Appendix B

TRAFFIC ANALYSIS REPORT

Julian Ng, Incorporated

November 2000

Traffic Analysis Report

Hawaii Commercial Harbors 2020 Master Plan

Hilo Harbor, Hilo, Hawaii

Kawaihae Harbor, Kawaihae, Hawaii

Prepared for: State of Hawaii
Department of Transportation
Harbors Division
and
R. M. Towill Corporation

Prepared by: Julian Ng, Incorporated
P. O. Box 816
Kaneohe, Hawaii 96744

January, 2001

Table of Contents

Traffic Analysis Report
Hawaii Commercial Harbors 2020 Master Plan
January, 2001

Introduction

The State of Hawaii, Department of Transportation, Harbors Division will be constructing improvements over the next 20 years to implement the year 2020 master plan that was prepared for the commercial harbors on the island of Hawaii. The projects listed in the master plan will improve port facilities at Hilo Harbor and Kawaihae Harbor to accommodate expected increases in container shipments, bulk cargo, and cruise passengers.

A traffic study was done to evaluate existing and future traffic conditions in the vicinity of the two harbors and to identify roadway improvements that will be necessary to provide adequate access to the harbors.

Existing peak hour traffic volumes were factored to obtain estimates of future peak hour volumes. The required roadway configurations were determined from evaluations of alternative roadway layouts using vehicular density and analyses of conditions at intersections during the peak hours. The level of service concept described in the *Highway Capacity Manual* was used. Six levels are defined, using the letters A through F. The range is from Level of Service (LOS) A describing low densities or no delays to LOS F describing very high densities and very long delays at intersections. In rural areas, desirable conditions are LOS C or better; in urban areas, LOS D is acceptable.

On roadway segments, densities were used to evaluate conditions given the number of lanes. For arterial roadways with speed limits up to 45 miles per hour, level of service criteria are:

Level of Service	Traffic density (passenger cars per lane-mile)
A	density $\leq$ 12
B	12 < density $\leq$ 20
C	20 < density $\leq$ 28
D	28 < density $\leq$ 34
E	34 < density $\leq$ 45
F	density greater than 45

Reference: *Highway Capacity Manual*

The analysis procedure for unsignalized intersections as described in Chapter 10 of the 1997 update to the *Highway Capacity Manual* was used to determine average vehicular delays and levels of service at unsignalized intersections. In this analysis, traffic flows on the major street

(those that do not yield to other traffic) are used to determine the capacities and delays to minor flows at the intersection. From these parameters, average vehicular delays are computed and levels of service for each minor flow (major street left turns against oncoming traffic and minor street movements wishing to enter the major street) are determined using the following criteria:

Level of Service A:	0 seconds < delay $\leq$ 10 seconds
Level of Service B:	10 seconds < delay $\leq$ 15 seconds
Level of Service C:	15 seconds < delay $\leq$ 25 seconds
Level of Service D:	25 seconds < delay $\leq$ 35 seconds
Level of Service E:	35 seconds < delay $\leq$ 50 seconds
Level of Service F:	50 seconds < delay

A critical movement analysis as described in the 1985 edition of the *Highway Capacity Manual* was used to evaluate signalized intersections. In this analysis, conflicting movements at an intersection are summed to determine overall conditions. A sum of 1,200 vehicles per hour per lane is considered under capacity (desirable condition) and a sum greater than 1,400 would indicate over capacity (unacceptable) conditions. Between these limits, conditions would be described as "near capacity" which may or may not be acceptable.

Existing Traffic

The State Highways Division estimates the average daily traffic on defined segments of all highway facilities in the State. For the island of Hawaii, estimates are made for even-numbered years based on traffic count data collected in those years. The latest published highway statistics are for year 1996. Tables 1 and 2 summarize the recent estimates of average daily traffic on several roadway segments near the commercial harbors.

Table 1
Average Daily Traffic
Vicinity of Hilo Harbor

	Kuhio Street (1)	Kalanianaole Street (2)	Kamehameha Avenue (3)	Kanoelehua Avenue (4)
1988	2,228	14,497	20,699	20,974
1990	4,678	18,474	24,123	29,076
1992	4,166	17,142	25,705	27,729
1994	3,228	17,825	22,690	27,712
1996	1,639	14,504	18,846	20,363

Note: (1) North of Kalanianaole Street; (2) between Kuhio Street and Kamehameha Avenue; (3) between Kalanianaole Street and Manono Street; (4) between Kamehameha Avenue and Hualani Street

Source: State Highways Division. *Traffic Summary, Island of Hawaii* 1996.

Table 2
Average Daily Traffic
Vicinity of Kawaihae Harbor

	Akoni Pule Highway (1)	Kawaihae Road (2)	Kawaihae Road (3)	Q. Kaahumanu Highway (4)
1988	3,841	3,797	4,729	4,850
1990	4,238	5,389	6,261	8,298
1992	3,951	4,914	6,200	7,273
1994	3,987	6,106	5,953	8,949
1996	4,378	5,462	6,533	9,254

Note: (1) North of Kawaihae Wharf; (2) between Kawaihae Wharf and Queen Kaahumanu Highway; (3) between Queen Kaahumanu Highway and Akulani Street, (4) between Kawaihae Road and Waikoloa Road

Source: State Highways Division. *Traffic Summary, Island of Hawaii* 1996.

The State Highways Division average daily traffic estimates indicate that traffic volumes near Hilo Harbor vary considerably, but there is no definite upward or downward trend. The daily traffic estimates near Kawaihae Harbor also exhibit considerable variation but show an increasing trend on all roadways.

The State Highways Division has completed the collection of the 2000 traffic counts at various locations on the island of Hawaii. Tables 3 and 4 summarize the daily and peak hour volumes at several locations near the two commercial harbors which correspond to the segments described in Tables 1 and 2. Tables 3 and 4 also show the arithmetic averages of the daily traffic estimates for 1988, 1990, 1992, 1994, and 1996 and the most recent 24-hour count totals and peak hour totals (of two-way traffic).

Table 3 shows that peak hour traffic volumes in the immediate vicinity of Hilo Harbor are generally higher in the AM Peak Hour than in the PM Peak Hour. On Kanoelehua Avenue, however, PM Peak Hour volumes tend to be higher than AM Peak Hour volumes. As shown in Table 4, traffic volumes near Kawaihae Harbor are higher in the PM Peak Hour than in the AM Peak Hour.

From the 2000 traffic count data, estimates of existing traffic volumes at two critical intersections near each harbor were developed. Exhibit 2 shows the peak hour volumes at the signalized intersection of Kanoelehua Avenue and Kamehameha Avenue and at the unsignalized intersection of Kalanianaole Street and Kuhio Street (and the nearby intersection with Silva Street). Exhibit 3 shows the peak hour volumes at the presently unsignalized intersections of Kawaihae Road and Queen Kaahumanu Highway and Kawaihae Road assuming all harbor traffic use a single access road.

Table 3
Recent Traffic Count Data
Vicinity of Hilo Harbor

	Kuhio Street (1)	Kalanianaole Street (2)	Kamehameha Avenue (3)	Kanoelehua Avenue (4)
1988-1996 *	3,190	12,490	22,410	25,170
1998 daily	2,654	12,769	18,202	22,032
AM Peak Hour	329	1,234	1,642	1,697
PM Peak Hour	249	1,007	1,498	1,827
2000 daily	2,300	15,764	21,569	24,665
AM Peak Hour	220	1,400	1,894	1,821
PM Peak Hour	175	1,264	1,898	2,001

Note: (1) North of Kalanianaole Street; (2) between Kuhio Street and Kamehameha Avenue; (3) between Kalanianaole Street and Manono Street; (4) between Kamehameha Avenue and Hualani Street; * average of ADTs

Source: State Highways Division.

Table 4
Recent Traffic Count Data
Vicinity of Kawaihae Harbor

	Akoni Pule Highway (1)	Kawaihae Road (2)	Kawaihae Road (3)	Q. Kaahumanu Highway (4)
1988-1996 *	4,080	5,135	5,935	7,725
1998 daily	4,163	6,197	6,463	9,229
AM Peak Hour	281	433	463	631
PM Peak Hour	315	442	509	685
2000 daily	5,244	6,725	7,650	10,365
AM Peak Hour	355	442	565	734
PM Peak Hour	507	603	740	923

Note: (1) North of Kawaihae Wharf; (2) between Kawaihae Wharf and Queen Kaahumanu Highway; (3) between Queen Kaahumanu Highway and Akulani Street, (4) between Kawaihae Road and Waikoloa Road; * average of ADTs

Source: State Highways Division.

The segments of Kamehameha Avenue east of Kanoelehua Avenue and on Kalanianaole Street west of Kuhio Street operate poorly during existing peak hours, due to high volumes on narrow streets. The unsignalized intersections of Kalanianaole Avenue with Silva Street and with

Kuhio Street are in close proximity with each other and were analyzed as a single unsignalized intersection. The analyses show very long delays and poor levels of service for traffic from Silva Street. All traffic leaving or entering Hilo Harbor pass through the signalized intersection of Kamehameha Avenue and Kanoelehua Avenue. Analyses of this intersection indicate that it is presently operating at under capacity conditions in the AM Peak Hour and near capacity conditions in the PM Peak Hour.

Table 5
Existing Levels of Service
Vicinity of Hilo Harbor

	AM Peak Hour		PM Peak Hour	
Roadway segments (density, LOS)				
Kamehameha Avenue west of Kanoelehua Ave.				
westbound	18.9	B	20.3	C
eastbound	19.4	B	22.4	C
Kamehameha Avenue east of Kanoelehua Ave.				
westbound	45.0	E	44.8	E
eastbound	50.8	F	45.9	F
Kalanianaole Avenue west of Kuhio Street				
westbound	37.8	E	30.4	D
eastbound	32.9	D	28.6	D
Kalanianaole Avenue east of Kuhio Street				
westbound	31.0	D	22.0	C
eastbound	24.6	C	23.1	C
Kanoelehua Avenue south of Kamehameha Avenue				
southbound	16.3	B	19.9	B
northbound	16.6	B	18.1	B
Unsignalized Intersection, Kalanianaole Avenue, Silva Street, Kuhio Street (average delay in seconds, LOS)				
Kuhio Street approach	18.6	C	12.9	B
left turns to Silva Street	8.8	A	8.6	A
left turns to Kuhio Street	9.6	A	8.7	A
Silva Street approach	163.1	F	57.1	F
Signalized Intersection, Kanoelehua Avenue and Kamehameha Avenue				
Critical Movement Sum	1,188		1,234	
Overall intersection condition	under capacity		near capacity	

In Kawaihae, acceptable (LOS C or better) conditions were found for roadway segments and at intersections. Findings of the analyses of existing conditions are summarized in Table 6.

Table 6
Existing Levels of Service
Vicinity of Kawaihae Harbor

	AM Peak Hour		PM Peak Hour	
Roadway segments (density, LOS)				
Akoni Pule Highway, north of harbor				
northbound	5.4	A	11.0	A
southbound	10.4	A	10.3	A
Kawaihae Road, south of harbor				
northbound	11.2	A	15.0	B
southbound	11.3	A	15.7	B
Queen Kaahumanu Highway, south of Kawaihae Rd.				
northbound	9.2	A	18.5	B
southbound	17.7	B	15.2	B
Kawaihae Road, east of Queen Kaahumanu Highway				
westbound	20.3	C	16.3	B
eastbound	8.4	A	21.4	C
Unsignalized Intersections (average delay in seconds, LOS)				
Kawaihae Harbor access road at Kawaihae Road				
left turns from Kawaihae Road	7.9	A	7.8	A
left turn to Kawaihae Road	11.4	B	11.8	B
right turn to Kawaihae Road	9.5	A	10.1	B
Queen Kaahumanu Highway at Kawaihae Road				
left turns from Kawaihae Road	8.1	A	8.1	A
left turn to Kawaihae Road	20.4	C	21.5	C
right turn to Kawaihae Road	9.1	A	11.1	B

Future Traffic

Future traffic volumes at the critical intersections near the commercial harbors have been estimated for the year 2020 by factoring existing traffic volumes. Future traffic movements in and out of Hilo Harbor were estimated to increase by 40% over existing volumes, based on the description of the harbor improvements for year 2020. Similarly, future traffic volumes in and out of Kawaihae Harbor were estimated to increase 200% over existing volumes. Other, non-harbor traffic volumes were increased by 30% to 50% near Hilo Harbor and by 110% near Kawaihae Harbor.

Exhibits 4 and 5 show the future peak hour traffic assignments, assuming existing roadway configurations. The results of the analyses are shown in Table 7 (Hilo Harbor) and Table 8 (Kawaihae Harbor).

Table 7 also show the results of the analyses assuming that Kamehameha Avenue east of Kanoelehua Avenue is widened by one lane in each direction, and Kalanianaole Street is widened to five lanes (two in each direction plus a dedicated left turn lane). The analysis of the assumed improved condition indicates that further improvement of Kamehameha Avenue east of Kanoelehua Avenue may be needed in order to achieve LOS D or better conditions.

Table 7
Future Levels of Service
Vicinity of Hilo Harbor

	Existing Roadway Layout				Improved Kalanianaole Street			
	AM Pk. Hr.		PM Pk. Hr.		AM Pk. Hr.		PM Pk. Hr.	
Existing roadway segments (density, LOS)								
Kamehameha Avenue west of Kanoelehua Ave.								
westbound	28.3	D	30.6	D	28.3	D	30.6	D
eastbound	29.2	D	33.6	D	29.2	D	33.6	D
Kamehameha Avenue east of Kanoelehua Ave.								
westbound	67.8	F	67.2	F	33.9	D	33.6	D
eastbound	76.3	F	68.8	F	38.2	E	34.4	E
Kalanianaole Avenue west of Kuhio Street								
westbound	49.3	F	39.7	E	24.6	C	19.8	C
eastbound	43.0	F	36.9	E	21.5	C	18.5	B
Kalanianaole Avenue east of Kuhio Street								
westbound	40.4	E	29.1	D	20.2	C	14.5	B
eastbound	32.1	D	30.3	D	16.1	B	15.2	B
Kanoelehua Avenue south of Kamehameha Avenue								
southbound	24.5	C	30.0	D	24.5	C	30.0	D
northbound	25.0	C	27.1	C	25.0	C	27.1	C
Unsignalized Intersection, Kalanianaole Avenue, Silva Street, Kuhio Street (average delay in seconds, LOS)								
Kuhio Street approach	59.1	F	20.6	C	31.1	D	15.1	C
left turns to Silva Street	9.4	A	9.2	A	9.6	A	9.3	A
left turns to Kuhio Street	10.9	B	9.3	A	11.2	B	9.4	A
Silva Street approach	>300	F	>300	F	>300	F	127.1	F
Signalized Intersection, Kanoelehua Avenue and Kamehameha Avenue								
Critical Movement Sum	1,788		1,853		1,118		1,200	
Overall intersection condition	over capacity		over capacity		near capacity		near capacity	

Table 8 shows that peak hour conditions on Kawaihae Road south of the harbor will be unacceptable if no changes are made to the roadway system. Queen Kaahumanu Highway to the south and Kawaihae Road to the east would also be congested.

Table 8
Future Levels of Service
Vicinity of Kawaihae Harbor

Existing Roadways	AM Peak Hour		PM Peak Hour	
Roadway segments (density, LOS)				
Akoni Pule Highway, north of harbor				
northbound	12.3	B	25.6	C
southbound	24.5	C	22.5	C
Kawaihae Road, south of harbor				
northbound	31.1	D	34.4	E
southbound	28.3	C	43.2	E
Queen Kaahumanu Highway, south of Kawaihae Rd.				
northbound	19.3	B	38.6	E
southbound	37.2	E	32.0	D
Kawaihae Road, east of Queen Kaahumanu Highway				
westbound	50.1	F	37.2	E
eastbound	22.2	C	55.4	F
Unsignalized Intersections (average delay in seconds, LOS)				
Kawaihae Harbor access road at Kawaihae Road				
left turns from Kawaihae Road	9.6	A	8.7	A
left turn to Kawaihae Road	35.2	E	41.5	E
right turn to Kawaihae Road	12.9	B	26.3	D
Queen Kaahumanu Highway at Kawaihae Road				
left turns from Kawaihae Road	10.5	B	11.4	B
left turn to Kawaihae Road	>300	F	>300	F
right turn to Kawaihae Road	11.3	B	109.9	F

The results shown in Tables 7 and 8 support other studies that have recommended roadway improvements in the vicinity of the harbors. In Hilo, the widening of Kalanianaole Avenue to four lanes with separate turning lanes at major intersections has been identified as a "Tier 1" project (to be programmed for construction prior to 2005) in the *Hawaii Long Range Land Transportation Plan* (1998). As indicated in Table 7, this improvement will provide LOS D or better conditions along Kalanianaole Street; additional improvements may be needed on Kamehameha Avenue east of Kanoelehua Avenue.

In Kawaihae, the construction of a new two-lane road from Queen Kaahumanu Highway to Akoni Pule Highway that will bypass the harbor area is also listed as a Tier 1 project in the long-range plan. In addition, a new road between Waimea and Kawaihae has been proposed as a Tier 2 (2006-2010) project. The widening of Queen Kaahumanu Highway to a four-lane divided highway with improvements at major intersections is a Tier 3 (2011-2020) project in the long-range plan. With these improvements in place, there would be adequate access to the harbors.

The proposed bypass road will reduce traffic volumes in the immediate vicinity of Kawaihae Harbor. Access would be provided by the existing road, which would be connected at an improved junction with the future Queen Kaahumanu Highway to Akoni Pule Highway corridor. Exhibit 6 shows estimated traffic volumes for the future peak hours with all of the proposed improvements in place. Stop controls at the future intersection of Queen Kaahumanu Highway and Kawaihae Road would not provide adequate service; if signalized, the intersection would operate at desirable under capacity condition (critical movement sums of 885 in the AM Peak Hour of 980 in the PM Peak Hour). Table 9 shows the results of the analyses when these improvements are considered.

Table 9
Future Levels of Service
Vicinity of Kawaihae Harbor

Proposed Roadway System	AM Peak Hour		PM Peak Hour	
Roadway segments (density, LOS)				
Akoni Pule Highway, north of harbor				
northbound	9.9	A	21.2	C
southbound	15.2	B	12.4	B
Kawaihae Road, between harbor access roads				
northbound	14.9	B	19.0	B
southbound	16.2	B	21.2	C
Kawaihae Road, south of harbor				
northbound	24.3	C	20.5	C
southbound	19.2	B	33.6	D
Harbor Bypass Road, north of Kawaihae Rd.				
northbound	24.3	C	17.4	B
southbound	7.6	A	10.4	A
Queen Kaahumanu Highway, south of Kawaihae Rd.				
northbound	14.3	B	16.6	B
southbound	13.7	B	19.2	B
Kawaihae Road, east of Queen Kaahumanu Highway				
westbound	8.3	A	10.4	A
eastbound	6.8	A	13.9	B
Unsignalized Intersections (average delay in seconds, LOS)				
Kawaihae Harbor north access road at Kawaihae Road				
left turns from Kawaihae Road	8.2	A	7.9	A
left turn to Kawaihae Road	13.6	B	14.0	B
right turn to Kawaihae Road	10.2	B	11.1	B
Kawaihae Harbor south access road at Kawaihae Road				
left turns from Kawaihae Road	8.5	A	8.5	A
left turn to Kawaihae Road	17.4	C	16.5	C
right turn to Kawaihae Road	10.7	B	15.1	C

Conclusions and Recommendations

The traffic analyses indicate that a single access to Hilo Harbor from Kalanianaole Street would be adequate. However, the harbor master plan indicates that additional access roads will be constructed to separate the access to differing functions within the harbor area. Intersection levels of service would be improved if additional access roads are provided.

The traffic analyses for Kawaihae Road show that a decrease in through traffic near the harbor and the addition of a second access road from Kawaihae Road would provide acceptable peak hour conditions along the roadway and at the critical intersections.

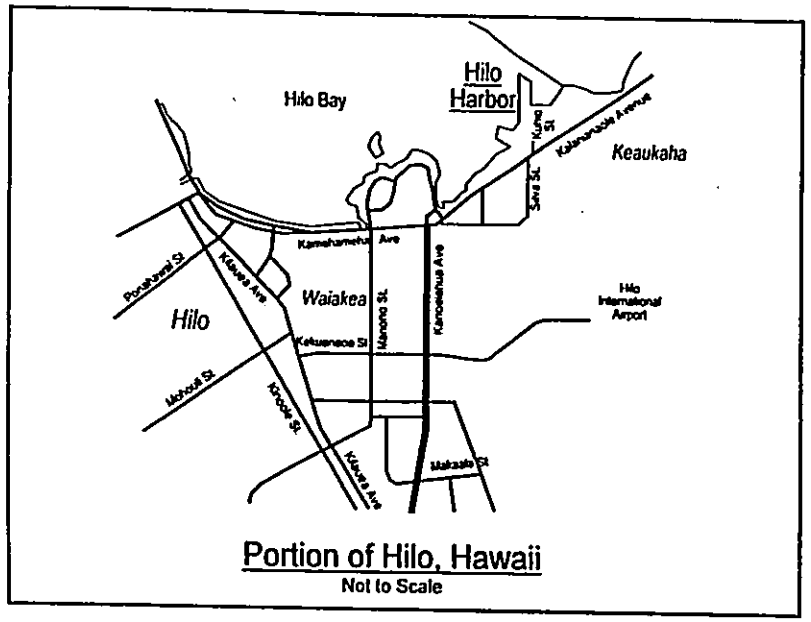
In both cases, the implementation of the roadway improvements previously identified in an islandwide study will be necessary to maintain adequate access to the harbor facilities. These improvements include:

- Widening of Kalanianaole Street (Kamehameha Avenue to Kuhio Street) to five lanes (two in each direction plus a left turn lane) [Tier 1].
- Construction of a new roadway bypassing the Kawaihae Harbor area (Queen Kaahumanu Highway to Akoni Pule Highway) [Tier 1].
- Construction of a new roadway between Waimea and Kawaihae (Mamalahoa Highway to Queen Kaahumanu Highway) [Tier 2].
- Widening of Queen Kaahumanu Highway south of Kawaihae Road [Tier 3].

["Tiers" were used in the islandwide plan to identify a timetable for the proposed improvements. Tier 1 projects were to be programmed for construction prior to 2005, Tier 2 between 2006 and 2010, and Tier 3 between 2011 and 2020.]

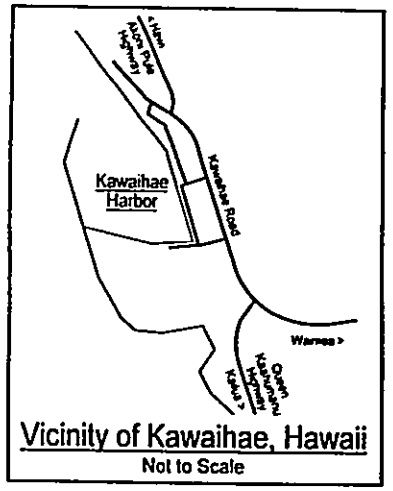
An additional turn lane from westbound Kamehameha Avenue to southbound Kanoelehua Avenue has been identified as a mitigation measure to improve conditions and provide adequate access. A new project could be defined:

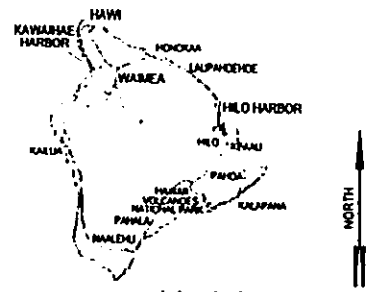
- Widening of Kamehameha Avenue (east of Kanoelehua Avenue) to five lanes.



Portion of Hilo, Hawaii

Not to Scale





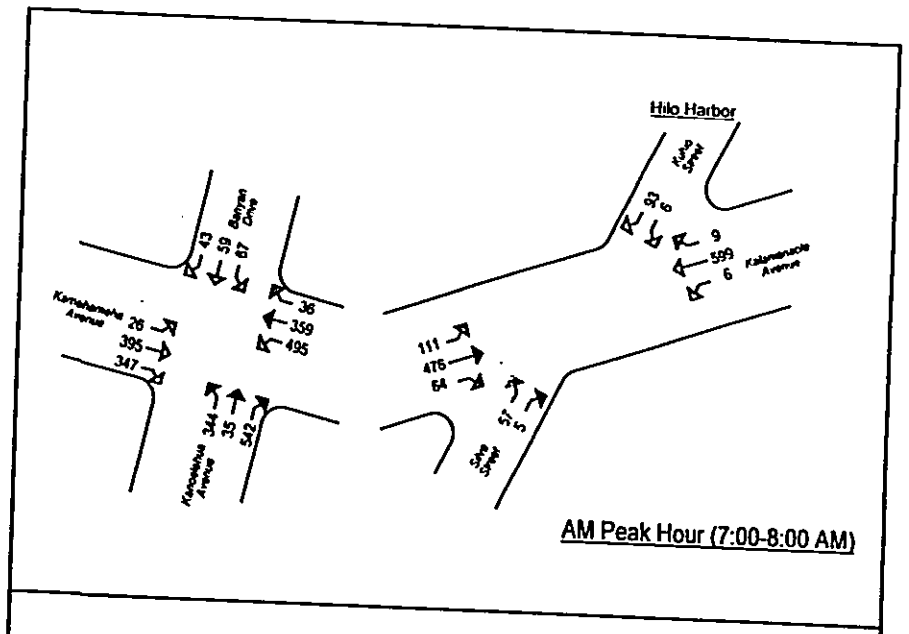
Vicinity of Kawaihae, Hawaii

Not to Scale

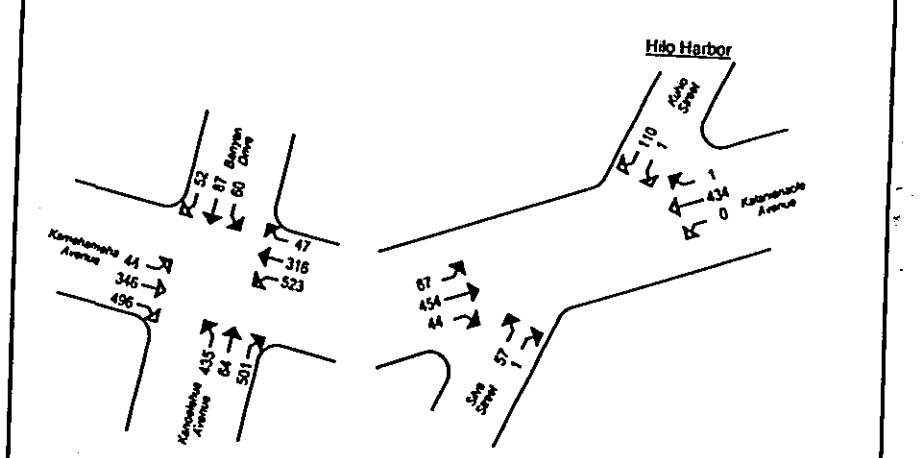
Island of Hawaii

Not to Scale

Hawaii Commercial Harbors 2020 Master Plan Traffic Analysis	Project Location and Vicinity Maps	Exhibit 1
	prepared by: Julian Ng, Inc. January 2001	

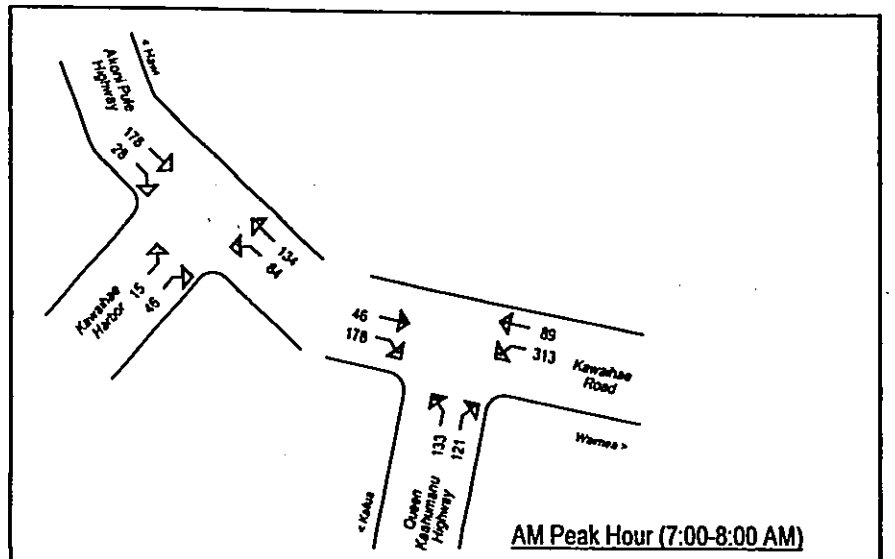


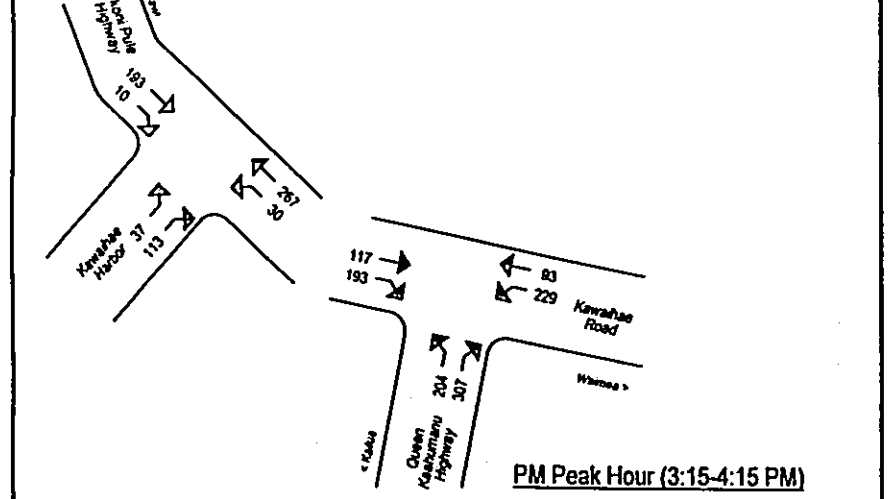
AM Peak Hour (7:00-8:00 AM)



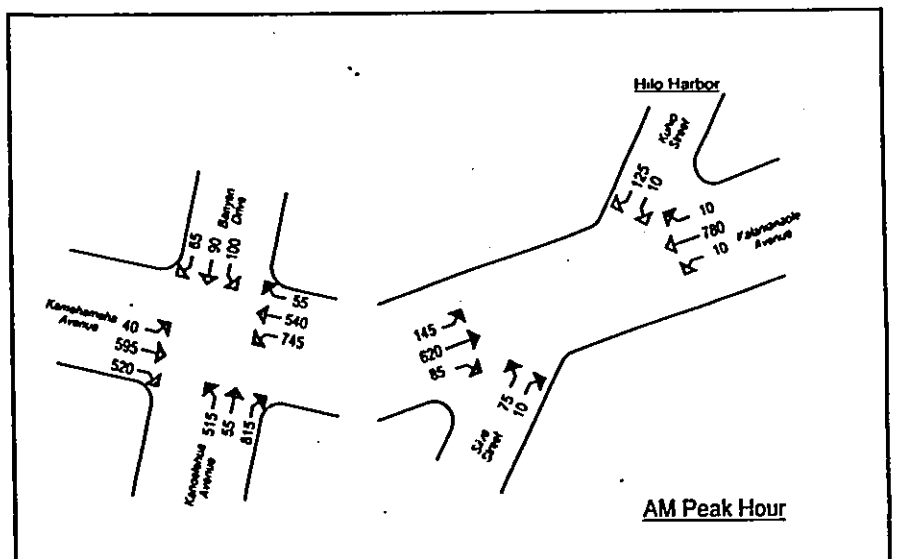
PM Peak Hour (3:15-4:15 PM)

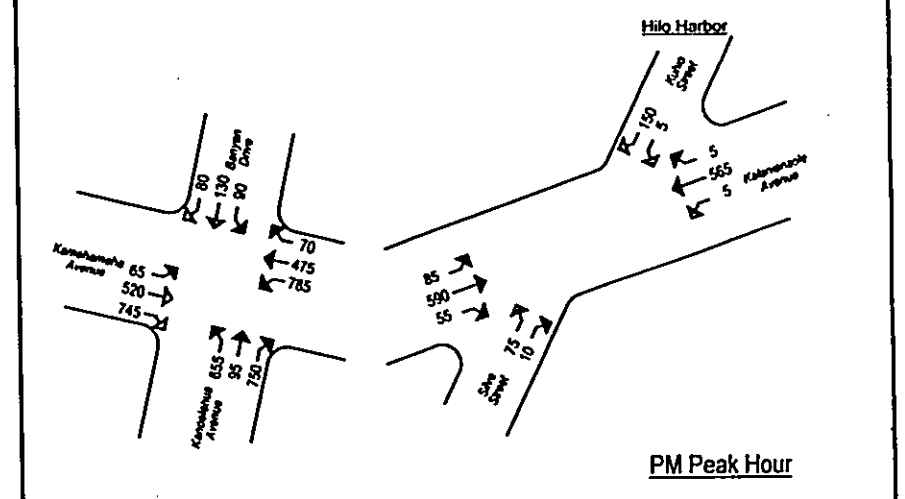
Hawaii Commercial Harbors 2020 Master Plan Traffic Analysis	Existing Peak Hour Traffic Vicinity of Hilo Harbor	Exhibit 2
	prepared by: Julian Ng, Inc. January 2001	



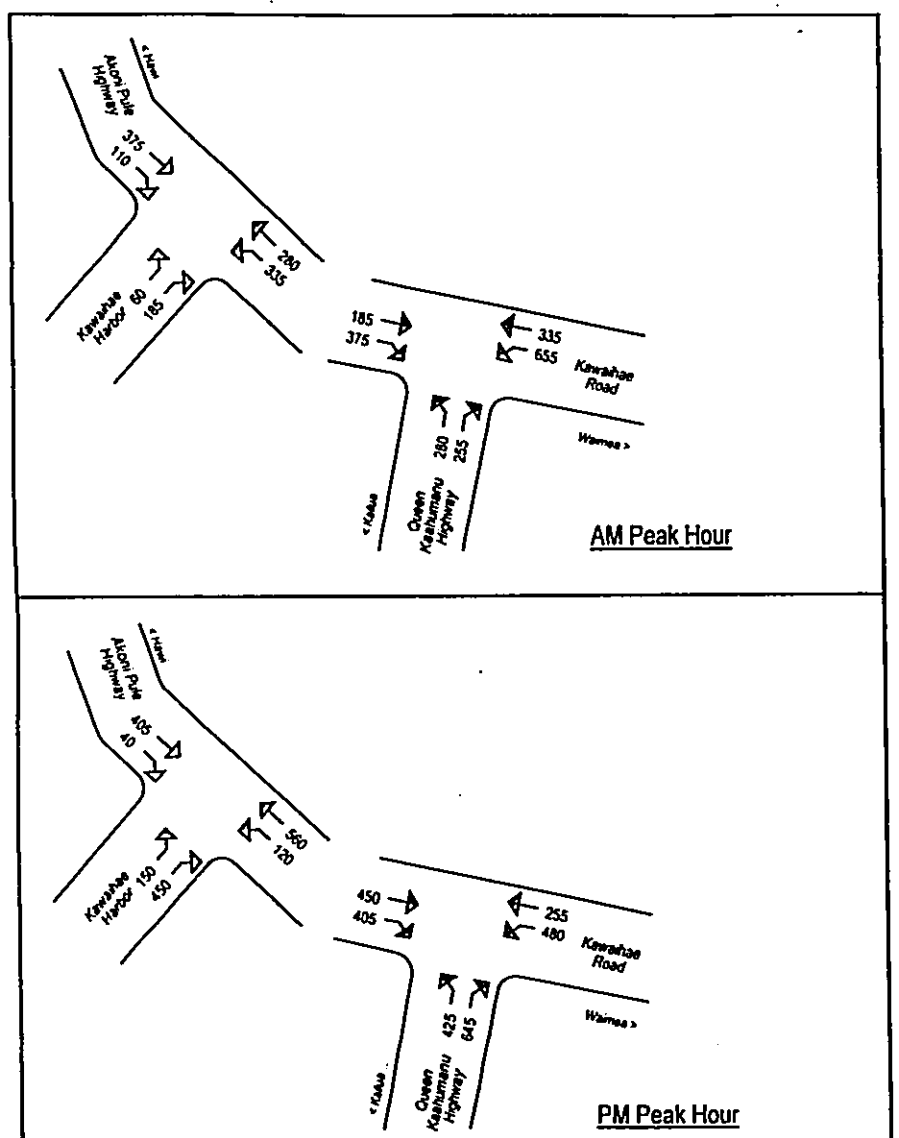


Hawaii Commercial Harbors 2020 Master Plan Traffic Analysis	Existing Peak Hour Traffic Vicinity of Kawaihae Harbor	Exhibit 3
	prepared by: Julian Ng, Inc. January 2001	

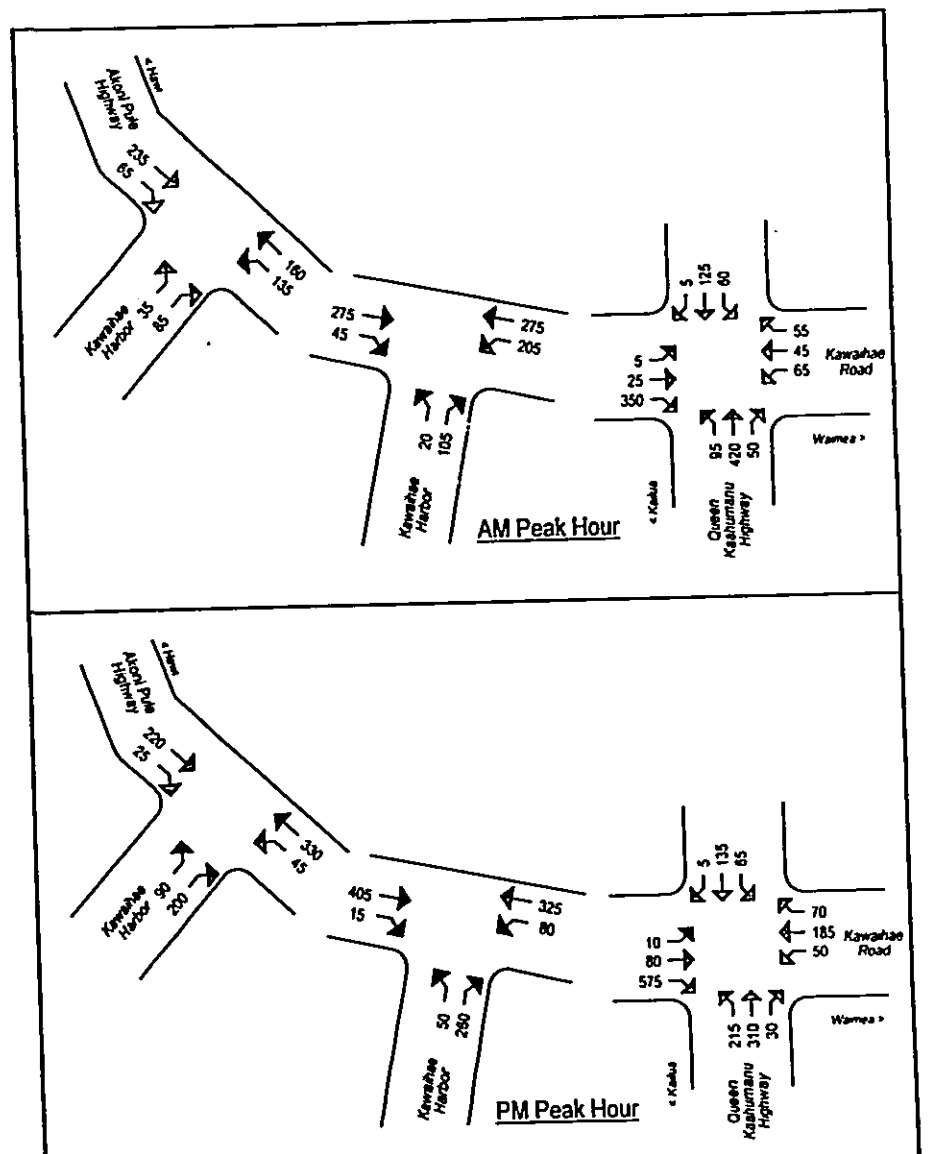




Hawaii Commercial Harbors 2020 Master Plan Traffic Analysis	Future Peak Hour Traffic Vicinity of Hilo Harbor	Exhibit 4
	prepared by: Julian Ng, Inc. January 2001	



Hawaii Commercial Harbors 2020 Master Plan Traffic Analysis	Future Peak Hour Traffic Vicinity of Kawaihae Harbor prepared by: Julian Ng, Inc. January 2001	Exhibit 5



Hawaii Commercial Harbors 2020 Master Plan Traffic Analysis	Future Peak Hour Traffic Vicinity of Kawaihae Harbor prepared by: Julian Ng, Inc. January 2001	Exhibit 6

Appendix C

BOTANICAL SURVEY
HILO HARBOR

Winona P. Char
Char & Associates, Inc.

