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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

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

December 16, 2020

MEMORANDUM

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

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

Suzanne D. Case

SUBJECT: Environmental Impact Statement Preparation Notice (EISPN)
Waikīkī Beach Improvement and Maintenance Program
Kona District, Island of O'ahu
Tax Map Keys:(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 Hawai'i Department of Land and Natural Resources (DLNR) requests the Environmental Impact Statement Preparation Notice (EISPN) 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 and/or human environment, the DLNR has determined at the outset that an environmental impact statement is required for the proposal pursuant to Hawai'i Revised Statutes §343-5(e) and Hawai'i Administrative Rules (HAR) §11-200.1-14(d)(2).

The required publication forms and files, including an electronic copy of the EISPN 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 EISPN have been submitted to the Waikīkī-Kapahulu Public Library and with the Hawai'i Documents Center.

Pursuant to HAR §11-200.1-23(10)(c), publication of the EISPN in *The Environmental Notice* initiates a 30-day public comment period for the public to provide comments regarding potential effects of the proposed action. Public comments should be submitted to Sea Engineering with copies to the DLNR-Office of Conservation and Coastal Lands.

Should there be any questions, contact Sam Lemmo of the Office of Conservation and Coastal Lands at 587-0377.

21-091

From: webmaster@hawaii.gov
To: HI Office of Environmental Quality Control
Subject: New online submission for The Environmental Notice
Date: Tuesday, December 15, 2020 10:38:29 AM

Action Name

Waikīkī Beach Improvement and Maintenance Program

Type of Document/Determination

Environmental impact statement preparation notice (EISPN)

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

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

DLNR-Office of Conservation and Coastal Lands

1151 Punchbowl St., Room 132
Honolulu, HI 96813
United States
Map It

Public Scoping Meeting information

January 7, 2021/ 2-5pm virtual https://zoom.us/j/94554967228

Accepting authority

Governor, State of Hawaii

Accepting authority contact name

David Ige

Accepting authority contact email or URL

transmit.docs@hawaii.gov

Accepting authority contact phone

(808) 586-0034

Accepting authority address

Office of the Governor
415 South Beretania St
Honolulu, HI 96813
United States
Map It

Was this submittal prepared by a consultant?

No

Action summary

The State Department of Land and Natural Resources proposes beach improvement and maintenance projects in the Fort DeRussy, Halekulani, Royal Hawaiian, and Kuhio Beach sectors of Waikiki. 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 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.

Attached documents (signed agency letter & EA/EIS)

- EISPN-Memo-part-1-signed.pdf
- SEI-Waikiki-Beach-Improvement-and-Maintenance-Program-EISPN-2020-12-14.pdf

Action location map

- Waikiki-Project-Area.zip

Authorized individual

K.Tiger Mills

Authorization

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

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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Should there be any questions, contact Sam Lemmo of the Office of Conservation and Coastal Lands at 587-0377.

AGENCY
PUBLICATION FORM

Project Name:	Waikīkī Beach Improvement and Maintenance Program
Project Short Name:	Waikīkī Beach Improvement and Maintenance Program
HRS §343-5 Trigger(s):	Use of State lands, Use of Conservation District, Shoreline area, Proposed use in Waikiki
Island(s):	Oʻahu
Judicial District(s):	Honolulu
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
Permit(s)/Approval(s):	Conservation District Use Permit Clean Water Act Section 401 Water Quality Certification Coastal Zone Management Act Consistency Determination Department of the Army Permit (Section 10 and Section 404) Special Management Area Permit
Proposing/Determining Agency:	Department of Land and Natural Resources Office of Conservation and Coastal Lands
Contact Name, Email, Telephone, Address	Samuel Lemmo, Administrator sam.j.lemmo@hawaii.gov (808) 587-0377 1151 Punchbowl St., Room 131 Honolulu, HI 96813
Accepting Authority:	Governor, State of Hawaiʻi
Contact Name, Email, Telephone, Address	The Honorable David Y. lge, Governor (808) 586-0034 http://governor.hawaii.gov/contact-us/contact-the-governor/ Executive Chambers State Capitol 415 South Beretania St. Honolulu, Hawaiʻi 96813
Consultant:	Sea Engineering, Inc.
Contact Name, Email, Telephone, Address	David A. Smith, PhD, PE dsmith@seaengineering.com (808) 259-7966 ext. 30 41-305 Kalanianaole Highway Waimanalo, Hawaiʻi 96795

Status (select one)	**Submittal Requirements**
____ DEA-AFNSI	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEA, and 4) a searchable PDF of the DEA; a 30-day comment period follows from the date of publication in the Notice.
____ FEA-FONSI	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; no comment period follows from publication in the Notice.
____ FEA-EISPN	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; a 30-day comment period follows from the date of publication in the Notice.
_X_ Act 172-12 EISPN (“Direct to EIS”)	Submit 1) the proposing agency notice of determination letter on agency letterhead and 2) this completed OEQC publication form as a Word file; no EA is required and a 30-day comment period follows from the date of publication in the Notice.

____ DEIS	Submit 1) a transmittal letter to the OEQC and to the accepting authority, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEIS, 4) a searchable PDF of the DEIS, and 5) a searchable PDF of the distribution list; a 45-day comment period follows from the date of publication in the Notice.
____ FEIS	Submit 1) a transmittal letter to the OEQC and to the accepting authority, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEIS, 4) a searchable PDF of the FEIS, and 5) a searchable PDF of the distribution list; no comment period follows from publication in the Notice.
____ FEIS Acceptance Determination	The accepting authority simultaneously transmits to both the OEQC and the proposing agency a letter of its determination of acceptance or nonacceptance (pursuant to Section 11-200-23, HAR) of the FEIS; no comment period ensues upon publication in the Notice.
____ FEIS Statutory Acceptance	Timely statutory acceptance of the FEIS under Section 343-5(c), HRS, is not applicable to agency actions.
____ Supplemental EIS Determination	The accepting authority simultaneously transmits its notice to both the proposing agency and the OEQC that it has reviewed (pursuant to Section 11-200-27, HAR) the previously accepted FEIS and determines that a supplemental EIS is or is not required; no EA is required and no comment period ensues upon publication in the Notice.
____ Withdrawal	Identify the specific document(s) to withdraw and explain in the project summary section.
____ Other	Contact the OEQC if your action is not one of the above items.

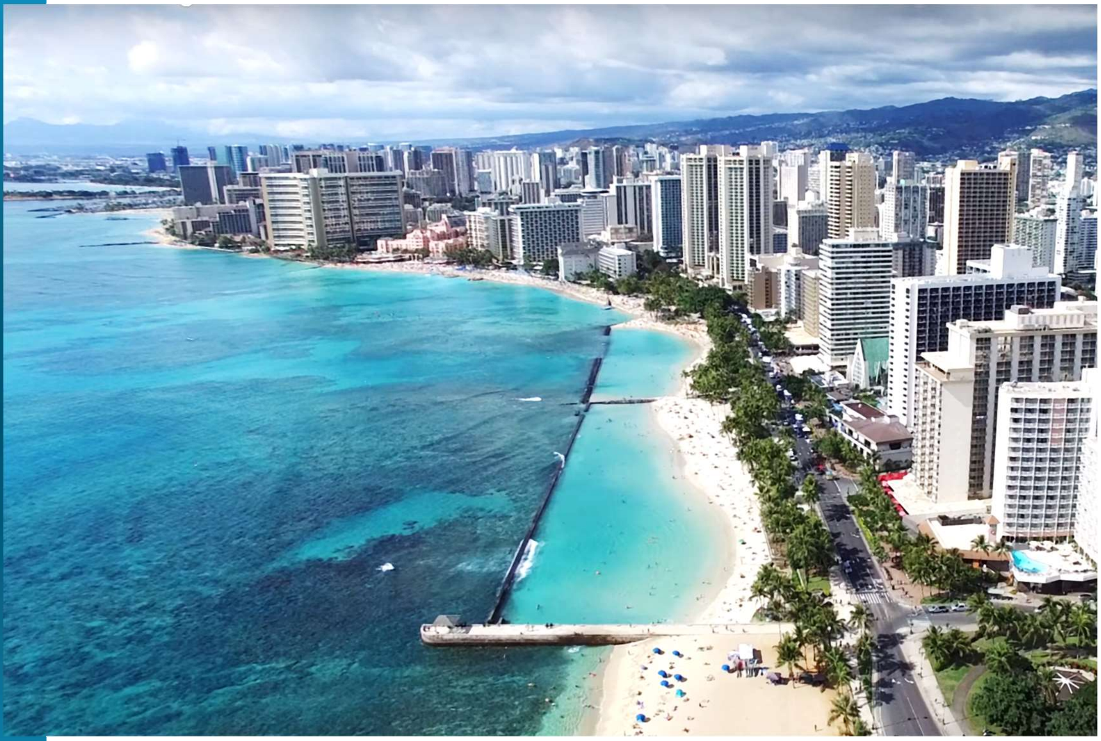
Project Summary

Waikīkī Beach extends along the shoreline of Mamala Bay on the south shore of the island of Oʻahu, Hawaiʻi. 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 Hawaiʻi 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.

ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE

Waikīkī Beach Improvement and Maintenance Program

December 2020



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

Prepared by:
Sea Engineering, Inc.
Makai Research Pier
41-305 Kalanianaʻole Hwy
Waimānalo, Hawaiʻi 96795

Job No. 25548

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AMAP	Applicable Monitoring and Assessment Plan
BLNR	(State of Hawaiʻi) Board of Land and Natural Resources
BMP	Best Management Practices
BMPP	Best Management Practices Plan
CDUP	Conservation District Use Permit
UHCGG	(University of Hawaiʻi) Coastal Geology Group
CWA	Clean Water Act
CZM	Coastal Zone Management
DA	Department of the Army
DAR	Department of Aquatic Resources
DEIS	Draft Environmental Impact Statement
DLNR	Department of Land and Natural Resources
DOH	Department of Health
DOBOR	Division of Boating and Ocean Recreation
CWB	(Department of Health) Clean Water Branch
EISPN	Environmental Impact Statement Preparation Notice
EPA	(United States) Environmental Protection Agency
FEIS	Final Environmental Impact Statement
FIRM	Flood Insurance Rate Map
HAR	Hawaiʻi Administrative Rules
HRS	Hawaiʻi Revised Statutes
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MSL	Mean Sea Level
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NWP	(Department of the Army) Nationwide Permit
OCCL	Office of Conservation and Coastal Lands
OEQC	Office of Environmental Quality Control
ROH	Revised Ordinances of Honolulu
SEI	Sea Engineering, Inc.
SLR	Sea Level Rise
SMA	Special Management Area
SOEST	(University of Hawaiʻi) School of Ocean Earth Science and Technology
TMK	Tax Map Key
UH	University of Hawaiʻi
USACE	United States Army Corps of Engineers
USAMH	United States Museum of History
USFWS	United States Fish and Wildlife Service
WBCAC	Waikīkī Beach Community Advisory Committee
WBSIDA	Waikīkī Special Improvement District Association
WIA	Waikīkī Improvement Association
WNB	Waikīkī Neighborhood Board
WQC	(Section 401) Water Quality Certification

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 Email: sam.j.lemmo@hawaii.gov
Approving Authority:	The Honorable David Y. Ige, Governor Executive Chambers State Capitol 415 South Beretania St. Honolulu, Hawaiʻi 96813 Contact: (808) 586-0034 http://governor.hawaii.gov/contact-us/contact-the-governor/
Location:	Waikīkī Beach, Honolulu, Oʻahu, Hawaiʻi
State Land Use District:	Conservation (Resource Subzone)
County Zoning:	None
Proposed Action:	The Hawaiʻi 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.
Required Permits And Approvals:	Environmental Impact Statement Conservation District Use 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 Pollution 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 and the use of State funds.

Consultant:

Sea Engineering, Inc.
41-305 Kalaniana‘ole Hwy
Waimanalo, Hawai‘i 96795
Contact: David Smith, Ph.D., P.E. (808) 259-7966 ext. 30
Email: waikiki@seaengineering.com

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 side of the beach) is frequently flooded, particularly during high tides and high surf events. Over the past several years, Hawaii 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 likely result in substantial beach loss in Waikīkī. For the purposes of this EISPN, *beach loss* is defined as the loss of the dry recreational beach and lateral shoreline access during typical wave and tidal conditions. 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 Hawai‘i’s tourism-based economy and preserve the recreational, social, cultural, environmental, and aesthetic value of Waikīkī for future generations.

This Environmental Impact Statement Preparation Notice (EISPN) presents proposed beach improvement and maintenance actions in four beach sectors of Waikīkī.

- Fort DeRussy Beach – Beach Maintenance (Sand Backpassing)
- Halekulani Beach – Beach Nourishment with Stabilizing Groins
- Royal Hawaiian Beach – Beach Nourishment and Maintenance
- Kūhiō Beach – Beach Nourishment, Segmented Breakwater, and Beach Maintenance

The primary objectives of the proposed actions are as follows:

- 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.

1. INTRODUCTION

1.1 Project Area Description

Waikīkī Beach extends along the shoreline of Mamala Bay on the south shore of the island of O‘ahu, Hawai‘i (Figure 1-1). The Waikīkī shoreline originally consisted of a narrow barrier beach backed by wetlands, duck ponds, taro farms, and fishponds. In the late 1800’s, the first tourist attractions to the area. 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 Kalakaua Avenue) at the entrance to Kapi‘olani Park. In 1901, the Moana Hotel (now Moana Surfrider) 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 1900’s, 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 reportedly significant volumes of sand were 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 Hawai‘i 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 Hawai‘i 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 longer 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 littoral cells (sectors).

In 1928, the Waikīkī Beach Reclamation agreement was established between the Territory of Hawai‘i 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-foot-wide public easement along the beach measured from 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 is the subject of a separate agreement between the Territory and the subject Waikīkī landowners established on May 28, 1965.

From about 1930 until the late 1970s, it is estimated that over 400,000 cubic yards of sand has been placed on Waikīkī Beach, from a variety of sources including other beaches on Oʻahu and Molokaʻi, backshore dune deposits, and even crushed coralline limestone. Between 1925 and 2001, the Waikīkī shoreline moved about 40 feet seaward, reflecting the extensive man-made shoreline alteration (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.

Figure 1-1 Overview map of the project area

1.2 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 1900's, 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 and offshore sources. Beach stability is largely dependent on the presence of numerous groins that stabilize the sand along the shoreline.

Waikīkī is recognized as Hawai'i'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 O'ahu and nearly half of all units in the State of Hawai'i (HTA, 2018). In 2002, tourism-related activities in Waikīkī accounted for an estimated $3.6 billion, which was 8% of Hawai'i'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 Hawai'i's Gross State Product (State of Hawai'i, 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 and the State of Hawai'i. 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 (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 maintenance to sustain the unique qualities and values of Waikīkī Beach.

Many of Hawai'i's sandy beaches are suffering from erosion. Fletcher et al. (2012) found that 70% of beaches in Hawai'i are undergoing chronic (long-term) erosion and over 10% (13 miles) of Hawai'i's beaches have been completely lost to erosion over the past century. The Island of O'ahu has 66.5 miles of sandy beaches, approximately 60% of which are experiencing erosion (Fletcher et al. 2011).

Beach erosion is negatively impacting the economic, social, aesthetic, recreational, environmental, cultural, and historical qualities of Waikīkī Beach.

Many sections of Waikīkī Beach are substantially narrowed, and some have been completely lost to erosion due to a long history of shoreline modification, and chronic and episodic sand loss. Miller and Fletcher (2003) estimate that, between 1951 and 2001, approximately 100,000 cubic yards of sand was lost from the sediment budget in Waikīkī Beach.

Sea level rise has emerged as a serious threat to the beaches of Waikīkī. The earth is experiencing climatic changes that are unprecedented in human history. The earth and oceans are rapidly warming, and one inexorable result of this is a rise in sea level 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 almost half 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. Beach erosion and beach loss in Hawaiʻi are expected to increase significantly as sea level rises. Anderson et al. (2015) found that, due to sea level rise, the average shoreline recession 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 feet 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 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.

Complete erosion of Waikīkī Beach would result in an annual loss of $2.223 billion in visitor expenditures (Tarui, et al. 2018).

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 Hawaiʻi's tourism-based economy, very little has been spent on improving and maintaining the beaches of Waikīkī. From 2006 to 2020, approximately $6 million dollars was invested in beach improvement projects in Waikīkī, an average of just $400,000/year. In 2019, the Hawaiʻi State Legislature appropriated $8,850,000 to support beach improvement and maintenance projects in Waikīkī.

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.

1.3 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 Hawai‘i's tourism-based economy.

This Environmental Impact Statement Preparation Notice (EISPN) presents proposed improvement and maintenance actions in four beach sectors of Waikīkī:

- Fort DeRussy Beach – Beach Maintenance (Sand Backpassing)
- Halekulani Beach – Beach Nourishment with Stabilizing Groins
- Royal Hawaiian Beach – Beach Nourishment and Maintenance
- Kūhiō Beach – Beach Nourishment, Segmented Breakwater, and Beach Maintenance

The primary objectives of the proposed actions are as follows:

- Restore and improve the beaches of Waikīkī's.
- 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.

1.4 Project Stakeholders and Proponents

The actions proposed for implementation in Waikīkī will be undertaken by the State of Hawai‘i 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 (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 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.*

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, which provides technical support, education and outreach, and project coordination. The WBCAC held five (5) formal meetings from 2017 to 2019. The outcomes of those meetings are included as Appendix A. The WBCAC will continue to provide feedback on the proposed actions throughout the environmental review process.

1.5 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 eight individual "littoral cells" (sectors) that are semi-contained with various degrees of sediment transport between adjacent sectors. The beach sectors are shown in Figure 1-2 and summarized below (from west to east).

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

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

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

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

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

- ***Queen's Beach*** consists of approximately 1,050) feet of shoreline extending from the Kapahulu storm drain to the Queen's Surf groin.

- ***Kapi'olani Beach*** consists of approximately 1,250 feet 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 feet 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 the disruption and inconvenience of construction to beach users, commercial operations, and stakeholders to one sector at a time.

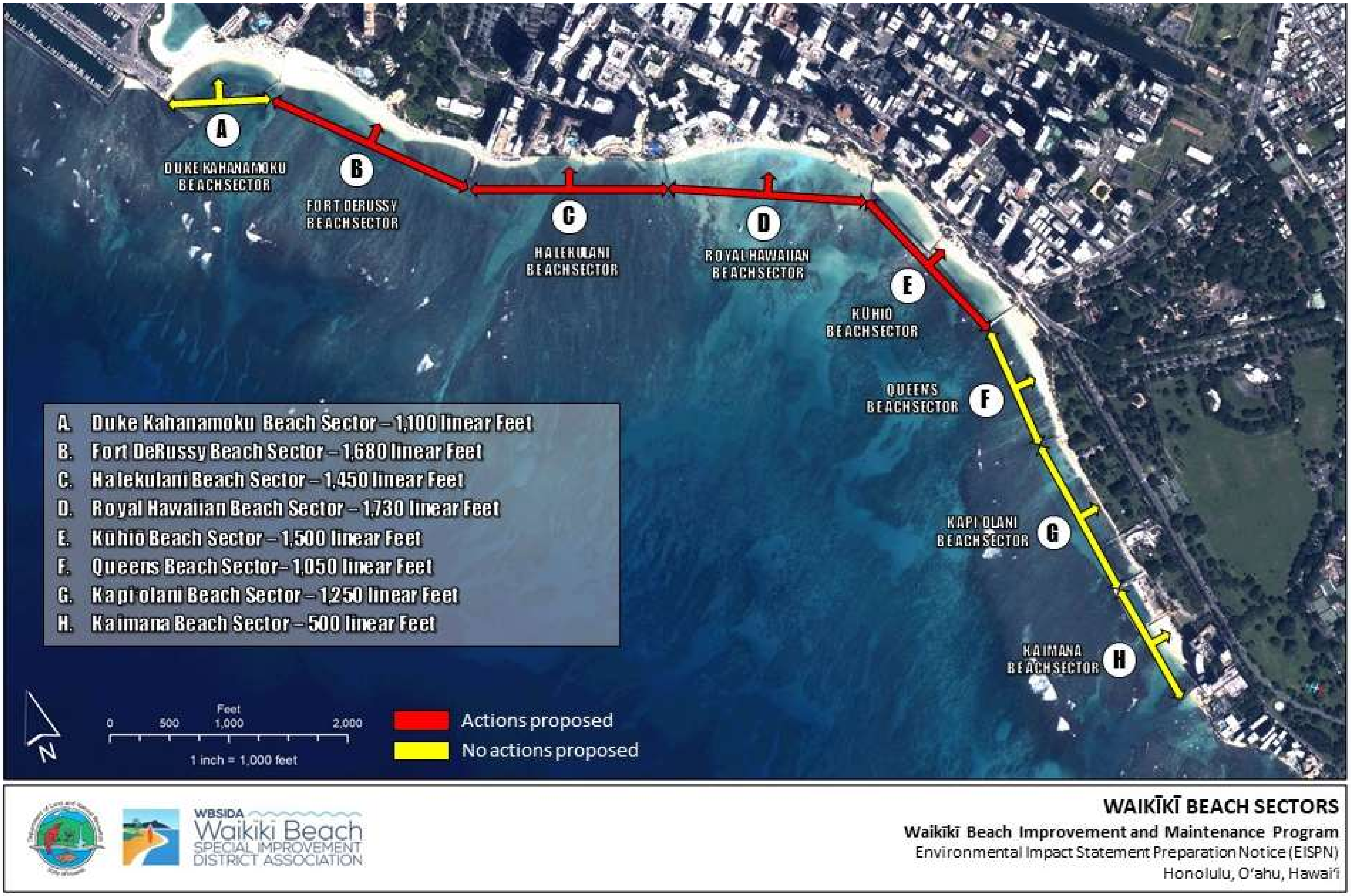


Figure 1-2 Waikīkī beach sectors

1.6 Beach Sectors Selected for Improvement

The DLNR, the WBSIDA, and the WBCAC evaluated the desired assets and uses, existing issues and problems, and design criteria and potential options for each beach sector. Four beach sectors were identified as being the highest priorities for beach improvements and maintenance (Figure 1-3):

- Fort DeRussy Beach
- Halekulani Beach
- Royal Hawaiian Beach
- Kūhiō Beach

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 (planned for 2021)

Waikīkī Beach Maintenance I (completed May 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 Queens and Canoes 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. The average rate of sand recovery was approximately 500 cubic yards per day. The sand discharge pipeline was an 8-inch high-density polyethylene (HDPE) pipe with a total length of 3,200 feet. Sand was pumped into a dewatering basin that was constructed in the Diamond Head basin of Kūhiō Beach Park. The dewatering basin measured approximately 100 feet wide and 400 feet long. Sand was pushed into large piles with an excavator and bulldozer and then transported to the sand placement area on Waikīkī Beach. The project widened the beach by an average of 37 feet, which aligned with the position of the shoreline in 1985. The permits included a second nourishment effort approximately 10 years after the initial nourishment.

Waikīkī Beach Management Plan (2018)

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 leadership, coordination and cost sharing has improved the ability of State and local stakeholders to secure leveraged funding for beach improvement and maintenance projects in Waikīkī. The WBSIDA has taken the lead on facilitating, coordinating, and supporting key 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 and sustainability and stability of the public beach and nearshore resources along Waikīkī Beach. The Waikīkī Beach Management Plan is part of a broader environmental initiative, *Ho'omau 'O 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 support and compliment the beach improvement and maintenance actions proposed in this EISPN.

Kūhiō Sandbag Groin (2019)

Beach monitoring following the 2012 Waikīkī Beach Maintenance I project showed steady erosion and beach recession of the east and west ends of the Royal Hawaiian Beach sector, with beach recession of about 4.5 feet per year 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 'Ewa groin.

The approved plan to stabilize the east end of Royal Hawaiian Beach adjacent to the Kūhiō Beach 'Ewa groin and to help ensure that the Waikīkī Tavern concrete foundation remnants remain covered included a sandbag groin placed 140 feet west of the existing Kūhiō Beach west groin. The designed 95-foot 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 feet on the inshore end to address additional beach erosion.

The Kūhiō Sandbag Groin was constructed during November 2019 (Figure 1-4 and Figure 1-5). The groin consists of 83 ElcoRock containers to construct and 275 cy of sand to fill the containers. Each sand container held 2.5 cubic meters of sand and weighed over 10,000 lbs when full. The non-woven geotextile fabric is UV and vandal 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.

Royal Hawaiian Groin Replacement (2020)

The original Royal Hawaiian groin was in an extremely deteriorated condition. Its failure could have destabilized 1,730 feet of sandy shoreline east of the groin in the Royal Hawaiian Beach sector. The Hawai'i 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 maintain the beach so that it could provide its intended recreational and aesthetic benefits, facilitate lateral access along the shoreline, and provide a first line of defense to the backshore in the event of storm wave attack. 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 1-6 and Figure 1-7). 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 crest cap. The new groin extends 125 feet from the seawall fronting the Sheraton Waikīkī Hotel, and then angles to the southeast to create a 50-foot-long L-head, for a total crest length of 175 feet. 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-foot wide by 3.5-foot-thick concrete crest cap 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 crest cap elevation is +9 feet msl for its first 40 feet, then transitions down to +6 feet on a 1V:8H slope, then remains at +6 feet for the remainder of its length. The stone crest elevation is +7 feet for the first 40 feet and then transitions down to +4 feet for the remainder of the groin length.

The existing concrete block groin was reduced in elevation to a maximum elevation of +4 to +1 feet to facilitate construction of the new groin. Approximately 40 linear feet of the original groin, beginning at about 120 feet 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.

Waikīkī Beach Maintenance II (planned for 2021)

The permits for the 2012 Waikīkī Beach Maintenance I project authorized a second nourishment effort to be performed within 10 years. The project planned to begin in January 2021. The project will consist of recovery of approximately 20,000 cy of sand from the same offshore sand deposit that was used in the 2012 project. Sand will be pumped into a dewatering basin in the Diamond Head basin of Kūhiō Beach Park. The dewatering basin will be approximately 100 feet wide and 300 feet long. Sand will be pushed into large piles with an excavator and bulldozer and then transported to the sand placement area on Waikīkī Beach.

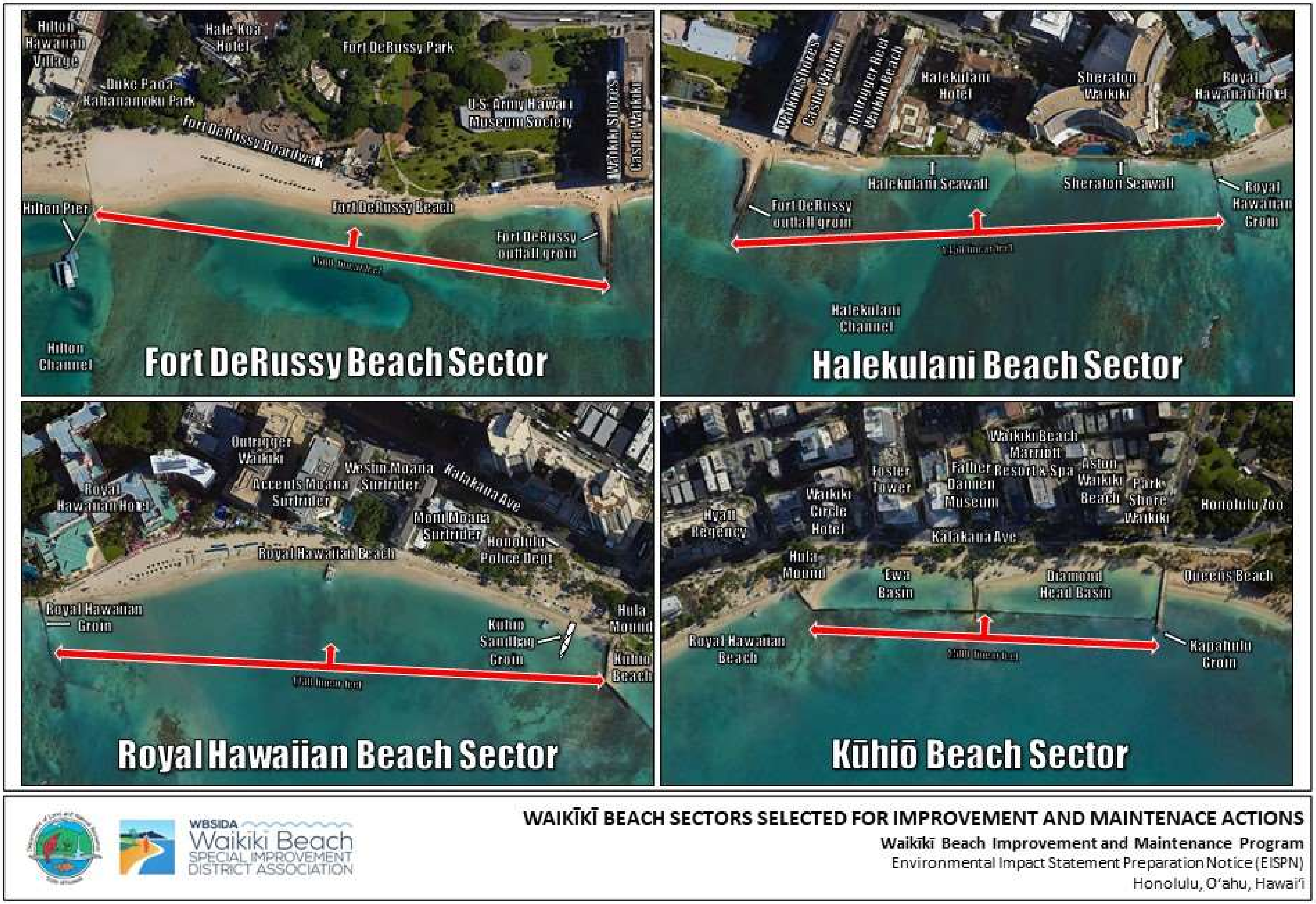


Figure 1-3 Waikīkī beach sectors selected for improvement

Figure 1-4 Conditions before construction of Kūhiō Sandbag Groin

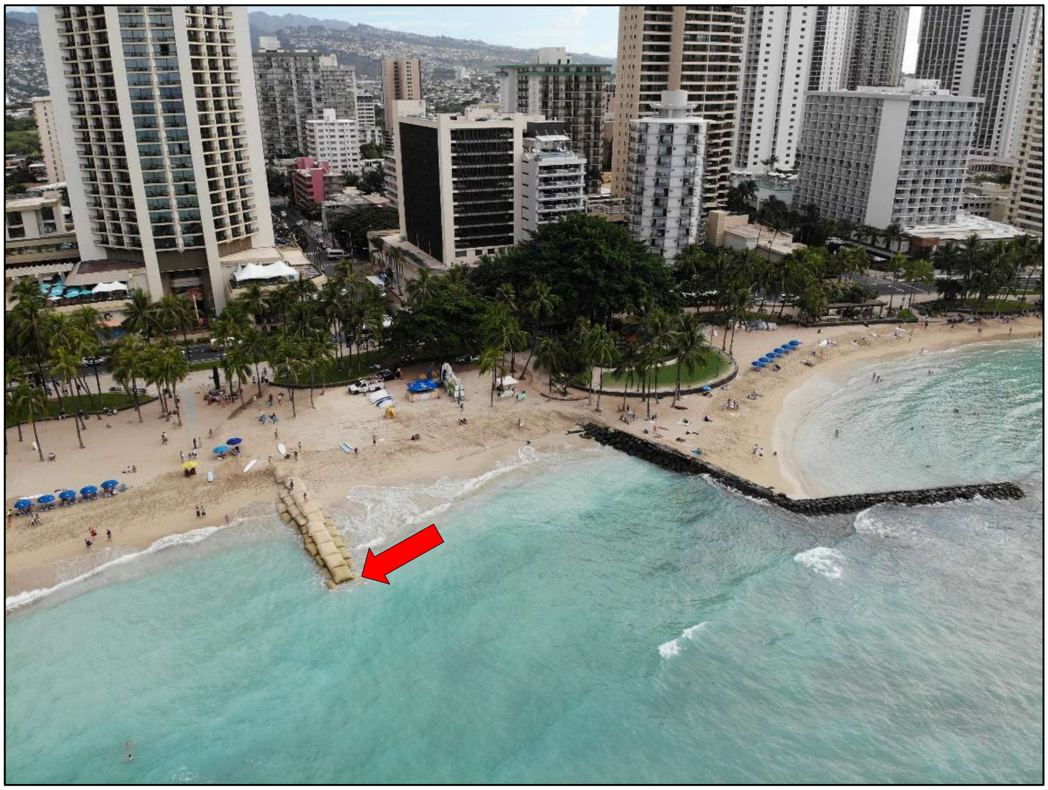


Figure 1-5 Conditions after construction of Kūhiō sandbag groin (Nov 2019)

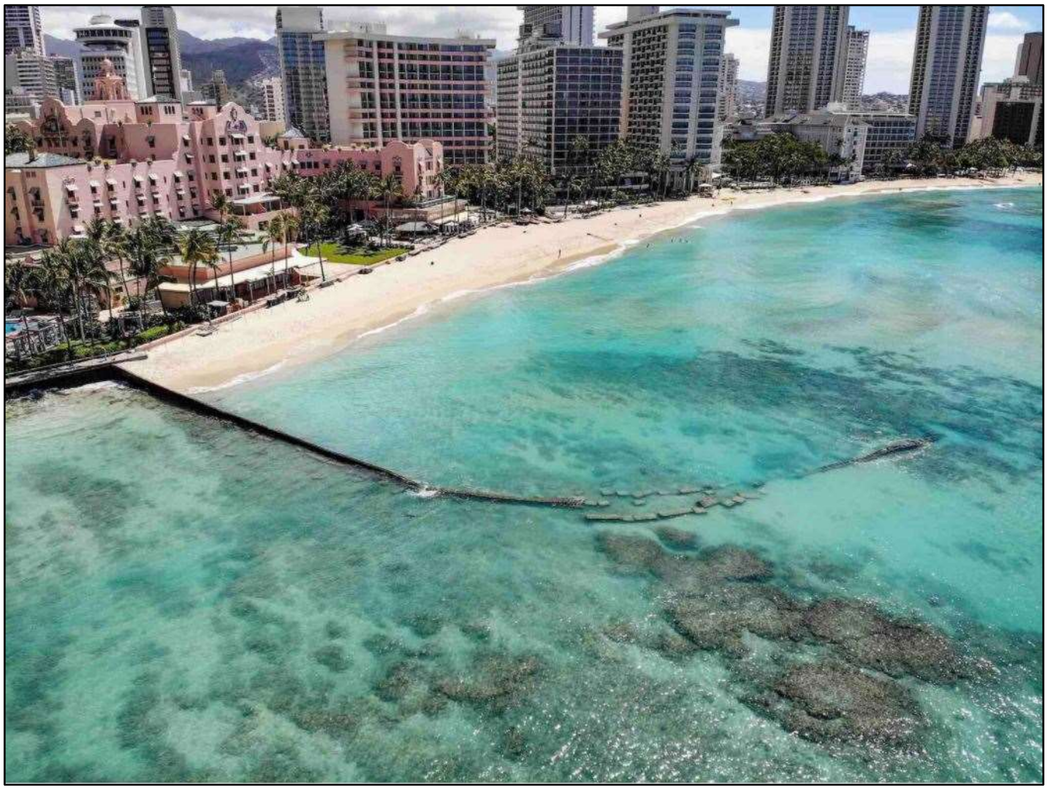


Figure 1-6 Conditions before replacement of Royal Hawaiian groin

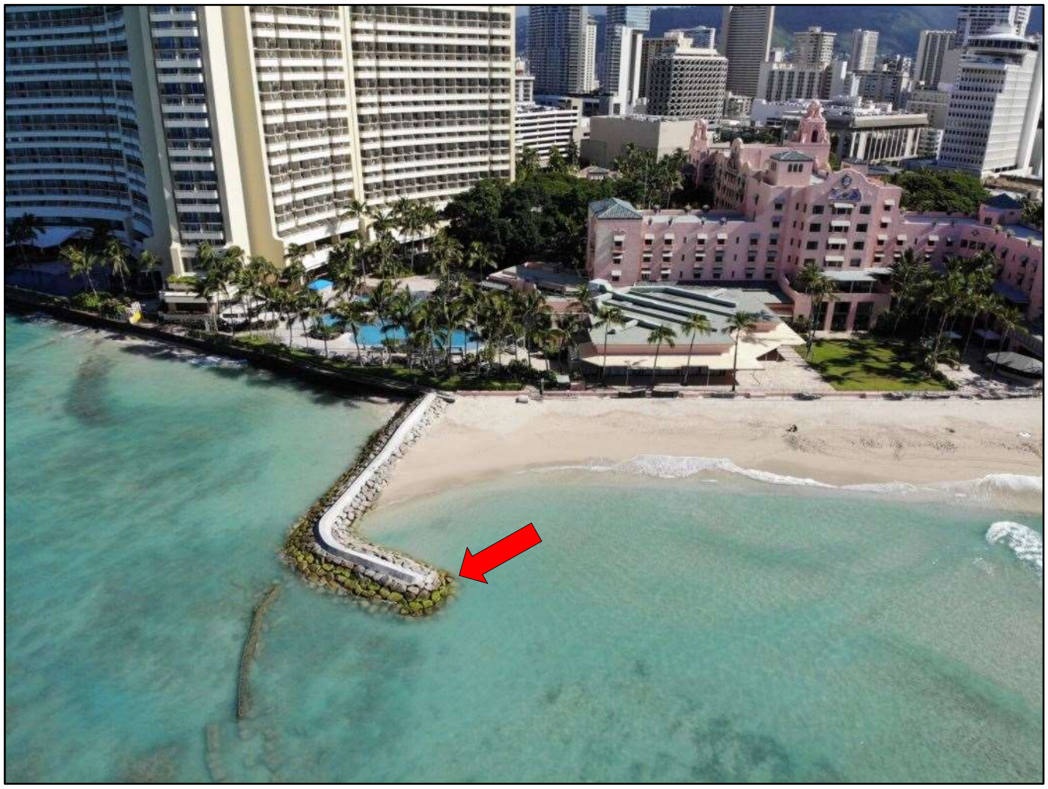


Figure 1-7 Conditions after replacement of Royal Hawaiian groin (Aug 2020)

1.7 EISPN Organization

This Environmental Impact Statement Preparation Notice (EISPN) presents conceptual beach improvement and maintenance actions that were developed in collaboration with the DLNR, the WBSIDA, and the WBCAC. A range of alternatives and their potential impacts will be presented and evaluated in the Draft Environmental Impact Statement (DEIS).

This EISPN is organized as follows:

- ***Chapter 2*** describes the proposed actions to be undertaken in the selected beach sectors.
- ***Chapter 3*** describes the proposed action at the Fort DeRussy Beach sector.
- ***Chapter 4*** describes the proposed action at the Halekulani Beach sector.
- ***Chapter 5*** describes the proposed action at the Royal Hawaiian Beach sector.
- ***Chapter 6*** describes the proposed action at the Kūhiō Beach sector.
- ***Chapter 7*** provides an overview of the existing environment that could potentially be affected by the proposed actions.
- ***Chapter 8*** summarizes the Federal, State, and County rules, regulations, and policies that affect planning and implementation of the proposed actions.
- ***Chapter 9*** presents the determination that the project will require preparation of a Hawaiʻi Revised Statutes (HRS) Chapter 343 Environmental Impact Statement (EIS).
- ***Chapter 10*** lists the parties that have been consulted during preparation of this EISPN.
- ***Chapter 11*** lists the parties that will be included on the EISPN distribution list.
- ***Chapter 12*** lists the references used during preparation of this EISPN.

2. SUMMARY OF PROPOSED ACTIONS

2.1 Introduction

The DLNR is proposing beach improvement and maintenance actions in four beach sectors in Waikīkī – Fort DeRussy Beach, Halekulani Beach, Royal Hawaiian Beach, and Kūhiō Beach. These beach sectors were selected based on the issues and priorities established by the WBCAC. No improvements are 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 conceptual improvements being proposed.

2.2 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:

- Improvements should increase beach stability and sand retention.
- Improvements should 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 current 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 for 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.

The proposed actions are intended to maintain the economic, social, aesthetic, recreational, environmental, cultural, and historical qualities of Waikīkī.

A conceptual rendering showing the proposed actions for all four beach sectors is shown in Figure 2-1. The conceptual designs will be updated based on comments received during the review of the EISPN and incorporated into the Draft Environmental Assessment (DEIS).

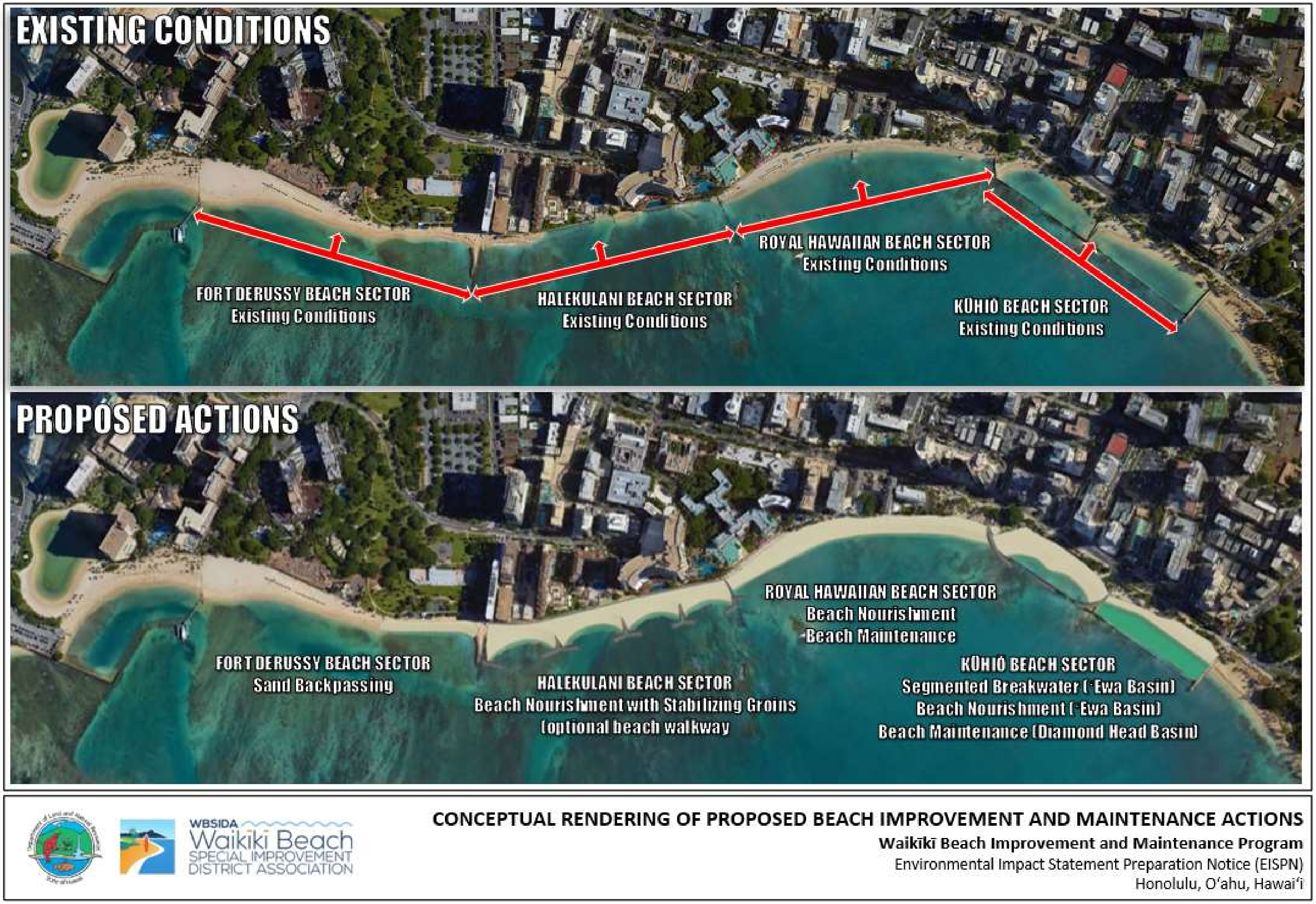


Figure 2-1 Conceptual rendering of the proposed actions

2.3 Anticipated Project Lifespans

For the design of coastal structures today, a key component is anticipated future sea level rise. 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, 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.

The proposed actions are necessary to ensure that the beaches of Waikīkī are sustainable and resilient to sea level rise.

The proposed actions are being 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 2-1.

Table 2-1 NOAA sea level rise projections (in feet) 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 actions are designed to be implemented in phases, with the initial phase being designed for approximately 1.5 feet 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 should be noted however, that sea level rise is a moving target, and predicted increases are changing as more and better sea level and climate change data 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.

2.5 Sand Sources

2.5.1 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, and forams. 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 (Smith and Cheung, 2003).

In the past, sand for beach nourishment was typically obtained from other beaches on Oʻahu and Molokaʻi or from terrestrial deposits that were commercially available. Mokulēʻia terrestrial 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 terrestrial sand is moderately sorted and the median grain size (D_{50}) is 0.60 mm. This sand has been used for beach nourishment projects at the Hilton Hawaiian Village and Kūhiō Beach.

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 upland 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.

Offshore 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.

2.5.2 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:

- The sand shall contain no more than 6% fine material (grain size smaller than 0.074 mm).
- The 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 grain size distribution.
- The overfill ratio of the fill sand to existing sand shall not exceed 1.5.
- The sand will be free of contaminants such as silt, clay, sludge, organic matter, turbidity, grease, pollutants, and others.
- The 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. To determine 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 grain size (D_{50}), which represents the grain diameter that is finer than 50% of the sample, is often used to quantify the grain size of a sample. Color, texture, density, angularity, sphericity, and abrasion resistance are also important characteristics of fill sand.

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 are 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; however, after 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.

2.5.3 Representative Waikīkī Offshore Sand Deposits

A number of offshore sand deposits are located along the South Shore of O‘ahu 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 are potential candidates to support the proposed beach improvement and maintenance actions. The estimated area and volume of each deposit are shown in Table 2-2. The locations of the deposits are shown in Figure 2-2.

Table 2-2 South Shore offshore sand deposits and estimated volumes

Offshore Deposit	Estimated Volume (cubic yards)	Estimated Area (acres)
Reef Runway	200,000	79
Ala Moana	190,000	26
Hilton Channel	45,000	11
Halekulani Channel	580,000	28
Canoes/Queens	50,000	10
Diamond Head	110,000	26
TOTALS	1,175,000	180

Reef Runway

This deposit is located approximately 1,500 feet offshore of the west end of the Reef Runway at Daniel K. Inouye International Airport in water depths of 20 to 70 feet. The deposit covers approximately 79 acres and contains an estimated 200,000 cubic yards of sand that varies in thickness from 2 to 8 feet. The typical median grain size (D_{50}) is 0.2 mm. The sand at the Reef Runway deposit does not comply with State of Hawaiʻi requirements for use in Waikīkī. The grain size is too fine compared to the existing beach sand.

Ala Moana

This deposit is located approximately 3,700 feet offshore of Ala Moana Beach Park in water depths of 75 to 120 feet. The deposit covers more than 25 acres and contains more than 190,000 cubic yards of sand that varies in thickness from 5 to 15 feet. 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, which contains approximately, 75,000 cy of sand, 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 it is not used at Ala Moana Regional Park, could potentially support beach nourishment in the Halekulani and Kūhiō beach sectors.

Hilton

This deposit is located approximately 2,700 feet offshore of the Hilton Hawaiian Village Waikīkī Beach Resort in water depths of 40 to 60 feet. The deposit covers approximately 11 acres and contains an estimated 45,000 cubic yards of sand that varies in thickness from 4 to 8 feet. 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 sand deposit complies with State of Hawaiʻi requirements and could potentially support beach nourishment in the Fort DeRussy, Halekulani, and Kūhiō beach sectors.

Halekulani Channel

This deposit is located in the Halekulani Channel, which extends approximately 4,000 feet offshore from the Halekulani Hotel where it widens into a broad sand field in 40 to 80 feet of water. This sand source has been investigated numerous times since the 1970s. The deposit covers approximately 28 acres and contains an estimated 200,000 cubic yards of sand that is up to 40 feet thick. The median grain size (D_{50}) ranges from 0.2 mm to 0.4 mm, with coarser sand nearshore in shallower water. The sand quantity and grain size in the Halekulani 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 Halekulani beach sector. The deeper deposits contain a substantial of sand; however, the sand is generally finer than the existing beach sand in Waikīkī.

Canoes/Queens

This deposit is located approximately 1,200 feet offshore of Royal Hawaiian Beach in water depths of 10 to 20 feet. The deposit covers approximately 10 acres and contains an estimated 25,000 to 50,000 cubic yards of sand that varies in thickness from 3 to 7 feet. 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) and is proposed for use again on Royal Hawaiian Beach in 2021. The sand at the Canoes/Queens deposit complies with State of Hawai‘i requirements and, while it could potentially support beach nourishment in the Kūhiō and Halekulani beach sectors, it is best suited for beach nourishment in the Royal Hawaiian Beach sector.

Diamond Head

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

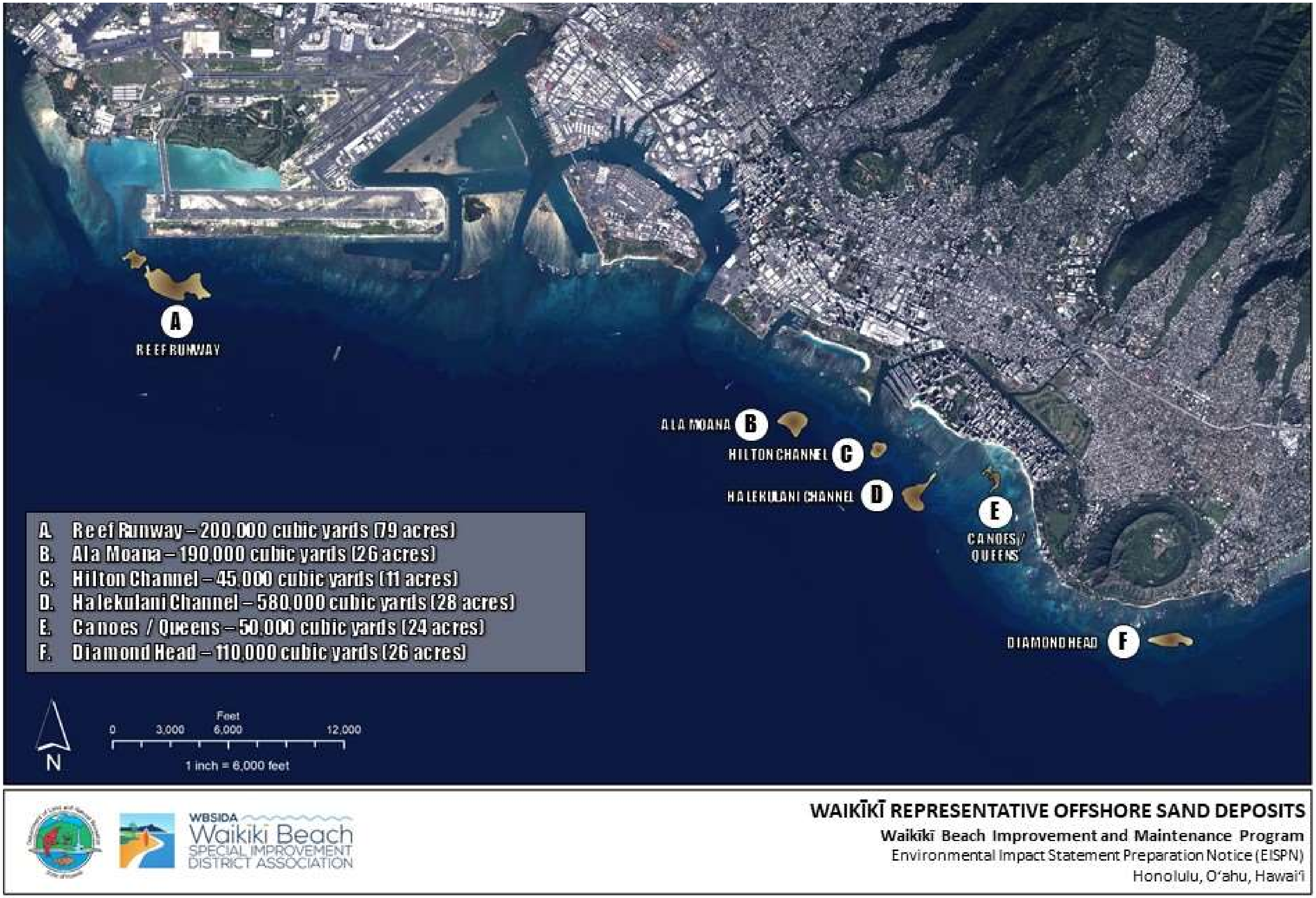


Figure 2-2 Representative Waikīkī offshore sand deposits

2.5.4 Offshore Sand Recovery and Transport Methodology

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 Hawai‘i are submersible slurry pumps, 2) self-contained hydraulic suction dredges, and 3) clamshell buckets.

