DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
PHONE: (808) 768-8000 • FAX: (808) 768-6041
DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

FILE COPY

JUL 08 2019

KIRK CALDWELL
MAYOR

KATHY K. SOKUGAWA
ACTING DIRECTOR

TIMOTHY F. T. HIU
DEPUTY DIRECTOR

EUGENE H. TAKAHASHI
DEPUTY DIRECTOR

June 21, 2019

2019/ED-1(AB)

Mr. Scott Glenn
Office of Environmental Quality Control
Department of Health
State of Hawaii
235 South Beretania Street, Room 702
Honolulu, Hawaii 96813

RECEIVED
'19 JUN 21 A10:52
OFC. OF ENVIR. QUALITY CONTROL

Dear Board Members:

SUBJECT:	Chapter 343, Hawaii Revised Statutes Draft Environmental Assessment (DEA)
Project:	Shoreline Protection for 1326 Mokulua Drive
Applicant:	Nadir Safai, Angela Zupan, and Chris Furie
Agent:	G70 (Rachel Shaak)
Location:	1326 Mokulua Drive - Lanikai
Tax Map Key:	4-3-004: 077

With this letter, the Department of Planning and Permitting hereby transmits the DEA and anticipated finding of no significant impact (DEA-AFNSI) for the Shoreline Protection Project at 1326 Mokulua Drive (Tax Map Key 4-3-004: 077), in the Koolaupoko District on the island of Oahu, for publication in the July 8, 2019, edition of "The Environmental Notice."

Enclosed, please find a completed Office of Environmental Quality Control (OEQC) Publication Form, a hard copy of the DEA, and a disc with a copy of the DEA-AFNSI. We have also emailed an electronic copy of the publication form in MS Word.

Should you have any questions, please contact Alex Beatty, of our staff, at 768-8032.

Very truly yours,

for Kathy K. Sokugawa
Acting Director

Enclosures: OEQC Publication Form
Hard Copy of the DEA
Disc with Copy of the DEA-AFONSI

19-402

APPLICANT
PUBLICATION FORM

Project Name:	Shoreline Protection for 1326 Mokulua Drive
Project Short Name:	Shoreline Protection Mokulua Drive
HRS §343-5 Trigger(s):	HRS 343-5(a)(3) Use within a Shoreline Setback Area, ROH Chapter 23, Shoreline Setbacks
Island(s):	Oahu
Judicial District(s):	Koolau Poko
TMK(s):	(1) 4-3-004: 077
Permit(s)/Approval(s):	• Certified Shoreline Survey (Department of Land and Natural Resources (DLNR)) • Shoreline Setback Variance (Department of Planning and Permitting (DPP), Honolulu City Council) • Minor Shoreline Structure (DPP) • Building Permits (Structure) (DPP) • Grading, Grubbing, Trenching and Stockpiling Permits (DPP)
Approving Agency:	City and County of Honolulu, Department of Planning and Permitting, Planning Division
Contact Name, Email, Telephone, Address	Alex Beatty Email: abeatty@honolulu.gov Teephone: (808) 768-8032 650 South King Street, 7th Floor, Honolulu, Hawaii, 96813
Applicant:	Nadir Safai, Angela Zupan, and Chris Furie
Contact Name, Email, Telephone, Address	Nadir Safai, Angela Zupan, and Chris Furie Email: nadir@orangefurniture.com, chris@chrisfurie.com Telephone: (310) 600-0220 1326 Mokulua Drive, Kailua, Hawaii 96734
Consultant:	G70
Contact Name, Email, Telephone, Address	Rachel Shaak AICP, LEED AP Email: rachels@g70.design Telephone: (808) 523-5866 111 South King Street, Suite 170, Honolulu, Hawaii, 96813

Status (select one)	**Submittal Requirements**
_X_ DEA-AFNSI	Submit 1) the approving agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEA, and 4) a searchable PDF of the DEA; a 30-day comment period follows from the date of publication in the Notice.
___ FEA-FONSI	Submit 1) the approving agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; no comment period follows from publication in the Notice.
____ FEA-EISPN	Submit 1) the approving agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; a 30-day comment period follows from the date of publication in the Notice.
____ Act 172-12 EISPN ("Direct to EIS")	Submit 1) the approving agency notice of determination letter on agency letterhead and 2) this completed OEQC publication form as a Word file; no EA is required and a 30-day comment period follows from the date of publication in the Notice.
____ DEIS	Submit 1) a transmittal letter to the OEQC and to the approving agency, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEIS, 4) a searchable PDF of the DEIS, and 5) a searchable PDF of the distribution list; a 45-day comment period follows from the date of publication in the Notice.

19-402

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

Project Summary

Shoreline protection is planned for 1326 Mokulua Drive as the property has been adversely affected by shoreline erosion. The parcel, located on Tax Map Key (TMK): (1) 4-3-004: 077, has a total area of 12,380 square feet. The Project area will encompass 1,690 square feet of the nearshore portion of the TMK. A temporary emergency sandbag structure was installed by the previous owner to protect the property from ongoing erosion conditions. The Project site is the sole property without hardened structures along the southern Lanikai coastline. The property is surround by armored shorelines including a mix of vertical seawalls, rock aprons, and revetments. Armored shorelines extend approximately 1,050 feet to the north and 2,100 feet to the south of the property. The Project proposes removal of the existing sandbag structure and replacing it with a new seawall with boulder slope scour apron that extends along the approximately 75-foot section of the Lanikai shoreline.

SHORELINE PROTECTION FOR 1326 MOKULUA DRIVE

DRAFT ENVIRONMENTAL ASSESSMENT

KAILUA, ISLAND OF O'AHU

APPLICANT:

NADIR SAFAI, ANGELA ZUPAN, AND CHRIS FURIE

PREPARED BY:

G70

111 S. KING STREET, SUITE 170
HONOLULU, HI 96813

JUNE 2019

SHORELINE PROTECTION
1326 MOKULUA DRIVE

DRAFT ENVIRONMENTAL ASSESSMENT

KAILUA, ISLAND OF O'AHU
TMK: (1) 4-3-004:077 (POR.)

APPLICANT:

NADIR SAFAI, ANGELA ZUPAN, AND CHRIS FURIE
1326 MOKULUA DRIVE
KAILUA, O'AHU, HAWAI'I

PREPARED BY:

G70
111 S. KING STREET, SUITE 170
HONOLULU, HI 96813

APPROVING AGENCY:

CITY AND COUNTY OF HONOLULU
DEPARTMENT OF PLANNING AND PERMITTING
650 SOUTH KING STREET
HONOLULU, HAWAI'I 96813

JUNE 2019

Table of Contents

SECTION **PAGE**

List of Figures ..... **iv**

List of Tables ..... **v**

Appendices ..... **v**

1.0 Introduction **1-1**

1.1 Project Information Summary 1-1
1.2 Project Area 1-2
1.3 Project Background 1-2
1.4 Overview of the Planned Project 1-2
1.5 Purpose of the Environmental Assessment 1-3
1.6 Permits and Approvals Required 1-3
1.7 Agencies, Organizations and Individuals Contacted During the Pre-Consultation Process 1-3

2.0 Description of the Project **2-1**

2.1 Site Characteristics 2-1
2.2 Purpose of the Project 2-5
2.3 Proposed Action 2-5
2.4 Construction Characteristics 2-10
2.5 Utilities and Infrastructure 2-11
2.6 Summary of Projected Costs 2-11

3.0 Description of the Environmental Setting, Potential Impacts and Mitigation Measures **3-1**

3.1 Topography 3-1
3.2 Soils and Shoreline Erosion Conditions 3-5
3.3 Climate 3-9
3.4 Natural Hazards 3-9
3.5 Sea Level Rise 3-12
3.6 Biological Resources 3-15
3.6.1 Terrestrial Biology 3-15
3.6.2 Marine Biology 3-16
3.7 Ocean Water and Marine Resources 3-17
3.8 Air Quality 3-19

3.9 Noise 3-20
3.10 Utilities and Infrastructure 3-20
3.11 Traffic and Roadways 3-21
3.12 Socio-Economic Characteristics 3-21
3.13 Public Facilities and Services 3-22
3.13.1 Educational Facilities 3-22
3.13.2 Recreational Facilities 3-22
3.13.3 Police 3-23
3.13.4 Fire 3-23
3.13.5 Emergency Medical Emergencies 3-23
3.13.6 Solid Waste Management 3-23
3.14 Historic, Archaeological and Cultural Resources 3-24
3.14.1 Historic and Archaeological Resources 3-24
3.14.2 Cultural Resources 3-26
3.15 Visual Resources 3-27
3.16 Potential Cumulative and Secondary Impacts 3-34

4.0 Alternatives to the Proposed Project

4.1 Alternative A – No-Action Alternative 4-1
4.2 Alternative B – Sandbag Removal 4-3
4.3 Alternative C – Beach Nourishment 4-4
4.4 Alternative D – Rock Revetment 4-5
4.4.1 Rock Revetment Design 4-8
4.4.2 Rock Revetment Design per Court Settlement 4-9
4.5 Alternative E – Delayed Action 4-10
4.5.1 Hybrid Seawall-Revetment Design 4-12
4.6 Preferred Alternative/Proposed Action – Seawall with Scour Apron 4-14
4.6.1 Seawall Design 4-16
4.7 Preferred Alternative/Proposed Action – Seawall with Scour Apron 4-19
4.8 Other Considerations 4-23
4.8.1 Replacement of Sandbag Structure and Potential Impacts to Neighboring Structures 4-23
4.8.2 Potential Removal of Beach Access Headwall 4-24
4.8.3 Shoreline Hardening in the State Conservation District 4-25

5.0 Plans and Policies

5.1 Hawai‘i State Plan 5-1
5.2 Hawai‘i State Land Use District Boundaries 5-3
5.3 Hawai‘i Coastal Zone Management Program 5-4
5.4 Hawai‘i Water Quality Standards 5-11
5.5 City and County of Honolulu General Plan 5-11

5.6 City and County of Honolulu Land Use Ordinance Guidelines 5-13
5.7 City and County of Honolulu Koʻolau Poko Sustainable Communities Plan (2017)..... 5-13
5.8 Shoreline Setbacks 5-14
5.9 Special Management Area 5-16

6.0 Findings Supporting The Anticipated Determination

6.1 Anticipated Determination.....6-1
6.2 Reasons Supporting the Anticipated Determination 6-1
6.3 Summary.....6-3

7.0 List of References

7.1 Publications.....7-1
7.2 Geographical Information Systems Data.....7-3
7.3 Websites 7-3
7.4 Document Preparers.....7-4

8.0 List of Agencies, Organizations and Individuals Receiving Copies of the EA

List of Figures

Figure **Page**

1-1 Project Location and TMK Parcels 1-5
2-1 Residence and Shoreline Transition 2-1
2-2 Shoreline Protection Adjacent to the Project Site 2-2
2-3 Adjacent Property to the North with Seawalls (G70, 2018) 2-3
2-4 Public Access Pathway and Transition to Submerged Beach (G70, 2018) 2-3
2-5 Adjacent Properties to the South (G70, 2018) 2-3
2-6 Project TMK and Adjacent Properties 2-4
2-7 Certified Shoreline Survey 2-7
2-8 Preliminary Shoreline Structure Footprint 2-8
2-9 Section View of Preliminary Shoreline Structure Design 2-9
2-10 Connections at Wing Walls 2-10
3-1 Site Topography 3-3
3-2 Soils Map 3-6
3-3 Existing Sandbag Shoreline Protection Profiles 3-7
3-4 Existing Sandbag Shoreline Protection Profiles 3-8
3-5 Flood Zone 3-11
3-6 3.2 Foot Sea Level Rise Scenario 3-13
3-7 Hawai‘i Sea Level Rise Projections (Adapted from NOAA, 2017) 3-14
3-8 Previous Archaeological Investigations in Lanikai (Keala Pono 2018) 3-25
3-9 Site Photo Key (Source: Google Earth) 3-28
3-9A View 1 from Mokulua Drive Facing Makai Toward the Residence and Project Area 3-29
3-9B View 2 from Adjacent Beach Access Point Facing Makai 3-29
3-9C View 3 from Property Facing Makai Toward Mokulua Islands 3-30
3-9D View 4 from Eroding Flank Facing Northeast 3-30
3-9E View 5 from Eroded Shoreline of Temporary Seabags Facing Kāne’ohe 3-31
3-9F View 6 from Public Access, Transition to Shoreline 3-31
3-9G View 7 from Public Access, Transition to Shoreline 3-32
3-10 Lanikai Shoreline Aerial View 3-33
4-1 Shoreline Location after a 50-year Design Life if Sandbags are Removed 4-3
4-2 Rock Revetment at Kahului Harbor (Kahului, Maui, Hawaii) 4-7
4-3 Section View of Revetment Alternative 4-8

4-4 Revetment Alternative Footprint 4-9
4-5 Court Settlement Revetment Footprint 4-10
4-6 Hybrid Seawall-revetment (Kapaʻa, Kauaʻi, Hawaiʻi) 4-11
4-7 Section View of Hybrid Seawall-revetment Option 4-13
4-8 Hybrid Seawall-Revetment Option Footprint 4-13
4-9 CRM and Concrete Seawalls (Lanikai, Oʻahu, Hawaiʻi) 4-15
4-10 Curved Seawall Option Footprint 4-17
4-11 Straight Aligned Seawall Option Footprint 4-18
4-12 Section View of Seawall Option 4-18
4-13 Seawall with Scour Apron, (Lanikai, Oʻahu, Hawaiʻi) 4-20
4-14 Section View of the Seawall with Toe Apron Alternative 4-22
4-15 Seawall with Scour Apron Option Footprint 4-22
4-16 South End of Sandbag Revetment Adjacent to Public Access Headwall (March 2018) 4-23
4-17 North End of Sandbag Revetment at Adjacent Property (March 2018) 4-24

List of Tables

Table **Page**

3-1 Water Quality 3-18
8-1 Agencies, Organizations and Individuals Receiving Copies of the EA 8-1

Appendices

A. 1326 Mokulua Drive Past Documents

B. Certified Shoreline Survey

C. Early Consultation

D. Sea Engineering, Inc. Coastal Assessment 1326 Mokulua Drive (April 2019)

E. Marine Research Consultants, Inc. Baseline Assessment of the Marine Environment 1326 Mokulua Drive, Kailua, Hawaii, Shoreline Improvements (August 2018)

F. Keala Pono Archaeological Consulting, LLC Archaeological Assessment for 1326 Mokulua Drive in Lanikai, Kailua Ahupuaʻa, Koʻolaupoko District, Island of Oʻahu (April 2018)

G. Shinsato Engineering, Inc. Geotechnical Investigation (May 2018)

H. Sea Engineering, Inc., Memorandum on Lanikai Association Beach Access Headwall Removal (March 2019)

Section 1

Introduction

Chapter 1

Introduction

This Environmental Assessment (EA) has been prepared in accordance with the requirements of Chapters 23 of the Revised Ordinances of Honolulu (ROH), Chapter 343, Hawai‘i Revised Statutes (HRS), and Hawai‘i Administrative Rules (HAR), Title 11, Department of Health, which set forth the requirements for the preparation of environmental assessments.

1.1 Project Information Summary

Type of Document:	Environmental Assessment (EA)
Project Name:	Shoreline Protection for 1326 Mokulua Drive
Applicants:	Nadir Safai, Angela Zupan, and Chris Furie
Agent:	G70 111 S. King Street, Suite 170 Honolulu, HI 96813
Accepting Authority:	Department of Planning and Permitting 650 South King Street, 7th Floor Honolulu, HI 96813 Telephone: (808) 768-8049
EA Trigger:	HRS 343-5(a)(3) Use within a Shoreline Setback Area ROH Chapter 23, Shoreline Setbacks
Project Location:	1326 Mokulua Drive Kailua, O‘ahu, Hawai‘i *(Figure 1-1)*
Tax Map Keys (TMK) and Landowners:	(1) 4-3-004:077 – Fairwater Hawaii LLC, Sandbags LLC *(Figure 1-1)*
Project Area:	Approximately 1,690 square feet (SF) (nearshore portion of 12,380 SF TMK)
State Land Use District:	Urban District
City & County of Honolulu Zoning:	R-10 (Residential District)
Ko‘olau Poko Sustainable Communities Plan:	Low Density Residential
Special Management Area:	Within SMA
Flood Zone:	AE/X
Anticipated Determination:	Finding of No Significant Impact (FONSI)

1.2 Project Area

The project area is a shoreline lot along Mokulua Drive in the area of Lanikai, Kailua, O‘ahu (*Figure 1-1*). The project is situated on Low Density Residential zoned lands which are privately owned. The properties are adjacent to the Pacific Ocean to the northeast, Mokulua Drive to the southwest, a vacant lot to the west and a public shoreline access path that also functions as a drainage easement to the east.

1.3 Project Background

The property was previously owned by Allen Davis and an illegal rock revetment was in place along the shoreline fronting the property. In 1993, the City brought a civil action against Davis pertaining to a revetment and side wall located in the shoreline area of 1326 Mokulua Drive *(Appendix A: Settlement Agreement, Dec. 1994)*. As a result of the settlement of the civil action, Davis agreed to remove the illegal rock structure and was permitted to construct a temporary sandbag structure to protect the property, and to pursue a Shoreline Setback Variance. An April 17, 1995 letter from the City Department of Corporation Counsel stated in paraphrase from the Settlement Agreement, “Davis may protect the Property with sandbags until a design for a revetment for the protection of the Property is approved by the City after a public hearing, but in any event, the sandbags will be removed within 90 days of approval of the variance, or as otherwise agreed to by the parties.” *(Appendix A: City Corp. Counsel, Apr. 1995)* Davis worked with the Lanikai Community Association to determine what materials and design were best suited for shoreline sandbag protection, and subsequently constructed a sandbag revetment in line with the recommendations of the association. Based on the events that transpired in the 1990s, the current sandbag structure was permitted by the City, and was maintained and improved in accordance with existing authorization in 2014.

It has been over 20 years since the settlement agreement. The settlement agreement lists several terms and conditions, including payment of civil fines and contributions to the Lanikai Community Association. The applicants are new owners and do not have records confirming that payments were made. Records pertaining to the settlement agreement, including a sand replenishment/beach stabilization study, were requested from Lanikai Community Association, however, no records were received. The new owners have actively communicated with neighbors and the Lanikai Community Association to work collaboratively toward protection of the shoreline and the public beach access.

The settlement agreement was intended to facilitate application for a Shoreline Setback Variance in support of a rock revetment to protect the property at 1326 Mokulua Drive. The proposed action to construct a seawall with boulder slope scour apron is considered to satisfy the intent of the settlement. This environmental assessment demonstrates that a seawall with scour apron is a site appropriate solution in relation to the current certified shoreline. The new seawall with scour apron would be located outside of the State Conservation District, starting mauka of the certified shoreline and extending inland. The boulder slope of the scour apron provides the same functionality as a rock revetment would: to dissipate wave energy and promote sand accretion. The seawall provides long-term preservation/protection for the owner’s private residence. The proposed action will also open up an additional 20 feet of lateral access for the public. After years of neglect, the new owners wish to follow through with applying for a Shoreline Setback Variance in support of permanent shoreline protection at 1326 Mokulua Drive.

This EA is being prepared in support of an application for a Shoreline Setback Variance.

1.4 Overview of the Planned Project

A shoreline protection structure is planned to be constructed at 1326 Mokulua Drive as the property has been adversely affected by shoreline erosion. A temporary emergency sandbag structure was installed by the previous owner to protect the property from ongoing erosion conditions. The project proposes removal of the existing sandbag structure and replacing it with a shoreline structure composed of a seawall with boulder slope scour apron that will extend across the approximately 75-foot shoreline area. The removal of the 20 ft. wide sandbag complex will improve lateral access across this shoreline.

1.5 Purpose of the Environmental Assessment

In accordance with the requirements of Chapter 343, HRS, an EA has been prepared in support of an application to the City and County of Honolulu Department of Planning and Permitting for a Shoreline Setback Variance. This Draft EA will be published in the Office of Environmental Quality Control Environmental Notice, which will commence a 30-day public review period.

This EA is presented in eight sections and includes the following: a summary and project description; a list of necessary approvals; a description of the environmental setting; a discussion of potential impacts and proposed mitigation measures on identified natural, cultural, and socioeconomic resources as well as existing infrastructure; a description of alternatives; a discussion of the project's relationship to State and County land use plans and policies; findings supporting the anticipated determination; a list of references used in developing the EA; and a list of agencies, organizations, and individuals that participated in the pre-consultation phase of the EA.

After the 30-day review period of the Draft EA has concluded, public comments received will be considered and addressed to the extent feasible within the project scope and evaluation. A Final EA is prepared, highlighting key areas of the document that were revised, updated, or modified based upon information received during the public comment period. Upon acceptance of the Final EA, a Finding of No Significant Impact (FONSI) is anticipated.

1.6 Permits and Approvals Required

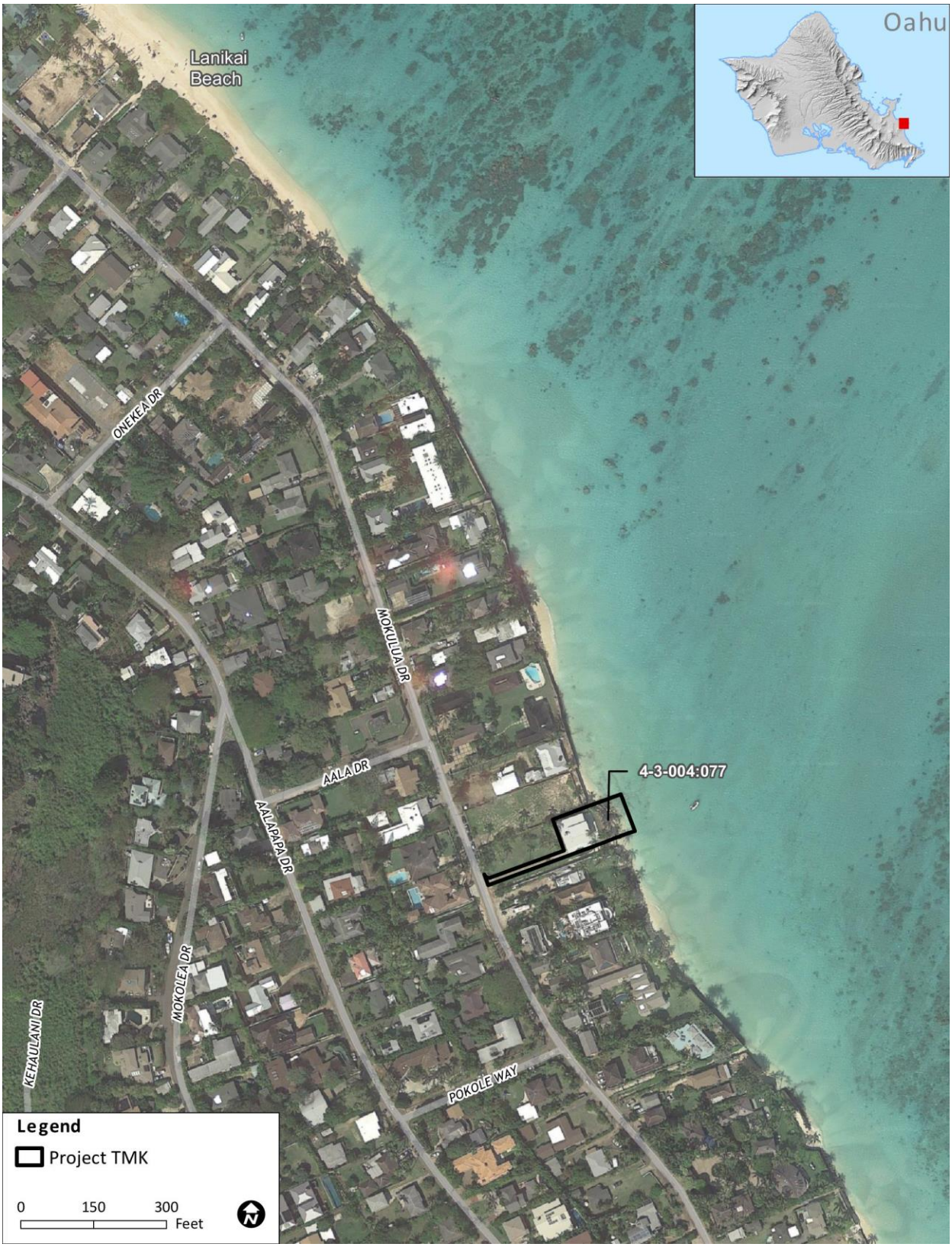
Several other approvals will be required from the State of Hawai‘i and City and County of Honolulu to implement the proposed action, some of which will include:

- Certified Shoreline Survey (Department of Land and Natural Resources (DLNR))
- Shoreline Setback Variance (Department of Planning and Permitting (DPP), Honolulu City Council)
- Minor Shoreline Structure (DPP)
- Building Permits (Structure) (DPP)
- Grading, Grubbing, Trenching and Stockpiling Permits (DPP)

The shoreline fronting the subject property has been surveyed and the approved shoreline certification from the Department of Land and Natural Resources is included in (*Appendix B*).

1.7 Agencies, Organizations and Individuals Contacted During the Pre-Consultation Process

To initiate the environmental review process pre-consultation communications were conducted with The Lanikai Association, property neighbors, DPP, and DLNR, Office of Conservation and Coastal Lands (OCCL) in 2018. A list of agencies and other parties that will be provided an opportunity to review the Draft EA is provided in *Section 8.0* of this document.



Project Location and TMK Parcel **Figure 1-1**

Section 2

Description of the Project

Chapter 2

Description of the Project

2.1 Site Characteristics

Location

The project is located in the Lanikai community in the Koʻolaupoko District of the island of Oʻahu, Hawaiʻi, within the traditional moku of Koʻolaupoko and ahupuaʻa of Kailua. The project site is located on the 1,690 SF seaward portion of Tax Map Key (TMK) (1) 4-3-004:077. The property is adjacent to the Pacific Ocean to the east, Mokulua Drive to the west, a vacant residential lot to the north and a public shoreline access path/drainage easement to the south *(Figure 1-1)*.

Existing On-Site Land Uses

The project is located on the seaward portion of a 12,380 SF flag lot owned by Fairwater Hawaii LLC and Sandbags LLC. A rock wall forms the property boundary on the north and south sides of the property. A concrete driveway connects Mokulua Drive to the existing two-story single-family home *(Figure 2-1)*, which is currently being threatened by active shoreline erosion. A narrow strip of sand separates the residence from the temporary sandbag structure which spans approximately 75 feet of shoreline. The existing sandbag structure was permitted by the City and County of Honolulu for shoreline protection in 1995. The sandbag structure is approximately 30 feet deep, starts at a depth of approximately -1 foot msl, and slopes inland up to an elevation of nearly 10 feet msl.

Additional site photographs of existing conditions are shown in *Chapter 3, Figure 3-8A through 3-8G.*

Residence and Shoreline Transition **Figure 2-1**

Adjacent Land Uses

Land uses adjacent to the project site include residential areas to the north and south, Mokulua Drive to the west, and the Pacific Ocean to the east. There is approximately 1,050 linear feet of armored shoreline to the north of the subject property. The project area is the sole property without hardened structures along the southern Lanikai coastline (*Figure 2-2).* Immediately adjacent the project site to the north is a vacant residential lot protected by a seawall (*Figure 2-3).* Adjacent to the south side of the property on TMK 4-3-004:096 is a public shoreline access pathway and drainage easement that abuts a concrete headwall at the shoreline. Makai of the headwall are sandbags located where the path transitions to a submerged sand beach (*Figure 2-4*). The owners will continue to coordinate with the Lanikai Community Association on matters pertaining to the public beach access. Two single-family residences are located on the property to the south side of the access pathway. Those residences are protected by a rip rap shoreline protection structure with a wing wall at the public shoreline access (*Figure 2-5*). Further south of the project area is approximately 2,100 linear feet of armored shoreline extending to Wailea Point, characterized by a mix of seawalls, rock aprons, and revetments. Adjacent properties are not evaluated in this EA, and will not be included in the application for a Shoreline Setback Variance.

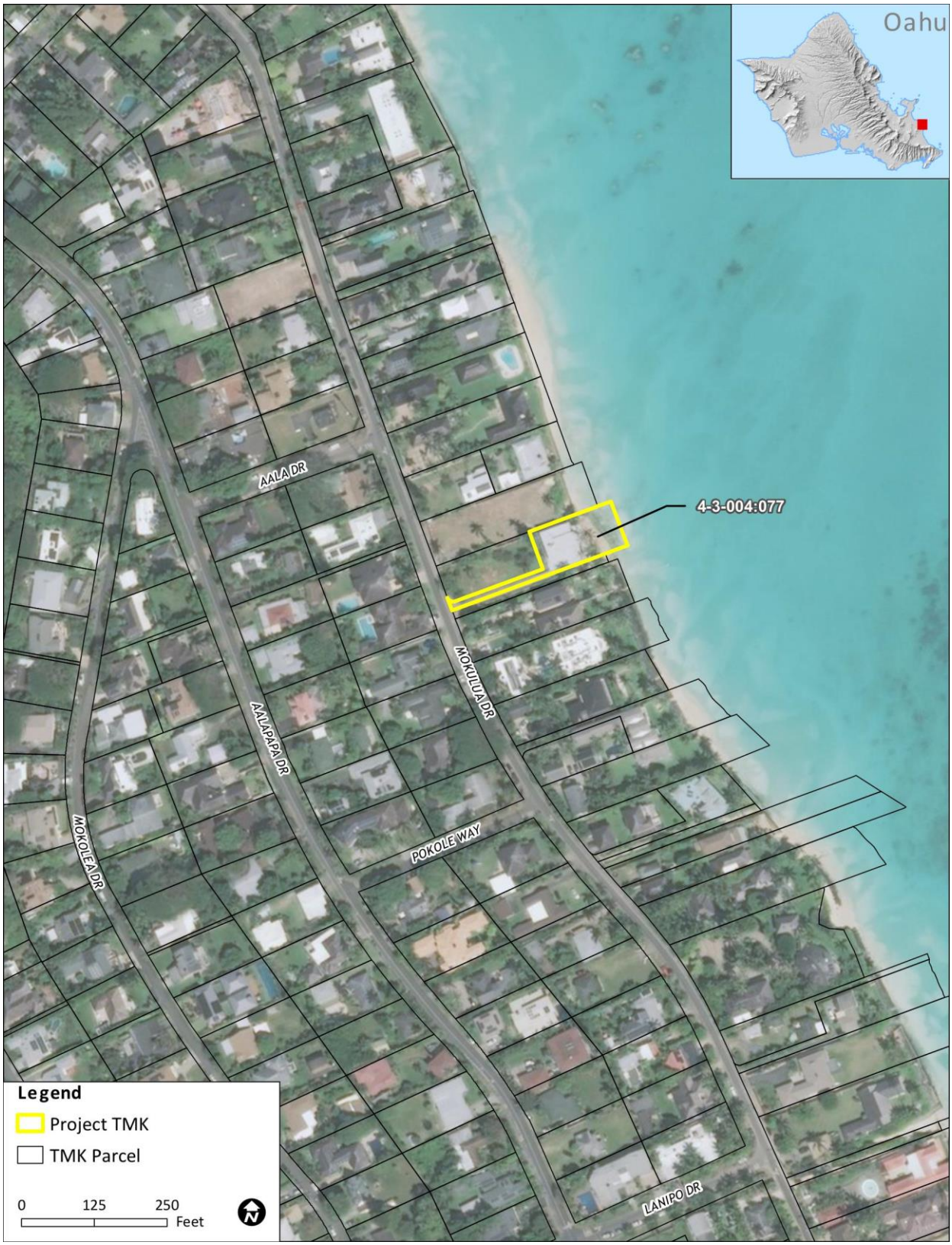
Narrow sand beaches exist along portions of the Lanikai shoreline and there is some public access to these areas, but lateral shoreline access is limited between them. Shoreline public access is available alongside the subject property. The public who access this part of the shoreline currently walk makai of the sandbags for lateral access. The subject beach, with wide fringing limestone reef flats protecting the coastline, is a recreational destination for snorkelers, swimmers, and spear-fishermen. Though the project area is used by beachgoers, there is limited parking and large portions of the beach are often submerged at high tide. There are no notable surf breaks directly offshore of the project site. Surfing areas are located far offshore, outside of the reef crest for the wide, shallow, fringing reef.

Shoreline Protection Adjacent to the Project Site **Figure 2-2**

Adjacent Property to the North with Seawalls (G70, 2018) **Figure 2-3**

Public Access Pathway and Transition to Submerged Beach (G70, 2018) **Figure 2-4**

Adjacent Properties to the South (G70, 2018) **Figure 2-5**



Project TMK and Adjacent Properties **Figure 2-6**

Shoreline Characteristics

The project coastline is characterized by a wide fringing limestone reef flat stretching over 3,000 feet offshore and along the Mokulua Islands. The fringing reef is incised with channels or depressions at numerous locations and has numerous sand patches. The fringing reef's shallow reef crest and reef flat provide protection to the shoreline from wave action. During typical conditions, significantly less wave energy reaches the shoreline than exists in deep water due to the shallow depths of the reef and subsequent wave breaking. Wave energy, however, still reaches the shore at higher water levels and cross-shore currents still exist. Sand in Lanikai Beach and the nearshore sand fields are mobilized through active longshore transport. Typical patterns on O'ahu's East Shore have shown beach sand being pushed offshore with winter swell events and a gradual transport back onshore during summer trade conditions. Longer term sand dynamics of Lanikai Beach have changed with the armoring of the shoreline. Prior to the late 1970's, Lanikai Beach showed a trend of accretion. This trend reversed causing erosion along the shoreline, and in response, property owners constructed seawalls and other hardened shoreline structures. In general, sand volume is vital to beach health, which helps to support and stabilize the beach and dune profile. A stable, sandy shoreline and frontal dune system provides excellent natural mitigation to coastal natural hazards (*Appendix D: Coastal Assessment).*

2.2 Purpose of the Project

Shoreline Protection

The project is intended to stabilize the shoreline and protect the property from increased coastal erosion. Shoreline erosion has encroached on properties in Lanikai with nearly all properties protected by shoreline protection structures (Figure 2-2). Geotextile sand bags have been installed along the subject property shoreline for emergency protection authorized by DLNR OCCL as a temporary measure to slow erosion. However, coastal erosion has persisted, posing increased threats to the property and home.

Shoreline Setback Variance

This EA is being prepared in accordance with HRS Chapter 343, as development in a shoreline area triggers the state Environmental Impact Statement law. An EA is also requisite for submittal of the forthcoming Shoreline Setback Variance. Activities in a shoreline area are defined and regulated in ROH Chapter 23. Per ROH 23-1.8 (b)(3), the director may grant a variance upon finding that the proposed activity meets the hardship standard. The proposed project meets the hardship criteria as listed in ROH 23-1.8 (b)(3) Hardship Standard. Please refer to Section 5.8 *Shoreline Setbacks* for further discussion.

2.3 Proposed Action

The project will involve construction of a seawall with scour apron along the shoreline. The existing sandbag revetment will be retained during construction to provide water quality protection. The project will begin with the placement of silt control features and site preparation. The seawall with a boulder slope scour apron will be installed inland of the certified shoreline *(Figure 2-7)* for the property. The existing temporary sand bags be removed after construction.

The seawall will consist of a vertical concrete wall with riprap scour apron used to protect the land from wave damage and erosion. A seawall is a proven, durable, and relatively low-maintenance shore

protection method. Seawalls also have the advantage of having a relatively small footprint along the shoreline, which helps to preserve lateral shoreline access.

The proper riprap toe apron structure will reduce scour of sand and significantly reduce reflected wave energy. This reduction in wave energy at the face of the seawall is expected to allow sand build up makai of the structure when there is available material. At the completion of the seawall and scour apron the existing sand bag complex will be removed.

The foundation of the seawall is critical for its stability, particularly on sandy and eroding shorelines. The seawall will be constructed on solid, non-erodible substrate, reinforced with concrete as necessary to fill voids. To minimize end scour and flanking erosion associated with the terminations of the seawalls, concrete wing walls joined with adjacent structures will be constructed at the north and south termini of the seawall.

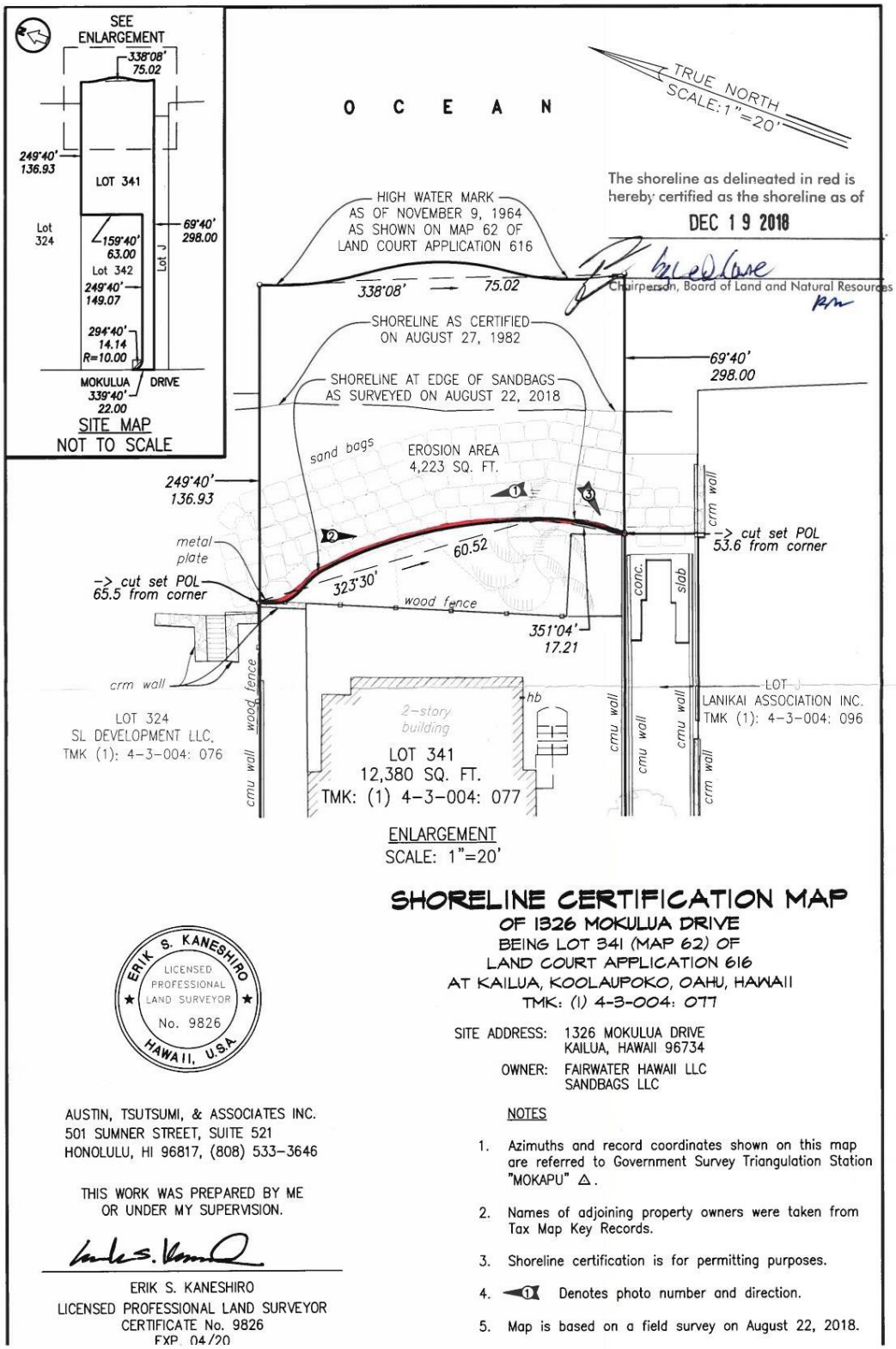
Preliminary Design of the Shoreline Structure

Tanimura and Associates, Inc. structural engineers prepared preliminary design drawings for the proposed seawall with boulder slope scour apron.

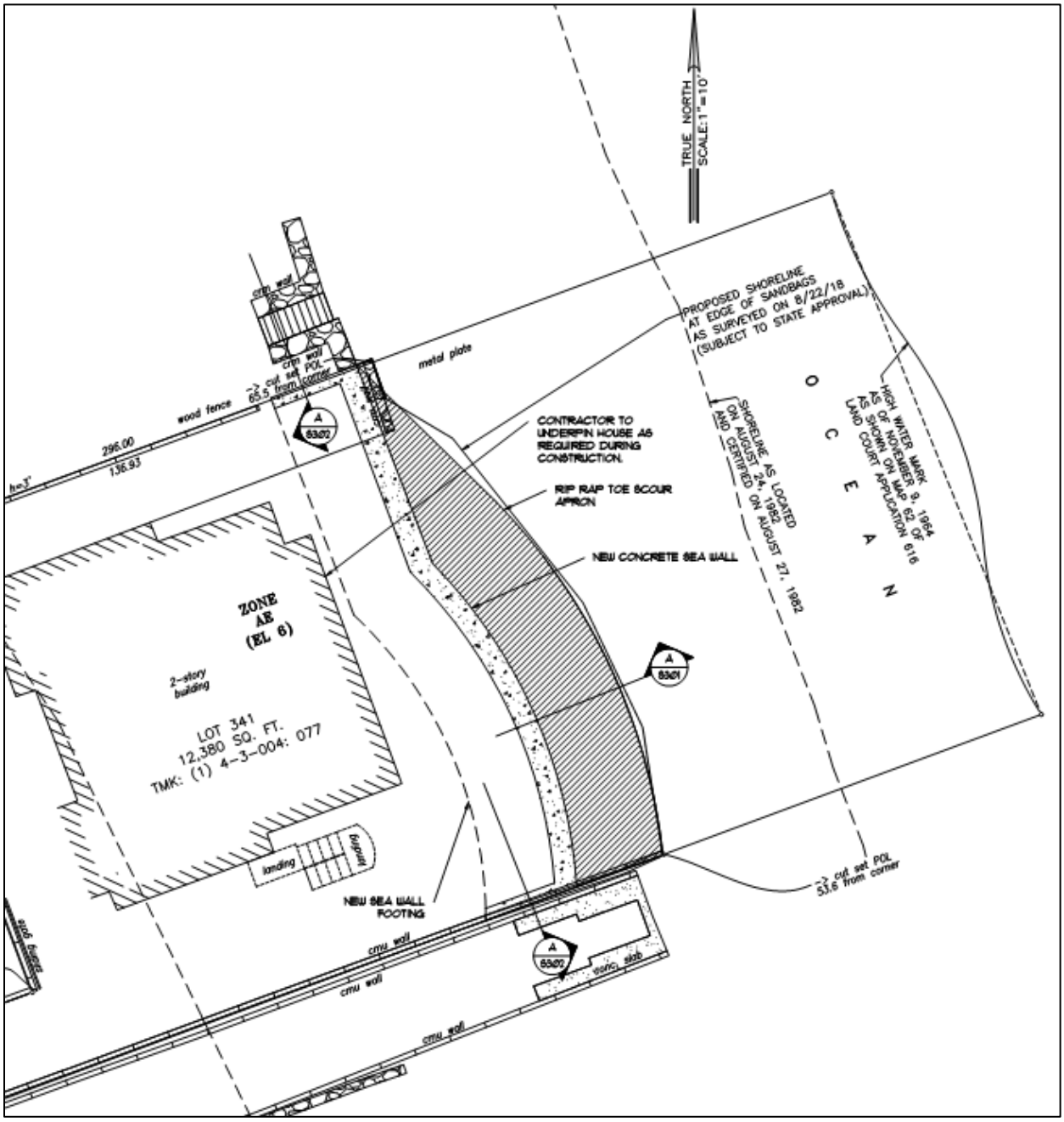
The seawall portion of the shoreline structure will be located mauka of the certified shoreline boundary and constructed of concrete or CRM. The total length of the seawall is approximately 75 linear feet, forming a gentle arc across the ocean side of the property (*Figure 2-8)*. The toe of the seawall would originate at approximately -8.0 feet msl to anchor in the hard substrate. The seawall would be approximately 18 feet tall, with 8 feet submerged below 0 msl, and 10 feet rising above water to meet existing ground level mauka of the wall (*Figure 2-9*). The mauka side of the structure will have granular backfill material wrapped in filter fabric. Wing walls would be constructed on the north and south end of the seawall as shown in *Figure 2-10, Connections at Wing Walls*.

A scour apron is a sloping boulder structure that is designed to dissipate wave energy and allow sand accretion. A boulder slope scour apron will be installed seaward of the proposed seawall. Riprap stone size is based on the design wave height of 5.1 feet at the structure during the 50-year NE swell event. The riprap structure shall consist of a gradation of stone sizes with an anticipated design face slope of 1V:1.5H (*Figure 2-9).* The scour apron will reduce reflected wave energy and will facilitate beach accretion in the area. Reflected energy reduction may not be significant, and structurally the apron is not necessary to protect the wall from scour.

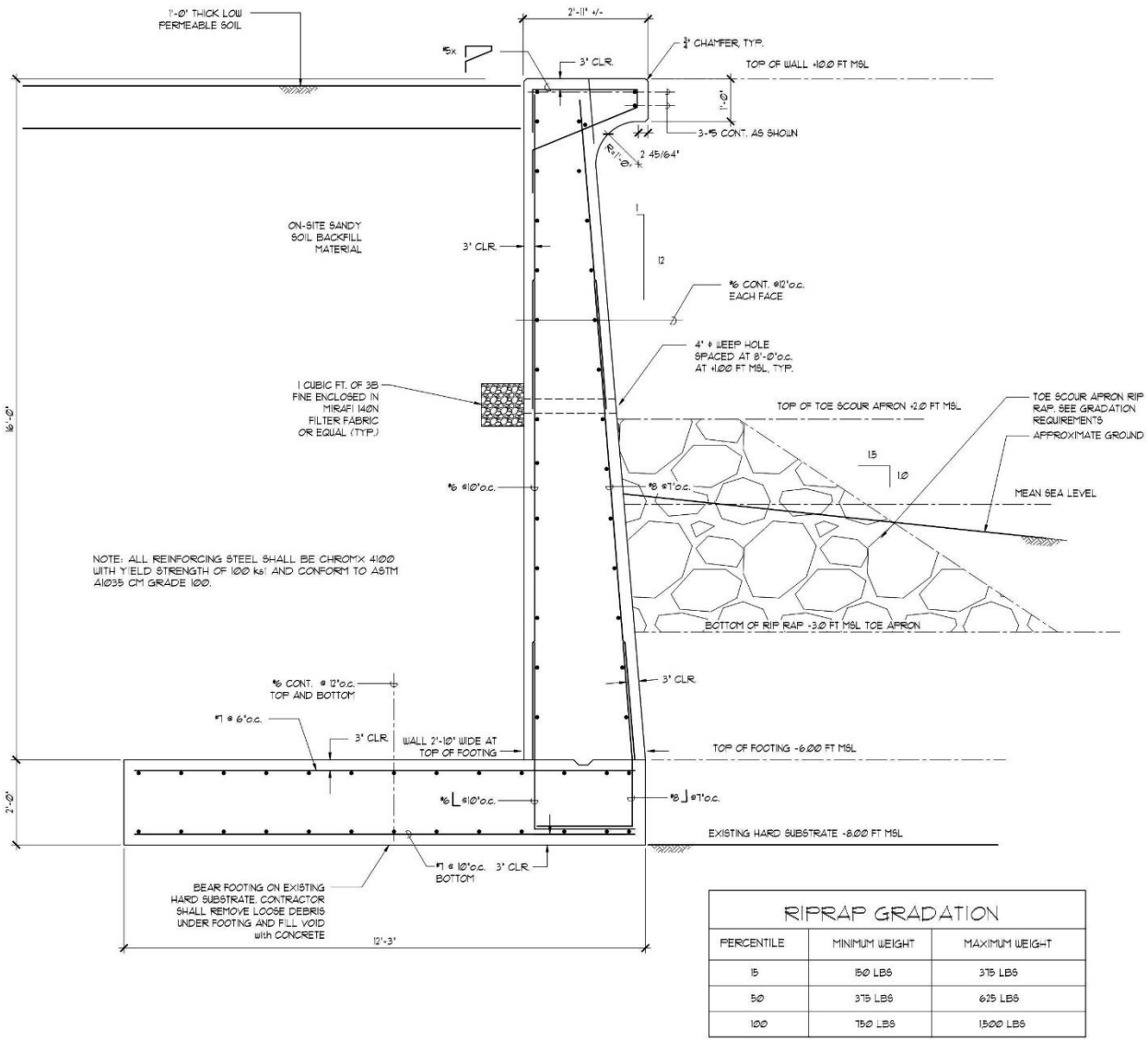
With the removal of the extensive 20 ft. wide sandbag complex fronting this shoreline property, the public lateral access will be substantially improved.



Certified Shoreline Survey **Figure 2-7**



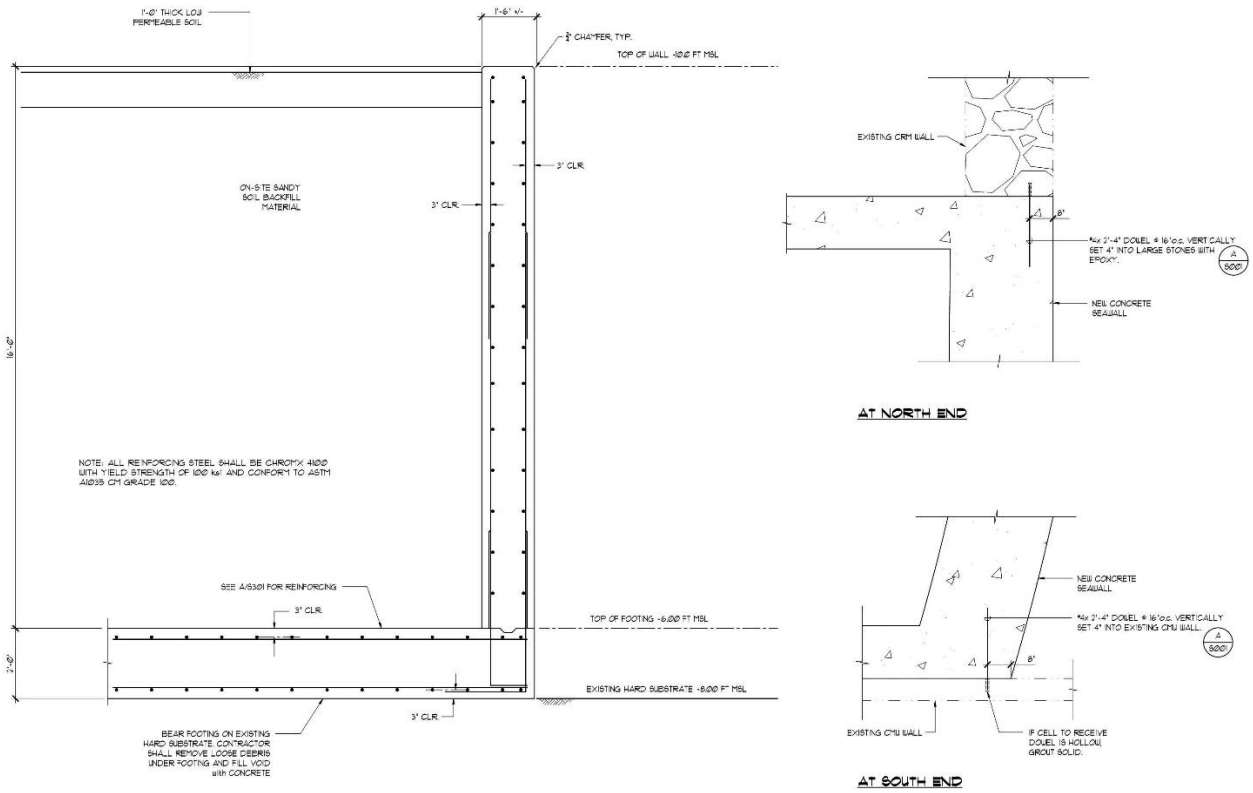
Preliminary Shoreline Structure Footprint (Tanimura & Associates, 2018) **Figure 2-8**



RIPRAP GRADATION

PERCENTILE	MINIMUM WEIGHT	MAXIMUM WEIGHT
15	150 LBS	375 LBS
50	375 LBS	625 LBS
100	750 LBS	1500 LBS

Section View of Preliminary Shoreline Structure (Tanimura & Associates, 2018) **Figure 2-9**



Connections at Wing Walls (Tanimura & Associates, 2018) **Figure 2-10**

2.4 Construction Characteristics

Construction can be accomplished from the upland areas with minimal disturbance to site topography. Vegetation clearing and grubbing will be very limited. There will be minor grading and excavation (cut and fill). Excavation will occur along the 75-foot revetment alignment to construct the foundation and concrete wall. Approximate excavation volume for the project is 836 cubic yards, which will be retained and backfilled. Construction materials and equipment will be stored on the property. Construction work will be performed in accordance with the Federal, State, and City code and design standards.

Construction activity hours will be from 7:00 am to 6:00 pm. Construction will adhere to applicable noise regulations as per Title 11, Chapter 46, of the Honolulu Administrative Rules 11-46. Typical construction vehicles will be used on the jobsite for the development of the project. These may include front-end loader, dump truck, and flatbed delivery trucks. As necessary, a permit will be obtained from DOT Highways for transport of light trucks, backhoe, oversize equipment and overweight loads.

Nearshore ocean water quality in the project vicinity will be protected by the implementation of Best Management Practices (BMPs) during the construction of the seawall. To minimize temporary effects of suspended sediments in nearshore waters, mitigation such as a floating silt curtain will be deployed along the seaward edge of the construction segment, to contain the limited amount of suspended material along the immediate beach area during construction. Retention of the sandbag revetment would serve as a functional barrier to protect the construction work area and be highly effective in maintaining runoff and suspended sediment from reaching the ocean. Excavation for the seawall will utilize a temporary cofferdam to contain loose material and suspended sediment and avoid wave

energy disruption of the excavation area. Excavation, dewatering, and placement of the foundation will be conducted over a short time period to minimize the period of disruption to the beach area and nearshore waters.

The combined effects of multiple BMPs should result in improved protection for both nearshore water quality and the construction area. Work will be completed over a course of 90 to 120 days.

2.5 Utilities and Infrastructure

Overall existing conditions, impacts, and mitigation measures for utilities are discussed in *Chapter 3.0* of this document. Existing vehicular access to the project site is from Mokulua Drive. The subject property has water supply (BWS), sewer, electricity (HECO), communications, and municipal solid waste collection services. The property is not served by storm drainage infrastructure. There will be no additions or changes to utilities and infrastructure.

2.6 Summary of Projected Costs

The construction cost for the shoreline protection is estimated at approximately $450,000.

Section 3

Description of the Environmental Setting, Potential Impacts and Mitigation Measures

Chapter 3

Description of the Environmental Setting, Potential Impacts, and Mitigation Measures

This section describes the existing environmental setting and identifies possible impacts of the planned shoreline protection structure. Strategies to mitigate potential impacts are also identified.

3.1 Topography

Existing Conditions

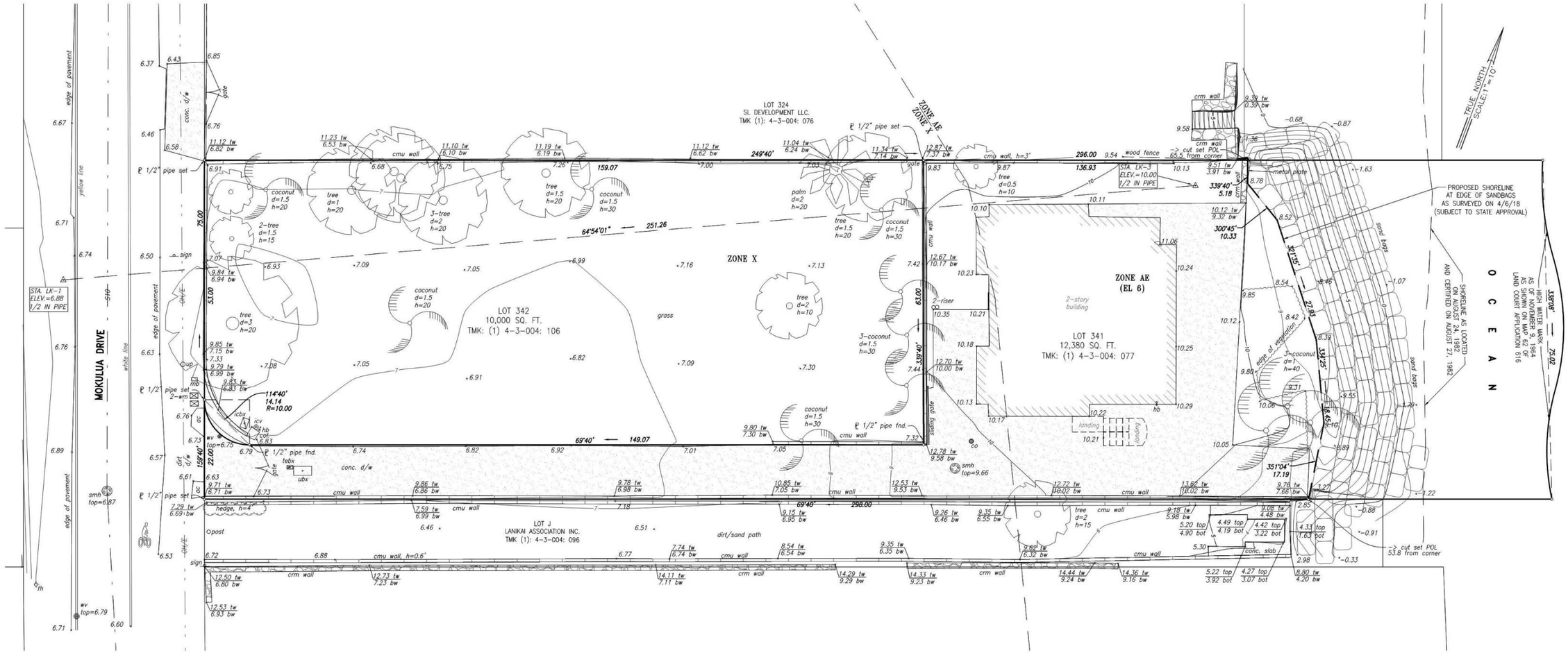
The subject property is located in the Lanikai neighborhood of Kailua, O‘ahu. The property rests on a relatively flat coastal plain and gently slopes from approximately 7 feet above sea level on the south/mauka side up to approximately 10 feet above sea level on the north/makai side. Stacked sandbags along the north side of the property form a temporary shoreline revetment that deters further shoreline erosion. The sandbag revetment starts at approximately 2 feet below sea level and stacks up against the north side of the property to approximately 9.5 feet above sea level (*Figure 3-1*).

The December11, 2018 ATA shoreline survey identified the shoreline boundary at the crest of the existing temporary shoreline protection sandbags. The DLNR issued certification of the shoreline on January 5, 2019.

Anticipated Impacts and Mitigation Measures

The shoreline protection structure will be constructed inland of the certified shoreline. No substantial changes to the site’s topography are proposed, although some excavation and grading will be required during the construction process to accommodate the new shoreline protection structure. Best Management Practices (BMP) will be implemented pursuant to the required Grading Permit to mitigate potential impacts of soil erosion and fugitive dust during grading or excavation. The removal of the 20 ft. wide sandbag complex will greatly improve public lateral access along this shoreline.

This page left intentionally blank.



ABBREVIATIONS:

bw	bottom wall
bot	bottom
cmu	concrete masonry unit
co	clean out
crm	concrete rubble masonry
d	diameter
elev	elevation
fh	fire hydrant
fnd	found
h	height
hb	hose bib
icbx	irrigation box
icv	irrigation control valve
mb	mail box
smh	sewer manhole
sta.	station
tebx	telephone box
tw	top wall
ubx	utility box
up	utility pole
wm	water meter
wv	water valve

Site Topography (Source: ATA 2018) **Figure 3-1**

This page left intentionally blank.

3.2 Soils and Shoreline Erosion Conditions

Existing Conditions

Soil types within the project site are identified in the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) Web Soil Survey. The USDA NRCS system classifies soils by type and permeability characteristics, including run-off and erosion. The site consists of Beaches and Jaucus Sand, 0-15 percent slopes (JaC) (*Figure 3-2*). This type of soil is well drained, and runoff is low. Boring samples conducted by Shinsato Engineering in April 2018 revealed soil composition as primarily sand with some elastic silt as shown in *Appendix G*.

The longer-term dynamics of Lanikai Beach's sands have changed with the gradual armoring of the shoreline. Prior to the late 1970s, Lanikai Beach showed accreting sands, which gradually reversed, causing erosion along the shoreline. In response, seawalls and other hardened shoreline structures were constructed by shoreline property owners.

Offshore of the site, the project area is characterized by expansive fringing limestone reef flats over 3,000 feet offshore along the Mokulua Islands. There are channels or depressions at numerous locations along the reef. During typical conditions, significantly less wave energy reaches the shoreline. Wave energy still reaches the shore at high water levels and cross-shore currents still exist. Sands in the area are mobilized through active longshore transport. Typical patterns for East O'ahu show sand being pushed offshore with winter swells and gradual transport back onshore during summer trades.

The shoreline at the project site has experienced erosion for many years, but the process was buffered with sandbags since 1994. The project area shoreline is bounded by a rock seawall at the north end and riprap at the south end. North of the project area is approximately 450 linear feet of armored shoreline. The shoreline makai of the sandbags is a wet beach that moves with inflation and deflation. There is no dry beach at the project site. Sediment is transported in the region under the influence of waves and nearshore currents.

Since the initial sandbags were installed in 1994, many iterations of maintenance to the structures have been required. In 2014, the sandbag structure was partially rebuilt during a maintenance effort. The sandbags are an attractive coastal recreation location for residents and the public who come and sit on the sandbags. Public uses of the sandbag structure may have contributed to wear over the years, which has resulted in a security concern of the property owners. In 2017, additional maintenance was conducted on the structure, including replacing sandbags along sections of the structure to repair the face and to prevent wave over-topping. Currently, the sandbag structure has seen the loss of several sandbags on the face and needs repair or replacement in some areas.

Topographic surveys performed by Sea Engineering, Inc. (SEI) in March 2018 and by ATA in April 2018 were combined to generate three shoreline profiles to show the cross-shore profile of the sandbag revetment *(Figure 3-3)*. The shoreline boundary is located at the crest of the existing temporary sandbag erosion control structure.

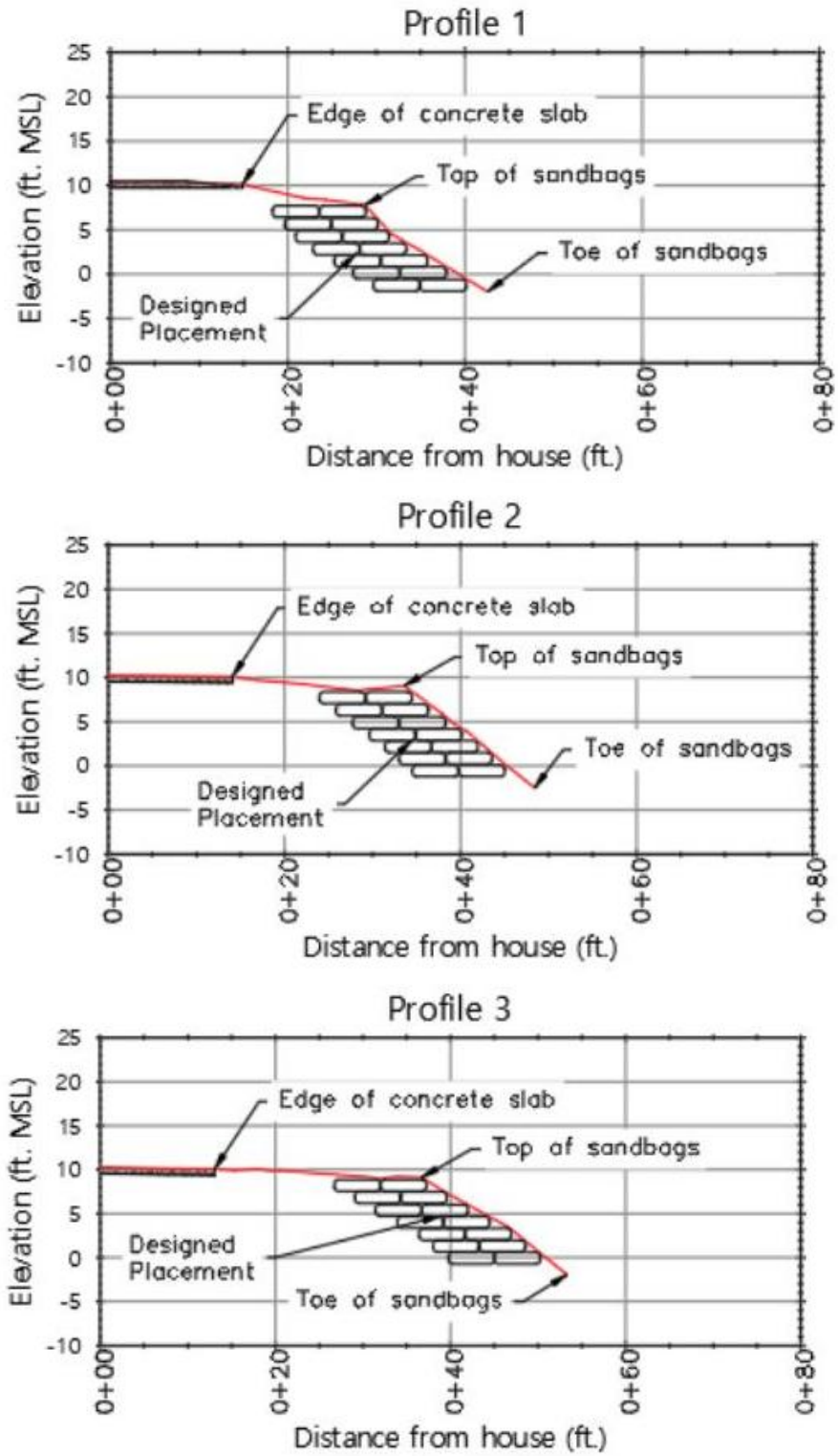
Soils Map **Figure 3-2**

Existing Sandbag Shoreline Protection Profiles **Figure 3-3**

Profile 1: Profile 1 is located on the northern portion of the parcel and extends from the makai boundary of the concrete slab of the home to the beach toe (*Figure 3-3 and 3-4*). The profile ends at the toe of the sandbags.

Profile 2: Profile 2 is located on the mid portion of the parcel, and extends from the boundary of the concrete slab of the home to the toe of the sandbags (*Figure 3-3 and 3-4*).

Profile 3: Profile 3 is located on the southern portion of the parcel and extends from the edge of concrete slab of the home to the toe of the sandbags (*Figure 3-3 and 3-4*).



Exisiting Sandbag Shoreline Protection Profiles **Figure 3-4**

Anticipated Impacts and Mitigation Measures

There will be limited soil disturbance during project construction. Erosion control practices will comply with County, State, and Federal regulations. BMPs will be implemented pursuant to the required Grading Permit to mitigate potential impacts of soil erosion and fugitive dust during grading or excavation. These practices could include sediment traps, silt fences, dust fences.

In the long term, the new shoreline structure with boulder slope scour apron would slow the impacts from rapid erosion along the shoreline. The soil composition will not change due to the shoreline structure. The placement of this structure is not anticipated to cause adverse effects to the shoreline of adjoining properties. The removal of the 20-foot wide sandbag complex will greatly improve public lateral access and sand flow.

3.3 Climate

Existing Conditions

According to the University of Hawai‘i Geography Department *Climate of Hawai‘i* interactive mapping tool, the windward and northern regions of the island are typically wetter than the western and southern regions. A typical year in Lanikai has approximately 31.4 inches of rainfall, and an average of 2.6 inches of rainfall per month. The wettest month of the year is December with an average of 4.9 inches of rainfall. The annual average air temperature in Lanikai is 73.8°F. The average monthly low temperature is around 70.1°F in January and the average monthly high temperature is around 77.3°F in August.

Anticipated Impacts and Mitigation Measures

The project will have no long-term effect on climatic conditions, and therefore no mitigation measures are required. The project will make provisions in response to anticipated effects of climate change and sea level rise as discussed in *Section 3.5, Sea Level Rise*.

3.4 Natural Hazards

Existing Conditions

Flooding

Based on the Federal Emergency Management Agency’s *Flood Insurance Rate Map*, the project site is located in Zone AE and Zone X. Zone AE is defined as, “areas subject to inundation by the 1-percent chance flood event by detailed methods.” Zone X is defined as “areas of minimal flood hazard, which are the areas outside the Special Flood Hazard Area and higher than the elevation of the 0.2 percent-chance flood” (FEMA 2017) (*Figure 3-5*).

Tsunami

While tsunami inundation of low lying coastal areas is a natural phenomenon in Hawai’i, it is infrequent. The islands are exposed to the major tsunami wave generating areas of the Pacific Ocean. The coast falls within the County’s tsunami inundation evacuation zone.

Seismic Activity

Per the 2006 International Building Code (IBC) seismic design maps, the entire City and County of Honolulu could experience seismic activity around 0.15 of the earth's gravitational acceleration (g-force) under a 1.0 second spectral response acceleration event. In comparison, the County of Hawai'i, with its ongoing volcanic activity, could experience ground motion anywhere from 0.30 up to 1.23 of the earth's g-force. In May 2018, the island of Hawai'i experienced a 6.9 magnitude earthquake due to volcanic activity at Kīlauea (USGS Earthquake Hazards Program).

Anticipated Impacts and Mitigation Measures

The purpose of the project is to reduce the subject property's overall vulnerability to natural hazards that may contribute to shoreline erosion conditions. The project is expected to help alleviate typical erosion activity along this shoreline, and create protection from high wave action during storm events.

Flood Zones **Figure 3-5**

3.5 Sea Level Rise

Existing Conditions

Sea level rise has the potential to impact beaches and shorelines in Hawai‘i. Impacts may include beach narrowing and beach loss, loss of land due to erosion, and infrastructure damage due to inundation and flooding. The impacts from anomalous sea level events (e.g., king tides, mesoscale eddies, storm surge) are also likely to increase

In 2017, the National Oceanic and Atmospheric Administration (NOAA) revised their sea level change projections through 2100 considering up-to-date scientific research and measurements. Figure 3-7 presents mean sea level rise scenarios for Hawai‘i based on NOAA projections. An important conclusion of this regional climate assessment is that NOAA recommends the revised *Intermediate* rate for planning and design purposes in Hawai‘i. The *Intermediate* rate projects that sea level in Hawai‘i will rise 2.3 feet by 2070. Given the recent upwardly revised projections and the potential for future revisions, consideration may also be given to the *Intermediate-High* rate for planning and design purposes, which projects that sea level in Hawai‘i will rise 3.4 feet by 2070.

In 2017, State of Hawai‘i recently published the *Sea Level Rise Vulnerability and Adaptation Report for Hawaii*, which discusses the anticipated impacts of projected future sea level rise on coastal hazards, and the potential physical, economic, social, environmental, and cultural impacts of sea level rise in Hawai‘i (Hawaii Climate Change Mitigation and Adaptation Commission, 2017). The report combines data from the Intergovernmental Panel on Climate Change (IPCC) Assessment Report 5 (IPCC 2014), the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration, and the best-available peer-reviewed scientific research articles. According to the report, “While the IPCC’s “business as usual” scenario, where GHG emissions continue at the current rate of increase, predicts up to 3.2 feet of global sea level rise by year 2100 (IPCC 2014), recent observations and projections suggest that this magnitude of sea level rise could occur as early as year 2060 under more recently published highest-end scenarios (Sweet et al. 2017). As such, questions remain around the exact timing of that rise due largely to uncertainties around future behavior of Earth’s cryosphere and global GHG emission trajectories. For this reason, it is vital that the magnitude and rate of sea level rise is tracked as new projections emerge, plan for 3.2 feet of sea level rise now, and be ready to adjust that projection upward.”

At the City level, Mayor Kirk Caldwell issued an executive order on climate change and sea level rise in July 2018 with the intention of establishing City policies to address climate change and sea level rise in accordance with the 2017 *Sea Level Rise Vulnerability and Adaptation Report for Hawaii*, and two publications from the Climate Change Commission: *Sea Level Rise Guidance* and the *Climate Change Brief*, both of which were adopted on June 5, 2018. The guidance issued through these publications echoed that a 3.2-foot sea level rise scenario by the end of the century was a reasonable benchmark for planning purposes (City Climate Change Commission, 2018).

3.2-Foot Sea Level Rise Scenario **Figure 3-6**

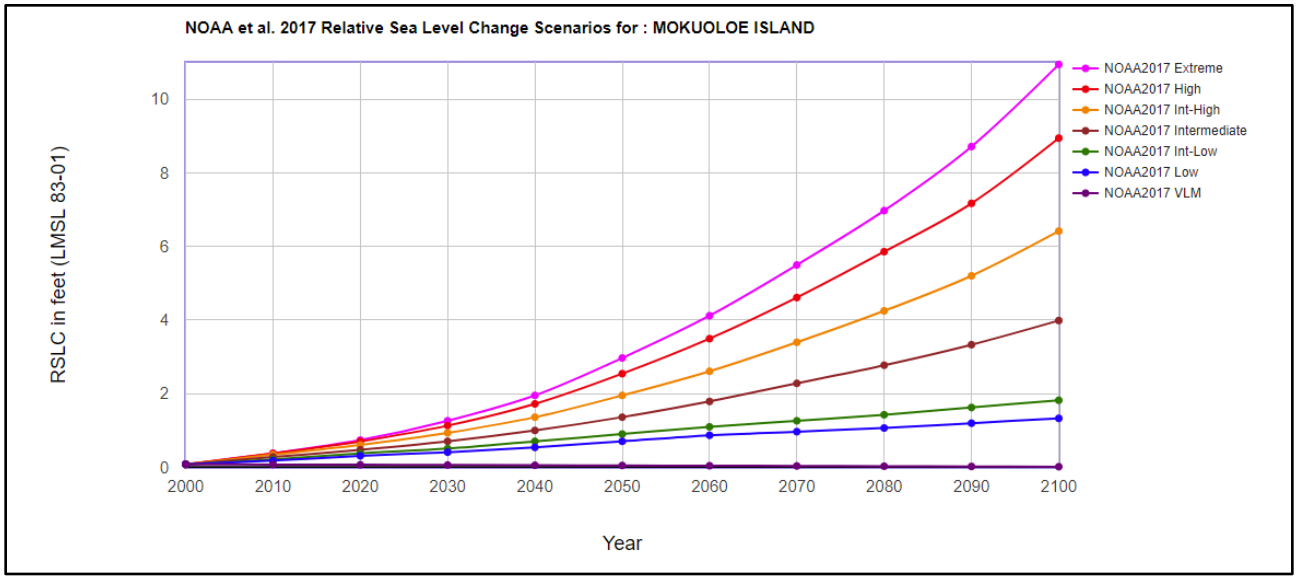


Figure 3-7 **Hawai'i Sea Level Rise Projections (adapted from NOAA, 2017)**

Anticipated Impacts and Mitigation Measures

A sea level rise of 2.3 feet was chosen by Sea Engineering, Inc. for design purposes at the project property. This sea level rise scenario was utilized as a basis for the design life for the various shoreline protection alternatives discussed in Chapter 4. The 2.3-foot sea level rise scenario corresponds to NOAA's *Intermediate* rate over a 50-year shoreline structure design life which is suitable for planning and design purposes for a project of this scale. While critical infrastructure such as roads, power plants, and hospitals may require the highest level of protection, it is reasonable to design coastal protection and stabilization structures for a lesser level, in this case a 50-year lifespan. Coastal structures require ongoing monitoring and regular maintenance due to their exposure to the degrading effect of marine processes. The basis of design parameters, and consequent design life are based on typical functional use of similar coastal structures. Designing for conditions, such as significantly higher sea levels, that are predicted for time periods that well exceed the design life of the structure will produce more robust installations but will well exceed their functional performance requirements during their serviceable lifespans.

Designing for a lesser sea level rise is still consistent with the City directive, as the sea level rise that the coastal stabilization structures evaluated in this report are expected to experience during their design lifetime would likely be much less than the 3.2 feet presented in the directive.