October 2000

BOTANICAL SURVEY
HILO HARBOR
SOUTH HILO DISTRICT, HAWAI'I

by

Winona P. Char

CHAR & ASSOCIATES

Botanical Consultants
Honolulu, Hawai'i

Prepared for: **R.M. TOWILL CORPORATION**

October 2000

BOTANICAL SURVEY
HILO HARBOR
SOUTH HILO DISTRICT, HAWAI'I

INTRODUCTION

A survey of the botanical resources was made for the undeveloped portions of the Hilo Harbor property. These are the areas proposed for the overseas container terminal and the ocean research facility.

The field studies were conducted on 27 September 2000. The primary objectives of the survey were to:

1) provide a general description of the vegetation on the two parcels;
2) inventory the flora;
3) search for threatened and endangered species as well as species of concern; and
4) identify areas of potential environmental problems or concerns and propose appropriate mitigation measures.

SURVEY METHODS

Prior to undertaking the field studies, site maps and a recent colored aerial photograph were examined to determine vegetation cover patterns, terrain characteristics, access, boundaries, and reference points. The proposed ocean research site was accessed via Oceanview Drive. An unpaved road provided access to the proposed overseas container terminal site; the unpaved road accesses the rubble mound breakwater.

forest are gunpowder *(Trema occidentalis)* and bingabing *(Macaranga mappa)* trees. Ground cover is sparse under the dense tree canopy, consisting primarily of leaf and branch litter. Scattered here and there are vines of golden pothos or taro vine *(Epipremnum pinnatum)*. Around the edges of the forest where there is more light, there are dense, tall mats of California grass *(Brachiaria mutica)*. Vines of maile-pilau *(Paederia foetida)* form a dense tangle over the woody components.

Along the mauka portion of Oceanview Drive, there is a line of trees composed primarily of bingabing and *Macaranga tanarius* with smaller patches of hau *(Hibiscus tiliaceus)*. Also found in this area is a small patch of bananas *(Muse* X *paradisiaca)*. Again, California grass and a number of weedy species are abundant alongside the margins of this line of trees. The indigenous seabean or ka'e'e *(Mucuna gigantea)*, with its rounded clusters of apple-green flowers, is locally common.

Overseas Container Terminal

The forest here is from 50 to 80 feet tall and consists of a mixture of trees which include Chinese banyan, ironwood, guaruma *(Cercropia obtusifolia)*, melochia *(Melochia umbellata)*, bingabing, African tulip tree *(Spathodea campanulata)*, mango *(Mangifera indica)*, coconut, avocado, and *Eucalyptus* sp. Stands of ironwood, false kamani, and tree heliotrope *(Tournefortia argentea)* are found along the shoreline.

Understory vegetation consists of saplings of the trees mentioned above as well as a mixture of various shrubs which include pikake hohono *(Clerodendrum chinensis)*, white shrimp plant *(Justicia betonica)*, dog tail *(Buddleia asiatica)*, sourbush *(Pluchea carolinensis)*, and odontonema *(Odontonema strictum)*. Vines

of maile-pilau, moonflower *(Ipomoea alba)*, and maunaloa *(Canavalia cathartica)* are locally abundant. California grass and Hilo grass *(Paspalum conjugatum)* are abundant along the margins of this forested area.

The camp sites scattered through this parcel support a few ornamental species as well as papaya and young coconut trees.

DISCUSSION AND RECOMMENDATIONS

The vegetation on the undeveloped portions of the two parcels is dominated by introduced or alien plant species such as bingabing, Chinese banyan, California grass, etc. Introduced plants are all those species which were introduced by humans, intentionally or accidentally, after Western contact, that is, Cook's discovery of the Hawaiian Islands in 1778. This is not surprising as the two parcels appear to have been disturbed for a long time; there are remnants of former structures such as concrete blocks on both parcels.

Of a total of 71 species observed on the parcels, 60 (85%) are introduced; 3 (4%) are originally of Polynesian introduction; and 8 (11%) are native. All the native species are indigenous, that is, they are native to the Hawaiian Islands and elsewhere. These plants are the pakahakaha fern *(Pleopeltis thunbergiana)*, moa *(Psilotum nudum)*, koali'awe *(Ipomoea indica)*, seabean *(Mucuna gigantea)*, popolo *(Solanum americanum)*, hau *(Hibiscus tiliaceus)*, *Pycreus polystachyos* sedge, and hala *(Pandanus tectorius)*.

None of the plants found on the unmaintained portions of the two parcels is a threatened and endangered species or a species of concern (U.S. Fish and Wildlife

Service 1999). All of the plants can be found in similar wet, disturbed, windward habitats throughout most of the main Hawaiian Islands.

The proposed development of the two parcels is not expected to have a significant negative impact on the botanical resources. There are no botanical reasons to impose any restrictions, conditions, or impediments to proposed development of these two parcels.

LITERATURE CITED

Evenhuis, N.L. and S.E. Miller, editors. 1995-1998. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers Nos. 41-56.

Evenhuis, N.L. and L.C. Eldredge, editors. 1999. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers Nos. 58-59.

Lamoureux, C.H. 1988. Draft checklist of Hawaiian Pteridophytes, "Kupukupu O Hawaiti Ne'i." Lyon Arboretum, University of Hawai'i, Manoa, Honolulu.

U.S. Fish and Wildlife Service. 1999. U.S. Fish and Wildlife Service species list, plants. March 23, 1999. Pacific Islands Ecoregion Office, Honolulu, HI.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai'i. 2 vols. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI. Bishop Museum Special Publication 83.

PLANT SPECIES LIST — Hilo Harbor, Hawai'i

The following checklist is an inventory of the plants observed during the field studies. The plant names are arranged alphabetically by families within each of three groups—Ferns and Fern Allies, Dicots, and Monocots. The taxonomy and nomenclature of the Ferns and Fern Allies follow Lamoureux (1988), while the flowering plants, Dicots and Monocots, are in accordance with Wagner *et al.* (1990). The few recent name changes for the flowering plants follow those reported in the Hawaii Biological Survey series (Evenhuis and Miller, 1995-1998; Evenhuis and Eldredge, 1999).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:

   I = indigenous = native to the Hawaiian Islands and also elsewhere.

   I? = questionably indigenous = data not clear if dispersal to islands by natural or human-related mechanisms, but weight of evidence suggests probably natural.

   P = Polynesian introduction = plants originally of Polynesian introduction prior to Western contact, that is, Cook's discovery of the Islands in 1778.

   X = introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact (1778).

Scientific name	Common name	Status
FERNS & FERN ALLIES		
NEPHROLEPIDACEAE (Swordfern family)		
Nephrolepis multiflora (Roxb.) Jarrett ex Morton	hairy swordfern, 'okupukupu	X
POLYPODIACEAE (Common fern family)		
Phlebodium aureum (L.) J. Sm.	rabbit's foot fern, laua'e haole	X
Phymatosorus scolopendria (Burm.) Pic.-Ser.	laua'e, lauwa'e	X
Pleopeltis thunbergiana Kaulf.	pakahakaha, 'ekaha 'akolea	I
PSILOTACEAE (Whisk fern family)		
Psilotum nudum (L.) Beauv.	moa, moa nahele, pipi	I
FLOWERING PLANTS		
DICOTS		
ACANTHACEAE (Acanthus family)		
Dicliptera chinensis (L.) Juss.	diclipter	X
Justicia betonica L.	white shrimp plant	X
Odontonema strictum (Nees) Kuntze	odontonema	X
AMARANTHACEAE (Amaranth family)		
Amaranthus spinosus L.	spiny amaranth, pakai kuku	X
ANACARDIACEAE (Mango family)		
Mangifera indica L.	mango, manako	X
ASTERACEAE (Daisy family)		
Ageratum conyzoides L.	maile hohono	X
Bidens pilosa L.	Spanish needle, ki, ki nehe	X
Crassocephalum crepidioides (Berth.) S. Moore		X
Eclipta prostrate (L.) L.	false daisy	X
Pluchea carolinensis (Jacq.) G. Don	sourbush, pluchea	X
Spagneticola trilobata (L.) Pruski	wedelia	X
Synedrella nodiflora (L.) Gaertn.	nodeweed	X
BALSAMINACEAE (Touch-me-not family)		
Impatiens wallerana J.D. Hook	impatiens	X

Scientific name	Common name	Status
BIGNONIACEAE (Bignonia family)		
Spathodea campanulata P. Beauv.	African tulip tree	X
BORAGINACEAE (Borage family)		
Tourneforthia argentea L.f.	tree heliotrope	X
BUDDLEIACEAE (Butterfly bush family)		
Buddleia asiatica Lour.	dog tail, huelo 'ilio	X
CAPRIFOLIACEAE (Honeysuckle family)		
Sambucus mexicana K. Presl ex A. DC	Mexican elder, elderberry	X
CARICACEAE (Papaya family)		
Carica papaya L.	papaya, mikana	X
CASUARINACEAE (She-oak family)		
Casuarina equisetifolia L.	ironwood, paina	X
CECROPIACEAE (Cecropia family)		
Cecropia obtusifolia Bertol.	guaruma	X
COMBRETACEAE (Indian almond family)		
Terminalia catappa L.	tropical almond, false kamani	X
CONVOLVULACEAE (Morning glory family)		
Ipomoea alba L.	moonflower, koali pehu	X
Ipomoea indica (J. Burm.) Merr.	koali 'awe, koali 'awahia	I
Ipomoea triloba L.	little bell, pink bindweed	X
EUPHORBIACEAE (Spurge family)		
Macaranga mappa (L.) Mull. Arg.		X
Macaranga tanarius (L.) Mull. Arg.	bingabing	X
Ricinus communis L.	castor bean, koli	X
FABACEAE (Pea family)		
Canavalia cathartica Thouars	maunaloa	X
Desmodium incanum DC	Spanish clover, ka'imi	X
Desmodium triflorum (L.) DC	three-flowered beggarweed	X
Leucaena leucocephala (Lam.) de Wit	koa haole, ekoa	X
Mucuna gigantea (Willd.) DC	seabean, ka'e'e	I
Neonotonia wightii (Wight & Arn.) Lackey		X
Senna alata (L.) Roxb.	candle bush	X
LAMIACEAE (Mint family)		
Hyptis pectinata (L.) Poit.	comb hyptis	X
LAURACEAE (Laurel family)		
Persea americana Mill.	avocado, alligator pear	X

Scientific name	Common name	Status
MALVACEAE (Mallow family)		
Hibiscus tiliaceus L.	hau	I?
MORACEAE (Mulberry family)		X
Ficus microcarpa L.f.	Chinese banyan	
MYRTACEAE (Myrtle family)		
Eucalyptus sp.	gum tree, eucalyptus	X
PLANTAGINACEAE (Plantain family)		
Plantago major L.	broad-leaved plantain, laukahi	X
RUBIACEAE (Coffee family)		
Paederia foetida L.	maile-pilau	X
SOLANACEAE (Nightshade family)		
Solanum americanum Mill.	popolo, glossy nightshade	I?
STERCULIACEAE (Cacao family)		
Melochia umbellata (Houtt.) Stapf	melochia	X
ULMACEAE (Elm family)		
Trema occidentalis (L.) Blume	gunpowder tree, charcoal tree	X
URTICACEAE (Nettle family)		
Pilea microphylla (L.) Liebm.	artillery plant	X
VERBENACEAE (Verbena family)		
Clerodendrum chinensis (Osb.) Mabb.	pikake hohono	X
MONOCOTS		
AGAVACEAE (Agave family)		
Cordyline terminalis (L.) A. Chev.	ti, ki	P
ARACACEAE (Aroid family)		
Alocasia macrorrhiza (L.) Schott	'ape	P
Epipremnum pinnatum (L.) Engl.	taro vine, pothos, golden pothos	X
ARECACEAE (Palm family)		
Cocos nucifera L.	coconut, niu	P
COMMELINACEAE (Spiderwort family)		
Commelina diffuse N.L. Burm.	honohono	X

DOCUMENT CAPTURED AS RECEIVED

Scientific name	Common name	Status
CYPERACEAE (Sedge family)		
Cyperus alternifolius ssp. flabelliformis (Rottb.) Kukenth.	umbrella plant, 'ahu 'awe	
	haole, pu'uka'a haole	X
Kyllinga brevifolia Rottb.	green kyllinga, kili'o'opu	X
Kyllinga nemoralis (J.R. Forster & G. Forster) Dandy ex Hutchinson & Dalziel	white kyllinga, kilito'opu	X
Pycreus polystachyos (Rottb.) P. Beauv.		I
MUSACEAE (Banana family)		
Musa X paradisiaca L.	banana, mai'a	X
PANDANACEAE (Hale family)		
Pandanus tectorius S. Parkinson ex Z	pandanus, hale, pu hale	I
POACEAE (Grass family)		
Brachiaria mutica (Forssk.) Stapf	California grass, Para grass	X
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X
Digitaria sp.	crabgrass	X
Eleusine indica (L.) Gaertn.	wiregrass, manienie ali'i	X
Eragrostis pectinacea (Michx.) Nees		X
Paspalum conjugatum Bergius	Hilo grass, mau'u Hilo	X
Paspalum vaginatum Sw.	seashore paspalum	X
Setaria palmifolia (J. Konig.) Stapf	palmgrass	X
Sporobolus diander (Retz.) P. Beauv.	Indian dropseed	X

Appendix D

BOTANICAL SURVEY
KAWAIHAE HARBOR

Winona P. Char
Char & Associates, Inc.

October 2000

BOTANICAL SURVEY
KAWAIHAE HARBOR
SOUTH KOHALA DISTRICT, HAWAI'I

by

Winona P. Char

CHAR & ASSOCIATES

Botanical Consultants
Honolulu, Hawai'i

Prepared for: **R.M. TOWILL CORPORATION**

October 2000

BOTANICAL SURVEY
KAWAIHAE HARBOR
SOUTH KOHALA DISTRICT, HAWAI'I

INTRODUCTION

The project site is located on the southern portion of the Kawaihae Harbor facilities on the area planned for the liquid bulk terminals. The majority of the site is disturbed and consists of fill land; coral dredged from the harbor was used for the fill and is also stockpiled on the site. The remainder of the site supports kiawe forest on Kawaihae extremely stony very fine sandy loam soils.

Field studies to assess the botanical resources on the project site were conducted on 19 September 2000 by a team of two botanists. The primary objectives of the survey were to:

1) provide a general description of the vegetation on the site;
2) inventory the flora;
3) search for threatened and endangered species as well as species of concern; and
4) identify areas of potential environmental problems or concerns and propose appropriate mitigation measures.

SURVEY METHODS

Prior to undertaking the field studies, site maps and a colored aerial photograph were examined to determine vegetation cover patterns, terrain characteristics, access, boundaries, and reference points.

A walk-through survey methods was used. Notes were made on plant associations and distribution, substrate types, disturbances, drainage, topography, exposure, etc. Plant identifications were made in the field; plants which could not be positively identified were collected for later determination in the herbarium, and for comparison with the recent taxonomic literature. The less disturbed kiawe forest area between the fill/stockpile area and the highway was more intensively surveyed as this portion of the property was more likely to harbor native plant communities and, perhaps, rare plants.

The species recorded are indicative of the season ("rainy" vs. "dry") and the environmental conditions at the time of the survey. A survey taken at a different time of the year and under varying environmental conditions would no doubt yield slight variations in the species list, especially of the weedy, annual plants.

DESCRIPTION OF THE VEGETATION

Two vegetation types are recognized on the project site. Ruderal or weedy, wayside vegetation covers the disturbed portions of the property, while kiawe forest occurs on the undisturbed areas. A list of all the plants inventoried within the two vegetation types is presented in the plant checklist at the end of the report.

Ruderal Vegetation

Ruderal or weedy, wayside vegetation occurs on the disturbed area covered by coral fill. Piles of coral as well as boulders, soil, concrete pilings, etc., are stockpiled on this portion of the study area. Much of the site is barren with vegetation cover 5 to

20% in most places. Closer to the edges of the disturbed area where it adjoins patches of kiawe trees, the weedy cover is 40 to 50%.

Atriplex cardleyae, an introduced saltbush from Australia, and buffelgrass *(Cenchrus ciliaris)*, native to Africa and tropical Asia, are the most abundant plants. Other plants occurring here in scattered mats include swollen fingergrass *(Chloris barbata)*, Australian saltbush *(Atriplex semibaccata)*, fountain grass *(Pennisetum setaceum)*, *Sporobolus piliferus*, sourbush *(Pluchea carolinensis)*, and three native species: 'akulikuli *(Sesuvium portulacastrum)*, 'ilima *(Side fallax)*, and 'uhaloa *(Waltheria indica)*. Scattered here and there are small stands of kiawe trees *(Prosopis pallida)*, 12 to 20 feet tall.

Kiawe Forest

Kiawe forest is found between the fill/stockpile area and the highway. The tree canopy cover is closed in most places, that is, the branches of the trees overlap and cover is 60% or more. The trees are occasionally cut for firewood as evidenced by old stumps and cut branches scattered here and there.

The ground cover is largely leaf and branch litter with scattered clumps of buffelgrass, 1 to 3 feet tall. Other plants found under the kiawe trees include hairy merremia vine *(Merremia aegyptia)*, 'aheahea *(Chenopodium murale)*, and hairy abutilon *(Abutilon grandifolium)*. Where the canopy is more open as along the edge of the forest, plants of fountain grass, slender mimosa *(Desmanthus virgatus)*, running pop *(Passiflora foetida)*, Natal redtop grass *(Melinis repens)*, and coat buttons *(Tridax procumbens)* are found.

Where the property adjoins the Mailekini Heiau parcel, there is a small stream with kaluha sedge *(Bolboschoenus maritimus)* and seashore paspalum *(Paspalum vaginatum)*, but this is outside of project site.

DISCUSSION AND RECOMMENDATIONS

The fill/stockpile area is proposed for development. The vegetation on this heavily disturbed area is composed of a weedy mixture of species, primarily the introduced buffelgrass and *Atriplex eardleyae* with scattered patches of kiawe. The undisturbed portion of the property, between the fill/stockpile area and the highway, supports kiawe forest; no development is planned for this area.

Only 22 plant species were inventoried on the site. Of these, 17 (77%) are introduced or alien species; one (5%) is originally of Polynesian introduction; and four (18%) are native. All of the native plants are indigenous, that is, native to Hawai'i and elsewhere. These are the 'akulikuli *(Sesuvium portulacastrum)*, 'ilima *(Side fallax)*, milo *(Thespesia populnea)*, and 'uhaloa *(Waltheria indica)*. No endemic species, i.e. native only to Hawai'i, were encountered. None of the plants is a threatened and endangered species or a species of concern (U.S. Fish and Wildlife Service 1999). All of the plants can be found in similar lowland, dry, disturbed habitats.

Given the findings above, the proposed use of the site is not expected to have a significant negative impact on the botanical resources.

LITERATURE CITED

Evenhuis, N.L. and S.E. Miller, editors. 1995-1998. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers Nos. 41-56.

Evenhuis, N.L. and L.C. Eldredge, editors. 1999. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers Nos. 58-59.

U.S. Fish and Wildlife Service. 1999. U.S. Fish and Wildlife Service species list, plants. March 23, 1999. Pacific Islands Ecoregion Office, Honolulu, HI.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai'i. 2 vols. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI. Bishop Museum Special Publication 83.

PLANT SPECIES LIST — Kawaihae Harbor, Hawai'i

The following checklist is an inventory of the plants observed during the field studies. The plant names are arranged alphabetically by families within each of two groups: Dicots, and Monocots. The taxonomy and nomenclature of the flowering plants are in accordance with Wagner *et al.* (1990). The few recent name changes for the flowering plants follow those reported in the Hawaii Biological Survey series (Evenhuis and Miller, 1995-1998; Evenhuis and Eldredge, 1999).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:
   - I = indigenous = native to the Hawaiian Islands and also elsewhere.
   - I? = questionably indigenous = data not clear if dispersal by natural or human-related mechanisms, but weight of evidence suggests probably natural.
   - P = Polynesian introduction = plants originally of Polynesian introduction prior to Western contact, that is, Cook's discovery of the Islands in 1778.
   - X = introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact (1778).
   - X? = questionably introduced = date of introduction unclear; could possibly be indigenous or perhaps of Polynesian introduction.
4. Presence (+) or absence (-) of a particular species within each of two vegetation types recognized on the study sites (see text for discussion):
   - r = Ruderal Vegetation
   - k = Kiawe Forest

Scientific name	Common name	Status	Vegetation Type r	k
FLOWERING PLANTS				
DICOTS				
AIZOACEAE (Fir-marigold family)				
Sesuvium portulacastrum (L.) L.	'akulikuli	I	+	-
ASTERACEAE (Daisy family)				
Emilia fosbergii Nicolson	pualele	X	-	+
Pluchea carolinensis (Jacq.) G. Don	sourbush, pluchea	X	+	-
Tridax procumbens L.	coat buttons	X	-	+
CHENOPODIACEAE (Goosefoot family)				
Atriplex cardleyae Aellen		X	+	-
Atriplex semibaccata R. Br.	Australian saltbush	X	+	+
Chenopodium murale L.	'aheahea	X	-	+
CONVOLVULACEAE (Morning-glory family)				
Merremia aegyptia (L.) Urb.	hairy merremia, koali kua hulu	X?	-	+
FABACEAE (Pea family)				
Desmanthus pernambucanus (L.) Thellung	slender mimosa, virgate mimosa	X	+	-
Leucaena leucocephala (Lam.) de Wit	koa haole, ekoa	X	-	+
Prosopis pallida (Humb. & Bonpl. Ex) Willd.) Kunth	kiawe	X	+	+
MALVACEAE (Mallow family)				
Abutilon grandifolium (Willd.) Sweet	hairy abutilon, ma'o'	X	-	+
Sida fallax Walp.	'ilima	I	+	-
Thespesia populnea (L.) Sol. Ex Correa	milo	I?	-	+
PASSIFLORACEAE (Passion flower family)				
Passiflora foetida L.	running pop, pohapoha	X	-	+
STERCULIACEAE (Cacao family)				
Waltheria indica L.	'uhaloa, hi'aloa, kanakaloa	I?	+	+

Scientific name	Common name	Status	Vegetation Type r	k
MONOCOTS				
ARECACEAE (Palm family)				
Cocos nucifera L.Cocos nucifera L.	coconut, niu	P	+	-
POACEAE (Grass family)				
Cenchrus ciliaris L.	buffelgrass	X	+	+
Chloris barbata (L.) Sw.	swollen fingergrass, mau'ulei	X	+	-
Melinis repens (Willd.) Zizka	Natal redtop grass, Natal grass	X	-	+
Pennisetum setaceum (Forssk.) Chiov.	fountain grass	X	+	+
Sprobolus piliferus (Trin.) Kunth		X	+	-

Appendix E

REVIEW OF WATER QUALITY AND MARINE BIOLOGY

AECOS, Inc.

November 2000
Revised June 2001

Review of Water Quality and Biology in Kawaihae and Hilo Harbors for the Harbors 2020 Master Plan Implementation EIS[1]

June 4, 2001 — *AECOS* No. 963

S. A. Cattell, S. Coles, and E. Guinther
AECOS, Inc. 970 N. Kalaheo Ave., Suite C311
Kailua, Hawai'i 96734
Phone: (808) 254-5884 Fax: (808) 254-3029 Email: aecos@aecos.com

Introduction

This report attempts to summarize what is known about water quality and resident biota within the Big Island's two major harbors: Kawaihae Harbor on the west side and Hilo Harbor, within Hilo Bay on the east side (see Figure 1). The purpose of the report is to provide input for an EIS in preparation by R.M. Towill Corp. for implementation of the Harbors 2020 Masterplan for harbors improvements and expansions; that is, to serve as a basis for assessing impacts to water quality and biota of specific harbor projects at Kawaihae and Hilo.

Methods

Although some information does exist for each of the harbors, much of it generated during past environmental assessments, it was decided that additional water quality data, and underwater reconnaissance surveys would be useful in making current our understanding of these harbor environments, particularly in specific locations of planned harbor projects. Water samples were collected and analyzed by *AECOS* Inc. (Hilo) and *AECOS* Laboratory of Hawaii (Kawaihae). Sample locations are indicated in Figures 2 and 3. Table 1 is a listing of the analytical methods employed for these samples.

[1] Report prepared for R. M. Towill Corporation for an environmental assessment entitled: "" This report will become part of the public record.

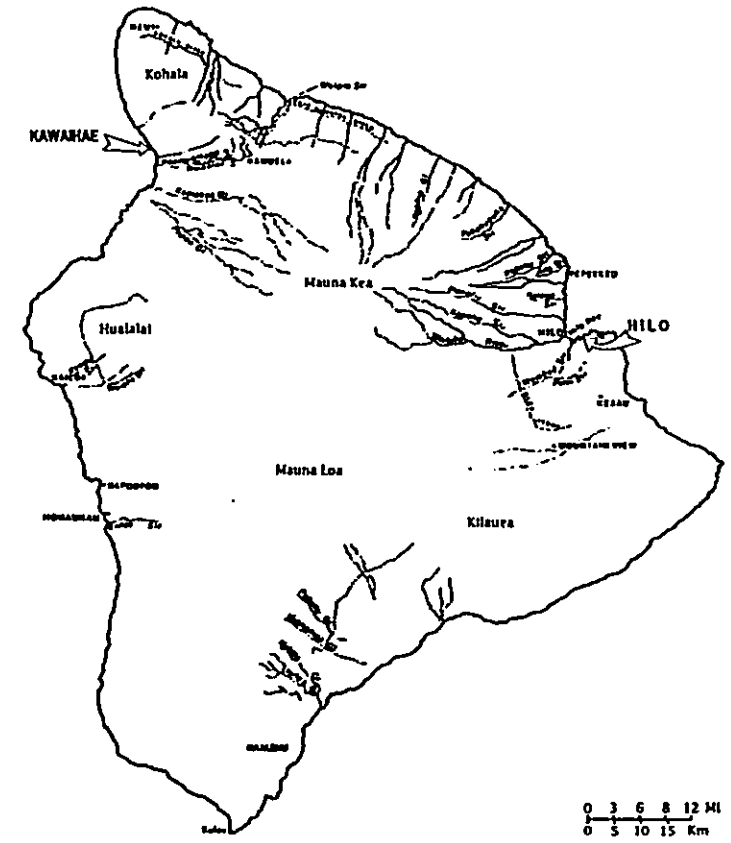


Figure 1. Map of the Big Island of Hawai'i showing the locations of Kawaihae and Hilo harbors.

Water samples from the inner harbor of Hilo Bay were collected on September 24, 2000 at the following station locations: C1 – at channel marker 7 (19° 44.05' N / 155° 3.67' W); P1 – Pier 1 about 50 feet from corner on line from corner to marker (19° 44.04' N / 155° 3.26' W); P2 – 50 feet from P1 in line towards red buoy No. 10 (19° 43.83' N / 155° 3.41' W); P3 – midway along a line from red buoy No. 10 to black buoy near shore (19° 43.76' N / 155° 3.49' W); and R1 – middle of Radio Bay (19° 43.96' N / 155° 3.18' W).

DOCUMENT CAPTURED AS RECEIVED

Table 1. Analytical methods and instruments used for the September 2000 sampling in Hilo and Kawaihae harbors, Island of Hawai'i

Analyses List	Method	Reference	Instrument
Ammonia	alkaline phenol	Koroleff in Grasshoff et al. (1986)	Technicon AutoAnalyzer II
Chlorophyll a	Method 10200H	Standard Methods 18th Edition (1992)	Turner Model 112 fluorometer
Dissolved Oxygen	EPA 360.1	EPA (1979)	YSI Model 58 DO meter
Nitrate + Nitrite	EPA 353.2	EPA (1993)	Technicon AutoAnalyzer II
pH	EPA 150.1	EPA (1979)	Orion SA 250 pH meter / Ross combination electrode
Temperature	thermister calibrated to NBS cert. Thermometer (EPA 170.1)	EPA (1979)	YSI Model 58 DO meter
Total Nitrogen	persulfate digestion /EPA 353.2	D'Elia et al. (1977) / EPA (1993)	Technicon AutoAnalyzer II
Total Phosphorus	persulfate digestion /EPA 365.1	Koroleff in Grasshoff et al. (1986) / EPA (1993)	Technicon AutoAnalyzer II
Total Suspended Solids (TSS)	Method 2540D (EPA 160.2)	Standard Methods 18th Edition (1992); EPA (1979)	Mettler H31 balance
Turbidity	Method 2130B (EPA 180.1)	Standard Methods 18th Edition (1992); EPA (1993)	Hach 2100P Turbidimeter
Salinity	Bench salinometer	Grasshoff in Grasshoff et al. (1986)	AGE Model 2100

D'Elia, C.F., P.A. Steudler, & N. Corwin. 1977. *Limnol. Oceanogr.* 22(4): 760-764.

EPA. 1979. Methods for Chemical Analysis of Water and Wastes. U.S. Environmental Protection Agency, EPA 600/4-79-020.

EPA. 1993. Methods for the Determination of Inorganic Substances in Environmental Samples. EPA 600/R-93/100.

EPA. 1994. Methods for Determination of Metals in Environmental Samples, Supplement 1. EPA/600/R-94/111. May 1994.

Grasshoff, K., M. Ehrhardt, & K. Kremling (eds). 1986. Methods of Seawater Analysis (2nd ed). Verlag Chemie, GmbH, Weinheim.

Standard Methods. 1992. Standard Methods for the Examination of Water and Wastewater. 18th Edition. 1992. (Greenberg, Clesceri, and Eaton, eds.). APHA, AWWA, & WEF. 1100 p.

For this report, the interior perimeter and existing piers of Kawaihae Harbor (Figure 2) were surveyed by a biologist on September 16 and 17, 2000. Using SCUBA, an investigator familiar with the biota found in Hawaiian harbors and on coral reefs in Hawai'i conducted a series of dives along the harbor wall and piers and down to the design depth of the harbor noting the dominant algae, invertebrates and fishes that were encountered and recording

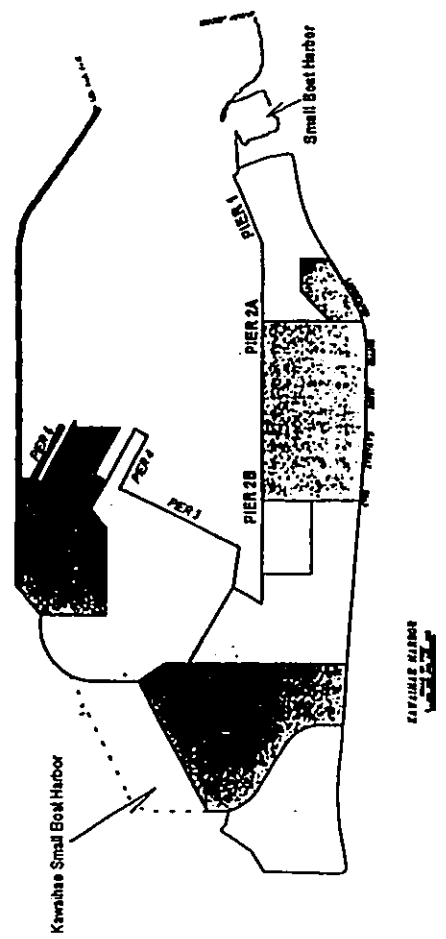


Figure 2. Kawaihae Harbor showing existing Piers 1 - 2B and proposed Piers 3 - 5.

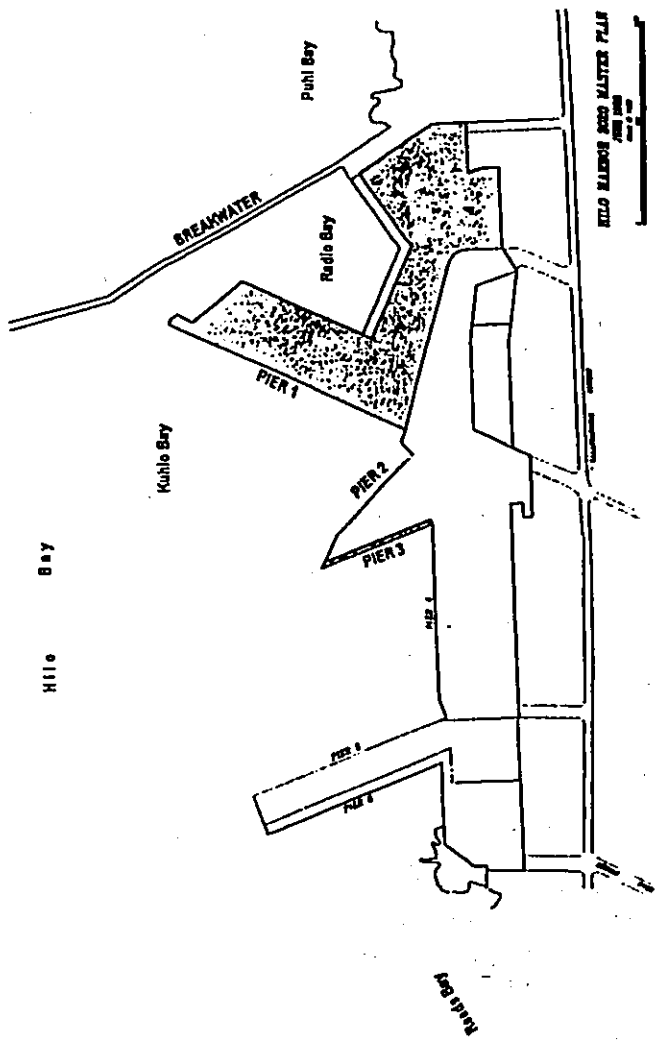


Figure 3. Hilo Harbor showing existing Piers 1 - 3 and proposed Piers 4 - 6.

their identities on underwater paper. For organisms requiring closer inspection to determine their identification, samples were taken, stored in a cooler and held frozen until they could be inspected under a dissecting microscope.

Sections of Hilo Harbor (Figure 3) were surveyed on September 23, 2000 by the same investigator using the methodology as described above for Kawaihae Harbor. Areas surveyed were: 1) the southeast pier wall and shallow area along the northeast jetty of the small harbor called Radio Bay; 2) from the boulder reinforced shoreline at the east end of Pier 3 along the undeveloped shoreline proposed for Pier 4; 3) the offshore area along the proposed Pier 5-6 alignment; and 4) the pilings at the end of Piers 2-3, where dolphins are proposed to be constructed.

Kawaihae Harbor

Kawaihae Harbor lies about 17 miles south of Upolu Point, the northwest tip of the Island of Hawai'i (Figure 1). It is a commercial, deep-water harbor bounded by a stone revetment on the ocean side, with a long entrance channel passing through the reef flat offshore. Kawaihae Harbor was constructed in 1959 by dredging out a portion of the coral reef offshore and constructing a revetment of basalt boulders on the harbor's seaward side (ORCA/Cheny 1981). Prior to this, a small boat harbor and wharf existed on the site. In 1969-70, a small boat harbor was added on the south side of the harbor jetty seaward of the revetment. This small craft harbor was modified in 1995, and an attempt made to moderate the environmental impact of revetment construction by transplanting corals that would have been eliminated by the project (Jokiel et al., 1999). The commercial harbor's basin was expanded through additional dredging in 1972.

The constructed surfaces within the Kawaihae Harbor are large basalt boulders that form the jetty or concrete or metal sheet piling bulkheads which form the docks. The eastern side of the harbor is a wide beach shoreline formed by the tailings from the dredging of the harbor from the original coral reef. Natural beaches occur outside the harbor on the seaward side of the small boat harbor, inside Pu'u Kohala Bay and at Spenser Beach Park.

Along with the commercial port operations conducted in Kawaihae Harbor, it is used for a number of other water related activities, including mooring of fishing and sailing boats along the east side of the harbor, a public boat launching ramp adjacent to the harbor entrance, and canoe racing practices conducted within the calm water of the harbor.

Water Quality

Kawaihae Harbor is located in a low rainfall area with an average annual rainfall of 16.33 inches (NCDC, 2000). There are no major surface fresh water discharges into the harbor. Fresh water runoff from Makeahua Gulch (*AECOS* Consultants, 2000). behind the harbor may occur during storm events, but this water apparently enters the marine environment behind the breakwater of the small boat harbor, and does not flow directly in Kawaihae Harbor (Woolsey, Miyabara, & Assoc., 1985).

Kawaihae Harbor is categorized as a Class A embayment by the State Department of Health (HAR §11-54-06; DOH, 1992) and is subject to the State's "dry" embayment water quality criteria (Table 2): "dry" criteria apply to embayments where the average daily fresh water inflow from the land is less than one percent of the embayment volume.

Table 2. State of Hawaii "dry" water quality criteria for embayments (HAR §11-54-06)(DOH, 1992).

Parameter	Geometric Mean value not to exceed this value	Value not to be exceeded more than 10% of the time	Value not to be exceeded more than 2% of the time
Total Nitrogen (µg N/l)	150 0	250 0	350 0
Ammonia (µg N/l)	3 5	8 5	15 0
Nitrate + Nitrite (µg N/l)	5 0	14 0	25 0
Total Phosphorus (µg P/l)	20.0	40 0	60 0
Chlorophyll a (µg/l)	0 50	1.50	3 00
Turbidity (ntu)	0 4	1.0	1.5

Other "standards":

- pH units shall not deviate more than 0 5 units from a value of 8 1, except at coastal locations where and when freshwater from stream, storm drain or groundwater discharge may depress the pH to a minimum level of 7.0.
- Dissolved oxygen shall not decrease below 75% saturation.
- Temperature shall not vary more than 1 C° from ambient conditions.
- Salinity shall not vary more than 10% from natural or seasonal changes considering hydrologic input and oceanographic factors.

There is little vertical stratification in salinity/temperature in Kawaihae Harbor based on data collected by Oceanic Institute (1991) on March 26, 1991 (Table 3), indicating that there is little groundwater input, or surface runoff into this basin. Virtually all of the waters within the harbor are chemically and physically similar to the oceanic waters outside, with mean temperatures ranging from 24.73 to 25.45 C and salinities from 34.63 to 34.73 ‰. Surface waters in the harbor at Kawaihae are slightly warmer than the deeper waters due to solar

heating during the day. Mean DO levels ranged from 6.35 to 6.54 mg/l, with the highest levels in the upper 5 meters of the water column.

Nitrogen and phosphorus levels were low during the March 2, 1991 sampling and well below State water quality criteria (see Table 3). Interestingly, nitrate + nitrite levels were lower inside the harbor than outside the harbor.

Consistent with the low nutrient concentrations observed at Kawaihae, chlorophyll levels were below 0.50 µg/l throughout the harbor on this date. Average chlorophyll levels inside the harbor (Table 3) were slightly higher than those outside, probably due to increased residence time within the harbor as compared with adjacent coastal waters. The slightly higher chlorophyll concentrations and residence times may account for the slightly lower nitrate + nitrite nitrogen levels within the harbor noted above, these nitrogen moieties being removed from the water column by algal metabolism.

Table 3. Mean water quality conditions at Kawaihae Harbor area on March 26. 1991 (after OI, 1991)

	Temp (°C)	Salinity (‰)	DO (mg/l)	DO (% sat)	Turbidity (ntu)	NO_3+ NO_2 (µg/l)	NH_4 (µg/l)	TN (µg/l)	TP (µg/l)	Chl. α (µg/l)
Harbor										
surface	25.45	34.63	6.35	95	0.51	3	2	43	10	0.13
5 meters	24.87	34.73	6.53	96	0.80	1	3	41	11	0.14
10 meters	24.66	34.73	6.49	97	1.23	1	1	42	12	0 30
mean	24.99	34.70	6.46	96	0.85	2	2	42	11	0.19
Coast										
surface	25.23	34.67	6.54	97	0.39	4	1	38	10	0.14
5 meters	24.97	34.70	6.50	96	0.40	4	1	35	9	0.11
10 meters	24.73	34.72	6.42	95	0.38	3	1	35	10	0.13
mean	25.00	34.70	6.49	95	0.39	4	1	36	10	0.13

Greyed areas indicate that mean (or geometric mean) values of State water quality criteria were exceeded.

