BOARD OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 1109
WAILUKU, MAUI, HAWAII 96793-7109

March 14, 1995

Mr. Gary Gill, Director
Office of Environmental Quality Control
220 South King Street
Central Pacific Plaza, Suite 400
Honolulu, Hawaii 96813

Dear Mr. Gill:

Subject: PROPOSED 300,000 GALLON WATER STORAGE TANK AND RELATED IMPROVEMENTS AT MAALAEA, MAUI, HAWAII; FINAL ENVIRONMENTAL ASSESSMENT

The Maui County Department of Water Supply has determined that the proposed Maalaea Water Storage Tank Project will not have significant environmental effects and has issued a negative declaration. Please publish this notice in the April 8, 1995, OEQC Bulletin.

One comment letter was received during the 30-day public comment period which began on October 23, 1994. The EA was modified by including a section regarding potential secondary impacts based on the comments in this letter. The letter and our reply are included as Appendix A in the Final EA.

Transmitted herewith are four (4) copies of the Final Environmental Assessment prepared for the Maalaea Water Storage Tank Project, and a completed OEQC Bulletin Publication form.

We thank you for your assistance in handling this matter. Please contact Mr. Rory Frampton of Chris Hart & Partners at 242-1955 if you have any questions.

Sincerely,

DAVID R. CRADDICK
Director

Enclosures

xc: Rory Frampton, Chris Hart & Partners

1995-04-08-MA-FEA-Maalae Water Storage Tank and Related Improvement

APR - 8 1995

DRAFT

FINAL ENVIRONMENTAL ASSESSMENT

300,000 GALLON WATER STORAGE TANK AND RELATED IMPROVEMENTS AT MA'ALAEA, MAUI, HAWAII

TMK: 3-6-01:14 (portion)

CHRIS HART & PARTNERS

Prepared for:

Department of Water Supply
County of Maui
200 S. High Street
Wailuku, Maui, Hawaii 96793

Prepared by:

Chris Hart & Partners
1955 Main Street, Suite 200
Wailuku, Maui, Hawaii 96793

on behalf of:

Ma'alaea Triangle Partnership
75-B North Church Street
Wailuku, Maui, Hawaii 96793

MARCH, 1995

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ENVIRONMENTAL ASSESSMENT

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MARCH, 1995

Preface

The County of Maui, Department of Water Supply, proposes to construct a new 300,000 gallon water storage tank, transmission line, access road and other necessary appurtenances, within the State Conservation District on State owned land in Ma'alaea, Maui, Hawaii (TMK 3-6-01:14). Pursuant to Chapter 343, Hawaii Revised Statues, Chapter 200 of Title 11, Administrative Rules, Environmental Impact Statement Rules, and in connection with the Conservation District Use Application, this Environmental Assessment (EA) documents the Project's technical characteristices and environmental impacts, and advances findings and conclusions relative to the significance of the project.

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I. PROJECT OVERVIEW

A. PROJECT LOCATION, LAND OWNERSHIP AND EXISTING USE

The applicant, County of Maui, Department of Water Supply, is proposing to construct a new 300,000 gallon water storage tank, access road and other necessary appurtenances and related works to service the Ma'alaea area.

The proposed tank site is approximately 1,000 feet mauka of Honoapiilani Highway, at an elevation of approximately 220 feet above Mean Sea Level (M.S.L.) This site is west (mauka) of an existing tank site located approximately 550 feet mauka of Honoapiilani Highway at an elevation of approximately 120 feet above M.S.L. which until recently was the site of two 12,000 gallon steel water tanks (See Figures 1-3.)

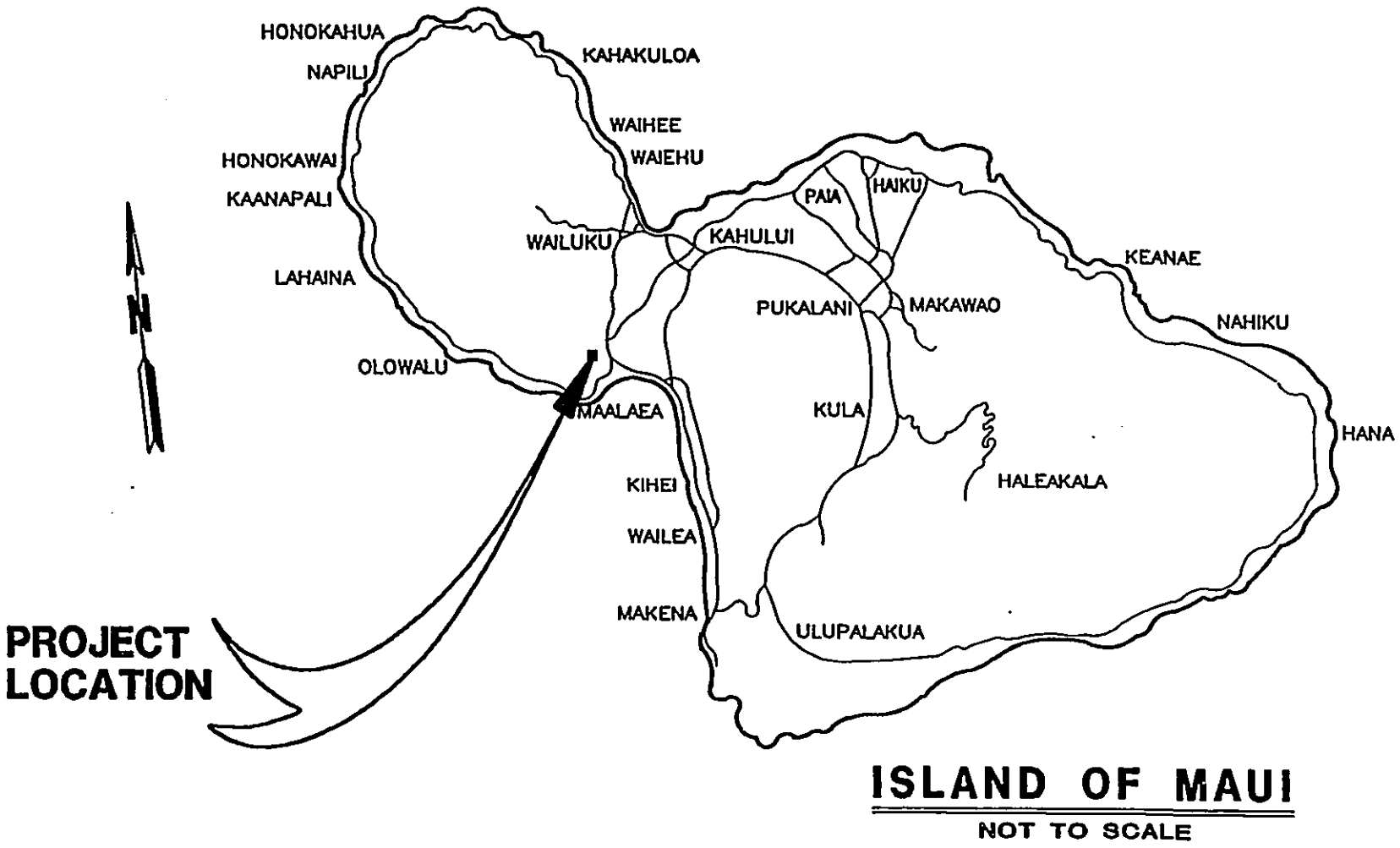
The project site is located on State owned land, west (mauka) of the Ma'alaea Small Boat Harbor. The entire project area is located within the State Conservation Land Use District ("Limited" and "General" subzones).

The State currently leases the property for cattle ranch operations (State Lease No. S-5277.)

B. PROJECT NEED

Current water storage for fire protection in the Ma'alaea area is not available. The two former 12,000 gallon steel tanks were badly corroded and removed from the site in July, 1994. The proposed project will provide improved water distribution and fire flow capabilities to service the existing Ma'alaea community.

The project is also intended to meet the fire flow and water distribution needs of the proposed Ma'alaea Triangle mixed use commercial development. The Ma'alaea Triangle project would require construction of a 240,000 gallon storage facility. The owners of the Ma'alaea Triangle property (Ma'alaea Triangle Partnership) and the Maui County Board of Water Supply have entered into a joint agreement for purposes of constructing the tank and related facilities in order to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N
PROJECT
LOCATION
ISLAND OF MAUI
NOT TO SCALE

FIGURE 1

source: WARREN S. UNEMORI ENGINEERING, INC.

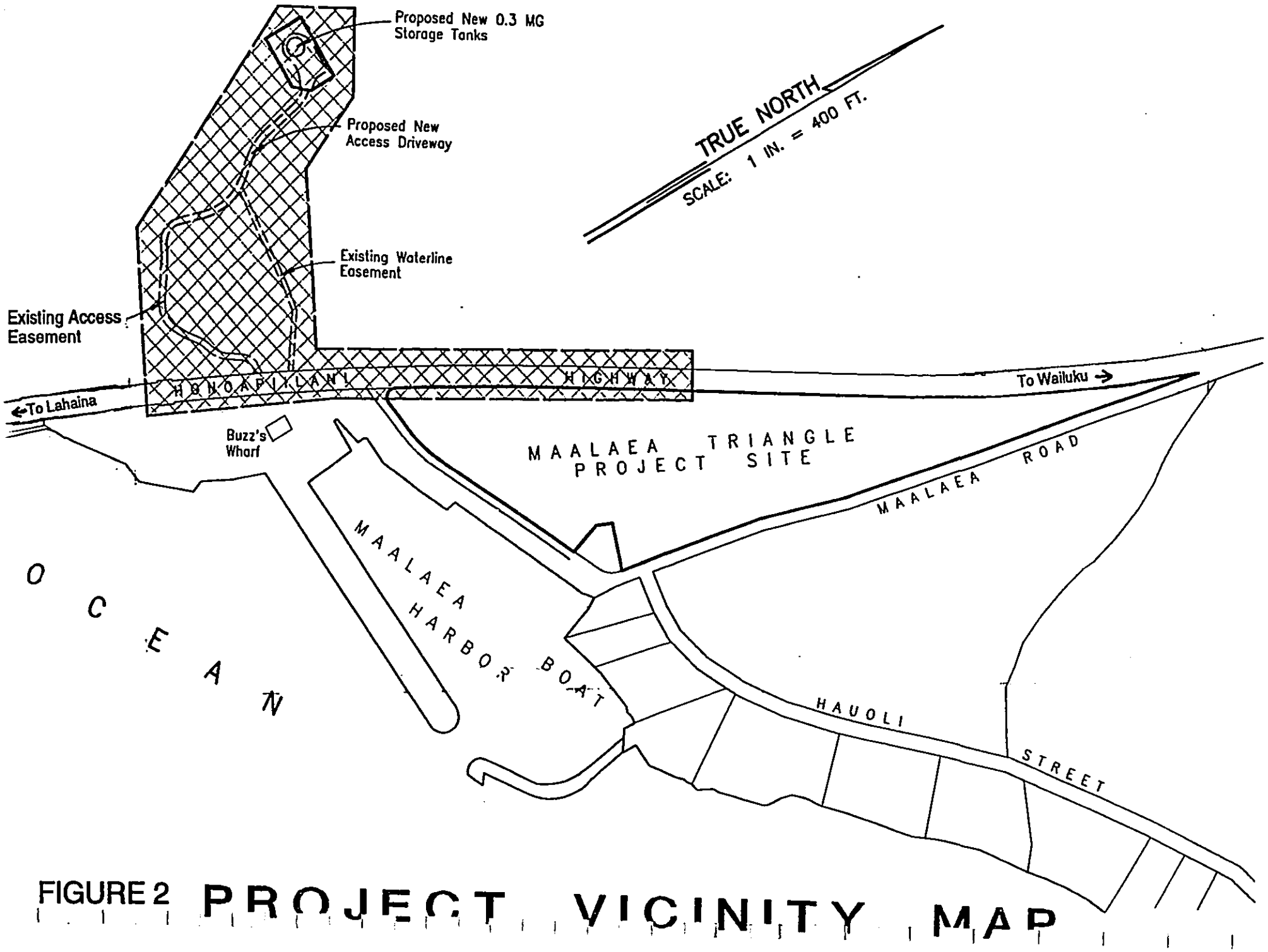
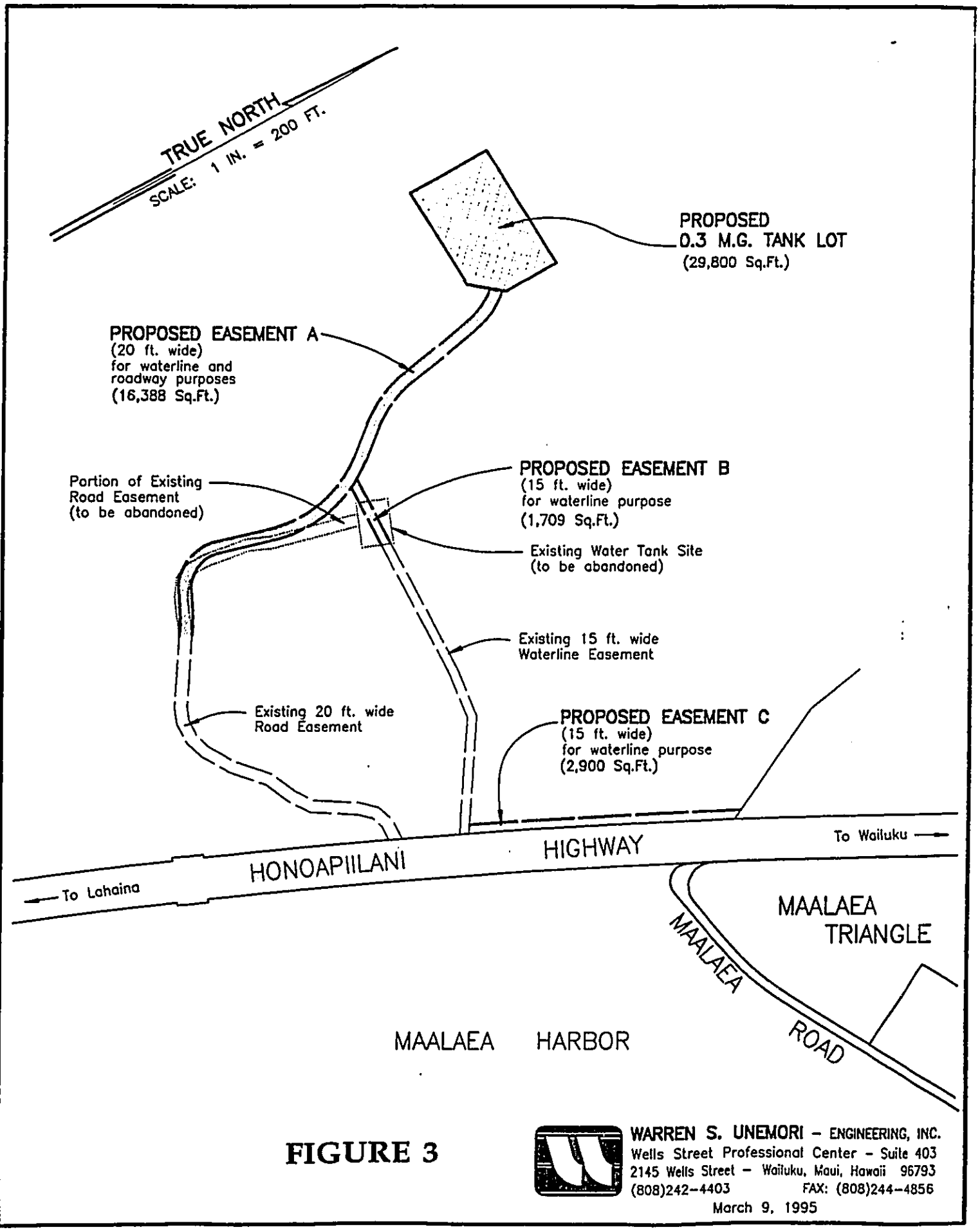


FIGURE 2 PROJECT VICINITY MAP



projects\87036\tankesmt

FIGURE 3

WARREN S. UNEMORI – ENGINEERING, INC.
Wells Street Professional Center – Suite 403
2145 Wells Street – Wailuku, Maui, Hawaii 96793
(808)242-4403 FAX: (808)244-4856

March 9, 1995

provide adequate service for the existing Ma'alaea Community and the Ma'alaea Triangle project.

C. PROPOSED ACTION

The proposed improvements consist of the construction of a 300,000 gallon reinforced concrete reservoir, access road, transmission lines and necessary connections and appurtenances, and tank site improvements including but not limited to valves and valve manholes, asphalt paved perimeter road, fencing, drainage ditches, grassing and landscaping. (See Figure 4.)

The property will be subdivided to create a lot for the tank site of approximately 29,800 square feet.

The proposed concrete tank will be approximately 60 feet wide and 22 feet high.

Access to the site will be from Honoapiilani Highway via the existing easement to the two 12,000 gallon steel tanks. The entire driveway access will paved from the highway to the tank site, this will involve improving the existing access to the former site of the two 12,000 gallon tanks, which is currently an unimproved dirt road.

The finished floor elevation of the proposed tank will be 220 feet above M.S.L.

The new access easement would begin near the existing tank site. The tank site will be abandoned. The Department of Water Supply has removed the two 12,000 gallon steel tanks and other related and unnecessary appurtenances in and around the existing tank site.

In addition, a new waterline access easement will run parallel to Honoapiilani Highway for approximately 580 feet. (See Figure 3.)

Preliminary estimates indicate the project will cost approximately $1 million. The Board of Water Supply and Ma'alaea Triangle Partnership will share in the cost of the construction of the project on the basis that the Board shall pay twenty percent of the contract construction costs, up to a maximum of $300,000.

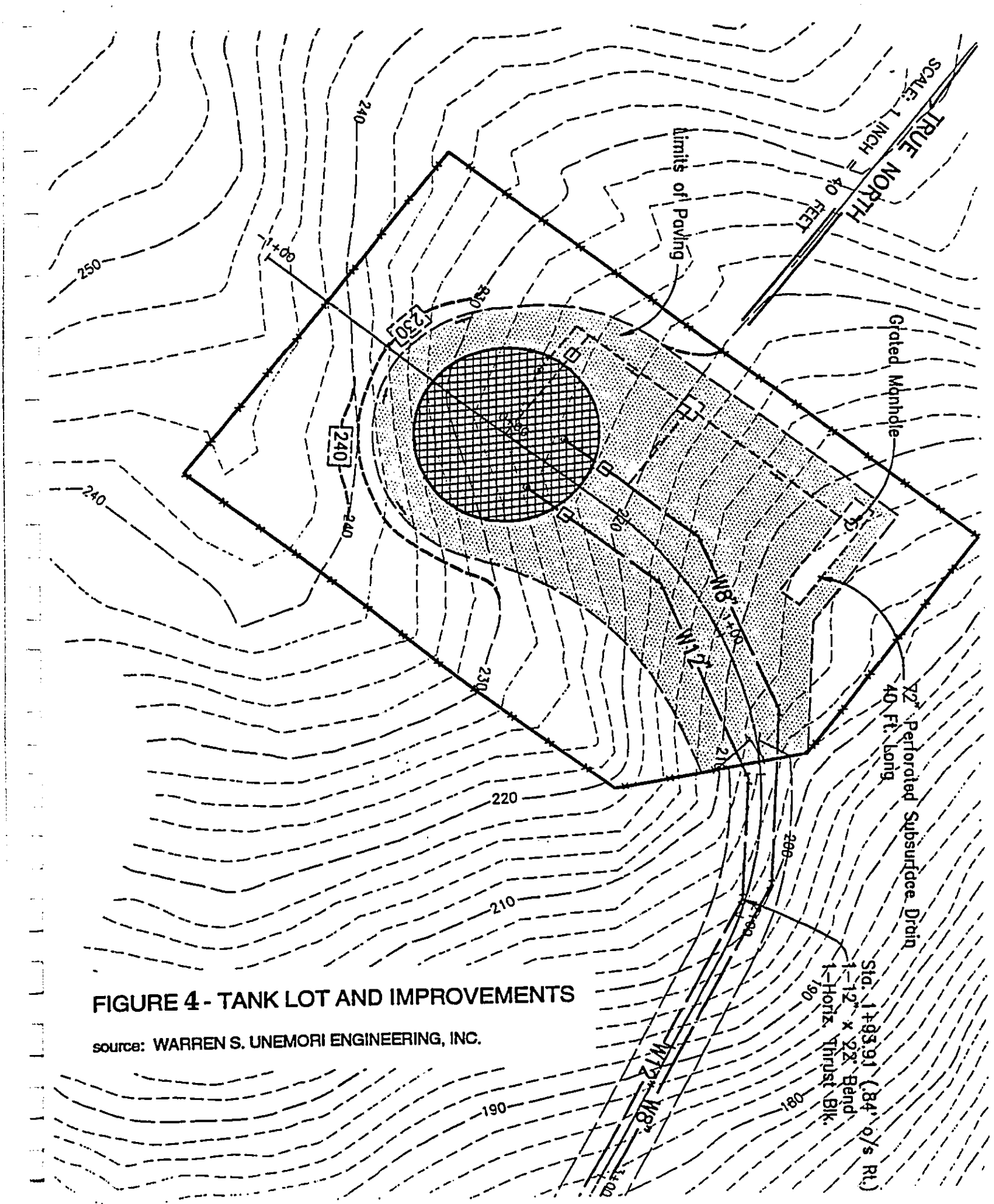


FIGURE 4 - TANK LOT AND IMPROVEMENTS

source: WARREN S. UNEMORI ENGINEERING, INC.