3.6 Biological Resources

3.6.1 Terrestrial Biology

Existing Conditions

The project site is situated within a coastal residential area of Kailua. Vegetation on the property includes patches of naupaka *(Scaevola taccada)*, coconut trees (*Cocos nucifera), ‘*akoko (*Chamaesyce celastroides),* and other ornamental plants. No plant species found within the project site are known to be protected under State or Federal environmental laws.

Mammalian species commonly found in beach environments on the Windward side of the island include rats (*Rattus sp.*), house mouse (*Mus musculus*), and Indian mongoose (*Herpestes a. auropunctatus*).

Avian species common to Lanikai include the common mynah (*Acridotheres tristis*), Red-Crested Cardinal (*Paroaria coronate*), Northern Cardinal (*Cardinalis cardinalis*), Java Sparrow (*Padda oryzivora*), Spotted Dove (*Streptopelia chenensis*), Zebra Dove (*Geopelia striata*), and Japanese White-eye (*Zosterops japonicus*). In addition, Hawaiian seabirds may traverse the project area during Seabird Fallout Season (September 15 - December 15) when young seabirds and adults start their navigation out to sea (DOFAW Seabird Fallout Season). The project site is in close proximity to a nesting population of wedged-tailed shearwaters (*puffinus pacificus*), known in Hawaiian as ‘ua‘u kani, and other common shorebird species (DOFAW, Mokulua Islets State Wildlife Sanctuary). During the breeding season wedge-tailed shearwaters excavate burrows on low, flat islands, and sand splits with little or no vegetation. Most eggs are laid in June with most young fledging in November (DLNR, Seabirds ‘Ua‘u kani or Wedge-tailed Shearwater).

The Hawaiian Hoary bat (*Lasiurus cinereus semotus*), known in Hawaiian as ‘ōpe‘ape‘a, is an endangered species endemic to the Hawaiian Islands. According to the Department of Land and Natural Resources, the Hawaiian Hoary Bat*,* roosts in native and non-native vegetation from one to nine meters (3 to 29 feet) above ground level (DLNR, ‘Ōpe‘ape‘a or Hawaiian Hoary Bat). The bat is known to inhabit forested areas and is not commonly observed in coastal environments.

There are no known threatened or endangered terrestrial species present on the site or in the vicinity of the site.

Anticipated Impacts and Mitigation Measures

The project will affect a patch of naupaka shrub plants and three palm trees on site. None of the vegetation within the project site is known to be Federal or State threatened or endangered or candidate species. No threatened or endangered mammals will be affected by construction or implementation of the project.

There will be no new lighting associated with the shoreline revetment. Construction activities will be limited to daylight hours and will avoid the use of construction work lights which may attract and disorient migrating seabirds. There is no known habitat for wedge-tailed shearwater on the site. Further, the shoreline is currently protected by shoreline erosion control sandbags; as such, the shoreline does not currently provide preferred habitat for shearwater birds. Although no habitat is present, a visual survey for seabirds will be done prior to construction, If any stranded seabirds are found on the project site, especially during fallout season, a relocation plan will be developed in consultation with Sealife Park’s Seabird Rehabilitation Facility or other comparable organization…

3.6.2 Marine Biology

Existing Conditions

A Base Assessment of the Marine Environment was prepared by Marine Research Consultants, Inc. (MRCI) in June 2018 (*Appendix E*). MRCI conducted field assessments of the physical, chemical, and biological composition of the nearshore waters encompassing the areas that could be affected by the shoreline improvements. During the course of the swim surveys, several species of fish were noted, including surgeon fish (e.g., *acanthurus triostegus),* tetradonts (e.g., *canthigastor jactotor),* a Chinese trumpetfish (*aulostomus chinensis)*, and unidentified juveniles. These species are common on Hawaiian reefs and are not rare or unique species assemblages. No large individuals that would be considered favorable for human consumption were observed.

The nearshore benthic environment is very sandy with fossil coralline substrate and encrusting algae with common invertebrates. There are no live coral colonies found in the nearshore area offshore the property.

Marine protected species that frequent Hawaiian waters include the indigenous populations of Hawksbill turtle (*eretmochelys imbricate*) and the Hawaiian green sea turtle (*Chelonia mydas*), listed as endangered and threatened under the Endangered Species Act (ESA), respectively. Each of these species shows fidelity to their natal beaches, returning to nest during their reproductive years. Hawksbill turtles are known to mainly nest on the islands of Maui, Molokai and Hawai‘i (NOAA Fisheries, Hawksbill). The majority of the Hawaiian green sea turtle nesting (96%) occurs in the French Frigate Shoals located in the Northwestern Hawaiian Islands (NOAA Green Sea Turtle profile). Neither species of turtle was observed within the survey area over the course of the MRCI study.

The Hawaiian monk seal (*monachus schauinslandi)* is another ESA listed species that is endemic to the waters off the Hawaiian Islands. These endangered seals commonly haul out onto sandy beaches to rest. NOAA Fisheries has revised the ESA Critical Habitat for the Hawaiian monk seal in the main Hawaiian Islands to include terrestrial habitat that extends 5 meters inland from the shoreline between designated boundary points (NOAA Fisheries Hawaiian Monk Seal Critical Habitat). The shoreline would not meet the criteria to support monk seal conservation because it is not a natural sandy shoreline environment. No seals were observed during the survey work at the property.

Anticipated Impacts and Mitigation Measures

Due to the narrow or non-existent beachfront at the subject property, with no sand dune habitat and an extreme seasonal fluctuation in beach sand levels, the probability of sea turtles nesting or foraging in the project area is minimal. Work in the beach area will closely monitored during the sea turtle nesting or hatching season (May to October). To avoid potential effects to sea turtles that may bask in the nearshore area during construction, the marine construction company will evaluate the shoreline area prior to construction work daily to ensure no turtles are present. If a basking sea turtle is found, all mechanical or construction activities will cease within 100 feet until the animal voluntarily leaves the area. Further, any construction-related debris or beach equipment that may pose an entanglement threat to green sea turtles from the project site shall be removed if not actively being used at the conclusion of the project. Project-related materials will not be stockpiled in the intertidal zone and reef flats. In the long term, a stabilized shoreline setting and natural seasonal fluctuation of the beach inflation/deflation will result in improved conditions for turtles than exists presently.

The hardened shoreline environment along this shoreline does not provide monk seal habitat and no further mitigation is necessary.

Water quality best management practices will also be incorporated into the design to minimize erosion and sedimentation in the marine environment.

3.7 Ocean Water and Marine Resources

SEI conducted a coastal assessment of the project shoreline, included in *Appendix D*. The coastal assessment addresses guidelines set forth by the Office of Environmental Quality Control (OEQC) for assessing shoreline projects, including: a detailed description of the existing shoreline and coastal processes; historical shoreline erosion rates; site maps; oceanographic setting; coastal hazards; description of improvements; and alternatives.

A baseline assessment of the marine resources in the area was prepared by Marine Research Consultants, Inc (June 2018). The full report is included in *Appendix E.* The assessment provides a quantitative depiction of the existing condition of marine water chemistry in the nearshore ocean waters.

Existing Conditions

The Pacific Island Ocean Observing System's Voyager mapping program displays the National Oceanic and Atmospheric Administration's (NOAA) benthic habitat for the project area. The geomorphology and biology of benthic habitat for the area offshore of the project site is characterized by sand, scattered coral rock, and aggregate patch reef. Nearshore waters are classified by the USFWS as marine, intertidal, rocky shore that is regularly flooded. Offshore, coastal waters are classified as marine, subtidal, unconsolidated bottom.

The shoreline of Lanikai Beach consists either of coarse white sand beach or hardened structures (seawalls or boulder revetments). The exception occurs at the property, where the shoreline is composed of the sandbag revetment. The marine area off Lanikai Beach consists of a semi-embayment bounded by a reef crest approximately one kilometer offshore. All areas of the nearshore environment consist of open coastal areas with unrestricted circulation with the ocean.

The results of all water chemistry analyses on samples collected off 1326 Mokulua Drive in May 2018 are shown in *Table 3-1*. The results show elevated values of several inorganic nutrient constituents at the shoreline on all the transects. The elevated concentration of dissolved nutrients is likely a result of mixing groundwater with ocean water in the nearshore zone. Owing to the input from land, it is not unexpected that some nutrient water quality constituents do not comply with open ocean criteria, which does not take input of high-nutrient groundwater into account.

Table 3-1 Water Chemistry Analysis

STATION	DEPTH (m)	DFS (m)	PO_4^{3-} (µg/L)	$NO_3^-+NO_2^-$ (µg/L)	NH_4^+ (µg/L)	Si (µg/L)	TOP (µg/L)	TON (µg/L)	TP (µg/L)	TN (µg/L)	TURB (ntu)	SALINITY (o/oo)	pH std. units	Chl-a (µg/l)	TEMP deg. C	Diss. O_2 % sat.
TRANSECT 1	1	1	6.82	2.24	6.16	259.56	9.61	135.38	16.43	143.78	6.49	33.85	8.10	0.41	25.36	105.69
	2	2	6.51	1.40	13.72	211.96	8.37	158.48	14.88	173.60	6.37	34.09	8.10	0.45	24.97	110.93
	3	10S	4.96	BDL	1.26	186.48	7.75	117.60	12.71	118.86	5.50	34.18	8.09	0.29	24.73	103.83
	4	10B	5.58	0.42	1.12	157.08	7.75	124.32	13.33	125.86	4.93	34.29	8.09	0.32	24.72	2.00
	5	20S	5.58	0.56	2.24	161.84	7.44	159.74	13.02	162.54	3.21	34.33	8.09	0.34	24.60	104.41
	6	20B	5.89	0.28	1.82	123.20	7.13	152.60	13.02	154.70	2.69	34.47	8.09	0.37	24.60	104.76
	7	50S	4.65	0.56	0.42	147.56	10.23	142.38	14.88	143.36	2.28	34.47	8.09	0.24	24.55	104.02
	8	50B	4.96	BDL	3.08	128.24	8.06	119.84	13.02	122.92	2.27	34.64	8.09	0.21	24.61	106.26
TRANSECT 2	9	1	6.82	22.40	10.92	365.40	11.16	123.20	17.98	156.52	5.66	33.48	8.08	0.34	25.10	110.47
	10	2	6.51	4.76	4.62	206.36	10.23	133.98	16.74	143.36	5.30	34.00	8.10	0.37	24.92	110.81
	11	10S	4.65	2.10	3.64	185.08	12.09	115.36	16.74	121.10	4.62	34.26	8.09	0.42	24.78	106.96
	12	10B	5.58	0.98	9.66	165.76	12.71	114.80	18.29	125.44	3.79	34.29	8.09	0.31	24.76	106.55
	13	20S	5.27	1.26	6.58	159.88	12.40	114.52	17.67	122.36	2.96	34.33	8.09	0.20	24.69	107.24
	14	20B	4.96	0.56	2.94	105.00	12.71	110.32	17.67	113.82	2.91	34.47	8.10	0.19	24.67	107.95
	15	50S	4.65	1.82	8.82	138.60	13.64	129.92	18.29	140.56	2.03	34.37	8.09	0.23	24.65	106.25
	16	50B	3.72	BDL	3.64	82.60	16.43	123.34	20.15	126.98	1.25	34.58	8.10	0.19	24.65	109.74
TRANSECT 3	17	1	6.82	526.54	5.32	1866.20	6.82	79.24	13.64	611.10	3.65	28.27	7.97	0.31	25.35	82.20
	18	2	4.96	3.36	9.52	172.76	14.88	104.30	19.84	117.18	4.09	34.13	8.09	0.28	25.00	107.94
	19	10S	5.58	1.96	8.82	169.96	13.33	95.48	18.91	106.26	3.76	34.27	8.09	0.26	24.94	107.23
	20	10B	5.27	0.98	10.22	132.44	13.02	118.44	18.29	129.64	3.75	34.45	8.10	0.33	24.81	107.01
	21	20S	4.34	1.96	5.32	186.76	11.16	83.44	15.50	90.72	2.87	34.34	8.09	0.25	24.80	106.37
	22	20B	3.10	0.42	1.12	91.84	12.71	90.44	15.81	91.98	2.93	34.52	8.10	0.18	24.74	107.42
	23	50S	2.79	1.26	4.20	151.20	13.64	104.58	16.43	110.04	2.59	34.31	8.09	0.18	24.73	106.23
	24	50B	2.79	0.28	4.06	97.72	14.57	78.82	17.36	83.16	1.45	34.53	8.11	0.12	24.70	107.27
DOH WQS	DRY	NTE 10%		10.00	5.00				30.00	180.00	0.50	*	**	0.50	***	****
		NTE 2%		20.00	9.00				45.00	250.00	1.00	*	**	1.00	***	****
Analytical Method			EPA 365.3	EPA 353.2	EPA 350.1	EPA 370.1			SM 4500P B5	SM 4500N C	SM 2130B	SM 2520	EPA 150.1	SM 10200	SM 2550B	SM 4500 OG

The consistently elevated values of turbidity above the open coastal standards are likely a result of resuspension of fine grained sediment that form the ocean floor, rather than from inputs from land.

Lowest salinity was observed at the shoreline, with increasing values moving seaward, indicating input of freshwater at the shoreline that mixes with seawater forming both vertical and horizontal gradients in the nearshore zone. Groundwater input is highest at the southern end of the property and lowest at the northern end.

Most of the project area meets criteria of the State Water Quality Standards. As a result, it does not appear that there are any significant inputs of materials from land beyond the immediate shoreline that are affecting coastal ocean waters offshore of the project area.

Anticipated Impacts and Mitigation Measures

According to the marine study, the physical structure of the marine habitats adjacent to the shoreline structure location is in an intertidal area consisting of sand. The water chemistry from samples collected along the transects from the shoreline to open waters indicate groundwater inputs at the shoreline, particularly at the north end of the project site. The effects of groundwater on nearshore waters is limited to a small mixing zone.

The construction of the shoreline structure with scour apron is not anticipated to adversely impact the health of the nearshore marine environment of live corals offshore. Allowing the existing sandbag structure to remain in place will help minimize runoff during the construction period and reduce construction impacts on the nearshore marine environment. During the construction period, erosion will further be minimized through compliance with the City and County's grading ordinance and the applicable provisions of the DOH's Water Quality Standards (Title 11, Chapter 54, HAR) and Water Pollution Control requirements (Title 11, Chapter 55, HAR). Standard Best Management Practices (BMPs) will be employed to minimize impacts, as detailed in subsequent construction plans. No significant storm drainage runoff to coastal water is anticipated. Construction BMPs for the project could include a floating silt curtain along the seaward edge to contain limited amounts of suspended material along the immediate beach area; utilization of a temporary cofferdam to contain loose material and suspended sediment during excavation; and potentially, limited dewatering to protect both nearshore quality and the construction area.

3.8 Air Quality

Existing Conditions

The State Department of Health (DOH), Clean Air Branch (CAB) has established the State Ambient Air Quality Standards (SAAQS). The DOH-CAB regularly samples ambient air quality at monitoring stations throughout the State, and annually publishes this information. On O‘ahu, there are four monitoring stations. The closest station to the project site is located in Honolulu, which measures SO_2, CO, PM_{10}, and $PM_{2.5}$.

Air quality in the State of Hawai‘i continues to be one of the best in the nation, and criteria pollutant levels remain well below SAAQS. According to the *Annual Summary 2015 Hawai‘i Air Quality Data,* air quality monitoring data compiled by the DOH indicates that the established air quality standards for all monitored parameters are consistently met throughout the State and on the island of O‘ahu. Present air quality in the project area is primarily affected by motor vehicles, with carbon monoxide being the most abundant of the pollutants emitted. Air quality data from the nearest monitoring stations suggest that all National and State air quality standards are currently being met, although occasional exceedances of the more stringent State standards for carbon monoxide may occur near congested roadway intersections.

Anticipated Impacts and Mitigation Measures

Fugitive dust generation from vehicle movement and soil excavation will be the two types of short-term air quality impacts as a result of construction activities for the project. On-site/off-site emissions from moving construction equipment and commuting construction workers will also be present on site.

State of Hawai‘i Air Pollution Control regulations prohibit visible emissions of fugitive dust from construction activities at the property line. A dust control program will be implemented to control dust from construction activities. Fugitive dust emission will be controlled through the mitigation measures such as watering active upland work areas, using wind screens, keeping adjacent paved roads clean, covering open-bodied trucks and limiting the area to be disturbed at any given time.

The shoreline structure will not result in outputs that will affect long-term air quality. No emissions of dust will be generated directly in the long term as a result of the project.

3.9 Noise

Existing Conditions

There are natural noises in the project area due to wind in the surrounding foliage and the ocean waves. Existing background ambient noise levels within the project area are largely attributed to motor vehicle traffic along Mokulua Drive mauka of the project site. The noise levels around the project site are consistent with noise levels found in residential areas.

Anticipated Impacts and Mitigation Measures

There will be short-term noise generated during the construction; however, noise levels are not expected to adversely affect residents near the project site. Construction activities will comply with the provisions of the regulations for community noise control. The contractor will be required to obtain a noise permit if the noise levels from construction activities are expected to exceed allowable levels. Heavy vehicles traveling to and from project sites will comply with the State’s administrative rules for vehicular noise control. Over the long term, the project will not affect ambient noise levels.

3.10 Utilities and Infrastructure

Existing Conditions

There are no existing drainage or wastewater facilities serving the project site. A sewer lateral from the property connects to the gravity sewer main along Mokulua Drive. Stormwater at the properties currently infiltrates rapidly into the sandy soils, with peak period flow overland towards the shoreline. Electrical services are provided to the properties by Hawaiian Electric Company’s overhead distribution lines. Existing uses at the property generate a demand for electrical and communication services.

Anticipated Impacts and Mitigation Measures

The project will have no adverse effect on public infrastructure such as roadways, water supplies, and electrical power. The project will not affect existing overhead service. No mitigation is proposed.

3.11 Traffic and Roadways

Existing Conditions

Mokulua Drive is the primary roadway serving the project site. Mokulua Drive is a one-way city highway, which provides the only vehicular access to the area and the project. Private driveways provide vehicular access into the property.

Bus service is provided to the project site by routes along Mokulua Drive, including Route 70. Generally, smooth traffic flow is characteristic along this state highway.

Traffic is typically busiest during weekday commuter periods and weekend afternoons. In addition to restricted parking on three-day weekends, the City reconfigured the intersection at Kailua Road and S. Kalaheo Avenue into a roundabout in 2017, alleviating some of the area's traffic congestion due to the popularity of Kailua Beach Park and Lanikai Beach.

Anticipated Impacts and Mitigation Measures

The construction of the shoreline structure will not alter public roadways. While the project is not expected to have any long-term traffic impacts, the following mitigation measures are will be adhered to for optimal traffic conditions during construction:

- Construction activities and construction material or waste should be located and stored away from vehicular traffic. Sight lines for drivers on the roadway should be carefully maintained.
- Trucks delivering construction material and disposing of construction waste should be scheduled on weekdays during times of non-peak commuter periods (9:00 AM to 3:00 PM).

3.12 Socio-Economic Characteristics

Existing Conditions

The project site is located in Koʻolaupoko, Oʻahu in Census tract 112.02. In 2010, the Census tract had a residential population of approximately 1,609, which was approximately 0.1% of Oʻahu's total population. The population in this Census tract is slightly older in age compared to the overall age of the Oʻahu population as a whole. The racial mix of the area is comprised of proportionately more Caucasians, and fewer Native Hawaiians and Pacific Islanders than the island as a whole. The median household income in 2010 for Census tract 112.02 was $113,542, however, approximately 19.1% of families in Census tract 112.02 live below the poverty level. The area near the project site and throughout Lanikai consists primarily of single family homes and Lanikai Beach recreational area. The nearest commercial area is located about 2.5 miles to the northeast in Kailua.

Anticipated Impacts and Mitigation Measures

The project is not expected to result in adverse socio-economics impacts. The project will not increase population of the Koʻolaupoko District. The project will generate short-term economic benefits through construction materials expenditures and construction employment. Upon completion, the new shoreline protection structure is expected to have beneficial long-term impacts by providing the property with protection from wave action erosion.

3.13 Public Facilities and Services

This section discusses the potential for impacts to public facilities and services.

3.13.1 Educational Facilities

Existing Conditions

The Kailua area currently contains 15 public schools operated under the State Department of Education. There are nine elementary schools, one intermediate school and two high schools. Educational facilities that serve the project area include:

- Kailua Elementary School located at 315 Ku‘ulei Road, is approximately 2.5 miles from the project site.
- Kailua Intermediate School located at 145 South Kainalu Drive, is approximately 2.2 miles from the project site.
- Kalaheo High School is located at 730 Ilaina Street, is approximately 4 miles from the project site.

Anticipated Impacts and Mitigation Measures

The project is not expected to affect educational facilities. The project will not increase the population in the Ko‘olaupoko District. No mitigation is proposed.

3.13.2 Recreational Facilities

Existing Conditions

The primary recreational area located in the vicinity of the project site is Kailua Beach Park. The 35-acre City beach park is divided by Ka’elepulu Stream. The stream runs throughout Kailua and feeds into the beach. Kailua beach park includes covered and open picnic tables, food concession stands, barbeque grills, restroom facilities, beach showers, parking lots with free parking, kayak rentals, volleyball courts, and lifeguards on duty from 9:00AM to 5:30PM. The public can easily gain lateral access to the shoreline. Kailua Beach Park is heavily used by the public and has ongoing issues with shoreline erosion. High surf has taken out chunks of the shoreline reducing beach recreation areas and causing trees to lean or fall forcing the city to come and cut down trees. The city tried to fix the problem by spreading 1,500 cubic yards of sand along the shoreline, but eventually high surf caused areas that were filled with sand to become exposed again.

Anticipated Impacts and Mitigation Measures

The project is not expected to significantly impact existing recreational facilities, including Kailua Beach Park, therefore no mitigation is proposed. Placement of a shoreline protection structure at 1326 Mokulua Drive will not deter the chronic erosion at Kailua Beach Park.

The removal of the 20 ft. wide sandbag complex will greatly improve public shoreline and lateral access.

3.13.3 Police

Existing Conditions

The Lanikai area is served by Honolulu Police Department (HPD) District 4 which covers the area from Waimanalo to Kahuku. The Kailua Substation is located approximately 2.4 miles from the project site.

Anticipated Impacts and Mitigation Measures

This project will not impact the HPD's operations or ability to provide adequate services to the surrounding community. No adverse impacts are anticipated and no mitigation measures are proposed.

3.13.4 Fire

Existing Conditions

The Honolulu Fire Department (HFD) has 45 operating Fire Station on the island of O'ahu. There are two fire stations serving the project site. Fire Station 18 is located approximately 2.4 miles from the project site. Fire Station 19 Aikahi is located approximately 4 miles from the project site. HFD will dispatch the closest fire engine in the case of an emergency.

HFD works with the Emergency Medical Services (EMS), who dispatches the closest available unit. During an emergency, this may be either an EMS ambulance or a fire engine depending on the type of emergency and location. Since there are only 20 EMS stations on O'ahu, fire companies are frequently the first responder.

Anticipated Impacts and Mitigation Measures

This project is not expected to impact the HFD's operations or ability to provide fire protection services to the project area and the surrounding residential neighborhood.

3.13.5 Emergency Medical Services

Existing Conditions

The nearest hospital to the project site is Adventist Health Castle, located approximately 4.2 miles east. The closest EMS ambulance is stationed at the Kailua Fire Station, which transports patients to Castle Medical Center.

Anticipated Impacts and Mitigation Measures

The project will not impact the handling of EMS or medical emergencies to the project area and the surrounding neighborhood. Castle Medical Center will be accessible should there be an accident or illness affecting workers at the project site. No mitigation is proposed.

3.13.6 Solid Waste Management

Existing Conditions

Solid waste collection for the project area is provided by the City and County of Honolulu.

Anticipated Impacts and Mitigation Measures

Project construction will involve removal and disposal of the sandbag revetment. generate very limited amounts of construction waste. Waste material will be removed from the site for proper disposal. No mitigation is proposed.

3.14 Historic, Archaeological and Cultural Resources

3.14.1 Historic and Archaeological Resources

An Archaeological Inventory Survey (AIS) was conducted by Keala Pono Archaeological Consulting (April 2018). The survey was designed to identify historic properties in the project area, include a 100% pedestrian survey, and subsurface test excavations. There were no archaeological resources identified in the survey of the subject properties. Due to findings, the AIS results were presented as an Archaeological Assessment *(Appendix F)*. The Archaeological Assessment report was submitted to DLNR SHPD for agency review in December 2018.

Existing Conditions

History of the Project Area

Historical documentation of the broader Kailua area indicates that the property was part of the subdivision of Mokulua within an area called Alaapapa in the late 1800s. Land use in the area consisted primarily of fisheries, and eventually coconut groves, cattle ranching, and dairies. As early as 1910, speculation of developing Kailua into a vacation destination and residential area began. Development of the area began in 1924, with Charles Frazier creating the 311-acre beachfront community called Lanikai in Kāʻohao.

Previous Archaeological Research in the Vicinity of the Project

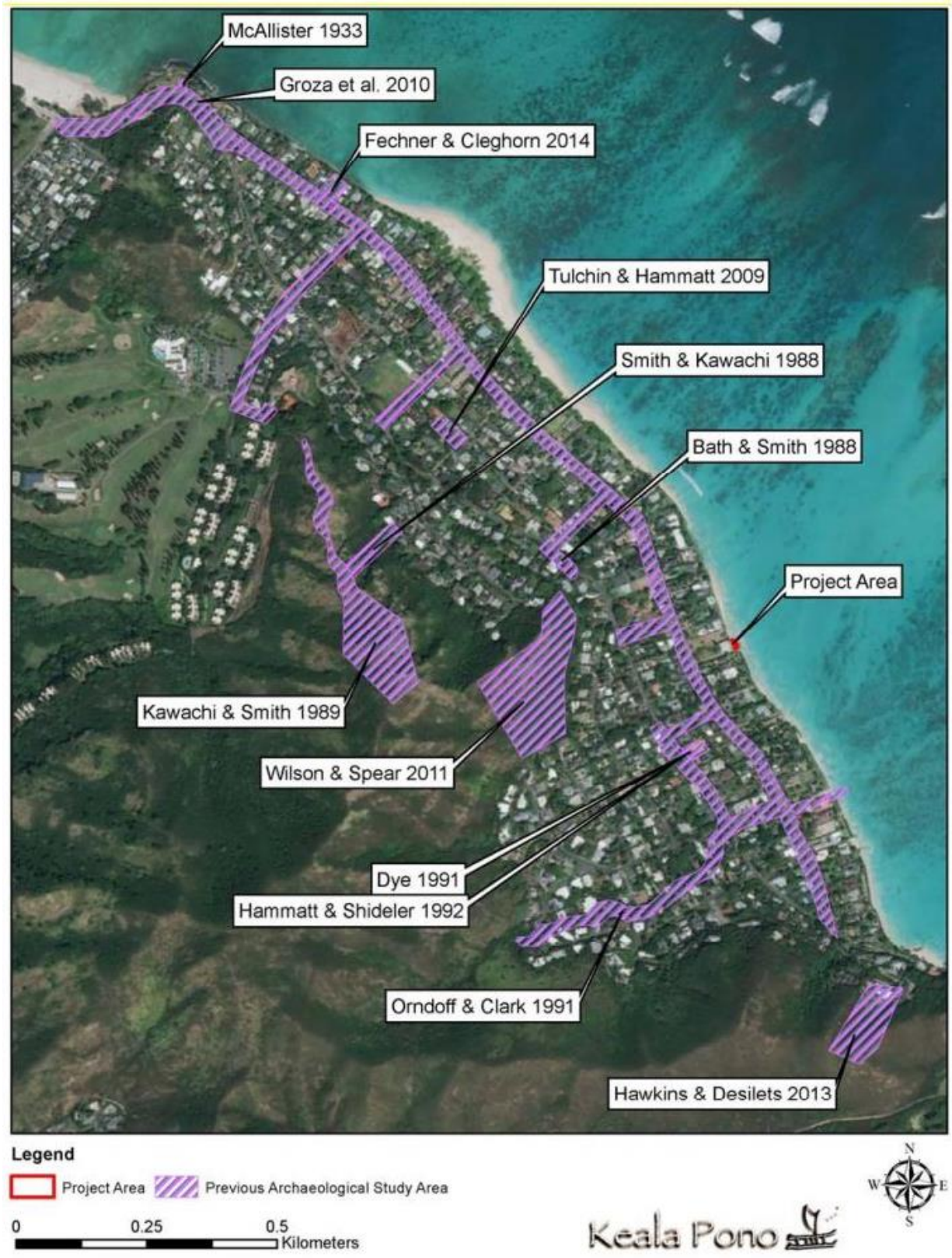
Information on known historic properties in the Lanikai area has been reported by numerous authors between 1933 and 2014. A heiau, WWII bunkers, human remains, and a pre-contact hearth have been identified or recovered from areas near the project parcel. The closest findings were documented by Dye (1991), Hammatt & Shideler (1992), and Groza et al. (2010), which identified human burials in beach lots south of the project area and a subsurface cultural layer to the west of the project area *(Figure 3-7)*.

Results of the Archaeological Inventory

The pedestrian survey of 100% of the project area as well as subsurface testing of three trenches of the project area resulted in negative findings for subsurface archaeological deposits or material. No archaeological resources were found. The entire project area has been previously disturbed by modern activity, and subsurface testing did not yield evidence of subsurface archaeological features or deposits. Stratigraphy from the site consisted primarily of fill associated with the sandbag shoreline structure installation.

Anticipated Impacts and Mitigation Measures

The project is not expected to result in significant adverse impacts to historic properties of the site. Due to the presence of fill within the project area, there is a very low expectation for the occurrence of historic properties. No adverse effects on archaeological, or historical resources are anticipated as a result of the project. No further archaeological work is recommended. The report has been submitted to SHPD for review under HRS §6E-42.



Previous Archaeological Investigations in Lanikai (Keala Pono 2018) **Figure 3-8**

3.14.2 Cultural Resources

Background

Historic Mo'olelo

Kailua is associated with Menehune and early settlement of Oʻahu in pre-history. Menehune are the legendary race of people hailing from Kahiki who were known to be smaller in stature. They are known for having constructed things in Kailua and Puowaina. In particular, the Mokulua Islands are said to have been built by the Menehune for protection. However, the construction was never completed after one night's work.

Traditional Land Use

Kailua was a significant place of rule. King Kamehameha lived and ruled from Kailua, and also worked in the fishponds. Upon the death of Kamehameha in 1819, windward lands under his rule were divided between his sons, Liholiho and Kauikeaouli. The ahupuaʻa of Kailua went to Kauikeaouli (Kamehameha III).

After Kamehameha III's Māhele in 1848, land claims in windward Oʻahu were awarded to commoners. In the Koʻolaupoko District, 199 awards were awarded in the Kailua and Waimānalo ahupuaʻa. Most of the lands in windward Oʻahu went to Queen Kalama. She became the dominant landholder of those lands in Kailua, including claims in Kawainui and the ili of Mōkapu, Oneawa, and Keahupuaanui.

For commoners who sought individual land titles, the process required filing a claim with the Land Commission, having their land claim surveyed, testifying in person on behalf of their claim, and submitting a final Land Commission Award for a binding royal patent. Due to reasons such as an unfamiliarity with the process, distrust of the process, and/or the desire to cling to the traditional way of land tenure, the majority of the native population never received Land Commission Awards recognizing their land holdings.

No Land Commission Awards are near the project area, possibly due to the arid environment which was not conducive to wetland taro cultivation.

Historic Land Use

In 1850 the Resident-Alien Act allowed foreigners to purchase lands in Hawaiʻi. After attempts to cultivate sugarcane and pineapple, Chinese laborers moved off plantations to start rice farming in Kailua. By the end of the 1800s, the cattle industry also established a presence in the area, with operations near the Kailua flatlands by J.P. Mendonca and C. Bolte.

Historic maps show fisheries of Koʻolaupoko, naming Alaapapa Fishery and Kailua Fishery in the Lanikai area. Inland, Kaelepulu Fishpond is located where the subdivision of Enchanted Lakes is today.

In the beginning of the 20th century, the copra industry began in Kailua, with 10,000 coconut trees planted in 1908. The following year, an additional 130,000 trees were planted along 320 acres behind Kailua's shoreline, known today as Coconut Grove.

Around the same time, cattle ranching began expanding operations alongside existing dairy operations from Kaʻelepulu and Olomana down to Bellows Beach in Waimanalo. Raw milk was initially trucked from these operations to Meadow Gold (Dairymen's) in Honolulu for processing, but in 1950's the Campos, Moanalua, and Rico dairies united to form the Foremost Dairy based in Honolulu.

As early as 1910, speculation of turning Kailua into a vacation destination began. Beachfront properties along Kaleheo road began being advertised for summer cottages. In 1917, following a decline in coconut oil

demand, Arthur Rice of Hawaiian Copra Company initiated plans for residential subdivision development. More development followed, with upscale beachfront developments in Lanikai developed in 1924 by Charles R. Frazier. The name Lanikai was chosen by Frazier, thinking that it translated to 'heavenly sea,' although the literal Hawaiian translation is "sea heaven" or "marine heaven." The faux lighthouse of Lanikai was erected in 1926 as a monument, which has since been nominated to the National Register of Historic Places.

The Lanikai area was also historically used by the military during World War II. The "Lanikai Pillboxes" were constructed in the 1940s as observation bunkers for Battery Wailea and the nearby Bellows Field. Batter Wailea was armed with two guns and was operational between 1942 and 1945.

Existing Conditions

No known cultural practices currently occur on the project site. It is possible that the adjacent public access pathway is used to access State waters for traditional fishing or throw net practices, or to access the Mokulua Islands for other cultural purposes.

Anticipated Impacts and Mitigation Measures

Background research indicate that there are no known cultural resources within the project area. Minimal to no impacts to Hawaiian cultural practices or resources are anticipated. Existing cultural practices, such as fishing, that occur in the greater surrounding area will not be affected as existing public access to shoreline areas will be maintained. With potential for inadvertent cultural finds, should cultural materials be discovered during construction activities, all work shall cease immediately and an archaeologist from SHPD shall be notified. All work in the area will be suspended until further recommendations are made for the appropriate treatment of archaeological and/or cultural materials.

3.15 Visual Resources

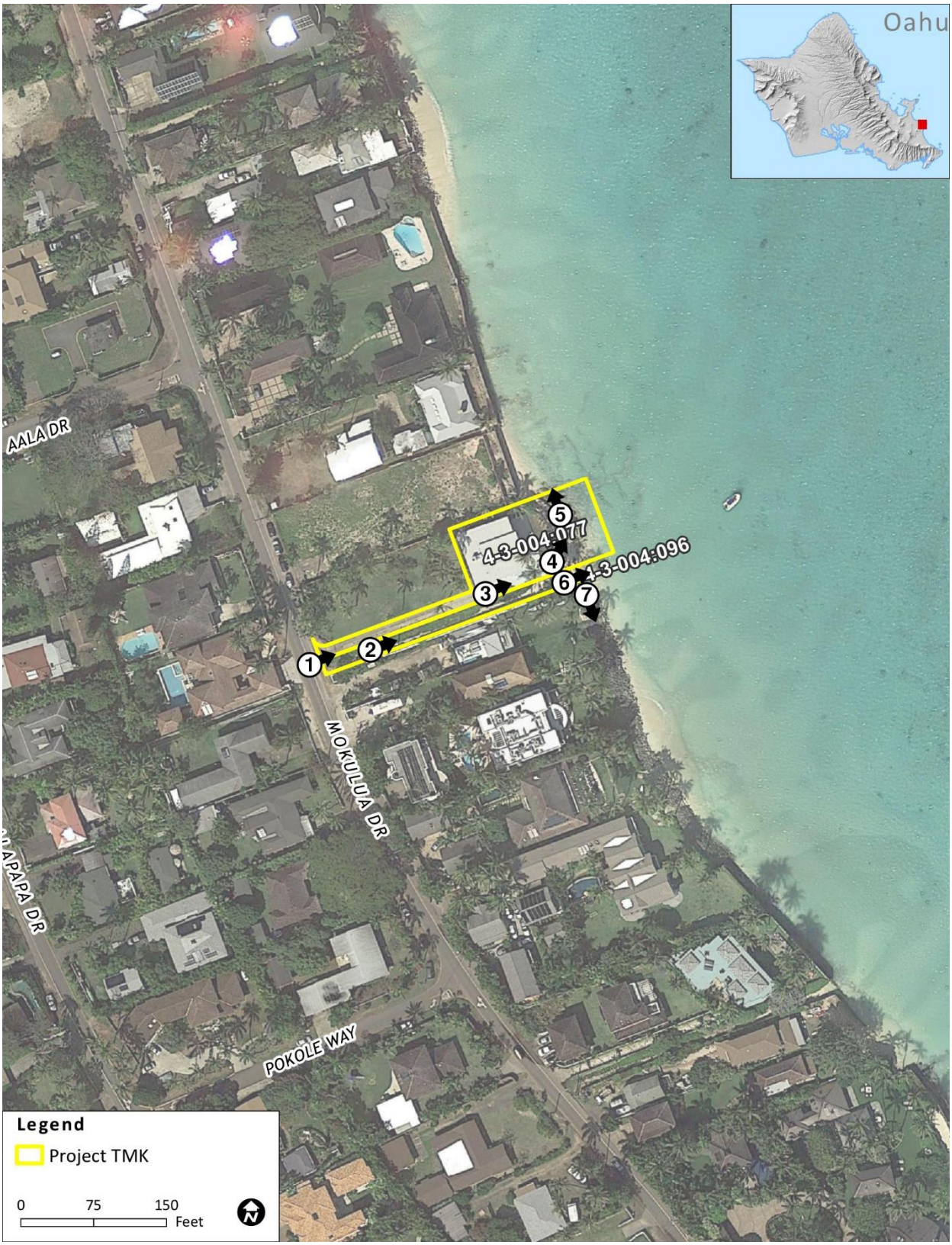
Existing Conditions

The project site is located in Kailua on the coast of Lanikai, in the Koʻolaupoko District on the island of Oʻahu. The private residential property is developed with an existing home along with a rock walls that demarcate the lot boundary. The project site is bounded by the Pacific Ocean, existing homes, and Mokulua Drive (*Figure 3-8A through 3-8G*).

Scenic viewsheds in the project area are identified in the Koʻolau Poko Sustainable Communities Plan in Map A-1 *Open Space*. The existing sandbag revetment is the only sandbag structure along this portion of the Lanikai coastline and visually disrupts the continues views of the shoreline, as visible from the ocean. *Figure 3-9* provides an aerial perspective of the Lanikai shoreline.

Anticipated Impacts and Mitigation Measures

With removal of the sandbag structure, the shoreline structure will blend with existing similar shoreline protection structures in this part of Lanikai. The shoreline protection structure will be developed on private land, mauka of the shoreline setback, fronting a residential property along the coast, and will not be visible from Mokulua Drive. The project will be visible from the ocean looking towards the coast. The removal of the current sandbag structure and placement of the new shoreline structure will be more compatible with the existing visual nature of the coastline, since it will open up an additional 20 ft. of beach width. No significant adverse impacts to coastal views, scenic vistas or existing landscapes are anticipated. Public access to the shoreline and ocean views will continue to be available from the adjacent public access path.



Site Photo Key (Source: Google Earth) **Figure 3-9**

View 1 from Mokulua Drive Facing Makai Toward the Residence and Project Area **Figure 3-8A**

View 2 from Adjacent Beach Access Point Facing Makai **Figure 3-8B**

View 3 from Property Facing Makai Toward Mokulua Islands **Figure 3-8C**

View 4 from Eroding Flank Facing Northeast **Figure 3-8D**

View 5 from Eroded Shoreline of Temporary Seabags Facing Kāne'ohe **Figure 3-8E**

View 6 from Public Access, Transition to Shoreline **Figure 3-8F**

View 7 from Public Access, Transition to Shoreline **Figure 3-8G**

Lanikai Shoreline Aerial View **Figure 3-10**

3.16 Potential Cumulative and Secondary Impacts

Cumulative effects are impacts which result from the incremental effects of an activity when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertake such other actions.

Erosion has occurred for decades along the Lanikai Shoreline. Since, Lanikai is a chronically eroding shoreline, many homeowners opted to construct shoreline protection structures to stabilize the rapid recession of the shoreline. Placement of a seawall and scour apron at the subject property will help to stabilize this one unprotected shoreline section, and this is not anticipated to adversely affect shoreline processes at other sections of the Lanikai shoreline. The seawall and scour apron are designed to address concerns, such as energy dissipation to minimize the potential of wave energy reflection. The shoreline protection structure at the property will not result in cumulative or secondary impacts, as a permanent shoreline structure will be similar to the shoreline protection structures adjacent to the property and of those found across the Lanikai coastline. The removal of the 20 ft. wide sandbag complex will greatly improve public lateral access along this shoreline.

The shoreline revetment is consistent with applicable development plans and policies. The applicant will seek a Shoreline Setback Variance and will adhere to the applicable terms and conditions of approval tied to the permit.

Construction activity during the proposed project will generate direct employment as well as indirect employment in construction-related industries. The project is expected to cost approximately $450,000 which will be spent in Hawai‘i.

Short-term construction-related impacts on the environment will be generated by the project, and mitigation measures will be implemented to minimize these impacts. Construction related impacts will be temporary and will be in the immediate vicinity of the project site. Federal, State, and County environmental regulations will be met throughout the construction and operation of the project.

Section 4

Alternatives to the Proposed Project

Chapter 4

Alternatives to the Proposed Project

The following chapter presents an analysis of project alternatives and rationale for selection of the preferred alternative. Alternatives for shoreline protection at 1326 Mokulua Drive include the following options:

A. No-Action
B. Sandbag Removal
C. Beach Nourishment
D. Revetment
E. Hybrid Seawall-Revetment
F. Seawall
G. Preferred Alternative/Proposed Action - Seawall with Scour Apron

Each alternative was evaluated according to the project objectives and whether it met the criteria, as outlined below.

The primary objectives for this project are:

- To provide long-term preservation/protection the habitable dwelling in its current location;
- To stabilize/maintain the shoreline near or mauka of its current location with no portion of the structure located in State submerged lands;
- To not de-stabilize adjacent property structures;
- To not impact the public lateral access or recreational value fronting the property; and
- To minimize potential negative impacts to the shoreline environment.

Alternatives were evaluated based on the following criteria:

- Effectiveness (i.e., likelihood of satisfying the project objectives)
- Design Considerations (i.e., suitability, design life, durability)
- Costs (i.e., initial costs, recurring costs, entitlement costs)
- Feasibility (i.e., regulatory support, community support)
- Potential Impacts (i.e., shoreline, coastal process, marine habitat, shoreline access, and neighboring property and shoreline structures)

4.1 Alternative A – No-Action Alternative

The “no-action” alternative is the baseline against which all other alternatives are measured, as it refers to the future site conditions that would result should the project not proceed. The no-action alternative would maintain the permitted sandbag revetment in place with no new construction elements. This option would require periodic maintenance to limit further damage to the sandbag structure, maintain its effectiveness, and reduce erosion risk to the property. Without maintenance, the sandbags would be expected to deteriorate and become displaced, eventually leading to

undermining of the lawn, lanai concrete slab, and house. The inconveniences and constraints associated with allowing the shoreline to further encroach on the property through this temporary solution would continue to adversely affect the homeowner and potentially render their residence unusable.

The sandbag structure also poses as an attractive nuisance. The structure attracts people recreating and partying, which often results in disrespectful and vagrant behavior. There is also a health risk associated with the sandbags. The bags retain water, and during conditions of direct sun and little wind, the bags release musty humid air that drifts back into the residence, resulting in air quality and mold concerns.

There is no expected potential impact to adjacent property shoreline structures, beach access, and sand dynamics fronting the property if the sand bags are left in place and are maintained. This, however, does not account for future sea level rise (SLR) and/or regional change to sand dynamics.

A sandbag structure is modular by nature and is easily adapted to future changes in sea level. A rise of 2.3 feet in sea level will require additional height to the crest of the structures. Increased wave energy may also require additional toe bags or larger bags or both. Modification of the sandbag structure at this time for future sea level rise is not recommended, as modification can be incorporated into regular maintenance activities.

No-Action Alternative Evaluation:

<u>Project Objectives</u>

- Disadvantage – Does not provide long-term preservation/protection for the habitable dwelling in its current location and requires extensive maintenance.
- Disadvantage - Stabilizes/maintains the shoreline near or mauka of its current location when actively maintained; however, it does have a very large footprint located in State submerged lands.
- Advantage - Not de-stabilize adjacent property structures.
- Advantage - Has no negative impact on the public lateral access or recreational value fronting the property.
- Neutral – Has no change to potential negative impacts.

<u>Evaluation Criteria</u>

- Disadvantage – Due to the constant maintenance required, this option is not considered effective.
- Disadvantage – Though the suitability is good, the design life and durability are very poor.
- Neutral - Low initial costs, and moderate recurring costs through maintenance.
- Advantage – There is already existing regulatory and community support for this structure.
- Neutral – No change is expected to potential impacts, including shoreline, coastal process, marine habitat, shoreline access, and neighboring property and shoreline structures.

This alternative would not provide for long-term protection from further shoreline erosion and wave action damage. This alternative would continue to place the private home in jeopardy by enabling ongoing increased beach loss and erosion. It also would not curb the loitering and disrespectful behavior from the attractive nuisance created by the seabag structure, or alleviate air quality concerns. For these reasons, the no-action alternative is not a preferred solution.

4.2 Alternative B – Sandbag Removal

The sandbag removal alternative involves removing the existing sandbag revetment and allowing the shoreline to naturally migrate to its equilibrium position. The shoreline is expected to migrate mauka of the current shoreline position as the profile adjusts and would likely undermine the house structure, cause flanking to adjacent property infrastructure, and threaten the public beach access.

Erosion caused by removal of the sandbags would be exacerbated by future changes in sea level. Figure 4-1 shows the approximate location of the shoreline after initial removal of sandbags and after 10, 25, and 50 years. After approximately 10 years the shoreline is estimated to be in dangerous proximity to the house structure leading to undermining. These shoreline positions were determined based on historical erosion rates without accounting for future sea level rise. The influence of sea level rise would most likely cause these shoreline positions to shift further mauka. A rise of 2.3 feet in sea level, as is assessed in this report, is predicted to result in loss of nearly the entire makai parcel.

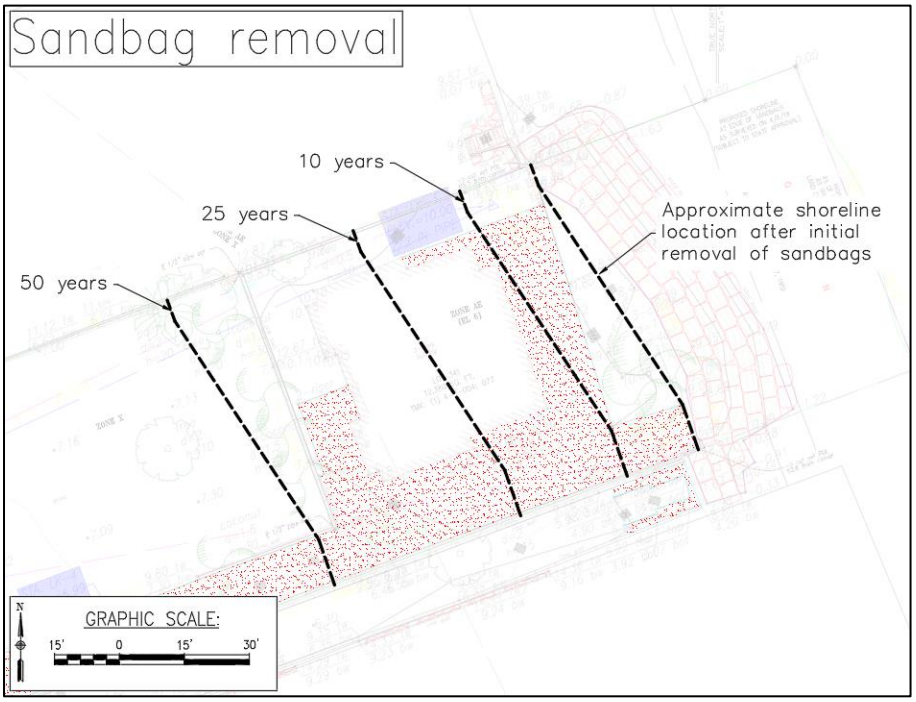


Figure 4-1 Shoreline Location after a 50-year Design Life if Sandbags are Removed

Sandbag Removal Alternative Evaluation:

<u>Project Objectives</u>

- Disadvantage – Provides no preservation/protection for the habitable dwelling in its current location.
- Disadvantage – Does not stabilize/maintain the shoreline near or mauka of its current location
- Disadvantage – Does de-stabilize adjacent property structures.
- Advantage - Have no negative impact on the public lateral access or recreational value fronting the property.
- Disadvantage – Does not minimize potential negative impacts.

Evaluation Criteria

- Disadvantage – This is not an effective solution (i.e., likelihood of satisfying the project objectives).
- N/A – The design life and durability are not applicable for this alternative.
- Disadvantage – The cost to backshore improvements is very high with this alternative.
- Neutral – Both regulatory support and community support are expected to be mixed with this alternative.
- Disadvantage – High potential Impacts are expected for neighboring property and shoreline structures.

Removal of the sandbags does not meet the objective of protecting the backshore and adjacent property infrastructure and would put the house structure in immediate danger of undermining. Therefore, the removal of sandbags is not a preferred solution.

4.3 Alternative C – Beach Nourishment

The beach nourishment alternative would consist of sand placement fronting the subject property shoreline to increase the sand volume available to the submerged beach. The very narrow sand beach currently at the property is part of a much larger littoral cell that includes the nearshore sand and adjacent beaches along this stretch of coastline. If sufficient beach-quality sand were available, it is possible that the beach could be nourished, thereby adding a certain level of protection to the subject property. Any sand used for beach nourishment must meet the State Department of Land and Natural Resources (DLNR) requirements to match the characteristics of the native beach sand. Sand placed only at the project site, however, would be unstable and would be expected to end up being spread throughout the entire littoral cell during normal seasonal beach processes. The volume of sand that could be placed along the property's shoreline is a very small percentage of the entire sand system's volume and would result in an extremely thin cover after it is spread through the littoral cell within the first season. There is very little mid or long-term protection available for the property without a large scale, regional beach nourishment effort. This level of effort is beyond the capacity of a single property owner.

Construction of sand stabilization structures such as groins could be integrated into the beach nourishment design to minimize sand movement. Groin design would also require a regional effort, as the down drift effects of these structures can potentially affect nearby shorelines. A regional effort would likely entail construction of a groin field, utilizing multiple groins to better maintain a beach along this section of coastline.

In addition to the necessary scale of a successful beach restoration project, finding an appropriate source of beach sand has become a significant challenge for projects in the Hawaiian Islands. Offshore sand mining has become a viable alternative to terrestrial sand mining; however, high costs, extensive permitting and regulatory constraints, and equipment requirements for the operation make it feasible for larger beach nourishment operations only.

A rise of 2.3 feet in sea level will require a significant increase in placed beach sand to stabilize a sandy shoreline in the current coastal configuration, without structures. It may not be feasible to maintain a sandy shoreline, given the projected increase in wave energy exposure with the likely submergence of the reef crest. If stabilizing structures are utilized on a regional scale, then rock size, crest height, and orientation should take into consideration oceanographic changes likely to occur with a sea-level rise of 2.3 feet.

Beach Nourishment Alternative Evaluation:

Project Objectives

- Disadvantage – Does not provide long-term preservation/protection for the habitable dwelling in its current location.
- Disadvantage – Does not provide long-term stabilization of the shoreline near or mauka of its current location without backstop structures mauka of beach.
- Disadvantage – Ongoing erosion of the beach nourishment material will de-stabilize adjacent property structures.
- Advantage - Have no negative impact on the public lateral access or recreational value fronting the property.
- Neutral - Minimizes potential negative impacts to the beach and recreation while nourishment activities are ongoing; however, it exposes the dwelling and neighboring properties to an increased risk of erosion hazard.

Evaluation Criteria

- Disadvantage – Not an effective solution for satisfying the project objectives.
- Disadvantage – Beach nourishment at the parcel level is not suitable and has a very short design life with very poor durability.
- Disadvantage – Implementing beach nourishment at the parcel level for shoreline stabilization comes at a moderate initial cost but has very high recurring costs.
- Advantage – Beach nourishment usually has very high regulatory support with DLNR and DPP and high community support. There is typically lack of support through Department of Health and National Marine Fisheries Service.
- Neutral – Minimizes potential negative impacts to the beach, coastal processes, marine habitat, shoreline access, and recreation while nourishment activities are ongoing; however, it exposes the dwelling and neighboring properties to an increased risk of erosion hazard.

Beach nourishment for the subject property will not provide mid- and long-term mitigation for the backshore or mid- and long-term mitigation of return wave energy. Beach nourishment is therefore not a practical engineering solution for an individual property of this size along this coastline and is not considered a preferred alternative.

4.4 Alternative D – Rock Revetment

A rock revetment could be considered for the project area. This approach would involve removing the existing sandbag revetment and constructing a sloping rock rubble mound revetment. A rock revetment is a sloping, un-cemented structure constructed of wave-resistant material. The most common method of revetment construction is to place a layer of armor stone, sized according to the design wave height, over an underlayer of smaller rock that sits atop filter fabric. The underlayer is designed to distribute the weight of the armor layer and to prevent loss of fine shoreline material through voids in the revetment. An example of a rock revetment at Kahului Harbor (Kahului, Maui, Hawai‘i) is shown in Figure 4-2.

Properly designed and constructed rock revetments are durable, flexible, and highly resistant to wave damage. A major advantage of revetments is that their design consists of a rough porous rock surface and relatively flat slopes, which tend to absorb wave energy and reduce wave reflection and help to promote accretion of sand along beaches.

One major disadvantage of a revetment is that it would have the largest footprint within the existing landscape at Mokulua. A revetment footprint would be wide relative to the beach fronting the property. The location of the revetment would also affect the overall cost and permitting requirements. A revetment seaward of the shoreline would represent an encroachment on State submerged land, in which case an easement would likely be required for the structure. Construction of the revetment landward of the shoreline would require extensive excavation and grading of the coastal dune. It is important to note that, even if the revetment were constructed landward of the shoreline, the future certified shoreline would likely be located at or near the crest of the structure, so an easement may eventually be required.

Rock revetment design is dependent on sea level elevation, design wave height, and scour depth. The revetment design presented below incorporates a 2.3-foot higher than present sea level, with consequent increases in predicted wave exposure and scour depth. Utilizing 2.3 feet of sea level rise, which is currently projected for 50 years in the future, provides suitable design criteria within the effective life span of similar structures. Structure maintenance, improvements, or replacement are appropriate at the end of the structure's projected life span or when the environment changes beyond design conditions. Adaptation to sea levels and their resulting impacts predicted at time frames beyond the structure's design life should be incorporated at that time.

Rock Revetment Alternative Evaluation:

<u>Project Objectives</u>

- Disadvantage – Does not provide long-term preservation/protection for the habitable dwelling in its current location. Effectiveness of satisfying the project objectives is only achieved if a substantial portion of the structure is built onto State lands, which is not supported by the DLNR when other options are available. If the structure is built inland of State submerged lands, then the dwelling will have to be partially or wholly demolished and flank protection will be required for the adjacent shoreline structures.
- Disadvantage – There are no design options that stabilize the shoreline near or mauka of its current location and do not extend into State submerged lands. The DLNR does not support structures on submerged lands, when other options are available.
- Disadvantage – The shoreline access structures would be de-stabilized without additional flank protection along the side of the sloped revetment. Additional flanking protection may be required for the northern neighbor's property, depending on the location and slope of the revetment.
- Advantage – Will likely result in a footprint that is farther mauka than the existing sandbag structure.
- Disadvantage – The revetment minimizes potential negative impacts to the dwelling, but only if built into State Conservation lands, which is not currently supported by the DLNR. Building outside of State submerged lands requires demolition of some or all of the existing dwelling.

Evaluation Criteria

- Disadvantage - Effectiveness of satisfying the project objectives is only achieved if a substantial portion of the structure is built onto State lands, which is not supported by the DLNR when other options are available. If the structure is built inland of State submerged lands, then the dwelling will have to be partially or wholly demolished and flank protection will be required for the adjacent shoreline structures.
- Neutral – Suitability based on location and size are low, though design life and durability are excellent.
- Neutral – Shoreline structures typically have high costs for design, permitting, and construction; however, well designed and constructed revetments have low maintenance costs.
- Disadvantage – There is unlikely to be regulatory support from the State for a structure that extends onto State lands, when other options are available. There is likely to be mixed support from the community.
- Disadvantage – The revetment is more likely to allow sand accumulation than vertical structures, but less likely than a natural beach environment. That said, the size constraints on the parcel preclude design and construction of a revetment that protects the dwelling and neighboring properties and does not extend onto State land. The State is not supportive of shoreline structures on submerged lands when other options are available.

In order to avoid the existing residence, the revetment would need to be shifted seaward. This shift would encroach in the Conservation District on State submerged land, which is not supported by DLNR when other options are available. If the structure is built inland of the certified shoreline to avoid State submerged land, then the existing dwelling would have to be partially or wholly demolished. The sloped revetment would also de-stabilize neighboring shoreline access and shoreline protection structures, requiring the construction of additional flank protection at those locations. For the reasons discussed, a sloping rock revetment is not a preferred solution.

Figure 4-2 **Rock Revetment at Kahului Harbor (Kahului, Maui, Hawai‘i)**

4.4.1 Rock Revetment Design

Figure 4-3 shows a typical revetment section and stone placement. The crest of the structure would be placed at +10 feet msl to match the existing backshore topography. The toe of the structure would be placed on hard substrate located at approximately 8 feet below MSL. The overall width of the structure from the back of crest to toe would be approximately 32 feet.

Figure 4- shows the footprint of a rock revetment structure with the toe of the structure placed mauka of the certified shoreline. The house structure and revetment footprint would overlap by up to 15 feet in this configuration. In order to not impact the house, the revetment would need to be shifted seaward, in which case it would extend seaward of the certified shoreline.

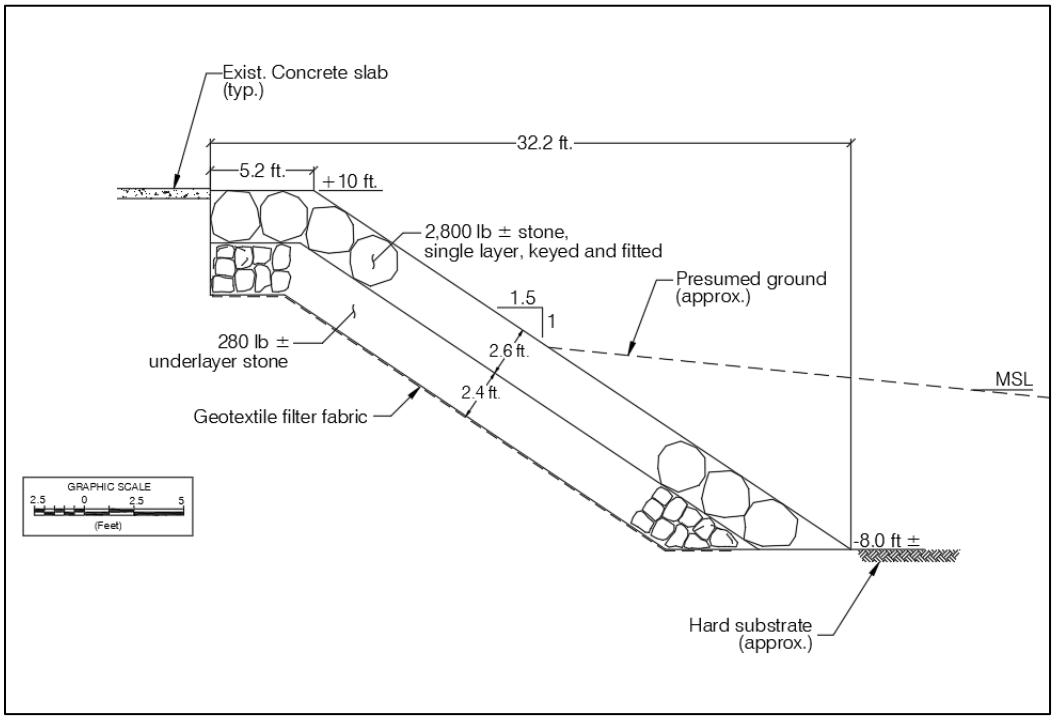


Figure 4-3 **Section View of Revetment Alternative**

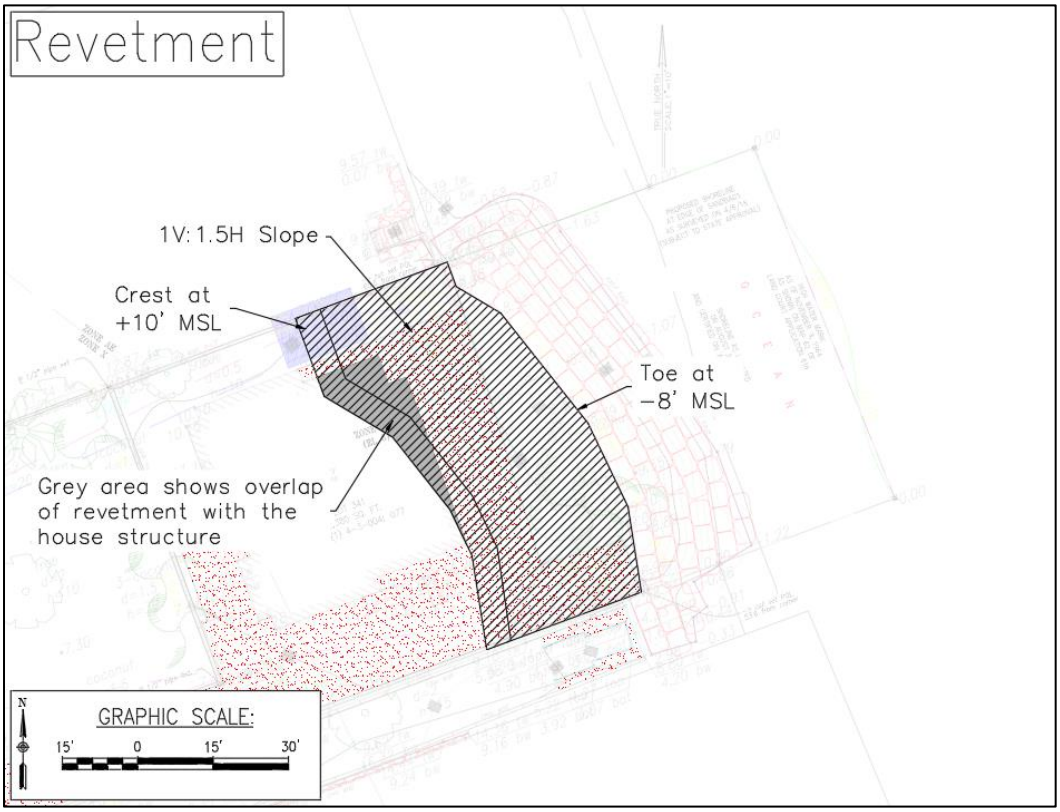


Figure 4-4 **Revetment Alternative Footprint**

The revetment design shown above illustrate that a rock revetment is too large to be constructed between the certified shoreline and the existing house structure. The primary objective of the project is to provide long-term preservation/protection of the habitable dwelling. The settlement states that the revetment is for the purpose of protecting the property at 1326 Mokulua Drive. Because applying a typical revetment design in relation to the current shoreline would result in the loss of the existing residence, other alternatives are considered that would be more suitable to provide protection for the property.

4.4.2 Rock Revetment Design per Court Settlement

An alternative rock revetment layout is provided which meets the specifications outlined in the original 1994 settlement agreement for the Mokulua Drive property (see *Appendix A*). The specified configuration of the revetment includes the following:

- Crest elevation at +7 ft msl, 244 ft makai of Mokulua Drive
- Slope of 2.5 to 1.0 from crest to top of toe
- Top of toe elevation at -3 ft msl, 269 ft makai of Mokulua Drive
- Revetment will have a smooth face, in that the stones will be in the same plane
- Water will still be able to percolate and run through the structure

The footprint for this configuration is shown in Figure 4-5 in relation the property infrastructure. It should be noted that this type of revetment would require a seawall or other slope amendment to retain the soil between the +10 ft msl backshore elevation and the specified +7 ft msl crest elevation

of the revetment. This design includes a three stone crest since the structure is expected to be overtopped, and a three stone toe since the toe is above scour depth and hard substrate.

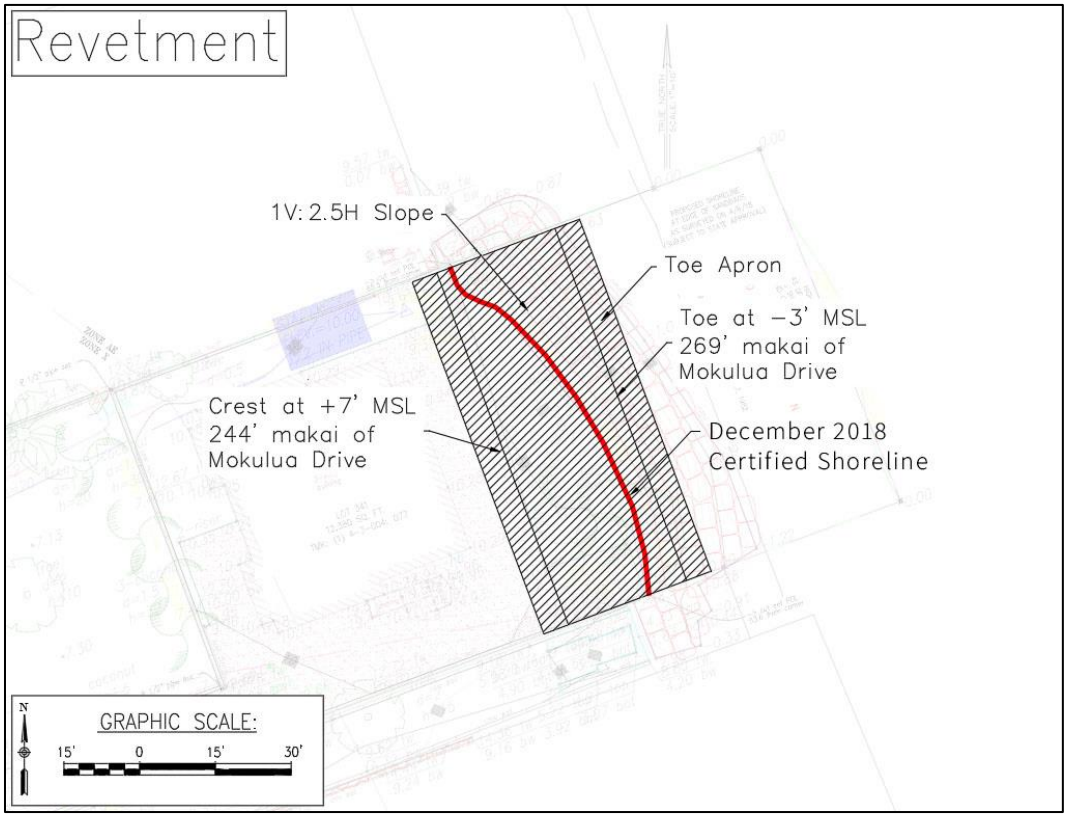


Figure 4-5 **Court Settlement Revetment Footprint**

Applying the design and location parameters of the 1994 settlement in relation to the current shoreline would result in placement of the revetment seaward of the 2018 certified shoreline in contravention of state policy, and would also result in an undersized revetment based upon (1) the +10 ft msl backshore elevation and (2) the toe elevation at -3 ft msl being above the scour depth and hard substrate. The revetment design per the 1994 settlement would also not tie into the seawall at the adjoining property to the north. For these reasons, a revetment design per the 1994 settlement is not a preferred solution.

4.5 Alternative E – Hybrid Seawall-Revetment

The hybrid seawall-revetment alternative would involve removing the existing sandbag revetment and constructing a hybrid structure composed of two primary elements: a seawall (i.e., vinyl sheet pile, reinforced concrete, or cemented rock masonry), and a uniform armor rock rubble mound revetment (*Figure 4-6*). A hybrid seawall-revetment would be designed to withstand extreme wave conditions, be minimally reflective, facilitate beach sand accretion, reduce turbidity in nearshore waters, and reduce the amount of material placed in navigable waters of the United States and the State Conservation District relative to a traditional rock revetment. A hybrid seawall-revetment would have a slightly smaller footprint than a traditional rock revetment, providing more lateral shoreline access than a revetment.

The hybrid seawall-revetment design is dependent on sea level elevation, design wave height, and scour depth. The design presented below incorporates a 2.3-foot higher than present sea level, with consequent increases in predicted wave exposure and scour depth. Utilizing 2.3 feet of sea level rise, which is currently projected for 50 years in the future, provides suitable design criteria within the effective life span of similar structures. Structure maintenance, improvements, or replacement are appropriate at the end of the structure's projected life span or when the environment changes beyond design conditions. Adaptation to sea levels and their resulting impacts predicted at time frames beyond the structure's design life should be incorporated at that time.

Figure 4-6 **Hybrid Seawall-Revetment (Kapaa, Kauai, Hawai'i)**

Hybrid Seawall-Revetment Alternative Evaluation:

<u>Project Objectives</u>

- Disadvantage – Does not provide long-term preservation/protection for the habitable dwelling in its current location. Effectiveness of satisfying the project objectives is only achieved if a substantial portion of the structure is built onto State lands, which is not supported by the DLNR when other options are available. If the structure is built inland of State submerged lands, then the dwelling will have to be partially or wholly demolished and flank protection will be required for the adjacent shoreline structures.
- Disadvantage – There are no design options that stabilize the shoreline near or mauka of its current location and do not extend into State submerged lands. The DLNR does not support structures on submerged lands, when other options are available.

- Disadvantage – The shoreline access structure to the south and the seawall to the north would be de-stabilized without additional flank protection along the sides of the lower sloped revetment.
- Advantage – Will likely result in a footprint that is farther mauka than the existing sandbag structure.
- Disadvantage – The hybrid structure minimizes potential negative impacts to the dwelling, but only if built into State Conservation lands, which is not currently supported by the DLNR. Building outside of State submerged lands requires demolition of some or all of the existing dwelling.

Evaluation Criteria

- Disadvantage - Effectiveness of satisfying the project objectives is only achieved if a substantial portion of the structure is built onto State Conservation lands, which is not supported by the DLNR when other options are available. If the structure is built inland of State submerged lands, then the dwelling will have to be partially or wholly demolished and flank protection will be required for the both of the adjacent shoreline structures.
- Neutral – Suitability based on location and size are low, though design life and durability are excellent.
- Neutral – Shoreline structures typically have high costs for design, permitting, and construction; however, well designed and constructed hybrid seawall-revetments have low maintenance costs.
- Disadvantage – There is unlikely to be regulatory support from the State for a structure that extends onto State Conservation lands, when other options are available. There is likely to be mixed support from the community.
- Disadvantage – The hybrid seawall-revetment is more likely to allow sand accumulation than vertical structures, but less likely than a natural beach environment. That said, the size constraints on the parcel preclude design and construction of a revetment that protects the dwelling and neighboring properties and does not extend onto State land. The State DLNR is not supportive of shoreline structures on submerged lands when other options are available.

4.5.1 Hybrid Seawall-Revetment Design

The armor and underlayer stone size and placement would be the same as for the revetment structure. Figure 4-7 shows the typical section and stone placement for the hybrid seawall-revetment structure. The overall width of the structure from back of wall to toe is 27.1 feet.

Figure 4-8 shows the footprint of a hybrid seawall-revetment structure with the toe of the structure placed mauka of the certified shoreline. The house structure and hybrid seawall-revetment footprint would overlap by up to 8 feet in this configuration. In order to avoid impact the house, the hybrid seawall-revetment would need to be shifted seaward, in which case it would extend seaward of the certified shoreline.

A hybrid seawall-revetment is too large to be constructed between the certified shoreline and the existing house structure.

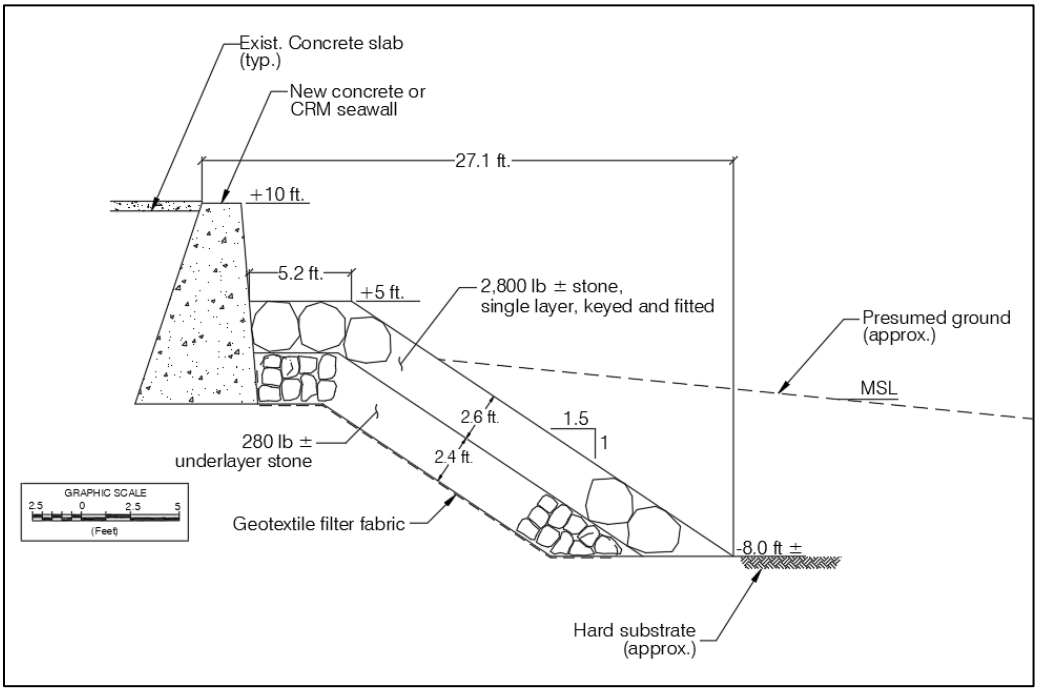


Figure 4-7 **Section View of Hybrid Seawall-revetment Option**

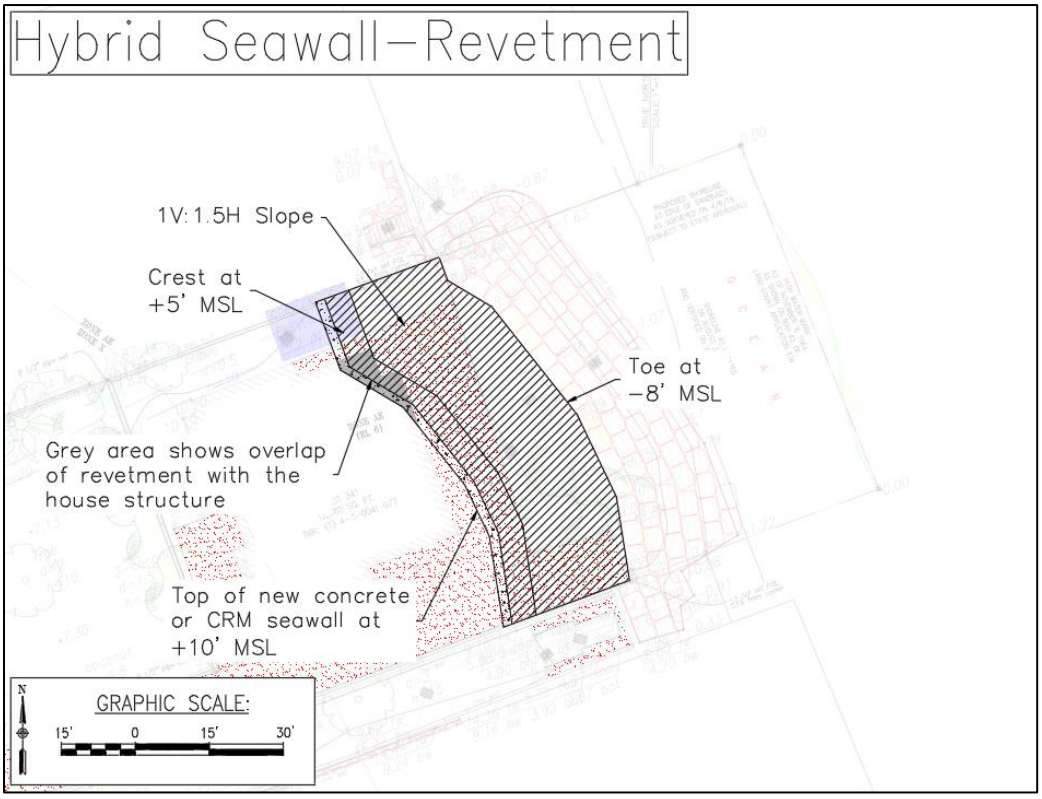


Figure 4-8 **Hybrid Seawall-Revetment Option Footprint**

The hybrid seawall-revetment has the potential to facilitate sand accretion seaward of the structure. However, similar to the sloping rock revetment alternative, if the toe of the structure were to be placed mauka of the certified shoreline, the house structure and the hybrid seawall revetment footprint would overlap by up to 8 feet in this configuration. To avoid impact to the existing residence, the hybrid seawall-revetment would need to be shifted seaward, encroaching onto State submerged land which would require an easement along with Federal and State permits. This would increase the overall costs for design, permitting, and construction. The shoreline access structure to the south and the seawall to the north would also be de-stabilized and require additional flank protection

For reasons similar to the sloping rock revetment, a hybrid seawall-revetment is not a preferred shoreline protection alternative.