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 sand to a dewatering basin onshore. An example of a submersible slurry pump is shown in Figure 2-3. An advantage of a 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 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 beneficial.

A disadvantage of a submersible pump is the significant amount of seawater recovered with and used to pump the sand (typically, 1-part sand to 10-parts water), and the need to contain and control the dewatering of the sand onshore. A submersible pump was used for the 2012 Waikīkī Beach Maintenance I project, which recovered approximately 24,000 cy of sand from an offshore deposit and pumped it to a dewatering basin that was constructed in the Diamond Head basin at Kūhiō Beach Park.

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 2-4.

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 Hawai‘i Department of Land and Natural Resources in February 2000 (Noda, 2000). Approximately 1,400 cubic yards of sand was dredged from a deposit located 1,500 feet offshore of Kūhiō Beach and pumped to a dewatering site excavated into the dry beach area within the Diamond Head basin.

Figure 2-3 Example of submersible slurry pump (HTBI)

Figure 2-4 Example of hydraulic suction dredge (Ellicott Dredges)

Clamshell Dredging

Clamshell dredging involves mechanically scooping and lifting sediment, in this case sand, from the seafloor. Clamshell dredging is often used in association with a large barge on which the 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 waiting barge. Once the sand is deposited onto the barge, the barge will transit to a dock where the sand can be offloaded and transported to a stockpiling area or dewatering site. An example of clamshell dredging is shown in Figure 2-5.

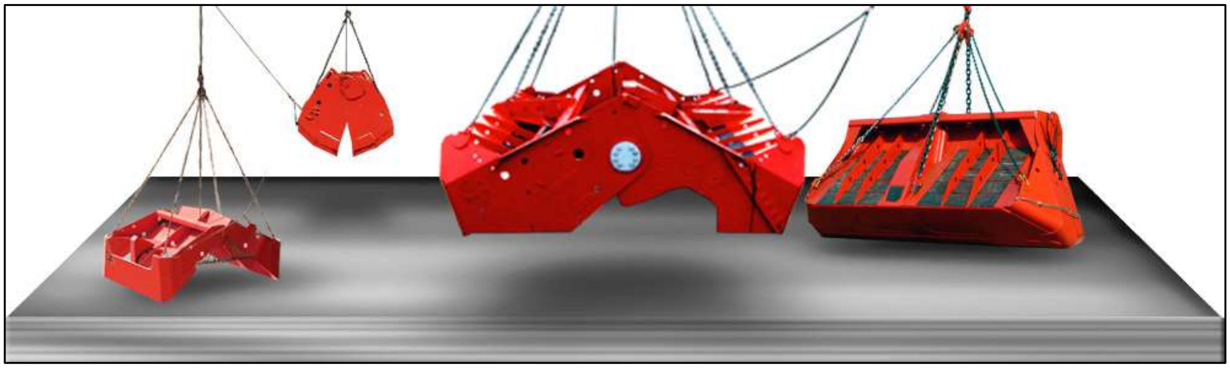


Figure 2-5 Example of clamshell dredging (Cable Arm, Inc.)

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 feet 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 – Fort DeRussy Channel, Hilton Channel, Hilton Lagoon
- Halekulani Beach Sector – Halekulani Channel
- Royal Hawaiian Beach Sector – Canoes/Queens, Royal Hawaiian Sandbar
- Kūhiō Beach Sector – ‘Ewa Basin, Diamond Head 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.

Remote Operated Submersible Dredge

A Remote Operated Submersible Dredge (ROV subdredge) is an electrically powered tracked hydraulic pump manufactured by EddyPump Corporation (Figure 2-6). 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.

To recover nearshore sand deposits in Waikīkī, the 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. The production rate for the ROV subdredge is reported by the company to be up to 60 cubic yards 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.

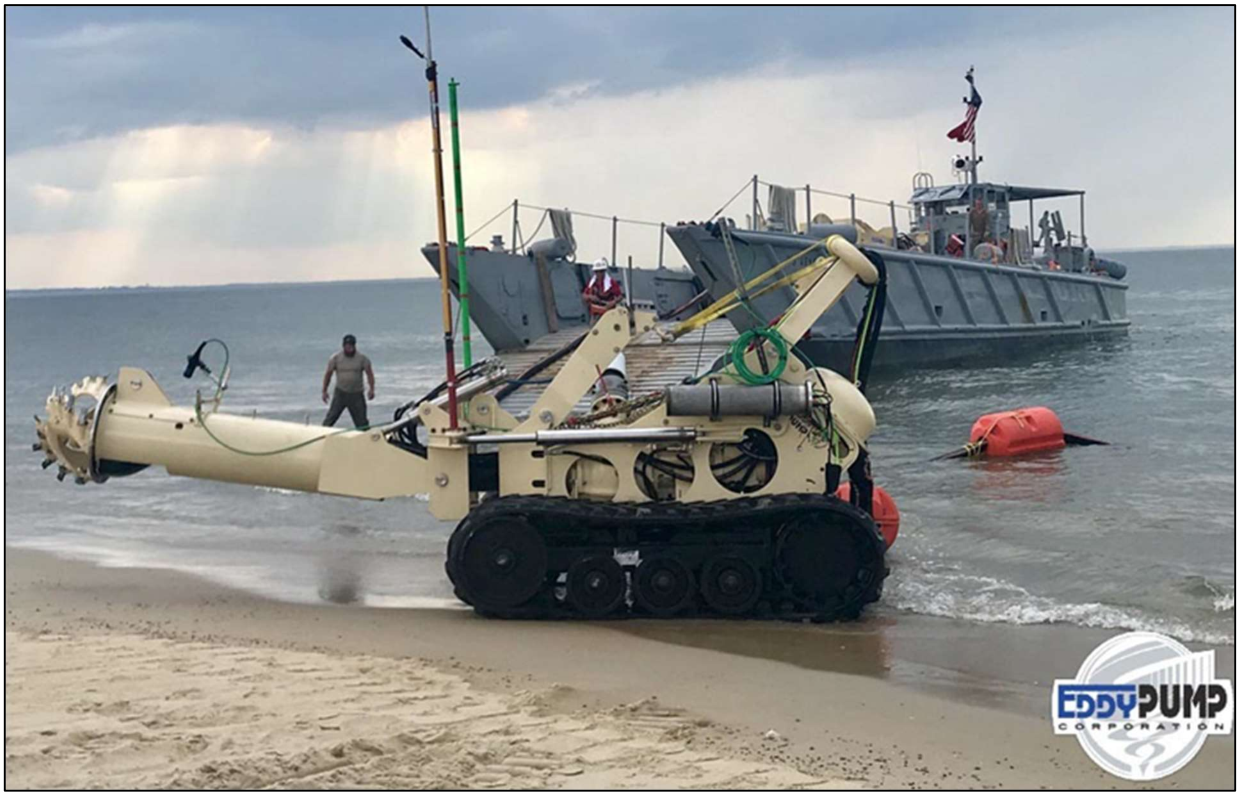


Figure 2-6 Remote Operated Submersible Dredge (EddyPump Corporation)

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 2-7 shows a diver-operated dredge pump manufactured by EddyPump Corporation. The diver-operated dredge pump is roughly 6 feet long, 3 feet wide, and 3 feet tall, but dimensions vary depending on the size of the pump chosen. Figure 2-8 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 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 feet, which would enable the diver to dredge sand within a 100-foot radius of the pump. 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.

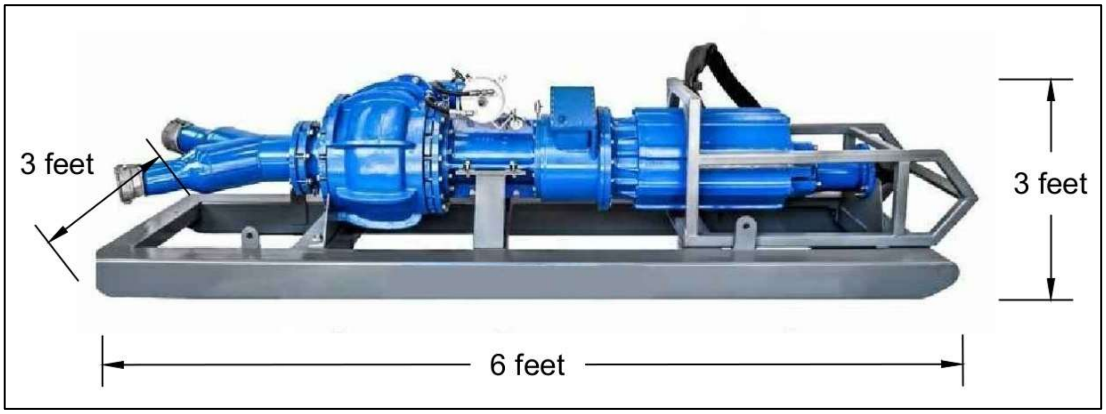


Figure 2-7 Diver-operated dredge pump

Figure 2-8 Surface supplied air diver using a diver-operated dredge

3. PROPOSED ACTION: FORT DERUSSY BEACH SECTOR

3.1 General Description

The Fort DeRussy Beach sector spans approximately 1,680 feet of shoreline that extends from the Hilton Hawaiian Village pier (Hilton Pier) 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 Hawai‘i. An overview map of the Fort DeRussy Beach sector is shown in Figure 3-1.

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 Waikīkī hotel. The backshore, which was primarily wetlands, was filled with crushed coral material that was dredged from the adjacent reef. In the 1950’s, the Hilton Hawaiian Village pier (Hilton Pier) and Hilton Channel were constructed at the west end of the sector. The beach was constructed in 1969 using approximately 160,000 cubic yards of crushed coral material that was dredged from the nearshore reef (USACE, 1993). In 1976, a 2-foot-thick layer of carbonate sand was placed over the crushed coral base (USACE, 2002). Sand was periodically placed on the beach up through 1994 but no beach improvements or maintenance has been performed since then. The history of coastal engineering in the Fort DeRussy Beach sector is summarized in Figure 3-2. Historical photographs of the Fort DeRussy Beach sector are shown in Figure 3-3. Aerial photographs comparing the shoreline conditions at the Fort DeRussy Beach sector in 1949 and 2015 are shown in Figure 3-4.

Existing Conditions

The Fort DeRussy Beach sector is an entirely engineered shoreline. The west end of the 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 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 shoreline. 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 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 pier, 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 Fort DeRussy beach walkway provides lateral access along the shoreline from Hilton Hawaiian Village to the Castle Waikīkī Shores. Perpendicular access to the shoreline is available through Fort DeRussy Park. There are no lifeguard towers in the Fort DeRussy Beach sector. The existing beach walkway has a ground elevation of about +5 feet MSL. Sand often gets pushed landward over the boardwalk by wave action, particularly during high tides and high surf events. Concessions back this section of the beach walkway. Behind the concessions is Fort DeRussy Park and the U.S. Army Hawai‘i Museum of History.

Swim surveys found the most biodiversity of corals, fish, and sea turtles in the western portion of the sector in the vicinity of the Hilton Pier. Adjacent to the pier is a wide sand channel (Hilton Channel) with scattered rubble. East of the Hilton Channel, rubble covered in macroalgae begins with few small, scattered corals all the way 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 3-5.

Historical and Projected Shoreline Change

The 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 feet/year (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 feet/year, whereas the west end of the beach (transects 154 to 169) has been accreting at an average rate of 0.4 feet/year. 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 et al. 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 feet (9.4 meters) by 2050 and up to 81 feet (24.7 meters) by 2100 (UHCGG, 2019). The entire length of the shoreline in the Fort DeRussy Beach sector is armored by a seawall. 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 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 beach is already narrow and often submerged during high tides and high surf events.

There have been no beach improvement or maintenance projects in the Fort DeRussy Beach sector since the mid-1990s.

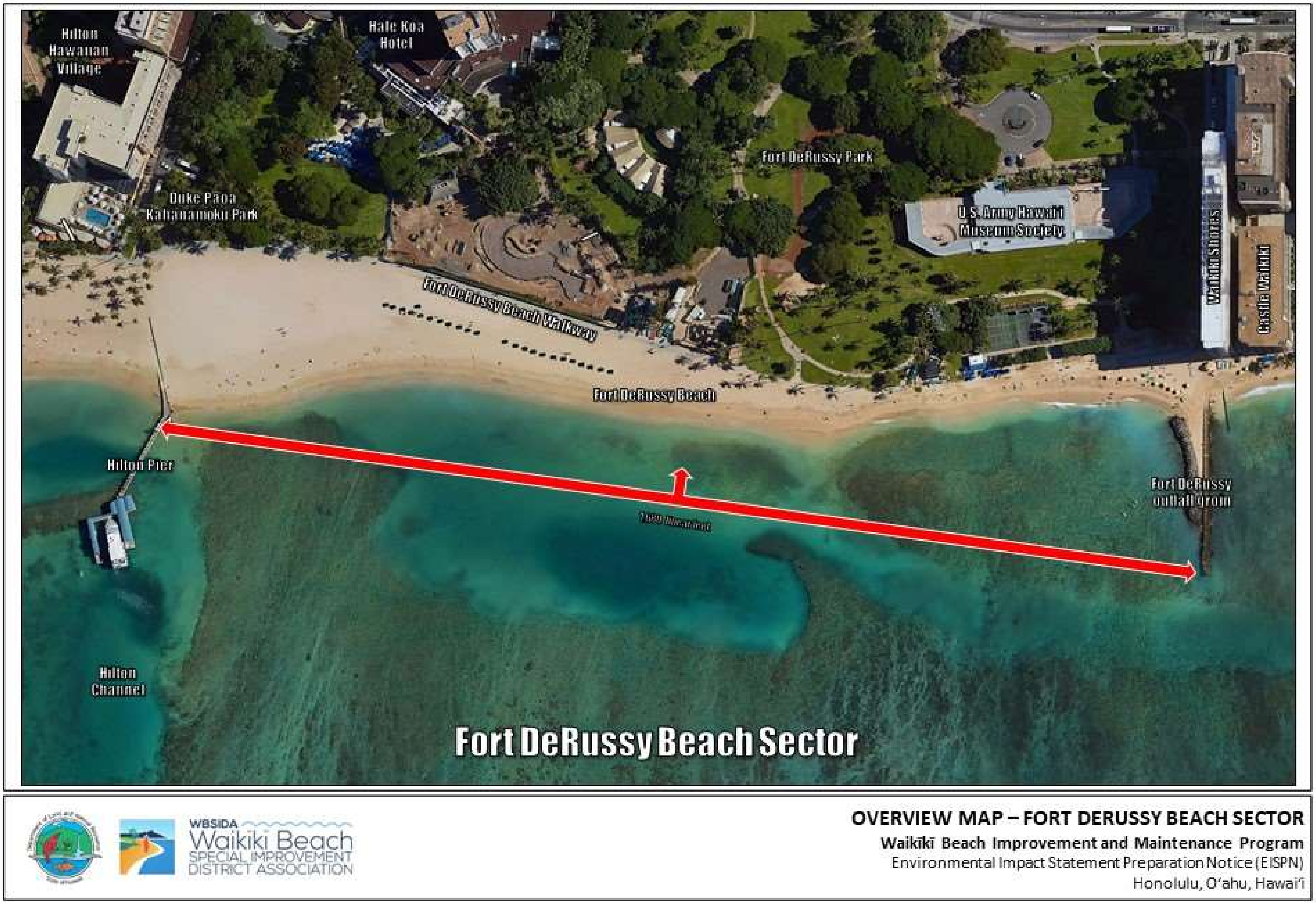
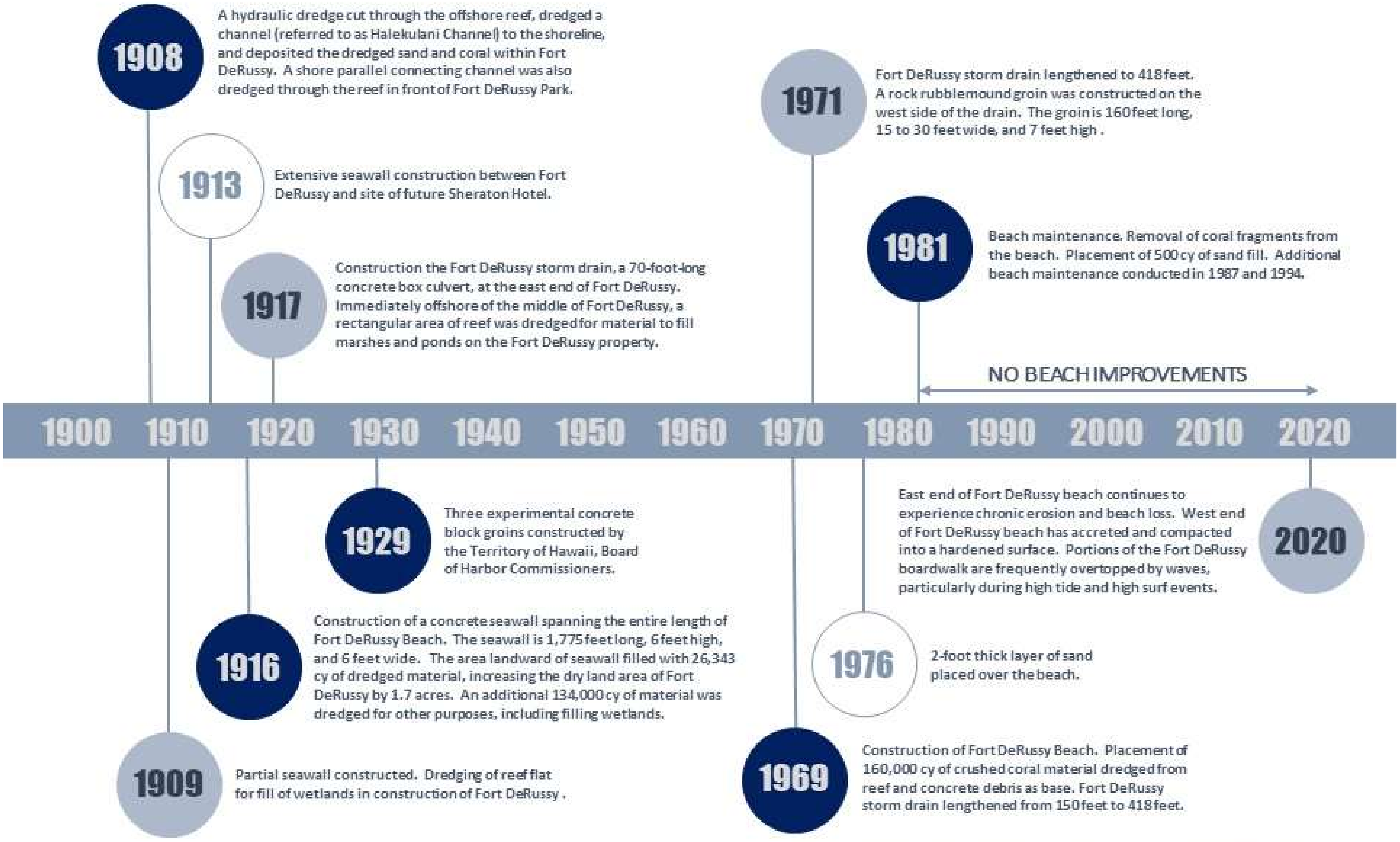


Figure 3-1 Overview map – Fort DeRussy Beach sector



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

1909 Partial seawall constructed. Dredging of reef flat for fill of wetlands in construction of Fort DeRussy.

1913 Extensive seawall construction between Fort DeRussy and site of future Sheraton Hotel.

1916 Construction of a concrete seawall spanning the entire length of Fort DeRussy Beach. The seawall is 1,775 feet long, 6 feet high, and 6 feet wide. The area landward of seawall filled with 26,343 cy of dredged material, increasing the dry land area of Fort DeRussy by 1.7 acres. An additional 134,000 cy of material was dredged for other purposes, including filling wetlands.

1917 Construction the Fort DeRussy storm drain, a 70-foot-long concrete box culvert, at the east end of Fort DeRussy. Immediately offshore of the middle of Fort DeRussy, a rectangular area of reef was dredged for material to fill marshes and ponds on the Fort DeRussy property.

1929 Three experimental concrete block groins constructed by the Territory of Hawaii, Board of Harbor Commissioners.

1969 Construction of Fort DeRussy Beach. Placement of 160,000 cy of crushed coral material dredged from reef and concrete debris as base. Fort DeRussy storm drain lengthened from 150 feet to 418 feet.

1971 Fort DeRussy storm drain lengthened to 418 feet. A rock rubblemound groin was constructed on the west side of the drain. The groin is 160 feet long, 15 to 30 feet wide, and 7 feet high.

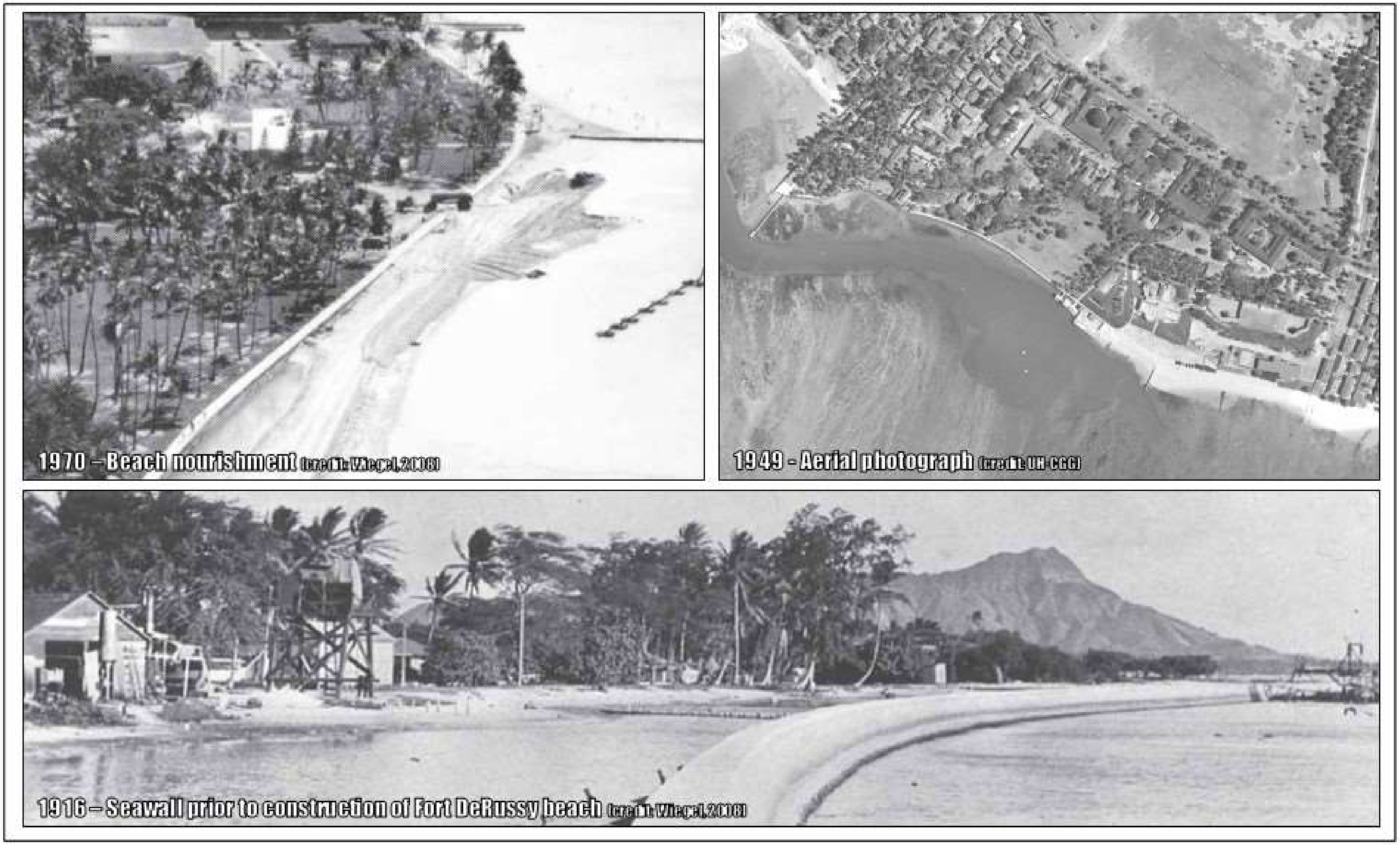
1976 2-foot thick layer of sand placed over the beach.

1981 Beach maintenance. Removal of coral fragments from the beach. Placement of 500 cy of sand fill. Additional beach maintenance conducted in 1987 and 1994.

2020 East end of Fort DeRussy beach 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 boardwalk are frequently overtopped by waves, particularly during high tide and high surf events.

Compiled from Department of Public Works (1931, 1951), Crane (1972), U.S. Army Corps of Engineers (1968, 1992), Gerritsen (1978), Noda and Associates (1991, 1999), Miller & Fletcher (2003), Weigel (2008), Conger & Eversole (2013)

Figure 3-2 History of coastal engineering – Fort DeRussy Beach Sector



WBSIDA Waikiki Beach SPECIAL IMPROVEMENT DISTRICT ASSOCIATION

HISTORICAL PHOTOGRAPHS – FORT DERUSSY BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, Oʻahu, Hawaiʻi

Figure 3-3 Historical photographs – Fort DeRussy Beach Sector

WBSIDA
Waikiki Beach
SPECIAL IMPROVEMENT
DISTRICT ASSOCIATION

HISTORICAL SHORELINE POSITIONS – FORT DERUSSY BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, O'ahu, Hawai'i

Figure 3-4 Comparison of historical shorelines– Fort DeRussy Beach sector

Figure 3-5 Existing conditions – Fort DeRussy Beach sector

3.2 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 seawall protects the beach walkway from scour and undermining. Waves periodically overtop the beach crest pushing sand over the beach walkway. The elevation of the beach walkway is currently at the wave run-up elevation. Without beach improvements or maintenance, the beach walkway will experience more frequent overtopping with future sea level rise.

Erosion along the Fort DeRussy Beach 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 feet) at the east end of the sector. Wave overwash on the landward side of the beach is problematic where beach widths are narrow (USACE, 2009). Photographs of existing issues and problems in the Fort DeRussy Beach sector are shown in Figure 3-6.

The Waikīkī Beach Community Advisory Committee (WBCAC) 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 WBCAC determined that the highest priorities for the Fort DeRussy Beach sector are to:

- Address beach loss at the east end of Fort DeRussy Beach
- Prevent wave overtopping of the Fort DeRussy beach walkway

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Waikiki Beach
SPECIAL IMPROVEMENT
DISTRICT ASSOCIATION

ISSUES & PROBLEMS – FORT DERUSSY BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, O'ahu, Hawai'i

Figure 3-6 Issues and problems – Fort DeRussy Beach sector

3.3 Conceptual Design

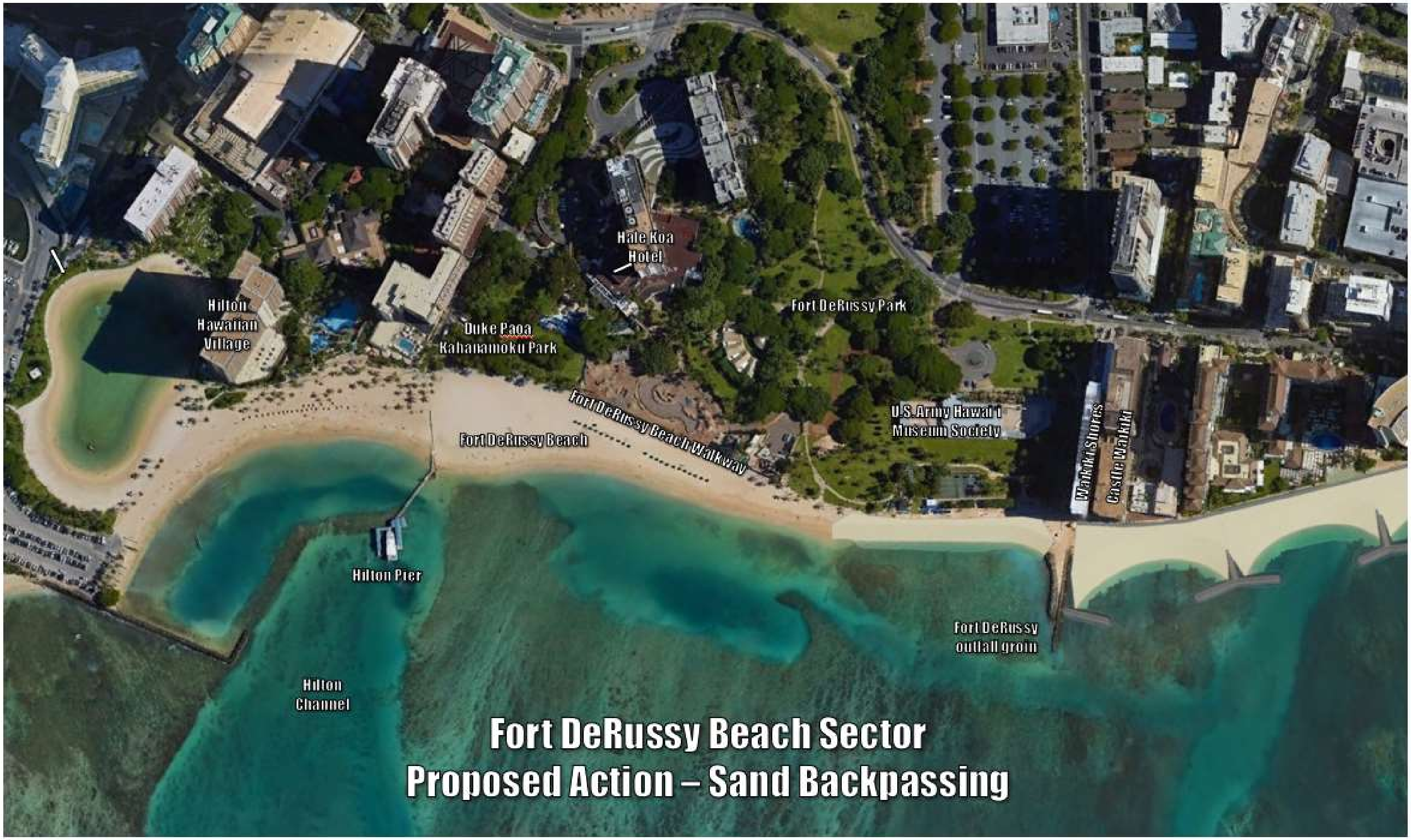
3.3.1 Sand Backpassing

The proposed action for the Fort DeRussy Beach sector is to conduct sand backpassing. Sand would 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 would be obtained from the beach face on the east side of the Hilton Pier, where sand eroded from the east end of the Fort DeRussy Beach sector has accreted over the years. Sand would be excavated from the beach face extending inshore only as far as necessary to obtain the required volume of sand, stopping before reaching the consolidated backshore sand.

The proposed sand backpassing would relocate approximately 1,200 cubic yards of sand. The sand would be manually transported from the excavation site to the fill site, where it would be placed along the beach face from the beach toe to the crest, widening the beach by an average of 10 feet. A conceptual rendering of the proposed action is shown in Figure 3-7.

Sand backpassing would need to be conducted periodically to maintain a stable beach profile in this area. Due to the narrow width of the existing beach, some sand would need to be placed into the ocean to achieve an initially stable profile. The State of Hawaiʻi, Department of Land and Natural Resources recently obtained a Final Environmental Assessment and Finding of No Significant Impact for a Small-Scale Beach Restoration (SSBR) programmatic permit that could streamline the permitting requirements for sand backpassing at this location.

Sand backpassing could be performed as a single project, or as a multi-year maintenance program, in which periodic maintenance would be performed on an as-need basis. The maintenance program would allow for sand backpassing to be conducted when beach conditions reach some pre-defined topographic triggers without having to go through the permit process again. Beach monitoring would be required to determine when the triggers have been met.



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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, O'ahu, Hawai'i

Figure 3-7 Conceptual rendering of proposed action – Fort DeRussy Beach sector

3.3.2 Construction Methodology

Sand backpassing would require heavy equipment such as excavators and front-end loaders to recover the borrow sand and place it into dump trucks. To prepare the borrow site for sand recovery, the upper layer (approximately 6 inches) of unconsolidated sand on the flat beach face at the west end could be temporarily pushed to the side to expose the consolidated sand layer, which would provide the access path for equipment to transit between the borrow site and placement area. The proposed project layout is shown in Figure 3-8. This boundary would be accompanied by signage to divert beach users away from the active work areas. The sand could be taken from the beach face with an excavator that is situated on the dry beach reaching into the water. Sand would be taken from the beach face and would not reduce the beach crest elevation.

Dump trucks would be used to transport the sand from the borrow site to the placement area. A bulldozer would be used to distribute the sand to achieve the design template. Approximately 100 truckloads would be required to move 1,200 cubic yards of sand. If two dump trucks were rotated between the borrow site and placement area, approximately 30 to 40 loads could be transported per day. The total work time would be approximately one week with an additional week for mobilization and demobilization and a week as a weather contingency.

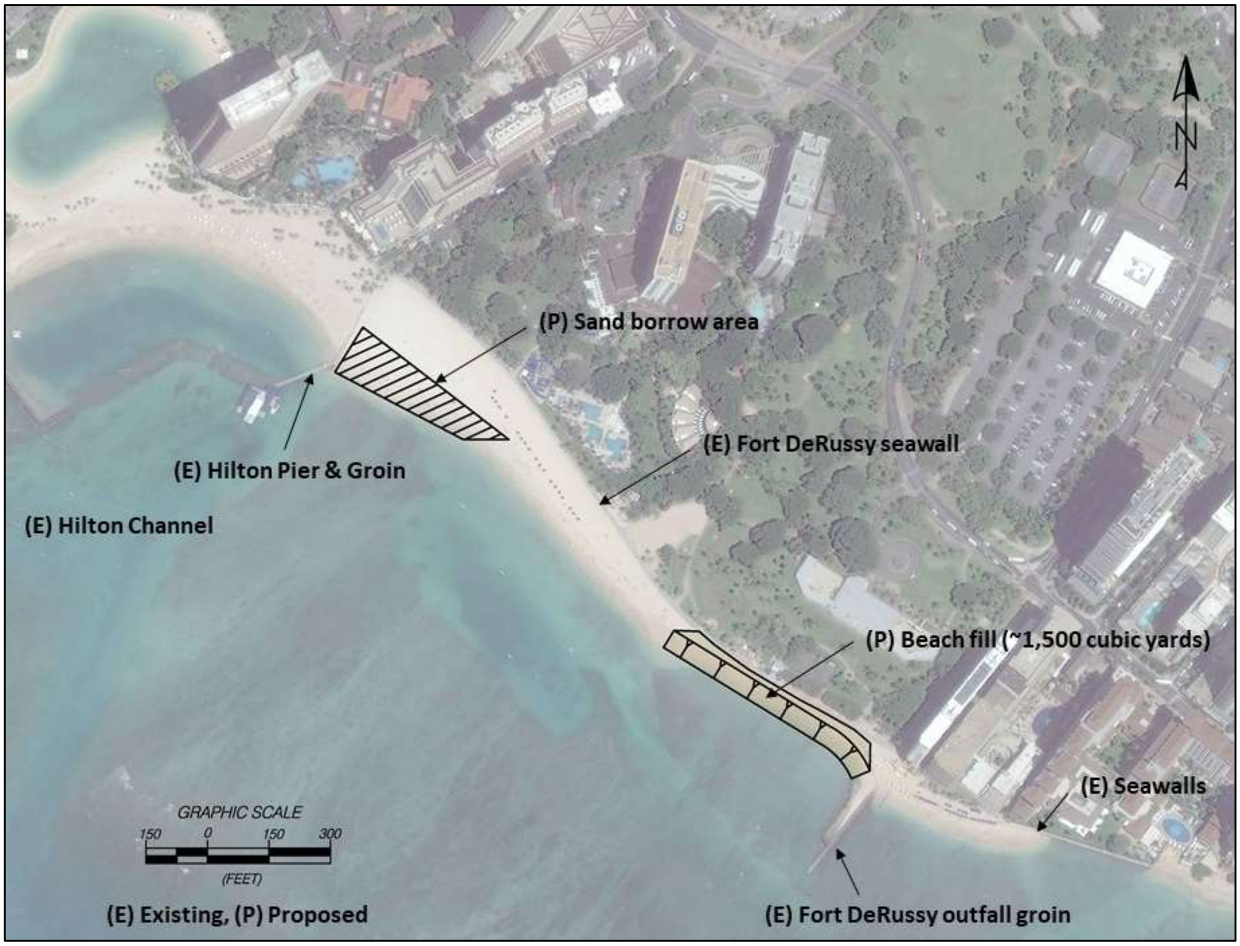

Figure 3-8 Sand Backpassing plan - Fort DeRussy Beach Sector

3.4 Alternatives to the Proposed Action

The following alternatives were considered and will be discussed in further detail in the Draft Environmental Impact Statement (DEIS):

- No Action
- Deferred Action
- Repair or Modification of Existing Structures
- Beach Maintenance (e.g., sand pushing)
- Beach Nourishment (e.g., offshore sand or nearshore small-scale maintenance dredging)
- Seawall and Walkway Improvements

4. PROPOSED ACTION: HALEKULANI BEACH SECTOR

4.1 General Description

The Halekulani Beach sector spans approximately 1,450 feet 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 Hotel, Halekulani Hotel, and the Sheraton Waikīkī Beach Resort Hotel. The Halekulani Channel extends perpendicular from the shoreline fronting the Halekulani Hotel. An overview map of the Halekulani Beach sector is shown in Figure 4-1.

History

Shoreline modifications in the Halekulani beach sector occurred generally coincident with modifications in the Fort DeRussy beach sector. In the early 1900's, the Halekulani 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 Halekulani Beach sector is summarized in Figure 4-2. Historical photographs of the Halekulani Beach sector are shown in Figure 4-3. Aerial photographs comparing the shoreline conditions at the Halekulani Beach sector in 1949 and 2020 are shown in Figure 4-4.

Existing Conditions

The Halekulani 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 400 feet east from the Fort DeRussy outfall groin fronting the Castle Waikīkī Shore and Outrigger Reef Waikīkī Beach Resort. The beach ends at the Halekulani seawall, which consists of a vertical seawall that spans approximately 335 feet of shoreline fronting the Halekulani 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 feet MSL and is frequently overtopped by waves during high tide and high surf events.

Two small pocket beaches, backed by vertical seawalls, are located between the Halekulani and Sheraton Waikīkī 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 1900's. The west pocket beach spans approximately 100 feet of shoreline. The beach has a crest elevation up to approximately +7.5 feet MSL and a crest width of about 5 to 10 feet. A relict groin is located near the center of the pocket beaches and extends approximately 125 feet seaward of the shoreline. The groin is almost entirely submerged.

The east pocket beach spans approximately 125 feet of shoreline. The beach has a beach crest elevation between +5.5 to +6.5 feet MSL. The crest width varies from 0 to 25 feet. The beach terminates at the west end of a vertical seawall that spans approximately 500 feet of shoreline fronting the Sheraton Waikīkī hotel. A concrete walkway on top of the seawall and 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. Lateral access to the areas east and west of the pocket beaches is often limited due to the inaccessible stairway which used to connect the seawall to the pocket beach. Approximately 75 feet along the seawall is closed to the public and there is no lateral access along this portion of the shoreline. Closure of this area inhibits lateral shoreline access between the east and west portions of Waikīkī Beach. The seawall continues east and terminates at the existing Royal Hawaiian groin, which marks the east boundary of the Halekulani Beach sector.

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 Halekulani Beach sector that were constructed in the early 1900's. The groins are deteriorated, largely submerged, and do not appear to perform any significant function.

Photographs of existing conditions in the Halekulani Beach sector are shown in Figure 4-5.

Historical and Projected Shoreline Change

The UHCGG historical shoreline change analysis for the Halekulani 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 Waikīkī Hotel (UHCGG, 2019). Miller et al. (2003) found that sediment transport in the Halekulani 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 fluctuates seasonally but has been relatively stable. The pocket beaches in the central portion of the sector (transects 126 to 129), between the Halekulani and Sheraton Waikīkī hotels, are aligned with the Halekulani Channel and have experienced moderate erosion at a rate of -0.2 feet/year (UHCGG, 2019). The pocket beaches are dynamic and sand volumes and beach width often fluctuate. The pocket beaches are often completely submerged during high tide 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 Waikīkī 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 Halekulani 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 feet (1.2 meters) by 2050 and up to 14.1 feet (4.3 meters) by 2100 (UHCGG, 2019). These projections do not account for the presence of the existing seawalls that span the entire length of the Halekulani 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.

Beach Improvements and Maintenance

The most recent beach improvement project in the Halekulani Beach sector was the replacement of the Royal Hawaiian Groin, which was completed in August 2020. The original Royal Hawaiian groin was in an extremely deteriorated condition. Its failure would have destabilized 1,730 feet 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 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 crest cap. The new groin extends 125 feet from the seawall fronting the Sheraton Waikīkī Hotel, and then angles to the southeast to create a 50-foot-long L-head, for a total crest length of 175 feet. 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-foot wide by 3.5-foot-thick concrete crest cap 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 crest cap elevation is +9 feet msl for its first 40 feet, then transitions down to +6 feet on a 1V:8H slope, then remains at +6 feet for the remainder of its length. The stone crest elevation is +7 feet for the first 40 feet and then transitions down to +4 feet for the remainder of the groin length.

The existing concrete block groin was reduced in elevation to a maximum elevation of +4 to +1 feet to facilitate construction of the new groin. Approximately 40 linear feet of the existing groin, beginning at about 120 feet 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, seaward of the new groin head, was left in place.

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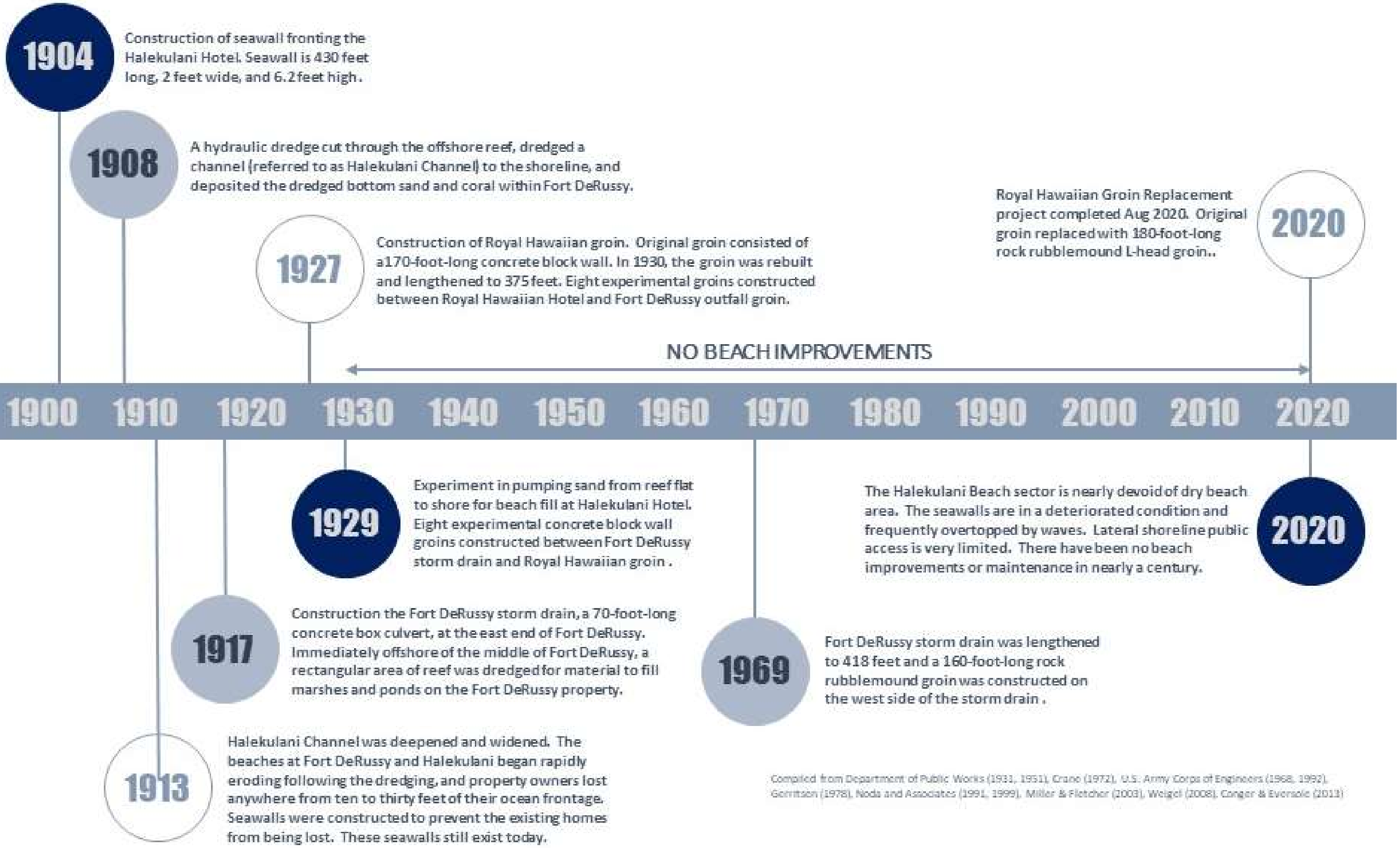
Waikiki Beach
SPECIAL IMPROVEMENT
DISTRICT ASSOCIATION

OVERVIEW MAP – HALEKULANI BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, Oʻahu, Hawaiʻi

Figure 4-1 Overview map – Halekulani Beach sector



1904 Construction of seawall fronting the Halekulani Hotel. Seawall is 430 feet long, 2 feet wide, and 6.2 feet high.

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.

1927 Construction of Royal Hawaiian groin. Original groin consisted of a170-foot-long concrete block wall. In 1930, the groin was rebuilt and lengthened to 375 feet. Eight experimental groins constructed between Royal Hawaiian Hotel and Fort DeRussy outfall groin.

2020 Royal Hawaiian Groin Replacement project completed Aug 2020. Original groin replaced with 180-foot-long rock rubblemound L-head groin..

1929 Experiment in pumping sand from reef flat to shore for beach fill at Halekulani Hotel. Eight experimental concrete block wall groins constructed between Fort DeRussy storm drain and Royal Hawaiian groin .

2020 The Halekulani Beach sector is nearly devoid of dry beach area. The seawalls are in a deteriorated condition and frequently overtopped by waves. Lateral shoreline public access is very limited. There have been no beach improvements or maintenance in nearly a century.

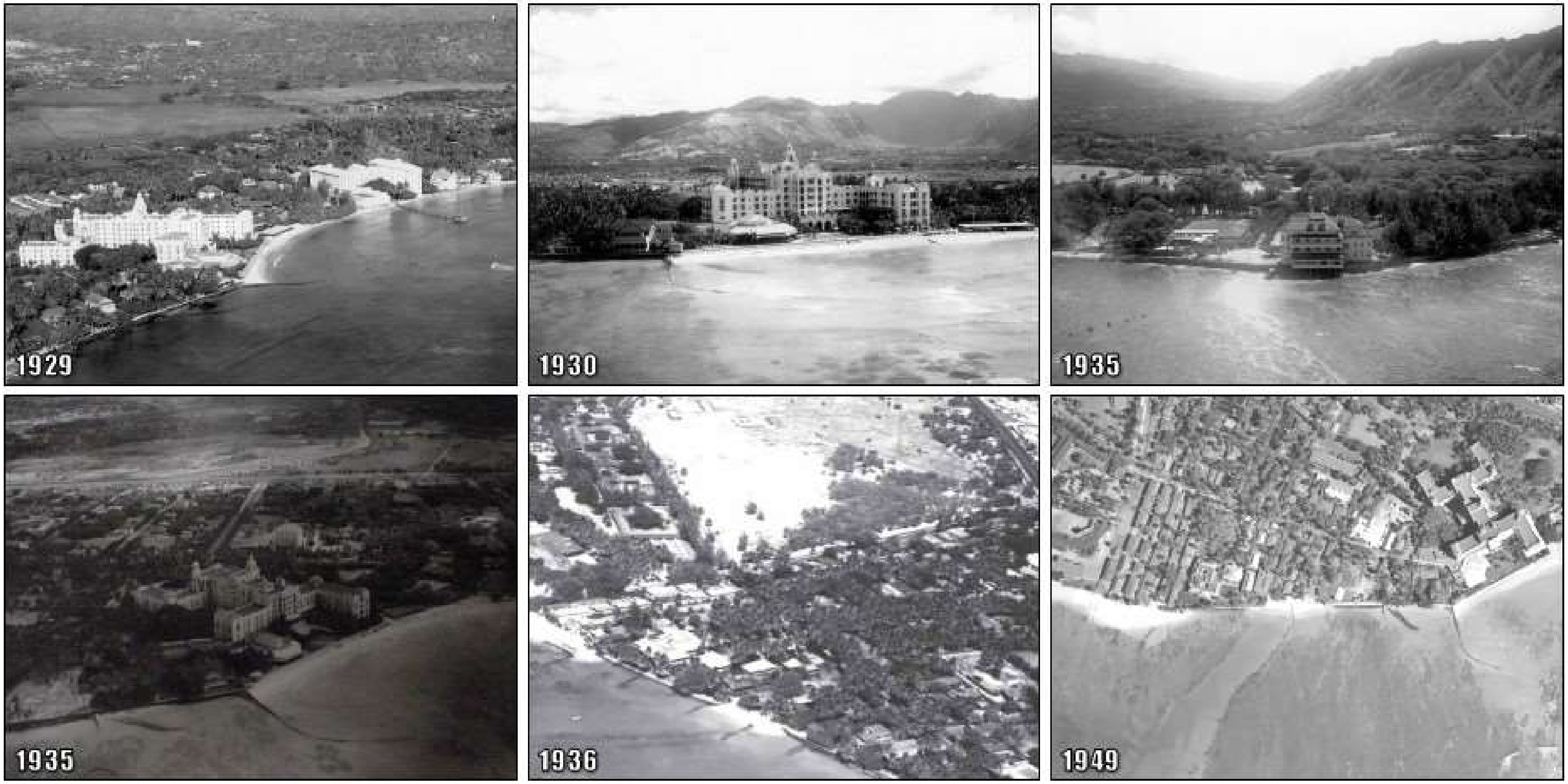
1917 Construction the Fort DeRussy storm drain, a 70-foot-long concrete box culvert, at the east end of Fort DeRussy. Immediately offshore of the middle of Fort DeRussy, a rectangular area of reef was dredged for material to fill marshes and ponds on the Fort DeRussy property.

1969 Fort DeRussy storm drain was lengthened to 418 feet and a 160-foot-long rock rubblemound groin was constructed on the west side of the storm drain .