II. DESCRIPTION OF THE EXISTING ENVIRONMENT

A. PHYSICAL SETTING

1. Surrounding Land Uses

The proposed project area is located within the 4,800 acre Perreira Cattle Ranch. This ranch extends from Honoapiilani Highway mauka to an elevation of approximately 2,500 feet above M.S.L.

Ma'alaea Small Boat Harbor is located directly across Honoapiilani Highway from the project's access road (See Figure 2). As one of only two small boat harbors on Maui, the harbor is a center of activity for the fishing, charter, and tour boat industries.

The proposed Ma'alaea Triangle project would be located on a triangular shaped parcel situated approximately 100 feet north and mauka of Ma'alaea Small Boat Harbor. Ma'alaea Road borders its makai and eastern boundaries and Honoapiilani Highway borders the mauka (west) boundary.

2. Topography

The lower portion of the project area, bordering Honoapiilani Highway, is gradually sloping (4 to 6%). A transition is made to the more steeply shaped Mauka slopes approximately 300 to 400 feet west of the Highway. In the vicinity of the proposed tank site slopes range between 14 and 22%.

3. Geology and Soils

The island of Maui is part of a large volcanic mass of two volcanoes. West Maui is the geologically older of the two as is evident form the valleys caused by a long process or erosion, which is still continuing. The geology of the project is derived form the Wailuku volcanic series. Soils in the upper project area have been classified as Rock land (rRK), and the lower area near the Highway as Stony alluvial land (rSM). (U.S. Soil Conservation Service, 1972) Rock land is made up of areas where exposed rock covers 25 to 90 percent of the surface. Rock outcrops and shallow soils are the main characteristics. The rock outcrops are mainly basalt and andesite. Stony alluvial land (rSM)

consists of stones, boulders, and soil deposited by streams along the bottoms of gulches and on alluvial fans.

4. Climate

The predominant winds in the Hawaiian Islands are the northeast tradewinds, which occur approximately 75% of the year. At Ma'alaea the northeast tradewinds become northerly as they are funneled between the volcanoes of east and west Maui.

During the winter, the northeast tradewinds weaken, and Kona or south to southwesterly winds may occur. Kona winds range from light and variable to gale force winds produced by local low pressure systems. Rainfall at the site averages less than 15 inches per year. Most of the rainfall in the Ma'alaea area is produced by higher intensity Kona rains during the winter months.

5. Flood Hazard

The proposed project area is designated by the Flood Insurance Rate Map as Zone C, an area of minimal flooding and no tsunami hazard (Community Panel No. 150003 0235B).

6. Flora and Fauna

Vegetation is typical of dry leeward lowlands and consists mostly of kiawe with assorted groundcover, including buffel grass, Guinea grass, piligrass and Chinese violet, 'aheahea (Chenopodium murale) and lion's ear (Leonotis nepetifolia).

Terrestrial fauna in the area is typical of dry lowland areas in Hawaii. Bird species believed to exist in this area include: mynah, house sparrow, grey francolin, lace necked dove and barred dove, housefinch, mockingbird, northern cardinal, Japanese white-eye and possibly spotted munia. Mammals and reptiles are limited to introduced species.

7. Archaeological Resources

The subject property, being located on the dry, leeward side of Maui, is an area which may have been marginal to prehistoric subsistence and settlement and, accordingly, there is a paucity of ethnographic accounts of the region. (For a complete discussion of the archaeological resources of the area refer to the Appendix.) Background research has indicated that several historic sites have been identified in the vicinity of the subject property. Site 1440 which consists of a piko stone and grinder stones know as "Kings Table" are located in the vicinity of Buzz's Wharf. State records also indicate that there are two petroglyph sites located immediately mauka of Maalaea Bay, Sites 1169 and 1199. The northern corner tank site is located approximately 100 meters south of the area described as Site 1169.

Site 1287 is described as the Maalaea Complex and consists of scattered structural remains and isolated surface scatters of midden extending along the coast from Maalaea Bay almost to McGregor Point. The current project area is near the northern edge of the Maalaea Complex.

Because of the proximity to known features in the area, an archaeological inventory survey with limited subsurface testing was conducted on the project site. A midden deposit which was known to exist along the current access easement was determined to have likely derived from the late pre-contact period. The midden site was investigated and assigned State Site #50-50-09-3555. The site was found to contain subsurface features in the form of fire pits from which samples were radiocarbon date to a probable calibrated age range of between A.D. 1660 - 1944. Additionally, a variety of cultural materials indicative of a pre-contact habitation site were recovered. Subsequent field investigations determined that there are no subsurface features within the proposed roadway corridor in the vicinity of site 3555.

In the area west (mauka) of the existing tank site, a number of features which appear to be remanants of dry land agricultural terraces were found. These features were collectively assigned State Site #50-50-09-4022. The condition of these features are extremely deteriorated due to the grazing of cattle accross the property. The majority of the feature remanants lie outside of the proposed construction corridor.

8. Visual Resources

The proposed tank site is not located in a important visual corridor. Portions of the site are visible from the Kihei and Ma'alaea area. The lands mauka of Honoapiilani Highway in this area are expansive and barren, free of structures.

B. SOCIAL AND ECONOMIC ENVIRONMENT

Ma'alaea Small Boat Harbor provides mooring for commercial fishing boats, charter boats and private pleasure craft. As one of only two small boat harbors on Maui, the harbor is now a bustling center of activity for the fishing, charter and tour boat industries. A developed strip of residential condominiums lies to the east along Haoli Street. The proposed Ma'alaea Triangle project is located directly adjacent to Ma'alaea Harbor (See Figure 2) and would result in the development of a mixed-use commercial center which would include the proposed Maui Ocean Center, a marine display oceanarium, restaurants, office, and other retail type uses.

C. INFRASTRUCTURE

1. Roadways

Access to the proposed project area is from Honoapiilani Highway, the major thoroughfare linking the resort communities of West Maui to Central and East Maui.

2. Drainage

Run-off from the project area is currently conveyed across Honoapiilani Highway through box culverts and into Ma'alaea Harbor and Bay.

3. Water

The water source for Ma'alaea is located in Mokuhau where several wells provide a total capacity of 10 million gallons per day. From this source 24 and 18 inch transmission lines transport water south toward Kihei. An 8 inch line

then branches off from this transmission system to serve the Ma'alaea community. Storage facilities in the area at one time included the two 12,000 gallon steel tanks, which were located within the project area, approximately 550 feet mauka of Honoapiilani Highway. The Water Department dismantled these tanks in July, 1994. A 50,000 gallon corrugated steel tank is located along the north side of Kihei Road, approximately 1200 feet makai of the Kihei Road/Honoapiilani Highway intersection. This storage tank is old, deteriorated and no longer in use.

Existing facilities do not provide adequate fire flow protection and delivery for the Ma'alaea Community. The County Department of Water Supply determined in 1985 that a storage tank of at least 100,000 gallons was necessary to meet the needs of the Ma'alaea Community, and that a 300,000 gallon tank would be needed to meet future needs. The proposed 300,000 gallon tank would meet the needs of the Ma'alaea Community and the proposed Ma'alaea Triangle project.

III. POTENTIAL IMPACTS AND MITIGATION MEASURES

A. PHYSICAL ENVIRONMENT

1. Surrounding Uses

The proposed water tank, access road and other improvements should not adversely affect the surrounding cattle ranch operations. Water tanks are commonly situated within cattle grazing areas. The proposed tank site will be fenced so as to preclude cattle from entering the area.

2. Topography/Landform

The proposed project will involve the clearing, grubbing and grading of approximately 23,000 square feet of land that is presently undeveloped. The proposed tank site was chosen as the preferred location since it is an area of lessor slopes than surrounding areas at the required elevation. In general, finished contours have been designed to follow existing grades in order to minimize earthwork costs. At the tank site, approximately sixteen feet of excavation will occur at the west (mauka) portion to provide a level area large

enough for the tank. In order to minimize construction related impacts related to soil and wind erosion, mitigation measures such as watering for dust control and revegetation of the site as soon practical will be implemented. In addition, the tank site has been designed so that the tank is not overly obtrusive visually.

3. Flora and Fauna

The proposed project will result in the removal of some existing vegetation from the site, however, it appears that there are no significant floral resources in the area. The project will be landscaped with plants which are compatible with the project setting. Similarly, the project would not result in the alteration or destruction of any significant animal habitats.

4. Archaeological Resources

Based on the project's proximity to nearby heiau and petroglyph sites, an inventory survey with limited subsurface testing was conducted on the subject property (see Appendix). The property shows evidence of extensive disturbance, almost certainly the result of grazing livestock over the past century. Two sites of historic significance were identified as being within the immediate project area (Sites 3555 and 4022).

Site 3555 was found to contain subsurface features in the form of fire pits from which samples were radiocarbon dated to a probable calibrated age range of between A.D. 1660 - 1944. However, further investigation revealed that htere are no subsurface materials in the roadway corridor and it was determined that Site 3555 lies adjacent to the access easement. Thus, the future roadway development should have "no adverse effect" on this site.

Site 4022 contains remanents of dry land agricultural terraces, small portions of which lie within the roadway corridor. Because of the extant of the deterioration to all of the features this site, the scientific value of this site appears to be minimal. However, the features which are within the roadway corridor will be sufficiently documented through mapping and descriptive information provided in the final inventory survey report which is requried to be reviewed and approved by the State Historic Preservation Division of the Department of Land and Natural Resources.

There are also a number of archaeological sites in close proximity to the project area. These sites will be appropriately identified during construction in order to prevent the potential for inadvertant damage or demolition from construciton related activities.

5. Visual Resources

Although the proposed project will not result in the impact any significant view planes there is a potential for the tank to represent a rather visually obtrusive image on a hill side which is currently free of structures. There are three mitigation measures which have or will be implemented in order to minimize this potential impact. First, siting of the tank has been done so that it is tucked into the hillside, thus, minimizing its visibility. Second, the tank will be painted with a color that blends in with the surrounding environment as opposed to the standard green which is normally used by the Water Department. Third, the tank site will be landscaped with trees that will act as a visual buffer. With the employment of these three mitigation measures, it is anticipated that the water tank will have minimal impact on visual resources.

B. SOCIAL-ECONOMIC ENVIRONMENT

On a short term basis, the project will support construction and construction related employment.

On a long term basis, the project will aid the long-term economic vitality of the region by ensuring the integrity of fire protection and water delivery services for existing and planned residential and business establishments in the Ma'alaea area.

C. INFRASTRUCTURE

1. Roadways

With the relatively low number of trips generated by the proposed use, the project's impacts on the public roadway system is not expected to be significant.

2. Drainage

Surface runoff is expected to increase slightly due to the increase in impermeable surfaces. Runoff form the tank site and paved areas will either be directed into a dry well filled with large crushed rocks and/or a perforated drainline or handled in another manner developed during the required National Pollution Discharge Elimination System (NPDES) review process.

3. Water

As indicated previously, the intent of the proposed project is to improve water delivery and fire flow protection for the Ma'alaea community. The project will result increased water storage and delivery head for the existing community and will meet the needs of the planned Ma'alaea Triangel commercial development.

D. SECONDARY OR CUMULATIVE IMPACTS

Major infrastructure projects have the potential to generate secondary impacts by removing constraints for future developement and stimulating the pace of growth. The decision to build a 300,000 gallon tank was based on satisfying the needs of the existing community and the Maalaea Triangle project. Although there will be some capacity to meet additional future needs, this capacity is very limited and any major development would be required to construct additional storage facilities. Thus, the proposed project does not have the potential to facilitate or encourage new development in the Ma'alaea area.

It is also important to note that regional growth and development in Maui County is guided by Community Plans as well as the State Land Use Law and Maui County zoning. The Department of Water Supply is mandated by the Maui County Charter to implement the Community Plans. New development projects cannot occur unless they are consistent with the Community Plan Land Use Map and policies, as well as State and County zoning. Besides the Ma'alaea Triangle project, there is very little vacant land in Maalaea designated for future growth. Thus, major land use policiy changes would need to occur before significant growth could take place in the Maalaea area.

In sum, with regards to future development potential in the Ma'alaea area, this project is considered to have minimal impacts based on the limited amount of additional storage capacity and the lack of vacant lands designated or zoned for urban development.

IV. RELATIONSHIP TO GOVERNMENT PLANS, POLICIES AND CONTROLS

A. STATE LAND USE DISTRICTS

The Hawaii Land Use Law, Chapter 205, Hawaii Revised Statutes, establishes four major land use districts in which all lands in the State are placed. These districts are designated "Urban", "Rural", "Agriculture", and "Conservation". The subject property is located within the "Conservation" district. Conservation District lands are governed by the Board of Land and Natural Resources and Title 13, Chapter 2, Administrative Rules of the Department of Land and Natural Resources. All proposed uses within the Conservation District must be approved by the Board. The rules establish four subdistricts within the Conservation District, the subject action would occur within the "General" and "Limited" subzones. The development of water storage and transmission facilities is listed as an "identified land use" within the "General" and "Limited" subzones which require a Conservation District Use Permit from the Board of Land and Natural Resources.

B. GENERAL PLAN OF THE COUNTY OF MAUI

The General Plan of the County of Maui (1990 update) provides long term goals, objectives and policies directed toward the betterment of living conditions in the county. Addressed are social, environmental, and economic issues which influence future growth in Maui County. The following General Plan objectives and policies are addressed by the proposed project:

Objective: To provide an adequate supply of potable and irrigation water to meet the needs of Maui County's residents.

Policies:

- Support the improvement of water transmission systems to those areas which historically experience critical water supply problems provided the improvements are consistent with the water priorities and the County's Water Use and Development Plan provisions for the applicable Community Plan area.

- Develop improved systems to provide better fire protection.

Objective: To create an atmosphere which will convey a sense of security for all residents and visitors and aid in the protection of life and property.

Policy:

- Reduce fire losses by improving and maintaining fire fighting apparatus.

C. KIHEI-MAKENA COMMUNITY PLAN

Nine (9) community plan regions have been established in Maui County. Each region's growth and development is guided by a Community Plan which contain objectives and policies in accordance with the County General Plan. The purpose of the Community Plan is to outline a relatively detailed agenda for carrying out these objectives.

The proposed project is located within the Kihei-Makena Community Plan region. The proposed project would facilitate implementation of the Kihei-Makena Plan by addressing the following objective:

"Support and expand the projected development of the Central Maui Water System development program to keep pace with future Kihei water needs and assist in coordinating needed utility improvements with resident needs."

V. FINDINGS AND CONCLUSIONS

The proposed water tank, transmission line and associated improvements will improve the domestic water delivery and fire flow protection systems for the Ma'alaea community. Improved fire protection and water delivery resulting from the proposed project will promote the health, safety and welfare of residents and visitors to the area. The project will also support future commercial growth in the area which is consistent with existing plans, policies and ordinances of the county of Maui and State of Hawaii.

The proposed project will involve earthwork and construction activities. In the short term, these activities may generate temporary impacts related to soil and wind erosion, however, mitigation measures will be employed to minimize potential adverse effects. As there are no residences in the immediate area, nuisances normally associated with construction activities will be minimal.

From a long-term perspective, the proposed project is not anticipated to result in adverse environmental impacts. There are no known unique or endangered species or habitats in the area. An archaeological site adjacent to the roadway easement (Site 3555) has been identified and examined and it has been determined that the roadway should have no significant affect on this site. The features of Site 4022 which lie within the roadway corridor will be suffciently documented, as per the requirements of the State Historic Preservation Division Office.

The proposed tank site is situated so as to minimize adverse visual impacts and the project will be landscaped provided for additional visual screening.

In light of the foregoing findings, it is concluded that the proposed action will not result in any significant impacts.

VI. AGENCIES CONTACTED IN THE PREPARATION OF THE DRAFT ENVIRONMENTAL ASSESSMENT

The following agencies were consulted in preparing this environmental assessment:

County of Maui:

1. Department of Planning

State of Hawaii

1. Department of Land and Natural Resources
   - Division of Historic Sites
   - Division of Land Management
   - Office of Conservation and Environmental Affairs

APPENDIX A
Draft Environmental Assessment
COMMENTS AND CORRESPONDANCE

University of Hawai'i at Mānoa

Environmental Center
A Unit of Water Resources Research Center
Crawford 317 • 2550 Campus Road • Honolulu, Hawai'i 96822
Telephone: (808) 956-7361 • Facsimile: (808) 956-3980

November 7, 1994
EA:0097

Mr. Ed Kagehiro
Department of Water Supply
County of Maui
200 South High Street
Wailuku, Hawaii 96793

Dear Mr. Kagehiro:

Draft Environmental Assessment (DEA)
Maalaea Water Storage Tank and Related Improvements
Wailuku, Maui

The referenced project involves construction of a 300,000 gallon water storage tank, an access road, a 12 inch pipeline, and other appurtenances. The proposed tank will be used to upgrade the fire protection capability of the Maalaea community. The owners of the Maalaea Triangle property and the Maui County Board of Water Supply have entered into a joint agreement for purposes of constructing the water tank.

Our review was completed with the assistance of Chris Welch of the Environmental Center.

Although the document satisfactorily addressed many impacts of the proposed tank development, two major omissions need to be remedied in the final document. First, the document does not discuss broader issues of water resources in the area. Will the water for the new tank also be drawn from developed wells in Mokuhau, or will new sources need to be developed in the future? How does the current project fit into water plans for the County of Maui? If fire suppression is a major objective of this development, has use of non-potable sources been considered? Since water is a limiting and scarce resource for development in Hawaii, these questions are pertinent.

Second, although several concurrent developments are mentioned, most consideration of cumulative and secondary impacts of the proposed action is confined to a perspective of meeting existing and future needs. Sections 11-200-12(b)(6) and (8) HAR, define secondary

and cumulative impacts as criteria for significance determination. Water infrastructure projects can have tremendous impacts in terms of future development potential for any region. Secondary impacts including, but not limited to wastewater disposal, traffic, and government service needs, which relate to this potential should be defined and assessed.

It is noted that the Maalaea area has been undergoing tremendous change. Recently, a DEA was published concerning a sea water system and drainage improvement project for the Maalaea Triangle and Maui Ocean Center. At the harbor adjacent to the Maalaea Triangle the US Army Corps of Engineers is undertaking a project that will extend the ewa harbor breakwall. These projects are cumulative in nature. The proposed project, if implemented, will have synergistic effects upon these other ventures which need to be identified and assessed.

Thank you for the opportunity to comment.

