FINAL
ENVIRONMENTAL IMPACT STATEMENT
FOR THE
KAHAWAINUI STREAM FLOOD CONTROL
LAIE, OAHU, HAWAII

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This environmental document is prepared pursuant
to Chapter 343, HRS

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CITY & COUNTY OF HONOLULU

Proposing Agency:
Department of Public Works
City and County of Honolulu

Accepting Authority:
Governor, State of Hawaii
and
Department of Land Utilization
City and County of Honolulu

Responsible
Official: Alfred J. Thiede Date: 6/9/87
ALFRED J. THIEDE
Director and Chief Engineer

PREPARED BY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF ENGINEERING

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EXECUTIVE CHAMBERS

HONOLULU

JOHN WAIHEE
GOVERNOR

October 7, 1987

MEMORANDUM

TO: Marvin T. Miura, Ph.D.
Interim Director
Office of Environmental Quality Control

VIA: Honorable John Lewin, Director
Department of Health

SUBJECT: Final Environmental Impact Statement for Kahawainui Stream Flood Control

Based upon the recommendation of your office, I am pleased to accept the Final Environmental Impact Statement for Kahawainui Stream Flood Control as satisfactory fulfillment of the requirements of Chapter 343, Hawaii Revised Statutes. This environmental impact statement will be a useful tool in the process of deciding whether the action described therein should be allowed to proceed. My acceptance of the statement is an affirmation of the adequacy of that statement under applicable laws, and does not constitute an endorsement of the proposed action.

When the decision is made regarding the proposed action itself, I expect the proposing agency to weigh carefully whether the societal benefits justify the environmental impacts which will likely occur. These impacts are adequately described in the statement, and, together with the comments made by reviewers, provide useful analysis to the proposed action.

JOHN WAIHEE

cc: Department of Public Works
City and County of Honolulu

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I. SUMMARY

A. DESCRIPTION OF THE ACTION

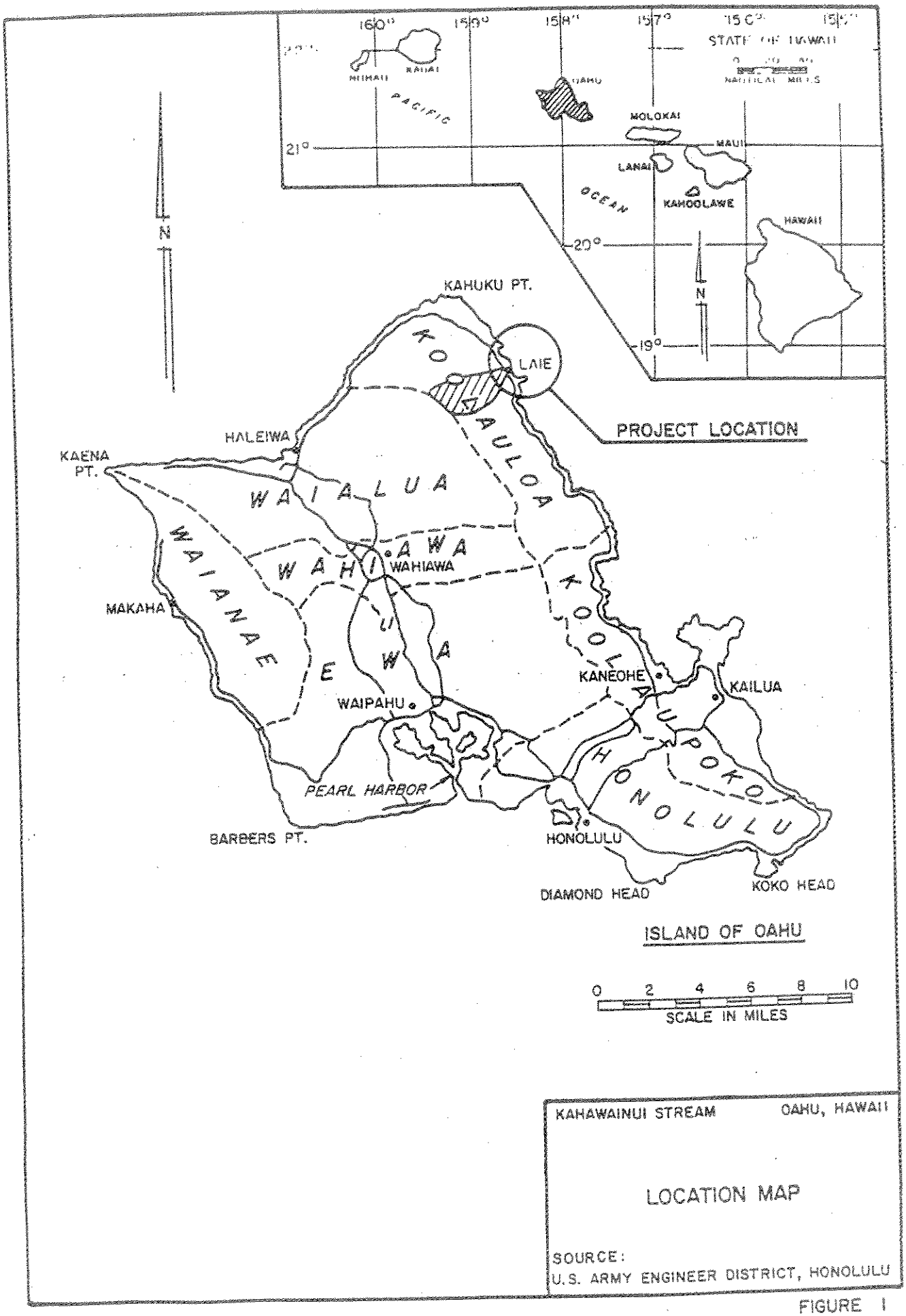
The proposed project is located in Laie on the northeastern coast of the Island of Oahu (see Figure 1). The project will consist of channel improvements and a levee along the right bank of Kahawainui and Laiewai Streams to relieve the flooding problems in the area. The project will provide for a standard project flood (SPF) level of protection which is approximately equal to a 285-year flood event.

