge of concerns elicited in community consultations conducted in Waikīkī and across O‘ahu Island.

- Address the concern that *iwi kūpuna* may be encountered during the course of development through proactive planning, including cultural monitoring. In the event of inadvertent burial and cultural finds, lineal and cultural descendants, appropriate agencies, and community groups (SHPD, OIBC, etc.), should be immediately notified and consulted regarding handling and treatment of remains.

- It is advised that project proponents carefully consider where sand for beach replenishment is being sourced. Should sand be obtained from other parts of O‘ahu or elsewhere in Hawai‘i, it will expand the scope of the project (including the CIA requirements) and may be strongly opposed by the community from which it is sourced as well as Waikīkī and broader community stakeholders.

- Proactively engage Waikīkī shoreline and broader community stakeholders to address issues such as beach access, ocean water quality, protecting surf breaks, safety issues, protecting threatened aquatic wildlife with an emphasis on turtle feeding habitat, and—with rising sea levels—planned shoreline setbacks. Stakeholders should be engaged in all phases of the planning and implementation of the beach improvements project.

IV. RECOMMENDATIONS

The responses provided by the cultural consultants who evaluated the proposed Waikīkī Beach Improvement and Maintenance Program emphasize that the inadvertent disturbance of *iwi kūpuna* is a primary cultural concern. As the current Waikīkī Beach shoreline is engineered and consists entirely of imported sand, at least two options are available to mitigate this cultural concern:

1. Carefully evaluate where the sand for future beach replenishment will be collected, in order to ensure that *iwi kūpuna* and other cultural material potentially present in the sand are not disturbed. Offshore sand deposits have a low likelihood of containing human skeletal remains and should be a preferred source for beach replenishment.
2. Require an archaeological monitor and/or cultural monitor to be present during all ground-disturbing project work within the historical (pre-20th century) shoreline to regularly inspect the redeposited sand for *iwi kūpuna* or archaeological material. If *iwi* or archaeological material is encountered, all construction work in the area should stop, and the appropriate government agencies, descendant groups, and cultural organizations contacted. A written plan to address the inadvertent disturbance of cultural material during project work should be in place before construction work begins, and developed in consultation with the appropriate government agencies and cultural stakeholders/organizations.

Several consultants are also concerned about the cremated remains of loved ones that have been scattered in the ocean off of Waikīkī Beach, and their potential disturbance if they have settled in offshore sand deposits that will be dredged for beach replenishment. This concern is difficult to verify physically, as it is not clear what happens to the ashes after they are scattered in the sea, or if they would be identifiable in a submerged sand deposit. However, the probability that identifiable *iwi kūpuna* (e.g., skeletal or dental elements) are present in the offshore sands is very low due to the capability of typical marine transport processes. Nevertheless, project proponents should remain sensitive to this issue and reasonably accommodate community members who express concern, perhaps by holding public information sessions or sponsoring a blessing ceremony before near-shore dredging begins.

The waters of Kawehewehe in the Halekūlani sector are also a major concern for responding cultural consultants, as Hawaiian healing and purification rituals are still practiced there, and *limu kālā*—a plant used in healing and *ho'oponopono* ceremonies—may still grow in the area. To address these concerns, project proponents should make efforts to clearly delineate the Kawehewehe area in project plans, avoid burying or damaging the area during construction work, and allow Hawaiian practitioners regular and reasonable access to the waters throughout the duration of the project. The project's marine biological and water quality resources survey (AECOS, Inc. 2021:24) states that groin construction in the Halekūlani sector will improve shoreline and nearshore conditions and recommends a biological and water quality monitoring program, which can also address some of the concerns of cultural consultants. Additionally, sand placement and groin construction is not anticipated to significantly impede submarine groundwater discharge (pers. comm. from Shellie Habel [Hawai'i Sea Grant][3] to Andy Bohlander [Sea Engineering, Inc.], April 19, 2021). Available and forthcoming (via monitoring) biological and water quality data should be conveyed in a clear and timely manner to cultural consultants and the public.

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[3] Also quoting Henrietta Dulai and Craig Glenn of the Coastal Groundwater Research Group at the University of Hawai'i-Mānoa.

Finally, although not explicitly mentioned by the cultural consultants who evaluated the current project, the proactive involvement of Waikīkī cultural stakeholders and community members in all aspects of future project planning—including cultural issues, beach access, ocean water quality, the protection of wildlife habitats and surf breaks, and project design and landscaping—is a priority emphasized in a review of previous CIAs for the Waikīkī area (Gollin 2017). Positive and transparent engagement between project proponents and the spectrum of interested parties affected by the planned work will likely encourage an open exchange of ideas and opinions and facilitate community engagement and support. Waikīkī descendants in particular should be engaged as early as possible during the project planning stage, and be given monthly updates and opportunities to provide feedback as work progresses. Appropriate accommodations should also be made for descendants who are unable to regularly attend project meetings.

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GRM 1720

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GLOSSARY OF HAWAIIAN WORDS

Hawaiian Spelling*	Definition
ahupuaʻa	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 a pig (puaʻa), or because a pig or other tribute was laid on the altar as tax to the chief
ʻāina	land, earth
aliʻi	chief, chiefess, officer, ruler, monarch, peer, headman, noble, aristocrat, king, queen, commander
aliʻi nui	high chief
hānai	to adopt, to raise; adopted or fostered
haole	foreign; belonging to another country
heiau	temple, shrine
honu	general name for turtle and tortoise
hoʻoponopono	mental cleansing: family conferences in which relationships are set right through prayer, discussion, confession, repentance, and mutual restitution and forgiveness
ʻili	traditional land unit, a subdivision of an ahupuaʻa
iwi	bone, carcass, core, bone of the dead
kahuna (singular); kāhuna (plural)	priest, sorcerer, magician, wizard, minister, expert in any profession; in the 1845 laws, doctors, surgeons, and dentists were called kahuna
kalo	taro, *Colocasia esculenta*
kanaka	human being, person, individual
kanu	planting, burial
konohiki	head man of an ahupuaʻa land division under the chief
kuleana	small piece of property, as within an ahupuaʻa; right, privilege, concern, title, property, estate, portion, interest, claim, ownership
kūpuna	elder, grandparent, ancestor
limu	a general name for all kinds of plants living under water, both fresh and salt, also algae growing in any damp place in the air, as on the ground, on rocks, and on other plants
limu kala	common, long, brown seaweeds (*Sargassum echinocarpum*); used in ceremonies to drive away sickness and to obtain forgiveness
loʻi	irrigated terrace, especially for taro (loʻi kalo)

Hawaiian Spelling*	Definition
lua	hand-to-hand fighting involving bone breaking, joint dislocation, and pressure points
mahele	portion, division, section, zone, lot, piece, quota, installment, bureau, department, precinct, category, scene or act in a play; share, as of stocks; measure in music; land division of 1848 (the great mahele)
makaʻāinana	commoner
makai	toward the sea
mauka	toward the mountain, or inland
moku	district; island
moʻolelo	story, tale, myth, history, tradition, literature, legend, journal, log, yarn, fable, essay, chronicle, record, article
muliwai	river mouth, estuary, pool near the mouth of a stream
naio	bastard sandalwood, *Myoporum sandwicense*; indigenous shrubs and small trees
niu	coconut palm , *Cocos nucifera*
ʻohana	family, relative, kin group; related
pīkai	to sprinkle with sea water or salted fresh water to purify or remove taboo
poʻo kanaka	class of sacrificial heiau (lit. human head, skull)
ʻuala	sweet potato, *Ipomoea batatas*
ʻulu maika	disk-shaped gaming stone
wai	water

* Adapted from Mary K. Pukui and Samuel H. Elbert, 1986, *Hawaiian Dictionary*, University of Hawaii Press, Honolulu, unless otherwise noted.

APPENDIX A: REQUEST LETTER TO PROSPECTIVE CONSULTANTS

IA INTERNATIONAL ARCHAEOLOGY, LLC

January 14, 2020

SUBJECT: Request for Cultural Consultation for a Proposed Waikīkī Beach Improvement and Maintenance Program.

Dear Sir or Madam,

My name is Hannah Kaumakamanōkalanipō Anae, and I am an archaeologist/cultural anthropologist with International Archaeology, LLC (IA), a cultural resource management firm based in Honolulu. My company is currently preparing a Cultural Impact Assessment (CIA) for inclusion into an Environmental Impact Statement (EIS) by Sea Engineering, Inc. (SEI) for the State Department of Land and Natural Resources' (DLNR) proposed Waikīkī Beach Improvement and Maintenance Program. The EIS will examine and analyze potential beach improvements for portions of the Waikīkī shoreline, including construction of new beach stabilization structures and shoreline replenishment using sand recovered from offshore areas.

We are writing to ask your assistance in preparing this CIA. The purpose of the CIA is to collect information about the past and present cultural resources and practices associated with Waikīkī Beach, in order to identify any issues and concerns that may arise from the proposed beach improvements as well as future maintenance activities. Examples of information that would be helpful to this effort include:

- General history and present and past land use of the Waikīkī Beach project area.
- Knowledge of cultural sites – for example, historical sites, archaeological sites, and burials.
- Traditional gathering practices in the project area, both past and ongoing.
- Legends, places and place names, and traditional uses in the project area.
- Cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the project area.

With your permission, your response will be added to the CIA and subsequent EIS and will influence all future planning for the project. In addition to the CIA, IA is preparing separate reports that will inventory and describe all known archaeological and architectural sites within and immediately adjacent to the project area.

Details about the specific work areas, planned actions, and construction methods proposed for the project are summarized below. Please refer to the end of this letter for project area maps and conceptual renderings of the proposed improvements.

Summary of Planned Waikīkī Beach Improvements

The Waikīkī Beach improvements are intended to address the ongoing erosion of the shoreline and frequent flooding of the backshore. Without improvements and follow-up maintenance, sand erosion and rising sea level will likely result in the total loss of Waikīkī Beach by the end of the 21st century. The project's immediate goals are to restore and improve Waikīkī's public beaches, increase beach stability, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise.

The DLNR is proposing improvements for four sections of the Waikīkī shoreline, listed below from west to east:

- Fort DeRussy Beach, consisting of approximately 1,680 feet of shoreline extending from the Hilton Hawaiian Village pier to the Fort DeRussy outfall groin.
- Halekūlani Beach (formerly "Gray's Beach"), consisting of approximately 1,450 feet of shoreline extending from the Fort DeRussy outfall groin to the Royal Hawaiian groin.
- Royal Hawaiian Beach, consisting of approximately 1,730 feet of shoreline extending from the Royal Hawaiian groin to the ʻEwa (west) groin at Kūhiō Beach Park.
- Kūhiō Beach, consisting of approximately 1,500 feet of shoreline extending from the ʻEwa (west) groin at Kūhiō Beach Park to the Kapahulu storm drain.

To better understand the impact of the project on the Waikīkī shoreline, the planned actions and construction methods for each beach section are summarized below:

- For Fort DeRussy Beach, sand will be transported from an accretion area at the west end of the beach (near the Hilton Pier) to an eroding area at the east end. The sand will be excavated from the existing beach face extending inshore only as far as necessary to obtain the required amount, estimated to be approximately 1,200 cubic yards. Dump trucks will transport the sand across the beach, and a bulldozer will distribute it across the eroding area. This process will need to be repeated periodically in the future to maintain a stable beach profile.
- For Halekūlani Beach, a new beach with stabilizing groins will be constructed. Three new sloping rock rubble mound T-head groins will be combined with the existing Fort DeRussy and Royal Hawaiian groins to create four stable beach cells. The groin stems will extend approximately 200 feet seaward from the shoreline and will be of sufficient size to stabilize a +10-foot beach crest elevation. The groin stem crests could also be wide enough (approximately 10 feet) to accommodate construction equipment or a pedestrian walkway. The Halekūlani Channel will be left unobstructed for beach catamaran navigation. In addition, approximately 60,000 cubic yards of sand fill (recovered from offshore deposits) will be used to create approximately 3.8 acres of new dry beach area. Construction equipment and materials will likely be transported into the area across the east end of Fort DeRussy Beach, which may require construction of a temporary access road from Kalia Road to the beach and a temporary rock rubble mound access berm along the shoreline from Fort DeRussy to the Royal Hawaiian groin.
- For Royal Hawaiian Beach, sand recovered from deposits directly offshore will be used to widen and replenish the beach. The beach crest elevation will be increased from about +7 feet above mean sea level (MSL) to +8.5 feet MSL. Approximately 30,000 cubic yards of recovered sand will be required to complete the work. To counter ongoing erosion and shoreline recession, beach nourishment will need to be repeated every eight to 10 years or more frequently if required. The recovered sand will probably be dredged with a submersible pump mounted on a crane barge and pumped through a bottom-mounted pipeline to a dewatering basin in the Diamond Head basin of Kūhiō Beach Park. After drying, the sand will be stockpiled and transported to Royal Hawaiian Beach, where it will be distributed using bulldozers.
- For Kūhiō Beach, separate plans are proposed for the ʻEwa basin (west) and the Diamond Head basin (east):
    - For the ʻEwa basin, the existing groins on the east and west ends will be removed and reconstructed to accommodate sea level rise. The west groin will be approximately 150 feet long with a crest elevation of +7.5 feet MSL, and the east groin will be approximately 125 feet long and vary in elevation from +7.5 feet MSL at the shoreline to +6 feet MSL at the head. A 125-foot-long detached breakwater will be built in the gap between the groins and will be approximately +6 feet MSL to match the heads of the groins. Construction equipment and material would be transported to the work area through either the central portion of the park or along the shoreline past the Duke Kahanamoku statue. Demolition and construction will be conducted with an excavator that is supported by a temporary work

platform extending from the shore to the breakwater. Sand fill from offshore deposits will be added to the beach after the new structures are completed.

  - For the Diamond Head basin, existing structures will not be modified, but the beach will be replenished using eroded sand that has settled in a submerged deposit just offshore. Approximately 4,500 cubic yards will be recovered and spread across the beach, widening the existing shoreline by approximately 18 to 26 feet and reducing the offshore depth of the basin to a uniform bottom elevation of -4 feet MSL. The sand will be recovered and redeposited using either a long-reach excavator operating on an excavated sand causeway, or a diver-operated dredge that will pump the sand to an onshore recovery area. A bulldozer and/or skid-steer will spread the sand across the beach.

Construction work will be confined to the active sand portion of Waikīkī Beach and nearshore marine areas up to approximately 200 feet offshore. The work will not extend outside the inland boundary of the active beach, which is defined by any buildings, roads, seawalls, or other types of construction that constrain the sand beach.

The sand required for beach nourishment will be almost exclusively recovered from submerged offshore deposits. In addition to the near-offshore areas mentioned in the descriptions above, sand will be dredged from one or more known deposits further offshore of the south coast of O‘ahu, using submersible slurry pumps, self-contained hydraulic suction dredges, and/or clamshell buckets. A map showing the locations of several proposed deposits is included in this letter.

Cultural Issues and Concerns

Although Waikīkī is now known internationally as the center of the Hawaiian hospitality industry, the region has been an important traditional Hawaiian cultural location for hundreds of years, noted primarily for its associations with *ali‘i* (chiefs) and its advanced agricultural and aquacultural development, including *lo‘i* (wetland fields) and fishponds. It also served as a beachside retreat for Hawaiian royalty and wealthy Honolulu residents during the 19th century. Multiple archaeological sites have been exposed during construction in Waikīkī over recent decades, typically consisting of buried cultural deposits representing traditional Hawaiian and post-Contact historical occupation. *Iwi kūpuna* (human skeletal remains) associated with traditional and historical Hawaiian burials have also been found in the area, ranging from isolated fragments to intact burial pits. In addition, Waikīkī contains many architectural sites that date to the post-Contact historical period, including buried seawalls along the shoreline that may have been built during the late 19th century, as well as places that have no physical remains but whose names and locations are still well known today.

When evaluating the potential impact of the planned beach improvements on the cultural resources and significance of Waikīkī Beach, it is important to note that the Waikīkī shoreline has been extensively engineered since the late 19th century and now consists almost entirely of sand imported from other locations. Further, the vast majority of known archaeological and architectural resources in Waikīkī is located inland from the active beach and will not be affected by project work. Nevertheless, several potential cultural resources within or near the proposed refurbishment area have been identified through literature review and archival research and may merit consideration when evaluating the impact of project activity. These resources are listed below, organized by the beach section where they are (or are thought to be) located:

- Fort DeRussy Beach
  - The Fort DeRussy Groin may require evaluation as a potential historic property.
- Halekūlani Beach
  - The Royal Hawaiian Groin, the Fort DeRussy Groin, and five other groins in the area may require evaluation as potential historic properties.

- Royal Hawaiian Beach
    - The ʻEwa Kūhiō Groin complex and the Royal Hawaiian Groin may require evaluation as potential historic properties.
    - Buried cultural deposits in the area of the former ʻApuakēhau Stream, or buried cultural deposits and/or burials related to mid-19th century Land Commission awards (LCAs) 6616:4 and 7597:3, and/or the beach residences of Kalākaua and Kūhiō, may exist in the area. Buried cultural deposits could also be inland of the buried seawall at the southeast end of the Royal Hawaiian Cell.
    - Additional review and consultation for the historical places, ʻApuakēhau, Helumoa, Hamohamo, and Pualeilani, may be required, as all of these places are associated with important people in Hawaiʻi's history and/or have traditional associations.
- Kūhiō Beach
    - The existing beach infrastructure (Kapahulu Storm Drain, Slippery Wall, and the ʻEwa Kūhiō Groin complex) may require evaluation as potential historic properties.
    - Buried deposits and/or burials related to the LCA 1433:1, and the subsequent homes of Liliʻuokalani (Kealohilani) and Kūhiō (Pualeilani) could exist in the area, although they are unlikely to be present within the active beach.
    - Though the homes are no longer standing, Kealohilani and Pualeilani are significant historical places that may merit additional review and consultation.

The project's most important cultural concern will be the inadvertent discovery or disturbance of *iwi kūpuna* or other cultural material during construction work. Procedures will be in place during the project to protect known archaeological and historical sites in the project area, to monitor any ground-disturbing work that may impact cultural resources, and in the event of inadvertent burial or cultural finds, to immediately notify and consult with lineal and cultural descendants, appropriate government agencies, and community groups regarding the handling and treatment of the remains and/or material. Nevertheless, any additional concerns or recommendations the community may have about these procedures will be carefully considered.

Lastly, the cultural significance of Waikīkī Beach does not depend solely on the cultural material it contains, but also on its "integrity," or how the area's physical qualities combine to convey its significance. Several qualities contribute to this sense of integrity, including the area's physical environment or setting, the design, materials, and workmanship used for the physical elements it contains, and its overall aesthetic or historic feeling. Although integrity can sometimes be a subjective judgment, it is an important factor to consider when evaluating the impact of the proposed improvements on the current shoreline.

Request for Cultural Information and Assessment of Project Effects

This letter is being distributed to cultural stakeholders and community members who have a demonstrated interest in the historical and cultural significance of Waikīkī, and who can provide thoughtful and informed opinions about the cultural impacts the proposed project may have on the Waikīkī shoreline and associated areas. We humbly ask that you share with us any knowledge you can about the cultural resources or ongoing cultural practices that may be affected by the project work described above. We would also appreciate any insight you can provide into how the project may impact the cultural integrity and significance of Waikīkī Beach, and/or propose alternative actions that could help mitigate the project's impact on the shoreline's cultural legacy.

All responses received will be summarized or reproduced in full for the CIA report. Your name and cultural/community affiliation will normally be attached to your response, but you may request that your contribution remain anonymous or that certain information not be shared publicly. Please share as much (or as little) information as you like. Also, if you know of other community members who you feel should review and comment on the proposed work, please forward this letter to them.

The deadline for receiving responses is Friday, February 12, 2021. Please send your response by email to hanae@iarii.org, or by conventional mail to:

International Archaeology, LLC
ATTN: Kaumaka Anae
2081 Young Street
Honolulu, HI 96826-2231

Due to time considerations and current COVID-19 community restrictions, we will be unable to arrange in-person, phone, or online interviews.

Mahalo for your kokua,

Kaumaka Anae, M.A.
Archaeologist and Cultural Specialist

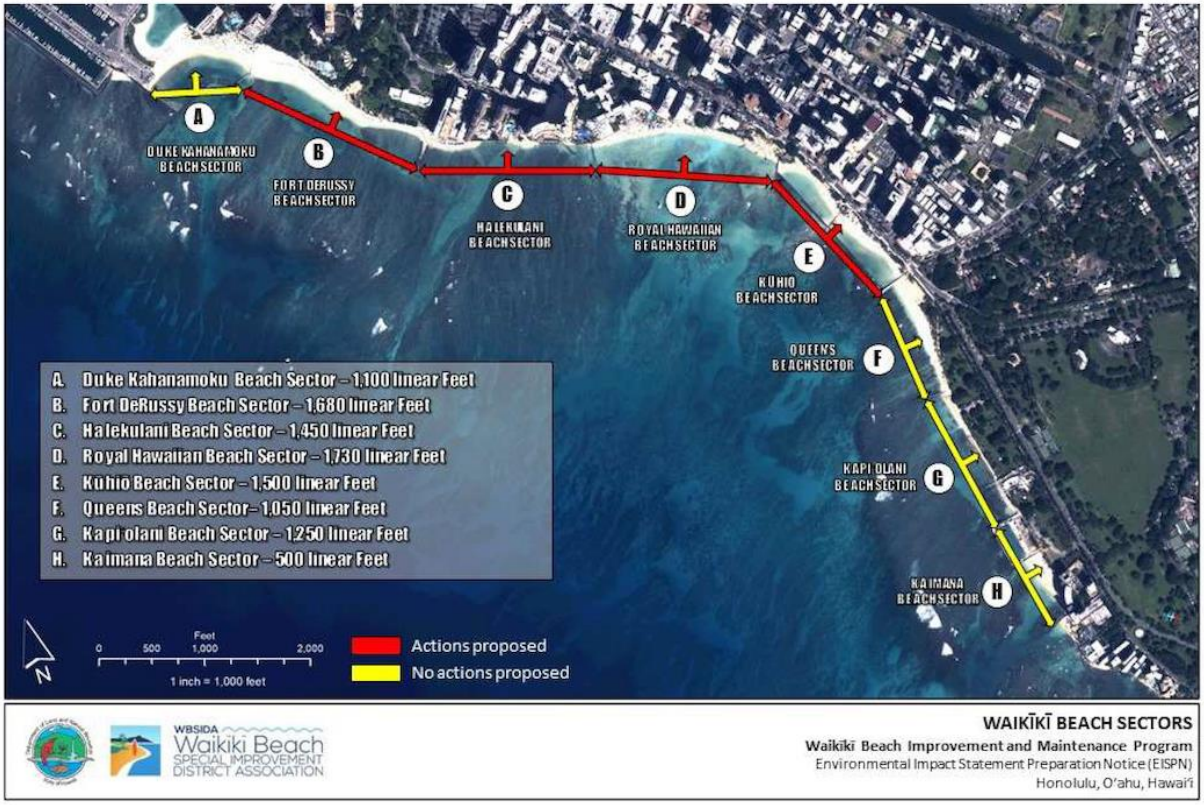


Figure 1-2 Waikīkī beach sectors

WBSIDA
Waikiki Beach
SPECIAL IMPROVEMENT
DISTRICT ASSOCIATION

CONCEPTUAL RENDERING OF PROPOSED BEACH IMPROVEMENT AND MAINTENANCE ACTIONS
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, Oʻahu, Hawaiʻi

Figure 2-1 Conceptual rendering of the proposed actions

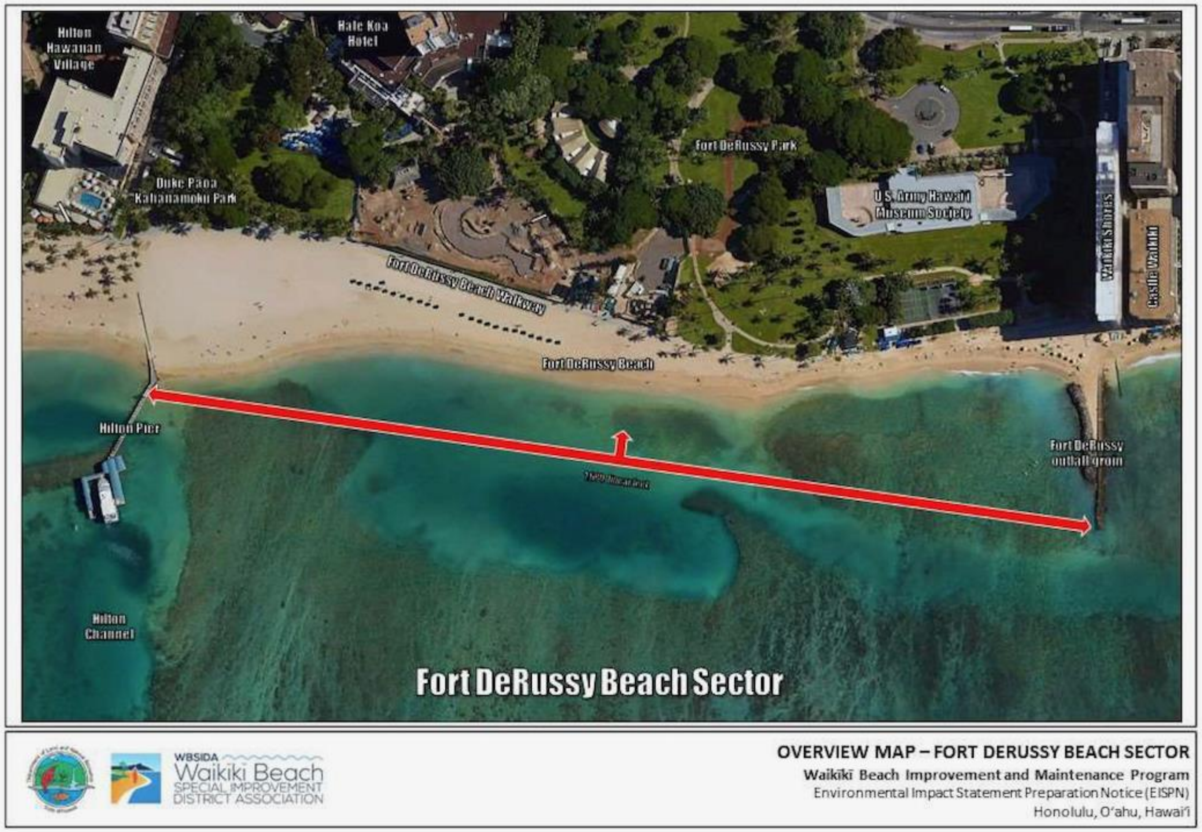
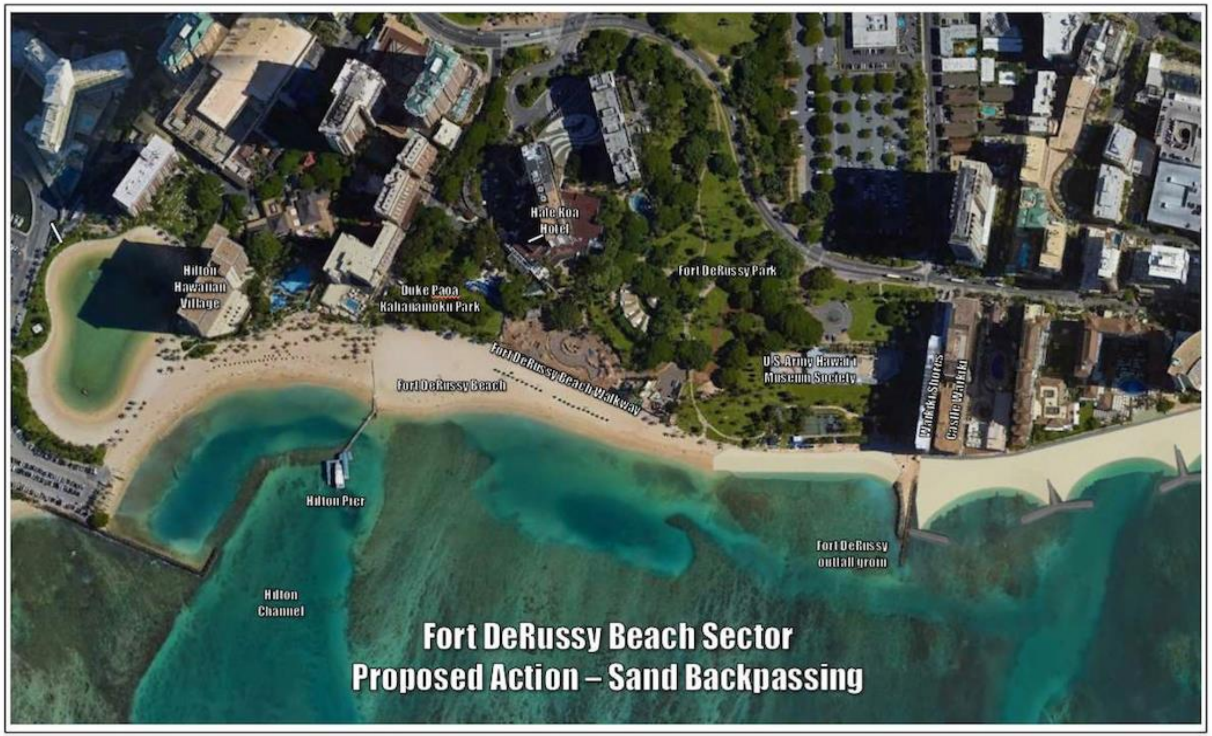


Figure 3-1 Overview map – Fort DeRussy Beach sector



WBSIDA Waikiki Beach SPECIAL IMPROVEMENT DISTRICT ASSOCIATION

CONCEPTUAL RENDERING OF PROPOSED ACTION – FORT DERUSSY BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, Oʻahu, Hawaiʻi

Figure 3-7 Conceptual rendering of proposed action – Fort DeRussy Beach sector

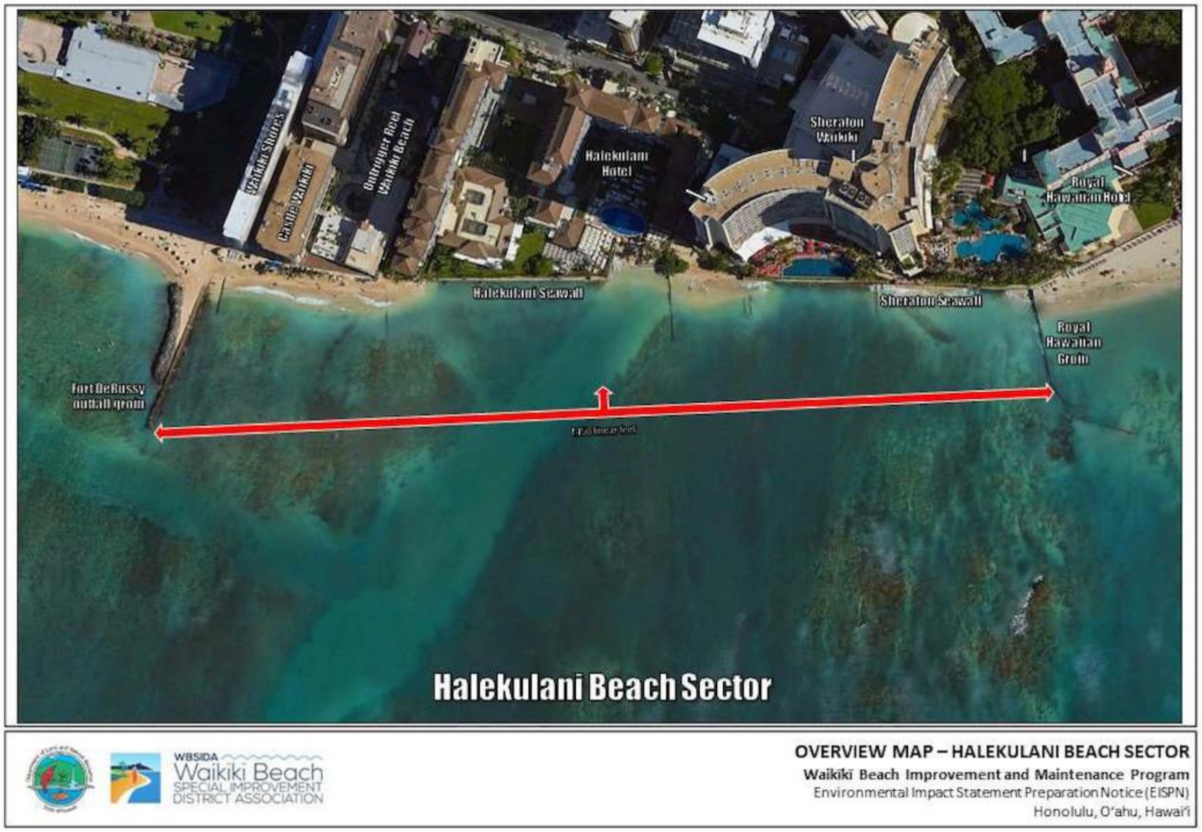
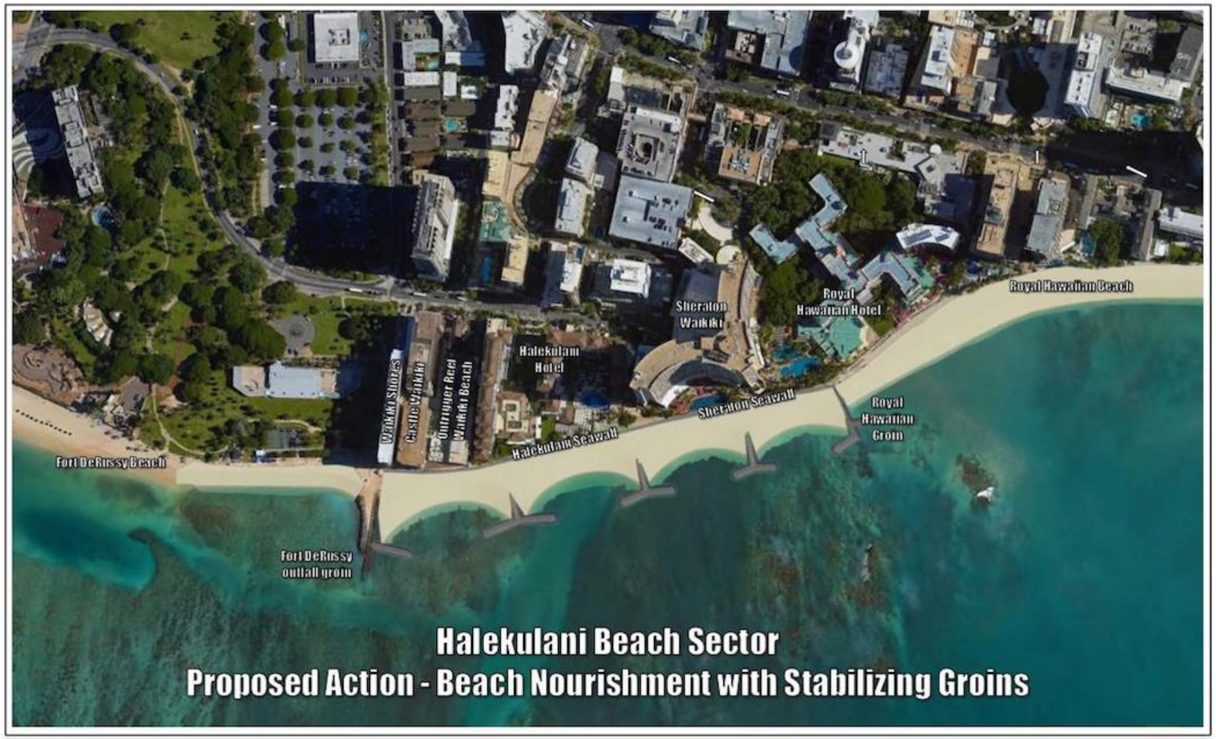


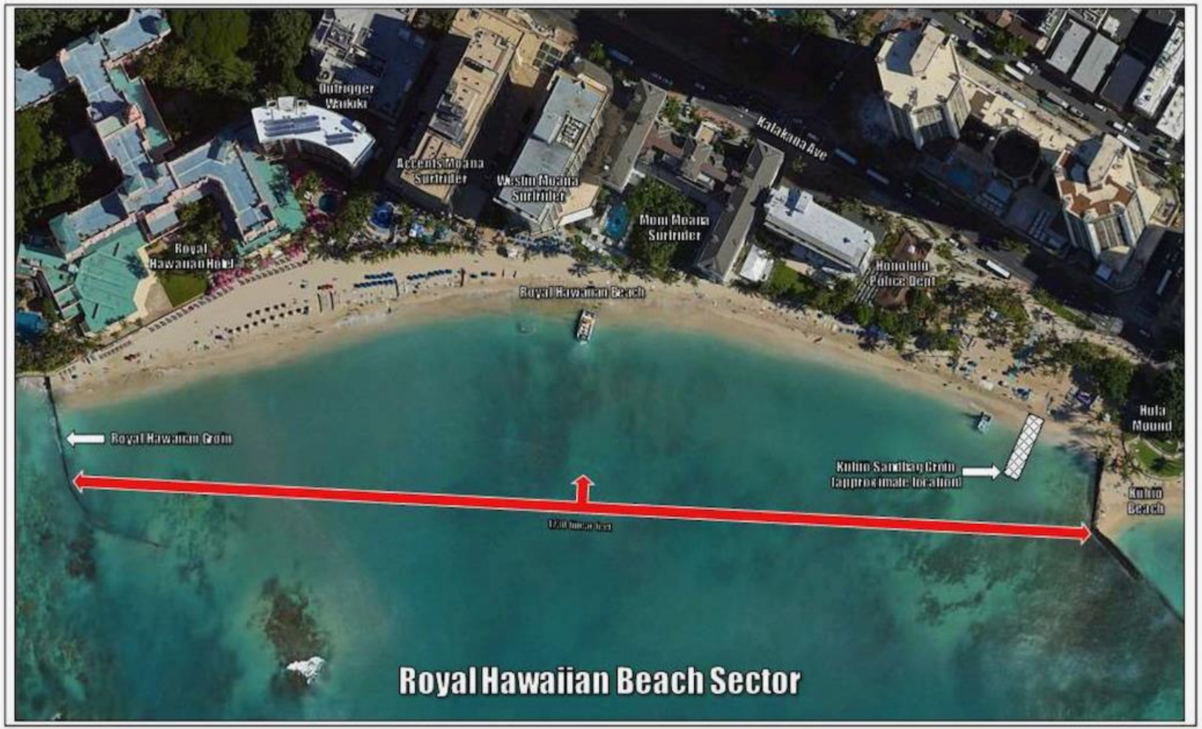
Figure 4-1 Overview map – Halekulani Beach sector



CONCEPTUAL RENDERING OF PROPOSED ACTION – HALEKULANI BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, Oʻahu, Hawaiʻi

WBSIDA Waikiki Beach SPECIAL IMPROVEMENT DISTRICT ASSOCIATION

Figure 4-8 Conceptual rendering of proposed action – Halekulani Beach sector



OVERVIEW MAP – ROYAL HAWAIIAN BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, O'ahu, Hawai'i

Figure 5-1 Overview map – Royal Hawaiian Beach sector

CONCEPTUAL RENDERING OF PROPOSED ACTION – ROYAL HAWAIIAN BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, Oʻahu, Hawaiʻi

Figure 5-8 Conceptual rendering of proposed action – Royal Hawaiian Beach +

OVERVIEW MAP – KŪHIŌ BEACH SECTOR

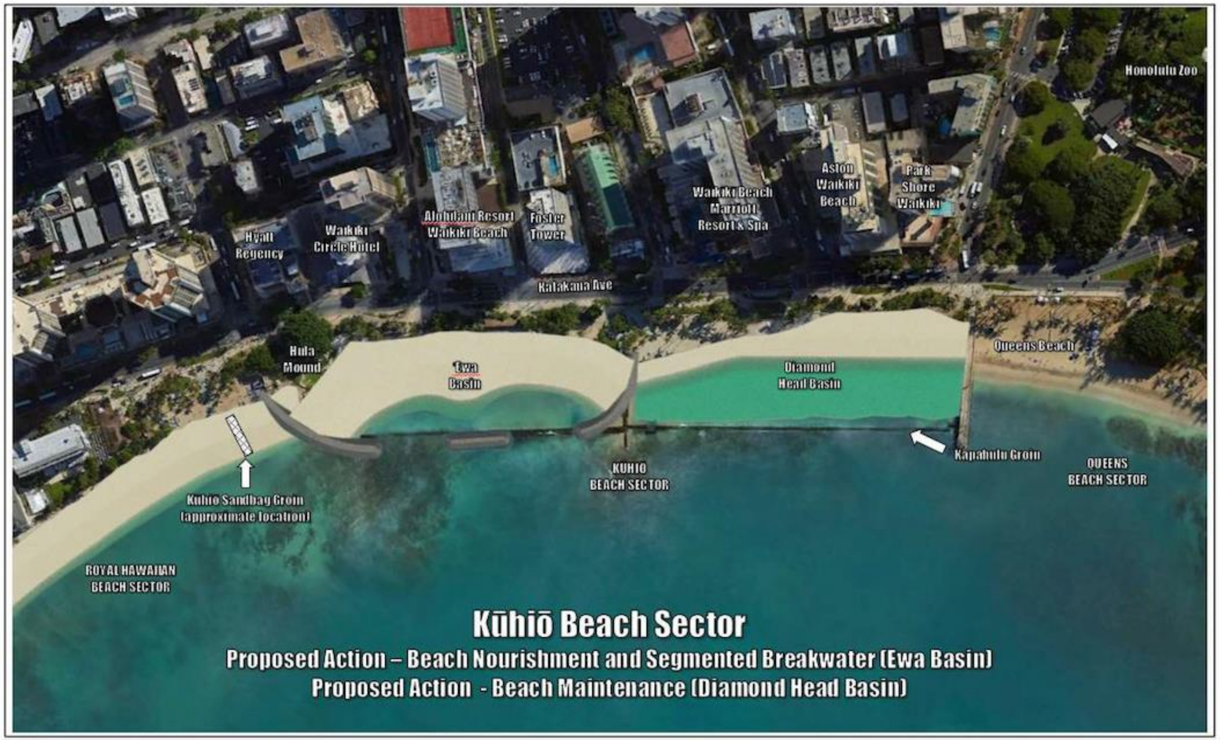
Waikīkī Beach Improvement and Maintenance Program

Environmental Impact Statement Preparation Notice (EISPN)

Honolulu, Oʻahu, Hawaiʻi

WBSIDA Waikiki Beach SPECIAL IMPROVEMENT DISTRICT ASSOCIATION

Figure 6-1 Overview map – Kūhiō Beach sector



WBSIDA Waikiki Beach SPECIAL IMPROVEMENT DISTRICT ASSOCIATION

CONCEPTUAL RENDERING OF THE PROPOSED ACTIONS – KŪHIŌ BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, O'ahu, Hawai'i

Figure 6-13 Conceptual rendering of proposed action for Kūhiō Beach sector

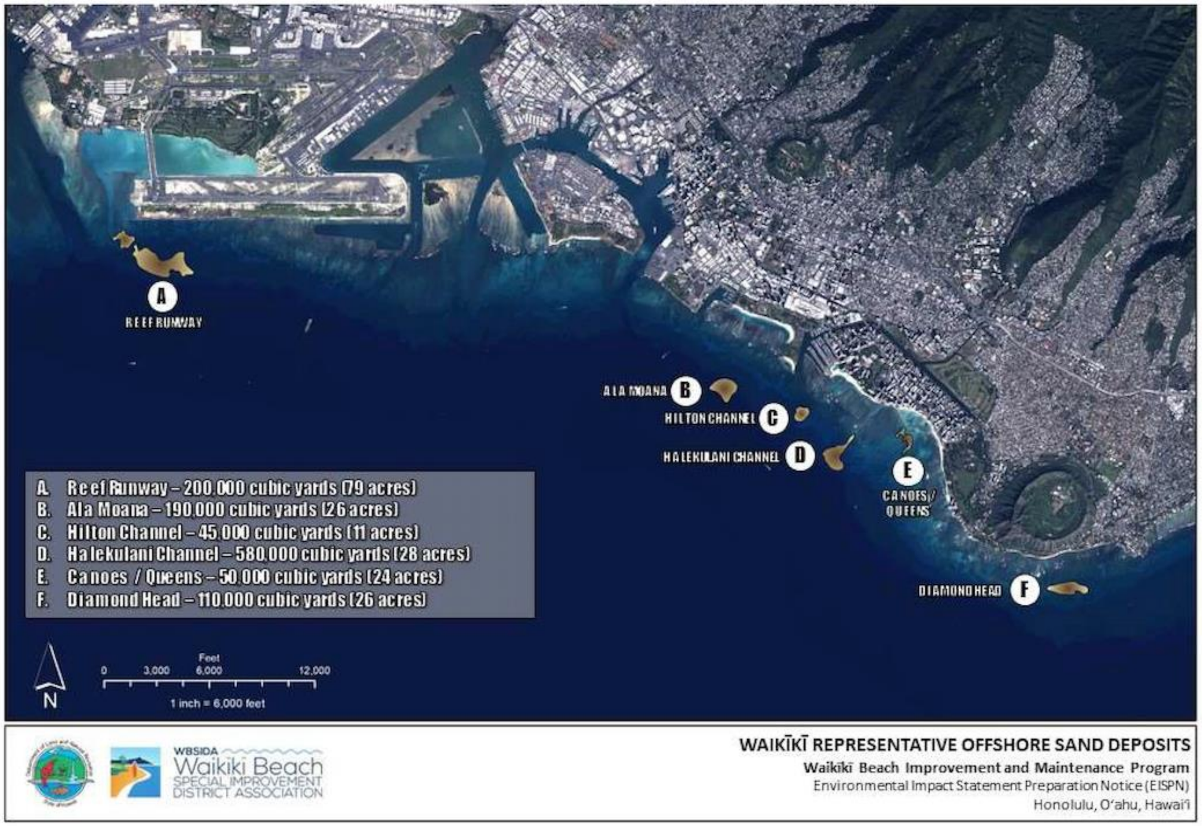


Figure 2-2 Representative Waikīkī offshore sand deposits

APPENDIX B: INDIVIDUALS APPROACHED TO PROVIDE CULTURAL CONSULTATION FOR THE WAIKĪKĪ BEACH IMPROVEMENT AND MAINTENANCE PROGRAM

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Abordo, Chelsea	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Abrams, Mary	U.S. Department of the Interior, Fish and Wildlife Service; Pacific Islands Fish and Wildlife Office	Field Supervisor	01/07/2021	L	N/A	None
Ahlo, Charles	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Akau, Marlene	Royal Hawaiian Center	General Manager	01/07/2021	L	N/A	None
Akimo Jr., Peter Ahoe	Waikīkī kupuna		01/07/2021	L	N/A	None
Alapa, Clarence	Waikīkī cultural descendant		01/05/2021	E	N/A	None
Anderson, Jim	Waikīkī kupuna		01/07/2021	L	N/A	None
Apo, Peter	Office of Hawaiian Affairs (OHA)		01/05/2021	E	--	Received (see Table 7)
ʻĀpuakēhau, Jay	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Arcalas, Cara	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Ayau, Edward Halealoha	Ka Wai Ola (OHA)	Executive Director; Author	01/05/2021	E	N/A	None
Bates, Cline	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Bates, Keʻala	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Battle, Cherie Kahealani Keohokālole	Waikīkī cultural descendant		01/07/2021	L	N/A	None

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Bautista, Jerome	City and County of Honolulu, Waikīkī Neighborhood Board No. 9, Subdistrict 1		01/07/2021	L	N/A	None
Becket, Jan	Hawaiian historian, author, and photographer		01/07/2021	L	N/A	None
Bissen, Tony	Cultural Historian, Moana Surfrider Hotel	Pūʻā Foundation Executive Director	01/05/2021	E	N/A	None
Blangiardi, Rick	City and County of Honolulu	Mayor	01/07/2021	L	N/A	None
Boyack, Robert	City and County of Honolulu, Waikīkī Neighborhood Board No. 9, Subdistrict 1		01/07/2021	L	N/A	None
Boyd, Manu	Royal Hawaiian Shopping Center; Hawaiian Civic Club of Honolulu	Cultural Director; President	01/07/2021	L	N/A	None
Bridges, Cy	Native Hawaiian Hospitality Association	President	01/07/2021	L	N/A	None
Brown, Desoto	Bishop Museum Archivist		01/05/2021	E	N/A	None
Brown, Michael	City and County of Honolulu, Waikīkī Neighborhood Board No. 9, Subdistrict 3		01/07/2021	L	N/A	None
Bush, Ted	Waikīkī Beach Services	Owner	01/05/2021	E	02/10/2021	Received but not shown (see Section III)

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Cabanero, Lisa	City and County of Honolulu, Waikīkī Neighborhood Board No. 9, Subdistrict 1	Secretary	01/07/2021	L	N/A	None
Cáceres, Norman "Mana"	Waikīkī cultural descendant; Ohana Kūpono Consulting, Inc.		01/07/2021	L		Received (see Table 7)
Carroll, Helen T.	City and County of Honolulu, Waikīkī Neighborhood Board No. 9, Subdistrict 1		01/07/2021	L	N/A	None
Cayan, Phyllis ("Coochie")	State Historic Preservation Division (SHPD)	Intake Specialist	01/05/2021	E	01/05/2021	None
Ching, Dylan	TS Restaurants	Regional Manager	01/07/2021	L	N/A	None
Ching, Ricky	Historic Hawaiʻi Foundation	President, Board of Trustees	01/07/2021	L	N/A	None
Christensen, Makani	Aha Moku		01/05/2021	E	N/A	None
Clark, John	Author and *kūpuna* who frequented Waikīkī		02/10/2021		02/10/2021	Received (see Table 7)
DaMate, Leimana	DLNR Aha Moku Advisory Committee	Executive Director	03/09/2021	E	N/A	None
Deguair, Connie	Hilton Hawaiian Village	Special Projects Manager	01/07/2021	L	N/A	None
Deltoro, Benjamin	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Deltoro, Daniel	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Deltoro, Rachel	Waikīkī cultural descendant		01/07/2021	L	N/A	None

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Deltoro, Samuel	Waikīkī cultural descendant		01/07/2021	L	N/A	None
DeMello, Mark	Aqua-Aston Hospitality LLC	General Manager/Special Projects	01/07/2021	L	N/A	None
Diamond, Randy	Aston Waikīkī Beach Hotel	General Manager	01/07/2021	L	N/A	None
Downing, Keone	Save Our Surf Organization; Waikīkī kupuna		01/05/2021	E	N/A	None
Egged, Rick	Waikīkī Improvement Association	President	01/05/2021	E	N/A	None
Erteschik, Louis	City and County of Honolulu, Waikīkī Neighborhood Board No. 9, Subdistrict 2	Vice Chairperson	01/07/2021	L	N/A	None
Eversole, Dolan	Hawaiʻi Sea Grant	Secretary	01/05/2021	E	N/A	None
Filek, Melissa	City and County of Honolulu, Waikīkī Neighborhood Board No. 9, Subdistrict 3		01/07/2021	L	N/A	None
Finley, Robert J.	City and County of Honolulu, Waikīkī Neighborhood Board No. 9, Subdistrict 2	Chairperson	01/07/2021	L	N/A	None
Flood, Walt	City and County of Honolulu, Waikīkī Neighborhood Board No. 9, Subdistrict 2		01/07/2021	L	N/A	None

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Foti, Thomas	Waikīkī Beach Marriott Resort & Spa	General Manager	01/07/2021	L	N/A	None
Garrity, Mark	City and County of Honolulu, Waikīkī Neighborhood Board No. 9, Subdistrict 1		01/07/2021	L	N/A	None
Gersaba, Nalani J.	Waikīkī descendant		01/07/2021	L	N/A	None
Gomes, Celeste (Fukuhara)	Waikīkī descendant		01/07/2021	L	N/A	None
Gomes, Jared	Waikīkī descendant		01/07/2021	L	N/A	None
Gomes, Jeffrey	Waikīkī descendant		01/07/2021	L	N/A	None
Gomes, Phoebe	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Gomes, Robert Jr.	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Gomes, Robin	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Gonser, Matthew	City and County of Honolulu, Office of Climate Change, Sustainability and Resiliency	Chief Resilience Officer and Executive Director	01/05/2021	E	N/A	None
Gomes-Silva, Lisa	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Gora, Amelia K.	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Grace, Nadine	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Hampton, Bob	Waikīkī Beach Activities	Chairperson	01/07/2021	L	N/A	None
Harris, Cy	Waikiki Halia Aloha descendants		01/07/2021	L	N/A	None
Hatchie, Andrew	Waikīkī cultural descendant		01/07/2021	L	N/A	None

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Heanu, Arthur Lanakila Jr.	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Heanu, Gilbert Kahōkūokalani	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Heanu, Glenn Ione	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Heanu, Jadelyn Kealohilani	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Heanu, Kyle Ikaika	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Heanu, Sharleen	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Hemenway, Samantha	State Historic Preservation Division (SHPD)	O‘ahu Island Archaeologist	01/05/2021	E	N/A	None
Henski, Kathryn	City and County of Honolulu Waikīkī Neighborhood Board No. 9, Subdistrict 3		01/07/2021	L	N/A	None
Hilo, Regina	State Historic Preservation Division (SHPD)	Burial Sites Specialist	01/05/2021	E	N/A	None
Hinaga, Reid	Bank of Hawai‘i, Waikīkī	Treasurer	01/07/2021	L	N/A	None
Hoen, Kelly	Outrigger Reef Waikīkī Beach	Area Manager/General Manager	01/07/2021	L	N/A	None
Ho‘ohuli, William	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Iaukea, Lesley K.	SHPD	Burial Sites Specialist	01/05/2021	E	N/A	None
Joto, Lorelei	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Ka‘awakauo, Emma	Waikīkī kupuna		01/07/2021	L	N/A	None
Kahanamoku, Samuel A.	Waikīkī/Kālia kupuna		01/07/2021	L	N/A	None

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Kaleikini, Ali‘ikaua (Arthur W. Kaleikini Jr)	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Kaleikini, Hāloa Keko‘o Namakaokalani	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Kaleikini, Kala	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Kaleikini, No‘eau	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Kaleikini, Paulette	Waikīkī cultural descendant; Oiwi Cultural Resources				N/A	Deceased
Kaleikini, Tuahine	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Kam, George	Quicksilver	Ambassador of Aloha	01/07/2021	L	N/A	None
Kam, Thelma	Sheraton Waikīkī	Cultural Director	01/07/2021	L	N/A	None
Kamai, Dwynn	Waikīkī Hawaiian Civic Club		01/05/2021	E	N/A	None
Kanakanui, Sam	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Kanohokula, Shanlyn Maile	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Kawainui, Eryke Kalani Naeole	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Ke‘ana‘āina, Betty	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Ke‘ana‘āina, Kīhei	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Ke‘ana‘āina, Luther	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Ke‘ana‘āina, Michelle	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Ke‘ana‘āina, Noelani	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Ke‘ana‘āina, Regina	Waikīkī cultural descendant		01/07/2021	L	N/A	None

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Ke‘ana‘āina, Vicky	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Ke‘ana‘āina, Wilsam	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Keala, Kathryn	Office of Hawaiian Affairs (OHA)		01/05/2021	E	N/A	None
Keaweamahi, April Leimomi	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Keaweamahi, Michael Alan Lani Jr.	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Kekaula, Ashford	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Kekaula, Mary K.	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Keli‘ipa‘akaua, Chase	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Keli‘ipa‘akaua, Justin	Waikīkī cultural descendant		01/07/2021	L		Received but not shown (see Section III)
Keli‘inoi, Moani	*Kona moku* cultural descendant		01/07/2021	L	N/A	None
Keohokālole, Adrian K.	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Keohokālole, Dennis Ka'imina'auao	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Keohokālole, Emalia E.	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Keohokālole, James Hoapili	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Keohokālole, Joseph Moses Keaweaheulu	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Keohokālole, Lori Lani	Waikīkī cultural descendant		01/07/2021	L	N/A	None

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Kihikihi, Kauna	Waikīkī cultural historian, E Noa Tours		01/07/2021	L	N/A	None
Kini, Debbie (Norman)	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Kini, Nalani or Nalani Gasper	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Koko, Kanaloa	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Kozlov, Alex	City and County of Honolulu, Department of Design and Construction	Director	01/07/2021	L	02/17/2021	Received (see Table 7)
Krauer, Ulrich	Halekūlani Hotel	General Manager	01/07/2021	L	N/A	None
Kruse, T. Kehaulani	Former member of the Oahu Island Burial Council (OIBC)		01/07/2021	L	N/A	None
Kuloloio, Manuel	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Lau, Clifford	City and County of Honolulu,Department of Design and Consultation, 650 S. King St., 11th floor, Honolulu, HI 96813	Facilities Branch Chief	01/07/2021	E	1/7/21	Received (see Table 7)
Lebo, Susan A.	State Historic Preservation Division (SHPD)	Archaeology Branch Chief	01/05/2021	E	N/A	None
Lemmo, Sam	DLNR-Conservation & Coastal Lands	Administrator	01/05/2021	E	01/05/2021	Received (see Table 7)
Lew, Haumea (Haumea Hanakahi)	Waikīkī cultural descendant		01/07/2021	L	N/A	None
L‘Heureux, Ray L.	Pacific Historic Parks		01/05/2021	E	N/A	None

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Lindsey, Keola	Office of Hawaiian Affairs (OHA)		01/05/2021	E	N/A	None
Lopes, Kamahaʻo	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Lopes, Leinaʻala (Moses-Hukiku)	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Lopes, Puahone Kini	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Lopes, Wilfred	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Luka, Alika	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Luthy, Tamara	State Historic Preservation Division (SHPD)	Ethnographer	01/05/2021	E	N/A	None
Makahi, Merlin	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Mamac, Violet L. Medeiros	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Mau, Alika	Waikīkī Business Plaza	Vice President	01/07/2021	L	N/A	None
Maxwell Jr., Philip P.	Waikīkī kupuna		01/05/2021	E	N/A	Deceased
Medeiros, David	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Medeiros, Jacob L.	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Medeiros, Jaimison K.	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Medeiros, Jayla A.	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Medeiros, Kareen K.	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Medeiros, Lincoln K.	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Medeiros, Lolani			01/07/2021	L	N/A	None
Medeiros, Roland	Waikīkī cultural descendant		01/07/2021	L	N/A	None

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Merz, Jeffrey D.	City and County of Honolulu Waikīkī Neighborhood Board No. 9, Subdistrict 1		01/07/2021	L	N/A	None
Miller, ʻIhilani Silva	Sheraton Moana Surfrider	Entertainer	01/07/2021	L	N/A	None
Miyamoto, Florence Kamakaʻōpiopio Clark	Waikīkī *kupuna*		01/07/2021	L	N/A	None
Morvant, Irby	Hyatt Regency Waikīkī Beach Resort and Spa	General Manager	01/07/2021	L	N/A	None
Naeole, Joelle Kamakaonaona	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Naeole, Kainoa Kanewokawaiola	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Naguwa, Joan	Executive Director Waikīkī Community Center		01/07/2021	L	N/A	None
Nakaoka, Bruce	Queen Emma Land Company, Queen's Hospital	Vice President	01/07/2021	L	N/A	None
Nakayama, Jennifer	Waikīkī Business Improvement District Association	President & Executive Director	01/07/2021	L	N/A	None
Napoleon, Nanette	Hawaiian historian, writer, and researcher		01/05/2021	E	N/A	None
Nigro, John	City and County of Honolulu Waikīkī Neighborhood Board No. 9, Subdistrict 3		01/07/2021	L	N/A	None
Nobrega-Olivera, Malia	Waikīkī Hawaiian Civic Club	Director	01/05/2021	E	N/A	None

Name	**Organization or Affiliation**	**Title**	**Date Request Sent**	**Email (E) or Letter (L)**	**Date Response Received**	**Response**
Norman, Carolyn (Keli‘ipa‘akaua)	Waikīkī cultural descendant		01/07/2021	L		Received (see Table 7)
Norman, Eileen	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Norman, Kaleo	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Norman, Keli‘inui	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Norman, Theodore	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Olds, Nalani	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Orr, Fred	Sheraton Princess Kai‘ulani	General Manager	01/07/2021	L	N/A	None
Paglinawan, Richard	Queen Emma Trust; *lua* expert		01/07/2021	L	N/A	None
Paik, Kaleo	DLNR Aha Moku Advisory Committee		01/05/2021	E	N/A	None
Paoa, Robert Clarke	Waikīkī/Kālia kupuna		01/07/2021	L	N/A	None
Pascua, Bruce H.	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Pauio, Alvina (Angeline) Napua	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Peters, David	Queen Lili‘uokalani Trustee		01/07/2021	L	01/12/2021	Received but not shown (see Section III)
Phua, April Haunani	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Phua, Kamakani	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Polido, Mahealani	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Polido, Matthew	Waikīkī cultural descendant		01/07/2021	L	N/A	None

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Polido, Melinda (Tajon)	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Polido, Michael	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Rafid, Raiyan	City and County of Honolulu Waikīkī Neighborhood Board No. 9, Subdistrict 2		01/07/2021	L	N/A	None
Rash, Regina	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Robello, Harry "Didi"	Waikīkī descendant and beachboy		01/07/2021	L	N/A	None
Robinson, Rob	Springboard Hospitality	Vice President	01/07/2021	L	N/A	None
Rodrigues, Hinano R.	State Historic Preservation Division (SHPD)	History & Culture Branch Chief	01/05/2021	E	N/A	None
Roy, Jr., Corbett	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Sasamura, Ross	City and County of Honolulu, Department of Facility Maintenace	Director & Chief Engineer	01/07/2021	L	N/A	None
Shirai, Jacqueline	Waikīkī cultural descendant		01/05/2021	E	N/A	None
Shirai, Jr., Thomas T.	Waikīkī cultural descendant		01/05/2021	E	N/A	None
Smith, Mark	City and County of Honolulu Waikīkī Neighborhood Board No. 9, Subdistrict 3		01/07/2021	L	N/A	None
Solis, Kaʻāhiki	State Historic Preservation Division (SHPD)	Cultural Historian (Oʻahu, Kauaʻi, and Niʻihau)	01/05/2021	E	01/06/2021	None
Sorensen, Betty Dyer	Waikīkī kupuna		01/07/2021	L	N/A	None

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Souza, William D.	Royal Order of Kamehameha, Kūhiō Chapter		01/07/2021	L	N/A	None
Spinney, Charles	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Suzuki, Ashley	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Suzuki, Ashley	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Suzuki, Kimberly	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Takaki, Miles	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Takaki, Moses	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Takaki, Tracy (Kaahanui)	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Takayama, Mike	Kyoya Hotel and Resorts LP	Director of Real Estate	01/07/2021	L	N/A	None
Takizawa, Lorna Medeiros	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Theone, Nicole Gulia	Waikīkī cultural descendant		01/07/2021	L	N/A	None
Thielen, Laura	City and County of Honolulu, Department of Parks & Recreation	Director	01/05/2021	E	N/A	None
Tomczyk, Piʻikea	Waikīkī Hawaiian Civic Club	President	01/05/2021	E	N/A	None
Utterdyke, Aileen	Pacific Historic Parks	Chief Executive Officer	01/05/2021	E	N/A	None
Valbuena, Manuel	City and County of Honolulu, Budget and Fiscal Services	Deputy Director	01/05/2021	E	N/A	None
Wagner, Pat (Low)	Waikīkī kupuna		01/07/2021	L	N/A	None

Name	Organization or Affiliation	Title	Date Request Sent	Email (E) or Letter (L)	Date Response Received	Response
Walker, Isaiah	Waikīkī cultural descendant; Brigham Young University—Hawaii	Professor	01/05/2021	E	N/A	None
Waters, Tommy	City and County of Honolulu, City Council, District 4	Council Chair and Presiding Officer	01/05/2021	E	N/A	None
Wiencek, Jacob	City and County of Honolulu Waikīkī Neighborhood Board No. 9, Subdistrict 2		01/07/2021	L	N/A	None
Wilder, Kenny D.	City and County of Honolulu Waikīkī Neighborhood Board No. 9, Subdistrict 2		01/07/2021	L	N/A	None
Wong, Donna	Oʻahu Island Parks Conservancy		01/05/2021	E	N/A	None
Wong-Kalu, Hinaleimoana	Oʻahu Island Burial Council (OIBC)	Chair	01/07/2021	L	N/A	None
Yagi, Pamela	Hilton Grand Vacations at Hilton Hawaiian Village	General Manager	01/07/2021	L	N/A	None
Yokooji, Dayleen	Waikīkī cultural descendant		01/07/2021	L	N/A	None

APPENDIX C: CONSULTANT CONSENT LETTERS

3/12/2021 iarii.org Mail - Please Review Your Comment for the Waikiki Beach Improvement CIA

IARII

Robert Pacheco [redacted]

Please Review Your Comment for the Waikiki Beach Improvement CIA

3 messages

Robert Pacheco [redacted] Sat, Mar 6, 2021 at 9:50 AM
To: [redacted]
Cc: Hannah Anae [redacted]

Aloha e Mr. Apo,

Mahalo for your recent contribution to the Cultural Impact Assessment (CIA) being prepared by International Archaeology, LLC (IA), for the Waikīkī Beach Improvement and Maintenance Program. As mentioned in our initial request letter, your comments about the cultural impacts of the project will be reproduced in the CIA so they can be read and considered during future project planning.

We would like to give you a final opportunity to review your comment as it will appear in the CIA. IA has edited your original response slightly for clarity, but we believe that your information and opinions are still accurately represented. The text of your response is reproduced below:

"I am familiar with the Waikiki shoreline erosion situation particularly with respect to iwi. If there is any specific aspect of your quest to be inclusive in your reach out to the community I'd be happy to opine. But, there's too many land mines in navigating iwi issues along the Waikiki corridor so I can't give you a general response. Also, Rob Iopa, a person with whom I shared your email of the project is head of WCIT Architecture whose company has a long history of Waikiki development projects."

If you agree that your comment as presented above may appear in the CIA, please confirm your agreement via email reply as soon as possible. We will not include your comment in the CIA without your consent.

If you would like to edit or add more to your response, please do so and send it to us, and we will replace your original statement with the revised comment. Alternatively, if you no longer want your comment to be included in the CIA, we will remove it from the report at your request. There are no consequences for revising or retracting your comment. If you decide on either option, please inform us as soon as possible, as we cannot alter your response once the CIA is finalized.

As noted in our request letter, your name and cultural/community affiliation will be added to your response in the CIA. If you want your comment to be anonymous, we can remove your identifying information upon request.

Finally, we would like to remind you that the CIA is a public document that will be added to an Environmental Impact Statement (EIS) by Sea Engineering, Inc. (SEI), on behalf of the Hawai'i Department of Land and Natural Resources' (DLNR). The purpose of the CIA is to collect information about the past and present cultural resources and practices associated with Waikīkī Beach in order to identify any issues and concerns that may arise from the proposed beach improvements or future maintenance activities. Your participation in this project is completely voluntary, and there will be no negative consequences if you decide not to participate.

We look forward to hearing from you soon.

Mahalo,
Robert Pacheco

--
Robert Pacheco, M.A.
Project Director / Ethnographer / Safety Officer
International Archaeology, LLC (IA)
2081 Young Street
Honolulu, HI 96826
[redacted]
www.internationalarchaeologyllc.com

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Peter Apo [redacted] Sat, Mar 6, 2021 at 4:06 PM
To: Robert Pacheco [redacted]
Cc: Hannah Anae [redacted]

Yes, I approve. Mahalo

Peter Apo
[Quoted text hidden]
--
The Peter Apo Company
[redacted]
www.peterapocompany.com
www.peterapomusic.com

Robert Pacheco [redacted] Mon, Mar 8, 2021 at 9:57 AM
To: Peter Apo [redacted]
Cc: Hannah Anae [redacted]

Mahalo e Mr. Apo.

Sincerely,
Robert
[Quoted text hidden]

IARII

Robert Pacheco [redacted]

Please Review Your Comment for the Waikiki Beach Improvement CIA

3 messages

Robert Pacheco [redacted] Mon, Mar 8, 2021 at 2:32 PM
To: [redacted]
Cc: Hannah Anae [redacted]

Aloha e Mr. Cáceres,

Mahalo for your recent contribution to the Cultural Impact Assessment (CIA) being prepared by International Archaeology, LLC (IA), for the Waikīkī Beach Improvement and Maintenance Program. As mentioned in our initial request letter, your comments about the cultural impacts of the project will be reproduced in the CIA so they can be read and considered during future project planning.

We would like to give you a final opportunity to review your comment as it will appear in the CIA. IA has edited your original response slightly for clarity, but we believe that your information and opinions are still accurately represented. The text of your response is reproduced below:

"After reading the information sent to us, my ʻohana and I support the project. As State Recognized Cultural Descendants to native Hawaiian Human Remains documented in Waikīkī as well as being trained burial practitioners, we have both extensive knowledge as well as a responsibility to ensure the proper care and protection of the iwi kūpuna of that area. Beach erosion is a serious concern to us because the more the beach erodes the more potential impacts there are to burials along the coast. Just a few weeks ago we were assisting the community and descendants of the Kaʻaʻawa area in protecting two burials that were exposed due to erosion."

If you agree that your comment as presented above may appear in the CIA, please confirm your agreement via email reply as soon as possible. We will not include your comment in the CIA without your consent.

If you would like to edit or add more to your response, please do so and send it to us, and we will replace your original statement with the revised comment. Alternatively, if you no longer want your comment to be included in the CIA, we will remove it from the report at your request. There are no consequences for revising or retracting your comment. If you decide on either option, please inform us as soon as possible, as we cannot alter your response once the CIA is finalized.

As noted in our request letter, your name and cultural/community affiliation will be added to your response in the CIA. If you want your comment to be anonymous, we can remove your identifying information upon request.

Finally, we would like to remind you that the CIA is a public document that will be added to an Environmental Impact Statement (EIS) by Sea Engineering, Inc. (SEI), on behalf of the Hawaiʻi Department of Land and Natural Resources' (DLNR). The purpose of the CIA is to collect information about the past and present cultural resources and practices associated with Waikīkī Beach in order to identify any issues and concerns that may arise from the proposed beach improvements or future maintenance activities. Your participation in this project is completely voluntary, and there will be no negative consequences if you decide not to participate.

We look forward to hearing from you soon.

Mahalo,
Robert Pacheco

--
Robert Pacheco, M.A.
Project Director / Ethnographer / Safety Officer
International Archaeology, LLC (IA)
2081 Young Street
Honolulu, HI 96826
[redacted]
www.internationalarchaeologyllc.com

Mana Caceres [redacted]
To: Robert Pacheco [redacted]
Cc: Hannah Anae [redacted]

Mon, Mar 8, 2021 at 2:48 PM

Aloha e Robert,

Mahalo for the follow up regarding the comments I've made for the CIA mentioned above. Please feel free to use my statement, quoted above, in the CIA. You can also leave my name and affiliation in the CIA.

Please let me know if there is anything else I can do to support the efforts to mitigate the erosion issues in Waikīkī.

Ola nā iwi,

Mana

e kolo ana nō ke ēwe i ka ʻiewe

descendants of the same ancestors crawl together

Mana Kaleilani Cáceres

[Quoted text hidden]

Robert Pacheco [redacted]
To: Mana Caceres [redacted]
Cc: Hannah Anae [redacted]

Mon, Mar 8, 2021 at 2:54 PM

Mahalo e Mr. Cáceres.

Sincerely,
Robert
[Quoted text hidden]

IARII

Robert Pacheco [redacted]

Please Review Your Comment for the Waikiki Beach Improvement CIA

3 messages

Robert Pacheco [redacted] Sat, Mar 6, 2021 at 9:50 AM
To: [redacted]
Cc: [redacted]

Aloha e Mr. Clark,

Mahalo for your recent contribution to the Cultural Impact Assessment (CIA) being prepared by International Archaeology, LLC (IA), for the Waikīkī Beach Improvement and Maintenance Program. As mentioned in our initial request letter, your comments about the cultural impacts of the project will be reproduced in the CIA so they can be read and considered during future project planning.

We would like to give you a final opportunity to review your comment as it will appear in the CIA. IA has edited your original response slightly for clarity, but we believe that your information and opinions are still accurately represented. The text of your response is reproduced below:

"If you have a copy of Hawaiian Surfing: Traditions from the Past, I included a section at the end called "Waikiki Place Names Related to Surfing." There's material in it that addresses some of the information that you're after.
Several years ago the Department of Education asked me if I would narrate a surfing history of Waikīkī. We finished it in 2017 and premiered it at my alma mater in Waikīkī, Jefferson Elementary School. If you haven't seen it, this is the link: *https://www.youtube.com/watch?v=NbFigfXH5Yg*. **FYI, it's 48 minutes long. Please feel free to share it."**

If you agree that your comment as presented above may appear in the CIA, please confirm your agreement via email reply as soon as possible. We will not include your comment in the CIA without your consent.

If you would like to edit or add more to your response, please do so and send it to us, and we will replace your original statement with the revised comment. Alternatively, if you no longer want your comment to be included in the CIA, we will remove it from the report at your request. There are no consequences for revising or retracting your comment. If you decide on either option, please inform us as soon as possible, as we cannot alter your response once the CIA is finalized.

As noted in our request letter, your name and cultural/community affiliation will be added to your response in the CIA. If you want your comment to be anonymous, we can remove your identifying information upon request.

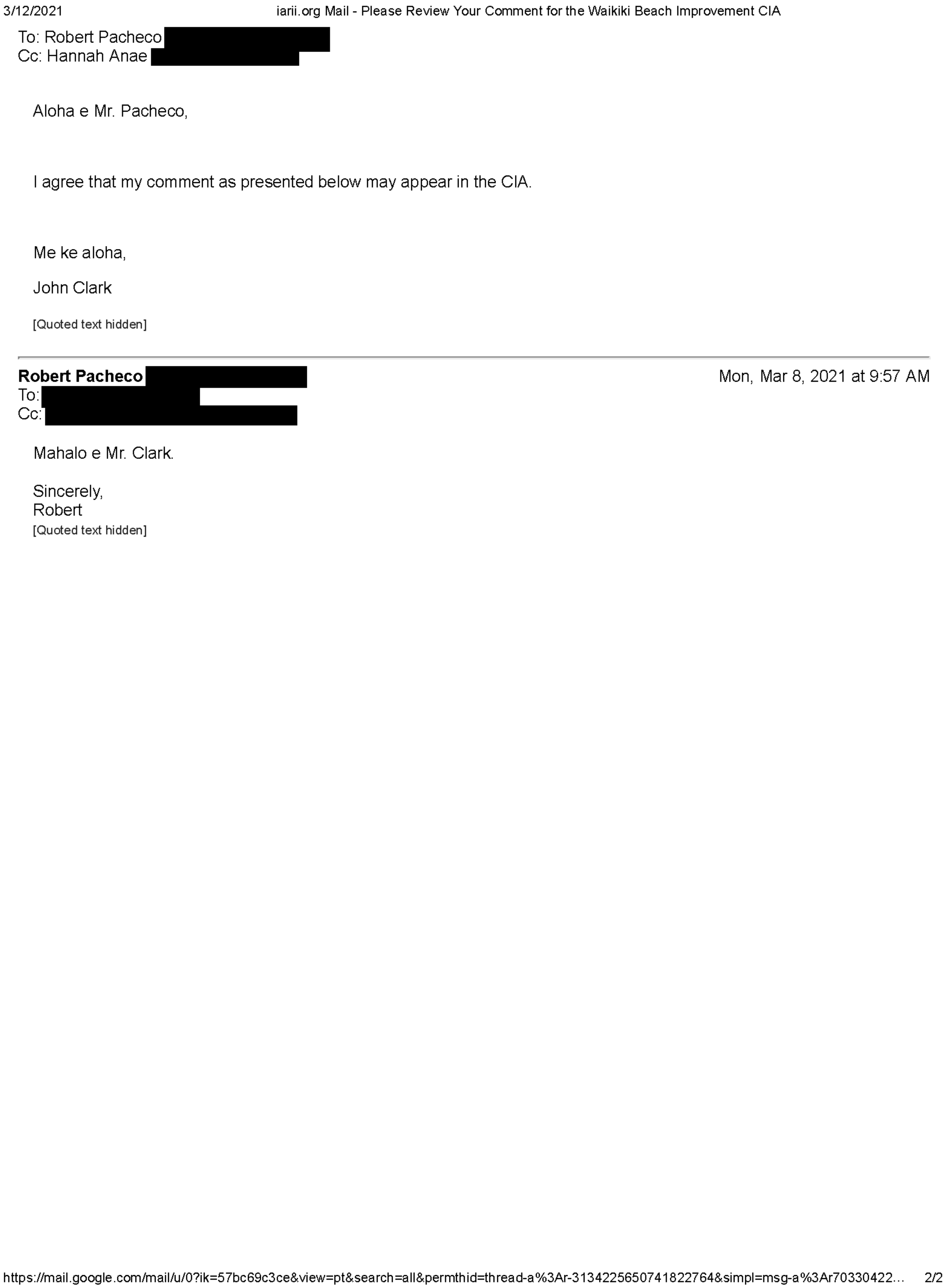
Finally, we would like to remind you that the CIA is a public document that will be added to an Environmental Impact Statement (EIS) by Sea Engineering, Inc. (SEI), on behalf of the Hawai'i Department of Land and Natural Resources' (DLNR). The purpose of the CIA is to collect information about the past and present cultural resources and practices associated with Waikīkī Beach in order to identify any issues and concerns that may arise from the proposed beach improvements or future maintenance activities. Your participation in this project is completely voluntary, and there will be no negative consequences if you decide not to participate.

We look forward to hearing from you soon.

Mahalo,
Robert Pacheco

--
Robert Pacheco, M.A.
Project Director / Ethnographer / Safety Officer
International Archaeology, LLC (IA)
2081 Young Street
Honolulu, HI 96826
[redacted]
www.internationalarchaeologyllc.com

[redacted] Sat, Mar 6, 2021 at 3:55 PM



To: Robert Pacheco [redacted]
Cc: Hannah Anae [redacted]

Aloha e Mr. Pacheco,

I agree that my comment as presented below may appear in the CIA.

Me ke aloha,

John Clark

[Quoted text hidden]

Robert Pacheco [redacted] Mon, Mar 8, 2021 at 9:57 AM
To: [redacted]
Cc: [redacted]

Mahalo e Mr. Clark.

Sincerely,
Robert
[Quoted text hidden]

IARII

Robert Pacheco [redacted]

Please Review Your Comment for the Waikiki Beach Improvement CIA

3 messages

Robert Pacheco [redacted] Sat, Mar 6, 2021 at 9:51 AM
To: [redacted]
Cc: Hannah Anae [redacted]

Aloha e Mr. Lau,

Mahalo for your recent contribution to the Cultural Impact Assessment (CIA) being prepared by International Archaeology, LLC (IA), for the Waikīkī Beach Improvement and Maintenance Program. As mentioned in our initial request letter, your comments about the cultural impacts of the project will be reproduced in the CIA so they can be read and considered during future project planning.

We would like to give you and Mr. Kozlov a final opportunity to review your comments as they will appear in the CIA. IA has edited your original responses slightly for clarity, but we believe that your information and opinions are still accurately represented. The text of your responses is reproduced below:

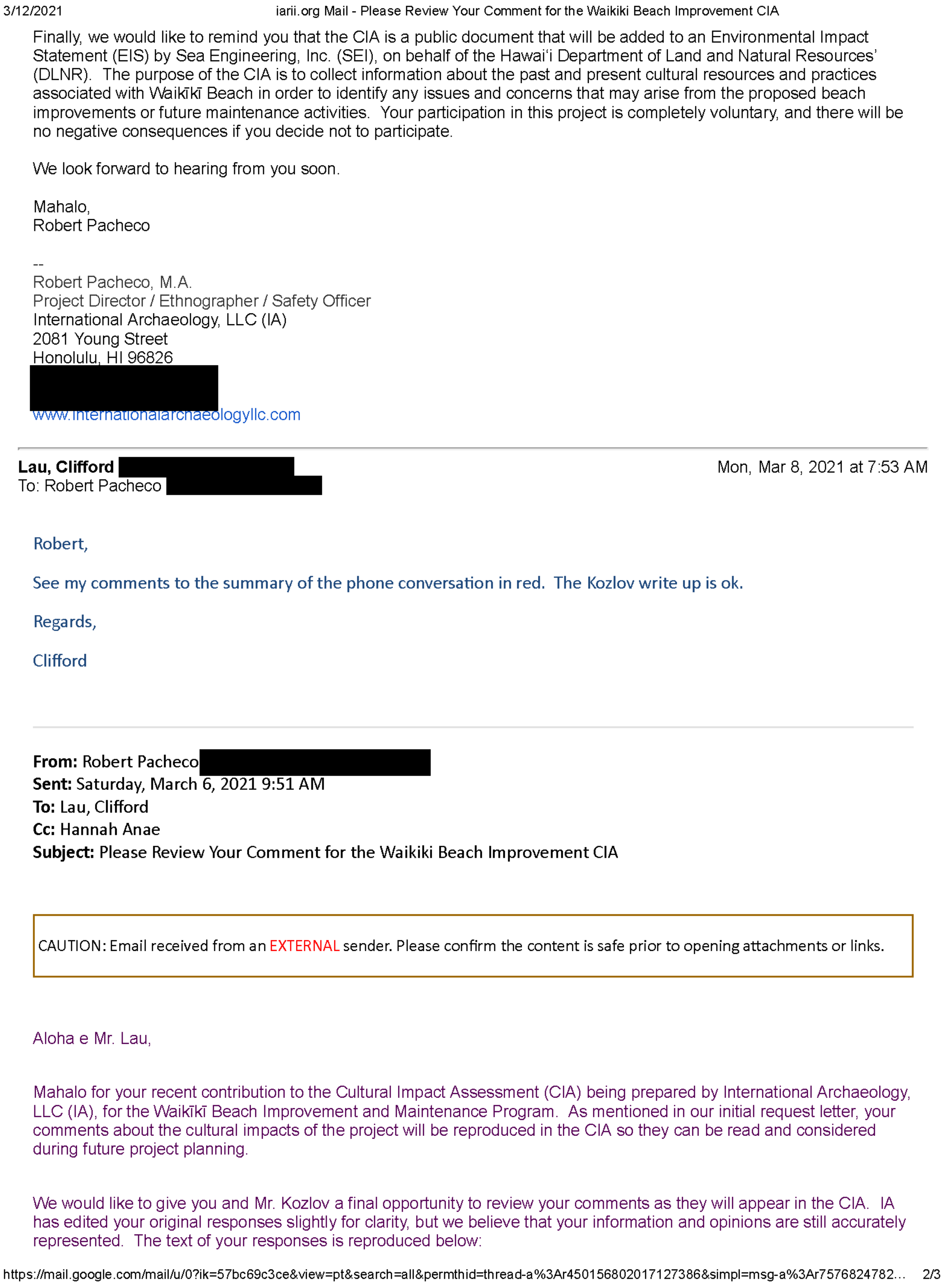
[redacted]

Mr. Kozlov:
Thank you for the opportunity to review and comment. The Department of Design and Construction's Facilities Division has the following comments.
1. The proposed project along the Halekulani Beach Sector will restore a severely eroded section of beach in an area which tourists and local residents historically could access and utilize our valuable beach resource for recreational and cultural practices. The erosion is resulting in the closure of Brow 141A to protect the public from a hazardous condition. This project will insure that free access can be restored and protect against future sea level rise and coastal erosion.
2. Along the C, D, and E areas the City provides valuable lifeguard services which insures the safety of both tourists and locals who enjoy the various water activities that this shoreline has been and will continue to be intensively used for. To undertake this service the City has in place lifeguard towers which are key to enable the lifeguards to perform their duties. The severe erosion has endangered those structures which make it more difficult for the City to provide this service. The restoration of those shorelines will protect these structures ensuring that the City lifeguards will be able to continue to provide their service.
3. All around the island we see severe erosion of the shoreline at beach parks. When this occurs we see burials in the sand deposits being exposed. We see this project providing protection of sensitive cultural deposits which exist inland from the immediate beach area. If this kind of project is not undertaken we fully expect that the coastal erosion will progress mauka and will expose burial which we know to exist in this coastal area. With sea level rise taking no action to restore the beach and raise the elevation will leave the sensitive cultural areas exposed.
Sincerely,
Alex Kozlov, P.E.
Director Designate

If you agree that your comments as presented above may appear in the CIA, please confirm your agreement via email reply as soon as possible. We will not include your comments in the CIA without your consent.

If you would like to edit or add more to your responses, please do so and send them to us, and we will replace your original statements with the revised comments. Alternatively, if you no longer want your comments to be included in the CIA, we will remove them from the report at your request. There are no consequences for revising or retracting your comments. If you decide on either option, please inform us as soon as possible, as we cannot alter your responses once the CIA is finalized.

As noted in our request letter, your names and cultural/community affiliations will be added to your responses in the CIA. If you want your comments to be anonymous, we can remove your identifying information upon request.



Finally, we would like to remind you that the CIA is a public document that will be added to an Environmental Impact Statement (EIS) by Sea Engineering, Inc. (SEI), on behalf of the Hawaiʻi Department of Land and Natural Resources' (DLNR). The purpose of the CIA is to collect information about the past and present cultural resources and practices associated with Waikīkī Beach in order to identify any issues and concerns that may arise from the proposed beach improvements or future maintenance activities. Your participation in this project is completely voluntary, and there will be no negative consequences if you decide not to participate.

We look forward to hearing from you soon.

Mahalo,
Robert Pacheco

--
Robert Pacheco, M.A.
Project Director / Ethnographer / Safety Officer
International Archaeology, LLC (IA)
2081 Young Street
Honolulu, HI 96826
[redacted]
www.internationalarchaeologyllc.com

Lau, Clifford [redacted] Mon, Mar 8, 2021 at 7:53 AM
To: Robert Pacheco [redacted]

Robert,

See my comments to the summary of the phone conversation in red. The Kozlov write up is ok.

Regards,

Clifford

From: Robert Pacheco [redacted]
Sent: Saturday, March 6, 2021 9:51 AM
To: Lau, Clifford
Cc: Hannah Anae
Subject: Please Review Your Comment for the Waikiki Beach Improvement CIA

CAUTION: Email received from an EXTERNAL sender. Please confirm the content is safe prior to opening attachments or links.

Aloha e Mr. Lau,

Mahalo for your recent contribution to the Cultural Impact Assessment (CIA) being prepared by International Archaeology, LLC (IA), for the Waikīkī Beach Improvement and Maintenance Program. As mentioned in our initial request letter, your comments about the cultural impacts of the project will be reproduced in the CIA so they can be read and considered during future project planning.

We would like to give you and Mr. Kozlov a final opportunity to review your comments as they will appear in the CIA. IA has edited your original responses slightly for clarity, but we believe that your information and opinions are still accurately represented. The text of your responses is reproduced below:

Mr. Lau:

[The following paragraph is a summary of a phone conversation with Mr. Lau.]
Mr. Lau says that the Department of Design and Construction supports [redacted] the proposed project as it will restore shoreline access and protect lifeguard stations along Waikiki Beach which being endangered by the beach erosion.

[Quoted text hidden]

Robert Pacheco [redacted] Mon, Mar 8, 2021 at 9:58 AM
To: "Lau, Clifford"
Cc: Hannah Anae

Mahalo e Mr. Lau. We will change your response as indicated.

Sincerely,
Robert
[Quoted text hidden]

IARII

Robert Pacheco [redacted]

Please Review Your Comment for the Waikiki Beach Improvement CIA

12 messages

Robert Pacheco [redacted] Sat, Mar 6, 2021 at 9:53 AM
To: [redacted]
Cc: Hannah Anae [redacted]

Aloha e Mr. Lemmo,

Mahalo for your recent contribution to the Cultural Impact Assessment (CIA) being prepared by International Archaeology, LLC (IA), for the Waikīkī Beach Improvement and Maintenance Program. As mentioned in our initial request letter, your comments about the cultural impacts of the project will be reproduced in the CIA so they can be read and considered during future project planning.

We would like to give you a final opportunity to review your response as it will appear in the CIA. Although you did not provide commentary on the project, IA will instead include a short statement acknowledging your response to our initial request letter. The text of this summary is reproduced below:

[Mr. Lemmo requested a copy of a 2008 report by Robert Wiegel (Waikīkī Beach, O'ahu, Hawai'i: History of Its Transformation from a Natural to an Urban Shore), but provided no further comment.]

If you agree that your response as presented above may appear in the CIA, please confirm your agreement via email reply as soon as possible. We will not include your response in the CIA without your consent.

If you would like to edit or add more to your response, please do so and send it to us, and we will replace your original statement with the revised comment. Alternatively, if you no longer want your comment to be included in the CIA, we will remove it from the report at your request. There are no consequences for revising or retracting your comment. If you decide on either option, please inform us as soon as possible, as we cannot alter your response once the CIA is finalized.

As noted in our request letter, your name and cultural/community affiliation will be added to your response in the CIA. If you want your comment to be anonymous, we can remove your identifying information upon request.

Finally, we would like to remind you that the CIA is a public document that will be added to an Environmental Impact Statement (EIS) by Sea Engineering, Inc. (SEI), on behalf of the Hawaiʻi Department of Land and Natural Resources' (DLNR). The purpose of the CIA is to collect information about the past and present cultural resources and practices associated with Waikīkī Beach in order to identify any issues and concerns that may arise from the proposed beach improvements or future maintenance activities. Your participation in this project is completely voluntary, and there will be no negative consequences if you decide not to participate.

We look forward to hearing from you soon.

Mahalo,
Robert Pacheco

--
Robert Pacheco, M.A.
Project Director / Ethnographer / Safety Officer
International Archaeology, LLC (IA)
2081 Young Street
Honolulu, HI 96826
[redacted]
www.internationalarchaeologyllc.com

Lemmo, Sam J [redacted] Mon, Mar 8, 2021 at 10:13 AM
To: Robert Pacheco [redacted]
Cc: Hannah Anae [redacted]

I would like tom talk to you folks when you have an opportunity.

Mahalo

[Quoted text hidden]

Robert Pacheco [redacted] Mon, Mar 8, 2021 at 11:07 AM
To: "Lemmo, Sam J" [redacted]
Cc: Hannah Anae [redacted]

Dear Mr. Lemmo,

Yes, we'd be happy to talk. Can we reach you at these numbers?
[redacted]

Mahalo,
Robert
[Quoted text hidden]

Lemmo, Sam J [redacted] Mon, Mar 8, 2021 at 11:38 AM
To: Robert Pacheco [redacted]
Cc: Hannah Anae [redacted]

Thanks Robert. [redacted] is the best number to reach me. Can we talk tomorrow in the morning sometime?

[Quoted text hidden]

Robert Pacheco [redacted] Mon, Mar 8, 2021 at 11:42 AM
To: "Lemmo, Sam J" [redacted]
Cc: Hannah Anae [redacted]

Sounds good. We'll call tomorrow morning between 9 and 11. Just shoot us an email if you want to narrow the window.

Mahalo,
Robert
[Quoted text hidden]

[redacted]

Lemmo, Sam J [redacted] Mon, Mar 8, 2021 at 12:23 PM
To: Robert Pacheco [redacted]
Cc: Hannah Anae [redacted]

OK, I will get back to you.

[Quoted text hidden]

[redacted]

Lemmo, Sam J [redacted] Tue, Mar 9, 2021 at 8:16 AM
To: Robert Pacheco [redacted]
Cc: Hannah Anae [redacted]

Can you call me at 10:00 please?

[Quoted text hidden]

Robert Pacheco [redacted] Tue, Mar 9, 2021 at 8:35 AM
To: "Lemmo, Sam J" ([redacted]
Cc: Hannah Anae [redacted]

Yes, will do.

Mahalo,
Robert
[Quoted text hidden]

Lemmo, Sam J [redacted] Tue, Mar 9, 2021 at 3:25 PM
To: Robert Pacheco [redacted]
Cc: Hannah Anae [redacted]

Thanks for the conversation. I do recommend you reaching out to [redacted]

Mahalo

[redacted]

[Quoted text hidden]

Robert Pacheco [redacted] Tue, Mar 9, 2021 at 3:32 PM
To: "Lemmo, Sam J" [redacted]
Cc: Hannah Anae [redacted]

Thank you, Sam. [redacted], I will send you our initial consultation request letter in a separate email.

Mahalo,
Robert
[Quoted text hidden]

IARII

Robert Pacheco [redacted]

Please Review Your Comment for the Waikiki Beach Improvement CIA

3 messages

Robert Pacheco [redacted] Mon, Mar 8, 2021 at 2:33 PM
To: [redacted]
Cc: Hannah Anae [redacted]

Aloha e Ms. Norman,

Mahalo for your recent contribution to the Cultural Impact Assessment (CIA) being prepared by International Archaeology, LLC (IA), for the Waikīkī Beach Improvement and Maintenance Program. As mentioned in our initial request letter, your comments about the cultural impacts of the project will be reproduced in the CIA so they can be read and considered during future project planning.

We would like to give you a final opportunity to review your comment as it will appear in the CIA. IA has edited your original response slightly for clarity, but we believe that your information and opinions are still accurately represented. The text of your response is reproduced below:

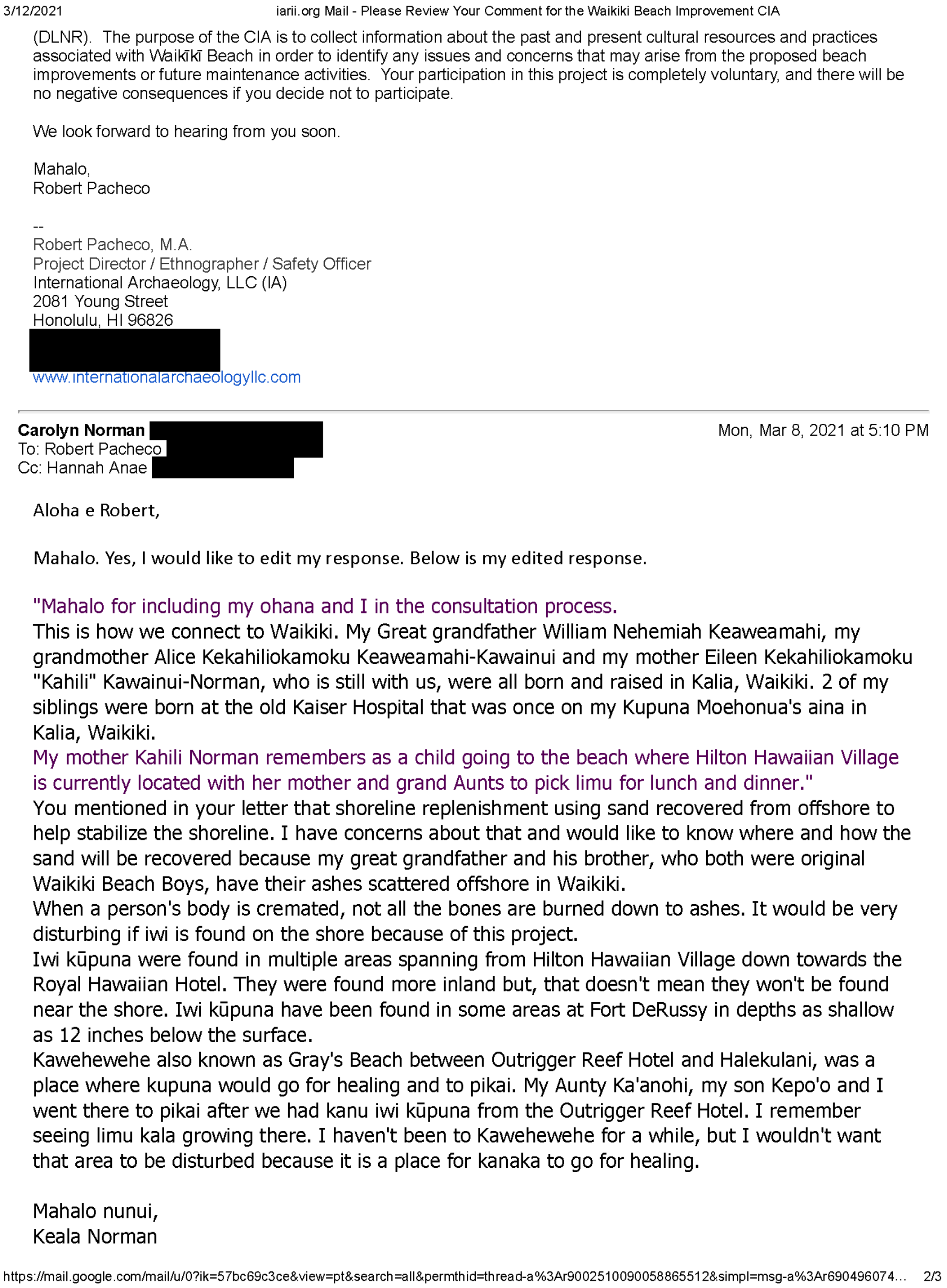
[redacted]

If you agree that your comment as presented above may appear in the CIA, please confirm your agreement via email reply as soon as possible. We will not include your comment in the CIA without your consent.