Sincerely,

John T. Harrison
Environmental Coordinator

cc: OEQC
Chris Hart & Partners
Roger Fujioka
Chris Welch

BOARD OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 1109
WAILUKU, MAUI, HAWAII 96793-7109

February 8, 1995

Mr. John T. Harrison
Environmental Coordinator
UH ENVIRONMENTAL CENTER
317 Crawford
Honolulu, Hawaii 96822

Dear Mr. Harrison:

Re: MAALAEA WATER STORAGE TANK AND RELATED IMPROVEMENTS
DRAFT ENVIRONMENTAL ASSESSMENT (DEA)

This letter is in response to the Environmental Center's comments, dated November 7, 1994, regarding the DEA prepared for the subject project.

Your comments essentially requested more information regarding the project's relation to water resources in the area and the potential for secondary or cumulative impacts. The following responses relate to these concerns in the order they were presented.

Water Resources:

Water for the new tank will continue to be provided from the Mokuhau source, no new sources are currently planned. Implementation of this project is one step towards providing adequate fire flow throughout Maui County. Maui County does not have a dual system for drinking water and fire protection and thus there is no non-potable distribution line developed in the Maalaea area nor are there plans for implementing such a system due to cost constraints.

Secondary Impacts:

As stated in the DEA, this project is primarily intended to meet the fire flow protection needs for existing development in the Maalaea area as well as the Maalaea Triangle mixed-used commercial development. At present, water storage for fire protection in Maalaea is not available. In 1985, it was determined that a

storage tank of at least 100,000 gallons was necessary to meet the needs of the Maalaea Community, and that a 300,000-gallon tank would be needed to meet future needs. The water storage requirements for the Maalaea Triangle project is 230,000 gallons. The decision to build a 300,000-gallon tank was based on satisfying the needs of the existing community and the Maalaea Triangle project. Although there will be some capacity to meet additional future needs, this capacity is very limited; and any major development would likely be required to construct additional storage facilities. Thus, the proposed project does not have the potential to facilitate or encourage new development in the area.

It is also important to note that regional growth and development in Maui County is guided by Community Plans as well as the State Land Use Law and Maui County zoning. The Department of Water Supply is mandated by the Maui County Charter to implement the Community Plans. New development projects cannot occur unless they are consistent with the Community Plan Land Use Map and policies, as well as State and County zoning. Besides the Maalaea Triangle project, there is very little vacant land in Maalaea designated for future growth. Thus, major land use policy changes would need to occur before significant growth could take place in the Maalaea area.

In sum, with regard to future development potential in the Maalaea area, this project is considered to have minimal impacts based on the limited amount of additional capacity and the lack of vacant lands designated or zoned for urban development.

The impacts of the Maalaea Triangle and the Maui Ocean Center have been thoroughly documented during the Special Management Area permitting process. The proposed water system improvements would insure that adequate fire flow capacities are in place and would not increase the development potential of the Maalaea Triangle project beyond that which has been already assessed and approved via the SMA process.

It is our understanding that the nature of the harbor expansion project has yet to be defined; and, as such, future water needs are not certain. When project plans are more clearly defined and detailed, an analysis of water storage and transmission needs will be made.

APPENDIX B
ARCHAEOLOGICAL REPORT

CORRECTION

THE PRECEDING DOCUMENT(S) HAS BEEN REPHOTOGRAPHED TO ASSURE LEGIBILITY
SEE FRAME(S)
IMMEDIATELY FOLLOWING

BOARD OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 1109
WAILUKU, MAUI, HAWAII 96793-7109

February 8, 1995

Mr. John T. Harrison
Environmental Coordinator
UH ENVIRONMENTAL CENTER
317 Crawford
Honolulu, Hawaii 96822

Dear Mr. Harrison:

Re: MAALAEA WATER STORAGE TANK AND RELATED IMPROVEMENTS
DRAFT ENVIRONMENTAL ASSESSMENT (DEA)

This letter is in response to the Environmental Center's comments, dated November 7, 1994, regarding the DEA prepared for the subject project.

Your comments essentially requested more information regarding the project's relation to water resources in the area and the potential for secondary or cumulative impacts. The following responses relate to these concerns in the order they were presented.

Water Resources:

Water for the new tank will continue to be provided from the Mokuhau source, no new sources are currently planned. Implementation of this project is one step towards providing adequate fire flow throughout Maui County. Maui County does not have a dual system for drinking water and fire protection and thus there is no non-potable distribution line developed in the Maalaea area nor are there plans for implementing such a system due to cost constraints.

Secondary Impacts:

As stated in the DEA, this project is primarily intended to meet the fire flow protection needs for existing development in the Maalaea area as well as the Maalaea Triangle mixed-used commercial development. At present, water storage for fire protection in Maalaea is not available. In 1985, it was determined that a

storage tank of at least 100,000 gallons was necessary to meet the needs of the Maalaea Community, and that a 300,000-gallon tank would be needed to meet future needs. The water storage requirements for the Maalaea Triangle project is 230,000 gallons. The decision to build a 300,000-gallon tank was based on satisfying the needs of the existing community and the Maalaea Triangle project. Although there will be some capacity to meet additional future needs, this capacity is very limited; and any major development would likely be required to construct additional storage facilities. Thus, the proposed project does not have the potential to facilitate or encourage new development in the area.

It is also important to note that regional growth and development in Maui County is guided by Community Plans as well as the State Land Use Law and Maui County zoning. The Department of Water Supply is mandated by the Maui County Charter to implement the Community Plans. New development projects cannot occur unless they are consistent with the Community Plan Land Use Map and policies, as well as State and County zoning. Besides the Maalaea Triangle project, there is very little vacant land in Maalaea designated for future growth. Thus, major land use policy changes would need to occur before significant growth could take place in the Maalaea area.

In sum, with regard to future development potential in the Maalaea area, this project is considered to have minimal impacts based on the limited amount of additional capacity and the lack of vacant lands designated or zoned for urban development.

The impacts of the Maalaea Triangle and the Maui Ocean Center have been thoroughly documented during the Special Management Area permitting process. The proposed water system improvements would insure that adequate fire flow capacities are in place and would not increase the development potential of the Maalaea Triangle project beyond that which has been already assessed and approved via the SMA process.

It is our understanding that the nature of the harbor expansion project has yet to be defined; and, as such, future water needs are not certain. When project plans are more clearly defined and detailed, an analysis of water storage and transmission needs will be made.

Thank you for commenting on the Draft Environmental Assessment. If you have any further questions, you may contact Mr. Ed Kagehiro of my staff at 243-7835 or Mr. Rory Frampton of Chris Hart & Partners at 242-1955.

Sincerely,

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI

David R. Craddick
Director

DRC:as
xc: Rory Frampton

APPENDIX B
ARCHAEOLOGICAL REPORT

AN ARCHAEOLOGICAL INVENTORY SURVEY REPORT FOR THE PROPOSED MA'ALAEA WATER TANK LOCATED AT TMK: 3-6-01: 14 IN UKUMEHAME AHUPUA'A, WAILUKU DISTRICT ISLAND OF MAUI

AUGUST 1994

DRAFT

Prepared for: Mr. Michael Spalding
Ma'alaea Triangle Partners
75-B North Church Street
Wailuku, Hawaii 96793

Prepared by: Archaeological Consultants of Hawaii, Inc.
James R. Moore, B.S.
Joseph Kennedy, M.A.
59-624 Pupukea Road
Haleiwa, Hawaii 96712

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Abstract

An archaeological inventory survey with limited subsurface testing was conducted on a property planned to be utilized for a water tank serving the proposed Ma'alaea Triangle Project. A midden deposit which was known to exist along the current access easement to an existing water tank was investigated and was determined to have likely derived from the late pre-contact period. No other sites of historic significance were identified on the subject property.

The midden deposit which was investigated in the current survey has been assigned State Site #50-50-09-3555. The site was found to contain subsurface features in the form of fire pits from which samples were radiocarbon dated to a probable calibrated age range of between A.D. 1660 - 1944. Additionally, a variety of cultural materials indicative of a pre-contact habitation site were recovered. Plans indicate that the access easement along which Site 3555 lies is in an area not scheduled for improvement and future developments will have "no adverse effect" on significant historic sites located on the subject property.

Section 1: Introduction

At the request of Mr. Michael Spalding of Michael Spalding Realty an archaeological inventory survey with subsurface testing was conducted by Archaeological Consultants of Hawaii, Inc. (ACH) on a property located at TMK: 3-6-01:14 at Kealaloloa, in the ahupua'a of Ukumehame, Wailuku District, on the Island of Maui (see Map 1). The current owner of the property is the State of Hawaii. The purpose of an inventory survey is to evaluate the significance of historic resources located on a property and to make recommendations concerning the mitigation of future construction activities upon possibly significant historic resources.

Section 2: Physical Setting

The subject property is located at geographic grid coordinates 20 47'35"N by 156 31'10"W and at UTM coordinates 2301200mN and 758200mE (see Map 2). The area surveyed by ACH is located mauka of Honoapiilani Highway across from Ma'alaea Small Boat Harbor. The parcel surveyed consists of a pair of connecting easements (existing waterline and access easements) and the proposed location of the new water tank.

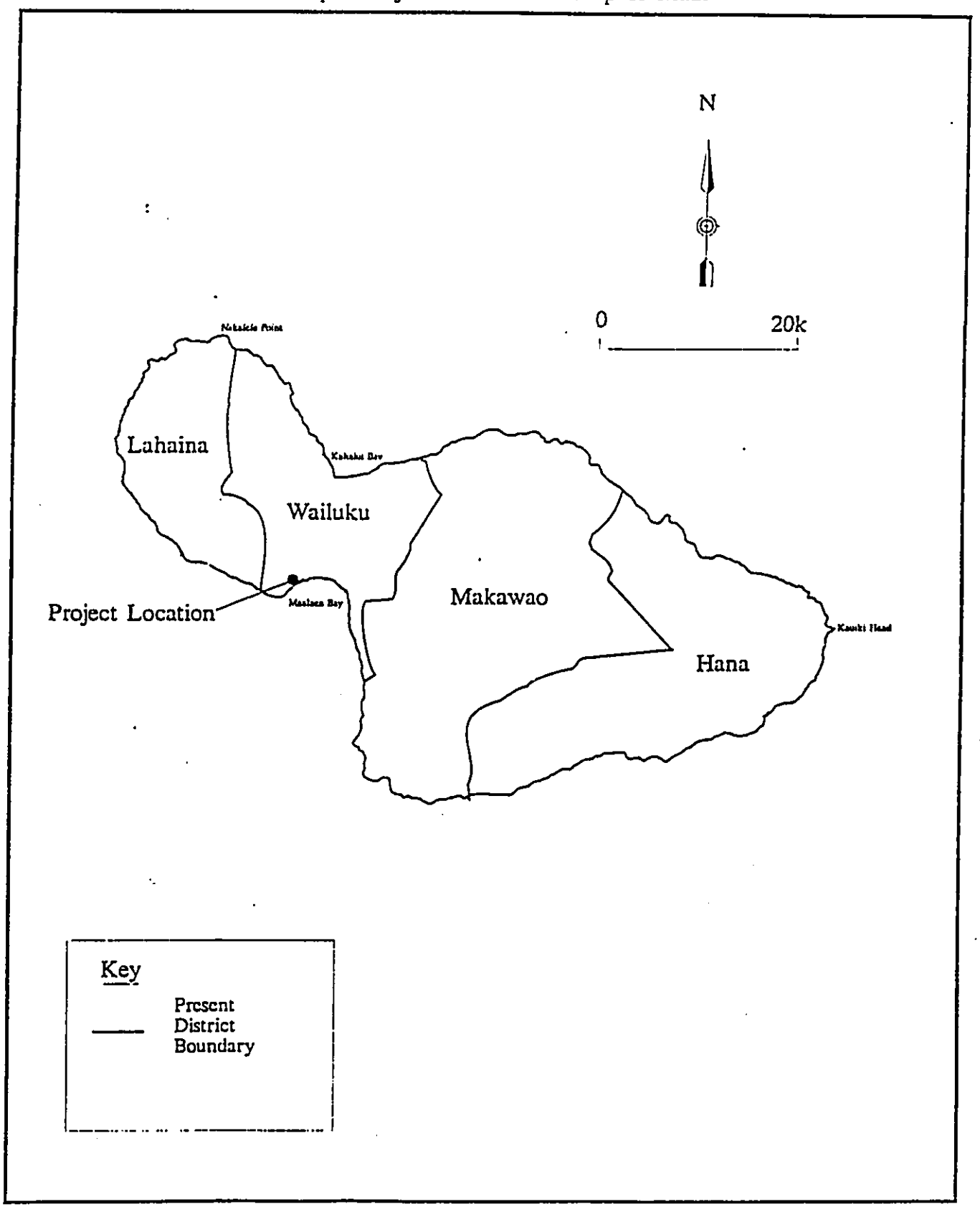
The parcel, located at the base of Kealaloloa Ridge, varies in elevation between 20 and 250ft above mean sea level (AMSL). Average annual rainfall measures approximately 15 inches (Armstrong 1973). Foote et al. (1972) depict the expected soils on the subject property to be Stony Alluvial Land at the lower elevations and as Rock Land at elevations above approximately 50ft AMSL. Vegetation on the subject property consists entirely of scattered, scraggly kiawe (Prosopis pallida) interspersed by isolated tufts of exotic grasses. This is due to the continual grazing of cattle across the property.

Section 3: Historic Review

Section 3.1: Land Use History

Today, the surveyed property is located near agricultural lands (the pineapple fields) to the east on the fringe of conservation (livestock grazing) lands extending westward. The subject property received no Land Commission Awards during the Great Mahele. However, a grant to lease these, and adjacent lands was enacted between the Territory of Hawaii and the Wailuku Sugar Company as recorded on a 1941 document. According to informant testimony, sugarcane has been grown in the Ma'alaea plains east of the subject property, by the Wailuku Sugar Company, since the turn of the century.

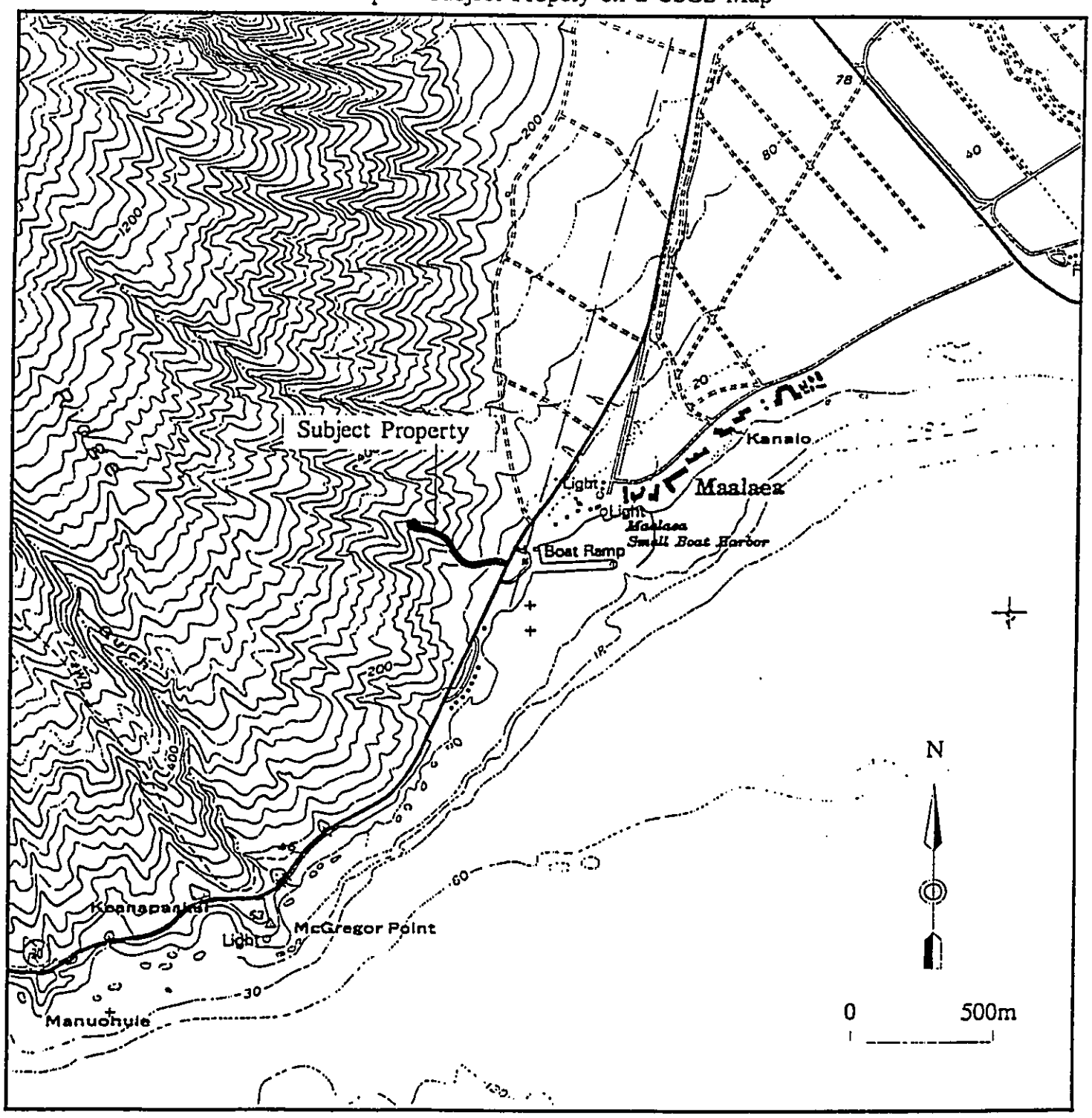
Map 1: Project Loaction on Map of Maui



TMK: 3-6-01: 14 & 4-8-01: 1 Ma'alaea Tank Site

Archaeological Consultants of Hawaii, Inc. 1994

Map 2: Subject Propety on a USGS Map



TMK: 3-6-01: 14 & 4-8-01: 1 Ma'alaea Tank Site source: USGS 7.5 Minute Series (Topographic) Ma'alaea Quadrangle 1983

The subject property, being located on the dry, leeward side of Maui, is an area which may have been marginal to prehistoric subsistence and settlement and, accordingly, there is a paucity of ethnographic accounts of the region. The subject property was likely the relatively peripheral, intermediate lands of the ahupua'a, removed geographically from habitation zones typical of prehistoric Maui. Inhabited areas were: the initially settled shoreline endowed with the marine resources, (locally, the Ukumehame coastal flats); and the uplands, utilized for dryland agriculture, which supported the late prehistoric population expansion (the West Maui Mountains). This scenario is substantiated, for Maui, by Kirch, who states:

> Moving inland, the intermediate zone is relatively devoid of sites until the uplands are reached ... (1985:138).

The historic population centers of this region are located to the east and southwest of the project area, in the vicinity of Kealia Pond and the Ukumehame State Beach Park, respectively (Tomonari-Tuggle & Tuggle 1991 and Moore & Kennedy 1994). A small population was thought to have utilized the area near the subject property at Ma'alaea Harbor in the late pre-contact period. The distribution of known sites at the Department of Land and Natural Resources, State Historic Preservation Department (DLNR-SHPD), reflects this former settlement pattern.

Cattle production and sugarcane cultivation were introduced to the area sometime after 1823, by James Louzada of Waimea, Hawaii. Ten years later, sugarcane as well as taro was under cultivation by the local population for there were reports of drought affecting these two crops at Waikapu. Cane production intensified following the construction of a steam driven mill in 1862. Inspection of Monserratt's 1875 (Waikapu Ahupua'a) and 1879 (Coast Line of Kahului & Ma'alaea Bays) island survey maps revealed that by the time of the surveys there were no structures remaining in the vicinity of the property.

Today, much of the lands surrounding the subject property continue to be used for the production of cane and the grazing of cattle. In the recent past, condominiums have been developed in the coastal areas to the east. With the pressures of an increasing population and a decline in state-wide sugar production, it is likely that the area will continue to experience expansion and development.