1913 Halekulani Channel was deepened and widened. The beaches at Fort DeRussy and Halekulani 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), Crane (1972), 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 – Halekulani Beach Sector



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HISTORICAL PHOTOGRAPHS – HALEKULANI BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, O'ahu, Hawai'i

Figure 4-3 Historical photographs – Halekulani Beach Sector

Imagery and shoreline location data courtesy of University of Hawai'i Coastal Geology Group

Imagery and shoreline location data courtesy of University of Hawai'i Coastal Geology Group

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

Figure 4-4 Comparison of historical shorelines– Halekulani Beach sector

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EXISTING CONDITIONS – HALEKULANI BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, Oʻahu, Hawaiʻi

Figure 4-5 Existing conditions – Halekulani Beach sector

4.2 Purpose and Need for the Proposed Action

The Halekulani 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 San Souci (Kaimana) Beach). Walkways on top of the seawalls fronting the Halekulani and Sheraton Waikīkī hotels provide lateral access along the shoreline. The walkways are very narrow and are not ADA-accessible. The seawalls 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. Perpendicular access to the shoreline is limited due to the density of development in the backshore area. The only perpendicular access is a narrow walkway between the Halekulani and Sheraton Waikīkī hotels, extending from Kalia Road to the small pocket beaches between the hotels. There are no lifeguard towers in the Halekulani Beach sector.

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 the past half century. There has historically been a limited amount of stable dry beach in the Halekulani Beach sector since the 1970's, with the exception of a 400-foot-long stretch of 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 Halekulani Channel, and two small pocket beaches at the head of the channel between the Halekulani and Sheraton Waikīkī hotels. The location of the hotels immediately adjacent to the shoreline severely limits lateral shoreline access throughout the Halekulani Beach sector. Access past the Halekulani Hotel is available via a twisty, 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 Halekulani and Sheraton Waikīkī hotels. Lateral access is accomplished by walking around the back of the beach which, given its low elevation, is often submerged during high tide and high surf events. A narrow walkway on the top of the seawall fronting the Sheraton Waikīkī Hotel, which had provided a small measure of wave-splashed lateral access, has been closed for over three years due to hazardous conditions, forcing people to walk through the hotel grounds. Photographs of existing issues and problems in the Halekulani Beach sector are shown in Figure 4-6.

The Waikīkī Beach Community Advisory Committee (WBCAC) determined that the primary issues and problems in the Halekulani 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 WBCAC determined that the highest priorities for the Halekulani Beach sector are to:

- Maintain or improve mixed recreational uses (swimming, surfing, bathing)
- Maintain or improve water quality
- Preserve submarine groundwater discharge at Halekulani Channel (Kawehewehe)
- Preserve and protect surf sites (Populars, Threes, Fours)

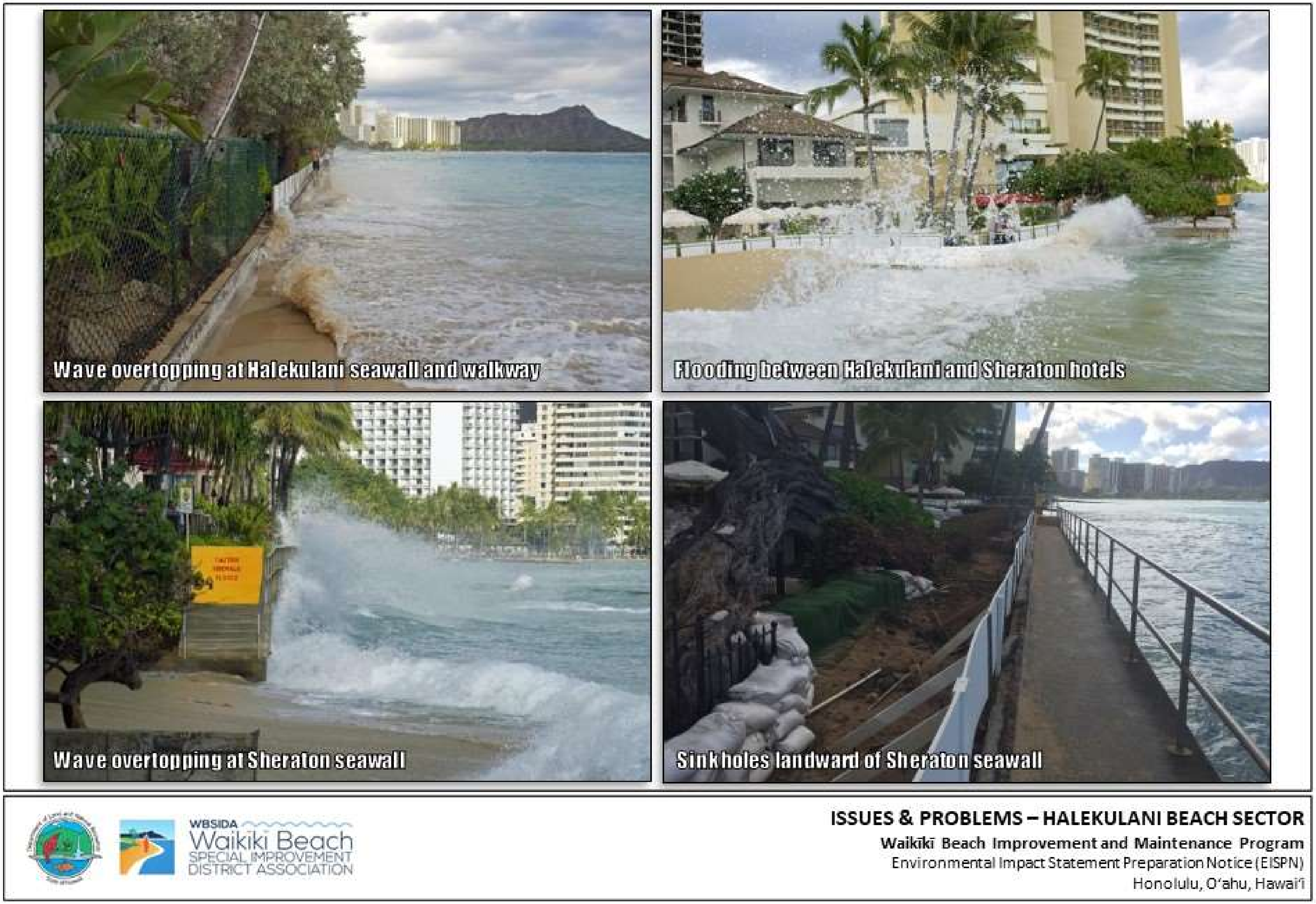


Figure 4-6 Issues and problems – Halekulani Beach sector

4.3 Conceptual Design

The proposed action for the Halekulani Beach sector is to construct a new beach 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 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 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 a stable arc-shaped beach between adjacent groins.

The project layout and conceptual rendering for the proposed action for the Halekulani Beach sector are shown in Figure 4-7 and Figure 4-8, respectively. The project would consist of construction of three new sloping rock rubblemound T-head groins, and modification of the existing Fort DeRussy outfall groin and the recently replaced Royal Hawaiian groin to create four stable beach cells. The T-head groins and beach fill would produce a wide, stable beach in an area that has previously had limited beach resources. plan would require approximately 60,000 cubic yards of sand fill and would create approximately 3.8 acres of new dry beach area.

> *T-head groins are an effective approach to restore and maintain a stable beach and provide safe lateral shoreline access in the Halekulani Beach sector.*

The groins would be designed for an initial +8.5-foot beach crest elevation (existing Waikīkī beaches are about +7 feet) to account for 1.5 feet of sea level rise, with the ability to increase the beach crest elevation to +10 feet to account for additional sea level rise. The groin stem length (distance seaward from the shoreline) would be up to about 200 feet and would also be sufficient to stabilize up to a +10-foot beach elevation. The minimum beach crest width at its narrowest point midway between the groins would be about 20 to 30 feet, and the beach slope would be 1:8 (vertical to horizontal). The Halekulani Channel would remain unobstructed for beach catamaran navigation. The groin stem crests could be wide enough, say about 10 feet, to allow construction equipment access to the groin heads should it be necessary to raise the groin elevation in the future, and the cap could provide a pedestrian walkway along the groin stems.

An optional component of the design is the addition of a beach walkway to provide ADA-accessible lateral shoreline access between the Royal Hawaiian Beach and Fort DeRussy Beach sectors. The beach walkway would connect to the existing walkway that runs from Hilton Hawaiian Village past the Fort DeRussy Army Museum, providing continuous lateral shoreline access for approximately 4,500 feet (0.85 miles). The beach walkway could include turnouts to allow users to stop while not affecting pedestrian traffic. Should an event cause dramatic erosion to the beach, the beach walkway would still be available for lateral access. The beach walkway would be wide enough to be compliant with ADA requirements. Construction options for the optional beach walkway will be further evaluated and discussed in the Draft Environmental Impact Statement (DEIS).

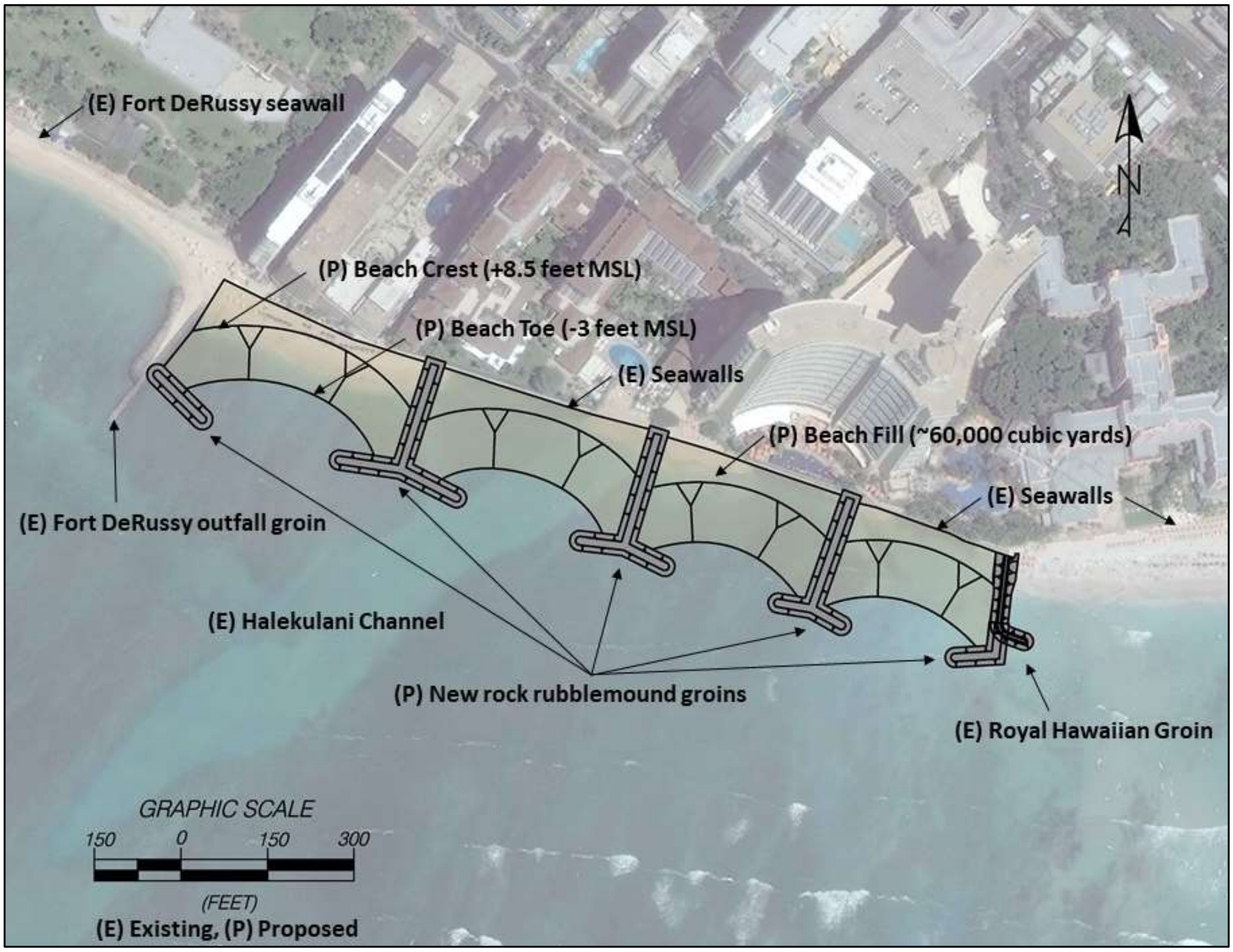


Figure 4-7 Proposed project layout - Halekulani Beach sector

CONCEPTUAL RENDERING OF PROPOSED ACTION – HALEKULANI BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, O'ahu, Hawai'i

Figure 4-8 Conceptual rendering of proposed action – Halekulani Beach sector

4.4 Construction Methodology

Access to the shoreline in the Halekulani Beach sector is limited, especially during periods of high tide and high surf. 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. 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 considered, but access is limited by the shallow water depths in the nearshore.

It is proposed to construct a temporary construction access road across Fort DeRussy from Kalia Road to the beach, and then to construct a temporary rock rubblemound construction access berm along the shoreline from Fort DeRussy to the Royal Hawaiian groin. Groin construction would proceed from the Royal Hawaiian groin and progress from east to west. Sand fill would be placed following completion of the groins, moving west to east with the new beach serving as access for sequential placement of sand fill.

4.5 Alternatives to the Proposed Action

The following alternatives were considered and will be discussed in further detail in the Draft Environmental Impact Statement (DEIS):

- No Action
- Deferred Action
- Repair of Modification of Existing Structures
- Replacement of Existing Structures
- Removal of Existing Structures
- Revetment (with or without beach walkway)
- Beach Maintenance
- Beach Nourishment (with or without stabilizing structures)

5. PROPOSED ACTION: ROYAL HAWAIIAN BEACH SECTOR

5.1 General Description

The Royal Hawaiian Beach sector spans approximately 1,730 feet of shoreline extending from the Royal Hawaiian groin east to the ‘Ewa (west) groin at Kūhiō Beach Park. Prominent features in this sector include the Royal Hawaiian Hotel, Outrigger Waikīkī, Westin Moana Surfrider, Honolulu Police Department substation, and the Duke Kahanamoku statue. An overview map of the Royal Hawaiian Beach sector is shown in Figure 5-1.

History

In the early 1900’s, Royal Hawaiian Beach was relatively narrow, and portions of the beach were submerged at high tide. Following construction of the Royal Hawaiian Groin in 1927, the beach began to widen. In 1971, the vegetation line began shifting landward and the beach has been chronically eroding since 1985 (Miller & Fletcher, 2003). Extensive seawall construction occurred in the early 1900s and the Royal Hawaiian Groin was built in 1927 to stabilize the beach. The history of coastal engineering in the Royal Hawaiian Beach sector is summarized in Figure 5-2. Historical photographs of the Royal Hawaiian Beach sector are shown in Figure 5-3. Aerial photographs comparing the existing shoreline conditions at the Royal Hawaiian Beach sector in 1949 and 2015 are shown in Figure 5-4.

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 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. In the early 1900’s, seawalls were constructed along nearly the entire length of the shoreline landward of the beach, and most of the walls remain in place today.

Royal Hawaiian Beach provides lateral shoreline access along the entire sector. Perpendicular access to the shoreline is limited due to the density of development in the backshore. Perpendicular shoreline access is available from Kalakaua Avenue at two locations: one between the Royal Hawaiian and Outrigger hotels, and one between the Moana Surfrider and the Honolulu Police Department substation. Public access is much more open 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.

Photographs of existing conditions in the Royal Hawaiian Beach sector are shown in Figure 5-5.

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 feet/year (UHCGG, 2019). The accretion is likely attributable to the addition of beach sand due to previous beach restoration efforts. Miller et al. (2003) found that sediment transport is predominantly in a northwesterly direction and that a rip current in the eastern 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 Royal Hawaiian Beach using the UHCGG shoreline positions from 1985 to 2005. The year 1985 was chosen as the initial year since no significant non-natural alterations of the beach had occurred since then. From 1985 to 2005, the dominant trend was shoreline erosion at rates of 1 foot to nearly 3 feet per year. The highest recession rates were found in front of the Diamond Head Tower of the Moana Surfrider and in front of the east wing of the Royal Hawaiian Hotel. The exception to this trend is found at the three transects adjacent to the Royal Hawaiian groin, which show accretion of up to 1.5 feet/year. Thus, it appears likely that some of the eroding sand has been moved west and is held by the groin, which is consistent with findings by Miller et al. (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 feet (26.6 meters) by 2050 and up to 216.2 feet (65.9 meters) by 2100 (UHCGG, 2019). These projections 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 or the compounding effects of erosion and increasing coastal flooding.

Without beach improvements and 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 tide and high surf events. Loss of the recreational dry beach and lateral shoreline access in the vicinity of the Moana Hotel could occur in the next several decades as waves currently overtop the seawalls in this area during extreme high tide 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 (planned for 2021)

Waikīkī Beach Maintenance I (completed May 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 Queens and Canoes 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. The average rate of sand recovery was approximately 500 cubic yards per day. The sand discharge pipeline was an 8-inch high-density polyethylene (HDPE) pipe with a total length of 3,200 feet. Sand was pumped into a dewatering basin that was constructed in the Diamond Head basin of Kūhiō Beach Park. The dewatering basin measured approximately 100 feet wide and 400 feet long. Sand was pushed into large piles with an excavator and bulldozer and then transported to the sand placement area on Waikīkī Beach. The project widened the beach by an average of 37 feet, which aligned with the position of the shoreline in 1985. 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 steady erosion and beach recession of the east and west ends of the Royal Hawaiian Beach sector, with beach recession of approximately 4.5 feet per year at the east end of the sector 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 ‘Ewa groin of Kūhiō Beach Park. 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 fill material (dirt) inshore of the foundation.

Kūhiō Sandbag Groin (completed November 2019)

In 2019, the DLNR developed a plan to stabilize the east end of Royal Hawaiian Beach adjacent to the ‘Ewa groin of Kūhiō Beach Park and to help ensure that the Waikīkī Tavern concrete foundation remnants remain covered. The sandbag groin was placed 140 feet west of the existing ‘Ewa groin of Kūhiō Beach Park. The designed 95-foot 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 feet on the inshore end to address additional beach erosion between final design and beginning of construction.

The Kūhiō Sandbag Groin was completed in November 2019. The groin consists of 83 ElcoRock containers to construct and 275 cy of sand to fill the containers. Each sand container held 2.5 cubic meters of sand and weighed over 10,000 lbs when full. The non-woven geotextile fabric is UV and vandal 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.

Royal Hawaiian Groin Replacement (completed November 2020)
The most recent beach improvement project in the Royal Hawaiian Beach sector was the replacement of the Royal Hawaiian Groin, which was completed in August 2020. The original Royal Hawaiian groin was in an extremely deteriorated condition. Its failure could have destabilized 1,730 feet 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 maintain the beach so that it could provide its intended recreational and aesthetic benefits, facilitate lateral access along the shoreline, and provide a first line of defense to the backshore in the event of storm wave attack. 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 crest cap. The new groin extends 125 feet from the seawall fronting the Sheraton Waikīkī Hotel, and then angles to the southeast to create a 50-foot-long L-head, for a total crest length of 175 feet. 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-foot wide by 3.5-foot-thick concrete crest cap 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 crest cap elevation is +9 feet msl for its first 40 feet, then transitions down to +6 feet on a 1V:8H slope, then remains at +6 feet for the remainder of its length. The stone crest elevation is +7 feet for the first 40 feet and then transitions down to +4 feet for the remainder of the groin length.

The existing concrete block groin was reduced in elevation to a maximum elevation of +4 to +1 feet to facilitate construction of the new groin. Approximately 40 linear feet of the original groin, beginning at about 120 feet 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.

Waikīkī Beach Maintenance II (planned for 2021)
The permits for the 2012 Waikīkī Beach Maintenance I project authorized a second nourishment effort to be performed within 10 years. The project planned to begin in January 2021. The project will consist of recovery of approximately 20,000 cy of sand from the same offshore sand deposit that was used in the 2012 project. Sand will be pumped into a dewatering basin in the Diamond Head basin of Kūhiō Beach Park. The dewatering basin will be approximately 100 feet wide and 300 feet long. Sand will be pushed into large piles with an excavator and bulldozer and then transported to the sand placement area on Waikīkī Beach.

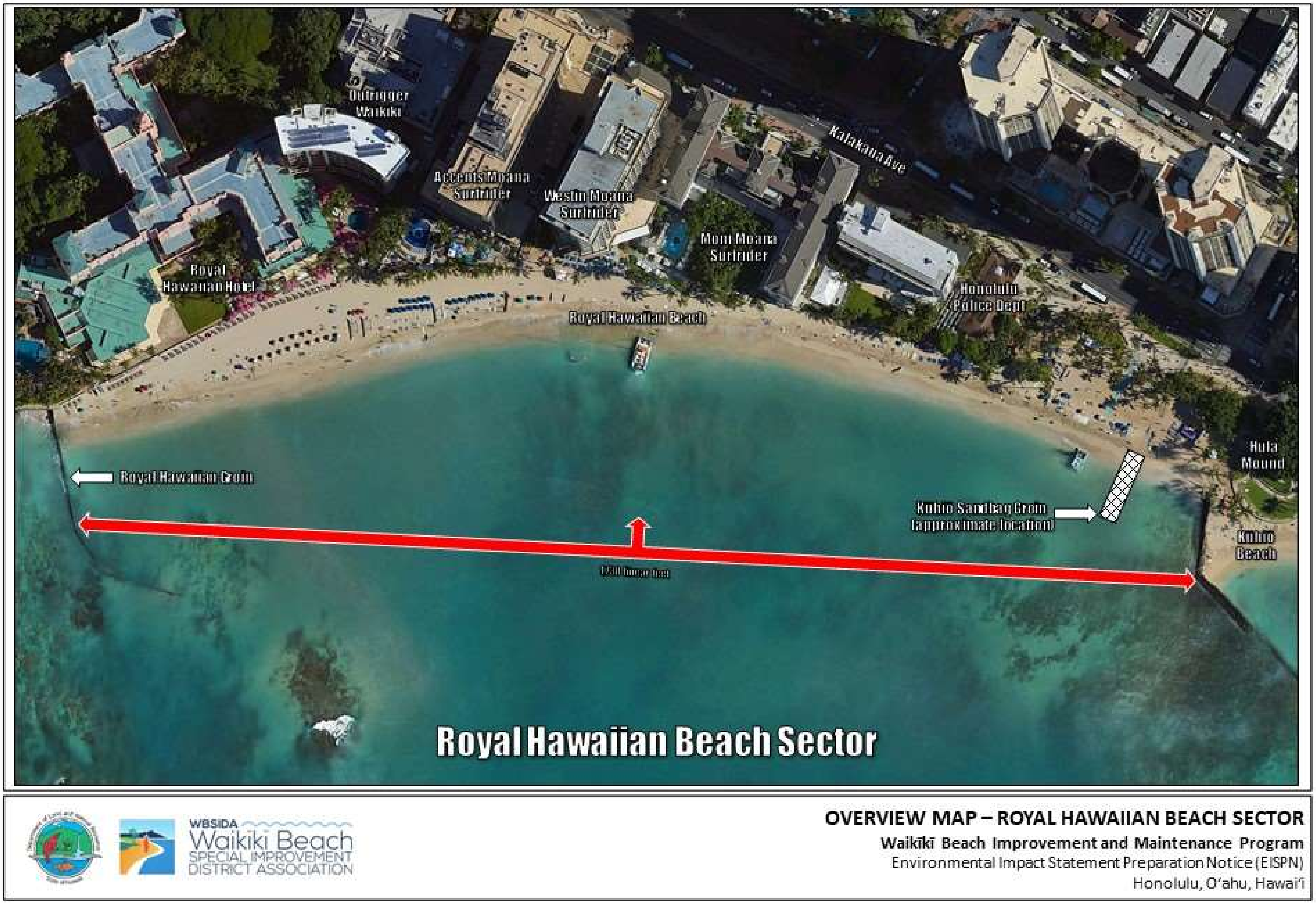
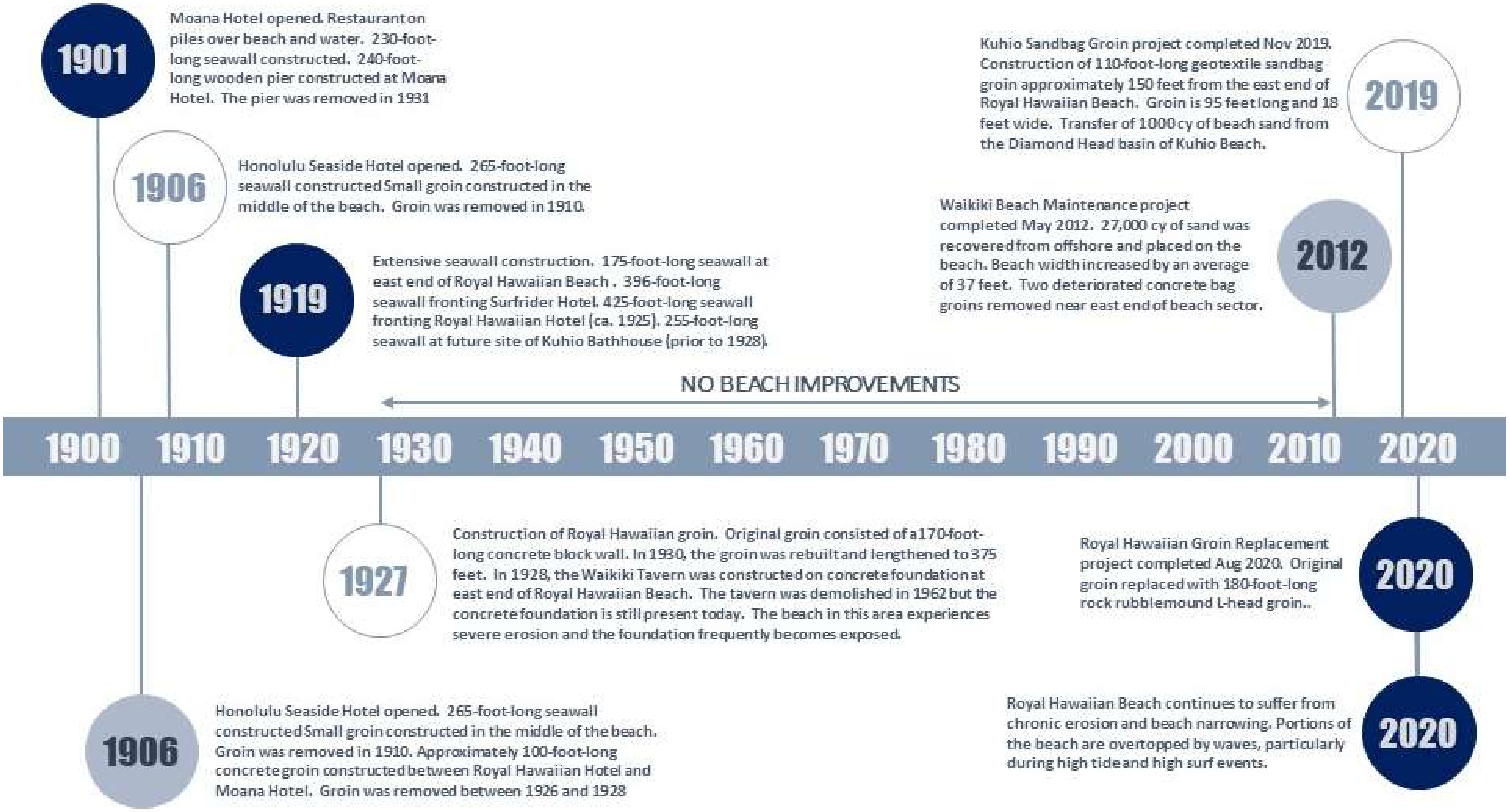


Figure 5-1 Overview map – Royal Hawaiian Beach sector



Moana Hotel opened. Restaurant on piles over beach and water. 230-foot-long seawall constructed. 240-foot-long wooden pier constructed at Moana Hotel. The pier was removed in 1931

Honolulu Seaside Hotel opened. 265-foot-long seawall constructed Small groin constructed in the middle of the beach. Groin was removed in 1910.

Extensive seawall construction. 175-foot-long seawall at east end of Royal Hawaiian Beach . 396-foot-long seawall fronting Surfrider Hotel. 425-foot-long seawall fronting Royal Hawaiian Hotel (ca. 1925). 255-foot-long seawall at future site of Kuhio Bathhouse (prior to 1928).

Kuhio Sandbag Groin project completed Nov 2019. Construction of 110-foot-long geotextile sandbag groin approximately 150 feet from the east end of Royal Hawaiian Beach. Groin is 95 feet long and 18 feet wide. Transfer of 1000 cy of beach sand from the Diamond Head basin of Kuhio Beach.

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

Construction of Royal Hawaiian groin. Original groin consisted of a 170-foot-long concrete block wall. In 1930, the groin was rebuilt and lengthened to 375 feet. In 1928, the Waikiki Tavern was constructed on concrete foundation at east end of Royal Hawaiian Beach. The tavern was demolished in 1962 but the concrete foundation is still present today. The beach in this area experiences severe erosion and the foundation frequently becomes exposed.

Royal Hawaiian Groin Replacement project completed Aug 2020. Original groin replaced with 180-foot-long rock rubblemound L-head groin..

Honolulu Seaside Hotel opened. 265-foot-long seawall constructed Small groin constructed in the middle of the beach. Groin was removed in 1910. Approximately 100-foot-long concrete groin constructed between Royal Hawaiian Hotel and Moana Hotel. Groin was removed between 1926 and 1928

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.

Compiled from Department of Public Works (1931, 1951), Crane (1972), 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 – Royal Hawaiian Beach Sector

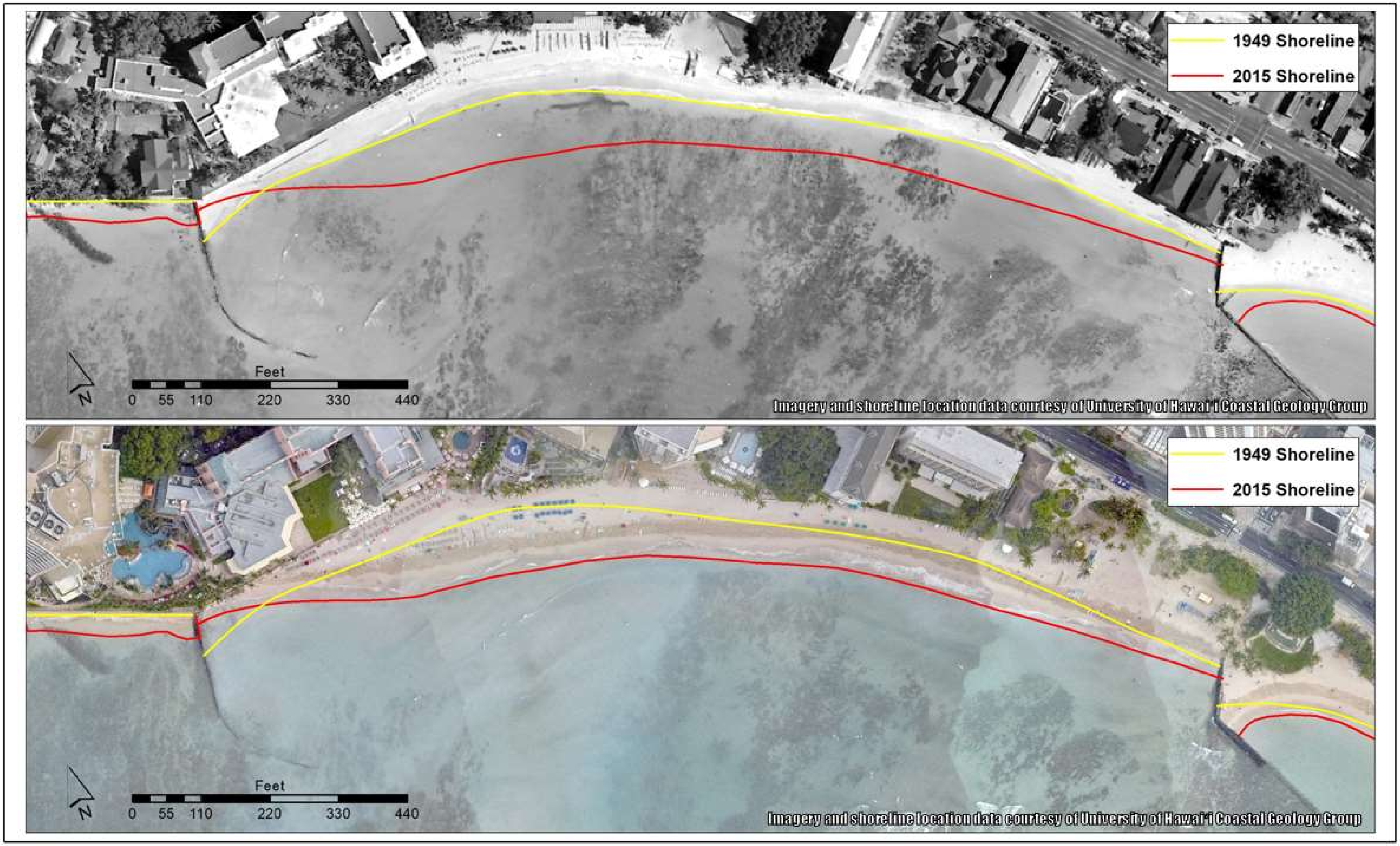
HISTORICAL PHOTOGRAPHS – ROYAL HAWAIIAN BEACH SECTOR

Waikīkī Beach Improvement and Maintenance Program

Environmental Impact Statement Preparation Notice (EISPN)

Honolulu, Oʻahu, Hawaiʻi

Figure 5-3 Historical photographs – Royal Hawaiian Beach Sector



Imagery and shoreline location data courtesy of University of Hawai'i Coastal Geology Group

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HISTORICAL SHORELINE POSITIONS – ROYAL HAWAIIAN BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
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Figure 5-4 Comparison of historical shorelines – Royal Hawaiian Beach sector

Figure 5-5 Existing conditions – Royal Hawaiian Beach sector

5.2 Purpose and Need for the Proposed Action

Royal Hawaiian Beach is the most popular beach in Waikīkī. The beach is heavily used for numerous water recreation activities, so the use of structures is less desirable. Erosion and beach narrowing have reduced the amount of dry beach available, which negatively impacts the recreational value and aesthetic quality of the beach.

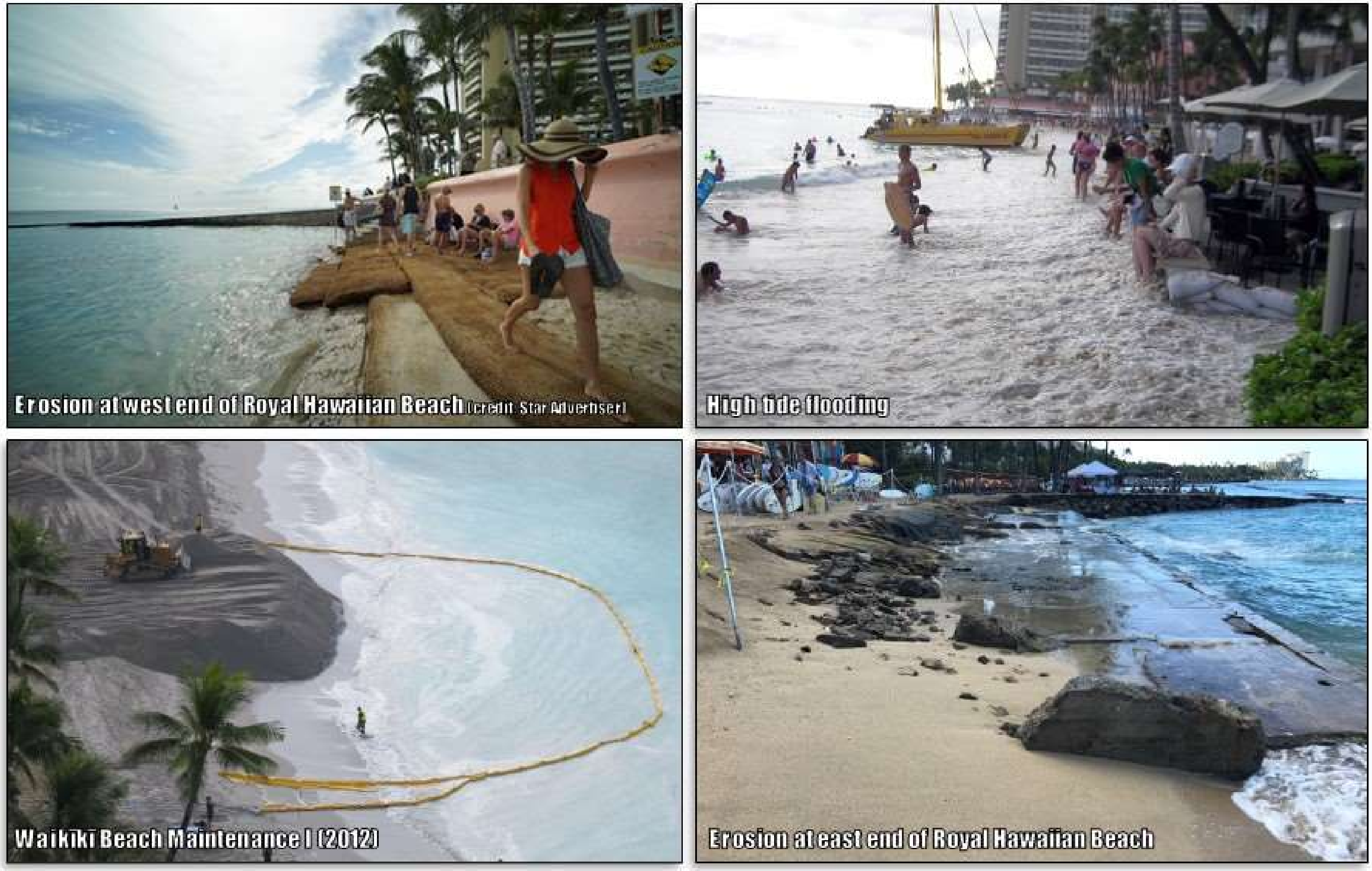
The State of Hawai‘i recognizes that, given the chronic nature of the erosion, there is a need to develop a strategy for using offshore sand so support periodic beach nourishment. This involves identification, mapping, and analysis of offshore sand deposits, and recovery of this sand and its placement on the beach. This “recycling” strategy provides an efficient method of maintaining a recreational beach as well as mitigating some of the environmental effects of sand imported to the Waikīkī ecosystem over the past century. Wave-induced currents predominate inside the breaker zone, generating both 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 contributes to beach narrowing. This sand can be periodically recovered and recycled back to the beach. Photographs of existing issues and problems in the Royal Hawaiian Beach sector are shown in Figure 5-6.

The Waikīkī Beach Community Advisory Committee (WBCAC) 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 end of the beach sector
- Overcrowding and beach use conflicts

The WBCAC determined that the objectives for 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



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ISSUES & PROBLEMS – ROYAL HAWAIIAN BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, Oʻahu, Hawaiʻi

Figure 5-6 Issues and problems – Royal Hawaiian Beach sector

5.3 Conceptual Design

The proposed action for the Royal Hawaiian Beach sector is to conduct periodic beach nourishment 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 1982 shoreline was further seaward than the 1985 shoreline and was initially proposed as the widening limit; however, the 1982 shoreline was based on an aerial image that was taken just three months after Hurricane Iwa struck the island and the Department of the Army determined that that it was not representative of the "natural" shoreline location.

The proposed action would involve recovering sand from deposits located directly offshore and placing it on the beach. The current beach crest is approximately +7 feet MSL. The proposed action would increase the beach crest elevation to +8.5 feet MSL to provide greater resilience against wave overtopping and flooding. Based on a beach survey conducted in August 2019, an estimated 30,000 cubic yards of sand would be required to widen the beach to the historical 1985 and 2012 nourishment position and increase the beach crest elevation by 1.5 feet. A structural engineering analysis will be required to determine if existing structures (e.g., seawalls, fence walls, lanais) would need to be modified or replaced to accommodate the increased beach crest elevation. The project layout and a conceptual rendering of the proposed action are shown in Figure 5-7 and Figure 5-8, respectively.

> *Beach nourishment is a cost-effective approach to maintain a stable beach and provide safe lateral shoreline access in the Royal Hawaiian Beach sector.*

Assuming the historical average rates of erosion and shoreline recession continue, it is estimated that beach nourishment would be required approximately every 8 to 10 years. However, as sea levels continue to rise, the amount of wave energy reaching the shoreline will increase and the rate of erosion and shoreline recession is likely to accelerate, in which case more frequent beach nourishment and/or small-scale beach maintenance may be required to maintain a stable dry beach in this sector.

5.4 Construction Methodology

The construction methodology is expected to be similar to that of the 2012 Waikīkī Beach Maintenance I project, during which sand was recovered from a deposit located directly offshore near the Canoes and Queens surf sites. Sand would be dredged using a submersible pump mounted on a crane barge. The recovered sand would be pumped to shore through a bottom-mounted12-inch diameter high-density polyethylene (HDPE) pipeline. The sand/water slurry would be pumped into a dewatering basin constructed in the Diamond Head basin of Kūhiō Beach Park. The sand would be stockpiled and placed into dump trucks and transported along the beach where bulldozers would level the sand to achieve the design profiles. Alternative sand transportation methods are being investigated and will be discussed in further detail in the Draft Environmental Impact Statement (DEIS).

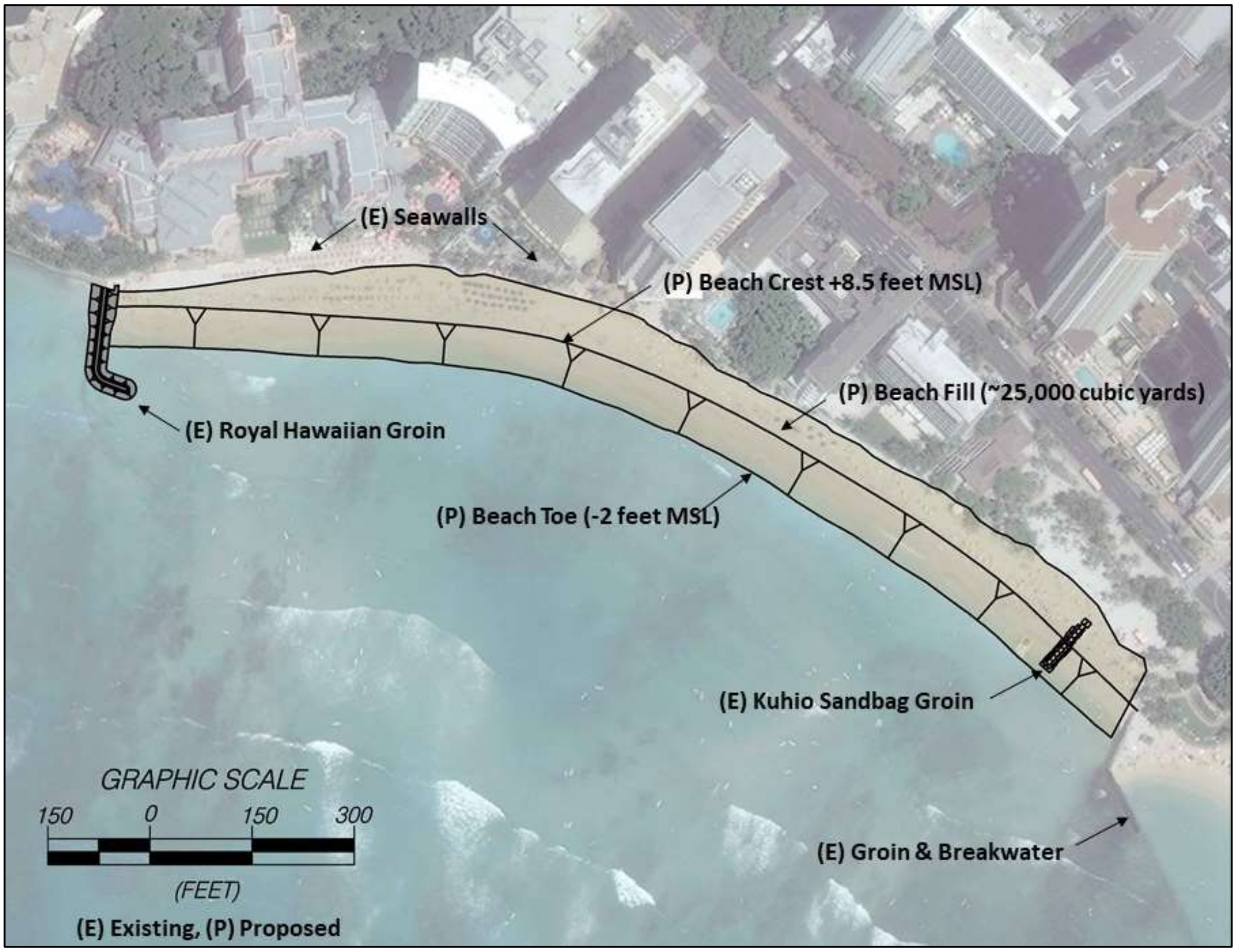

Figure 5-7 Royal Hawaiian beach sector project layout

5.5 Alternatives to the Proposed Action

The following alternatives were considered and will be discussed in further detail in the Draft Environmental Impact Statement (DEIS):

- No Action
- Deferred Action
- Repair or Modification of Existing Structures
- Replacement of Existing Structures
- Removal of Existing Structures
- Beach Maintenance (e.g., sand pushing, small-scale maintenance dredging)
- Beach Nourishment (with or without stabilizing structures)

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CONCEPTUAL RENDERING OF PROPOSED ACTION – ROYAL HAWAIIAN BEACH SECTOR
Waikīkī Beach Improvement and Maintenance Program
Environmental Impact Statement Preparation Notice (EISPN)
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Figure 5-8 Conceptual rendering of proposed action – Royal Hawaiian Beach +

6. PROPOSED ACTION: KŪHIŌ BEACH SECTOR

6.1 General Description

The Kūhiō Beach sector spans approximately 1,500 feet of shoreline extending from the ʻEwa groin at Kūhiō Beach Park east to the Kapahulu storm drain. Prominent features in this sector include the Kūhiō Beach Park, the Hula Mound, and Kūhiō Promenade. The backshore area landward of Kalakaua Avenue is densely developed with shops, restaurants and resorts including the Aston Waikīkī Circle, 'Alohilani Resort, Waikīkī Beach Marriott, Aston Waikīkī Beach, and Park Shore Waikīkī. An overview map of the Kūhiō Beach sector is shown in Figure 6-1.

History

The Kūhiō Beach sector has been the subject of numerous studies and modifications attempting to produce stable beach cells. The modifications began in the 1800s with seawall construction to protect the road. One of the breakwaters (crib wall) was constructed in 1939, followed in the 1950s by construction of the Kapahulu storm drain 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 6-2. Historical photographs of the Kūhiō Beach sector are shown in Figure 6-3. Aerial photographs comparing the shoreline conditions in the Kūhiō Beach sector in 1949 and 2015 are shown in Figure 6-4.

Existing Conditions

The Kūhiō Beach sector is an entirely engineered shoreline. The west end of the sector is bounded by a rock rubblemound groin that separates the Kūhiō and Royal Hawaiian beach sectors. The central portion of the sector consists of two swim basins that are separated by a rock rubblemound groin. The east end of the sector is bounded by the Kapahulu storm drain, which separates the Kūhiō and Queen's Beach sectors. The seaward portion of the sector is bounded by a concrete breakwater (referred to as "crib walls"). The 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 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 feet long, bounded by the Kapahulu storm drain to the southeast, a rock rubblemound groin that separates the two basins, and a concrete breakwater (crib wall) along the ocean side with a crest elevation of about +3 feet MSL (referred to as "slippery wall" due to its slippery covering of algae). Narrow offset gaps at either end of the breakwater allow for ocean water to enter and exit the basin. The gaps, combined with the low elevation of the breakwater, allows wave overtopping that facilitates circulation and water exchange in the basin.

Conditions are typically shallow and calm, which makes the basin very popular for sunbathing, wading, floating and swimming. The dry beach is typically 20 to 30 feet wide at the east end, and gradually widens to about 90 feet at the west end. The Diamond Head basin is well protected from incident wave energy. The beach face is aligned approximately parallel to the incident wave crests along the breakwater. The cuspate beach shape within each basin indicates some wave influence at the beach, particularly in the ‘Ewa (west) basin. While water circulation is limited, routine water quality testing by the Hawai‘i Department of Health has not indicated water quality issues except after heavy rain events.

The ‘Ewa (west) basin is about 680 feet 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 segmented breakwater along the ocean side. There is a 220-foot-wide gap in the breakwater on the west side, 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 feet, and ranges from 40 to 80 feet on the west side. Opposite the gap in the breakwater, the dry beach is typically very narrow (10 to 20 feet).

Kūhiō Beach provides lateral shoreline access from the terminal groin at the west end of the ‘Ewa basin to the Kapahulu storm drain at the east end of the Diamond Head basin. A sidewalk along Kalakaua Avenue provides ADA-compliant lateral access landward of the shoreline along the entire beach sector. Most of Kūhiō Beach Park is backed by a concrete rubble masonry (CRM) seawall. A series of openings in the seawall, most with stairs, provide access from the sidewalk to the beach. Two City and County of Honolulu lifeguard towers are located in the Kūhiō Beach sector: one in the ‘Ewa (west) basin, and one 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 Queen’s, a popular break for visitors and beginner surfers, is located seaward of the west end of the ‘Ewa 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 basin breakwater, adjacent to the Kapahulu storm drain, is a very popular body surfing and boogie boarding site known as *The Wall*, where intrepid wave riders ride up to, onto, and sometimes over, the breakwater.

The nearshore bathymetry 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-degree 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 ‘Ewa 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 6-5.

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 feet/year (UHCGG, 2019). The erosion is more pronounced in the Diamond Head basin with the predominant direction of sediment transport being from east to west (Miller et al. 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 ‘Ewa 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 feet (10.1 meters) by 2050 and 86.6 feet (26.4 meters) 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 tide and high surf events. Without beach improvements and 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.

Beach Improvements and Maintenance

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

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 cubic yards 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.