If you would like to edit or add more to your response, please do so and send it to us, and we will replace your original statement with the revised comment. Alternatively, if you no longer want your comment to be included in the CIA, we will remove it from the report at your request. There are no consequences for revising or retracting your comment. If you decide on either option, please inform us as soon as possible, as we cannot alter your response once the CIA is finalized.

As noted in our request letter, your name and cultural/community affiliation will be added to your response in the CIA. If you want your comment to be anonymous, we can remove your identifying information upon request.

Finally, we would like to remind you that the CIA is a public document that will be added to an Environmental Impact Statement (EIS) by Sea Engineering, Inc. (SEI), on behalf of the Hawai'i Department of Land and Natural Resources'



(DLNR). The purpose of the CIA is to collect information about the past and present cultural resources and practices associated with Waikīkī Beach in order to identify any issues and concerns that may arise from the proposed beach improvements or future maintenance activities. Your participation in this project is completely voluntary, and there will be no negative consequences if you decide not to participate.

We look forward to hearing from you soon.

Mahalo,
Robert Pacheco

--
Robert Pacheco, M.A.
Project Director / Ethnographer / Safety Officer
International Archaeology, LLC (IA)
2081 Young Street
Honolulu, HI 96826
[redacted]
www.internationalarchaeologyllc.com

Carolyn Norman [redacted] Mon, Mar 8, 2021 at 5:10 PM
To: Robert Pacheco [redacted]
Cc: Hannah Anae [redacted]

Aloha e Robert,

Mahalo. Yes, I would like to edit my response. Below is my edited response.

"Mahalo for including my ohana and I in the consultation process.
This is how we connect to Waikiki. My Great grandfather William Nehemiah Keaweamahi, my grandmother Alice Kekahiliokamoku Keaweamahi-Kawainui and my mother Eileen Kekahiliokamoku "Kahili" Kawainui-Norman, who is still with us, were all born and raised in Kalia, Waikiki. 2 of my siblings were born at the old Kaiser Hospital that was once on my Kupuna Moehonua's aina in Kalia, Waikiki.
My mother Kahili Norman remembers as a child going to the beach where Hilton Hawaiian Village is currently located with her mother and grand Aunts to pick limu for lunch and dinner."
You mentioned in your letter that shoreline replenishment using sand recovered from offshore to help stabilize the shoreline. I have concerns about that and would like to know where and how the sand will be recovered because my great grandfather and his brother, who both were original Waikiki Beach Boys, have their ashes scattered offshore in Waikiki.
When a person's body is cremated, not all the bones are burned down to ashes. It would be very disturbing if iwi is found on the shore because of this project.
Iwi kūpuna were found in multiple areas spanning from Hilton Hawaiian Village down towards the Royal Hawaiian Hotel. They were found more inland but, that doesn't mean they won't be found near the shore. Iwi kūpuna have been found in some areas at Fort DeRussy in depths as shallow as 12 inches below the surface.
Kawehewehe also known as Gray's Beach between Outrigger Reef Hotel and Halekulani, was a place where kupuna would go for healing and to pikai. My Aunty Ka'anohi, my son Kepo'o and I went there to pikai after we had kanu iwi kūpuna from the Outrigger Reef Hotel. I remember seeing limu kala growing there. I haven't been to Kawehewehe for a while, but I wouldn't want that area to be disturbed because it is a place for kanaka to go for healing.

Mahalo nunui,
Keala Norman

From: Robert Pacheco [redacted]
Sent: Monday, March 8, 2021 2:33 PM
To: [redacted]
Cc: Hannah Anae [redacted]
Subject: Please Review Your Comment for the Waikiki Beach Improvement CIA

[Quoted text hidden]

Robert Pacheco [redacted] Mon, Mar 8, 2021 at 7:14 PM
To: Carolyn Norman [redacted]
Cc: Hannah Anae [redacted]

Mahalo e Ms. Norman. We will use your revised response for the CIA.

Sincerely,
Robert
[Quoted text hidden]

27. APPENDIX E: DRAFT ARCHAEOLOGICAL ASSESSMENT

— Draft —

An Archaeological Overview for the Waikīkī Beach Improvement and Maintenance Program, Waikīkī Ahupua‘a, Kona District, Island of O‘ahu, Hawai‘i

TMK (1) 2-6-001:002, 003, 004, 008, 012, 013, 015, 017, 018, 019; 2-6-002:005, 006, 017, 026; 2-6-004:005, 006, 007, 008, 009, 010, 012; 2-6-005:001, 006; 2-6-008:029

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INTERNATIONAL ARCHAEOLOGY, LLC
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— DRAFT —

AN ARCHAEOLOGICAL OVERVIEW FOR THE WAIKĪKĪ BEACH IMPROVEMENT AND MAINTENANCE PROGRAM

WAIKĪKĪ AHUPUA‘A, KONA DISTRICT, ISLAND OF O‘AHU, HAWAI‘I

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ABSTRACT

At the request of Sea Engineering, Inc. (SEI), and on behalf of the Department of Land and Natural Resources (DLNR), Office of Conservation and Coastal Lands, International Archaeology, LLC prepared an archaeological overview in support of the proposed Waikīkī Beach Improvement and Maintenance Program. The beach improvement and maintenance program encompasses four areas of Waikīkī Beach—the Kūhiō Beach sector, the Royal Hawaiian sector, the Halekūlani sector, and the Fort DeRussy sector—along the shoreline of Māmala Bay in the Kona District of the Island of Oʻahu, seaward of TMKs (1) 2-6-001:002, 003, 004, 008, 012, 013, 015, 017, 018, 019; 2-6-002:005, 006, 017, 026; 2-6-004:005, 006, 007, 008, 009, 010, 012; 2-6-005:001, 006; and 2-6-008:029. These sectors include portions of the active beach and nearshore marine areas and extend to a maximum of approximately 70 m offshore. The archaeology overview is a component of the program's Environmental Impact Statement prepared by SEI for the DLNR. The proposed project includes the construction of new beach stabilization structures and shoreline replenishment primarily using sand recovered from offshore areas.

The Waikīkī region was an important traditional location, noted for its chiefly associations as well as the wealth of its agricultural and aquacultural development. It has historical associations as the beachside retreat for the 19th century Hawaiian royalty and wealthy Honolulu residents, and has more recently become the center of the modern Hawaiian hospitality economy. During the past 130 years, the Waikīkī shoreline has been substantially engineered to create larger sandy beaches for recreation. As such, most of the maintenance program will occur within modern beach deposits seaward of the 19th century and early 20th century shorelines. For the purposes of this report, previous archaeological investigations and known archaeological sites were evaluated within a study area that is inclusive of both the project area and a 50-m buffer extending outward from the project area.

The immediate shoreline project area, much of which consists of active beach or imported sand, contains few archaeological resources. The Royal Hawaiian sector is the only portion of the maintenance program with known archaeological resources. These consist of a partially exposed seawall (no State Inventory of Historic Places number has been assigned) and an extension of Site 50-80-14-5863, which was the location of a human bone fragment found on a graded fill surface; this fragment was recovered at the time of discovery and did not represent an in situ burial. A 50-m-wide area surrounding the maintenance program sectors included 15 archaeological sites with human remains and 10 sites representing buried archaeological deposits or discrete features.

Given the cultural and historical importance of the region, as well as the possibility that the active beach may abut intact archaeological deposits in the Kūhiō Beach and Royal Hawaiian sectors, we recommend that an archaeological monitor be present during ground-disturbing project work in areas within the historical shorelines. We also recommend historic preservation documentation and review of the exposed seawall and possible building foundation exposed in the Royal Hawaiian sector. Documentation of the beach control features along the shoreline, including the Kapahulu Storm Drain, the Kūhiō groin complex, the Royal Hawaiian Groin, Fort DeRussy Groin, and several unnamed groins, prior to commencement of the project is also recommended (these recommendations are discussed in the maintenance program's companion historical architectural overview [Moore and Tomonari-Tuggle 2021]).

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I. INTRODUCTION

At the request of Sea Engineering, Inc. (SEI), and on behalf of the Department of Land and Natural Resources (DLNR), Office of Conservation and Coastal Lands, International Archaeology, LLC (IA) prepared an archaeological overview in support of the proposed Waikīkī Beach Improvement and Maintenance Program (Figure 1 and Figure 2). The beach improvement and maintenance program encompasses four sectors of Waikīkī Beach— Kūhiō Beach, Royal Hawaiian, Halekūlani, and Fort DeRussy—along the shoreline of Māmala Bay in the Kona District of the Island of O‘ahu, seaward of TMKs (1) 2-6-001:002, 003, 004, 008, 012, 013, 015, 017, 018, 019; 2-6-002:005, 006, 017, 026; 2-6-004:005, 006, 007, 008, 009, 010, 012; 2-6-005:001, 006; and 2-6-008:029. These sectors include portions of the active beach and nearshore marine areas and extend to a maximum of approximately 70 m offshore. The archaeological overview is a component of the program's Environmental Impact Statement (EIS) prepared by SEI for the DLNR. The proposed project includes the construction of new beach stabilization structures and shoreline replenishment primarily using sand recovered from offshore areas.

PROJECT AREA DESCRIPTION

Waikīkī Beach is an approximately 3,130-m (10,260-ft.) ocean shoreline along the southwest edge of the Waikīkī neighborhood of Honolulu, extending from a breakwater fronting the Hilton Hawaiian Village Waikīkī Beach Resort to the west to a groin fronting the New Otani (Kaimana) Hotel to the east. Almost the entire length of the beach is armored by seawalls and stabilized by groins that compartmentalize the shoreline into eight individual "littoral cells" or sectors. The Waikīkī Beach Improvement and Maintenance Program will affect four of these sectors (Figure 3 through Figure 7), which are described individually.

1. The Kūhiō Beach sector consists of approximately 460 m (1,500 ft.) of shoreline extending from the ‘Ewa (west) groin at Kūhiō Beach Park to the Kapahulu storm drain. The northwestern half of the sector (called the ‘Ewa basin here) was created in 1939 (Figure 3); the southeastern half of the sector (called the Diamond Head basin here) was built between 1951 and 1953 (Figure 4). The sector is essentially an enclosed body of water within a set of constructed crib walls and groins. It is at the southern end of the curving and protected portion of the Waikīkī coastline, between two of the three major stream outlets (Ku‘ekaunahi and ‘Āpuakēhau) that once flowed into the ocean.

2. The Royal Hawaiian Beach sector consists of approximately 530 m (1,730 ft.) of shoreline extending from the Royal Hawaiian groin to the ‘Ewa (west) groin at Kūhiō Beach Park (Figure 5). It lies at an inward curve in the Waikīkī coastline that allows the development of a wide sand beach, and sits between two of the three major stream outlets (Ku‘ekaunahi and ‘Āpuakēhau) that once flowed into the ocean. This sector is the core of traditional and historical activity in Waikīkī.

3. The Halekūlani Beach sector consists of approximately 440 m (1,450 ft.) of shoreline extending from the Fort DeRussy outfall groin to the Royal Hawaiian groin (Figure 6). The south-facing shoreline is a mix of seawalls and discontinuous, small, and narrow sand beaches that front a fully developed urban landscape. The Royal Hawaiian groin was constructed in 1925-1926; the Fort

DeRussy groin was built in 1917 and was extended in 1969. The remains of at least five, 10- to 20-m concrete block groins are spaced along the length of the sector.

4. The Fort DeRussy Beach sector consists of approximately 510 m (1,680 ft.) of shoreline extending from the Hilton Hawaiian Village pier to the Fort DeRussy outfall groin (Figure 7). The southwest-facing shoreline is a continuous sand beach that fronts a landscaped open space of tended lawn and coconut trees in the Fort DeRussy Armed Forces Recreation Center. The Hale Koa Hotel is just inland of the western portion of the sector, and the U.S. Army Museum of Hawai‘i, housed in the historic 1914 Battery Randolph, is at the eastern end of the sector. A wide concrete promenade runs along the inland edge of the beach.

THE WAIKĪKĪ BEACH IMPROVEMENT AND MAINTENANCE PROGRAM

The proposed Waikīkī Beach Improvement and Maintenance Program is intended to address the ongoing erosion of the shoreline and frequent flooding of the backshore. Without improvements and follow-up maintenance, sand erosion and rising sea level will likely result in the total loss of Waikīkī Beach by the end of the 21st century. The project’s immediate goals are to restore and improve Waikīkī’s public beaches, increase beach stability, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise.

The planned actions and construction methods for each beach sector in the project area are summarized below:

1. For the Kūhiō Beach sector, separate plans are proposed for the ‘Ewa basin (west) and the Diamond Head basin (east):
   a. For the ‘Ewa basin, the existing groins on the east and west ends will be removed and reconstructed to accommodate sea level rise (see Figure 3). The west groin will be approximately 150 feet long with a crest elevation of +7.5 feet mean sea level (msl), and the east groin will be approximately 125 feet long and vary in elevation from +7.5 feet msl at the shoreline to +6 feet msl at the head. A 125-foot-long detached breakwater will be built in the gap between the groins and will be approximately +6 feet msl to match the heads of the groins. Construction equipment and material would be transported to the work area through either the central portion of the park or along the shoreline past the Duke Kahanamoku statue. Demolition and construction will be conducted with an excavator that is supported by a temporary work platform extending from the shore to the breakwater. Sand fill from offshore deposits will be added to the beach after the new structures are completed.
   b. For the Diamond Head basin, existing structures will not be modified, but the beach will be replenished using eroded sand that has settled in a submerged deposit just offshore (see Figure 4). Approximately 4,500 cubic yards will be recovered and spread across the beach, widening the existing shoreline by approximately 18 to 26 feet and reducing the offshore depth of the basin to a uniform bottom elevation of -4 feet msl. The sand will be recovered and redeposited using either a long-reach excavator operating on an excavated sand causeway, or a diver-operated dredge that will pump the sand to an onshore recovery area. A bulldozer and/or skid-steer will spread the sand across the beach.
2. For the Royal Hawaiian Beach sector, sand recovered from deposits directly offshore will be used to widen and replenish the beach (see Figure 5). The beach crest elevation will be increased from

about +7 feet msl to +8.5 feet msl. Approximately 30,000 cubic yards of recovered sand will be required to complete the work. To counter ongoing erosion and shoreline recession, beach nourishment will need to be repeated every eight to 10 years or more frequently if required. The recovered sand will probably be dredged with a submersible pump mounted on a crane barge and pumped through a bottom-mounted pipeline to a dewatering basin in the Diamond Head basin of Kūhiō Beach Park. After drying, the sand will be stockpiled and transported to Royal Hawaiian Beach, where it will be distributed using bulldozers.

3. For the Halekūlani Beach sector, a new beach with stabilizing groins will be constructed (see Figure 6). Three new sloping rock rubble mound T-head groins will be combined with the existing Fort DeRussy and Royal Hawaiian groins to create four stable beach cells. The groin stems will extend approximately 200 feet seaward from the shoreline and will be of sufficient size to stabilize a +10-foot beach crest elevation. The groin stem crests could also be wide enough (approximately 10 feet) to accommodate construction equipment or a pedestrian walkway. The Halekūlani Channel will be left unobstructed for beach catamaran navigation. In addition, approximately 60,000 cubic yards of sand fill recovered from offshore deposits will be used to create approximately 3.8 acres of new dry beach area. Construction equipment and materials will likely be transported into the area across the east end of Fort DeRussy Beach, which may require construction of a temporary access road from Kālia Road to the beach and a temporary rock rubble mound access berm along the shoreline from Fort DeRussy to the Royal Hawaiian groin.

4. For the Fort DeRussy Beach sector, sand will be transported from an accretion area at the west end of the beach (near the Hilton Pier) to an eroding area at the east end (see Figure 7). The sand will be excavated from the existing beach face extending inshore only as far as necessary to obtain the required amount, estimated to be approximately 1,200 cubic yards. Dump trucks will transport the sand across the beach, and a bulldozer will distribute it across the eroding area. This process will need to be repeated periodically in the future to maintain a stable beach profile.

Construction work will be confined to the active sand portion of Waikīkī Beach and nearshore marine areas up to approximately 200 feet offshore. The work will not extend outside the inland boundary of the active beach, which is defined by any buildings, roads, seawalls, or other types of construction that constrain the sand beach.

The sand required for beach nourishment will be almost exclusively recovered from submerged offshore deposits. In addition to the near-offshore areas mentioned in the descriptions above, sand will be dredged from one or more known deposits further offshore of the south coast of Oʻahu, using submersible slurry pumps, self-contained hydraulic suction dredges, and/or clamshell buckets.

PROPOSED TASKS

This overview presents a general discussion of the Waikīkī region, as well as a more detailed discussion of the four beach sectors. The general discussion addresses the extent of coverage by previous archaeological studies, and provides a summary of findings in the format of a cultural history of the region and associated relevant contributions to Hawaiian archaeology. This includes a synthesis of the area's pre-Contact chronology based on the analysis of the suite of radiocarbon dates generated by previous archaeology projects. For the specific beach sectors, the more detailed discussion identifies [1] previous archaeological studies and results within each area, [2] historical records that can inform on the potential for archaeological remains, [3] historical changes to the shoreline, as represented on historical maps and other archival records, and [4] sites that could be anticipated to occur within each sector.

Research to carry out these tasks focused on compiling archaeological reports from the IA library, the State Historic Preservation Division (SHPD) library, and the State Office of Environmental Quality Control (OEQC) online library of environmental assessments and impact statements. Historical maps of Waikīkī were downloaded from the State Land Survey Division online map library, and were also researched at the Hawai‘i State Archives. A set of five maps of the Waikīkī shoreline from the Ala Wai to Diamond Head (Kanahele 1928a, 1928b, 1928c, 1928d, 1928e) provide detailed information on the coast as it appeared in 1928. The State Archives was also a source for historical photographs of Waikīkī.

Published works on Waikīkī were a primary resource for background information, most notably (but not limited to) Wiegel (2008) for a history of shoreline changes, Hibbard and Franzen (1986) for a history of the resort area, including a chapter on traditional Hawaiian settlement (Nāpōkā 1986), and Kanahele (1995) for a general history of Waikīkī from pre-Contact times to 1900.

ORGANIZATION OF THE REPORT

This document is organized as follows. Section I is the introduction. Section II summarizes the physical environmental characteristics and important cultural background information for the project area and Waikīkī region. Section III provides an overview of the archaeological resources of the Waikīkī shoreline, summarizes historical and archaeological information for each of the four sectors, and provides information about changes to the coastline that may affect the potential of each sector to contain intact archaeological resources. Section IV addresses expectations and recommendations for each sector based on the foregoing information. A list of cited references and a glossary of Hawaiian terms used in the text are included at the end of this document.

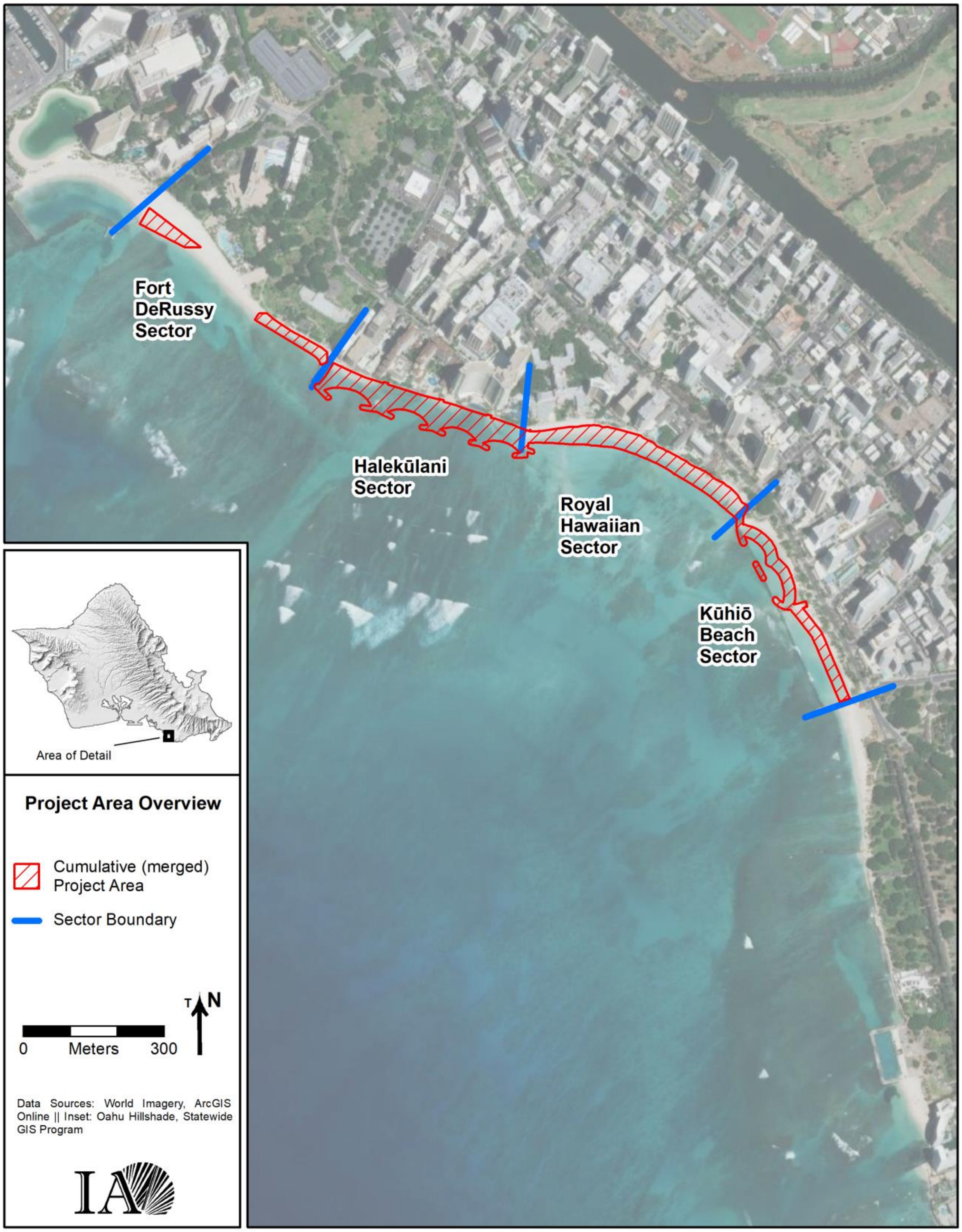

Figure 1. The Waikīkī Beach Improvement and Maintenance Program project area overlaid onto the Honolulu 1998 topographic quadrangle map.

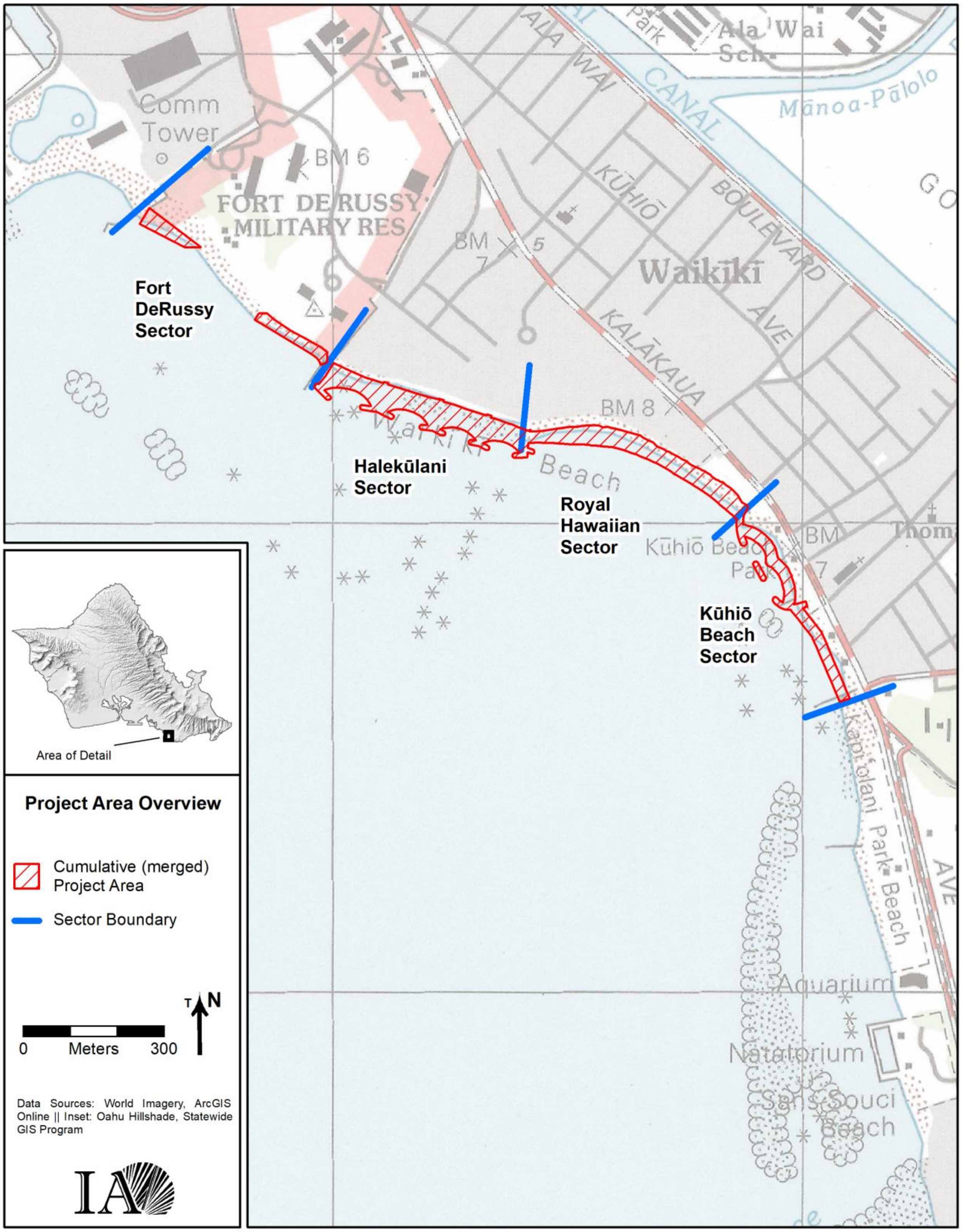

Figure 2. The Waikīkī Beach Improvement and Maintenance Program project area overlaid onto aerial imagery.

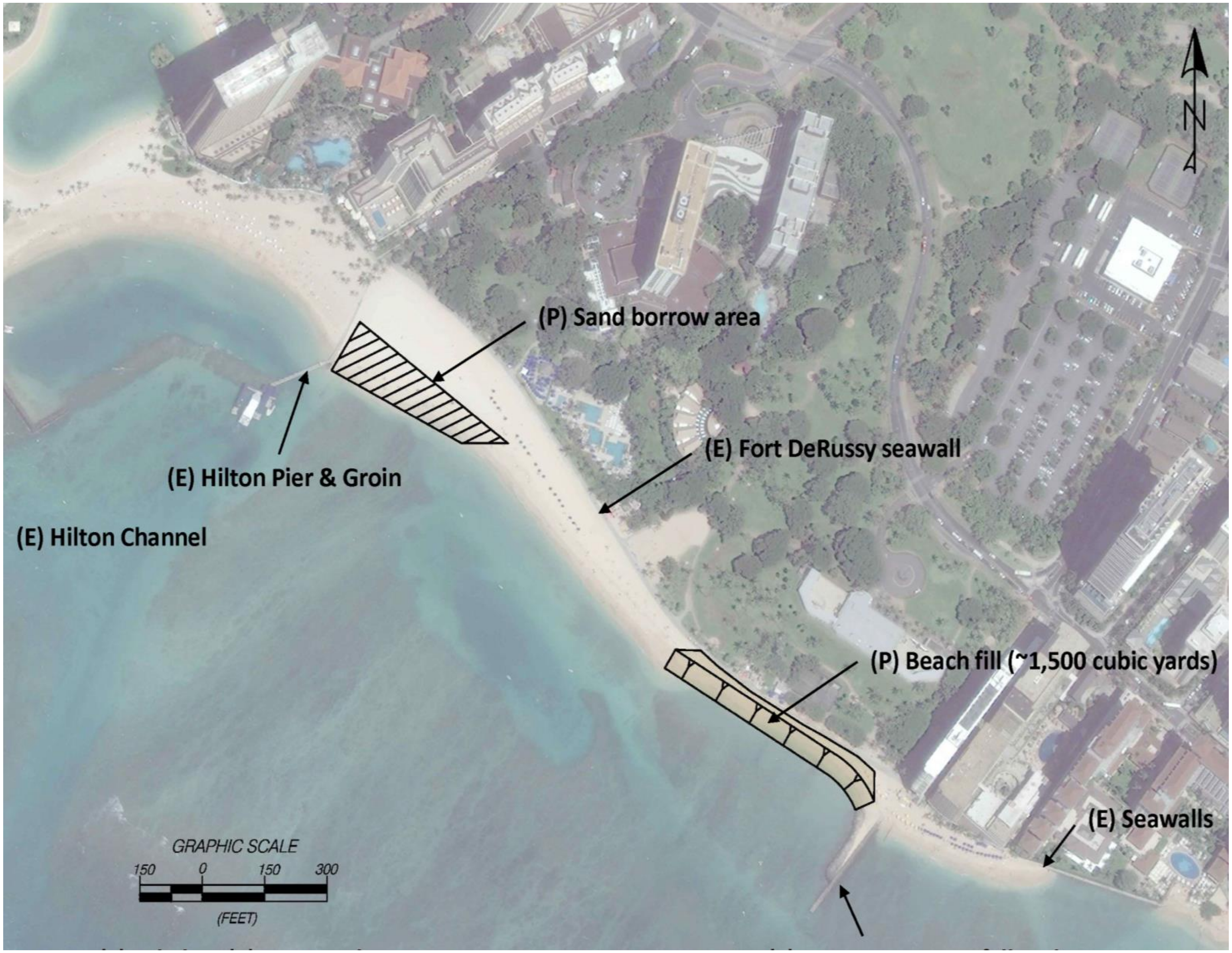

Figure 3. Planned beach improvement activates within the Kūhiō Beach sector, ‘Ewa basin. Image provided by Sea Engineering, Inc.

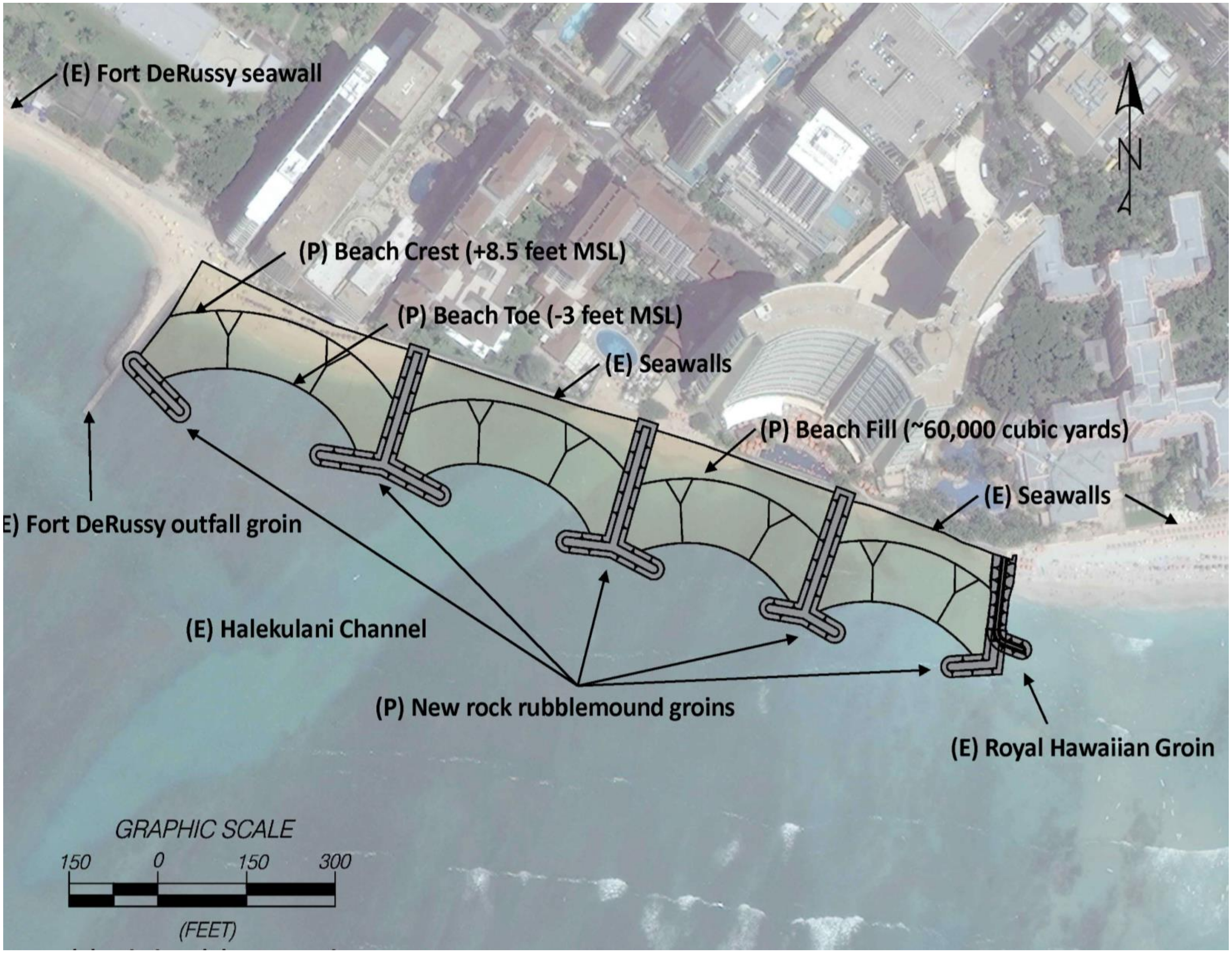

Figure 4. Planned beach improvement activities within the Kūhiō Beach sector, Diamond Head basin. Image provided by Sea Engineering, Inc.

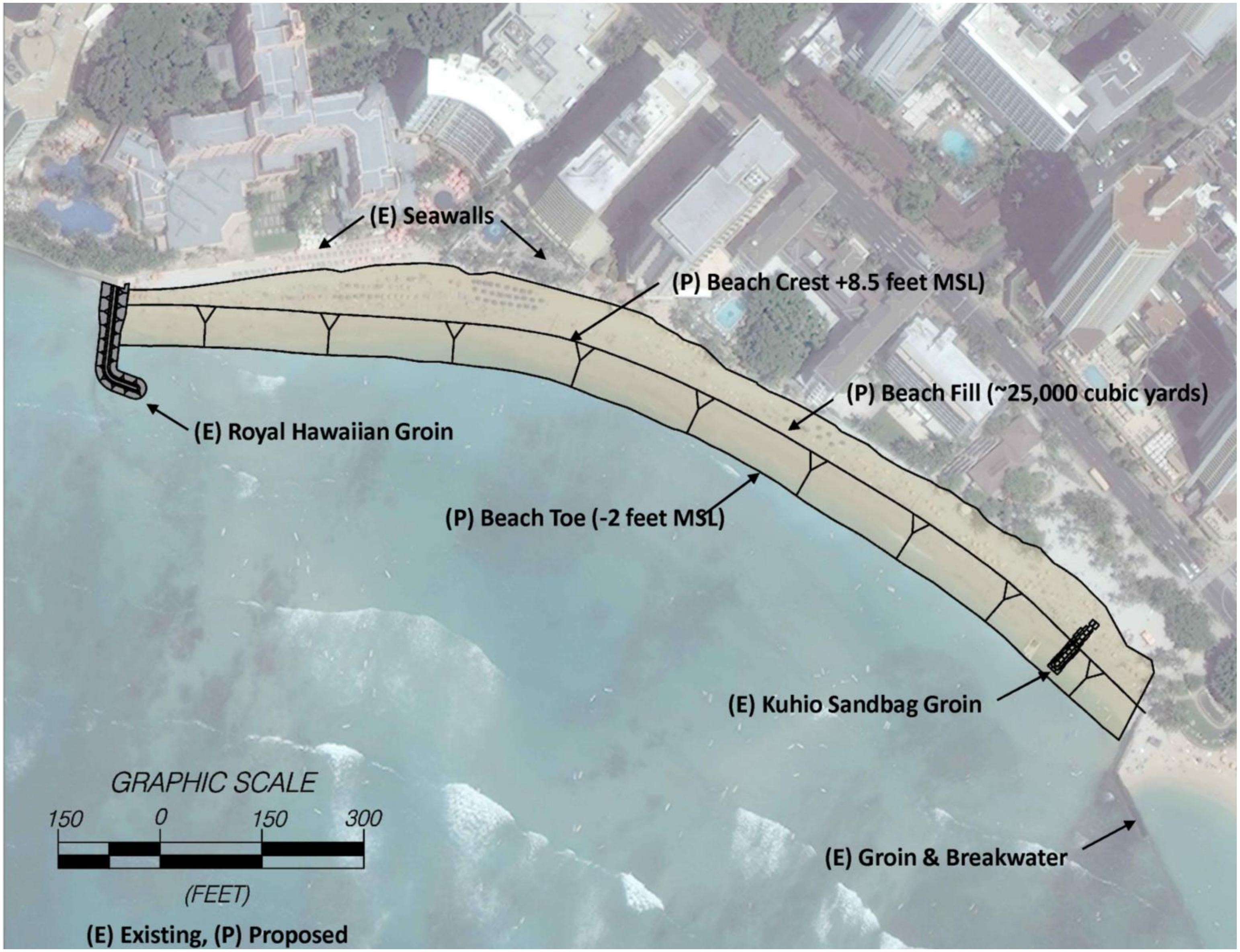

Figure 5. Planned beach improvement activities within the Royal Hawaiian sector. Image provided by Sea Engineering, Inc.

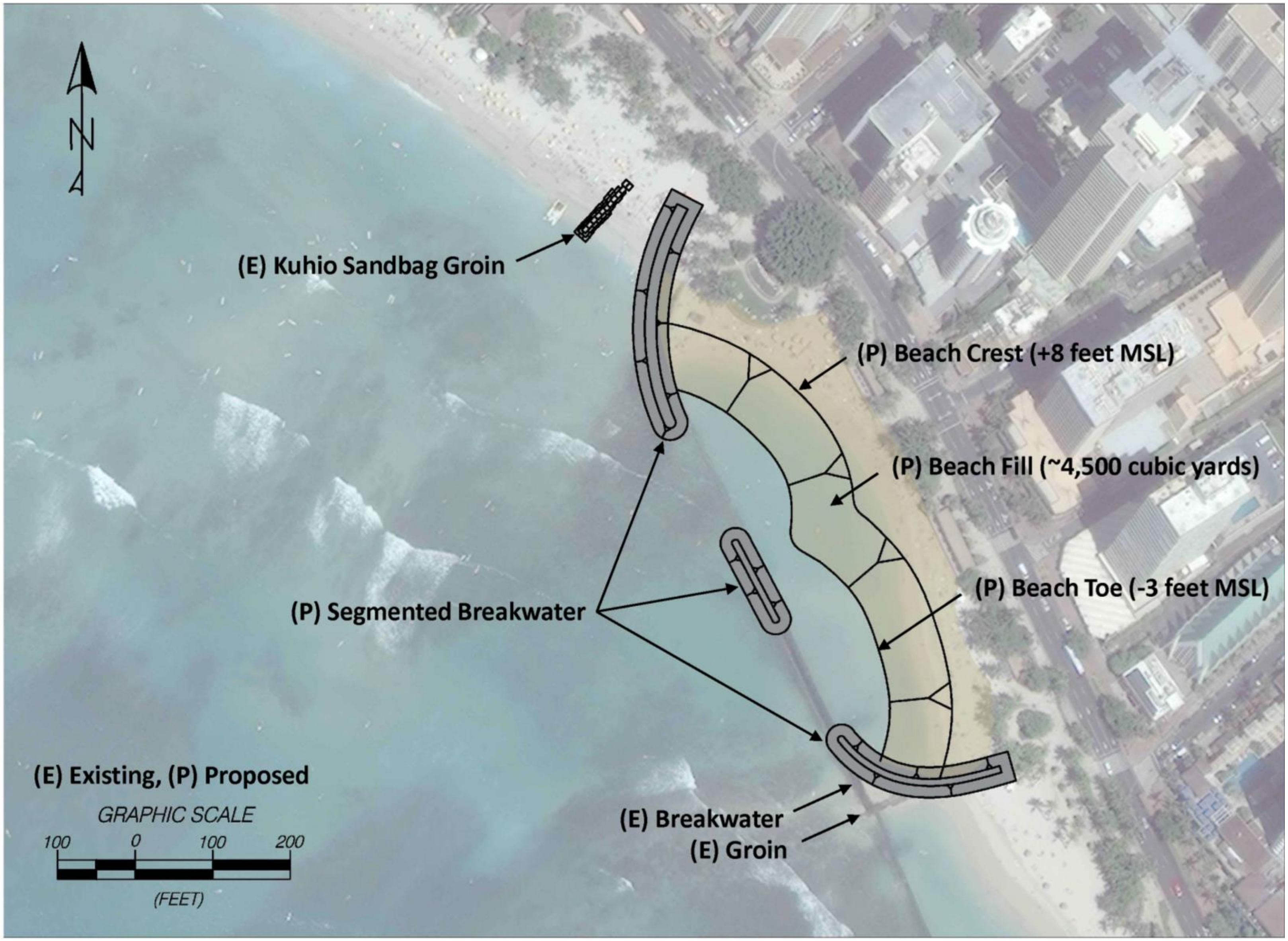

Figure 6. Planned beach improvement activities within the Halekūlani sector. Image provided by Sea Engineering, Inc.

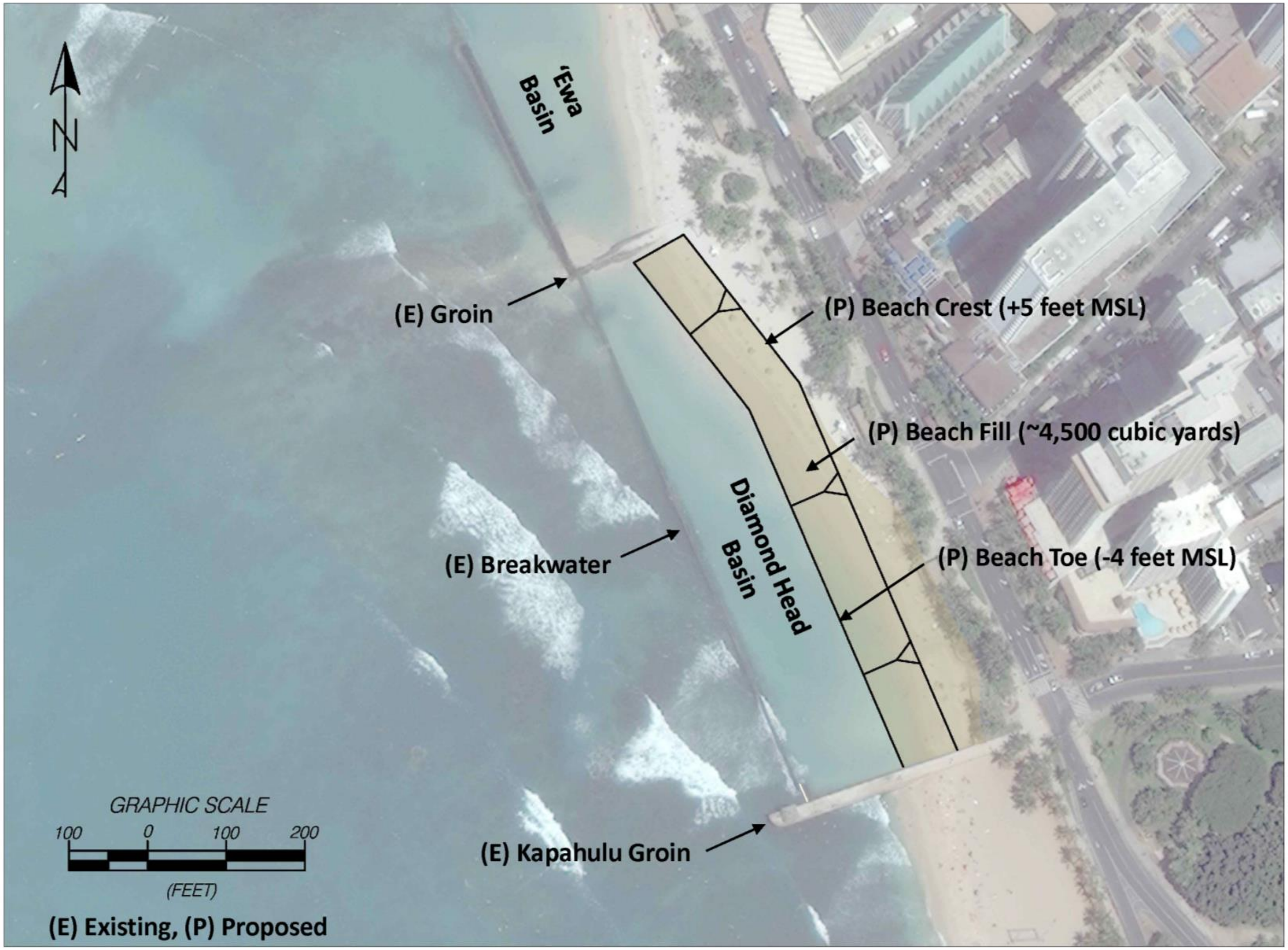

Figure 7. Planned beach improvement activities within the Fort DeRussy sector. Image provided by Sea Engineering, Inc.

II. ENVIRONMENTAL AND HISTORICAL BACKGROUND

This section presents information about the physical and cultural environment, history, and archaeology of the project area and the general Waikīkī region, which is intended to provide context for the discussion of individual beach sectors that follows. Portions of this section have been adapted from Duarte et al. (2017) and Rieth et al (2017).

PHYSICAL SETTING

The project area extends along approximately 2 km of shoreline in the Waikīkī area of southern O‘ahu. Waikīkī Beach occupies the seaward edge of a coastal plain of coral limestone along the southern leeward shore of the island. The underlying geology for the greater area is limestone bedrock formed from elevated coral reefs, in places interbedded with Honolulu Series lava flows (Macdonald and Abbott 1970:355). Before large-scale land reclamation in the early 20th century, much of coastal Waikīkī was covered by ponds, wetlands, and streams.

The project area includes portions of the beach and surf zone; the soil unit is beach sand (BS) (Foote et al. 1972) (Figure 8). Sand cover on the reef on the Waikīkī beaches is shallow, with limestone bedrock generally about 0.6 m deep below the sand (Wiegel 2008:5). The beach within the project area incorporates both naturally deposited and imported sand. Sedimentary analysis suggests that until beach alteration began in the early 20th century, the Waikiki beach environment was depositional or prograding, at least in the area of the Halekūlani Hotel (Allen-Wheeler 1984:IV-7).

The project area falls within the tropical savannah climate zone. Rainfall in Waikīkī near the project area is approximately 640 mm per year. The majority of precipitation occurs between October and March, with these months seeing 63.6 to 94.8 mm of rain per month (Giambelluca et al. 2013). The average daily temperature in Waikīkī ranges from a high of 78.2°F in August to a low of 71.1°F in January.

The project area was once watered by several watercourses: Ku‘ekaunahi, ‘Āpuakēhau, and Pi‘inaio Streams, and the outlet of Kawehewehe. These streams originated in Mānoa and Pālolo Streams, and were known as Kālia and Pāhoa Streams after entering the coastal plain of Waikīkī. Converging together “near Hamohamo (*mauka* of the Kapahulu Library),” these streams diverged again into Ku‘ekaunahi, ‘Āpuakēhau, and Pi‘inaio Streams to flow into the ocean[1] (Kanahele 1995:7). Mānoa and Pālolo Streams have since been re-routed into the Ala Wai Canal and now bypass the Waikīkī Plain.

Vegetation in the vicinity of the project area, which has been much altered over the past century, consists of modern landscaping dominated by exotic grasses and coconut palm (*Cocos nucifera*). Kanahele (1995:8) describes the types of vegetation that would have been found in the area prior to Polynesian settlement:

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[1] Kanahele (1995:7) indicates that Kawehewehe is another name for ‘Āpuakēhau Stream; however, Kawehewehe is shown on at least one 19th-century map (Government Registered Map No. 1720) as a separate watercourse and apparent outlet for the Kālia fishpond complex and is considered as such in this report.

> The beaches and marshlands are covered with grasses and sedges, many of which look alike. The *ʻakiʻaki* [*Sporobolus virginicus*] grows profusely on the shore (a name that refers to the supposed power of this grass to exorcise evil spirits) as do the succulent *ʻakulikuli* [*Sesuvium portulacastrum*]. The different sedges include the common *puʻukaʻa* [*Cyperus trachysanthos*] which is somewhat related to the *makaloa* [*Cyperus laevigatus*] native to Niʻihau. The three-to-nine-feet tall *ʻakaʻakai* [*Schoenoplectella tabernae-montani*] or bulrush also grows here.

Other shore plants may have included *naupaka* (*Scaevola taccada*), *alaheʻe* (*Psydrax odorata*), *lama* (*Diospyros sandwicensis*), *wiliwili* (*Erythrina sandwicensis*), and *hala* (*Pandanus tectorius*) (Kanahele 1995:9).

Birds would likely have included the heron (*ʻaukuʻu*), Hawaiian duck (*koloa*), Hawaiian stilt (*aeʻo*), coot (*ʻalae keʻokeʻo*), and mud hen (*ʻalaeʻula*). While exposed reef is largely absent between the former locations of the Piʻinaio and Kuʻekaunahi stream mouths, abundant fish were present at either end of the project area. The mouth of Piʻinaio was particularly known for its aquatic resources and array of *limu* in the early 20th century (and to this day), and presumably this abundance would have also characterized earlier periods. As described by Fred Paoa (SSRI 1985:532-535):

> We lived at Kalia, where my dad was a net fisherman. He caught kala [surgeonfish, Acanthuridae], mullet, and weke [Mullidae, surmullets, or goatfish]. He also caught squid. There was limu eleele [green seaweed, *Enteromorpha prolifera*] where Piʻinaio Stream entered the ocean. Towards Fort DeRussy there was limu manauea [red seaweed, *Gracilaria coronopifolia*] and limu huluhulu waena and a lot of wana [sea urchin]. We caught lobsters using nets at night. We used to catch a lot of kala. Where the stream entered the ocean, there was a lot of mud, and there were clams in the mud. We caught opae [shrimp] and oopu [freshwater fishes such as Eleotridae, Gobiidae, or Blennidae] in the stream. We fished for papio [juvenile crevalle, jack, or pompano] and white eels. We caught two types of crabs, aama and alamihi. On the reef my dad dived for uhu [parrotfish, Scaridae] and kumu [goatfish, Mullidae], and we did torch fishing at night for mullet, uhu, and kumu.

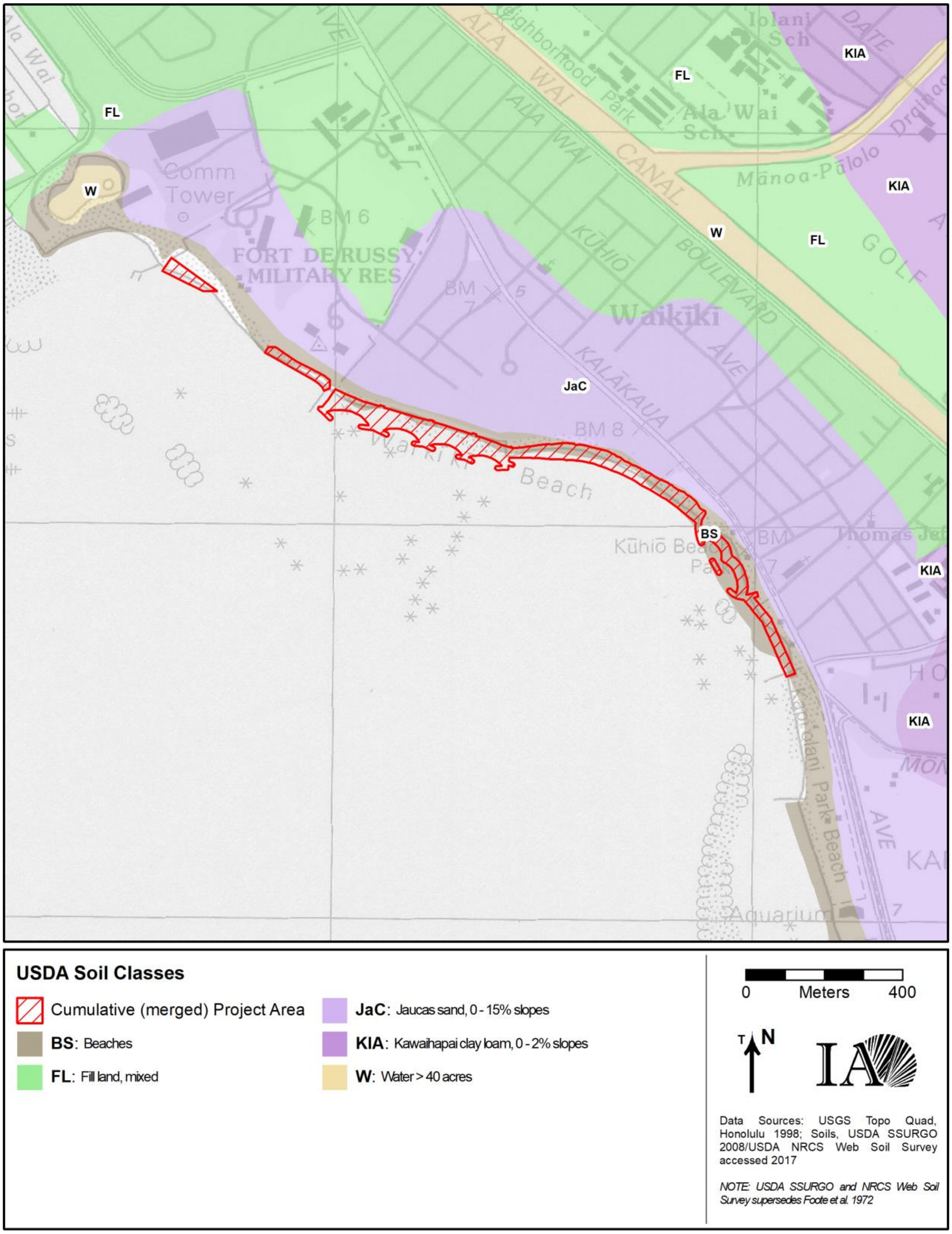
CULTURAL GEOGRAPHY

The cultural geography of Waikīkī includes numerous place names and traditions. The following summary provides general information about the project area and immediate vicinity. Primary references include Bishop (1881), Kamakau (1991, 1992a, 1992b), Pukui et al. (1974), and Sterling and Summers (1978).

The project area falls within the *ahupuaʻa* of Waikīkī and the traditional *moku* of Kona. Mid-19th-century land records recognize a number of *ʻili* or smaller subdivisions of land within the greater area. The project area overlaps or is adjacent to the subdivisions Kekio, Hamohamo, Helumoa, Keōmuku, and Kālia.

PLACE NAMES

Table 1 lists place names for the area along the shoreline between the Kapahulu storm drain and the Hilton Hawaiian Village pier. Figure 9 shows their general locations. Waikīkī translates as "spouting water" (Pukui and Elbert 1986:223), in reference to the wetlands and abundant water sources of this region. Unsurprisingly, many of these place names refer to water or the beach environment. ʻĀpuakēhau may be the name of a rain. The sea itself is referenced in the names ʻAuʻaukai and Hamohamo, with ʻAuʻaukai meaning "to bathe in the sea" and Hamohamo "to rub gently (as the sea on the beach)." The meaning of Keōmuku is said to be "the shortened sand," while Kekio means "pool."



Data Sources: USGS Topo Quad, Honolulu 1998; Soils, USDA SSURGO 2008/USDA NRCS Web Soil Survey accessed 2017

NOTE: USDA SSURGO and NRCS Web Soil Survey supersedes Foote et al. 1972

Figure 8. Soils within and around the Waikīkī Beach Improvement and Maintenance Program project area.

TRADITIONS

The traditions of Waikīkī denote its significance for intertwining historical threads of *ali‘i* histories and as a highly productive agricultural region. In ancient times, Waikīkī was a center of power of the *ali‘i*, "a land beloved of the chiefs" who resided there because the lands were rich and the surfing was excellent (Kamakau 1991:44).

Chiefly Associations

The shoreline within the project area, particularly the area near the mouth of ‘Āpuakēhau Stream within the Royal Hawaiian sector, became the focus of chiefly activities in Waikīkī as early as the mid-1400s. The stream emptied into a protected curve of the shoreline that created a renowned surf break called Kalehuawehe. The O‘ahu ruling chief Ma‘ilikūkahi is said to have moved the royal seat of O‘ahu to Waikīkī around this time (Beckwith 1970:383). Oral traditions record that the O‘ahu chief Kakūhihewa lived at the "chief-eating sands" of Ulukou in the 1500s (Nāpōkā 1986:2). The great Maui chief Kiha-a-Pi‘ilani was born at ‘Āpuakēhau in the 1600s (Kamakau 1991:50).

In the 18th century, after his conquest of the island, Maui king Kahekili made his home at Waikīkī, residing at Helumoa near the mouth of ‘Āpuakēhau Stream. After some time on Maui and Hawai‘i Island, Kahekili returned to Waikīkī, where he died in 1794. He was succeeded by his son, Kalanikūpule.

Kamehameha also lived at Waikīkī after wresting control of the island from Kalanikūpule. He established his capital at Waikīkī and set up a residence, named Kūihelani, at Pua‘ali‘ili‘i on the northwest side of ‘Āpuakēhau Stream and just inland of the shore (‘Ī‘ī 1959:17; Kanahele 1995:91, 92). He was joined by his favorite wife, Ka‘ahumanu, as well as his retainers who likely occupied the entire coast around the stream mouth.

The immediate vicinity of the project area includes several 19th century *ali‘i* land awards. Hamohamo was part of a large award to the high chiefess Keohokālole, who was the principal heir to two Kona chiefs, Keaweaheulu and Kame‘eiamoku. These two chiefs were instrumental in Kamehameha's rise to power (Kame‘eleihiwa 1992:230, 245). Keohokālole was the mother of the future rulers of Hawai‘i, Kalākaua and Lili‘uokalani. Additional *ali‘i* awards included the award of Kapuni/Uluniu to Mataio Kekūanaō‘a, Kekio to Pehu for his wife Ke‘ekapu, and Keōmuku to Samuel Kuluwailehua.

Agriculture and Fishponds

Waikīkī is famous for its extensive irrigated pondfields and fishponds that covered the coastal plain "from the inland side to the coconut grove beside the sea" (Kamakau 1991:45). Fed by the waters of Mānoa and Pālolo Valleys and by the numerous springs that gave Waikīkī its name, the wetland system with its expansive *lo‘i* is credited to the AD 1400s-era ruling chief Kalamakua-a-Kaipūhōlua (Kamakau 1991:45):

> He was noted for cultivating, and it was he who constructed the large pond fields Ke‘okea, Kūalulua, and Kalāmanamana, and the other lo‘i in Waikīkī. He traveled about his chiefdom with his chiefs and household companions to cultivate the land and gave produce to the commoners, the *maka‘āinana*.

Table 1. Place Names of Lands and Physiographic Features within and near the Project Area.

Name	Description	Translation	Reference
‘Āpuakēhau	stream, *muliwai*; site of present-day Moana Hotel	basket [of] dew, probably named for a rain	Bishop (1881, 1882) Kamakau (1991:50, 1992b)
‘Au‘aukai	land area; designated Fort Land	to bathe in the sea	Bishop (1882); Pukui and Elbert (1986)
Halemau‘uola (Loko Halemau‘uola)	fishpond	--	Bishop (1881)
Hamohamo	land area *(‘ili lele*?)	rub gently (as the sea on the beach)	Bishop (1881, 1882)
Helumoa	name of *‘ili* that was a royal center from at least the 15th century; site of present-day Royal Hawaiian Hotel	chicken scratch (chickens scratched to find maggots in the victim’s body, possibly a reference to the supernatural chicken Ka‘au-hele-moa)	Bishop (1881); Nāpōkā (1986); Kanahele (1995); Pukui et al. (1974:44)
Ka‘ihikapu (Loko Ka‘ihikapu)	fishpond	the taboo sacredness	Bishop (1881); Pukui et al. (1974)
Kawehewehe	stream, *muliwai*; outlet for fishpond complex in inland Kālia (Fort DeRussy); shown as “Muliwai Kawehewehe” on GRM 1720 but not on other historical maps	the removal	Reg. Map 1720; Pukui et al. (1974:99)
Kawehewehe	location of the residence of John Papa ‘Ī‘ī, an advisor to Kamehameha, from around 1803 when Kamehameha moved to O‘ahu; also the “reef entrance and channel off Gray’s Beach, just east of the Hale-kū-lani Hotel, Waikīkī, Honolulu”; the sea water of Kawehewehe is said to have had healing qualities and was known for its fragrant *līpoa* seaweed	the removal	‘Ī‘ī (1959:17); Pukui et al. (1974:99); Kanahele (1995:98); McGuire et al. (2001:69-70); Pukui (1983:246)

Name	Description	Translation	Reference
Kahuamokomoko	athletic field, including *‘ulu maika* field, said to be on grounds of Royal Hawaiian Hotel; see Site 9980	*kahua mokomoko*, “a place where people assembled to wrestle”(Andrews 1922:239)	McAllister (1933:77); Kanahele (1995:99)
Kālia	name of *‘ili* and general area of Fort DeRussy	waited for	Bishop (1881); Pukui et al. (1974:77)
Kapuni	land area, surf break	the surrounding (perhaps named for the spreading banyan tree on the Cleghorn ‘Āina-hau estate)	Bishop (1881); Kamakau (1991:44, 1992b:290)
Kapu‘uiki (Loko Kapu‘uiki)	fishpond	the small hill	Bishop (1881); Thrum (1922:646)
Kaohai (Loko Kaohai)	fishpond	the ‘*ōhai* shrub (*Sesbania tomentosa*)	Bishop (1881); Thrum (1922:644)
Kealohilani	beachside home of Queen Lili‘uokalani; later site of Prince Kūhiō’s second Pualeilani home; this is just seaward of Site 5859	heavenly brightness	Pukui et al. (1974:102)
Kekio	land area	pool	Bishop (1881, 1882); Thrum (1922:650)
Keōmuku Kamoku Kamaku	land area	the shortened sand	Bishop (1881, 1882); Pukui et al. (1974:108)
Ku‘ekaunahi Kukaunahi Kuka‘iunahi	stream, *muliwai*; see Site 5943	--	Bishop (1881, 1882); Kamakau (1964:74); Winieski, Perzinski, Shideler et al. (2002)
Kūihelani	Kamehameha’s residence at Pua‘ali‘ili‘i near the mouth of ‘Āpuakēhau Stream	standing at Helani (a mythical land), name of one of Kamehameha’s chiefs	Kanahele (1995:136); Pukui et al. (1974:120)
‘Ō‘ō (Loko ‘Ō‘ō)	fishpond	black honeyeater, *Moho nobilis*	Bishop (1881); Pukui et al. (1974:171)

Name	Description	Translation	Reference
Paweo (Loko Paweo I/Loko Paweo II)	fishpond	turn aside	Bishop (1881); Pukui et al. (1974:182)
Pi‘inaio	stream, *muliwai*, *kahawai*	ascend for (go upstream in search of?) *naio*, *Myoporum sandwicense*	Bishop (1881, 1882); Thrum (1922:666)
Pua‘ali‘ili‘i	place of Kamehameha’s residence Kūihelani near the mouth of ‘Āpuakēhau Stream	little pig	Kanahele (1995:91); Pukui et al. (1974:190)
Pualeilani	name of two residences of Prince Kūhiō; see Site 5859 and Site 5863	royal garland of flowers	Hibbard and Franzen (1986:37-39)
Uluniu	land area	coconut grove	Pukui et al. (1974:215)

Figure 9. Place names plotted along the late 19th century Waikīkī coastline.

Kamakau (1992b:192) also credits Kamehameha with the creation of the extensive pondfield system, including the pondfields attributed to Kalamakua, but this likely reflects Kamehameha's modification or expansion of extant *lo'i*.

Fishponds were another important source of food for the inhabitants of Waikīkī. While the relatively small *loko i'a kalo* or taro fishponds were found throughout Waikīkī, several large inshore ponds or *loko pu'uone* were clustered near the mouth of Pi'inaio Stream at Kālia. These fishponds were at the present location of Fort DeRussy (Figure 10). The *loko pu'uone* were fed by streams or *'auwai* and were used to raise *'ama'ama* (mullet) and *awa* (milkfish), which grew well in the brackish water (Kanahele 1995:44).

The development the Kālia fishponds may have been concurrent with the intensification of taro cultivation attributed to the chief Kalamakua (Davis 1989:11). The complex just *mauka* of the Fort DeRussy sector contained at least 10 large fishponds by the end of the 19th century. Bishop's (1881) map of Waikīkī gives several of the pond names, including Ka'ihikapu, Paweo (I and II), Kaohai, Kapu'uiki, and Kaipuni.

Heiau

The significance of Waikīkī Ahupua'a is also emphasized by the number and kinds of *heiau* distributed across the area, particularly along the coast (Kamakau 1992a:144; Thrum 1906:44-45). Three of the eight *heiau* identified by Thrum (1906) (Table 2) are of the *po'o kanaka* class, i.e.., sacrificial *heiau* that were "only for the paramount chief, the *ali'i nui*, of an island or district (*moku*)" (Kamakau 1992a:129).

Helumoa Heiau (also known as 'Āpuakēhau) was near the mouth of 'Āpuakēhau Stream, which falls within the project area. Helumoa Heiau is said to have been the "principal *heiau luakini*" of O'ahu for centuries until it was replaced by Papa'ena'ena (Becket and Singer 1999:xii). Although the *heiau*'s exact location is unknown, it is presumed to have been on or near the grounds of the Royal Hawaiian Hotel.

Battles

In the late 1700s, warfare in the islands raged. High chiefs amassed huge armies and sailed flotillas of war canoes between islands in the quest for territorial expansion. At least two assaults on O'ahu took place on the beaches of Waikīkī. From Maui in 1779 came the warrior-chief Kahekili, who conquered O'ahu after three years of fighting. With victory, the high chief made Waikīkī his home, specifically at Helumoa near the mouth of 'Āpuakēhau Stream (the location of Helumoa Heiau).

In 1795, a year after Kahekili's death, Kahekili's chief rival for power, Kamehameha, staged an attack on O'ahu. It is said that his armada, which included 1,200 double canoes and 10,000 warriors, landed at Waikīkī, a beachhead of relatively calm waters that offered abundant water, taro, and other supplies for his vast army (Kanahele 1995:87). Unlike Kahekili's three-year battle, Kamehameha was quickly successful in defeating Kahekili's son Kalanikūpule, and taking control of O'ahu. Like the Maui chief, Kamehameha settled in Waikīkī near the mouth of 'Āpuakēhau Stream. Along with Kona on Hawai'i Island and Lāhainā on Maui, Waikīkī served as one of the capitals of his unified kingdom (except for Kaua'i).

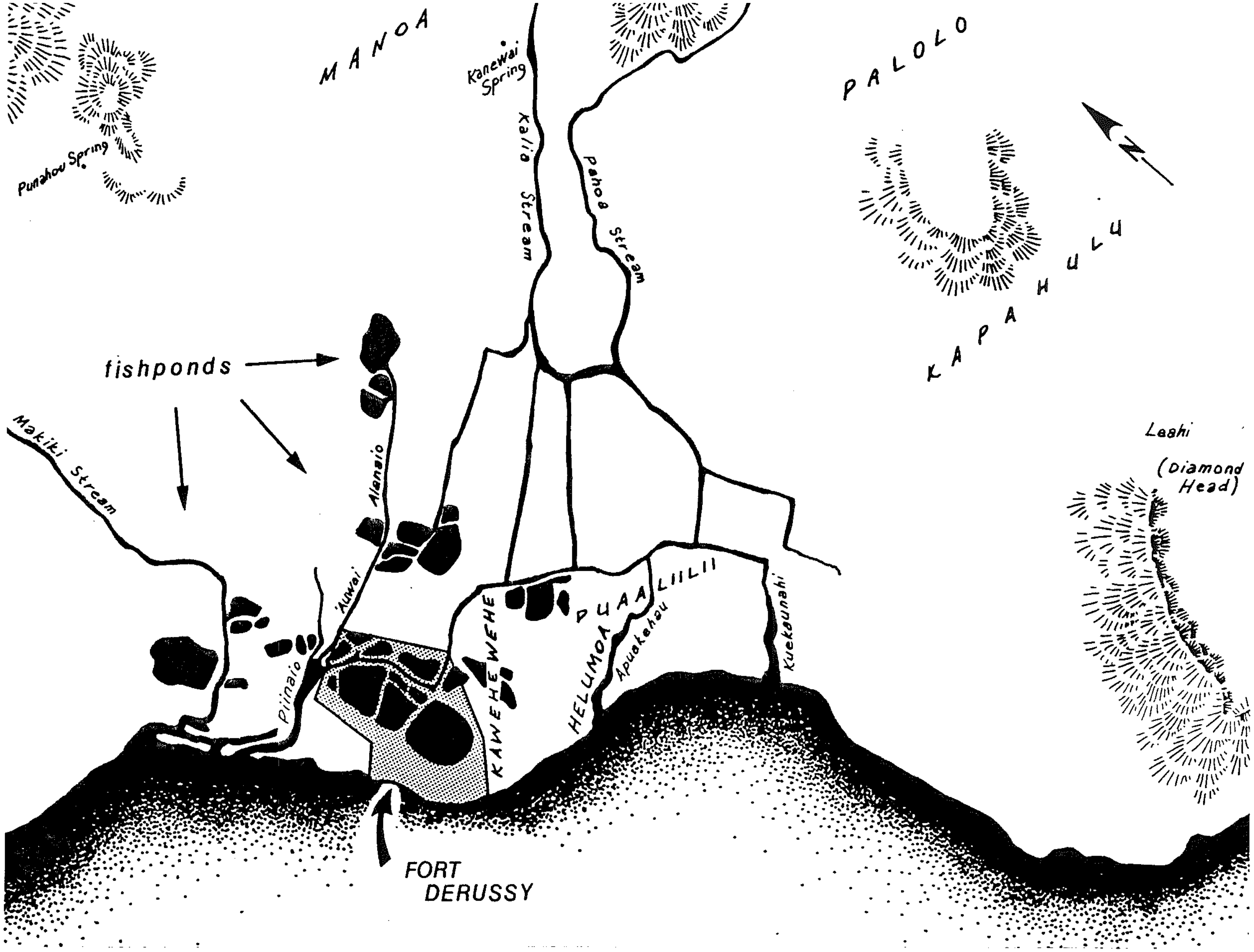


Figure 10. Reconstruction of Waikīkī ca. 1800-1810, reproduced from Davis (1989:2). The Kālia fishpond complex is on the current grounds of Fort DeRussy.

Table 2. *Heiau* in Waikīkī, Based on Thrum (1906).

Name	Location	Type	Description from Thrum (1906)
Helumoa	ʻĀpuakēhau	*Heiau poʻo kanaka*	place of sacrifice of Kauhi-a-Kama, defeated *mōʻī* of Maui, after his failed raid on Oʻahu in the early 1600s, during the reign of Oʻahu chief Kaʻihikapu
Papaʻenaʻena	at foot of Diamond Head slope	*Heiau poʻo kanaka*	walled and paved structure of open terraced front; destroyed by Kana'ina about 1856, and the stones used to enclose Queen Emma's premises and for road work; said to be the place of a number of sacrifices by Kamehameha I in early 1800s
Kupalaha	Kapiʻolani Park	unknown	said to be associated with working of Papaʻenaʻena; entirely obliterated by 1906
Kapua	Kapiʻolani Park	*Heiau poʻo kanaka*	torn down in 1860; said to be the place of sacrifice of Kaolohaka, a chief from Hawaiʻi, on suspicion of being a spy
Kamauakapu	Kapahulu, Diamond Head	husbandry class	erected by Kalākaua in 1888 for his Naua Society; in partial ruins in 1906
Kulaihakoi	Waikīkī	unknown	site of grass house on Kalākaua's premises; in ruins in 1862 (walls torn down much earlier)
Makahuna	Diamond Head	*Kūʻula*	large enclosure dedicated to Kāne and Kanaloa
Pahu-a-Maui	Diamond Head (site of lighthouse station)	unknown	destroyed by 1906

Trails

By the late pre-Contact period, an extensive network of trails had been developed to link important places across the island. ʻĪʻī (1959:92) describes the old route leading between Honolulu and Waikīkī, as he knew it ca. 1810:

> A trail led out of the town at the south side of the coconut grove of Honuakaha and went on to Kalia. From Kalia it ran eastward along the borders of the fish ponds and met the trail from lower Waikiki … [It] went along Kaananiau, into the coconut grove at Pawaa, the coconut grove of Kuakuaka, then down to Piinaio; along the upper side of Kahanamaikai's coconut grove, along the border of Kaihikapu pond, into Kawehewehe; then through the center of Helumoa to Puaaliilii, down to the mouth of the Apuakehau stream; along the sandy beach of Ulukou to Kapuni, where the surfs roll in; then to the stream of Kuekaunahi; to Waiaula and to Paliiki, Kamanawa's house site.

Although the route described by ʻĪʻī ran along the coast on the *makai* side of the fishponds, by the 1850s the route as shown by La Passe (1855) had shifted to approximate the current alignment of Kalakaua Avenue. Originally known as Waikiki Road, this path led from the intersection at Pawaʻa to the vicinity of ʻĀpuakēhau Stream near the contemporary entrance of Kapiʻolani Park.

PRE-CONTACT SETTLEMENT AND HISTORY

The following discussion frames the chronology of changes in Waikīkī settlement within the context of Oʻahu and the archipelago as a whole, using both archipelago-wide studies such as those of Hommon (1986, 2013) and Kirch (2010) and Oʻahu-based studies (e.g., Cordy 2002). In these studies, archaeological data is considered alongside oral traditions obtained from sources such as Fornander (1919), Kamakau (1991), Beckwith (1970), and others.

The most recent paleoenvironmental and archaeological studies indicate that the Hawaiian Islands were settled sometime between AD 940 and 1130, with the most likely date for initial settlement falling between AD 1000 and 1100 (Athens et al. 2014; see also Kirch 2011). Hawaiʻi's first colonists found well-forested islands with lush rainforests in the wet uplands and open, dry forests on the leeward lowlands. These forests offered little in the way of plant food; it is easy to imagine that a colonizing party's first priority was to establish gardens of the starchy plants that comprise the bulk of the typical Polynesian diet.

The first settlements in the archipelago were likely small communities distributed sparsely and discontinuously, primarily along the coast in the fertile windward regions. The windward *ahupuaʻa* of Waimānalo, Kailua, and Kāneʻohe may have been among the first settled locations on Oʻahu; during the earliest period of settlement, Oʻahu residents dwelling in windward areas may have come to the drier leeward areas for selected resources like fish and birds (Cordy 2002:9).

By the AD 1200s, populations in the archipelago had begun to increase exponentially (Kirch 2010; see also Dye and Komori 1992). Hawaiians moved outward from their original settlements, spreading into leeward areas of the islands; on Oʻahu, this expansion would likely have included Oʻahu's southern shores. Between the AD 1200s and 1400s, Oʻahu, as well as Kauaʻi and Molokaʻi, likely saw the construction of large-scale taro irrigation systems in the most advantageous areas (Kirch 2010:128).

Coastal Waikīkī, which offered easy access to rich ocean resources, a ready freshwater supply from springs and streams, level and easily developed lands for cultivation and aquaculture, and a bounty of wild foods like ducks and other wildfowl, was almost certainly settled early in the period of leeward expansion. Some cultivation probably followed the stream courses into valleys like Mānoa and Pālolo, which were also sources for items like hardwood (for tools, weapons, and building materials) and birds (for feathers).

The limited number of reliable radiocarbon dates for Waikīkī makes it difficult to pinpoint the chronology of initial settlement with any certainty. A summary of previously obtained radiocarbon dates is provided in Table 3. The earliest radiocarbon dates obtained so far suggest that the settlement of Waikīkī likely began sometime between the AD 1200s and 1400s. A piece of unidentified charcoal[2] from a burial pit at Fort DeRussy produced a radiocarbon determination of 580±140 BP (Denham and Pantaleo 1997b), which calibrates to AD 1170-1640. Denham and Pantaleo (1997a) obtained another radiocarbon determination of 520±50 BP from an uncharred *Aleurites moluccana* (*kukui*) endocarp[3]—a Polynesian-introduced plant—which provides a bi-modal calibrated date of AD 1306-1364 and AD 1385-1458.

The period between the 1400s and the 1500s saw the Hawaiian political system change, as political power gradually replaced kinship as the means of legitimizing rule (Hommon 1986, 2013; Kirch

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[2] Unidentified charcoal may result in inbuilt age for radiocarbon dating, that is, the dated event (i.e., death of the plant) is significantly older than the target archaeological event (e.g., use of the wood for fuel in a hearth).

[3] Note that the *kukui* nut was recovered from the base of a sand berm with no clear cultural association.

2010). At some point during this period, Oʻahu was unified into a single polity, called the Oʻahu Kingdom by Cordy (2002:24), with the royal center initially located at Līhuʻe in inland ʻEwa. One way that chiefs expressed their power was through construction of monumental architecture including *heiau*, irrigation systems, and fishponds.

The mouth of ʻĀpuakēhau Stream was the major outlet of drainages originating in Mānoa and Pālolo Valleys and served as the focus of *aliʻi* activity along the Waikīkī shoreline. This area, which extends from the Royal Hawaiian Hotel to the north side of the Moana Hotel, is said to have been the home of the Oʻahu chiefs from at least the 1400s (Nāpōkā 1986; Hibbard and Franzen 1986). While the construction chronology of the large Waikīkī *heiau* is unknown, it is possible that they may have been built as early as the AD 1400s when similar structures were built on Maui (Kolb 1994).

As noted above, the construction of the extensive taro fields (and probably fishponds) at Waikīkī is credited to the AD 1600s-era ruler Kalamakua. The earliest radiocarbon dates on Waikīkī agricultural sediments are from the AD 1400s to 1600s, providing support for the initiation of widespread agriculture by that time. A piece of unidentified charcoal from agricultural sediments near the base of a large berm or bund near the intersection of Kūhiō Avenue and ʻOlohana Street produced a radiocarbon determination of 490±40 BP (Borthwick et al. 2002), which has a bi-modal calibrated date of AD 1305-1365 and AD 1383-1452. Tulchin et al. (2004) obtained a similar radiocarbon determination of 500±50 BP from an *Aleurites moluccana* (*kukui*) endocarp, which has a bi-modal calibrated date of AD 1312-1362 and AD 1387-1478.

The earliest radiocarbon dates obtained on buried fishpond sediments trend slightly later. Denham and Pantaleo (1997a) obtained ages of 520±50 BP and 380±50 BP from a sand berm pre-dating the construction of Loko Paweo II; the calibrated dates are AD 1306-1364 and AD 1385-1458 and AD 1441-1637, respectively. Davis (1989) obtained an age of 390±70 BP from the pond wall separating Loko Paweo I from the ʻAuwai of Pau; the calibrated date is AD 1421-1646. Together, these dates suggest that use of Loko Paweo I began between the AD 1400s and 1600s, while Loko Paweo II was first used no earlier than the AD 1400s.

In the final stage before European contact, beginning ca. AD 1650, the archipelago was characterized by a high-density yet stable population that had grown to occupy all ecological zones (Kirch 2010). While rulers continued to make investments in *heiau* building, corvée labor as a means to express authority appears to have been usurped by ritual consumption facilitated by taxation (Kolb 1994). In a full-land situation with constant population, a by-product of the taxation system was an increasing reliance on wars of plunder and conquest that could expand a chief's tax base quickly. Conquest warfare became increasingly frequent after the late AD 1600s, with chiefly competition extending beyond district-level rivalries to encompass rivalries between rulers of differing islands (Kolb 1991:67).

On Oʻahu, this period saw a disintegration of the unified kingdom, replaced by warring factions among district chiefs. It also saw the intensification of existing settlements and expansion into more remote (and thus probably less desirable) locales. Cordy (2002:36-37) summarizes archaeological data for the construction of permanent residences in the upper Mākaha, Nānākuli, and Lualualei Valleys in the dry leeward Waiʻanae District, in upper Hālawa in ʻEwa District, and in upland Kāneʻohe on the windward side of the island. Irrigation systems were pushed into comparatively more remote and difficult localities.

Table 3. Summary of Radiocarbon Determinations for Waikīkī; Determinations Obtained from Archaeological Sites near the Current Project Area are Shaded Gray.

Lab No. (Beta-)	Site (50-80-14-)	Sample Type	Provenience	Feature Type	Conventional Radiocarbon Age	13C/12C	Calibrated Date Range	Reference
66282	4966	unidentified charcoal	4966:1, Unit 7, Layer V, 80-90 cmbs	burial pit	580±140 BP	-26.5	AD 1170-1640 (0.95)	Denham and Pantaleo (1997b:Appendix B)
95117	4579	*Aleurites moluccana* (*kukui*) endocarp, uncharred	Area C, Layer IV-5	base of sand berm (pre-dating Loko Paweo II)	520±50 BP	-25.5	AD 1306-1364 (0.27) AD 1385-1458 (0.69)	Denham and Pantaleo (1997a:67)
183617	6407	*Aleurites moluccana* (*kukui*) endocarp	TU 1, Str. IIIc, 188-208 cmbs	*paukū* agricultural sediments	500±50 BP	-25.5	AD 1312-1362 (0.15) AD 1387-1478 (0.80)	Tulchin et al. (2004:Appendix A)
169337	6407	unidentified charcoal	unspecified	agricultural sediments near base of large berm or bund	490±40 BP	-25.6	AD 1305-1365 (0.33) AD 1383-1452 (0.63)	Borthwick et al. (2002:Appendix A)
31307	Loko Paweo/‘Auwai o Pau	*Aleurites moluccana* (*kukui*) endocarp, uncharred	Trench 6, Layer Va/b, 202-205 cmbs	beneath *‘auwai*	480±50 BP	not provided	AD 1322-1357 (0.07) AD 1391-1502 (0.87) AD 1598-1616 (0.02)	Davis (1989:74)
13195	n/a	unidentified charcoal	Feat. 5, Grid 4, Layer III, 52-56 cmbd	firepit	470±60 BP	-25.6	AD 1320-1359 (0.07) AD 1389-1524 (0.79) AD 1572-1630 (0.09)	Beardsley and Kaschko (1998:49)
66283	4966	unidentified charcoal	4966:1, Unit 8, Layer V, 66-76 cmbs	burial pit	460±70 BP	-19.8	AD 1321-1359 (0.07) AD 1390-1529 (0.70) AD 1540-1635 (0.19)	Denham and Pantaleo (1997b:Appendix B)

Lab No. (Beta-)	Site (50-80-14-)	Sample Type	Provenience	Feature Type	Conventional Radiocarbon Age	13C/12C	Calibrated Date Range	Reference
31310	4570	unidentified charcoal	Trench 19, Str. III, Pit B1, 90-100 cmbs	hearth	410±50 BP	-24.3	AD 1422-1529 (0.65) AD 1546-1635 (0.31)	Davis (1989:74)
31308	Loko Paweo/‘Auwai o Pau	unidentified charcoal	Trench 6, Layer IV, 155-165 cmbs	pond walls	390±70 BP	not provided	AD 1421-1646 (0.95)	Davis (1989:74)
13193	n/a	unidentified charcoal	Feat.1, Grids 2&10, Layer III, 51-57 cmbd	firepit	390±60 BP	-21.37	AD 1431-1639 (0.95)	Beardsley and Kaschko (1998:49)
169338	6407	unidentified charcoal	Trench 6, Str. III, ca. 180 cmbs	agricultural sediments near base or large berm or bund	380±80 BP	-26.3	AD 1409-1662 (0.95)	Borthwick et al. (2002:Appendix A)
95116	4579	*Aleurites moluccana* (*kukui*) endocarp, uncharred	Area B, Layer IV-6	base of sand berm (pre-dating Loko Paweo II)	380±50 BP	-24.6	1441-1637 (0.95)	Denham and Pantaleo (1997a:67)
183616	6407`	*Aleurites moluccana* (*kukui*) endocarp	TU 1, Str. IIIc, 168-178 cmbs	*paukū* agricultural sediments	360±60 BP	-23.9	AD 1442-1646 (0.95)	Tulchin et al. (2004:Appendix A)
26725	1947	unidentified charcoal	Area 7, Profile 20	cultural layer near Individual 13	350±90 BP	not provided	AD 1408-1684 (0.89) AD 1735-1803 (0.05) AD 1930-1950 (0.01)	Simons et al. (1991:205)
13194	n/a	unidentified charcoal	Feat. 4, Grid 3, Layer III, 58-64 cmbd	firepit	340±60 BP	-14.37	AD 1446-1657 (0.95)	Beardsley and Kaschko (1998:49)
138915	5940	unidentified charcoal	Feat. C, Str. II, 70-85 cmbs	hearth	340±60 BP	-25.0	AD 1446-1657 (0.95)	Winieski, Perzinski, Shideler et al. (2002:202)

Lab No. (Beta-)	Site (50-80-14-)	Sample Type	Provenience	Feature Type	Conventional Radiocarbon Age	13C/12C	Calibrated Date Range	Reference
31312	sand berm/Loko Paweo II	unidentified charcoal	Trench 10, Layer V, 95-125 cmbs	pond subsoil	320±90 BP	not provided	AD 1421-1695 (0.83) AD 1725-1812 (0.10) AD 1873-1876 (0.00) AD 1916-1950 (0.03)	Davis (1989:74)
96115	4579	possible *Acacia koa*	Trench 92-1, Layer IV-4	base of spit edge	320±70 BP	-27.8	AD 1437-1679 (0.91) AD 1741-1752 (0.01) AD 1763-1800 (0.04)	Denham and Pantaleo (1997a:67)
158863	n/a	unidentified charcoal	Trench 10	*imu* (with burnt pig)	320±60 BP	-23.2	AD 1449-1665 (0.94) AD 1784-1795 (0.01)	Bush et al. (2002:Appendix C)
354014	5796	plant material	Trench 14, Str. IIb	wetland sediments	310±30 BP	-20.6	AD 1490-1649 (0.95)	Pammer et al. (2014:Appendix A)
26726	1947	unidentified charcoal	Area 1, Profile 3	cultural layer?	300±130 BP	not provided	AD 1424-1895 (0.89) AD 1903-1950 (0.06)	Simons et al. (1991:206)
66280	4570	unidentified charcoal	4570:8, pit fill	burial pit	290±80 BP	-26.2	AD 1441-1695 (0.77) AD 1725-1812 (0.14) AD 1839-1845 (0.00) AD 1852-1877 (0.01) AD 1916-1950 (0.04)	Denham and Pantaleo (1997b:Appendix B)
259332	n/a	unidentified charcoal	Trench E, Feat. 1	midden	290±40 BP	-27.6	AD 1483-1665 (0.93) AD 1784-1795 (0.02)	Runyon et al. (2009:Appendix C)
55779	4576	unidentified charcoal	Area B, 102N/99E, Lens F	Loko Paweo II fill	280±70 BP	-26.2	AD 1449-1694 (0.77) AD 1726-1812 (0.15) AD 1917-1950 (0.04)	Denham and Pantaleo (1997a:67)
55780	4570	unidentified charcoal	Trench 92-5, Layer V-2	basalt sediment beneath bund	280±70 BP	-27.3	AD 1449-1694 (0.77) AD 1726-1812 (0.15) AD 1917-1950 (0.04)	Denham and Pantaleo (1997a:67)
157184	5940	unidentified charcoal	Feat. A, Str. II, 100 cmbs	charcoal lens	280±60 BP	-27.8	AD 1458-1684 (0.81) AD 1734-1804 (0.12) AD 1929-1950 (0.02)	Winieski, Perzinski, Shideler et al. (2002:202)

Lab No. (Beta-)	Site (50-80-14-)	Sample Type	Provenience	Feature Type	Conventional Radiocarbon Age	13C/12C	Calibrated Date Range	Reference
48483	4570	unidentified charcoal	Unit 1/2, Layer IIf/III, Hearth B3/I, 79-97 cmbs	hearth	280±60 BP	-25.3	AD 1458-1684 (0.81) AD 1734-1804 (0.12) AD 1929-1950 (0.02)	Davis (1992:50)
138915	5940	unidentified charcoal	Fea. C, Stratum II, 70-85 cmbs	Hearth	240±60 BP	-25.0	AD 1488-1699 (0.53) AD 1722-1814 (0.29) AD 1835-1885 (0.05) AD 1910-1950 (0.09)	Winieski, Perzinski, Shideler et al. (2002)
66277	4570	unidentified charcoal	4570:8, pit fill	burial pit	230±80 BP	-26.6	AD 1491-1896 (0.85) AD 1902-1950 (0.10)	Denham and Pantaleo (1997b:Appendix B)
183614	6407	unidentified charcoal	TU 1, Str. IIIb, 149 cmbs	lower level of *kuāuna* feature	220±30 BP	-22.8	AD 1639-1687 (0.37) AD 1731-1807 (0.50) AD 1926-1950 (0.08)	Tulchin et al. (2004:Appendix A)
259333	7066	unidentified charcoal	Trench O, Feat. 2	unidentified pit feature	210±40 BP	-24.4	AD 1530-1539 (0.01) AD 1635-1699 (0.29) AD 1722-1814 (0.48) AD 1835-1885 (0.05) AD 1910-1950 (0.13)	Runyon et al. (2010:Appendix C)
157185	5940	unidentified charcoal	Str. III, 75-80 cmbs	charcoal pocket	210±40 BP	-22.3	AD 1530-1539 (0.01) AD 1635-1699 (0.29) AD 1722-1814 (0.48) AD 1835-1885 (0.05) AD 1910-1950 (0.13)	Winieski, Perzinski, Shideler et al. (2002:202)
183615	6407	*Aleurites moluccana* (*kukui*) nutshell	TU 1, Str. IIIc, 158-168 cmbs	*paukū* agricultural sediments	190±80 BP	-23.5	AD 1521-1585 (0.07) AD 1623-1950 (0.89)	Tulchin et al. (2004:Appendix A)
158862	n/a	bone collagen (pig bone)	Trench 10	*imu* (burnt pig)	160±60 BP	-17.8	AD 1661-1950 (0.95)	Bush et al. (2002:Appendix C)

Lab No. (Beta-)	Site (50-80-14-)	Sample Type	Provenience	Feature Type	Conventional Radiocarbon Age	13C/12C	Calibrated Date Range	Reference
66279	4570	unidentified charcoal	4570:8, pit fill	burial pit	140±90 BP	-27.0	AD 1529-1548 (0.01) AD 1634-1950 (0.94)	Denham and Pantaleo (1997b:Appendix B)
254012	5796	plant material	Trench 14, Str. IIa	wetland sediments	140±30 BP	-27.5	AD 1672-1778 (0.37) AD 1798-1944 (0.58)	Pammer et al. (2014:Appendix A)
70726	4570	unidentified charcoal	4570:4, pit fill, 53-100 cmbs	firepit	130±70 BP	-28.6	AD 1664-1786 (0.40) AD 1793-1950 (0.56)	Denham and Pantaleo (1997b:Appendix B)
48481	4570	unidentified charcoal	Unit 1, Layer IId, over Hearth N, 59-69 cmbs	cultural layer immediately over hearth	130±60 BP	-26.0	AD 1666-1784 (0.39) AD 1795-1950 (0.57)	Davis (1992:50)
259984	7068	bulk sediment	Trench G, cultural layer	cultural layer	90±40	-26.0	AD 1680-1740 (0.26) AD 1753-1763 (0.01) AD 1800-1940 (0.68)	Thurman et al. (2009)
288158	1735	*Metrosideros polymorpha* (*‘ōhi‘a lehua*) charcoal	Trench 6, Pit Feature 27	unidentified pit feature	90±40 BP	-25.3	AD 1680-1740 (0.26) AD 1753-1763 (0.01) AD 1800-1940 (0.68)	Yucha et al. (2013:126)
354016	5796	plant material	Trench 14, Str. IId	pond material	80±30 BP	-27.9	AD 1691-1729 (0.26) AD 1808-1921 (0.69)	Pammer et al. (2014:Appendix A)
48482	4570	unidentified charcoal	Unit 1, Layer IIe, Hearth O, 79-84 cmbs	hearth	40±60 BP	-24.8	AD 1679-1742 (0.27) AD 1752-1764 (0.02) AD 1799-1941 (0.67)	Davis (1992:50)
55775	4970	unidentified charcoal	Trench 92-1, Lens E	bund separating *‘auwai* from Loko Paweo I	10±60 BP	-27.4	AD 1682-1738 (0.27) AD 1754-1762 (0.01) AD 1801-1938 (0.68)	Denham and Pantaleo (1997a:67)

In the early AD 1700s, the chief Kualiʻi came to power and reestablished the primacy of the island ruler. He also ventured into the political dominions of neighboring islands, gaining windward Kauaʻi and making war against chiefs on Molokaʻi, Lānaʻi, and Hawaiʻi (Cordy 2002:32).

When British Captain James Cook made the first Western landfall in Hawaiʻi in 1778, he found a group of islands ruled by an elite corps of chiefs, served by a multi-layered hierarchy of lower *aliʻi* and a body of *makaʻāinana*. On Oʻahu, Waikīkī was the chiefly center of the southern Oʻahu coast, home to the ruling chief and his subordinate *aliʻi* (Cordy 2002; Nāpōkā 1986). ʻĪʻī (1959:69) writes that the "chiefs like to live at Waikīkī because of the surfing." Houses clustered among the coconut trees on the shoreline from Kālia to the base of Diamond Head. Several large *heiau*, including Helumoa (ʻĀpuakēhau) and Papaʻenaʻena, were the focus of chiefly religious ceremonies.

WAIKĪKĪ AT EUROPEAN CONTACT

Following Cook's 1778 arrival in the archipelago, other European and American explorers and traders soon began to visit the south shore of Oʻahu. Although many wrote accounts and journals, these observations are difficult to pinpoint in terms of location and provide only a general description of the Waikīkī coastal plain. Nonetheless, they provide an image of the wetland agricultural landscape that occupied the area at that time. For example, the first written descriptions of Waikīkī were made by Vancouver's party in 1792. Vancouver (quoted in Kanahele 1995:82-83) provides the following description:

> 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…
>
> … [After landing] our boats remained perfectly quiet on the beach, having passed to the shore between some rocks, which completely protected it from the surf. The natives, who were present, received us in a very orderly manner … and on inquiring for water, they directed us to some stagnant brackish ponds near the beach. This being rejected, we were given to understand that good water was to be had in abundance at some distance, to which they readily took us; … Our guides led us northward through the village, to an exceedingly well-made causeway, about twelve feet broad, with a ditch on each side.
>
> This opened to our view a spacious plain, which … had the appearance of the open common fields of 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 which 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.