4.6 Alternative F – Seawall

This approach would involve removing the existing sandbag revetment and constructing a seawall. A seawall is a vertical or sloping concrete, concrete rubble masonry (CRM), cement masonry unit (CMU), or sheet pile wall used to protect the land from wave damage and erosion. A seawall, if properly designed and constructed, is a proven, durable, and relatively low-maintenance shore protection method. Seawalls also have the advantage of having a relatively small footprint along the shoreline, which helps to preserve lateral shoreline access.

Seawalls are not flexible structures and their structural stability is dependent on the design and strength of their foundations. If the foundation of a seawall is breached, hydraulic action can erode fill material behind the wall. With the loss of enough fill, the ground surface behind the seawall will collapse and sinkholes will form. Sinkholes can compromise the structural integrity of a seawall and may result in failure of the structure. To avoid foundation problems, the seawall foundation should be well below the potential scour depth, which can require extensive excavation. Figure 4-9 shows an example of CRM and concrete seawalls.

Figure 4-9 **CRM and Concrete Seawalls (Lanikai, Oʻahu, Hawaiʻi)**

The impervious and vertical face of a seawall results in very little wave energy dissipation. Incident wave energy is deflected upward, downward, and seaward. Reflected wave energy can inhibit accretion of sand seaward of the wall. The downward energy component can cause scour at the base of the wall. Therefore, the foundation of a seawall is critical for its stability, particularly on sandy and eroding shorelines. Ideally, seawalls are constructed on solid, non-erodible substrate. There may also be end effects (e.g., end scour and flanking erosion) associated with the terminations of the seawalls along the coastline.

Regulatory agencies tasked with beach and shoreline management are generally reluctant to permit the construction of seawalls due to concerns about potential impacts to beach resources, particularly in areas with beaches and coastal dunes. One of the primary concerns expressed by the agencies is the potential for seawalls to impound dune sand that may otherwise be released onto the beach, providing a form of "natural beach nourishment."

Seawall design is dependent on sea level elevation, design wave height, and scour depth. The design presented below incorporates a 2.3-foot higher than present sea level, with consequent increases in predicted wave exposure and scour depth. Utilizing 2.3 feet of sea level rise, which is currently projected for 50 years in the future, provides suitable design criteria within the effective life span of similar structures. Structure maintenance, improvements, or replacement are appropriate at the end of the structure's projected life span or when the environment changes beyond design conditions. Adaptation to sea levels and their resulting impacts predicted at time frames beyond the structure's design life should be incorporated at that time.

Seawall Alternative Evaluation:

Project Objectives

- Advantage – Does provide long-term preservation/protection for the habitable dwelling and neighboring shoreline structures in their current locations. Does stabilize the shoreline at or mauka of the existing shoreline location. Does not have a negative impact on lateral shoreline access, but will likely have a negative impact on recreational value due to reflected waves.
- Advantage – The structure will stabilize the shoreline, mauka of State submerged lands.
- Advantage – The shoreline access structure to the south and the seawall to the north would not be de-stabilized if the seawall curves to tie into both structures.
- Disadvantage – Will likely result in higher reflected wave energy off the face of the structure, which is likely to negatively impact lateral shoreline access and recreational value.
- Neutral – The vertical seawall minimizes impacts to dwelling and neighboring shoreline structures; however, it also increases the impacts associated with return wave energy and beach deflation.

Evaluation Criteria

- Neutral - Effectiveness of protection of mauka dwelling and structures is high, but increased return wave energy is likely to have negative impacts on access and recreation seaward of the structures.
- Neutral – The structure has a long design life and high durability on the shoreline; however, the highly reflective nature of the vertical structure can make it less desirable than an open, sloped structure.
- Neutral – Shoreline structures typically have high costs for design, permitting, and construction; however, well designed and constructed hybrid seawall-revetments have low maintenance costs.
- Neutral – There is likely to be mixed support from the permitting agencies. There is likely to be less support for this structure from the community.
- Disadvantage – The seawall is less likely to allow sand accumulation than other sloped structures and the beach environment. That said, a vertical seawall will protect the dwelling and neighboring properties and does not extend onto State land. Higher reflected wave energy associated with vertical seawalls is more likely to negatively impact marine habitat, shoreline processes, shoreline access, and recreation than other sloped alternatives.

A seawall would provide an effective, durable, long-term solution for protecting the backshore land and infrastructure, and it would also provide maximum space for lateral access. This solution would, however, require a major construction effort in coordination with neighboring property owners, and the costs for design, permitting, and construction would be high. The seawall structure is also highly reflective and sand accretion could be a challenge. Construction of a seawall is not a preferred solution.

4.6.1 Seawall Design

The planform of the new seawall may be either curved (Figure 4-10) or aligned straight with the neighboring seawall to the north (Figure 4-1). The curved seawall has the advantage of connecting directly with both the northern neighbor's and southern access's structures. This not only protects the neighboring structures, but also creates a smooth transition to the alignment of structures to the south of the subject property. A straight seawall would cause a distinct discontinuity along the shoreline where it intersects the adjacent public access to the south. During the winter season when north swell dominates, this area is expected to fill with sand, as evidenced by sand accretion on the north side of

the existing sandbag structure. During the summer, however, when tradewind waves dominate and transport sand alongshore from the south, there would be no structure to interrupt the flow of sand and no accretion is expected fronting the southern neighbor's property. This may result in additional deflation of the wet beach and flanking at the adjacent neighboring structure and public access. A straight seawall may also reflect more wave energy than a curved seawall, also impeding accretion along the shoreline.

Figure 4-12 shows a generalized section view of the Seawall alternative. If this alternative is selected, the team's structural engineer would determine the final design of the seawall.

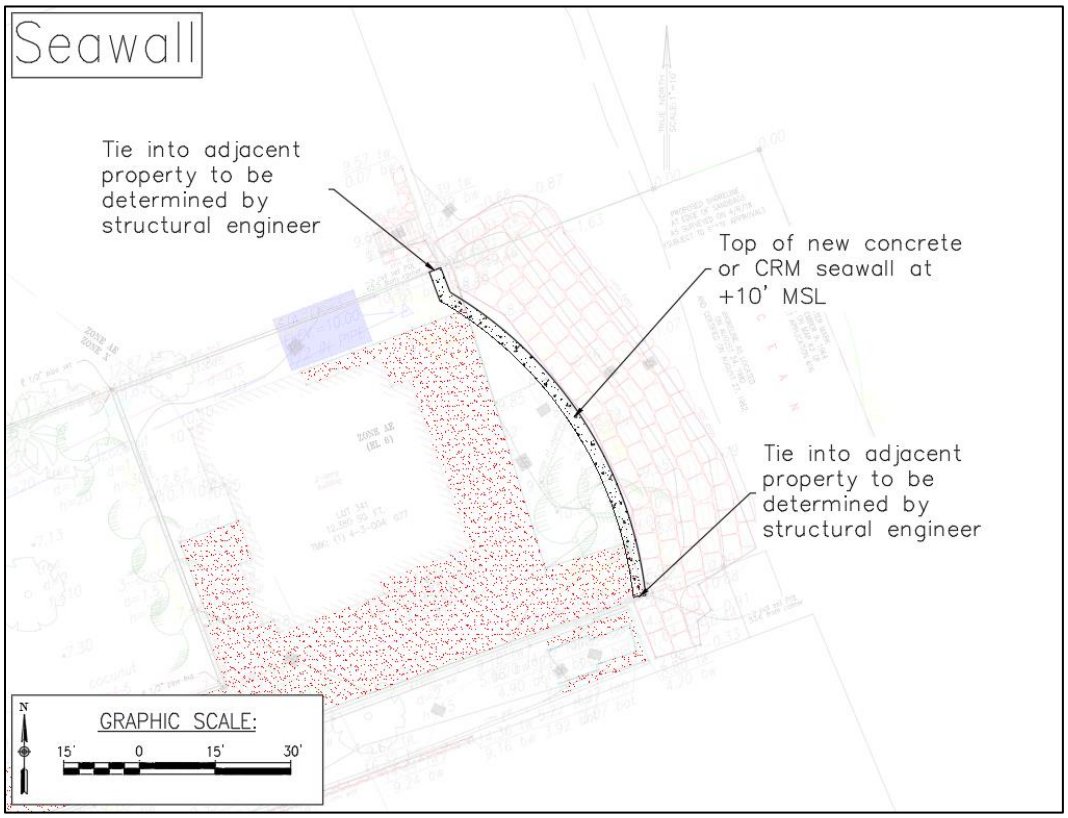


Figure 4-10 **Curved Seawall Option Footprint**

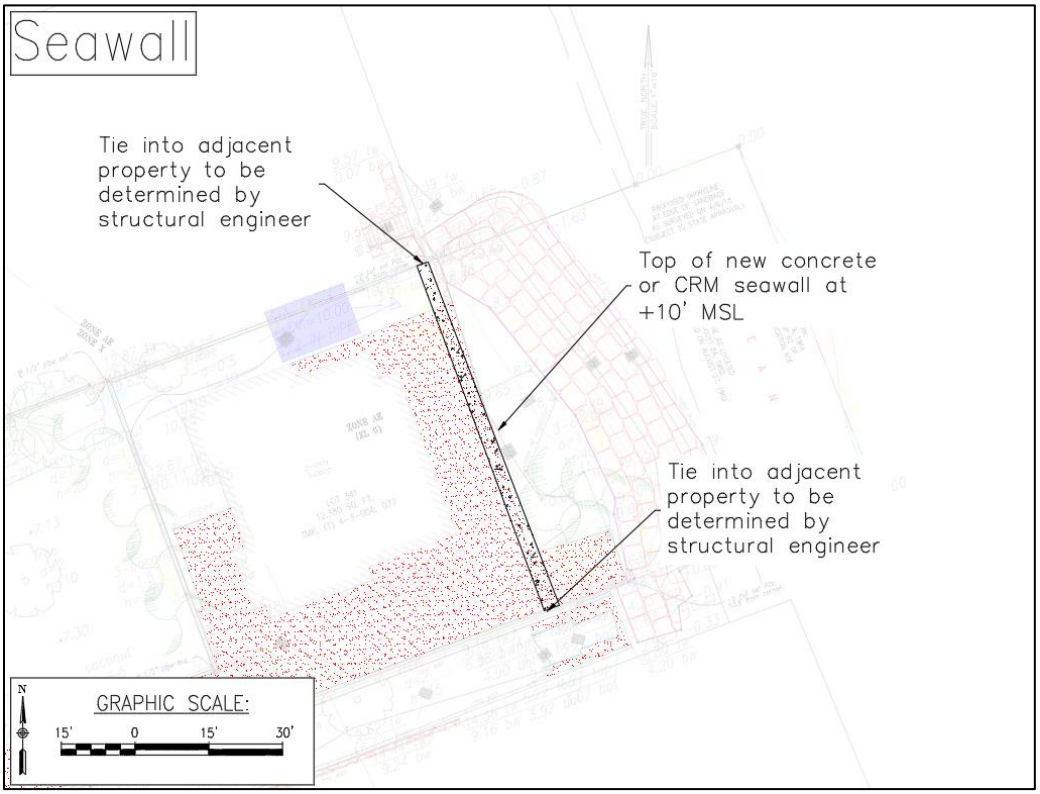


Figure 4-11 **Straight Aligned Seawall Option Footprint**

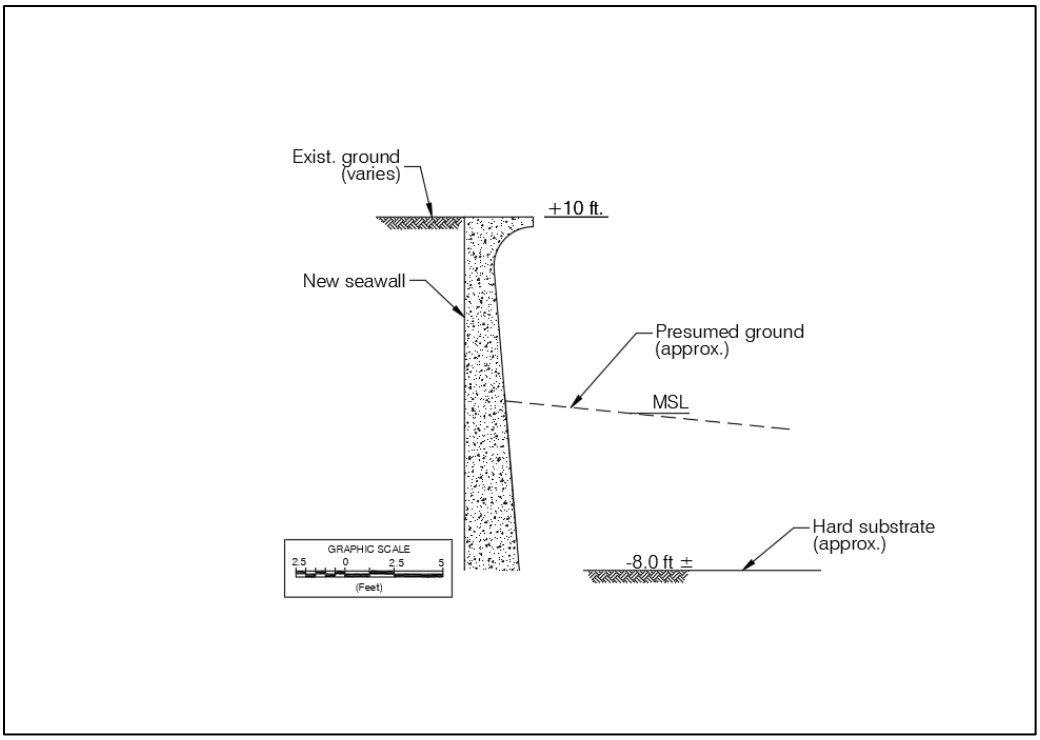


Figure 4-12 **Section View of Seawall Option**

4.7 Preferred Alternative/Proposed Action – Seawall with Scour Apron

The preferred alternative is the construction of a seawall with a rip rap scour apron. This approach would involve removing the existing sandbag revetment and constructing a seawall with a riprap scour apron (Figure 4-13). Seawall construction is described above in Alternative F. A scour apron is a sloping, un-cemented structure built of wave resistant material. The most common method of construction is to place riprap sized according to the design wave height along the lower face of the seawall. A toe apron has a much smaller horizontal footprint than a traditional revetment, and generally uses smaller stones than standalone structures. Traditionally used in sub-aerial installations, the goal of this design is to prevent scour at the toe of the vertical wall. The toe apron disperses wave energy, preventing the downward motion of reflected wave energy that results in scour of the natural sediment as well as reducing reflected wave energy. These installations improve the longevity of the backing structure and assist in protecting the backshore when paired with a seawall.

Sea Engineering, Inc. performed a field study in 2008 to measure the reflected wave energy from different shorelines in Waikīkī and found that wave energy reflected off beaches and rock revetments was of the same magnitude, while seawalls had the highest measured wave energy reflection. Similarly, Lipp (1995) showed that measured beach profiles in Lanikai were of similar slope fronting beaches and dissipative seawalls (i.e., seawalls with rubblemound). With the proper riprap toe apron structure, the scour of sand will be reduced along with a significant reduction in reflected wave energy. This reduction in wave energy at the face of the seawall is expected to steepen the beach profile and allow sand to build up makai of the structure when there is available material.

Seawall with scour apron design is dependent on sea level elevation, design wave height, and scour depth. The design presented below incorporates a 2.3-foot higher than present sea level, with consequent increases in predicted wave exposure and scour depth. Utilizing 2.3 feet of sea level rise, which is currently projected for 50 years in the future, provides suitable design criteria within the effective life span of similar structures. The scour apron is designed to allow 30-40% damage during a 50-year wave event at a sea level 2.3 feet higher than present. The scour apron is expected to require more frequent maintenance as sea level rises above present. The entire structure is expected to require maintenance, improvements, or replacement at the end of the structure's projected life span or when the environment changes beyond design conditions. Adaptation to sea levels and their resulting impacts predicted at time frames beyond the structure's design life should be incorporated at that time.

Figure 4-13 **Seawall with Scour Apron, (Lanikai, Oʻahu, Hawaiʻi)**

Seawall with Scour Apron Alternative Evaluation:

Project Objectives

- Advantage – Does provide long-term preservation/protection for the habitable dwelling and neighboring shoreline structures in their current locations. Does stabilize the shoreline at or mauka of the existing shoreline location. Does not have a negative impact on lateral shoreline access and is unlikely have a negative impact on recreational value due to reduced energy in reflected waves.
- Advantage – The structure will stabilize the shoreline, mauka of State submerged lands.
- Advantage – The shoreline access structure to the south and the seawall to the north would not be de-stabilized if the seawall curves to tie into both structures.
- Advantage – Will likely result in a footprint that is farther mauka than the existing sandbag structure.
- Advantage – The seawall with scour apron structure minimizes potential negative impacts to the dwelling and the neighboring shoreline structures. It also minimizes the impacts of reflected wave energy and allows for sand accumulation at a level approaching that of a sloped rock revetment.

Evaluation Criteria

- Advantage - Effectiveness of protection of mauka dwelling and structures is high and is combined with decreased return wave energy and likely improved lateral shoreline access.
- Advantage – The structure has a long design life and high durability on the shoreline. Moreover, the dissipative nature of the scour apron is desirable from a shoreline access and recreational use perspective.
- Neutral – Shoreline structures typically have high costs for design, permitting, and construction; however, well designed and constructed seawall with scour apron will have low maintenance costs.
- Advantage – There is likely to be mixed support from the permitting agencies; however, there is likely to be net positive support from the community, based on the performance of similar structures in the near area.
- Advantage – The seawall with scour apron is more likely to allow sand accumulation than vertical seawalls or sandbags and is expected to have accumulation potential nearing that of a sloped rock revetment. This structure will also protect the dwelling and neighboring properties and does not extend onto State land. Attenuated reflected wave energy associated with scour aprons is more likely to mitigate impacts to marine habitat, shoreline processes, shoreline access, and recreation than other alternatives (not including revetments and beach faces).

A properly designed and constructed seawall with scour apron is a durable and relatively low maintenance shoreline protection method. Seawalls are not flexible structures and their structural stability is dependent on the design and strength of their foundations. If the foundation of a seawall is breached, hydraulic action can erode fill material behind the wall. With the proper riprap toe apron structure, the scour of sand will be reduced along with a significant reduction in reflected wave energy. This reduction in wave energy at the face of the seawall is expected to allow sand build up makai of the structure when there is available material. The removal of the 20-ft. wide sandbag complex will greatly improve public lateral access along this shoreline.

The seawall with boulder scour apron alternative stands out among the other alternatives because it combines the provision of an additional 20 feet of lateral access with the expectation of sand accretion at the sloping rock scour apron. This structure will attenuate wave energy and protect the existing dwelling and neighboring properties. Providing the most advantages over the other alternatives, the seawall with scour apron was selected as the preferred alternative and evaluated as the proposed action.

4.7.1 Seawall with Scour Apron Design

A typical toe apron section is shown in Figure 4-14 and the plan view of this alternative is shown in Figure 4-15. The apron would reduce reflected wave energy and may facilitate beach accretion in the area.

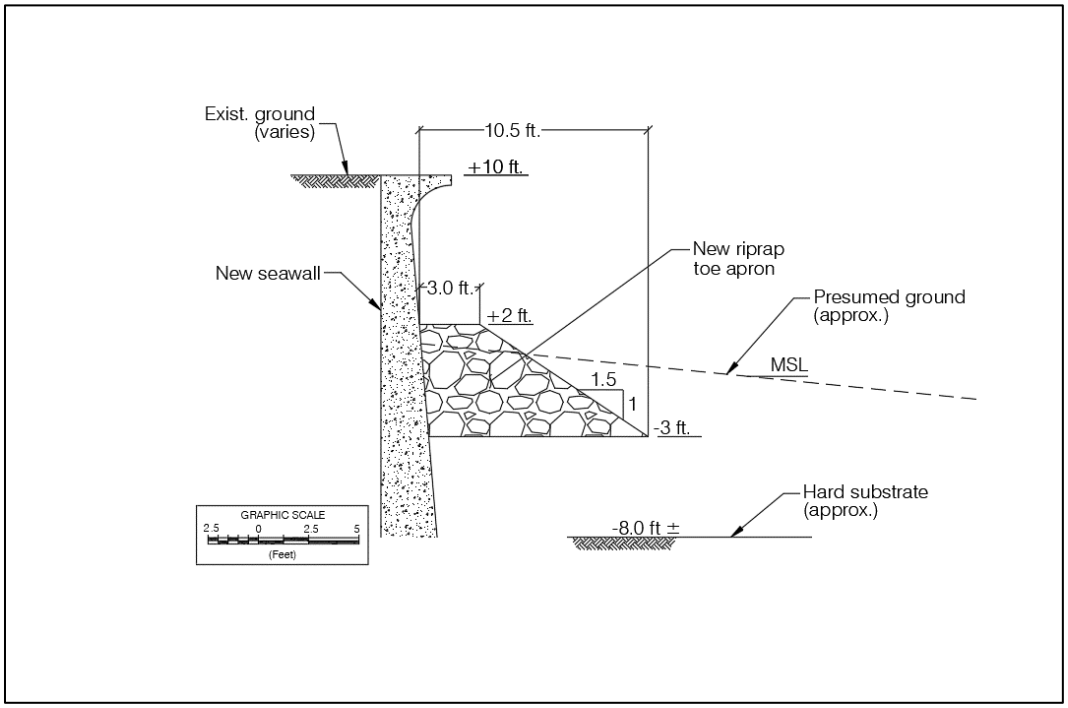


Figure 4-14 **Section View of the Seawall with Toe Apron Alternative**

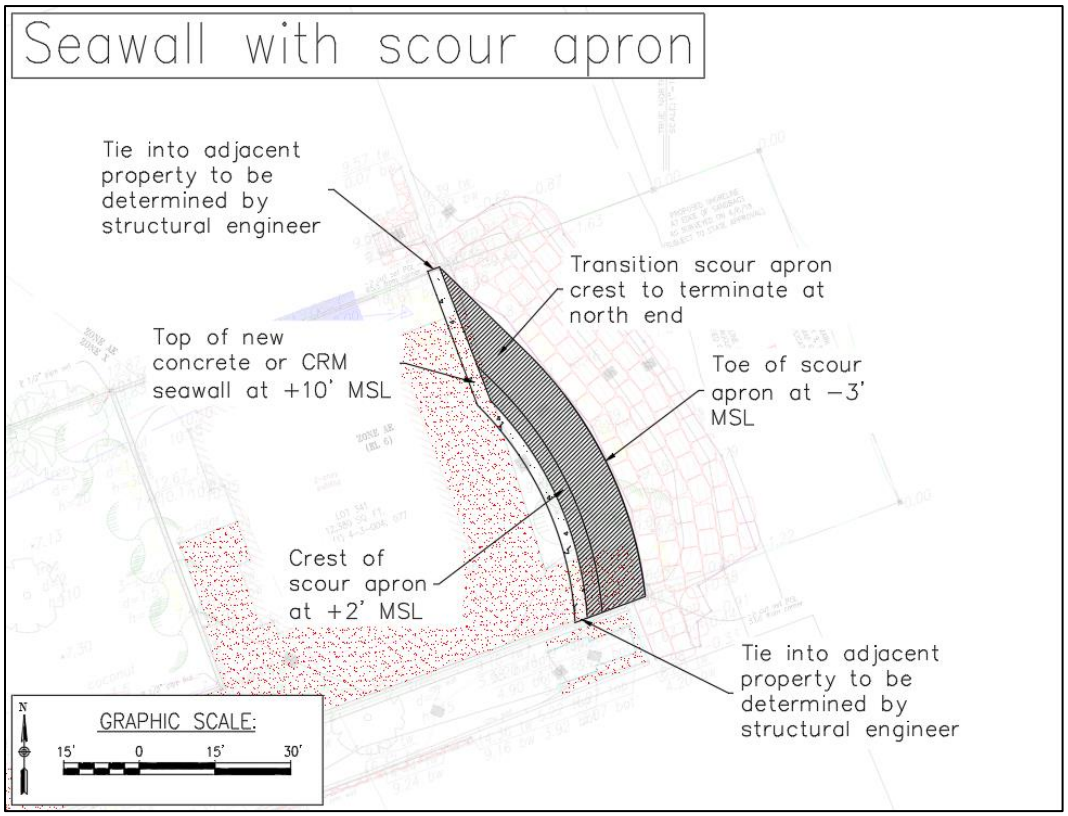


Figure 4-15 **Seawall with Scour Apron Option Footprint**

4.8 Other Considerations

This section examines issues not specifically part of the proposed action, but related and considered in the planning for shoreline protection at 1326 Mokulua Drive. These issues include potential impacts to neighboring structures, removal of the beach access headwall, and potential for construction in the State Conservation District.

4.8.1 Replacement of Sandbag Structure and Potential Impacts to Neighboring Structures

The property to the south is protected by a rock revetment that extends to a wing wall at the beach access, as shown in Figure 4-16. The rock revetment and the sandbag revetment are approximately aligned, with the sand bags offering a certain amount of protection to the beach access and the wing wall from waves approach from the northeast direction during the winter months. Removal of the sandbag revetment may result in sand accretion against the wing wall; however, it will also expose the wing wall to winter wave forces.

The property to the north is protected by a vertical seawall with access stairway connecting the backshore to the beach, as shown in Figure 4-17. The vertical seawall and sandbag revetment are not aligned with each other which appears to cause an accretion of sand at the interface between the sandbags and the seawall. Removal of the sandbag revetment may result in the accreted sand migrating laterally south towards the public access during the winter months when waves approach from the northeast direction. During the summer months when waves approach from the east, the sand may migrate back to the front of the seawall and may also expose the wall to more easterly waves that were before blocked by the sandbag revetment.

Minimizing impacts to neighboring structures was included in the criteria for evaluation of the project alternatives.

Figure 4-16 South End of Sandbag Revetment Adjacent to Public Access Headwall (March 2018)

Figure 4-17 North End of Sandbag Revetment at Adjacent Property (March 2018)

4.8.2 Potential Removal of Beach Access Headwall

The Lanikai Community Association owns the public beach access right-of-way adjacent to 1326 Mokulua Drive. The community has expressed interest in removal of the concrete headwall on the makai side of the public access (shown in *Figure 4-16*) which could be done in conjunction with the proposed sandbag removal and replacement project.

SEI, Inc. issued a technical memorandum concerning the removal of the headwall (*Appendix H*). According to SEI, removal of the headwall and sandbags fronting the public access, assuming no further improvements were made to the public access, would cause the waterline at the beach access to rapidly migrate inland.

SEI anticipates that the sandy substrate would progressively recede landward over time as waves funnel into the public access and wash into the pathway. According to SEI, natural short-term erosion combined with projected future erosion associated with rising sea levels would like result in a significantly landward position of the shoreline within the public access.

This shoreline retreat is highly likely to result in flanking and possible undermining of the properties and shoreline structures on either side of the public access. If the headwall were removed, the shoreline structures would require a retrofit to ensure their foundations are protected from undermining and the adjacent properties would require additional shoreline structures on their side boundaries to protect from flanking erosion. These flank protection structures should be extended well inland, as the full extent of potential erosion at the public access is not known.

Removal of the headwall in the public shoreline access is not considered part of the proposed action, however, potential impacts to the shoreline environment and adjacent structures should be considered if plans for removal are considered in the future.

4.8.3 Shoreline Hardening in the State Conservation District

State marine waters are considered to be in the Conservation District (HAR §13-5-2) and defined as seaward of the upper reach of the wash of waves on the shore (HRS §190D-3). A certified shoreline delineates that upper wash of the waves for the purposes of implementing shoreline setbacks and related laws (HAR §13-222-1).

The shoreline for the property was certified by the State BLNR in December 2018. The existing sandbag revetment structure is located makai of the certified shoreline, and therefore within the Conservation District and the jurisdiction of the State. One possible scenario would be to seek permit approvals to construct the new permanent shoreline structure in the same location as the existing temporary sandbag structure.

The land use permitting process for a structure in the Conservation District would include HRS §343 environmental compliance and a Conservation District Use Application (CDUA). Upon approval of a Conservation District Use Permit (CDUP), the applicant would be required to obtain a lease of state maritime waters pursuant to HRS §190D-21 to lease the State water and land under the new permanent shoreline structure.

For a shoreline structure proposed at this position, the U.S. Army Corp of Engineers would require approval of a Section 404 permit for the discharge of dredge or fill material into the waters of the U.S.. There would also be a corresponding permit required from the State of Hawai‘i Department of Health Clean Water Branch for a Section 401 Water Quality Certification.

One advantage of encroaching in the Conservation District would be the provision of adequate space to construct a full-scale low-slope rock revetment. A revetment would be expected to provide for the greater dissipation and distribution of wave energy. This approach to shoreline protection in the same location as the sandbags would avoid the loss of yard space front of the house. Utilizing the Conservation District would allow the landowner to retain the front yard between the existing house and the sandbag structure.

Utilizing the State Conservation District would also have significant disadvantages. Building makai of the certified shoreline would retain the structure would stay in approximately the same location, and no additional shoreline area would be created for public lateral access. This structure location may also decrease sand accretion in the area of the beach access.

Shoreline hardening in the Conservation District would be inconsistent with State policy. As discussed earlier in Section 5.3, pursuant to HRS §205A-2(9) Beach Protection, State policy is to:

(A) Locate new structures inland from the shoreline setback to conserve open space and to minimize loss of improvements due to erosion;

(B) 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;

Building within the Conservation District would utilize public land and encumber public open space. This alternative is inconsistent with State policy to prohibit construction of private erosion-protection structures seaward of the shoreline.

As mentioned above, the CDUP, and Section 404 and 401 permitting would result in a lengthy entitlement and permitting process with no expectation of approval due to policy inconsistencies. This

option would also result in a lease fee to the State for utilization of ocean land in the Conservation District.

Despite some advantages, building in the State Conservation District was not considered for the proposed action because it would be inconsistent with State beach protection policy.

Section 5

Plans and Policies

Chapter 5

Plans and Policies

In this chapter, the project's consistency with applicable land use policies set forth in the Hawai‘i State Plan, State Land Use Law, State Coastal Zone Management Program, Hawai'i Water Quality Standards, City and County of Honolulu General Plan, City and County of Honolulu Land Use Ordinance, City and County of Honolulu Ko‘olau Poko Sustainable Communities Plan, Shoreline Setbacks, and Special Management Area are discussed.

5.1 Hawai‘i State Plan

The Hawai‘i State Plan establishes a statewide planning system that provides goals, objectives, and policies that detail priority directions and concerns of the State of Hawai‘i; these will be discussed as they relate to the project.

It is the goal of the State, under the Hawai‘i State Planning Act (Chapter 226, HRS), to achieve the following:

- A strong, viable economy, characterized by stability, diversity, and growth, that enables the fulfillment of the needs and expectations of Hawai‘i present and future generations.
- A desired physical environment, characterized by beauty, cleanliness, quiet, stable natural systems, and uniqueness, that enhances the mental and physical well-being of the people.
- Physical, social, and economic well-being, for individuals and families in Hawai‘i, that nourishes a sense of community responsibility, of caring, and of participation in community life (Chapter 226-4, HRS).

Specific objectives and policies of the State Plan that pertain to the project are as follows:

Section 226-11 Objectives and policies for the physical environment—land-based, shoreline, and marine resources.

(a) Planning for the State's physical environment with regard to land-based, shoreline, and marine resources shall be directed towards achievement of the following objectives:

(1) Prudent use of Hawai‘i's land-based, shoreline, and marine resources.

(2) Effective protection of Hawai‘i's unique and fragile environmental resources.

(b) To achieve the land-based, shoreline, and marine resources objectives, it shall be the policy of this State to:

(1) Exercise an overall conservation ethic in the use of Hawai‘i's natural resources.

(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 use without generating costly or irreparable environmental damage.

(6) Encourage the protection of rare or endangered plant and animal species and habitats native to Hawai‘i.

(8) Pursue compatible relationships among activities, facilities, and natural resources.

Discussion

The project’s use of this area is consistent with State and County land use districts and zoning designations. No endangered plant species, animal species, or habitats are known in the project area. The project is not anticipated to pose threats to Native Hawaiian endangered plant or animal species and habitats. However, as noted in *Section 3.5* of this document, the federally threatened sea turtle, may nest in the shoreline areas of the subject properties, and seabirds may overfly the project area.

Construction activities will be limited to daylight hours and will not use construction work lights to avoid attracting seabirds and/or disorienting sea turtles. The project is not anticipated to result in substantial impacts to environmental and marine resources.

Section 226-12 Objectives and policies for the physical environment—scenic, natural beauty, and historic resources.

(a) Planning for the State's physical environment shall be directed towards achievement of the objective of enhancement of Hawai‘i’s scenic assets, natural beauty, and multi-cultural/historical resources:

(b) To achieve the scenic, natural beauty, and historic resources objectives, it shall be the policy of this State to:

(1) Promote the preservation and restoration of significant natural and historic resources.

(3) Promote the preservation of views and vistas to enhance the landscapes, and other natural features.

(5) Encourage the design of developments and activities that complement the natural beauty of the islands.

Discussion

The project will not pose adverse impacts to existing scenic assets or cultural/historical resources at the project site. As reviewed in *Section 3.14* of this EA, scenic viewsheds identified in the Ko‘olau Poko Sustainable Communities Plan and the Coastal View Study include panoramic views of the coastline from the ocean. As the project is being proposed along Mokulua Drive among existing homes, the project will not be visible from roadway views toward the ocean, and the views toward the coast from the ocean will not be a noticeable change, given that the surrounding properties include shoreline protection structures. A seawall with scour apron would have a smaller footprint than the existing sandbag revetment and could be considered an aesthetic improvement to the shoreline.

An Archaeological Assessment was conducted for the project. The study indicated no effects to cultural, archaeological, or historical resources are anticipated to result from the project.

Section 226-13 Objectives and policies for the physical environment–land, air, and water quality.

(a) Planning for the State's physical environment with regard to land, air, and water quality shall be directed towards achievement of the following objectives:

(1) Maintenance and pursuit of improved quality in Hawai‘i's land, air, and water resources.

(b) To achieve the land, air, and water quality objectives, it shall be the policy of this State to:

(2) Promote the proper management of Hawai‘i's land and water resources.

(5) Reduce the threat to life and property from erosion, flooding, tsunamis, hurricanes, earthquakes, volcanic eruptions, and other natural or man-induced hazards and disasters.

(6) Encourage design and construction practices that enhance the physical qualities of Hawai‘i’s communities.

Discussion

The project is appropriately scaled and will maintain Hawai‘i’s natural and scenic resources. The project is not anticipated to adversely affect coastal resources. Protective measures will be carried out to address potential impacts to the physical environment (land, air, and water) that may occur during construction of the project.

5.2 Hawai‘i State Land Use District Boundaries

Under the Chapter 205, HRS, all lands of the State are to be classified in one of four categories: urban, rural, agricultural, and conservation lands. The State Land Use Commission (LUC), an agency of the State Department of Business, Economic Development, and Tourism (DBEDT), is responsible for each district’s standards and for determining the boundaries of each district (Chapter 205-2(a), HRS). The LUC is also responsible for administering all requests for district reclassifications and/or amendments to district boundaries, pursuant to Chapter 205-4, HRS, and the HAR, Title 15, Chapter 15 as amended. Under this Chapter, all lands in Hawai‘i are classified into four land use districts: (1) Conservation, (2) Agricultural; (3) Urban, and (4) Rural.

The Urban District generally includes lands characterized by “city-like” concentrations of people, structures and services. This District also includes vacant areas for future development. Jurisdiction of this district lies primarily with the respective counties. Generally, lot sizes and uses permitted in the district area are established by the respective County through ordinances or rules.

Discussion

As classified by the State of Hawai‘i LUC, the project site is situated within the State Urban District. The project is consistent with permitted uses for the Urban District with a Special Management Area use permit, and will not require district reclassification or boundary amendments.

Include a discussion of the benefits or difficulties of encroaching into the conservation district so OCCL can comment on those options. (Maybe correlating section in Chapter 4 on alternative that extends into Conservation district)

5.3 Hawai'i Coastal Zone Management Program

The Coastal Zone Management Act of 1972 (16 USC Section 1451), as amended through Public Law 104-150, created the coastal management program and the National Estuarine Research Reserve system. The coastal states are authorized to develop and implement a state coastal zone management program. Hawai‘i Coastal Zone Management (CZM) Program received federal approval in the late 1970's. The objectives of the State's Hawai‘i Coastal Zone Management (CZM) Program, Section 205A-2, HRS, are to protect valuable and vulnerable coastal resources such as coastal ecosystems, special scenic and cultural values and recreational opportunities. The objectives of the program are also to reduce coastal hazards and to improve the review process for activities proposed within the coastal zone. Each county is responsible for designating a Special Management Area (SMA) that extends inland from the shoreline. Development within this SMA is subject to County approval to ensure the proposal is consistent with the policies and objectives of the Hawai‘i CZM Program. The entire project site is within the SMA as delineated by the City and County of Honolulu. The following subsections examine the objectives of the Hawai‘i CZM Program and the projects impacts relative to the State CZM objectives and policies. Specific City and County of Honolulu SMA policies are also discussed in *Section 5.9*.

RECREATIONAL RESOURCES

Objective: Provide Coastal Recreational Opportunities Accessible to the Public.

(A) Improve coordination and funding of coastal recreation planning and management.

(B) Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:

- Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas;
- Requiring replacement of coastal resources having significant recreational value, including but not limited to surfing sites and sandy beaches, when such resources will be unavoidable damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;
- Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;
- Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;
- Encouraging expanded public recreational use of county, state, and federally owned or controlled shoreline lands and waters having recreational value;
- Adopting water quality standards and regulating point and non-point sources of pollution to protect and where feasible, restore the recreational value of coastal waters;
- Developing new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, artificial reefs for surfing and fishing; and
- Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the land use Commissions, board of land and natural resources, county planning commissions, and crediting such dedication against the requirements of Section 46-6.

Discussion

The project will not affect coordination and funding of coastal recreation planning and management.

The project includes minor grading and grubbing and the construction of a new, authorized sloping shoreline protection structure. The project will comply with State CZM guidelines and improve coastal recreational opportunities. Narrow sand beaches exist sporadically along portions of the entire Lanikai coastline, with public beach access points throughout the area. A beach access point exists north of the project area. The next closest shoreline access to the project site is located at Lanikai Beach, which offers swimming grounds. The project will not infringe on public access to the beach. The removal of the 20 ft. wide sandbag complex will greatly improve public lateral access along this shoreline.

Construction will be in accordance with State and federal water quality regulations. No storm water or sewer management systems are necessary.

HISTORIC RESOURCES

Objective: Protect, Preserve and, Where Desirable, Restore Those Natural and Man-Made Historic and Pre-Historic Resources in the Coastal Zone Management Area that are Significant in Hawai‘i and American History and Culture.

(A) Identify and analyze significant archaeological resources;

(B) Maximize information retention through preservation of remains and artifacts or salvage operations; and

(C) Support state goals for protection, restoration, interpretation and display of historic resources.

Discussion

An Archaeological Assessment was conducted for the project area to assess the potential for locating archaeological resources. The study did not identify evidence of archaeological or cultural resources at the site. The report determined no action was required due to negative findings.

SCENIC AND OPEN SPACE RESOURCES

Objective: Protect, Preserve and Where Desirable, Restore or Improve the Quality of Coastal Scenic and Open Space Resources.

(A) Identify valued scenic resources in the coastal zone management area;

(B) Insure 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.

(C) Preserve, maintain and where desirable, improve and restore shoreline open space and scenic resources; and

(D) Encourage those developments which are not coastal dependent to locate in inland areas.

Discussion

As described in *Section 3.14,* the action will not adversely affect vistas or scenic resources. The project is consistent with the City and County of Honolulu General Plan, Ko‘olau Poko Sustainable Communities Plan, and Zoning regulations.

COASTAL ECOSYSTEMS

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

(A) Exercise an overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources;

(B) Improve the technical basis for natural resource management;

(C) Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance;

(D) Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs; and

(E) Promote water quantity and quality planning and management practices which reflect the tolerance of fresh water and marine ecosystems and prohibit land and water uses which violate state water quality standards.

Discussion

The project will bring many private and public benefits from protecting this shoreline property from high wave action events and rapid erosion. As discussed in *Section 3.5*, the project is not anticipated to pose adverse effects to coastal ecosystems.

ECONOMIC USES

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

(A) Concentrate coastal dependent development in appropriate areas;

(B) 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

(C) 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:

i. Use of presently designated locations is not feasible;

ii. Adverse environmental effects are minimized; and

iii. The development is important to the State's economy

Discussion

The project is consistent with State and County plans and land regulations, and is seeking a Shoreline Setback Variance for construction of the shoreline protection structure. Since a shoreline protection structure is considered accessory to single-family dwellings, per Section 25-1.3 of the ROH, an SMA application is not required for this project. The project is not anticipated to result in adverse social, visual, and environmental impacts in the coastal zone management area.

COASTAL HAZARDS

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

(A) Develop and communicate adequate information about storm wave, tsunami, flood, erosion, subsidence, and point and nonpoint source pollution hazards;

(B) Control development in areas subject to storm wave, tsunami, flood, erosion, hurricane, wind, subsidence, and point and nonpoint source pollution hazards;

(C) Ensure that developments comply with requirements of the Federal Flood Insurance Program; and

(D) Prevent coastal flooding from inland projects.

Discussion

The purpose of the project is to prevent high wave action and flooding from further exacerbating coastal erosion issues fronting the residential property. The project supports the objectives and policies with regards to coastal hazards.

MANAGING DEVELOPMENT

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

(A) Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development;

(B) Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and

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

Discussion

The project supports the objectives and policies with regards to managing development in coastal areas. This EA complies with the requirements for assessing and communicating the potential short and long-term impacts of a coastal structure.

PUBLIC PARTICIPATION

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

(A) Promote public involvement in coastal zone management processes;

(B) Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal issues, developments, and government activities; and

(C) Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.

Discussion

Public participation is a requirement of the HRS Chapter 343 environmental review process. The Office of Environmental Quality Control (OEQC) is the governing agency of EA publications, and makes available all EAs for public review and comment. The public is provided 30 days to submit comments on the EA. Information regarding the coastal issues and processes is publicly provided in the EA, along with proposed mitigation measures for coastal concerns. Consulted parties in the process are also encouraged to provide inputs regarding the project during the Draft EA.

BEACH PROTECTION

Objective: Protect beaches for public use and recreation.

(A) Locate new structures inland from the shoreline setback to conserve open space and to minimize loss of improvements due to erosion;

(B) 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;

(C) Minimize the construction of public erosion-protection structures seaward of the shoreline;

(D) Prohibit private property owners from creating a public nuisance by inducing or cultivating the private property owner's vegetation in a beach transit corridor; and

(E) Prohibit private property owners from creating a public nuisance by allowing the private property owner's unmaintained vegetation to interfere or encroach upon a beach transit corridor.

Discussion

The proposed shoreline protection structure is to be located inland of the existing shoreline, as surveyed by Austin Tsutsumi and Associates in August 2018. The shoreline survey was certified by the DLNR in December 2018. Shoreline protection will also reduce the potential for losing the residential structure due to erosion. The subject property has faced ongoing threats from erosion that would eventually undermine the structural integrity of existing home. The seawall and scour apron will not interfere with existing surrounding recreational and waterline activities in Lanikai. The removal of the 20 ft. wide sandbag complex will greatly improve public lateral access along this shoreline.

MARINE RESOURCES

Objective: Implement the State's ocean resources management plan.

(A) Exercise an overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources;

(B) Assure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial;

(C) Coordinate the management of marine and coastal resources and activities management to improve effectiveness and efficiency;

(D) 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;

(E) 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

(F) Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.

Discussion

The project will not directly affect marine resources. A Coastal Assessment by SEI (2018) examined the alternatives to stabilize the Lanikai shoreline fronting the subject property and taking into consideration the marine resources of the area (*Appendix D)*. The shoreline seawall with scour apron is the preferred alternative.

PART III. SHORELINE SETBACKS

A shoreline setback variance is required when structures are planned within the shoreline area. Shoreline area is defined by HRS Chapter 205A-41 as,

"'Shoreline area' shall include all of the land area between the shoreline and the shoreline setback line and may include the area between mean sea level and the shoreline; provided that if the highest annual wash of the waves is fixed or significantly affected by a structure that has not received all permits and approvals required by law or if any part of any structure in violation of this part extends seaward of the shoreline, then the term 'shoreline area' shall include the entire structure."

Certified Shoreline Requirement

The Office of Conservation and Coastal Lands (OCCL), at the Department of Land and Natural Resources (DLNR), is the regulatory agency responsible for managing land uses on the State's submerged lands, which extend to the highest wash of the highest wave, as identified by the certified shoreline defined in HRS 205A. Permits for any development on the property are contingent upon a new approved certified shoreline from DLNR.

To pursue development of a new shoreline protection structure located mauka of the Certified Shoreline, the applicant must obtain approvals from the City and County of Honolulu for Shoreline Setback Variance.

Discussion

The shoreline fronting the subject property has been surveyed by ATA in August 2018. The shoreline certification application was approved by the Board of Land and Natural Resources in December 2018. The project qualifies for a variance under (a)(9), as a private improvement that artificially fixes the shoreline. The current shoreline fronting the subject property is highly susceptible to exacerbated erosion conditions that may likely cause hardship to the applicant, whose home's structural integrity would eventually be undermined at the current rates of erosion.

Criteria for Granting a Shoreline Setback Variance

Criteria for granting a shoreline setback variance are provided in Part III of HRS Chapter 205A- 46 and Chapter 23-1.8, ROH. The planned shoreline protection structure is anticipated to meet the criteria required for a Shoreline Setback Variance under both regulations.

HRS Chapter 205A-46 (a) (9) reads:

(a) A variance may be granted for a structure or activity otherwise prohibited in this part if the authority finds in writing based on the record presented that the proposed structure of activity is necessary or ancillary to:

9. Private facilities or improvements that may artificially fix the shoreline; provided that the authority also finds that the shoreline erosion is likely to cause hardship to the applicant if the facilities or improvements are not allowed within the shoreline area, and the authority imposes conditions to prohibit any structure seaward of the existing shoreline unless it is clearly within the public interest.

Erosion is a serious concern with the removal of the erosion protection measures at the subject property. Erosion without shoreline protection would result in release of sediment into the nearshore waters as the bank erodes, with negative environmental impacts to the marine environment and further encroachment of the shoreline into the residential property. Installing a new permitted shoreline protection structure inland of the new certified shoreline will prevent environmental degradation and loss of property resulting from erosion.

The proposed action will also meet the required conditions listed in 205A-46(c). A reconstructed shoreline structure will help to: (1) enlarge and maintain safe lateral shoreline access, (2) minimize adverse impacts on shoreline sediment movement processes, and (3) improve public views along the shoreline.

Further discussion of shoreline setbacks is provided in Section 5.8.

5.4 Hawai'i Water Quality Standards

The State of Hawaiʻi Department of Health, Clean Water Branch Hawaiʻi Water Quality Standards 11-54, Hawaiʻi Administrative Rules (HAR) were most recently revised in 2014.

The project is consistent with the applicable objectives and policies for state water quality standards as described below.

General Policy of Water Quality Antidegradation

(a) Existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

(b) Where the quality of the waters exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the director finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the state's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In allowing such degradation or lower water quality, the director shall assure water quality adequate to protect existing uses fully. Further, the director shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable best management practices for nonpoint source control.

(c) Where existing high quality waters constitute an outstanding resource, such as waters of national and state parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

(d) In those areas where potential water quality impairment associated with a thermal discharge is involved, the antidegradation policy and implementing method shall be consistent with section 316 of the Clean Water Act.

Discussion

Construction of the shoreline protection structure may cause temporary elevated levels of suspended sediment. Construction BMPs will be implemented to control water quality fronting the project area. After the shoreline protection structure is installed, long term water quality impacts are not anticipated.

5.5 City and County of Honolulu General Plan

Adopted by resolution in 1977, the 1992 revised edition of the General Plan for the City and County of Honolulu sets forth the long-range objectives for the general welfare and prosperity of the people of Oʻahu and broad policies to attain those objectives. The Draft 2035 Oʻahu General Plan Update was published in November 2012, and the Revised General Plan was submitted to the City Council in April 2018 for approval. A Final Revised General Plan Update is still pending as of January 2019. The General Plan Update provides objectives and policies intended to guide and coordinate City land use planning and regulation, and budgeting for operations and capital improvements.

The project is consistent with the applicable objectives and policies of the City and County of Honolulu Revised 2035 Oʻahu General Plan described below.

Natural Environment

Objective A: To protect and preserve the natural environment.

- Policy 2: Seek the restoration of environmentally damaged areas and natural 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, as well as plan for coastal hazards that threaten life and property.
- Policy 7: Protect the natural environment from damaging levels of air, water, and noise pollution.
- Policy 8: Protect plants, birds, and other animals that are unique to the State of Hawai‘i and the Island of O‘ahu, and protect their habitats.

Objective B: To preserve and enhance natural landmarks and scenic views of O’ahu for the benefit of both residents and visitors as well as future generations.

- Policy 2: Protect O‘ahu’s scenic views, especially those seen from highly developed and heavily traveled areas.
- Policy 4: Promote public access to the natural environment for recreational, educational and cultural purposes and the maintenance thereof in a way that does not damage natural or cultural resources.

Public Safety and Community Resilience

Objective B: To protect residents and visitors and their property against natural disasters and other emergencies, traffic and fire hazards, and unsafe conditions.

- Policy 2: Require all developments in areas subject to floods and tsunamis, and coastal erosion to be located and constructed in a manner that will not create any health or safety hazards or cause harm to natural and public resources.

Culture and Recreation

Objective B: To protect, preserve and enhance O‘ahu’s cultural, historic, architectural, and archaeological resources.

- Policy 2: Identify, and to the extent possible, preserve and restore buildings, sites, and areas of social, cultural, historic, architectural, and archaeological significance.

Objective D: To provide a wide range of recreational facilities and services that are readily available to residents and visitors alike, and to balance access to natural areas with the protection of those areas.

- Policy 7: Ensure and maintain convenient and safe access to beaches, ocean environments and mauka recreation areas in a manner that protects natural and cultural resources.

Discussion

The project supports the objectives of the Revised General Plan Update. Development of the project will not pose significant adverse impacts to the natural environment, and seeks to preserve the existing shoreline from accelerated erosion rates. As discussed in *Section 3.13,* an Archaeological Assessment was conducted for the project site which indicated no significant findings. Lastly, the recreational resources and public access points at Lanikai Beach will be unaffected by the project. The removal of the 20 ft. wide sandbag complex will greatly improve public lateral access along this shoreline.

5.6 City and County of Honolulu Land Use Ordinance Guidelines

The purpose of the LUO is to regulate land use in a manner that will encourage orderly development in accordance with adopted land use policies, including the County General Plan and development plans. The LUO is also intended to provide reasonable development and design standards. These standards are applicable to the location, height, bulk and size of structures, yard areas, off-street parking facilities, and open spaces, and the use of structures and land for agriculture, industry, business, residences or other purposes (Revised Ordinance for the City and County of Honolulu, Chapter 21).

Discussion

The subject property is designated as R-10 Residential by the City and County of Honolulu's LUO. The intent of R-10 zoning district is to provide areas for large lot developments, typically located at the outskirts of urban development. A shoreline protection structure is a permitted use within this zoning district, but is subject to approval of a Shoreline Setback Variance by the Honolulu City Council.

5.7 City and County of Honolulu Koʻolau Poko Sustainable Communities Plan (2017)

The Koʻolau Poko Sustainable Communities Plan (SCP) by the City and County of Honolulu Department of Planning and Permitting establishes policy to preserve the character and promote sustainable development in the Koʻolau Poko District. The Koʻolau Poko SCP was last revised in 2017.

The Koʻolau Poko SCP establishes the region's role in Oʻahu's development pattern by establishing policies in the following areas: Open Space Preservation; Parks and Recreation; Historic and Cultural Resources; Agricultural Use; Residential Use; Commercial and Industrial Uses; Institutional Uses; and Military Uses. The policies and/or guidelines applicable to the project area provided below:

Open Space Preservation– Shoreline Areas

- Prepare beach management plans to maintain lateral access along popular beaches that are subject to long-term and seasonal erosion, particularly at Lanikai and Kualoa, emphasizing non-structural approaches and prevention of adverse effects on adjacent coral reef ecosystems such as greater shoreline setbacks for new structures along these and other unstable shoreline areas. The Kailua Beach and Dune Management Plan could serve as a prototype for beach management plans at other locations. Effective beach management plans are very location-specific and incorporate the consideration of long-term effects such as climate change and sea level rise, as well as seasonal and long-term erosion and accretion.
- Prohibit the use of shore armoring structures, considering alternative measures such as beach replenishment.
- Analyze the possible impact of sea level rise for new public and private projects in shoreline areas and incorporate, where appropriate and feasible, measures to reduce risks and increase resiliency to impacts of sea level rise.

Discussion

The addition of the new shoreline protection structure will fit with the existing setting of similar shoreline protection structures in the surrounding Lanikai area. Assisting with visual shoreline transition, the proposed shoreline protection structure will include a gradual sloped boulder scour apron.

The purpose of the project fits with the policies and guidelines relating to addressing coastal hazards, as the subject property has been under increased threat by coastal erosion and overwash from storm events. The new shoreline protection structure will protect the existing residential structure from rapid erosion threats, sea level rise, and ensure the continued habitability of the residence.

The project site is identified in the Ko‘olau Poko SCP Open Space Map, and is designated as a panoramic viewshed from the ocean looking towards the coastline.

The removal of the 20 ft. wide sandbag complex will greatly improve public lateral access along this shoreline.

5.8 Shoreline Setbacks

The project area is located within the Shoreline Setback area, which is defined as 40 feet inland from the certified shoreline. Shoreline Setbacks rules are defined in Chapter 23 of the Revised Ordinances of Honolulu, and are pursuant to HRS Chapter 205A. The policy was established to “protect and preserve the natural shoreline, especially sandy beaches; to protect and preserve public pedestrian access laterally along the shoreline and to the sea; and to protect and preserve open space along the shoreline. Secondarily, the policy also seeks reduce hazards to property from coastal floods. The specific purpose of Chapter 23 establishes standards that generally prohibit within the shoreline area any construction or activity which may adversely affect beach processes, public access along the shoreline, or shoreline open space.

ROH Section 23-1.5(b). The following structures and activities are prohibited within the shoreline area, with the following exceptions:

(1) Minor structures and activities permitted under rules adopted by the department which do not affect beach processes or artificially fix the shoreline and do not interfere with public access, public views or open space along the shoreline. If, due to beach erosion or other cause, the director determines that a minor structure permitted under this section may affect beach processes or public access or has become located seaward of the shoreline, the director or other governmental agency having jurisdiction may order its removal;

(2) Minor structures and activities necessary for or ancillary to continuation, but not expansion, of agriculture or aquaculture in the shoreline area on June 16, 1989;

(3) Maintenance, repair, reconstruction, and minor additions to or alterations of legal, publicly owned boating, maritime, or ocean sports recreational facilities, which result in little or no interference with natural shoreline processes. Privately owned boating, maritime, or ocean sports recreational facilities are specifically excluded from this exception;

(4) Nonconforming structures or structures that have received a shoreline setback variance;

(5) Construction, installation, maintenance, repair, and replacement of civil defense warning or signal devices and sirens.

<u>Discussion</u>

The existing temporary emergency protection sandbags are approved by the State DLNR. The proposed shoreline protection structure would be placed inland of the certified shoreline and result in removal of the sandbags. The new shoreline structure will protect the existing residence currently under threat from shoreline erosion. As such, the applicant will obtain a shoreline setback variance prior to construction of the shoreline protection structure.

ROH 23-1.8 (b)(3) Hardship Standard

(A) A variance may be granted for a activity or structure that is necessary or ancillary to the following private facilities or improvements, if hardship will result to the applicant if the facilities or improvements are not allowed within the shoreline area:

(i) Private facilities or improvements which will neither adversely affect beach processes nor artificially fix the shoreline; and

(ii) Private facilities or improvements that may artificially fix the shoreline, but only if hardship is likely to be caused by shoreline erosion and conditions are imposed prohibiting any such structure seaward of the existing shoreline unless it is clearly in the public interest.

Discussion

The proposed seawall with scour apron is a structure that will be ancillary to a private residence. The existing residence is located at only 20 feet from the certified shoreline. Hardship will result to the applicant if the improvements are not allowed within the shoreline area because coastal erosion will continue to cause the shoreline to recede, threatening the existing private residence and undermining its structural stability. Removal of the existing temporary shoreline protection structure without replacement would instantly result in active erosion of the land. This action would release large quantities of earth material into the nearshore water while causing a significant landward movement of the shoreline. The shoreline protection structure will artificially fix the shoreline, prevent further erosion and provide stability to the subject residential property. No structures would be constructed seaward of the certified shoreline. Public interest will be served by the removal of the 20-foot side sandbag complex, opening up lateral beach access and sand flow.

(B) For the purposes of this subsection, hardship may be found only if:

(i) For the purposes of this subsection, hardship may be found only if: The applicant would be deprived of reasonable use of the land if quired to comply fully with the shoreline setback ordinance and the shoreline setback rules;

Discussion

An existing private residence is considered reasonable use of land. Without permanent shoreline protection, the shoreline would continue to erode and threaten the existing private residence. Loss of a private residence due to compliance with shoreline setback rules would deprive the owner of reasonable use of the land. It is not possible for the residence to be relocated on the property since there is little open space remaining and the home is slab on grade construction.

(ii) The applicant's proposal is due to unique circumstances and does not draw into question the reasonableness of this chapter and the shoreline setback rules;

Discussion

Unique circumstances exist in the Lanikai shoreline setting. The subject shoreline has had a large erosion scarp along the shoreline for many years that has been buffered with sandbags since 1994. The project area is bounded by a rock wall at the north end and riprap at the south end. South of the project area there is approximately 450 linear feet of armored shoreline. North of the project area there is approximately 1,160 linear feet of armored shoreline.

Coastal erosion losses at this property has narrowed the depth of the property. Sea Engineering, Inc. has provided detailed information on the historical trend of erosion along the Lanikai property shoreline. Their study concluded that the shoreline for the project area has been eroding at an average rate of 1.75 feet/year over the period of 1911 to 2005. The shoreline makai of the sandbags is a wet beach that moves with inflation and deflation. There is no dry beach at the project site.

(iii) The proposal is the practicable alternative which best conforms to the purpose of this chapter and the shoreline setback rules.

Discussion

Alternatives were thoroughly evaluated in Chapter 4 of the EA, including the no-action alternative, removal of the sandbags, a rock revetment, a hybrid seawall-revetment, delaying the action, and a seawall with scour apron. In addition, relocation of the applicant's residential structure using the remaining unbuilt side/rear yard land areas is not possible. From site context and an engineering standpoint, a seawall with sloping boulder scour apron was determined to be the best practicable alternative that best met the purpose of the shoreline setback rules.

Public Benefit Considerations

The removal of the temporary shore protection and construction of a seawall with sloping boulder scour apron mauka of the certified shoreline will create a 20-foot wider beach profile with improved lateral access, sand flow, and seasonal accretion. Provision of a fixed shoreline and removal of migrating sandbags would stabilize the adjacent public access path and improve shoreline and lateral access for the public.

Additional discussion will be provided in a forthcoming Shoreline Setback Variance application.

5.9 Special Management Area

The project area is located within the Special Management Area (SMA), which was established to preserve, protect, and where possible, to restore the natural resources of the coastal zone of Hawai'i. Special controls on development within the SMA are necessary to avoid permanent loss of valuable resources and foreclosure of management options. The review guidelines of Section 25-3.2 of the Revised Ordinances of Honolulu (ROH) are used by the Department of Planning and Permitting and the City Council for the review of developments proposed in the SMA. These guidelines are derived from Section 205A-26 HRS.

(1) All Development in the Special Management Area shall be subject to reasonable terms and conditions set by the council in order to ensure that:

- Adequate access, by dedication or other means, to publicly owned or used beaches, recreation areas, and natural reserves is provided to the extent consistent with sound conservation principles;
- Adequate and properly located public recreation areas and wildlife preserves are reserved;
- Provisions are made for solid and liquid waste treatment, disposition, and management which will minimize adverse effects upon special management area resources; and
- Alteration to existing land forms and vegetation, except crops, and construction of structures shall cause minimum adverse effect to water resources and scenic and recreational amenities and minimum danger of floods, landslides, erosion, siltation or failure in the event of an earthquake.

Discussion

The closest public access to the beach area in front of the site is located approximately 450 feet north of the subject properties, with Lanikai Beach public access located approximately 0.5 miles north of the project area. The project will not adversely affect access to any public shoreline or recreation area. No wildlife preserves or public areas will be affected by the shoreline protection structure. No wastewater improvements are proposed as a part of the project, and the project will not generate solid waste apart from the construction activities.

Alterations to the land and vegetation for the construction of the shoreline protection structure are not anticipated to adversely affect coastal areas or recreational resources. The required permit conditions and best management practices will be implemented following the construction of the shoreline protection structure.

(2) No development shall be approved unless the council has first found that:

- The development will not have any substantial, adverse environmental or ecological effect except such adverse effect is minimized to the extent practicable and clearly outweighed by public health and safety, or compelling public interests. Such adverse effect shall include, but not be limited to, the potential cumulative impact of individual developments, each one of which taken in itself might not have a substantial adverse effect, and the elimination of planning options;
- The development is consistent with the objectives and policies set forth in Section 25-3.2 and area guidelines contained in Section 205A-26, Hawai‘i Revised Statutes; and
- The development is consistent with the County General Plan, Development Plans, Zoning and subdivision codes and other applicable ordinances.

Discussion

As discussed in *Section 3.5* of this EA, no substantial adverse environmental or ecological cumulative impacts are anticipated from the project. The project is consistent with applicable plans and policies for the State of Hawai‘i and the City and County of Honolulu.

(3) The Council Shall Seek to Minimize, Where Reasonable:

- Dredging, filling or otherwise altering any bay, estuary, salt marsh, river mouth, slough or lagoon;
- Any development which would reduce the size of any beach or other area usable for public recreation;
- Any development which would reduce or impose restrictions upon public access to tidal and submerged lands, beaches, portions of rivers and streams within the special management area and the mean high tide line where there is no beach;
- Any development which would substantially interfere with or detract from the line of sight toward the sea from the State highway nearest the coast; and
- Any development which would adversely affect water quality, existing areas of open water free of visible structure, existing and potential fisheries and fishing grounds, wildlife habitats, or potential or existing agricultural uses of land.

Discussion

The project will not interfere with existing public access, nor will it pose adverse impacts to public beaches or recreation areas. The shoreline protection structure at this location is not anticipated to affect shoreline erosion along other surrounding sections of the Lanikai coastline, which primarily consists of vertical seawalls. The project will not have adverse impacts on areas of open water, potential fisheries, fisheries, wildlife habitat, or agricultural land. Construction mitigation measures will be implemented as outlined in Section 3.5 to prevent impacts to biological resources. As previously discussed, the project will not affect the line of sight to the ocean from Mokulua Drive or any State highway.

Section 6

Findings Supporting the Anticipated Determination

Chapter 6

Findings Supporting the Anticipated Determination

6.1 Anticipated Determination

Based on a review of the significance criteria outlined in Chapter 343, HRS, and Section 11-200-12, State Administrative Rules, Contents of EA, the project has been determined to not result in significant adverse effects on the natural or human environment. A Finding of No Significant Impact (FONSI) is anticipated.

6.2 Reasons Supporting the Anticipated Determination

The potential impacts of the project have been fully examined and discussed in this EA. As stated earlier, there are no significant environmental impacts expected to result from the project. This determination is based on the assessments as presented below for criterion (1) to (13).

(1) Involve an irrevocable loss or destruction of any natural or cultural resources.

The archaeological and cultural landscapes have been documented in studies conducted specifically for the project area. As detailed in *Section 3.13* of this report, the project does not involve any known loss or destruction of existing natural, cultural, archaeological or historical resources. There is the potential for the inadvertent discovery of subsurface historical or cultural resources, including the possibility of iwi kūpuna (ancestral remains). If any cultural or archaeological resources are unearthed or ancestral remains are inadvertently discovered, the DLNR, SHPD, the O‘ahu Island Burial Council representative and participating interests from lineal descendants and individuals will be notified. The treatment of these resources will be conducted in strict compliance with the applicable historic preservation and burial laws.

(2) Curtail the range of beneficial uses of the environment.

The project will not curtail the range of beneficial uses of the environment. Existing uses conform to existing land use designations. The project will provide a beneficial effect, by protecting the existing home and preventing erosion of the shoreline.

(3) Conflict with the State’s long-term environmental policies or goals and guidelines as expressed in Chapter 344, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders.

The project does not conflict with the State’s long-term environmental policies or goals and guidelines as expressed in Chapter 344, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders.

(4) Substantially affects the economic or social welfare of the community or State.

The project will result in short-term economic benefits during construction that include direct, indirect, and induced employment opportunities and multiplier effects, but not at a level that would generate significant economic activity. The project will provide a new shoreline protection structure along the coast, protecting an existing residence from extensive erosion and property loss.

(5) Substantially affects public health.

The project is consistent with existing land uses and is not expected to affect public health. However, there will be temporary short-term impacts to air quality from possible dust emissions and temporary degradation of the acoustic environment in the immediate vicinity resulting from construction equipment operations. The project will comply with State and County regulations during the construction period and will implement BMPs to minimize temporary impacts.

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

The project will provide a new seawall with sloped boulder scour apron protecting a shoreline residence in Lanikai, Kailua. The approval of the project will not incur secondary impacts, such as population changes or effects on public facilities. There is a public shoreline access path adjacent to the southern boundary of the project site. The public access path will not be negatively impacted by installation of the revetment, rather, the project would remove migrated sandbags and improve lateral shoreline access. The new seawall with sloped boulder scour apron is also the preferred alternative for minimizing potential impacts to neighboring shoreline structures.

(7) Involves a substantial degradation of environmental quality.

The project will not involve a substantial degradation of environmental quality. Long-term impacts to air and water quality, noise, and natural resources are not anticipated. The use of standard construction and erosion control BMPs will minimize the anticipated construction-related short-term impacts. During construction, the existing sandbag revetment would remain in place and provide further protection against runoff and sediment in nearshore waters

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

The entire coast of Lanikai has experienced long-term chronic erosion as evidenced by the presence of the continuous line of shoreline structures in the region. Constructing the seawall and scour apron will not have substantial negative effects upon the environment, and will not be a precursor for future actions, as the property will be the last along the coastline to implement a long-term erosion solution.

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

The project site does not contain known identified rare, threatened, or endangered species or habitat. There is no known hoary bat habitat. Due to the narrow or non-existent beachfront at the subject property, the probability of sea turtles nesting or foraging in the project area is minimal. The hardened shoreline environment also does not provide monk seal habitat. Visual surveys for seabirds will be conducted prior to construction, in the unlikely event that they may nest or become stranded within the project area. No impacts are anticipated.

(10) Detrimentally affects air or water quality or ambient noise levels.

General temporary impacts associated with construction are identified in Chapter 3 of this EA. Mitigation measures which are outlined in this EA will be applied during short-term construction activity. No detrimental long-term impacts to air, water, or acoustic quality are anticipated with the project improvements.

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

The entire project site lies within Zone AE and Zone X and within the designated tsunami zone. Zone AE is defined as, "areas subject to inundation by the 1-percent chance flood event by detailed methods." Zone X is defined as "areas of minimal flood hazard, which are the areas outside the Special Flood Hazard Area and higher than the elevation of the 0.2 percent- chance flood. The project site located along an erosion-prone shoreline area. The purpose of the project is to reduce wave action threats to the structural integrity of the existing ocean front home. The proposed seawall with sloping boulder scour apron will reduce the potential for damage caused by an erosion-prone shoreline.

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

The project will be located on a privately-owned property at 1326 Mokulua Drive along the Lanikai coast of O'ahu. The existing sandbag revetment interrupts the continuous views of the Lanikai coast identified in the KPSCP Open Space map. The addition of the new seawall with boulder scour apron will restore a consistent view of the shoreline within the project vicinity. No adverse impacts are anticipated.

(13) Require substantial energy consumption.

Construction of the project will not require substantial energy consumption when compared to other similar sized projects.

6.3 Summary

Based on the above findings, further evaluation of the project's impacts through the preparation of an Environmental Impact Statement is not warranted. The EA recommends mitigation measures to alleviate impacts when such impacts are identified. The project will have beneficial effects protecting beachfront residences from ongoing erosion. Overall, the project will provide a public benefit while resulting in minimal impacts to the surrounding environment.

A Finding of No Significant Impact (FONSI) is anticipated for this project.

Section 7

List of References

Chapter 7

List of References

7.1 Publications

City and County of Honolulu, Department of Planning and Permitting. 2013. *O'ahu General Plan* (Public Review Draft). Accessed online: http://honoluludpp.org/Portals/0/pdfs/planning/generalplan/PubRevDraft_Part1_Nov2012.pdf

City and County of Honolulu, Office of the Mayor. 2018. Memorandum. *City and County of Honolulu Actions to Address Climate Change and Sea Level Rise*. Accessed online: https://static1.squarespace.com/static/59af5d3cd7bdce7aa5c3e11f/t/5b725bcdaa4a998f8502eb4f/1534221263208/Mayor%27s+Directive+18-02.pdf

City and County of Honolulu, Climate Change Commission. 2018. *Sea Level Rise Guidance*. Accessed online: https://static1.squarespace.com/static/59af5d3cd7bdce7aa5c3e11f/t/5bef1aa688251b73aaaeff92/1542396587587/Sea+Level+Rise+Guidance.pdf

City and County of Honolulu, Climate Change Commission. 2018. *Climate Change Brief*. Accessed online: https://static1.squarespace.com/static/59af5d3cd7bdce7aa5c3e11f/t/5bda020bf950b7dd16a458d6/1541014029634/Climate+Change+Brief.pdf

City and County of Honolulu. 2017. *Ko'olau Poko Sustainable Communities Plan.*

Giambelluca, T.W., X. Shuai, M.L. Barnes, R.J. Alliss, R.J. Longman, T. Miura, Q. Chen, A.G. Frazier, R.G. Mudd, L. Cuo, A.D Businger. 2014: Evapotranspiration of Hawai'i. Final report submitted to the U.S. Army Corps of Engineers – Honolulu District, and the Commission on Water Resource management, State of Hawai'i.

Hawai'i Climate Change Mitigation and Adaptation Commission. 2017. Hawai'i Sea Level Rise Vulnerability and Adaptation Report. Prepared by Tetra Tech, Inc. and the State of Hawai'i Department of Land and Natural Resources, Office of Conservation and Coastal Lands, under the State of Hawai'i Department of Land and Natural Resources Contract No: 64064.

Keala Pono Archaeological Consulting, LLC. 2018. *Archaeological Assessment for a Revetment at 1326 Mokulua Drive in Lanikai, Kailua, Ahupua'a, Ko'olaupoko District, Island of O'ahu.*

Marine Research Consultants, Inc. 2018. *Baseline Assessment of the Marine Environment 1326 Mokulua Drive, Kailua, Hawaii Shoreline Improvements*.

National Marine Sanctuaries and National Oceanic & Atmospheric Administration, Hawaiian Islands Humpback Whale National Marine Sanctuary. 2018. Accessed online: https://hawaiihumpbackwhale.noaa.gov/about/overview.html

National Oceanic and Atmospheric Administration Fisheries, Pacific Islands Regional Office. *Critical Habitat.* Accessed online: https://www.fpir.noaa.gov/PRD/prd_critical_habitat.html

National Oceanic and Atmospheric Administration Fisheries, Pacific Islands Regional Office. *Green Sea Turtle.* Accessed online: https://www.fpir.noaa.gov/PRD/prd_green_sea_turtle.html

National Oceanic and Atmospheric Administration Fisheries, Pacific Islands Regional Office. *Hawaiian Monk Seal Critical Habitat.* Accessed online: https://www.fpir.noaa.gov/Library/PRD/Hawaiian%20monk%20seal/HMS_CH_FAQ_Tabloid_FNL.pdf

National Oceanic and Atmospheric Administration Fisheries, Pacific Islands Regional Office. *Hawksbill.* Accessed online: https://www.fpir.noaa.gov/PRD/prd_hawksbill.html

Pacific Islands Ocean Observing System. 2017. *Sea Level Rise : Hawai‘i Sea Level Rise Viewer.* Accessed online: https://www.pacioos.hawaii.edu/shoreline/slr-hawaii/

Sea Engineering, Inc. 2019. *Coastal Assessment for 1326 Mokulua Drive, Lanikai, Oahu, Hawaii.*

State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife. *Mokulua Islets State Wildlife Sanctuary.* Accessed online: http://hbmpweb.pbrc.hawaii.edu/dlnr/projects/sanctuaries/mokulua

State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife. 2005. *‘Ōpe‘ape‘a or Hawaiian Hoary Bat.* Accessed online: https://dlnr.hawaii.gov/wildlife/files/2013/09/Fact-sheet-hawaiian-hoary-bat.pdf

State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife. 2005. *‘Ua‘u kani or Wedge-tailed Shearwater.* Accessed online: https://dlnr.hawaii.gov/wildlife/files/2013/09/Fact-Sheet-Wedge-Tailed-Shearwater.pdf

State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife. 2018. *Seabird Fallout Season.* Accessed online: https://dlnr.hawaii.gov/wildlife/seabird-fallout-season/

Surging Seas Risk Finder. *Kailua, Hawaii, USA.* Accessed online: https://riskfinder.climatecentral.org/place/kailua.hi.us?comparisonType=place&forecastType=NOAA2017_int_p50&level=2&unit=ft&zillowPlaceType=place

United States Geological Survey, Earthquake Hazards Program. 2018. *M 6.9 – 19km SSW of Leilani Estates, Hawaii*. Accessed online: https://earthquake.usgs.gov/earthquakes/eventpage/hv70116556/executive

University of Hawaiʻi at Mānoa. 2014. *Climate Change Impacts in Hawaiʻi - A summary of climate change and its impacts to Hawaiʻi's ecosystems.*

7.2 Geographical Information Systems Data

Aerial Imagery: Google Earth Aerial Imagery, 2018.

TMK: City & County of Honolulu, April 2018

Soils: USDA NRCS SSURGO, Oct. 2017

Flood: FEMA DFIRM, Nov. 2014

7.3 Websites

Climate:

http://rainfall.geography.hawaii.edu/interactivemap.html

http://climate.geography.hawaii.edu/interactivemap.html

Traffic and Roadways:

http://geoportal.hawaii.gov/datasets/bus-routes-oahu-honolulu-county/data?geometry=-157.983%2C21.333%2C-157.439%2C21.445

Socio-Economic Conditions:

http://islandbreath.org/

https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t

https://datausa.io/profile/geo/honolulu-county-hi/

Air Quality:

http://emdweb.doh.hawaii.gov/air-quality/

Educational Facilities:

http://www.hawaiipublicschools.org/ParentsAndStudents/EnrollingInSchool/SchoolFinder/Pages/home.aspx

http://apps.schoolsitelocator.com/index.html?districtCode=00005

Parks and Rec:

https://www.google.com/maps/d/viewer?hl=en&mid=1H5JvvB3Yuuw5kfqL050OHit5EVs&ll=21.43101874364014%2C-158.01275284545898&z=11

HPD:

http://www.honolulupd.org/contact/index.php?page=locations

EMS:

http://www.honolulu.gov/cms-esd-menu/site-esd-sitearticles/717-ambulance-locations.html

7.4 Document Preparers

Below is a list of individuals that contributed to the preparation and completion of this Draft EA. The list includes the name of the individual and their role, or the name of the company and the subfield of professional expertise utilized to conduct and complete the EA.