Mean values for samples collected in the surface waters in the Kawaihae Harbor area on September 17 and 29, 1999 are shown in Table 4. In comparison with the OI data above, DO saturation levels and turbidity levels were somewhat lower in September 1999, while TN, TP and chlorophyll α concentrations were notably higher. The TN and TP levels for the 1991 may have been filtered prior to analysis and would therefore represent just the dissolved fractions of nitrogen and phosphorus.

Table 4. Mean water quality conditions in the surface waters at Kawaihae Harbor on September 17 and 29, 1999

Harbor	Temp (°C)	Salinity (‰)	DO (mg/l)	DO (% sat)	Turbidity (ntu)	NO_3+ NO_2 (µg/l)	NH_4 (µg/l)	TN (µg/l)	TP (µg/l)	Chl. a (µg/l)
surface Coast	26.2	34.37	5.66	85	0.29	<1	2	130	17	0.52
surface	26.4	34.35	5.84	88	0.31	1	1	130	15	0.34

A comparison of water quality conditions in Kawaihae Harbor (Tables 3 and 4) with the State water quality criteria as shown in Table 2 suggests that the harbor is generally in conformance with all criteria; a possible exception is turbidity. The progressive increase in turbidity with depth that is apparent in the March 1991 data, suggests that sediment has accumulated in significant amounts on the harbor floor over the years. Periods of turbulence, such as high wind conditions or the movement of large vessels into and out of the harbor, may increase turbidity levels throughout the water column, as noted by the divers on September 16 (see "Pier 1" below). Since turbidity levels were well within the State criteria during the September 1999 sampling events, further monitoring would be required to determine whether long-term mean levels exceeded the State criteria.

It is noteworthy that water quality conditions within and outside of the harbor are quite similar, indicating that water quality within the harbor are generally quite good. The lack of significant surface water discharge and groundwater inputs along this section of the coast are the primary reasons for the generally pristine water quality conditions in this harbor.

Biota

A limited amount of biological information is available for the marine environment of the boat harbor and surrounding area (U. S. Army Corps of Engineers, 1971, 1975; Brock and Brock 1974; Hawaii Department of Land and Natural Resources, 1974; Hawaii Electric Light Co. Inc., 1976; Ball 1977; Cheney et al 1977; ORCA 1978; OI Consultants, Inc. 1991; Marine Research Consultants 1995). Most of these surveys were summarized in ORCA/Cheny (1981) with an annotated bibliography of all environmental studies conducted in the Kawaihae area along with a general description of the Kawaihae marine environment. The only previous studies of conditions within the harbor itself are given in ORCA (1978) and Hawaii Electric Light Inc. (1976). A transect established in the latter study just inside the harbor on the reef remnant

beside the breakwater found a total coral cover of 32% composed of 11 hard coral and one soft coral species, as well as the presence of five echinoderm and one serpulid species.

The taxa of organisms recorded on the harbor survey are shown in Table 5 along with totals of invertebrates and fishes for portions of the harbor corresponding to prospective Piers 1, 2a, 3 and 4, the existing Pier (designated here as 2b) and the reef remnant at the end of the jetty adjacent to the harbor entrance (Figure 2). A total of 116 organisms were identified on the underwater surveys, composed of 56 species of invertebrates, 59 species of fish, and one reptile: the green sea turtle, *Cholonia midas*.

Pier 1 Site

This area includes the piers planned for the Dry Bulk Terminals and includes existing piers for about half of its distance (Figure 2). Starting adjacent to the entrance of small boat harbor, the existing shoreline consists of large lava boulders, with coral growing on the rocks right up to the water line. Below this point, the bottom extends from about 1.5 m (5 ft) depth to the bottom of the harbor at about 11 m (36 ft). The rock and limestone hard substratum on the bottom supports a high coverage of hermatypic corals of around 50-60% dominated by *Porites lobata, Pocillopora meandrina* and *Porites compressa*. This coverage by live corals occurs down to about 8 m (26 ft) depth, below which coral heads are more widely scattered. The overall appearance is that of a pristine coral community. At the time of the initial survey on September 16, 2000 water clarity was high, but clarity was substantially lower on the following day because of a swell outside the harbor entrance which stirred up bottom sediments.

Approximately halfway along the zone indicated for Pier 1 (Figure 2) the existing pier for the main dock area of the harbor begins, and this pier extends along most of the north side of the harbor. The community more typical of open coastal environments ends abruptly at the beginning of this pier, and the bottom substratum is coarse sand and coral rubble, with filamentous brown algae and silt, extending from depths of about 7 m (23 ft) right by the pier to the harbor depth of 11 m (36 ft). Little live coral or other macrobiota occurs on the bottom, but coral coverage is high on the metal sheet piling that forms the harbor wall along the pier. Fishes, which were abundant over the coral bottom further west, were noticeably fewer here in both species and abundance. This condition pertains until the southeast end of Pier 1 is

Table 5. Organisms recorded on survey of Kawaihae Harbor, September 16-17, 2000

Taxa 1	Taxa 2	Genus Species	Author, Date	Pier 1	Pier 2a	Pier 2b	Pier 3-5	Jetty
Rhodophyta	Corallinaceae	*Hydrolithon reinboldii*	(Web.-van Bosse & Foslie) Foslie					x
		Porolithon onkodes	(Heydrich) Foslie					x
Porifera	Callyspongiidae	†*Callyspongia diffusa*	(Ridley, 1884)		x			
	Microcionidae	*Clathria sp.*					x	
	Dysideidae	†*Dysidea cf. avara*	Schmidt, 1862	x	x	x		
	Myxillidae	†*Iotrocha protea*	(de Laubenfels, 1950)	x	x			
	Spiristellidae	*Spiristella vagabunda*	Ridley, 1884	x				
Hydrozoa	Pennariidae	†*Pennaria disticha*	Goldfuss, 1820	x	x			x
Anthozoa	Pocilloporidae	*Pocillopora meandrina*	Dana, 1852	x	x	x	x	x
	Pocilloporidae	*Pocillopora eydouxi*	Milne-Edwards & Haime, 1860		x			
	Pocilloporidae	*Pocillopora damicornis*	(Linnaeus, 1758)	x	x	x	x	
	Acroporidae	*Montipora capitata*	(Dana, 1846)	x	x			x
		Montipora patula	Verrill, 1864	x			x	x
	Poritidae	*Porites compressa*	Dana, 1848	x	x	x	x	x
		Porites lobata	Dana, 1846	x	x	x	x	x
		Porites evermanni	Vaughan, 1907	x	x		x	
	Agariciidae	*Pavona varians*	Verrill, 1864	x	x		x	x
	Fungiidae	*Fungia scutaria*	Lamarck, 1801					x
	Faviidae	*Cyphastrea ocellina*	(Dana, 1846)					x
	Fe	*Leptastrea purpurea*	Dana, 1846	x			x	x
	Antipathidae	*Cirrhipathes anguina*	Dana, 1846		x			
Polychaeta	Amphinomidae	*Eurythoe complanata*	(Pallas, 1766)			x		
	Chaetopteridae	†*Chaetopterus* sp.		x	x			
		Mesochaetopterus cf sagittarius	(Claparede, 1870)	x				
	Terebellidae	*Loimia medusa*	(Savigny, 1818)	x		x	x	x
	Sabellidae	†*Sabellastarte spectabilis*	(Grube,1878)	x	x	x	x	
	Serpulidae	†*Salmacina dysteri*	(Huxley, 1855)		x			
		Spirobranchus giganteus	(Pallas,1776)	x				
Crustacea	Cirripedia	†*Balanus reticulatus*	Utinomi, 1960		x			
		†*Chthamalus proteus*	Dando & Southward, 1980		x	x	x	
	Stenopididae	*Stenopus hispidus*	Rathbun, 1907		x		x	
	Grapsidae	*Grapsus tenuicrustatus*	(Herbst, 1783)		x			
Gastropoda	Neritidae	*Nerita picea*	(Recluz, 1841)	x				
	Cassidae	*Charonia tritonis*	(Linn., 1758)					x
	Littorinidae	*Littoraria pintado*	(Wood, 1828)	x	x			
	Vermetidae	†*Eualates tulipa*	(Chenu, 1843)	x				
	Cypraeidae	*Cypraea caputserpentis*	Linnaeus	x				
	Cypraeidae	*Cypraea chinensis*	Gmelin, 1791	x				
	Hipponicidae	*Hipponix* sp.		x				
Opisthobranchia	Chromodorididae	*Hypselodoris infurcata*	(Ruppell & Leukart, 1828				x	

Table 5 (continued).

Taxa 1	Taxa 2	Genus Species	Author, Date	Pier 1	Pier 2a	Pier 2b	Pier 3-5	Jetty
Bivalvia	Ostreidae	†*Crassostrea gigas*	(Thunberg, 1793)	x	x			
		Dendostrea sandvicensis	Sowerby, 1871				x	
	Spondylidae	*Spondylus violacescens*	Lamarck, 1819		x			
Cephalopoda	Octopodidae	*Octopus cyanea*	Gray, 1849				x	
Ectoprocta	Vesiculariidae	†*Amathia distans*	Busk, 1886		x		x	
Ectoprocta	Diaperoecidae	*Diaperoecia intricata*					x	
Echinoidea	Diadematidae	*Diadema paucispinum*	Agassiz, 1863			x	x	
		Echinothrix diadema	Linnaeus, 1758	x			x	x
		Echinothrix calamaris	(Pallas, 1774)	x		x	x	x
	Toxopneustidae	*Tripneustes gratilla*	(Linnaeus, 1758)	x		x	x	x
	Echinometridae	*Echinometra mathaei*	(Blainville, 1825)	x			x	x
		Echinostrephus aciculatus	A. Agassiz, 1863		x			
		Heterocentrotus mammillatus	Linnaeus, 1758	x			x	x
	Holothuriidae	*Actinopyga mauritiana*	(Quoy & Gaimard, 1833)	x		x		
Urochordata	(Ascidacea)	*Didemnum* sp.			x			
		†*Herdmania momus*	(Savigny, 1816)				x	
		Total Invertebrate Taxa		31	26	13	25	19
Osteichthyes	Synodontidae	*Saurida flamma*	Waples, 1982	x				
	Belonidae	*Platybona argalus*	(Bennett, 1832)	x				
	Holocentridae	*Sargocentron sp.*					x	
	Aulostomidae	*Aulostomus chinensis*	(Linnaeus, 1766)				x	
	Fistularidae	*Fistularia commersonii*	Rüppell, 1838			x		
	Cirrhitidae	*Paracirrhites forsteri*	(Bloch & Schneider, 1801)	x				x
		Paracirrhites arcatus	(Cuvier, 1829)	x	x			x
	Kuhliidae	*Kuhlia sandvicensis*	(Steindachner, 1876)					x
	Carangidae	*Caranx melampygus*	Cuvier and Valenciennes, 1833		x	x		
		Caranx sexfasciatus	Quoy and Gaimard, 1824				x	
	Lutjanidae	†*Lutjanus fulvus*	(Quoy and Gaimard, 1824)	x	x	x		
		†*Lutjanus kasmira*	(Forsskal, 1775)					x
	Mullidae	*Mulloidichthys flavolineatus*	(Lacepede, 1801)	x		x	x	x
		Mulloidichthys vanicolensis	(Valenciennes, 1831)	x		x	x	
		Parupeneus multifasciatus	Quoy & Gaimard, 1824	x			x	x
		Parupeneus porphyreus	Jenkins, 1903			x		x
	Kyphosidae	*Kyphosus bigibbus*	Lacepede, 1802				x	
		Chaetodon quadrimaculatus	Gray, 1833	x			x	x
	Chaetodontidae	*Chaetodon auriga*	Forsskal, 1775	x		x		
		Chaetodon fremblii	Bennett, 1829			x		
		Chaetodon lunula	(Lacepede, 1803)		x	x	x	
		Chaetodon miliaris	Quoy & Gaimard, 1826					x
		C.omalissimus	Cuvier 1831	x			x	x
		C.quadrimaculatus	Gray, 1833	x			x	x
		Chaetodon reticulatus	Cuvier, 1831					x

Table 5 (continued).

Taxa 1	Taxa 2	Genus Species	Author, Date	Pier 1	Pier 2a	Pier 2b	Pier 3-5	Jetty
	Chaetodontidae	*Forciper flavissimus*	Jordon and McGregor, 1898	x			x	x
	Pomacentridae	*Abudefduf vaigensis*			x			x
		Abudefduf abdominalis	(Quoy & Gaimard, 1824)		x		x	
		Chromis hanui	Randall and Swerdloff,1973					x
		Dascyllus albisella	Gill, 1863	x	x	x	x	x
		Plectroglyphidodon johnstonianus	Vaillant and Sauvage, 1875	x			x	x
		Stegastes fasciolatus	(Ogilby, 1889)	x		x	x	
	Serranidae	*Cephalopholis argus*	Bloch & Schneider, 1801					x
	Labridae	*Bodianus bilunulatus*	(Valenciennes, 1839)			x		
		Gomphosus varius	Lacepede, 1801				x	x
		Labroides phthirophagus	Randall 1960	x				x
		Thalassoma duperrey	(Quoy and Gaimard, 1824)	x	x	x	x	x
	Scaridae	*Scarus* sp. (juv.)				x	x	x
	Acanthuridae	*Acanthurus nigrofuscus*	(Forsskal, 1775)	x	x	x	x	x
		Acanthurus triostegus	(Linnaeus, 1758)	x			x	
		Acanthurus nigroris	Valenciennes, 1835	x				
		Acanthurus blochii	Valenciennes, 1835	x	x	x	x	
		Acanthurus achilles	Shaw, 1803	x				x
		Acanthurus olivaceus	Bloch & Schneider, 1801	x				x
		Acanthurus dussumieri	Cuvier & Valenciennes, 1835		x		x	
		A. leucopareius	(Jenkins, 1903)				x	x
		Ctenochaetus strigosus	(Bennett, 1828)	x			x	x
		Naso literatus	(Bloch & Schneider, 1801)	x			x	x
		Naso brevirostris	(Valenciennes, 1835)			x	x	
		Zebrasoma flavescens	(Bennett, 1828)				x	x
	Zanclidae	*Zanclus cornutus*	(Linnaeus, 1758)	x		x	x	x
	Ostraciontidae	*Ostracion meleagris*	Shaw and Nodder, 1796	x	x	x	x	x
	Tetraodontidae	*Arothron hispidus*	(Linnaeus, 1758)				x	
		Canthigaster jactator	(Jenkins, 1901)	x	x	x	x	x
	Diodontidae	*Diodon holocanthus*	Linnaeus, 1758				x	
	Balistidae	*Melichthys vidua*	(Solander, 1844)				x	x
		Melichthys niger	(Bloch, 1786)					x
		Rhinecanthus aculeatus	(Linnaeus, 1758)				x	x
		Sufflamen bursa	(Bloch & Schneider, 1801)	x	x			x
			Total Fish Taxa	29	14	20	34	35
Reptilia	Chelonidae	*Chelonia midas*			x			x
			Total Taxa	60	41	33	58	55

† - Species thought to be introduced (alien to Hawaiian Islands); All others are considered to be native species, with those in bold representing the endemics (found only in the Hawaiian Islands).

reached, where coral on the bottom increases to about 30% coverage and fishes again become moderately abundant.

A total of 60 organisms were recorded along Pier 1, which included 31 invertebrates dominated by corals and echinoderms, and 29 species of fish. This was the highest number of invertebrates and total organisms observed on of the five areas surveyed at Kawaihae, and all were sighted along the relatively short section of coral bottom corresponding to the area proposed for Pier 1

Pier 2a

This is the main pier area for the harbor, and it consists of concrete pier pilings about 0.6 m (2 ft) in cross section that extends from the surface down to the harbor bottom at 11 m (36 ft) depth. The deck of the pier is supported by these piers, and the sheet piling wall of the pier is recessed about 10 from the pier's edge, forming a large area underwater which is dimly lit where the bottom slopes gradually up to the pier wall. The bottom substratum under the pier is coarse sand and the water tends to be turbid. These factors have prevented settlement and growth of corals under the pier, although the corals *Montipora capitata* and *Porites lobata* are common on the pier pilings near the edge of the pier where light is sufficient to support them. *M. capitata* colonies on the pier pilings are sometimes quite large, reaching 0.5 m (1.6 ft) in greatest dimension.

Going southeastward along the pier toward the head of the harbor, the dominant biota on the pier pilings changes from open-coastal type organism to those more commonly found in Hawaiian harbors, such as polychaetes, tunicates, and especially bryozoans. Numbers of invertebrates decreased from the 31 species found along the relatively short distance of prospective Pier 1 to only 13 along the entirety of Pier 2a (Table 5). A similar reduction occurred in the numbers of fish species sighted, from 60 at Pier 1 to 30 along Pier 2a, resulting in a total number of only 60 taxa observed along the entirety of Pier 2a.

Pier 2b Site

This area is designated for future expansion as a passenger terminal, research station and/or cargo expansion area. At present it is composed of wooden docks at the east end of Pier 2 that are being used to moor sailboats and other pleasure craft. The docks lie outside lava boulders used to surface the limestone substratum, which extends to 7 m (23 ft) depth at the shoreline. Hermatypic corals are more abundant here than along Pier 2a. Live coral coverage as high as 30% occurs near the surface, decreasing with depth down to a limit at about 5 m (16 ft), with most of the coral and fishes occurring near the surface at less than 2 m (6 ft) depth. The decreasing numbers of species observed along the length of Pier 2a in the southeasterly direction essentially continues here, with only 13 invertebrates and 20 fishes recorded (Table 5), for a total of 33 species in this small area near the head of the harbor. This location also had the highest water turbidity of any area on the survey, which may in part be a factor in the

low number of organisms observed, especially for the fishes. That is, fishes were decidedly more difficult to observe and identify in the water.

Piers 3-5 (proposed) Site

The Piers 3-5 Site extends along the southern shoreline of the harbor to the jetty that protects the harbor on it's seaward side. Planned usage is for an inter-island cargo area (Pier 3) along most of the existing shoreline and a military cargo area (Pier 4) on the seaward 100 m (300 plus feet), with a small pier (Pier 5) at the beginning of the jetty on the seaward side of the existing LST/LSU ramp.

At present the shoreline along the southeast side of the harbor is a beach area that was formed from dredge tailings material when the present harbor was formed. Although the beach is not particularly attractive and is composed of packed sediment and cobbles, it is apparently quite popular with the public for recreational use. Approximately 30 people were observed to use the area each day on September 16 and 17 when our survey was conducted. This popularity is apparently due in part to many small tide pools and quiet swimming areas behind rocks dredged up in harbor construction that are used by families with small children.

It has been pointed out (Momi Subiono, pers. comm.) that this beach area is used for collecting small mollusk (called micromollusk) shells. The conditions that contribute to favoring deposits of these shells (called a death assemblage by marine biologists) in this area are essentially unknown. For example, it is unclear whether these shells come from populations of snail species now extant (living) in the harbor, or populations that lived on the former reef flat that existed here prior to harbor dredging and construction of the breakwater. According to Ms. Subiono, some species are "very rare" and "not found on other beaches along the Kona coast." None, however, is listed as endangered, threatened, proposed, or as a candidate species by the U.S. Fish and Wildlife Service under the Endangered Species Act of 1973 as amended (ESA), or by the State of Hawai'i under it's endangered species program (State DLNR, 1996; CFR, 1999; Federal Register 1999).

Off the beach and shoreline rocks, the bottom slopes down at about a 30° angle to a coarse sand and rubble bottom at about 5 m (16 ft) depth. Above this depth the substratum is mostly rocky outcrops separated by cobbles and coarse sand which continue up to the shoreline which is composed of lava boulders framing the small tidepools. On the hard substratum at 3 m (6 ft) depth, corals are common, ranging from about 25% coverage near the head of the harbor to about 80% near the west end of the proposed Pier 3. The boulders and outcrops provide substantial vertical relief and habitat for fishes and motile invertebrates. Most of the coral coverage on the hard substratum is *Porites lobata* and *Pocillopora meandrina*, but *Pocillopora damicornis, Montipora patula, Porites compressa, Leptastrea purpurea, Porites evermanni* and *Pavona varians* were also present. Twenty-five invertebrate species and 34 fish species were recorded along this segment of the survey, for a total of 58 species (Table 5), the second highest total number on the survey. The area is primarily a highly altered reef flat/slope

environment with limited biotic diversity due to distance from the harbor entrance and resulting restrictions on waves and water flow. Near the northeast side of the LST/LCU boat ramp this shallow bottom community broadens to about 50 m (164 ft) width with approximately 80% coral coverage of mostly *Porites compressa* down to about 5 m (16 ft) depth, despite high turbidity and a fair amount of fine sediment on the bottom.

On the other side of the LST/LCU ramp, at the proposed site of Pier 5, are dolphins with concrete legs that provide habitat for different types of organism than occur along the rest of this shoreline, species that would be regarded as more typical of harbor biota. This was the only location where the bryozoans, *Amathia distans* and *Diaperoecia intricata*, and the ascidian, *Herdmania momus*, were found. These are dominant organisms in O'ahu harbors, and their presence within Kawaihae harbor suggests that they could become more common if additional concrete substratum were to become available from expanded pier development.

End of Harbor Jetty

This segment of the survey was conducted on the reef remnant from just inside of the end of the harbor jetty around to its seaward face. The reef remnant rises steeply out of the dredged channel from about 13 m (43 ft) to a margin at about 1.5 m (5 ft) depth. Environmental conditions are pristine, with high water clarity and abundant coral coverage of about 75%, marked by large coral heads and high vertical relief. This structure provides substantial habitat and refuge for fishes. Despite the relatively small area surveyed, 55 species were recorded, composed of two calcareous algae, 19 invertebrates and 35 fishes, the highest number found during our survey (Table 5).

Hilo Harbor

Hilo Bay is a broad indentation in the northeastern coastline of the island of Hawaii. The beginnings of the present configuration of Hilo Harbor date to the start of the Hilo breakwater construction in 1908. Originally built of stone quarried from Waiakea and Puna (and later from Waipio Valley), the breakwater was constructed on the inner part of the reef fronting Hilo Bay and was completed in 1929 to its present length of 10,170 ft (3,100 m; Kelley et al., 1981). The pier that was originally called Kuhio Wharf was constructed in 1912-16 at the present Pier 1 site, with the harbor bottom near the pier having been dredged at that time to a depth of 35 ft (10 m). Completion of this pier removed most ship loading and unloading activity from the former Railroad Pier and the Government Wharf that had existed near the mouth of Wailoa River at Waikea. Pier 2 was constructed in 1921-23 and Pier 3 in 1926-27. Large areas of the harbor basin were dredged during this period to accommodate approaches to these piers (Kelley et al., 1981).

This construction and modification of this section of Hilo Bay undoubtedly dramatically altered the oceanographic environment, creating a more stagnant water column with high

turbidity levels compared with the formerly relative unrestricted conditions in Hilo Bay. Remarkably, there does not seem to be any studies or reports that describe the biological environment within the confines of Hilo Harbor or any surveys of the organisms that occur there.

Water Quality

The region draining to Hilo Bay is very wet, with an annual rainfall ranging from about 130 to 300 inches (NCDC, 2000). The bay receives surface water runoff from several streams – mostly notably Wailuku Stream. The breakwater constructed in the early 1900's has resulted in increased residence time for waters within its confines. The harbor can be divided into two sections: (1) the inner harbor which is the area bounded by the breakwater, the shoreline and an imaginary line from Cocoanut Island to the edge of the breakwater; and (2) the outer harbor is that area west of the imaginary line.

The Wailuku River drains a watershed of some 256 square miles and flows into the outer harbor area (USGS, 2000). The average flow of the Wailuku River into Hilo Bay is about 300 mgd (Cox and Gorden, 1970). The flow of fresh basal groundwater to the bay occurs at a nearly constant rate in comparison with surface runoff, which varies with weather conditions, and is often the overwhelmingly dominant freshwater component entering the bay. To the north, between the Wailuku River and Alealea Point (outer harbor), 10 to 20 mgd of groundwater flow issues at the coast, about equivalent to the low flow of the river. In Hilo Harbor east of Wailuku River (inner harbor), the flow is on the order of 500 mgd (M&E Pacific, 1980).

There is a continuous net outflow of the less saline cooler surface layer from the harbor. Discharges to the surface layer will move out of the harbor mouth at a rate dependent upon the freshwater input, the wind speed and direction. There is a net inflow to the harbor in the bottom waters that is dependent on the tide and the rate of mixing with the surface layer. Typical residence times vary from 2.5 to 3.5 days for the surface waters in the outer harbor and from 5.9 to 6.6 days for the inner harbor. In the bottom waters, residence times vary from about 2.1 to 2.4 days for the outer harbor and from 6.7 to 6.9 days for the inner harbor waters (M & E Pacific, 1980).

Hilo Harbor is defined as a Class A embayment by the State Department of Health (HAR §11-54-06, DOH, 1992) and is subject to the State's "wet" embayment water quality criteria (Table 6): "wet" criteria applying to embayments when the average fresh water inflow from the land is greater than one percent of the embayment volume per day.

Table 6. State of Hawaii "wet" water quality criteria for embayments (HAR §11-54-06)(DOH, 1992).

Parameter	Geometric Mean value not to exceed this value	Value not to be exceeded more than 10% of the time	Value not to be exceeded more than 2% of the time
Total Nitrogen (µg N/l)	200	250 0	350 0
Ammonia (µg N/l)	6	8 5	15 0
Nitrate + Nitrite (µg N/l)	8	14 0	25 0
Total Phosphorus (µg P/l)	25	40 0	60 0
Chlorophyll α (µg/l)	1.50	1.50	3 00
Turbidity (ntu)	1.5	1.0	1.5

Other "standards":

- pH units shall not deviate more than 0 5 units from a value of 8.1, except at coastal locations where and when freshwater from stream, storm drain or groundwater discharge may depress the pH to a minimum level of 7 0.
- Dissolved oxygen shall not decrease below 75% saturation.
- Temperature shall not vary more than 1 C° from ambient conditions.
- Salinity shall not vary more than 10% from natural or seasonal changes considering hydrologic input and oceanographic factors.

Vertical stratification of salinity/temperature in Hilo Bay is pronounced (Table 7) and caused by freshwater influxes from both terrestrial surface and groundwater sources. This results in a well-defined surface layer of low salinity water and a denser, more saline, bottom layer. Salinity ranges from about 5 ‰ in the surface waters of the outer harbor during major storm events to about 32 ‰ in the bottom waters outside of the harbor. Water temperatures in the Harbor are relatively cool and there is typically a difference of about 2 C° (3.6 F°) between the cooler surface and warmer bottom layers.

DO levels tend to be relatively high in the surface waters, and typically exceed saturation levels, while average DO levels in the bottom waters are less than saturation levels (Table 7). Mean pH levels are fairly uniform in the inner and outer harbor areas of Hilo Bay. The somewhat reduced pH levels in the surface waters outside the harbor may result from the lower chlorophyll α concentrations here; algal photosynthesis causing pH to rise by removing carbon dioxide from the water column. During storm events, pH in the surface waters is notably reduced in both the inner and outer harbor areas.

Table 7. Mean water quality conditions at Hilo Harbor (after M & E Pacific, 1980; Sunn, Low, Tom & Hara, 1977)

	Temp (°C)	Salinity (‰)	DO (mg/l)	DO (% sat.)	pH	Turbidity (ntu))	NO_3+ NO_2 (µg/l)	TN (µg/l)	TP (µg/l)	Chl. a (µg/l)
Outside Harbor										
surface	22.8	20.2	8.04	105	8.13	2.32	24	219	41	1.10
bottom	24.5	32.0	6.73	97	8.21	0.92	5	158	24	0.36
Outer Harbor										
surface	22.5	17.7	8.64	111	8.17	3.09	22	200	32	3.60
bottom	24.5	31.2	6.63	95	8.18	2.28	6	171	26	1.54
Inner Harbor										
surface	23.0	19.6	7.70	101	8.18	2.31	41	204	35	2.23
bottom	24.2	29.6	6.16	87	8.18	3.44	16	161	32	1.71
Wailuku River										
surface	20.3	0	10.28	114	7.77	6.45	25	241	45	2.20

Grayed areas indicate that mean (or geometric mean) values of State water quality criteria were exceeded.

Mean turbidity levels are relatively high within the harbor (Table 7) and in the surface waters outside of the harbor. Most of the turbidity originates from land derived suspended material entering the bay as surface runoff from Wailuku River. It is notable that turbidity in the surface waters of the outer harbor during a March 1980 storm event (Table 8) was nearly an order of magnitude higher than average values for this sector of the bay.

Average nitrogen and phosphorus concentrations in all sections of the bay are higher in the surface waters, indicating that they originate primarily from freshwater sources. The relatively high mean concentrations of nitrate + nitrite nitrogen in both the surface and bottom waters of the inner harbor (Table 7) is probably indicative of the major groundwater inputs that occur in this sector of the bay.

Table 8. Water quality conditions in the vicinity of Hilo Harbor during a storm event (after M&E Pacific, 1980)

	Temp (°C)	Salinity (‰)	DO (mg/l)	DO (% sat.)	pH	Turbidity (ntu))	NO_3+ NO_2 (µg/l)	TN (µg/l)	TP (µg/l)	Chl. a (µg/l)
Outer Harbor										
surface	19.7	5.1	9.70	110	7.63	21.7	86	394	26	—
bottom	23.9	32.4	6.50	93	8.05	3.86	5	212	18	—
Inner Harbor										
surface	19.8	6.6	9.26	106	7.69	7.77	116	233	14	—
bottom	23.4	29.8	5.90	83	8.06	5.18	22	271	17	—

Chlorophyll levels in both the inner and outer harbor areas are typically higher than the waters outside the harbor (Table 7) and may be related, in part, to longer residence times in these sectors of the bay.

Water quality in Hilo Harbor was monitored during a major storm event in March, 1980 (Table 8; M & E Pacific, 1980). The 24-hour rainfall occurring on March 17-18, 1980 measured 15.66 inches and was on the order of a "ten-year" storm. Significant increases in turbidity and nitrogen moieties are apparent in the surface waters during this storm, with notable decreases in temperature, salinity and pH in those same waters.

A comparison of the mean water quality parameters in Table 7 with the State's water quality criteria in Table 6, reveals that the harbor waters are in conformance for salinity, temperature, DO saturation levels and pH. Turbidity, nitrate + nitrite nitrogen, total nitrogen, total phosphorus and chlorophyll α typically exceed State criteria, especially in the surface waters. Water quality tends to improve in Hilo Bay away from the shore and the inner harbor.

Water quality conditions in the inner harbor waters of Hilo Bay on September 24, 2000 (Table 9) were in general agreement with mean values from earlier studies (see Table 7 above) with the following exceptions: turbidity levels were somewhat lower on September 24, 2000, while nitrate + nitrite nitrogen levels were notable higher. The high nitrate + nitrite levels on September 24, 2000 do not appear to be storm-related as salinity levels were not particularly depressed on this date. Further, turbidity levels in this section of the harbor would be expected to be elevated during or following a storm event, and they are in fact quite low compared with both storm-related conditions (Table 8) and average conditions (Table 7). Also, salinities on September 24, 2000 appear to be too high for attributing high nitrate + nitrite concentrations to groundwater inputs (compare the average salinities in Table 7 with those in Table 9).

Table 9. Water quality conditions in the surface waters of the inner harbor at Hilo Bay on September 24, 2000.

Station	Temp (°C)	Salinity (‰)	DO (mg/l)	DO (% sat.)	pH	Turbidity (ntu))	TSS (mg/l)	NO_3+ NO_2 (µg/l)	NH_3 (µg/l)	TN (µg/l)	TP (µg/l)	Chl. a (µg/l)
C1	26.1	22	6.40	90	8.0	0.72	1.2	149	<1	216	30	2.55
P1	22.7	20	6.31	82	8.0	0.70	1.1	194	<1	234	36	2.27
P2	24.6	18	6.30	84	8.0	0.81	0.8	230	1	275	41	1.24
P3	23.7	20	6.16	82	8.0	1.02	1.4	228	<1	260	42	1.13
R1	23.8	15	5.54	72	8.0	0.36	0.4	315	2	420	64	0.49
mean	24.2	19	6.14	82	8	0.68	0.9	216	1	273	41	1.32

Water quality conditions in Hilo Harbor are determined primarily by influxes of surface water runoff from Wailuku River and groundwater. Thus, as the influx of freshwater into the harbor increases, there is a corresponding deviation of water quality from optimal conditions, especially in the surface waters.

Biota

Searches of various databases of marine-related studies for the Hilo area produced 16 reports or publications for the area (O'Connell and Walter, 1963; Matthews and Marumoto, 1971; Sunn Low Tom and Hara Inc., 1977; Walsh, 1991; M & E Pacific Inc., 1980; Kelly et al., 1981; Sea Engineering Inc., 1981; U.S. Army Corps of Engineers - Pacific Ocean Division, 1983; Dollar, 1985; Hallacher et al., 1985; Taguchi et al., 1985; Dudley, 1986; M & E Pacific Inc., 1986; Brock, 1991; Dudley and Hallacher, 1991; Sato, 1992). No biological studies have apparently been conducted (or reported) for the harbor.

The taxa of organisms recorded on our survey are shown in Table 10 along with totals of invertebrates and fishes for portions of the harbor corresponding to the

Table 10. Organisms recorded on survey of Hilo Harbor, September 23, 2000

Taxa 1	Taxa 2	Genus Species	Author, Date	Radio Bay	Pier 4	Pier 5-6	Pier 2-3
Chlorophyta	Caulerpaceae	*Caulerpa racemosa*	(Forsskal) J Agardh		x		
		Cladophora fasciculatis	(Mertens) Kutzing			x	
		Cladophora patula	Sakai	x	x		
Phaeophyta		*Lobophora variegata*	(Lamourouz) Womsley		x		
	Sargassaceae	*Sargassum* sp.			x		
Rhodophyta	Rhodomelaceae	*Amansia glomerata*	C. Agardh		x		
	Corallinaceae	*Porolithon onkodes*	(Heydrich) Foslie			x	
		Martensia fragilis	Harvey		x		
	Rhodomelaceae	*Spyridia filamentosa*	(Wulfen) Harcey		x	x	
			Total Algae Taxa	1	7	3	0
Porifera	Callyspongiidae	*Callyspongia* cf. *diffusa*	(Ridley, 1884)		x	x	
	Microcionidae	*Clathria* sp.			x		
	Dysideidae	†*Dysidea* cf. *avara*	Schmidt, 1862	x	x	x	x
	Desmacellidae	†*Biemna fistulosa*	(Topsent, 1897)		x	x	
	Myxillidae	†*Iotrocha protea*	(de Laubenfels, 1950)		x		
		Blue-green sponge			x		
		Green sponge		x			
		Pink sponge		x			
		Red sponge		x			
Hydrozoa	Pennariidae	†*Pennaria disticha*	Goldfuss, 1820				x
	Aglaopheniidae	*Gymnangium hians*	(Busk, 1852)			x	
Anthozoa	Octocorallaciae	*Arbacia bicolor*	(Nutting, 1908)		x		
	Telestidae	†*Carijoa riisei*	Duchassaing & Michelotti, 1860		x		x
	Pocilloporidae	*Pocillopora damicornis*	(Linnaeus, 1758)		x	x	
	Acroporidae	*Montipora capitata*	(Dana, 1846)		x	x	
	Siderastreidae	*Psammocora verrilli*	Vaughan, 1907			x	
Polychaeta	Chaetopteridae	†*Chaetopterus* sp.			x	x	
	Sabellidae	†*Sabellastarte spectabilis*	(Grube,1878)	x	x	x	
	Sirorbidae			x			
Crustacea	Cirripedia	†*Balanus* reticulatus	Utinomi, 1960	x	x		x
		†*Balanus* ebumeus	Gould 1841	x			
		†*Chthamalus proteus*	Dando & Southward, 1980	x			x
	Panuliridae	*Panulirus pencillatus*	(Olivier, 1791)		x		
	Grapsidae	*Grapsus tenuicrustatus*	(herbst, 1783)	x			
Gastropoda	Vermetidae	†*Eualates tulipa*	(Chenu, 1843)	x			
	Siphonariidae	*Siphonaria normalis*	Gould, 1848	x			
	Ischnochitonidae	*Ischnochiton petaloides*	(Gould, 1846)	x			
Bivalvia	Mytilidae	*Brachidontes crebristriatus*	Conrad	x			
	Ostreidae	†*Crassostrea gigas*	(Thunberg, 1793)	x	x		
Ectoprocta	Schizoporellidae	†*Schizoporella* sp.					x
			Total Invertebrate Taxa	15	15	9	6

Table 10. (continued).

Taxa 1	Taxa 2	Genus Species	Author, Date	Radio Bay	Pier 4	Pier 5-6	Pier 2-3
Osteichthyes	Muraenidae	*Gymnothorax flavimarginatus*	(Ruppell, 1830)	x			
	Atherinidae	*Pranesus insularum*	Jordan and Everman, 1903	x			
	Carangidae	*Caranx* sp.		x			
		Caranx melampygus	Cuvier and Valenciennes, 1833				x
	Lutjanidae	†*Lutjanus fulvus*	(Quoy and Gaimard, 1824)		x	x	x
		†*Lutjanus kasmira*	(Forsskal, 1775)	x			
	Mullidae	*Mulloidichthys vanicolensis*	(Valenciennes, 1831)		x		
		Parupeneus multifasciatus	Quoy & Gaimard, 1824		x		
		Parupeneus porphyreus	Jenkins, 1903		x		x
	Chaetodontidae	*Chaetodon auriga*	Forsskal, 1775	x	x		
		Chaetodon fremblii	Bennett, 1829				
		Chaetodon lunula	(Lacepede, 1803)				x
		Chaetodon miliaris	Quoy & Gaimard, 1826		x		
		Heniochus diphreutes	Jordon, 1904				x
	Pomacentridae	*Abudefduf abdominalis*	(Quoy & Gaimard, 1824)			x	
		Dascyllus albisella	Gill, 1863		x	x	
		Stegastes fasciolatus	(Ogilby, 1889)		x		
	Scaridae	*Scarus* sp. (juv.)		x			
	Gobiidae	*Bathygobius fuscus*	(Ruppell, 1828)	x			
	Acanthuridae	*Acanthurus triostegus*	(Linnaeus, 1758)	x		x	
		Acanthurus blochii	Valenciennes, 1835	x	x	x	x
		Acanthurus dussumieri	Cuvier & Valenciennes, 1835				x
	Zanclidae	*Zanclus cornutus*	(Linnaeus, 1758)				x
	Tetraodontidae	*Arothron hispidus*	(Linnaeus, 1758)	x	x	x	x
			Total Fish Taxa	10	10	6	9
Reptilia	Chelonidae	*Chelonia midas*					x
			Total Taxa	26	32	18	15

† - Species thought to be introduced (alien to Hawaiian Islands); All others are considered to be native species, with those in bold representing the endemics (found only in the Hawaiian Islands).

areas describe above. A total of only 63 species were recorded on the surveys (Table 10) composed of 9 macroalgae, 29 invertebrates, 24 species of fish, and the green seaturtle, *Chelonia midas*.

Radio Bay

This is a very enclosed small harbor basin (Figure 3) with a narrow entrance on the northwest side that connects to the rest of Hilo Harbor, and is presently used primarily for mooring yachts. With its lack of circulation with the open ocean this basin is the most stagnant area in the harbor, which is reflected by the resident biota, dominated by forms usually found in harbor areas, and no invertebrates usually associated with coral reefs were found. The pier

wall along the harbor's southeast side (Figure 2) extends vertically to the bottom at about 3 m (10 ft) depth, where conditions are very turbid with visibility of less than 1 m, and the sediments are extremely fine, jelly-like silt. The prominent feature in the water column is an approximately 1 m (3 ft) thick surface layer of cold, fresh to brackish water that exists to some degree throughout the harbor but is most pronounced here in Radio Bay. Virtually no marine macro-organisms occur in the intertidal zone affected by this freshwater lens, which was approximately 5 C° (9 F°)cooler than the more saline water below. Below this zone the subtidal community is heavily dominated by nonindigenous barnacles, small *Chthamalus proteus* in the upper few cm (inch) of the zone and the larger *Balanus reticulatus* and *Balanus trigonus* below. The balanids are extremely abundant, making up over 95% of the benthic organisms found on the pier wall. Only 15 invertebrates, 10 fishes and one macroalga were recorded along the pier wall and along the shoreline to he northeast, for a total of 26 species of organisms identified in Radio Bay (Table 10).