Archibald Menzies (1920:23-24, the naturalist and surgeon accompanying Vancouver, further described the wetland agricultural landscape of Waikīkī in the late 18th century:

> The verge of the shore was planted with a large grove of cocoanut palms, affording a delightful shade to the scattered habitations of the natives.… We pursued a pleasing path back to 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 labour and industry of these people by the luxuriancy of its productions.

The ocean provided an array of fish; a visitor in the 1850s described a typical catch (Nāpōkā 1986:3, quoting Harriet Newell Foster Deming):

> Sometimes four canoes would be drawn up on the beach at once, filled with shining beauties in nets … the wealth of color fascinated us as we hung over the sides of the canoes as we watched the bronzed fishermen who, naked except for a loincloth, scooped up the fish in their hands and laid them in piles on the sand.

Fishponds were another important source of food for the inhabitants of Waikīkī. Bloxam (1925:35-36), who sailed past on the *Blonde* in 1825, provides some details about the appearance of the fishponds that filled Waikīkī in the early 19th century:

> The whole distance [from Honolulu] 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. It [the village of Waikīkī] is pleasently 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.

HISTORICAL BACKGROUND

This section describes historical land use in Waikīkī with a focus on the shoreward area. Waikīkī has undergone many changes during this period, transitioning from an agricultural center and *ali'i* settlement to a highly developed tourist destination.

EARLY POST-CONTACT PERIOD

Although Kamehameha initially settled at Waikīkī on O'ahu, the growing number of American and European traders arriving in Hawai'i looked to the harbor at Kou (present-day downtown Honolulu) as a safer and therefore favored berth for their deeper draft ships. In the first decade of the 19th century, Kamehameha gradually shifted his capital to that once-rural village and, by 1809, he had an established residence near the Honolulu harbor frontage. His family and members of court also made the move, leaving Waikīkī in the care of lesser chiefs and land managers (Kanahele 1995:104-105). As the only place near the city with beaches and surf, Waikīkī provided an easy escape from the Western atmosphere of the new capital (Hibbard and Franzen 1986:10). *Ali'i*, particularly members of the Kamehameha extended family, built beach cottages on the ocean front. As the 19th century progressed, they replaced their grass-roofed, wooden buildings with more elaborate homes.

By the early 19th century, land use in Waikīkī had begun to shift gradually away from intensive taro cultivation and other traditional Hawaiian subsistence practices. During an 1828 visit to the area, the missionary Levi Chamberlain (1957:26) observed that large areas of the Waikīkī agricultural lands appeared to have been recently abandoned:

> Our path led us along the border so 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.

The introduction of epidemic disease to the Hawaiian population is understood to have resulted in widespread and catastrophic population loss by the early 1830s, which certainly affected the residents of Waikīkī. The emergence of nearby Honolulu Harbor as a center for commerce and trade by the early 19th century may also have drawn some former inhabitants away from the Waikīkī fields to other parts of the island.

CHANGES IN LAND TENURE

In the mid-19th century, major structural changes were made in the manner in which land was held in Hawaiʻi. In 1848, the traditional system of land tenure was replaced with a Western system of fee-simple land ownership. This radical restructuring, called the Mahele, divided all lands between the king and 245 high-ranking *aliʻi*; the king later divided his lands between himself (called Crown Lands) and the government (Kameʻeleihiwa 1992). Subsequently, commoners were offered the opportunity to claim fee simple title to the land on which they lived or improved; these lands became known as *kuleana* lands and were awarded in the form of Land Commission awards (LCAs) (often referred to as *kuleana* lands).

Unlike most *aliʻi* land awards that were for entire *ahupuaʻa*, *aliʻi* awards in the *ahupuaʻa* of Waikīkī were for *ʻili*. As Kameʻeleihiwa (1992:232) explains, land on Oʻahu was desirable and therefore *ʻili* on Oʻahu were as valuable as *ahupuaʻa* on the other islands:

> On Oʻahu, the moku of Kona (especially in Honolulu and Waikīkī), ʻEwa, and Koʻolaupoko were defined predominantly by ʻili. This division of ʻĀina into a great number of rather small areas indicates that Oʻahu was not only more populated, but its ʻĀina were more desired by the Aliʻi and konohiki.… Although an ʻili was almost always smaller in size than an ahupuaʻa, an ʻili on Oʻahu was considered as desirable as an ahupuaʻa on the outer islands.

About 250 Land Commission awards were made in Waikīkī to six *aliʻi* and the remaining to local land managers and commoners (Kanahele 1995:115). The *aliʻi* awardees included Kauikeaouli (Kamehameha III) (62 acres), high chiefs William Lunalilo (2,229 acres) and Ana Keohokālole (100 acres), and three lesser ranked chiefs, Mataio Kekūanaōʻa (133 acres), Keoni Ana (11 acres), and Kaisara Kapaʻakea (9 acres). As noted by Kanahele (1995:116), "Their properties all included choice spots located near the beach, streams or fish ponds." It is notable that the heirs of these *aliʻi* awardees include the monarchs Kamehameha V, David Kalākaua, and Liliʻuokalani, queen consorts Emma Rooke and Kapiʻolani, Princesses Ruth Keʻelikōlani, Likelike, and Kaʻiulani, and Prince Jonah Kūhiō Kalanianaʻole.

Kuleana awards, most of which were generally less than an acre, lined the Waikīkī shore, with associated inland pieces that provided land for farming. Of the shoreline *ʻāpana*,[4] five fall in the Fort DeRussy sector, 11 in the Halekūlani sector, three in the Royal Hawaiian sector, and seven in the Kūhiō Beach sector (Figure 11 and Figure 12). There were no LCAs awarded south of Kuʻekaunahi Stream (roughly the alignment of present Paoakalani Avenue).

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[4] Only those LCAs that fall in or adjacent to the Waikīkī beach improvements project area are counted.

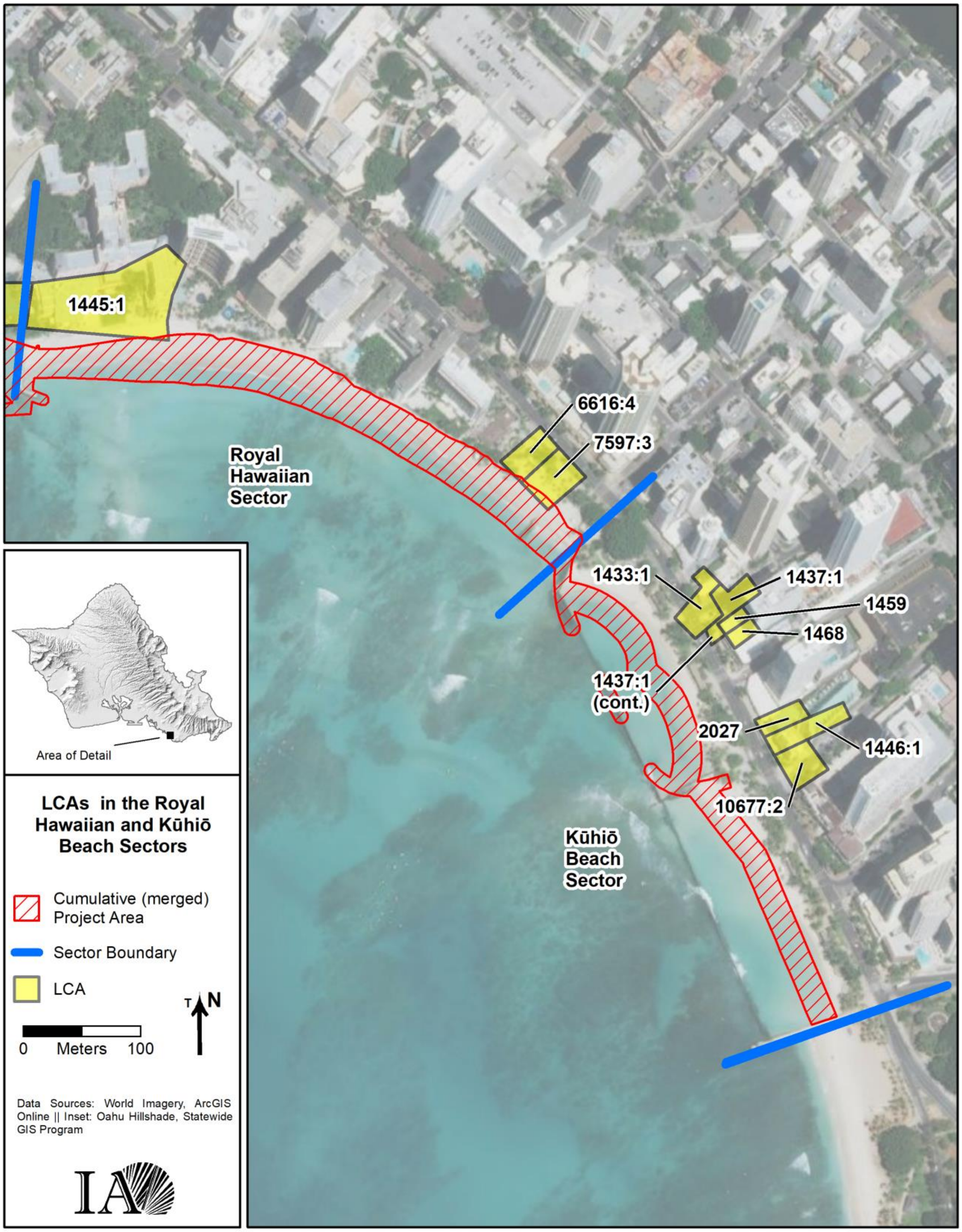

Figure 11. *Kuleana* awards in the Royal Hawaiian and Kūhiō Beach sectors.

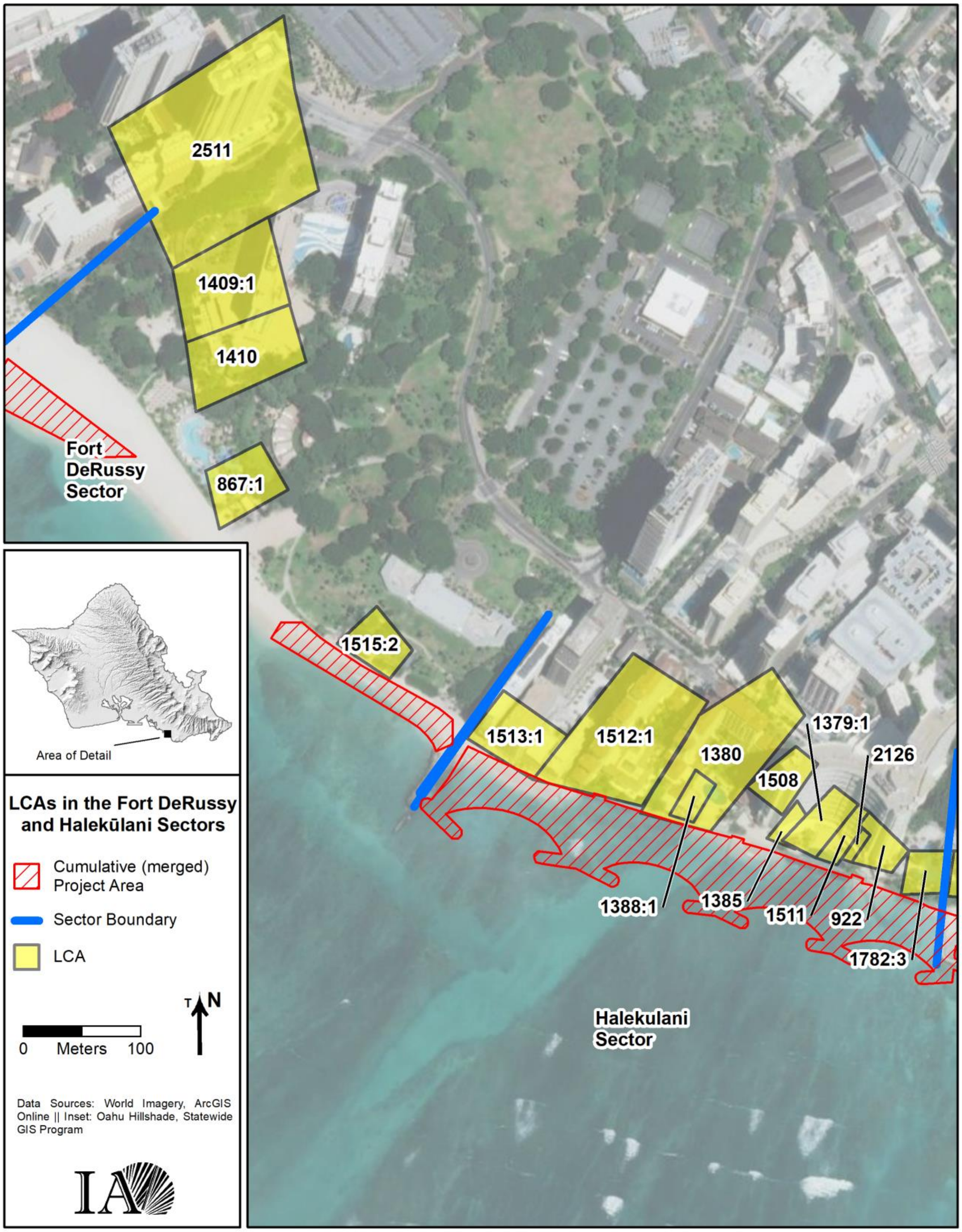

Figure 12. *Kuleana* awards in the Fort DeRussy and Halekūlani sectors.

AFTER THE MAHELE

While much of the Waikīkī Plain continued to be used as agricultural lands into the second half of the 19th century, the amount of land being used for traditional Hawaiian agriculture began to decrease. The La Passe (1855) map shows Waikīkī as filled with "Marais et Pecheries" (marshlands and fishponds), stretching from the edge of downtown Honolulu eastward nearly to Diamond Head.

In the 1860s, rice cultivation experienced a boom across the islands, directed at two markets: export to California for Chinese emigrants who had settled there after the mid-century Gold Rush and local consumption by a growing number of Chinese contract laborers who had come to Hawaiʻi to work on the sugarcane plantations[5]. Rice was second only to sugar in the economic hierarchy in the islands (Haraguchi 1987:xiii). Like sugar, Hawaiʻi's rice production filled the void created by the U.S. Civil War, when rice farming in the southern United States was severely curtailed (Coulter and Chun 1937:13). During negotiations for the Reciprocity Treaty between the U.S. and Hawaiian governments, efforts were made to ensure that rice shared the same protection as sugar.

Land speculators purchased taro fields, and in some cases, pulled up young taro plants to replace with rice seedlings (Haraguchi 1987:viv). Many *kuleana* owners leased their former taro fields to rice entrepreneurs, although in some cases, they retained land for the Hawaiian staple food. By 1892, there were 542 acres in Waikīkī planted in rice, representing almost 12 percent of the total 4,659 acres in rice cultivation on Oʻahu (Hammatt and Shideler 2007:17). Nakamura (1979:20, quoting Iwai 1933:80, brackets added) notes that Waikīkī was one of "the most important [rice] growing districts on Oahu."

Whereas at the time of the Mahele the Waikīkī fishponds were all awarded to Hawaiians, in succeeding decades they left Hawaiian hands as many ponds were leased to Chinese farmers. According to Kanahele (1995:128):

> … by 1900 the 15 ponds of Waikīkī, with the exception of one which had been planted in rice, were being leased to, and operated by, Chinese. Some of these Chinese operators included Ah Kiau and Leong Fook in Kālia; Chun Yat in Kawehewehe; and Young Chong in Kapaʻakea.

Chinese entrepreneurs continued to raise *ʻamaʻama* and *ʻawa* for the Hawaiian market. The fishponds were also used to grow goldfish (*iʻa pake* or Chinese fish), which many Hawaiians liked to eat raw, and ducks (Kanahele 1995:128-129).

An overview of the extent of rice cultivation in Waikīkī is provided by a late 19th-century map by Wall (1893), which shows the rice fields as extending from a point north of Waikiki Road (now Kalākaua Avenue) *mauka* to the lower part of Mānoa Valley and, when measured along the coast, from King Street to Kapiʻolani Park (Figure 13).

HOTELS AND TOURISM

As early as the 1860s, Waikīkī began to attract foreign residents and beachgoers, especially Americans. In 1873, the region was described by one visitor as "a hamlet of plain cottages, whither the people of Honolulu go to revel in bathing clothes, mosquitoes, and solitude, at odd times of the year" (Bliss 1873:195-196). Kapiʻolani Park in 1877 was originally developed as a private recreational/open space amenity for high-end residences at the base of Diamond Head and along the coast (Brown and

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[5] By 1884, there were 18,254 Chinese in the islands (see Coulter and Chun 1937:13).

Monsarrat 1883). Over time, Waikīkī emerged as both a popular residential area and a hub for tourists, with attendant hotels, restaurants, and other establishments.

By the end of the 19th century, proprietors were opening bathhouses such as the Long Branch, established at Ulukou in 1881, where bathers could change their clothes for a small charge. The Long Branch was soon followed by other bathing pavilions such as the Ilaniwai Baths and the Waikiki Villa (Hibbard and Franzen 1986:53-54).

In 1901, the first major hotel, the Moana, opened on the grounds of W.C. Peacock's home on the south side of the river (Photo 1). The Moana Hotel was outfitted with a 300-ft-long pier (which was demolished in 1930). After the establishment of the Moana Hotel, hotels and other guest-oriented businesses sprang up alongside elegant homes of the wealthy. Five years after the establishment of the Moana Hotel, the cottage-style Seaside Hotel opened on Bernice Pauahi Bishop's property in Helumoa.

West of the Moana Hotel, several smaller establishments were introduced in the early 20th century. In 1907, a small hotel called the Hau Tree opened in the former home of Robert Lewers. The Hau Tree, which became the Halekūlani in 1917, eventually incorporated the neighboring resort property Gray's-By-the Sea. In 1925-1926, the iconic Royal Hawaiian Hotel replaced the Seaside (Photo 2); the Royal Hawaiian Groin was constructed around this time.

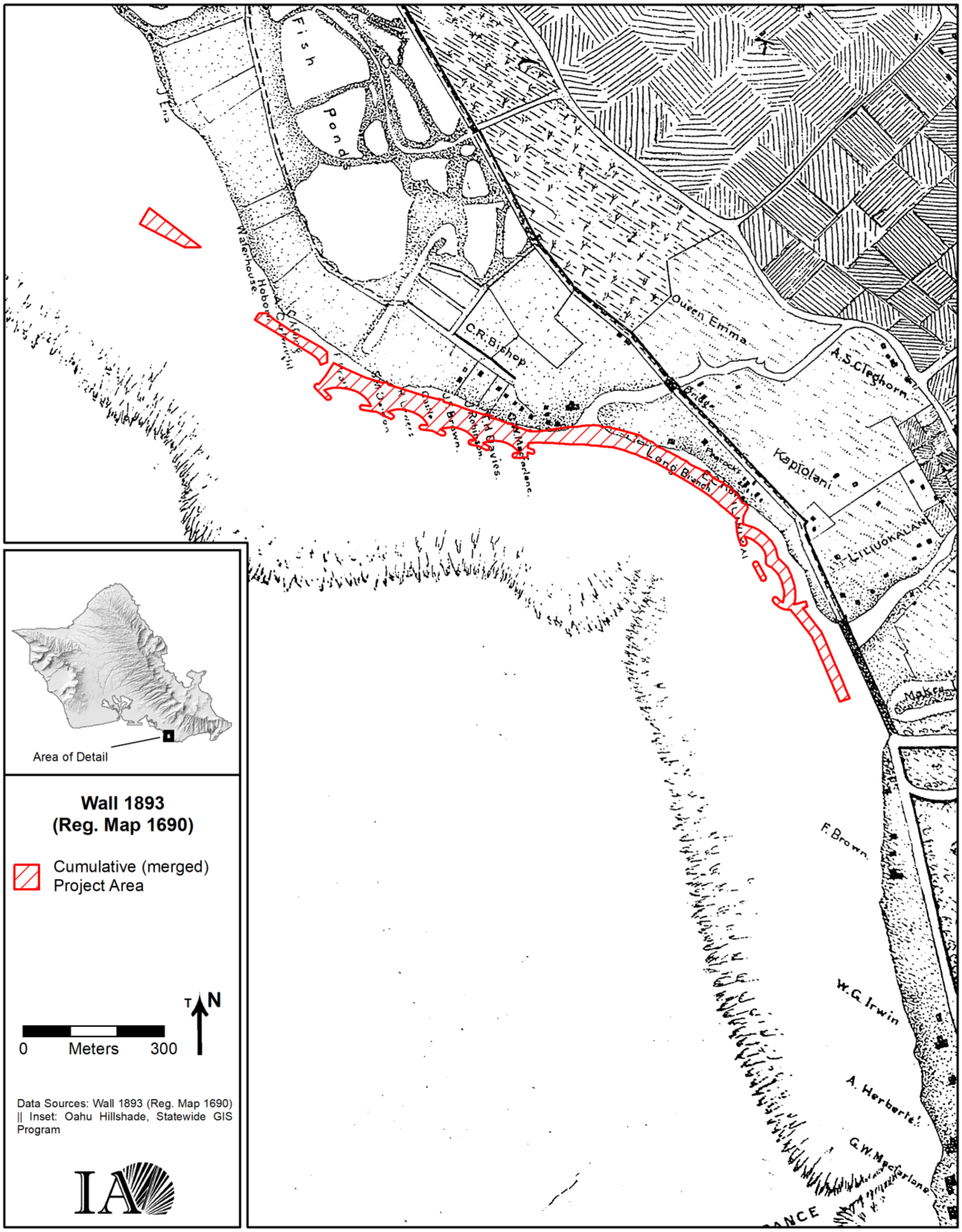
FORT DERUSSY

The U.S. Army Corps of Engineers began to acquire land for a military reservation in the area of the Kālia fishponds and along the beach between 1904 and 1908. It was subsequently occupied by a detachment from the 1st Battalion of Engineers from Fort Mason, California. The fort was first referred to as Kalia Military Reservation but was subsequently renamed in honor of Brevet Brigadier General Rene Edward DeRussy, a veteran of both the War of 1812 and the Civil War (White and Kraus 2007:80). Land acquisition for Fort DeRussy continued into World War I (Davis 1989:7). The U.S. Army immediately began to fill the new Fort DeRussy property, including the Kālia fishponds, by dredging material from the offshore reefs (Hibbard and Franzen 1986:79).

Construction of Batteries Randolph and Dudley was begun at Fort DeRussy in 1910 as part of a coastal defense system intended to protect Honolulu. The fort housed these batteries, equipped with two 14-inch guns, between ca. 1910 and 1944. Figure 14 presents the Waikīkī coastline, including Fort DeRussy, ca. 1909-1912.

ALA WAI CANAL

The land reclamation project responsible for excavating the Ala Wai Canal brought permanent changes to Waikīkī. In 1920, the Territory of Hawai'i began to solicit bids to fill the low-lying and marshy lands, with the fill to be dredged during the construction of a new artificial waterway. For Waikīkī, the canal was seen as remedying the perceived impact of outflow from the wetlands on the growing bathing industry, since "the proposed drainage canal would carry the runoff away from the Waikiki beaches" (Steele 1992:8-4). Construction began in 1921, with Walter F. Dillingham's Hawaiian Dredging Company contracted by the Territory of Hawaii to carry out the work (Nakamura 1979:90). By 1928, the canal was completed; a proposed outflow from Kapahulu Road to the eastern end of Waikīkī was never finished, aborted by a concern that the on-shore current would take canal runoff west onto the pristine beaches (Cocke 2013).



Data Sources: Wall 1893 (Reg. Map 1690) || Inset: Oahu Hillshade, Statewide GIS Program

Figure 13. The Waikīkī beach improvements project area overlaid on map by Wall (1893). Note the fishpond complex, backed by marshland, and then a gridded network of rice fields (former taro fields).

Photo 1. Moana Hotel, ca. 1905. Hawai‘i State Archives (Call No. PPWD-10-2-014).

Photo 2. Royal Hawaiian Hotel, ca. 1928. The Royal Hawaiian Groin is visible to the left of the hotel. University of Hawai‘i Library (Call No. B-1252).

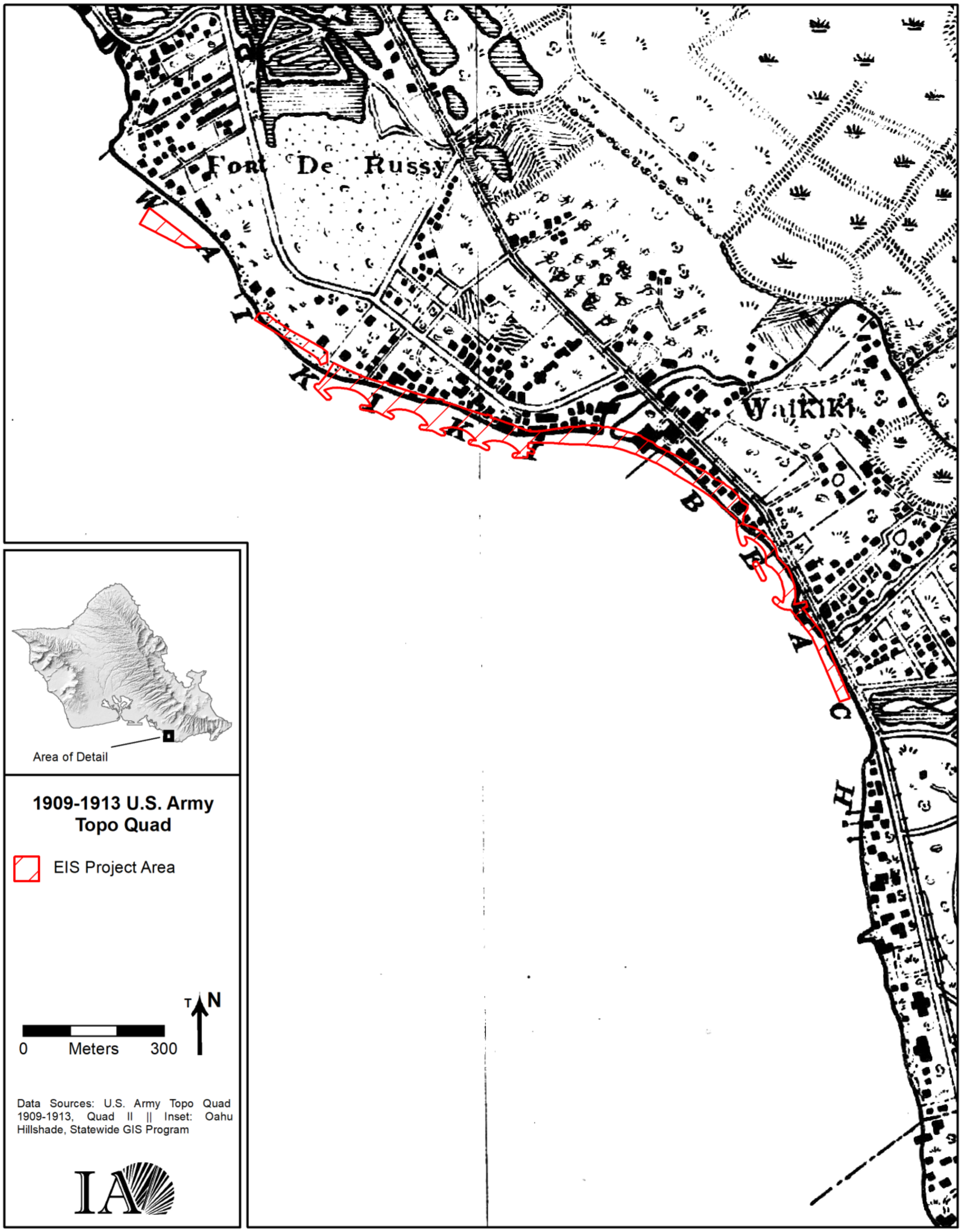


Figure 14. The Waikīkī beach improvements project area overlaid on 1909-1913 U.S. Army topographical quadrangle map (1913).

Construction of the Ala Wai Canal and accompanying land reclamation resulted in the in-filling of all remaining ponds and irrigated fields in Waikīkī; the filled areas also extended to the surrounding neighborhoods of Kapahulu, Mōʻiliʻili, McCully, and lower Makiki and Mānoa. Following land reclamation, the filled area was gridded with streets and house lots according to a "standard plan for new neighborhoods" (Johnson 1991:311).

While the areas along the coast, including the project area, were not filled as part of the Waikīkī land reclamation project, the construction of the Ala Wai Canal still had significant effects for the shoreline. Principally, construction of the canal cut off the three waterways—Kuʻekaunahi Stream, Āpuakēhau Stream, and Piʻinaio Stream—that previously entered the sea within the project area by rerouting water flowing from the uplands into the canal. The stream mouths have since been filled, and no visible traces remain.

POST-WORLD WAR II

As the popularity of Waikīkī among Hawaiʻi residents, particularly the *haole* population, and visitors grew, the region was eyed for development. The growth of the tourist industry in the 1950s, in the aftermath of World War II, led to increasing urbanization along the shoreline and throughout Waikīkī. Several major attractions opened in the post-war period, including the Honolulu Zoo (1952), the Waikīkī Aquarium (1955), and the Duke Kahanamoku Beach and Lagoon (1956). Kūhiō Beach Park had opened just prior to World War II, in 1940, with the building of an off-shore seawall creating a sheltered area for inexperienced swimmers. The Waikiki Tavern (which included the Waikiki Inn), was opened in the 1920s and occupied the lot just ʻEwa to the Kūhiō groin complex (Photo 3; Figure 15); it was demolished in 1960 to make way for Waikīkī Beach Center (Clark 1977:54; Hibbard and Franzen 1986:51)

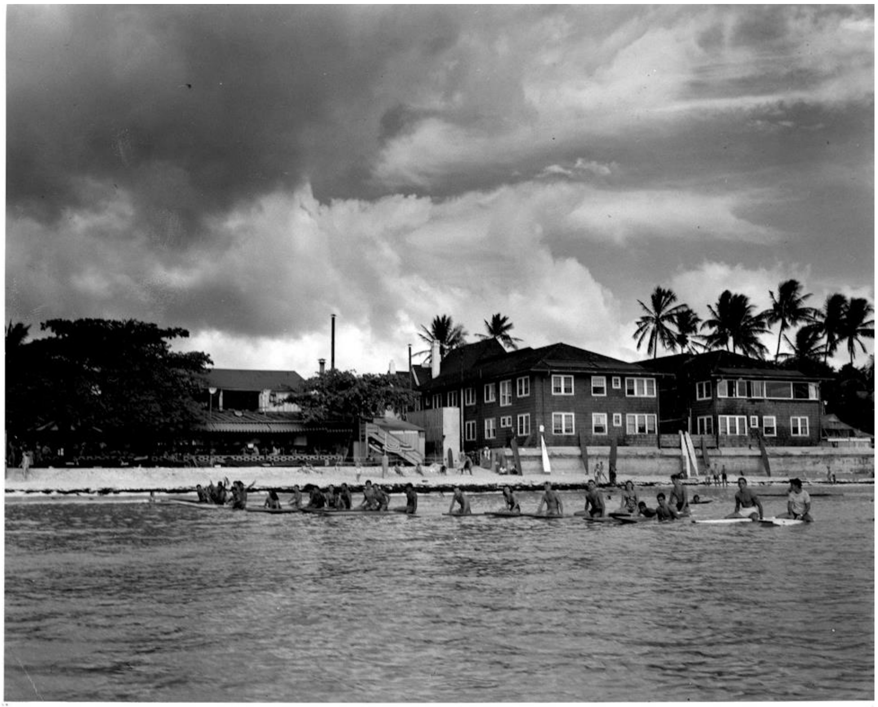


Photo 3. Surfers in front of Waikīkī Beach, ca. 1951. The building at right (containing two separate wings) is the Waikiki Inn, which was part of the Waikiki Tavern. Photo courtesy of Ian Lind.

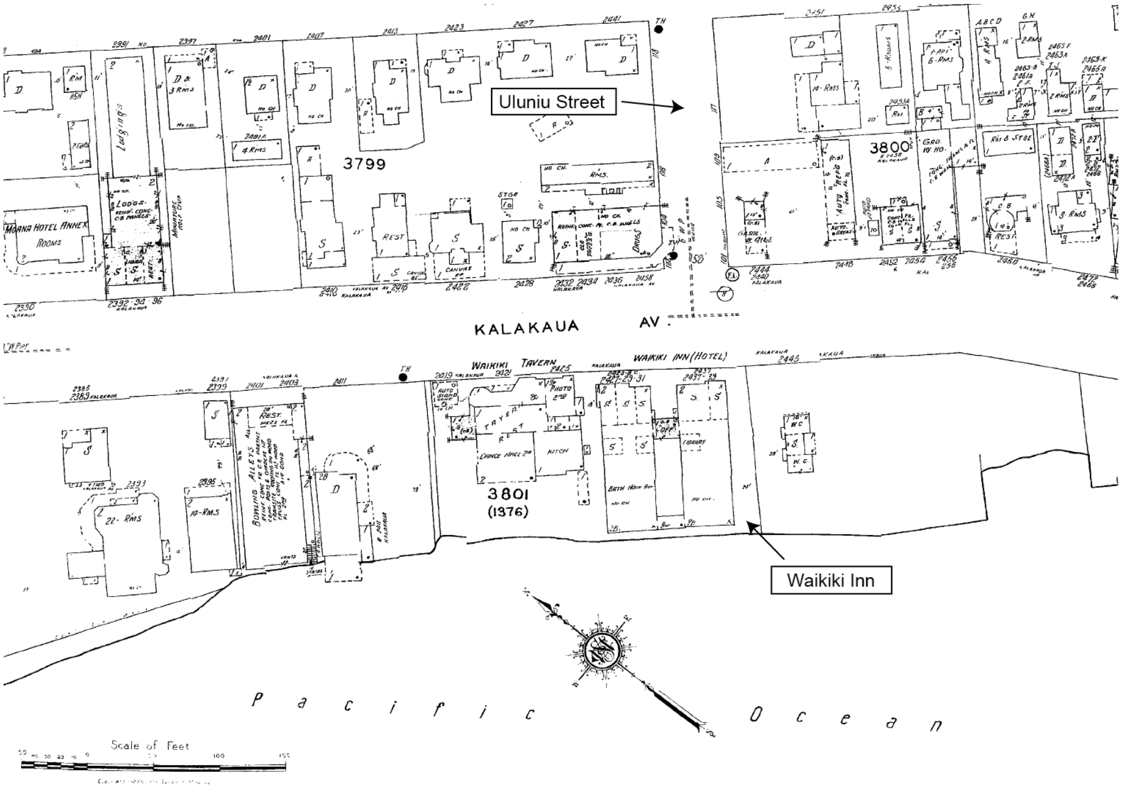


Figure 15. A 1949 Sanborn Fire Insurance map showing the Waikiki Inn (part of Waikiki Tavern).

III. ARCHAEOLOGICAL RESOURCES OF THE WAIKĪKĪ SHORELINE

The following discussion presents an overview of archaeological resources along the Waikīkī shoreline and detailed reviews for each of the four beach sectors. No known archaeological sites are within the Kūhiō Beach, Halekūlani, and Fort DeRussy sectors, though sites abut the latter two areas. One site partially overlaps with the Royal Hawaiian sector with three additional sites adjacent to its inland edge.

PREVIOUS ARCHAEOLOGICAL PROJECTS

A summary of previous archaeological projects within 50 m of the present project area is provided in Table 4 and their locations are shown in Figure 16. The locations of known archaeological sites and burials within and near the Waikīkī Beach Improvement and Maintenance Program area are shown in Figure 17.

One of the earliest archaeological surveys in Waikīkī was Thrum's (1906:44) listing of *heiau*, which described eight *heiau*. Although no remnants have yet been found, ʻĀpuakēhau or Helumoa Heiau was placed by Thrum near the shoreline at Helumoa close to the mouth of ʻĀpuakēhau Stream. McAllister (1933:74-78) subsequently devoted several pages of discussion to pre-Contact and early post-Contact-era Waikīkī, which he listed as Oʻahu's "Site 60." McAllister (1933:76) describes the *heiau* mentioned by Thrum and the taro lands and fishponds that once covered the area, noting that "all of this land has now been drained and filled."

The construction of the major hotels along the Waikīkī shoreline early in the 20th century encountered numerous burials, although these were not subjected to preservation or technical investigation. Kenneth Emory of the Bishop Museum collected human skeletal remains from five individuals at Helumoa, Waikīkī, in 1923, which were considered to be "victims of the 1853 smallpox epidemic" (NPS 1998:4278). Hammatt and Shideler (2007c:59) suggest these individuals, which they link to Bishop Museum ID numbers Oa-19 through Oa-23, were disinterred during the construction at the Royal Hawaiian Hotel[6]. It also appears likely, based on later finds by Simons et al. (1991), that human skeletal remains were disturbed and reinterred during the construction of the Moana Hotel ca. 1901.

Further inadvertent discoveries of human skeletal remains prior to the initiation of systematic, compliance-related investigations include remains observed eroding from a sand dune in front of the future Surfrider Hotel in 1964 (Bishop Museum site files, referenced in Davis 1989:24-25) and the disinterment of eight individuals during "excavations for tank construction" at the Sheraton Hotel in 1970 (NPS 1998:4282). The exact locations of these finds are unknown[7].

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[6] There are accounts of numerous *ʻulu maika* encountered during construction work for the Royal Hawaiian Hotel in the 1920s, with the *ʻulu maika* thought likely to be associated with the royal sports field Kahuamokomoko (Kanahele 1995:99).

[7] A human female "forearm bone" was reportedly encountered during construction ca. 1993 at the Sheraton Waikīkī Hotel and reinterred on the property (Hammatt and Shideler 2007c:59).

Table 4. Previous Archaeological Projects within 50 m of the Current Project Area.

Fieldwork Year	**Reference**	**Type of Investigation**	**General Location**	**Sector^**	**Findings (Site 50-80-14-)***
--	Thrum (1906)	reconnaissance survey	Hawai‘i	all	Helumoa Heiau placed at ‘Āpuakēhau on or near the grounds of the Royal Hawaiian Hotel
--	McAllister (1933)	reconnaissance survey	O‘ahu	all	Waikīkī was designated as McAllister’s (1933) “Site 60”
early 1920s	reported in Kanahele (1995:99), numerous reports	construction	Royal Hawaiian Hotel	RH	9980: many *‘ulu maika* thought to be associated with former sports field (Kahuamokomoko)
1923	reported in Hammatt and Shideler (2007c:59) and NPS 1998:4278)	inadvertent discovery	Royal Hawaiian Hotel	RH	five human burials collected by Dr. Kenneth Emory of Bishop Museum from Helumoa, possibly associated with Royal Hawaiian Hotel construction (BM ID Nos. OA0019-OA0022)
1964	referenced in Davis (1989:24-25, Groza et al. (2010:54)	inadvertent discovery	Moana Surfrider Hotel	RH	3705: burials eroding from sand dune in front of 1969 Surfrider Hotel (BM Site No. Oa-A4-24)
1970	reported in Hammatt and Shideler (2007c:59) and NPS (1998:4282)	inadvertent discovery	Sheraton Waikīkī Hotel	HK	human skeletal remains from eight individuals (BM ID No. OA0522)
1978	Rogers- Jourdane (1978)	reconnaissance survey	Halekūlani Hotel	HK	None
1981	Neller (1981)	reconnaissance survey	Halekūlani Hotel	HK	9957: four sets of disturbed human skeletal remains and historic artifacts
1981-1982	Davis (1984)	data recovery	Halekūlani Hotel	HK	9957: pre-Contact features, historic trash pits, privies, and animal burials, and human burials
1988	Simons et al. (1991)	data recovery and monitoring	Moana Surfrider Hotel	RH	1974: firepits, postholes, possible planting pits, cat burials, human burials and dispersed skeletal remains

Fieldwork Year	Reference	Type of Investigation	General Location	Sector[^]	Findings (Site 50-80-14-)[*]
1989	Davis (1989)	reconnaissance survey	Fort DeRussy	FD	4570: pre-Contact to mid-19th century habitation deposits
1990-1991	Davis (1992)	data recovery and monitoring	Fort DeRussy	FD	4570: pre-Contact to mid-19th century habitation deposits and 19th-century human burial
1992	Pietrusewsky (1992)	inadvertent discovery	Moana Surfrider Hotel	RH	human mandible fragment
1993	reported in Hammatt and Shideler (2007c:59)	recovery and reinterment of human skeletal remains	Sheraton Waikīkī Hotel	HK	human female “forearm bone”
1992-1995	Denham and Pantaleo (1997a, 1997b, 1998)	data recovery and monitoring	Fort DeRussy	FD	4570: five human burials
2001	Cleghorn (2001a, 2001b)	burial recovery	Waikīkī Burger King	KB	5861: four sets of human skeletal remains
--	PHRI (2001)	assessment	Waikīkī Beach Walk	HK	None
1997-1998	Winieski and Hammatt (2001)	monitoring	Kalākaua Avenue	KB	None
1999-2000	Bush et al. (2002); Perzinski et al. (2001); Winieski, Perzinski, Shideler et al. (2002); Winieski, Perzinski, Souza et al. (2002)	monitoring	Kalākaua Avenue	KB; RH	5857: one burial; 5858: nine burials; 5859: eight burials; 5860: 24 burials; 5861: five burials; 5862: two burials; 5863: five burials: 5940: pre-Contact cultural deposit; 5941: historic-era pit; 5942: light-gauge rail; 5943: Muliwai Kuʻekaunahi; 5948: historic seawall

Fieldwork Year	Reference	Type of Investigation	General Location	Sector^	Findings (Site 50-80-14-)*
2006	Groza et al. (2010)	literature review and field inspection	Sheraton Waikīkī Hotel (Gray's Beach)	HK	None
2006	Hammatt and Shideler (2007c)	literature review and field inspection	Royal Hawaiian Hotel; Sheraton Waikīkī Hotel	HK; RH	None
2007	Hammatt and Shideler (2007b)	monitoring	Moana Surfrider Hotel	RH	None
2007	Thurman and Hammatt (2008)	monitoring	Royal Hawaiian Hotel; Sheraton Waikīkī Hotel	HK; RH	None
2009	Thurman et al. (2009)	inventory survey	Moana Surfrider Hotel	RH	7068: historic-period cultural layer; 7069: historic-period trash pit
2009	Runyon et al. (2010)	monitoring	Moana Surfrider Hotel	RH	None
2011	Thurman et al. (2012)	monitoring	Royal Hawaiian Hotel	RH	None
2010-2011	Yucha et al. (2013)	inventory survey	St. Augustine-by-the-Sea	KB	None

Fieldwork Year	Reference	Type of Investigation	General Location	Sector[^]	Findings (Site 50-80-14-)[*]
2012-2013	Lima et al. (2014)	monitoring	Kalākaua Avenue	KB	None
2020	Morrison (2020)	monitoring	Royal Hawaiian Groin	RH	None

[^] FD = Fort DeRussy, HK = Halekūlani, KB = Kūhiō Beach, RH = Royal Hawaiian.

[*] Only archaeological findings 50 m from the present project area (or of unknown location, possibly within 50 m of the project area) are shown.

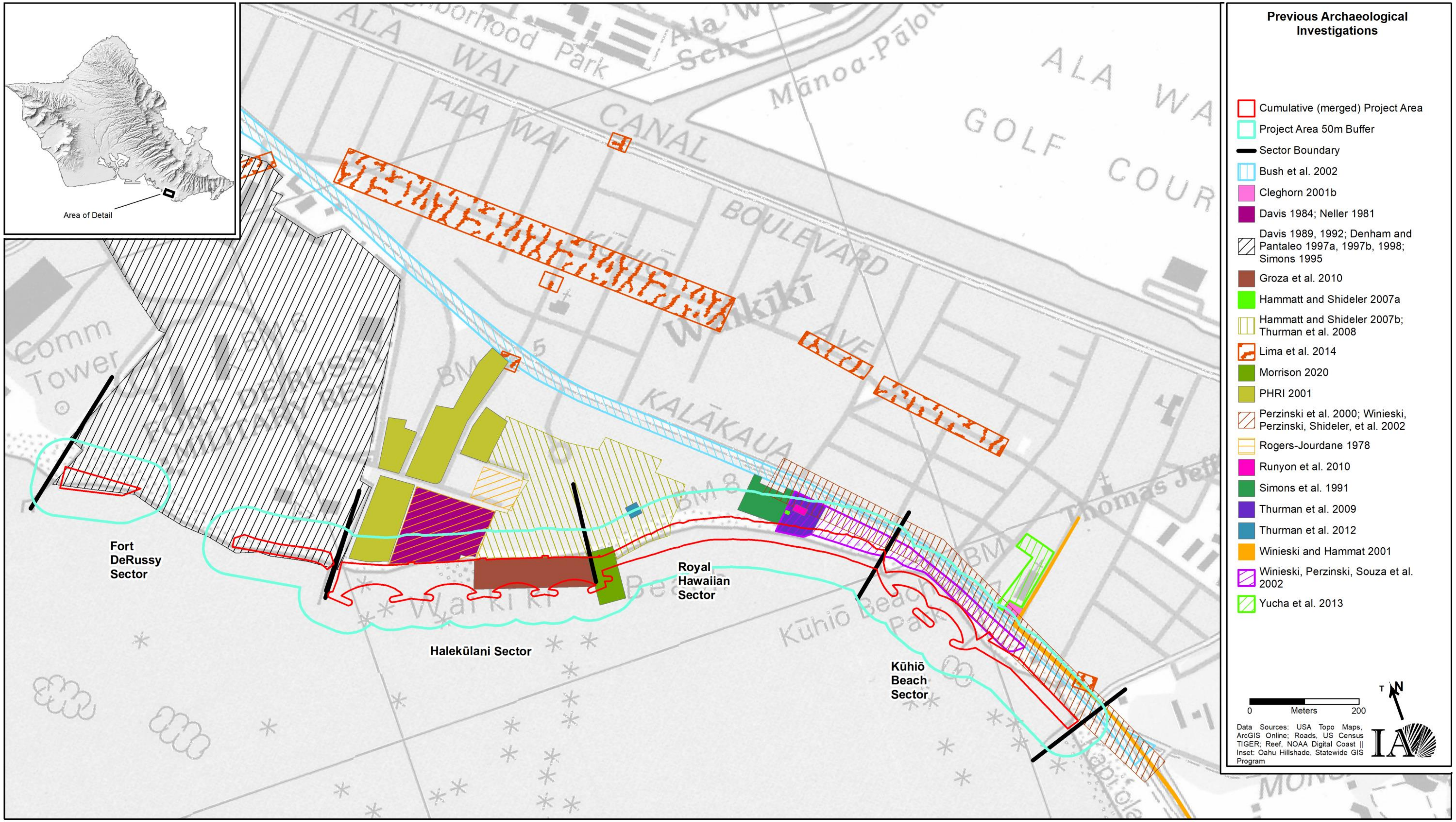


Figure 16. Previous archaeological investigations within 50 m of the project area.

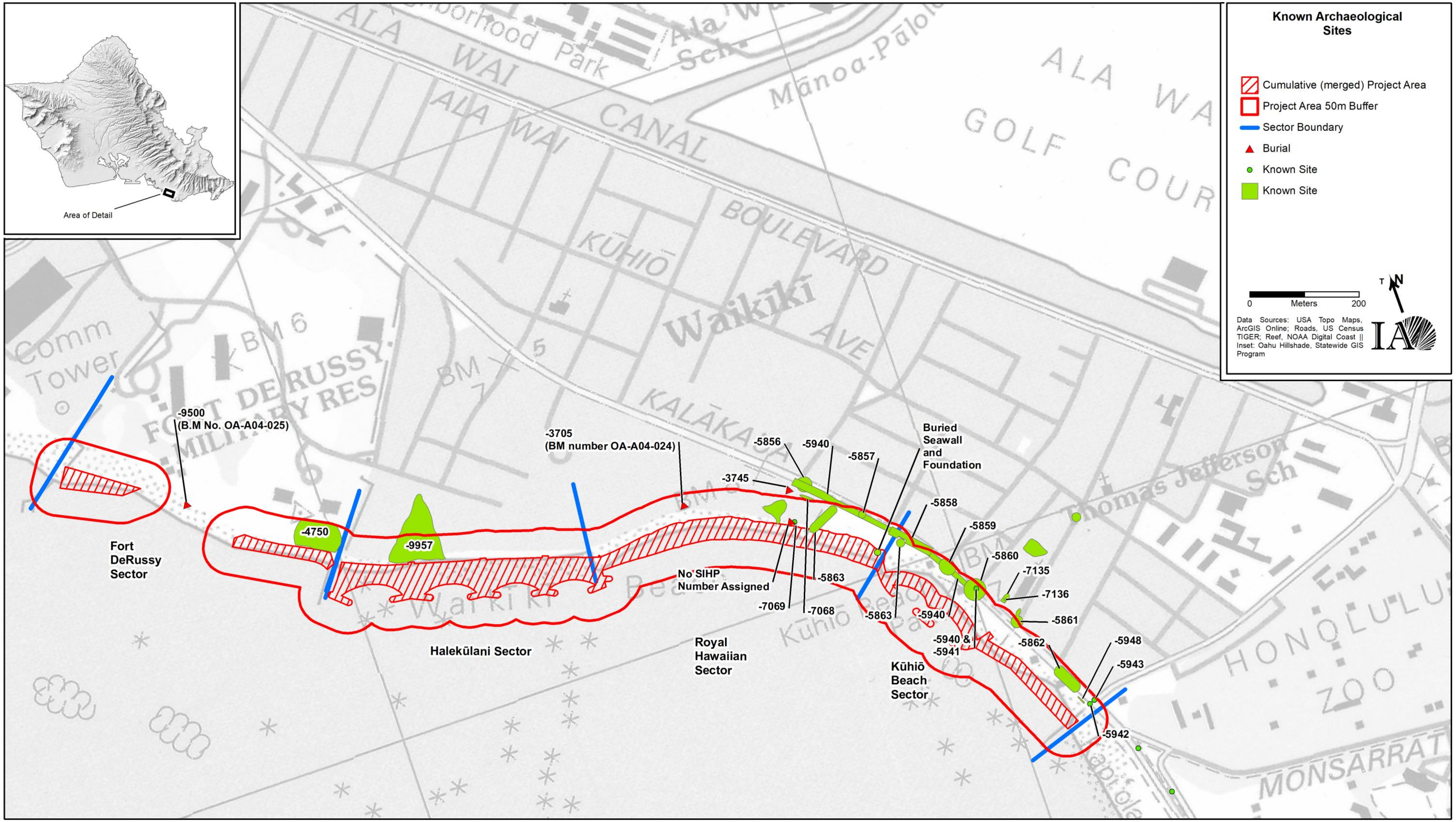


Figure 17. Known archaeological sites and burials within 50 m of the project area.

One of the earliest data recovery investigations in Waikīkī was conducted at the site of the Halekūlani Hotel. Neller (1981) documents an emergency reconnaissance survey during construction on the Halekūlani Hotel grounds after the discovery of numerous human bones and glass bottles was reported to the SHPD. At least four disturbed burials were noted during a site visit, along with various ceramic and glass artifacts, but construction was reportedly not stopped to allow additional investigations (Neller 1981:5). Davis (1984) subsequently conducted data recovery investigations and monitoring at the Halekūlani Hotel site in late 1981 and 1982. Fieldwork, which included excavation of nine trenches and 30 m^2 of controlled excavation, identified discrete archaeological deposits and human burials dating to the pre-Contact to early post-Contact eras and historic eras, respectively. The late 19th-century deposits were interpreted as most likely associated with the Robert Lewers residence built between 1881 and 1897.

Davis (1989, 1992) conducted a second large-scale project, including reconnaissance survey, monitoring, and data recovery, on the grounds of Fort DeRussy. Testing at Fort DeRussy encountered features associated with the Kālia fishpond complex, including pond sediments, walls, *ʻauwai*, and a sand berm, as well as traditional Hawaiian habitation deposits with hearths, *imu*, post molds, and midden, 19th-century trash pits, and debris associated with early 20th-century use of the property by the U.S. Army. Deposits from Loko Kaipuni (three ponds), Loko Paweo I and II, Loko Kaʻihikapu, and Loko o Pau, as well as the ʻAuwai o Pau that brought water to the fishponds from the uplands were recorded. Subsequent data recovery investigations at LCA 1515:2 encountered both pre-Contact-era and historic-era cultural deposits and a historic-era human burial.

Simons et al. (1991) conducted monitoring, data recovery, and historical research associated with renovations at the Moana Surfrider Hotel. Investigations revealed layers of historical-era fill overlying discrete archaeological deposits dating to the pre-Contact and post-Contact periods. A total of 24 "sets of human bones" were identified, which account for at least 17 individuals (Simons et al. 1991:99). The skeletal remains had no associated artifacts and were presumed to be of pre-Contact or early post-Contact age. The position of some of the remains suggested they were disturbed and reinterred during the original construction of the Moana Hotel in 1901. Pietrusewsky (1992) later documented the inadvertent discovery of a human mandible fragment on the grounds of the hotel.

BioSystems Analysis, Inc., conducted monitoring and data recovery at Fort DeRussy in the early 1990s in association with the realignment of Kālia Road and construction at the Hale Koa Hotel. The results of this fieldwork were later compiled by Denham and Pantaleo (1997a, 1997b, 1998), with a burial report by Carlson et al. (1994). Fieldwork was carried out across the Fort DeRussy property, with only a small portion occurring near the coastline. Investigations yielded features associated with the Kālia fishponds, including Loko Paweo (I and II), Loko Kaʻihikapu, and historical-era cultural deposits.

Another major set of archaeological investigations involved monitoring of several projects by Cultural Surveys Hawaiʻi in the late 1990s and early 2000s. These projects were conducted for the installation of anti-crime lighting along Kalākaua Avenue (Bush et al. 2002), the installation of a water main (Perzinski et al. 2000; Winieski, Perzinski, Shideler et al. 2002), the installation of a force main (Winieski and Hammatt 2001), and the expansion of Kūhiō Beach Park (Winieski, Perzinski, Souza et al. 2002). These projects encountered both pre-Contact and historical-era archaeological deposits, as well as numerous burials. Results of these projects demonstrate that substantial buried archaeological deposits exist along Kalākaua Avenue near the former location of Kuʻekaunahi Stream.

An archaeological inventory survey by Thurman et al. (2009) on the grounds of the Moana Surfrider Hotel provided additional data on subsurface deposits near the former ʻĀpuakēhau Stream. This project, which was undertaken in advance of the renovations of the hotel's Diamond Head Tower, encountered archaeological deposits dating to the late pre-Contact or early post-Contact periods and the historical era.

Several additional recent archaeological investigations have taken place along coastal Waikīkī with negative results, at least near the current project area. These projects include field inspections by Groza et al. (2010) and Hammatt and Shideler (2007c); monitoring by Hammatt and Shideler (2007a), Thurman and Hammatt (2008) Runyon et al. (2010), Thurman et al. (2012), Lima et al. (2014), and Morrison (2020); and an archaeological inventory survey by Yucha et al. (2013).

OVERVIEW OF ARCHAEOLOGICAL RESOURCES

The archaeological record of the Waikīkī shoreline is fragmented, disturbed, and damaged by over a century of urbanization. Nonetheless, archaeological investigations have shown that remnants of the former landscape lie beneath the asphalt and concrete of the modern resort area. This record can be characterized as an extensive but discontinuous buried A-horizon, with high-density clusters of archaeological material and burials representing the most intensive pre-Contact and historical-period occupations.

There are 15 sites that contain human skeletal remains, including at least 97 identifiable individuals (Table 5). The largest burial clusters include Sites 50-80-14-1974 and 50-80-14-5860, each of which contained 24 discrete burials. Site 50-80-14-1974 is on the grounds of the Moana Surfrider Hotel, while Site 50-80-14-5860 is at the intersection of Kalākaua Avenue and Kealohilani Avenue. Also along Kalākaua Avenue are Sites 50-80-14-5858 and 50-80-14-5859, which include eight burials each. Site 50-80-14-5861 at the intersection of Kalākaua and ʻŌhua Avenues includes seven burials.

There are also 10 sites that are buried archaeological deposits or discrete features (Table 6). Of particular note is Site 50-80-14-5940, which is described as a discontinuous deposit of very dark-stained sand containing diffuse charcoal flecks, traditional Hawaiian artifacts, midden, firepits, hearths, and other pits. It is a linear site that runs along Kalākaua Avenue between Kaʻiulani and Liliʻuokalani Avenues. This delineation of a site boundary is deceptive in two respects: (1) burial Sites 50-80-14-5857 through 50-80-14-5859, as well as the inland edge of Site 50-80-14-5863, fall within same area and thus could be included as clusters within the site; and (2) archaeological deposits have been identified with burial associations at the not-distant Sites 50-80-14-5860 and 50-80-14-5861 to the south and Sites 50-80-14-1974, 50-80-14-3705, 50-80-14-4570, and 50-80-14-9975 to the north and northwest. Thus, in actuality, it could be argued that the pre-Contact and historical-era occupation of Waikīkī beach encompasses the entire length of the shoreline adjacent to the project area, with probable concentrations of occupation at advantageous locations near stream mouths, fishing grounds, or easy canoe access to the open ocean.

Ten radiocarbon dates have been obtained from archaeological sites near the Waikīkī Beach Improvement and Maintenance Program area (Table 3). The earliest radiocarbon determination for the shoreward area is 410±50 BP (Davis 1989), obtained on a piece of unidentified charcoal from a hearth, which produces a bi-modal calibrated date of AD 1422-1529 and AD 1546-1635. Most dates indicate that the shoreline was occupied by the 15th or 17th centuries AD. It reasonable to assume, however, given the lack of extensive archaeological investigations in this area and the presence of earlier dates elsewhere on the Fort DeRussy property, that the immediate area was settled even earlier.

Table 5. Summary of Archaeological Sites with Human Remains within 50 m of Project Area.

SIHP No. (50-80-14-)	Site Description	Reference	Sector^
--	5 burials found during construction of Royal Hawaiian Hotel in October 1923, specific location unknown	reported in Hammatt and Shideler (2007c:59) and NPS (1998:4278)	RH
--	human mandible fragment identified on grounds of Moana Surfrider Hotel in 1992	Pietrusewsky (1992)	RH
--	human skeletal remains from eight individuals recovered on the grounds of the Sheraton Waikīkī in 1970	reported in Hammatt and Shideler (2007c:59) and NPS (1998:4282)	HK
--	human female "forearm bone" recovered on the grounds of the Sheraton Waikīkī Hotel in 1993	reported in Hammatt and Shideler (2007c:59)	HK
1974	24 burials plus pre-Contact and historic-period deposits; exposed during renovations of Moana Hotel in 1988	Simons et al. (1991)	RH
3705	burials eroding from sand dune in front of Surfrider Hotel, observed in 1964; specific location unknown	Bishop Museum site files; referenced in Davis (1989:24-25), Groza et al. (2010:54)	RH
4570	traditional Hawaiian and historic-period deposits; associated with LCA 1515:2; 1 historic-period burial	Davis (1989, 1992)	FD
5857	1 burial on Kalākaua Avenue between Ka‘iulani and Lili‘uokalani Avenues	Perzinski et al. (2000); Winieski, Perzinski, Shideler et al. (2002)	RH
5858	8 burials along Kalākaua Avenue between Uluniu and Lili‘uokalani Avenues	Perzinski et al. (2000); Winieski, Perzinski, Shideler et al. (2002); Winieski, Perzinski, Souza et al. (2002)	KB
5859	8 burials near intersection of Kalākaua and Lili‘uokalani Avenues	Perzinski et al. (2000); Winieski, Perzinski, Shideler et al. (2002)	KB
5860	pre-Contact and historic-period cultural deposits; 24 burials near intersection of Kalākaua Avenue and Kealohilani Avenue	Bush et al. (2002); Perzinski et al. (2000); Winieski, Perzinski, Shideler et al. (2002)	KB
5861	7 burials near intersection of Kalākaua and ‘Ōhua Avenues; pre-Contact and historic-period features and materials	Cleghorn (2001a, 2001b); Perzinski et al. (2000); Winieski, Perzinski, Shideler et al. (2002)	KB

SIHP No. (50-80-14-)	**Site Description**	**Reference**	**Sector**^
5862	pre-Contact and historic-period cultural deposits; two burials along Kalākaua Avenue between Paoakalani and Kapahulu Avenues	Perzinski et al. (2000); Winieski, Perzinski, Shideler et al. (2002); Winieski, Perzinski, Souza et al. (2002)	KB
5863	two burials *makai* of Kalākaua Avenue between Kaʻiulani and Uluniu Avenues	Winieski, Perzinski, Souza et al. (2002)	RH
9957	intact cultural deposit containing animal burials, postholes, trash pits, privies, pits; four burials; historic material associated with Robert Lewers residence	Davis (1984); Neller (1981)	HK

^ FD = Fort DeRussy, HK = Halekūlani, KB = Kūhiō Beach, RH = Royal Hawaiian.

Table 6. Summary of Archaeological Sites Without Human Remains within 50 m of the Project Area.

SIHP No. (50-80-14-)	**Site Description**	**Reference**	**Sector**^
--	portion of historic seawall; buried section extending northwest from inland end of Kūhiō Beach's ʻEwa basin; possibly associated with Waikiki Tavern	Nick Belluzzo, personal communication (2016); Davis (2017); Kanahele (1928c)	RH
5940	very dark-stained sand with diffuse charcoal flecks; contains traditional Hawaiian artifacts, midden, firepits, hearths, other pits; discontinuous, along Kalākaua Avenue between Kaʻiulani and Liliʻuokalani Avenues	Winieski, Perzinski, Shideler et al. (2002); Winieski, Perzinski, Souza et al. (2002)	KB
5940	very dark-stained sand with diffuse charcoal flecks; contains traditional Hawaiian artifacts, midden, firepits, hearths, other pits; discontinuous, along Kalākaua Avenue between Kaʻiulani and Liliʻuokalani Avenues	Winieski, Perzinski, Shideler et al. (2002); Winieski, Perzinski, Souza et al. (2002)	RH
5941	historic trash pit overlying Burial 36 of Site 5860	Winieski, Perzinski, Shideler et al. (2002)	KB
5942	remnant of the historic Honolulu Transit light-gauge trolley rail	Winieski, Perzinski, Shideler et al. (2002)	KB
5943	low-energy alluvial sediments associated with now-channelized Muliwai Kuʻekaunahi; near intersection of Kalākaua and Kapahulu Avenues	Winieski, Perzinski, Shideler et al. (2002)	KB

SIHP No. (50-80-14-)	Site Description	Reference	Sector^
5948	basalt boulder retaining wall exposed near intersection of Kalākaua and Kapahulu Avenues; may be remains of wall built as early as 1890 to protect Waikīkī Road (Kalākaua Avenue)	Winieski, Perzinski, Souza et al. (2002)	KB
7068	intact historic-period cultural layer; on north side of Moana Hotel Diamond Head Tower, along Kalākaua Avenue	Thurman et al. (2009)	RH
7069	historic-period trash pit; just inland of seawall at Moana Hotel Diamond Head Tower	Thurman et al. (2009)	RH
9980	several *ʻulu maika* found during construction of Royal Hawaiian Hotel in 1925; specific location unknown	reported in Kanahele (1995); numerous reports	RH

^ KB = Kūhiō Beach, RH = Royal Hawaiian.

KŪHIŌ BEACH SECTOR

The Kūhiō Beach sector consists of approximately 460 m (1,500 ft.) of shoreline extending from the ʻEwa (west) groin at Kūhiō Beach Park to the Kapahulu storm drain. The shoreline within this sector, which includes the southern portion of Kūhiō Beach Park, is essentially an enclosed body of water within a set of seawalls and groins built in the mid-20th century. This sector is at the southern end of the curving, protected portion of the Waikīkī coastline, where the shoreline runs nearly adjacent to Kalākaua Avenue. Until the late 1800s, Kuʻekaunahi Stream flowed as a wide, slow-moving estuary into the ocean in the southern portion of the Kūhiō Beach sector (around the present alignment of Paoakalani Avenue). This sector comprises portions of the *ʻili* of Hamohamo, Uluniu/Kapuni, and Kekio.

Kalākaua Avenue runs almost adjacent to the shoreline within this sector and there are no major buildings *makai* of Kalākaua Avenue. The Kūhiō Beach Hula Mound is at the northern end of the sector, and an outdoor concession stand is *mauka* of the ʻEwa basin of the Kūhiō groin complex.

HISTORICAL EVENTS

Notable historical events pertaining to the potential for archaeological resources within the Kūhiō Beach sector are summarized in Table 7. The sector is immediately south-southeast of the former mouth of ʻĀpuakēhau Stream, which served as the royal center of Hawaiian rulers in Waikīkī since the mid-1400s based on oral traditions.

Lands within and near the sector were transferred during the Māhele via three *aliʻi* land awards and seven *kuleana* awards (Table 8; Figure 18). The *aliʻi* awards included Kapuni/Uluniu in the north to Mataio Kekūanaōʻa (LCA 104FL:5); Hamohamo in the center (on the north side of Kuʻekaunahi Stream) to Keohokālole (LCA 8452:1), and Kekio in the south (on the south side of the stream) to Pehu for his wife Keʻekapu (LCA 5931:2). Hamohamo, which encompassed extensive inland lands, also included the coastal strip between Kuʻekaunahi and ʻĀpuakēhau Stream—nearly all of the Kūhiō Beach and Royal Hawaiian sectors—and as a result, Kapuni/Uluniu did not have any coastal access in this area.

Table 7. Historical Events Pertaining to the Kūhiō Beach Sector.

Year	Event	Reference
ca. 1400s	area near mouth of ʻĀpuakēhau Stream (Royal Hawaiian sector) becomes chiefly center for Oʻahu rulers	Beckwith (1970:383)
ca. 1848	LCAs included 3 *aliʻi* awards and 7 *kuleana* awards along shoreline	Māhele Book; NT
1859	Liliʻuokalani received the land of Hamohamo from her mother, Keohokālole (who was awarded the land in the Māhele)	Hibbard and Franzen (1986:8)
1877	Kapiʻolani Park opened	Hibbard and Franzen (1986:43)
1880	around this time, a bridge/causeway was built across mouth of Kuʻekaunahi Stream at entrance to Kapiʻolani Park; the bridge ran from around the present ʻŌhua Avenue to Monsarrat Avenue	Wiegel (2008:26)
1890	390-foot long retaining wall built to protect Waikiki Road (now Kalākaua Avenue), replacing part of bridge and causeway near entrance to Kapiʻolani Park	Wiegel (2008:26)
1890	ca. 130-foot long wooden timber pier on piles built sometime prior to 1890 off of Liliʻuokalani's Kealohilani residence; known as Queen Liliʻuokalani Pier or Kūhiō Pier	Kanahele (1995:136); Wiegel (2008:17)
1918	Prince Kūhiō acquired Liliʻuokalani's beach residence Kealohilani and built a new home called Pualeilani (his second home of the same name) on the property	Clark (1977:52); Hibbard and Franzen (1986:37)
1934-1935	City and County purchased the second Pualeilani house, including Liliʻuokalani Pier, and demolished both for beach improvements	Hibbard and Franzen (1986:38); Wiegel (2008:17, 26)
1939	650-foot long crib wall built along ʻEwa portion of Kūhiō Beach sector about 200 feet from shore (parallel to shore), with shore return structures at each end	Wiegel (2008:17)
1940	Kūhiō Park officially dedicated	Clark (1977:52)
1951	355-foot long Kapahulu Storm Drain built as part of Waikīkī Beach Improvement Project	Clark (1977:53); Wiegel (2008:17)
1953	750-foot long retaining wall built on ʻEwa side of Kapahulu Groin to keep sand from eroding away; called "Slippery Wall"	Clark (1977:53); Wiegel (2008:17, 27)
1972	retaining wall to protect Kalākaua Avenue removed	Wiegel (2008:27)

Table 8. LCAs in the Vicinity of the Kūhiō Beach Sector (Based on Bishop 1881).

LCA No.	Grantee	Description/Land Use	Other Reference
104 FL:5	Mataio Kekūanaōʻa	*aliʻi* award of Kapuni and Uluniu	NR Vol. 3, pp. 765-766
1433:1	Kaluhi	house lot in Hamohamo	NR Vol. 3, p. 109
1437:1	Kauhulenui (also Kaohulenui)	house lot	NR Vol. 3, p. 111
1446:1	Naa	unfenced house lot	NR Vol. 3, pp. 114-115
1459	Kuihewa	fenced house lot with two houses	NR Vol. 3, pp. 119-120
1468:1	Kaiahopuwale	fenced house lot with one house *mauka* of Government Road	NR Vol. 3, p. 123
2027	Palaualelo	house lot	NR Vol. 3, p. 329
5931:2	Pehu (for Keʻekapu)	*aliʻi* award of Kekio	NR Vol. 5, p. 182
8452:3	Analea Keohokālole	*aliʻi* award of Hamohamo (later inherited by Liliʻuokalani)	NR Vol. 5, pp. 567-568
10677	Pupuka	house lot	NR Vol. 4, p. 576

No *kuleana* awards were made within the Kūhiō Beach sector, though several were nearby. These clustered in two locations along the coast, one along the north side of Kuʻekaunahi Stream and the other about 80 m farther to the north. The southern cluster falls at the present intersection of Kalākaua and ʻŌhua Avenues. The northern cluster is at the intersection of Kalākaua and Liliʻuokalani Avenues. All are described in claims and testimonies as house lots.

LCA 1433:1, originally awarded to Kaluhi, is particularly notable because it is just inland of the location of Liliʻuokalani's beachside residence Kealohilani, which was subsequently the second Pualeilani home of Prince Jonah Kūhiō Kalanianaʻole (Figure 19). In the mid-century Mahele, the *ʻili* of Hamohamo was awarded to the high chief Keohokālole. In 1859, Keohokālole transferred the land to her daughter Liliʻuokalani (future queen of Hawaiʻi), who established Waikīkī residences at Paoakalani (*makai* of the present Ala Wai Canal) and a beachside cottage on the former LCA 1433:1 that she called Kealohilani.

One of the earliest structures to modify the shoreline was a bridge and causeway built across the mouth of Kuʻekaunahi Stream at the entrance to Kapiʻolani Park, which opened in 1877 (Photo 4). In 1890, a 390-foot-long retaining wall was built to protect Waikīkī Road (now Kalākaua Avenue), replacing part of the original bridge and causeway (Photo 5). Photo 6 shows a retaining wall at this location in 1931. The 1890 retaining wall is said to have been removed in 1972 (Wiegel 2008: 27); as discussed below, an existing portion of the wall may have been discovered during construction along Kalākaua Avenue.

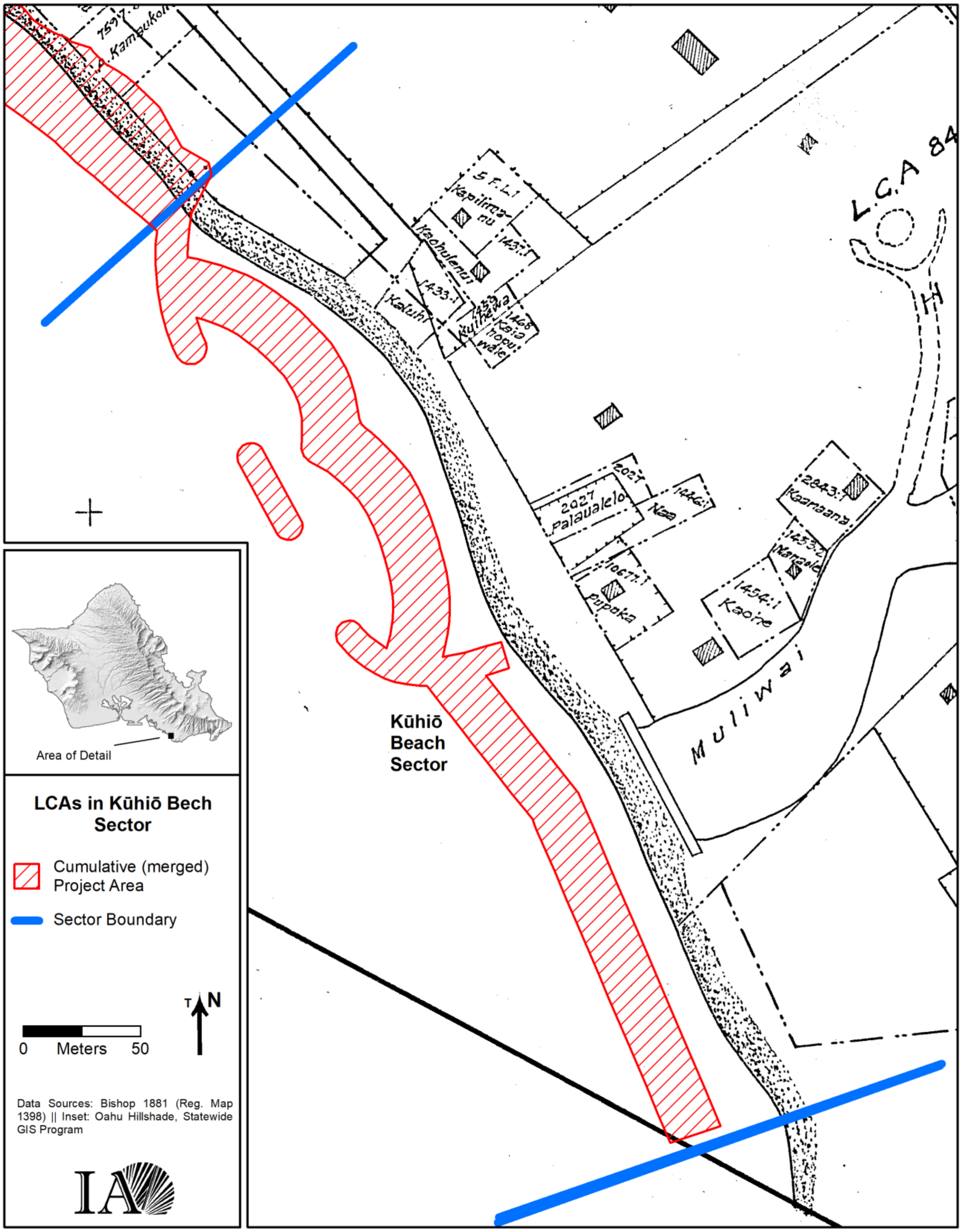


Figure 18. Overlay of Bishop's (1881) map showing LCAs near the Kūhiō Beach sector.

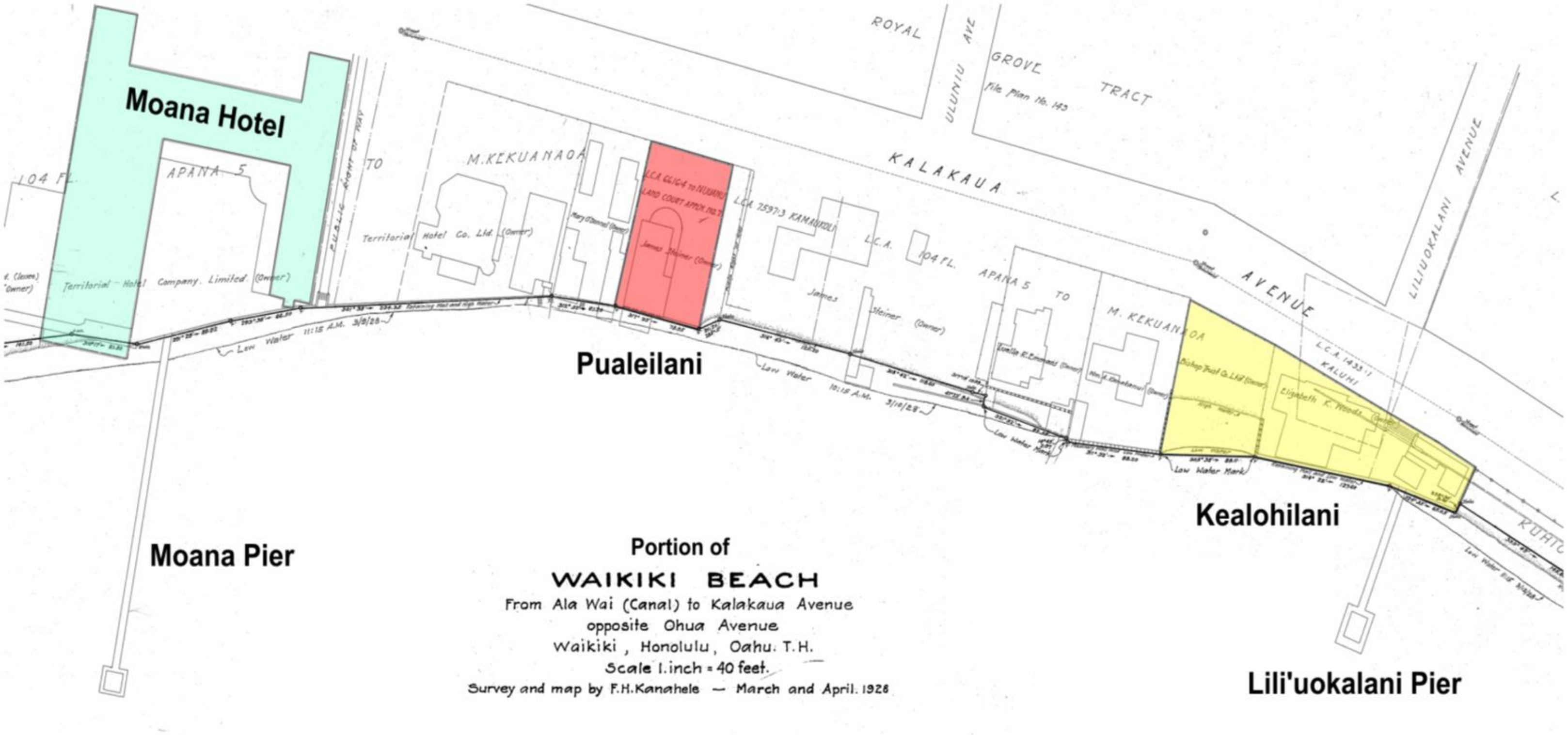


Figure 19. Section of Kanahele’s (1928c) map of the Waikīkī shoreline, showing the location of Liliʻuokalani’s Kealohilani parcel and Liliʻuokalani Pier; also shown is the location of Prince Kūhiō’s original Pualeilani parcel and the Moana Hotel (in the Royal Hawaiian Beach sector).

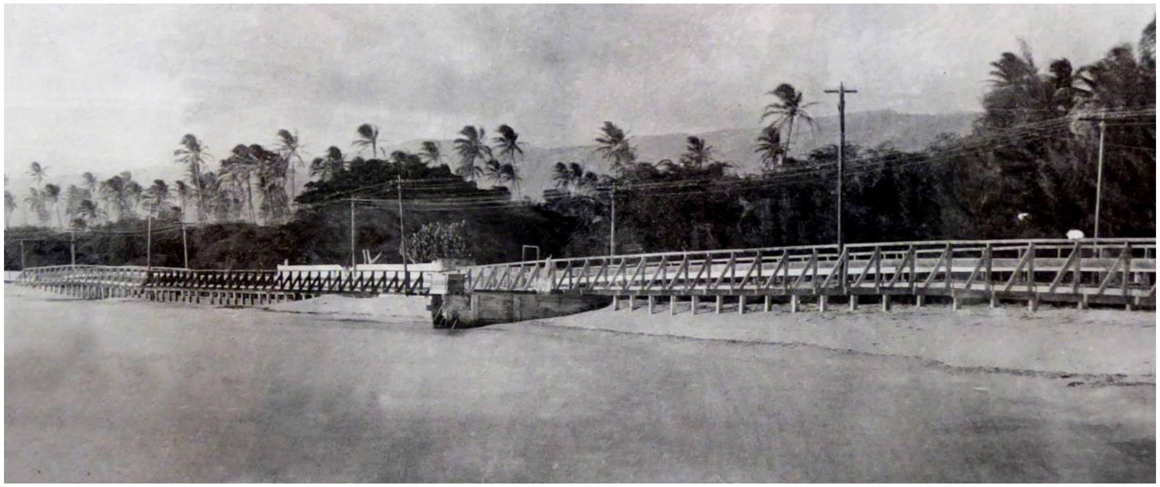


Photo 4. Bridge/causeway at the entrance to the new Kapiʻolani Park, around 1880, view to northeast. Hawaiʻi State Archives (PP115-11-006).

Photo 5. Kalākaua Avenue near Kapiʻolani Park, 1914; note the seawall along the left side of the photograph. Source: Hawaiʻi State Archives (PP115-7-012).

Photo 6. Aerial view of the Waikīkī shoreline, 1931. The retaining wall protecting Kalākaua Avenue is in the center of the photograph. Source: Hawai‘i State Archives.

An approximately 130-foot-long timber pier on piles was built sometime prior to 1890 off of Lili‘uokalani’s Kealohilani residence (Photo 7). Known as Queen Lili‘uokalani or Kūhiō Pier, it was demolished in 1934 (Kanahele 1995:136; Wiegel 2008:17).

Prince Kūhiō acquired Kealohilani in 1918 through an out-of-court settlement from his challenge to Lili‘uokalani’s establishment of a trust (Hibbard and Franzen 1986:37). He built a new home called Pualeilani on the property. This Pualeilani was the second home of this name owned by Kūhiō; his former Pualeilani home was approximately 300 m to the north (in the Royal Hawaiian sector). In 1922, the *Paradise of the Pacific* magazine noted that it was the last space in Waikīkī that was retained by a member of the royal family (Hibbard and Franzen 1986:38). The property was acquired by the City and County in 1934-1935 and the house was demolished for beach improvements (Hibbard and Franzen 1986:38).

Preparations for the opening of Kūhiō Beach Park in 1940 included the construction of a 650-foot-long crib wall built in 1939 200 feet from shore (parallel to shore) off the ‘Ewa end of Kūhiō Beach, with shore return structures at each end of the seawall (Wiegel 2008:17). The 355-foot-long Kapahulu Storm Drain was built in 1951 at the end of Kapahulu Avenue. The structure is an extension of the storm drain running under Kapahulu Avenue; the storm drain and groin, which is still a prominent feature of the

Waikīkī Beach shoreline, is commonly referred to as "The Wall" (Clark 1977:53). Other improvements included construction of a retaining wall on the Diamond Head side of the groin and importing sand.

In 1953, a 750-foot-long retaining wall was built between the 1939 crib wall and the Kapahulu Groin to keep sand from eroding. This wall, also still extant, is called "Slippery Wall" because of its very slick surface when wet due to the growth of fine seaweed (Clark 1977:53; Wiegel 2008:17, 27). It forms the boundary of Kūhiō Beach's Diamond Head basin. The beach sand has been further supplemented several times, including through off-shore dredging ca. 2000 (Wiegel 2008:19).

Photo 7. Lili'uokalani Pier, ca. 1890-1934. Hawai'i State Archives..

SHORELINE CHANGES

The Kūhiō Beach sector has seen extensive modification over the past century and a half. A comparison of the historical and contemporary coastlines shows that the present project area is entirely within beach that has been added since ca. 1880s (Figure 20). Nineteenth-century maps of the Waikīkī coastline show that this sector contained the mouth (*muliwai*) of Ku'ekaunahi Stream. Ku'ekaunahi Stream ceased to flow in the 1920s after it was cut off from the upland waterways by the Ala Wai Canal.

Shore structures built along the Kūhiō Beach sector shoreline are summarized in Table 9. The earliest of these was a bridge or causeway built along Kalākaua Avenue at the entrance to Kapi'olani Park. Subsequent structures include Lili'uokalani Pier (removed in 1934), a retaining wall along Kalākaua Avenue (possibly removed in 1972), and the structures of the Kūhiō groin complex, which include two shore-parallel seawalls enclosing a protected swimming area supplemented by groins. The most prominent of these groins is the Kapahulu Storm Drain at the Diamond Head end of the complex.

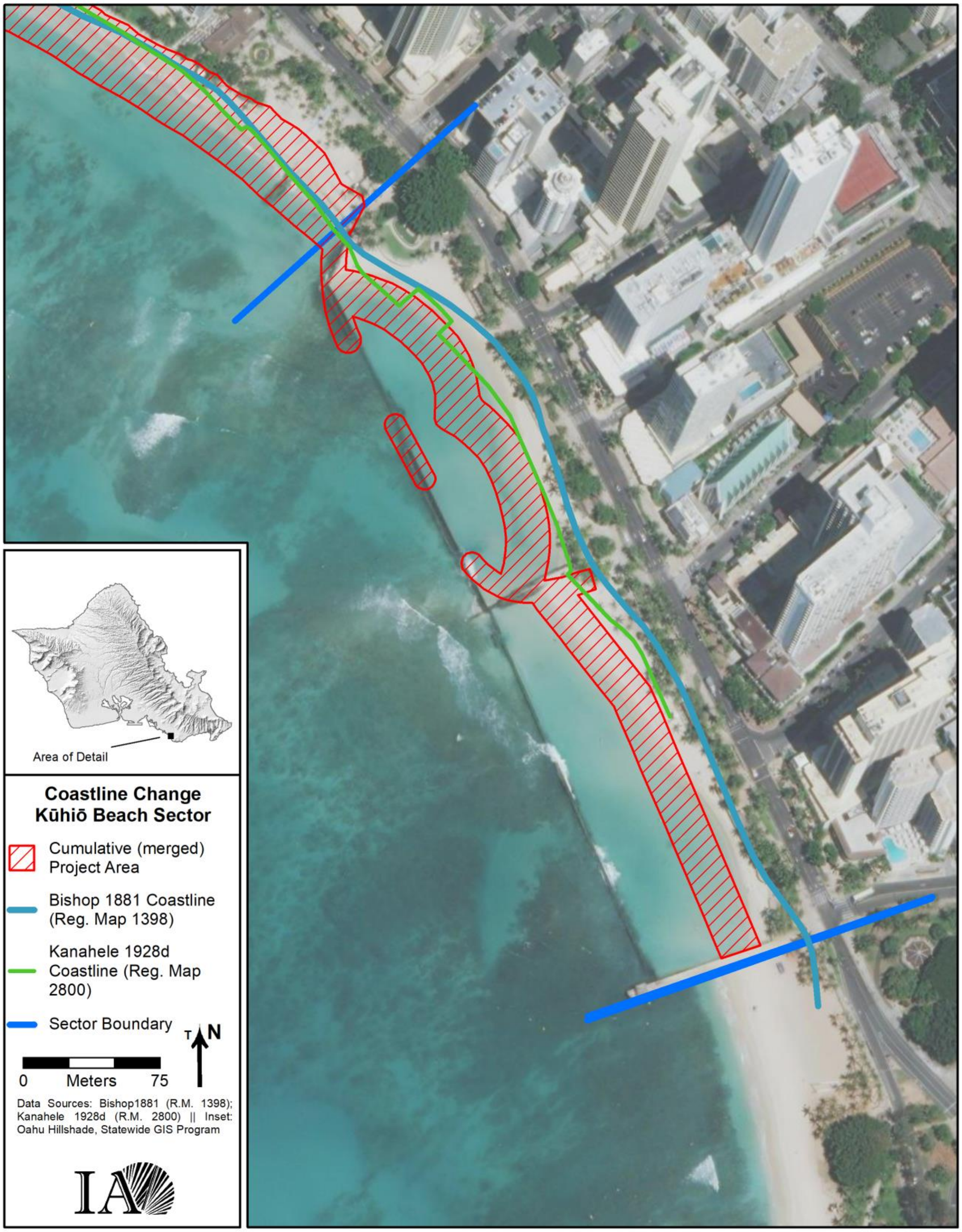


Figure 20. Historical coastlines in the Kūhiō sector.

Table 9. Seawalls and Groins within the Kūhiō Beach Sector.

Year Built	Year Demolished	Description	Length	Location	Reference
ca. 1880	1972?	bridge/causeway	?	Kapiʻolani Park entrance	Wiegel 2008:26
before 1890	1934	Liliʻuokalani (Kūhiō) Pier	130 ft	end of Liliʻuokalani Avenue	Kanahele 1995:136; Wiegel 2008:17
1890	1972?	retaining wall to protect Waikīkī Road (Kalākaua Avenue)	390 ft	Kapiʻolani Park entrance	Wiegel 2008:26, 27
1939	Extant	crib wall	650 ft	ʻEwa portion of Kūhiō Beach; 200 ft from shore	Wiegel 2008:17
1951	Extant	Kapahulu Storm Drain/Groin (“The Wall”)	355	end of Kapahulu Avenue	Clark 1977:53
1953	Extant	retaining wall (“Slippery Wall”)	750	ʻEwa side of Kapahulu Groin	Clark 1977:53; Wiegel 2008:17

KNOWN ARCHAEOLOGICAL SITES

No known archaeological sites are within the Kūhiō Beach sector. Eleven sites, inclusive of 52 burials, have been recorded within 50 m of the project area (Figure 21; Table 10). Site 50-80-14-5859 is a cluster of eight burials near the intersection of Kalākaua and Liliʻuokalani Avenues, which is the location of LCA 1433:1 and a group of nearby *kuleana* awards (LCAs 5FL:1, 1437:1, 1459, and 1468); it is also the location of Liliʻuokalani’s beach residence, Kealohilani. Non-burial sites include Site 50-80-14-5940 (an extensive but discontinuous archaeological deposit along Kalākaua Avenue between Kaʻiulani and Liliʻuokalani Avenues), Site 50-80-14-5941 (historical trash pit), Site 50-80-14-5942 (remnant of light-gauge rail), Site 50-80-14-5943 (low-energy alluvial deposits related to Kuʻekaunahi Stream), and Site 50-80-14-5948 (an exposed seawall that might date to around 1890) (Figure 22).

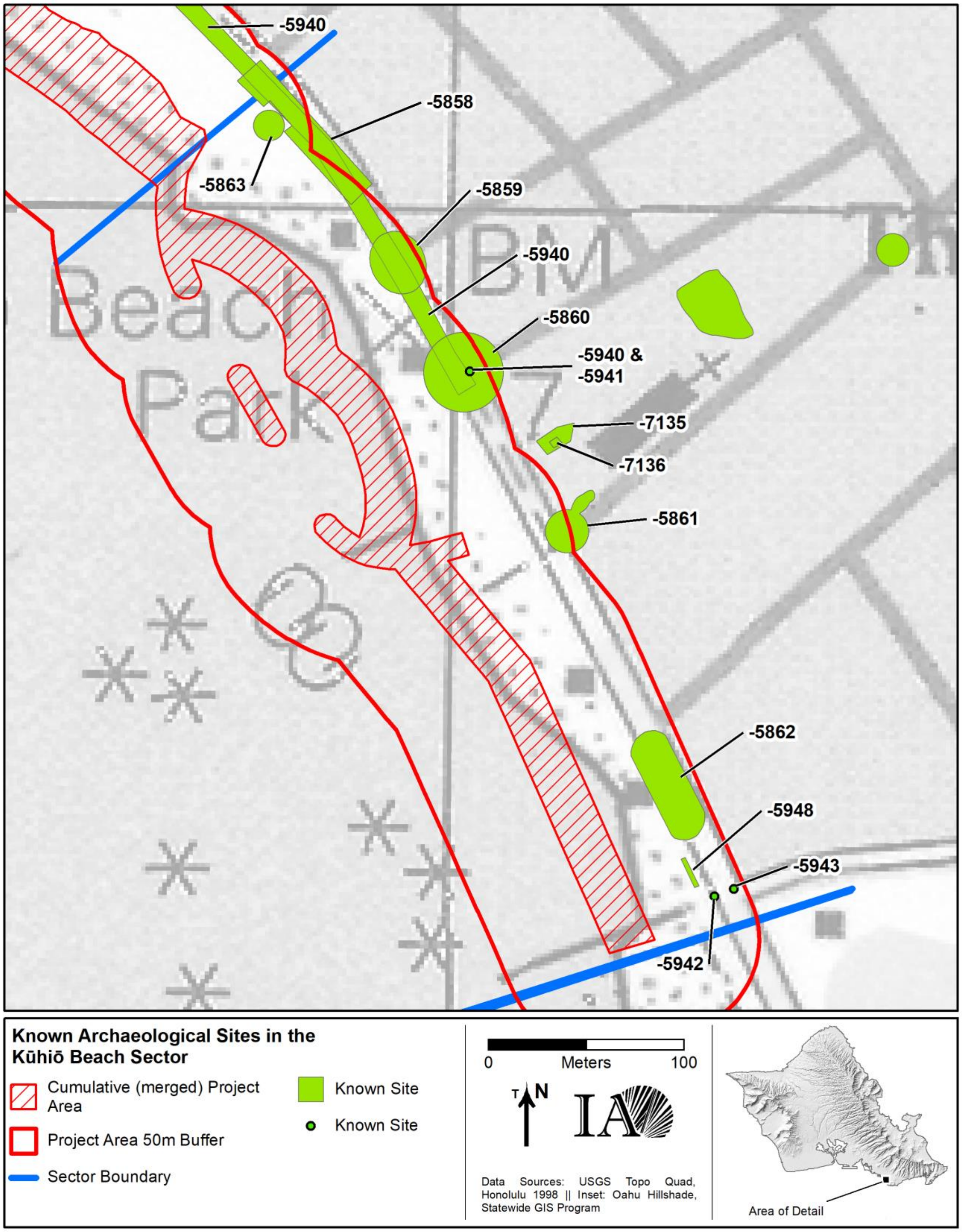


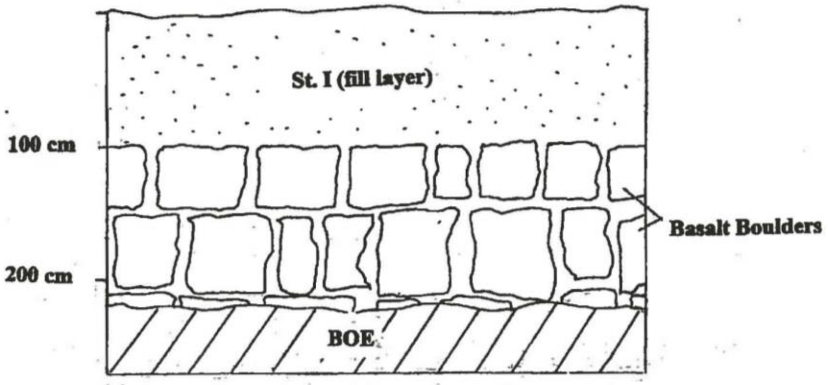
Figure 21. Known archaeological sites within 50 m of the project area, Kūhiō Beach sector.

Table 10. Known Archaeological Sites Within 50 m of the Kūhiō Beach Sector.

SIHP No. (50-80-14-)	Site Description	Reference
5858	8 burials along Kalākaua Avenue between Uluniu and Liliʻuokalani Avenues; buried A-horizon visible in some burials may be extension of Site 5940	Perzinski et al. (2000); Winieski, Perzinski, Shideler et al. (2002); Winieski, Perzinski, Souza et al. (2002)
5859	8 burials near intersection of Kalākaua and Liliʻuokalani Avenues; location of LCA 1433:1, near Queen Liliʻuokalani's beach residence Kealohilani; buried A-horizon visible in some burials may be extension of Site 5940	Perzinski et al. (2000); Winieski, Perzinski, Shideler et al. (2002)
5860	pre-Contact and historical-period deposits, 24 burials near intersection of Kalākaua Avenue and Kealohilani Avenue; buried A-horizon visible in some burials may be extension of Site 5940	Bush et al. (2002); Perzinski et al. (2000); Winieski, Perzinski, Shideler et al. (2002)
5861	7 burials near intersection of Kalākaua and ʻŌhua Avenues, pre-Contact and historical-period features and materials; location of LCA 10677:2; buried A-horizon visible in some burials may be extension of Site 5940	Cleghorn (2001a, 2001b); Perzinski et al. (2000); Winieski, Perzinski, Shideler et al. (2002)
5862	pre-Contact and historical-period deposits; 2 burials along Kalākaua Avenue between Paoakalani and Kapahulu Avenues	Perzinski et al. (2000); Winieski, Perzinski, Shideler et al. (2002); Winieski, Perzinski, Souza et al. (2002)
5863	3 burials at two locations near intersection of Kalākaua and Uluniu Avenues; may be part of Site 5858; 2 additional burials found in the Royal Hawaiian sector	Winieski, Perzinski, Shideler et al. (2002); Winieski, Perzinski, Souza et al. (2002)
5940	very dark-stained sand with diffuse charcoal flecks; contains traditional Hawaiian artifacts, midden, firepits, hearths, other pits; discontinuous, along Kalākaua Avenue between Kaʻiulani and Liliʻuokalani Avenues; burials and other deposits in this area are likely associated with this site; also encountered in the Royal Hawaiian sector	Winieski, Perzinski, Shideler et al. (2002); Winieski, Perzinski, Souza et al. (2002)
5941	historical trash pit overlying Burial 36 of Site 5860	Winieski, Perzinski, Shideler et al. (2002)
5942	remnant of the historical Honolulu Transit light-gauge trolley rail	Winieski, Perzinski, Shideler et al. (2002)
5943	low-energy alluvial sediments associated with now-channelized Muliwai Kuʻekaunahi; near intersection of Kalākaua and Kapahulu Avenues	Winieski, Perzinski, Shideler et al. (2002)
5948	basalt boulder retaining wall exposed near intersection of Kalākaua and Kapahulu Avenues, may be remains of wall built as early as 1890 to protect Waikiki Road (Kalākaua Avenue)	Winieski, Perzinski, Souza et al. (2002)

Figure 29 Photograph of Portion of Historic Sea Wall (State Site 50-80-14-5948), View East.