G70

Jeffrey H. Overton, AICP, LEED AP	Principal Planner
Rachel Shaak, AICP, LEED AP	Senior Planner
Lauren Esaki	Planner
Cody Winchester	Planner
Silas Haglund	Graphics and Document Specialist
Stephanie Saephan, GISP	GIS Specialist
Reyna DePonte	Administrative Support

Technical Consultants	Area of Specialty
Sea Engineering, Inc	Coastal Assessment
Keala Pono Archaeological Consulting, LLC	Archaeological Assessment
Marine Research Consultants	Marine Environment
ATA	Topography and Shoreline Setback
Shinsato Engineering	Geotechnical
Tanimura and Associates	Structural Engineering

Section 8

List of Agencies, Organizations and Individuals Receiving Copies of the EA

Chapter 8

List of Agencies, Organizations and Individuals Receiving Copies of the EA

Table 8-1 Agencies, Organizations and Individuals Receiving Copies of the EA			
Respondents and Distribution	**Receiving Draft EA**	**Comments Received**	**Receiving Final EA/ FONSI**
Federal Agencies			
U.S. Army Corps of Engineers	X		
U.S. Fish and Wildlife Service	X		
U.S. National Marine Fisheries Service	X		
State of Hawai'i Agencies			
Department of Accounting and General Services	X		
Department of Business, Economic Development & Tourism (DBEDT)	X		
Department of Health (DOH)	X		
Department of Land and Natural Resources (DLNR)	X		
DLNR, Division of Aquatic Resources	X		
DLNR, State Historic Preservation Division	X		
DLNR, Office of Conservation and Coastal Lands	X		
Office of Environmental Quality Control	X		
University of Hawaii, Environmental Center	X		
Office of Hawaiian Affairs	X		
City and County of Honolulu Agencies			
Department of Corporation Counsel	X		
Department of Facility Maintenance	X		
Department of Planning and Permitting	X		
Department of Parks and Recreation	X		
Office of Climate Change, Sustainability and Resiliency	X		
State Senator Laura Thielen– State Senate District 25	X		

Table 8-1 Agencies, Organizations and Individuals Receiving Copies of the EA			
Respondents and Distribution	**Receiving Draft EA**	**Comments Received**	**Receiving Final EA/ FONSI**
State Representative Chris Lee – State House District 51	X		
Council Member Ikaika Anderson– Honolulu City Council District 3	X		
Kailua Neighborhood Board No. 31	X		
Libraries			
Hawai‘i State Library, Hawai‘i Documents Center	X		
Kailua Public Library	X		
Private Organizations			
Lanikai Community Association	X		
Individuals			
Lee Bell	X		
Phil and Mollie Foti	X		
Phillip Binney	X		
Peter Binney	X		
Tom Cestare	X		

Appendices

Appendix A

1326 Mokulua Drive Past Documents

Appendix A-1

Settlement Agreement (December 1994)

SETTLEMENT AGREEMENT

This Settlement Agreement (the "Agreement") is made by and between the City and County of Honolulu (the "City"), and Allen Von Cleve Davis ("Allen Davis" or "Davis"), is dated December 12, 1994, and is made with reference to the following:

A. On November 26, 1993, the City commenced a civil action, City and County of Honolulu v. Allen Von Cleve Davis, Civil No. 93-4591-11, in the First Circuit Court of the State of Hawaii (the "Action"). The City's complaint alleges various claims and causes of action pertaining to a revetment and side wall located in the shoreline area at the beachfront of a lot located at 1326 Mokulua Dr., Kailua, Hawaii (hereinafter the "Property").

B. The matter was removed to the United States District Court for the District of Hawaii and is pending as City and County of Honolulu v. Allen Von Cleve Davis, Civil No. 93-00984 ACK (hereinafter "civil action"). On January 20, 1994 the Defendant filed a counterclaim asserting various claims and causes of action.

C. The Lanakai community is considering the pursuit of a comprehensive plan for the replenishment and accumulation of sand and to decrease and otherwise reverse the erosion of the shoreline in the proximity of the Property and neighboring properties to protect shoreline property and structures and enhance the safety and use of the beach by the public,

including a possible redesign with stairs or like sloped structure at the public right of way to the east of the Property.

NOW, THEREFORE, in consideration of the following terms, covenants, and conditions, the parties agree as follows:

1. That Allen Davis will have opportunity to apply for a variance under the Shoreline Setback Rules of the City and County of Honolulu; and that pending the decision on the application for a variance that the above civil action will be dismissed <u>without</u> prejudice; and that all of each party's legal rights, claims, defenses and causes of action, except with respect to fines, existing or capable of having been raised as of January 20, 1994 in the above litigation shall be reserved by and preserved to the parties up to and including sixty (60) days after a final determination on the application for a variance by Allen Davis pursuant to this Agreement. Such legal rights, claims, defenses and causes of action shall not be limited, modified or otherwise voided by any action by either party pursuant to this Agreement; specifically, the legal rights of the respective parties with respect to the existing shoreline protection shall be preserved, including the right to replace that existing as of January 20, 1994, subject to and after final determination of the rights of the parties by a court should a variance not be issued after consideration of the results of the public hearing on the matter.

2. Davis agrees that he will: (1) remove the existing rocks, which the City considers a revetment, on the beachfront of the Property by December 31, 1994 subject to the provisions of this Agreement with respect to preservation of the rights of the parties; (2) remove at least twenty-six (26) feet of the seaward end of the side wall by December 31, 1994; (3) within thirty (30) days apply for a variance for the construction of a revetment for the Property and the adjacent Olds property beginning at its high point two hundred and forty four (244) feet from the Mokulua Drive property line of the Property and seven (7) feet above mean sea level and extending at a slope of 2.5 to 1 to the top of its toe three (3) feet below mean sea level and two hundred and sixty nine (269) feet from the Mokulua Drive property line of the Property; and, that the revetment will have a smooth face, in that the outward surfaces of its face will be substantially in the same plane but such that water can percolate and run through it.

3. Without prejudging the matter, the City represents that it has the authority to grant the proposed variance. However, any approval of a variance is subject to and contingent upon the results of the public hearing on the matter, but that pending the input from that hearing that it appears to be a reasonable proposal and as such the City would have no objection to the design and location of the shoreline protection as proposed.

4. Notwithstanding any other provision of this Agreement, the parties hereby agree to a final settlement of all fines to a civil fine of $2,000. Allen Davis agrees to pay a civil fine of $2,000 and the City agrees to forgive all liability for any and all fines related to the subject matter of the civil action. The City has taken into consideration Davis' voluntary support for a comprehensive plan by the community for sand replenishment and other remedial work on the south end of Lanikai Beach. Specifically, Allen Davis has agreed to contribute the sum of $5,000 toward the cost of an expert, acceptable to the City, to be hired by the Lanakai Community Association to do a sand replenishment and/or beach stabilization study for the public beach area adjacent to the Property and to the adjacent Binny lot, the Lanakai Community Association right-of-way, the Olds lot and the Carpenter lot. Further, Allen Davis has agreed to contribute an additional $2,000 toward any unforseen costs associated with the study. In addition, Allen Davis has advised the City that he is willing to include in the environmental assessment for the revetment for the Property, the adjoining Olds property, and the right-of-way and a revetment of the same design applied for at the same time for the Binney and Carpenter properties, with the understanding that costs associated with the design, engineering and construction necessary for any revetment for the Binney and Carpenter properties will be borne by the respective owners. Allen Davis will use an ocean engineer or

environmental consultant for the purpose of preparing the environmental assessment and agrees that the City will have the right to approve his selection of the preparer of the environmental assessment. The City has advised Allen Davis that Noda and Associates, the experts previously retained by Allen Davis, are acceptable to the City to perform the environmental assessment. Allen Davis agrees that he will cooperate fully with the City by providing for a representative to attend and address a reasonable number of hearings and meetings related thereto.

5. The City agrees that Davis may protect the Property with sandbags until either a design for a revetment for the protection of the Property is approved by the City after a public hearing and a revetment is constructed in accordance with it, or, in the event no variance is issued, a court makes a final determination of the rights of the parties with respect to the existing shoreline protection. Notwithstanding any other provisions of the Agreement, the sandbags will be removed within 90 days of approval of the variance or as otherwise agreed to by the parties. The City acknowledges that Allen Davis and/or the community may request that the sandbags remain for a longer period depending on the progress and prospects for the sand replenishment project.

6. No Admission of Liability. The parties agree that the covenants and releases contained herein, and the consideration for this Agreement, are not to be deemed or

construed as an admission of any liability or fault of any kind whatsoever by the parties or any other person whatsoever, but are to be construed strictly as a compromise and settlement of the dispute between the parties for the purpose of avoiding further controversy, litigation and expense. The parties further agree that all claims or allegations of fault, liability, negligence, or legal responsibility have been and are denied by them.

7. Hawaii Law Governs. This Agreement shall be subject to, governed by, and construed and enforced pursuant to the laws of the State of Hawaii.

8. Dismissal. Upon the full execution and delivery of this Agreement, the undersigned parties shall execute a dismissal without prejudice of any and all claims or demands in the Action against any party with each party to be responsible for its own attorneys' fees and costs. The Stipulation for Dismissal will not be binding on any party until signed by all parties and filed with the court.

9. The parties agree for the purpose of interpretation of this Agreement that neither party is to be deemed draftsman of this Agreement.

10. Counterparts. This Agreement can be executed in counterparts by the parties and the various counterparts shall together constitute the final complete agreement; provided, however, this Agreement shall not be effective until all the parties have signed and the various counterparts are delivered

to the respective attorneys for the parties. Telecopied counterparts can be used for delivery; provided, however, the original signature pages shall be sent to the other party or its attorneys promptly upon execution.

IN WITNESS WHEREOF, the parties have executed this Settlement Agreement as of the date first written above.

CITY AND COUNTY OF HONOLULU

By Loretta Chee
Its Deputy Director, Department of Land Utilization

for DONALD A. CLEGG, Director
Department of Land Utilization,
City and County of Honolulu

ALLEN VON CLEVE DAVIS

APPROVED AS TO FORM:

LAWRENCE D. KUMABE
Deputy Corporation Counsel
Attorney for City and County of Honolulu

DANIEL A. BENT
Attorney for Allen Davis

Settlement Agreement
Between the City and County of Honolulu and Allen Von Cleve Davis

X9430804

Appendix A-2

Letter from City Corporation Counsel to Mr. Davis (April 1995)

DEPARTMENT OF THE CORPORATION COUNSEL
CITY AND COUNTY OF HONOLULU
HONOLULU, HAWAII 96813
FAX NUMBER: (808) 523-4583

JEREMY HARRIS
MAYOR

CAROLYN H. LENDIO
CORPORATION COUNSEL

April 17, 1995

Mr. Allen Von Cleve Davis
1326 Mokulua Drive
Kailua, Hawaii 96734

Dear Mr. Davis:

Re: Settlement Agreement
City and County of Honolulu v. Allen Von Cleve Davis, U.S.D.C. Civil No. 93-00984 ACK

This letter is to formally advise you that, as the City and County of Honolulu (hereinafter "City") understands it, under Paragraph 5 of the above-mentioned Settlement Agreement, ". . . Davis may protect the Property with sandbags until . . . a design for a revetment for the protection of the Property is approved by the City after a public hearing . . . " but, in any event, the ". . . sandbags will be removed within 90 days of approval of the variance or as otherwise agreed to by the parties." (Emphasis added).

Based on this paragraph and on our meeting on April 6, 1995, with your representative, Mr. Joseph Correa, the City and Allen Von Cleve Davis (hereinafter "Davis") have further agreed that:

1. Joseph Correa is representing Davis for the purpose of obtaining approval from the City of suitable materials and design for shoreline sandbag protection.

2. Presently, Davis is also working with the Lanikai Community Association in deciding on suitable materials and design for the shoreline sandbag protection.

3. S.E.A. bags from Bulklift or other suitable materials will be used, as part of a pilot project in Lanikai, as shoreline protection devices for

the Davis and Old properties. The bags will be installed by Davis within ninety (90) days, provided that Davis and/or the Lanikai Community Association receives the necessary State and City approvals.

4. In the meantime, the existing rocks can remain on the beach in front of the Davis property without removal, provided Davis is in the process of obtaining the necessary State and City approvals for the bags, without violating the terms of the Settlement Agreement.

5. Within five (5) days of the receipt and acknowledgement of this letter, Davis will transmit to the City for payment to the Lanikai Community Association, the sum of FIVE THOUSAND AND NO/100 DOLLARS ($5,000.00), as provided in Paragraph 4 of the Settlement Agreement.

Sincerely,

LAWRENCE D. KUMABE
Deputy Corporation Counsel

UNDERSTOOD AND AGREED:

ALLEN VON CLEVE DAVIS
Date: 4-28-95

LDK:ey

cc: Patrick Onishi, Director
Department of Land Utilization
Arthur Challacomb, Chief
Environmental Review Branch
Mr. and Mrs. Phil Fody
Lanikai Community Association (LCA)
Thomas Cestare, Esq., LCA
Daniel Orondenker, Esq., LCA
Mr. Kenneth Olds, LCA
Mr. Cecil Santos, State DLNR
Mr. Joseph Correa

Appendix B

Certified Shoreline Survey (Dec. 19, 2018)

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

RECEIVED
OCT 11 2018
AUSTIN, TSUTSUMI & ASSOCIATES, INC.
Honolulu, Hawaii 96817-5031

October 8, 2018

File No.: OA-1834

Austin, Tsutsumi & Associates, Inc.
501 Sumner Street, Suite 521
Honolulu, Hawaii 96817

Dear Applicant:

Subject: Accepted Application for Shoreline Certification
Owner(s): Fairwater Hawaii LLC, Sandbags LLC
Tax Map Key: (1) 4-3-004:077

Your application for shoreline certification of the subject property has been accepted for processing. The commencement date for application processing is **October 8, 2018** and the completion date is **January 5, 2019**.

The file number assigned to this application for shoreline certification is **OA-1834.**

We have submitted your application for publication in the **October 8, 2018** OEQC Environmental Notice to allow public comment. We have also transmitted your application to the Department of Accounting and General Services (DAGS) Survey Division for their review and action. Upon receipt of the State Land Surveyor's recommendation, we will schedule another public notice in the next available OEQC Environmental Notice.

If you have any questions, please feel free to contact us at (808) 587-0424 or DAGS Survey Division at (808) 586-0380. Thank you.

Sincerely,

Cal Miyahara
Shoreline Disposition Specialist

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

RECEIVED
DEC 26 2018
AUSTIN, TSUTSUMI & ASSOCIATES, INC.
Honolulu, Hawaii 96817-5031

December 19, 2018

File No.: OA-1834

Austin, Tsutsumi & Associates, Inc.
501 Sumner Street, Suite 521
Honolulu, Hawaii 96817

Dear Applicant:

Subject: Transmittal of Signed Shoreline Certification Maps
Owner(s): Fairwater Hawaii LLC, Sandbags LLC
Tax Map Key: (1) 4-3-004:077

Enclosed please find three (3) copies of the certified shoreline survey maps for the subject property.

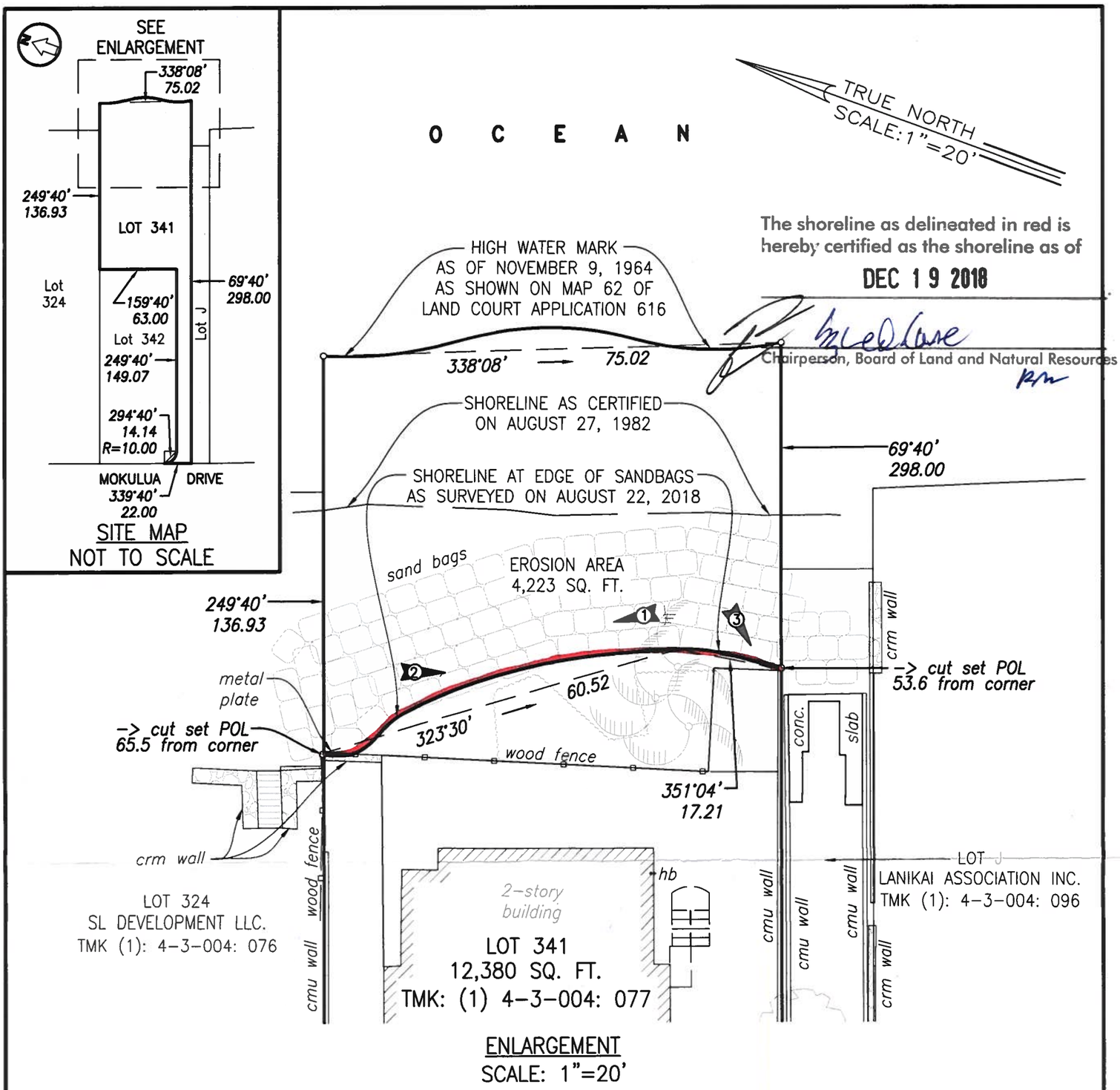
If you have any questions, please feel free to call us at (808) 587-0424. Thank you.

Sincerely,

Cal Miyahara
Shoreline Disposition Specialist

Enclosures

cc: DAGS



The shoreline as delineated in red is hereby certified as the shoreline as of

DEC 19 2018

Chairperson, Board of Land and Natural Resources

ENLARGEMENT
SCALE: 1"=20'

SHORELINE CERTIFICATION MAP

OF 1326 MOKULUA DRIVE

BEING LOT 341 (MAP 62) OF
LAND COURT APPLICATION 616
AT KAILUA, KOOLAUPOKO, OAHU, HAWAII
TMK: (1) 4-3-004: 077

SITE ADDRESS: 1326 MOKULUA DRIVE
KAILUA, HAWAII 96734

OWNER: FAIRWATER HAWAII LLC
SANDBAGS LLC

ERIK S. KANESHIRO
LICENSED PROFESSIONAL LAND SURVEYOR
No. 9826
HAWAII, U.S.A.

AUSTIN, TSUTSUMI, & ASSOCIATES INC.
501 SUMNER STREET, SUITE 521
HONOLULU, HI 96817, (808) 533-3646

THIS WORK WAS PREPARED BY ME
OR UNDER MY SUPERVISION.

ERIK S. KANESHIRO
LICENSED PROFESSIONAL LAND SURVEYOR
CERTIFICATE No. 9826
EXP. 04/20

NOTES

1. Azimuths and record coordinates shown on this map are referred to Government Survey Triangulation Station "MOKAPU" △.
2. Names of adjoining property owners were taken from Tax Map Key Records.
3. Shoreline certification is for permitting purposes.
4. ◄① Denotes photo number and direction.
5. Map is based on a field survey on August 22, 2018.

Appendix C

Early Consultation

From: Rachel Shaak
Sent: Monday, September 17, 2018 1:06 PM
To: Tiger Mills (kimberly.mills@hawaii.gov)
Cc: Jeff Overton; Nadir Safai
Subject: Shoreline Protection for 1326 Mokulua Drive - Environmental Assessment
Attachments: TMKProjecLoc.jpg

Categories: Lanikai Shoreline Protection

Aloha Tiger,

We are contacting you regarding a property located at 1326 Mokulua Drive in Lanikai, Kailua, O'ahu, TMK 4-3-004:077 (see attached location map). A temporary sandbag structure was permitted by the City and County of Honolulu for shoreline protection in 1995. The property was recently acquired by Lanikai resident Nadir Safai and co-owner Chris Furie, and the owners are pursuing approval to construct a permanent shoreline erosion control structure to protect the existing residence.

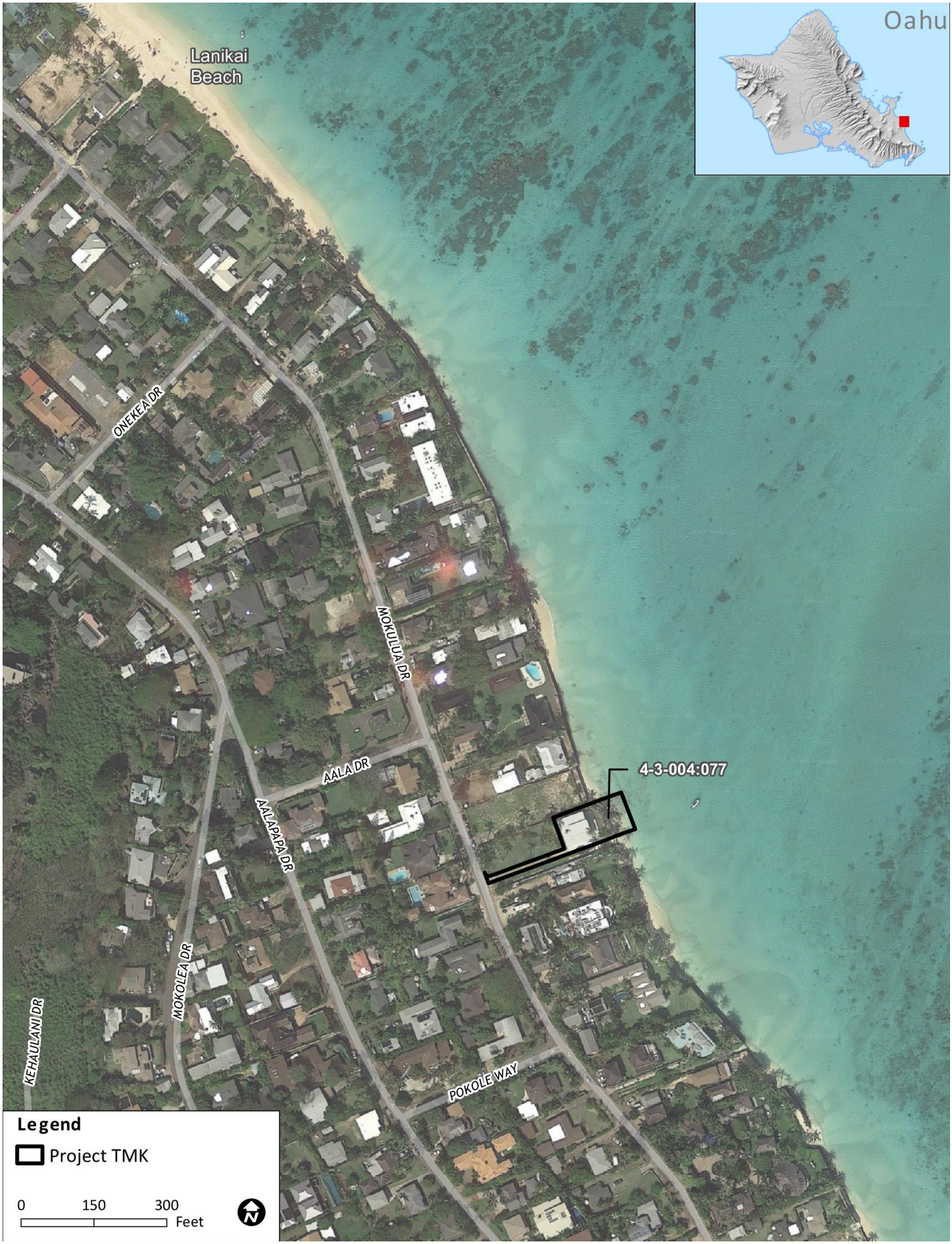
G70 is preparing an Environmental Assessment (EA) in support of the Shoreline Setback Variance, and this email is part of early consultation to determine the scope of the EA. We are seeking your input regarding the plan for shoreline protection due to your association with the project. If you have comments we'd appreciate hearing from you by September 28th. Comments can be provided to Rachel Shaak at mokulua@g70.design or by phone at 523-5866.

Mahalo,

Rachel Shaak, AICP, LEED AP
Senior Planner

111 S. King Street, Suite 170
Honolulu, Hawaii 96813
t 808.523.5866
e rachels@g70.design
www.G70.design

*Note: We've moved! Please note our address has changed.


Oahu
Lanikai Beach
ONEKEA DR
MOKULUA DR
AALA DR
AALAPAPA DR
MOKOLEA DR
KEHAULANI DR
POKOLE WAY
4-3-004:077
Legend
Project TMK
0
150
300
Feet

DAVID Y. IGE
GOVERNOR OF
HAWAI'I

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

JEFFREY T. PEARSON, P.E.
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAI'I
DEPARTMENT OF LAND AND NATURAL RESOURCES

OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAI'I 96809

REF:OCCL:SS

RECEIVED
OCT - 9 2018
G70

Correspondence: OA 19-55

OCT - 3 2018

Rachel Shaak, Senior Planner
G70
111 S. King Street, Suite 170
Honolulu, HI 96813

SUBJECT: Environmental Assessment Pre-Consultation regarding Shoreline Protection for 1326 Mokulua Drive, Lanikai, Kailua, Oahu; Tax Map Key (1) 4-3-004:077

Dear Ms. Shaak,

Thank you for contacting the Department of Land and Natural Resources, Office of Conservation and Coastal Lands (OCCL) regarding the Environmental Assessment (EA) that is being prepared for the new owners of the subject property. Your letter states that the new owners are pursuing approval to construct a permanent erosion control structure within the shoreline setback area of the subject property and are in the process of acquiring a Shoreline Setback Variance (SSV) to allow the proposed construction of a shoreline protection structure.

The OCCL appreciates your notification of the proposed construction and will wait until the Draft Environmental Assessment (DEA) is received before making any comments, determinations, or decisions.

If you have further questions, please feel free to contact Salvatore Saluga in the Office of Conservation and Coastal Lands at 587-0399 or Salvatore.J.Saluga@hawaii.gov.

Sincerely,

SAMUEL J. LEMMO, ADMINISTRATOR
OFFICE OF CONSERVATION AND COASTAL LANDS

From: Rachel Shaak
Sent: Monday, September 17, 2018 1:07 PM
To: 'stagawa@honolulu.gov'
Cc: Jeff Overton; 'Nadir Safai'
Subject: Shoreline Protection for 1326 Mokulua Drive - Environmental Assessment
Attachments: TMKProjecLoc.jpg

Categories: Lanikai Shoreline Protection

Aloha Steve,

We are contacting you regarding a property located at 1326 Mokulua Drive in Lanikai, Kailua, O‘ahu, TMK 4-3-004:077 (see attached location map). A temporary sandbag structure was permitted by the City and County of Honolulu for shoreline protection in 1995. The property was recently acquired by Lanikai resident Nadir Safai and co-owner Chris Furie, and the owners are pursuing approval to construct a permanent shoreline erosion control structure to protect the existing residence.

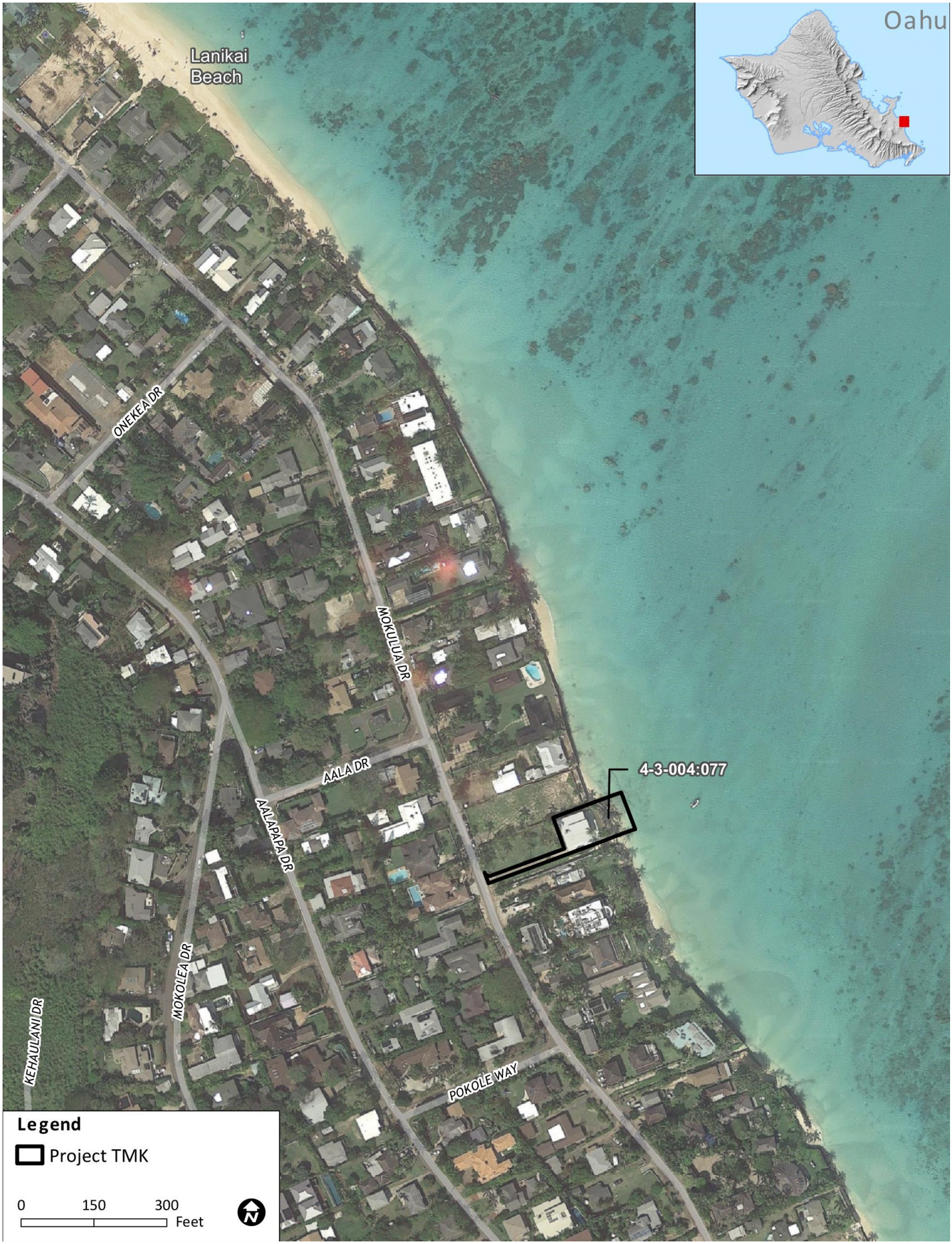
G70 is preparing an Environmental Assessment (EA) in support of the Shoreline Setback Variance, and this email is part of early consultation to determine the scope of the EA. We are seeking your input regarding the plan for shoreline protection due to your association with the project. If you have comments we’d appreciate hearing from you by September 28th. Comments can be provided to Rachel Shaak at mokulua@g70.design or by phone at 523-5866.

Mahalo,

Rachel Shaak, AICP, LEED AP
Senior Planner

111 S. King Street, Suite 170
Honolulu, Hawaii 96813
t 808.523.5866
e rachels@g70.design
www.G70.design

*Note: We've moved! Please note our address has changed.


Oahu
Lanikai Beach
ONEKEA DR
MOKULUA DR
AALA DR
AALAPAPA DR
MOKOLEA DR
KEHAULANI DR
POKOLE WAY
4-3-004:077
Legend
Project TMK
0
150
300
Feet

From: Tagawa, Steve H. <stagawa@honolulu.gov>
Sent: Monday, September 17, 2018 4:46 PM
To: Rachel Shaak
Cc: Krueger, Elizabeth S
Subject: RE: Shoreline Protection for 1326 Mokulua Drive - Environmental Assessment

Rachel,

Hello Rachel, it's been awhile.

Anyway, this is the former Davis property which in 2014, we said that the sand bags could stay a part of that Court settlement. I haven't been involved since then.

I'm okay with an early consultation meeting, but were you going to submit something officially, perhaps with a preliminary proposal? In this case, the shoreline's location would be a key sticking point, especially for a new shore-protection proposal. Oddly, if there was an unauthorized structure there, our After-the-fact procedures would afford a postponement of the certified shoreline's location issue, until after an SV were adjudicated.

Steve T.

From: Rachel Shaak [mailto:rachels@g70.design]
Sent: Monday, September 17, 2018 1:07 PM
To: Tagawa, Steve H.
Cc: Jeff Overton; Nadir Safai
Subject: Shoreline Protection for 1326 Mokulua Drive - Environmental Assessment

Aloha Steve,

We are contacting you regarding a property located at 1326 Mokulua Drive in Lanikai, Kailua, Oʻahu, TMK 4-3-004:077 (see attached location map). A temporary sandbag structure was permitted by the City and County of Honolulu for shoreline protection in 1995. The property was recently acquired by Lanikai resident Nadir Safai and co-owner Chris Furie, and the owners are pursuing approval to construct a permanent shoreline erosion control structure to protect the existing residence.

G70 is preparing an Environmental Assessment (EA) in support of the Shoreline Setback Variance, and this email is part of early consultation to determine the scope of the EA. We are seeking your input regarding the plan for shoreline protection due to your association with the project. If you have comments we'd appreciate hearing from you by September 28th. Comments can be provided to Rachel Shaak at mokulua@g70.design or by phone at 523-5866.

Mahalo,

G70
Rachel Shaak, AICP, LEED AP
Senior Planner

111 S. King Street, Suite 170
Honolulu, Hawaii 96813
t 808.523.5866
e rachels@g70.design
www.G70.design

*Note: We've moved! Please note our address has changed.

From: Rachel Shaak
Sent: Monday, September 17, 2018 1:09 PM
To: 'Lee Bell'
Cc: Jeff Overton; 'Nadir Safai'
Subject: Shoreline Protection for 1326 Mokulua Drive - Environmental Assessment
Attachments: TMKProjecLoc.jpg

Categories: Lanikai Shoreline Protection

Aloha Lee,

We are contacting you regarding a property located at 1326 Mokulua Drive in Lanikai, Kailua, Oʻahu, TMK 4-3-004:077 (see attached location map). A temporary sandbag structure was permitted by the City and County of Honolulu for shoreline protection in 1995. The property was recently acquired by Lanikai resident Nadir Safai and co-owner Chris Furie, and the owners are pursuing approval to construct a permanent shoreline erosion control structure to protect the existing residence.

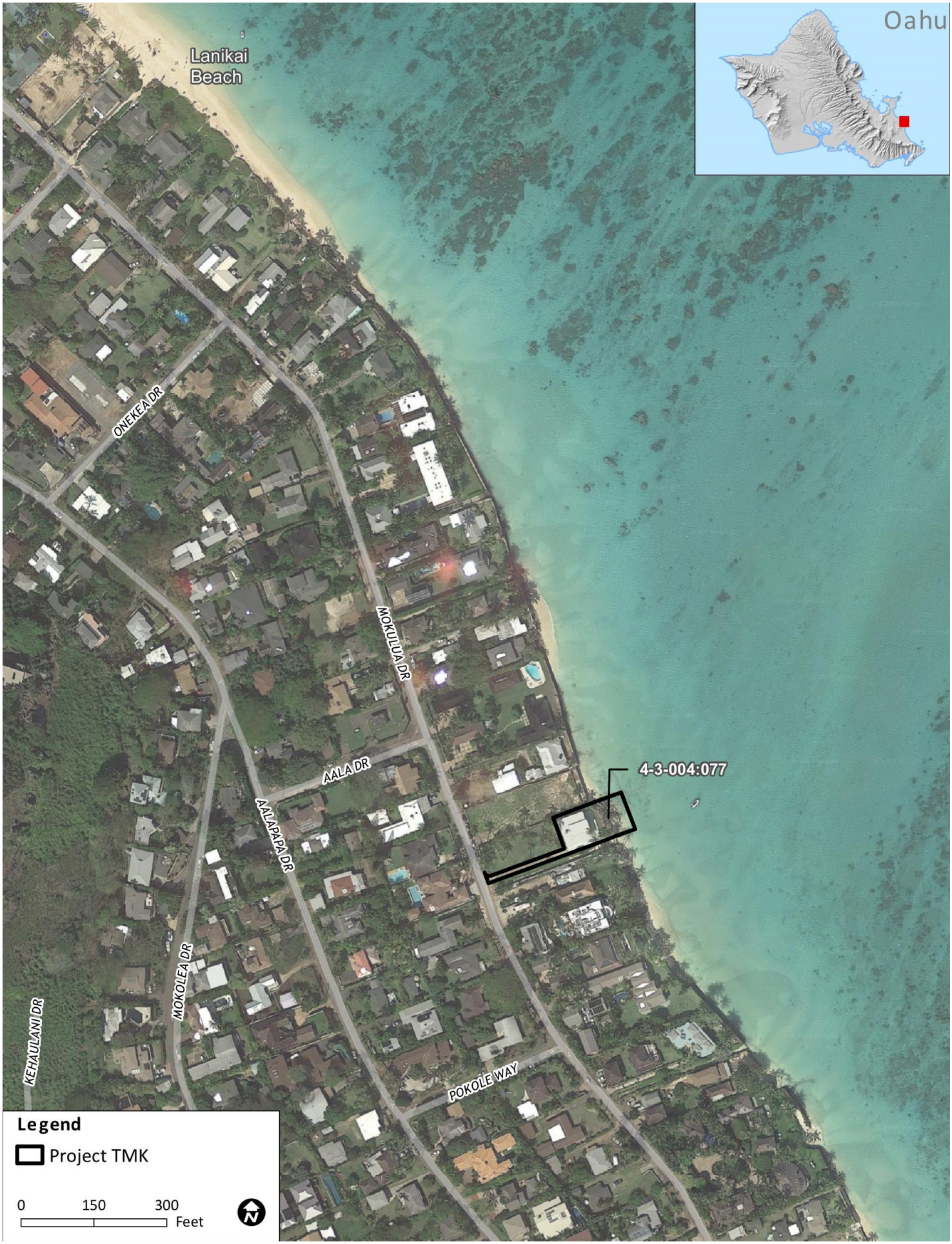
G70 is preparing an Environmental Assessment (EA) in support of the Shoreline Setback Variance, and this email is part of early consultation to determine the scope of the EA. We are seeking your input regarding the plan for shoreline protection due to your association with the project. If you have comments we'd appreciate hearing from you by September 28th. Comments can be provided to Rachel Shaak at mokulua@g70.design or by phone at 523-5866.

Mahalo,

Rachel Shaak, AICP, LEED AP
Senior Planner

111 S. King Street, Suite 170
Honolulu, Hawaii 96813
t 808.523.5866
e rachels@g70.design
www.G70.design

*Note: We've moved! Please note our address has changed.


Oahu
Lanikai Beach
ONEKEA DR
MOKULUA DR
AALA DR
AALAPAPA DR
MOKOLEA DR
KEHAULANI DR
POKOLE WAY
4-3-004:077
Legend
Project TMK
0
150
300
Feet

From: Lee Bell <jkbell007@gmail.com>

Sent: Monday, September 17, 2018 3:25 PM

To: Rachel Shaak

Cc: Jeff Overton; Nadir Safai

Subject: Re: Shoreline Protection for 1326 Mokulua Drive - Environmental Assessment

Attachments: A'ala LOT J.docx; ROW Lanikai Assn FLOOD CONTROL.pdf; Sand grabber installed by City and County with Tile wall per settlement.pdf; Damage to City and County System.pdf; Crack in wall and grabber moving.pdf; Looking North to Safai.pdf; Looking South to Binney.pdf

Aloha Rachel,

Thank you for taking my call. Attached for your files regarding A'ala ROW Lot J.

History in here regarding Flood Easement system that is suppose to me maintained by City and letters of background.

I would love to be able to bring to the table 3 parties for understanding and I think would go very far with good faith for this projects success. Tom Cestare as he is the President of Lanikai Association, Phil Foti as long time resident on this ROW and Peter Binney as he is the other owner that is across the way from Mr. Safai.

All of these folks are interested in getting a FINAL solution that works Mr. Safai to enjoy his newly acquired property and some how benefit the Association with its need on this ROW .....and to get the City and County to maintain their stated obligation.

In discussion we all have stated and supported the "***riprap scour apron placement***" style for design but feel it is important to have these folks at the table.

I would be happy to host a meeting at my house or on site if appropriate.

Malama Pono and A hui hou!

On Mon, Sep 17, 2018 at 1:08 PM, Rachel Shaak <rachels@g70.design> wrote:

Aloha Lee,

We are contacting you regarding a property located at 1326 Mokulua Drive in Lanikai, Kailua, O'ahu, TMK 4-3-004:077 (see attached location map). A temporary sandbag structure was permitted by the City and County of Honolulu for shoreline protection in 1995. The property was recently acquired by Lanikai resident Nadir Safai and co-owner Chris Furie, and the owners are pursuing approval to construct a permanent shoreline erosion control structure to protect the existing residence.

G70 is preparing an Environmental Assessment (EA) in support of the Shoreline Setback Variance, and this email is part of early consultation to determine the scope of the EA. We are seeking your input regarding the plan for shoreline protection due to your association with the project. If you have comments we'd appreciate hearing from you by September 28th. Comments can be provided to Rachel Shaak at mokulua@g70.design or by phone at 523-5866.

Mahalo,

Rachel Shaak, AICP, LEED AP
Senior Planner

111 S. King Street, Suite 170
Honolulu, Hawaii 96813
t 808.523.5866
e rachels@g70.design

www.G70.design

*Note: We've moved! Please note our address has changed.

--

A hui hou!

Lee

- TMK: 1-4-3-004-096
- 3,909 square feet
- LCA 616 and Harold Kainalu Long Castle. Transfer Certificate of Title No. 183,278 issued to Lanikai Association
- February 7, 1991 drainage easement filed as Land Court Document N.o 1810022.
    - Correspondence in January 31, 1992 states L.A. retains ownership of the property

STORMS THAT STARTED DISUSSION

LANIKAI FLOOD CONTROL

Two major storms; one in November 1984 and one in February 1985. Major damages occurred at (1) ditch along Lanipo Dr., (2) between Aala & Pokole. Gully above Mokulea was the cause, & (3) along hillside.

During 1985 – 86 the City and the LA studied and completed a very detailed study of flooding problems. Some of the highlights of the documents produced are as follows:

1985:

- The City acknowledges maintenance responsibility of the City-owned drainage facilities.
- Only ROW's 4-3-6:85 (Haokea) and 4-3-8:65 (Kaelepulu) could be cut down without difficulty. The remaining ROW's may pose problems to adjacent properties which may require retaining walls.
- City proposed that LA clears ROW's and the City would clear them during storms is LA holds City harmless.
- City says existing drainage systems are inadequate and recommends we need new drain pipes with additional drain inlets and curbs and gutters to the drain inlets.
- As of 10/85 the City Div. of Engineering completed locating the existing drainage systems and determined the ownership and maintenance responsibilities of the drains.
- The City recommends an Improvement District and the cost of the project would be near $17 million.

1986:

- Drainage survey completed. 50% of residents responded (275 out of 571).
- Residents were in favor installing curbs where it would be necessary to control storm runoff, which may require a drainage ID.
- Residents were strongly against a complete streets ID project.
- Residents wanted the ROWs cut down to provide for an overflow channel when storm drains become blocked.
- Residents wanted interceptor ditches installed along the back of the hillside properties.
- Residents wanted a ban on building on the hillsides and wanted property owners to raise the elevation of the floors and new homes to be required to be built above the flood level.

1988:

- Letter from City to LA Residents:
- Kwock Assoc. study recommended 4 options:
    - Concrete lining 4 ROWs at cost to city of $140,000
    - Widening and improvement of Lanipo Ditch at City cost of $2.9 million.
    - Options 3 & 4 involves an ID, where property owners' share to be $.64/sq. ft. to cover drainage, roadway and channel improvements.
    -

Copies of documents during this time period are attached.

DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

SAM CALLEJO
DIRECTOR AND CHIEF ENGINEER

C. MICHAEL STREET
DEPUTY DIRECTOR

In reply refer to:
M92-102

January 31, 1992

Philip R. Foti, M.D.
Hawaii Physicians & Surgeons Assoc., Inc.
Kailua Professional Center, Suite 601
30 Aulike Street
Kailua, Hawaii 96734

Dear Dr. Foti:

Subject: **Beach Access Right-of-Way Between 1324 and 1336 Mokulua Drive, TMK:4-3-04:96**

Thank you for your letter regarding the clarification of maintenance responsibilities for the subject right-of-way.

Our records show the City acquired an easement for drainage purposes over this property as you indicated. We stand corrected. The Lanikai Association retained ownership of the property and controls the right-of-way. However, we allowed beach access to continue over the drain easement and in light of that, we agree that maintaining the area with only drainage considerations in mind is not compatible with its use as a beach access. Therefore, we will hereafter maintain the area with consideration for pedestrian safety in a manner consistent with a public right-of-way.

As you may be aware, on January 24, we removed the rock piles adjacent to the right-of-way (Mr. Davis' property) and repaired the eroded areas within the right-of-way. We also removed loose rocks at the seaward end. The sandbags scattered within this area were placed along the adjacent property walls to help prevent erosion.

On a follow-up inspection held on January 27, we noted that wave action moved the sandbags back to the center of the right-of-way and also exposed rocks which were previously buried beneath the sand. The sandbags will be removed as they are not preventing erosion but, instead, pose a potential hazard to beachgoers. We will also remove loose rocks but not rocks and sandbags that are firmly anchored, although exposed, as this may exacerbate the erosion problem.

Hereafter, we will remove loose rocks from the right-of-way as well as along the beach areas, as needed. It appears that these rocks are the result of failures of private revetment structures. As we have no ordinance presently to require repairs or cleanup, we have referred the revetment problems to the Departments of Building and Land Utilization to look into this concern.

Should you have any further maintenance concerns, please call Mr. Daniel Kupahu, District Road Maintenance Superintendent, at 262-4346.

Very truly yours,

C. Michael Street

for SAM CALLEJO
Director and Chief Engineer

cc: Roy Bell, et al.
State DLNR (Land Management)
Building Department
DLU

HAWAII PHYSICIANS & SURGEONS ASSOC., INC.
(KA HUI O NA KAUKA HAWAII)
KAILUA PROFESSIONAL CENTER
SUITE 601, 30 AULIKE STREET
KAILUA, HAWAII 96734

TELEPHONE (808) 262-6951

PHILIP R. FOTI, M.D.
INTERNAL MEDICINE & PULMONARY DISEASE
HOWARD I. KELLER, M.D., F.A.C.P.
INTERNAL MEDICINE & KIDNEY DISEASE

February 10, 1992

Mr. Sam Callejo
Director and Chief Engineer
City and County of Honolulu
Department of Public Works
650 South King Street, 11th Floor
Honolulu, Hawaii 96813

Dear Mr. Callejo:

My thanks for your last letter, dated January 31. You usually hear from us with complaints. This is simply a memo to thank you for your prompt, efficient, and appropriate response. The C&C workers were very nice and did a job very much appreciated by all of us who utilize and enjoy this area of Lanikai beach. Your letter's attention to the persistent problems associated with the revetments and walls was also apropos.

Mahalo for the kokua,

Philip R. Foti /km

Philip R. Foti, M.D.

PRF:km
Dictated, but not read.

FEB 10 1992

Consultation with Lanikai Association

Shoreline Protection for 1326 Mokulua Drive, Lanikai, Kailua, Oahu, HI

Date: November 9, 2018

Attending:

Lee Bell, Lanikai, tel 497-6546 jkbell007@gmail.com
Mollie Foti, 1343 Mokulua Drive, 261-5550 fotiprmk@hawaiiantel.net
Phillip Binney, 1336 Mokulua Drive, 349-7457 keliikahi@yahoo.com
Peter Binney, 1336 Mokulua Drive, Kailua, 96734 kaipacific@earthlink.net
Nadir Safai (Owner) 1326 Mokulua Drive nadirsafai@gmail.com
Jeff Overton (G70) Planner 351-4200 jeff@g70.design

Subjects Discussed:

1. An overview of the planned shoreline structure for 1326 Mokulua was presented to explain the background of the 1990's sandbags installation, 2018 shoreline survey and preliminary plan for the shoreline structure (vertical seawall with boulder scour apron), and EA/Variance process.
2. LCA owns the beach access adjacent to 1326 Mokulua and wishes to coordinate with the Owner in the planning and permitting of the shoreline structure. This meeting provides input for the EA.
3. The beach access has a concrete headwall structure with an open section intended to serve as a "sand grabber". Over the course of a typical year, the sand accumulates in the summer and fall and recedes in the winter and spring. Sand bags are positioned at the foot of the access to allow a transition, since there is big drop-off at times when the sand levels are low.
4. LCA is pleased that the new owners are willing to discuss the plans and work together to help maintain and improve the beach access.
5. LCA has worked with the City over the years to make certain improvements to the beach access, including CMU retaining walls along either side.
6. According to LCA, the City is responsible for maintenance of the beach access, although there has been no action to keep the access clear.
7. Ed Noda designed the Binney revetment in the 1980's. Purposefully used a very low slope 4 horiz:1 vertical to allow for energy dissipation and sand accumulation. Their revetment "flexes" over time to settle differentially but still functions as intended,
8. Mollie Foti has historical photos of the Lanikai beach and the subject beach access, showing changes to the shoreline and beach width over time.
9. Lee Bell noted that retired US Army COE civil works director Jim Berssons lives in Lanikai and has offered to provide advice and support to the group effort regarding the beach access.
10. Design comments for the shoreline structure is a preference for a sloping revetment. It is understood that the proximity of the home cannot accommodate the revetment horizontal extent. A vertical seawall with inclusion of a rip-rap boulder scour apron would help to serve the same purpose. If possible, the scour apron boulders should be not be grouted to provide voids in the structure to collect sand and dissipate energy.
11. Question if the "sand grabber" structure can be modified to function better. Ideally this should allow for better sand transport and accumulation, and to serve as a broad low step or tapered ramp to ease the transition for paddlers and ocean/beach users.
12. Concern that the removal of the sandbags from the front of 1326 Mokulua will allow more north angle wave energy to affect the 1336 Mokulua (Binney) revetment and the beach access. Request to study the ocean engineering conditions and predict the sand accumulation response.

Next steps and follow up:

1. Notes from the Nov 9 site visit meeting to be provided to the group attending.
2. Ongoing communications with LCA to work towards options for improvement of the beach access.
3. Sharing technical study information when available, and inform LCA of each step in the process.

Appendix D

Sea Engineering, Inc. Coastal Assessment 1326 Mokulua Drive (July 2018)

Coastal Assessment
1326 Mokulua Drive
Revision 1.3

Lanikai, Oahu, Hawaii

April 2019

Prepared for:
G70 Design
111 S. King St., Suite 170
Honolulu, HI 96813

Prepared by:
Sea Engineering, Inc.
Makai Research Pier
41-305 Kalanianaole Hwy
Waimanalo, HI 96795

Job No. 25627

Page intentionally left blank

TABLE OF CONTENTS

1. INTRODUCTION 1

1.1 BACKGROUND 1
1.2 LOCATION 1
1.3 OBJECTIVES 1

2. PROJECT SITE DESCRIPTION 4

2.1 REGIONAL SETTING 4
2.2 EXISTING CONDITIONS 4
2.3 SANDBAG REVETMENT PROFILES 7
2.4 SHORELINE HISTORY 10
2.5 RECENT SHORELINE CHANGE 15
2.6 GEOLOGY & SOILS 17
2.7 BATHYMETRY 18
2.8 BENTHIC HABITAT 18
2.9 COASTAL USES 18
2.10 ZONING & LAND USES 19

3. OCEANOGRAPHIC SETTING 22

3.1 WINDS 22
3.2 WATER LEVELS 23
3.2.1 Tides 23
3.2.2 Sea Level Rise 24
3.3 WAVES 27
3.3.1 General Wave Climate 27
3.3.2 Prevailing Deepwater Waves 28
3.3.3 Extreme Deepwater Waves 31
3.4 NUMERICAL MODELING OF WAVE APPROACH 33
3.5 STILL WATER LEVELS AND NEARSHORE WAVE HEIGHTS 35

4. COASTAL HAZARDS 36

4.1 HURRICANES 36
4.2 KONA STORMS 36
4.3 TSUNAMI 36
4.4 STILL WATER RISE 37
4.5 COASTAL FLOODING 38
4.6 PROJECTED IMPACTS OF SEA LEVEL RISE 39

5. PROJECT ALTERNATIVES 42

5.1 INTRODUCTION 42
5.2 NO ACTION / MAINTAIN SANDBAGS 42
5.3 REMOVAL OF SANDBAGS 43
5.4 BEACH NOURISHMENT 44
5.5 ROCK REVETMENT 46
5.5.1 Rock Revetment Design 48
5.5.2 Revetment Design per Court Settlement 51

5.6 HYBRID SEAWALL-REVETMENT 52
5.6.1 Hybrid Seawall-Revetment Design 54
5.7 SEAWALL 56
5.8 SEAWALL WITH SCOUR APRON 60
5.8.1 Seawall with Scour Apron Design 62

6. OTHER CONSIDERATIONS 65

6.1 REPLACEMENT OF SANDBAG STRUCTURE WITH ALTERNATIVES – POTENTIAL IMPACTS TO COASTAL PROCESS, SAND ACCUMULATION, AND WAVE ACTION 65

REFERENCES 66

LIST OF FIGURES

FIGURE 1-1 PROJECT AREA LOCATION ON OAHU, HAWAII (GOOGLE EARTH) 2
FIGURE 1-2 PROJECT AREA LOCATION IN LANIKAI, OAHU (GOOGLE EARTH) 2
FIGURE 1-3 OBLIQUE AERIAL PHOTO OF THE PROJECT AREA (1996) 3
FIGURE 1-4 OBLIQUE AERIAL PHOTO OF THE PROJECT AREA (2013) 3
FIGURE 2-1 FRONTING SANDBAG REVETMENT LOOKING SOUTH. PHOTO DATE: MARCH 2018 5
FIGURE 2-2 FRONTING SANDBAG REVETMENT LOOKING NORTH. PHOTO DATE MARCH 2018 5
FIGURE 2-3 NORTH END OF SANDBAG REVETMENT AT ADJACENT PROPERTY. PHOTO DATE MARCH 2018 6
FIGURE 2-4 SOUTH END OF SANDBAG REVETMENT AT ADJACENT PUBLIC ACCESS HEADWALL. PHOTO DATE MARCH 2018 6
FIGURE 2-5 VOID LEFT BY DISPLACED SANDBAG SHOWN IN RED. PHOTO DATE MARCH 2018 7
FIGURE 2-6 DAMAGED SANDBAG WITH LOSS OF SAND. PHOTO DATE MARCH 2018 7
FIGURE 2-7 PROFILE TRANSECT LOCATIONS THROUGH TOPO SURVEY DATA 8
FIGURE 2-8 PROFILES OF SANDBAG REVETMENT FROM MARCH AND APRIL 2018 TOPO SURVEYS 9
FIGURE 2-9 JULY 1959 AERIAL IMAGE, USED BY THE UH COASTAL GEOLOGY GROUP 10
FIGURE 2-10 NOVEMBER 1963 AERIAL IMAGE, USED BY THE UH COASTAL GEOLOGY GROUP 11
FIGURE 2-11 FEBRUARY 1971 AERIAL IMAGE, USED BY THE UH COASTAL GEOLOGY GROUP 11
FIGURE 2-12 DECEMBER 1982 AERIAL IMAGE, USED BY THE UH COASTAL GEOLOGY GROUP 12
FIGURE 2-13 AUGUST 1996 AERIAL IMAGE, USED BY THE UH COASTAL GEOLOGY GROUP 12
FIGURE 2-14 DECEMBER 2005 AERIAL IMAGE, USED BY THE UH COASTAL GEOLOGY GROUP 13
FIGURE 2-15 HISTORICAL SHORELINE CHANGE RATES FOR LANIKAI, OAHU (CGG, 2008) 14
FIGURE 2-16 HISTORICAL SHORELINE CHANGE RATES FOR THE PROJECT AREA (CGG, 2008) 15
FIGURE 2-17 PROJECT SITE AFTER SANDBAGS WERE INSTALLED (PHOTO TAKEN 12/25/2014) 16
FIGURE 2-18 PROJECT SITE ABOUT 8 MONTHS AFTER SANDBAGS WERE INSTALLED (PHOTO TAKEN 8/7/2015) 16
FIGURE 2-19 PROJECT SITE AFTER ADDITIONAL SANDBAGS WERE INSTALLED (PHOTO TAKEN 8/22/2017) 17
FIGURE 2-20 CURRENT CONDITION OF SANDBAGS (PHOTO TAKEN 3/27/2018) 17
FIGURE 2-21 SOIL TYPES WITHIN THE PROJECT AREA (USDA) 19
FIGURE 2-22 BATHYMETRY FOR THE PROJECT AREA, IN METERS (LIDAR) 19
FIGURE 2-23 BATHYMETRY FOR THE PROJECT AREA ZOOMED IN, IN METERS (LIDAR) 20
FIGURE 2-24 PROJECT AREA BENTHIC HABITAT GEOMORPHOLOGY (PACIOOS) 20

FIGURE 2-25 PROJECT AREA BENTHIC HABITAT BIOLOGY (PACIOOS) 21
FIGURE 3-1 WIND ROSE KANEOHE MCBH (JULY 2016-JULY 2018) 23
FIGURE 3-2 MEAN SEA LEVEL TREND, MOKUOLOE, STATION 1612480, 1957 TO 2017 (NOAA, 2017) 26
FIGURE 3-3 HAWAII SEA LEVEL RISE PROJECTIONS (ADAPTED FROM NOAA, 2017) 26
FIGURE 3-4 HAWAII DOMINANT SWELL REGIMES 28
FIGURE 3-5 PROJECT SITE AND VIRTUAL BUOY LOCATIONS 29
FIGURE 3-6 STATION 51202 VIRTUAL BUOY WAVE HEIGHT ROSE FROM JAN 1979 - JAN 2010 30
FIGURE 3-7 STATION 51202 VIRTUAL BUOY WAVE PERIOD ROSE FROM JAN 1979 - JAN 2010 30
FIGURE 3-8 LOCATION OF CDIP BUOY 098 IN RELATION TO THE PROJECT SITE 31
FIGURE 3-9 CDIP 098 RETURN PERIOD 17-YR (AUG 2000 - MAR 2018) 32
FIGURE 3-10 LAYOUT OF SWAN NESTED GRIDS 34
FIGURE 3-11 NEARSHORE SIGNIFICANT WAVE HEIGHT TRANSFORMATION FROM THE DESIGN 50-YR NORTHEAST SWELL EVENT 34
FIGURE 4-1 COMPOSITE HAZARD MAP WITH PROJECT AREA SHOWN IN RED (USGS, 2002) 37
FIGURE 4-2 FLOOD HAZARD ZONES WITH PROJECT AREA SHOWN IN RED (FEMA) 38
FIGURE 4-3 PASSIVE FLOODING WITH 3.2 FEET OF SEA LEVEL RISE (PACIOOS) 39
FIGURE 4-4 ANNUAL HIGH WAVE FLOODING WITH 3.2 FEET OF SEA LEVEL RISE (PACIOOS) 40
FIGURE 4-5 COASTAL EROSION WITH 0.5 TO 3.2 FEET OF SEA LEVEL RISE (PACIOOS) 40
FIGURE 4-6 COMBINED HAZARD EXPOSURE WITH 3.2 FEET OF SEA LEVEL RISE (PACIOOS) 41
FIGURE 5-1 SHORELINE LOCATION AFTER A 50-YEAR DESIGN LIFE IF SANDBAGS ARE REMOVED 44
FIGURE 5-2 ROCK REVETMENT AT KAHULUI HARBOR (KAHULUI, MAUI, HAWAII) 48
FIGURE 5-3 SECTION VIEW OF REVETMENT ALTERNATIVE 50
FIGURE 5-4 REVETMENT ALTERNATIVE FOOTPRINT 51
FIGURE 5-5 COURT SETTLEMENT REVETMENT FOOTPRINT 52
FIGURE 5-6 HYBRID SEAWALL-REVETMENT (KAPAA, KAUAI, HAWAII) 53
FIGURE 5-7 SECTION VIEW OF HYBRID SEAWALL-REVETMENT OPTION 55
FIGURE 5-8 HYBRID SEAWALL-REVETMENT OPTION FOOTPRINT 55
FIGURE 5-9 CRM AND CONCRETE SEAWALLS (LANIKAI, OAHU, HAWAII) 56
FIGURE 5-10 CURVED SEAWALL OPTION FOOTPRINT 59
FIGURE 5-11 STRAIGHT ALIGNED SEAWALL OPTION FOOTPRINT 59
FIGURE 5-12 SECTION VIEW OF SEAWALL OPTION 60
FIGURE 5-13 SEAWALL WITH SCOUR APRON, (LANIKAI, OAHU, HAWAII) 61
FIGURE 5-14 SECTION VIEW OF THE SEAWALL WITH TOE APRON ALTERNATIVE 64
FIGURE 5-15 SEAWALL WITH SCOUR APRON OPTION FOOTPRINT 64

LIST OF TABLES

TABLE 3-1 WATER LEVEL DATA FOR MOKUOLOE, STATION 1612480 (NOAA) 24
TABLE 3-2 HAWAII LOCAL MEAN SEA LEVEL RISE SCENARIOS (FEET) 26
TABLE 3-3 RETURN PERIOD SIGNIFICANT WAVE HEIGHTS AT CDIP 098 32
TABLE 3-4 TOP 10 NE EVENTS RECORDED AT CDIP 098 33

1. INTRODUCTION

1.1 Background

Sea Engineering, Inc. (SEI) has been contracted to prepare a coastal assessment for the project area, which is located at 1326 Mokulua Drive in Lanikai, Oahu, Hawaii, Tax Map Key (1) 4-3-004:077. The project area has a history of chronic erosion that has degraded the coastline and caused extensive beach loss. The property owners are evaluating potential long-term solutions to mitigate erosion to the subject property.

The purpose of this Coastal Assessment is to collect the data and information necessary to understand the erosion problem and inform the development of conceptual engineering solutions that are appropriate for the project site conditions. The objective of this Coastal Assessment is to assess current conditions, evaluate erosion management alternatives, and present concept alternative designs. The Coastal Assessment is an important component of the environmental review and regulatory permitting process. This Coastal Assessment complies with the Office of Environmental Quality Control (OEQC) guidelines for assessing shoreline alteration projects, including a detailed description of the existing shoreline and coastal processes; historical shoreline erosion rates; site maps; oceanographic setting; coastal hazards; description of improvements; and review of alternatives.

1.2 Location

The project area consists of approximately 76 linear feet of shoreline fronting one (1) residential property on the east coast of Oahu. The shoreline is east-facing and characterized by a low-lying coastal plain, a narrow sand beach, and a shallow fringing reef. The subject property is bounded by a rock wall at the north end. Along the southern edge of the property is a public beach access walkway. The property just south of the public access has a riprap shoreline protection structure. Further south of the project area is approximately 450 linear feet of armored shoreline. North of the project area there is approximately 1,160 linear feet of armored shoreline. The project area is bounded by Mokulua Drive to the west and the Pacific Ocean to the east. The subject property is the sole property without hardened structures along the southern Lanikai coastline. There are currently sandbags on the makai edge of the subject property protecting it from erosion. The location of the project area is shown in Figure 1-2 and Figure 1-2. Oblique aerial photographs of the project area are shown in Figure 1-3 and Figure 1-4.

1.3 Objectives

The subject shoreline has had a high erosion scarp along the shoreline for many years that has been buffered with sandbags since 1994. The objectives of the proposed project are to identify a long-term solution to stabilize the shoreline, preserve the habitable dwelling in its current location, cause no destabilization of neighboring structures and properties, have no negative impact on lateral access or recreational value, and minimize environmental impacts.

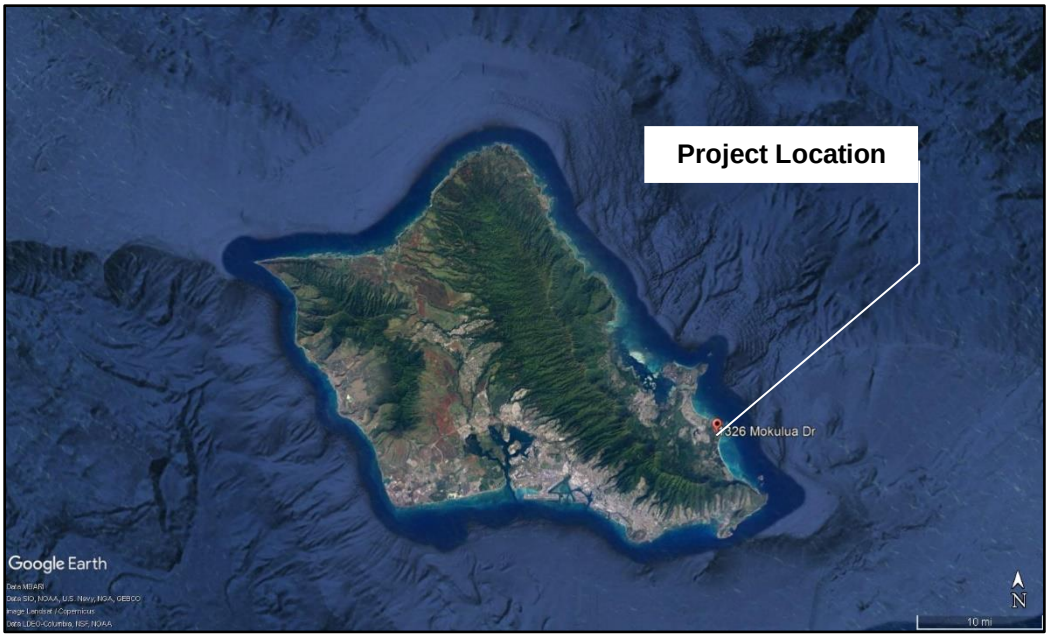


Figure 1-1 Project area location on Oahu, Hawaii (Google Earth)

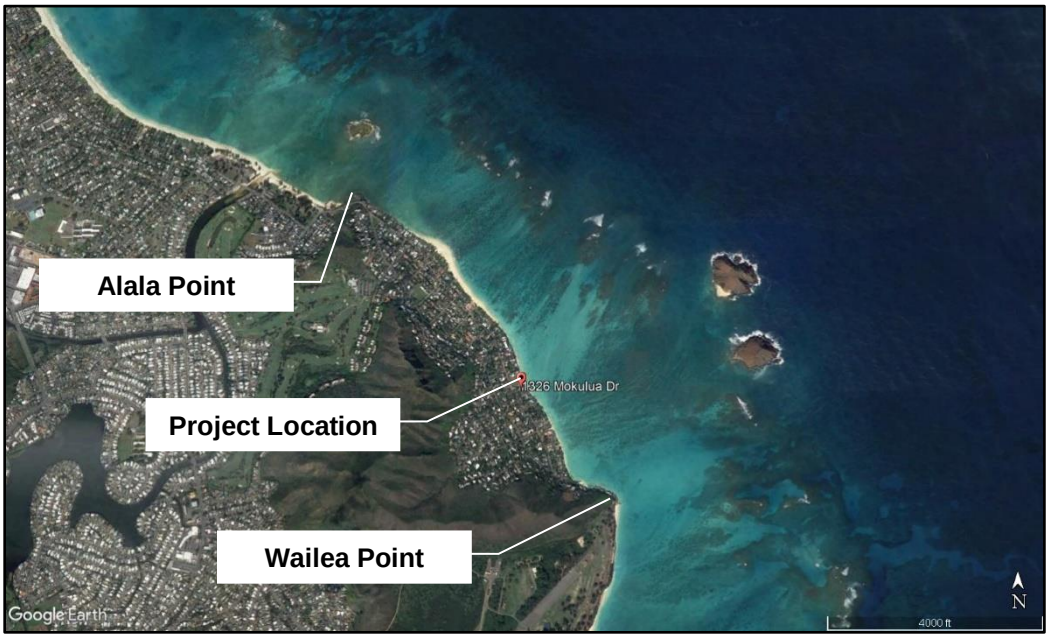


Figure 1-2 Project area location in Lanikai, Oahu (Google Earth)

Figure 1-3 Oblique aerial photo of the project area (1996)

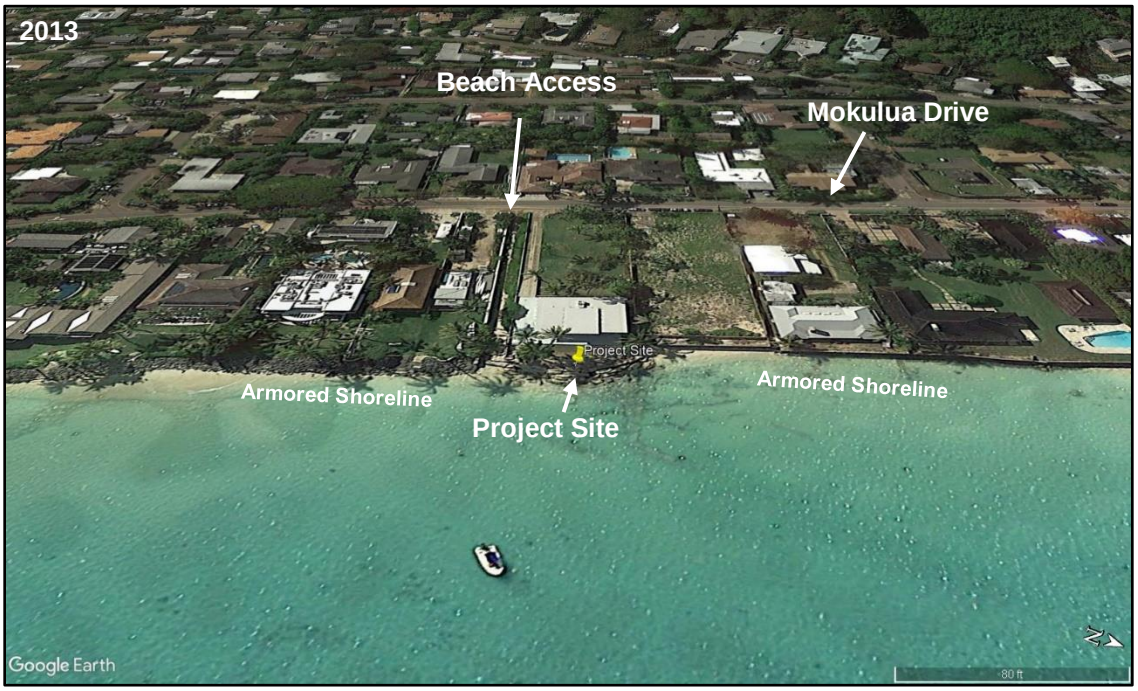


Figure 1-4 Oblique aerial photo of the project area (2013)

2. PROJECT SITE DESCRIPTION

2.1 Regional Setting

The project area is located at the seaward edge of a relatively flat coastal plain along Mokulua Drive in the community of Lanikai on the southeast coast of Oahu. The coastline is dominated by narrow beaches, discontinuous coastal dunes, and broad shallow fringing reefs. The region is extensively developed, and many beaches suffer from chronic and episodic erosion. The backshore area at the project site consists of two a privately-owned residential parcel. Alongside the subject parcel on the south side is a shore-perpendicular public beach access point. Lateral shoreline access is limited due to the extensive shoreline armoring and lack of beach width in the Lanikai area.

2.2 Existing Conditions

The project site is at address 1326 Mokulua Drive (TMK (1) 4-3-004:077) and consist of an 'L' shaped parcel with a total shoreline frontage of 75 feet (Figure 2-1 and Figure 2-2). The land elevation ranges from 7 to 10 feet above mean sea level (msl). The lot is fronted by a sandbag revetment composed of ElcoRock sandbags. The revetment appears to be in moderate condition with some signs of damage resulting from extreme wave events since the revetment's construction and what appears to be vandalism. The damage consists of displaced sandbags (Figure 2-5) along with some isolated cuts and tearing of the sandbag material (Figure 2-6).

The abutting property to the north has a vertical seawall with access stairway (Figure 2-3). The sandbags slope down extending slightly in front of the adjacent seawall to the north. Vertical seawalls and rock aprons or revetments line additional properties to the north of the subject property for approximately 0.2 miles. The shoreline north of the contiguous line of seawalls and revetments transitions to a wider, dry beach with backshore dune formation and stable vegetation. These properties are fronted by buried hardened shoreline structures and have accreted a sand beach with vegetation growth atop and makai of the structures. The beach extends approximately 0.5 miles north where it once again pinches out against shoreline structures. These shoreline structures extend approximately 0.2 miles north to Alala Point,

A public access path abuts the south end of the project shoreline. The path ends with a concrete headwall (Figure 2-4). The submerged sand beach continues south beyond the abutting public access headwall. The shoreline south of the beach access is characterized by armoring structures with a mixture of seawalls, rock aprons, and revetments. This stretch of coastline is composed of shore protection structures stretching over 0.4 miles to Wailea Point.

The project coastline is characterized by a wide fringing limestone reef flat stretching over 3,000 feet offshore and along the Mokulua Islands, shown previously on Figure 1-2. The fringing reef is incised with channels or depressions at numerous locations and has numerous sand patches. The fringing reef's shallow reef crest and reef flat provide protection to the shoreline from wave action. During typical conditions, significantly less wave energy reaches the shoreline than exists in deep water due to the shallow depths of the reef and subsequent wave breaking. Wave energy, however, still reaches the shore at higher water levels and cross-shore currents still exist. Sand in Lanikai Beach and the nearshore sand fields are mobilized through active longshore transport. Typical patterns on Oahu's East Shore show sand being pushed offshore with winter swell events and a gradual transport back onshore during summer trade conditions. Longer term sand dynamics of

Lanikai Beach have changed with the armoring of the shoreline. Prior to the late 1970's, Lanikai Beach showed a trend of accretion. This trend reversed causing erosion along the shoreline, and in response, property owners constructed seawalls and other hardened shoreline structures (Romine and Fletcher, 2012). In general, sand volume is vital to beach health, which helps to support and stabilize the beach and dune profile. A stable, sandy shoreline and frontal dune system provide excellent natural mitigation to coastal natural hazards.

Figure 2-1 Fronting sandbag revetment looking south. Photo date: March 2018

Figure 2-2 Fronting sandbag revetment looking north. Photo date March 2018

Figure 2-3 North end of sandbag revetment at adjacent property. Photo date March 2018

Figure 2-4 South end of sandbag revetment at adjacent public access headwall. Photo date March 2018

Figure 2-5 Void left by displaced sandbag shown in red. Photo date March 2018

Figure 2-6 Damaged sandbag with loss of sand. Photo date March 2018

2.3 Sandbag Revetment Profiles

Topographic surveys were performed by SEI in March 2018 and by Austin Tsutsumi & Associates (ATA) in April 2018 to collect elevation data of the sandbag revetment and backshore/adjacent property infrastructure. Three shoreline profiles were generated through the combined topo survey data (Figure 2-7) to show the cross-shore profile of the sandbag revetment. Figure 2-8 shows the

profile elevations extending from the face of the house to the toe of the sandbags. Elevations are given relative to msl.