Section 3.2: Previous Archaeology

Earlier this century, Winslow M. Walker conducted an island-wide survey of Maui for the B.P. Bishop Museum. Walker's inventory concentrated on sites involving monumental

constructions and included two heiau at Ukumehame and a heiau with associated petroglyphs at Ma'alaea. He wrote that along the coast between Ma'alaea and McGregor Point:

> ... at least 45 [shelters] were noted. The shelters are low walled semi-circular or oval enclosures built against some large rock or group of rocks. Shells and pebbles are found around these sites (Walker unpublished).

Background research has indicated that several prehistoric sites have been identified in the vicinity of the subject property in Ukumehame Ahupua'a as well as neighboring Waikapu Ahupua'a. Among the sites near Ma'alaea Bay is Site 1440 which consists of a piko stone and grinder stones known as "Kings Table" located immediately behind Buzz's Wharf (see Map 3).

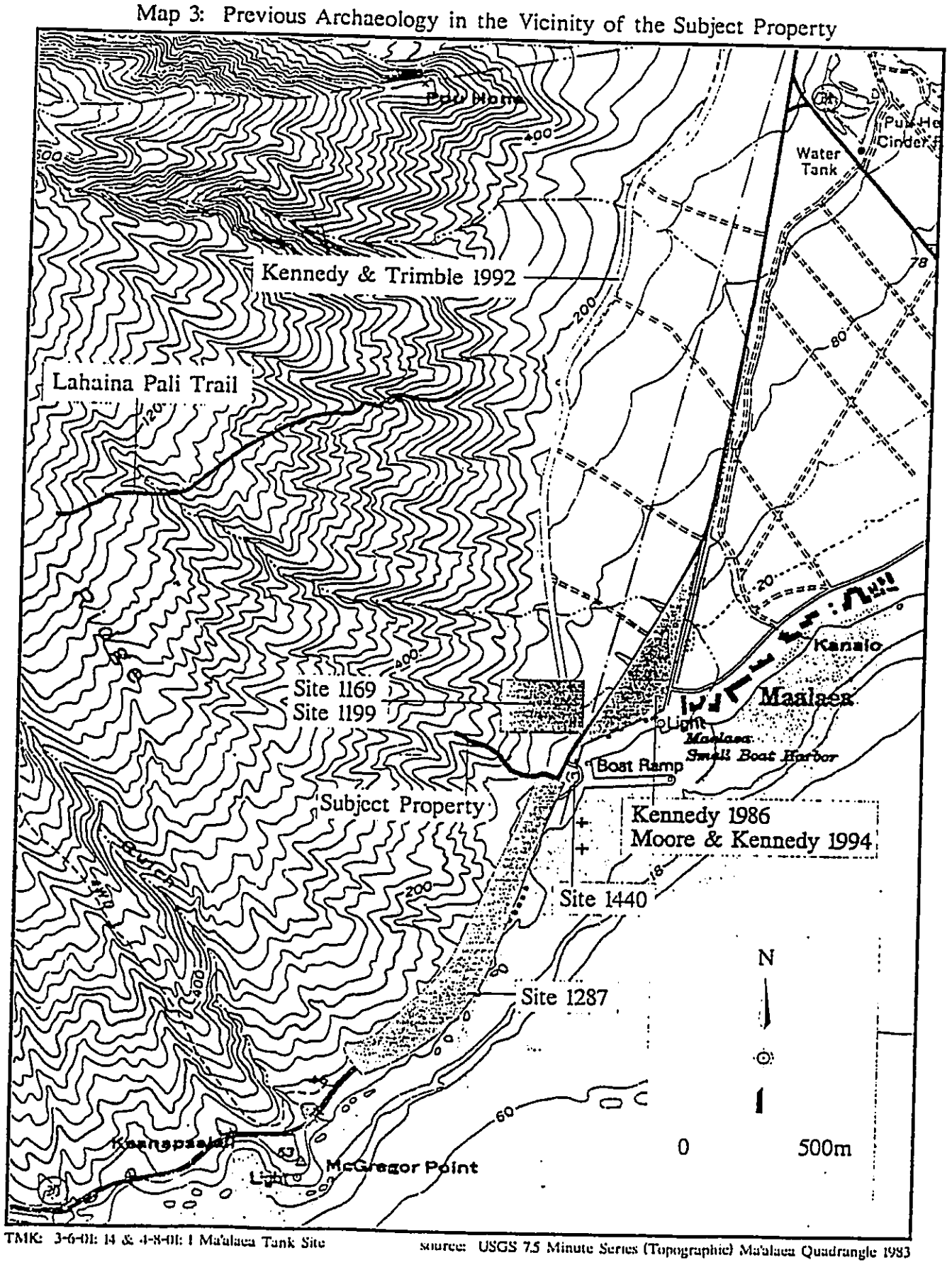
State records indicate there are two petroglyph sites located immediately mauka of Ma'alaea Bay. Site 1169 is described as petroglyphs carved on a number of adjacent boulders located in an area bounded by geographic grid co-ordinates 20 47'48"N/156 31'00"W on its northeastern corner and 20 47'40"N/156 31'12"W on its southwestern corner. Site 1199, also described as petroglyphs carved on boulders, is said to be located at 20 47'45"N/156 31'06"W, a point located in the center of the area bounded by the coordinates given for Site 1169. It is likely that these two site numbers describe the same cluster of boulders with petroglyphs. The northern corner of the current subject property (the location of the proposed tank) is located approximately 100m south of the area described as Site 1169 (see Map 3).

Site 1287 is described as the Ma'alaea Complex. This site, consisting of scattered structural remains and isolated surface scatters of midden, is shown on maps at the Department of Land and Natural Resources, State Historic Preservation Division (DNLR-SHPD) offices to extend along the coast from Ma'alaea Bay almost to McGregor Point (see Map 3). It is possible that Site 3555, investigated in the current survey, represents an isolated midden scatter located along the northern edge of Ma'alaea Complex.

The heiau noted by Walker at Ma'alaea Bay is believed to no longer exist, perhaps having been destroyed by the military or agricultural clearing. Because this heiau was described by Walker as having associated petroglyphs and there are known petroglyph sites at the coordinates described above, it is possible that the heiau was located in the immediate vicinity.

Several recent archaeological studies have been conducted in the ahupua'a. In 1991, Tomonari-Tuggle and Tuggle investigated the Lahaina Pali Trail. This trail

Map 3: Previous Archaeology in the Vicinity of the Subject Property



TMK: 3-6-01: 14 & 4-8-01: 1 Ma'alaea Tank Site

source: USGS 7.5 Minute Series (Topographic) Ma'alaea Quadrangle 1983

extends 4.5 miles across the lower southern slopes of the west Maui Mountains, specifically Kealaloa Ridge in Ukumehame Ahupua'a. At its western end, the trail is situated mauka of the Honoapiilani Highway, just east of Ukumehame State Beach Park. The trail's eastern end disappears mauka of the pineapple fields near Ma'alaea Harbor. The trail traverses an elevation range from about 100 feet to 1600 feet above mean sea level (see Map 3).

Walker did not mention the Lahaina Pali Trail, although Tomonari-Tuggle and Tuggle, in their survey, identified 18 sites along this path. In their words, the trail:

> ... is an illustration of 19th century craftsmanship, which in a sense (given the fact that the trail was built less than 50 years after Western contact) is an extension of traditional Hawaiian craftsmanship adapted to new circumstances (Tomonari-Tuggle and Tuggle 1991:26).

Tomonari-Tuggle and Tuggle, despite their thorough survey of the trail and their documentation of the sites along the Lahaina Pali Trail, failed to locate any continuation of this path to the Ma'alaea coast possibly due to its obliteration from cultivation of the nearby lands. Concerning the terminus of the Lahaina Pali Trail in the conservation lands north of the project area, Tomonari-Tuggle and Tuggle surmise that:

> Although several transects were run through this area, no trace of the trail could be found. The area appears to have been graded and there are military picket fenceposts and rolls of rusted barbed wire scattered throughout the area, which was reported to have been used by the U.S. military for training during WWII (1991:25-26).

In 1992, ACH conducted an inventory survey of corridor of land located in Ukumehame Ahupua'a extending from near the coast at Ma'alaea Harbor about 2km inland (Kennedy and Trimble 1992). This property was reported to have been used historically for the cultivation of pineapple. No sites of historic significance were identified in these surface examinations.

Archaeological investigations have been conducted makai of the subject property on lands adjacent to Ma'alaea Small Boat Harbor. A walk-through examination of the parcel was conducted by ACH in 1986 (Kennedy 1986). This study described the property, "... with the mauka (and majority) sections covered in sugarcane ..., and a narrow string of contemporary dwellings in the makai section, fronting Maalaea Road". The report asserted that the area was subject to alluvial progradation and that, therefore, the chances of

extant subsurface deposits were good. A single significant historic site, the Ma'alaea Ebisu Kotohira Jinsha, was identified during this study and recommendations were made concerning its preservation. Recent subsurface investigations on this property identified two sites (Sites 3553 and 3554) consisting of isolated human burials (Moore and Kennedy 1994). It was determined that historic activities, including the repeated plowing of the majority of the property, had disturbed both the surface and upper subsurface soils possibly destroying former significant sites or deposits..

Section 3.3: Predictive Model and Expected Finds

Based upon the information summarized above, the expected finds for the subject property can be surmised. While the base of the ridge is considered an area marginal utilization, from Walker's description of the area we know that scattered habitation features were located along the coast from "Ma'alaea to McGregor Pt." Both heiau and petroglyph sites are described as having existed nearby. It is possible that remnants of these sites may still remain on the surface.

Possible subsurface finds on the subject property would take the form of deposits such as fire pits, trash pits, midden deposits, foundation pavements, or submerged structural remains. In the Hawaiian Islands it is known that coastal areas are used for the interment of the deceased so there is also the possibility of encountering burials in the makai portions of the property during subsurface testing.

Section 4: Methodology

Archaeological investigations were conducted under the direction of the principal investigator, Joseph Kennedy, M.A.. Field work was conducted June 6th and 7th, 1994 by the field supervisor Michael O'Shaughnessy, B.A., with field archaeologist Tim Lawrence, B.A..

A 100% surface survey of the subject property was conducted. The field crew swept the property on north-south transects spaced approximately 5m apart. Visibility was excellent due to the paucity of vegetation. Limited subsurface testing consisted of the excavation of two shovel test pits (STP's) to determine the presence of absence of cultural materials. These STP's were to measure a minimum of 50cm in diameter and were to be excavated in arbitrary 20cm increments with 100% of cultural materials recovered from one quarter inch screens collected. When cultural materials were identified from a STP, a test unit (TU) was to be placed nearby. Test units were to measure a minimum of one meter square and were to be excavated in natural stratigraphic

layers with 100% of cultural materials recovered from nested one quarter in one eighth inch screens collected. Soil samples were collected from each stratigraphic layer and a profile drawn of a representative face of the test unit. All materials collected were delivered to ACH's offices located at 59-624 Pupukea Rd., Haleiwa HI. for laboratory analyses.

Section 5: Archaeological Findings

Section 5.1: Results of the Surface Survey

The 100% surface survey identified two features. The first of these features consisted of a rock, located near the northeastern corner of the proposed tank lot, on which a stick figure which appeared to be wearing a dress had been scratched. This figure was determined to be modern in origin and not considered as historically significant. The remaining feature identified consists of a surface midden scatter, assigned Site 3555, which was also visible as a submerged deposit in the cut-back face of an embankment. The areal extent of this deposit was delineated by noting the edge of cultural remains visible on the surface. Site 3555 measures approximately 50m in length and 15m in width (see Map 4).

Section 5.2: Excavation Results

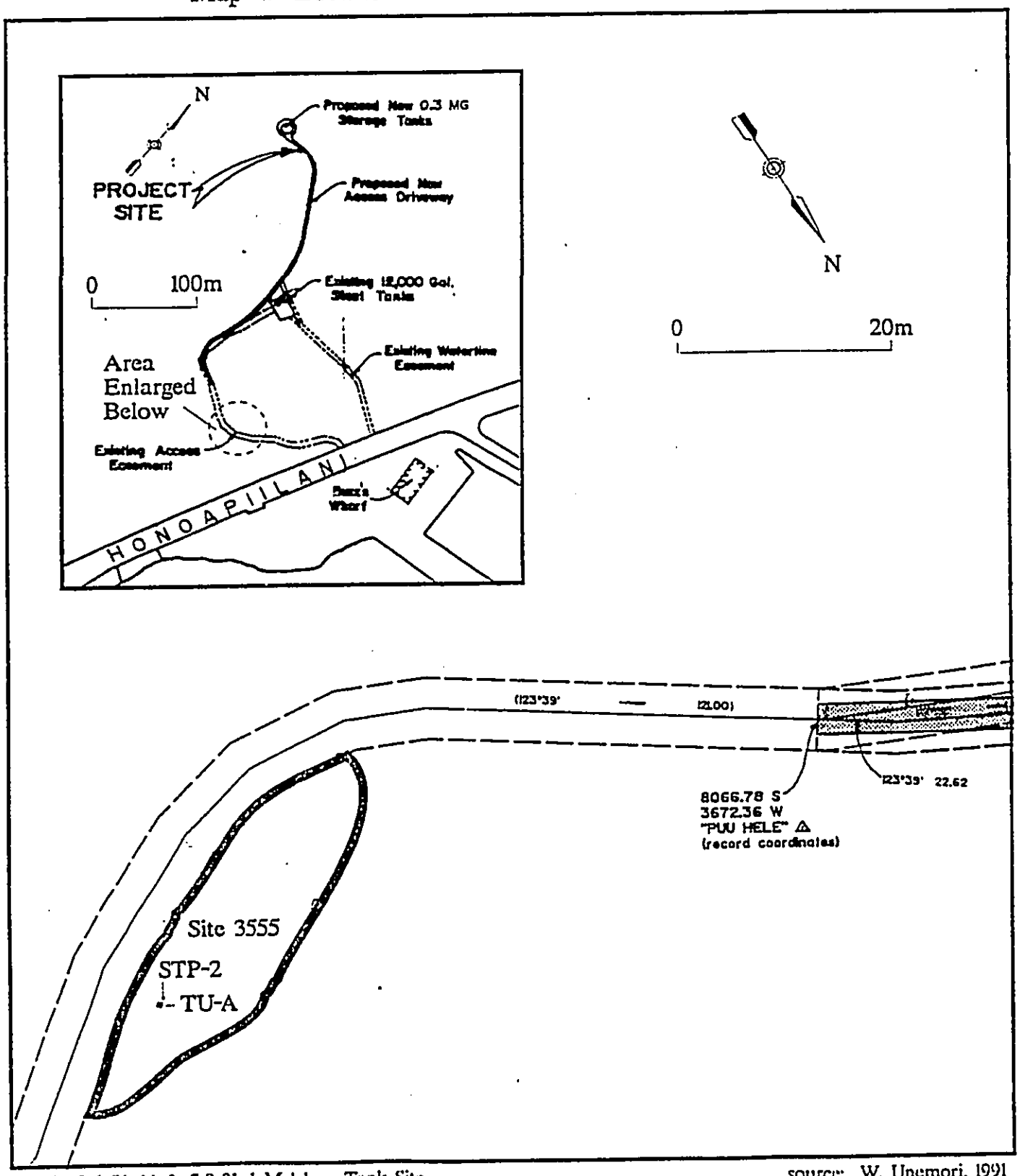
The stratigraphy on the subject property was consistent with the expected soils as described by Foote et al. (1972). The soils encountered, following the removal of many small to medium sized stones, are dark reddish brown Ewa silty clays with a fine granular structure which is hard, friable, sticky and plastic.

Subsurface testing consisted of the excavation of two STP's (STP-1 and STP-2) and a single test unit (TU-A). STP-1 encountered no cultural materials while both STP-2 and TU-A, excavated within Site 3555, recovered a variety of cultural material including a relatively large amount of marine shell remains, a variety of faunal remains, and several traditionally worked artifacts.

STP-1: This shovel test pit was placed in the lot at the northern end of the property where the proposed water tank is to be placed (see Map 5). This pit was placed in a small hollow, protected from the prevailing winds, where a pocket of soils had accumulated. STP-1 measured approximately 60cm in diameter. Two levels were excavated reaching a maximum depth of approximately 42cm below surface (cmbs). No cultural materials of any kind were encountered.

STP-2: This shovel test pit was placed within the boundaries of the surface midden scatter, Site 3555 (see Map 4). This

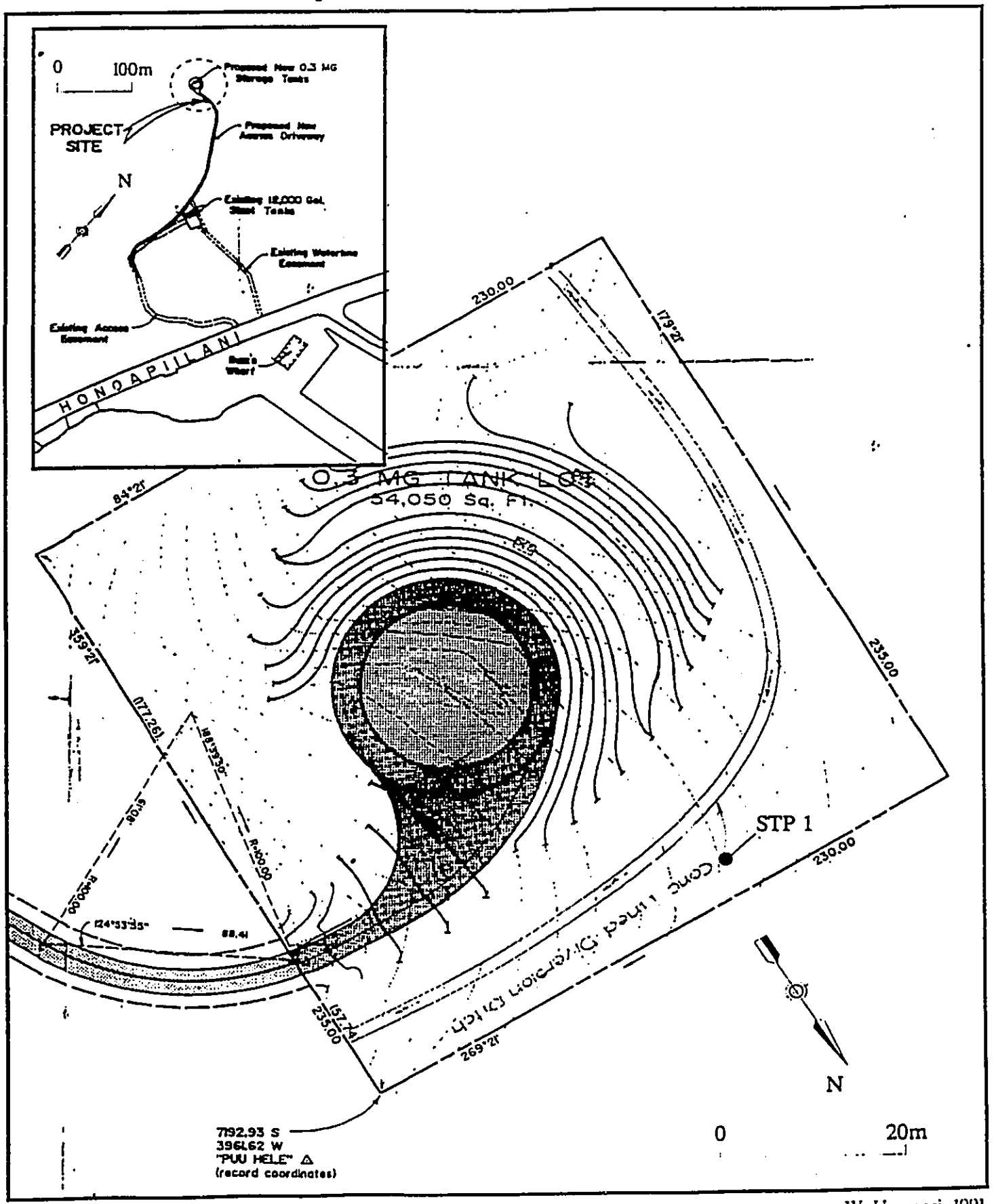
Map 4: Location of Site 3555 and Excavation Units



