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DEPARTMENT OF LAND AND NATURAL RESOURCES
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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

REF:OCCL:DH

CDUA OA-3584

Acceptance Date: March 9, 2011
180-Day Exp. Date: September 26, 2011

MEMORANDUM

MAR - 9 2011

To: Mr. Gary Hooser, Acting Director
Office of Environmental Quality Control

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

Subject: Draft Environmental Assessment (EA) for CDUA OA-3584
Proposed Hawaii Kai Marina and Entrance Channel Dredging Project, Hawaii Kai, Maunalua Bay, Island of Oahu.

The Department of Land and Natural Resources has reviewed the Draft Environmental Assessment (DEA) for the subject project CDUA OA-3584, and anticipates a Finding of No Significant Impact (FONSI) determination. Please publish notice of availability for this project in the March 23, 2011 issue of the Environmental Notice. We have enclosed four hard copies of the DEA document. The applicant will submit an electronic copy of the project summary and the OEQC Bulletin Publication Form.

Please contact Dawn Hegger of our Office of Conservation and Coastal Lands staff at 587-0380 should you have any questions.

Enclosures

ENVIRONMENTAL ASSESSMENT

HAWAII KAI MARINA AND ENTRANCE CHANNEL MAINTENANCE DREDGING

Prepared for

Hawaii Kai Marina Community Association

377 Keahole Street, D-1C

Honolulu, Hawaii 96825

Prepared by

Anchor QEA, L.P.

26300 La Alameda, Suite 240

Mission Viejo, California 92691

January 2011

PROJECT SUMMARY

Project Name	Hawaii Kai Marina and Entrance Channel Dredging
Applicant	Hawaii Kai Marina Community Association
Approving Agency	State of Hawaii Department of Land and Natural Resources 1151 Punchbowl Street, Room 131 Honolulu, Hawaii 96813 Contact: Sam Lemmo Phone: (808) 587-0377 Fax: (808) 587-0322
Consultant	Anchor QEA, L.P. 26300 La Alameda, Suite 240 Mission Viejo, California 92691 Contact: Michael Whelan, P.E. Phone: (949) 347-2780 Fax: (949) 334-9646 Email: mwhelan@anchorqea.com
Location	Hawaii Kai Marina, Maunalua Bay, Honolulu, Hawaii
Tax Map Keys	39007011, 39008035, 39002011, 39002010, 39002009
State Land Use District	Conservation District
County Zoning	None
Required Permits and Approvals	• Environmental Assessment and Finding of No Significant Impact (Hawaii Revised Statutes Chapter 343 and Hawaii Administrative Rule Section 11-200) • U.S. Army Corps o f Engineers Section 10 and Section 404 • Department of Health Clean Water Act Section 401 Water Quality Certification • Department of Planning Coastal Zone Management Act Consistency Determination • Conservation District Use Permit • Department of Health National Pollutant Discharge Elimination System Permit
Actions Requiring Environmental Assessment	Work within the State Conservation District and within navigable waters of the United States

Anticipated Determination	Finding of No Significant Impact
Estimated Cost	$2 to $4 million
Time Frame	July 2011 to December 2011
Unresolved Issues	None
Consulted Organizations/Individuals	• Dawn Hegger, State of Hawaii Department of Land and Natural Resources • Dolan Eversole, State of Hawaii Department of Land and Natural Resources • Farley Watanabe, U.S. Army Corps of Engineers • Keith Kaizumi, State of Hawaii Department of Parks and Recreation • Martha McDaniel, State of Hawaii Department of Parks and Recreation • Joanna Seto, State of Hawaii Department of Health • Shane Sumida, State of Hawaii Department of Health

Proposed Action

The project proposes maintenance dredging of several areas within the Hawaii Kai Marina and the entrance channel under the Kalanianaole Highway Bridge. The goals of the project are to restore adequate depths for navigation and vessel berthing while making use of dredged material as a beneficial resource to the greatest extent possible.

Sediment removed from the marina will be disposed of through a combination of on-site, upland disposal and offshore, open-ocean disposal, while sediment dredged from the entrance channel will be disposed of via beach nourishment. Proposed disposal options are based on a programmatic sediment investigation through which sediment types were matched by physical and chemical properties with the most appropriate disposal alternative.

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
µg	microgram
BMP	best management practice
CDUA	Conservation District Use Permit
cy	cubic yard
DAR	Division of Aquatic Resources
dB(A)	decibel
DEA	Draft Environmental Assessment
DLNR	Department of Land and Natural Resources
DO	dissolved oxygen
ESA	Endangered Species Act
FEA	Final Environmental Assessment
FONSI	Finding of No Significant Impact
FR	Federal Regulation
HAR	Hawaii Administrative Rule
HKMCA	Hawaii Kai Marina Community Association
L	liter
mg	milligram
MLLW	mean lower low water
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit
psu	practical salinity unit
rms	microPascal/m
SOODMDS	South Oahu Ocean Dredged Material Disposal Site
SPCC	Spill Prevention, Control, and Countermeasures
TSS	total suspended solid
TTS	temporary threshold shift
USACE	U.S. Army Corps of Engineers

USC	United States Code
USEPA	U.S. Environmental Protection Agency
WQMP	Water Quality Monitoring Plan

1 INTRODUCTION AND SUMMARY

1.1 Project Location and General Description

The community of Hawaii Kai is located on the southern coast of Oahu, at the eastern end of Maunalua Bay about 12 miles east of downtown Honolulu, Hawaii (Figure 1). Construction of this mixed-use development began in 1959; the development now includes approximately 265 acres of open-water area, 2,400 single- and multi-family residences, three commercial shopping centers, and a full-service marina. The Hawaii Kai Marina serves more than 1,000 registered vessels while also providing important public functions, such as safe harbor for passing vessels and a base of operations for fire and rescue operations during times of emergency.

Navigation to and from the Hawaii Kai Marina is through the entrance channel located under the Kalanianaole Highway Bridge. The channel is bounded by Maunalua Bay Beach Park to the west and Portlock Beach to the east and connects the marina with the open waters of Maunalua Bay. The entrance channel was dredged during World War II for military purposes (Oceanit 1998).

1.2 Project Purpose and Objectives

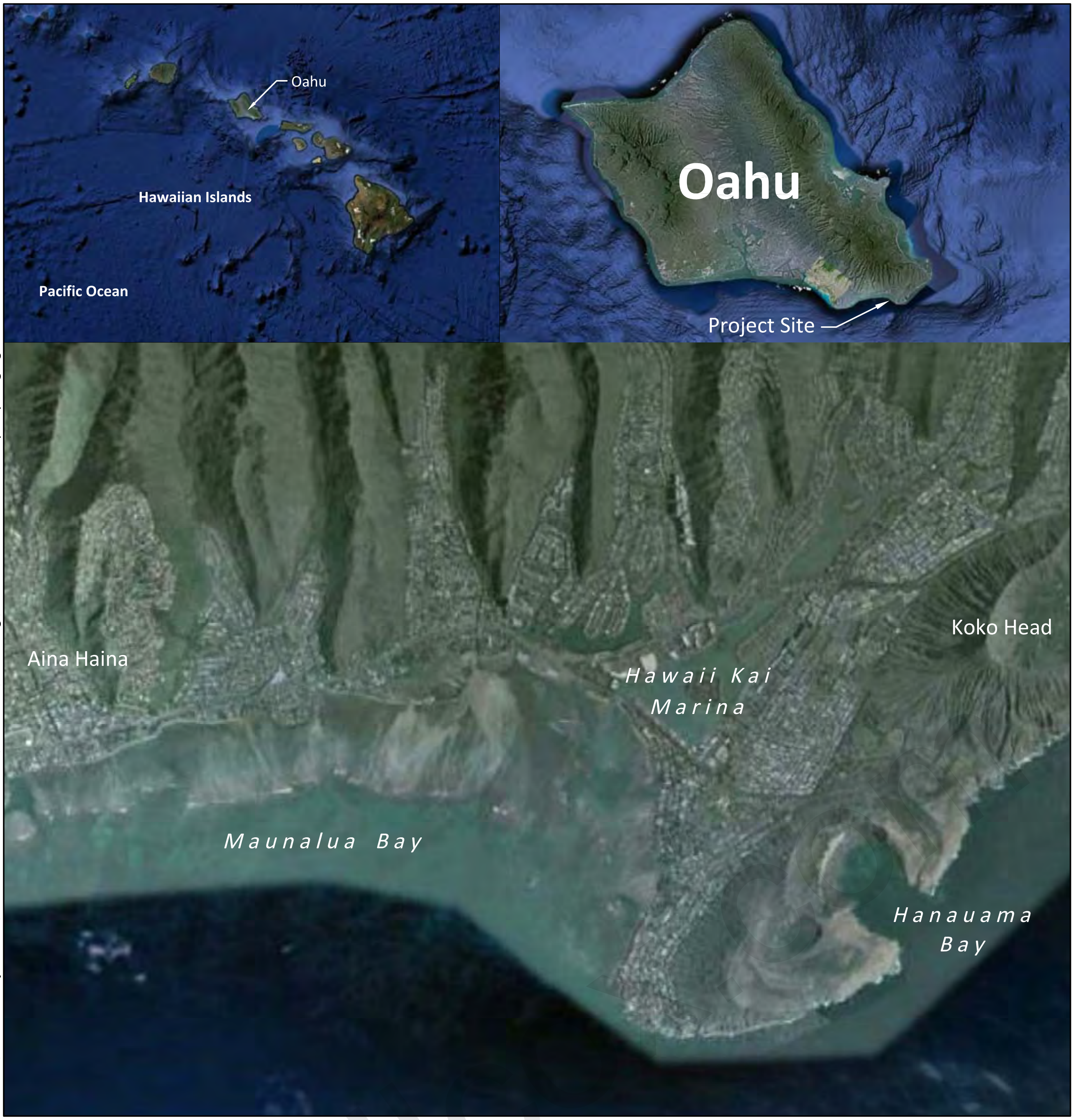
The purpose of the Hawaii Kai Marina and entrance channel maintenance dredging project is to restore navigable depths within a marina and its entrance channel, located in Honolulu, Hawaii. The Hawaii Kai Marina Community Association (HKMCA) intends to perform this maintenance dredging in 2011.

Significant shoaling of the marina's entrance channel has been ongoing for a number of years, with sediment deposits forming within the channel and threatening to hinder navigation. Similarly, ongoing sedimentation within the marina necessitates periodic maintenance dredging to maintain adequate depths for safe navigation and vessel berthing. Although the state of Hawaii was previously responsible for maintaining the entrance channel from Maunalua Bay, the HKMCA currently bears this responsibility as well as that for maintaining depths within the marina. An historical overview of past dredging events in the marina and entrance channel is included in Table 1. Additionally, adjacent portions of Portlock Beach are known to be receding at a rate of 0.56 +/- 0.35 feet per year (Coastal

Geology Group 2009), and the beach at Maunalua Bay Beach Park appears to be experiencing a similar erosive pattern.

Table 1
Review of Previous Dredging Events at Hawaii Kai Marina

Date	Dredging Event
1959	The Hawaii Kai Marina underwent initial dredging to near its present configuration, including dredging material from Kupuā Pond to depths of -6 feet in the marina and -8 feet in the entrance channel.
1960	Rim Islands Nos. 1 and 2 constructed from dredged material to serve as disposal islands for future marina dredging.
1077	The U.S. Army Corps of Engineers issued a maintenance dredging permit that included the marina and entrance channel.
1981	The marina was dredged using hydraulic equipment, with sediments disposed of at Nansay Peninsula and along the shoreline between Keahole Bridge and Hawaii Kai Bridge.
1985	Kaiser dredged the entrance channel from Maunalua Bay into the marina inside the Kalanianaole Highway Bridge using mechanical means from a landward approach.
1994	State legislature passed Act 231, recognizing the marina and associated entrance channel as a navigation channel important to public health, safety, and welfare; State funds were appropriated for maintenance dredging efforts.
1996	The HKMCA dredged approximately 53,600 cubic yards from within the marina and placed the material on Rim Island Nos. 1 and 2.
1998	A significant storm event occurred, causing failure of a poorly designed rock catch basin at the entrance to Kawaihae Channel (near Duck Island). The failure of the rock catch basin prompted subsequent cleanup operations to remove major rock piles, debris, and silt deposited in Kawaihae Channel.
1988	Maintenance dredging of approximately 8,000 cubic yards (from the entrance channel between the marina and the Maunalua Bridge) was conducted to achieve depths to -6 feet mean lower low water (MLLW), with dredged sand placed on Portlock Beach. The project also included construction of a sandbag groin on the west side of Portlock Beach to stabilize the shoreline and minimize the migration of sediment around the shoreline tip and into the navigation channel.
2004	Department of Boating and Ocean Resources dredged the entrance channel and placed sand material on Portlock Beach.
2004	The HKMCA worked toward obtaining a permit for dredging the marina and entrance channel, including placement of dredged material on Rim Island No. 2; however, the state of Hawaii and U.S. Fish and Wildlife Service expressed concerns regarding the endangered Hawaiian stilt (*Himantopus mexicanus knudseni*) at the proposed disposal location of Rim Island No. 2. The HKMCA did not obtain a permit for this activity.



L:\AutoCAD Project Files\080520-Hawaii Kai Marina\08052001\Permitting\08052001-RP-001-Site Vicinity Map.dwg Figure 1

Nov 17, 2010 11:26am banaya

SOURCE: Drawing prepared from Google Earth Pro.

Not to Scale

Figure 1
Site Vicinity Map
Hawaii Kai Marina and Entrance Channel Maintenance Dredging

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1.3 Alternatives Considered and Eliminated

No alternative locations were considered for dredging, because the proposed project is maintenance of an existing marina and is, thus, site specific. The extent of dredging was closely examined, and the minimal depth and area of dredging required to keep the marina in good operation was selected. The selected dredge plan will minimize the duration of construction, the number of haul barge trips, the degree of temporary disruption to recreational and commercial activities, and the magnitude and duration of short-term effects on the environment, such as localized turbidity during dredging.

A range of alternatives was evaluated for management of the dredged material. Within the marina, a pair of islands (Rim Island Nos. 1 and 2) was originally constructed specifically for the purposes of dredged material placement. While Rim Island No. 1 was identified as a legitimate sediment management option for this project, Rim Island No. 2 was eliminated, because it was found to have suitable habitat for the Hawaiian stilt (*Himantopus mexicanus knudseni*; USFWS 2003), which is a federally listed endangered species.

Off-site, upland disposal options, such as fill for upland development or landfill daily cover, were explored to supplement the limited capacity of the on-site, upland disposal options. However, attempts to identify off-site, upland disposal options were unsuccessful. Oahu's lack of landfills with need for daily cover and the capacity to handle sediment as well as the island's constraints on large development projects, left no viable options for off-site, upland sediment disposal.

The use of sand dredged from the entrance channel to nourish other eroded beaches was dismissed because of the demonstrated need for nourishment of Maunalua Bay Beach Park and Portlock Beach and the additional environmental impacts that would result from transporting the material to distant sites.

1.4 No Action

Taking no action to maintain the navigability of the marina and entrance channel would result in continued shoaling and sedimentation within the marina and entrance channel. Boat traffic would become more restricted, and boats would more frequently hit their bottoms causing damage and possible injury to occupants. Continued shoaling in the marina would make it more difficult for residents to access their docks. This No Action option would, therefore, adversely affect access from the marina to the ocean. It would jeopardize the function of safe harbor for passing vessels and also for fire and rescue operations.

1.5 Required Federal and State Approvals and Applicable Regulatory Requirements

The HKMCA is applying for the following permits for the proposed maintenance dredging:

- U.S. Army Corps of Engineers (USACE) Section 404/10 Standard Individual Permit
- Department of Health Section 401 Water Quality Certification and National Pollutant Discharge Elimination System (NPDES) permits
- Department of Land and Natural Resources (DLNR) Conservation District Use Permit
- Department of Planning Coastal Zone Management Program Federal Consistency Review

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

1.5.1 Applicable Federal Laws, Regulations, and Executive Orders

Laws and regulations requiring analysis, or approvals from, or consultations with federal agencies other than the USACE include the:

- National Historic Preservation Act of 1966 (16 United States Code [USC] Section

470[F])

- Clean Air Act (42 USC Section 7506[C])
- Coastal Zone Management Act (16 USC Section 1456[C][1])
- Endangered Species Act (ESA; 16 USC 1536[A] [2] and [4])
- Fish and Wildlife Coordination Act of 1934, as amended (16 USC Section 661-666[C] et seq.)
- Magnuson Stevens Fishery Conservation and Management Act (16 USC Section 1801 et seq.)
- Marine Mammal Protection Act of 1972, as amended (16 USC Section 1361-1421[H] et seq.)
- Executive Order 13089, Coral Reef Protection (63 Federal Regulation [FR] 32701)

The Honolulu District of the USACE will be the lead federal agency ensuring compliance with these statutes. Additionally, the state of Hawaii accepting agency (DLNR) and the state of Hawaii Department of Health will review the analyses and conclusions drawn in this DEA and will decide whether to issue the necessary permits and approvals that the applicant has requested, to issue the permits and approvals with special conditions, or to deny the permits and approvals.

A summary of permitting history in the Hawaii Kai Marina (Table 2) lists the state and federal dredging-related permits issued and activities authorized in the marina and near the entrance channel to Maunalua Bay since 1959. The most recent permit issued was a 10-year maintenance dredging permit from the USACE (PODCO 93-017) on January 26, 1994. A new 10-year maintenance dredging permit will be obtained to replace the one that expired in 2004.

Table 2

Known Dredging-Related Permits Issued to Hawaii Kai Marina Since 1959

Date	Authorizing Agency	Permit and Authority	Activities Authorized (and conducted, if known)
1959 PODCO 557	USACE	Department of Army, Section 10	Dredging of entrance channel to state boat ramp in Maunalua Bay
1961 PODCO 626	USACE	Department of Army, Section 10	Dredging of state boat ramp and channel area in Maunalua Bay
1962 PODCO 627	USACE	Department of Army, Section 10	Dredging of Portlock Beach area in Maunalua Bay
1965 PODCO 792D	USACE	Department of Army, Section 10	Dredging of 1,330 cy of area adjacent to Kalanianaole Highway Bridge
1967 PODCO 820	USACE	Department of Army, Section 10	Dredging of 37,000 cy of entrance channel under Kalanianaole Highway Bridge
1974 CDUA-0A-1/10/74-517	DLNR	CDUA	Maintenance dredging of Kupuā Pond
1975 PODCO 1217D	USACE	Department of Army, Section 10	Dredging of Hahaione Spillway (probably issued to City and County of Honolulu)
1977 PODCO-O 1077-D	USACE	Department of Army, Section 10	5-year maintenance dredging of 750,000 cy in marina and entrance channel (200,000 to 250,000 cy was suction dredged from marina in 1981)
1983 PODCO 1077D	USACE	Department of Army, Section 10	Maintenance dredging of 10 designated areas in marina
1986 PODCO GP 82-1-J	USACE	Department of Army, Section 10	Dredging of 3,000 cy of area adjacent to Kalanianaole Highway Bridge (Entrance channel was dredged with a dragline bucket. Results were poor and silt moved back within 4 months)
1988 PODCO 2036	USACE	Department of Army, Section 10	Dredging of Kawaihae Street spillway
1994 PODCO 93-017	USACE	Department of Army, Section 10	Maintenance dredging of marina and entrance channel (In 1996, 53,600 cy was dredged from marina with bucket and barge. Material was disposed on Rim Islands Nos. 1 and 2).
2001 CDUA	DLNR	CDUA	Dredging of entrance channel, nourishment of Portlock Beach, and construction of temporary groin (In 2002, 7,500 cy was dredged from entrance channel and placed on Portlock Beach. A 90-foot temporary groin was built.)

Notes:
Table created from AECOS 2010.
CDUA = Conservation District Use Permit
cy = cubic yards

2 DETAILED DESCRIPTION OF THE PROPOSED ACTION

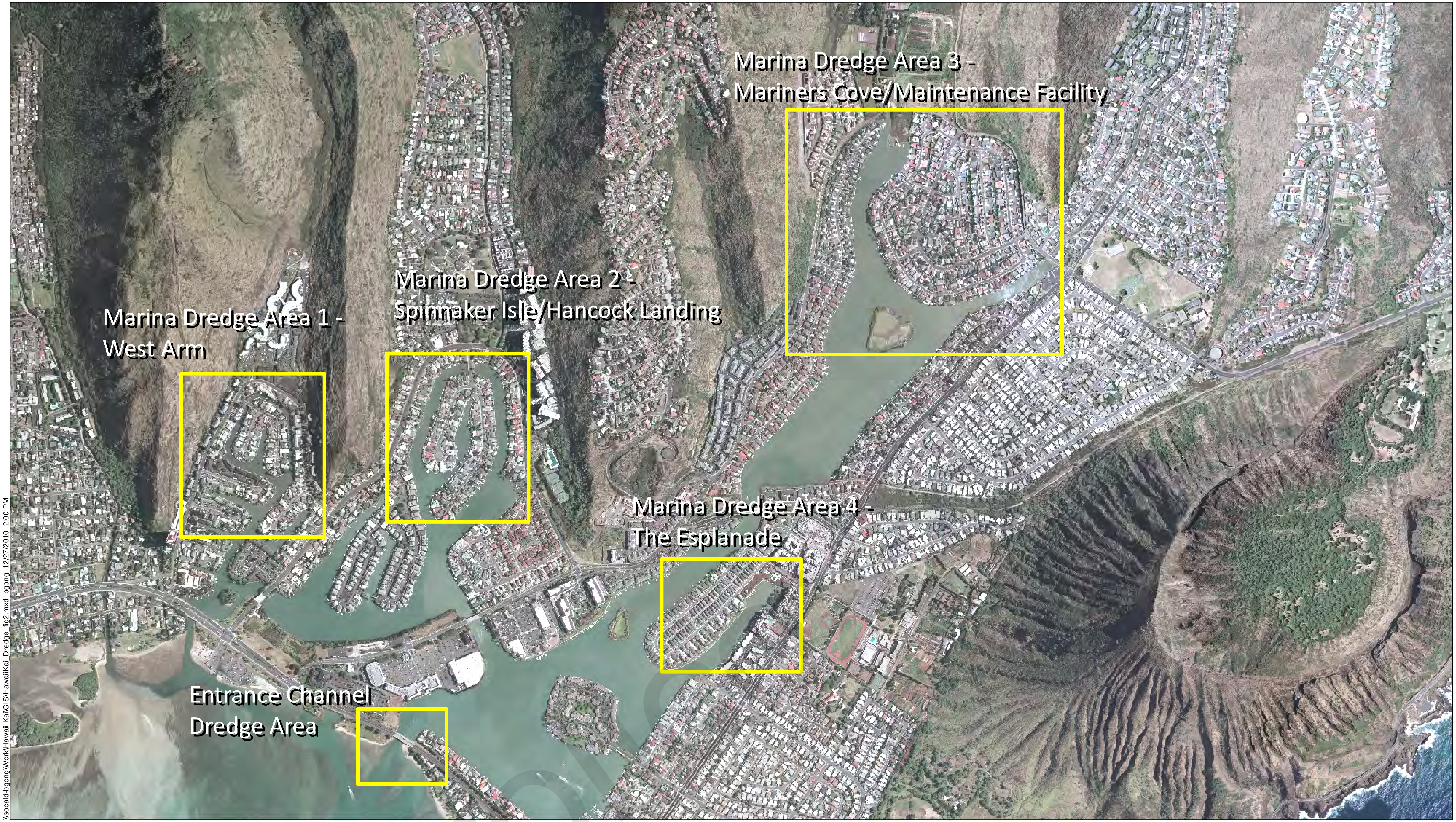
2.1 Marina and Entrance Channel Dredging

Dredging within the marina is proposed in four specific areas where a 2009 bathymetry survey indicated that shoaling has occurred. Dredge areas inside the marina are generally located in the upper areas of the marina, which experience reduced tidal currents, allowing suspended sediments to settle and accumulate, eventually compromising navigability and vessel berthing capabilities.

Up to 111,900 cubic yards (cy) of material (and possibly less) will be removed from the identified locations within the marina by dredging approximately 37 acres of water area. The maximum planned dredge depth for marina dredging is -6 feet relative to mean lower low water (MLLW) datum; dredging will be required to depths of -4 to -5 feet MLLW, with 1 foot of allowable overdredge (Figure 2). The estimated volumes and the approximate footprint of proposed marina dredge areas are presented in Table 3.

Table 3
Marina Dredging Areas and Volume Estimates

Location			Maximum Anticipated Dredging Volume (cy)			Dredge Footprint
Dredge Area	**Sub-Area**	**Reference Name**	**Dredge to -5 feet**	**1 Foot of Allowable Overdepth**	**Total Volume**	**Area (acres)**
1 – West Arm	1a	Awini Channel and Keokea Place	7,600	9,500	17,100	5.8
	1b	Keokea Place				
	1c	Kawaihae Place	200	700	900	0.4
	1d	Milolii Place	200	200	400	0.1
	1e	Hakalau Place	900	1,600	2,500	1.0
2 – Spinnaker Isle/Hancock Landing	2a	Kumukahi Place	1,100	1,300	2,400	0.8
	2b	Hancock Landing	16,600	14,700	31,300	9.1
	2c	Kumukahi Place	1,200	5,800	7,000	3.6
3 – Mariners Cove/Maintenance Facility	3a	Maintenance Facility Area	3,000	6,000	9,000	4.1
	3b	Mariners Cove	18,000	16,000	34,000	10.4
4 – The Esplanade		The Esplanade	4,000	3,300	7,300	2.0
		Total	**52,800**	**59,100**	**111,900**	**37.3**



\\socald-bgong\Work\Hawaii Kai\GIS\HawaiiKai_Dredge_fig2.mxd bgong 12/27/2010 2:00 PM

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Feet
0 500 1,000

Figure 2
Proposed Dredge Areas
Hawaii Kai Marina and Entrance Channel Maintenance Dredging

Maintenance dredging of the entrance channel in the vicinity of the Kalanianaole Highway Bridge will involve the removal of approximately 10,000 cy of material. Dredging will be required to a depth of -7 feet MLLW, with 1 foot of allowable overdredge, for a maximum dredge depth of -8 feet MLLW. The dredge area is approximately 200 feet wide and 650 feet long, resulting in a total dredge footprint of approximately 3 acres.

The dredge design is intended to not only restore adequate depths through the entrance channel but to also provide sufficient depth in which future sediment deposition can occur before restricting access through the channel and, thereby, lengthen the time before another maintenance dredging event is needed.

2.2 Placement of Dredged Material

The HKMCA conducted a sequenced search for sediment management options to accommodate the proposed dredged material. This approach prioritized beneficial use of sandy sediment for beach nourishment and on-site, upland use of fine sediments physically unsuitable for beach nourishment.

This sequenced search for sediment management alternatives led the HKMCA to conclude that disposal of dredged material from the Hawaii Kai Marina can be most feasibly accomplished with a combination of on-site, upland disposal areas; beach nourishment at two adjacent beaches; and off-site, open-ocean disposal of fine sediments from the marina.

2.2.1 Placement of Dredged Material at Rim Island No. 1

Much of the sediment to be dredged from the marina does not appear to contain a suitable percentage of sand to qualify for beach nourishment. To accommodate a portion of this sediment, upland disposal within the marina will include filling Rim Island No. 1 to its full capacity as well as placing fill material on the Yacht Club Property (see Section 2.4), which is owned by the HKMCA. These upland fill locations are identified on Figure 3.

Feet
0 500 1,000

Figure 3
Proposed Upland Areas for Dredged Material Placement
Hawaii Kai Marina and Entrance Channel Maintenance Dredging

Rim Island No. 1 is a man-made island, approximately 1 acre in size, within the marina. The island was constructed in the 1960s by using dredged material for the sole purpose of future dredged material management. Since Rim Island No. 1's construction, dredged material from the marina has routinely been placed on this island during maintenance dredging events. Rim Island No. 1 appears to remain suitable for sediment placement, and based on a topographic survey conducted in 2009, existing capacity of the island to contain dredged material is estimated to be 12,000 cy.

Prior to commencing dredging operations, Rim Island No. 1 would be partially stripped of vegetation and re-graded to facilitate maximum use of the site. Improvements to the existing earthen berm around the island's perimeter would be made as necessary prior to dredging, as to ensure dredged material is adequately contained within the upland area before site stabilization. Placement at this on-site, upland area would be conducted by mechanical (not hydraulic) means, where dredged material from within the marina would raise the elevation of the island to a maximum elevation of +13 feet MLLW and would then be stabilized with vegetative cover. Figure 4 depicts an existing plan view for sediment placement at Rim Island No. 1.

2.2.2 Sediment Placement at Yacht Club Property

On the northeast side of the intersection of Kalanianaole Highway and Hawaii Kai Road is an undeveloped low-lying parcel of 5 acres owned by the HKCMA. This parcel is commonly referred to as the Yacht Club Property, owing to a redevelopment option that was explored in the past, although there are no current plans for future development of this parcel. The HKMCA plans to use this site for sediment disposal. Prior to commencing dredging operations, the Yacht Club Property would be stripped of vegetation and re-graded to facilitate maximum usage of the site. Earthen berms around the parcel's perimeter would be constructed as necessary prior to dredging to ensure dredged material is adequately contained within the upland area before site stabilization. Similar to disposal operations at Rim Island No. 1, placement of dredged material would be limited to mechanical means. Dredged material would be placed and allowed to dry prior to final site grading and stabilization with vegetative cover. Upon project completion, the site would have an approximate elevation of +13 feet MLLW. Figure 5 depicts a topographic survey displaying existing site conditions.

2.2.3 Placement as Beach Nourishment

Consistent with typical tidal inlet settings, shoaled material within the marina's entrance channel has been identified as coarse- to medium-grained sand/sediment, similar in nature to the sandy material currently present at adjacent ocean beaches.

The project proposes to use the coarser-grained sandy material within the entrance channel shoaling area for placement along the adjacent shorelines of Portlock Beach (Photograph 1) and Maunalua Bay Beach Park (Photograph 2). This beneficial reuse alternative is preferred to upland or offshore disposal options, because it returns sand to the littoral system. The resulting beach nourishment also offers benefits of increased habitat, protection of existing shoreline infrastructure, and enhancement of public recreation opportunities by replacing sand in highly eroded shoreline areas of Maunalua Bay.

Photograph 1

Portlock Beach proposed beach nourishment location (east of entrance channel)

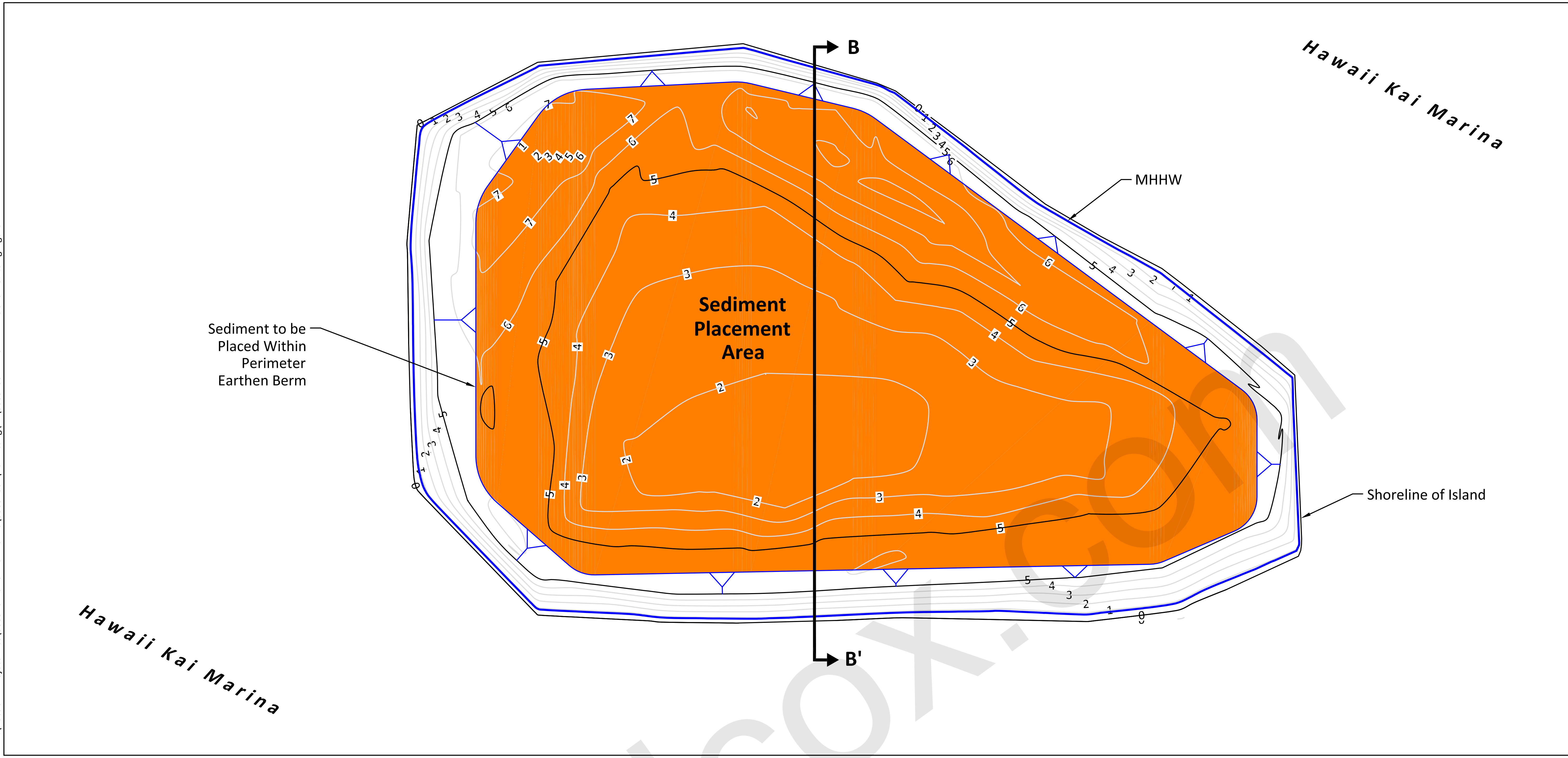
Photograph 2

Maunalua Bay Beach Park proposed beach nourishment location (west of entrance channel)

Grain size of sediment from the entrance channel was evaluated to determine potential suitability for placement along the two proposed beach nourishment locations. Samples were predominantly coarse-grained material. All samples met DLNR guidelines of no more than 6 percent fines and no more than 50 percent material less than 0.125 mm. Conceptual cross sections for placement of beach-quality sand on Maunalua Bay Beach Park and Portlock Beach are presented on Figure 6.

