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
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KIRK CALDWELL
MAYOR

GEORGE I. ATTA, FAICP
DIRECTOR

ARTHUR D. CHALLACOMBE
DEPUTY DIRECTOR

2015/ELOG-231(ST)
2015/ED-1

April 27, 2015

Ms. Jessica Wooley, Director
Office of Environmental Quality Control
State Office Tower, Room 702
235 South Beretania Street
Honolulu, Hawaii 96813-2437

FILE COPY
MAY 08 2015

RECEIVED
'15 APR 28 A9:39
OFC. OF ENVIRONMENTAL QUALITY CONTROL

Dear Director:

SUBJECT: Chapter 343, Hawaii Revised Statutes
Draft Environmental Assessment
Shoreline Setback Variance

Project:	Kernot Residence Shoreline Protection Project
Applicant:	William Kernot
Agent:	Little Environments PLLC (Joseph Little)
Location:	59-151A Ke Nui Road - Paumalu (Sunset Beach)
Tax Map Key:	5-9-2: 5
Request:	Shoreline Setback Variance (SV), Chapter 23, Revised Ordinances of Honolulu
Proposal:	Injection of bonding agent into shoreline sand for shoreline projection within the 40-foot shoreline setback.

We respectfully request publication of the Draft Environmental Assessment (DEA) in the next edition of The Environmental Notice. We anticipate a finding of no significant impact (AFNSI) for the proposed shoreline protection project at an existing residential lot along the Paumalu (Sunset Beach).

Enclosed is the completed OEQC Publication Form, one hard copy of the DEA and a pdf file on a compact disk. Simultaneously with this letter, these documents were also sent via electronic mail to your office.

If you have any questions, please contact Steve Tagawa of our staff at 768-8024.

Very truly yours,

George I. Atta, FAICP
Director

Enclosures

APPLICANT ACTIONS
SECTION 343-5(C), HRS
PUBLICATION FORM (JANUARY 2013 REVISION)

Project Name: Kernot Residence Shoreline Protection Project in the 40-foot shoreline setback
Island: Oahu
District: Paumalu (Sunset Beach)
TMK: (1)5-9-2: 5
Permits: Shoreline Setback Variance
Approving Agency: Department of Planning and Permitting
City and County of Honolulu
650 South King Street, 7th Floor
Honolulu, Hawaii 96813
Steve Tagawa, (808) 768-8024
Applicant: William Kernot
168 Narrabeen Park Parade
Mona Vale, NSW, 2103 Australia
(808) 799-3983
Consultant: Little Environments PLLC (Joseph Little, P.E.)
3814 Cobb Street
Garner, North Carolina 27529
Joseph Little P.E. (919) 916-9061

Status (check one only):

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

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

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

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

__DEIS — The applicant simultaneously transmits to both the OEQC and the approving agency, a hard copy of the DEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the DEIS (you may send both the summary and PDF to oeqc@doh.hawaii.gov); a 45-day comment period ensues upon publication in the periodic bulletin.

__FEIS — The applicant simultaneously transmits to both the OEQC and the approving agency, a hard copy of the FEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the FEIS (you may send both the summary and PDF to oeqc@doh.hawaii.gov); no comment period ensues upon publication in the periodic bulletin.

__ Section 11-200-23 Determination — The approving agency simultaneous transmits its determination of acceptance or nonacceptance (pursuant to Section 11-200-23, HAR) of the FEIS to both OEQC and the applicant. No comment period ensues upon publication in the periodic bulletin.

__Statutory hammer Acceptance — The approving agency simultaneously transmits its notice to both the applicant and the OEQC that it failed to timely make a determination on the acceptance or nonacceptance of the applicant's FEIS under Section 343-5(c), HRS, and that the applicant's FEIS is deemed accepted as a matter of law.

__Section 11-200-27 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 not required. No EA is required and no comment period ensues upon publication in the periodic bulletin.

__Withdrawal (explain)

Summary: The Applicant seeks a Shoreline Setback Variance to allow the injection of a fast bonding, fast setting liquid agent into the sand under and makai of the existing dwelling within the 40-foot shoreline setback area. According to the Applicant, the proposed bonding agent is approved by the Environmental Protection Agency (EPA), the National Science Foundation (NSF), and the American National Standards Institute (ANSI), and which sets within five hours to create a non-leaching synthetic sandstone which has the strength of rock, yet remains natural in appearance. The bonding agent will be injected as much as 25 feet below the existing surface across most of the 50-foot width of the lot. The injection area will be 35 feet wide, but will be kept five feet mauka of the shoreline as determined (certified) by the State Department of Land and Natural Resources (DLNR). No other construction is included in the proposed project.

The 6,883-square-foot shoreline parcel is zoned R-5 Residential District and contains two existing dwellings. About 650 square feet of the parcel has been lost to erosion and was part of the DLNR and the U. S. Army Corps of Engineers emergency authorizations in 2013 and 2014, which allowed temporary shoreline protection actions including pushing (bulldozing) of beach sand (dune restoration) in front of the dwellings. The Applicant's request in October 2014 (Emergency OA-15-07) to install a scour curtain (polymer fabric) with ballast toe (sandbags) was denied by DLNR. In September 2014, the Department of Planning and Permitting granted an Minor Shoreline Structure (No. 2014/MSS-9) for the placement of the scour curtain with ballast toe inside the 40-foot shoreline setback area.

Environmental Assessment (EA) and Environmental Impact Statement(EIS) for Proposed Geotechnical Improvement on the Property of 59-151A Ke Nui Rd, Sunset Beach, 96712, Oahu, Hawaii

(DRAFT for Comment)

Prepared by: Little Environments PLLC
16 West Martin St., Level 5, Suite 7
Raleigh, NC, 27601, USA
+1 (919) 916 9061

For: William Kernot and Sunset Oasis LLC
59-151A Ke Nui Rd
Sunset Beach, 96712, Oahu, Hawaii

and

168 Narrabeen Park Parade
Mona Vale, NSW, 2103, Australia

Submitted to: Department of Planning and Permitting
Land Use Approval Branch
650 So. King St., Honolulu, HI 96813
info@honoluludpp.org

(61 pages)
61 pages does not include accompanying documents

1.0 General Information

A	Applicant Name:	William Kernot Sunset Oasis LLC
	Mailing Address:	168 Narrabeen Park Parade Mona Vale, NSW, 2103, Australia
	Phone Number:	+1 (808) 638-4091
B	Recorded Fee Owner name:	William Kernot Sunset Oasis LLC
	Mailing Address:	168 Narrabeen Park Parade Mona Vale, NSW, 2103, Australia
	Phone Number:	+1 (808) 638-4091
C	Agent Name:	Little Environments PLLC Attn: Joseph Little PE
	Mailing Address:	3814 Cobb St., Garner, NC, 27529,USA
	Phone Number:	+1 (919) 916 9061
D	Tax Map Key:	59002005:0000
E	Recorded Lot Area:	6,883 square feet on record with the City and County as of 14th August 2014
	Erosion Adjusted Area:	5,383 square feet as estimated by engineer on 25th October, 2014
F:	Agencies Consulted in Making Assessment: *Correspondence as Appendix	City and County of Honolulu

2.0 Description of the Proposed Action

2.0-A Description of the Proposed Action

2.0-A-1 Narrative Description of Proposed Project

The proposed project is for the geotechnical stabilization of the earth below the residential and inhabited structure located on the property of 59-151A, Ke Nui Rd, Sunset Beach, Oahu. The proposed project is not visible from above ground and is only the geotechnical modification of the existing soil. The soil below the house structure will be stabilized to prevent catastrophic erosion and seismic liquefaction by injecting an environmentally safe and proven bonding agent. Effectively, the injected bonding agent will serve as a method for expediting the formation of sandstone by bonding existing sand particles in place.

The basis for this project is preparation for expected threatening catastrophic wave events beyond normal wave cycles or expected wave height and energy return intervals. The property of 59-151A Ke Nui Rd has experienced multiple beyond normal wave and climatic events, including two hurricanes, a tropical storm, a 30 year wave event, and a 10 year wave event in a period of less than 2 years. Additionally the property has lost about 10 feet of land in the last 2-3 years, significantly surpassing the DLNR and University of Hawaii maximum annual erosion of one foot

per annum. Based on current limited information on the shoreline and recent events the project owner is seeking peace of mind trough stabilization of his house structure foundation.

2.0-A-2 Relation of Parcel to Shoreline Setback

The existing house structure is located on the northwest portion of the property. The registered property size with the City and County of Honolulu is 6,883 square feet. This area does not include recent and significant losses due to exacerbated erosion. An engineering estimate of 1,500 square feet have been lost to the ocean based on measurements made on the 25th October, 2014 to the DLNR identified and interpreted shoreline. This location is identified in Appendix D atop the existing survey on file with the City and County of Honolulu as the "top of scarp" and "end of conservation zone." Effectively the parcel size is now 5,383 square feet representing a 21.8% reduction in land size.

The existing house structure is currently 25' to 29' from the DLNR defined shoreline on the 25th October 2014 on the parcel.

The existing house structure is less than 25' from the shoreline on the adjacent southwest property. The south west adjacent property has experienced more significant erosion and has the remnants of a pool structure that remain as rubble.

The proposed project will not be past the shoreline of the property. The proposed project will sole be below ground and not above the existing grade. The toe foundation of the proposed project will be approximately 5 feet behind the existing shoreline.

The house structure is currently 10 to 15 feet into the 40-foot shoreline setback zone.

A certified shoreline survey will accompany this submission that is being prepared simultaneously and is not expected to significantly vary from Appendix D.

2.0-A-3 Location Map

The following map shows the location of the property. The map is 1"=1000' on 8.5"x11" paper.

Figure 1. Site Vicinity Map
(Adapted from Google maps)

2.0-A-4 Land Use Approvals Required

No other land use approvals are expected to be required beyond a shoreline setback variance.

2.0-B Technical Characteristics

2.0-B-1 Use Characteristics

The existing property used is for residential purposes and zoned R-5. The proposed project will solely be on the property and is for the use purpose of stabilizing the foundation of the existing residence. Access to the site is from a shared access way connected to Ke Nui Rd. On the property, access to the area of geotechnical improvement is available by two corridors on the property. The corridor on the northeast side of the property is approximately 14 feet. The corridor on the south side of the property is approximately 6 feet.

2.0-B-2 Physical Characteristics

The layout of the property is shown in appendix D and on the accompanying shoreline survey in appendix E. The property has two main existing building structures. The rear of the lot, to the southeast, has a garage building with accompanying rooms. The building on the northwest, fronting the ocean, is the main habitable residence. The rear east corner of the lot contains a septic field of unknown size. Drawings for the septic field or ses-pit are not available.

The elevation of the lot is predominantly 19 feet above sea level and is zoned a combination of VE 19 and AE 19.

2.0-B-3 Construction Characteristics

This project will not include any demolition, removal or excavation of material, modification of existing structures, clearing, or grading. The construction process of the geotechnical improvement will include saturation of the existing sand voids with a fast bonding, fast setting, non-leaching, long term, solidifying material. There are many products on the market available for this purpose that are EPA approved, NSF approves, and ANSI approved. The final design documents will have environmental requirements that the constructing or applying contractor must adhere to. The long-term strength of the material is similar to rock and is aesthetically appeasing if ever exposed.

The method of construction involved application spears and an application truck. The truck can be easily parked in the rear driveway of the residence, while the spears are inserted into the ground and the bonding agent is applied. Immediate strength can be achieved in 5 hours. The entire process is not expected to take more than 2 weeks. Temporary monitoring wells will be placed inland of the conservation district by 5 feet to ensure that no material is applied in the conservation zone. The 5 feet will serve as safety zone.

2.0-B-4 Other Pertinent Information

Evaluation of Synthetic Sand Stone Bonding Process

2.0-B-4 Relevance to Shore Protection Structures

The proposed works in the shoreline setback zone are to take place under the structure of the house and in the geotechnical zone critical to the foundation of the house/residence. The work will not take place seaward of the DLNR defined shoreline, the works will not take place in the beach zone or conservation use district, the works will only take place underground and under the house and underground in the zone of geotechnical influence that supports the house structure.

This zone of influence is approximately 25 feet from the front of the house. A geotechnical report accompanies this document that demonstrates the depth of sand to rock as well as uniformity of the existing sand. The geotechnical report is provided in appendix F.

No existing current shoreline, or shoreline following previous exacerbated erosion events will be affected by this project. The area inland and in the SSV zone, to be geotechnical improved, has experienced no erosion in recorded history.

Should natural erosion continue, the geotechnical improvement is not expected to be exposed or revealed above grade for 50 to 75 years. If non-probable and beyond abnormal events occur, the top of the fortification could be exposed in 35 years. This analysis is based on general extrapolation techniques similar to those implemented by the University of Hawaii. The geotechnical improvement is expected to last a 100-year design life. Sand will be bound from the geotechnical surface, just below grade, down 22-24' to bedrock. The bedrock is composed of limestone and igneous extrusions. Over time, the applied material is expected to improve in strength and hardness. Slight maintenance may be necessary if complete exposure occurs but this may only happen after 150 to 200 years. Toe protection is not necessary as the material will bond to the base limestone/igneous rock as a continuous artificial stone formation similar to sand stone or breccia. In areas, the synthesized stone will have porous release areas to allow free transmission of groundwater. The material will be completely covered for an expected 50 years and hence no flanking protection is necessary and no wave run-up will occur based on this geotechnical improvement. If the geotechnical improvement is exposed in 50+ years, the wave run-up would be significantly less, considering current bathymetric conditions. The design and construction will have no effect on the current shoreline, without exception. Further, the geotechnical improvement is the least invasive and least environmentally impacting approach that can be implemented.

Table 1. Summary In Relation to SSV Requirements

a	"The affected shoreline"	Not affected
	"beach profile"	Not Affected
	"offshore depths"	Not Affected, Environment Improved
	"foreshore and backshore areas littoral transport"	Not Affected, Environment Improved
	"cyclical and abnormal changes of beach form"	Not Affected, Environment Improved
	"changes for water level"	Not Affected
	"wave run-up and changes in sources of sand"	Not Affected

3.0 Affected Environment

3.0-A Subject Site and Surrounding Area

3.0-A-1 Subject Site

The subject site is narrow at approximately 48' in width and shallow in size. The site was previously 147.71' in depth on the southwest boundary of the property and 133.12' in depth on the NE boundary of the property. Due to recent erosion, these dimensions have been reduced to approximately 117' and 103' respectively.

The site is used for residential purposes and has a LUO zoning designation of R-5. The residential site has no real unique features. The previous land use is reported to be residential. The following figure depicts the existing structures on the property as well as property access. Access to the property is limited by way from the beach and by way from the local access rd.

Figure 2. Photos of Subject Site Structures and Erosion

3.0-A-2 Surrounding Area

The immediate area surrounding the property includes, (1) the un-surveyed sunset beach conservation zone and Pupukea-Paumalu Sunset beach Park to the NW, (2) A well vegetated residential cottage to the NE (TMK5-9-02:04), (3) a shared access road on the NE side of the property and to the south (TMK3-9-02:08), (4) a large residential dwelling to the SE, not abutting sunset beach(TMK5-9-02:07), and (5) a large residential dwelling covering the majority of the lot with little impervious area to the SW. The area behind sunset beach is generally residential and agriculturally zoned.

<u>3.0-A-2.1 Along Shore</u>

Residential property number 2 and residential property number 5 are adjacent the subject site and front the Pupukea-Pamalu (Sunset) beach park.

Currently this area of Pupukea-Pamalu (Sunset beach) has no definitive management plan. A management plan was created for the north-eastern section of Sunset Beach. Its scope of management stops at the North Eastern side of the Pakulena Stream.

Other properties have experienced significant amount of erosion along the southwest section of Sunset Beach. Local community leaders have attempted to seek a collaborative approach at property protection in the past, however efforts have failed due to differing interest deriving from differing states of threat to properties, financial capacity of different property owners to protect their properties, types of property foundations and differing geotechnical aspects, and other factors.

Figure 2.1. Property 2

Figure 2.2. Property 5

Figure 2.3. Attempted Sand Pushing on Property in the Vicinity of the 59-151A Ke Nui Rd

Figure 2.4. Photo Showing Eroded Coastline

3.0-A-2.2 Inland and Toward the Mountains

Across Ke Nui Rd and the Kamehameha Hwy, toward the mountains the primary land use is AG-2 or agricultural. This land drains into the Pakulena Stream and discharges into either (1) the ocean when sand is not present or rainfall is high or (2) into an effective retention basin formed by sand in the center of Sunset Beach. Additional land use that is up catchment from this property includes an US army training area. A map is shown in appendix G from the DPP Sustainable Communities Plan that outlines this area.

3.0-B Federal FIRM Zone, LUO Flood Hazards, other Geotechnically Hazardous Land Conditions

3.0-B-1 Federal FIRM Zone

The subject site where the geotechnical improvement is to occur is partially rated VE19 and AE19. Zone VE indicates that the base flood elevation due to wave induced flooding is at 19 feet above datum. Zone AE19 is based off of the base flood elevation being 19 feet and not derived from

velocity associated with waves, but from excessive overland flow from Paumalu Stream (Also duly named Pakulena Stream). The VE zone is located at the front of the property. The AE zone is located at the rear of the property. This FIRM zone information was last updated in 2006 by the DLNR. The geotechnical improvement will not alter wave run-up scenarios nor will it affect the existing defined base flood plane elevations (BFE).

3.0-B-2 LUO Flood Hazards

Figure 8, later shown in the flora and fauna section of this document depicts the LUO flood plain. The site is in the 100-year flood plain. The depth of water in this area will be unchanged by this project, as the project is underground. Further the groundwater storage volume in the voids of the sand that will be displaced is drastically insignificant to the volume of water in a flood.

3.0-B-3 Geotechnically Hazardous Land Conditions

In an un-saturated, sunny day condition, there are few geotechnical hazards immediately on this site. However, the dwelling structures on this site are reliant on consolidated, large diameter, relatively uniformly graded, sand within the property. This includes consolidated sand that is (a) immediately below the house and (b) consolidated sand that is in the supporting friction angle when not exposed, or the angle of repose when the sand is exposed, or whichever slope angle is the least. The sand will remain consolidated until it is either (i) excessively saturated with water by flood, tidal inundation, or excessive rainfall, (ii) eroded past the angle of repose or angle of shear, (iii) subjected to pore pressure increasing vibrations from minor to major seismic events, including wave impact, (iv) excessively loaded, or (v) any combination of these events.

As the property of 59-151A Ke Nui Rd has experience critical, exacerbated, and excessive erosion, the probability of sand foundation liquefying or varying from consolidation is highly probable. Liquefaction is probably for primarily for reason (i), reason (ii), reason (iii), and reason (v). If the sand for which the dwelling structure is built upon varies from the current level of consolidation the foundation and house will collapse. The current status of geotechnical hazard is the reason for the geotechnical improvement. The method of construction has been selected because of the limitations with working with heavy machinery atop adjacent geological formations to the house structure. The method of geotechnical will avoid further risks of excessive loading and will not pose a treat to supporting geological formations of adjacent properties. A photo of the sand is provided below. The sand is non-angular and contains no cohesive soils, further demonstrating the geotechnical hazard.

Figure 3. Sand Supporting Structure at 59-151A Ke Nui Rd.

3.0-C Coastal Views

The following photos demonstrate recent current conditions of the coastline. Post "sand push" photos are provided in Appendix H.

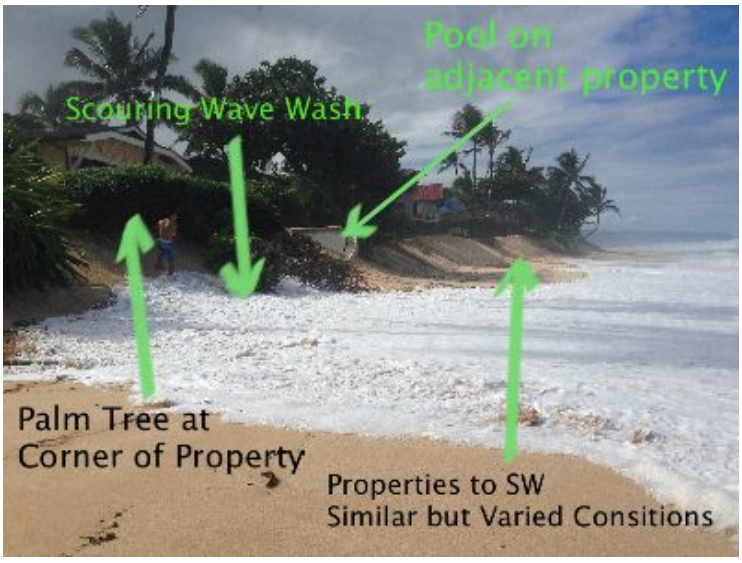

Figure 4. View from NE, Photo Taken Nov 13, 2014

Figure 5. View from SW, Photo Taken Nov 13, 2014

Figure 6. Vegetation Photos on Shoreline as of 23, October 2014

3.0-D Project Site in Relation to Publicly Owned or Used Beach Access

The project site is immediately adjacent to the DLNR OCCL Conservation district, which overlaps the Pupukea-Paumalu Sunset Beach park. The primary public area of Sunset Beach is to the NE along the beach, and past Paumalu Stream. This area of beach is regulated by executive order No. 2598. The City and County have the responsibility of maintenance of this area.