TMK: 3-6-01: 14 & 5-8-01: 1 Ma'alaea Tank Site

source: W. Unemori, 1991

Map 5: Tank Lot and Shovel Pit Location



TMK: 3-6-01: 14 & 5-8-01: 1 Ma'alaea Tank Site

source: W. Unemori, 1991

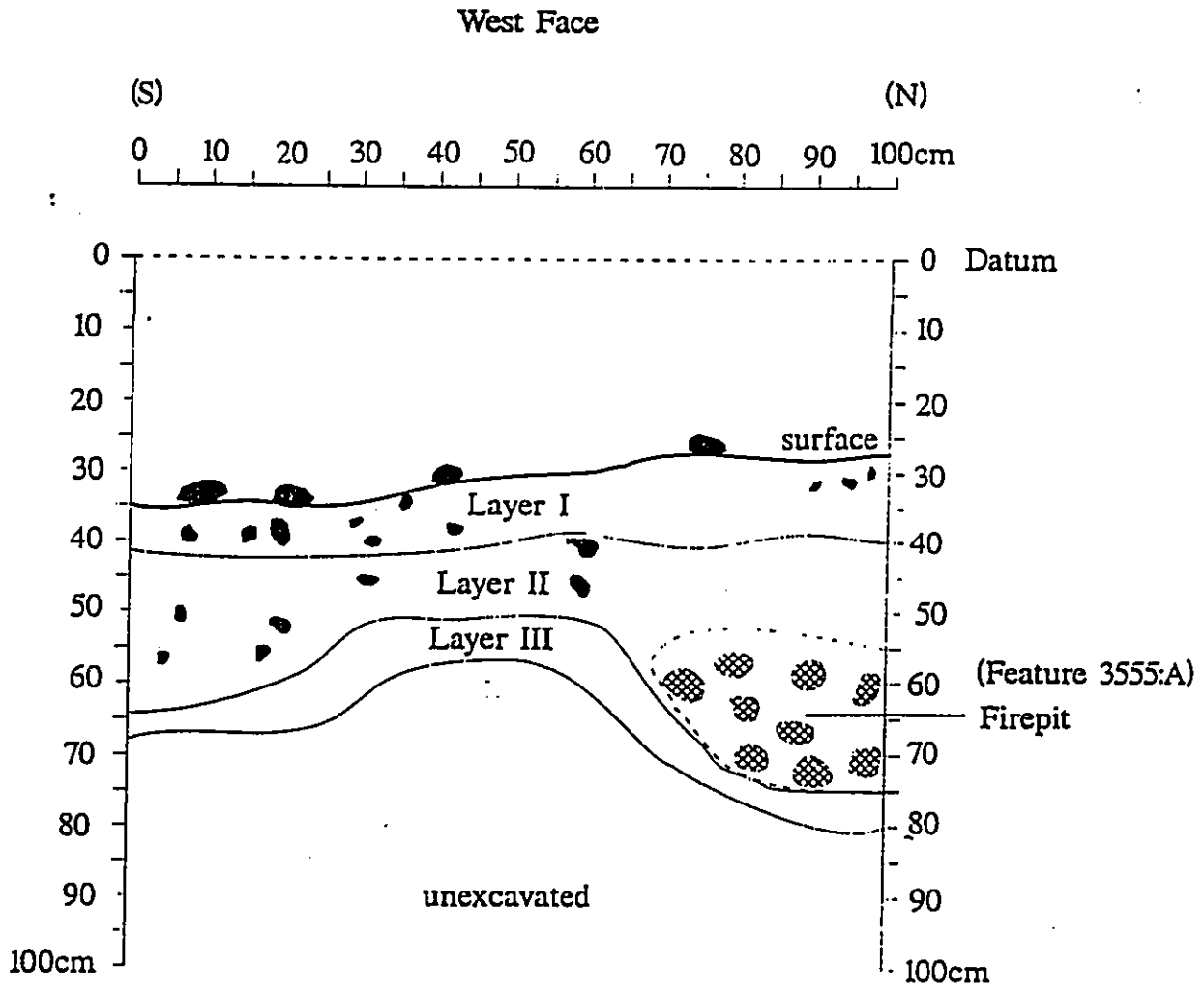
pit was placed next to a scattering of larger rocks which were thought to possibly be the disturbed remains of a former alignment or low wall. STP-2 measured approximately 65cm in diameter and reached a maximum depth of 40cmbs. Excavations were conducted in arbitrary 20cm levels in order to determine the presence or absence, as well as the extent of, cultural materials.

A variety of cultural materials were collected from both levels (refer to Appendix A, Tables 2 through 4). This material included artifacts of traditional manufacture such as both worked and waste flakes of volcanic glass, a piece of worked bone, and a waste flake of basalt (refer to Table 2). Faunal remains were collected consisting primarily of fish remains though bird remains were included and a small amount of mammal bone was identified (refer to Table 3). Marine shell remains were also recovered with Nerita sp., Cypraea sp., Brachidontes cerebristriatus, and Isognomon sp. being the predominant genera collected (refer to Table 4). Little can be determined based on the differences between levels due to their arbitrary nature which did not distinguish stratigraphic variables. While recovery of artifactual and faunal material decreased slightly with depth, the recovery of marine shell remains increased slightly with depth. Test Unit A was subsequently excavated adjacent to STP-2 (approximately 1m west) in order to document the midden deposit stratigraphically.

TU-A: This test unit was placed within Site 3555, towards the eastern end of the deposit (see Map 4). A local datum was established on a nearby rock and TU-A, measuring one meter square, had its corners staked. Excavation encountered a surface layer (Layer I) of dark reddish brown (2.5YR 2.5/3) silty clay that measured between 7 and 13cm thick and reached a maximum depth of 49cm below datum (cmbd) in the units northeastern corner. Layer I was underlain by a layer (Layer II) of dusky red (2.5YR 3/2) silty clay that measured between 12 and 40cm thick and reached a maximum depth of 75cmbd it the units northwestern corner where a fire pit (Feature 3555:A) was dug into the basal layer. Layer II was underlain by a layer (Layer III) of dark reddish brown (2.5YR 2.5/4) silty clay that was excavated to maximum depth of approximately 80cmbd (See Figure 1).

Two subsurface features were identified in, and a variety of cultural materials were recovered from, this excavation unit. Layer I contained sparse midden remains and a single waste flake of volcanic glass (Artifact MWT-005; refer to Tables 2 and 4). Within Layer II there was a dramatic increase in the recovery of cultural materials (refer to Tables 2 through 4). Both subsurface features originate in this layer, cut into Layer III which was determined to be sterile. Based upon the recovery of cultural materials, it was determined that Layer II consisted

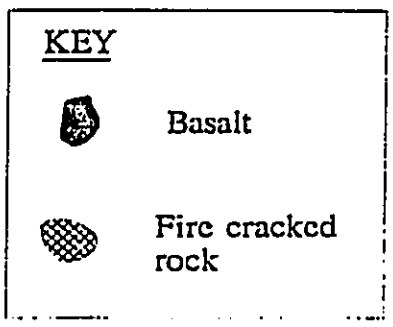
Figure 1: Profile. Test Unit A



Layer I: 2.5YR 2.5/3, Dark reddish brown; silty clay.

Layer II: 2.5YR 3/2, Dusky red; silty clay.

Layer III: 2.5YR 2.5/4, Dark reddish brown; silty clay.



of the cultural deposit designated Site 3555. This layer represents a former living surface on which various activities took place. Layer I, above the cultural layer, has developed in the historic period with small amounts of the cultural materials from below mixed with these soils through the activities of grazing cattle. Layer III was determined to be sterile, containing no cultural materials.

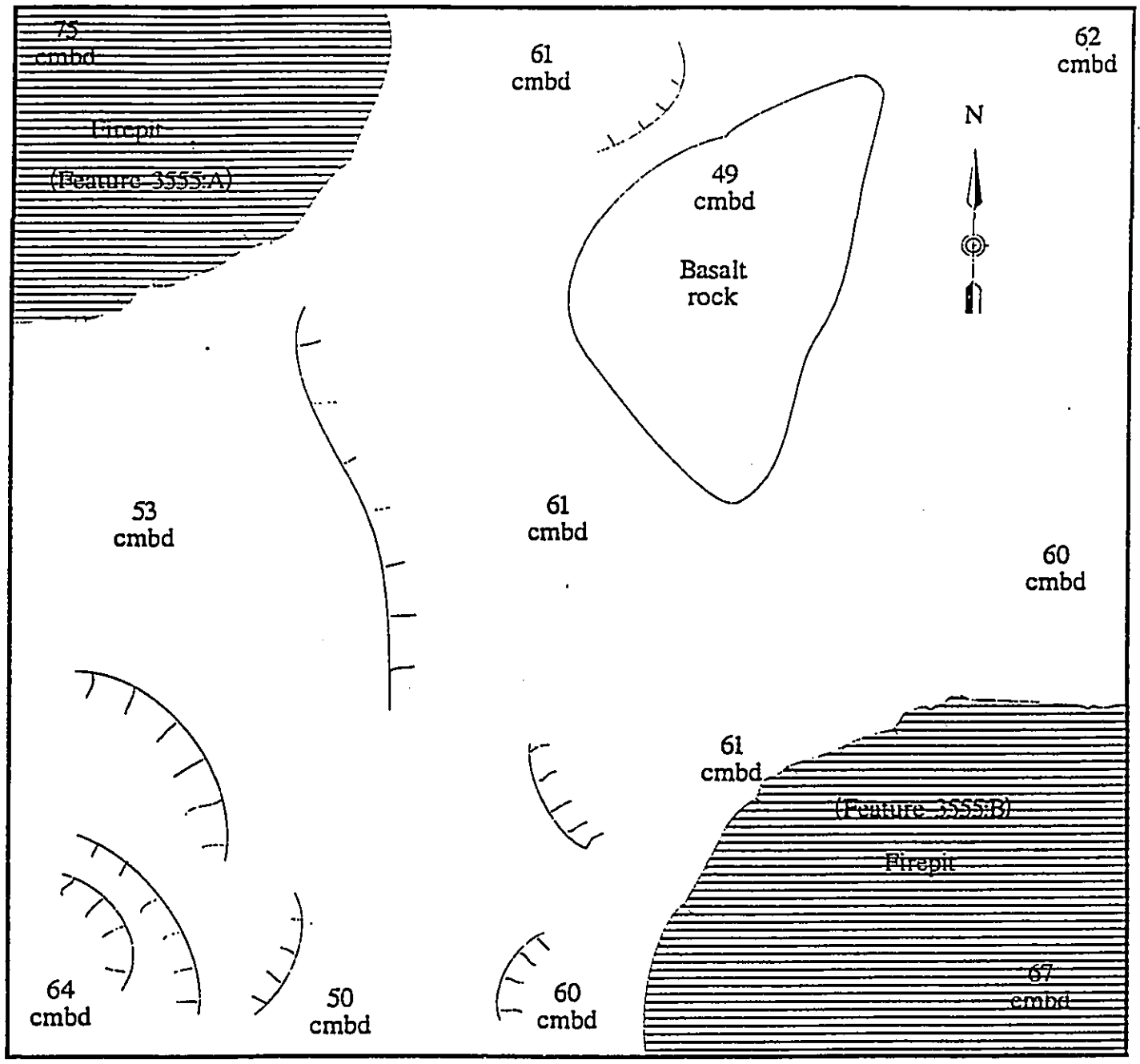
The subsurface features identified within Layer II consist of firepits located in opposite corners of the unit (see Figure 2). Feature 3555:A was located in the northwestern corner of the unit. It was initially encountered at a depth of 54cmbd and was cut into Layer III to a depth of 75cmbd. The feature extended 30cm into TU-A from the corner and reached a maximum thickness of 21cm. A charcoal sample collected from this feature at a depth of 75cmbd was radiocarbon dated yielding a calibrated range age of between A.D. 1660 - 1887 (two sigma, 95.4% probability according to Radiocarbon Calibration Program Rev. 3.0.3; Stuiver and Reimer 1993; refer to Table 5 and Appendix B for complete calibration results). Feature 3555:B was located in the southeastern corner of the unit. It was initially encountered at a depth of 40cmbd and was cut into Layer III to a depth of 67cmbd. The feature extended approximately 35cm into TU-A from the corner and reached a maximum thickness of 27cm. A charcoal sample collected from this feature at a depth of 44cmbd was radiocarbon dated yielding a calibrated range age of between A.D. 1800 - 1944 (two sigma, 95.4% probability according to Radiocarbon Calibration Program Rev. 3.0.3; Stuiver and Reimer 1993; refer to Table 5 and Appendix B).

Section 5.3: Discussion of Findings

The current investigations identified a single site of historic significance (Site 3555) located on the subject property. Based upon the results of the excavation of TU-A, Site 3555 can be characterized. Site 3555 consists of a permanent habitation site utilized from the late pre-contact period until the early historic period in which a variety of activities took place.

The age of utilization is based upon the radiocarbon dating of separate and stratigraphically isolated fire pits (Features 3555:A and 3555:B). Both features originated in Layer II and were cut into Layer III. The combined calibrated age range for the two fire pits places the age of the site at between A.D. 1660 - 1944 (refer to Table 5). The results of faunal identifications indicated that no historically introduced species were present and noted that traditionally worked fragments of bone were present (refer to Tables 2 & 3, and Appendix C). One of the pieces of worked bone was initially thought to be of human origin and was sent to Sara Collins, PhD. for forensic identification. She

Figure 2: Test Unit A, Top Plan, Bottom of Layer II



TMK: 3-6-01: 14 & 4-8-01: 1 Ma'alaea Tank Site

Archaeological Consultants of Hawaii, Inc. 1994

determined that it was not human osteological material but originated from a large mammal. While the lack of historic materials in the artifact assemblage and the lack of historically introduced species in the faunal assemblage imply an occupation in the pre-contact period, the presence of a traditionally worked piece of large mammal bone (of which, all were introduced in the historic period) corroborates the radiocarbon dating which indicates that this site was utilized into the historic period.

Based upon the artifact assemblage recovered we know that tool use and/or manufacture occurred at the site as evidenced by the waste flakes of both basalt and obsidian (refer to Table 2). Interestingly, the worked bone fragments appear to derive from ornamental items as opposed to functional tools. Additional activities occurring at Site 3555 include the consumption of meals. A wide variety of marine shells as well as fish species were consumed (refer to Tables 3 and 4). In his analyses of the faunal assemblage, Dr. Ziegler noted that the individual fish identified were of medium to large size suggesting " ... that favorable selection was made in relation to which fish were to be eaten" (refer to Appendix C). The recovery of traditionally worked artifacts thought to be derived from ornamental items and the selective consumption of fish species taken into consideration with the fact that a heiau was known to exist in the immediate vicinity, suggests that Site 3555 may have been associated with the heiau.

Section 5.4: Evaluation of Site Significance

Site 3555 consists of a permanent habitation site utilized from the pre-contact period into the early historic period. This site is considered significant to the interests of historic preservation for its scientific value, criterion "D" of the National Register of Historic Places criteria (refer to Table 1).

Table 1: Summary of Site Significance Evaluations

Site	Feature	Description	Significance Evaluations Prior to IS	After IS
3555		Midden Deposit	D	D
	A	Fire Pit		
	B	Fire Pit		

Code For Significance Evaluation Criteria

NS - Not Significant
NLS - No Longer Significant
A - Site Reflects Major Trends in History
B - Site is Associated with the Life of a Significant Person
C - Site is an Excellant Example of a Site Type
D - Site Likely to Yield Important Scientific Data
E - Site has Cultural Significance (heiau, shrine, burial, etc.)

note: IS = Inventory Survey

Conclusion

An inventory survey with limited subsurface testing was conducted on the subject property. The property shows evidence of extensive disturbance, almost certainly the result of grazing livestock over the past century. A single site of historic significance was identified.

Site 3555 was found to contain subsurface features in the form of fire pits from which samples were radiocarbon dated to a probable calibrated age range of between A.D. 1660 - 1944. A variety of cultural materials indicative of a pre-contact habitation site were also recovered. Plans indicate that the access easement along which Site 3555 lies is in an area not scheduled for improvment and future developments will have "no adverse effect" on significant historic sites located on the subject property.

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APPENDIX A

Tables

Table 2: ANALYSIS OF ARTIFACTS

Excavation Unit	Provenience	Depth	Artifact #	Material	Object	Description	Weight (g)	Size (cm)	Count
STP-2	Level 1	Surface-20cmbs	MWT-001	Basalt	Waste flake		0.5	2.0x1.0	1
			MWT-002	Obsidian	Worked flake		0.5	1.5x0.5	1
			MWT-003	Bone	Worked bone	Worked on one side, scratched; broken	0.5	1.5x0.4	1
	Level 2	20-40cmbs	MWT-004	Obsidian	Waste flakes	3xTrace, 2x1.0g, 2x1.5g	5.5	0.7 to 1.5	7
TU-A	Layer I	27-49cmbd	MWT-005	Obsidian	Waste flake		1.0	1.4x0.8	1
	Layer II	38-75cmbd	MWT-006	Obsidian	Waste flakes	Trace to 0.5g	1.0	0.8 to 1.0	3
			MWT-007	Bone	Worked bone	From large mammal	3.0	4.5x2.5	1
			MWT-008	Bone	Worked bone	Notched on end; broken; possibly pendant	3.0	3.5x1.5	1

Table 3: QUANTITATIVE ANALYSIS OF FAUNAL MATERIAL

Excavation Unit	STP-2	STP-2	TU-A
Layer/Level	Level 1	Level 2	Layer II
Depth	0-20cmbs	20-40cmbs	38-75cmbd
Non-Vertebrate			
Echinoderm		1.0	0.5
Crustacean		0.5	1.0
Mollusk		3.0	0.5
Chondrichthyes/Osteichthyes			
Albulid	0.5		
Carangid	1.0	1.5	0.5
Scarid	2.0		1.0
Acanthurid			0.5
Balistid	2.0	0.5	
Fish	2.0	2.0	4.5
Aves			
Order Procellariiformes			
Family Procellariidae			
Puffinus pacificos			0.5
Medium Procellariid	0.5	0.5	
Order Galliformes			
Family Phasianidae			
Gallus gallus	1.5	1.5	
Order and Family Indeterminate			
Medium Bird		1.0	0.5
Mammalia			
Order Carnivora			
Family Canidae			
Canis familiaris			1.0
Order and Family Indeterminate			
Small-to-Medium Mammal			
Medium Mammal	1.0		1.0
Class Indeterminate			
Order and Family Indeterminate			
Medium Vertebrate	0.5	0.5	0.5

Note: Weights in grams

Table 4: QUANTITATIVE ANALYSIS OF MIDDEN MATERIAL

Excavation Unit	STP-2	STP-2	TU-A	TU-A
Layer/Level	Level 1	Level 2	Layer I	Layer II
Depth	0-20cmbs	20-40cmbs	27-49cmbd	38-75cmbd
SHELL				
Gastropoda				
Cellana sp.	2.0	TR.		2.0
Trochus sp.		0.5		
Turbo sp.	15.5	14.0	5.0	54.5
opercula		2.0		4.0
Nerita sp.	51.0	75.0	13.0	378.5
Theodoxus sp.				
Littorina sp.	3.5	5.5	2.0	24.0
Strombus sp.	1.5	6.5		
Calyptraeidae				
Hipponix sp.	0.5	1.0	TR.	5.0
Cypraea sp.	33.5	26.0	15.0	200.5
Natica sp.				
Cassididae				
Cymatium sp.	0.5			2.0
Drupa sp.	4.0	7.5	4.0	27.0
Morula sp.				
Neothais sp.				
Nassarius sp.				
Columbellidae				
Latirus sp.				
Marginella sp.				
Conus sp.	7.0	6.5	8.0	139.5
Terebra sp.		5.0		
Pyramidella sp.				
Siphonaria sp.	TR.	0.5		
Bivalvia				
Barbatia sp.				
Brachidontes sp.	36.5	105.0	15.0	136.0
Pinctada radiata				
Isognomon sp.	46.0	52.5	10.0	353.0
Haumea sp.				
Lima sp.				
Ostrea sp.				
Lucina sp.				
Chama sp.				
Ctena sp.		TR.		
Macoma sp.				
Tellina sp.				
Periglypta sp.				1.0
Unidentified shell	5.0	8.5	2.0	55.0
OTHER				
Charcoal				
Coral	26.5	54.5	4.0	99.0
Crustacea				TR.
Echinoderm	5.5	8.0	0.5	13.5
Fish scale				
Kukui nut				
Rock		4.5		71.5
Wood				

Note: Weights in grams

Table 5: Results of Radiocarbon Analysis

Feature	Test Unit	Provenience	Beta Lab #	C13 Adjusted Age	Most Probable Calibrated Age Ranges A.D. 1 Sigma	2 Sigma
3555:B	TU-A	LII, 44cmbd	73904	90 +/- 70	1811-1923	1800-1944
3555:A	TU-A	LII, 75cmbd	73905	170 +/- 50	1724-1785	1660-1887

note - Calibrated using the University of Washington, Quaternary Isotope Lab's Radiocarbon Calibration Program Rev. 3.0.3; refer to Appendix B.