Historic Sea Wall Remnant (50-80-14-5948) *



Stratum	Depth (cm.)	Description
I	0-100	10YR 4/3 sandy clay loam fill

*** Profile Reconfigured from Field Notes and Photograph Documentation**

Figure 22. Exposed seawall under Kalākaua Avenue (Site 50-80-14-5948). Photograph and profile drawing reproduced from Winieski, Perzinski, Souza et al. (2002:Figure 30).

ROYAL HAWAIIAN SECTOR

The Royal Hawaiian sector is approximately 530 m (1,730 ft.) of shoreline extending from the ʻEwa basin of the Kūhiō groin complex to the Royal Hawaiian Groin. It lies at an inward curve in the Waikīkī coastline that allows the development of a wide sand beach and sits between two of the three former major stream outlets (Kuʻekaunahi and ʻĀpuakēhau) that once flowed into the ocean. ʻĀpuakēhau Stream once flowed into the ocean near the northern edge of the sector (near the present location of the Royal Hawaiian Hotel). This sector is adjacent to the core of traditional and historical activity in Waikīkī. It falls within portions of the traditional *ʻili* of Helumoa and Hamohamo.

The Royal Hawaiian sector contains the beachfront of several prominent Waikīkī hotels, including the Royal Hawaiian Hotel and the Moana Surfrider. The southern end of the sector is the Kūhiō Beach Park and the Waikīkī Beach Center, which contains the Honolulu Police Department's Waikīkī Substation and the Duke Paoa Kahanamoku Statue.

HISTORICAL EVENTS

Notable historical events pertaining to the potential for archaeological resources within the Royal Hawaiian sector are summarized in Table 11. ʻĀpuakēhau Stream was the major outlet of drainages originating in Mānoa and Pālolo Valleys and was the focus of *aliʻi* activity along the Waikīkī shoreline. Waikīkī was the home of Oʻahu ruling chiefs from at least the 1400s, during which Maʻilikūkahi moved the political center of Oʻahu to Waikīkī (Nāpōkā 1986:2; Beckwith 1970:383). From that time, it was the residence, either permanently or part-time, of the high *aliʻi*; the mouth of ʻĀpuakēhau Stream was the focal point of chiefly residence.

Around 1783, Maui king Kahekili landed an invasion force at Waikīkī and encamped at ʻĀpuakēhau. After successfully conquering the island, Kahekili established his residence on the bank of ʻĀpuakēhau Stream (Fornander 1919:VI-2:289; Kanahele 1995:79). After some time on Maui and Hawaiʻi, Kahekili returned to Waikīkī, where he died in 1794.

In 1795, following the death of Kahekili, Waikīkī was the landing for an invading force led by Kamehameha. Although the invasion was successful, it was not until 1803 that Kamehameha moved permanently to Oʻahu (ʻĪʻī 1959:16). He established his capital at Waikīkī and set up a residence, named Kūihelani, at Puaʻaliʻiliʻi on the northwest side of ʻĀpuakēhau Stream just inland of the shore (ʻĪʻī 1959:17; Kanahele 1995:91, 92). The residence would have been between the present-day locations of the Moana and Royal Hawaiian hotels on the west side of ʻĀpuakēhau Stream just inland of the shore (ʻĪʻī 1959:17; Kanahele 1995:91, 92). ʻĪʻī (1959:17) describes the compound, which was surrounded by the houses of his wife Kaʻahumanu and his retainers:

> Kamehameha's houses were at Puaaliilii, makai of the old road, and extended as far as the west side of the sands of Apuakehau. Within it was Helumoa, where Kaʻahumanu *ma* went to while away the time. The king built a stone house there, enclosed by a fence; and Kamalo, Wawae, and their relatives [the Luluka family of John Papa ʻĪʻī] were in charge of the royal residence.

During the Māhele, four LCAs were recorded in or adjacent to the shoreline within the Royal Hawaiian sector (Table 12). An *aliʻi* land award for the coastal portion of Hamohamo was made to Keohokālole (LCA 8452:1). Three *kuleana* awards on the shoreline include LCAs 6616:4 and 7597:3 at the east end of the sector, and LCA 1445:1 at the west end (Figure 23); all three are described as house lots in land claims and testimonies. The *mauka* portion of the Royal Hawaiian sector overlaps slightly with the *makai* edge of these awards.

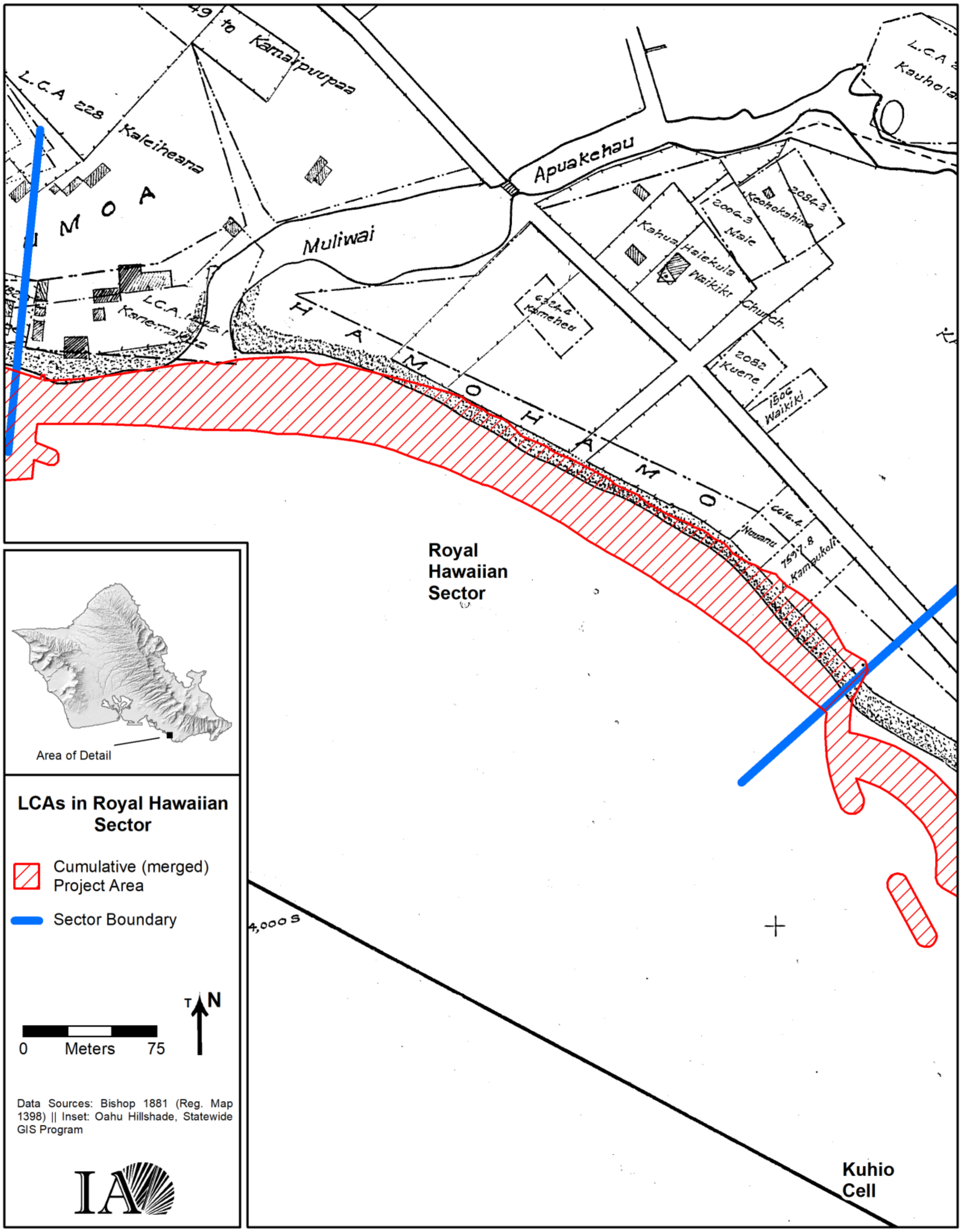
Table 11. Historical Events Pertaining to the Royal Hawaiian Sector.

Year	Event	Reference
1400s	Maʻilikūkahi moved the political center of Oʻahu to Waikīkī	Nāpōkā (1986:2); Beckwith (1970:383)
1500s	ruling chief of Oʻahu Kakūhihewa lived at Ulukou; during his reign, legend of Kalehuawehe and Pīkoi (surfing at what is now called Populars)	Pukui (1983:161-162); Nāpōkā (1986: 2); Kanahele (1995:73)
1600s	Maui chief Kauhi-a-Kama attacked Oʻahu; landed at Waikīkī but was defeated and killed by Oʻahu chief Kaʻihikapu, and then sacrificed at Helumoa Heiau	McAllister (1933:76); Nāpōkā (1986:5); Kanahele (1995:74)
1783	Maui king Kahekili conquered Oʻahu while camping at ʻĀpuakēhau; subsequently established a residence at ʻĀpuakēhau	Fornander (1919:VI-2:289); Kanahele (1995:79)
1794	Kahekili died at his home at Ulukou	--
1803	Kamehameha established his residence Kūihelani at Puaʻaliʻiliʻi	ʻĪʻī (1959:17); Kanahele (1995:91, 92)
ca. 1848	LCAs included an aliʻi award to Keohokālole and three *kuleana* awards	Māhele Book; NT
1859	Liliʻuokalani received the land of Hamohamo from her mother, Keohokālole (who was awarded the land in the Mahele)	Hibbard and Franzen (1986:8)
1866	Kamehameha V purchased property at Helumoa (LCA 1445:1)	Kanahele (1995:132)
1868	Kamehameha V purchased additional property (LCA 228) at Helumoa (inland of LCA 1445:1)	Kanahele (1995:132)
1880	Kalākaua purchased beachfront land at Uluniu and built a house (LCA 6616:4)	Kanahele (1995:133)
1881	James Dodd established the first bathhouse in Waikīkī at Ulukou; called the Long Branch, it was a cottage where bathers could change their clothes for a small charge	Hibbard and Franzen (1986:53); Kanahele (1995:152)
1883	Bernice Pauahi Bishop inherited the lands of Ruth Keʻelikōlani, which included the estate of Kamehameha V (who died in 1872); this included Helumoa, where Bishop and her husband built a house on the former LCA 1445:1	Kanahele (1995:132)
1884	first building constructed at location of present Waikīkī Beach Center; known over the years as Ilaniwai Baths, Wright's Villa, Waikiki Inn, Heinie's Tavern, and Waikiki Tavern	Clark (1977:54); Hibbard and Franzen (1986:51)
1890	240-foot long timber pier on piles constructed off the W.C. Peacock home (at the subsequent location of the Moana Hotel); originally called Peacock Pier and subsequently renamed Moana Pier	Wiegel (2008:21)
1899	Prince Kūhiō inherited his beachside property at Uluniu called Pualeilani from his *hānai* mother Kapiʻolani; this was the location of LCA 6616:4	Kanahele (1995:134)

Year	Event	Reference
1901	Moana Hotel opened, Waikīkī's first major hotel; 230-foot long seawall built in front of hotel	Hibbard and Franzen (1986:58-59); Wiegel (2008:21, 26)
1906	cottage-style Seaside Hotel opened	Hibbard and Franzen (1986:62)
1918	concrete wings added to Moana Hotel, doubling hotel's capacity	Hibbard and Franzen (1986:61)
1918	Prince Kūhiō opened his first Pualeilani home to the public (he moved to Liliʻuokalani's Kealohilani property about 1,000 feet to the southeast and built a second Pualeilani home)	Clark (1977:52); Hibbard and Franzen (1986:37)
1925-1926	Royal Hawaiian Hotel built on the site of the former Seaside Hotel; groin built at same time; new seawall built shoreward of old seawall	Wiegel (2008:21, 26)
1927	concrete groin between Moana Hotel and Royal Hawaiian Hotel removed	Wiegel (2008:26)
1930	Royal Hawaiian Groin extended to 368 feet	Wiegel (2008:26)
1931	Moana Pier demolished	Wiegel (2008:21, 26)
1937	Territory acquired Dean's Hotel and Luella Emman's properties to be used for park (present Kūhiō Park)	SSRI (1985:A-15)
1969	21-story Surfrider Hotel opened on the west side of the Moana Hotel	Wiegel (2008:21)

Table 12. LCAs in the Vicinity of the Royal Hawaiian Sector (Based on Bishop 1881).

LCA No.	Grantee	Description/Land Use	Other Reference
1445:1	Kanemakua	house lot	NR Vol. 3, p. 114
6616:4	Nuʻuanu	house lot; later site of Pualeilani, Prince Kūhiō's first beach home	NR Vol. 5, p. 382
7597:3	Anederea Kamaukoli	house lot	NR Vol. 5, pp. 413-415
8452	Analea Keohokālole	*aliʻi* award of Hamohamo, including coastal strip along length of Royal Hawaiian sector (later inherited by Liliʻuokalani)	NR Vol. 5, pp. 567-568



Data Sources: Bishop 1881 (Reg. Map 1398) || Inset: Oahu Hillshade, Statewide GIS Program

Figure 23. Overlay of Bishop's (1881) map showing LCAs in the Royal Hawaiian sector.

In the 19th century, this area became the beachside retreat for the *ali‘i*. Lili‘uokalani received the land of Hamohamo from her mother, Keohokālole, in 1859. Kamehameha V purchased property, including the former LCA 1445:1 at Helumoa, in 1866 on the northwest side of ‘Āpuakēhau Stream. This land was subsequently bequeathed to Bernice Pauahi Bishop, who built a house on the property. Land was purchased at Uluniu (at the southern end of the Hamohamo coastal strip) by Kalākaua and his wife Kapi‘olani, which was later inherited by Prince Kūhiō. Kūhiō built a home he called Pualeilani (see Kūhiō sector section for a description of Kūhiō's second Pualeilani home, located approximately 300 m to the south)

The ‘Āpuakēhau Stream outlet to the ocean transitioned from the focus of Waikīkī's *ali‘i* residences to the heart of the region's hospitality. The Long Branch Bathhouse, where bathers could change their clothes for a small charge, was established in 1881 at Ulukou (Hibbard and Franzen 1986:53). The first building at the location of the present Waikīkī Beach Center, the Ilaniwai Baths, was built in 1884 (Clark 1977:54; Hibbard and Franzen 1986:53).

In 1901, the first major hotel, the Moana, opened on the grounds of W.C. Peacock's home on the south side of the river (Figure 24). The hotel was originally outfitted with a 300-ft-long pier, originally called Peacock Pier, that was a landmark of the Waikīkī shoreline until it was demolished in 1931 (Wiegel 2008:21) (Photo 8). Two concrete five-story wings were added to the original four-story wooden structure in 1918, doubling the hotel's capacity (Hibbard and Franzen 1986:77). Five years after the establishment of the Moana Hotel, the cottage-style Seaside Hotel opened on Bernice Pauahi's property in Helumoa.

One of the earliest known seawalls in Waikīkī was a 230-foot-long seawall built ca. 1901 in front of the Moana Hotel (Hibbard and Franzen 1986:58-59; Wiegel 2008:21, 26). A concrete groin reportedly built between the Moana Hotel and Royal Hawaiian Hotel at an unknown date had been removed by 1927 (Wiegel 2008:26). The Moana Groin was a concrete wall built into the ocean on the Diamond Head side of ‘Āpuakēhau Stream sometime between 1906 and 1907 (see Photo 8); it was removed in 1927 (Kanahele 1928c; Wiegel 2008:26) (Photo 8).

The 21-story Surfrider Hotel opened on the western side of the Moana Hotel in 1969 (Wiegel 2008:21); the original Moana Hotel has been replaced by a newer building, and the Moana and Surfrider today operate as a single establishment called the Moana Surfrider[8].

Construction of the Royal Hawaiian Hotel on the grounds of the former Seaside Hotel began in 1925 and the hotel opened in 1927. The distinctive six-story building, with its pink-colored stucco concrete façade, contributed to the coastline's growing allure as a glamorous tourist destination. The hotel continues to operate in its original building. According to Hibbard and Franzen (1986:95):

> The 'pink palace' towered over its neighbors and had a majestic aura new to Waikīkī. Sheer massiveness, capped by a central tower that soared 150 feet above the street, enabled the Royal Hawaiian to join the Moana in dominating the beach's palm-filled skyline. Furthermore, its four hundred rooms, each with a bath, balcony, and view of either mountains or ocean, almost doubled the guest capacity of Waikiki.

A second seawall was built shoreward of the old seawall during the construction of the Royal Hawaiian Hotel ca. 1925-1927, and the 170-foot-long Royal Hawaiian Groin was added west of the hotel in 1927. The groin was extended to a length of 368 feet in 1930 and was substantially rebuilt in 2020 (Morrison 2020; Wiegel 2008:21, 26).

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[8] The full name of the hotel is Moana Surfrider, A Westin Resort & Spa, Waikīkī Beach.

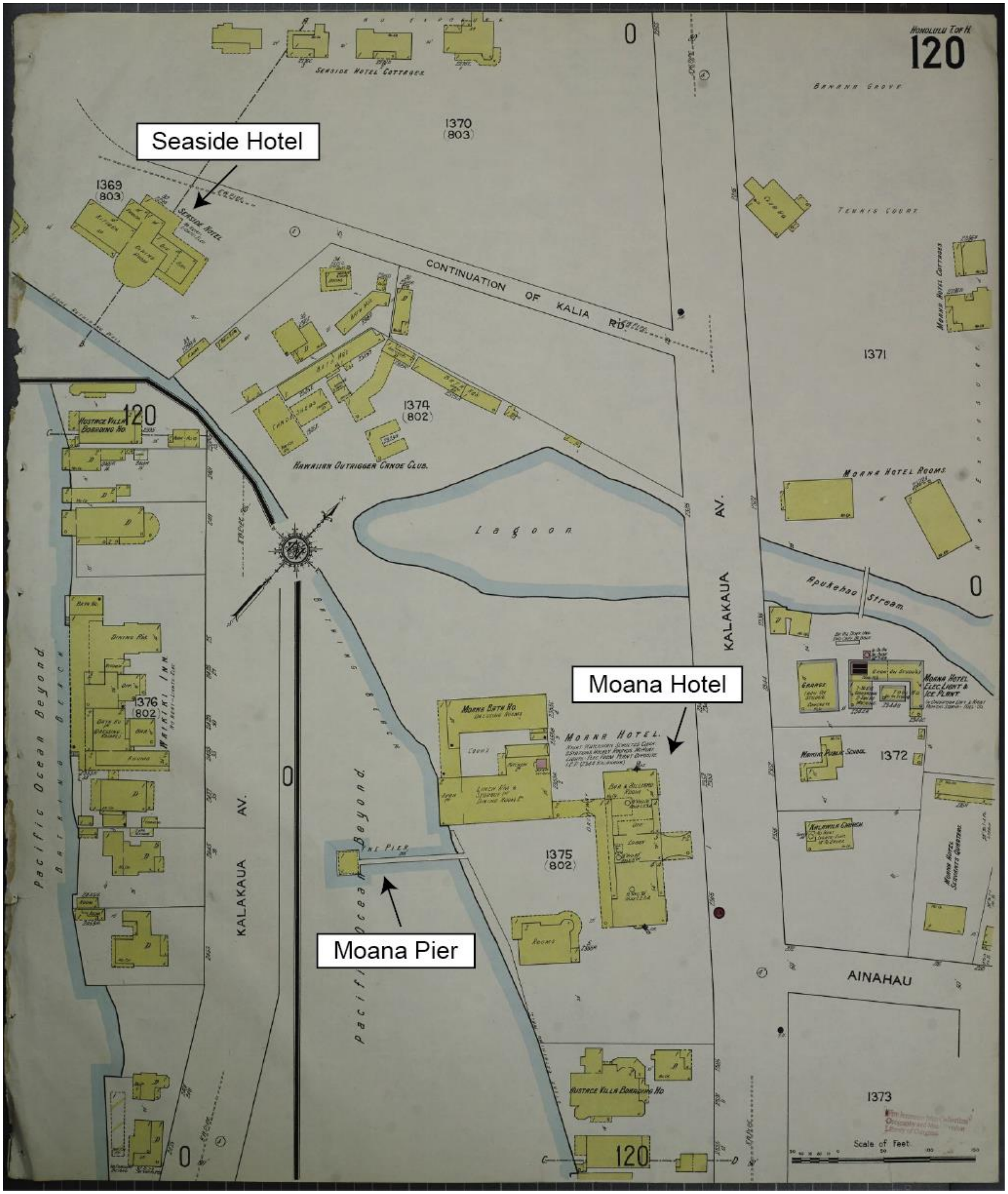


Figure 24. A 1914 Sanborn Fire Insurance map showing the location of the Moana Hotel and pier. The Seaside Hotel is also visible at the upper left.

Photo 8. View of the Moana Groin (foreground) and Moana Pier (midground), taken sometime between 1906 and 1920. Hawai‘i State Archives (Call No. PP115-12-003).

The Waikiki Tavern was operating on the Diamond Head-end of the Royal Hawaiian sector by the 1920s, at which time it was known as the “only place other than hotel dining rooms [along Kalākaua Avenue] where a person could obtain a meal” (Hibbard and Franzen 1986:117). The Waikiki Tavern was demolished in 1960 (Clark 1977:54). Kūhiō Beach Park, which occupies the southern portion of the sector, was dedicated in 1940 (Clark 1977:52).

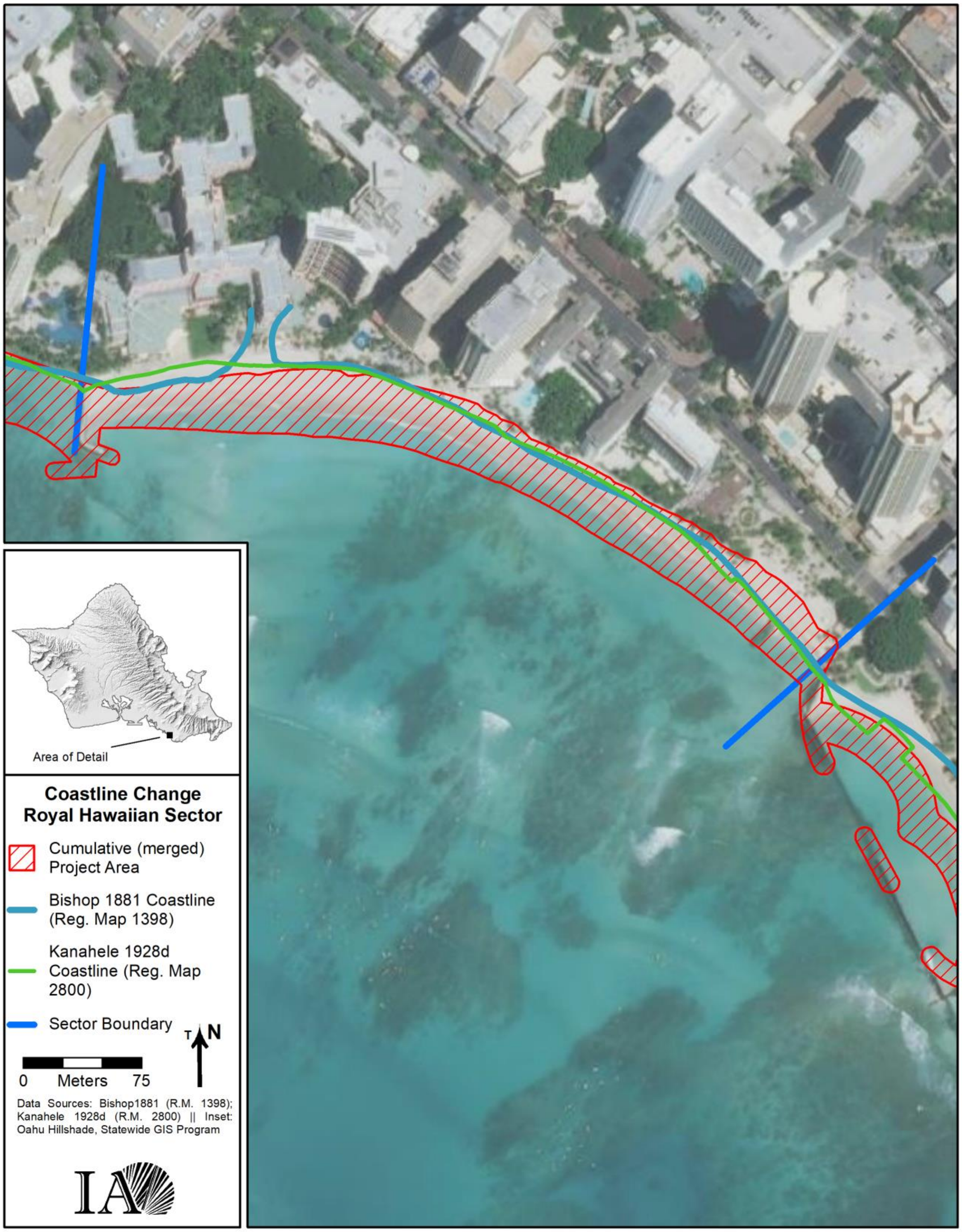
SHORELINE CHANGES

A comparison of the historical and contemporary shorelines within the Royal Hawaiian sector shows that several shoreline structures were built during the early 20th century (Table 13) and that the beach has expanded considerably since ca. 1880s (Figure 25), especially on the ‘Ewa side in front of the Royal Hawaiian Hotel. This sector was the location of the mouth (*muliwai*) of ‘Āpuakēhau Stream. Based on historical photographs, the stream mouth was nearly blocked by sand by the end of the 19th century (e.g., Wiegel 2008:Figure 2); the stream was made obsolete by the construction of the Ala Wai Canal in the 1920s.

The earliest shoreline structures was a seawall built in front of the Moana Hotel in 1901; it was followed by a second seawall in front of the Royal Hawaiian Hotel in 1925-1926. A groin between the Moana and Royal Hawaiian Hotel was demolished in 1927. The Royal Hawaiian Groin, built in 1927, was substantially rebuilt in 2020 but remains a prominent feature of the Waikīkī shoreline.

Table 13. Seawalls and Groins within the Royal Hawaiian Sector.

Year Built	Year Demolished	Description	Length	Location	Reference
1901	Extant?	seawall	230 ft.	in front of Moana Hotel	Hibbard and Franzen (1986:58-59); Wiegel (2008:21, 26)
?	1927	Moana Groin; concrete	?	between Moana Hotel and Royal Hawaiian hotels	Wiegel (2008:26)
1925-1926	Extant	seawall (shoreward of old seawall)	?	in front of Royal Hawaiian Hotel	Wiegel (2008:21, 26)
1927	Extant	Royal Hawaiian Groin	170 ft. (extended to 368 ft. in 1930; substantially rebuilt in 2020)	in front of Royal Hawaiian Hotel	Morrison (2020; Wiegel (2008:21, 26)



Data Sources: Bishop1881 (R.M. 1398); Kanahele 1928d (R.M. 2800) || Inset: Oahu Hillshade, Statewide GIS Program

Figure 25. Historical coastlines, Royal Hawaiian sector.

KNOWN ARCHAEOLOGICAL SITES

One archaeological site overlaps with the Royal Hawaiian sector with two sites and one burial adjacent to the inland margin (Table 14; Figure 26). At least 33 burials have been identified within approximately 50 m of the project area. Twenty-four burials (Site 50-80-14-1974) were identified on the grounds of the Moana Hotel, along with a possible pre-Contact archaeological deposit extending under both wings of the hotel. Site 50-80-14-5863, which contains two burials, overlaps with the sector boundary. This site is within LCA 6616:4, which later became the residence of Kalākaua and Kapiʻolani and which was eventually developed by Prince Kūhiō as his beachside home Pualeilani. Non-burial sites include Site 50-80-14-5940 (an extensive archaeological deposit), Site 50-80-14-7068 (a historical-period archaeological layer), and Site 50-80-14-7069 (a historical-period trash pit). Site 50-80-14-9980 was assigned to numerous *ʻulu maika* collected during the construction of the Royal Hawaiian Hotel (see Kanahele 1995:99).

Investigations by Simons et al. (1991) on the grounds of the Moana Hotel revealed layers of historical-era fill overlying discrete archaeological deposits dating to the post-Contact and pre-Contact periods. Two radiocarbon dates were obtained from the unidentified charcoal recovered from the pre-Contact layer. One sample from an ash lens produced a determination of 350±90 BP, which calibrates to AD 1408-1684, AD 1735-1803, and AD 1930-1950. Another charcoal specimen from an unspecified context produced a determination of 300±130 BP, which calibrates to AD 1424-1895 and AD 1903-1950. Because the Moana Hotel has occupied the site since 1901, the post-1900 probability ranges can be discarded for both dates. Archaeological features included firepits, post molds, unidentified pit features, animal burials (cat), and planting pits. The cat burials were thought to be associated with the Peabody family residence, and the planting pits were associated with early 20th century use of the property.

Burial 3 of Site 50-80-14-5863 was found at the *mauka* edge of the Royal Hawaiian sector, near the Waikīkī Police Station. Burial 3 is a modified human femur fragment moved by grading activities. The femur fragment was found to have been "deeply scored and snapped by a sawing or cutting instrument just below the lesser trochanter at the pectineal line" and thought to have been used in the manufacture of fish hooks (Winieski, Perzinski, and Souza et al. 2002:25). The original location of the femur fragment (prior to disturbance by grading) could not be identified and it was recovered for reburial at a dedicated off-site interment location.

The Moana Hotel, which opened in 1901 on the site of the former W.C. Peabody home as the first major hotel in Waikīkī, has been designated as Site 50-80-14-9901. The Moana Hotel was placed on the National Register of Historic Places (NRHP) in 1972.

Also within this sector is a portion of a buried seawall its Diamond Head end, immediately west of the hula mound. The buried seawall was observed by SHPD staff[9] (Nick Belluzzo, personal communication 2016) and is likely associated with a structure illustrated on Kanahele's (1928c) map of Waikīkī (Photo 9; Figure 27). A recent news article (Davis 2017) identifies the exposed concrete structure as part of the foundation of the Waikiki Tavern.

Helumoa Heiau was placed by Thrum (1906:44) at ʻĀpuakēhau. Based on a field inspection, Hammatt and Shideler (2007c:33) suggest its likely location as "the prominent point just on the Sheraton side of the Royal Hawaiian Hotel."

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[9] The wall was examined by SHPD staff in 2016 but does appear to have been assigned an SIHP number.

Table 14. Known Recorded Archaeological Sites Within 50 m the Royal Hawaiian Sector.

SIHP No. (50-80-14-)	Site Description	Reference
1974	24 burials (large cluster in Banyan Court on *makai* side of hotel) plus pre-Contact and historic-period deposits; exposed during renovations of Moana Hotel in 1988; BM Site 50-Oa-A4-27	Simons et al. (1991)
3705	burials eroding from sand dune in front of 1969 Surfrider Hotel, observed in 1964; specific location unknown; BM Site 50-Oa-A4-24	Bishop Museum site files; referenced in Davis (1989:24-25), Groza et al. (2010:54)
5857	1 burial on Kalākaua Avenue between Kaʻiulani and Liliʻuokalani Avenues; falls with Site 5940 deposit	Perzinski et al. (2000); Winieski, Perzinski, Shideler et al. (2002)
5863	2 burials *makai* of Kalākaua Avenue between Kaʻiulani and Uluniu Avenues; location of LCA 6616:4, later the residence of King Kalākaua and eventually Prince Kūhiō who called it Pualeilani; 3 additional burials found in Kūhiō sector	Winieski, Perzinski, Souza et al. (2002)
5940	very dark-stained sand with diffuse charcoal flecks; contains traditional Hawaiian artifacts, midden, firepits, hearths, other pits; discontinuous, along Kalākaua Avenue between Kaʻiulani and Liliʻuokalani Avenues; burials and archaeological deposits in this area are likely associated with this site; also encountered in Kūhiō Beach sector	Winieski, Perzinski, Shideler et al. (2002); Winieski, Perzinski, Souza et al. (2002)
7068	intact historical-period archaeological layer; on north side of Moana Hotel Diamond Head Tower, along Kalākaua Avenue; possibly an extension of Site 5940	Thurman et al. (2009)
7069	historical-period trash pit; just inland of seawall at Moana Hotel Diamond Head Tower	Thurman et al. (2009)
9980	several *ʻulu maika* found during construction of Royal Hawaiian Hotel in 1925, specific locations unknown; possibly associated with the sports field Kahuamokomoko	reported in Kanahele (1995); numerous reports
--	5 burials found during construction of Royal Hawaiian Hotel in October 1923, specific location unknown; "…five individuals from Helumoa, Waikiki, Oahu were collected by Kenneth P. Emory. Museum information indicates they were victims of the 1853 smallpox epidemic" (NPS 1998:4278)	reported in Hammatt and Shideler (2007c:59) and NPS (1998:4278)
--	human mandible fragment identified on grounds of Moana Surfrider Hotel in 1992	Pietrusewsky (1992)
--	portion of historic seawall; buried section extending northwest from inland end of Kūhiō groin complex's ʻEwa basin; possibly associated with Waikiki Tavern	Nick Belluzzo, personal communication (2016); Davis (2017); Kanahele (1928c)

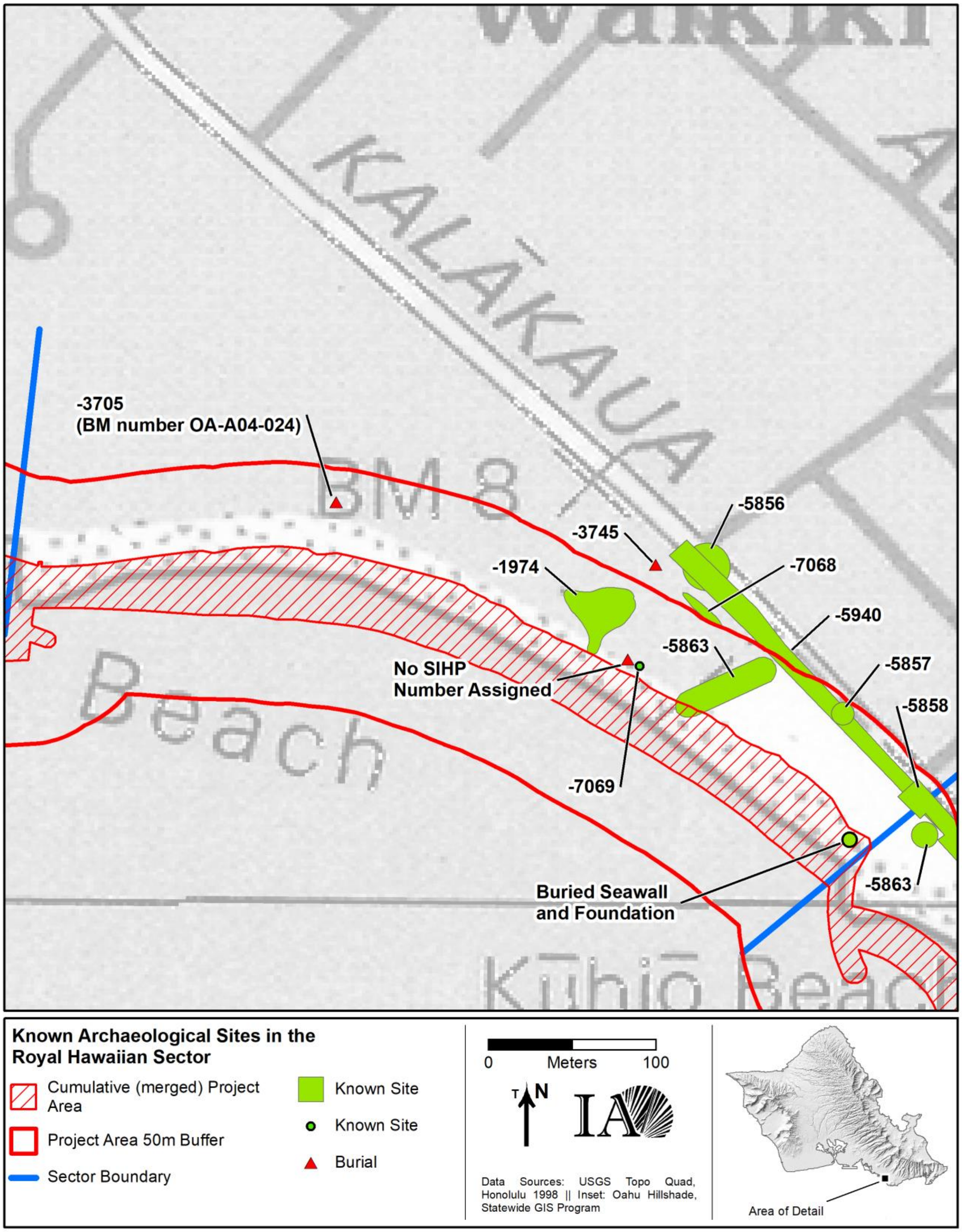

Figure 26. Known archaeological sites within 50 m of the project area, Royal Hawaiian sector.

Photo 9. Buried seawall in beach sand at south end of Royal Hawaiian sector (source: State GIS; photo courtesy of Nick Belluzzo).

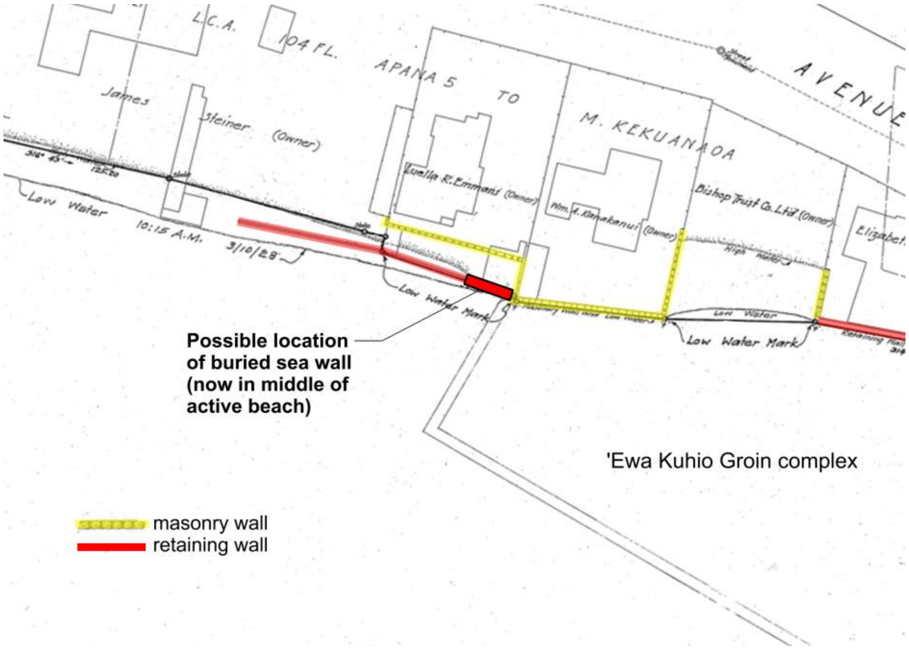

Figure 27. Portion of the Kanahele (1928c) map of Waikīkī, showing the possible location of the wall section exposed in Photo 9.

HALEKŪLANI SECTOR

The Halekūlani sector consists of approximately 440 m (1,450 ft.) of shoreline extending from the Fort DeRussy outfall groin to the Royal Hawaiian groin. This sector includes Halekūlani Beach, formerly known as Gray's Beach. The south-facing shoreline is a mix of seawalls and discontinuous, small, narrow sand beaches that front a fully developed urban landscape. Prior to modern development, the Halekūlani sector lay between two drainages, ʻĀpuakēhau to the east (in the Royal Hawaiian sector) and Kawehewehe to the west (along the boundary with the Fort DeRussy sector). Kawehewehe was the outflow from the large fishpond complex of Kālia, the inland area of present Fort DeRussy. This sector comprises portions of the traditional *ʻili* of Helumoa and Keōmuku.

Like the Royal Hawaiian sector, the Halekūlani sector contains the beachfronts of major Waikīkī hotels. From south to north, the hotels are the Sheraton Waikīkī, the Halekūlani Hotel, and the Outrigger Beach Waikīkī Beach Resort.

HISTORICAL EVENTS

Notable historical events with relevance for archaeological resources within the Halekūlani sector are summarized in Table 15. This sector was immediately ʻEwa of the mouth of ʻĀpuakēhau Stream (within the Royal Hawaiian sector), which served as the seat of the Waikīkī chiefs as early as the mid-1400s.

ʻĪʻī (1959:15) records that the area near the mouth of Kawehewehe Stream became the residence of the Luluka family, of which he was a member, when they moved to Oʻahu in the company of Kamehameha who was preparing for the invasion of Kauaʻi around 1803. ʻĪʻī's uncle was a member of the royal court, and members of the Luluka family were responsible for the royal residence at Puaʻaliʻiliʻi at Helumoa (in the Royal Hawaiian sector).

Twelve LCAs were awarded along the shoreline of the Halekūlani sector (Table 16). An *aliʻi* award of Keōmuku was made to Samuel Kuluwailehua (LCA 1281:1). Unlike the other sectors in the maintenance program, the shoreline within the Halekūlani sector is almost completely encompassed by *kuleana* awards (Figure 28). These awards are primarily house lots, although the Māhele claims indicate farming was also undertaken.[10]

In 1907, a small hotel called the Hau Tree opened in the former home of Robert Lewers. The Hau Tree, which became the Halekūlani in 1917, continued to grow in size and eventually incorporated the neighboring resort property Gray's-By-the-Sea. The Gray's-By-the-Sea boarding house was established by La Vancha Maria Chapin Gray in a two-story house built by Minnie Gilman (Mrs. Joseph A. Gilman) in 1903 and is the source of the name "Gray's Beach" sometimes used for this area (Clark 1977:56). A new Halekūlani Hotel was opened in 1932; the hotel was completely rebuilt in the 1980s to accommodate over 600 rooms.

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[10] By the end of the century, however, and in some cases, within 30 years, Hawaiian landowners were gone, replaced by people with names like Brown, Davies, Castle, Lewers, Robinson, Macfarlane, and Damon (Wall 1893).

Table 15. Historical Events Pertaining to the Halekūlani Sector.

Year	Event	Reference
ca. 1400s	area near mouth of ʻĀpuakēhau Stream (Royal Hawaiian sector) becomes chiefly center for Oʻahu rulers	Beckwith (1970:383)
ca. 1803	Kawehewehe became residence of the Luluka family when they moved to Oʻahu as part of Kamehameha's entourage	ʻĪʻī (1959:17)
1912	Gray's by the Sea boarding house established by La Vancha Maria Chapin Gray	Clark (1977:56)
1926-1929	eight groins built between Royal Hawaiian Hotel and Fort DeRussy	Wiegel (2008:26)
1929	Charles Kimball acquired Gray's by the Sea and adjacent land and established Halekūlani Hotel	Clark (1977:56)
1931	new Halekūlani Hotel opened	Hibbard and Franzen (1986:103)
1932	aerial photograph shows five piers or groins	Wiegel (2008:Figure 19)

Table 16. LCAs in the Vicinity of the Halekūlani Sector (from Bishop 1881).

LCA No.	Grantee	Description/Land Use	Other Reference
922	Okuu	house lot	NR Vol. 2, p. 536
1281:1	Samuel Kuluwailehua	*aliʻi* award of Keōmuku, including coconut grove and fishery	NR Vol. 3, p. 54
1379:1	Kapule	fenced house lot with two houses	NR Vol. 3, p. 93
1380	Kahaaheo	taro patch	NR Vol. 3, p. 93
1385	Kaelemakule	house lot	NR Vol. 3, pp. 94-95
1388:1	Kahaleuliuli (also Kahelehulihuli)	house lot and *kula*	NR Vol. 3, p. 95
1508	Kahouluolu (also Kahoouluulu)	house lot	NR Vol. 3, p. 139
1511	Kanae	fenced house lot	NR Vol. 3, p. 140
1512:1	Nalaweha	partly fenced house lot	NR Vol. 3, p. 140
1513:1	Wailehua	fenced house lot	NR Vol. 3, p. 140
1782:3	Kahope	house lot	NR Vol. 3, p. 252
2126	Keoho (also Keaho)	house lot, pond, two rows and some hills of taro, section of irrigation ditch	NR Vol. 3, p. 365

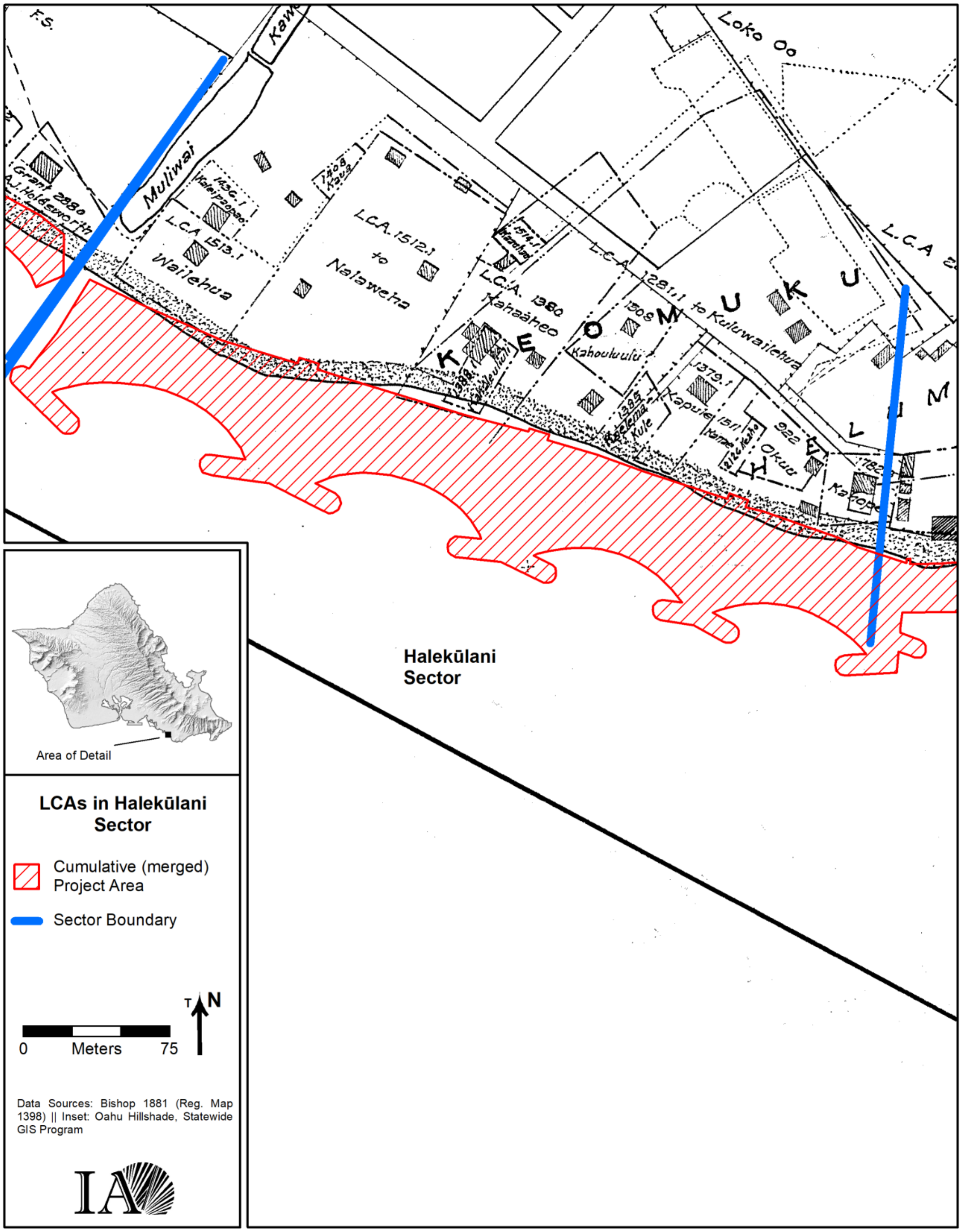

Figure 28. Overlay of Bishop’s (1881) map showing LCAs in the Halekūlani sector.

The first seawalls in this vicinity were built in front of the S.C. Wilder home and Gray's By-the-Sea in 1913-1914, and in 1916 a 1,150-foot-long seawall was built along the shoreline in front of Fort DeRussy (Wiegel 2008: 26, Figure 18). The seawalls were constructed after offshore dredging in front of Fort DeRussy reportedly destabilized the coastline (Wiegel 2008:11). Kīnaʻu Wilder (quoted in Wiegel 2008:11) describes the drastic changes of that period to the shoreline:

> [After the dredging, the] beach at Waikiki was never the same. Instead of the reef holding the sands of the beach and preventing them from being carried out by the changing tides, the sand was swept through the hole in the reef, never to return. What had been a glorious beach – which no other beach on earth could touch – was nothing. Property owners lost anywhere from ten to thirty feet of their frontage. Everyone was forced to put up seawalls to keep from losing their houses as well. Instead of running from the grass right out to the ocean, we had to go down slippery steps to a miserable little strip of sand which, during certain months, was non-existent. At times I could jump from our seawall right into the water…

According to Wiegel (2008:26), eight groins were built "between [the] Royal Hawaiian Hotel and Fort DeRussy" between 1926 and 1929. Four groins are said to have been removed from this area in 1970 (Wiegel 2008:22). An aerial photograph taken in 1932 (Photo 10) shows five groins in the vicinity. The ʻEwa groin may be the original Fort DeRussy Groin at the boundary of the Halekūlani and Fort DeRussy sectors; the original Fort DeRussy Groin, built in 1917, was 70 feet long (Wiegel 2008:22).

Photo 10. A 1932 aerial photograph showing groins along the shoreline of the Halekūlani sector (source: Wiegel 2008:Figure 19).

SHORELINE CHANGES

The Halekūlani sector contains minimal beach, with sections in front of the Sheraton and Halekūlani Hotels fronted by concrete retaining walls. Several shoreline structures were built during the early 20th century (Table 17) and the small beach in front of the Outrigger Reef Resort developed after ca. 1881 (Figure 29). This is the former location of the outlet of a small waterway identified on Bishop's (1882) map as Kawehewehe (Bishop 1882), which may have drained the Kālia fishponds. This waterway, which may have been a small stream or artificial watercourse, may have been filled along with the Kālia fishponds in conjunction with the construction of Fort DeRussy.

Seawalls were built as early as 1914 after dredging offshore of Fort DeRussy initiated nearby beach erosion. Eight groins were built in this vicinity in the 1920s, four of which were removed in 1970.

Table 17. Seawalls and Groins in the Halekūlani Sector.

Year Built	Year Demolished	Description	Length	Location	Reference
1914	Extant?	seawall	290 ft.	in front of S.C. Wilder home and Gray's-By-the-Sea	Wiegel (2008:26)
1914?	Extant?	seawall	430 ft.	in front of Gray's Hotel	Wiegel (2008:26)
1914?	Extant?	seawall	225 ft.	Diamond Head of Gray's Hotel	Wiegel (2008:26)
1926-1929	1970	eight groins; four said to have been removed in 1970	various	between Royal Hawaiian Hotel and Fort DeRussy	Wiegel (2008: 22, 26)

KNOWN ARCHAEOLOGICAL SITES

No archaeological sites are known to be within the Halekūlani sector, with one site abutting a portion of the inland sector boundary (Table 18; Figure 30). Site 50-80-14-9957 was mapped and excavated in 1981-1982 during renovations to the Halekūlani Hotel (Davis 1984). A major portion of the site lies just inland of the seawall at the southwest corner of the hotel property (now occupied by the ʻEwa hotel tower). Murabayashi and Dye (2014:10-11) summarize the results:

> While most of the property was disturbed by recent construction, an area along the beach and an isolated area in the center of the property remained relatively intact. Excavations uncovered 32 features, including human skeletal remains, a dog burial, postholes, trash pits, privies, and several pits. Most of the trash pits contained bottles, ceramics, and metal. Although the area had been heavily disturbed by the recent construction, significant cultural materials dating to the late 1800s remained intact.

Additional archaeological finds include human skeletal remains recovered on the grounds of the Sheraton Waikīkī. The skeletal remains of eight individuals were collected in 1970 (NPS 1998:4282), and a single female "forearm bone" was collected in 1993 (Hammatt and Shideler 2007c:59).

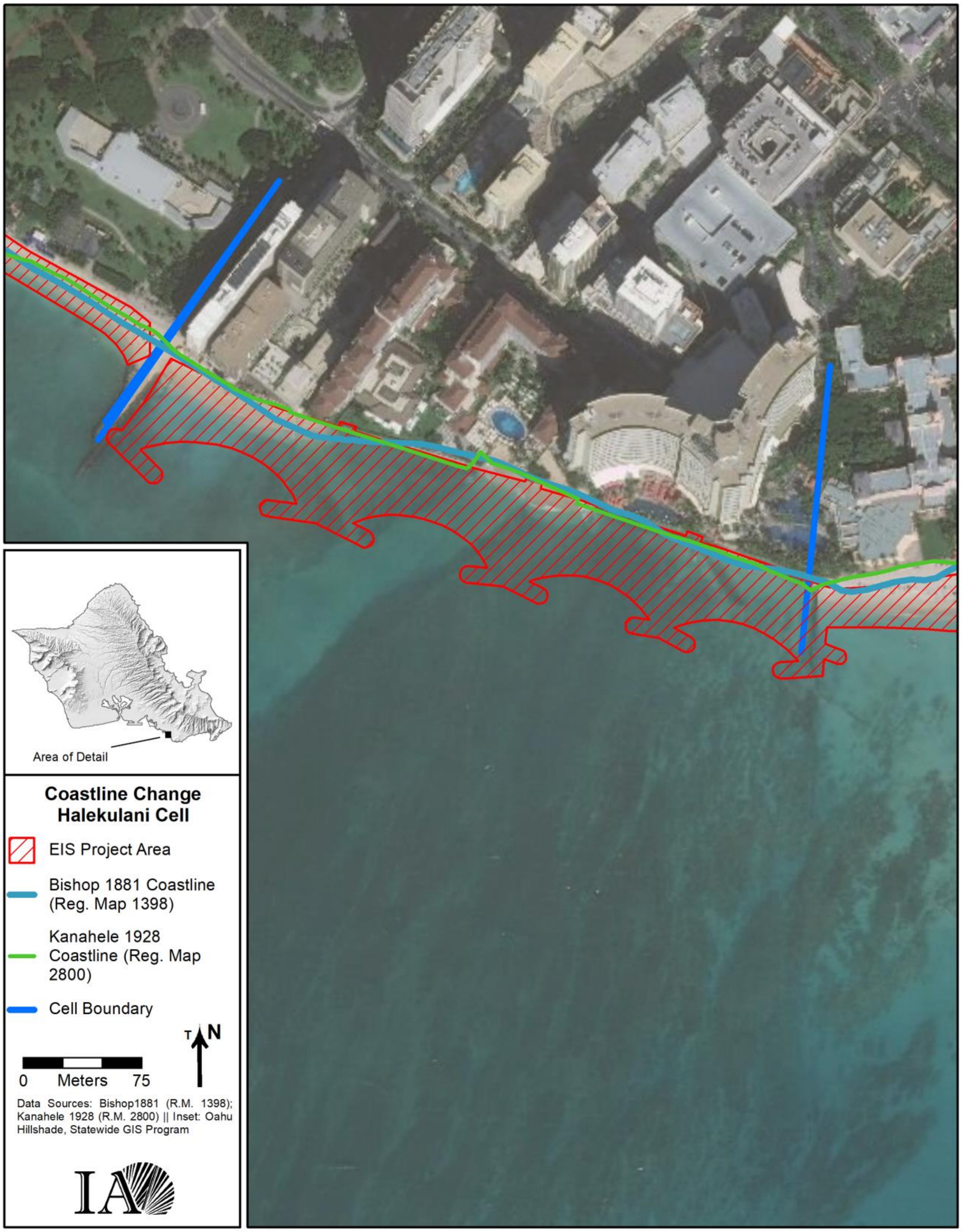

Figure 29. Historical coastlines, Halekūlani sector.

Table 18. Known Archaeological Sites Within 50 m of Halekūlani Sector.

SIHP No. (50-80-14-)	Site Description	Reference
9957	intact archaeological deposit containing animal burials, postholes, trash pits, privies, pits; 4 burials; historical material associated with Robert Lewers residence; site is inland of present seawall (BM Site No. Oa-A4-26)	Davis (1984); Neller (1981)
--	human skeletal remains from eight individuals recovered on the grounds of the Sheraton Waikīkī in 1970 (BM ID No. OA0522)	reported in Hammatt and Shideler (2007c:59) and NPS (1998:4282)
--	human female "forearm bone" recovered on the grounds of the Sheraton Waikīkī Hotel in 1993	reported in Hammatt and Shideler (2007c:59)

FORT DERUSSY SECTOR

The Fort DeRussy sector consists of approximately 510 m (1,680 ft.) of shoreline extending from the Hilton Hawaiian Village pier to the Fort DeRussy outfall groin. The southwest-facing shoreline is a continuous sand beach that fronts a landscaped open space of tended lawn and coconut trees in the Fort DeRussy Armed Forces Recreation Center. Until the early 20th century, Kawehewehe Stream, the outlet for the Kālia fishponds, ran into the sea along the southern edge of this sector. Pi‘inaio Stream entered the sea at a broad delta or estuary approximately 350 m north of the sector, near the southern end of the Ala Wai Boat Harbor. This sector is within the traditional *‘ili* of Kālia.

Today, the Hale Koa Hotel is just inland of the western portion of the sector and the U.S. Army Museum of Hawai‘i, housed in the historic 1914 Battery Randolph, is at the eastern end of the sector. A wide concrete promenade runs along the inland edge of the beach.

HISTORICAL EVENTS

Notable historical events pertaining to the potential for archaeological resources within the Fort DeRussy sector are summarized in Table 19. The shoreline within the Fort DeRussy sector was further removed from the Waikīkī chiefly center at the mouth of ‘Āpuakēhau Stream; nevertheless, this land near Pi‘inaio Stream and the Kālia fishponds was likely associated with noble families.

Like the Halekūlani sector, the Fort DeRussy sector includes portions of Kawehewehe. As noted above, Kawehewehe was known as the residence of the Luluka family, which moved to O‘ahu from Lāhainā with Kamehameha around 1803. The family maintained the royal residence at Pua‘ali‘ili‘i as retainers of Kamehameha (‘Ī‘ī 1959:17).

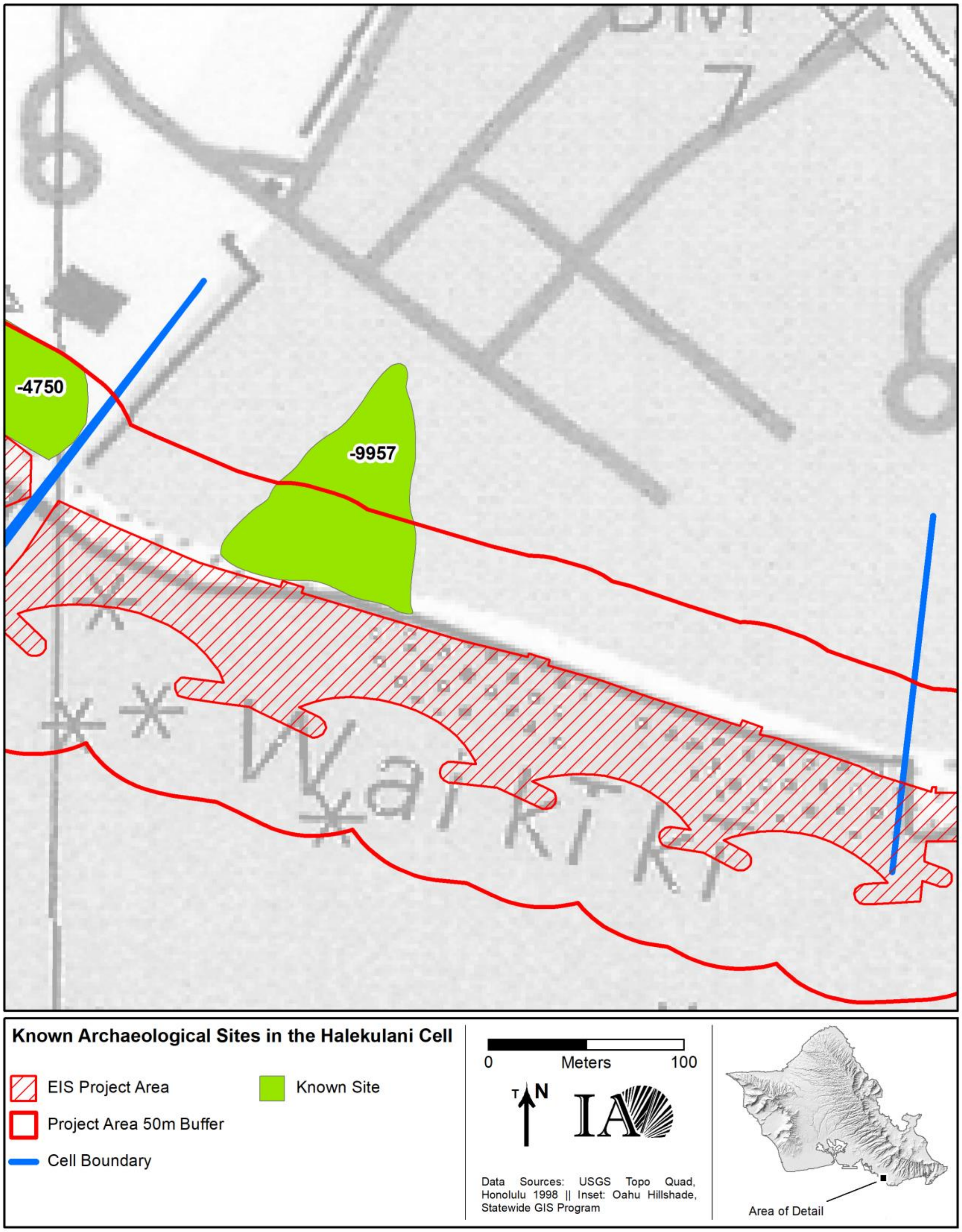

Figure 30. Known archaeological sites within 50 m of the project area, Halekūlani sector.

Table 19. Historical Events Pertaining to the Fort DeRussy Sector.

Year	Event	Reference
ca. 1400s	area near mouth of ʻĀpuakēhau Stream (Royal Hawaiian sector) becomes chiefly center for Oʻahu rulers	Beckwith (1970:383)
ca. 1803	Luluka family established residence at Kawehewehe, when they moved to Oʻahu with Kamehameha; members of family were in charge of the royal residence at Puaʻaliʻiliʻi	ʻĪʻī (1959:17)
1904-1910	U.S. War Department acquired 73 acres of Kalia through purchase, condemnation, and Executive Order	Hibbard and Franzen (1986:79)
1909	Fort DeRussy established; over next two years, Kalia fishponds filled by dredging off-shore reefs and pumping into ponds	Hibbard and Franzen (1986:79); Clark (1977:58)
1910-1914	Batteries Randolph and Dudley constructed as part of Artillery District of Honolulu	Davis (1989:7)
1916	1,150-foot long seawall built along Fort DeRussy shoreline	Wiegel (2008:Figure 18, 26)
1917	70-foot long groin built at east boundary of Fort DeRussy sector	Wiegel (2008:22)
1941	shoreline of Fort DeRussy closed to the public for duration of WWII	Clark (1977:58)
1945	Fort DeRussy beach reopened to public	Clark (1977:58)
1969	Fort DeRussy groin at east boundary lengthened from 70 to 300 feet	Wiegel (2008:22)
1971	rubble-mound groin added to Fort DeRussy groin	Wiegel (2008:22)

During the mid-19th century land division, Kālia, including the large complex of six fishponds inland of the Fort DeRussy sector, was awarded to the high chief Mataio Kekūanaōʻa as LCA 104 FL:6 (Davis 1989:14). Five *kuleana* awards (Table 20) and five land grants (Table 21) were made along the coast (Figure 31). LCA 867:1 to Nihopuu, located at the middle of the sector, was a small house lot at the shore, with separate inland taro patches and an *ʻauwai*; the house lot contained one house surrounded by a wooden fence (Davis 1989:83). LCA 1515:2 to Kaihoolua, seaward of Battery Randolph, was also a fenced house lot (Davis 1989:87). The five land grants were also awarded in the mid-19th century. Grant 2880 to H.J.K. Holdsworth, which is at the southern edge of the sector, overlaps slightly with the project area.

The U.S. Army began to acquire land in the Kālia area in 1904. Extensive dredging of the reef off Fort DeRussy was conducted between 1908 and 1910, with the dredged coral used to infill the Kālia fishponds (Wiegel 2008:10). In 1913, a “deep channel was dredged through the reef in front of Fort DeRussy” to facilitate the arrival of a bargeload of 69-ton guns (Thompson 1985:37). The dredging is said to have contributed significantly to the erosion of beach sand long the Waikīkī shoreline by altering the currents (see discussion in Halekūlani sector section, above).

Battery Randolph was completed and armed by 1914. Battery Dudley, which was adjacent to and northwest of Randolph, was armed in 1916. To protect the remaining beach in front of Fort DeRussy, a 1,150-foot-long seawall was built on the reef in 1916; the area behind the seawall was later infilled with dredged coral to significantly expand the active beach (Wiegel 2008:12). A 70-foot-long box culvert and groin at the Diamond Head edge of the Fort DeRussy sector, originally built in 1917, was lengthened to

300 feet in 1969 and supplemented by a rubble mound groin ca. 1971 (Wiegel 2008:22). Photo 11 is a 1919 aerial image of the batteries and seawall, which is estimated to lie just seaward of the present promenade.

Both batteries were decommissioned in 1944, and Battery Dudley was demolished in 1970 (see Davis 1989:21). Battery Randolph has housed the U.S. Army Museum of Hawai‘i since 1976. The Artillery District of Honolulu (Site 50-80-14-1382), which includes Battery Randolph, was listed on the NRHP in 1984.

Table 20. LCAs in the Vicinity of the Fort DeRussy Sector (from Bishop 1881).

LCA No.	**Grantee**	**Description/Land Use**	**Other Reference**
867:1	Nihopuu	fenced house lot, taro patches, and *‘auwai* (taro patches and *‘auwai* in inland portion)	NR Vol. 3, p. 531
1409:1	Nakoko	partly fenced house lot	NR Vol. 3, pp. 100-102
1410	Paele	unfenced house lot	NR Vol. 3, p. 101
1515:2	Kaihoolua (also Kaihuolua)	house lot, four *lo‘i*, a *kula*, and a fishery	NR Vol. 3, pp. 140-141
2511	Alapai (also Alapa)	house lot and coconut grove	NR Vol. 3, p. 531

Table 21. Land Grants in the Vicinity of the Fort DeRussy Sector (from Bishop 1881).

Grant No.	**Grantee**	**Year**	**Acres**	**Other Reference**
2607	Francis Spencer	1859	1.4	Vol. 12, pp. 443-444
2636	George McLean	1859	0.4	Vol. 12, pp. 501-502
2739	George McLean[*]	1860	1.1	Vol. 13, pp. 133-134
2880	H.J.K. Holdsworth[**]	1862	0.45	Vol. 13, pp. 415-416
2997	Elisha H. Allen	1865	0.88	Vol. 14, pp. 49-50

[*] Bishop’s (1881) map assigns the grant to “C. Afong/G. Mclean.”

[**] Bishop’s (1881) map assigns the grant to “R.H. Holdsworth.”

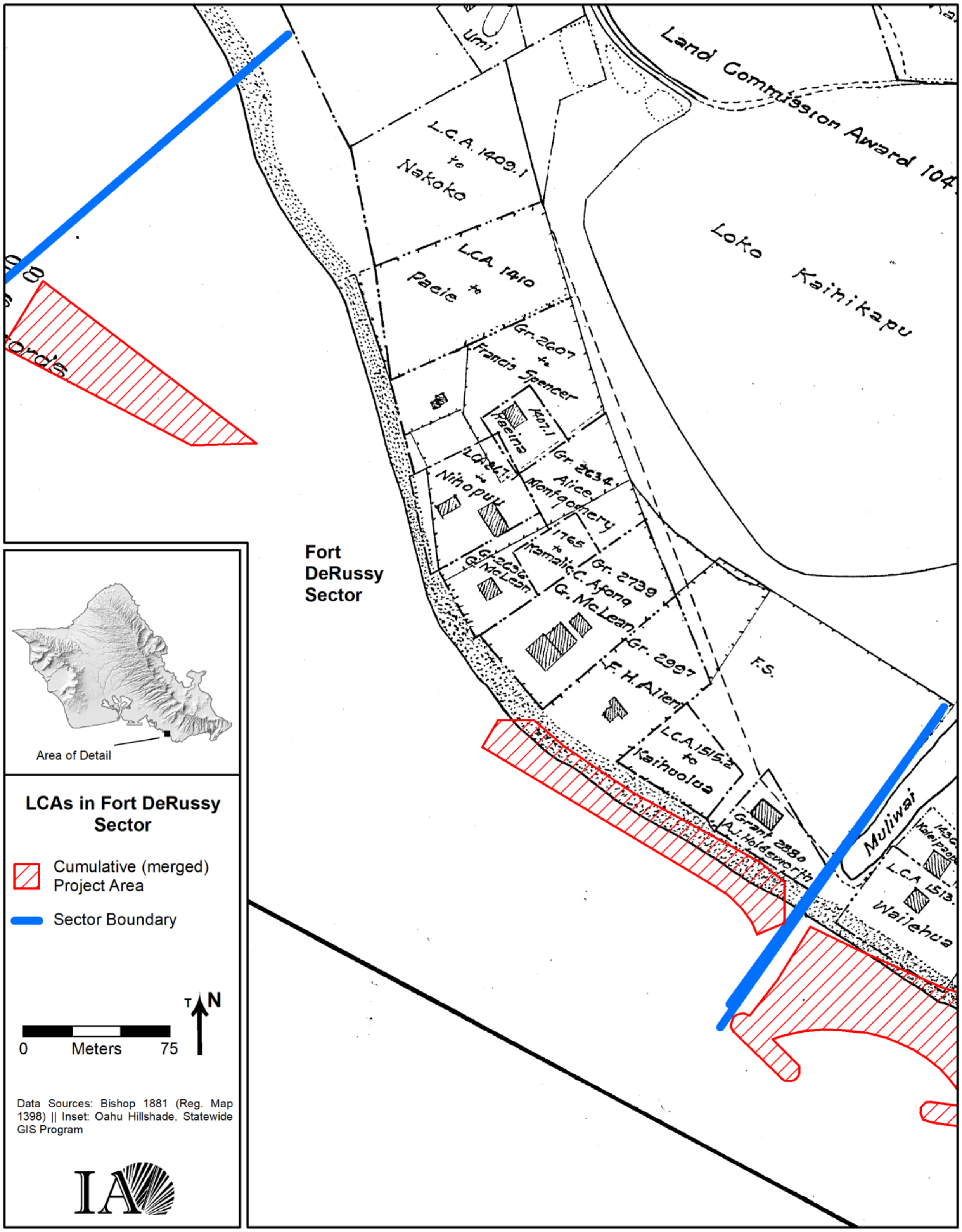

Figure 31. Overlay of Bishop’s (1881) map showing LCAs in the Fort DeRussy sector.

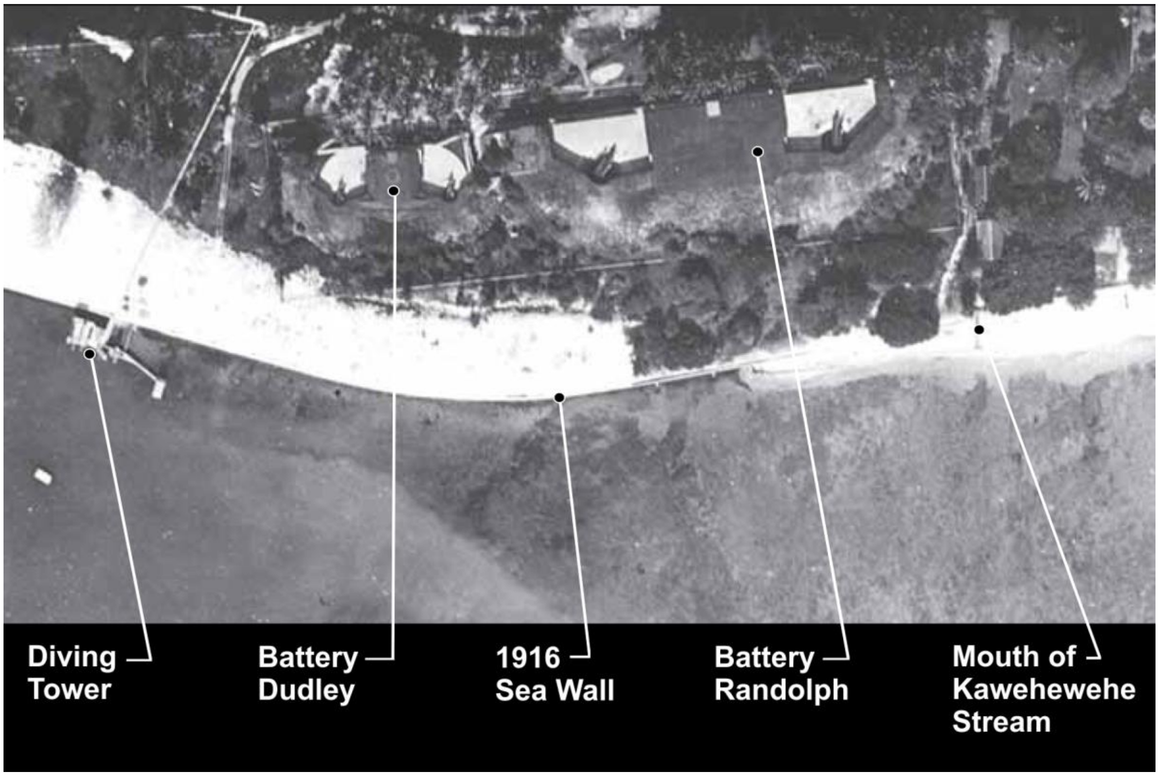

Photo 11. Aerial view of Battery Randolph and Battery Dudley, showing the straight line of the 1916 constructed seawall (source: Wiegel 2008:Figure 15). The diving tower at photo left is at the head of the channel dredged to bring the 69-ton guns to Battery Randolph (Thompson 1980:37).

SHORELINE CHANGES

The Fort DeRussy shoreline is an almost completely constructed beach (Figure 32). A narrow strip of coastal land formerly separated a large complex of fishponds from the ocean; immediately inland of the Fort DeRussy sector was one of the larger ponds, Loko Kaʻihikapu. Bishop's (1881) map of Waikīkī shows that the shoreline at the western boundary of the sector was over 150 m inland of its present location. The outlet of a small waterway identified on Bishop's (1882) map as Kawehewehe was on the Diamond Head boundary of the sector.

Known shore structures in the Fort DeRussy sector are summarized in Table 22. These structures include a seawall built in 1916 and a box culvert and groin built in 1917 (subsequently extended in 1969 and supplemented by a rubble-mound groin in 1971).

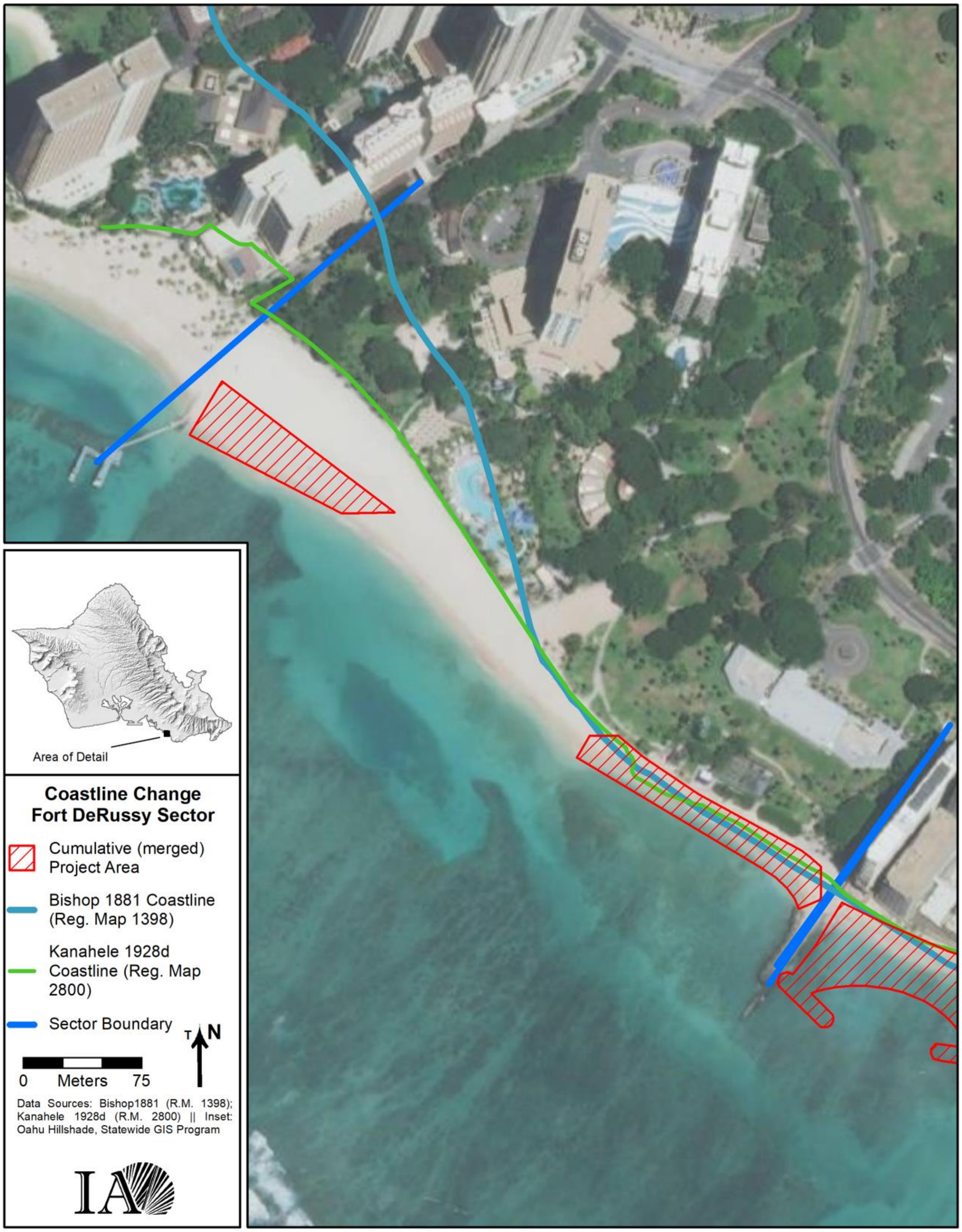

Figure 32. Historical coastlines, Fort DeRussy sector.

Table 22. Seawalls and Groins within the Fort DeRussy Sector.

Year Built	Year Demolished	Description	Length	Location	Reference
1916	Extant	seawall	1,150 ft.	Fort DeRussy	Wiegel (2008:Figure 18, 26)
1917	Extant	box culvert/groin; rubble mound groin added ca. 1971	70 ft. (lengthened to 300 ft. in 1969)	Fort DeRussy	Wiegel (2008:22)

KNOWN ARCHAEOLOGICAL SITES

No archaeological sites have been identified within the Fort DeRussy sector. Site 50-80-14-4570, a multi-component deposit with traditional Hawaiian and historical-period layers (Davis 1989, 1992; Denham and Pantaleo 1997a, 1997b, 1998), is along the inland boundary of the eastern portion of the sector (Figure 33). This site is within LCA 1515:2, awarded to Kaihuoloa, and Grant 2880, purchased by H.J.H. Holdsworth. Davis' (1989) trenches revealed two distinct archaeological layers, the uppermost of which (Layer II) contained an *imu* and other pit features, as well as historical artifacts. Subsequent data recovery documented 40 features, including 24 hearths, 12 pits of unknown function, three post molds, and a historical-period burial pit. Unidentified charcoal from Layer III, the earliest archaeological deposit, produced a radiocarbon determination of 410±50 BP (Beta-31310), which provides a calibrated date of AD 1422-1529 and AD 1546-1635.

BioSystems Analysis, Inc., conducted monitoring and data recovery at Fort DeRussy in association with the realignment of Kālia Road and construction at the Hale Koa Hotel (Denham and Pantaleo 1997a, 1997b, 1998). Site 50-80-14-4570 was assigned to "all non-spatially contiguous features on the former spit" and encompasses numerous pre-Contact-era to historical-era subsurface features dispersed across the Fort DeRussy property (Denham and Pantaleo 1998:I, Figure 4-1), along with Davis' (1989, 1992) previous finds.

BioSystems' Feature 23, a group of five burials, was near the Fort DeRussy sector. The burials appeared to have been previously disturbed by landscaping activities and were associated with both traditional Hawaiian and historical-period artifacts (Denham and Pantaleo 1998:28).

Site 50-80-14-9500 falls outside of the Fort DeRussy sector but is worthy of mention based on its proximity and its ability to inform on the potential for human burials along the Fort DeRussy coastline. This site designation was assigned to six burials encountered during construction of the Hale Koa Hotel in 1976. Five of the burials were identified as pre-Contact or early post-Contact, and one burial immediately beneath a 20th-century pavement was thought possibly to represent a homicide victim (Kimble 1976, cited in Armstrong and Spear 2009:6-7).

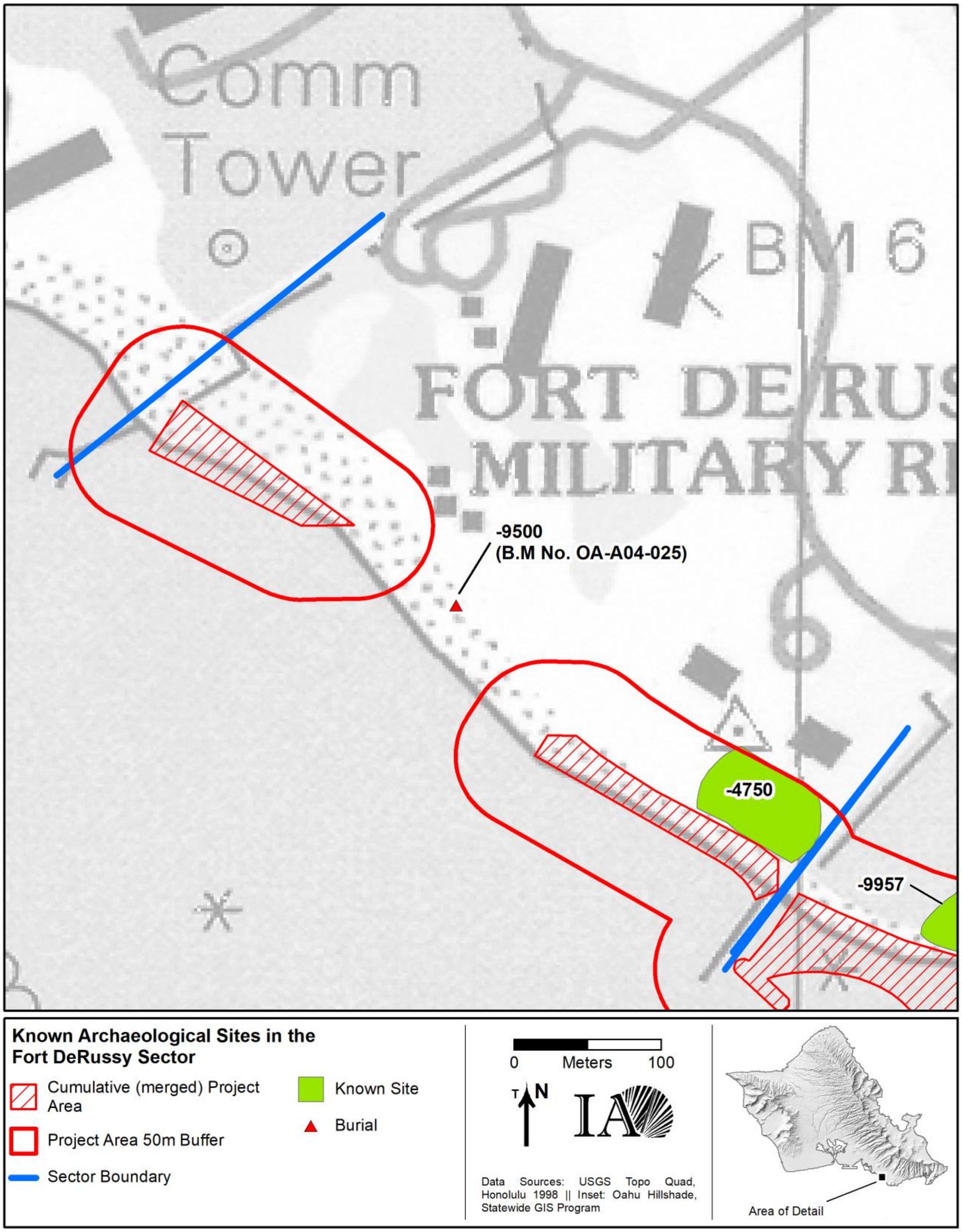

Figure 33. Known archaeological sites within 50 m of the Fort DeRussy sector.

IV. EXPECTATIONS AND RECOMMENDATIONS

This section presents the archaeological expectations and recommendations for each maintenance program sector. Identified archaeological and architectural resources generally lie inland of each sector, although in some cases they are in such close proximity that sites may extend into the active beach zone.

KŪHIŌ BEACH SECTOR

Beach improvement activities are proposed at both basins of the Kūhiō groin complex. In the Diamond Head basin, proposed work includes the addition of approximately 4,500 cubic yards of sand between +5 and -4 feet mean sea level (msl). No alterations to the shore structures are planned. In the ‘Ewa basin, proposed work includes the addition of approximately 4,500 cubic yards of sand between +8 and -3 feet msl, along with the construction of a segmented breakwater partially overlapping the existing 1939 “crib wall” and adjacent shore return structures.

The proposed work in the Diamond Head basin, which consists of sand fill only, will occur *makai* of the ca. 1881 and ca. 1928 coastlines as depicted by Bishop (1881) and Kanahele (1928c), respectively. The location of Site 50-80-14-5948, a retaining wall thought to be the 1890 wall replacing the ca. 1880 bridge/causeway to Kapi‘olani Park, is approximately 27 m *mauka* of the Kūhiō Beach sector. The buried wall is beneath the seaward sidewalk of Kalākaua Avenue, so any intact archaeological deposits would lie inland of this wall and thus, under the roadway. While several archaeological sites, including burials, have been identified along Kalākaua Avenue near the Diamond Head basin, planned project work will be limited to an area of imported beach sand that likely post-dates the 1950s.

Proposed work in the ‘Ewa basin, which includes sand fill and breakwater construction, will also occur *makai* of the ca. 1881 coastline and primarily seaward of the ca. 1928 coastline, although the sand fill area extends *mauka* of a “masonry wall” depicted on Kanahele’s (1928c) map on the north side of the ‘Ewa basin.

RECOMMENDATIONS

Periodic spot-check monitoring is recommended for maintenance work within the Diamond Head basin since all work is within the post-late-19th century shoreline. Scheduled monitoring is recommended during ground-disturbing activities within the historical shorelines within the ‘Ewa basin.

Given the presence of potentially significant existing beach infrastructure, including the Kapahulu Storm Drain/Groin (“The Wall”), “Slippery Wall,” the “crib wall,” and the shore return structures on either side of the crib wall, we recommend historic preservation documentation and evaluations of the existing beach infrastructure prior to commencement of the project.

ROYAL HAWAIIAN SECTOR

Beach improvement activities proposed for the Royal Hawaiian sector include the addition of approximately 25,000 cubic yards of sand fill between +8.5 and -2 feet msl. The proposed work will partially overlap the ca. 1881 and ca. 1928 shorelines as illustrated by Bishop (1881) and Kanahele (1928c).

Any ground disturbance *makai* of the ca. 1881/ca. 1928 shorelines in the Royal Hawaiian sector has the potential encounter cultural deposits or burials. The presence of a partially buried seawall and possible Waikiki Tavern foundation at the Diamond Head end of the Royal Hawaiian sector suggests that intact beach sediments may extend into the *mauka* portion of the project area; as a result, cultural deposits and burials such as those found along Kalākaua Avenue may occur within the beach maintenance and restoration area.

RECOMMENDATIONS

The addition of sand fill is unlikely to result in significant ground disturbance. However, due to the proximity of previously recorded buried deposits and burials, significant traditional places, and chiefly residences, archaeological monitoring is recommended during all work within the historical shorelines.

Given the presence of potentially significant existing beach infrastructure, including the Royal Hawaiian Groin, historic preservation documentation and evaluations of these structures prior to commencement of the project is recommended.

HALEKŪLANI SECTOR

Beach improvement activities proposed for the Halekūlani sector include the addition of approximately 60,000 square yards of sand fill between +8.5 feet and -3 feet msl. The construction of five groins between the Royal Hawaiian Groin and the Fort DeRussy Box Culvert/Groin is also planned. Because the proposed work is expected to occur *makai* of the existing seawalls, shown in a 1932 photograph with no beach on its seaward side, there is a negligible likelihood of archaeological materials in the present active beach.

Given the proximity of cultural deposits and burials associated with Sites 4570 and 9957, ground disturbance *mauka* of the ca. 1881/ca. 1928 shorelines has the potential to encounter cultural deposits or burials. Because the area *makai* of the existing seawall is unlikely to contain beach sand or natural sediments pre-dating the 1930s, project work in this location has little potential to encounter archaeological resources or burials.

RECOMMENDATIONS

The addition of sand fill is unlikely to result in significant ground disturbance. However, due to the proximity of previously recorded buried deposits and burials, significant traditional places, and multiple LCA lots, archaeological monitoring is recommended during all work within the historical shorelines.

Historic preservation documentation and evaluations of the existing five small groins within the Halekūlani sector, as well as the Royal Hawaiian and Fort DeRussy groins, prior to commencement of the project is recommended.

FORT DERUSSY SECTOR

Beach improvement activities proposed for the Fort DeRussy sector include the addition of approximately 1,500 cubic yards of sand fill near the Diamond Head edge. A sand borrow area is proposed at the ‘Ewa end of the sector adjacent to the Hilton Hawaiian Village pier. The proposed project work will be confined to the area *makai* of the Fort DeRussy seawall, which consists of beach constructed during the 20th century.

Any ground disturbance *makai* of the ca. 1881 and ca. 1928 shorelines has the potential to encounter archaeological deposits; Site 50-80-14-4570 at the Diamond Head end of the sector is inland of the present promenade.

RECOMMENDATIONS

The addition of sand fill is unlikely to result in significant ground disturbance. However, due to the proximity of previously recorded buried deposits and burials, archaeological monitoring is recommended during all work within the historical shorelines. No monitoring is recommended for work at the sand borrow area since this is an area of relatively recent sand accretion.

Historic preservation documentation and evaluation of the Fort DeRussy groin prior to commencement of the project is recommended.

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GLOSSARY OF HAWAIIAN WORDS

Hawaiian Spelling	Definition*
ahupuaʻa	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 a pig (*puaʻa*), or because a pig or other tribute was laid on the altar as tax to the chief
aliʻi	chief, chiefess, officer, ruler, monarch, peer, headman, noble, aristocrat, king, queen, commander
ʻāpana	piece, portion, section; used to refer to a parcel within a Land Commission award
ʻauwai	irrigation ditch
heiau	temple, shrine
ʻili	traditional land unit, a subdivision of an *ahupuaʻa*
imu	underground oven
kuleana	small piece of property, as within an *ahupuaʻa*; right, privilege, concern, title, property, estate, portion, interest, claim, ownership
līpoa	bladelike, branched, brown seaweeds with unique aroma and flavor
loko	pond
makai	toward the sea
mauka	toward the mountain, or inland
muliwai	river, river mouth; poor near mouth of a stream, as behind a sand bar, enlarged by ocean water left there by high tide; estuary
poʻo kanaka	class of sacrificial *heiau* (lit., human head, skull)
ʻulu maika	stone used in *maika* game (a bowling-like game)

* Adapted from Mary K. Pukui and Samuel H. Elbert, 1986, *Hawaiian Dictionary*, University of Hawaii Press, Honolulu.

28. APPENDIX F: DRAFT ARCHITECTURAL ASSESSMENT

— Draft —

Historical Architecture Overview for the Proposed Waikīkī Beach Improvement and Maintenance Program, Waikīkī Ahupua‘a, Kona District, Island of O‘ahu, Hawai‘i

TMK (1) 2-6-001:002, 003, 004, 008, 012, 013, 015, 017, 018, 019; 2-6-002:005, 006, 017, 026; 2-6-004:005, 006, 007, 008, 009, 010, 012; 2-6-005:001, 006; 2-6-008:029

Prepared by:
Summer Moore
M.J. Tomonari-Tuggle

Prepared for:
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Waimānalo, Hawai‘i 96795

INTERNATIONAL ARCHAEOLOGY, LLC

MARCH 2021

IA201639

— DRAFT —

HISTORICAL ARCHITECTURE OVERVIEW FOR THE PROPOSED WAIKĪKĪ BEACH IMPROVEMENT AND MAINTENANCE PROGRAM, WAIKĪKĪ AHUPUA‘A, KONA DISTRICT, ISLAND OF O‘AHU, HAWAI‘I

TMK (1) 2-6-001:002, 003, 004, 008, 012, 013, 015, 017, 018, 019; 2-6-002:005, 006, 017, 026; 2-6-004:005, 006, 007, 008, 009, 010, 012; 2-6-005:001, 006; 2-6-008:029

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March 2021

ABSTRACT

At the request of Sea Engineering, Inc. (SEI), and on behalf of the Department of Land and Natural Resources (DLNR), Office of Conservation and Coastal Lands, International Archaeology, LLC (IA) prepared a historical architectural overview in support of the proposed Waikīkī Beach Improvement and Maintenance Program. The beach improvement and maintenance program encompasses four areas of Waikīkī Beach—the Kūhiō Beach sector, the Royal Hawaiian sector, the Halekūlani sector, and the Fort DeRussy sector—along the shoreline of Māmala Bay in the Kona District of the Island of O‘ahu, seaward of TMKs (1) 2-6-001:002, 003, 004, 008, 012, 013, 015, 017, 018, 019; 2-6-002:005, 006, 017, 026; 2-6-004:005, 006, 007, 008, 009, 010, 012; 2-6-005:001, 006; and 2-6-008:029. These sectors include portions of the active beach and nearshore marine areas and extend to a maximum of approximately 70 m offshore. The historical architectural overview is a component of the program's Environmental Impact Statement prepared by SEI for the DLNR. The proposed project includes the construction of new beach stabilization structures and shoreline replenishment primarily using sand recovered from offshore areas.