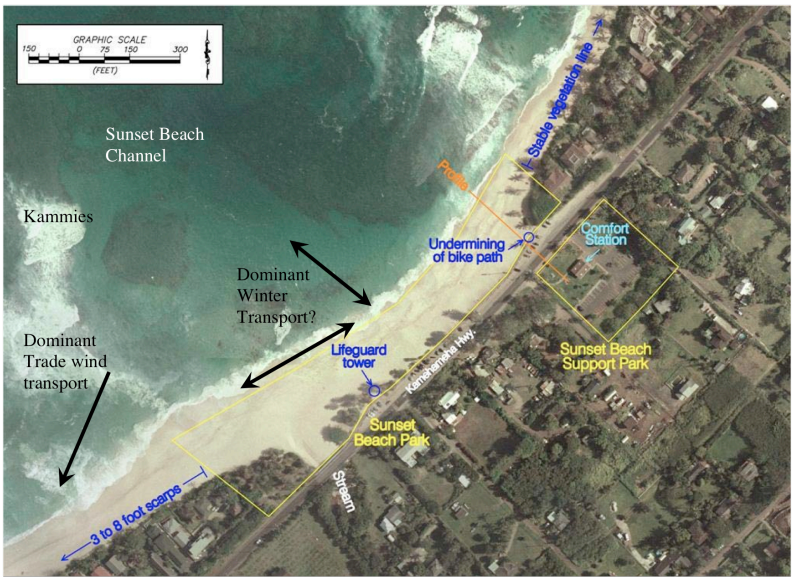

Figure 7. Sunset Beach Park Map
(From Eversole, D. 2009)

Sunset Beach and adjacent beaches are world renown surfing sites and attract surfers from around the world year round. Access to the beach by the public is primarily through the Sunset Beach park. Additional access is available by City and County right of way access to southwest of the property, along the beach. This southwest access is approximately 450' along the beach or 9 beachfront properties away. There are no wildlife preserves adjacent or that will be affected by this project. There are no wetlands involved in this project. To the northeast, at the mouth of the Paumalu Stream, temporary tidal affected lagoons are often formed that hold water. This same area has been the source of sand for recent sand-pushing on the beach. When sand is taken from this area, the lagoon is sometimes not present, allowing immediate discharge of stream water into the ocean. This varies as with beach accretion and erosion processes as well. The implementation of this project will reduce environmental impacts on the stream head, as it will alleviate the reoccurring need for sand excavation from this area. Sand extraction from this area interferes with natural processes at the mouth of the Paumalu Stream. Figure 8, below in the Flora and Fauna section of this document, demonstrate that there are no critical habitats in this area. The primary resources in the area are the beach sand and beach parks that attract tourist, further supporting local business and local economy. The aquatic ecology in the area is limited due to the high-energy wave environments. Further there were no threatened or endangered species present. This is elaborated on further in the Flora Fauna section of this document.

3.0-E Location and Site Maps

Figure 1, above, shows the location of the site. An additional tax map, showing the location is provided in appendix I.

4.0 Project Impacts

The following section outlines environmental impacts of the proposed geotechnical stabilization.

4.1 Surface Water Quality Impacts

Directly on site, there will be no surface water quality impacts. The mimicked sandstone geotechnical improvement will be completely underground and will not have any impact on the

surface water. Brief disruption of existing yard may occur during the instillation due to rutting or traversing of equipment. The installing contractor will be required to remedy any surface disturbances and temporarily manage any potential changes to the storm. Excess geotechnical stabilization product will be required to be removed on site as not to impact stormwater process. There will be no significant surface water, stormwater impacts by this project.

Included improvement in stormwater will occur offsite vicinity of sunset beach due to this project. Existing beach management at this site has only allowed the pushing of sand from the Paumalu stream mouth. This project will allow for the alleviation of sand pushing on an on-going basis. Pollutants can accumulate in the bed of stream and in the sand. Viau, et.al 2011, evaluated streams around Hawaii and found that 21 of 22 streams have an elevated present of bacterial agents including Salmonella and enterococci. The sand that is pushed from the mouth of the stream is saturated with sediments and standing stream water that may contain bacterial agents and other pollutants. When the sand is pushed in front of houses, it allows for rapid discharge and exposure of the pollutants when subjected to storm events into the immediate receiving waters of the Pacific ocean. Reducing and alleviating the sand pushing eliminates this hazard. This project indirectly reduces the risk of discharge of potentially harmful, concentrated stormwater pollutants into the recreational waters of Sunset beach.

This project is expected to have no surface water impacts and is expected to only improve the water quality.

4.2 Ground Water Quality Impacts

This project is expected to have no significant groundwater quality impacts. Currently the groundwater in the area is approximately 5 feet above the limestone formation or about 17 feet below the surface. The accompanying geotechnical report includes this information. This depth is controlled by the tide and remains relatively constant. The current soil is a well-drained calcium carbonate sand. The material to be injected for geotechnical improvement is inert, EPA certified for safe with drinking water, and hence will not chemically affect the ground water. There are no wells in the area, however there is a sess-pit or septic field in the rear of the lot. The implementation of this project will prevent septic ground water flows from being discharged onto and through the beachfront. The proposed project will not significantly impact the groundwater quality.

4.3 Flora Fauna Impacts

This project will be completely underground and will have no flora or fauna impacts. Figure 8, below demonstrates how the property is not in any area of threatened or endangered plants, is not in any critical habitats, nor in any wetland area. Further, this project will relieve stress on the current ecosystem through the elimination and reduction of the need for sand push approaches. When sand is pushed from its natural consolidated state, it is made loose and becomes unconsolidated. This makes the sand more susceptible to erosion and transport offshore. When unconsolidated sand is transported in large volumes, it has the potential to blind over benthic habitats and impact delicate ecosystems. By eliminating the need for continuous sand pushing, the project is relieving stress from the natural aquatic ecosystem and improving the local ecosystem.

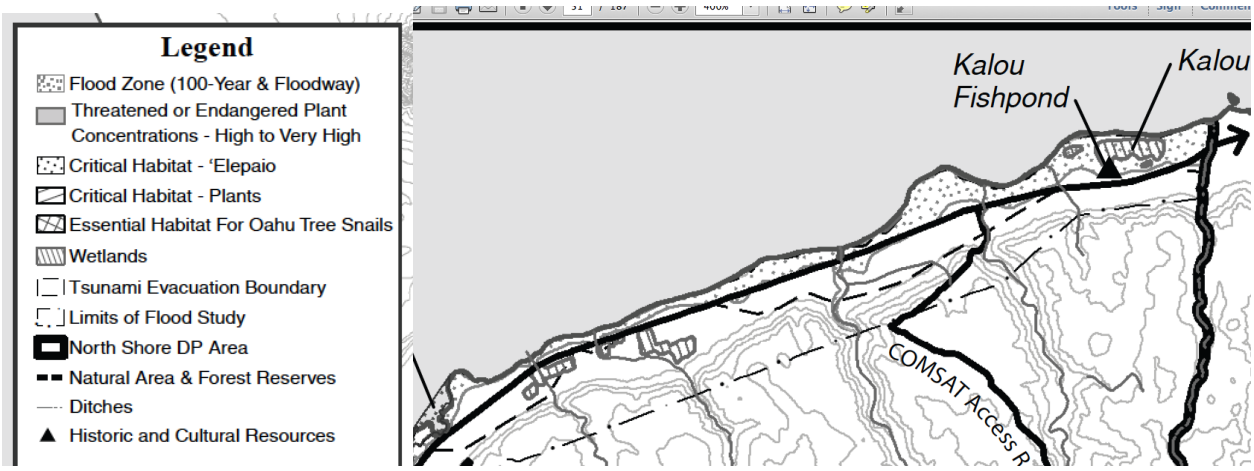

Figure 8. Map Showing no Local Threatened or Endangered Plant Concentrations
(From DPP Sustainable Communities Plan , Map Referenced 2009)

FLORA FAUNA RESULTS

Provided below are the results for the Flora and fauna survey that were carried out at and offshore from the project site in December 2014.

1. Sharks Cove (21°39'00.85"N, 158°03'47.63'W)
2. Banzai Pipeline (21°40'00.28"N, 158°03'00.69'W)
3. Project Site (21°40'21.44"N, 158°02'37.08'W)
4. Adjacent Beach to Project Site (21°40'22.68"N, 158°02'32.09'W)
5. Kanuala Beach (21°40'50.18"N, 158°02'17.38'W)
6. Turtle Bay (21°42'021.21"N, 157°59'49.92'W)

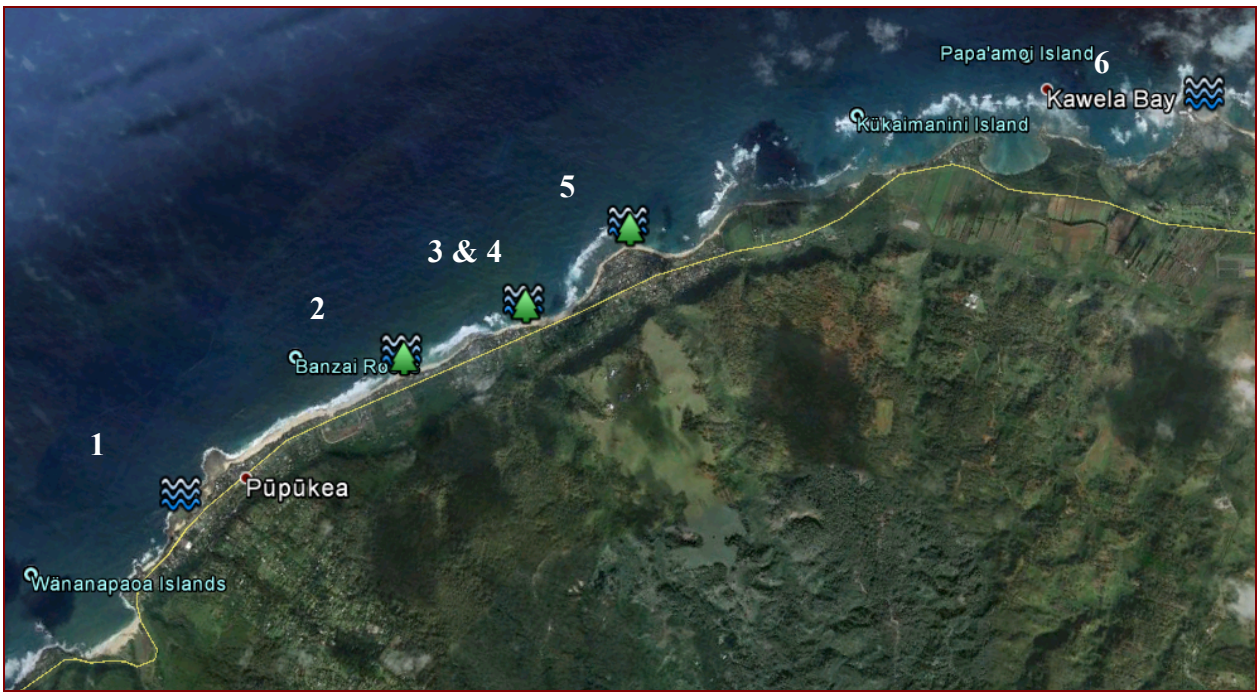

Figure 9. Map of the North Shore, Oahu including the six assessment areas. Wave icons = areas in which snorkel surveys were conducted and tree icons = areas of terrestrial flora and fauna surveys.

The following tables include the common and scientific names of all terrestrial and aquatic flora and fauna observed at the six assessment areas identified above.

Table 2. Sharks Cove (21°39'00.85"N, 158°03'47.63'W)

Common Name	Scientific Name
Invertebrates	
Aquatic Molluscs	
Periwinkle snail	*Littorina* sp.
Black nerite snail	*Nerita picea*
Cone snail	*Conus lividus*
Echinoderms	
Black sea cucumber	*Holothuria atra*
Corals	
Lobe coral	*Porites lobata*
False brain coral	*Pavona varians*
Blue rice coral	*Montipora flabellata*
Cauliflower coral	*Pocillopora meandrina*
Crust coral	*Leptastrea purpurea*
Segmented Worms	
Featherduster worm	*Sabellastarte sanctijosephi*
Spaghetti worm	*Loimia medusa*
Sea Urchins	
Banded urchin	*Echinothrix calamaris*
Pale rock-boring urchin	*Echinometra mathaei*
Plants	
Aquatic Plants	
Green algae	*Cladophora sericea*
Pterocladiella capillacea	*Pterocladiella capillacea*
Limu mane`one`o	*Laurencia* spp.
Melan	*Amansia glomerata*
Coralline algae	*Porolithon* spp.
Ear seaweed	*Padina japonica*
Caulerpa racemosa	*Caulerpa racemosa*
Dictyosphaeria spp.	*Dictyosphaeria* spp.
Fishes	
Square-spot goatfish	*Mulloidichthys flavolineatus*
Hawaiian flagtail	*Kuhlia xenura*
Spotted boxfish	*Ostracion meleagris*
Threadfin butterflyfish	*Chaetodon auriga*
Hawaiian sergeant	*Abudefduf abdominalis*
Hawaiian gregory	*Stegastes marginatus*

Common Name	Scientific Name
Yellowfin goatfish	*Mulloidichthys vanicolensis*
Moorish idol	*Zanclus cornutus*
Striped mullet	*Mugil cephalus*
Keeltail needlefish	*Platybelone argalus*
Palenose parrotfish	*Scarus psittacus*
Hawaiian whitespotted toby	*Canthigaster jactator*
Convict tang	*Acanthurus triostegus*
Brown surgeonfish	*Acanthurus nigrofuscus*
Sleek unicornfish	*Naso hexacanthus*
Bluespine unicornfish	*Naso unicornis*
Wedgetail triggerfish	*Rhinecanthus rectangulus*
Pacific trumpetfish	*Aulostomus chinensis*
Pearl wrasse	*Anampses cuvier*
Raccoon butterflyfish	*Chaetodon lunula*
Bluefin trevally	*Caranx melampygus*
Belted wrasse	*Stethojulis balteata*
Saddle wrasse	*Thalassoma duperrey*

Table 3. Banzai Pipeline (21°40'00.28"N, 158°03'00.69'W)

Common Name	Scientific Name
Birds	
Red junglefowl	*Gallus gallus*
Common myna	*Acridotheres tristis*
Zebra dove	*Geopelia striata*
Crabs	
Pallid ghost crab	*Ocypode pallidula*
Plants	
Terrestrial Plants	
Coconut palm	*Cocos nucifera*
Seagrape	*Coccoloba uvifera*
Queen emma lily	*Crinum augustum*
Sea hibiscus	*Hibiscus tiliaceus*
Beach morning glory	*Ipomoea pes-caprae subsp. brasiliensis*
Beach naupaka	*Scaevola taccada*
Tropical almond	*Terminalia catappa*
Sagebush	*Pluchea carolinensis*
Fishes	
Hawaiian flagtail	*Kuhlia xenura*

Table 4. Project Site and Adjacent Beach (21°40'21.44"N, 158°02'37.08'W)

Common Name	Scientific Name
Birds	
Red junglefowl	*Gallus gallus*
Common myna	*Acridotheres tristis*
Zebra dove	*Geopelia striata*
Invertebrates	
Terrestrial Molluscs	
Giant African land snail	*Achatina fulica*
Crabs	
Pallid ghost crab	*Ocypode pallidula*
Plants	
Terrestrial Plants	
Coconut palm	*Cocos nucifera*
Seagrape	*Coccoloba uvifera*
Tiare	*Gardenia taitensis*
Spider lily	*Crinum asiaticum*
Croton	*Codiaeum variegatum*
Zoysiagrass	*Zoysia* sp.
Beach naupaka	*Scaevola taccada*
Aquatic Plants	
Green algae	*Cladophora sericea*
Pterocladiella capillacea	*Pterocladiella capillacea*
Fishes	
Square-spot goatfish	*Mulloidichthys flavolineatus*
Bluefin trevally	*Caranx melampygus*

Table 5. Adjacent Beach to Project Site (21°40'22.68"N, 158°02'32.09'W)

Common Name	Scientific Name
Birds	
Red junglefowl	*Gallus gallus*
Common myna	*Acridotheres tristis*
Zebra dove	*Geopelia striata*
Cattle egret	*Bubulcus ibis*
Invertebrates	
Terrestrial Molluscs	
Giant African land snail	*Achatina fulica*
Aquatic Molluscs	
Periwinkle snail	*Littorina sp.*
Black nerite snail	*Nerita picea*
Cone snail	*Conus lividus*

Common Name	Scientific Name
Crabs	
Pallid ghost crab	*Ocypode pallidula*
Echinoderms	
Black sea cucumber	*Holothuria atra*
Plants	
Terrestrial Plants	
Coconut palm	*Cocos nucifera*
Seagrape	*Coccoloba uvifera*
Tiare	*Gardenia taitensis*
Spider lily	*Crinum asiaticum*
Croton	*Codiaeum variegatum*
Zoysiagrass	*Zoysia* sp.
Sea hibiscus	*Hibiscus tiliaceus*
Casuarina tree	*Casuarina equisetifolia*
Tropical almond	*Terminalia catappa*
Sagebush	*Pluchea carolinensis*
Aquatic Plants	
Green algae	*Cladophora sericea*
Pterocladiella capillacea	*Pterocladiella capillacea*
Limu mane`one`o	*Laurencia* spp.
Melan	*Amansia glomerata*
Asteronema	*Asteronema breviarticulatum*
Coralline algae	*Porolithon* spp.
Hard bubble seaweed	*Dictyosphaeria versluysii*
Fishes	
Square-spot goatfish	*Mulloidichthys flavolineatus*
Bluefin trevally	*Caranx melampygus*
Hawaiian flagtail	*Kuhlia xenura*
Hawaiian whitespotted toby	*Canthigaster jactator*

Table 6. Kanuala Beach (21°40'50.18"N, 158°02'17.38'W)

Common Name	Scientific Name
Birds	
Red junglefowl	*Gallus gallus*
Common myna	*Acridotheres tristis*
Zebra dove	*Geopelia striata*
Invertebrates	
Aquatic Molluscs	
Periwinkle snail	*Littorina* sp.
Black nerite snail	*Nerita picea*
Cone snail	*Conus lividus*

Common Name	Scientific Name
Crabs	
Pallid ghost crab	*Ocypode pallidula*
Echinoderms	
Black sea cucumber	*Holothuria atra*
Plants	
Terrestrial Plants	
Coconut palm	*Cocos nucifera*
Seagrape	*Coccoloba uvifera*
Queen emma lily	*Crinum augustum*
Sea hibiscus	*Hibiscus tiliaceus*
Casuarina tree	*Casuarina equisetifolia*
Beach morning glory	*Ipomoea pes-caprae subsp. Brasiliensis*
Pandanus	*Pandanus tectorius*
Wedelia	*Sphagneticola trilobata*
Beach naupaka	*Scaevola taccada*
Aquatic Plants	
Green algae	*Cladophora sericea*
Pterocladiella capillacea	*Pterocladiella capillacea*
Limu mane`one`o	*Laurencia* spp.
Melan	*Amansia glomerata*
Coralline algae	*Porolithon* spp.
Fishes	
Square-spot goatfish	*Mulloidichthys flavolineatus*
Bluefin trevally	*Caranx melampygus*
Hawaiian flagtail	*Kuhlia xenura*

Table 7. Turtle Bay (21°42'021.21"N, 157°59'49.92'W)

Common Name	Scientific Name
Reptiles	
Turtles	
Green sea turtle	*Chelonia mydas*
Invertebrates	
Aquatic Molluscs	
Cone snail	*Conus lividus*
Echinoderms	
Black sea cucumber	*Holothuria atra*
Corals	
Lobe coral	*Porites lobata*
False brain coral	*Pavona varians*
Blue rice coral	*Montipora flabellata*
Cauliflower coral	*Pocillopora meandrina*

Common Name	Scientific Name
Segmented Worms	
Featherduster worm	*Sabellastarte sanctijosephi*
Spaghetti worm	*Loimia medusa*
Sea Urchins	
Banded urchin	*Echinothrix calamaris*
Pale rock-boring urchin	*Echinometra mathaei*
Lobsters	
Hawaiian spiny lobster	*Panulirus marginatus*
Plants	
Aquatic Plants	
Green algae	*Cladophora sericea*
Pterocladiella capillacea	*Pterocladiella capillacea*
Limu mane`one`o	*Laurencia* spp.
Melan	*Amansia glomerata*
Coralline algae	*Porolithon* spp.
Ear seaweed	*Padina japonica*
Caulerpa racemosa	*Caulerpa racemosa*
Dictyosphaeria spp.	*Dictyosphaeria* spp.
Finger seaweed	*Neomeris vanbosseae*
Halimeda opuntia	*Halimeda opuntia*
Fishes	
Bluefin trevally	*Caranx melampygus*
Wedgetail triggerfish	*Rhinecanthus rectangulus*
Hawaiian whitespotted toby	*Canthigaster jactator*
Convict tang	*Acanthurus triostegus*
Brown surgeonfish	*Acanthurus nigrofuscus*
Spotted boxfish	*Ostracion meleagris*
Milletseed butterflyfish	*Chaetodon miliaris*
Lagoon triggerfish	*Rhinecanthus aculeatus*
Wedgetail triggerfish	*Rhinecanthus rectangulus*
Square-spot goatfish	*Mulloidichthys flavolineatus*
Hawaiian flagtail	*Kuhlia xenura*
Whitesaddle goatfish	*Parupeneus porphyreus*
Saddle wrasse	*Thalassoma duperrey*
Bluestripe snapper	*Lutjanus kasmira*
Sleek unicornfish	*Naso hexacanthus*
Bluespine unicornfish	*Naso unicornis*
Yellowfin surgeonfish	*Acanthurus xanthopterus*
Blackstripe coris	*Coris flavovittata*
Thornback cowfish	*Lactoria fornasini*
Pearl wrasse	*Anampses cuvier*
Belted wrasse	*Stethojulis balteata*

Common Name	Scientific Name
Hawaiian gregory	*Stegastes marginatus*
Longspine porcupinefish	*Diodon holocanthus*
Hawaiian sergeant	*Abudefduf abdominalis*
Moorish idol	*Zanclus cornutus*
Keeltail needlefish	*Platybelone argalus*

From examining the results of the Flora and Fauna survey, which show less species present at Sunset Beach it can be deducted that Sunset Beach has less biodiversity than the adjacent beaches. This is reported to be primarily due to the high wave energy environment. With a high wave energy environment, it is much more probable that unconsolidated sand that is pushed will be mobilized. This project will have no net environmental impact in regards to flora and fauna as it will only be on the private property and underground.