APPENDIX B

Results of Radiocarbon Analyses and Calibrations

BETA ANALYTIC INC.
DR. J.J. STIPP and DR. M.A. TAMERS
UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964
E-mail: beta@analytic.win.net

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Mr. Joseph Kennedy
Archaeological Consultants of Hawaii, Inc.

DATE RECEIVED: June 28, 1994
DATE REPORTED: July 20, 1994

Sample Data	Measured C14 Age	C13/C12 Ratio	Conventional C14 Age (*)
Beta-73904	100 +/- 70 BP	-25.5 o/oo	90 +/- 70 BP

SAMPLE #: MAAWT TU-A LII-44cmbd
ANALYSIS: radiometric-standard
MATERIAL/PRETREATMENT:(charred material): acid/alkali/acid

Beta-73905	170 +/- 50 BP	-25.2 o/oo	170 +/- 50 BP

SAMPLE #: MAAWT TU-A LII-75cmbd
ANALYSIS: radiometric-standard
MATERIAL/PRETREATMENT:(charred material): acid/alkali/acid

B1

Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By international convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

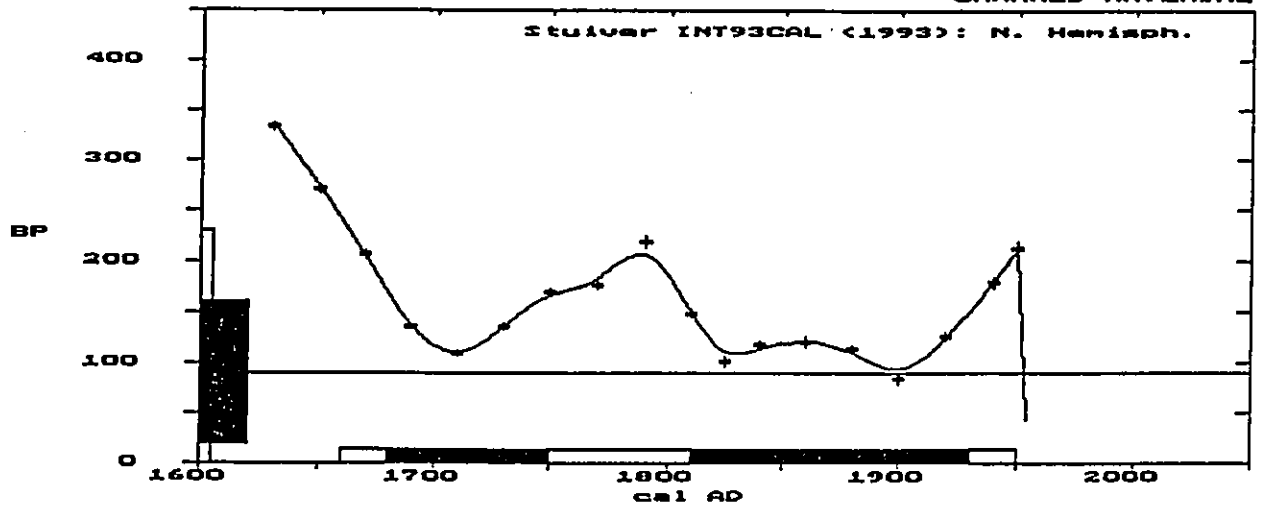
Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables:C13/C12=-25.5:lab mult.=1)

Laboratory Number:	Beta-73904
Conventional radiocarbon age:	**90 +/- 70 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal AD 1660 to 1950**
Intercept data:	
1 sigma calibrated results: (68% probability)	cal AD 1680 to 1750 and cal AD 1810 to 1930

CHARRED MATERIAL



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

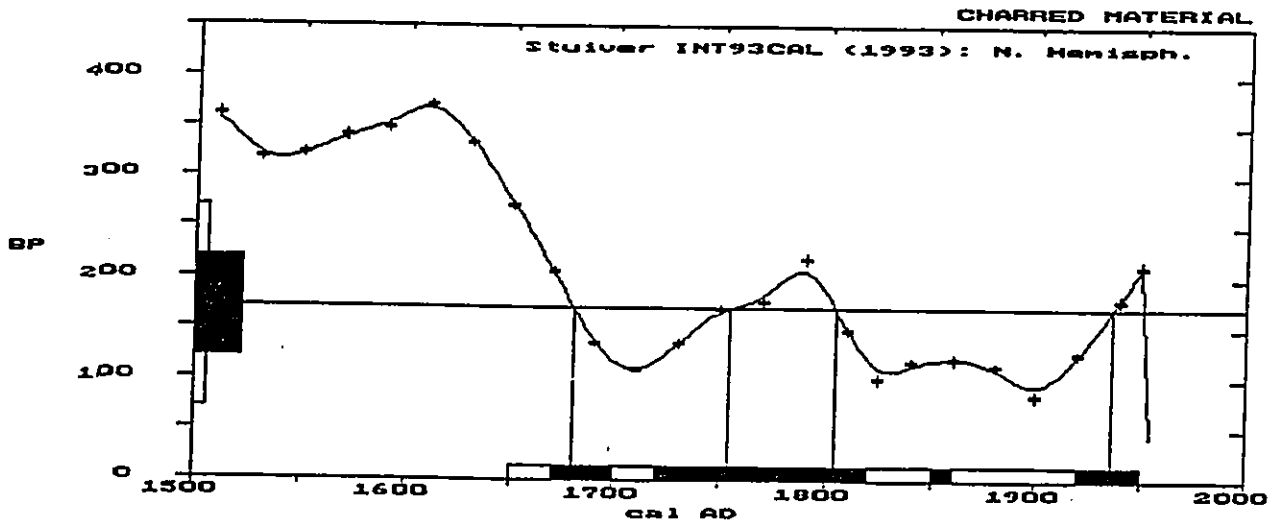
Results prepared by:

Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables:C13/C12=-25.2:lab mult.=1)

Laboratory Number:	Beta-73905
Conventional radiocarbon age:	**170 +/- 50 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal AD 1650 to 1950**
Intercept data:	
Intercepts of radiocarbon age with calibration curve:	cal AD 1680 and cal AD 1760 and cal AD 1800 and cal AD 1940
1 sigma calibrated results: (68% probability)	cal AD 1670 to 1700 and cal AD 1720 to 1820 and cal AD 1850 to 1860 and cal AD 1920 to 1950



References:

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Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

UNIVERSITY OF WASHINGTON
QUATERNARY ISOTOPE LAB
RADIOCARBON CALIBRATION PROGRAM REV 3.0.3
Stuiver, M. and Reimer, P.J., 1993, Radiocarbon, 35, p. 215-230.

Calibration file(s): UWTEN93.14C
Listing file: MWT.TXT

ACH LII 44CMBD

Radiocarbon Age BP 90 ± 70 Reference(s)
Calibrated age(s) cal AD 1894, 1908, 1955* (Stuiver and Becker, 1993)

cal AD/BC age ranges obtained from intercepts (Method A):
one Sigma** cal AD 1682 - 1735 1807 - 1935
1954 - 1955*
two Sigma** cal AD 1664 - 1955*

Summary of above:

minimum of cal age ranges (cal ages) maximum of cal age ranges:
1σ cal AD 1682 (1894, 1908, 1955*) 1955*
2σ cal AD 1664 (1894, 1908, 1955*) 1955*

cal AD/BC age ranges (cal ages as above)
from probability distribution (Method B):

% area enclosed	cal AD age ranges	relative area under probability distribution
68.3 (1σ)	cal AD 1691 - 1729	.25
	1811 - 1923	.75
95.4 (2σ)	cal AD 1672 - 1780	.37
	1800 - 1944	.63

References for datasets used:
Stuiver, M and Becker, B, 1993, Radiocarbon, 35, 35-65.

Comments:
†This standard deviation (error) includes a lab error multiplier.
** 1 sigma = square root of (sample std. dev.^{2} + curve std. dev.^{2})
2 sigma = 2 x square root of (sample std. dev.^{2} + curve std. dev.^{2})

0* represents a "negative" age BP
1955* denotes influence of bomb C-14
For cal yrs between 5500-5190 BC an offset of 25 years is possible.
NOTE: Cal ages and ranges are rounded to the nearest year which may be too precise in many instances. Users are advised to round results to the nearest 10 yr for samples with standard deviation in the radiocarbon age greater than 50 yr.

UNIVERSITY OF WASHINGTON
QUATERNARY ISOTOPE LAB
RADIOCARBON CALIBRATION PROGRAM REV 3.0.3
Stuiver, M. and Reimer, P.J., 1993, Radiocarbon, 35, p. 215-230.

Calibration file(s): UWTEN93.14C
Listing file: MWT2.TXT

ACH LII 75CMBD

Radiocarbon Age BP 170 ± 50 Reference(s)
Calibrated age(s) cal AD 1680, 1743, 1750 (Stuiver and Becker, 1993)
1759, 1806, 1937
1954

cal AD/BC age ranges obtained from intercepts (Method A):
one Sigma** cal AD 1667 - 1702 1724 - 1815
1844 - 1864 1867 - 1876
1917 - 1954
two Sigma** cal AD 1650 - 1955*

Summary of above:

minimum of cal age ranges (cal ages) maximum of cal age ranges:
1σ cal AD 1667 (1680, 1743, 1750, 1759, 1806, 1937,
1954) 1954
2σ cal AD 1650 (1680, 1743, 1750, 1759, 1806, 1937,
1954) 1955*

cal AD/BC age ranges (cal ages as above)
from probability distribution (Method B):

% area enclosed	cal AD age ranges	relative area under probability distribution
68.3 (1σ)	cal AD 1667 - 1701	.20
	1724 - 1785	.40
	1795 - 1814	.11
	1849 - 1860	.05
	1872 - 1876	.02
	1917 - 1952	.21
	1952 - 1955*	.01
95.4 (2σ)	cal AD 1660 - 1887	.83
	1911 - 1955*	.17

References for datasets used:
Stuiver, M and Becker, B, 1993, Radiocarbon, 35, 35-65.

Comments:
┼This standard deviation (error) includes a lab error multiplier.
** 1 sigma = square root of (sample std. dev.^{2} + curve std. dev.^{2})
2 sigma = 2 x square root of (sample std. dev.^{2} + curve std. dev.^{2})

0* represents a "negative" age BP
1955* denotes influence of bomb C-14
For cal yrs between 5500-5190 BC an offset of 25 years is possible.
NOTE: Cal ages and ranges are rounded to the nearest year which may be too precise in many instances. Users are advised to round results to the nearest 10 yr for samples with standard deviation in the radiocarbon age greater than 50 yr.

APPENDIX C

Comments on Faunal Identifications and Faunal Taxonomy

COMMENTS ON MA`ALAEA, MAUI, FAUNAL MATERIAL

General. All of the Test Units here show evidence that a "good" habitation site has been sampled--presumably Polynesian or, at most, early Historic in age, judging from the presence of traditionally worked bones and the absence in the present material of obvious historically introduced animals. Various fishes and a couple of types of birds--but essentially no mammals--seem to have made up the usual vertebrate diet.

STP-2 0-20cmBS. A traditionally worked mammal bone appears. A relatively good amount and variety of fishes of common inshore families are present (--I assume the large "Carangid" fish was taken along the shore, although it could just as well have been hooked from a watercraft offshore). Also, the individual fish are almost all of medium or large size, thus suggesting that favorable selection was made in relation to which fish were to be eaten. Presumed Chicken (cf. Gallus gallus) and "Medium Procellariid" were also occasionally eaten, but essentially no mammals.

STP-2 20-40cmBS. About the same as the excavation unit described immediately above, except that there is no artifactual material, and the fishes are not as varied in terms of family.

Test Unit A, [two layers]. Generally quite similar to the preceding two excavation units except that two traditionally worked mammals bones are present (one possibly human), there is no chicken, and a tooth of dog (Canis familiaris) appears.

* * *

CATEGORIES USED FOR ARCH. CONSULS. OF HAWAII FAUNAL IDENTIFICATIONS

Alan C. Ziegler
Revised 6 May 1994

MISCELLANEOUS

Artifact.....any historically manufactured item as well as any geological, vegetal, osteological, or other material obviously or possibly intentionally "worked", including bones showing apparent butchering marks.

NON-VERTEBRATE

Basalt.....all non-disintegrated volcanically derived material, including pumice, and volcanic glass fragments not included under "Artifact".

Inorganic.....usually, geological material not included under either of the 2 foregoing categories.

Coal

Charcoal

Vegetable.....all uncharred or otherwise unmodified vegetal material.

Coral Reef Rubble.....including fragments of mollusk, echinoderm, etc., that seem obviously to have weathered out of the reef or to be quite beachworn, and thus probably not human food midden.

Coral.....non-fossil material that seems to have entered the deposit in a relatively fresh condition, although sometimes beach-worn.

Echinoderm.....usually, exoskeleton remains of sea urchin quite possibly being human food midden.

Mollusk.....non-fossil material of marine, freshwater and/or terrestrial forms that seems to have entered the deposit in a relatively fresh condition, most of the non-terrestrial material probably being human food midden.

Crustacean.....usually, exoskeleton remains of crab or lobster, with an occasional barnacle plate, much--but not all--probably being human food midden.

Invertebrate.....remains of invertebrate groups either not more specifically identifiable, or other than those listed above; for example, bryozoan exoskeletons, calcareous polychaete worm tubes, etc.

VERTEBRATE

CLASS CHONDRICHTHYES (Sharks and Rays) AND/OR OSTEICHTHYES (Bony Fishes) [Arrangement and nomenclature follow Gosline, W.A., and V.E. Brock, 1960 (reprinted 1965), *Handbook of Hawaiian Fishes*, University of Hawaii Press, Honolulu.]

Shark.....not identified to any lower taxonomic level; in Hawai'i there are 9 families comprising about 22 species.

Ray.....not identified to any lower taxonomic level; in Hawai'i there are 3 families comprising about 5 species.

Albulid.....member(s) of the family Albulidae (Bonefishes), of which there is a single species reported for Hawai'i; usually found near shore in open sand-bottomed areas, and reaching about 90 cm in length.

Muraenid.....member(s) of the family Muraenidae (Moray Eels), of which there are over 35 species in Hawai'i; some reaching a length of 150 cm.

Congrid.....member(s) of the family Congridae (Conge Eels), of which there are at least 7 species in Hawai'i; some reaching a length of 150 cm.

Belonid.....member(s) of the family Belonidae (Needlefishes), of which there are 3 species in Hawai'i; usually found somewhat offshor near the ocean surface, and reaching 100 cm in length.

Holocentrid.....member(s) of the family Holocentridae (Squirrelfishes), of which there are about 15 species in Hawai'i; many of them found in deeper reef areas, with most of them fairly small and only 1 or 2 approaching 45 cm in length.

Sphyraenid.....member(s) of the family Sphyraenidae (Barracudas), of which there are 2 species in Hawai'i; most often pelagic but sometimes found either singly or in small schools near shore, usually about 50-80 cm in length although an occasional individual may reach almost 200 cm.

Mugilid.....member(s) of the family Mugilidae (Gray Mullets), of which there are only 2 species in Hawai'i; both relatively common inshore forms, reaching a maximum length of about 45 cm.

Polynemid.....member(s) of the family Polynemidae (Threadfins), of which *Polydactylus sexfilis* (Moi) of inshore sand-bottomed areas is apparently the only species thus far reported for Hawai'i, reaching perhaps 45 or 50 cm length.

Apogonid.....member(s) of the family Apogonidae (Cardinalfishes), of which there are 11 species in Hawai'i; all relatively common inshor forms but active mostly only at night, with the largest species reaching no more than about 18 cm in length.

Carangid.....member(s) of the family Carangidae (Jacks), of which there are over 20 species in Hawai'i; most of them deeper-water and fairly large forms; the species *Caranx ignobilis* (Ulua--or Pāpio for the smaller young) sometimes ranging in close to shore, and reaching 100 cm or more in length.

Lutjanid.....members(s) of the family Lutjanidae (Snappers), of which there are 10 or 11 native species in Hawai'i; most of them offshore deep-water--although not pelagic--forms, reaching maximum lengths of 30 to almost 100 cm.

Mullid.....member(s) of the family Mullidae (Goatfishes), of which there are 10 species in Hawai'i; many of them living on the reef c frequently visiting it, usually about 20-25 cm long but a few reaching 40-60 cm.

Cirrhitid.....member(s) of the family Cirrhitidae (Hawkfishes), of which there are 5 or 6 species in Hawai'i; all inshore forms, only 1 of which reaches as much as 30 cm in length.

Labrid.....member(s) of the family Labridae (Wrasses) which is the largest family of fishes in Hawai'i with over 40 species; predominately inshore forms, most of them fairly small but with a few larger forms reaching about 50 cm in length.

Scarid.....member(s) of the family Scaridae (Parrotfishes), of which the genera *Calotomus* (2? species) and *Scarus* (4-5 species) are essentially the only 2 expected to occur in Hawai'i; both being typically inshore groups, and including 1 or 2 species that may reach 70 cm in length.

Acanthurid.....member(s) of the family Acanthuridae (Surgeonfishes), of which there are over 20 species in Hawai'i; most of them inshore forms, with the genus *Naso* (Unicornfish or [mostly] Kala) comprising the 5 generally largest of these, reaching 40 to 75 cm in length.

Scombrid.....member(s) of the family Scombridae (Tuna and Mackerels), of which there are perhaps a dozen species in Hawaiian waters; almost all open-ocean (pelagic) forms, many reaching a m or more in length.

Scorpaenid.....members of the family Scorpaenidae (Scorpionfishes), of which there are perhaps as many as 25 species in Hawai'i; a majority of them inshore, and fairly small (8-15 cm), forms, although several species may reach between 25 and 50 cm in length.

Balistid.....member(s) of the family Balistidae (Triggerfishes), of which there are about 10 species in Hawai'i; mostly inshore forms, with the largest reaching about 35 cm in length.

Monacanthid.....member(s) of the family Monacanthidae (Filefishes), of which the small *Pervagor spilosoma* (Fantail Filefish), reaching only about 15 cm in length and sometimes washing up on beaches dead in great numbers, is by f. the most abundant of the 8 species to be expected in near-shore Hawaiian waters; the ge *Alutera* contains the largest species, reaching about 60 cm in length.

Tetraodontid.....member(s) of the family Tetraodontidae (Smooth Puffers), of which there are about 5 species, ranging up to 50 cm in length, in Hawai'i (--or perhaps close to a dozen if the several, generally small, species of the genus *Canthigaster* [considered to constitute the family Canthigasteridae (Sharp-backed Puffers) by some authors] are included--); a few forms of both types of these puffers ma found in shallower inshore areas, and all of the species may possess an intrinsic poison although the flesh is apparently sometimes eaten without ill effects.