The levees would be about 1,760 feet in length and would have a maximum height of about 12.6 feet. The levees would consist of compacted earth-fill with the side slope along the stream lined with concrete riprap downstream of Station 27+70 to prevent erosion of the levee by the floodflows. The backside slope and the levee crest would be grassed. A concrete I-wall would be provided between Stations 27+70 and 30+33. The levee would require that a road be raised to a maximum height of about 10.0 feet near Station 27+63 for access to cemetery areas, and that another road be raised to a maximum height of about 10.1 feet near Station 38+35.

The existing stream would be realigned upstream of Kamehameha Highway and replaced with a trapezoidal channel with 3 to 1 side slopes from the bridge to Station 21+00 for a length of about 490 feet. The channel would be concrete lined from the bridge at Station 16+40 to Station 17+50 and concrete riprap lined from Station 17+50 to Station 21+00. The channel invert would be V-shaped to channelize low flows. Above Station 21+00, the floodplain would be graded to concentrate low flows with a swale and to guide flows from the existing stream to the channel improvements. The upstream end of the channel improvement is widened from an 80-foot base width at Station 19+00 to 150 feet at Station 21+00 to reduce flow depths and upstream right bank levee height requirements. The State-owned Laiewai Bridge on Kamehameha Highway would be modified by cleaning and excavating the stream under the bridge to an invert center-line elevation of -3.2 feet mean sea level (MSL) and the invert under the bridge would be lined with concrete riprap. The bridge abutments would be extended to Station 16+50 to form a wedge type transition to the upstream channel improvements. Bridge pier extensions would be provided to improve flow considerations and reduce debris impacts. Flows will not overtop the highway. The channel improvements would require relocation of one residential structure, three sheds and a fuel tank which are situated on the left bank and center of the channel above Kamehameha Highway.

B. BENEFICIAL AND ADVERSE IMPACTS AND MITIGATION MEASURES

The project will provide protection to the residents of Laie town proper from periodic flooding thereby reducing property flood damages from Kahawainui Stream. It will reduce public health hazards and other adverse economic impacts and enhance community safety. Overall, community growth will be encouraged. The project will contribute to the efficient use of lands consistent with the land use plans and floodplain management policies.



KAHAWAINUI STREAM OAHU, HAWAII

LOCATION MAP

SOURCE:
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 1

The project will also involve altering and filling portions of the wetland area. As mitigation for wetland loss, the remaining wetland acreage would be preserved and enhanced by pond clearing, and habitat improvement consistent with US FWS recommendations. The proposed project will also require the relocation of one residence, three sheds and a fuel tank. The project would result in a general loss of vegetation during construction, although the levees and berms will be revegetated.