2.2.4 Ocean Disposal

The remainder of the dredged material from the marina would go to the South Oahu Ocean Dredged Material Disposal Site (SOODMDS; Figure 7). Results of a recent sediment characterization study indicate that the proposed dredged material from within the marina is suitable for disposal at the SOODMDS pending approval by the USACE and U.S. Environmental Protection Agency (USEPA; Anchor QEA 2010).



L:\AutoCAD Project Files\080520-Hawaii Kai Marina\08052001\Permitting\EA\08052001-RP-024-Rim Island No.1.dwg Figure 4

Jan 17, 2011 1:07pm banaya

SOURCE: Drawing prepared from Austin, Tsutsumi & Associates, Inc., file named, "09-15.dwg" dated March 23, 2009.
HORIZONTAL DATUM: All azimuths are referred to Goverment Survey Triangulation Station "KOKO HEAD3."
VERTICAL DATUM: Elevations referred to Benchmark L-11, (Elev. = 16.00) mean sea level (MSL).

NOTES:
1. MHHW determination (+0.82' MSL) based on NOS Station 1612340 (Honolulu) for the 1983-2001 tidal epoch.

LEGEND:

Approximate Extent of Sediment Placement Area

MHHW (+0.82' MSL)

0 40
Scale in Feet

Figure 4
Proposed Sediment Placement Area - Rim Island No. 1
Hawaii Kai Marina and Entrance Channel Maintenance Dredging

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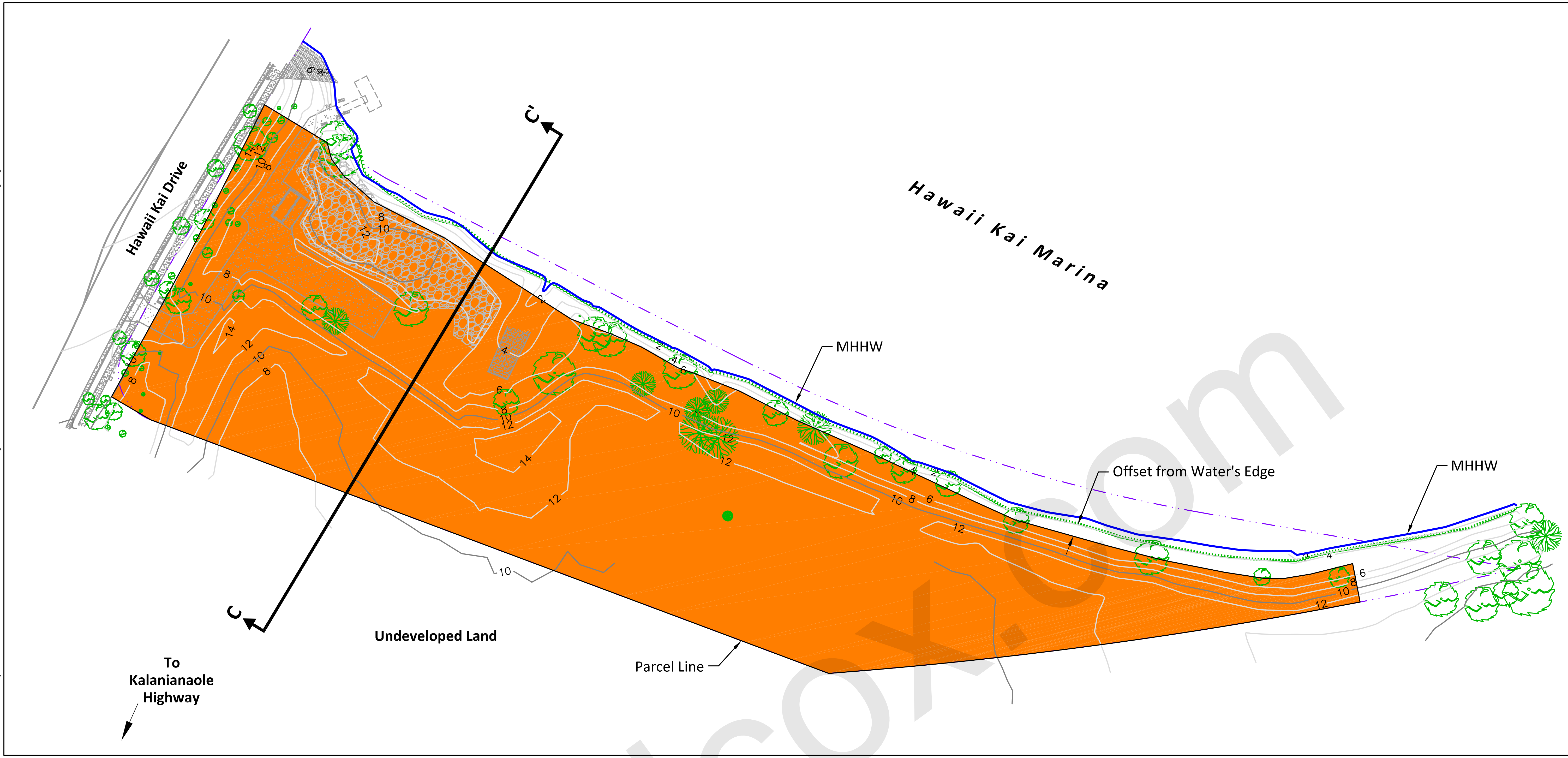


L:\AutoCAD Project Files\080520-Hawaii Kai Marina\08052001\Permitting\EA\08052001-RP-025-Marina Cross Section and Yacht Club.dwg Figure 5

Jan 17, 2011 1:10pm banaya

SOURCE: Drawing prepared from electronic file provided by Towill, Shigeoka & Associates Inc., dated September 17, 2004.
VERTICAL DATUM: mean sea level (MSL).

NOTES:
1. MHHW determination (+0.82' MSL) based on NOS Station 1612340 (Honolulu) for the 1983-2001 tidal epoch.

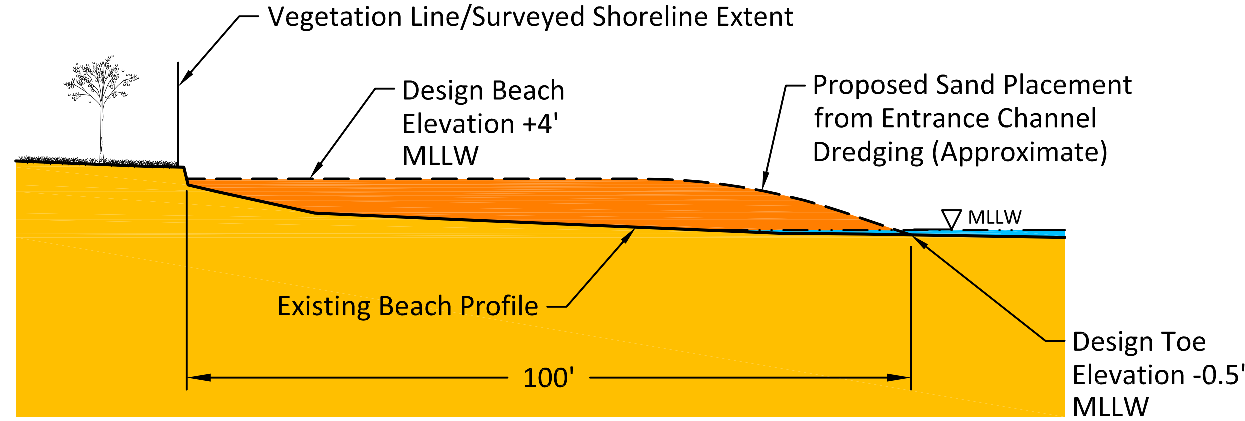
LEGEND:

- Approximate Extent of Sediment Placement Area
- MHHW (+0.82' MSL)

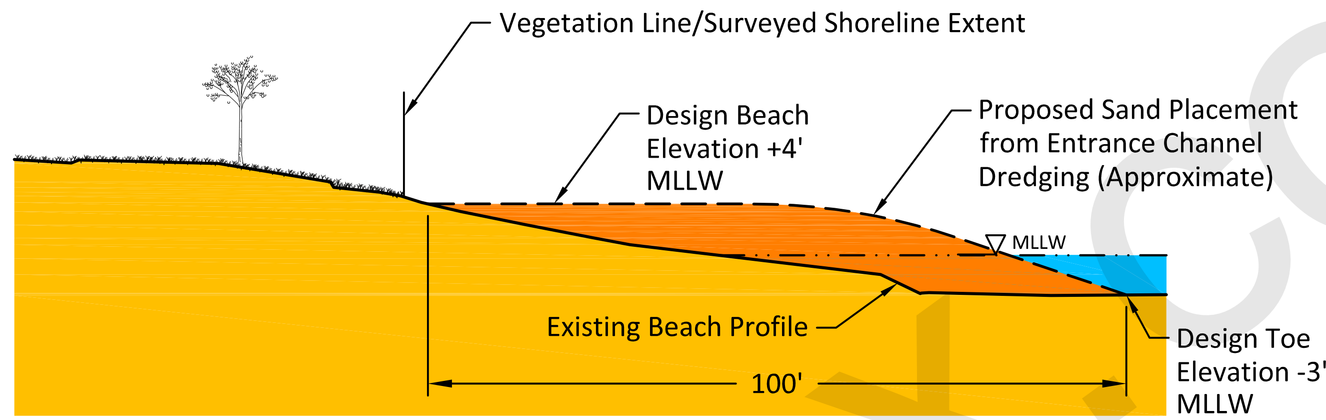
0 60
Scale in Feet

Figure 5
Proposed Sediment Placement Area - Yacht Club Property
Hawaii Kai Marina and Entrance Channel Maintenance Dredging

ANCHOR QEA



Maunalua Bay Beach Park (Typical)



Portlock Beach (Typical)

HORIZONTAL DATUM: Hawaii State Plane, Zone 3, NAD83 HARN.
VERTICAL DATUM: mean lower low water (MLLW).

NOTES:
1. Bathymetric survey performed by Northwest Maritime Industrial in January 2009.
2. Topographic survey of adjacent Shoreline performed by Austin, Tsutsumi, and Associates Inc., in February 2009.

Horizontal Scale in Feet
0 30 60
0 15 30
Vertical Scale in Feet
Vertical Exaggeration x 2

ANCHOR QEA

Figure 6
Conceptual Cross Sections - Beach Nourishment Areas
Hawaii Kai Marina and Entrance Channel Maintenance Dredging

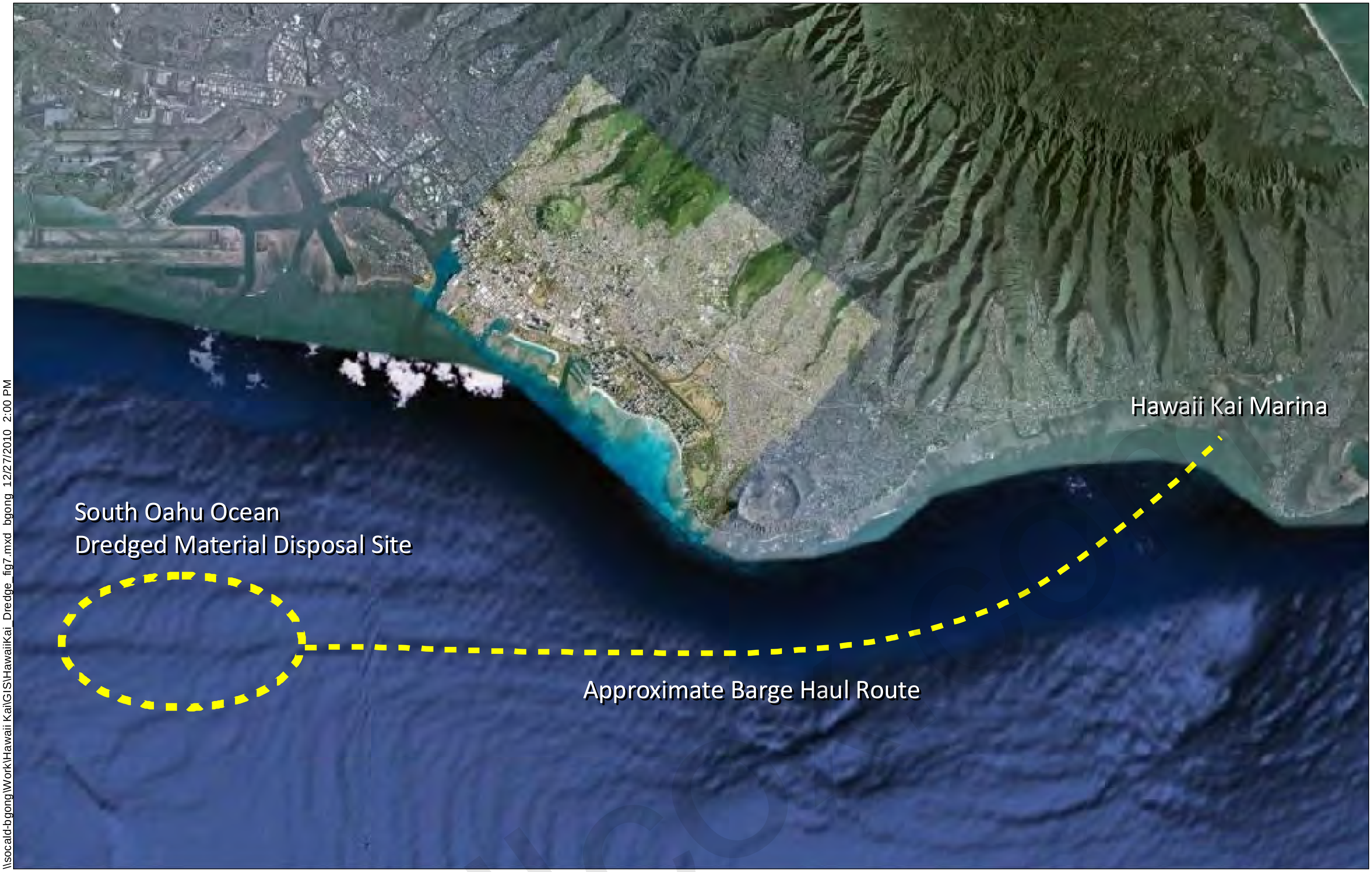


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Figure 7
Approximate Location of South Oahu Ocean Dredged Material Disposal Site
Hawaii Kai Marina and Entrance Channel Maintenance Dredging

The HKMCA plans to use the SOODMDS to dispose of marina sediments remaining after the available on-site, upland placement options (Rim Island No. 1 and the Yacht Club Property) have been filled to capacity and sand from the entrance channel has been used for beach nourishment.

2.3 Dredging and Transport and Dewatering Specifics

2.3.1 Hydraulic Dredging

Hydraulic dredging equipment may be used for portions of the proposed project, in particular for dredging of sand from the entrance channel. Hydraulic dredges remove and transport sediment in the form of a slurry through the inclusion or addition of high volumes of water that is pumped along with the sediment. This technique results is a considerably higher material processing rate than would be achieved by mechanical dredging, although the solids content of the slurry is likely to be considerably less than that of the in situ sediment due to the intermixing of water. The excess water is usually discharged as effluent at the treatment or disposal site.

Hydraulic dredging (typically using a “cutterhead” device) is generally capable of excavating most types of sediment material. An advantage of the cutterhead is that it is capable of continuously dredging at a high rate, and it can pump dredged material directly to the disposal or treatment area, thereby reducing costs. The cutterhead dredge pipeline can also obstruct navigation. Therefore, buoys and markers will be used along the dredge and pipeline route to minimize navigation hazards.

2.3.2 Mechanical Dredging

Mechanical dredging equipment is likely to be used for significant portions of the proposed project, particularly dredging of the marina in which sediments are placed at on-site, upland areas or into barges for transport to the SOODMDS. Mechanical dredge equipment excavates material using a bucket apparatus to secure material, pull it up through the water column, and move it to a barge for transport. The most common type of mechanical dredge is the clamshell dredge, which consists of a clamshell bucket operated from a crane or derrick mounted on a barge. Excavator-type buckets, such as might be seen on a backhoe, are also used in some instances.

Mechanical dredges are particularly useful for removing loose to hard, compacted materials and are well-suited for dredging in areas located along the shoreline or in close proximity to in-water structures, where use of a hydraulic dredge will be difficult and may interfere with harbor operations. Mechanical dredges are commonly used for removing material located around docks and piers or within other restricted areas. When compared to hydraulic dredging equipment, mechanical dredges can typically be operated more accurately when excavating to specific depths below the sediment surface, and they produce much less excess water with the sediment that will also require disposal or management.

The main disadvantages with the use of a clamshell dredge are that they usually leaves an irregular bottom surface and typically results in a higher sediment degree of sediment resuspension than would a hydraulic dredge. Operational controls, or best management practices (BMPs), can be used to reduce potential impacts from turbidity during dredging.

2.3.3 Material Transport

The dredging contractor will likely use various methods of transporting sediment from the point of dredging to disposal locations. For dredged material destined for on-site, upland areas (Rim Island No. 1 and the Yacht Club Property), mechanical means will most likely be used. Material will be removed from haul barges by an excavator or crane-supported clamshell bucket, placed into the disposal area, and then regarded within the area using standard earth-moving equipment (bulldozer, grader, etc.). For dredging of sand from the entrance channel, a hydraulic pipeline (as previously described) may be used to quickly and economically transport the sand directly to adjoining beach areas. Finally, for sediment disposal at the SOODMDS, sealed and U.S. Coast Guard-certified bottom-dump barges will be used to transport the material. Barges will be positioned at the mandated coordinates and will then release the sediment load directly into the water column by opening the bottom dump "doors" on the underside of the barge. Bottom-dump barges typically have a maximum capacity of between 1,000 and 2,000 cy per load. Note that the actual type and size of dredging equipment and barges used will be determined by the dredging contractor, subject to the approval of the managing engineer.

All material transport, placement, and disposal activities will be completed in accordance with all regulatory approvals and conditions, including but not limited to requirements for leakage prevention, vessel positioning within the authorized disposal area, and water quality monitoring. Real-time disposal tracking systems may be used to provide regulatory agencies and stakeholder groups the opportunity for consistent monitoring of project operations, but a reasonable assumption is that each barge would hold on average of approximately 1,000 cy per load.

2.4 Operational Considerations

The Hawaii Kai Marina poses unique challenges to dredging operations, owing primarily to its relatively shallow depths (dredging will target final depths of -4 to -5 feet MLLW) and its narrow channels. These characteristics put constraints on the type and size of dredging equipment and haul barges that can be used to perform the work. It is likely that one or more relatively small and easily maneuverable dredging scow will be used, possibly with an excavator-bucket assembly, to dredge the shallow and narrow channels that comprise much of the dredge areas.

Furthermore, the shallow depths within the marina may preclude entry of standard ocean-going barges into dredge areas, because they may need greater water draft than is available in these locations. To access the shallower areas, the dredging contractor may use smaller, shallower barges directly alongside their dredging equipment, which, after being loaded with sediment, would transport the sediment load out to one or more larger ocean-ready barge(s), positioned in locations with greater depth (possibly outside of the marina limits). In this scenario, it would be likely that several loads from the smaller barges would be used to fill the larger barge before it hauls the material to the SOODMDS.

3 OVERVIEW OF EXISTING ENVIRONMENT

3.1 Climate

The Hawaiian Islands are located south of the Eastern Pacific semi-permanent high-pressure cell, the most influential feature affecting air circulation in the region. Over the Island of Oahu, this high-pressure cell produces very persistent trade winds. During winter months, cold fronts move across the north central Pacific Ocean, bringing rain to Oahu and modifying the trade wind regime. Thunderstorms, which are rare but most frequent in the mountains, also contribute to annual precipitation (Sea Engineering 2010).

3.2 Temperature and Rainfall

Due to the tempering influence of the Pacific Ocean and the low-latitude location, the Hawaiian Islands experience extremely small diurnal and seasonal variations in ambient temperature. Average temperatures in the coolest and warmest months at Honolulu International Airport are 72.9 degrees Fahrenheit (°F; January) and 81.4°F (July), respectively. These temperature variations are quite modest compared to those that occur at inland continental locations. Typically, the most rainfall occurs between the months of November and April. The mean annual rainfall is approximately 23 inches, and the relative humidity ranges between 56 and 72 percent.

3.3 Wind

The prevailing wind throughout the year is the northeasterly trade wind. Its average frequency varies from more than 90 percent during the summer season to only 50 percent in January, with an overall annual frequency of 70 percent. Westerly, or Kona, winds occur primarily during the winter months, generated by low pressure or cold fronts that typically move from west to east past the islands.

3.4 Waves

The wave climate in Hawaii is typically characterized by four general wave types: northeast trade wind waves, southern swell, North Pacific swell, and Kona wind waves. Tropical storms and hurricanes also generate waves that can approach the islands from virtually any direction. Unlike winds, any and all of these wave conditions may occur at the same time.

4 POTENTIAL IMPACTS AND MITIGATION MEASURES

4.1 Noise

HAR Section 11-46, "Community Noise Control," establishes maximum permissible sound levels (Table 4). These standards are intended to protect public health and welfare and to prevent significant degradation of the environment. These limits are applicable at the property line of adjacent properties.

Table 4
Maximum Permissible Sound Levels in Decibels

Zoning Districts	Daytime (7 AM to 10 PM)	Nighttime (10 PM to 7 AM)
Class A – includes all areas equivalent to lands zoned residential, conservation, preservation, public space, open space, or similar type	55	45
Class B – includes all areas equivalent to lands zoned for multi-family dwellings, apartment, business, commercial, hotel, resort, or similar type	60	50
Class C – includes all areas equivalent to lands zoned agriculture, country, industrial, or similar type	70	70

Notes:
Table created from HAR Section 11-46, "Community Noise Control."
The maximum permissible sound levels apply to any excessive noise source emanating within the specified zoning district and at any point at or beyond (past) the property line of the premises. Noise levels may exceed the limit up to 10 percent of the time within any 20-minute period. Higher noise levels are allowed only by permit or variance issued under Sections 11-46-7 and 11-46-8.
For mixed zoning districts, the primary land use designation is used to determine the applicable zoning district class and the maximum permissible sound level.
The maximum permissible sound level for impulsive noise is 10 decibels (as measured by the asuredermissible sound level for impulsive noissible sound levels shown.

It is expected that the dredging contractor will be required to conduct the dredging work during normal business and daylight hours, but they will be given an option to request longer work hours (i.e., nighttime work) if they find it necessary to meet scheduling requirements. For nighttime work to be approved, the dredging contractor would need to demonstrate that operations are not exceeding the mandated sound levels, as previously described in Table 4.

4.1.1 Current Conditions

Existing ambient noise levels vary considerably within the project area. In general, existing background sound levels along Maunalua Bay are relatively high, 55 to 60 decibels (dBA), due to surf, traffic, aircraft, and boat activity.

4.1.2 Potential Impacts

Temporary, minor noise impacts will occur during dredging and grading associated with upland disposal and beach nourishment. In general, it is expected that dredging operations will remain below mandated noise levels. The total number of days of temporary impacts and construction will depend on the final dredge design, which is in progress, and on the dredging contractor's sequence of activities, which will be determined during their work preparation and the submittal process. The state of Hawaii Department of Health noise regulations and conditions for construction activities will be complied with during project construction.

4.2 Air Quality

Ambient air quality pertains to the purity of the general outdoor atmosphere, external to buildings, to which the general public has access. The USEPA established national ambient air quality standards for six criteria pollutants: carbon monoxide, nitrogen dioxide, lead, ozone, and particulate matter. In addition to these pollutants, the state of Hawaii has an ambient air standard for hydrogen sulfide. State air quality standards are generally more stringent than national standards.

4.2.1 Current Conditions

According to the state of Hawaii Department of Health annual air quality data summary in 2008, criteria air pollutant levels were well below state and federal ambient air quality standards at all state and local air quality monitoring stations.

4.2.2 Potential Impacts

The proposed project is not expected to significantly impact ambient air quality. The proposed project will not include new air pollution sources that require additional air quality permits. The principal source of short-term air quality impacts will be construction activity, including dredging equipment and vessel and particulate emissions associated with earth-moving operations for grading of upland disposal areas. These impacts will be minor and of short duration. All construction activities will comply with the provisions of HAR Section 11-60.1-33, "Fugitive Dust." There will be no long-term impacts on air quality.

4.3 Water Quality

A marine and water quality resources study was completed for the Hawaii Kai Marina (AECOS 2010). The study characterized water quality of the marina and contributed to establishing baseline water quality in the project area. Results from this study are summarized below.

4.3.1 Current Conditions

The waters of Maunalua Bay between Paikō Peninsula and Koko Head are classified in the Hawaii Water Quality Standards (HDOH 2009) as a Class A "embayment" and as a "Class II nearshore reef flat." It is the objective of Class A waters that their use for recreational purposes and aesthetic enjoyment be protected. Other uses are permitted so long as it is compatible with the protection and propagation of fish, shellfish, and wildlife and with recreation in and on these waters. Class A waters shall not act as receiving waters for any discharge that has not received the best degree of treatment or control.

The marine and water quality resources study established 11 sampling stations within the marina and six near the entrance channel (Figure 8) and included a sampling event on November 13, 2007, at the beginning of the rainy season. Samples were collected from just below the water surface at each station, and temperature, salinity, pH, and dissolved oxygen (DO) were measured in the field. Water samples for all other analytes (turbidity, total suspended solids, nitrate-nitrite, ammonia, total nitrogen, total phosphorus, and chlorophyll α) were collected in appropriate containers, preserved on ice, and taken to

AECOS in Kāneʻohe, Oahu (Log No. 23551) for laboratory analyses. The results of this sampling event are provided in Table 5.

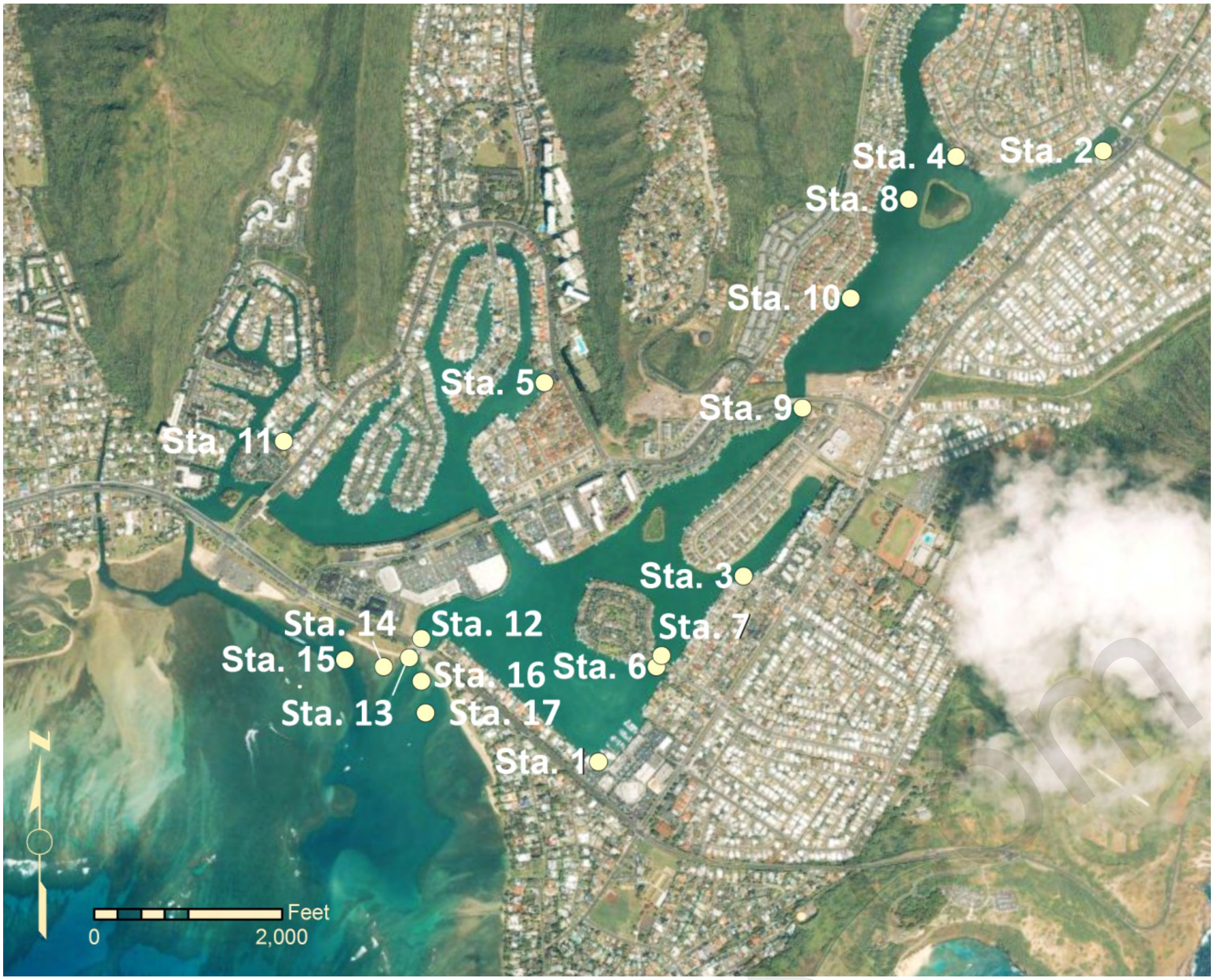
Temperatures measured at all stations are fairly typical for embayments in Hawaii. The most notable observation is that afternoon temperatures are higher than measurements made in the morning. pH also demonstrates an increasing trend as the day progresses, which is likely due to photosynthesis, which removes dissolved carbon dioxide (a weak acid) from the water column, resulting in higher pH values. Waters of the marina are saturated with oxygen and are supersaturated at almost half of the stations, especially in the afternoon, which is also due to photosynthesis by phytoplankton (algae) in the water. Salinity values are typical for oceanic waters (average 34 practical salinity units [psu]). Turbidity and total suspended solid (TSS) levels were high at all 17 stations. Total nitrogen concentrations (consisting of organic, inorganic, and particulate moieties) were elevated at all stations inside of the marina and the entrance channel (Stations 1 through 13) but were relatively low at the stations in Maunalua Bay (Stations 14 through 17). Nitrate-nitrite nitrogen concentrations followed this same pattern, but ammonia nitrogen concentrations were elevated at five stations inside the marina (Stations 1 through 5) but were very low or non-detectable at the remaining stations inside of the marina, the entrance channel, and the Maunalua Bay (Stations 6 through 17). Total phosphorus concentrations (consisting of organic, inorganic, and particulate moieties) were elevated at nine stations inside the marina (Stations 2 through 8, 11, and 12). Chlorophyll α levels were elevated at most stations inside the marina (Stations 2 through 9) and the entrance channel (Stations 12 and 13).

Table 5

Water Quality Measured on November 13, 2007, at 17 Stations in Hawaii Kai Marina

Station	Time	Temp. (°C)	Salinity (psu)	pH	DO (mg/L)	DO Sat (%)	Turbidity (NTU)	TSS (mg/L)	Ammonia (µg N/L)	Nitrate-Nitrite Nitrogen (µg N/L)	Total Nitrogen (µg N/L)	Total Phosphorus (µg P/L)	Chlorophyll α (µg/L)
1	0850	25.9	34	7.98	5.43	81	2.42	7.6	13	106	380	28	1.67
2	0905	26.6	30	8.12	6.79	100	6.16	13	28	680	1230	71	5.80
3	0915	26.0	34	8.25	6.63	99	4.98	13	16	340	903	77	7.88
4	0925	26.4	32	8.28	7.22	107	5.98	13	22	240	919	63	9.77
5	1000	26.5	32	8.17	6.23	93	4.54	11	14	92	443	32	6.02
6	1030	26.1	34	8.21	6.46	97	5.30	12	<1	194	559	47	4.14
7	1035	25.7	34	8.31	7.14	106	4.44	12	<1	250	647	47	5.81
8	1050	26.9	34	8.30	7.27	110	6.44	16	<1	197	755	52	8.94
9	1125	26.3	34	8.23	5.77	87	3.36	13	2	75	301	27	3.61
10	1130	26.4	34	8.31	5.93	89	3.20	7.0	<1	88	357	21	2.86
11	1140	27.0	34	8.23	5.56	84	4.88	9.8	3	77	259	30	2.92
12	1155	26.6	34	8.35	6.61	100	4.96	10	<1	40	374	31	3.52
13	1155	26.6	34	8.33	6.67	101	5.60	12	<1	121	286	29	3.48
14	1315	27.4	34	8.38	7.93	121	3.05	12	2	35	245	23	1.70
15	1320	28.6	36	8.44	8.91	140	3.42	14	<1	8	171	16	0.92
16	1335	27.2	34	8.28	6.83	104	7.60	17	<1	24	210	25	1.85
17	1335	26.8	34	8.27	6.59	100	9.24	22.0	<1	7	191	29	1.72

Notes:
Table created from AECOS 2010.
°C = degrees Celsius
µg P/L = micrograms of phosphorus per liter
µg N/L = micrograms of nitrogen per liter
mg/L = milligrams per liter
NTU = Nephelometric Turbidity Unit



Source: AECOS, Inc., 2010. *Marine Biological and Water Quality Resources at Hawaii Kai Marina, Hawaii Kai, Oahu*. Prepared for Anchor QEA, L.P. October 2010.