Figure 2-7 Profile transect locations through topo survey data

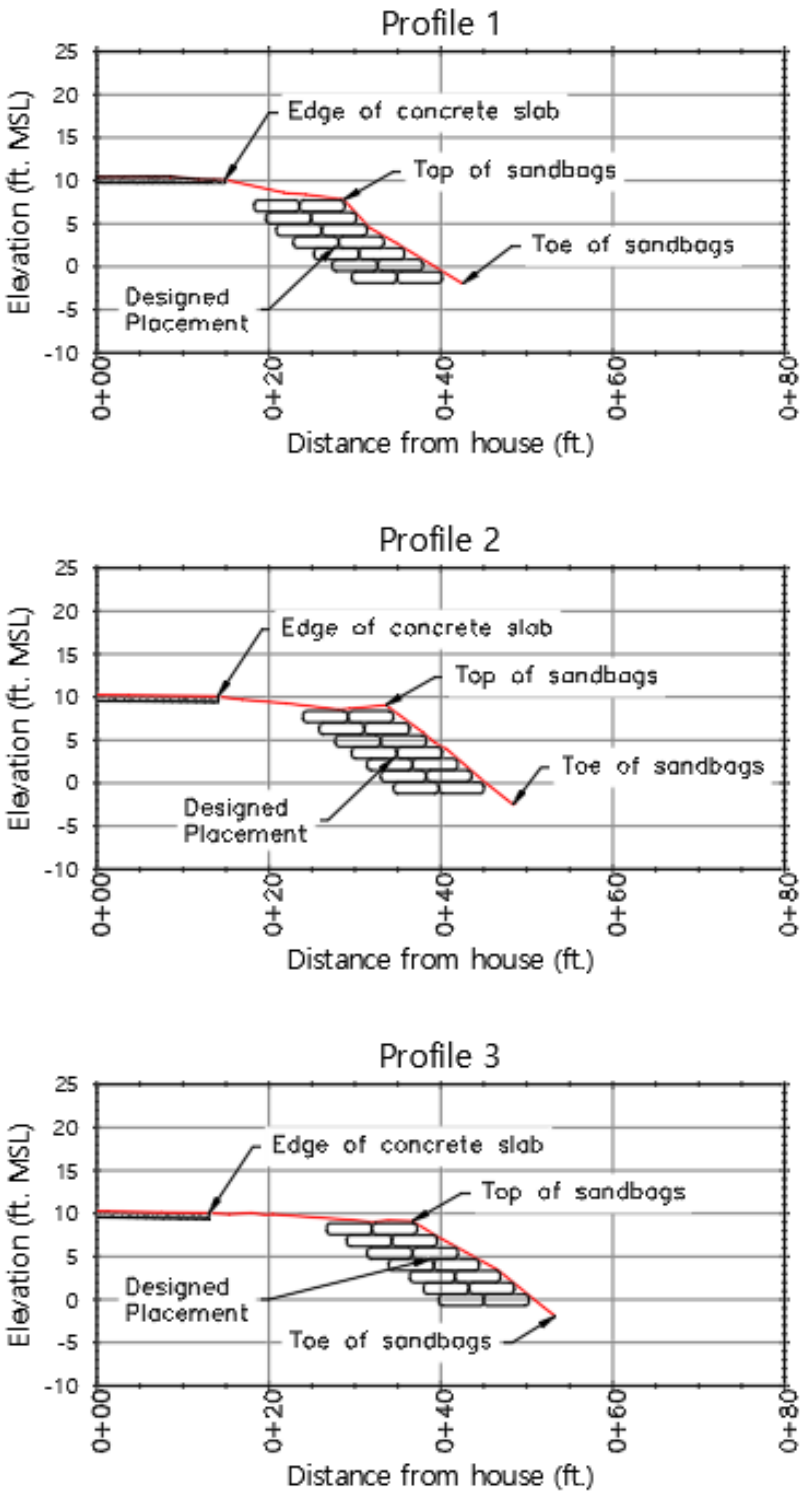


Figure 2-8 Profiles of sandbag revetment from March and April 2018 topo surveys

2.4 Shoreline History

The erosion history of Lanikai has been analyzed with aerial photographs by the University of Hawaii Coastal Geology Group (2010). The CGG compared the low water mark digitized from 8 aerial photographs between 1949 and 2006, and National Ocean Survey topographic survey charts (T-sheets) from 1911 and 1928. In the project vicinity, photographs from 1949, 1959, 1963, 1967, 1971, 1975, 1982, 1988, 1989, 1996, and 2005 were available. A subset of these images from 1959, 1963, 1971, 1982, 1996, and 2005 are shown in Figure 2-9 through Figure 2-14. Areas of the beach are present in each of the photographs prior to 2005, with some variation in beach width between photographs. Traditionally, East Shore beaches on Oahu have seasonal morphology patterns associated with their dynamic response to changes in the wave environment.

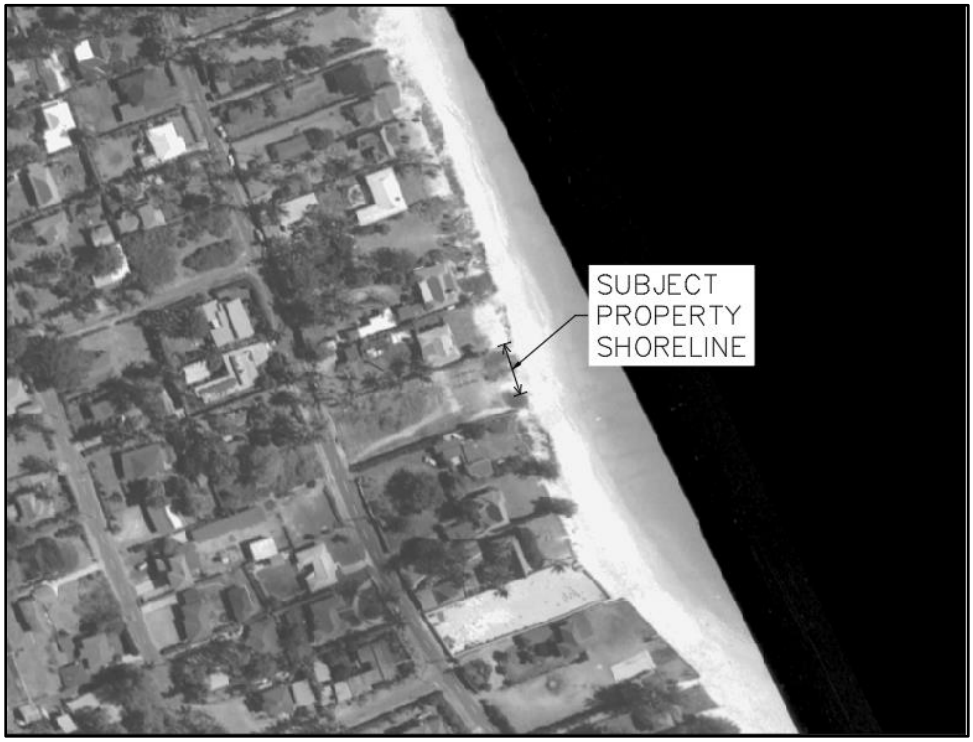


Figure 2-9 July 1959 aerial image, used by the UH Coastal Geology Group

Figure 2-10 November 1963 aerial image, used by the UH Coastal Geology Group

Figure 2-11 February 1971 aerial image, used by the UH Coastal Geology Group

Figure 2-12 December 1982 aerial image, used by the UH Coastal Geology Group

Figure 2-13 August 1996 aerial image, used by the UH Coastal Geology Group

Figure 2-14 December 2005 aerial image, used by the UH Coastal Geology Group

The results of the CGG study for the project vicinity are presented in Figure 2-15. The shoreline positions were used to calculate annual shoreline change rates.

The analyses for the project area shoreline are presented at Transects 80 through 83 on the CGG erosion map (Figure 2-16). The CGG analysis determined that the dominant shoreline change trend for the project area has been eroding at an average rate of 1.75 feet/year. While this rate is representative of the average, smoothed, long-term trend for the shoreline from 1911 to 2005, it does not account for fluctuations in beach width that have occurred since the study was completed.

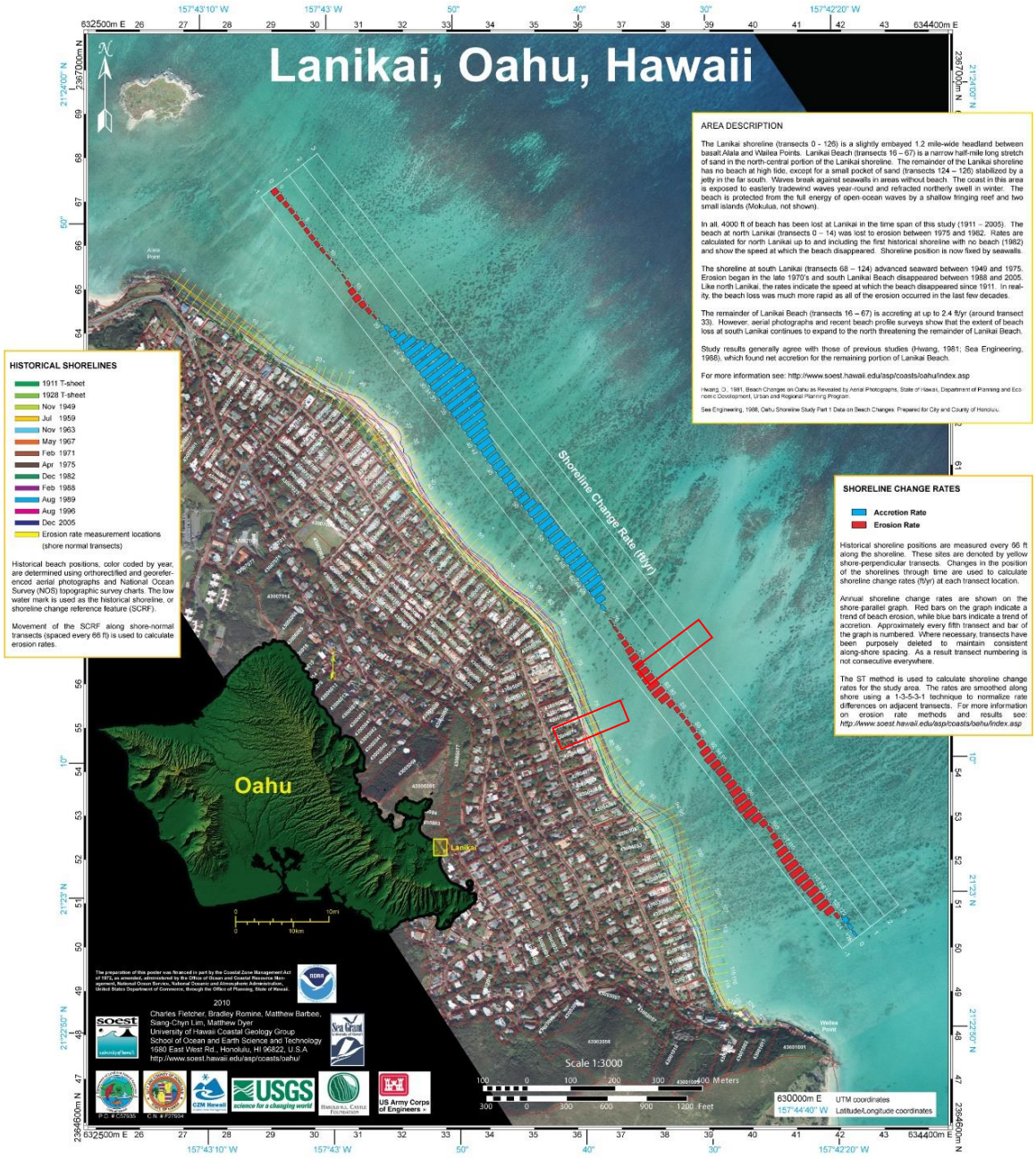


Figure 2-15 Historical shoreline change rates for Lanikai, Oahu (CGG, 2008)

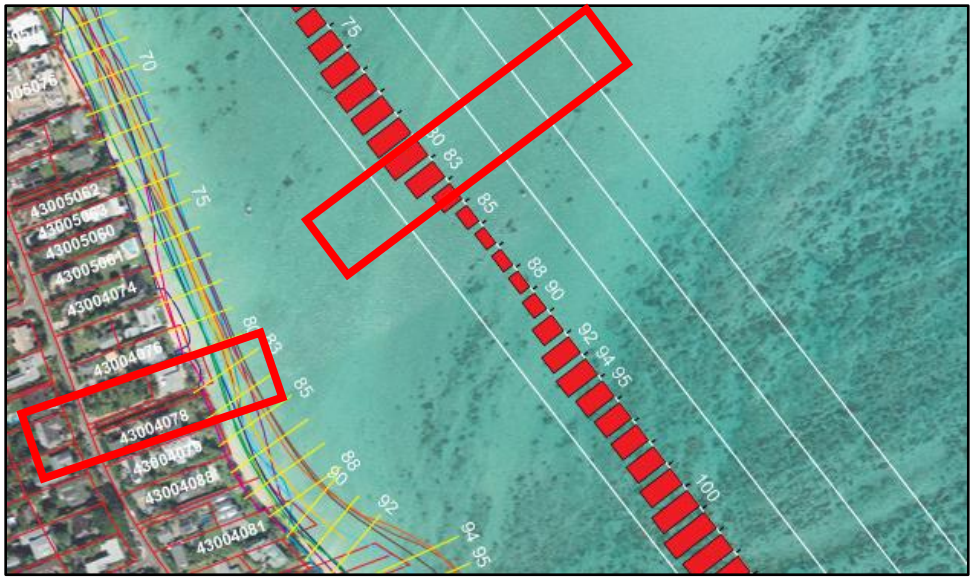


Figure 2-16 Historical shoreline change rates for the project area (CGG, 2008)

As mentioned in a paper by Romine and Fletcher (2012), prior to the late 1970s a pattern of accretion was present in southern Lanikai and is evidenced from Figure 2-10 and Figure 2-11. This effect can be seen to the north and south of the subject property in Figure 2-12 through Figure 2-14. This pattern can be observed over the nearly 60-year period of the study.

2.5 Recent Shoreline Change

The subject shoreline has had a large erosion scarp along the shoreline for many years that has been buffered with sandbags since 1994. The project area is bounded by a rock wall at the north end and riprap at the south end. South of the project area there is approximately 450 linear feet of armored shoreline. North of the project area there is approximately 1,160 linear feet of armored shoreline. The shoreline makai of the sandbags is a wet beach that moves with inflation and deflation. There is no dry beach at the project site. Sediment is transported in the region under the influence of waves and nearshore currents.

Since the initial sandbag installation in 1994, there have been many iterations of maintenance to the sandbag structure. In 2014 the sandbag structure was partially rebuilt during a maintenance effort (Figure 2-17). The sandbags are an attractive coastal recreation location for residents and the public who come and sit on the sandbags (Figure 2-18). The public use of the sandbag structure may have contributed to wear on the structure over the years and has been a security concern of the property owners. In 2017 additional maintenance was conducted on the sandbag structure. This maintenance effort included replacing sandbags along sections of the structure to repair the face and to prevent wave over-topping (Figure 2-19). Currently, the sandbag structure has seen the loss of several sandbags on the face and needs repair or replacement in some areas (Figure 2-20).

Figure 2-17 Project site after sandbags were installed (Photo taken 12/25/2014)

Figure 2-18 Project site about 8 months after sandbags were installed (Photo taken 8/7/2015)

Figure 2-19 Project site after additional sandbags were installed (Photo taken 8/22/2017)

Figure 2-20 Current condition of sandbags (Photo taken 3/27/2018)

2.6 Geology & Soils

The surficial geology of the low-lying Lanikai coastal plain is primarily Holocene beach deposits (Sherrod et al., 2007) windward of the Ko‘olau Volcano. The Ko‘olau lavas are found within the watershed mauka of the project area. They are divided into the Ko‘olau Basalt and the Honolulu Volcanics.

The Ko'olau Basalt primarily consists of Pliocene aged shield stage tholeiitic basalt, which plays an important role in the Ka'elepulu watershed. Ko'olau Basalt rocks can be divided into three groups; lava flows (a'a and pahoehoe), pyroclastic deposits, and dikes. Lava flows associated with Ko'olau basalt are usually thinly bedded. Each bed is a unique flow, composed of a'a and pahoehoe flows. Interspersed with these flows are pyroclastic deposits. A'a flows contains a solid central core between two gravely clinker layers. Pahoehoe flows are usually characterized by a smooth ropy texture. Pyroclastic deposits originate from explosive volcanism and are composed of friable sand-like ash and indurated tuff deposits. Dikes are thin near planar sheets of rock that intruded or squeezed into existing lava flows or pyroclastic deposits.

The shoreline is characterized by an extensive fringing reef complex associated with a broad, shallow, and generally smooth reef flat. The fringing reef parallels most of the coastline. The Lanikai shoreline consists of carbonate sand beaches with varying widths. The foreshore (beach) soils are classified as "beaches" (Figure 2-21). Landward of the subject property, soils are classified as Jaucus Sand (JaC) with 0 to 15% slopes (USDA, 2018).

2.7 Bathymetry

Bathymetric data (Figure 2-22, Figure 2-23) shows water depths (in meters) relative to mean sea level (MSL) offshore of the project area. Water depths range from 0 to 5 meters on the inner reef flat, which extends approximately 3,700 feet offshore. Water depths along the reef crest range from 1 to 3 meters. Water depths on the outer reef range from 3 to 10 meters before dropping off into deeper waters offshore.

2.8 Benthic Habitat

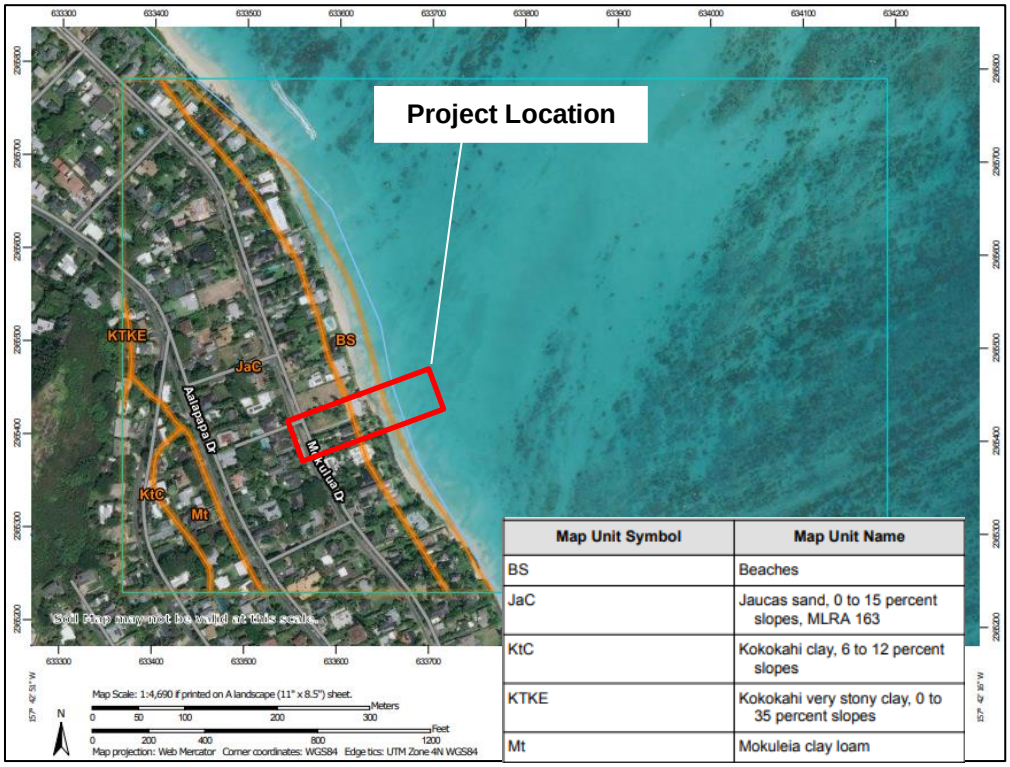
The Pacific Island Ocean Observing System's (PacIOOS) Voyager web-based mapping program displays the National Oceanographic and Atmospheric Administration's (NOAA) benthic habitat data for the project area. These maps show the geomorphology (Figure 2-24) and biology (Figure 2-25) of benthic habitat for the project area. The area offshore of the project site is characterized by sand, scattered coral rock, and aggregate patch reef that is uncolonized or has live coral. The U.S. Fish and Wildlife Service classifies the nearshore waters as marine, intertidal, rocky shore that is regularly flooded. Offshore, the coastal waters are classified as marine, subtidal, unconsolidated bottom. The Hawaii Department of Health (DOH) classifies the nearshore waters as Class A Marine Waters.

2.9 Coastal Uses

The subject shoreline is primarily residential and is property class Residential A. Narrow sand beaches exist along portions of the shoreline and there is some public access to these areas, but lateral shoreline access is limited between them. Shoreline public access is available alongside the subject property. The public who access this part of the shoreline currently walk makai of the sandbags for lateral access. The subject beach, with wide fringing limestone reef flats protecting the coastline, is a recreational destination for snorkelers, swimmers, and spear-fishermen. Though the project area is used by beachgoers, there is limited parking and large portions of the beach are often submerged at high tide. There are no notable surf breaks directly offshore of the project site. Surfing areas are located well offshore, outside of the reef crest for the wide, shallow, fringing reef.

2.10 Zoning & Land Uses

The project site is located in a Special Management Area (SMA) and Urban Land Use District. The lands seaward of the shoreline are located in the Resource Subzone of the Conservation District.



Map Unit Symbol	Map Unit Name
BS	Beaches
JaC	Jaucas sand, 0 to 15 percent slopes, MLRA 163
KtC	Kokokahi clay, 6 to 12 percent slopes
KTKE	Kokokahi very stony clay, 0 to 35 percent slopes
Mt	Mokuleia clay loam

Figure 2-21 Soil types within the project area (USDA)

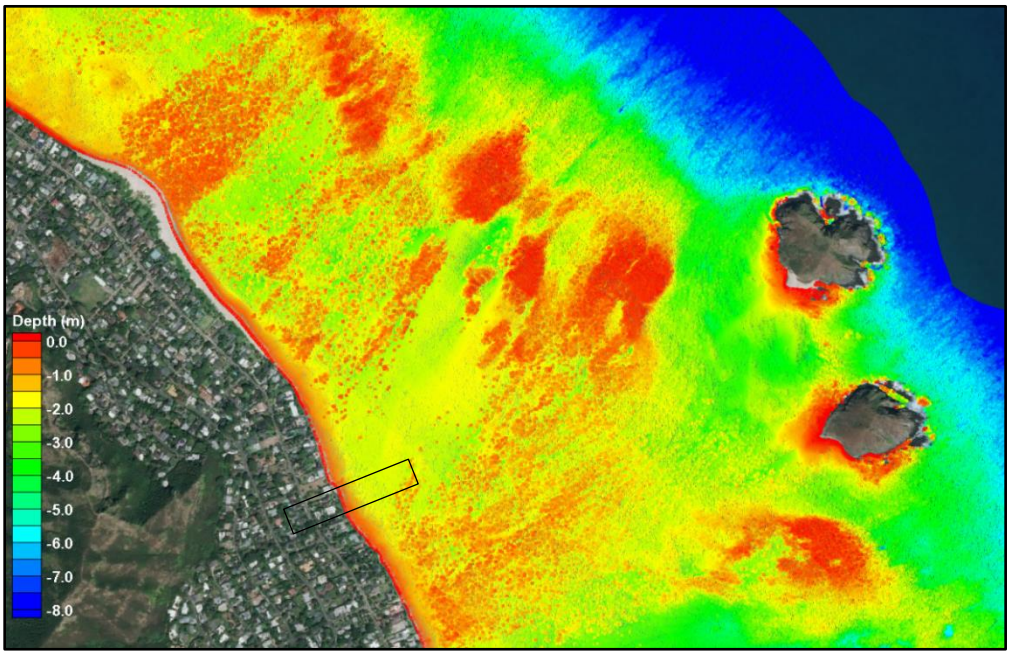


Figure 2-22 Bathymetry for the project area, in meters (LiDAR)

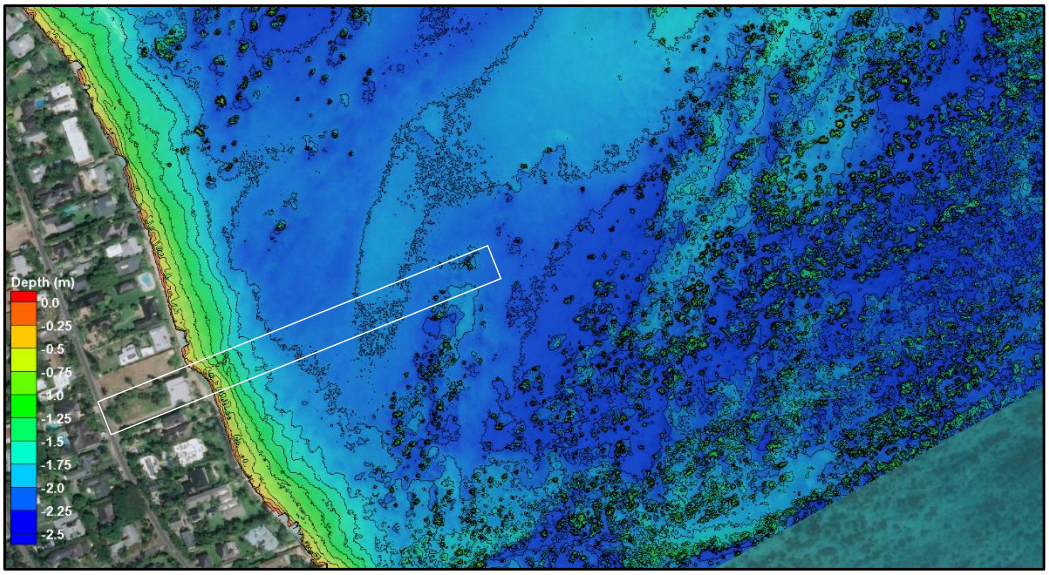


Figure 2-23 Bathymetry for the project area zoomed in, in meters (LiDAR)

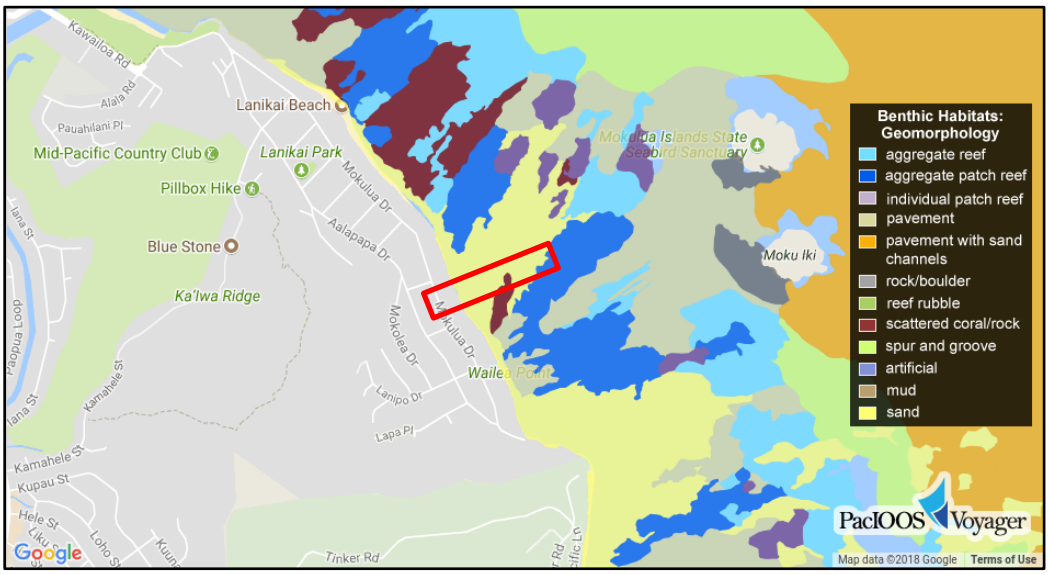


Figure 2-24 Project area benthic habitat geomorphology (PacIOOS)

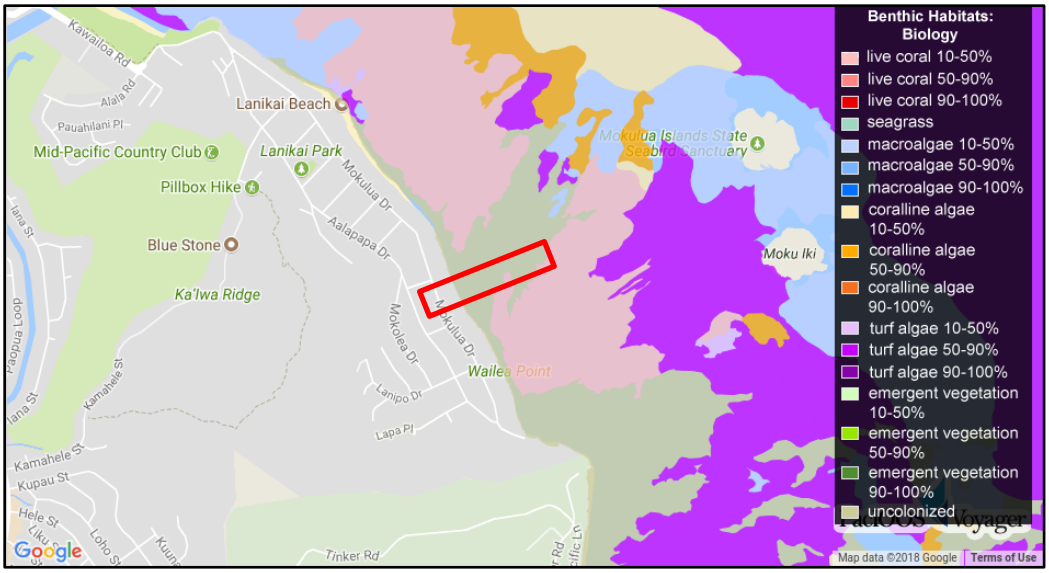


Figure 2-25 Project area benthic habitat biology (PacIOOS)

3. OCEANOGRAPHIC SETTING

The neighborhood of Lanikai is nestled between the mountains and the ocean on the windward side of Oahu. The 1.5-mile long shoreline lies between Alala Point to the north and Wailea Point to the south. By 1959, the Lanikai coastline was highly developed and a series of seawalls and revetments had been constructed to protect properties from the effects of coastal erosion. The north and south portions of the Lanikai coastline have experienced extensive beach loss and those seawalls and revetments are presently exposed to wave attack.

The reef flat offshore of Lanikai is primarily a fossilized reef. Portions of the reef are emergent at low tide and the deeper areas are covered with a veneer of sand. The Mokulua Islands, large basaltic outcrops from the sea floor, are located about 4,000 feet offshore and rise approximately 200 feet above sea level. The water becomes increasingly deeper offshore of the islands.

The shoreline is shaped by the prevailing tradewind waves. These waves experience refraction and diffraction past the Mokulua Islands and over the shallow fringing reef, resulting in a very complex nearshore wave pattern. Bulges in the sandy shoreline are centered 1,900 feet and 3,800 feet south of Alala Point. These bulges are produced by convergent wave patterns caused by refraction and diffraction past the Mokulua Islands and the reef. A third bulge, centered opposite Lanipo Drive, has been armored.

3.1 Winds

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 3-1 shows a wind rose diagram applicable to the site based on wind data recorded daily at the Kaneohe MCBH.

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 International Airport, wind speeds resulting from these storms have on several occasions exceeded 60 mph. Kona winds are generally from a southerly to a 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.

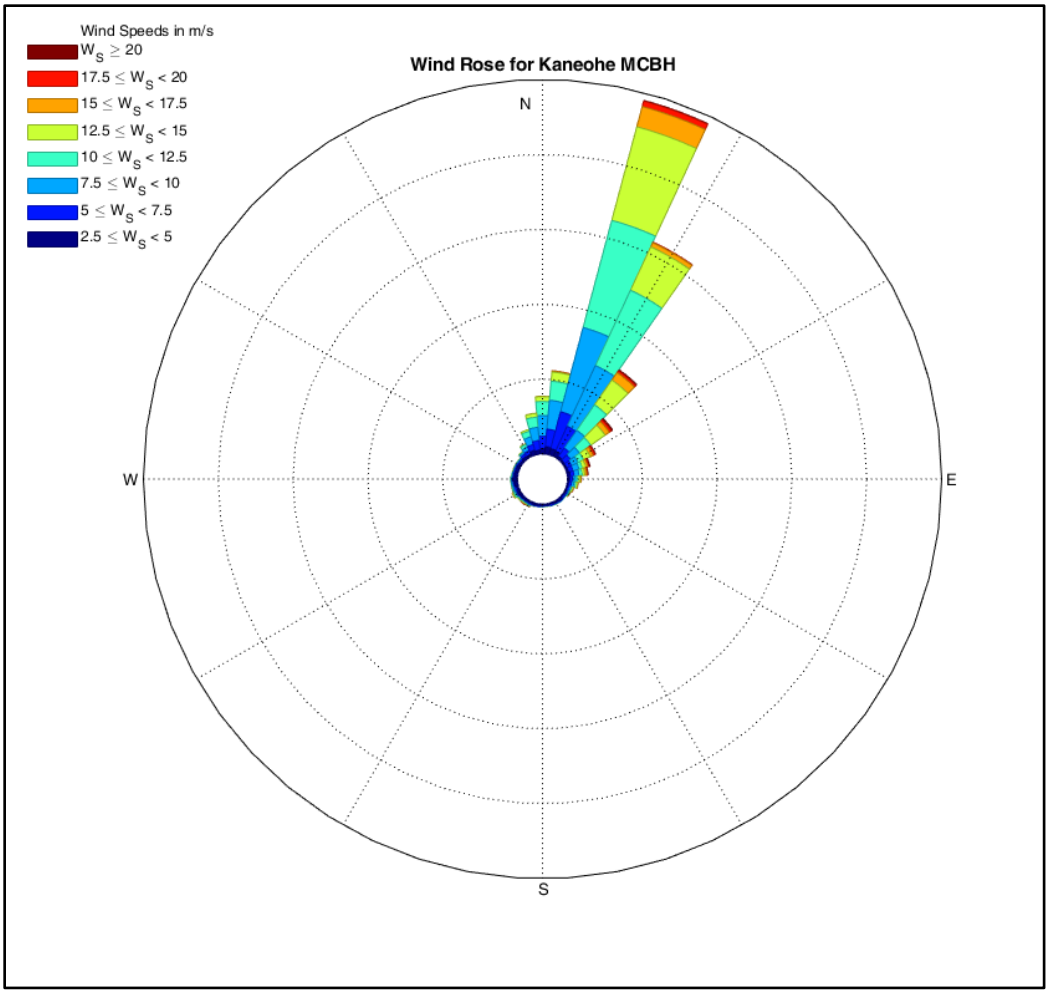


Figure 3-1 Wind Rose Kaneohe MCBH (July 2016-July 2018)

3.2 Water Levels

3.2.1 Tides

Hawaii tides are semi-diurnal with pronounced diurnal inequalities (i.e., two high and low tides each 24-hour period with different elevations). A modulation of the tidal range results from the relative position of the moon and the sun: when the moon is new or full, the moon and the sun act together to produce larger "spring" tides; when the moon is in its first or last quarter, smaller "neap" tides occur (Rapaport, 2013). The cycle of spring to neap tides and back is half the 27-day period of the moon's revolution around the earth and is known as the fortnightly cycle. The combination of diurnal, semi-diurnal and fortnightly cycles dominates variations in sea level throughout the islands.

The geometry of the oceans - the basin shape, local coastline, bays, and even harbor geometry - has a major effect on the local behavior of the tides. On scales of oceanic basins, tides exist as very long waves propagating in patterns determined by their period and the geometry of the basin. Lines along which high tide occurs at the same time (called phase lines) converge to several points where the tidal range is zero. There are four of these points, called "amphidromes" in the Pacific: one in

the North Pacific near the dateline, one near the equator in the eastern North Pacific, one in the central South Pacific near Tahiti, and one east of New Zealand. Phase lines rotate counter-clockwise around the amphidromes in the North Pacific and clockwise around the ones in the South Pacific. For example, at the Hawaiian Islands, the offshore diurnal tide reaches Hawaii island first, then sweeps across Maui, Oahu, and finally Kauai. Tidal currents result from tidal variations of sea level, and near the shore are often stronger than the large-scale circulation (Rapaport, 2013).

Tidal predictions and historical extreme water levels are given by the Center for Operational Oceanographic Products and Services, NOS, NOAA, website. A tide station is located at Mokuoloe (Coconut Island) in Kaneohe Bay, and the water level data based on the 1983-2001 tidal epoch is shown in Table 3-1.

Table 3-1 Water level data for Mokuoloe, Station 1612480 (NOAA)

Datum	Elevation (feet, MLLW)	Elevation (feet, MSL)
Mean Higher High Water	+2.1	+1.1
Mean High Water	+1.8	+0.8
Mean Sea Level	+1.1	0.0
Mean Low Water	+0.3	-0.7
Mean Lower Low Water	0.0	-1.1

Hawaii is also subject to periodic extreme tide levels due to large oceanic eddies and other oceanographic phenomena that have recently been recognized and that sometimes propagate through the islands. *Mesoscale eddies* produce tide levels that can be up to 0.5 to 1.0 ft higher than normal for periods up to several weeks (Firing and Merrifield, 2004). Temporary sea-level rise has also been associated with phenomena related to the El-Nino/Southern Oscillation (ENSO).

3.2.2 Sea Level Rise

The present rate of global mean sea-level change (SLC) is +3.4 ± 0.4 mm/year (Sweet, 2017), where a positive number represents a rising sea level. SLC appears to be accelerating compared to the mean of the 20th Century. Factors contributing to the measured rise in sea level include decreasing global ice volume and warming of the ocean. Sea level, however, is highly variable. The historical sea level trend for Mokuoloe, Station 1612480, is shown in Figure 3-2 (NOAA, 2017). The mean historical rate of sea level change (RSLC) is +1.43 ± 0.54 mm/yr based on monthly data for the period 1957 to 2017. The tide gauge data also show interannual anomalies exceeding 0.5 feet (15 cm) in Mokuoloe that are likely mesoscale eddies.

The National Oceanic and Atmospheric Administration (NOAA) recently revised their sea level change projections through 2100 taking into account up-to-date scientific research and measurements. NOAA is projecting that global sea level rise as shown by their “Extreme” scenario could be as high as about 8 feet by 2100. NOAA’s recent report also identifies specific regions that are susceptible to a higher than average rise in sea level. Hawaii has thus far experienced a rate of sea level rise that is less than the global average; however, this is expected to change. Hawaii is in the “far field” of the effects of melting land ice. This means that those effects have been significantly less in Hawaii compared to areas closer to the ice melt. Over the next few decades,

this effect is predicted to spread to Hawaii, which will then experience sea level rise greater than the global average.

Figure 3-3 presents mean sea level rise scenarios for Hawaii based on the revised NOAA projections, taking into account the far-field effects. While the projections are based on the most current scientific models and measurements, discretion is necessary for selecting the appropriate scenario. Selecting the appropriate sea level change projection is a function of many parameters, including topography, coastal setting, criticality of infrastructure, the potential for resilience, budget, and function.

An important conclusion of the regional climate assessment is that NOAA's revised *Intermediate* rate is recommended for planning and design purposes in Hawaii. The *Intermediate* rate projects that sea level in Hawaii will rise 2.3 feet by 2070 (Table 3-2). Given the recent upwardly revised projections and the potential for future revisions, consideration may also be given to the *Intermediate-High* rate for planning and design purposes, which projects that sea level in Hawaii will rise 3.4 feet by 2070.

Sea level rise has the potential to impact beaches and shorelines in Hawaii. Impacts may include beach narrowing and beach loss, loss of land due to erosion, and infrastructure damage due to inundation and flooding. The impacts from anomalous sea level events (e.g., king tides, mesoscale eddies, storm surge) are also likely to increase. A 2015 study found that, due to increasing sea level rise, average shoreline recession (erosion) in Hawaii is expected to be nearly twice the historical extrapolation by 2050, and nearly 2.5 times the historical extrapolation by 2100 (Anderson et al., 2015).

The State of Hawaii recently published the *Sea Level Rise Vulnerability and Adaptation Report for Hawaii*, which discusses the anticipated impacts of projected future sea level rise on coastal hazards, and the potential physical, economic, social, environmental, and cultural impacts of sea level rise in Hawaii (Hawaii Climate Change Mitigation and Adaptation Commission, 2017). The University of Hawaii conducted numerical modeling to estimate the potential impacts that a 3.2-foot rise in sea level would have on coastal hazards including passive flooding, annual high wave flooding, and coastal erosion.

A sea level rise of 2.3 feet was chosen for design purposes at the project property. This corresponds to the *Intermediate* rate over a 50-year design life which is suitable for planning and design purposes for a project of this scale. While critical infrastructure such as roads, power plants, and hospitals may require the highest level of protection, it is reasonable to design coastal protection and stabilization structures for a lesser level, in this case a 50-year lifespan. Coastal structures require ongoing monitoring and regular maintenance due to their exposure to the degrading effect of marine processes. The basis of design parameters, and consequent design life are based on typical functional use of similar coastal structures. Designing for conditions, such as significantly higher sea levels, that are predicted for time periods that well exceed the design life of the structure will produce more robust installations but will well exceed their functional performance requirements during their serviceable lifespans. Designing for a lesser sea level rise is still consistent with the Mayor's directive, as the sea level rise that the coastal stabilization structures evaluated in this report are expected to experience during their design lifetime would likely be much less than the 3.2 feet presented in the directive.

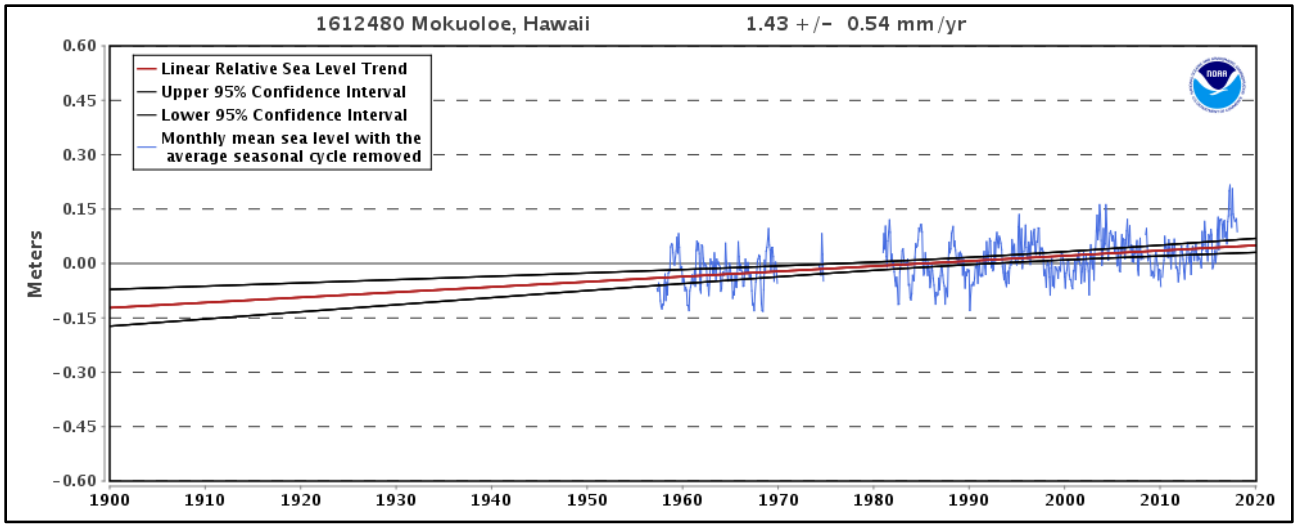


Figure 3-2 Mean sea level trend, Mokuoloe, Station 1612480, 1957 to 2017 (NOAA, 2017)

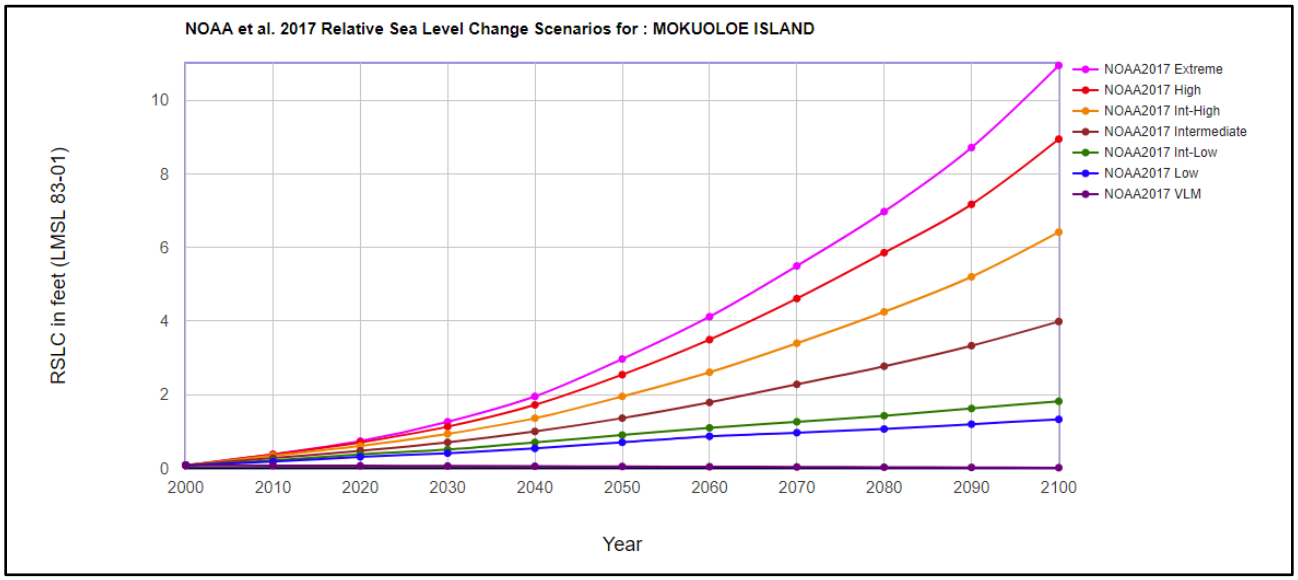


Figure 3-3 Hawaii sea level rise projections (adapted from NOAA, 2017)

Table 3-2 Hawaii Local Mean Sea Level rise scenarios (feet)

Scenario	2020	2030	2040	2050	2060	2070	2080	2090	2100
Extreme	0.7	1.3	2.0	3.0	4.1	5.5	7.0	8.7	10.9
High	0.7	1.1	1.7	2.5	3.5	4.6	5.9	7.2	8.9
Intermediate-High	0.6	0.9	1.4	2.0	2.6	3.4	4.3	5.2	6.4
Intermediate	**0.5**	**0.7**	**1.0**	**1.4**	**1.8**	**2.3**	**2.8**	**3.3**	**4.0**
Intermediate-Low	0.4	0.5	0.7	0.9	1.1	1.3	1.4	1.6	1.8
Low	0.3	0.4	0.5	0.7	0.9	1.0	1.1	1.2	1.3

3.3 Waves

3.3.1 General Wave Climate

The wave climate in Hawaii is dominated by long period swell generated by distant storm systems, by relatively low amplitude, short period waves generated by more local winds, and the occasional bursts of energy associated with intense local storms. Typically, Hawaii receives five general surface gravity wave types: 1) northeast tradewind waves, 2) southeast tradewind waves 3) southern swell, 4) North Pacific swell, and 5) Kona wind waves. The dominant swell regimes for Hawaii are shown in Figure 3-4 .

Tradewind waves occur throughout the year and are the most persistent April through September when they usually dominate the local wave climate. These winds 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 and 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 directly exposed to tradewind waves and these waves represent a significant 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 directly exposed to North Pacific swell approach from the north and northeast directions and these waves represent a significant source of wave energy reaching the project site.

Southern swell is generated by storms in the southern hemisphere and is most prevalent during the summer months of April through September. Traveling distances of up to 5,000 miles, these waves arrive with relatively low deepwater wave heights of 1 to 4 feet and periods of 14 to 20 seconds. Depending on the positions and tracks of the southern hemisphere storms, southern swells approach between the southeasterly and southwesterly directions. The project site is well sheltered from the direct approach southern swell by the island itself, and only a portion of the wave energy refracting and diffracting around the southeast end of the island reaches the shoreline.

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. The project site is well sheltered from the direct approach of Kona storm waves by the island itself, and only a portion of the wave energy refracting and diffracting around the southeast end of the island may reach the site.

Severe tropical storms and hurricanes obviously have the potential to generate extremely large waves, which in turn could potentially result in large waves at the project site. 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 a frequent or even likely event, they should be considered in the project design, particularly with regard to shoreline structures, both in the water and on land near the shore.

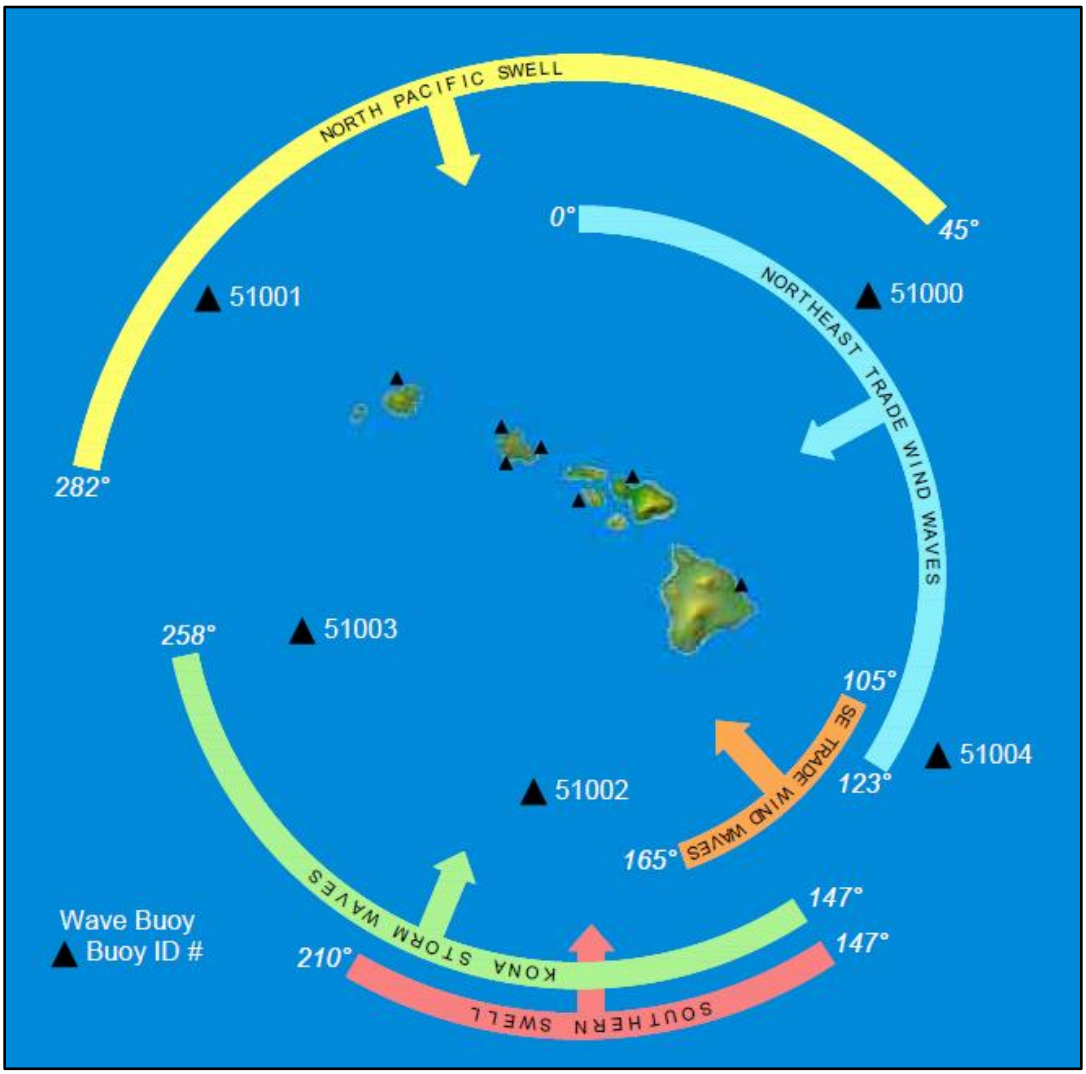


Figure 3-4 Hawaii dominant swell regimes

3.3.2 Prevailing Deepwater Waves

Wave data available from the National Oceanographic and Atmospheric Administration (NOAA) was compiled and analyzed to identify the primary components of the wave climate affecting the project site. These data provide a 31-year wave record and were statistically analyzed to determine the frequency of occurrence of different wave heights, periods, and directions along the coast. Coastal processes in this region are dominated by wave energy, as this coastline is exposed to both

Tradewind waves and North Pacific swell. Understanding the magnitude and frequency of these events at the stream mouths and along the entire region's coastline is a key aspect of evaluating stream flow impacts to the marine ecosystem.

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

WaveWatch III (WWIII) is a numerical wave model used to forecast and hindcast waves. Hindcast data for a 31-year period (1979-2010) are available around the Hawaiian Islands from NOAA/NCEP. For this study, hindcast data were obtained from virtual buoy Station 51202, located approximately 3 miles offshore of the project site (Figure 3-5).

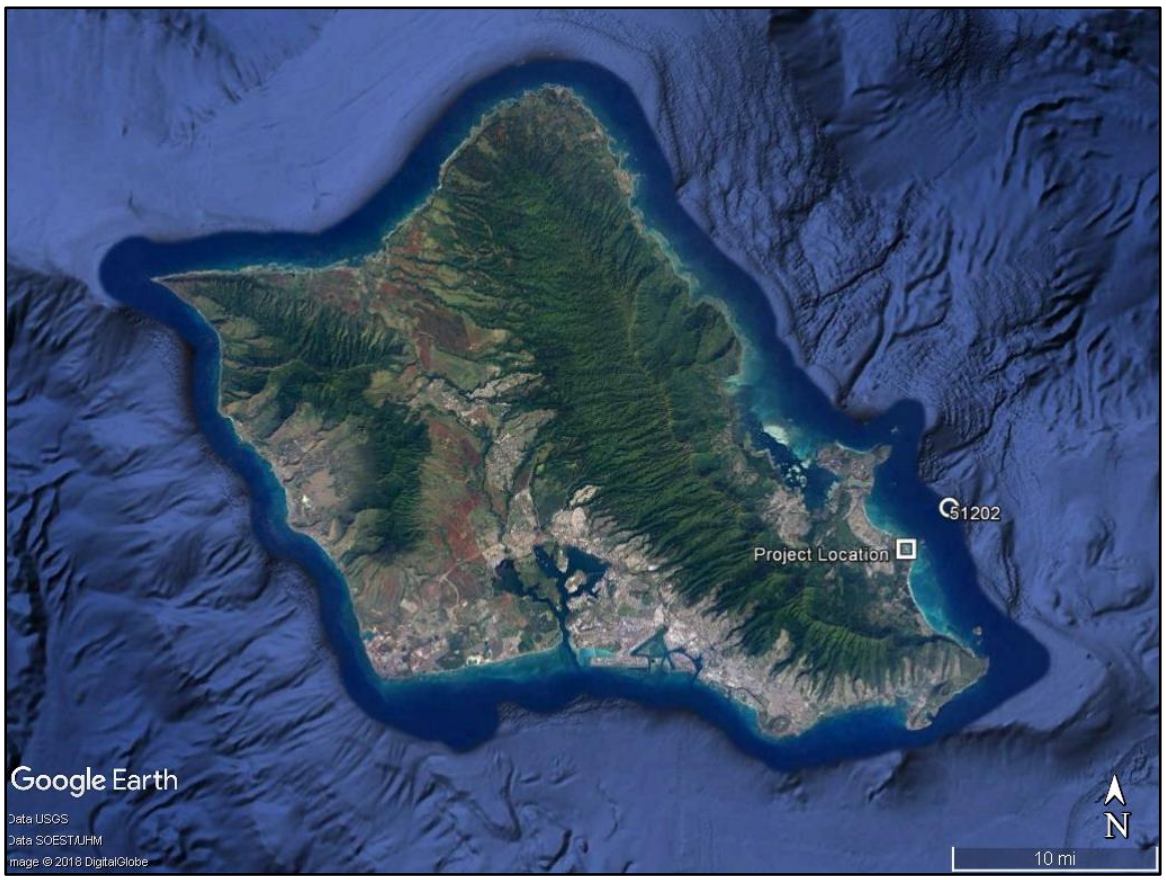


Figure 3-5 Project site and virtual buoy locations

It is rare for the sea state to consist of a singular wave condition. Wave events are described by wave height, peak period, and peak direction. The wave parameters from the hindcast model are calculated from a modeled wave spectrum. The spectrum shows the distribution of wave energy relative to wave frequency (wave frequency is the inverse of wave period) and wave direction. This methodology allows multiple wave conditions to be accounted for at the same time for a more accurate description of the sea state. Figure 3-6 is a wave height rose diagram that shows the

percent occurrence of wave height and direction for waves as measured at Station 51202. Figure 3-7 is a wave period rose diagram that shows the percent occurrence of wave period and direction for waves as measured at Station 51202.

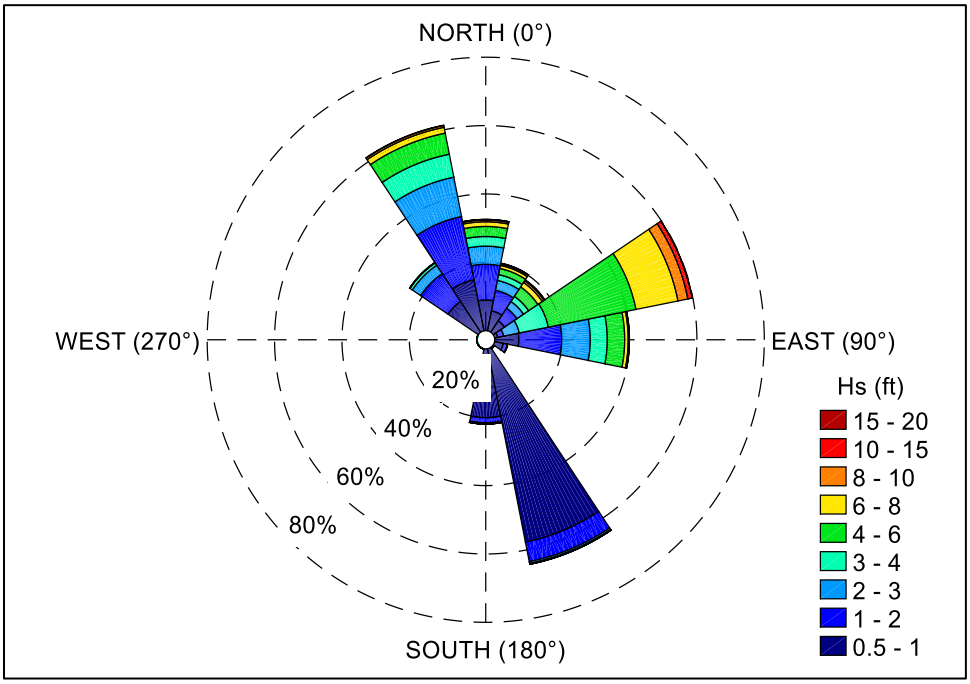


Figure 3-6 Station 51202 virtual buoy wave height rose from Jan 1979 - Jan 2010

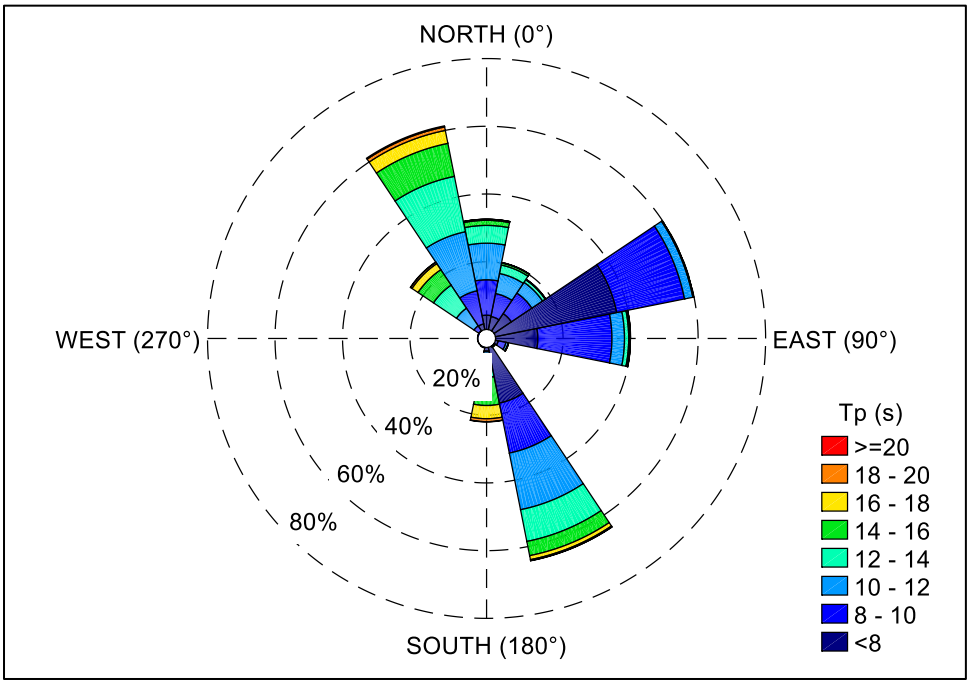


Figure 3-7 Station 51202 virtual buoy wave period rose from Jan 1979 - Jan 2010

3.3.3 Extreme Deepwater Waves

Historical wave buoy data allows the prediction of extreme wave events. These are infrequent, large, powerful, low probability wave events that are typically used for design purposes. For example, a 50-year return period wave event is an extreme event with a 1/50 (i.e., 2%) chance of occurring in any given year. Wave buoy data was compiled from The Coastal Data Information Program (CDIP) buoy station 098 located approximately 3 miles to the northeast of the project site (Figure 3-8). Wave data for this buoy spans over a 17-year period between August 2000 to March 2018. Extreme wave heights were investigated by filtering the buoy data by direction and period for waves within the project site's direct exposure window, between 0˚ and 45˚ (NE swell), with periods of 12 seconds or greater.

The extreme wave height data were used to generate a Weibull extreme value distribution for return period wave heights. The Weibull Distribution is a tool for looking at the relationship between the size of waves and how frequently they occur at a given location. Analysis requires a long-term data set with well-documented wave events. These events are sorted by size, and frequency of occurrence can be assessed by how often these events occur in the record. The relationship is logarithmic, and a linear fit can be established with a best fit linear regression of the data. Though not all wave events will be co-located on the line, its general trend represents the nature of the size and frequency relationship of wave events at a specific location.

Wave height versus return period is shown on Figure 3-9 and Table 3-3. The ten largest wave events from directions south to west (180º to 270º TN) during the period of record are shown on Table 3-4.

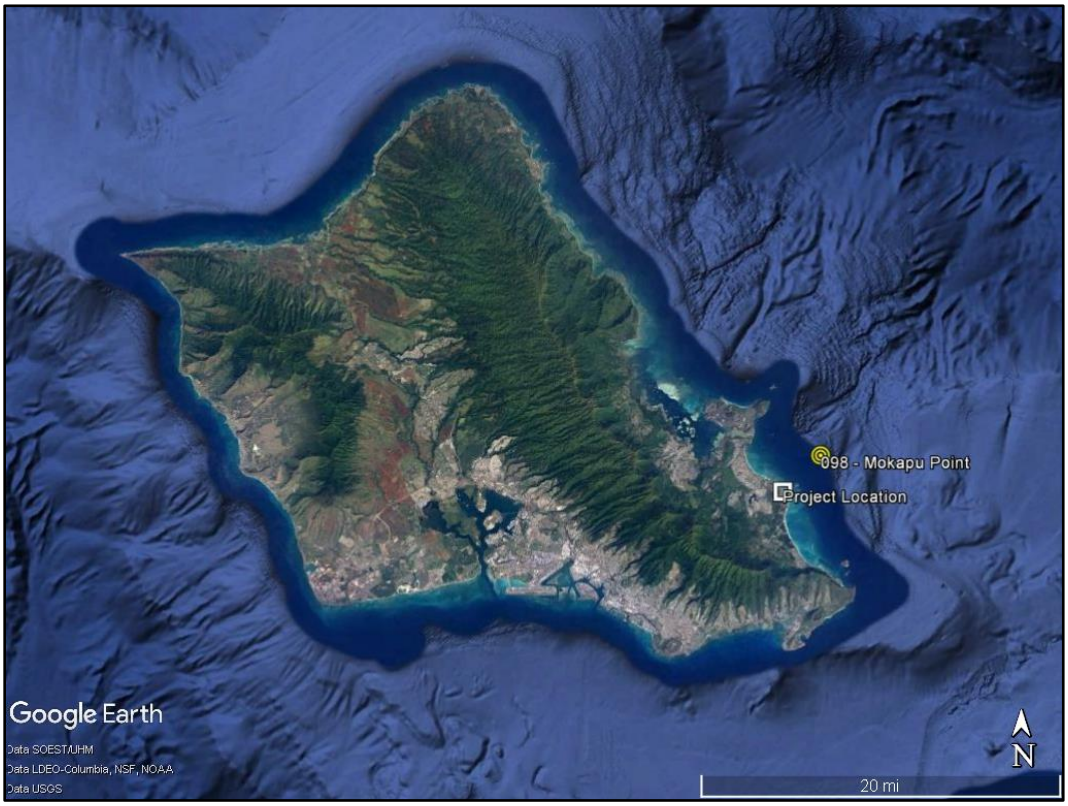


Figure 3-8 Location of CDIP buoy 098 in relation to the project site

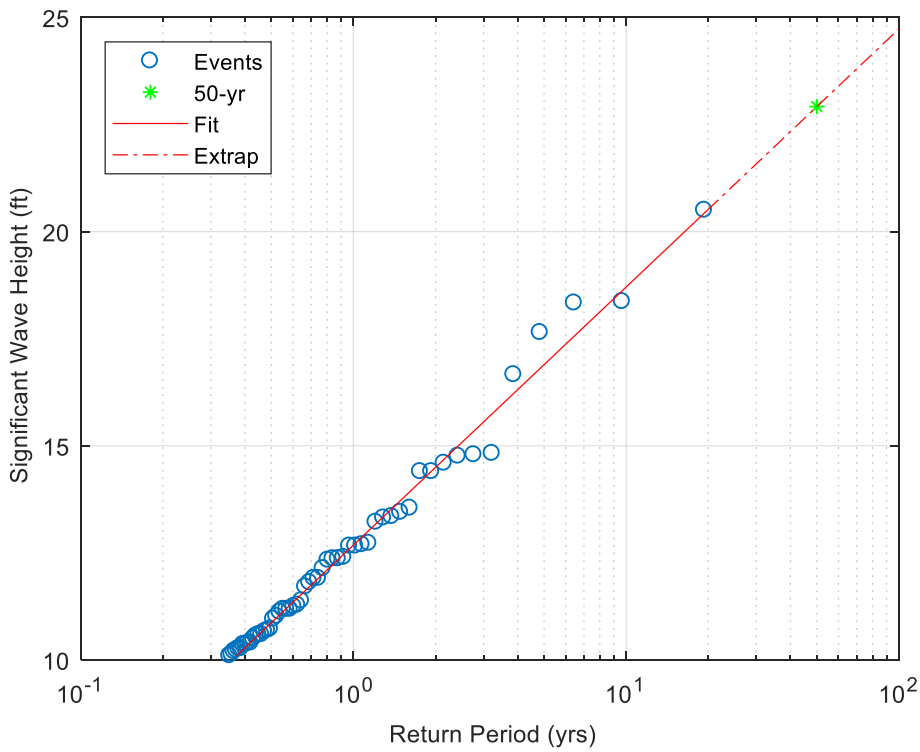


Figure 3-9 CDIP 098 Return period 17-yr (Aug 2000 - Mar 2018)

Table 3-3 Return period significant wave heights at CDIP 098

Return Period (yrs)	Hs (ft)
1	12.7
2	14.5
5	16.9
10	18.7
25	21.1
50	22.9

Table 3-4 Top 10 NE events recorded at CDIP 098

Date	Hs	Tp	Dp
November 21, 2003	20.5	17	37
February 22, 2016	18.4	18	1
March 14, 2009	18.3	14	10
November 12, 2009	17.6	13	28
November 29, 2003	16.7	13	7
December 1, 2002	14.8	17	7
November 23, 2017	14.8	15	5
January 27, 2008	14.8	13	44
March 18, 2016	14.6	15	13
December 4, 2007	14.4	18	2

3.4 Numerical Modeling of Wave Approach

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

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

A nested 4-grid setup in the SWAN wave model was used to propagate the extreme deepwater design waves to the project area. The wave conditions are applied along all boundaries of the largest grid, which has a resolution of 1,640 feet and nests intermediate grids down to a nearshore grid with a resolution of 66 feet. The SWAN nesting grid layout is shown in Figure 3-10. Figure 3-11 shows the nearshore transformation of the 50-year Northeast swell (22.9 ft significant wave height, 12 second period, and 35° direction) to the project site.

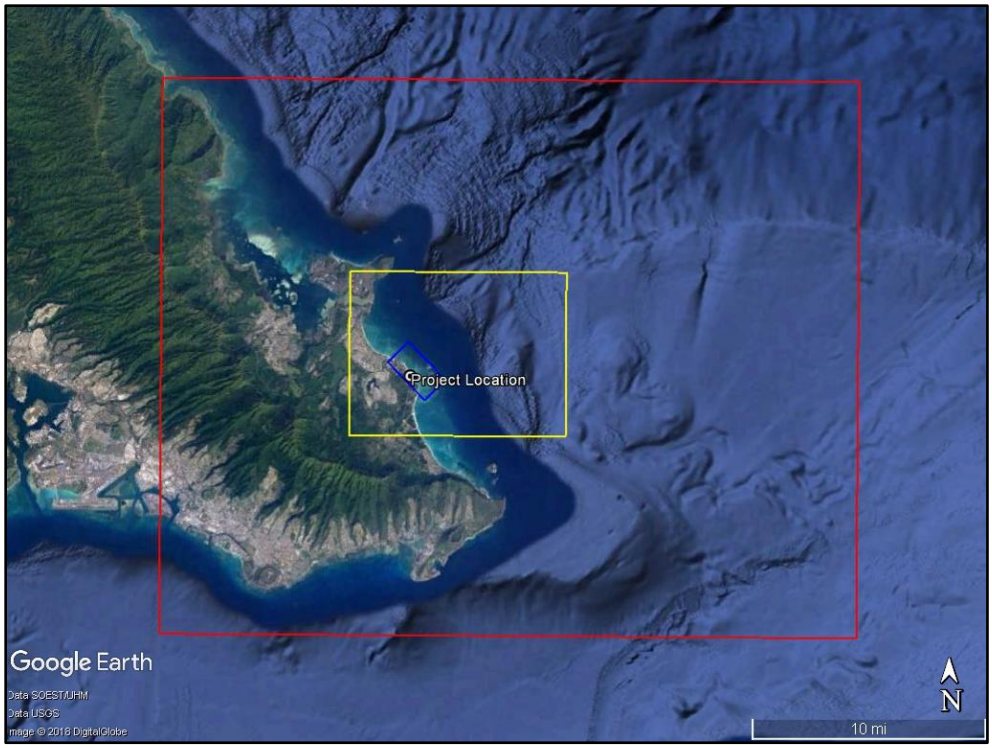


Figure 3-10 Layout of SWAN nested grids

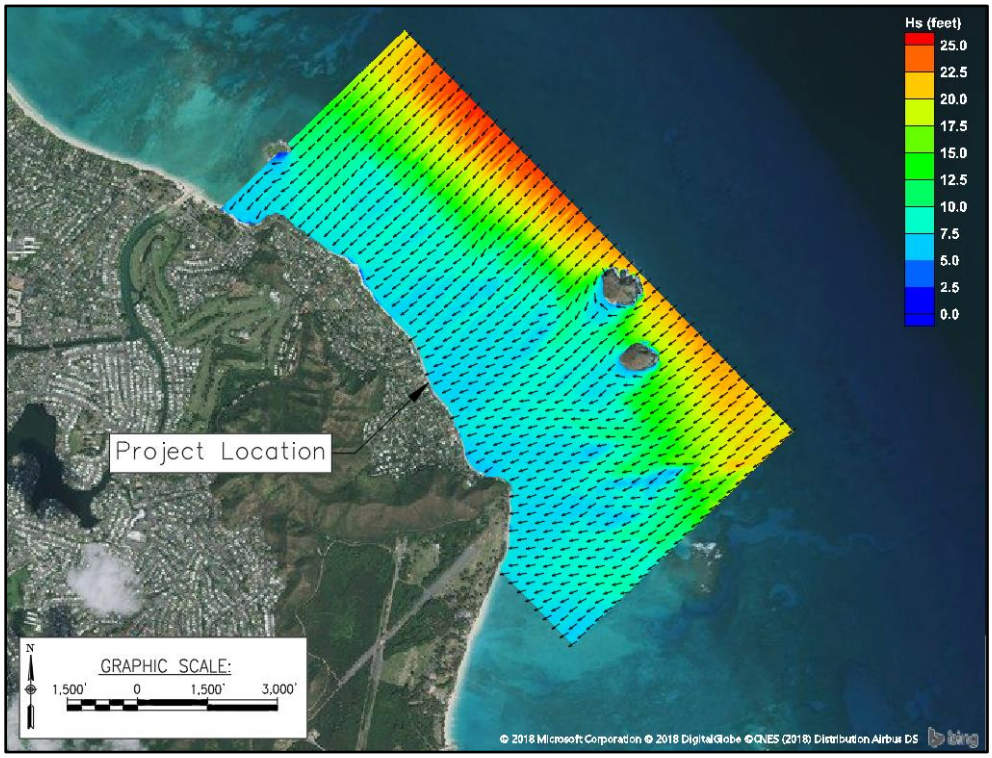


Figure 3-11 Nearshore significant wave height transformation from the design 50-yr Northeast swell event

3.5 Still Water Levels and Nearshore 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 still water level.

During a 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. Estimation of still water level rise for a specific design wave event may be accomplished by a traditional analytical methodology which uses bathymetry and wave heights as inputs. 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 U.S. Army Corps of Engineers Shore Protection Manual (1984) and Coastal Engineering Manual (2006). Experience has shown that these methods tend to overpredict 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.

4. COASTAL HAZARDS

4.1 Hurricanes

Tropical cyclones originate over warm ocean waters, and they are considered hurricane strength when they generate sustained wind speeds over 64 knots (74 mph). Hurricanes that form near the equator, and in the central North Pacific usually move toward the west or northwest. During the primary hurricane season of July through September, hurricanes generally form off the west coast of Mexico and move westward across the Central Pacific. These storms typically pass south of the Hawaiian Islands and sometimes have a northward curvature near the islands. Late season hurricanes follow a somewhat different track, forming south of Hawaii and moving north toward the islands. Three hurricanes have passed through the Hawaiian Islands in the past 25 years: Hurricanes Iwa in 1982 and Iniki in 1992, both passing near or over the island of Kauai as well as Hurricane Iselle in 2014 passing over the island of Hawaii. These storms caused high surf and wave damage on multiple shores of the islands.

The *Windward Oahu Hurricane Vulnerability Study* (Sea Engineering, 1990) indicates that a theoretical model hurricane passing over the island from the south/southwest could result in deep-water waves 44.2 feet high with periods of 14.6 seconds for Oahu's north and east shores.

4.2 Kona Storms

Although somewhat protected by the southeast tip of Oahu, the study site is susceptible to damage from Kona storms, which occur during winter months, generally between October and April. Kona storms typically generate waves with significant heights of 9 to 16 feet and periods of 8 to 11 seconds. Occasional strong Kona storms have caused extensive damage to the south- and west-facing shorelines on Oahu. Deepwater wave heights during a severe Kona storm in January 1980 were about 17 feet with a period of 9 seconds.