Each of the maintenance program sectors have one or more potentially significant historical architectural resources. The Kūhiō Beach sector encompasses the Kūhiō groin complex, comprised of the ‘Ewa basin crib wall, Diamond Head basin and "Slippery Wall," and Kapahulu Storm Drain. Additionally, a buried portion of the 1890 masonry seawall (Site 50-80-14-5948) is present. The Royal Hawaiian Groin, recently rebuilt, a former seawall, and a possible building foundation are within the Royal Hawaiian sector, while the Moana Surfrider and Royal Hawaiian Hotels abut the inland margin of the sector boundary. Five groins presumed to have been built during the early 20th century are within the Halekūlani sector. The Fort DeRussy sector includes the Fort DeRussy Groin; it is believed that at least portions of the 1916 seawall may be present.

Historic American Engineering Records are recommended for the Kūhiō groin complex, the Halekūlani sector groins, and the Fort DeRussy Groin. Architectural or archaeological recording is recommended for the former seawall and possible building foundation exposed in the Royal Hawaiian sector.

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I. INTRODUCTION

At the request of Sea Engineering, Inc. (SEI), and on behalf of the Department of Land and Natural Resources (DLNR), Office of Conservation and Coastal Lands, International Archaeology, LLC (IA) prepared a historical architectural overview in support of the proposed Waikīkī Beach Improvement and Maintenance Program (Figure 1 and Figure 2). The beach improvement and maintenance program encompasses four areas of Waikīkī Beach—the Fort DeRussy Beach sector, the Halekūlani Beach sector, the Royal Hawaiian Beach sector, and the Kūhiō Beach sector—along the shoreline of Māmala Bay in the Kona District of the Island of O‘ahu, seaward of TMKs (1) 2-6-001:002, 003, 004, 008, 012, 013, 015, 017, 018, 019; 2-6-002:005, 006, 017, 026; 2-6-004:005, 006, 007, 008, 009, 010, 012; 2-6-005:001, 006; 2-6-008:029. These sectors include portions of the active beach and nearshore marine areas and extend to a maximum of approximately 70 m offshore. The historical architectural overview is a component of the program's Environmental Impact Statement (EIS) prepared by SEI for the DLNR. The proposed project includes the construction of new beach stabilization structures and shoreline replenishment primarily using sand recovered from offshore areas.

PROJECT AREA DESCRIPTION

Waikīkī Beach is an approximately 3,130-m (10,260-ft.) ocean shoreline along the southwest edge of the Waikīkī neighborhood of Honolulu, extending from a breakwater fronting the Hilton Hawaiian Village Waikīkī Beach Resort to the west to a groin fronting the New Otani (Kaimana) Hotel to the east. Almost the entire length of the beach is armored by seawalls and stabilized by groins that compartmentalize the shoreline into eight individual "littoral cells" or sectors. The Waikīkī Beach Improvement and Maintenance Program will affect four of these sectors (Figure 3 through Figure 7), which are described individually.

1. The Kūhiō Beach sector consists of approximately 460 m (1,500 ft.) of shoreline extending from the ‘Ewa (west) groin at Kūhiō Beach Park to the Kapahulu storm drain. The northwestern half of the sector (called the ‘Ewa basin here) was created in 1939 (Figure 3); the southeastern half of the sector (called the Diamond Head basin here) was built between 1951 and 1953 (Figure 4). The sector is essentially an enclosed body of water within a set of constructed crib walls and groins. It is at the southern end of the curving and protected portion of the Waikīkī coastline, between two of the three major stream outlets (Ku‘ekaunahi and ‘Āpuakēhau) that once flowed into the ocean.

2. The Royal Hawaiian Beach sector consists of approximately 530 m (1,730 ft.) of shoreline extending from the Royal Hawaiian groin to the ‘Ewa (west) groin at Kūhiō Beach Park (Figure 5). It lies at an inward curve in the Waikīkī coastline that allows the development of a wide sand beach, and sits between two of the three major stream outlets (Ku‘ekaunahi and ‘Āpuakēhau) that once flowed into the ocean. This sector is the core of traditional and historical activity in Waikīkī.

3. The Halekūlani Beach sector consists of approximately 440 m (1,450 ft.) of shoreline extending from the Fort DeRussy outfall groin to the Royal Hawaiian Groin (Figure 6). The south-facing shoreline is a mix of seawalls and discontinuous, small, and narrow sand beaches that front a fully developed urban landscape. The Royal Hawaiian groin was constructed in 1925-1926; the Fort DeRussy groin was built in 1917 and was extended in 1969. The remains of at least five, 10- to 20-m concrete block groins are spaced along the length of the sector.

4. The Fort DeRussy Beach sector consists of approximately 510 m (1,680 ft.) of shoreline extending from the Hilton Hawaiian Village pier to the Fort DeRussy outfall groin (Figure 7). The southwest-facing shoreline is a continuous sand beach that fronts a landscaped open space of tended lawn and coconut trees in the Fort DeRussy Armed Forces Recreation Center. The Hale Koa Hotel is just inland of the western portion of the sector, and the U.S. Army Museum of Hawaiʻi, housed in the historic 1914 Battery Randolph, is at the eastern end of the sector. A wide concrete promenade runs along the inland edge of the beach.

THE WAIKĪKĪ BEACH IMPROVEMENT AND MAINTENANCE PROGRAM

The proposed Waikīkī Beach Improvement and Maintenance Program is intended to address the ongoing erosion of the shoreline and frequent flooding of the backshore. Without improvements and follow-up maintenance, sand erosion and rising sea level will likely result in the total loss of Waikīkī Beach by the end of the 21st century. The project's immediate goals are to restore and improve Waikīkī's public beaches, increase beach stability, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise.

The planned actions and construction methods for each beach sector in the project area are summarized below:

1. For the Kūhiō Beach sector, separate plans are proposed for the ʻEwa basin (west) and the Diamond Head basin (east):

    a. For the ʻEwa basin, the existing groins on the east and west ends will be removed and reconstructed to accommodate sea level rise (see Figure 3). The west groin will be approximately 150 feet long with a crest elevation of +7.5 feet mean sea level (msl), and the east groin will be approximately 125 feet long and vary in elevation from +7.5 feet msl at the shoreline to +6 feet msl at the head. A 125-foot-long detached breakwater will be built in the gap between the groins and will be approximately +6 feet msl to match the heads of the groins. Construction equipment and material would be transported to the work area through either the central portion of the park or along the shoreline past the Duke Kahanamoku statue. Demolition and construction will be conducted with an excavator that is supported by a temporary work platform extending from the shore to the breakwater. Sand fill from offshore deposits will be added to the beach after the new structures are completed.

    b. For the Diamond Head basin, existing structures will not be modified, but the beach will be replenished using eroded sand that has settled in a submerged deposit just offshore (see Figure 4). Approximately 4,500 cubic yards will be recovered and spread across the beach, widening the existing shoreline by approximately 18 to 26 feet and reducing the offshore depth of the basin to a uniform bottom elevation of -4 feet msl. The sand will be recovered and redeposited using either a long-reach excavator operating on an excavated sand causeway, or a diver-operated dredge that will pump the sand to an onshore recovery area. A bulldozer and/or skid-steer will spread the sand across the beach.

2. For the Royal Hawaiian Beach sector, sand recovered from deposits directly offshore will be used to widen and replenish the beach (see Figure 5). The beach crest elevation will be increased from about +7 feet above msl to +8.5 feet msl. Approximately 30,000 cubic yards of recovered sand will be required to complete the work. To counter ongoing erosion and shoreline recession, beach nourishment will need to be repeated every eight to 10 years or more frequently if required. The recovered sand will probably be dredged with a submersible pump mounted on a crane barge and

pumped through a bottom-mounted pipeline to a dewatering basin in the Diamond Head basin of Kūhiō Beach Park. After drying, the sand will be stockpiled and transported to Royal Hawaiian Beach, where it will be distributed using bulldozers.

3. For the Halekūlani Beach sector, a new beach with stabilizing groins will be constructed (see Figure 6). Three new sloping rock rubble mound T-head groins will be combined with the existing Fort DeRussy and Royal Hawaiian groins to create four stable beach cells. The groin stems will extend approximately 200 feet seaward from the shoreline and will be of sufficient size to stabilize a +10-foot beach crest elevation. The groin stem crests could also be wide enough (approximately 10 feet) to accommodate construction equipment or a pedestrian walkway. The Halekūlani Channel will be left unobstructed for beach catamaran navigation. In addition, approximately 60,000 cubic yards of sand fill recovered from offshore deposits will be used to create approximately 3.8 acres of new dry beach area. Construction equipment and materials will likely be transported into the area across the east end of Fort DeRussy Beach, which may require construction of a temporary access road from Kalia Road to the beach and a temporary rock rubble mound access berm along the shoreline from Fort DeRussy to the Royal Hawaiian groin.

4. For the Fort DeRussy Beach sector, sand will be transported from an accretion area at the west end of the beach (near the Hilton Pier) to an eroding area at the east end (see Figure 7). The sand will be excavated from the existing beach face extending inshore only as far as necessary to obtain the required amount, estimated to be approximately 1,200 cubic yards. Dump trucks will transport the sand across the beach, and a bulldozer will distribute it across the eroding area. This process will need to be repeated periodically in the future to maintain a stable beach profile.

Construction work will be confined to the active sand portion of Waikīkī Beach and nearshore marine areas up to approximately 200 feet offshore. The work will not extend outside the inland boundary of the active beach, which is defined by any buildings, roads, seawalls, or other types of construction that constrain the sand beach.

The sand required for beach nourishment will be almost exclusively recovered from submerged offshore deposits. In addition to the near-offshore areas mentioned in the descriptions above, sand will be dredged from one or more known deposits further offshore of the south coast of O‘ahu, using submersible slurry pumps, self-contained hydraulic suction dredges, and/or clamshell buckets.

PROPOSED TASKS

This overview presents a review of the historical architecture within and immediately adjacent to the maintenance program sectors based on existing historic architectural literature. It summarizes the history of the built environment of Waikīkī using extant studies and provides detailed discussions of historic buildings and structures based on sources such as government records, government maps, Sanborn Fire Insurance maps, and National Register of Historic Places (NRHP) nomination forms

Research relied on historical architectural reports from the IA library, the State Historic Preservation Division (SHPD) library, and the State Office of Environmental Quality Control (OEQC) online library of environmental assessments and impact statements. Historical maps of Waikīkī were downloaded from the State Land Survey Division online map library, and were also researched at the Hawai‘i State Archives. A set of five maps of the Waikīkī shoreline from the Ala Wai to Diamond Head (Kanahele 1928a, 1928b, 1928c, 1928d) provide detailed information on the coast as it appeared in 1928. The State Archives was also a source for historical photographs of Waikīkī.

Published works on Waikīkī were a primary resource for background information, most notably (but not limited to) Wiegel (2008) for a history of shoreline changes, Hibbard and Franzen (1986) for a history of the resort area, including a chapter on traditional Hawaiian settlement (Nāpōkā 1986), and Kanahele (1995) for a general history of Waikīkī from pre-Contact times to 1900.

ORGANIZATION OF THE REPORT

This document is organized as follows. Section I is the introduction. Section II provides an overview of the historical architectural resources within and adjacent to the maintenance program sectors. Section III summarizes expectations and historic preservation recommendations for each sector based on the foregoing information. A list of cited references and a glossary of Hawaiian terms used in the text are included at the end of this document.

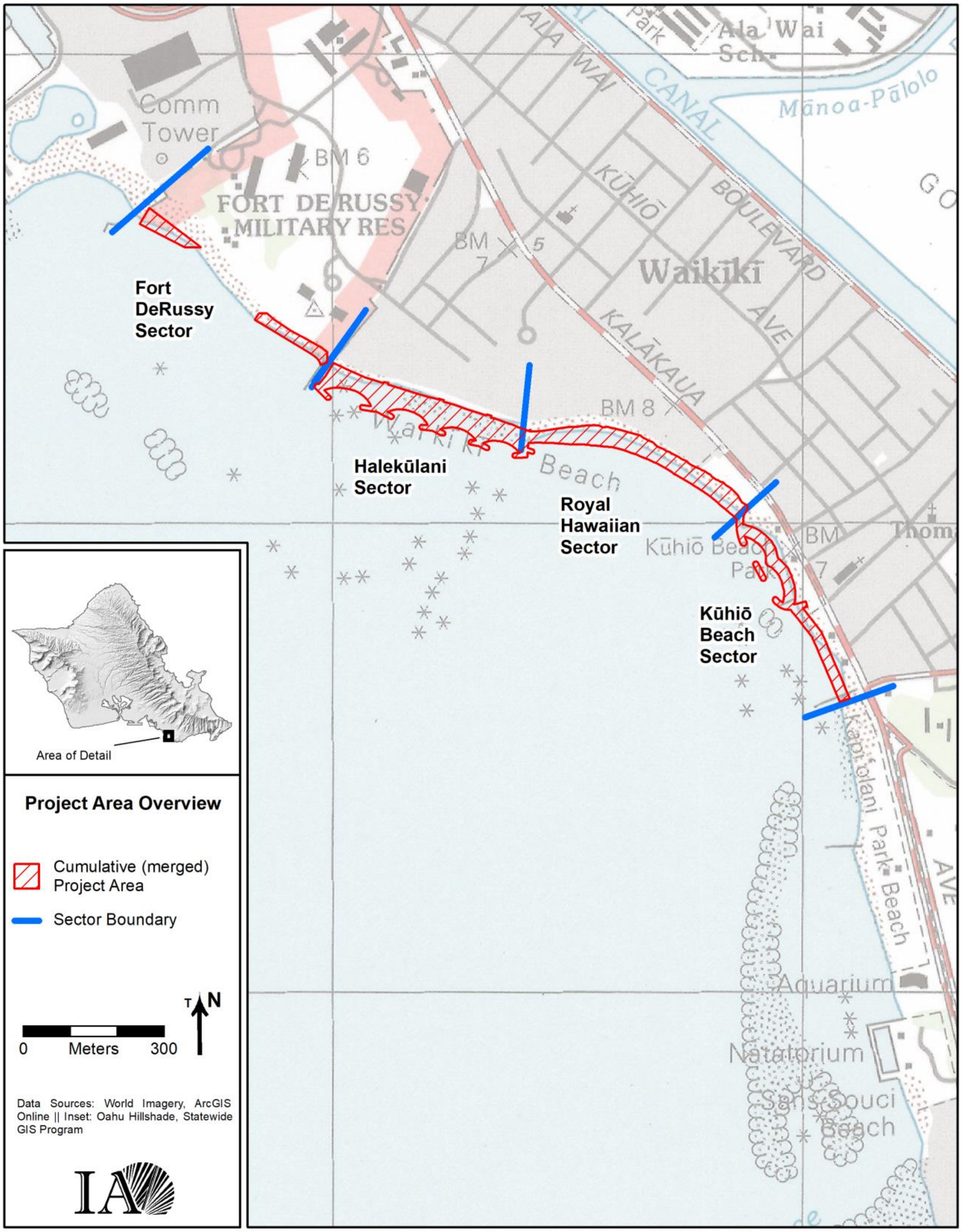

Figure 1. The Waikīkī Beach Improvement and Maintenance Program project area overlaid onto the Honolulu 1998 topographic quadrangle map.

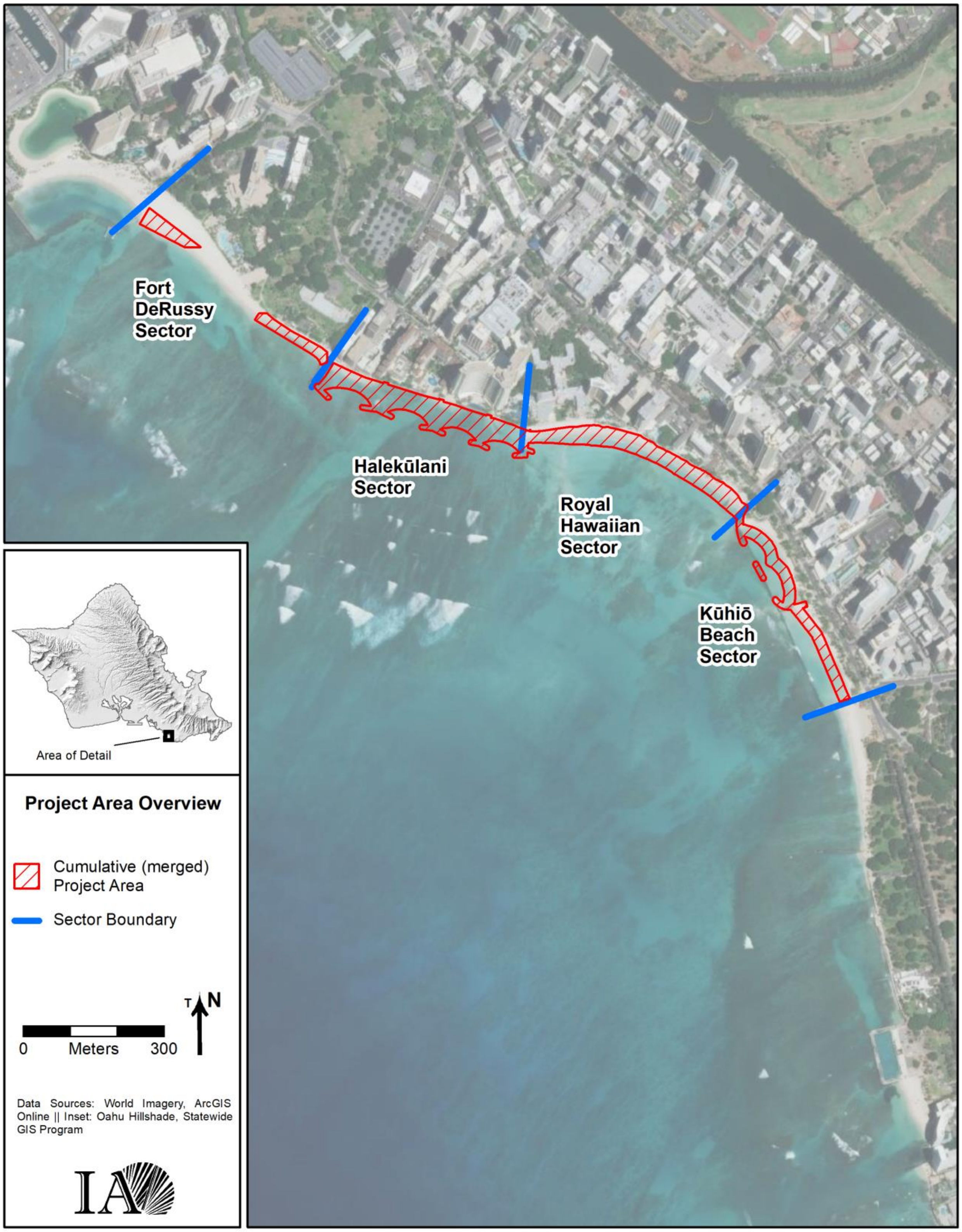

Figure 2. The Waikīkī Beach Improvement and Maintenance Program project area overlaid onto aerial imagery.

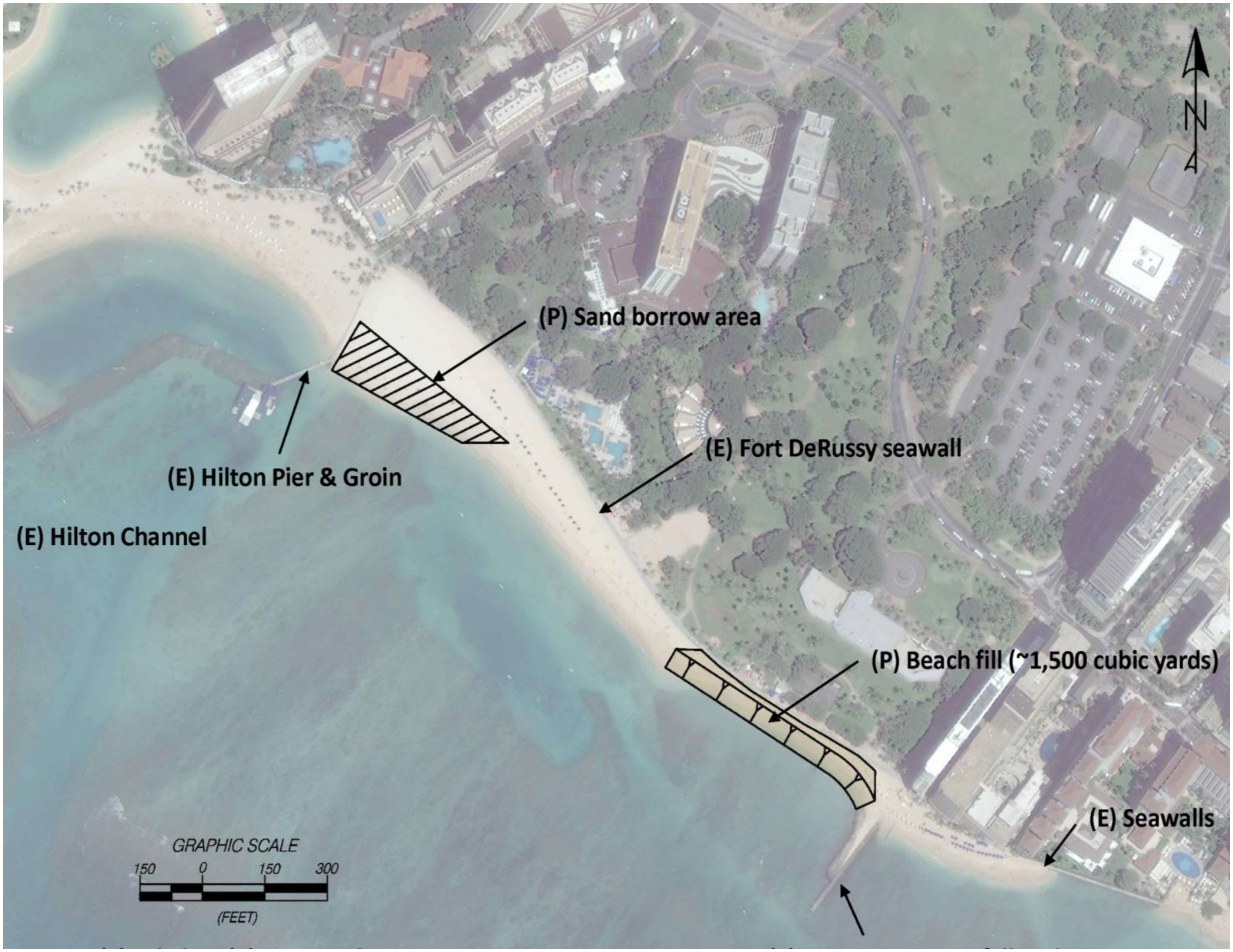

Figure 3. Planned beach improvement activates within the Kūhiō Beach sector, ‘Ewa basin. Image provided by Sea Engineering, Inc.

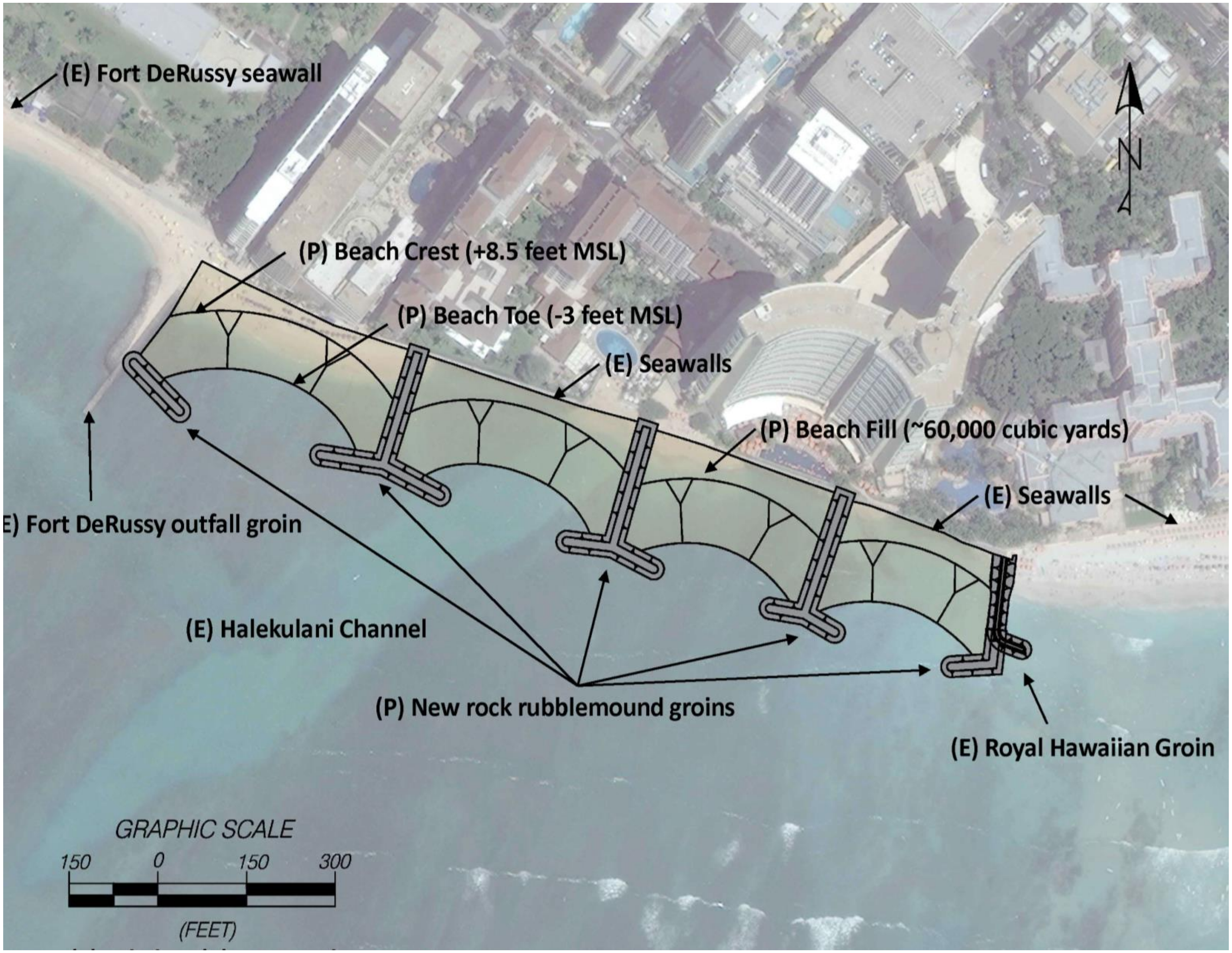

Figure 4. Planned beach improvement activities within the Kūhiō Beach sector, Diamond Head basin. Image provided by Sea Engineering, Inc.

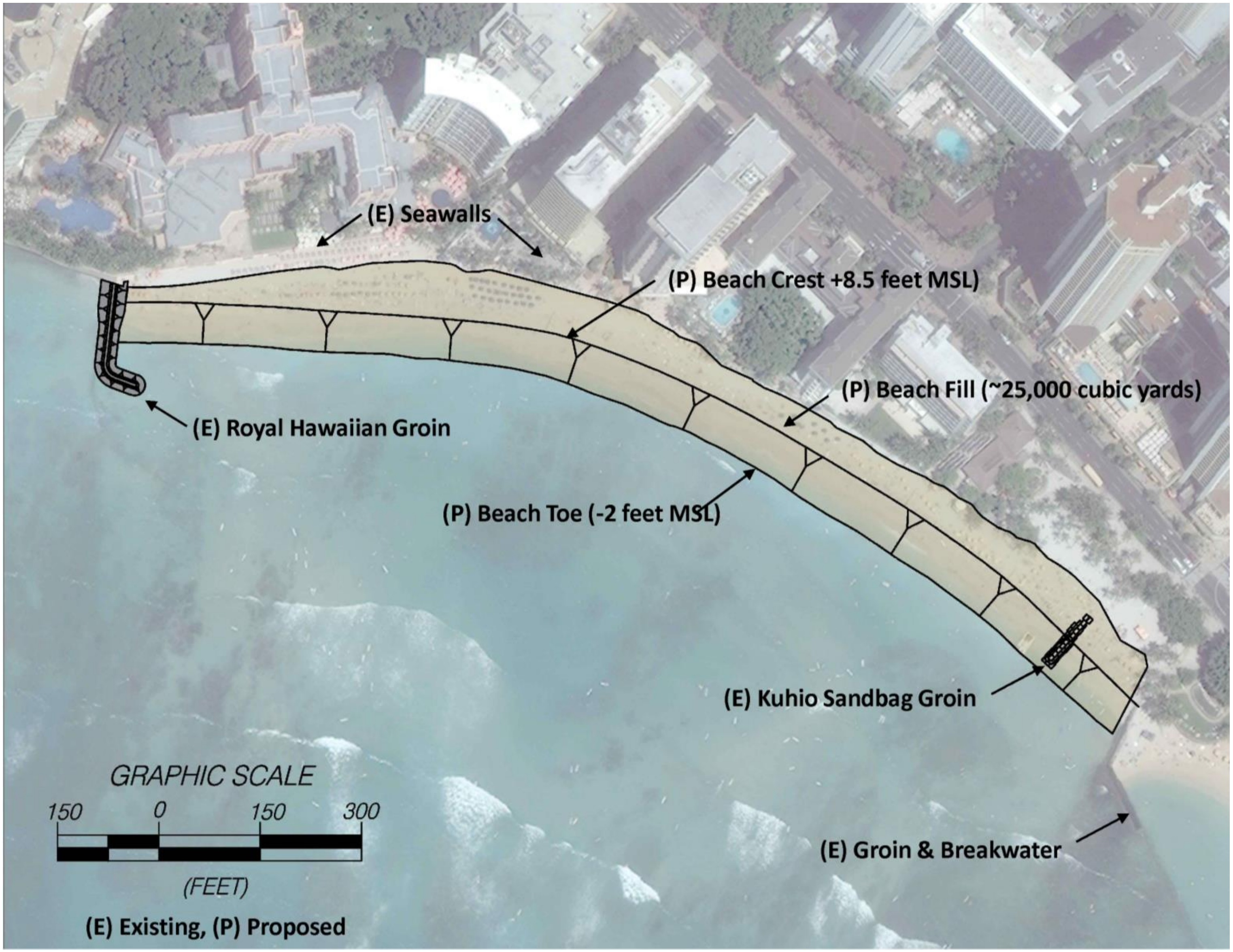

Figure 5. Planned beach improvement activities within the Royal Hawaiian sector. Image provided by Sea Engineering, Inc.

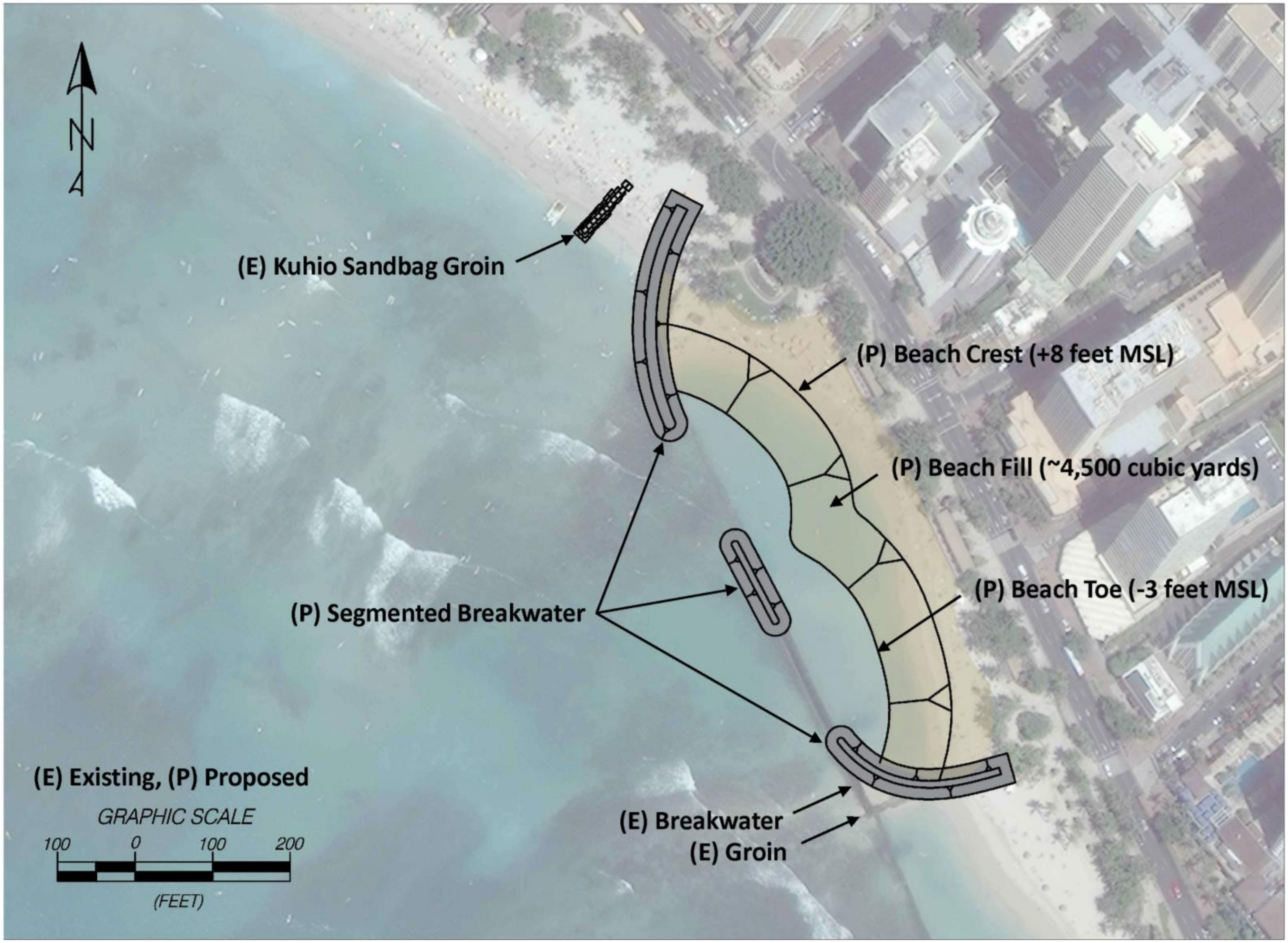

Figure 6. Planned beach improvement activities within the Halekūlani sector. Image provided by Sea Engineering, Inc.

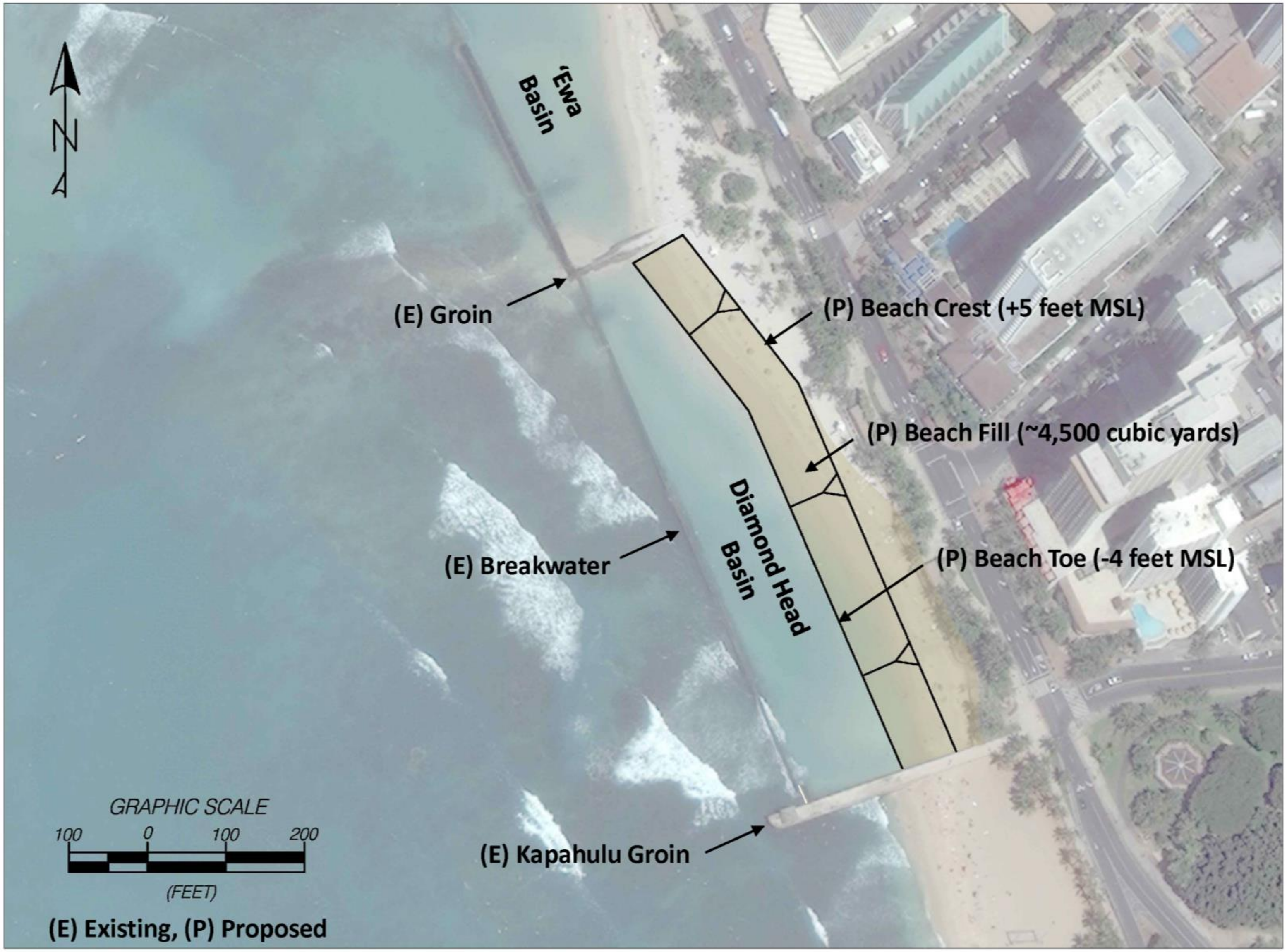

Figure 7. Planned beach improvement activities within the Fort DeRussy sector. Image provided by Sea Engineering, Inc.

II. HISTORICAL ARCHITECTURAL RESOURCES OF THE WAIKĪKĪ SHORELINE

The Waikīkī shoreline has long been noted as a center of traditional Hawaiian activity, and by the late 19th century, it emerged as a prominent resort for the wealthy and a tourist destination. This discussion presents an overview of the historical architectural resources between the Kapahulu Storm Drain and the Hilton Hawaiian Village Pier. A definition of architectural resources is provided, followed by a brief historical background to Waikīkī, an overview of the project area's historical architectural resources, and a discussion of architectural resources within each project sector.

DEFINITION OF HISTORICAL ARCHITECTURAL RESOURCES

The cultural resources of the Waikīkī shoreline are the tangible and intangible references to the area's past. Tangible resources include pre-Contact and historical-period archaeological sites, burials, buildings, and other structures. Intangible resources consist primarily of historically documented places for which no physical evidence remains: royal centers, important streams, named residences and land parcels, and former beach infrastructure features. Archaeological resources are addressed in the project's companion archaeological overview (Moore et al. 2021) with the project's Cultural Impacts Assessment discussing traditions and contemporary activities within the area and community perspectives on the maintenance program (Pacheco and Anae 2021). Table 1 defines the three resource categories and links these categories to federal and state definitions of historic properties under the National Historic Preservation Act (NHPA) and the National Register of Historic Places (NRHP). Table 2 summarizes the NHPA and NRHP categories of historic properties.

The term "historic property" is used sparingly in the present review because it has a specific definition under the NHPA: "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior (36 CFR Part 800.16)." As described in 36 CFR Part 60.4, properties are assessed for significance relative to NRHP eligibility by four criteria:

> (A) are associated with events that have made a significant contribution to the broad patterns of our history;
>
> (B) are associated with the lives of persons significant in our past;
>
> (C) embody distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> (D) have yielded, or may be likely to yield, information important in prehistory or history.

The property must also possess integrity of location, design, setting, materials, workmanship, feeling, and association; integrity is the authenticity of a property's historic identity, evidenced by the survival of physical characteristics that existed during the property's historic or prehistoric period. The State of Hawaiʻi (Hawaiʻi Administrative Rules [HAR] §13-284-6) uses similar significance definitions, with the addition of a fifth criterion:

Have an important value to the native Hawaiian people or to another ethnic group of the state due to association with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events, or oral accounts – these associations being important to the groups' history and cultural identity.

Table 1. Cultural Resource Categories in the Waikīkī Beach Improvements Project Area.

Category	Definition	NRHP Category
Archaeological	Physical remains of past human activity. Along the Waikīkī shoreline, these are typically buried deposits formed through traditional Hawaiian pre-Contact and historical period occupation and/or historical period Western or Asian activity. In Waikīkī, archaeological deposits often also contain human skeletal remains, which typically are listed in reports as "burials." The term includes both isolated fragments as well as complete remains in intact burial pits. There are also numerous instances of intact burials or isolated human skeletal remains that are not associated with an archaeological deposit.	site
Architectural	Building, structure, or object dating to the post-Contact historical period. All of the boundary groins and storm drains in the project area are included in this category. In addition, other examples of architectural features include Site 50-80-14-5948, a buried historic seawall that may date to 1890 (Winieski et al. 2002; see Kanahele 1928e) and a buried seawall that extends northwest from the inland end of the ʻEwa basin of the Kūhiō groin complex (no number; SHPD GIS, N. Belluzzo, pers. comm.; see Kanahele 1928c).	building, structure, object
Historical place	Site or location that has been traditionally or historically documented but at which no physical remains are left; divided into three sub-categories: places and place names, mid-19th century land parcels, and former beach infrastructure. An example of a historical place/place name is Hamohamo, which was a land area awarded to Keohokālole in the Mahele and subsequently given to her daughter, the future queen of Hawaiʻi, Liliʻuokalani, in 1859 (Hibbard and Franzen 1986:8); a section of Hamohamo covers almost the entire beach in the Royal Hawaiian sector and a large section of the Kūhiō Beach sector. An example of a mid-19th century land parcel is LCA 1515:2 in the Fort DeRussy sector. An example of former beach infrastructure is Moana Pier, which was built in 1890 and was a landmark of the Waikīkī shoreline for 40 years until its demolition.	site

Table 2. Historic Property Categories under the National Register of Historic Places.

NRHP Category	National Register Definition (NPS 1997)	Working Category and Description	Waikīkī Beach Cultural Resource Category
Building	A building is created principally to shelter any form of human activity, or may be applied to a historically and functionally related unit (e.g., house and barn).	The category includes all standing buildings that retain sufficient integrity to be classified as architectural sites (as opposed to buildings in ruins which are then classed as archaeological sites).	architectural
Structure	A structure is a functional construction made usually for purposes other than human shelter.	A structure is a constructed facility that is not a building or an object; examples are bridges, dams, roads, and fences (a structure in ruins would be categorized as an archaeological site).	architectural
Object	An object is a construction that is primarily artistic in nature or is relatively small in scale and simply constructed. Although it may be, by nature or design, movable, an object is associated with a specific setting or environment.	An object is a material thing of functional, aesthetic, cultural, historical, or scientific value that may be, by nature or design, movable yet related to a specific setting or environment (see 36 CFR Part 65.3). These are often classed as architectural sites.	architectural
Site	A site is the location of a significant event, a prehistoric or historic occupation or activity, or a building or structure (whether standing, ruined, or vanished) where the location itself possesses historic, cultural, or archaeological value regardless of the value of any existing structure.	A site is the physical remains of human activity. This category includes the remains of pre-contact and historical period occupation, as well as the remnants of historical structures that are too deteriorated to be considered as architectural sites. A site can also be a location with no physical remains, such as a traditional or historical place.	archaeological historical place
District	A district possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development.	n/a	architectural*

* Note that the Artillery District of Honolulu (Site 50-80-14-1382), which contains a group of thematically linked buildings, was nominated to the NRHP as a site rather than a district.

HISTORICAL BACKGROUND TO WAIKĪKĪ

When Captain James Cook made landfall in Hawai‘i in 1778, he found a group of islands ruled by an elite corps of chiefs, served by a multi-layered hierarchy of lower *ali‘i* and a body of *maka‘āinana*. On O‘ahu, Waikīkī was the chiefly center of the southern coast, home to the ruling chief and his subordinate *ali‘i* (Cordy 2002 Nāpōkā 1986. ‘Ī‘ī (1959:69) writes that the “chiefs like to live at Waikīkī because of the surfing.” Houses clustered among the coconut trees on the shoreline from Kālia to the base of Diamond Head. Several large *heiau*, including Helumoa (‘Āpuakēhau) and Papa‘ena‘ena, were the focus of chiefly religious ceremonies.

As early as the 1860s, Waikīkī began to attract foreign residents and beachgoers, especially Americans. In 1873, the region was described by one visitor as “a hamlet of plain cottages, whither the people of Honolulu go to revel in bathing clothes, mosquitoes, and solitude, at odd times of the year” (Bliss 1873:195-196). Kapi‘olani Park in 1877 was originally developed as a private recreational open space amenity for high-end residences at the base of Diamond Head and along the coast (Brown and Monsarrat 1883). Over time, Waikīkī emerged as both a popular residential area and a hub for tourists, with attendant hotels, restaurants, and other establishments. In 1901, the first major hotel, the Moana, opened on the grounds of W.C. Peacock’s home on the south side of ‘Āpuakēhau Stream. Five years after the establishment of the Moana Hotel, the cottage-style Seaside Hotel opened on a seaside property that had once belonged to Bernice Pauahi Bishop. In 1925-1926, the iconic Royal Hawaiian Hotel replaced the Seaside; the Royal Hawaiian groin was constructed around this time.

The U.S. Army Corps of Engineers began to acquire land for a military reservation in the area of the Kālia fishponds and along the beach between 1904 and 1908. It was subsequently occupied by a detachment from the 1st Battalion of Engineers from Fort Mason, California. The fort was first referred to as Kalia Military Reservation but was subsequently renamed in honor of Brevet Brigadier General Rene Edward DeRussy (White and Kraus 2007:80). The U.S. Army immediately began to fill the new Fort DeRussy property, including the Kālia fishponds, by dredging material from the offshore reefs (Hibbard and Franzen 1986:79). The fort was home to Batteries Randolph and Dudley between 1914 and 1944.

One of the earliest structures to modify the shoreline was a bridge and causeway built across the mouth of Ku‘ekaunahi Stream at the entrance to Kapi‘olani Park. In 1890, a 390-foot-long retaining wall was built to protect Waikiki Road (now Kalākaua Avenue), replacing part of the original bridge and causeway. Many additional seawalls and groins were built in the 1910s and 1920s, after the dredging of a deep channel in the reef off Fort DeRussy reportedly initiated widespread beach erosion (Wiegel 2008:11).

The growth of the tourist industry in the 1950s led to increasing urbanization along the shoreline and throughout Waikīkī. Several major attractions opened in the post-war period, including the Honolulu Zoo (1952), the Waikīkī Aquarium (1955), and the Duke Kahanamoku Beach and Lagoon (1956). Kūhiō Beach Park had opened just prior to World War II, in 1940, and the building of an off-shore seawall created a sheltered area for inexperienced swimmers. The Waikiki Tavern (which included the Waikiki Inn) occupied the lot northwest of the Kūhiō groin complex from the 1920s to the 1950s; it was demolished in 1960 to make way for Waikīkī Beach Center (Clark 1977:54; Hibbard and Franzen 1986:51).

OVERVIEW OF ARCHITECTURAL RESOURCES

Architectural resources within and adjacent to the Waikīkī shoreline project area consist of beach infrastructure (groins and seawalls) and adjacent buildings. These resources (Table 3; Figure 8) are described in more detail in the sections below. The groins (including storm drains) form the boundaries between each of the sectors: Kapahulu Storm Drain/Groin, ‘Ewa Kūhiō Groin, Royal Hawaiian Groin, and Fort DeRussy Groin. They were built at different times, with dates of origin from 1917 (Fort DeRussy) to 1951 (Kapahulu Storm Drain). A complex of shore-parallel seawalls in the Kūhiō Beach sector was built in 1939 and extended in 1953. Estimates of construction dates have been made using historical maps and photographs, as well as references in Waikīkī historical sources (e.g., Clark 1977; Wiegel 2008).

With one exception (Site 50-80-14-5948), these beach infrastructure features have not been recorded in detail nor assigned State Inventory of Historic Places (SIHP) numbers. However, based on age (at least 50 years old) and their relevance to Waikīkī’s history they may be considered historic properties.

Inland of the shoreline maintenance program areas are three important historic buildings, which will not be physically affected by beach improvement activities but warrant mention: Battery Randolph (Site 50-80-14-1382), the Moana Hotel (Site 50-80-14-9901), and the Royal Hawaiian Hotel (no SIHP number). Both Battery Randolph and the Moana Hotel are listed on the NRHP.

Table 3. Architectural Resources near the Waikīkī Beach Improvement and Maintenance Program Sectors.

Site	Comment	Reference	Sector
Kapahulu Storm Drain	355-foot-long Kapahulu Groin built in 1951 as part of beach improvement; groin is referred to as “The Wall”	Clark (1977:53); Wiegel (2008:17)	Kūhiō Beach
“Slippery Wall”	750-foot-long retaining wall built in 1953 on ‘Ewa side of the Kapahulu Storm Drain to keep sand from eroding away	Clark (1977:53); Wiegel (2008:17, 27)	Kūhiō Beach
Kūhiō groin complex, ‘Ewa basin	650-foot-long crib wall built in 1939 about 200 feet from shore (parallel to shore), with shore return structures at each end	Clark (1977); Wiegel (2008:17)	Kūhiō Beach
Site 50-80-14-5948, portion of historical seawall	basalt boulder retaining wall exposed near intersection of Kalākaua and Kapahulu Avenues; may be remains of wall built around 1890 to protect Waikiki Road	Kanahele (1928e); Wiegel (2008:26); Winieski et al. (2002)	Kūhiō Beach
portion of historical seawall	buried section of seawall extending northwest from inland end of the ‘Ewa basin of the Kūhiō groin complex; associated with possible remains of Waikiki Inn foundation	Kanahele (1928c); Nick Belluzzo, pers. comm.	Royal Hawaiian
Royal Hawaiian Hotel	constructed in 1925-1926 on the grounds of the 1906 Seaside Hotel; formerly residence of Charles and Bernice Pauahi Bishop	Hibbard and Franzen (1986); Wiegel (2008)	Royal Hawaiian

Site	Comment	Reference	Sector
Moana Hotel (Site 50-80-14-9901)	first major hotel in Waikīkī, opened in 1901	Hibbard and Franzen (1986); Wiegel (2008)	Royal Hawaiian
Royal Hawaiian Groin	curving groin built in 1927; new seawall in front of hotel built shoreward of old seawall	Kanahele (1928c); Wiegel (2008:21)	Royal Hawaiian
Fort DeRussy Groin	70-foot-long box culvert/groin built in 1917 at east boundary of Fort DeRussy; 1,150-foot-long seawall built in 1916 along Fort DeRussy shoreline	Kanahele (1928b); Wiegel (2008:22, Figures 18, 26)	Fort DeRussy
Battery Randolph (Site 50-80-14-1382)	completed in 1914; part of Artillery District of Honolulu	Clark (1977:58); Wiegel (2008:26)	Fort DeRussy

KŪHIŌ BEACH SECTOR

The Kūhiō Beach sector extends along approximately 460 m (1,500 ft.) of shoreline from the ‘Ewa (west) groin at Kūhiō Beach Park to the Kapahulu Storm Drain. Based on the proximity of Kalākaua Avenue to the shoreline within this sector, there are no major buildings *makai* of the road. The Kūhiō Beach Hula Mound is at the northern end of the sector and an outdoor concession stand is *mauka* of the ‘Ewa Groin Complex.

There are four known historical architectural structures within the Kūhiō Beach sector, all of which are beach stabilization structures (Figure 9): the ‘Ewa Basin of the Kūhiō groin complex built in 1939, the Kapahulu Storm Drain and “Slippery Wall” (forming the Diamond Head Basin of the Kūhiō groin complex) built in 1951-1953, and Site 50-80-14-5948, a buried remnant of the 1890 seawall.

SITE 50-80-14-5948, BURIED SEAWALL

Site 50-80-14-5948 is a buried historical seawall approximately 4 m seaward of the Kalākaua Avenue curb near the intersection of Kalākaua and Kapahulu Avenues (Winieski et al. 2002:55). The top of the 15 m-long wall, which is built of mortared large basalt boulders, was exposed by construction excavation at about 1 m below the surface and the base of the wall, extended below the base of excavation at 2.2 m below surface. Figure 10 is a photograph and profile drawing of the exposed wall. Photo 1 shows a retaining wall at this location in 1931; the wall is also shown on Kanahele’s (1928d) map of Waikīkī beach. The seawall was evaluated as significant under the State of Hawai‘i’s Criterion d[1].

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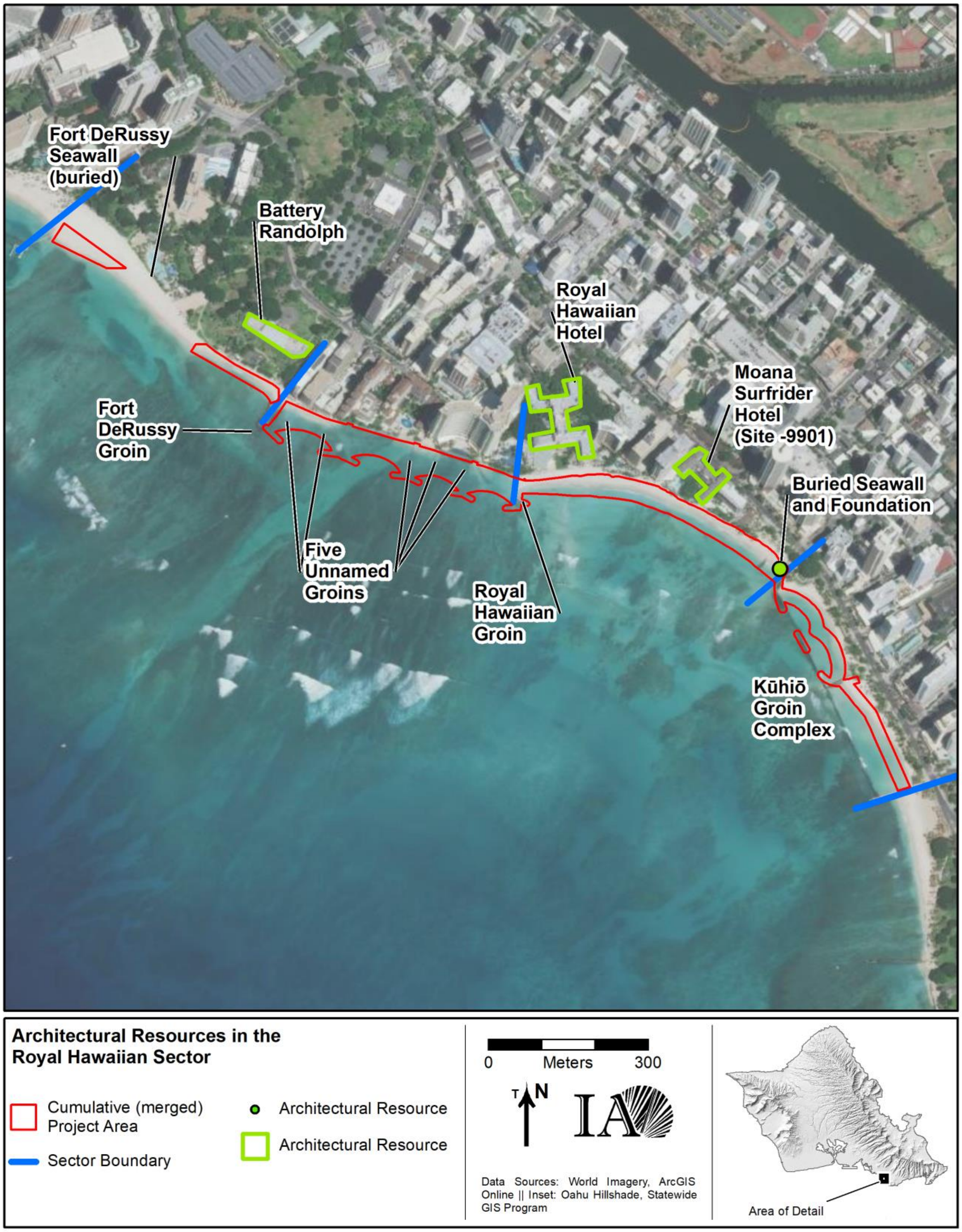
[1] Criterion d under the HAR §13-284-6 requires that a historic property both “possess integrity of location, design, setting, materials, workmanship, feeling and association” and “have yielded, or [be] likely to yield information important in prehistory or history.”



Data Sources: World Imagery, ArcGIS Online || Inset: Oahu Hillshade, Statewide GIS Program

Figure 8. Overview of historical architectural resources near the project area.

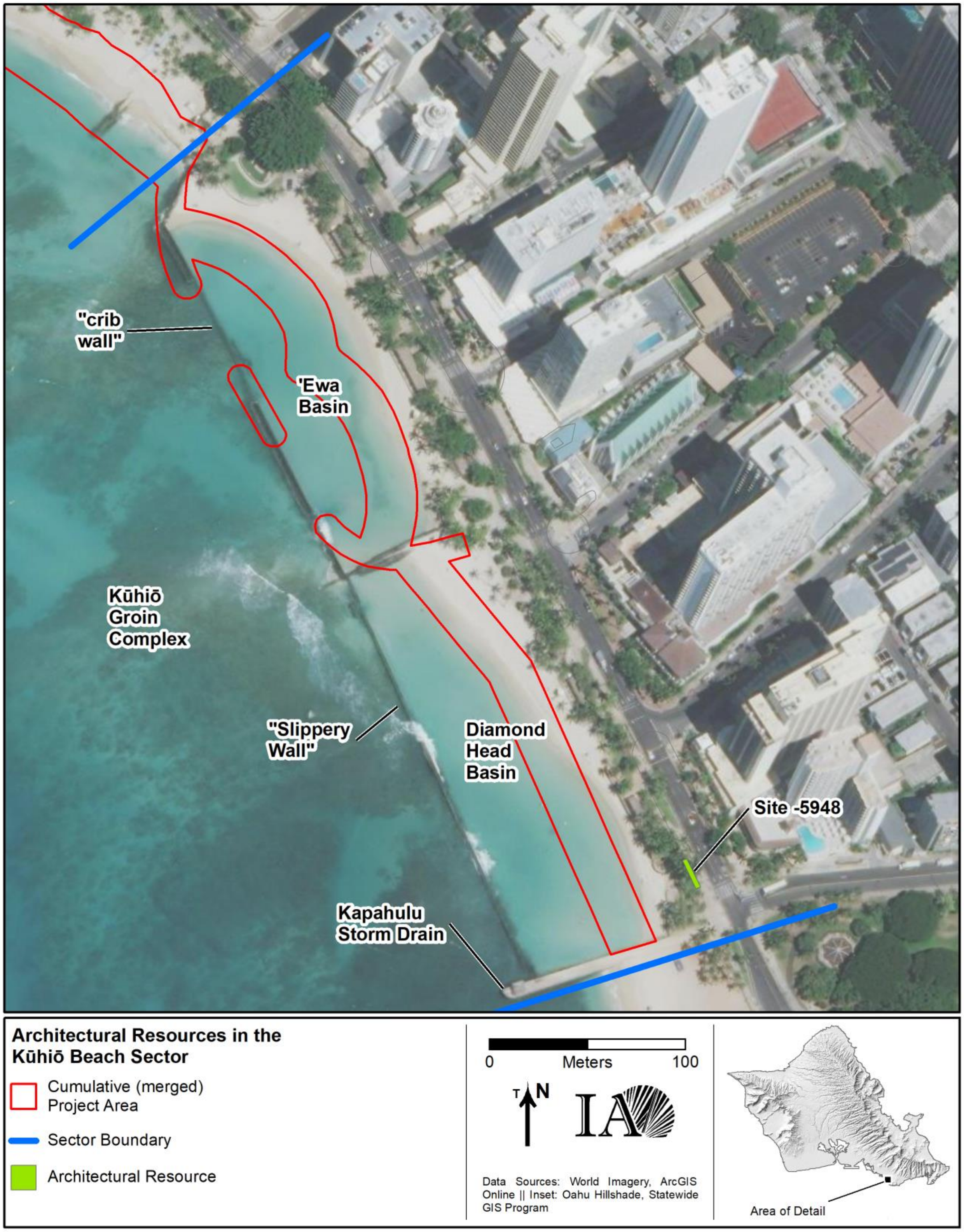
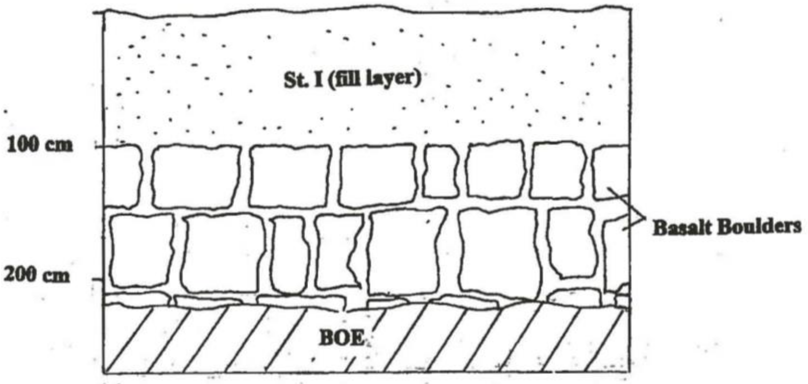


Figure 9. Historical architectural resources in the Kūhiō Beach sector.

Figure 29 Photograph of Portion of Historic Sea Wall (State Site 50-80-14-5948), View East.

Historic Sea Wall Remnant (50-80-14-5948) *



Stratum	Depth (cm.)	Description
I	0-100	10YR 4/3 sandy clay loam fill

*** Profile Reconfigured from Field Notes and Photograph Documentation**

Figure 10. Exposed seawall under Kalākaua Avenue (Site 50-80-14-5948). Photograph and profile drawing reproduced from Winieski et al. (2002:Figure 30).

Photo 1. Aerial view of the Waikīkī shoreline, 1931. The retaining wall protecting Kalākaua Avenue is in the center of the photograph. Source: Hawai‘i State Archives.

KŪHIŌ GROIN COMPLEX (‘EWA BASIN)

In 1939, preparations for the opening of Kūhiō Beach Park in 1940 included the construction of a 650-foot-long breakwater built 200 feet from shore (parallel to shore) along the ‘Ewa end of Kūhiō Beach, with shore return structures at each end of the seawall. The breakwater is known as the “crib wall.” At least 7,000 cubic yards of sand were also placed on the beach around the same time (Wiegel 2008:17).

KŪHIŌ GROIN COMPLEX (DIAMOND HEAD BASIN AND “SLIPPERY WALL”)

In 1953, a 750-foot-long retaining wall was built between the 1939 crib wall and the Kapahulu Storm Drain to keep sand from eroding away. This wall is called “Slippery Wall” because of its slick surface when wet due to the growth of fine seaweed (Clark 1977:53; Wiegel 2008:17, 27). It forms the boundary of the Diamond Head basin of the Kūhiō groin complex. The beach sand along Kūhiō Beach has been supplemented several times, including through off-shore dredging ca. 2000 (Wiegel 2008:19).

KAPAHULU STORM DRAIN

The 355-foot-long Kapahulu Storm Drain was built in 1951 at the end of Kapahulu Avenue. Other improvements included construction of a retaining wall on the Diamond Head side of the Kapahulu Storm Drain and importing sand. The structure is an extension of the storm drain running under Kapahulu Avenue, which discharges storm water at its seaward end. The storm drain/groin, which is still a prominent feature of the Waikīkī Beach shoreline, is commonly referred to as "The Wall" (Clark 1977:53).

ROYAL HAWAIIAN SECTOR

The Royal Hawaiian sector consists of approximately 530 m (1,730 ft.) of shoreline extending from the Royal Hawaiian groin to the ʻEwa (west) groin at Kūhiō Beach Park. This sector contains the beachfront of several prominent Waikīkī hotels, including the Royal Hawaiian Hotel and the Moana Surfrider. Near the southern end of the sector are the Kūhiō Beach Park and the Waikīkī Beach Center, which contains the Honolulu Police Department's Waikīkī Substation and the Duke Paoa Kahanamoku Statue.

The Royal Hawaiian sector contains two beach stabilization structures and has two historic buildings, the Moana Hotel and the Royal Hawaiian Hotel, immediately inland of the sector's northern margin (Figure 11). The beach infrastructure consists of the Royal Hawaiian Groin (built in 1927), which marks the boundary with the Halekūlani sector, and a buried seawall at the southern end of the sector.

ROYAL HAWAIIAN GROIN

The 170-foot-long Royal Hawaiian Groin, which marks the boundary of the Royal Hawaiian and Halekūlani sectors, was built to the west of the Royal Hawaiian Hotel in 1927. The groin was extended to a length of 368 feet in 1930 (Wiegel 2008:21, 26) and substantially rebuilt in 2020. The recent groin expansion included the construction of a 125-foot-long boulder rubble-mound groin overlying a portion of the existing Royal Hawaiian Groin and a 50-foot-long dog-leg to the east (Photo 2). Archaeological monitoring conducted during the groin expansion yielded no significant finds (Morrison 2020).

Photo 2. View of the renovated Royal Hawaiian Groin. Reproduced from Pennybacker (2020:B1).

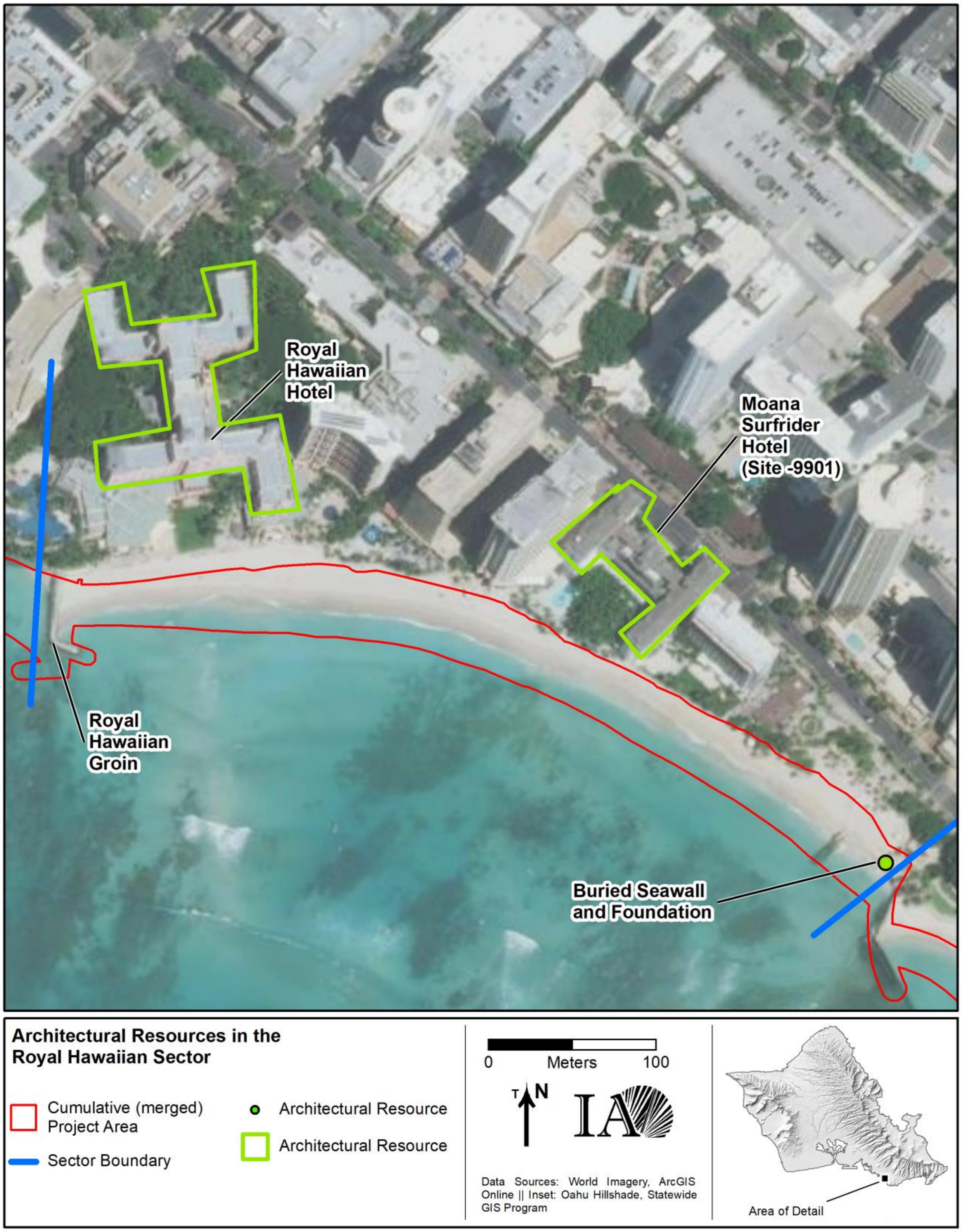


Figure 11. Architectural resources in the Royal Hawaiian sector.

BURIED SEAWALL AND FOUNDATION

A buried concrete slab was examined by SHPD staff in 2013 at the Diamond Head end of the sector, immediately west of the Kūhiō Beach Hula Mound (Nick Belluzzo, personal communication 2017) (Photo 3). Subsequent beach erosion (Photo 4) has exposed a larger portion of the concrete slab, which is in the same location as the Waikīkī Inn (part of the Waikiki Tavern) as shown on a 1950 Sanborn Fire Insurance map (Figure 12). The buildings of the Waikiki Tavern were built in the 1920s and demolished ca. 1960 for the development of Kūhiō Beach Park. A photo of the Waikiki Tavern ca. 1951 is shown in Photo 5. The buried seawall may be associated with a structure illustrated on Kanahele's (1928c) map of Waikīkī (Figure 13).

Photo 3. Buried seawall in beach sand at Diamond Head end of the Royal Hawaiian sector. Photo courtesy of Nick Belluzzo.

Photo 4. Concrete foundation exposed by erosion at the Diamond Head end of the Royal Hawaiian sector, May 17, 2017. Photo courtesy of Matt Bell.

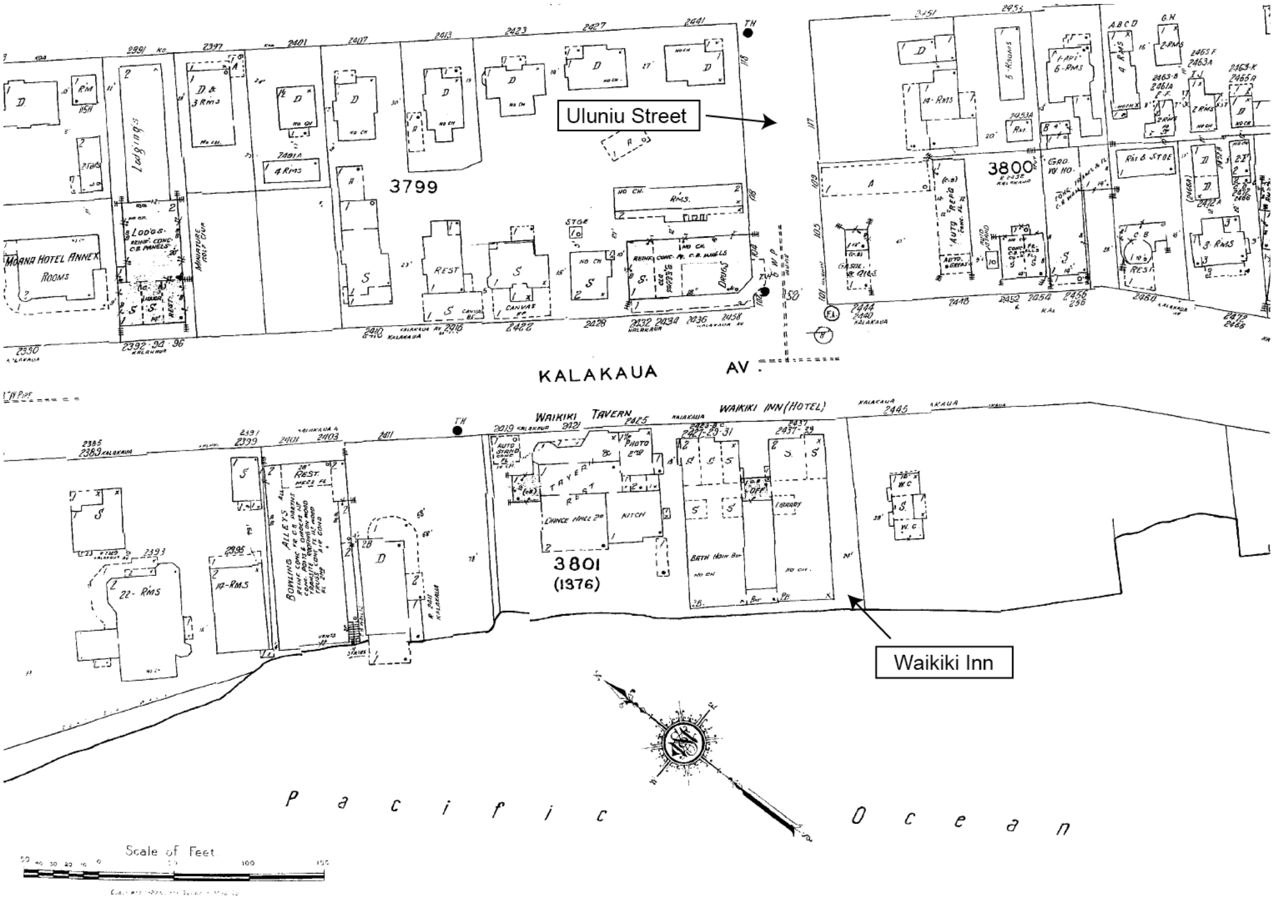


Figure 12. A 1949 Sanborn Fire Insurance map showing the Waikiki Inn (part of the Waikiki Tavern).

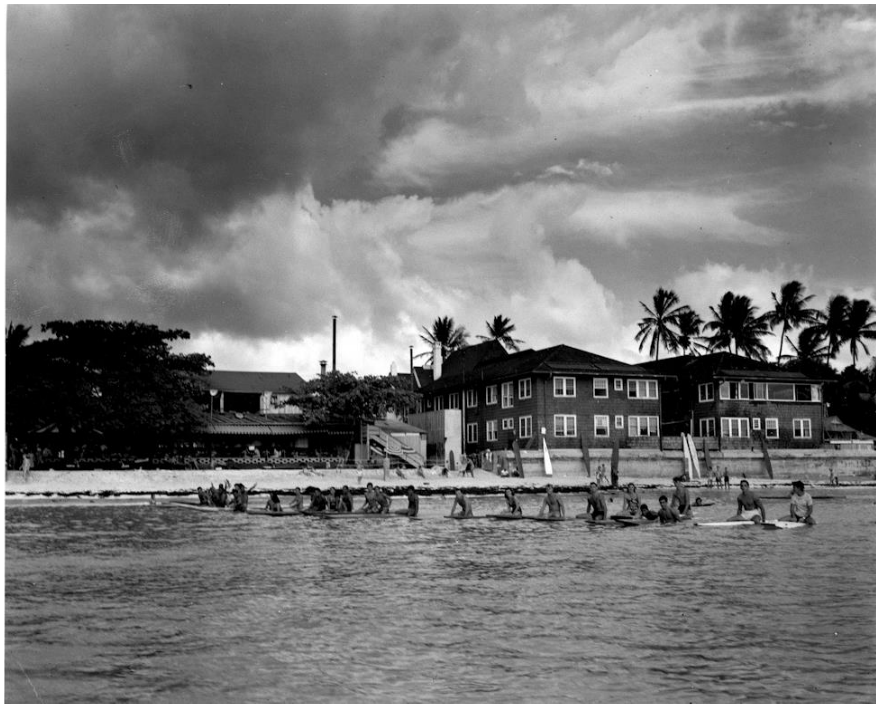
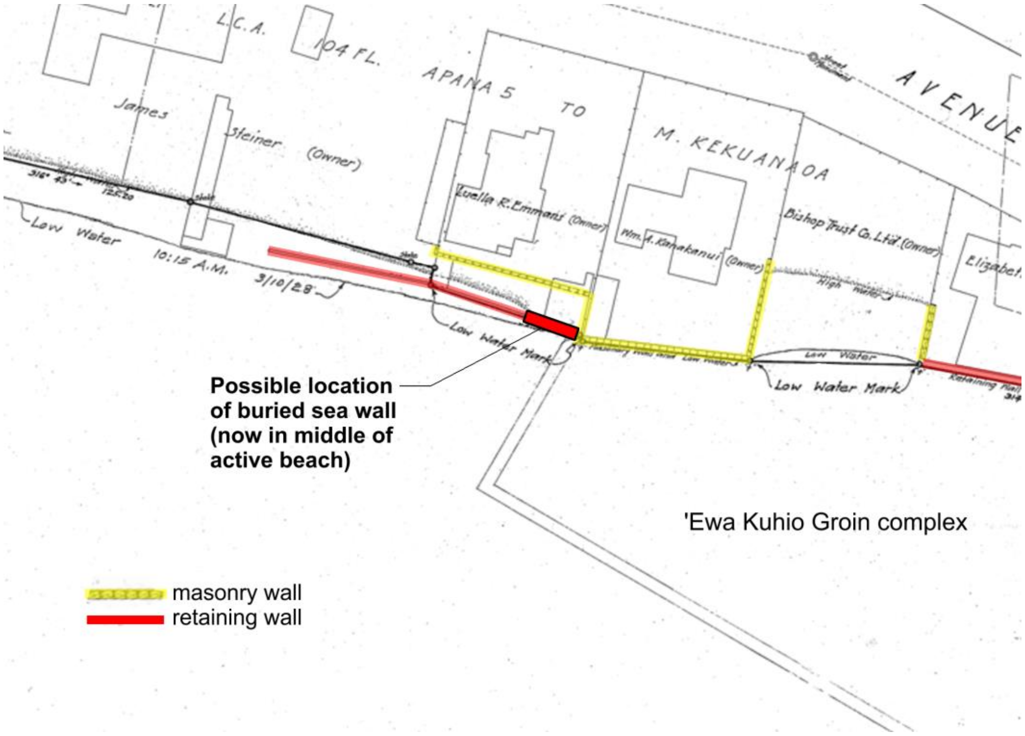


Photo 5. Surfers in front of Waikīkī Beach, ca. 1951. The building at right (containing two separate wings) is the Waikīkī Inn, which was part of the Waikiki Tavern. The building at left was also part of the Waikiki Tavern. Photo courtesy of Ian Lind.



Possible location of buried sea wall (now in middle of active beach)

Figure 13. Portion of the Kanahele (1928c) map of Waikīkī showing the possible location of the wall section exposed in Photo 3.

MOANA SURFRIDER HOTEL (SITE 50-80-14-9901)

In 1901, Waikīkī's first major hotel, the Moana, opened on the grounds of W.C. Peacock's former home on the south side of the ʻĀpuakēhau Stream mouth (Photo 6). The Moana Hotel, which was designed by O.G. Traphagen, "features an elaborately designed lobby which extends to open lanais and is open to the Banyan Court and the sea" (Riconda 1972:3). The hotel was outfitted with a 300-foot-long pier, originally called Peacock Pier, that was a landmark of the Waikīkī shoreline until it was demolished in 1931 (Wiegel 2008:21) (Photo 7). The Moana Groin was a concrete wall built into the ocean on the Diamond Head side of ʻĀpuakēhau Stream sometime between 1906 and 1907; it was removed in 1927 (Kanahele 1928c; Wiegel 2008:26). During the early 20th century, the hotel's dining room was built on piles and extended nearly to the water; this dining room has since been removed (Figure 14). Two concrete five-story wings were added onto the original four-story wooden structure in 1918, doubling the hotel's capacity (Hibbard and Franzen 1986:77).

The 21-story Surfrider Hotel opened on the western side of the Moana Hotel in 1969 (Wiegel 2008:21); the Moana and Surfrider today operate as a single establishment known as the Moana Surfrider[2].

The Moana Hotel, which has been designated as Site 50-80-14- 9901, was listed on the NRHP in 1972. According to the NRHP nomination form (Riconda 1972:3):

> The original wooden center structure of the Moana Hotel, built in 1901, is the oldest existing hotel in Waikiki. As such, it deserves recognition as a landmark in Hawaii's tourist industry. The Moana was one of the earliest "high-rise" buildings in Hawaii and was the costliest and most elaborate hotel in the islands. In spite of numerous renovations and changes, it has retained its tropical openness and is a welcome change from the more modern highrises [*sic*] that surround it. The Moana represents an important architectural link in the development of Waikiki.

Photo 6. Moana Hotel, ca. 1905. Hawaiʻi State Archives (Call No. PPWD-10-2-014).

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[2] The hotel's full name is the Moana Surfrider, a Westin Resort & Spa, Waikīkī Beach.

Photo 7. View of Moana Groin and Moana Pier, taken sometime between 1906 and 1920. Hawai‘i State Archives (Call No. PP115-12-003).

ROYAL HAWAIIAN HOTEL

In 1925-1926, the iconic Royal Hawaiian Hotel was built on the grounds of the former Seaside Hotel, and it opened in 1927 (Photo 8). The distinctive six-story building, with its pink stucco concrete façade, contributed to the coastline’s growing allure as a glamorous tourist destination. According to Hibbard and Franzen (1986:95):

> The ‘pink palace’ towered over its neighbors and had a majestic aura new to Waikīkī. Sheer massiveness, capped by a central tower that soared 150 feet above the street, enabled the Royal Hawaiian to join the Moana in dominating the beach’s palm-filled skyline. Furthermore, its four hundred rooms, each with a bath, balcony, and view of either mountains or ocean, almost doubled the guest capacity of Waikiki.

The Royal Hawaiian Hotel continues to operate in its original building. Although undoubtedly a historically significant structure, it has not been assigned an SIHP number or evaluated in terms of its eligibility for the NRHP.

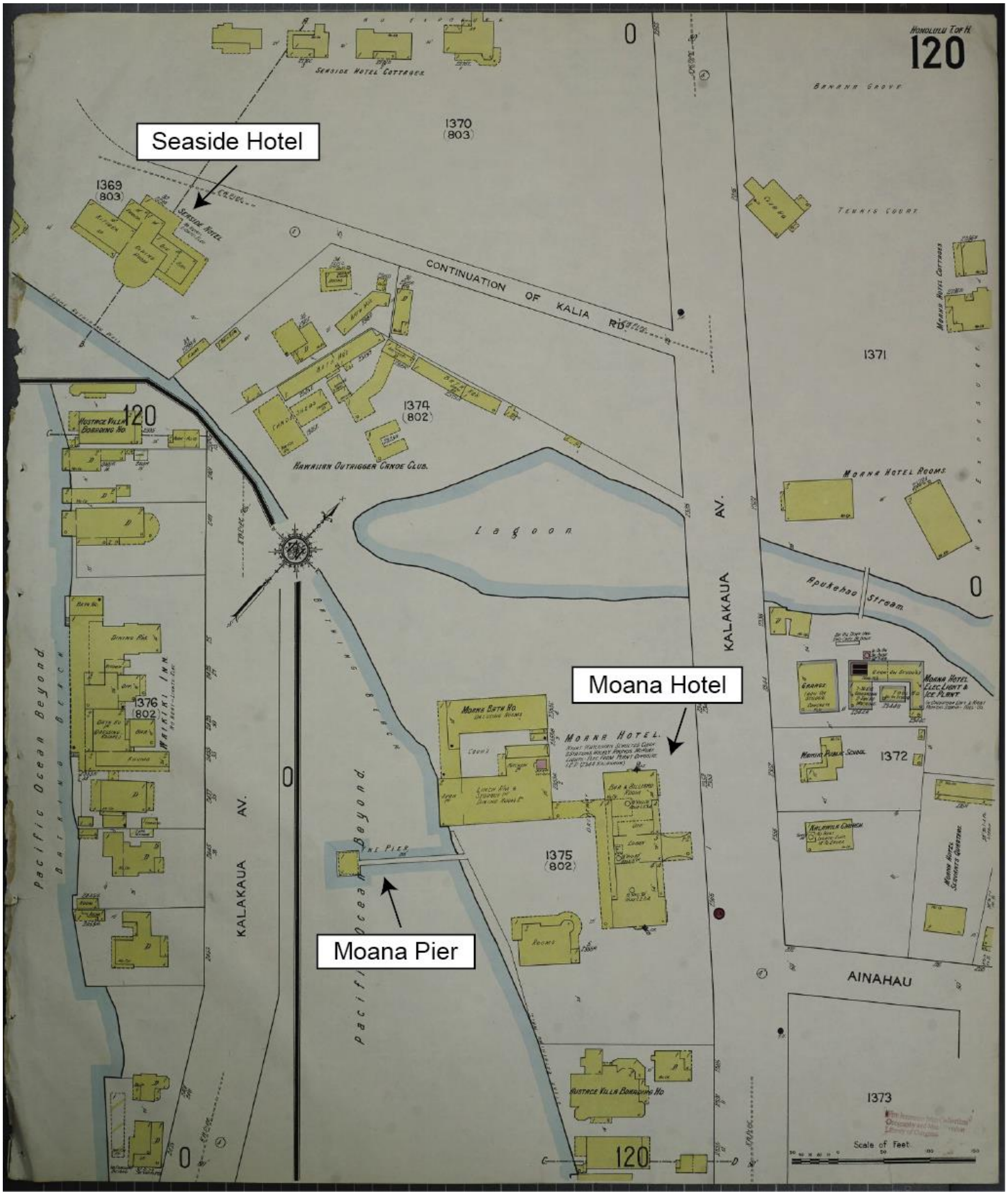


Figure 14. A 1914 Sanborn Fire Insurance map showing the location of the Moana Hotel and pier. In the hotel's early years, the dining room extended over the waterline. The Seaside Hotel is also visible at the upper left.

Photo 8. Royal Hawaiian Hotel, ca. 1928. The Royal Hawaiian Groin is visible to the left of the hotel. University of Hawaiʻi Library (Call No. B-1252).

HALEKŪLANI SECTOR

The Halekūlani Sector covers approximately 440 m (1,450 ft.) of shoreline extending from the Fort DeRussy outfall groin to the Royal Hawaiian Groin. Like the Royal Hawaiian sector, the Halekūlani sector contains the beachfronts of several major Waikīkī hotels. From south to north, the hotels are the Sheraton Waikīkī, the Halekūlani Hotel, and the Outrigger Beach Waikīkī Beach Resort.

Possible historical structures within the Halekūlani sector include five groins of uncertain ages (Figure 15).

UNNAMED GROINS

Five concrete block groins visible in aerial photographs of the Halekūlani sector may be historical structures. Similar groins can be seen in a 1932 aerial photograph (Photo 9). Eight groins were built between the Royal Hawaiian Hotel and Fort DeRussy from 1926 to 1929 (Wiegel 2008:26). Four groins in this area were removed in 1970 (Crane 1972, cited in Wiegel 2008:22).

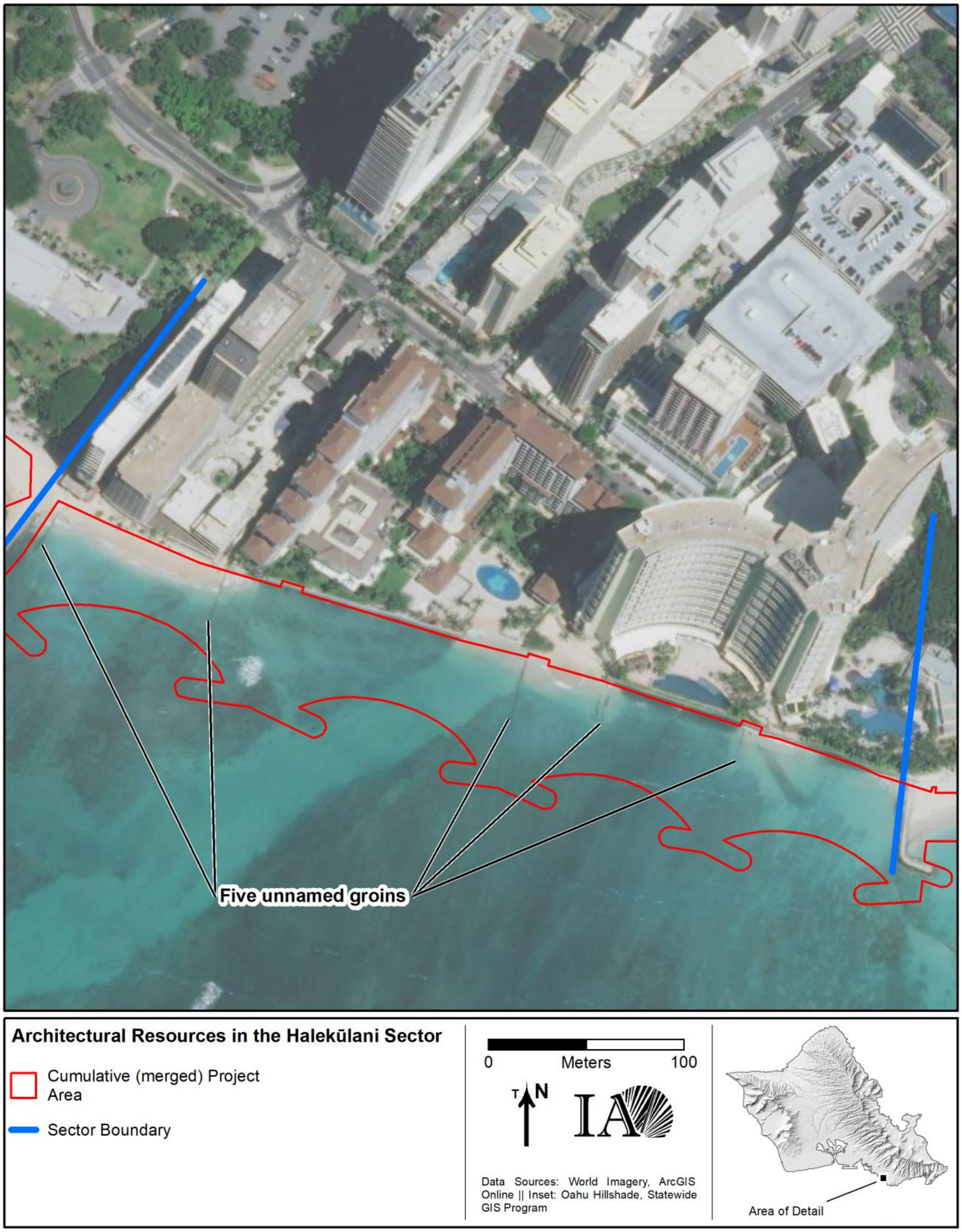


Figure 15. Architectural resources in the Halekūlani Sector.

Photo 9. A 1932 aerial photograph showing groins along the shoreline of the Halekūlani sector. Reproduced from Wiegel 2008:Figure 19.

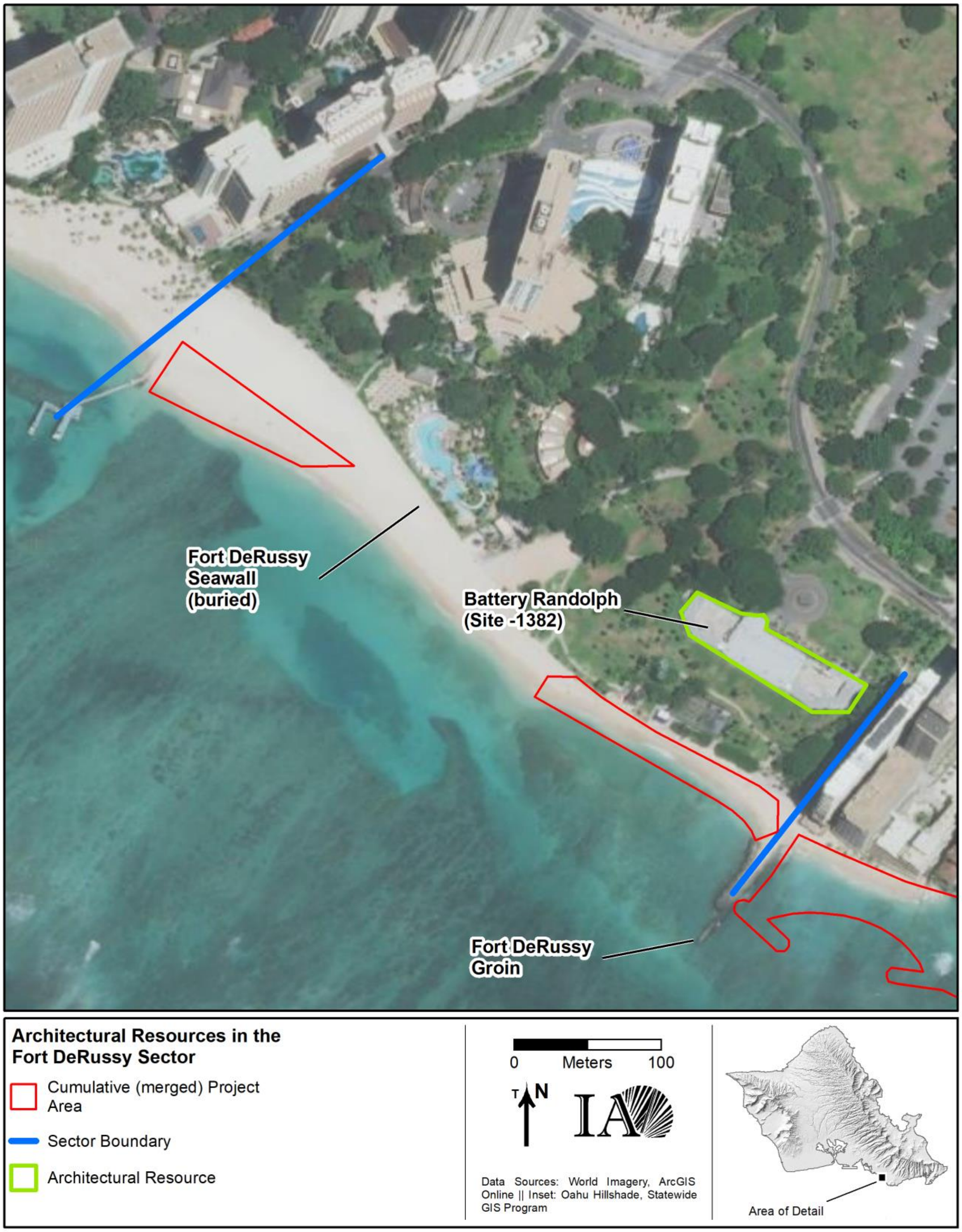
FORT DERUSSY SECTOR

The Fort DeRussy sector consists of approximately 510 m (1,680 ft.) of shoreline extending from the Hilton Hawaiian Village pier to the Fort DeRussy outfall groin. Today, the Hale Koa Hotel is just inland of the western portion of the sector and the U.S. Army Museum of Hawai‘i, housed in the historic 1914 Battery Randolph, is at the eastern end of the sector. A wide concrete promenade runs along the inland edge of the beach.

The Fort DeRussy sector contains the Fort DeRussy Groin beach control structure with Battery Randolph just inland of the sector’s northeastern boundary (Figure 16). A former seawall may also be present.

FORT DERUSSY GROIN

A 70-foot-long box culvert/groin at the Diamond Head end of the sector was built in 1917. The groin was lengthened to 300 feet in 1969 and supplemented by a rubble mound groin ca. 1971 (Wiegel 2008:22). It is unclear whether the existing groin immediately south of the Fort DeRussy Groin is the original 1917 groin, or if the 1917 groin was destroyed or covered during the 1969 extension of the structure.