Diodontid.....member(s) of the family Diodontidae (Spiny Puffers), of which 2 species of the genus *Diodon*, ranging from 35 to 70 cm in maximum length, are by far the most abundant in Hawaiian inshore waters, the single remaining species reported for Hawai'i (genus *Chilomycterus*, 50 cm in length) apparently being qu rare here; all of these species are suspected of possessing an intrinsic poison although the flesh is apparently sometimes eaten without ill effects.

Fish.....material of indeterminate class and fami

CLASS AMPHIBIA

Order Anura
Family Bufonidae: (True Toads)

Bufo marinus (Giant Neotropical Toad).....introduced to the Hawaiian Islands in 19

CLASS REPTILIA

Order Testudinata (Order Chelonia of some authors)
Family Cheloniidae: (Typical Sea Turtles) and/or Dermochelyidae: (Leatherback Sea Turtles)

Sea Turtle.....comprises fragmentary remains that could not be assigned to a particular one of the half-dozen species of marine turtle found in the Pacific; among the several cheloniids, *Chelonia mydas* (Green Sea Turtle) is possibly the most abundant and, apparently, the one most often taken for food; *Eretmochelys imbricata* (Hawksbill Sea Turtle) is usually found much less frequently and is apparently not eaten although the horny scutes of the carapace and plastron ("tortoise shell") are used artifactually; while the sole dermochelyid, *Dermochelys coriacea* (Leatherback Sea Turtle--which lacks the large flat bony plates of the carapace found in all other sea turtles) is an important egg-producer for human food purposes in Indonesia, Malaysia, an probably other areas of the Southwest Pacific, although it does not lay eggs in Hawai'i.

Family Indeterminate

Freshwater or Land Turtle.....turtle(s), terrapin(s), and/or tortoise(s of a non-marine family; any one of about 6 such groups could conceivably be represented, none of which is native to the Hawaiian Islands. *Trionyx sinensis* (Chinese Softshell Turtle; family Trionychidae) was once propagated here in fish ponds as a historic food

item, but members of other families have also been imported alive and were probably likewise occasionally eaten although none seems to have been locally raised for this purpose.

Order Squamata
Family Indeterminate

Small Lizard.....lizard(s) with a head-and-body length o less than about 10 or 15 cm; usually not identified to any lower taxonomic level altho in Hawai'i, most or all of the material probably represents the Polynesian-introduced f families Gekkonidae (geckos) and/or Scincidae (skinks) rather than any of the smaller members of historically introduced families.

CLASS AVES [Arrangement and nomenclature of historically known forms--unless modified the various Olson and James' references listed below--follow Pratt, H.D., P.L. Brune and D.G. Berrett, 1987, *The Birds of Hawaii and the Tropical Pacific*, Princeton University Press, Princeton, New Jersey; while information on prehistorically extinc forms is drawn from Olson, S.L., and H.F. James, 1982, Prodromus of the fossil avifau of the Hawaiian Islands, *Smithsonian Contributions to Zoology*, No. 365; Olson, S.L., H.F. James, 1991, Descriptions of thirty-two new species of birds from the Hawaiian Islands: Part I. Non-passeriformes, *Ornithological Monographs* No. 45; and James, H.F. and S.L. Olson, 1991, Part II. Passeriformes, *ibid.* No. 46.]

Order Procellariiformes
Family Diomedeidae: (Albatrosses)

Diomedea sp. (Albatross)

Family Procellariidae: (Shearwaters, Petrels, and Fulmars)

Puffinus pacificus (Wedge-tailed Shearwater)

Puffinus sp. (Shearwater).....(see "Small Procellariid" and "Medium Procellariid" categories below for the various species of this genus most likely represented.)

Bulweria bulwerii (Bulwer's Petrel)

Pterodroma phaeopygia (Hawaiian Petrel)

Pterodroma sp. (Petrel).....(see "Small Procellariid" and "Medium Procellariid" categories below for the various species of this genus most likely represented.)

Small Procellariid.....smaller member(s) of the family Procellariidae, in the general size range of *Puffinus nativitatis* (Christmas Shearvater) *Bulweria bulwerii* (Bulwer's Petrel), *Pterodroma hypoleuca* (Bonin Petrel), as well as, apparently, *Puffinus lherminieri* (Audubon's Shearwater) and the possibly undescribed "*Pterodroma* sp.", both noted as previously being found on Moloka'i and/or O'ahu by Olson and James 1982:32-33.

Medium Procellariid.....medium-sized member(s) of the family Procellariidae, in the general size range of *Puffinus pacificus* (Wedge-tailed Shearvater *Puffinus newelli* (Newell's Shearvater), and *Pterodroma phaeopygia* (Hawaiian Petrel).

Family Hydrobatidae (Family Oceanitidae of Olson and James 1982:33): (Storm-Petrels)

Oceanodroma castro (Band-rumped Storm-Petrel)....material of a very small member of this family, presumably this species but I have not been able to obtain comparative skeletal material of it either locally or from the Smithsonian Institution, although I have satisfactory material of the larger *Oceanodroma tristrami* (Tristram's Storm-Petrel).

Order Pelicaniformes
Family Phaethontidae: (Tropicbirds)

haethon lepturus (White-tailed Tropicbird).....the smallest of the 3 tropicbird species occurring in the Pacific.

Order Ciconiiformes
Family Ardeidae: (Herons, Egrets, and Bitterns)

lycticorax nycticorax (Black-crowned Night-Heron)

Order Anseriformes
Family Anatidae: (Swans, Geese, and Ducks)

Branta sp. (Goose).....presumably, either the historically known *Branta sandvicensis* (Hawaiian Goose) or one of the prehistorically extinct, apparently semiflightless--or possibly even flightless--medium-sized forms morphologically similar to, but evidently specifically distinct from, *Branta sandvicensis*; (see Olson and James 1991:42-47).

Thambetochen xanion (O'ahu Lowland Moa-nalo)

Thambetochen sp. (Moa-nalo, in part).....prehistorically extinct, large, "toothed-jawed", flightless, goose-like member(s) of the family Anatidae; (see Olson and James 1991:28-32,35-38).

Moa-nalo (Large Flightless Anatid).....prehistorically extinct, large, obviously flightless, goose-like member(s) of the family Anatidae; (see Olson and James 1991:28-42 for the various genera and species potentially represented on the different Hawaiian Islands).

Small Anatid.....duck(s) in the size range of *Anas wyvilliana* (Hawaiian Duck), *Anas laysanensis* (Laysan Duck), and some migrant or accidental continental teal; smaller than most other migrant ducks that often reach the Hawaiian Islands, which are often in the general "medium" size range of continental *Anas platyrhynchos* (Mallard).

Medium Anatid.....member(s) of the family Anatidae in the general size range of smaller geese and larger ducks, such as *Branta sandvicensis* (Hawaiian Goose) and continental races of *Anas platyrhynchos* (Mallard).

Order Galliformes
Family Phasianidae: (Turkeys, Peafowl, Guineafowl, Chickens, Pheasants, Quail, etc.)

Gallus gallus (Red Junglefowl).....(in almost all cases, fragmentary material representing pre-Contact Polynesian junglefowl would not be distinguishable from that of historically introduced chicken breeds of this same species. Also, I am not sure that most such material of other phasianids such as various species of larger pheasants [*Phasianus, Lophura*, etc.], as well as guineafowl [*Numida*],--all historically introduced--could usually be distinguished.)

Small-to-Medium Galliform.....member(s) of an indeterminate family (--although, in Hawai'i, most likely family Phasianidae--) in the general size range of historically introduced *Alectoris chukar* (Chukar) and various *Francolinus* (francolins), all also historically introduced.

Medium Galliform.....member(s) of an indeterminate family (--although, in Hawai'i, most likely family Phasianidae--) in the general size range of *Gallus gallus* (Red Junglefowl [=Chicken]) and various larger species of pheasants (*Phasianus, Lophura*, etc.) as well as guineafowl (*Numida*), the latter two types all beir historically introduced forms.

Large Galliform.....member(s) of an indeterminate family (--although, in Hawai'i, most likely all historically introduced members of the family Phasianidae--) in the general size range of *Pavo cristatus* (Common Peafowl; introduced

the Hawaiian Islands in 1860) and *Meleagris gallopavo* (Wild [and Domestic] Turkey; introduced in 1788).

Order Gruiformes
Family Rallidae: (Rails, Moorhens or Gallinules, Coots, etc.)

Porzana sp. (Hawaiian Flightless Rail).....(formerly "Small Flightless Rallid"); sparrow- to plover-sized flightless member(s) of the family Rallidae; (see Olson and Jar 1991:49-62 for the various species potentially represented on the different Hawaiian Islands).

Gallinula chloropus (Common Moorhen)Medium

Medium Rallid.....member(s) of the family Rallidae in the general size range of *Gallinula chloropus* (Common Moorhen) and *Fulica* cf. *alai* (Hawaiian Coot); most of the material probably consists of certain bones of 1 or both of these 2 species that I cannot satisfactorily distinguish, especially in the case of fragmentary material.

Order Charadriiformes
Family Charadriidae: (Plovers and Dotterels)

Pluvialis dominica (Lesser Golden-Plover).....this relatively common migratory species most abundant--and thus most readily available for capture--in the Hawaiian Islands from August through April, although a few individuals may occasionally be found here all year.

Family Scolopacidae: (Curlews, Turnstones, Tattlers, Sandpipers, etc.)

Numenius tahitiensis (Bristle-thighed Curlew)

Medium Scolopacid.....member(s) of the family Scolopacidae, smaller than curlew, in the general size range of *Arenaria interpres* (Ruddy Turnstone), *Heteroscelus incanus* (Wandering Tattler) or a slightly larger species.

Family Laridae: (Gulls, Terns, and Jaegers)

Medium Larid.....member(s) of the family Laridae in the general size range of jaegers and medium-sized gulls, none of which breed in the Hawaiian Islands although several species are relatively frequent vagrants or winter visitants here.

Order Columbiformes
Family Columbidae: (Pigeons and Doves)

Columba livia (Rock Dove).....introduced to the Hawaiian Islands in 1796 (There are no native Hawaiian columbiforms, and of the 20 or so species of the order [all family Columbidae except for 1 sandgrouse of the family Pteroclidae] historically introduced to the State only 4 managed to establish widespread, long-surviving, populations: *Columba livia* [Rock Dove or "Domestic Pigeon"], *Streptopelia chinensis* [Spotted Dove], *Geopelia striata* [Zebra Dove], and *Zenaidura macroura* [Mourning Dove--apparently only in the Pu'uwa'awa'a area in the North Kona District of Hawai'i Island]. Thus, I presume most or all bones of columbids found will represent only these 4 forms although in a few cases osteologically similar species--introduced but now extirpated--could conceivably be represented.)

Streptopelia chinensis (Spotted Dove).....introduced to the Hawaiian Islands sometime in the 1800's; (see note under "*Columba livia*", above).

Geopelia striata (Zebra Dove).....introduced to the Hawaiian Islands in 1922; (see note under "*Columba livia*", above).

Order Strigiformes
Family Strigidae: (Typical Owls)

Asio flammeus (Short-eared Owl)

Medium Strigid.....comprises owl material that does not app to be the sole Hawaiian representative of the family Tytonidae *Tyto alba* (Common Barn-Ow introduced to the Hawaiian Islands in 1958), but very likely represents either or both t native *Asio flammeus* (Short-eared Owl) and the prehistorically extinct owl genus *Grallistrix* (Stilt-Owls) of Olson and James 1991:57-81 (both family Strigidae), many of whose bones I cannot yet satisfactorily distinguish, especially when fragmentary.

Order Passeriformes
Family Corvidae: (Ravens, Crows, Magpies, and Jays)

Corvus hawaiiensis (Hawaiian Crow)

Corvus (large species) (Crow)..... member(s) of the genus in the general s range of continental *Corvus corax* (Common Raven); presumably either or both the prehistorically extinct Hawaiian *Corvus impluviatus* and *C. viriosus* of James and Olson 1991:11-22 could be included.

Corvus sp. (Crow).....comprises material presumably representing this genus but that could not be certainly assigned to any of the 3 above-mentioned Hawaiian species.

Family Meliphagidae: (Honeyeaters)

Chaetoptila sp. (Kioea).....(historically extinct on Hawai'i Island, and known only fossil elsewhere in the State.)

Family Indeterminate

Small Passeriform.....member(s) of 1 or more families of this order ("Perching Birds" or "Songbirds"), up to the general size of cardinals or smaller thrushes; most of the extinct and extant endemic Hawaiian passeriform species--as well as a number of the historically introduced ones--would be of this size.

Medium Passeriform.....member(s) of this order in the general si range of myna and robin to larger jays; among endemic Hawaiian passeriform species, apparently only the extinct *Chaetoptila* sp. (family Meliphagidae) and, possibly, a very few of the larger prehistorically extinct species of Hawaiian Honeycreepers and Finches (subfamily Drepanidinae of the family Fringillidae; see James and Olson 1991)--as well a a few of the historically introduced species of various families--would be of this size.

Order and Family Indeterminate

Small Bird.....member(s) of indeterminate order and famil up through the general size of storm-petrel, quail, plover, sparrow, myna, and thrush; probably a large amount of the material represents passeriforms but smaller native or historically introduced species of 3 or 4 other orders could well be included, also.

Medium Bird.....member(s) of indeterminate order and famil in the general size range of shearwater and petrel, tropicbird, night-heron, duck, hawk, junglefowl (=chicken), moorhen and coot, curlew, gull, owl, crow, and so on; in Hawai'i, probably no passeriforms other than Hawaiian species of the genus *Corvus* would be included, but a number of native or historically introduced species of up to a half-dozen other orders could potentially be.

Large Bird.....member(s) of indeterminate order and family in the general size range of albatross, booby, frigatebird, goose, eagle, turkey, raven, and so on; in Hawai'i, a number of native or historically introduced species of up to a half-dozen orders could potentially be included.

CLASS MAMMALIA [Insofar as possible, arrangement and nomenclature follow Tomich, P.Q., 1986, *Mammals in Hawai'i, Second Edition*, Bishop Museum Press, Honolulu; except that more generally accepted name *Mus musculus* is used here instead of *Mus domesticus*.]

Order Chiroptera
Family Vespertilionidae: (Common Bats)

Lasiurus cinereus (Hoary Bat)

Order Primata
Family Hominidae: (Humans)

Homo sapiens (Modern Human)

Order Lagomorpha
Family Leporidae: (Hares and Rabbits)

Oryctolagus cuniculus (European Rabbit).....introduced to the Hawaiian Islands somet: after 1778; known to have become established by 1825.

Order Rodentia
Family Muridae: (Old World Rats and Mice)

Rattus exulans (Polynesian Rat).....comprises all material of this Polynesian introduced species that, because of its relatively small size, could be distinguished wi some degree of certainty from corresponding material of the 2 larger *Rattus* species (see following category) historically introduced to the Hawaiian Islands.

Rattus norvegicus and/or *R. rattus* (Norway and/or Roof Rat)...comprises all material that, because of its relatively large size, could be distinguished with some degree of certain from that of the smaller *Rattus exulans*; although, except for essentially intact crania, doubt that isolated skeletal elements of these 2 larger, post-Contact, species can safel be distinguished from each other.

Rattus sp. .....comprises material presumably all representing this genus but that could not be assigned to any particular 1 of the 3 *Ratt:* species named in the just-preceding 2 categories, usually because of either its fragmentary nature or its relative immaturity.

Mus musculus (House Mouse).....introduced to the Hawaiian Islands someti: after 1778.

Order Mysticeti
Family Balaenopteridae: (Fin-back Whales) and/or Balaenidae: (Right Whales)

Mysticete.....member(s) of the order Mysticeti (Whalebon Whales), of which perhaps 6 species might be expected to occur in the Central Pacific, with adult lengths ranging from about 8 to 30 m.

Order Odontoceti
Family Delphinidae: (Porpoises, Dolphins, etc.), Physeteridae: (Sperm Whales), and/or Ziphiidae: (Beaked Whales)

Physeter macrocephalus (Sperm Whale).....a physeterid, with largest individuals (♂♂ reaching a length of 19 m.

Small Odontocete.....members(s) of the order Odontoceti (Toothed Whales) up to about 3 m or so in length, thus including in the Pacific a half-dozen or more porpoise- and dolphin-like species of the family Delphinidae, as well as the 2 unusual tiny physeterids of the genus *Kogia* (Pygmy and Dwarf Sperm Whales).

Medium Odontocete.....member(s) of the order Odontoceti (Toothed Whales) from about 3 to 9 m in length, thus including here only the 4 largest species of Pacific Delphinidae, as well as both Pacific members of the family Ziphiidae.

Order Carnivora
Family Canidae: (Wolves, Dogs, Foxes, etc.)

Canis familiaris (Domestic Dog).....(I doubt that it is possible to distinguish remains of pre-Contact Polynesian dogs from morphologically similar forms of historically introduced ones, although individuals of very large or otherwise osteologically distinct introduced modern breeds of this same species might be successfully identified as such.)

Family Viverridae: (Mongooses, Civets, etc.)

Herpestes auropunctatus (Small Indian Mongoose)...introduced to the Hawaiian Islands in 1883.

Family Felidae: (Lions, Tigers, Cats, etc.)

Felis catus (House Cat).....introduced to the Hawaiian Islands sometime after 1778.

Order Perissodactyla
Family Equidae: (Horses, Donkeys, Zebras, etc.)

Equus caballus (Domestic Horse).....member(s) of the family Equidae in the horse size range; although I have referred all such material to this species (introduced to the Hawaiian Islands in 1803), in reality, the similar-sized *Equus asinus* x *Equus caballus* (Mule; introduced or produced locally by at least 1851)--and perhaps even the smaller *Equus asinus* (Donkey; introduced by at least 1825)--could not always be distinguished from it on the basis of most fragmentary material. (In addition, there are apparently no comparative skeletons of Mule, and only a few miscellaneous bones of Donkey, available in Hawai'i.)

Order Artiodactyla.
Family Suidae: (Pigs, Babirusa, Wart Hogs, etc.)

Sus scrofa (Pig).....(just as in the case of the Domestic Dog, I doubt that it is possible to distinguish remains of pre-Contact Polynesian pigs from morphologically similar breeds of historically introduced ones, although individuals of extremely large or otherwise osteologically distinct introduced modern breeds of this same species might be successfully identified as such.)

Family Cervidae: (Muntjacs, Deer, Elk, Pudu, Moose, Caribou, etc.)

Medium Cervid.....member(s) of the family Cervidae in the size range of *Axis axis* (Axis Deer) and *Odocoileus hemionus* (Mule Deer), both of which have been introduced to various Hawaiian Islands, the former in 1867 and the latter, definitely, in 1961, if not as early as about 1816 (see pp. 133-134 in the Tomich 1986 reference cited on the preceding page of this List).

Family Bovidae: (Cattle, Buffalo, Goats, Sheep, etc.)

Bos taurus (Domestic Cattle).....member(s) of the family Bovidae in the cattle size range; although I have referred all such material to this species (introduced to the Hawaiian Islands in 1793), in reality, other such large bovids as *Bubalus bubalis* (Water Buffalo; introduced about 1881?) and *Bison* (North American Bison; introduced in 1968) could not be distinguished from it on the basis of most fragmentary material.

Capra hircus/Ovis sp. (Domestic Goat/Sheep).....comprises fragmentary material from 1 or more smaller historically introduced members of, presumably, the family Bovidae, with the osteologically very similar *Capra hircus* (Domestic Goat; introduced to the Hawaiian Islands in 1778) and *Ovis aries* (Domestic Sheep; introduced in 1791) being the species most likely represented, although *Ovis musimon* (Mouflon; introduced in 1954) is an additional possibility on some Hawaiian Islands. (Except for portions of the cranium, I doubt that isolated, often fragmentary, bone material of these 2 genera can safely be distinguished, considering both their general skeletal similarity and the osteological variation occasioned by possible interbreeding with and among the different breeds of domestic stock.)

Family Indeterminate

Medium Artiodactyl.....member(s) of indeterminate family, other than Suidae (=pig); although on most isolated Pacific islands the possibilities (all historically introduced) are probably limited to Cervidae (various deer) and smaller Bovidae (*Capra hircus* [Domestic Goat] and *Ovis aries* [Domestic Sheep]); however, in Hawai'i, *Antilocapra americana* (Pronghorn) of the family Antilocapridae, as well as the bovid *Ovis musimon* (Mouflon)--introduced here in 1959 and 1954, respectively--must additionally be considered.