4.4 Public Access, Amenity, and Use Impacts

The Sunset Beach, Pupukea-Paumalu Beach park is easily accessible to the public on a year round basis. Sunset beach's renown surfing history and heritage draws tourist from all over the world who access the beach by travelling along the Kamehameha Highway and parking at the beach park, parking locations shown in figure 7, above. Tourist beach visitors then primarily access the beach by foot. Local residents of the area typically use the beach access ROW's along the beach. These include swimmers, snorkelers, divers, walkers, surfers, and other users.

The current proposed project will only be landward of the highwater line, landward of the defined shoreline, and is in no way in the conservation zone or Pupukeap-Paumalu Beach park. The proposed project will occur in the Shoreline setback zone and below the surface of the ground or below grade. The proposed project will give the property owner certainty in protection of the dwelling allowing the previously defined natural accretion and erosion processes to continue. The proposed geotechnical improvement will also allow for certainty in the protection of public safety in case of the instance of an unnatural wave event that could cause the structure to fall onto the public beach or into the water.

The current project will alleviate the need for on-going sand pushing and resultantly improve public access. Sand pushing requires access to the beach by heavy equipment on an on-going basis. Machinery on the beach limits useability by the public and reduces the amenity of the beach for beach goers. The alleviation of sand pushing will also improve water quality and allow for an aquatic environment that supports more robust biodiversity that is not subject to sand blinding. This improved aquatic environment can be enjoyed by means of snorkelling and swimming by tourist and local residents.

In summary, the proposed project will have no significant impacts on public use, public amenity, and public access.

4.5 Alternatives Analysis

It is required that alternatives be considered in the selection of a proposed project. The geotechnical improvement by creation of synthetic sandstone in the shoreline setback zone is the preferred alternative environmentally. The proposed project can be installed and constructed with

no significant impacts and will have no significant impacts after installation. When the proposed project is compared with traditional approaches outlined below, current and on-going environmental impacts are abated.

4.5.1 Sea Wall Alternative

Sea walls have been implemented in the vicinity of the project site, to the north at Sunset Point and to the south at Rocky Point. Sea walls can be effective at managing erosion, however if not correctly implemented, can increase erosion rates. The sea walls located at Sunset point have higher limestone base elevations to be construed atop. This contributes significantly to their success in this area. The Sea walls that exist at Rocky Point have a deeper limestone base and are withholding larger elevations of sand from collapse. This intermediate and increased depth has contributed to their partial demise. Sea walls also limit public access. A sea wall solution was dismissed from consideration for these reasons.

4.5.2 Sand Container Revetment Alternative

A sand container revetment has proven successful in many applications around the world. A sand container revetment would need to be applied at an approximate 1.5 horizontal to 1 vertical slope, considering the current wave run-up climate. To install a sand container revetment that would work technically in this area would require the excavation, disruption, and deconsolidation of significant amounts of sand on public and private land. The construction period would also require significant risk of additional exposure of the property and structure to wave erosion in an unstabilized state. For these reasons a sand container revetment solution was dismissed from consideration.

4.5.3 Groins, Accreting Technologies, and other Heavy Civil Projects on State and Federal Lands

Groins, reef restoration, sand nourishment, continuous multi-property revetments, breakwaters, sheet-pile walls, and other heavy civil engineering coastal solutions may be applicable at this site however they are economically expensive and require coordination, cooperation, and agreement between all involved property owners and government entities to make the project a success. These types of projects would have to be applied on state or federal lands and are extensive in permitting and financing. The property owners along the front of Sunset beach are of various ages, incomes, and ownership status. Obtaining agreement and cooperation between all property owners is not probable. For these reasons, no heavy coastal civil engineering project was considered as an alternative. Should a project of this type be implemented in the future, the proposed will have no impact on the option for a heavy civil project and is compatible with a future heavy civil project.

4.5.4 On-going Ad-hoc "Sand Pushing", Effective Excavation of Sand from Paumalu Stream and Gulch and Placement in Front of Properties

Along Sunset Beach, high volume pushing of sand has been prescribed or suggested by the Department of Land and Natural Resources, Office of Coastal Conservation and Lands. This has entailed taking sand from the mouth of the Paumalu Stream, where the Paumalu Stream flows into the Paumalu gulch in the Pacific Ocean. Sand has been excavated on an on-going basis for at least two years from the Paumalu Stream mouth, adjacent the Paumalu Bridge, and then placed in front of existing properties.

The state of the sand before excavation, in its natural deposited state, was consolidated. The state of the sand after pushing by construction machinery and placement was unconsolidated. This method of beach management relies on no quantitative data and the scientific and engineering precedence for implementation of this method is questionable. A report was created in 2009 for the Department of Land and Natural Resources, Office of Conservation and Coastal Lands by the University of Hawaii, Sea grant College program that provides a "preliminary review of current beach maintenance practices" that provide sand pushing as an example. Sand in an unconsolidated state has significantly more erosion potential than sand in a natural state.

Storm water in the Paumalu Stream contains pollutants that are washed over land. When rainfalls are low, these pollutants can saturate into the beach sand when the beach is in an accreted state. Pollutants can be excessive nutrients, hazardous chemicals or metals, or microbial agents. When sand is pushed from the mouth of Paumalu stream, these pollutants and agents are pushed as well. This practice is not further recommended until any probable and potential threats to public safety and environment can be identified. Further, The "North Shore Sustainable Communities Plan" specifically states in section 4.6.2 "Guidelines":

"Retain Natural Gulches as flood plains and open space resources. Restrict development within gulches, and prohibit grading or other disturbance of gulch walls" and later "Limit any modification to gulches. "

The continuation of sand-pushing is not considered a sustainable practice nor a practice that is in the public interest of safety. The practice of sand excavating and pushing also has significant environmental impacts. For this reason, continued sand pushing is not sought after as an alternative nor is it further recommended.

4.5.6 Structure Re-Location

The current property has already lost at least 21.8% of its already limited area of 6,883 square feet. Another additional 18% of the property is imminently threatened. Access to the site is limited to smaller machinery. The larger machinery needed to relocated the house safely cannot reasonably reach the house. Further, the only exposed land behind the habituated structure is used for septic pit or ses-pit purposes. The inhabited structure cannot be reasonable relocated without making a large environmental impact on the public beach and is therefore dismissed from consideration.

4.5.7 Synthetic Injected Sandstone Geotechnical Improvement and Stabilization

Geotechnical stabilization of fine-grained materials has been carried out for generations via saturation with a bonding agent from above or though injection to deeper depths. Monitoring bores around the perimeter of the site combined with sophisticated flow-monitoring equipment allows for safe, to the second geotechnical stabilization that is non-invasive and requires little disturbance of the surface.

Based on the observations and conclusions by the DLNR, OCCL and University of Hawaii the natural erosion rate in the area is less than 1 foot per annum and the accretion rate may be up to 1 Foot per annum. Based on these rates, the proposed geotechnical improvement of injected sandstone formation will not be exposed in the near future. These rates are larger than existing rates for the purpose of seeking agreement with DLNR. Rates published by Romine and Fletcher in 2012 publish rates for the North Shore of Oahu as the following:

	Long Term Erosion Rate (Meters per year)	Short Term Erosion Rate (Meters per year)
North Shore Oahu Erosion Rates	-0.11+/-0.01	-0.07+/-0.01

Should the geotechnical improvement ever become exposed, the amenity and finish is similar to that of local sandstone formations. It will have no negative impact on amenity. It should be noted that before improbable and unanticipated exposure of the geotechnical improvement, adjacent properties and structures will have failed due to closer proximity to the ocean. For this reason, the geotechnical stabilization of the sand below the house structure will have no impact on present or future along shore processes.

The injected bonding agent is EPA approved, environmental engineered reviewed, and has no adverse or toxic leachates. The potential exposure of the constituents in the ses-pit or septic field is a significantly higher environmental concern. Drawings of the proposed geotechnical stabilization are provided in appendix B. A sample of a set and bound in-situ material is shown in the following figure 10.

Figure 10. Sample Synthesised Sandstone for Geotechnical Improvement
(Sample Provided by Structural Solutions Hawaii)

4.6 Finding of no significant impact (FONSI) and Abatement of Existing and On-Going Impacts (AEOGI)

The proposed project will have no significant environmental impacts without exception. The implementation of this project will also aid in the abatement of existing and on-going impacts.

Best Regards,

Joseph Little PE
Managing Director
Little Environments PLLC

5.0 Mitigation Measures

The proposed project contractor will be required to meet all storm water and ground water regulations. Precautionary monitoring boreholes will be implemented to ensure that the geotechnical improvement does not extend beyond boundaries identified in the drawings. As no ground surface is expected to be altered, no significant mitigation measures are deemed necessary. The proposed project is effectively mitigating the probable present and future impacts of the existing sand pushing.

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Appendix A- Flora/Fauna Definitions

OBSERVED SPECIES DESCRIPTIONS

Birds

Red junglefowl (*Gallus gallus*)

Source: Pyle, R.L., and P. Pyle. 2009

The red junglefowl is a tropical member of the Phasianidae family. It is thought to be ancestral to the domestic chicken, with some hybridization with the grey junglefowl. The red junglefowl was first domesticated at least five thousand years ago in Asia, then taken around the world, and the domestic form is kept globally as a very productive food source of both meat and eggs. The range of the wild form stretches from Tamil Nadu, South India (where it has almost certainly been diluted with cross breeding from domestic breeds) eastwards across southern China and into Malaysia, the Philippines — where it is locally known as "labuyo" — and Indonesia. Junglefowl are established on several of the Hawaiian Islands, but these are feral descendants of domestic chickens. They can also be found on Christmas Island and the Mariana Islands.

Common myna (*Acridotheres tristis*)

Source: http:birds.Audubon.org/

Common myna are around 9-10 in (23-26 cm), stocky, mostly dark-brown; head glossy, black; legs, bill, and bare orbital region yellow legs; large white patch visible in flight and at rest; tail brown, tipped with white. They are commonly found around open country, forest edges, agricultural areas, residential gardens, city streets, and suburbs; avoids dense forest. In Hawaii, they are routinely seen around airstrips and shopping mall parking lots (Florida). Their native range includes south and central Asia, east through the Indian subcontinent, and much of Southeast Asia. They common myna has been introduced in many other parts of the world including Florida and Hawaii.

Introduced into Hawaiian Islands in 1865 to control insects; by 1879, the common myna was reported as abundant in Honolulu. Thought to have had little or no involvement in the drastic declines of native Hawaiian bird populations; however, on Mauritius competes for nest cavities with endangered Echo Parakeet and Mauritius Kestrels.

Zebra Dove (*Geopelia striata*)

Source: Pyle, R.L., and P. Pyle. 2009

The zebra dove is small and slender with a long, narrow tail. The upperparts are brownish-grey with black-and-white barring. The underparts are pinkish with black bars on the sides of the neck, breast and belly. The face is blue-grey with bare blue skin around the eyes. There are white tips to the tail feathers. Juveniles are duller and paler than the adults. Zebra Doves are 7-9 (18-23 cm) inches in length with a wingspan of 10 in (25 cm). The native range of the species extends from Southern Thailand, Tenasserim, Peninsular Malaysia and Singapore to the Indonesian islands of Sumatra and Java. It may also be native to Borneo, Bali, Lombok, Sumbawa, and the Philippine islands. The Zebra Dove is popular in captivity and many populations have appeared outside its native range due to birds escaping or being deliberately released. It can now be found in central Thailand, Laos, Borneo, Sulawesi, Hawaii (introduced in 1922), Tahiti (1950), New Caledonia, the Seychelles, the Chagos Archipelago (1960), Mauritius (before 1768), Réunion and Saint Helena. It inhabits scrub, farmland and open country in lowland areas and is

commonly seen in parks and gardens. Zebra Doves are among the most abundant birds in some places such as Hawaii and the Seychelles.

Cattle egret (*Bubulcus ibis*)

Source: McCarthy, Eugene M, 2006

The cattle egret is a cosmopolitan species of heron (family Ardeidae) found in the tropics, subtropics and warm temperate zones. It is a white bird adorned with buff plumes in the breeding season. It nests in colonies, usually near bodies of water and often with other wading birds. The nest is a platform of sticks in trees or shrubs. Cattle egrets exploit drier and open habitats more than other heron species. Their feeding habitats include seasonally inundated grasslands, pastures, farmlands, wetlands and rice paddies. They often accompany cattle or other large mammals, catching insect and small vertebrate prey disturbed by these animals. Some populations of the cattle egret are migratory and others show post-breeding dispersal. The cattle egret has undergone one of the most rapid and wide reaching natural expansions of any bird species. In addition to the natural expansion of its range, cattle egrets have been deliberately introduced into a few areas, including Hawaii in 1959.

Invertebrates

Terrestrial Molluscs

Giant African land snail (*Achatina fulica*)

Source: Florida Department of Environmental Protection

"Giant African land snail" is the common name used to describe any of the three snail species native to Africa. The giant African snail (*Achatina fulica*), the giant Ghana tiger snail (*Achatina achatina*), and margies (*Archachatina marginata*) are large, terrestrial snails that can reach up to 8 inches in length and 4 inches in maximum diameter. The brownish shell with darker brown vertical stripes covers at least half of the length of the snail. The giant African land snail, believed to be originally from East Africa, has been established throughout the Indo-Pacific Basin, including the Hawaiian Islands. This mollusk has also been introduced to the Caribbean islands of Martinique and Guadeloupe. Recently, the snails were detected on Saint Lucia and Barbados.

Aquatic Molluscs

Periwinkle snail (*Littorina* sp.)

Source: Reid, David G.; Gofas, S., 2011

The common periwinkle or winkle is a species of small edible sea snail, a marine gastropod mollusc that has gills and an operculum, and is classified within the family Littorinidae, the periwinkles. This is a robust intertidal species with a dark and sometimes banded shell.

Black nerite snail (*Nerita picea*)

Source: Bourne, G. C., 1908

The Black Nerite Snail, or the Hawaiian endemic pipipi snail is one of the most common marine snails in Hawai‘i. Pipipi tend to aggregate in large groups just above the water level, preferring smooth (pahoehoe) rocks to rough (a‘a) counterparts. They are typically about a centimeter in size. Pipipi may bunch together in groups for "protection in numbers" from their predators (e.g. large carnivorous snails, aquarium

collectors). Like all gastropods (including their ‘opihi cousin), they have a muscular foot to move around and stick to their rock substrate, tentacles with eyespots to glean information about the environment they live in, a mouth with a radula (toothed tongue) to scrape algae off the rocks, and a shell to protect their soft insides. However, in addition, marine snails like the pipipi have an operculum or lid-like cover for their shell.

Cone shell (*Conus lividus*)

Source: Conus Linnaeus, 1758.

Cone snails are predatory animals, stinging their victims with a venomous harpoon-like tooth which can be hazardous to humans. Though cone snails primarily use their tooth to subdue prey, it can also be used defensively, stinging other animals, or humans, that get too close. Though all cone snails have venom glands, only a few species are dangerous enough to be fatal to humans. Cone snails are generally buried in the sand or rubble during the day and are active during the night. They hunt by smell using a siphon which can be extended away from the shell's opening. Depending on the species, cones may prefer marine worms, snails (including other cones) or sleeping fishes. The venomous tooth is located at the tip of the proboscis, a muscular extension of the mouth. Cone snails are found in all habitats from shallow to moderate depths. Cone snails, one of the largest families of marine snails, have heavy, smooth shells. The live snails are covered by a skin-like layer called a periostracum which can either be opaque or translucent. The patterns on the shell can often be obscured by the periostracum or algal and calcareous growths growing on the skin. There are at least 34 different species of cone snails in Hawaii, and one snail is found nowhere else in the world. Most cones in Hawaii are less than 3 (7.6 cm) inches, but the largest one, the leopard cone, can be up to 9 (23 cm) inches.

Crabs

Pallid ghost crab (*Ocypode pallidula*)

Source: John P. Hoover, 1999

The pallid ghost crab is pale with a light pattern on its body, and 10 white speckled legs that allow them to move forward or sideways with speed. They are difficult to see because they blend in with the sand and so named the Ghost Crab. Ghost crabs lives in sandy burrows on the beach close to the water, however the Pallid Ghost Crab live higher on the beach. Their burrows are at the base of a fan-shaped pattern of small sand clumps created by the crabs’ excavated sand. The ghost crab is carnivorous and cannibalistic.

Echinoderms

Black sea cucumber (*Holothuria atra*)

Source: Paulay, Gustav, 2010

The black sea cucumber or lollyfish, is a species of marine invertebrate in the family Holothuriidae. The black sea cucumber is a sausage-shaped sea cucumber that can grow to a length of 24 in (61 cm) but 8 in (20 cm) is a more common size. It has a smooth, pliable, entirely black skin which often has sand adhering to it, especially in smaller individuals. The mouth is on the underside at one end and is surrounded by a fringe of 20, black, branched tentacles. The anus is at the other end. The black sea cucumber is found in the tropical Indo-Pacific region, its range extending from the Red Sea and East Africa to Australia. It is found on the seabed, in shallow waters on reefs and sand flats and in seagrass meadows at depths of up to 60 ft (18 m). Its coloring makes it conspicuous but it is very often camouflaged by a coating of sand which may also serve to keep it cool by protecting it from the sun's

rays. It favors reef flats where it is not fully exposed to the waves but the water is well aerated, and shallows beside slabs of rock from under which cool water wells out when the tide retreats. In such places it is often found in pools above the low tide mark which are warmed by the sun during the day.

Corals

Lobe coral (*Porites lobata*)

Source: Gulko, D., 1998

Lobe coral is a species of stony coral in the family Poritidae. It is found growing on coral reefs in tropical parts of the Indian and Pacific Oceans. It is a hermatypic or reef-building coral, and varies greatly in size and shape depending on its environment. On wave-exposed reef slopes it is encrusting whereas in calm water areas it can grow into large helmet-shaped or hemispherical hummocks up to 20 ft (6 m) high and wide. Growth rates are very slow, sometimes being as little as 0.5-1 in (1-3 cm) per year, implying that large corals are very old. The general color is greenish, yellow or tan because of the zooxanthellae, single-celled microalgae that live symbiotically within the tissues. The species range extends from East Africa, the Red Sea and the Gulf of Aden, through Indonesia and Australian waters to the Pacific coasts of California and Central America. It is the most common coral species in Hawaii, and is often the dominant species on reef margins, in lagoons and on fringing reefs at depths down 100 ft (300 m).