Data Sources: World Imagery, ArcGIS Online || Inset: Oahu Hillshade, Statewide GIS Program

Figure 16. Architectural resources in the Fort DeRussy Sector.

FORT DERUSSY SEAWALL

In 1916, a 1,150-foot-long seawall was built along the entire Fort DeRussy Coast. The seawall was built on the coral reef where there was no sand, and the area behind it was filled with coral rock and rubble dredged from the reef (Wiegel 2008:11). Photo 10 is a 1919 aerial image of the batteries and seawall, which is estimated to lie just seaward of the present promenade.

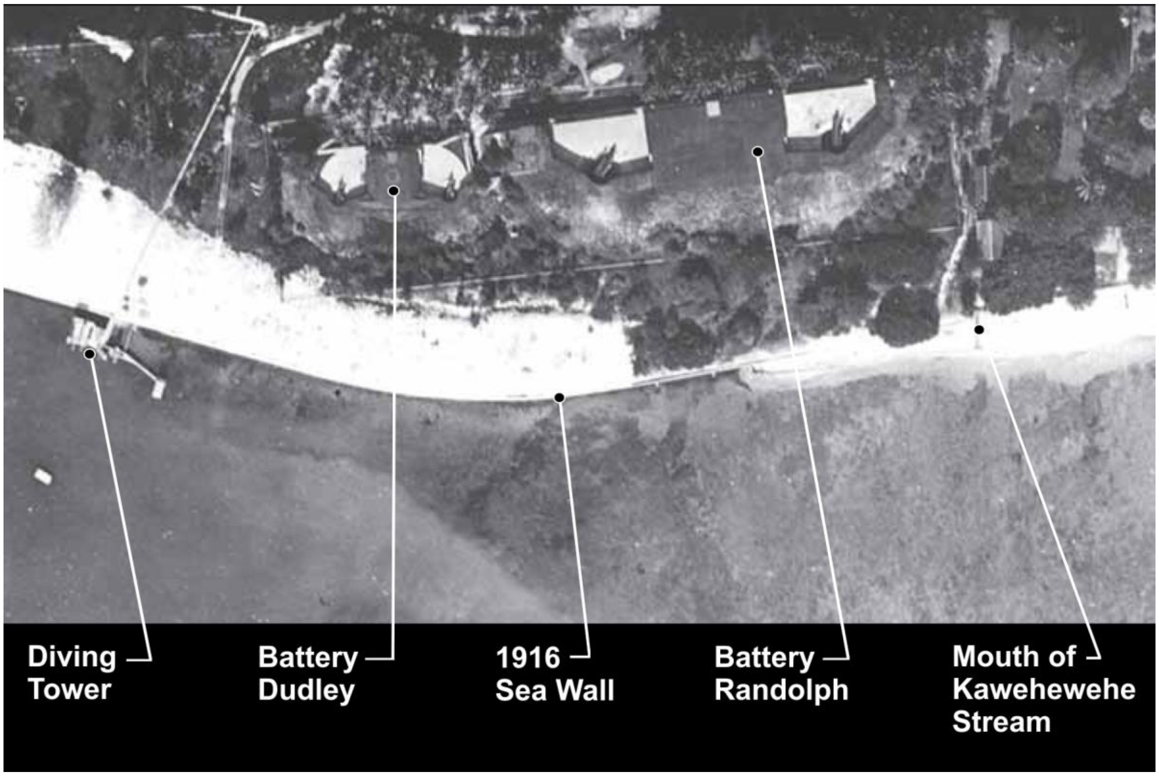


Photo 10. Aerial view of Battery Randolph and Battery Dudley, showing the straight line of the 1916 seawall (reproduced from Wiegel 2008:Figure 15). The diving tower at photo left is at the head of the channel dredged to bring the 14-inch guns to Battery Randolph (Thompson 1980:37).

BATTERY RANDOLPH (SITE 50-80-14-1382)

Construction of Battery Randolph was begun in 1910 by the U.S. Army as part of the Artillery District of Honolulu (later renamed the Headquarters Coast Defense of Oahu) intended to protect the coast of O‘ahu, including Honolulu Harbor. The Artillery District included Forts Armstrong, DeRussy, Kamehameha, and Ruger. Battery Randolph was completed and armed by 1914. Battery Dudley, which was adjacent to and northwest of Battery Randolph, was armed in 1916[3]. A deep channel was cut into the reef to facilitate the installation of two 14-inch guns.

Battery Randolph is built of reinforced concrete, with its design intended to camouflage it from military attack (Photo 11). The appearance of the building is described in its NRHP nomination:

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[3] Battery Dudley was demolished in 1970 (see Davis 1989:21).

> In contrast to the stark, vertical walls of older forts, the new works of reinforced concrete [at Fort DeRussy, including Battery Randolph, and Fort Kamehameha] were designed to blend, so far as possible, into the surrounding landscape. The low profile, massive emplacements all possess concrete frontal walls as much as twenty feet thick behind 30 or more additional feet of earth. The batteries were (and still are) all but invisible and invulnerable from the seaward direction. The permanency of construction is also evident by their present condition (Char 1983:4)

Battery Randolph was deactivated in 1944, and its guns and mounts were removed. Since 1976, the building has housed the U.S. Army Museum of Hawaii. It was entered on the NRHP in 1984 as part of the Artillery District of Honolulu (Site 50-80-14-1382) along with Batteries Selfridge, Jackson, Hawkins, Hawkins Annex, and Hasbrouck at Fort Kamehameha.

Photo 11. Battery Randolph from the ocean, 1961. U.S. Army Engineer District, Honolulu. Reproduced from the Artillery District of Honolulu (Site 1382) NRHP nomination (Char 1983).

III. EXPECTATIONS AND RECOMMENDATIONS

Historical architectural resources within the maintenance program sectors are limited to beach stabilization infrastructure, with one possible exception being a former building foundation. Two historical buildings, the Moana Surfrider and Royal Hawaiian Hotels, and one structure, Battery Randolph, are adjacent to two sectors. The shoreline structures, the oldest of which is a buried 1890 seawall in the Kūhiō Beach sector, are associated with the emergence of Waikīkī as an urban tourist destination. Additionally, the beach infrastructure in the Fort DeRussy sector may be linked thematically to the development of Oʻahu's coastal defense system in the early 20th century. While the historic buildings along the shoreline are outside the area planned for beach improvements, several beach control structures are within the project area and will likely experience impacts from the proposed project.

KŪHIŌ BEACH SECTOR

Beach improvement activities are proposed at both basins of the Kūhiō groin complex. In the Diamond Head Basin, the planned work includes the addition of approximately 4,500 cubic yards of sand between +5 and -4 feet mean sea level (msl). No alterations to the shore structures are planned. In the ʻEwa Basin, proposed work includes the addition of approximately 4,500 cubic yards of sand between +8 and -3 feet msl and the construction of a segmented breakwater partially overlapping the existing 1939 "crib wall" and adjacent shore return structures.

Beach control structures within the Kūhiō Beach Sector include the Kapahulu Storm Drain ("The Wall"), "Slippery Wall", the "crib wall," and shore return structures on either side of the crib wall. The 1939 crib wall and adjacent shore return structures, which will be partially covered by the proposed addition of a segmented breakwater, have the potential to incur significant impacts.

RECOMMENDATIONS

Preparation of a Historic American Engineering Record (HAER) for the Kūhiō groin complex to mitigate any potential adverse effects caused by the maintenance program is recommended.

ROYAL HAWAIIAN SECTOR

Beach improvement activities proposed for the Royal Hawaiian sector include the addition of approximately 25,000 cubic yards of sand fill between +8.5 and -2 feet msl.

Historic buildings along the shoreline in the Royal Hawaiian Sector include the Moana Surfrider and Royal Hawaiian Hotels; beach control structures comprise the Royal Hawaiian Groin (recently rebuilt), and a buried seawall and foundation. The proposed project work will not result in disturbance to the shoreline hotels, which are behind the active beach. The addition of sand fill is not expected to result in disturbance to the Royal Hawaiian Groin or the possible buried seawall or foundation. The seawall or foundation will likely no longer be visible beneath the sand fill but is unlikely to experience significant impacts.

RECOMMENDATIONS

Historic preservation documentation and review of the remaining portions of the original Royal Hawaiian Groin prior to commencement of the project is recommended. Also recommended is historic preservation documentation and review of the exposed seawall and possible Waikiki Inn/Tavern foundation at the eastern end of the sector.

HALEKŪLANI SECTOR

Beach improvement activities proposed for the Halekūlani sector include the addition of approximately 60,000 square yards of sand fill between +8.5 feet and -3 feet msl. The construction of five groins between the Royal Hawaiian Groin and the Fort DeRussy Box Culvert/Groin is also planned.

The Halekūlani sector contains five groins possibly built between 1926 and 1929, although the northernmost of these may be the 1917 groin built at Fort DeRussy. The proposed construction of several new groins within the Halekūlani sector is likely to result in significant disturbance to the existing groins.

RECOMMENDATIONS

Preparation of a HAER for the existing groins to mitigate any potential adverse effects caused by the maintenance program is recommended.

FORT DERUSSY SECTOR

Beach improvement activities proposed for the Fort DeRussy sector include the addition of approximately 1,500 cubic yards of sand fill near the Diamond Head edge. A sand borrow area is proposed at the ʻEwa end of the sector adjacent to the Hilton Hawaiian Village pier. The proposed project work will be confined to the area *makai* of the Fort DeRussy seawall, which consists of beach constructed during the 20th century.

The shoreline within the Fort DeRussy sector contains the Fort DeRussy Groin and presumably a now-buried 1917 seawall. The 1914 Battery Randolph is well beyond the active beach and will not be affected by the maintenance program. The Fort DeRussy Groin is at the Diamond Head end of the Fort DeRussy sector, separating it from the Halekūlani sector. Installation of new rock rubble mound groins on the Halekūlani-side of the Fort DeRussy groin may affect this structure.

RECOMMENDATIONS

Preparation of a HAER for the Fort DeRussy Groin to mitigate any potential adverse effects caused by the maintenance program is recommended.

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1928b [map] *Waikiki Beach from Ala Wai (Canal) to Kalakaua Avenue opposite Ohua Avenue, Waikiki, Honolulu, Oahu, T.H.* Scale 40 feet=1 inch. Survey made for Board of Harbor Commissioners of the Territory of Hawaii, as provided for by Act 273, Session Laws of 1927. Government Registered Map 2799, Sheet 2 of 3. On file at Land Division, Department of Land and Natural Resources, State of Hawai‘i, Honolulu.

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GLOSSARY OF HAWAIIAN WORDS

Hawaiian Spelling*	Definition
ali‘i	chief, chiefess, officer, ruler, monarch, peer, headman, noble, aristocrat, king, queen, commander
heiau	temple, shrine
maka‘āinana	commoner
makai	toward the sea
mauka	toward the mountain, or inland

* Adapted from Mary K. Pukui and Samuel H. Elbert, 1986, *Hawaiian Dictionary*, University of Hawaii Press, Honolulu, unless otherwise noted.

29. APPENDIX G: EISPN COMMENTS AND RESPONSES

The Store With Aloha

ABC Stores
766 Pohukaina Street
Honolulu, Hawaii 96813-5391
www.abcstores.com

Telephone: (808) 591-2550
Fax: (808) 591-2039
E-mail: mail@abcstores.com

January 07, 2020

TO:
Sam Lemmo, Administrator
Office of Conservation and Coastal Lands
Department of Land and Natural Resources, State of Hawaii
1151 Punchbowl Street, Room 131
Honolulu, Hawaii 96813

FROM:
Paul Kosasa, President CEO
ABC Stores
766 Pohukaina Street
Honolulu, Hawaii 96813

SUBJECT: Environmental Impact Statement Preparation Notice (EISPN) for the Waikīkī Beach Improvement and Maintenance Project. Waikīkī Beach, Oahu

ABC Stores **strongly supports** the proposed beach improvement projects by the Hawaiʻi Department of Land and Natural Resources (DLNR). The DLNR proposes beach improvement and maintenance projects in the Fort DeRussy, Halekulani, Royal Hawaiian, and Kūhiō Beach sectors of Waikīkī. These projects include the construction of new beach stabilization structures, and the recovery of offshore sand and its placement on the shoreline. The objectives of the proposed actions are to restore and improve Waikīkī's public beaches, increase beach stability through improvement and maintenance of shoreline structures, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise. The proposed actions are intended to maintain the economic, social, aesthetic, recreational, environmental, cultural, and historical qualities of Waikīkī.

Over the past several years, and as recently as November of 2020, Waikiki has experienced record high tides (King Tides) that have exacerbated erosion and flooding. These events have highlighted the impacts of sea level rise on the beaches of Waikīkī. As sea levels continue to rise, beach loss will progressively degrade the recreational, social, cultural, environmental, aesthetic, and economic value of Waikīkī. After nearly 50 years of no new beach stabilization projects in Waikīkī, we are now at a crossroads with a clear and increasingly urgent need to implement maintenance and improvements to the shoreline in order to preserve and protect this unique and highly prized natural resource.

We strongly support these improvement projects and recognize its urgency. With the combination of beach erosion and King Tides, the backshore is frequently flooded, particularly during high surf events, accelerating damage to backshore infrastructure. Without beach improvements and maintenance, sea level rise is likely to result in total beach loss in Waikīkī before the end of the century and result in an estimated economic loss of $50 million to $150 million per hectare[1]. The loss of Waikīkī Beach alone would result in an annual loss of $2.223 billion in visitor expenditures[1]. Improvements and maintenance like those proposed in the EISPN are necessary to restore and maintain the beaches of Waikīkī to continue to support Hawaii's tourism-based economy.

We offer the following summary of project-specific comments.

1. The proposed beach improvement projects in Waikīkī are essential for the future goal to maintain a viable beach in these areas. Several beachfront areas in Waikīkī are seeing the rapid deterioration of both public and private backshore infrastructure such as groins, seawalls and walkways. This highlights the need to make long-term investments into beach stabilizing structures throughout Waikīkī in addition to more immediate emergency repairs to damaged infrastructure.

2. Climate change impacts including sea-level rise projected by the state of Hawaiʻi Climate Change Commission indicate significant flooding, wave overtopping and beach erosion in Waikīkī for the coming decades and suggest stakeholders and communities plan for 3.2 feet of sea-level rise now. This project has a strong climate change adaption component that is consistent with the recommendations of the State Climate Commission.

3. Without a stabilizing and energy-buffering beach to protect public and private coastal infrastructure, the WBSIDA anticipates even larger and more expensive structural repair and improvement projects to be required soon to prevent the destruction of threatened coastal structures.

Thank you for the opportunity to provide comments on this project.

---

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DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
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

June 4, 2021

Paul Kosasa, President CEO
ABC Stores
766 Pohukaina Street
Honolulu, Hawaii 96813

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Kosasa:

Thank you for your comment letter dated January 7, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you state that you strongly support the proposed beach improvement and maintenance actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

We recognize that you provided three project-specific comments, all in support of the proposed actions. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement (DPEIS).

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

DAVID Y. IGE
GOVERNOR

CURT T. OTAGURO
COMPTROLLER

AUDREY HIDANO
DEPUTY COMPTROLLER

STATE OF HAWAII
DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES
P.O. BOX 119, HONOLULU, HAWAII 96810-0119

(P)21.001

JAN - 7 2020

Mr. Andy Bohlander
Sea Engineering, Inc.
Makai Research Pier
41-305 Kalanianaole Highway
Waimanalo, HI 96795

Dear Mr. Bohlander:

Subject: Environmental Impact Statement Preparation Notice
Waikiki Beach Improvement and Maintenance Program
Kona District, Island of Oahu

Thank you for the opportunity to provide comments on the subject project. The project does not impact any of the Department of Accounting and General Services' projects or existing facilities, and we have no comments to offer at this time.

If you have any questions, your staff may call Mr. David DePonte of the Planning Branch at 586-0492.

Sincerely,

CHRISTINE L. KINIMAKA
Public Works Administrator

DD
c: Mr. Dean Shimomura, DAGS CSD

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
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BUREAU OF CONVEYANCES
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ENGINEERING
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HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

June 4, 2021

Christine Kinimaka, Public Works Administrator
Department of Accounting and General Services
State of Hawaii
P.O. Box 119
Honolulu, Hawaii 96810-9119

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Ms. Kinimaka:

Thank you for your comment letter dated January 7, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

We acknowledge that the project does not impact any of the Department of Accounting and General Services' projects or existing facilities.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

From: Bob Fowler <lumbob.tennis@gmail.com>
Sent: Tuesday, January 12, 2021 12:51 PM
To: Andy Bohlander

Why wasn't sea level rise discussed in your article written by Allison Schaefers of the Star Advertiser? We need to spend our money on diverse income other then tourism in these troubling times.

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
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M. KALEO MANUEL
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HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

June 4, 2021

Bob Fowler
lumbob.tennis@gmail.com

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Fowler:

Thank you for your email dated January 12, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your email you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: "Why wasn't sea level rise discussed in your article written by Allison Schaefers of the Star Advertiser? We need to spend our money on diverse income other than tourism in these troubling times."

> **Response:** Thank you for your comment. The article you referenced in your letter notes that one of the objectives of the Waikīkī Beach Improvement and Maintenance Program is "to increase resilience to coastal hazards and sea level rise".
>
> The Program consists of *beach improvement* actions and *beach maintenance* actions. *Beach improvements* refers to actions that involve adding new sand, adding new structures, and/or modifying existing structures. *Beach maintenance* refers to actions that involve using existing sand or adding sand with no new structures or modification of existing structures.
>
> The proposed beach improvement actions in the Halekūlani beach sector and the ʻEwa (west) basin of the Kūhiō beach sector are designed to create a stable beach profile. The designs account for 1.5 ft of sea level rise and can be adapted to accommodate up to 2.7 ft of sea level rise. We anticipate that the beaches would be stable and periodic renourishment would not be required.

The proposed beach maintenance action in the Fort DeRussy beach sector is sand backpassing, which would involve recovering existing sand from the accreted area at the west end of the beach and placing it in the eroded area at the east end of the beach. Sand would be excavated from the beach face extending inshore only as far as necessary to obtain the required volume of sand. The proposed action would not require offshore dredging and there would be no increase in the volume of sand in the littoral system. The proposed action is intended to be conducted on a periodic basis and may be adapted as sea levels continue to rise.

The proposed beach maintenance action in the Diamond Head (east) basin of the Kūhiō beach sector is sand pumping, which would involve recovering approximately 4,500 cy of existing sand from within the basin onto the dry beach. The proposed action would not require offshore dredging and there would be no increase in the volume of sand in the basin. The proposed action is intended to be conducted on a periodic basis and may be adapted as sea levels continue to rise.

The proposed beach maintenance action in the Royal Hawaiian beach sector is beach nourishment, which would involve recovering approximately 25,000 cy of sand from the *Canoes/Queens* offshore sand deposit and placing it on the beach. This is the only action proposed that would require periodic renourishment to maintain the beach at its 1985 location. The *Canoes/Queens* offshore sand deposit consists of sand that has eroded from Royal Hawaiian Beach. This sand source has been used in previous beach nourishment projects in 2012 and 2021. Reusing this sand on a periodic basis would not increase in the volume of sand in the littoral system.

For more information about anticipated project lifespans, please see Section 3.3 of the DPEIS. For more information about sea level rise, please see Section 8.3.5 of the DPEIS.

We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement (DPEIS).

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

From:	sidney sealine <sidneysealine@yahoo.com>
Sent:	Tuesday, January 12, 2021 1:25 PM
To:	Andy Bohlander
Subject:	Suggestion how to save Waikiki Beach

January 12th 2021

Dear Mr. Bohlander:

I just read your article in today's star advertiser where you solicit suggestions on how to save Waikiki Beach. I am a retired lawyer who has lived in my condo in Waikiki for 10 years. Before that I lived for 14 years in a beachfront apartment in Cancun Mexico.

During my residence in Cancun ... the city and indeed the Yucatan peninsula was struck by a major hurricane named Wilma. It recorded the lowest barometric pressure reading of any hurricane in the history of the Caribbean and it wiped out the formerly magnificent indeed famously magnificent Beach in Cancun.

To restore the beach Cancun hired a company who performed what I consider an absolutely miraculous job of restoring that magnificent beach. Because my unit overlooked the beach I was able to take videos which demonstrate the incredible job they accomplished.

If you are interested let me know and I will forward to you the videos which demonstrate the miracle this company performed. Your job ... if you are sufficiently motivated ... would be to contact the government there in Cancun and find out the name and contact information of the company that restored Cancun's beach after it was destroyed by hurricane Wilma.

If you are truly and sincerely interested you will contact me and if you're not then you won't.

Kind regards.

SIGNED: SIDNEY SEALINE
EMAIL: sidneysealine@yahoo.com
USA CELL PHONE: +1 310 876 9175
USA FAX: 1 206 350 8917
WhatsApp: + 1 310 876 9175

"Carpe diem, quam minimum credula postero." Seize the day, trusting as little as possible in the future." Horace - Odes. 23 B.C."

From:	sidney sealine <sidneysealine@yahoo.com>
Sent:	Saturday, January 16, 2021 11:59 AM
To:	Andy Bohlander
Subject:	Re: Suggestion how to save Waikiki Beach

january 16, 2021

i sent you the below email four days ago. it is of great importance to your upcoming project but you never even acknowledged receipt of that letter.

the company was a DUTCH company.

SIGNED: SIDNEY SEALINE
E-MAIL: sidneysealine@yahoo.com
USA CELL PHONE: +1 310 876 9175
USA FAX: + 1 206 350 8917
WhatsApp: +1 310 876 9175
"Carpe diem, quam minimum credula postero." Seize the day, trusting as little as possible in the future. Horace - Odes. 23 B.C.

On Tuesday, January 12, 2021, 01:25:27 PM HST, sidney sealine <sidneysealine@yahoo.com> wrote:

January 12th 2021

Dear Mr. Bohlander:

I just read your article in today's star advertiser where you solicit suggestions on how to save Waikiki Beach. I am a retired lawyer who has lived in my condo in Waikiki for 10 years. Before that I lived for 14 years in a beachfront apartment in Cancun Mexico.

During my residence in Cancun ... the city and indeed the Yucatan peninsula was struck by a major hurricane named Wilma. It recorded the lowest barometric pressure reading of any hurricane in the history of the Caribbean and it wiped out the formerly magnificent indeed famously magnificent Beach in Cancun.

To restore the beach Cancun hired a company who performed what I consider an absolutely miraculous job of restoring that magnificent beach. Because my unit overlooked the beach I was able to take videos which demonstrate the incredible job they accomplished.

If you are interested let me know and I will forward to you the videos which demonstrate the miracle this company performed. Your job ... if you are sufficiently motivated ... would be to contact the government there in Cancun and find out the name and contact information of the company that restored Cancun's beach after it was destroyed by hurricane Wilma.

If you are truly and sincerely interested you will contact me and if you're not then you won't.

Kind regards.

SIGNED: SIDNEY SEALINE
EMAIL: sidneysealine@yahoo.com
USA CELL PHONE: +1 310 876 9175
USA FAX: 1 206 350 8917
WhatsApp: + 1 310 876 9175

"Carpe diem, quam minimum credula postero." Seize the day, trusting as little as possible in the future." Horace - Odes. 23 B.C."

DAVID Y. IGE
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SUZANNE D. CASE
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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 4, 2021

Sidney Sealine
sidneysealine@yahoo.com

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Sealine:

Thank you for your emails dated January 12 and 16, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your email you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: "During my residence in Cancun ... the city and indeed the Yucatan peninsula was struck by a major hurricane named Wilma. It recorded the lowest barometric pressure reading of any hurricane in the history of the Caribbean and it wiped out the formerly magnificent indeed famously magnificent Beach in Cancun. To restore the beach Cancun hired a company who performed what I consider an absolutely miraculous job of restoring that magnificent beach. Because my unit overlooked the beach I was able to take videos which demonstrate the incredible job they accomplished. If you are interested let me know and I will forward to you the videos which demonstrate the miracle this company performed. Your job ... if you are sufficiently motivated ... would be to contact the government there in Cancun and find out the name and contact information of the company that restored Cancun's beach after it was destroyed by hurricane Wilma."

> **Response:** Contractor selection is not part of the environmental review process and will be completed after the final designs are completed and the necessary permits are approved. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement (DPEIS).

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

Andy Bohlander

From: Mandy Blake <mblake47@punahou.edu>
Sent: Tuesday, January 12, 2021 1:31 PM
To: Andy Bohlander
Subject: Waikiki Beach

Today's newspaper article on Waikiki beach... does not mention Gray's Beach. Being a keiki o ka aina, I recall walking along the wall that bordered it. Since my neighbor was Ernest Gray, I remember it well. Gray's Beach is pictured/listed in the O'ahu Mapbook, 2004 edition.

I am too old to attend meetings. And not competent with computers (I do try!)

I look forward to a follow-up article in the newspaper. Mahalo, Mandy Bowers

--
Mandy Blake Bowers

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
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DEPUTY DIRECTOR - WATER

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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 4, 2021

Mandy Blake Bowers
mblake47@punahou.edu

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Ms. Blake Bowers:

Thank you for your email dated January 12, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your email you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawai‘i Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: **“**Today's newspaper article on Waikiki beach... does not mention Gray's Beach. Being a keiki o ka aina, I recall walking along the wall that bordered it. Since my neighbor was Ernest Gray, I remember it well. Gray's Beach is pictured/listed in the O'ahu Mapbook, 2004 edition. I am too old to attend meetings. And not competent with computers (I do try!). I look forward to a follow-up article in the newspaper.”

> **Response:** Thank you for your comment. The Halekūlani beach sector is often referred to as “Gray’s Beach” in reference to a boardinghouse called “Gray's by the Sea” that existed at this site in the early 1900’s, and the “Gray’s Hotel (now the Halekūlani Hotel), which was constructed in 1916.

We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

Andy Bohlander

From: Bob Hampton <bob@waikikibeachactivities.com>
Sent: Tuesday, January 12, 2021 4:02 PM
To: Andy Bohlander
Subject: Environmental Impact Statement Preparation Notice (EISPN) for the Waikīkī Beach Improvement and Maintenance Project. Waikīkī Beach, Oahu

Aloha Andy:

Waikiki Beach Activities, Ltd. has served Hilton on Waikiki Beach and in Mamala Bay for over 30 years, operating Hilton's full service beach operation and our full service catamarans from the Hilton Pier on Duke Kahanamoku Beach. We have watched first-hand the deterioration of Waikiki Beach due to Sea Level Rise and we know first-hand the immediate need to provide safe access to and along all of Waikiki shoreline and increased resilience to coastal hazards.

Although, no action is proposed at this time for Duke Kahanamoku Beach which is an extremely important part of the Waikiki Beach community it should also be included in all planning for beach improvements such as increased beach stability through improvement and maintenance of shoreline structures.

I first became aware of the gravity of Sea Level Rise (SLR) and its growing impact on islands in the Pacific while attending the International Union of Conservation of Nature Summit (IUCN) held at Hilton Hawaiian Village in September 2016. Governor Ige along with 25 South Pacific nations were there, each telling of how they were adapting to the reality of SLR. From Tahiti to Samoa and Tonga to Cook Island, each of their leaders described the ongoing flooding, erosion and devastation to their beaches as a result of SLR.

Just over a year later, an alarm went off when Hawaii’s Attorney General issued a 12-page legal opinion to the Department of Land and Natural Resources confirming that *whenever the high wash of the waves extends onto private property, the boundary line demarking State ownership automatically and without notification adjusts, thereby granting the State ownership of the newly-wetted private property (Oceanfront Hotels).* According to the ruling, the ownership is immediate, permanent and cannot be contested.

Then about four months later, Waikiki was hit by a new and growing phenomenon called *King Tides* that rose up and over Waikiki Beaches spreading onto the surrounding sidewalks, just feet (and in some cases inches) from Oceanfront hotel-owned “private property.”

Because the AG’s opinion stated that the wash of the waves includes sea level rise, it is now very clear that SLR threatens all of the Oceanfront hotels causing them to possible loss of their title to critical portions of their hotels forcing them to address the question of what to do with their structures that sit on the land that’s title now belongs to the state. The answer to this question is clear. For the former owner (Oceanfront hotel) to continue to use their structure they must secure an easement from the State for the land that lies under their hotel improvements. And according to the law the former owner must pay fair market rent for the property they once owned prior to the “Wash of the Waves.”

The very big question of how to adapt to SLR and prevent this catastrophe from occurring is before us right now. Because seawalls are unsightly, restrictive and almost impossible to get permitted, the simplest and most cost-effective adaptation solution is to repair our existing groins and build up the height of the beach by way of sand replenishment. This is the best solution for all Oceanfront hotels on Waikiki Beach. DLNR together with the private sector propose to do this now. Doing it now is critical as we are probably only a couple more King Tides from a disastrous “*wash of the waves*.”

Adaptation raises the pragmatic question: Where does the funding come from to raise Waikiki Beach? In regard to building a “sand defense” against rising ocean levels, we are looking at inches maybe a foot in height to meet the possible SLR in the next couple of years, maybe even provide protection for the next decade.

The Legislature which is to open this month needs to find State funding and to support the private sector in this all-out effort to adapt to SLR now. Funding now can prevent the possible worst-case scenario of a contentious property rights dispute which is sure to result as outlined in the Attorney General’s December 11, 2017 Opinion to DLNR.

Furthermore, in Deeds and Agreements dating back to the 40s’ and 50s’ between the Territorial Government and the Oceanfront hotels, the Territory, now State, promised the Waikiki Oceanfront hotel owners that the government would “permanently maintain” the newly created Waikiki Beach. Adaptation to SLR requires that the State’s promise be kept now.

Time is of the essence. If we do not adapt to SLR <u>this year</u>, 2021, the Big Story in late 2021-2022 could be**:**

“Some Waikiki Waterfront Hotels have lost their property titles to the State due to Rising Sea Levels. According to the State’s Attorney General and the State Supreme Courts Recent Rulings, ownership by the State is <u>immediate, permanent and cannot be contested</u>. The Oceanfront hotels that lost their property tiles are claiming it is the States fault for failure to protect Waikiki Beach as they promised to do in their prior written agreements.”

Aloha,

Bob Hampton

(808) 479-9947

Chairman, Waikiki Beach Activities, LTD.

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

SUZANNE D. CASE
CHAIRPERSON
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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

June 4, 2021

Mr. Bob Hampton, Chairman
Waikiki Beach Activities, Ltd.
bob@waikikibeachactivities.com

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Hampton:

Thank you for your email dated January 12, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawai‘i Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: “Although, no action is proposed at this time for Duke Kahanamoku Beach which is an extremely important part of the Waikiki Beach community it should also be included in all planning for beach improvements such as increased beach stability through improvement and maintenance of shoreline structures.”

> **Response:** Selection of the proposed beach improvement and maintenance actions was a primarily stakeholder-driven process. We relied heavily on feedback and direction from the Waikīkī Beach Community Advisory Committee (WBCAC) to identify issues, needs, priorities, and design criteria for beach sector. The sectors that were selected for beach improvement and maintenance actions were identified as the highest priorities by the WBCAC. While the other beach sectors of Waikiki – Duke Kahanamoku, Queens, Kapi‘olani, and Kaimana - were not identified as priorities by the WBCAC, these areas are clearly important and we recognize that, as sea levels continue to rise, beach improvements and/or maintenance may be required in these beach sectors in the future. For more information about the WBCAC and the project selection process, please see Section 2 and Appendix A of the DPEIS.

Comment: “Where does the funding come from to raise Waikiki Beach? In regard to building a “sand defense” against rising ocean levels, we are looking at inches maybe a foot in height to meet the possible SLR in the next couple of years, maybe even provide protection for the next decade. The Legislature which is to open this month needs to find State funding and to support the private sector in this all-out effort to adapt to SLR now."

> **Response:** The proposed actions will be funded by a combination of public and private funds. In 2019, the Hawai‘i State Legislature appropriated $8,850,000 to support beach improvement and maintenance projects in Waikīkī with up to $3 million of this support provided by the Waikīkī Beach Special Improvement District Association (WBSDIA). For additional information regarding funding for the proposed beach improvement and maintenance actions, please Section 2.2 of the DPEIS.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement (DPEIS).

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

January 13, 2021

TO:
Sam Lemmo, Administrator
Office of Conservation and Coastal Lands
Department of Land and Natural Resources, State of Hawaii
1151 Punchbowl Street, Room 131
Honolulu, Hawaii 96813

FROM:
Brett Greenberg, Regional Director
Aqualani Beach & Ocean Recreation

SUBJECT: Environmental Impact Statement Preparation Notice (EISPN) for the Waikīkī Beach Improvement and Maintenance Project. Waikīkī Beach, Oahu

The Aqualani Beach & Ocean Recreation **strongly supports** the proposed beach improvement projects by the Hawaiʻi Department of Land and Natural Resources (DLNR). The DLNR proposes beach improvement and maintenance projects in the Fort DeRussy, Halekulani, Royal Hawaiian, and Kūhiō Beach sectors of Waikīkī. These projects include the construction of new beach stabilization structures, and the recovery of offshore sand and its placement on the shoreline. The objectives of the proposed actions are to restore and improve Waikīkī's public beaches, increase beach stability through improvement and maintenance of shoreline structures, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise. The proposed actions are intended to maintain the economic, social, aesthetic, recreational, environmental, cultural, and historical qualities of Waikīkī.

Over the past several years, and as recently as November of 2020, Waikiki has experienced record high tides (King Tides) that have exacerbated erosion and flooding. These events have highlighted the impacts of sea level rise on the beaches of Waikīkī. As sea levels continue to rise, beach loss will progressively degrade the recreational, social, cultural, environmental, aesthetic, and economic value of Waikīkī. After nearly 50 years of no new beach stabilization projects in Waikīkī, we are now at a crossroads with a clear and increasingly urgent need to implement maintenance and improvements to the shoreline in order to preserve and protect this unique and highly prized natural resource.

We strongly support these improvement projects and recognize its urgency. With the combination of beach erosion and King Tides, the backshore is frequently flooded, particularly during high surf events, accelerating damage to backshore infrastructure. Without beach improvements and maintenance, sea level rise is likely to result in total beach loss in Waikīkī before the end of the century and result in an estimated economic loss of $50 million to $150 million per hectare[1]. The loss of Waikīkī Beach alone would result in an annual loss of $2.223 billion in visitor expenditures[1]. Improvements and maintenance like those proposed in the EISPN are necessary to restore and maintain the beaches of Waikīkī to continue to support Hawaii's tourism-based economy.

We offer the following summary of project-specific comments.

1. The proposed beach improvement projects in Waikīkī are essential for the future goal to maintain a viable beach in these areas. Several beachfront areas in Waikīkī are seeing the rapid deterioration of both public and private backshore infrastructure such as groins, seawalls and walkways. This highlights the need to make long-term investments into beach stabilizing structures throughout Waikīkī in addition to more immediate emergency repairs to damaged infrastructure.

2. Climate change impacts including sea-level rise projected by the state of Hawai'i Climate Change Commission indicate significant flooding, wave overtopping and beach erosion in Waikīkī for the coming decades and suggest stakeholders and communities plan for 3.2 feet of sea-level rise now. This project has a strong climate change adaption component that is consistent with the recommendations of the State Climate Commission.

3. Without a stabilizing and energy-buffering beach to protect public and private coastal infrastructure, the WBSIDA anticipates even larger and more expensive structural repair and improvement projects to be required soon to prevent the destruction of threatened coastal structures.

Thank you for the opportunity to provide comments on this project.

---

[1] Tarui, N., Peng, M., Eversole, D. (2018). *Economic Impact Analysis of the Potential Erosion of Waikīkī Beach*. University of Hawai'i Sea Grant College Program. April 2018.

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

June 4, 2021

Brett Greenberg, Regional Director
Aqualani Beach & Ocean Recreation
bgreenberg@aqualani.com

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Greenberg:

Thank you for your email dated January 13, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you express your strong support for the proposed beach improvement and maintenance actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

We recognize that you provided three project-specific comments, all in support of the proposed actions. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement (DPEIS).

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

Waikiki

From: Russell Leong <mr_russ@hotmail.com>
Sent: Thursday, January 14, 2021 9:21 AM
To: Waikiki
Subject: COMMENTS - Waikiki Beach Stabilization Project

1. We should have never gotten rid of the old groin and then spent more money putting a new one back.
2. I am "for" your plan for new groins along Waikiki Beach.
3. Hilton pier also contains a storm drain outfall, termination point is not know.
4. Beach fill area near Fort DeRussy outfall should have plans and specs restrict contractor from placing heavy construction equipment over old box culvert. City condition survey of box culvert showed numerous spalled areas of the box soffit (crown).
5. Design shows a natural beach bottom. Consider widened beaches even more with shore protection of the beach sand. Maybe for one of the coves. See American Samoa for the use of the COE Samoan stone.
6. For any of your rock groins, consider altering the specs for contractors to **place** in lieu of dumping rock. Some of the past COE projects a contractor had a track mounted grinder capable of grinding and shaping the stone to fit in locations of his revetment. I know we try for lowest cost, but if you build it lets make it last and not shift due to large wave events.
7. Last, much of the sand probably has fines (minus 200) which presents a problem with DOH CWB and a 401 WQC. From past projects they have made this an issue about the silt in the newly place sand being suspended in the water column. Consider in your design a portable plant to hydrodynamically remove fines and get the sand gradation you want.
8. Hopefully hotel owners are already planning for their half basements being flooded during king tides and sea level rise.

Russell Leong

Sent from Mail for Windows 10

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 4, 2021

Russell Leong
mr_russ@hotmail.com

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Leong:

Thank you for your email dated January 14, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawai‘i Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: “Hilton pier also contains a storm drain outfall, termination point is not known.”

> **Response:** The proposed sand backpassing in the Fort DeRussy beach sector will involve recovering a small volume of sand (less than 1,500 cy) from the dry beach east of the Hilton Pier and groin. The sand recovery will be completed using small machinery and no impacts to existing drainage infrastructure are anticipated.

Comment: “Beach fill area near Fort DeRussy outfall should have plans and specs restrict contractor from placing heavy construction equipment over old box culvert. City condition survey of box culvert showed numerous spalled areas of the box soffit (crown).”

> **Response:** No heavy equipment will be operated on or adjacent to the existing box culvert.

Comment: “Design shows a natural beach bottom. Consider widened beaches even more with shore protection of the beach sand. Maybe for one of the coves. See American Samoa for the use of the COE Samoan stone.”

> **Response:** A discussion on concrete armor units is included in Section 5.3.3.1 of the DPEIS, which presents Tribar armor units for shore protection, as well as environmentally-friendly concrete armor units. There is only one installation of

Samoa Stone, that being at Vatia in American Samoa, where Samoa Stone was used as armor for a revetment.

Comment: "For any of your rock groins, consider altering the specs for contractors to place in lieu of dumping rock. Some of the past COE projects a contractor had a track mounted grinder capable of grinding and shaping the stone to fit in locations of his revetment. I know we try for lowest cost, but if you build it lets make it last and not shift due to large wave events."

Response: The final construction plans and specifications will require special or keyed-and-fit placement, as opposed to random placement, to achieve the required level of interlocking and stability.

Comment: "Last, much of the sand probably has fines (minus 200) which presents a problem with DOH CWB and a 401 WQC. From past projects they have made this an issue about the silt in the newly place sand being suspended in the water column. Consider in your design a portable plant to hydrodynamically remove fines and get the sand gradation you want."

Response: We acknowledge that sand recovery, transport, and placement operations have the potential to cause turbidity. All of the offshore sand proposed for use in Waikīkī will contain less than 6% fines per DLNR guidelines, and ideally less, in compliance with the State of Hawaiʻi guidelines for beach nourishment projects. Appropriate methods for dewatering and removal of fines to mitigate turbidity will be established during the final design and permitting process. All methods will be reviewed and approved by the Hawaiʻi Department of Health, Clean Water Branch as part of the Clean Water Act Section 401 Water Quality Certification (WQC) review process. For more information about sand characteristics and quality, please see Sections 3.5 and 8.9 of the DPEIS. For more information about water quality and turbidity, please see Section 8.7 of the DPEIS.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

OFFICE OF PLANNING
STATE OF HAWAII

DAVID Y. IGE
GOVERNOR

MARY ALICE EVANS
DIRECTOR
OFFICE OF PLANNING

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: http://planning.hawaii.gov/

DTS 202012300952HE

January 14, 2021

Mr. David A. Smith, Ph.D., P.E.
Senior Coastal Engineer
Sea Engineering, Inc.
41-305 Kalanianaole Highway
Waimanalo, Hawaii 96795

Dear Mr. Smith:

Subject: Environmental Impact Statement Preparation Notice for the Waikiki Beach Improvement and Maintenance Program
Honolulu, Oahu; Seaward of
TMKs: (1) 2-6-001:003, (1) 2-6-004:007, (1) 2-6-005:001, (1) 2-6-008:029, (1) 2-6-002:026, (1) 2-6-001:019, (1) 2-6-004:012, (1) 2-6-002:017, (1) 2-6-001:013, (1) 2-6-001:012, (1) 2-6-001:002, (1) 2-6-001:015, (1) 2-6-001:008, (1) 2-6-004:006, (1) 2-6-004:005, (1) 2-6-001:017, (1) 2-6-004:008, (1) 2-6-004:009, (1) 2-6-004:010, (1) 2-6-001:018, (1) 2-6-005:006, (1) 2-6-001:004, (1) 2-6-002:006, and (1) 2-6-002:005

Thank you for the opportunity to provide comments on the request for agency comments on the Environmental Impact Statement Preparation Notice (EISPN) for the Waikiki Beach Improvements and Maintenance Program. We were notified of this EISPN request for comments via letter dated December 16, 2020.

It is our understanding that the Hawaii Department of Land and Natural Resources (DLNR) proposes beach improvement along the shoreline of Waikiki Beach that include Fort DeRussy, Halekulani, Royal Hawaiian, and Kuhio Beach. The beach improvements would include the construction of new beach stabilization structures, and the recovery of offshore sand and its placement on the shoreline. The objectives of the proposed beach improvements are to restore and improve Waikiki's public beaches, increase beach stability through improvement and maintenance of shoreline structures, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise.

The Office of Planning (OP) has reviewed the transmitted material and has the following comments to offer:

1. <u>Prohibited Construction of Seawalls Along the Shoreline</u>
   Section 1.1, page 10 of the EISPN states that in 1917, the Hawaii's Board of Harbor

Commissioners prohibited construction of seawalls along the shoreline. The DEIS may provide more information on this seawall prohibition and discuss why the seawall prohibition was widely ignored during that time.

2. <u>Anticipated Project Lifespans</u>
   Section 2.3 page 28 of the EISPN discusses anticipated lifespans of the beach improvements. The DEIS should clarify the definition of "anticipated project lifespans" given that the proposed program includes beach nourishment and maintenance, and construction of groins and segmented breakwater structure. For example, whether the lifespans of the proposed actions that will be designed for a nominal 50-year lifespan include beach nourishment and maintenance, or only the proposed groin and breakwater structures.

3. <u>Coastal Zone Management Act (CZMA) federal consistency</u>
   Section 8.2, page 152 of the EISPN accurately identifies that the project is subject to a CZMA federal consistency review. The CZMA federal consistency review is separate from the HRS Chapter 343 process. DLNR, or a representative, should contact our office on the policies and procedures that govern CZMA federal consistency reviews.

4. <u>Special Management Area (SMA)</u>
   Section 8.3, page 152 of the EISPN acknowledges that the project is subject to SMA use permitting. The DEIS should discuss the activities and stored materials for proposed staging areas that will be located within the SMA. To minimize the potential impacts on ocean and the shoreline area as defined in Hawaii Revised Statutes (HRS) § 205A-41, it is better to locate proposed staging areas outside of the shoreline area. OP recommends that the DLNR consult with the Department of Planning and Permitting, City and County of Honolulu, on the requirement of SMA use and shoreline setbacks.

5. <u>The Hawaii State Planning Act</u>
   Pursuant to HAR § 11-200.1-24(d)(6), the DEIS will need to assess the relationship of the proposed action with the provisions of the Hawaii State Planning Act, as found in HRS Chapter 226. The Hawaii State Planning Act, HRS Chapter 226, serves as a guide for long-term development for the State. It provides 1) goals, objectives, and policies; 2) the allocation of resources through planning coordination and implementation efforts; and 3) priority guidelines for the State.

6. <u>Hawaii Coastal Zone Management (CZM) Program</u>
   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" (HRS § 205A-1).

   Pursuant to HAR § 11-200.1-24(d)(6), the DEIS should also contain analysis on the project's consistency with the objectives and supporting policies of the Hawaii CZM Program, HRS

§ 205A-2, as amended. This assessment should include a discussion on public access to recreational resources, and specifically discuss mitigation measures to mitigate potential impacts on public access to ocean and the beach recreation areas from the proposed program.

In implementing the objectives and supporting policies of the Hawaii CZM program, agencies, such as DLNR, shall consider ecological, cultural, historic, esthetic, recreational, scenic, open space values, coastal hazards, and economic development. Compliance with HRS § 205A-2 is an important component for satisfying HRS Chapter 343 requirements.

7. Cumulative Impacts
   OP suggests that the DEIS assess and discuss the cumulative impacts from the preferred alternative for each of four beach sectors such as Fort DeRussy Beach Sector, Halekulani Beach Sector, Royal Hawaiian Beach Sector, and Kuhio Beach Sector.

If you have any questions regarding this comment letter, please contact Joshua Hekekia at (808) 587-2845; on SMA use issues please contact Shichao Li at (808) 587-2841; and for CZMA federal consistency, please contact John Nakagawa, at (808) 587-2878.

Sincerely,

Mary Alice Evans

Mary Alice Evans
Director

cc: Sam Lemmo, Administrator, DLNR, Office of Conservation and Coastal Lands

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 4, 2021

Mary Alice Evans, Director
Office of Planning
P.O. Box 2359
Honolulu, HI 96804

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Ms. Evans:

Thank you for your comment later dated January 14, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawai‘i Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: "Prohibited Construction of Seawalls Along the Shoreline - Section 1.1, page 10 of the EISPN states that in 1917, the Hawaii's Board of Harbor Commissioners prohibited construction of seawalls along the shoreline. The DEIS may provide more information on this seawall prohibition and discuss why the seawall prohibition was widely ignored during that time."

> **Response:** Most of the seawalls in Waikīkī were constructed in the late 1800's and early 1900's, prior to Statehood. The DLNR does not have access to data or information related to previous applications or authorizations for seawall construction in Waikīkī; thus, we are unable to opine as to the reasons why the prohibition on seawall construction was not enforced. For information about the history of coastal engineering in Waikīkī, see Sections 2.1, 4.1, 5.1, 6.1, and 7.1 the DPEIS.

Comment: "Anticipated Project Lifespans - Section 2.3 page 28 of the EISPN discusses anticipated lifespans of the beach improvements. The DEIS should clarify the definition of "anticipated project lifespans" given that the proposed program includes beach nourishment and maintenance, and construction of groins and segmented breakwater structure. For example, whether the lifespans of the proposed actions that will be designed for a nominal 50-year lifespan include beach nourishment and maintenance, or only the proposed groin and breakwater structures."

> **Response:** The Waikīkī Beach Improvement and Maintenance Program consists of beach improvement actions and beach maintenance actions. *Beach improvements* refers to actions that involve adding new sand, adding new structures, and/or modifying existing structures. *Beach maintenance* refers to actions that involve using existing sand or adding sand with no new structures or modification of existing structures.
>
> The proposed beach improvement actions in the Halekūlani beach sector and the ʻEwa (west) basin of the Kūhiō beach sector are designed to account for 1.5 ft of sea level rise and can be adapted to accommodate up to 2.7 ft of sea level rise. The proposed beach maintenance actions in the Fort DeRussy and Royal Hawaiian beach sectors and the Diamond Head (east) basin of the Kūhiō beach sector are intended to be conducted on a periodic basis and may be adapted as sea levels continue to rise. For more information about anticipated project lifespans, please see Section 3.3 of the DPEIS.

Comment: "Coastal Zone Management Act (CZMA) federal consistency - Section 8.2, page 152 of the EISPN accurately identifies that the project is subject to a CZMA federal consistency review. The CZMA federal consistency review is separate from the HRS Chapter 343 process. DLNR, or a representative, should contact our office on the policies and procedures that govern CZMA federal consistency reviews."

> **Response:** We acknowledge that the proposed actions are subject to Coastal Zone Management Act (CZMA) federal consistency review. The DLNR will submit formal applications to the Hawaiʻi Office Planning for CZMA federal consistency review during the final design and permitting process.

Comment: "Special Management Area (SMA) - Section 8.3, page 152 of the EISPN acknowledges that the project is subject to SMA use permitting. The DEIS should discuss the activities and stored materials for proposed staging areas that will be located within the SMA. To minimize the potential impacts on ocean and the shoreline area as defined in Hawaii Revised Statutes (HRS) § 205A-41, it is better to locate proposed staging areas outside of the shoreline area. OP recommends that the DLNR consult with the Department of Planning and Permitting, City and County of Honolulu, on the requirement of SMA use and shoreline setbacks."

> **Response:** We acknowledge that the proposed actions are subject to Special Management Area (SMA) use permitting. The DLNR will submit formal applications for any activities in the SMA to the City and County of Honolulu, Department of Planning and Permitting. For information about the relationship of the proposed actions with the provisions of the SMA, please see Section 16.3.4 of the DPEIS.

Comment: "Hawaii State Planning Act - Pursuant to HAR § 11-200.1-24(d)(6), the DEIS will need to assess the relationship of the proposed action with the provisions of the Hawaii State Planning Act, as found in HRS Chapter 226. The Hawaii State Planning Act, HRS Chapter 226, serves as a guide for long term development for the State. It provides 1) goals, objectives, and policies; 2) the allocation of resources through planning coordination and implementation efforts; and 3) priority guidelines for the State."

> **Response:** We acknowledge that the proposed actions are subject to the Hawai'i State Planning Act. For information about the relationship of the proposed actions with the provisions of the Hawai'i State Plan, please see Section 16.2.3 of the DPEIS.

Comment: "Hawaii 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" (HRS §205A-1). Pursuant to HAR § 11-200.1-24(d)(6), the DEIS should also contain analysis on the project's consistency with the objectives and supporting policies of the Hawaii CZM Program, HRS § 205A-2, as amended. This assessment should include a discussion on public access to recreational resources, and specifically discuss mitigation measures to mitigate potential impacts on public access to ocean and the beach recreation areas from the proposed program. In implementing the objectives and supporting policies of the Hawaii CZM program, agencies, such as DLNR, shall consider ecological, cultural, historic, esthetic, recreational, scenic, open space values, coastal hazards, and economic development. Compliance with HRS § 205A-2 is an important component for satisfying HRS Chapter 343 requirements."

> **Response:** We acknowledge that the proposed actions should be consistent with the objectives and supporting policies of the Hawaii CZM Program, HRS § 205A-2, as amended. For information about the relationship of the proposed actions with the provisions of HRS § 205A-2, as amended, please see Section 16.2.5 of the DPEIS.

Comment: "Cumulative Impacts - OP suggests that the DEIS assess and discuss the cumulative impacts from the preferred alternative for each of four beach sectors such as Fort DeRussy Beach Sector, Halekulani Beach Sector, Royal Hawaiian Beach Sector, and Kuhio Beach Sector."

> **Response:** We acknowledge that the proposed actions have the potential to result in cumulative impacts. The potential impacts of the proposed actions are discussed in Sections 8 and 9 of the DPEIS. The cumulative and secondary impacts of the proposed actions are discussed in Section 10 and Section 11 of the DPEIS, respectively.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

January 18, 2021

TO:
Sam Lemmo, Administrator
Office of Conservation and Coastal Lands
Department of Land and Natural Resources, State of Hawaii
1151 Punchbowl Street, Room 131
Honolulu, Hawaii 96813

FROM:
John Clark
P. O Box 25277
Honolulu, HI 96825

SUBJECT: Environmental Impact Statement Preparation Notice (EISPN) for the Waikīkī Beach Improvement and Maintenance Project. Waikīkī Beach, Oahu

I support the proposed beach improvement projects by the Hawai‘i Department of Land and Natural Resources (DLNR). The DLNR proposes beach improvement and maintenance projects in the Fort DeRussy, Halekulani, Royal Hawaiian, and Kūhiō Beach sectors of Waikīkī. These projects include the construction of new beach stabilization structures, and the recovery of offshore sand and its placement on the shoreline. The objectives of the proposed actions are to restore and improve Waikīkī's public beaches, increase beach stability through improvement and maintenance of shoreline structures, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise. The proposed actions are intended to maintain the economic, social, aesthetic, recreational, environmental, cultural, and historical qualities of Waikīkī.

I offer the following project-specific comments for the Kūhiō Beach Basin Sector.

1. There is a surf break fronting the Ewa Basin that is called Baby Cunha’s. As a young Waikīkī surfer in the 1950s and 1960s, I surfed there often, when other nearby breaks like Queen’s and Canoes were too crowded. It wasn’t as good as the other spots because reflected waves from the concrete breakwater (crib wall) travel seaward into incoming waves, but it was still a viable alternate surf break in Waikīkī.
2. During my personal research of Waikīkī Beach, I learned this surf break was especially popular with young bodysurfers and bodyboarders before the concrete breakwater was constructed. I have a copy of an old movie that shows local children bodysurfing there in the early 1930s.
3. I believe removing sections of the existing concrete breakwater (crib wall) and the construction of the three segmented breakwaters as shown in Figure 6-8 will reduce the

reflected waves and enhance the surf break. I see this project as a once-in-a-lifetime opportunity to restore a historic surf break in the heart of Waikīkī.

4. One final comment. I noticed that the Kapahulu Groin is also variously referred to as the Kapahulu storm drain or outfall. I believe that was its original purpose when it was built in 1951, but I don’t think it transports any storm water today.

Thank you for the opportunity to provide comments on this project.

Me ka mahalo,
John Clark

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
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June 4, 2021

John Clark
P. O. Box 25277
Honolulu, HI 96825

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Clark:

Thank you for your comment later dated January 18, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: “I believe removing sections of the existing concrete breakwater (crib wall) and the construction of the three segmented breakwaters as shown in Figure 6-8 will reduce the reflected waves and enhance the surf break. I see this project as a once-in-a-lifetime opportunity to restore a historic surf break in the heart of Waikīkī.”

> **Response:** Sea Engineering, Inc. conducted detailed wave modeling to evaluate the potential for the proposed actions to impact waves, currents, and surf sites in Waikīkī. Dredging of offshore sand deposits involves removing sand from the deposits, resulting in a lowering of the bottom elevation or changing the bathymetry. Dredging could occur at the *Ala Moana*, *Canoes/Queens*, or *Hilton* offshore sand deposits. Wave modeling was used to assess the impact of dredging on nearby surf sites.
>
> A wave reflection analysis was also conducted to evaluate the potential for the proposed structures in the Halekūlani and Kūhiō beach sectors to reflect waves that could negatively impact surf sites, primarily in the Halekūlani beach sector. To evaluate potential impacts, wave modeling of the existing conditions and with the proposed structures was performed. Based on the results of the wave modeling, the dredge analysis, and the wave reflection analysis, no significant impacts to waves, currents, or surf sites in Waikīkī are anticipated.

> For more information about the wave modeling results and potential impacts to waves, currents, and surf sites, please see Sections 8.2, 8.6 and 9.4.6 of the DPEIS.

Comment: “I noticed that the Kapahulu Groin is also variously referred to as the Kapahulu storm drain or outfall. I believe that was its original purpose when it was built in 1951, but I don’t think it transports any storm water today.”

> **Response:** We have inquired with the City and County Honolulu, Department of Public Works to confirm whether the Kapahulu storm drain is still active.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

WBSIDA
Waikīkī Beach
SPECIAL IMPROVEMENT
DISTRICT ASSOCIATION

January 5, 2020

TO:
Sam Lemmo, Administrator
Office of Conservation and Coastal Lands
Department of Land and Natural Resources, State of Hawaii
1151 Punchbowl Street, Room 131
Honolulu, Hawaii 96813

FROM:
Rick Egged, President
Waikīkī Beach Special Improvement District Association
2250 Kalakaua Ave Suite 315
Honolulu, Hi 96815

SUBJECT: Environmental Impact Statement Preparation Notice (EISPN) for the Waikīkī Beach Improvement and Maintenance Project. Waikīkī Beach, Oahu

The Waikīkī Beach Special Improvement District Association (WBSIDA**) strongly supports** the proposed beach improvement projects by the Hawai‘i Department of Land and Natural Resources (DLNR). The DLNR proposes beach improvement and maintenance projects in the Fort DeRussy, Halekulani, Royal Hawaiian, and Kūhiō Beach sectors of Waikīkī. These projects include the construction of new beach stabilization structures, and the recovery of offshore sand and its placement on the shoreline. The objectives of the proposed actions are to restore and improve Waikīkī's public beaches, increase beach stability through improvement and maintenance of shoreline structures, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise. The proposed actions are intended to maintain the economic, social, aesthetic, recreational, environmental, cultural, and historical qualities of Waikīkī.

The history of Waikīkī as a predominantly engineered shoreline is an important environmental rationale for a project of this scale and nature. The beaches of Waikīkī are all manmade, almost entirely composed of imported sand and the current shoreline configuration is largely the result of past construction efforts to widen and stabilize the beaches. Likewise, most of the beaches of Waikīkī are chronically eroding, with frequent backshore flooding, particularly during high tides and high surf events. Over the past several years, and as recently as November of 2020, Waikiki has experienced record high tides (referred to as King Tides) that have exacerbated erosion and flooding. These events have highlighted the impacts of sea level rise on the beaches of Waikīkī. As sea levels continue to rise, beach loss will progressively degrade the recreational, social, cultural, environmental, aesthetic, and economic value of Waikīkī. After nearly 50 years of no new beach stabilization projects in Waikīkī, we are now at a crossroads with a clear and increasingly urgent need to implement maintenance and improvements to the shoreline in order to preserve and protect this unique and highly prized natural resource.

The Hawai‘i Sea Level Rise Vulnerability and Adaptation Report[1] found that 3.2 feet of sea level rise will have profound impacts on O‘ahu. $12.9 billion in structures and land could be lost; 3,800 structures could be flooded, including hotels and resorts in Waikīkī; over 13,000 residents could be displaced; and nearly 18 miles of major roads could be flooded. The report estimates that O‘ahu will account for an estimated 66% of the total statewide economic losses due to sea level rise. The State recommended that private and public entities in Waikīkī should begin planning for sea level rise adaptation, including beach restoration, to prepare for higher sea levels in the future.

Waikīkī Beach is a globally recognized icon of Hawai‘i and is the state's largest tourist destination. Waikīkī generates approximately 42% of the state's visitor industry revenue and is responsible for 8% ($5 billion) of the Gross State Product[2]. Beaches are a primary attraction for visitors to Waikīkī and we know that Waikīkī Beach accounts for over $2 billion in annual income for the local economy. However, a 2008 visitor survey found that 12% of visitors would not return to Waikīkī due, in part, to limited beach area and resulting overcrowding[3]. Waikīkī Beach also has tremendous cultural significance as a former playground of Hawaiian royalty and the birthplace of the sport and culture of surfing. The beaches and myriad of world-renowned surf breaks and reef ecosystem located offshore are valuable natural resources that support the culture and lifestyle of Hawai‘i, and the idyllic image of Waikīkī. Preserving and maintaining these beach resources are of critical importance for the social, cultural, economic and environmental value for Hawai‘i's communities.

The WBSIDA strongly supports these improvement projects and recognizes its urgency. With the combination of beach erosion and King Tides, the backshore is frequently flooded, particularly during high surf events, accelerating damage to backshore infrastructure. Without beach improvements and maintenance, sea level rise is likely to result in total beach loss in Waikīkī before the end of the century and result in an estimated economic loss of $50 million to $150 million per hectare[1]. The loss of Waikīkī Beach alone would result in an annual loss of $2.223 billion in visitor expenditures[4]. Improvements and maintenance like those proposed in the EISPN are necessary to restore and maintain the beaches of Waikīkī to continue to support Hawaii's tourism-based economy.

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[1] Hawai‘i Climate Change Mitigation and Adaptation Commission. 2017. *Hawai'i Sea Level Rise Vulnerability and Adaptation Report*. Prepared by Tetra Tech, Inc. and the State of Hawai‘i Department of Land and Natural Resources, Office of Conservation and Coastal Lands. Page 152-162

[2] http://www.waikikibid.org/

[3] Waikīkī Improvement Association (2008) *Economic Impact Analysis of the Potential Erosion of Waikiki Beach, Final Report*.

[4] Tarui, N., Peng, M., Eversole, D. (2018). *Economic Impact Analysis of the Potential Erosion of Waikīkī Beach*. University of Hawai‘i Sea Grant College Program. April 2018.

The WBSIDA offers the following summary of project-specific comments.

1. The proposed beach improvement projects in Waikīkī are essential for the future goal to maintain a viable beach in these areas. Several beachfront areas in Waikīkī are seeing the rapid deterioration of both public and private backshore infrastructure such as groins, seawalls and walkways. This highlights the need to make long-term investments into beach stabilizing structures throughout Waikīkī in addition to more immediate emergency repairs to damaged infrastructure.

2. Climate change impacts including sea-level rise projected by the state of Hawaiʻi Climate Change Commission indicate significant flooding, wave overtopping and beach erosion in Waikīkī for the coming decades and suggest stakeholders and communities plan for 3.2 feet of sea-level rise now. This project has a strong climate change adaption component that is consistent with the recommendations of the State Climate Commission.

3. A project benefit to cost analysis was completed by the U.S. Army Corps of Engineers in 2002 to determine Federal interest in restoring and improving Waikiki Beach, with a ratio greater than one indicating that benefits exceeded costs[5]. The overall benefit to cost ratio for all of Waikiki was about 6 to 1. The total Waikiki Gross National Product (GNP) contribution to the annual Federal economy is an estimated $3.3 billion. This estimate excludes spending by mainland west coast visitors.

4. The proposed projects are consistent with existing engineering standards and planning studies for Waikiki Beach improvements, and are capable of being implemented as phased or stand-alone projects.

5. The WBSIDA has agreed to provide a partial project match as part of a public-private partnership demonstrating the value and economic importance of this project to the stakeholders and community of Waikīkī.

6. Alternative groin design recommendations, including T-Head groins have been previously assessed and recommended as possible strategies for beach improvements in Waikīkī[6,7]. Other examples such as Iroquois Point at Pearl Harbor demonstrate the successful use of T-head groins in a similar nearshore setting.

7. Without a stabilizing and energy-buffering beach to protect public and private coastal infrastructure, the WBSIDA anticipates even larger and more expensive structural repair

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[5] U.S. Army Corps of Engineers (2002). *Waikīkī Beach Erosion Control Reevaluation Report: Island of Oʻahu, Hawaiʻi.* Honolulu District.

[6] *Beach and Surf Parameters in Hawaii* (Gerritsen, 1978), *Final Environmental Assessment, Kuhio Beach Improvements* (Noda, 1999), *Independent Evaluation Study of Proposed Kuhio Beach Improvements* (Bodge, 2000)

[7] Sea Engineering, Inc. (2008). *Environmental Assessment / Environmental Impact Statement Preparation Notice for Gray's Beach Restoration Project.* Waikīkī, Oʻahu, Hawaiʻi. Prepared for Kyo-ya Hotels & Resorts LP. SEI Job No. 25103. August 2008.

> and improvement projects to be required soon to prevent the destruction of threatened coastal structures.

WBSIDA is a 501©3 non-profit which has committed to partially supporting beach improvement projects in the Waikīkī district as a public-private partnership. The WBSIDA looks forward to further developing the project scope in partnership with the DLNR. Thank you for the opportunity to provide comments on this project.

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
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LAND
STATE PARKS

June 4, 2021

Rick Egged, President
Waikīkī Beach Special Improvement District Association
2250 Kalakaua Ave Suite 315
Honolulu, HI 96815

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Egged:

Thank you for your comment later dated January 5, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you state that you strongly support the proposed beach improvement and maintenance actions. As the Applicant, the Hawai‘i Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

We recognize that you provided seven project-specific comments, all in support of the proposed actions. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement (DPEIS).

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

CWL

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January 21, 2021

Mr. Andy Bohlander
Sea Engineering, Inc.
Makai Research Pier
41-305 Kalanianaole Hwy.
Waimanalo, Hawaii 96795

Re: EIS Preparation Notice
Waikiki Beach Improvement and Maintenance Program

Dear Mr. Bohlander:

Thank you for the opportunity to provide comment on the EIS Preparation Notice (EISPN) for the Waikiki Beach Improvement and Maintenance Program.

These comments are submitted on behalf of King Parsons Enterprises, Inc., owner and operator of the catamaran MAITA'I, and Holokai Catamaran, Inc., owner and operator of the catamaran HOLOKAI. MAITA'I and HOLOKAI are among six (6) catamarans which have Revocable Permits (RP) from the State of Hawaii to land and pick up/drop off passengers on Waikiki Beach. MAITA'I's RP site is located on the beach fronting the Sheraton Waikiki. HOLOKAI's RP site is on the beach fronting the Waikiki Reef hotel.

We appreciate the commitment of the State to improve conditions at Waikiki Beach and acknowledge the hard work of Sea Engineering, Inc. in developing this EISPN. However, we have serious concerns regarding the effects of the planned improvements on the navigability and safety of the Halekulani Beach Sector area. These concerns are listed as follows:

1. The T-groins may interfere with the safe navigation of the MAITA'I and HOLOKAI catamarans.

The EISPN indicated that three new T-groins are proposed for the Halekulani Beach Sector which will be located near or over existing and/or relict groins. In addition, the Fort DeRussy outfall groin and Royal Hawaiian groins will be modified. The modification of the Royal Hawaiian groin and construction of the groin immediately to the west of the Royal Hawaiian groin do not appear problematic and will not likely interfere with the operations of the catamarans.

However, the center T-groin that bisects the existing sand beach between the Halekulani and Sheraton hotels will directly impede the navigation of MAITA'I, which accesses its landing area by entering the Halekulani Channel and maneuvering in the starboard direction towards the Sheraton. In addition to blocking access to MAITAI's landing area from the Halekulani Channel, the proposed center groin is too close to the groin immediately to its east. There will be insufficient distance between the two groins for the vessel to safely navigate onto the beach during certain weather and ocean conditions, particularly those which may cause the lateral movement of the vessel.

The groin proposed for the beach fronting Halekulani may also pose problems. Diagrams of the groin appear to depict some encroachment into the Halekulani Channel. In fact, there should be no structure interfering with the channel, which was specifically created as a navigation channel.

The Fort DeRussy outfall groin, as modified, may interfere with HOLOKAI's access to its RP site in front of the Outrigger Reef hotel. The extension eastward of the Fort DeRussy outfall T-groin limits the area within which HOLOKAI can maneuver. There does not appear to be sufficient area between the outfall groin and the groin immediately to the east to permit the safe operation of the vessel.

We believe that the Halekulani Channel and beach area fronting the Outrigger, Halekulani and Sheraton hotels should be optimized for navigation and beach catamaran operations. Creating a safe environment for catamaran operations also serves to increase safety for swimmers, surfers and other beach users. Options for consideration may include removal of the center groin and reconfiguration of the adjacent groins.

2. The EISPN does not address a linear concrete structure which stretches across the west "pocket beach" in front of the Sheraton.

In recent years a semi-exposed linear concrete structure, which may have been a walkway or a wall, began appearing on the beach fronting the Sheraton. (See photographs attached hereto). Interestingly, the structure may be visible in the 1949 photograph of the area on page 58 of the EISPN. Today, the structure stretches across the beach and comes dangerously close to MAITAI's permit site and beach anchor. It clearly poses a hazard to the vessel, passengers and crew, as well to beachgoers traversing the area. Due to the clear dangers posed by the structure, it should be removed.

3. The old submerged groins are potentially hazardous and should be evaluated for possible removal.

The EISPN depicts multiple old groins which are submerged or partially submerged in the waters off the Halekulani Sector. To the extent any of these old groins will not be used for the construction of new groins, we suggest they be inspected and evaluated for any hazards they may pose to the public and vessels in navigation. If the old groins are found to be dangerous, we recommend they be removed when work is done on the Halekulani Sector.

4. To the extent that reducing the number of groins will affect the longevity of sand deposits on the beach, we suggest that periodic sand replenishment be factored into the long-term management of the Halekulani Sector.

The Halekulani Sector appears particularly susceptible to coastal erosion and loss of sand deposits. In the event that reducing the number of T-groins renders the area more vulnerable to the loss of sand, we recommend that regular beach nourishment, such as anticipated for the Royal Hawaiian Beach Sector, be taken into consideration.

5. The slope of the beach is also important for the safe navigation and landing of the vessels.

We hope that consideration will also be given to the slope of the beach as it affects the safe landing of catamarans. We therefore request information on the projected slope of the beach after sand placement.

Pursuant to the terms of its commercial use permits, MAITA’I and HOLOKAI are required to navigate in and out of the Halekulani Channel. Over the years, MAITA’I and HOLOKAI have experienced significant and ongoing difficulties accessing their RP sites due to rising sea levels and continued coastal erosion. As the result of increasingly unsafe conditions along the Halekulani Sector, both vessels have been forced to find temporary alternate landing areas, including Fort DeRussy beach.

In order to fully convey the situation faced by the catamarans, we believe it is important that a site visitation with all interested parties, including Sea Engineering, the Waikiki Improvement Association and DLNR be conducted in the near future. This site inspection can be accomplished prior to or during consideration of the comments and recommendations made herein.

As we will need to ascertain the distance between T-groins to more precisely evaluate the navigability of the area, we also ask that markers be placed where the proposed groins are to be constructed. This can be accomplished at our site meeting.

Thank you for the opportunity to provide comment to the EISPN. We welcome further discussion regarding this project of vital importance to the future of Waikiki and the State of Hawaii.

Sincerely,

/s/ Cynthia A. Farias

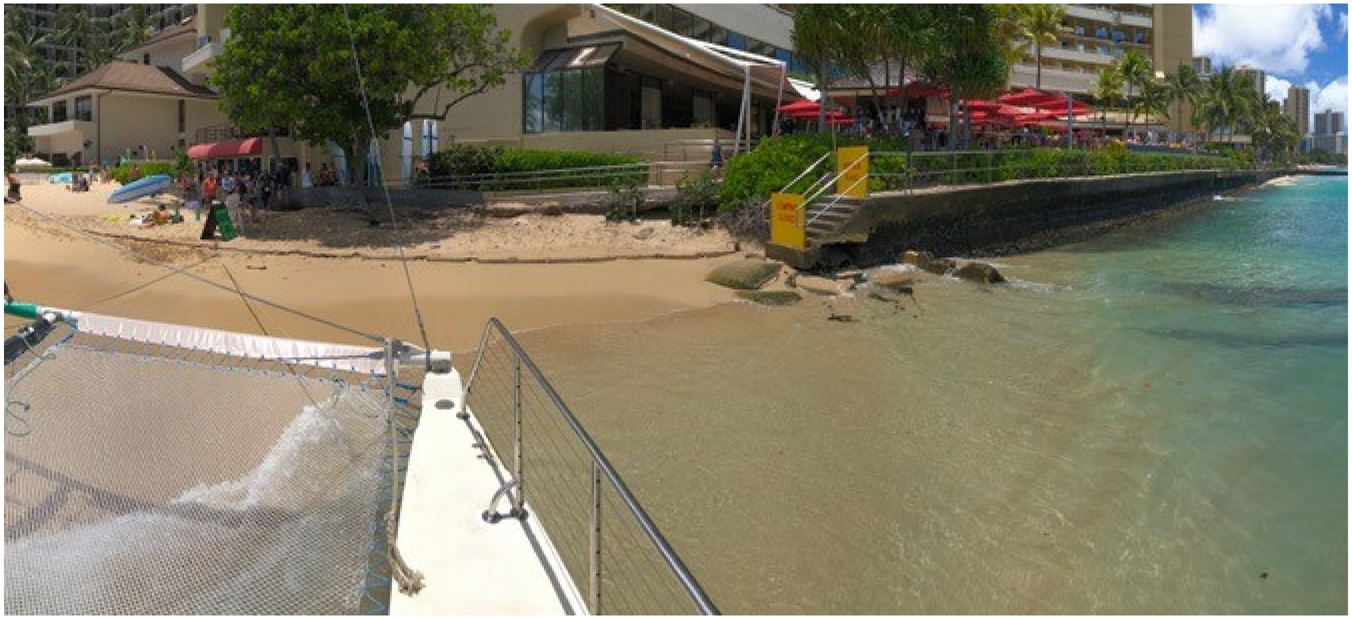
CYNTHIA A. FARIAS
COX WOOTTON LERNER GRIFFIN
& HANSEN

Enclosures

cc: George Parsons
King Parsons Enterprises, Inc.

Soo Stover
Richard Stover
Holokai Catamaran, Inc.

Attachment 1 Close up of steps and concrete structure (taken before hotel closure)



Attachment 2 Gray's beach with closed walkway and concrete structure (taken before hotel closure)

Attachment 3 concrete structure

Attachment 4 - Beach Hazard

Attachment 5 Anchor and mooring taken before hotel shutdown

Attachment 6 Exposed concrete close to dead-man anchor

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
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LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 4, 2021

Ms. Cynthia Farias
Cox Wootton Lerner Griffin & Hansen LLP
841 Bishop Street, Suite 1099
Honolulu, HI 96813

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Ms. Farias:

Thank you for your comment letter dated January 21, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. We understand that these comments were submitted on behalf of King Parsons Enterprises, Inc., owner and operator of the catamaran Maitaʻi, and Holokai Catamaran, Inc., owner and operator of the catamaran Holokai. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: “The T-groins may interfere with the safe navigation of the Maitaʻi and Holokai catamarans.”

> **Response:** The proposed action in the Halekūlani beach sector is not anticipated to have any negative impacts on catamaran operations. The minimum beach crest width at its narrowest point midway between the groins would be about 20 to 30 ft, and the beach slope would be 1V:8H (vertical to horizontal). Maintaining a stable beach with a gentler slope will provide additional space for the catamarans to tie up and safely load and offload guests. The Halekūlani Channel would remain unobstructed to allow for safe navigation. The groin stem length (distance seaward from the shoreline) would be up to about 200 ft and the gaps between the groin heads would be approximately 200 ft wide.
>
> The catamarans are approximately 45 ft long and 25ft wide, so the gaps between the groin heads should be sufficiently wide to provide safe ingress and egress for catamaran access to/from the shoreline. The current travel path for the

catamarans would shift slightly to the west to align with the gap between the groins on either side of the Halekūlani Channel. The new beach and groins would also eliminate the seasonal erosion that forces the catamarans to relocate their operations to the Fort DeRussy beach sector. Thus, no negative impacts to navigation or catamaran operations are anticipated.

For information regarding potential impacts to navigation and catamarans, please see Sections 5.3.1, 9.4.4.3, and 9.4.6 of the DPEIS.

Comment: "The EISPN does not address a linear concrete structure which stretches across the west "pocket beach" in front of the Sheraton." and "The old submerged groins are potentially hazardous and should be evaluated for possible removal."

Response: There are several remnant structures along the Halekūlani beach sector shoreline. These structures are low elevation and are expected to be removed or buried with sand as part of the proposed action.

Comment: "To the extent that reducing the number of groins will affect the longevity of sand deposits on the beach, we suggest that periodic sand replenishment be factored into the long-term management of the Halekulani Sector."

Response: The proposed groins are designed to stabilize the beach to mitigate erosion and create a stable beach profile. The groins are designed to account for 1.5 ft of sea level rise and can be adapted in the future to accommodate up to 2.7 ft of sea level rise.

We evaluated the alternative of beach nourishment without stabilizing structures in the Halekūlani beach sector. This would involve recovering approximately 40,000 cy of sand from offshore and placing it along the shoreline. Based on the projected erosion rates in the Halekūlani beach sector, the beach would need to be renourished every 5 years. Due to the combination of nearshore wave patterns, seawalls, and the Halekūlani Channel, it is possible that the beach could erode more rapidly, in which case renourishment would need to be conducted more frequently. While beach nourishment without stabilizing structures is technically feasible, it is not being proposed due to the cumulative impacts associated with periodic dredging and renourishment. Furthermore, beach nourishment may not be a viable long-term solution due the limited volume of compatible offshore sand to support periodic renourishment. For more information about this alternative, please see Sections 5.4.1 and 10.2 of the DPEIS.

Comment: "The slope of the beach is also important for the safe navigation and landing of the vessels."

Response: The minimum beach crest width at its narrowest point midway between the groins would be about 20 to 30 ft, and the beach slope would be

1V:8H (vertical to horizontal). Maintaining a stable beach with a gentler slope will provide additional space for the catamarans to tie up and safely load and offload guests. The Halekūlani Channel would remain unobstructed to allow for safe navigation. For additional information, please see Sections 5.4.1 and 10.2 of the DPEIS.

Comment: "In order to fully convey the situation faced by the catamarans, we believe it is important that a site visitation with all interested parties, including Sea Engineering, the Waikiki Improvement Association and DLNR be conducted in the near future. This site inspection can be accomplished prior to or during consideration of the comments and recommendations made herein. As we will need to ascertain the distance between T-groins to more precisely evaluate the navigability of the area, we also ask that markers be placed where the proposed groins are to be constructed. This can be accomplished at our site meeting."

Response: A site visit was conducted on February 10, 2021 with representatives from the catamaran operations, WBSIDA, and Sea Engineering, Inc. to discuss the proposed action and the locations of the groins. Sea Engineering, Inc. also provided the catamaran operators with GPS coordinates for the groins to further evaluate potential impacts to navigation.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

SAVE OUR SURF HAWAI'I
SURFING EDUCATION ASSOCIATION
501- c (3) non profit corporation

January 20, 2021

To: Sam Lemmo, Administrator
Office of Conservation and Coastal Lands
Department of Land and Natural Resources, State of Hawaii
1151 Punchbowl Street, Room 131
Honolulu, Hawaii 96813

From: Keone Downing
Save Our Surf
3017 Waialae Ave.
Honolulu, Hawaii 96816

Subject: Environmental Impact Statement Preparation Notice (EISPN) for the Waikīkī Beach Improvement and Maintenance Project. Waikīkī Beach, Oahu

EISPN Project Summary

Waikīkī Beach extends along the shoreline of Mamala Bay on the south shore of the island of O‘ahu, Hawai‘i. The beaches of Waikīkī are chronically eroding, and the backshore is frequently flooded, particularly during high tides and high surf events. As the beaches continue to erode, a process that is likely to accelerate as sea levels continue to rise, the shoreline will migrate further landward. Without beach improvements and maintenance, sea level rise is likely to result in total beach loss in Waikīkī before the end of the century.

The loss of Waikīkī Beach would result in an annual loss of $2.223 billion in visitor expenditures (Tarui, et al. 2018). Improvements and maintenance are necessary to restore and maintain the beaches of Waikīkī to continue to support Hawaii’s tourism-based economy. The State of Hawai‘i Department of Land and Natural Resources proposes beach improvement and maintenance projects in the Fort DeRussy, Halekulani, Royal Hawaiian, and Kūhiō Beach sectors of Waikīkī. Projects would include the construction of new beach stabilization structures, and the recovery of offshore sand and its placement on the shoreline.

The objectives of the proposed actions are to restore and improve Waikīkī's public beaches, increase beach stability through improvement and maintenance of shoreline structures, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise.

Thank you for bringing this notice of the Waikīkī Beach environmental study preparation notice to our attention, so we can address general community needs and issues.

Save Our Surf (SOS) Questions

1. Why does the EIS stop short of addressing loss of sand at both ends of adjacent local beaches such as Duke Kahanamoku Beach and Kapiolani Park?

Why was the beaches which are used mostly by our local community not addressed at this time.

While restoration of the beach is beneficial in general, we believe the economic loss to Waikiki is incorrect. In 2019, with very little beach available to the public, there were still over 10.4 million visitors.

2. There are some concerns about the designs proposed in the EIS: T-head groins, beach fill, modification to one swim basin, which date back over 20 years ago. Why is a design from 20 years ago being considered?

   One design done by Noda and Associates is an example. At the time the design was deemed needing a second opinion by DLNR through the Office of Conservation and Coastal Lands (OCCL). In 2000 OCCL hired a firm from Florida, Olsen Associates, to study the plan. Olsen developed their own plan which was a new design, three T-Head groins. Sam Lemmo, in an article written by Treena Shapiro, said "his staff should focus energy on the Olsen design because it seems more of an optimal solution for Waikiki. We believe that it will stabilize the beach better". Now 20 years later OCCL, Sea Engineering, and WBSIDA is choosing a design similar to Noda and Associates. Would like to know why?

3. Has DLNR looked at new designs using new materials since technology and science allowed for development of better materials from 20 years ago. What is the outcome of the research?

4. SOS would like to ask for a comprehensive study on the effectiveness of historic and recent shoreline structures that OCCL and Sea Engineering have done in addressing erosion trends. Would like the study to include two projects: A. Sandbag groin by the Duke Kahanamoku statue, B. Royal Groin

5. Is there a study on the short and long-term impacts of the project on reef health and impacts to endangered sea turtles (fronting the Sheraton and Halekulani hotels)?

6. SOS would like a comprehensive analysis of the impacts to all surfing waves in Waikiki using advanced modeling tools for a variety of rideable wave conditions. In the Halekulani Sheraton section, building and placement of these groins will create adverse actions to surf breaks such as Populars, Paradise, and Threes, to name a few, especially as sea levels rise. SOS believes by channelizing the lateral movement of water and sand these structures will change the currents as it exist today.

7. Does the State have a comprehensive plan on the cause and effects of littoral cells and solutions that addresses armoring?

Thank you for the opportunity to submit comments and questions on this project.

Keone Downing

Save Our Surf

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 4, 2021

Keone Downing
Save Our Surf
3017 Waialae Ave.
Honolulu, Hawaii 96816

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Downing:

Thank you for your comment letter dated January 20, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: “Why does the EIS stop short of addressing loss of sand at both ends of adjacent local beaches such as Duke Kahanamoku Beach and Kapiolani Park? Why was the beaches which are used mostly by our local community not addressed at this time? While restoration of the beach is beneficial in general, we believe the economic loss to Waikiki is incorrect. In 2019, with very little beach available to the public, there were still over 10.4 million visitors.”

> **Response:** Selection of the proposed beach improvement and maintenance actions was a primarily stakeholder-driven process. We relied heavily on feedback and direction from the Waikīkī Beach Community Advisory Committee (WBCAC) to identify issues, needs, priorities, and design criteria for beach sector. The sectors that were selected for beach improvement and maintenance actions were identified as the highest priorities by the WBCAC. While the other beach sectors of Waikīkī – Duke Kahanamoku, Queens, Kapiʻolani, and Kaimana - were not identified as priorities by the WBCAC, these areas are clearly important and we recognize that, as sea levels continue to rise, beach improvements and/or maintenance may be required in these beach sectors in the future. For more information about the WBCAC and the project selection process, please see Sections 2.4 and 2.6 and Appendix A of the DPEIS.

Comment: “There are some concerns about the designs proposed in the EIS: T-head groins,beach fill, modification to one swim basin, which date back over 20 years ago. Why is a design from 20 years ago being considered? One design done by Noda and Associates is an example. At the time the design was deemed needing a second opinion by DLNR through the Office of Conservation and Coastal Lands (OCCL). In 2000 OCCL hired a firm from Florida, Olsen Associates, to study the plan. Olsen developed their own plan which was a new design, three T-Head groins. Sam Lemmo, in an article written by Treena Shapiro, said "his staff should focus energy on the Olsen design because it seems more of an optimal solution for Waikiki. We believe that it will stabilize the beach better". Now 20 years later OCCL, Sea Engineering, and WBSIDA is choosing a design similar to Noda and Associates. Would like to know why?”

> **Response:** The existing beach, groin, and breakwater system in the Kūhiō beach sector is a relatively simple engineered environment that can be engineered and reconfigured in multiple different ways to produce many different outcomes. In this case, the proposed beach improvement and maintenance actions were specifically designed to address issues and priorities that were identified by the Waikīkī Beach Community Advisory Committee (WBCAC) (see Sections 2.4 and 2.6 and Appendix A of the DPEIS).
>
> The WBCAC determined that the highest priority for the Kūhiō beach sector Diamond Head (east) basin was to maintain calm and shallow water uses and beach-ocean interaction (e.g., swimming, bathing). The WBCAC determined that the preferred action is limited to periodic beach maintenance with no structural modifications.
>
> The WBCAC determined that the highest priorities for the Kūhiō beach sector ‘Ewa (west) basin are to maintain a moderately-energetic wave environment, maintain ocean access, reduce sand loss through the breakwater channel, and stabilize seasonal beach dynamics. The WBCAC determined that the preferred action is beach nourishment with a segmented breakwater. The proposed action is different from the Noda design and more consistent with the Bodge design. The WBCAC also determined that the proposed action should be designed to mitigate chronic and seasonal erosion on the west side of the ‘Ewa (west) groin. To achieve this objective, a recessed head is proposed to be added to the ‘Ewa (west) groin to improve beach stability in this area. For additional information, please see Section 7.3 of the DPEIS.

Comment: “Has DLNR looked at new designs using new materials since technology and science allowed for development of better materials from 20 years ago. What is the outcome of the research?

> **Response:** We evaluated various options for alternative armor units (see Section 5.3.3.1 of the DPEIS). One of the primary objectives identified by the WBCAC was to maintain a cultural/historical sense of place and preserve open beach and view planes. As a result, the proposed actions are designed to minimize impacts

to the existing appearance, character, and view planes along Waikīkī Beach. For this reason, we have proposed the use of basalt armor stone, which is similar in size, color, texture, and appearance to the existing groins and breakwater system in Waikīkī.

Comment: "SOS would like to ask for a comprehensive study on the effectiveness of historic and recent shoreline structures that OCCL and Sea Engineering have done in addressing erosion trends. Would like the study to include two projects: A. Sandbag groin by the Duke Kahanamoku statue, B. Royal Groin."

Response: The University of Hawaii Coastal Geology Group (UHCGG) has and is continuing to conduct periodic monitoring of the Kūhiō Sandbag Groin. Initial findings based on approximately one year of survey data indicate that the groin is functioning as intended. The efficacy of the groin is evident by significant sand buildup on the Diamond Head (east) side of the structure throughout the year, indicating that longshore transport was altered as intended to mitigate extreme erosion at this section of beach. Sediment capture by the groin has not resulted in significant erosion on the ʻEwa (west) side of the structure, which would be evidenced by sediment depletion and flanking directly adjacent to the structure.

Overall, one year following completion the structural integrity and efficacy of the groin structure has been confirmed. No adverse effects of the project have been observed. No significant deficiencies with the ElcoRock sandbags and/or the overall groin performance have been observed. We will continue to monitor the structure throughout the coming year. The effectiveness or need for the structure will be further evaluated after we accomplish improvements to the ʻEwa (west) basin in the Kūhiō beach sector. For additional information about the Kūhiō Sandbag Groin, please see Sections 2.6, 6.1, and 8.5.3 of the DPEIS.

The Royal Hawaiian Groin Replacement project was completed in August 2020. The project proponents, consultants, and contractors routinely observe the shoreline conditions in this area to evaluate the performance of the structure. Initial observations indicate that the groin is performing its primary function to stabilize the beach on the Diamond Head (east) side of the groin. The beach in this area is currently wider than it was pre-construction, and the shoreline has naturally taken the arc-shape anticipated from the groin design. For additional information about the Royal Hawaiian Groin, please see Sections 2.6, 6.1, and 8.5.3 of the DPEIS.

Comment: "Is there a study on the short and long-term impacts of the project on reef health and impacts to endangered sea turtles (fronting the Sheraton and Halekulani hotels)?"

Response: We acknowledge that the proposed action in the Halekūlani beach sector has the potential to affect marine habitat and protected species. Sea turtle disturbance would be limited to within about a 130-ft radius of the sand recovery areas. Turtles would be expected to move away from the disturbance, and as the impact areas are relatively small and the seafloor is primarily sandy, dredging is not anticipated to have any significant effect on turtle foraging. The groins and sand fill will bury a portion of the existing subtidal environment of primarily low relief sand, rubble, and limestone. Ecological services of reef flat habitat will be lost within the project footprint (sand and groins) but is anticipated to recover over time as the benthic community re-establishes.

Best Management Practices (BMPs), as typically recommended by the National Marine Fisheries Service (NMFS), will be adhered to during construction of the proposed actions to avoid or minimize impacts to marine habitat protected species. A biological and water quality monitoring program will be implemented to enhance control over potential construction impacts. We anticipate that marine species will repopulate from surrounding habitat after construction is completed and sessile organisms will colonize new hard surfaces.

We also acknowledge that the proposed action in the Halekūlani beach sector has the potential to affect corals. AECOS (2021) found that coral assemblages in Waikīkī are limited by availability of stable hard bottom, silt cover, competition with algae, and freshwater influence among other factors. At the Halekūlani beach sector, overall coral cover at the proposed groin locations is very low (mean of 0.1 colony/m^2). In general, coral colonies here are small, with 64% being less than 10 cm in diameter. The lack of large coral heads is evidence that this area is not particularly favorable to coral growth.

We anticipate that the proposed structures will provide stable, hard bottom for coral settlement and possibly calmer waters for coral development; however, coral assemblage development may be compromised by competition for space, freshwater influence, sediment transport, and heavy utilization of the nearshore by the human population.

Based on the limited amount of coral in the Halekūlani beach sector, the proposed actions are not anticipated to significantly affect corals. Measures proposed to be exercised to protect corals during construction include:

- Locating and marking significant corals in the vicinity of the sand recovery areas;
- Identifying pipeline route corridors to minimize the potential for damage to coral and other benthic fauna; and
- Transplanting corals, as necessary and where practicable, to relocate them from the construction site, particularly along the pipeline route.

For more information about potential impacts to marine habitat and protected species in the Halekūlani beach sector, habitat, please see Sections 8.10, 8.11, 8.12, 10.2, and 11.2 and Appendix C of the DPEIS.

Comment: "SOS would like a comprehensive analysis of the impacts to all surfing waves in Waikiki using advanced modeling tools for a variety of rideable wave conditions. In the Halekulani Sheraton section, building and placement of these groins will create adverse actions to surf breaks such as Populars, Paradise, and Threes, to name a few, especially as sea levels rise. SOS believes by channelizing the lateral movement of water and sand these structures will change the currents as it exists today."

> **Response:** We acknowledge your concerns regarding the potential for the proposed actions to impact surf sites in Waikīkī. Sea Engineering, Inc. conducted detailed wave modeling to evaluate the potential for the proposed actions to impact waves, currents, and surf sites in Waikīkī. Dredging of offshore sand deposits involves removing sand from the deposits, resulting in a lowering of the bottom elevation or changing the bathymetry. Dredging could occur at the *Ala Moana*, *Canoes/Queens*, or *Hilton* offshore sand deposits. Wave modeling was used to assess the impact of dredging on nearby surf sites.
>
> A wave reflection analysis was also conducted to evaluate the potential for the proposed structures in the Halekūlani and Kūhiō beach sectors to reflect waves that could negatively impact surf sites, primarily in the Halekūlani beach sector. To evaluate potential impacts, wave modeling of the existing conditions and with the proposed structures was performed. Based on the results of the wave modeling, the dredge analysis, and the wave reflection analysis, no significant impacts to waves, currents, or surf sites in Waikīkī are anticipated.
>
> For more information about the wave modeling results and potential impacts to waves, currents, and surf sites, please see Sections 8.2, 8.6 and 9.4.6 of the DPEIS.

Comment: "Does the State have a comprehensive plan on the cause and effects of littoral cells and solutions that addresses armoring?"

> **Response:** The littoral cells (beach sectors) of Waikīkī were evaluated and defined by Miller et.al. (2003). The littoral cells are primarily defined by the presence of engineered structures including groins, breakwaters, storm drains, and seawalls. Almost the entire length of the Waikīkī shoreline is armored by seawalls, most of which were constructed in the late 1800's and early 1900's. To our knowledge, that last seawall was constructed in Waikīkī nearly a century ago. The DLNR does not regulate land uses mauka (landward) of the shoreline in Waikīkī. Responsibility for regulation and permitting rests with the City and County of Honolulu. Furthermore, the existing seawalls are privately-owned structures and are located outside of the Conservation District.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

SURFRIDER
FOUNDATION
OʻAHU

January 21, 2021

Surfrider Foundation Oahu Chapter
PO Box 283092
Honolulu HI 96828

Andy Bohlander
Sea Engineering
abohlander@seaengineering.com

Aloha,

This letter is in response to the EISPN for the proposed Waikiki Beach Improvement and Maintenance Project. The project aims to restore a continuous beach along the hotel areas of Waikiki. It involves construction of several new groin structures to maintain beach sand where there has been none. The plan will also modify existing coastal structures near Dukes surf break.

Since the proposed project is in close proximity to famous surf breaks and is along a very popular shoreline for visitors and residents to enjoy the ocean, Surfrider Foundation has a strong interest in this proposed project. While restoration of the beach may be beneficial in many ways, our community has several questions that may be addressed in the EIS:

1. What is the impact of the proposed project (structures, sand placement, dredging, etc.) on the adjacent beaches, shorelines and offshore resources in the project vicinity?
2. What are the short- and long-term impacts to water quality, beach sand quality, reef health, surf breaks and near-shore ocean currents?
3. What is the potential to add affordable public parking (for multi-modal forms of transportation) for local residents and surfers (with long surfboards or other watercraft) in close proximity to the maintained beach area?
4. Can additional beach access locations be added near the maintained beach areas (e.g., between hotels)?
5. What are the advantages and disadvantages of various design options for the proposed plans?
6. How much public money was spent on planning and maintaining Waikiki beach in the last several decades? How does this compare to other beaches in the state?
7. Assuming resources are limited, what are the socio-economic impacts of maintaining Waikiki beach over other areas?
8. How will projected sea level rise influence the feasibility of maintaining Waikiki Beach as proposed?
9. How has the beach responded to the recently installed sandbag groin? Will this structure be removed or modified?
10. What are the impacts of the recently modified Royal Hawaiian groin?

Surfrider suggests that the proposed management framework for this EIS be expanded to address comprehensive community concerns as we have for over a decade of planned discreet improvements. The plan ends at the hotels and does not go on to adjacent local beaches at either end such as at

Kahanamoku Beach and Kapiolani Park Beach, where beach loss is severe and usage by local residents is high. We advocate for a comprehensive approach to improve and maintain all of the Waikiki shoreline for residents and visitors alike.

The Surfrider Foundation is greatly concerned about public beach access and coastal zone resources island-wide. Many of our beaches are at great risk due to erosion and development pressures, and our members have been advocates for protecting these areas for the enjoyment of all people and wildlife (i.e., Sunset Beach, Mokuleia, Wawamalu, Waimanalo, Lanikai, Diamond Head, Ewa, East Oahu, etc.). While we agree that Waikiki Beach is important to maintain, limited public resources must also be allocated to help mitigate erosion and sea level rise problems state-wide. We encourage the government to develop a comprehensive beach management strategy for all of our disappearing shorelines. This EIS may include a suggested framework to help the government allocate limited resources between Waikiki and other priority coastal areas in critical need of maintenance and restoration.

We appreciate your consideration.

Mahalo,

Doorae Shin

Doorae Shin
Surfrider Foundation Oahu Chapter Coordinator

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
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HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

June 4, 2021

Ms. Doorae Shin
Surfrider Foundation Oahu Chapter
PO Box 283092
Honolulu HI 96828

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Ms. Shin:

Thank you for sending your comment letter for the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: “What is the impact of the proposed project (structures, sand placement, dredging, etc.) on the adjacent beaches, shorelines and offshore resources in the project vicinity? What are the short- and long-term impacts to water quality, beach sand quality, reef health, surf breaks and near-shore ocean currents?”

> **Response:** We acknowledge that the proposed actions have the potential to result in a variety of short and long-term impacts. Based on previous projects in Waikīkī, we anticipate that the proposed actions will result in some short-term impacts that will be temporary in nature; however, no negative long-term impacts are anticipated. Industry-standard Best Management Practices (BMPs) will be utilized to avoid and minimize potential impacts to the maximum extent practicable. The potential impacts of the proposed actions are discussed in Sections 8 and 9 of the DPEIS. The cumulative and secondary impacts of the proposed actions are discussed in Sections 10 and 11 of the DPEIS, respectively.