Order and Family Indeterminate

Small Mammal.....member(s) of indeterminate order and family up through the general size of *Rattus* sp. and mongoose; in Hawai'i, Polynesian- or historically introduced species of at least 3 orders could potentially be included.

Small-to-Medium Mammal.....member(s) of indeterminate order and family in the general size range of wallaby, rabbit, dog, and cat; in Hawai'i, Polynesian- or historically introduced species of at least 3 orders could potentially be included.

Medium Mammal.....member(s) of indeterminate order and family in the general size range of man, porpoise, seal, pig, deer, and goat/sheep; in Hawai'i native or introduced species of at least 4 orders could potentially be included.

Large Mammal.....member(s) of indeterminate order and family in the size range of medium and large whales, horse, mule, donkey, and cattle; native or historically introduced species of up to 4 orders could potentially be included.

CLASS INDETERMINATE

Order and Family Indeterminate

Small Vertebrate.....comprises highly fragmented bone material representing member(s) of indeterminate class, order, and family, but with an estimated head-and-body length less than about 0.3 m.

Medium Vertebrate.....comprises highly fragmented bone material representing member(s) of indeterminate class, order, and family but with an estimated head-and-body length of from about 0.3 m to, roughly, 2.0 m.

Large Vertebrate.....comprises highly fragmented bone material representing member(s) of indeterminate class, order, and family, but with an estimated head-and-body length of more than about 2.0 m.

APPENDIX D

Marine Shell Taxonomy

Marine Shell Taxonomy

Phylum Mollusca
Class Gastropoda
Subclass Prosobranchia
Order Archaeogastropoda
Superfamily Patellacea
Family Patellidae

Cellana spp. (Reeve, 1854; Gould, 1846)
Synonyms - Patella spp.; Helcioniscus spp.

NATIVE HABITAT: Within the Hawaiian Island chain Cellana are restricted in their occurrence to the shorelines of volcanic islands. They are generally found on basalt shorelines from the sprayzone where they occur with the nerite, Nerita picea, and the algae Ulva, et.al., seaward to the calcareous algal zone; except C. talcosa which occur at depths of 1 to 10m.
NATIVE USE AND NOMENCLATURE: The Hawaiian limpets were grouped together and called ʻopihi. The ʻopihi were extremely well liked as a food item and were reportedly the most commonly eaten shells. The favorite method of preparation was raw and salted, either with or without seaweed. They were sometimes washed clean and then cooked in the shell, in a calabash with hot stones. The shells were picked out later. This method enabled the broth (kai) to be used, especially by the sick and young. The meat was pulled from the shells or sometimes scooped out with a smaller, empty ʻopihi shell. ʻOpihi shells were used for scooping, peeling, and scraping because of their sharp edges. The Hawaiians differentiate among the various ʻopihi. ʻOpihi koʻele (Cellana talcosa) are large and tough with a yellow foot. They occur on rocks 1 to 10m deep along abrupt coastlines. ʻOpihi ʻalinalina (Cellana sandwicensis), also with a yellow foot, were the favorite of the Hawaiians. They live off the calcareous algae at the waters edge where the surf breaks. ʻOpihi makaiauli (Cellana exarata) with soft, dark meat which lives higher on the rocks than ʻalinalina.

Superfamily Trochacea
Family Trochidae

Trochus intextus (Kiener, 1850)
Synonyms - Trochus ignobilis, T. sandwicensis

NATIVE HABITAT: These gastropods commonly occur in shallow, sandy areas studded with rocks, such as in Kaneohe Bay, Oahu. Worn shells are often frequented by hermit crabs. Pleistocene fossils are known from Oahu and Molokai.
NATIVE USE AND NOMENCLATURE: These snails were used as a food source. They were known to Hawaiians as haʻupu and ʻokoleʻoiʻoi.

Family Turbinidae

Turbo sandwicensis (Pease, 1861)
Synonyms - Turbo semicostasus; T. intercostalis; Marmorostoma intercostalium

NATIVE HABITAT: These mollusks are common under rocks in shallow waters shoreward of fringing reefs and on the outer edges of reefs. Worn shells have been dredged at depths of 56 to 86m. Pleistocene fossils are known from Oahu and Molokai.
NATIVE USE AND NOMENCLATURE: Known to be edible these shells were called alilea on the big island. On Oahu they were known as mahina (literally, moon shell) because the operculum is round like the moon.

Superfamily Neritacea
Family Neritidae

Nerita picea (Recluz, 1841)
Synonym - Neritina insculpta

NATIVE HABITAT: N. picea is the dominant nerite along Hawaiian shorelines, abundant on all rocky substrates from the splash zone to the high water mark just below the littorines. This species is recorded in Pleistocene deposits on Oahu. Samples of N. picea collected from Barbers Point, Oahu Island were radiocarbon dated and the results compared with dates obtained from charcoal from the same location. After calculating against the world reservoir a value for Delta R of 1040+/-150 was determined for samples of this species.
NATIVE USE AND NOMENCLATURE: N. picea and Theodoxus neglectus are two species of common pipipi. Pipipi is a general name for small mollusks used with modifying terms to indicate various species with habits and habitats similar to the nerites. The Hawaiians observed that pipipi do not hide whereas kupe'e only come out on some nights while hiding beneath stones or sand at day. Pipipi were used as a food source. They were both eaten as they were collected and cooked by boiling or by wrapping in leaves and broiling. A needle or pick was required to remove the meat and some people made a broth adding other shells for flavor. The shells were also used in leis.

Nerita polita (Linnaeus, 1758)

NATIVE HABITAT: These mollusks live beneath the surface of the sand among boulders at the high tide line. Seldom seen during the day, the snails emerge at night, plowing through the sand and crawling up the algae covered rocks on which they feed.
NATIVE USE AND NOMENCLATURE: Known as kupe'e by the Hawaiians, shells of N. polita were prized as items of

adornment and the animals were used as food. The Hawaiians had names for many kupe'e according to their markings. There were the kupe'e 'ula (red); the anuenue (rainbow), red or black striped; the palaoa (whale tooth ivory), creamy white; the 'ele'ele (black), the most common; the kani'o (vertical stripes), black and white streaks; the mahiole (warrior's helmet), white with red stripes; and the puna, rare. The rarest were the 'ula, anuenue, mahiole, and puna, and these were saved for the chiefs. The rare 'ula was believed to have the ability to leap and hide. Drilled and made into bracelets and necklaces, the kupe'e was an emblem of mourning for the ali'i. Custom varied among localities regarding the manner of preparing the kupe'e for eating. Eaten both raw and cooked the larger ones were always cooked in the shell and then extracted.

Theodoxus neglectus (Pease, 1861)
Synonym - Nerita neglectus

NATIVE HABITAT: These snails appear to be euryhaline and are found not only at seaward edges of basalt and solution benches and in tide pools, but they form a dominant element in brackish water assemblages. They are found immersed, both on the surface of the substratum and under rocks and rubble. T. neglectus is recorded form Pleistocene deposits on Oahu.
NATIVE USE AND NOMENCLATURE: Known to Hawaiians, along with other nerites, as pipipi these mollusks were used as a source of food. The brackish water varieties were called hihiwai.

Order Mesogastropoda
Superfamily Littorinacea
Family Littorinidae

Littorina pintado (Wood, 1828)
Synonyms - Littorina ambigua; L. serialis

NATIVE HABITAT: These littorines are abundant in the supratidal region along all rocky shores from Midway to Hawaii. They are the most common mollusks of the high shoreline where they feed on algae and detritus which they rasp from the surface of rocks. Fossils of L. pintado occur in pleistocene deposits on Oahu.
NATIVE USE AND NOMENCLATURE: These mollusks were known as 'akolea by the hawaiians with various modifications including kukae-kolea, pipipi-kolea, and pupu-kolea. They are known to be used as a food source.

Superfamily Strombacea
Family Stombidae

Strombus maculatus (Sowerby, 1842)

NATIVE HABITAT: This is the only commonly occurring strombid in the Hawaiian Islands, found on intertidal solution benches

and to depths of 2m. Strombids are herbivores, feeding on filamentous algae. They were apparently at one time more abundant and diverse in Hawaiian waters than they are today with an extinct endemic subspecies, S. mutabilis ostergaardi, being widely distributed in pleistocene deposits on Oahu.
NATIVE USE AND NOMENCLATURE: Not identified as a source of food, the only known name is mamaiki.

Superfamily Hipponacea
Family Hipponicidae

Hipponix spp. (Deshayes, 1832)

NATIVE HABITAT: These limpets are common under rocks in tide pools and shallow bays and abundant on the algal ridge of fringing reefs.
NATIVE USE AND NOMENCLATURE: Not eaten as food these shells were small and bitter to the taste. Said to be used by "sorcerers" they were known as ʻopihi-ʻawa. They were also called "the kind that clings" to water-worn boulders (paʻala).

Superfamily Cypraeacea
Family Cypraeidae

Cypraea spp. (Linnaeus, 1758)

NATIVE HABITAT: The cowrie are among the best known of all mollusks, their highly polished, elaborately patterned shells long prized in collections. In habitat cowries range from the intertidal to depths of about 100m. The most common species in the genus in the Hawaiian Islands are found in shallow water under loose rocks and boulders along the shoreline and in crevices at the seaward edge of solution benches and fringing reefs. Samples have been reported from Pleistocene fossil deposits on Oahu. Samples of Cypraea spp. collected from South Point, Hawaii Island were radiocarbon dated and the results compared with dates obtained from wood from the same location. After calculating against the world reservoir a value for Delta R of 170+/-210 was determined for samples of this genus.
NATIVE USE AND NOMENCLATURE: This shell group was of major importance in the Hawaiian economy as food, ornaments, tools, and octopus fishing lures. Leho is the general name for the family Cypraeidae while poleholeho refers to the smaller species. To prepare leho for consumption, the shells were broken open, the meat then removed and worked with salt. The flesh was wrapped in ti leaves and cooked over coals. Some people merely boiled the shell and then removed the meat. On Kauai, leho were either boiled as the only method of cooking or eaten raw. Poleholeho were not eaten. Small yellow and white leho were reserved for the aliʻi to use as ornaments and were occasionally used as a currency. Larger shells were used to make scrapers for removing the skin from cooked taro

and breadfruit and for grating coconut. Cowrie scrapers with a sharp, serrated edge were also used to incise wauke bark to remove it from the plant. The mauritius and sometimes the tiger cowries were used as lures in fishing for octopus.

Superfamily Tonnacea
Family Cymatiidae

Cymatium spp. (Linnaeus, 1758; Roding, 1798)

NATIVE HABITAT: These triton shells vary in habitat from species common in shallow water, occurring under rocks in sandy areas and shoreward on fringing reefs, to species rarely found dredged from depths of up to 100m. These mollusks are carnivorous, feeding on other mollusks and echinoderms by paralyzing the prey with an acid fluid excreted from their salivary glands.
NATIVE USE AND NOMENCLATURE: These gastropods are known by a number of native names including; naunau, 'ole-kiwi, and pupu hohopu (Hilo name). All species were used as a source of food.

Order Neogastropoda
Superfamily Muricacea
Family Thaididae

Drupa spp. (Linnaeus, 1758)

NATIVE HABITAT: These gastropods are common of benches, reefs, and basalt shores where there is heavy surf action and on rocky substrates to depths of 15m. The shells are often covered with a heavy growth of coralline algae. They have been reported in Pleistocene fossil deposits on Oahu.
NATIVE USE AND NOMENCLATURE: These muricids were used as a source of food with the larger specimens having a lip that is long, sharp, and strong enough to be made into small adzes. A variety of names were used including aupupu, 'awa, makaloa, and pupu makaloa literally meaning shell with a long, sharp edge.

Morula spp. (Roding, 1798)

NATIVE HABITAT: Morula are common in the intertidal zone on hard substrates where there is strong wave action. These gastropods feed by drilling into their prey, usually other mollusks such as vermetids and oysters.
NATIVE USE AND NOMENCLATURE: Known both as maka'awa and makaloa these muricids were plentiful on "kaloa" nights. They were a favored food.

Neothais harpa (Conrad, 1837)

NATIVE HABITAT: N. harpa is found in the high splash zone of the shoreline with Littorina pintado and Nerita picea. N.

harpa is endemic to the Hawaiian Islands.
NATIVE USE AND NOMENCLATURE: These muricids were used as a source of food and known by a variety of names including aupupu, 'awa, and makaloa.

Superfamily Conacea
Family Conidae

Conus spp. (Linnaeus, 1758)

NATIVE HABITAT: Cones are among the most conspicuous gastropods of reefs and benches that fringe the shoreline, as well as of deeper waters offshore in the Hawaiian Islands. Of the 25 species which have been found on reefs and benches, six are dominant on marine benches and two are dominant on subtidal reefs. In dredge hauls off the leeward coast of Oahu at depths of 20-200m, two species comprise 18 percent of the large gastropods collected. Pleistocene fossils are known from Oahu.
NATIVE USE AND NOMENCLATURE: Family Conidae was known by two names. The pupu-'ala were distinguished as species that do not sting. Kay (1949) reports that one species, C. millepunctatus, was used by only a few families for food, but that the shell was prized as an ornament. The cone shells that sting were known as pupu poniuniu (literally, dizzy shell).

Family Terebridae

Terebra spp. (Linnaeus, 1758)

NATIVE HABITAT: Terebrids are common in sandy areas from depths slightly below the mean low water level to depths of more than 100m. In shallow water these mollusks occur where there is little or no wave action and soft sand. They are carnivorous feeding, commonly, on large hemichordates.
NATIVE USE AND NOMENCLATURE: Known by hawaiians as nunui and oi'oi (Maui name), natives were very fond of the flesh. Shells were used as drill points, as stoppers for water gourds, and as scrapers.

Phylum Mollusca
Class Bivalvia
Superfamily Arcacea
Family Arcidae
Subfamily Arcinae

Barbatia decussata (Sowerby, 1823)
Synonyms - Arca candida; A. hawaiiensis; Barbatia oahua

NATIVE HABITAT: Sandy bottom dwellers, these bivalves were formerly common in Kaneohe Bay, Oahu, at depths of 1 to 3 meters but are only occasionally found in the area today.

NATIVE USE AND NOMENCLATURE: These native clams were known by the general name ʻolepe. All of the bivalves known as ʻolepe were used as a source of food though a favorite variety was never recorded. The Arcidae family were known as ʻOlepe-papaua.

Superfamily Mytilacea
Family Mytilidae

Brachidontes cerebristriatus (Conrad, 1837)
Synonym - Mytilus cerebristriatus

NATIVE HABITAT: These mytilids are extremely abundant on limestone shorelines where they pave patches of solution benches at the 0 tide mark. They are found in lesser densities along basalt shores and are ubiquitous around the shorelines of the windward islands. The shells occurring where there is freshwater outflow are generally larger, thinner, and less sculptured than those which are found in normally saline waters.
NATIVE USE AND NOMENCLATURE: B. cerebristriatus was known by the general name nahawele. It was reported that in Pearl Harbor nahawele grew to finger length and more and were popular as food. In Kaneohe Bay they were said to be smaller but good to eat raw or cooked. Other names included ʻoaʻoaka (literally, open-shut mouth), nahawele-liʻiliʻi, and kio-nahawele.

Superfamily Pteriacea
Family Pteriidae

Isognomon californicum (Conrad, 1837)
Synonyms - Perna hawaiiensis; Isognomon vitrea

NATIVE HABITAT: These bivalves form dense beds attached to the substrate at the tide line in brackish water on Hawaii and Maui, and are found singly in more saline environments throughout the Hawaiian chain.
NATIVE USE AND NOMENCLATURE: Called by the name nahawele and known to be a food source, this family could also be called ʻoaʻoaka allthough they were not known by as many names as B. cerebristriatus. The larger of these shells could have been a minor source of material for mother-of-pearl fish hooks.

Superfamily Ostreacea
Family Ostreidae

NATIVE HABITAT: Oysters are a common and well known group of bivalves. They are sedentary, usually living totally submerged in tubid free, saline waters cemented to hard surfaces. Most occur at depths near the tidal zone, though some species are known to exist at depths of up to 200m. The endemic, extinct species Pycnodonta kamehameha has been found in abundance in Pleistocene deposits on Oahu and on emerged

reefs near Waianae and at Black Point, Oahu.
NATIVE USE AND NOMENCLATURE: This family of oysters are known as mahamoe, though they were also called pahikaua. They were said to be plentiful at Ewa though of little or no economic value as food. It is likely that all species of oysters were used as a supplemental source of protein while the mother-of-pearl from their shells was used to fashion fishhooks, jewelery, and tools.

Superfamily Chamacea
Family Chamidae

Chama iostoma (Conrad, 1837)

NATIVE HABITAT: Rock oysters are sedentary bivalves, their left valve being cemented to the substrate. C. iostoma is common in shallow waters such as tide pools and areas shoreward of fringing reefs. They have also been found on rocks and benches exposed to the surf as well as from sediments dredged from depths of up to 100m.
NATIVE USE AND NOMENCLATURE: These bivales were known in Hawaiian as kupekala, or sometimes simply as kala. The meat from these shells was used for food and the taste was said to be richer than pipi, or pearl oysters (Pinctada radiata).

Superfamily Lucinacea
Family Lucinidae

Ctena bella (Conrad, 1837)
Synonym - Codakia ramulosa

NATIVE HABITAT: These bivalves are ubiquitous, common in shallow water in sandy tide pools, on sand patches, and in sandy pockets on fringing reefs, and have been dredged from depths of more than 60m. This species is recorded as a Pleistocene fossil on Oahu.
NATIVE USE AND NOMENCLATURE: These native clams were known by the general name ʻolepe. All of the bivalves known as ʻolepe were used as a source of food though a favorite variety was never recorded. This family was known as ʻolepe-kupe with C. bella specifically called ʻolepe-kupe ʻopiopio.

Superfamily Tellinacea
Family Tellinidae

Tellina palatam (Iredale, 1929)
Synonym - Tellina rugosa; Quidnipagus palatam

NATIVE HABITAT: These bivalves are found in silty sand inshore of fringing reefs and at depths of from 2 to 3m. This family of clams burrow into a sandy substrate where they insert their incurrent siphons, sifting organic detritus on which they subsist. When calibrating radiocarbon dated age ranges for T. palatam samples, a Delta R of 30+/-90 is the

accepted value.
NATIVE USE AND NOMENCLATURE: These native clams were known by the general name ʻolepe. All of the bivalves known as ʻolepe were used as a source of food though a favorite variety was never recorded. No specific name is known for T. palatam.

Superfamily Veneracea
Family Veneridae

Periglypta reticulata (Linnaeus, 1758)
Synonym - Periglypta edmondsoni

NATIVE HABITAT: This is a *common species* found in shallow water along all the shorelines of the Hawaiian Islands.
NATIVE USE AND NOMENCLATURE: These native clams were known by the general name ʻolepe. All of the bivalves known as ʻolepe were used as a source of food though a favorite variety was never recorded. P. reticulata was also called pupu-kupa and pupu kupe.

Note: There are problems with the radiocarbon dating of marine shells within the Hawaiian Archipelago due to varying marine reservoirs of available carbon between islands and shorelines of the same island which may cause the calibration of the age ranges to vary as much as 1000 years. Ongoing calculations of Delta R values are continually updating our ability to calibrate dates obtained from marine shell. Those values for Delta R are reported with this taxonomy. The currently accepted general value for all shell material from the Hawaiian Islands for Delta R is 57+/-113.

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Note: Taxonomic nomenclature is derived from the above cited authorities. Full bibliographical references are generally not cited for the basic presentation of taxonomic nomenclature (See Kay and Schoenburg-Dole 1991). All taxonomic nomenclature is presented according to the accepted, standard format to allow for the inclusion of as much information as possible (including the presentation of the first, accepted, use and source of the nomenclature).