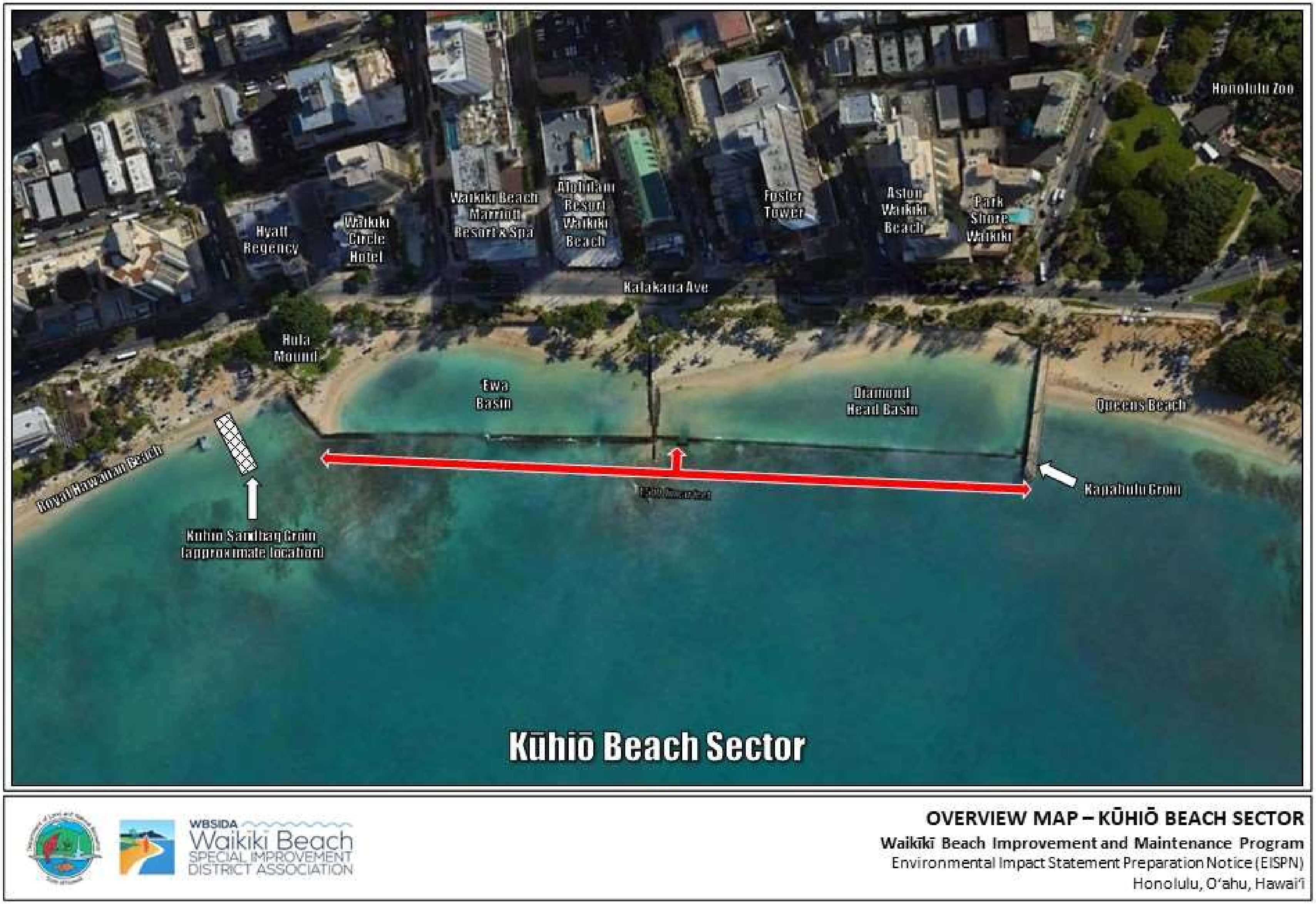
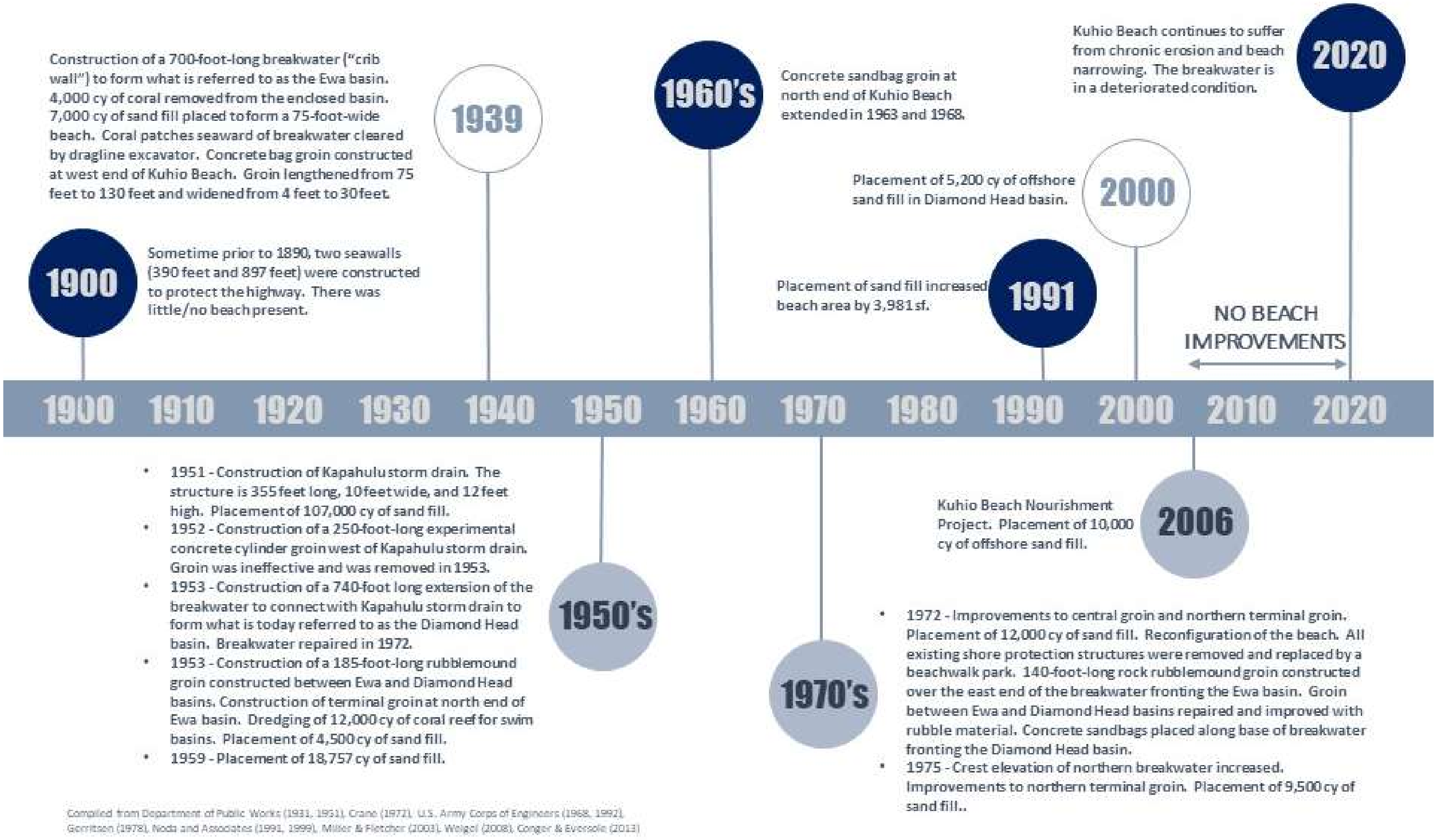


Figure 6-1 Overview map – Kūhiō Beach sector



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

Construction of a 700-foot-long breakwater ("crib wall") to form what is referred to as the Ewa basin. 4,000 cy of coral removed from the enclosed basin. 7,000 cy of sand fill placed to form a 75-foot-wide beach. Coral patches seaward of breakwater cleared by dragline excavator. Concrete bag groin constructed at west end of Kuhio Beach. Groin lengthened from 75 feet to 130 feet and widened from 4 feet to 30 feet.

- 1951 - Construction of Kapahulu storm drain. The structure is 355 feet long, 10 feet wide, and 12 feet high. Placement of 107,000 cy of sand fill.
- 1952 - Construction of a 250-foot-long experimental concrete cylinder groin west of Kapahulu storm drain. Groin was ineffective and was removed in 1953.
- 1953 - Construction of a 740-foot long extension of the breakwater to connect with Kapahulu storm drain to form what is today referred to as the Diamond Head basin. Breakwater repaired in 1972.
- 1953 - Construction of a 185-foot-long rubblemound groin constructed 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.
- 1959 - Placement of 18,757 cy of sand fill.

Concrete sandbag groin at north end of Kuhio Beach extended in 1963 and 1968.

- 1972 - Improvements to central groin and northern terminal groin. Placement of 12,000 cy of sand fill. Reconfiguration of the beach. All existing shore protection structures were removed and replaced by a beachwalk park. 140-foot-long rock rubblemound groin constructed over the east end of the breakwater fronting the Ewa basin. Groin between Ewa and Diamond Head basins repaired and improved with rubble material. Concrete sandbags placed along base of breakwater fronting the Diamond Head basin.
- 1975 - Crest elevation of northern breakwater increased. Improvements to northern terminal groin. Placement of 9,500 cy of sand fill..

Placement of sand fill increased beach area by 3,981 sf.

Placement of 5,200 cy of offshore sand fill in Diamond Head basin.

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

Kuhio Beach continues to suffer from chronic erosion and beach narrowing. The breakwater is in a deteriorated condition.

Compiled from Department of Public Works (1931, 1951), Crane (1972), 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 – Kūhiō Beach Sector

HISTORICAL PHOTOGRAPHS – KŪHIŌ BEACH SECTOR

Waikīkī Beach Improvement and Maintenance Program

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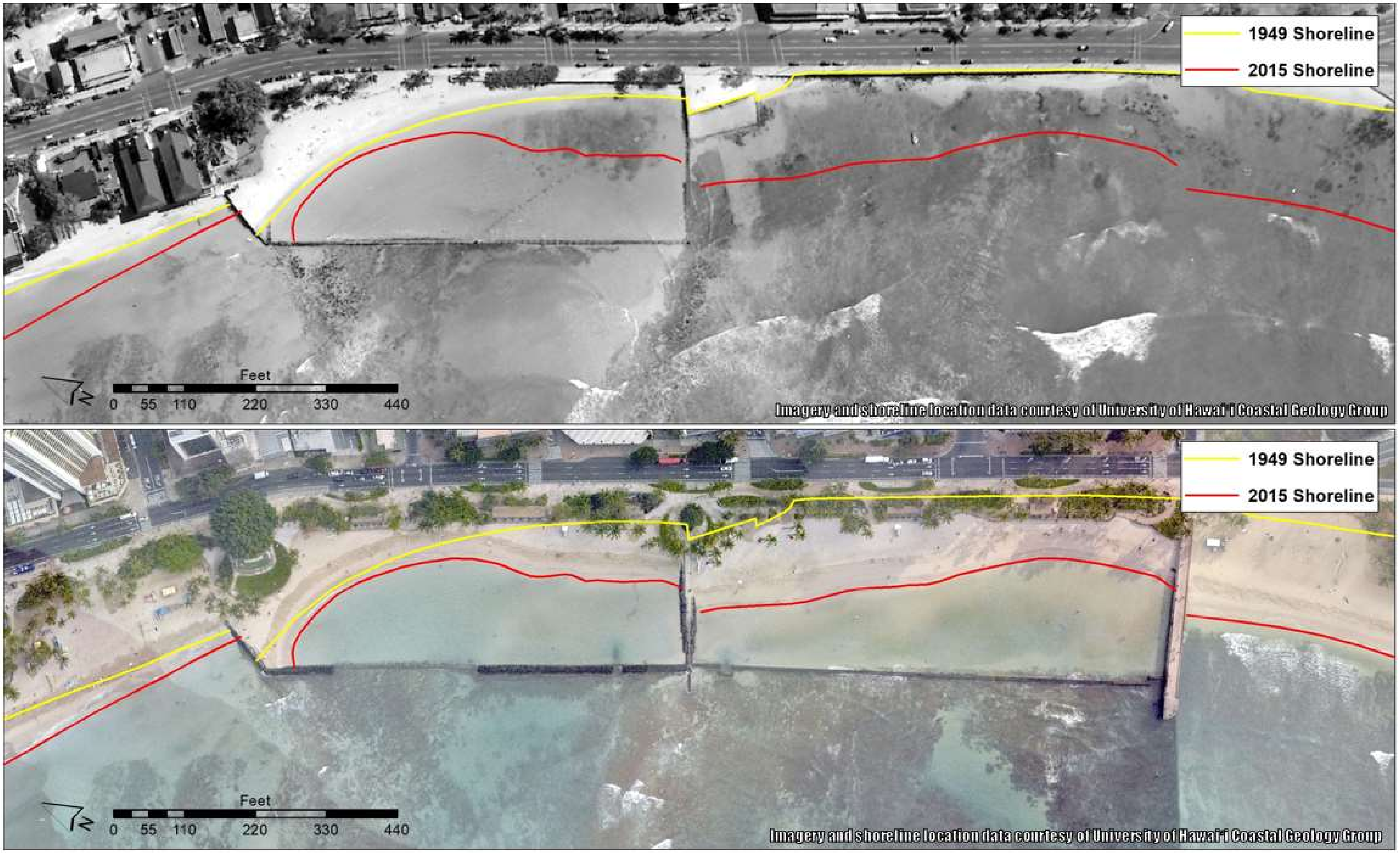
Figure 6-3 Historical photographs – Kūhiō Beach Sector



Imagery and shoreline location data courtesy of University of Hawai'i Coastal Geology Group

Imagery and shoreline location data courtesy of University of Hawai'i Coastal Geology Group

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Figure 6-4 Comparison of historical shoreline conditions – Kūhiō Beach sector

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EXISTING CONDITIONS – KŪHIŌ BEACH SECTOR

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Figure 6-5 Existing shoreline conditions – Kūhiō Beach sector

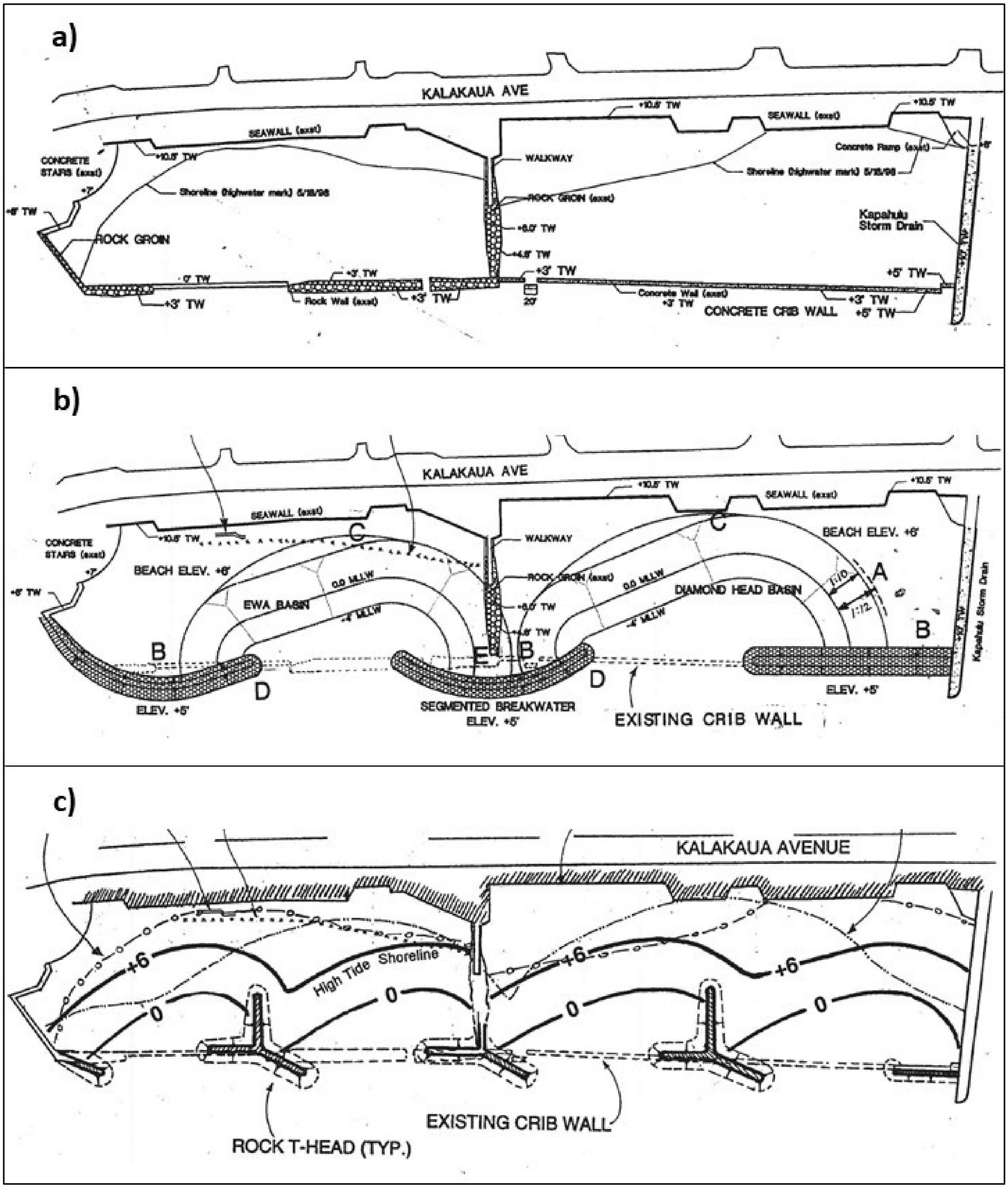

Figure 6-6 (a) existing, b) EKNA proposed (1999), and c) Bodge proposed (2000)

6.2 Purpose and Need for the Proposed Action

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 slump seaward (flatten out) in the basins, 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 was noted to rapidly diminish, beach profiles showed that the volume of sand in the basins had not decreased; rather, the sand had slumped into the basins below the water line.

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 feet 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 6-7.

The Waikīkī Beach Community Advisory Committee (WBCAC) determined that the primary issues and problems in the Kūhiō Beach sector are:

- Beach narrowing and seaward slumping of the beach
- 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 basin

The WBCAC determined that the objectives for 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 ‘Ewa 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 and esplanade
- Preserve and protect surf sites (e.g., Walls, Queens, Baby Queens, Cunha’s)

ISSUES & PROBLEMS – KŪHIŌ BEACH SECTOR

Waikīkī Beach Improvement and Maintenance Program

Environmental Impact Statement Preparation Notice (EISPN)

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Figure 6-7 Issues and problems – Kūhiō Beach sector

6.3 Conceptual Design

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 basin, and the Diamond Head basin.

6.3.1 ʻEwa Basin

The proposed action is beach nourishment and structural improvements to the ʻEwa basin, which 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 project layout for the ʻEwa basin is shown in Figure 6-8

The ʻEwa groin would be removed and reconstructed to account for sea level rise. The groin would be located slightly outside of the existing footprint to address the erosion on the ʻEwa side of the groin. The center groin would also be removed and replaced. A detached breakwater constructed between the two groins would reduce wave energy entering the basin and create diffraction patterns that would produce a less-curved beach than presently exists. By orienting the gap between the groins approximately parallel to the prevailing wave approach direction, they would function similarly to a T-head groin system to control the wave approach to the shoreline and create a stable concave beach configuration, while producing a continuous beach the full length of the basin. The west groin would be approximately 150 feet long with a crest elevation of +7.5 feet MSL. The east groin would be approximately 125 feet long and would vary in elevation from +7.5 feet MSL at the shoreline to +6 feet MSL at the head. This groin could potentially be designed to incorporate a pedestrian walkway along the crest. This option will be further investigated in the Draft Environmental Impact Statement (DEIS).

Beach nourishment and structural improvements are an effective approach to maintain a stable beach and provide safe lateral shoreline access in the Kūhiō Beach sector.

The concept design also includes a 125-foot-long detached breakwater situated in the gap between the two new groins. The breakwater would function to widen the beach in its lee. The breakwater elevation would be approximately +6 feet MSL to match the heads of the groins. The existing structures, including the ʻEwa groin and portions of the existing breakwater and submerged sill, would be modified or removed as necessary to accommodate the new structures.

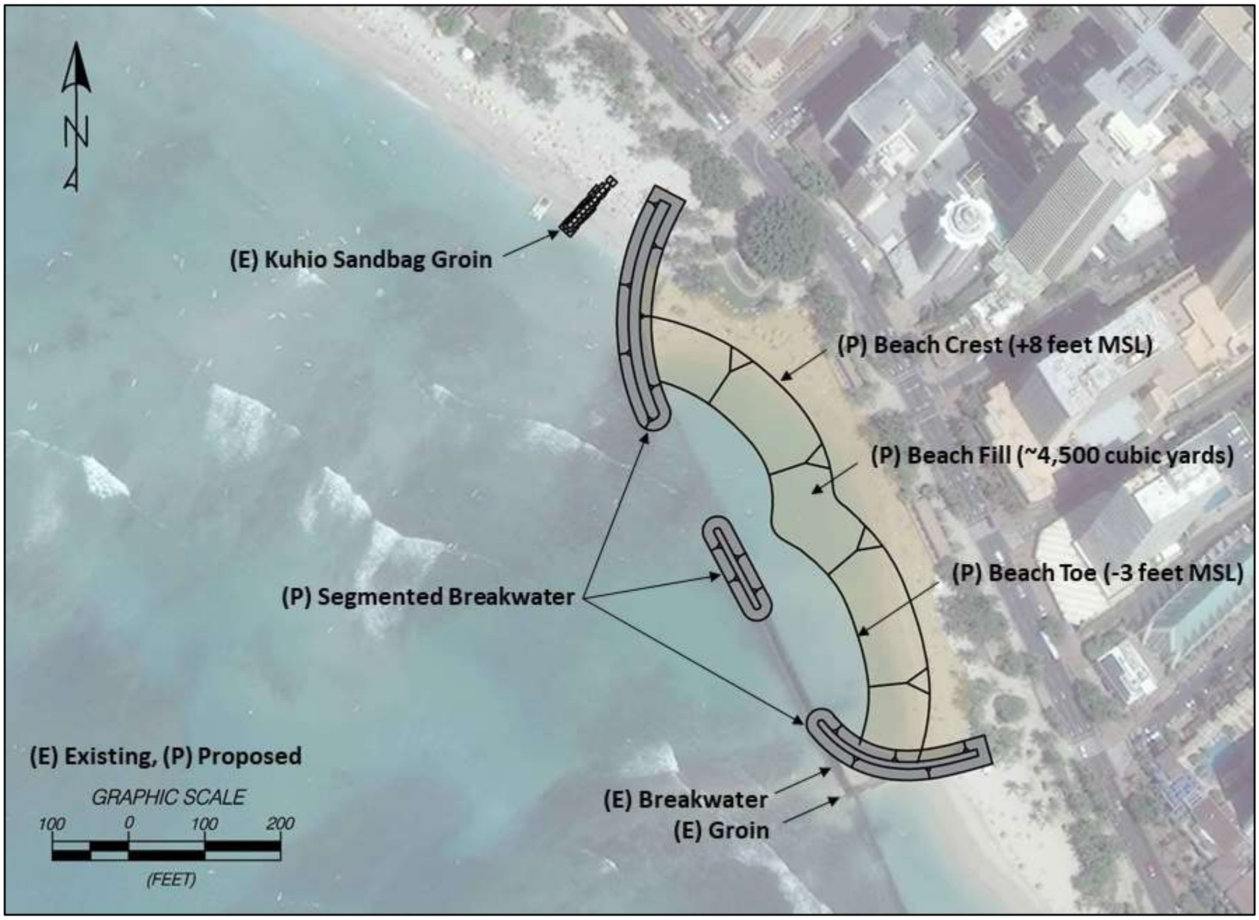


Figure 6-8 Kūhiō beach sector project layout (‘Ewa basin)

6.3.2 Diamond Head Basin

The proposed action in the Diamond Head basin would consist of beach maintenance with no modifications to the existing structures. The WBCAC determined that the Diamond Head 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 slumped into the water, with no natural means to return sand to the beach face. This slumping has resulted in a large, submerged sand deposit and a reduction in water depth. To increase dry beach width, the sand would have to be manually recovered and placed back onto the beach. The project layout is shown in Figure 6-9.

In 2018, SEI engineers conducted air jet probing and push core sampling in the Diamond Head basin. Sand thickness in some areas of the basin was measured to be greater than 8 feet (Figure 6-10). The Diamond Head (east) basin was estimated to contain approximately 4,500 cubic yards of sand seaward of the waterline. Offshore sand in the basin was found to be beige to dark grey, but the dark grey sand was shown to lighten rapidly when exposed to sunlight.

The proposed action would involve recovery of approximately 4,500 cubic yards of submerged sand from within the Diamond Head basin and placement of that sand on the beach. This would lower the depth of the basin to a uniform bottom elevation of -4 feet MSL and widen the dry beach by approximately 18 and 26 feet along the length of the basin. Because the basin is nearly enclosed, turbidity curtains would only be deployed at the offshore crib wall openings on the north and south end 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 seaward to account for the existing palm trees and lifeguard tower. The existing and design profiles are shown in Figure 6-11. A plan view of the design contours is shown in Figure 6-12. A conceptual rendering of the proposed actions is shown in Figure 6-13.

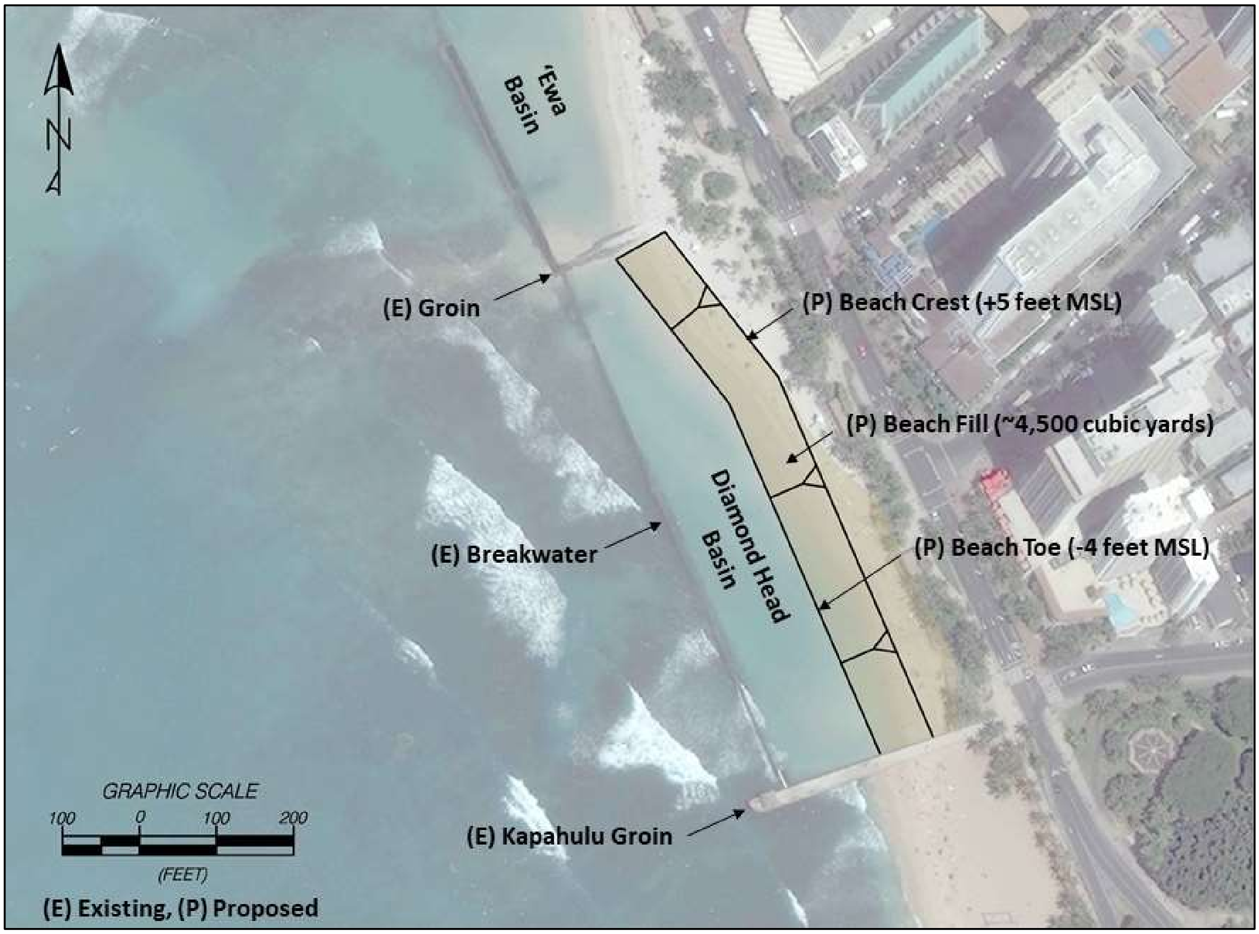


Figure 6-9 Kūhiō beach sector project layout (Diamond Head basin)

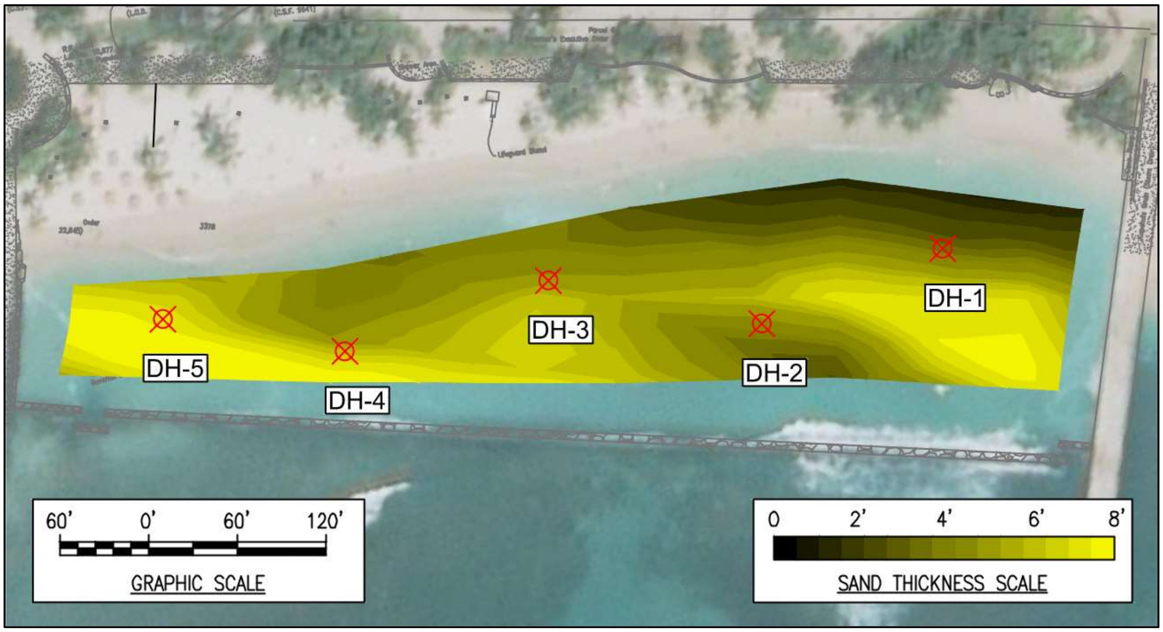


Figure 6-10 Diamond Head Basin sand thickness

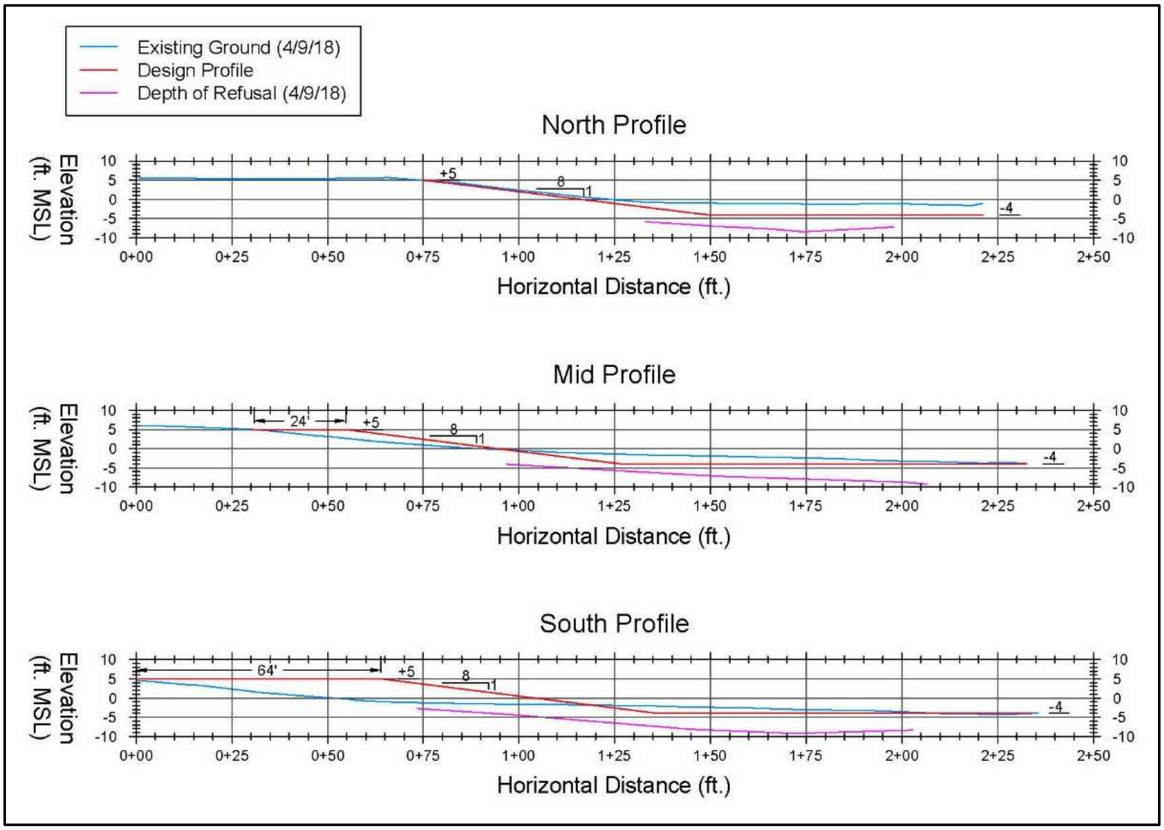


Figure 6-11 Beach nourishment profiles for Kūhiō Beach - Diamond Head Basin

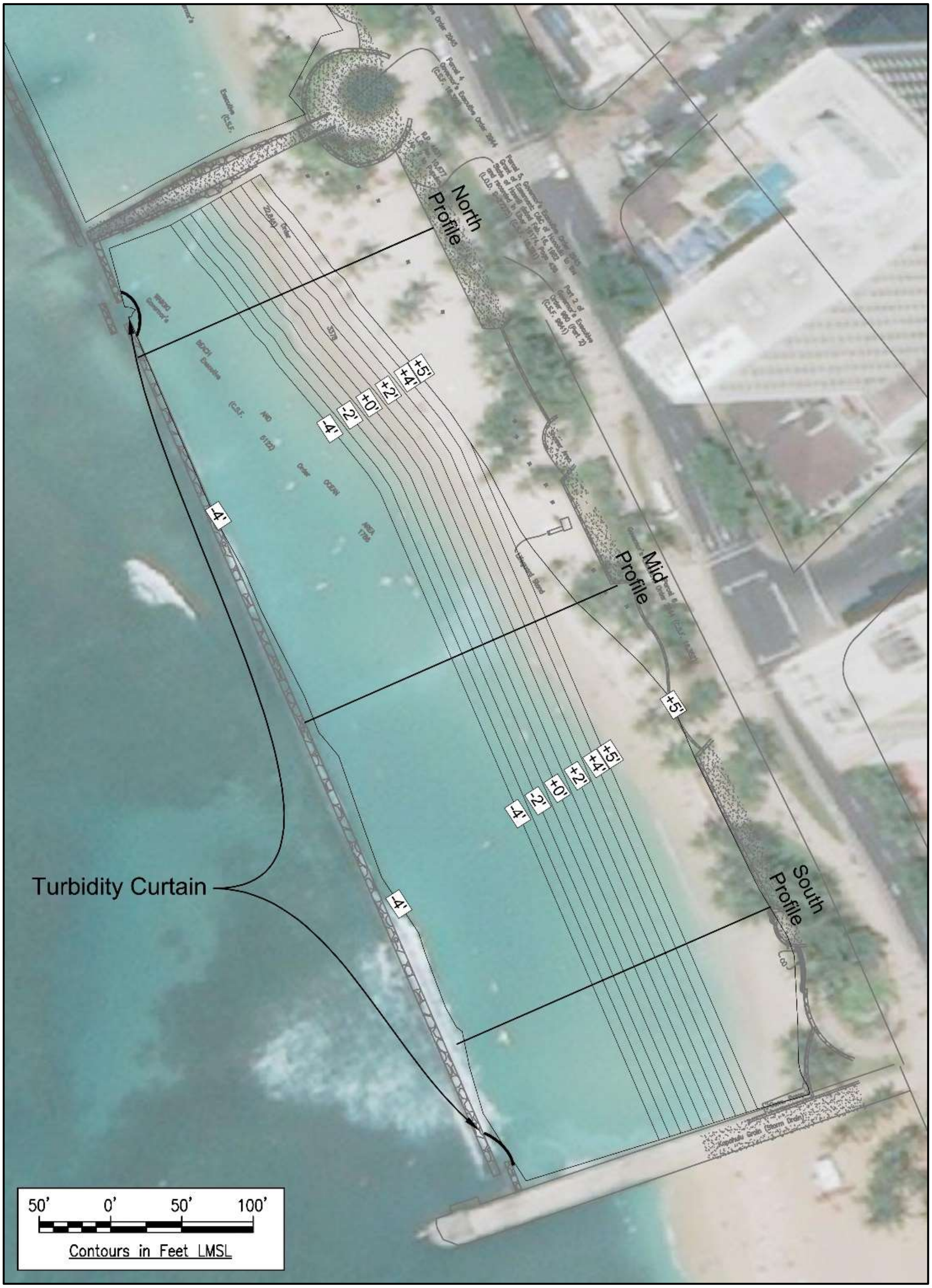
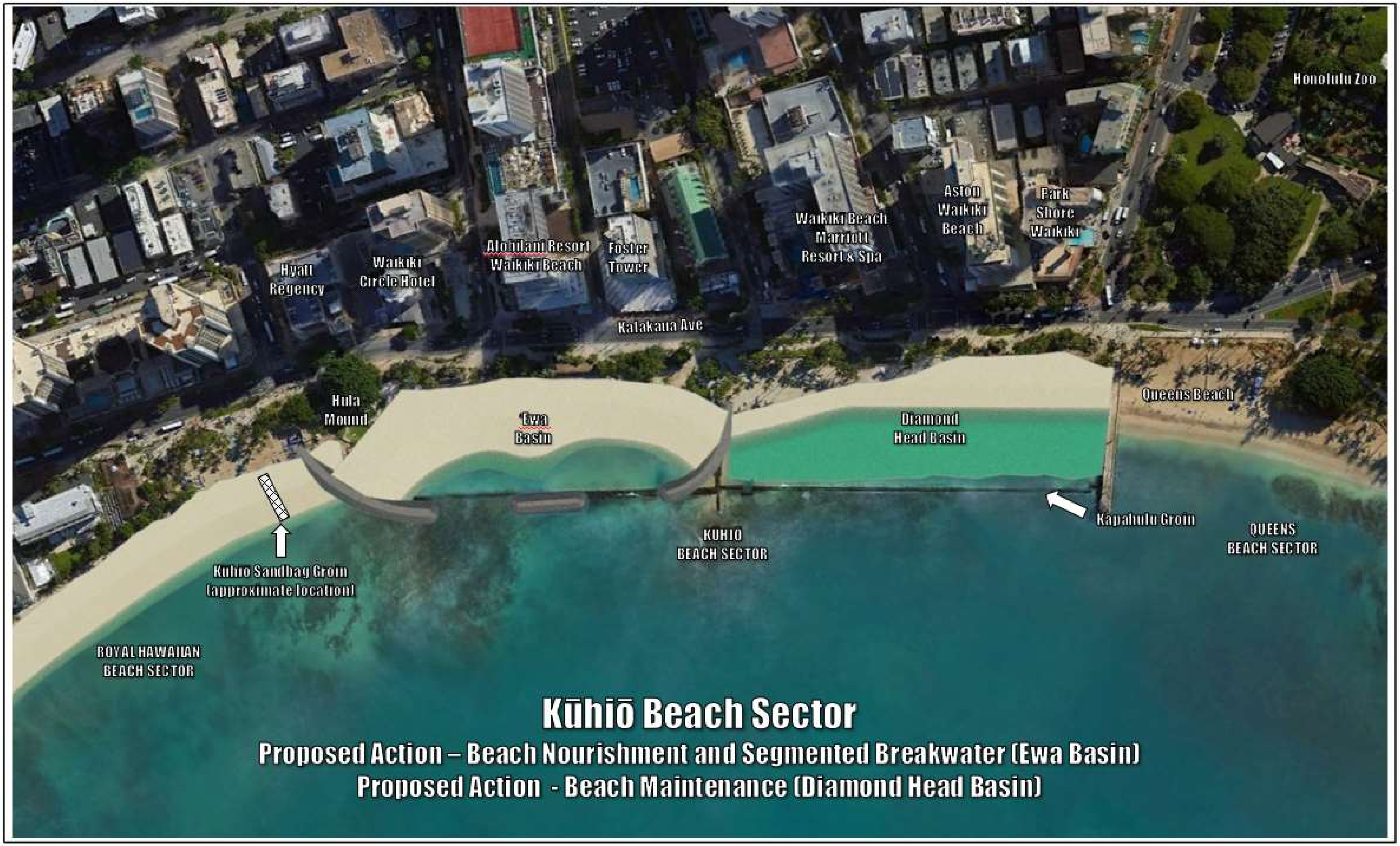


Figure 6-12 Beach nourishment contours for Kūhiō Beach - Diamond Head Basin



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, Oʻahu, Hawaiʻi

Figure 6-13 Conceptual rendering of proposed action for Kūhiō Beach sector

6.4 Construction Methodology

6.4.1 ‘Ewa Basin

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 crib walls would be removed as necessary as the excavators progressed along the groin alignment. Underlayer and possibly armor stones would be placed to form a work platform to keep the excavator out of the water. The platform would need to be extended to the detached breakwater. Armor stone would be placed beginning at the head and progressing landward, and excess material would be removed. Sand fill would be placed following completion of the structures.

6.4.2 Diamond Head Basin

Two possible methods are presented to recover sand from the Diamond Head basin: one using a long-reach excavator, and one using a diver-operated dredge.

Excavator Method
The most efficient method of sand recovery for the Diamond Head basin would be accomplished using a long-reach excavator Figure 6-14. A long-reach excavator has a longer arm than a traditional excavator, allowing it to reach further. Long-reach excavators are available for lease on island and would not require any equipment to be shipped in from outside the 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 excavated sand. A bulldozer and/or skid-steer would be required to spread the sand to the achieve the design profiles.

Figure 6-14 Long-reach excavator

Diver-Operated Dredge Method

An alternative method of sand recovery for the Diamond Head basin would be with a diver-operated dredge. 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 6-15 shows a diver-operated dredge pump manufactured by EddyPump. The diver-operated dredge pump is roughly 6 feet long, 3 feet wide, and 3 feet tall, but dimensions vary depending on the output of the pump chosen. Figure 6-16 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 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 feet, which would enable the diver to dredge sand within a 100-foot radius of the pump. 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.

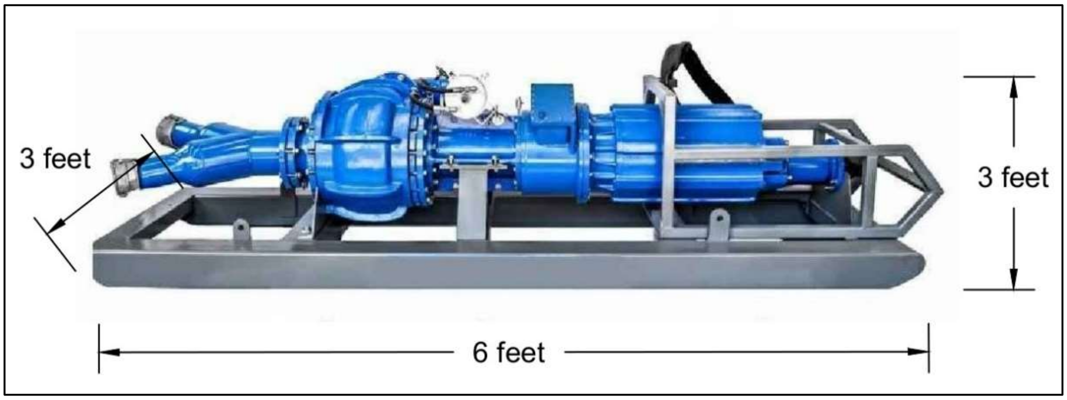


Figure 6-15 Diver-operated dredge pump

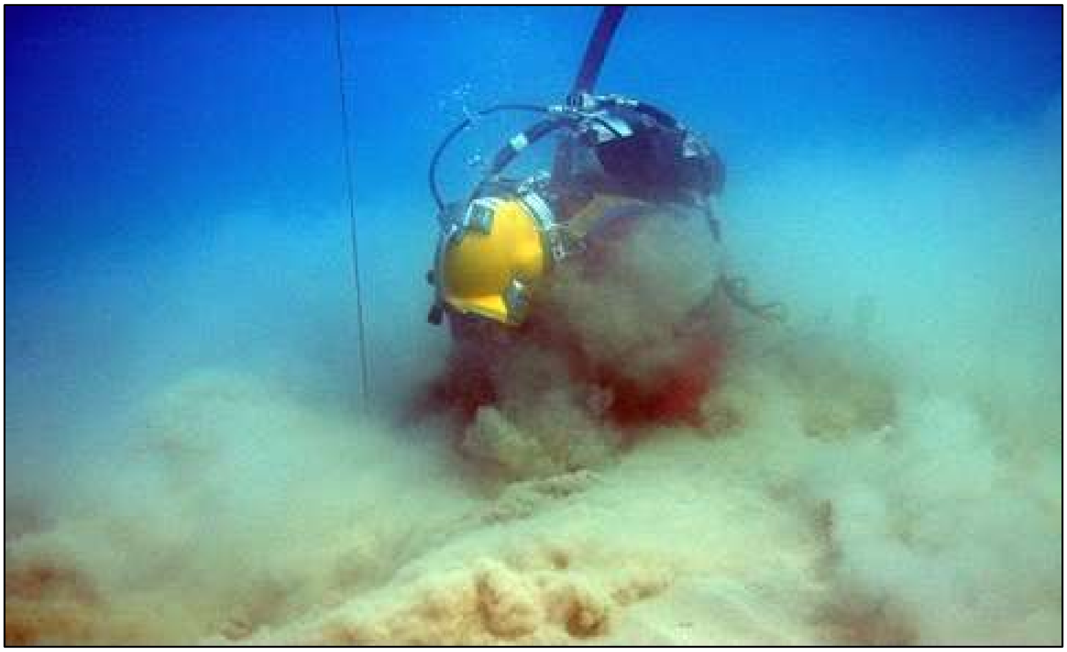


Figure 6-16 Surface supplied air diver using a diver-operated dredge

6.5 Alternatives to the Proposed Action

The following alternatives were considered and will be discussed in further detail in the Draft Environmental Impact Statement (DEIS):

- No Action
- Deferred Action
- Repair or Modification of Existing Structures
- Replacement of Existing Structures
- Removal of Existing Structures
- Beach Maintenance
- Beach Nourishment
- Other (redirect stormwater, improve water circulation, improve public safety)

7. SUMMARY OF THE EXISTING ENVIRONMENT

7.1 Land Use and Ownership

Waikīkī is a densely developed urban, commercial area, famous for its diverse water recreation activities. 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. A summary of the major landowners in the project area is shown in Table 7-1.

Table 7-1 Summary of land ownership in the project area

Beach Sector	Tax Map Key	Address	Owner
Fort DeRussy	(1) 2-6-005:001	2066 Kalia Road	United States of America
Fort DeRussy	(1) 2-6-005:006	192 Paoa Place	State of Hawaiʻi
Halekulani	(1) 2-6-004:012	2161 Kalia Road	Waikīkī Shore
Halekulani	(1) 2-6-004:010	2169 Kalia Road	ORTG ORF LLC
Halekulani	(1) 2-6-004:008	2199 Kalia Road	Halekulani Corporation
Halekulani	(1) 2-6-004:007	2199 Kalia Road	Halekulani Corporation
Halekulani	(1) 2-6-004:006	2199 Kalia Road	Halekulani Corporation
Halekulani	(1) 2-6-004:005	2199 Kalia Road	Multiple Owners
Halekulani	(1) 2-6-002:026	Undefined	Multiple Owners
Halekulani	(1) 2-6-002:026	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 Kalia Ave	City and County of Honolulu
Kūhiō	(1) 2-6-001:003	2501 Kalia 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, Hawaiʻi'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 (Hawai'i 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 "navigable waters of the United States". The relevant jurisdictional boundaries for shoreline construction in Hawai'i are shown in Figure 7-1.

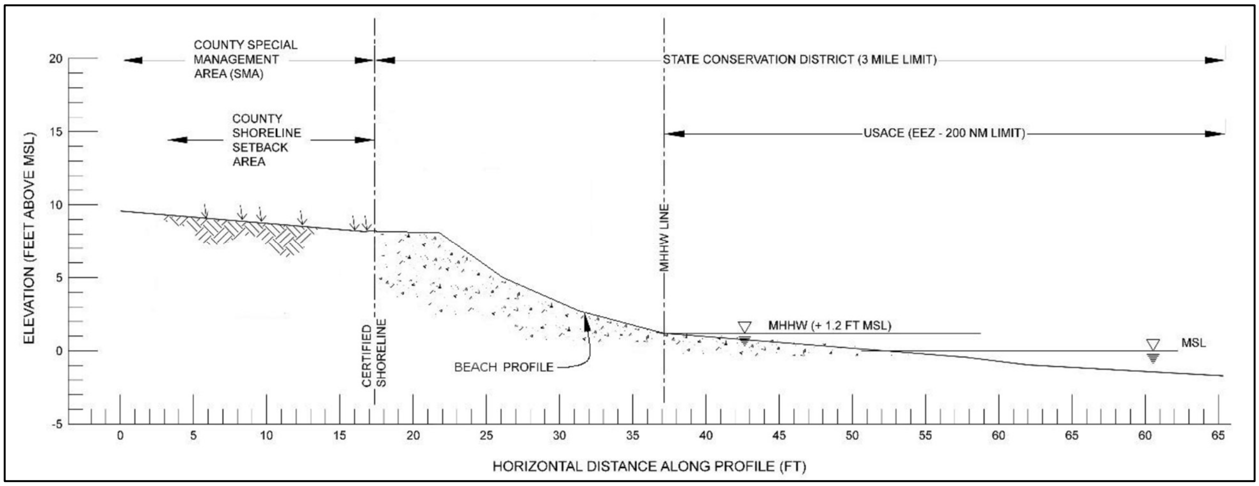


Figure 7-1 Jurisdictional boundaries for shoreline construction in Hawai'i

The county, state, and federal 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.

Fort DeRussy Beach Sector

Fort DeRussy is a United States military reservation that is under the jurisdiction of the United States Army. Most the backshore area between the shoreline and Kalia 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.

Halekulani Beach Sector

The backshore area between the shoreline and Kalia 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 Hotel, Halekulani Hotel, and the Sheraton Waikīkī Beach Hotel.

Royal Hawaiian Beach

The backshore area between the shoreline and Kalakaua Avenue is almost entirely privately owned and densely developed with hotels, resorts, shops, and restaurants. Major development in this sector includes Royal Hawaiian Hotel, Outrigger Waikīkī, Westin Moana Surfrider. The Honolulu Police Department is located east of the Westin Moana Surfrider. At the east end of the sector, there is an open area of public beach park seaward of Kalakaua Avenue that is managed by the City and County of Honolulu Department of Enterprise Services. The area is leased to a number of 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 Kalakau Avenue. The area landward of Kalakaua Avenue is privately owned and densely developed with hotels, resorts, shops, and restaurants. Major development in this sector includes the Aston Waikīkī Circle, Alohilani Resort, Waikīkī Beach Marriott, Aston Waikīkī Beach, 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-foot-wide public easement along the beach measured from the new mean high water mark.

The 1928 agreement covers the Waikīkī beach area including the 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 segment between the Royal Hawaiian Hotel and the Moana Surfrider is the subject of a separate agreement between the Territory and the subject Waikīkī landowners entered into on May 28, 1965.

The potential impacts of the proposed actions on land use and ownership in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.2 Climate

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

7.2.1 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. Additional temperature data from Honolulu International Airport are summarized in Table 7-2 and Table 7-3.