Comment: “What is the potential to add affordable public parking (for multi-modal forms of transportation) for local residents and surfers (with long surfboards or other watercraft) in close proximity to the maintained beach area?”

Response: The DLNR does not regulate land uses mauka (landward) of the shoreline in Waikīkī. Responsibility for managing transportation and parking in Waikīkī rests with the City and County of Honolulu, Department of Transportation Services.

Comment: "Can additional beach access locations be added near the maintained beach areas (e.g., between hotels)?"

Response: The DLNR is the lead agency with authority for maintaining *lateral* public access along Hawaii's shorelines. The right of access to Hawaii's shorelines includes the right of transit along the shoreline and within beach transit corridors. *Beach transit corridors* are defined as the areas extending seaward of the shoreline and these areas are considered public property (HRS §115-5, HRS §205A-1). The DLNR does not regulate land uses mauka (landward) of the shoreline in Waikīkī. Responsibility for maintaining *perpendicular* public access to Hawaii's shorelines rests with the City and County of Honolulu.

Comment: "What are the advantages and disadvantages of various design options for the proposed plans?"

Response: We evaluated various alternatives for each beach sector. The advantages and disadvantages of these alternatives are discussed in Sections 3.4, 4.4, 5.4, 6.4, 7.4, 7.6, 10, and 11 of the DPEIS.

Comment: "How much public money was spent on planning and maintaining Waikiki beach in the last several decades? How does this compare to other beaches in the state?"

Response: Hawai'i has over 750 miles of coastline. There are approximately 24 miles of safe, clean, accessible, and generally suitable-for-swimming sandy beaches across the six main Hawaiian Islands and 184 additional miles of sandy shoreline in the state (Kaiser et al., 1998). Due to funding and staffing limitations, the DLNR seeks to strategically fund beach improvement and maintenance projects that have the broadest and most direct positive impacts to the citizens and the economy of the State of Hawai'i.

Over the past decade, the DLNR has funded five beach improvement and maintenance projects in Waikīkī with a total cost of approximately $10 million. The DLNR is also funding the Kā'anapali Beach Restoration and Berm Enhancement project at Kā'anapali Beach on the Island of Maui with a total cost of approximately $11 million. These projects have been prioritized because Waikīkī and Kā'anapali are critical components of the economies of the State of Hawai'i, City and County of Honolulu, and County of Maui. We are currently evaluating options to support beach restoration projects at Hale'iwa and Punalu'u on the Island of O‘ahu. These later projects would be conducted in partnerships with the City and County of Honolulu and the Federal government.

The DLNR has also invested over $1 million in funding and in-kind staff support to develop the Small-scale Beach Nourishment (SSBN) and Small-scale Beach Restoration (SSBR) programs. These programs are intended to consolidate and streamline the regulatory process to make beach improvement and maintenance projects more feasible and cost effective for individuals, communities, and public agencies that handle beach sand. It is important to note that, while beach restoration is generally a preferred alternative, it not practicable or feasible at many locations in Hawai‘i.

Comment: “Assuming resources are limited, what are the socio-economic impacts of maintaining Waikiki beach over other areas?”

Response: Waikīkī is a critical component of Hawaii’s tourism-based economy. The Waikīkī economy generates jobs and tax revenue that benefit everyone in the State of Hawai‘i. The beach and its culture are major amenities that help maintain O‘ahu and Waikīkī as an attractive visitor destination. The socioeconomic impacts of not maintaining Waikīkī Beach would likely have a negative impact on all citizens of the State of Hawai‘i. The economic impacts of beach loss in Waikīkī are discussed in Sections 1, 2.2, 3.4, 3.4, 9.1, 9.1, 10, and 11 of the DPEIS.

Comment: “How will projected sea level rise influence the feasibility of maintaining Waikiki Beach as proposed?”

Response: The Waikīkī Beach Improvement and Maintenance Program consists of *beach improvement* actions and *beach maintenance* actions. *Beach improvements* refers to actions that involve adding new sand, adding new structures, and/or modifying existing structures. *Beach maintenance* refers to actions that involve using existing sand or adding sand with no new structures or modification of existing structures.

The proposed beach improvement actions in the Halekūlani beach sector and the ‘Ewa (west) basin of the Kūhiō beach sector are designed to create a stable beach profile. The designs account for 1.5 ft of sea level rise and can be adapted to accommodate up to 2.7 ft of sea level rise. We anticipate that the beaches would be stable and periodic renourishment would not be required.

The proposed beach maintenance action in the Fort DeRussy beach sector is sand backpassing, which would involve recovering existing sand from the accreted area at the west end of the beach and placing it in the eroded area at the east end of the beach. Sand would be excavated from the beach face extending inshore only as far as necessary to obtain the required volume of sand. The proposed action would not require offshore dredging and there would be no increase in the volume of sand in the littoral system. The proposed action is intended to be conducted on a periodic basis and may be adapted as sea levels continue to rise.

The proposed beach maintenance action in the Diamond Head (east) basin of the Kūhiō beach sector is sand pumping, which would involve recovering approximately 4,500 cy of existing sand from within the basin onto the dry beach. The proposed action would not require offshore dredging and there would be no increase in the volume of sand in the basin. The proposed action is intended to be conducted on a periodic basis and may be adapted as sea levels continue to rise.

The proposed beach maintenance action in the Royal Hawaiian beach sector is beach nourishment, which would involve recovering approximately 25,000 cy of sand from the *Canoes/Queens* offshore sand deposit and placing it on the beach. This is the only action proposed that would require periodic renourishment to maintain the beach at its 1985 location. The *Canoes/Queens* offshore sand deposit consists of sand that has eroded from Royal Hawaiian Beach. This sand source has been used in previous beach nourishment projects in 2012 and 2021. Reusing this sand on a periodic basis would not increase in the volume of sand in the littoral system.

For more information about anticipated project lifespans, please see Section 3.3 of the DPEIS. For more information about sea level rise, please see Section 8.3.5 of the DPEIS.

Comment: “How has the beach responded to the recently installed sandbag groin? Will this structure be removed or modified?”

Response: The University of Hawaii Coastal Geology Group (UHCGG) has and is continuing to conduct periodic monitoring of the Kūhiō Sandbag Groin. Initial findings based on approximately one year of survey data indicate that the groin is functioning as intended. The efficacy of the groin is evident by significant sand buildup on the Diamond Head (east) side of the structure throughout the year, indicating that longshore transport was altered as intended to mitigate extreme erosion at this section of beach. Sediment capture by the groin has not resulted in significant erosion on the ‘Ewa (west) side of the structure, which would be evidenced by sediment depletion and flanking directly adjacent to the structure.

Overall, one year following completion the structural integrity and efficacy of the groin structure has been confirmed. No adverse effects of the project have been observed. No significant deficiencies with the ElcoRock sandbags and/or the overall groin performance have been observed. We will continue to monitor the structure throughout the coming year. The effectiveness or need for the structure will be further evaluated after we accomplish improvements to the ‘Ewa (west) basin in the Kūhiō beach sector. For additional information about the Kūhiō Sandbag Groin, please see Sections 2.6, 6.1, and 8.5.3 of the DPEIS.

Comment: “What are the impacts of the recently modified Royal Hawaiian groin?”

> **Response:** The Royal Hawaiian Groin Replacement project was completed in August 2020. The project proponents, consultants, and contractors routinely observe the shoreline conditions in this area to evaluate the performance of the structure. Initial observations indicate that the groin is performing its primary function to stabilize the beach on the Diamond Head (east) side of the groin. The beach in this area is currently wider than it was pre-construction, and the shoreline has naturally taken the arc-shape anticipated from the groin design. For additional information about the Royal Hawaiian Groin, please see Sections 2.6, 6.1, and 8.5.3 of the DPEIS.

Comment: “Surfrider suggests that the proposed management framework for this EIS be expanded to address comprehensive community concerns as we have for over a decade of planned discreet improvements. The plan ends at the hotels and does not go on to adjacent local beaches at either end such as at Kahanamoku Beach and Kapiolani Park Beach, where beach loss is severe and usage by local residents is high. We advocate for a comprehensive approach to improve and maintain all of the Waikiki shoreline for residents and visitors alike.”

> **Response:** Selection of the proposed beach improvement and maintenance actions was a primarily stakeholder-driven process. We relied heavily on feedback and direction from the Waikīkī Beach Community Advisory Committee (WBCAC) to identify issues, needs, priorities, and design criteria for beach sector. The sectors that were selected for beach improvement and maintenance actions were identified as the highest priorities by the WBCAC. While the other beach sectors of Waikīkī – Duke Kahanamoku, Queens, Kapiʻolani, and Kaimana - were not identified as priorities by the WBCAC, these areas are clearly important and we recognize that, as sea levels continue to rise, beach improvements and/or maintenance may be required in these beach sectors in the future. For more information about the WBCAC and the project selection process, please see Section 2 and Appendix A of the DPEIS.

Comment: “The Surfrider Foundation is greatly concerned about public beach access and coastal zone resources island-wide. Many of our beaches are at great risk due to erosion and development pressures, and our members have been advocates for protecting these areas for the enjoyment of all people and wildlife (i.e., Sunset Beach, Mokuleia, Wawamalu, Waimanalo, Lanikai, Diamond Head, Ewa, East Oahu, etc.). While we agree that Waikiki Beach is important to maintain, limited public resources must also be allocated to help mitigate erosion and sea level rise problems state-wide. We encourage the government to develop a comprehensive beach management strategy for all of our disappearing shorelines. This EIS may include a suggested framework to help the government allocate limited resources between Waikiki and other priority coastal areas in critical need of maintenance and restoration."

> **Response:** We appreciate your recognition of the need to develop a comprehensive beach management strategy for all of the shorelines of Hawaiʻi. Unfortunately, we do not have sufficient funding and staff resources to develop such plans and strategies. However, towards this end, we have developed the Small-scale Beach Nourishment (SSBN) and Small-scale Beach Restoration (SSBR) programs to facilitate proactive beach management state-wide.
>
> We also completed the *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* in December 2017. The report provides specific recommendations to protect Hawaii's beaches including:
>
> - Amend the State Legacy Lands Act to set aside funding for preserving priority coastal lands and use of a variety of practices and tools to enable legacy beaches to persist.
> - Conduct a state-wide assessment of legacy beach conservation priorities.
> - Establish a "willing seller" program to move development away from legacy beaches.
> - Develop public-private partnerships for coastal land acquisition, beach management, and reef protection
>
> We have also been instrumental, as has The Surfrider Foundation, in promoting and supporting legislation to improve shoreline management in Hawaiʻi, including requiring mandatory disclosure for private properties and public offerings located in areas with potential exposure to sea level rise, exploring the use of transfer of development rights and purchase of development rights programs that facilitate managed retreat and legacy beach preservation, prohibiting driving vehicles on beaches, increasing shoreline setbacks for coastal development, and increasing penalties for activities that harm beaches.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

From: Douglas Meller <douglasmeller@gmail.com>
Sent: Friday, January 22, 2021 12:34 AM
To: Lemmo, Sam J; Waikiki; Andy Bohlander; David Smith; Dolan Eversole
Subject: January 21, 2021 Comments on EISPN for Waikiki Beach Improvement and Maintenance Program
Attachments: 1-21-21 Douglas Meller Comments on Waikiki Beach Improvement EISPN.pdf; 1982-03-OA-REIS-KALIA-RD-RELIEF-DRAINAGE.pdf; 6-17-16 email to DLNR re illegal beach fences.pdf; Title 13 Chapter 255, HAR - prohibitions on business operations on Waikiki Beach.pdf; 10-9-18 DPP letter re SMA & SV requirements for commercial uses of state shoreline property.pdf; 3-12-19 Waikiki Shore NOV.pdf; 3-1-13 email with DLNR staff re commercial storage on Waikiki Beach.pdf; 12-20-16 DLNR Waikiki-Beach-User-Conflict-Rpt.pdf; 3-6-19 Sen. Morikawa letter to DLNR - CASE, SUZANNE 2019-03-06.pdf

Department of Land and Natural Resources
Office of Conservation and Coastal Lands
Attention: Samuel Lemmo, Administrator
email: sam.j.lemmo@hawaii.gov

Sea Engineering, Inc.
Attention: Andy Bohlander and David A. Smith, PhD, PE
email: waikiki@seaengineering.com
abohlander@seaengineering.com
dsmith@seaengineering.com

Dolan Eversole
UH Sea Grant College Program
Waikiki Beach Management Coordinator
email: eversole@hawaii.edu

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT (EIS) PREPARATION NOTICE
WAIKIKI BEACH IMPROVEMENT AND MAINTENANCE PROGRAM

I support the EIS Preparation Notice proposals to widen, stabilize, and maintain Waikiki Beach. I also support the "optional" proposal for construction of an ADA-compliant beach walkway between the Royal Hawaiian groin and the existing Fort DeRussy beach walkway.

If only limited funding were available, my priority would be to relocate accreted sand from the west end to the eroding east end of Fort DeRussy Beach. If sufficient funding were available, my next priority would be to widen/construct/stabilize a continuous beach between the Royal Hawaiian groin and Kalia Road Relief Drain.

Apart from my priorities for beach improvements, I request that the Draft EIS address my following comments which concern acquisition of private littoral rights, regulation of development, and regulation of commercial use of the beach.

ACQUISITION OF PRIVATE LITTORAL RIGHTS

I recommend that the Draft EIS propose use of eminent domain to acquire all private littoral rights between the Royal Hawaiian Hotel groin and Fort DeRussy. In 1928-1929, the Territory of Hawaii executed beach-widening agreements which authorized property owners abutting this section of beach to install portable fences to privatize, and prevent the public from using, part of any significant public beach widening. During the 1970s and 1980s, Federal and State initiatives to widen this section of beach failed because abutting property owners refused to voluntarily quitclaim private littoral rights established under the 1928-1929 beach widening agreements. Private littoral rights established under the Territorial agreements might also preclude construction of a continuous beach walkway as proposed in the EIS Preparation Notice. More Information and references are provided in the attached pdf file for Kalia Road Relief Drain Revised EIS.

I also recommend that the Draft EIS propose use of eminent domain to acquire private littoral rights makai of the existing "Line A" under the 1965 SurfRider-Royal Hawaiian Sector Beach Agreement. The 1965 Agreement includes exhibits which designate a "Line A" and a "Line B" over the beach between the eastern end of the Moana Surfrider and the western end of the Royal Hawaiian. "Line A" is mauka of and not parallel to "Line B". The 1965 Agreement provides that the beach mauka of "Line A" is privately owned and not subject to a public easement; the beach between "Line A" and "Line B" is privately owned and subject to a public easement for public recreational use; and any beach constructed or accreted makai of "Line B" is publicly owned. Under the 1965 Agreement, abutting property owners are allowed to install portable fences and signs to exclude the public from private property mauka of "Line A", but are prohibited from any kind of commercial activity on the beach subject to public easement. Item 9 of the 1965 SurfRider-Royal Hawaiian Sector Beach Agreement explicitly requires that

> *The State will not conduct or permit any commercial activity of any kind on the public beach in the SurfRider-Royal Hawaiian Sector of Waikiki Beach, including … the area … subject to public easement…. The Owners [of the beach subject to public easement and abutting property] will not conduct or permit any commercial activity of any kind on the area … subject to public easement….*

As recently as June 2016, as explained in an attached 6/17/16 email pdf file, both Moana Surfrider and Royal Hawaiian beach fences were located makai of "Line A" and improperly reserved part of the public easement for exclusive commercial use by hotel patrons. Although commercial activity has been prohibited for more than half a century, hotel beach concessions still routinely place unrented commercial beach chairs and umbrellas on the beach makai of "Line A". Tourists intermittently rent the stored commercial equipment. The beach concessions use kiosks located mauka of "Line A" to collect payment for rental of their commercial equipment.

SHORELINE-RELATED LAND USE REGULATION

State law and DLNR rules require public notice on applications for shoreline certification, establish procedures for public comment, and authorize appeals of proposed DLNR determinations of the shoreline. **I request that the Draft EIS describe any informal procedures used to determine the shoreline when property owners request emergency permits to protect their property from beach retreat.**

DLNR certification of a shoreline survey determines the makai boundary of the City special management area (SMA) and usually determines the makai boundary of the City shoreline setback area. The City regulates development within the SMA with SMA permits, and the City regulates development within the shoreline setback area with shoreline variances. State law and City ordinance require public hearings on applications for both SMA permits and shoreline variances.

State law requires SMA permits prior to other permits to authorize development which straddles the shoreline.

> ***§205A-29 Special management area use permit procedure.*** *. . .*
> *(b) No agency authorized to issue permits pertaining to any development within the special management area shall authorize any development unless approval is first received in accordance with the procedures adopted pursuant to this part….*

After-the-fact permit applications for development which straddles the shoreline often result in a regulatory quagmire. The City requires shoreline certification before accepting an application for a SMA permit or a shoreline variance. DLNR rules prohibit shoreline certification when the inland wash of waves is affected by development which requires but has not obtained either a shoreline variance or a SMA permit. And State law provides that when the inland wash of waves is affected by development which requires after-the-fact permits, the shoreline setback area extends makai of the shoreline.

> ***§205A-41 Definitions.*** *. . .*
> *"Shoreline area" shall include all of the land area between the shoreline and the shoreline setback line . . .; provided that if the highest annual wash of the waves is fixed or significantly affected by a structure that has not received all permits and approvals required by law or if any part of any structure in violation of this part extends seaward of the shoreline, then the term "shoreline area" shall include the entire structure.*

I request that the Draft EIS address whether certification of the shoreline further makai after beach widening would include more of the beach within the SMA. The EIS Preparation Notice proposes that the DLNR apply for certification of a shoreline survey and obtain permits to widen Waikiki Beach. After the beach is widened, waves would not wash as far inland. DLNR rules and court rulings require certification of the shoreline at the farthest inland wash of waves. Hence, an application for shoreline certification after the beach is widened would likely result in certification of the shoreline further makai than prior to beach widening.

I request that the Draft EIS address whether a SMA permit is required for placement/storage of commercial beach chairs and umbrellas within the SMA. Attached pdf files for a 10/9/18 City DPP letter and a 3/12/19 City DPP Notice of Violation concern SMA permit requirements for placement/storage of other kinds of portable commercial equipment within the SMA.

I request that the Draft EIS address whether certification of the shoreline further makai after beach widening might allow development closer to the beach. The shoreline setback area is 40 feet wide. After beach widening, If the shoreline is certified further makai, then more of the beach would be within the shoreline setback area and less property mauka of the beach would be within the shoreline setback area.

I request that the Draft EIS address whether certification of the shoreline further makai after beach widening would relocate the boundary between the Conservation District and the Urban District. I suggest that the Draft EIS include a declaratory ruling from the State Land Use Commission. Land Use Commission rules imply that shoreline certification normally determines the boundary between the Conservation District and the Urban District in Waikiki. However, the Reef Runway precedent implies that the Conservation District boundary might not be amended when development relocates the shoreline. (Construction of the Honolulu International Airport Reef Runway relocated the shoreline further makai. However, the Reef Runway remained within the Conservation District until the State Land Use Commission approved the State's petition to reclassify the property from the Conservation District to the Urban District.)

I request that the Draft EIS address whether certification of the shoreline further makai after beach widening would relocate the makai boundary of City resort zoning for any private Waikiki shoreline property. Zoning district boundaries are set by City ordinance. Where the beach is owned by abutting resort property, shifting the City resort zoning district boundary further makai (onto the beach) could increase both the maximum permitted building floor area and market value of abutting resort property. However, if the DLNR acquired private littoral rights prior to beach widening, it would be irrelevant whether part of the beach was rezoned for resort use.

ILLEGAL COMMERCIAL BEACH USES

I request that the Draft EIS include maps and text which explain where the commercial placement/storage of unrented commercial beach chairs and umbrellas is currently illegal on Waikiki Beach. I also request that the Draft EIS include maps and text which address DLNR regulation of commercial beach use after beach widening. I have attached several pdf files which provide background information concerning DLNR regulation of commercial beach use in Waikiki.

Hawaii Administrative Rules Title 13 Subtitle 11 Part III Chapter 255 prohibits placement or storage of unrented commercial beach chairs on the public beach easement makai of the Moana Surfrider, Outrigger, and Royal Hawaiian hotels.

> *§13-255-6 Waikiki Beach uses and activities; restrictions. . . .*
>
> *(c) Storage, parking, and display prohibited. No person shall store, park, moor, place, or display any thing or personal property on or at Waikiki Beach for the purpose of engaging in, conducting, transacting, or soliciting business of any kind; provided that an outrigger canoe or sailing catamaran registered by the department pursuant to Hawaii ocean waters and shores rules may be placed, moored, or anchored below the mean high water mark. . . .*

The following 12/29/20 picture, used for a 1/4/21 Star Advertiser article, shows unrented commercial beach chairs and umbrellas which were illegally placed/stored on the public beach easement makai of the Outrigger Hotel.

The following 1/18/19 pictures show unrented commercial beach chairs and umbrellas which were illegally placed/stored on the public beach easement makai of the Royal Hawaiian Hotel.

The DLNR has not authorized any concession or other commercial use of the State-owned beach makai of the Waikiki Shore Condominium or the State-owned beach makai of Fort DeRussy. However, the following 9/6/19 picture shows unrented commercial beach chairs and umbrellas which were illegally placed/stored on both the State-owned beach makai of the Waikiki Shore Condominium and the State-owned beach makai of Fort DeRussy. The red line on this picture is the Waikiki Shore Condominium's 10/15/19 certified shoreline.

I look forward to reviewing the Draft EIS.

Douglas Meller

9 PDF ATTACHMENTS

Douglas Meller
email: douglasmeller@gmail.com

January 21, 2021

Department of Land and Natural Resources
Office of Conservation and Coastal Lands
Attention: Samuel Lemmo, Administrator
email: sam.j.lemmo@hawaii.gov

Sea Engineering, Inc.
Attention: Andy Bohlander and David A. Smith, PhD, PE
email: waikiki@seaengineering.com
abohlander@seaengineering.com
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Dolan Eversole
UH Sea Grant College Program
Waikiki Beach Management Coordinator
email: eversole@hawaii.edu

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I request that the Draft EIS address whether certification of the shoreline further makai after beach widening might allow development closer to the beach. The shoreline setback area is 40 feet wide. After beach widening, If the shoreline is certified further makai, then more of the beach would be within the shoreline setback area and less property mauka of the beach would be within the shoreline setback area.

I request that the Draft EIS address whether certification of the shoreline further makai after beach widening would relocate the boundary between the Conservation District and the Urban District. I suggest that the Draft EIS include a declaratory ruling from the State Land Use Commission. Land Use Commission rules imply that shoreline certification normally determines the boundary between the Conservation District and the Urban District in Waikiki. However, the Reef Runway precedent implies that the Conservation District boundary might not be amended when development relocates the shoreline. (Construction of the Honolulu International Airport Reef Runway relocated the shoreline further makai. However, the Reef Runway remained within the Conservation District until the State Land Use Commission approved the State's petition to reclassify the property from the Conservation District to the Urban District.)

I request that the Draft EIS address whether certification of the shoreline further makai after beach widening would relocate the makai boundary of City resort zoning for any private Waikiki shoreline property. Zoning district boundaries are set by City ordinance. Where the beach is owned by abutting resort property, shifting the City resort zoning district boundary further makai (onto the beach) could increase both the maximum permitted building floor area and market value of abutting resort property. However, if the DLNR acquired private littoral rights prior to beach widening, it would be irrelevant whether part of the beach was rezoned for resort use.

ILLEGAL COMMERCIAL BEACH USES

I request that the Draft EIS include maps and text which explain where the commercial placement/storage of unrented commercial beach chairs and umbrellas is currently illegal on Waikiki Beach. I also request that the Draft EIS include maps and text which address DLNR regulation of commercial beach use after beach widening. I have attached several pdf files which provide background information concerning DLNR regulation of commercial beach use in Waikiki.

Hawaii Administrative Rules Title 13 Subtitle 11 Part III Chapter 255 prohibits placement or storage of unrented commercial beach chairs on the public beach easement makai of the Moana Surfrider, Outrigger, and Royal Hawaiian hotels.

> *§13-255-6 Waikiki Beach uses and activities; restrictions. . . .*
>
> *(c) Storage, parking, and display prohibited. No person shall store, park, moor, place, or display any thing or personal property on or at Waikiki Beach for the purpose of*

> *engaging in, conducting, transacting, or soliciting business of any kind; provided that an outrigger canoe or sailing catamaran registered by the department pursuant to Hawaii ocean waters and shores rules may be placed, moored, or anchored below the mean high water mark. . . .*

The following 12/29/20 picture, used for a 1/4/21 Star Advertiser article, shows unrented commercial beach chairs and umbrellas which were illegally placed/stored on the public beach easement makai of the Outrigger Hotel.

The following 1/18/19 pictures show unrented commercial beach chairs and umbrellas which were illegally placed/stored on the public beach easement makai of the Royal Hawaiian Hotel.

The DLNR has not authorized any concession or other commercial use of the State-owned beach makai of the Waikiki Shore Condominium or the State-owned beach makai of Fort DeRussy. However, the following 9/6/19 picture shows unrented commercial beach chairs and umbrellas which were illegally placed/stored on both the State-owned beach makai of the Waikiki Shore Condominium and the State-owned beach makai of Fort DeRussy. The red line on this picture is the Waikiki Shore Condominium's 10/15/19 certified shoreline.

I look forward to reviewing the Draft EIS.

Douglas Meller

ATTACHMENTS

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
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

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 4, 2021

Mr. Douglas Meller
douglasmeller@gmail.com

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Meller:

Thank you for your email dated January 22, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your email you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

We appreciate your support for the overall objectives of the Program to widen, stabilize, and maintain Waikīkī Beach. We also appreciate your prioritized list of sub-projects to be initiated sequentially as part of the overall Program.

Your letter also included requests for additional content to be provided in the Draft Programmatic Environmental Impact Statement (DPEIS) for the Program. Responses to these requests are included below:

- Regarding your request that the DPEIS propose the use of eminent domain to acquire property rights for several sections of Waikīkī Beach, EIS documents are not appropriate tools in which to exercise actions such as eminent domain.

- Regarding your request that the DPEIS describe any informal procedures used to determine the shoreline when emergency permit requests are made, we would like to clarify that there are no informal procedures for doing so. The State only follows formal procedures for situations in which a property owner requests an emergency permit. Such requests and land uses are regulated and enforced according to Hawaiʻi Administrative Rules (HAR) §13-5-35 Emergency Permits.

- Regarding your questions on the process of shoreline certification conducted as part of beach nourishment projects, as with all nourishment projects conducted within the State of Hawai‘i, beach restoration projects may not be used to move a regulatory boundary or a land ownership boundary in a seaward direction.

- Regarding your question about SMA permit requirements for placement/storage of commercial beach chairs and umbrellas within the SMA, this is a matter to be determined by the City and County of Honolulu if those land uses are located within their jurisdiction. Long term storage of such elements is not allowed seaward of the shoreline. Management of commercial beach concessions and issues related to “presetting” will continue to be controlled so as not to infringe upon the general public’s right to use and enjoy Waikīkī Beach.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
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RICK BLANGIARDI
MAYOR

DEAN UCHIDA
DIRECTOR DESIGNATE

DAWN TAKEUCHI APUNA
DEPUTY DIRECTOR

EUGENE H. TAKAHASHI
DEPUTY DIRECTOR

January 22, 2021

2020/ELOG-2557(ST)

SENT VIA EMAIL

Mr. David A. Smith
waikiki@seaengineering.com

Subject: Waikiki Beach Improvement and Maintenance Project
Environmental Impact Statement (EIS) Preparation Notice
State Department of Land and Natural Resources
Office of Conservation and Coastal Lands
Tax Map Keys various

It is the Department of Planning and Permitting understanding that the proposed beach improvement and maintenance (Project) is the second phase of the 2012 Waikiki Beach Maintenance Project, and involves the placement of approximately 20,000 cubic yards of sand extracted from locations off-shore and placed along various stretches of Waikiki Beach.

We note that most of the Project involves work makai of the regulatory shoreline, and therefore beyond the Special Management Area regulated by the City pursuant to Chapter 25, Revised Ordinances of Honolulu (ROH), or within the Shoreline Setback established by Chapter 23, ROH. However, we will reserve further comment until the Draft EIS is available for review.

Should you have any questions, please contact Steve Tagawa, of our Land Use Approvals Branch, at 768-8024.

Very truly yours,

FOR

Dean Uchida
Director Designate

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 4, 2021

Dean Uchida, Director
Department of Planning and Permitting
City and County of Honolulu
650 South King Street, 7th Floor
Honolulu, HI 96813

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Uchida:

Thank you for your comment later dated January 22, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: "We note that most of the Project involves work makai of the regulatory shoreline, and therefore beyond the Special Management Area regulated by the City pursuant to Chapter 25, Revised Ordinances of Honolulu (ROH), or within the Shoreline Setback established by Chapter 23, ROH. However, we will reserve further comment until the Draft EIS is available for review."

> **Response:** We acknowledge that the proposed beach improvement and maintenance actions are subject to Special Management Area (SMA) use permitting. The DLNR will submit formal applications for any activities in the SMA to the City and County of Honolulu, Department of Planning and Permitting. For information about the relationship of the proposed actions with the provisions of the SMA, please see Section 16.3.4 of the DPEIS.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

January 22, 2021

The National Marine Fisheries Service, Pacific Islands Regional Office (PIRO) received a request from the Department of Land and Natural Resources, Division of Conservation and Coastal Lands (DLNR OCCL) for comments on the Environmental Impact Statement Preparation Notice (EISPN) for the Waikīkī Beach Improvement and Maintenance Program. Our comments are provided below and are intended to help the DLNR OCCL comply with the essential fish habitat (EFH) provision of the Magnuson-Stevens Fishery Conservation and Management Act (MSA; Section 305(b)(2) as described by 50 CFR 600.920), which will presumably be required as part of the U.S. Army Corps of Engineers, Honolulu District, Regulatory Branch's (hereafter, USACE; cc'd here) permitting process. These comments do not fulfill any federal responsibilities and this response does not constitute an EFH consultation. Compliance with the EFH provisions of the MSA can also be achieved through pursuance to the Fish and Wildlife Coordination Act (FWCA, 16 U.S.C. 661-666c). For all questions related to consultations with us in the future, please contact us through the email address EFHESAconsult@noaa.gov.

Project Description

The DLNR OCCL proposes multiple beach nourishment and coastal improvement construction projects on Waikīkī Beach, O‘ahu, Hawai‘i at the Fort DeRussy, Halekulani, Royal Hawaiian, and Kuhio Beach sectors including beach stabilization structures, recovery of offshore sand, and placement of sand on the shoreline. The purpose of the proposed actions are to increase beach stability, provide safe access to the shoreline, and increase resilience to coastal hazards and sea level rise. More specifically, the project proposes these actions at four beach sectors in Waikīkī:

1. **Fort DeRussy Beach** – Along a 1,680 foot stretch of shoreline, the DLNR OCCL proposes to transport 1,200 cubic yards of sand from an accreted area at the west end of the beach, and move it to the east end of the beach. The action would not require in-water work, but rather excavators, front-end loaders, and dump trucks would transport the sand from the borrow site to the placement site.
2. **Halekulani Beach** – Along the 1,450 foot-long shoreline, DLNR OCCL proposes to construct a series of five groins and placing 60,000 cubic yards of sand fill from a dredge recovery area. Due to challenges accessing the beach in this area, these actions may require the use an ocean-based barge and/or construction of a temporary rubblemound construction access berm.
3. **Royal Hawaiian Beach** – This shoreline is approximately 1,730 feet long and DLNR OCCL proposes to place 20,000 cubic yards of sand from an offshore collection site. Construction methodology would be similar to the 2012 Waikīkī Beach Maintenance I project with sand being dredged using a submersible pump mounted on a crane barge. Sand would be stockpiled in the Diamond Head basin of Kuhio Beach Park until it is placed with dump trucks onto the beach. This section of beach includes the newly constructed Royal Hawaiian Groin as well as the Kuhio sandbag groin.
4. **Kuhio Beach** – Along this 1,500 foot shoreline, DLNR OCCL proposes to conduct beach nourishment and structural improvements to two rock basins. The Ewa Basin would be

removed and reconstructed into three distinct breakwaters to account for sea level rise and wave energy. Underlayer and possibly armor stones would be placed to form a work platform for an excavator. In the Diamond Head basin, no structural modifications would occur but a sand causeway may be constructed to support an excavator for sand delivery. An alternative would be a diver-operated dredge, which would entail a dredge pump and a 100 foot hose. In each basin, 4,500 cubic yards of sand would be placed on the shoreline, in the Ewa Beach basin sand would be from a dredged location and in the Diamond Head basin the sand would be excavated or dredged from the basin itself.

PIRO Habitat Mandates

Magnuson Stevens Fishery Conservation and Management Act

A consultation with NMFS is required when a federal agency conducts, funds, or permits work that may adversely affect EFH (Section 305(b)(2) as described by 50 CFR 600.920). The EFH consultation process entails the federal action agency contacting NMFS and providing an EFH assessment (EFHA), which contains key information: a description of the proposed action, a determination from the federal agency as to how the action will affect EFH, an assessment of those adverse effects, and proposed ways to mitigate for the adverse effects, if applicable. An adverse effect to EFH is anything that reduces the quality and or quality of EFH. It may include direct, indirect, and site specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of an action. NMFS will then review the EFHA and may provide conservation recommendations to avoid, minimize, offset for or otherwise mitigate expected adverse effects.

EFH consultations are scalable and commensurate to the severity and type of adverse effects to EFH. The greater the adverse effect, the greater the scrutiny in making a determination. As the order of effect increases, qualitative, semi-quantitative, and quantitative EFH Assessments are appropriate, sequentially. Often, once EFH resources need to be quantified, PIRO is likely to request an "expanded" EFH consultation as opposed to "abbreviated" (50 CFR 600.920(h)(i)), unless sufficient quantification of unavoidable losses has been provided.

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 700 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 Plans. 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, mangrove, lagoon, estuarine, surge zone, deep-slope terraces and pelagic/open ocean.

For clarity, federal agencies may incorporate the EFHA into documents prepared for other purposes, such as Endangered Species Act Biological Assessments, National Environmental Policy Act documents, etc. If an EFHA is contained in another document, it must still include all of the mandatory contents as per the EFH guidelines. It must also be clearly identified in the table of contents and text of the document as an EFHA. Alternatively, an EFHA may incorporate by reference other relevant environmental assessment documents that have already been completed. The referenced document must be provided to NMFS with the EFHA.

The EFHA process can also be combined with existing environmental consultation and review processes. The EFH guidelines at 50 CFR 600.920(f) enable federal action agencies to use existing consultation or environmental review procedures to satisfy the MSA consultation requirements if the procedures meet the following criteria: 1) the existing process must provide NMFS with timely notification of actions that may adversely affect EFH; 2) notification must include an assessment of the proposed action's impacts on EFH that meet the requirements for EFHA discussed in section 600.920(e); and 3) NMFS must have made a finding pursuant to section 600.920(f)(3) that the existing process satisfies the requirements of section 305(b)(2) of the MSA. For the purposes of this beach nourishment proposed action, the EFHA should be integrated with the FWCA (see below) coordination process. In situations where a Federal action may adversely affect designated EFH for federally managed fisheries, EFH Conservation Recommendations can be considered within the FWCA reporting recommendations.

Fish and Wildlife Coordination Act

The FWCA (16 U.S.C. 661-666c) mandates that wildlife, including fish, receive equal consideration and be coordinated with other aspects of water resource development. This is accomplished through consultation with NMFS, the U.S. Fish and Wildlife Service (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, and recommendations to prevent harm (NMFS 2004). In all, the FWCA compliance process includes the following four steps: consultation (notice of initiation); reporting (e.g., field surveys and summary reports) and recommendations to protect, mitigate, and restore natural resources; Action agency consideration of recommendations, and Action agency implementation of recommendations.

NMFS Concerns

Concern #1 - Cumulative Impacts of Beach Maintenance: NMFS is concerned about the cumulative impacts of multiple and repeated beach nourishment and coastal construction projects on EFH within and surrounding the project area. NMFS has recently consulted on and provided conservation recommendations for several of the previous beach maintenance projects in

Waikīkī including Waikīkī Beach Maintenance I, the Kuhio sandbag groin, and the Royal Hawaiian groin replacement. In addition, NMFS consulted on the nearby Ala Moana Beach Park Beach Nourishment project in April 2020 (POH-2019-00194). The EISPN indicates that the proposed actions are part of a larger Waikīkī Beach Management Plan and Hoʻomau ʻO Waikīkī Kahakai, which lays out guidance for beach management, improvement, and maintenance projects in Waikīkī. As the lifespan of the proposed work is stated to be about 50 years, the intention is to continue beach maintenance project in phases over time. Cumulative impacts of continuous beach maintenance projects in Waikīkī should be addressed and described in the EFHA pursuant to 50 CFR 600.910(a) and 600.920(e)(3)(ii).

Concern #2 - Sediment Modelling: Data and evaluation of marine currents, water flow, and sediment plume modelling are recommended near sand donor sites to justify final locations and clarify potential adverse effects to EFH from sediment resuspension and deposition during dredge operations and after beach nourishment. The modelling effort should also include and consider the following areas: the groin footprints, between the groins, offshore of the groins, and offshore sand borrow areas. NMFS is concerned that sediment deposition may occur over sensitive and hard-to-replace hard-bottom habitat, corals, or submerged aquatic vegetation (e.g., seagrass) during dredging activities at borrow sites and after during and after beach nourishment. Completing the modelling effort and including it in the Draft EIS and EFHA would help reduce uncertainty and better inform conservation recommendations. If there is a high probability that sediment resuspension and deposition will occur over sensitive and hard-to-replace hard-bottom habitat, corals, and submerged aquatic vegetation, these areas should be prioritized survey areas both before and after construction.

Concern #3 - Dredge Methods: The 2012 dredging in Waikīkī resulted in the leaching and resuspension of micrytic calcium carbonate. The Ala Moana Beach Nourishment consultation from the USACE suggested that the dredge method from 2012, which included the pumping of sand through small diameter hoses, resulted in the mechanical breakdown of sand sized particles resulting in portion that was much smaller (e.g., <4 microns). The DLNR OCCL should ensure that the dredging methods avoid duplicating the same method that may have resulted in the enhanced presence of micrytic calcium carbonate in 2012.

Concern #4 - Final locations, composition, and surrounding habitats of sand collection sites: Several sand collection site options were described in the EISPN. NMFS is concerned about the lack of information about sand collection sites as the final decision will affect the EFH adverse effect and stressor analyses. Descriptions of the final locations should include sand composition and grain size, species and size classes for any adjacent coral or area of seagrass resources, presence or absence of invasive species, and the oceanographic setting. Marine resource survey assessments should be conducted over and along both hard and soft bottom (e.g., sand, unconsolidated sediment, etc.) substrate; however, surveys should ensure that ensure that coral and seagrass habitats are prioritized and that surveys and data are statistically powerful.

Concern #5 Uncertainty of distribution of coral and seagrass throughout the project area: Quantitative resource survey assessments are described in the EISPN and will be included in the

Draft EIS and EFHA. Without this information, NMFS would be concerned about the lack of information on how project activities could affect habitat-forming EFH resources. If high uncertainty remains, NMFS must assume habitat-forming resources will be adversely affected by the project activities. The assumption would be that adverse effects may require coral and/or seagrass transplantation minimization and if there could be unavoidable loss, then offset measures to compensate for those losses must be in place.

Concern #6 Use of geotextile sandbags: NMFS is also concerned about the existing Kuhio Sandbag groin and the continued use of geotextile sandbags. It was unclear in the EISPN if the sandbags will be removed, left in place, or buried during future beach nourishment. As they were intended as a short-term solution to coastal erosion, the EFHA should detail plans for the sandbags and their future lifespan.

Concern #7 Additional adverse effects to EFH: Finally, NMFS is concerned that there are a variety of adverse effects from stressors on EFH that have not been fully considered in the EISPN. Short-term, long-term to permanent, and cumulative adverse effects to EFH may occur from the preferred alternative due to physical damage, sedimentation and turbidity, introduction of invasive species, and nutrients and chemical contamination.

Stressor Effects

Physical Damage: Direct contact to EFH resources (e.g., corals, submerged aquatic vegetation, hardbottom habitat) from removal of existing structures, construction equipment and materials, as well as from installation activities, can lead to permanent and lesser adverse effects. The level of these adverse effects (i.e., short-term, long-term to permanent, and cumulative) will depend on the density and extent of EFH resources present and the dredge and/or sediment retention designs that are chosen. For example, the 2012 Waikīkī Beach Nourishment and Dredging Project resulted in physical damage to the fossil limestone reef rock bordering sand borrow areas that were dredged. Due to this stressor, a variety of measures to avoid and minimize physical damage to EFH may be needed to reduce unavoidable losses. Overall, steps should be taken during dredging and sand transport to avoid and minimize physical damage to corals and submerged aquatic vegetation. Dredging equipment and turbidity control measures should consider wave energy and provide appreciable buffer space between construction equipment and nearby EFH resources.

Sedimentation and Turbidity: Enhanced sedimentation and turbidity may occur from dredging at borrow areas (e.g., pump heads causing re-distribution and settlement of fine sediment), land-based beach filling activities, after-the-fact leaching of micritic calcium carbonate from beach fill, and sediment resuspension from groins if they alter local hydrodynamics.

Nutrients and Chemical Contamination: Adverse effects of increased nutrients and chemical contamination may occur during dredging from borrow areas and after beach fill is placed due to release of sediment-bound nutrients and chemical contaminants. The latter may also occur from leaking construction equipment and introduction of treated materials into the marine environment. Sediment chemical analysis will be helpful to help better understand potential impacts.

Invasive Species: There is a concern that there would be an increased risk of spreading invasive species, which have been detected around at least one proposed sand collection site. *A. erecta* is an invasive species observed in Honolulu Harbor in 2014 (Wade et al. 2018) and patches of *A. erecta* have been observed near the Ala Moana dredging site; there is an increased risk of spreading this species through project activities if they are not deterred through avoidance measures and contingency planning. Invasive species rapidly increase in abundance to the point that they come to dominate their new environment, creating adverse ecological effects to other species of the ecosystem and the functions and services it may provide (Goldberg and Wilkinson 2004). Invasive species can decrease species diversity, change trophic structure, and diminish physical structure, but adverse effects are highly variable and species-specific.

EFH Assessment Content

An EFHA should be included for the upcoming EFH consultation, and specific content should be considered for inclusion to inform an EFH determination and the EFH effects analysis. If a USACE permit is required, the USACE would be the lead federal action agency responsible for developing the EFHA. As described in the EISPN, before the USACE permit application process is initiated, we recommend that quantitative marine resource survey assessments, new sediment modeling, robust sediment testing, and water quality monitoring are conducted; in addition, we recommend that your water quality monitoring plan include assessments before (e.g., baseline), during, and after construction activities (see below). The EFHA should consider the full suite of potential stressors to habitat forming EFH. Below we provide details related to these concerns and guidance on how these issues can be resolved through continued early coordination. In addition, we provide an Enclosure at the end of this letter with specific avoidance and minimization measures that would be applicable to the project.

Mitigation and Unavoidable Loss

If the proposed activities will adversely affect EFH, various forms of mitigation (e.g., avoidance, minimization, and compensation to offset losses; see FR 85 43350 and CEQ 2011 Guidance) may be required, including the potential transplantation of corals and seagrass. In such cases, a minimization plan with post-transplantation monitoring for survivability should be included in the EFHA for evaluation. If unavoidable loss is expected due to proposed activities, these losses should be quantified and a plan to offset the losses of ecosystem services should be included in the EFHA. Information on the species; abundance, size and total area lost; and locations should be included in the offset plan. NMFS also recommends a habitat suitability analysis for any transplantation site.

Quantitative Resource Survey Assessments

We recommend that you conduct preliminary, quantitative benthic marine survey assessments of the entire project footprint area within the littoral cell—hard and soft bottom, groin footprints, between groins, offshore of the groins, where sediment models predict deposition, and offshore sand borrow areas—before an EFH consultation is initiated. The level of complexity of surveys will scale proportionally with the extent of habitat forming EFH resources (e.g., corals and submerged aquatic vegetation) that may suffer adverse effects (i.e., direct, indirect, and cumulative). Contingencies should be designed to accommodate analyses that require greater replication and higher statistical power to avoid the need to obtain higher resolution data. Hard-bottom and areas with habitat forming EFH should be prioritized over soft bottom substrate, though it will be important to characterize the latter. Post-action monitoring plans would reduce uncertainty during potential EFH offset determinations. Completing the survey work and including it in the Draft EIS and EFHA would help reduce uncertainty and better inform EFH conservation recommendations and any potential offset determinations for unavoidable loss. NMFS is ready and willing to provide assistance to further refine and clarify the types and complexity of survey information to potentially include for any EFH consultation.

Sediment Modeling

Sediment modeling is recommended to predict how the preferred alternative may adversely affect EFH substrate (e.g., hard and soft bottom), habitat forming EFH (e.g., corals and submerged aquatic vegetation), and water column EFH. Modeling should consider how T-groins may alter sediment deposition over time. We are particularly concerned about redistribution and settling of fine sediment including limestone mud (i.e., microcrystalline calcium carbonate <4 microns in diameter) that may leach from beach fill and smother habitat forming EFH that may be nearby. The modelling effort should include and consider the following areas: the groin footprints, between the groins, offshore of the groins, sand nourishment areas, and offshore sand borrow areas. If there is a high probability that sediment deposition will occur over sensitive and hard-to-replace hard-bottom habitat, corals, and submerged aquatic vegetation, these areas should be prioritized survey areas both before and after construction. Completing the modelling effort and including it in the Draft EIS and EFHA would help reduce uncertainty and better inform EFH If there is a high probability that sediment deposition will occur over sensitive and hard-to-replace hard-bottom habitat, corals, and submerged aquatic vegetation, these areas should be prioritized survey areas both before and after construction.

Sediment Testing

Sediment testing should be robust and specific; it should be done before sediment is collected from borrow sites and after it is deposited on beaches. The latter would help minimize the potential resuspension of micrytic calcium carbonate by informing contingency planning and sedimentation control measures. Information about sediment chemistry, nutrient content, and other chemical characterization should be considered for both bulk samples (i.e., all size fractions) and within each size fraction or sediment class (e.g., mud, silt, fine sand, sand, etc.). This would be helpful because smaller size fractions that include silt and mud classes typically retain higher organic carbon content and are more detrimental to habitat forming EFH than those sediment types with larger sizes. In addition, micrytic calcium carbonate is more difficult for hard corals to clear off of their tissue, and can result in mortality. This information should also be considered for inclusion in the Draft EIS and EFHA to inform conservation recommendations and potential offset determinations. Completing the sediment testing effort and including it in the Draft EIS and EFHA would help reduce uncertainty and better inform EFH conservation recommendations and any offset determinations.

Water Quality Monitoring

Robust water quality monitoring (e.g., turbidity, sedimentation rates, nutrients, dissolved oxygen, etc.) would be helpful to assess conditions before (i.e., baseline), during, and after beach restoration activities. These activities should be informed by the sediment modeling and daily tide and current velocity predictions (https://www.pacioos.hawaii.edu/voyager/) to select sampling locations. Special attention and consideration should be placed on collecting turbidity and sedimentation rate information at areas where there are habitat forming EFH resources, including corals and submerged aquatic vegetation (e.g., seagrass). For other criteria needed for beach restoration projects, NMFS would defer to the requirements of the Environmental Protection Agency (EPA) delegated through the state of Hawaiʻi, Department of Health, Clean Water Branch's (DOH), 401 Water Quality Certification (WQC), Applicable Monitoring and Assessment Plans (AMAP). Completing the water quality monitoring planning effort and including it in the Draft EIS and EFHA would help reduce uncertainty and better inform EFH conservation recommendations and any offset determinations.

Summary

We greatly appreciate your early EFH coordination and the opportunity to provide comments on the EISPN. In summary, we expect that the proposed beach restoration project may have short-term, long-term to permanent, and cumulative adverse effects to EFH. Depending on the final results of additional data gathering and monitoring, the preferred alternative may result in unavoidable loss of EFH, which would require offset considerations. The prospective EFH consultation led by the USACE would be better informed with a description of cumulative impacts, sediment modelling data, description of dredge methods, final locations and information about sand collection areas, maps of coral and/or seagrass areas, details on the use of geotextile sandbags, and outlining additional impacts including physical damage, sedimentation, increased nutrients, and invasive species. We have described the stressor impacts to EFH from the proposed activities and have provided guidance on the EFH consultation process and mandatory content needed to include in an EFHA. In the Enclosure at the end of this email, we also provide specific avoidance and minimization recommendations by stressor-type.

For all additional questions related to consultations with us (e.g., EFH, and FWCA) in the future, please contact us through the email address: EFHESAconsult@noaa.gov and for FWCA contact Steve Kolinski (steve.kolinski@noaa.gov).

References

Council on Environmental Quality. 2011. Appropriate Use of Mitigation and Monitoring and Clarifying the Appropriate Use of Mitigated Findings of No Significant Impact.

Goldberg, J. and Wilkinson, C., 2004. Global threats to coral reefs: coral bleaching, global climate change, disease, predator plagues and invasive species. *Status of coral reefs of the world*, *2004*, pp.67-92.

Wade, R.M., Spalding, H.L., Peyton, K.A., Foster, K., Sauvage, T., Ross, M. and Sherwood, A.R., 2018. A new record of Avrainvillea cf. erecta (Berkeley) A. Gepp & ES Gepp (Bryopsidales, Chlorophyta) from urbanized estuaries in the Hawaiian Islands. *Biodiversity data journal*, (6).

Enclosure

Recommended Avoidance and Minimization Measures
Below is a list of avoidance and minimization measures that you could anticipate to include in your Draft EISPN potential EFHA during EFH consultation.

Physical Damage

1. Restrict all physical contact with the bottom to unconsolidated sediments devoid of coral and seagrass.
2. Work platforms should be selected based on the following preferential hierarchy:
   a. conduct all work from land;
   b. use a barge with auto-positioning systems where thrusters will not cause increased turbidity;
   c. anchor barges to (1) shoreline infrastructure; (2) nearby existing moorings; (3) anchors or spuds in/on sand only (as possible, have SCUBA divers lay anchors by hand in sand areas).
3. Prior to mobilizing, ensure all construction equipment, ballast, and vessel hulls do not pose a risk of introducing new invasive species and will not increase abundance of those invasive species present at the project location.
4. Minimize physical contact by divers and construction related tools, equipment, and materials with live benthic organisms, regardless of size, especially corals and seagrass.
5. Prevent trash and debris from entering the marine environment through the use of nets or barriers.
6. Relocate infrastructure materials (e.g., riprap, piles, boulders) that are colonized with benthic communities according to an approved relocation plan. Approved plans must ensure corals are moved to adjacent area(s) with similar habitat conditions, onto suitable substrates, using reliable attachment methods, in similar orientations. Monitoring is not required. If infrastructure materials (e.g. riprap, piles, boulders) that are colonized with benthic communities will be removed or destroyed as part of permitted activities, relocate these materials to an appropriate receiving site.
7. Have a qualified marine biologist identify and relocate hard corals that would be otherwise lost to project activities and which can be logistically moved according to an approved relocation plan. Approved plans must ensure corals are moved to adjacent area(s) with similar habitat conditions, onto suitable substrates, using reliable attachment methods, in similar orientations; and corals must be monitored for success (more frequently at the beginning, and for a duration of no less than 2 years). To provide accountability reference corals or a reference reef site should

also be monitored concurrently to compare observed changes.
8. Ensure that new structures minimize shading impacts to marine habitats. Incorporate measures that increase the ambient light transmission under structures. Some of these measures include: maximizing the height of the structure and minimizing the width of the structure to decrease shade footprint; grated decking material; using the fewest number of pilings necessary to support the structures to allow light into under-pier areas and minimize impacts to the substrate; and aligning the boardwalk in a north-south orientation for the path of the sun to cross perpendicular to the length of the structure and reduce the duration of shading
9. Perform pre-deployment reconnaissance (e.g., divers, drop cameras) to ensure that all anchors are set on hard or sandy bottom devoid of corals and seagrass and that chosen anchor locations take into consideration damage that could occur from the anchor chain if the vessel swings due to currents or tides.
10. Require a long-term maintenance plan for gear, instrumentation, and equipment to prevent failures that lead to permanent adverse effects to EFH (e.g., vessel groundings).
11. Ensure structures are properly weighted to prevent movement from currents or waves and implement a maintenance plan to ensure integrity over time.
12. Lower utility lines or cables and maneuver the placement in a controlled manner using SCUBA in order to avoid all coral resources, when practicable.
13. Develop a Wave and Storm Contingency Plan for construction materials and equipment.
14. Develop a monitoring plan to consistently assess the condition of groin materials as well as a contingency plan if the condition is endangering EFH.

Sedimentation and Turbidity

1. Conduct intertidal work at low and or slack tide.
2. Conduct work during calm sea states; stop work during high surf, winds, and currents.
3. Perform work outside of the main coral spawning period in summer (May to August) to minimize sedimentation and turbidity effects to coral eggs and larvae in the area. Peak spawning periods vary by species and geography, and are based on best available science.
4. If appropriate, consider using cofferdams to dewater the project impact site.
5. Install sediment, turbidity, and/or pneumatic curtains, and use real-time monitoring (automated or manual) for barges and dredge vessels to detect failure and implement stop-work processes if pre-determined project thresholds are reached (use standards from Clean Water Act 401 water quality certification). In areas of soft sediment, consider partial length turbidity curtains in order to reduce resuspension of sediment during high winds and currents.
6. Use soft and/or natural engineering solutions to maintain/restore natural flow volumes and velocity.
7. Minimize disturbances to stream banks, and place abutments outside of the floodplain whenever possible. Seek to maintain baseline water flow volume and velocity within the system.
8. Utilize environmental clamshell buckets for mechanical dredging.
9. Design the nourishment activities to maintain or replicate natural stream channel and flow conditions to the greatest extent practicable.
10. Revegetate shoreline areas with appropriate native species and fully stabilize disturbed

upland areas prior to removing silt fences and erosion prevention measures.

Chemical Contamination

1. Conduct work during the dry season when possible; stop work during storms or heavy rains. Neutralize or treat contaminated sediments and/or waters prior to release from the project site.
2. Inspect all equipment prior to beginning work each day to ensure the equipment is in good working condition, and there are no contaminant (oil, fuel, etc.) leaks.
3. All equipment found to be leaking contaminants must be removed from service until repaired.
4. All fueling or repairs to equipment must be done in a location with the appropriate controls that prevents the introduction of contaminants to marine environment.
5. Prevent discharges of chemicals and other fluids dissimilar from seawater into the water column.
6. Use materials that are nontoxic to aquatic organisms, such as untreated wood, concrete, or steel (avoid pressure treated lumber).
7. Use diffusers on the end of subtidal discharge pipes to minimize impacts from discharges.
8. Prevent bentonite drilling fluid from contacting live benthic organisms.

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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

June 4, 2021

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SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Dr. Chung:

Thank you for your comment letter dated January 22, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

We acknowledge that the proposed actions are subject to the provisions and requirements of the Magnuson Stevens Fishery Conservation and Management Act (MSA) (Section 305(b)(2) as described by 50 CFR 600.920) and the Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661-666c). We will conduct formal consultations with the NOAA National Marine Fisheries Services (NMFS) and the U.S. Fish and Wildlife Service (USFWS) during the final design and permitting process to ensure compliance with the Essential Fish Habitat (EFH) provisions of the MSA and the FWCA.

Comment: "Concern #1 - Cumulative Impacts of Beach Maintenance: NMFS is concerned about the cumulative impacts of multiple and repeated beach nourishment and coastal construction projects on EFH within and surrounding the project area. NMFS has recently consulted on and provided conservation recommendations for several of the previous beach maintenance projects in Waikīkī including Waikīkī Beach Maintenance I, the Kuhio sandbag groin, and the Royal Hawaiian groin replacement. In addition, NMFS consulted on the nearby Ala Moana Regional Park Beach Nourishment project in April 2020 (POH-2019-00194). The EISPN indicates that the proposed actions are part of a larger Waikīkī Beach Management Plan and Hoʻomau ʻO Waikīkī Kahakai, which lays out guidance for beach management, improvement, and maintenance projects in Waikīkī. As the lifespan of the proposed work is stated to be about 50 years, the intention is to continue beach maintenance projects in phases over time. Cumulative impacts of continuous beach maintenance projects in Waikīkī should be addressed and described in the EFHA pursuant to 50 CFR 600.910(a) and 600.920(e)(3)(ii)."

Response: The Waikīkī Beach Improvement and Maintenance Program consists of *beach improvement* actions and *beach maintenance* actions. *Beach improvements* refers to actions that involve adding new sand, adding new structures, and/or modifying existing structures. *Beach maintenance* refers to actions that involve using existing sand or adding sand with no new structures or modification of existing structures.

The proposed *beach improvement* actions in the Halekūlani beach sector and the ʻEwa (west) basin of the Kūhiō beach sector are designed to create a stable beach profile. The designs account for 1.5 ft of sea level rise and can be adapted to accommodate up to 2.7 ft of sea level rise. We anticipate that the beaches would be stable and periodic renourishment would not be required.

The proposed *beach maintenance* action in the Fort DeRussy beach sector is sand backpassing, which would involve recovering existing sand from the accreted area at the west end of the beach and placing it in the eroded area at the east end of the beach. Sand would be excavated from the beach face extending inshore only as far as necessary to obtain the required volume of sand. The proposed action would not require offshore dredging and there would be no increase in the volume of sand in the littoral system.

The proposed *beach maintenance* action in the Diamond Head (east) basin of the Kūhiō beach sector is sand pumping, which would involve recovering approximately 4,500 cy of existing sand from within the basin onto the dry beach. The proposed action would not require offshore dredging and there would be no increase in the volume of sand in the basin.

The proposed *beach maintenance* action in the Royal Hawaiian beach sector is beach nourishment, which would involve recovering approximately 25,000 cy of sand from the *Canoes/Queens* offshore sand deposit and placing it on the beach. This is the only action proposed that would require periodic renourishment to maintain the beach at its 1985 location. The *Canoes/Queens* offshore sand deposit has been used in previous beach nourishment projects in Waikīkī in 2012 and 2021. Reusing this sand on a periodic basis would not increase in the volume of sand in the littoral system.

For more information about anticipated project lifespans, please see Section 3.3 of the DPEIS. For more information about the potential impacts of the proposed actions, please see Sections 8 and 9 of the DPEIS. For more information about the cumulative and secondary impacts of the proposed actions, please see Sections 10 and 11 of the DPEIS, respectively.

Comment: "Concern #2 - Sediment Modelling: Data and evaluation of marine currents, water flow, and sediment plume modelling are recommended near sand donor sites to justify final locations and clarify potential adverse effects to EFH from sediment resuspension and deposition during dredge operations and after beach nourishment. The modelling effort should also include and consider the following areas: the groin footprints, between the groins, offshore of the groins, and offshore sand borrow areas. NMFS is concerned that sediment deposition may occur over sensitive and hard-to-replace hard-bottom habitat, corals, or submerged aquatic vegetation (e.g., seagrass) during dredging activities at borrow sites and after during and after beach nourishment. Completing the modelling effort and including it in the Draft EIS and EFHA would help reduce uncertainty and better inform conservation recommendations. If there is a high probability that sediment resuspension and deposition will occur over sensitive and hard-to-replace hard-bottom habitat, corals, and submerged aquatic vegetation, these areas should be prioritized survey areas both before and after construction."

> **Response:** We acknowledge that dredging operations have the potential to impact benthic habitat in the vicinity of the sand recovery areas. Sea Engineering, Inc. conducted analytical modeling to evaluate the potential impacts of sedimentation on benthic habitat resulting from clamshell dredging for the *Ala Moana* and *Hilton* offshore sand deposits. (see Figure 1 and Figure 2). The modeling results indicate that there would be no anticipated impacts to benthic habitat in the vicinity of the sand recovery areas. For more information about the modeling results and potential impacts to benthic habitat, please see Section 8.10.1 of the DPEIS.
>
> We have not conducted analytical modeling to evaluate the potential impacts of sedimentation on benthic habitat resulting from dredging activities for the *Canoes/Queens* offshore sand deposit. This deposit has been used in previous beach nourishment projects in 2012 and 2021. Sand recovery for those projects was accomplished using a hydraulic suction dredge and pumping the sand through a high-density polyethylene (HDPE) pipe to a dewatering basin in the Diamond Head (east) basin of Kūhiō Beach Park. When compared to clamshell dredging, hydraulic suction dredging significantly reduces the potential for sedimentation that could impact benthic habitat.
>
> Sea Engineering, Inc. also conducted detailed wave modeling to evaluate the potential for the proposed actions to impact waves, currents, and surf sites in Waikīkī. Dredging of offshore sand deposits involves removing sand from the deposits, resulting in a lowering of the bottom elevation or changing the bathymetry. Dredging could occur at the *Ala Moana*, *Canoes/Queens*, or *Hilton* offshore sand deposits. Wave modeling was used to assess the impact of dredging on waves, currents, and nearby surf sites.

A wave reflection analysis was also conducted to evaluate the potential for the proposed structures in the Halekūlani and Kūhiō beach sectors to reflect waves that could negatively impact surf sites, primarily in the Halekūlani beach sector. To evaluate potential impacts, wave modeling of the existing conditions and with the proposed structures was performed. Based on the results of the wave modeling, the dredge analysis, and the wave reflection analysis, no significant impacts to waves, currents, or surf sites in Waikīkī are anticipated.

For more information about the wave modeling results and potential impacts to waves, currents, and surf sites, please see Sections 8.2, 8.6 and 9.4.6 of the DPEIS.

Comment: "Concern #3 - Dredge Methods: The 2012 dredging in Waikīkī resulted in the leaching and resuspension of micrytic calcium carbonate. The Ala Moana Beach Nourishment consultation from the USACE suggested that the dredge method from 2012, which included the pumping of sand through small diameter hoses, resulted in the mechanical breakdown of sand sized particles resulting in portion that was much smaller (e.g., <4 microns). The DLNR OCCL should ensure that the dredging methods avoid duplicating the same method that may have resulted in the enhanced presence of micrytic calcium carbonate in 2012."

Response: We acknowledge that sand recovery, transport, and placement operations have the potential to cause turbidity. The cause of the turbidity generated during the 2012 Waikīkī Beach Maintenance I project has not been positively identified. The ongoing 2021 Waikīkī Beach Maintenance II project includes sampling and analysis of sand from the dredging and stockpile sites to help determine the cause of the turbidity. That sampling is ongoing and results are not yet available. For more information regarding dredging methods, please see Section 3.6 of the DPEIS.

Comment: "Concern #4 - Final locations, composition, and surrounding habitats of sand collection sites: Several sand collection site options were described in the EISPN. NMFS is concerned about the lack of information about sand collection sites as the final decision will affect the EFH adverse effect and stressor analyses. Descriptions of the final locations should include sand composition and grain size, species and size classes for any adjacent coral or area of seagrass resources, presence or absence of invasive species, and the oceanographic setting. Marine resource survey assessments should be conducted over and along both hard and soft bottom (e.g., sand, unconsolidated sediment, etc.) substrate; however, surveys should ensure that ensure that coral and seagrass habitats are prioritized and that surveys and data are statistically powerful."

Response: We acknowledge that the proposed actions have the potential to impact benthic habitat in the vicinity of the sand recovery areas. For information regarding the potential offshore sand recovery areas, please see Section 3.5.3 of the DPEIS. Final selection of the sand recovery areas will be based on comments received on the DPEIS and formal consultations with various agencies during the permitting process. We acknowledge that additional quantitative resource surveys may be required pursuant to the formal ESA-EFH consultations, which will be conducted during the permitting process.

Comment: "Concern #5 Uncertainty of distribution of coral and seagrass throughout the project area: Quantitative resource survey assessments are described in the EISPN and will be included in the Draft EIS and EFHA. Without this information, NMFS would be concerned about the lack of information on how project activities could affect habitat-forming EFH resources. If high uncertainty remains, NMFS must assume habitat-forming resources will be adversely affected by the project activities. The assumption would be that adverse effects may require coral and/or seagrass transplantation minimization and if there could be unavoidable loss, then offset measures to compensate for those losses must be in place."

Response: We acknowledge that the proposed actions have the potential to impact habitat-forming resources. A Marine Biological and Water Quality Assessment was conducted by AECOS (April 2021) and is included as Appendix C of the DPEIS. For additional information about the marine biological environment, see Section 8.10, 8.11, and 8.12 of the DPEIS. We acknowledge that additional quantitative resource surveys may be required pursuant to the formal ESA-EFH consultations, which will be conducted during the permitting process.

Comment: "Concern #6 Use of geotextile sandbags: NMFS is also concerned about the existing Kuhio Sandbag groin and the continued use of geotextile sandbags. It was unclear in the EISPN if the sandbags will be removed, left in place, or buried during future beach nourishment. As they were intended as a short-term solution to coastal erosion, the EFHA should detail plans for the sandbags and their future lifespan."

Response: We acknowledge your concerns regarding the use of geotextile sandbags. The University of Hawaii Coastal Geology Group has and is continuing to conduct periodic monitoring of the Kūhiō Sandbag Groin. Initial findings based on approximately one year of survey data indicate that the groin is functioning as intended. The efficacy of the groin is evident by significant sand buildup on the Diamond Head (east) side of the structure throughout the year, indicating that longshore transport was altered as intended to mitigate extreme erosion at this section of beach. Sediment capture by the groin has not resulted in significant erosion on the ʻEwa (west) side of the structure, which would be evidenced by sediment depletion and flanking directly adjacent to the structure.

Overall, one year following completion the structural integrity and efficacy of the groin structure has been confirmed. No adverse effects of the project have been observed. No significant deficiencies with the ElcoRock sandbags and/or the overall groin performance have been observed. We will continue to monitor the

> structure throughout the coming year. The effectiveness or need for the structure will be further evaluated after we accomplish improvements to the ʻEwa (west) basin in the Kūhiō beach sector. For additional information about the Kūhiō Sandbag Groin, please see Sections 2.6, 6.1, and 8.5.3 of the DPEIS.

Comment: "*Stressor Effects:* Physical Damage: Direct contact to EFH resources (e.g., corals, submerged aquatic vegetation, hardbottom habitat) from removal of existing structures, construction equipment and materials, as well as from installation activities, can lead to permanent and lesser adverse effects. The level of these adverse effects (i.e., short-term, long-term to permanent, and cumulative) will depend on the density and extent of EFH resources present and the dredge and/or sediment retention designs that are chosen. For example, the 2012 Waikīkī Beach Nourishment and Dredging Project resulted in physical damage to the fossil limestone reef rock bordering sand borrow areas that were dredged. Due to this stressor, a variety of measures to avoid and minimize physical damage to EFH may be needed to reduce unavoidable losses. Overall, steps should be taken during dredging and sand transport to avoid and minimize physical damage to corals and submerged aquatic vegetation. Dredging equipment and turbidity control measures should consider wave energy and provide appreciable buffer space between construction equipment and nearby EFH resources."

> **Response:** We acknowledge that the proposed actions have the potential to impact EFH resources. For information about potential impacts and mitigation measures to EFH, please see Section 8.11 of the DPEIS. We acknowledge that additional mitigation measures and/or Best Management Practices may be required pursuant to the formal EFH consultation, which will be conducted during the permitting process.

Comment: "*Stressor Effects:* Sedimentation and Turbidity: Enhanced sedimentation and turbidity may occur from dredging at borrow areas (e.g., pump heads causing re-distribution and settlement of fine sediment), land-based beach filling activities, after-the-fact leaching of micritic calcium carbonate from beach fill, and sediment resuspension from groins if they alter local hydrodynamics.

> **Response:** We acknowledge that sand recovery, transport, and placement operations have the potential to cause turbidity. All of the offshore sand proposed for use in Waikīkī will contain less than 6% fines per DLNR guidelines, and ideally less, in compliance with the State of Hawaiʻi guidelines for beach nourishment projects. Appropriate methods for dewatering and removal of fines to mitigate turbidity will be established during the final design and permitting process. All methods will be reviewed and approved by the Hawaiʻi Department of Health, Clean Water Branch as part of the Clean Water Act Section 401 Water Quality Certification (WQC) review process. For more information about sand characteristics and quality, please see Sections 3.5, 4.3.2, 5.3.2, 6.3.2, 7.3.2, and 7.5.2 of the DPEIS. For more information about water quality and turbidity, please see Section 8.8 of the DPEIS.

Sea Engineering, Inc. conducted analytical modeling to evaluate the potential impacts of sedimentation on benthic habitat resulting from clamshell dredging for the *Ala Moana* and *Hilton* offshore sand deposits. (see Figure 1 and Figure 2). The modeling results indicate that there would be no anticipated impacts to benthic habitat in the vicinity of the sand recovery areas. For more information about the modeling results and potential impacts to benthic habitat, please see Section 8.10.1 of the DPEIS.

Comment: "*Stressor Effects:* Nutrients and Chemical Contamination: Adverse effects of increased nutrients and chemical contamination may occur during dredging from borrow areas and after beach fill is placed due to release of sediment-bound nutrients and chemical contaminants. The latter may also occur from leaking construction equipment and introduction of treated materials into the marine environment. Sediment chemical analysis will be helpful to help better understand potential impacts."

Response: We acknowledge your concerns regarding the potential for increased nutrients and chemical contamination associated with sand recovery, transport, and placement operations. The *Ala Moana* offshore sand deposit was tested for contaminants for the City and County of Honolulu's Ala Moana Regional Park beach nourishment project. The State of Hawaiʻi Department of Health concluded that the sand was satisfactory for beach nourishment. There have been no recent events to indicate that the other offshore sand deposits would be contaminated. Best Management Practices (BMPs) will be in place to limit the potential impacts of equipment on the ocean environment.

Comment: "*Stressor Effects:* Invasive Species*:* There is a concern that there would be an increased risk of spreading invasive species, which have been detected around at least one proposed sand collection site. A. erecta is an invasive species observed in Honolulu Harbor in 2014 (Wade et al. 2018) and patches of A. erecta have been observed near the Ala Moana dredging site; there is an increased risk of spreading this species through project activities if they are not deterred through avoidance measures and contingency planning. Invasive species rapidly increase in abundance to the point that they come to dominate their new environment, creating adverse ecological effects to other species of the ecosystem and the functions and services it may provide (Goldberg and Wilkinson 2004). Invasive species can decrease species diversity, change trophic structure, and diminish physical structure, but adverse effects are highly variable and species-specific."

Response: We acknowledge your concerns regarding the potential for the proposed actions to increase the spread of invasive species. Areas where A. erecta have been observed will be identified and avoided during sand recovery operations. We also note that two common algae species found in Waikīkī are non-native and invasive: *A. spicifera* and *G. salicornia*. These species are widespread off the shores of the Hawaiian Islands and *A. spicifera* is a food favored by green sea turtle. The proposed groin structures in the Halekulani beach sector are not anticipated to affect species introductions to Hawaiʻi but may serve as habitat for existing introduced species. Future monitoring events will note any changes in the distribution of *A. spicifera* and other invasive species in Waikīkī.

Comment: "*EFH Assessment:* An EFHA should be included for the upcoming EFH consultation, and specific content should be considered for inclusion to inform an EFH determination and the EFH effects analysis. If a USACE permit is required, the USACE would be the lead federal action agency responsible for developing the EFHA. As described in the EISPN, before the USACE permit application process is initiated, we recommend that quantitative marine resource survey assessments, new sediment modeling, robust sediment testing, and water quality monitoring are conducted; in addition, we recommend that your water quality monitoring plan include assessments before (e.g., baseline), during, and after construction activities (see below). The EFHA should consider the full suite of potential stressors to habitat forming EFH. Below we provide details related to these concerns and guidance on how these issues can be resolved through continued early coordination. In addition, we provide an Enclosure at the end of this letter with specific avoidance and minimization measures that would be applicable to the project."

Response: We acknowledge that an EFHA will be required during the formal EFH consultation. We will ensure that the ESFA addresses the stressors identified in your comment letter. We further acknowledge that additional mitigation measures and/or Best Management Practices may be required pursuant to the formal EFH consultation, which will be conducted during the permitting process.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

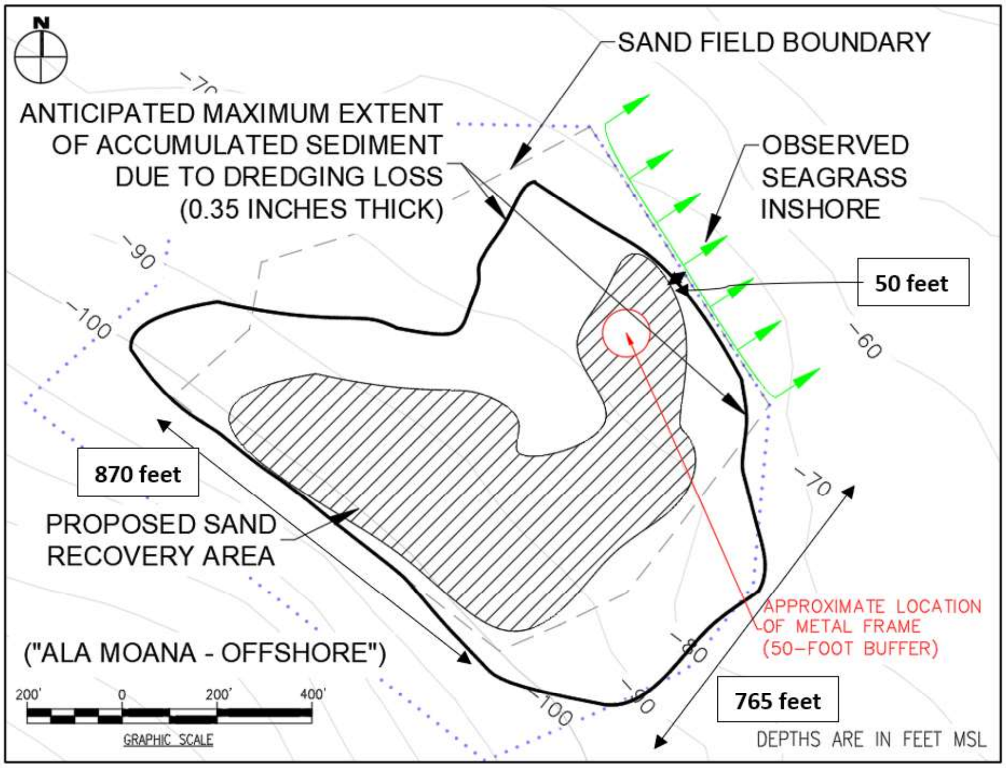

Figure 1 Sediment plume modeling results for *Ala Moana* offshore sand deposit

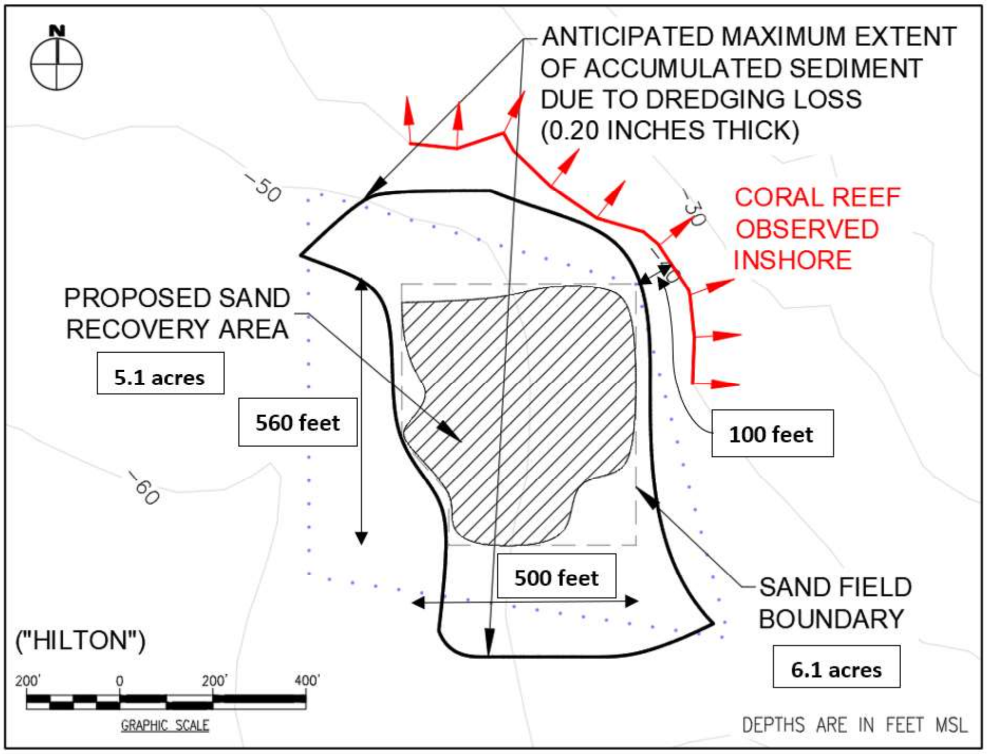

Figure 2 Sediment plume modeling results for *Hilton* offshore sand deposit

QUEEN EMMA LAND COMPANY

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January 22, 2021

Mr. Andy Bohlander (via email: waikiki@seaengineering.com)
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SUBJECT: Environmental Impact Statement Preparation Notice (EISPN) for the Waikiki Beach Improvement and Maintenance Project, Waikiki Beach, Oahu

Aloha,

The Queen Emma Land Company is pleased to submit this letter which supports the efforts of the State of Hawaii's Department of Land and Natural Resources (DLNR) to preserve and enhance iconic Waikiki Beach as set forth in DLNR's Waikiki Beach Improvement and Maintenance Program described in the Environmental Impact Statement Preparation Notice dated December 2020.

As the owner of 18 acres of heritage land in Waikiki including the site underlying the Outrigger Waikiki Beach Resort which comprises a portion of the Royal Hawaiian Beach Sector of Waikiki Beach, the long term viability of this historic, economic and cultural resource is vital to Hawaii and to support the critical mission of The Queen's Health Systems, which is to provide, in perpetuity, quality health care services to improve the well-being of Native Hawaiians and all of the people of Hawaii. The importance of the income generated by these lands has never been more evident during this COVID-impacted time.

We have all seen the impact of changing weather patterns and king tides. As chronic erosion and flooding from the impact of sea level rise increases, Waikiki Beach serves as more than a scenic or recreational amenity, but as the natural buffer to protect oceanfront and landward assets. We are relying on DLNR and others with relevant expertise to research and select the appropriate technology and engineering needed to achieve the goal of stabilizing, restoring, preserving and enhancing Waikiki Beach for the benefit of all.

Mahalo for the opportunity to provide comments on this important project.

Sincerely,

Eric K. Martinson
President

Bruce Nakaoka
Vice President

cc: Sam Lemmo, Administrator
Office of Conservation and Coastal Lands

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
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

June 4, 2021

Eric K. Martinson, President
Bruce Nakaoka, Vice President
Queen Emma Land Company
1301 Punchbowl Street
Honolulu, HI 96813

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Martinson and Mr. Nakaoka:

Thank you for your comment later dated January 22, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawai‘i Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

We recognize that you provided two project-specific comments, both in support of the proposed actions. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement (DPEIS).

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

HSBPA
HAWAII SHORE & BEACH PRESERVATION ASSOCIATION

January 22, 2021

Samuel J. Lemmo, Administrator
Department of Land and Natural Resources
Office of Conservation and Coastal Lands
1151 Punchbowl Street, Room 131
Honolulu, HI 96813

Aloha Mr. Lemmo,

On behalf of the Board of Directors and Members of the Hawai‘i Chapter of the American Shore and Beach Preservation Association (ASBPA) we are providing this letter of support for the Waikīkī Beach Improvement and Maintenance Project as proposed by the Department of Land and Natural Resources (DLNR).

The DLNR proposes beach improvement and maintenance projects in the Fort DeRussy, Halekulani, Royal Hawaiian, and Kūhiō Beach Sectors of Waikīkī. These projects include the construction of new beach stabilization structures and the recovery of offshore sand and its placement on the shoreline. The objectives of the proposed actions are to restore and improve Waikiki's public beaches, increase beach stability through improvement and maintenance of shoreline structures, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise. The proposed actions are intended to maintain the economic, social, aesthetic, recreational, environmental, cultural, and historical qualities of Waikīkī.

Specifically, we support the tailoring of solutions for each unique beach cell at Waikīkī. Sand backpassing is proposed in the Fort DeRussy Beach Sector to move sand from one end of the cell to the other end where it is needed. T-head groins with beach fill is proposed in the Halekulani Beach Sector to stabilize the chronically eroding beach and retain sand longer. Ongoing beach nourishment is proposed in the Royal Hawaiian Beach Sector to mitigate chronic erosion. Beach nourishment with a segmented breakwater is proposed in the Kūhiō-Eva Beach Sector, while beach maintenance is proposed in the Kūhiō-Diamond Head Beach Sector. This project clearly demonstrates that there is no “One-Size-Fits-All” solution for preserving beaches.

ASBPA recognizes the need for, and endorses the concept of, resilient coastal systems to increase the sustainability of coastal communities. Beaches are nature’s way of dividing the land from the sea. Preservation of beaches using beach management, maintenance, and stabilization methods, such as those identified within the Waikīkī Beach Improvement and Maintenance Project, replicate natural systems that attenuate wave energy and support coastal resilience. The proposed beach improvement and maintenance program serves as a great demonstration project that showcases possible solutions to the coastal erosion challenges facing much of the state’s coastline; we applaud the DLNR for their involvement and look forward to the possibility of continuing this programmatic support at other beaches within the state.

We have reviewed the Environmental Impact Statement Preparation Notice (EISPN) and find that the beach improvement and maintenance plan is consistent with the coastal preservation principles and policies of the state and represents a holistic approach to enhance coastal resilience for Waikīkī. Although we support the proposed actions identified in the EISPN, we have identified several items that we would like to see more fully addressed within the Environmental Impact Statement (EIS). These additional items for consideration include the following:

- Identify and examine opportunities to incorporate vegetation and other natural elements into the proposed actions. For example, there may be opportunities in the Halekulani sector as part of the beach promenade option.

- Identify opportunities to integrate protection from extreme events into the proposed actions. For example, the proposed beach promenade in the Halekulani sector may serve a dual purpose of lateral access and backshore storm protection.

- Incorporate multiple purposes and functions where possible in the assessment and design of structures. For example, the groins and breakwaters proposed may also serve as fishing or viewing platforms with crowd-sourced shoreline monitoring stations.

- We recommend that the EIS clearly disclose the various layouts and alternatives examined for each beach sector and the benefits of the proposed actions over these alternatives.

- We recommend that the impacts on adjacent beaches outside the project boundary be examined and incorporated into the EIS. Specifically, we recommend that both individual project components and combined or cumulative impacts of all project components be examined and discussed within the EIS.

- We recommend that the EIS clarify why the proposed beach sectors were selected and limited to the center of Waikiki. For example, the Duke Kahanamoku, Queens, Kapiolani, and Kaimana Beach Sectors did not include project components.

The Hawaiʻi Shore and Beach Preservation Association (HSBPA, http://asbpa.org/hawaii/) is an organization of private sector, academic, and government professionals, students, and local community members dedicated to the preservation, restoration, and sustainable use of Hawaii's beaches and coastal environments. As the Hawaiʻi Chapter of the ASBPA, we are dedicated to preserving, protecting, and restoring Hawaii's coasts by merging science with public policy. All board and general members involved with the referenced project recused themselves from developing this letter (i.e. Andy Bohlander, Chris Conger, Dolan Eversole, Shellie Habel, and Brad Romine).

Sincerely,

Andrew Wycklendt
President, Hawaiʻi Shore and Beach Preservation Association

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
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SUZANNE D. CASE
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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

June 4, 2021

Andrew Wycklendt, President
Hawaiʻi Shore and Beach Preservation Association
Andrew.Wycklendt@aptim.com

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Wycklendt:

Thank you for sending your comment letter dated January 22, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: “Identify and examine opportunities to incorporate vegetation and other natural elements into the proposed actions. For example, there may be opportunities in the Halekulani sector as part of the beach promenade option.”

> **Response:** We acknowledge that aesthetics is an important consideration. Waikīkī is a heavily used area and there is little to no existing vegetation makai (seaward) of the shoreline. Almost the entire length of the Waikiki shoreline is armored by seawalls, so any vegetation would need to be located on the beaches. Promoting vegetation growth makai (seaward) of the shoreline would reduce recreational dry beach area and inhibit lateral shoreline access, which is already limited in many areas of Waikīkī.
>
> The DLNR is the lead agency with authority for maintaining *lateral* public access along Hawaii’s shorelines. The right of access to Hawaii’s shorelines includes the right of transit along the shoreline and within beach transit corridors. *Beach transit corridors* are defined as the areas extending seaward of the shoreline and these areas are considered public property (HRS §115-5, HRS §205A-1). Promoting vegetation growth over the dry beach area in Waikīkī This would

contradict the objectives of the Program and the objectives of HRS §115-5 and HRS §205A-1.

Comment: "Identify opportunities to integrate protection from extreme events into the proposed actions. For example, the proposed beach promenade in the Halekulani sector may serve a dual purpose of lateral access and backshore storm protection."

Response: The proposed actions are intended to mitigate the impacts of wave overtopping and flooding by increasing dry beach width and elevation, which will provide a protective buffer between the ocean and the existing backshore infrastructure. This will increase the wave energy dissipating properties of the beaches and decrease the landward extent of wave runup, reducing the susceptibility to backshore flooding during large swell and high tide events. For more information about coastal hazards, please see Section 8.4 of the DPEIS.

Comment: "Incorporate multiple purposes and functions where possible in the assessment and design of structures. For example, the groins and breakwaters proposed may also serve as fishing or viewing platforms with crowd-sourced shoreline monitoring stations."

Response: The proposed actions are intended to support a broad array of existing and potential future uses in Waikīkī. Supporting additional uses was not identified as a priority or design criteria by the Waikīkī Beach Community Advisory Committee (WBCAC); thus, they are not incorporated into the designs for the proposed actions. Options to incorporate additional purposes and functions in the designs may be further considered and in the final design and permitting phase.

Comment: "We recommend that the EIS clearly disclose the various layouts and alternatives examined for each beach sector and the benefits of the proposed actions over these alternatives."

Response: We evaluated various alternatives for each beach sector. For a discussion of alternatives, please see Sections 3.4, 4.4, 5.4, 6.4, 7.4, and 7.6 of the DPEIS.

Comment: "We recommend that the impacts on adjacent beaches outside the project boundary be examined and incorporated into the EIS. Specifically, we recommend that both individual project components and combined or cumulative impacts of all project components be examined and discussed within the EIS."

Response: Beach improvement and maintenance actions are proposed in four beach sectors that span approximately 6,360 ft of shoreline in Waikīkī. The beach sectors are compartmentalized by structures including seawalls, groins, breakwaters, and storm drains. The east end of the project area is bounded by the Hilton Pier groin, which separates the Duke Kahanamoku and Fort DeRussy beach sectors. The east end of the project area is bounded by the Kapahulu storm drain/groin, which separates the Kūhiō and Queens beach sectors. The beach sectors are discrete units that are semi-contained with limited sediment transport between adjacent sectors. As a result, no significant impacts to adjacent beaches beyond the four selected beach sectors are anticipated. For a more detailed discussion of the beach sectors, please see Section 2.5 and 2.6 of the DPEIS.

We acknowledge that the proposed beach improvement and maintenance actions have the potential to result in cumulative impacts. The potential impacts and of the proposed actions are discussed in Sections 8 and 9 of the DPEIS. The cumulative and secondary impacts of the proposed actions are discussed in Sections 10 and 11 of the DPEIS, respectively.

Comment: “We recommend that the EIS clarify why the proposed beach sectors were selected and limited to the center of Waikiki. For example, the Duke Kahanamoku, Queens, Kapiolani, and Kaimana Beach Sectors did not include project components.”

Response: Selection of the proposed beach improvement and maintenance actions was a primarily stakeholder-driven process. We relied heavily on feedback and direction from the Waikīkī Beach Community Advisory Committee (WBCAC) to identify issues, needs, priorities, and design criteria for beach sector. The sectors that were selected for beach improvement and maintenance actions were identified as the highest priorities by the WBCAC. While the other beach sectors of Waikīkī – Duke Kahanamoku, Queens, Kapi‘olani, and Kaimana - were not identified as priorities by the WBCAC, these areas are clearly important and we recognize that, as sea levels continue to rise, beach improvements and/or maintenance may be required in these beach sectors in the future. For more information about the WBCAC and the project selection process, please see Sections 2.4 and 2.6 and Appendix A of the DPEIS.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

G70

111 S. King Street
Suite 170
Honolulu, HI 96813
808.523.5866
www.g70.design

22 January 2021

Dr. David Smith, Project Manager
Sea Engineering, Inc.
41-305 Kalanianaʻole Highway
Waimānalo, HI 96795
waikiki@seaengineering.com

Subject: Comment Letter on EIS Preparation Notice
Waikīkī Beach Improvement and Maintenance Program
Request for Inclusion of Duke Kahanamoku Beach Fronting Hilton Hawaiian Village

On behalf of Hilton Hawaiian Village LLC and its parent company, Park Hotels & Resorts, Inc., owners of the Hilton Hawaiian Village resort, G70 is providing comments on the Environmental Impact Statement Preparation Notice (EISPN) published on December 23, 2020.

Duke Kahanamoku Beach is the shoreline sector at the western end of Waikīkī Beach fronting Hilton Hawaiian Village, as shown in the attached Figure 1-2 from the subject EISPN. This 1,100 ft sector of Waikīkī Beach is enjoyed by the general public and resort visitors. The future health and integrity of this beach is important to our community and visitors to the Village.

Without making any financial commitment at this time, we ask that you consider including the beach fronting Hilton Hawaiian Village in the Environmental Impact Statement for the Waikīkī Beach Improvement and Maintenance Program, and for the beach nourishment and restoration project. Please address consideration of potential future actions to enhance and support the Duke Kahanamoku Beach Sector in the DLNR project and EIS studies. We see this of particular importance since actions are planned for the adjacent Fort DeRussy Sector of Waikīkī Beach.

Thank you for considering this comment letter and our request, on behalf of the owner of Hilton Hawaiian Village, for inclusion of Duke Kahanamoku Beach in the DLNR EIS. Please contact me at 808-351-4200 if you have questions or require additional information.

Sincerely,

GROUP 70 INTERNATIONAL, INC. (dba G70)

JEFFREY H. OVERTON, AICP, LEED-AP
Principal

Attachment

cc: Sam Lemmo, DLNR OCCL
Debbie Bishop, Hilton Hawaiian Village
Carl Mayfield, Park Hotels & Resorts
Duane Fisher, Esq., Starn O'Toole Marcus & Fisher

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
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M. KALEO MANUEL
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AQUATIC RESOURCES
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LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 4, 2021

Jeffrey H. Overton
Group 70 International
111 S. King Street, Suite 170
Honolulu, HI 96813

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Overton:

Thank you for your comment letter dated January 22, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). We understand that your letter was submitted on behalf of Hilton Hawaiian Village LLC and its parent company, Park Hotels & Resorts, Inc., owners of the Hilton Hawaiian Village resort.
In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: "Duke Kahanamoku Beach is the shoreline sector at the western end of Waikīkī Beach fronting Hilton Hawaiian Village, as shown in the attached Figure 1-2 from the subject EISPN. This 1,100 ft sector of Waikīkī Beach is enjoyed by the general public and resort visitors. The future health and integrity of this beach is important to our community and visitors to the Village. Without making any financial commitment at this time, we ask that you consider including the beach fronting Hilton Hawaiian Village in the Environmental Impact Statement for the Waikīkī Beach Improvement and Maintenance Program, and for the beach nourishment and restoration project. Please address consideration of potential future actions to enhance and support the Duke Kahanamoku Beach Sector in the DLNR project and EIS studies. We see this of particular importance since actions are planned for the adjacent Fort DeRussy Sector of Waikīkī Beach."

> **Response:** Selection of the proposed beach improvement and maintenance actions was a primarily stakeholder-driven process. We relied heavily on feedback and direction from the Waikīkī Beach Community Advisory Committee (WBCAC) to identify issues, needs, priorities, and design criteria for beach

sector. The sectors that were selected for beach improvement and maintenance actions were identified as the highest priorities by the WBCAC. While the Duke Kahanamoku beach sector was not identified as a high priority by the WBCAC, this area of Waikīkī is clearly important and we recognize that, as sea levels continue to rise, beach improvements and/or maintenance may be required in these beach sectors in the future. For more information about the WBCAC and the project selection process, please see Section 2 and Appendix A of the DPEIS.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

Andy Bohlander

From:	Andy Bohlander
Sent:	Friday, January 22, 2021 2:53 PM
To:	Waikiki
Subject:	FW: Waikiki Beach restoration

From: Richard Criley <criley6814@gmail.com>
Sent: Friday, January 22, 2021 2:21 PM
To: Andy Bohlander <abohlander@seaengineering.com>
Subject: Waikiki Beach restoration

May I just put in a plea to restore the sandy beach that used to exist in front of the Barefoot Cafe at Queens Surf beach.   It has been washed away due to a combination of king tides and currents changed by sand mining out from the main Waikiki Beach and the new groin near the Royal Hawaiian hotel. In February 2020, the ramp leading down to the beach was damaged by the surf and this month the ramp and adjoining rock wall were removed.
I know this is not part of the planning for the tourist beach area, but tourists did come to this beach and it has been a quieter beach for us locals, as well. Photos going back a couple decades show that a decent beach did exist there.

Richard Criley
criley6814@gmail.com

Queens Surf beach in 2000.

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

M. KALEO MANUEL
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AQUATIC RESOURCES
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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 4, 2021

Richard Criley
criley6814@gmail.com

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Criley:

Thank you for your email dated January 22, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: “May I just put in a plea to restore the sandy beach that used to exist in front of the Barefoot Cafe at Queens Surf beach. It has been washed away due to a combination of king tides and currents changed by sand mining out from the main Waikiki Beach and the new groin near the Royal Hawaiian hotel. In February 2020, the ramp leading down to the beach was damaged by the surf and this month the ramp and adjoining rock wall were removed. I know this is not part of the planning for the tourist beach area, but tourists did come to this beach and it has been a quieter beach for us locals, as well. Photos going back a couple decades show that a decent beach did exist there.”

> **Response:** Selection of the proposed beach improvement and maintenance actions was a primarily stakeholder-driven process. We relied heavily on feedback and direction from the Waikīkī Beach Community Advisory Committee (WBCAC) to identify issues, needs, priorities, and design criteria for beach sector. The sectors that were selected for beach improvement and maintenance actions were identified as the highest priorities by the WBCAC. While the Queens beach sector was not identified as a priority by the WBCAC, it is clearly an important part of Waikīkī and we recognize that, as sea levels continue to rise, beach improvements and/or maintenance may be required in the Queens beach sector in the future. For more information about the WBCAC and the project selection process, please see Section 2 and Appendix A of the DPEIS.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

Mark A. Robinson Trusts
J.L.P. Robinson LLC

1100 ALAKEA STREET, SUITE 600 ▪ HONOLULU, HAWAII 96813
PHONE (808) 440-2730 ▪ FAX (808) 440-2710

January 22, 2021

Sea Engineering, Inc. waikiki@seaengineering.com
David A. Smith
41-305 Kalanianaole Highway
Waimanalo, Hawaii 96795

Department of Land and
Natural Resources
1151 Punchbowl St., Room 131
Honolulu, HI 96813
Attention Sam Lemmo Sam.j.lemmo@hawaii.gov

Re: Waikiki Beach Improvement and Maintenance Program
Comments to Environmental Impact Statement Preparation Notice ("EISPN")

Gentlemen:

The Mark Robinson Trusts and J.L.P. Robinson LLC (collectively "Owners") are the majority fee owners of Tax Map Keys (1) 2-5-004-005 and (1) 2-6-002-026. These properties underlie portions of the Halekulani Hotel and the Sheraton Waikiki Beach Resort Hotel and are located in the Halekulani Beach Sector.