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Figure 8
Locations of Water Quality Stations (November 13, 2007, Sampling Event)
Hawaii Kai Marina and Entrance Channel Maintenance Dredging

Mean temperature, salinity, and pH at the Maunalua Bay offshore stations (Stations 441, 442, and 443) are representative of open coastal and oceanic water, as are the low geometric mean turbidity levels. Mean salinity levels at these offshore stations are somewhat lower, and mean pH levels are slightly higher compared with the nearshore means. The differences in salinity may reflect the effect of solar radiation in shallow water (reef flat) locations, resulting in heating effects and higher evaporation rates (leading to higher salinities) and the high turbidities measured at the nearshore stations are caused by the resuspension of fine materials on the reef flat. The higher and less variable pH levels of the offshore stations demonstrate the buffering properties of seawater. The concentrations of nutrients (nitrogen inorganics, total nitrogen, and total phosphorus) are low in the offshore waters, but the concentration of phytoplankton (as measured by chlorophyll α) is slightly elevated.

4.3.2 Potential Impacts

During dredging and sediment placement, temporary, localized turbidity is likely to occur. A Water Quality Monitoring Plan (WQMP) will be developed prior to initiating construction activities, and BMPs will be implemented during dredging and sediment placement. There will be no long-term, adverse affects on water quality as a result of the proposed project.

Water quality BMPs to be implemented include:

- A continuous barrier of floating silt curtains will be maintained around the perimeter of the active dredge area.
- All dredged material will be handled and transported such that it does not re-enter surface waters of the state outside of the protected immediate work area and designated placement sites.
- The load line on disposal barges will be predetermined, and the barge will not be filled above this predetermined level. Before each disposal barge is transported to the SOODMDS, the dredging contractor and a site inspector will certify that it is filled correctly.
- Multiple horizontal dredge cuts will be taken where a thick horizontal volume must be dredged, as to avoid overfilling the bucket and causing spillage.
- A WQMP will be submitted for agency approval prior to construction. The WQMP

will be designed to monitor conditions in accordance with permit requirements.

- A Spill Prevention, Control, and Countermeasures (SPCC) Plan will be submitted by the dredging contractor for agency approval prior to construction. The dredging contractor will be required to follow the SPCC Plan, which will require, among other things, following established refueling, spill containment and countermeasures, and good housekeeping procedures.

4.4 Recreation

4.4.1 Current Conditions

There are three main areas that would be affected by this project: the Hawaii Kai Marina, Maunalua Bay Beach Park, and Portlock Beach. The community of Hawaii Kai is a mixed-use development encompassing a total area of more than 6,000 acres and consisting of single and multi-family residences, various shopping areas, education and community facilities, and a full-service marina. The Hawaii Kai Marina in located within Hawaii Kai and encompasses approximately 265 acres and has around 1,000 registered vessels. The marina is used for power boating, fishing, kayaking, sailing, water skiing, paddling, and swimming. In addition to docking private vessels, the marina also serves several important public functions by providing safe harbor for passing vessels during storm events as well as a base of operations for fire and rescue operations during times of emergency. Significant shoaling has occurred in portions of the marina, adversely affecting recreational activities, such as boating. The proposed dredging of the marina would also enhance recreation by maintaining the safe navigability of the waterways.

This project proposes maintenance dredging of the marina and entrance channel, with beneficial use of the sand dredged from the entrance channel to nourish the adjacent Maunalua Bay Beach Park and Portlock Beach, both of which have experienced substantial erosion. Maunalua Bay Beach Park is used mostly for access for kayaking, canoeing, and fishing. The beach is not used often for swimming, because it is shallow and rocky. Portlock Beach is a small beach accessed primarily by homeowners in the Portlock community. The small portion of the beach accessed from public property is used for swimming and fishing. Nourishment of the Maunalua Bay Beach Park and Portlock Beach is anticipated to enhance recreation in the areas by expanding the sandy beaches and providing greater access to the public.

4.4.2 Potential Impacts

Recreation may be temporarily affected during various phases of the project. Access to portions of Maunalua Bay Beach Park and Portlock Beach will be restricted during sand placement for beach nourishment to ensure public safety and to avoid disruptions to the construction process. The duration of restricted access is expected to be relatively brief because of the limited volume of sand to be placed on each beach.

Similarly, access to specific locations throughout the marina will be restricted during dredging due to the presence of dredging equipment. Because dredging will progress through different portions of the marina, restricted access to specific portions of the marina will be of short duration. Providing sand as beach nourishment to local beaches and increasing navigability through the marina and entrance channel will have a positive effect on recreation.

4.5 Economics

4.5.1 Current Conditions

In addition to docking approximately 1,000 private vessels, the marina also serves several important public functions by providing safe harbor for passing vessels during storm events and serving as a base of operations for fire and rescue operations during times of emergency. The marina is used by a number of commercial businesses serving the needs of tourists for activities, such as fishing, diving, sightseeing, surfing, and kayaking.

4.5.2 Potential Impacts

The proposed project would benefit the local economy by restoring the navigable capacity of the marina and entrance channel. In general, the restoration of local beaches is also expected to benefit the economy by encouraging recreational use of these beaches by residents and visitors.

4.6 Scenery and Aesthetics

4.6.1 Current Conditions

The proposed project will involve dredging of the Hawaii Kai Marina and entrance channel and nourishment of the Maunalua Bay Beach Park and Portlock Beach. The dredging component of the project is a maintenance activity and would not result in any new structures or development. None of these actions are anticipated to negatively affect the quality of coastal scenic and open-space resources. Beach nourishment would improve the quality of the coastal scenic and open spaces by providing broader sandy beaches for public access. Rim Island No. 1 and the Yacht Club Property will be graded and revegetated following sediment placement.

4.6.2 Potential Impacts

The proposed maintenance dredging of the marina and entrance channel might have temporary, localized effects on aesthetics as a result of the presence of construction equipment, but upon project completion, the aesthetics of the landscape will not be altered and there will be no adverse effect on aesthetics.

4.7 Cultural Resources

4.7.1 Current Conditions

The project area includes at least one previously recorded archaeological site and may include two others, but it is unlikely that the sites will be affected by the project. Limited archaeological monitoring will be conducted to verify that the project has no effects to archaeological sites. The project will not demolish or alter existing structures and will not change the surrounding view shed, so there will be no direct or indirect effects to the historically built environment. A cultural resources review has been conducted for the project and is attached as Appendix A. The results of the review are summarized here.

The project is within the boundaries of a large traditional Hawaiian fishpond site (State Site No. 50-80-15-049). The fishpond, named Keahupua-o-Maunalua, was in use at the time of historic contact and appears on historic maps and in contemporaneous narrative descriptions. It was actively fished until the creation of the Hawaii Kai development, which began in

1959. Development of marina facilities included significant dredging and land creation within the fishpond's boundaries; the Hawaii Kai Marina has been dredged at least nine times since 1959. The fishpond is no longer recognizable, though some archaeological evidence may remain outside the limits of previous dredging.

A second possible archaeological site may be present in the project area. A rock-walled fish trap associated with the fishpond appears on a 1921 map of the area near what is now the entrance channel. If any portion of the fish trap remains, it may be in or near the project area. Finally, a habitation site in the Haha'ione valley adjacent to the marina may be within the project area. The site (State Site No. 50-80-15-04) has been recorded in various locations and sizes since 1933. At least one of the locations intersects with the project area. All three sites have been previously impacted by development.

4.7.2 Potential Impacts

The current project is designed to be contained within the likely limits of previous dredging, and no impacts to archaeological resources are expected. However, the exact vertical and horizontal extents of previous dredging episodes are not recorded. Therefore, it cannot be conclusively stated that dredging will not affect any remaining portions of the fishpond, fish trap, or habitation site.

Limited archaeological monitoring of dredge spoils will be conducted to ascertain that no cultural materials were impacted. No further mitigation is proposed.

4.8 Biological Survey

4.8.1 Current Conditions

Seaward of the reef off Maunalua Bay Beach Park, the bottom of Maunalua Bay is largely sand with scattered limestone outcrops. The limestone outcrops were surveyed for the proposed Maunalua Bay Ferry Terminal, and the following description is taken largely from that report (Brock 1988a). A limestone mound biotope commences approximately 2,953 feet from shore in 11.5 feet of water and extends seaward at least an additional 984 feet to a depth of 20 feet or more. The limestone outcrops range in size from 33 feet by 50 feet to more than 98 feet by 262 feet. The patches are spaced from 98 to more than 328 feet apart and are separated by sand bottom. Benthic communities in this biotope are sparse; little shelter is available, and sand scour is likely frequent. Coral cover on the limestone mounds was less than 4 percent, and macroalgae coverage was less than 8 percent. Species of corals reported from this survey are *Porites lobata*, *Pocillopora meandrina*, *Montipora capitata*, *Montipora patula*, and *Cyphastrea ocellina*.

The reef flats off Maunalua Bay Beach Park (located to the north of the entrance channel) and off Portlock Beach (located to the south) were surveyed by AECOS biologists in November 2007 and October 2009 (Figure 9). Table 6 presents a list of organisms observed by AECOS biologists on the reef flat in these surveys.

Table 6

Checklist of Organisms Observed in the Hawaii Kai Marina Entrance Channel and On the Adjacent Reef Flat in November 2007 and October 2009

Genus species	Common name	Abundance	Status	Location
Blue-Green Algae				
Cyanophyta				
Lyngbya majuscule		C	Indigenous	Reef Flat
Algae				
Rhodophyta				
Anotrichium tenue		O	Indigenous	Reef Flat
Acanthophora spicifera	limu ʻakiʻaki	A	Indigenous	Reef Flat
Avrainvillea amadelpha	leather mudweed	C	Naturalized	Reef Flat
Gracilaria parvispora		R	Endemic	Reef Flat
Gracilaria salicornia	gorilla ogo	O	Naturalized	Reef Flat
Galaxaura rugosa		R	Indigenous	Reef Flat
Gelidium pluma		R	Endemic	Entrance Channel
Hydrolithon reinboldii		O	Indigenous	Reef Flat
Hypnea cervicornis		O	Indigenous	Reef Flat
Hypnea musciformis	Hookweed	R	Indigenous	Reef Flat
Spyridia filamentosa		R	Indigenous	Reef Flat
Spirocladia hodgsoniae		O	Endemic	Reef Flat
Chlorophyta				
Bryopsis hypnoides		R	Indigenous	Reef Flat
Cladophora catenata		R	Indigenous	Reef Flat
Cladophora seriacea		R	Indigenous	Reef Flat
Caulerpa taxifolia		U	Indigenous	Reef Flat

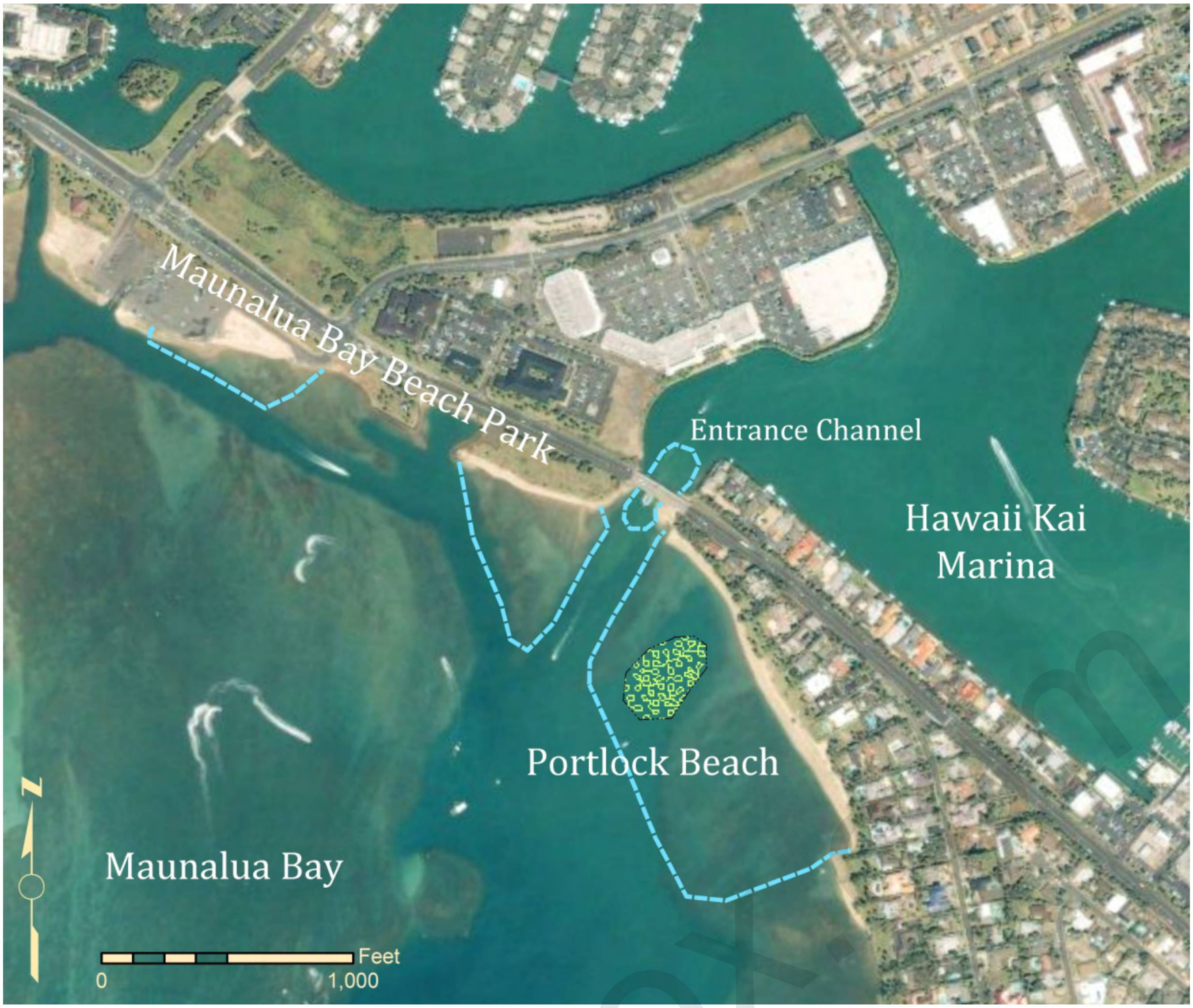
Genus species	Common name	Abundance	Status	Location
Chaetomorpha antennina		R	Indigenous	Reef Flat
Halimeda discoidea		O	Indigenous	Reef Flat
Neomeris sp.		R	Indigenous	Reef Flat
Ulva fasciata	limu pālahalaha	U	Indigenous	Reef Flat
Ventricaria ventricosa	sailor's eyeballs	R	Indigenous	Reef Flat
		Phaeophtya		
Dictyota ceylanica		O	Indigenous	Reef Flat
Padina australis		U	Indigenous	Reef Flat
		Flowering Plants		
		Magnoliophyta		
Halophila decipiens	Caribbean seagrass	C, U‡	Naturalized	Reef Flat
Halophila hawaiiana	Hawaiian seagrass	C, U‡	Endemic	Reef Flat
		Invertebrates		
		Porifera, Demospongia		
unid.	blue sponge	O	--	Entrance Channel
		Niphatidae		
Gelloides fibrosa	grey encrusting sponge	O	Naturalized	Entrance Channel
		Suberitidae		
Terpios zeteki	variable terpios	R	Naturalized	Entrance Channel
		Cnidaria, Hydrozoa		
		Pennariidae		
Pennaria disticha	Christmas tree hydroid	R	Naturalized	Entrance Channel
		Cnidaria, Scyphozoa		
		Carybdeadae		
Carybdea alata	box jellyfish	R	Indigenous	Reef Flat
		Cnidaria, Anthozoa Actinaria		
		Actinidae		
Gyractis sesere	Sesere's anemone	R	Indigenous	Reef Flat
		Cnidaria, Anthozoa Scleractinia		
		Pocilloporidae		
Pocillopora damicornis	lace coral	R	Indigenous	Reef Flat
Pocillopora meandrina	cauliflower coral	R	Indigenous	Reef Flat
		Poritidae		
Porites lobata	pōhaku puna, lobe coral	R	Indigenous	Reef Flat
Porites compressa	finger coral	R	Endemic	Reef Flat
		Acroporidae		
Montipora capitata	rice coral	R	Indigenous	Reef Flat

Genus species	Common name	Abundance	Status	Location
Montipora flabellata	blue rice coral	R	Endemic	Reef Flat
Cnidaria, Anthozoa Ceriantharia				
Acontiferidae				
Isarachnanthus bandanensis	ghost tube anemone	R	Indigenous	Reef Flat
Annelida, Polychaeta				
Chaetopteridae				
Chaetopterus sp.	parchment worm	R	Indigenous	Entrance Channel
Sabellidae				
Sabellastarte spectabilis	feather duster worm	O	Indigenous	Entrance Channel
Bryozoa, Gymnolaemata				
unid.	unidentified bryozoan	R		Entrance Channel
Vesiculariidae				
Amathia distans	bushy bryozoan	R	Indigenous	Entrance Channel
Mollusca, Gastropoda				
Conidae				
Conus lividus	spiteful cone	R	Indigenous	Reef Flat
Mollusca, Gastropoda, Doridacea				
Choromodoridae				
Choromodoris decora	decorated nudibranch	R	Indigenous	Reef Flat
Mollusca, Bivalvia				
Anomidae				
Anomia noblis	jingle shell	R	Naturalized	Entrance Channel
Ostreidae				
Dendostrea sandvicensis	Hawaiian oyster	U	Indigenous	Entrance Channel
Teredinidae				
unid.	Shipworm	R	--	Entrance Channel
Arthropoda, Crustacea, Decapoda				
Callianassidae				
Corallianassa borradailei	Borradaile's ghost shrimp	R	Indigenous	Reef Flat
Grapsidae				
Grapsus tenuicrustatus	ʻaʻama, thin shelled rock crab	R	Indigenous	Entrance Channel
Echinodermata, Ophuiroidea				
Amphiuroidae				

Genus species	Common name	Abundance	Status	Location
Ophiactis sp.	sponge brittle star	R	Indigenous	Entrance Channel
		Ophiocomidae		
Ophicoma dentata	toothed brittle star	R	Indigenous	Entrance Channel
		Echinodermata, Echinoidea		
		Toxopneustidae		
Tripneustes gratilla	ʻhāwaʻe poʻo hina, collector urchin	R	Indigenous	Reef Flat
		Chordata, Ascidacea		
		Ascidiidae		
Ascidea sydneiensis	yellow-green sea squirt	R	Naturalized	Entrance Channel
Phallusia nigra	black sea squirt	R	Naturalized	Entrance Channel
		Diademnidae		
Diademnum sp.	colonial tunicate	R	--	Entrance Channel
		Fishes		
		Muraeniidae		
Echidna nebulosa	puhi kapa, snowflake moray	R	Indigenous	Reef Flat
		Kuhliidae		
Kuhlia sandvicensis	āholehole, zebra-headflagtail	R	Indigenous	Reef Flat
		Mullidae		
Mulloidichthys flavolineatus	weke ā, yellow stripe goatfish	R	Indigenous	Reef Flat
Upeneus arge	weke pueo, bandtail goatfish	R	Indigenous	Reef Flat
		Chaetodintidae		
Chaetodon miliaris	lau wiliwili, milletseed butterflyfish	R	Indigenous	Reef Flat
Forcipiger flavissimus	lauwiliwilinukunukuʻoiʻo, yellow longnose butterflyfish	U	Indigenous	Entrance Channel
		Pomacentridae		
Abudefdef abdominalis	Hawaiian sergeant	O	Endemic	Reef Flat
Dascyllus albisella	ʻaloʻiloʻi, Hawaiian dascyllus	U	Endemic	Entrance Channel
		Labridae		
Stethojulis balteata	ʻōmaka, belted wrasse	U	Endemic	Reef Flat
Thalassoma trilobatum	ʻawela, Christmas wrasse	R	Indigenous	Reef Flat
		Scaridae		

Genus species	Common name	Abundance	Status	Location
Chlorurus sordidus	uhu, bullethead parrotfish	R	Indigenous	Reef Flat
		Gobiidae		
Asterropteryx semipunctatus	halfspotted goby	R	Indigenous	Reef Flat
		Zanclidae		
Zanclus cornutus	kihikihi, Moorish idol	R	Indigenous	Reef Flat
		Acanthuridae		
Acanthurus blochii	pualu, ringtail surgeonfish	O	Indigenous	Reef Flat
Acanthurus triostegus sandvicensis	manini, convict surgeonfish	C	Endemic	Entrance Channel
		Tetraodontidae		
Arothron hispidus	ʻoʻopu hue, stripebelly puffer	C	Indigenous	Reef Flat

Notes:
Table created from AECOS 2010.
Abundance categories:
P – Present – identified but abundance not assessed
R –Rare – only one or two individuals observed
U – Uncommon – several to a dozen individuals observed
O – Occasional – seen irregularly and always in small numbers
C – Common – observed everywhere, generally not in large numbers
A – Abundant – observed in large numbers and widely distributed
Status categories:
Endemic – species found only in Hawaii
Indigenous – species found in Hawaii and elsewhere
Naturalized – not native to Hawaii; introduced and surviving in the wild
† – species presence inferred from non-living material or evidence
‡ - common offshore of Portlock Beach, uncommon offshore Maunalua Bay Beach Park



Notes: Areas surveyed (outlined by blue dashed lines)in channel and on nearshore reef remnant November 2007 and October 2009. Approximate area of seagrass bed (green) off Portlock Beach also shown.

Source: AECOS, Inc., 2010. *Marine Biological and Water Quality Resources at Hawaii Kai Marina, Hawaii Kai, Oahu*. Prepared for Anchor QEA, L.P. October 2010.

Based on preferred habitats and sighting information, Hawaiian stilt and *honu* or green sea turtle (*Chelonia mydas*), listed under the ESA, are known to occur, or could reasonably be expected to occur, in the vicinity of the proposed project area. *Koholā* or humpback whale (*Megaptera novaeangliae*) are present in the deeper waters of Maunalua Bay and *ʻilio holo ika uaua* or Hawaiian monk seal (*Monachus schauinslandi*) and *honuʻea* or hawksbill sea turtle (*Eretmochelys imbricata*) may be found in Maunalua Bay or farther offshore. There is no designated or proposed critical habitat for any listed species within or adjacent to the project area (NMFS 1998). Seagrass beds and coral reefs, which occur in Maunalua Bay near the entrance channel to Hawaii Kai Marina, are designated as special aquatic sites under the Clean Water Act. The taking of corals is prohibited by the State (DLNR 2002), and three species of coral are known to occur in the vicinity of the project area (*Cyphastrea ocellina*, *Montipora patula*, and *Psammocora stellata*) are proposed for protection under federal law (NMFS 2010).

4.8.1.1 Marina Entrance Channel

When Kalanianaole Highway was built in the late 1930s, the main entrance channel from Kuapā Pond to Maunalua Bay was widened to 40 feet and another channel to the west arm of the marina was constructed to provide better water exchange (WOA 1988). The entrance channel was built at a natural break in the reef, probably a drainage channel for the brackish water of Kuapā Pond initially formed during a lower stand of the sea (AECOS 1979). The entrance channel was again dredged in the 1940s to facilitate landing craft operations and to service the military installation during World War II. As part of the development of the Hawaii Kai community, the entrance channel was widened to 250 feet and dredged to 6.2 feet to accommodate potential runoff from a 100-year storm (PODCO 820D). At that time, an access channel from Kuliʻouʻou Stream to the entrance channel was dredged parallel to the shore, and the second channel to the west arm of the marina was dredged. The material from this dredging project was used to construct Maunalua Bay Beach Park and the boat launching area. Since the 1960s, the entrance channel has largely filled in and, despite maintenance dredging once every 10 years, now more closely resembles the 40-foot-wide channel that was first created in the 1930s.

The bottom of the entrance channel consists largely of shifting sands and silt and does not provide suitable habitat for most reef organisms. Table 6 presents a list of organisms observed in the entrance channel in the November 2007 and October 2009 surveys made by AECOS biologists. The hard surfaces, such as areas where the channel bisects the reef flat and concrete piles of the bridge, are colonized by a variety of flora and fauna, primarily introduced fouling organisms. The piles, in particular, are heavily covered with *Carijoa riisei*, an introduced octocoral, and *Amathia distans* (bushy bryozoan). *Gracilaria salicornia* (gorilla *ogo*), an introduced red alga, is also attached to the piles. *Aloʻiloʻi* or Hawaiian domino damselfish (*Dascyllus albisella*), *manini* or convict tang (*Acanthurus triostegus*), *lauwiliwili nukunukuʻoiʻoi* or yellow longnose butterflyfish (*Forcipiger flavissimus*), and juvenile wrasses (*Labridae* family) were observed in the entrance channel in the recent surveys.

4.8.1.2 Hawaii Kai Marina

Prior to its development as a marina, Kuapā Pond was a brackish fishpond used to raise ʻ*amaʻama* or mullet (*Mugil cephalus*), *ʻawa* or milkfish (*Chanos chanos*), and *āholehole* or (*Kuhlia xenura*; Sakoda 1975). Fish still inhabit the marina, and several fish species have been reported in the marina (USACE 1975): cardinal fish (*Apogon* sp.), squirrel fish (*Holocentrus diadema*), yellow tang (*Zebrasoma flavescens*), sailfin tang (*Z. veliferum*), parrot fish (*Scarus* sp.), *āholehole* (*Kuhlia sandvicensis*), *lae* (*Scomberioides sanctipetri*), eagle ray (*Aetobatus narinari*), several species of butterfly fish from the *Chaetodontidae* family, and schools of *Stolephorus (Encrasicholina) purpureus* (*nehu*). A survey conducted in 2002 by the Bishop Museum found that the sampling stations in Kuapā Pond (Hawaii Kai Marina) showed the highest percentage (40 percent) of introduced or cryptogenic species (collectively termed nonindigenous species or NIS) determined in Hawaii (Coles et al. 2002). Hard surfaces within the marina are moderately fouled with suspension feeders commonly found in Oahu waters. Green sea turtles may occasionally enter the Hawaii Kai Marina and feed on the reef flat and rest on the beaches surrounding the entrance channel.

4.8.1.3 Upland Disposal Areas

Dredged material that is not suitable for beach nourishment will be placed at on-site, upland locations that avoid unmanaged return sediment to marina or other state waters. Rim Island

No. 1 was originally created by stockpiling dredged material from the surrounding marina. The island initially consisted of a berm surrounding an interior depression, but the depression was partially filled in with dredged material in 1995 and 1996. The central part of the islet remains a depression with pickleweed (*Salicornia virginica*) and ornamental vegetation. However, open, standing water is not present on Rim Island No. 1. The islet is maintained and irrigated by the HKMCA.

The Yacht Club Property is an unused, upland parcel located between Hawaii Kai Drive and Keahole Street along the south side of the marina. The parcel supports ruderal vegetation and has been disturbed by adjacent development activities, including construction of the marina and adjacent roads. The parcel is currently used by the HKMCA for maintenance access and includes a paved area and access to a gangway and floating dock.

4.8.1.4 Maunalua Bay Beach Park and Portlock Beach

Maunalua Bay Beach Park (see Figure 9) was created in the 1960s from dredged material resulting from dredging of the west channel to the marina and a connecting channel just off the shore. Presently, the shore is a mix of coral rubble, silt, and sand. A boat launching area is located at the eastern end of the park, and a 600-foot rock revetment lines the west end of the park. The nearshore channel is approximately 148 feet in width and 8.2 feet in depth. Presently, this channel serves as a collection point for the discharge of freshwater and terrigenous materials from Paikō Lagoon, Kuliʻouʻou Stream, and the west channel into the marina (Brock 1988b). Maunalua Bay Beach Park is within the urban district pursuant to Hawaii Land Use Law (HRS, Chapter 205).

Portlock Beach lies directly east of the entrance channel to the marina (Figure 10) and is a 2,140-foot-long, narrow, sand beach. Portlock Beach is within the urban district pursuant to Hawaii Land Use Law (HRS, Chapter 205). Inland of the beach is an upscale residential area. Beyond Portlock Beach, towards Kawaihoa Point (Koko Head), the shoreline is artificially stabilized with revetments and seawalls and by low cliffs and benches cut in the tuff of the headland. The sand on Portlock Beach is actively eroding; longshore currents move the sand westward into the marina entrance channel. The main portion of Portlock Beach is presently receding at a rate of 0.56 +/- 0.35 feet per year (Coastal Geology Group 2009). The nearshore bottom immediately off Portlock Beach is sand with occasional coral rubble. No fish, corals, or large invertebrates inhabit this area, although sea urchins and burrows of small invertebrates are present.

The reef flat remnants off Maunalua Bay Beach Park and Portlock Beach are highly-eroded, low-relief limestone platforms. The shallow (less than 3 feet) reef areas are covered with a veneer of sand and silt. Some sections are exposed at low tide. The benthic communities close to shore are highly disturbed and dominated by sessile filter and suspension feeding organisms.

In 2002, Coles et al. found benthic cover on the reef flat off Portlock Beach to be an abundance of a non-native alga (*Avrainvillea amadelpha*) growing in sand and on a small limestone outcrop supporting the coral (*Pavona varians*). Native seagrass (*Halophila hawaiiana*) was present. Today, the reef flat off Maunalua Bay Beach Park and Portlock Beach continues to be dominated by non-indigenous algae, such as *Acanthophora spicifera* (most abundant), *A. amadelpha,* and *Lyngbya majuscule; Gracilaria salicornia* is occasionally found. The algae grow on limestone rubble, easily rolled by waves and swells. Algal growth is most dense close to shore. Other algae present on the reef flat include species that are preferred (Arthur and Balazs 2008) by green sea turtles, such as *Ulva fasciata*, *Hypnea cervicornis*, *Spyridia filamentosa*, *Cladophora catenata*, and *C. seriacea* (as well as the abundant *A. spicifera*). A seagrass bed (see Figure 9), consisting of both the endemic *H. hawaiiana* and the introduced *H. decipiens*, is located off Portlock Beach. Seagrass is another important component of the diet of green sea turtle (Arthur and Balazs 2008).

Very few coral colonies are present on the reef flat, with the first colony appearing more than 330 feet offshore. Coral colonies present include *Montipora capitata*, *M. flabellata*, *Poc. damicornis*, *Poc. meandrina*, *P. compressa*, and *P. lobata*. Other reef macro-invertebrates (such as brittle stars, sea urchins, and sea anemones) are relatively uncommon. Fish biomass and diversity are very low in the nearshore areas of low relief bottom. Fifteen species of fishes were observed on the reef flat. *Oʻopu hue* or stripebelly puffer (*Arothron hispidus*) and *māʻiʻi* or brown surgeonfish (*Acanthurus nigrofuscus*) are common, while *mamo* or Hawaiian sergeant (*Abudefduf abdominalis*) and *pualu* or ringtail surgeonfish (*Acanthurus blochii*) are seen occasionally.

Source: AECOS, Inc., 2010. *Marine Biological and Water Quality Resources at Hawaii Kai Marina, Hawaii Kai, Oahu*. Prepared for Anchor QEA, L.P. October 2010.

4.8.2 Potential Impacts to Marine Biota

DLNR Division of Aquatic Resources (DAR) commented on the 1993 permit application to perform maintenance dredging in the Hawaii Kai Marina that dredging activities “are not likely to further diminish aquatic resource values in the marina (Kuapā Pond) which is a highly developed and modified area. Some turbidity can be expected during dredging, but impacts adverse to the existing resident aquatic resource populations in the marina should be minimal and temporary” (DLNR 1993).

Dredging of sand from the entrance channel will lead to the loss of some benthic organisms. However, benthic organisms inhabiting the sand bottoms of other channels on the reef flat will quickly recolonize the dredged entrance channel without any foreseeable long-term impact. No significant adverse impacts are expected to occur to any species that are currently listed as endangered, threatened, or proposed for listing under either the federal or state endangered species programs that are within the immediate vicinity of the entrance channel. Additionally, no significant adverse impacts to live coral or seagrass beds are expected from the project.

The biological community in the marina has adapted to turbid conditions and, therefore, is not likely to be negatively impacted by a temporary increase in turbidity and suspended sediments caused by dredging. The biological community in the nearshore waters of Maunalua Bay has also adapted to turbid water quality conditions and a high load of suspended sediments in the water column, so a short-term pulse of sediments from dredging should not have a long-term impact on the biological community. Sessile benthic infauna existing within the areas of the marina proposed to be dredged will experience direct mortality, although the existing population is not expected to be large (USACE 1975). Only a small portion of the marina bottom is slated to be dredged and benthic organisms inhabiting the remaining marina bottom should quickly recolonize dredge areas without any foreseeable long-term impact.

4.8.2.1 Potential Impacts to Protected Species

No significant adverse impacts are expected to occur to any marine species that are currently listed as endangered, threatened, or proposed for listing under either the federal or state endangered species programs that are within the immediate vicinity of the entrance channel. Federal and state listed species status follows species identified in Department of Land and Natural Resources (DLNR 1998) and U.S. Fish and Wildlife Service (USFWS; 2005, 2010). Additionally, no significant adverse impacts to live coral or seagrass beds are expected from the project.