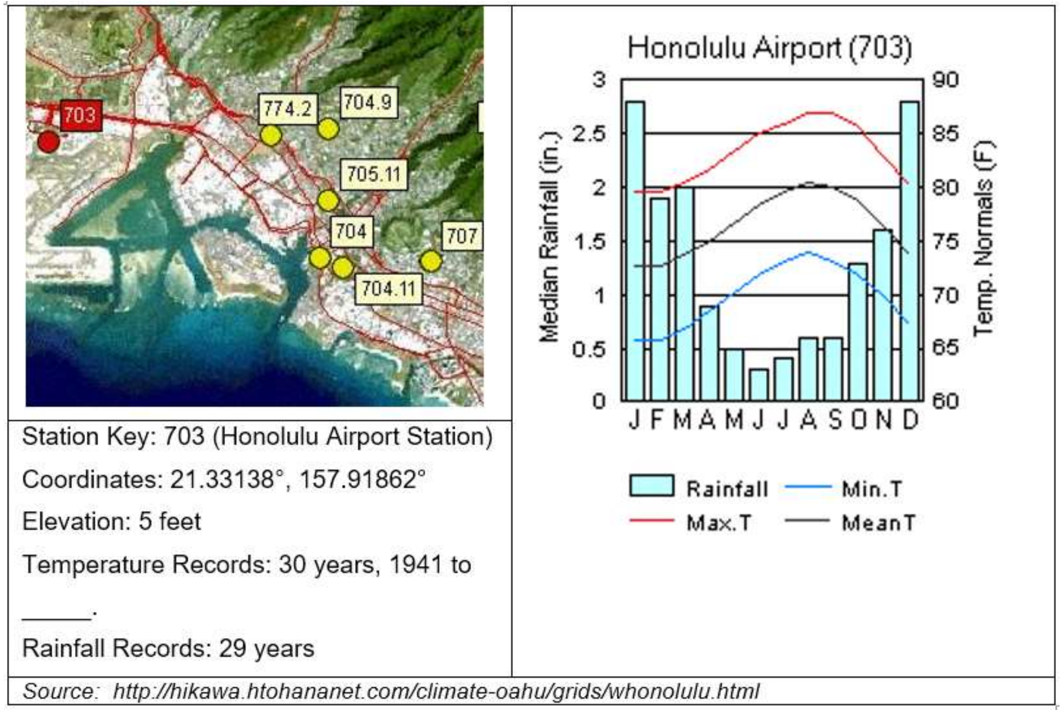
Topography and the dominant northeast trade winds are the two primary factors that influence the amount of rainfall that falls on any given location on O‘ahu. Near the top of the Koolau Range on the windward side of O‘ahu that is fully exposed to the trade winds, rainfall averages nearly 250 inches per year. On the leeward side of the island, where the project is located, the rainfall is much lower, average annual rainfall in Waikīkī is less than 20 inches per year. 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 7-2 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 Hawai‘i Data Book 2003 (Data from Honolulu International Airport)

Table 7-3 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

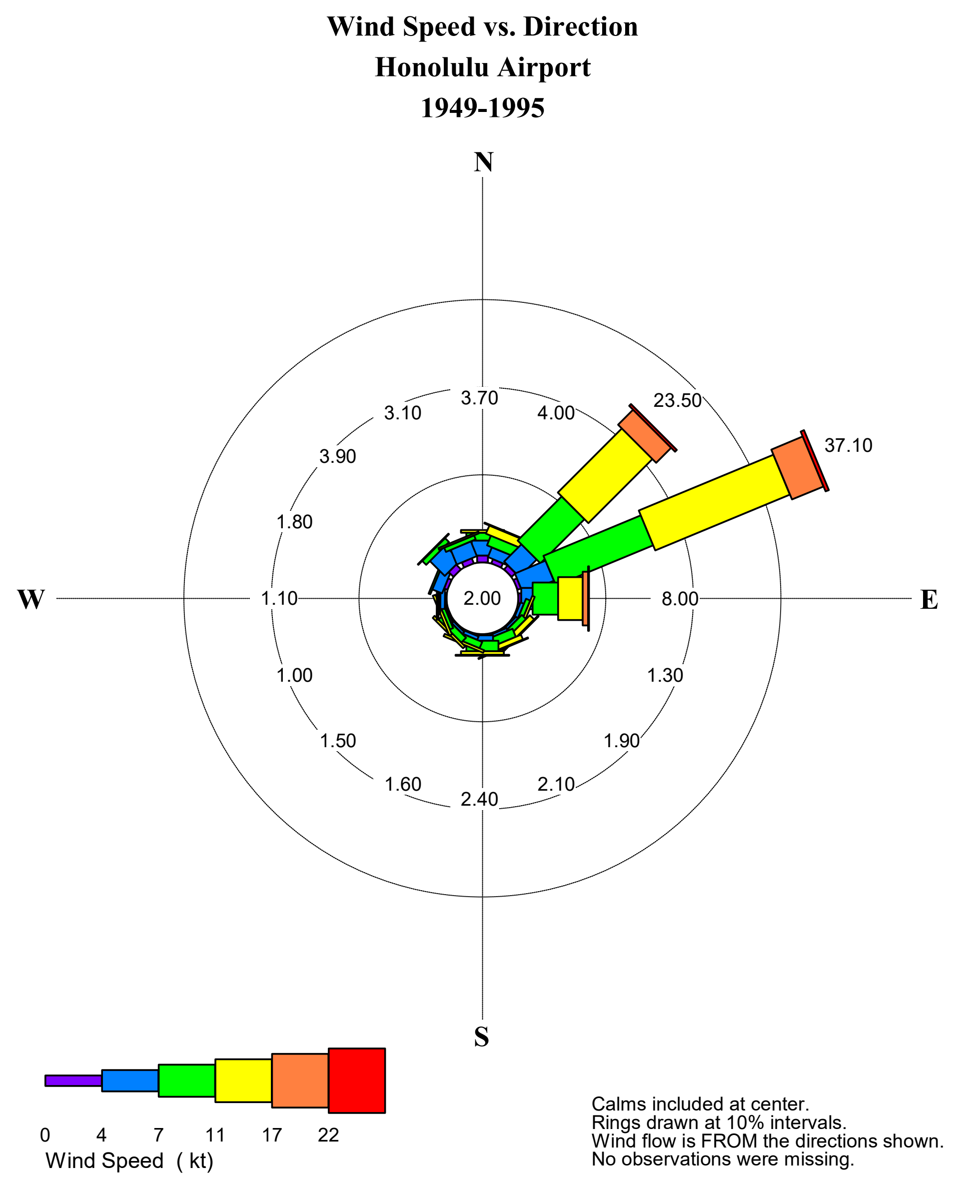
Source: http://hikawa.htohananet.com/climate-oahu/grids/whonolulu.html

7.2.2 Wind

The prevailing wind throughout the year is the northeasterly tradewind. Its average 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 islands. Figure 7-2 shows a wind rose diagram applicable to the site 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 known as the Pacific High. The center of this system is located well north and east of the Hawaiian chain 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 to blow; 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 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 island chain. These storms are often accompanied by heavy rains.



Calms included at center.
Rings drawn at 10% intervals.
Wind flow is FROM the directions shown.
No observations were missing.

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 7-2 Wind rose for Honolulu Airport (1949 to 1995)

7.2.3 Air Quality

The U.S. Environmental Protection Agency has set 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 Hawai‘i has also adopted ambient air quality standards for some pollutants. In some cases, these are more stringent than the Federal standards. At present, the State has set standards for five of the six criteria pollutants (excluding $PM_{2.5}$) in addition to hydrogen sulfide (DOH, 2003).

Generally, air quality in the area is excellent. The State of Hawai‘i Department of Health monitors ambient air quality on O‘ahu using a system of 9 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 area during this 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 Department of Health’s only ozone monitoring station on O‘ahu is located on Sand Island. Existing ozone concentrations at that location also meet State and Federal ambient air quality standards.

The potential impacts of the proposed actions on climate and air quality in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.3 Physical Marine Environment

7.3.1 Wave Climate

The wave climate in Hawai‘i is typically characterized by four general wave types. These include northeast 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 Hawai‘i are shown on Figure 7-3.

Tradewind waves occur throughout the year and are the 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 feet high with periods of 5 to 10 seconds, 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 site 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 miles, these waves arrive with relatively low deepwater wave heights of 1 to 4 feet and periods of 14 to 20 seconds. Depending on the positions and tracks of the southern hemisphere storms, southern swells approach between the southeasterly and southwesterly directions. The project site is directly exposed to swell from the southerly direction and these waves represent the greatest source of wave energy reaching the project site.

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 beaches on the north shores of the island of Oʻahu famous. Deepwater wave heights often reach 15 feet and in extreme cases can reach 30 feet. Periods vary between 12 and 20 seconds, depending on the location of the storm. The project site is sheltered by the island itself from swell approach from the north and northwest.

Kona storm waves also directly approach the project site; 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 seconds with heights of 5 to 10 feet, and approach from the southwest. Deepwater wave heights during the severe Kona storm of January 1980 were about 17 feet. 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 Kauai 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 shore.

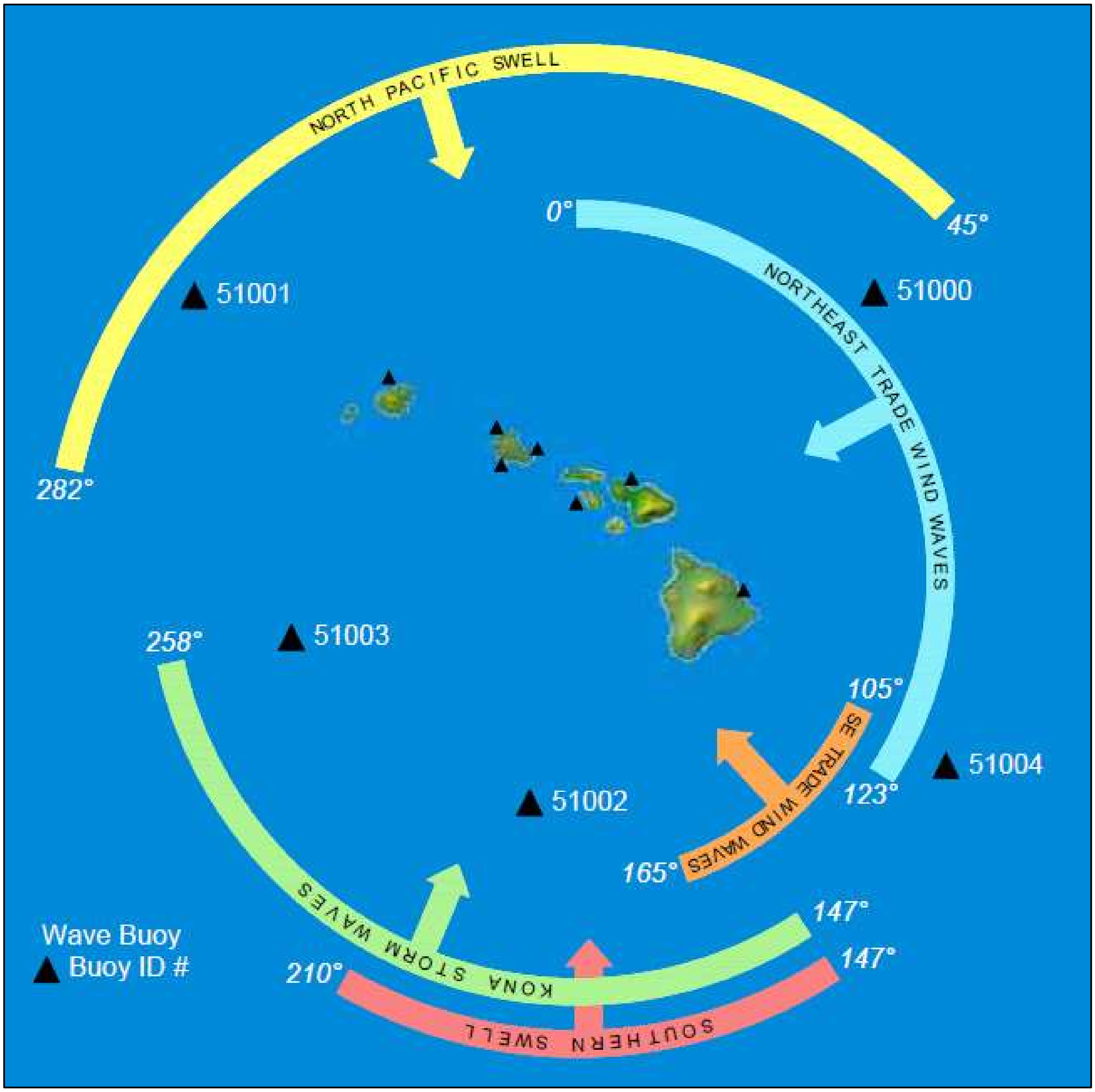


Figure 7-3 Hawai‘i dominant swell regimes (Vitousek and Fletcher, 2008))

7.3.2 Prevailing Deepwater Waves

Wave data available from the National Oceanographic and Atmospheric Administration (NOAA) was compiled and analyzed to identify the primary components of the wave climate affecting the project site. These data provide a 31-year wave record and were statistically analyzed to determine the frequency of occurrence of different wave heights, periods, and directions along the coast.

Wave hindcasting is a tool used to calculate past wave events based on weather models and historical data (Hubertz, 1992). With the proper inputs, wave hindcast models can calculate historical wave climates anywhere in the world. Hindcast model outputs are often recorded for a single location, known as a "virtual buoy".

WaveWatch III (WWIII) is a numerical wave model used to forecast and hindcast waves. Hindcast data for a 31-year period (1979-2010) are available around the Hawaiian Islands from NOAA/NCEP. For this study, hindcast data were obtained from the virtual buoy Station HNL11, located approximately 26 miles south-southwest of the project site at 21°N, 158.25°W.

It is rare for the sea state to consist of a singular wave condition. Wave events are described by wave height, peak period, and peak direction. The wave parameters from the hindcast model are calculated from a modeled wave spectrum. The spectrum shows the distribution of wave energy relative to wave frequency (wave frequency is the inverse of wave period) and wave direction. This methodology allows multiple wave conditions to be accounted for at the same time for a more accurate description of the sea state.

Figure 7-4 is a wave height rose diagram that shows the percent occurrence of wave height and direction for waves as measured at Station HNL11. Table 7-4 is the corresponding histogram. Figure 7-5 is a wave period rose diagram that shows the percent occurrence of wave period and direction for waves as measured at Station HNL11. Table 7-5 is the corresponding histogram. A directional filter was applied within the analysis to only include waves approaching from the south direction between east (90°) and west (270°). The prevailing deepwater wave condition for the project site has a significant wave height of 2.0 feet, a peak period of 15 seconds, and a direction of SSW.

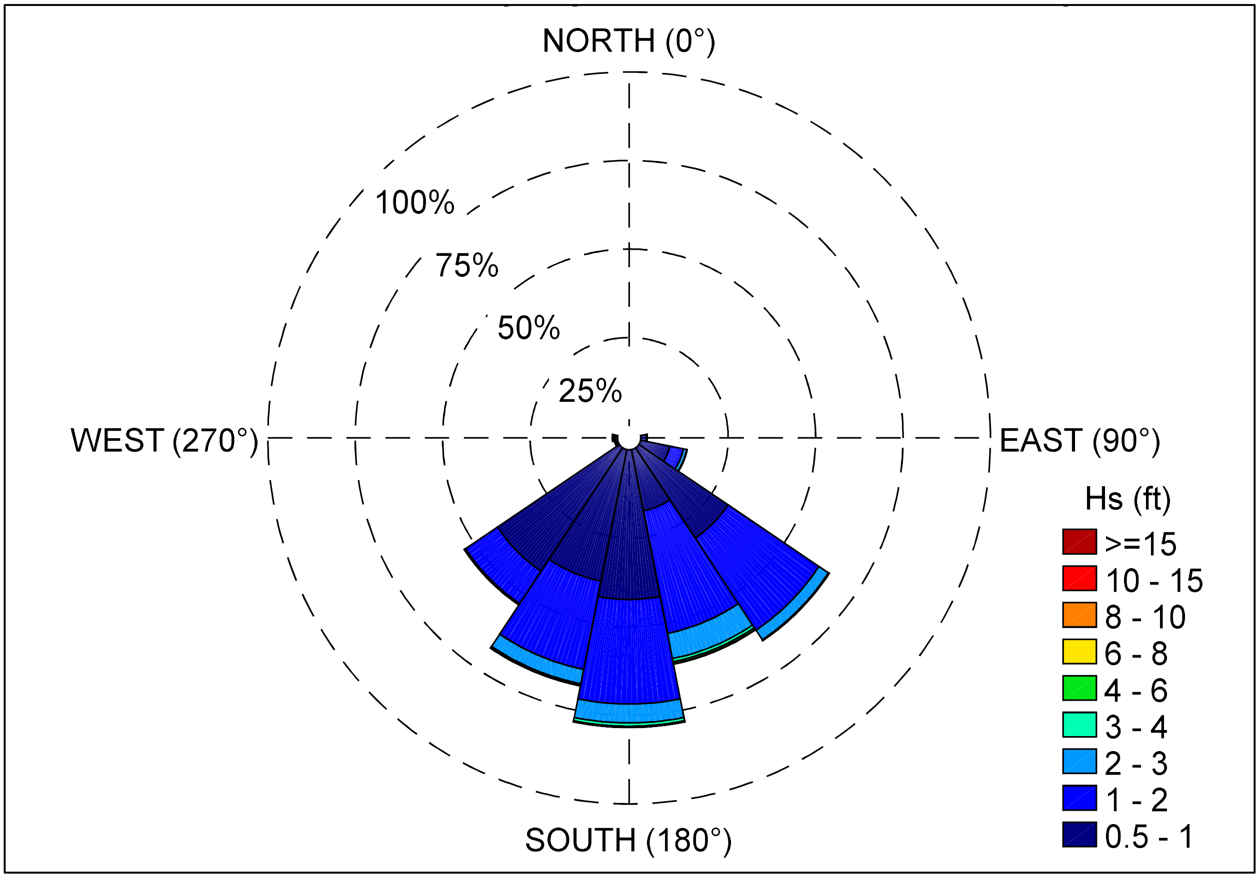


Figure 7-4 Station HNL11 virtual buoy wave height rose from Jan 1979 - Jan 2010.

Table 7-4 HNL11 wave height and direction histogram from Jan 1979 - Jan 2010.

Hs (ft) \ Dir (deg)	**90**	**112.5**	**135**	**157.5**	**180**	**202.5**	**225**	**247.5**	**270**
0.5-1.0	1.7	8.5	30.7	17.6	42.3	37.9	41.9	0.4	0.6
1-2	0.1	4.0	31.3	35.3	29.5	25.4	11.0	0.2	0.3
2-3	0.1	1.0	3.3	7.3	5.4	4.2	0.3	0.1	0.2
3-4	0.0	0.1	0.2	0.9	0.9	0.4	0.1	0.1	0.1
4-6	0.0	0.0	0.0	0.5	0.2	0.1	0.0	0.1	0.1
6-8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
8-10		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10-12				0.0	0.0	0.0	0.0	0.0	0.0
12-14				0.0	0.0	0.0	0.0	0.0	0.0
14-16					0.0	0.0	0.0	0.0	0.0
16-20					0.0	0.0	0.0	0.0	0.0
20+					0.0	0.0	0.0		
Total	1.9	13.5	65.5	61.8	78.4	68.0	53.3	0.9	1.5
	90	**112.5**	**135**	**157.5**	**180**	**202.5**	**225**	**247.5**	**270**
Mean	0.78	1.01	1.13	1.42	1.13	1.09	0.83	2.57	2.04
Standard Deviation	0.66	0.58	0.48	0.71	0.63	0.56	0.40	2.93	2.15
Minimum	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Maximum	7.74	8.07	8.10	13.35	20.18	23.75	20.34	19.91	17.06

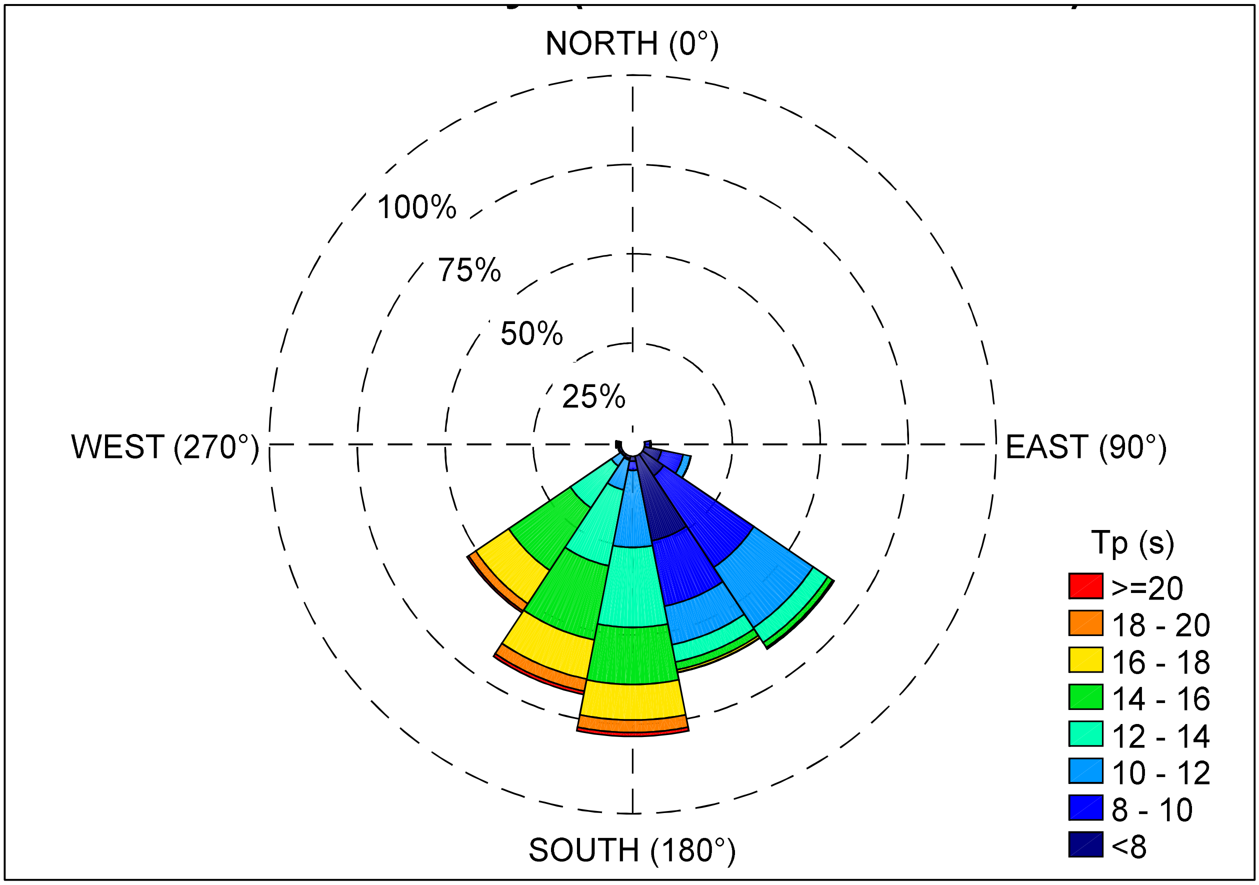


Figure 7-5 Station HNL11 virtual buoy wave period rose from Jan 1979 - Jan 2010.

Table 7-5 HNL11 wave period and direction histogram from Jan 1979 - Jan 2010.

Tp (s) \Dir (deg)	90	112.5	135	157.5	180	202.5	225	247.5	270
4-6	0.1	4.7	2.1	6.8	0.7	0.3	0.3	0.3	0.2
6-8	0.1	0.3	5.2	17.4	0.7	0.4	0.3	0.3	0.2
8-10	1.4	6.3	30.8	18.6	2.6	0.4	0.1	0.2	0.3
10-12	0.2	2.2	20.3	11.0	21.6	8.5	3.3	0.1	0.4
12-14	0.0	0.1	5.0	4.9	22.4	21.7	14.0	0.0	0.2
14-16	0.0	0.0	1.6	2.2	16.0	21.2	21.1	0.0	0.1
16-18			0.4	0.7	10.0	11.1	11.2	0.0	0.0
18-20			0.0	0.1	3.5	3.5	2.4		0.0
20+			0.0	0.0	1.0	0.9	0.6		0.0
Total	1.9	13.5	65.5	61.8	78.4	68.0	53.3	0.9	1.5
	90	112.5	135	157.5	180	202.5	225	247.5	270
Mean	9.16	7.91	9.84	8.97	13.52	14.36	14.79	7.32	9.69
Standard Deviation	1.35	2.44	1.91	2.61	2.71	2.36	2.16	2.17	3.04
Minimum	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01
Maximum	15.30	15.14	20.59	22.05	24.46	23.65	23.33	16.59	22.03

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 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 will 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 will cause the spreading of waves in a shadow zone, such as occurs behind a breakwater or other barrier.

Wave transformations are mathematically complex, and calculations over broad areas and complicated bathymetry require the use of numerical computer models. XBeach is an open-source numerical wave model originally developed to simulate hydrodynamic and morphological processes along sandy shorelines. The XBeach Non-Hydrostatic (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. Water surface elevation images produced by XBeach-NH have previously been compared with wave patterns found in aerial imagery and the wave patterns have been found to match well.

The XBeach-NH model was utilized to assess the complex wave pattern along the Waikīkī shoreline. Figure 7-6 shows the XBeach-NH output of wave patterns for a high-prevailing south swell. Figure 7-7 through Figure 7-10 show the XBeach-NH output of wave patterns for a high-prevailing south swell for each of the four beach sectors – Fort DeRussy (Figure 7-7), Halekulani (Figure 7-8), Royal Hawaiian (Figure 7-9), and Kūhiō Beach (Figure 7-10).

The potential impacts of the proposed actions on wave conditions in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

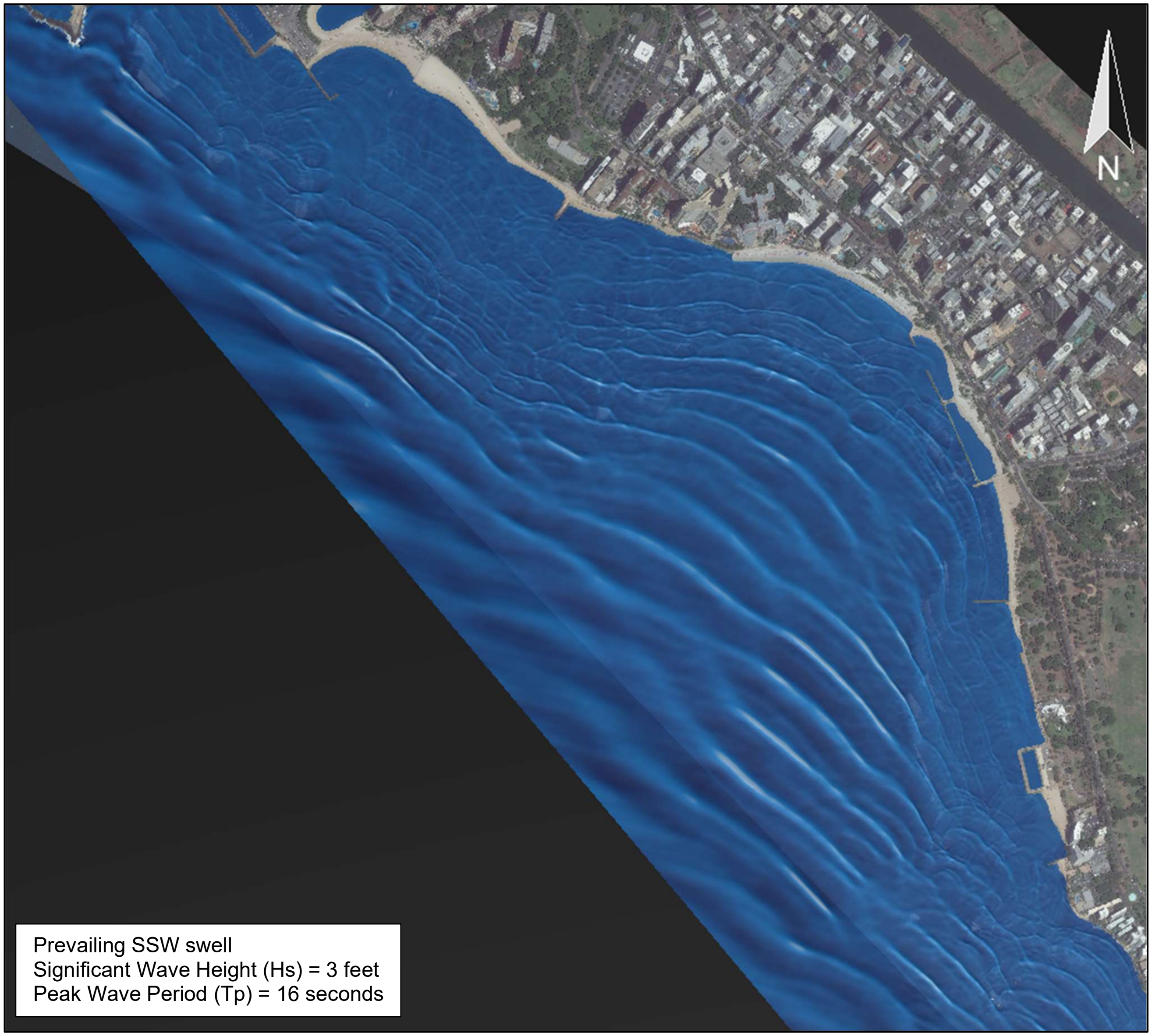


Figure 7-6 XBeach-NH wave pattern output for prevailing SSW swell

Figure 7-7 XBeach-NH wave pattern for prevailing SSW swell – Fort DeRussy Beach Sector

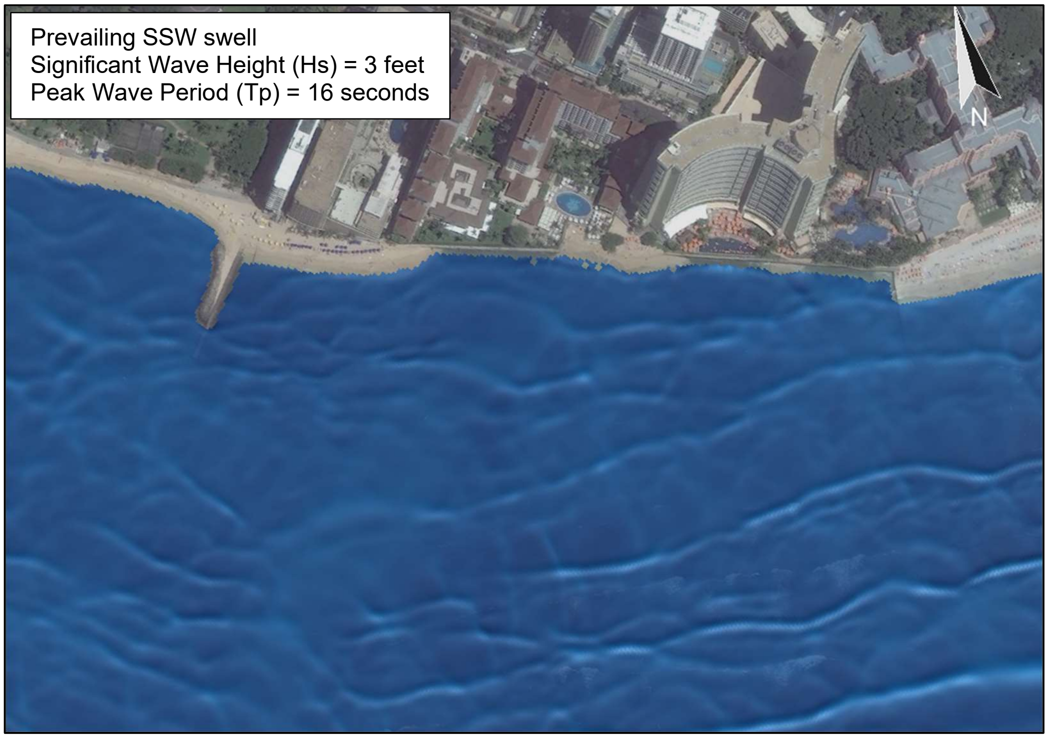


Figure 7-8 XBeach-NH wave pattern for prevailing SSW swell – Halekulani Beach Sector

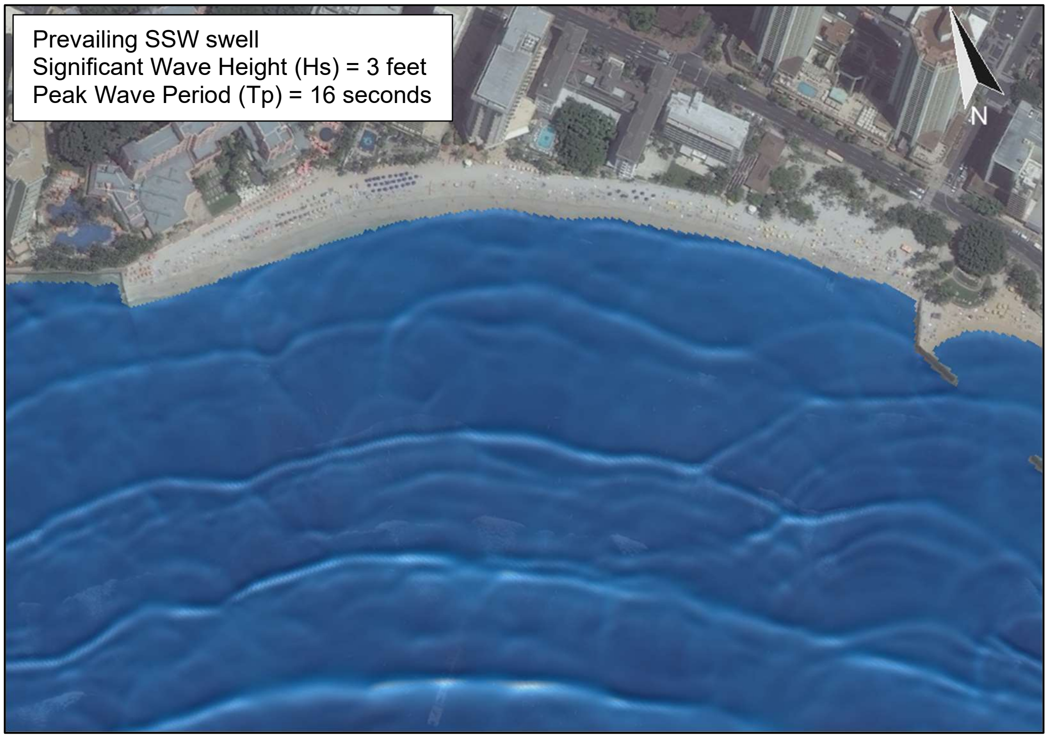


Figure 7-9 XBeach-NH wave pattern for prevailing SSW swell – Royal Hawaiian Beach Sector

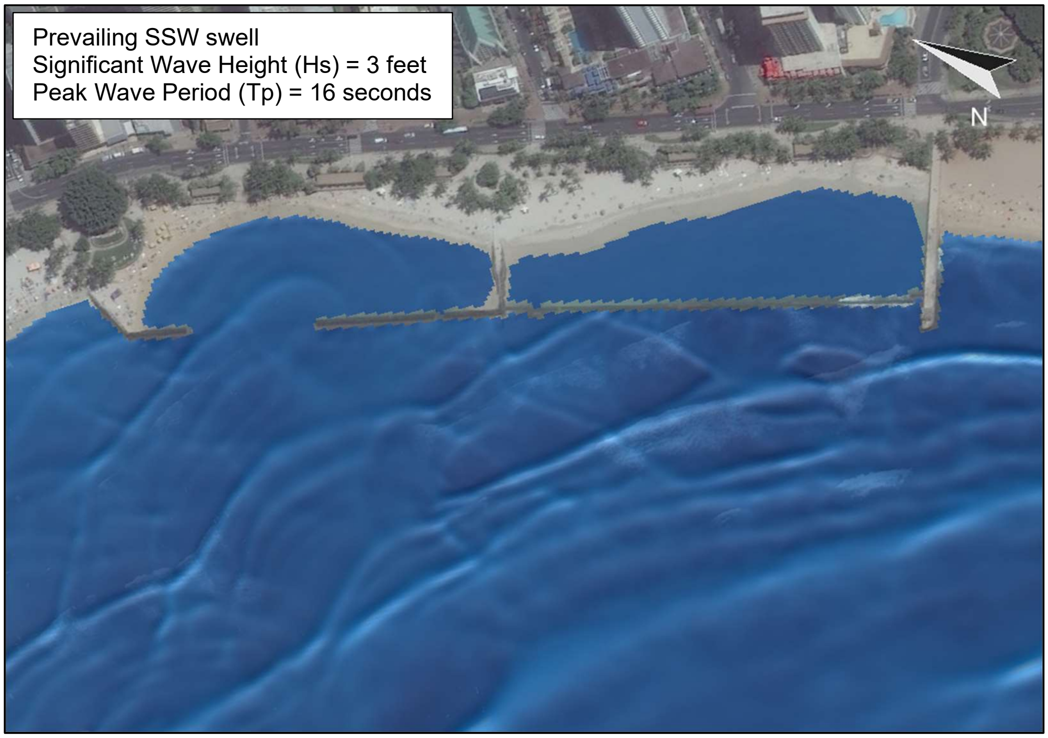


Figure 7-10 XBeach-NH wave pattern for prevailing SSW swell – Kūhiō Beach Sector

7.3.3 Extreme Deepwater Waves

The Hawaiian Islands are annually exposed to severe storms and storm waves generated by passing low-pressure systems (Kona storms) and tropical cyclonic storms (hurricanes). Kona storms occur when winter low-pressure systems that travel across the North Pacific Ocean dip south and approach the islands. Strong southerly and southwesterly winds generated by these storms result in large waves on exposed shorelines and often heavy rains. 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. While they typically pass south of the Hawaiian Islands, their paths are unpredictable, and they will occasionally pass near or over the islands. Hurricane Iwa (1982) and Hurricane Iniki (1992) directly hit the island of Kauai and resulted in large waves along O‘ahu's southern shores. Damage from these hurricanes was extensive not only on Kauai, which was subject to both high winds and waves, but also along coastal areas of other islands exposed to the large waves.

Detailed studies of hurricane storm wave inundation limits for the island of O‘ahu have been completed by Bretschneider and Noda (1985) for two hurricane scenarios – a model, or most probable type hurricane, and a worst-case hurricane. Deepwater hurricane wave heights, periods, and approach directions off the south shore of O‘ahu as reported by Bretschneider and Noda for the model and worst-case hurricanes are 31 ft, 12 seconds, 175 degrees and 41 ft, 14 seconds, 210 degrees, respectively.

Historical wave buoy data also 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-year return period wave event is an extreme event with a 1/50 (i.e., 2%) chance of occurring in any given year. Extreme wave heights were investigated by filtering the virtual buoy data by direction and period for waves within the project site's direct exposure window, between 90˚ and 270˚ (south swell), with periods of 12 seconds or greater.

The extreme wave height data from the HNL11 dataset were used to generate a Weibull extreme value distribution for return period wave heights. The Weibull Distribution is a tool for looking at the relationship between the size of waves and how frequently they occur at a given location. Analysis requires a long-term data set with well-documented wave events. These events are sorted by size, and frequency of occurrence can be assessed by how often these events occur in the 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.

Wave height versus return period is shown in Figure 7-11 and Table 7-6. The ten largest wave events from directions east to west (90º to 270º TN) during the period of record are shown in Table 7-7. These waves are generated by long-period deepwater southerly swell that is capable of generating breaking wave heights that can be more than double the recorded swell heights.

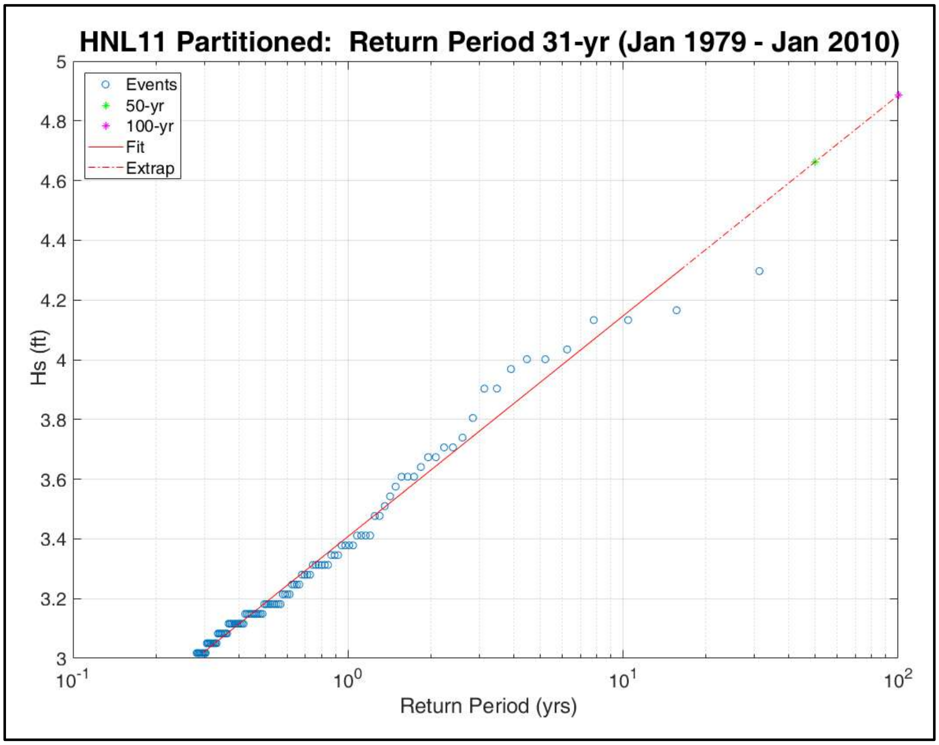


Figure 7-11 Virtual buoy HNL11 return period

Table 7-6 Return period significant wave heights at HNL11

Return Period	Wave Height (feet)
1	3.4
2	3.6
5	3.9
10	4.2
25	4.4
50	4.7
100	4.9

Table 7-7 Top 10 events recorded at HNL11

Date	Wave Height (ft)	Period (s)	Direction (degrees)
5/12/1980	4.3	17.3	190.7
10/3/1987	4.2	17.6	189.6
5/5/1992	4.1	17.0	190.5
6/12/1998	4.1	17.5	185.5
2/13/1995	4.0	17.8	191.6
6/20/1982	4.0	16.4	186.4
5/4/2003	4.0	16.6	190.4
6/22/1988	4.0	15.4	182.1
8/3/1980	3.9	16.6	190.3
8/4/1980	3.9	16.5	190.3

The report *Hurricanes in Hawai‘i* (Haraguchi, 1984), prepared for the USACE, Honolulu Engineer District, presents hypothetical model and worst-case hurricane scenarios for the Hawaiian Islands. These scenario hurricanes have been used for detailed studies of hurricane storm wave inundation limits for the islands of O‘ahu and Kauai prepared by Bretschneider and Noda (1985) and SEI (1986, 1993, and 2000) for the USACE Honolulu Engineer District. The model hurricane is defined as the probable hurricane that will strike Hawai‘i in the future, based on the characteristics of storms previously approaching or striking the islands. The worst-case hurricane characteristics are based on subjective analysis of the data from 20 critical hurricanes in the Central Pacific and an understanding of the basic atmospheric and oceanic conditions surrounding the Hawaiian Islands. For this study, deepwater model hurricane wave parameters off the south shore of O‘ahu as reported by Bretschneider and Noda (1985) are selected as hurricane waves. Wave heights, periods, and approach directions for the model hurricanes are 30.8 feet, 12 seconds, 175 degrees, and 36.2 feet, 13.3 seconds, and 220 degrees, respectively.

The design wave conditions selected for further analysis are summarized in Table 7-8.

Table 7-8 Selected design wave conditions

Type of Wave	Deepwater Wave Height (feet)	Wave Period (sec.)
1-Year Wave	3.4	17
50-Year Wave	4.7	17
Kona Storm Wave (1980)	17.0	9
Model Hurricane	30.8	12

7.3.4 Still Water Level

The total water depth at a particular location is composed of the depth below the 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)

The potential impacts of the proposed actions on still water levels in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.3.5 Tides

Hawai‘i tides are semi-diurnal with pronounced diurnal inequalities (i.e., two high and low tides each 24-hour period with different elevations). Variation of the tidal range results from the relative position of the moon and the 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 dominates 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. A *King Tide* 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 7-9.

Table 7-9 Water level data for Honolulu Harbor (NOAA Station 1612340)

Datum	Elevation (feet MLLW)	Elevation (feet 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

The potential impacts of the proposed actions on tides in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.3.6 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, the Pacific Decadal Oscillation, 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 feet 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 feet has also been associated with phenomena related to the El Niño / Southern Oscillation.

In 2017, Hawai‘i 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 7-12. The plot also shows the corresponding predicted tide and SLA for the daily maximum recorded tide. Table 7-10 extends this data, presenting the recorded and predicted tides at Honolulu Harbor from February 2017 to present.

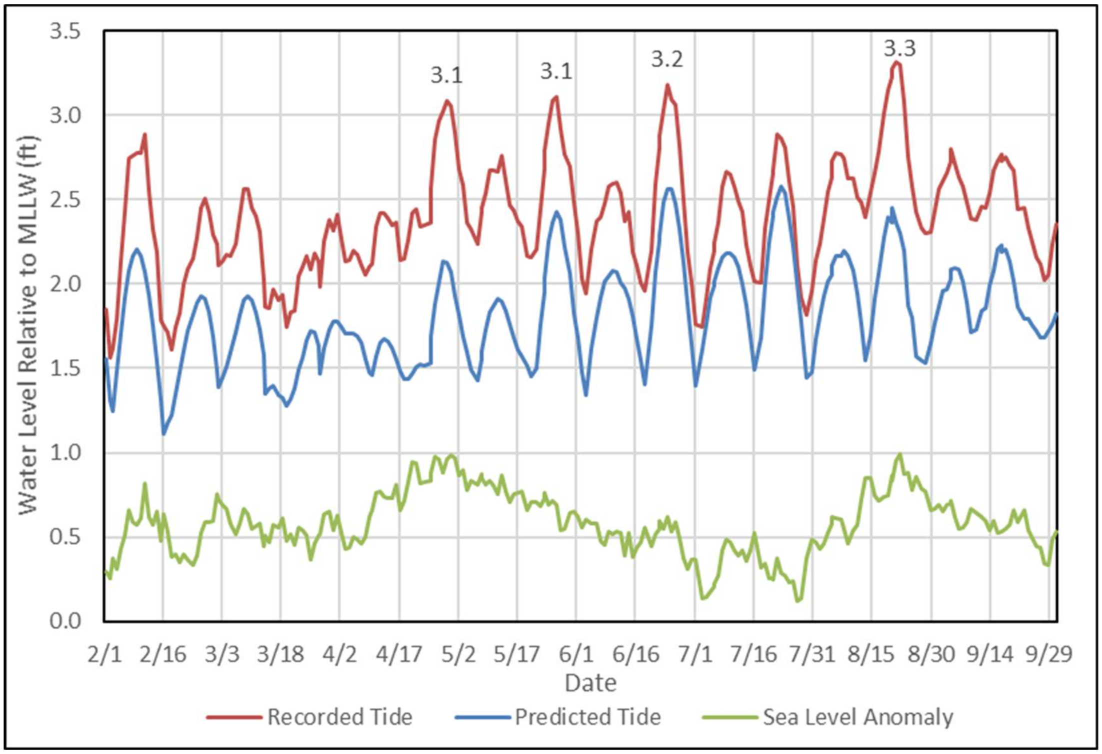


Figure 7-12 Daily maximum measured tides at Honolulu Harbor and corresponding predicted tides and sea level anomaly (February 1-October 1, 2017)

Table 7-10 Peak recorded tide levels at Honolulu Harbor from 2017 to present

Date	Recorded Tide (feet MLLW)	Predicted Tide (feet 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

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 added to the inundation. The end of 2019 also marked an extended period of large SLA. Figure 7-13 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.

The potential impacts of the proposed actions on sea level anomalies in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

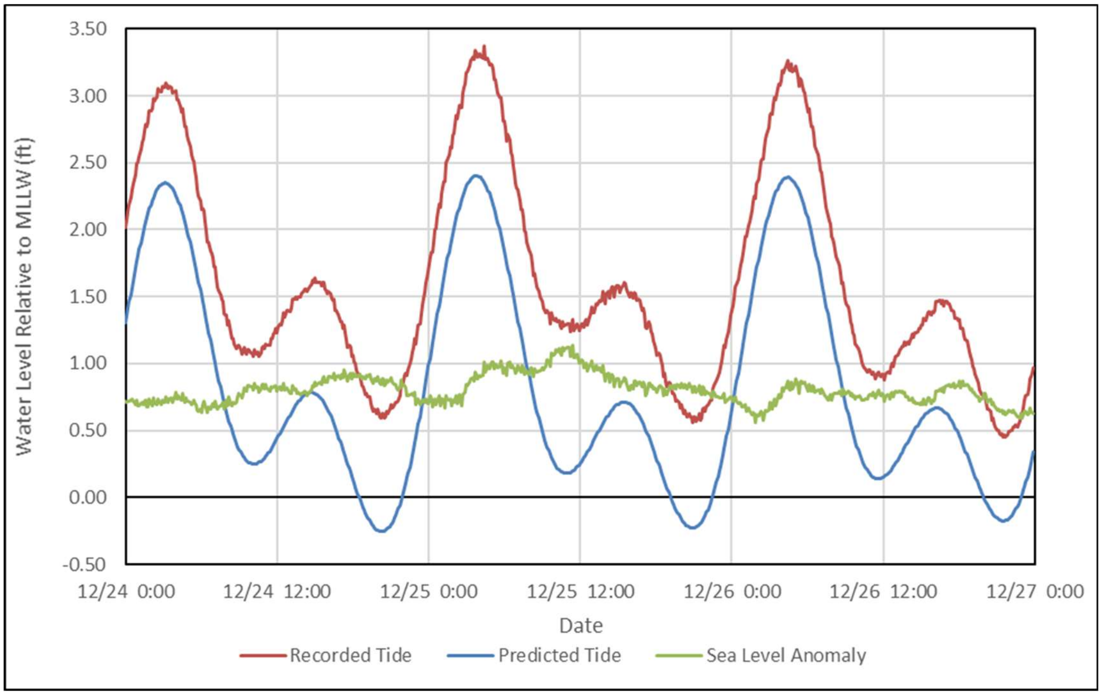


Figure 7-13 Predicted and measured tides at Honolulu Harbor (Dec 24-26, 2019)

7.3.7 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 7-14 (NOAA, 2020). The rate of sea level change is +1.51 ± 0.21 mm/yr based on monthly data from 1905 to present. Figure 7-14 also shows interannual anomalies exceeding 0.5 feet (15 cm) in magnitude due to natural oceanic variability from processes such as the El Niño Southern Oscillation (ENSO).

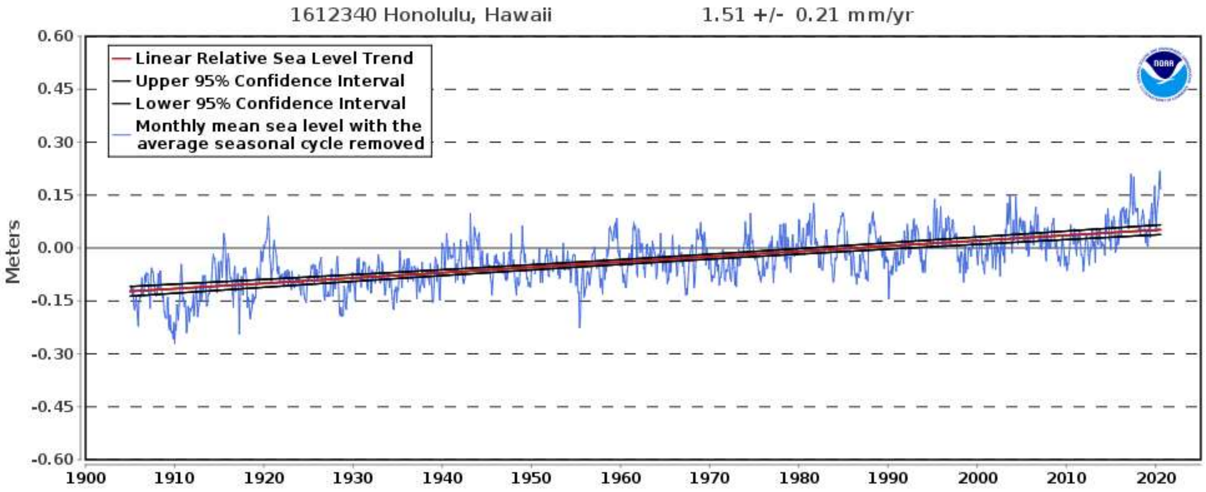


Figure 7-14 Mean sea level trend, Honolulu Harbor, 1905 to present (NOAA, 2020)

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 feet of sea level rise by 2100 and their *Extreme* scenario represents more than 8 feet of sea level rise by 2100 (Table 7-11). 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. 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 nearer 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. Table 7-11 shows NOAA's most recent global mean sea level rise scenarios. Table 7-12 and Figure 7-15 present mean sea level rise scenarios for Hawaii based on the revised NOAA (2017) projections, taking into account the far field effects.