During construction, increased turbidity, noise and air pollution may result from use of heavy equipment. Dredging and disturbance of bottom sediments would cause increased turbidity and degradation of water quality. Suspended material can interfere with the respiratory and feeding mechanisms of aquatic organisms. Turbidity effects would be most significant upon the juvenile stages and sessile organisms. Noise and air pollution may temporarily disturb nearby nesting birds and residents of Laie town.

In order to minimize adverse impacts to biological resources, the following mitigation measures will be incorporated for structural alternatives based upon recommendations provided by the U.S. Fish and Wildlife Service.

(1) A low flow channel will be incorporated along the lined portion of the channel above Kamehameha Highway.

(2) The wetland north of the levee will be improved for Gallinule habitat.

(3) As much as practical, construction activities will take place during periods of low stream flow.

(4) All construction activities within and adjacent to the water will be conducted so as to minimize turbidity and control erosion.

(5) The existing water regimes of the ponds along Kahawainui Stream will be maintained to prevent impacts upon the endangered Hawaiian Gallinule.

C. ALTERNATIVES CONSIDERED

1. Plans Considered during Preliminary Screening

A preliminary screening of feasible alternatives conducted by the Corps of Engineers and those eliminated from more detailed analysis were as follows:

a. Upstream Reservoirs. Developing a system of several small detention ponds upstream at various subdrainage areas was considered. Development of several small upstream reservoirs at each subdrainage area would require excavation, grading, and vegetation clearing in wooded or semi-wooded areas at approximately 100-foot elevations. Storing floodwaters for gradual release would require periodic inundation

of up to 70 acres of mesic woodland dominated by guava and haole koa trees and shrubs. Upstream detention ponds would require frequent maintenance since the Paumalu-Badland soils located above the reservoir sites are typically subject to severe erosion. Estimated costs for four upstream reservoirs would be $25 million.

b. Diversion Channels. Diversion channels could be constructed to divert floodwaters from flood prone streams into other streams or drainage areas. Possible diversion channels were considered for Wailele and Malaekahana Streams. Estimated costs for the diversion alignments are $7.6 Million and $9.6 Million, respectively. In addition to the high monetary costs, environmental effects of the proposed channels would also be significant. Diverting floodwaters would require extensive excavation through wooded areas, agricultural areas, and developed and undeveloped lands. Approximately 5,000 to 6,000 lineal feet of diversion channels would be affected. Modifying the receiving drainage basin would also be required in order to accommodate additional floodwaters. The increased floodflow would affect the water quality of coastal receiving waters by increasing sediment loading.

c. No Action. With no action, flooding may be expected to continue as a recurring problem within the Kahawainui Flood Hazard Zone. Laie residents will continue to suffer inconveniences and flood damages to property, public facilities and services. Time, manpower and money would have to be committed for cleanup operations and to repair or replace damaged property and goods.

2. Plans Considered in Detail

Three alternative structural plans and one alternative nonstructural plan were analyzed in detail for flood damage reduction on Kahawainui Stream. Alternative Plan 1 incorporates floodplain management and levee development. Alternative Plan 2 incorporates floodplain management and a combination of levee and channel improvements. Alternative 3, the so-called nonstructural plan, incorporates floodproofing and floodplain management. Alternative 4 incorporates floodplain management and channel improvement.

D. UNRESOLVED ISSUES

There were no unresolved issues encountered by the Corps of Engineers and the City and County of Honolulu thus far.

E. COMPATIBIITY WITH COMMUNITY AND LISTING OF PERMITS AND APPROVALS

The proposed project would provide protection to residents in the Laie town area from periodic flooding from the overflow from the Kahawainui and Laiewai Streams. It would provide protection from flooding anticipated with the standard project flood (285-year) event, a 100-year flood event, a 50-year flood event or a 25-year flood event. It would

also reduce potential public health hazards and other adverse economic impacts, and improve safe movement within the town during storms.

The concrete I-wall, levee sections and raised roadway would be an intrusion into the sense of tranquility and natural greenery that now prevails at the Laie Cemetery. Levee side slopes will be grassed to minimize visual impacts. This segment of the project was redesigned to eliminate the severe social impacts of grave relocation, however, aesthetic impacts are unavoidable.

On the whole, community growth and greater land use flexibility would be permitted with the construction of the project by exempting most residences and properties in the protected area from the restrictive flood insurance regulations.

As part of the project requirements, the Corps of Engineers was required to fulfill the requirements of the Fish and Wildlife Coordination Act, the Coastal Zone Management Act, the Endangered Species Act, the National Historic Preservation Act and Reservoir Salvage Act, as amended and the Clean Water Act as amended.

In compliance with the Fish and Wildlife Coordination Act, the Corps of Engineers initiated coordination with the U.S. Fish and Wildlife Service (FWS) at the beginning of the study to fulfill the requirements of the Fish and Wildlife Coordination Act (FWCA). A preliminary report was submitted by FWS on March 26, 1981 describing fish and wildlife resources in the project area, and was used as a planning aid during the study. A supplemental report was submitted on May 7, 1981. A draft FWCA report was submitted in September 1983, and a final report was submitted in January 1984. The reports are included in Appendix G.

A coastal zone consistency determination report prepared by the Corps of Engineers is provided in Appendix A. The report was submitted by the Corps to the State Coastal Zone Management Office for review. The consistency evaluation summarizes the project's conformance with the policies of the Hawaii State Coastal Zone Management Program.

A listing of the statutes, permits and approvals that were addressed or will be addressed by the Corps of Engineers and the City are listed in Table 1.

Table 1

STATUTES, PERMITS, APPROVALS AND OTHER ENVIRONMENTAL REQUIREMENTS

Federal Statutes	Status	Comments
Archaeological and Historic Preservation Act, as amended	Full compliance	Cultural resources report to be submitted to NPS.
Clean Air Act, as amended	Full compliance	EIS to be submitted to EPA for review and comment.
Clean Water Act, as amended	Full compliance	404(b)(1) evaluation completed.
Coastal Zone Management Act, as amended	Full compliance	CZM consistency determination completed; reviewed by State CZM.
Endangered Species Act, as amended	Full compliance	Sec 7 consultation completed.
Estuary Protection Act	Full compliance	EIS to be submitted to Secretary of the Interior for review and comment.
Federal Water Project Recreation Act, as amended	Full compliance	EIS to be submitted to Secretary of the Interior for review and comment.
Fish and Wildlife Coordination Act, as amended	Full compliance	Draft FWCA Report received.
Land and Water Conservation Fund Act, as amended	Full compliance	EIS to be submitted to Secretary of the Interior for review and comment.
Marine Protection, Research and Sanctuaries Act	Not applicable	Project does not entail ocean dumping of dredged material.
National Historic Preservation Act, as amended	Full compliance	Cultural resources data and SHPO correspondence included in EIS; 1985 survey report to be submitted for review.
National Environmental Policy Act, as amended	Full compliance	
Rivers and Harbors Act	Not applicable	No requirements for Corps projects or program authorized by Congress.
Watershed Protection and Flood Prevention Act	Not applicable	No requirements for Corps activities.
Wild and Scenic Rivers Act	Not applicable	No wild and scenic rivers in POD.
Executive Orders, Memoranda		
Floodplain Management (E.O. 11988)	Full compliance	Evaluation completed.
Protection of Wetlands (E.O. 11990)	Full compliance	Evaluation completed.
Analysis of Impacts on Prime and Unique Farmlands (CEQ Memorandum, 11 Aug 80)	Full compliance	EIS to be submitted to USDA for review and comment.
State and Local Policies		
State EIS Law (Chap 343, HRS)	Full compliance	EIS to be submitted to State of Hawaii and City Department of Land Utilization for acceptance.
State CZMA (Rev 26 Sep 80)	Full compliance	CZM consistency determination completed.
City SMA Ordinance No. 84-4	Full compliance	Application to be submitted to the Department of Land Utilization.
State Protection of Instream Uses of Water (Chap 176, HRS)	Full compliance	Application to be submitted to the State Department of Land and Natural Resources.
401 Water Quality Certification	Not applicable	Federal permit not required. Corps of Engineers in the lead agency for this project.
Shoreline Setback Variance (Chap 205, HRS)	Not applicable	Project to be constructed outside the 40-foot shoreline setback.

also reduce potential public health hazards and other adverse economic impacts, and improve safe movement within the town during storms.

The concrete I-wall, levee sections and raised roadway would be an intrusion into the sense of tranquility and natural greenery that now prevails at the Laie Cemetery. Levee side slopes will be grassed to minimize visual impacts. This segment of the project was redesigned to eliminate the severe social impacts of grave relocation, however, aesthetic impacts are unavoidable.

On the whole, community growth and greater land use flexibility would be permitted with the construction of the project by exempting most residences and properties in the protected area from the restrictive flood insurance regulations.

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II. PROJECT COORDINATION, PROBLEMS, NEEDS AND OBJECTIVES OF THE PROPOSED ACTION

A. PROJECT COORDINATION

The proposed project is a cooperative project between the U.S. Army Corps of Engineers and the City and County of Honolulu.

The responsible lead agency for the project is the U.S. Army Corps of Engineers, Honolulu District. The local sponsoring agency is the City and County of Honolulu.

The materials and information for this environmental impact statement were obtained from the Final Detailed Project Report and Environmental Impact Statement prepared by the U.S. Army Corps of Engineers dated November 1985.

B. PUBLIC CONCERNS

The Laie community of Oahu has experienced serious flooding problems with approximately 12 recorded floods since 1879, however, the flood history is poorly documented. Flooding in 1982 resulted in extensive property damage and public inconvenience and threatened the welfare and personal safety of residents and visitors alike. Between 1963 and 1972, five storms occurred which caused extensive damage to the community. According to local residents, past flooding in Laie was characterized by flood heights as high as 6 feet in low lying areas and necessitated temporary evacuation by the American Red Cross. Poor surface drainage, low-lying topography, vegetation encroachment, inadequate channel capacity and the accumulation of sediment and debris in Kahawainui Stream appear to contribute to flooding problems during periods of heavy rainfall. Most of the residential structures located in the floodplain are not designed to avoid or prevent flood damages. Unless preventive and corrective measures are taken, the Laie community would continue experiencing flood damage and threats to public safety.

C. FLOOD PROBLEM

1. History of Past Storms and Flooding. Approximately 12 damaging floods have occurred in the Laie area since 1879. Documentation of the extent of these floods is not available. The most recent storms were in March 1982, April 1972, February 1969, November 1965, May 1965 and April 1963.

2. Flooding. The overbank flooding problem on Kahawainui Stream is attributed to its inadequate channel capacity and is probably compounded by the accumulation of vegetation and debris in the stream channel and mouth. There are two critical areas, one at the confluences of Ihiihi Gulch and Kahawainui Stream, and the other at Laiewai and Kahawainui Streams, where storm waters exceed the channel capacity and cause overland flows into the Laie community (subdrainage area "A", Figure 2). Floodflows on Kahawainui Stream are characterized by sharp

rises of relatively short duration, followed by rapid recessions. The sharp rises are the result of concentrated storms and rapid run-off, due to the steep and abrupt topography of the drainage basin.

The Laie community is also subjected to flooding due to sheetflow generated by rainfall within its own subdrainage areas (subdrainage areas "C" and "D", Figure 2). Concentrated storms generate large volumes of rainfall within these subdrainage areas. The rainfall exceeds the interior urban drainage system, which tends to exacerbate the overbanking flood problem of Kahawainui Stream. Figure 3 shows the probable flood outlines for the standard project flood (SPF), 100-year, 50-year and 25-year flood events under existing conditions. The flood outlines represent a combination of riverine and interior flooding.

The Wailele Stream (subdrainage "E" on Figure 2) was included in the evaluation to determine if it contributed to the overall flooding problems of the Laie community. Although the SPF and 100-year flood events cause overbanking, the flood limits are contained within a flood fringe, which does not convey waters in the Laie community nor flood any property.

The overall flood problem is also aggravated by the topography of the Laie community. The Laie drainage area is bounded by the steep mountains and high beach berms, with a limited number of drainage outlets across Kamehameha Highway, which contributes to ponding within the lowlying areas.

D. DISCHARGE-FREQUENCY VALUES

Discharge frequency values used for the project's study are summarized in Table 1a for selected concentration points at selected frequencies. The levee and channel modifications are located relatively close to the mouth of the stream and the effects of the proposed improvements on the lower frequency discharges are negligible.