A discussion of potential impacts to listed species from project activities is presented below. The proposed project is not anticipated to have any significant impacts on protected species. Potential impacts include:

1. Collision with project-related vessels (sea turtles and marine mammals)
2. Entrainment or impingement by dredging equipment and activity (sea turtles)
3. Exposure to elevated noise levels of dredging equipment (sea turtles and marine mammals)
4. Loss or degradation of foraging habitat (green sea turtle)

Collision with project-related vessels. Sea turtles and marine mammals must surface to breathe, and they are known to rest or bask at the surface. When at or near the surface within the project area, these animals are at risk of being struck by vessels (or propellers) as the vessels transit to and from the project site. Green sea turtle are known to forage and transit though the nearshore waters of Maunalua Bay near the entrance channel to the marina, where vessel collisions could be a potential impact. Vessel collisions are not anticipated to increase with the proposed project, as no significant change in vessel traffic is anticipated as an outcome of the project. To reduce the chance of vessel collisions, any vessels associated with construction traveling during winter whale season (November to May) should follow BMPs to avoid protected species. These BMPs include: 1) keep vessels at least 100 yards from whales and at least 50 yards from other marine mammals and sea turtles; 2) reduce vessel speeds to 10 knots or less when in the proximity of marine mammals and 5 knots or less when in areas of known or suspected turtle activity; and 3) use silt curtains to create barriers, preventing turtles from entering an area of potential harm (D. Hubner, NOAA-NMFS, pers. comm.; HIHWNMS 2008).

Entrainment or impingement by dredging equipment and activity. If and when the dredging method uses a hydraulic dredge, the suction force that removes sediment from the bottom as slurry (sand/water mixture) could cause entrainment or impingement to marine animals. Entrainment occurs when an organism is sucked into the dredge intake, and impingement occurs when an animal becomes held fast against the dredge head by suction. Both entrainment and impingement could result in an animal drowning or being injured. Recommended BMPs include the use of an excluder device on hydraulic dredging equipment, as similarly recommended for the Waikiki Beach Maintenance Project (Tosatto 2010). Also, the National Marine Fisheries Service (NMFS) Protected Resources Division BMPs require construction crews to watch for sea turtles and marine mammals 30 minutes prior to beginning work and to halt or postpone that work when those animals are within 50 yard (Tosatto 2010). It is expected that sea turtles and marine mammals will avoid the area during dredging operations, and therefore, the risk of entrainment or impingement of sea turtles and marine mammals is unlikely.

Exposure to elevated noise levels of dredging equipment. Hydraulic dredges can produce underwater noise that is continuous and of high enough intensity to affect marine life adversely. Effects vary with the frequency, intensity, and duration of the sound source and the hearing characteristics of the exposed animal. The sound generated from dredging activities is not anticipated to be substantial enough to cause an acoustic disturbance to protected species in nearshore waters. Project plans should ensure that sound emanation from the project site is below the temporary threshold shift (TTS) of 180 to 190 dB re 1 microPascal/m (rms) for marine mammals (NOAA 2005). Currently, no acoustic thresholds have been established for sea turtles. Current research suggests that sea turtles may be less acoustically sensitive than cetaceans, relying more heavily on visual cues, rather than auditory input (Hazel et al. 2007; Ridgeway et al. 1969). Therefore, application of the marine mammal thresholds is considered conservative for sea turtles.

Loss or degradation of forage habitat. The nearshore area off Maunalua Bay Beach Park and Portlock Beach consists of a limestone platform covered by turf-forming macroalgae with very little coral present. Green sea turtle forage across the shallows and are the only listed marine species known to forage in the area. As such, they are the only ESA species potentially impacted by this stressor. Dredging is proposed for the entrance channel, which does not support seagrasses or macroalgae. Because very little macroalgae and no seagrasses nor corals are present in the footprint of the beach proposed for nourishment with the dredged sand, this proposed project will not affect forage resources for sea turtles or environment used by seagrasses.

Other potential impacts. The proposed project will have no impact on the Hawaiian stilt, because dredged material will not be deposited on Rim Island 2. "Turtle Canyon," located offshore the entrance channel, experiences regular daily boat traffic, and dredging operations will not contribute to a significant increase in vessel numbers or vessel speeds. Green sea turtle may haul out and rest on the widened beach that is to be created from the placed dredged material. Because no nesting (green or hawksbill sea turtles) beaches are close to the project area and hatchlings quickly move to the open ocean, it is unlikely hatchlings will transit the project area. The primary food resource for hawksbill turtles (i.e., sponges) occur, but are uncommon, in the project area. No corals or seagrasses are found in the entrance channel or within the footprint of the beaches proposed to be nourished.

Invasive species occur in Maunalua Bay, including introduced algae (*A. spicifera*, *G. salicornia*, and *A. amadelpha*). Invasive algal removal efforts on Oahu have focused attention on Paikō Lagoon and Maunalua Bay. BMPs can minimize the chance of additional introductions and reduce the chance of contributing to existing populations of invasive species. Barges will also be inspected for possible invasive species prior to being moved to the site for dredging operations.

4.9 Environmental Impacts

Dredging within the marina and entrance channel will likely cause a temporary increase in turbidity in the immediate vicinity of dredging operations. A WQMP will be developed for the project, and silt curtains and other standard BMPs will be used to minimize dispersion of suspended sediments during the dredging operation during construction. The WQMP will be developed in accordance with all state, federal, and local permit regulations and will consist of qualitative visual inspections in combination with quantitative sampling and analysis.

The placement of dredged material at Maunalua Bay Beach Park and Portlock Beach may temporarily increase turbidity within the nearshore zone immediately adjacent to the nourishment site. Turbidity is expected to be minimal, because the sediment proposed for beach nourishment is coarse sand with few fines and, therefore, will settle from the water column very quickly. In addition, the sediment will be placed at elevations above the high tide line to the extent practicable to achieve the desired beach configuration. Placement of the sand above the high tide line will further minimize turbidity and will allow return water to percolate into the sand. Only sediment within the acceptable range of grain sizes determined by the regulatory agencies will be placed at these beaches.

All disturbed upland areas (Rim Island No. 1 and Yacht Club Property) will be properly stabilized upon completion of any phase of construction activities. Standard BMPs will be used as necessary to prevent sediment runoff during construction. A grading permit will be required from the County of Honolulu, and the project's Temporary Erosion Control Plan will clearly present all proposed measures of erosion control.

The assessment of biological resources and water quality (AECOS 2010) suggests that the project will result in only temporary, minimal impacts to the environment. The report suggests that the proposed dredge areas support relatively depauperate communities, including many nonnative species. It is anticipated that the soft bottom benthic communities disrupted by dredging operations will be recolonized quite rapidly from neighboring areas without any long-term impacts.

The draft biological resources report also concludes that no endangered or threatened species, or species proposed for listing, will be adversely affected by the project. In addition, the report states that no impacts to live corals or seagrasses are expected to result from the project. To ensure that natural resources are not adversely affected, the report recommends that in addition to a WQMP, a BMPs Plan should be developed and implemented for the project (AECOS 2010).

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APPENDIX A
ARCHAEOLOGICAL ASSESSMENT AND SECTION 106 REVIEW

— Revised Draft —

Archaeological Assessment and Section 106 Review, Hawai‘i Kai Marina and Channel Maintenance Dredging, Maunalua Ahupua‘a, Kona District, O‘ahu, Hawai‘i

TMK: (1) 3-9-3:37, 7:11, 8:11, 8:37, 17:33, 29:75, 32:61, 34:62, 50:27, 52:56, 52:57, 58:59, 68:15.

By

Nichole Jordan
Jane Allen

Prepared for

Anchor QEA, LP
Mission Viejo, California

INTERNATIONAL ARCHAEOLOGICAL RESEARCH INSTITUTE, INC.

DECEMBER 2010

— REVISED DRAFT —

ARCHAEOLOGICAL ASSESSMENT AND SECTION 106 REVIEW, HAWAI‘I KAI MARINA AND CHANNEL MAINTENANCE DREDGING, MAUNALUA AHUPUA‘A, KONA DISTRICT, O‘AHU, HAWAI‘I

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ABSTRACT

At the request of Anchor QEA, LP, International Archaeological Research Institute, Inc., (IARII) has completed an archaeological assessment and Section 106 review as part of the proposed maintenance dredging project in Hawaiʻi Kai Marina. The proposed project is the latest of many dredging projects that have taken place in the Marina. Dredging is necessary to ensure that navigable depths within the Marina are maintained.

This report presents the results of background research to determine whether the proposed project could have an adverse impact on historic or potentially historic archaeological resources ("historic" meaning significant). Based on archival research results, the proposed project does have the potential to affect adversely three potentially historic sites, which are recommended here as eligible for nomination to the National Register of Historic Places (NRHP). The three sites, portions of which overlap or are contained in one of the 15 project areas that constitute the project Area of Potential Effect (APE), include State Site 50-80-15-049, Loko Keahupua-o-Maunalua, once one of the largest traditional Hawaiian fishponds on Oʻahu; Site 50-80-15-043, a habitation site with traditional and post-Contact (post-A.D. 1778) components; and an unnumbered fish trap mapped historically in the inlet/outlet between the fishpond and Maunalua Bay. Sites outside the APE, none expected to be affected by the planned project, are reviewed to provide additional context for the fishpond, habitation site, and fish trap.

Limited archaeological monitoring is recommended during proposed dredging, to ensure that any cultural materials recovered from dredged sediments and soils are archaeologically documented for their information potential to ensure mitigation of any adverse effects of dredging on the resources. Dredging will be archaeologically monitored near the outlet, and dredged materials will be inspected in spoil piles in various locations in the APE. The redeposition of dredged materials at several disposal locations in the APE is not expected to affect any cultural resources and does not require monitoring or other mitigation.

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INTRODUCTION

The proposed project consists of maintenance dredging in 10 areas, totaling 66,516 cubic meters (m^3) (87,000 cubic yards) of material, in Hawaiʻi Kai Marina, Maunalua Ahupuaʻa, Kona District, Oʻahu (spellings throughout this report follow those of Pukui and Elbert 1986 and Pukui et al. 1986). In addition, areas to be affected include five disposal locations – four upland sites and one offshore area (Figure 1). These 15 areas constitute the project Area of Potential Effect (APE).

REGULATORY STANDARDS AND PERMITS REQUIRED

The project requires a permit from the U.S. Army Corps, Engineer USACE 404/10/103). The Army Corps, as the federal agency overseeing the project, will ensure that the project is conducted in compliance with Sections 106 and 110(f) of the National Historic Preservation Act (NHPA), as amended (16 U.S. Code Section 470 et seq.); implementing regulations set forth in 36 Code of Federal Regulations (CFR) Part 800; the Antiquities Act of 1906; the Archaeological Resources Protection Act (ARPA) of 1979, and the ARPA-implementing regulations presented in 32 CFR Part 229.

Additional permits required for the project include the following: a Hawaiʻi State Department of Land and Natural Resources Conservation District Land Use Permit; a Hawaiʻi State Department of Health 401 Water Quality Certification; a Hawaiʻi Office of Planning/National Oceanic and Atmospheric Administration (NOAA) Coastal Zone Permit; and a Honolulu City and County Erosion and Sediment Control Permit and Grading Permits (M. Whelan, by e-mail, September 3, 2010).

SECTION 106 CRITERIA AND INTEGRITY

As part of the permitting process, Anchor QEA, LP, has asked International Archaeological Research Institute, Inc., (IARII) to complete an archaeological assessment, including a Section 106 review, of all archaeological resources located in any of the project areas that make up the APE. Archaeological properties are assessed here for potentially historic (significant) status: historic sites are eligible for nomination to the National Register of Historic Places (NRHP). Historic sites must satisfy at least one of the **criteria** listed below and must also retain **integrity**.

The NRHP criteria, which are set forth in 36 Code of Federal Regulations [CFR] Part 60 (available, http://www.nps.gov/history/nr/regulations.htm, accessed Dec. 3, 2010) and in National Register Bulletin 15 (U.S. National Park Service 2002; available, http://www.nps.gov/nr/publications/bulletins/nrb15/, accessed Dec. 3, 2010) follow:

Criteria for evaluation. The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and

(a) that are associated with events that have made a significant contribution to the broad patterns of our history; or

(b) that are associated with the lives of persons significant in our past; or

(c) that embody distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) that have yielded, or may be likely to yield, information important in prehistory or history.

Criteria considerations. Ordinarily cemeteries, birthplaces, or graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years shall not be considered eligible for the National Register. However, such properties will qualify if they are integral parts of districts that do meet the criteria or if they fall within the following categories:

(a) A religious property deriving primary significance from architectural or artistic distinction or historical importance; or

(b) A building or structure removed from its original location but which is significant primarily for architectural value, or which is the surviving structure most importantly associated with a historic person or event; or

(c) A birthplace or grave of a historical figure of outstanding importance if there is no appropriate site or building directly associated with his productive life.

(d) A cemetery which derives its primary significance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or

(e) A reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or

(f) A property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own exceptional significance; or

(g) A property achieving significance within the past 50 years if it is of exceptional importance. This exception is described further in the National Park Service's Bulletin 22, entitled *Guidelines for Evaluating and Nominating Properties That Have Achieved Significance Within the Past Fifty Years* (available, http://www.nps.gov/history/nr/publications/bulletins, accessed Sept. 16, 2008).

Bulletin 15 (U.S. National Park Service 2002::44 [Section 8]; available, http://www.nps.gov/nr/publications/bulletins/nrb15/) stipulates that, in order to be listed in the NRHP, a property must not only satisfy one criterion or more but also must retain integrity: "Integrity is the ability of a property to convey its significance." "The evaluation of integrity is sometimes a subjective judgment, but it must always be grounded in an understanding of a property's physical features and how they relate to its significance." Properties either retain integrity or they do not retain integrity. Seven aspects of integrity are recognized: integrity of location, design, setting, materials, workmanship, feeling, and association.

Discussing archaeological sites in particular, the U.S. National Park Service's (2002) Bulletin 15 (section entitled Determining the Relevant Aspects of Integrity – Criteria A and B) stipulates that:

> Archeological sites eligible under Criteria A and B must be in overall good condition with excellent preservation of features, artifacts, and spatial relationships to the extent that these remains are able to convey important associations with events or persons.

For archaeological sites and other properties that are significant according to Criterion D, Bulletin 15 (Determining the Relevant Aspects of Integrity – Criterion D) indicates that:

> [L]ess attention is given to their overall condition, than if they were being considered under Criteria A, B, or C. Archeological sites, in particular, do not exist today exactly as they were formed. There are always cultural and natural processes that alter the deposited materials and their spatial relationships.

King (2008:96) suggests the following considerations during assessment of an archaeological site:

> "Would a person from the property's period of significance recognize it?" If the answer is "yes," it has integrity; if "no," it doesn't. . . . A place that has been radically transformed may—even as a result of its transformation—convey something important about the past to a viewer.

PLANNED ACTIVITIES AND ANTICIPATED ADVERSE IMPACTS TO SIGNIFICANT ARCHAEOLOGICAL SITES

Most disposal areas in the APE are either composed of landfills or are covered by landfills. It appears unlikely that the redeposition of dredged materials will harm archaeological resources buried beneath the surface. Maintenance dredging will be conducted in the water and should not have a direct impact on the shoreline, but it is possible that increased water turbidity may affect the stability of archaeological resources located along the shoreline or beside marina waters.

Dredging may adversely affect three archaeological resources located wholly or in part in the APE. These sites are assessed here as potentially eligible for nomination to the NRHP. They are not yet listed on the NRHP or the Hawaiʻi State Register of Historic Sites (http://hawaii.gov/dlnr/hpd/hpregistr.htm, accessed Dec. 7, 2010).

The three sites include, first and largest, State Site 50-80-15-049 (State Site Numbers abbreviated as the final, unique digits here), Loko Keahupua-o-Maunalua, often mistakenly called Loko Kuapā (it is not the type of fishpond known as *loko kuapā)*. Loko Keahupua-o-Maunalua is the *loko puʻuone* (*loko* = pond; *puʻuone* = pond wall aligned along the shoreline) that covers most of Hawaiʻi Kai Marina.

The other two potentially historic archaeological sites that are located in or include portions in the APE are Site 50-80-15-043 (abbreviated Site 43), a habitation site in Hahaʻione Valley with traditional and post-Contact components (post-Contact refers to the period since A.D. 1778, when Captain James Cook reached the Hawaiian Islands); and a fish trap with no site number that was mapped historically in the inlet/outlet between the fishpond and Maunalua Bay. In the limited surrounding areas (areas outside the project APE) where past archaeological investigations have taken place, documented archaeological resources include: pre- and post-Contact habitation sites, fishing shrines, and a number of human burials.

The next section of this report summarizes the project methods and the literature and other data searches that have been completed. The third section, which presents the results of the searches, discusses the physical and cultural environments of Hawaiʻi Kai and the APE during traditional Hawaiian and more recent times and reviews the available information concerning archaeological sites in the APE and surrounding portions of Maunalua Ahupuaʻa. The fourth section considers the results of the archaeological assessment with reference to Section 106 and discusses each site within the APE in terms of potential eligibility for nomination to the NRHP. The fifth section recommends limited archaeological monitoring during the project to ensure mitigation of any adverse effects to sites within the APE. Appendix A includes a list of historical photographs that are on file and available for inspection at the Hawaiʻi State Archives. Appendix B, excerpted from an earlier report, provides background information concerning the kinds of archaeological information that Hawaiian fishponds and their floor soils and sediments can provide. The final section is a list of references cited.

Figure 1. Project area location; base map (U.S. Geological Survey- Koko Head (2000) and Honolulu (2000)), project location data georeferenced (Anchor QEA, LP, 2010).

METHODS AND RESEARCH TOOLS

Several databases and archives were searched in order to prepare the cultural contextual information and land-use data presented here. A record search of the State Historic Preservation Division (SHPD) library was conducted by IARII archaeologist Darby Brown, whose search produced a wealth of previous archaeological reports that were reviewed in preparation of this report. The SHPD library, although extensive, is not exhaustive, so other sources were also searched in order to provide the fullest possible coverage. An additional review of the in-house IARII report and historical map libraries was conducted, and the University of Hawaiʻi at Mānoa and Hawaiʻi State Library holdings were also utilized. Finally, the Hawaiʻi State Survey Office, the State Archives database, the Waihona ʻĀina online database, and two websites concerning Maunalua were searched by the senior author.

The Waihona ʻĀina database offers a searchable tool for accessing information associated with Māhele, the Boundary Commission, Royal Patents, and Land Grants. The Land Commission Records office was created by an act of the U.S. Congress in 1846 and operated until 1855. The commissioners who headed this office were not authorized to grant land but rather organized land-use and property-dimension data associated with existing land awards. The Land Commission Records office had processed 9,337 land awards before the office was closed and, in a report filed by the Minister of the Interior in 1856, the office admitted confusion as to the scope and magnitude of the goals of the office (Maly 2002:7). In 1848 Kamehameha III instituted the Māhele ʻĀina (the major 19th-century division and redistribution of lands; Chinen 1958; Kameʻeleihiwa 1992), which replaced the traditional system of land tenure and ultimately introduced private property law, radically altering land ownership. The Māhele ʻĀina "gave the *hoaʻāina* (native tenant) an opportunity to acquire fee-simple property interest (*kuleana ʻāina*) in land on which they lived and actively cultivated" (Maly 2002:1). The Māhele ʻĀina records detail traditional uses of the land. Later, in 1862, the Boundary Commission was created to determine the extents of large tracts of land awarded in the Māhele but not yet surveyed.

A Waihona ʻĀina data search was carried out on August 28, 2010, using the Waihona ʻĀina online database. The online search returned limited information so Dr. Victoria S. Creed, the Waihona ʻĀina database manager, was contacted and was very helpful. The results of her search are summarized in the next subsection.

Another particularly informative website is http://Maunalua.net, which provides information regarding sites and places across Maunalua Ahupuaʻa. Internal pages within the maunalua.net website provide historical photographs, art, and cultural information focused on Loko Keahupua o Maunalua (http://web.me.com/amkirk/Maunalua/Views_of_Kuapa_Pond.html, both URLs accessed, Nov. and Dec. 2010). An e-mail has been sent to the web site's creator, Ann Marie Kirk, requesting permission to include some of the illustrations in the final report.

Many maps were reviewed and are displayed as figures in this report. These maps illustrate changes to the landscape overtime and often focus on the fishpond. Six historical maps (Jackson 1884; Mann 1921; U.S. Geological Survey 1927, 1934; Wall 1881; Webster 1851) and one contemporary map (U.S. Geological Survey 2000) are included here. In addition, a number of historical photographs reviewed at the State Archives are included as figures here. These resources photo-document changes to the landscape and often substantiate and further describe mapped data (see Appendix A).

BACKGROUND INFORMATION

The summaries concerning the physical and cultural environments provided in this section are compiled from the sources researched at the State, IARII, and other repositories just mentioned. The cultural background information includes the history of traditional Hawaiian life in the area and reviews the most important post-Contact changes and contemporary patterns.

PHYSICAL ENVIRONMENT

The Hawaii Kai Dredging project will be conducted within what is currently called "Hawai'i Kai Marina," which is situated on leeward lowlands at the base of the south slopes of the Koʻolau Range. The area now occupied by the marina was once a traditional Hawaiian fishpond that also supported vast marshlands and was enclosed from the sea by a natural sand embankment, a beach ridge, that is now buried beneath the present-day Kalanianaʻole Highway and fills. The area has experienced at least 60 years of development and continued expansion of Hawaii Kai Marina and the residential community. This development has drastically altered the traditional landscape.

LANDFORMS, GEOLOGY, AND HYDROLOGY

The project APE is located just south of the southeastern terminus of the Koʻolau Range, near the southeastern tip of the island of Oʻahu. The Koolau Range is the remnant of a shield volcano, one of the two volcanoes that created Oʻahu; the Koʻolau volcano probably ceased erupting circa (ca.) 1,000,000 years ago (Macdonald et al. 1983:298). Deeply bisected by drainages and now forming a jagged ridgeline, the Koʻolau Range reaches elevations of 946 and 960 meters (m) (3,105 and 3,150 feet [ft.]) above sea level (asl) at Kōnāhuanui's two peaks (U.S. Geological Survey 1983) and stretches 59.5 kilometers (km) (37 miles), trending north by southeast, from the north shore to the eastern tip of the island at Kawaihoa Point, the south point of Koko Head.

The other high ground affecting Hawaiʻi Kai, beginning at its east edge, was created by a much later (Pleistocene) series of eruptions, the Honolulu Volcanic Series. Vitric tuff cones known as the Koko fissure volcanics form a row from Kawaihoa Point northeastward, including among others Hanauma Bay, Koko Crater, and Makapuʻu Point. The row ends offshore at Mānana Island in the northeast (Macdonald et al. 1983:450). These cones erupted primarily hydromagmatically (underwater), expelling vitric ash now consolidated into tuff. The craters exhibit varying shapes and sizes that are dependent on the numbers of vents that contributed to their formation, the location of eruption, weather patterns at time of eruption, successive geologic overlay events, and patterns of erosion (Macdonald et al. 1983:449) (Figure 2).

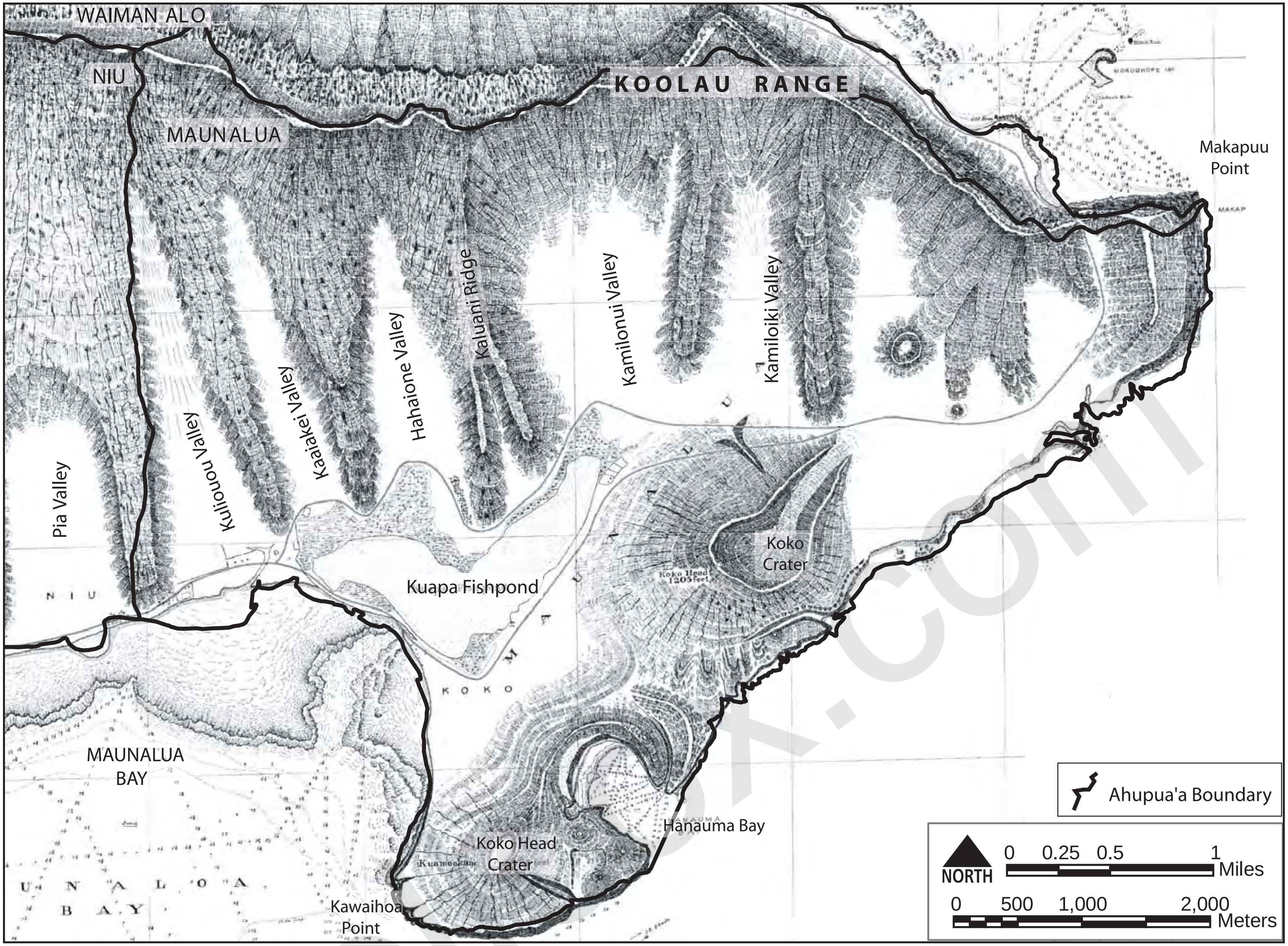

Figure 2. Geographic reference; base map (Jackson 1884).

CLIMATE

The weather in the Hawaii Kai area is moderate to dry, and coastal, with average temperatures ranging between 22.72 and 27.4° Celsius (72.9-81.4°Fahrenheit), throughout the year (http://www.climate-zone.com/climate/united-states/hawaii/honolulu/, accessed 11/27/2010). The dominant winds are the northeast trades, which lose most of their rain along the windward side of the island, just over the Koʻolau Range to the north.

SOILS

Most natural soils in the area weather on alluvial sediments eroded from volcanic ash, cinders, and tuff. Foote et al. (1972:72, Map sheets 67 and 68) describe the majority of the soils in the marina area as water and landfills, but areas surrounding the fishpond and the APE are dominated by natural silty and clayey soils formed on diverse alluvial sediments (Figure 3). Generally stated, the clayey soils are actively eroding into valleys from the Koʻolau Range or are weathering on fine sediments eroded from the Koʻolau, while the silty soils weather on fine sediments eroding from Koko Head.

The north reaches of the fishpond and the APE consist of north/south-trending ridgelines dominated by Rock Land (symbol rRK) on the higher slopes and a diversity of usually clay and clay-loam soils belonging to series that include, among others, Lualualei and Kawaihapai (Foote et al. 1972: Map sheets 67 and 68, symbols LuA, KlA) in associated canyons. From east to west, soils formed on fine sediments eroded from the Koʻolau Range dominate Kamilo Iki, Kamilo Nui, Hahaʻione, and Kaʻaiakei Valleys (see Figure 2).

The dominant soils in a large residential area on the east side of the fishpond, at the base of the northwest slopes of Koko Head, are Koko silt loams with varying slopes; these are well-drained soils that weather in the volcanic ash, cinders, and tuff of Koko Head. "These soils are used for homesites, pasture, and truck crops" (Foote et al. 1972:72). The soils in the Koko type (basic) profile occupy smooth slopes and reach thicknesses of approximately 81 centimeters (cm) (32 inches [in.]). Blocky gravels are often exposed along cut banks. Koko soils are only moderately permeable, with a slight to severe erosion hazard, depending on the slope.

In summary, the fishpond area generally contains soils composed of mainly clay and silt. Rock outcrops are common on the surrounding slopes, and many stony, gravelly soils are associated with these outcrops. As indicated, the majority of the fishpond is now classified as either water or fill. The soils in the fishpond itself may, uncertainly, once have included wetland taro pondfield (*loʻi kalo*) soils around pond margins, as was true for many *loko* (ponds).

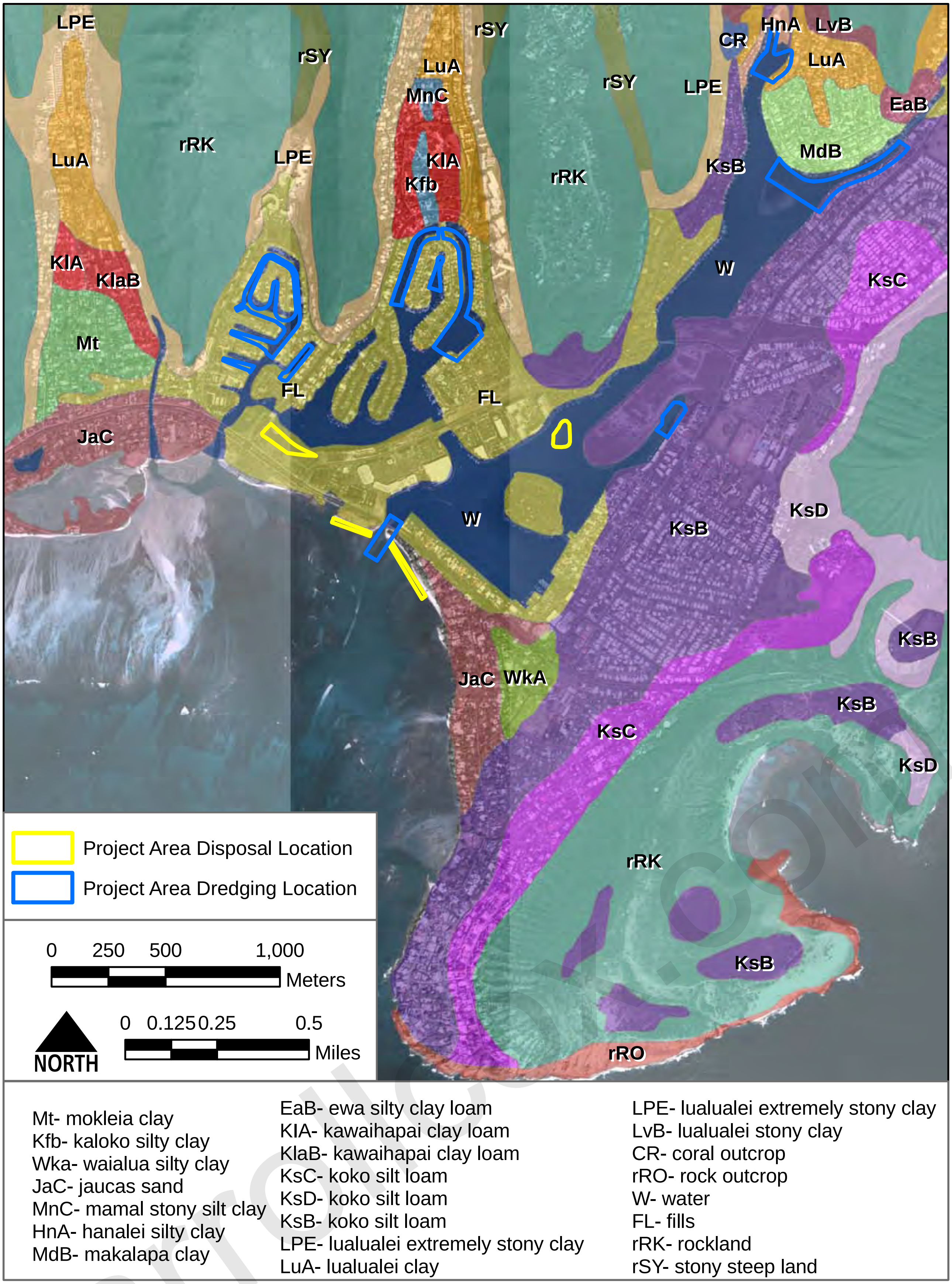

Figure 3. Soil reference map; National Cooperative Soil Survey data accessed 9.16.2010 from Geommunity, aerial photograph (U.S. Department of Agriculture 2/7/2001), project location data georeferenced (Anchor QEA, LP, 2010).