Along the shoreline that is the location of the proposed pier, the bottom is coarse sand overlaid with silt with no visible macrobiota on the surface, but with abundant burrow openings marking the location of subsurface dwelling organisms such as ghost shimp (*Callianassa* sp.) or snapping shrimp (Alpheidae). Rock cobbles become abundant on the bottom with approach to the shoreline and water clarity improves. Although few macro-organisms other than barnacles are evident on the rock's upper surfaces, sponges and serpulid worms can be found on the bottom of rocks when they are overturned. The only fish observed in the area were a single jack (Carangidae) and a school of *iao, Pranesus insularum*.

Within about 10 m (33 ft) of the shoreline the bottom rises sharply and is composed of large stones which appear to be a submerged rock wall that may mark the location of a former fishpond, now submerged. The shoreline, although indicated on Figure 2 to be a rock jetty, resembles a tree-covered beach, which at the time of the survey, was being used by numerous campers. It therefore appears that the area is considered a local recreational area.

Prospective Pier 4

This area begins at the east end of Pier 3 where the bottom is a rock reinforced sloping wall down to 11m depth where the bottom is fine silt, with some rock rubble at intermediate depths. The rubble and rock wall supports abundant macroalgae with a coating of fine sediment. Many invertebrates were found in this area not seen elsewhere along this shoreline, such as two of the only four octocorals that occur in Hawaii, the native *Arbacia bicolor*, and the introduced *Carijoa riisei*. Other invertebrates recorded were various species of sponges and two hard corals *Pocillopora damicornis* and *Montipora capita*, which were present but not common.

Starting approximately 100 m (330 ft) from Pier 3, the shoreline is undeveloped and covered with overhanging *Hau* trees that extend over the water's edge for about 100 m (330 ft) of shore. Then begins a residential area where houses have been built with their backyards

ending at the shoreline at small white sand beaches and seawalls. These houses and yards continue thorough the entire length of shoreline indicated for development, ending at approximately the heiau location indicated on Figure 2, totaling approximately 15 houses. This area, called Baker's Beach, is perhaps the only white sand beach in the Hilo area and reportedly was man-made from coral dredged from Hilo Bay between 1925 and 1930 (Sun, Low Tom & Hara 1977; Kelley et al. 1981). However, the consistent medium-grained nature of the sand on the beach and offshore indicates that the beach could not be derived from coral rubble. Offshore of this shoreline the bottom flattens out at a depth of approximately 2.5 m (8 ft) with a substratum of pebbles and cobbles in sand and silt. The only common macrofauna are various sponges growing on the rock surfaces. Further out, the bottom becomes mostly medium to fine white sand with numerous burrow openings interspersed with cobbles and patches of consolidated coral rubble.

Observations along this entire shoreline of approximately 550 m (180 ft) recorded 7 macroalgae, 15 macroinvertebrates and 10 fishes for a total of 32 macro-organisms, the largest number that were observed in any of the areas in Hilo Harbor.

Pier 5-6 Alignment

The area in the approximate location of the proposed Pier 5-6 alignment was surveyed by starting about 300 m (1,000 ft) offshore and swimming shoreward on a bearing of 185°. Depth along most of this transect was about 3.5 m (11 ft) and the substratum coarse white sand with intermittent outcrops of coral rubble, both with a fine silt coating. Sand cover became more abundant with approach to the shoreline and was about 95% of the substratum for most of the length of the transect.

Because of lack of solid substratum and vertical relief, few species macrobiota occurred along this transect. Only three species of algae, 9 invertebrates and 6 fishes were recorded, for a total of 18 species, the second lowest on these surveys. Two uncommon invertebrate species of interest usually occurring on coral reefs were found along this transect, the stinging pen hydroid *Gymnangium hians* and the encrusting hard coral *Psammacora terrilli*.

End of Piers 2 and 3

The area offshore of the end of Pier 3 proposed for location of mooring dolphins is a flat fine silt bottom in 11.5 m (38 ft) depth, with high turbidity and no apparent macrobiota. The pier pilings at the end of Pier 2-3 were inspected and found to have a limited but interesting community of macroinvertebrates and fishes. Only 5 invertebrates and 9 fishes were recorded on or near the pilings. However, these included two introduced invertebrates, the hydroid *Pennaria disticha* and the bryozoan *Schizoporella* sp., not found elsewhere on the survey but are generally common in Hawaiian harbors. Also found here was the introduced octocoral, *Carijoa riisei*, which was otherwise found only at the beginning of the Pier 4 transect and was very abundant on pilings at the end of Pier 3, and the only lobster (*Panulirus pencillatus*)

observed on these surveys. Also unique for this station were the fishes the Moorish Idol (*Zanclus cornutus*), the Pennant Butterflyfish (*Heniochus diphreutes*) and the Racoon Butterflyfish (*Chaetodon lunula*) more commonly seen in reef environments, and one green turtle, *Chelonia midas*.

Conclusions

The primary water quality impacts to be expected from construction activities in Kawaihae Harbor are likely to be temporary increases in turbidity in the water column if the bottom area of the harbor is disturbed. Secondary impacts could include lowering of DO levels and an increase in nitrogen and phosphorus levels in the disturbed area due to mixing of bottom sediments into the water column. Prudent use of turbidity curtains in the construction areas will minimize these potential impacts on the surrounding environment.

Similar impacts can be expected for construction activities in Hilo Harbor. However, because this harbor is the receiving basin for runoff via the Wailuku River, it is likely that major sediment deposits have accrued over the years in the vicinity of potential pier construction areas. Thus, greater perturbations for turbidity and nutrient levels in the water column might be expected in comparison with Kawaihae Harbor, necessitating greater care and caution in the deployment and maintenance of siltation currents around construction activities.

Kawaihae Harbor Water Quality and Biota

Vertical stratification of the seawater within Kawaihae Harbor is minimal, indicating that there is relatively little groundwater input to the harbor basin. Virtually all of the water within the harbor is very similar to the oceanic water outside. Surface water in the inner harbor is somewhat warmer than the deeper water due to solar heating during the day. DO levels are close to saturation, with the highest concentrations observed near the inner part of the entrance channel. Slightly elevated nutrient levels at low tide and the slightly reduced salinity of surface water indicate that groundwater discharge has a minor effect on water quality in Kawaihae Harbor. Locally elevated nitrate levels suggest that this groundwater discharge is most significant near the inland portion of the entrance channel and along the coast north of the harbor. Consistent with the low nutrient concentrations observed at Kawaihae, chlorophyll levels are below 1 µg/l throughout the harbor. Chlorophyll levels inside the harbor are only slightly higher than those outside, probably reflecting a slightly greater residence time of the inside water mass.

Due to its location on the leeward coast of the Island of Hawaii and its accessibility to open coastal water circulation, Kawaihae Harbor has perhaps the most pristine marine environment of any harbor in the Hawaiian Islands. Biotic conditions are therefore more typical of open coastal areas throughout a large part of the harbor rather than conditions seen in most typical harbors having generally more turbid and nutrient enriched water masses.

Within the harbor, a distinct contrast can be seen between the conditions in dredged but undeveloped areas such as proposed Piers 1 and 3-5, which continue to support biological communities typical of nearshore coastal environments outside the harbor, compared with the dredged and developed areas at Pier 2 and the dolphins at proposed Pier 5. In these latter areas, where artificial substrata provide settling surfaces for filter feeding invertebrates, the harbor biological community more closely resembles that in harbors elsewhere in Hawaiian Islands. It is likely that the proposed development/expansion within the harbor basin will further this transition to fewer open coastal invertebrates and fishes, with generally reduced overall diversity.

The honu or Pacific green sea turtle (*Chelonia mydas agassizi*) was the only protected species observed within Kawaihae Harbor, although the gastropod mollusk known as ʻopihi (*Cellana* spp.) can be anticipated as present in low numbers, possibly within the harbor and likely on the outside face of the harbor breakwater. The honu is protected by both State and Federal endangered species laws: listed as a threatened species by both the Department of Land and Natural Resources (DLNR, 1998) and U.S. Fish and Wildlife Service (CFR, 1999). The project area is not prime habitat for this threatened species, which may however, regularly wander into the harbor. The State of Hawaii has a prohibition on talking ʻopihi under a certain size for purposes of selling the meat (DLNR, 1981) without a permit. However, this rule does not protect the species from either catches for personal use or from other sorts of destruction. The ʻopihi is not a listed species nor a candidate for listing under Federal endangered species rules (CFR, 1999; Federal Register, 1999).

Hilo Harbor Water Quality and Biota

Vertical stratification of the water in Hilo Bay is pronounced and is caused by large freshwater influxes from both surface and groundwater sources. This density (salinity/temperature) stratification persists throughout the dry season, undoubtedly due to the large groundwater inputs to the harbor. Salinity ranges from about 5 ‰ in the surface water to about 33 ‰ in the bottom water of the outer harbor. Water temperatures in the harbor range from about 23 to 26 °C (73 to 79 °F). DO levels tend to be relatively high in the surface water, especially during the wet season. DO levels in the bottom water tend to be low, sometimes approaching anaerobic conditions in the wet season due to lack of mixing with surface water.

Nutrient levels are high during the wet season. Nitrate-nitrite levels are especially high in groundwater, while phosphorus concentrations are high in surface runoff waters. During the wet season in Hilo Bay, and especially during a storm event, chlorophyll levels are typically low. Chlorophyll levels are generally more than an order of magnitude higher during the dry season, probably due to the longer residence times, greater water clarity, and lower fluctuation in salinity.

Remarkably, there does not seem to be any studies or reports that describe the biological environment within the confines of Hilo Harbor or any surveys of the organisms that occur

there. The areas subject to be affected by the proposed Harbor developments are inhabited by a low diversity of typical harbor-dwelling organisms with a presumed high tolerance to turbidity, sedimentation, fresh water input, elevated nutrients, and other environmental factors associated with survival in marine areas of restricted circulation. Many of the organisms (18%) found by our biological survey are introduced or alien species. It is not likely that proposed harbor expansion and development will impact any population or community of marine organisms that are regarded as sensitive or valuable, with the possible exception of the green turtle (*Chelonia midas*), a listed species, seen occasionally inside the harbor.

Only one protected species was observed with Hilo Harbor: the honu or Pacific green sea turtle. Possibly ʻopihi occur on the harbor breakwater, especially on the seaward face. The protective status of the honu and the ʻopihi are described above under Kawaihae Harbor. The project area is not prime habitat for these species. Turtles may, however, wander into the harbor from Hilo Bay.

References Cited

AECOS Consultants. 2000. Biological reconnaissance survey of Waiulaula Gulch at ʻOuli, South Kohala, Island of Hawaiʻi. Prep. for DEI. Rept. No. AC020: 14 pp.

Ball, F. 1977. Puu Kohala National Historic Site; Marine Flora. Report No. 16, Cooperative National Park resources Study unit.

Brock, J. H. and R. E. Brock. 1974. The marine fauna of the coast off Northern Kona, Hawaii. UNIHI-SEAGRANT-AR-74-02, Univ. of Hawaii Sea Rrant, Honolulu.

Brock, R. E. 1991. Acute toxicity program for Kahului, Shipman and Honolulu discharges: year 1 summary. EAC Rept. No. 91-09, Environmental Assessment Co.

Cheney, D. P., D. E. Hemmes, and R. Noland. 1977. The physiography and marine fauna of inshore and intertidl areas in Puukohola Heeiau National Historic Site. Tech. Rep. 13, Cooperative National Park Resources Studies Unit, Univ. of Hawaii, Honolulu.

Code of Federal Regulations (CFR). 1999. Title 50 – Wildlife and Fisheries, Part 17 – Endangered and Threatened Wildlife and Plants, Subpart B – Lists. 50 CFR §17.11 and §17.12. U.S. Government Printing Office. 37 pp. (Also URL: `http://endangered.fws.gov`).

Cox, D.C. and L.C. Gordon, Jr., 1970. Estuarine Pollution in the State of Hawaii, Volume 1, Statewide Study, Water Resourves Research Center, Technology Report 31, University of Hawaii.

Dollar, S. J. 1985. Environmental assessment of Hilo Bay: Marine biological community structure in the vicinity of the proposed Hilo sewage outfall extension. baseline.

Dudley, W. C. 1986. Baseline study of the geochemistry and sedimentology of nearshore marine sediments in selected areas of the Island of Hawaii. Department of Planning and Economic Development, State of Hawaii Marine Mining Program, Honolulu.

_____, and L. E. Hallacher. 1991. Distribution and dispersion of sewage pollution in Hilo Bay and contiguous waters. University of Hawaii, Hilo.

Federal Register. 1999. Department of the Interior, Fish and Wildlife Service, 50 CFR 17. Endangered and Threatened Wildlife and Plants. Endangered and Threatened Wildlife and Plants; Review of Plant and Animal Taxa that are Candidates or Proposed for Listing as Endangered or Threatened; Annual Notice of Findings on Recycled Petitions, and Annual Description of Progress on Listing Actions. *Federal Register*, 64 (205 (Monday, October 25, 1999)): 57534-57547.

Hallacher, L. E., E. B. Kho, N. D. Bernard, A. M. Orcutt, J. W.C. Dudley, and T. M. Hammond. 1985. Distribution of arsenic in the sediments and biota of Hilo Bay, Hawaii. Pacific Science 39:266-273.

Hawaii Department of Land and Natural Resources. 1974. Survey of fish and habitat progress report for statewide Dingell-Johnson program. Unpublished Report State of Hawaii, Honolulu.

Hawaii Electric Light Co. Inc. 1975. Envirnmental impact analysis for a proposed West Hawaii generating station, Island of Hawaii, Hawaii. Holmes and Narver Inc., Anaheim.

Jokiel, P. L., E. F. Cox, F. T. Te, and D. Irons. 1999. Mitigation of reef damage at Kawaihae Harbor through transplantation of reef corals. U. S. Fish and Wildlife Service, Pacific Islands Ecoregion, Honolulu, 21 pp.

Kelly, M., B. Nakamura, and D. B. Barrere. 1981. Hilo Bay: A chronological history. Bernice P. Bishop Museum, Department of Anthropology, Honolulu.

M & E Pacific, Inc. 1980. Hilo Area Comprehensive Study: Geological, Biological, and Water Quality Investigations of Hilo Bay. Prep for the U.S. Army Engineer District, Honolulu.

_____. 1986. Draft Supplemental Environmental Impact Statement for the Proposed Hilo Bay Outfall Sewer Extension, Hilo, Hawaii. M & E Pacific, Inc., Honolulu.

Marine Research Consultants. 1995. Assessment of water quality and marine community structure in the vicinity of Kawaihae Harbor, Hawaii; Kawaihae Co-Generation Facility. Unpublished report Tom Nance Water Resource Engineering, Honolulu.

Matthews, E., and K. Marumoto. 1971. The abundance of fish and environmental conditions in Hilo Bay. University of Hawaii, Hilo.

NCDC. 2000. National Climatic Data Center. http://www.ncdc.noaa.gov.

Ocean Research Consulting and Analysis, L. O. 1978. Reconnaissance surveys of the marine environment at Kawaihae small boat harbor project site, Island of Hawaii. Tech. Rep., Hawaii State Department of Planning and Economic Development, Honolulu.

Ocean Research Consulting and Analysis, L. O. 1981. West Hawaii Coral Reef Inventory. Tech. Rep., Contr. No. DAWC84-80-C-0003, U. S. Army Corps of Engineers, Pacific Div., Honolulu.

Oceanic Institute, 1991. Studies of Water Quality, Ecology, and Mixing Process at Honokohau and Kawaihae Harbors on the Island of Hawaii. Prep. for Muana Lani Resort, Inc. Kohala Coast, Hawaii.

O'Connell, R. L., and C. M. Walter. 1963. A study of dispersion in Hilo Bay, Hawaii. U.S. Department of Health, Education, and Welfare, Public Health Service.

OI Consultants, I. 1991. Studies of water quality, ecology, and mixing processes at Honokohau and Kawaihae Harbors on the Island of Hawaii. Unpublished report Mauna Lani Resort, Inc, Kohala, Hawaii.

ORCA/Cheney, D. P. 1981. West Hawaii coral reef inventory. DAWC84-80-C-0003, U. S. Army Corps of Engineers, Pacific Div., Honolulu.

Sato, L. 1992. Fishery resource distribution maps for Hilo Harbor. Available from the Division of Aquatic Resources, State of Hawaii Department of Land and Natural Resources, Honolulu, Hawaii.

Sea Engineering Inc. 1981. Circulation and sediment transport study, Hilo Bayfront Beach, Hilo Hawaii. Sea Engineering, Inc., Makai Pier.

State of Hawaii, Department of Health (DOH). 1992. Hawaii Administrative Rules, Title 11; Department of Health, Chapter 54, Water Quality Standards. 67 p.

_____. Department of Land and Natural Resources (DLNR). 1981. Hawaii Administrative Rules. Title 13, Department of Land and Natural Resources, Subtitle 4, Fisheries, Part V, Protected Marine Fisheries Resources, Chapter 92, Opihi. 2 p.

Sunn Low Tom and Hara Inc. 1977. Final report: First spring season environmental studies Hilo Bay, Hawaii. Sunn, Low, Tom and Hara, Inc., Honolulu.

Taguchi, S., J. Hirota, E. D. Stroup, T. Suzuki, R. Young, and R. Harman. 1985. Oceanographic observations of the fishing area off Hilo, Hawaii. UNIHI SEAGRANT Technical Report TR-85-01 University of Hawaii Sea Grant College Program, Manoa.

U. S. Army Corps of Engineers (USACOE). 1971. Final environmental statement for Kawaihae Harbor for light draft vessels. EIS U. S. Army Corps of Engineers, Pacific Div., Honolulu.

_____. 1975. Environmental assessment, Kawaihae small boat harbor. EIS U. S. Army Corps of Engineers, Pacific Div., Honolulu.

U. S. Army Corps of Engineers (USACOE). 1978. Kawaihae Harbor for light-draft vessels, Hawaii: draft informational supplement to the final environmental statement. United States. Army. Corps of Engineers. Pacific Ocean Division, Honolulu.

_____. 1994. Final environmental assessment for Kawaihae Harbor for light-draft vessels, Hawaii, Hawaii. United States. Army. Corps of Engineers. Honolulu District, Honolulu.

_____. 1983. Hilo area comprehensive study: Draft survey report and draft environmental impact statement. DEIS U.S. Army Corps of Engineers, Fort Shafter.

U.S. Geological Survey (USGS). 2000. Water Resources of the United States. URL: http://water.usgs.gov.

Walsh, W. J., and D. A. Ziemann. 1991. An assessment of the potential for environmental effects of a stock enhancement program with striped mullet, *Mugil cephalus*, near Hilo, Hawaii.

Woolsey, Miyabara & Associates, Inc. 1985. Final Environmental Impact Statement for Development of Kawaihae Boat Harbor, Kawaihae, Hawaii. Prep. for Harbors Division, Department of Transportation, State of Hawaii.

Appendix F

PHASE 1 - ENVIRONMENTAL SITE ASSESSMENT
HILO HARBOR

R.M. Towill Corporation

November 2000

Phase I - Environmental Site Assessment

HILO HARBOR
TMK (3)-2-1-7 AND (3)-2-1-9
Hilo, Hawaii

NOVEMBER 2000

Prepared For:

Harbors Division, Dept. of Transportation
State of Hawaii
79 South Nimitz Highway
Honolulu, Hawaii 96813

R. M. TOWILL CORPORATION
SINCE 1930

420 Waiakamilo Rd., Suite 411
Honolulu, Hawaii 96817-4941
(808) 842-1133 • Fax: (808) 842-1937
(RMTC Ref: 1-18844-01)

PHASE I - ENVIRONMENTAL SITE ASSESSMENT

Hilo Harbor

Tax Map Key (3)-2-1-7 and (3)-2-1-9

Hilo, Hawaii

PREPARED FOR:

Harbors Division, Dept. of Transportation
State of Hawaii
79 South Nimitz Highway
Honolulu, Hawaii 96813

PREPARED BY:

R. M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817

November 2000

TABLE OF CONTENTS

PAGE

EXECUTIVE SUMMARY

R. M. Towill Corporation (RMTC) has performed a Phase 1 Environmental Site Assessment for the Hilo Harbor, a State of Hawaii property, located on Tax Map Key Plat #s (3)-2-1-7 and (3)-2-1-9, located in the South Hilo District of the Island of Hawaii. The property is currently the site of an active harbor operation for the east side of the island and is surrounded by commercial, industrial and residential lands.

The property covers approximately 80 acres and is currently owned by the Harbors Division, Department of Transportation, State of Hawaii according to the most recently available property deed records.

This assessment was conducted to determine whether conditions or situations at the site might result in present real or potential hazards, or environmental liabilities as dictated by federal, state, and local statutes and regulations. Specific areas investigated included: historical uses of the subject property; signs of gross surface contamination; hazardous materials and wastes; and the presence of equipment containing polychlorinated biphenyls (PCBs), and underground storage tanks (USTs).

A review of the environmental regulatory databases indicated the following:

- ☐ No U.S. EPA or state Superfund sites are within a one-mile radius of the property;
- ☐ No CERCLIS site is located within a half-mile radius of the property;
- ☐ No RCRA treatment, storage, and disposal facility is located within a half-mile radius of the property;
- ☐ No RCRA corrective action sites were identified within a one-mile radius.
- ☐ Six RCRA generators are located on the property or on adjacent properties;
- ☐ Four underground storage tanks are located within a quarter-mile radius of the property;
- ☐ Two leaking underground storage tank facilities are located within a half-mile radius of the property.
- ☐ No active landfills are located within a half-mile radius of the property; and
- ☐ No spills or incidents connected with the property are entered on the ERNS database.

A site reconnaissance at the property, performed on August 9, 2000 found no significant, observable environmental conditions connected with the property. The following potential environmental concerns were identified during the site assessment process:

- There is a large number of aboveground and underground storage tanks on harbor properties and in the vicinity. There exists the potential for leakage of petroleum product to the soils and ground water in this area. No evidence was noted to verify this possibility, however no sub-surface investigations were performed.

- There is a large system of piping that carries the petroleum product from ships at the piers to the storage tanks. These pipes may leak causing contamination of the soils and ground water in this area. No leakage was observed or documented, however additional investigation may be required to verify this potential problem.

- Some of the buildings at the harbor contain asbestos-containing building materials. No thorough study was performed to determine the extent of the presence of asbestos or lead-based paint. An inspection should be preformed in the harbor buildings to determine if these contaminants are present on the property to assist future construction and demolition projects.

1.0 INTRODUCTION

R. M. Towill Corporation (RMTC) has performed a Phase 1 Environmental Site Assessment for the Hilo Harbor, a State of Hawaii property. The harbor consists of approximately 78 parcels located across two Tax Map Key Plats, (3)-2-1-7 and (3)-2-1-9. The parcels are located on Kalanianaole Road in the town of Hilo in the South Hilo District on the Island of Hawaii. Throughout this ESA the parcels of interest will be referred to as the subject property.

1.1 *Purpose*

The purpose of this Phase I Environmental Site Assessment was to investigate past and present land uses of the subject property and surrounding areas to determine if the potential for hazardous materials contamination exists. This site assessment is being performed as a part of the Environmental Impact Statement for the Hawaii Commercial Harbors 2020 Master Plan. The Master Plan describes the plans for the development of the harbor properties over the next 20 years. Specific attention was paid to the areas of the property that are scheduled to be impacted during the planned expansion activities.

1.2 *Scope of Work*

This assessment was performed in accordance with American Society for Testing and Materials (ASTM) Standard: E 1527-00, "Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process." The ASTM Standard defines customary practice for conducting environmental site assessments of a parcel of commercial real estate with respect to contaminants within the scope of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and to petroleum products.

RMTC performed the following tasks:

- Reviewed available documents including maps and aerial photographs to assess past land use at the property;

- Conducted a database review and contacted local and State agencies to determine the regulatory history associated with the property;

- Conducted site reconnaissance to assess present site conditions;

- Reviewed site geology and hydrogeology; and

- Prepared Phase I Environmental Site Assessment Report which documents RMTC's findings.

This assessment is based on information that has been provided to RMTC by applicable agencies and individuals. Conclusions and recommendations are drawn from the cumulative findings of the aforementioned sections.

1.3 *Limitations*

The conclusions presented in this report are professional opinions based solely upon visual observations of the sites and their respective vicinities, and our interpretation of the available historical information and documents reviewed. They are intended exclusively for the purpose outlined herein and at the site location and project indicated. The scope of services performed in execution of this investigation may not be appropriate to satisfy the needs of other users, and any use or re-use of this document or the findings, conclusions, or recommendations presented herein is at the sole risk of said user.

R. M. Towill Corporation's services are performed, within the limits prescribed by its Clients, with the usual thoroughness and competence of the consulting profession, in accordance with the standard for professional services at the time those services are rendered. No warranty or representation, either expressed or implied, is included or intended in its proposals, contracts, or reports.

Opinions and recommendations presented herein apply to site conditions existing at the time of our investigation and those reasonably foreseeable; they cannot necessarily apply to site changes of which this office is not aware and has not had the opportunity to evaluate.

2.0 SITE DESCRIPTION

2.1 *Location and Legal Description*

The property consists of approximately 78 parcels located in two Tax Map Key Plats, (3)-2-1-7 and (3)-2-1-9, located on the shore of the Kuhio Bay on the windward side of the island of Hawaii. The property is on Kalanianaole Road. The total area of the property is approximately 80 acres. The property is located in an area of mixed commercial, industrial and residential land usage.

2.2 *Site and Vicinity Characteristics*

According to the U.S. Geological Survey topographic map of the area (Hilo Quadrangle), the property is located at approximately 19° 43 57.7 North latitude and 155° 3 24.5 West longitude. The property is located in the South Hilo District of the Island of Hawaii, on the shoreline of the Kuhio Bay. The elevation of the property is less than 10 feet above mean sea level (amsl).

2.2.1 Geologic Setting and Soils

The property is located near the city of Hilo, along the shoreline of the Pacific Ocean at Kuhio Bay on the Island of Hawaii, on land classified by the U.S. Department of Agriculture Soil Conservation Service as a single type: fKFD of the Keaukaha Series. The Keaukaha Series consists of well drained, thin organic soils overlying pahoehoe lava bedrock. These soils occupy the low areas of Mauna Loa. It is undulating to rolling and follows the topography of the underlying pahoehoe lava. Rock outcrops occupy about 25 percent of the area. The surface of this soil is very dark brown muck about 8 inches thick. The soil is strongly acid.

2.2.2 Groundwater

The property is situated down gradient of the underground injection control (UIC) line, according to the Hawaii Department of Health Underground Injection Program Map from 1984. This indicates that the ground water is not likely to be used for drinking water due to the presence of a significant amount of salt water from the ocean. Groundwater elevations in the area are expected to be at sea level or slightly above. There are no public drinking water supplies within a mile of the property and there are two drinking water wells between a half mile and a mile to the southwest. The use for these wells is not available, however it is unlikely that any site activities will impact the quality of the water in these wells.

2.2.3 Surface Waters

There are no significant surface drainages that traverse the harbor site from areas up gradient of the site. A river mouth is located approximately one mile to the west of the property, but there is no likely impact from harbor operations on the quality of the water in this resource. Surface runoff of the site runs directly into the Kuhio Bay. Therefore any spills or releases of chemicals on the site are likely to impact that area. However, no evidence of such impacts was noted in this assessment.

2.3 *Current Uses of Property*

The properties that are owned by the State of Hawaii and operated by the Harbors Division of the Department of Transportation are used for the direct operation of the harbors, and lands leased by the state for a variety of uses. The properties around the harbor lands are used for a variety of light industrial and commercial operations, agriculture, and Hilo International Airport.

Lands leased by the state at the harbor are used for residential purposes, petroleum storage and distribution, cement mixing and loading, shipping container receiving and storage, automobile receiving and storage, and sugar product loading and storage facilities. Also on harbor property, there is a small area that is occupied by squatting families on the edge of Radio Bay on the east side of the harbor. There are approximately 30 - 40 temporary structures on the property.

3.0 ENVIRONMENTAL RECORDS REVIEW

In order to identify the presence of adverse environmental conditions at the subject property, several published sources of environmental records were searched. This section lists those environmental databases that were searched and the results of each search. The importance of the entries of each database is listed in the following sections.

3.1 *Agency Lists Reviewed*

A review was performed of the environmental regulatory databases (all updated within 90 days of search, or at most recent update available) required by ASTM methodology at the respective search distances specified by the methodology.

3.2 *Federal Database Search Results*

3.2.1 USEPA National Priorities List

The National Priorities List compiled by the U.S. Environmental Protection Agency lists the Superfund Hazardous Waste Sites as required by federal law. The identification of the worst hazardous waste sites in the country is mandated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) passed in 1980. This list is prioritized according to the severity of the risk to public health and the environment.

There are no NPL sites located within one mile of the subject property.

3.2.2 USEPA RCRA TSD Facilities List

The EPA maintains a list of Treatment, Storage, and Disposal (TSD) Facilities that either treat, store or dispose of hazardous waste as defined by the hazardous waste regulations published by the EPA according to the Resource Conservation and Recovery Act (RCRA). This information is contained in the Resource Conservation and Recovery Information System (RCRIS).

There are no TSD facilities located within a half of a mile of the Hilo Harbor.

3.2.3 USEPA RCRA CORRACTS List

The RCRA CORRACTS or Corrective Action Report, lists those facilities that generate, treat, store, or dispose of hazardous wastes that have undergone remediation activity. These sites have experienced spills or releases of hazardous chemicals prompting the need for clean up action. The extent and type of contamination is listed in this report as well as the status of the corrective actions.

There are no hazardous waste facilities located within one mile of the subject property that have undergone corrective action according to this report.

3.2.4 USEPA CERCLIS List

The CERCLIS List, or Comprehensive Environmental Response, Compensation, and Liability Information System contains data on potentially hazardous waste sites that have been reported to the EPA by states, municipalities, private companies, and private persons. These sites are considered for possible clean up activities or inclusion onto the NPL.

There are no entries on the CERCLIS for properties within a half of a mile of the subject property.

3.2.5 USEPA ERNS List

The Emergency Release Notification System list, compiled by the US EPA, lists the locations and other data on reported releases of oil and hazardous substances. All releases in excess of threshold quantities are required to be reported and included in this list.

No spills or incidents connected with the property are entered on the ERNS database.

3.2.6 USEPA RCRA Generators List

The EPA tracks all facilities that generate hazardous wastes in excess of threshold quantities set in the RCRA regulations. RCRA large quantity generators LQG) are those that produce in excess of 1000 kilograms of hazardous waste per month, and small quantity generators (SQG) are those that produce in excess of 100 kg per month and less than 1000 kg per month.

The following hazardous waste generators were listed on the EPA RCRA list within a quarter of a mile.

Facility / Location	Generator Status	Other Information
Tosco Hilo Terminal 607 Kalanianaole Ave.	Large Quantity Generator (LQG)	No violations found
Shell Oil Co. Hilo Plant 661 Kalanianaole Ave.	LQG	No violations found
Farmer Pesticide Disposal Project 60 Kuhio Road	Small Quantity Generator (SQG)	No violations found

Facility / Location	Generator Status	Other Information
Brewer Chemical Corp. 60 Kuhio Road	Conditionally exempt SQG	No violations found
Tesoro Hawaii Hilo Terminal No. 2 595 Kalanianaole Ave.	SQG	No violations found
Tesoro Hawaii Hilo Terminal No. 3 607 Kalanianaole Ave.	SQG	No violations found
Big Island Nissan 471 Kalanianaole Ave.	SQG	No violations found
Chevron Products Co. Hilo Terminal 666 Kalanianaole Ave.	SQG	No violations found

3.3 *State and Local Database Search Results*

3.3.1 State of Hawaii Hazardous Waste Sites

This list includes all facilities, sites, or areas in which the Office of Hazard Evaluation and Emergency Response has an interest, has investigated or may investigate under Hawaii Revised Statutes.

There are no state recognized hazardous waste sites within a mile of the subject property.

3.3.2 State of Hawaii Landfill Sites

The state list of Solid Waste Facilities and Landfill Sites contains an inventory of solid waste disposal facilities or landfills in the state. These facilities may be active or inactive or open dumps that failed to meet RCRA criteria for proper solid waste landfills.

There are no state recognized landfills or disposal sites within a half of a mile of the harbor properties.

3.3.3 State of Hawaii UST List

This list of registered underground storage tanks is administered by the State of Hawaii UST division. All tanks that are registered as required by the federal RCRA regulations are contained

on this list. The database also includes the number and types of tanks registered, the regulatory status of the tanks, and whether they have been removed and closed according to state law.

There were four underground storage tank sites listed in the state list of registered USTs located within a quarter of a mile of the site.

Facility / Location	No. and Types of USTs	Regulatory Status
Jack L. Ayers, Jr. 555 Kalanianaole Ave.	1 - unknown capacity, installation date not reported.	Tank was taken permanently out of use in 1991.
Theo H. Davies 500 Kalanianaole Ave.	1 - 1000 gallon tank, installed 1976, diesel 1 - 2000 gallon tank, installed 1976, gasoline	Both tanks were taken permanently out of use. No information on the closure and removal was available.
Big Island Nissan 471 Kalanianaole Ave.	1 - 500 gallon tank, installed 1967, used oil 1 - 1000 gallon tank, installed 1967	Both tanks were taken permanently out of use in 1989.
Pacific Machinery 456 Kalanianaole Ave.	1 - 1000 gallon tank, installed 1962, gasoline 2 - 550 gallon tank, installed 1962, diesel and other substance	All of the tanks were taken permanently out of use in 1995.

Two of the facilities listed in the UST section of the regulatory report were also identified on the Leaking Underground Storage Tank (LUST) Listing and are discussed in the LUST findings below. The remaining facilities listed in the UST section of the regulatory report are not listed on any other database, such as the LUST database, which reports releases, spills or other incidents. The UST database is merely a listing of all required facilities to register their USTs for tracking purposes and is not necessarily of facilities with reported contamination incidents. Based on the absence of reported releases, these facilities are not anticipated to have a significant adverse impact on the environmental integrity of the subject property. Additional investigation may be required at these sites if excavation or construction activities are proposed for these properties.

3.3.4 State of Hawaii Leaking UST List

The state Department of Health Underground Storage Tank Division records the location and regulatory status of all sites in which leaking underground storage tanks have been identified. There was only one leaking underground storage tank site identified within a half of a mile of the subject property. Information on this site was reviewed with the Department of Health files to determine the current status of the site clean up activities. The result of this records review is summarized on the following table.

Facility Location	Records Searched	Status of Site
Pacific Machinery 456 Kalanianaole Ave	Leaking Underground Storage Tanks (LUST)	All tanks were installed in 1962 and taken permanently out of use in 1995.
Kuwaye Trucking Inc. 2055 Kamehameha Ave.	Leaking Underground Storage Tanks (LUST)	All tanks were installed in 1961 and have been taken permanently out of use by 1993 or before.

Files were reviewed at the State of Hawaii Department of Health for the four leaking underground storage tank facilities listed in the LUST database. Two of the sites are part of the subject property and the other two are within a half-mile of the subject property. All four facilities were found to have localized environmental contamination. The contamination at each of the sites was discovered during UST removal operations. The contamination was minimal and measures were taken to excavate contaminated soils. The State of Hawaii Department of Health issued No Further Action (NFA) letters to the responsible parties. In each case, the analysis of soil samples collected from underneath the tanks showed contamination levels either below the detection limit or below the DOH standards for clean soils after closure.

3.4 *Historical Use of Property*

3.4.1 Aerial Photographs

Aerial photographs were obtained from the RMTC Photogrammetry Department for the property from the years 1952, 1969, 1972, 1985 and 1998 and examined for indications of previous site usage.

The 1952 photograph shows the existence of the harbor and a few structures on the subject property. There are several aboveground storage tanks on the south edge of the subject property. To the south and to the east of the subject property is wooded with some residences directly to the southeast. The land southwest and west of the subject property is developed. The development appears to be for industrial uses. The photograph shows several aboveground storage tanks on properties southwest and west of the subject property.

The 1969 photograph shows the site with additional aboveground storage tanks on the site. Gasoline storage tanks and approximately fifteen large propane storage tanks have been erected on the east side of the property. There is increased development on surrounding properties with aboveground storage tanks appearing to the south. The continued development is concentrated to the south and west of the subject property. A wastewater treatment plant is shown on the property to the east of the subject property.

The 1972 photograph shows the site much as it was in 1969, but with added development on the surrounding properties. The continued development is concentrated to the south and west of the subject property.

The 1985 photograph shows the property much as it was in 1972. Development on the surrounding properties continues to increase. The land to the southeast remains residential.

The 1998 photograph shows the site much as it appears now. Four storage tanks were removed from the site. The tanks were located just to the west of the water tower. The land to the southeast remains residential.

3.4.2 Historical Use Information

Hilo Bay's first reported recognition as a viable harbor location took place in 1825. Traffic to the area was light and the need for a developed harbor was not yet needed. The United States Exploring Expedition, in 1940-41, surveyed Hilo and its surrounding areas. Due to the praise of the expedition that the bay is an excellent location for a harbor, the increased cultivation of sugar cane, and the growing number of visitors, the scene was set for the development of Hilo Harbor.

From the mid-to-late nineteenth century, several small landings and piers were built along the shores of Hilo Bay. Around 1895, the government of the Republic of Hawaii appropriated money for the construction of 2 piers, a small boat landing and a ship wharf, and the construction of a breakwater. The two piers were built between 1897 and 1899. The small boat pier was quickly leased to a private company after the Minister of the Interior decided it was inadequate for their use. The 250-foot ship wharf remained operational. The breakwater was constructed in six sections between 1908 and 1930. The 10,000-foot long breakwater was built along the Blonde Reef starting on the shore of Kuhio Bay.

The old government ship wharf was removed and a new wharf constructed on the shores of Kuhio Bay near the start of the breakwater. This wharf is known as Pier 1, or Kuhio Wharf, and was constructed in 1912. Pier 1 marks the beginning of permanent construction on the current site of Hilo Harbor. The construction of Pier 2 was completed in 1923. It was originally 528 feet long and 110 feet wide. Pier 3 was constructed in 1926-27 and was made a part of Pier 2. All three of the Piers had a double line of railroad tracks on their berthing sides. Large sheds were built on top of the piers.

A tsunami hit Hilo in 1946, leaving behind massive damage to the harbor facilities and the breakwater. After 2 years of assessment, construction of permanent structures began. A second tsunami hit the Hilo area, but the damage to the harbor was not as significant as what was caused by the tsunami in 1946.

Several large improvements were made at the harbor in the years to come. In 1948, Matson Navigation Co. built four steel silos and associated equipment needed for the handling and

storage of bulk sugar. In the 1960's, in 1980 and again in 1987 dredging activities were conducted for the expansion of the piers.

In 1993 and 1995, improvements to the Harbor were concentrated on the expansion and improvement to existing cargo handling space. The area behind Pier 3 was paved, land was purchased and used for cargo space, and a cargo yard on the south side of the site was expanded by almost three acres.

4.0 SITE RECONNAISSANCE

4.1 *Site Inspection*

On August 9, 2000, David Gerow of RMTC performed a site visit of the site to review current site usage and to look for evidence of chemical contamination and other potential environmental problems. The property consists of approximately 78 parcels covering approximately 80 acres.

The subject property consists of an active harbor operation and land leased to a variety of commercial companies. The harbor operation consists of 3 piers and buildings associated with the operation of the harbor. While the subject property is mostly State-owned land, a portion of the subject property is leased to private businesses. Some of the tenants maintain gasoline and propane storage tanks on the subject property. The petroleum storage tanks are fed via an underground pipeline from Pier 3. The pipeline runs in a north/south direction. At the southwest corner of the subject property are two aboveground tank farms, gasoline and propane.

The existence of parcels on the subject property containing aboveground and underground fuel storage tanks is a concern regarding the potential for soils and/or groundwater contamination. Additional research was undertaken regarding knowledge of past incidences with leaks resulting in localized contamination and with the potential for unknown existing contamination.

A tour of the neighborhood revealed a mix of residential and commercial areas in the neighboring properties. Lands to the south and west of the subject property are occupied by industrial facilities, some of which contain aboveground storage tanks, which appear to be used to store petroleum products. Residences are located southeasterly from the subject property.