The proposed conceptual Waikiki Beach Improvement and Maintenance Program ("Program") to restore and maintain the beaches of Waikiki is welcomed and long overdue. The Owners support restoration and improvement to the beaches, increase beach stability through improvement and maintenance of shoreline structures, safe access to and along the shoreline and increase resilience to coastal hazards and sea level rise.

Owners have no comment to the scope of the EISPN at this time. We look forward, with great interest, to receiving the Environmental Impact Statement for this Program.

J.L.P. Robinson LLC

By W Rhett Taber

William Rhett Taber
Its Executive Director

Mark A. Robinson Trusts Trustees

W Rhett Taber

William Rhett Taber, Trustee

Allan Zawtocki

Allan Zawtocki, Trustee

James E Hallstrom

James E. Hallstrom, Jr., Trustee

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

June 4, 2021

William Rhett Taber, Executive Director
J.L.P. Robinson LLC
1100 Alakea Street, Suite 600
Honolulu, HI 96813

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Taber:

Thank you for your comment letter dated January 22, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). We understand that your letter was submitted on behalf of the Mark Robinson Trusts and J.L.P Robinson LLC (collectively “Owners”) who are the majority fee owners of Tax Map Keys (1) 2-5-003:005 and (1) 2-6-002:026. In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

We recognize that you provided comments in support of the proposed actions. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement (DPEIS).

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

Little Environments PLLC
Engineers & Environmental Consultants

22 January 2021

To: Sea Engineering/DLNR
Office of Conservation and Coastal Lands
1151 Punchbowl St, Rm 131
Honolulu Hawai'i, 96813

From: Joseph Little PE
Little Environments PLLC
PO Box 6388
Raleigh, NC 27628

Subject: Response and Comment on Environmental Impact Statement Preparation Notice
Respond by Date 22 Jan 2021. (2 pages)

To Whom it May concern,

It was a pleasure to observe the presentation of the EISPN for Waikiki improvements by Andy Bolander and introduced by Sam Lemmo. The work and consideration that has gone into this is extensive. It is no simple task to compile an analysis or provide a statement on an area with such rich and outstanding history and significance. It was one of the best virtual consultations I have observed.

I put forward the following comments as testimony:

In a statistical multi-dimensional dynamic environment we need to acknowledge that we don't know everything deterministically until it has been measured precisely or with allowance for error or future variance. While the satellite generated patterns and analysis are good, acknowledging the need and potential for future calibration of the structures, nourishment, and beach deposits would provide an opportunity for optimizing the performance of the overall project. Wave monitoring buoys have come a long way over the last 10 years to the point where they are as affordable as a nice computer. It is recommended that bouys be deployed before, during, and after the projects so that principles of adaptive management can allow for better and more economic management of the beach nourishment and the long term performance of the project.

Many onshore-offshore structures are prescribed or considered in this approach. Given the nearshore depts of Waikiki are relatively shallow, opportunity exists to evaluate other options such as near shore artificially stabilized shoals and artificially stabilized natural reefs.

Net environmental impacts may be prudent to consider as alternatives in the execution of improving the already engineered beach area. An example of such is considering the displacement of marine life by a structure for a structure that supports more marine life or marine habitat. Ultimately this would be a net positive environmental impact. The "touching nothing" approach due to various environmental sensitivities and fear of negative environmental recourse completely disregards the reliance in our ability as humans to be environmental stewards in our built environment.

Back passing is referred to in the EISPN. The type of duration of back passing is not elaborated on. In some parts of the world, permanent back passing is implemented via the installation of permanent infrastructure that is maintained to adapt and react to discrete events and one off shifts in sand without having to mobilize and demobilize significant equipment that disrupts the use of the beach. One example of this is Noosa Beach, just north of Brisbane Australia. It is recommended that permanent back-passing infrastructure be considered and evaluated for portions of the Waikiki Beach improvements. If it can be carried out in other parts of the world economically and effectively with silica sand, it can be executed successfully with carbonate or manufactured carbonate sand.

Given the cultural significant of this site in relation to surfing and the history of surfing around the world, it is recommended that consideration of various surf breaks at this site and the impact on these surf breaks be considered. Additionally principles of access and egress for surfing and other existing ocean recreational activities should be discussed and considered in the interest of public safety.

Best Regards in The Interest of the Future of our Coastlines,

Joseph Little PE
Owner/Fluids Engineer/ Environmental Consultant
Little Environments PLLC
PO Box 6388
Raleigh, NC 27628
(919) 916 9061

JOSEPH M. LITTLE
22 Jan 2021
LICENSED PROFESSIONAL ENGINEER
No. PE-16050
HAWAII U.S.A.

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
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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

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 4, 2021

Joseph Little, PE
Little Environments PLLC
P.O. Box 6388
Raleigh, NC 27628

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Little:

Thank you for your comment letter dated January 22, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

We acknowledge that you provided four project-specific comments:

Comment: “It is recommended that buoys be deployed before, during, and after the projects so that the principles of adaptive management can allow for better and more economic management of the beach nourishment and the long term performance of the project”.

> **Response:** We appreciate your suggestion to utilize wave monitoring buoys for monitoring purposes to support adaptive management. We will consider this option during the final design and permitting phase when monitoring protocols are established.

Comment: “Many onshore-offshore structures are prescribed or considered in this approach. Given the nearshore depths of Waikiki are relatively shallow, opportunity exists to evaluate other options such as near shore artificially stabilized shoals and artificially stabilized natural reefs”.

> **Response:** We appreciate your suggestion to evaluate additional the potential application of artificially stabilized shoals and artificially stabilized natural reefs in Waikīkī. Selection of the proposed beach improvement and maintenance actions

was a primarily stakeholder-driven process. We relied heavily on feedback and direction from the Waikīkī Beach Community Advisory Committee (WBCAC) to identify issues, needs, priorities, and design criteria for beach sector. One of the primary objectives identified by the WBCAC was to prevent any potential impacts to surf sites in Waikīkī. In recognition of concerns that have been expressed regarding potential impacts on surfing waves and ocean recreational, the proposed actions are designed to remain within the existing footprint of the shoreline as much as possible. We feel that the proposed actions are capable of achieving the program objectives without having to install new structures further offshore.

Comment: "It is recommended that permanent backpassing infrastructure be considered and evaluated for portions of the Waikiki Beach Improvements."

Response: The proposed sand backpassing in the Fort DeRussy beach sector is a small-scale beach maintenance effort. Small equipment will be utilized to recover and place a nominal volume of sand (less than 1,500 cy). We feel that the magnitude of the proposed sand backpassing is not significant enough to warrant construction of permanent backpassing infrastructure. For additional information about the proposed action in the Fort DeRussy beach sector, please see Section 4 of the DPEIS.

Comment: It is recommended that consideration of various surf breaks at the site and the impact on these surf breaks be considered. Additionally, principles of access and egress for surfing and other existing ocean recreational activities should be discussed and considered in the interest of public safety.

Response: We acknowledge your concerns regarding the potential for the proposed actions to impact surf sites in Waikīkī. Sea Engineering, Inc. conducted detailed wave modeling to evaluate the potential for the proposed actions to impact waves, currents, and surf sites in Waikīkī. Dredging of offshore sand deposits involves removing sand from the deposits, resulting in a lowering of the bottom elevation or changing the bathymetry. Dredging could occur at the *Ala Moana*, *Canoes/Queens*, or *Hilton* offshore sand deposits. Wave modeling was used to assess the impact of dredging on nearby surf sites.

A wave reflection analysis was also conducted to evaluate the potential for the proposed structures in the Halekūlani and Kūhiō beach sectors to reflect waves that could negatively impact surf sites, primarily in the Halekūlani beach sector. To evaluate potential impacts, wave modeling of the existing conditions and with the proposed structures was performed. Based on the results of the wave modeling, the dredge analysis, and the wave reflection analysis, no significant impacts to waves, currents, or surf sites in Waikīkī are anticipated.

For more information about the wave modeling results and potential impacts to waves, currents, and surf sites, please see Sections 8.2, 8.6 and 9.4.6 of the DPEIS.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

Kyoya Hotels & Resorts, LP

January 22, 2021

TO:
David A. Smith, PhD, PE
dsmith@seaengineering.com
Sea Engineering, Inc.
41-305 Kalanianaole Highway
Waimanalo, HI 96795

FROM:
Cyrus I. Oda
coda@kyo-yaco.com
Kyo-ya Hotels & Resorts, LP
2255 Kalakaua Ave.
Honolulu, HI 96815

SUBJECT: Environmental Impact Statement Preparation Notice ("EISPN") for the Waikīkī Beach Improvement and Maintenance Program. Waikīkī Beach, Oahu

Kyo-ya Hotels & Resorts, LP **supports in concept** the beach improvement program proposed by the Hawaiʻi Department of Land and Natural Resources ("***DLNR***") and outlined in the EISPN.

As a family-owned company, Kyo-ya Hotels & Resorts, LP has been doing business in Hawaii since 1961. We are the steward of five major hotel properties in Hawaii- **Sheraton Waikiki Hotel, The Royal Hawaiian Hotel, Moana Surfrider Hotel, Sheraton Princess Kaiulani Hotel, and Sheraton Maui Hotel.**

Over the past several years, and as recently as November of 2020, Waikīkī has experienced record high tides ("***King Tides***") that have exacerbated erosion and flooding. These events have highlighted the impacts of sea level rise on the beaches of Waikīkī. As sea levels continue to rise, beach loss will progressively degrade the recreational, social, cultural, environmental, aesthetic, and economic value of Waikīkī. After nearly 50 years without new beach stabilization projects in Waikīkī, we are now at a crossroads with a clear and increasingly urgent need to implement maintenance and improvements to preserve and protect the shoreline.

We are encouraged by the DLNR's desire to address chronic erosion, flooding, limited lateral shoreline access, and other public health and safety problems impacting Waikīkī Beach. The proposed long term and comprehensive solution aids the survival and resilience of Waikīkī Beach into the future. We are also encouraged by DLNR's willingness to collaborate with the community stakeholders through the Waikiki Beach Special Improvement District Association ("***WBSIDA***") and Waikiki Beach Community Advisory Committee ("***WBCAC***"). Collaboration at this early stage in the planning process identifies and establishes the program's priorities and objectives, and guides the development of the proposed beach improvement and maintenance actions.

We support this improvement program in concept and recognize its urgency. With the combination of beach erosion and King Tides, the backshore is frequently flooded, particularly during high surf events, accelerating damage to backshore infrastructure. Without beach improvements and maintenance, sea level rise is likely to result in total beach loss in Waikīkī before the end of the century and result in an estimated economic loss of $50 million to $150 million per hectare.[1] The loss of Waikīkī Beach alone would result in an annual loss of $2.223 billion in visitor expenditures.[1] Improvements and maintenance proposed in the EISPN is necessary to restore and maintain the beaches of Waikīkī to continue to support Hawaii's economy.

We offer the following summary of project-specific comments in response to the published EISPN for the Waikīkī Beach Improvement and Maintenance Program.

1. <u>1928 Waikīkī Beach Reclamation Agreement</u>
   In its discussion of the 1928 Waikīkī Beach Reclamation Agreement, Section 1.1 on page 11 of the EISPN states (and Section 7.1 on page 102 of the EISPN is substantially the same),

   > *The agreement provided that the Territory of Hawai'i would build a beach seaward from the* ***existing high water mark*** *and that title of the newly created beach would be vested by the abutting landowners. The Territory of Hawai'i and private landowners further agreed that no new structures would be built on the beach in Waikīkī. The private landowners agreed to provide a 75-foot-wide public easement along the beach measured from the* ***new mean high water mark****. (Emphasis added.)*

   To eliminate ambiguity, we request that references to the high water mark in connection with the 1928 Waikīkī Beach Reclamation Agreement be clarified. The reference to the "**existing high water mark**" should be changed to the "**then-existing mean high water mark**" and the reference to the "**new mean high water mark**" should be changed to the "**then-existing mean high water mark**" which is defined in metes and bounds in <u>Exhibit A</u> to the 1928 Waikīkī Beach Reclamation Agreement.

2. <u>Stream</u>
   In reviewing the EISPN, we are pleased to see that page 60 of the EISPN acknowledges the determination by the WBCAC that a highest priority for Halekulani Beach sector is to

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[1] Tarui, N., Peng, M., Eversole, D. (2018). *Economic Impact Analysis of the Potential Erosion of Waikīkī Beach.* University of Hawai'i Sea Grant College Program. April 2018.

"Preserve submarine groundwater discharge at Halekulani Channel (Kawehewehe)." We are in agreement with this identified priority.

3. Access Path
   Section 4.4 on page 65 of the EISPN states, "There are two narrow walkways that provide **public access** to the shoreline: one between the Halekulani and Sheraton Waikīkī hotels, extending from Kalia Road to the small pocket beaches between the hotels and another between the Halekulani Hotel and Outrigger Reef Waikīkī Beach Resort." (Emphasis added.)

   Please be advised that there is no easement for public access between the Halekulani Hotel and Sheraton Waikiki Hotel. To eliminate confusion, we request that future references to this pathway describe "a privately owned pathway where access by the public is presently allowed."

4. Groin and Walkway Design
   We are pleased to see in Section 7.11 on page 149 of the EISPN that "[t]he potential impacts of the proposed actions on scenic and aesthetic resources in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS)." The appearance of the walkway and groins involved in this project are of particular interest. We would appreciate additional detail and renderings, including those looking seaward from each of the shoreline properties from a normal human height viewpoint, being provided in the DEIS so that we may have the opportunity for further evaluation and comment.

5. TMK Correction
   Table 7-1 on page 100 of the EISPN references TMK (1) 2-6-002:**026** as being owned by Kyo-ya Resorts & Hotels, LP. (Emphasis added.) We request that the tax map key number for that parcel owned by Kyo-ya Resorts & Hotels, LP be corrected in future project documents. The correct TMK number is (1) 2-6-002:**006**.

6. Name Corrections
   The EISPN variously references the "Moana Surfrider Hotel," the "Westin Moana Surfrider," the "Moana Hotel" and the "Moana Surfrider." The EISPN also references the "Sheraton Waikīkī Hotel," the "Sheraton Waikīkī hotel," and the "Sheraton Waikīkī Beach Resort Hotel" on page 52.

   We request that the correct name of "Moana Surfrider Hotel" be used in future project documents. In addition, please be aware that the proper name of the Sheraton Waikiki Hotel does not use Hawaiian diacritical marks. We therefore request that the name be corrected to read "Sheraton Waikiki Hotel" in future project documents.

7. Caption Correction
   Bottom right corner image in Figure 4-6 on page 61 of the EISPN references "Sink holes landward of Sheraton seawall." We request that the caption reads "Sink holes landward of Halekulani seawall".

Thank you for the opportunity to provide comments on this important project. Again, Kyo-ya Hotels & Reosrts, LP **supports in concept** the beach improvement program proposed by the DLNR and outlined in the EISPN.

Sincerely

Cyrus I. Oda
Senior Vice President and Treasurer

Copy via mail:

Sam Lemmo, Administrator
Sam.j.lemmo@hawaii.gov
DLN- Office of Conservation and Coastal Lands
Department of Land and Natural Resources, State of Hawaii
1151 Punchbowl Street, Room 131
Honolulu, Hawaii 96813

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
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COMMISSION ON WATER RESOURCE MANAGEMENT

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STATE PARKS

STATE OF HAWAII
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HONOLULU, HAWAII 96809

June 4, 2021

Cyrus I. Oda
Kyo-ya Hotels and Resorts, LP
2255 Kalakaua Ave.
Honolulu, HI 96815

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Oda:

Thank you for your comment letter dated January 22, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawai‘i Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: "1928 Waikīkī Beach Reclamation Agreement: In its discussion of the 1928 Waikīkī Beach Reclamation Agreement, Section 1.1 on page 11 of the EISPN states (and Section 7.1 on page 102 of the EISPN is substantially the same),

> *The agreement provided by the Territory of Hawai‘i would build a beach seaward from the **existing high water mark** and that title of the newly created beach would be vested by the abutting landowners. The Territory of Hawai‘i and private landowners further agreed that no new structures would be built on the beach in Waikiki. The private landowners agreed to provide a 75-foot-wide public easement along the beach measured from the **new mean high water mark**. (Emphasis added.)*

To eliminate ambiguity, we request that references to the high water mark in connection with the 1928 Waikīkī Beach Reclamation Agreement be clarified. The reference to the "**existing high water mark"** should be changed to the "**then-existing high water mark**" and reference to the "**new mean high water mark**" should be changed to "**then-existing mean high water mark**" which is defined in metes and bounds in Exhibit A to the 1928 Waikīkī Beach Reclamation Agreement."

> **Response:** Thank you for your comment. Your concerns have been noted.

Comment: "Stream: In reviewing the EISPN, we are pleased to see that page 60 of the EISPN acknowledges the determination by the WBCAC that a highest priority for Halekulani Beach sector is to "Preserve submarine groundwater discharge at Halekulani Channel (Kawehewehe)." We are in agreement with this identified priority".

> **Response:** The proposed action in the Halekūlani beach sector is not anticipated to have any negative impacts on submarine groundwater discharge. Dredging of the Ala Wai canal may have intercepted the shallow groundwater conduits so in general, in comparison to pre-development, submarine groundwater discharge has decreased because of that. The proposed action does not include shore parallel structures penetrating to depths that would prevent submarine groundwater discharge, including tidal pumping. Sand would not be a barrier to flow, it would just make the seepage more diffuse, so submarine groundwater discharge would not be significantly altered. Any submarine groundwater discharge in this area would continue to flow to the ocean with placement of groins and sand, and the sand may provide some filtration. For additional information about Kawehewehe, please see Section 9.2 of the DPEIS.

Comment: "Access path: Section 4.4 on page 65 of the EISPN states, "There are two narrow walkways that provide **public access** to the shoreline: one between the Halekulani and Sheraton Waikiki hotels, extending from Kalia Road to the small pocket beaches between the hotels and another between the Halekulani Hotel and Outrigger Reef Waikiki Beach Resort." (Emphasis added.). Please be advised that there is no easement for public access between the Halekulani Hotel and Sheraton Waikiki Hotel. To eliminate confusion, we request that future references to this pathway describe "a privately owned pathway where access by the public is presently allowed."

> **Response:** We appreciate clarification of the ownership status of the existing walkway. Per your request, all references to the walkway have been corrected accordingly and are now referred to as "a privately owned pathway where access by the public is presently allowed."

Comment: "Groin and Walkway Design: We are pleased to see in Section 7.11 on page 149 of the EISPN that "[t]he potential impacts of the proposed actions on scenic and aesthetic resources in Waikiki will be discussed in the Draft Environmental Impact Statement (DEIS)." The appearance of the walkway and groins involved in this project are of particular interest. We would appreciate additional detail and renderings, including those looking seaward from each of the shoreline properties from a normal human height viewpoint, being provided in the DEIS so that we may have the opportunity for further evaluation and comment".

> **Response:** We prepared conceptual renderings for each of the proposed actions. The renderings for the proposed action in the Halekūlani beach sector

are shown in Section 3.2 and 5.3.1 of the DPEIS. We selected viewpoints that provide realistic perspectives of the proposed actions as they relate to the individual and adjacent beach sectors. We also previously developed ground-level renderings for the Hawaii Kai Entrance Channel Groin and Royal Hawaiian Groin Replacement projects, which are similar to the groins being proposed in the Halekūlani beach sector (see Figure 1 and Figure 2). We hope that you find these renderings to be helpful and informative.

Comment: "TMK Correction: Table 7-1 on page 100 of the EISPN references TMK (1) 2-6-002:**026** as being owned by Kyo-ya Resorts & Hotels LP. (Emphasis added.) We request that the tax map key number for that parcel owned by Kyo-ya Resorts & Hotel, LP be corrected in future project documents. The correct TMK number is (1) 2-6-002:**006**."

> **Response:** We appreciate clarification of the correct tax map key number for the subject property. Per your request, all references to the subject property Tax Map Key number have been corrected accordingly and are now referred to as "(1) 2-6-002:006".

Comment: "Name Corrections: The EISPN variously references the "Moana Surfrider Hotel", the "Westin Moana Surfrider", the "Moana Hotel" and the "Moana Surfrider." The EISPN also references the "Sheraton Waikiki Hotel," the "Sheraton Waikiki hotel", and the "Sheraton Waikiki Beach Resort Hotel" on page 52. We request that the correct name of the "Moana Surfrider Hotel" be used in future project documents. In addition, please be aware that the proper name of the Sheraton Waikiki Hotel does not use Hawaiian diacritical marks. We therefore request that the name be corrected to read "Sheraton Waikiki Hotel" in future project documents."

> **Response:** We appreciate clarification of the correct names for the subject properties. Per your request, all references to the subject property names have been corrected accordingly.

Comment: "Caption Correction: Bottom right corner image in Figure 4-6 on page 61 of the EISPN references "Sink holes landward of Sheraton seawall." We request that the caption reads "Sink holes landward of Halekulani seawall".

> **Response:** Per your request, the subject figure caption has been corrected accordingly and now reads "Sinkholes landward of seawall at Halekūlani Hotel".

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

Figure 1: Conceptual rendering of T-head groin for Royal Hawaiian Groin

Figure 2: Conceptual rendering of L-head groin for Hawaii Kai Entrance Channel

WAIKIKI NEIGHBORHOOD BOARD NO. 09
c/o NEIGHBORHOOD COMMISSION OFFICE •
TEL: (808) 768-3710 INTERNET: www1.honolulu.gov/nco

January 22, 2021

Department of Land and Natural Resources
Office of Conservation and Coastal Lands
Attn: Sam Lemmo
1151 Punchbowl Street, Room 131
Honolulu, HI 96813

Office of Environmental Quality Control
235 South Beretania Street, Suite 702
Honolulu, HI 96813

David A. Smith, PhD, PE
Sea Engineering, Inc
41-305 Kalanianaole Highway
Waimanalo, HI 96795

Re: Environmental Impact Statement Preparation Notice- Waikiki Beach Improvement and Maintenance Program

Thank you for circulating the Environmental Impact Statement Preparation Notice (EISPN) for the proposed project described above. The Waikiki community appreciates the Waikiki Beach Special Improvement District Association members' financial and professional commitment to rehabilitating Waikiki Beach, improving the beach connection to the adjacent built environment, and planning for climate change and sea level rise.

Our community understands that these investments, while costly, time-consuming and disruptive at times, are crucial to ensuring Waikiki Beach remains a preferred global visitor destination, an integral neighborhood of choice in Hawaii, and an economic engine for the State as a whole. Most importantly, these improvements will enhance the beach experience for the enjoyment of residents and visitors alike, for generations to come.

In the draft Environmental Impact Statement please ensure the following topics are included with a robust analysis and discussion for each.

Section 1.6
While eight beach sectors are mentioned as having been considered for analysis in the EIS, elaborate on why the specific four sectors were selected for analysis and more importantly, why the others were not. While we understand the Proposed Action's focus would naturally be on beaches fronting lodging properties in Waikiki, shorelines do not fully operate independently as hydrologic, shoreline systems. There are visible erosion, seawall collapse and infrastructure damage currently present along Sectors F,G and H and the community will inquire about these during the EIS process. Summarize the criteria from which alternatives were selected and how the four beach sectors selected interact with each other from a hydrological and littoral perspective.

Section 2.5
In the past, use of inappropriate sand sources to replenish beaches in Hawaii has occurred. While current sand sourcing protocols are robust, ensure the EIS continues the dialogue of why appropriate sand selection is so important to successful project implementation.

Chapters 3 through 6

Various groins and other in-water infrastructure concepts are being proposed for many of the project sectors. Explain how this infrastructure may or may not impact surf breaks, waves and other ocean and shoreline processes. The specific concern will be among the surfing community that uses the area.

Explain the equipment to be used for implementation of the Proposed Action and if there are any new technologies or equipment being considered to reduce the disruption at project sites and/or reduce the time to implement said projects.

Section 7.1

The presence of federal lands abutting the shoreline at the Fort DeRussy Beach Sector poses unique challenges and opportunities. In the EIS, discuss U.S. Army consultation for this project, Fort DeRussy Master Plans that may inform beach management projects, and if there are any opportunities being considered with the U.S. government for cost-sharing, direct funding or technical expertise and other resources, to assist the State in implementing various features of the Proposed Action.

The community is looking forward to reviewing how this project complies with/helps implement the full range of plans and policies applicable to Waikiki. Most importantly, the EIS analysis should specifically discuss the Proposed Action's compliance with resilience, climate change, shoreline and sea level rise policies, regulations, laws and directives approved recently at both the Hawaii State and City and County of Honolulu, level.

Again, thank you for engaging with the Waikiki community and we look forward to continued dialogue, a review of the Draft EIS, and a subsequent successful and expeditious implementation of the Proposed Action.

Sincerely,

Jeff Merz AICP, LEED AP
Waikiki Neighborhood Board
Development Review

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
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CHAIRPERSON
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CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

June 4, 2021

Jeff Merz, AICP, LEED AP
Waikiki Neighborhood Board No. 09
343 Hobron Lane
Honolulu, HI 96815

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Merz:

Thank you for your comment letter dated January 22, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment: "While eight beach sectors are mentioned as having been considered for analysis in the EIS, elaborate on why the specific four sectors were selected for analysis and more importantly, why others were not."

> **Response:** Selection of the proposed beach improvement and maintenance actions was a primarily stakeholder-driven process. We relied heavily on feedback and direction from the Waikīkī Beach Community Advisory Committee (WBCAC) to identify issues, needs, priorities, and design criteria for beach sector. The sectors that were selected for beach improvement and maintenance actions were identified as the highest priorities by the WBCAC. While the other beach sectors of Waikīkī – Duke Kahanamoku, Queens, Kapiʻolani, and Kaimana - were not identified as priorities by the WBCAC, these areas are clearly important and we recognize that, as sea levels continue to rise, beach improvements and/or maintenance may be required in these beach sectors in the future. For more information about the WBCAC and the project selection process, please see Sections 2.4 and 2.6 and Appendix A of the DPEIS.

Comment: "In the past, use of inappropriate sand sources to replenish beaches in Hawaii has occurred. While current sand sourcing protocols are robust, ensure the EIS continues the dialogue of why appropriate sand selection is so important to successful project implementation."

> **Response:** We acknowledge that sand recovery, transport, and placement operations have the potential to cause turbidity. All of the offshore sand proposed for use in Waikīkī will contain less than 6% fines per DLNR guidelines, and ideally less, in compliance with the State of Hawaiʻi guidelines for beach nourishment projects. Appropriate methods for dewatering and removal of fines to mitigate turbidity will be established during the final design and permitting process. All methods will be reviewed and approved by the Hawaiʻi Department of Health, Clean Water Branch as part of the Clean Water Act Section 401 Water Quality Certification (WQC) review process. For more information about sand characteristics and quality, please see Section 3.5 of the DPEIS. For more information about water quality and turbidity, please see Section 8.7 of the DPEIS.

Comment: "Various groins and other in-water infrastructure concepts are being proposed for many of the project sectors. Explain how this infrastructure may or may not impact surf breaks, waves and other ocean and shoreline processes. The specific concerns will be among the surfing community that uses the area."

> **Response:** Sea Engineering, Inc. conducted analytical modeling to evaluate the potential for the proposed actions to impact waves, currents, and surf sites in Waikīkī. Dredging of offshore sand deposits involves removing sand from the deposits, resulting in a lowering of the bottom elevation or changing the bathymetry. Dredging could occur at the Ala Moana, Canoes/Queens, or Hilton offshore sand deposits. Wave modeling was used to assess the impact of dredging on waves, currents, and nearby surf sites.
>
> A wave reflection analysis was also conducted to evaluate the potential for the proposed structures in the Halekūlani and Kūhiō beach sectors to reflect waves that could negatively impact surf sites, primarily in the Halekūlani beach sector. To evaluate potential impacts, wave modeling of the existing conditions and with the proposed structures was performed. Based on the results of the wave modeling, the dredge analysis, and the wave reflection analysis, no significant impacts to waves, currents, or surf sites in Waikīkī are anticipated.
>
> For more information about the wave modeling results and potential impacts to waves, currents, and surf sites, please see Sections 8.2, 8.6 and 9.4.6 of the DPEIS.

Comment: "The presence of federal lands abutting the shoreline at the Fort DeRussy beach sector poses unique challenges and opportunities. In the EIS, discuss U.S. Army consultation for this project, Fort DeRussy Master Plans that may inform beach management projects, and if there are any opportunities being considered with the U.S.

government for cost sharing, direct funding or technical expertise and other resources, to assist the State in implementing various features of the Proposed Action."

> **Response:** The U.S. Army Corps of Engineers conducted a study in 2009 and concluded that sand backpassing was the preferred solution to address erosion at the east end of the Fort DeRussy beach sector. The project proponents agree with the U.S. Army Corps of Engineers findings and recommendations. A formal consultation with the U.S. Army Corps of Engineers will be conducted during the final design and permitting process.

Comment: "Most importantly, the EIS analysis should specifically discuss the Proposed Action's compliance with resilience, climate change, shoreline and sea level rise policies, regulations, laws and directives approved recently at both the Hawaii State and City and County of Honolulu, level."

> **Response:** We acknowledge and agree that the proposed beach improvement and maintenance actions must comply with existing policies, regulations, laws and directives relating to resilience, climate change, shoreline and sea level rise. For information about the relationship of the proposed actions with the existing policies, regulations, laws and directives, please see Section 16 of the DPEIS.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement (DPEIS).

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

Jan 20, 2021

Comments pertaining to

ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE
Waikīkī Beach Improvement and Maintenance Program
December 2020

Hawaiʻi Department of Land and Natural Resources
Office of Conservation and Coastal Lands
1151 Punchbowl Street, Suite 131
Honolulu, Hawaiʻi 96813

Comments by Dennis Furukawa, Honolulu

PROJECT OBJECTIVES

According the EIS Preparation Notice dated December 2020, the primary objectives of the proposed actions are as follows:

- **Restore and improve Waikiki's public beaches.**
  Renourishment activities are applicable to that objective and are not a subject of these comments, however significant environmental impacts are likely.
- **Increase beach stability through improvement and maintenance of shoreline structures.**
  Those portions of the proposed project that involve the improvement and maintenance of EXISTING shoreline structures is not a subject of these comments.
- **Provide safe access to and along the shoreline.**
  These comments pertain in part to these objectives.
- **Increase resilience to coastal hazards and sea level rise.**
  These comments pertain in part to these objectives.

Comments by Dennis Furukawa:

1. Regarding the portion fronting Halekulani and Sheraton hotels (Halekulani Beach Sector) referred to herein in this document as the "subject shoreline":
    a. That portion of subject waterfront has never had a significant sandy beach, except that portion known as Grays Beach, and is currently fronted by seawalls (see Exhibit A-2). Therefore any placement of beach sand, boulders etc would not constitute "replenishment" but rather be new fill, and be subject to The Clean Water Act Section 404, and be subject environmental review.
    b. Likely significant environmental impacts of placing new fill:
        i. The nearshore waters (those within 50 yards of the existing seawalls) directly fronting the subject properties are known to be habitat for a large number of sea turtles, who can be

observed feeding and swimming in that area in particular, as it is not currently popular as a surfing or swimming area.
In contrast, the nearshore waters directly in front of the Royal Hawaiian and Moana Surfrider hotels are largely devoid of turtles or fish, as the water quality is poor due to the large numbers of swimmers and surfers causing turbulence, walking on coral and disturbing sand, and introducing waterborne pollutants (urine, sunscreen, rubbish, fragrances, hormones, noise etc.).

    ii. The proposed T-shaped groins (see Exhibit A-1) will alter the flow of water and sand, and will likely adversely affect the popular surf spots (Popular's, Paradise, and Three's) by establishing new structures that will reflect wave energy, and alter the seafloor contours through sand migration and the smothering of coral reefs.
    iii. The establishment of beach where people will congregate will increase the amount of waterborne pollutants (urine, sunscreen, rubbish, fragrances, hormones, noise etc.), resulting in the loss of suitable habitat for the aquatic life.
    iv. No facilities are planned for the subject shoreline, namely any restrooms, showers, rubbish cans, or lifeguard towers. These are essential facilities, as the beach users can be expected to try using facilities in the Sheraton or Halekulani hotels, which is almost certain to create problems with hotel management and guests. Note that beach showers are a significant source of pollutants, and should not be located where they drain directly into the ocean or groundwater.

c. Pedestrian access issues
    i. The proposed design (Exhibit A-1) makes no mention of how pedestrians will be accommodated between Ft. DeRussy and Royal Hawaiian beaches. Sand is not an accessible pathway, and T-groins themselves are barriers.
    ii. Prior to the closure of the walkways fronting the Halekulani and the Shereton hotels, pedestrians were afforded views directly down into the water, where many locals and visitors alike were able to view turtles and fish, even the occasional shark. That walkway was the only spot in along the main Waikiki waterfront where such viewing was possible, especially for disabled persons (the groins and rock jetties are not accessible and are subject to overtopping by waves). Placing a beach there would eliminate that unique resource.
    iii. Accessible pathways:
        1. The existing walkways are too narrow to permit two-way pedestrian traffic, and should be increased in width to a minimum of 10" clear width to meet the spirit of

        accessible pathways laws and allow groups of pedestrians the ability to pass one another.
    2. Access to the waterfront does not currently meet the American Disability Act, and must be provided, as the improvements are public in nature, using public funds.
  d. Sea level rise:
    i. As oceans rise, the proposed beaches will erode more rapidly each year. The beaches will require increasing amounts of sand to be placed in order to maintain dry sand. In order for that to happen a foundation of sand will need to be maintained and expanded, each time increasing the environmental impacts of placing the sand there in the first place.
    ii. The seawalls that currently front the Halekulani and Sheraton hotels are not subjects of the proposed projects, however they are in a degraded condition, and are integral to the objective of providing pedestrian access between the Ft. DeRussy and Royal Hawaiian beaches. At some point those seawalls will be too low to prevent overtopping of waves, as is already apparent at Grays Beach, where the sand is already piling 3'-4' above the Hau Tree Terrace lawn and patio elevations.
    iii. Sandbags have been placed at the Sheraton's beach services concessions to allow the sand to build up higher than the paved areas and walkways leading to Kalia St. Therefore it would be better to rebuild the seawalls as a more practical response to rising sea levels.
    iv. The design of the T-groins was proposed years ago (draft April 2000) as part of recommendations for beach improvements. As part of that proposal hydrodynamic modeling was not done, and so far the only information that has been presented appears to be based upon the opinions of the project proposers. Considering that the subject waterfront is such a critical resource for the State and the County's economy, physical modeling the proposed designs is essential to prevent unintended consequences, especially as sea levels rise.

2. Regarding the portion of the shoreline between Halekulani and Ft. DeRussy, which is referred to herein as the "Outrigger shoreline", and differs from the subject shoreline in the following respects:
    i. Sandy beach has been present for many decades;
    ii. Shoreline properties are not fronted by seawalls;
    iii. Paved shoreline pathways have never been in place.
    iv. Buildings are closer to the shoreline
  a. Because of the above points it may make more sense to treat the Outrigger shoreline as a part of the Ft. DeRussy shoreline than the subject shoreline.
  b. Likely environmental impacts of placing new fill:

        i. The top of pavement elevation of the walkway dividing Ft. DeRussy and the Aston Waikiki Shore was measured at 40" above the water level at the storm drain grates in that walkway. The existing beach sand at the makai edge of pavement is higher than the walkway by over one foot currently. Waves already overtop the sand and wash down the walkway during high tides and moderately large swells.
        ii. As the beach fill responds to currents and waves, the slope of the resulting beach will steepen (as evidences by the steep slopes at the Moana shoreline, and increase backwash towards the Three's surfbreak.
    c. Pedestrian access issues:
        i. in order to provide ADA accessible travel in front of the Outrigger, a concrete sidewalk supported by a retaining wall foundation would be ideal, thus providing both access and protection. Therefore it would seem that it is an opportunity to construct the pathway as part of protecting the Outrigger's shoreline.
        ii. Walkways leading from Saratoga St. to the shoreline are ADA accessible, so making the shoreline pathway accessible is a simple matter.
    d. Sea level rise:
        i. Due to the location of Outrigger, waves already break against the makai exterior walls of the hotel. As sea levels rise, sand placed in front of the hotel will not stop wave action from washing the sand away, as evidenced by sandbags placed at the Moana Surfrider's Banyan Tree Terrace, and at Grays Beach access walkway. The seaward wall of the Outrigger will reflect wave energy back towards the sea taking the sand with it.
        ii. In recognition of the fact that waves already wash down the walkways leading to Kalia St, pushing sand inland, alternatives to beach renourishment should be prioritized.

3. Alternative proposal
    a. In the Project Objectives in this paper's introduction, objective #3 is "Providing safe access to and along the shoreline." As this access is not discussed in the EIS Preparation Notice, I am proposing an alternative design that seeks to address that objective. In addition, my proposed alternative design is intended to address all of the Project Objectives 1-4.
    b. Alternative Project Description (see Exhibits B-1 through B-5)
        i. Access
            1. The project would focus on reestablishing public access to the shoreline by creating an ADA accessible pathway by improving the existing pathways fronting the Halekulani and Sheraton hotels. A new 10' walkway

would cantilever over the water at the same elevation of that fronting the Sheraton (approx. +7' MSL) supported by new stone buttresses placed perpendicular to the existing seawall (see Exhibit B-1). The walkway structure would span between the existing Royal Hawaiian groin to Grays beach, and from Gray's beach to the Outrigger shoreline.

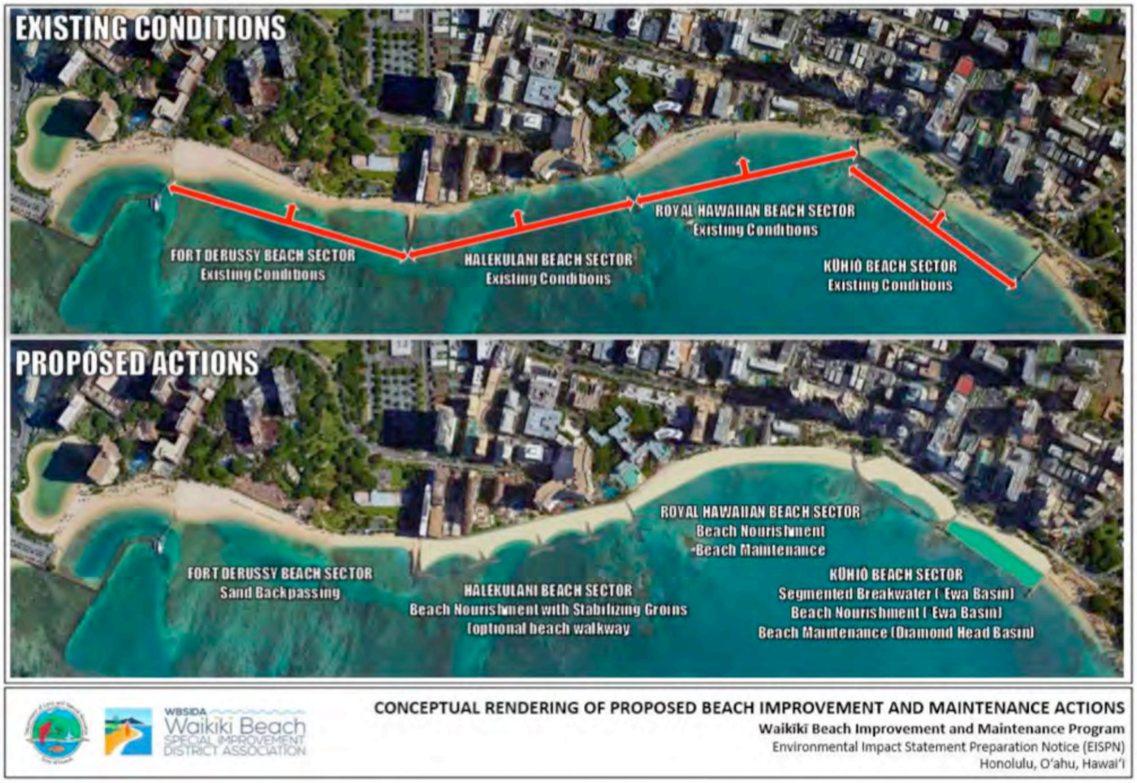
    2. The walkway would be constructed as a horizontal tubular truss, fabricated from corrosion-resistant materials, and finished with a pedestrian traffic surface, and fitted with guardrails that minimize visual obstruction, and are also corrosion resistant (see Exhibit B-2). The walkway would tie into the Sheraton's pool deck pathways on the east end, and the Grays beach access pathway, and continue westward along the Halekulani shoreline frontage.
    3. At the Outrigger shoreline, a walkway that also acts as a seawall (no illustration provided) would be placed against the hotel seaward wall with a walkway elevation higher than the existing aforementioned walkways accessing Kalia St.

ii. Seawall protection
    1. The walkway structure would be engineered to mount equipment that would reduce the energy of wave action. The equipment could be used to absorb wave energy and convert it into electric or thermal energy. The energy produced could be used for operating pumps (such as to reduce water levels in the storm drains) or lighting along the walkways and shoreline parks.
    2. The energy-conversion technologies (ECTs) would be mounted below the walkway and remain largely unseen except from beyond the shoreline, and placed close to the seawalls to minimize intrusion into the ocean. The devices must not introduce threats to marine life or be an attractive nuisance for children and tourists. The ECTs must be virtually silent, quiet on land and in the water.
    3. Possible technologies include piezoelectric elements, geared levers, pneumatics, or others. Repairs and upgrades to the ECTs would be simple as the entire array of equipment would be accessible from the walkway. No element of the ECTs would be founded or mounted in seafloor or reef, and clearance from reef or seafloor would be a minimum of 12", with large enough spaces to allow the passing of large sea turtles below

and beside the devices. Electric cables or pneumatic hoses would be mounted on the underside of the walkway.

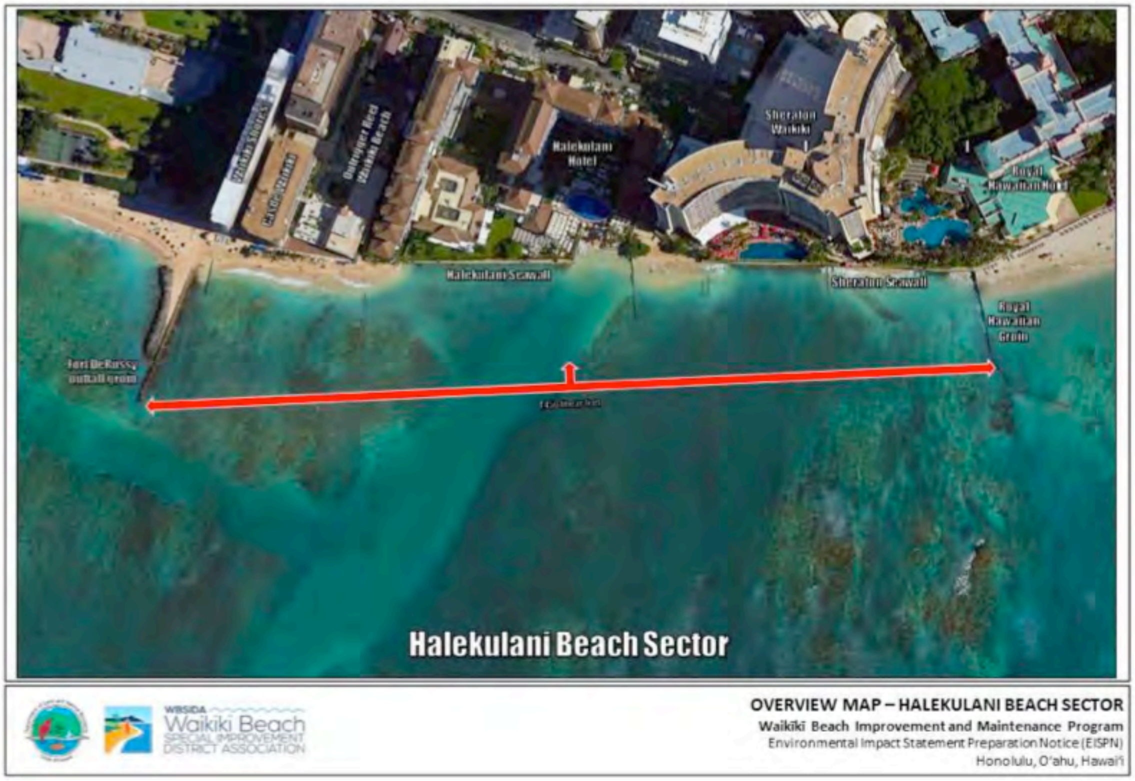
- iii. Sea level rise
    1. Mounted at the elevation of the existing walkway (+7' MSL) at the Sheraton, the walkway and the seawall protection + ECTs should have a long useful lifetime, as it should be high enough to accommodate over 12" of sea level rise.

Exhibit A-1



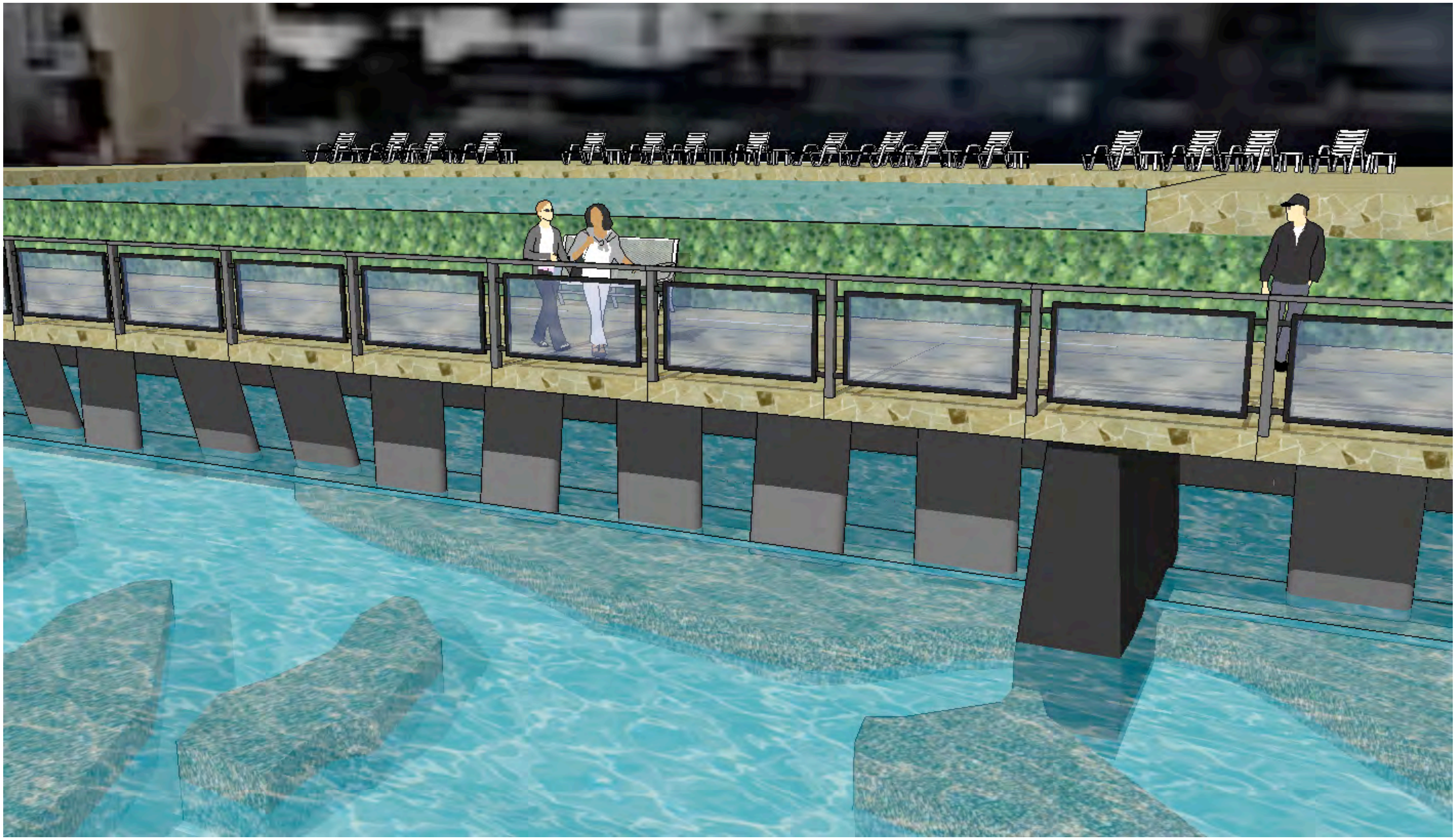
Proposed improvements

Exhibit A-2



Existing Conditions

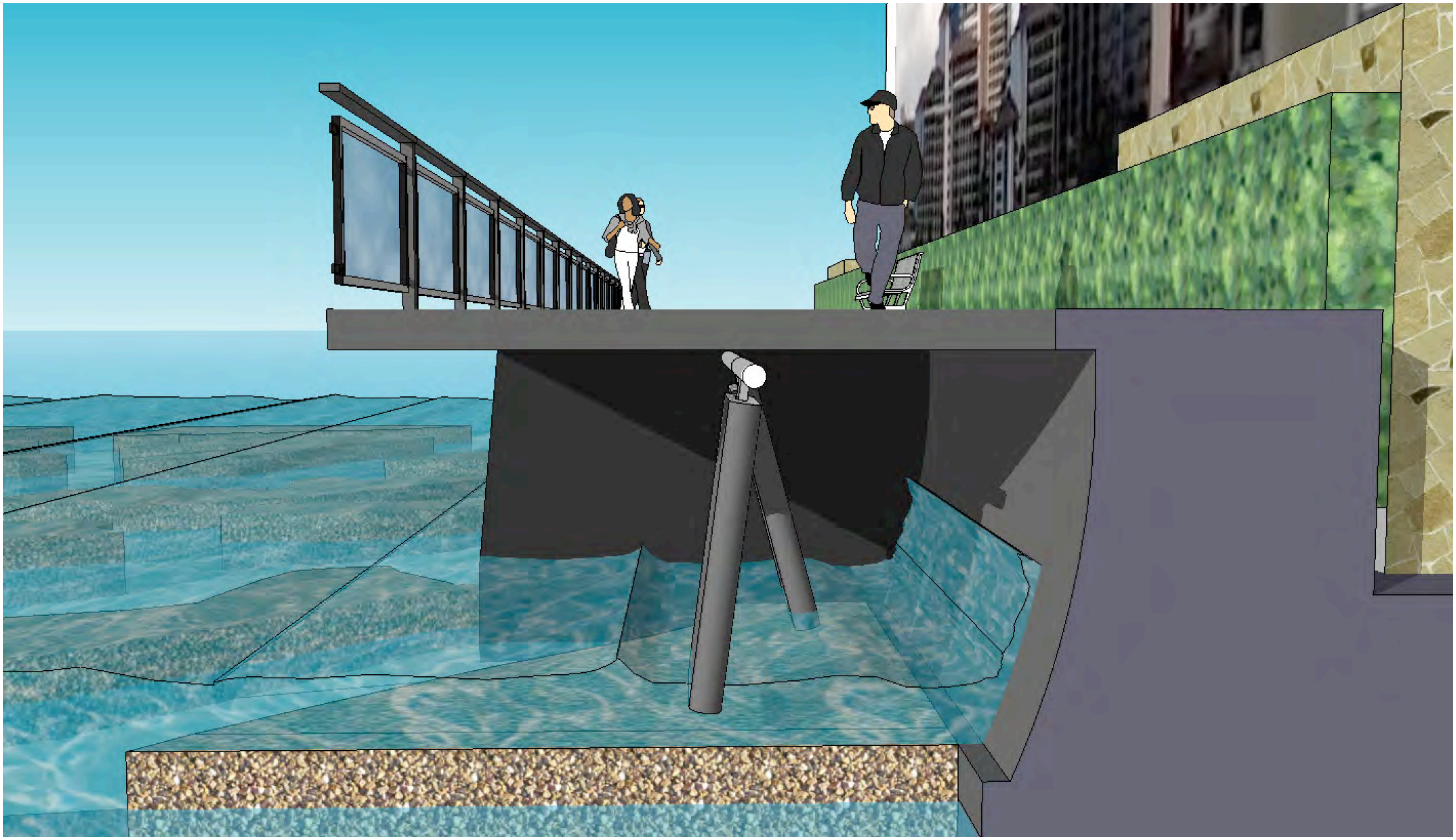
Exhibit B-1



Sheraton Shoreline Walkway Conceptual Rendering
Walkway with energy-conversion devices below

WAIKĪKĪ BEACH IMPROVEMENT AND MAINTENANCE PROGRAM
Comments and illustrations by Dennis Furukawa

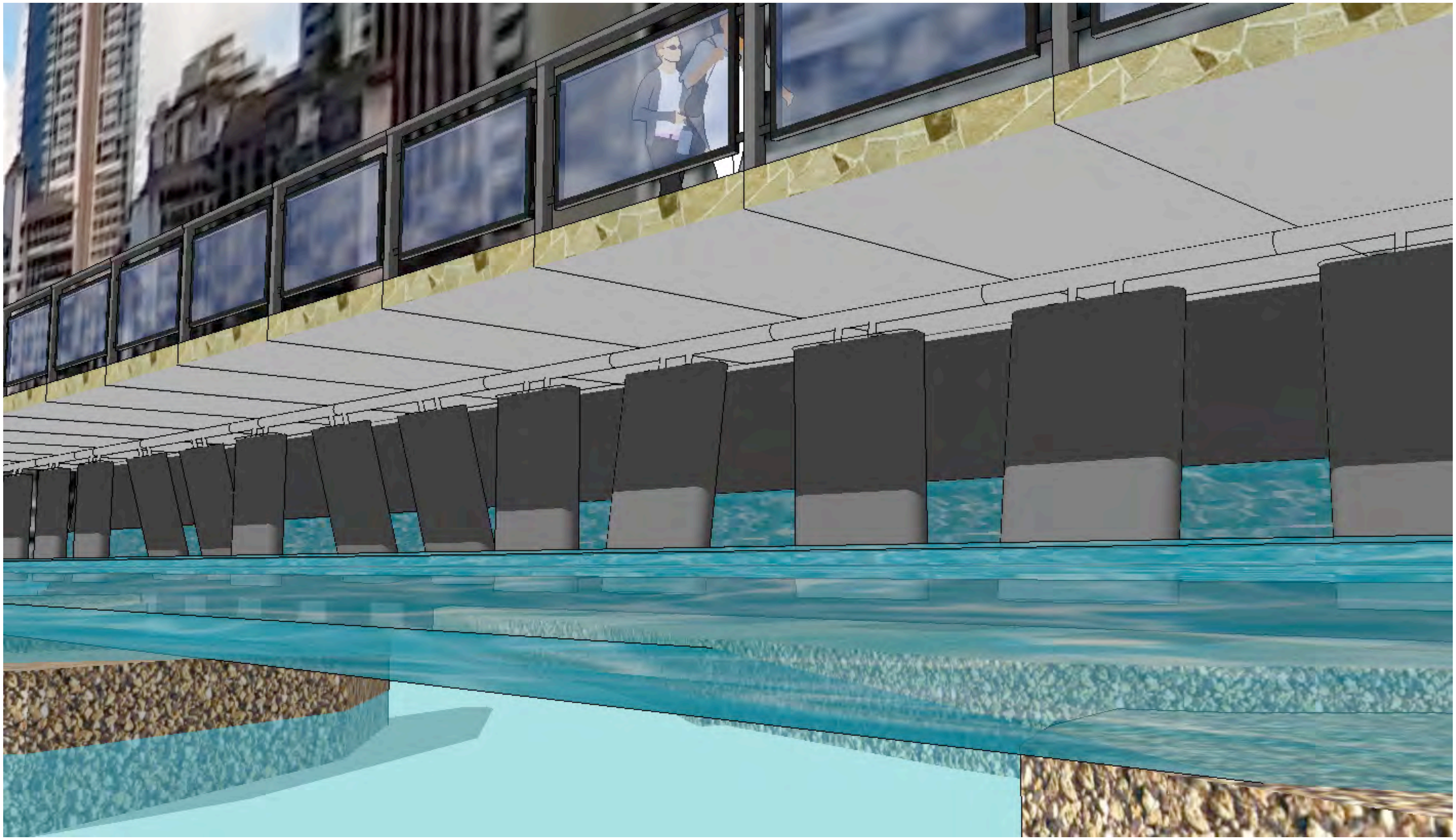
Exhibit B-2



Sheraton Shoreline Walkway Conceptual Rendering
Section through walkway, energy-conversion devices
that absorb wave energy below.

WAIKĪKĪ BEACH IMPROVEMENT AND MAINTENANCE PROGRAM
Comments and illustrations by Dennis Furukawa

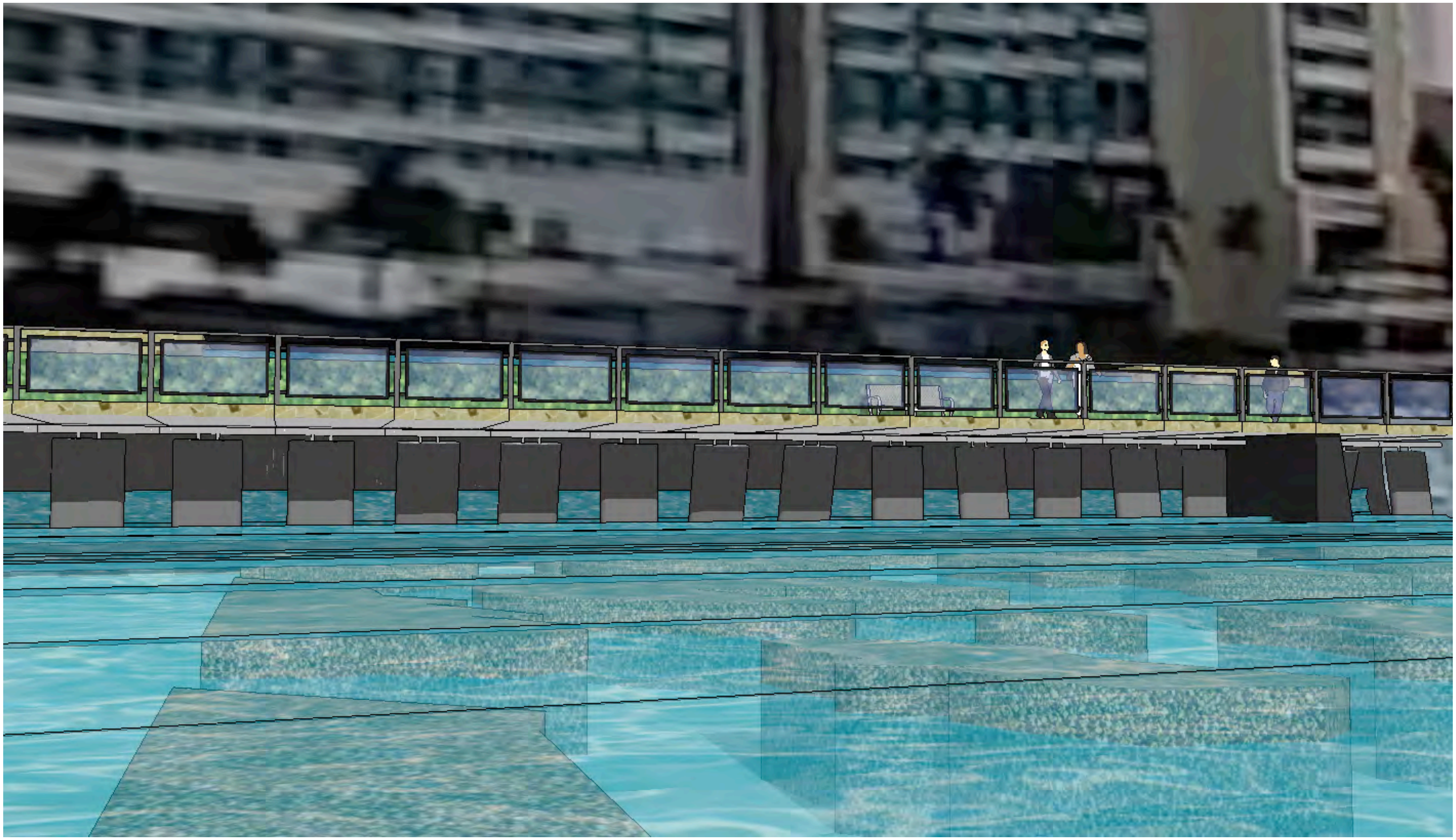
Exhibit B-3



Sheraton Shoreline Walkway Conceptual Rendering

WAIKĪKĪ BEACH IMPROVEMENT AND MAINTENANCE PROGRAM
Comments and illustrations by Dennis Furukawa

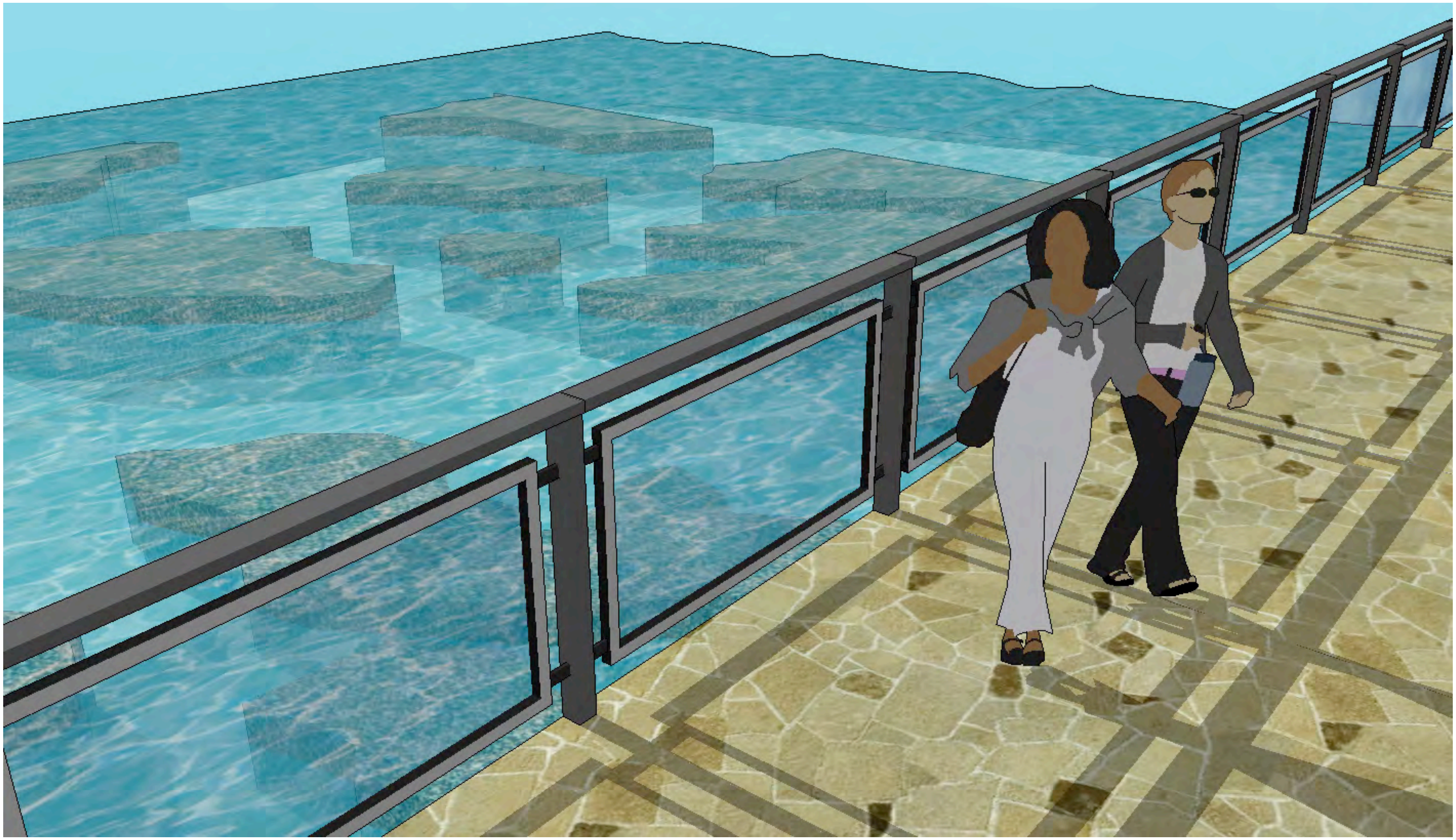
Exhibit B-4



Sheraton Shoreline Walkway Conceptual Rendering

WAIKĪKĪ BEACH IMPROVEMENT AND MAINTENANCE PROGRAM
Comments and illustrations by Dennis Furukawa

Exhibit B-5



Sheraton Shoreline Walkway Conceptual Rendering
Offers views of reef and marine sea life.

WAIKĪKĪ BEACH IMPROVEMENT AND MAINTENANCE PROGRAM
Comments and illustrations by Dennis Furukawa

End of document

By:
Dennis Furukawa
435 Seaside Ave. #1608
Honolulu, Hawai`i 96815

email: rgp.dennis@gmail.com
ph. 415.860.2388

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
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

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 4, 2021

Dennis Furukawa
435 Seaside Ave., #1608
Honolulu, HI 96815

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Furukawa:

Thank you for your comment letter dated January 22, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

Comment:

1. Regarding the portion fronting Halekulani and Sheraton hotels (Halekulani Beach Sector) referred to herein in this document as the "subject shoreline":
    a. "That portion of subject waterfront has never had a significant sandy beach, except that portion known as Grays Beach, and is currently fronted by seawalls (see Exhibit A-2). Therefore, any placement of beach sand, boulders etc. would not constitute "replenishment" but rather be new fill, and be subject to The Clean Water Act Section 404, and be subject environmental review."

       Response: We acknowledge that the proposed action in the Halekūlani beach sector will require a Clean Water Act Section 404 permit. For additional information about requirements of the Clean Water Act, please see Section 16.1.2 of the DPEIS.

    b. "Likely significant environmental impacts of placing new fill:
        i. "The nearshore waters (those within 50 yards of the existing seawalls) directly fronting the subject properties are known to be habitat for a large number of sea turtles, who can be observed feeding and swimming in that area in particular, as it is not currently popular as a surfing or swimming area. In contrast, the nearshore

waters directly in front of the Royal Hawaiian and Moana Surfrider hotels are largely devoid of turtles or fish, as the water quality is poor due to the large numbers of swimmers and surfers causing turbulence, walking on coral and disturbing sand, and introducing waterborne pollutants (urine, sunscreen, rubbish, fragrances, hormones, noise etc.)."

Response: We acknowledge that the proposed beach improvement and maintenance actions have the potential to affect marine habitat and protected species. Sea turtle disturbance would be limited to within about a 130-ft radius of the sand recovery areas. Turtles would be expected to move away from the disturbance, and as the impact areas are relatively small and the seafloor is primarily sandy, it is not anticipated to have any significant effect on turtle foraging. The groins and sand fill will bury a portion of the existing subtidal environment of primarily low relief sand, rubble, and limestone. Ecological services of reef flat habitat will be lost within the project footprint (sand and groins) but are anticipated to recover over time as the benthic community re-establishes.

Best Management Practices (BMPs), as typically recommended by the National Marine Fisheries Service (NMFS), will be adhered to during construction of the proposed actions to avoid or minimize impacts to marine habitat protected species. A biological and water quality monitoring program will be implemented to enhance control over potential construction impacts. We anticipate that marine species will repopulate from surrounding habitat after construction is completed and sessile organisms will colonize new hard surfaces.

We also acknowledge that the proposed actions have the potential to affect corals. AECOS (2021) found that coral assemblages in Waikīkī are limited by availability of stable hard bottom, silt cover, competition with algae, and freshwater influence among other factors. No corals were observed in the Royal Hawaiian Beach Sector, and one colony was observed in the Fort DeRussy beach sector. At the Kuhio beach sector (‘Ewa (west) Basin), no colonies were observed on the breakwater and groin structures. At the Halekūlani beach sector, overall coral cover at the proposed groin locations is very low (mean of 0.1 colony/m^2). In general, coral colonies here are small, with 64% being less than 10 cm in diameter. The lack of large coral heads is evidence that this area is not particularly favorable to coral growth.

We anticipate that the proposed structures will provide stable, hard bottom for coral settlement and possibly calmer waters for coral development; however, coral assemblage development may be compromised by competition for space, freshwater influence, sediment transport, and heavy utilization of the nearshore by the human population.

Measures proposed to be exercised to protect corals during construction activities include:

- Locating and marking significant corals in the vicinity of the sand recovery areas;
- Identifying pipeline route corridors to minimize the potential for damage to coral and other benthic fauna; and
- Transplanting corals, as necessary and where practicable, to relocate them from the construction site, particularly along the pipeline route.

For more information about potential impacts to marine habitat and protected species, habitat, please see Sections 8.10, 8.11, 8.12, 10, and 11 and Appendix C of the DPEIS.

ii. “The proposed T-shaped groins (see Exhibit A-1) will alter the flow of water and sand, and will likely adversely affect the popular surf spots (Popular’s, Paradise, and Three’s) by establishing new structures that will reflect wave energy, and alter the seafloor contours through sand migration and the smothering of coral reefs.”

Response: We acknowledge your concerns regarding the potential for the proposed actions to impact surf sites in Waikīkī. Sea Engineering, Inc. conducted detailed wave modeling to evaluate the potential for the proposed actions to impact waves, currents, and surf sites in Waikīkī. Dredging of offshore sand deposits involves removing sand from the deposits, resulting in a lowering of the bottom elevation or changing the bathymetry. Dredging could occur at the *Ala Moana*, *Canoes/Queens*, or *Hilton* offshore sand deposits. Wave modeling was used to assess the impact of dredging on nearby surf sites.

A wave reflection analysis was also conducted to evaluate the potential for the proposed structures in the Halekūlani and Kūhiō beach sectors to reflect waves that could negatively impact surf sites, primarily in the Halekūlani beach sector. To evaluate potential impacts, wave modeling of the existing conditions and with the proposed structures was performed. Based on the results of the wave modeling, the dredge analysis, and the wave reflection analysis, no significant impacts to waves, currents, or surf sites in Waikīkī are anticipated.

For more information about the wave modeling results and potential impacts to waves, currents, and surf sites, please see Sections 8.2, 8.6 and 9.4.6 of the DPEIS.

iii. "The establishment of beach where people will congregate will increase the amount of waterborne pollutants (urine, sunscreen, rubbish, fragrances, hormones, noise etc.), resulting in the loss of suitable habitat for the aquatic life."

Response: We acknowledge the potential for beach users to generate waterborne pollutants. The number of annual visitors to Hawaiʻi has steadily increased since the 1970's. The total number of Oʻahu visitors increased by 18.5% between 2007 and 2016, and the State of Hawaiʻi set a new record in 2019 with 10.4 million visitors. The intent of the proposed action in the Halekūlani beach sector is to create a stable beach to improve lateral shoreline access and support ongoing recreational uses in Waikīkī. Increasing dry beach area will provide additional space to accommodate the ever-growing number of beach users in Waikīkī. Providing additional space for beach users could potentially make the discharge of waterborne pollutants more diffuse.

iv. "No facilities are planned for the subject shoreline, namely any restrooms, showers, rubbish cans, or lifeguard towers. These are essential facilities, as the beach users can be expected to try using facilities in the Sheraton or Halekulani hotels, which is almost certain to create problems with hotel management and guests. Note that beach showers are a significant source of pollutants, and should not be located where they drain directly into the ocean or groundwater."

Response: The DLNR does not regulate land uses mauka (landward) of the shoreline in Waikīkī. The amenities you refer to – restrooms, showers, rubbish cans, and lifeguard towers – are the responsibility of the City and County of Honolulu and private landowners in Waikīkī.

c. Pedestrian access issues

i. "The proposed design (Exhibit A-1) makes no mention of how pedestrians will be accommodated between Ft. DeRussy and Royal Hawaiian beaches. Sand is not an accessible pathway, and T-groins themselves are barriers."

ii. "Prior to the closure of the walkways fronting the Halekulani and the Shereton hotels, pedestrians were afforded views directly down into the water, where many locals and visitors alike were able to view turtles and fish, even the occasional shark. That walkway was the only spot in along the main Waikiki waterfront where such viewing was possible, especially for disabled persons (the groins and rock jetties are not accessible and are subject to overtopping by waves). Placing a beach there would eliminate that unique resource.”

iii. Accessible pathways:
    1. “The existing walkways are too narrow to permit two way pedestrian traffic, and should be increased in width to a minimum of 10” clear width to meet the spirit of accessible pathways laws and allow groups of pedestrians the ability to pass one another.”
    2. “Access to the waterfront does not currently meet the American Disability Act, and must be provided, as the improvements are public in nature, using public funds.”

Response: Creating a new beach in the Halekūlani beach sector will enhance lateral shoreline access in Waikīkī. We are also evaluating options to incorporate a beach walkway into the overall design and will continue looking into matter in the DPEIS. We will be consulting with the Hawaiʻi Disability and Communication Access Board (DCAB). We acknowledge your concerns regarding potential impacts to existing view planes along the shoreline. We feel that the proposed actions will expand and enhance view planes in Waikīkī.

d. Sea Level Rise
    i. “As oceans rise, the proposed beaches will erode more rapidly each year. The beaches will require increasing amounts of sand to be placed in order to maintain dry sand. In order for that to happen a foundation of sand will need to be maintained and expanded, each time increasing the environmental impacts of placing the sand there in the first place.”

Response: The Waikīkī Beach Improvement and Maintenance Program consists of *beach improvement* actions and *beach maintenance* actions. *Beach improvements* refers to actions that involve adding new sand, adding new structures, and/or modifying existing structures. *Beach maintenance* refers to actions that involve using existing sand or adding sand with no new structures or modification of existing structures.

The proposed *beach improvement* actions in the Halekūlani beach sector and the ʻEwa (west) basin of the Kūhiō beach sector are designed to create a stable beach profile. The designs account for 1.5 ft of sea level rise and can be adapted to accommodate up to 2.7 ft of sea level rise. We anticipate that the beaches would be stable and periodic renourishment would not be required.

The proposed *beach maintenance* action in the Fort DeRussy beach sector is sand backpassing, which would involve recovering existing sand from the accreted area at the west end of the beach and placing it in the eroded area at the east end of the beach. Sand would be excavated from the beach face extending inshore only as far as necessary to obtain the required volume of sand. The proposed action would not require offshore dredging and there would be no increase in the volume of sand in the littoral system.

The proposed *beach maintenance* action in the Diamond Head (east) basin of the Kūhiō beach sector is sand pumping, which would involve recovering approximately 4,500 cy of existing sand from within the basin onto the dry beach. The proposed action would not require offshore dredging and there would be no increase in the volume of sand in the basin.

The proposed *beach maintenance* action in the Royal Hawaiian beach sector is beach nourishment, which would involve recovering approximately 25,000 cy of sand from the *Canoes/Queens* offshore sand deposit and placing it on the beach. This is the only action proposed that would require periodic renourishment to maintain the beach at its 1985 location. The *Canoes/Queens* offshore sand deposit consists of sand that has eroded from Royal Hawaiian Beach. This sand source has been used in previous beach nourishment projects in 2012 and 2021. Reusing this sand on a periodic basis would not increase in the volume of sand in the littoral system.

For more information about anticipated project lifespans, please see Section 3.3 of the DPEIS. The potential impacts of the proposed actions are discussed in Sections 8 and 9 of the DPEIS. The cumulative and secondary impacts of the proposed actions are discussed in Sections 10 and 11 of the DPEIS, respectively.

ii. “The seawalls that currently front the Halekulani and Sheraton hotels are not subjects of the proposed projects, however they are in a degraded condition, and are integral to the objective of providing pedestrian access between the Ft. DeRussy and Royal Hawaiian beaches. At some point those seawalls will be too low to prevent overtopping of waves, as is already apparent at Grays Beach, where the sand is already piling 3’-4’ above the Hau Tree Terrace lawn and patio elevations.”

Response: The DLNR does not regulate land uses mauka (landward) of the shoreline in Waikīkī. Responsibility for regulation and permitting rests with the City and County of Honolulu.

Furthermore, the existing seawalls are privately-owned structures and are located outside of the Conservation District.

iii. “Sandbags have been placed at the Sheraton’s beach services concessions to allow the sand to build up higher than the paved areas and walkways leading to Kalia St. Therefore it would be better to rebuild the seawalls as a more practical response to rising sea levels.”

Response: The DLNR does not regulate land uses mauka (landward) of the shoreline in Waikīkī. Responsibility for regulation and permitting rests with the City and County of Honolulu. Furthermore, the existing seawalls are privately-owned structures and are located outside of the Conservation District.

iv. “The design of the T-groins was proposed years ago (draft April 2000) as part of recommendations for beach improvements. As part of that proposal hydrodynamic modeling was not done, and so far the only information that has been presented appears to be based upon the opinions of the project proposers. Considering that the subject waterfront is such a critical resource for the State and the County’s economy, physical modeling the proposed designs is essential to prevent unintended consequences, especially as sea levels rise.”

Response: Please see previous response to comment 1.b.ii regarding the detailed wave modeling that was conducted to evaluate the potential for the proposed actions to impact waves, currents, and surf sites in Waikīkī.

2. Regarding the portion of the shoreline between Halekulani and Ft. DeRussy, which is referred to herein as the “Outrigger shoreline”, and differs from the subject shoreline in the following respects:
    i. “Sandy beach has been present for many decades;
    ii. Shoreline properties are not fronted by seawalls;
    iii. Paved shoreline pathways have never been in place.
    iv. Buildings are closer to the shoreline”

    a. “Because of the above points it may make more sense to treat the Outrigger shoreline as a part of the Ft. DeRussy shoreline than the subject shoreline.”

    Response: We acknowledge the differences you note between the east and west ends of the Halekūlani beach sector. We defined the beach sector based on the physical processes and structures that affect beach stability along this portion of the shoreline. For more information about how the beach sector boundaries were determined, please see Section 2.5 of the DPEIS.

b. Likely environmental impacts of placing new fill:
    i. “The top of pavement elevation of the walkway dividing Ft. DeRussy and the Aston Waikiki Shore was measured at 40” above the water level at the storm drain grates in that walkway. The existing beach sand at the makai edge of pavement is higher than the walkway by over one foot currently. Waves already overtop the sand and wash down the walkway during high tides and moderately large swells.”

    Response: Increasing dry beach width and elevation at the east end of the Fort DeRussy beach sector is anticipated to dissipate wave energy and reduce the frequency of wave inundation in this area. We acknowledge that, as sea levels continue to rise, additional actions may be required to address wave inundation in this area.

    ii. “As the beach fill responds to currents and waves, the slope of the resulting beach will steepen (as evidences by the steep slopes at the Moana shoreline, and increase backwash towards the Three’s surfbreak.”

    Response: Please see previous response to comment 1.b.ii regarding the detailed wave modeling that was conducted to evaluate the potential for the proposed actions to impact waves, currents, and surf sites in Waikīkī.

c. Pedestrian access issues:
    i. “in order to provide ADA accessible travel in front of the Outrigger, a concrete sidewalk supported by a retaining wall foundation would be ideal, thus providing both access and protection. Therefore it would seem that it is an opportunity to construct the pathway as part of protecting the Outrigger’s shoreline.”
    ii. “Walkways leading from Saratoga St. to the shoreline are ADA accessible, so making the shoreline pathway accessible is a simple matter.”

    Response: Creating a new beach in the Halekūlani beach sector would enhance lateral shoreline access in Waikīkī. We are also evaluating options to incorporate a beach walkway into the overall design and will continue looking into this matter in the DPEIS. We will be consulting with the Hawaiʻi Disability and Communication Access Board (DCAB).

d. Sea level rise:
    i. “Due to the location of Outrigger, waves already break against the makai exterior walls of the hotel. As sea levels rise, sand placed in

front of the hotel will not stop wave action from washing the sand away, as evidenced by sandbags placed at the Moana Surfrider's Banyan Tree Terrace, and at Grays Beach access walkway. The seaward wall of the Outrigger will reflect wave energy back towards the sea taking the sand with it."

        ii. "In recognition of the fact that waves already wash down the walkways leading to Kalia St, pushing sand inland, alternatives to beach renourishment should be prioritized."

        Response: Increasing dry beach width and elevation in the Halekūlani beach sector is anticipated to dissipate wave energy and reduce the frequency of wave inundation in this area. We do not anticipate that the existing seawalls and buildings will be exposed to wave action. Furthermore, the proposed T-head groins and sand fill are designed to be stable. A similar design was implemented at Iroquois Point, Oʻahu in 2013. We note that the beach at Iroquois Point has been stable since that time and the existing structures in the backshore have not been exposed to wave action.

3. Alternative proposal
    a. "In the Project Objectives in this paper's introduction, objective #3 is "Providing safe access to and along the shoreline." As this access is not discussed in the EIS Preparation Notice, I am proposing an alternative design that seeks to address that objective. In addition, my proposed alternative design is intended to address all of the Project Objectives 1-4.
    b. "Alternative Project Description (see Exhibits B-1 through B-5)
        i. Access
            1. The project would focus on reestablishing public access to the shoreline by creating an ADA accessible pathway by improving the existing pathways fronting the Halekulani and Sheraton hotels. A new 10' walkway would cantilever over the water at the same elevation of that fronting the Sheraton (approx. +7' MSL) supported by new stone buttresses placed perpendicular to the existing seawall (see Exhibit B-1). The walkway structure would span between the existing Royal Hawaiian groin to Grays beach, and from Gray's beach to the Outrigger shoreline.
            2. The walkway would be constructed as a horizontal tubular truss, fabricated from corrosion-resistant materials, and finished with a pedestrian traffic surface, and fitted with guardrails that minimize visual obstruction, and are also corrosion resistant (see Exhibit B-2). The walkway would tie into the Sheraton's pool deck pathways on the east end, and the Grays beach access pathway, and continue westward along the Halekulani shoreline frontage.

3. At the Outrigger shoreline, a walkway that also acts as a seawall (no illustration provided) would be placed against the hotel seaward wall with a walkway elevation higher than the existing aforementioned walkways accessing Kalia St."

ii. "Seawall protection
    1. The walkway structure would be engineered to mount equipment that would reduce the energy of wave action. The equipment could be used to absorb wave energy and convert it into electric or thermal energy. The energy produced could be used for operating pumps (such as to reduce water levels in the storm drains) or lighting along the walkways and shoreline parks.
    2. The energy-conversion technologies (ECTs) would be mounted below the walkway and remain largely unseen except from beyond the shoreline, and placed close to the seawalls to minimize intrusion into the ocean. The devices must not introduce threats to marine life or be an attractive nuisance for children and tourists. The ECTs must be virtually silent, quiet on land and in the water.
    3. Possible technologies include piezoelectric elements, geared levers, pneumatics, or others. Repairs and upgrades to the ECTs would be simple as the entire array of equipment would be accessible from the walkway. No element of the ECTs would be founded or mounted in seafloor or reef, and clearance from reef or seafloor would be a minimum of 12", with large enough spaces to allow the passing of large sea turtles below and beside the devices. Electric cables or pneumatic hoses would be mounted on the underside of the walkway."

iii. "Sea level rise
    1. Mounted at the elevation of the existing walkway (+7' MSL) at the Sheraton, the walkway and the seawall protection + ECTs should have a long useful lifetime, as it should be high enough to accommodate over 12" of sea level rise."

Response: Thank you for suggesting an additional alternative for the Halekūlani beach sector. We appreciate the time and effort you put into describing the alternative and the renderings you developed. We note that this alternative would require removal of the existing seawalls. The DLNR does not regulate land uses mauka (landward) of the shoreline in Waikīkī. Responsibility for regulation and permitting rests with the City and County of Honolulu. Furthermore, the existing seawalls are privately-owned structures and are located outside of the Conservation District.

The alternative you propose has the potential to provide safe lateral access along the shoreline. However, we have concerns about potential risks to public health, safety, and welfare if ocean users and/or marine species were to enter the area under the walkway. Furthermore, the alternative you propose would not achieve the program objectives to restore and improve the beaches and increase beach stability in Waikīkī. The proposed beach improvement action in the Halekūlani beach sector is designed to account for 1.5 ft of sea level rise and can be adapted in the future to accommodate up to 2.7 ft of sea level rise.

Thank you for taking the time to review and comment on the EISPN. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement.

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

Waikiki Shore AOAO, Inc.

2161 Kalia Road
Honolulu, HI 96815
(808) 923-7245
aoao@waikikishoreapts.com

January 21, 2021

TO:
Sam Lemmo, Administrator
Office of Conservation and Coastal Lands
Department of Land and Natural Resources, State of Hawaii
1151 Punchbowl Street, Room 131
Honolulu, Hawaii 96813

David Smith, Ph.D., P.E.
Sea Engineering, Inc.
Makai Research Pier
41- 305 Kalaniana'ole Highway
Waimanalo, Hawaii 96795

FROM:
Waikiki Shore Apartments Board of Directors and General Manager
2161 Kalia Road
Honolulu, Hawaii 96815

SUBJECT: Environmental Impact Statement Preparation Notice (EISPN) for the Waikīkī Beach Improvement and Maintenance Program, Waikīkī Beach, Oahu

The Waikiki Shore Apartments Board of Directors and General Manager **strongly supports** the proposed Waikīkī Beach Improvement and Maintenance Program by the Hawaiʻi Department of Land and Natural Resources (DLNR). In fact, we have become increasingly more involved in discussions with neighboring property managers and business owners about the degradation of Waikiki Beach due to these erosion and flooding problems, as they are increasing in severity. It is apparent that the remedies require government intervention, and we thank you for this important proposed program to save Waikiki Beach.

Over the past several years, and as recently as November of 2020, Waikiki has experienced record high tides (King Tides) that have exacerbated erosion and flooding. These events have highlighted the impacts of sea level rise on the beaches of Waikīkī. As sea levels continue to rise, beach loss will progressively degrade the recreational, social, cultural, environmental, aesthetic, and economic value of Waikīkī. After nearly 50 years of no new beach stabilization projects in Waikīkī, we are now at a crossroads with a clear and increasingly urgent need to implement maintenance and improvements to the shoreline in order to preserve and protect this unique and highly prized natural resource.

We cannot over emphasize the importance of these improvement projects and or their urgency. With the combination of beach erosion and King Tides, the backshore is frequently flooded, particularly during high surf events, accelerating damage to backshore infrastructure. Without beach improvements and maintenance, sea level rise is likely to result in total beach loss in Waikīkī before the end of the century and result in an estimated economic loss of $50 million to $150 million per hectare[1]. The loss of Waikīkī Beach alone would result in an annual loss of $2.223 billion in visitor expenditures[1]. Improvements and maintenance like those proposed in the EISPN are necessary to restore and maintain the beaches of Waikīkī to continue to support Hawaii's tourism-based economy.

We offer the following summary of project-specific comments.

1. The proposed beach improvement projects in Waikīkī are essential for the future goal to maintain a viable beach in these areas. Several beachfront areas in Waikīkī are seeing the rapid deterioration of both public and private backshore infrastructure such as groins, seawalls and walkways. This highlights the need to make long-term investments into beach stabilizing structures throughout Waikīkī in addition to more immediate emergency repairs to damaged infrastructure.

---

[1] Tarui, N., Peng, M., Eversole, D. (2018). *Economic Impact Analysis of the Potential Erosion of Waikīkī Beach.* University of Hawai'i Sea Grant College Program. April 2018.

2. Climate change impacts including sea-level rise projected by the state of Hawai'i Climate Change Commission indicate significant flooding, wave overtopping and beach erosion in Waikīkī for the coming decades and suggest stakeholders and communities plan for 3.2 feet of sea-level rise now. This project has a strong climate change adaption component that is consistent with the recommendations of the State Climate Commission.

3. Without a stabilizing and energy-buffering beach to protect public and private coastal infrastructure, the WBSIDA anticipates even larger and more expensive structural repair and improvement projects to be required soon to prevent the destruction of threatened coastal structures.

Sincerely,

Bob Warren, President, Board of Directors of Waikiki Shore Apartments

Randy Ahlo, General Manager, Waikiki Shore Apartments

CC:
Office of the Mayor, Rick Blangiardi, 530 South King Street, Room 300, Honolulu, HI 96813
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Kyo-ya Hotels & Resorts, Cyrus Oda, cyrus.oda@sheraton.com
Halekulani Corporation, Patricia Tam, 2199 Kalia Road, Honolulu, HI 96815
Outrigger Reef Waikiki Beach Resort, Carly Clement, carly.clement@outrigger.com

CC:
Outrigger Hospitality Group, Bob Berges, bob.berges@outrigger.com
Embassy Suites by Hilton, Simeon Miranda, simeon.miranda@embassysuiteswaikiki.com
Hilton Grand Vacations, Robert Ishihara, Robert.ishihara@hgv.com

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
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KAHOOLAWE ISLAND RESERVE COMMISSION
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STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 4, 2021

Bob Warren, President
Randy Ahlo, General Manager
Waikiki Shore Apartments
2161 Kalia Road
Honolulu, HI 96815

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Warren and Mr. Ahlo:

Thank you for your comment letter dated January 22, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you state that you strongly support the proposed beach improvement and maintenance actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

We recognize that you provided three project-specific comments, all in support of the proposed actions. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement (DPEIS).

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8480 • Fax: (808) 768-4567
Web site: www.honolulu.gov

RICK BLANGIARDI
MAYOR

ALEX KOZLOV, P.E.
DIRECTOR DESIGNATE

HAKU MILLES, P.E.
DEPUTY DIRECTOR

January 28, 2021

SENT VIA EMAIL

Mr. Andy Bohlander
waikiki@seaengineering.com

Dear Mr. Bohlander,

Subject: Environmental Impact Statement Preparation Notice
Waikiki Beach Improvement and Maintenance Program
Kona District, Island of Oahu

Thank you for the opportunity to review and comment. The Department of Design and Construction's Facilities Division has the following comment.

> The proposed project to restore and stabilize these severely eroded beaches will allow the reopening of 141A and improve conditions at existing lifeguard stands. These City improvements have all been severely impacted by the loss of beach area. We fully support this project as the major benefits it will provide to existing City facilities.

Should you have any further questions, please contact me at 768-8480.

Sincerely,

FOR Alex Kozlov, P.E.
Director

AK:cf (836346)

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
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HONOLULU, HAWAII 96809

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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

June 4, 2021

Alex Kozlov, P.E.
Department of Design and Construction
City and County of Honolulu
650 South King Street, 11th Floor
Honolulu, HI 96813

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Kozlov:

Thank you for your comment later dated January 28, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you summarized your consideration of and comments for the proposed actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

We recognize that you provided comments in support of the proposed actions. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement (DPEIS).

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

OUTRIGGER
HOSPITALITY GROUP

RECEIVED
OFFICE OF CONSERVATION
AND COASTAL LANDS

2021 JAN -8 A 10:40

DEPT. OF LAND &
NATURAL RESOURCES
STATE OF HAWAII

January 5, 2021

TO:
Sam Lemmo, Administrator
Office of Conservation and Coastal Lands
Department of Land and Natural Resources, State of Hawaii
1151 Punchbowl Street, Room 131
Honolulu, Hawaii 96813

FROM:
Mike Shaff, Vice President Hotel Operations - Hawaii/Guam
Outrigger Hotels Hawaii
2375 Kuhio Avenue
Honolulu, Hawaii 96815

SUBJECT: Environmental Impact Statement Preparation Notice (EISPN) for the Waikīkī Beach Improvement and Maintenance Project. Waikīkī Beach, Oahu

Outrigger Hotels Hawaii **strongly supports** the proposed beach improvement projects by the Hawai'i Department of Land and Natural Resources (DLNR), including the construction of new beach stabilization structures and replenishing the shoreline between Fort DeRussy and Kūhiō beach sectors of Waikīkī. These projects are intended to restore and improve Waikīkī's public beaches, increase beach stability through improvement and maintenance of shoreline structures, provide safe access to and along the shoreline, and increase resilience to coastal hazards and sea level rise. The proposed actions are intended to maintain the economic, social, aesthetic, recreational, environmental, cultural, and historical qualities of Waikīkī.

As sea levels continue to rise, beach loss will progressively degrade the recreational, social, cultural, environmental, aesthetic, and economic value of Waikīkī unless something is done soon. After nearly 50 years of no new beach stabilization projects in Waikīkī, we are now at a crossroads with a clear and increasingly urgent need to implement maintenance and improvements to the shoreline in order to preserve and protect this unique and highly prized natural resource.

We strongly support these improvement projects and recognize its urgency. With the combination of beach erosion and King Tides, the backshore is frequently flooded, particularly during high surf events, accelerating damage to backshore infrastructure. Without beach improvements and maintenance, sea level rise is likely to result in total beach loss in Waikīkī before the end of the century and result in an estimated economic loss of $50 million to $150 million per hectare[1]. The loss of Waikīkī Beach alone would result in an annual loss of $2.223 billion in visitor expenditures[1]. Improvements and maintenance like those proposed in the EISPN are necessary to restore and maintain the beaches of Waikīkī to continue to support Hawaii's tourism-based economy.

We offer the following summary:

1. Outrigger's DNA is built on caring for the guest, the host, and the place. As a premier beach resort brand, our link to the ocean and shoreline is unbreakable and we see its stewardship as a responsibility that's deeply aligned with caring for the place.

2. Over the years, Outrigger has partnered with other organizations that share the same ideals, such as the Waikiki Aquarium, NOAA (National Oceanic and Atmospheric Administration), Sustainable Coastlines, Surfrider Foundation and PacIOOS (Pacific Islands Ocean Observing System). In 2014, Outrigger formally created an environmental platform, called OZONE (Outrigger's ZONE), as a global conservation initiative centered on coral health and resiliency in the world's oceans, with special focus on the waters that surround the iconic beach destinations of Outrigger Resorts around the world, including Waikīkī.

3. The proposed beach improvement projects in Waikīkī are essential for the future goal to maintain a viable beach in these areas. Several beachfront areas in Waikīkī are seeing the rapid deterioration of both public and private backshore infrastructure such as groins, seawalls and walkways. This highlights the need to make long-term investments into beach stabilizing structures throughout Waikīkī in addition to more immediate emergency repairs to damaged infrastructure.

4. Climate change impacts including sea-level rise projected by the state of Hawai'i Climate Change Commission indicate significant flooding, wave overtopping and beach erosion in Waikīkī for the coming decades and suggest stakeholders and communities plan for 3.2 feet of sea-level rise now. This project has a strong climate change adaption component that is consistent with the recommendations of the State Climate Commission.

5. Without a stabilizing and energy-buffering beach to protect public and private coastal infrastructure, the WBSIDA anticipates even larger and more expensive structural repair and improvement projects to be required soon to prevent the destruction of threatened coastal structures.

Thank you for the opportunity to provide comments on this project.

---

[1] Tarui, N., Peng, M., Eversole, D. (2018). *Economic Impact Analysis of the Potential Erosion of Waikīkī Beach.* University of Hawai'i Sea Grant College Program. April 2018.

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
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SUZANNE D. CASE
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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

June 4, 2021

Mike Schaff, Vice President Hotel Operations – Hawaii/Guam
Outrigger Hotels Hawaii
2375 Kuhio Avenue
Honolulu, HI 96815

SUBJECT: Response to Environmental Impact Statement Preparation Notice (EISPN) Comment Letter on the Waikīkī Beach Improvement and Maintenance Program

Dear Mr. Schaff:

Thank you for your comment later dated January 5, 2021 regarding the Waikīkī Beach Improvement and Maintenance Program Environmental Impact Statement Preparation Notice (EISPN). In your letter you state that you strongly support the proposed beach improvement and maintenance actions. As the Applicant, the Hawaiʻi Department of Land and Natural Resources (DLNR) is pleased to provide the following responses to your comments.

We recognize that you provided five project-specific comments, all in support of the proposed actions. We look forward to any additional comments you may have on the Draft Programmatic Environmental Impact Statement (DPEIS).

Should you have any questions pertaining to this letter, please contact Sam Lemmo, Administrator of the DLNR Office of Conservation and Coastal Lands at 808-587-0377.

Sincerely,

Sam Lemmo

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands