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LAND
STATE PARKS

**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**

OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF: OCCL: BR

**MEMORANDUM**

**TO:** Scott Glenn, Director
*Office of Environmental Quality Control*

**FROM:** Samuel J. Lemmo, Administrator
*Office of Conservation and Coastal Lands*

**SUBJECT:** **DRAFT ENVIRONMENTAL ASSESSMENT (DEA) FOR THE ROYAL HAWAIIAN GROIN IMPROVEMENT PROJECT, WAIKIKI BEACH, OAHU.**

The Department of Land and Natural Resources has reviewed the Draft Environmental Assessment (DEA) for the proposed project and anticipates a Finding of No Significant Impact (FONSI) determination. Please publish notice of availability for this project in the **January 23, 2016** issue of the *Environmental Notice*. We have enclosed the applicant's OEQC Bulletin publication form, a CD with a copy of the DEA and Publication Form and a hardcopy of the DEA.

Should you wish to provide comments regarding this project **please respond by February 22, 2016**. If no response is received by the suspense date, we will assume there are no comments. Please contact Bradley Romine at the Office of Conservation and Coastal Lands at (808) 587-0049 should you have any questions.

*Enclosures:* *One (1) CD with a copy of DEA and Publication Form*
*OEQC Bulletin Publication Form (hard copy)*
*DEA (Hard Copy)*

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July 2015 Revision

# AGENCY ACTION
# SECTION 343-5(b), HRS
# PUBLICATION FORM

JAN 23 2016

**Project Name: Royal Hawaiian Groin Replacement**

**HRS §343-5 Trigger(s):** Use of state/county lands/funds – Section 343-5(a)(1), HRS
Use of conservation district – Section 343-5(a)(2), HRS

**Island: Oahu**

**District: Conservation, Resource Subzone**

**TMK: (1) 2-06-001:019**

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**Permits:** 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)

**Proposing/Determination Agency:**
Department of Land and Natural Resources
Samuel Lemmo, Administrator, Office of Conservation and Coastal Lands
(808) 587-0377

**Accepting Authority: N/A**

**Consultant:**
Sea Engineering, Inc.
Scott Sullivan, Vice President
(808) 259-7966

**Status (check one only):**

_X_DEA-AFNSI — Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of DEA, a completed OEQC publication form, along with an electronic word processing summary and a PDF copy (you may send both summary and PDF to oeqchawaii@doh.hawaii.gov); a 30-day comment period ensues upon publication in the periodic bulletin.

__FEA-FONSI — Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of the FEA, an OEQC publication form, along with an electronic word processing summary and a PDF copy (send both summary and PDF to oeqchawaii@doh.hawaii.gov); no comment period ensues upon publication in the periodic bulletin.

__FEA-EISPN — Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of the FEA, an OEQC publication form, along with an electronic word processing summary and PDF copy (you may send both summary and PDF to oeqchawaii@doh.hawaii.gov); a 30-day consultation period ensues upon publication in the periodic bulletin.

__Act 172-12 EISPN — Submit the proposing agency notice of determination on agency letterhead, an OEQC publication form, and an electronic word processing summary (you may send the summary to oeqchawaii@doh.hawaii.gov). NO environmental assessment is required and a 30-day consultation period upon publication in the periodic bulletin.

| | |
|---|---|
| __DEIS | The proposing agency simultaneously transmits to both the OEQC and the accepting authority, a hard copy of the DEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the DEIS (you may send both the summary and PDF to oeqchawaii@doh.hawaii.gov); a 45-day comment period ensues upon publication in the periodic bulletin. |
| __FEIS | The proposing agency simultaneously transmits to both the OEQC and the accepting authority, a hard copy of the FEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the FEIS (you may send both the summary and PDF to oeqchawaii@doh.hawaii.gov); no comment period ensues upon publication in the periodic bulletin. |
| __ Section 11-200-23 Determination | The accepting authority simultaneously transmits its determination of acceptance or nonacceptance (pursuant to Section 11-200-23, HAR) of the FEIS to both OEQC and the proposing agency. No comment period ensues upon publication in the periodic bulletin. |
| __Section 11-200-27 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 not required. No EA is required and no comment period ensues upon publication in the periodic bulletin. |
| __Withdrawal (explain) | |

**Summary** (Provide proposed action and purpose/need in less than 200 words. Please keep the summary brief and on this one page):

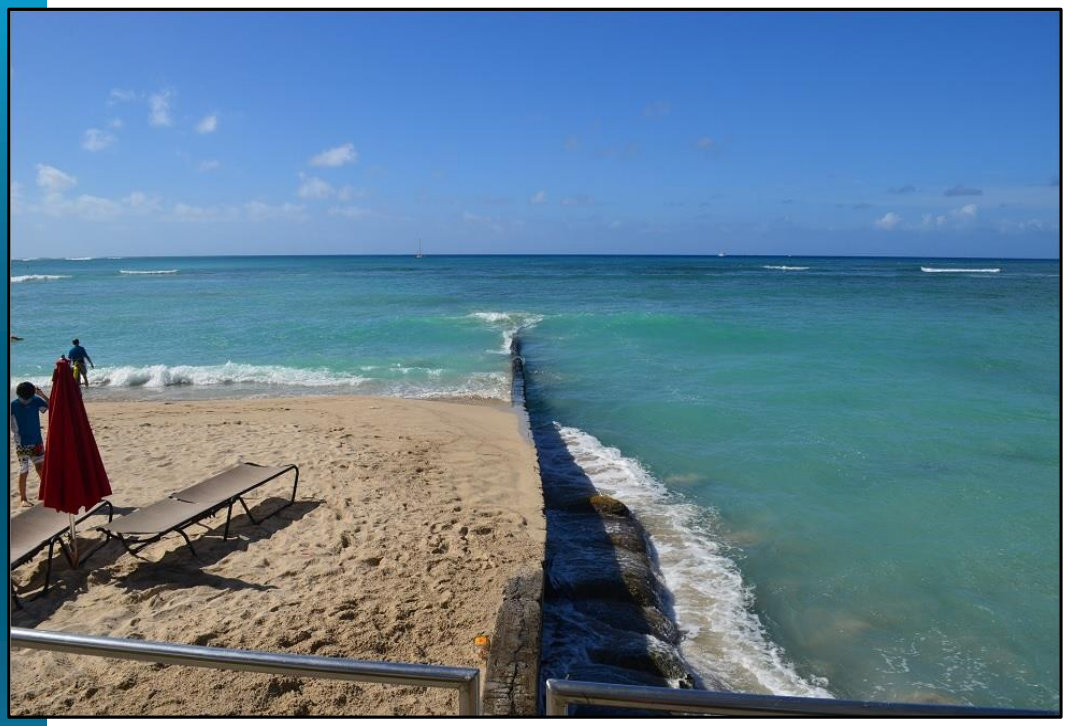
The existing Royal Hawaiian groin, located between the Waikiki Sheraton and the Royal Hawaiian hotels, is in an extremely deteriorated condition. Its failure would result in the destabilization and loss of 1,730 feet of sandy shoreline located to the east of the groin. The Department of Land and Natural Resources (DLNR) proposes to replace the existing Royal Hawaiian groin with a stable, engineered groin. The objective of the proposed project is to maintain the beach so that it can provide its intended recreational and aesthetic benefits, facilitate lateral access along the shore, and provide a first line of defense to the backshore in the event of storm wave attack. The groin would be designed so as to maintain the approximate beach width of the 2012 Waikiki Beach Maintenance shoreline nourishment project. No significant enlargement of the beach is proposed.

Four options for a new groin are proposed: 1) a new 180-foot-long rock L or T-head groin, 2) a new 280-foot-long rock L or T-head groin, 3) adaptive re-use of the existing groin as the core of a new rock L-head groin, and 4) a vertical concrete wall groin. Selection of the preferred option will be made following coordination and review of the Draft Environmental Assessment (DEA). Expected impacts of the four options are similar.

# DRAFT ENVIRONMENTAL ASSESSMENT
# ROYAL HAWAIIAN GROIN IMPROVEMENT PROJECT

Honolulu, Oahu, Hawaii

*January 2016*



***Prepared for:***
State of Hawaii
Department of Land and Natural Resources
P.O. Box 621
Honolulu, HI  96813

***Prepared by:***
Sea Engineering, Inc.
Makai Research Pier
Waimanalo, HI 96795

*Job No. 25428*

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# ANTICIPATED FINDING OF NO SIGNIFICANT IMPACT (AFONSI) ROYAL HAWAIIAN GROIN IMPROVEMENT PROJECT HONOLULU, HAWAII

**Proposing and Approving Agency:** Department of Land and Natural Resources
State of Hawaii
1151 Punchbowl Street, Room 131
Honolulu, Hawaii 96813

**Proposed Action:** The existing Royal Hawaiian groin, located between the Waikiki Sheraton and the Royal Hawaiian hotels, is in an extremely deteriorated condition. Its failure would result in the destabilization and loss of 1,730 feet of sandy shoreline located to the east of the groin. The Department of Land and Natural Resources (DLNR) proposes to repair or replace the existing Royal Hawaiian groin with a stable, engineered groin. The objective of the proposed project is to maintain the beach so that it can provide its intended recreational and aesthetic benefits, facilitate lateral access along the shore, and provide a first line of defense to the backshore in the event of storm wave attack. The groin would be designed so as to maintain the approximate beach width of the 2012 Waikiki Beach Maintenance shoreline nourishment project. No enlargement of the beach is proposed.

Four options for a new groin are proposed: 1) a new 180-foot-long rock L or T-head groin, 2) a new 280-foot-long rock L or T-head groin, 3) adaptive re-use of the existing groin as the core of a new 160-foot-long rock L-head groin, and 4) a new160-foot-long vertical concrete wall groin. Selection of the preferred option will be made following coordination and review of the Draft Environmental Assessment (DEA). Expected impacts of the four options are similar.

**Determination:** In accordance with the potential impacts outlined in Section 4 of the Draft Environmental Assessment, the provisions of Chapter 343 Hawaii Revised Statutes (HRS), and Hawaii Administrative Rules (HAR) §11-200 significance criteria, the Approving Agency, the Department of Land and Natural Resources, State of Hawaii, is anticipated to make a Finding Of No Significant Impact (FONSI).

**Basis for Determination:** The project will not significantly alter or affect presently on-going sand transport and shoreline processes, wave-driven currents, circulation patterns, overall water quality, or offshore wave breaking. Construction activities will be designed so as to avoid and minimize impacts to marine biota so far as practicable, and no long term impacts to marine biota are anticipated. The new groin will be placed on existing nearshore sand and rubble bottom; thus, there will be no significant loss of marine habitat. The rock rubblemound groin options may actually benefit the nearshore ecosystem by providing habitat for fish and other marine biota. Construction BMPs will be used to avoid impacts to protected marine species, such as the green sea turtle. Construction can be expected to result in temporary disruption of beach use and recreational activities, and increased noise and short term degradation of air quality from the operation of construction equipment. Localized increases in water turbidity may occur in the immediate area of construction activity; however, containment barriers and turbidity screens will be in place to control and minimize the area of impact. In a letter dated July 21, 2015, the State

Historic Preservation Division (SHPD) of DLNR stated that the existing groin may potentially be eligible for inclusion within the Hawaii and National Register of Historic Places. Consultation with SHPD will be conducted to assess potential groin improvement impacts on architectural and archaeological historic resources, and appropriate mitigation measures for adverse impacts.

Chapter 343, Hawaii Revised Statutes (HRS), and Hawaii Administrative rules (HAR) §11-200, establish certain categories of action that require the agency processing an applicant's request for approval to prepare an environmental assessment. HAR §11-200-11.2 established procedures for determining if an environmental assessment (EA) is sufficient or if an environmental impact statement (EIS) should be prepared for actions that may have a significant effect on the environment. HAR §11-200-12 lists the following criteria to be used in making such a determination.

*Involves an irrevocable commitment to, loss, or destruction of any natural or cultural resource.*

Groin improvement will contribute to the stability of Waikiki Beach, a very valuable natural resource. Failure of the existing groin would destabilize the 1,730-foot-long beach section to the east, with a likely significant loss of sand from this area and resultant beach recession. This sand would be lost to the west and offshore, with the offshore loss possibly changing the bathymetry (water depth) and covering presently exposed hard fossil limestone reef flat bottom. The proposed project would repair or replace the existing groin with a stable, engineered groin, reducing the likelihood of failure and beach loss.

Implementation of the project does not involve construction on or excavation of land that might contain physical historic or archaeological remains. The work on land will take place in an area which has already been substantially altered over more than a century, and is entirely makai of the shoreline where the existence of any cultural artifacts or remains is very unlikely. The proposed project is unlikely to have any significant adverse effect on known practices customarily and traditionally exercised for subsistence, cultural and religious purposes.

*Curtails the range of beneficial uses of the environment.*

The proposed project would reduce the risk of destabilizing Waikiki Beach by replacing the existing deteriorated groin with a stable, engineered groin. This would reduce the risk of groin failure and subsequent destabilization of the heavily utilized recreational beach, which would significantly impact recreational activities of the environment in the project area. No adverse long term impacts to the environment are anticipated to result from this project. There may be temporary short-term impacts during construction; however, these are not anticipated to be significant, and will be mitigated to the maximum extent practicable by the use of BMPs and monitoring procedures.

*Conflicts with the State's long-term environmental policies or goals and guidelines as expressed in Chapter 343, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders.*

The proposed project is consistent with Hawaii's State Environmental Policy as established in Chapter 343(4)(A), HRS, to establish, preserve, and maintain recreation areas, including the shoreline, for public recreational use.

*Substantially affects the economic welfare, social welfare, and cultural practices of the community or State.*

The economic value of Waikiki Beach to Hawaii's visitor industry and the economic success of Waikiki as a visitor destination is extremely significant to the State of Hawaii. The estimated socio-economic loss to the State would be quite high if the Royal Hawaiian Groin failed and Waikiki Beach eroded away – a $2 billion loss in overall visitor expenditures, a $150 million loss in tax revenue, and a job loss of 6,350 people. The proposed project will help maintain this very valuable socio-economic resource.

*Substantially affects public health.*

The proposed project will have some impact on air, noise, and water quality during construction; however, these will be mitigated to the maximum extent practicable by BMPs and monitoring procedures. The project will not result in any post-construction or long-term effects on public health.

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

The project will not alter the existing land use pattern in and around the project site. The beach is likely to continue to attract beach users; however, the number of users is not likely to increase because of the project. The proposed project has little or no potential to affect public infrastructure and services. Once completed it will require no water, power, sanitary wastewater collection, or additional emergency services.

*Involves a substantial degradation of environmental quality.*

Other than temporary, short-term environmental impacts during construction, which are generally not considered significant, the proposed project would not result in impacts that could degrade the environmental quality in the project area. In fact, a similar project in Hawaii has produced a very significant increase in marine biota density and diversity attributable to the stable habitat provided by rock groins.

*Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions.*

The proposed project involves replacing the existing groin with a stable, engineered groin. It does not alter the beach position. The proposed project offers the availability for beach construction to the west; however, it would not require or commit to future larger actions.

*Substantially affects a rare, threatened, or endangered species, or its habitat.*

The nearshore area off Waikiki is frequented by the threatened green sea turtle, which feeds on the algae-covered hard fossil limestone bottom areas. Hawaiian monk seals have been infrequently seen in Waikiki. Marine biota surveys identified algae growing to the west of the existing groin. The project will temporarily remove a small portion of this turtle food source; however, it is anticipated that algae will quickly become established on the new groin. Turtle protection procedures as recommended by the National Marine Fisheries Service will be in place during construction. There will be no long term impact to rare, threatened, or endangered species.

*Detrimentally affects air or water quality or ambient noise levels.*

There will be some temporary, short-term impacts to air and water quality and noise levels during construction. However, these impacts will be limited to the construction period and will not be significant. BMP's, water turbidity controls, and a water quality monitoring program will be in effect to help minimize the construction impacts. The contractor will be required to submit an Environmental Protection Plan for approval prior to the start of construction, which will include provisions for reducing air, water, and noise impacts. Once construction is complete there would be no activity or mechanism for further air, water, or noise impacts.

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

The proposed project will repair or replace the existing groin, thus helping to provide a beneficial impact by maintaining the space between the water and the backshore infrastructure. This buffer dissipates wave energy, decreasing wave runup and flooding of the backshore area, and thus reduces susceptibility to natural ocean hazards. The proposed project will not change the shoreline elevation and will not change the existing tsunami flood hazard. The beach is subject to long-term chronic erosion, and this is expected to continue.

*Substantially affects scenic vista and view planes identified in county or state plans or studies.*

The proposed project is relevant to objectives of the Oahu General Plan, including protecting and improving the natural environment, restoring natural resources, retaining scenic resources, and enhancing scenic views. The groin replacement will be larger and more visible than the existing structure, however, the new groin will be lower in elevation than the beach crest and backshore ground, and will not significantly alter the Waikiki view plane. The sand beach itself will remain essentially unchanged, and will be stable over the long term.

*Requires substantial energy consumption.*

Other than energy expended during construction operations, the project would require no additional energy consumption.

**Contact Person:**

Proposing Agency: Samuel Lemmo, Administrator
Office of Conservation and Coastal Lands, DLNR
Phone: (808) 587-0377
Email: sam.j.lemmo@hawaii.gov

Consultant: Scott Sullivan, Sea Engineering, Inc.
Phone: (808) 259-7966, ext. 22
Email: ssullivan@seaengineering.com

## PROJECT SUMMARY

**Project:** Royal Hawaiian Groin Improvement Project

**Proposing and Approving Agency:**
Department of Land and Natural Resources
State of Hawaii
1151 Punchbowl Street, Room 131
Honolulu, Hawaii 96813
Contact: Sam Lemmo, Phone (808) 587-0377
Fax (808) 587-0322

**Consultant:**
Sea Engineering, Inc.
Makai Research Pier
41-305 Kalanianaole Highway
Waimanalo, HI 96744
Contact: Scott Sullivan, Phone (808) 259-7966, ext. 22
Email: ssullivan@seaengineering.com

**Location:** Waikiki Beach, Oahu, Hawaii

**Tax Map Keys:** None

**State Land Use District:** Conservation (Resource Zone)

**County Zoning:** None

**Proposed Action:** DLNR proposes to repair or replace the existing Royal Hawaiian groin with a stable, engineered groin. The objective of the proposed project is to maintain the beach so that it can provide its intended recreational and aesthetic benefits, facilitate lateral access along the shore, and provide a first line of defense to the backshore area in the event of storm wave attack. A new groin will improve beach stability, and a stable beach will also help reduce the adverse impacts of sand being moved offshore. The groin would be designed so as to maintain the approximate beach width of the 2012 Waikiki Beach Maintenance Project shoreline nourishment project. No enlargement of the beach is proposed.

Four options for a new groin are proposed: 1) a new 180-foot-long rock L or T-head groin, 2) a new 280-foot-long rock L or T-head groin, 3) reuse of the existing groin as the core of a new 160-foot-long rock L-head groin, and 4) a new 160-foot-long concrete wall groin. Selection of the preferred option will be made following

coordination and review of the Draft Environmental Assessment (DEA).

The project will not significantly alter or affect presently on-going sand transport and shoreline processes, wave-driven currents, circulation patterns, overall water quality, or offshore wave breaking. Construction activities will be designed so as to avoid and minimize impacts to marine biota so far as practicable, and no long term impacts to marine biota are anticipated. The new groin will be placed on existing nearshore sand and rubble bottom; thus, there will be no significant loss of marine habitat. The rock rubblemound groin options may actually benefit the nearshore ecosystem by providing habitat for fish and other marine biota. Construction BMPs will be used to avoid impacts to the protected marine species such as the green sea turtle. Construction can be expected to result in temporary disruption of beach use and recreational activities, and increased noise and short term degradation of air quality from the operation of construction equipment. Localized increases in water turbidity may occur in the immediate area of construction activity; however, containment barriers and turbidity screens will be in place to control and minimize the area of impact. The State Historic Preservation Division (SHPD) of DLNR has stated that the existing groin may potentially be eligible for inclusion within the Hawaii and National Register of Historic Places. Consultation with SHPD will be conducted to assess potential groin replacement impacts on architectural and archaeological historic resources, and appropriate mitigation measures for adverse impacts.

**Required Permits & Approvals:**

Environmental Assessment and FONSI (Chapter 343, HRS and §11-200, HAR)
Department of the Army Permit (Section 10 and Section 404)
Clean Water Act Section 401 Water Quality Certification
Coastal Zone Management Act Consistency Determination
Conservation District Use Permit

**Actions Requiring Environmental Assessment:** Work within the State Conservation District and within navigable waters of the United States

**Anticipated Determination:** Finding of No Significant Impact (FONSI)

**Estimated Cost:** $1,000,000 - $2,000,000

**Time Frame:** Construction will begin when the necessary permits and approvals are obtained and a construction contract is awarded, currently estimated for winter/spring 2017. The construction period is estimated to be 60 to 90 days.

**Unresolved Issues:** Permit requirements

**Consulted Organizations/Individuals:**

Federal

U.S. Army Corps of Engineers, Honolulu District, Regulatory Branch
U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office
NOAA, National Marine Fisheries Service, Pacific Islands Regional Office
U.S. Environmental Protection Agency, Region IX, Pacific Islands Contact Office

State of Hawaii

Office of Environmental Quality Control
Department of Land and Natural Resources
- Aquatic Resources Division
- Historic Preservation Division
- Office of Conservation and Coastal Lands
- Engineering Division
- Division of Boating and Ocean Recreation
Department of Health, Clean Water Branch
DBEDT, Office of Planning, Coastal Zone Management Program
Department of Transportation, Harbors Division
Office of Hawaiian Affairs
Hawaii Tourism Authority
Rep. Tom Brower, House District 22
Sen. Brickwood Galuteria, Senate District 12

City & County of Honolulu

Department of Planning and Permitting
Department of Design and Construction
Department of Emergency Services, Ocean Safety & Lifeguard Services Division
Waikiki Neighborhood Board No. 9
Councilman Trevor Ozawa

Other

Waikiki Improvement Association
Sheraton Waikiki Hotel
Royal Hawaiian Hotel
Outrigger Waikiki Hotel
Moana Surfrider Hotel
Kamehameha Schools
Kyo-ya Hotels & Resorts
Brunetti, Vince. Manager of the food concession in the HPD Waikiki Substation building.

Bush, Ted. Owner, Waikiki Beach Services.
Carvalho, David. Manager, Hawaiian Oceans beach concession.
Chang, Hubert. Owner, Hawaiian Oceans beach concession.
Couch, Tom. Staff, Hawaiian Oceans beach concession.
Downing, George. Save Our Surf.
Coleman, Stuart. Surfrider Foundation
Bergstrom, Rafael. Surfrider Foundation
Harada, Ivan. Waikiki Lifeguard, retired.
Howe, Jim. Operations Chief, Ocean Safety Division, Honolulu, Emergency Services.
Iaukea, Rocky. Manager, Mana Kai catamaran.
Lipton, Sheila. Owner, Kapoikai catamaran.
Merino, Paul. Waikiki District Lifeguard Captain, Ocean Safety Division, Honolulu Emergency Services.
Oahu District Manager, DOBOR.
Quintal, Sidney. Director, Department of Environmental Services.
Robello, Didi. Owner, Aloha Beach Services.
Santiago, Jay. Captain, Kapoikai catamaran.
Savio, John. Owner, Na Hoku and Manu Kai catamarans.
Shipley, Jack. Waikiki surf contest judge.
Rutledge, Aaron. Owner, Star Beachboys.
Wright, Chalian. Concession Specialist, Department of Environmental Services, C&C of Honolulu.
King, Robert. Outrigger Catamaran
Parsons, George. Maitai Catamaran

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# 1. INTRODUCTION

## 1.1 Project Location and General Description

The existing Royal Hawaiian Groin (RHG) is located on Waikiki Beach, along the shoreline of Mamala Bay on the south shore of the island of Oahu, Hawaii. An overview of the project site is shown on Figure 1-1, and the existing groin is shown on Figure 1-2. The approximately 370-foot-long groin extends seaward from the shoreline between the Sheraton Waikiki and Royal Hawaiian hotels. The groin anchors and stabilizes the middle section of Waikiki Beach, known as the Royal Hawaiian Beach Sector or Royal Hawaiian Littoral Cell, which extends from the groin 1,730 feet east to the Ewa Kuhio Beach crib wall. The Royal Hawaiian Beach backshore is occupied from west to east by the Royal Hawaiian, the Outrigger Waikiki, and the Moana Surfrider hotels, and three beach concession operations at the east end. The Moana (1901) and the Royal Hawaiian (1927) are, respectively, the oldest and second oldest hotels in Waikiki. The RHG was originally constructed in 1927, and lengthened and heightened in 1930. No reported maintenance of the groin has been accomplished since that time. The location of the groin, the regulatory shorelines, property lines, and TMK's in the project area are shown on Figure 1-3.

**Figure 1-1 Overview of project site**

**Figure 1-2 Photo of existing groin (September 25, 2014)**

## 1.2 Project Purpose and Objectives

The RHG is in a very deteriorated condition, and it is estimated that it could fail at any time. Its failure would destabilize the 1,730-foot-long beach section to the east, with a likely significant loss of sand from this area and resultant beach recession. This sand would be lost to the west and offshore. The purpose of the proposed project is to repair or replace the aging RHG with a new stable structure engineered for this location. The new groin would be constructed in the immediate vicinity of the existing groin. The old groin could be removed once the new groin is in place to stabilize the beach, or if desired left in place and covered with sand. The objectives of the proposed project are 1) to maintain the beach so that it can provide its intended recreational and aesthetic benefits (up to 2012 nourishment project beach size and shape), 2) facilitate lateral access along the shore, and 3) provide a first line of defense to the backshore area in the event of storm wave attack. The new groin will improve beach stability, and a stable beach will also help reduce the adverse impacts to marine biota of sand being moved offshore. The groin would be designed so as to be able to maintain the approximate beach width of the 2012 Waikiki Beach Maintenance Project shoreline nourishment project. No enlargement of the beach is proposed. In order to support the State's goals, the project involves three primary work tasks:

1. obtain an approved Environmental Assessment (EA) and necessary Federal, State and County permits for construction of a replacement groin,
2. design and prepare construction documents for the replacement groin, and
3. complete construction of the replacement groin.

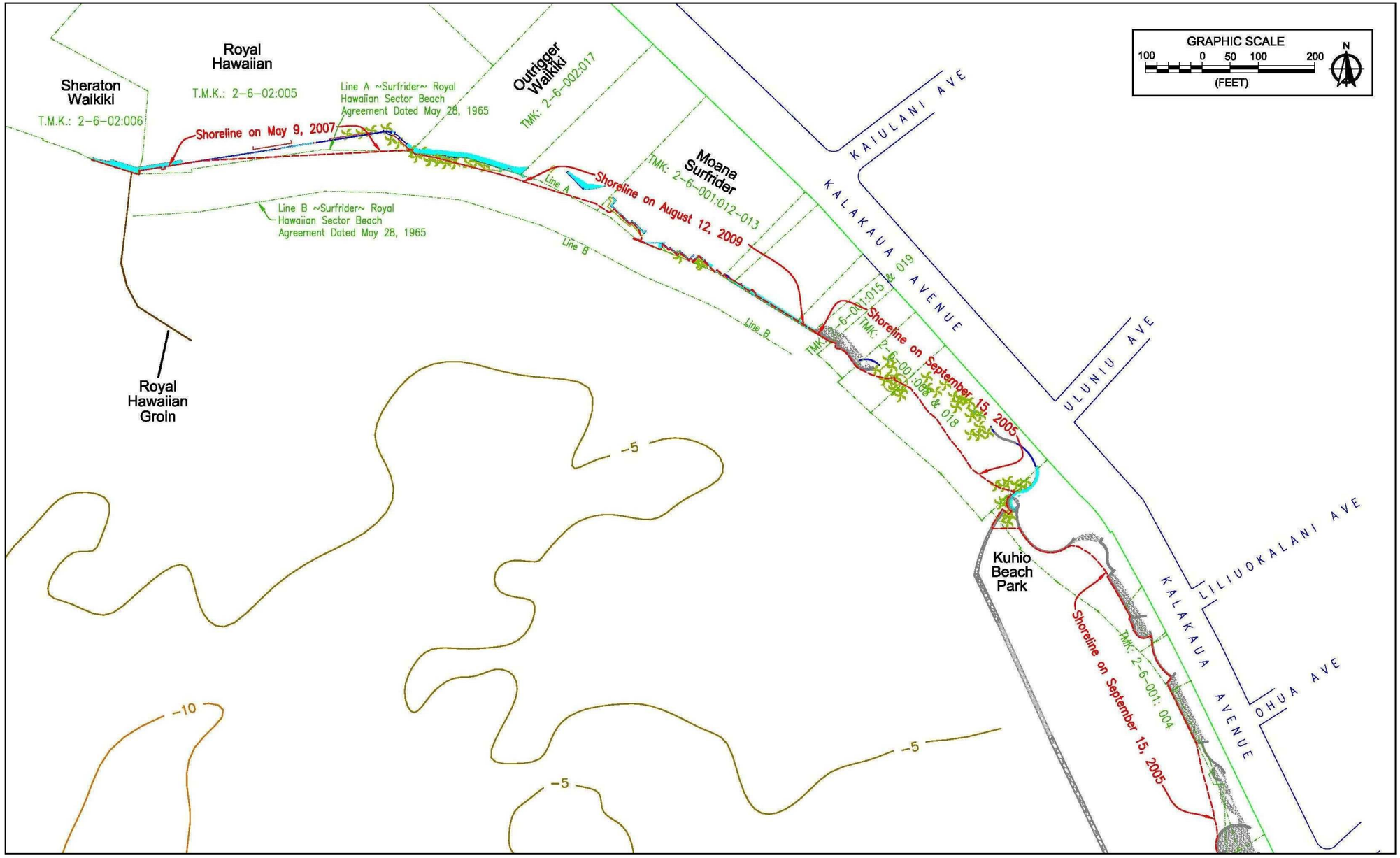



**Figure 1-3 Regulatory shorelines and property lines in the project area**

## 1.3 Summary Description of the Proposed Action

The preferred project alternative is to replace the existing RHG with a new structure engineered to perform the same basic function as the existing structure. Shoreline alterations, the construction of hotels in the backshore with their attendant structures intended to stabilize the shoreline, and the importation of large quantities of sand fill over the past 100 years has resulted in no natural shoreline between Honolulu Harbor and Diamond Head. Maintenance of this shoreline is required in order for it to remain in place. The RHG is just one of many structures along Waikiki Beach that require replacement, redesign or maintenance.

## 1.4 Alternatives Considered

### *1.4.1 Maintenance of the Existing Groin*

The existing groin was constructed 88 years ago out of concrete blocks cemented together. Some of the blocks are broken or cracked, much of the mortar between the blocks is gone, and the blocks are badly undermined. Beginning 165 feet from the shoreline the top of the groin is below mean sea level, and thus relatively ineffective for beach stabilization. In addition, the offshore half of the groin has failed, resulting in numerous displaced blocks scattered on the bottom. Given the extremely deteriorated condition of the groin there is simply no reasonable engineering way to design a repair and maintenance plan for the groin with any expectation that it will remain in place and functional for any reasonable length of time. The State DLNR accomplished an emergency repair in 2012, stacking large 3,000 pound sand bags along the shoreward end of the west side of the groin to buttress it and help prevent it from toppling over. This was an emergency repair, and the temporary sand bags cannot be expected to support the failing RHG indefinitely. Given the infeasibility of repairing/maintaining the existing groin this was eliminated as an alternative.

### *1.4.2 Removal of the Existing Groin*

Sand transport on the shore is primarily from east to west, driven by the wave uprush on the beach in the swash zone. The RHG stabilizes the middle section of Waikiki beach by acting as a terminal groin and preventing the loss of sand to the west. This 1,730-foot-long beach sector, Royal Hawaiian Beach, fronts three major hotels and three beach concessions, and is one of the heaviest used recreational beach sectors in the state. Complete removal of the groin would result in the rapid loss of sand and resultant reduction of beach width in this sector of Waikiki Beach and significantly affect beach availability for residents and visitors alike. Given the significant impact complete removal of the groin would have on coastal resources, it is not considered an acceptable alternative.

### *1.4.3 Other Types of Beach Stabilization Structures*

An offshore breakwater, or series of breakwaters, oriented parallel to the shoreline, can provide protection from wave energy for the shoreline on their leeward side. This reduction of wave energy in the breakwater's shadow reduces the transport of sand by wave action and sand transported by a predominant longshore current will tend to be deposited in the lee of the breakwater, thus helping to build a wider and more stable beach. However, they do not offer uniform protection along the shoreline, with the shoreline moving seaward in their lee and receding landward at the ends or between gaps in the breakwaters. In addition, functional design

guidance for offshore breakwaters is lacking, and prediction of their performance is inexact, thus they have not been used extensively in the U.S. Given that a breakwater would be located entirely offshore it would also be more difficult and costly to construct. Furthermore, offshore breakwaters may be situated more on hard fossil reef seafloor, potentially producing greater environmental impacts. The uncertainties associated with this type of beach stabilization structure, and the construction difficulties, eliminate it from further consideration as an alternative.

Groins and offshore breakwaters intended as permanent beach stabilization structures are typically constructed of stone, sloping rock rubblemound structures designed for the site specific wave conditions. Beach stabilization options have been developed and installed that are less permanent in nature than rock structures, and built with the concept of eventual removal. They have been used when the sand loss threat is perceived as seasonal or temporary, or for emergency situations where more time is necessary for the design and permitting of a permanent structure. Two basic types of temporary structures have typically been used to-date in Hawaii: geotextile sand bags and sand-filled geotextile tubes. Small, hand-filled sand bags are an ancient shore protection remedy, and they are still frequently used. However, they tend to degrade quickly and loose bags in the water can be an environmental nuisance. Geotextile sea bags are a more recent development, and large geotextile bags (e.g., ElcoRock and Bulklift Sea Bags) have been used for emergency/temporary shore protection/beach stabilization in Hawaii in recent years. An advantage to using sand bags is their ease of installation; filling and placing typically require no special equipment. A disadvantage is that the bags may not be stable under wave attack and the material may degrade over time. ElcoRock bags were recently used to buttress the existing RHG.

An extension of the sand bag concept is sand-filled geotextile tubes (geotubes). They are woven of high-tenacity polyester yarns, and are available in a range of sizes (diameters and lengths). The material is inert to biological degradation and resistant to naturally-encountered chemicals, alkalis, and acids. Tubes exposed to sunlight can be coated with Polyurea, an elastomer coating frequently used in the marine environment. Geotextile mats with small anchor tubes are placed under the main tubes, and as sand is scoured from around the base of the structure the mats settle to form a scour prevention apron. The tubes are filled in-place by pumping them full of a sand/water slurry, with the water dissipating through the fine weave of the fabric. While they have not been used much in Hawaii, they were used to construct groins for the Stable Road erosion control demonstration project on the north shore of Maui, and to construct tsunami damage repairs to Waikoloa Beach on the island of Hawaii.

Given the temporary nature of sand bag or geotube structures, and the need for permanent, long term stabilization of Waikiki Beach, they are not considered a viable alternative for this project.

## 1.5 No Action

As previously discussed, given the extremely deteriorated condition of the existing RHG, its failure as a viable beach stabilization structure is likely in the near future, and thus there is the very real possibility of sand loss and a significant change in the functional sandy shoreline in the middle portion of Waikiki Beach. This will obviously reduce the attractiveness of Waikiki as a beach resort, as indicated by two recent economic studies (Lent, 2002; and Hospitality Advisors,

LLC, 2008), and will increase the threat of storm wave damage to valuable onshore infrastructure. However, as undesirable as it may be, No Action is an alternative, and is therefore carried through the EA evaluation in order to weigh the potential impacts of simply doing nothing. The No Action alternative provides decision makers with a benchmark against which to compare the magnitude of environmental effects of the proposed action alternative. The No Action alternative represents a "future without project" scenario: a continuation of existing activities and natural processes that leads to a picture of the future conditions most likely to occur if the proposed action (environmental approval, issuance of necessary permits, and the subsequent implementation of the applicant's proposed project) does not occur. Its purpose is to provide a "reasonable" baseline for assessing the impacts of the action alternative.

## 1.6 Required Federal and State Approvals, and Applicable Regulatory Requirements

### *1.6.1 Required Federal Approvals*

Department of the Army (DA) permits are issued by the U.S. Army Corps of Engineers (COE) pursuant to Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403) and Section 404 of the Clean Water Act (33 USC 1344). All work or structures in or affecting the course, condition, location, or capacity of navigable waters, including tidal wetlands, require DA authorization pursuant to Section 10. In addition, activities involving the discharge of dredged or fill material into waters of the United States requires a DA permit pursuant to Section 404. As the proposed project will be constructed in navigable waters of the U.S., it will require a DA permit issued pursuant to Section 10 and Section 404.

### *1.6.2 Required State of Hawaii Approvals*

The proposed project will require preparation of a Draft and Final Environmental Assessment (DEA and FEA) pursuant to the State of Hawaii's environmental impact assessment process, Chapter 343, Hawaii Revised Statutes, and its implementing regulations. Hawaii Administrative Rules (HAR) Title 11, Chapter 200, addresses the determination of significance and contents of an environmental assessment. If the FEA and Finding of No Significant Impact (FONSI) are approved by the Department of Land and Natural Resources, the project can then proceed to implementation, once all other required permits and approvals are obtained.

The project will require a Conservation District Use Permit (CDUP) pursuant to Title 13 Chapter 5, Hawaii Administrative Rules (HAR).

The requirement for a DA permit pursuant to Section 404 of the Clean Water Act will also require a Section 401 Water Quality Certification to be issued by the State Department of Health. The project will also require a Hawaii Coastal Zone Management (CZM) Program review for consistency with the CZM objectives and policies (HRS Chapter 205A).

### *1.6.3 Applicable Federal Laws, Regulations and Executive Orders*

The approvals and consultations that will be needed from Federal agencies other than the Corps of Engineers include the:

Archaeological and Historic Preservation Act (16 U.S.C. § 469a-1);

National Historic Preservation Act (NHPA) of 1966 (16 U.S.C. § 470(f));

Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 USC § 3001);

Clean Air Act (42 U.S.C. § 7506(C));

Coastal Zone Management Act (16 U.S.C. § 1456(C) (1));

Endangered Species Act (16 U.S.C. 1536(A) (2) and (4));

Fish and Wildlife Coordination Act (FWCA) of 1934, as amended (16 USC §§ 661-666[C] et seq.);

Magnuson-Stevens Fishery Conservation and Management Act (16 USC § 1801 et seq.);

Marine Mammal Protection Act (MMPA) of 1972, as amended (16 USC §§ 1361-1421(H) et seq.);

EO 13089, Coral Reef Protection (63 FR 32701).

## 1.7 Decision to be Made

The Army Corps of Engineers, Honolulu District, the State of Hawaii Department of Land and Natural Resources, the Hawaii Coastal Zone Management (CZM) Program, and the State Department of Health will review the analyses and conclusions drawn in this EA and decide whether to issue the necessary permits and approvals that the applicant has requested, to issue the permits and approvals with special conditions, or to deny the permits and approvals.

# 2. DETAILED DESCRIPTION OF THE PROPOSED ACTION

## 2.1 General Description of the Groin Plan

The stated groin length in the following sections, as well as the rest of this document, is the length along the crest, i.e., the stem length plus the head length. This length is greater than the distance the groin extends from shore, e.g., the 180-foot-long groin extends a distance of 170 feet from shore and the 280-foot-long groin extends 250 feet from shore.

### *2.1.1 Option 1 – 180 Foot Long Rock L or T Head Groin*

The new groin would be constructed immediately to the west of the existing groin, extending a total length of 180 feet from the seawall fronting the Sheraton Waikiki Hotel. The groin would have an "L" head extending east from the end of the groin stem to help maintain beach width adjacent to the groin and reduce the potential for rip (seaward flowing) current formation along the stem. The groin could also have a "T" head, with a similar extension to the west, in order to facilitate possible sand accretion and beach formation fronting the Sheraton Waikiki Hotel. Given that it would be very difficult and costly to modify the groin once construction is complete, and the relatively small incremental difference in impacts and construction cost versus the potential future benefit of a T-head groin, the T-head configuration is recommended. The groin stem would be rock rubblemound construction, a single layer of carefully placed (keyed and fit) 2,500 to 4,500 pound armor stone over a 250 to 450 pound underlayer stone, with a concrete core wall to prevent the migration of sand through the structure. The stem crest elevation would vary from +7 feet mean sea level (MSL) for 40 feet nearshore, the same elevation as the beach crest, and then uniformly slope down to an elevation of +4 feet at the location of the beach toe, about 110 feet from the start of the groin, and maintain this elevation for the rest of its length. The L or T head would be constructed entirely of stone, without the concrete core, with a crest elevation of +4 feet and crest width of 8 feet. A plan view of the proposed groin is shown on Figure 2-1, and typical section and elevation views are shown on Figure 2-2. This plan would potentially maintain the 2012 nourishment project beach configuration and width; however, it would not result in the opportunity for a wider beach. The proposed RHG improvement project does not include additional beach nourishment, so the actual width of the beach adjacent to the groin will depend on the existing available sand volume and the sand transport processes occurring at any given time.

### *2.1.2 Option 2 – 280 Foot Long Rock L or T Head Groin*

A longer groin, which could potentially increase the beach width and area, could be constructed. This groin would be of similar construction as Option 1; however, its total length would be 280 feet, as shown on Figure 2-3. This longer groin could stabilize a wider beach adjacent to the groin, with a possible beach area increase of about 5,000 square feet, assuming sufficient sand is available. However, the increased beach area would be limited to the immediate vicinity of the groin unless the entire Royal Hawaiian Beach Sector was widened considerably further than accomplished by the 2012 nourishment project. The 2012 nourishment project, which approximated the 1985 beach width, was considered the best beach configuration with regard to maintaining a viable beach area for recreation and backshore protection and minimizing impact to the nearshore marine environment. A wider beach would be more difficult to obtain the necessary permits and approvals for due to increased impacts to the marine environment, and would require more sand to be recovered from offshore to maintain the larger beach area.

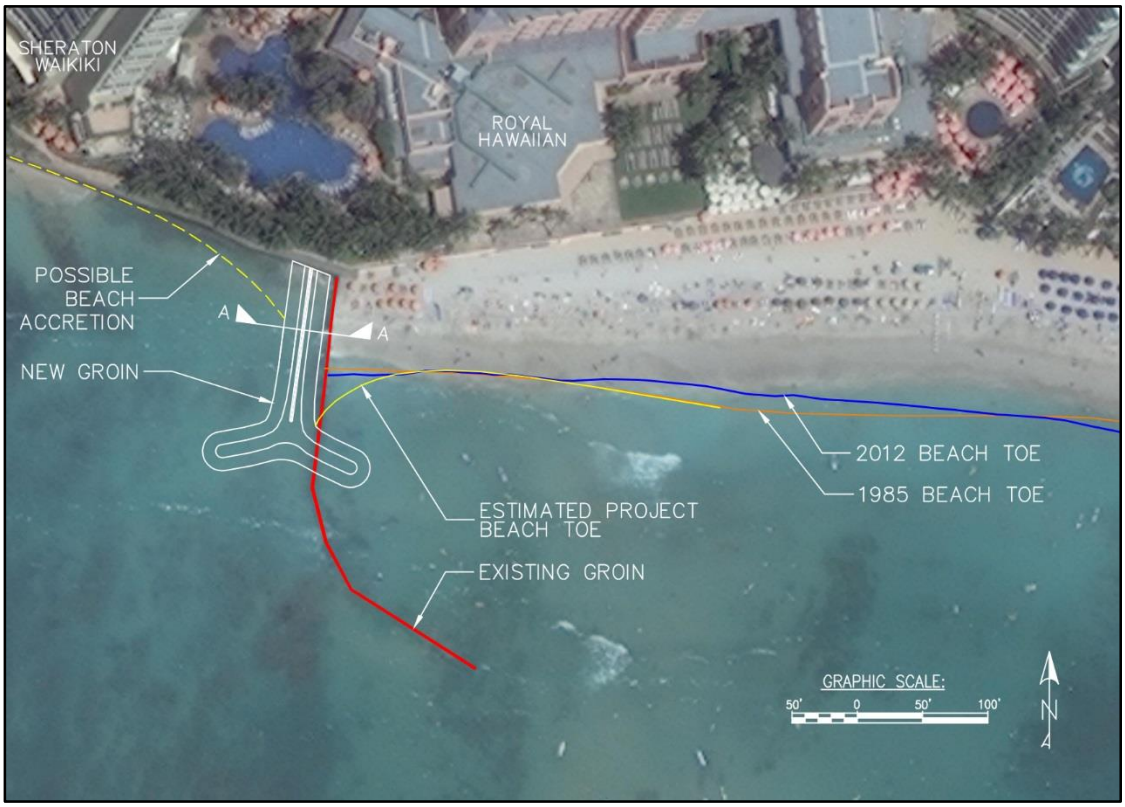



**Figure 2-1 Plan view of proposed 180-foot long groin**

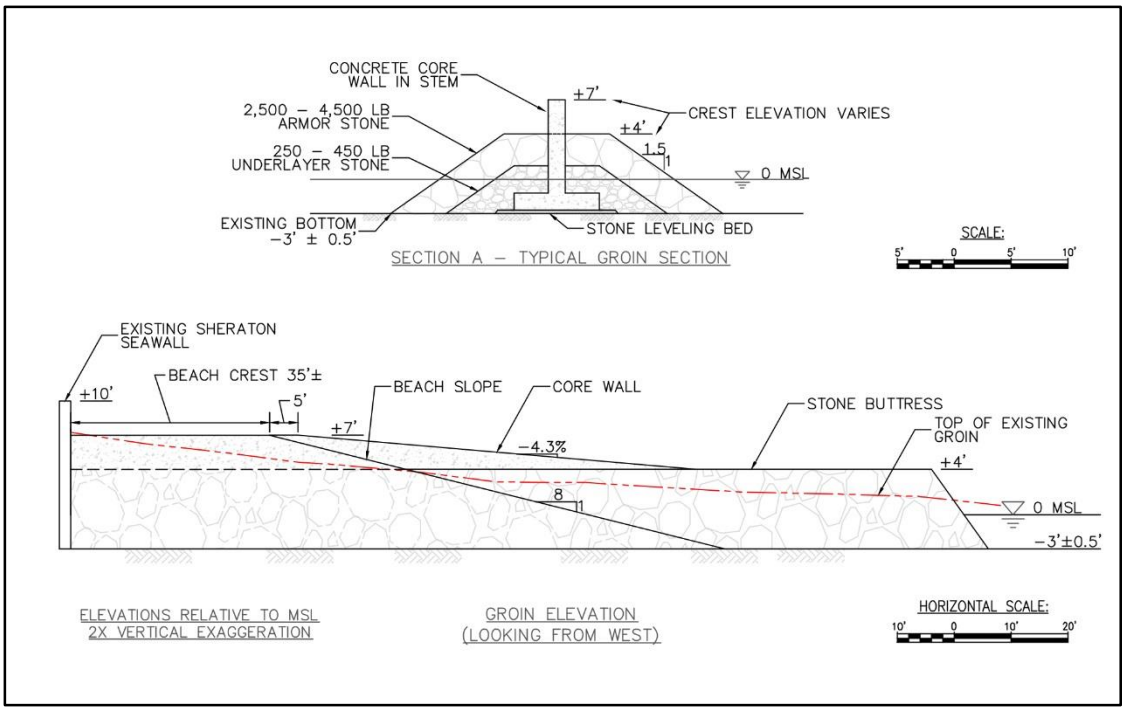



**Figure 2-2 Groin section and elevation views**

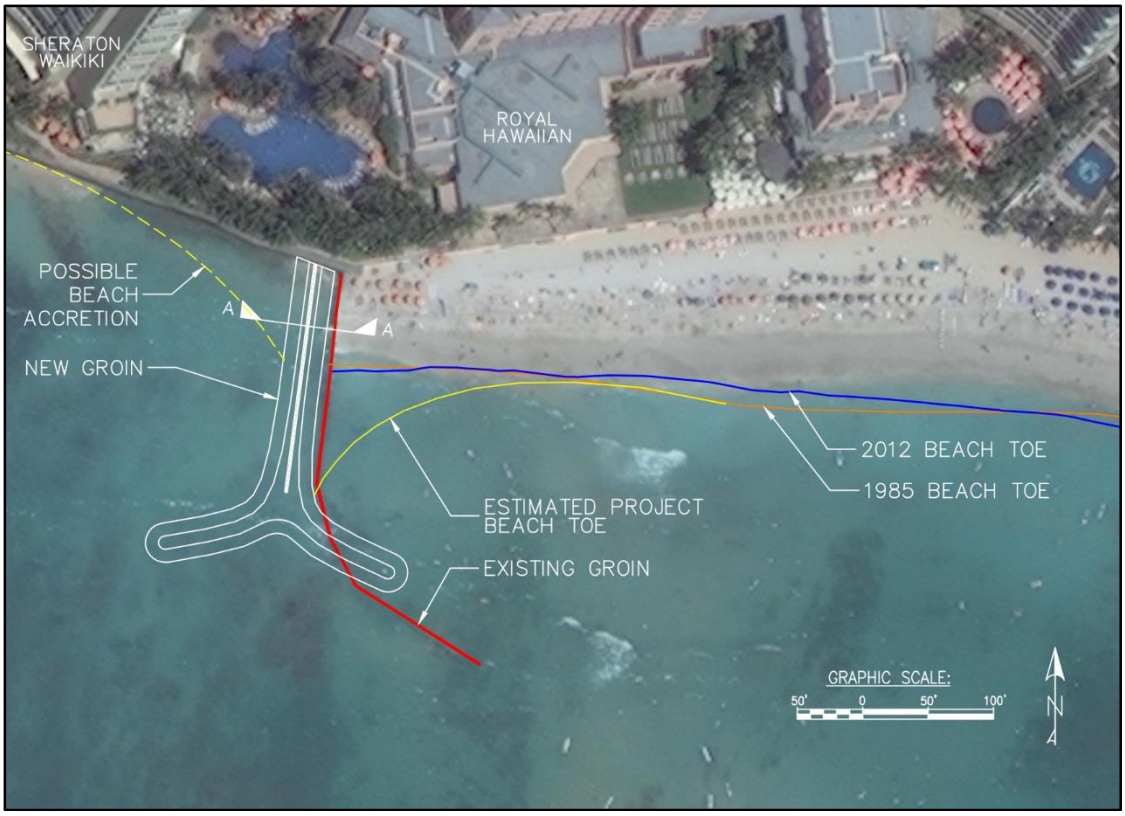



**Figure 2-3 Plan view of 280-foot long groin**

### *2.1.3 Option 3 – Adaptive Reuse of the Existing Groin*

While the existing groin is very deteriorated, it would be possible to construct a rock rubblemound groin structure around the remnants of the existing groin, with the existing groin then becoming the core wall to prevent sand migration through the structure. This plan is shown on Figure 2-4 and Figure 2-5 and would consist of a 130-foot-long stem centered on the existing groin, and a 30-foot-long L-head, for a total length of 160 feet. This option would have the same general section and elevation profile as options 1 and 2. The nearshore the rock crest elevation would be +7 feet to fully buttress the existing groin, and would transition to +4 feet 60 feet from shore. A cast-in-place crest cap would be constructed to raise the crest elevation of the existing groin by up to 2 feet after placement of the rock. Given the fragile nature of the existing concrete block groin, construction around it would have to be done very carefully to avoid damage to or displacement of the existing structure. Construction would also require installation of a temporary barrier, such as steel sheet pile, near the east side of the groin to hold the sand back and permit excavation of sand adjacent to the groin for stone placement, and placement of a temporary stone construction access causeway from shore.

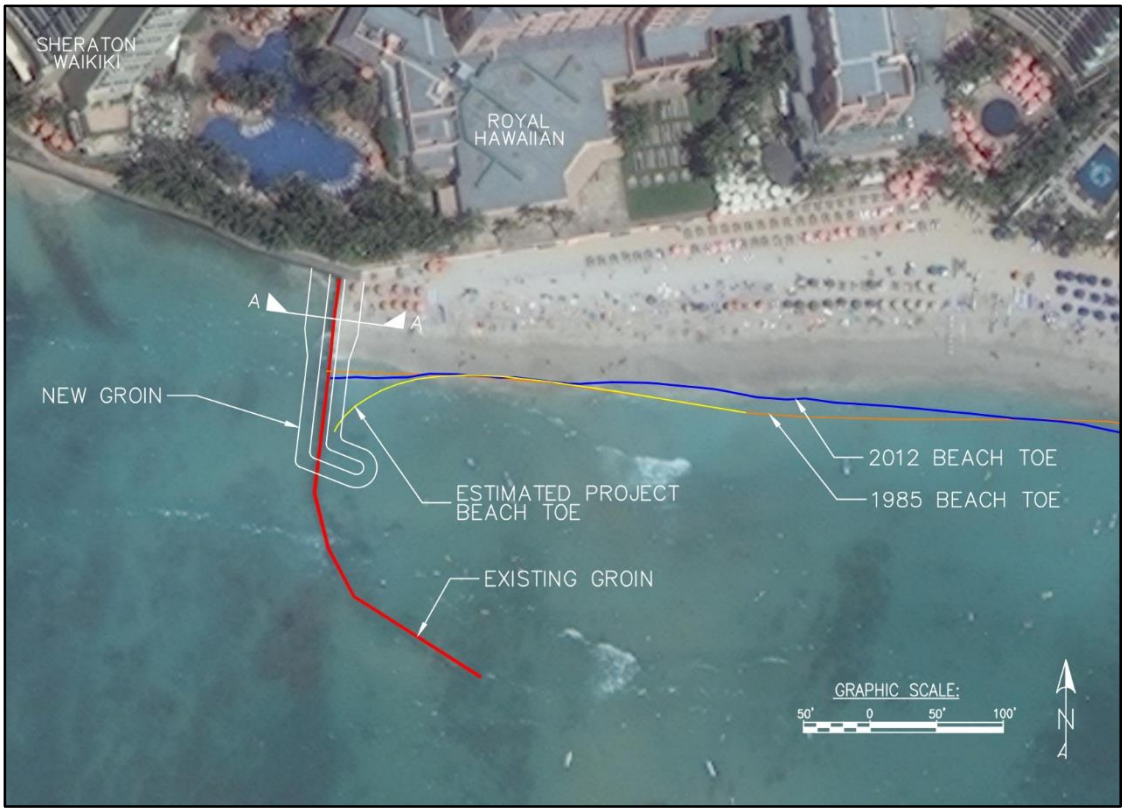



**Figure 2-4 Adaptive Reuse groin plan view**

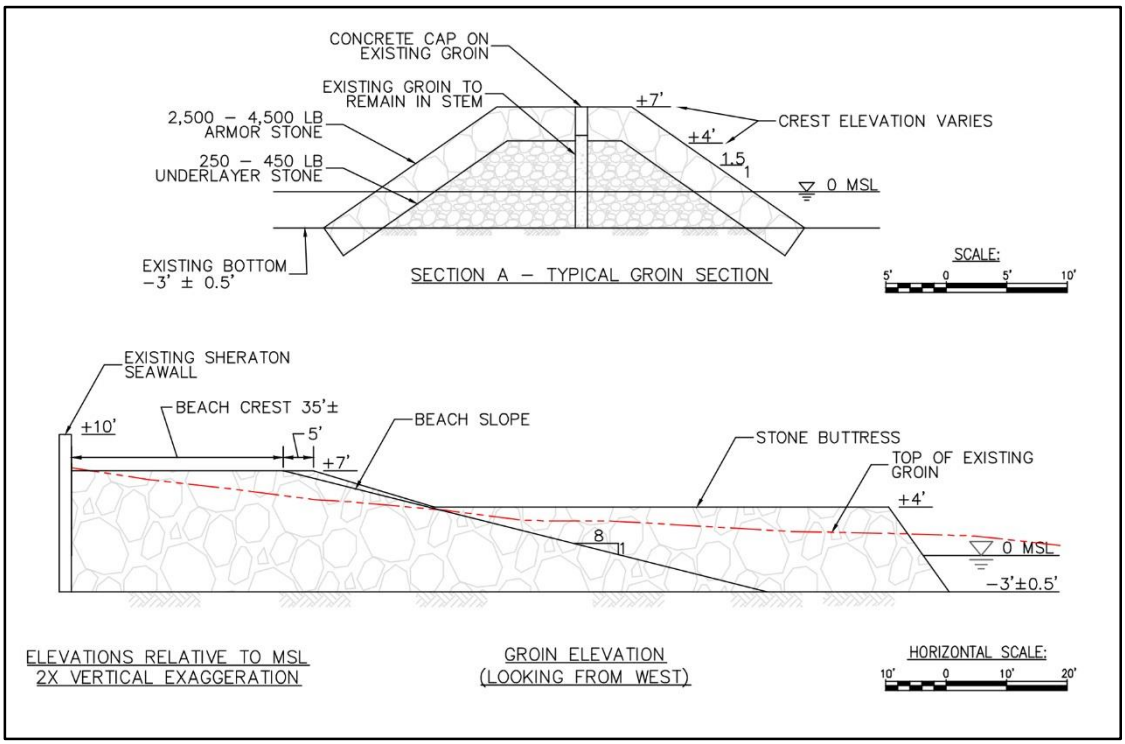



**Figure 2-5 Adaptive Reuse groin section and elevation**

### *2.1.4 Option 4 – Concrete Wall Groin*

The existing groin is basically a vertical concrete wall. While this type of construction is not considered optimum for a sand stabilization structure due to its high wave energy reflectivity, it would minimize the overall mass and footprint of the groin. The concrete wall groin is illustrated on Figure 2-6 and Figure 2-7. The vertical wall groin would be stabilized by embedding it into a footing trench excavated in the sea floor and by footing "wings" on either side resting on the bottom. The wall base would be precast sections, and following placement of these sections, the footing trench would be pumped full of tremie concrete through holes in the footing wings to lock the sections in place. The precast base sections would extend vertically up to elevation +2.5 feet msl, which is above the mean higher high water line, and following placement of the base sections a cast-in-place crest would be constructed to complete the groin to the design crest elevations of +7 feet (nearshore beach crest), and then sloping down to +4 feet for the offshore portion. Non-ferrous (e.g., fiberglass) concrete reinforcing bar would be used to eliminate the potential for long term corrosion problems. The groin would have a 130-foot-long stem and a 30-foot-long L-head, similar to Option 3. The alignment of the groin would be parallel to, and immediately west of, the existing groin. A temporary boulder causeway would be constructed from the existing beach seaward to the vicinity of the new groin head in order to provide construction access. Bottom material excavated to form the toe trench would be disposed of on-land.

**Figure 2-6 Concrete wall groin plan view**

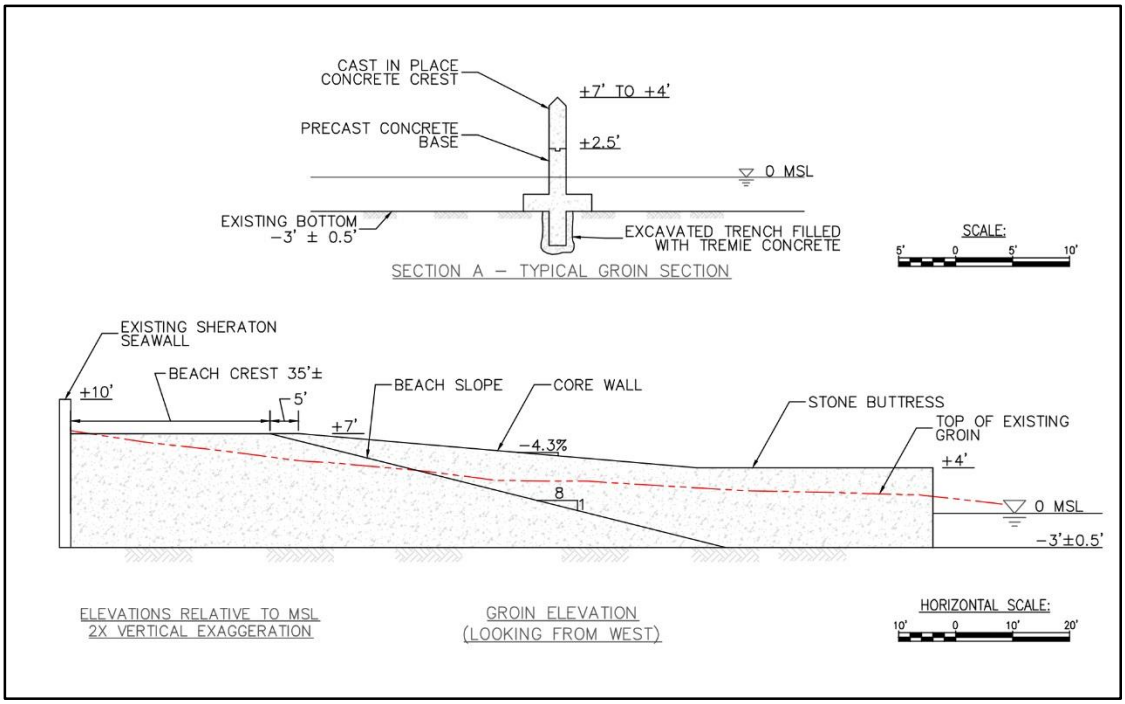



**Figure 2-7 Concrete wall groin section and elevation**

## 2.2 Groin Design Considerations

A conventional rock rubblemound groin structure is recommended. Stone, sized according to the design wave conditions, is typically used for groin construction when the required size and quantities are available. Stone design and construction is tried and proven, with a long history of testing and actual structure performance monitoring. In addition, a sloping rock rubblemound structure provides good wave energy dissipation and minimal wave reflection back toward the offshore surf breaks (Sea Engineering, Inc., 2007). The groin design is based on methodology contained in the Shore Protection Manual (1984), the Coastal Engineering Manual (2006), and the Coastal Engineering Design & Analysis System (CEDAS), all based on research by the U.S. Army Corps of Engineers, Coastal Engineering Research Center.

Nearshore Water Level Rise and Breaker Height: The project site is an open coast, exposed to waves from various sources and directions – the prevailing tradewind generated seas from the northeast which refract and diffract around Diamond Head, summer season South Swell generated by southern hemisphere winter storms, and Kona waves from the west generated by low pressure systems passing through the islands. The site is also exposed to extreme storm events, such as hurricanes. While infrequent in Hawaii, hurricane conditions are a prudent design consideration for permanent coastal structures such as the RHG improvement, due to the difficulty and expense of future repairs. The seafloor seaward of the groin location is a relatively shallow, flat sloped, and broad fossil reef flat, which significantly limits wave energy reaching the shoreline. Large deepwater waves approaching shore break seaward of the reef, then reform and continue shoreward as smaller waves, sometimes breaking several times before reaching shore. Wave heights at the shore are thus termed "depth limited waves," i.e., their maximum height is a function of the total water depth. The total water depth is composed of the depth below the sea level datum, plus factors such as the astronomical tide, storm surge and wave setup during hurricane conditions, and potential sea level rise over the life of the project. The sea level datum for this project is mean sea level (msl), the average tide elevation, and the typical water depth at the head of the groin is 3.3 feet below msl. A tide elevation of +0.7 feet, equivalent to mean high water (mhw), the average of all the annual high tides, is used due to the relative frequency of occurrence of this elevation. Storm surge and wave setup during typical hurricane conditions are estimated to be 2.3 feet. Potential 50-year sea level rise is estimated to be 0.7 feet. These factors result in a total design water depth of 7.0 feet.

Breaker Height on the Structure: The groin will be located landward of an essentially flat bottom slope, and the breaker height on the structure is a function of the wave period, the bottom slope and the water depth near the structure toe, i.e., a depth-limited breaker height. The storm wave period is 12.9 seconds, the bottom slope is 1 on 100, and the total water depth at the structure is 7.0 feet. From Figure 7-4 of the Shore Protection Manual, the breaker index is 0.78, and the design breaker height is 5.5 feet.

Design Analysis: Key structure design parameters include height, slope, composition, stone size, and crest width. The groin is designed as a rock rubblemound structure with side slopes of 1V:1.5H, a single stone thick, keyed-and-fit armor layer over an underlayer, or core, of smaller stone.

*Armor Stone Size*: Armor stone size is based on the design wave height of 5.5 feet. The required groin armor stone weight for stability under this design wave height is given by the Hudson Formula (USACE, 2006):

$$W = \frac{w_r H^3}{K_D (S_r - 1)^3 \cot\theta}$$

where:

$W$ = weight in pounds of an individual armor stone
$w_r$ = unit weight of the stone, 160 lb/ft$^3$
$H$ = wave height, 5.5 ft
$K_D$ = armor stone stability coefficient, 1.5
$S_r$ = specific gravity of the stone relative to seawater, use 2.5
$\cot\theta$ = cotangent of the groin side slope, 1.5

The resultant armor stone weight would be approximately 3,500 lbs with a corresponding nominal diameter of about 2.8 feet. A range of ±25% of the median weight is typically utilized, which yields a stone weight range of 2,500 to 4,500 lbs. The armorstone would be carefully placed (keyed-and-fit) for an added level of stability.

*Underlayer Stone*: Underlayer stone is sized at approximately 1/10 the armor weight, resulting in underlayer stone size between about 250 to 450 lbs. The sizing is important for providing porosity for energy dissipation rather than reflection, to achieve interlocking between the armor and underlayer, and to insure that the underlayer material cannot be removed through voids in the armor layer.

*Crest Elevation*: The elevation of the groin crest determines the amount of wave overtopping that will occur during selected wave conditions. For design of a beach stabilization structure it is reasonable to design for minimal overtopping during average tide elevations and typically prevailing wave conditions. Assuming a total water depth seaward of the groin head of 3.3 feet, the depth-limited wave height at the groin head would be about 2.6 feet. Runup on the rough and permeable groin face would be about 3 feet above the water level. Including the possible future SLR of 0.7 feet, a crest elevation of +3.7 feet, say +4 feet, above mean sea level would prevent overtopping during typically prevailing water level and wave conditions. A crest width equal to three stone diameters is typically utilized for crest stability, about 8 feet for this project.

*Wave Forces:* Wave forces were calculated for the concrete wall groin presented as Option 4. While the other option also have concrete components, those are held stable by the surrounding rocks. The wave forces were calculated separately for the head and the stem, since those components have different exposed wall heights, and the design (hurricane) condition was applied to each. The groin head is oriented approximately parallel to the incident wave crest. Waves incident upon the stem, however, are assumed to be at an approximate 45-degree angle; this is taken into account in the calculations.

**Table 2-1 Summary of pressure and forces on proposed Option 4 groin for the Model Hurricane**

| Component Value | Head | Stem |
|---|---|---|
| Maximum hydrodynamic pressure (lb/ft$^2$) | 570 | 540 |
| Maximum hydrostatic pressure (lb/ft$^2$) | 440 | 440 |
| Hydrodynamic force (lb/ft) | 4,110 | 5,240 |
| Hydrostatic force (lb/ft) | 1,530 | 1,530 |
| Total horizontal force (lb/ft) | 5,640 | 6,770 |

## 2.3 Groin Renderings

Computer generated renderings shown in Figure 2-8 through Figure 2-10 illustrate what the proposed new rock groin would look like to a beach user standing on the beach. The renderings are accurately scaled and positioned, and the perspective is accurate. The 180-foot T-Head groin is shown in Figure 2-8 and Figure 2-9; however, the 160-foot long Adaptive Reuse groin would not appear much different in scale, with the exception of having an L head instead of a T head. The concrete wall groin is illustrated in Figure 2-10.

**(a)**

**(b)**

**Figure 2-8 Project site looking west: (a) existing condition, (b) with proposed 180-ft rock groin**

**(a)**

**(b)**

**Figure 2-9 Project site looking offshore: (a) existing condition, (b) with proposed 180-ft rock groin**

**(a)**

**(b)**

**Figure 2-10 Project site looking offshore: (a) existing condition, (b) with 160-ft concrete wall groin**

## 2.4 Construction Methodology

While construction of the RHG improvement project is a relatively straightforward marine construction effort, its location in the middle of Waikiki and fronting one of the largest and oldest hotels presents construction challenges. The biggest challenge is construction access and limited space for a staging area on the shoreline. Thus the project must entail a replacement groin design and construction methodology that is relatively quick to construct and minimizes impacts to the adjacent hotel operations and recreational users.

A narrow pedestrian beach access between the Royal Hawaiian and Outrigger Hotels provides access to the project site from Kalakaua Avenue; however, its width (nominal 8 feet) significantly limits the size of equipment that can use it. Large construction equipment and materials will have to come through Kuhio Beach 1,730 feet to the east and then move up the beach. A preliminary staging area for material would be located in the vicinity of Kuhio Beach. A second staging area would be located on the beach adjacent to the existing groin (fronting the Royal Hawaiian Hotel) for equipment storage and a limited amount of construction material. Stone would be delivered to the staging areas by truck every couple of days, or possibly even daily, early in the morning. Construction equipment would consist primarily of a large excavator and large off-road capable trucks for stone and precast concrete delivery (similar to those used to move sand during the 2012 Waikiki Beach Nourishment project). Construction access and staging areas are shown on Figure 2-11.

The rock groin construction sequence would be approximately as follows:

- Clear loose material fronting the seawall on the west side of the existing groin and begin constructing the groin stem. The landward end of the stem would be overbuilt with stone as necessary for construction equipment and material access from the existing beach and over the existing groin.
- Starting from shore, clear loose material from the seafloor, place the leveling stone bed, place the precast concrete wall section on the leveling bed, and then immediately place the core stone and armor stone up to the +2.5-foot elevation. Place temporary additional armor stone on both sides to provide for adequate equipment access width along the stem.
- Move seaward constructing the lower portion of the stem until the head area is reached, then construct the lower portion of the head(s) out to their end(s). (Note that the heads would be constructed entirely of stone, without the concrete core wall.)
- Work backward toward shore constructing the finished groin to the design elevation, using the temporary armor stone placed along the sides. The top portion of the concrete core wall would be cast-in-place in order to obtain a uniform finished top of wall elevation. Remove the existing RHG remnants as construction proceeds back to the shore.

The Adaptive Reuse and Concrete Wall groin options would require placement of a temporary stone causeway extending from shore for construction access. This would be removed as construction proceeded from the groin head back to shore.

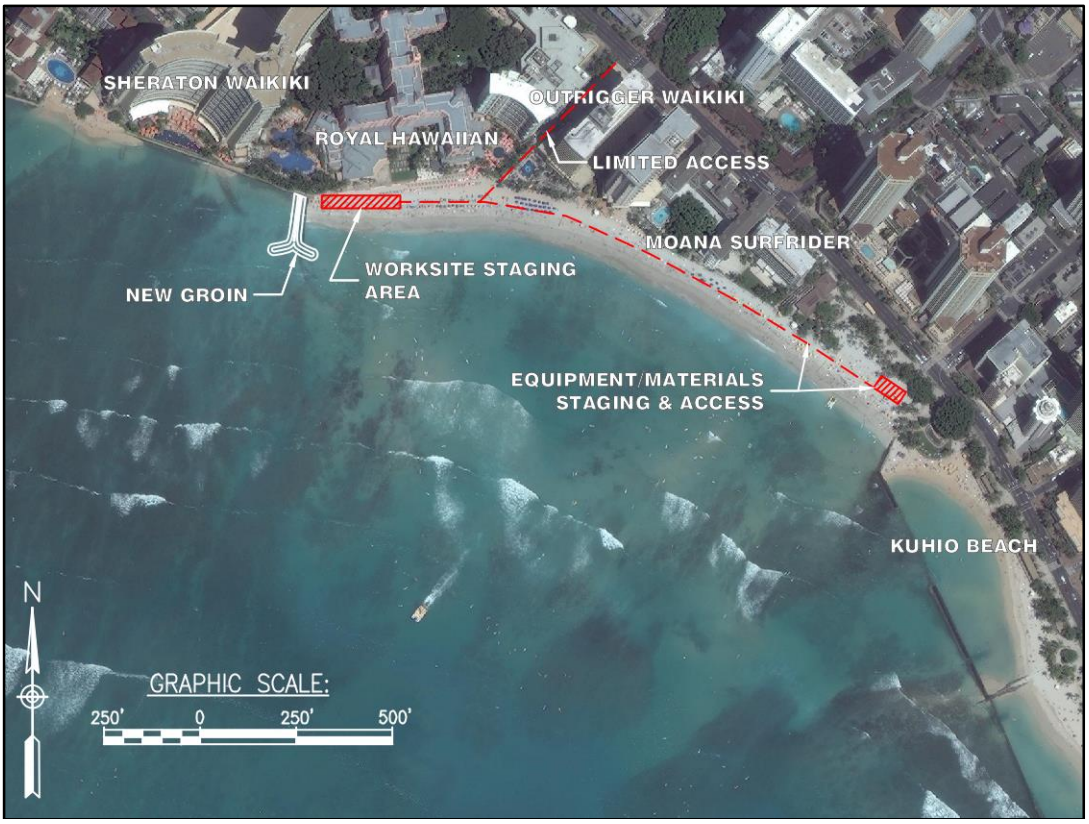



**Figure 2-11 Construction access and staging areas**

## 2.5 Construction Cost

The preliminary estimated construction cost for the groin improvement options are as follows:

| Option | Cost |
|---|---|
| 180-ft L-Head Groin | $ 880,000 |
| 180-ft T-Head Groin | $1,200,000 |
| 280-ft L-Head Groin | $1,510,000 |
| 280-ft T-Head Groin | $1,730,000 |
| Adaptive Reuse Groin | $1,240,000 |
| Concrete Wall Groin | $ 910,000 |

**Table 2-2 Summary Comparison of Groin Improvement Options**

| | Existing Condition | Option 1 | Option 2 | Option 3 | Option 4 |
|---|---|---|---|---|---|
| **Groin type** | Concrete block | Rock rubblemound w/concrete core | Rock rubblemound w/concrete core | Adaptive re-use w/ rock rubblemound | Concrete wall |
| **Configuration** | L head | L or T head | L or T head | L head | L head |
| **Length (along crest)** | 370 ft | 180 ft | 280 ft | 160 ft | 160 ft |
| **Crest elevation** | +8 to -3 ft. | +7 to +4 ft | +7 to +4 ft | +7 to +4 ft | +7 to +4 ft |
| **Footprint on seafloor** | | | | | |
| **L head** | 550 sf | 5,900 sf | 9,050 sf | 5,990 sf | 1,100 sf |
| **T head** | n/a | 7,480 sf | 12,080 sf | n/a | n/a |
| **Volume** (1) | | | | | |
| **L head** | n/a | 850 cy | 1,320 cy | 1,160 cy | 175 cy |
| **T head** | n/a | 1,120 cy | 1,780 cy | n/a | n/a |
| **Energy reflection** (2) | 60% (3) | 20% | 20% | 20% | 60% |
| **Construction cost** | | | | | |
| **L head** | n/a | $880,000 | $1,510,000 | $1,240,000 | $910,000 |
| **T head** | n/a | $1,200,000 | $1,730,000 | n/a | n/a |

(1) The volume is a measure of the mass of the structure
(2) The percentage of the incoming wave energy that is reflected back seaward
(3) Assumes the existing groin is in its original upright position

## 3. EXISTING GROIN CONDITION

The Royal Hawaiian Groin is approximately 370 feet in total length, and curves to the southeast beyond the toe of the beach. Only the first approximately 150 feet of the groin is functional; after that it is submerged and broken apart. The groin was originally built in 1927 (Figure 3-1), and utilized a large rubble mound on the western side to assist in structural stability. This rock buttress no longer exists. Of primary concern is the landward portion of the groin which holds the existing sand beach in place, and which is severely undermined, missing a significant portion of the inter-block grout, and leaning to the west (Figure 3-2 through Figure 3-5). The partial failure of the structure has led to increased undermining of the foundation and loss of sand from the newly nourished beach on the east side. As a result, large sink holes developed on the east side of the groin (Figure 3-6) and were subsequently filled.

Continued deterioration of the groin will lead to collapse of the structure, releasing the sand from Waikiki Beach that is impounded on its eastern side. The recently completed 2012 Waikiki Beach Maintenance project nourished this beach with approximately 24,000 cubic yards of sand, creating a beach berm with elevation of approximately +7 feet msl and extending the dry sand area by 35 to 40 feet in width. As the structure is failing along the entire beach berm width, its collapse would destabilize the beach. Sediment transport in the area is typically east to west, which would allow the existing beach fronting the Royal Hawaiian Hotel to drain to the west. The sand would then likely move west to the Halekulani sand channel, which is considered to be a sink for nearshore sediment. The end result would be a significant loss of the recently placed beach nourishment sand.

In December of 2012, DLNR stacked about 45 large sand-filled geotextile bags against the west side of the groin extending about 42 feet from shore to buttress the groin and help prevent it from toppling over. The bags immediately after placement and their current deteriorated condition are shown on Figure 3-7 and Figure 3-8. As can be seen on Figure 3-8, the entire top row of bags has been displaced, resulting in loss of contact with the groin and decreasing the effectiveness in stabilizing the groin. These sand bags were meant as a temporary measure until a permanent groin improvement plan could be implemented.

**Figure 3-1 1930 historic photograph of the Royal Hawaiian Groin. Rocks are placed on the west side of the structure, near the shoreline, to stabilize the stacked concrete block structure.**

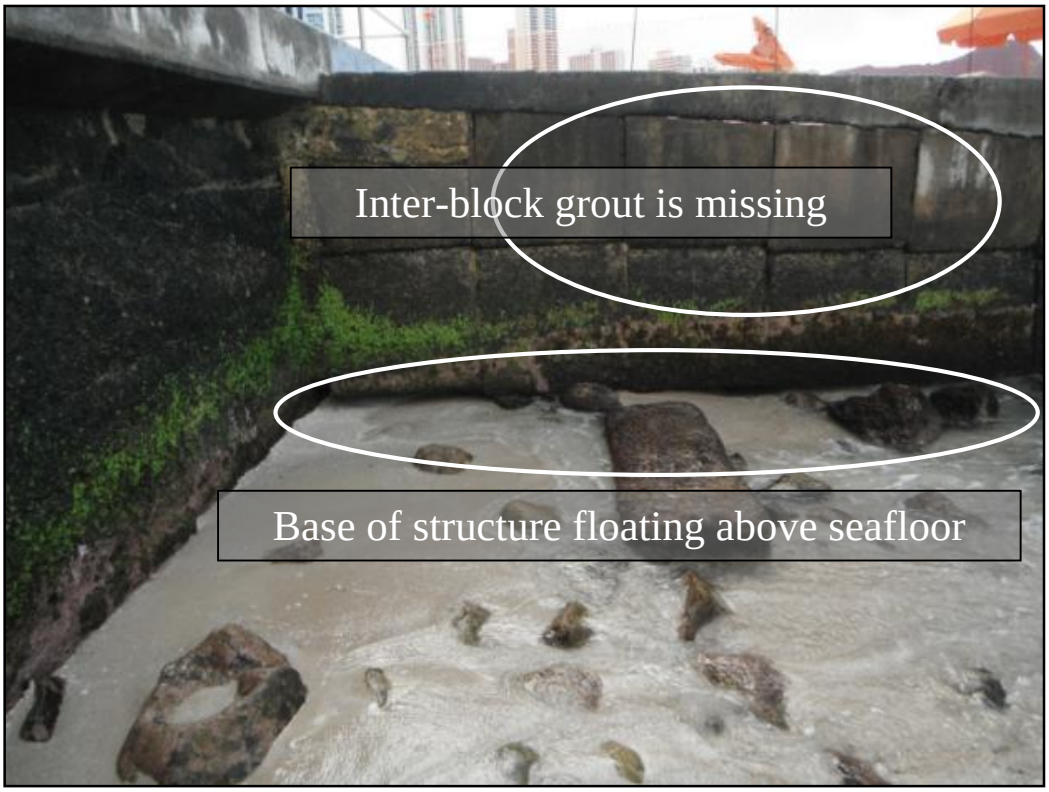



**Figure 3-2 Looking east at the western side of the groin where it joins the Sheraton seawall.**

**Figure 3-3 Looking between the blocks where the grout is missing.**

**Figure 3-4 Base of groin is floating above the sand and rock seafloor.**

**Figure 3-5 Gaps below base of structure are greater than four inches high in many locations.**

**Figure 3-6 Looking seaward along the crest of the groin, from the Sheraton seawall.**

**Figure 3-7 ElcoRock sand bags one month after placement (photo date January 21, 2013)**

**Figure 3-8 Several displaced ElcoRock sand bags (photo date September 24, 2014)**

# 4. OVERVIEW OF THE EXISTING ENVIRONMENT

## 4.1 Physical Environment

### *4.1.1 Bathymetry and Nearshore Bottom Conditions*

Waikiki is located on the south shore of Oahu, 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 bathymetry and surf sites in the project area are presented in Figure 4-1.

The groin improvement project area seafloor is primarily a sandy bottom, with coralline and rock rubble, and patches of fossil limestone reef rock. The patches of hard bottom show significant evidence of sand scour, and have little or no benthic biota on them.

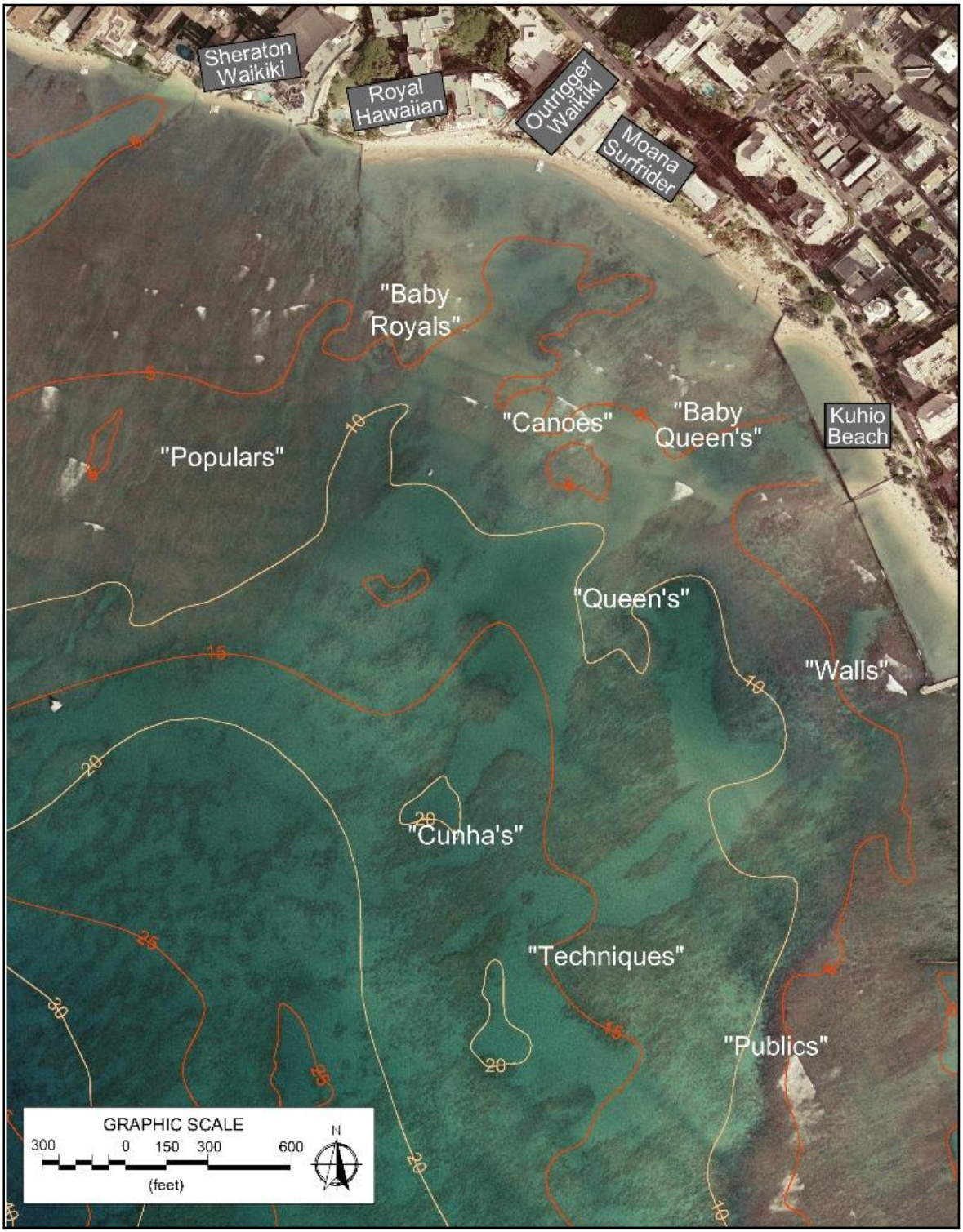



**Figure 4-1 Project area bathymetry (contours in feet) and surf sites**

### *4.1.2 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.

#### *4.1.2.1 Temperature and Rainfall*

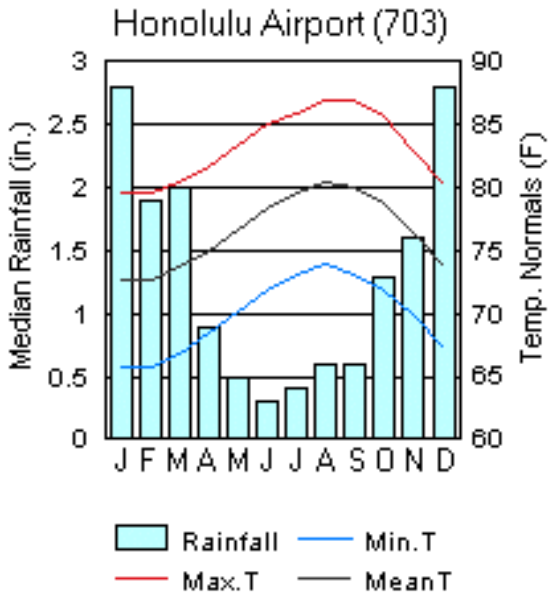
Due to the tempering influence of the Pacific Ocean and their low-latitude location, the Hawaiian Islands experience extremely small diurnal and seasonal variations in ambient temperature. Average temperatures in the coolest and warmest months at Honolulu International Airport are 72.9˚ Fahrenheit (F) (January) and 81.4˚F (July). 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 4-1 and Table 4-2.

**Table 4-1 Average Monthly Temperature, Rainfall, and Humidity**

| Month | Normal Ambient Temperature, ºFahrenheit | | Average Monthly Rainfall (inches) | | Average Relative Humidity (%) |
|---|---|---|---|---|---|
| | Daily Minimum | Daily Maximum | Monthly Minimum | Monthly Maximum | |
| January | 65.7 | 80.4 | 0.18 | 14.74 | 71.0 |
| February | 65.4 | 80.7 | 0.06 | 13.68 | 69.0 |
| March | 66.9 | 81.7 | 0.01 | 20.79 | 65.0 |
| 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 | 59.0 |
| July | 73.8 | 87.8 | 0.03 | 2.33 | 60.0 |
| August | 74.7 | 88.9 | T | 3.08 | 60.0 |
| 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 | 67.0 |
| 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 Hawaii Data Book 2003 (Data from Honolulu International Airport).* | | | | | |

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 Oahu. Near the top of the Koolau Range on the windward side of Oahu 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 Waikiki 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 4-2 Seasonal Rainfall and Temperature Patterns**




Station Key: 703 (Honolulu Airport Station)

Coordinates: 21.33138°, 157.91862°

Elevation: 5 feet

Temperature Records: 30 years, 1941 to 1970.

Rainfall Records: 29 years

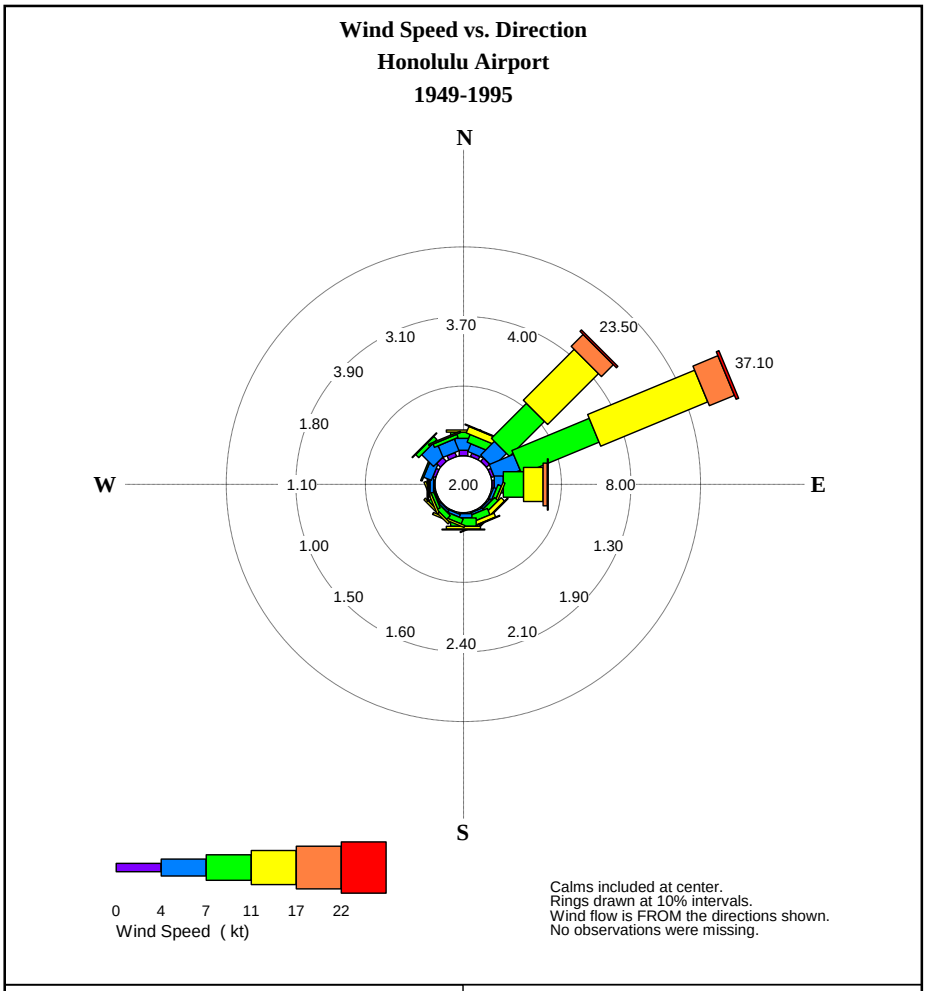
*Source: http://hikawa.htohananet.com/climate-oahu/grids/whonolulu.html*

### *4.1.2.2 Wind*

The prevailing wind throughout the year is the northeasterly trade wind. 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 4-2 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.




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 4-2 Wind rose for Honolulu Airport (1949 to 1995)**

### *4.1.2.3 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 Hawaii Department of Health monitors ambient air quality on Oahu 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 Oahu is located on Sand Island. Existing ozone concentrations at that location also meet State and Federal ambient air quality standards.

### *4.1.3 Tide*

Hawaii tides are semi-diurnal with pronounced diurnal inequalities (i.e., two high and low tides each 24-hour period with different elevations). Tidal predictions and historical extreme water levels are given by the Center for Operational Oceanographic Products and Services, NOS, NOAA, website. The nearest tide station to Waikiki is at Honolulu Harbor, where the water level data, based on the 1983-2001 tidal epoch, is shown in Table 4-3.

**Table 4-3 Water level data for Honolulu Harbor**

| Datum | Elevation (ft mllw) | Elevation (ft msl) |
|---|---|---|
| Mean Higher High Water | 1.9 | 1.1 ft. |
| Mean High Water | 1.5 | 0.7 ft. |
| Mean Tide Level | 0.8 | 0.0 ft. |
| Mean Low Water | 0.2 | -0.6 ft. |
| Mean Lower Low Water | 0.0 | -0.8 ft. |

Hawaii is also subject to periodic extreme tide levels due to large scale oceanic eddies that propagate through the islands. These eddies produce tide levels up to about 0.5 feet higher than normal for periods of up to several weeks.

### *4.1.4 Sea Level Change*

The present rate of global mean sea-level change (SLC) is +3.16 mm/yr (NASA, 2015), where a positive number represents a rising sea level. SLC appears to be accelerating compared to the mean of the 20$^{th}$ Century. Factors contributing to the rise in sea level include decreased global ice volume and warming of the ocean. Recent climate research by the Intergovernmental Panel on Climate Change (IPCC) predicts continued or accelerated global warming for the 21$^{st}$ Century and possibly beyond, which will cause a continued or accelerated rise in global mean sea level (USACE, 2011). It is estimated that global sea level rise may reach 1 m (3.3 ft) by the end of

this century, and the U.S. Army Corps of Engineers estimates possible sea level rise as high as 1.4 m (4.6 ft).

Sea level, however, is highly variable. The sea level trend for Honolulu Harbor for the period of 1905 to present is shown in Figure 4-3 (NOAA, 2015). The rate of sea level change (RSLC) is shown in the figure as being +1.41 ± 0.22 mm/yr based on monthly data for the period 1905-2013. Figure 4-3 shows interannual anomalies of up to about 0.5 ft (15 cm) in Honolulu Harbor.

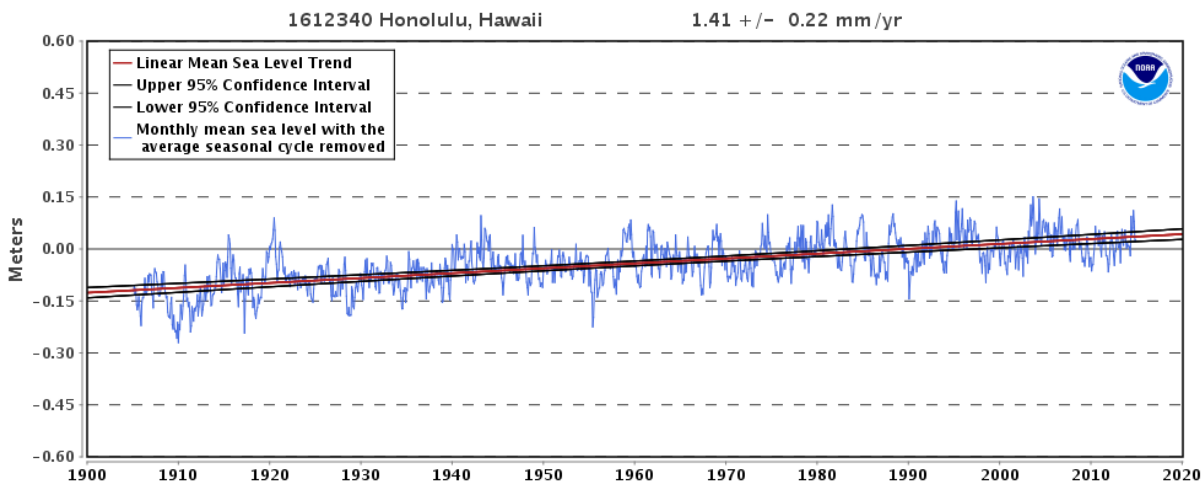



**Figure 4-3 Mean sea level trend, Honolulu Harbor, 1905 to present (NOAA, 2015)**

The U.S. Army Corps of Engineers (USACE, 2011) provides guidance for calculating site-specific RSLC in their Engineering Circular EC 1165-2-212, Appendix C. A wide range of predictions for future SLR rates is given in Figure B-10 of the EC by various researchers, and the procedure produces low, intermediate, and high SLC curves following the National Research Council's (NRC) recommendation of using a multiple-scenario approach. To facilitate calculation of site-specific SLC, the USACE has also developed a climate change website that performs the calculations presented in EC 1165-2-212. The website contains a database of information for the tidal stations within the USACE's jurisdiction, allowing the user to select a project location and project start and end years, and the website quickly calculates the projected SLC for the project site. The USACE has developed criteria for three curves which are the historic rate of SLC ("USACE Low Rate"), a modification of the NRC-I curve ("USACE Intermediate Rate"), and a modification of the NRC-III curve ("USACE High Rate").

Sea level rise for Oahu using the three USACE scenarios is shown in
Table 4-4 and Figure 4-4. Positive numbers indicate a rise in sea level. The intermediate rate is generally accepted as a reasonable prediction for future sea level at the project site. For a project design life of 50 years, the calculations predict an increase of 0.68 ft (8 in) by 2065. For comparison, the low and high estimates using the same procedure are 0.25 ft (3 in) and 2.03 ft (24 in) respectively.

**Table 4-4 Projected Sea Level Change, Honolulu Harbor (USACE, 2014); values in feet**

| Year | USACE Low Rate | USACE Int Rate | USACE High Rate |
|---|---|---|---|
| 2015 | 0.00 | 0.00 | 0.00 |
| 2020 | 0.02 | 0.05 | 0.12 |
| 2025 | 0.05 | 0.10 | 0.26 |
| 2030 | 0.07 | 0.16 | 0.41 |
| 2035 | 0.10 | 0.22 | 0.59 |
| 2040 | 0.12 | 0.28 | 0.78 |
| 2045 | 0.15 | 0.35 | 0.99 |
| 2050 | 0.17 | 0.43 | 1.23 |
| 2055 | 0.20 | 0.51 | 1.47 |
| 2060 | 0.22 | 0.59 | 1.74 |
| 2065 | 0.25 | 0.68 | 2.03 |

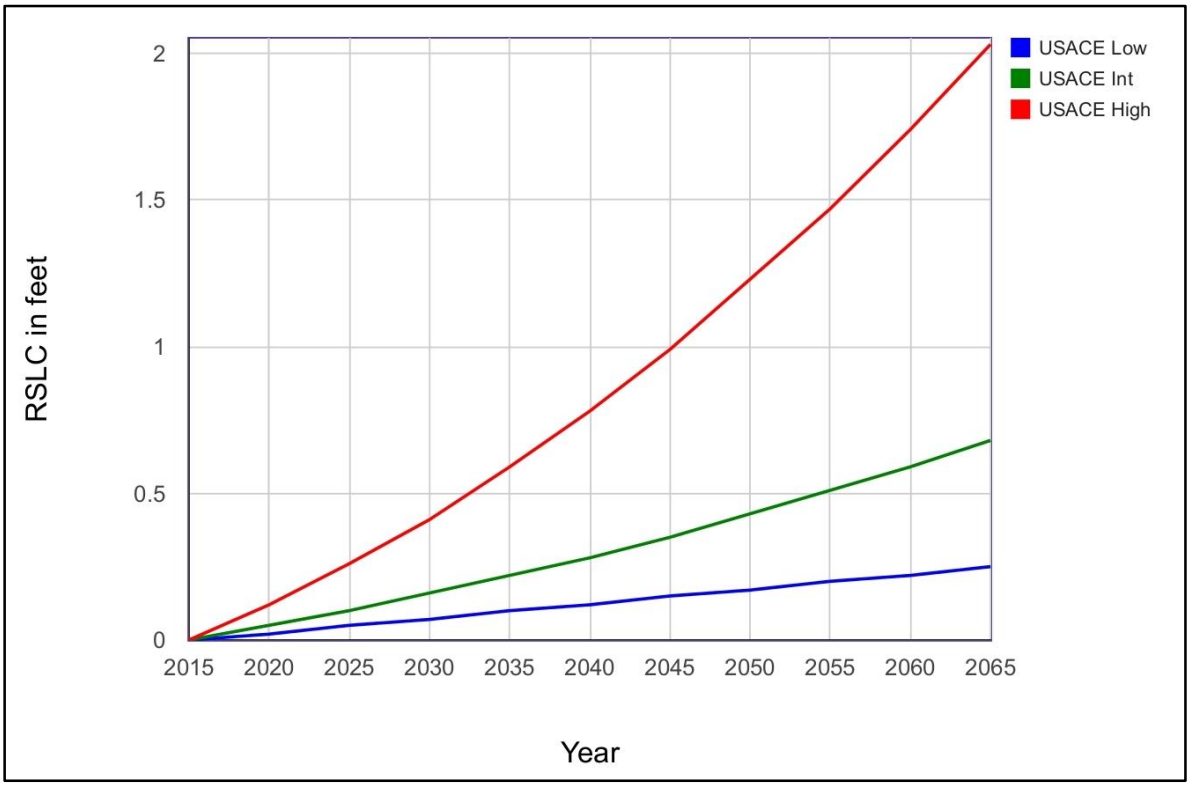



**Figure 4-4 Projected Sea Level Change, Honolulu Harbor (USACE, 2014)**

### *4.1.5 Waves*

#### *4.1.5.1 General Wave Climate*

The wave climate in Hawaii 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.

Tradewind waves occur throughout the year and are most persistent April through September when they usually dominate the local wave climate. These waves 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 of Oahu itself, and only a portion of the tradewind wave energy refracting and diffracting around the southeast end of the island reaches Waikiki.

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 swell approaches from the southeasterly to 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 Oahu and Maui 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 fairly 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 Oahu.

Severe tropical storms and hurricanes have the potential to generate extremely large waves, which in turn could potentially result in large waves at the project site. Recent hurricanes impacting the Hawaiian Islands include Hurricane Iwa in 1982 and Hurricane Iniki in 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 frequent or

even likely events, they should be considered in the project design, particularly with regard to shoreline structures, both in the water and on land near the shore.

#### *4.1.5.2 Prevailing Deepwater Waves*

Waikiki is exposed to south swell during the summer months, kona storm waves during winter and spring, and refracted tradewind waves at any time of the year. Additionally, Waikiki is exposed to hurricane waves during summer and winter months. The characteristics of each of these wave types was determined from measured and hindcast wave data from around Hawaii. Each data set was analyzed statistically with the exception of hurricane wave information, which was obtained following recent hurricane modeling efforts (Exponent, Inc., 2008). Deepwater wave parameters of significant wave height $H_s$, peak period $T_p$, and peak direction $D_p$ were developed to characterize these waves, and are presented in Table 4-5. These parameters were used as input to the wave modeling analysis presented in Section 4.1.7.

**Table 4-5 Deepwater wave parameters for general wave types**

| Wave type | Data Source | Deepwater Wave Parameter | | |
|---|---|---|---|---|
| | | Height $H_s$ (ft) | Period $T_p$ (sec) | Direction $D_p$ (deg TN) |
| Tradewinds | CDIP 098 | 6 | 8 | 75 |
| South Swell | WIS 114 | 4 | 14 | 202.5 |
| Kona Storm | WIS 114 / CDIP 146 | 8.4 | 8 | 237 |
| Model Hurricane | Exponent Inc. | 28.5 | 12.9 | 228 |

### *4.1.6 Nearshore Water Levels and Wave Heights*

During high wave conditions, the nearshore water level may be elevated above the tide level by the action of breaking waves. This water level rise, termed wave setup, could be as much as 1 to 2 feet during severe storm wave conditions. During hurricane conditions, an additional water level rise due to wind stress and reduced atmospheric pressure can occur. Collectively termed "storm surge," this can potentially add another 1 to 2 feet to the stillwater level. For example, during the 1992 passage of Hurricane Iniki over Port Allen Harbor on the island of Kauai, a National Weather Service tide gauge recorded a water level rise of 4.4 feet above the predicted tide elevation.

During storm or large wave conditions, there may be multiple zones of wave breaking. Wave heights are said to be *depth-limited* because once the water depth becomes shallow enough the wave breaks, losing size and energy. The wave, however, may reform before it reaches the shoreline and break again when the depth-limited ratio is again attained. The still water level rise during storm events is an important design consideration because it allows larger wave heights to reach the shoreline than during lower water levels. Still water level rise at the shoreline is a combination of astronomical tide, storm surge, and wave setup.

Wave setup is a function of the breaking wave height, period, and bottom topography. The mass transport of water due to breaking waves produces wave setup—the increase in water depth

shoreward of the breaker zone. The available analytical methods for calculating wave setup have been simplified and assume long, straight, parallel bathymetric contours, continuous breaking waves, and breaker zones relatively near shore; these methods are presented in the Shore Protection Manual (1984) and Coastal Engineering Manual (2006). Experience has shown that these methods tend to over-predict wave setup, because the natural environment has discontinuous breaking zones, irregular bathymetry, channels, and gaps in the reef that allow for a relief of wave setup. The complex wave and bathymetry in coastal regions has necessitated the use of numerical models for reliable estimates of wave setup and design wave heights.

### *4.1.7 Nearshore Coastal Processes*

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

The nearshore waters of Waikiki include shallow reef, natural and dredged channels, and shore protection structures. Wave and circulation modeling were performed using the Surface-water Model System (SMS) suite of products to identify Waikiki's coastal processes. BOUSS2D, a component of SMS, is a shallow-water non-linear wave model that also includes the processes of wave shoaling, refraction, diffraction, and breaking. BOUSS2D is a time domain model and has been shown to be particularly useful in modeling wave/structure interaction. The model has the capability of creating animations of water surface elevations, and was used primarily to show wave propagation and nearshore wave patterns.

CMS-Flow is a two-dimensional, finite-difference numerical approximation of the depth-integrated continuity and momentum equations. The model simulates currents, water level, sediment transport, and morphology in the coastal zone. CMS-Wave is a two-dimensional wave spectral transformation model that employs a forward-marching, finite-difference method to solve the wave action conservation equation. It is a phase-averaged model, which neglects changes in the wave phase in calculating wave and other nearshore processes. CMS-Wave contains theoretically-developed approximations for both wave diffraction and reflection, and therefore, is suitable for conducting wave simulations at coastal inlets and channels. CMS-Wave and CMS-Flow were used in tandem to produce circulation vectors and animations.

BOUSS2D, CMS-Wave, and CMS-Flow are best used as nearshore models, where their offshore boundaries are in intermediate or shallow water and their domains are composed of relatively small grid cells. Since modeling waves from deepwater to the shoreline would require a great deal of computing time and power, the waves presented in Table 4-5 were modeled from deepwater to the nearshore model domains using SWAN (**S**imulating **WAv**es **N**earshore). The SWAN model is a non-stationary (non-steady state) third generation wave model, based on the discrete spectral action balance equation and is fully spectral (over the total range of wave frequencies). Wave propagation is based on linear wave theory, including the effect of wave generated currents. The processes of wind generation, dissipation, and nonlinear wave-wave

interactions are represented explicitly with state-of-the-science third-generation formulations. The SWAN model can also be applied as a stationary (steady-state) model. This is considered acceptable for most coastal applications because the travel time of the waves from the seaward boundary to the coast is relatively small compared to the time scale of variations in the incoming wave field, the wind, or the tide. SWAN provides many output quantities including two-dimensional spectra, significant wave height and mean wave period, and average wave direction and directional spreading. The SWAN model has been successfully validated and verified in several laboratory and complex field cases.

Animations are a very valuable output of SMS. Water surface animations produced by BOUSS2D show wave propagation toward shore, transforming through the processes of refraction, diffraction, shoaling, and breaking, while the CMS-Flow circulation animation shows the wave-driven currents that may affect the site. Since the nearshore waters contain complex bathymetry, visualization through the model animations allows for greater understanding of the coastal processes and guidance for concept design development.

Figure 4-5 shows a snapshot of the water surface elevation for the south swell wave condition. The bathymetry is underlain and is shown as spectral colors where red is shallow and blue is deep. The water surface is shown as nearly transparent, allowing waves and bathymetry to be seen together. The model results show that the wave patterns are predominately a function of the nearshore reef structure. The wave pattern offshore of Kuhio Beach Park's ewa groin shows a complex wave pattern resulting from wave interaction with the reef that produces surf at Canoes, Baby Canoes, Queens, and Baby Queens. The incident waves refract and diffract off the reef, while also diffracting through the larger gaps in the reef, such as between Canoes and Queens, presenting a series of curved wave fronts. These waves, which offshore were a continuous wave, are shown in the figure to be separate and interacting with each other. Toward the center of Waikiki Beach, the incident wave pattern is also shown in Figure 4-5 to be curved. As the waves propagate to the shoreline, the angle between the wave crest and the shoreline produces alongshore transport potential, and the shoreline shape adjusts to approximate the wave crest pattern.

The wave pattern shown in Figure 4-5 confirms the curved shoreline shape in the center of the beach. The shoreline straightens toward the Royal Hawaiian Groin. Adjacent to Kuhio Beach Park's ewa groin, the wave pattern can move sand away from the groin, in particular when there is strong tradewind swell. This has been witnessed during each of the last two winters. During south swell or kona storm wave conditions, the sand quickly returns.

Waves drive a circulation pattern shown by vectors in Figure 4-6. The colors show the magnitude of the flow (red is fastest and blue is slowest) and the arrows show direction. As with the wave patterns, the flow is quite complex, with circulation driven primarily though gaps in the reef. The circulation patterns are consistent with the nearshore sand transport patterns, where the sand is transported from the shoreline through gaps in the reef to the known deposits, particularly the one immediately offshore of the Canoes and Queens surf sites.

**Figure 4-5 Water surface snapshot from BOUSS2D**

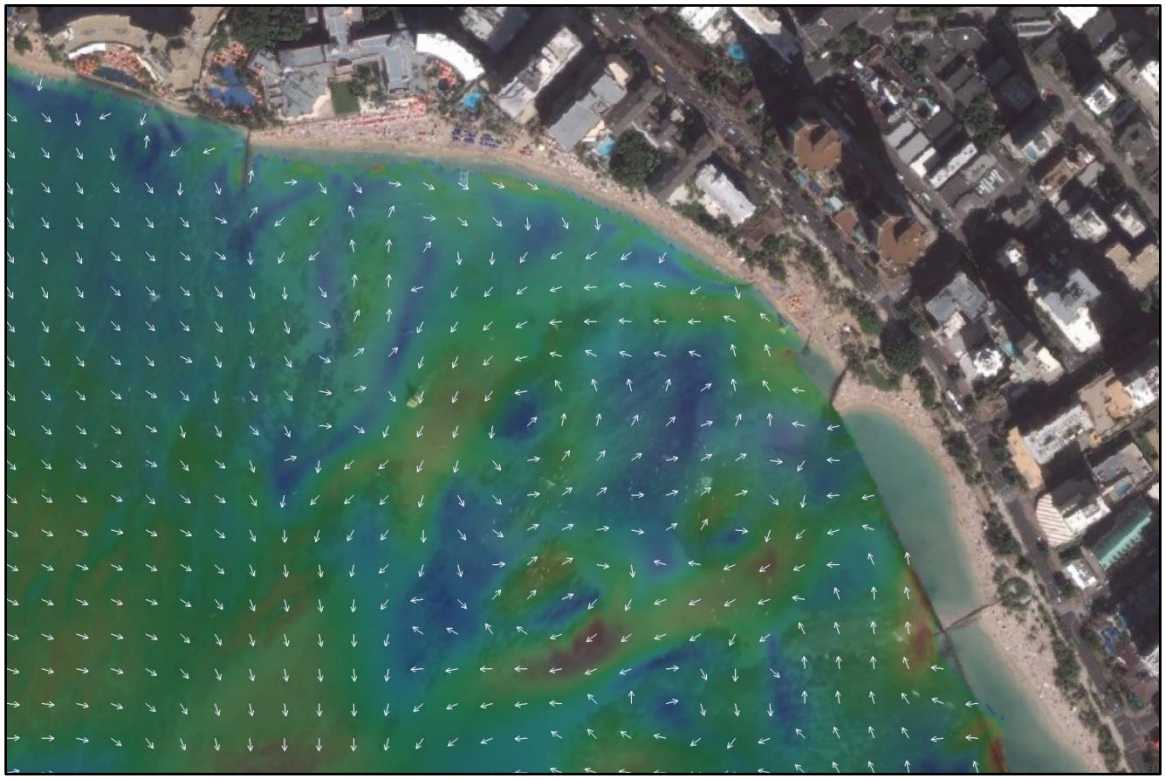


**Figure 4-6 Circulation magnitude and vectors from CMS-Wave and CMS-Flow**

### *4.1.8 Design Still Water Level and Wave Height*

Design parameters discussed earlier are presented in Table 4-6. The design wave condition for armorstone stability is the model hurricane, while structure crest elevation will be developed based on the runup and overtopping produced by the prevailing southern swell. The astronomical tide level chosen for design conditions is mhw, given its likelihood of occurrence during hurricane conditions. The three other wave cases were run at tide level of msl.

The maximum wave height that can pass over the reef is a function of the water depth and bottom slope. The limiting water depth is found over the shallow reef flat about 200 feet offshore of the existing Royal Hawaiian groin. Depths in that area are typically about 3.3 feet below msl. Wave setup, a component of the design water depth, was determined from CMS-Wave and was thereby incorporated in the computations for design wave height.

**Table 4-6 Design water level and wave conditions on the reef (relative to msl)**

| | Tradewind wave | South swell | Kona Storm | Model Hurricane |
|---|---|---|---|---|
| Deepwater Wave Type | | | | |
| $H_o$ (ft) | 6.0 | 4.0 | 8.4 | 28.5 |
| $T_p$ (sec) | 8.0 | 14.0 | 8.0 | 12.9 |
| *Dir* (°TN) | 075 | 202.5 | 237 | 228 |
| Still Water Level Rise | | | | |
| Astronomical tide (ft) | 0.0 | 0.0 | 0.0 | 0.7 |
| Sea level rise (ft) | 0.7 | 0.7 | 0.7 | 0.7 |
| Wave setup (ft) | 0.0 | 0.1 | 0.3 | 2.3 |
| Total SWL rise (ft) | 0.7 | 0.8 | 1.0 | 3.7 |
| Nominal Water Depth (ft) | 3.3 | 3.3 | 3.3 | 3.3 |
| Design Water Depth (ft) | 4.0 | 4.1 | 4.3 | 7.0 |
| Design Wave Height *H* (design, ft) | 3.1 | 3.2 | 3.4 | 5.5 |

### *4.1.9 Shoreline Characteristics and Coastal Processes*

#### *4.1.9.1 Waikiki Shoreline History*

Waikiki Beach was originally a narrow barrier beach fronting backshore wetlands, duck ponds, wetland taro farming and fishponds. Beginning in the 1880s, the Waikiki shoreline has been extensively modified; until today, not a foot of natural shoreline exists between Honolulu Harbor and Diamond Head. In 1881 Long Beach Baths bathhouse was built on the beach at the water's edge (Wiegel, 2008). They serviced visitors by providing changing rooms, towels, swimsuits and access to the beach, all for a fee, which caught the attention of Waikiki business men (Miller and Fletcher, 2003). The Moana Hotel (today Moana Surfrider) opened in 1901, with a restaurant on piles over the beach and water (Wiegel, 2008). In 1890 a seawall was constructed to protect Waikiki Road (now Kalakaua Avenue) at the entrance to Kapiolani Park. Seawalls to protect shoreline property then rapidly proliferated, and by the 1910s their adverse impact on the sandy shoreline had become a recognized problem. In 1917 the Board of Harbor Commissioners prohibited the building of seawalls along the shoreline; however, the prohibition was widely

ignored, and by about 1920 seawalls lined most of Waikiki Beach (Miller and Fletcher, 2003; Wiegel, 2008). A 1926 investigation of Waikiki Beach by the Engineering Association of Hawaii 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). In 1922 construction of the Ala Wai Canal commenced to drain the wetlands and divert streams away from Waikiki. With completion of the canal in 1926 urban development of Waikiki began in earnest. Construction of the Royal Hawaiian Hotel was completed in 1927, including a new seawall and a 170-foot long groin at the site of the still existing RHG. Reportedly 8 to 11 groins were constructed around this time between the Royal Hawaiian Hotel and Fort DeRussy; however, only the RHG remains today. The RHG was reportedly the only groin that effectively captured sand (Coastal Geology Group, 2013), and to this day it stabilizes about 1,730 linear feet of beach in the middle of Waikiki, the "Royal Hawaiian Beach" sector, which extends from the western Kuhio Beach crib wall west to the RHG. This beach sector fronts the Royal Hawaiian, Outrigger Waikiki, and Moana Surfrider hotels, three of the oldest and largest hotels on Waikiki Beach. The original groin was about 170 feet long, it was lengthened to about 370 feet in 1930, and later heightened (Weigel, 2002; Miller and Fletcher, 2003). It is constructed primarily of grouted concrete blocks, and originally utilized large stone on the western side to aid stability. This stone is now gone.

From about 1930 until the late 1970s an estimated 400,000 plus cubic yards of sand has been placed on Waikiki Beach, from varied sources such as other beaches on Oahu, backshore dune deposits, and even crushed coralline limestone. National Oceanographic and Atmospheric Administration (NOAA) 1925 shoreline survey data (T-sheets) and aerial photographs beginning in 1951 establish an 80 year shoreline history. Between 1925 and 2001 the mean Waikiki shoreline moved about 40 feet seaward, reflecting the extensive manmade shoreline alteration (Miller and Fletcher, 2003). However, chronic erosion and sand loss results in most of the sand placed on the beach over the years unaccountable for today. Despite the past beach nourishment, Miller and Fletcher (2003) estimate that Waikiki has a sand volume deficit of at least 100,000 cy for the time period between 1951 and 2001, due to permanent offshore loss.

#### *4.1.9.2 Coastal Processes in the Project Vicinity*

The RHG forms the western boundary of the "Royal Hawaiian Beach" sector of Waikiki Beach, which extends 1,730 feet east to the Kuhio Beach crib walls. The RHG and the Ewa groin at Kuhio Beach Park effectively prevent longshore sediment transport into and out of the littoral cell; thus sand transport within the cell is accomplished primarily through onshore-offshore transport. There is, however, longshore transport within the cell itself. In the nearshore waters and on the beach wave generated longshore currents are the major factor for direction and magnitude of sand transport, and sand transport is mostly in the western direction (Gerritsen, 1978; Miller and Fletcher, 2003). Sandy shorelines in general are quite dynamic and change in response to incident wave conditions, such as a change in approach direction or wave height which can quickly alter the beach width. A recent example of rapid wave induced sand transport occurred during the period between December 2014 and January 2015. In December 2014, a period of east and southeast wave approach rapidly moved sand away from the east end of the cell, exposing old concrete structure remnants which are typically buried. In December a period of strong westerly waves moved 1,500 cy of sand back to the east, again burying the concrete remnants and essentially returning the east end to its 2012 post-nourishment width. By February

2015 continuing westerly waves had moved all the sand away from the vicinity of the RHG and exposed the foundation of the seawall fronting the Royal Hawaiian Hotel.

High surf also generates rip currents which can transport sand offshore. Rip currents have been noted in the vicinity of the RHG (Gerritsen, 1978; Noda and Associates, 1991; Miller and Fletcher, 2003). The paleo-channel of Apuakehau Stream, which prior to construction of the Ala Wai Canal had flowed into the sea in the Royal Hawaiian Beach sector, constitutes a low-lying bathymetric feature that may provide a conduit for offshore sand loss (Fletcher, 2013). During high surf, the channel becomes the site of rip currents capable of transporting quantities of sand away from the beach and depositing them offshore.

From 1985 to 2009 the primary trend within the Royal Hawaiian cell was shoreline recession, with the shoreline retreating at rates up to 2.4 feet per year, and an average rate of 1.5 feet (Sea Engineering, 2010). The highest recession rates were found in front of the Moana Surfrider, while the lowest recession rates were adjacent to the RHG. According to Miller and Fletcher (2003), the Royal Hawaiian littoral cell accounts for 93% of the sand loss in Waikiki, with the RHG rip current likely representing the largest source of sediment loss for Waikiki beach. The rip current, coupled with the prevailing longshore transport to the west, help account for prevailing long term sand loss. Beach surveys following the 2012 beach nourishment project showed that the beach width decreased an average of 2.9 feet over the year following completion of the nourishment project (Coastal Geology Group, 2013). The width change varied by location within the cell, ranging from +5.7 feet in the central segment to -9.4 feet at the west end near the RHG. Continued monitoring of the 2012 beach nourishment project shows that after 2.7 years the beach (nearshore and offshore) retained much of the total placed volume, with overall sand loss in the order of the historical rate of loss, and the loss of roughly half of the original placed width. Loss of width is primarily attributable to beach profile flattening and sand moving further offshore. The monitoring also confirmed predominant longshore transport to the west and onshore-offshore transport through the deeper paleo stream channel.

### *4.1.10 Natural Hazards*

#### *4.1.10.1 Flooding*

Flood hazards for the portion of Waikiki in which the project is located are depicted on Flood Insurance Rate Map (FIRM) Flood Sheet 15003C0370F. That map indicates that there are no threats of flooding from streams but that the shoreline is exposed to flooding caused by storm waves and tsunami. The area immediately inland of the shoreline is in Zone AE with a base flood elevation of 7 feet above mean sea level.

#### *4.1.10.2 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 Hawaii 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 Hawaii, and the network of sensors that is part of the Pacific tsunami warning system are able to give Hawaii 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 Oahu 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 Oahu." This means that, on average, one damaging tsunami reaches Oahu every 19 years. The recent record (1946 to the present) has seen four tsunami cause damage on Oahu, a rate that is very close to the longer term average. In view of this, the U.S. Geological Survey (Fletcher et al.) has given 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 Waikiki is below that elevation.

#### *4.1.10.3 Storm Waves*

The wave regime along the project shoreline is discussed in considerable detail in Section 4.1.5 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.

### *4.1.11 Marine Biota*

#### *4.1.11.1 Waikiki General*

The fringing reef off Waikiki is an eroded limestone platform influenced by sand suspension and scour caused by impinging waves. Sand-filled pockets are abundant and support diverse assemblages of sediment-dwelling invertebrates (Bailey-Brock and Krause, 2008); exposed limestone outcrops support mostly turf-forming algae (AECOS, 1979, 2009). Live coral is sparse in the nearshore waters off Waikiki, accounting for less than one percent of the bottom (OI, 1991; MRC, 2007; AECOS, 2007, 2008, 2009, 2010, 2012). Other reef macro-invertebrates, such as sea urchins and sea cucumbers, are conspicuous but relatively uncommon (OI, 1991; MRC, 2007; AECOS, 2009, 2012).

The dominant taxa of benthic organisms on the reef platform off Waikiki are marine fleshy algae (*limu* or seaweed), which cover most exposed reef rock surfaces that are not scoured or buried by shifting sand. The growth form of much of this *limu* is short stature or turf-forming. Although the flora of Waikiki reef remains relatively diverse, two invasive red algae (Rhodophyta), *Acanthophora spicifera* or spiny seaweed, and *Gracilaria salicornia*, or gorilla *ogo*, dominate the benthic flora and now cover much of the hard substrata (Smith et al., 2004; Huisman et al., 2007; MRC, 2007; AECOS, 2007, 2008, 2009, 2012). In addition to these two non-native

species, *Dictyota sandvicensis*, *Padina australis*, *Pterocladiella* spp., *Galaxaura* spp, *Asparagopsis taxiformis*, *Trichoglea* spp., and *Sargassum obtusifolium* are common on hard surfaces of the reef (MRC, 2007, AECOS, 2007, 2008, 2009, 2012). Another invasive species, *Avrainvillea amadelpha*, is present on this reef flat. At least two algal species preferred by green sea turtle (NMFS-USFWS, 1998) are present: the invasive *A. spicifera* is abundant and *Ulva fasciata* is common.

Surveys on the reef off Waikiki have observed common macroinvertebrates including various echinoderms such as *Holothuria atra*, *H. nobilis*, *Echinothrix diadema*, *Tripneustus gratilla*, *Echinometra mathaei*, *Echinostrephus aciculatus*, and miscellaneous sponges (OI Consultants, 1991); *E. mathaei*, *E. aciculatus*, and *H. atra* (MRC, 2007); and an unidentified stomatopod, *E. diadema*, *E. mathaei*, *T. gratilla*, *Actinopyga mauritiana*, *H. atra*, and *H. cinerascens* (AECOS, 2007, 2008, 2012). The boring urchin, *E. mathaei*, and the black sea cucumber or *loli*, *H. atra*, are the most conspicuous animals on the Waikiki reef (AECOS, 2010, 2012), but are present in relatively low numbers.

Corals are rare on the reef platform offshore of Waikiki (Chave, et al., 1973; AECOS, 1987, 1995, 2009, 2010, 2012; OI, 1991). Colonies are sparse and account for less than one percent of the nearshore bottom (AECOS, 2007, 2008, 2012; MRC, 2007). Off Gray's Beach, nearby to the west, coral cover is <1% and colonies are small, with an average coral colony size of 7 cm (2.8 in) in diameter. In a recent survey (AECOS, 2010) for the Waikiki Beach maintenance project, no coral growth was observed on the limestone outcrops directly off the beach area proposed for sand replenishment. No large (>50 cm or 20 in diameter) mound-forming corals were observed anywhere in the survey area. Observed coral colonies were limited, and included medium-sized *Pocillopora meandrina* (cauliflower coral) and *Porites lobata* (lobe coral) colonies on the shallow reef.

Benthic infauna are aquatic animals that live within the substratum (sand in this case) rather than on its surface. Infauna have been documented from sand deposits in the Halekulani Channel (Bailey-Brock and Krause, 2008). Most of the diverse species observed are less than 1 mm (0.04 in) in size (meiofauna) and have relatively low abundances. Worms are most abundant, making up 85% of the total fauna, followed by arthropods, echinoderms, and mollusks.

The fish assemblage in the nearshore waters off Waikiki is largely structured by the minimal topographic relief, with fishes being generally uncommon. Recent surveys off Waikiki (MRC, 2007; AECOS, 2009, 2010, 2012) found the most common species to be wrasses (*Thalassoma duperrey*, *T. trilobatum*, and *Stethojulis balteata*), *manini* (*Acanthurus triostegus*), and reef triggerfish (*Rhinecanthus rectangulus*). These surveys off Waikiki identified 58 species. The underwater visual survey technique, typically used for these surveys, does not accurately census seasonal, cryptic, nocturnal, and burrow-inhabiting fishes, although they could comprise half or more of the total fish biomass of an area of reef (Willis, 2001).

#### *4.1.11.2 Project Site*

On September 11 and 18, 2014, AECOS, Inc. conducted a rapid assessment and quantitative survey of the marine community composition and coral size class distribution in the project vicinity (see appendix A). The survey area included the existing groin and surrounding seafloor

60 feet to either side of the groin. Two survey areas were established: 1) "inner groin" extending 160 feet seaward from the shore to where the existing groin bends; and 2) "outer groin" covering the portion of the existing groin curving to the southeast, which is comprised of some 25 broken concrete blocks of various sizes. A total of eight 20-m long transects were used to survey the marine biota, six in the inner groin area and two in the outer groin area, oriented both parallel and perpendicular to the groin axis. In addition, each of the blocks in the outer groin area were examined.

General: In general, the community structure of the benthos on the Royal Hawaiian groin and on the reef bottom surrounding the groin is dominated by macro and turf algae. Use of the area by large numbers of waders and swimmers influences the biotic community. Areas with little or no vertical relief are affected by constantly shifting sands and tend to have little algal or macro-invertebrate diversity, with no coral colonies present. These hard bottom areas may be regularly covered and uncovered by shifting sands and loose rubble. The richest biotic assemblages occur in the areas where vertical relief of the limestone affords some protection from wave-driven sand particles and longevity of exposure.

The intertidal zone of the existing inner groin is covered with small numbers of nerite snail (*Nerita picea*), thin shelled rock crab (*Grapsus tenuicrustatus*), and macroalgae (*Ulva fasciata*, *Asteronema breviarticulatum*, *Hydrolithon* spp., *Acanthophora spicifera*, and *Gracilaria salicornia*. Common invertebrates on the inner groin include urchins (*Echinometra mathaei* and *Diadema paucispinum*) and sea cucumbers (*Holothuria cinerascens*). One coral colony (*Pocillopora meandrina*) in the 21-40 cm size class was observed on the east side of the inner groin, approximately 10 ft (3 m) from the shoreline. Sand bags extend out from the seawall on the west side of the groin. Algae (*A. spicifera*, *Ralfsia* sp. and cyanobacteria) coat the sandbags. The outer groin concrete blocks are covered with turf and macroalgae algae and sand. Algae observed on the outer groin included: *Ulva fasciata*, *Laurencia nidifica*, *Graciliaria salicornia*, and *A. spicifera*. Macroinvertebrates are uncommon, but include hoof shell (*Hipponix conicus*), variable worm snail (*Serpulorbis variabilis*), sea urchins (*Echinometra mathaei*), and sea cucumbers (*Holothuria atra* and *H. cinerascens*). No coral heads were observed in the outer groin area.

The seafloor surrounding the groin is a relatively flat bottom of sand with patches of limestone and rubble. A large area of sand lies to the east of the groin, fronting a stretch of Waikiki beach. In this area, beachgoers and swimmers are common. The reef platform to the south and west of the groin is coated with turf and macroalgae, which covers virtually all exposed hard surfaces that are not scoured or buried by shifting sand. Algal species observed in this area include: *G. salicornia*, *A. spicifera*, *Dictyosphaeria reticulata*, *Bryopsis* sp., *Halimeda discoidea*, *Neomeris annulata*, *Ulva fasciata*, *Dictyota sandvicensis*, and *Padina* sp. Urchins (*Echinometra mathaei* and *Diadema paucispinum*) and sea cucumbers (*Holothuria cinerascens*, *H. atra*, *H. whitmaei*, and *Actinopyga mauritiana*) are found on the reef platform.

A total of 17 species of fishes were identified in the groin and surrounding area surveys. Fishes observed included: surgeonfishes (*Acanthurus triostegus*, *Acanthurus blochii*, juvenile *Naso unicornis*), flagtail (*āholehole* or *Kuhlia xenura*), snappers (*Lutjanus kasmira* and *L. fulvus*),

schools of needlefish (*Platybelone argalus*), and goatfishes (*Parupeneus multifasciatus* and *P. porphyreus*).

Benthic Community Composition: Data collected from two 20-m transects in the inner groin area and 25 concrete blocks in the outer groin area were used to calculate benthic community composition. The dominant benthic type on the inner groin is turf algae (43% mean cover) and macroalgae (33% mean cover). Macroinvertebrate mean cover is 19% and CCA is minimal, with 5% cover. No corals were recorded at the point intercepts, but one 21-40 cm size class *P. meandrina* coral was observed outside of the transect area, on the east side of the inner groin. As in the inner groin area, dominant benthic types in the outer groin area are macroalgae (43% mean cover) and turf algae (36% mean cover). Macroinvertebrate mean cover is 11%; CCA cover is minimal at 1%. Coral cover here was zero.

Data obtained from six, 20-m transects on the seafloor surrounding the groin were used to calculate benthic community composition. The dominant benthic type on the seafloor is sand (56% mean cover). Turf and macroalgae mean cover are similar, at 15% and 13%, respectively. Rubble mean cover is 5% and CCA cover is minimal, at 1%. Macroinvertebrate and coral cover are zero.

### *4.1.12 Protected Species*

No listed (endangered or threatened; USFWS, 2013) species were encountered in the September 2014 surveys. Listed species (sea turtles, Hawaiian monk seal, and humpback whale) can occur in the general vicinity. State protected species (hermatypic corals) occur at the project site in very low numbers.

Sea turtles—Of the sea turtles found in the Hawaiian Islands, only the green sea turtle is common in the project vicinity. The hawksbill sea turtle (*Eretmochelys imbricata*) is rare in the Hawaiian Islands and only known to nest in the southern reaches of the state (NMFS-USFWS, 1998; NOAA-NMFS, 2007). In 1978, the green sea turtle was listed as a threatened species under the Endangered Species Act (ESA; USFWS, 1978, 2001). Since protection, the green sea turtle has become the most common sea turtle in Hawaiian waters with a steadily growing population (Chaloupka et al., 2008). Threats to the green sea turtle in Hawaii include: disease and parasites, accidental fishing take, boat collisions, entanglement in marine debris, loss of foraging habitat to development, and ingestion of marine debris (NMFS-USFWS, 1998). Green sea turtle nesting mostly occurs on beaches of the Northwestern Hawaiian Islands, with 90% occurring at French Frigate Shoals (Balazs et al., 1992). None of the Hawaiian sea turtles are known to nest in the project vicinity.

The green sea turtle diet consists primarily of benthic macroalgae (Arthur and Balazs, 2008), which the shallow reefs of the main Hawaiian Islands provide in abundance. Red macroalgae generally make up 78% of their diet, whereas green macroalgae make up 12%. Turbidity (murky water) does not appear to deter green sea turtles from foraging and resting areas and construction projects in Hawaii have found sea turtles adaptable and tolerant of construction-related disturbances (Brock, 1998a,b). During the survey, no green sea turtles were observed, although preferred algal food species are found here, and turtles are commonly observed foraging in the vicinity of the RHG.

Monk seal—The beaches and coastline of Oahu are used by the endangered Hawaiian monk seal (*Monachus schauinslandi*) for hauling out and for pupping and nursing. These mammals are known to occur in the waters off Waikiki. The majority of monk seal sighting information collected in the main Hawaiian Islands is reported by the general public and is highly biased by location and reporting effort. Systematic monk seal count data come from aerial surveys conducted by the Pacific Islands Fisheries Science Center (PIFSC). Aerial surveys of all the main Hawaiian Islands were conducted in 2000-2001 and in 2008 (Baker and Johanos, 2004, PIFSC unpublished data). One complete survey of Oahu was conducted for each of these years. The 2000 survey was conducted from an airplane and the 2001 and 2008 surveys were conducted by helicopter. No Hawaiian monk seals were sighted off Waikiki during any of the three surveys.

Reports by the general public, which are non-systematic and not representative of overall seal use of main Hawaiian Islands shorelines, have been collected in the main Hawaiian Islands since the early 1980s. In total, seventy-six Hawaiian monk seal sightings have been reported off Waikiki, east of the project vicinity between Queen's Beach and Sans Souci Beach, between 2002 and 2011. A sighting is defined as a calendar day during which an individual seal was documented as present at a given location. It should be noted that the majority of monk seal sightings are reported when seals are sighted onshore. No births have been documented for the area.

Currently, only the remote Northwestern Hawaiian Islands are considered critical habitat for this species (50 CFR 226.201). However, the waters surrounding the Main Hawaiian Islands have been proposed as monk seal critical habitat (NOAA-NMFS, 2011). The shoreline and marine environment extending seaward to the 500-m depth contour of the project area are included in the proposed monk seal critical habitat designation.

Humpback whale—The humpback whale or *koholā* (*Megaptera novaeangliae*) was listed as endangered in 1970 under the ESA. In 1993 it was estimated that there were 6,000 humpback whales in the North Pacific Ocean, and that 4,000 of these regularly came to the Hawaiian Islands. The population is estimated to be growing at between 4 and 7% per year. Today, as many as 10,000 humpback whales may visit Hawaii each year (HIHWNMS, 2014).

The waters of Maunalua Bay to the east of the Royal Hawaiian groin are within the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS). Humpback whales normally occur in Hawaiian waters annually from November to May with the peak between January and March (HIHWNMS, 2014). The project will not directly affect humpback whales, and sounds generated from groin improvement activities are not anticipated to be substantial enough to cause an acoustic disturbance to protected species in nearshore waters. The effects thresholds currently used by NMFS are marine mammal specific and based on levels of harassment as defined by the Marine Mammal Protection Act (MMPA). For exposure to sounds in water, $\geq$180 dB and $\geq$190 dB are the thresholds for Level A harassment (i.e., injury and/or PTS) for cetaceans and pinnipeds, respectively. The thresholds for Level B harassment for all marine mammals in the form of TTS and other behavioral impacts are $\geq$160 dB for impulsive noises and $\geq$120 dB for continuous noises (NOAA, 2013).

Coral—Coral species are protected under Hawaii State law, which prohibits "breaking or damaging, with any implement, any stony coral from the waters of Hawaii, including any reef or mushroom coral" (HAR §13-95-70, DLNR, 2010). It is also unlawful to take, break or damage with any implement, any rock or coral to which marine life of any type is visibly attached (HAR §13-95-71, DLNR, 2002).

In February 2010, 83 species of corals world-wide were petitioned for listing as threatened or endangered under ESA (NOAA-NMFS, 2010). In response to the petition, National Oceanic and Atmospheric Administration (NOAA) completed a status review report (Brainard et al., 2011) in March 2011 and a management report of the candidate species (PIRO-NOAA, 2012) in November 2012. A proposed rule was published in December 2012 (NOAA-NMFS, 2012) with public comment extended through April 6, 2013 (NOAA-NMFS, 2013). On August 27, 2014, a final rule was released (NOAA-NMFS, 2014), to implement the final determination to list 20 coral species as threatened. None of the listed corals occurs in Hawaii.

### *4.1.13 Essential Fish Habitat*

The 1996 Sustainable Fishery Act amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and subsequent Essential Fish Habitat (EFH) Regulatory Guidelines (NOAA, 2002) describe provisions to identify and protect habitats of federally-managed marine and anadromous fish species. Under the various provisions, federal agencies that fund, permit, or undertake activities that may adversely affect EFH are required to consult with the National Marine Fisheries Service (NMFS). EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." EFH is further defined by existing regulations as (MSFCMA, 1996; NOAA, 2002). "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" is defined as required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' life cycle.

The proposed project is located within waters designated as EFH (including water column and all bottom areas) for coral reef ecosystem, bottomfish, pelagic, and crustacean MUS. Of the thousands of species which are federally managed under the coral reef FMP, at least 58 (juvenile and adult life stages) are known to occur in the general vicinity of Waikiki beach (MRC, 2007; AECOS, 2009, 2010, 2012).

### *4.1.14 Water Quality*

Field measurements of temperature, salinity, pH, and dissolved oxygen were taken and water samples for analysis of salinity (by salinometer), turbidity, total suspended solids (TSS), ammonia, nitrate+nitrite, total nitrogen, total phosphorus, and chlorophyll were collected from three stations on September 11, 12, and 18, 2014. Samples were collected from just below the surface of the water. Sampling stations 1 and 2 were located approximately 20 feet west and east of the bend midway along the groin ("West" and "East"), and station 3 was located 10 feet from

the seaward end of the groin ("Terminus"). Details of the water quality measurements can be found in Appendix A.

Results of the three water quality sampling events are summarized in Table 4-7 (physical parameters) and Table 4-8 (nutrients and chlorophyll α). The results for physical water quality parameters were constant comparing the three sampling events. Mean turbidity was lowest at Sta. Terminus compared with Stas. West and East, but mean TSS was highest at Sta. Terminus. The results for nutrients and chlorophyll α (Table 4-8) showed little variation between the three sampling events and there were no discernible differences between stations.

**Table 4-7 Summary of physical water quality results near the Royal Hawaiian groin**

| **Station** Statistic | **Temp.** (°C) | **Salinity** (PSU) | **DO** (mg/L) | **DO Sat.** (%) | **pH** | **Turbidity†** (NTU) | **TSS†** (mg/L) |
|---|---|---|---|---|---|---|---|
| **West** | | | | | | | |
| mean | **27.8** | **35.4** | **6.02** | **94** | **7.96** | **4.00** | **8.1** |
| range | 27.7-27.8 | 34.9-36.3 | 6.00-6.04 | 93-94 | 7.91-8.05 | 2.81-6.02 | 6.5-9.6 |
| *n* | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **East** | | | | | | | |
| mean | **27.9** | **35.6** | **6.03** | **94** | **7.99** | **3.73** | **8.2** |
| range | 27.8-28.0 | 35.0-36.5 | 6.00-6.05 | 93-95 | 7.94-8.02 | 2.11-5.06 | 7.0-9.6 |
| *n* | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Terminus** | | | | | | | |
| mean | **28.2** | **35.6** | **6.01** | **94** | **7.96** | **2.38** | **11** |
| range | 28.1-28.4 | 35.0-36.72 | 5.90-6.08 | 13-94 | 7.90-8.02 | 1.71-3.86 | 10-12 |
| *n* | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

† - geometric mean; all others are arithmetic.

**Table 4-8 Summary of geometric means for nutrients and chlorophyll α water quality results near the Royal Hawaiian groin.**

| **Station** Statistic | **Ammonia** (µgN/L) | **Nitrate+ Nitrite** (µgN/L) | **Total N** (µgN/L) | **Total P** (µgP/L) | **Chl. A** (µg/L) |
|---|---|---|---|---|---|
| **West** | | | | | |
| mean | **1** | **2** | **78** | **13** | **0.39** |
| range | <1-2 | 2-2 | 74-81 | 11-14 | 0.38-0.40 |
| *n* | 3 | 3 | 3 | 3 | 3 |
| **East** | | | | | |
| mean | **<1** | **2** | **84** | **12** | **0.35** |
| range | <1 | 2-2 | 76-97 | 12-12 | 0.24-0.47 |
| *n* | 3 | 3 | 3 | 3 | 3 |
| **Terminus** | | | | | |
| mean | **<1** | **2** | **74** | **11** | **0.40** |
| range | <1 | 1-2 | 69-77 | 10-12 | 0.31-0.45 |
| *n* | 3 | 3 | 3 | 3 | 3 |

The waters offshore Waikiki Beach are classified in the Hawaii Water Quality Standards (HDOH, 2012) 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. Other uses are permitted as long as compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. Class A waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control.

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

Applicable state water quality criteria for the Royal Hawaiian Groin are shown in Table 4-9. Water quality results from three sampling events met state criteria for temperature, salinity, pH, and DO saturation. The results for turbidity and chlorophyll α exceeded applicable criteria. There are no state criteria for TSS, but this parameter is typically measured for projects that involve construction and/or disturbance of bottom sediments. Turbidity levels in nearshore coastal waters are typically elevated compared with the state geometric mean criterion due to effects of waves and wind which stir up sediments from a shallow bottom.

**Table 4-9 Selected state water quality criteria (dry season) applicable to open coastal marine waters after HAR §11-54-6.3(b) (HDOH, 2012).**

| Parameter | Geometric Mean value not to exceed this value | Value not to be exceeded more than 10% of the time | Value not to be exceeded more than 2% of the time |
|---|---|---|---|
| Total Nitrogen (µg N/L) | 110.0 | 180.0 | 350.0 |
| Ammonia (µg N/L) | 2.0 | 5.0 | 9.0 |
| Nitrate+Nitrite (µg N/L) | 3.5 | 10.0 | 20.0 |
| Total Phosphorus (µg/L) | 16.0 | 30.0 | 45.0 |
| Chlorophyll α (µg/L) | 0.15 | 0.50 | 1.00 |
| Turbidity (NTU) | 0.20 | 0.50 | 1.00 |
| Other "standards":<br>- pH units shall not deviate more than 0.5 units from ambient and not lower than 7.0 nor higher than 8.6.<br>- Dissolved oxygen shall not decrease below 75% of saturation.<br>- Temperature shall not vary more than 1C° from ambient conditions.<br>- Salinity shall not vary more than 10% from ambient. | | | |

## 4.2 Noise

Hawaii Administrative Rules §11-46, "Community Noise Control" establishes maximum permissible sound levels (see Table 4-10) 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 site itself is in the Conservation District, but there are no noise-sensitive uses in that area at the present time. Because of that, the Class B limits applicable to land zoned for resort use appears the most applicable. 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 4-10 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 4-10 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 |

Table 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: Hawaii Administrative Rules §11-46, "Community Noise Control"*

### *4.2.1 Existing Sound Levels*

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 Waikiki 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.

## 4.3 Historic, Cultural and Archaeological Resources

In prehistoric and early historic periods, Waikiki 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. Waikiki was also the site of at least two important battles, the 1793 invasion of Oahu by the forces of the Moi of Maui, Kahekili and the 1795 invasion of Oahu 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 Hawaii, Inc. (Groza et al, 2009).

*Habitation.* Waikiki was a center of population and political power on Oahu beginning long before the Europeans arrived in the Hawaiian Islands during the late eighteenth century. Kanahele (1995:134) notes that Waikiki's ancient chiefs had located their residences there for hundreds of years and that Kamehameha V's residence was at Helumoa (near where the proposed project is located). Kanahele (1995:134-1345) goes on to explain that: "Three features were common to royal locations in Waikiki. 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 Waikiki 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 Waikiki 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. Hawaiian 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),

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

*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.

<u>*Marine and Freshwater Resources Gathering Practices*</u>. 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. 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 Waikiki 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 Waikiki 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 Waikiki, 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

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

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 Waikiki, 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 Waikiki'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 ("Great Kelea who flutters,") has been preserved as a reminder of the role that surfing played in the history of Waikiki (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 Waikiki 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, Waikiki.

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 Waikiki. He said that: "Kawaiahao which led to lower Waikiki 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).

[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.

Based on ‘I‘i’s description, the trail from Honolulu to Waikiki 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 Waikiki.

*Burials.* The discovery of burials in the Waikiki area during recent construction projects has caused increasing concern over the last few years. There are approximately 14,500 records associated with LCA claims during the Mahele of 1847-1853. Of these records, 432 are for claims both awarded and unawarded in Waikiki. 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 located, based on the boundaries given in the testimony (Native Register, Vol. 2: 299-300) found in www.waihona.com, it is speculated that it might be adjacent to the old Waikiki 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. The circumstances of the burials discovered closer to the project area are more mundane than battle deaths or human sacrifices, with the vast majority of the known deceased being the common people of Kalia. Withington (1953:16), probably referring to the *‘oku‘u* (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 Waikiki 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).

## 4.4 Recreation

John Clark, a locally recognized expert on ocean recreation and cultural activities in Hawaii, has completed an assessment of ocean recreation activities in the project vicinity (see Appendix B). His assessment included observation of ocean activities and ocean conditions in the project area, interviews with shoreline users, and evaluation of possible project effects and impacts on recreation activities. The project site, including the waters offshore, is part of the most heavily used section of Waikiki Beach, and is used for many different 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. Four beach concessions are located at the east end of the Royal Hawaiian Sector, providing beach umbrella and surfboard rentals, surfing lessons, and canoe rides. Four sailing catamarans are presently permitted to operate on Waikiki Beach. The beach concessions (Star Beach Boys and Hawaiian Oceans) lease their concession sites from the City and County of Honolulu. The sailing catamarans are permitted by the State DLNR/DOBOR.

*Sunbathing.* Sunbathing is prevalent everywhere in the project vicinity, but the heaviest concentration of sunbathers is near the RHG end of the beach, where it is widest, fronting the Outrigger Waikiki and the Royal Hawaiian Hotels.

*Swimming*. Swimming is also prevalent in the project vicinity, and the greatest concentration of swimmers tends to be in the middle of the beach, fronting the Moana Hotel, away from the surfboard rental, canoe ride, and catamaran ride concessions that might endanger swimmers.

*Snorkeling*. The reef in the project vicinity 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. For this reason snorkeling is a minor activity here. In addition, during periods of high surf, visibility over the reef is poor due to wave agitation of the ocean bottom. The channel between the surf spots Canoes and Sandbars, however, is a feeding site for green sea turtles. They may be seen at all times of the day eating the seaweed that grows on the reef flat.

During periods of low or no surf, some snorkeling for lost valuables such as rings, watches, and coins occurs at Canoes. This activity is an extension of the treasure hunting with metal detectors that takes place on the beach.

*Surfing*. Waikiki is the site of numerous named surf breaks. The breaks Populars and Baby Royals are located offshore of the RHG, and Canoes is located to the east, seaward of the Moana Hotel. Canoes is the most highly used surf spot in Hawaii for commercial surfing activities, including surfboard rentals, surfing lessons, and outrigger canoe rides. Beginning surfers and surf instructors with beginners receiving lessons are concentrated on the smaller inside waves, which is known as Baby Canoes, while intermediate and advanced surfers ride the bigger waves outside.

Queen's is the name of the surf spot located directly off the Duke Kahanamoku Statue. The waves at Queen's are steeper than those at Canoes and are concentrated in a much smaller area, so beginning surfers and surf instructors with beginners receiving lessons generally do not surf here. Waves at Queen's, however, reform near shore on the shallow reef at the east end of the project site. This surf spot is known as Baby Queen's and attracts beginning surfers and surf instructors with lessons.

*Canoe Surfing*. Catching waves with an outrigger canoe in Waikiki takes place at Canoes, the famous surf spot off the Moana Hotel that was named for this activity. The waves on the west edge of Canoes are ideal for this canoe surfing and often have enough momentum to carry the canoes all the way to shore.

All four 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 Hawaii. DOBOR controls boating in Waikiki 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 Waikiki. Known as the Walter J. MacFarlane Regatta, the race course begins on the beach fronting the Moana Hotel and then circles 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 Waikiki 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 Waikiki coast for specified periods of time.

Four catamarans are presently permitted to conduct catamaran ride operations on Waikiki Beach. From east to west, they are the Mana Kai, which is owned by William Brown, and operates at the east end of the Royal Hawaiian Beach Sector; the Na Hoku and the Manu Kai, which are owned by John Savio, and the Kapoikai, which is owned by Sheila Lipton, all of which operate at the west end of the Royal Hawaiian Beach Sector near the project site.

The Division of Boating and Ocean Recreation (DOBOR), Department of Land and Natural Resources (DLNR), State of Hawaii, controls boating in Waikiki shore waters. Administration of the beach landing areas for the catamarans in the project site comes under DOBOR's Oahu 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.

*Fishing and Gathering*. Two types of fishing occur in the project vicinity, spear fishing and pole fishing, but both are infrequent. 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 fish hooks.

The project vicinity was once known as a good place to gather edible seaweeds, or limu, especially *limu lipoa*, but little if any edible seaweed seems to remain in Waikiki today. No gathering activities of seaweed, shellfish, or other marine species were observed during the field trips or noted by the informants.

The Waikiki Marine Managed Areas (MMA) consists of two parts: the Waikiki Marine Life Conservation District (MLCD) and the Waikiki-Diamond Head Fisheries Management Area (FMA). The project site is not included in the Waikiki MMA.

*Boating*. The Division of Boating and Ocean Recreation (DOBOR), Department of Land and Natural Resources (DLNR), State of Hawaii, controls boating in Waikiki 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 Waikiki shore waters. The catamarans and personal water crafts operated by the lifeguards are the only vessels under power that are permitted in the project vicinity. Non-motorized boats such as surf skis (racing kayaks) and ocean kayaks (recreational kayaks) are permitted.

## 4.5 Economic Setting

Waikiki Beach is recognized as the State's primary tourist destination, attracting millions of visitors yearly. Waikiki 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 Waikiki 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 Waikiki beach (Lent, 2002; 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 Waikiki Beach, with a ratio greater than one indicating that benefits exceeded costs. The overall benefit to cost ratio for all of Waikiki was about 6. The total Waikiki Gross National Product (GNP) contribution to the annual Federal economy is an estimated $3.3 billion. This estimate excludes spending by mainland west coast visitors (USACE, 2002).

An economic analysis of the importance of Waikiki Beach accomplished by Hospitality Advisors LLC (2008) for the Waikiki 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 Waikiki, 58% of all westbound visitors said they would not consider staying in Waikiki without the beach.

## 4.6 Scenic and Aesthetic Resources

The gentle curve of the Waikiki 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 shoreline hotels along the project area, the Royal Hawaiian, Outrigger Waikiki, and Moana Surfrider, 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.

## 4.7 Public Infrastructure and Services

### *4.7.1 Transportation*

*Vehicular and Pedestrian Access*. Pedestrian access is available from Kalakaua Avenue through public rights-of-way, one of which is located between the Royal Hawaiian and Outrigger hotels.

*Harbors*. The nearest harbor is the Ala Wai Harbor, which is owned and operated by the State of Hawaii. Commercial cargo arrives and departs through Honolulu Harbor.

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

### *4.7.2 Water, Sewer and Communications Systems*

*Water Supply.* The Honolulu Board of Water Supply (BWS) is responsible for the management, control and operation of Oahu's municipal water system that serves the entire Primary Urban Center Development Plan area. The BWS system is an integrated, island-wide system with interconnections between water sources and service areas. Water is exported from areas of available supply to areas of municipal demand.

No BWS facilities are present *makai* of the shoreline where the proposed groin improvement would occur. BWS does not maintain or 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.

*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 Waikiki 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.

### *4.7.3 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 Nanakuli, and private companies are responsible for solid waste collection from virtually all of the island's commercial organization.

### *4.7.4 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 project would facilitate police patrolling along the beach. The nearest police station is located at the Waikiki 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 Kapiolani 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.

# 5. POTENTIAL IMPACTS OF THE PROPOSED PROJECT

This chapter summarizes the probable adverse and beneficial effects that are likely to result from the proposed project. The discussion is organized by type of potential resource impact (e.g., coastal processes effects, marine biological effects, water quality effects, etc.). Good project design and implementation integrates features and practices intended to avoid or mitigate potential environmental effects into the overall design of the project. Because of this, in most cases the discussion of "mitigation measures" is integrated into the overall discussion rather than limited to a separate section of the report. Each resource section in this chapter includes a discussion of criteria used to determine the significance effects on the resource.

## 5.1 Effects on Seafloor and Shoreline Processes

The following criteria are considered in determining whether the effects that the proposed action would have on the physical characteristics of the seafloor and shoreline processes would be significant:

- Interfere with existing sand transport processes and beach stability/erosion;
- Affect the shape of the shoreline or the bottom in such a way as to interfere with existing recreational or commercial uses;
- Permanently alter a unique or recognized shoreline or bottom feature;
- Affect the bottom in such a way as to degrade the quality of waves used by surfers; and
- Conflict with existing federal, state, or county statutes or regulations.

### *5.1.1 Impacts During Construction*

In-water construction impacts would be limited to the immediate area of groin construction. The new groin footprint area would be carefully delineated, and no construction activities or in-water material storage would be permitted outside of this area. The seafloor in the project area is primarily sand, with loose rubble and some patches of exposed fossil reef rock. The existing RHG would remain in place until the new groin was sufficiently complete to replace its beach stability function. Construction of the proposed new groin will alter the bathymetry of the area it covers. Once construction of the project begins, swimmers and other users of the nearshore area at the project site will be forced to take a more seaward route past this section of shoreline. Construction would be in accordance with all necessary permits and approvals necessary for the project.

### *5.1.2 Long Term Effects on the Shoreline*

Long term impacts to the seafloor and bathymetry will be limited to the actual footprint of the new groin. The RHG forms the west end of a discrete shoreline cell, the Royal Hawaiian Beach sector, and there is typically very little interaction between this cell and the Halekulani Beach sector to the west. To the east, the Royal Hawaiian beach's stability is a result of impoundment by the RHG. Replacing the existing RHG with an L or T head rock rubblemound groin will provide superior stability for the beach. The vertical concrete wall option would be a functional groin; however, its greater wave energy reflectivity will reduce beach stability. The head of the new groin will help prevent the formation of offshore rip current formation along the groin stem, and thus reduce sand transport seaward and its subsequent impacts of the offshore seafloor. The

groins would terminate well landward of the offshore surf breaks, and will not alter the bathymetry or wave formation characteristics of the existing seafloor.

At present, there is very little sand on the west side of the RHG fronting the Sheraton Waikiki. The prevailing sand transport in the project vicinity is from east to west, and transport westerly past the Royal Hawaiian Hotel is blocked by the existing RHG. Construction of a new groin will not change the existing transport processes, or starve the shoreline to the west of any natural nourishment. However, construction of a T head groin, in lieu of an L head, may result in some natural accretion and retention of sand during periods of west to east sand transport such as occurs during winter westerly winds and waves. Over time this may result in some beach formation fronting the Sheraton Waikiki seawall.

Numerical wave modeling accomplished using CMS Wave and Flow, components of the Surface-water Model System suite of models developed by the U.S. Army Corps of Engineers, showed no change between existing conditions and the proposed project in the general nearshore circulation patterns in the project vicinity. A snapshot of the circulation pattern was shown previously on Figure 4-6.

## 5.2 Water Quality Impacts

The following criteria are considered in the evaluation of whether the effects of the proposed action on water quality would be significant:

- Consistency with the provisions of the Clean Water Act;
- The degree to which it would comply with applicable water quality standards or with other regulatory requirements related to protecting or managing water resources; and
- The extent to which it would degrade water quality in a manner that would reduce the existing or potential beneficial uses of the water.

### *5.2.1 Impacts During Construction*

Construction would be accomplished using conventional heavy equipment, and would proceed from shore with the placement of stone to form a working platform, and then working back to shore placing stone to the finished groin lines and grades. A temporary increase in turbidity levels in the immediate area of construction is expected; however, this would be mitigated by the employment of Best Management Practices (BMPs) and the requirements of the State Department of Health Water Quality Certification which will be required for the project. BMPs and environmental protection measures to be employed are summarized in Section 8. Water quality protection measures will include the following general requirements:

- Turbidity containment barriers shall be installed and maintained to completely surround the work area so as to control and contain construction generated turbidity.
- The water area affected by construction shall be monitored, and if monitoring indicates that the turbidity standards are being exceeded, construction shall be suspended until the condition is corrected.
- The construction contractor shall be required to employ standard BMPs for construction in coastal waters, such as daily inspection of equipment for conditions that could cause

spills or leaks; cleaning of equipment prior to operation near the water; proper location of storage, refueling, and servicing sites away from the water; implementation of adequate on site spill response procedures; and stormy weather preparation plans.
- All construction activities shall be confined to the immediate area of construction, and no excess construction material shall be stockpiled in the water.
- Construction materials (e.g., stone and concrete) shall be inert and free of earthen and any other deleterious substances.

### *5.2.2 Long Term Effect on Water Quality*

Following completion of construction and removal of turbidity containment devices, the affected water body is expected to return to its pre-construction condition. No long term effects on water quality or water circulation in the project area are expected.

## 5.3 Biological Effects

Several aspects of the proposed project have the potential to affect marine biota. These include the following:

- Direct physical disturbance of the seafloor and water column during construction.
- Indirect effects associated with project related changes in water quality.
- Indirect effects related to re-colonization patterns as biota re-establishes itself in areas that were disturbed by temporary construction activities following the completion of construction.

This section of the report describes those potential biological effects. Effects are considered to be significant to the extent that they exceed the following criteria:

- Change environmental conditions (e.g., water quality, ambient noise level, wave energy, etc.) within a substantial part of the range of an important marine community.
- Involve work in a habitat believed to be used by known sensitive species (Federal or State listed endangered, essential fish habitat, etc.) or in a conservation district.
- Substantially affect the spawning area available to a marine species.

### *5.3.1 Construction Period Impacts*

Direct impacts to marine biological resources at the Royal Hawaiian groin improvement project site will result in the loss of marine resources that occur on the existing groin and within the footprint of the present structure. These communities are dominated by a number of algal species. One *Poc. meandrina* coral colony in the 21-to-40 cm size class is located on the existing groin. Impact to the coral can be avoided by relocating the colony prior to construction. Most adult fish in the project vicinity are mobile and will actively avoid direct impacts from project activities. There is potential for demersal fish eggs to be buried; however, new hard substrata created by the groin stone would provide greater surface area for these species to lay eggs in the future. Some impairment of ability of EFH managed species to find prey items could occur, but this effect should be temporary and spatially limited to the immediate vicinity of construction activities. Turbidity containment barriers will effectively isolate the construction

activities from the adjacent seafloor and water column; thus, impacts to marine biota will be limited to the immediate construction area. Construction of the new groin will occur on a primarily sand and rubble seafloor, with very limited benthic biota. In general, the biota on the seafloor in the project area is dominated by macro and turf algae, primarily the introduced and invasive species *Acanthophora spicifera* and *Gracileria salicornia*. The area has little vertical relief and is affected by shifting sands and tends to have little algal or macro-invertebrate diversity, with no coral colonies present. Construction activities will be curtailed during typical periods of coral spawning.

### *5.3.2 Long Term Impacts*

The rock rubblemound groin option will replace about 6,000 to 7,500 square feet (180-foot-long rock L-head groin and T-head, respectively) of primarily sand and rubble seafloor with a high relief rock rubblemound groin structure. The rock groin would provide bare, stable surfaces for recruitment of corals, algae, and other invertebrates. The groin would be a porous, permeable structure, with approximately 37 percent interstitial void space between stones. Obligate reef dwellers are often limited by the availability of suitable shelter, especially juveniles. Reef fishes prefer reef holes and crevices commensurate with the size of the fish. The interstitial spaces between stones would also provide habitat for benthic (crabs, shrimps, worms, etc.) and sessile organisms (sponges and tunicates) which would provide additional foraging resources for fishes. The boulders also provide a hard, stable surface for coral colonization, and elevates them above the shifting sand and rubble bottom.

The recently constructed *Iroquois Point Beach Nourishment and Stabilization Project* on the south shore of Oahu, immediately west of the Pearl Harbor entrance channel, involved the construction of nine rock rubblemound groins very similar in size and construction to the proposed RHG improvement. The Iroquois Point project was completed in May 2013. Extensive marine ecosystem monitoring is being accomplished for this project (AECOS, 2014). The 1-year post-construction marine ecosystem monitoring shows that the project has resulted in a significant increase in marine species diversity and density. In the vicinity of the groins there has been a 25-fold increase in fish abundance, not counting small baitfish, and a tripling of species richness (number of species). Fish biomass is more than six times greater than prior to construction. Prior to construction of the groins, fish biomass at Iroquois Point was considered low compared to island averages around the state, roughly on par with the shallow reef flats off Waikiki (AECOS, 2009b, 2011, 2014). After construction the biomass at the groins is on par with maximum values observed around the state (AECOS, 2014). Other changes in the vicinity of the groins includes an increase in crustose coralline algae cover from 1% to 60%, coral cover increase from 0 to 0.6% and macroinvertebrate cover from 1.4% to 6.3%. Coral abundance in the groin vicinity increased from 0 to 16 colonies per 10 $m^2$, with the most common coral species being *Pocillopora damicornis*. These changes are attributable to the creation of hard, stable habitat for colonization.

The concrete wall groin option would have a significantly smaller groin footprint (1,100 square feet); however, it would not provide the long term marine habitat improvement of a rock rubblemound structure.

## 5.4 Effects on Endangered Species

As discussed in Section 4.1.12, the nearshore area off Waikiki is frequented by the threatened green sea turtle (*Chelonia mydas*), which feeds on the algae covered bottom. Hawaiian monk seals (*Monachus schauinslandi*) have been seen in Waikiki on rare occasions, but this is exceptional, and they have not been reported in the vicinity of the proposed project. No other listed species have been observed.

As discussed in Section 4.1.12, biologists have noted the regular presence of sea turtles in the project area. No obvious congregation or resting areas have been seen, but the turtles clearly forage on the algae that grows abundantly in the nearshore area. Turtle surveys in the general area indicate that turtle abundance is not negatively affected by the number of people in the water or all the water recreation activities which occur in Waikiki. Turtles would be expected to move away from the construction activities, and as the impact area is relatively small and primarily on sandy bottom construction would not affect turtle foraging area. Construction of the groin will not involve in water work, such as pile driving, which would be expected to result in significant underwater sound that would adversely affect marine creatures.

The following Best Management Practices (BMPs) as typically recommended by the National Marine Fisheries Service (NMFS) will be adhered to during construction of the project to avoid impacts to the turtles or other marine protected species:

1. Conduct a survey for marine protected species before any work in the water starts, and if a marine protected species is in the area, a 150-foot buffer must be observed between the protected species and the work zone.
2. Establish a safety zone around the project area whereby observers will visually monitor this zone for marine protected species 30 minutes prior to, during, and 30 minutes post project in-water activity. Record information on the species, numbers, behavior, time of observation, location, start and end times of project activity, sex or age class (when possible) and any other disturbances (visual or acoustic).
3. Conduct activities only if the safety zone is clear of all marine protected species.
4. Upon sighting of a marine protected species within the safety zone during project activity, immediately halt the activity until the animal has left the zone. In the event a marine protected species enters the safety zone and the project activity cannot be halted, conduct observations and immediately contact NMFS staff in Honolulu to facilitate agency assessment of collected data.
5. For on-site project personnel that may interact with a marine protected species potentially present in the project area, provide education on the status of any listed species and the protections afforded to those species under Federal laws.

A summary of anticipated effects on endangered species is as follows:

- By using the above BMPs, noise/physical disturbance to green sea turtles is expected to be temporary and insignificant and not result in adverse behavioral changes.
- Based on the in-water work being conducted in very shallow water with turbidity containment barriers surrounding the work area, any exposure of marine protected species to turbidity and sedimentation is expected to be temporary and not significant.

Given the extensive turtle foraging area in Waikiki, and the relatively small percent loss which would result from the project, the change in turtle foraging habits and habitats is not expected to be significant.

## 5.5 Noise Impacts

It is not feasible to mitigate construction noise to the extent that it does not at times exceed existing background noise levels or is inaudible to beach users, hotel guests, etc. Some reduction is practical; however, and the following measures would be implemented.

- Equipment operation on the shoreline will be limited to the hours between 7:00 a.m. and 7:00 p.m.
- Broadband noise backup alarms in lieu of higher frequency beepers will be required for construction vehicles and equipment. Broadband noise alarms tend to be less audible and intrusive with distance as they blend in with other background noise sources.
- The project will specify use of the quietest locally available equipment, e.g., high insertion loss mufflers, fully enclosed engines, and rubber tired equipment when possible.
- The use of horns for signaling will be prohibited.
- Worker training on ways to minimize impact noise and banging will be required.
- A noise complaint hot line will be provided at the job site to allow for feedback from the hotel operators, which can be used to help develop modifications to construction operations whenever feasible.

## 5.6 Effects on Historic, Cultural, and Archaeological Resources

As discussed in Section 4.3 of this report, the Waikiki area has a rich historical and cultural legacy. However, two aspects of the project make it unlikely that it would have a significant adverse effect on historic or archaeological sites.

1. Implementation of the project does not involve construction on or excavation of backshore land areas that might contain physical remains. Work on land would take place only on the beach in areas recently nourished. Care will be taken when working on the beach to avoid disturbing previously undisturbed sandy sediments that might hide subsurface deposits.
2. The second is that the construction of the new groin would take place completely in the water, seaward of the shoreline (seawall), and does not involve modification of soft deposits which could reasonably be expected to have the potential to hide archaeological materials or burials.

During scoping coordination for the DEA the State Historic Preservation Division (SHPD) has stated that the existing groin is potentially eligible for inclusion within the Hawaii and National Register of Historic Places under Criterion C, for engineering, at the local level of significance (letter dated July 21, 2015). Coordination with SHPD will be conducted to assess potential impacts of replacing the groin on architectural and archaeological historic resources, and possible measures to mitigate any adverse impacts.

There do not appear to be any known traditional Hawaiian cultural practices that would be adversely affected by the proposed project, nor does it seem like the activities associated with the project will conflict with traditional cultural practices as expressed in legend. The proposed project would be accomplished in an area which has been substantially altered over more than a century, and is entirely makai (seaward) of the shoreline where the existence of any cultural artifacts or remains are very unlikely. Based on the above, the proposed project is unlikely to have an adverse effect on rights customarily and traditionally exercised for subsistence, cultural and religious purposes.

## 5.7 Recreational Impacts

### *5.7.1 Impacts on Sunbathing and Swimming Opportunities*

An approximate 8,000 square foot (0.2 acre) construction work and storage area would be located in the immediate project area, fronting the Royal Hawaiian Hotel, and a similar sized area would be located east of the project site in the vicinity of the beach concessions. These areas would not be available for sunbathing for the duration of construction activity. The temporary loss of beach area would be less than 10% of the available dry beach area in the Royal Hawaiian Beach sector. A turbidity containment barrier will surround the in-water construction activity and effectively "fence" off the work from people in the water, impacting swimming in the immediate vicinity of the groin construction.

### *5.7.2 Impacts on Surfing*

The proposed new groin will extend about 150 to 170 feet from the existing shoreline, and terminate about 140 feet landward of the existing RHG terminus. The groin would be located well landward of the nearby surf breaks, with the head about 800 feet landward of the Populars surf break riding zone. Incoming wave energy dissipation by a sloping, permeable rock groin head is similar to that of a sand beach, with about 80% of the incoming energy dissipated by wave runup on the rocks. Thus little wave energy would be reflected back seaward toward the surf site breaker zone. Wave energy dissipation for the vertical concrete wall option is considerably less, with about 60% of the incoming energy being reflected back seaward. The groin head could pose a hazard to surfboards separated from their riders and washing toward shore; however, the common usage of a leash to tether the board to the rider and the relatively long distance between the riding zone and the groin minimize this potential hazard. The new groin design would reduce the potential for rip current formation in the vicinity of the groin and the resultant loss of beach sand to the offshore waters, thus reducing sand buildup offshore which can alter the wave breaking patterns at the surf site.

### *5.7.3 Impacts on Beach Concessions and Catamaran Rides*

The project would have some temporary impact on the beach concessions during construction, as a portion of this area will be utilized for access and equipment/material storage. This impact would cease immediately following completion of construction, and every effort will be made to minimize potential impacts. Beach concessions are primarily located in the large open area east of the Moana Surfrider, in the vicinity of the Duke Kahanamoku statue. The hotels also offer beach services located along the top of the beach. The Royal Hawaiian Hotel beach concession activities would be significantly impacted during construction. Beach catamaran operations on

and off the beach would not be affected by construction activities. Equipment movement on the beach and construction material delivery to the work site would be done early in the morning or late afternoon and early evening, when beach use is reduced and the concessions have ceased activity for the day.

### *5.7.4 Impacts on Other Recreational Activities*

*Snorkeling*. The shallow reef in the project area is not known as a particularly good site for snorkeling, and the surfing, canoes, catamarans, and other recreational craft make snorkeling somewhat risky. The reef does not seem to attract the volume or variety of fish that other reefs do, and for this reason snorkeling is an infrequent activity here. In addition, during periods of high surf, visibility over the reef is poor due to wave agitation of the ocean bottom. A turbidity containment barrier will surround the in-water construction activity and effectively "fence" off the work from people in the water. Hence, the proposed project is not expected to have any negative impact on snorkeling activities.

*Kayaking.* Touring kayaks are not common in Waikiki. However, they are available for rent from the ocean activity desk at Fort DeRussy and are occasionally seen in the project area. However, as with snorkeling, the construction site will be fenced off and easy to avoid.

*Fishing and Gathering*. Two types of fishing occur in the project area, spear fishing and pole fishing, but both are infrequent. The offshore hard bottom was once noted octopus grounds, but they do not have that reputation today. Nonetheless, some spear fishermen still try their luck in these areas. Clark observed two divers looking for octopus during his reconnaissance survey. The reef fronting the project area is not known as a productive fishing area, so pole fishing is an infrequent activity. However, at certain times of the year, schools of *nehu*, small anchovy-sized fish, may congregate near shore. The *nehu* attract larger predators like *papio*, which are prized eating fish, which in turn attract pole fishermen. Pole fishermen whip for *papio*, which has the potential to create conflicts between them and swimmers. The proposed project will not significantly affect fishing in the area during construction.

Many areas of Waikiki were once known as good places to gather edible seaweeds, or limu, but little if any edible seaweed seems to remain in Waikiki today. No gathering activities of seaweed, shellfish, or other marine species were observed during the field trips or noted by the informants. The recovered sand will be placed on existing nearshore sand bottom, where limu does not grow. Hence, no significant adverse effect on the limu resource is expected.

*Waikiki Marine Managed Areas*. The Waikiki Marine Managed Areas (MMA) consists of two parts: the Waikiki Marine Life Conservation District (MLCD) and the Waikiki-Diamond Head Fisheries Management Area (FMA). As the project area is not included in the Waikiki MMA, no effects are anticipated.

### *5.7.5 Long Term Impacts*

The proposed project will result in a stable recreational beach area, and help reduce the need for periodic beach maintenance in this sector. No long term adverse impacts to recreational uses are expected. By accomplishing this project the beach recreational benefits can be better maintained

in an improved condition over the long term. Concerns raised by the C&C Water Safety Division during DEA scoping meetings include 1) possible lifeguard view plane interruption as a result of the larger groin, and 2) people may walk out on the groin and jump/dive into the water. Discussion with Water Safety Division personnel indicates that these concerns can be mitigated through measures such as a possible increase in water safety staff near the new groin and by signage. In addition, the relatively low elevation of the groin crest would not significantly block the view plane from the beach crest.

## 5.8 Changes in Susceptibility to Natural Hazards

The proposed project will replace the existing Royal Hawaiian Groin with a stable, engineered groin. The improvement is necessary to improve the stability of the groin and the adjacent beach. The beach is necessary to maintain space between the water and the existing backshore infrastructure. The beach is necessary to dissipate wave energy, thereby decreasing wave runup and flooding of the backshore area. The stabilized beach will be a significant benefit with regard to reducing the susceptibility to natural ocean hazards.

The proposed groin improvement is located in an area that does not receive runoff from adjacent areas. It is not within the flood plain of a stream or canal. Hence, there is no potential for increased risk from this source, and the physical change in the shore that is proposed does not have the potential to alter storm runoff risks in adjacent areas.

## 5.9 Air Quality Impacts

Because most of the work that will take place will be in the water, or on the sandy shoreline, the proposed project differs from many construction projects in that it involves little or no on-site soil disturbance that could result in particulate emissions. Potential sources of air pollution as a result of the project are related to the construction phase.

During the actual construction process, construction activities will create temporary degradation in air quality in the immediate vicinity of the project area. This negative impact to air quality will be limited to typical work hours, and will end once the groin is in place. The emissions from these internal combustion engines are far too small to have a significant or lasting effect on air quality. As part of the construction process, the contractor will observe all BMPs to keep construction related emissions to the lowest practicable levels.

Short-term degradation of air quality may occur due to emissions from construction equipment and would include carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compounds (VOCs), directly-emitted particulate matter ($PM_{10}$ and $PM_{2.5}$), and toxic air contaminants such as diesel exhaust particulate matter. Sulfur dioxide ($SO_2$) is generated by oxidation during combustion of organic sulfur compounds contained in diesel fuel. Off-road diesel fuel meeting Federal standards can contain up to 5,000 parts per million (ppm) of sulfur, whereas on-road diesel is restricted to less than 15 ppm of sulfur.

These construction impacts to air quality are short-term in duration and, therefore, will not result in adverse or long-term conditions. Implementation of the following measures will reduce any air quality impacts resulting from construction activities:

- Apply water or dust palliative to the site and equipment as frequently as necessary to control fugitive dust emissions.
- Properly tune and maintain construction equipment and vehicles.
- Locate equipment and materials storage sites as far away from hotels and commercial uses as practical. Keep construction areas clean and orderly.

Once construction is completed, the project will have no long-term air emissions or impact on air quality.

## 5.10 Land Use and Socio-Economic Effects

The proposed project will stabilize and improve an existing public beach. The economic value of this beach to the commercial success of Waikiki is extremely significant. A study by Hospitality Advisors, LLC (2008) accomplished for the Waikiki Improvement Association showed that if Waikiki Beach is not maintained and allowed to erode away it could result in a $2 billion annual loss in overall visitor expenditures, a $150 million annual loss in State tax revenue, and a loss of 6,350 jobs in the hotel industry alone. The project will not alter the existing land use pattern shoreward of the beach restoration, and there is no change in beach use patterns expected. Some negative economic impact on commercial activities may result during construction; however, every effort will be made to minimize adverse impacts, particularly during the prime daytime beach use hours.

The direct socio-economic effects of the proposed project are limited principally to construction employment and related business activity. The direct construction employment and business expenditures are not large enough to affect the larger socio-economic context of the area.

Overall, the economic effect on existing land use is expected to be beneficial, and result in small gains for the general tourism industry. The no action alternative could result in failure of the existing groin and loss of beach, which would have a very significant effect on Waikiki and Hawaii tourism in general. Waikiki has 87% of the total hotel rooms on Oahu, and approximately 69% of all Oahu visitors participate in swimming/sunbathing/beach activities (Hospitality Advisors, LLC, 2008).

## 5.11 Visual Impacts

Both residents and the tourist industry depend on Waikiki's scenic resources. The beauty of its coastline draws millions of tourists to its sights and beaches each year. Map A-1 of the City and County of Honolulu's *Primary Urban Center Development Plan* identifies all of Waikiki as being within a "Significant Panoramic View" zone. The *Waikiki Special Design Guideline*'s Urban Design Control Map also identifies the area within which the access right-of-way and construction staging area are located as being within the Waikiki Special Design district "Major View Corridor".

The City & County of Honolulu Land Use Ordinance (LUO) §9.80-3(a) designates some of the visual landmarks and significant vistas to be protected in the Waikiki area, as:

- Views of Diamond Head from many vantage points
- Continuous views of the ocean along Kalakaua Avenue from Kuhio Beach to Kapahulu Avenue
- Intermittent ocean views from Kalia Road across Fort DeRussy Park, Ala Wai Yacht Harbor, and the Ala Wai Bridge on Ala Moana Boulevard
- *Mauka* views from streets *mauka* of Kuhio Avenue
- Views towards Ala Wai Yacht Harbor from Magic Island Park

Due to its low elevation and profile, the proposed project does not have the potential to impact these views.

Construction equipment, material stockpiles, and construction activities will be present within the project area for several weeks during the construction of the project. These impacts are temporary and will not be present once the construction phase of the project is completed.

## 5.12 Impacts on Public Infrastructure and Services

The proposed groin improvement has little potential to affect public infrastructure and services. Once in operation it will not require water or electrical power. In and of itself, it does not generate a need for additional sanitary wastewater collection and treatment facilities and it would not affect stormwater runoff that might impact the City's stormwater system. Most people visiting that end of the beach would come by foot rather than in vehicles, and the improvements are not expected to increase the resident or visitor population of the island.

Prior to commencement of construction activities, the Police Department, Fire Department, and Emergency Medical Services will be informed of the project construction schedule and apprised of the emergency vehicle access routes to be used during construction. The contractor will be required to provide ample clearance for emergency vehicles at all times. The proposed project does not involve any activities that would permanently alter the need for, or ability to provide, emergency services.

Construction of the project will involve a relatively small construction crew, estimated to range between 6 and 12 workers onshore. During most of the construction these workers can park either in a construction staging area or existing public parking facilities. Mobilization and demobilization of the on-shore equipment and materials will involve some heavy truck traffic through Waikiki; however, this would be of limited duration. Equipment and materials would be transported along Waikiki Beach to the project site, thus requiring a secure trucking lane on the beach. The trucks would be escorted to assure public safety, and the delivery of materials and equipment would be timed such that impact to beach users would be minimized. Upon completion of the project, the number of trips along the beach will be less, as only the equipment and a fraction of the materials will need to be removed.

Because of the small number of vehicle-trips involved, construction worker and equipment/material delivery trips do not have the potential to substantially affect traffic volumes and/or the level of service on area roadways and do not require substantial mitigation efforts.

## 6. POTENTIAL IMPACTS OF NO ACTION

"No Action" consists of the Army Corps of Engineers or State of Hawaii agencies denying DLNR the necessary permits and approvals for the Royal Hawaiian Groin improvement project. Without the project the existing groin will continue to deteriorate until it ultimately fails. Given the current condition of the groin, failure is expected at any time. Should the groin fail and no longer be able to function to retain and stabilize the west end of the Royal Hawaiian Beach Sector of Waikiki Beach, rapid loss of sand from this beach sector would occur as sand is transported to the west and offshore. This will result in a significant narrowing of the beach and decrease in usable dry beach area, and a resultant loss of shoreline recreation and commercial opportunity. The majority of the backshore area, behind the beach is protected by old seawalls, presently covered by the beach in front of them. Loss of sand can be expected to begin to expose these seawalls, which will exacerbate the erosion problem, and could result in wall damage and the need for repairs in order to protect valuable backshore infrastructure.

The existing beach and offshore sand deposits do not affect coastal water quality, with the exception of contributing to turbidity. During periods of high surf there is typically a general increase in nearshore water turbidity due to the suspension of fine bottom material by wave action, and this can be expected to continue with or without the proposed project. The "No Action" alternative could exacerbate the turbidity problem as a result of sand loss offshore.

"No Action" could also adversely affect the nearshore biological environment. Potential sand movement offshore would abrade and smother benthic biota, and further worsen the deteriorated and relatively depauperate marine biota environment in Waikiki and the growth of invasive algae. However "No Action" would not affect protected or endangered species.

"No Action" would not affect historic, cultural, and archaeological resources, with the exception of whatever historic/cultural significance the existing groin and the beach itself have.

"No Action" will ultimately have a very significant impact on beach-related recreation resources. The diminished beach area will severely limit sunbathing, will decrease the access for swimming, surfing, and other water recreation activities, and will reduce the business opportunities for the beach concessions and catamaran rides.

The socio-economic impacts resulting from the loss of the Royal Hawaiian Beach Sector of Waikiki Beach would be very extensive. This beach area fronts three of the oldest and largest hotels in Waikiki, and supports numerous beach and water-related businesses and economic opportunities. In 2008 the Waikiki Improvement Association commissioned Hospitality Advisors, LLC, to conduct an economic impact analysis of the effect of the complete erosion of Waikiki Beach (Hospitality Advisors, 2008). A summary of the study results are as follows.

- Waikiki Beach is recognized as a major tourism destination in Hawaii, as well as a popular recreational spot for visitors and residents. On average, there are 25,600 hotel rooms available in Waikiki on a daily basis, 87% of the total hotel supply on Oahu.

- According to a DBEDT Visitor Satisfaction Survey, approximately 69% of all Oahu visitors participate in swimming/sunbathing/beach activities. More than one-third of

westbound (e.g., mainland U.S.) and Japanese visitors cited beach or swimming as their primary reason for staying in Waikiki. The top four planned activities for both westbound and Japanese visitors were swimming, sunbathing, surfing, and snorkeling.

- An overwhelming majority, 76% to 79%, of all visitors consider beach availability to be very important. When presented with the possibility of the complete erosion of Waikiki Beach, 58% of all westbound visitors and 14% of Japanese visitors said they would not consider staying in Waikiki without the beach.

- There has been substantial recent capital investment in Waikiki in an effort to keep it competitive as a visitor destination; examples are the Outrigger Waikiki Beach Walk and Starwood property renovations/upgrades (Sheraton Waikiki Hotel, Royal Hawaiian Hotel, and the Moana Surfrider Hotel).

- The estimated socio-economic loss to the State if Waikiki Beach is not maintained and allowed to erode away is very significant:

    - an estimated $661 million loss in annual hotel revenues
    - a $2 billion loss in overall visitor expenditures
    - a $150 million loss of State tax revenue
    - a hotel industry job loss of 6,350 people

# 7. RELATIONSHIP TO RELEVANT PLANS, POLICIES, AND CONTROLS

This chapter discusses the compliance and compatibility of the proposed Royal Hawaiian Groin improvement with pertinent plans, policies, and regulations at county, state, and federal levels.

## 7.1 City and County of Honolulu

In May 2015, Honolulu Mayor Kirk Caldwell signed two bills (Bills 81 and 82) into law to establish the Waikiki Beach Special Improvement District. This allows the city to charge an extra fee for commercial property owners in the area and use the money to help fix and maintain the beach. Repair of the Royal Hawaiian groin will be one of the first projects undertaken.

The proposed Royal Hawaiian Groin improvement project is seaward of the certified shoreline and is therefore outside of the jurisdiction of the City and County of Honolulu. The only land-based activity involved in the project is the temporary staging and stockpiling area on the beach near the project site. Thus, the project does not require any City-administered permits or approvals. The project does, however, relate to several of the goals and objectives set forth in the City and County's regional and island wide planning documents. The project is discussed in the context of each of the relevant documents in the following sections.

### *7.1.1 Oahu General Plan*

The proposed Royal Hawaiian Groin improvement is relevant to four key objectives outlined in the Oahu General Plan. Each of these objectives and the relevant policies are listed below, followed by a discussion of the project's relationship to them.

- II. Economic Activity, Objective B: To maintain the viability of Oahu's visitor industry.
- Policy 2: Provide for a high quality and safe environment for visitors and residents in Waikiki.
- Policy 3: Encourage private participation in improvements to facilities in Waikiki.
- Policy 8: Preserve the well-known and widely publicized beauty of Oahu for visitors as well as residents.

*Discussion:* According to the objectives listed in Section 1.2, the proposed project is intended to replace the old deteriorated concrete block groin with a stable engineered groin. The sand beach between the groin and Kuhio Beach Park is stabilized by the groin, and failure of the groin would result in rapid and likely permanent loss of beach sand. The action would replace the old groin, thereby reducing the likelihood of a groin failure that could destabilize the beach. Waikiki Beach is Oahu's top visitor destination, and the loss of the beach would be detrimental to Oahu's economy. The discussion in this DEA explains why we believe that the selected alternative best fulfills these objectives, and therefore why it is compatible with the vision of the Oahu General Plan.

> III. Natural Environment, Objective A: To protect and preserve the natural environment. Policy 1: Protect Oahu's natural environment, especially the shoreline, valleys, and ridges, from incompatible development.

Policy 2: Seek the restoration of environmentally damaged areas and natural resources.
Policy 3: Retain the Island's streams as scenic, aquatic, and recreation resources.
Policy 4: Require development projects to give due consideration to natural features such as slope, flood and erosion hazards, water-recharge areas, distinctive land forms, and existing vegetation.
Policy 5: Require sufficient setbacks of improvements in unstable shoreline areas to avoid the future need for protective structures.
Objective B: To preserve and enhance the natural monuments and scenic views of Oahu for the benefit of both residents and visitors.
Policy 1: Protect the Island's well-known resources: its mountains and craters; forests and watershed areas; marshes, rivers, and streams; shoreline, fishponds, and bays; and reefs and offshore islands.

*Discussion:* The existing Royal Hawaiian Groin is greatly deteriorated, and it is estimated that it could fail at any time. The proposed project would replace the existing groin with a stable, engineered groin, thus reducing the chance of groin failure and subsequent beach loss. Beach loss would remove the important buffer between the ocean and the backshore properties, exposing those properties to seawater inundation and property damage that could occur as a result of waves overtopping a narrow beach or impacting the presently buried seawalls. The scenic views of the beach would also be impacted by the loss of the beach. Additionally, failure of the existing groin would release the beach sand into the nearshore environment with potential impacts to the marine ecosystem.

X. Culture and Recreation, Objective D: To provide a wide range of recreational facilities and services that are readily available to all residents of Oahu.
Policy 5: Encourage the State to develop and maintain a system of natural resource-based parks, such as beach, shoreline, and mountain parks.
Policy 6: Provide convenient access to all beaches and inland recreation areas.
Policy 8: Encourage ocean and water-oriented recreation activities that do not adversely impact on the natural environment.
Policy 10: Encourage the private provision of recreation and leisure-time facilities and services.

*Discussion:* As discussed in Section 5.7, failure of the existing groin and the subsequent loss of sandy beach will decrease the recreational opportunities for visitor and resident beachgoers. The beach is heavily used for recreational purposes, and a wide beach provides the greatest recreational aspect for the users. Replacing the Royal Hawaiian Groin would help keep the value of the beach at its highest.

## 7.2 State of Hawaii Laws and Regulations

### *7.2.1 Hawaii State Planning Act*

The Hawaii State Planning Act (Chapter 226, Hawaii Revised Statutes, as amended) outlines themes, goals, guidelines, and policies for statewide planning. The proposed Royal Hawaiian Groin relates to the following objectives stated in §226-11: "*Objectives and policies for the physical environment--land-based, shoreline, and marine resources*":

1. Exercise an overall conservation ethic in the use of Hawaii's natural resources.
2. Ensure compatibility between land-based and water-based activities and natural resources and ecological systems.
3. Take into account the physical attributes of areas when planning and designing activities and facilities.
4. Manage natural resources and environs to encourage their beneficial and multiple uses without generating costly or irreparable environmental damage.
5. Pursue compatible relationships among activities, facilities, and natural resources.
6. Promote increased accessibility and prudent use of inland and shoreline areas for public recreational, educational, and scientific purposes [L 1978, c 100, pt of §2; am L 1986, c 276, §10].

*Discussion:* The proposed project is intended to replace the existing deteriorated groin with a fully functional structure in order to prevent failure of the old groin from destabilizing the beach. Failure of the groin would result in the rapid loss of sand beach area, and its possible transport into the nearshore waters, potentially impacting the marine ecosystem. Groin improvement would provide additional stability to the beach; and would increase the recreational value of an area that is already heavily-used by locals and tourists and supports multiple recreational uses. Thus, it is consistent with the above objectives.

### *7.2.2 State Land Use Laws*

The Board of Land and Natural Resources (BLNR) regulates uses of the State Conservation District by issuing Conservation District Use Permits for approved activities. The criteria that the OCCL will use in evaluating the project are outlined in Hawaii Administrative Rules §13-5-30. Each criterion is listed below, followed by a discussion of how the proposed project complies with it.

1. The proposed land use is consistent with the purpose of the conservation district;

*Discussion:* The purpose of the Conservation District is to conserve, protect, and preserve the important natural resources of the State through appropriate management and use to promote their long-term sustainability and the public's health, safety, and welfare (HAR §13-5-1). As discussed throughout this EA, the proposed project is expected to reduce the chance of groin failure and beach loss, thereby maintaining the variety of and access to water-oriented recreational activities while protecting other valuable coastal resources. Thus, it is in keeping with the purpose of the Conservation District. The project is consistent with the Coastal Erosion Management Plan (COEMAP), adopted by the Board of Land and Natural Resources, and which identifies beach maintenance and restoration as a long-term strategy where applicable for maintaining the shoreline.

2. The proposed land use is consistent with the objectives of the subzone of the land on which the use will occur;

*Discussion:* The proposed project is in the Resource Subzone of the Conservation District, and consists of land use activities consistent with use R-6 Marine Construction (HAR §13-5-25). As

specified in HAR §13-5-24(c)(4), this use is permitted in this Subzone with the acquisition of a Land Board-approved Conservation District Use Permit. The applicant is seeking this permit coverage for the project.

3. The proposed land use complies with provisions and guidelines contained in chapter 205A, HRS, entitled "Coastal Zone Management," where applicable;

*Discussion:* A Hawaii Coastal Zone Management Program Consistency Review will be accomplished to confirm the consistency of the project with the Coastal Zone Management Act and the objectives outlined in Chapter 205A, HRS (see Section 7.3.5).

4. The proposed land use will not cause substantial adverse impact to existing natural resources within the surrounding area, community, or region;

*Discussion:* The proposed project involves replacement of the existing concrete block groin with a stable, engineered groin. Marine biota surveys have shown much of the affected area to be sandy or other mobile substrate. The recently constructed Iroquois Point Beach Nourishment and Stabilization project, which included nine rock rubblemound groins, has resulted in a significant increase in marine species and diversity, including fish, coralline algae, and corals. At the same time, the project will be reducing the likelihood of sand being released into the nearshore waters due to a groin failure, which would adversely impact habitat.

5. The proposed land use, including buildings, structures, and facilities, shall be compatible with the locality and surrounding areas, appropriate to the physical conditions and capabilities of the specific parcel or parcels;

*Discussion:* The proposed project will replace the existing groin with a stable engineered groin. From the nearby hotels or vessels on the ocean, the groin will not impact the view plane, and will stabilize this portion of Waikiki Beach.

6. The existing physical and environmental aspects of the land, such as natural beauty and open space characteristics, will be preserved or improved upon, whichever is applicable;

*Discussion:* The proposed groin improvement will be no higher than the existing beach crest. Rock rubblemound groins are more natural than concrete blocks, and there are already several rock rubblemound groins in Waikiki. There are also existing concrete groin structures. This action would have no negative impact on the continuity of Waikiki's beachfront appearance.

7. Subdivision of land will not be utilized to increase the intensity of land uses in the conservation district;

*Discussion:* No property subdivision is needed for the proposed project.

8. The proposed land use will not be materially detrimental to the public health, safety, and welfare.

*Discussion:* Once the proposed project has been completed, there will be no regular sources of emissions or waste that could prove detrimental to public health. All offshore uses have inherent safety risks to users (e.g., inclement weather, rough seas, potentially dangerous marine life). However, as discussed in Section 5.1.2, the project will not create a significant hazard to public safety and welfare.

## 7.3 Federal Acts and Legislation

### *7.3.1 Archaeological and Historic Preservation Acts*

Consultation with the State Historic Preservation Division will be accomplished to ensure that the project complies with the provisions of the Archaeological and Historic Preservation Act (16 U.S.C. § 469a-1) and the National Historic Preservation Act (NHPA) (16 U.S.C. § 470(f)). A NHPA Section 106 review will be accomplished during federal (Department of the Army) permit processing for work in the water.

### *7.3.2 Clean Air Act (42 U.S.C. § 7506(c))*

As discussed in Section 5.9, the only emissions associated with the project would be during construction. Once construction is completed the proposed project will not produce any emissions. It is consistent with the provisions of the Clean Air Act.

### *7.3.3 Clean Water Act (CWA) of 1977, as amended (33 USC §§1251-1387)*

The Clean Water Act (CWA) is the key legislation governing surface water quality protection in the United States. Sections 401, 402, and 404 of the Act require permits for actions that involve wastewater discharges or discharge of dredged or fill material into waters of the United States. The placement of stone and precast concrete into nearshore marine waters constitutes fill as defined in the CWA and is subject to regulations implementing the CWA. An application will be made to the Department of the Army for authorization to construct the project under Section 404 of the CWA. In Hawaii, the U.S. Environmental Protection Agency has delegated responsibility for implementing Section 401 of the Act to the State. A Section 401 Water Quality Certification Application for this project will be submitted to the State Department of Health.

### *7.3.4 Rivers and Harbors Act (33 USC §403)*

Section 10 of the Rivers and Harbors Act, 33 USC §403, requires a Department of the Army (DA) permit for any activity that obstructs or alters navigable waters of the U.S., or the course, location, condition, or capacity of any port, harbor, refuge, or enclosure within the limits of any breakwater, or of the channel of any navigable water. The proposed groin improvement would extend into navigable water; hence the project requires a Section 10 permit from the Army Corps of Engineers.

### *7.3.5 Coastal Zone Management Act (16 U.S.C. § 1456(c) (1))*

Enacted as Chapter 205A, HRS, the Hawaii Coastal Zone Management (CZM) Program was promulgated in 1977 in response to the Federal Coastal Zone Management Act of 1972. The CZM area encompasses the entire state, including all marine waters seaward to the extent of the

state's police power and management authority, as well as the 12-mile U.S. territorial sea and all archipelagic waters. Application will be made to the State Office of Planning, CZM Program, for a CZM Consistency Determination.

#### *7.3.5.1 Recreational Resources*

*Objective:* Provide coastal recreational opportunities accessible to the public.

*Policies:*

- Improve coordination and funding of coastal recreational planning and management;
- Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area;
- Protect coastal resources uniquely suited for recreational activities that cannot be provided in other areas;
- Require replacement of coastal resources having significant recreational value including, but not limited to, surfing sites, fishponds, and sand beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;
- Provide and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;
- Provide an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;
- Ensure public recreational uses of county, state, and federally owned or controlled shoreline lands and waters having recreational value consistent with public safety standards and conservation of natural resources;
- Adopt water quality standards and regulating point and nonpoint sources of pollution to protect, and where feasible, restore the recreational value of coastal waters;
- Develop new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, and artificial reefs for surfing and fishing; and
- Encourage reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the Land Use Commission, Board of Land and Natural Resources, and county authorities.

*Discussion:* The primary purpose of the project is to replace the existing groin with a stable, engineered groin to maintain a public recreational beach and the coastal recreational opportunity.

#### *7.3.5.2 Historic Resources*

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

*Policies:*

- Identify and analyze significant archaeological resources;

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

*Discussion:* The SHPD will be consulted to determine requirements for the proposed project to comply with Section 106 of the National Historic Preservation Act and Hawaii Revised Statutes (HRS) §6E-8. The construction specifications will contain provisions to protect any historic resources and alert the proper agencies should any be found during the construction activities.

#### *7.3.5.3 Scenic and Open Space Resources*

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

*Policies:*

- Identify valued scenic resources in the coastal zone management area;
- Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;
- Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources; and
- Encourage those developments that are not coastal dependent to locate in inland areas.

*Discussion:* The proposed project will preserve the quality of coastal scenic and open space resources by maintaining the sandy beach area.

#### *7.3.5.4 Coastal Ecosystems*

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

*Policies:*

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

*Discussion:* The proposed project will have no significant long-term impacts on the coastal ecosystem. The project construction specifications will include requirements which will reduce, minimize, and avoid the potential for adverse impacts during construction to the maximum extent practicable. Marine biota surveys have shown much of the affected area to be sandy or other mobile substrate. A recent rock rubblemound groin project (Iroquois Point) has produced an increase in fish abundance, an increase in crustose coralline algae cover, coral cover increase, and an increase in macroinvertebrate cover, all attributable to the creation of hard, stable habitat for shelter and colonization. At the same time, the project will be reducing the likelihood of sand being released into the nearshore waters should the existing groin fail, which would adversely impact marine habitat.

#### *7.3.5.5 Economic Uses*

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

*Policies:*

- Concentrate coastal dependent development in appropriate areas;
- Ensure that coastal dependent development such as harbors and ports, and coastal related development such as visitor industry facilities and energy generating facilities, are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area; and
- Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:
- Use of presently designated locations is not feasible;
- Adverse environmental effects are minimized; and
- The development is important to the State's economy.

*Discussion:* The proposed RHG improvement project will provide significant economic benefit to the visitor industry and the State by helping to maintain the sand beach resource.

#### *7.3.5.6 Coastal Hazards*

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

*Policies:*

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

*Discussion:* The proposed project will stabilize the shoreline, maintaining the space between the water and land-side development. This will support the ability of the beach to dissipate wave energy and reduce runup, and thus protect backshore infrastructure. It will not have a significant effect on tsunami run-up.

#### *7.3.5.7 Managing Development*

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

*Policies:*

- Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development;
- Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and
- Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the public to facilitate public participation in the planning and review process.

*Discussion:* The proposed project permitting and approval process will provide an opportunity for public participation in the plan formulation process.

#### *7.3.5.8 Public Participation*

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

*Policies:*

- Promote public involvement in coastal zone management processes;
- Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal issues, developments, and government activities; and
- Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.

*Discussion:* The public will have an opportunity to review and comment on this EA as part of the public review process.

### *7.3.6 Beach Protection*

*Objective:* Protect beaches for public use and recreation.

*Policies:*

- Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion;
- Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities; and
- Minimize the construction of public erosion-protection structures seaward of the shoreline.

*Discussion:* As discussed in Section 5.7, the proposed groin improvement will help maintain an existing public beach and beach-related recreation opportunity.

#### *7.3.6.1 Marine Resources*

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

*Policies:*

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

*Discussion:* The proposed project will not significantly affect marine and coastal resources. The project plan will be fully coordinated with federal and state marine resource agencies, including NOAA/NMFS, USFWS, USEPA and DLNR/DAR.

### *7.3.7 Endangered Species Act (16 U.S.C. 1536(a)(2) and (4))*

The Endangered Species Act (16 U.S.C. §§ 1531-1544, December 28, 1973, as amended 1976-1982, 1984 and 1988) provides broad protection for species of fish, wildlife, and plants that are listed as threatened or endangered in the U.S. or elsewhere. The Act mandates that federal agencies seek to conserve endangered and threatened species and use their authorities in furtherance of the Act's purposes. It provides for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The Act outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species, and contains exceptions and exemptions.

Existing biota on and near the project site and potential impacts of the proposed project are discussed in Sections 4.1.11, 4.1.12, 4.1.13, 5.3, and 5.4 of this EA. The endangered green sea turtle is known to frequent the project area; however, no significant impacts to turtles are anticipated to occur as a result of the project.

#### *7.3.8 Fish and Wildlife Coordination Act (FWCA) of 1934, as amended (16 USC §§661-666[c] et seq.)*

The FWCA provides for consultation with the USFWS and other relevant Federal and State agencies when a Federal action proposes to modify or control U.S. waters for any purpose. This consultation will be initiated during the federal permitting process.

#### *7.3.9 Magnuson-Stevens Fishery Conservation and Management Act (16 USC §1801 et seq.)*

The Magnuson-Stevens Act (16 USC §1801 et seq.), as amended by the Sustainable Fisheries Act, PL 104-297, calls for action to stop or reverse the loss of marine fish habitat. The waters out to 200 miles (mi) around the Hawaiian Islands are under the jurisdiction of the Western Pacific Regional Fishery Management Council (WPRFMC). The WPRFMC has approved a Fisheries Management Plans (FMP) for Hawaii that designates all the ocean waters surrounding Oahu, from the shore to depths of over 100 feet, including the area that would be affected by the proposed project as "Essential Fish Habitat" (EFH).

The WPRFMC has also identified "Habitat Areas of Particular Concern" (HAPC). As defined in the 1996 amendments to the Act, these habitats are a subset of EFH that are "rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area." The area that would be affected by the proposed project is not within a HAPC.

#### *7.3.10 Marine Mammal Protection Act (MMPA) of 1972, as amended (16 USC §§1361-1421(h) et seq.)*

Reauthorized in 1994, the MMPA establishes a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas and on importing of marine mammals and marine mammal products into the U.S. The proposed project will be accomplished in accord with the requirements of the MMPA.

##### *7.3.10.1 Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 USC §§703 712 et seq.)*

The MBTA is a bilateral migratory bird treaty with Canada, Mexico, Japan, and Russia. Sections 703 to 712 of the Act prohibit the taking of migratory birds in the absence of a permit. The actions involved in nourishing and maintaining the beach are not anticipated to have the potential to affect migratory birds.

#### *7.3.11 National Historic Preservation Act (NHPA) of 1966 (16 USC §470 et seq.)*

Section 106 of the NHPA of 1966, 16 USC §470(f), as amended, requires Federal agencies having direct or indirect jurisdiction over a Federal undertaking to take into account effects on any district, site, building, structure, or object that is included or is eligible for inclusion in the

National Register of Historic Places (NRHP) prior to the approval of expenditure of any funds or issuance of any license or permit. The applicant's informal consultation with the Historic Preservation Division of the State of Hawaii Department of Land and Natural Resources indicates that the existing groin may potentially be eligible for inclusion in the Hawaii and National Register of Historic Places, under Criteria C, for engineering, at the local level of significance. Formal consultation with the Hawaii State Historic Preservation Officer (SHPO) will be made to confirm this and to develop possible mitigation measures as necessary.

#### *7.3.11.1 Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 USC §3001)*

NAGPRA provides for the protection and repatriation of Native American and Native Hawaiian human remains and cultural items discovered on Federal lands. The Proposed Action does not involve the use of Federal land and is not, therefore, subject to the Act.

#### *7.3.11.2 EO 13089, Coral Reef Protection (63 FR 32701)*

EO 13089, dated June 11, 1998, directs all Federal agencies whose actions may affect U.S. coral reef ecosystems to:

- Identify their actions that may affect U.S. coral reef ecosystems;
- Utilize programs and authorities to protect and enhance the condition of such ecosystems; and
- Ensure that any actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems.

Marine biological consultants have inventoried the coral resources in and around the areas that could be affected by the proposed project. The results of these surveys will be used to confirm the extent to which the proposed action is likely to affect coral reefs and to identify measures that will be undertaken to mitigate these unavoidable effects.

#### *7.3.11.3 EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds (16 USC §§ 703-711) (66 FR 3853)*

Under EO 13186, dated January 10, 2001, all Federal agencies taking actions that have, or are likely to have, a measurable negative impact on migratory bird populations are directed to develop and implement a Memorandum of Understanding (MOU) with USFWS that promotes the conservation of migratory bird populations. The applicant's preliminary assessment indicates that the proposed project would not affect habitat used by migratory bird populations. The USFWS will be consulted to confirm this determination.

#### *7.3.11.4 EO 12898, Environmental Justice*

Under EO 12898, dated February 11, 1994, Federal agencies are required to address the potential for disproportionately high and adverse environmental effects of their actions on minority and low-income populations. Agencies are required to ensure that their programs and activities that affect human health or the environment do not directly or indirectly use criteria, methods, or

practices that discriminate on the basis of race, color, or national origin. NEPA documents are specifically required to analyze effects of Federal actions on minority and low-income populations and, whenever feasible, to develop mitigation measures to address significant and adverse effects on such communities. The EO states that the public, including minority and low-income communities, should have adequate access to public information relating to human health or environmental planning, regulation, and enforcement.

The proposed project would maintain the amount of sandy beach available to the general public in Waikiki, including members of low-income and minority groups. Unless information to the contrary arises out of the environmental review process, there does not appear to be any mechanism through which the proposed project could impose disproportionately high adverse effects on minority or low-income populations.

#### *7.3.11.5 EO 13123, Greening the Government through Efficient Energy Management (65 FR 24595)*

E0 13123, Part 2, Section 204, dated April 21, 2000, states "each agency shall strive to expand the use of renewable energy within its facilities and in its activities by implementing renewable energy projects and by purchasing electricity from renewable energy sources." Construction of the new groin does not involve the ongoing use of electricity. The applicant's general policy is to promote energy efficiency throughout its operations, and it will include a statement to that effect in its construction contract.

## 7.4 Project Relationship With Waikiki Beach

### *7.4.1 Waikiki Beach Development*

There is little evidence to suggest that Waikiki Beach, generally considered to extend from the Elks Club on the east to the Ala Wai Boat Harbor to the west, is or ever was "master planned". What exists today is a series of individual actions by property owners and government agencies along various segments of the beach and then reactions to problems that ensued, beginning more than 100 years ago. At present, Waikiki Beach is entirely man-made; there is no natural shoreline between Honolulu Harbor and Diamond Head. However, there have been general overall improvement plans suggested by various investigators over the years. In the early 1960s, investigations by the U.S. Army Corps of Engineers (USACE) led to a congressionally authorized improvement plan, which was de-authorized in the mid-1970s as a result of public concerns and opposition. In 1978, the report *Beach and Surf Parameters in Hawaii* (Gerritsen, 1978) was published by the University of Hawaii Sea Grant Program, and included a section on "Measures for Improvement" of Waikiki Beach. In the 1990s, the State DLNR contracted with the engineering firm of Edward K. Noda and Associates, Inc. for an extensive study of Waikiki Beach and possible improvements. This work is summarized in the *Final Environmental Assessment, Kuhio Beach Improvements* (Noda, 1999). The report *Independent Evaluation Study of Proposed Kuhio Beach Improvements* (Bodge, 2000) prepared for the State DLNR included a chapter on overall "Waikiki Beach Improvements".

USACE (1965) – The USACE plan consisted of:

- Widening the average dry beach width to 180 feet from Duke Kahanamoku Beach (Hilton Hotel) to the Natatorium, and 75 feet from the Natatorium to the Elks Club.
- Constructing or modifying the following structures:
  - Extension of the existing box culvert/groin at the east end of Fort DeRussy Beach to 350 feet.
  - Construction of a new 350-foot groin between the Sheraton Waikiki and the Royal Hawaiian hotels.
  - Construction of a new 350-foot groin at the north end of Kuhio Beach.
  - Extension of the existing Kapahulu Avenue storm drain by 130 feet.
  - Raising the 190-foot long shoreward crest elevation of the Queen's Surf groin from 4.5 feet to 8 feet.
  - Construction of a new 350-foot groin near the Aquarium.
  - Construction of a 100-foot stub groin extension from the southwest corner of the Natatorium.
  - Construction of up to four additional groins if required.

The USACE did not construct any of the authorized improvements. In 1969, Fort DeRussy beach was improved by the Army. Work included beach fill and the construction of a box culvert and rock groin on the eastern boundary adjacent to the Outrigger East hotel. The State of Hawaii completed improvements to Kuhio Beach in 1972; however, they deviated extensively from the USACE plan.

Gerritsen (1978) – Dr. Gerritsen identified many issues and concerns regarding improvements to Waikiki Beach, and presented his suggestions from a purely technical standpoint. Suggested improvements were generally as follows:

Fort DeRussy – no improvement necessary

- Fort DeRussy to Royal Hawaiian Hotel
  - Beach nourishment
  - Extend the Fort DeRussy culvert/groin and add a spur on the east side of the head
  - Construct a new T-head groin in the vicinity of the Halekulani Hotel
  - Replace the existing Royal Hawaiian groin with a new T-head groin

- Royal Hawaiian Hotel to Kapahulu Storm Drain/Groin
  - Beach nourishment
  - Construct a new offshore breakwater fronting the Moana Hotel
  - Construct a new groin at the north end of Kuhio Beach
  - Improve the effectiveness of the Kuhio Beach Crib Wall

- Kapahulu Storm Drain to the Elks Club: Beach nourishment stabilized by T-head groins, the number and configuration of which would depend on whether or not the Natatorium is removed.

DLNR (1999) – The Kuhio Beach improvement plan proposed by DLNR/DOBOR consisted of reconstruction of the offshore crib wall system and restoration and improvement of the beach. The plan proposed replacing the concrete and stone crib walls with new rock groins at each end and a segmented breakwater in the middle. The proposed improvements to Kuhio Beach have not yet been implemented by the State.

Bodge (2000) – The DLNR Land Division contracted with Dr. Kevin Bodge of Olsen Associates, Inc., to conduct a review of the proposed Kuhio Beach improvements. Dr. Bodge and his firm have considerable experience with the design and construction of beach projects similar to the Kuhio Beach plan, i.e. beach fill stabilized by T-head groins. Dr. Bodge presented some general design considerations and improvement suggestions for the entire beach. He suggested that the beach is already "compartmentalized", both by existing structures and backshore usage/facilities, and that this compartmentalizing readily allows for beach improvements to be made in a step-by-step or piece-wise approach. He further suggested that "it is not necessary to address, design or construct, all of the Waikiki improvements at one time", and that different sponsorship and funding could be utilized for different areas. For the Royal Hawaiian beach sector Dr. Bodge recommends "*Periodic beach nourishment between the Royal Hawaiian Hotel and Kuhio Beach, without stabilizing structures, or, the possible use of three or four T-head groins to stabilize the beach and eliminate the need for periodic re-nourishment*."

The proposed beach improvement plans outlined above were all also discussed in terms of discrete beach sectors or compartments, generally defined by existing structures and backshore usage. Beach improvements were discussed in terms of each reach being a separate project, capable of being implemented incrementally as stand-alone improvements. The beach sectors are generally defined from east to west as follows (Gerritsen, 1978; Miller and Fletcher, 2003).

1. Sans Souci (Kaimana) Beach: Kaimana Hotel/Elks Club to the Natatorium
2. Queens Beach: Natatorium to the Queen's groin
3. Kapiolani Beach: Queen's groin to the Kapahulu storm drain
4. Kuhio Beach: Kapahulu storm drain to the Duke Kahanamoku statue
5. Royal Hawaiian Beach: Duke Kahanamoku statue to the Royal Hawaiian groin
6. Halekulani Beach: Royal Hawaiian groin to the Ft. DeRussy groin/drain culvert
7. Ft. DeRussy Beach: Ft. DeRussy groin to the Hilton pier
8. Duke Kahanamoku Beach: Hilton pier to the Ala Wai Boat Harbor

The proposed groin improvement is located in the Royal Hawaiian beach sector, fronting the Royal Hawaiian hotel. Thus, the proposed project is consistent with existing planning studies for Waikiki Beach improvements, and is capable of being implemented as a stand-alone project. It would also integrate well with future beach improvement projects should they be implemented.

### *7.4.2 Recent Waikiki Beach Maintenance*

In 2006, the State DLNR performed beach maintenance in the Kuhio Beach sector of Waikiki. The project consisted of the recovery of 10,000 cubic yards of sand from deposits immediately offshore of Kuhio Beach, pumping it to shore for dewatering, and placing it on the beach to nourish and widen the beach. The sand was primarily placed within the confines of the crib

walls; however, approximately 20% was placed on the beach west of the crib wall, fronting the Duke Kahanamoku statue.

The 2012 Waikiki Beach Maintenance project nourished this beach with approximately 24,000 cubic yards of sand, creating a beach berm with elevation of approximately +7 feet msl and a dry sand area of greater than 40 feet in width. Beach fill extended over 1,730 feet between Kuhio Beach Park and the Royal Hawaiian Groin.

In May 2015, Honolulu Mayor Kirk Caldwell signed two bills (Bills 81 and 82) into law to establish the Waikiki Beach Special Improvement District. This allows the city to charge an extra fee for commercial property owners in the area and use the money to help fix and maintain the beach. Repair of the Royal Hawaiian groin will be one of the first projects undertaken.

### *7.4.3 Possible Future Waikiki Projects*

Two Waikiki Beach improvement projects for beach sectors other than the project area are presently being considered.

*Natatorium*. The City & County of Honolulu is exploring alternatives for the aging and deteriorated Waikiki Natatorium (between the Sans Souci and Queens beach sectors). Alternatives include replacing the natatorium with a beach, possibly including rock groin stabilizing structures.

*Kuhio Beach*. DLNR has considered improvements to Kuhio Beach in the past, and it is considered likely that improvements will be re-visited in the future.

As these would be accomplished in separate discrete beach sectors it is reasonable to consider them as stand-alone projects.

# 8. MITIGATION

## 8.1 Mitigation During Construction

### *8.1.1 Protection of Endangered Species*

The following endangered species BMPs as recommended by the National Marine Fisheries Service (NMFS) shall be adhered to during construction of the project.

1. Establish a safety zone around the project area whereby observers shall visually monitor this zone for marine protected species 30 minutes prior to, during, and 30 minutes post daily project activity. Record information on the species, numbers, behavior, time of observation, location, start and end times of project activity, sex or age class (when possible), and any other disturbances (visual or acoustic).
2. If a marine protected species is in the area, either hauled out onshore or in the nearshore waters, a 150-foot buffer must be observed with no humans approaching it. If a monk seal/pup pair is seen, a minimum 300-foot buffer must be observed.
3. In the event a marine protected species enters the safety zone and the project activity cannot be halted, conduct observations and immediately contact NMFS staff in Honolulu to facilitate agency assessment of collected data. For monk seals contact the Marine Mammal Response Coordinator, David Schofield, at (808) 944-2269, as well as the monk seal hotline at (808) 220-7802. For turtles, contact the turtle hotline at (808) 983-5730.
4. For on-site project personnel that may interact with a listed species potentially present in the action area, provide education on the status of any listed species and the protections afforded to those species under Federal laws. NMFS may be contacted for scheduling educational briefings to convey information on marine mammal behavior, and explain why and when to call NMFS and other resource agencies.

### *8.1.2 Best Management Practices During Construction*

Best Management Practices (BMPs) for construction operations will be developed to help minimize adverse impacts to coastal water quality and the marine ecosystem. The project specifications will require the Construction Contractor to adhere to environmental protection measures, including, but not limited to, the following:

- The Contractor shall perform the work in a manner that minimizes environmental pollution and damage as a result of construction operations. The environmental resources within the project boundaries and those affected outside the limits of permanent work shall be protected during the entire duration of the construction period.
- Any construction related debris that may pose an entanglement hazard to marine protected species must be removed from the project site if not actively being used and/or at the conclusion of the construction work.
- The Contractor shall submit a Best Management/Environmental Protection Plan for approval prior to initiation of construction. The plan shall include, but not be limited to:
    1. Protection of Land Resources
    2. Protection of Water Resources
    3. Disposal of Solid Waste
    4. Disposal of Sanitary Waste

5. Disposal of Hazardous Waste
6. Dust Control
7. Noise Control

- The construction contractor shall be required to employ standard BMPs for construction in coastal waters, such as daily inspection of equipment for conditions that could cause spills or leaks; cleaning of equipment prior to operation near the water; proper location of storage, refueling, and servicing sites; and implementation of adequate spill response procedures, stormy weather preparation plans, and the use of silt curtains and other containment devices.
- Designated project personnel will be responsible for daily inspections and maintenance of all project BMPs. Inspections and observations will be noted upon Daily Production Reports and, combined with Water Quality Monitoring Reports, will be submitted to the contracting officer daily.
- No contamination (trash or debris disposal, alien species introductions, etc.) of marine (reef flats, lagoons, open oceans, etc.) environments adjacent to the project site shall result from project related activities.
- The Contractor shall confine all construction activities to areas defined by the drawings and specifications. No construction materials shall be stockpiled in the marine environment outside of the immediate area of construction.
- The Contractor shall keep construction activities under surveillance, management and control to avoid pollution of surface or marine waters. Construction related turbidity at the project site shall be controlled so as to meet water quality standards. All water areas affected by construction activities shall be monitored by the Contractor. If monitoring indicates that the turbidity standards are being exceeded due to construction activities, the Contractor shall suspend the operations causing excessive turbidity levels until the condition is corrected. Effective silt containment devices shall be deployed where practicable to isolate the construction activity, and to avoid degradation of marine water quality and impacts to the marine ecosystem. In-water construction shall be curtailed during sea conditions that are sufficiently adverse to render the silt containment devices ineffective.
- Underlayer fill shall be protected from erosion with armor units as soon after placement as practicable.
- Waste materials and waste waters directly derived from construction activities shall not be allowed to leak, leach or otherwise enter marine waters.
- The presence of heavy equipment on the shoreline creates a potential for pollutants, such as fuel and petroleum products, to enter the water. To prevent such discharges from occurring, heavy equipment will be visually inspected at the beginning and end of each work day to ensure early detection of potential leaks or line breaks. Equipment will be kept clean to ensure that grease or dirt does not enter the water. Fuel will be delivered to the site at sufficiently frequent intervals such that the volume of fuel stored on site is minimal. Spill kits will be kept at the site and workers will be trained on spill response.
- Fueling of project related vehicles and equipment should take place away from the water. A contingency plan to control the accidental spills of petroleum products at the construction site should be developed. Absorbent pads, containment booms and skimmers will be stored on site to facilitate the cleanup of petroleum spills.
- In the event of a spill, the following actions shall be taken:

1. STOP FUELING / OILING IMMEDIATELY!
2. Reduce the amount of the spill by shutting down the equipment, shutting off the valve, shutting off the pump, uprighting the container, etc. Place a pan or bucket under the leak to catch as much of the spill as possible.
3. Confine fuel to containment areas as much as possible.
4. Notify the Company Spill Response Safety Officer by radio or telephone. He will take over coordination of operations and further notifications. Whether assistance is required or not, all supervisors and personnel shall follow these notification steps.
5. If the spill is too large to handle with on-site resources, then an emergency spill clean-up contractor will be notified and mobilized.
6. Notify the Contracting Officer immediately.
7. The spill clean-up contractor will take over containment, clean-up, and disposal of the spill and any contaminated material in accordance with their established procedures. The contractor will provide whatever aid the spill clean-up contractor requires.

- Any spills or other contaminations shall be immediately reported to the DOH Clean Water Branch (808-586-4309).
- The project shall be completed in accordance with all applicable State and County health and safety regulations.
- All construction material shall be free of contaminants of any kind including: excessive silt, sludge, anoxic or decaying organic matter, turbidity, temperature or abnormal water chemistry, clay, dirt, organic material, oil, floating debris, grease or foam or any other pollutant that would produce an undesirable condition to the beach or water quality.
- Best management practices shall be utilized to minimize adverse effects to air quality and noise levels, including the use of emission control devices and noise attenuating devices.
- The contractor, at his own expense, shall keep the project area and surrounding area free from dust nuisance. A dust control program shall be implemented, and wind-blown sand and dust shall be prevented from blowing offsite by watering when necessary. The work shall be in conformance with applicable federal and local laws and regulations regarding air pollution control.
- Public safety best practices shall be implemented, possibly including posted signs, areas cordoned off, and on-site safety personnel.
- Areas of operation upon the shoreline will be clearly marked with fencing, barricades, or other approved devices, to protect the public from the hazards of construction. All work areas will have posted signs advising the public of current construction activities and related hazard warnings.
- Public access along the shoreline during construction shall be maintained so far as practicable and within the limitations necessary to ensure safety.
- The Contractor shall review all best management practices with the project applicant/representative prior to the commencement of beach nourishment activities.
- Work will not be performed until a preconstruction survey is conducted, where necessary, to identify structures, significant environmental features, etc. This survey will determine baseline conditions to which the area will be returned, following the completion of construction. Resources landward of construction areas will be protected from construction activities as necessary.

- The Project Staging Area will be used as the primary point of collection of all waste derived from project construction. Rubbish and construction debris will be collected and confined to waste bins. The containers will be serviced as needed to prevent build-up of large amounts of waste stored on-site.
- Portable chemical toilets will be located on-site and will be serviced weekly, at a minimum.
- All storage containers will be free of leaks to prevent solid/sanitary waste from entering the environment. If leaks are detected at any time, repairs will be made immediately or the deficient container will be replaced.
- No wash down of project equipment, or runoff from such activities, will be permitted on this project.
- Hazardous waste will not be generated during the performance of the contract. Typical petroleum products used during the normal course of construction activities may potentially be sources of hazardous waste. Only the minimum amounts required to perform the work activities will be stored on-site.
- The contractor shall coordinate his haul route, staging area, and all associated requirements, such as land use permit, with the contracting officer and the affected landowners.
- The contractor shall be responsible for the clearing and removal of all silt and debris generated by his construction work and deposited and accumulated on roadways and other areas.
- All existing utilities, concrete walkways, steps and walls, whether or not shown on the drawings, except those designated to be removed, shall be protected from damage at all times during construction and grading work. Any damages to them shall be repaired by the contractor at his expense.
- The contractor shall verify dimensions, locations, elevations, etc., that are indicated for verification and inform the contracting officer in writing of any differences prior to installation of new facilities.
- The contractor shall tone the area to be excavated to ascertain the location of uncharted utilities. The contractor shall be responsible and shall pay for all damages to existing utilities. The contractor shall also contact the necessary utility companies to properly locate the underground utilities and cables that lie in and adjacent to the roadway.
- Work shall be done between 7:00 AM and 5:00 PM HST. No work shall be done on Saturdays, Sundays, holidays, or after normal work hours at any time, without special arrangement and prior approval by the contracting officer. Project work shall be in conformance with applicable federal and local laws and regulations regarding community noise control.
- No blasting will be allowed on this project.
- Waste material will be disposed of at an approved off-site disposal area. The contractor shall be responsible for locating the disposal area.
- The contractor shall take extreme care in performing work near existing concrete electrical/communication ducts. Appropriate protection shall be implemented as required to prevent damage to those lines.

- If the contractor uncovers any cultural remains, such as artifacts or burials, during excavation work, the contractor shall stop work in the area of the find and notify the contracting officer.
- No contractor shall perform any demolition, grubbing, stockpiling, and grading operation so as to cause falling rocks, soil, or debris in any form to fall, slide, or flow onto adjoining properties, streets, or natural watercourses. Should such violation occur, the contractor may be cited and the contractor shall immediately make all remedial actions necessary.
- The contractor shall provide for access to and from all existing driveways and walkways at all times.

# 9. DETERMINATION

## 9.1 Determination Criteria

Chapter 343, Hawaii Revised Statutes (HRS), and Hawaii Administrative rules (HAR) §11-200, establish certain categories of action that require the agency processing an applicant's request for approval to prepare an environmental assessment. HAR §11-200-11.2 established procedures for determining if an environmental assessment (EA) is sufficient or if an environmental impact statement (EIS) should be prepared for actions that may have a significant effect on the environment. HAR §11-200-12 lists the following criteria to be used in making such a determination.

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

Groin improvement will contribute to the stability of Waikiki Beach, a very valuable natural resource. Failure of the existing groin would destabilize the 1,730-foot-long beach section to the east, with a likely significant loss of sand from this area and resultant beach recession. This sand would be lost to the west and offshore, with the offshore loss possibly changing the bathymetry (water depth) and covering presently exposed hard fossil limestone reef flat bottom. The proposed project would replace the existing groin with a stable, engineered groin, reducing the likelihood of failure and beach loss.

Implementation of the project does not involve construction on or excavation of land that might contain physical historic or archaeological remains. The work on land will take place in an area which has already been substantially altered over more than a century, and is entirely makai of the shoreline where the existence of any cultural artifacts or remains is very unlikely. The proposed project is unlikely to have any significant adverse effect on known practices customarily and traditionally exercised for subsistence, cultural and religious purposes.

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

The proposed project would reduce the risk of destabilizing Waikiki Beach by replacing the existing deteriorated groin with a stable, engineered groin. This would reduce the risk of groin failure and subsequent destabilization of the heavily utilized recreational beach, which would significantly impact recreational activities of the environment in the project area. No adverse long term impacts to the environment are anticipated to result from this project. There may be temporary short-term impacts during construction; however, these are not anticipated to be significant, and will be mitigated to the maximum extent practicable by the use of BMPs and monitoring procedures.

3. *Conflicts with the State's long-term environmental policies or goals and guidelines as expressed in Chapter 343, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders.*

The proposed project is consistent with Hawaii's State Environmental Policy as established in Chapter 343(4)(A), HRS, to establish, preserve, and maintain recreation areas, including the shoreline, for public recreational use.

4. *Substantially affects the economic welfare, social welfare, and cultural practices of the community or State.*

The economic value of Waikiki Beach to Hawaii's visitor industry and the economic success of Waikiki as a visitor destination is extremely significant. The estimated socio-economic loss to the State would be quite high if the Royal Hawaiian Groin failed and Waikiki Beach eroded away – a $2 billion loss in overall visitor expenditures, a $150 million loss in tax revenue, and a job loss of 6,350 people. The proposed project will help maintain this very valuable socio-economic resource.

5. *Substantially affects public health.*

The proposed project will have some impact on air, noise and water quality during construction; however, these will be mitigated to the maximum extent practicable by BMPs and monitoring procedures. The project will not result in any post-construction or long-term effects on public health.

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

The project will not alter the existing land use pattern in and around the project site. The beach is likely to continue to attract beach users; however, the number of users in not likely to increase because of the project. The proposed project has little or no potential to affect public infrastructure and services. Once completed it will require no water, power, sanitary wastewater collection, or additional emergency services.

7. *Involves a substantial degradation of environmental quality.*

Other than temporary, short-term environmental impacts during construction, and which are generally not considered significant, the proposed project would not result in impacts which can be expected to degrade the environmental quality in the project area. In fact, a similar project in Hawaii has produced a very significant increase in marine biota density and diversity attributable to the stable habitat provided by rock groins.

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

The proposed project involves replacing the existing groin with a stable, engineered groin. It does not alter the beach position. The proposed project offers the availability for beach construction to the west; however, it does not require or commit to future larger actions.

9. *Substantially affects a rare, threatened, or endangered species, or its habitat.*

The nearshore area off Waikiki is frequented by the threatened green sea turtle, which feeds on the algae covered hard fossil limestone bottom areas. Hawaiian monk seals have been infrequently seen in Waikiki. Marine biota surveys identified algae growing to the west of the existing groin. The project will temporarily remove a small portion of this turtle food source; however, it is anticipated that algae will quickly become established on the proposed groin. Turtle protection procedures as recommended by the National Marine Fisheries Service will be

in place during construction. There will be no long term impact to rare, threatened, or endangered species.

*10. Detrimentally affects air or water quality or ambient noise levels.*

There will be some temporary, short-term impacts to air and water quality, and noise levels, during construction. However, these impacts will be limited to the construction period and will not be significant. BMP's, water turbidity controls, and a water quality monitoring program will be in effect to help minimize the construction impacts. The contractor will be required to submit an Environmental Protection Plan for approval prior to the start of construction, which will include provisions for reducing air, water, and noise impacts. Once construction is complete and the sand is placed on the beach there would be no activity or mechanism for further air, water or noise impacts.

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

The proposed project will replace the existing groin, thus helping to provide a beneficial impact by maintaining the space between the water and the backshore infrastructure. This buffer dissipates wave energy, decreasing wave runup and flooding of the backshore area, and thus reducing susceptibility to natural ocean hazards. The proposed project will not change the shoreline elevation, and will not change the existing tsunami flood hazard. The beach is subject to long-term chronic erosion, and this is expected to continue.

*12. Substantially affects scenic vista and view planes identified in county or state plans or studies.*

The proposed project is relevant to objectives of the Oahu General Plan, including protecting and improving the natural environment, restoring natural resources, retaining scenic resources, and enhancing scenic views. The groin improvement will be larger and more visible than the existing structure; however, the new groin head will be lower in elevation than the beach crest and backshore ground, and will not significantly alter the Waikiki view plane. Coastal processes will remain unchanged over the long term.

*13. Requires substantial energy consumption.*

Other than energy expended during construction operations, the project would require no additional energy consumption.

## 9.2 Determination

In accordance with the potential impacts outlined in Section 4 of the Final Environmental Assessment, the provisions of Chapter 343 Hawaii Revised Statutes (HRS), and Hawaii Administrative Rules (HAR) §11-200 significance criteria discussed above, the Approving Agency, the Department of Land and Natural Resources, State of Hawaii, is anticipating to make a Finding Of No Significant Impact (FONSI).

# 10. CONSULTATION

## 10.1 Parties Consulted

An EA scoping meeting was held on April 2, 2015. The names of individuals and organizations invited to attend the scoping meeting are summarized below, and those who attended or responded by letter are indicated by asterisks.

**EA Scoping Meeting April 2, 2015**

Federal

U.S. Army Corps of Engineers, Honolulu District, Regulatory Branch *
U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office
NOAA, National Marine Fisheries Service, Pacific Islands Regional Office
U.S. Environmental Protection Agency, Region IX, Pacific Islands Contact Office

State

Office of Environmental Quality Control
Department of Land and Natural Resources
- Aquatic Resources Division *
- Historic Preservation Division *
- Office of Conservation and Coastal Lands *
- Engineering Division
- Division of Boating and Ocean Recreation *
Department of Health, Clean Water Branch *
DBEDT, Office of Planning, Coastal Zone Management Program *
Department of Transportation, Harbors Division *
Office of Hawaiian Affairs *
Hawaii Tourism Authority
Rep. Tom Brower, House District 22
Sen. Brickwood Galuteria, Senate District 12

City & County of Honolulu

Department of Planning and Permitting *
Department of Design and Construction
Department of Emergency Services, Ocean Safety & Lifeguard Services Division
Waikiki Neighborhood Board No. 9
Councilman Trevor Ozawa

Other

Waikiki Improvement Association *
Sheraton Waikiki Hotel *
Royal Hawaiian Hotel *
Outrigger Waikiki Hotel
Moana Surfrider Hotel *
Kamehameha Schools
Kyo-ya Hotels & Resorts *

Brunetti, Vince. Manager of the food concession in the HPD Waikiki Substation building.
Bush, Ted. Owner, Waikiki Beach Services.
Carvalho, David. Manager, Hawaiian Oceans beach concession.
Chang, Hubert. Owner, Hawaiian Oceans beach concession.
Couch, Tom. Staff, Hawaiian Oceans beach concession.
Downing, George. Save Our Surf. *
Coleman, Stuart. Surfrider Foundation *
Bergstrom, Rafael. Surfrider Foundation *
Howe, Jim. Operations Chief, Ocean Safety Division, Honolulu, Emergency Services.
Robello, Didi. Owner, Aloha Beach Services.
Rutledge, Aaron. Owner, Star Beachboys.

## 10.2 EA Preparers

The Royal Hawaiian Groin Improvement Project DEA was prepared by Sea Engineering, Inc. The respective contributions of individuals are as follows:

| | |
|---|---|
| Scott P. Sullivan<br>M.S. Ocean Engineering | Principal-in-Charge |
| David A. Smith<br>Ph.D. Ocean Engineering<br>P.E. Civil Engineering | Contributing Author |

Technical consultants included the firm of AECOS, Inc. (marine biology and water quality) and John Clark (water and beach recreation).

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# Appendix A

*Water Quality and Biological Surveys at the Royal Hawaiian Groin, Waikiki, Honolulu, Oahu*

AECOS, Inc. (2014)

*AECOS* No. 1394

# Water quality and biological surveys atthe Royal Hawaiian Groin, Waikiki, Honolulu, Oʻahu

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October 10, 2014

# Water quality and biologicalsurveys at the Royal Hawaiian Groin, Waikīkī, Honolulu, Oʻahu

October10, 2014 | ***Draft*** | *AECOS* No. 1394

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# Introduction

The Hawai'i Department of Land and Natural Resources (DLNR) proposes to replace the existing groin in front of the Royal Hawaiian Hotel in Waikīkī. The groin is located along the south shore of O'ahu, Hawai'i (see Figure 1). *AECOS*, Inc. was contracted to conduct environmental surveys to support permitting for the project ("Project")[1]. Our surveys wereconducted on three days in September 2014 and includedboth water quality and biologicalsurveyson the groin and surrounding area.This report details findings of those surveys.

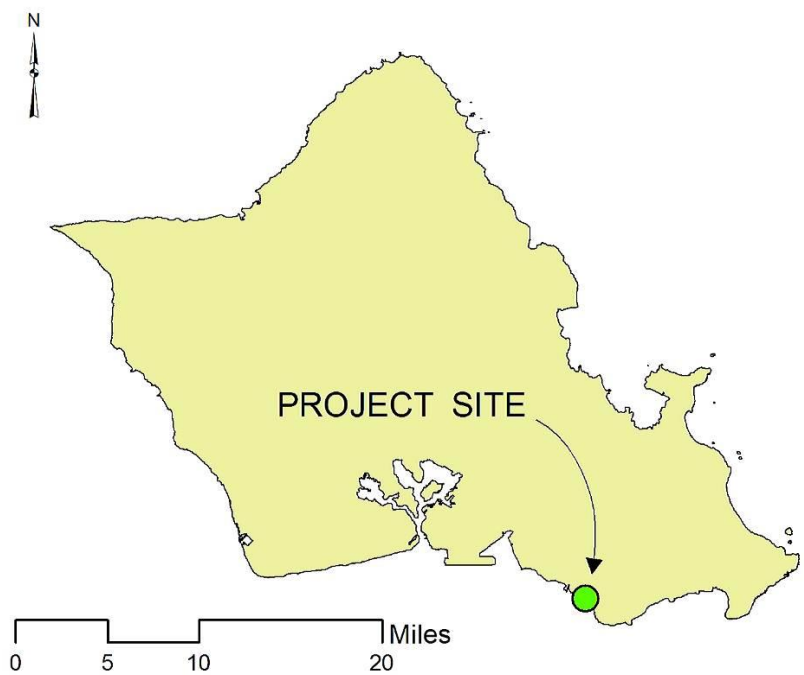


Figure 1. General location of project area on the island of O'ahu.

## Project Description

The existing Royal Hawaiian groin is proposed to be removed and a new groin to be built within an area approximately 20 m (60 ft) to either side of the existing groin (see Figure 2). The proposed new groin will be built on the west side of the existing groin, and then the existing groin will be removed. No sand nourishment is being proposed (S. Sullivan, pers. comm.).

[1] Report prepared for Sea Engineering, Inc. for environmental entitlements. This report will become part of the public record for the Project.

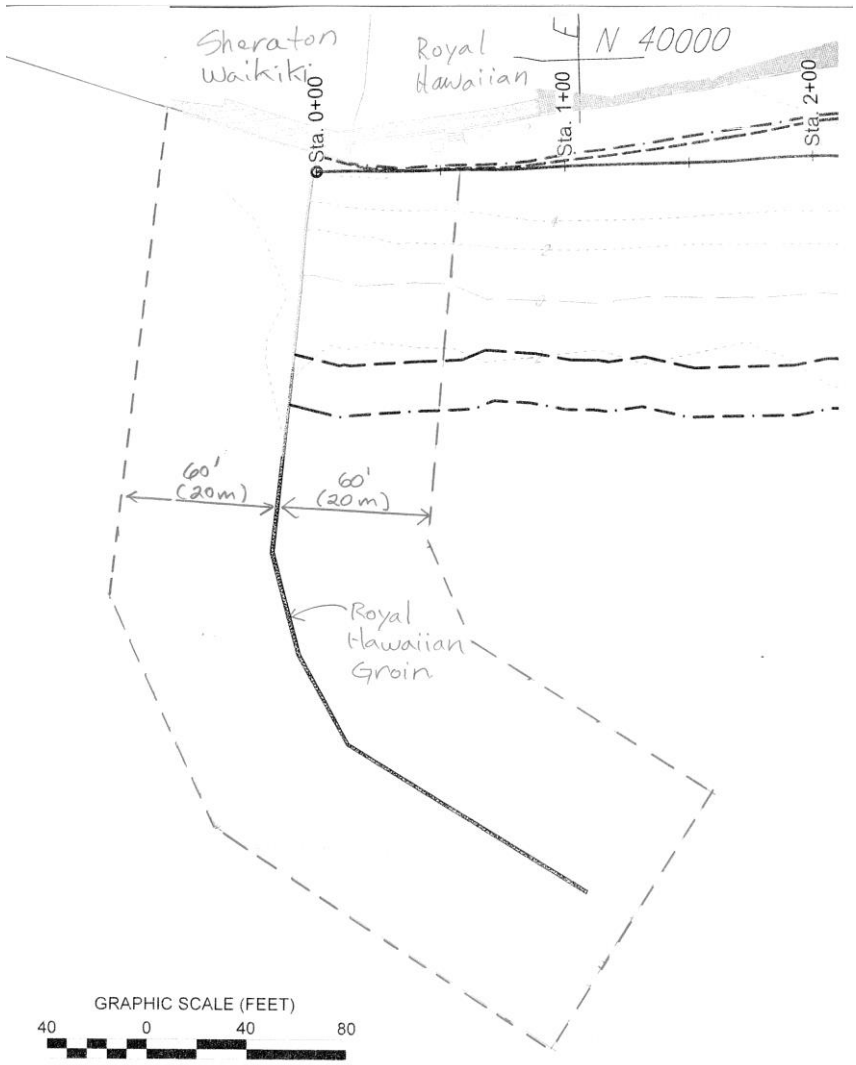


Figure 2. Proposed project footprint (sketch from Sea Engineering, Inc).

## Site Description / Previous Studies

The Project site is located along the shoreline adjacent to the Royal Hawaiian Hotel at 2259 Kalakaua Ave. The entire Waikīkī Beach shoreline from Kahanamoku Beach on the west to Sans Souci Beach on the southeast is highly altered by seawalls, groins, and jetties, all placed in an effort to stabilize the shoreline and beach. Over 382,300 $m^3$ (500,000 $yd^3$) of sand have been placed on the beach at Waikīkī since 1928 (Fletcher and Miller, 2003).

The fringing reef off Waikīkī is an eroded limestone platform influenced by sand suspension and scour caused by impinging waves. Sand-filled pockets are abundant and support diverse assemblages of sediment-dwelling invertebrates (Bailey-Brock and Krause, 2008); exposed limestone outcrops support mostly turf-forming algae (*AECOS*, 1979, 2009). Live coral is sparse in the nearshore waters off Waikīkī, accounting for less than one percent of the bottom (OI, 1991; MRC, 2007; *AECOS*, 2007, 2008, 2009, 2010, 2012). Other reef macro-invertebrates, such as sea urchins and sea cucumbers, are conspicuous but relatively uncommon (OI, 1991; MRC, 2007; *AECOS*, 2009, 2012).

The dominant taxa of benthic organisms on the reef platform off Waikīkīare marine fleshy algae (*limu* or seaweed), which cover most exposed reef rock surfaces that are not scoured or buried by shifting sand. The growth form of much of this *limu*is short stature or turf-forming.Although the flora of Waikīkī reefremains relatively diverse, two invasive red algae(Rhodophyta), *Acanthophora spicifera* or spiny seaweed and *Gracilaria salicornia*or gorilla *ogo*, dominate the benthic flora and now cover much of the hard substrata (Smith et al., 2004; Huisman et al., 2007; MRC, 2007; *AECOS*, 2007, 2008, 2009, 2012).In addition to these two non-native species, *Dictyota sandvicensis*, *Padina australis*, *Pterocladiella* spp., *Galaxaura* spp, *Asparagopsis taxiformis*, *Trichoglea* spp and *Sargassum obtusifolium* are common on hard surfaces of the reef (MRC, 2007, *AECOS*, 2007, 2008, 2009, 2012). Another invasive species, *Avrainvillea amadelpha*, is present on this reef flat. At least two algal species preferred by green sea turtle (NMFS-USFWS, 1998) are present: the invasive *A. spicifera* is abundant and *Ulva fasciata*is common.

Surveys on the reef off Waikīkī have observed common macroinvertebrates including various echinoderms such as *Holothuria atra*, *H. nobilis*, *Echinothrix diadema*, *Tripneustus gratilla*, *Echinometra mathaei*, *Echinostrephus aciculatus*, and miscellaneous sponges (OI, 1991); *E. mathaei*, *E. aciculatus*, and *H. atra* (MRC, 2007); and an unidentified stomatopod, *E. diadema*, *E. mathaei*, *T. gratilla*, *Actinopyga mauritiana*, *H. atra*, and *H. cinerascens* (*AECOS*, 2007, 2008, 2012). The boring urchin, *E. mathaei*, and the black sea cucumber or*loli*,*H. atra,* are the most conspicuous animals on the Waikīkī reef(*AECOS*, 2010, 2012), but are present in relatively low numbers.

Corals are rare on the reef platform offshore of Waikīkī (Chave, et al., 1973;*AECOS*, 1987, 1995, 2009, 2010, 2012; OI, 1991). Colonies are sparse and account for less than one percent of the nearshore bottom (*AECOS*, 2007, 2008, 2012; MRC, 2007). Off Gray's Beach,nearby to the west, coral coveris <1% and colonies are small, with an average coral colony size of 7 cm (2.8 in) in diameter. In a recent survey (*AECOS*, 2010) for the Waikīkī Beachmaintenance project, no coral growth was observed on the limestone outcrops directly off the beach area

proposed for sand replenishment. No large, (>50 cm or 20 in diameter) mound-forming corals were observed anywhere in the survey area (Fig. 3). Observed coral colonies were limited, and included medium-sized *Pocillopora meandrina*(cauliflower coral) and *Porites lobata*(lobe coral) colonies on the shallow reef.

Figure 3. Locations of water quality stations sampled on September 11, 12 and 18, 2014.

Benthic infauna are aquatic animals that live within the substratum (sand in this case) rather than on its surface. Infauna have been documented from sand deposits in the Halekūlani Channel (Bailey-Brock and Krause, 2008). Most of the diverse species observed are less than 1 mm (0.04 in) in size (meiofauna) and have relatively low abundances. Worms are most abundant, making up 85% of the total fauna, followed by arthropods, echinoderms, and mollusks.

The fish assemblage in the nearshore waters off Waikīkī is largely structured by the minimal topographic relief, with fishes being generally uncommon. Recent

surveys off Waikīkī (MRC, 2007; *AECOS*, 2009, 2010, 2012) found the most common species to be wrasses (*Thalassoma duperrey*, *T. trilobatum*, and *Stethojulis balteata*), *manini* (*Acanthurus triostegus*), and reef triggerfish (*Rhinecanthus rectangulus*). These surveys offWaikīkīidentified 58 species. The underwater visual survey technique, typically used for these surveys, does not accurately census seasonal, cryptic, nocturnal, and burrow-inhabiting fishes, although they could comprise half or more of the total fish biomass of an area of reef (Willis, 2001).

# Methods

## Water Quality

Field measurements of temperature, salinity, pH and dissolved oxygen were taken and water samples for analysis of salinity (by salinometer), turbidity, total suspended solids (TSS), ammonia, nitrate+nitrite, total nitrogen, total phosphorus and chlorophyll were collected from three stations on September11, 12, and 18, 2014. Samples were collected from just below the surface of the water. Analytical methods and instruments for all parameters are listed in Table 1. Water samples were stored in ice for transport to the *AECOS*, Inc laboratory (Log Nos. 30327, 30331, and 30345).

The location of sampling stations is depicted in Fig.3 (above). Station 1 was located approximately 5 m (20 m) west of the "elbow" of the groin.. Station 2 was located on the east side of the groin, approximately 5 ft (20 m) from the elbow. Station 3 was located approximately 3 m (10 ft) south of the terminus of the outer groin.

## Marine Survey

On September 11 and 18, 2014, *AECOS* biologists conducted a rapid assessment and quantitative survey of the marine community composition and coral size class distribution in the Project vicinity. The survey area included the existing groin and seafloor 20 m (60 ft) out from the groin structure (see Fig. 2). Two survey areas were established: 1) "inner groin", extending seaward from the seawall at the shore approximately 50 m (164 ft) to where the groin bends;and 2) "outer groin", covering the portion of thegroin curving to the southeast, another approximately 50 m (164 ft). This submerged outer groin comprises some 25 broken concrete blocks of various sizes, each of which was examined.

Table 1. Analytical methods and instruments used
for water quality analyses for the Royal Hawaiian groin project.

| Analysis | Method | Reference | Instrument† |
|---|---|---|---|
| Temperature | SM 2550 B | SM (1998) | YSI Model PRO 2030 DO meter thermistor |
| Salinity(field) | SM 2510-B | SM (1998) | YSI Model PRO 2030 DO meter - conductivity calc. |
| pH | SM 4500 H+ | SM (1998) | pHep HANNA meter |
| Dissolved Oxygen | SM 4500-O G | SM (1998) | YSI Model PRO 2030 DO meter |
| Salinity (salinometer) | SM 2510-B | SM (1998) | AGE Model 2100 salinometer |
| Turbidity | EPA 180.1 Rev 2.0 | EPA (1993) | HACH 2100N Turbidimeter |
| Total Suspended Solids | Method 2540 D | SM (1998) | Mettler Toledo H31 analytical balance |
| Ammonia | SM 4500-$NH_3$ | SM (1998) | Seal AA3 Autoanayzer, colorimetric |
| Nitrate + Nitrite | EPA 353.2 | EPA (1993) | Seal AA3 Autoanayzer, colorimetric |
| Total Nitrogen | NCASI TN-TP W10900 | NCASI (2011) | Seal AA3 Autoanayzer, UV |
| Total Phosphorus | EPA 365.3 | EPA (1993) | Seal AA3 Autoanayzer, UV |
| Chlorophyll*a* | SM 10200-H | SM (1998) | Turner Fluorometer |

† typical instruments listed, others may have been substituted.

A total of eight, 20-m long transects were used to survey the marine biota: six transects in the inner groin area and twoin the outer groin area (see Figure 4). Six of the transects sampled the seafloor extending away from the groin; two transects were oriented along the groin off in the inner groin area. The latter two transects (along with examination of the various blocks in the outer groin area) were conducted on September 11 and began at 10:30 AM, approximately 150 minutes before a predicted +0.33 ft low tide (relative to MLLW; Honolulu, HI. Station ID 1612340; NOAA, 2014). Thetransect surveys covering the sea-

Figure 4. Approximate locations of September 2014
Royal Hawaiian groin and seafloor transect locations.

floor surrounding the groin was conducted on September 18 and began at 9:00 AM, approximately 192 minutes after a +0.43 ft low tide. Underwater visibility on both datesranged from 1 to 3 ft. Maximum water depth recorded was 9 ft (3 m). Marine biota were identified in the field and verified with various resource texts: algae (Huisman et al., 2007; Abbott, 1999; Abbott and Huisman, 2004), macroinvertebrates (Hoover, 1999), and fishes (Hoover, 2008), and a species list is presented as Appendix A.

Groinsurveys—One 20-m transect was placedparallel to the groin on each side. These transects were positioned midway between the base of the boulders and the waterline. On each transect, a line-point intercept protocol was used. At 1-m intervals, the bottom at each point was identified and assigned to one of the following categories: live coral, crustose coralline alga (CCA), macroalga, turf alga, macroinvertebrate, sand, rubble, or bare rock (limestone, basalt, or man-

made structure). Macroalgae (*Acanthophora spicifera*, *Avrainvillea amadelpha*, *Amansia glomerata*, *Gracilaria coronopifolia*, *Gracilaria salicornia*, *Gelidium* sp., *Hypnea* sp., *Pterocladiella* sp., *Sargassum obtusifolium*, *S. echinocarpum*, *S. polyphyllum*, and *Ulva* sp.)and all corals observed were identified to a field identifiable taxon. Benthic percent cover was calculated for each transect by dividing the total number of points for a category by the total number of points sampled.

The 25 broken concrete blocks of the outer groin area were surveyed for community composition and coral abundance. On three sides of each block, the mid-point was estimated and the bottom at each point was identified and assigned, as described above for the inner groin.

Coral size class distribution data were collected for all coral colonies observed on the groin. The following parameters were recorded for coral colonies observed: species name, maximum diameter measured to the closest 5 cm, morphology, and health. Coral colonies were recorded as belonging to a size-class of 1 - 5 cm; 6 – 10 cm; 11 - 20 cm; 21 - 40 cm; 41 - 80 cm; 81 - 160 cm; or ≥161 cm.

Seafloor surrounding groin— A total of 6, 20-m transects were laid more or less perpendicular to the groin (at least in the inner groin area) to assess coral and benthic composition on the reef bottom. At intervals of 1 meter on each transect line, the bottom "type" was identified and assigned to one of the categories as described above. Coral size class data were collected for all coral colonies observed within 1 m to either side of a transect line (if 50% of a colony fell within this 40 $m^2$ survey area).

### Protected Species

Biologists recorded observations of any listed (threatened or endangered) marine species encountered during the survey.

## Survey Results

### Water Quality

Results of the three water quality sampling events are summarized in Table 2 (physical parameters) and Table 3 (nutrients and chlorophyll α). The results for physical water quality parameters were constant comparing the three sampling events. Mean turbidity was lowest at Sta. Terminus compared with Stas. West

and East, but mean TSS was highest at Sta. Terminus. The results for nutrients and chlorophyll α (Table 3) showed little variation between the three sampling events and there were no discernible differences between stations.

Table 2. Summary of means for physical water quality results near the Royal Hawaiian groin

| Station<br>Statistic | Temp.<br>(°C) | Salinity<br>(PSU) | DO<br>(mg/L) | DO Sat.<br>(%) | pH | Turbidity†<br>(NTU) | TSS†<br>(mg/L) |
|---|---|---|---|---|---|---|---|
| **West** | | | | | | | |
| mean | **27.8** | **35.4** | **6.02** | **94** | **7.96** | **4.00** | **8.1** |
| range | 27.7-27.8 | 34.9-36.3 | 6.00-6.04 | 93-94 | 7.91-8.05 | 2.81-6.02 | 6.5-9.6 |
| *n* | *3* | *3* | *3* | *3* | *3* | *3* | *3* |
| **East** | | | | | | | |
| mean | **27.9** | **35.6** | **6.03** | **94** | **7.99** | **3.73** | **8.2** |
| range | 27.8-28.0 | 35.0-36.5 | 6.00-6.05 | 93-95 | 7.94-8.02 | 2.11-5.06 | 7.0-9.6 |
| *n* | *3* | *3* | *3* | *3* | *3* | *3* | *3* |
| **Terminus** | | | | | | | |
| mean | **28.2** | **35.6** | **6.01** | **94** | **7.96** | **2.38** | **11** |
| range | 28.1-28.4 | 35.0-36.72 | 5.90-6.08 | 13-94 | 7.90-8.02 | 1.71-3.86 | 10-12 |
| *n* | *3* | *3* | *3* | *3* | *3* | *3* | *3* |

† - geometric mean; all others are arithmetic.

## General Observations

Groin—The intertidal zone of the existing inner groin is covered with small numbers of nerite snail (*Nerita picea*), thin shelled rock crab (*Grapsus tenuicrustatus*), and macroalgae (*Ulva fasciata*, *Asteronema breviarticulatum*, *Hydrolithon*spp., *Acanthophora spicifera* and *Gracilaria salicornia*; Figure5). Common invertebrates on the inner groin include urchins (*Echinometra mathaei* and *Diadema paucispinum*) and sea cucumbers (*Holothuria cinerascens*). One coralcolony (*Pocillopora meandrina*) in the 21-40 cm sizeclass was observed on the east side of the inner groin, approximately 10 ft (3 m) from the shoreline. Sand bags extend out from the seawall on the west side of the groin (Fig. 5). Algae (*A. spicifera*, *Ralfsia* sp. and cyanobacteria) coat the sandbags.

Table 3. Summary of geometric means for nutrients and chlorophyll α water quality results near the Royal Hawaiian groin.

| Station<br>Statistic | Ammonia<br>(µgN/L) | Nitrate+<br>Nitrite<br>(µgN/L) | Total N<br>(µgN/L) | Total P.<br>(µgP/L) | Chl. α<br>(µg/L) |
|---|---|---|---|---|---|
| **West** | | | | | |
| mean | **1** | **2** | **78** | **13** | **0.39** |
| range | <1-2 | 2-2 | 74-81 | 11-14 | 0.38-0.40 |
| *n* | *3* | *3* | *3* | *3* | *3* |
| **East** | | | | | |
| mean | **<1** | **2** | **84** | **12** | **0.35** |
| range | <1 | 2-2 | 76-97 | 12-12 | 0.24-0.47 |
| *n* | *3* | *3* | *3* | *3* | *3* |
| **Terminus** | | | | | |
| mean | **<1** | **2** | **74** | **11** | **0.40** |
| range | <1 | 1-2 | 69-77 | 10-12 | 0.31-0.45 |
| *n* | *3* | *3* | *3* | *3* | *3* |

The outer groin concrete blocks are covered with turf and macroalgae algae and sand. Algae observed on the outer groin included: *Ulva fasciata*, *Laurencia nidifica*, *Graciliariasalicornia*, and *A. spicifera*. Macroinvertebrates are uncommon, but include hoof shell (*Hipponix conicus*), variable worm snail (*Serpulorbis variabilis*), sea urchins (*Echinometra mathaei*), and sea cucumbers (*Holothuria atra* and *H. cinerascens*).No coral heads were observed in the outer groin area.

Seafloor beyond groin— The seafloor surrounding the groin is a relatively flat bottom of sand with patches of limestone and rubble (Figure 6). A large area of sand lies to the east of the groin, fronting a stretch of Waikīkī beach. In this area, beach-goers and swimmers are common. The reef platform to the south and west of the groin is coated with turf and macroalgae, which virtually covers all exposed hard surfaces that are not scoured or buried by areas of shifting sand. Algal species observed in this area include:*G. salicornia*, *A. spicifera*, *Dictyosphaeria reticulata*, *Bryopsis* sp., *Halimeda discoidea*, *Neomeris annulata*, *Ulva fasciata*,*Dictyota sandvicensis*, *Padina* sp.Urchins (*Echinometra mathaei* and *Diadema paucispinum*) and sea cucumbers (*Holothuria cinerascens*, *H. atra*, *H. whitmaei*, and *Actinopyga mauritiana*) are found on the reef platform.

Figure 5. The inner groin is coated in macroalgae and crustose coralline algae (CCA; photo at left). Several stacked sand bags, with macroalgal and cyanobacteria; growth,liealong the base of the west side of the groin (photo at right).

Fish resources— A total of 17 species of fishes were identified in the groin and surrounding area surveys. Fishes observed included: surgeonfishes (*Acanthurus triostegus*, *Acanthurus blochii*, juvenile *Naso unicornis*), flagtail (*āholehole* or *Kuhlia xenura*), snappers (*Lutjanus kasmira* and *L. fulvus*), schools of needlefish (*Platybelone argalus*), and goatfishes (*Parupeneus multifasciatus* and *P. porphyreus*).

## Benthic Community Composition

Groin—Data collected from two, 20-m transects in the inner groin area and 25 concrete blocks in the outer groin area were used to calculate benthic community composition (Figure 7). The dominant benthic type on the inner groin is turf algae (43% mean cover) and macroalgae (33% mean cover). Macroinvertebrate mean cover is 19% and CCA is minimal, with 5% cover No corals were recorded at the point intercepts, but one 21 -40 cm size class *P. meandrina*coral was observed outside of the transect area, on the east side of

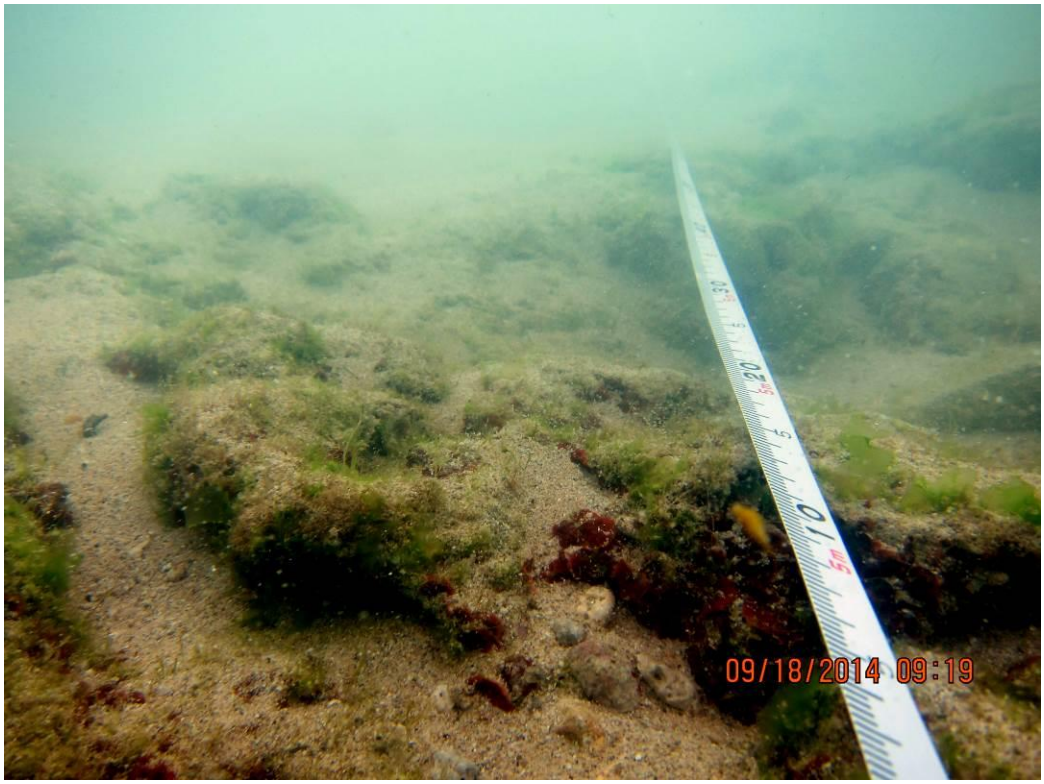


Figure 6.The east side in the inner groin area is a relatively flat bottom of limestone outcrops and patches of limestone and rubble.

the inner groin. As in the inner groin area, dominant benthic types in the outer groin area are macroalgae (43% mean cover) and turf algae (36% mean cover). Macroinvertebrate mean cover is 11%, CCA cover is minimal at 1%. Coral cover here was zero.

Seafloor surrounding groin—Data obtained from six, 20-m transects on the seafloor surrounding the groin were used to calculate benthic community composition (Figure 8). The dominant benthic type on the seafloor is sand (56% mean cover). Turf and macroalgae mean cover are similar, at 15% and 13%, respectively. Rubble mean cover is 5% and CCA cover is minimal, at 1%. Macroinvertebrate and coral cover are zero.

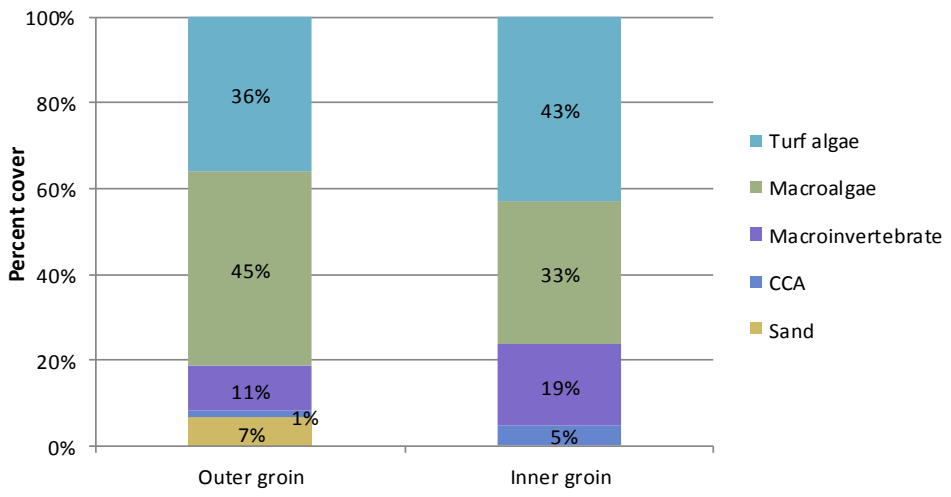


Figure 7. Mean percent benthic cover for groin, as measured using point-intercepts on two (inner groin), 20-m transects and on 25 outer groin concrete blocks.

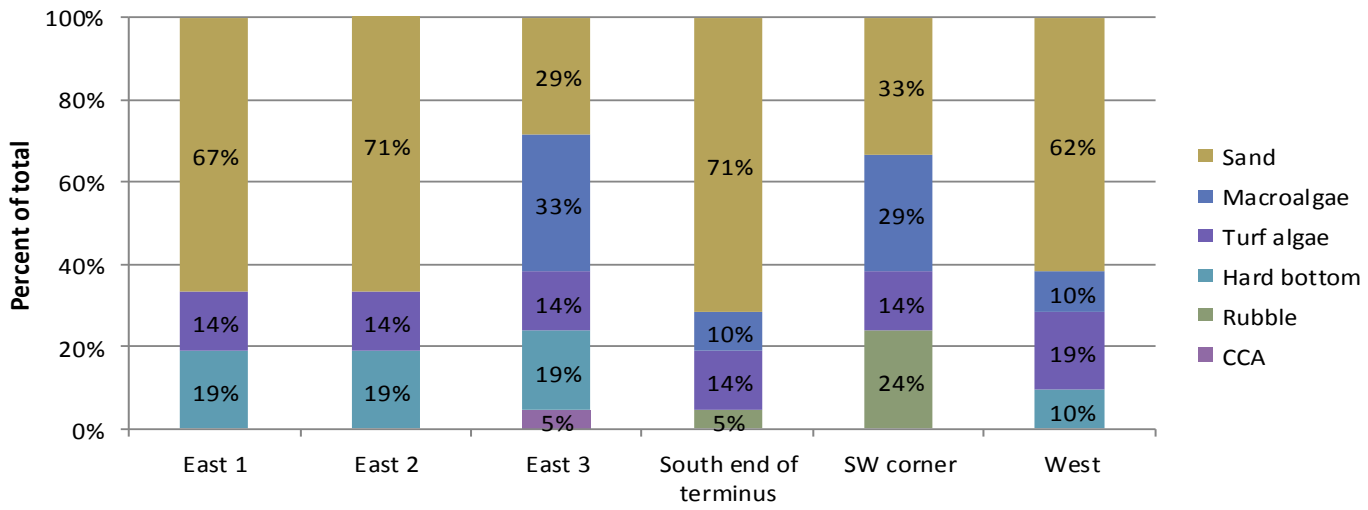


Figure 8. Mean percent benthic cover on reef surrounding groin as measured using point-intercepts onsix, 20-m transects.

# Discussion

## Water Quality

The waters offshore Waikīkī Beach are classified in the Hawai'i Water Quality Standards (HDOH, 2012) 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. Other uses are permitted as long as compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. Class A waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control.

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

Applicable state water quality criteria for the Royal Hawaiian Groin are shown in Table 4. Water quality results from three sampling events met state criteria for temperature, salinity, pH, and DO saturation. The results for turbidity and chlorophyll α exceeded applicable criteria. There are no state criteria for TSS, but this parameter is typically measured for projects that involve construction and/or disturbance of bottom sediments.

Turbidity levels in nearshore coastal waters are typically elevated compared with the state geometric mean criterion due to effects of waves and wind which stir up sediments from a shallow bottom. During groin replacement, it will be necessary to have the project site enclosed within silt/sediment barriers as a Best Management Practice (BMP) to contain particulates.

Water quality results for Sta. West can be compared with results from this same station location in 2007 and 2009 (AECOS, 2007, 2009) as shown in Tables 5 and 6. Since only two samples at each station were collected during the 2009 surveys, means were not calculated and the raw data are presented.

It is noteworthy that both DO saturation and pH were somewhat elevated in 2007 and 2009 as compared with the present survey results. The differences may indicate primary productivity was higher in the 2007 and 2009 as oxygen

is produced by this process and, at the same time, pH is increased by lowering carbon dioxide and bicarbonate in the water.

Table 4. Selected state water quality criteria (dry season) applicable to open coastal marine waters after HAR §11-54-6.3(b) (HDOH, 2012).

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

Other "standards":

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

The comparisons in Table 7 show that inorganic nitrogen moieties (ammonia and nitrate+nitrite) concentrations were quite low during all of these surveys. Total N, Total P and chlorophyll α concentrations, on the other hand, were elevated in the 2007 and 2009 surveys, compared with the present results. In fact, Total N and Total P did not meet state geometric criteria in the 2007 survey and likely not in the 2009 survey, where only two samples were collected; i.e., three samples are required to compute a geometric mean.

Table 5. Comparison physical parameters results at Sta. West withtwo previous surveys.

| Station<br>Statistic | Temp.<br>(°C) | Salinity<br>(PSU) | DO sat.<br>(%) | pH<br>(SU) | Turbidity†<br>(NTU) | TSS†<br>(mg/L) |
|---|---|---|---|---|---|---|
| **Sta. West** | | | | | | |
| mean | **27.8** | **35.4** | **94** | **7.96** | **4.00** | **8.1** |
| range | 27.7-27.8 | 34.9-36.3 | 93-94 | 7.91-8.05 | 2.81-6.02 | 6.5-9.6 |
| *n* | *9* | *9* | *9* | *9* | *9* | *9* |
| **2007** | | | | | | |
| mean | **27.2** | **34.7** | **97** | **8.07** | **5.03** | **16** |
| range | 25.4-29.0 | 33.9-35.3 | 84-114 | 7.80-8.20- | 4.11-7.00 | 10-23 |
| *n* | *6* | *6* | *6* | *6* | *6* | *6* |
| **2009** | | | | | | |
| morning | 26.1 | 35.3 | 111 | 8.14 | 1.38 | 12 |
| afternoon | 27.4 | 34.9 | 99 | 8.28 | 3.92 | 14 |

† - geometric mean; all others are arthrimetic.

Table 6. Comparison of nutrient at chlorophyll α results at Sta. West with two previous surveys.

| Station<br>Statistic | Ammonia<br>(µgN/L) | Nitrate+<br>Nitrite<br>(µgN/L) | Total N<br>(µgN/L) | Total P.<br>(µgP/L) | Chl. α<br>(µg/L) |
|---|---|---|---|---|---|
| **West 2014** | | | | | |
| mean | **<1** | **2** | **79** | **12** | **0.38** |
| range | <1-11 | 1-2 | 69-97 | 10-14 | 0.24-0.47 |
| *n* | *9* | *9* | *9* | *9* | *9* |
| **West 2007** | | | | | |
| mean | **<1** | **3** | **170** | **20** | **0.57** |
| range | <1 | 1-7 | 142-232 | 15-29 | 0.30-1.28 |
| *n* | *6* | *6* | *6* | *6* | *6* |
| **West 2009** | | | | | |
| morning | <1 | 3 | 172 | 18 | 0.51 |
| afternoon | <1 | 4 | 199 | 21 | 0.62 |

Most of the total N is organic and likely represents the breakdown of biotic matter—most likely fragments of algae that dominate the benthos near the groin (See General Observations section of this report). The notably lower total N and total P concentrations in the present survey results could represent a decrease in the benthic algal population near the groin or reduced wave activity generating fewer algal fragments. The lower DO saturation and pH in the present survey results suggest primary productivity in the groin area has decreased compared with previous results.

Water quality in the Royal Hawaiian groin area during the present survey met state criteria for all measured parameters, except for turbidity and chlorophyll α. Particulates, both turbidity and TSS, are often elevated in shallow, nearshore waters due to wind and wave effects stirring up bottom sediment. Comparison of the present water quality survey results with previous surveys show that total N and total P are improved and meet state geometric mean criteria, a situation not pertaining in 2007 and 2008 water quality results.