Table 7-11 Global mean sea level rise scenarios (NOAA, 2017)

Scenario (feet)	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 7-12 Hawai‘i local mean sea level rise scenarios (adapted from NOAA, 2017)

Scenario (feet)	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

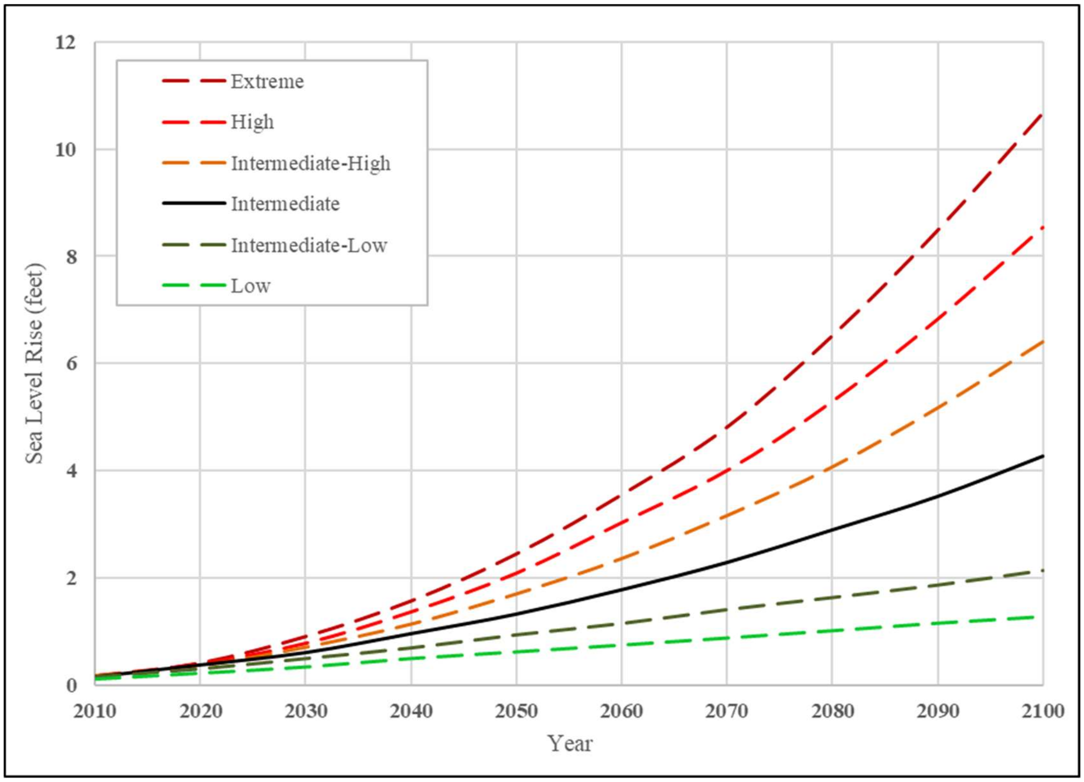


Figure 7-15 Hawai‘i local mean sea level rise projections (adapted from NOAA, 2017)

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

The Hawai‘i *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 Hawai‘i. The report concluded that the potential impacts of 3.2 feet of sea level rise on O‘ahu include the loss of $12.9 billion in structures and land; 3,800 structures including hotels in Waikīkī; the displacement of 13,300 residents; and the loss of 17.7 miles of major roads. (Honolulu Star Advertiser, 2020). Public and private facilities and infrastructure in Waikīkī are severely vulnerable to sea level rise. 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.

A key component of the report was a numerical modeling effort by the University of Hawai‘i Coastal Geology Group (UHCGG) to estimate the potential impacts of a 3.2-foot 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 feet 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 feet to 8.8 feet 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-foot rise in sea level would 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 UHCGG modeling results are published in the Hawaii Sea Level Rise viewer and shown in Figure 7-16 through Figure 7-19.

Figure 7-16 depicts the potential for passive flooding with 3.2 feet 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). The model projects no passive flooding on the project site with 3.2 feet of sea level rise.

Figure 7-17 depicts the potential for annual high wave flooding with 3.2 feet 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-meter digital elevation model. The model depicts the spatial extent of inundation that is greater than 10cm in depth.

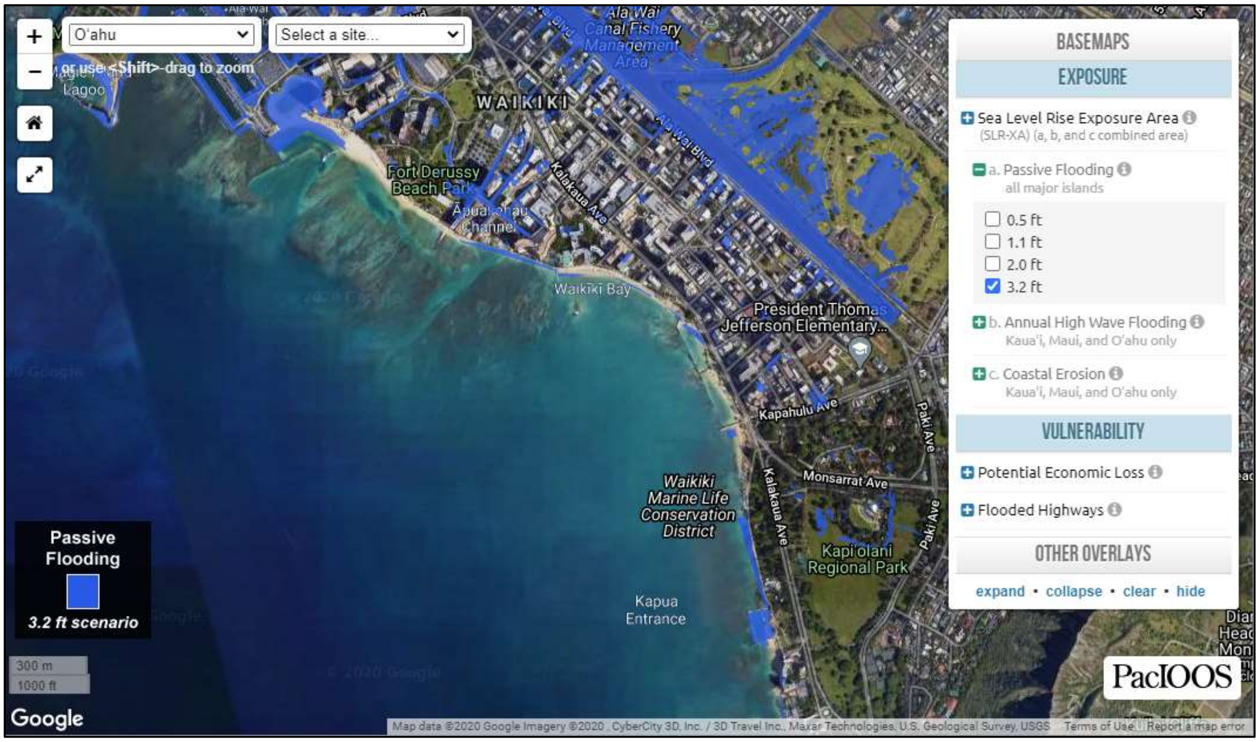
Figure 7-18 depicts the estimated area that could be exposed to erosion with 0.5 to 3.2 feet of sea level rise. The results of the erosion model represent the combined results of measured, historical erosion rates and the compounding impacts of projected higher water levels associated with projected sea level rise. The erosion model results are a useful tool for considering the potential impacts of erosion at the island or community level; however, there are certain assumptions, limitations, and uncertainties that must be understood when considering the results at the parcel level.

The projected erosion hazard lines for Waikīkī are shown in Figure 7-18 are derived from historical erosion rates that are based on shoreline location measurements collected at individual transects located 20 meters apart along the coastline. Each transect is characterized by a unique combination of physical and environmental factors that influence shoreline change at that specific transect. While erosion projections that are based on historical erosion rates may not be entirely accurate predictions of the future, they are often used for planning purposes.

The SLR-XA erosion model assumes an “all sand” environment for projecting future shoreline change. However, the model but does not account for the presence of engineered shore protection structures, such as seawalls and revetments. Typically, these structures are utilized to abate the impacts of shoreline erosion and act counter to the natural pressure influencing shoreline retreat. Given the extensive shoreline armoring in Waikīkī, it is unlikely that erosion would extend landward of the existing structures. Without beach improvements and 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.

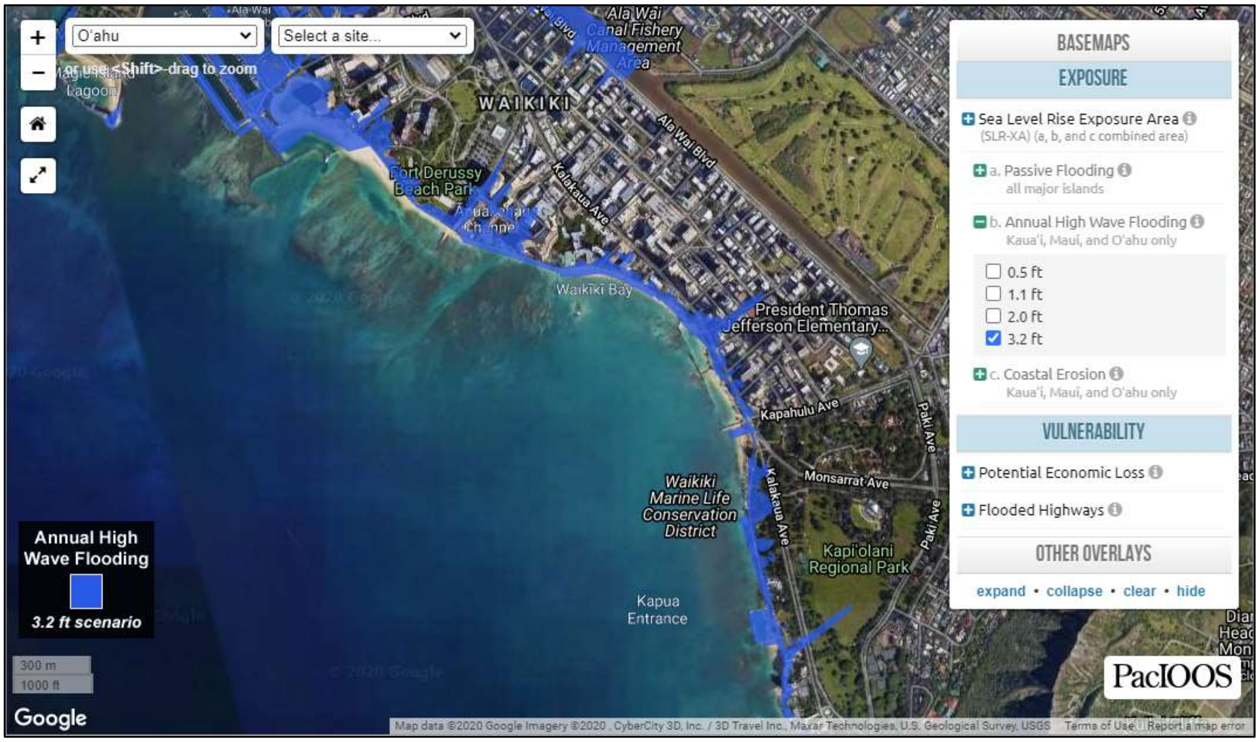
Figure 7-19 depicts the projected extent of chronic flooding with 3.2 feet of sea level rise, referred to as the Sea Level Rise Exposure Area (SLR-XA). The SLR-XA represents the combined footprint of the three individual hazards that were modeled - passive flooding, annual high wave flooding, and coastal erosion. The model results indicate that coastal flooding, particularly annual high wave flooding, will increase significantly as sea levels continue to rise. Increasing beach width and elevation would provide a natural buffer to reduce the potential for wave overtopping and flooding.

The potential impacts of the proposed actions to mitigate the potential impacts of sea level rise in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).



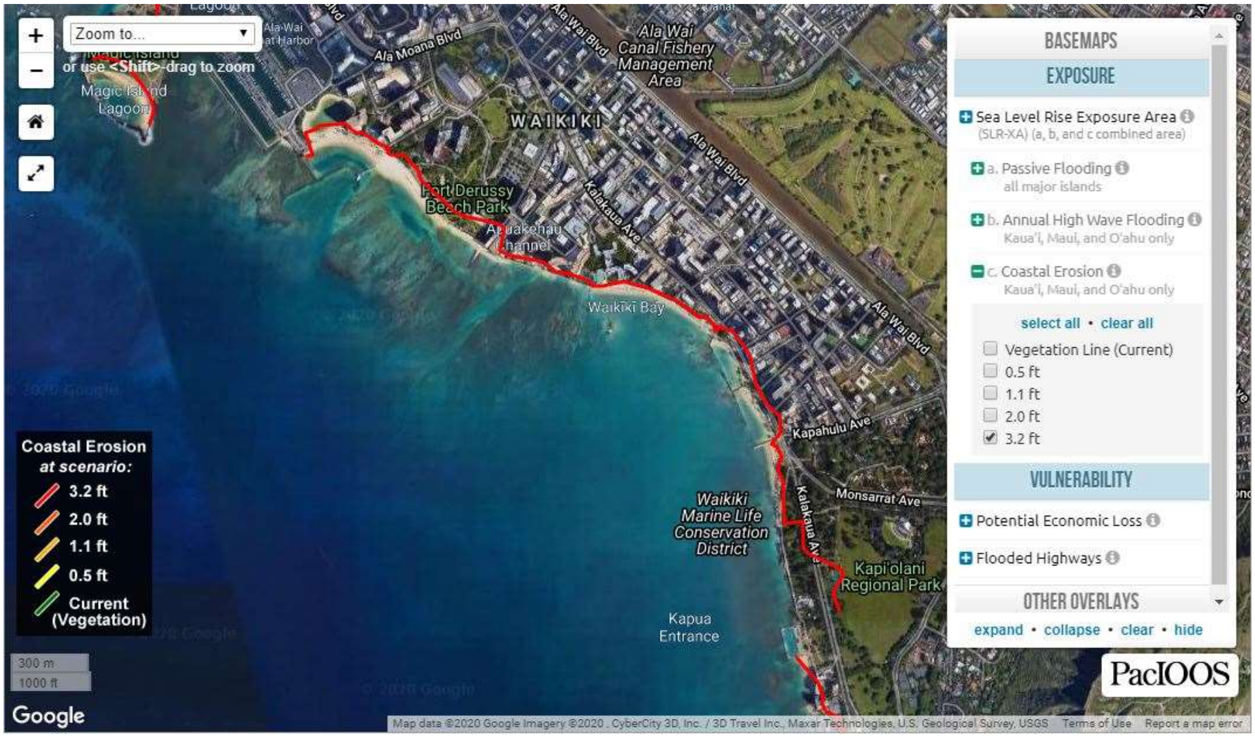
Sea Level Rise Exposure Area (SLR-XA) (a, b, and c combined area)
a. Passive Flooding all major islands
☐ 0.5 ft
☐ 1.1 ft
☐ 2.0 ft
☑ 3.2 ft
b. Annual High Wave Flooding Kaua'i, Maui, and O'ahu only
c. Coastal Erosion Kaua'i, Maui, and O'ahu only

Figure 7-16 Passive flooding with 3.2 feet of sea level rise (UHCGG, 2017)



Sea Level Rise Exposure Area (SLR-XA) (a, b, and c combined area)
a. Passive Flooding all major islands
b. Annual High Wave Flooding Kaua'i, Maui, and O'ahu only
☐ 0.5 ft
☐ 1.1 ft
☐ 2.0 ft
☑ 3.2 ft
c. Coastal Erosion Kaua'i, Maui, and O'ahu only

Figure 7-17 Annual high wave flooding with 3.2 feet of sea level rise (UHCGG, 2017)



BASEMAPS

EXPOSURE

Sea Level Rise Exposure Area (SLR-XA) (a, b, and c combined area)

a. Passive Flooding all major islands

b. Annual High Wave Flooding Kaua'i, Maui, and O'ahu only

c. Coastal Erosion Kaua'i, Maui, and O'ahu only

select all • clear all

☐ Vegetation Line (Current)
☐ 0.5 ft
☐ 1.1 ft
☐ 2.0 ft
☑ 3.2 ft

VULNERABILITY

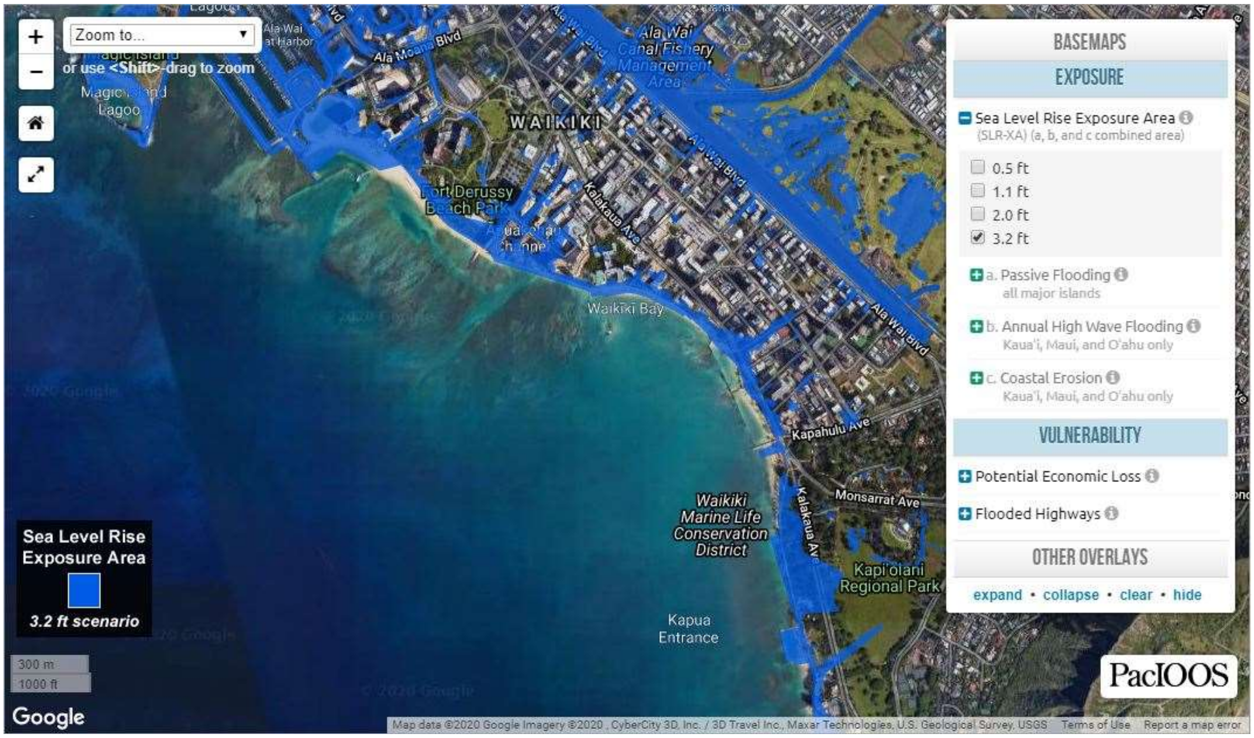
Potential Economic Loss

Flooded Highways

OTHER OVERLAYS

expand • collapse • clear • hide

Figure 7-18 Coastal erosion with 3.2 feet of sea level rise (UHCGG, 2017)



BASEMAPS

EXPOSURE

Sea Level Rise Exposure Area (SLR-XA) (a, b, and c combined area)

☐ 0.5 ft
☐ 1.1 ft
☐ 2.0 ft
☑ 3.2 ft

a. Passive Flooding all major islands

b. Annual High Wave Flooding Kaua'i, Maui, and O'ahu only

c. Coastal Erosion Kaua'i, Maui, and O'ahu only

VULNERABILITY

Potential Economic Loss

Flooded Highways

OTHER OVERLAYS

expand • collapse • clear • hide

Figure 7-19 Sea Level Rise Exposure Area (SLR-XA) with 3.2 feet of sea level rise (UHCGG, 2017)

7.3.8 Wave Setup

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, termed *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.

The potential impacts of the proposed actions on wave setup in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.3.9 Storm Surge

During tropical storm and hurricane conditions, with high winds and very low pressures, an additional water level rise, termed storm surge, can occur. Storm surge on continental coasts can be amplified by the wide and shallow continental shelf. This type of surge is only minimally present in Hawai‘i due to the narrow insular shelf that surrounds the islands. There is no storm surge component to waves generated by distant storms. As with wave setup, storm surge causes an increase in water depth and the maximum wave height.

The potential impacts of the proposed actions on storm surge in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.3.10 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.

The potential impacts of the proposed actions on combined stillwater levels in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.3.11 Bathymetry and Nearshore Bottom Conditions

Waikīkī is located on the south shore of O‘ahu, west of Diamond Head, along a pronounced embayment in the shoreline (Mamala Bay). This embayment is evident in the 18-foot depth contour, located approximately ½ mile offshore. Seaward of this, contours become straighter and bottom slope increases. A fringing fossil reef intersected by several relic stream channels extends approximately 1 mile offshore. The shoreline is fronted by a shallow fossil limestone reef including channels and pockets filled with sand. This extends approximately 1,500 feet offshore, with depths generally 5 feet or less. Seaward of the surf zone (approximate 10-foot depth), to a depth of 40 feet, the average bottom slope is very gradual, 1V:100H. Between the 40 and 60-foot depth contours, bottom slopes increase to 1V:50H and further increase seaward of the 60-foot contour to 1V:15H. Detailed nearshore bathymetry information is available via the U.S. Army Corps of Engineers (USACE) Scanning Hydrographic Operational Airborne Lidar Survey (SHOALS) dataset. The nearshore bathymetry in Waikīkī is very complicated, with shallow fossil reef bisected by paleo stream channels. This results in complex nearshore wave patterns.

The potential impacts of the proposed actions on bathymetry and nearshore bottom conditions in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.3.12 Currents and Circulation

Offshore tidal driven currents in Waikīkī generally flow toward the north-northwest (‘Ewa) during high tide and south-southwest (Diamond Head) during low tide, generally flowing parallel with the bottom contours (Noda, 1991). Currents landward of the 30-foot bottom contour are weaker than the currents further offshore. Velocities are typically 0.15 to 0.5 feet/sec (0.1-0.3 knots). Wind speed and direction influences the surface (top 3 feet) current, creating eddies when opposed to the tide flow and enhancing it when blowing in the same direction.

Wave-induced currents predominate inside the breaker zone, generating both longshore (shore parallel) and onshore/offshore (rip) currents, which contribute significantly to sediment transport. 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 east of the Queen’s surf groin and east of the Royal Hawaiian Hotel 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 rip current typically forms fronting the Royal Hawaiian Hotel, with current speeds sufficient to result in a significant movement of sand offshore. The result of this can be seen as a shoal or sandbar offshore, which is popular with beach users. A rip current is also typical in the deeper water channel fronting the Outrigger Waikīkī and Moana Surfrider hotels used by beach catamarans.

The potential impacts of the proposed actions on currents and circulation in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.3.13 Shoreline Change

The University of Hawaiʻi Coastal Geology Group (UHCGG) conducted a historical analysis of Oʻahu's shoreline 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 7-20 and Table 7-13. The rates presented in Table 7-13 represent the average shoreline change rates from 1927 to 2015; however, rates can be substantially higher in areas that are more susceptible to erosion.

Erosion, coastal flooding, and beach loss are expected to continue and accelerate in Waikīkī in the coming decades as sea levels continue to rise. Recent record high water levels and severe erosion events indicate that this acceleration may already be occurring. Anderson et al. (2015) forecasted future coastal change in Hawaiʻi by combining historical shoreline trends with projected accelerations in sea level rise using the Davidson-Arnott profile model. The analysis found that, due to sea level rise, the average shoreline recession is projected to be nearly twice 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 (Hawaiʻi Climate Change Mitigation and Adaptation Commission (2017), Anderson et al. 2015). The erosion projections for the Fort DeRussy, Halekulani, Royal Hawaiian, and Kūhiō Beach sectors are shown in Table 7-14. These projections do not account for the presence of shoreline armoring, which spans nearly the entire length of the Waikīkī shoreline. Based on the projections, 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 during high tides and high surf events.

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 feet/year (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 feet/year, whereas the west end of the beach (transects 154 to 169) has been accreting at an average rate of 0.4 feet/year. The erosion is more pronounced at the east end of the beach because predominant sediment transport direction is from east to west along this portion of the Waikīkī shoreline (Miller et al. 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 feet (9.4 meters) by 2050 and up to 81 feet (24.7 meters) by 2100 (UHCGG, 2019). The entire length of the shoreline in the Fort DeRussy Beach sector is armored by a seawall. 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 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.

Halekulani Beach Sector

The historical shoreline change analysis for the Halekulani 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 Waikīkī Hotel (UHCGG, 2019). Miller et al. (2003) found that sediment transport in the Halekulani 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 fluctuates seasonally but has been relatively stable. The pocket beaches in the central portion of the sector (transects 126 to 129), between the Halekulani and Sheraton Waikīkī hotels, are aligned with the Halekulani Channel and have experienced moderate erosion at a rate of -0.2 feet/year (UHCGG, 2019). The pocket beaches are dynamic and sand volumes and beach width often fluctuate. The pocket beaches are often completely submerged during high tide and high wave 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 Waikīkī 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 Halekulani 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 feet (1.2 meters) by 2050 and up to 14.1 feet (4.3 meters) by 2100 (UHCGG, 2019). These projections do not account for the presence of the existing seawalls that span the entire length of the Halekulani 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 tides and high surf events.

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 feet/year (UHCGG, 2019). The accretion is likely attributable to the addition of beach sand due to previous beach restoration efforts. Miller et al. (2003) found that sediment transport is predominantly in a northwesterly direction and that a 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.

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 feet (26.6 meters) by 2050 and up to 216.2 feet (65.9 meters) 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 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 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.

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 feet/year (UHCGG, 2019). The erosion is more pronounced in the Diamond Head (east) basin with predominant sediment transport direction from east to west along this portion of the Waikīkī shoreline (Miller et al. 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 ‘Ewa (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 feet (10.1 meters) by 2050 and 86.6 feet (26.4 meters) 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 extreme high tides and high surf events. Without beach improvements and 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.

The potential impacts of the proposed actions on shoreline change in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

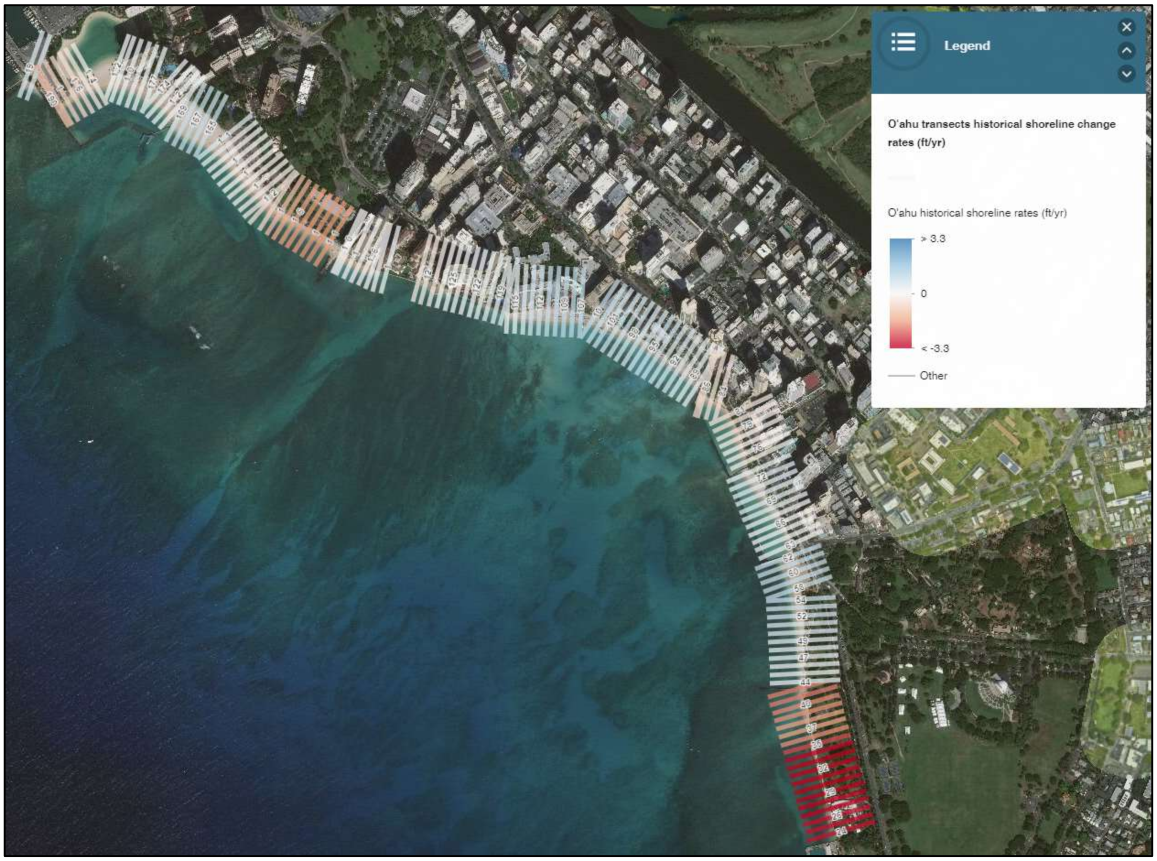


Figure 7-20 Waikīkī historical shoreline change rates,1927 to 2015 (UHCGG)

Table 7-13 Waikīkī historical shoreline change rates,1927 to 2015 (UHCGG, 2019)

Beach Sector	Historical Shoreline Change Rate (feet/year)
Fort DeRussy Beach	-0.4
Halekulani Beach	0.0
Royal Hawaiian Beach	+0.6
Kūhiō Beach	0.0

Table 7-14 Waikīkī projected shoreline change with sea level rise (UHCGG, 2019)

Beach Sector	Projected Erosion by 2050 (feet)	Projected Erosion by 2100 (feet)
Fort DeRussy Beach	-30.8	-81.0
Halekulani Beach	-3.9	-14.1
Royal Hawaiian Beach	-87.3	-216.2
Kūhiō Beach	-33.1	-86.6

7.4 Natural Hazards

7.4.1 Flooding

Flood hazards for the portion of Waikīkī in which the project is located are depicted on Flood Insurance Rate Map (FIRM) Flood Sheet 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 seaward of the shoreline is the VE Zone with a Base Flood Elevation (BFE) of +11 to +12 feet MSL. The area immediately landward of the shoreline is in Zone AE with a BFE of +7 to +8 feet MSL.

7.4.2 King Tide Flooding

During King Tide events, the still water level can exceed an elevation of as much as +3 feet 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 King Tide flooding. Flooding during these times is most pronounced when there are also high waves, such as during the summer surf season.

7.4.3 Wave Inundation

High water levels associated with El Nino, King Tides, and Sea Level Rise allow more wave energy to reach the shoreline. This results in higher wave runup and overtopping of the beach berm that can cause backshore flooding. 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.

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 7-21 shows a diagram of the elements of wave runup and inundation as modeled in the SLR-XA study.

The proposed projects would extend the shoreline seaward, and increase beach width and elevation, thereby increasing the space between the water and the existing backshore infrastructure. This will greatly increase the wave energy dissipating properties of the beach and decrease the landward extent of wave inundation. The increased energy dissipation of the widened beach is anticipated to reduce the susceptibility to backshore flooding from large wave events.

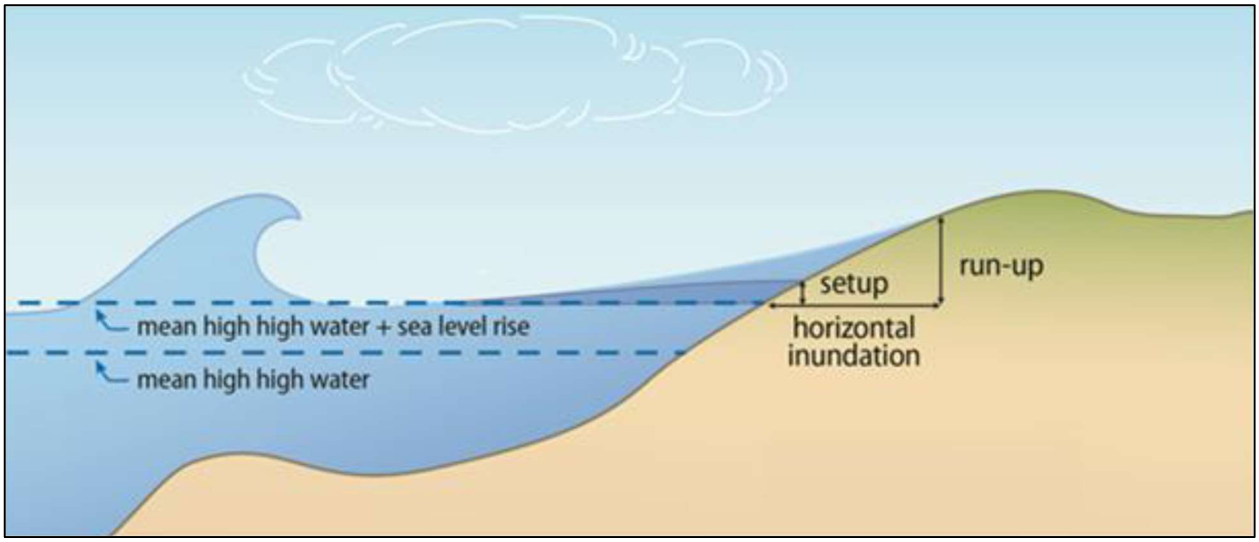


Figure 7-21 Diagram of wave runup (Hawai‘i Climate Change Commission, 2017)

7.4.4 Tsunami

Tsunami are sea waves that result from large-scale seafloor displacements. They are most commonly caused by earthquakes (magnitude 7.0 or greater) 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 they can have wave lengths of hundreds of miles and travel at 500 miles per hour. When they approach shore, they too begin to feel bottom and slow down, but not into a surf-shaped wave. Instead, the water increases greatly in height and pushes 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 Hawai‘i originate from the tectonically active areas located around the Pacific Rim (e.g., Alaska and Chile). Waves originating with earthquakes in these take hours to reach Hawai‘i, and the network of sensors that is part of the Pacific tsunami warning system can give Hawai‘i several hours advance warning of tsunami from these locations. Less commonly, tsunamis originate from seismic activity in the Hawaiian Islands, and there is much less advance warning for these. The 1975 Halape earthquake (magnitude 7.2) produced a wave that reached O‘ahu in less than a half hour, for example.

Fletcher et al. (2002) report that 10 of the 26 tsunamis with flood elevations greater than 3.3 feet (1 m) that have made landfall in the Hawaiian Islands during recorded history have had “significant damaging effects on O‘ahu.” This means that, on average, one damaging tsunami reaches O‘ahu every 19 years. The recent record (1946 to the present) has seen four tsunami cause damage on O‘ahu, a rate that is very close to the longer-term average. In view of this, the U.S. Geological Survey (Fletcher et al. 2002) assigned the Honolulu coastal zone a moderate to high (5) Overall Hazard Assessment (OHA). The report notes that, while observations of tsunami flooding have not exceeded 8 feet, much of the Waikīkī shoreline is below that elevation.

7.4.5 Storm Waves

The wave regime along the project shoreline is discussed in considerable detail in Section 7.4.1 of this report. The U.S. Geological Survey (Fletcher, et al. 2002) rates the threat from high waves along the shoreline as moderate to high because this region regularly receives nearshore breaking wave heights on the order of 6 feet 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 which impacted the south shore of Oʻahu include Hurricane Iwa in 1982 and Hurricane Iniki in 1992. Although not frequent events, they should be considered in shoreline planning and design. Climate change and ocean warming may increase the likelihood of hurricane events in the Hawaiian Islands.

The potential impacts of the proposed actions on natural hazards in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.5 Water Quality

The waters offshore of Waikīkī Beach 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. It is the objective of Class A waters that their use for recreational purposes and aesthetic enjoyment be protected. Investigations for the 2012 Waikīkī Beach Maintenance I project showed that in water quality in Waikīkī is generally consistent with that typically found in Hawaiʻi's coastal waters, with temperature, salinity, dissolved oxygen, and pH within normal limits. Total nitrogen and total phosphorus are typically slightly high, and turbidity levels generally exceed State water quality criteria. The high turbidity levels are attributed to wave action stirring up and suspending fine bottom sediment. The State Department of Health, Clean Water Branch, 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 Hawaiʻi Water Quality Standards, particularly during the wet season.

The potential impacts of the proposed actions on water quality in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.6 Marine Biota

7.6.1 General Conditions

The nearshore seafloor is a highly bio-eroded fossil limestone reef platform with sand-filled pockets and channels. Corals are generally absent from the reef platform offshore of Waikīkī. Coral colonies typically account for less than one percent of the bottom area and are composed almost entirely of two species, *Porites lobata* and *Pocillopora meandrina*. Wave-induced scour from suspended sand is likely responsible for the observed limited coral abundance. The dominant species of benthic organisms on the reef platform are marine algae, which cover virtually all exposed reef surfaces. The invasive algae species *Acanthophora spicifera* and *Gracilaria salicornia* dominate the benthic flora in Waikīkī. The most common macroinvertebrates on the reef platform are the rock-boring urchin *Echinometra mathaei* and the black sea cucumber *Holothuria atra*.

7.6.2 Essential Fish Habitat

The marine water column from the surface to a depth of 1,000 meters from shoreline to the outer boundary of the Exclusive Economic Zone (EEZ) (5,150 kilometers/200 nautical miles/ 230 miles), and the seafloor from the shoreline out to a depth of 700 m around each of the Hawaiian Islands, have been designated as Essential Fish Habitat (EFH). As such, the water column along Waikīkī Beach is designated as EFH and support various life stages for the management unit species (MUS) identified under the Western Pacific Regional Fishery Management Council's Pelagic and Hawaiʻi Archipelago Fishery Management Plan. There are no areas within the project area that have been designated as Habitat Areas of Particular Concern (HAPC) under the EFH regulations and no portion of the proposed project area would qualify as a HAPC.

7.6.3 Rare, Endangered and Protected Species

Listed protected species, sea turtles, Hawaiian monk seal, and humpback whales occur in the project vicinity. State protected hermatypic corals occur in Waikīkī in very low numbers. Of the sea turtles found in the Hawaiian Islands, only the green sea turtle is common in the project vicinity. Turtles can frequently be seen foraging on the abundant benthic macroalgae in nearshore waters. However, turtles are not known to nest on Waikīkī Beach, with the exception of Kaimana Beach and Kapua Beach (fronting the Outrigger Canoe Club) east of the project site. Turtles are often found in the vicinity of swimmers and surfers and do not appear to be deterred or bothered by human activities. The beaches and coastline of Oʻahu are used by the endangered Hawaiian monk seal for hauling out (resting) and for pupping and nursing. Seals have been observed in the waters off Waikīkī, and a seal recently gave birth to a pup on Kaimana beach. Endangered Humpback whales can regularly be seen in Hawaiian waters during the winter; however, the shallow Waikīkī nearshore waters prevent them from coming close to shore.

The potential impacts of the proposed actions on marine biota in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.7 Noise

Hawaiʻi Administrative Rules §11-46, "Community Noise Control" establishes maximum permissible sound levels (

Table 7-15) 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 pre-determined 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 7-15 if it is in the public interest and subject to any reasonable conditions. Those conditions can include requirements to employ the best available noise control technology.

Table 7-15 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: Hawai'i Administrative Rules §11-46, "Community Noise Control"

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.

The potential impacts of the proposed actions on noise in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.8 Historical, Cultural and Archaeological Resources

In prehistoric and early historic periods, Waikīkī was a place of great cultural significance for Hawaiians. It was important as an agricultural center, a site of royal residences and *heiau*, as well as being a center for traditional Hawaiian cultural practices including human sacrifice, surfing, gathering of *limu*, and the traditional healing ablutions in the waters of Kawehewehe. Waikīkī was also the site of at least two important battles, the 1793 invasion of Oʻahu by the forces of the Moi of Maui, Kahekili and the 1795 invasion of Oʻahu by Kamehameha the Great which led up to the unification of the Hawaiian Islands under his rule. The following general discussion of historical and cultural resources in the project vicinity is based on investigations accomplished by Cultural Surveys Hawaiʻi, Inc. (Groza et al, 2009).

Habitation

Waikīkī was a center of population and political power on O‘ahu beginning long before the Europeans arrived in the Hawaiian Islands during the late eighteenth century. Kanahele (1995:134) notes that Waikīkī’s ancient chiefs had located their residences there for hundreds of years and that Kamehameha V’s residence was at Helumoa (near where the Royal Hawaiian Hotel is currently located). Kanahele (1995:134-1345) goes on to explain that: “Three features were common to royal locations in Waikīkī. They were situated 1) near the beach, 2) next to a stream or *‘auwai* (canal) and 3) among a grove of coconut or *kou* trees.”

Agriculture

Beginning in the fifteenth century, an extensive system of irrigated taro fields (*lo‘i kalo*) was constructed across the littoral plain from Waikīkī to lower Manoa and Palolo Valleys. This field system – thought to have been designed by the chief Kalamakua – took advantage of streams descending from Makiki, Manoa and Palolo valleys, which also provided ample fresh water for the people living in the ahupuaa. Water was also available from springs in nearby Moiliili and Punahou. Closer to the Waikīkī shoreline, coconut groves and fishponds dotted the landscape. A sizeable population developed amidst this Hawaiian-engineered abundance.

Aquaculture

The area known as Fort DeRussy (Kalia) contained ten Hawaiian fishponds used for aquaculture. Hawaii an aquaculture is especially notable as it was not practiced elsewhere in the Pacific in the same form. The majority of fishponds most likely were constructed in the sixteenth century. There are four basic types of ponds:[1]

loko i‘a kalo (fish and taro raised together in a pond),
loko wai (inland freshwater fishpond),
loko pu‘uone (isolated shore fishpond formed by a barrier sand berm creating a single elongated ridge parallel to the coast), and
loko kuapā (seawall on a reef with sluice gates)

Davis (1989, 1991) classified the ten fishponds at Fort DeRussy as *loko pu‘uone* with salt-water lens intrusion and fresh water entering from upland *‘auwai* (canals). Kahawai Piinaio was this type of stream. The 10 ponds are inland, swale-based ponds constructed between beach ridges that may have formed along the coast within the last millennium. Existing depressions in the sand were chosen to make the *loko pu‘uone*, and brush was cleared out. During traditional times, the ponds were used to farm fish, usually for the Hawaiian *ali‘i* (royalty). The *‘ama‘ama* (mullet) and the *awa* (milkfish) were the two types of fish traditionally raised in the ponds.

Marine and Freshwater Resources Gathering Practices

Kālia was once renowned for the fragrant *limu līpoa*, as well as several other varieties of seaweed such as *manauea*, *wāwae‘iole*, *‘ele‘ele*, *kala* and some *kohu*. The area between the Royal Hawaiian and the Halekulani was the area where *limu līpoa* was traditionally gathered.

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[1] Note: the prefix *loko* in the name means “body of water” and the suffix describes the specific type.

Oral information passed down to Mr. Bob Paoa[2] confirmed the great fishing and the abundant *limu* in the Kalia area. The project area was valued for harvesting of *limu kala* in particular to make *lei* for offerings.

McDonald (1985:66) notes that the "*lei limu kala* was and is still offered at the *ku'ula* [stone god used to attract fish] by fishermen or anyone who wishes to be favored by or is grateful to the sea". It is also well-known as an area where Green Sea Turtles or *honu* foraged.

Green Sea Turtles (which are now listed as endangered and threatened) were once a food source for Native Hawaiians. The meat, viscera, and eggs supplemented the more common food sources like fish, birds, shellfish, coconuts, breadfruit and taro. Native Hawaiians valued the adult female turtle as a delicacy because of its high amount of green body fat (http://www.fws.gov/pacificislands/ fauna/honu.html). *Honu* were also incorporated into religious and traditional ceremonies and were (and are) considered by some Native Hawaiian families to be a personal family deity or '*aumakua*. The harvesting of turtles was often regulated according to *kapu* rules, reserved exclusively for the use of chiefs, priests or only men for special occasions such as a wedding, funeral, religious ceremony, building of a canoe, etc. Native Hawaiians used the green fat for medicinal purposes to treat burns and other skin disorders.

Interviews reported in Chiogioji et al. (2005) confirm that the Waikīkī shoreline was abundant in many varieties of fish and *limu*, certain varieties of crab and lobster, as well as being good squid grounds. Fishermen who presently use the Waikīkī coast confirm this is still true today. Where one chooses to fish depends on the crowds at the beach and time of day as well as the distribution of favored resources. In Waikīkī, especially due to the high volume of people on the beaches, many fishermen these days go fishing at night. The more favorable fishing grounds are in front of the old Niumalu Hotel (Hilton Hawaiian Village), the Royal Hawaiian and Halekulani hotels, and the area fronting the Natatorium. Specifically, the area between Diamond Head and the Kapahulu Groin was considered better fishing grounds than the Outrigger Reef on the Beach/Fort DeRussy portion of the shoreline. Likewise, the squid grounds are located between the Kapahulu groin and Diamond Head.

Surfing and Other Sports

In pre- and early post-contact Waikīkī, surfing was popular to both chiefs (*ali'i*) and commoners (*maka'āinana*). So important was surfing that there is a major *heiau* dedicated to the *nalu* or surf, and its riders. Papaenaena, a terraced structure built at the foot 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 surfers call today "First Break," 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

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[2] Mr. Paoa is a community consultant who has participated in past cultural impact assessments by Cultural Surveys, Inc.

("Great Kelea who flutters,") has been preserved as a reminder of the role that surfing played in the history of Waikīkī (Kanahele, 1995:56-58). Kawehewehe, once the name of the surfing site off the project area, is called "Populars" today.

Wahi Pana (Storied Places)

The proposed project area, and the Waikīkī ahupuaa is a *wahi pana* (storied place), rich in *mo'olelo* (legends, myths), such as stories about *mo'o* (water spirits) associated with fishponds, springs and water resource areas that they guard and protect. Most noteworthy is Kawehewehe Pond, a place of spiritual healing. Kawehewehe is understood as the name of the beach on the 'Ewa side of the Royal Hawaiian Hotel (adjacent to Helumoa), just east of the Halekulani Hotel, Waikīkī.

Kawehewehe takes its meaning from the root word, "*wehe*" which mean "to remove" (Pukui et al. 1974:383). Thus, as the name implies, Kawehewehe was a traditional place where people went to be cured of all types of illnesses – both physical and spiritual – by bathing in the healing waters of the ocean.[3] The patient might wear a seaweed (*limu kala*) lei and leave it in the water as a request that his sins be forgiven; hence the origin of the name *kala* (Lit., the removal; Pukui et al. 1974:99). After bathing in the ocean, the patient would duck under the water, releasing the lei from around his neck and letting the *lei kala* float out to sea. Upon turning around to return to shore, the custom is to never look back, symbolizing the 'oki (to sever or end) and putting an end to the illness. Leaving the lei in the ocean also symbolizes forgiveness (*kala*) and the leaving of anything negative behind.

Hawaiian Trails

In *Fragments of Hawaiian History* John Papa 'I'i described the "Honolulu trails of about 1810" (1959: 89), including the trail from Honolulu to Waikīkī. He said that: "Kawaiahao which led to lower Waikīkī went along Kaananiau, into the coconut grove at Pawaa, the coconut grove of Kuakuaka, then down to Piinaio; along the upper side of Kahanaumaikai's coconut grove, along the border of Kaihikapu pond, into Kawehewehe; then through the center of Helumoa of Puaaliilii, down to the mouth of the Apuakehau Stream. ('I'i, 1959: 92).

Based on 'I'i's description, the trail from Honolulu to Waikīkī in 1810 coursed through the *makai* side of the present Fort DeRussy grounds in the vicinity of Kalia Road. It is likely that this trail was a long-established traditional route through Waikīkī.

Burials

The discovery of burials in the Waikīkī area during recent construction projects has caused increasing concern over the last few years. There are approximately 14,500 records associated with Land Commission Award (LCA) claims during the Mahele of 1847-1853. Of these records, 432 are for claims both awarded and unawarded in Waikīkī. Among these 432 claims, there is only one mention of a graveyard or burial place, Claim 613 (to Kuluwailehua) which was not awarded (www.waihona.com). Although it is uncertain where the reported burial ground is

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[3] It is uncertain if the tradition of Kawehewehe as a healing place originated hundreds of years ago in Hawaiian history or whether it began after the introduction of foreign diseases and epidemics that decimated thousands of Hawaiians.

located, based on the boundaries given in the testimony (Native Register, Vol. 2: 299-300) found at www.waihona.com, it is speculated that it might be adjacent to the old Waikīkī Church near Kaiulani Avenue. If that is correct, it places the burials at least one-half mile from the closest point on the project site. Withington (1953:16), probably referring to the *ʻokuʻu* (Lit., to squat on the haunches) or (possibly, cholera) plague (circa 1804), wrote:

> *"…a few years of peace settled over the Islands. Kamehameha and other warring chiefs took this opportunity to re-establish their forces, which had been greatly reduced through war and disease. A terrible epidemic of measles had attacked the people of the islands. It is claimed that more than three hundred bodies were carried out to sea from Waikīkī in one day" (Withington: 1953:16).*

It is possible that some of the Kalia burials discovered to date reflect such early depopulation by introduced diseases. Hawaiians placed significance on the *iwi* (bones), which were regarded as a lasting physical manifestation of the departed person and spirit. "The bones of the dead were guarded, respected, treasured, venerated, loved or even deified by relatives; coveted and despoiled by enemies" (Pukui et al. 1974:107).

The potential impacts of the proposed actions on historical, cultural and archaeological resources in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS), which will include a Cultural Impact Assessment (CIA) and Ka Paʻakai analysis.

7.9 Recreation

John Clark, a locally recognized expert on ocean recreation and cultural activities in Hawaiʻi, 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). His assessments included observation of ocean activities and ocean conditions in the project area, interviews with shoreline users, and evaluation of possible effects and impacts on recreation activities.

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. Sailing catamarans are permitted to operate on Waikīkī Beach. Beach concessions in the Fort DeRussy Beach sector 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.

Surfing

In pre- and early post-contact Waikīkī, surfing was popular to both chiefs (*ali‘i*) and commoners (*maka‘āinana*). So important was surfing that there is a major heiau dedicated to the *nalu* (surf) and its riders. Papa‘ena‘ena, a terraced structure built at the foot 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 Hawai‘i, where surfing was a national pastime. Native Hawaiians surfed at hundreds of surf spots on all eight of the major 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 to Native Hawaiians. Wave-riding and surfboard-crafting were both ceremonious and skillful arts that demonstrated the important connection between 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 7-22). Notable surfing sites offshore of the project area include:

- Fort DeRussy Beach Sector – Kaiser Bowls, Fours, Threes
- Halekulani 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, CNE

Figure 7-22 Waikīkī surfing sites

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 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 Queen's 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 informant 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 informants.

Marine Managed Areas

The Waikīkī Marine Managed Areas (MMA) includes two designated areas: 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 Hawai‘i, 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 surf spot Queen’s 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.

The potential impacts of the proposed actions on recreation in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.10 Socioeconomic Environment

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. Quantifying the economic implications of the degraded beach condition is difficult. However, 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 who do not revisit cite crowding and congestion (considered to be of the beach) as reasons. 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 come, would spend an estimated $181 million/year.

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 accomplished by Hospitality Advisors LLC (2008) for the Waikīkī Improvement Association 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.