False brain coral (*Pavona varians*)

Source: Gulko, D., 1998

False brain coral grows as encrusting globular masses, are tan or tan-brown in color. The fine structure is elongate, angular, with steep-sided ridges and calices in valleys, as well as a septa line on the sides of ridges. False brain coral is found on reef flats and slopes.

Blue rice coral (*Montipora flabellate*)

Source: Gulko, D., 1998

Only found in Hawaii, blue rice coral is uncommon and thrives in shallow reefs pounded by waves. Although this coral is usually flat and sheetlike, on one reef in Molokai it grows branches with an opening at the tip that provides a home to small shrimp. Blue rice coral is vulnerable to bleaching, habitat degradation, and disease.

Cauliflower coral (*Pocillopora meandrina*)

Source: Gulko, D., 1998

Sometimes found in only a few inches of water, cauliflower coral exploit harsh environments and thrive. Cauliflower coral is generally a branching coral existing exclusively in the Pacific Ocean realm, ranging from portions of the west coast of Central and South America, cropping up again in the Hawaiian Archipelago, and abundant from Australia northwards from the eastern Indian Ocean to the China Sea. Healthy specimens contain symbiotic dinoflagellates (*Symbiodinium* spp.). Most colonies in Hawai'i are of small diameter, and rarely exceed 16 in (60 cm), with most being 6-8 in (25-20 cm).

Crust coral (*Leptastrea purpurea*)

Source: Veron, J.E.N., 1986

Colonies of crust coral are flat with angular subcerioid corallites of very variable size. Crust coral is usually pale yellow or cream on the upper surface with dark sides, grey with pale oral discs. It is a common coral species and occurs in a wide range of habitat including seagrass beds, reef flats, and turbid waters. Colonies form encrustations in which the polygonal or rounded corallites (2-10 mm across [less than 1 inch]) are flush with the surface, tightly packed and have prominent, radiating septa. Crust coral is found in the Indo-West Pacific, Red Sea and Gulf of Aden, Southwest Indian Ocean, Northwest Indian Ocean and Arabian/Iranian Gulf, Northern Indian Ocean, Central Indo-Pacific, Australia, Southeast Asia, Japan and East China Sea, oceanic West Pacific, Central Pacific, and the Hawaiian Islands and Johnston Atoll.

Segmented Worms

Featherduster worm (*Sabellastarte sanctijosephi*)

Source: Read, G., 2010

Worldwide, feather dusters come in a variety of often pale, entrancing colors. The most commonly spotted feather duster in Hawaii is either tan or orange-colored with brown and white bands running through it. Its tentacles form a crown or fan and each tentacle comes equipped with tiny, hair-like cilia. This species is sometimes referred to as the Hawaiian feather duster or giant feather duster even though it doesn't get much bigger than three inches in length, including the crown. The feather duster worm's actual body is hidden out of sight inside a leathery or parchment-like tube, where the worm lives its entire life. It uses its flared crown or fan of hairy tentacles to trap and filter food particles and to breathe. Feather dusters are found in tropical and temperate waters at depths between seven and 165 ft (50 m). This species prefers turbid or at least moving water that provides a steady supply of food. Once food particles become trapped inside the tentacles, the cilia direct the small particles toward the worm's mouth in the center of the crown. Larger particles are used to build and extend the length of the tube, which may eventually exceed the length of the worm itself. These larger particles are stored in the worm's ventral sacks, mixed with mucous secretions and combined with sand. Strands of this mixture are sent to the collar at the top of the tube - lengthening the tube as the worm rotates and wiggles up and down inside it.

Spaghetti worm (*Loimia medusa*)

Source: Kaplan, Eugene Herbert, 1999

The spaghetti worm is a species of Annelida from the class polychaete. It is marine dwelling organism with a circumtropical distribution. The spaghetti worm can inhabit rock pools, bays, reef systems, warm estuaries and even open ocean, feeding on organic detritus by means of long slender tentacles which can extend to an incredible 18 in (45 cm). Typically subtidal, this polychaete ranges from the intertidal and shallow subtidal sands to muddy habitats of depths exceeding 130 ft (40 m). The spaghetti worm has two body regions: the thorax which is brick red and usually thick in comparison to the rest of the body with dorsal bundles of setae and ventral pads bearing hooked setae; and the abdomen which is significantly thinner with reduced parapodia. The solitary lifestyle coupled with its ability to remain unseen within its environment mean that there is little information with regards to the species populations and life history of this animal. This being said it displays an array of unique morphological and behavioral characteristics whilst serving vital roles in the way of sediment recycling within the vast array of ecosystems it inhabits

Sea Urchins

Banded urchin (*Echinothrix calamaris*)

Source: Le Bris, Sylvain and Maran, Vincent, 2010

The banded sea urchin has a slightly oval test (shell), reaching a diameter of about 2 in (5 cm). Like almost all the Diadematidae, it has two different sets of spines, shorter and slender closed spines which are going from yellow to dark (through brown) in color and can deliver a nasty sting, and longer and thicker spines that are often banded with light and dark color (but sometimes all dark or all white), and reaching 4 to 6 in (10-15 cm) in length. The spines are grouped so as to let appear five naked zones on the central part of the test, in a star pattern (called "iridophores"): this pattern can be colored, often in blue. The anal papilla is big, more or less translucent and very obvious on the aborale face; it is generally whitish and speckled with black and white dots, circled by a ring of visual receptors that grant it a rudimentary vision. The banded sea urchin is widespread throughout the tropical waters of the Indo-Pacific region, from eastern coast of Africa to French Polynesia, including Hawaii and the Red Sea, and occurs from the surface to 230 ft (70 m) in depth and can be found in lagoons, external reef slopes and channels.

Pale rock-boring urchin (*Echinometra mathaei*)

Source: Kroh, Andreas, 2010

The color of pale rock-boring urchins is quite variable but the test is usually a dark color. The spines are sometimes green and purple with purple tips or entirely green with purple tips. This species of urchin can be easily distinguished from others by a characteristic pale ring at the base of each spine. The pale rock-boring urchin grows to a test diameter of about 2 in (5 cm), and is found on reefs in tropical parts of the Indo-Pacific Ocean at depths down to 450 ft (137 m). Its range extends from Madagascar, the East African coast and the Red Sea to Hawaii.

Hawaiian spiny lobster (*Panulirus marginatus*)

Source: M. Butler, A. Cockcroft & A. MacDiarmid, 2009

The Hawaiian spiny lobster is in the family Palinuridae, which is endemic to the Hawaiian Islands, and is the subject of extensive commercial and recreational fisheries. These lobsters can be found in shallow water under rocks and crevices on rocky bottoms and even to depths as deep as 470 ft (143 m). This species is nocturnal. Although longevity and age at maturity are not known for this species, inference from similar species (e.g., the Caribbean Spiny Lobster *Panulirus argus*) suggests a longevity of up to 20 years and sexual maturity at around four years.

Fish

Spotted boxfish (*Ostracion meleagris*)

Source: Myers, R.F., 1991

This is Hawaii's most common boxfish. Females (and perhaps juvenile males) are blackish brown covered on all sides with small white spots. Mature males have dark blue sides covered with black spots and their heads and tails are adorned with gold trim. Everywhere but Hawaii the lateral black spots on mature males contain conspicuous gold centers. Lacking these, the Hawaiian population has been given the subspecies name camurum (although males with scattered gold spots are occasionally observed here.) These fish often enter the shallows where waders and even people walking along shore can see them. The spotted boxfish grow to about 6 in (15 cm) and are found in the Indo-Pacific and Eastern Pacific.

Thornback cowfish (*Lactoria fornasini*)

Source: Myers, R.F., 1991

The thornback cowfish has two forward-pointing "horns" on the head, a thornlike spike in the center of the back, and two backward-pointing spines under the tail fin, one on each side. It is light tan with dusky areas and light blue lines or spots, which intensify in males during spawning. The fused hexagonal or pentagonal plates forming in the carapace are particularly evident in this species. It is found most often over mixed rubble and sand. The thornback cowfish grow to about 5 in (13 cm) and are found in the Indo-Pacific.

Threadfin butterflyfish (*Chaetodon Auriga*)

Source: Allen, G.R., 1985

The threadfin butterflyfish has a whitish body which darkens to gold in the back and is marked with sets of fine right-angled diagonal lines. One of the soft dorsal spines is elongated into a threadlike filament. Juveniles lack the filament and have a larger black spot. These large omnivores are strongly paired. Common but not abundant, they occur on all parts of the reef and are one of the few butterflyfishes that forage over sand They feed primarily on sessile and sand-dwelling invertebrates and defend a large feeding territory against members of their own species. The species name means "charioteer," probably because of the whiplike dorsal filament. The threadfin butterflyfish grow to about 8 in (20 cm), reportedly reaching its greatest size in Hawaii, and are found in the Indo-Pacific.

Raccoon butterflyfish (*Chaetodon lunula)*

Source: Heemstra, P.C., 1986

The face of the raccoon butterflyfish, with its masked eyes and white curved bar, resembles that of its namesake, the American mammal. The body, orange-yellow with diagonal brown stripes, darkens to brownish on the upper sides. A broad dark bar bordered in yellow runs diagonally back behind the white curved bar, and there is a dark spot at the base of the tail. Juveniles, which live in tide pools, are brighter yellow with a large false eyespot above the base of the tail. By day these fish often rest in large semi-stationary aggregations that frequent the same locations year after year. Sometimes they patrol the reef in schools, but it is not uncommon to find them in pairs or as single individuals. They do not appear to be nocturnal, as some sources claim. The raccoon butterflyfish grow to about 8 in (20 cm) and are found in the Indo-Pacific.

Hawaiian sergeant (*Abudefduf abdominalis*)

Source: Allen, G.R., 1991

The Hawaiian sergeant are one of the more common damsels found throughout Hawaii – the young, yellowish fish with five black bars, often occur in tide pools. Adults vary from brassy green to yellow with five vertical black bars which are widest and darkest along the upper back. The bars may shorten, lighten, or almost disappear. The ground color, too, may lighten or darken, and the abdomen may develop subtle yellow striping. The most distinct color changes occur during spawning and nest-guarding. Plankton-eaters, Hawaiian sergeants spend much of their time swarming high in the water to feed, usually over a specific area of the reef where they shelter and reproduce. When disturbed they dive as one for cover, but soon rise again to resume feeding. In addition to plankton, they also consume algae or almost anything else they can find. These fish can also be abundant near the bottom where they nest, spawn, and guard their purplish-red patches of eggs (usually deposited in crevices between boulders or under ledges, but when necessary, on flat hard bottom.) The Hawaiian sergeant grows to almost 10 in (25 cm), but usually smaller, and is endemic to Hawaii.

Hawaiian Gregory (*Stegastes marginatus*)

Source: Hawaii's Fishes: A Guide for Snorkelers and Divers 2nd Edition

The Hawaiian gregory is a drab, blackish or brownish gray damselfish, with bright lemon-yellow eyes and, often, a patchy, unkempt appearance due to some scales being lighter than others. Common in Hawaii, it prefers areas with moderate to low wave activity and feeds primarily on green filamentous algae. Each individual maintains an all-purpose territory (containing shelter and a nesting site as well as food), which it boldly defends against all other algae-eating fishes. The territory extends about 2-4 ft (0.6-1.2 m) in all directions from the shelter hole and is usually defined by natural formations such as coral heads or clumps of weed. Like similar Indo-Pacific and Caribbean damsels, the Hawaiian gregory "farms" its patch of filamentous algae by removing undesirable coralline algae and will unfailingly attempt to drive any other herbivore from its territory. Juveniles, bluish black with a pale yellow tail, appear during the summer months, often on wave-scoured reef flats. The Hawaiian gregory grow to about 6 in (15 cm), and are endemic to Hawaii but closely relate to the Pacific gregory (*S. fasciolatus*) found elsewhere in the Pacific. The Hawaiian species has a subtly different color pattern, including a black spot between the 2nd and 3rd dorsal spines visible only when the dorsal fin is raised.

Hawaiian flagtail (*Kuhlia xenura*)

Source: Randall, J.E. and H.A. Randall, 2001

By day, these silvery fish form dense stationary schools, usually near the tops of reefs or along drop-offs in areas of heavy surge where turbulence and fine bubbles screen them from predators. They also aggregate in caves and crevices where there is turbulence. Subadults will school in very shallow water along protected sandy beaches and in stream mouths. Resting schools often occupy the same location year after year, although they sometimes shift locations temporarily. At night the fish disperse to feed on plankton. Adults are silvery, sometimes with an olive or bronze tinge along the back, and occasionally with bronze patches on the side. The young have banded tails, but are otherwise plain. Juveniles are abundant in tide pools and will enter brackish water; sometimes they penetrate some distance up streams. The Hawaiian flagtail grow to about 12 in (30 cm) and are endemic to Hawaii.

Square-spot goatfish (*Mulloidichthys flavolineatus*)

Source: Myers, R.F., 1991

This common goatfish is most easily recognized by a squarish black spot on the side which is embedded within a yellow stripe running from head to tail. The black spot, often intense while the fish is feeding, may fade or disappear when it is resting or schooling. The yellow stripe may also fade. These fish often aggregate at predictable spots on the reef, either hovering in midwater or lying on the sand. When schooling with the black spot "turned off," they can be difficult to distinguish from the yellow goatfish (*Mulloidichthys vanicolensis*). However, they never turn pink or red, as yellowfin goatfish sometimes do. The species name means "yellow stripe." The Square-spot goatfish grow to about 16 in (40 cm) and are found in the Indo-Pacific.

Yellowfin goatfish (*Mulloidichthys vanicolensis*)

Source: Myers, R.F., 1991

When in the open during the day, the yellowfin goatfish have whitish bodies with some yellow along the back, yellow fins, and a yellow stripe from eye to tail. The yellow stripe may be bordered faintly with blue. They feed only at night, resting by day in tight schools which hang almost motionlessly in midwater, usually at the same spot on the reef year after year. They also congregate in caves and under ledges, where they often turn entirely pink or red, including the yellow stripe and fins. When posing to be cleaned by wrasses they typically take on the darker red color, perhaps to make parasites stand out. They also turn reddish when taken from the water, thus the Hawaiian name, meaning "red weke." These goatfish will sometimes enter brackish water. The yellowfin goatfish grow to about 15 in (38 cm) and are found in the Indo-Pacific.

Whitesaddle goatfish (*Parupeneus porphyreus*)

Source: Randall, J.E., 2004

The whitesaddle goatfish can be grayish purple, greenish, or reddish, but almost always has a small white spot, or saddle, above the base of the tail. Pale streaks along the body above and below the eye are another identifying feature. It feeds at night and is often seen resting by day, alone or in small groups. The whitesaddle goatfish grow to about 15 in (38 cm) and are endemic to Hawaii.

Bluefin trevally (*Caranx melampygus*)

Source: Paxton, J.R., D.F. Hoese, G.R. Allen and J.E. Hanley, 1989

The bluefin trevally is the most common large jack in the main Hawaiian Islands. These predators are silvery blue with scattered dark blue spots on the sides and beautiful blue fins. They can alter their color in seconds, however, becoming almost black. Smaller individuals are silvery with yellow pectoral fins. Swimming singly, in pairs, or in small groups, these fish typically occur on shallow reefs, sometimes in only a few feet of water. Bluefin trevally are adept at appearing suddenly, surprising a fish, and nabbing it before it can take cover. They will also strike at fish from midwater or from a hidden ambush position. The bluefin trevally grow to about 3 ft (0.9 m) and are found in the Indo-Pacific and Eastern Pacific.

Moorish idol (*Zanclus cornutus*)

Source: Myers, R.F., 1991

The moorish idol have light gold bodies marked with jet-black bands, long orange and white striped snouts, and graceful trailing filaments. They typically swim singly, in pairs, or in small schools, but occasionally twenty or thirty will band together. Common, even in silty harbors, they can often be seen from shore grazing in very shallow water. They feed primarily on sponges. Adults have a thornlike spine

in front of each eye, larger in males, giving rise to the species name *cornutus* ("horned"). Little is known about the biology or reproductive habits of moorish idols, surprising for such a conspicuous and widely distributed fish. They grow to about 8 in (20 cm) and are found in the Indo-Pacific and Eastern Pacific.

Striped mullet (*Mugil cephalus*)

Source: Harrison, I.J., 1995

These are Hawaii's largest mullets, and are silvery gray with faint stripes along the scale rows. The striped mullet has a blunt snout and its tail fins are often edged in black. Although common in some marine conservation zones, such as Hanauma Bay, O'ahu, and Honolua Bay, Maui, striped mullets are seldom seen at other snorkeling or diving sites. Primarily in brackish water, they are easily raised in fish ponds. The striped mullet grow to about 20 in (50 cm) and are found in tropical seas around the world.

Keeltail needlefish (*Platybelone argalus*)

Source: Böhlke, J.E. and C.C.G. Chaplin, 1993

Schools of keeltail needlefish are common at many shallow snorkeling areas, just below the surface. They have a silvery blue stripe along the side and the lower lobe of the tail fin, which is about the same size as the upper lobe. The caudal peduncle is flattened and bears a prominent keel on each side. These fish appear to rest by day and feed at night. The keeltail needlefish grow to about 15 in (38 cm) and are found in all tropical seas, with a different subspecies in the Atlantic.

Palenose parrotfish (*Scarus psittacus*)

Source: Randall, J.E., G.R. Allen and R.C. Steene, 1990

The species name *psittacus* means "parrot," and this is the original "parrotfish," described over 200 years ago from the Red Sea by Swedish explorer/naturalist Peter Forsskål. Common throughout the Indo-Pacific, it is probably the most abundant parrotfish in the main Hawaiian Islands. Supermales are green and blue with lavender tints above the head. There may be a yellow spot at the base of the tail and/or a yellow patch covering some or almost all of the side. While patrolling their territories or when chasing rival males, they develop a dark blue-black "cap." Initial phase fish (both sexes), often quite small, usually graze the reef in tight schools. They are plain light gray to dark brownish gray often with reddish pelvic fins. The distinctively shaped snout is sometimes paler than the rest of the body, but only in the initial phase fish. The palenose parrotfish grow to about 1 ft (30 cm) and are found in the Indo-Pacific.

Longspine porcupinefish (*Diodon holocanthus*)

Source: Leis, J.M., 1984

The longnose porcupinefish are light brown, marked with several large dark blotches and bars on the back and sides and many small dark spots. Long, backward-pointing spines lie flat along the entire body, erecting only when the fish inflates. Except for the larger dark blotches and smaller body size, this fish is similar enough to the giant porcupinefish that ichthyologists once suspected they were variants of the same species. Distinguishing characteristics of the longspine porcupinefish include short barbels under the chin and clear fins containing few or no spots. By day they rest on the bottom or hover quietly under ledges or in sheltered areas. These fish grow to about 15 in (38 cm), but are usually half that size, and are found in all tropical seas and are generally considered poisonous to eat.

Hawaiian whitespotted toby (*Canthigaster jactator*)

Source: Randall, J.E., 1985

Tobies are diminutive puffers, generally less than 4 in (10 cm) long, with a somewhat elongated snout. This species is brown with numerous white spots (those on the head often showing a slight green fluorescence), and is by far the most common toby in Hawaii. Usually seen in pairs, it occurs on hard substrate almost everywhere, from areas of complete coral cover to dead silty places where little else seems to live. The species name means "boaster" or "braggart "because of the fish's ability to inflate. The Hawaiian whitespotted toby grow to about 3.5 in (9 cm) and are endemic to Hawaii.

Bluestripe snapper (*Lutjanus kasmira*)

Source: Allen, G.R., 1985

The bluestripe snapper is yellow with four narrow, dark-edged, blue longitudinal stripes. Schools of these showy snappers are a common sight around wrecks and reefs in Hawaii. Although introduced from the Marquesas in 1958 for commercial reasons, they have not done well in island markets and are usually regarded by fishermen as a pest rather than an asset. The bluestripe snapper grow to around 15 in (38 cm), but are usually smaller, and are found in the Indo-Pacific.

Brown surgeonfish (*Acanthurus nigrofuscus*)

Source: Randall, J.E., 1956

This common surgeonfish varies from dark brown to light grayish brown with a definite lavender tinge, especially on the fins. There are dull orange spots on the head and two dark spots at the base of the crescent-shaped tail, one above the other. It typically feeds in shallow water close to shore, where it may defend a small feeding territory, but can also occur in schools. The brown surgeonfish grow to about 8 in and are found in the Indo-Pacific.

Yellowfin surgeonfish (*Acanthurus xanthopterus*)

Source: Randall, J.E., 1956

The yellowfin surgeonfish is purplish gray to almost black, with yellow and blue banded dorsal and anal fins. These large surgeonfish have deep blue lyre-shaped tails, often with a white ring at the base. These fish feed primarily on algae and diatoms growing on compacted sand and sometimes swim in large schools. The yellowfin surgeonfish grow to around 22 in (56 cm) and are found in the Indo-Pacific and Eastern Pacific.

Sleek unicornfish (*Naso hexacanthus*)

Source: Myers, R.F., 1991

These fish can change almost instantly from a metallic blue-gray to entirely dark. Plankton-eaters, they aggregate in midwater, usually near dropoffs. When courting or chasing rivals, large males darken the front of the body and flash several highly contrasting white marks and bars. Spawning aggregations occur in areas of strong currents around the time of high tide. These fish grow to around 30 in (76 cm) and are found in the Indo-Pacific.

Bluespine unicornfish (*Naso unicornis*)

Source: Myers, R.F., 1991.

The bluespine unicornfish has bright blue tail spines and a medium-size horn. Males have tail streamers and small specimens lack a horn entirely. When feeding, these fish often darken except for a light, often bluish patch above the pectoral fin, perhaps warning competitors to keep away. This fish is solitary or occurs in small schools, but may form large spawning aggregations. These fish grow to about 27 in (69 cm) and are found in the Indo-Pacific.

Wedgetail triggerfish (*Rhinecanthus rectangulus*)

Source: Matsuura, K., 2001

Blocks of color, geometrically arranged, give this curiously patterned fish one of its common names – Picasso triggerfish. A solid black wedge echoed by double gold lines marks the base of the tail. Blue and black bands between the eyes form a colorful "hat." The upper lip is bordered with intense blue and the pectoral fin base is bright red. The independently movable eyes are positioned high and about one third of the way down the body, enabling the fish, in theory, to attack long-spined sea urchins. More commonly, it feeds on small bottom-dwelling invertebrates, and is typically seen pecking briefly at the substrate then swimming off ejecting a trail of sand and sediment from tis gills. These fish grow to around 10 in (25 cm) and are found in the Indo-Pacific.

Lagoon triggerfish (*Rhinecanthus aculeatus*)

Source: Myers, R.F., 1991

Similar to the wedgetail triggerfish, this species prefers a sandier, weedier habitat and is far less common. Its blue hat, yellow lips bordered with blue, and yellow bridle make this unusual fish a treat to see in bright sunlight. A black patch on the side is marked with diagonal white bands. A bullseye-like mark is conspicuous on the fish's back, when viewed from above. Rows of rough, file-like spines at the base of the tail face outward as protection when the fish retreats into a hole. These fish grow to around 1 ft (30 cm) and are found in the Indo-Pacific.

Pacific trumpetfish (*Aulostomus chinensis*)

Source: Fritzsche, R.A., 1984

Inflexible and sticklike, these elongated predators are usually gray or brown, but may be bright yellow or, less commonly, almost black. When stalking or attempting to blend with the background, gray-brown individuals can rapidly assume pale vertical bars, longitudinal stripes, or both. Bars are displayed to signal aggression. Trumpetfish feed mostly on other fish, but also take crustaceans. These predators ambush or stalk their prey, maneuvering slowly and carefully within striking range, sometimes from an almost vertical position. Their bladelike snout can expand suddenly to engulf a fish the diameter of the predator itself. Trumpetfish swim stealthily by fluttering nearly transparent dorsal and anal fins set extremely far back on the body, out of sight of potential prey. They sometimes hunt by swimming closely alongside a non-predator such as a puffer or parrotfish, using it as a blind, or by swimming alongside a school of browsing surgeonfishes. While easy to spot from the side, a trumpetfish is almost impossible to see from the perspective of its prey – head on- allowing the predator to approach within inches. A barbel on its chin may serve as a final lure or distraction before the hapless victim is sucked headfirst into the long expandable gullet. These fish grow to around 27 in (69 cm) and are found in the Indo-Pacific and Eastern Pacific.

Pearl wrasse (*Anampses cuvier*)

Source: Randall, J.E., 1972

The pearl wrasse gets its name from the female color pattern: dark reddish brown with lines of white dots like strings of pearls. Males are green with fine blue lines and marks, especially on the head and tail, sometimes with a light vertical bar on the side. Although seen most often in bouldery areas close to shore, these fish also enter deeper water. Their diet consists mostly of small crustaceans and sometimes polychaete worms. These fish grow to around 14 in (36 cm) and are endemic to Hawaii.

Blackstripe coris (*Coris flavovittata*)

Source: Randall, J.E., 1999

Females are white with three black stripes running lengthwise along the upper side and a black bar on the tail fin, whereas the males are mottled light blue-green overall. Juveniles are black with four or five white (sometimes, light yellow) stripes which break up into spots and lines in tiny specimens. Like many Hawaiian endemics, these fish are most common in the northwestern chain. In the main islands, subadult females or juveniles are seen most often. Mature females are uncommon, and males are rarely encountered. The blackstripe coris grow to around 20 in (51 cm) and are endemic to Hawaii.

Belted wrasse (*Stethojulis balteata*)

Source: Randall, J.E., 2000

Supermales are green with several vivid blue lines on the head and body, a broad orange stripe from pectoral fin to tail, and an orange dorsal fin. The top of the head becomes yellow when aroused. Initial adult phases (both sexes) are gray striped with fine white spots, with a bright yellow spot at the base of the pectoral fin. Fast-moving and always on the go, these fish feed on a wide variety of small invertebrates which they pluck from the sand or rubble. Following the typical wrasse pattern, these fish spawn during daytime high tides, typically at the downcurrent ends of reefs. Terminal males spawn individually with females whereas initial phase adults spawn in groups. These fish grow to around 6 in and are endemic to Hawaii.

Saddle wrasse (*Thalassoma duperrey*)

Source: Randall, J.E., 1985

These ubiquitous wrasses occur from the shallows down to about 70 ft (21 m). Initial phase adults (both sexes) have a dark blue-green head followed by a band of dull orange. The rest of the body is blue-green with numerous narrow magenta vertical lines. Terminal males have a diffuse white bar behind the orange band and a crescent-shaped (lunate) tail fin, in which the white bar may be turned on or off. Juveniles are whitish with a dark strip running from the snout to tail. Juveniles and small adults sometimes establish cleaning stations, even copying the bobbing "dance" of a cleaner wrasse. Adults feed on a wide variety of small invertebrates, grow to around 10 in (25 cm), and are endemic to Hawaii.

Reptiles

Turtles

Green turtle (*Chelonia mydas*)

Source: Hawaii's Fishes: A Guide for Snorkelers and Divers 2nd Edition

Green turtles are the most widespread and numerous of Hawaii's marine turtles. Adults and subadults feed mostly on algae and sea grasses, generally grazing along the shore in the early morning and late afternoon. When not feeding, they often rest, seemingly asleep. Green turtles tend to rest in "traditional" areas, either under ledges and in caves or directly on the reef, where they may create permanent depressions. Traditional cleaning areas also exist where turtles come to have surgeonfishes (often goldring surgeonfish, but also brown surgeonfish, achilles tangs, sailfin tangs, and yellow tangs) eat the algae off their shells. Sometimes saddle wrasses will pick commensal barnacles off their skin. Hawaiian green turtles are unusual in that they often ask on land during the day, a rare behavior when compared to other green turtles elsewhere in the world.

When male green turtles reach maturity at around age 25, they grow a conspicuous long heavy tail. Immature males and females have quite short tails. In Hawaii, adult green turtles of both sexes migrate periodically to their nesting beaches, which are almost always at French Frigate Shoals, an atoll in the Northwestern Hawaiian Islands. After mating offshore, females crawl up on the beach at night to dig a pit and deposit their eggs. They do not nest every year, but when reproductively active they may nest up to five times in a season. After hatching in about two months, juvenile Hawaiian green turtles remain at sea for about 4 to 6 years feeding on jellyfish and other surface-dwelling animals.

Green turtles reach a length of about 4 ft (1.2 m), but the average adult in Hawaiian waters is around 3 ft (0.9 m), and their maximum weight is around 400 lbs (181 kg). These turtles are found worldwide in warm seas.

Plants

Aquatic Plants

Green algae (*Cladophora sericea*)

Source: Russell, D. J. and G. H. Balazs, 2000

Green algae is described as pale green to grass green in color, and is bushy or spreading in shape, not tufted. This small green alga is usually a small part of the biomass of the diverse, highly competitive intertidal community. By virtue of its dense and self-shading form, the alga rarely experiences photo inhibition except in the branches on the very top of the tuft, and thus tends to attach to solid substrate areas that are quite exposed. In addition, the alga has demonstrated nitrate storage capabilities which increase its longevity in stressful conditionsIts filaments are slightly to profusely branched. Plants are usually observed in soft to stiff clumps, often floating. The main axis branches dichotomously and has lateral branches that are shorter, narrower (20 - 40 µm diameter), and arranged alternately, opposite or on one side. Lateral branches near the tip often have shorter branches between longer branches. Attachment is by rhizoids from basal poles of mid to lower cells, or by cluster of basal rhizoids. Green algae occurs in small amounts with other algae or in abundant loose strands attached to coral, basalt substrate, and other hard surfaces on reef flats near low tide line to 6 ft (2 m) deep. It has a world-wide distribution: Australia, Atlantic Ocean, Mediterranean, Caribbean, Indian and Pacific Oceans, and is found on the Northwest Hawaiian Islands, Oʻahu, Maui, Kauaʻi, Lanaʻi, Molokaʻi and Hawaiʻi Island. Nutrient loading, water temperature fluctuations, and downwelling illumination all influence the growth rates and longevity of these alga. In areas of eutrophication, opportunistic species like green algae may play an important role in coral reel community shifts. Green algae has demonstrated invasive characteristics in Hawaiʻi, having previously became exceedingly abundant on leeward reefs in Maui and large blooms now occur seasonally. During the blooms, large masses of the alga drift in the water column, snagging on coral and rock outcroppings and smothering out the organisms beneath.

Pterocladiella capillacea (*Pterocladiella capillacea*)

Source: Abbott, I.A., and Huisman, J.M., 2004

Pterocladiella capillacea has strap-shaped blades that are opposite branching and pinched at the base. It is often dark red to green in color and occurs predominantly in single species mats. It is considered firm, wiry, and grows to roughly 2.5 in (6 cm) high. Pterocladiella capillacea and other Pterocladiella spp. are very common on nearshore intertidal reef flats, tidepools and subtidally, attached to basalt and other hard substrates in areas of high wave exposure. This species may form extensive unialgal masses seasonally, with peak growth in Hawai`i in December.

Limu mane`one`o (*Laurencia* spp.)

Source: Abbott, I.A., and Huisman, J.M., 2004

There over 16 species of Laurencia in Hawai`i. Plants are usually erect and fleshy with variable branching patterns, each order of branching shorter than the preceding. Most Laurencia species have cylindrical branches, but a few intertidal species are compressed. Plants usually range in size from a few cm to 10 in (25 cm), and are pink-purple to red but can have yellow and even green portions. *Laurencia* spp. are found in clumps or as components of turfs attached to eroded coral or basalt rocks intertidally to subtidally, and are often associated with *Acanthophora spicifera.*

Melan (*Amansia glomerata*)

Source: Abbott, I.A., and Huisman, J.M., 2004

Melan has semi-transparent, strap-shaped blades arranged in rosettes at top of tough, stem-like stalks, giving plant top-heavy look. Stalk bare below rosettes, and may branch several times. Blades are usually less than 1 cm long, with midribs, edges serrated to smooth, and tips rounded. Melan typically grows to 2-3 in (5-8 cm) high, and is often a dark maroon red color. It typically grows on rock and coral rubble, and is often found in low light habitats such as crevices or among coral fingers. Melan is often covered with epiphytic crustose coralline seaweeds, giving it a pink appearance.

Coralline algae (*Porolithon* spp.)

Source: Aguirre, J., Perfectti, F., and Braga, J. C., 2010

Coralline algae are red algae in the order Corallinales. They are characterized by a thallus that is hard because of calcareous deposits contained within the cell walls. The colors of these algae are most typically pink, or some other shade of red, but other species can be purple, yellow, blue, white or gray-green. Coralline algae play an important role in the ecology of coral reefs. Sea urchins, parrot fish, limpets (mollusks), and chitons (mollusks), feed on coralline algae. Many are typically encrusting and rock-like, found in marine waters all over the world. Unattached specimens (maerl, rhodoliths) may form relatively smooth compact balls to warty or fruticose thalli. A close look at almost any intertidal rocky shore or coral reef will reveal an abundance of pink to pinkish-grey patches, splashed as though by a mad painter over rock surfaces. These patches of pink "paint" are actually living algae: crustose coralline red algae. The red algae belong to the division Rhodophyta, within which the coralline algae form a distinct, exclusively marine order, the Corallinales. There are over 1600 described species of nongeniculate coralline algae.

Ear seaweed (*Padina japonica*)

Source: Abbott, I.A., and Huisman, J.M., 2004

Ear seaweed have flat calcified brown blades that may be rolled into a circle or flat and broad. The overall color is chalky white to light yellow-brown, and attaches to substrate with a small holdfast. The degree of calcification can vary between species but is often visible in horizontal circular rings, in which the upper surface is usually more calcified than the lower. Size varies from a few cm to greater than 8-12 in (20-30 cm) in height. This genus is common in Hawai`i and can be found in both intertidal and subtidal zones. Ear seaweed is common in tide pools and on basalt benches, while other species can found in silty disturbed areas.

Caulerpa racemosa (*Caulerpa racemosa*)

Source: Abbott, I.A., and Huisman, J.M., 2004

Caulerpa racemosa have upright branches between less than one to 6 inches in height. This algae is noteworthy for having small, bead-like branchlets 1 – 1.5 in (2-4 cm) in diameter, and are light to bright green in color. This algae attaches to substrate by creeping runners that are often branched, and forms mats up to 2 in (5 cm) thick. C. racemosa forms intertwined mats in tidepools and on reef flats. Horizontal runners tightly anchor mats to rocks and sand and in calm to moderately heavy surf areas.

Dictyosphaeria spp. and Hard bubble seaweed (*Dictyosphaeria* spp.)

Source: Abbott, I.A., and Huisman, J.M., 2004

Dictyosphaeria spp. are referred to as the "Green Bubble Alga" due to its large round cells. It forms hollow spheres when small; when larger spheres burst becoming convoluted and cup-shaped, forming large mats. *D. versluysii* also has bubble-like cells but is completely solid and remains rounded, less than 1 to 2 in (2-5 cm) wide, and are grass green to bluish in color. *Dictyosphaeria* spp. are found attached to rocks or coral rubble on shallow, calm reef flats and in tidepools. Older *D. cavernosa* plants can form large convoluted mats, less than one to 4 in (10 cm) thick, that may cover large subtidal areas to 180 ft (55 m) deep. *Dictosphaeria* spp. are found world-wide in the Eastern Atlantic, Caribbean, Indian and Pacific Oceans, and are found in Hawaii on the Northwest Hawaiian Islands, O‘ahu, Kaua‘i, Kaho‘olawe, Lana‘i and Hawai‘i Island.

Finger seaweed (*Neomeris vanbosseae*)

Source: Abbott, I.A., and Huisman, J.M., 2004

Finger seaweed is common on shallow reefs and in tidepools. Calcified spherical gametangia are attached individually on base, not organized into concentric rings. Finger seaweed is found in Hawaii and the Tropical Pacific.

Halimeda opuntia (*Halimeda opuntia*)

Source: Abbott, I.A., and Huisman, J.M., 2004

Halimeda opuntia is green to chalky white and has blades that are kidney-shaped calcified thick segments, less than one inch wide, with a midrib down the middle of each segment. These plants are large and spreading, to one foot (30 cm), and are attached to substrate frequently with rhizoids (small filamentous root-like structures). Halimeda opuntia is found attached to hard substrates subtidally between rocks or under coral overhangs. It is the most widespread species of Halimeda and is the major producer of carbonate sands in many tropical reef areas.

Terrestrial Plants

Coconut palm (*Cocos nucifera*)

Source: Mounts, M. U, 1964

The coconut palm is a perennial evergreen that grows up to 100 ft (30 m) tall, but usually less. It produces a tiny yellowish green or creamy yellow flower that occurs year-round. The tiny, yellowish or greenish flowers are in inflorescences that emerge from the leaf axils. Each inflorescence is enveloped by a large, lanceolate spathe. The smaller male flowers are at the tip of the inflorescence, while the larger female flowers are at the base. The female flowers are followed by large, up to 1 ft (0.3 m) or more long, single seeded fruits (drupes) known as coconuts. The coconuts have a thick, fibrous husk surrounding a hard, brown, woody shell that contains milky water and a lining of white meat. The leaves are in a tuft at the top of the plant and are pinnate with green, linear-lanceolate leaflets. The old leaves are shed and don't form a skirt at the base of the leaves. The single trunks have a thickened base and are gray-brown, ringed with scars from fallen leaf bases, unbranched, and often gracefully curved. These long-lived palms can live for up to a century. This naturalized Polynesian canoe plant is originally native to Malesia and Australasia, and is introduced in Hawaii. They are found in coastal areas, often close to the ocean's edge since these palms are salt tolerant and the buoyant fruits can be dispersed by ocean current, and are by far the most common palm species in Hawaii.

Seagrape (*Coccoloba uvifera*)

Source: Agriculture Handbook no. 679 by Elbert L. Little Jr. and Roger G. Skolmen, published by the Forest Service, U.S. Dept. of Agriculture, in 1989. Its present format is that of a reprint version published by the College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa, 2003.

Seagrapes are grown as both spreading, evergreen shrubs and trees that reach approximately 30 ft (9 m) in height. The leaves are round, alternate, and measure as much as 6 in (15 cm) in diameter. Leaf texture is leathery, and color is bright green to reddish nearest the petioles. Older leaves are often rust colored before they drop. Flowers are small and white, blooming nearly year round. Fruits are fleshy and hang in grape-like clusters. Individual fruits typically measure under 1 in (2.5 cm) in diameter. Immature fruit is green in color, while mature fruits are reddish or purple. Seagrapes are common in coastal dunes, backdunes, and hammocks. They are also heavily utilized as landscaping plants. The seagrape ranges throughout the American subtropics. It is native to Florida, the West Indies and the Bahamas, but has been naturalized on both coasts of Mexico, as well as much of coastal Central and South America to northern Peru and Brazil. It has been introduced as an ornamental into the Indo-Pacific and Hawaii.

Tiare (*Gardenia taitensis*)

Source: International Organization for Plant Information (IOPI). "Plant Name Search Results" (HTML). International Plant Names Index. Retrieved December 2014.

Tiare is a species of plant in the Rubiaceae family. It is an evergreen tropical shrub that grows to 12 ft (3.7 m) tall, it has glossy dark green leaves (2–6 in [5-15 cm] long) that are oppositely arranged along the stem. The flower is creamy white, pinwheel-shaped with 5 to 9 lobes (each lobe 1-2 in [2.5 – 5 cm] long) and very fragrant. Native to the highland shores of the South Pacific, it has the distinction of being one of the few cultivated plants native to Polynesia. The tiare plant originates from Melanesia and Western Polynesia, and is an aboriginal introduction to the Cook Islands and French Polynesia and possibly Hawaii.

Spider lily (*Crinum asiaticum*)

Source: PLANTS Profile for Spider lily, United States Department of Agriculture, 2009 USDA-HL8.

The spider lily is a large, bulbous, rosette-like herb with numerous, oblong, acute leaves, up to 6 ft (2 m) long and clasping at the base. Numerous narrow, straight or curved white to reddish, fragrant flowers with a tube up to 4 in (10 cm) long are produced at the top of a fleshy scape in a funnel shape six long petals or spread widely. The spider lily is native to Southern Asia where it is used medicinally, and is now cultivated in numerous tropical areas.

Croton (*Codiaeum variegatum*)

Source: Watson, L., and Dallwitz, M. J., 1992

Croton has glossy, leathery leaves that are very variable in shape, highly colored and variegated. The leaves can be ovate or linear and variegated with pink, orange, green, brown, yellow and white. In addition the plant may change color as it matures. The plant produces hardly noticeable star-shaped yellow flowers. The green-leaf croton is native to Fiji and other islands west of Australia. In Hawaii, the colored-leaf varieties are the most commonly seen yard plants. They can grow up to 12 ft (3.7 m) tall and are often trimmed as hedges.

Zoysiagrass (*Zoysia* sp.)

Source: Deputy, J., 2009

Zoysiagrasses are warm season grasses native to China, Japan and other parts of Southeast Asia, and were introduced into the United States in 1911. Zoysiagrass is nearly as salt tolerant as Bermudagrass, and is widely grown along sandy seashores where drainage is adequate. Zoysiagrass does not tolerate poorly drained soils whether they are saline or otherwise. Zoysiagrasses are among the most wear tolerant turf grasses. However, their slow rate of growth gives them poor recuperative potential. Zoysiagrass is extremely drought tolerant. Although it does turn straw colored under severe drought conditions, it has the capacity to respond to subsequent irrigation or rainfall. Its water requirements are similar to those of Bermudagrass. The leaf blades of Zoysiagrass are among the first to roll under drought conditions, thus it tends to conserve moisture more effectively than other species. Zoysiagrass also has a deep root system allowing it to more effectively extract water from greater soil depths.

Beach naupaka (*Scaevola taccada*)

Source: Wagner, Warren L., Darrel R. Herbst, and S. H. Sohmer, 1990

Beach naupaka is a dense, spreading shrub that generally grows up to 3 ft (0.9 m) tall, but can be up to 10 ft (3 m) tall and 6 to 15 ft (2-4.5 m) wide. The medium green leaves are waxy and fleshy. They grow from 2 to 8 in (5-20 cm) long, are much narrower than they are wide, and are broader at the tip than the base. Often the edges of the leaves roll under. The flowers are white or cream colored, often with purple streaks, and have a pleasant fragrance. They have an irregular shape with all five petals on one side of the flower making them appear to have been torn in half. The flowers grow in small clusters from between the leaves at the ends of the stems. Beach naupaka is an indigenous shrub and is common in hot dry coastal areas on most of the Hawaiian Islands except for some of the Northwest islands. It is also found throughout the tropical and subtropical Pacific and Indian Ocean islands and coasts.

Sea hibiscus (*Hibiscus tiliaceus*)

Source: NatureServe Explorer

Sea hibiscus reaches a height of 13-33 ft (4–10 m), with a trunk up to 6 in (15 cm) in diameter. The flowers of sea hibiscus are bright yellow with a deep red center upon opening. Over the course of the day, the flowers deepen to orange and finally red before they fall. The branches of the tree often curve over time. Sea hibiscus is a common coastal plant in Eastern and Northern Australia, Oceania, Maldives and Southeast Asia. It has become naturalized in parts of the New World, such as Florida, Puerto Rico, and the Virgin Islands. It is uncertain if the species is native to Hawaii, as it may have been introduced by the Polynesians. Sea hibiscus can be found at elevations from sea level to 2,600 ft (800 m) in areas that receive 35-98 in (900–2,500 mm) of annual rainfall. It is commonly found growing on beaches, by rivers and in mangrove swamps. Sea Hibiscus is well adapted to grow in coastal environment in that it tolerates salt and waterlogging and can grow in quartz sand, coral sand, marl, limestone, and crushed basalt.

Casuarina tree (*Casuarina equisetifolia*)

Source: Boland, D. J.; Brooker, M. I. H.; Chippendale, G. M.; McDonald, M. W, 2006

The casuarina tree is an evergreen tree growing to 20-115 ft (6–35 m) tall. The foliage consists of slender, much-branched green to grey-green twigs 0.020 – 0.039 in (0.5–1 mm) diameter, bearing minute scale-leaves in whorls of 6–8. The flowers are produced in small catkin-like inflorescences; the male flowers in simple spikes 0.28-1.57 in (0.7–4 cm) long, the female flowers on short peduncles. Unlike most other species of Casuarina (which are dioecious) it is monoecious, with male and female flowers produced on the same tree. The fruit is an oval woody structure 0.39-0.94 in (10–24 mm) long and 0.35-0.51 in (9–13 mm) in diameter, superficially resembling a conifer cone made up of numerous carpels each containing a single seed with a small wing 0.24-0.31 in (6–8 mm) long. The casuarina tree is a she-oak species of the genus Casuarina. The native range extends from Burma and Vietnam throughout Malesia east to French Polynesia, New Caledonia, and Vanuatu, and south to Australia (north of Northern Territory, north and east Queensland, and north-eastern New South Wales). Populations are also found in Madagascar, but it is doubtful if this is within the native range of the species. The species has been introduced to the Southern United States and West Africa. It is an invasive species in Florida and South Africa.

Tropical almond (*Terminalia catappa*)

Source: Pankaj Oudhia and Robert E. Paull, 2008

The tropical almond grows to 115 ft (35 m) tall, with an upright, symmetrical crown and horizontal branches. Tropical almond has corky, light fruit that are dispersed by water. The seed within the fruit is edible when fully ripe, tasting almost like almond. As the tree gets older, its crown becomes more flattened to form a spreading, vase shape. Its branches are distinctively arranged in tiers. The leaves are large, 6-10 in (15–25 cm) long and 4-5.5 in (10–14 cm) broad, ovoid, glossy dark green, and leathery. They are dry-season deciduous; before falling, they turn pinkish-reddish or yellow-brown, due to pigments such as violaxanthin, lutein, and zeaxanthin. The tree has been spread widely by humans, so the native range is uncertain. It has long been naturalized in a broad belt extending from Africa to northern Australia and New Guinea through Southeast Asia and Micronesia into the Indian Subcontinent. More recently, the plant has been introduced to parts of the Americas.

Sagebush (*Pluchea carolinensis*)

Source: Natural Resources Conservation Service, 2002.

Sagebush is a shrub 3.3-9.8 ft (1 to 3 m) in height and up to 2.3 in (6 cm) in basal stem diameter. The stem wood of sagebush is moderately soft and brittle. Older plants are supported by many flexible, lateral roots and may be sparsely branched to somewhat branchy. The twigs of sagebush are stout, and the foliage is concentrated on the branch ends. Leaves have petioles 0.5-1.2 in (1 to 3 cm) long, and ovate to elliptic blades 2.3-8 in (6 to 20 cm) long with rounded bases, pointed ends, usually entire edges, upper surfaces glabrate to densely pubescent, and lower surfaces velvet-pubescent. The terminal inflorescences are broadly rounded corymbose panicles of heads of over 500 flowers each. The corollas are usually pink, but vary from light purple to white. The achenes are tiny and brown, and have a pappus of 10 to 15 yellowish-white bristles. Sagebush is native to Florida, Bermuda, the Bahamas, the West Indies, Mexico, Central America, and Colombia, Venezuela, and Ecuador in South America, and has been naturalized in Hawaii, Guam and other Pacific Islands, Taiwan, West Africa, and probably in many other places in the tropics.

Beach morning glory (*Ipomoea pes-caprae subsp. Brasiliensis*)

Source: PLANTS Profile for Beach morning glory, United States Department of Agriculture, 2009 USDA-HL8.

Beach morning glory is a large trailing vine common on sandy beaches. It has orbicular leaves that are thick and shiny, with flowers roughly 3 in (8 cm) wide. This subspecies is indigenous to Hawaii & the Tropical Pacific, replaced by *Ipomoea pes-caprae subsp. pes-caprae* in tropics elsewhere.

Pandanus (*Pandanus tectorius*)

Source: Lamb, Samuel H, 1981

Pandanus is a small tree growing 20 to 30 feet in height and from 15 to 35 feet in diameter. The trunk is stout and the branches grow at wide angles to it. It has distinctive long blade-like leaves about 2 inches wide and over 2 feet long. Most varieties have spines along the edges and on the midribs of the leaves, although spineless and variegated forms are available. The leaves are spirally arranged towards the ends of the branches and leave a spiral pattern on the trunk when they fall. Pandanus trees develop support or prop roots at the base of the trunk and sometimes along the branches. Pandanus trees are either male or female. Female trees produce a large, segmented fruit somewhat resembling a pineapple. Male trees produce large clusters of tiny, fragrant flowers surrounded by white to cream colored bracts. These clusters are about 1 foot long and are called hinano in Hawaiian. Currently, there is only one species of Pandanus formally recognized from the Hawaiian Islands - *Pandanus tectorius*. It is currently thought to be indigenous to Hawai'i, but there may have been additional introductions by the early Polynesians. Pandanus is found on all the main islands except Kaho'olawe. It is also found on Pacific islands in the rest of Polynesia, in Micronesia, in Melanesia, and as far west as northern Australia. Pandanus grows in moist coastal locations and valley slopes to an elevation of 2,000 feet.

Wedelia (*Sphagneticola trilobata*)

Source: Wagner, W.L., D.R. Herbst and S.H. Sohmer, 1999

Wedelia is a creeping, mat-forming perennial herb with rounded stems that root at the nodes. This creeping herb is native to the tropics of Central America and West Indies.

Queen emma lily (*Crinum augustum*)

Source: OnlinePlantGuide.com. Retrieved December 2014

The queen emma lily is a sterile hybrid with blossoms that are purple with white strips and clustered on heave inflorescences that often bend and touch the ground, and a long leafy neck supporting the spreading leaves. The plant can reach 5 ft. tall and has strappy foliage from giant fleshy bulbs. The queen Emma Lily is said to come from Sumatra.

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Watson, L., and Dallwitz, M. J. 1992. The Families of Flowering Plants: Descriptions,Illustrations, Identification, and Information Retrieval.

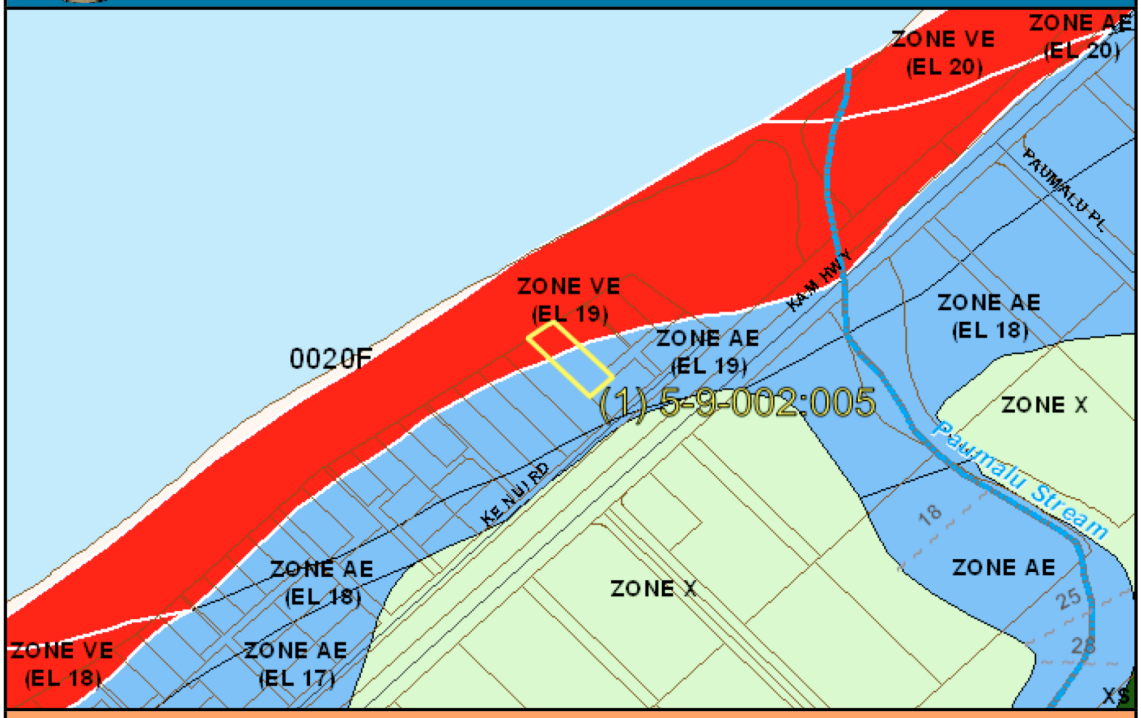
Appendix B- Concept Drawings of Proposed Geotechnical Stabilization

(See Accompanying Documents)

Appendix C- FEMA Flood Plain Flood Hazard Assessment Report

State of Hawaii

FLOOD HAZARD ASSESSMENT REPORT



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD ZONE DEFINITIONS

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD – The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone A, AE, AH, AO, V, and VE. The Base Flood Elevation (BFE) is the water-surface elevation of the 1% annual chance flood. Mandatory flood insurance purchase applies in these zones:

- **Zone A:** No BFE determined.
- **Zone AE:** BFE determined.
- **Zone AH:** Flood depths of 1 to 3 feet (usually areas of ponding); BFE determined.
- **Zone AO:** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined.
- **Zone V:** Coastal flood zone with velocity hazard (wave action); no BFE determined.
- **Zone VE:** Coastal flood zone with velocity hazard (wave action); BFE determined.
- **Zone AEF:** Floodway areas in Zone AE. The floodway is the channel of stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without increasing the BFE.

NON-SPECIAL FLOOD HAZARD AREA – An area in a low-to-moderate risk flood zone. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

- **Zone XS (X shaded):** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
- **Zone X:** Areas determined to be outside the 0.2% annual chance floodplain.

OTHER FLOOD AREAS

- **Zone D:** Unstudied areas where flood hazards are undetermined, but flooding is possible. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

PROPERTY INFORMATION

COUNTY:	HONOLULU
TMK NO:	(1) 5-9-002-005
PARCEL ADDRESS:	59-151A KE NUI RD HALEIWA, HI 96712
FIRM INDEX DATE:	JANUARY 19, 2011
LETTER OF MAP CHANGE(S):	NONE
FEMA FIRM PANEL(S):	15003C0020F
PANEL EFFECTIVE DATE:	SEPTEMBER 30, 2004

PARCEL DATA FROM:	APRIL 2014
IMAGERY DATA FROM:	MAY 2006

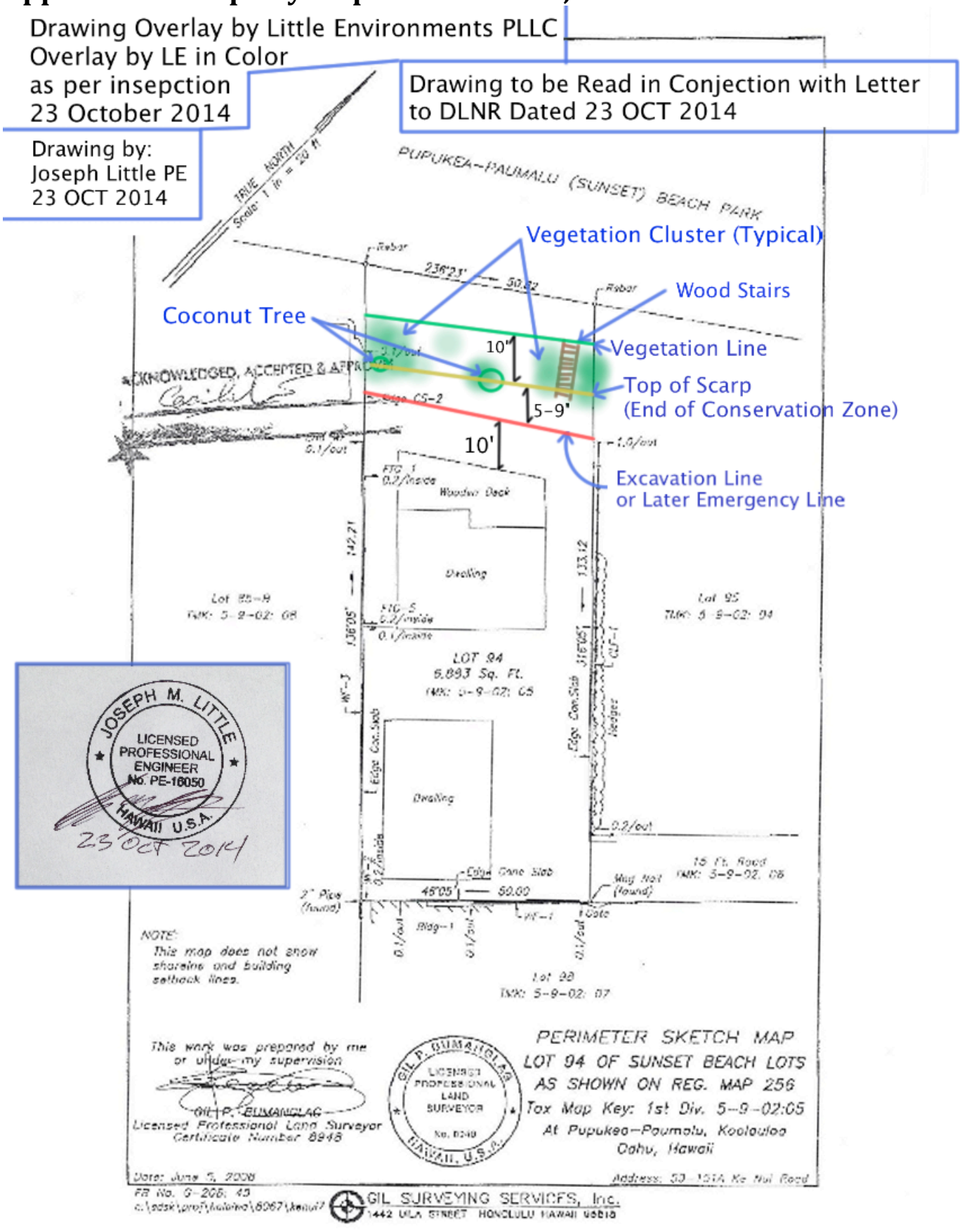
IMPORTANT PHONE NUMBERS

County NFIP Coordinator	
City and County of Honolulu	
Mario Siu-Li, CFM	(808) 768-8098
State NFIP Coordinator	
Carol Tyau-Beam, P.E., CFM	(808) 587-0267

Disclaimer: The Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use of the information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR from any liability, which may arise from its use.

If this map has been identified as 'PRELIMINARY' or 'UNOFFICIAL', please note that it is being provided for informational purposes and is not to be used for official/legal decisions, regulatory compliance, or flood insurance rating. Contact your county NFIP coordinator for flood zone determinations to be used for compliance with local floodplain management regulations.