## Marine Resources

In general, the community structure of the benthos on the Royal Hawaiian groin and on the reef bottom surrounding the groin is dominated by macro and turf algae. Useof the area by large numbers of waders and swimmers influences the biotic community. Areas with little or no vertical relief are affected by constantly shifting sands and tend to have little algal or macro-invertebrate diversity, with no coral colonies present. These hard bottom areas may be regularly covered and uncovered by shifting sands and loose rubble. The richest biotic assemblages occur in the areas where vertical relief of the limestone affords some protection from wave-driven sand particles and longevity of exposure.

## ESA-listed and state protected species

No listed (endangered or threatened; USFWS, 2013) species were encountered in the September 2014 surveys. Listed species (sea turtles, Hawaiian monk seal, and humpback whale) can occur in the general vicinity. State protected species (hermatypic corals) occur at the Project site in very low numbers.

<u>Sea turtles</u>—Of the sea turtles found in the Hawaiian Islands, only the green sea turtle is common in the Project vicinity. The hawksbill sea turtle (*Eretmochelys imbricata*) is rare in the Hawaiian Islands and only known to nest in the southern reaches of the state (NOAA-USFWS, 1998; NOAA-NMFS, 2007). In 1978, the green sea turtle was listed as a threatened species under the

Endangered Species Act (ESA; USFWS, 1978, 2001). Since protection, the green sea turtle has become the most common sea turtle in Hawaiian waters with a steadily growing population (Chaloupka et al., 2008). Threats to the green sea turtle in Hawai'i include: disease and parasites, accidental fishing take, boat collisions, entanglement in marine debris, loss of foraging habitat to development, and ingestion of marine debris (NMFS-USFWS, 1998).Green sea turtle nesting mostly occurs on beaches of the Northwestern Hawaiian Islands, with 90% occurring at French Frigate Shoals (Balazs et al., 1992). None of the Hawaiian sea turtles are known to nest in the Project vicinity.

The green sea turtle diet consists primarily of benthic macroalgae (Arthur and Balazs, 2008), which the shallow reefs of the main Hawaiian Islands provide in abundance. Red macroalgae generally make up 78% of their diet, whereas green macroalgae make up 12%. Turbidity (murky water) does not appear to deter green sea turtles from foraging and resting areas and construction projects in Hawai'i have found sea turtles adaptable and tolerant of construction-related disturbances (Brock, 1998a,b). During our survey, no green sea turtles were observed, although preferred algal food species are found here.

<u>Monk seal</u>— The beaches and coastline of O'ahu are used by the endangered Hawaiian monk seal (*Monachus schauinslandi*) for hauling out and for pupping and nursing.These mammals are known to occur in the waters off Waikīkī. The majority of monk seal sighting information collected in the main Hawaiian Islands is reported by the general public and is highly biased by location and reporting effort. Systematic monk seal count data come from aerial surveys conducted by the Pacific Islands Fisheries Science Center (PIFSC). Aerial surveys of all the main Hawaiian Islands were conducted in 2000-2001 and in 2008 (Baker and Johanos 2004, PIFSC unpublished data). One complete survey of O'ahu was conducted for each of these years. The 2000 survey was conducted from an airplane and the 2001 and 2008 surveys were conducted by helicopter. No Hawaiian monk seals were sighted off Waikīkī during any of the three surveys.

Reports by the general public, which are non-systematic and not representative of overall seal use of main Hawaiian Islands shorelines, have been collected in the main Hawaiian Islands since the early 1980s. In total, seventy-six Hawaiian monk seal sightings have been reported off Waikīkī, east of the Project vicinity between Queen's Beach and Sans Souci Beach,between 2002 to 2011. A sighting is defined as a calendar day during which an individual seal was documented as present at a given location. It should be noted that the majority of monk seal sightings are reported when seals are sighted onshore. No births have been documented for the area.

Currently, only the remote Northwestern Hawaiian Islands are considered critical habitat for this species (50 CFR 226.201). However, the waters surrounding the Main Hawaiian Islands have been proposed as monk seal critical habitat (NOAA-NMFS, 2011). The shoreline and marine environment extending seaward to the 500-m depth contour of the Project area are included in the proposed monk seal critical habitat designation.

Humpback whale— The humpback whale or *koholā* (*Megaptera novaeangliae*) was listed as endangered in 1970 under the ESA. In 1993 it was estimated that there were 6,000 humpback whales in the North Pacific Ocean, and that 4,000 of these regularly came to the Hawaiian Islands. The population is estimated to be growing at between 4 and 7% per year. Today, as many as 10,000 humpback whales may visit Hawaiʻi each year (HIHWNMS, 2014).

The waters of Maunalua Bay to the east of the Royal Hawaiian groin are within the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS). Humpback whales normally occur in Hawaiian waters annually from November to May with the peak between January and March (HIHWNMS, 2014). The Project will not directly affect humpback whales, and sounds generated from groin replacement activities are not anticipated to be substantial enough to cause an acoustic disturbance to protected species in nearshore waters. The effects thresholds currently used by NMFS are marine mammal specific and based on levels of harassment as defined by the Marine Mammal Protection Act (MMPA). For exposure to sounds in water, ≥180 dB and ≥190 dB are the thresholds for Level A harassment (i.e. injury and/or PTS) for cetaceans and pinnipeds, respectively.The thresholds for Level B harassment for all marine mammals in the formof TTS and other behavioral impacts are ≥160 dB for impulsive noises and ≥120 dB for continuous noises (NOAA, 2013).

Coral— Coral species are protected under Hawaiʻi State law, which prohibits "breaking or damaging, with any implement, any stony coral from the waters of Hawaiʻi, including any reef or mushroom coral" (HAR §13-95-70, DLNR, 2010). It is also unlawful to take, break or damage with any implement, any rock or coral to which marine life of any type is visibly attached (HAR §13-95-71, DLNR, 2002).

In February 2010, 83 species of corals world-wide were petitioned for listing as threatened or endangered under ESA (NOAA-NMFS, 2010). In response to the petition, National Oceanic and Atmospheric Administration (NOAA) completed a status review report (Brainard et al., 2011) in March 2011 and a management report of the candidate species (PIRO-NOAA, 2012) in November 2012. A proposed rule was published in December 2012 (NOAA-NMFS, 2012) with public comment extended through April 6, 2013 (NOAA-NMFS, 2013). On

August 27, 2014, a final rule was released (NOAA-NMFS, 2014), to implement the final determination to list 20 coral species as threatened. None of the listed corals occur in Hawai'i.

## Essential Fish Habitat

The 1996 Sustainable Fishery Act amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and subsequent Essential Fish Habitat (EFH) Regulatory Guidelines (NOAA, 2002) describe provisions to identify and protect habitats of federally-managed marine and anadromous fish species. Under the various provisions, federal agencies that fund, permit, or undertake activities that may adversely affect EFH are required to consult with the National Marine Fisheries Service (NMFS).

Congress defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." EFH is further defined by existing regulations as (MSFCMA, 1996; NOAA, 2002). "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" is defined as required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species life cycle.

EFH provisions in MSFCMA designate that species harvested in sufficient quantities to require fisheries management be subdivided into similar Management Unit Species (MUS). Four MUS are currently managed in Hawaiian waters: bottomfish, precious corals, crustaceans, and coral reef ecosystem. In the waters surrounding the Hawaiian Islands, EFH for coral reef ecosystem MUS as defined by the Final Coral Reef Ecosystem Fishery Management Plan (WPRFMC, 2001) and subsequent Fishery Ecosystem Plan for the Hawaiian Archipelago (WPRFMC, 2005) and "includes all waters and habitat at depths from the sea surface to 50 fathoms extending from the shoreline (including state and territorial land and waters) to the outer boundary of the Exclusive Economic Zone (EEZ)."

EFH provisions in MSFCMA designate that species harvested in sufficient quantities to require fisheries management may be subdivided into similar Management Unit Species (MUS). Five MUS groups are currently managed in Hawaiianwaters: bottomfish, pelagics, precious corals, crustaceans, and coral reef ecosystem. TheWesternPacificRegional Fishery ManagementCouncil (WPRMC) is moving towards an ecosystem-based approach to fisheries

management and has restructured its management framework from species-based fishery management plans (FMPs) to place-based fishery ecosystem plans (FEPs). The Hawai'i Archipelago FEP establishes the framework under which the WPRMC will manage fishery resources, and begin the integration and implementation of ecosystem approaches to management in the Hawai'i Archipelago. This FEP does not establish any new fishery management regulations, but rather consolidates existing fishery regulations for demersal species. Specifically, this FEP identifies as MUS those species known to be present in waters around the Hawaii Archipelago and incorporates all of the management provisions of the Bottomfish and Seamount Groundfish FMP, the Crustaceans FMP, the Precious Corals FMP, and the Coral Reef Ecosystems FMP that are applicable to the area.

The proposed Project is located within waters designated as EFH (including water column and all bottom areas) for coral reef ecosystem, bottomfish, pelagic and crustacean MUS. Of the thousands of species which are federally managed under the coral reef FMP, at least 58(juvenile and adult life stages) are known to occur in the general vicinity of Waikīkī beach(MRC, 2007; *AECOS*, 2009, 2010, 2012).

## Direct Impacts

Direct impacts to marine biological resources at the Royal Hawaiian site will result in the loss of marine resources that occur on the existing groin and within the footprint of the present structure.These communities are dominated by a number of algal species. One *Poc. meandrina* coral colony in the 21–to-40 cm size class occurs on the groin. Impact to the coral can be avoided by relocating the colony prior to construction. Biological assemblages residing on and around the present Royal Hawaiian groin will be impacted, but it is expected that similar communities will recolonize any newly placed solid structure. Recruitment of biota to the new groin structures will likely include marine species established nearby, and may include corals.

Most adult fish in the Project vicinity are mobile and will actively avoid direct impacts from Project activities. Some impairment of ability of EFH managed species to find prey items could occur, but this effect should be temporary and spatially limited to the immediate vicinity of construction activities. Most of theMUS that use the EFH species are not tied to artificial substrates, and routinely experience turbid and sand scoured environment in the area. The new structure will maintain fish habitat in the project area, and will provide additional fish foraging resources on the new groin. Construction of the groin on essentially sand bottom is not expected to adversely affect fish populations, fish

habitat, or fish foraging resources. Infaunal resources are expected to recover rapidly.

### Indirect Impacts

Potential indirect impacts to coral reef ecosystems and associated EFH from construction and operation of the Project may occur from degradation of water quality. Project construction may temporarily increase the amount of suspended sediment in the water column. It is anticipated that most fishes will avoid construction areas, and that potential impacts would be temporary and minor, resulting in displacement followed by rapid postconstruction recolonization by these species. Such avoidance would occur only in those areas where active in-water work is occurring. Impacts to water quality associated with Project activities will be temporary and can be minimized using appropriate construction BMPs. Indirect impacts on EFH from construction are not expected if BMPs are implemented and adhered to. Thus, it will be necessary to enclose the groin project area with silt/sediment barriers as a BMP to contain particulates during in-water work. At a minimum, monitoring before, during, and after construction should be conducted for temperature, salinity, pH, DO, and particulates to insure compliance with state water quality criteria.We also suggest biological monitoring programs be developed that focus on the specific components of particular interest to the resource and permitting agencies, including changes in densities and distribution of macro-invertebrates on (a) the new groin structure and (b) the seafloor area surrounding the newly constructed groin.

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Appendix A. Inventory of aquatic biota observed off the Royal Hawaiian groin and surrounding seafloor, Waikīkī, Oʻahu (September 2014)

| **PHYLUM, CLASS, ORDER, FAMILY** *Genus species* | Common name *&Hawaiian name* | Status | Abundance by location Groin | Seafloor |
|---|---|---|---|---|
| | **ALGAE** | | | |
| **CHLOROPHYTA** | GREEN ALGAE | | | |
| *Avrainvillea amadelpha* | | Nat. | | R |
| *Caulerpa* sp. | | Ind. | | U |
| *Derbesia fastigata* | | Ind. | | U |
| *Dictyosphaeria versluysii* | | Ind. | | O |
| *Halimeda discoidea* | | Ind. | | O |
| *Ulva fasciata* | sea lettuce *pālahalaha* | Ind. | A | C |
| *Neomeris* spp | | Ind. | R | O |
| **RHODOPHYTA** | RED ALGAE | | | |
| *Acanthophora specifera* | spiny seaweed | Nat. | C | C |
| *Gracilaria salicornia* | | Nat. | O | C |
| *Coelothrix irregularis* | | Ind. | O | |
| *Hydrolithon onkodes* | | Ind. | R | C |
| *Hydrolithon reinboldi* | | Ind. | | U |
| *Laurnecia nidifica* | | Ind. | R | |
| *Pterocladiella capillacea* | | Ind, | O | O |
| *Spyridia filamentosa* | | Ind. | | U |
| *Tolypiocladia/ Neosiphonia / Polysiphonia* unk. | red fuzz | | C | O |
| **OCHROPHYTA** | BROWN ALGAE | . | | |
| *Asteronema breviarticulatum* | | Ind. | R | |
| *Dictyota acutiloba* | *alani* | Ind. | R | R |
| *Dictyota sandvicensis* | *alani* | End. | R | C |
| *Padina sanctae-crucis* | | Ind. | R | C |
| **CYANOBACTERIA** | | | | |
| *Lyngbya majuscule* | | | | O |
| **CNIDARIA, ANTHOZOA, SCLERACTINIA, POCILLOPORIDAE** | | | | |
| *Pocillopora meandrina* | cauliflower coral | Ind. | R | |

| **PHYLUM, CLASS, ORDER, FAMILY** *Genus species* | Common name &*Hawaiian name* | Status | Abundance by location Groin | Seafloor |
|---|---|---|---|---|
| **ANNELIDA, POLYCHAETA, SABELLIDAE** | | | | |
| *Sabellastarte spectabilis* | feather duster worm | Ind. | | O |
| **MOLLUSCA, GASTROPODA PATELLIDAE** | | | | |
| **NERITIDAE** | | | | |
| *Nerita picea* | black nerite *pipipi* | Nat. | R | |
| **VERMETIDAE** | | | | |
| *Serpulorbis variabilis* | variable worm snail | Nat. | O | |
| **THAIDIDAE** | | | | |
| *Morula uva* | grape morula | Ind. | | R |
| **HIPPONIX** | | | | |
| *Hipponix conicus* | hoof shell | Ind. | U | |
| **ARTHROPODA, MALACOSTRACA, DECAPODA** | | | | |
| **GRAPSIDAE** | | | | |
| *Grapsus tenuicrustatus* | thin shelled rock crab;*ʻaʻama* | Ind. | O | |
| **ECHINODERMATA, ECHNOIDEA, ECHINOMETRIDAE** | SEA URCHINS | | | |
| *Echinometra mathaei* | rock boring urchin *ʻina kea* | Ind. | O | R |
| **DIADEMATIDAE** | | | | |
| *Diadema paucispinum* | long-spined urchin; *wana hālula* | Ind. | R | |
| **TOXOPNEUSTIDAE** | | | | |
| *Tripneustes gratilla* | collector urchin; *hāwaʻe maoli* | Ind. | O | O |
| **ECHINODERMATA, HOLOTHUROIDEA** | SEA CUCUMBERS | | | |
| *Holothuria atra* | black sea cucumber *loli okuhi kuhi* | Ind. | O | O |
| *Holothuria cinerascens* | ashy sea cucumber | Ind. | C | C |
| *Holothuria whitmaei* | teated sea cucumber | Ind. | O | O |

| **PHYLUM, CLASS, ORDER, FAMILY** *Genus species* | Common name &*Hawaiian name* | Status | Abundance by location Groin | Seafloor |
|---|---|---|---|---|
| **HOLOTHUROIDEA**(continued) | | | | |
| *Actinopyga mauritiana* | white spotted sea cucumber | Ind. | R | R |
| **VERTEGRATA, ACTINOPTERYGII** | BONY FISHES | | | |
| **POMACENTRIDAE** | DAMSELFISH | | | |
| *Abudefduf abdominalis* | Hawaiian sergeant *mamo* | End. | R | O |
| *Abudefduf sordidus* | blackspot sergeant; *kūpīpī* | Ind. | | O |
| **KUHLIIDAE** | | | | |
| *Kuhlia xenura* | Hawaiian flagtail *āholehole* | End. | O | O |
| **ACANTHURIDAE** | | | | |
| *Naso unicornis* (juv) | juvenile bluespine unicornfish; *kala* | Ind. | C | C |
| *Naso brevirostris* | Paletail unicornfish; *kala lōlō* | Ind. | | R |
| *Acanthurus triostegus* | convict tang; *manini* | Ind. | C | C |
| *Acanthurus blochii* | ringtail surgeonfish | Ind. | | C |
| **AULOSTOMIDAE** | | | | |
| *Aulostomus chinensis* | Pacific trumpetfish; *nūnū* | Ind. | | R |
| **CHAETODONTIDAE** | | | | |
| *Chaetodon lunula* | raccoon butterflyfish; *kīkākpau* | Ind. | | O |
| *Chaetodon frembili* | bluestripe butterflyfish; *kīkākpau* | End. | | R |
| **ZANCLIDAE** | | | | |
| *Zanclus comultus* | moorish idol; *kihikihi* | Ind. | R | |
| **LUTJANIDAE** | | | | |
| *Lutjanus kasmira* | bluestripe snapper; *ta'ape* | Ind. | | C |
| *Lutjanus fulvus* | blacktail snapper; *to'au* | Ind. | | O |

| **PHYLUM, CLASS, ORDER, FAMILY** *Genus species* | Common name &*Hawaiian name* | Status | Abundance by location Groin | Seafloor |
|---|---|---|---|---|
| **BELONIDAE** | | | | |
| *Platybelone argalus* | keeltail needlefish; *'aha* | Ind. | O | O |
| **MULLIDAE** | | | | |
| *Parupeneus multifasciatus* | manybar goatfish; *moano* | Ind. | | R |
| *Parupeneus porphyreus* | whitesaddle goatfish; *kūmū* | End. | | R |
| **CARANGIDAE** | | | | |
| *Caranx* sp. | juvenile jack | Ind. | | R |

KEY TO SYMBOLS USED:

Abundance categories:

R – Rare – only one or two individuals observed.
U – Uncommon – several to a dozen individuals observed.
O – Occasional – seen irregularly in small numbers
C – Common – observed everywhere, although generally not in large numbers.
A – Abundant – observed in large numbers and widely distributed.

Status categories:

End – Endemic – species found only in Hawaii
Ind. – Indigenous – species found in Hawai'i and elsewhere
Nat. – Naturalized – species were introduced to Hawai'i intentionally, or accidentally.

# Appendix B

*Ocean Activities Survey*
*for the*
*Royal Hawaiian Groin Improvement Project*
*at*
*Waikiki, Honolulu, Hawaii*

John Clark (2014)

# Ocean Activities Survey
# for the
# Royal Hawaiian Groin Improvement Project
# at
# Waikiki, Honolulu, Hawaii

Prepared for:

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October 1, 2014

# 1.0 OCEAN ACTIVITIES SURVEY

## Purpose

This ocean activities survey is intended to provide background information to Sea Engineering, Inc., for the replacement of an existing groin on Waikiki Beach near the Royal Hawaiian Hotel. Sea Engineering is preparing the environmental assessment for the proposed project.

## Project Location

The project location is the shoreline of Waikiki Beach between the Royal Hawaiian Hotel and the Sheraton Waikiki Hotel. The existing groin designated for replacement extends from the common boundary between the two hotels and curves east.

## Project Description

The project is to implement a replacement groin for the existing structure, which anchors 1700 feet of Waikiki Beach on its east side. The replacement groin will follow the contour of the existing groin, which extends seaward approximately 300 feet. The outer 1/3 of the existing groin is broken, collapsed and submerged. The dimensions and the design of the replacement groin will be determined in the concept planning process.

## 1.4 Scope

The scope of work included:

1. Observing ocean recreation activities and ocean conditions at and in the vicinity of the project site.

2. Identifying ocean recreation activities at and in the vicinity of the project site and determining whether the proposed project affects these activities.

3. Interviewing shoreline users, including staff of the surfboard/canoe ride/catamaran ride beach service concessions and City and County of Honolulu lifeguard staff.

4. Identifying potential impacts of the groin replacement project on the ocean recreation activities in the project site.

## 1.5 Survey Methodology

Information for this survey was gathered from site visits and from interviews with people familiar with the shoreline of Waikiki Beach, especially in the project area. Site visits and interviews were conducted during September 2014.

## 2.0 Physical Conditions

### 2.1 Historic Site Description

Waikiki Beach was a favorite swimming, bodysurfing, surfing and canoe surfing site among Native Hawaiians for hundreds of years, which eventually led to its development as an international visitor destination. Two of Waikiki's most famous surf spots, Queen's and Canoes, lie directly off the center of the beach.

The shoreline of Waikiki Beach between the Duke Kahanamoku Statue and the Royal Hawaiian Hotel, historically the center of Waikiki Beach, fronts three hotels. From east to west they are the Sheraton Moana-Surfrider, the Outrigger Waikiki Beach Resort, and the Royal Hawaiian. The Moana-Surfrider, which opened in 1901, is the oldest hotel in Waikiki. The original owner of the hotel chose the center of Waikiki Beach for its location. The Outrigger Waikiki opened in the 1967 on the site of the original Outrigger Canoe Club. The Royal Hawaiian, also one of the oldest hotels in Waikiki, opened in 1927.

The section of beach fronting these hotels was widened in a beach restoration project in 2012. Sand from the ocean bottom was pumped inland through a pipeline from a barge anchored offshore. Onshore, the sand was stockpiled at a dewatering site and then spread along the beach.

### 2.2 Present Site Description

The existing groin anchors the west end of Waikiki Beach, which fronts the hotels described above. The groin extends offshore and curves east, where its outer end is broken, collapsed and submerged. Episodes of high surf from the west in 2006 undermined the base of the groin where it joins the vertical seawall fronting the Royal Hawaiian and the Sheraton Waikiki. The undermining created a large sink hole in the beach adjoining the groin, which was temporarily filled with large sand bags.

### 2.13 Ocean Bottom.

The ocean bottom on the east side of the groin fronting the Royal Hawaiian is a shallow sandbar. Although a sandbar has always been located in this area, its size has increased over the past two years when sand from the 2012 beach restoration project migrated from the east end of the beach to the west.

The ocean bottom on the west side of the groin fronting the Sheraton Waikiki is a shallow coral reef flat with several small pockets of sand at the base of the high seawall. The sand pockets are covered during high tides.

### 2.14 Boat Channel.

The channel that separates the two surf spots of Canoes and Sandbars was created by fresh water intrusion from the former Apuakehau Stream. Apuakehau Stream crossed Waikiki Beach approximately between the Moana-Surfrider and the Outrigger Waikiki, but its stream waters were cut off during the 1920s by construction of the Ala Wai Canal. Its streambed was

filled by normal sand migration during the same project. The channel created by the stream passes between the two surf spots and further offshore on its west margin passes the surf spot called Populars.

This channel is used by boats that are authorized to access Waikiki Beach, including four catamarans, outrigger canoes, and various rescue craft.

## 3.0 Ocean Recreation Activities.

The project site, including the waters offshore, is part of the most heavily used section of Waikiki Beach where many ocean recreation activities take place. These include sunbathing, swimming, surfing, standup surfing, bodyboarding, skimming, canoe surfing, snorkeling, spear fishing, pole fishing, strolling, wading, and metal detecting.

Commercial ocean recreation activities include bodyboard and surfboard rentals, surfing lessons, surfing lesson photography, canoe rides, and catamaran rides.

### 3.1 Sunbathing.

The heaviest concentration of sunbathers in Waikiki is located at the west end of the beach, near the existing groin. This is where the beach is widest, fronting the Outrigger Waikiki and the Royal Hawaiian. The beach is most crowded with sunbathers at low tide during periods of little or no surf.

### 3.2 Swimming.

Swimming occurs from one end of the beach to the other, but the greatest concentration of swimmers tends to be in the middle of the beach, fronting the Moana-Surfrider. With surfboard rental, canoe ride, and catamaran ride concessions concentrated at the ends of the beach, the least amount of traffic that might endanger swimmers is in the center of the beach.

### 3.3 Snorkeling.

Snorkeling is an infrequent activity in the project area, occurring primarily on the west side of the groin. The shallow reef there is not known as a good site for snorkeling. It does not attract the volume or variety of fish that other reefs do, and for this reason few people snorkel there. In addition, during periods of high surf, visibility over the reef is poor due to wave agitation of the ocean bottom.

This reef, however, is well-known as a feeding site for green sea turtles. They may be seen at all times of the day, often close to shore, feeding on seaweed that grows on the reef. Observing the turtles occurs primarily by people standing on the seawall fronting the Sheraton Waikiki rather than by people snorkeling over the reef.

3.4 Surfing.

Canoes is the name of the surf spot located directly off the Moana-Surfrider Hotel. It is the most highly used surf spot in Hawaii for commercial surfing activities, including surfboard rentals, surfing lessons, and outrigger canoe rides. Beginning surfers and surf instructors with beginners receiving lessons are concentrated on the smaller inside waves, which is known as Baby Canoes, while intermediate and advanced surfers ride the bigger waves outside.

Queen's is the name of the surf spot located directly off the Duke Kahanamoku Statue. The waves at Queen's are steeper than those at Canoes and are concentrated in a much smaller area, so beginning surfers and surf instructors with beginners receiving lessons generally do not surf here. Waves at Queen's, however, reform near shore on the shallow reef at the east end of the project site. This surf spot is known as Baby Queen's and attracts beginning surfers and surf instructors with beginners receiving lessons.

Sandbars is the name of the surf spot located directly off the Royal Hawaiian. It is also known as Baby Royals. As the size of the sandbar has increased in recent years, the surf spot has evolved into a popular spot for beginning surfers and surf instructors with beginners receiving lessons.

Canoes, Queen's and Sandbars are located on the south shore of Oahu, which generally receives its biggest surf during the spring and summer months. However, there is almost always enough surf at each of these spots in the fall and winter to sustain commercial surfing activities throughout the year. Two beach concessions are located on the west end of the beach near the project site, Aloha Beach Services under Didi Robello, and Waikiki Beach Services under Ted Bush. Two beach concessions are located on the east side of the beach near the Duke Kahanamoku Stature, Star Beach Boys under Aaron Rutledge and Hawaiian Oceans under Hubert Chang.

3.5 Canoe Surfing.

Catching waves with an outrigger canoe in Waikiki takes place at Canoes, the famous surf spot off the Moana-Surfrider. The surf spot was named for this activity. 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.

All four of the beach concessions offer outrigger canoe rides. Use of commercial canoes in Waikiki is controlled by the Division of Boating and Ocean Recreation (DOBOR), Department of Land and Natural Resources (DLNR), State of Hawaii. DOBOR controls boating in Waikiki 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.

3.7 Catamaran Rides.

Catamaran rides are a popular activity on Waikiki Beach. The catamarans park on the beach, where they load and unload passengers. They motor in and out of the beach, then sail up and down the Waikiki coast for specified periods of time.

Four catamarans are permitted to conduct catamaran ride operations on Waikiki Beach. The Mana Kai, which is owned by William Brown, operates at the east end of the beach near the Duke Kahanamoku Statue. The Na Hoku and the Manu Kai, which are owned by John Savio, and the Kapoikai, which is owned by Sheila Lipton, operate at the west end of the beach.

Another catamaran, the Maitai, which is owned by George Parsons, operates on the west side of the groin at Gray's Beach, the pocket of sand between the Sheraton Waikiki and the Halekulani Hotel.

The Division of Boating and Ocean Recreation (DOBOR), Department of Land and Natural Resources (DLNR), State of Hawaii, controls boating in Waikiki shore waters. Administration of the beach landing areas for the catamarans in the project site comes under DOBOR's Oahu 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.

3.8 Fishing and Gathering.

Two types of fishing occur near the groin, 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 deterrent to activities involving spears and fish hooks.

The reef near the groin was once known as a good place to gather edible seaweeds, or limu, especially limu lipoa, but little edible seaweed remains in Waikiki today. No gathering activities of seaweed, shellfish, or other marine species were observed during the field trips or noted by informants.

The Waikiki Marine Managed Areas (MMA) consists of two parts: the Waikiki Marine Life Conservation District (MLCD) and the Waikiki-Diamond Head Fisheries Management Area (FMA). The project site is not included in the Waikiki MMA.

3.9 Boating.

The Division of Boating and Ocean Recreation (DOBOR), Department of Land and Natural Resources (DLNR), State of Hawaii, controls boating in Waikiki 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 Waikiki shore waters. The catamarans and personal water crafts 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.

## 4.0 Impacts on Ocean Recreation Activities.

The groin replacement project proposes to replace the existing Royal Hawaiian groin with an armor stone (boulder) groin similar to the groins that were constructed at Iroquois Beach on the west side of the Pearl Harbor entrance channel. Possible impacts that the replacement groin might have on ocean recreation activities follow below. They were identified by the shoreline users interviewed for this survey.

### 4.1 Short Term Impacts.

The location of the staging area for the boulders and the heavy equipment will impact the ocean recreation activities at the east end of the beach. It may eliminate use of that particular section of beach for all commercial and non-commercial users for the duration of the project. In addition, as boulders and equipment are moved from the east end of the beach to the west end, all commercial and non-commercial users on the beach will be temporarily displaced during the process.

The location of the boulder staging site will specifically impact the operations of one or both of the beach concessions at the east end of the beach for the duration of the project. The two beach concessions are Star Beachboys and Hawaiian Oceans. Both of them lease their concession sites from the City and County of Honolulu's Department of Environmental Services (DES). The DES Concessions Contract Specialist is Charlian Wright.

According to Ms.Wright, there are provisions in the beach concession contracts that provide for impacts to their businesses due to City or State construction projects. The City has the ability to make adjustments to the monthly lease rents, which are otherwise fixed. The City also has the ability to permit the lessees to relocate their operations from their present sites, which are also fixed. However, even if these adjustments are made, work opportunities for the concessions' staff and surf instructors may be considerably reduced or eliminated.

Ms. Wright also handles the food service concession in the Honolulu Police Department's substation near the Duke Kahanamoku Statue. The food service concession is leased to Rus Murakami, who operates it as the Waikiki Beachside Bistro. He noted that the project will reduce access to the beach for visitors, which will directly reduce sales at his concession. Visitors, not local residents, are the majority of his customers. According to Ms.Wright, there are provisions in the food service concession contract that provide for impacts on the food concession business due to City or State construction projects.

The location of the staging area may impact the operations of the catamaran concession at the east end of the beach. The catamaran's landing area is under the jurisdiction of the State of Hawaii's Division of Boating and Ocean Recreation (DOBOR), Oahu District Manager.

The location of the staging area may impact surfing contests, which set up their towers and tents at the east end of the beach near the Duke Kahanamoku Statue. Surfing contests are held in Waikiki during the spring and summer months, so this impact will only occur if the project takes place at that time of year.

The location of the staging area may impact cultural and entertainment activities at the Hula Mound, which is on the seaward side of the banyan tree at the east end of the beach.

Noise from the heavy equipment and the construction activities may disturb everyone in the immediate area.

Sediment, silt, and discoloration of the water may result from the construction.

Project timeline.

Most of the informants recommended scheduling the project during the winter months, except for the month of December, which is one of the busiest months of the year. Otherwise, October and November are slow months for visitors and the slowest time of year for commercial ocean recreation activities on Waikiki Beach. It is also the least likely time of year for south shore surf and kona storms. In addition, no surfing contests are held in Waikiki after September. One informant also recommended January and February. No one wanted to see the project start in the spring. If the project was delayed, it might run into summer, which is their busiest time of year.

Summary.

The most commonly identified short term impacts include: temporary beach closures, disruption to beach access, reduction of water quality, introduction of negative visual and noise activities, and loss of revenue for the beach concessions. However, most informants said if the long term impacts of the project were positive, they would outweigh the negative short term impacts during construction.

4.2 Long Term Impacts.

In regard to long term impacts of the project, almost all the informants commented first on the beach restoration project that took place in 2012. While they agreed that a wider beach attracts more visitors, which in turn is better for business, they also pointed out that the project had some negative impacts on the physical characteristics of the beach and the surf spots offshore. The following are some of the negative impacts.

a. Currents, high tides, and surf, especially during the spring and summer months have eroded sand at the east end of the beach and moved it west, where it has accumulated and enlarged the shallow sandbar in front of the Royal Hawaiian, which is the surf spot called Sandbars.
b. The removal of two small, partially submerged groin remnants at the east end of the beach seems to have caused permanent rather than seasonal erosion of the beach. The

sand has not returned and another concrete structure, which may have been part of a former shoreline residence, is now permanently exposed. (See attached photo.)

c. Eroding sand from the beach has also migrated into the reef of the surf spot called Canoes, changing the characteristics of the way the waves break. Canoes is the single most important commercial surf spot in Hawaii, and there is concern that changes to the way the waves break, which are now ideal for beginners and canoe surfing, may impact its value as a surfing resource.
d. Eroding sand has extended into the channel between Canoes and Sandbars, making it more difficult for the catamarans at the west end of the beach to enter and exit at low tide.

Safety Concerns from the City and County of Honolulu Lifeguards.

a. The existing groin is too narrow for people to sit or walk on, which from a water safety point of view is a good thing. The replacement groin will be just the opposite. It will have a negative impact on the safety of the entire area. Whether it has a concrete cap or not, it will still invite people from the beach to walk its entire length. This is true of all the boulder groins in Waikiki, where people walk out on them to sight-see, take photos, and feed the fish. One of the dangers for this particular wall is that it may be subject to waves washing over it during periods of high surf. This means wet rocks, which are a slip hazard, and the possibility of people being caught in the crevices or washed off the wall into the ocean.
b. This style of wall will encourage children and young adults to jump or dive into the ocean. This is a dangerous activity. So far this year two Chinese visitors have suffered serious neck injuries diving off the Kapahulu Groin in Waikiki.
c. The outer end of the existing groin is broken, collapse and submerged. If this section of the existing groin is also replaced, the new groin will trap much more of the sand that migrates from the east end of the beach to the west, further enlarging the sandbar that is there now. Beach users like to walk out on the sandbar, especially at low tide. There are drop offs and several deep holes near its outer edge, where poor and non-swimmers get into trouble and need to be rescued. Further expansion of the sandbar may increase the dangerous areas and increase these incidents.
d. Almost all the beach goers at the project site are visitors. They will not be aware of the dangers, and experience has shown that for the most part that visiors ignore any warning signs that are posted. In addition, lifeguards are only on duty during the day. Visitors will also access the groin before and after hours, including at night, especially during fireworks displays offshore Waikiki.
e. Building this style of groin will not only add another hazard to the beach, it will change the view plane in the heart of Waikiki.
f. The groin may add another fish feeding station to Waikiki. It may also provide another turtle watching view point.
g. Public access to the groin is the biggest concern. It will introduce a new risk to Waikiki that will create additional injuries and rescues. Someone will have to manage the activities that take place on it. DLNR has no first-responder resources, so the responsibility will fall primarily to the City lifeguards. This will require additional staffing and additional funding.

h. If the existing groin needs to be replaced, replace it with a groin that's similar to the one that's there now. In other words, a groin that will anchor the beach, but one that won't attract any pedestrian traffic.

4.3 Additional Comments.

a. One informant suggested removing the groin in front of the Royal Hawaiian and not replacing it, which would allow sand to erode and accrete naturally. He suggested this might eliminate the sandbar and the issues that go with it and that it might create a beach in front of the Sheraton Waikiki without the construction of any groins.
b. Another informant hoped the replacement groin would help to establish a sand beach fronting the Sheraton Waikiki.
c. Another informant suggested the replacement groin might attract new marine life to the area and create a good snorkeling site for visitors.
d. Another informant suggested that disruption to the entire beach could be minimized by moving the boulders and heavy equipment prior to 9:00 am and after 4:00 pm.
e. The replacement groin may not only enlarge the existing sandbar, but may trap enough sand to create a new beach fronting the Royal Hawaiian.
f. Several informants recommended that this project be part of a comprehensive beach management plan, which would include monitoring the environmental impacts of the new groin and providing mitigation options if negative impacts occur.

4.4 Summary.

While some informants were against the groin replacement project, most thought that it is a good idea. When it is completed, they think it will enhance the image of Waikiki Beach, that visitors will enjoy it, and that it will stimulate business for the beach and catamaran concessions. They hope the new groin will continue to anchor the existing beach and perhaps make it more attractive to visitors. Additional beach users mean more commercial opportunities for the beach concessions and catamaran operators.

Informants who were against the groin replacement were not opposed to the intent of the groin, but were rather opposed to its design. They believe that a boulder groin similar to the ones installed at Iroquois Beach will add another hazard to Waikiki Beach, putting our visitors at risk. They also predict that the introduction of dangers that do not exist now will increase the workload of first responders, especially lifeguards, with more injuries and rescues.

Other possible permanent long term impacts include: degradation of reefs and surf sites, unanticipated sand transport, change in water quality, and a change to the view plane in the heart of Waikiki.

5.0 Individuals Contacted for this Survey.

Ted Bush, Waikiki Beach Services (Royal Hawaiian and Moana-Surfrider Hotels)
Hubert Chang, Hawaiian Oceans Waikiki
Stuart Coleman, Hawaii Coordinator, Surfrider Foundation
George Downing, Save Our Surf (SOS)
Marvin Heskett, Oahu Chapter Chairperson, Surfrider Foundation
Jim Howe, Director, Ocean Safety and Lifeguard Services, City and County of Honolulu

Rocky Iaukea, Mana Kai Catamaran
Robert King, Outrigger Catamaran
Sheila Lipton, Kepoikai Catamaran
Jonathan Maki, Waikiki surfer
Paul Merino, Captain, South Shore Operations, Ocean Safety and Lifeguard Services, CCH
Yusuke Motohashi, Waikiki surfer
Rus Murakami, Waikiki Beachside Bistro
George Parsons, Maitai Catamaran
Didi Robello, Aloha Beach Services
Aaron Rutledge, Star Beachboys
Mindy Sanford, Maitai Catamaran
John Savio, Na Hoku and Manu Kai Catamarans
Ayami Shiraishi, Waikiki surfer
Meghan Statts, Oahu District Manager, DOBOR, State of Hawaii
Bigshot Wright, Kepoikai Catamaran
Charlian Wright, Concessions Contract Specialist, Department of Environmental Services, CCH