During this inspection, it was noted that the sugar handling facilities were about to be demolished and the properties will be used for additional container storage and handling yards. Some of the sugar handling buildings contain asbestos-containing transite panels that must be removed prior to demolition. If the panels are not properly removed, asbestos debris and fibers will contaminate the area and the vehicles used for transport, and will expose workers in the area to the toxic dusts.

4.2 *Interviews*

On August 9, 2000, RMTC interviewed the Harbor Master of the Hilo Harbor for information on any environmental issues that he may be aware of. Mr. Ian Birnie is a long time employee of the harbor. According to Mr. Birnie, there have not been any spills of hazardous materials, no releases of petroleum from any of the underground or aboveground storage tanks, or other environmental issues at the Hilo Harbor.

5.0 FINDINGS AND CONCLUSIONS

RMTC has performed a Phase I Environmental Site Assessment in conformance with the scope and limitations of ASTM Standard E 1527-00 for the property identified in Tax Map Key Plat #s (3)-2-1-7 and (3)-2-1-9. The assessment included a site reconnaissance to observe existing conditions, and a review of available local, state, and federal records. This assessment has revealed no evidence of significant, recognized environmental conditions in connection with the property, however several potential conditions exist that may affect the future development of the property and the liability of the owner of the properties. These conditions include:

- Due to the presence of aboveground and underground petroleum storage tanks, there is a possibility of sub-surfacial soil and groundwater contamination on the affected properties. While no leaks or spills were identified in this assessment, the potential exists for there to be releases of petroleum to the ground. Prior to excavation work on or near these properties, precautions should be taken to protect the environment and the workers in the area from exposure to these hydrocarbons.

- A number of piping systems are present to carry petroleum products from ships at the piers to the storage tanks on or near the harbor properties. While no releases from these piping systems were documented during this assessment, the potential exists that there have been leaks from these pipes. Prior to any excavation work in the vicinity of these pipes, additional investigation may be required or precautions should be taken to protect the environment and the workers in this area.

- Several of the buildings in the harbor complex apparently contain transite asbestos siding, including the Pier 1 Shed and the sugar handling buildings scheduled for demolition. Additional asbestos-containing materials and lead-based paint may also exist in these buildings based on their age and the type of construction used. An asbestos and lead paint inspection should be performed to identify the presence of all asbestos containing building materials and lead-based paint hazards in the harbor buildings. Knowing the location and types of these materials present is useful in designing future renovation and demolition projects.

No other environmental conditions were observed at the property or during the survey of the surrounding properties.

6.0 SIGNATURES

The Phase I Environmental Site Assessment was performed by Mr. David Gerow of R. M. Towill Corporation.

David Gerow, CIH, CSP — Date 11/14/00

7.0 REFERENCES

Experian, State of Hawaii Realty Directory, 31th Edition (1997).

Sato, Harry H; Ikeda, Warren; Paeth, Robert; Smyth, Richard; Takahiro, Jr., Minoru; Soil Survey
of the Island of Hawaii, State of Hawaii (December 1993).

State of Hawaii DOH, LUST Database (October 2, 2000).

State of Hawaii DOH, UST Database (October 2, 2000).

State of Hawaii DOH, Permitted Landfills in the State of Hawaii (August 3, 2000).

U.S. Environmental Protection Agency (EPA), CERCLIS (August 28, 2000).

U.S. EPA, Emergency Response Notification System Database (August 2, 2000).

U.S. EPA, National Priority List (August 7, 2000).

U.S. EPA, RCRIS (September 26, 2000).

APPENDIX A

FIGURES

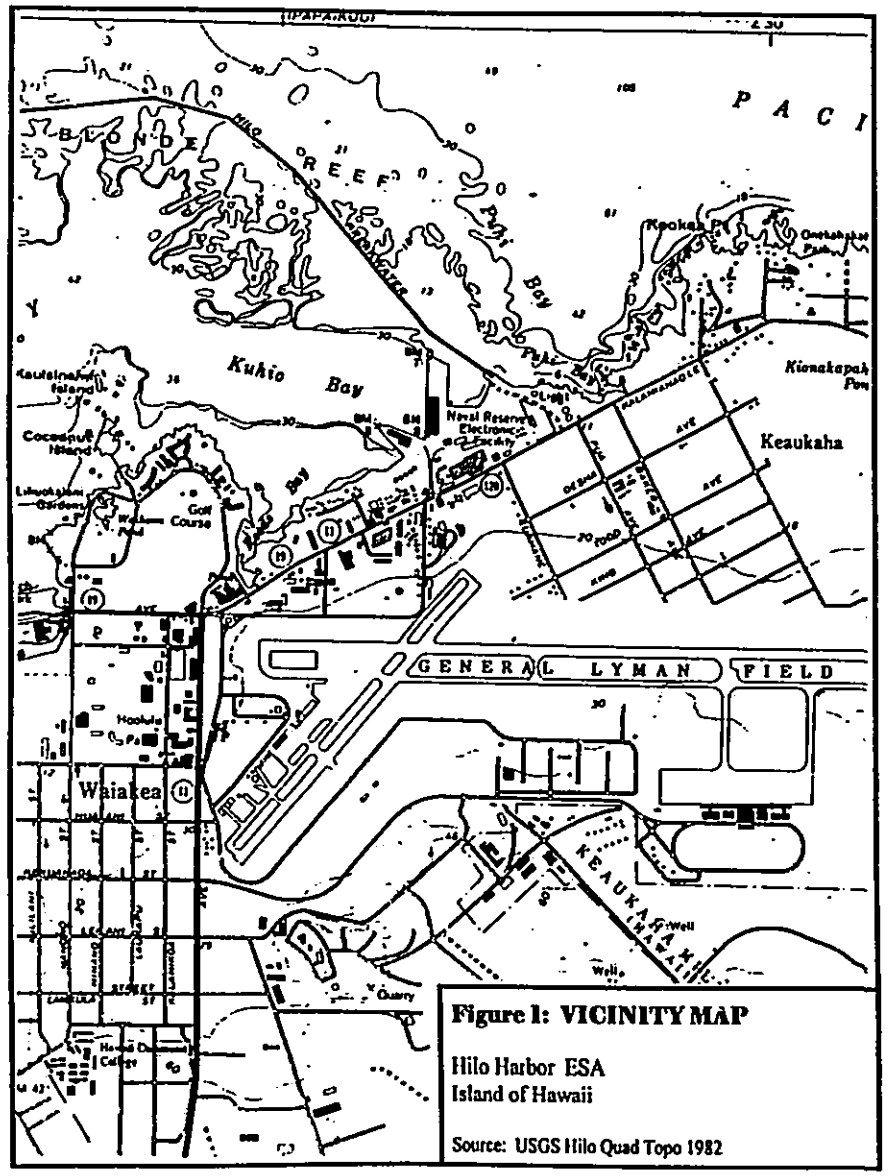
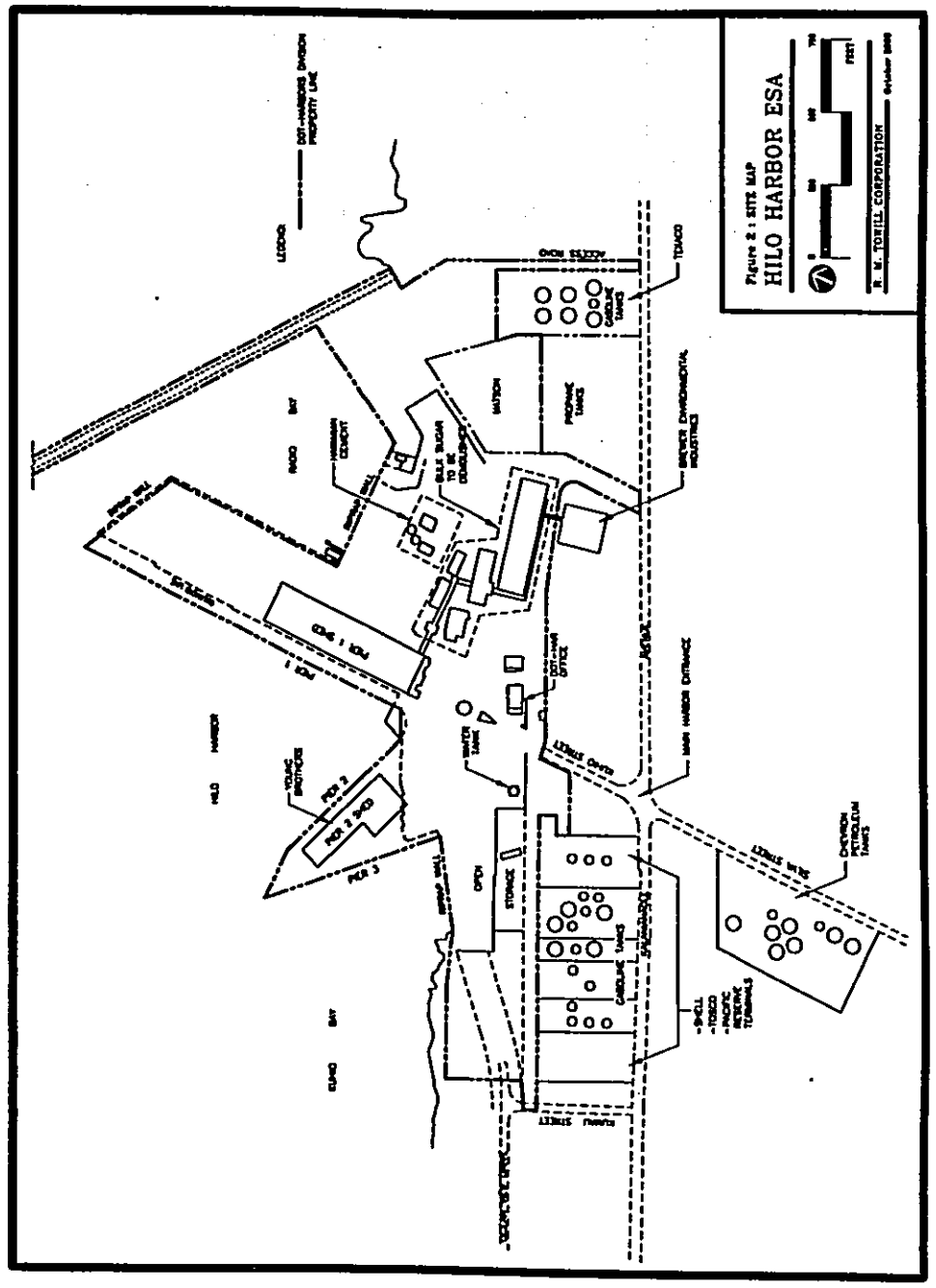


Figure 1: VICINITY MAP

Hilo Harbor ESA
Island of Hawaii

Source: USGS Hilo Quad Topo 1982



DOCUMENT CAPTURED AS RECEIVED

DOCUMENT CAPTURED AS RECEIVED

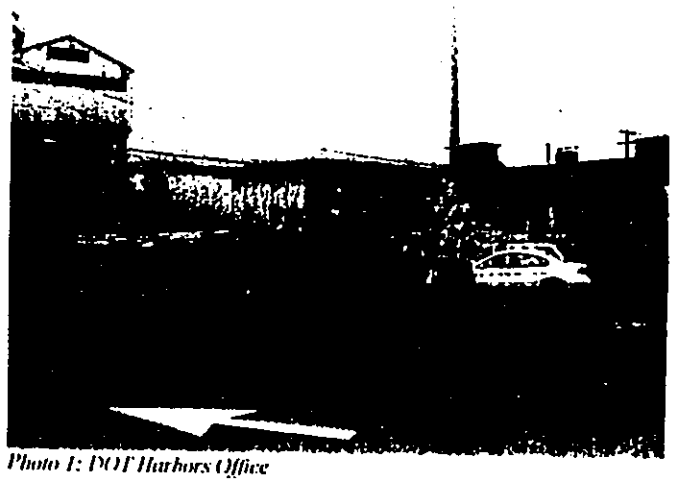


Photo 1: DOT Harbors Office

APPENDIX B

PHOTODOCUMENTATION

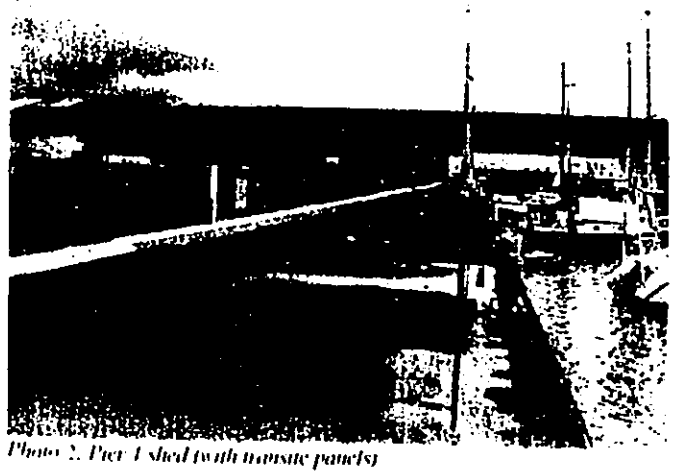


Photo 2: Pier 1 shed (with transite panels)

DOCUMENT CAPTURED AS RECEIVED

Photo 3: From Pier 1 towards tank farm

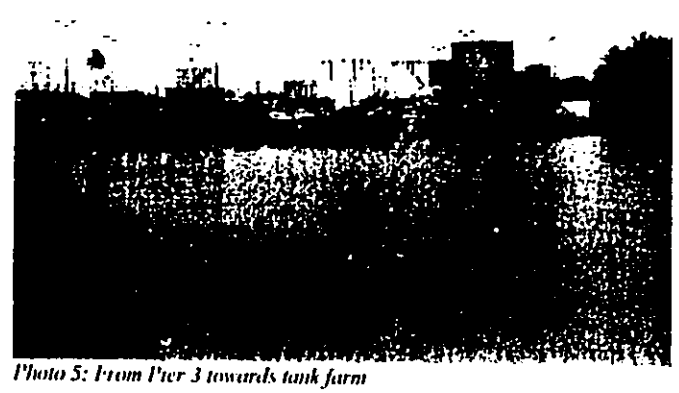


Photo 5: From Pier 3 towards tank farm

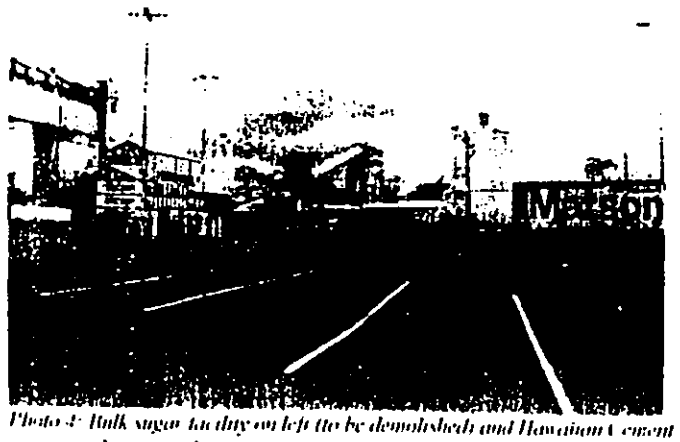


Photo 4: Bulk sugar facility on left (to be demolished) and Hawaiian Cement plant on right

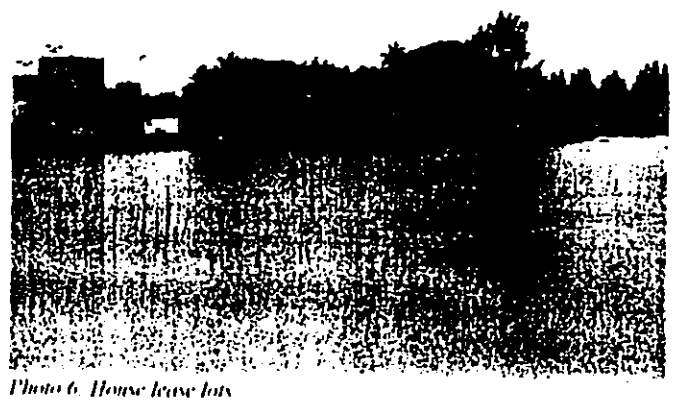


Photo 6: House lease lots

Appendix G

PHASE 1 - ENVIRONMENTAL SITE ASSESSMENT
KAWAIHAE HARBOR

R.M. Towill Corporation

November 2000

Phase I - Environmental Site Assessment

KAWAIHAE HARBOR
TAX MAP KEY (3)-6-1-3
Kawaihae, Hawaii

NOVEMBER 2000

Prepared For:

Harbors Division, Dept. of Transportation
State of Hawaii
79 South Nimitz Highway
Honolulu, Hawaii 96813

R. M. TOWILL CORPORATION

420 Waiakamilo Rd., Suite 411
Honolulu, Hawaii 96817-4941
(808) 842-1133 • Fax: (808) 842-1937
RMTC Ref 1-18844.0E

Kawaihae Harbor

Tax Map Key Plat Map (3)-6-1-3

Kawaihae, Hawaii

PREPARED FOR:

Harbors Division, Dept. of Transportation
State of Hawaii
79 South Nimitz Highway
Honolulu, Hawaii 96813

PREPARED BY:

R. M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817

November 2000

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The R. M. Towill Corporation (RMTC) performed a Phase 1 Environmental Site Assessment for the Kawaihae Harbor, a State of Hawaii property, located on Tax Map Key Plat Map # (3)-6-1-3, in the South Kohala District of the Island of Hawaii. The property is a currently the site of an active state commercial harbor operation. Neighboring properties contain a mix of agricultural, commercial, and residential uses.

The property covers nearly 100 acres of land in 28 parcels along the shore of Kawaihae Bay and is currently owned by the Harbors Division, Department of Transportation, State of Hawaii according to the most recently available property deed records. Some of the property is leased to transportation companies, fuels suppliers, materials providers, and other commercial ventures.

This assessment was conducted to determine whether conditions or situations at the site might result in present real or potential hazards, or environmental liabilities as dictated by federal, state, and local statutes and regulations. This investigation is also intended to identify areas of potential contamination that may be encountered during construction planned for future expansion of the harbor operations. Specific items investigated included: present and historical uses of the properties; signs of gross surface contamination; the presence of hazardous materials and wastes; above ground and underground storage tanks (ASTs and USTs), and other indications of the presence of chemical contamination. These conditions may exist either on the subject property or on nearby properties to constitute an environmental liability to the owners of the property.

A review of the environmental regulatory databases indicated the following:

- No U.S. EPA or state Superfund sites are located within a one-mile radius of the subject property;
- No CERCLIS sites are located within a half-mile radius of the subject property;
- No RCRA treatment, storage, and disposal facilities are located within a half-mile radius of the property;
- No RCRA corrective action sites were identified within a one-mile radius;
- One RCRA small generator is located within a quarter-mile of the property, and no large quantity generators are located within that search radius. The SQG, the TOSCO Kawaihae Terminal, was not found to have any reported incidents or violations of hazardous waste regulations;

- Two sites with underground storage tanks are located within a quarter-mile of the property. One of these sites was found to be a source of leaked or spilled petroleum products, however the extent of the contamination is unknown;

- One leaking underground storage tank facility is located within a half-mile radius of the property. This site underwent a partial clean up of soil contamination, however some additional site remediation was required by the State Department of Health according to government records on this property. No record of the additional remediation work having been done was found;

- No active landfills are located within a half-mile radius of the property; and

- One spill incident connected with the property was entered on the ERNS database. This spill occurred on September 30, 1993 and involved the release of approximately 2 pounds of hydraulic oil from a boat in the harbor. The spilled material was cleaned up and no long-term environmental liability should come as a result of the incident.

A site reconnaissance at the property, performed on August 10, 2000 found only one observable, adverse environmental condition connected with the property. This refers to the Akana Petroleum site that has spilled petroleum product on the surface of the soils in their property. The site is bermed to prevent surface run-off of the oils, however no information on the presence of a liner to prevent ground water contamination was found. The harbor property contains several operations that may also potentially contribute to adverse environmental conditions, however, records available at the time of this report did not reveal any problems identified to date. These operations include approximately 15 large, above ground petroleum storage tanks, dockside petroleum unloading facilities, and pipelines for transporting the petroleum product to the storage tanks. Any of these facilities may have leaked causing soil and ground water contamination.

Based on the available information reviewed, RMTC concludes that the only significant potential for environmental liability on this property is the presence of the underground storage tanks, above ground petroleum storage tanks, associated piping and loading facilities and surface contamination present at the Akana Petroleum property. RMTC recommends that additional environmental investigation be undertaken if excavation or earthwork are proposed for the identified areas. These investigations would involve the determination of the extent and concentration of petroleum hydrocarbons in work areas. If identified, these contaminated materials would require proper management, treatment or disposal, and proper worker protection during the work.

1.0 INTRODUCTION

The R. M. Towill Corporation (RMTC) has been retained by the Harbors Division, Department of Transportation, State of Hawaii to perform a Phase I - Environmental Site Assessment (ESA) for the Kawaihae Harbor, identified on Tax Map Key (TMK) Plat Map # (3)-6-1-3. The property is located on Kawaihae Road near the village of Kawaihae in the South Kohala District on the northeast side of the Island of Hawaii in the State of Hawaii.

This report details the work performed to identify the presence of significant, adverse environmental liabilities associated with this site. Throughout this ESA the parcel of interest will be referred to as *the subject property* or *the property.*

1.1 *Purpose*

The purpose of this Phase I Environmental Site Assessment was to investigate past and present land uses of the subject property and surrounding areas to determine if the potential for hazardous materials contamination exists. This site assessment is being performed as a part of the Environmental Impact Statement for the Hawaii Commercial Harbors 2020 Master Plan. The Master Plan describes the plans for the development of the harbor properties over the next 20 years. Specific attention was paid to the areas of the property that are scheduled to be impacted during the planned expansion activities.

1.2 *Scope of Work*

This assessment was performed in accordance with American Society for Testing and Materials (ASTM) Standard: E 1527-00, "Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process". The ASTM Standard defines customary practice for conducting environmental site assessments of a parcel of commercial real estate with respect to contaminants within the scope of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and to petroleum products. Adherence to these guidelines is intended to limit liability of property owners from inherited environmental contamination.

RMTC performed the following tasks:

- Reviewed available documents including maps and aerial photographs to assess past land use at the property;

- Conducted an environmental records review and contacted local and State agencies to determine the regulatory history associated with the property;

- Conducted site reconnaissance to assess present site conditions;

- Reviewed site geology and hydrogeology; and

- Prepared this Phase I Environmental Site Assessment Report which documents the findings of this evaluation.

This assessment is based on information that has been provided to RMTC by applicable agencies and individuals. Conclusions and recommendations are drawn from the cumulative findings of the aforementioned sections.

1.3 *Limitations*

The conclusions presented in this report are professional opinions based solely upon visual observations of the sites and their respective vicinities, and our interpretation of the available historical information and documents reviewed. They are intended exclusively for the purpose outlined herein and at the site location and project indicated. The scope of services performed in execution of this investigation may not be appropriate to satisfy the needs of other users, and any use or re-use of this document or the findings, conclusions, or recommendations presented herein is at the sole risk of said user.

R. M. Towill Corporation's services are performed, within the limits prescribed by its Clients, with the usual thoroughness and competence of the consulting profession, in accordance with the standard for professional services at the time those services are rendered. No warranty or representation, either expressed or implied, is included or intended in its proposals, contracts, or reports.

Opinions and recommendations presented herein apply to site conditions existing at the time of our investigation and those reasonably foreseeable; they cannot necessarily apply to site changes of which this office is not aware and has not had the opportunity to evaluate.

2.0 SITE DESCRIPTION

2.1 *Location and Legal Description*

The property consists of approximately 28 parcels of land in the TMK Plat Map # (3)-6-1-3 (Figures 1 and 2) located near the village of Kawaihae on the leeward side of the island of Hawaii. The property is along Kawaihae Road at Kawaihae Bay. The total area of the properties is approximately 100 acres.

According to the U.S. Geological Survey topographic map of the area (Kawaihae Quadrangle), the property is located at approximately 20° 2' 24.0" North latitude and 155° 49' 54.5 " West longitude. The property is located in the village of Kawaihae in the South Kohala District on the Island of Hawaii in the State of Hawaii, along the Pacific Ocean at Kawaihae Bay. The site is generally flat and located below an elevation of 30 feet above sea level.

Property records indicate that the current owner of the property is Harbors Division, Department of Transportation, State of Hawaii.

2.2 *Site and Vicinity Characteristics*

2.2.1 Geologic Setting and Soils

The property is located near the village of Kawaihae, on the shoreline of the Pacific Ocean at Kawaiau Bay on the island of Hawaii. The harbor is situated at the base of the Kohala Mountain range on the northeast portion of the island. The soils at the site are in the Kawaihae Series (KOC) described by the US Department of Agriculture Soil Conservation Service as very rocky, very fine sandy loam at 6 - 12 percent slopes. The area is severely eroded in which small gullies are forming and the vegetation is sparse. The Kawaihae series consists of somewhat excessively drained extremely stony soils that formed in volcanic ash. These soils have a very thin surface layer of fine sandy loam over silt loam and loam. The annual rainfall is 5 - 20 inches per year, falling mostly in the winter months.

2.2.2 Groundwater

The property is situated makai or towards the ocean of the underground injection control (UIC) line, according to the Hawaii Department of Health Underground Injection Program Map from 1982. This indicates that the ground water at the site is not used for drinking water. Due to the proximity to the ocean, the water likely has a high salt content and would not be considered to be potable. Ground water on the site is expected to be at or slightly above sea level.

There are five water wells located within a mile of the property. These wells are all located upgradient of the subject property and therefore will not likely be affected by the site activities. The use of these wells is not known at this time. According to the State Department of Health, there are three injection wells and three other wells located either on the harbor property or immediately adjacent to the site. These wells are likely permitted for disposal of septic sewage or other waste water systems.

Based on this information, any impacts to the ground water from on-site or off-site operations are not likely going to have significantly affect future uses of the ground water at the property or to affect any drinking water uses nearby.

2.2.3 Surface Waters

The harbor property contains two streams that flow from the Kohala Mountains from the east to the ocean at the port. One of these streams flows only when there is rainfall in the vicinity and is a dry drainage for most of the year. The other stream flows to the south of the harbor across harbor properties. This steam will have to be managed in accordance with state and federal regulations during future construction activities.

2.2.4 Site Flood Boundaries

A review of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (Community Panel Number 155166 0137, revised May 3, 1982) indicates that the coastal areas of the harbor property fall within a Coastal High Hazard Area. This designation indicates the potential for flooding during storm events and during times of high surf coming from the west in areas along the shoreline. The areas at the base of the gulches in this area are also considered to be within the 100 year flood boundary. During times of extremely wet and rainy weather, these areas may flood from water flowing down the mountain towards the ocean. Other areas of the site have not been determined for the flood hazard.

2.3 *Current Uses of Property*

The site consists of an active state harbor operation, leased lands for a variety of uses, and undeveloped land. The area is flat, surrounded by the ocean on the west, mixed residential and agricultural lands to the north and south, and undeveloped lands up the hillside of the Kohala Mountains to the east. Several of the harbor properties are leased for fuel storage, blending, and distribution facilities; shipping container loading and storage, cement mixing and loading, and sugar product loading and storage facilities. A coral rock landfill created to place dredged harbor materials is now the site of a rock excavation and loading operation operated by C. Brewer. A landing spot along the harbor is owned by the U.S. Army for training operations. The landing is connected to a small staging area and a dirt road leading to the interior of the island. The total area of the Army property is 24 acres. Other adjacent lands are used for a canoe club, small boat harbors maintained and operated by the State Department of Land and Natural Resources, and a campground. A National Historical Site, the Puu O Kohola Heiau, is located just to the south of the harbor property.

3.0 ENVIRONMENTAL RECORDS REVIEW

In order to identify the presence of adverse environmental conditions at the subject property, several published sources of environmental records were searched. This section lists environmental databases that were searched and the results of each search. Important entries of each database are listed in the following sections.

3.1 *Agency Lists Reviewed*

A review was performed of the environmental regulatory databases (all updated within 90 days of search, or at most recent update available) required by ASTM methodology at the respective search distances specified by the methodology.

3.2 *Federal Database Search Results*

3.2.1 USEPA National Priorities List

The National Priorities List compiled by the U.S. Environmental Protection Agency lists the Superfund Hazardous Waste Sites as required by federal law. The identification of the hazardous waste sites presenting the greatest risk to human health and the environment (in the U.S.) is mandated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) passed in 1980. This list is prioritized according to the severity of the risk to public health and the environment.

There are no NPL sites located within one mile of the subject property.

3.2.2 USEPA RCRA TSD Facilities List

The EPA maintains a list of Treatment, Storage, and Disposal (TSD) Facilities that either treat, store or dispose of hazardous waste as defined by the hazardous waste regulations published by the EPA according to the Resource Conservation and Recovery Act (RCRA). This information is contained in the Resource Conservation and Recovery Information System (RCRIS).

There are no TSD facilities located within a half of a mile of the Kawaihae Harbor.

3.2.3 USEPA RCRA CORRACTS List

The RCRA CORRACTS or Corrective Action Report, lists those facilities that generate, treat, store, or dispose of hazardous wastes that have undergone remediation activity. These sites have experienced spills or releases of hazardous chemicals prompting the need for clean up action. The extent and type of contamination is listed in this report as well as the status of the corrective actions.

There are no hazardous waste facilities located within one mile of the subject property that have undergone corrective action according to this report.

3.2.4 USEPA CERCLIS List

The CERCLIS List, or Comprehensive Environmental Response, Compensation, and Liability Information System contains data on potentially hazardous waste sites that have been reported to the EPA by states, municipalities, private companies, and private persons. These sites are considered for possible clean up activities or inclusion onto the NPL.

There are no entries on the CERCLIS for properties within a half of a mile of the subject property.

3.2.5 USEPA ERNS List

The Emergency Release Notification System list, compiled by the US EPA, lists the locations and other data on reported releases of oil and hazardous substances. All releases in excess of threshold quantities are required to be reported and included in this list.

The only entry to the ERNS on the subject property was the following reported release.

Location	Details of Reported Incident
Kawaihae Port	On September 30, 1993, 2 pounds of hydraulic oil were spilled from the ship the M/V Sgt William R. Button when a hydraulic hose ruptured. A boom was deployed and the oil cleaned up. No further action was required.

3.2.6 USEPA RCRA Generators List

The EPA tracks all facilities that generate hazardous wastes in excess of threshold quantities set in the RCRA regulations. RCRA large quantity generators LQG) are those that produce in excess of 1000 kilograms of hazardous waste per month, and small quantity generators (SQG) are those that produce greater than 100 kg per month but less than 1000 kg per month.

The following hazardous waste generators were the only facilities listed on the EPA RCRA list within a quarter of a mile of the harbor property.

Facility / Location	Generator Status	Other Information
Tosco Kawaihae Terminal	SQG	No violations of hazardous waste regulations were found.
King Kona Productions Inc.	SQG	This operation was on land leased to a movie production company for use during movie filming in 1995. No violations of hazardous waste regulations were noted.

3.3 *State and Local Database Search Results*

3.3.1 State of Hawaii Hazardous Waste Sites

This list includes all facilities, sites, or areas in which the Office of Hazard Evaluation and Emergency Response has an interest, has investigated or may investigate under Hawaii Revised Statutes.

There are no State-recognized hazardous waste sites within a mile of the subject property.

3.3.2 State of Hawaii Landfill Sites

The state list of Solid Waste Facilities and Landfill Sites contains an inventory of solid waste disposal facilities or landfills in the state. These facilities may be active or inactive or open dumps that failed to meet RCRA criteria for proper solid waste landfills.

There are no state recognized landfills or disposal sites within a half of a mile of the harbor properties.

3.3.3 State of Hawaii UST List

This list of registered underground storage tanks is administered by the State of Hawaii UST division. All tanks that are registered as required by the federal RCRA regulations are contained on this list. The database also includes the number and types of tanks registered, the regulatory status of the tanks, and whether they have been removed and closed according to state law.

There were two underground storage tank sites listed in the State of Hawaii list of registered USTs located within a quarter of a mile of the site.

Facility / Location	No. and Types of USTs	Regulatory Status
Young Brothers, Ltd. Kawaihae Wharf Approach Rd.	1 - 600 gallon gasoline tank installed 1966	Tank was taken permanently out of use. No information on the closure and removal was available.
Kawaihae Service Akoni-Pule St.	3 - 3000 gallon tanks, gas and diesel	All tanks are permanently out of use. Remedial action is pending due to soil contamination detected during closure.

3.3.4 State of Hawaii Leaking UST List

The state Department of Health Underground Storage Tank Division records the location and regulatory status of all sites in which leaking underground storage tanks have been identified. There was only one leaking underground storage tank site identified within a half of a mile of the subject property. Information on this site was reviewed from the Department of Health files to determine the current status of the site clean up activities. The results of this records review are summarized on the following table.

Facility Location	Records Searched	Status of Site
Kawaihae Service (corner of Kawaihae Wharf Rd and Akoni-Pule Rd.)	Leaking Underground Storage Tanks (LUST)	In 1980, a leak in one of the fuel tanks was detected and the tank was replaced. In 1998, during removal of tanks, a release was identified and reported. In 1999, the DOH required additional clean up of the site and no record of the clean up activities was found.

3.4 *Historical Use of Property*

The following information was reviewed pertaining to the historical uses of the harbors properties and the surrounding area.

3.4.1 Aerial Photographs

Aerial photographs obtained from the R. M. Towill Corporation Photogrammetry Department for the property from the years 1949, 1966, 1977, and 1990 and examined for evidence of previous site usage.

In the 1949 photograph, the harbor site is mostly undeveloped. Only a few small houses are present on the photograph. The town of Kawaihae has approximately 20 structures, and the harbor site has about 5 houses. No industrial or commercial uses of the harbor property are evident in this photo.

In the 1966 photo, the harbor operations have been developed. The harbor is cleared and the "coral flats" area over the ocean has been filled in with the harbor dredgings. The entire property from the highway to the piers is filled in with the coral dredgings. The harbor appears to be developed primarily for sugar loading and storage and petroleum handling. Large structures were constructed for the handling and loading of sugar products. Several large aboveground storage tanks are present on the north end of the site. While some of these tanks appear to be for the storage of molasses, some also appear be used for petroleum products. The small boat harbor on the north end of the site has been built, but the small boat harbor on the south end of the property has not yet been developed. The small fisheries area currently present within the harbor at the delta of a small drainage was not built at the time of this photo.

In the 1977 photo, the harbor operations have expanded onto previously undeveloped areas of the property. A new set of petroleum aboveground storage tanks is present in the middle of the property at the present Akana Petroleum site. The coral flats area has been expanded a little since the 1966 photo and a coral mining operation is underway to remove some of the coral piled on the site. The fisheries area of the harbor has been formed with the coral dredgings.

In the 1990 photo, both the inter-island and the international shipping areas of the harbor have been constructed, and there is a considerable amount of container storage on the site. The current site of the small boat harbor on the south side of the harbor property has not yet been developed at the time of the photo. No additional fuel storage facilities have been constructed from the 1977 photo. Much of the site appears as it does today with respect to the major uses of the property. The military landing site is present in this photo, however no permanent land based structures are visible on the military property.

3.4.2 Historical Use Information

The historical use of the Kawaihae Harbor property was documented through a review of several books, files, and reports, and the inspection of several historical photographs. The references used are listed in Section 7.0.

The harbor property was developed in the early 1960's to address the need for commercial shipping access to the western side of the island of Hawaii. The eastern portions of the island were served by the Port of Hilo for many years, but new development in the Kona and Kohala Districts prompted the need for another harbor on the leeward side. The 1950 Rivers and Harbors Act authorized the construction of the Kawaihae Harbor by the US Army Corps of Engineers. Construction was completed in 1962.

In 1969 - 70, the USACOE undertook Project Tugboat to build a small boat harbor immediately to the south of the harbor. The project was performed by the Nuclear Cratering Group involving the use of chemical explosives and ammonium nitrate, to create a row crater to excavate the harbor and entrance to the facility. This phase of the project was completed in late 1970 after clearing the harbor areas and constructing an 850-foot breakwater to shelter the harbor basin. One history of the site referred to the use of nuclear weapons during this operation. Further discussions and research found that only chemical explosives were used.

Direct barge service to Kawaihae began in 1982. Also in that year, the channel and turning basin were deepened to a depth of 40 - 53 feet. In 1983, a 2,400 square foot shed was built for the storage of perishable farm products awaiting barge shipments. In the fall of 1986, an inter-island container company began operation. In 1992, a half acre of cargo handling yard was added to the overseas cargo area, and 1 acre of the container yard was paved for inter-island cargo.

Also in 1992, there was a 550 foot extension of the overseas pier along with dredging to increase the draft in front of the facility, construction of a 38-foot extension of the marginal wharf, demolition of the existing dock, and the construction of a new 40-foot loading dock and two dinghy storage racks.

4.0 SITE RECONNAISSANCE

4.1 *Site Inspection*

On August 10, 2000, David Gerow of RMTC visited the Kawaihae Harbor to assist in the identification of the presence or potential for presence of any adverse environmental conditions on the property. This inspection also included an interview with the Marine Cargo Specialist at the site, Henry Pasco (see Section 4.2). Mr. Pasco is a long time employee of the Harbors Division at this location.

A visual inspection of the Kawaihae Harbor property did not reveal any visible signs of surface contamination, except for areas near above ground storage tanks at the Akana Bulk Fuel Facility. There were areas that appeared to be stained with oil or other petroleum products. This area is largely contained with a concrete berm and is not anticipated to contribute to the surface contamination of other areas of the property. No information was available on whether the site is lined to prevent contamination of ground water.

Other conditions noted during the site visit that may represent environmental concerns include:

- A total of approximately 15 aboveground petroleum storage tanks are located on lands leased from the State of Hawaii Department of Transportation Harbors Division by oil and gasoline distributors. Several of these tanks were situated in concrete bermed areas to collect any spilled product on the ground. Due to the age of several of the petroleum facilities, it is possible that leaks and spills of the petroleum product may have contaminated the soils under the tanks or the groundwater in the area. Some of the tanks and facilities have been upgraded to current standards. An additional review of the status of these facilities may be required to fully assess the potential liability of the operation of these facilities.

- The Akana Petroleum Facility takes gasoline from the Hilo Port facility and blends it into different grades of gasoline. There were oil stains on the surface soils within this compound.

- There are several petroleum pipelines running from the piers to the petroleum storage tanks. These pipelines were not visible at the time of the inspection and have the potential to have leaked and caused soil and ground water contamination.

- The gasoline station at the corner of Akone-Pule Road and Kawaihae Road is immediately adjacent to harbor properties. A release of petroleum was reported for this site and a clean up has not been completed. There is a possibility that this contamination has migrated onto harbor property.

4.2 *Interviews*

On August 10, an interview with the Marine Cargo Specialist at the harbor, Mr. Pasco was performed. During that interview Mr. Pasco was asked about his knowledge of any environmental incidents or conditions on the property. Mr. Pasco has been employed at the port for a number of years, but he was unaware of any spills, leaks or other incidents. He was asked if he was aware of the use of nuclear explosives during the excavation of the small boat harbor and he was unaware of any such program. The Operation Tug Boat work was done prior to his starting work at the harbor.

5.0 FINDINGS AND CONCLUSIONS

RMTC has performed a Phase I Environmental Site Assessment in conformance with the scope and limitations of ASTM Standard E 1527-00 for the property identified as TMK # (1)-1-6-15:6. This assessment has revealed the presence of several conditions that may present significant environmental liability to the property owners and operators and may affect the manner in which future development of the site may occur. The significant findings of this report include:

- Several of the harbor properties have been leased to facilities that store, transport by pipeline, and distribute petroleum products. These facilities include the Tosco Terminal and the Akana Petroleum, Inc. sites. Both of these sites have large above ground storage tanks with a significant amount of fuel storage. While there are no records of releases at either of these sites, surface staining was noted at the Akana site during the site inspection. Excavation work that may be undertaken in the area of these tanks should be performed with due precautions for worker and environmental protection.

- The petroleum storage facilities mentioned also are connected to the piers with sub-surface piping systems that carry the product from the ships to the tanks. No evidence of any sub-surface investigations was found to determine whether any leaks have occurred from these piping systems. Prior to any excavations in the area of these pipelines, additional investigation activities may be required to identify whether soil contamination will be encountered.

- The Kawaihae Service station located at the corner of the Kawaihae Rd. and Akoni-Pule Road had a release of petroleum identified during the removal of an underground storage tank. While the State of Hawaii Department of Health has requested that the contamination be characterized and remediated, no record of this work being performed was found. The possibility exists that this contamination has migrated onto harbor property.