Appendix D- Property Inspection Results, 23 October 2014-12-29

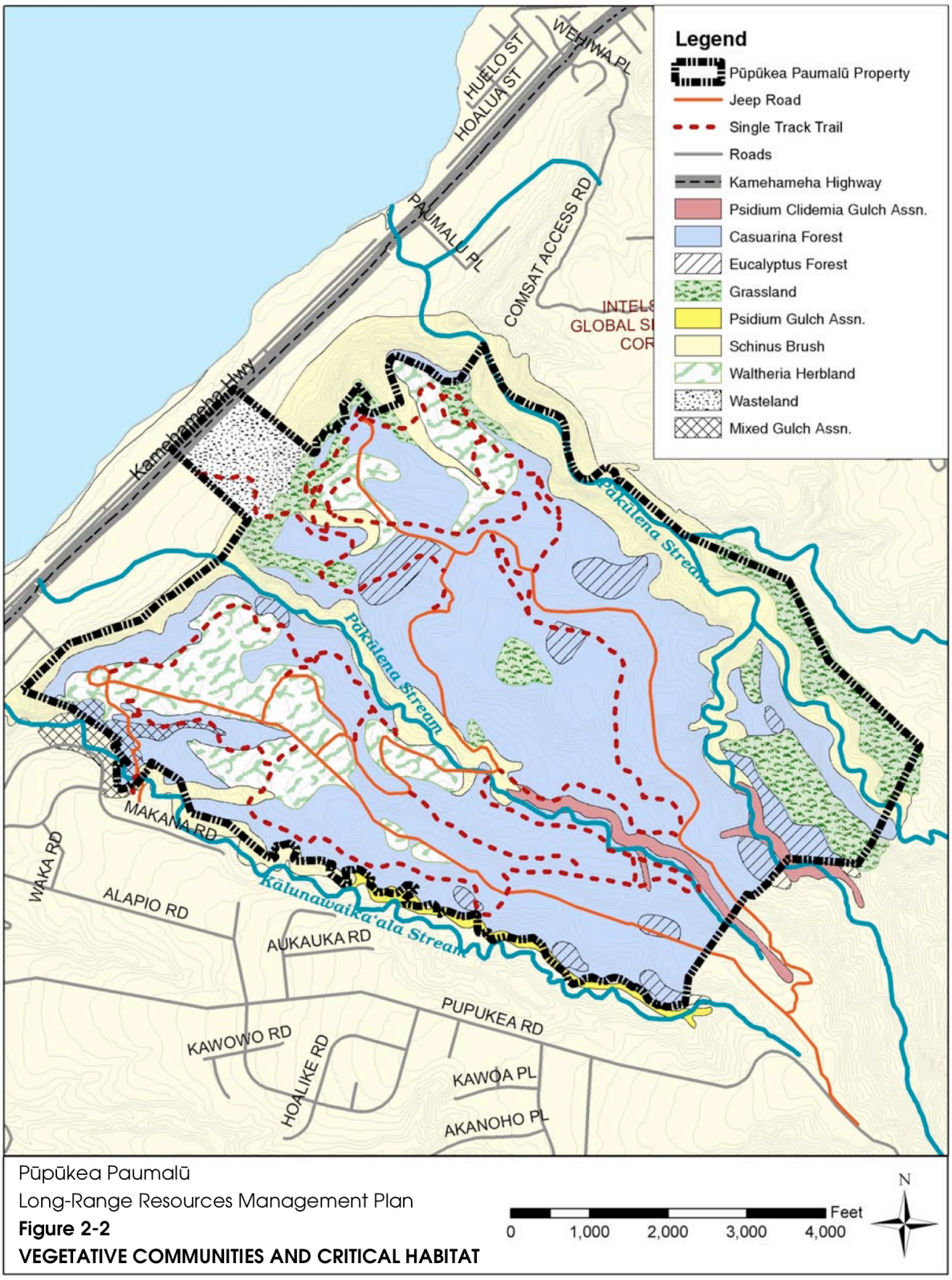


Appendix E- Shoreline Survey

Appendix F- Geotechnical Report

(See Accompanying Documents)

Appendix G- Upland Figure From Management Plan



Appendix H- Photos of Property April 14th, 2014

August 21 2014 Property 59-151A Ke Nui Rd, Sunset Beach Oahu, HI 26712
TMK 5-9-02:05 PHOTO SET FOR OFFICIAL PURPOSES
Photo Graph Set ___

PHTOT 1- From North April 14th 2014 ~9am

*Palm trees represent markers for reference
PHOTO 2 – From South West April 14th 2014 ~9am

JOSEPH M. LITTLE
LICENSED PROFESSIONAL ENGINEER
No. PE-16050
HAWAII U.S.A.
Aug 21 2014

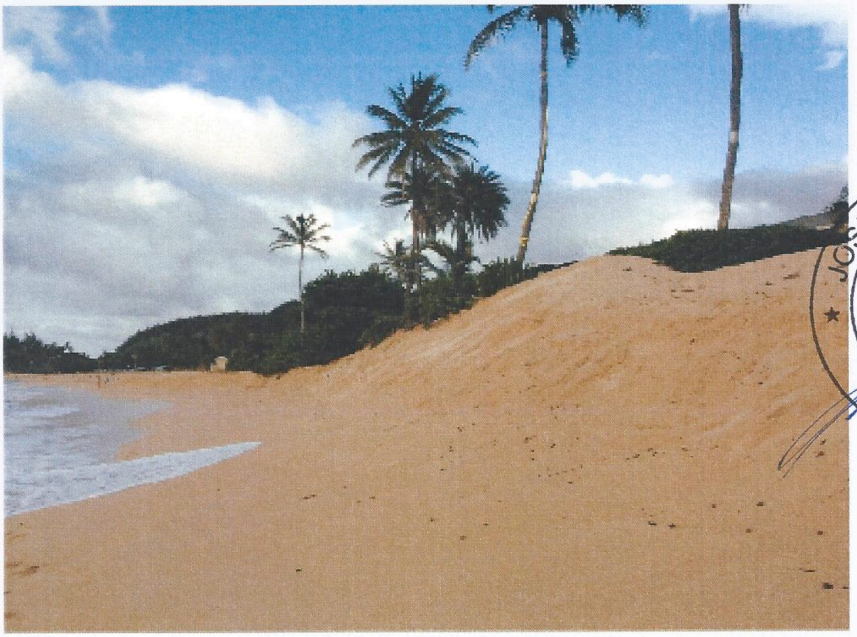
*Palm trees represent markers for reference

August 21 2014 Property 59-151A Ke Nui Rd, Sunset Beach Oahu, HI 26712
TMK 5-9-02:05 PHOTO SET FOR OFFICIAL PURPOSES

PHOTO 3 - April 14th 2014 From North/North West ~9am

*Palm trees represent markers for reference, Note also horizontal markers shot

PHOTO 4 – August 12th 2014 From South West (Compare with Photo 2) ~7pm

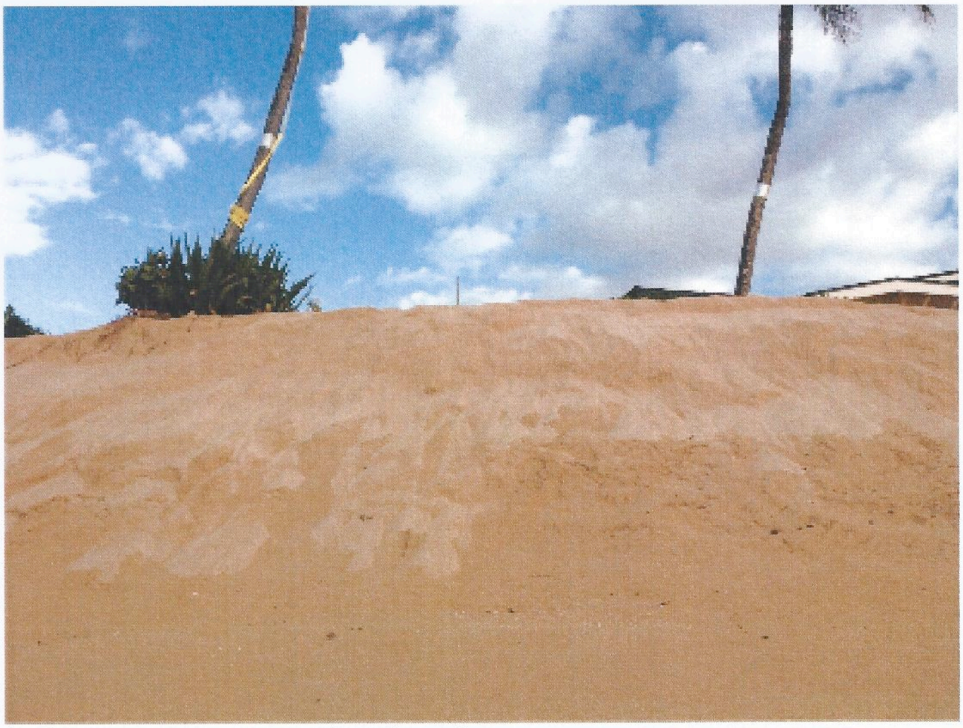


JOSEPH M. LITTLE
LICENSED PROFESSIONAL ENGINEER
No. PE-16050
HAWAII U.S.A.
Aug 21 2014

*Palm trees represent markers for reference

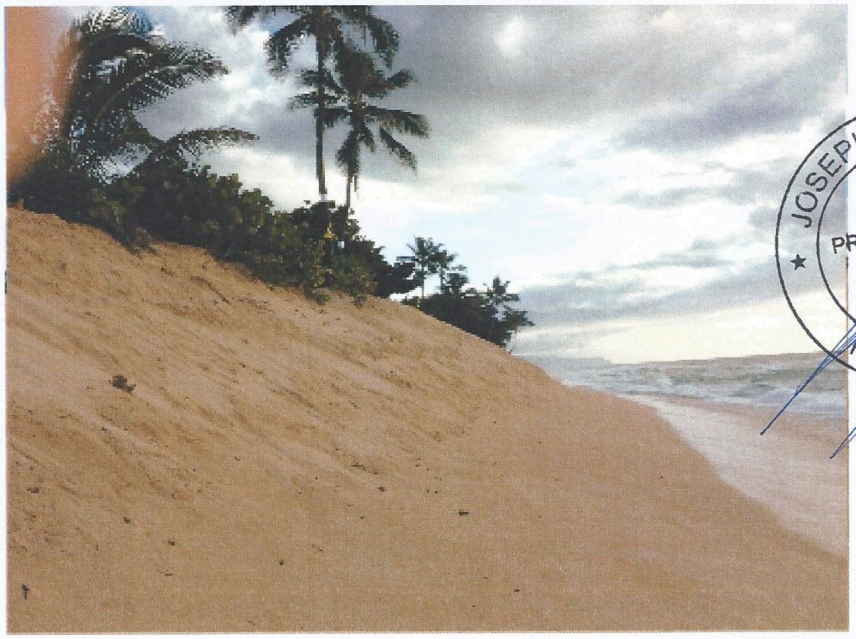
August 21 2014 Property 59-151A Ke Nui Rd, Sunset Beach Oahu, HI 26712
TMK 5-9-02:05 PHOTO SET FOR OFFICIAL PURPOSES

PHOTO 5 - August 12th 2014 From North West ~7pm



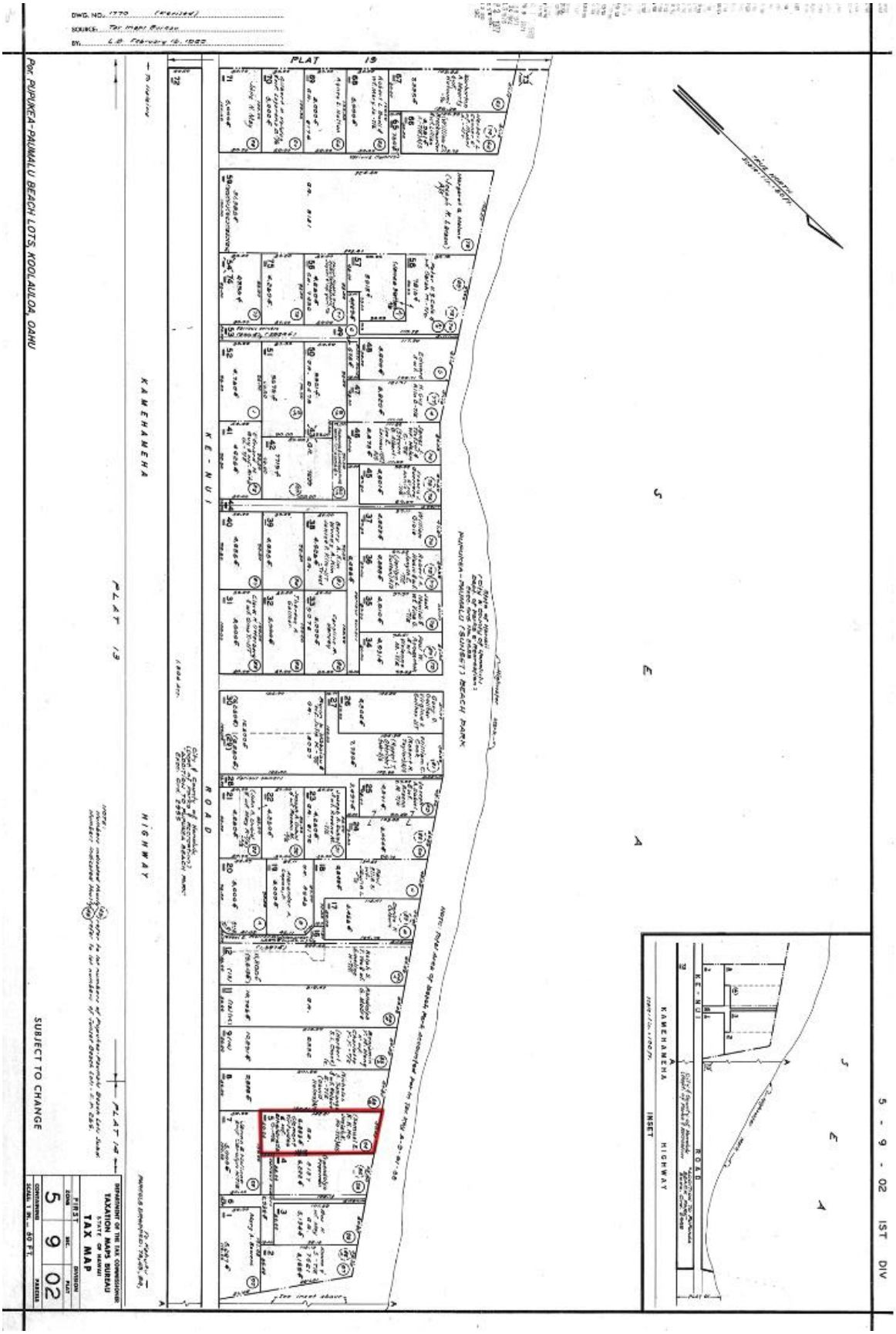
*Palm trees represent markers for reference

PHOTO 6 - August 12th 2014 From North/North East Down Shore (Compare with Photo 1) ~7pm



JOSEPH M. LITTLE
LICENSED PROFESSIONAL ENGINEER
No. PE-16050
HAWAII U.S.A.
Aug 21 2014

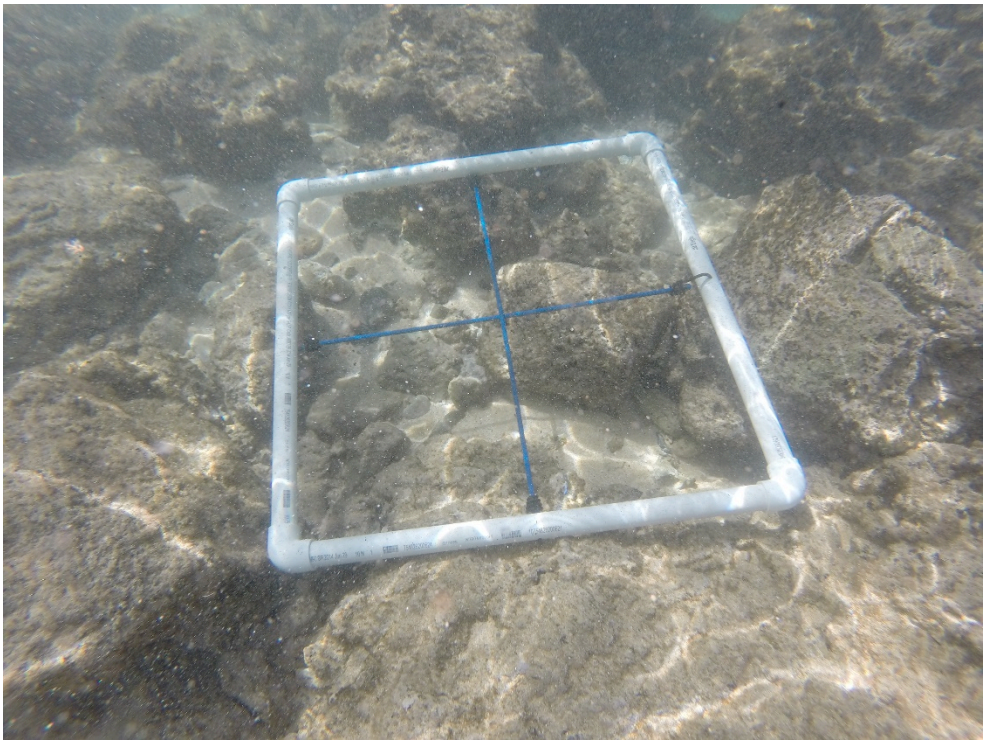
Appendix I- Tax Map of Property



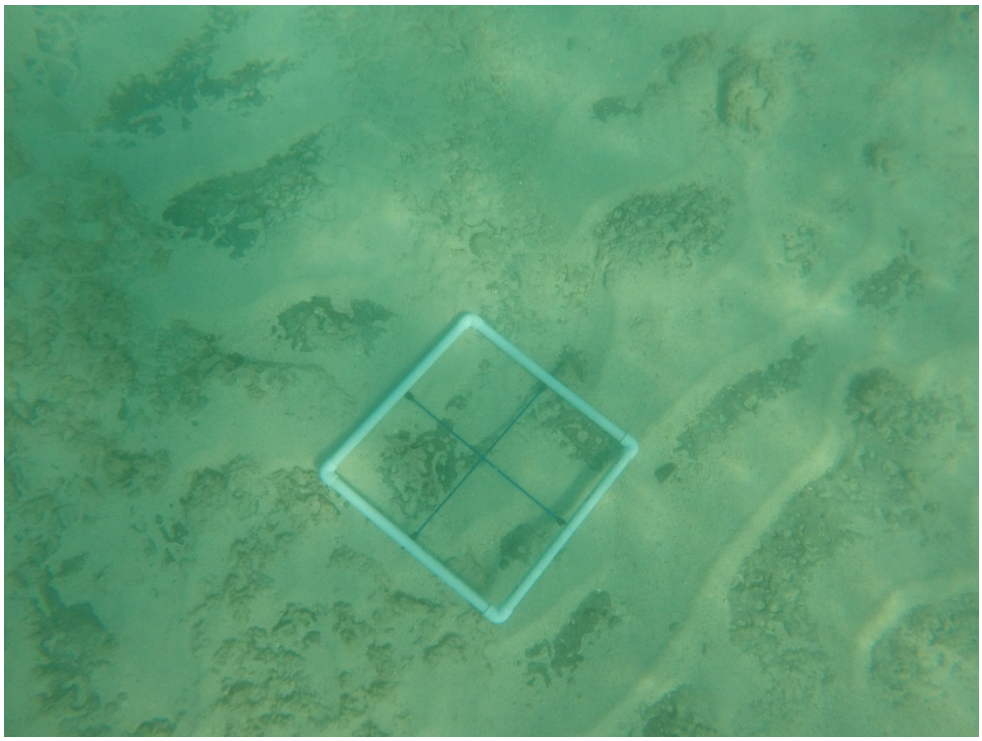
Appendix J- Photos of Benthic Habitats on Adjacent Beaches

(Note: Photos were not achievable just off shore from proposed project site due to significant turbulence, particulate matter, and wash)

Sharks Cove Example Transect

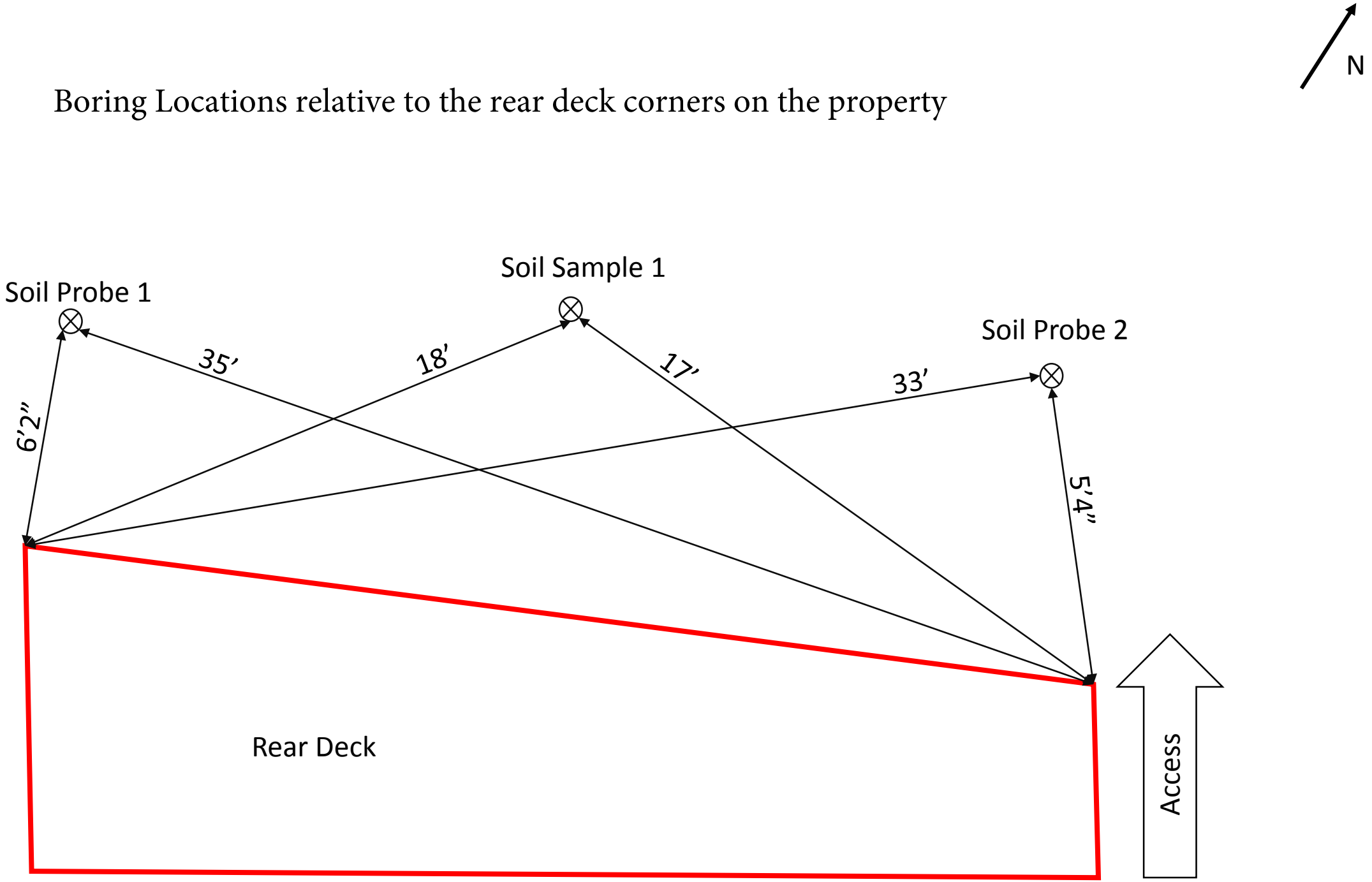


Turtle Bay Example Transect



Sunset Beach, Ke Nui Rd, Haleiwa, HI. Soil Investigation 6/28/2014 by GeoTek Hawaii, Inc.