The 2008 analysis of the value of Waikīkī Beach has been updated using 2016 economic and visitor arrival data (Tarui et al. 2018). Hospitality Advisor's 2008 report concludes that just under $2 billion (2007 U.S. dollars) in overall visitor expenditures could be lost annually due to a complete erosion of Waikīkī Beach. The 2008 report investigated the economic impact of the erosion of Waikīkī Beach through visitor surveys and analysis of data provided by the Hawai‘i Department of Business, Economic Development and Tourism, Hawai‘i Tourism Authority, and Smith Travel Research.

Tarui et al. (2018) updated the economic impact estimates with the most recent set of complete tourism data available for 2016. The estimated potential loss in spending and revenue increased slightly to $2.223 billion in 2016 (about a 1.4% decrease from 2007 after adjustment for inflation). While the total number of O‘ahu visitors increased by 18.5% between 2007 and 2016, the rate of change differs among visitors from different parts of the world, whose spending patterns and likelihood to revisit Waikīkī after complete beach erosion varies. The average daily rate for hotel accommodation increased by 15.0%, but the average daily expenditure per visitor decreased by 6.2% between 2007 and 2016 (daily expenditures outside hotels decreased by more than 16%). O‘ahu, in particular, has many new visitors, but on average these visitors spend less than the visitors to the neighbor islands do. These factors together explain the 1.4% reduction in the estimated economic impact of the erosion of Waikīkī Beach between 2007 and 2016 when adjusted for inflation.

The potential impacts of the proposed actions on the socioeconomic environment in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.11 Scenic and Aesthetic Resources

The gentle curve of the Waikīkī shoreline, the wide expanse of water with multiple surf breaks, the changing colors resulting from the varying water depths and bottom types, and the backdrop of Diamond Head make the seaward and long-shore 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 shore in the project area block the viewplane. As a result, views inland from this shoreline are not one of the "significant panoramic views" identified in the City and County of Honolulu's Development Plan for the area. The appearance of the beach is of significant interest to the resorts 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 Kalakaua Avenue.

The potential impacts of the proposed actions on scenic and aesthetic resources in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.12 Public Infrastructure and Services

7.12.1 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 Natatorium to the Queen's Surf groin, and then merges into the sidewalk along Kalakaua Ave. up to the Moana Surfrider hotel. Lateral pedestrian shoreline access is then only available by walking along Royal Hawaiian Beach seaward of the hotels. At high tide and during 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 shoreline sidewalk resumes at Fort DeRussy and extends to the Hilton Hawaiian Village.

Harbors

The nearest harbor is the Ala Wai Harbor, which is owned and operated by the State of Hawai‘i. Commercial cargo arrives and departs through Honolulu Harbor.

Airports

Honolulu International Airport is approximately six miles west of the project site.

The potential impacts of the proposed actions on public infrastructure and services in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.12.2 Water, Sewer, Power and Communications Systems

Water Supply

The Honolulu Board of Water Supply (BWS) is responsible for the management, control and operation of O‘ahu'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 beach maintenance would occur. Neither does it maintain nor operate any pipelines or other water supply facilities within the area that would be used by construction equipment.

Sanitary Wastewater Collection and Treatment Facilities

The City's 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.

Solid Waste Collection and Disposal

The City's 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.

Telecommunication Facilities

There are no telecommunication lines within the shoreline area or in the area which would 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.

The potential impacts of the proposed actions on water, sewer, power and communications systems in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

7.12.3 Police, Fire and Emergency Medical Services

Police Protection

The Department of Land and Natural Resources Division of Conservation and Resources Enforcement (DOCARE) is responsible for enforcement activities in areas controlled by the Department of Land and Natural Resources, which includes the area seaward of the certified shoreline where the beach maintenance would take place. In addition, Honolulu Police Department officers patrol accessible areas of the beach on all-terrain vehicles (ATVs). Presently, officers only patrol as far as the Royal Hawaiian due to the limited shoreline access. The proposed actions would 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 Kalakaua Avenue adjacent to the Moana 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 Kapi'olani 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.

The potential impacts of the proposed actions on police, fire and emergency medical services in Waikīkī will be discussed in the Draft Environmental Impact Statement (DEIS).

8. REQUIRED FEDERAL, STATE AND COUNTY APPROVALS

8.1 Required Federal 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)

8.2 Required State of Hawaiʻi Approvals

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

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

8.3 Required City and County of Honolulu Approvals

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

- Special Management Area Permit
- Shoreline Certification
- 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 8-1.

Table 8-1 Summary of Required Regulatory Approvals	**FORT DERUSSY**	**HALEKULANI**	**ROYAL HAWAIIAN**	**KŪHIŌ**
FEDERAL				
Department of the Army Nationwide Permit (NWP)	TBD	N	N	TBD
Department of the Army Individual Permit (IP)	TBD	R	R	TBD
STATE OF HAWAIʻI				
Environmental Impact Statement (EIS)	R	R	R	R
Small Scale Beach Restoration (SSBR)	TBD	N	TBD	TBD
Shoreline Certification	TBD	TBD	TBD	TBD
Conservation District Use Permit (CDUP)	TBD	R	R	R
Right of Entry Permit (ROE)	R	R	R	R
Coastal Zone Management Federal Consistency (CZM)	R	R	R	R
National Pollution Discharge Elimination System (NPDES)	R	R	R	R
Section 401 Water Quality Certification (WQC)	R	R	R	R
CITY COUNTY OF HONOLULU				
Shoreline Setback Determination	R	R	R	R
Shoreline Setback Variance	TBD	TBD	TBD	TBD
Special Management Area Permit	TBD	TBD	TBD	TBD
Grubbing, Grading and Stockpiling Permit	N	R	TBD	TBD
Building Permit	N	TBD	N	TBD

R = REQUIRED
N = NOT REQUIRED
TBD= TO BE DETERMINED

9. 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.

10. EARLY CONSULTATIONS

The proposed actions presented in this EISPN 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 Consultations

12/16/2016	Coordination meeting Waikīkī Beach Special Improvement District Association
11/07/2017	Waikīkī Beach Community Advisory Committee Meeting
12/05/2017	Public meeting at Waikīkī Community Center
01/28/2018	Coordination meeting Waikīkī Beach Special Improvement District Association
03/20/2018	Waikīkī Beach Community Advisory Committee Meeting
07/13/2018	Coordination meeting Waikīkī Beach Special Improvement District Association
02/13/2019	Waikīkī Beach Community Advisory Committee Meeting
06/19/2019	Coordination meeting Waikīkī Beach Special Improvement District Association
07/02/2019	Coordination meeting Waikīkī Beach Special Improvement District Association
10/30/2019	Waikīkī Beach Community Advisory Committee Meeting
10/30/2019	Coordination meeting Waikīkī Beach Special Improvement District Association
12/06/2019	Coordination meeting Waikīkī Beach Special Improvement District Association

Public Scoping Meeting

Pursuant to Hawaiʻi Administrative Rules (HAR) Chapter 11-200.1-4(b)(4), a public scoping meeting will be held during the EISPN 30-day public comment period. The purpose of the public scoping meeting is 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 Draft EIS and the significant issues to be analyzed in depth in the Draft EIS. The public scoping meeting will include a separate portion reserved for oral comments and that portion of the public scoping meeting will be audio recorded. The information for the public scoping meeting is listed below:

Date: Jan 7, 2021 02:00 PM Hawaiʻi Standard Time
Topic: Waikīkī Beach Improvements and Maintenance Program EIS Preparation Notice
Link: https://zoom.us/j/94554967228
iPhone one-tap: US: +16699009128,,94554967228# or +12532158782,,94554967228#
Telephone: US: +1 669 900 9128 or +1 253 215 8782 or +1 346 248 7799 or +1 646 558 8656 or +1 301 715 8592 or +1 312 626 6799
Webinar ID: 945 5496 7228
International numbers available: https://zoom.us/u/acf9qrLSi

For additional information, please visit the project website at:
Comments may also be submitted to David Smith, Ph.D., P.E at waikiki@seaengineering.com.

11. EISPN DISTRIBUTION LIST

The following agencies, organizations, and individuals will be directly notified of publication of the Waikīkī Beach Improvements Environmental Impact Statement Preparation Notice (EISPN).

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 HAWAI‘I
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 Education
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
Department of Transportation
Environmental Health Administration
Legislative Reference Bureau Library
Office of Hawaiian Affairs
University of Hawai‘i, Sea Grant Program
University of Hawai‘i, Water Resources Research Center
University of Hawai‘i, Thomas H. Hamilton Library
University of Hawai‘i at Hilo Edwin H. Mo‘okini Library
University of Hawai‘i, Maui College Library
University of Hawai‘i, Kaua‘i 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

STATE LIBRARIES
Department of Education, Hawaiʻi State Library
Department of Education, Hawaiʻi Documents Center
Department of Education, Kaimuki Regional Library
Department of Education, Kaneohe Regional Library
Department of Education, Pearl City Regional Library
Department of Education, Hawaiʻi Kai Regional Library
Department of Education, Hilo Public Library
Department of Education, Kahului Regional Library
Department of Education, Līhuʻe Public 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 Beach Community Advisory Committee
Waikīkī Special Improvement District Association
Waikīkī Improvement Association
Waikīkī Neighborhood Board
Diamond Head/Kapahulu/St. Louis Neighborhood Board
Hawaiʻi Shore & Beach Preservation Association
The Surfrider Foundation, Oʻahu Chapter
Save Our Surf

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APPENDIX A: WAIKĪKĪ BEACH COMMUNITY ADVISORY COMMITTEE MEETING SUMMARIES

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

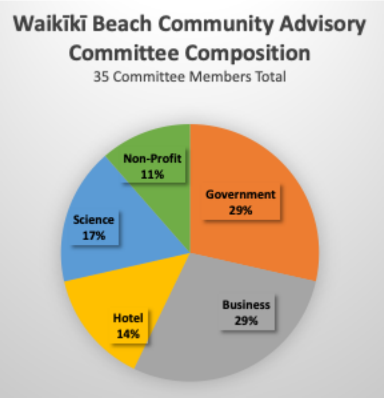
1. Advise the WBSIDA, the DLNR and UH Sea Grant on the development and implementation of a Waikīkī Beach Management Plan.
2. Ensure that future beach management projects address the issues and concerns of the Waikīkī community and local stakeholders.
3. Advise the State, County and stakeholders on beach 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.**

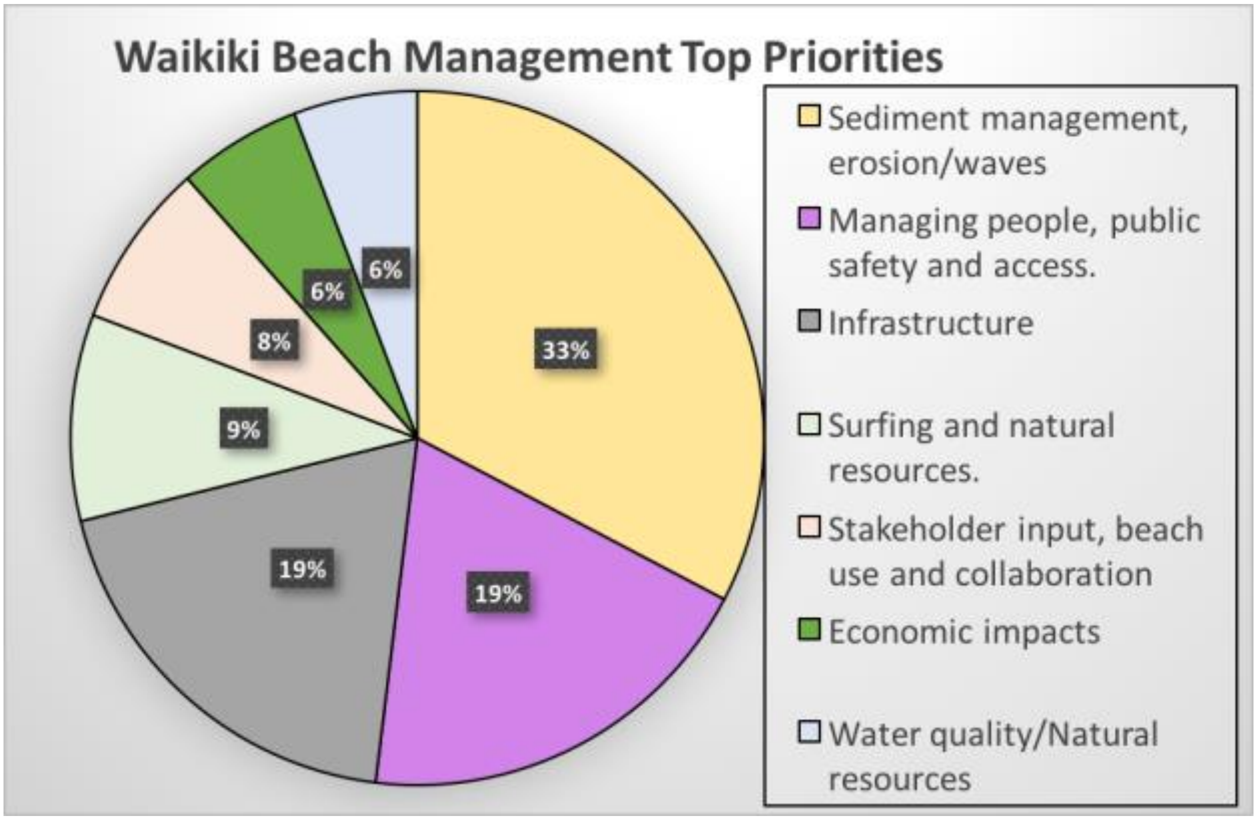
Summary of Priority Issue/Projects

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

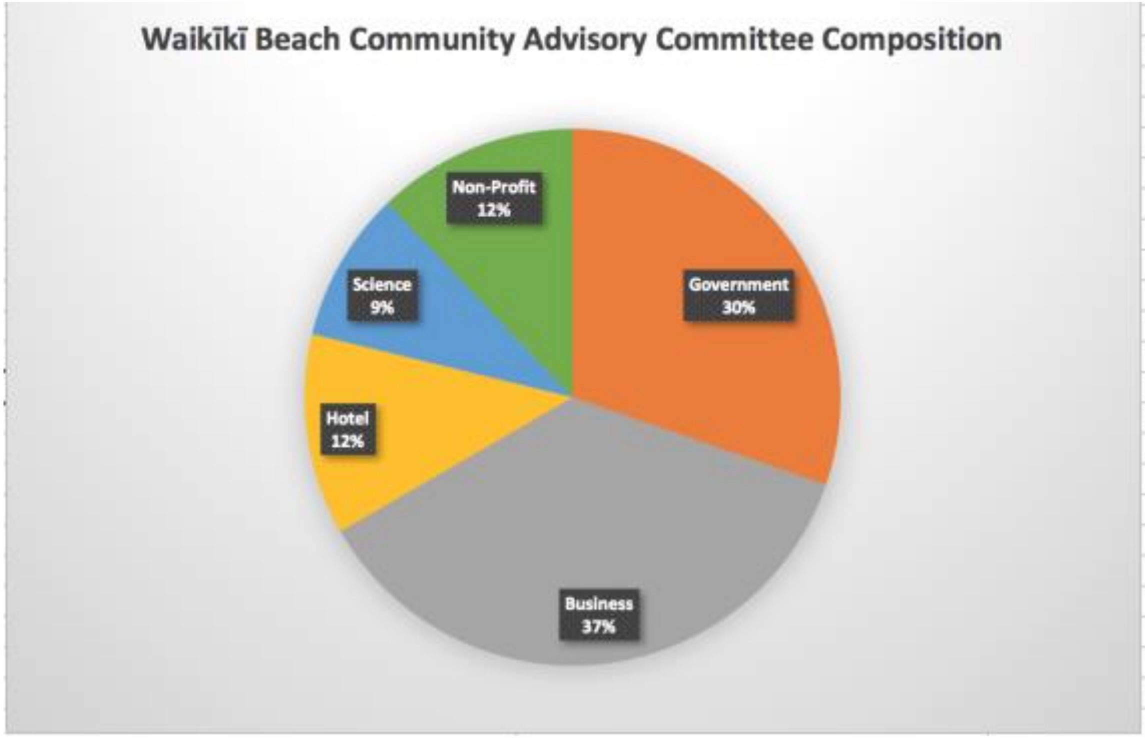
Name	**Comments**	**Primary Focus**	**Additional Focus**
Dolan Eversole *(UH Sea Grant/WBSIDA)*	Water quality, beach access alongshore, Reef health, Infrastructure maintenance. Economic studies will help justify maintenance projects in Waikīkī.	Water quality/Natural Resources	Infrastructure and access
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.

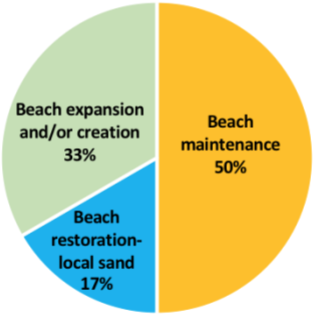
General Summary:

- 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

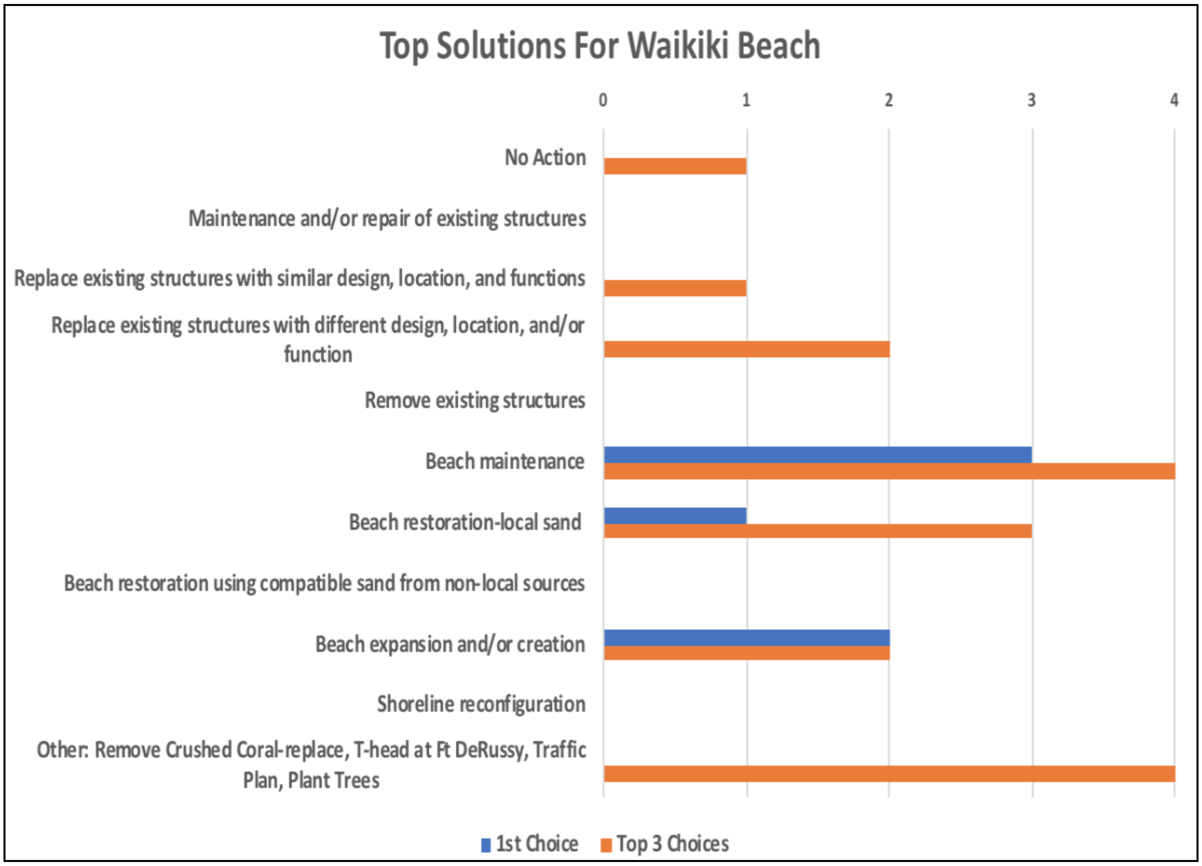
- The top solution identified for Waikīkī varied by cell but included beach maintenance and beach restoration using local sand sources with specific “other” options.

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:

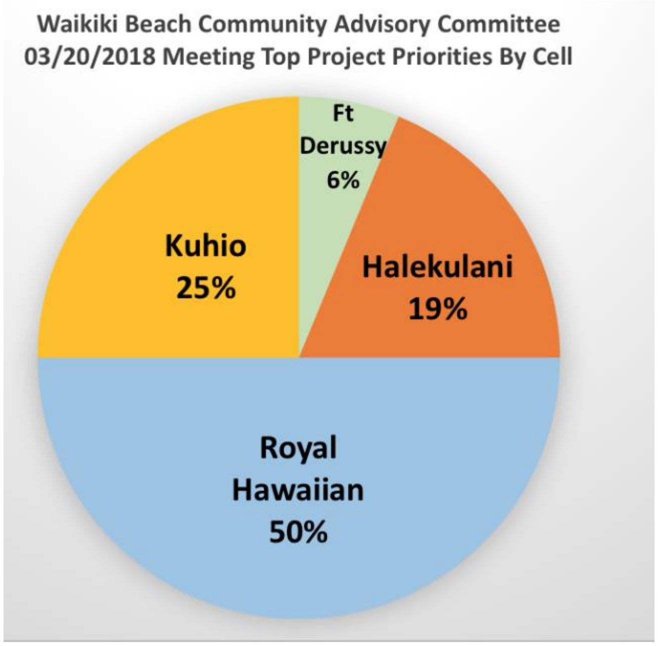
1. Committee members are supportive of a rapid response to the erosion problem here. A possible solution of sandbag groin(s) possibly 2 or 3 was discussed and seemed to be agreeable to the Committee. Although no vote was taken, there were no objections to the project moving forward into a design phase.
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.

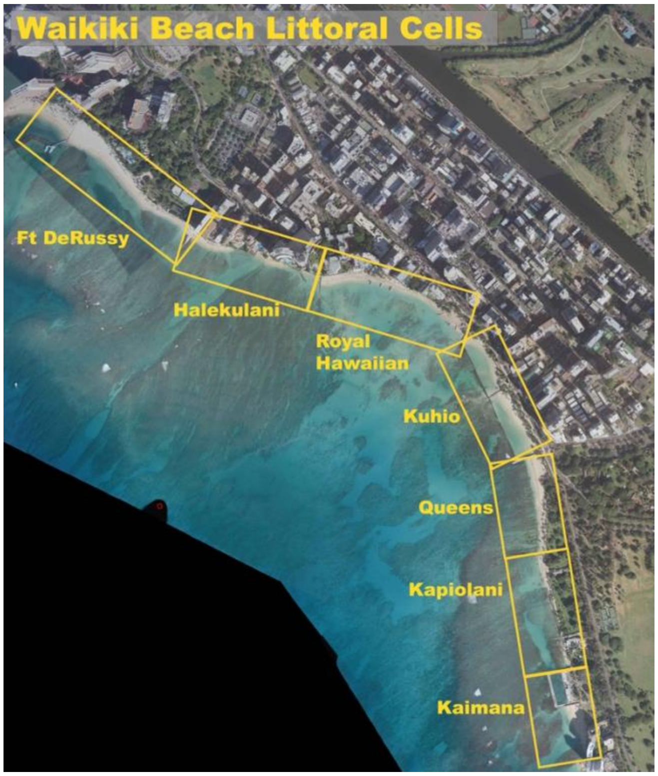
Discussion:

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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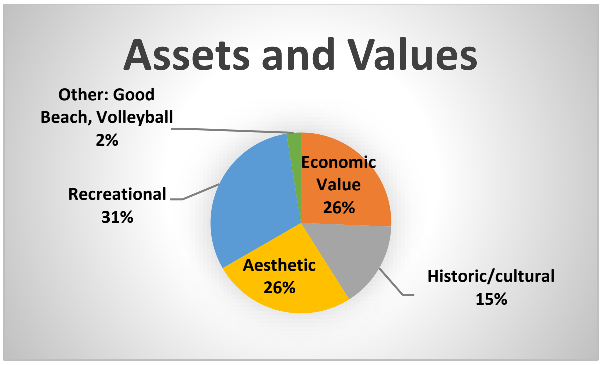
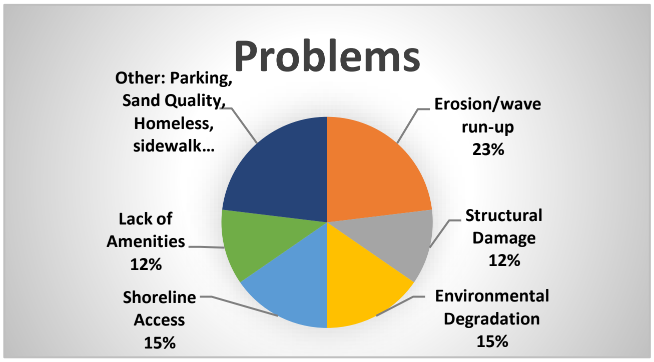
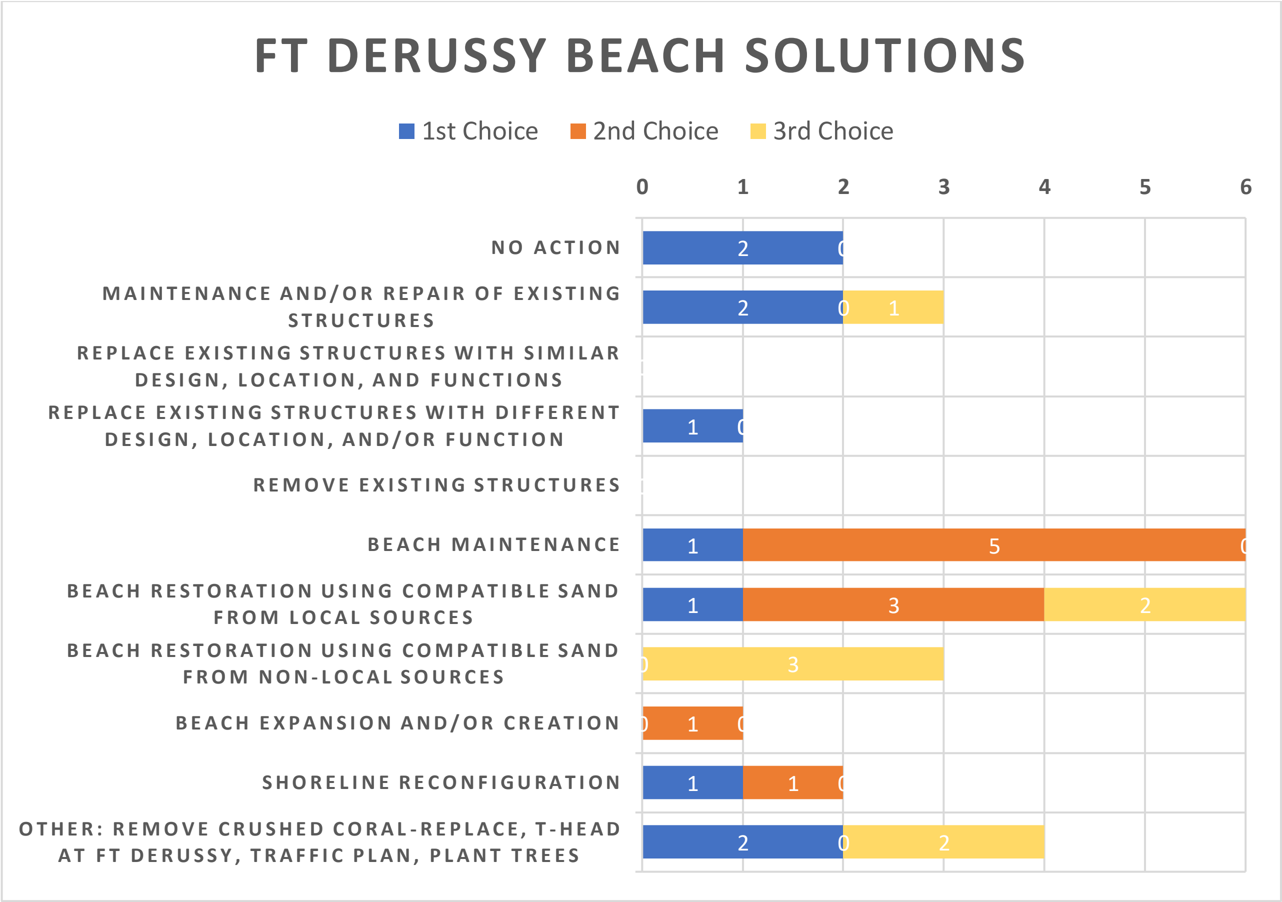
FT. DERUSSY BEACH, WAIKIKI

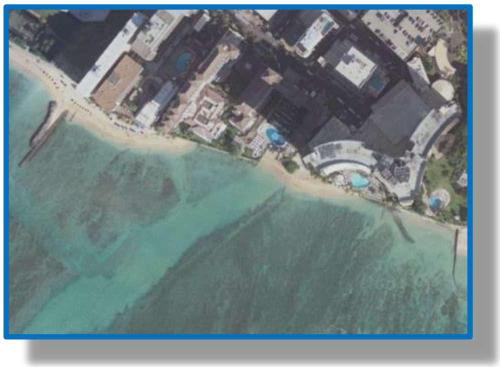
ASSETS & VALUES



ISSUES & PROBLEMS

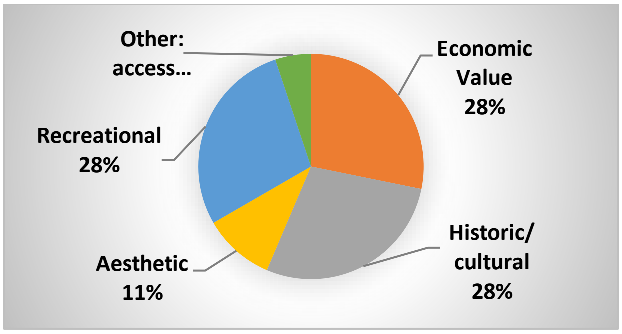




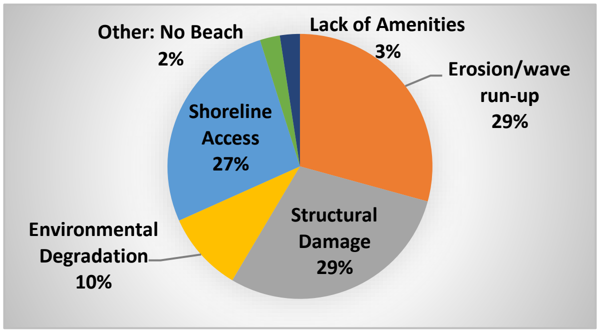


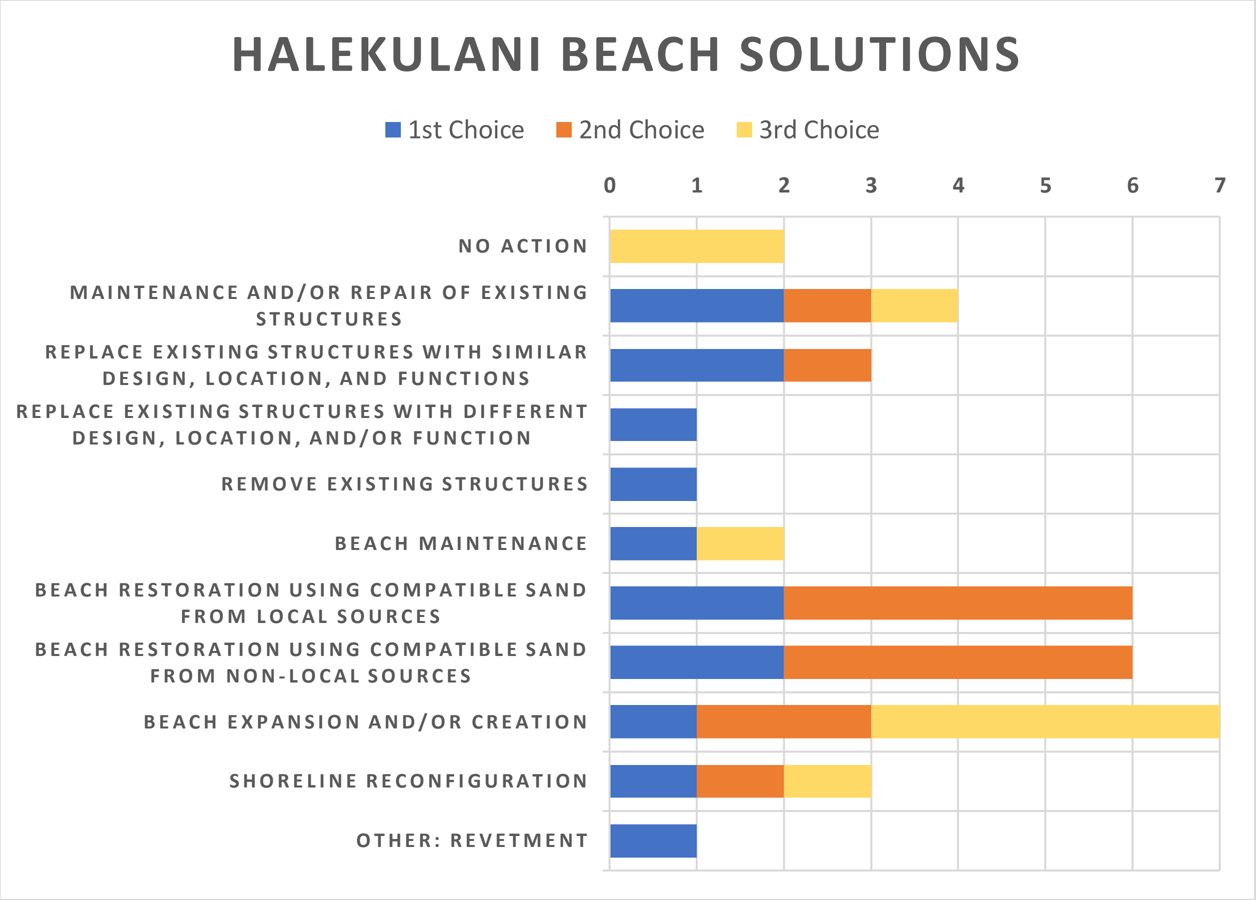
HALEKULANI BEACH, WAIKIKI

ASSETS & VALUES



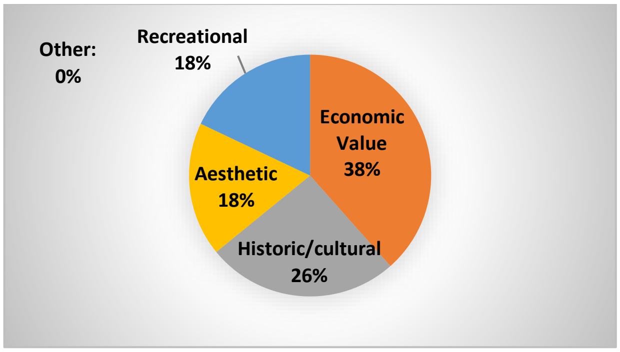
ISSUES & PROBLEMS



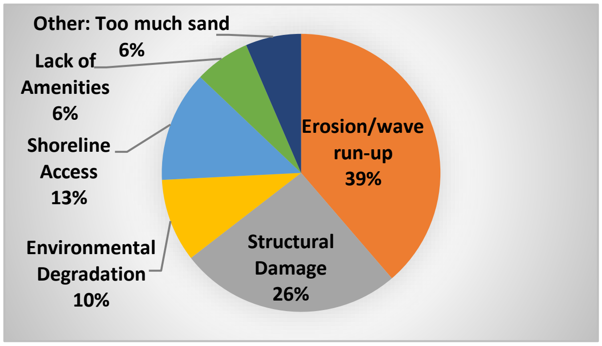


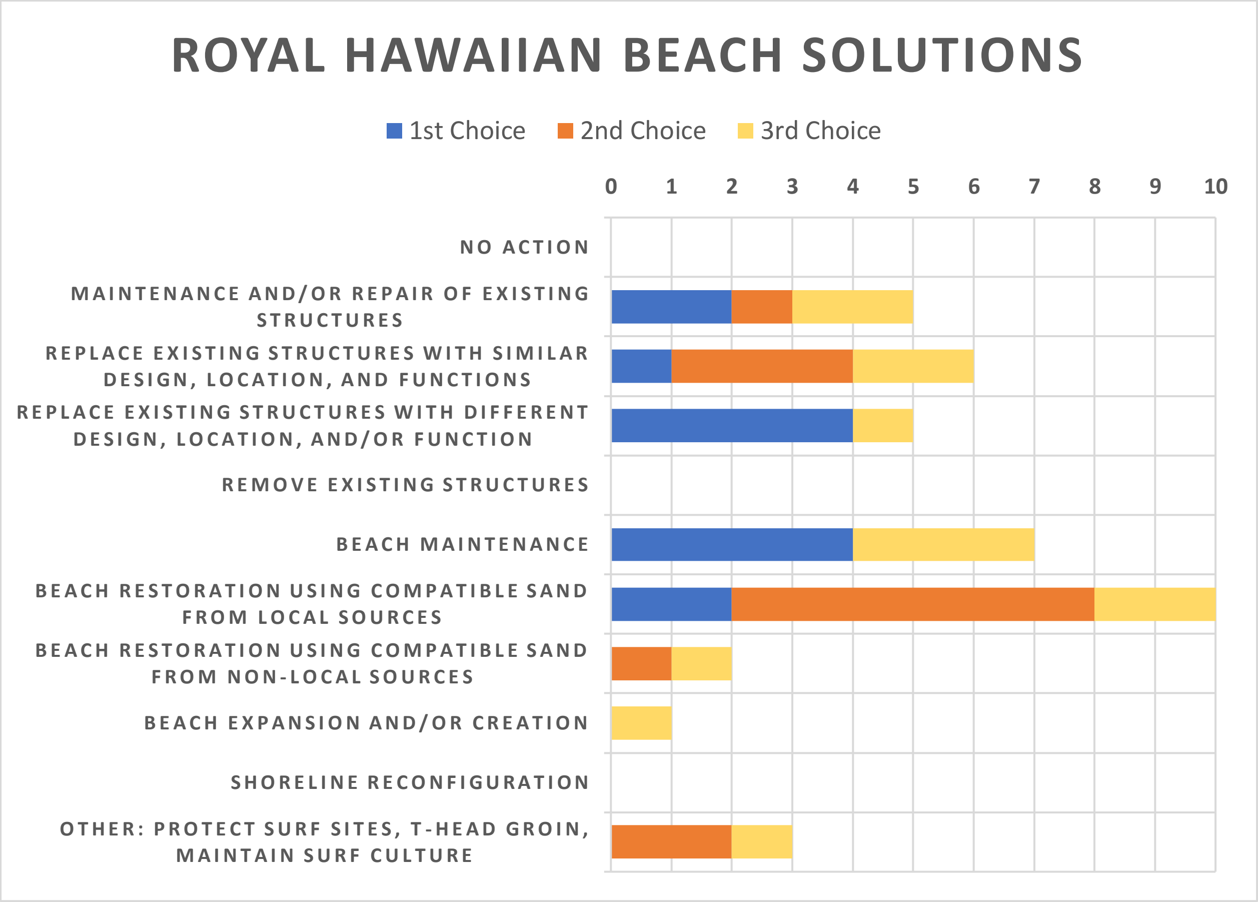
ROYAL HAWAIIAN BEACH, WAIKIKI

ASSETS & VALUES



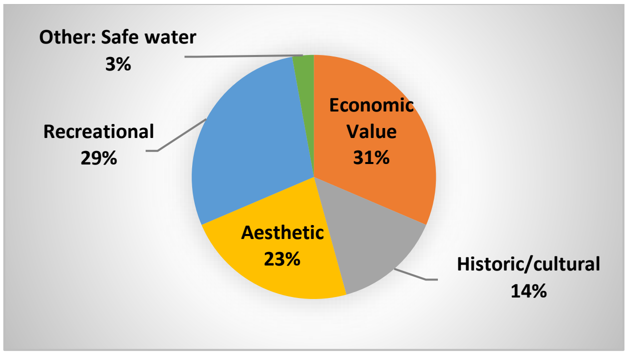
ISSUES & PROBLEMS



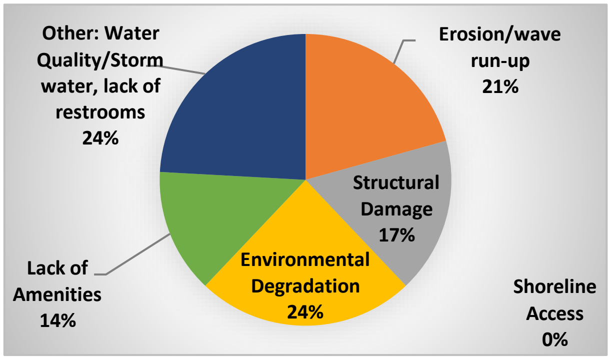


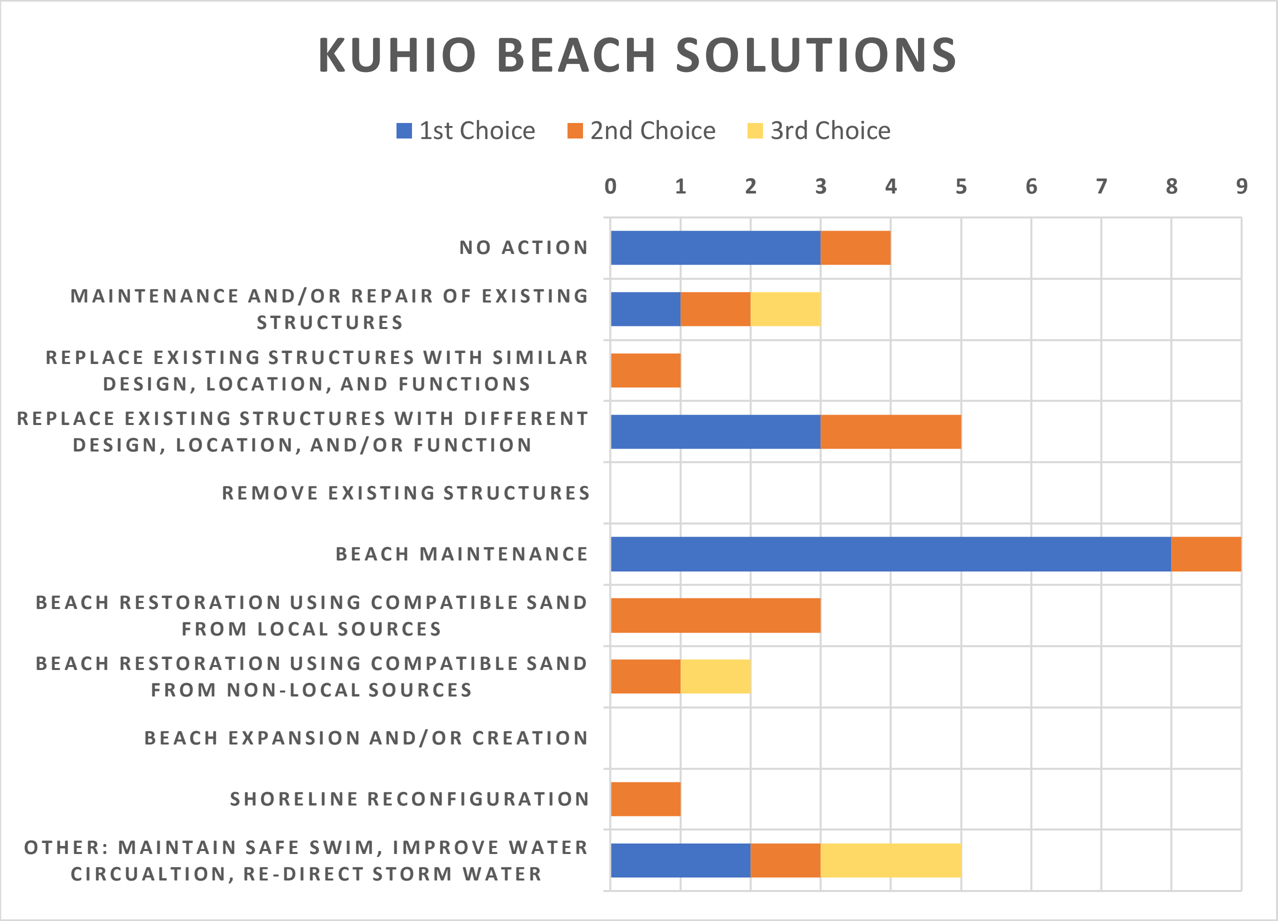
KUHIO BEACH WAIKIKI

ASSETS & VALUES



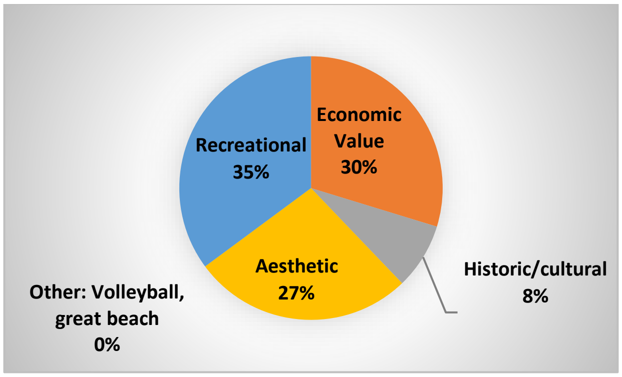
ISSUES & PROBLEMS



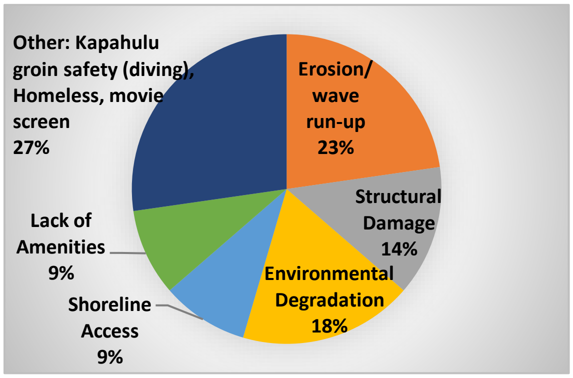


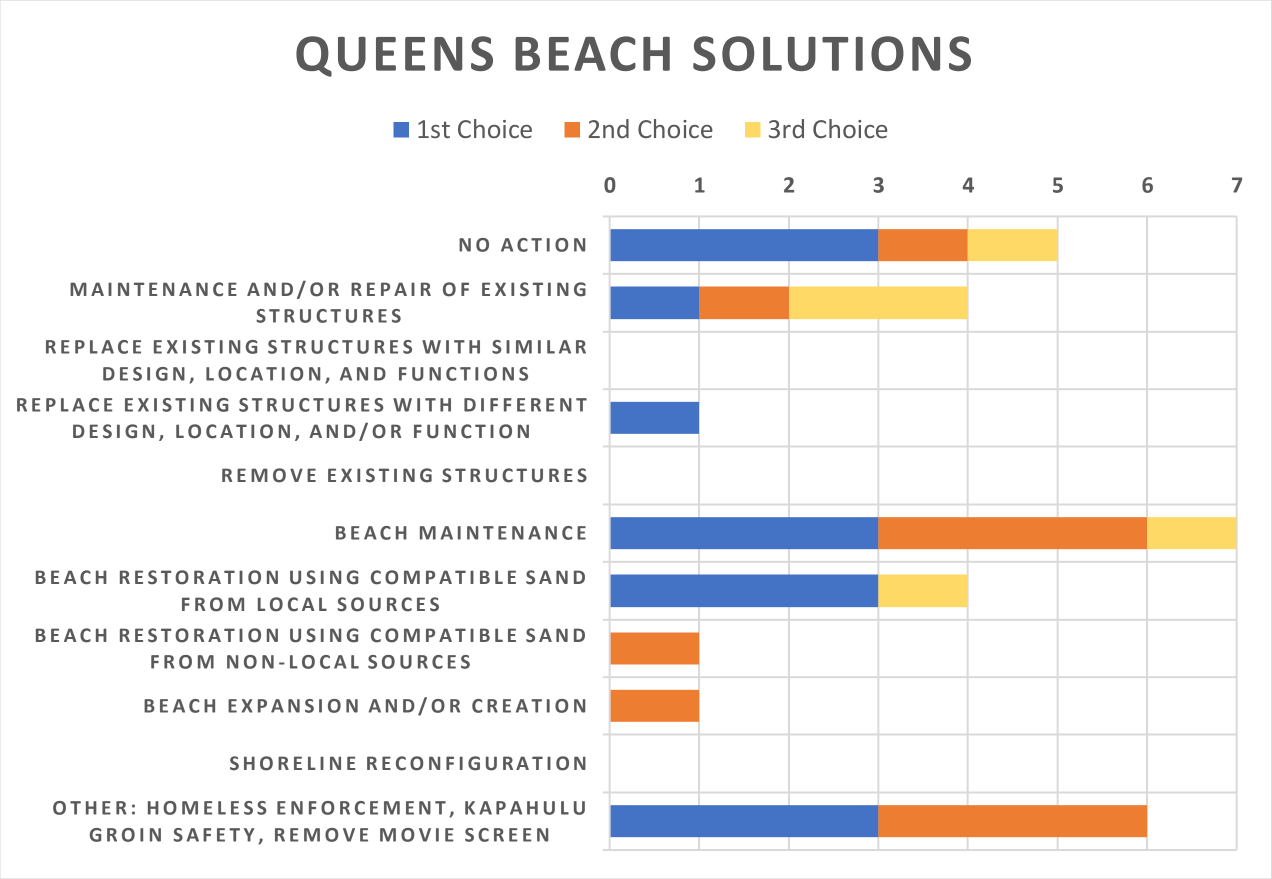
QUEENS BEACH WAIKIKI

ASSETS & VALUES



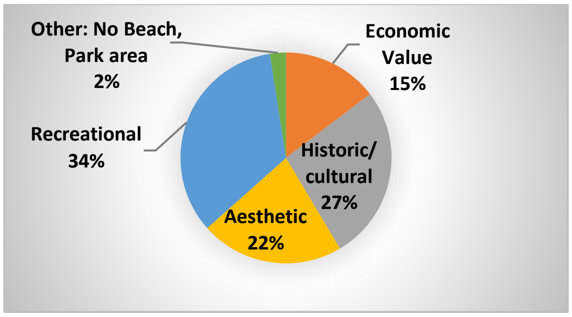
ISSUES & PROBLEMS



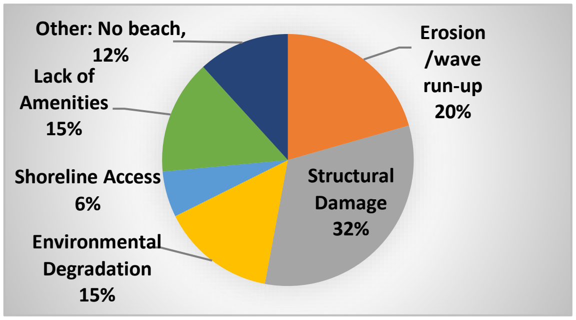


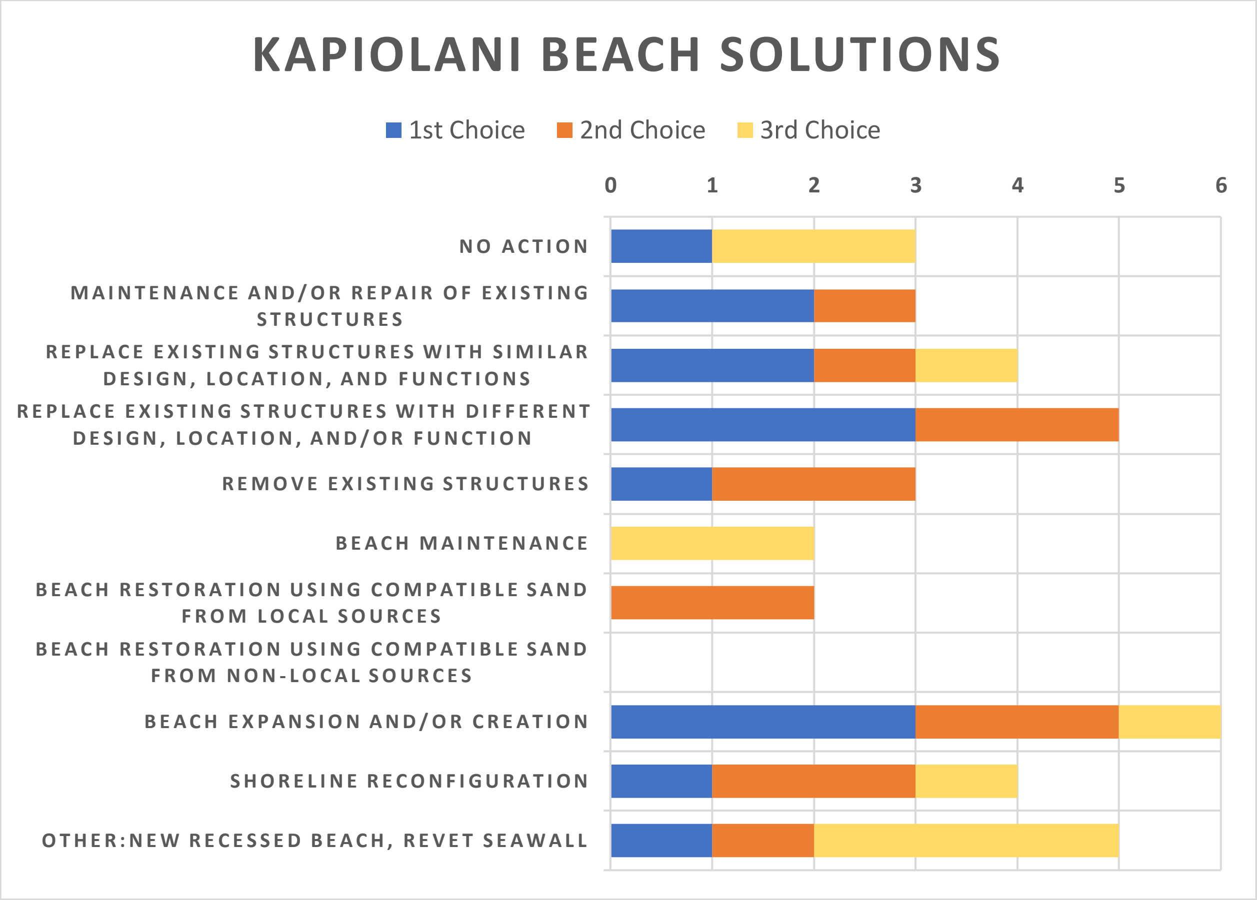
KAPIOLANI BEACH WAIKIKI

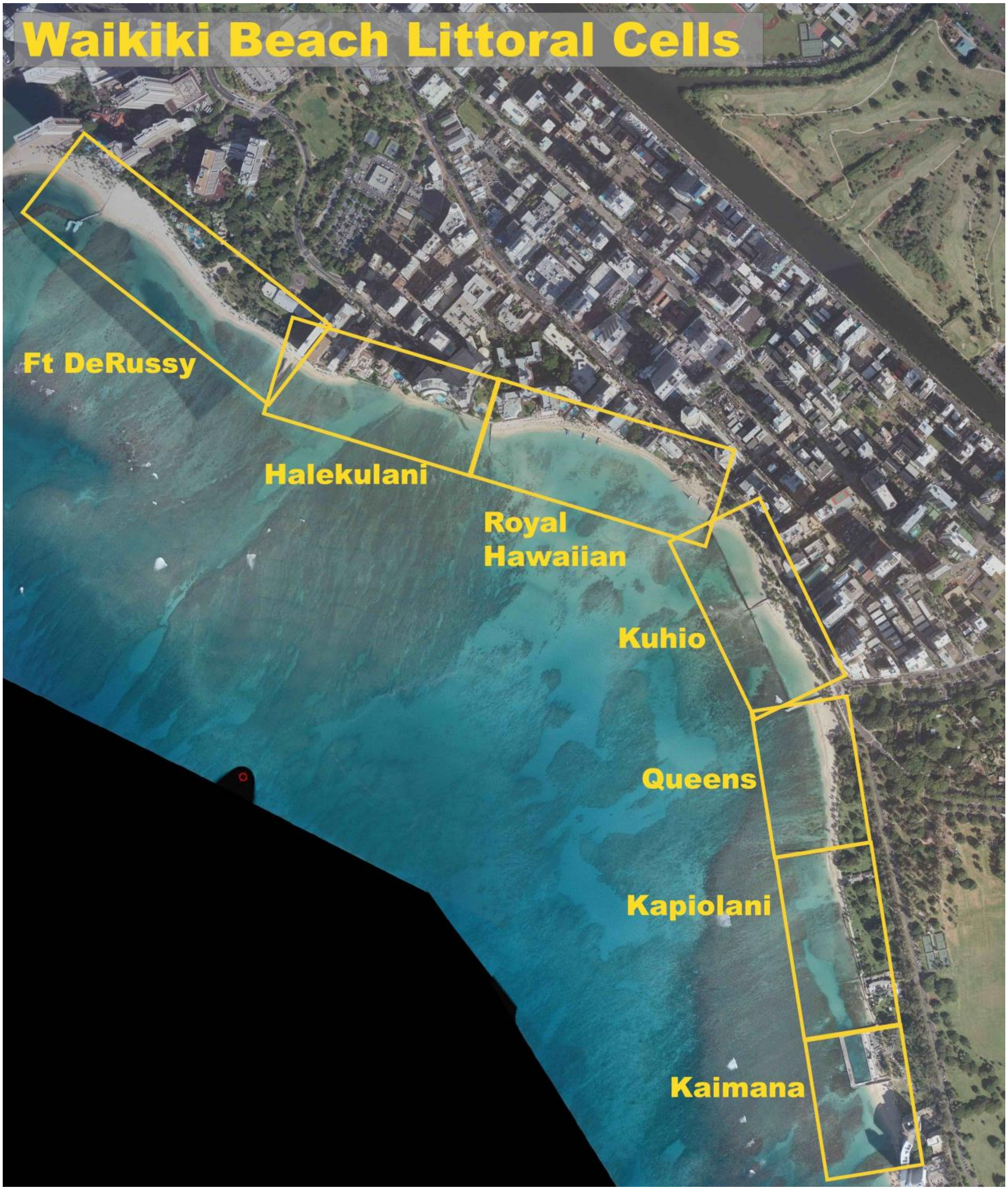
ASSETS & VALUES



ISSUES & PROBLEMS






Waikiki Beach Littoral Cells
Ft DeRussy
Halekulani
Royal Hawaiian
Kuhio
Queens
Kapiolani
Kaimana