VEGETATION

According to Cox and Moore (2010:232), before the arrival of Europeans and Polynesians the Hawaiian Islands supported 1,729 species of plants, including indigenous plants found throughout the Pacific and endemic plants found only in Hawaiʻi. Today there are over 4,600 introduced species of exotic and introduced plants in Hawaiʻi, many introduced in the past 200 years. The massive post-Contact influx of alien plants was fueled by the development of agriculture and urbanization, which are leading causes of ecologic decline.

By the time Keahupua-o-Maunalua – as noted, one of the largest fishponds in the Hawaiian Islands – was first mapped, the *loko* incorporated an extensive swamp around its margins. In addition to fish in the *loko*, the swamp would have sustained numerous varieties of aquatic plants, waterfowl, and probably shrimp and other invertebrates. "One early map indicated that the pond was subdivided by fish pens suggesting that the whole pond area was not utilized for *aquaculture*" (see Cultural Environment section) (U.S. Army Corps, Engineer, 1975:7). The possibility exists that areas under swamp around the pond margins when first mapped had actually supported wetland (irrigated, drained, or both) cultivation at one time, as was true in many fishponds, including those in Waikīkī and around Pearl Harbor's shores, and in Kawai Nui on the windward side of Oʻahu.

Today, the vegetation communities in the area consist of grasses and other plants, most exotic, that grow in the area's soils, and introduced garden ornamentals and aquatic floral varieties in the residential community. On Koko silt loam, as examples, escaped trees, grasses, and "weeds" include the naturalized exotics *kiawe* (*Prosopis pallida*), klu (*kolū*; *Acacia farnesiana*), *koa haole* (*Leucaena leucocephala*), fingergrass (*Chloris*) species, and bristly foxtail (*mauʻu pilipili*, *Setaria verticillata*) (Foote et al. 1972:72; Wagner et al. 1990). The ornamentals and aquatics depend on care provided by today's residents to maintain their diversity. The substantial residential community of Hawaii Kai supports diverse irrigated garden plants, most of which have been introduced to the islands as a consequence of urbanization.

CULTURAL ENVIRONMENT

The project APE is located within the traditional *moku* (district) of Kona and the *ahupuaʻa* of Maunalua. The *ahupuaʻa* is the basic Hawaiian land unit, typically reaching from mountains to sea and providing a broad range of resource zones (Pukui and Elbert 1986:9). Maunalua Ahupuaʻa is bordered by Niu Ahupuaʻa to the west and Waimānalo Ahupuaʻa to the north and spans an area of 3,553 hectares (ha) (8,780 acres). Along the coast, Maunalua Ahupuaʻa includes cultural and environmental landmarks including the Paikō Lagoon Wildlife Sanctuary, Keahupua-o-Maunalua Fishpond, Kawaihoa Point at Koko Head, Sandy Beach, and, at the northeast end, Makapuʻu Point. The *makai* (toward the sea) boundary of the *ahupuaʻa* is the shore. The north, *mauka* (toward the mountains), boundary crosses the uppermost reaches of the Koʻolau Range. The 10 project areas in the APE are situated near the south central portion of the *ahupuaʻa*, within the area now called Hawaiʻi Kai (see Figure 2).

One period for which little information has been found regarding land tenure and use in Maunalua is the mid-19th century, when the Māhele ʻĀina took place. During her records search, Dr. Creed found no entries for Maunalua but was able to find a Waimānalo claim with an

ʻili lele (part of an *ʻili*, which is a segment of the larger *ahupuaʻa* where an individual or family actually lived) in Kuliʻouʻou, the valley at the east edge of Hawaiʻi Kai. She explained that the Waihona ʻĀina database contains all grants listed in documents available from the Bureau of Conveyances up to 1922 (Grant 8019) but that many additional grants may have been issued, some perhaps in Hawaiʻi Kai. Dr. Creed added that, in 1848, little seems to have been happening in the Hawaiʻi Kai area in terms of land-dealing, and that, if there were residents – and presumably there were – for some reason they did not enter into the Māhele process.

TRADITIONAL CONTEXT

This section summarizes the daily activities that were conducted during traditional times in Hawaiʻi. Two types of subsistence exploitation – horticulture and aquaculture – are discussed first here. The third activity summarized is religious practice, which, like cultivation and aquaculture, has left many archaeological sites and features across the Hawaiian Islands.

Horticulture

Traditional Hawaiians were horticulturalists: they cultivated non-cereal crops (the term "agriculture" is generally used for cultivation of cereal crops) and tree crops, and raised introduced animals for subsistence. "Planting was a universal occupation throughout Polynesia; but nowhere else was it a systematic and engrossing occupation to the extent that it was in Hawaii" (Handy and Handy 1978:16). As noted earlier, Cox and Moore (2010) conclude that nearly 2,000 plants were already growing in the islands before the first Polynesian people settled in windward areas of the islands circa (ca.) A.D. 500 or earlier. Many others, especially economic plants such as foods, were brought during the early voyages or when the settlers made return trips to their home islands and brought back another resource (Handy and Handy 1978:13).

The plants introduced by Polynesians, and present in the islands before Contact, included importantly the staple taro (*kalo*, *Colocasia esculenta)*. Sweet potato (*ʻuala*, *Ipomoea batatas*) became another staple at some point long before Contact. A few examples of other plants present before Contact include, as examples, sugarcane (*kō, Saccharum officinalis*), banana (*maiʻa, Musa* spp.), and breadfruit (*ʻulu*, *Artocarpus altilis*). The animals brought to Hawaiʻi in Polynesian canoes included pigs (*puaʻa, Sus scrofa*), dogs (*ʻīlio;Canis familiaris*), and chickens (*moa*, jungle fowl, *Gallus gallus*); the Pacific rat (*ʻiole*, *Rattus exulans*) also arrived with the Polynesian settlers (e.g., Allen 1992, Allen et al. 2002:615, 620-623; Clark 1982; Handy and Handy 1978:13; Hommon 1976:229-296; Kirch 1985:2-3, 298; Malo 1980:37). Taro, sugarcane, bamboo, sweet potato, breadfruit, banana, and pig are all associated with traditional Hawaiian ancestors. These resources came into wide and diversified use in traditional Hawaiʻi and are cultivated by Hawaiians and others today.

Missionary accounts coupled with data provided by recent researchers suggest that sweet potato and similar root crops were grown in portions of Maunalua Ahupuaʻa outside the project APE. "Sweet potato culture was secondary in Hawaii to that of taro, the preferred dietary item, but owing to the exigencies of terrain and climate it was nevertheless widespread and attended by systematic care, both horticultural and ritualistic" (Handy and Handy 1978:124). In Hawaiʻi alone, there are at least 24 named varieties of sweet potato and 232 names, some imported post-Contact, for the plant. Many are traditional Hawaiian varieties, while others have been introduced since Contact from areas including North America, Okinawa, and the main islands of Japan (Handy and Handy 1978:124).

Speaking directly of the Maunalua area, Handy and Handy (1978:484) state, "… in the former hinterland of Maunalua and beyond there are many evidences of former sweet-potato culture." Sweet potato would have been grown on hillslopes and in drier lowlands. The fishpond and associated swamp would have been far too wet for sweet potato but, as suggested earlier, might possibly have supported wetland *kalo*.

Aquaculture

Fishponds were significant features in the traditional Hawaiian past, and they continue to reflect Hawaiian culture today. "Oahu boasted at least 184 fishponds, more than any other island" (Kirch 1996:31). There are many different structural types of fishponds as well as several different sociopolitical relationships that groups of people share with these features. In some cases, a traditional fishpond was small and was built by a family who maintained the pond on their own. Other ponds were very large and required a great deal of engineering to construct. These large, even monumental, fishponds were generally owned by the *ali'i*, or chiefs, who represented the *mo'o* (paramount chief, ruler). The *ali'i* employed *konohiki* (supervisors), who oversaw the work of *maka'āinana* (commoners), who did most of the daily maintenance work and harvesting.

Kikuchi (1973:8) describes the utility of fishponds:

> Only in the Hawaiian Islands was there an intensive effort to utilize practically every body of water, from the seashore to the upland forests, as a source of food, either agriculturally or aquaculturally. Fish, crustaceans, shellfish, and seaweed were some of the products of the total indigenous aquacultural system. This system was made up of numerous man-made ponds, pools, and lakes. It was the reservoir of fresh food, available in quantity at any time.

Kikuchi (1973:7) uses the term aquaculture to describe the type of socioeconomic exploitation that includes traditional fishpond construction and use, explaining:

> Aquaculture, then, encompasses the cultivation of marine mammals, fish, and vegetable lifeforms in the sea, along the shore, and in bodies of water in the interior of the land. … These systems can be thought of as estuaries which are more productive than open ocean fishing and even more productive than yields from a comparable plot of agricultural land.

Fishponds were so valuable that even during the Māhele 'Aina (as mentioned earlier, the Great Land Division of 1848) these ponds were considered part of the land and were included in land-division records. Their importance as a food source is suggested by the fishing shrines (*ko'a*) that are often associated. Fishponds, then, contain plentiful and nourishing resources and were carefully maintained in traditional times.

Since fishponds are often located on- and offshore along calm and attractive shorelines, they have been among the most sought-after areas for development over the past century. Many fishponds have been destroyed, and very few remain in their original condition. Even fewer still serve their traditional purpose. Loko Keahupua-o-Maunalua, as noted, was once one of the largest fishponds in the state; some researchers have called it the largest (Takemoto et al. 1975, U.S. Army Corps, Engineer, 1975). Today its condition and function have changed dramatically, as the result of development of Hawaiʻi Kai Marina since the 1950s. Although the fishpond has gone through physical transformation, it remains important to contemporary community groups, who want to protect the pond from further damage. This cultural and political issue is an important one in the State of Hawaiʻi, both for privately owned fishponds like Loko Keahupua-o-Maunalua and for fishponds owned by the State. State-owned fishponds have recently become protected by a law passed this year prohibiting their sale (Hawaiʻi Bill 1665, Act 210; http://www.capitol.hawaii.gov/session2010/lists/RptActsWoSignature.aspx, accessed November 19, 2010).

Religion and *Heiau*

Heiau are among the most substantial traditional spiritual structures in Hawaiʻi. These often large temples were usually built by the *aliʻi*. Most *heiau* are either walled or platform types. Generally, a platform *heiau* consists of a single platform (a rock-paved terrace), but sometimes several platforms were carefully constructed. J. Gilbert McAllister, one of the earliest archaeologists to record traditional Hawaiian sites on Oʻahu (McAllister 1933:11), added that: "All heiaus were without roof covering except as to the several small houses erected within their precincts. In two instances, both of which were on the island of Oahu, at Waialua and at Honolulu, heiaus were described as having been of stick fence construction." McAllister, visiting *heiau* sites in 1930, found many had been " so completely mutilated during the last hundred years that little remain[ed] of their original characteristics" (McAllister 1933:13).

Today, relatively few *heiau* remain, in part because of lack of continued maintenance. More often, *heiau* were destroyed during industrial and residential expansion from A.D. 1900 on. As will be explained later, three *heiau* still exist in the areas short distances outside the project APE, and two more in nearby valleys. A detailed description of each of these *heiau* is presented in the Archaeological Evidence section of this report.

POST-CONTACT CONTEXT

Maunalua Bay received her first Western visitors in the summer of 1786. During this time the political climate of the Hawaiian Islands was in flux. Chiefs were battling with the support of armies for supreme control over entire islands. Before Kamehameha the Great united the Hawaiian Islands in 1795, each island had a series of often-bloody overthrows. During this period of political turmoil, the first English ships, H.M.S. *King George* and H.M.S. *Queen Charlotte*, landed in Maunalua Bay. The following paragraphs are slightly modified from Putzi et al.'s (1998) historical review, which uses reports (not seen here) left by the captains of the two vessels.

Captain Nathaniel Portlock of the *King George* and Captain George Dixon of the *Queen Charlotte* were both veteran English sea captains who had sailed under Captain James Cook during his third Pacific journey from 1778 to 1779. Having had previous experience interacting with Hawaiian people, both kept detailed journals that chronicled, among many things, encounters with Hawaiians and sometimes descriptions of cultural behaviors and expressions, as well as detailed geographical accounts. Both captains would write about an altered political climate since their first visit with Captain Cook. This change was made obvious by the presence of sustained warfare among the Hawaiian people. During this time the island of Oʻahu was under the control of Kahekili, one of Kamehameha's primary rivals.

In Maunalua Bay, Hawaiian canoes greeted Portlock's and Dixon's vessels as soon as they dropped anchor, and extensive trade took place between the groups. Hawaiians traded coconuts, plantains, sugarcane and a sweet root (most likely sweet potato), while the English traded iron nails, beads, buttons, and small pieces of iron (Putzi et al. 1998:12). During an exploratory voyage into Keahupua-o-Maunalua Fishpond, Portlock writes:

> …we returned to the boats, and rowed to the Northward, close to a reef, which appears to run quite across the bay, about a quarter of a mile distant from the beach. Having proceeded nearly a mile in this direction, a small opening in the reef presented itself, for which we steered. The channel was narrow, but in the middle we had two fathoms water; and after getting through, there was from three to four fathoms over a bottom of fine sand, and good room between the reef and the beach for a number vessels [sic] to ride at anchor. We landed on a fine sandy beach amidst a vast number of inhabitants, who all behaved with great order, and never attempted to approach nearer to us than we desired. They informed us that there was no water near our landing-place, but that we should find plenty farther down along the shore, and one of the natives accompanied us as a guide: however, our progress was soon impeded by a little salt water river that has a communication with King George's bay. This putting a stop to our progress by land, we again had recourse to our boats, and attempted to get to Westward within the reef; but the water was too shallow that it was impracticable; so that we returned through the passage we came in at and afterwards rowed to the Westward, keeping close along the outside of the reef, until we got near the watering-place pointed out to us by the Indians. (Portlock 1789:71; quoted, Putzi et al. 1998:13)

When Portlock describes rowing close to a reef he is describing the reef that parallels the coastline in Maunalua Bay. The anchorage is Maunalua Bay, and the fine sandy beach is almost certainly the sand barrier that separates Loko Keahupua-o-Maunalua from the bay. The "salt water river" probably flowed from the fishpond out into the bay, through an opening in the sand barrier. The salt water may have been brackish or saline, as the fishpond would have received fresh water from streams inland and is described by McAllister (1933:69) as receiving water from a brackish-water spring about 427 m (1400 ft.) inland from the beach. It would also have received tidal salt water. Portlock was exploring the coast in search of water; when traditional Hawaiian people began trading water for nails, the Englishmen were soon supplied with enough water to continue their journey and were on their way. Though another visit was not planned, both Portlock and Dixon would return to Maunalua Bay during the fall of the same year, on November 30, 1786.

During the second visit the captains encountered yet another change in the political climate of Oʻahu. They report that the traditional Hawaiians with whom they had been able to trade earlier would not trade now, in spite of the captains' offering the same items. This led Portlock to believe that everything the island produced, including water, was under *kapu* (taboo) by order of the ruler of Oʻahu (Putzi et al. 1998:14). Soon after their arrival and the trading failure, Kahekili, Oʻahu's *moʻo*, boarded the vessel with an old priest (*kahuna*) (whom Portlock had met earlier that year), and the Englishmen were supplied with many gifts. Hogs, sweet potatoes, taro, sugarcane, yams, and water were offered in unprecedented abundance (Putzi et al.

1998:15). In a second visit, Kahekili also treated the Englishmen with mullet reportedly harvested from Keahupua-o-Maunalua Fishpond. Mullet were a very special gift, since they were *kapu* and were caught only for the *mo'o*'s use.

The Englishmen stayed in the protected waters of Maunalua Bay until the end of the year, when they were forced to pull anchor because relations with the *kahuna* and Kahekili became unsure. On December 14, 1786, Dixon noted an absence of Hawaiians on the vessels and a great deal of activity on the slopes of Koko Head. Dixon noted that the absence of Hawaiians was suspicious, and that the people were building a "house of some sort" on Koko Head (Putzi et al. 1998:17). Portlock and Dixon began taking defensive measures, in case of an attack by Kahekili. When Kahekili was welcomed aboard for the last time, a pig was shot dead by one of the ship's mates, and the gunfire startled the Hawaiians on board. Kahekili soon disembarked, notifying Portlock and Dixon that he would soon return to Waikīkī.

Before Kahekili left, the Hawaiians returned to the structure on Koko Head. On December 18th Portlock observed the "house" being demolished, and houses along the shore being burned. The next day the old *kahuna* explained to Portlock that the structures had been gods' houses. The chiefs were displeased with the gods and had burnt both the gods and their houses (Portlock 1789:166, cited, Putzi et al. 1998:19). The structure on Koko Head may have been a *heiau* observed by minister and teacher of Hawaiian language Henry Pratt Judd, in 1923.

Kahekili's rule was overthrown by Kamehameha I and his armies in the A.D. 1795 battle of Nu'uanu. The unification of the Hawaiian Islands put an end to at least 20 years of interisland war. Kamehameha took ownership of all the lands in his kingdom and redistributed them regularly throughout his rule. Table 1 provides a partial list of landholder and lessees names, as well as lineage descriptions of these people, the durations of their occupation, and the reported uses of the land in Maunalua Ahupua'a, with special focus on the fishpond area.

Post-Contact Land Use

In 1819, with Kamehameha's death, the new king, Liholiho, abolished the *kapu* system. Missionaries were now welcomed and soon spread their influence throughout the islands. Missionaries Gilbert F. Mathison and Levi Chamberlain visited the Keahupua-o-Maunalua Fishpond area in the late 1820s. Mathison (1826, not yet seen; cited, Putzi et al. 1998) noted approximately 100 huts in Maunalua, although the exact location of this village is unknown (McAllister 1933:69). He also noted several 'huts' within a grove of coconut trees, probably one of two coconut groves referenced on the 1884 Hawaiian Government Survey Map of Maunalua Bay (Figure 4). Chamberlain made detailed observations of the fishpond and the villages around it. Describing the sea wall, Chamberlain (1826:26 [not yet seen], quoted, O'Hare et al. 2003:7) writes:

> Then I came to a narrow strip of land resembling a causeway partially natural and partially constructed extending in a North west direction across what appeared to be considerable of a bay forming a barrier between the sea and the pond. At the further end of this causeway sluices are constructed and the waters of the sea unite with the pond and at every flood tide replenish it with a fresh supply of water.

Table 1. History of land ownership in Maunalua Ahupuaʻa.

Owner - Lessee	**Sublease**	**Description of Person**	**Duration**	**Known Uses of Land / Other Notes**
Kalanikupule		Ruler of Oʻahu	Prior to the Battle of Nuʻuanu, 1795	
Kamehameha I		Ruler of the Kingdom of Hawaiʻi	1795-1819	
Kū-i-helani		Kamehameha's steward	short-time	Caretaker of Oʻahu and Molokaʻi
Kū-i-helani		Kamehameha's steward	short-time grant	
Kamehameha I		Ruler of the Kingdom of Hawaiʻi	1795-1819	
Ke'eaumoku		Father of Kamehameha's wife	?-1804	
Victoria Kaʻahumanu		Daughter of Keʻeaumoku	1804-1819	
Kaʻahumanu		Kamehameha's favorite wife; land awarded after death of Kamehameha	1819-?	
Kalola		Kamehameha's wife while he lived in Kohala		Appointed her nephew, Abner Pakī, konohiki of the fishpond
Kaʻahumanu				
Kīnaʻu		Daughter of Kamehameha and wife of Mataio Kekūanaōʻa	?-1839	
Victoria Kamāmalu		Kīnaʻu's daughter	1839-1866	Full title (RP) 4475/ (LCA) 7713:30 in 1854 (confirming the RP) 7464 US ac
William Webster			1856-1886	Grazing and agriculture

Table 1. History of land ownership in Maunalua Ahupuaʻa (continued).

Owner -	Lessee	Sublease	Description of Person	Duration	Known Uses of Land / Other Notes
	Chun Hoon			5 years?	Chinese fisherman
Mataio Kekūanaōʻa			Father of Victoria Kamāmalu	1866-1868	First Circuit Court, Probate 2409
Lot Kamehameha			Son of Mataio Kekūanaōʻa	1868-1874	
Ruth Keʻelikōlani			Sister of Lot Kamehameha	1874-1883	Awarded through Probate 2412
Bernice Pauahi Bishop			Kalola's daughter/Ruth's cousin	1883-1884	First Circuit Court, Probate 2009 / Lease number 7920 / Last in the Kamehameha line
Bishop Estate			Bernice Pauahi Bishop trustees		Various: including Kamehameha Agricultural School
S.M. Damon and G. L. Campbell				1888-1926	Established Maunalua Ranch and leased land for ranching
Honolulu Honey Company				1920-1926	Apiary
				1926-1946	Ranching
Alan Davis					
Kamehameha School				1926-present	Agricultural School
	Kaiser-Aetna			1964-1984	Stockpiled excess rock in area east of Site 2900
	Bedford Properties			1984-	Developed Kaluanui 1 subdivision
Hawaii Kai Development Company				1992-	Limited warranty deed (Instrument 92-00186490)

*The data in this table were acquired primarily from a Memorandum of Title issued after the death of Bernice Pauahi Bishop for Maunalua Ahupuaʻa "and particularly to that area where the Kuapā pond settles" (included in Takemoto et al. 1975); Kamakau (1992a) and Putzi et al. (1998) provided additional information.

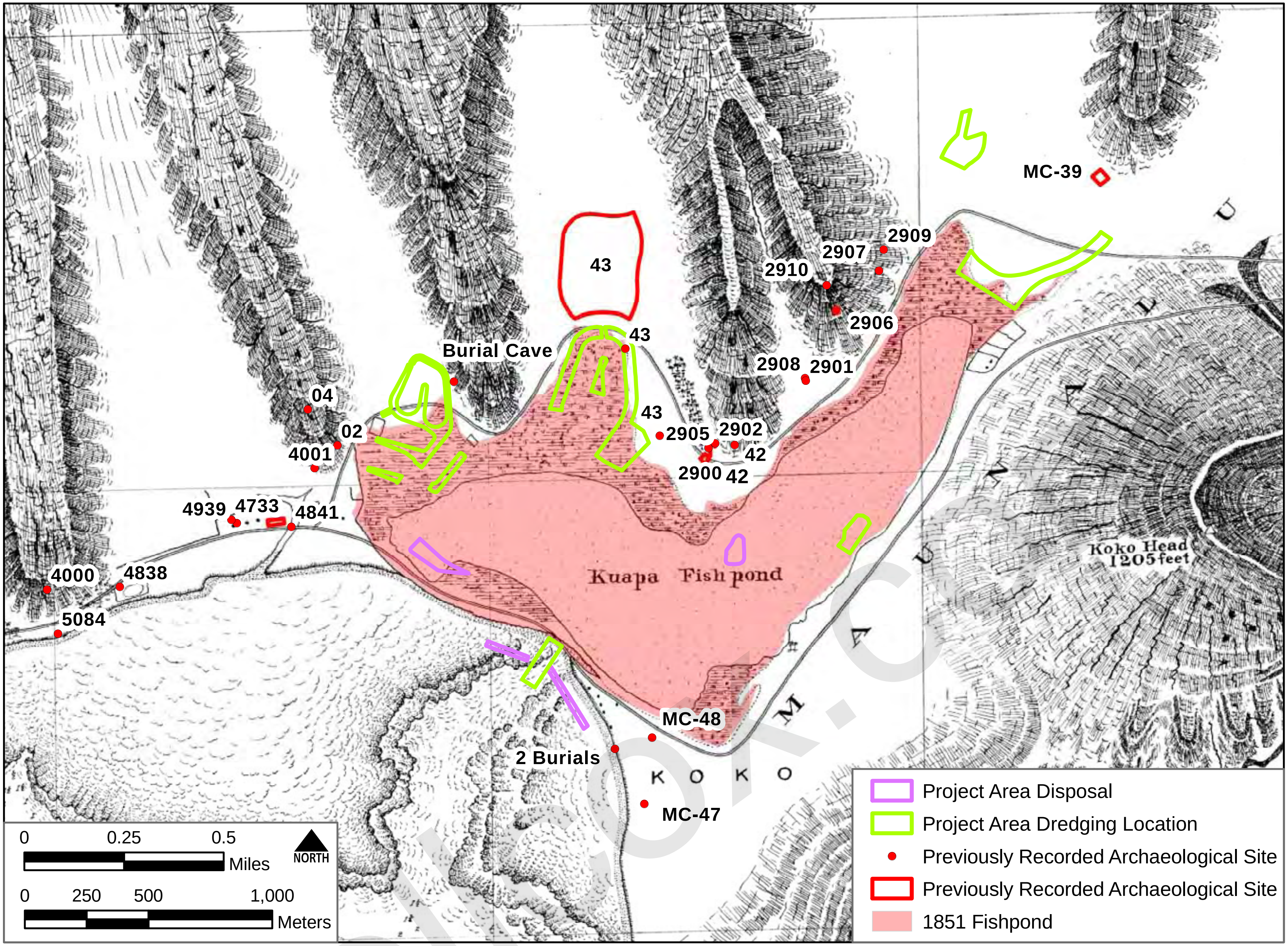

Figure 4. *Oahu East Coast Including Waimanalo, Hanauma and Maunalua Bays.* Proposed project areas (APE) and previously recorded archaeological resources added; base map (Jackson 1884), project location data georeferenced (Anchor QEA, LP, 2010), archaeological site location data georeferenced from various sources.

O'Hare (2003:7) reports:

> In 1826, he [Chamberlain] counted 18 houses in this village, which was located on a causeway on the pond. This may mean there was a population of about 90 to 100 at this time. In 1828, he talked to a group of about 30 people in the village, perhaps suggesting that the population was about 60 or more at that time. In 1828, 65 students attended school [at Kamehameha Agricultural School] in the area. Four years later, the number had dropped to only nineteen. This may be an indication of the rapid depopulation of the area.

In a recent archaeological review of the region, Erkelens and Athens (1994:19) note that pumpkins, squash and Irish potatoes were probably grown in this area during this time.

The 1851 map by Webster (base map, Webster 1851; Figure 5 here) illustrates the pond area, with mention of archaeological features. On this map, the pond is 212 ha (523 acres) in surface area, and a road starts at the *pali* (cliff) at Makapuʻu Bay and terminates in Kelakipapa Valley (outside the top margin of the figure). What Webster calls a "road" is described by Maly and Wong-Smith (not seen; quoted, O'Hare et al. 2003:7) as a trail that would have connected the Waimānalo inhabitants with the fishpond: "The road was paved with smooth stones, was 15 feet wide, and was bounded by a low wall on each side. This type of trail was used for horse-drawn carts and shows that the road may date to sometime after 1825."

The changeover from subsistence to commercial cultivation and land use that was taking place across Oʻahu during the last decades of the 19th century also had an effect on Loko Keahupua-o-Maunalua and the surrounding area. Mr. Kilmer Moe of Kamehameha Schools told McAllister (1933:69) that a large fishing village had once existed in Hahaʻione Valley, before the enclosure wall of the fishpond was constructed, cutting the pond from the sea. By 1890, the entire area, including the fishpond, was owned by Maunalua Ranch and was apparently leased out only for cattle ranching and commercial fishing. Not much is known about this era at the end of the 19th century, except that the area, once subsistence-oriented, now supported both commercial ranching and commercial fishing.

A 1921 map (Mann 1921; Figure 6 here) illustrates the diminished surface area of the pond, at 122 ha (301 acres), plus 43 ha (125 acres) of swampland (McAllister 1933:69; also, Sterling and Summers 1978:270). Descriptions of the fishpond and its wall around this time show that the pond was slowly falling into disrepair.

Early in the 20th century, communication towers were erected at Koko Head by various agencies including: Marconi Wireless Telegraph Company and RCA (Stump 1981:11). Bishop Estate acquired land in the area in 1932 and, in turn, leased it for grazing. During the 1940s, Kalanianaʻole State Highway (named for Prince Jonah Kūhiō Kalanianaʻole, former Territorial delegate to Congress after Hawaiʻi's annexation by the United States; Pukui et al. 1986:74) was constructed around the southeast portion of the island, meeting Farrington and Kamehameha Highways on the west side. The section of Kalanianaʻole Highway that passes through the Maunalua area is located on the natural sand barrier that once formed the base for the Keahupua-o-Maunalua Fishpond wall.

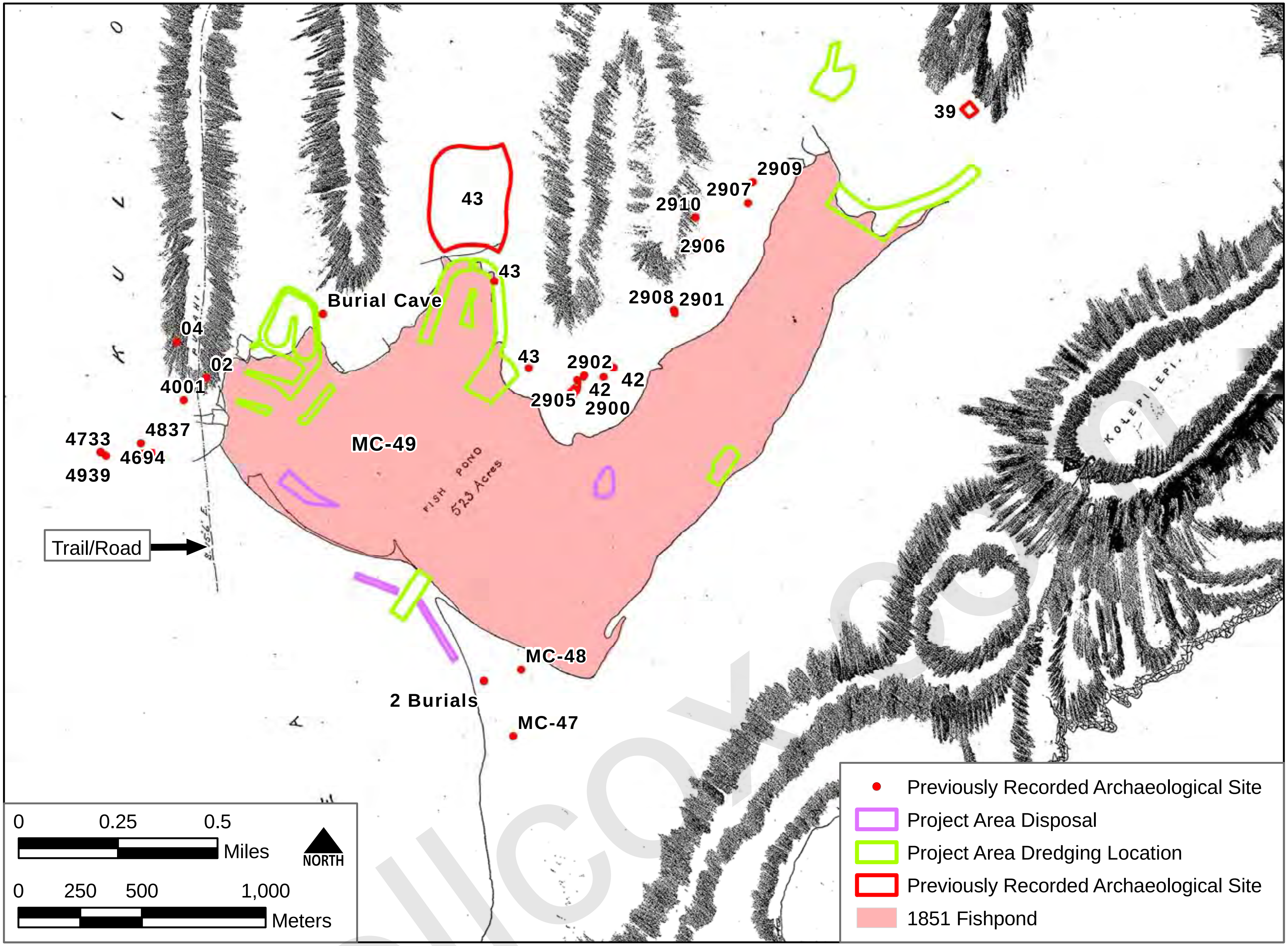

Figure 5. *Plan of the Land of Maunalua on Oahu the property of Victoria Kamamalu 1851.* Proposed project areas (APE) and previously recorded resources added; base map (Webster 1851), project location data georeferenced (Anchor QEA, LP, 2010), archaeological site location data georeferenced from various sources.