- Buildings materials used to construct the structures on the site may contain lead-based paint and asbestos. No samples were taken during this assessment to verify the presence of either of these contaminants. If buildings are to be demolished, samples should be

taken to identify the presence of lead and asbestos. If present, proper precautions should be taken to mitigate worker exposures and environmental impacts from these materials.

No other environmental conditions were observed at the subject property or noted during the records review for this site.

6.0 SIGNATURES

The Phase I Environmental Site Assessment was performed by Mr. David Gerow of R. M. Towill Corporation.

David Gerow 11/14/00

David Gerow, CIH, CSP Date

7.0 REFERENCES

Experian, *State of Hawaii Realty Directory, 31th Edition* (1997).

Foote, Donald; Hill, Elmer; Nakamura, Sakuichi; Stephens, Floyd; *Soil Survey of the Islands of Hawaii, State of Hawaii* (August 1972).

State of Hawaii DOH, *LUST Database* (July 7, 2000).

State of Hawaii DOH, *UST Database* (July 7, 2000).

State of Hawaii DOH, *Permitted Landfills in the State of Hawaii* (May 2, 2000).

U.S. Environmental Protection Agency (EPA), *CERCLIS* (May 31, 2000).

U.S. EPA, *Emergency Response Notification System Database* (May 16, 2000).

U.S. EPA, *National Priority List* (August 21, 2000).

U.S. EPA, *RCRIS* (June 19, 2000).

U.S. Army Engineer District, Honolulu, *Final Environmental Assessment for Kawaihae Harbor for Light-Draft Vessels*, Hawaii, Hawaii, (December 7,1994).

State of Hawaii, Department of Transportation, Harbors Division, *Hawaii Commercial Harbors, 2020 Master Plan*, August 1998.

Thompson, Erwin, *Pacific Ocean Engineers: History of the US Army of Engineers in the Pacific, 1905 - 1980*, pages 254 and 255.

Federal Emergency Management Agency, National Flood Insurance Map: Panel137 for Hawaii County, Hawaii, Revised May 3, 1982.

DOCUMENT CAPTURED AS RECEIVED

APPENDIX A

FIGURES

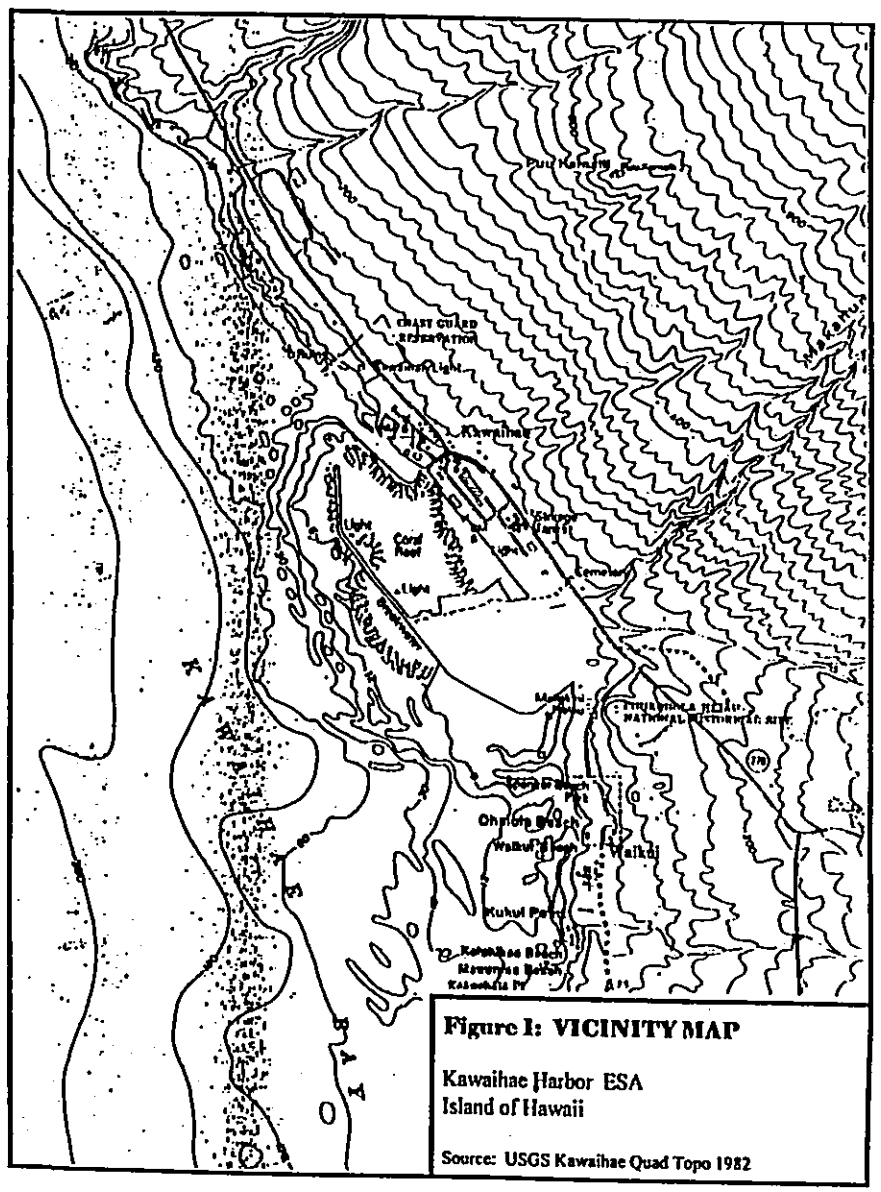
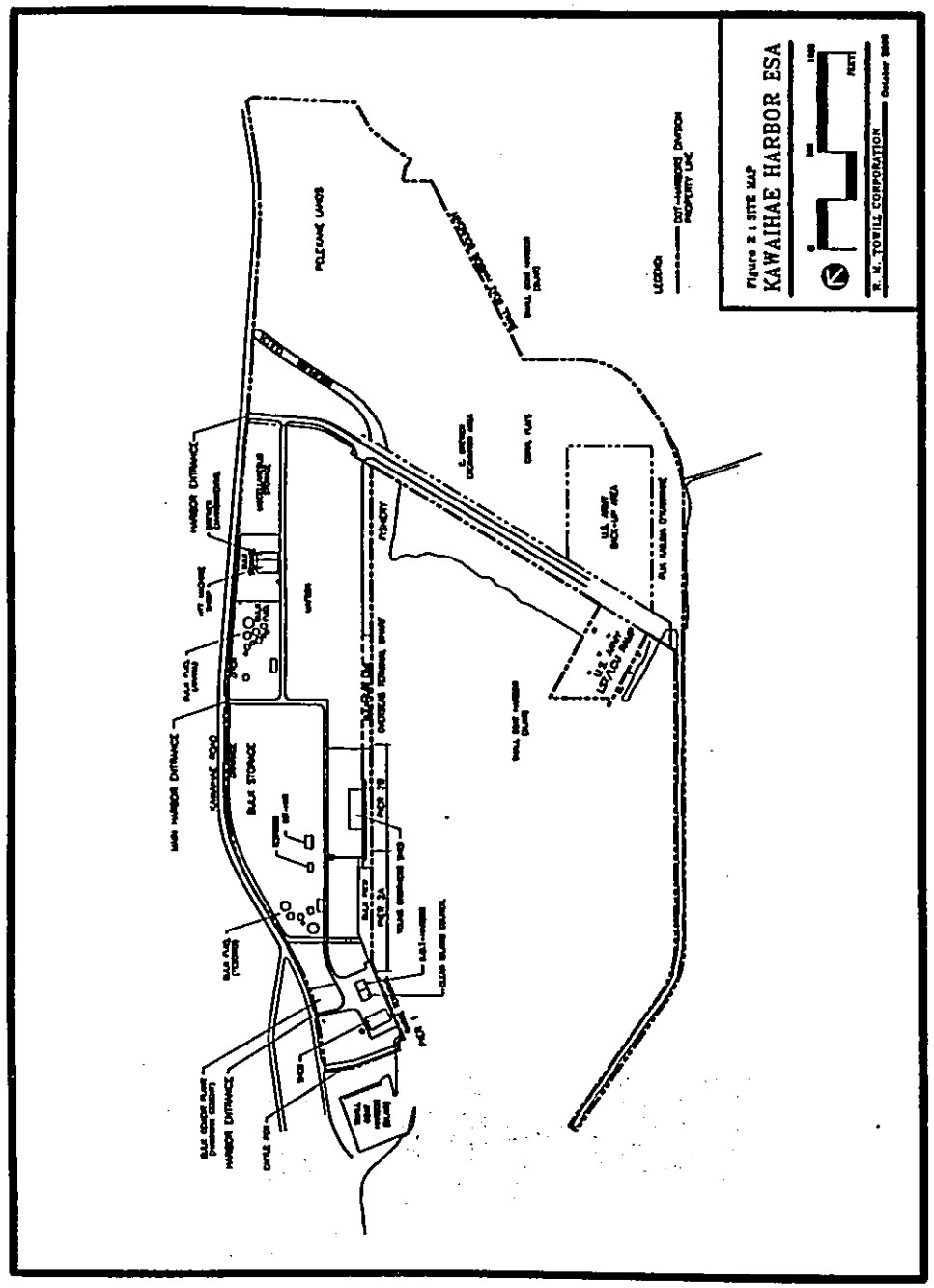


Figure 1: VICINITY MAP

Kawaihae Harbor ESA
Island of Hawaii

Source: USGS Kawaihae Quad Topo 1982



APPENDIX B

PHOTODOCUMENTATION

DOCUMENT CAPTURED AS RECEIVED

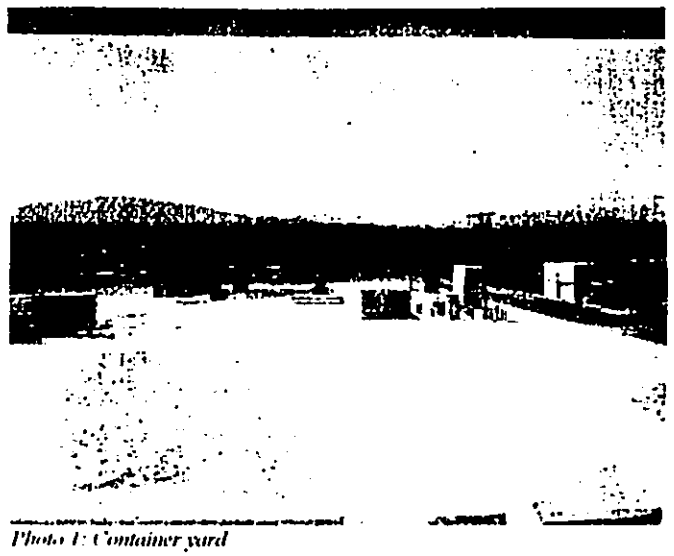


Photo 1: Container yard

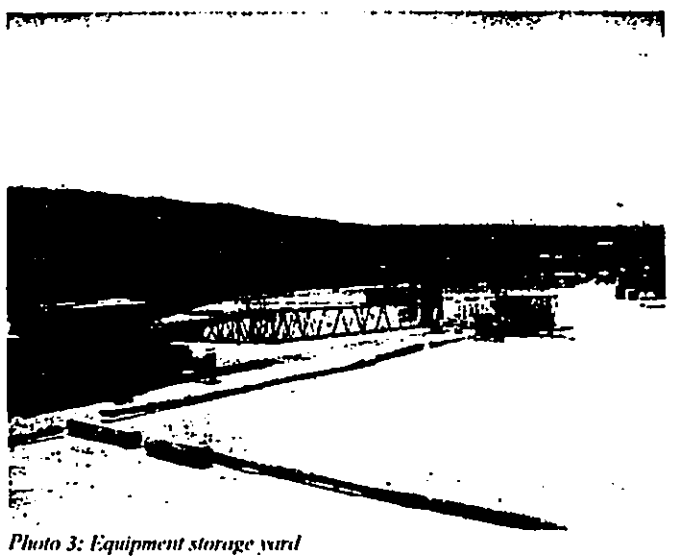


Photo 3: Equipment storage yard

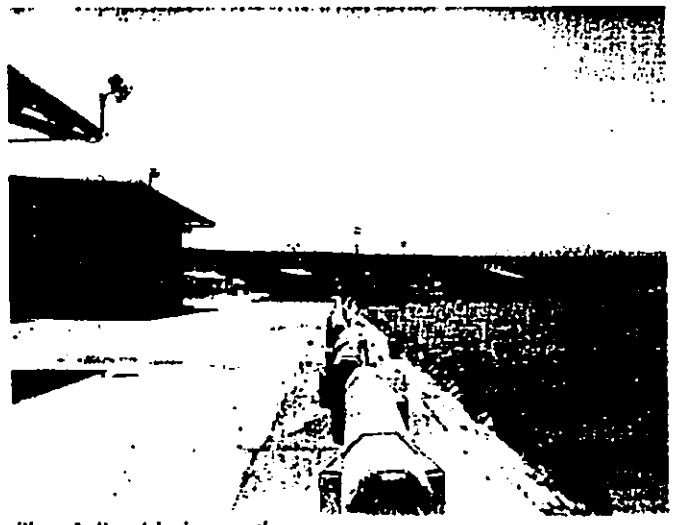


Photo 2: Pier 1 looking south

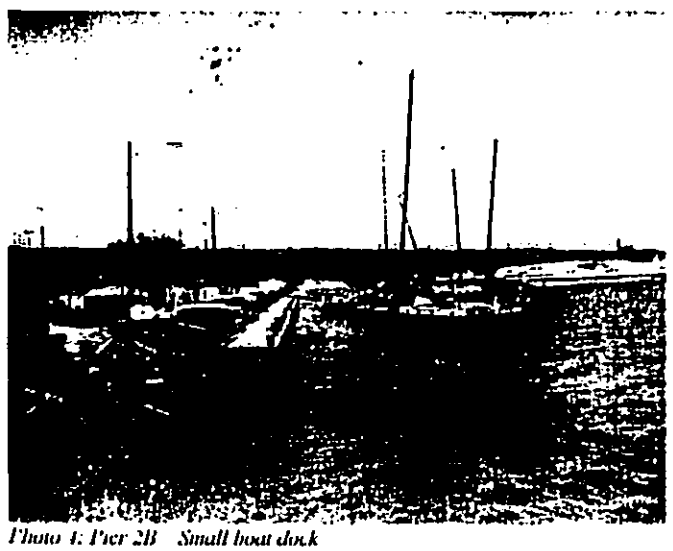


Photo 4: Pier 2B Small boat dock

DOCUMENT CAPTURED AS RECEIVED

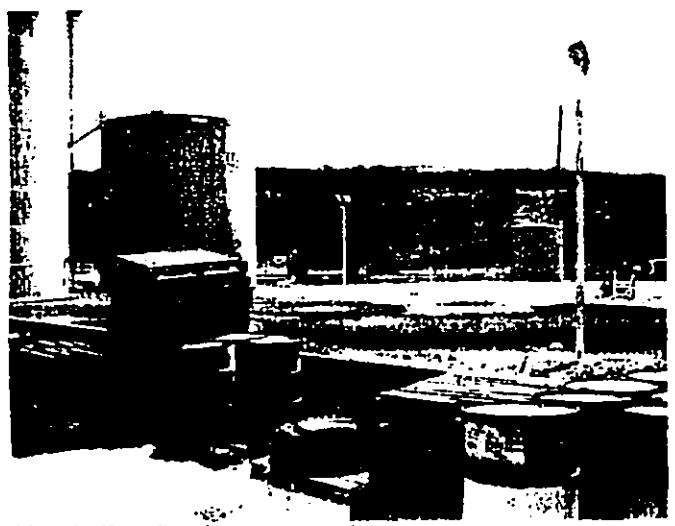


Photo 5: Akana Petroleum storage tanks

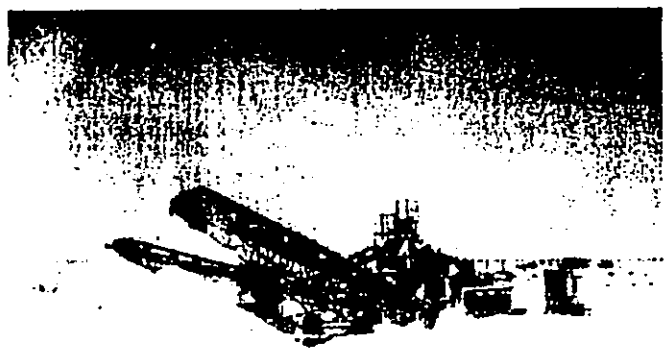


Photo 6: Brewer coral rock excavation site

Appendix H

ARCHAEOLOGICAL INVENTORY SURVEY
HILO HARBOR FACILITIES EXPANSION

Haun & Associates

October 2000

Report 009-090100

ARCHAEOLOGICAL INVENTORY SURVEY
HILO HARBOR FACILITIES EXPANSION
TMK: 3-2-1-09: 2, 12, 41, 42
AND TMK: 3-2-1-07: 20-37
LAND OF WAIAKEA, SOUTH HILO DISTRICT
ISLAND OF HAWAII

October 2000

Haun & Associates

Archaeological, Cultural, and Historical Resource Management Services
HCR 1 Box 4730, Keaau, Hawaii 96749 Phone: 982-7755 Fax: 982-6343

ARCHAEOLOGICAL INVENTORY SURVEY

HILO HARBOR FACILITIES EXPANSION

TMK: 3-2-1-09: 2, 12, 41, 42 AND TMK: 3-2-1-07: 20-37

LAND OF WAIAKEA, SOUTH HILO DISTRICT

ISLAND OF HAWAII

By:

Alan E. Haun, Ph.D.

and

Dave Henry, B.S.

Prepared for:

R.M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96821

October 2000

Haun & Associates

Archaeological, Cultural, and Historical Resource Management Services
HCR 1 Box 4730, Keaau, Hawaii 96749 Phone: 982-7755 Fax: 982-6343

SUMMARY

At the request of R.M. Towill Corporation, Haun & Associates conducted an archaeological inventory of two parcels: (a) a 14-acre-parcel (TMK: 3-2-1-09: 2, 12, 41, 42) and (b) a 6-acre parcel (TMK: 3-2-1-7: 20-37) at Hilo Harbor, in the Land of Waiakea, South Hilo District, Island of Hawaii. The objective of the survey was to satisfy historic preservation regulatory review inventory requirements of the Department of Land and Natural Resources-Historic Preservation Division (DLNR-HPD), as contained within Hawaii Administrative Rules, Title 13, DLNR, Subtitle 6, State Historic Preservation Rules.

Both parcels have been extensively altered by 1900s mechanical clearing and development. No prehistoric archaeological sites were identified. The eastern project parcel contains a recent asphalt pavement and the western project parcel contains a complex of historic structural remains. The remains, designated Site 22486, probably are the remnants of a U.S. Engineer facility dating to between 1908 and the 1910s.

Site 22846 is assessed as solely significant under Criterion "d". The site has yielded information important for understanding historic land use in project area. The mapping, written descriptions, and photography at the site adequately documents it and no further work or preservation is recommended.

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS (cont.)

TABLES

INTRODUCTION

This report presents the results of an archaeological inventory survey conducted at two parcels in Hilo Harbor (TMK: 3-2-1-09:2, 12, 41, 42, and TMK: 3-2-1-07:20-37), Land of Waiakea, South Hilo District, Island of Hawaii (*Figure 1*). The objective of the survey was to satisfy current historic preservation regulatory review inventory requirements of the Department of Land and Natural Resources-Historic Preservation Division (DLNR-HPD), as contained within Hawaii Administrative Rules, Title 13, DLNR, Subtitle 6, State Historic Preservation Rules (DLNR 1998).

The survey fieldwork was conducted on September 1, 2000. Described in this final report are the project scope of work, field methods, and survey findings. Also included is background information relevant to the project area, and significance assessments of the sites with recommended further treatments.

Scope Of Work

Based on DLNR-HPD rules for inventory surveys the following specific tasks were determined to constitute an appropriate scope of work for the project:

1. Conduct background review and research of existing archaeological and historical documentary literature relating to the project area and its immediate vicinity--including examination of Land Commission Awards, *ahupua'a* records, historic maps, archival materials, archaeological reports, and other historical sources;
2. Conduct a high intensity, 100% pedestrian survey coverage of the project area;
3. Conduct detailed recording of all potentially significant sites including scale plan drawings, written descriptions, and photographs, as appropriate;
4. Conduct limited subsurface testing (manual excavation) at selected sites (a) to determine the presence or absence of potentially significant buried cultural deposits or features, and (b) to obtain suitable samples for radiocarbon age determination analyses;
5. Analyze background research and field data; and
6. Prepare and submit Final Report.

Project Area Description

The current project consisted of the examination of two parcels totaling approximately 20-acres, located at Hilo Harbor. The parcels are referenced as the East and West Project Areas in this report. Rainfall in this area is c. 150 inches per year with an annual temperature range from 74 to 80 degrees (Juvik and Juvik 1998).

The East Project Area is a c. 14-acre parcel located on the eastern side of the Naval Reserve Electronic Facility. This portion of the project area is bounded by Kalanianaole Avenue on the south, by an unpaved road on the east and northeast, by the harbor and the Hilo Breakwater on the north and northwest, and by other harbor facilities on the west. Approximately 58% or 8.1-acres of the East Project Area has been mechanically altered. A 2.66-acre lot within this parcel is occupied by the Aloha Petroleum Company and a 2.6-acre lot to the northwest is occupied by large tanks and several buildings. The entire ground surface in these areas has been leveled and paved with crushed gravel where tanks or buildings are not present.

DOCUMENT CAPTURED AS RECEIVED

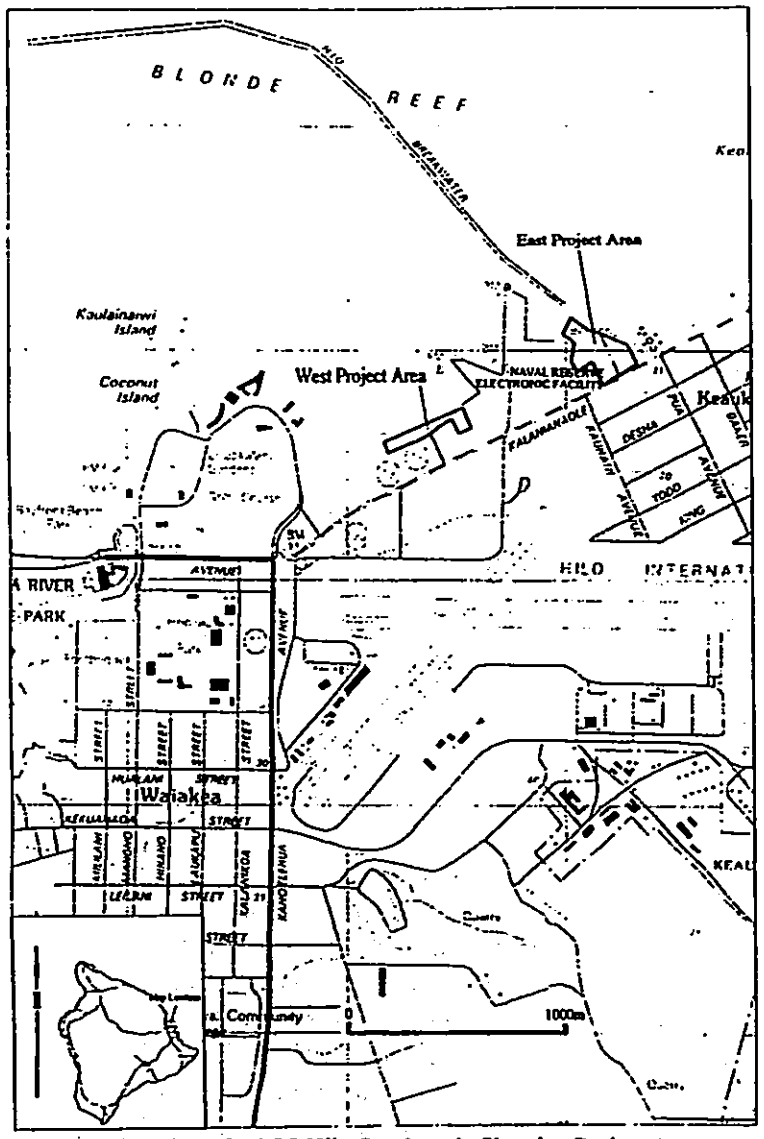


Figure 1. Portion of USGS Hilo Quadrangle Showing Project Areas

The remaining 2.84-acres of the disturbed area has apparently been bulldozed (*Figure 2*). The ground surface in this area is also level, though it is currently not in use. Several piles of gravel, boulders, and debris are located in this area. An asphalt pavement with an adjoining driveway, discussed in the Findings Section of this report, is also located within the disturbed area. The vegetation in this area consists of tall grasses and ferns, with scattered false koa (*koa-haole – Leucaena leucocephala* [Lam.] de Wit), papaya (*he'i, milikana, papala – Carica papaya* L.), small mango trees (*manako - Mangifera indica* L.), ironwood trees (*Casuarina equisetifolia* L.), and hibiscus (*aloalo - Hibiscus*. Spp.).

The remaining 42% or 5.9-acres within the East Project Area is occupied by a series residential structures consisting of wooden and plastic tarp shelters (*Figure 3*). There are approximately 12 shelters within this portion of the project area, and additional ones are located adjacent to the project area to the east. Several of the structures are constructed on stone foundations that appear to be modern. Large amounts of trash and debris are scattered throughout this portion of the East Project Area.

The terrain in this portion of the East Project Area is uneven and irregular, consisting of Keaukaha extremely rocky muck (6-20% slopes). This soil series is characterized by either pahoehoe outcrops occupying at least 25% of the surface, or a thin layer of very dark brown muck over lava bedrock (Sato et al. 1973). Vegetation in this area is comprised of large mango trees, guava (*kuawa – Psidium guajava* L.), coconut (*Cocos nuciferia*), taro (*kalo – Colocasia esculenta* [L]) Schott), plumeria (*Plumeria acuminata* Ait.), pandanus (*hala – Pandanus odoeatissimus* L. f.), and dense vines and ferns.

The West Project Area is a c. 6-acre parcel situated on the western side of the harbor facilities. The parcel is bounded on the south by Ocean View Drive, on the north by Kuhio Bay, on the east by a chain link fence, and on the west by an undeveloped lot. The western two-thirds of this area is occupied by leasehold house lots (*Figure 4*). There are 22 lots in this area, and all except one have a residence on them.

The remaining portion of this area consists of a densely vegetated tract that measures c.2-acres in size (*Figure 5*). A concrete slab complex, discussed in a following section, is located in this area. The area is relatively level and was likely once bulldozed. Numerous bulldozed piles of soil and rock are scattered throughout the area. Modern trash and debris is also present. The soil in this area is also the Keaukaha extremely rock muck, though fewer exposed outcrops are present. Vegetation consists of a large banyan tree (*Ficus benghalensis* L.), coconut, hibiscus, mango, pandanus and vines.

Field Methods

The undeveloped portions of the project area were subjected to 100% surface examination with surveyors paced at 10 to 15 m intervals depending on vegetation density. In the East Project Area, the transects were oriented in a roughly northwest/southeast direction, and in the West Project Area, they were oriented east-northeast by west-southwest. The remaining portions of the survey areas were examined by surveyors walking the perimeters of the developed areas.

Sites were flagged with pink and blue flagging tape and their locations plotted on a scaled project area map. The sites were recorded in detail, which consisted of preparing scaled plan maps, the completion of standardized site/feature forms and photographic documentation. No subsurface testing was undertaken during the current study because the ground surface consists of lava bedrock. Where soil is present, it is either imported fill or only a few centimeters of organic muck. Extensive ground-altering disturbance is evident throughout both project parcels.

DOCUMENT CAPTURED AS RECEIVED

Figure 2. East Project Area - Secondary Vegetation, View to South

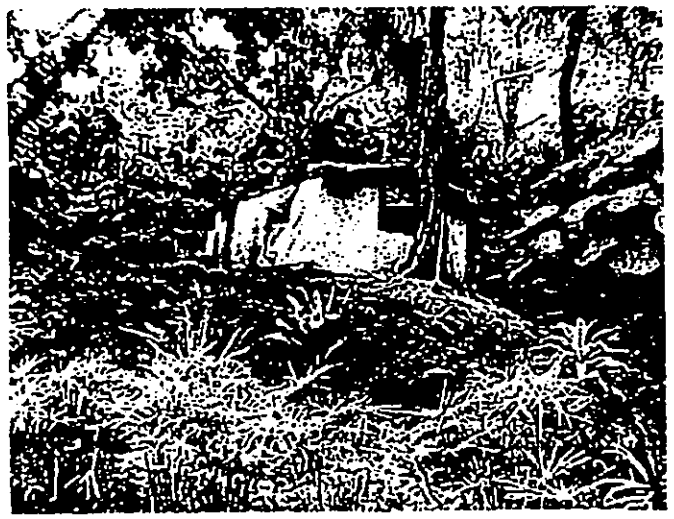


Figure 3. East Project Area - Temporary Shelter and Vegetation, View to West

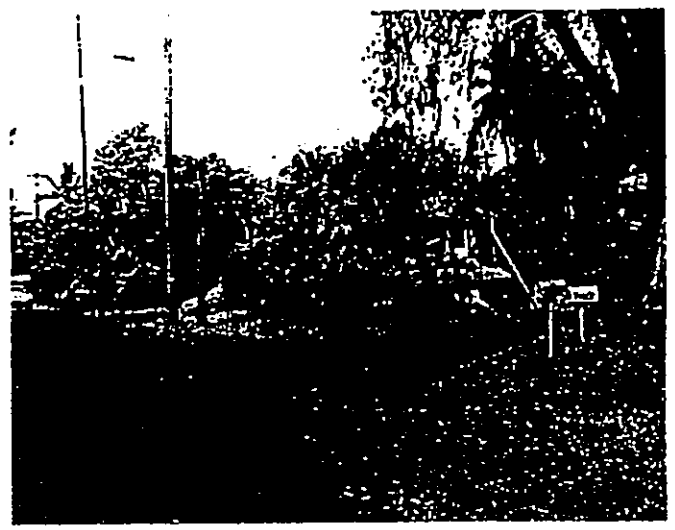


Figure 4. West Project Area - Developed Portion, View to West-Southwest

Figure 5. West Project Area - Undeveloped Portion, View to Northeast

DOCUMENT CAPTURED AS RECEIVED

ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

Historical Documentary Research

Archival research was conducted at the University of Hawaii-Hilo Hawaiian Collection, the Land Survey Office and the Archives Division of the Hawaii Department of Accounting and General Services, DLNR-HPD files, and the Hawaii State Public Libraries in Honolulu and Hilo.

The project area is situated in the *ahupua'a* of Waiakea in South Hilo District. The *ahupua'a* is one of the largest in the district covering over 95,000 acres. The *ahupua'a* extends along the coast from the west side of Hilo Bay to the Puna District boundary and inland to approximately 6,000 ft elevation. Much of the following is summarized from *Hilo Bay: A Chronological History* (Kelly et al. 1981), an extensive and thorough compendium of historical information about Hilo including Waiakea.

Hawaiian traditional and legendary accounts attest to the longstanding importance of Waiakea. The chief of the Hilo region, Kulukulu'a, who resided in Waiakea, was the first conquest of 'Umi-a-Liloa in his campaign to unify the districts of Hawaii Island. Hilo with its large bay, fishponds, wet taro fields, and abundant freshwater was a population center for commoners and royalty. Kamehameha I and his court resided in Hilo in the 1890s. In preparation for his planned invasion of Kauai in 1802, Kamehameha built a canoe fleet at Hilo, reportedly consisting of 800 vessels. Kamehameha gave his favorite wife, Ka'ahumanu, the *ili kupono* of Pi'opi'o in Waiakea

Early historic accounts also document the importance of Hilo. In 1823, Ellis estimated the population to be 2,000 people in 400 houses. Ellis described the extensive use of *lauhala* thatch in house construction in Hilo. Lauhala was gathered from eastern Waiakea beyond the Wailoa River. He described the land as intensively cultivated with plantains, bananas, sugar cane, taro, potatoes, melons, coconuts, and breadfruit. Wet taro was grown in mounds (*kipi*) in marshlands. Hilo was a center for trade between the people of Ka'u, Hamakua, and Hilo. Between the 1790s and 1820s, sandalwood was cut and brought to Hilo for export. *Pulu* and *pia* (arrowroot) were also exported. Ellis also describes coastal fishing.

In 1824, a missionary station was established in Waiakea. Soon after, churches and schools were established. Whaler's began stopping at Hilo in the mid-1820s. In the 1830s, a sawmill was built, and two stores were opened. By the end of the decade, a sugar cane plantation and mill were established on Ponahawai lands. In 1840, the Wilkes Expedition arrived in Hilo and constructed an observatory on Waiakea Point on the east side of Hilo Bay.

The Waihona 'Aina database (2000) lists 51 parcels claimed by 37 claimants within Waiakea in the mid-1800s (*Table 1*). All claims are for parcels situated southwest of the project area at the coast and immediately inland along the lower reaches of the Wailoa River less than 0.5 mi inland. Twenty-six parcels were awarded to 24 claimants. Chiefess Kamamulu was awarded the entire *ili* of Pi'opi'o under Land Commission Award (LCA) No. 7713 (*Figure 6*). The remaining claims are for *kuleana* parcels ranging from 0.24 to 13.14 acres in area with an average of 3.6 acres. All, except five claims, were for single parcels. The testimonies for several awarded *kuleana* include claims for parcels that were not awarded.

The claim testimonies refer to 18 *ili* land divisions. Five *ili*; Kalonoho,, Alenoho, Kolea, Pi'opi'o and Paeaahu; are mentioned two or more times and apparently were linear strips of land extending inland from the coast. *Ili* Kalonoho was situated next to the western *ahupua'a* boundary with Kukuau. Alenoho was the next *ili* to the east followed by Kolea, Pi'opi'o and Paeaahu. The latter two *ili* bordered the west bank of Wailoa River and Fishpond. Six *ili* for LCAs on the east side of the river, from the river mouth inland, consist of Kamakola, Keawe Kapu, Kialoa, Hinaauauwai, Puahua, and Kanahana. Kalihi was situated inland between Alenoho and Kolea. The geographic location of the remaining *ili* cannot be determined because they are mentioned in testimony for claims that were not awarded.

Table 1. Land Commission Award Claims

LCA	Claimant	Apana claimed	Apana awarded	Section	Ili	Land Use	Boundary North	Boundary East	Boundary South	Boundary West	Date Rec'd	Giver	Acreage	Comment
1E	Mahoe	1	1		Kaawe Kapu	cultivated	Konohiki's waste land	Mikanieki	Kaloaa	Kaoea		Konohiki Pae	.4 46	
1F	Kapu	1	1		N/D	cultivated, partly fenced	Kaula	Kamanuhaku	Konohiki's waste land	Kalae		Parents	1 6	
1198	Kahenui	1	0		N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	
2100	Kahaupuni	1	0		Alenoho	house lot	N/D	N/D	N/D	N/D	N/D	N/D	N/D	
1106	Haar (John Taylor)	1	0		Kolea	cultivated	N/D	N/D	N/D	N/D	N/D	N/D		
1279	S. Kolena Hale	1	1		Kolea	planting plot	konohiki	ocean	Kahanauea	Kaihuyu's house	1847	Kapuaaiwa	0 6	
1333	Kololo	1	1		Alenoho	cultivated field	Waiaiu	Kahenui	Kaluakane	Kahue	1840	Kuaana	2.23	
1335	Kahaunanui	1	0		Alenoho	cultivated field	Kahumu	Maaa	Kaluna Stream	Kahue	1841	Kuaana	0	
1738	I. Kahuahiaua	1	1		Kamakola	cultivated with 6 houses	Ili Ohele	Powaka's field	Mikanieki	road beside river	1843	Konohiki Pae	2.98	
2274	Kapuaaiwai	1	0		Paeaahu	house lot with 2 houses, grove	waste land	road to Volcano	waste land	waste land	1847	Kaunaoa	0	
2281	John B. Kaana	1	1		Alenoho	house lot	Kaapa	new road	waste land	waste land	1847	Kapuaaiwa	10.25	
2327	Barnaba	1	1		Kalihi	partly enclosed with 5 houses	Ili Alenoho	Ili Kolea	Ili Kolea	stone wall/govt land	1841	Pae	12.25	Claimant was District I school supervisor
2338	Samuela	1	0		Kolealii	breadfruit trees, sweet potatoes, coffee	Kaahopu	Ili Kolealii	Ili Kalihi	Ili Alenoho	1847	Konohiki	0	
2402	Kaunahe	1	1		N/D	2 kihapai; hala grove	Kaiaau Ahupuaa's	konohiki	Kahue	konohiki	1844	Kai'oe	3	
2603	Napuahi	1	1		Kialoa I	house lot with 4 houses; breadfruit and kukui trees	konohiki	Ili Kinaauauwai	konohiki	Ili Kialoa 2	Kam. I time	parents	1 3	
2663	Kahue	1	1		N/D	N/D	Kaunahe	konohiki	konohiki	konohiki	1844	Kaana	3 73	
3872	Peke	1	0		Alenoho	2 cultivated fields	Aiko	stream	konohiki	main road	N/D	N/D	0	
3996B	Hinaahewa	1	0		N/D	uncultivated	konohiki	konohiki	konohiki	konohiki	1847	Kamahia	0	
4004	Hale	1	1		Hinaauauwai or Makaa auwai 3	4 kihapai, two houses	konohiki	Ili Hinaauauwai 1st	konohiki	Ili Kialoa/Kaholoaa	Kam. I time	parents	4 25	
4344	Asae	3	1		Kolea						Kam. I time	parents	1 22	Unclear which section
				1		house lot with 3 houses	Barnaba	Barnaba	Samuela	Kaopou				
				2		cultivated field	Barnaba	Samuela	Ili Waiali	Kahaholo				
				3		uncultivated with one house	Ili Walenoho	Pahulu	konohiki	Kapeiea				
4737B	Wahine	1	1		Kalonoho	cultivated with house	govt land	govt road	Moealoha	konohiki	Kam. I time	Makaeae	1 01	
4737	Moealoha	1	1		Kalonoho	3 field & 1 house	Kaaua	Alaaue	Barnaba	konohiki	1839	Alakapa	1 03	
4735	Nahu	1	1		Kanahana	3 wet taro plots & 3 houses	fishpond	Ili Kaahua	konohiki	Ili Kaapea	1834	Kaahopu	1 03	
5018	Kaawe	1	1		Puahua	2 cultivated fields	konohiki	Ili Kialoa	Nahu	Ili Hanahana	1841	Konohiki Pae	0 24	

Table 1. Land Commission Award Claims (cont.)

LCA	Claimant	Apana claimed	Apana awarded	Section	Ili	Land Use	Boundary North	Boundary East	Boundary South	Boundary West	Date Rec'd	Giver	Acreage	Comment
5157	Kaahopu	6	2		Pigupo								12.14	Awarded 2 apana
				1		4 cultivated lokepa & 2 houses	Kalea	Kaihewe	Nnihau	Kalea				
				2		1 cultivated lokepa	Kaiwaono's garden	Kaaana	Kaihe	Kaihewe				
				3		1 lokepa taro mounds	Nnihau	Kane	N/D	N/D				
				4		6 taro mounds	Kane	konohiki	Kaubi	Kaawo				
				5		uncultivated	idle land	idle land	Samuela	Ili Alenobo				
				6		2 cultivated fields	Kabaleiaiu	idle land	Samuela	Kaihewe				
7713	Kamamalu	1	1		Pioplo	N/D	N/D	N/D	N/D	N/D	N/D	Kamehameha I		Awarded entire ili
8081	Hewahewa	1	0		Kaleiumu	2 cultivated lokepa, road	konohiki	konohiki	konohiki	konohiki	1847	Kamahio	0	Awarded 1 parcel in Kaaro
8802	Kane	1	0		Olowalolo	pasture, cultivated plot, 2 houses	idle land	idle land	idle land	idle land	1843	Baranaba	0	
8803	Kamanohaku	1	1		Pigupo	3 fields	Kaahopu	Lae	fishpond	Kaubi	1843	mother	1.02	
8811	Kiliop	1	0		Panlou	cultivated	idle land	N/D	N/D	idle land	1846	father	0	
8854	Kalea	4	1		Pigupo						Kam. II time	parents	1.4	
				1		house lot	Kaulu	Kamanohaku	fishpond	Kaubi				
				2		cultivated	konohiki	konohiki	Kaihewe	cart road				
				3		3 cultivated fields	Kaahopu	Kaulu	Hoomaru	Kaahopu				
				4		1 cultivated field	Hinanui	Kaahopu	konohiki	Nnihau				
8868	Kapaakiha	1	0		Pula	formerly	N/D	N/D	N/D	N/D	N/D	N/D	0	
9982	Lae	4	1		Paeaiho 1 & 2						N/D	Wahinapohakilo	0.8	Unclear which parcel awarded
				1		uncultivated	Kane	Nnihau	Kamahiai	Maaolaku				
				2		partly cultivated	Apua	Nnihau	Kamakahio	Apua				
				3		partly cultivated	Apua	Nnihau	Kamahiai	Apua				
				4		uncultivated	Apua	konohiki	fishpond	Ili Pueo				
10004	Lahaikila	1	1		Paaaloa	3 fields & house	Kamahoi	konohiki	fishpond	Lae	Kalaiopua time	N/D	6.9	
11030N	Kaikanui	2	2		Kalea						1843	Kapapa	3.19	Awarded 2 apana
				1		house	Halai	sea	Baranaba	konohiki				
				2		1 cultivated field & 1 house	Kaniumpu	konohiki	cart road	Baranaba				
11173	Wahineaiea	1	1		Alenobo	N/D	Kaaihe	Bogbry	konohiki	govt road	1834	Maalo	2.5	
11174	Kaaihe	1	1		Alenobo	N/D	Wahineaiea	road	Baranaba	Alenao Auwai	1834	Maalo	1	

source?