4.3 Tsunami

Tsunami are waves that result from large-scale displacements of the seafloor. They are most commonly caused by large magnitude earthquakes (typically magnitude 7.0 or greater). 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 typically have small wave heights in deep water but can have wavelengths of hundreds of miles and travel at speeds up to 500 miles per hour. A tsunami can travel from one side of the Pacific to the other in less than a day. The speed decreases rapidly as the water shoals. The waves increase greatly in height as they shoal and can push further inland. The water then recedes, also at considerable speed, and the recession often causes as much damage as the original wavefront itself.

Most tsunamis in Hawaii originate from the tectonically active areas located around the Pacific Rim (e.g., Alaska, Japan, and Chile). Waves created by earthquakes in these areas take hours to reach Hawaii, and the network of sensors that is part of the Pacific Tsunami Warning System can provide Hawaii with several hours advance warning prior to the arrival of tsunami waves generated from these locations. Less commonly, tsunamis originate from seismic activity in the Hawaiian Islands, and there is less warning for these locally-generated events.

In 1946, a tsunami was generated in the Aleutian Islands and was one of the most destructive tsunamis to strike Hawaii. The water level rise in Lanikai during the 1946 tsunami was 7 feet. The U.S. Geological Survey (Fletcher et al., 2002) has given the project area a tsunami hazard rating of 3 out of 4 **(**Figure 4-1**).**

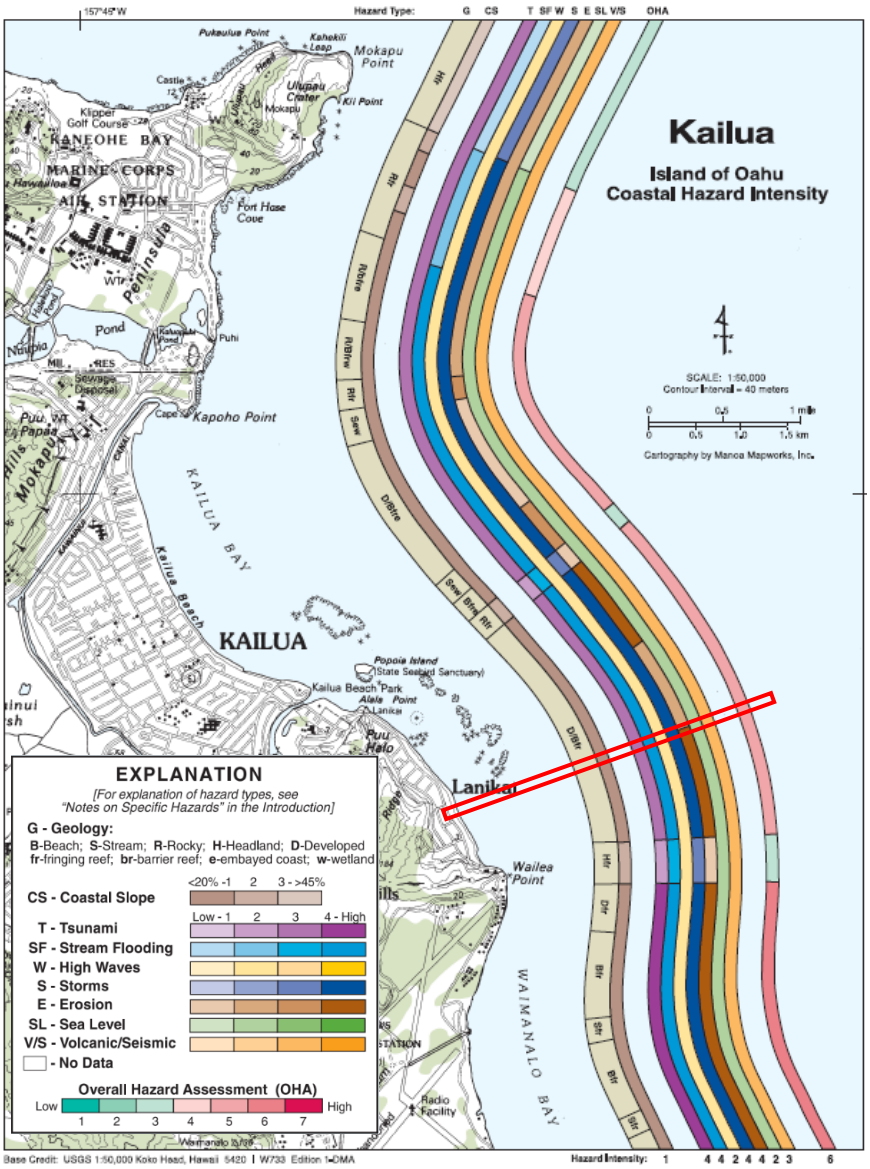


Figure 4-1 Composite hazard map with project area shown in red (USGS, 2002)

4.4 Still Water Rise

Storms and large waves produce storm surge and wave setup that results in elevated water levels at the project area shoreline. During prevailing annual conditions this water level rise can be on the order of a foot above the tide level. However, during extreme events, the still water level rise can be significantly greater.

4.5 Coastal Flooding

The National Flood Insurance Program, administered by the Federal Emergency Management Agency (FEMA), produces maps identifying flood hazards and risks. Figure 4-2 shows the flood hazard map for the project area. The map indicates that the area is rated as Flood Zone AE. Zone AE designates areas subject to inundation by the 1% annual chance flood event. The Base Flood Elevation (BFE) is 6 feet. The map indicates that the area inland of the subject shoreline is Flood Zone X. Zone X designates areas determined to be outside the 0.2% annual chance floodplain.

Figure 4-2 Flood hazard zones with project area shown in red (FEMA)

4.6 Projected Impacts of Sea Level Rise

Sea level rise has the potential to impact beaches and shorelines in Hawaii. Impacts may include beach narrowing and beach loss, loss of land due to erosion, and infrastructure damage due to inundation and flooding. The impacts from anomalous sea level events (e.g., king tides, mesoscale eddies, storm surge) are also likely to increase. A 2015 study found that, due to increasing sea level rise, average shoreline recession (erosion) in Hawaii is expected to be nearly twice the historical extrapolation by 2050, and nearly 2.5 times the historical extrapolation by 2100 (Anderson et al., 2015).

The State of Hawaii recently published the *Sea Level Rise Vulnerability and Adaptation Report for Hawaii*, which discusses the anticipated impacts of projected future sea level rise on coastal hazards, and the potential physical, economic, social, environmental, and cultural impacts of sea level rise in Hawaii. The University of Hawaii conducted numerical modeling to estimate the potential impacts that a 3.2-foot rise in sea level would have on coastal hazards including passive flooding, annual high wave flooding, and coastal erosion. The numerical modeling results are presented in Figure 4-3 through Figure 4-6. The modeling indicates that sea level rise has the potential to significantly increase hazard exposure in the project area.

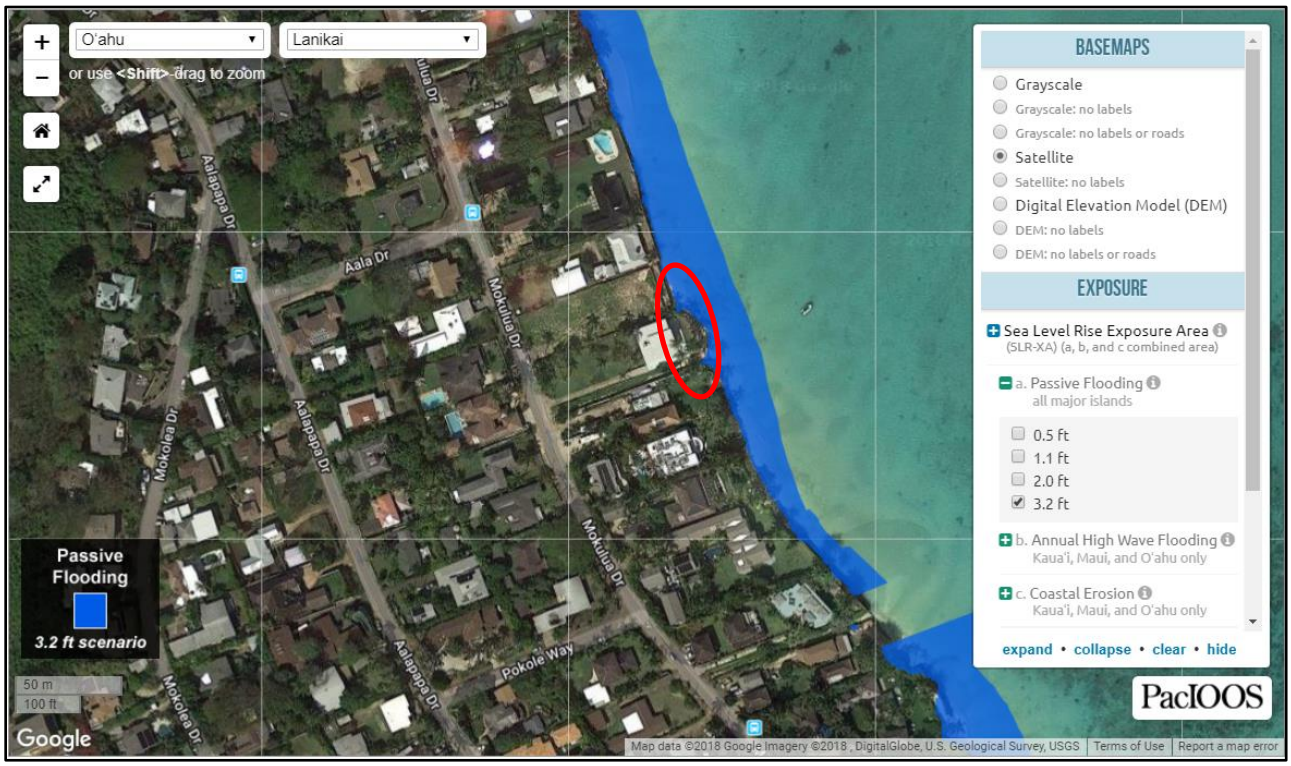


Figure 4-3 Passive flooding with 3.2 feet of sea level rise (PacIOOS)

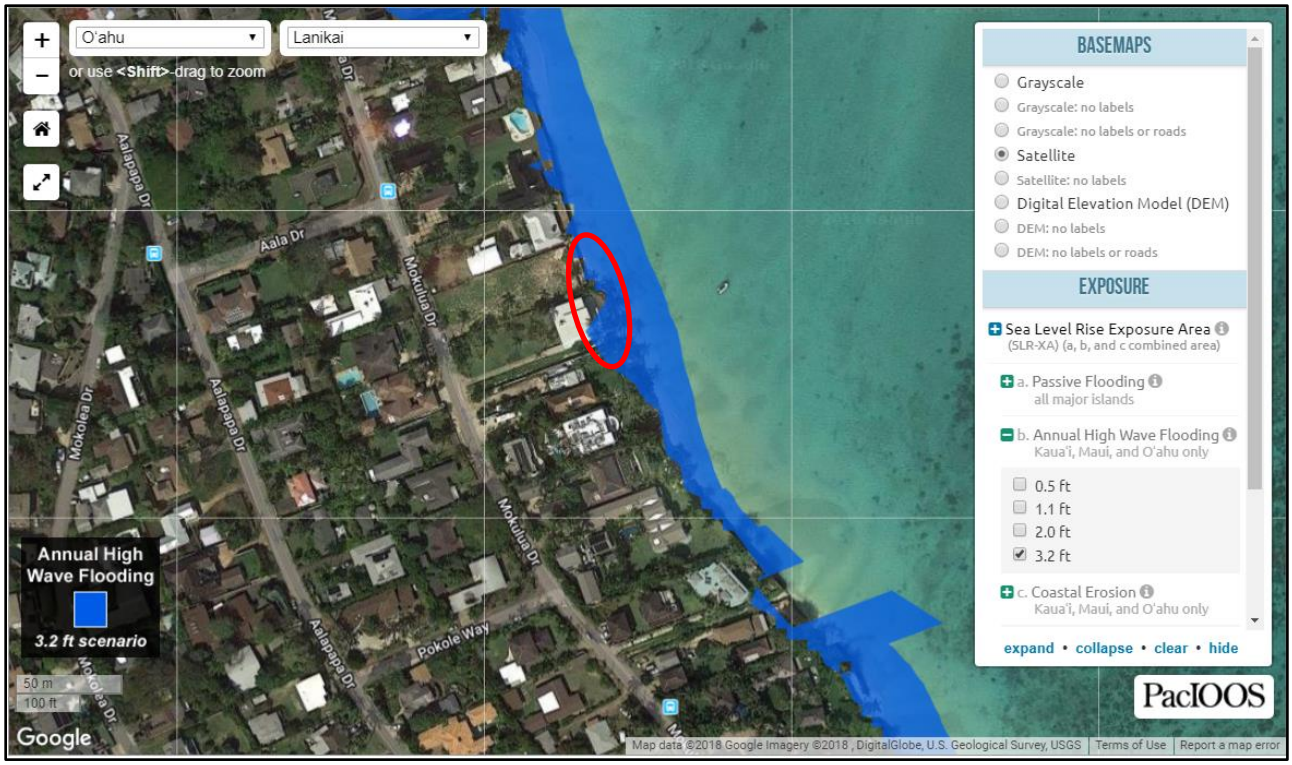


Figure 4-4 Annual high wave flooding with 3.2 feet of sea level rise (PacIOOS)

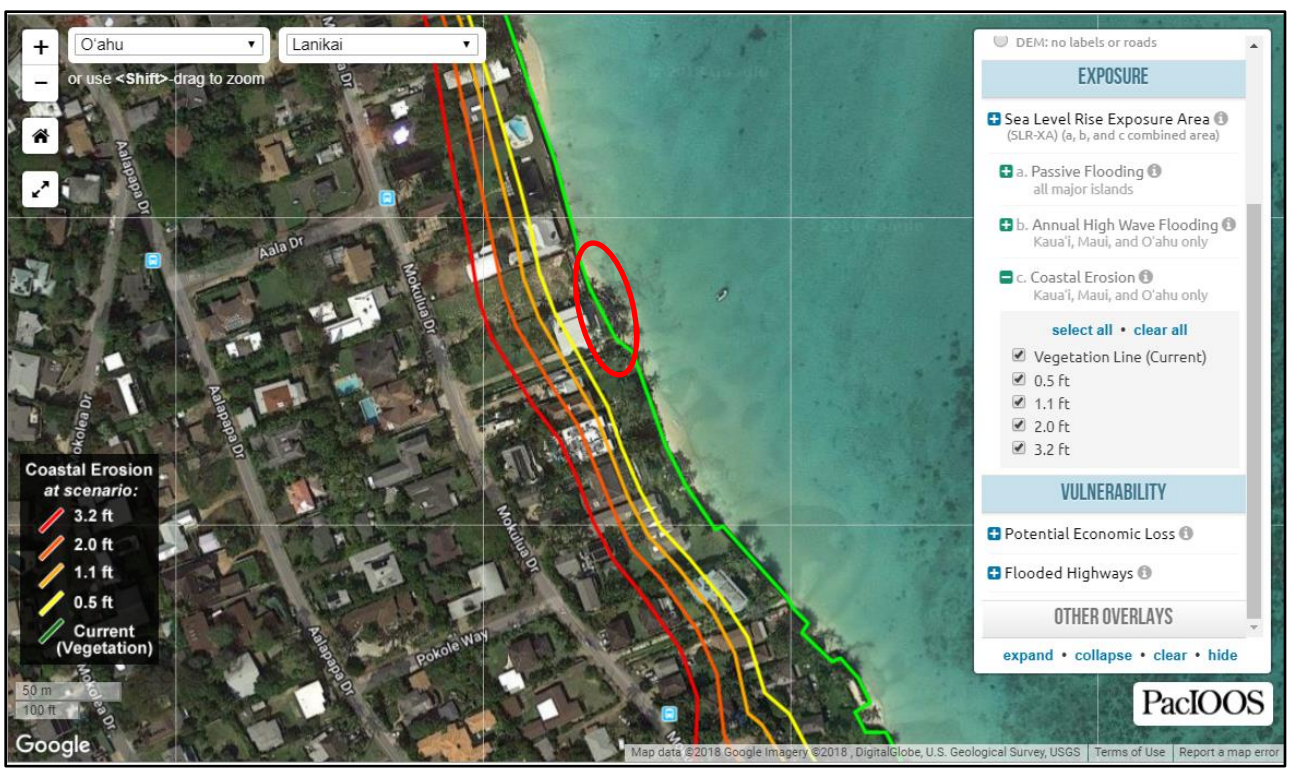


Figure 4-5 Coastal erosion with 0.5 to 3.2 feet of sea level rise (PacIOOS)

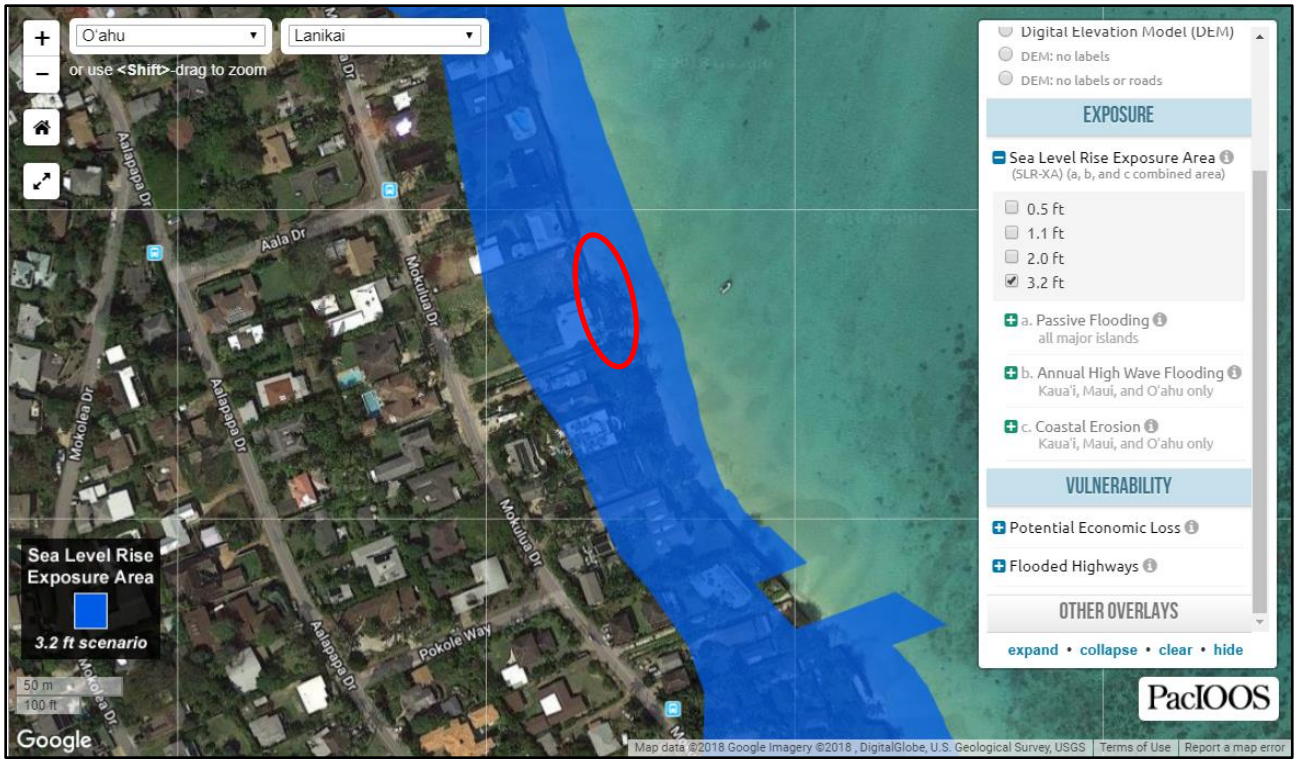


Figure 4-6 Combined hazard exposure with 3.2 feet of sea level rise (PacIOOS)

5. PROJECT ALTERNATIVES

5.1 Introduction

The primary objectives for this project are:

- To provide long-term preservation/protection the habitable dwelling in its current location;
- To stabilize/maintain the shoreline near or mauka of its current location with no portion of the structure located in State submerged lands;
- To not de-stabilize adjacent property structures;
- To have no negative impact on the public lateral access or recreational value fronting the property; and
- To satisfy all of the project objectives, while minimizing potential negative impacts.

Shoreline alternatives include the following options:

1. No Action Maintain
2. Sandbag Removal
3. Beach Nourishment
4. Revetment
5. Hybrid Seawall-Revetment
6. Seawall
7. Seawall with scour apron

Alternatives were evaluated based on the following criteria:

- Effectiveness (i.e., likelihood of satisfying the project objectives)
- Design Considerations (i.e., suitability, design life, durability)
- Costs (i.e., initial costs, recurring costs, entitlement costs)
- Feasibility (i.e., regulatory support, community support)
- Potential Impacts (i.e., shoreline, coastal process, marine habitat, shoreline access, and neighboring property and shoreline structures)

5.2 No Action / Maintain Sandbags

The *No Action / Maintain Sandbags* alternative involves leaving the permitted sandbag revetment in place with no new construction elements. This option would require periodic maintenance to limit further damage to the sandbag structure, maintain its effectiveness, and reduce erosion risk to the property. Without maintenance, the sandbags would be expected to deteriorate and become displaced, eventually leading to undermining of the lawn, lanai concrete slab, and house. There is no expected potential impact to adjacent property shoreline structures, beach access, and sand dynamics fronting the property if the sand bags are left in place and are maintained. This, however, does not account for future SLR and/or regional changes to sand dynamics.

A sandbag structure is modular by nature and is easily adapted to future changes in sea level. A rise of 2.3 feet in sea level will require additional height to the crest of the structures. Increased wave energy may also require additional toe bags or larger bags or both. Modification of the sandbag structure at this time for future sea level rise is not recommended, as modification can be incorporated into regular maintenance activities.

No Action / Maintain Sandbags Alternative Evaluation:
Project Objectives

- Disadvantage – Does not provide long-term preservation/protection for the habitable dwelling in its current location and requires extensive maintenance.
- Disadvantage - Stabilizes/maintains the shoreline near or mauka of its current location when actively maintained; however, it does have a very large footprint located in State submerged lands.
- Advantage - Not de-stabilize adjacent property structures.
- Advantage - Has no negative impact on the public lateral access or recreational value fronting the property.
- Neutral – Has no change to potential negative impacts.

Evaluation Criteria

- Disadvantage – Due to the constant maintenance required, this option is not considered effective.
- Disadvantage – Though the suitability is good, the design life and durability are very poor.
- Neutral - Low initial costs, and moderate recurring costs through maintenance.
- Advantage – There is already existing regulatory and community support for this structure.
- Neutral – No change is expected to potential impacts, including shoreline, coastal process, marine habitat, shoreline access, and neighboring property and shoreline structures.

No Action / Maintain is not a preferred solution.

5.3 Removal of Sandbags

The sandbag removal alternative involves removing the existing sandbag revetment and allowing the shoreline to naturally migrate to its equilibrium position. The shoreline is expected to migrate mauka of the current shoreline position as the profile adjusts and would likely lead to undermining of the house structure and cause flanking of adjacent property infrastructure.

Removal of the sandbag structure results in near instantaneous erosion, which is further exacerbated by future changes in sea level. A rise of 2.3 feet in sea level, as is assessed in this report, is predicted to result in loss of nearly the entire makai parcel.

Removal of Sandbags Alternative Evaluation:
Project Objectives

- Disadvantage – Provides no preservation/protection for the habitable dwelling in its current location.
- Disadvantage – Does not stabilize/maintain the shoreline near or mauka of its current location
- Disadvantage – Does de-stabilize adjacent property structures.
- Advantage - Have no negative impact on the public lateral access or recreational value fronting the property.
- Disadvantage – Does not minimize potential negative impacts.

Evaluation Criteria

- Disadvantage – This is not an effective solution (i.e., likelihood of satisfying the project objectives).
- N/A – The design life and durability are not applicable for this alternative.
- Disadvantage – The cost to backshore improvements is very high with this alternative.
- Neutral – Both regulatory support and community support are expected to be mixed with this alternative.
- Disadvantage – High potential Impacts are expected for neighboring property and shoreline structures.

Removal of Sandbags is not a preferred solution.

Figure 5-1 shows the approximate location of the shoreline after initial removal of sandbags and after 10, 25, and 50 years. After approximately 10 years the shoreline is estimated to be in dangerous proximity to the house structure leading to undermining. These shoreline positions were determined based on historical erosion rates without accounting for future sea level rise. The influence of sea level rise would most likely cause these shoreline positions to shift further mauka.

Removal of the sandbags does not meet the objective of protecting the backshore and adjacent property infrastructure and would put the house structure in immediate danger of undermining.

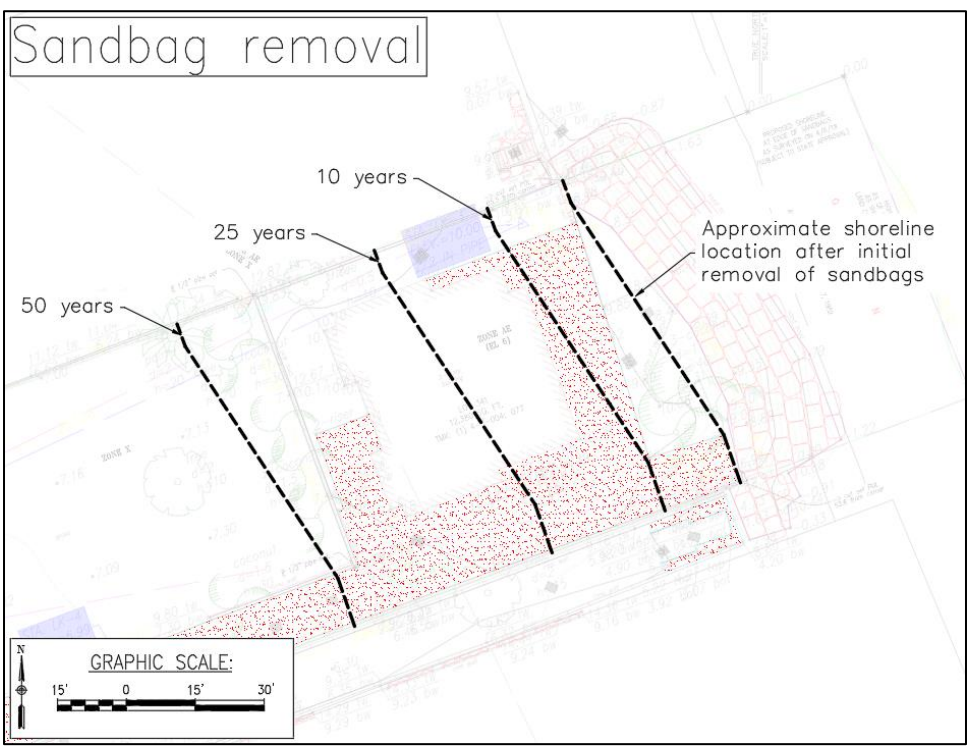


Figure 5-1 Shoreline location after a 50-year design life if sandbags are removed

5.4 Beach Nourishment

The beach nourishment alternative would consist of sand placement fronting the subject property shoreline to increase the sand volume available to the submerged beach. The very narrow sand

beach currently at the property is part of a much larger littoral cell that includes the nearshore sand and adjacent beaches along this stretch of coastline. If sufficient beach-quality sand were available, it is possible that the beach could be nourished, thereby adding a certain level of protection to the subject property. Any sand used for beach nourishment must meet the DLNR requirements to match the characteristics of the native beach sand. Sand placed only at the project site, however, would be unstable and would be expected to end up being spread throughout the entire littoral cell during normal seasonal beach processes. The volume of sand that could be placed along the property's shoreline is a very small percentage of the entire sand system's volume and would result in an extremely thin cover after it is spread through the littoral cell within the first season. There is very little mid or long-term protection available for the property without a large scale, regional beach nourishment effort. This level of effort is beyond the capacity of a single property owner.

Construction of sand stabilization structures such as groins could be integrated into the beach nourishment design to minimize sand movement. Groin design would also require a regional effort, as the down drift effects of these structures can potentially affect nearby shorelines. A regional effort would likely entail construction of a groin field, utilizing multiple groins to better maintain a beach along this section of coastline.

In addition to the necessary scale of a successful beach restoration project, finding an appropriate source of beach sand has become a significant challenge for projects in the Hawaiian Islands. Offshore sand mining has become a viable alternative to terrestrial sand mining; however, high costs, extensive permitting and regulatory constraints, and equipment requirements for the operation make it feasible for larger beach nourishment operations only.

A rise of 2.3 feet in sea level will require a significant increase in placed beach sand to stabilize a sandy shoreline in the current coastal configuration, without structures. It may not be feasible to maintain a sandy shoreline, given the projected increase in wave energy exposure with the likely submergence of the reef crest. If stabilizing structures are utilized on a regional scale, then rock size, crest height, and orientation should take into consideration oceanographic changes likely to occur with a sea-level rise of 2.3 feet.

Beach nourishment for the subject property will not provide mid and long-term mitigation for the backshore or mid and long-term mitigation of return wave energy. Beach nourishment is therefore not a practical engineering solution for an individual property of this size along this coastline.

Beach Nourishment Alternative Evaluation:
<u>Project Objectives</u>

- Disadvantage – Does not provide long-term preservation/protection for the habitable dwelling in its current location.
- Disadvantage – Does not provide long-term stabilization of the shoreline near or mauka of its current location without backstop structures mauka of beach.
- Disadvantage – Ongoing erosion of the beach nourishment material will de-stabilize adjacent property structures.
- Advantage - Have no negative impact on the public lateral access or recreational value fronting the property.

- Neutral - Minimizes potential negative impacts to the beach and recreation while nourishment activities are ongoing; however, it exposes the dwelling and neighboring properties to an increased risk of erosion hazard.

Evaluation Criteria

- Disadvantage – Not an effective solution for satisfying the project objectives.
- Disadvantage – Beach nourishment at the parcel level is not suitable and has a very short design life with very poor durability.
- Disadvantage – Implementing beach nourishment at the parcel level for shoreline stabilization comes at a moderate initial cost but has very high recurring costs.
- Advantage – Beach nourishment usually has very high regulatory support with DLNR and DPP and high community support. There is typically lack of support through Department of Health and National Marine Fisheries Service.
- Neutral – Minimizes potential negative impacts to the beach, coastal processes, marine habitat, shoreline access, and recreation while nourishment activities are ongoing; however, it exposes the dwelling and neighboring properties to an increased risk of erosion hazard.

Beach Nourishment at the parcel scale is not a preferred solution. Sand stabilizing structures are not recommended at a parcel scale.

5.5 Rock Revetment

This approach would involve removing the existing sandbag revetment and constructing a sloping rock rubble mound revetment. A rock revetment is a sloping, un-cemented structure constructed of wave-resistant material. The most common method of revetment construction is to place a layer of armor stone, sized according to the design wave height, over an underlayer of smaller rock that sits atop filter fabric. The underlayer is designed to distribute the weight of the armor layer and to prevent loss of fine shoreline material through voids in the revetment. Revetments in Hawaii are typically built on a slope of 1.5 to 2 horizontal to 1 vertical to ensure stability. Toe scour protection can be provided by excavating to place the toe on a solid substrate, constructing the foundation below the maximum depth of anticipated scour, or extending the toe to provide a scour apron of excess stone. It is important that the armor stone is carefully chosen and placed in a keyed and fitted manner to minimize gaps between stones, which increases the durability of the structure. An example of a rock revetment at Kahului Harbor (Kahului, Maui, Hawaii) is shown in Figure 5-2.

One major advantage of a revetment is that the rough porous rock surface and relatively flat slope of the structure absorbs wave energy, reduces wave reflection, and helps to promote accretion of sand on a sandy beach when sufficient sand volume is available in the littoral environment. Additional advantages of revetments are that construction is relatively simple, construction material is readily available, and localized damage can be easily repaired by placement of additional armor stone. Properly designed and constructed rock revetments are durable, flexible, and highly resistant to wave damage.

One major disadvantage of a traditional rock revetment is that, of the options discussed in this report, it would have the largest footprint within the existing landscape. A revetment footprint would be wide relative to the beach fronting the subject properties. The location of the revetment would affect the overall cost and permitting requirements. A revetment seaward of the shoreline

would represent an encroachment on State submerged land, in which case an easement would likely be required for the structure. Construction of the revetment landward of the shoreline would require extensive excavation and grading of the coastal dune. It is important to note that, even if the revetment were constructed landward of the shoreline, the future certified shoreline would likely be located at or near the crest of the structure, so an easement may eventually be required.

Rock revetment design is dependent on sea level elevation, design wave height, and scour depth. The revetment design presented below incorporates a 2.3-foot higher than present sea level, with consequent increases in predicted wave exposure and scour depth. Utilizing 2.3 feet of sea level rise, which is currently projected for 50 years in the future, provides suitable design criteria within the effective life span of similar structures. Structure maintenance, improvements, or replacement are appropriate at the end of the structure's projected life span or when the environment changes beyond design conditions. Adaptation to sea levels and their resulting impacts predicted at time frames beyond the structure's design life should be incorporated at that time.

Rock Revetment Alternative Evaluation:
<u>Project Objectives</u>

- Disadvantage – Does not provide long-term preservation/protection for the habitable dwelling in its current location. Effectiveness of satisfying the project objectives is only achieved if a substantial portion of the structure is built onto State lands, which is not supported by the DLNR when other options are available. If the structure is built inland of State submerged lands, then the dwelling will have to be partially or wholly demolished and flank protection will be required for the adjacent shoreline structures.
- Disadvantage – There are no design options that stabilize the shoreline near or mauka of its current location and do not extend into State submerged lands. The Department of Land and Natural Resources does not support structures on submerged lands, when other options are available.
- Disadvantage – The shoreline access structures would be de-stabilized without additional flank protection along the side of the sloped revetment. Additional flanking protection may be required for the northern neighbor's property, depending on the location and slope of the revetment.
- Advantage – Will likely result in a footprint that is farther mauka than the existing sandbag structure.
- Disadvantage – The revetment minimizes potential negative impacts to the dwelling, but only if built into State lands, which is not currently supported by the DLNR. Building outside of State submerged lands required demolition of some or all of the existing dwelling.

<u>Evaluation Criteria</u>

- Disadvantage - Effectiveness of satisfying the project objectives is only achieved if a substantial portion of the structure is built onto State lands, which is not supported by the DLNR when other options are available. If the structure is built inland of State submerged lands, then the dwelling will have to be partially or wholly demolished and flank protection will be required for the adjacent shoreline structures.
- Neutral – Suitability based on location and size are low, though design life and durability are excellent.

- Neutral – Shoreline structures typically have high costs for design, permitting, and construction; however, well designed and constructed revetments have low maintenance costs.
- Disadvantage – There is unlikely to be regulatory support from the State for a structure that extends onto State lands, when other options are available. There is likely to be mixed support from the community.
- Disadvantage – The revetment is more likely to allow sand accumulation than vertical structures, but less likely than a natural beach environment. That said, the size constraints on the parcel preclude design and construction of a revetment that protects the dwelling and neighboring properties and does not extend onto State land. The State is not supportive of shoreline structures on submerged lands when other options are available.

Rock Revetment is not a preferred solution.

Figure 5-2 Rock revetment at Kahului Harbor (Kahului, Maui, Hawaii)

5.5.1 Rock Revetment Design

Armor stone size is based on the design wave height, H_s, at the structure during a 50-year NE swell. This wave height H_s was modeled to be 5.1 feet. The required armor stone weight for stability under the design wave height is given by the Hudson Formula (USACE, 1984/2006):

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

where:

W = weight in pounds of an individual armor stone
w_r = unit weight of the stone, 160 lb/feet^3
H_s= wave height, 5.1 feet
K_D = armor stone stability coefficient, 2
S_r = specific gravity of the stone relative to seawater, 2.5
cot θ = cotangent of the groin side slope, 1.5

The armor layer is typically two stone diameters in thickness; however, adjustment can be made for single stone layer design. The stone weight is increased by 30% and the stones are required to be keyed and fitted for maximum stability.

The suggested armor stone weight using the Hudson Formula for single stone armor layer is 2,800 lbs with a corresponding nominal diameter of approximately 2.6 feet. A range of ±25% of the median weight is typically utilized, which yields a stone weight range of 2,100 to 3,500 lbs. Underlayer stone is sized at approximately 1/10 the armor stone weight, resulting in underlayer stone size between about 200 and 350 lbs. The nominal diameter for this stone weight is 1.2 feet. The underlayer sizing is important to provide porosity for energy dissipation, to achieve interlocking between the armor and underlayer, and to ensure that the underlayer material cannot be removed through voids in the armor layer. The underlayer stone should be placed in a layer two stone-widths thick, or 2.4 feet.

Figure 5-3 shows the typical revetment section and stone placement. The crest of the structure would be placed at +10 feet msl to match the existing backshore topography. The toe of the structure would be placed on hard substrate located at approximately 8 feet below MSL. Hard substrate was determined from bore hole logs reported in the geotechnical report prepared by Shinsato Engineering, Inc. (2018). The overall width of the structure from the back of crest to toe would be 32.2 feet.

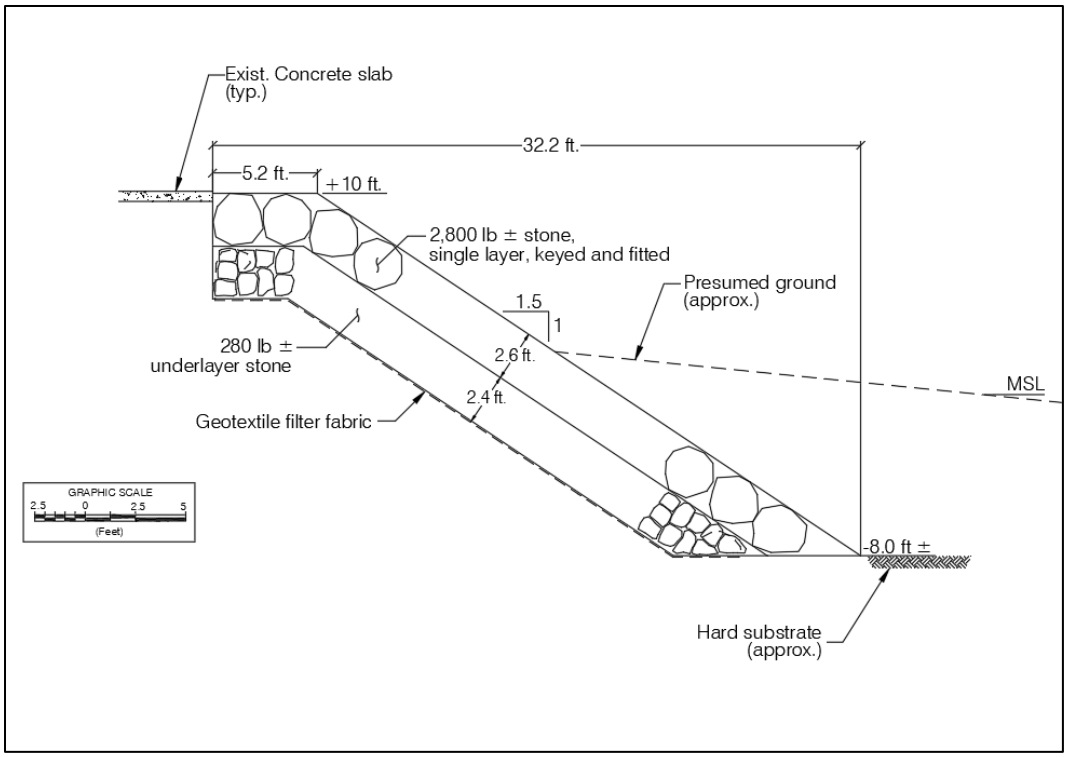


Figure 5-3 Section view of revetment alternative

Figure 5-4 shows the footprint of a *Rock Revetment* structure with the toe of the structure placed mauka of the certified shoreline. The house structure and *Revetment* footprint would overlap by up to 15 feet in this configuration. In order to not impact the house, the revetment would need to be shifted seaward, in which case it would extend seaward of the certified shoreline.

A *Rock Revetment* is too large to be constructed between the certified shoreline and the existing house structure.

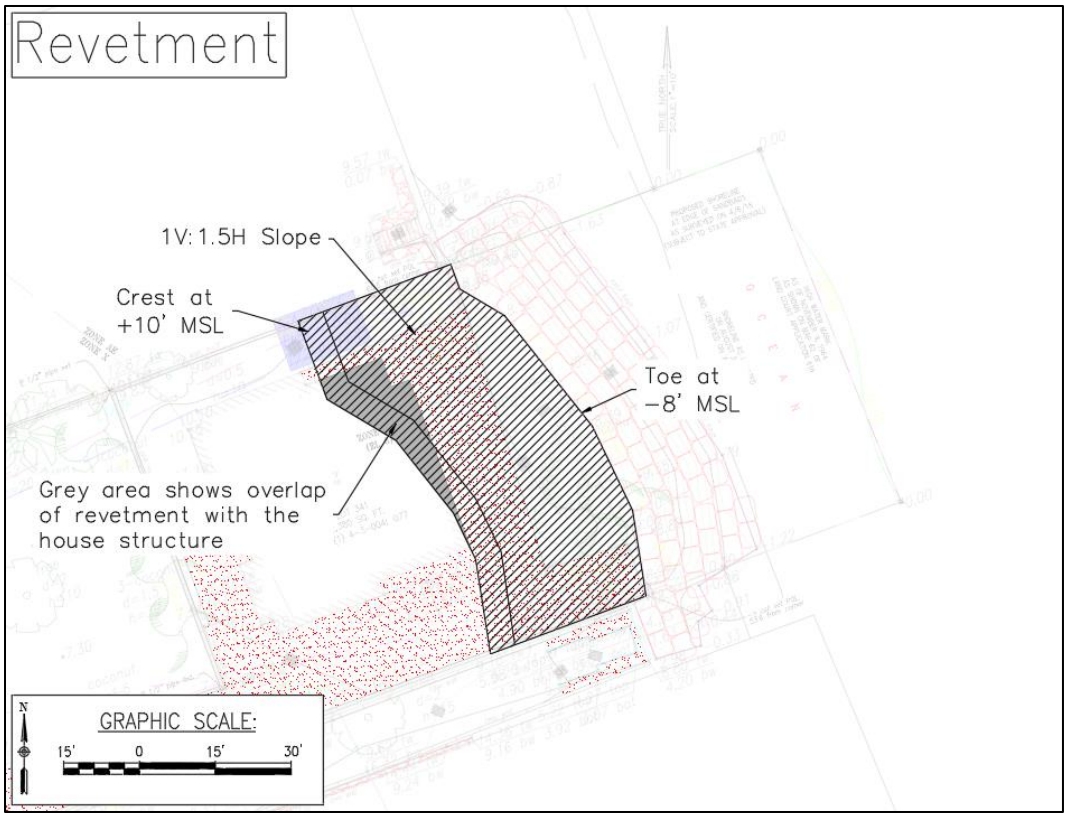


Figure 5-4 Revetment alternative footprint

5.5.2 Revetment Design per Court Settlement

An alternative rock revetment layout is provided which meets the specifications outlined in the original settlement agreement for the Mokulua Drive property. The specified configuration of the revetment includes the following:

- Crest elevation at +7 ft msl, 244 ft makai of Mokulua Drive
- Slope of 2.5 to 1.0 from crest to top of toe
- Top of toe elevation at -3 ft msl, 269 ft makai of Mokulua Drive
- Revetment will have a smooth face, in that the stones will be in the same plane
- Water will still be able to percolate and run through the structure

The footprint for this configuration is shown in Figure 5-5 in relation the property infrastructure. It should be noted that this type of revetment would require a seawall or other slope amendment to retain the soil between the +10 ft msl backshore elevation and the specified +7 ft msl crest elevation of the revetment. This design includes a three stone crest since the structure is expected to be overtopped, and a three stone toe since the toe is above scour depth and hard substrate.

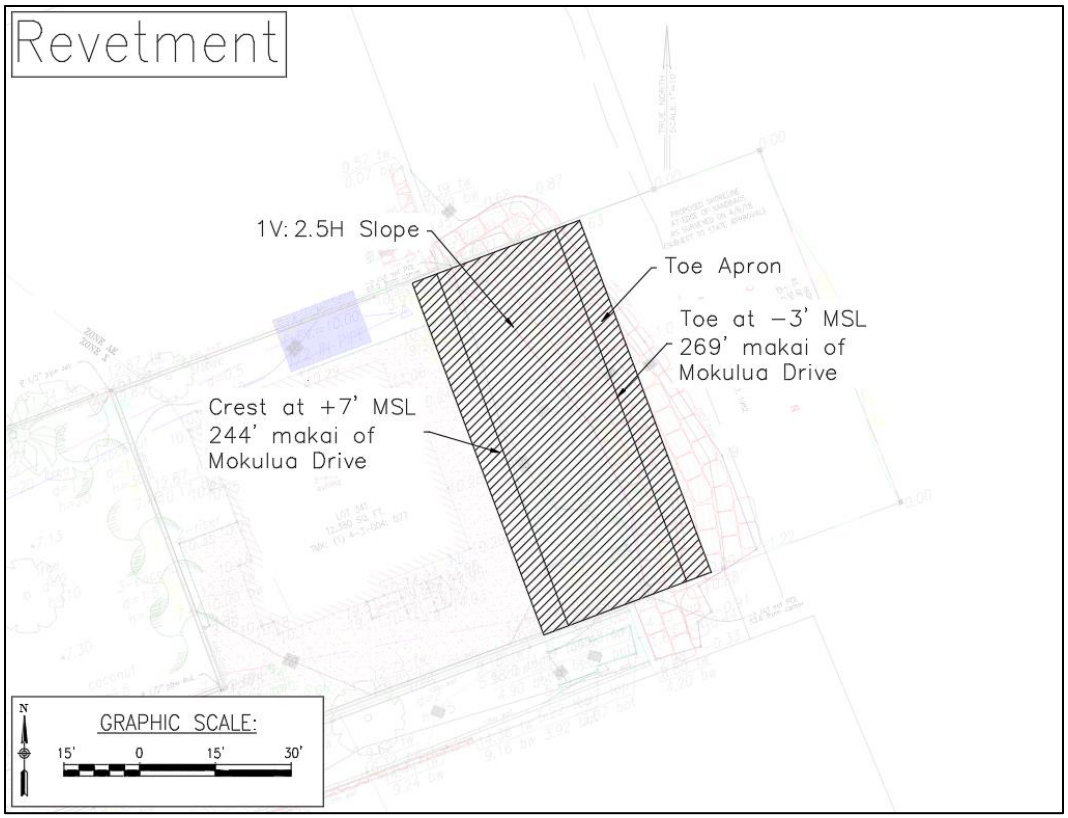


Figure 5-5 Court settlement revetment footprint

5.6 Hybrid Seawall-Revetment

This approach would involve removing the existing sandbag revetment and constructing a hybrid structure composed of two primary elements: a seawall (i.e., vinyl sheet pile, reinforced concrete, or cemented rock masonry), and a uniform armor rock rubble mound revetment. A *Hybrid Seawall-Revetment* would be designed to withstand extreme wave conditions, be minimally reflective, may facilitate beach sand accretion, provide lateral shoreline access, reduce turbidity in nearshore waters, and reduce the amount of material placed in navigable waters of the United States and the Conservation District relative to a traditional rock revetment. A *Hybrid Seawall-Revetment* would have a slightly smaller footprint than a traditional rock revetment.

The hybrid seawall-revetment design is dependent on sea level elevation, design wave height, and scour depth. The design presented below incorporates a 2.3-foot higher than present sea level, with consequent increases in predicted wave exposure and scour depth. Utilizing 2.3 feet of sea level rise, which is currently projected for 50 years in the future, provides suitable design criteria within the effective life span of similar structures. Structure maintenance, improvements, or replacement are appropriate at the end of the structure's projected life span or when the environment changes beyond design conditions. Adaptation to sea levels and their resulting impacts predicted at time frames beyond the structure's design life should be incorporated at that time.

Figure 5-6 Hybrid seawall-revetment (Kapaa, Kauai, Hawaii)

Hybrid Seawall-Revetment Alternative Evaluation:
Project Objectives

- Disadvantage – Does not provide long-term preservation/protection for the habitable dwelling in its current location. Effectiveness of satisfying the project objectives is only achieved if a substantial portion of the structure is built onto State lands, which is not supported by the DLNR when other options are available. If the structure is built inland of State submerged lands, then the dwelling will have to be partially or wholly demolished and flank protection will be required for the adjacent shoreline structures.
- Disadvantage – There are no design options that stabilize the shoreline near or mauka of its current location and do not extend into State submerged lands. The Department of Land and Natural Resources does not support structures on submerged lands, when other options are available.
- Disadvantage – The shoreline access structure to the south and the seawall to the north would be de-stabilized without additional flank protection along the sides of the lower sloped revetment.
- Advantage – Will likely result in a footprint that is farther mauka than the existing sandbag structure.
- Disadvantage – The hybrid structure minimizes potential negative impacts to the dwelling, but only if built into State lands, which is not currently supported by the DLNR. Building outside of State submerged lands required demolition of some or all of the existing dwelling.

Evaluation Criteria

- Disadvantage - Effectiveness of satisfying the project objectives is only achieved if a substantial portion of the structure is built onto State lands, which is not supported by the DLNR when other options are available. If the structure is built inland of State submerged lands, then the dwelling will have to be partially or wholly demolished and flank protection will be required for the both of the adjacent shoreline structures.
- Neutral – Suitability based on location and size are low, though design life and durability are excellent.
- Neutral – Shoreline structures typically have high costs for design, permitting, and construction; however, well designed and constructed hybrid seawall-revetments have low maintenance costs.
- Disadvantage – There is unlikely to be regulatory support from the State for a structure that extends onto State lands, when other options are available. There is likely to be mixed support from the community.
- Disadvantage – The hybrid seawall-revetment is more likely to allow sand accumulation than vertical structures, but less likely than a natural beach environment. That said, the size constraints on the parcel preclude design and construction of a revetment that protects the dwelling and neighboring properties and does not extend onto State land. The State is not supportive of shoreline structures on submerged lands when other options are available.

Hybrid Seawall-Revetment is not a preferred solution.

5.6.1 Hybrid Seawall-Revetment Design

The armor and underlayer stone size and placement would be the same as for the revetment structure. Figure 5-7 shows the typical section and stone placement for the hybrid seawall-revetment structure. The overall width of the structure from back of wall to toe is 27.1 feet.

Figure 5-8 shows the footprint of a *Hybrid Seawall-Revetment* structure with the toe of the structure placed mauka of the certified shoreline. The house structure and *Hybrid Seawall-Revetment* footprint would overlap by up to 8 feet in this configuration. In order to not impact the house, the *Hybrid Seawall-Revetment* would need to be shifted seaward, in which case it would extend seaward of the certified shoreline.

A *Hybrid Seawall-Revetment* is too large to be constructed between the certified shoreline and the existing house structure.

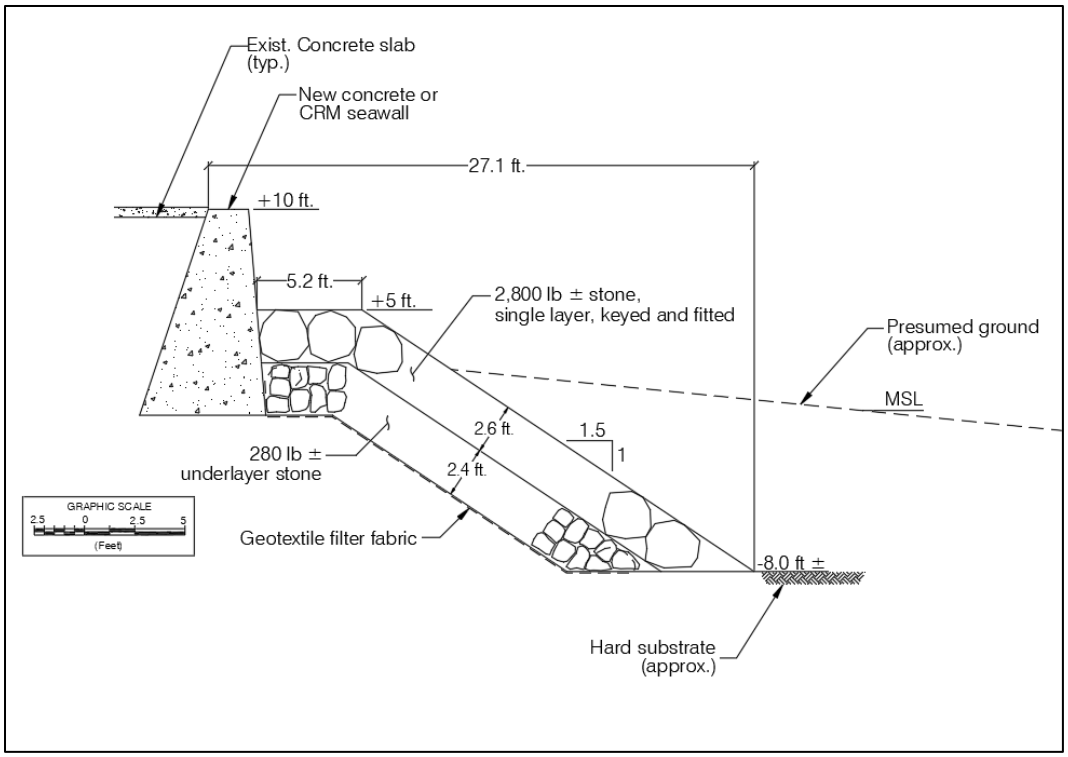


Figure 5-7 Section view of hybrid seawall-revetment option

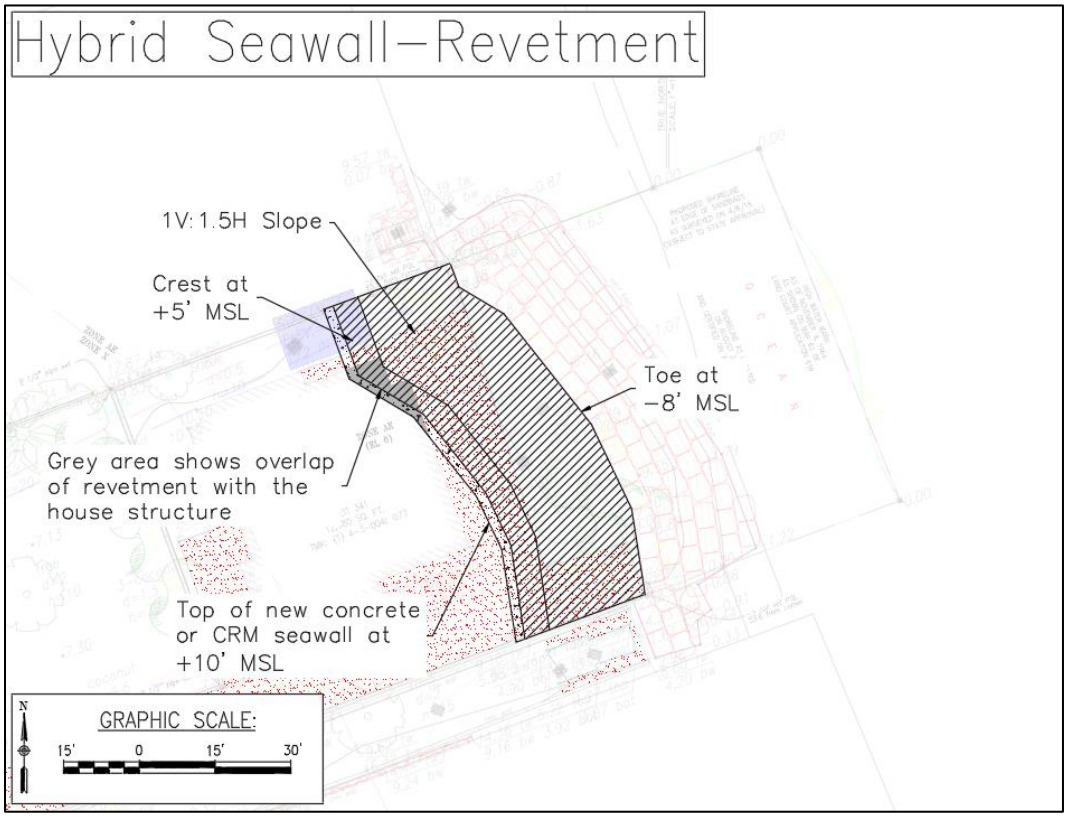


Figure 5-8 Hybrid Seawall-Revetment option footprint

5.7 Seawall

This approach would involve removing the existing sandbag revetment and constructing a seawall. A seawall is a vertical or sloping concrete, concrete rubble masonry (CRM), cement masonry unit (CMU), or sheet pile wall used to protect the land from wave damage and erosion. A seawall, if properly designed and constructed, is a proven, durable, and relatively low-maintenance shore protection method. Seawalls also have the advantage of having a relatively small footprint along the shoreline, which helps to preserve lateral shoreline access.

Seawalls are not flexible structures and their structural stability is dependent on the design and strength of their foundations. If the foundation of a seawall is breached, hydraulic action can erode fill material behind the wall. With the loss of enough fill, the ground surface behind the seawall will collapse and sinkholes will form. Sinkholes can compromise the structural integrity of a seawall and may result in failure of the structure. To avoid foundation problems, the seawall foundation should be well below the potential scour depth, which can require extensive excavation. Figure 5-9 shows an example of CRM and concrete seawalls.

Figure 5-9 CRM and concrete seawalls (Lanikai, Oahu, Hawaii)

The impervious and vertical face of a seawall results in very little wave energy dissipation. Incident wave energy is deflected upward, downward, and seaward. Reflected wave energy can inhibit accretion of sand seaward of the wall. The downward energy component can cause scour at the base of the wall. Therefore, the foundation of a seawall is critical for its stability, particularly on sandy and eroding shorelines. Ideally, seawalls are constructed on solid, non-erodible substrate. There may also be end effects (e.g., end scour and flanking erosion) associated with the terminations of the seawalls along the coastline.

Regulatory agencies tasked with beach and shoreline management are generally reluctant to permit the construction of seawalls due to concerns about potential impacts to beach resources, particularly in areas with beaches and coastal dunes. One of the primary concerns expressed by the agencies is the potential for seawalls to impound dune sand that may otherwise be released onto the beach, providing a form of "natural beach nourishment." There is also a history of public opposition to seawalls due to the perceived effect on sand accretion.

Wave reflection from a seawall creates an energy imbalance and moves sand seaward, limiting the ability of sand accretion along the seawall. Lipp (1995) performed a study on the effect of seawalls on beach profiles, noting that a nearshore beach profile is developed by both incident waves and reflective waves. He performed profile measurements along shorelines characterized as "Beaches", "Dissipative Seawalls", and "Reflective Seawalls". All shorelines are to some extent reflective, with beaches being the least reflective and vertical seawalls being the most reflective. He found that the beach profile slope was a function of the balance between incident wave energy and reflected wave energy. The measured profiles were the flattest and most depressed fronting reflective seawalls, indicating that the reflective energy from a seawall can impede sand from accreting along a seawall.

Seawall design is dependent on sea level elevation, design wave height, and scour depth. The design presented below incorporates a 2.3-foot higher than present sea level, with consequent increases in predicted wave exposure and scour depth. Utilizing 2.3 feet of sea level rise, which is currently projected for 50 years in the future, provides suitable design criteria within the effective life span of similar structures. Structure maintenance, improvements, or replacement are appropriate at the end of the structure's projected life span or when the environment changes beyond design conditions. Adaptation to sea levels and their resulting impacts predicted at time frames beyond the structure's design life should be incorporated at that time.

Seawall Alternative Evaluation:
<u>Project Objectives</u>

- Advantage – Does provide long-term preservation/protection for the habitable dwelling and neighboring shoreline structures in their current locations. Does stabilize the shoreline at or mauka of the existing shoreline location. Does not have a negative impact on lateral shoreline access, but will likely have a negative impact on recreational value due to reflected waves.
- Advantage – The structure will stabilize the shoreline, mauka of State submerged lands.
- Advantage – The shoreline access structure to the south and the seawall to the north would not be de-stabilized if the seawall curves to tie into both structures.
- Disadvantage – Will likely result in higher reflected wave energy off the face of the structure, which is likely to negatively impact lateral shoreline access and recreational value.
- Neutral – The vertical seawall minimizes impacts to dwelling and neighboring shoreline structures; however, it also increases the impacts associated with return wave energy and beach deflation.

Evaluation Criteria

- Neutral - Effectiveness of protection of mauka dwelling and structures is high, but increased return wave energy is likely to have negative impacts on access and recreation seaward of the structures.
- Neutral – The structure has a long design life and high durability on the shoreline; however, the highly reflective nature of the vertical structure can make it less desirable than an open, sloped structure.
- Neutral – Shoreline structures typically have high costs for design, permitting, and construction; however, well designed and constructed hybrid seawall-revetments have low maintenance costs.
- Neutral – There is likely to be mixed support from the permitting agencies. There is likely to be less support for this structure from the community.
- Disadvantage – The seawall is less likely to allow sand accumulation than other sloped structures and the beach environment. That said, a vertical seawall will protect the dwelling and neighboring properties and does not extend onto State land. Higher reflected wave energy associated with vertical seawalls is more likely to negatively impact marine habitat, shoreline processes, shoreline access, and recreation than other sloped alternatives.

Seawall is not a preferred solution.

A *seawall* would provide effective long-term protection for the backshore land and infrastructure. This solution would, however, require a major construction effort in coordination with neighboring property owners, and the costs for design, permitting, and construction would be high. The planform of the new seawall may be either curved (Figure 5-10) or aligned straight with the neighboring seawall to the north (Figure 5-11). The curved seawall has the advantage of connecting directly with both the northern neighbor's and southern access's structures. This not only protects the neighboring structures, but also creates a smooth transition to the alignment of structures to the south of the subject property. A straight seawall would cause a distinct discontinuity along the shoreline where it intersects the adjacent public access to the south. During the winter season when north swell dominates, this area is expected to fill with sand, as evidenced by sand accretion on the north side of the existing sandbag structure. During the summer, however, when tradewind waves dominate and transport sand alongshore from the south, there would be no structure to interrupt the flow of sand and no accretion is expected fronting the southern neighbor's property. This may result in additional deflation of the wet beach and flanking at the adjacent neighboring structure and public access. A straight seawall may also reflect more wave energy than a curved seawall, also impeding accretion along the shoreline.

Figure 5-12 shows a generalized section view of the Seawall alternative. If this alternative is selected, the team's structural engineer would determine the final design of the seawall.

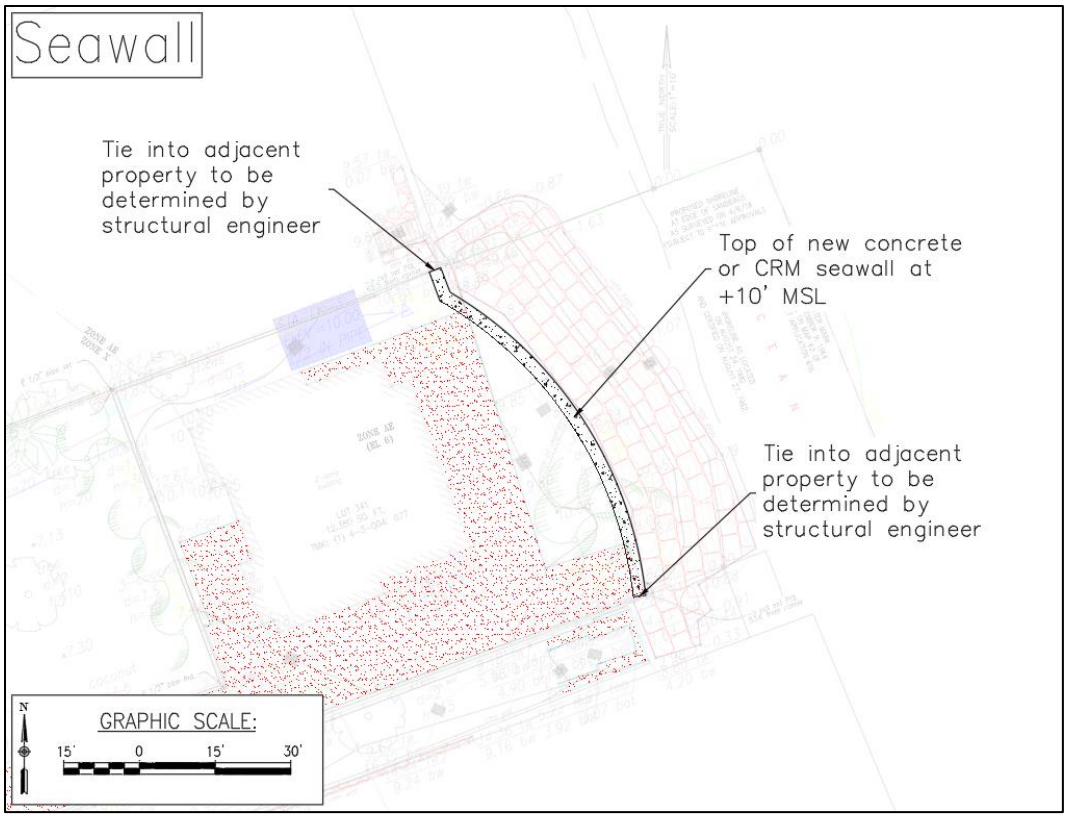


Figure 5-10 Curved seawall option footprint

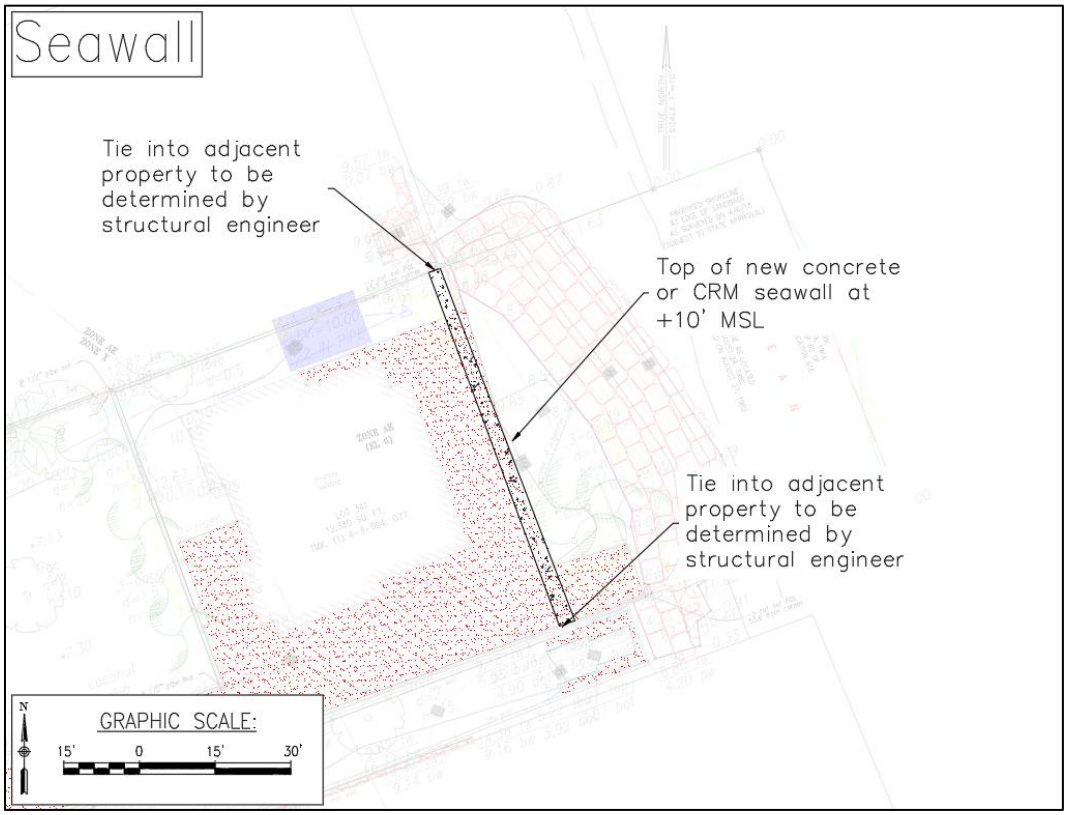


Figure 5-11 Straight aligned seawall option footprint

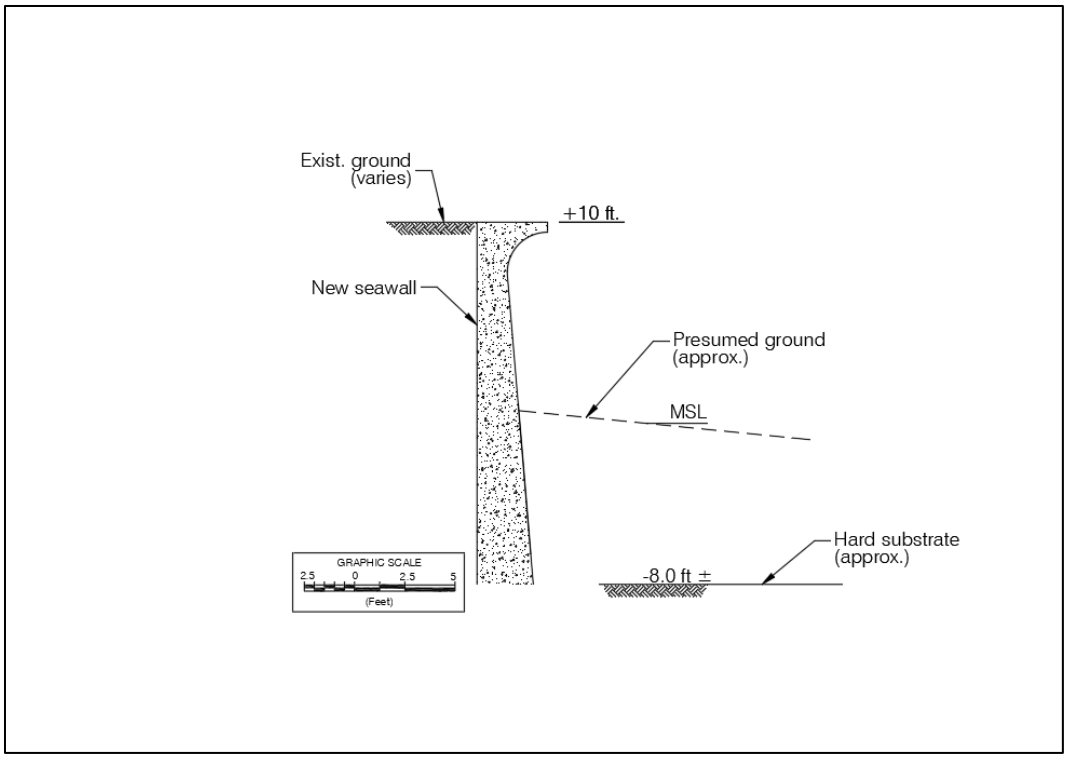


Figure 5-12 Section view of seawall option

5.8 Seawall with Scour Apron

This approach would involve removing the existing sandbag revetment and constructing a seawall with a riprap scour apron (Figure 5-13). A toe apron is a sloping, un-cemented structure built of wave resistant material. The most common method of construction is to place riprap sized according to the design wave height along the lower face of the seawall. A toe apron has a much smaller horizontal footprint than a traditional revetment, and generally uses smaller stones than standalone structures. Traditionally used in sub-aerial installations, the goal of this design is to prevent scour at the toe of the vertical wall. The toe apron disperses wave energy, preventing the downward motion of reflected wave energy that results in scour of the natural sediment as well as reducing reflected wave energy. These installations improve the longevity of the backing structure and assist in protecting the backshore when paired with a seawall.

Sea Engineering, Inc. performed a field study in 2008 to measure the reflected wave energy from different shorelines in Waikiki and found that wave energy reflected off beaches and rock revetments was of the same magnitude, while seawalls had the highest measured wave energy reflection. Similarly, Lipp (1995) showed that measured beach profiles in Lanikai were of similar slope fronting beaches and dissipative seawalls (i.e., seawalls with rubblemound). With the proper riprap toe apron structure, the scour of sand will be reduced along with a significant reduction in reflected wave energy. This reduction in wave energy at the face of the seawall is expected to steepen the beach profile and allow sand to build up makai of the structure when there is available material.

Seawall with scour apron design is dependent on sea level elevation, design wave height, and scour depth. The design presented below incorporates a 2.3-foot higher than present sea level, with consequent increases in predicted wave exposure and scour depth. Utilizing 2.3 feet of sea level rise, which is currently projected for 50 years in the future, provides suitable design criteria within the effective life span of similar structures. The scour apron is designed to allow 30-40% damage during a 50-year wave event at a sea level 2.3 feet higher than present. The scour apron is expected to require more frequent maintenance as sea level rises above present. The entire structure is expected to require maintenance, improvements, or replacement at the end of the structure's projected life span or when the environment changes beyond design conditions. Adaptation to sea levels and their resulting impacts predicted at time frames beyond the structure's design life should be incorporated at that time.

Figure 5-13 Seawall with scour apron, (Lanikai, Oahu, Hawaii)

Seawall with Scour Apron Alternative Evaluation:
<u>Project Objectives</u>

- Advantage – Does provide long-term preservation/protection for the habitable dwelling and neighboring shoreline structures in their current locations. Does stabilize the shoreline at or mauka of the existing shoreline location. Does not have a negative impact on lateral shoreline access and is unlikely have a negative impact on recreational value due to reduced energy in reflected waves.
- Advantage – The structure will stabilize the shoreline, mauka of State submerged lands.

- Advantage – The shoreline access structure to the south and the seawall to the north would not be de-stabilized if the seawall curves to tie into both structures.
- Advantage – Will likely result in a footprint that is farther mauka than the existing sandbag structure.
- Advantage – The seawall with scour apron structure minimizes potential negative impacts to the dwelling and the neighboring shoreline structures. It also minimizes the impacts of reflected wave energy and allows for sand accumulation at a level approaching that of a sloped rock revetment.

Evaluation Criteria

- Advantage - Effectiveness of protection of mauka dwelling and structures is high and is combined with decreased return wave energy and likely improved lateral shoreline access.
- Advantage – The structure has a long design life and high durability on the shoreline. Moreover, the dissipative nature of the scour apron is desirable from a shoreline access and recreational use perspective.
- Neutral – Shoreline structures typically have high costs for design, permitting, and construction; however, well designed and constructed seawall with scour apron will have low maintenance costs.
- Advantage – There is likely to be mixed support from the permitting agencies; however, there is likely to be net positive support from the community, based on the performance of similar structures in the near area.
- Advantage – The seawall with scour apron is more likely to allow sand accumulation than vertical seawalls or sandbags and is expected to have accumulation potential nearing that of a sloped rock revetment. This structure will also protect the dwelling and neighboring properties and does not extend onto State land. Attenuated reflected wave energy associated with scour aprons is more likely to mitigate impacts to marine habitat, shoreline processes, shoreline access, and recreation than other alternatives (not including revetments and beach faces).

***Seawall with Scour Apron* is the preferred solution based on project objectives and evaluation criteria.**

5.8.1 Seawall with Scour Apron Design

Riprap stone size is based on the design wave height, H_s, at the structure during the 50-year NE swell event. This wave height was modeled to be 5.1 feet. This design wave height may be reduced to allow for some damage during the design event. Since the scour apron does not provide structural protection to the seawall, some level of damage is acceptable. The modeled wave height is reduced by a factor of 1.47 (USACE, 1984, 2006) giving an adjusted design wave height of 3.4 feet. This adjusted wave height would allow for 30-40% damage during the design event. The damage is expected to occur along the seaward face of the apron with rocks being displaced from the top of the sloping face down towards the toe of the structure. As rocks are displaced the slope is expected to flatten until it reaches an equilibrium state and becomes more stable. The required armor stone weight for stability under the adjusted design wave height is given by the Hudson Formula (USACE, 1984, 2006):

$$W = \frac{w_r {H_s}^3}{K_{rr}(S_r - 1)^3 cot\theta}$$

where:

W = weight in pounds of an individual armor stone
w_r = unit weight of the stone (160 lb/ft^3)
H_s = adjusted design wave height (3.4 ft)
K_{rr} = riprap stability coefficient (2.5)
S_r = specific gravity of the stone relative to seawater (2.5)
cot θ = cotangent of the slope, (1.5)

A design face slope of 1V:1.5H is typical for riprap. The resultant median stone weight and nominal median diameter are 500 lbs and 1.5 feet, respectively, where

$$D_{nom} = \left(\frac{W}{w_r}\right)^{1/3}$$

The distribution of median armor stone weight is:

W_{50} (min) = 0.75 W_{50} = 375 lbs
W_{50} (max) = 1.25 W_{50} = 625 lbs

The riprap structure shall consist of a gradation of stone sizes based on the following 15th and 100th percentile mix of sizes:

W_{15} (min) = 0.4 W_{50} (min) = 150 lbs, W_{15} (max) = W_{50} (min) = 375 lbs
W_{100} (min) = 2 W_{50} (min) = 750 lbs, W_{100} (max) = 4 W_{50} (min) = 1,500 lbs

In summary, the riprap gradation shall be as follows:

Percentile	Minimum Weight	Maximum Weight
15	150 lbs	375 lbs
50	375 lbs	625 lbs
100	750 lbs	1,500 lbs

A typical toe apron section is shown in Figure 5-14 and the plan view of this alternative is shown in Figure 5-15. The apron would reduce reflected wave energy and may facilitate beach accretion in the area; however, the very large rock size makes it very difficult to construct within the limits of the project and would increase the construction cost. Reflected energy reduction may not be enough to warrant the additional expense, and structurally the apron is not necessary to protect the wall from scour if the seawall foundation is constructed on the hard substrate.