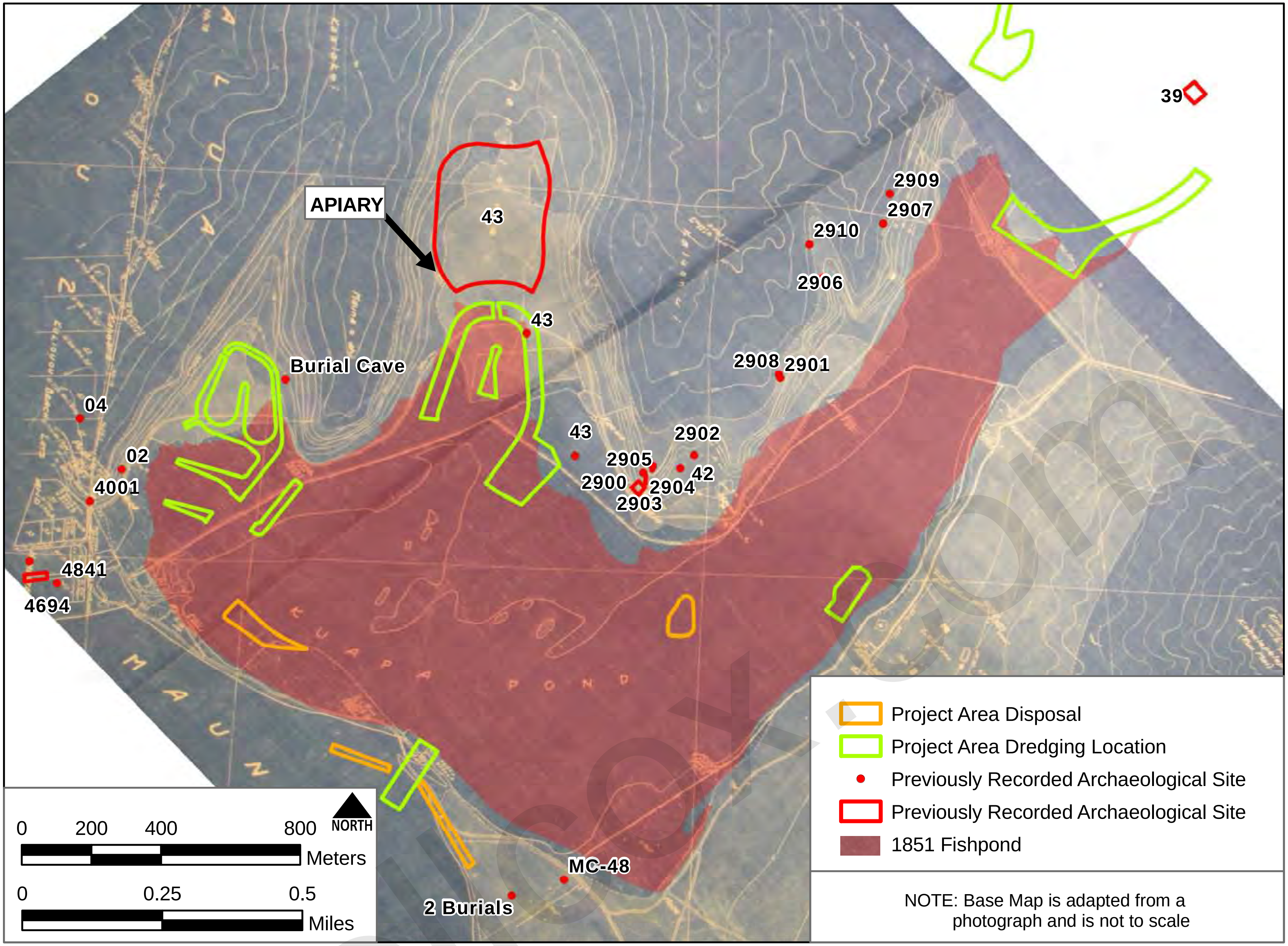

Figure 6. *Portion of Maunalua Apana 30, LCA 7713 R. P. 4475 to Victoria Kamamalu, Koolaupoko, Oahu, Makai Section.* Proposed project areas (APE) and previously recorded archaeological resources added; base map (Mann 1921), project location data georeferenced (Anchor QEA, LP, 2010), archaeological site location data georeferenced from various sources.

From the 1930s into the 1950s, land use around the fishpond diversified. Several dairies, chicken coops, pigpens, and floral farms occupied the landscape alongside commercial and illegal refuse disposal (Stump 1981:12, Takemoto et al.1975:25). Aerial photographs of the area in 1955 display large pieces of property in agricultural use. At this time public access to the fishpond was prohibited and could only be authorized by Bishop Estate or its lessees. Figures 7 and 8 are aerial photographs of the fishpond taken between 1939 and 1941, and in 1955.

Before the initial marina and residential development projects began, Keahupua-o-Maunalua Fishpond remained one of the largest wetland habitats for endangered birds in the state, the largest remaining traditional Hawaiian fishpond (U.S. Army Corps, Engineer, 1975:30).

Creation of Hawaiʻi Kai Residential Community and Marina

The American industrialist Henry Kaiser began developing the Keahupua-o-Maunalua Fishpond area into what would become the Hawai'i Kai residential community and marina beginning in the 1950s. "At this time Hawaiʻi Kai development was unique in that it was the first residential-marina community developed from a fishpond in the state" (U.S. Army Corps, Engineer, 1975:5). Together with several different partners and subcontractors, Kaiser developed conceptual plans and, by the 1960s, housing construction began.

> Work on Hawaiʻi Kai marina began in 1959 with the dredging of a channel to the pond by the Kaiser-Burns Development Co. (DA Permit 557). Dredging of the Kaalakei and Hahaione portions for the Kuapā Fishpond, and filling and clearing of the pond shoreline occurred shortly thereafter (No DA permit was issued for this portion of the Hawaiʻi Kai development). In 1961 the Trustees of the Estate of Bernice Pauahi Bishop entered into a development and lease agreement with Kaiser-Aetna to develop the 521-acre Kuapā Fishpond into a residential tract having a marina with a series of channels separated by fingers of land, and with islands. These peninsular and insular features and house site foundations would be constructed utilizing material dredged from the pond during construction of the marina. (U.S. Army Corps, Engineer, 1975:4)

During this first phase of development the Kaiser Development Company laid the infrastructure for future community development. This included limited dredging of a channel (as mentioned above), installation of electricity, plumbing, and construction of roads and sea walls using lava rock (Kaiser Hawaii-Kai Development Co. 1967:2). After 1967 the development company began subcontracting construction activities and assumed the single role of a concept developer. From 1965 to 1967 Kaiser-Aetna improved the bridge on Kalanianaʻole Highway and dredged the area around the main opening of the pond (U.S. Department of the Army permits 792, 799, and 820).

The Hawaii Kai Marina and residential community have since gone through several phases of development and expansion, which have included dredging, dewatering (filling), retaining-wall construction, and general building. The two historical aerial photographs below illustrate the massive amount of growth that took place during the early phases of construction. Figure 9, taken in 1963; chronicles the early stages of residential development. Figure 10, taken five years later, in 1968, shows the area after a great deal of expansion and development. Today, Hawaiʻi Kai is the largest residential community in the county of Honolulu (http://Hawaiʻi.gov/dbedt/info/economic/databook/db2000/, accessed 9/08/2010).

Figure 7. 1939 -1941 aerial photograph with the southeast portion of the fishpond at the left and the northwest portion at the right (U.S. Army Corps Series 1939-1941).

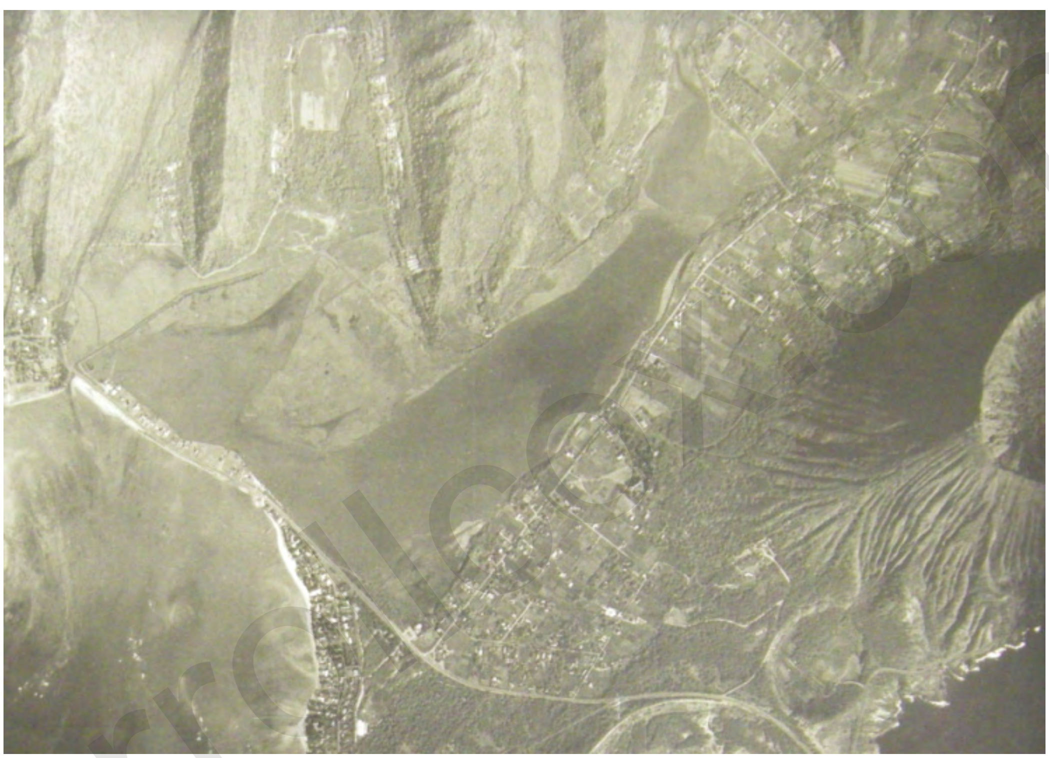

Figure 8. 1955 aerial photograph (Aerial Photo Surveys Series 1955).

Figure 9. 1963 aerial photograph (EKM Series 1963).

Figure 10. 1968 aerial photograph (GS-VXJ Series 1968).

Contemporary Land Use

Today Hawaiʻi Kai is primarily residential (Figure 11), with smaller amounts of land in commercial and agricultural use. The area that is zoned for agricultural use is located within Kamilo Nui Valley. This area continues to be the property of Kamehameha Schools, who supported their own private agricultural school in nearby Hahaione Valley during the early 1920s. The Hawaiʻi Kai Marina and residential community has grown to include the typical infrastructure of a growing affluent city, with strip malls, recreation centers, and parks woven into the residential fabric. The 2000 census indicates that, in 1990, Hawaiʻi Kai had a resident population of 27,432, occupying 8,835 households. In 2000, Hawaiʻi Kai had the highest median household income and one of the highest percentages of college graduates in the City and County of Honolulu (http://Hawaiʻi.gov/dbedt/info/economic/databook/db2000, accessed 9/08/2010).

Figure 11. Recent aerial photograph (U.S. Department of Agriculture 2001).

ARCHAEOLOGICAL EVIDENCE

J. Gilbert McAllister, Thomas Thrum, and Henry P. Judd recorded a number of O‘ahu sites in the early 20th century. All visited Maunalua Bay and surrounding areas during different times, each building from the other researchers' field notes and knowledge. Their accounts offer relatively reliable descriptions of archaeological resources as they appeared at the times of their visits, although the accompanying location maps are often small-scale and difficult to interpret. Field notes and publications by these researchers, along with related archival research, is complied by Sterling and Summers in *Sites of Oahu* (1978). Reviewing the work of Sterling and Summers, McAllister, Thrum, and Judd, coupled with observations made by early visitors, provides a fragmented but detailed overview concerning the historical and archaeological features present shortly after the turn of the 20th century.

The earliest archaeological investigations of sites on O‘ahu tended to emphasize *heiau* and other monumental or impressive sites. Table 2, below, briefly summarizes selected information for the *heiau* in the Hawai‘i Kai area.

Table 2. *Heiau* in areas near (outside) the project APE.

Recorder	**Site No.**	**Date**	**Condition**	**Name/Purpose**	**Notes**
McAllister	McAllister Site No. 22	1930*	Destroyed	Walled yard	"the Mann camp in the Bishop Estate Office marks the region" (Sterling and Summers 1978:262)
McAllister	McAllister No. 34	1930	Destroyed	Lookout for shipping canoes	"on the rim of the crater at its lowest elevation" (Sterling and Summers 1978:264)
McAllister	McAllister No. 39, Bishop Museum No. 01-A1-39??	1930	Partially Restored	Pahua/ husbandry	Located at the top of Makahuena Place - office of Hawaiian Affairs owns the land; excavated by Davis 1985, artifacts curated at U.H.
McAllister, Thrum	McAllister No. 42, State No. 50-80-15-0042	1930/1907	Portion destroyed in 2009	Hawea/ Hawea Drum	Unsure location, most likely either directly *mauka* or *makai* of Kaluanui Road, owner-Hawaii International Community Development Association (builder)
Dixon, Judd	"Probably Site 14" [Catherine C. Summer's note]	1923	?		200 feet due south of the second wireless mast, east of the east corner of the 21.85-acre lot leased to the radio corporation (Judd 1923 in Sterling and Summers 1978:262)

* McAllister visited the sites in 1930, although his report is dated 1933.

McAllister (1933) provides a synthesis of Judd's and Thrum's observations coupled with his own. He describes six archaeological sites, including two of the *heiau* listed in Table 2, in areas surrounding (outside) the project APE. Table 3 summarizes information concerning research completed at the six sites. Information concerning the locations of previous project areas and specific resource locations is recorded in Table 4 and illustrated in Figure 12.

Table 3. McAllister's (1933) archaeological sites in the project APE and in surrounding areas outside the APE.

McAllister's Site No.*	Site Type	Name / Location	Additional Researchers
39	Heiau	Pahua / Koʻolau ridge slope northeast of northeast arm of *loko*; outside APE	Davis 1985; Google Earth Georeference, 2010
42	Heiau	Hāwea / west side of northeast arm of *loko*; outside APE	Price-Beggerly and McNeill 1985; Schilz 1994 in O'Hare 2003
43	Habitation site	Hahaʻione Valley / north of main part of *loko*; portion in APE	Bayard 1967; Davis 1985
47	Fishing shrine for mullet (*ʻamaʻama*)	Huanui / north side of Site 48, at base of Koko Head, near east bay shore; outside APE	
48	Fishing shrine for scad (*akule*)	Hina / south of Site 47; outside APE	
49	Fishpond (*loko*)	Keahupua-o-Maunalua; in APE	Various historical resources

Information concerning the locations of previous project areas and specific resources is recorded in Table 4 and illustrated in Figure 12. The exact locations of some of these resources are not well documented. Since the sites were observed in the 1930s, there has been a substantial amount of development in the area that has further obscured the locations. Residential development in Hawaiʻi Kai Marina has definitely masked the surface expressions of many early sites and has most likely destroyed others. Recent researchers have attempted to relocate McAllister's sites, in some cases without being certain that they are documenting the same sites McAllister recorded. Fortunately, archaeologists excavated two of the sites, so that much more information is available for these two – McAllister's Sites 39 and 43. Site 43, the large habitation site, was excavated by Bayard (1967) in 1966; Pahua Heiau (Site 39) was excavated and reconstructed by Davis in 1985. As is often the case, however, each researcher from McAllister on has mapped the location of each resource slightly differently, which leaves several locations for a single resource. Site 43 includes three locations; Site 42 has two (see site descriptions, below).

Table 4 details the results of the literature search conducted to determine the locations of known archaeological sites in the area. Figure 12 illustrates the locations of these resources, showing multiple locations where necessary (e.g., Sites 42 and 43).

Table 4. Previous archaeological research projects conducted within the project APE and in the vicinity (outside the APE).

Ahupua‘a	Reference	TMK	Location or Size	Scope of Work	Comments
WITHIN PROJECT APE					
Maunalua	Mann (1921)		Hawai‘i Kai, outlet from Loko Keahupua–o-Maunalua	Map	Not listed elsewhere
Maunalua	McAllister (1933)	N/A	Island of O‘ahu		Sites 39, 42, 43, 47, 48 and 49
Maunalua	Bevacqua (1972)	N/A	Hawai‘i Kai	Excavation	Burial cave
Maunalua	Sterling and Summers (1978)	N/A	Island of Oahu		
Maunalua, Kuli‘ou‘ou	Takemoto et al. (1975)	N/A	Hawaii Kai	Historical/cultural essay	
OUTSIDE PROJECT APE					
Maunalua	Davis (1985)	N/A	Hawai‘i Kai	Excavation	Pahua Heiau
Maunalua	O’Hare et al. (2003)	3-9-08:42	Hawai‘i Kai	Phase II mitigation	Lalea rockfall
Maunalua	Bayard (1967)	N/A	Hawai‘i Kai	Survey and excavation	Site 0-16 MC-43
Maunalua	Magnuson (2003)	3-9-2:2	Hawai‘i Kai	Survey and monitoring	251 Portlock Road
Maunalua	Ikehara-Quebral (2002)	3-9-2:2	Hawai‘i Kai	Monitoring work plan	251 Portlock Road
Maunalua	Kam (1971)	3-9-08:portion of 13	Hawai‘i Kai	Inspection	Niumalu Loop burial
Maunalua	Ogden (1994)	3-9-080	Hawai‘i Kai	Data recovery	Site 2900
Maunalua	Kelly et al. (1984)	N/A		Cultural Resources Overview (CRO)	Queen's Beach Park
Maunalua	Price-Beggerly and McNeill (1985)		Hawai‘i Kai (Kaluanui 1, 2, and 3)	Reconnaissance	Marina zoning project
Maunalua	Collins (1999)	3-8-003: 12, 42, 62, and 63	Hawai‘i Kai	Excavation	Inadvertent discovery

Table 4. Previous archaeological research projects conducted within the project APE and in the vicinity (outside the APE) (continued).

Ahupuaʻa	Reference	TMK	Location or Size	Scope of Work	Comments
Maunalua	Elmore and Kennedy (1999)	3-8-003: 12, 42, 62, and 63	Hawaiʻi Kai	Excavation	Inadvertent discovery
Maunalua	Williams et al. (1978)	N/A	Hawaiʻi Kai	Site recording	Petroglyphs only
Maunalua	Tuggle (1972)		Hawaiʻi Kai	Site destruction notification	
Maunalua	Folk et al. (1993)	3-9-08:portion of 13	Hawaiʻi Kai	Survey	Kaluanui Park development
Niu, Kuli'ou'ou, Maunalua	Putzi and Carlson 1997; Putzi and Macintosh 1996; Putzi et al (1996a, 1996b, 1996c, 1997a 1997b, 1998)	3-07-10:6; 3-08-01:62; 3-08-02:79; 3-08-03:21; 3-08-03:29; 3-08-03:40; 3-08-04:11; 3-08-07:26	Kalanianaʻole Highway, East Halema'umaʻu Road to Keahole Street	Monitoring	Burial recovery
Maunalua	Kennedy (1988)	3-9-10:01-10		Survey	Negative results
Kuli'ou'ou	Hammatt (2006)	3-8-002, 003, 004, 007, 010, 016, and 017; 3-9-035		Monitoring work plan	Subsurface cultural deposits expected during sewer, wastewater pump station, fore-main work
Kuli'ou'ou	Cleghorn (1993, 1994a, 1994b, 1994c, 1994d)		Phase II Widening of Kalanianaʻole Highway	Monitoring and Burial Recovery	Burial Recovery
Kuli'ou'ou	Hammatt and Shideler (2002)	3-8-02 and 3-8-03	Summer Street, Paeoki Drive, Kuliʻouʻou Road, Bay Street, and Maunalua Drive	Monitoring work plan	Cultural discoveries expected during water-systems improvements
Maunalua	Emory and Sinoto (1961)		Kuliʻouʻou shelter, Makaniʻolu shelter, Hanauma shelter, Kawēkiu shelter	Excavation	

Table 4. Previous archaeological research projects conducted within the project APE and in the vicinity (outside the APE) (continued).

Ahupuaʻa	Reference	TMK	Location or Size	Scope of Work	Comments
Wailupe, Nui	Erkelens and Athens (1994)		Niu Valley	Excavation	SHPD Site No. 50-80-15-4497
Maunalua	Carlson and Rosendahl (1990)		Hawaiʻi Kai (Kaluanui 1)	Survey	Sites 2901, 2906, 2907, 2908, 2909, 2910 and bedrock cavity areas A, B, C, and D
Maunalua, Niu, Kuli'ou'ou	Putzi and Carlson 1997; Putzi and Macintosh 1996; Putzi et al (1996a, 1996b, 1996c, 1997a 1997b, 1998)	3-7-02:17, 79 and 3-7-10:006 and 3-08-01:62 and 3-8-03:21, 23, 29, 40 and 3-8-04:9 and 3-08-07:26	Northern edge of Maunalua Bay	Excavation	SHPD Site No. 50-80-15-4837, 50-80-15-4840, 50-80-15-4841, 50-80-15-4938, 50-80-15-4939, 50-80-15-5084

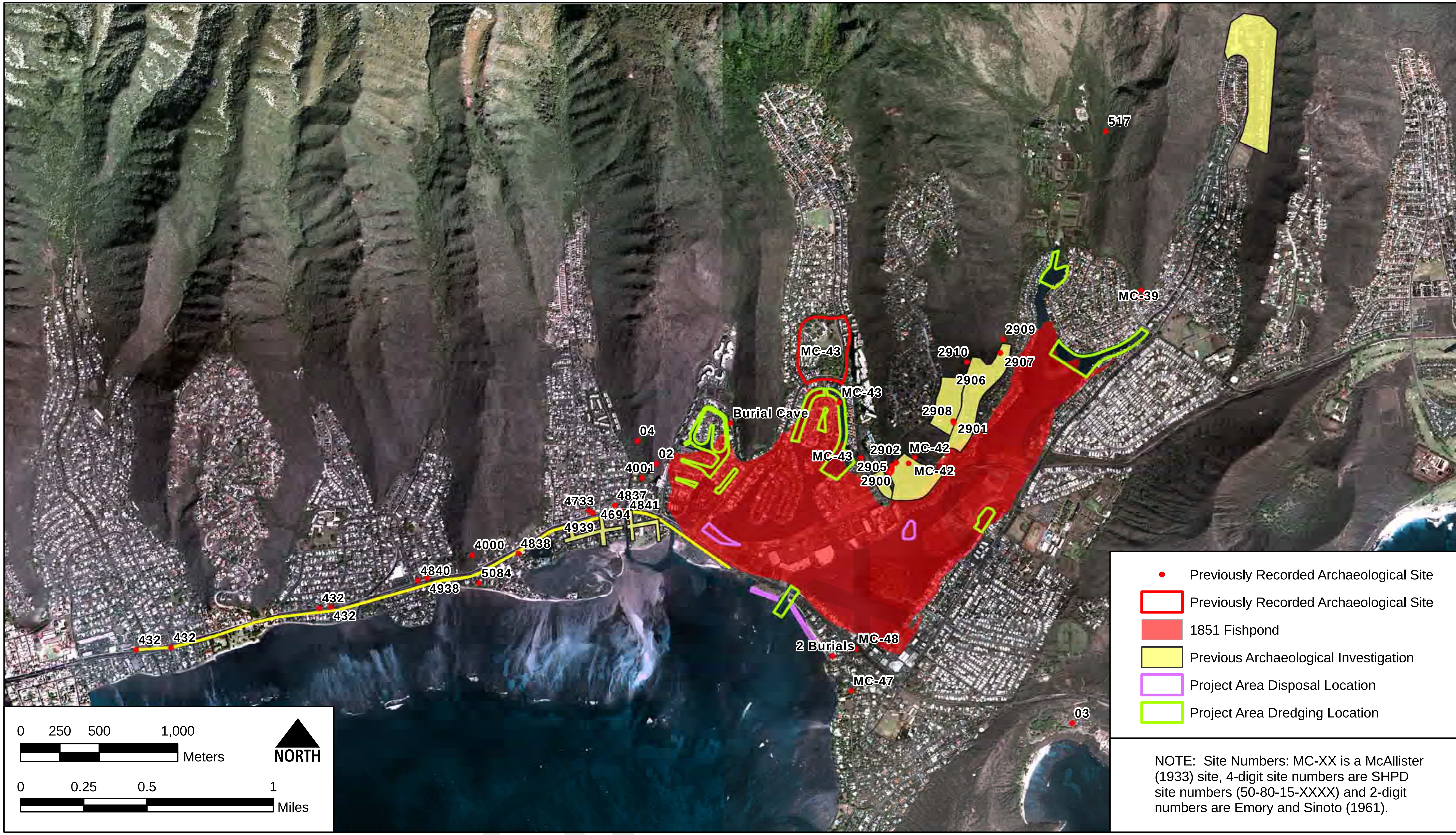

Figure 12. Previous archaeological sites and studies; base map (U.S. Department of Agriculture 2/7/2001), project location data georeferenced (Anchor QEA, LP, 2010).

Archaeological Sites Within the Area of Potential Effect

Three archaeological resources are believed to be located wholly or partially within one or more portions of the project APE. Each is described below.

Habitation Site in Haha‘ione Valley (State Site [50-80-15-0]43)

This archaeological resource contains both traditional Hawaiian and post-Contact components, which have been assessed and documented by three archaeologists and excavated by one of the three. The exact location of each site component remains unclear. McAllister (1933) describes the site as located in Haha‘ione Valley but plots it farther south, outside the planned dredging or disposal areas. McAllister (1933:67) observed: “ash, charcoal, broken glass, fish scales, decayed kukui shells, sea shells and a well-made top of a pounder” and a portion of house platform (which supported a grass hut), a rock-faced well, and a possible pigpen next to the fishpond wall. He notes (McAllister 1933:67) that: “According to Manuel Silva the grass hut was occupied by a Chinese [person] 25 years ago, though the site is Hawaiian.” This Chinese person was likely subleasing from S. M. Damon and G. L. Campbell, who leased the land from Bernice Pauahi Bishop’s Estate from 1888 to 1926.

Bayard (1967:1, 3) describes the large site, which he concludes is McAllister’s Site 43, as including areas “located at the western and southern margins of Kaluanui Ridge [at the east edge of Haha‘ione Valley] at the mouth of Hahaione Valley near the present location of the Hawaii-Kai recreation Center at the end of Hawaii Kai Drive… just beyond the boundary of the once-extensive swampland that formerly bordered Kuapa Fishpond… .” He describes features including an enclosure, two platforms, five small rockshelters, at least seven cairns, and a wall, and explains that: “These features almost certainly represent more than one related complex, and range in period from probable late prehistoric times to the first decades of this century.” Based on excavated stratigraphy, the enclosure dates to the early 19th century, the period when the grass hut at the site was occupied by the Chinese tenant McAllister’s consultant mentioned.

Bayard chose this site for an archaeological field school because the area “was scheduled for bulldozing and further development in the near future.” The area excavated was small, and he felt unable to draw definite conclusions about the site area as a whole. Bayard (1967) references a sketch map, but it is not attached to the available copy of the report. Site 43 is not described by Davis, whose research concerned Pahua Heiau, but the Site 43 location is used as a reference point in his site map (1985:Fig. 1).

Figure 12 includes three Site 43 plots to reflect the different areas plotted by the three researchers. Bayard’s (1967) large northern site area in the valley, the outlined area in Figure 12, is located outside the APE. One of the other two Site 43 locations (red dots in Figure 12), was mapped by McAllister and is probably slightly inaccurate, since it falls within an area scheduled for dredging and is therefore within the fishpond (see the more northerly of the two red dots in the figure). The actual location is likely adjacent to the fishpond; it could have involved a fishpond wall. Another possibility is that this location is really the one mapped by Davis (1985) (the southern of the two red dots), just east of the east boundary of the main proposed Haha‘ione Valley dredging area. McAllister’s (1933) and Davis’s (1985) site locations are both located either immediately next to the easternmost dredging area or within it; they are considered possibly located in the APE.

Adding to confusion, an 1881 map (Wall 1881; Figure 13 here) shows an un-described structure (small rectangle) near the south end of a palm grove at the base of the western slope of Kaluanui Ridge; this is the palm grove containing huts that missionary Mathison described in his journals. The structure's location is approximately the Site 43 location plotted by Davis (1995:Fig. 1) and that of one of Bayard's (1967) Site 43 areas. The structure illustrated in the 1881 map is no doubt an archaeological resource but is not explicitly referred to individually by McAllister, Davis, or Bayard. The most reasonable conclusion is probably that archaeological sites or features were once present at each location. Only archaeological field investigations could determine with certainty what site components remain, and precisely where.

From 1920 to 1926 the Honolulu Honey Company operated an apiary in Haha'ione Valley (Mann 1921; see Figure 6). This site is also the probable location of the Kamehameha Agricultural School, which operated at the foot of Haha'ione Valley for a few years beginning in 1925. Two U.S. Geological Survey maps prepared in 1927 and 1934 illustrate the probable location of the School or related structures (note two long, narrow, black rectangles on the east and west slopes at the back of the valley in Figures 14 and 15).

Site 43 is recommended for NRHP eligibility according to Criteria A and D. As explained in the Introduction, sites that satisfy Criterion A "are associated with events that have made a significant contribution to the broad patterns of our history" (U.S. National Park Service 2002). *Criterion A:* The site is associated with a significant event, Western Contact. With components that represent both traditional and post-Contact life styles and practices, it represents the important period of transition from traditional to post-Contact life in rural O'ahu – a broad pattern in our history. *Criterion D*: The site also possesses the potential to provide information important to history and prehistory. It is likely also associated with the changes in aquaculture and fishpond uses that followed the post-Contact introduction of the concepts of private property and a commercial economy.

In terms of integrity, although the locations of some internal features remain uncertain, and some features are undoubtedly damaged, it likely retains "the ability to convey its significance" and possesses archaeological integrity; it would be recognizable to "a person from the property's period[s] of significance," following King (2008:96). The site features described most recently probably retain integrity of location, setting, feeling, and association with traditional and post-Contact farming in Haha'ione Valley and probably also with use of the adjacent *loko*. Features may also still possess integrity of materials and workmanship.

Keahupua-o-Maunalua Fishpond (State Site [50-80-15-0]49)

The name "Keahupua-o-Maunalua" translates in English to "the-shrine-of-the-baby-mullet-of-Maunalua [Maunalua itself translates to 'two mountains']" (Handy and Handy 1978:483). As noted, Loko Keahupua-o-Maunalua was one of the largest fishponds in pre-Contact O'ahu (Handy and Handy 1978:483). The often-used name "Kuapā Fishpond" apparently resulted when "Keahupua-o" was shortened to "Kuapā" by William Webster, the 1851 lessee who created the first known map of the area (Webster 1851; see Figure 5). The name is misleading, because "*kuapā*" refers to a type of fishpond (*loko kuapā*), as detailed in Kikuchi (1973). Kikuchi classifies Keahupua-o-Maunalua not as a *loko kuapā* - an offshore type - but instead as a *loko pu'uone* – an onshore type (see Appendix B).

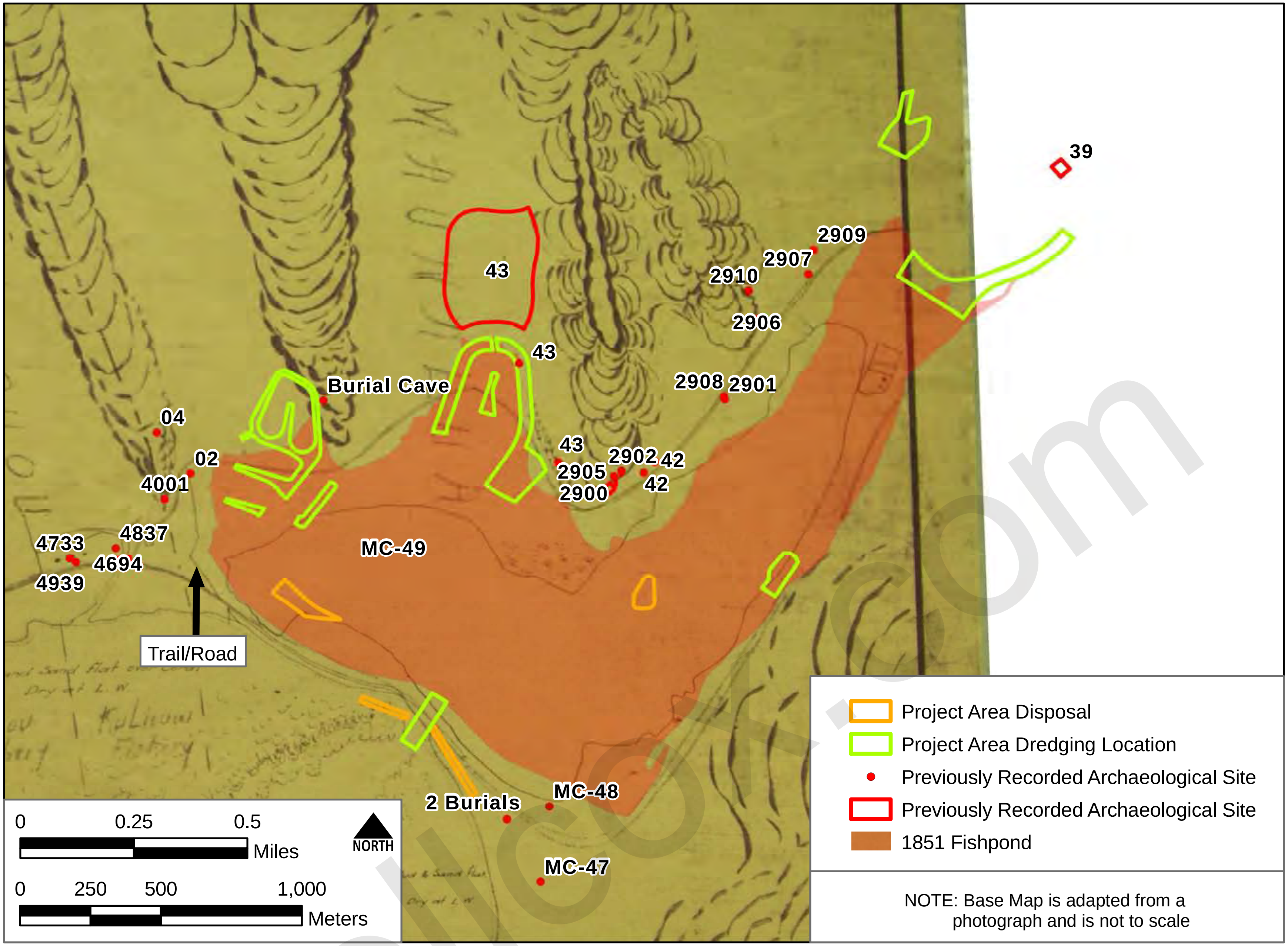

Figure 13. *Waialae Coast: Diamond Head to Koko Head, Island of Oahu.* Proposed project areas (APE) and previously recorded archaeological resources added; base map (Wall 1881), project location data georeferenced (Anchor QEA, LP, 2010), archaeological site location data georeferenced from various sources.