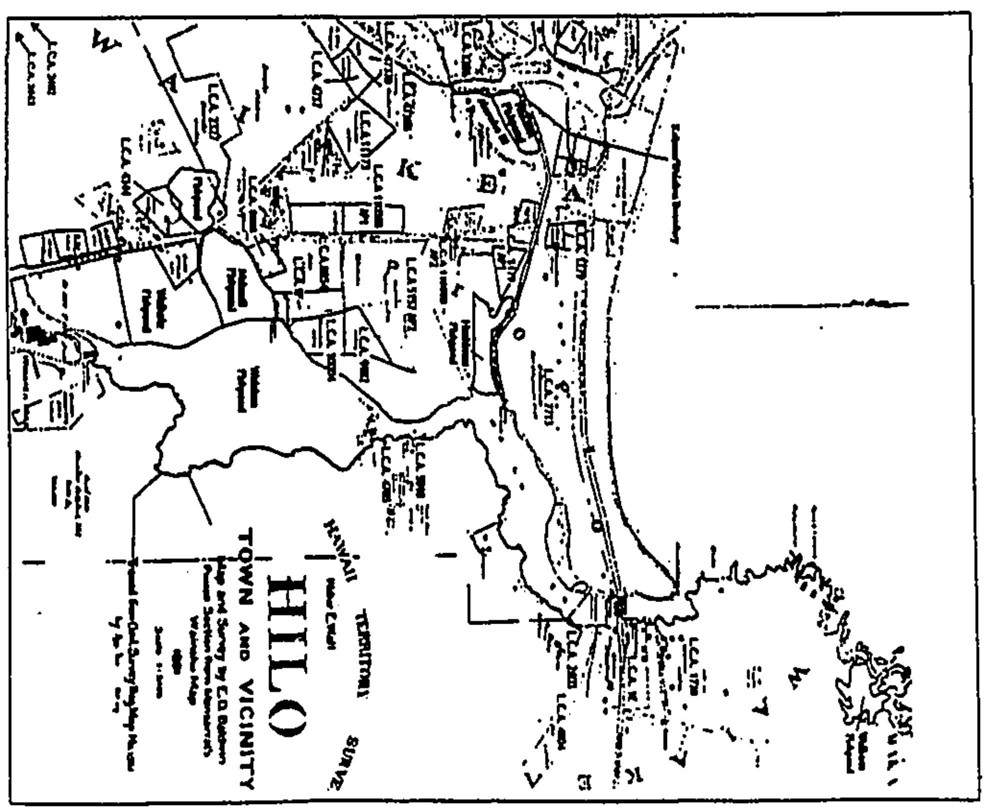


Figure 6. Portion of 1891 Map of Hilo (Modified from Kelly et al. 1981)

DOCUMENT CAPTURED AS RECEIVED

DOCUMENT CAPTURED AS RECEIVED

Land use described in the LCA claim testimony included agriculture, pasture, burial, and residence. Thirty-four houses are mentioned and LCA 2274 also describes the presence of a grave. Most of the claim testimony mentions cultivated fields. Crops include wet taro, sweet potatoes, breadfruit, coffee, and *kukui*. A hala (*Pandanus* spp.) grove and fishponds are also mentioned.

By 1857, there were three sugar cane mills in the Hilo area. Large tracts of land were put in the cane cultivation and cane was also grown by individuals around their houses. In 1861, a stone wharf was constructed at Waiakea landing on the west side of Waiakea Point. A sugar mill was established in Waiakea at the inland end of Waiakea Fishpond in the late 1870s. A railroad transport system was constructed for the Waiakea Mill between 1879 and 1880. By 1880, 1,400 acres of sugar cane were in cultivation and by the end of the decade over 5,600 acres were cultivated. In 1877, a 16 ft high tsunami struck the coast of Waiakea destroying all houses within 100 yards of the shore along with a wharf, storehouse, a quarantine hospital on Coconut Island, and a bridge. An 1882 map of Hilo Bay (*Figure 7*) shows a network of roads in Hilo Town situated on the west side of the lowlands adjacent to the Wailuku River.

Between the 1860s and 1880s there were two wharf facilities on the west side of Waiakea Point, one on the Wailoa River, and on the west side of the bay at the foot of Waianuenue Street. By the 1890s, the need for improved wharf facilities was recognized and the development of government harbor facilities began on the west side of Waiakea Point. A ship wharf was completed in 1899.

Between 1900 and the 1930s, the population of Hilo grew dramatically with the expansion of sugar cane cultivation, pineapple production, the timber industry, and other commercial developments. In the 1910s, the Hilo Railroad Company expanded the rail system to Puna and Hilo Town. A railroad wharf was built north of the mouth of the Wailoa River. Between 1909 and 1913, the railroad was extended to North Hilo and Hamakua Districts.

The pending opening of the Panama Canal and anticipated increase in trans-Pacific shipping lead to serious efforts to build a breakwater to protect shipping in Hilo Bay. Construction of the breakwater began in 1908. The breakwater was initially planned for a location just east of Coconut Island, but the plan was modified and the selected site was approximately 6,000 ft east of the island. The initial plans called for a 10,000 ft long breakwater along Blonde Reef. Stone for the structure was brought by railroad from quarries in Puna and Waiakea. The breakwater was completed in 1929. A 1912 map of Kuhio Bay (*Figure 8*) shows a large area of rock fill next to the breakwater. Railroad tracks extend on to the breakwater and rock fill. A U.S. Engineers Office quarters compound is present on shore to the west of the rock fill.

By the 1910s, the existing railroad and government wharf facilities were inadequate to support shipping. In 1912, the Territorial Government contracted the construction of a new wharf approximately one mile east of Coconut Island and the dredging of the adjacent portion of the bay. The new wharf, designated Kuhio Wharf was completed in 1916. From the beginning, the wharf was congested and plans for a second wharf were made. Construction of the wharf began in 1921 and it was completed in 1923. A third wharf was completed in 1927. *Figure 9* is a 1921 map of the harbor that depicts Kuhio Pier and the smaller Pier 2. Tracks of the Hawaii Consolidated Railroad extend from the piers along the coast to the west toward Hilo Town. A U.S. Naval Reservation and a U.S. Engineer Reservation occupy the shoreline next to the breakwater. *Figure 10* is a 1925 map showing the construction phases of the breakwater and *Figure 11* illustrates the dredged areas of Kuhio Bay.

In 1946, a tsunami struck Hilo Bay and extensively damaged the harbor facilities including the piers and breakwater. Reconstruction of the facilities was completed in 1948. *Figure 12* is a 1946 map of Hilo Harbor showing damage to the breakwater. Nine areas of damage are present. The map also shows a series of three circular structures, probably storage tanks and a square compound between the shoreline and the railroad tracks on the west side of Pier 3.

The shoreline to the west of the harbor facilities is known as Baker's Beach. The beach formed as a result of (a) harbor dredging between 1925 and 1930 and (b) reduced wave energy caused by the new breakwater (*Figure 13*). Today, there is very little sand present. According to a resident of the area, a man

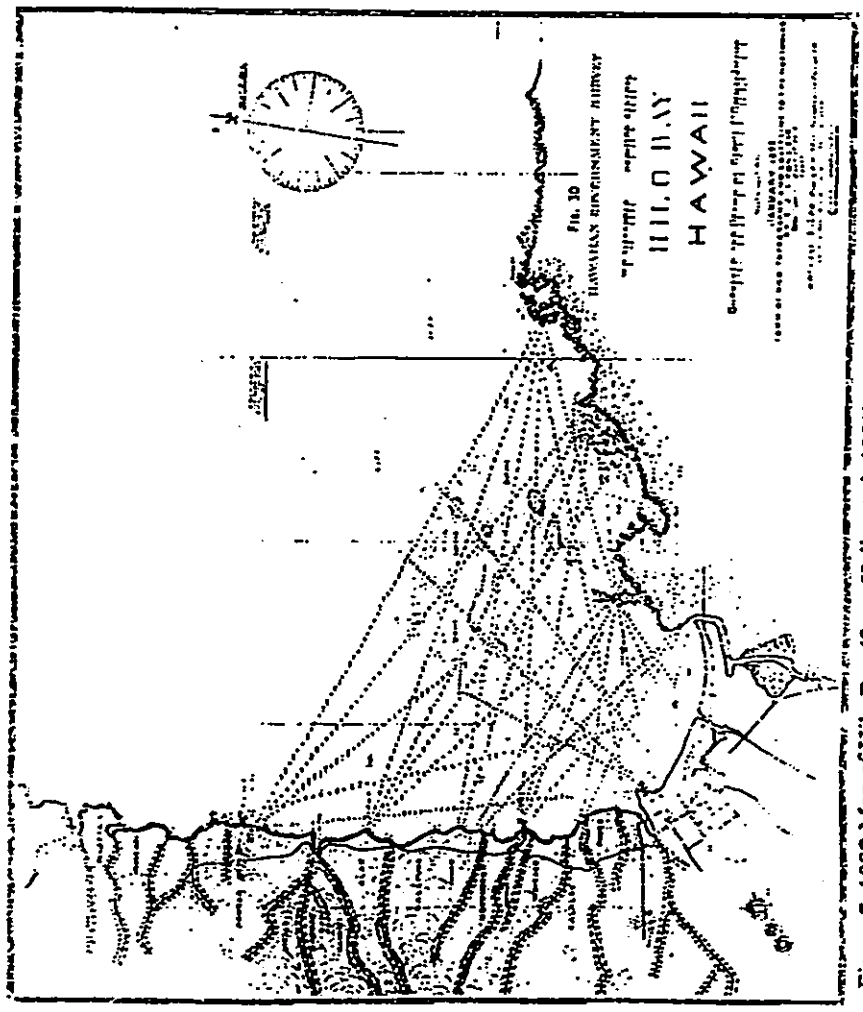


Figure 7. 1882 Map of Hilo Bay (from Kelly et al. 1981)

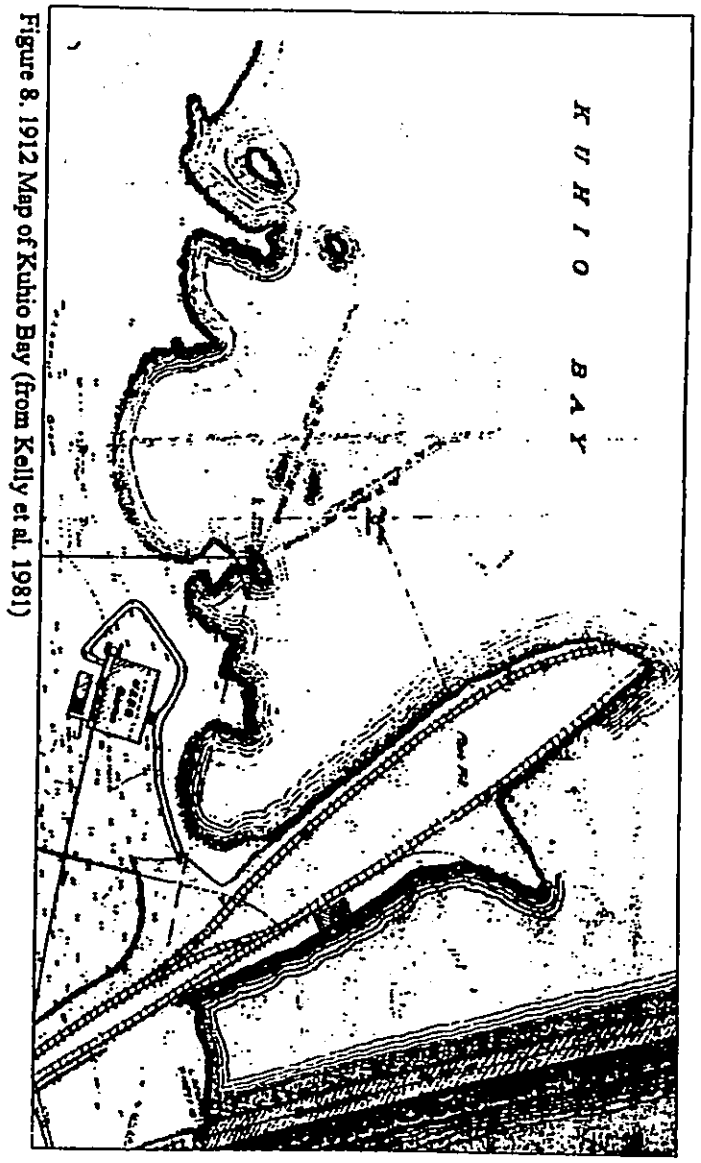


Figure 8. 1912 Map of Kuhio Bay (from Kelly et al. 1981)

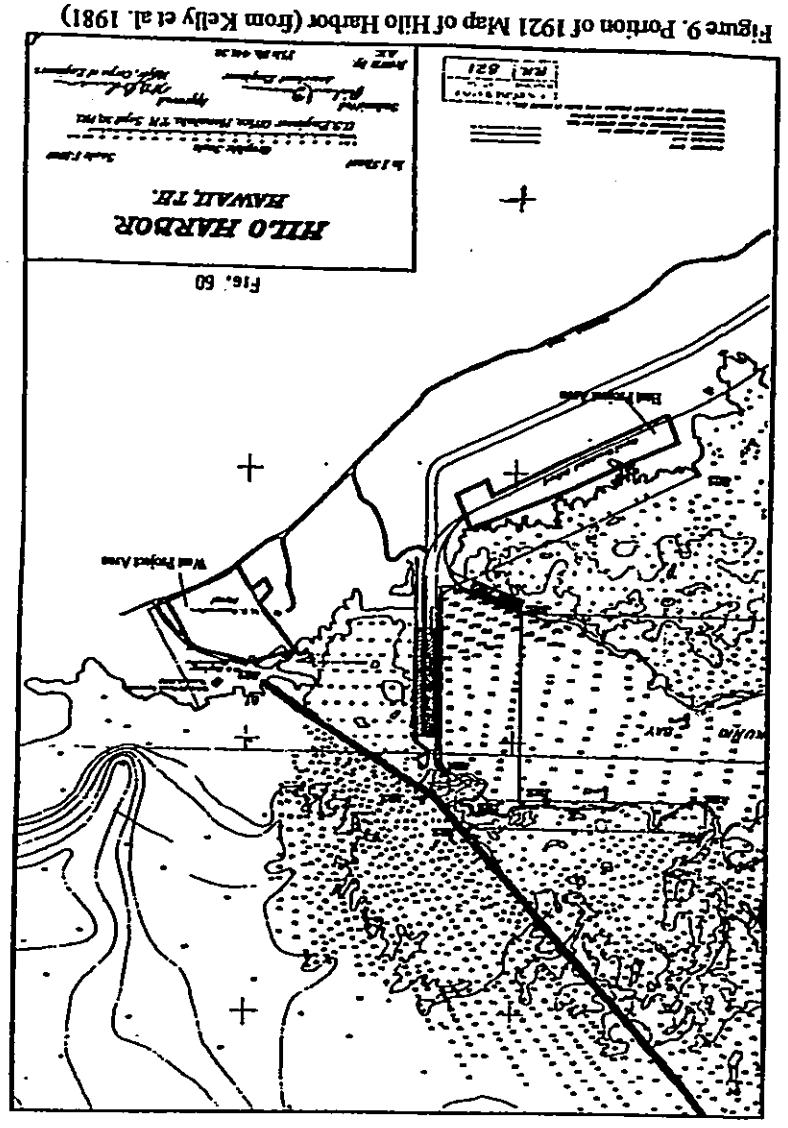


Figure 9. Portion of 1921 Map of Hilo Harbor (from Kelly et al. 1981)

DOCUMENT CAPTURED AS RECEIVED

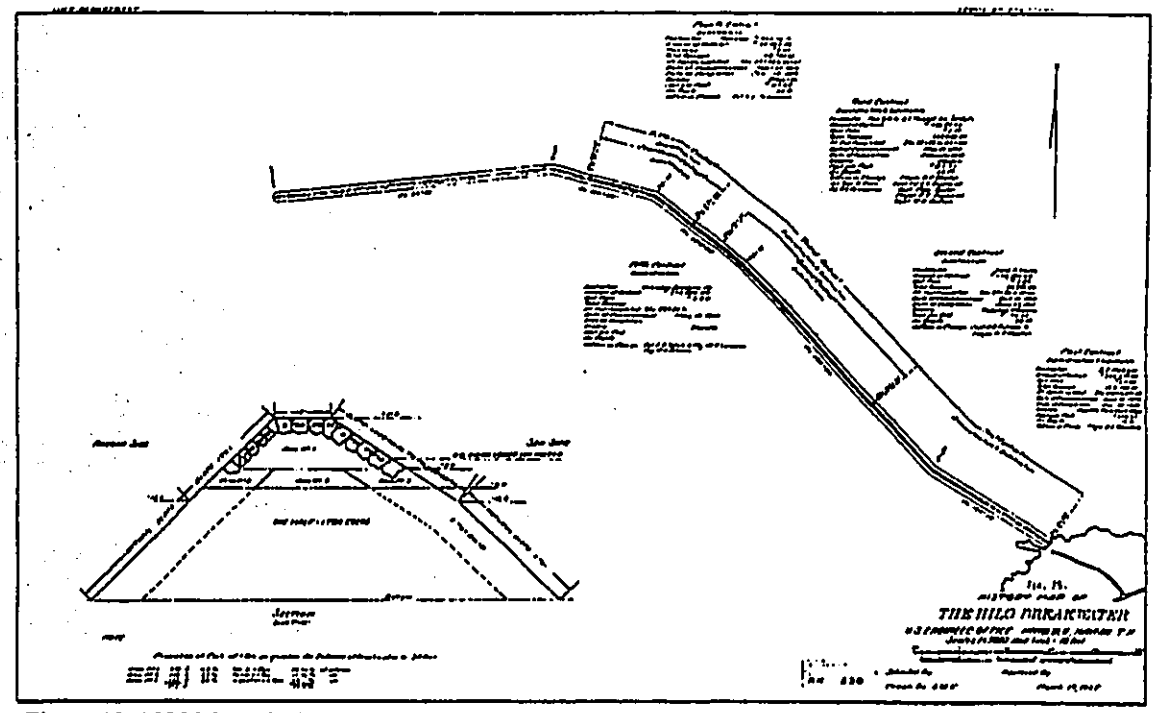


Figure 10. 1925 Map of Hilo Breakwater (from Kelly et al. 1981)

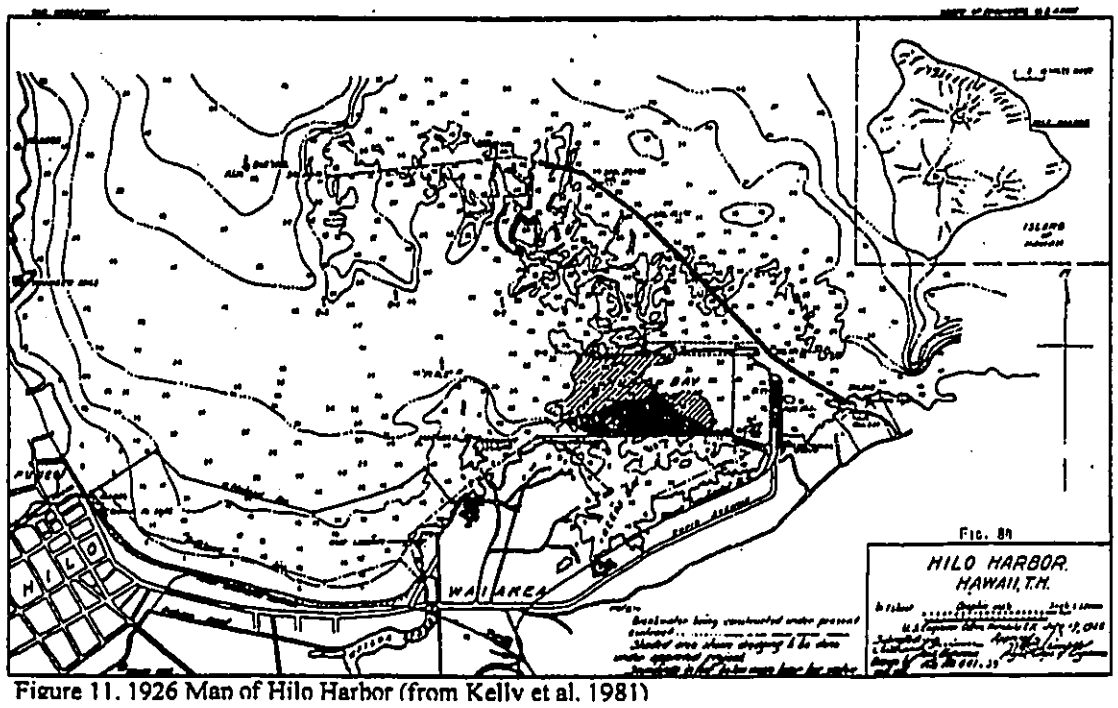


Figure 11. 1926 Map of Hilo Harbor (from Kelly et al. 1981)

DOCUMENT CAPTURED AS RECEIVED

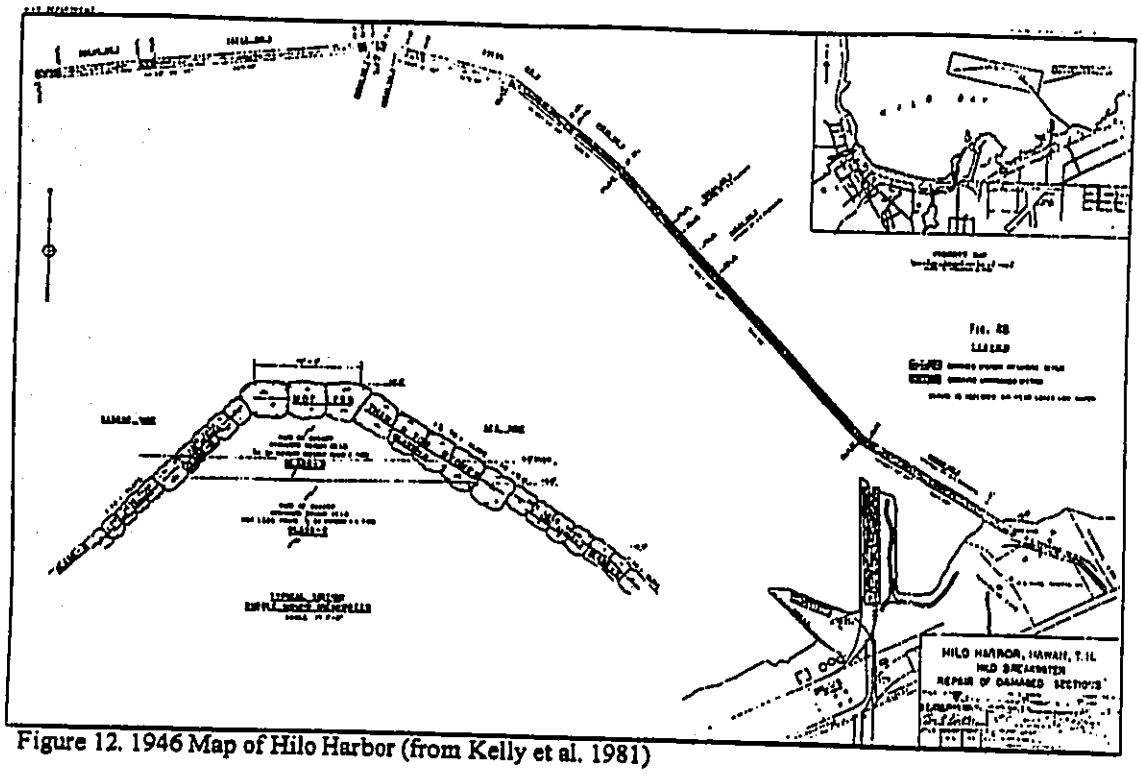


Figure 12. 1946 Map of Hilo Harbor (from Kelly et al. 1981)

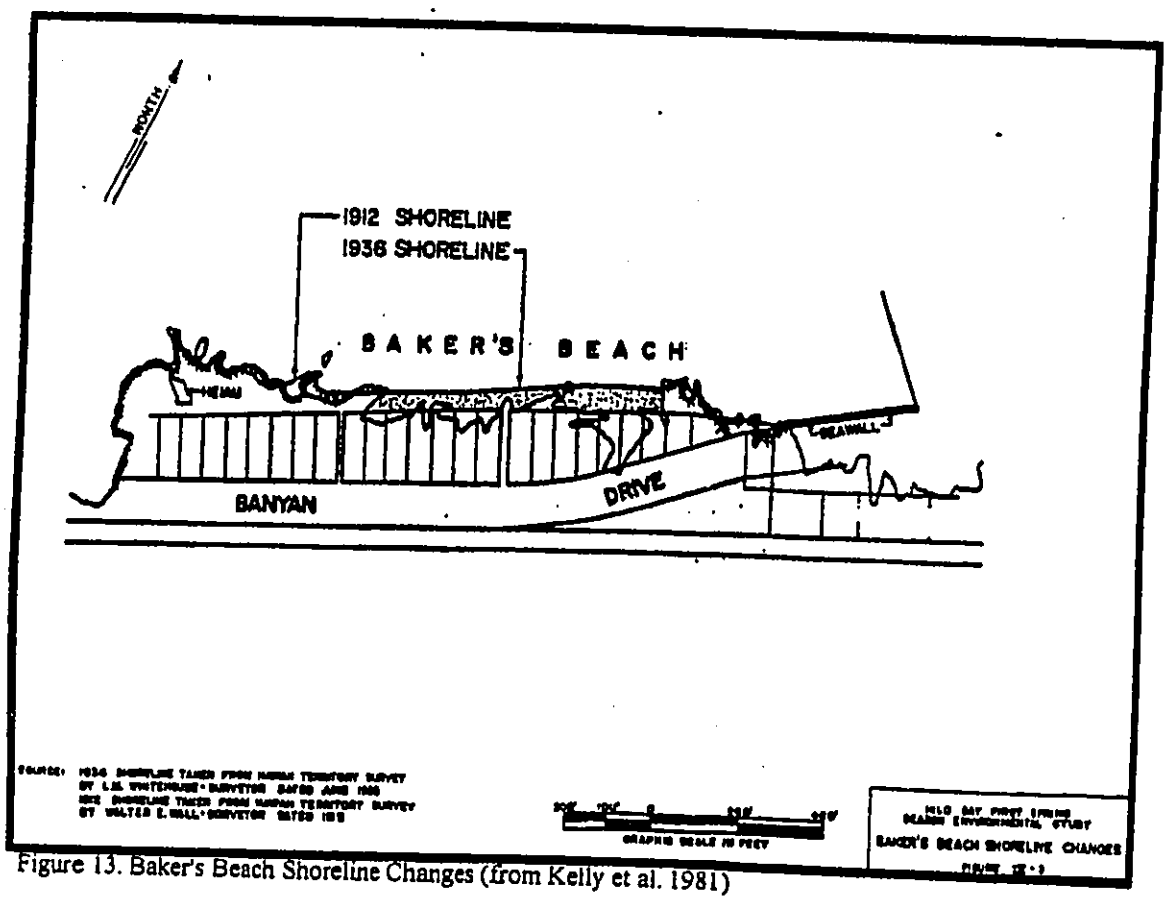


Figure 13. Baker's Beach Shoreline Changes (from Kelly et al. 1981)

DOCUMENT CAPTURED AS RECEIVED

CORRECTION

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

DOCUMENT CAPTURED AS RECEIVED

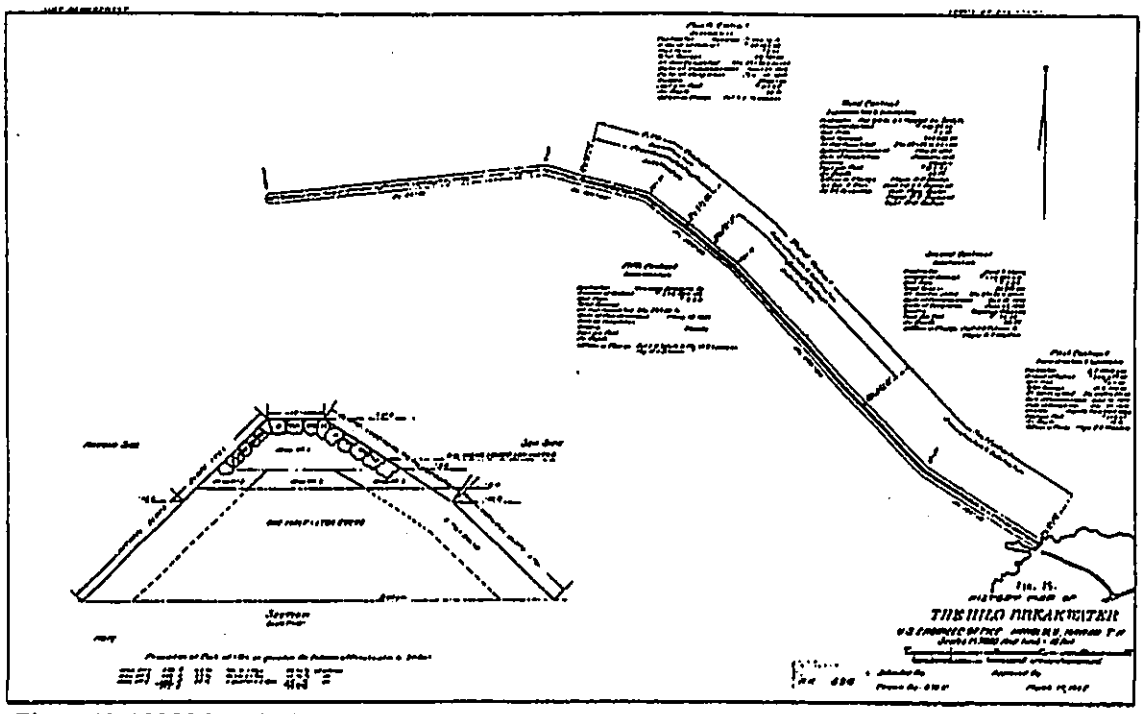


Figure 10. 1925 Map of Hilo Breakwater (from Kelly et al. 1981)

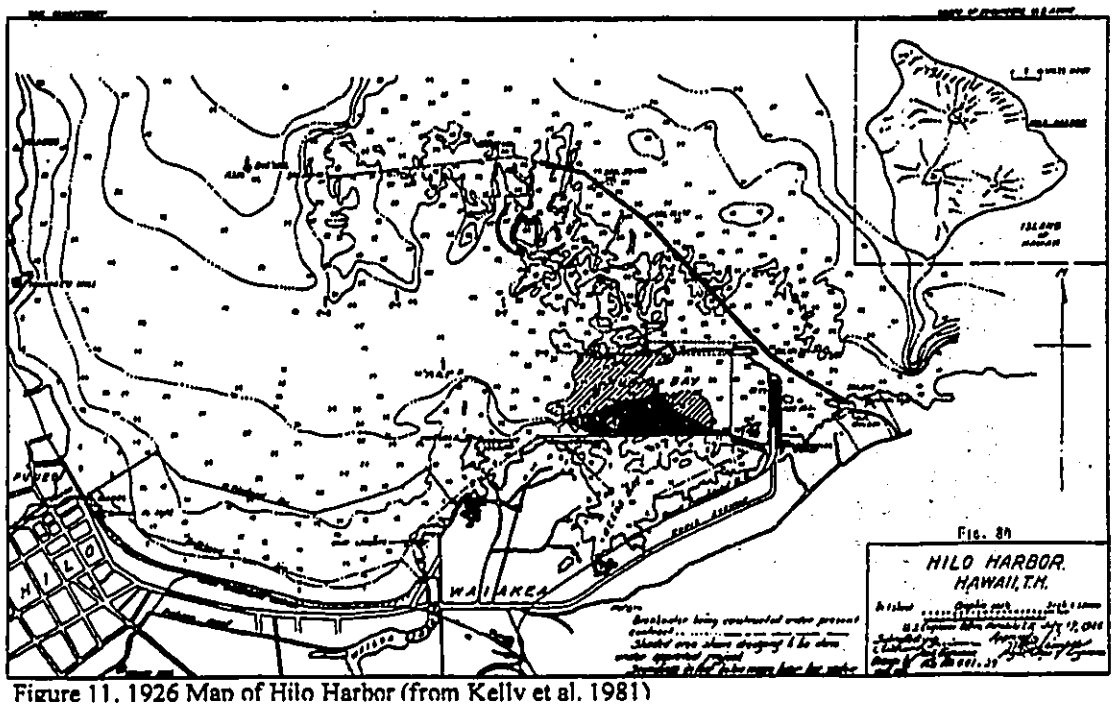


Figure 11. 1926 Map of Hilo Harbor (from Kelly et al. 1981)

DOCUMENT CAPTURED AS RECEIVED

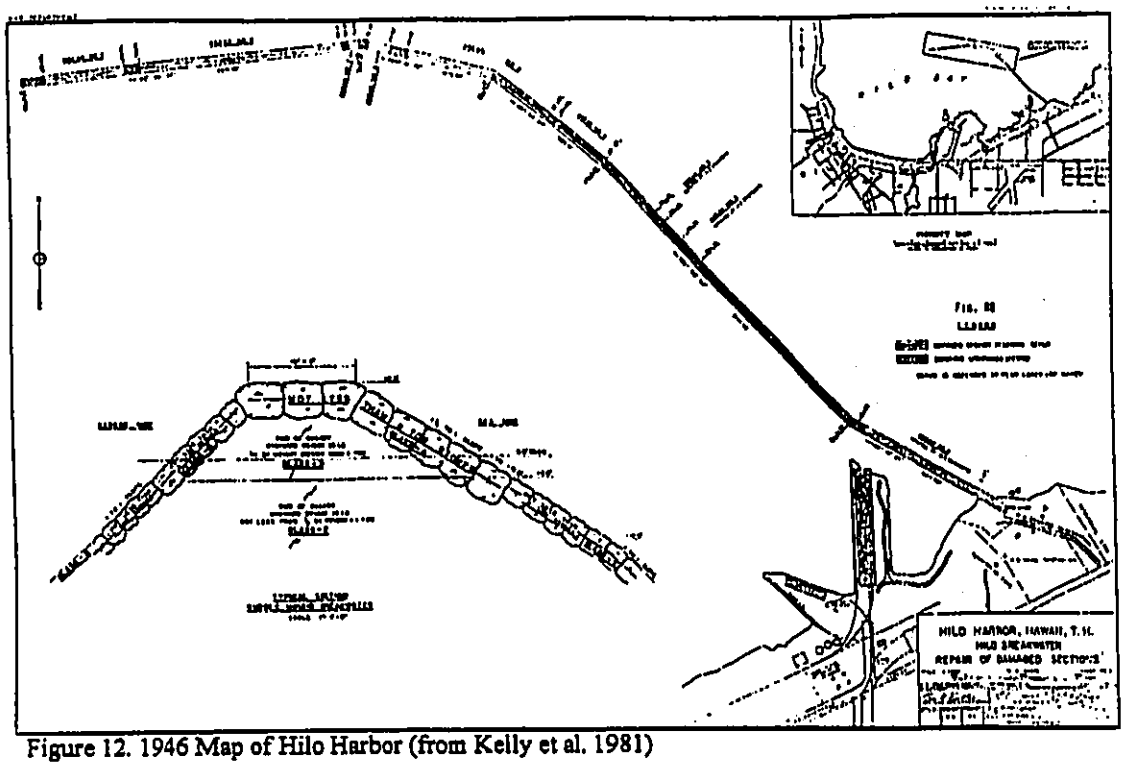


Figure 12. 1946 Map of Hilo Harbor (from Kelly et al. 1981)

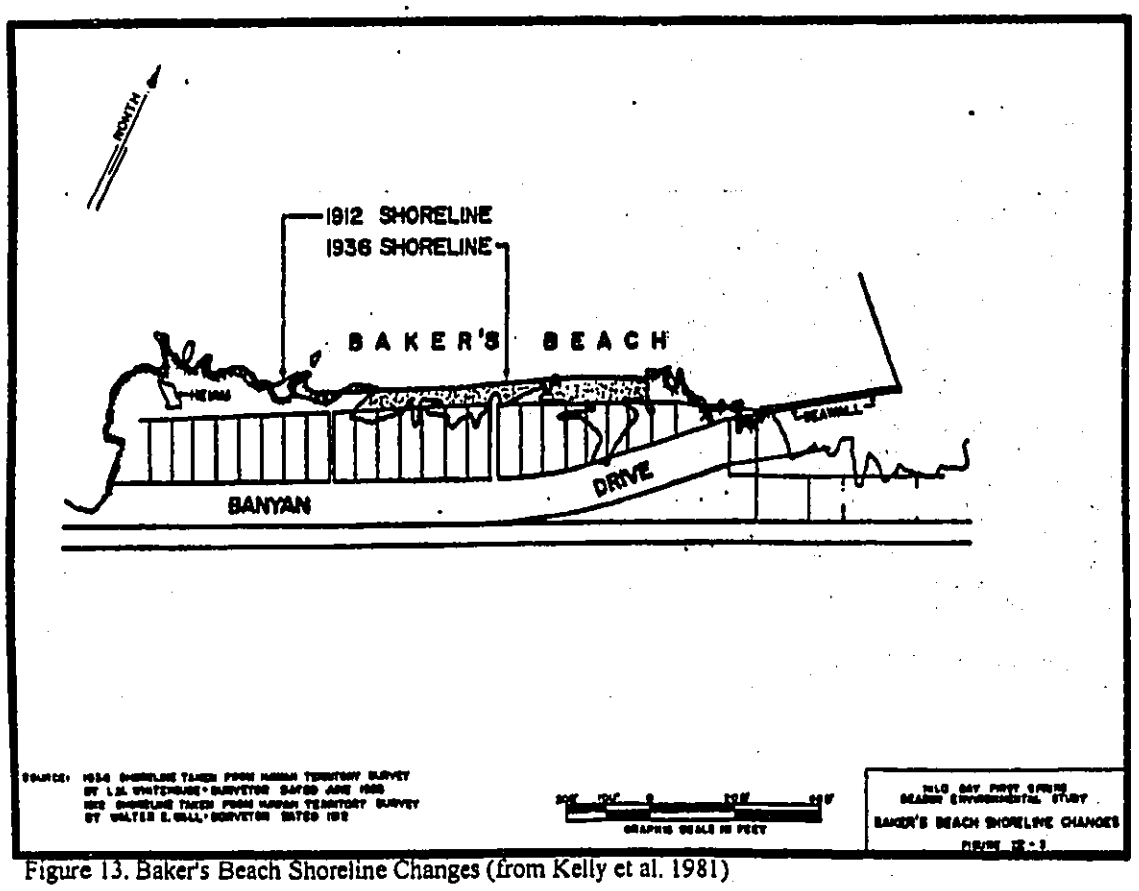


Figure 13. Baker's Beach Shoreline Changes (from Kelly et al. 1981)

Table 2. Summary of Previous Archaeological Research

Author	Date	Study Type*	Elevation	Acreage	Historic Use	No of sites	No of Feas	Traditional Features	Historic Features
Kam	1983	AR	0-5	<1	None	1	1	*heiau*	
Borthwick, Collins, Folk and Hammatt	1993	IN	140-330	183	Sugar cane	4	47		47
Borthwick and Hammatt	1993	IN	120-140	11	Sugar cane	-	4		4
Maly, Walker and Rosendahl	1994	IN	70-80	4.5	Sugar cane	4	51		51
Spear	1995	DR							
Walker and Rosendahl	1996	FI	0-460	129.8	sugar cane/ developed	5	?		1
Rosendahl	1994	FI	250-290	11	?	1	1		
Kennedy and Ireland	1994	RN	70-80	8	?	0			
Hunt and McDermott	1993	IN	200-1500	106	Sugar cane	11	88		88
Robins and Spear	1996	IN	200-1500	264	Sugar cane	3	18		18
Winieski, Borthwick and Hammatt	1996	IN	450-500	5.23	?	0			
Devereux, Borthwick, Hammatt and Orr	1997	RN	40-80	503.6	?				
Devereux, Borthwick, Hammatt and Orr; and Hammatt and Bush	1997/ 2000	RN/IN	40-80	503.6	Military	4	8	5 *ahu* and Puna Trail	3
Rechtman and Henry	1998	IN	120-205	40	Sugar cane	1	117		117
Carson	1999	IN		178	?	0			
McGerty and Spear	1999	IN	70	2.5	Sugar cane	1	13		13

* AR=Archival Research, RN=Reconnaissance Survey, IN=Inventory Survey, DR=Data Recovery

DOCUMENT CAPTURED AS RECEIVED

McEldowney used the limited site inventory and historic documentary evidence to develop a land use and settlement pattern model for the Hilo area. The model consists of five elevationally-defined zones: Coastal Settlement, Upland Agricultural, Lower Forest, Rainforest, and Sub-Alpine or Montane. The Coastal Settlement Zone extended approximately 0.5 miles inland from the shoreline between sea level and 50 ft elevation. The zone was the most densely populated with both permanent and temporary habitations, high status chiefly residences, and *heiau*. Settlements were concentrated at Hilo Bay and sheltered bays and coves. Also present were fishponds and gardens where breadfruit, coconut, *kukui*, banana, *wauke*, sugar cane, sweet potato, and wet and dryland taro were cultivated. The ocean provided fish and other marine resources.