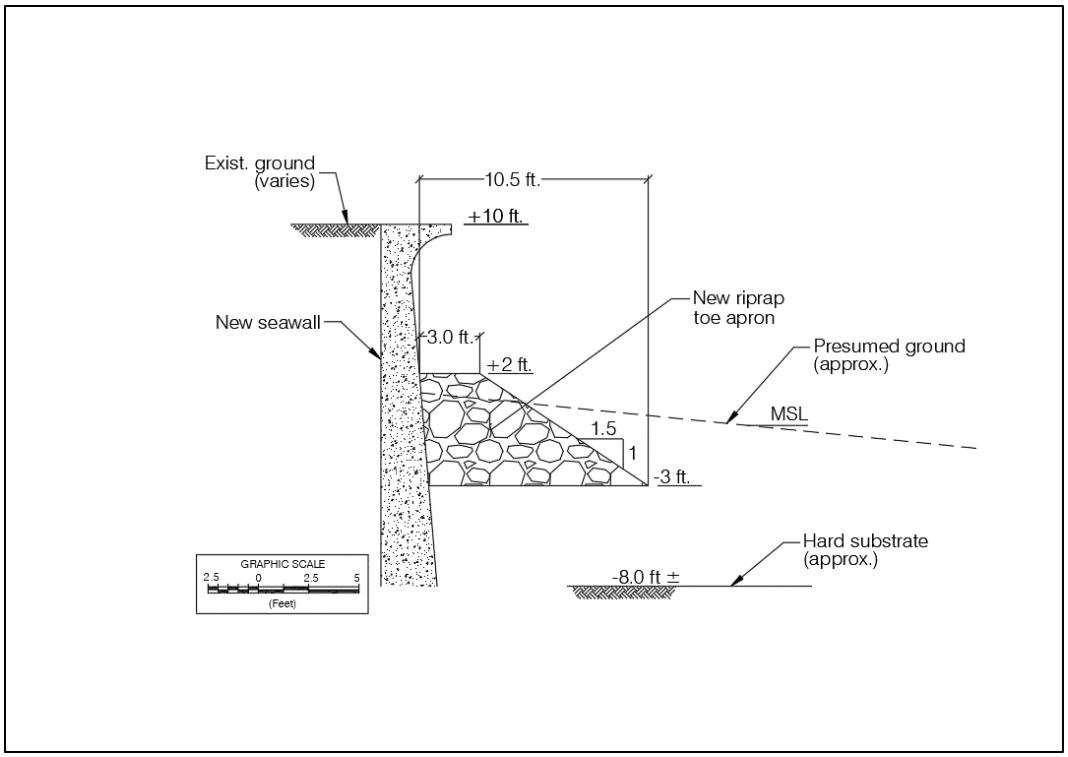


Figure 5-14 Section view of the seawall with toe apron alternative

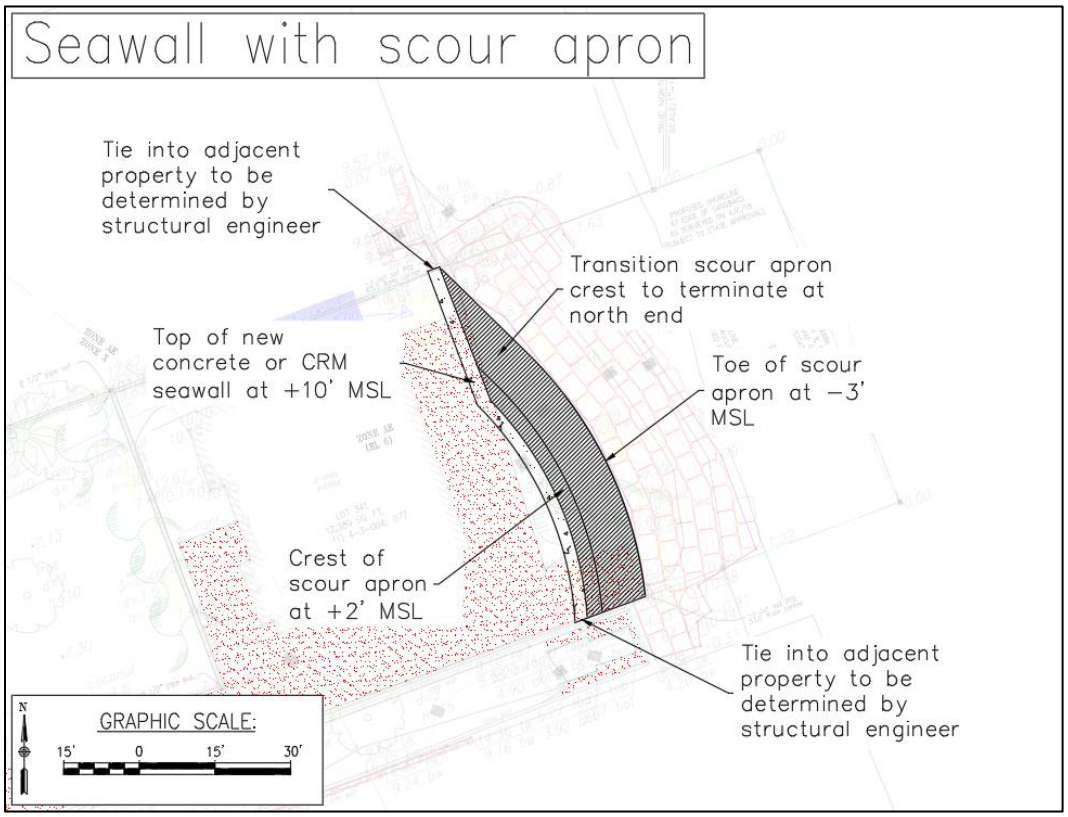


Figure 5-15 Seawall with scour apron option footprint

6. OTHER CONSIDERATIONS

6.1 Replacement of Sandbag Structure with Alternatives – Potential Impacts to Coastal Process, Sand Accumulation, and Wave Action

The property to the south is protected by a rock revetment that extends to a wing wall at the beach access, shown previously in Figure 2-4. The rock revetment and the sandbag revetment are approximately aligned, with the sand bags offering a certain amount of protection to the beach access and the wing wall from waves approach from the northeast direction during the winter months. Removal of the sandbag revetment may result in sand accretion against the wing wall; however, it will also expose the wing wall to winter wave forces.

The property to the north is protected by a vertical seawall with access stairway connecting the backshore to the beach, shown previously in Figure 2-3. The vertical seawall and sandbag revetment are not aligned with each other which appears to cause an accretion of sand at the interface between the sandbags and the seawall. Removal of the sandbag revetment may result in the accreted sand migrating laterally south towards the public access during the winter months when waves approach from the northeast direction. During the summer months when waves approach from the east, the sand may migrate back to the front of the seawall and may also expose the wall to more easterly waves that were before blocked by the sandbag revetment.

REFERENCES

Anderson, T.R., Fletcher, C.H., Barbee, M.M., Frazer, L.N., and Romine, B.M. 2015. *Doubling of coastal erosion under rising sea level by mid-century in Hawaii*, Natural Hazards, DOI: 10.1007/s11069-015-1698-6.

Booij, N., Ris, R. C., Holthuijsen, L. H. 1999. *A third-generation wave model for coastal regions: 1. Model description and validation,* Journal of Geophysical Research., 104(C4), 7649–7666, doi:10.1029/98JC02622.

Firing, Y. L. and M. A. Merrifield. 2004. "Extreme sea level events at Hawaii: influence of mesoscale eddies." *Geophysical Research Letters, 31:L24306.*

Fletcher, C., Grossman, E., Richmond, B., and Gibbs, A. 2002. *Atlas of Natural Hazards in the Hawaiian Coastal Zone.* U.S. Geological Survey. Geologic Investigations Series I-2761. United States Government Printing Office.

Hawaii Climate Change Mitigation and Adaptation Commission. 2017. *Hawaii Sea Level Rise Vulnerability and Adaptation Report*. Prepared by Tetra Tech, Inc. and the State of Hawaii Department of Land and Natural Resources, Office of Conservation and Coastal Lands, under the State of Hawaii Department of Land and Natural Resources Contract No: 64064.

Lipp, D.G. 1995. *Changes in Beach Profiles due to Wave Reflections off Seawalls at Lanikai, Hawaii*. Masters Thesis, University of Hawaii, Dept. of Ocean Engineering. 105 pages.

NOAA., 2017. *Relative Sea Level Trend 1612340 Honolulu, Hawaii*. Retrieved from https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=1612340

Rapaport, M., 2013. The Pacific Islands. University of Hawaii Press.

Sherrod, D.R., Sinton, J.M., Watkins, S.E., and Brunt, K.M., 2007. Geologic map of the State of Hawaii: U.S. Geological Survey Open-File Report 2007-1089 [http://pubs.usgs.gov/of/2007/1089/].

Shinsato Engineering, Inc., 2018. *Report Geotechnical Investigation Proposed Development 1324 and 1326 Mokulua Drive*. Geotechnical Investigation Report.

Sweet, W.V., R.E. Kopp, C.P. Weaver, J. Obeysekera, R.M. Horton, E.R. Thieler, and C. Zervas, *2017. Global and Regional Sea Level Rise Scenarios for the United States*. NOAA Technical Report NOS CO-OPS 083. NOAA/NOS Center for Operational Oceanographic Products and Services.

University of Hawaii Coastal Geology Group, 2010. Hawaii Coastal Erosion Website - Oahu. http://www.soest.hawaii.edu/coasts/erosion/

U.S. Army Corps of Engineers. 1984. *Shore Protection Manual.*

U.S. Army Corps of Engineers. 2003. *Regional Sediment Management.*

U.S. Army Corps of Engineers 2006. *Coastal Engineering Manual.*

USDA Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at https://websoilsurvey.nrcs.usda.gov/. Accessed [5/2/2018].

Wren, J., Kobayashi, D., Jia, Y., Toonen, R. 2016. *Modeled Population Connectivity across the Hawaiian Archipelago*. https://doi.org/10.1371/journal.pone.016762

Appendix E

Marine Research Consultants, Inc. Baseline Assessment of the Marine Environment 1326 Mokulua Drive, Kailua, Hawaii, Shoreline Improvements (August 2018)

BASELINE ASSESSMENT OF THE MARINE ENVIRONMENT
1326 MOKULUA DRIVE, KAILUA, HAWAII
SHORELINE IMPROVEMENTS

Prepared for:

G-70 Design
11 S. King Street, Suite 170
Honolulu, Hawaii 96813

By:

MARINE RESEARCH CONSULTANTS, INC.
1039 WAAKAUA PL.
HONOLULU, HI 96822

June 2018

I. INTRODUCTION AND PURPOSE

The residence at 1326 Mokulua Dr, Kailua Hawaii is located on the shoreline fronting Lanikai Beach. In order to stabilize an eroding shoreline, a temporary revetment constructed of large canvas sandbags was installed, sloping from the shoreline to the intertidal area (Figure 1). At present, planning is underway to replace the temporary sandbag revetment with a permanent structure, likely in the form of a hardened seawall, revetment, or a hybrid of these options. While the final design option is not yet selected, the project will require an Environmental Assessment (EA). This report, intended to support the EA, provides results of field assessments of the physical/ chemical and biological composition of nearshore waters encompassing the areas that may be affected by the shoreline improvements off 1326 Mokulua Drive.

II. WATER QUALITY

A. Methods

The purpose of the assessment is to provide a quantitative depiction of the existing condition of marine water chemistry in the area that has the potential to be affected by the proposed shoreline improvement project. Evaluation of the existing condition of water chemistry provides an insight into the physical and chemical factors that influence the marine setting. Understanding the existing physical and chemical conditions of the marine environment that presently occur provides a basis for predicting the potential affects that might occur as a result of the proposed project.

Water samples were collected on May 1, 2018. Water chemistry was assessed by collecting samples along three linear arrays (i.e. transects) extending perpendicular to the shoreline from the highest wash of waves to approximately 50 meters (m) [160 feet] offshore (Figure 2). All samples were collected by investigators swimming from the shoreline. Transect 1 was located off of the north end of the sandbag revetment, Transect 2 was located off the center of the revetment, and Transect 3 was located at the southern end of the sandbags (Figure 2).

Water samples were collected at five locations along each transect starting at the most landward area of water adjacent to the beach. Such a sampling scheme is designed to span the greatest range of salinity with respect to potential freshwater efflux at the shoreline. Sampling was more concentrated in the nearshore zone

because this area is closest to the region where shoreline improvements will occur, and hence is most important with respect to identifying the effects of shoreline modification. At sampling stations less than 10 m from the shoreline, water samples were collected at a single depth approximately in the mid-point of the water column. Beyond 10 m from the shoreline two samples were collected at each station; a surface sample was collected within 10 centimeters (cm) of the air-water interface and a bottom sample was collected within 20 cm of the seafloor.

Water quality parameters evaluated included all specific criteria designated for open coastal waters in Chapter 11-54, Section 06 (b) (Open Coastal waters) of the State of Hawaii Department of Health (DOH) Water Quality Standards. These criteria include: total nitrogen (TN), nitrate + nitrite nitrogen (NO_3^- + NO_2^-, hereafter referred to as NO_3^-), ammonium nitrogen (NH_4^+), total phosphorus (TP), Chlorophyll a (Chl *a*), turbidity, temperature, pH and salinity. In addition, silica (Si) and orthophosphate phosphorus (PO_4^{-3}) were also reported because these parameters are sensitive indicators of biological activity and the degree of groundwater mixing.

Water samples were collected by filling 1-liter (L) acid-washed, triple rinsed, polyethylene bottles that were subsequently stored on ice. Analyses for Si, NH_4^+, PO_4^{3-}, and NO_3^- were performed with a Technicon Autoanalyzer using standard methods for seawater analysis (Strickland and Parsons 1968, Grasshoff 1983). TN and TP were analyzed in a similar fashion following digestion. Total organic nitrogen (TON) and total organic phosphorus (TOP) were calculated as the difference between TN and dissolved inorganic N and TP and dissolved inorganic P, respectively.

Water for other analyses was sub-sampled from 1-liter polyethylene bottles and kept chilled until analysis. Chl *a* was measured by filtering enough water through glass-fiber filters to detect color; pigments on filters were extracted in 90% acetone in the dark at -20° C for 12-24 hours. Fluorescence before and after acidification of the extract was measured with a Turner Designs fluorometer. Salinity was determined using an AGE Model 2100 laboratory salinometer with a readability of 0.01parts per thousand (‰ or ppt). Turbidity was determined using a 90-degree nephelometer, and reported in nephelometric turbidity units (NTU) (precision of 0.01 NTU). *In-situ* measurements of salinity, temperature and depth were acquired using a RBR-Concerto CTD calibrated to factory standards.

EPA and Standard Methods (SM) methods that were employed for chemical analyses, as well as detection limits, are listed in the Code of Federal Regulations (CRF) Title 40,

Chapter 1, Part 136, are as follows:

NH_4^+: EPA 350.1, Rev. 2.0 or SM4500-NH3 G, detection limit 0.42 µg/L.
$NO_3^- + NO_2^-$: EPA 353.2, Rev. 2.0 or SM4500-NO3F, detection limit 0.28 µg/L
PO_4^{-3}: EPA 365.5 or SM4500-P F, detection limit 0.31 µg/L.
Total P: EPA 365.1, Rev. 2.0 or SM4500-P E J, detection limit 0.62 µg/L.
Total N: SM 4500-N C., detection limit 5.60 µg/L.
Si: EPA 370.1 or SM 4500 SiO2 E, detection limit 5.32 µg/L.
Chlorophyll *a*: SM 10200, detection limit 0.006 µg/L.
pH: EPA 150.1 or SM4500H+B, detection limit 0.002 pH units
Turbidity: EPA 180.1, Rev. 2.0 or SM2130 B, detection limit 0.008 NTU.
Temperature: SM 2550 B, detection limit 0.01 degrees centigrade.
Salinity: SM 2520, detection limit 0.003 ppt.
Dissolved Oxygen: SM4500 O G, and detection limit 0.01% sat.

All fieldwork was conducted by Dr. Steven Dollar and Ms. Andrea Millan. All laboratory analyses were conducted by Marine Analytical Specialists located in Honolulu, HI (Labcode: HI 00009). This analytical laboratory possesses acceptable ratings from EPA-compliant proficiency and quality control testing.

B. Results

1. *Distribution of Chemical Constituents*

The overall distribution of water chemistry constituents reflects the physical structure of the coastal area. The shoreline of Lanikai Beach consists either of a coarse white sand beach or hardened structures (seawalls or boulder revetments). The exception occurs at the subject property, where the shoreline is composed of the sandbag revetment described above. The marine area off of Lanikai Beach consists of a semi-embayment bounded by a reef crest approximately one kilometer (km) offshore. All areas of the nearshore environment consist of open coastal areas with unrestricted circulation with the ocean.

Table 1 shows results of all water chemistry analyses on samples collected off 1326 Mokulua Drive on May 1, 2018. Several patterns of distribution are evident in Table 1. Most evident is that there are elevated values of several inorganic nutrient constituents at the shoreline on all of the transects. While the values of dissolved silica

(Si) are elevated at the shoreline of all three transects, the increase is highest on Transect 3 (1,866 µg/L), which is approximately six-fold higher than at the shoreline of Transects 1 and 2. Salinity mirrors Si, with an anomalously low value of salinity (28.3‰) at the shoreline of Transect 3 (Table 1). Similarly, the concentrations of nitrate-nitrogen (NO_3^-) on all three transects are maximum at the shoreline and decrease with distance offshore. As with Si, the concentration of NO_3^- at the shoreline of Transect 3 (526 µg/L) is one to two orders of magnitude higher than the shoreline values at Transects 2 and 3 (2.2 and 22.4 µg/L, respectively) Inspection of the pattern of distribution of dissolved phosphate-phosphorus (PO_4^{-3}) also shows maximum values at the shoreline, with decreasing concentrations moving offshore. However, the magnitude of the gradient for PO_4^{-3} is far less than that for Si and NO_3^-.

The occurrence of elevated inorganic nutrients Si and NO_3^-, along with depressed salinity, is indicative of freshwater entering the ocean at the shoreline. Freshwater can be either in the form of submarine groundwater discharge or surface sheet or streamflow. As the sampling occurred during a period of dry weather, it is most likely that the elevated values of nutrients and depressed salinity are the result of a localized discharge of groundwater at the southern end of the sandbag revetment.

The values of dissolved nutrients ammonium nitrogen (NH_4^+) and total nitrogen (TN) show a general trend of elevated values at the shoreline with decreasing concentrations with distance from shore. Total phosphorus (TP), as well as the organic fractions of nitrogen (TON) and phosphorus (TOP) show no distinct horizontal gradients and are essentially constant in concentration across the length of all three transects.

Considering physical properties of the water column, temperature, turbidity and chlorophyll *a*, display similar patterns, with peak values at the shoreline, and decreasing values with distance seaward. Salinity shows a mirror image, with lowest values at the shoreline. Dissolved oxygen and pH show little variation, with similar values along the length of all three transects.

With respect to vertical stratification, at all stations from 10 m to 50 m offshore where surface and bottom samples were collected, values of salinity are lower in surface samples relative to bottom samples. Concentration of dissolved nutrients Si, NO3- and TN all show elevated values in surface samples compared to bottom samples. Such consistent vertical stratification indicates that a distinct surface layer that is a result of discharge of lower density freshwater at the shoreline.

In summary, nearshore waters off of 1326 Mokulua Drive exhibit a consistent pattern of maximum values of dissolved inorganic nutrients at the shoreline, with progressively decreasing values moving seaward. This pattern is coupled with lowest salinity at the shoreline and increasing values moving seaward. Such a pattern indicates input of freshwater at the shoreline that mixes with seawater forming both vertical and horizontal gradients in the nearshore zone. Groundwater input is highest at the southern end of the property and lowest at the northern end.

2. Compliance with DOH Criteria

State of Hawaii Department of Health Water Quality Standards (HDOH-WQS) that apply to the areas offshore of 1326 Mokulua Drive are listed as "open coastal water" in HRS Chapter §11-54-6(b). Two sets of standards are listed depending on whether an area receives more than 3 million gallons per day (mgd) of freshwater input per shoreline mile ("wet standards"), or less than 3 mgd of freshwater input per shoreline mile ("dry"). As the study area off the northeast coast of Oahu probably receives less than 3 mgd per mile, dry criteria were used for this evaluation.

The HDOH-WQS are also separated into three standards: geometric means, "not to exceed more than 10% of the time" and "not to exceed more than 2% of the time." As all of these classifications require multiple samplings, they cannot be used for a strict evaluation of whether a single sampling is within compliance standards. However, these values provide a guideline to evaluate the overall status of sampled waters in terms of the relation with State standards.

Shown in Table 1 are all values that exceed the "not to exceed more than 10% of the time", and "not to exceed more than 2% of the time" under dry conditions. Two values of nitrate nitrogen (NO_3^-), one value of TN, five values of ammonium nitrogen (NH_4^+), and all measurements of turbidity exceeded the 2% standard. The consistently elevated turbidity in excess of DOH standards criteria throughout the sampling regime is likely a result of resuspension of the fine-grained sediment that comprises the ocean floor off Lanikai Beach. Concentrations of TP and Chlorophyll *a* did not exceed either of the standards at any sampling site.

As discussed above, the elevated concentration of dissolved nutrients near the shoreline is likely a result of mixing of groundwater with ocean water in the nearshore zone. Owing to the input from land, it is not unexpected that some nutrient water quality constituents do not comply with open ocean criteria, which does not take

input of high-nutrient groundwater into accout. With regard to turbidity, the consistently elevated values above the open coastal standards are likely a result of resuspension of fine-grained sediment that form the ocean floor, rather than from inputs from land. Similar to the effect of groundwater input on inorganic nutrient concentrations that are not accounted for in DOH standards, resuspension of fine-grained material in the nearshore zone is also not a consideration in the water quality standards for open coastal waters.

Overall, with the exceptions described above, most of the area within the scope of the present project are close to or below the specific criteria of the State Water Quality Standards, with the caveat that this consideration is for a single sample set. As a result, does not appear that there are any significant inputs of materials from land beyond the immediate shoreline that are impacting coastal ocean waters offshore of 1326 Mokulua Drive.

III. BIOTIC COMMUNITY STRUCTURE

A. Methods

Biotic community structure of the marine environment was semi-quantitatively assessed by investigators swimming throughout the offshore area from the shoreline to approximately 80 m offshore. During these reconnaissance swims, notes were taken on physical structure and marine species abundance. Numerous photographs were taken of typical features of all habitats to provide a descriptive representation of the area fronting the project site.

B. Results

Following is a description of the distinct biotopes, or zones that occur in the marine environment off of 1326 Mokulua Drive (a biotope is an area of uniform environmental conditions providing a living place for a specific assemblage of plants and animals). Two groups of organisms that are of major interest for assessment are seagrass and reef building coral.

1. Benthic Composition and Community Structure

The intertidal zone consists of the juncture of the sandbags with the coarse white sand and rubble surfaces that comprise the seafloor (Figures 1, 3 and 4). Much of the

submerged surfaces of the sandbags were coved by mats of small gastropods. The only other macrobiota colonizing the canvas surfaces of the sandbags was several species of algae, particularly the red algae *Asparagopsis taxiformis*. No corals or seagrass colonized the sandbags or sand bottom adjacent to the sandbags.

Seaward of the sandbag revetment, bottom composition of the nearshore zone consists of a plain of white sand (Figure 5). No seagrass or macroalgae beds were observed on the sand flats. Scattered in the nearshore areas were numerous sections of canvas sandbags that had apparently been torn from the revetment. Most of these fragments were anchored in the sand bottom in a linear array between the locations of water sampling Transects 1 and 2 (Figure 2). As with the sandbags that remained as part of the intact revetment, the torn bag fragments were not colonized by any macrobiota other than the small gastropods.

Most of the offshore marine area fronting Lanikai beach consists of sand flats interspersed with an extensive spur and groove system and extensive patch reefs The exception is the area off of the section of shoreline fronting the project site (Figure 7). The existing patch reefs are all located at a sufficient distance from the project site as to not be affected by any construction activities that could be part of the shoreline improvements.

2. Reef Fish Composition and Community Structure

Quantitative fish surveys were beyond the scope of the present survey. During the course of swim surveys, several species of fish were noted. These included the surgeonfish *Acanthurus triostegus* and the tetradonts *Canthigastor jactator,* and *Ostracion meleagris*, a trumpetfish *Aulostomus chinensis*, and small schools of unidentified juveniles. All of these species are common on Hawaiian reefs, and do not constitute rare or unique species assemblages. No large individuals that would be considered “food fish” were observed.

3. Threatened and Endangered Species

Several species of marine animals that occur in Hawaiian waters have been declared threatened or endangered by Federal jurisdiction. The threatened green sea turtle (*Chelonia mydas*) occurs commonly throughout the Hawaiian Islands and are frequently observed throughout the Lanikai area. The endangered hawksbill turtle (*Eretmochelys imbricata*) is known infrequently from Hawaiian waters. No green sea

turtles or hawksbill turtles were observed within the survey area over the course of the present study.

Populations of the endangered humpback whale (*Megaptera novaeangliae*) winter in the Hawaiian Islands from December to April. While the present survey was conducted in May when whales are absent from Hawaiian waters, the survey area is not conducive to whale habitation owing to shallow depth and lack of access. The Hawaiian monk seal, (*Monachus schauinslandi*) is an endangered earless seal that is endemic to the waters off the Hawaiian Islands. Monk seals commonly haul out of the water onto sandy beaches to rest. No seals were observed during the present survey work at 1326 Mokulua Drive.

IV. DISCUSSION and CONCLUSIONS

The purpose of this assessment is to assemble a set of baseline information to make valid evaluations of the potential for influence to the marine environment from the proposed improvements to the shoreline at 1326 Mokulua Drive. The information collected in this study provides the basis to understand some of the important processes that are operating in the nearshore ocean, so as to be able to address any concerns that might be raised in the planning process for the proposed project.

The physical structure of the marine habitats where it is proposed to place shoreline structures in the intertidal area consist of sand. Results of analyses of water chemistry from samples collected along transects that extend from the shoreline to open waters indicate input of groundwater at the shoreline, particularly at the eastern end of the project site. The effect of the groundwater on nearshore waters is limited to a small mixing zone.

While the values of most water quality constituents are near Department of Health water quality standards specific criteria for open coastal waters, values of turbidity are consistently well above the values specified in DOH standards. The elevated values of turbidity are primarily a response to resuspended fine sediment emanating from beach sand that is in a state of constant resuspension from wave action. When new structures are placed in the intertidal zone to improve shoreline stability, nearshore turbidity may temporarily increase above existing levels. Such an increase would be expected to be small and temporary and have no significant impacts.

Results of biotic surveys reveal that there are no corals or seagrass near the project site. Corals require solid substratum to settle and grow, and such bottom structure is not present in the project area. Apparently, the canvas surfaces of the existing sandbags are not a suitable settlement surface for corals. As the specific habitat for Hawaiian seagrass is shallow calm water with soft sand substratum, the floor of the open coastal area is not a suitable habitat for seagrass.

The possible temporary changes to water quality from shoreline should not be of a magnitude to affect turtle or marine mammal behavior, as they seem unaffected by turbid waters. During construction of shoreline structures, observers should be in place to spot any turtles or marine mammals that might enter the work area. If such actions occur, a mitigation plan should be in effect to stop work until the protected species leave the area.

Based on the results of this survey, it can be concluded that with proper management and mitigation practices to limit to the extent possible release of any construction related material to the water column, the proposed shoreline improvement should have little or no potential for significant permanent effects to the existing marine environment.

V. REFERENCES CITED

Grasshoff, K. 1983. Methods of seawater analysis. Verlag Chemie, Weinheim, 419 pp.

Strickland J. D. H. and T. R. Parsons. 1968. A practical handbook of sea water analysis. Fisheries Research Bd. of Canada, Bull. 167. 311 pp.

FIGURE 1. Top photo shows residence and sandbag revetment at shoreline of 1326 Mokulua Dr., Kailua Hi. Bottom photo shows lower edge of sandbag revetment at low tide. Note torn sandbag remnants in nearshore submerged area.

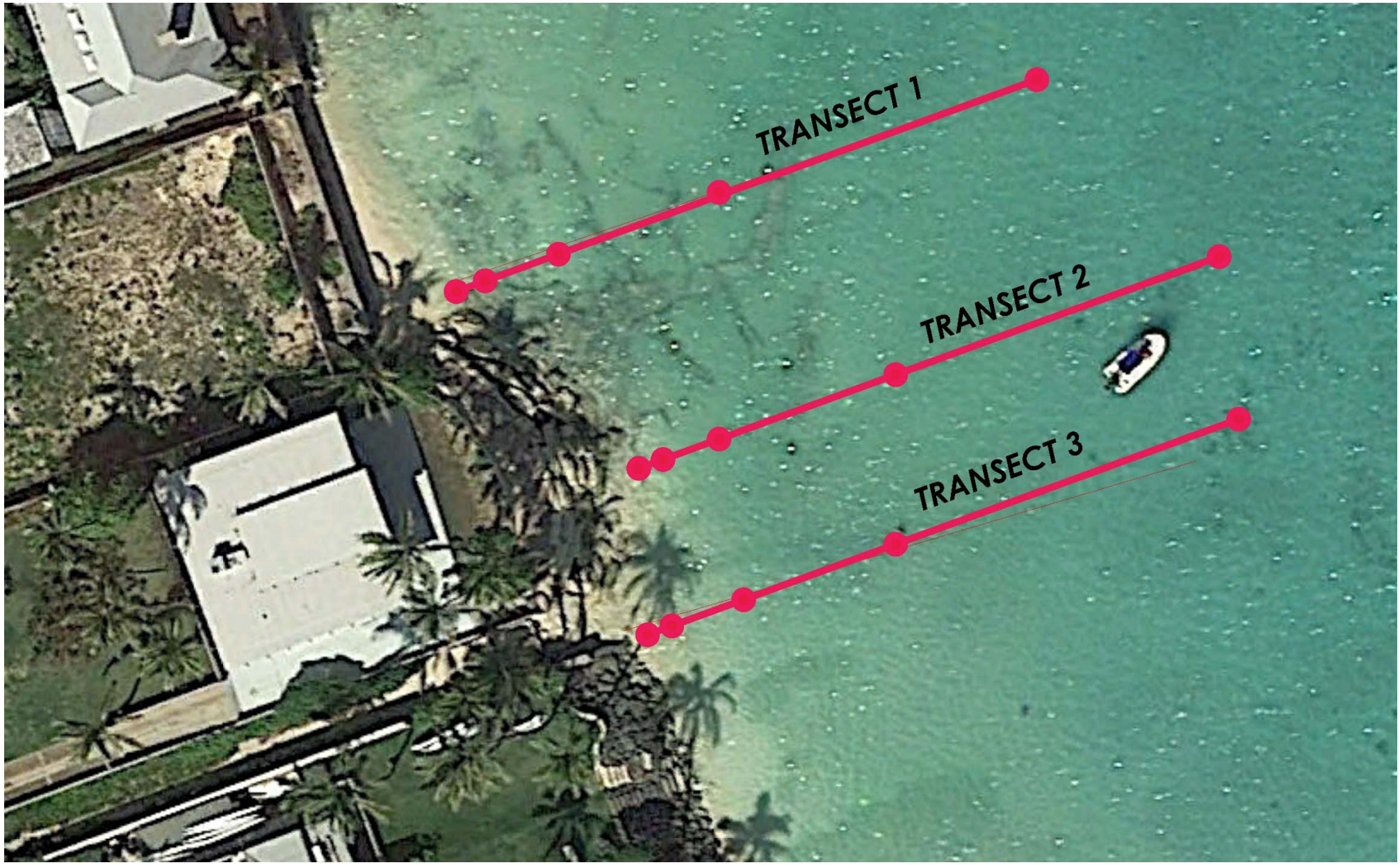


FIGURE 2. Aerial photo of residence at 1326 Mokulua Dr., Kailua, Oahu, Hawaii located on shoreline off Lanikai Beach. Sand bag shoreline revetment fronting residence is largely obscured by palm trees. Locations of three water sampling transects are shown as red lines; red circles indicate water sampling stations sampled on May 1, 2018. Note remnant sandbags in nearshore area between Transects 1 and 2.

TABLE 1. Results of water sampling off 1326 Molulua Dr. residence on May 1, 2018. Samples are collected 10 centimeters from the surface (S), and 20 cm from the ocean floor (B). Whee water depth was less than 50 cm, a single sample was collected. Also shown are the State of Hawaii, Department of Health Water Quality Standards (DOH WQS) "not to exceed more than 10% of the time" and "not to exceed more than 2% of the time" water quality standards for open coastal waters under "dry" conditions. Tan shaded shaded values exceed DOH 2% "dry" standards; blue shaded values exceed DOH 10% "dry" standards. For transect sampling station locations, see Figure 1.

STATION	DEPTH (m)	DFS (m)	PO_4^{3-} (µg/L)	$NO_3^-+NO_2^-$ (µg/L)	NH_4^+ (µg/L)	Si (µg/L)	TOP (µg/L)	TON (µg/L)	TP (µg/L)	TN (µg/L)	TURB (ntu)	SALINITY (o/oo)	pH (std. units)	Chl-a (µg/l)	TEMP deg. C	Diss. O_2 % sat.
TRANSECT 1	1	1	6.82	2.24	6.16	259.56	9.61	135.38	16.43	143.78	6.49	33.85	8.10	0.41	25.36	105.69
	2	2	6.51	1.40	13.72	211.96	8.37	158.48	14.88	173.60	6.37	34.09	8.10	0.45	24.97	110.93
	3	10S	4.96	BDL	1.26	186.48	7.75	117.60	12.71	118.86	5.50	34.18	8.09	0.29	24.73	103.83
	4	10B	5.58	0.42	1.12	157.08	7.75	124.32	13.33	125.86	4.93	34.29	8.09	0.32	24.72	2.00
	5	20S	5.58	0.56	2.24	161.84	7.44	159.74	13.02	162.54	3.21	34.33	8.09	0.34	24.60	104.41
	6	20B	5.89	0.28	1.82	123.20	7.13	152.60	13.02	154.70	2.69	34.47	8.09	0.37	24.60	104.76
	7	50S	4.65	0.56	0.42	147.56	10.23	142.38	14.88	143.36	2.28	34.47	8.09	0.24	24.55	104.02
	8	50B	4.96	BDL	3.08	128.24	8.06	119.84	13.02	122.92	2.27	34.64	8.09	0.21	24.61	106.26
TRANSECT 2	9	1	6.82	22.40	10.92	365.40	11.16	123.20	17.98	156.52	5.66	33.48	8.08	0.34	25.10	110.47
	10	2	6.51	4.76	4.62	206.36	10.23	133.98	16.74	143.36	5.30	34.00	8.10	0.37	24.92	110.81
	11	10S	4.65	2.10	3.64	185.08	12.09	115.36	16.74	121.10	4.62	34.26	8.09	0.42	24.78	106.96
	12	10B	5.58	0.98	9.66	165.76	12.71	114.80	18.29	125.44	3.79	34.29	8.09	0.31	24.76	106.55
	13	20S	5.27	1.26	6.58	159.88	12.40	114.52	17.67	122.36	2.96	34.33	8.09	0.20	24.69	107.24
	14	20B	4.96	0.56	2.94	105.00	12.71	110.32	17.67	113.82	2.91	34.47	8.10	0.19	24.67	107.95
	15	50S	4.65	1.82	8.82	138.60	13.64	129.92	18.29	140.56	2.03	34.37	8.09	0.23	24.65	106.25
	16	50B	3.72	BDL	3.64	82.60	16.43	123.34	20.15	126.98	1.25	34.58	8.10	0.19	24.65	109.74
TRANSECT 3	17	1	6.82	526.54	5.32	1866.20	6.82	79.24	13.64	611.10	3.65	28.27	7.97	0.31	25.35	82.20
	18	2	4.96	3.36	9.52	172.76	14.88	104.30	19.84	117.18	4.09	34.13	8.09	0.28	25.00	107.94
	19	10S	5.58	1.96	8.82	169.96	13.33	95.48	18.91	106.26	3.76	34.27	8.09	0.26	24.94	107.23
	20	10B	5.27	0.98	10.22	132.44	13.02	118.44	18.29	129.64	3.75	34.45	8.10	0.33	24.81	107.01
	21	20S	4.34	1.96	5.32	186.76	11.16	83.44	15.50	90.72	2.87	34.34	8.09	0.25	24.80	106.37
	22	20B	3.10	0.42	1.12	91.84	12.71	90.44	15.81	91.98	2.93	34.52	8.10	0.18	24.74	107.42
	23	50S	2.79	1.26	4.20	151.20	13.64	104.58	16.43	110.04	2.59	34.31	8.09	0.18	24.73	106.23
	24	50B	2.79	0.28	4.06	97.72	14.57	78.82	17.36	83.16	1.45	34.53	8.11	0.12	24.70	107.27
DOH WQS	DRY	NTE 10%		10.00	5.00				30.00	180.00	0.50	*	**	0.50	***	****
		NTE 2%		20.00	9.00				45.00	250.00	1.00	*	**	1.00	***	****
Analytical Method			EPA 365.3	EPA 353.2	EPA 350.1	EPA 370.1			SM 4500P B5	SM 4500N C	SM 2130B	SM 2520	EPA 150.1	SM 10200	SM 2550B	SM 4500 OG

FIGURE 3. Photos of sandbag surfaces in intertidal area. Red algae in both photos is *Asparagopsis taxiformis*. No corals were present growing on the sandbag surfaces.

FIGURE 4. Photos of submerged sandbag surfaces at seaward edge of sandbag revetment. No corals were present growing on the sandbag surfaces.

FIGURE 5. Top photo shows sand plain offshore of 1326 Mokulua Dr. sandbag revetment. Bottom photo shows coral rubble and coarse sand on sand plain. No patch reefs that occur in many nearshore areas off Lanikai Beach were present off the study site.

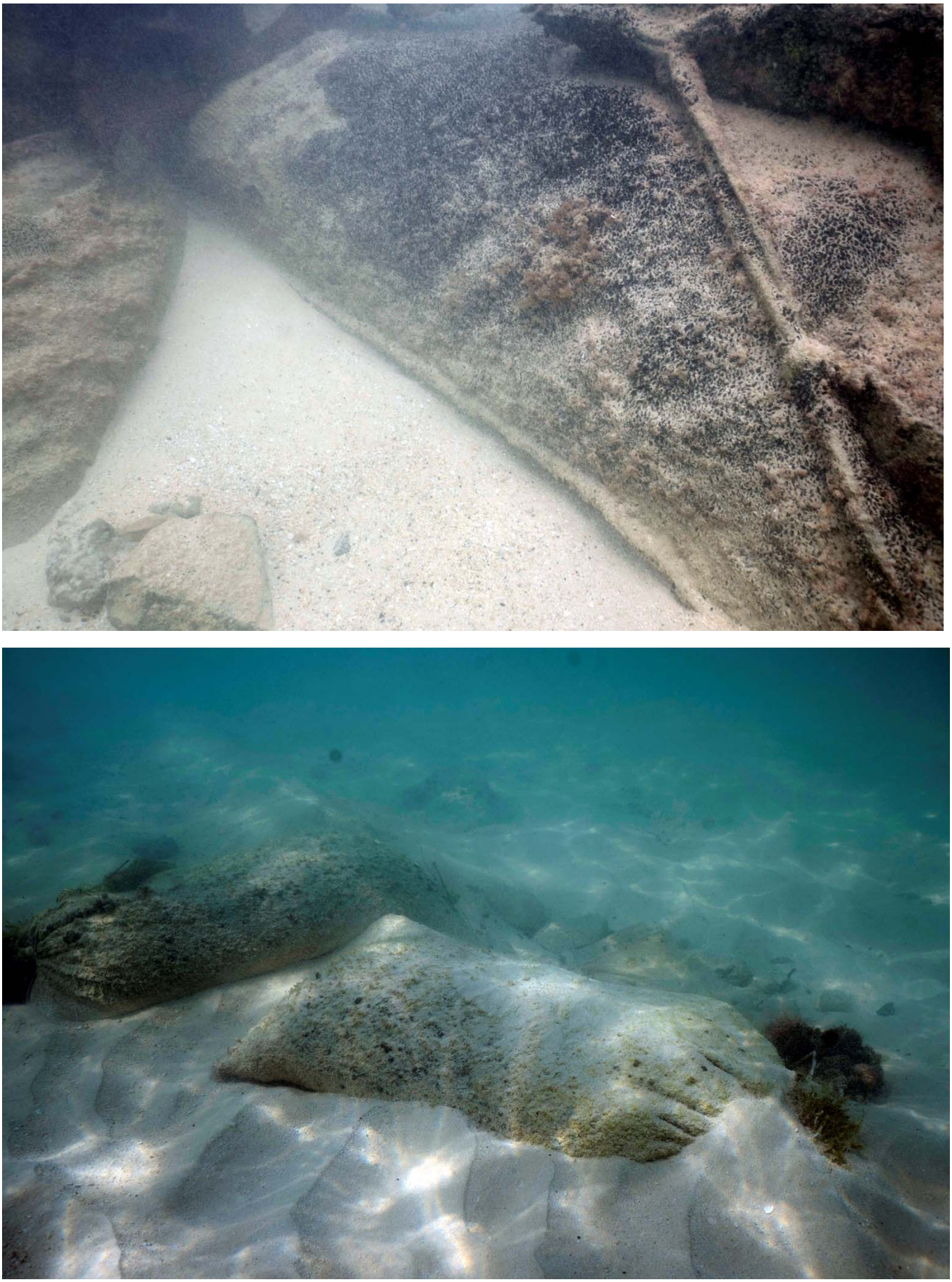


FIGURE 6. Photos of submerged sandbags offshore of sandbag revetment. No corals were present growing on the sandbag surfaces.

FIGURE 7. Aerial view of Lanikai beach showing location of 1326 Mokulua Drive shoreline improvements site. Evident in the photograph is the extensive reef structure throughout most of the area offshore of Lanikai beach. The exception is a large area consisting of sand flats fronting the project site.

Appendix F

Keala Pono Archaeological Consulting, LLC Archaeological Assessment for 1326 Mokulua Drive in Lanikai, Kailua Ahupuaʻa, Koʻolaupoko District, Island of Oʻahu (April 2018)

Archaeological Assessment for a Revetment at 1326 Mokulua Drive in Lanikai, Kailua Ahupuaʻa, Koʻolaupoko District, Island of Oʻahu

TMK: (1) 4-3-004:077

Prepared For:

Nadir Safai, Landowner

April 2018

Keala Pono Archaeological Consulting, LLC ● PO Box 1645, Kaneohe, HI 96744 ● Phone 808.381.2361

Archaeological Assessment for a Revetment at 1326 Mokulua Drive in Lanikai, Kailua Ahupuaʻa, Koʻolaupoko District, Island of Oʻahu

TMK: (1) 4-3-004:077

Prepared For:

Nadir Safai, Landowner

Prepared By:

Windy K. McElroy, PhD
Kālenalani McElroy, MA
and
Dietrix Duhaylonsod, BA

April 2018

Keala Pono Archaeological Consulting, LLC ● PO Box 1645, Kaneohe, HI 96744 ● Phone 808.381.2361

MANAGEMENT SUMMARY

An archaeological inventory survey (AIS) was conducted for two beach lots in Lanikai on Mokulua Drive, Kailua Ahupuaʻa, Koʻolaupoko District, Oʻahu at TMK: (1) 4-3-004-077. Due to negative findings, the AIS results are presented as an archaeological assessment (AA). The survey was done in preparation for ground disturbance associated with construction of a proposed revetment on the makai side of the properties. The archaeological work included a pedestrian survey that covered 100% of the project areas, as well as test excavations consisting of three test units. The properties have been disturbed by modern use, and no archaeological remains were found on the surface. Likewise, no subsurface cultural features or deposits were encountered during excavation. Subsurface testing confirmed that the entire project area has been filled in modern times. For this reason, no further work is recommended.

CONTENTS

MANAGEMENT SUMMARY i

FIGURES iv

TABLES iv

INTRODUCTION 5
- The Project Location and Description 5
- The Natural Environment 5

BACKGROUND 10
- Kailua in the Pre-Contact Era 10
  - Inoa ʻĀina: Place Names 10
  - Moʻolelo 11
  - ʻŌlelo Noʻeau 13
  - Ka Makani a me Ka Ua: The Wind and the Rain 14
  - Traditional Land Use 14
- Kailua in the Historic Era 15
  - Early Historical Accounts of Land Use in the Kailua Area 16
  - Land Ownership and Māhele Land Tenure 16
  - Historic Land Use 18
- Previous Archaeology 22
- Summary of Background Information 26
- Anticipated Findings and Research Questions 26

METHODS 28

RESULTS 29
- Pedestrian Survey 29
- Subsurface Testing 29
- Summary of Findings 31

SUMMARY AND RECOMMENDATIONS 35

GLOSSARY 36

REFERENCES 38

FIGURES

Figure 1. Project area on 1998 USGS quadrangle. 6
Figure 2. Project area (in red) shown on a portion of TMK plat (1) 4-3-13. 7
Figure 3. Soils in the vicinity of the project area. Data from Foote et al. (1972). 8
Figure 4. Portion of an early Kailua map (Wall 1899). 19
Figure 5. Portion of an early Kailua map (King 1900). 20
Figure 6. Portion of an Ko‘olaupoko fisheries map (Dunn n.d.). 21
Figure 7. Previous archaeology in the vicinity of the project area. 23
Figure 8. Previously recorded sites in the vicinity of the project area. 24
Figure 9. Excavation of TU 1 and 2. Orientation is to the north. 28
Figure 10. Location of test units on aerial imagery. The project area is outlined in red. 30
Figure 11. TU 1 east face profile drawing. 32
Figure 12. TU 1 east face photo. 32
Figure 13. TU 2 east face profile drawing. 33
Figure 14. TU 2 east face photo. 33
Figure 15. TU 3 south face profile drawing. 34
Figure 16. TU 3 south face photo. 34

TABLES

Table 1. Previous Archaeology in Lanikai 25
Table 2. Sediment Descriptions 31

INTRODUCTION

At the request of homeowner Nadir Safai, Keala Pono Archaeological Consulting conducted an archaeological inventory survey (AIS) for proposed revetment construction in Lanikai, Kailua Ahupuaʻa, Koʻolaupoko District, Oʻahu. Construction will take place on the makai (east) side of TMK: (1) 4-3-004:077. This work was designed to identify, document, assess significance, and provide mitigation recommendations for any historic properties that may be located in the project area in anticipation of the proposed construction.

This report is drafted to meet the requirements and standards of state historic preservation law, as set out in Chapter 6E of the Hawaiʻi Revised Statutes and the State Historic Preservation Division's (SHPD's) draft *Rules Governing Standards for Archaeological Inventory Surveys and Reports*, Hawaii Administrative Rules (HAR) §13–276. Due to negative findings, the AIS results are presented as an archaeological assessment per HAR §13–275-5(b)(5)(A).

The report begins with a description of the project area and a historical overview of land use, Hawaiian traditions, and archaeology in the area. The next section presents methods used in the fieldwork, followed by results of the survey. Project results are summarized and recommendations are made in the final section. Hawaiian words and technical terms are defined in a glossary at the end of the document.

The Project Location and Description

The project area is located in Kailua on the coast of Lanikai, Koʻolaupoko District, on the island of Oʻahu (Figure 1). The survey consists of 65 m^2 (700 ft^2) on the makai (east) side of the beachfront parcel TMK: (1) 4-3-004:077 (Figure 2). The parcel in total is .11 ha (.28 ac.) and owned by the Davis Trust. The property is bounded by the ocean on the east, Mōkapu Drive on the west, a beach access easement on the south, and a private lot on the north. The project consists of the replacement of temporary sandbag structures with either a sloping boulder revetment, vertical seawall, or hybrid structure on the makai side of the property. Excavations will extend to approximately 2.4–3 m (8–10 ft) below the existing grade.

The Natural Environment

Today's Kailua town proper is situated between the ocean on the east, by Kawainui Marsh and Puʻu O Ehu on the west, by Kaʻelepulu Stream on the south, and by Oneawa Hills, formerly called Mahinui Hills on the north. Lanikai is the section of Kailua between Alāla and Wailea Points on the southeast side of Kailua. About 3,500 years ago when the sea level was higher, this entire area was a submerged barrier reef with a huge sandbar. As the sea levels dropped, sand and alluvial sediments accumulated, forming the flatland foundation for Kailua town, and Kawainui, no longer open to the ocean, was transformed from a pond into a marsh. Today the coral reef extends approximately a half mile outside of Lanikai, providing a protected sandy beach (Clark 2005:65). Two islands off of Lanikai are the Mokuluas (Moku Nui and Moku ʻIki), which are Hawaiʻi State Seabird Sanctuaries.

Because of the geological history of Kailua, soils of the current project area are classified as Beaches (BS), backed by Jaucus sand (JaC), and the project area lies entirely in Beaches (Foote et al. 1972) (Figure 3). The Beaches soil classification is described as follows:

> Beaches (BS) occur as sandy, gravelly, or cobbly areas on all the islands… They are all washed and rewashed by ocean waves. The beaches consist mainly of light-colored sands derived from coral and seashells. A few of the beaches, however, are dark colored because their sands are from basalt and andesite. Beaches have no value for farming. Where accessible and free of cobblestones and stones, they are highly suitable

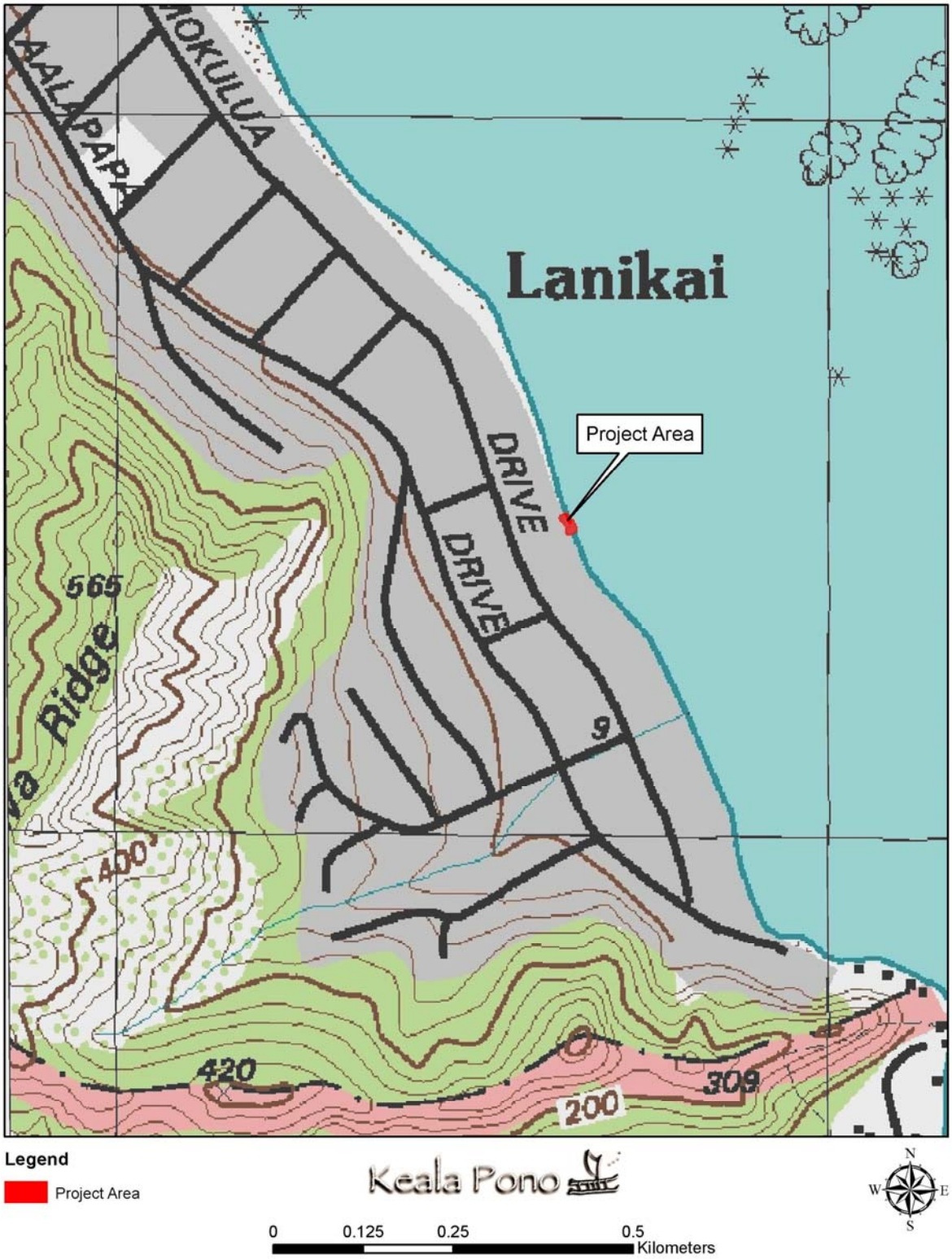
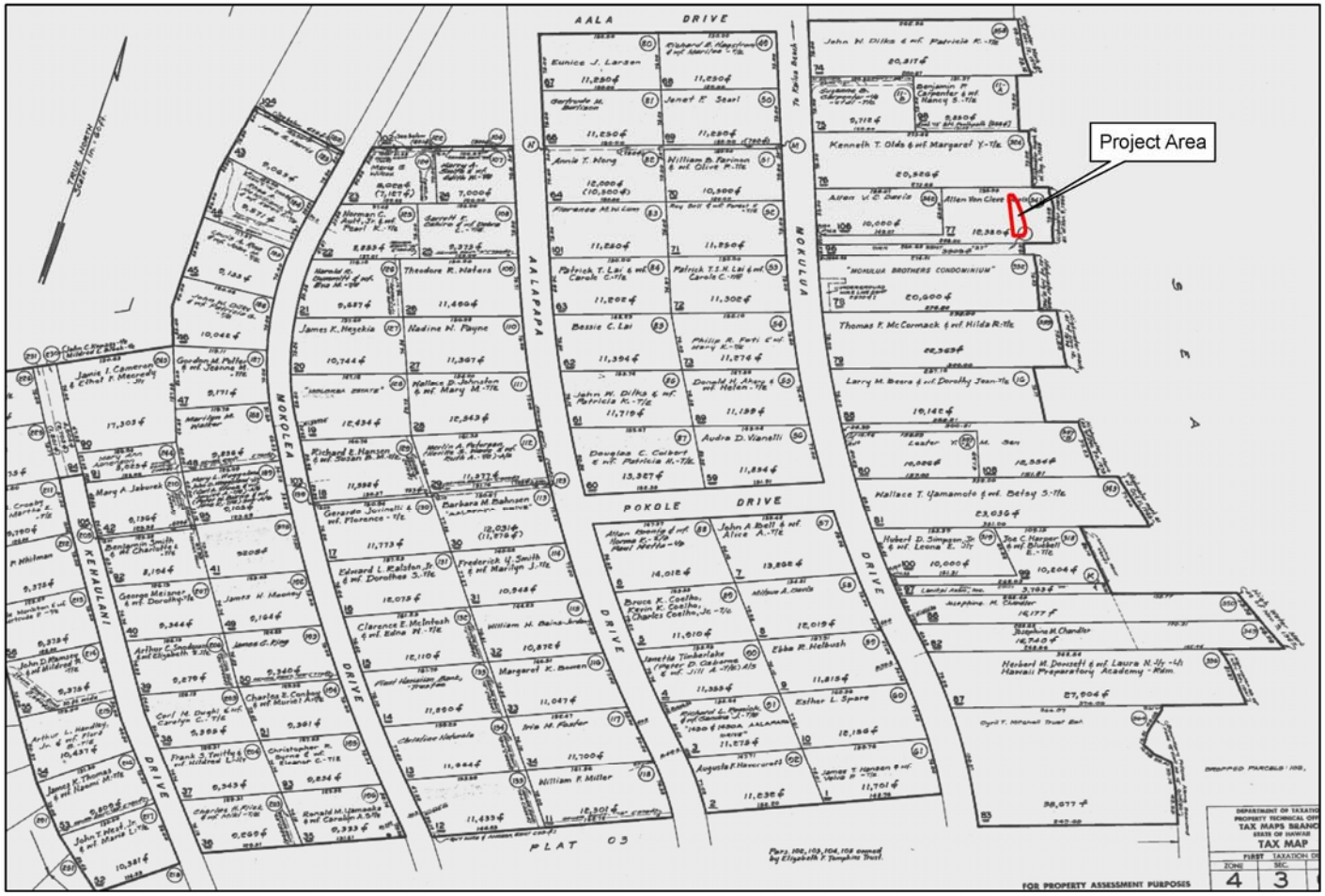


Figure 1. Project area on 1998 USGS quadrangle.



Legend

Project Area

0 0.05 0.1 0.15 0.2 Kilometers

Keala Pono

Figure 2. Project area (in red) shown on a portion of TMK plat (1) 4-3-13.

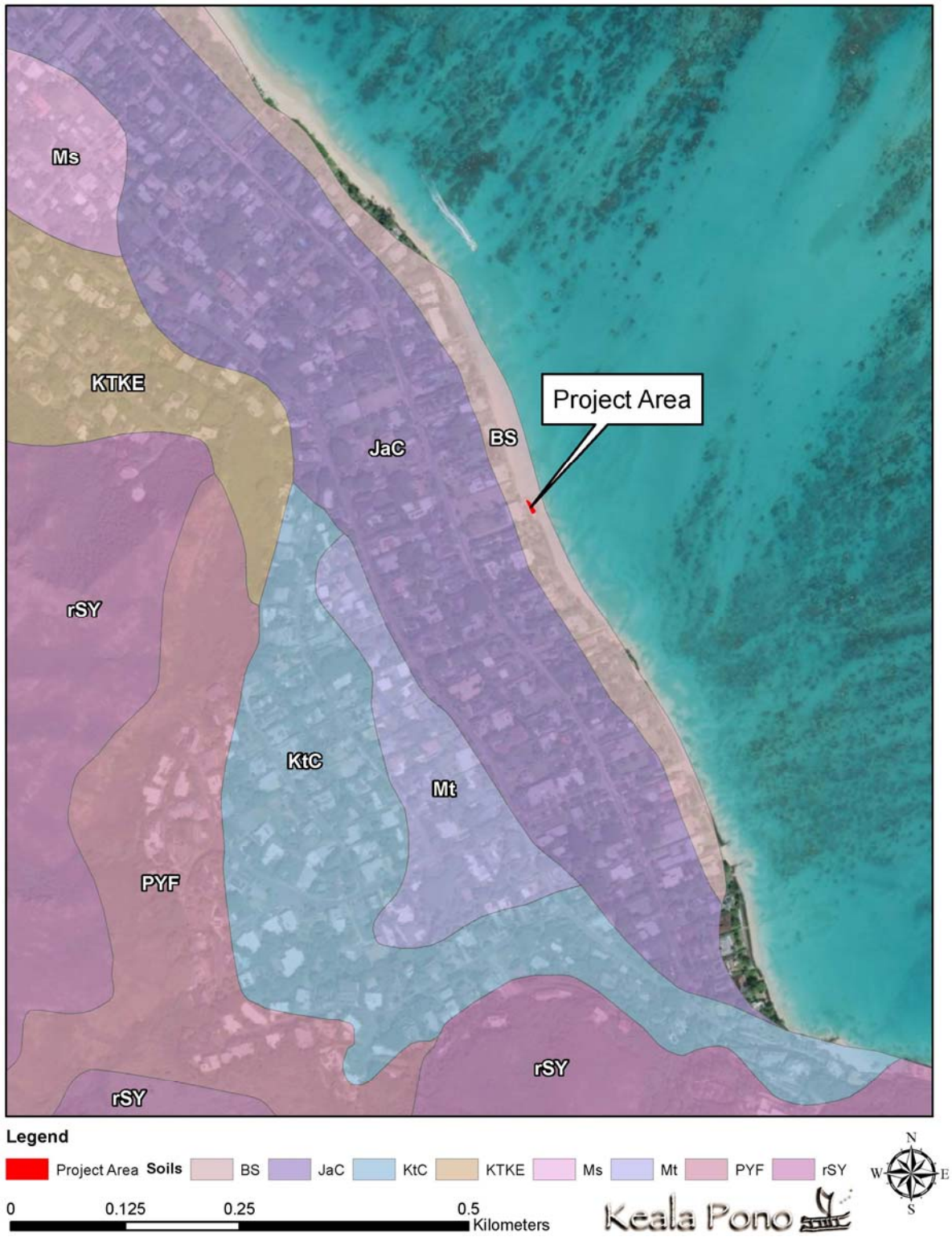


Figure 3. Soils in the vicinity of the project area. Data from Foote et al. (1972).

> for recreational uses and resort development. (Capability classification VIIIw, nonirrigated). (Foote et al. 1972:28)

Jaucus sands are described as "excessively drained soils that occur as narrow strips on coastal plains, adjacent to the ocean… developed in wind- and water-deposited sand from coral and seashells" (Foote et al. 1972:48). Jaucus sands are found from sea level to an elevation of 30 m (100 ft), and are further described as follows:

> Jaucus sand, 0 to 15 percent slopes (JaC) --- The slope range of this soil is 0 to 15 percent, but in most places the slope does not exceed 7 percent… In a representative profile the soil is single grain, pale brown to very pale brown, sandy, and more than 60 inches deep. In many places the surface layer is dark brown as a result of accumulation of organic matter and alluvium. The soil is neutral to moderately alkaline throughout the profile. Permeability is rapid, and runoff is very slow to slow. The hazard of water erosion is slight, but wind erosion is a severe hazard where vegetation has been removed. The available water capacity is 0.5 to 1.0 inch per foot of soil. In places roots penetrate to a depth of 5 feet or more. Workability is slightly difficult because the soil is loose and lacks stability for use of equipment. (Foote et al. 1972:48)

Topography of the project area is flat, with an approximately 3 m (10 ft) drop to the ocean on the east side. Rainfall in the project area averages 80 cm (31 in) per year (Giambelluca et al. 2013). The closest fresh water source to the project area is Mokulua Stream, a non-perennial watercourse which is approximately 320 m (.2 mi) away to the south.

BACKGROUND

This section provides an overview of the cultural and historical characteristics of the project area, including moʻolelo, place names, ʻōlelo noʻeau, a discussion of land use through time, historic maps, Māhele land documents, and summaries of previous archaeological studies. Research was conducted at the Hawaiʻi State Library, the University of Hawaiʻi at Mānoa libraries, the SHPD library, and online on the Office of Hawaiian Affairs website and the Waihona Aina, Huapala, and Ulukau databases. Archaeological reports, historic maps, and historical reference books were among the materials examined.

Kailua in the Pre-Contact Era

> Native traditions describe the formation (literally the birth) of the Hawaiian Islands and the presence of life on and around them, in the context of genealogical accounts… As this Hawaiian genealogical account continues, we find that these same god-beings, or creative forces of nature who gave birth to the islands, were also the parents of the first man (Hāloa), and from this ancestor, all Hawaiian people are descended. It was in this context of kinship, that the ancient Hawaiians addressed their environment. (Maly and Maly 2003)

The history of Kailua begins with the history of Oʻahu Island:

> Oʻahu is also a new name, given in memory of an ancestor of the people of Oʻahu. Lolo-imehani, Lalo-waia, and Lalo-oho-aniani were the ancient names of Oʻahu. Oʻahu was the child of Papa and Lua… and because Oʻahu was a good chief and the people lived harmoniously after the time of Wākea mā, Oʻahu's descendants gave the name of their good chief to the island --- Oʻahu-a-Lua. (Kamakau 1991:129)

Inoa ʻĀina: Place Names

There are other means, besides chanted genealogies and their accompanied stories, by which Hawaiʻi's history has been preserved. One often overlooked source of history is the information embedded in the Hawaiian landscape. Hawaiian place names "usually have understandable meanings, and the stories illustrating many of the place names are well known and appreciated… The place names provide a living and largely intelligible history" (Pukui et al. 1974:xii). Lanikai is situated between Alāla and Wailea Points in the ahupuaʻa of Kailua. The meanings of these place names and others in the vicinity are delineated in *Place Names of Hawaii*:

> Alāla. High point between Kailua beach and Lanikai, Oʻahu. A tall stone at the point is used by fishermen as a landmark to locate a fishing station at sea. *Lit*., awakening. (Pukui et al. 1974:9)
>
> Kaʻiwa….Peak and Ridge above Lanikai, Oʻahu, where frigate birds (*ʻiwa*) are often seen. (Pukui et al. 1974:70)
>
> Kaʻōhao. Old name for Lanikai, Oʻahu. *Lit*., the tying (two women were tied together here with a loincloth after being beaten in a kōnane game…). (Pukui et al. 1974:85)
>
> Kapoho….Point, Mōkapu Peninsula, Oʻahu, where salt was formerly obtained by evaporation of seawater. *Lit*., the depression. (Pukui et al. 1974:89)

> Lanikai. Section of Kailua, surfing beach, and elementary school, Mōkapu qd., Oʻahu. Development here began in 1924; the name was changed from Kaʻōhao to Lanikai, in the belief held that it meant ʻheavenly seaʼ …This is English word order; in Hawaiian the qualifier commonly follows the noun, hence Lanikai means ʻsea heaven, marine heavenʼ. (Pukui et al. 1974:129)
>
> Mokulua. Two islets (24.1 acres, 225 feet elevation) off Lanikai, Oʻahu. *Lit*., two islands. (Pukui et al. 1974:155)
>
> Wailea….Point between Lanikai and Waimānalo, Oʻahu. *Lit*., Water of Lea (canoe makers' goddess; also the name of a fish god that stands on this point). (Pukui et al. 1974:224)

Moʻolelo

Kailua is mentioned in several moʻolelo. Perhaps one of the most revealing aspects of the moʻolelo of Kailua is that they attribute many of the earliest construction works of the area, such as Ulupō Heiau and the islands and reef off of Lanikai, to the Menehune (Sterling and Summers 1978). The Menehune are a legendary race of small people originally from Kahiki that were brought to Oʻahu as servants to build things in Kailua and Pūowaina (Punchbowl) (Fornander 1969). Regarding the construction of the Mokulua Islands and reef, it is said that the Menehune began to build these for protection of the people, but after only one night of work the construction was never finished (McAllister in Sterling and Summers 1978). It can be debated whether or not the Menehune were literally small people, and whether or not they were brought to live in Kailua by force or decided to live there by their own free will, but what is more significant is that since they are of the earliest migrations to Hawaiʻi, the fact that they are credited with building many structures in Kailua suggests that Kailua is one of the earlier places of Oʻahu to be settled in pre-history.

Another migration to Kailua is chronicled by Kamakau. Perhaps this migration occurred after the Menehune because the names of the travelers and the name of their ship are still remembered:

> ʻO nā haole mua i ʻōlelo ʻia, ua hiki mai ma Koʻolau o Oʻahu, aia ma Kāneʻohe a me Kailua. I ka wā o ʻAuanini, ke aliʻi e noho ana ma Kapalawai [Kalapawai], ma Kailua, a ʻo Kaomealani ke aliʻi me Muaokalani, kāna wahine; e noho ana lāua ma Kaʻōpūloha i Kāneʻohe. Ua kū mai kekahi moku ma kai o Mōkapu, ʻo Ulupana ka inoa o ua moku lā; ʻo Mololana ke kāpena, a ʻo Mālaea ka wahine. A ʻo ka inoa o nā kānaka, ʻo ia hoʻi ʻo Olomana, ʻo Aniani a me Holokamakani; aia nō ko lākou mau inoa i kapa ʻia ma kekahi mau ʻāina a me nā puʻu kaulana. Na kēlā mau aliʻi i kapa i ko lākou mau inoa a hiki i kēia lā (Kamakau 1996:41).
>
> *The first foreigners, it is said, arrived at Koʻolau, Oʻahu, there at Kāneʻohe and Kailua, in the time of ʻAuanini, the chief who was living at Kapalawai [Kalapawai], at Kailua, and Chief Kaomealani with his wife Muaokalani, who were living at Kaʻōpūloha in Kāneʻohe. A ship anchored offshore of Mōkapu, Ulupana was the name of that ship; Mololana was the captain, and Mālaea was the wife. And the name of the people, they were Olomana, Aniani, and Holokamakani. Their names were indeed given to some lands and famous hills. Those were the chiefs who have given their names until today. [translation by D. Duhaylonsod]*

Several of the Kailua moʻolelo center on Kawainui. This implies the great significance of this resource to the history of the region. Like other fishponds, Kawainui was the home of a guardian spirit, also called a moʻo kiaʻi or akua moʻo. These guardian spirits looked after the well-being of

the people, ensuring that the land and/or sea would provide for the populace as long as the people remained good stewards. The guardian of Kawainui was a moʻo named Hauwahine, and Hauwahine's companion was the moʻo who dwelled near Kaʻelepulu Stream (Kelly and Nakamura 1981).

In addition to getting the benevolent help of their guardian spirits, the Kailua people also were assisted by the mythological tree, Mākālei. This tree came up from the sea, intending to go to Nuʻuanu. However, the shouting from the Menehune and other ʻeʻepa people caused Mākālei to fall near Kawainui. It became rooted there, and its magical powers attracted fish from the neighboring waters to the area (Kelly and Nakamura 1981).

So sustaining was the fishpond of Kawainui that even its mud was edible. The mud of Kawainui, or lepo ʻai ʻia, was purposely brought from Kahiki and put into the fishpond. According to a report by the Bishop Museum, a moʻolelo states that this mud even nourished Kamehameha and his warriors in more recent times:

> [The lepo ʻai ʻia mud] is found only there [at Kawainui]. When there was a shortage of taro in Kailua during the time Kamehameha and his warriors stayed there, the men of Kailua went to Kawainui Pond to get the edible mud. A strict kapu had to be imposed during diving for the mud. No one was allowed to utter a word at that time. If the kapu were broken, the ordinary mud in the pond would rise, cover the diver and drown him. (Kelly and Nakamura 1981:5)

The old name for Lanikai was Kaʻōhao, which translates to 'the tying,' in relation to part of the epic tale, "Story of Lonoikamakahiki" in the *Fornander Collection of Hawaiian Antiquities and Folklore* (Fornander 1916). Hauna, prophet of Lonoikamakahiki left Hawaiʻi island to sail to Oʻahu, where he landed in Lanikai and saw women playing kōnane with their husbands. Noticing that the women were going to win the game, he decided to make a wager and challenge them, first covering the board with a piece of kapa:

> The women said to Hauna "We have nothing to offer on our side excepting ourselves. If you beat us in this present unfinished game, you can take us as your property." Hauna then said: "I have two double canoes filled with things that are valuable; the chief articles of value on the canoes, however, are a large number of feather cloaks. If you two beat me, you two shall have the goods in the canoes together with the men on board." The women replied: "It is a bet." Hauna then said: "Let me make the first move"...But when the kapa was removed in order to continue the game, Hauna caught up some of the stones which gave the women the best advantage with the kapa. Hauna then made the first move and after a few more moves, the women were beaten. At this he said: "I have won you two."...Hauna took the women and tied them together with a loincloth and led them to the place where the canoes were lying. Because these women were led by Hauna, the place where this act took place was given the name Kaohao [Kaʻōhao] and it so remains to this day. The place is in Kailua, Koʻolaupoko, Oʻahu. (Fornander 1916:312, 314)

Lanikai was also home to a beautiful chiefess, Kaʻiwa, of which a hill in the area is named. Ahiki fell madly in love with Kaʻiwa and began coming to Lanikai to see her. One day, Kaulekoa of Kāneʻohe (also known as Kana) stopped Ahiki on his journey and that is why the peak named Ahiki stands in front of the other two, Mount Olomana and Pākuʻi (Sterling and Summers 1978).

In Lanikai, it is said that a cave at Alāla Point extends underground all the way to Mid Pacific Country Club, and that the cave was once used as a place of refuge (Sterling and Summers 1978).

Near the location of the cave, are several basalt and coral rocks collectively known as Kanepolū. According to moʻolelo, King Kamehameha III was fishing in Lanikai and staying in the cave. The king sent for a man named Kanepolū, who "was born, grew up, and died in one day" (Nawelu in Sterling and Summers 1978:238). The stones were set up as guardians to keep watch for the arrival of Kanepolū. However, Kanepolū arrived at the cave as night was beginning to fall, and he tripped on the coral stone and was killed. This stone represented his leg; the location of the rest of his body is unknown (Nawelu in Sterling and Summers 1978:238).

There was also a heiau at Alāla Point (McAllister 1933). When Kūaliʻi made this heiau kapu, a vast fire could be seen burning in the distance on Molokaʻi. Kūaliʻi was worried that the bright glow of the fire would prevent having a successful procession to the heiau, but his kahuna replied that the fire would die down if only Kūaliʻi was to say that it should be so. At these words, the kahuna prayed, and the fire subsided so that the procession could continue (Kamakau in Sterling and Summers 1978:238).

ʻŌlelo Noʻeau

Traditional proverbs and wise sayings, also known as ʻōlelo noʻeau, have been another means by which the history of Hawaiian locales have been recorded. In 1983, Mary Kawena Pukui published a volume of close to 3,000 ʻōlelo noʻeau or Hawaiian proverbs/wise sayings that she collected throughout the islands. The introductory chapter of that book reminds us that if we could understand these proverbs and wise sayings well, then we would understand Hawaiʻi well (Pukui 1983).

Only three ʻōlelo noʻeau concerning Kailua are recorded in Pukui's compilation. Two of these are suggested to commemorate Kamehameha's visits to Kailua after taking control of Oʻahu. The third ʻōlelo noʻeau does not pertain to any particular historical person, but rather, it points out the hau trees which grow at Kailua and the characteristics of the rope which can be made from its bark. Here are the sayings as they appear in Pukui's publication (1983:60, 193, 230).

> Hawaiʻi palu lāʻī.
>
> *Ti-leaf lickers of Hawaiʻi.*
>
> This saying originated after Kamehameha conquered the island of Oʻahu. The people of Kailua, Oʻahu, gave a great feast for him, not expecting him to bring such a crowd of people. The first to arrive ate up the meat, so the second group had to be content with licking and nibbling at the bits of meat that adhered to the ti leaves. In derision, the people of Oʻahu called them "ti-leaf lickers."
>
> Kini Kailua, mano Kāneʻohe.
>
> *Forty thousand in Kailua, four thousand in Kāneʻohe.*
>
> A great number. Said by a woman named Kawaihoʻolana whose grandson was ruthlessly murdered by someone from either Kailua or Kāneʻohe. She declared that this many would perish by sorcery to avenge him. Another version credits Keohokauouli, a kahuna in the time of Kamehameha, for this saying. He suggested sorcery as a means of destroying the conqueror's Oʻahu enemies.
>
> Mālama o ʻike i ke kaula ʻili hau o Kailua.
>
> *Take care lest you feel the hau-bark rope of Kailua.*
>
> Take care lest you get hurt. When braided into a rounded rope, hau bark is strong, and when used as a switch, it can be painful.

Ka Makani a me Ka Ua: The Wind and the Rain

With their lives closely connected to the natural environment and physical surroundings, Hawaiian winds and rains were individually named and associated with a specific place, region, or island. In *Hānau Ka Ua*, Akana and Gonzales (2015:xv) explain that kūpuna "knew when a particular rain would fall, its color, duration, intensity, the path it would take, the sound it made on the trees, the scent it carried, and the effect it had on people." The following wind and rain names associated with the project region offer further insight on kūpuna perspectives of the project area.