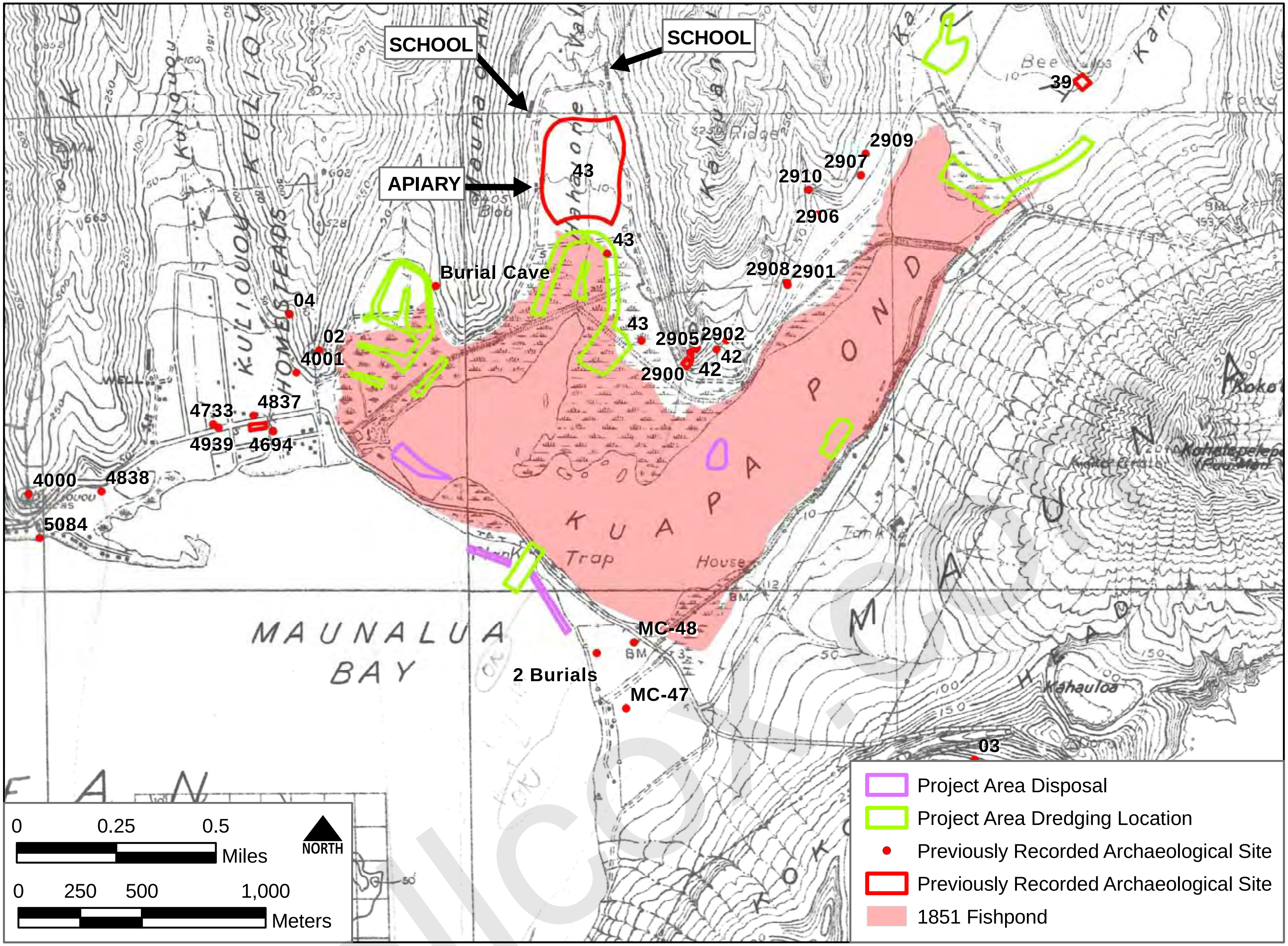

Figure 14. 1927 *Koko Head*. Topographic map. Proposed project areas (APE) and previously recorded archaeological sites added; base map (U.S. Geological Survey- Koko Head (1927)), project location data georeferenced (Anchor QEA, LP, 2010), archaeological site location data georeferenced from various sources.

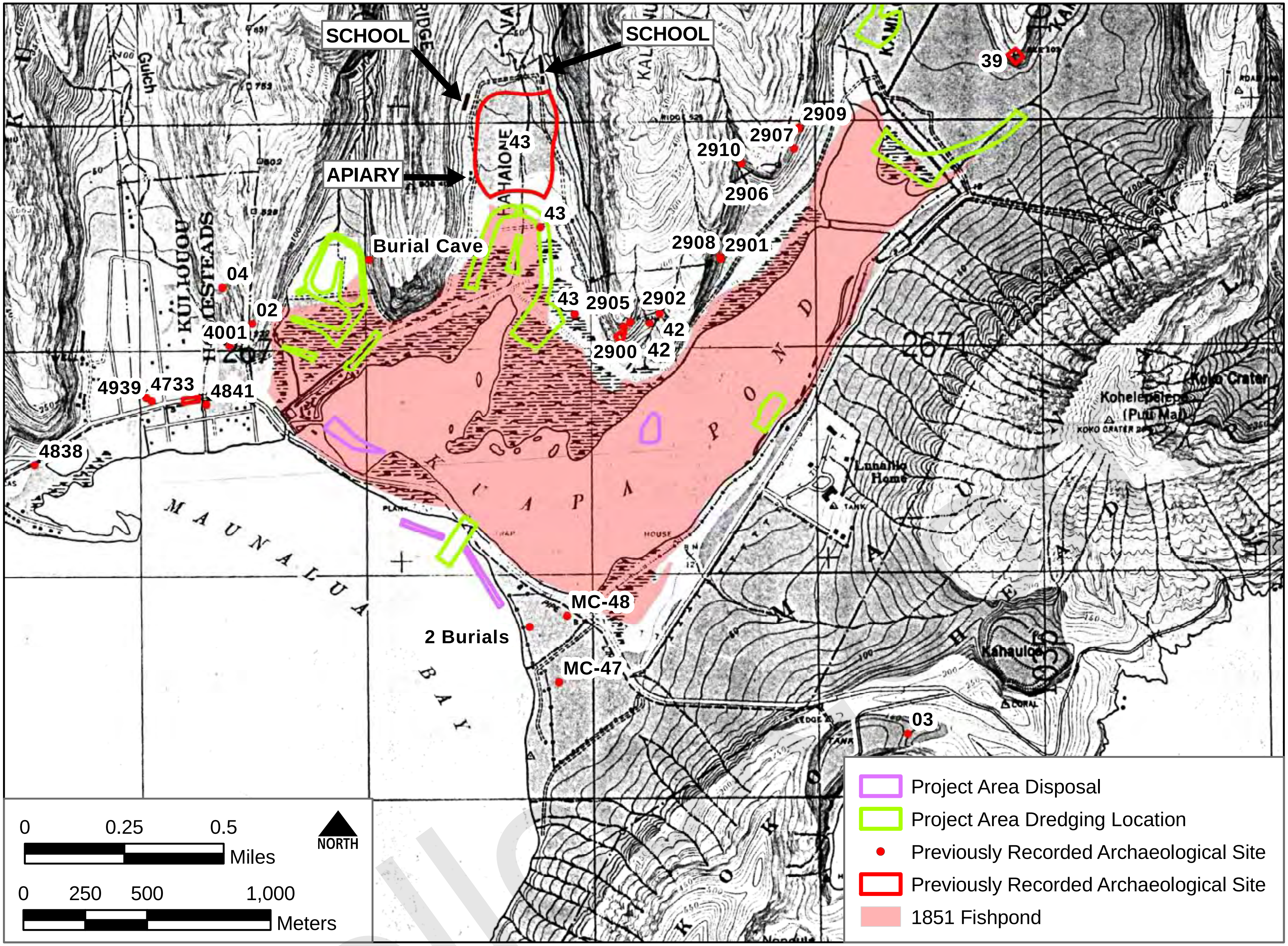

Figure 15. 1934 *Koko Head*. Topographic map. Proposed project areas (APE) and previously recorded archaeological sites added; base map (U.S. Geological Survey- Koko Head (1927)), project location data georeferenced (Anchor QEA, LP 2010), archaeological site location data georeferenced from various sources.

The typical *loko kuapā* is differentiated by its location in a bay or in the ocean and by the large, arcing seawall (*kuapā*) that separates the pond from the open water. The wall often has multiple gates or sluice grates (*mākaha*) that allow the young fish in and water in and out. The barrier enclosing the *loko pu‘uone* also separates the pond from offshore waters but is built on a natural sand barrier that follows the shoreline (Kikuchi 1973:9). The barrier may be built up with rock or sand, as is true at Loko Keahupua-o-Maunalua.

A few short references to Keahupua-o-Maunalua Fishpond exist from the period between the late 1820s and 1930, when McAllister (1933) visited. Chamberlain (1826:26 [not yet seen], quoted, O’Hare et al. 2003:7), provides the earliest mention of the fishpond and its “sea wall.” In December 1890 the “sea wall” was included in a lease from the Bernice Pauahi Bishop Estate to Lau Akau (Ewaliko 1975, in Takemoto et al. 1975:74).

Cobb (1903:748), mentioning that “Maunalua” fishpond was partially filled by 1903, also lists the area of the fishpond. Loko Keahupua-o-Maunalua covered 523 acres (212 ha) at that time, making it by far the largest fishpond he recorded on O‘ahu or any of the Hawaiian Islands. McAllister (1933:69) described the fishpond in detail, noting that the enclosure wall was approximately 1,524 m (5,000 ft.) long, based on a natural sand embankment approximately 3-5 m (10-15 ft.) thick at its base and faced at the top and on the seaward side with stacked lava and coral stones. The rock wall was “a few feet thick.”

Kikuchi defines the *loko pu‘uone* fishpond type as one that was owned by a chief (or used by the chief, with the permission of the *mo‘o* or *ali‘i nui*) and was managed by his appointed supervisor or *konohiki*. The *ali‘i* who owned Loko Keahupua-o-Maunalua throughout the period of its use are not known, but the pond’s uses and the *konohiki*’s function can be generalized. The *konohiki* (later, during post-Contact times, the manager) for Loko Keahupua-o-Maunalua was probably reappointed every time the *ali‘i* (later, lessee) changed. Among many duties, the *konohiki* commissioned labor to build and maintain the pond, and, perhaps most importantly, had the authority to remove resources from the pond, primarily for the *ali‘i* who owned or was allowed to use the pond. Evidence suggests that Kahekili, Ruler of O’ahu, and later his successor Kamehameha the Great collected fish from the pond and may have assisted in construction projects at the pond (Kamakau 1992a:192).

One of the illustrations provided by A. M. Kirk’s website (http://web.me.com/amkirk/Maunalua/Views_of_Kuapa_Pond.html) is an 1826 sketch by Dampier. The artist would have been standing on a ridge north of the fishpond; the view is to the south and west, across the *loko* and into the bay. Multiple walls segment the fishpond. Three walls apparently accessed from a single point at the west edge of an eastern inland portion of the fishpond diverge to the northeast, east, and south, creating four internal walled pond areas. Huts line the north edge of the fishpond closest to the artist; this land could possibly the south end of Haha‘ione Valley. A wall farther southwest, possibly coinciding with the westernmost portion of the APE, forms an elongate J open to the west. An opening that is probably the entrance-outlet to Maunalua Bay is visible in the distant south, in the background.

Figure 16 is a photograph of a man working at Keahupua-o-Maunalua Fishpond in the 1930s – shortly after McAllister had visited the pond. The photograph displays structures and a rock-outlined trench that paralleled the pond wall; the visible features include the rock wall, three small wood buildings or parts of one building on the wall, probable *mākaha* through the wall, and a wood railing. None are known to exist today. Resources including this segment of the rock wall and the rock-lined trench may have been partially or completely destroyed during earlier development, and the perishable constituents such as the wood used to enclose these structures have more than likely disintegrated. It is possible, however, that stacked rock, trenches, rock alignments, rock house platforms or other foundations, and various habitation debris might still remain.

Keahupua-o-Maunalua Fishpond was partly filled by 1901 (Cobb 1903:717, 748) but apparently continued in use as a fishpond until Henry Kaiser began developing the property. The area was actively used as a commercial fishery in 1964, when Kaiser began leasing the fishpond from the Bernice Pauahi Bishop Estate. Over the next 20 years Kaiser's development of the Hawai‘i Kai Marina and associated residential community drastically transformed the area.

Since Keahupua-o-Maunalua Fishpond has been part of Hawai‘i Kai Marina since the 1950s, the site has been dredged several times, as documented by the history of dredging provided by Anchor QEA's Hawai‘i Kai *Project Summary* (Anchor QEA 2010). Figures 17 and 18 are slightly modified after Anchor QEA's (2010) Appendix B.

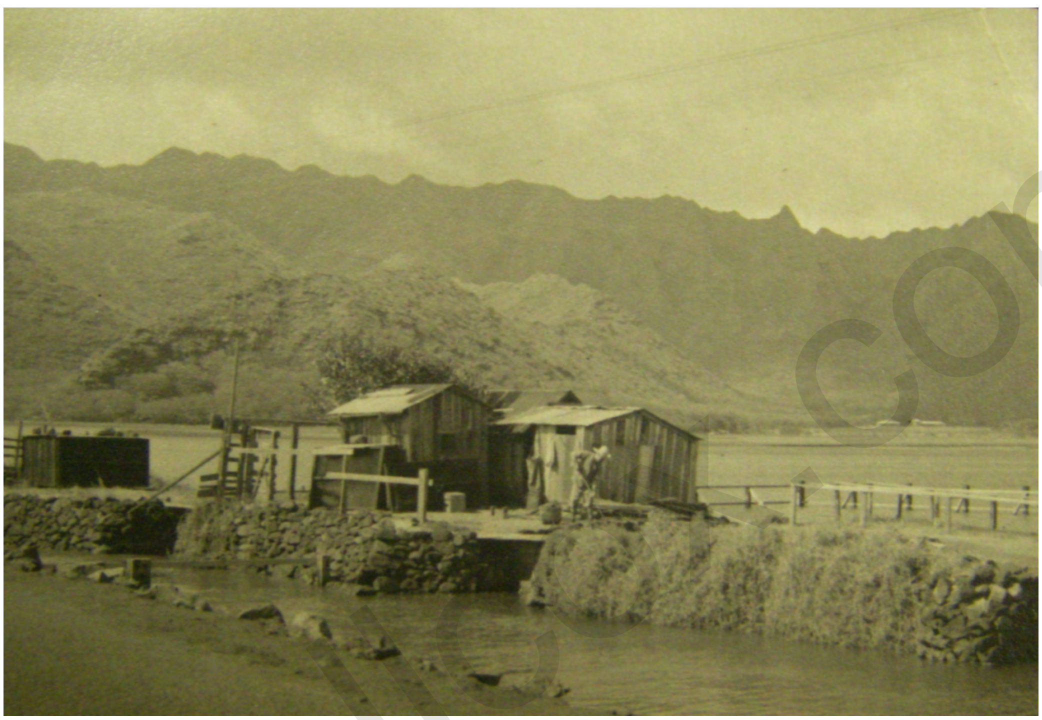

Figure 16. Photograph, "*Fishing Kuapa Pond. Where Kaiser Built Marina at Kokohead 1930s?*" (Fishponds 1930s?).

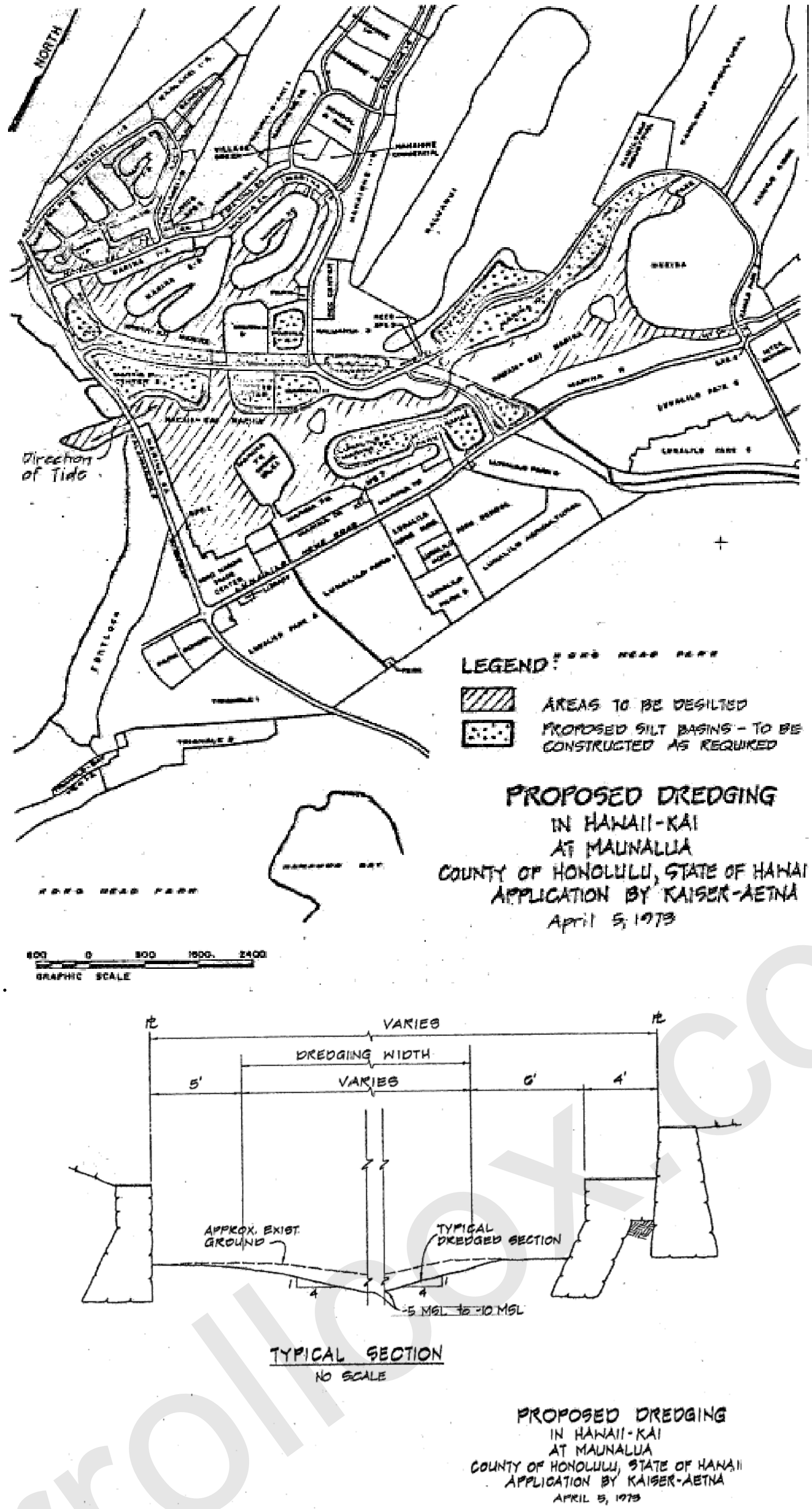

Figure 17. Proposed dredging areas in Hawai‘i-Kai, 1973 (adapted from U.S. Army Corps, Engineer, 1975).

REVIEW OF PREVIOUS DREDGING EVENTS AT HAWAII KAI MARINA

- **1959.** The Hawaii Kai Marina underwent initial dredging to near its present configuration, including dredging material from Kaupa Pond to depths of -6 feet in the marina and -8 feet in the entrance channel.
- **1960s.** Rim Islands No. 1 and No. 2 constructed from dredge material to serve as disposal islands for future marina dredging.
- **1977.** The U.S. Army Corps of Engineers (USACE) issued a maintenance dredging permit that included the marina and entrance channel.
- **1981.** The marina is dredged using hydraulic equipment, with sediments disposed of at Nansay Peninsula and along the shoreline between Keahole Bridge and Hawaii Kai Bridge.
- **1985.** Kaiser dredged the entrance channel from Maunalua Bay into the marina inside the Kalanianaole Highway Bridge using mechanical means from a landward approach.
- **1994.** State legislature passed Act 231, recognizing the Hawaii Kai Marina and associated entrance channel as a navigation channel important to public health, safety, and welfare; State funds were appropriated for maintenance dredging efforts.
- **1996.** Hawaii Kai Marina Association dredged approximately 53,600 cubic yards from within the marina and placed the material on Rim Island No. 1 and No. 2.
- **1998.** A significant storm event occurred, causing failure of a poorly designed rock catch basin at the entrance to Kawaihae Channel (near Duck Island). The failure of the rock catch basin prompted subsequent cleanup operations to remove major rock piles, debris, and silt deposited in Kawaihae Channel.
- **1998.** Maintenance dredging of approximately 8,000 cubic yards (from the entrance channel between Hawaii Kai Marina and Maunalua Bridge) was conducted to achieve depths to -6 feet MLLW, with dredged sand placed on Portlock Beach. Project also included construction of a sandbag groin on the west side of Portlock Beach to stabilize the shoreline and minimize the migration of sediment around the shoreline tip and into the navigation channel.
- **2004.** Department of Boating and Ocean Resources dredged the entrance channel and placed sand material on Portlock Beach.
- **2004.** Hawaii Kai Marina Association worked toward obtaining a permit for dredging the marina and entrance channel, including placement of dredged material on Rim

Figure 18. Review of previous dredging projects at Hawai‘i Kai Marina (adapted from Anchor QEA, LP, 2010).

No detailed information regarding the specifications of construction activities during these earliest phases has been located, although it is known that a channel was dredged from the marina into the ocean, and various other infrastructural developments took place. In 1975 an Environmental Impact Statement (EIS) was prepared as part of planning for Kaiser's growing development. The EIS details construction specifications, including dredging depths, for that project. A January 27, 1975, letter to Kaiser-Aetna from the Hawaiʻi State Historic Preservation Office stated that any former archaeological sites in the Hawaiʻi Kai Marina area had been destroyed during previous construction and that no archaeological resources remained (U.S. Army Corps, Engineer, 1975:Appendix C).

The permit issued in 1975 (U.S. Army Corps, Engineer, 1975:2) allowed

> Kaiser-Aetna to perform maintenance dredging in the Hawaii Kai Marina waterways and to maintain the existing marina depth of -5 to -8 feet [below] Mean Sea Level (MSL) in various areas though out the marina over a period of 5 years. … During the 5-year period, an estimated 400,000 cubic yards (CY) of material (estimated by Kaiser-Aetna), mainly silt, will be removed from the marina by suction or bucket dredge, and dewatered by evaporation in silt or drying ponds constructed on undeveloped urban filled land located adjacent to the marina. … Initially, Kaiser-Aetna intends to remove by dredging approximately 185,000 CY of material, consisting of 30,000 CY of material from high spots not removed during the original construction of the marina; 100,000 CY of material from areas where embankments have slumped into the marina, and 55,000 CY of material resulting from the sediment accumulated over the years since the initial construction of the marina. The Hahaione Stream outlet has been identified by marina residents as one of the most badly shoaled areas in the marina requiring immediate maintenance dredging.

After this initial dredging phase is completed "Kaiser-Aetna anticipates that future maintenance dredging requirements in the marina will be concentrated in areas under bridges; at the closed ends of the marina channels, and in areas where drainageways enter the marina from upland tributaries. The amount of the material needed to be dredged for these purposes is estimated not to exceed 215,000 CY…", totaling 400,000 CY (U.S. Army Corps, Engineer, 1975:2). Figure 17 includes the figure detailing construction activities throughout the marina and a cross section.

Since Kaiser's initial dredging (the 1975 permit, carried out in 1977) Keahupua-o-Maunalua Fishpond has been dredged at least six additional times (see Figure 18). The later dredging projects have served various areas of the marina based on immediate or future needs. The reports that must have accompanied these dredging projects cannot be located, and it cannot be assumed that the areas or depths dredged at various times were similar to those dredged during earlier projects or those planned for the current project. The scant information obtained suggests that the depths dredged have been designed to produce a marina floor that is 3 m (10 ft.) below mean sea level. Unfortunately, data concerning the natural/cultural depths of the fishpond, before dredging began, are not available. Consequently, it is not possible to determine the degree to which previous dredging projects have had an impact on the resource. It is possible that the proposed project could have an adverse impact on Keahupua-o-Maunalua Fishpond if portions of the fishpond floor (the active, organic debris-littered base of the pond while the fishpond was in use; see Appendix B) or associated walls remain, and if associated artifacts are present.

Site 49 appears likely to be eligible for nomination to the NRHP according to Criteria A and D. *Criterion A:* As one the largest traditional fishponds in Hawaiʻi, it is associated with the Polynesian introduction and development of Hawaiian fishponds, monumental aquacultural structures that contributed significantly to Hawaiian subsistence and chiefly economy and, after Contact, to commerce. It is also associated with Western contact and the changes in the practice of aquaculture that were introduced after Contact. *Criterion D:* The *loko* possesses the potential to produce information important to our understanding of Hawaiian history and prehistory (Criterion D).

Loko Keahupua-o-Maunalua is likely to retain "the ability to convey its significance" and is assessed as retaining at least some degree of archaeological integrity. It retains integrity of location, setting, and feeling. If wall segments are encountered, they may possess integrity of materials and workmanship, as well.

Fish Trap

Surveyor James B. Mann's (1921) map (Figure 19, below) of Loko Keahupua-o-Maunalua illustrates another, much smaller cultural feature that has not been described in any other available source. The 1921 map shows a "TRAP" located in the entrance/outlet from the *loko* into Maunalua Bay. "TRAP" likely refers to a fish trap, which, at that relatively early date, may have been a traditional Hawaiian fish trap. Fish traps include several types, including the *loko ʻume ʻiki*, a shore fishpond with lanes (Kikuchi 1973:229-230), and many smaller types including *pā*, *umiki*, *ʻūmiʻi* and others Pukui et al. 1986:210, 548). The *loko ʻume ʻiki* is a complex trap type that is described by Kikuchi (1973:9-10) as similar in form and construction to the *loko kuapā*, with numerous stone-lined lanes that lead fish into netting areas with the ebbing and flowing tide. A *pā* is a simpler trap, built out into a channel with an opening and a single lane to guide fish at high or low tide, but not both.

When McAllister observed the area in 1930 he did not record a fish trap. Kikuchi describes Keahupua-o-Maunalua Fishpond but, like McAllister, does not mention a fish trap. It is possible that the fish trap (which would have been completely submerged) was simply not visible and that both researchers missed it. It may have been destroyed either before or since their visits, but the possibility remains that rocks that were incorporated in its walls could still exist in the entrance channel.

It is not known whether the fish trap still exists. If it does, it is likely to be eligible for nomination to the NRHP according to Criteria A and D, for the same reasons as Site 49, the *loko*. *Criterion A:* Fish traps, of which few remain, were another important feature type in Hawaiian aquaculture and are associated with the Polynesian introduction and development of aquaculture in Hawaiʻi. The location of this trap within a *loko* is also unusual, and it is possible that it postdates Contact, in which case it is associated with Western contact and represents the post-Contact period of transition from traditional aquaculture to commercial fishing. *Criterion D:* The fish trap also possesses the potential to provide information important to our understanding of Hawaiian history and prehistory.

The trap's integrity remains in question. It will not be known until the project takes place whether the feature still remains, in the entrance-outlet between the fishpond and Maunalua Bay.

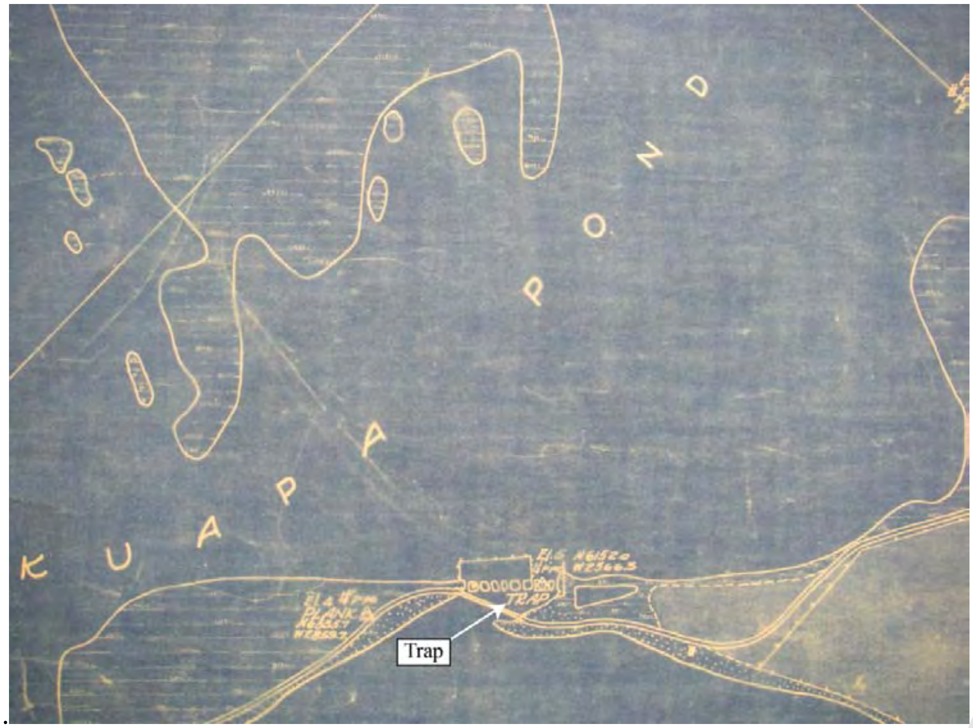

Figure 19. Close-up of Figure 6 (1921 Portion of Maunalua Apana 30, LCA 7713 R.P. 4475, Koolaupoko, Oahu - Surveyor Jas. B Mann) which illustrates the location of the "TRAP" and *loko pu'uone* at Keahupua-o-Maunalua Fishpond.

ARCHAEOLOGICAL SITES OUTSIDE THE AREA OF POTENTIAL EFFECT

At least 36 archaeological resources have been recorded previously within areas surrounding, but outside, the project APE. These resources are all traditional Hawaiian and range in feature types from complete villages to isolated human burials. For a complete list of these resources please see Table 4. Five of McAllister's (1933) sites near (outside) the APE are described below.

Pahua Heiau (State Site [50-80-15-0]39)

When McAllister (1933:65-66, Fig. 23) observed Pahua Heiau in 1930 he described its location and sketched a map that illustrates the internal features' dimensions. He determined that this is "one of the smaller heiau's, probably of the husbandry type" (McAllister 1933:65). The *heiau* measures 20.7 by 12 m (68 by 40 ft.) and is a platform *heiau*, with four internal rock-paved terraces at different levels, separated by low dividing walls and facings. The central section of the upslope edge is open, but the rest of the rear edge is faced against the slope.

The site was not relocated during the State Department of Land and Natural Resources (DLNR) archaeological survey in the 1970s. It is listed in Shimizu's (1980:Table 3, Appendix B [Fig. 11]) architectural thesis concerning *heiau* on Oʻahu as serving an unknown function; it is also mapped, with feature dimensions listed. Pahua Heiau was excavated and restored during a volunteer community service project directed by Bertell D. Davis in 1985. The 1985 restoration team included professionals and interested parties from a diverse group of agencies as well as Bishop Museum, the University of Hawaiʻi at Mānoa, and an Ohio University archaeology field school (Davis 1985:1). Excavation uncovered evidence that the *heiau* was constructed in several stages, but Davis was not able to determine the chronology of the construction sequence.

The generous support for this restoration and excavation process illustrates the importance of this cultural site to the community. The site is located on the slope at the south end of the ridge between Kamilo Nui and Kamilo Iki Valleys, overlooking the top end of Makahuena Place. It is owned by the Office of Hawaiian Affairs.

Hawea Heiau (State Site [50-80-15-0]42, McAllister's Site 42)

The first researcher to record Hawea Heiau was Thomas G. Thrum, in 1906. Thrum (1906:45) reported it as "[a]bout 75 feet square, now all gone; stones used to build walls with." When McAllister visited Hawea Heiau in 1930 he described it as partially destroyed: the rocks of the eastern half had been removed and used to reconstruct the walls of Keahupua-o-Maunalua Fishpond, and only the western half remained, with two or more terraces (McAllister 1933:66). McAllister does not estimate the previous extent of the entire *heiau* but rather takes measurements of internal features e.g., one platform [rock-paved terrace] measures 8.8 by 6.7 m (29 by 22 ft.) with a 1.2-m (4-ft.)-thick west wall 1 m (3.5 ft.) high inside the *heiau* and 2.4 m (8 ft.) high outside). This terrace contained a rectangular pit. Other internal features included a triangular step-like area on the *makai* side of the terrace just mentioned, and a soil-surfaced terrace on its *mauka* (mountain) side; evidence also suggested three soil-terrace remnants downslope.

Hawea Heiau is listed by Shimizu (1980) as serving an unknown function. In 1985 Price-Beggerly and McNeill (1985:13-14, Table 1) located a structural remnant they believed was probably Hawea Heiau during a reconnaissance survey in Kaluanui. Dense vegetation obscured the site, but at least two terraces were documented, bounded by three separate walls. The weathered coral noticed by McAllister earlier in walls and pavings was still present in 1985. O'Hare et al. (2003:13) refer to an Archaeological Assessment and Evaluation by Schilz (1994, not yet seen here), for which computer graphics were used successfully to locate Hawea Heiau. Figure 12 here includes both the McAllister and Schilz locations. Figure 20, below, a portion of a property map prepared by surveyor James B. Mann (1921), includes plots for Hawea Heiau and two nearby springs around 1921.