The Upland Agricultural Zone was situated between approximately 50 ft and 1,500 ft elevation. Settlement in the zone consisted of scattered residences among economically beneficial trees and agricultural plots of dryland taro and bananas. Lava tubes were utilized for shelter. A pattern of shifting cultivation is believed to have converted the original forest cover to parkland of grass and scatters groves of trees. Wetland cultivation of taro occurred along streams.

The Lower Forest Zone ranged from 1,500 ft to 2,500 ft elevation. Timber and other forest resources such as medicinal plants, *olona*, and birds were gathered from the zone. Site types consisted of temporary habitations, trails, shrines, and minor agricultural features in forest clearings and along streams. Sites in the Rainforest Zone (2,500-5,000 ft elevation) and Subalpine or Montane Zone (5,000-9,000 ft) were limited to trails and associated temporary habitations. These zones were used for intra-island travel and gathering of valued resources including hardwoods, birds, and stone for tool making.

PROJECT EXPECTATIONS

Prehistoric use of the project area likely included habitation, fishing and collecting of marine resources, burial and ritual; however, the construction activity associated with the breakwater and harbor facilities probably destroyed most sites in the project areas. Historic sites dating to the 1900s would consist of harbor-related infrastructure including roads and railroad track and potentially foundations for building and other structures.

FINDINGS

No prehistoric archaeological sites or features were present within the boundaries of the project area. The survey identified a modern asphalt pavement in the Eastern Project Area and a complex of concrete structural remains in the West Project Area. *Figure 15* depicts the location of these features. The features are described below.

Previously identified sites present adjacent to the project areas consist of the Hilo Harbor Breakwater (SIHP Site 7441) and a platform on State land near the northwest corner of the Western Project Area. The platform probably corresponds with the *heiau* reported by Kam (1983). The feature, which was viewed from a distance of approximately 10 m, is situated in a grove of ironwood trees in the backyard of a house on Parcel 20 of TMK: 3-2-1-07. The feature is roughly 3-4 m square at the top and tapers to approximately 5-6 m at the base. It is approximately 1.5 m high with sloping sides. There is a c. 0.5 m deep depression in the center of the paved upper surface.

East Project Area

An asphalt pavement was identified during the survey of East Project Area. The pavement is rectangular in shape and measures 60.2 m long (north-northwest by south-southeast), 13.0 m wide, and 0.1 to 0.14 m in height above the surrounding ground surface. The remains of vinyl floor tiles are present on the surface of the pavement. No other cultural remains were noted. An asphalt driveway extends to the southeast from the pavement towards Kalanianaole Avenue. It is 43.5 m long by 4.2 m wide. The pavement and the floor tiles are depicted in *Figures 16* and *17*.

West Project Area

A complex of four concrete features, Site 22486, was identified in the West Project (*Figure 18*). The features consist of two concrete slabs (Features A and B), a set of parallel concrete curbs (Feature C), and two displaced sections of concrete slab located at the water's edge (Feature D). These features are in fair condition and are altered. Piles of bulldozed materials bound the structural remains to the west, south, and east.

Feature A

Feature A is a rectangular concrete slab located c. 15 m east of western edge of the developed portion of the West Project Area. The seaward portion of the slab is buried beneath a large pile of soil, which may have been deposited by storm or tidal wave action. The exposed portion of the slab measures 23.5 m long (east-northeast by west-southwest) and from 6.3 to 6.6 m wide. The surface of the slab is 0.09 to 0.11m in height above the surrounding ground surface. A concrete road extends to the south-southeast from the southwest corner of the slab. The surface of the road is level with the ground surface. It is 12.5 m long (north-northwest by south-southeast) and 2.75 m wide (*Figure 19*).

Feature B

Feature B is a concrete slab situated to the southeast of Feature A. The main portion of the slab is rectangular in shape and is 9.6 m long (northeast by southwest) by 6.7 m wide. The slab ranges in height from 0.10 to 0.12 m. There is a concrete block at the southeastern corner of the slab. It is 2.3 m long (northwest by southeast) by 1.5 m wide and 0.08 m in height.

There is a raised concrete curb that forms an enclosure at the eastern end of the slab. This enclosure is 5.4 m long (northwest by southeast) and 2.7 m wide. The curb is 0.1 m wide and 0.08 m tall above the surface of the slab (*Figure 20*). There is a 4-inch (0.1 m) diameter hole in the slab adjacent to the southwestern corner of the raise curb. This hole may have functioned as a drain. A set of two concrete steps is located along the southern wall near the southwest corner. The stairs are 1.1 m long (northeast by southwest) with each step measuring 0.21 m wide and 0.2 m tall.

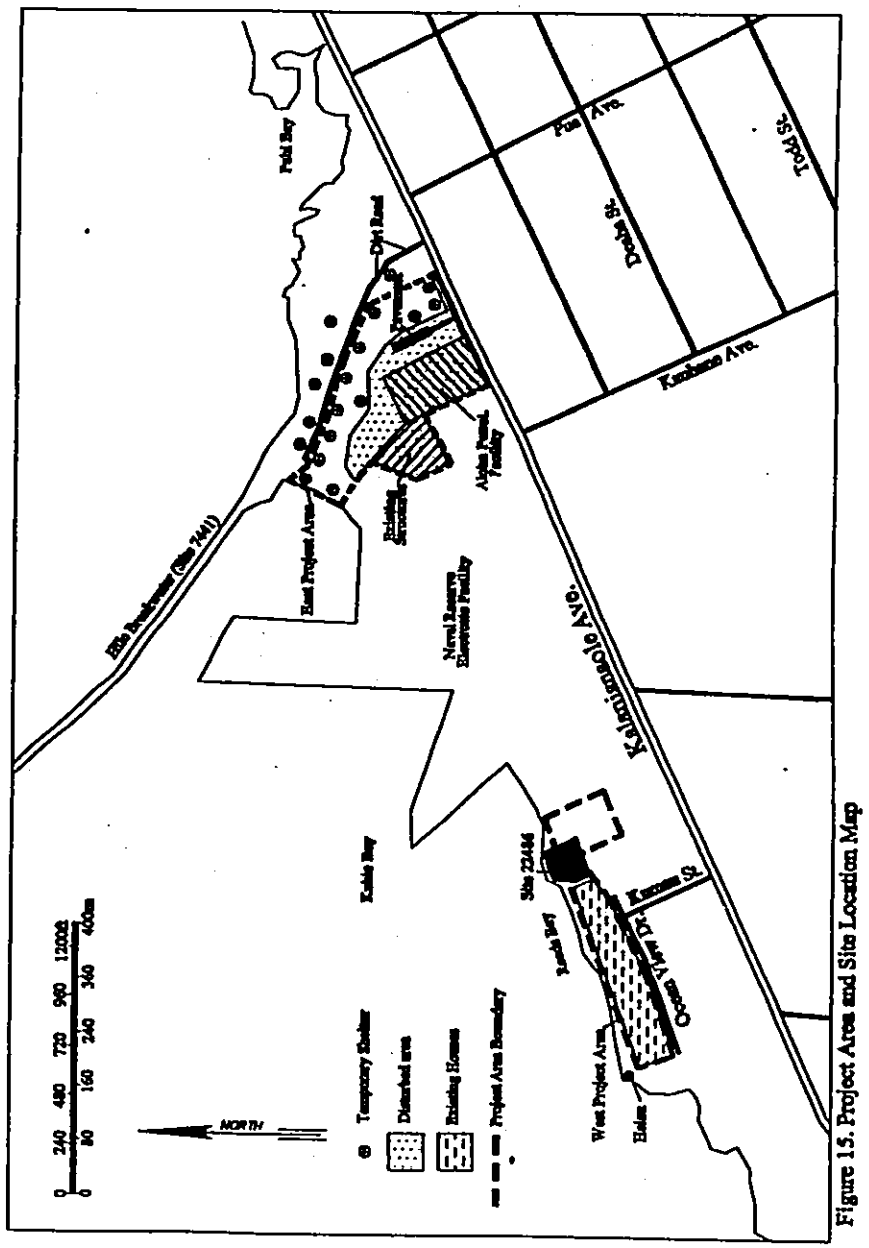


Figure 15. Project Area and Site Location Map

DOCUMENT CAPTURED AS RECEIVED

DOCUMENT CAPTURED AS RECEIVED

Figure 16. East Project Area - Asphalt Slab, View to North-Northwest

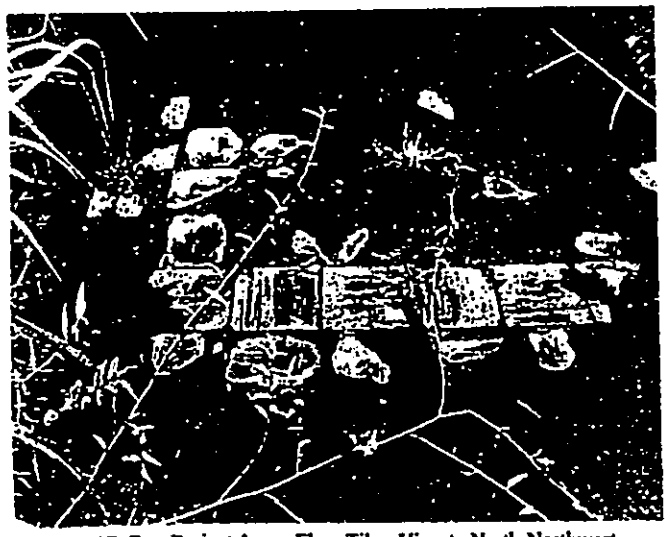


Figure 17. East Project Area - Floor Tiles, View to North-Northwest

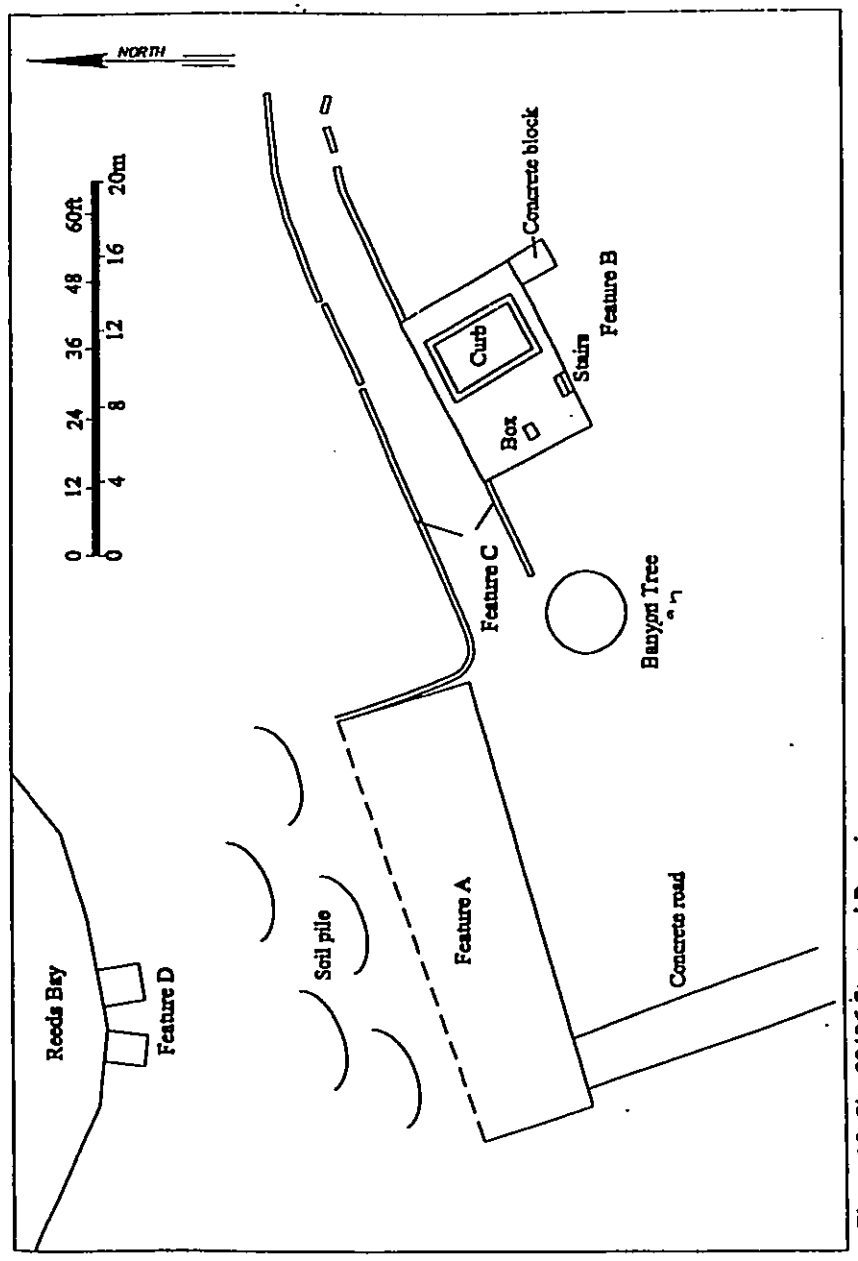


Figure 18. Site 22486 Structural Remains

DOCUMENT CAPTURED AS RECEIVED

Figure 19. West Project Area - Feature A Concrete Slab, View to Northwest

Figure 20. West Project Area - Feature B, Raised Curb, View to North-Northeast

A concrete box with a concrete cover is present near the center of the western wall. The box is 0.8 m long (northwest by southeast) by 0.55 m wide, and 0.05 m tall above the slab (*Figure 21*). There is a rusted metal handle in the center of the cover. An attempt was made to remove the cover, but the rusted handle prevented this. The nature of this portion of Feature B suggests that there is an enclosed space below the surface of the slab.

Feature C

Feature C consists of a set of parallel concrete curbs, located north of Feature B and east of Feature A. The curbs are 0.16 m in width and 0.1 m in height. The northern curb originates along the eastern side of the Feature A slab. It extends to the south-southeast for 6.5 m, then turns in an arc to the northeast for 32.9 m. The northeastern end of this section is broken and displaced from its original location (*Figure 22*).

The southern side of the curb is located 4.1 m southeast of the northern side. Soil is present in the space between the two curbs. This portion of the feature originates just east of a large banyan tree, extending to the east-northeast a distance of 5.75 m. At this point, the curb abuts the northwest corner of the Feature B slab. The curb continues on the northeastern side of the slab, extending to the east-northeast for 8.7 m (*Figure 23*). The northeastern end of this curb is also broken and displaced. It is likely that these curbs formed a narrow roadway that continued further to the east.

Feature D

Feature D consists of two displaced sections of concrete slab located at the water's edge north of the Feature A slab. The eastern slab is 2.3 m long (north-northwest by south-southeast) by 2.0 m wide. The western slab is 2.2 m long by 1.7 m wide (*Figure 24*). Both sections of slab are c. 0.15 m in thickness. These slab sections may have formed a pier or dock due to their location along the shoreline, or they may have simply been displaced to their current locations.

DOCUMENT CAPTURED AS RECEIVED

Figure 21. West Project Area - Feature B, Concrete Box with Cover, View to North

Figure 22. West Project Area - , Feature C Concrete Curb, View to North

Figure 23. West Project Area - Feature C Concrete Curb, View to South

Figure 24. West Project Area - Feature D Displaced Slab, View to Northwest

DOCUMENT CAPTURED AS RECEIVED

CONCLUSION

The absence of traditional sites within the project areas probably results from the extensive disturbance caused by construction activities associated with the breakwater and port facilities, and with the construction of residences along the shoreline in the West Project Area. During the 20 years of breakwater construction, the East Project Area would have been the primary staging area for construction activity. The area was later the site of U.S. Naval and U.S. Engineer Reservations. Modern port facilities and a series of temporary shelters occupy the area today. The presence of a possible *heiau* near the West Project Area conforms to expectations for traditional site types in the vicinity of the project area. No surface evidence of subsurface cultural deposits was identified and it is unlikely that such deposits would be present because there is very little soil over the lava bedrock in the area and because the area has been extensively disturbed by construction activity and periodic tsunami inundation.

The Site 22486 structural remains probably represent port-related facilities because the curb-lined road at the site extends to the east toward the developed portions of the port. The 1912 map of Kuhio Bay (see *Figure 8*) shows a curving road and a U.S. Engineers Office quarters facility in the general vicinity of Site 22486. The curving road segment (Feature C) at the site probably corresponds to the road on the 1912 map. The facility does not appear on subsequent maps of the port dating from the 1920s and later. The 1921 map of the harbor (see *Figure 9*) shows a U.S. Engineer Reservation on the coast next to the breakwater. Thus, it is likely that the facility was relocated between 1912 and 1921.The displaced concrete pads at the site may have been moved during the 1946 tsunami.

Significance Assessments and Recommended Treatments

Pursuant to DLNR (1998) Chapter 275-6 (d), the initial significance assessments provided herein are not final until concurrence from the DLNR has been obtained. Sites identified and relocated during the survey are assessed for significance based on the criteria outlined in the Rules Governing Procedures for Historic Preservation Review (DLNR 1998:Chap 275). According to these rules, a site must possess integrity of location, design, setting, materials, workmanship, feeling, and association and shall meet one or more of the following criteria:

1. Criterion "a". Be associated with events that have made an important contribution to the broad patterns of our history;
2. Criterion "b". Be associated with the lives of persons important in our past;
3. Criterion "c". Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value;
4. Criterion "d". Have yielded, or is likely to yield, information important for research on prehistory or history; and
5. Criterion "e". Have an important traditional cultural value to the native Hawaiian people or to another ethnic group of the state due to associations with traditional cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts--these associations being important to the group's history and cultural identity.

Based on the above criteria, Site 22846 is assessed as solely significant under Criterion "d". The site has yielded information important for understanding historic land use in project area. The mapping, written descriptions, and photography at the site adequately documents it and no further work or preservation is recommended.

References

Borthwick D., J. Collins, W.H. Folk and H.H. Hammatt
1993 Archaeological Survey and Testing of Lands Proposed for Research and Technology Lots at the University of Hawaii at Hilo (TMK:2-4-01:7 and 41). Prepared for Engineering Concepts.

Borthwick, D., and H.H. Hammatt
1993 Supplemental Archaeological Survey and Testing of the Proposed University of Hawaii at Hilo Expansion Area (TMK:2-4-01:10). Prepared for Engineering Concepts.

Carson, M.T.
1999 Archaeological Inventory Survey of the 176-acre Pana'ewa Campus Site, Waiakea Ahupua'a, Hilo District, Island of Hawaii (TMK:2-1-13:154)

Devereux, T.K., D.F. Borthwick, H. Hammatt, and M. Orr
1997 Archaeological Reconnaissance Survey of Keaukaha Military Reservation, South Hilo District, Hawaii Island, Cultural Surveys Hawaii.

DLNR (Department of Land and Natural Resources)
1998 Hawaii Administrative Rules, Title 13, Department of Land and Natural Resources, State Historic Preservation Division.

Hammatt, H.H. and A.R. Bush
2000 Archaeological Inventory Survey of Selected Portions of the Hawaii Army National Guard 503.6-acre Keaukaha Military Reservation, Waiakea Ahupua'a, South Hilo District, Hawaii Island (TMK:2-1-12:3 and 2-1-13:10).

Hudson, A.E.
1932 Archaeology of East Hawaii. B.P. Bishop Museum Manuscript. Honolulu.

Hunt, T.L., and M.J. McDermott
1993 Archaeological Inventory Survey, Puainako Street Extension Project, Lands of Waiakea, Kukuau 1 and 2,and Ponahawai, South Hilo District, Hawaii. Prepared for Okahara & Associates, Hilo.

Juvik, S.P. and J.O. Juvik (editors)
1998 *Atlas of Hawaii*. Third Edition. University of Hawaii Press. Honolulu.

Kam, W.
1983 Letter Report: Unrecorded Heiau on State Lands, Waiakea, South Hilo, Hawaii (TMK:2-1-07:11).

Kelly, M., B. Nakamura and D.B Barrere
1981 Hilo Bay: A Chronological History, Land and Water Use in the Hilo Bay Area, Island of Hawaii. Prepared for U.S. Army Engineer District, Honolulu.

Kennedy, J. and S. Ireland
1994 An Archaeological Survey for the Proposed Hilo Forestry Office Complex Extension located at TMK: 2-2-2701, in Waiakea Ahupua'a, South Hilo District, Island of Hawaii. Archaeological Consultants of Hawaii, Inc.

Kikuchi, W.K.
1973 Hawaiian Aquacultural Systems. Ph.D. Dissertation, University of Arizona.

DOCUMENT CAPTURED AS RECEIVED

Maly, K.
1996 Historical Documentary Research and Oral History Interviews: Waiakea Cane Lots (12, 13, 17, 18, 19, 20 & 20a). Prepared for UHH Honikaika Club.

Maly, K., A.T. Walker and P.H. Rosendahl
1994 Archaeological Inventory Survey, Waiakea Cane Lots, Portion of Parcel 6 Land of Waiakea, South Hilo District, Island of Hawaii (TMK:2-4-57:01) PHRI Report 1370. Prepared for Roy Takemoto.

McGerty, L., and R.L. Spear
1999 An Inventory Survey of an Additional Unsurveyed Portion of TMK:2-4-57:1, Land of Waiakea, South Hilo District, Island of Hawaii. Prepared for R.M. Towill Corp.

Moniz, J.J.
n.d. Historical and Archaeological Synthesis of Land Use and Settlement Patterns, Waiakea Ahupua'a, Hilo District.

Rechtman, R., and J.D. Henry
1998 University of Hawaii-Hilo, Kawili Street Development, Archaeological Inventory Survey (TMK:3-2-4-01:5), Waiakea Ahupua'a, South Hilo District, Island of Hawaii. PHRI Report 1877. Prepared for Inaba Engineering, Inc.

Robins, J.J., and R.L. Spear
1996 An Inventory Survey of the Puainako Street Realignment/Extension Project Expanded Corridor, Waiakea, Kukuau 1-2, and Ponahawai, South Hilo District, Island of Hawaii. Prepared for Okahara and Associates

Sato, H.H., E.W. Ikeda, R. Paeth, R. Smythe, and M. Takehiro Jr.
1973 *Soil Survey of the Island of Hawaii.* U.S. Dept. of Agriculture, Soil Conservation Service and University of Hawaii Agricultural Experiment Station. Washington D.C. Government Printing Office.

Spear, R.L.
1995 Data Recovery Excavations for Sites 50-10-35 19431, 19432, 19433 and 19434, Land of Waiakea, South Hilo District, Island of Hawaii (TMK:2-4-57:01). Prepared for Roy Takemoto.

Rosendahl, P.H.
1994 Archaeological Field Inspection, Hale Nani Work Release Center, Land of Waiakea, South Hilo District, Island of Hawaii. PHRI Letter Report 1516. Prepared for Belt Collins Hawaii.

Walker, A.T., and P.H. Rosendahl
1996 Archaeological Assessment Study, Hilo Judiciary Complex Project, South Hilo District, Island of Hawaii. PHRI Report 1721. Prepared for State of Hawaii, Dept. of Accounting and General Services.

Winieski, J., D. Borthwick, and H.H. Hammatt
1996 Archaeological Survey of a Proposed Reservoir and Waterline Easement for the University of Hawaii at Hilo, Infrastructure Improvements Phase IIA (TMK: 2-4-03:26 and 2-4-01:12). Prepared for Engineering Concepts.

Appendix I

ORAL HISTORY ACCOUNT, HILO HARBOR AREA
MR. JOHN MOSES

December 2000

DOCUMENT CAPTURED AS RECEIVED

Oral History, John Moses
44-Year Hilo Harbor Employee; Native Hawaiian
Oral history recorded on December 13, 2000 via Telephone when Mr. Moses was at Hilo Harbor, Hilo, Hawaii.

This history was recorded through handwritten notes by Gail Atwater, AICP, Senior Planner at R.M. Towill Corporation. Mr. Moses reviewed and edited the oral history and gave his permission to publish it in the Draft Environmental Impact Statement for the Hawaii Commercial Harbors 2020 Master Plan.

Mr. Moses was referred R.M. Towill Corporation by Ian Birnie, Harbormaster at Hilo Harbor because of Mr. Moses' longstanding familiarity with uses of the harbor and Hilo Bay vicinity.

Mr. Moses is a lifetime Hilo resident with 44 years of experience working at Hilo Harbor as an employee of the State of Hawaii, Department of Transportation. He has "seen lots of bosses [harbormasters] come and go and lots of governors come and go." Industrial sheds at Hilo Harbor have been built and torn down over the years. Sugar used to come into the harbor for shipment. Mr. Moses remembered when the bulk sugar processing plant at the harbor closed down. There used to be a sugar warehouse at the harbor that was torn down.

In the 1960s they took down half of the Pier 1 shed, which originally was 1,000 feet long. The shed used to be full of freight – lumber, paper goods and "staples for the Hilo community." Now all the cargo comes in containers. It was all break bulk back then, with freight covering one end of the pier to the other.

A lot of fishermen have used the harbor since the 1950s. Now they need a permit to fish at night from 6 pm to 6 am. They can fish during the day without a permit, but there are restrictions "when freight is being unloaded from barges and machines are going back and forth." Besides fishing, there have traditionally been no other non-commercial uses of Hilo Harbor. School children come for tours. The Coast Guard had a station at Radio Bay. The area behind Radio Bay will be developed for a marine research facility by the University of Hawaii at Hilo.

Areas that are best for fishing at Hilo Harbor are the ends of Pier 1 and Pier 3. Papio and halalu are caught there. One man comes to the harbor twice a year and catches 50-70 pound ulua off the dock. Some ulua up to 80 pounds have been caught. The Casting Club has a tournament all over the island, mostly during the summer and people come to fish at the harbor. There is seldom fishing around Baker's Beach. Some fishing occurs near the hotels [along Banyan Drive]. Mullet fishing is popular in Reed's Bay and Radio Bay.

The Baker's Beach area was once the site of an Army cottage where Mr. Moses' "first boss" (the Hilo Harbormaster) lived. There were also a machine shop and equipment storage in that area and a recreation hall for the troops during World War II. The 1960 tidal wave washed most of these buildings away. Mr. Moses remembers Captain Wickland, former harbormaster, who had been an officer in the U.S. Navy and was a former ship's pilot.

DOCUMENT CAPTURED AS RECEIVED

Hawaiian Electric Light Company used to have a meeting hall for employees at Baker's Beach that also used to be Mr. Moses' home. It used to be near the beach, and HELCO planned to move it to the beach. However, the tidal wave moved the structure to the beach "for them."

Appendix J

ORAL HISTORY ACCOUNT, KAWAIHAE HARBOR AREA

January 2001

Oral History, John Keola Lake
Kahuna Nui of Puukohola Heiau, Kawaihae
Oral history recorded on January 30, 2001, Columbia Inn, Kaimuki, Oahu, Hawaii

This history was recorded through handwritten notes by Gail Atwater, AICP, Senior Planner at R.M. Towill Corporation. Mr. Lake reviewed and edited the oral history and gave his permission to publish it in the Draft Environmental Impact Statement for the Hawaii Commercial Harbors 2020 Master Plan.

Mr. Lake was referred to R.M. Towill Corporation by Daniel Kawaiaea, Superintendent of the Puukohola Heiau National Historic Site, as preeminently knowledgeable about traditional cultural practices in the Kawaihae ahupuaa. Mr. Lake was interviewed on Oahu, where for the last 38 years he has been a chanter, teacher and lecturer in Hawaiian language and culture. Mr. Lake currently teaches Hawaiian language at Chaminade University in Honolulu and lectures on Hawaiian oral traditions at the Bernice Pauahi Bishop Museum. In the past he has lectured on oral traditions and chants at the University of Hawaii at Manoa, Department of Hawaiian Studies. Mr. Lake is 64 years old, three-fourths Hawaiian by ancestry and grew up on Maui.

Kawaihae

There have been numerous Kahuna Nui of Puukohola Heiau over the years. A succession of members of the Lono family served as Kahuna Nui previously. Many of them were also Christian ministers. The last of these was Reverand Edward Kealanahele. Mr. Lake explained the traditional role of the Kahuna Nui as the "conscience" of the alii (ruling class) who would suggest appropriate codes of conduct, settle land issues and conduct religious rites. In 1987, people who had been involved with the Puukohola Heiau asked Mr. Lake to assist in preparations for the re-dedication of the heiau at the bicentennial of its founding, which was to occur in 1991. Mr. Lake worked with Mr. Kalani Meinecke, who teaches Hawaiian Studies at Windward Community College on Oahu and Mr. Sam Kaai, to help develop a mission statement and prepare for the centennial of Puukohola Heiau. They asked Mr. Lake to compile oral histories and conduct research, which took two years. Mr. Lake worked closely with Mr. Parley Kanakaole on this research effort. Mr. Lake has now been Kahuna Nui of Puukohola Heiau for 10 years. Once the descendent of a Hawaiian chief wanted to get married in a traditional ceremony at the Puukohola Heiau. Mr. Lake requested and was granted recognition by the State of Hawaii as the Kahuna Nui and as such is permitted to conduct traditional Hawaiian wedding ceremonies at Puukohola Heiau.

Mr. Lake explained an incident at the Kapuni (shark) heiau in Kawaihae on the day he was to perform the bicentennial rededication ceremony at Puukohola Heiau in 1991. He led his group of chanters, his sons and daughter among them, down to the bay in which Kapuni heiau is submerged to conduct the *hiuwai* or cleansing rite in preparation for the ceremony. This involved walking out into the water while chanting. Mr. Lake said that eight green sea turtles entered the bay and arranged themselves near the surface around the chanters. "None [of the turtles] moved. They just sat there, one to two feet away." When the chanters reached chest-high depth, three sharks entered the harbor, made a circular path behind the chanters and turtles, and swam away. Normally turtles would flee such a situation, but they did not move. Mr. Lake says his son often recalls this event and says, "Dad, did that really happen?"

The Pelekane lands in Kawaihae were named after the British sailors who came to Kawaihae Bay at the beginning of Contact. Pre-contact, Makalii, where the Makalii Stream met the ocean, was a fishing village. After cattle production became the dominant industry of the area, many Kawaihae residents moved up to Waimea to find jobs on the ranches. In the 1850s and beyond, the area became a center for transportation of cattle from ranches in South Kohala. Cattle were "driven down what is now Kawaihae Road" and forced to swim into the ocean. Then their horns would be tied to the side of barges for transport to Honolulu. Mr. Lake recalls in 1944-48 cattle were still being driven down Kawaihae Road destined for the port.

Pre-contact, in the area from North Kona (Honokohau) and all along the coastline were inlets where fishing took place. These were "peaceful harbors for the alii, Kawaihae Bay included." This also included Hapuna, where fresh water and saltwater fish ponds were located, as well as Puako. Makalii Stream provided bait which was placed in fishponds to "regenerate the cycle of fish like mullet and limu." Following contact, the area was residential across from what is now Kawaihae Harbor. As a young boy in 1948, Mr. Lake remembers homes along this road with bananas growing in their yards. Mr. Lake shared information from anthropologist Marion Kelly, who noted a forest growing along the ridge above Kawaihae. He attributed the current dryness of the area to the "syphoning off of water" by ranching and developers. One of the streams that once emptied into the ocean no longer exists. A "river" used to run parallel to Kawaihae Road. Along the lowland river were banana and sweet potato patches. In the 1980s and 1990s, "they closed off more water" with construction of new homes.

Puukohola Heiau was dedicated in 1791. It is one of four heiau in this immediate area. The first and oldest heiau is Lono Heiau upon which Puukohola Heiau was built. This was an "agricultural" heiau where the sacrifices consisted of agricultural products such as taro, fish and "products of the field." Below on the hill is Mailekini Heiau, a structure similar in form and use to Lono Heiau. The third heiau, Puukohola, was the first luakini heiau at Kawaihae, meaning it would demand human sacrifice. Usually the sacrificed individual had broken the kapu or was "the first victim in warfare." When associated with warfare, this ritual killing was meant as a "show of bravado" to the enemy. It was such a strong signal that it "could even end the war." Mr. Lake said the Puukohola Heiau is the equivalent of the "State Temple of Hawaii."

The first sacrifice at Puukohola Heiau was in 1791 when the body of Keouakuahuula, Kamehameha I's cousin, was prepared at Mailekini Heiau and carried up to Puukohola to be "offered." Although Keouakuahuula had grown up with Kamehameha (who had carried the young boy on his shoulders), the young man was "trying to take over Kamehameha's area." The young man's upstart behavior had been observed by priests and chiefs, who killed him before Kamehameha knew what had happened.

The fourth heiau at Kawaihae is the submerged "Kapuni" heiau dedicated to sharks and eels. Hawaiians believed that each person had an "aumakua" or animal who was the reincarnation of a deceased family member who returned to "watch over" the person. It was important to know whether a certain animal was *your* aumakua, particularly when it was a shark. Aumakua had to be chosen carefully. The submerged Kapuni heiau consisted of stones which were dropped into

the water and then arranged. It was situated at the mouth of the Makalii Stream. It has been subject to siltation since the current Kawaihae Harbor breakwater disrupted the drainage patterns of the stream. However, "you can still dive in and see the rocks."

Mr. Lake was asked to describe the history of agricultural activity in the Kawaihae area. The "naulu rains" came from Waimea and watered the breadfruit trees which grew in a "forest" above the heiau. Kawaihae ahupuaa includes the Mauna Kea Beach Hotel to the south, to Hapuna and Puako. Waimea used to have heavy taro patches. Waimea supplied the "mountain" materials and products and Kawaihae produced the products of the sea in the traditional exchange of materials between upland and seaward areas of the ahupuaa.

Shoreline recreation at Kawaihae Bay pre-contact included swimming, deep sea diving, fishing and canoeing. Along the coast, the best diving spot was Hapuna to the south. Surfing did not occur at Kawaihae because it was "too calm." Deep sea diving gave chanters a chance to practice holding their breath for long periods of time to develop the "aho loa" or sustaining of breath that is needed in chanting. Chanters should be able to tell an entire story or deliver long phrases without stopping for breath.

Traditional gathering along the coastline was focused on limu (seaweed), especially where rivers and streams flowed into the ocean, creating brackish water. At Spencer and Hapuna beaches, there was a reef shelf. On the landside of the reef, Hawaiians would do "crabbing, squiding, and shallow water fishing." On the other side of the coral head they would do deep sea diving. They

"would use fish nets and floaters, then bring the fish in and have a hukilau." In the area where Kawaihae Harbor is now located were coconut trees. These were flat lands containing sedges growing in brackish waters that were used for mahaloa, for fine woven mats and hats.

Mookini Heiau is in the Kohala area near Hawi. This was the first great heiau in the islands. In the 4th to 6th centuries it was an agricultural heiau. In about the 12th century it became luakini heiau (one where humans were sacrificed) after the arrival of Paao, a great kahuna.

Mr. Lake described a traditional Hawaiian wedding ceremony, many of which he has conducted at the Puukohola Heiau. Chants are presented which are "centuries old." Wedding kapas (colored and hammered bark with designs), usually five layers thick. Once, a family brought a set of heirloon wedding kapa that were over 500 years old. Mr. Lake was overcome when he saw the old kapa and told the owners "how lucky they were" to possess such a treasure. The consistency of the kapa was similar to "Pellon" [fabric interfacing used in sewing]. In the traditional wedding ceremony, the priests and chanters provide the prayers, but the parents of each couple actually "perform the ceremony." If there are "no signs of discontent" voiced by the audience, the parents stand on both sides of the couple while the Kahuna "says prayers." The parents then place the kapa, which is approximately chest high in width and long enough to wrap around the couple while they stand facing each other. The parents wrap the kapa around the couple, symbolizing that they will be close together in marriage, to "demonstrate that this [sex] will take place.". In ancient times, the marriage was often consummated beneath the kapa during this ceremony. If there is chanting it "gives sanction to the wedding."

Hilo

Hilo Bay was a good place for the early Hawaiians to settle because it was flat and had a large, calm bay. The earliest Hawaiians mostly settled on windward (wet) parts of the islands because fresh water was plentiful. Later on as agricultural irrigation methods became more sophisticated, the Hawaiians were able to use a system of auwai to get the water from the mountains to the lowlands. This included tunnels dug with stone implements (for example, the Menehune Ditch on Kauai), water courses made from bamboo and flumes to bring the river water to the plains. Later, plantations followed the routes set by the Hawaiians to construct their much more elaborate irrigation systems.

In Hilo, myths and legends are tied to rivers, most the Wailuku river west of Hilo Bay. What is now called Coconut Island, Mokuola, was a birthing site for the Hawaiians. Women would wade over to the island at low tide. "Ice Pond" is a marine area near the harbor that is fed by cold fresh water that "feeds all the way to Leleiwi Point." There are fresh water springs all along Keaukaha. They are all fed by artesian wells. They made possible fresh water and saltwater ponds.

The Wailoa River and Waiakea Pond were the center of population and shoreline activity forthe ancient Hawaiians because "you could navigate from the ocean into these waters." "Not much happened" in the area where Hilo Harbor is now located. In the Keaukaha area south of the harbor was an "orchard area" where trees such as coconuts grew because their aerial roots would permit growth in the lava-dominated surface. South of Waiakea Pond were taro patches. In the

Panaewa area where Hilo International Airport is now located, another orchard area existed with coconuts and lauhala which were used for mats and tying canoes.

When asked about a supposed heiau near the Baker's Beach leased lots, Mr. Lake was not aware of a heiau with any religious significance to the Hawaiians in that location. He said the formation might be an "ahu" or boundary or dividing wall. At these ahus goods were collected and exchanged. The Kahuna Nui (high priest) and konohiki (tax collector) would go to the ahu to place the goods on the heiau.

Hanakahi was the great alii of Hilo and the Waiakea ahupuaa. There is a song, "Kaulana o Hilo Hanakahi" which is associated with Hilo and speaks of Hanakahi. Kukulu a is another "chiefly line" of Hilo.

For more information about traditional cultural practices in Hilo, Mr. Lake suggested the following sources: Edith Kanakaole Foundation (dedicated to preserving history of Hilo area), particularly the two "Kanakaole daughters" Pualani and Nalani; Larry Kimura of the University of Hawaii at Hilo; and Lokahi Belarmino, who just concluded historic research at UH Hilo.

It was very important in Hawaiian culture to develop strong individualism. However, the strong individual was always "molded by family and society."