Boring Locations relative to the rear deck corners on the property



GeoTek Hawaii, Inc.

FIELD LOG OF BORING

Project Name: Ke Nui
Job Number: HP14-088
Boring Number: Soil Boring 1
Date Drilled: 6/28/2014
Logged By: Quinton Wilson
Weather Conditions:

Drill Contractor: Geotek Hawaii, Inc.
Driller: Quinton Wilson
Drill Rig: Geoprobe 6620
Hammer Type:
Sampler: Macro Core

Depth ft.	Depth in.	Sample Number	Sampler Type	Sample Length in.	Recovery in.	Gravel %	Sand %	Silt %	Soil Description
		1	MC	60	40				grass, clayey sand and topsoil
1'									brown fine - medium sand. Trace organics
2'									
									tan fine - medium sand. Trace fine gravel.
3'									Trace shell fragments
4'									
5'		2	MC	60	30				
6'									
7'									
8'									
9'									
10'		3	MC	60	25				
11'									
12'									
13'									
14'									
15'		4	MC	60	0				
16'									
17'									
18'									
19'									
20		5	MC	60	59				
21									
22									
23									Tan fine - course sand, trace very small gravel
24									Refusal of sampler. Bottom of boring.
									Bottom of core was missing, but light colored stained fines in shoe.
25									Indicative of crushed limestone.

Note: bore hole collapsed at 18'-5", 15 minutes after boring completion. Tape measure was dry.

GeoTek Alaska, Inc.
P.O. Box 11-1155
Anchorage, Alaska 99511

GeoTek Hawaii, Inc.

FIELD LOG OF BORING

Project Name: Ke Nui
Job Number: HP14-088
Boring Number: Probe Boring 1
Date Drilled: 6/28/2014
Logged By: Quinton Wilson
Weather Conditions:

Drill Contractor: Geotek Hawaii, Inc.
Driller: Quinton Wilson
Drill Rig: Geoprobe 6620
Hammer Type:
Sampler: drive point on 1.5" rods

Depth ft.	Depth in.	Sample Numbe	Sampler Type	Sample Length in.	Recovery in.	Gravel %	Sand %	Silt %	Soil Description
									No cuttings to log. Reference soil boring log for information.
1'									
2'									
3'									
4'									
5'									
6'									
7'									
8'									
9'									
10'									
11'									
12'									
13'									
14'									
15'									
16'									
17'									
18'									
19'									
20									
21									21' - 8" markedly more dense and slower driving.
22									
									Refusal and bottom of probe at 22' - 6"

Note: crushed limestone on drive point

GeoTek Alaska, Inc.
P.O. Box 11-1155
Anchorage, Alaska 99511

GeoTek Hawaii, Inc.

FIELD LOG OF BORING

Project Name: Ke Nui
Job Number: HP14-088
Boring Number: Probe Boring 2
Date Drilled: 6/28/2014
Logged By: Quinton Wilson
Weather Conditions:

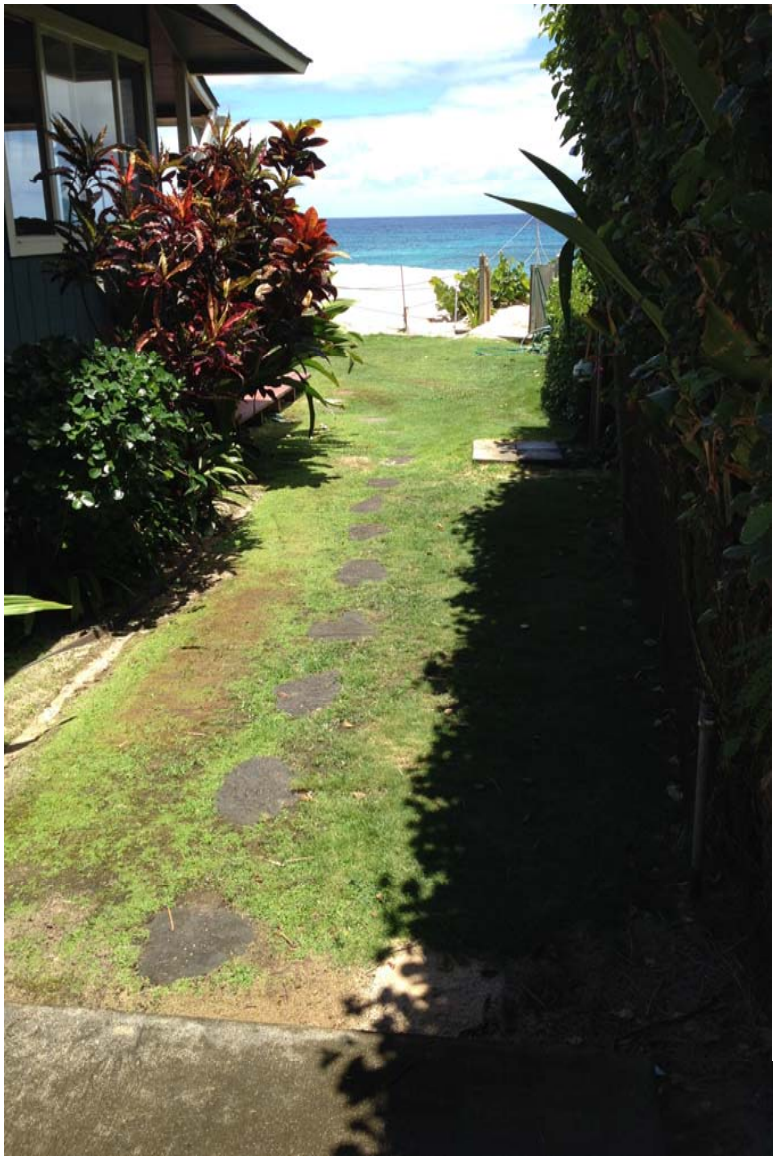
Drill Contractor: Geotek Hawaii, Inc.
Driller: Quinton Wilson
Drill Rig: Geoprobe 6620
Hammer Type:
Sampler: drive point on 1.5" rods

Depth ft.	Depth in.	Sample Numbe	Sampler Type	Sample Length in.	Recovery in.	Gravel %	Sand %	Silt %	Soil Description
									No cuttings to log. Reference soil boring log for information.
1'									
2'									
3'									
4'									
5'									
6'									
7'									
8'									
9'									
10'									
11'									
12'									
13'									
14'									
15'									
16'									
17'									
18'									
19'									
20									20' - 10" markedly more dense and slower driving.
21									
									Refusal and bottom of probe at 22' - 3"

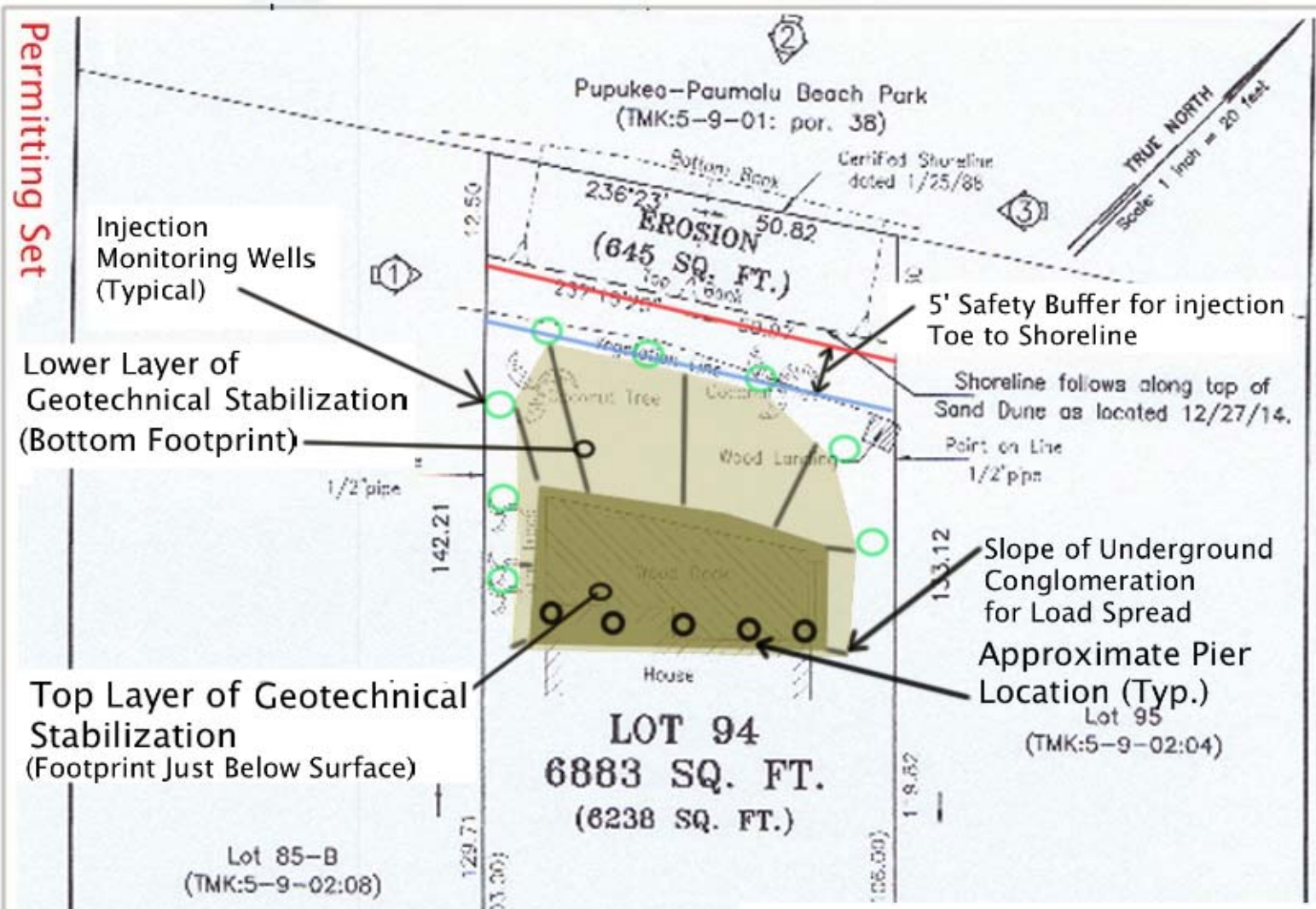
GeoTek Alaska, Inc.
P.O. Box 11-1155
Anchorage, Alaska 99511

Cores laid out top to bottom & left to right. Missing segment represents the zero recovery on 15'-20' run.

Condition of the property as we left, after drilling.



Permitting Set



Example Rendering of Geotechnical Stabilization via Sand Bonding

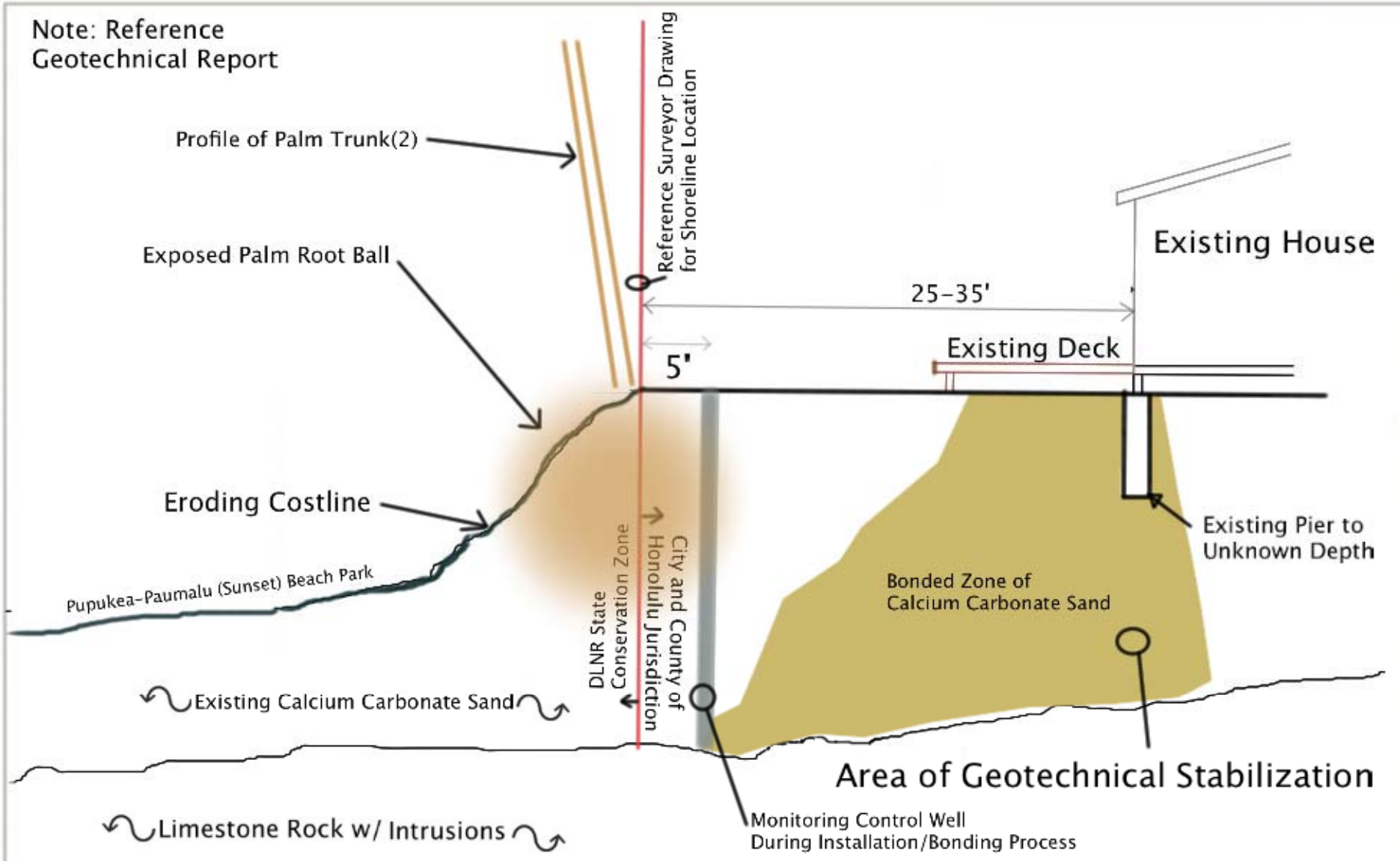
Synthetic Sandston to be Comperable in strength and Abraision resistance. Engineer to Approve of Specification.

Note: Contractor to monitor Geotechnical Surface top plane to prevent Breach

Contractor to be briefed by Engineer prior to Construction

Note: Drawing Shown on Top of Existing Survey Survey by others

Little Environments PLLC 16 West Martin St, Suite 507 Raleigh, NC 27601	Geotechnical Improvment Sand Bonding Plan	Drawn by:J.Little Reviewed/Checked by:J.Little Jan. 10 2015 | Dwg. 1 of 2



-10' 0' 5' 10'

1'

1"=10'
on 8.5"x11" Paper

Permitting Set

Note: Deck Structure is tied to House Structure

Note: Post on Piers are approximately on 5' by 5' grid. Pier is Concrete.

Drawn by:J.Little
Reviewed/Checked by:J.Little
Jan. 10 2015
Dwg 2 of 2

Geotechnical Stabilization
Section Drawing

Little Environments PLLC
16 West Martin St., S:507
Raleigh, NC, 27601

STATE OF HAWAII
DEPARTMENT OF LAND & NATURAL RESOURCES

SHORELINE CERTIFICATION
APPLICATION FORM

For DLNR use only:
Case file no.: _____
Date application recvd: _____
Date applic. complete: _____
Completion date (+90): _____
1st OEQC notice: _____
2nd OEQC notice: _____
Date appeals due (+20): _____
Date briefs due: _____
Date of decision (+60): _____

I. APPLICANT/AGENT

Applicant means the person submitting an application for shoreline certification.

Applicant name: Jaime F. Alimboyoguen

Applicant address: 92-324 Kewai Place

Kapolei, HI 96707

Phone numbers: (808) 672-8589 (808) 672-9515 alim808@hawaiiantel.net
Phone Fax E-mail

II. PROPERTY OWNER

Property owner means the equitable or legal holder of interest in, or the lessee holding under a recorded lease for the property for which a shoreline certification is requested, or the authorized agent.

Owner name: SUNSET OASIS LLC

Owner address: P.O. BOX 1054

HALEIWA, HI 96712

Signature: _____ Date: _____

III. LOCATION AND ADDRESS

Island: (x) Oahu ( ) Kauai ( ) Molokai
( ) Hawaii ( ) Maui ( ) Lanai

Town, District: Haleiwa Tax Map Key: 5-9-02:05

Address: 59-151A Ke Nui Road

Haleiwa, HI 96712

IV. PURPOSE

State the purpose for which the certification is being applied:

For building setback purposes.

V. CHECKLIST OF ENCLOSURES

(x) At least three (3) sets of color photographs of the shoreline, in accordance with §13-222-8, HAR:

- (x) Shoreline, as delineated on the map, is indicated on each photograph.
- (x) Permanent markings on the ground or flaggings are indicated on the photographs.
- (x) Each photograph is labeled by number or alphabet to coincide with the map showing the direction the photograph was taken.
- (x) Photographs provide accurate perspectives of the shoreline in relation to permanent markings or other land features.
- (x) Each photograph is marked with the date and time taken.

(x) At least seven (7) maps of the shoreline, in accordance with §13-222-9, HAR:

- (x) Maps are on whiteprints and are one of the following sizes (in inches): 8.5 x 13, 10 x 15, 13 x 23, 15 x 21, 21 x 32, 22 x 36, 24 x 36, 30 x 36, 36 x 42, 42 x 42-72.
- (x) Maps are drawn using an engineer or architect scale, in units of feet. Scale is clearly noted on the map. No reduced or enlarged maps allowed.
- (x) Maps are based on an actual field survey conducted within the prior 90 days.
- (x) Maps have the licensed surveyor's seal and testament indicating the work was done by the surveyor or under the surveyor's supervision.
- (x) Maps indicate true north pointing towards the top.
- (x) Map title and reference to location include the original source of title and name of awardee, patentee, or grantee and the ili, ahupuaa, and the TMK and the property owner's name and address.
- (x) Maps show all permanent identification marks established on the ground and all pertinent azimuths and distances.
- (x) Maps indicate the type of shoreline being determined (i.e., vegetation line, debris line, upper reaches of the wash of waves, face of artificial structure, or combination).
- (x) At least two (2) of the maps show the direction the photographs were taken and the point or shoreline depicted in the photographs.

(x) Field survey was conducted on 12/29/2014 (date of field survey) by Alfredo Pastoral (name of person who conducted field survey).

( ) The licensed land surveyor who made or supervised the field survey was:

Name Jaime F. Alimboyoguen
Address 92-324 Kewai Place, Kapolei, HI 96707
Phone no. 672-8589

(x) Application fee of $75 is enclosed.

(x) Statement signed by property owner granting the State of Hawaii the right to enter the property.

( ) Statement(s) signed by applicable owners granting the State of Hawaii the right to enter land not owned by the property owner necessary for access.

( ) Copy of any federal, State or county enforcement or other legal action involving the subject shoreline.

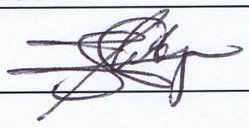
( ) If shoreline is being located at the base of a manmade structure, copy of all documents supporting that the structure has been approved by the appropriate government agencies or is exempt from such approval.

VI. CERTIFICATION

I hereby certify that the statements and information contained in this application, including all attachments, are true and accurate to the best of my knowledge and understand that if any statements are shown to be false or misrepresented, this application may be rejected. Further, I understand that the Department may review any shoreline certification during its 12-month validity period and may rescind the certification where there is substantial misrepresentation or material fact in the application, whether intentional or unintentional, as determined by the State Land Surveyor or the Department.

JAIME F. ALIMBOYOGUEN
Printed Name

Date

X 
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