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

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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/

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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.
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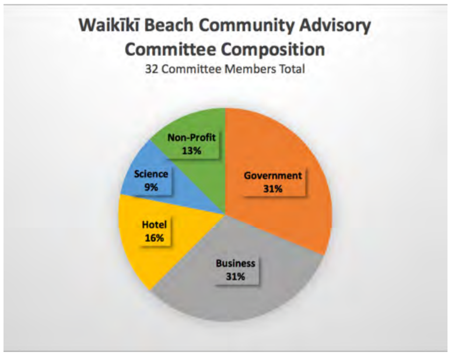

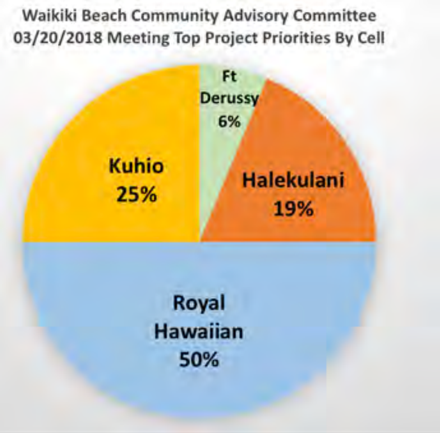

General Meeting Summary:

- 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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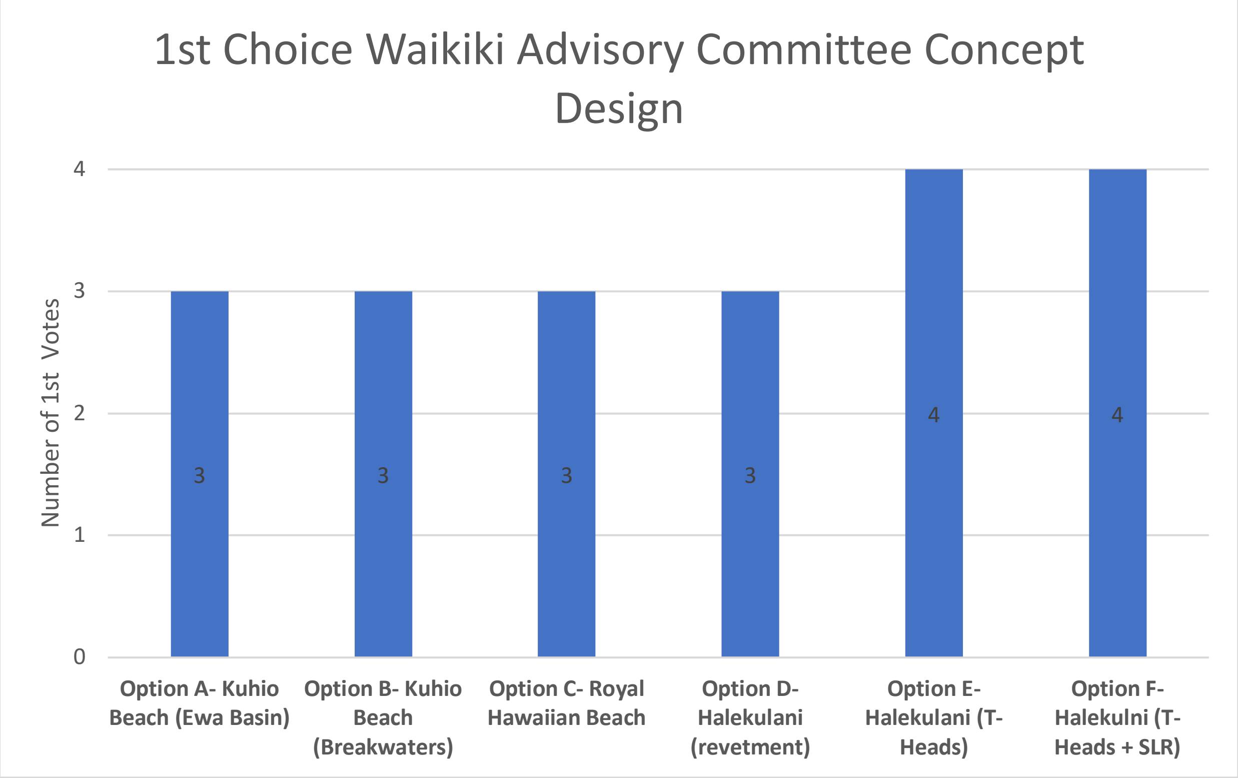
[1] A larger sample size will result in more statistically relevant and representative results. This could be done as an online survey to a wider stakeholder group and/or as public survey. Ideally future surveys will evaluate and rank various options for each cell rather than rank overall for all cells.

Conceptual Design Ranking Exercise – Results

Figure 1.



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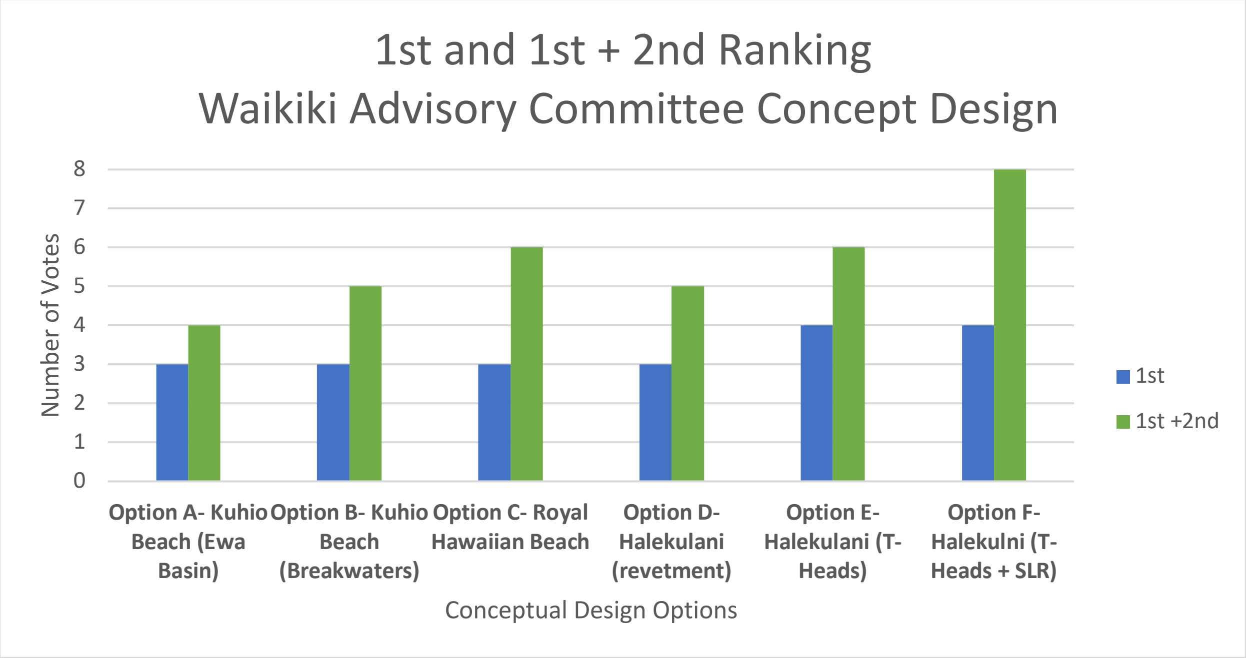
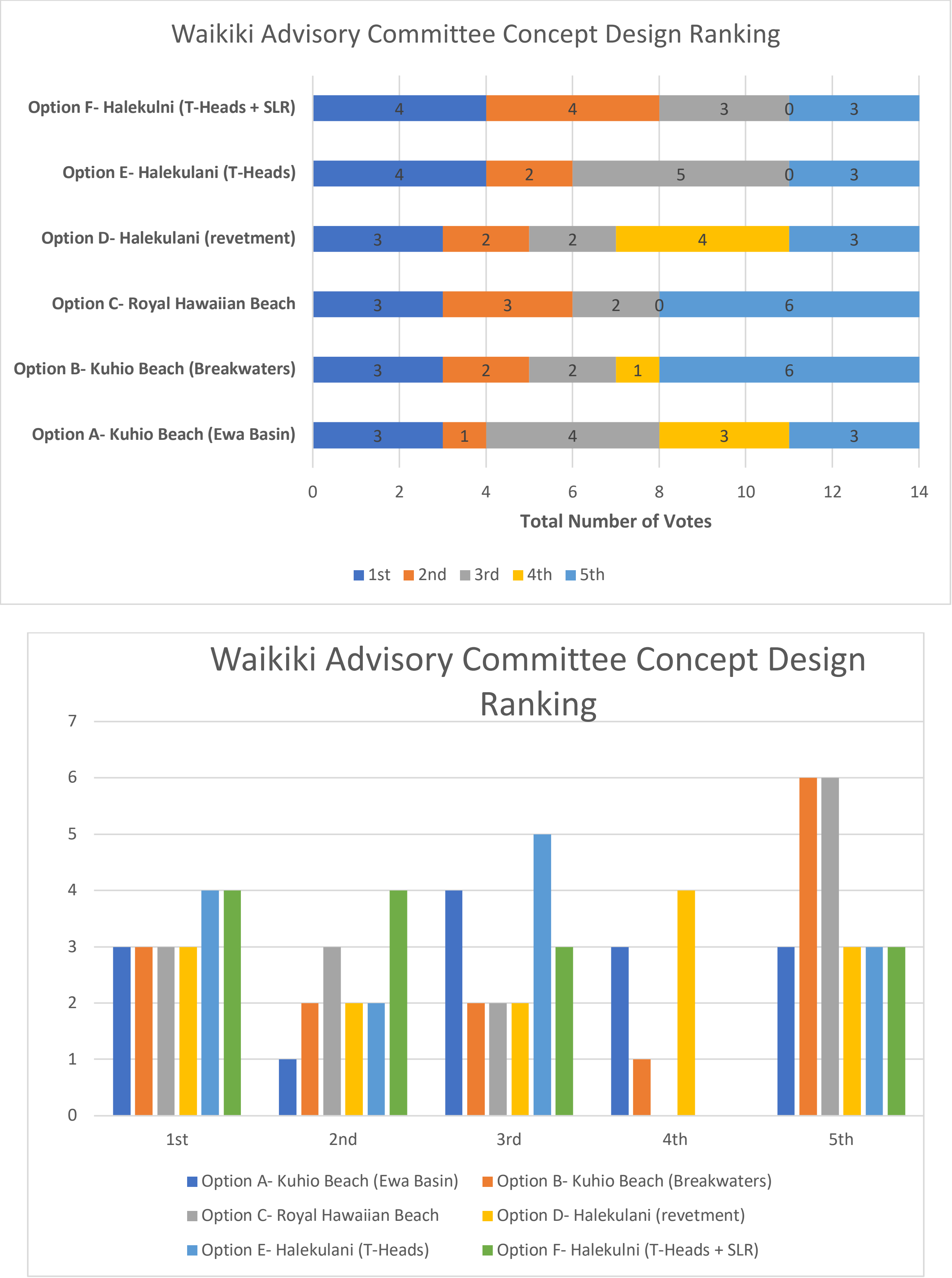


Figure 3.


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: ______________________________

WBSIDA Waikīkī Beach SPECIAL IMPROVEMENT DISTRICT ASSOCIATION

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] Kam	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 SeaGrant	

PRIORITY PROJECT AREAS

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 Hawaiʻi 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

HO'OMAU 'O WAIKĪKĪ KAHAKAI

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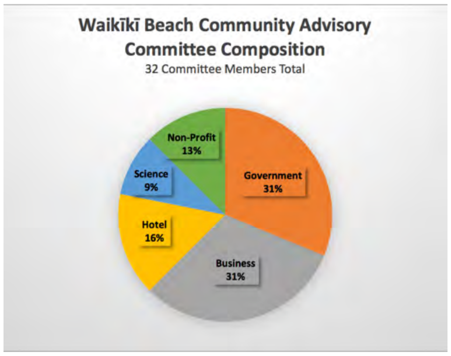

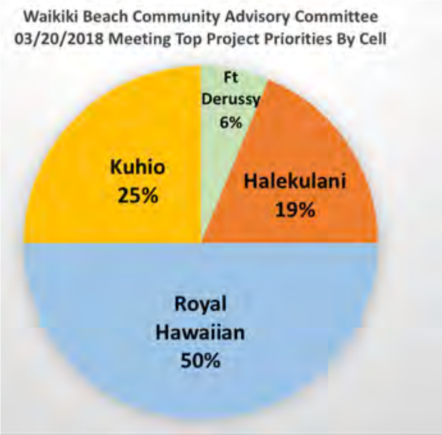

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f.

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Conceptual Design Ranking Exercise – Results

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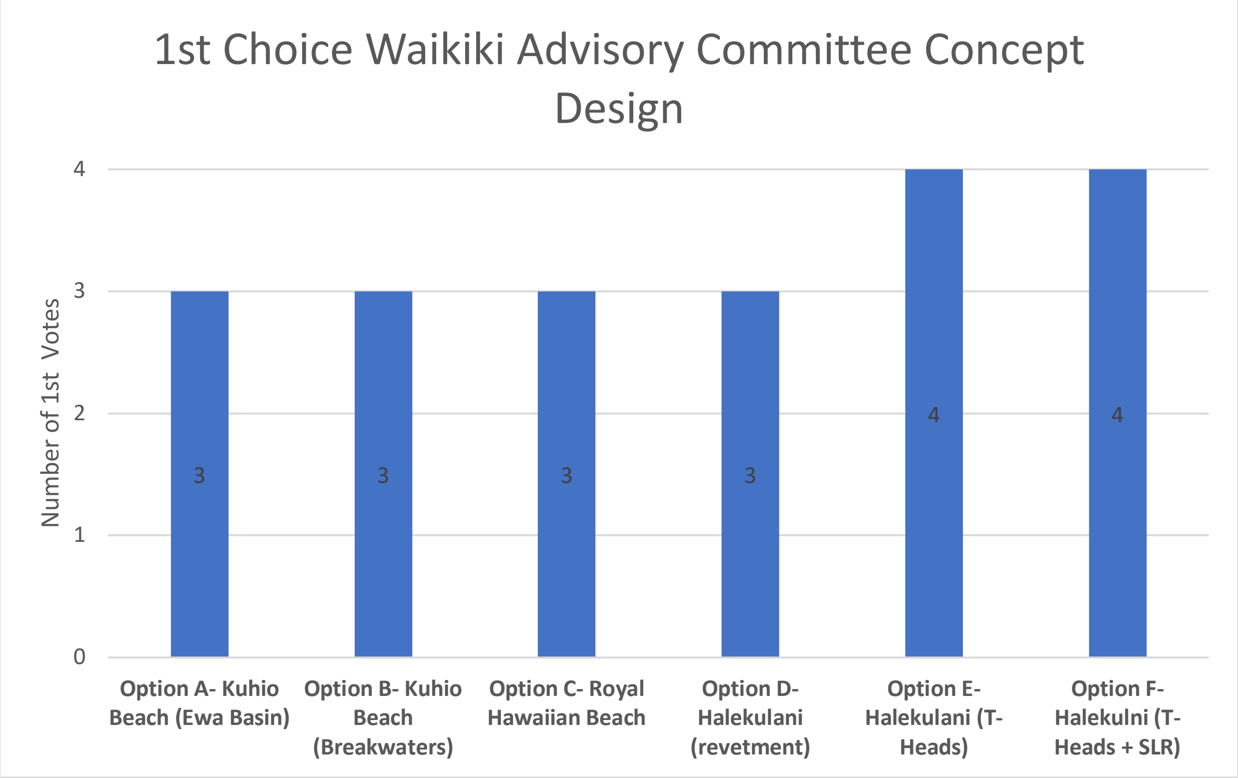

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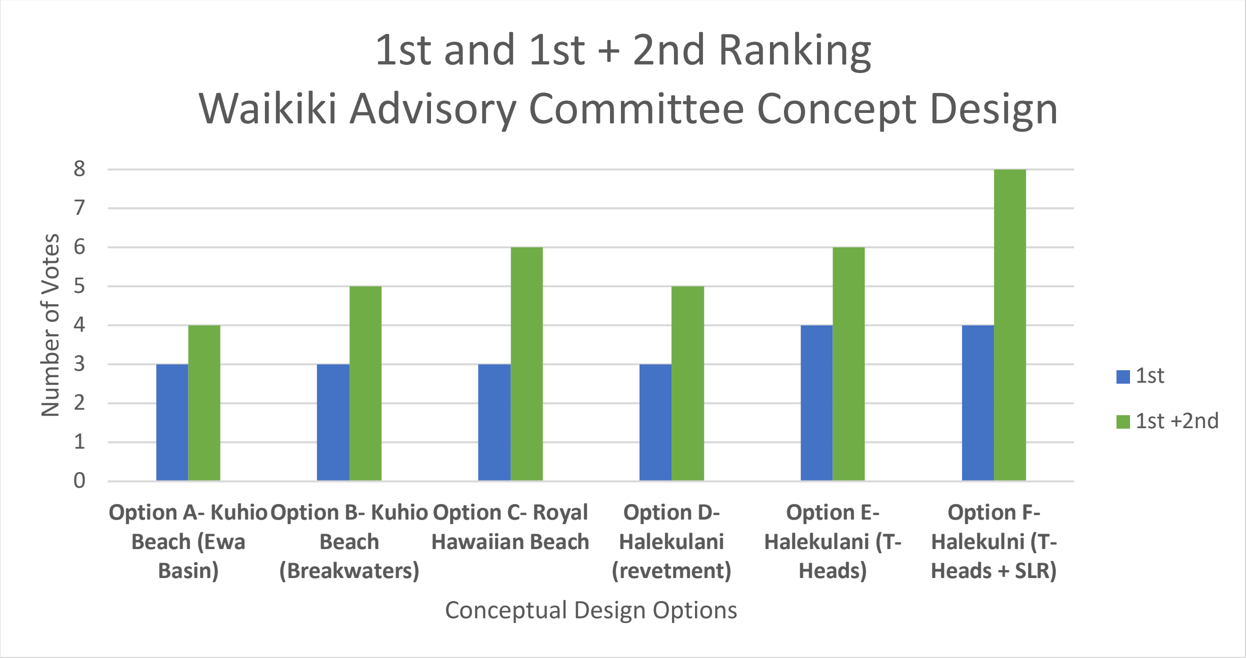

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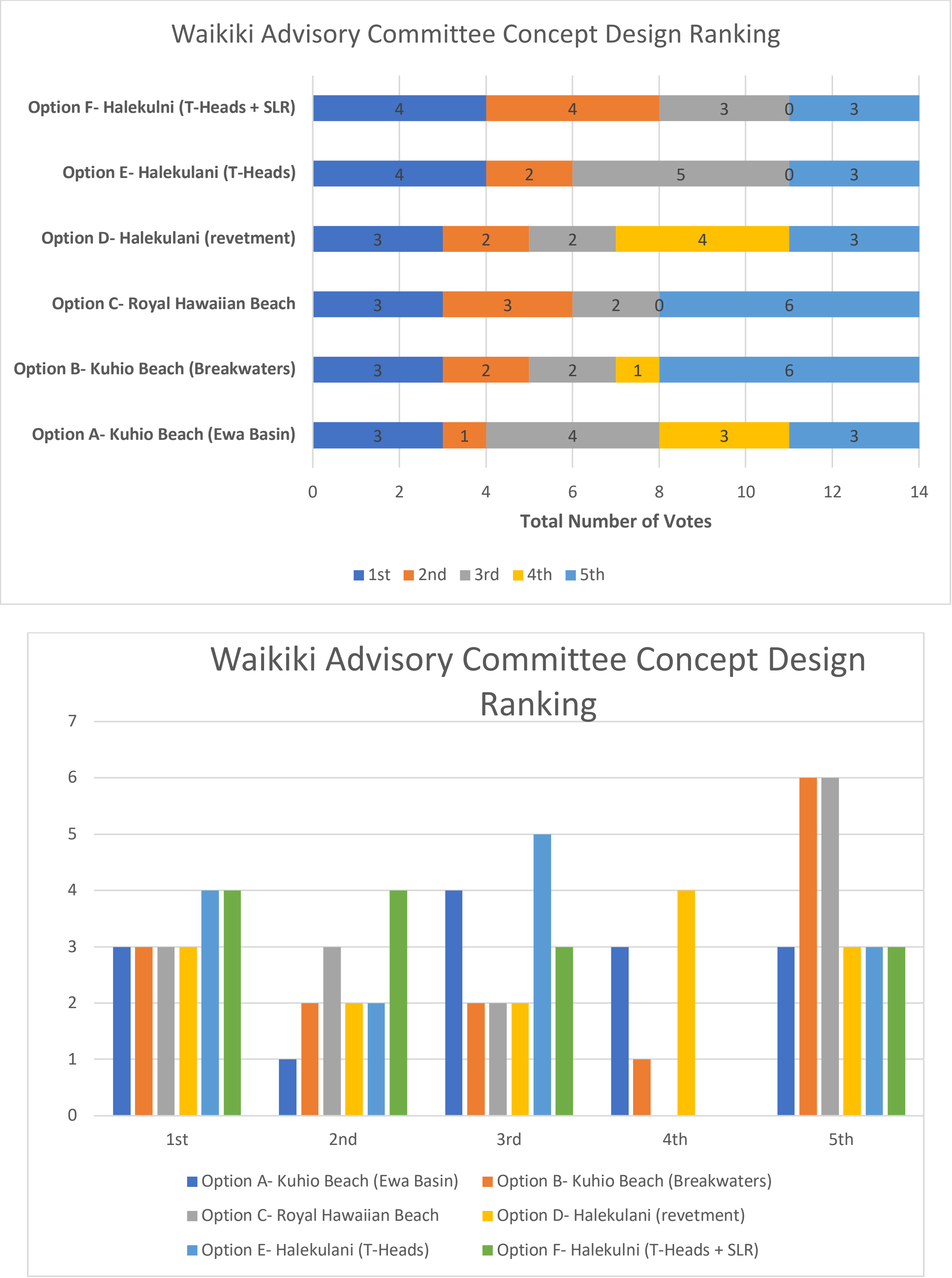
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Option C- Royal Hawaiian Beach
3 3 2 0 6
Option B- Kuhio Beach (Breakwaters)
3 2 2 1 6
Option A- Kuhio Beach (Ewa Basin)
3 1 4 3 3
0 2 4 6 8 10 12 14
Total Number of Votes
1st 2nd 3rd 4th 5th
Waikiki Advisory Committee Concept Design Ranking
0 1 2 3 4 5 6 7
1st 2nd 3rd 4th 5th
Option A- Kuhio Beach (Ewa Basin)
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(In no particular order)

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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?

____

____

____

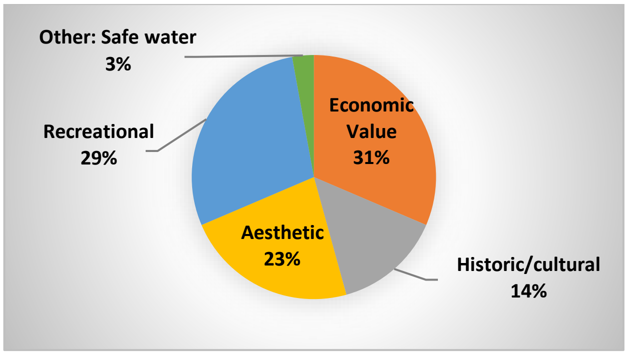
____

____

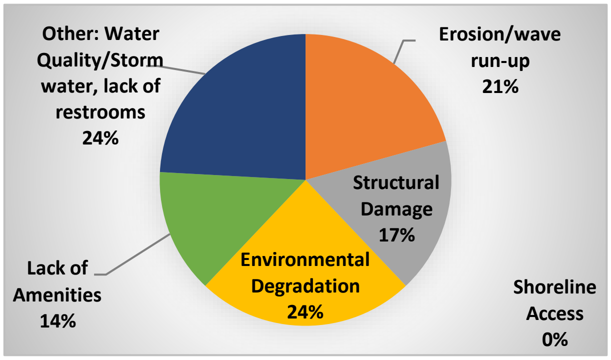
Waikīkī Beach Engineering Design Criteria

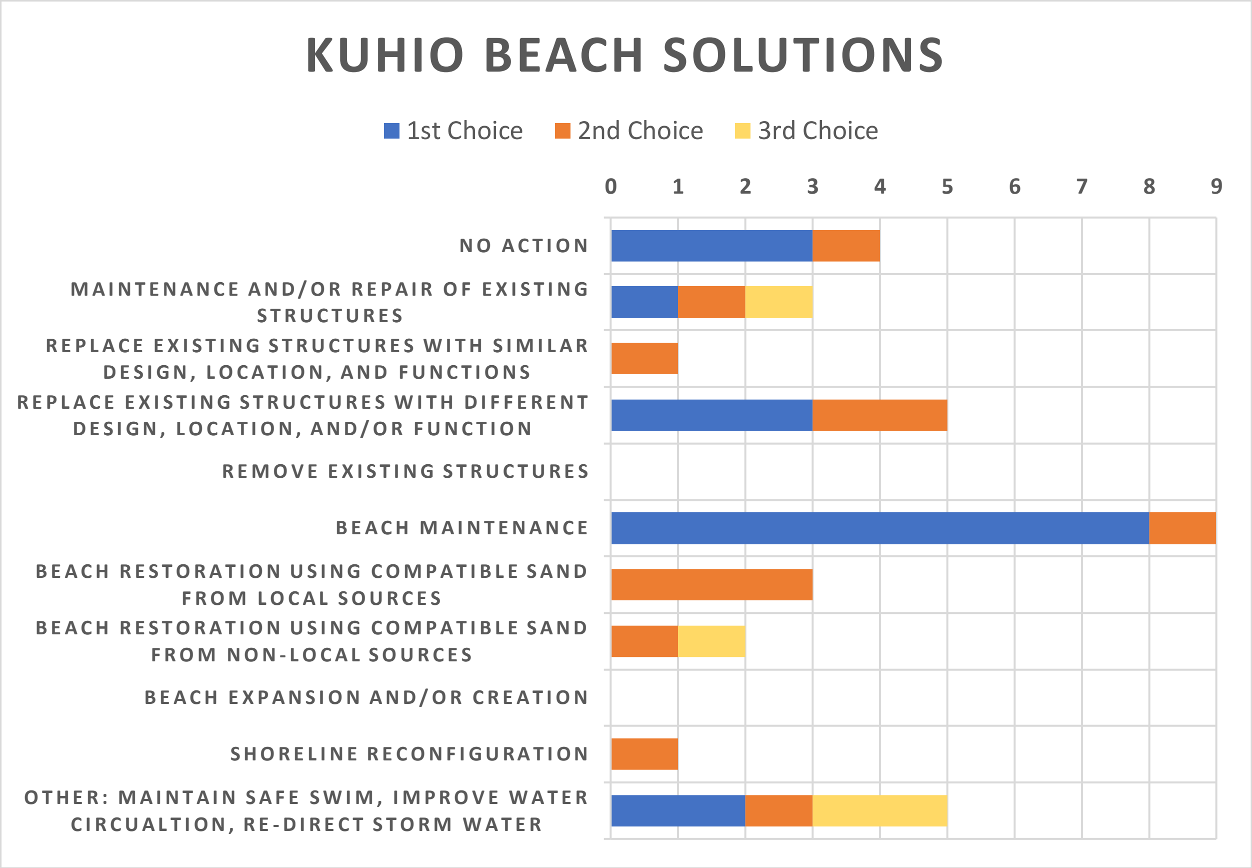
KUHIO BEACH WAIKIKI

ASSETS & VALUES



ISSUES & PROBLEMS





Waikīkī Beach Engineering Design Criteria

DESIRED ASSETS & USES

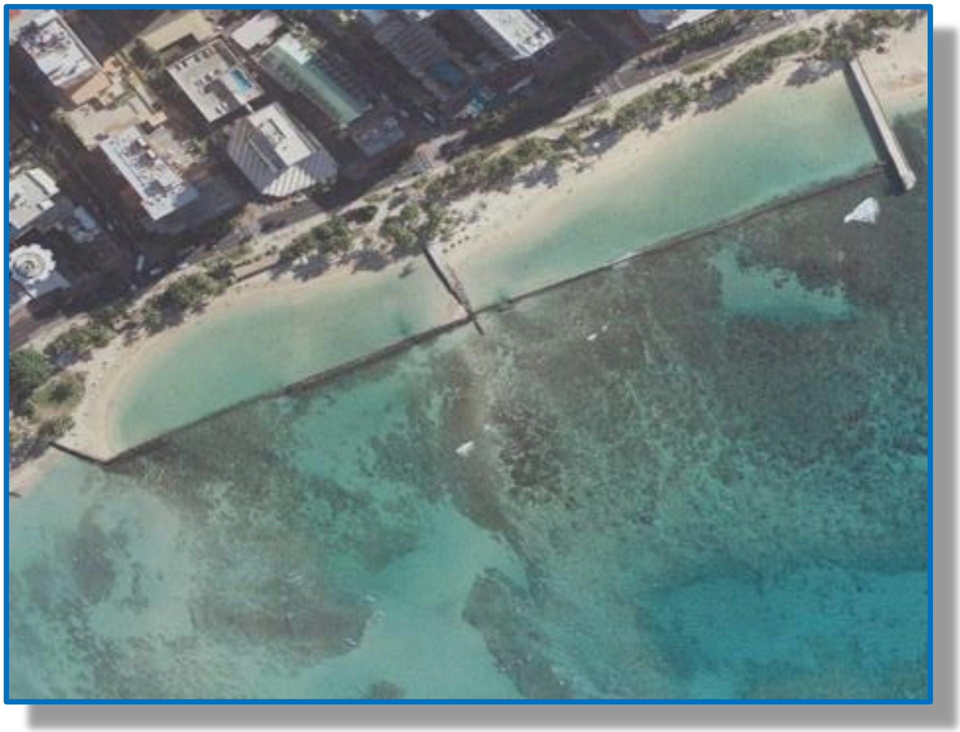
- Maintain calm and shallow water uses and beach-ocean interaction (swimming, bathing)
- Maintain ocean access at Ewa basin (Surfing access)
- Maintain existing commercial uses
- Maintain cultural/historical sense of place
- Maintain public access along Kapahulu groin and esplanade
- Preserve/protect 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

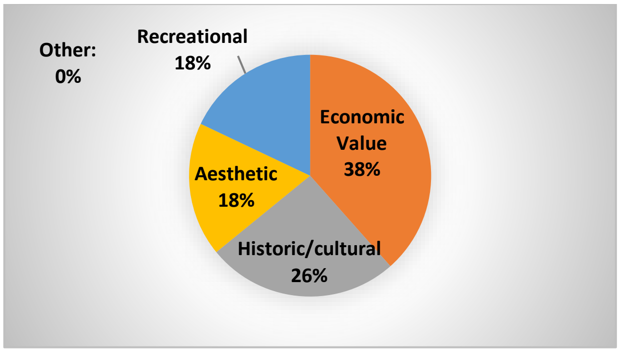
- Beach maintenance and restoration using locally sourced sand
- Small-scale beach maintenance (use existing basin sand for beach profile shaping)
- Replace existing structures with a different design function
- Improve water quality within basin (additional testing)
- Reduce sand loss through the breakwater channel
- Stabilize/manage seasonal beach dynamics



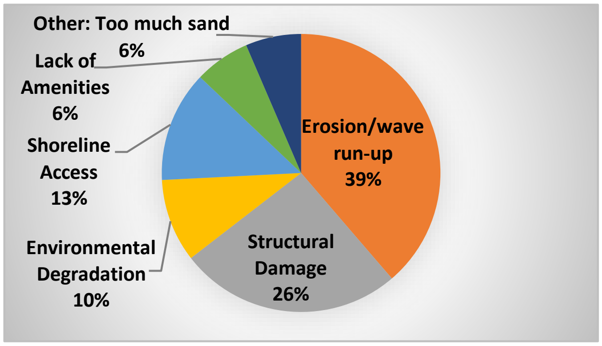
Waikīkī Beach Engineering Design Criteria

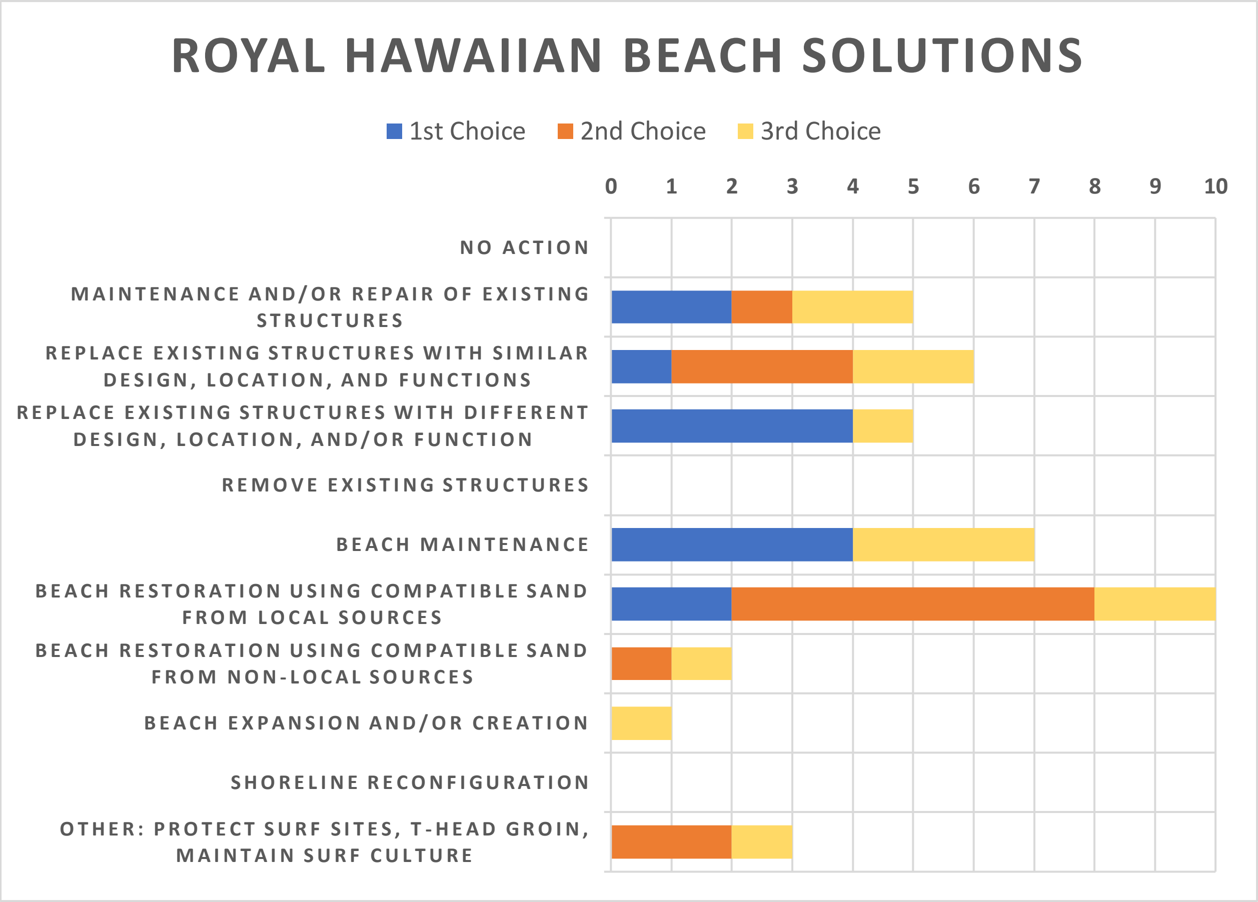
ROYAL HAWAIIAN BEACH, WAIKIKI

ASSETS & VALUES



ISSUES & PROBLEMS





Waikīkī Beach Engineering Design Criteria

DESIRED ASSETS & USES

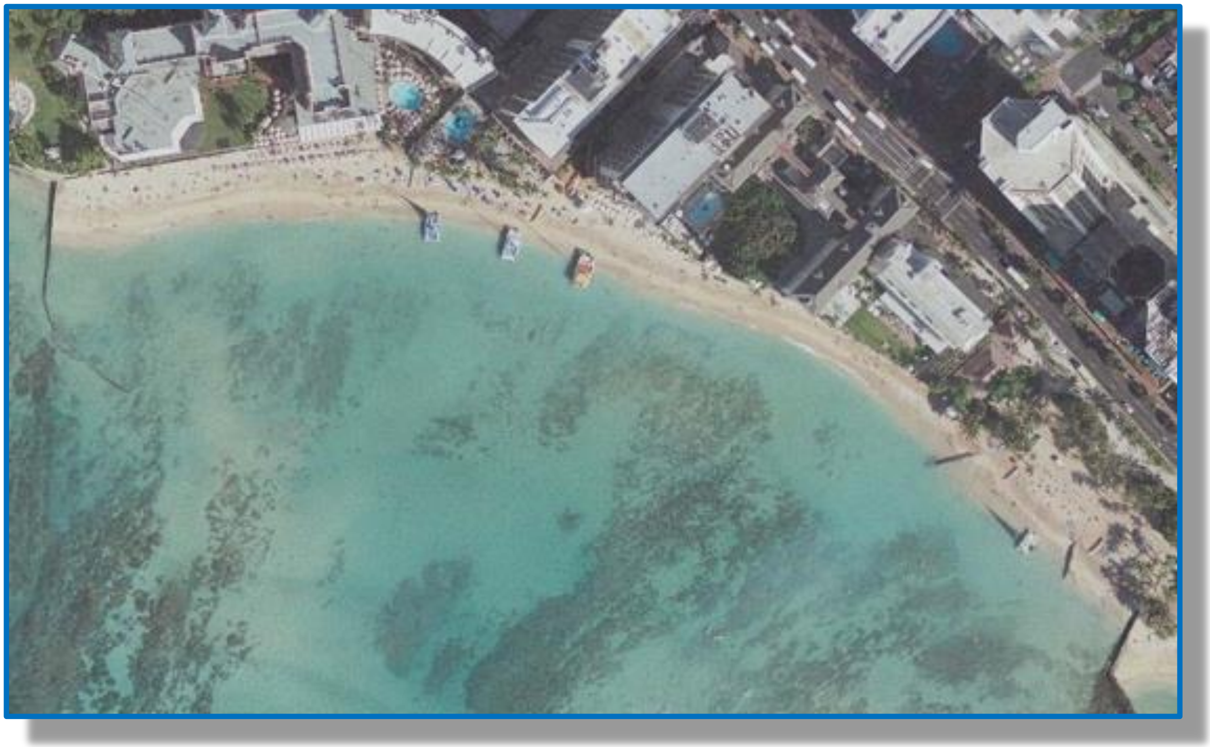
- Active uses and dynamic beach-ocean interaction
- Maintain mixed recreational use (swimming, surfing, bathing)
- Maintain economic/commercial use (catamarans, canoes, surf lessons/beach rentals)
- Maintain cultural/historical sense of place
- Maintain vessel ingress/egress through channel
- Preserve/protect 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

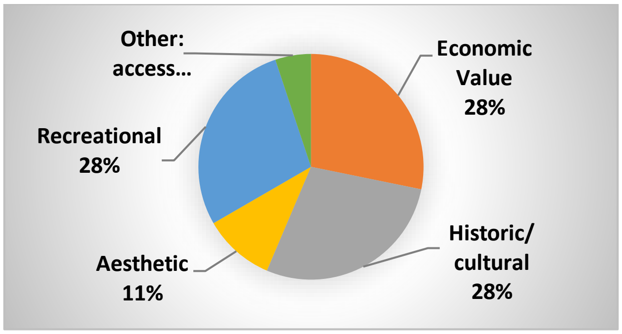
- Beach restoration using locally sourced sand
- Small-scale beach maintenance (use nearshore sandbar for sand back-passing)
- Replace existing structures with similar design
- Limited new shoreline structures-preserve open beach and view planes
- Improve lateral access alongshore (Pinch point at Moana)
- Reduce sand loss through the sand channel
- Stabilize/manage seasonal beach dynamics



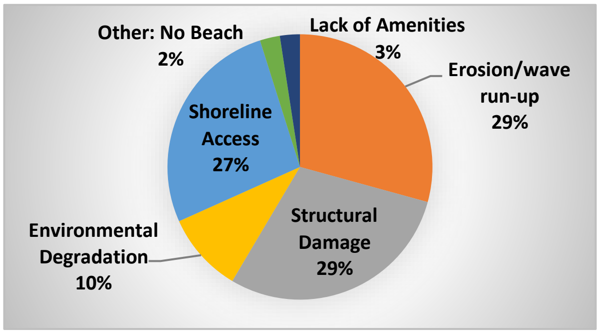
Waikīkī Beach Engineering Design Criteria

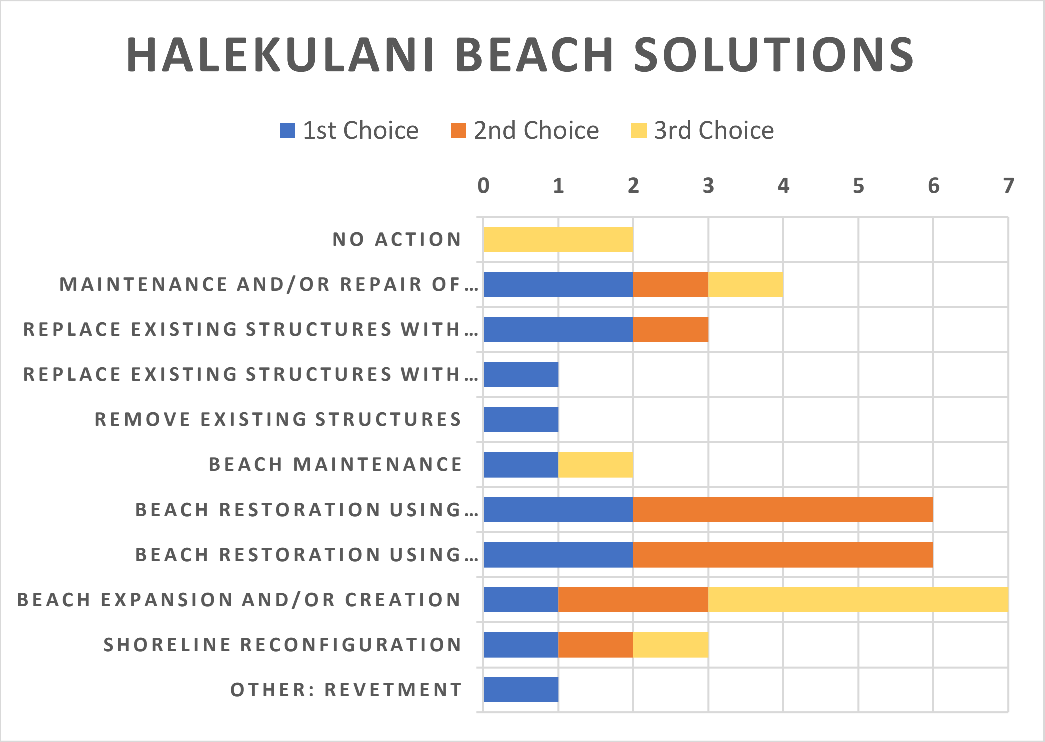
HALEKULANI BEACH, WAIKIKI

ASSETS & VALUES



ISSUES & PROBLEMS





Waikīkī Beach Engineering Design Criteria

DESIRED ASSETS & USES

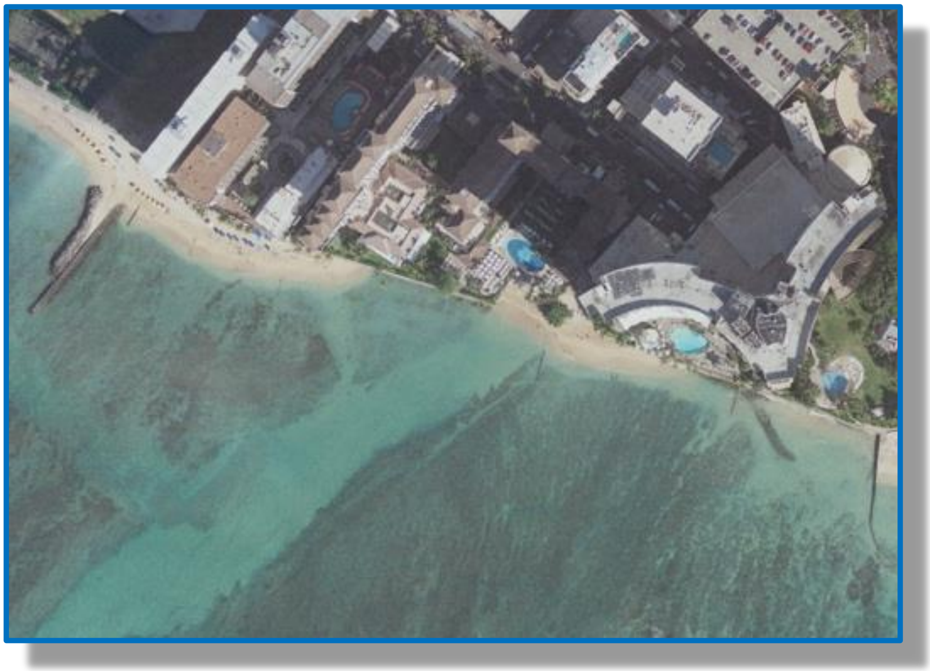
- Maintain mixed recreational use (swimming, surfing, bathing).
- Maintain high level of water quality
- Preserve submarine groundwater discharge at Halekulani Channel (Kawehewehe)
- Maintain vessel ingress/egress through Halekulani channel
- Preserve/protect surf sites (Populars, Threes, Fours)

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.

Department of Land and Natural Resources
State of Hawaii

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

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