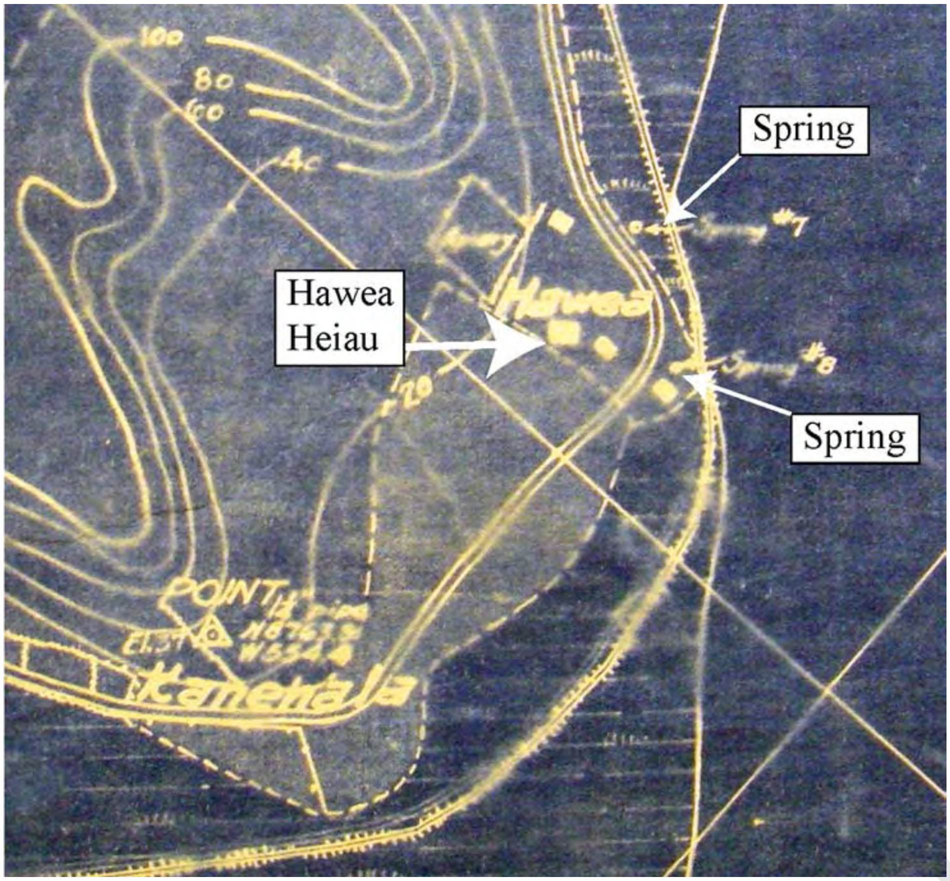

Figure 20. Close-up of Figure 6 (*Portion of Maunalua Apana 30, LCA 7713 R. P. 4475 to Victoria Kamamalu, Koolaupoko, Oahu, Makai Section* – Surveyor Jas. B Mann) which illustrates the location of the Hawea Heiau in 1921.

This *heiau* is still visited by Hawaiian people today and is also an important local cultural tourism site. The structure, which is located in the 180° bend in Kaluanui Road near its intersection with Hawaiʻi Kai Drive, was recently damaged during nearby construction. The local community was outraged and attracted the attention of Senator Clayton Hee, who made a field visit. KHON 2 news station aired a story about the incident in 2009. In a press release Hee said; "Each loss of important cultural sites such as the Hawea Heiau complex is an avoidable tragedy to Hawaiʻi's heritage, and I hope that the developer will work toward a mutual beneficial agreement to resolve this situation with sensitivity to the host culture and the East Oahu community" (Hee 2009). The KHON 2 story included stories shared by Hawaiian people concerning the traditional cultural landscape of the Hawaiʻi Kai area. These consultants were joined and supported by concerned neighbors and interested parties such as Livable Hawaiʻi Kai Hui and the Maunalua Fishpond Heritage Center. The community action that took place after the *heiau* was damaged is a testament to the living purpose of the *heiau* and its importance to today's community.

Fishing Shrines (State Sites [50-80-15- 0]47 and 48)

McAllister (1933:68-69) offers brief descriptions of these two *koa* and notes that they are located near each other. Site 47, called Huanui, is associated with mullet. It is described as a duplicate of Site 48 but slightly larger. Site 48, Hina, is located on the beach on the Honolulu side of Kuamoʻo Kāne and is associated with *akule* (scad). McAllister (1933:68-69) describes the site:

> The shrine is roughly square in shape with the corners rounded, and measures 16.5 feet across. It is formed by coral walls 1 foot high and from 1 to 2 feet wide. Inside the walls is a paving of small bits of coral and sand which is abut 6 inches higher than the outside. Facing the sea is an entrance 2.5 feet wide. Just within the entrance are six sharp lava stones forming an oval about 1 foot wide and 1.5 feet long. It was here that the offering of fish was placed. A foot from the wall opposite the entrance are two flat coral stones embedded securely in the paving. They protrude about 6 inches.

It seems likely that McAllister was the last researcher to observe these sites. They have almost certainly been damaged by development, but to what degree is not certain.

Unknown (Koko Head Heiau)

This *heiau* was observed by Judd in 1923 (field notes, not yet seen) and might be the *heiau* observed by English sea captains Portlock and Dixon in 1786. As detailed earlier, Dixon described the *heiau* as having been built and then destroyed within a few days. It was likely completely destroyed, as McAllister did not observe this site, and it is not mentioned in any available archaeological report written since his survey.

Burial Cave

This site was an inadvertent discovery encountered during construction in 1972. While stabilizing a hillside, the construction crews disturbed a cave that contained many Hawaiian burials (Bevacqua 1972). Kaiser-Aetna, in charge of the construction, contacted Bishop Museum, who sent a crew of archaeologists to the location (north of the northwest corner of the fishpond; see Figure 12).

The cave measured 1.8 by 2.4 m (6 x 8 ft. and was a meter (3 ft.) high. Large slab stones obscured the entrance. The cave contained several primary burials, one coffin burial, and an indeterminate number of bundle burials (Bevacqua 1972). No midden materials or charcoal were observed, among the remains of 10 separate individuals. The results of preliminary analysis indicate that five adults, one child, and four infants, including both males and females, had been interred in the cave. The cave had apparently been reserved for burial. Associated artifacts suggested that the burials had probably been interred between 1820 and 1860 (Bevacqua 1972).

The site was mapped, and the human skeletal remains were analyzed at Bishop Museum. This site, located on a hillside above the waterline, will not be affected during the planned dredging.

SUMMARY

This section first reviews the three archaeological sites in, or with portions in, the APE in terms of Section 106, assessing the potential eligibility of each of the three for nomination to the NRHP. The anticipated impacts of the project on the three sites in the APE are then summarized. The next section presents recommendations.

SECTION 106 REVIEW: STATE SITES 43 AND 49 AND FISH TRAP

The information reviewed here is also discussed in the subsection entitled Archaeological Sites Within the Project Area of Potential Effect. The three sites are evaluated as to whether they appear likely to satisfy Criteria A, B, C, or D and also in terms of integrity. As explained in the Introduction, both of these requirements – criteria and integrity standards – must be satisfied before an archaeological site can be recommended for nomination to the NRHP.

SITE 50-80-15-043 – HAHA'IONE VALLEY HABITATION SITE

Site 43 is recommended for NRHP eligibility according to Criteria A and D. *Criterion A*: The site represents important settlement and lifestyle patterns that have been influenced by Western contact – a significant event that changed virtually all patterns of Hawaiian life and history. Certain site components represent traditional Hawaiian life in a rural valley; others represent life during the early post-Contact period, when dramatic changes were taking place in traditional life.

Criterion D: With its multiple features and deposits; Site 43 possesses the potential to provide information important to history and prehistory.

While the locations of some of its features remain uncertain, and some features have been damaged, Site 43 retains "the ability to convey its significance." It possesses archaeological integrity. Persons from its periods of significance would certainly recognize it. Archaeological sites, which are usually in damaged condition, are expected to meet less stringent standards of integrity than those applied to some other site types, but features at Site 43 are believed to retain integrity of location, setting, feeling, association with the development of traditional and later post-Contact farming in Haha'ione Valley, and probable association with the use of Loko Keahupua-o-Maunalua . Certain features may also possess integrity of materials and workmanship.

SITE 50-80-15-049 – LOKO KEAHUPUA-O-MAUNALUA

Site 49 also appears likely to satisfy NRHP Criteria A and D. *Criterion A:* As one of the largest traditional fishponds in Hawai‘i, it is associated with the development of Hawaiian fishponds, monumental aquacultural structures that contributed significantly to Hawaiian subsistence and chiefly economy. It is also associated with Western contact, a significant event that resulted in great changes in the broad patterns of Hawaiian life and history, among other things introducing commercial fishing and fisheries to the fishpond and Maunalua. Its features are expected to reflect the changes in aquaculture and fishpond uses that followed the post-Contact introduction of the concepts of private property and a commercial economy.

Criterion D: The *loko* also has the potential to yield information important to our understanding of Hawaiian history and prehistory. In terms of integrity, Loko Keahupua-o-Maunalua is considered likely to retain "the ability to convey its significance." It would be recognizable to persons from the period of its significance and possesses archaeological integrity of location, setting, and feeling. If wall segments are encountered, they may possess integrity of materials and workmanship.

UNNUMBERED FISH TRAP BESIDE LOKO KEAHUPUA-O-MAUNALUA INLET/OUTLET

It is not known whether the "trap" recorded by Mann (1921) beside the bay entrance into Site 49 still exists. If so, it is likely to satisfy NRHP Criteria A and D, for the same reasons discussed in the previous paragraph regarding Site 49. *Criterion A:* Fish traps represent the Polynesian introduction and development of traditional aquaculture. The location of this trap within the inlet/outlet to a *loko* is somewhat unusual and might suggest that it is also, or alternatively, associated with Western contact, which introduced significant changes to aquaculture and to broader patterns of broader land use and economy.

Criterion D: The fish trap possesses the potential to provide information important to our understanding of Hawaiian history and prehistory (Criterion D). Its integrity remains in question. The project may reveal whether or not the feature still exists. If it does, it is anticipated that it will be encountered during planned dredging, as it is, or was, located in the area to be dredged in the inlet/outlet of the fishpond.

ANTICIPATED PROJECT EFFECTS

The portions of the APE that are scheduled as disposal sites, where dredged materials will be redeposited, are currently either composed of landfills or capped by landfills. Redeposition of soils and sediments is not expected to affect any cultural resources adversely.

The proposed dredging has the potential to affect three historic (significant) archaeological resources adversely. State Sites 50-80-15-043 and 50-80-15-049 and a third, unnumbered site (the fish trap at the entrance to Site 49), all recommended here as eligible for nomination to the NRHP, are located within, or include portions within, the APE. All three could be adversely affected by dredging.

Site 43, the Haha‘ione Valley habitation site, has been recorded and observed by several archaeologists, who mapped the site or portions of it in several different locations, two of which may be affected by dredging. McAllister’s (1933) and Davis’s (1985) locations fall either within or immediately next to a portion of the APE.

Several portions of Site 049, Loko Keahupua-o-Maunalua, are located in the APE. The fish trap recorded beside the pond inlet/outlet by Mann (1921) is also located in the APE. Although many portions of the *loko*, possibly including the trap, were probably damaged or destroyed during earlier phases or dredging and development, the degree to which the fishpond was damaged by each project seems remains unknown. Since neither the original fishpond depth nor the depths or extents dredged during earlier projects are documented, a real possibility exists that cultural materials or deposits may be encountered during the project in portions of the fishpond that have not been completely dredged.

Resources that might be encountered include, among others, rock wall or house platform remnants; traditional or post-Contact domestic equipment used in the house or houses once located on the fishpond wall, fishhooks and tools such as files that were used for making fishhooks, net-sinker stones, and other fishing equipment. One cultural resource with important data potential probably does still exist in portions of the *loko* – fishpond-floor soils, the cultural and natural debris that accumulate on the base of an active pond while it is used to store fish for harvesting (see Appendix B for further information). The post-Contact commercial fishery may also have left artifacts and debris, including both traditional materials and a variety of post-Contact materials such as glass, ceramics, metals, and wood.

Even if any found resources are not structurally intact, it is important that they be explored and documented, to produce as comprehensive an understanding of the area’s uses and resources as possible. The use of a combination of historical maps and photographs has led to intriguing questions that may suggest topics for investigation should any future research projects be conducted at sites in Maunalua Ahupua‘a.

RECOMMENDATIONS

State Sites 50-80-15-043 and 50-80-15-049 and a third, unnumbered site (the fish trap at the entrance to Site 49), all located in or overlapping portions of the project APE to be dredged, are recommended as eligible for nomination to the NRHP according to Criteria A and D. Sites 43 and 49 possess archaeological integrity. It is not yet known whether the fish trap still exists or in what condition.

Any buried archaeological resources in the portions of the APE to be used as disposal sites for dredged materials are not expected to be damaged during redeposition. Provided that no ground modification takes place at any of the disposal sites, no further archaeological work is recommended at the disposal sites.

Since it is possible that fish-trap components and fishpond features or materials remain and might be damaged or destroyed during the planned project, limited monitoring by a qualified archaeologist is recommended during dredging, to mitigate adverse impacts to sites within the APE. Archaeological monitoring will ensure that any significant sites are recognized, fully documented, and archaeologically assessed. Archaeological monitoring might be conducted during short intermittent periods rather than one longer period, to ensure monitoring during active dredging at the entrance/outlet into Maunalua Bay, inspection of dredged materials in spoil piles at various locations, and monitoring of subsequent dredging at any locations that produce significant materials during the project.

APPENDIX A.

Photographs on File,
Hawai‘i State Archives, Honolulu

Photo No.	Type	Description
203	Map	1947 ili of Maunalua - R.L. 313/47 - G2382.02:2KS8 (1947).1138 59
204	Map	1884 Oahu East coast including Waimanalo, Hanauma and Maunalua Bays - G4382.02:2m25 1884.H38.59
205	Map	1884 Oahu East coast including Waimanalo, Hanauma and Maunalua Bays - G4382.02:2m25 1884.H38.59
206	Map	1884 Oahu East coast including Waimanalo, Hanauma and Maunalua Bays - G4382.02:2m25 1884.H38.59
207	Map	1881, traced 1919 - Hawaii Territory Survey Waialae Coast - Walter E. Wall, Surveyor - G4382.02:2361919.H38.59
208	Map	1881, traced 1919 - Hawaii Territory Survey Waialae Coast - Walter E. Wall, Surveyor - G4382.02:2361919.H38.59
209	Map	1881, traced 1919 - Hawaii Territory Survey Waialae Coast - Walter E. Wall, Surveyor - G4382.02:2361919.H38.59
210	Map	1881, traced 1919 - Hawaii Territory Survey Waialae Coast - Walter E. Wall, Surveyor - G4382.02:2361919.H38.59
211	Map	1921 Portion of Maunalua Apana 30, LCA 7713 R.P. 4475, Koolaupoko, Oahu - Surveyor/Mapper Jas. B Mann - G4382.O2:2M25 192 .M3 full
212	Map	1921 Portion of Maunalua Apana 30, LCA 7713 R.P. 4475, Koolaupoko, Oahu - Surveyor/Mapper Jas. B Mann - G4382.O2:2M25 192 .M3 full
213	Map	1921 Portion of Maunalua Apana 30, LCA 7713 R.P. 4475, Koolaupoko, Oahu - Surveyor/Mapper Jas. B Mann - G4382.O2:2M25 192 .M3 full
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218	Map	1921 Portion of Maunalua Apana 30, LCA 7713 R.P. 4475, Koolaupoko, Oahu - Surveyor/Mapper Jas. B Mann - G4382.O2:2M25 192 .M3 full
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220	Map	1921 Portion of Maunalua Apana 30, LCA 7713 R.P. 4475, Koolaupoko, Oahu - Surveyor/Mapper Jas. B Mann - G4382.O2:2M25 192 .M3 full
221	Map	1921 Portion of Maunalua Apana 30, LCA 7713 R.P. 4475, Koolaupoko, Oahu - Surveyor/Mapper Jas. B Mann - G4382.O2:2M25 192 .M3 full
222	Map	1921 Portion of Maunalua Apana 30, LCA 7713 R.P. 4475, Koolaupoko, Oahu - Surveyor/Mapper Jas. B Mann - G4382.O2:2M25 192 .M3 full
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225	Map	1921 Portion of Maunalua Apana 30, LCA 7713 R.P. 4475, Koolaupoko, Oahu - Surveyor/Mapper Jas. B Mann - G4382.O2:2M25 192 .M3 full
226	Map	1884 Deep Sea Soundings taken in Oahu Channel - G4382.02.1844.B7.A3
227	Map	1884 Deep Sea Soundings taken in Oahu Channel - G4382.02.1844.B7.A3
228	Photo	Maunaloa Estate (do not use because in MaunalOa)
229	Photo	Maunaloa Estate (do not use because in MaunalOa)
230	Photo	Maunaloa Estate (do not use because in MaunalOa)
231	Photo	Maunaloa Estate (do not use because in MaunalOa)
232	Photo	Maunaloa Estate (do not use because in MaunalOa)
233	Photo	Kuapā Pond for Koko Head to Maunalua Bay: East Oahu - neg # HC31.322
234	Photo	Kuapā Pond for Koko Head to Maunalua Bay: East Oahu - neg # HC31.322
235	Photo	Kuapā Pond for Koko Head to Maunalua Bay: East Oahu - neg # HC31.322
236	Photo	Raidostation - Kuapā Pond from Koko Head to Maunalua Bay: East Oahu - neg # 31344
237	Photo	Raidostation - Kuapā Pond from Koko Head to Maunalua Bay: East Oahu - neg # 31344
238	Photo	Raidostation - Kuapā Pond from Koko Head to Maunalua Bay: East Oahu - neg # 31344
239	Photo	Raidostation - Kuapā Pond from Koko Head to Maunalua Bay: East Oahu - neg # 31344
240	Photo	Raidostation - Kuapā Pond from Koko Head to Maunalua Bay: East Oahu - neg # 31344
241	Photo	1963 EKM Series
242	Photo	1963 EKM Series
243	Photo	1963 EKM Series
244	Photo	1968 GS-VXJ Series
245	Photo	1968 GS-VXJ Series
246	Photo	1968 GS-VXJ Series
247	Photo	1968 GS-VXJ Series (4-3)
248	Photo	1968 GS-VXJ Series (4-3)
249	Photo	1955 Aerial Photo Surveys Series
250	Photo	1955 Aerial Photo Surveys Series
251	Photo	1955 Aerial Photo Surveys Series
252	Photo	1952 DACE Series
253	Photo	1952 DACE Series
254	Photo	1939-41 US Army Corps Series
255	Photo	1939-41 US Army Corps Series
256	Photo	1939-41 US Army Corps Series
257	Photo	Fishing Kuapā Pond. Where Kaiser Built Marina at Kokohead 1930s?- neg #19879
258	Photo	Fishing Kuapā Pond. Where Kaiser Built Marina at Kokohead 1930s?- neg #19879
259	Photo	Fishing Kuapā Pond. Where Kaiser Built Marina at Kokohead 1930s?- neg #19879
260	Photo	1914 Kokohead fishpond - neg #16841
261	Photo	1914 Kokohead fishpond - neg #16841

*Accessed at the State Archives 9.14.2010 by Nichole Jordan and Marshall Millett

APPENDIX B.
BACKGROUND INFORMATION CONCERNING FISHPONDS, AND CHARACTERISTICS OF FISHPOND-FLOOR SOILS

by Jane Allen

BACKGROUND INFORMATION CONCERNING FISHPONDS, AND CHARACTERISTICS OF FISHPOND-FLOOR SOILS

This summary is excerpted with additions and modifications from a discussion (Allen and Schilz 1999:4-7) concerned with the research potential of Hawaiian fishponds. That report concerns specifically Loko Weloka, a now-filled former *loko kuapā* on Pearl City Peninsula, Pearl Harbor.

BACKGROUND INFORMATION

Fishponds were once an important and highly visible feature of the Hawaiian landscape. Kikuchi (1973:8, 1976:295) and Kirch (1985:211) suggest that Hawai‘i's fishponds were unique in Polynesia and perhaps in Oceania, in contrast to traps and weirs, which were also found in other areas. In contrast to these systems, fishponds allowed both collection and actual production of fish for harvesting and could therefore support large numbers of people.

Kikuchi (1976:295) believes that fishponds may have developed from *lo‘i kalo*, taro pondfields as the seaward component in a coordinated and integrated system that combined cultivation and aquaculture. Stokes (1909:207-208) suggested instead that fishponds may have evolved out of fish traps when too many fish for immediate consumption were caught, requiring efforts to retain them for later harvesting.

Fishponds are documented for Ni‘ihau, Kaua‘i, O‘ahu, Moloka‘i, Maui, Lana‘i, and Hawai‘i Island. At least 493 fishponds are known to have existed formerly on the seven islands. On O‘ahu, many fishponds once existed both along the windward coast and around Pearl Harbor. Few of O‘ahu's fishponds, which once totaled at least 184, are now recognizable. Most were filled with landfills in the 20th century, during housing and other development (Cobb 1903:747; Devaney et al. 1982:especially 139-157, 198-201).

Many fishponds had high, massive rock walls, up to 1.8 meters (m) high, rarely to 2.7 m (Apple and Kikuchi 1975:17, 87, 100, 104, 129; Cobb 1905:746). Average thickness was 2.02 m; lengths varied widely. Fishpond depths are generally described as around 90-120 centimeters (cm), but much deeper basins, up to 370 cm and more, are described by Madden and Paulsen (1977; see also Kikuchi 1973:Table 1, 1976:296; Kirch 1985:211-214).

Most available archaeological information suggests that fishponds, as opposed to traps and weirs, were a relatively late pre-Contact development, possibly postdating A.D. 1300 (Kirch 1985:214). By the late pre-Contact period, most documented fishponds were the private preserves of *ali‘i*, members of the chiefly and ruling class, and were supervised for them by *konohiki*, managers. *Konohiki* were typically allowed to harvest fish for their own use at certain times.

Hawaiian fishponds are of six main types. Kikuchi's 1973:227ff., 1976:Figure 2) Type I, the *loko kuapā*, was usually constructed offshore behind a rock breakwater, the *kuapā*, a wall or berm that arced outward in a semicircle from the shore. *Loko kuapā* were particularly common on O'ahu and Moloka'i, were usually large, and incorporated long and often massive rock walls. Summers (1964:4) suggests that building a l*oko kuapā* took a year or more.

Loko pu'uone (Type II) were built immediately behind the shoreline, separated from the bay by a berm. *Loko pu'uone* are a near-shore, beach-associated type. Kikuchi (1973:9) explains that *loko pu'uone* usually formed as a barrier beach developed naturally and a sand ridge separated the wetland from the shore.

The four remaining Hawaiian fishpond types include *loko wai*, inland freshwater ponds that may incorporate ditches and *mākaha* (sluice grates); *loko i'a kalo*, irrigated taro fields also stocked with fish; *loko 'ume'iki*, large fish traps that resemble *loko kuapā* with numerous inward-leading lanes; and *kaheka* or *hapunapuna*, natural pools and ponds (DHM Planners and Applied Research Group 1989:I-1 – I-3).

Largely because most fishponds on O'ahu were filled with sediments for housing or other developments before fishpond research began, we still know relatively little about them archaeologically. Few radiocarbon or other dates are yet available for fishponds in most areas of O'ahu (but see Athens2000 for Pearl Harbor fishponds). Some fishpond dates reported in the relatively early archaeological literature (e.g., 1970s, 1980s) are not always clearly attributable to actual fishpond floors, as opposed to earlier or later sediments or soils.

Identifying and interpreting fishpond floors, the actual pond-bottom deposits that were created during use of the pond by fish, and distinguishing those from under-and overlying sediments that reached an area before pond construction or after abandonment of the fishpond, remain important goals for research into the uses and chronology of Hawaiian fishponds.

CHARACTERISTICS OF FISHPOND-FLOOR SOILS

Although fishpond deposits have often been identified incorrectly, based solely on the presence of gleyed colors (low chroma, produced in a reducing atmosphere such as saturation), gleying is inadequate as a fishpond-floor indicator. Many types of deposits, most but not all saturated, become gleyed. Gleying is produced by the reduction of iron and manganese under anaerobic conditions, as bacteria decompose the organic matter in the soil, consuming dissolved oxygen (North Carolina Agricultural Research Service 1992:5, 12). Gleying affects sands and most other deposits – not just fishpond-floor soils – that are submerged in relatively still waters like those in fishponds. If a former fishpond-floor soil or other saturated deposit dries out and becomes oxygenated, gleying may disappear.

Identifying the characteristics of fishpond-floor deposits is important for any fishpond-related research. The discussion that follows introduces a few expected traits of fishpond-floor soils and explains why they should be found.

Fishpond-floor soils should incorporate organic matter, which will smear brown when tested. Traditional foods for ponded fish included microbenthos, an algal complex that forms a crust on the fishpond floor in the littoral pond zone to depths of 60 cm in clear water (Summers 1964:2, 3). Gray or striped mullet (*ʻamaʻama*, *Mugil cephalus*; Goodson 1973; Hiatt 1947), among the favorite traditional food fish and dominant in fishponds, fed primarily on microbenthos. Milkfish (*ʻama*, *Chanos chanos*), another favorite fishpond fish, fed on other algae. Additional foods that were typically added to the pond, contributing to a humic floor deposit, included taro, seaweed, a mixture of seaweed and crushed *kukui* (*Aleurites moluccana*) nuts that was used in the pond as a purgative, and possibly sweet potato (*Ipomoea batatas*) (Devaney et al. 1982:124, 140-142, citing work by Fiddler and Hiatt; Handy and Handy 1972:135, 262; Hiatt 1947; Kikuchi 1976:298; Sterling and Summers 1979:52). Other components of the organic matter may include fish parts and fish waste.

As Athens (2000:6) states, the particle sizes in fishpond-floor deposits should be well-sorted. Fishpond-floor soils, as opposed to the natural deposits predating the fishpond, occupy a well-protected (usually walled) environment, in which the movement of water is slight. Fishpond-floor soils should also reflect different conditions in different environments, as revealed by soil and sedimentological studies including textural analysis, and identification of marine (calcium carbonate, in Hawaiʻi) vis à vis terrigenous (basaltic) components. Loko Keahupua-o-Maunalua occupied a very sheltered location in a sheltered bay, whereas many shoreline fishponds in Kāneʻohe or Waikīkī, for example, may have been affected more directly by longshore currents and storms. Textures should be fine in Loko Keahupua-o-Maunalua, and terrigenous sediments should be prominent because of former stream runoff from the Koʻolau Range.

In some situations such as *loko puʻuone*, where the ponding begins naturally in depressions (in calcareous sand in Hawaiʻi), an actual fishpond-floor deposit may not be visibly humic or possess other obvious soils characteristics, so that it may be difficult to distinguish floor soils from over- and underlying sediments. In such cases, Athens (2000) has used carbon-isotope analysis to distinguish between sediments and fishpond-floor deposits. Dye and Athens (2002:6) summarizes the results of a Kāneʻohe Bay study (1985 research by Stephen V. Smith, R. C. Schneider, and G. W. Tribble, not yet seen here), which obtained a $\delta^{13}C$ value of -23.3 ±1.1 for four samples of (relatively inorganic) stream particulates. In contrast, the pooled $\delta^{13}C$ value for 33 samples of seagrass, green algae, red algae, brown algae, and blue-green algae was -14.8 ± 3.7, and four plankton samples yielded a -18.6 ± 1.3 $\delta^{13}C$ value. These last two $\delta^{13}C$ values are interpreted as reflecting vigorous growth and (post-digestion) deposition of benthic algae and plankton. Three suspected fishpond-floor deposits from two Oʻahu fishponds, Loko Kunana in Pearl Harbor and Loko Kūwili in Iwilei (west Honolulu), yielded 19.6 ± 0.6 $\delta^{13}C$ values, indicating the presence of algae and plankton in significant quantities.

Each actual fishpond-floor soil should be discrete and relatively thin, Although several sequential floors may be present, each should be distinct and not an unremarkable part of a thick sequence of clean sands. The organic content and the floor itself will also usually appear churned and mixed. Any vegetation growing in the fishponds was removed regularly to keep the water clear for both the fish and the algae on which they fed. A farmer building a *loko puʻuone* cleared sedges, bulrushes, and weeds; deepened the pond; and piled up the cleared muck on the margins of the fishpond until "he had a clean pond" (Kamakau 1992b [1869-1870]:49). Removal of vegetation would probably leave pockets where roots came out, mix the soils to some degree, and produce abrupt, wavy to irregular boundaries.

Some fishponds were cleared of infilling silts through construction of entrances on the inland and ocean two sides of the fishpond. The flowing tide filled the fishpond with clean water, and the ebbing tide removed the silts. Coconut halves were also used once or twice a year to scoop out the mud that accumulated, and the pond bottom was then firmed to make a better bed for the fish foods (Summers 1964:11, 12). The organic muck that formed on the bottom as partially digested algae and other foods were deposited by fish also needed to be cleared if it became thick, because thick organic muck deposits deplete oxygen and create toxic hydrogen sulfide (Apple and Kikuchi 1975:30).

In some cases, the organic floor deposits were churned to disperse food for the fish, followed by clearing of muds and silts (Handy and Handy 1972:260-261). All these activities should produce mottling and erosional horizon boundaries. Although each cleaning event might damage or destroy previous boundaries, the last event should leave a clear record that will remain sharp if protected from erosion or disturbance, under either saturated or permanently dry (e.g., landfill) conditions. Coring, the only excavation technique possible in many fishpond situations, unfortunately produces extremely short boundary segments, making signs of erosion and clearing, or even the presence of a fishpond-floor soil, difficult to recognize. Trench excavation is recommended whenever feasible.

When it is possible, as during archaeological monitoring, to study deposits removed from a potential fishpond floor, the goals of archaeological research should include identifying as marine or terrigenous the sediments that became the fishpond floor soils; identifying the depositional agents (e.g., stream, gravity, humans, fish) and regimes (e.g., floods, tides, landslides, deposition in a still, protected pond) represented; differentiating fishpond-floor soils from natural sediments; recognizing signs of cultural uses such as cleaning; and identifying and tentatively interpreting any botanical or other environmental changes that affected the pond or areas nearby. The methods that can be used profitably in fishpond archaeological research include pedological (soil and sedimentological analyses; pollen and phytolith analyses; identification of diatoms, sponge spicules, and Foraminifera; and radiocarbon dating of the organic matter in fishpond-floor soils.

SUMMARY: GUIDELINES FOR ASSESSMENT OF FISHPOND-FLOOR SOILS

The deposit should be relatively thin. It is unlikely that an actively maintained fishpond floor soil will exceed 15-20 cm thick. Multiple thin, packed fishpond floors may be present.

Soil and sediment textures will include clays and silts in areas where terrigenous deposition is dominant, and sands and silts where in marine environments. Silts alone are easily agitated and could make pond waters too cloudy for most fish and shellfish. If silts, not sands, dominate a fishpond floor, they need to be stabilized in an active by the addition of colloidal clays or organic matter or both. Ponding and walling should exclude gravels and most coarse sands from floor deposits. The textures of pond deposits are usually finer than those of unprotected pre-pond sediments but may or may not be finer than the textures of the overlying, post-abandonment deposits.

Gleying, a color characteristic that is sometimes used to identify pond floors, should not be used as the sole criterion, because gleying does not distinguish pond floors from other deposits also formed under reducing conditions. Saturated sediments and soils are typically gleyed, but so are certain dry, reduced soils, for example those lining charcoal kilns.

Few fresh roots or mottles formed on roots should be present in a fishpond, as opposed to a marsh or pondfield. No dense root zones or mats such as those in marshes should be present. Pollen aggregates representing these plants are not expected to occur in ponds, as aggregates often reflect growth in situ. The exception is the *loko iʻa kalo*, where plant identification provides the best information.

If abundant pollens and phytoliths are present, a determination needs to be made as to whether they washed into the fishpond, as should be the case, or were produced by plants growing there, in which case the deposit may be a marsh or pondfield deposit.

A fishpond floor should contain evidence for algae and probably organic matter representing other fish foods, as well as fish debris. The organic matter should streak brown (charcoal streaks black). Fort DeRussy and Loko Kunana fishpond-bottom soils were found to contain fine fragments of organic matter that were not identified but seemed likely to include fish parts, fish excrement, algae, seaweed, and other plant-derived fish food. Microbenthos, as noted, forms a crust or mat on fishpond floors between the water surface and 60 cm below the surface; the deposits removed from or excavated along the shallow margins of a fishpond may reveal this microbenthos mat.

The terrigenous or marine nature of a fishpond-floor deposit may suggest which specific fish or shellfish could have lived in the fishpond.

The base of a fishpond wall or a *mākaha* should underlie slightly the organic fishpond soil that the structure served. A soil or sediment deeper than the structure almost certainly predates it; a deposit overlying the base of the structure is either contemporaneous with or postdates it and the fishpond. If enough of the floor is exposed, it should be possible to follow a fishpond-floor soil to the wall or berm. The fishpond-floor soil will not continue outside the pond.

Specialist analyses that are needed include radiocarbon-dating analysis; pollen, silica body (phytolith), and starch grain analyses; grain sizing and morphology (microscopy) in certain cases; soil chemistry, also in certain cases; and, in all cases, thorough soil and sedimentary profiling and interpretation, preferably accomplished in the field but completed in the laboratory as necessary.

Splitting of each sample among the various laboratories will significantly increase the available information, adding to our understanding of cultural and non-cultural influences and increasing the likelihood that, eventually, fishpond signatures may be predicted for various environments.

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