While several winds and rains are noted for the greater Kailua area, only one name was found that is specifically associated with Kaʻōhao (Lanikai). This is a rain known as Hāʻao, and it was mentioned in mele:

E nānā iho ana i Waipuʻilani	Gazing down on Waipuʻilani
E noho iho ana i Kaʻanaokāhinahina	Residing there at Kaʻanaokāhinahina
Eia au i ka ua a ka Hāʻao	Here am I in the Hāʻao rain
I walea ai i ke kui pua ʻāhihi	Delightedly stringing lehua ʻāhihi blossoms
He lei no Lea, wahine i ke kuahiwi	As a lei for Lea, woman of the mountain

> From a mele by Kapauakanoa…Note: "Lea is both the name of a goddess of canoe makers and the name of a fish god who stands in Wailea ("Water of Lea") Point between Kaʻōhao in Kailua and Waimānalo, Oʻahu… (Akana and Gonzalez 2015:27–28)

Rains of other parts of Kailua are ʻĀpuakea, Kapuaʻikanaka, and Kuahine (Akana and Gonzalez 2015). A wind of Kailua is Malanai, described as a gentle tradewind breeze (Nakuina 2005).

Traditional Land Use

In early Hawaiian history, Oʻahu's windward coast was noted for its "many attractive bays, beaches, and stream-watered lowlands and valleys all the way from Kailua to Laʻie" (Handy et al. 1991:268). Bays throughout Hawaiʻi, such as that at Kailua, "generally had a cluster of houses where the families of fishermen lived" (Handy et al. 1991:287). But the added abundant resources of Kailua's perennial streams and thriving fishponds clearly promoted a regional population that was greater than that of other areas. The ahupuaʻa of Kailua, along with Kāneʻohe, "was rich in fishponds and tillable lands, [and it] was the seat of the ruling chiefs of Koʻolaupoko (Short Koʻolau) which was the southern portion of the windward coast" (Handy et al. 1991:272). Handy et al. further illustrate why the Kailua area was a favorable place to live, citing not only the fishponds and streams but also the extensive wetlands, which were converted into agricultural terraces:

> Undoubtedly further reasons for the attractiveness of Kailua as a place of residence for an aliʻi nui with his large entourage were the great natural fishponds, Kaʻelepulu and Kawainui, and the complex of artificial salt-water ponds that are between Kailua and Kaneʻohe in the Mokapu area: Halelou, Nuʻupia, and Kaluapuhi. Kailua must formerly have been very rich agriculturally, having one of the most extensive continuous terrace areas on Oahu, extending inland one and a half miles from the margin of Kawainui Swamp. Terraces extended up into the various valleys that run back into the Koʻolau range. There were some terraces watered by springs and a small stream

> from Olomana mountain along the western slope of the ridge that lies southeast of Kawainui Swamp, and another system of terraces was east of the seaward end of the ridge, watered by the stream which joins Kawainui and Ka‘elepulu Ponds. There were also terraces north of the Kawainui Pond, and several terrace areas flanked Ka‘elepulu Pond at the base of the ridge to the eastward. (Handy et al. 1991:457)

From mountain to sea, the district of Kailua also had its fair share of religious structures to serve the needs of its large population. At the entrance of Lanikai, Alāla Heiau was thought to have been located on Alāla Point. McAllister (1933:190) states that “Tradition for ages past has credited the heiau of Alala...as having the distinction of being the temple where the ceremonies attending the royal birth of Kualii, about 1640, were performed, but of which no traces of any kind now remain...” According to McAllister (1933), no evidence or other features are present in that area. Charles Kamanu Sr., Solomon Mahoe Jr., and Nawelu also mention a cave used for refuge at Alāla Point, the entrances of which are now obstructed (Sterling and Summers 1978).

Furthermore, there were natural shrines on the hillsides named Alāla and Waile‘a. These were said to be used as lookouts by fishermen, as told in a 1939 account:

> The fishermen of old watched this big rock on the hill [Alāla] and Waile‘a another natural shrine a distance away at a place called Waile‘a, to locate the best fishing grounds in the sea. “It is too bad,” said Mrs. Ailona, “to deprive Alāla of an unobstructed view of the sea [speaking of a large house blocking the view], for Alāla is not only a shrine but a ‘fish’ god. So is Waile‘a.” (Charles in Sterling and Summers 1978:239)

Charles went on to say that the Waile‘a shrine was situated above “Hale Aloha,” where an old road was once located (Charles in Sterling and Summers 1978:239). Charles would use the road to participate in hukilau when she was young.

Between 1435 and 1508 Mokulua Drive, very close to the project area, it is said that there was once a stream which drained out into the sea, and the area was called Punawai (Mahoe in Sterling and Summers 1978). “In the olden days the women lived here at Punawai while their menfolk practiced spear-throwing at Ka‘ohao. The men were under kapu during these practice sessions, coming to their women only on weekends…” (Mahoe in Sterling and Summers 1978).

Kailua in the Historic Era

When the first Westerners arrived in the Hawaiian archipelago in 1778, the islands were not yet united under one sovereign. At that time, Kailua and the entire island of O‘ahu were under the rule of Chief Kahahana. In 1783, Chief Kahahana’s reign was ended with the invasion and victory of Chief Kahekili of Maui. This would forever be the end of O‘ahu’s independence as a separate island kingdom. When Chief Kahekili died in 1794, control of O‘ahu went to his son Kalanikūpule. The following year, Chief Kamehameha of Hawai’i Island invaded O‘ahu to engage Kalanikūpule in battle. Kamehameha overwhelmed Kalanikūpule’s warriors, effectively gaining control of all the islands from Hawai‘i to O‘ahu. Eventually, Kamehameha would make a peaceful agreement with Chief Kaumuali‘i of Kaua‘i, bringing that island and Ni‘ihau into the fold and thereby uniting the Hawaiian archipelago under one rule (Kamakau 1996, Kanahele 1995).

Early Historical Accounts of Land Use in the Kailua Area

It is recorded that in 1778 James Cook became the first westerner to see the Hawaiian Islands. Following Cook, a wave of other western explorers landed on Hawai‘i’s shores. In 1779, William Bligh, the “sailing master of the HMS Resolution, and his fellow crewmembers, are the first Westerners to get a look at the shores and hills of Kailua ahupuaa” (Hall 1998:22). The midshipman George Gilbert remarked about the cultivation of the land and the relative lack of trees seen:

> The interior part is hilly, the shore low and exceeding(ly) well cultivated but very bare of wood. The Natives here don’t appear to be very numerous and as soon as we came near the land they ventured onboard, without any hesitation and were very friendly… and in the evening sailed from the island; which is called by the Natives Oowahoo. (Gilbert in Hall 1998:22)

Around the same time as the arrival of the first westerners to Hawai‘i, O‘ahu was experiencing major political changes. It was during this time, as mentioned above, that O‘ahu’s sovereignty ended with the invasion of the Maui chiefs, and the Maui rule was subsequently overcome by the invasion of the forces from Hawai‘i Island. Yet throughout this tumultuous period, Kailua remained an important seat of O‘ahu governance. Kailua retained its prominence after the invasion of Kahekili from Maui in 1783:

> In historic times Kahekili, the high chief of Maui, battled the O‘ahu chiefs and finally killed Kahahana, taking his place as high chief [of O‘ahu]… [Kahekili] chose… and settled in Kailua with several of his supporting chiefs. (Kelly and Nakamura 1981:6)

And a decade later, after the invasion of Kamehameha from Hawai‘i Island, Kailua again retained its significance as a place of rule. Kamehameha not only lived and ruled from there, but the new king himself also worked in the fishponds of Kailua as an encouragement to his chiefs and commoners to be productive and raise food:

> The last, and most notable, chief who had attachments to Kailua and to Kawainui was Kamehameha I. He conquered O‘ahu in 1795, and had the problem of feeding the members of his retinue, far away from their homes on the Island of Hawai‘i. Kamehameha I encouraged the development of the natural resources of O‘ahu to provide his chiefs and followers with sufficient food… While he [Kamehameha] lived on Oahu he encouraged the chiefs and commoners to raise food and he went fishing and would work himself at carrying rock or timber. They all saw that he labored himself with his own hands. He worked at the fishponds at Kawainui, [and] Ka‘elepulu. (Kelly and Nakamura 1981:7)

When Kamehameha died in 1819, his windward lands were divided between his sons Liholiho and Kauikeaouli. Kailua Ahupua‘a went to the younger son, Kauikeaouli, who would later become Kamehameha III (Hall 1998).

Land Ownership and Māhele Land Tenure

The change in the traditional land tenure system in Hawai‘i began with the appointment of the Board of Commissioners to Quiet Land Titles by Kamehameha III in 1845. The Great Māhele took place during the first few months of 1848 when Kamehameha III and more than 240 of his chiefs

worked out their interests in the lands of the Kingdom. This division of land was recorded in the Māhele Book. The King retained roughly a million acres as his own as Crown Lands, while approximately a million and a half acres were designated as Government Lands. The Konohiki Awards amounted to about a million and a half acres, however title was not awarded until the konohiki presented the claim before the Land Commission.

In the fall of 1850 legislation was passed allowing citizens to present claims before the Land Commission for lands that they were cultivating within the Crown, Government, or Konohiki lands. By 1855 the Land Commission had made visits to all of the islands and had received testimony for about 12,000 land claims. This testimony is recorded in 50 volumes that have since been rendered on microfilm. Ultimately between 9,000 and 11,000 land claims were awarded to kamaʻāina totaling only about 30,000 acres and recorded in ten large volumes.

Although the Māhele had specifically set aside lands for the King, the government, and the chiefs, this did not necessarily alienate the makaʻāinana from their land. On the contrary, access to the land was fostered through the reciprocal relationships, which continued to exist between the commoners and the chiefs. Perhaps the chiefs were expected to better care for the commoners' rights than the commoners themselves who arguably might have been more ignorant of foreign land tenure systems. Indeed, the ahupuaʻa rights of the makaʻāinana were not extinguished with the advent of the Māhele, and Beamer points out that there are "numerous examples of hoaʻāina living on Government and Crown Lands Post-Mahele which indicate the government recognized their rights to do so" (Beamer 2008:274).

> Hoaʻāina who chose not to acquire allodial lands through the Kuleana Act continued to live on Government and Crown Lands as they had been doing as a class previously for generations. Since all titles were awarded, "subject to the rights of native tenants." The hoaʻāina possessed habitation and use rights over their lands. (Beamer 2008:274)

For those commoners who did seek their individual land titles, the process that they needed to follow consisted of filing a claim with the Land Commission; having their land claim surveyed; testifying in person on behalf of their claim; and submitting their final Land Commission Award to get a binding royal patent. However, in actuality, the vast majority of the native population never received any land commission awards recognizing their land holdings due to several reasons such as their unfamiliarity with the process, their distrust of the process, and/or their desire to cling to their traditional way of land tenure regardless of how they felt about the new system. In 1850, the king passed another law, this one allowing foreigners to buy land. This further hindered the process of natives securing lands for their families.

Hundreds of land claims up and down windward Oʻahu were awarded to commoners. In the Koʻolaupoko District, 199 awards were "granted in the Kailua and Waimanalo ahupuaʻa, each averaging roughly 10 acres" (Hall 1998:53). However, most of the windward Oʻahu lands went to Kamehameha III's queen, Kalama, and to several of the other high chiefs. Kailua in particular found Queen Kalama as its dominant landholder, followed by Princess Kamāmalu. Their land claims in Kailua are described as follows:

> Kamamalu submitted her claims for the ili of Kaelepulu and Keolu; while Kalama's claims included Kawainui and the ili of Mokapu, Oneawa, and Keahupuaanui. (Hall 1998:52)

There are no Land Commission Awards (LCAs) near the project area. This may be due to the arid environment, as many LCAs on the windward side of Oʻahu were situated along streams where wetland taro agriculture could be practiced.

Historic Land Use

Following the Resident-Alien Act in 1850 which allowed foreigners to "purchase (for the first time) fee simple lands in the islands… title to much of the land, which had only recently been made available to Hawaiian alii and commoners, is lost forever as it is passed into the hands of the newly arrived" (Hall 1998:54). The cultivation of both sugarcane and of pineapple, which would come after the turn of the century, would be attempted in Kailua but neither would be productive. Within a decade, the Chinese laborers moved off of Kāneʻohe plantations and started rice-farming operations in Kailua.

> Chinese cane laborers from the Kaneohe plantations have been permitted to begin establishing rice paddies in Kailua's Kaelepulu pond area and the Kawainui marshes… Wetland taro, which had been actively cultivated in the Kaelepulu and Kawainui marshes for nearly 500 years, will shortly be thoroughly displaced in the ponds and wetlands for the new cash crop. (Hall 1998:62)

Besides large-scale agricultural enterprises, Kailua also saw the imprint of the cattle industry. By the end of the 1800s, ranching operations found their foothold on the Kailua flatlands. J.P. Mendonca and C. Bolte partnered and approached the Kailua landowner D. Rice "to lease 15,000 acres of Kailua's central landholdings to raise Angus beef cattle… [their future company] will come to own practically all of Kailua, except for the lands held by the Bishop Estate" (Hall 1998:91).

Two historic maps were found that date to this time period. The first one is dated 1899 (Figure 4). It shows the smaller divisions of land within the district of Kailua. The current project area is located within the subdivision labeled as Mokulua, with an area called Alaapapa adjacent to the west. The map shows that numerous Land Commission Awards recognized throughout Kailua, although none are located in Mokulua.

The second map dates to 1900 (Figure 5). Like the previous map, this one shows the traditional names of the many ʻili throughout the ahupuaʻa. The map confirms what other textual references say, that the aliʻi residents of Kailua, such as Queen Kalama and Princess Kamāmalu, held onto their Kailua landholdings. However, other Kailua parcels clearly show that they have been bought by foreigners by that time. The land division of Mokulua is not shown on this map, and it appears that Alaapapa covers the two land divisions shown on the earlier map. A road that leads into Lanikai is labeled "Ala Aupuni."

A historic map of an unknown date illustrates the fisheries of Koʻolaupoko (Figure 6). This map focuses on the marine resources of the region and names the Alaapapa Fishery and Kailua (B) Fishery in Lanikai, with the project area belonging to the latter. Inland is the Kaelepulu Fishpond, where the subdivision of Enchanted Lakes is today. The road that loops around Lanikai is in place at this time, although none of the connecting streets within the loop or surrounding streets are shown.

In the first decade of the 20th century, the copra industry was also started in Kailua, beginning with the planting of 10,000 coconut trees in 1908, where Kalaheo and Oneawa streets are today, in a grassy expanse of sand flats (Hall 1998:113). The next year, investors planted an additional 130,000 trees, many of which were imported from Samoa, and all of these coconut trees were "laid out on 320 acres behind the 4-mile stretch of Kailua's shoreline…The 140,000 plantings, each with a life span of 100 years, will shortly lend the area its name of Coconut Grove" (Hall 1998:113, 123).

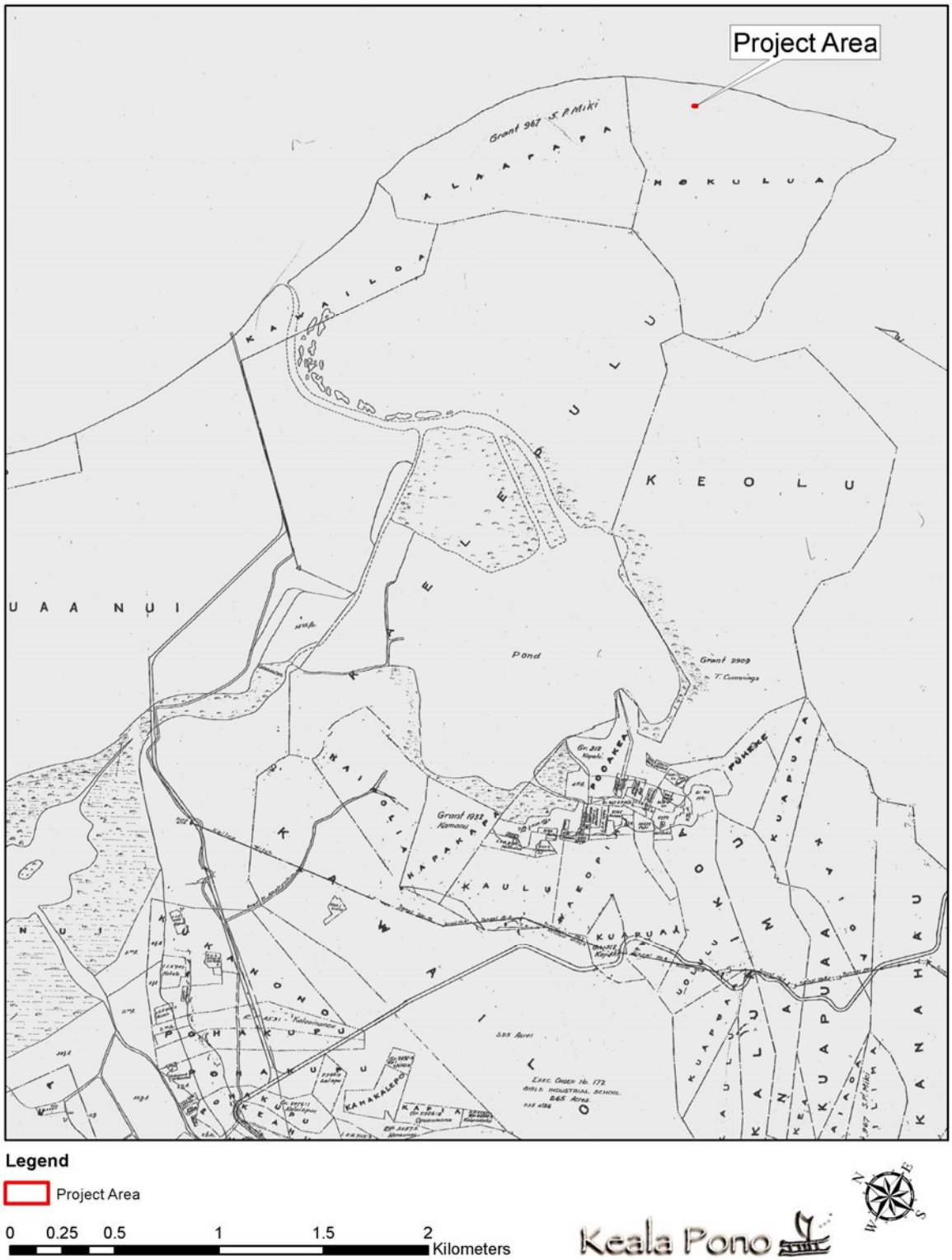


Figure 4. Portion of an early Kailua map (Wall 1899).

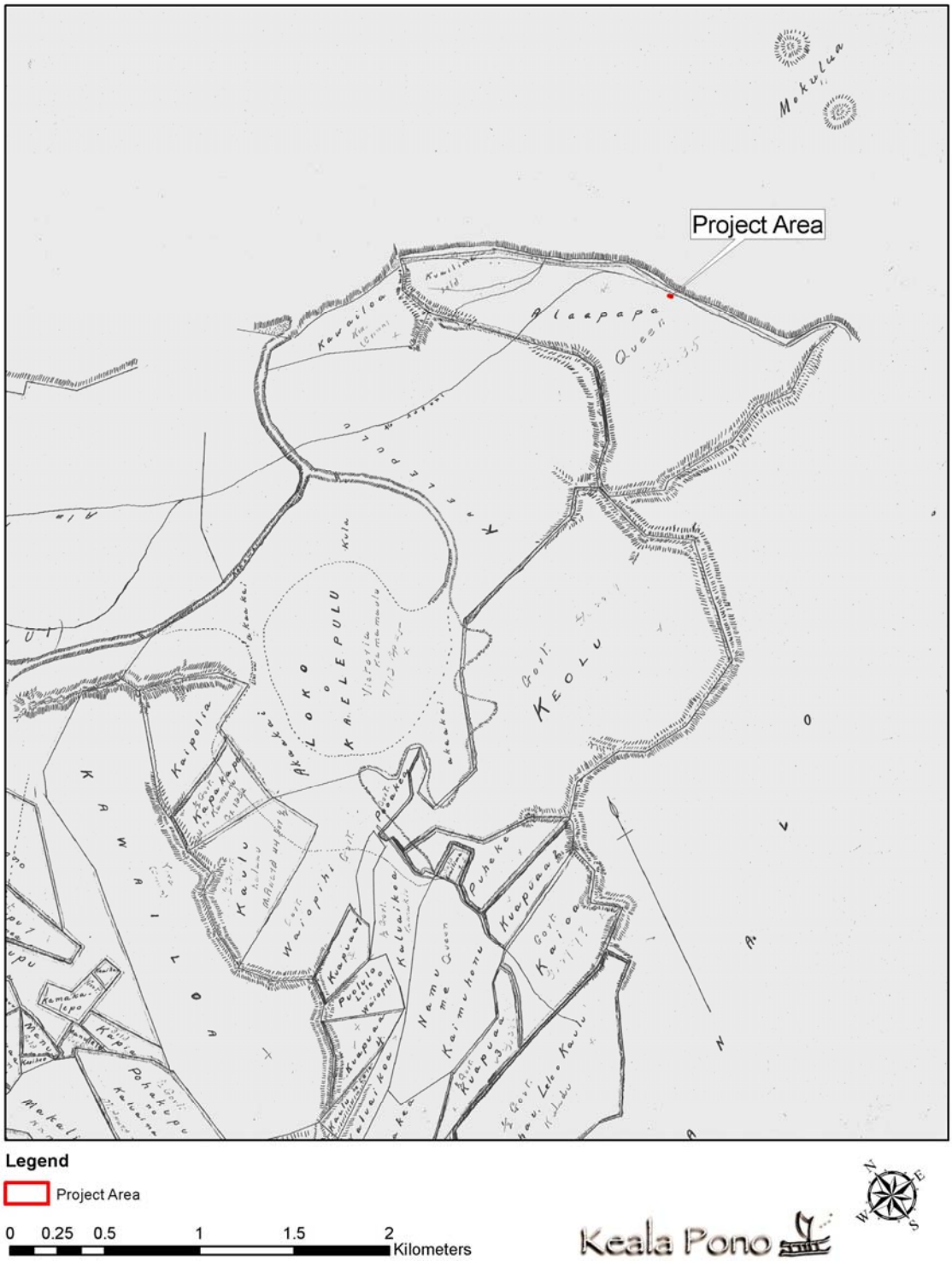


Figure 5. Portion of an early Kailua map (King 1900).

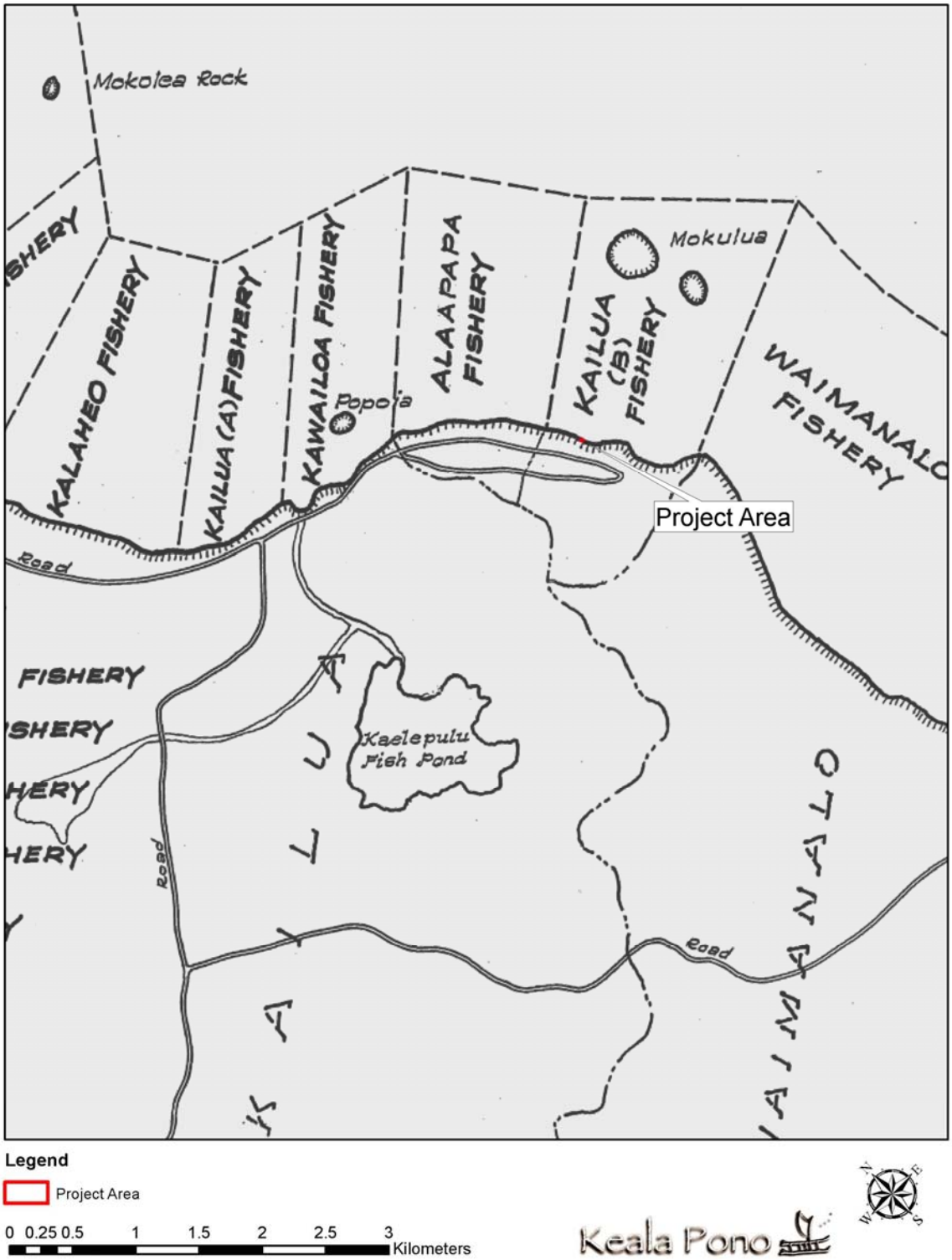


Figure 6. Portion of an Koʻolaupoko fisheries map (Dunn n.d.).

Expanding out of the cattle ranching enterprises, Arthur Rice and Harold Castle established the earliest dairies in the coastal regions of Kailua. This occurred around 1910, with dairies located at today's Coconut Grove area noted above (Kailua Historical Society 2009:182). Later, in the 1920s, the Campos family added their family dairy to the operations in Kailua, leasing land from Ka'elepulu and Olomana all the way to Bellows Beach in Waimānalo. "Initially, they trucked their raw milk to Meadow Gold (Dairymen's) in Honolulu for processing, but in the early 1950s the Campos, Moanalua, and Rico dairies united to form the Honolulu-based Foremost Dairy (Kailua Historical Society 2009:183).

Interestingly, as early as 1910 there was speculation of turning Kailua into a dream vacation destination of sorts. That year, "thirty-three 1-acre beachfront Kailua properties along Kalaheo Road are advertised in Honolulu for lease to those who wish to build summer cottages for their families on Kailua Bay's secluded 4-mile stretch of beach" (Hall 1998:117). In 1917, after the demand for coconut oil declined causing a decrease in copra profits, Arthur Rice of the Hawaiian Copra Company "plans to develop subdivision of 'tract housing' in the flat open coconut orchards… He initiates the first steps that, over time, will see Kailua become a year-round residential town… [and he] will become recognized as the founding father of what will develop as residential Kailua" (Hall 1998:123–124).

In 1924, development began in Ka'ōhao by Charles R. Frazier, who urbanized 311 acres, creating the upscale beachfront community of Lanikai that we know today (Clark 2002). Frazier chose the name Lanikai, thinking that the word translated to 'heavenly sea,' although the literal translation is more like 'sea heaven' or 'marine heaven' (Pukui et al. 1974:85). In 1926 a faux lighthouse was erected at the entrance to Lanikai, at Alāla Point, as a monument. Although the structure resembles a lighthouse, it does not function as such. Designed by the famous local architect Hart Wood, the structure still stands today and has been nominated to the National Register of Historic Places (NRHP).

What are now known as the "Lanikai Pillboxes" were constructed in the 1940s as observation bunkers for Battery Wailea and the nearby Bellows Field (Young 2015). Battery Wailea, situated at Waile'a Point, was armed with two guns and was operational for only a few years, between 1942 and 1945. The observation bunkers, located on Ka'iwa Ridge, were referred to as Fire Control Station Podmore, named after a nearby triangulation station (Young 2015).

Intense real estate development in Kailua occurred in the 1950s when the Pali Highway was built and tunnels were bored through the Ko'olau Mountains. This development soon displaced many of the agriculture and ranching enterprises of Kailua (Kailua Historical Society 2009:191–192).

Previous Archaeology

Several archaeological studies have been carried out in Lanikai, as summarized below. Each study is listed in Table 1 and illustrated in Figure 7. State Inventory of Historic Places (SIHP) numbers are prefixed by 50-80-11 (Figure 8).

The earliest archaeological work in the vicinity of the project area is from an island-wide survey conducted by J.G. McAllister (1933). Some of this work was based on descriptions of heiau provided by T.G. Thrum in various articles published in *Thrum's Hawaiian Almanac and Annual*.

McAllister identified one archaeological site in Lanikai, Alala Heiau (Site 378), and quoted Thrum's description of the heiau, although both Thrum and McAllister did not find any physical evidence of the site (McAllister 1933:190):

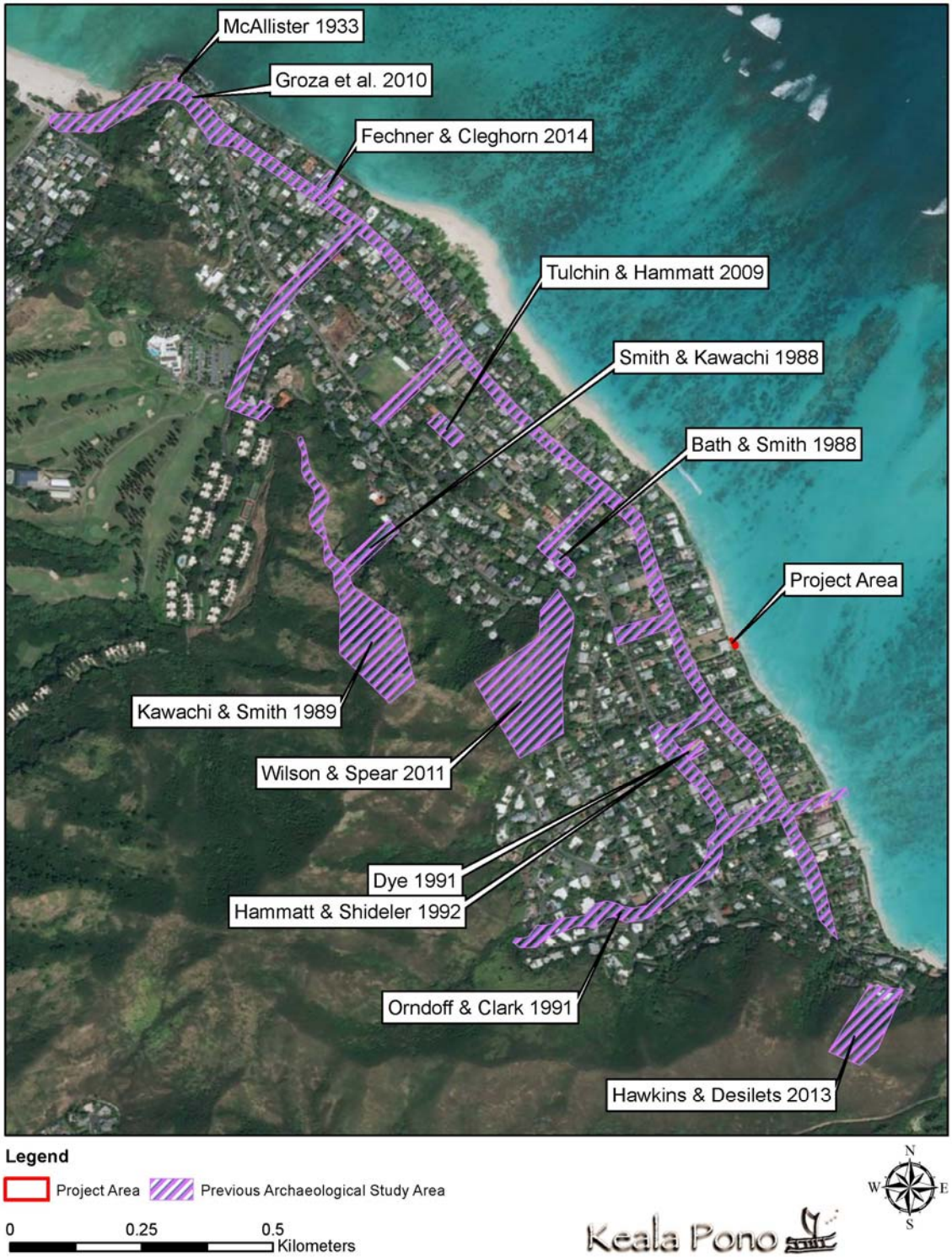


Figure 7. Previous archaeology in the vicinity of the project area.

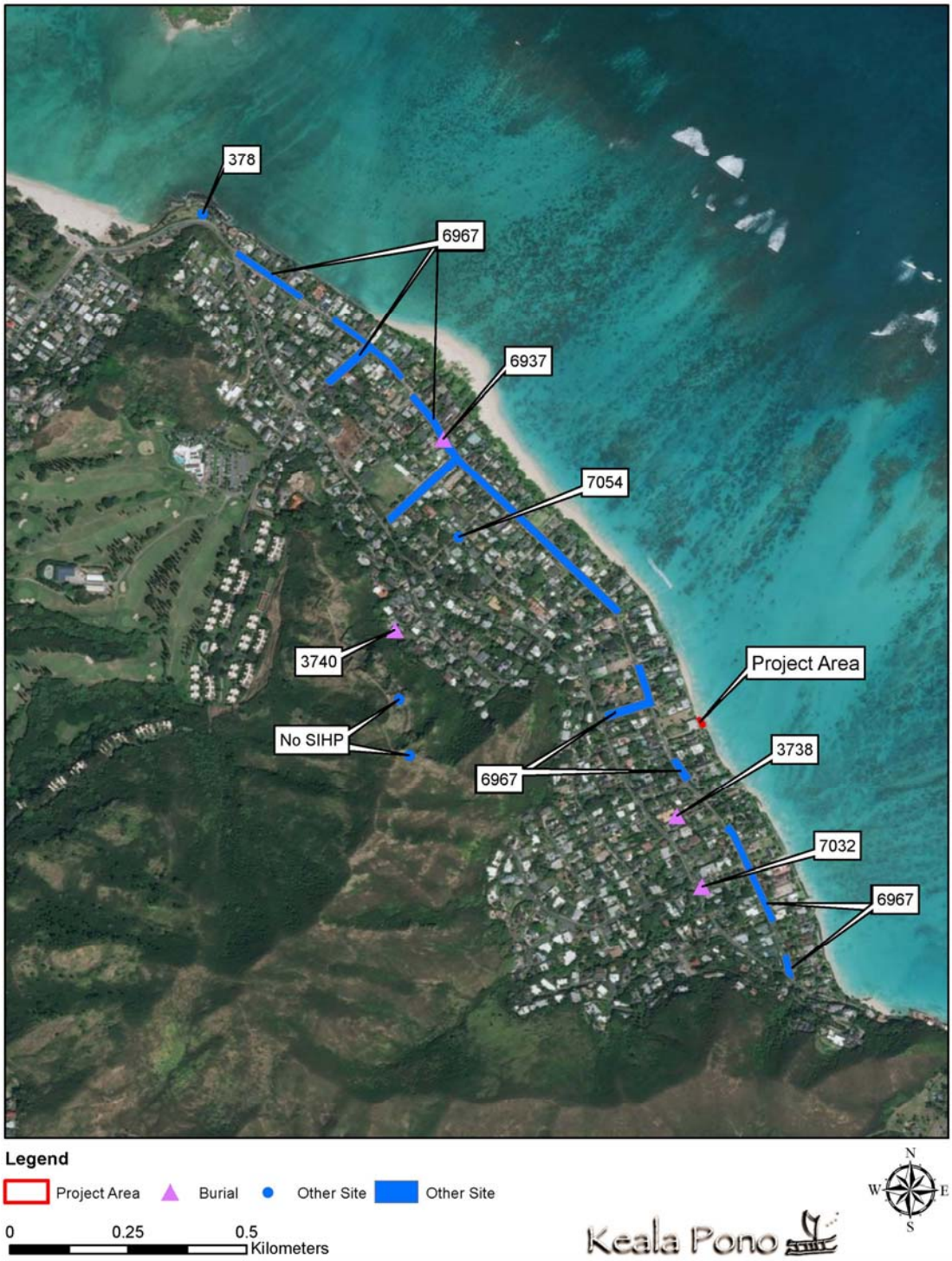


Figure 8. Previously recorded sites in the vicinity of the project area.

Table 1. Previous Archaeology in Lanikai

Author	Location	Work Completed	Findings
McAllister 1933	Island-Wide	Survey	Noted Alāla Heiau (Site 378) in Lanikai.
Bath & Smith 1988	Koʻohoʻo Pl.	Burial Report	Reported on the inadvertent discovery of human remains, SIHP 3738.
Smith & Kawachi 1988	1063 Koʻohoʻo Pl.	Burial Report	Recorded the inadvertent discovery of human remains, SIHP 3740
Kawachi & Smith 1989	Kaiʻwa Ridge	Field Check	Noted WWII bunkers; no SIHP numbers were assigned.
Dye 1991	1414 Aʻalapapa Dr.	Burial Report	Reported on the disinterment of human burials, SIHP 3738.
Orndoff & Clark 1991	Poʻopoʻo Gulch	Literature Review with Monitoring Findings	None.
Hammatt & Shideler 1992	1414 Aʻalapapa Dr.	Burial Report	Reported on the disinterment of human burials, SIHP 3738.
Tulchin & Hammatt 2009	136 Haokea Dr.	Archaeological Inventory Survey	Identified a pre-contact hearth, SIHP 7054.
Groza et al. 2010	Mokulua Dr., Multiple TMK	Archaeological Monitoring	Identified two sets of human remains (SIHP 6937 and 7032) and a subsurface cultural layer (SIHP 6967).
Wilson & Spear 2011	End of Kehaulani Dr.	Archaeological Inventory Survey	None.
Hawkins & Desilets 2013	1611 Mokulua Dr.	Archaeological Inventory Survey	None.
Fechner & Cleghorn 2014	860 Mokulua Dr.	Archaeological Inventory Survey	None.

Site 378. Alala heiau, said to have been at Alala Point, Kailua. When the site was indicated by Solomon Mahoe, my reaction was similar to that already expressed by Thrum:

> Tradition for ages past has credited the heiau of Alala…as having the distinction of being a temple where the ceremonies attending the royal birth of Kualii, about 1640, were performed, but of which no traces of any kind now remain…The site to which we were directed, while convenient and appropriate for a koʻa or fisher-folks' heiau, gave no evidence by stones of the vicinity, contour of the hill at the point shown, or other feature, of ever having been the location of a temple of the importance alleged.

In Hawaiʻi, sandy areas near the ocean are often related to traditional Hawaiian burials. Inadvertent discoveries of human remains have been documented in and around Lanikai and the current project

area, making these findings of particular significance. A single burial at Koʻohoʻo Place was designated as SIHP 3740 and disinterred (Smith and Kawachi 1988). Another single burial was found at the base of the hill near the end of Koʻohoʻo Place and designated as SIHP 3738 (Bath and Smith 1988). Human burials encountered nearby at Aʻalapapa Drive were subsumed under the SIHP 3738 site number (Dye 1991, Hammatt and Shideler 1992). This latter find included the remains of at least three individuals, all of which were disinterred. Two sets of human remains found on Mokulua Drive were designated as SIHP 6937 and 7032, respectively (Groza et al. 2010).

Other archaeological resources known for Lanikai include a subsurface cultural layer, a hearth, and two WWII bunkers. The cultural layer was found during archaeological monitoring that identified the two sets of human remains on Mokulua Drive (Groza et al. 2010). It was designated as SIHP 6967. The hearth was recorded during an archaeological inventory survey at Haokea Drive (Tulchin and Hammatt 2009). It was designated as SIHP 7054. The two WWII bunkers were identified during a field check of Kaʻiwa Ridge, although no SIHP numbers were assigned (Kawachi and Smith 1989). They are known today as the Lanikai Pillboxes, the history of which is noted above.

Other studies in Lanikai did not yield any findings. These consist of a literature review that also presented archaeological monitoring findings for Poʻopoʻo Gulch (Orndoff and Clark 1991), a pedestrian survey at the end of Kehaulani Drive (Wilson and Spear 2011), a survey that excavated 11 backhoe trenches on Mokulua Drive (Hawkins and Desilets 2013), and a survey that excavated two backhoe trenches also on Mokulua Drive (Fechner and Cleghorn 2014).

Summary of Background Information

Place names, moʻolelo, historic maps, and previous archaeological reports are among the sources that provide information on the pre- and post-contact use of Lanikai. Kailua once supported a sizeable population and has been associated with aliʻi in times past. The ocean and coast provided marine food sources, which were a main part of the traditional diet. Although Lanikai is relatively dry today, a stream was once located near the project area. This provided fresh water and may have been used to water crops. A heiau once stood at Alāla Point, and fishing lookouts were situated on Alāla and Waileʻa Points, on either end of Lanikai. Human burials are known to occur in sandy areas along the coast and elsewhere.

Anticipated Findings and Research Questions

Because of the modern use of the project area as a landscaped lawn, it is not likely that surface archaeological resources remain. Although no previous archaeological fieldwork has been done specifically within the project area, studies conducted nearby can help inform on the kinds of subsurface archaeological resources that may be found. Previous archaeological research nearby has identified human burials, a subsurface cultural layer, and a hearth These might be expected within the project area as well. Human burials may or may not be defined by a burial pit. They may be whole burials or fragmentary in nature. Cultural layers are characterized by darkened sediment, often with charcoal fragments, midden, and/or artifacts within the layer. Cultural layers might also contain features such as hearths. These are often bowl-shaped in cross-section and may contain fire-cracked rock in addition to darkened sediment and charcoal.

Research questions will broadly address the identification of the above archaeological resources and may become more narrowly focused based on the kinds of resources that are found. Initial research questions are as follows:

1. Are there subsurface cultural deposits or evidence of human burials within the survey area? Where are they located and what time period do they belong to?
2. Are there any vestiges of historic-era use of the project area, particularly surface remains or subsurface deposits associated with military use of the coastline?

Once these basic questions are answered, additional research questions may be developed in consultation with SHPD, tailored to the specific kinds of archaeological resources that occur in the project area.

METHODS

Pedestrian survey and subsurface testing were conducted on April 11, 2018 by Windy McElroy, PhD, Dietrix Duhaylonsod, BA, Jeffrey Lapinad, and Danielle Shemesh, BA. McElroy served as Principal Investigator, overseeing all aspects of the project.

For the pedestrian survey, the ground surface was visually inspected for surface archaeological remains, with transects walked for the entire area. Archaeologists were spaced approximately 2 m apart. Of the 65 m^2 (700 ft^2) survey area, 100% was covered on foot. Vegetation was very light, consisting of landscaped grass with a few large coconut trees and naupaka bushes, and did not affect visibility.

Test units (TU) were excavated in three locations throughout the project area. The excavation strategy was approved by SHPD beforehand via email but modified on the day of the survey because of preliminary findings. The modification of the excavation strategy was also approved by SHPD. Three 1 x 1 m units were hand-excavated with flat-bladed shovels and trowels, in 10 cm increments (Figure 9). All sediment was screened through 1/4-inch mesh. Vertical provenience was measured from the surface, and test units were excavated to as deep as safely possible. Profiles were drawn and photographed, and sediments were described according to USDA standards, using Munsell soil color charts and a sediment texture flowchart (Thien 1979). Test unit locations were recorded with a 3 m-accurate Garmin GPSmap 62st, and all units were backfilled after excavation.

The scale in all field photographs is marked in 10 cm increments. The north arrow on all maps points to magnetic north. Throughout this report rock sizes follow the conventions outlined in *Field Book for Describing and Sampling Soils*: Gravel <7 cm; Cobble 7–25 cm; Stone 25–60 cm; Boulder >60 cm (Schoeneberger et al. 2002:2–35). No materials were collected and no laboratory analyses were conducted.

Figure 9. Excavation of TU 1 and 2. Orientation is to the north.

RESULTS

Pedestrian survey and subsurface testing were conducted in the 65 m^2 (700 ft^2) project area. No archaeological resources were found on the surface. Excavation of three test units did not yield any evidence of subsurface archaeological deposits or features. Stratigraphy consisted entirely of fill.

Pedestrian Survey

The surface survey included 100% of the 65 m^2 (700 ft^2) project area. No surface archaeological remains were observed within any part of the project area; any archaeological features that may have once been present are no longer there because of the extensive modern use of these lands. The entire project area consists of a landscaped yard.

Subsurface Testing

A subsurface testing plan was approved by SHPD before excavation began. Because of the sensitive nature of the coastal environment, test units were excavated by hand and all excavated sediments were screened. The three test units were placed within the project area to determine the presence or absence of subsurface archaeological deposits or material (Figure 10 and Table 2). Throughout the excavation, modern debris was encountered. This, along with the stratigraphy, indicated modern fill. The landowner noted that the area had been filled when the sandbags were installed. This was done in 2014–2015 by Sea Engineering, Inc. After excavation of the first two test units yielded only fill, the landowner pointed out an area that may have retained intact deposits. This was located on the south side of the property behind a stand of coconut trees and naupaka. Another test unit was placed there and again only fill was encountered. No archaeological resources were found in any of the test units, and stratigraphy consisted entirely of fill. Details of the three excavations are as follows:

TU 1 was located in the north corner of the property (see Figure 10). The unit measured 1 x 1 m and was excavated to 90 cm below surface (cmbs). Stratigraphy consisted of three layers of fill. Buried sandbags were encountered at 13 cmbs, and modern debris was observed throughout the excavation, including glass, metal, plastic, and a 1997 dime (Figures 11 and 12, see Table 2). No archaeological deposits or materials were identified.

TU 2 was placed 1.5 m southeast of TU 1, also on the north side of the project area (see Figure 10). The unit measured 1 x 1 m and was excavated to 70 cmbs. Stratigraphy consisted of two layers of fill (Figures 13 and 14, see Table 2). Buried sandbags were encountered at 60 cmbs, and modern debris was observed throughout the excavation, including glass, metal, plastic, and geotextile fabric. No archaeological deposits or material were identified.

TU 3 was excavated on the south side of the project area (see Figure 10). The unit measured 1 x 1 m and extended to 90 cmbs. Stratigraphy consisted of seven layers of fill (Figures 15 and 16, see Table 2). Buried utility pipes were encountered from 10–90 cmbs, and modern debris was observed throughout the excavation, including glass, metal, rubber, and plastic. No archaeological deposits or material were identified.

Figure 10. Location of test units on aerial imagery. The project area is outlined in red.

Table 2. Sediment Descriptions

Location	Layer	Depth (cmbs)	Color	Description	Interpretation
TU 1	I	0–50	10YR 4/3	Coarse sand; modern debris; smooth, very abrupt boundary.	Fill
	II	50–60	10YR 8/3	Fine sand; modern debris; smooth, very abrupt boundary.	Fill
	III	60–90+	7.5YR 8/4	Coarse sand; modern debris; base of excavation.	Fill
TU 2	I	0–40	10YR 5/4	Coarse sand; modern debris; smooth, very abrupt boundary.	Fill
	II	40–70+	10YR 8/3	Fine sand; modern debris; base of excavation.	Fill
TU 3	I	0–8	10YR 3/5	Loamy sand; modern debris, many roots; broken, very abrupt boundary.	Fill
	II	8–14	10YR 3/4	Very fine sand; modern debris, many roots; wavy, very abrupt boundary.	Fill
	III	14–22	10YR 5/4	Very fine sand; modern debris, many roots; smooth, very abrupt boundary.	Fill
	IV	22–31	10YR 7/4	Coarse sand; modern debris, many roots; smooth, very abrupt boundary.	Fill
	V	31–66	10YR 5/4	Fine sand; modern debris, many roots; smooth, very abrupt boundary.	Fill
	VI	66–72	10YR 5/3	Fine sand; modern debris, many roots; smooth, very abrupt boundary.	Fill
	VI	72–90+	10YR 8/3	Fine sand; modern debris, many roots; base of excavation.	Fill

Summary of Findings

Pedestrian survey of 65 m^2 (700 ft^2) of a beachfront property in Lanikai yielded no findings. The entire project area has been disturbed by modern use, such as landscaping for lawns and installation of sandbags for temporary erosion control. Subsurface testing, consisting of three test units, did not identify any subsurface cultural deposits or features. Stratigraphy consisted entirely of fill.

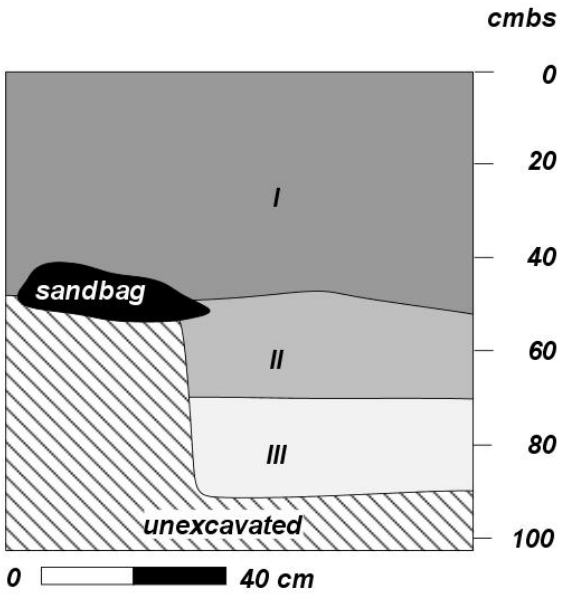


Figure 11. TU 1 east face profile drawing.

Figure 12. TU 1 east face photo.

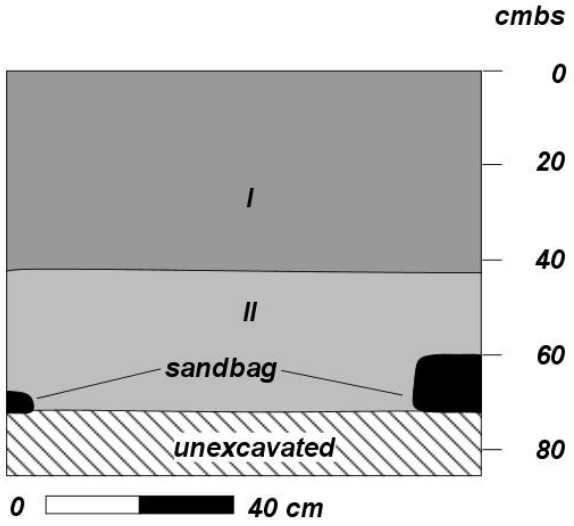


Figure 13. TU 2 east face profile drawing.

Figure 14. TU 2 east face photo.

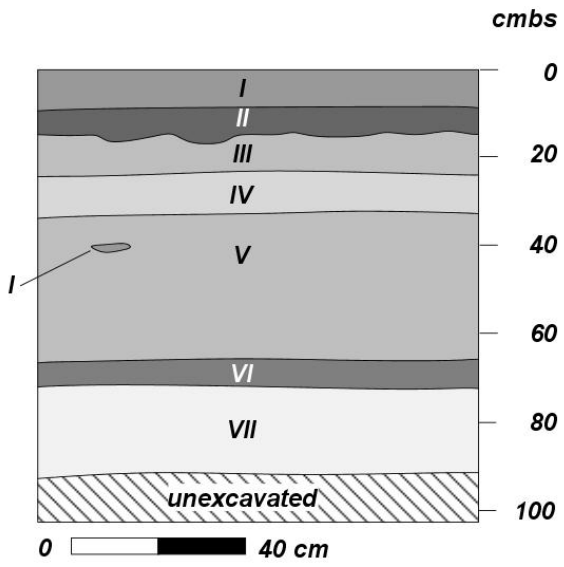


Figure 15. TU 3 south face profile drawing.

Figure 16. TU 3 south face photo.

SUMMARY AND RECOMMENDATIONS

An archaeological inventory survey was conducted on the makai (east) side of TMK: (1) 4-3-004:077 in Lanikai, Kailua Ahupuaʻa, Koʻolaupoko District, on the island of Oʻahu. A revetment is proposed for the property, to help curtail erosion. The archaeological work included pedestrian survey that covered 100% of the 65 m^2 (700 ft^2) project area, as well as test excavations consisting of three test units. Due to negative findings, the AIS results are presented as an archaeological assessment per HAR §13–275-5(b)(5)(A).

No surface archaeological remains were found during pedestrian survey of the project area. The entire area has been disturbed by modern activity, particularly the landscaping of the lawn and the construction of a temporary sandbag revetment. Likewise, subsurface testing did not yield any evidence of subsurface archaeological features or deposits. Stratigraphy consisted entirely of fill.

Subsurface testing confirmed that the entire project area has been filled in modern times. For this reason, no further work is recommended.

GLOSSARY

ahupuaʻa	Traditional Hawaiian land division usually extending from the uplands to the sea.
ʻai	Food or food plant, especially vegetable food as distinguished from iʻa, meat or fleshy food.
ʻāina	Land.
akua	God, goddess, spirit, ghost, devil, image.
aliʻi	Chief, chiefess, monarch.
aliʻi nui	High chief.
boulder	Rock 60 cm and greater**.**
cobble	Rock fragment ranging from 7 cm to 25 cm.
ʻeʻepa	Extraordinary, incomprehensible, abnormal, peculiar.
gravel	Rock fragment less than 7 cm.
hau	The indigenous tree *Hibiscus tiliaceous*, which had many uses in traditional Hawaiʻi. Sandals were fashioned from the bark and cordage was made from fibers. Wood was shaped into net floats, canoe booms, and various sports equipment and flowers were used medicinally.
heiau	Place of worship and ritual in traditional Hawaiʻi.
hoaʻāina	Native tenants that worked the land.
hukilau	A net for fishing; to fish with a net.
iʻa	Fish or other marine animal.
ʻili	Traditional land division, usually a subdivision of an ahupuaʻa.
inoa	Name, title, or namesake.
ʻiwa	The frigate bird *Fregata minor palmerstoni*.
Kahiki	A far away land, sometimes refers to Tahiti.
kahuna	An expert in any profession, often referring to a priest, sorcerer, or magician.
kamaʻāina	Native-born.
kapa	Tapa cloth.
kapu	Taboo, prohibited, forbidden.
kiaʻi	Guard, caretaker; to watch or guard; to overlook, as a bluff.
koʻa	Fishing shrine.
kōnane	A traditional Hawaiian game played with pebbles on a wooden or stone board.
konohiki	The overseer of an ahupuaʻa ranked below a chief; land or fishing rights under control of the konohiki; such rights are sometimes called konohiki rights.
kuleana	Right, title, property, portion, responsibility, jurisdiction, authority, interest, claim, ownership.
kupuna	Grandparent, ancestor; kūpuna is the plural form.

lepo	Dirt, earth; dirty.
Māhele	The 1848 division of land.
maka‘āinana	Common people, or populace; translates to “people that attend the land.”
makai	Toward the sea.
makani	Wind, breeze.
mele	Song, chant, or poem.
Menehune	Small people of legend who worked at night to build structures such as fishponds, roads, and heiau.
midden	A heap or stratum of refuse normally found on the site of an ancient settlement. In Hawai‘i, the term generally refers to food remains, whether or not they appear as a heap or stratum.
moku	District, island.
mo‘o	Lizard, dragon, water spirit.
mo‘olelo	A story, myth, history, tradition, legend, or record.
naupaka	The native shrub *Scaevola* sp., varieties of which are found both in the uplands and by the sea.
post-contact	After A.D. 1778 and the first written records of the Hawaiian Islands made by Captain James Cook and his crew.
pre-contact	Prior to A.D. 1778 and the first written records of the Hawaiian Islands made by Captain James Cook and his crew.
pu‘u	Hill, mound, peak.
stone	Rock fragment ranging from 25 cm to 60 cm.
ua	Rain, rainy, to rain.

REFERENCES

Akana, C.L. and K. Gonzales
2015 *Hānau Ka Ua Hawaiian Rain Names*. Kamehameha Publishing, Honolulu.

Bath, J. and M. Smith
1988 *Lanikai Eight Inch Water Main Project: Burial Removal, Kailua, Ko'olaupoko, O'ahu*.

Beamer B.
2008 *Na wai ka mana? 'Ōiwi Agency and European Imperialism in the Hawaiian Kingdom.* PhD Dissertation. University of Hawai'i, Honolulu.

Clark, J.R.K.
2002 *Hawai'i Place Names: Shores, Beaches, and Surf Sites*. University of Hawai'i Press, Honolulu.

2005 *Beaches of O'ahu. Revised Edition*. University of Hawai'i Press, Honolulu.

Dunn, J.M.
n.d. *Fisheries in Koolaupoko*. Hawaii Territory Survey Scale 1 in. = 300 ft. Tracing by R.L. Aug 25, 1954. Original map date not shown.

Dye, T.S.
1991 *Disinterment of Human Burials at Cole House Construction Site, Lanikai, Ko'olaupoko, O'ahu,* State Historic Preservation Division, Honolulu.

Fechner C.C. and P.L. Cleghorn
2014 *Archaeological Assessment for a Proposed Pool Located at 860 Mokulua Drive, Ka'ohao (Lanikai), Kailua Ahupua'a, Ko'olaupoko, Island of O'ahu, Hawai'i*. Pacific Legacy Inc., Kailua, Hawai'i.

Foote, D., E. Hill, S. Nakamura, and F. Stephens
1972 *Soil Survey of the Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii*. United States Department of Agriculture, Soil Conservation Service. Published in cooperation with the University of Hawaii Agricultural Experiment Station, Washington, D.C.

Fornander, A.
1916 *Fornander Collection of Hawaiian Antiquities and Folklore Volume IV*. Bishop Museum Press, Honolulu.

1969 *An Account of the Polynesian Race, Its Origin and Migrations and the Ancient History of the Hawaiian People to the times of Kamehameha I.* Charles E. Tuttle Co., Japan.

Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.-L. Chen, P.-S. Chu, J.K. Eischeid, and D.M. Delparte
2013 Online Rainfall Atlas of Hawai'i. Bulletin of the American Meteorological. Society 94: 313-316, doi: 10.1175/BAMS-D-11-00228.1.

Groza, R., M.F. Pammer, and H.H. Hammatt
2010 *Archaeological Monitoring Report for the Mokulua Drive 8-inch Water Main, Part II, Kailua Ahupua'a, Ko'olaupoko District, O'ahu Island*. Cultural Surveys Hawai'i, Inc., Kailua, Hawai'i.

Hall, W.T.
1998 *The History of Kailua, Hawaii*. Dolphin Printing and Publishing, Kailua, Hawai'i.

Hammatt, H.H., and D.W. Shideler
1992 *Archaeological Disinterment of Inadvertent Finds at Site 50-80-11-3738 Ka'ohao ("Lanikai"), Ko'olaupoko, O'ahu at a Residential House Lot TMK 4-3-4:5.* Cultural Surveys Hawai'i, Inc., Kailua, Hawai'i.

Handy, E.S.C., E.G. Handy, and M.K. Pukui
1991 *Native Planters in Old Hawaii: Their Life, Lore, and Environment*. Bishop Museum Press, Honolulu.

Hawkins, M.T. and M. Desilets
2013 *Archaeological Assessment Report 1611 Mokulua Drive, Lanikai, Kailua Ahupua'a, Ko'olaupoko District, Island of O'ahu, Hawai'i*. Garcia and Associates, Kailua, Hawai'i.

Kailua Historical Society
2009 *Kailua: In the Wisps of the Malanai Breeze*. Kailua Historical Society, Kailua, Hawai'i.

Kamakau, S. M.
1991 *Tales and Traditions of the People of Old: Na Mo'olelo a ka Po'e Kahiko*. Translated by Mary Kawena Pukui. Ed. by Dorothy B. Barrere. Bishop Museum Press, Honolulu.

1996 *Ke Kumu Aupuni*. 'Ahahui 'Ōlelo Hawai'i, Honolulu.

Kanahele, G.S.
1995 *Waikiki 100 B.C. To 1900 A.D.: An Untold Story*. The Queen Emma Foundation, Honolulu.

Kawachi, C.T., and M. Smith
1989 *Field Check and Removal of Burial at Ka'ili'ili, Maunalua, Kona, O'ahu*, State of Hawaii, Department of Land and Natural Resources, Historic Preservation Program, Honolulu.

Kelly, M. and B. Nakamura
1981 *Historical Study of Kawainui Marsh Area*. Bernice P. Bishop Museum, Honolulu.

King, R.D.
1900 Kailua Koolaupoko – Oahu. Scale 10 chains = 1 in. Traced from Register Map 588.

Maly, K. and O. Maly
2003 *He Wahi Mo'olelo No Ponahawai A Me Punahoa Ma Hilo: A Collection of Traditions and Historical Accounts for Ponahawai and Punahoa, District of Hilo, Island of Hawai'i (TMK 2-3-44:19; 2-3-49:53; 2-3-37:01).* Kumu Pono Associates, Hilo, Hawai'i.

McAllister, J.G.
1933 *Archaeology of O'ahu.* Bishop Museum Bulletin 104. Bernice P. Bishop Museum, Honolulu.

Nakuina, M.K.
2005 *The Wind Gourd of La'amaomao.* Second Edition. Kalamakū Press, Honolulu.

Orndoff, C. and S.D. Clark
1991 *Historical Literature and Documents Search Archaeological Surface Survey for the Phase I Flood Control Project, Lanikai, Kailua, O'ahu.* Honolulu.

Pukui, M.K.
1983 *'Ōlelo No'eau, Hawaiian Proverbs and Poetical Sayings*. Bishop Museum Press. Honolulu.

Pukui, M.K., S. Elbert, and E.T. Mookini
1974 *Place Names of Hawaii*. The University of Hawaii Press, Honolulu.

Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, and W.D. Broderson (editors)
2002 *Field Book for Describing and Sampling Soils, Version 2.0*. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, Nebraska.

Smith, M. and C. Kawachi
1988 *Burial Removal at 1063 Koohoo Place (TMK:4-3-06:14),* Lanikai, Kailua, O‘ahu.

Sterling, E.P. and C.C. Summers
1978 *Sites of Oahu*. Bishop Museum Press, Honolulu.

Thien, S.
1979 A Flow Diagram for Teaching Texture-By-Feel Analysis. *Journal of Agronomic Education* 8:54–55.

Tulchin, J. and H.H. Hammatt
2009 *Archaeological Inventory Survey for the Geary Residence at 136 Haokea Drive, Kailua Ahupua‘a, Ko‘olaupoko District, O‘ahu.* Cultural Surveys Hawai‘i, Inc., Kailua, Hawai‘i.

Wall, W.A.
1899 Map of Kailua Kookaupoko Oahu. Scale 500 ft. = 1 in. Register Map 2049.

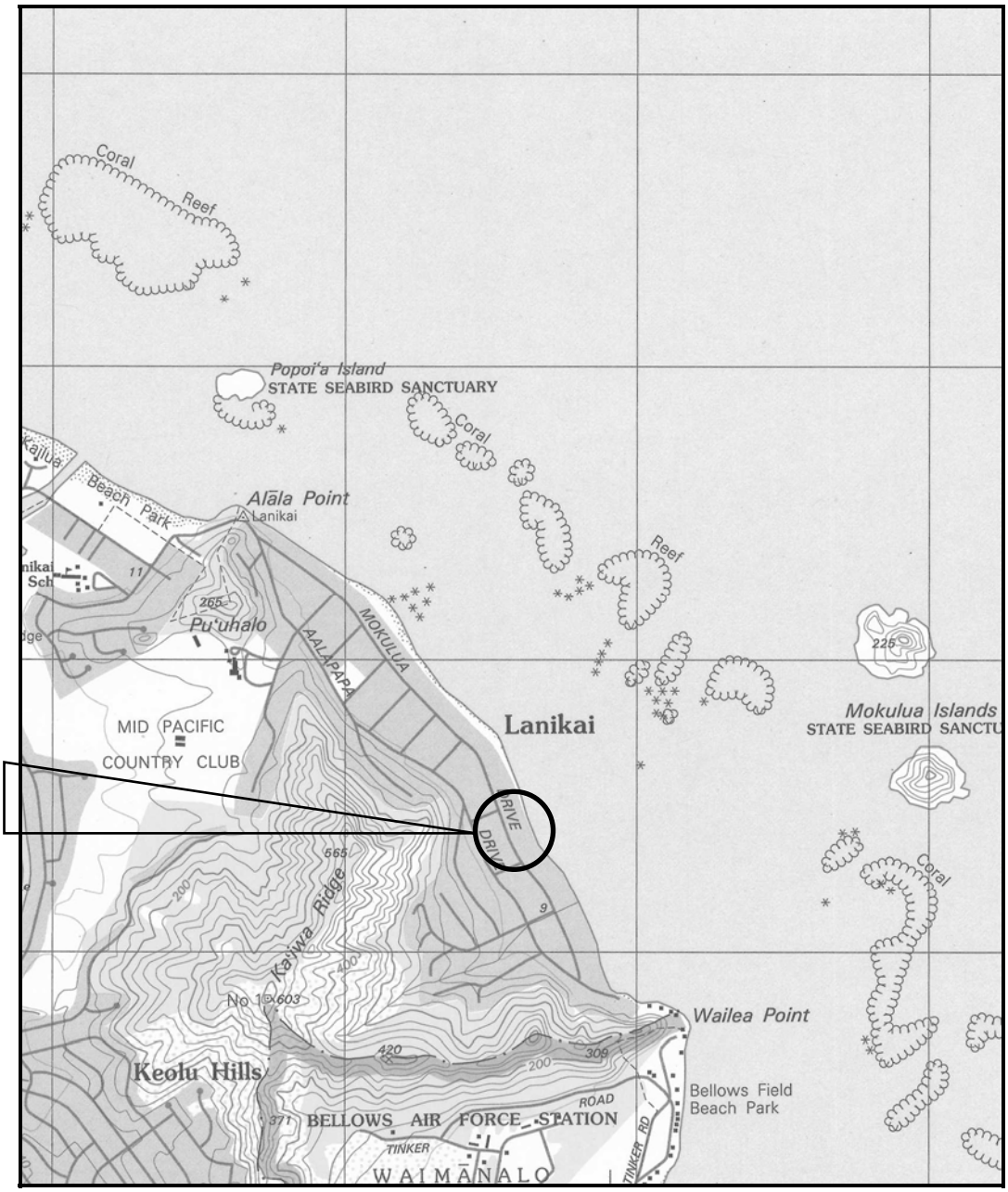
Wilson, J. and R.L. Spear
2011 *Archaeological Assessment on Approximately 7 Acres for a Residential Property in Lanikai, Kailua Ahupua‘a, Ko‘olaupoko District, Island of O‘ahu.* Scientific Consultant Services, Honolulu.

Young, P.T.
2015 “Podmore Fire Control Station.” *Images of Old Hawai‘i*. <http://imagesofoldhawaii.com/podmore_fire_control/> Accessed 4/7/2018.

Appendix G

Shinsato Engineering, Inc. Geotechnical Investigation Proposed Development 1326 Mokulua Drive Kailua, Oahu, Hawaii 96734 (May 2018)

VICINITY MAP

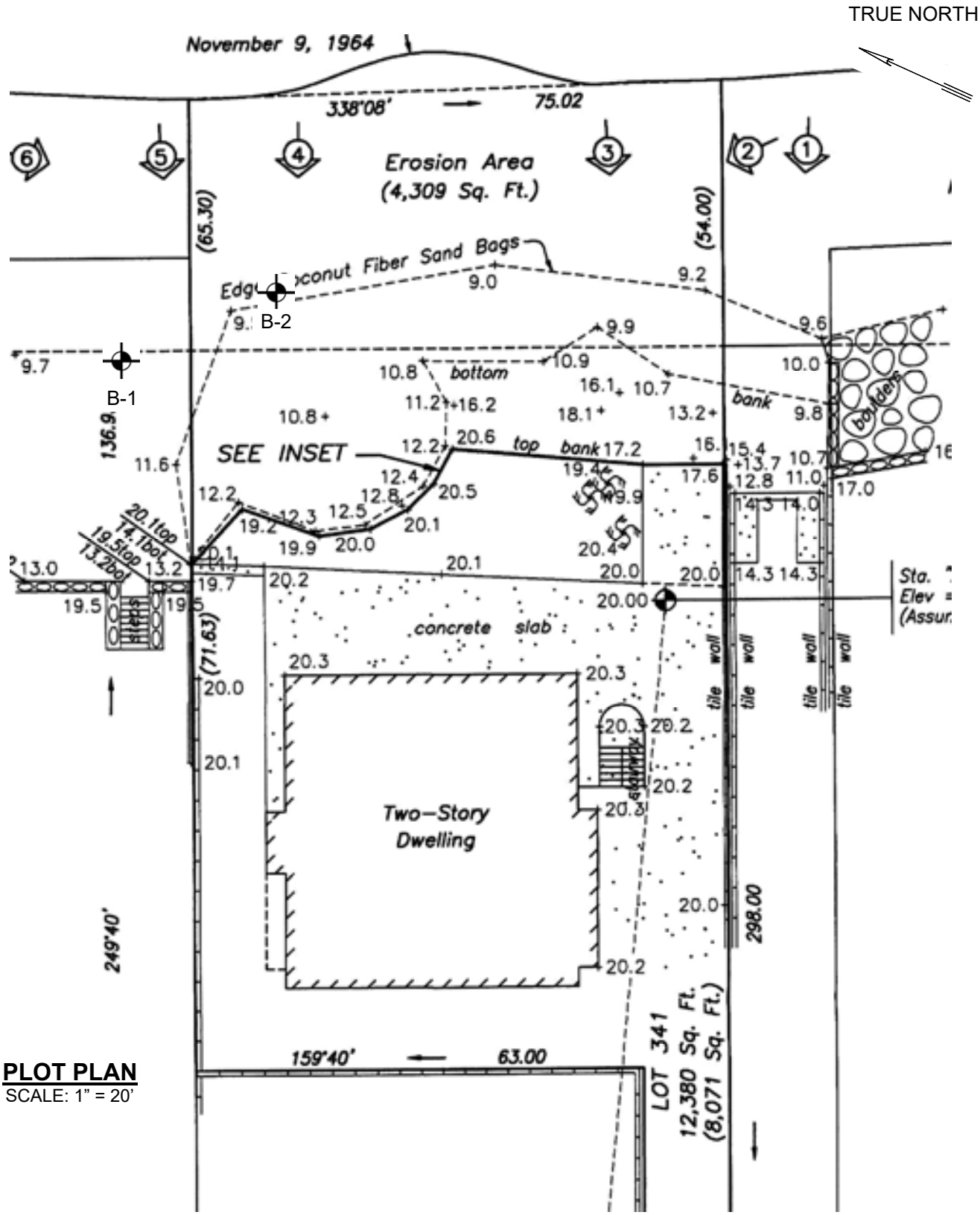


SITE LOCATION

TRUE NORTH

REFERENCE:
USGS TOPOGRAPHIC MAP
MOKAPU QUADRANGLE
DATED 1998
SCALE: 1"=2000'

Project: 1326 MOKULUA DRIVE Project No.: 18-0032	**SHINSATO ENGINEERING, INC.** CONSULTING GEOTECHNICAL ENGINEERS 98-747 KUAHAO PL. #E, PEARL CITY, HI 96782	**PLATE 1**



PLOT PLAN
SCALE: 1" = 20'

LEGEND: APPROXIMATE BORING LOCATION

Project: 1326 MOKULUA DRIVE Project No.: 18-0032	**SHINSATO ENGINEERING, INC.** CONSULTING GEOTECHNICAL ENGINEERS 98-747 KUAHAO PL. PEARL CITY, HI 96782	**PLATE 2**

LOG OF BORING NO. 1

DRILLING METHOD: **Badger Drill Rig**
HAMMER WEIGHT (lbs): **140**
HAMMER DROP (in): **30**

ELEVATION (FT.): **Unknown**
DEPTH OF BORING (FT.): **15**
DEPTH TO GROUNDWATER (FT.): **9.8**
DATE DRILLED: **April 4, 2018**

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	BLOWS/FOOT	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	TORVANE STRENGTH (TSF)
0		**MH**	elastic SILT; some sand			brown tan	moist	medium stiff				
				■	27				76.5	41.5	2.0	
2		**SP**	SAND (calcareous, fine grain);			tan		loose				
4				■	17				83.0	13.9		
6				■	10				81.8	11.6		
8								medium dense				
10				■	52		▼		89.6	27.5		
12												
14			--PROBE from 13.5' to 15.0'		30							
					22/6"			dense				
			END OF BORING									
16												
18												
20												
22												
24												
26												
28												
30												

Project: 1326 MOKULUA DRIVE

Project No.: 18-0032

SHINSATO ENGINEERING, INC.
CONSULTING GEOTECHNICAL ENGINEERS
98-747 KUAHAO PL. #E, PEARL CITY, HI 96782

PLATE 3

LOG OF BORING NO. 2

DRILLING METHOD: **Badger Drill Rig**
HAMMER WEIGHT (lbs): **140**
HAMMER DROP (in): **30**

ELEVATION (FT.): **Unknown**
DEPTH OF BORING (FT.): **18**
DEPTH TO GROUNDWATER (FT.): **10.0**
DATE DRILLED: **April 4, 2018**

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	BLOWS/FOOT	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)	TORVANE STRENGTH (TSF)
0		**SP**	SAND (calcareous, fine grain);			tan	moist	loose				
2					8				84.3	7.9		
4					15				87.7	14.4		
6					11				84.5	9.6		
8								medium dense				
10			--PROBE from 10.5' to 18.0'		49				88.4	30.4		
					16							
12					13							
					21							
14					33			dense				
					41							
16					35							
					34							
18			END OF BORING		48/6"			very dense				
20												
22												
24												
26												
28												
30												

Project: 1326 MOKULUA DRIVE

Project No.: 18-0032

SHINSATO ENGINEERING, INC.
CONSULTING GEOTECHNICAL ENGINEERS
98-747 KUAHAO PL. #E, PEARL CITY, HI 96782

Appendix H

Sea Engineering, Inc. Memorandum on Lanikai Association Beach Access Headwall Removal (March 2019)

Sea Engineering, Inc.
Makai Research Pier
41-305 Kalanianaole Hwy.
Waimanalo, Hawaii 96795-1820
Ph: (808) 259-7966 x26
Email: cconger@seaengineering.com
Website: www.seaengineering.com

Memorandum

DATE:	March 27, 2019
TO:	Rachel Shaak & Jeff Overton – Group 70 Design
FROM:	Chris Conger, David Smith, Ian Hardy
PROJECT:	1326 Mokulua Drive – Lanikai Association Beach Access Headwall Removal

Sea Engineering, Inc. (SEI) has been requested by G70 to provide comment on the removal of the concrete headwall at the Lanikai Association Beach access right-of-way adjacent to 1326 Mokulua Drive. A Coastal Assessment has been prepared by SEI and provided to G70 as part of the Environmental Assessment for removal and replacement of the existing sandbag structure at the subject property. The community has expressed interest in the removal of the headwall on the northern side of the public access which could be done in conjunction with the proposed sandbag removal and replacement project.

Each of the alternative options outlined in the Coastal Assessment include options to address the existing headwall at the end of the Lanikai Association public access right of way adjacent to the subject property. If the headwall were removed in conjunction with removal of the sandbags fronting the public access, and no further improvements were made to the public access, we anticipate the waterline at the beach access to migrate inland. Immediately following removal of the headwall, there would be a rapid retreat in the shoreline during the season of beach deflation. Following this initial retreat, the sandy substrate would progressively recede landward over time as waves funnel into the public access and wash into the pathway. Natural short-term erosion combined with project future erosion associated with rising sea levels would like result in a significantly landward position of the shoreline within the public access.

This shoreline retreat is highly likely to result in flanking and possible undermining of the properties and shoreline structures on either side of the public access. If the headwall were removed, the shoreline structures would require a retrofit to ensure their foundations are protected from undermining and the adjacent properties would require additional shoreline structures on their side boundaries to protect from flanking erosion. These flank protection structures should be extended well inland, as the full extent of potential erosion at the public access is not known.

Figure 1. Lanikai Association Beach access right-of-way (Photo taken 3/27/2018)