Table 1a. DISCHARGE FREQUENCY AT SELECTED CONCENTRATED POINTS ON KAHAWAINUI STREAM

Frequency	Discharge (cfs) At Confluence (4.53 sq mi)	Discharge (cfs) At Mouth (Routed) (4.99 sq mi)
2-year	1,450	1,600
5-year	3,500	3,800
10-year	5,400	5,700
25-year	8,300	8,800
50-year	10,800	11,400
100-year	13,500	14,200
SPF	18,500	17,800

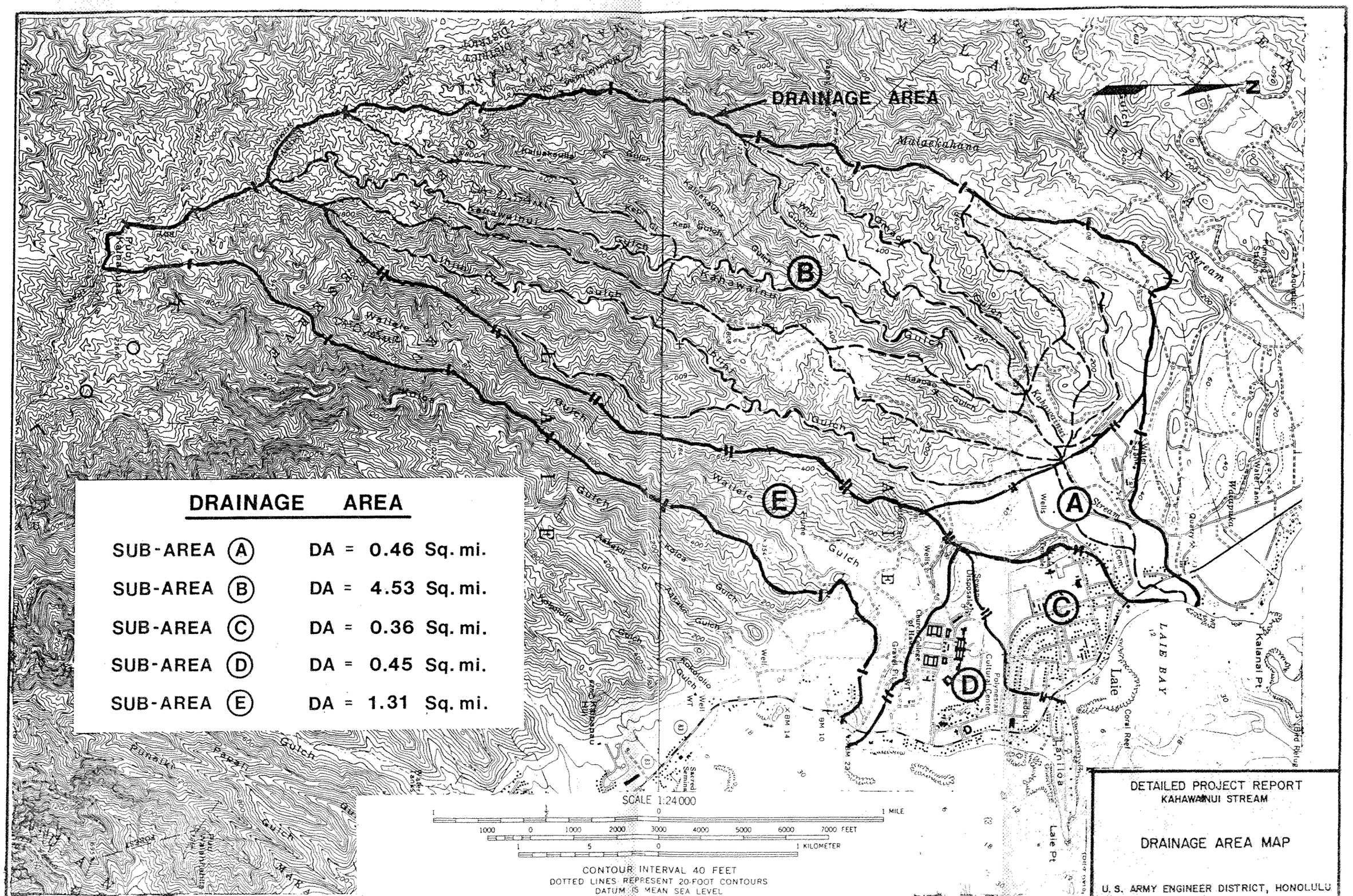
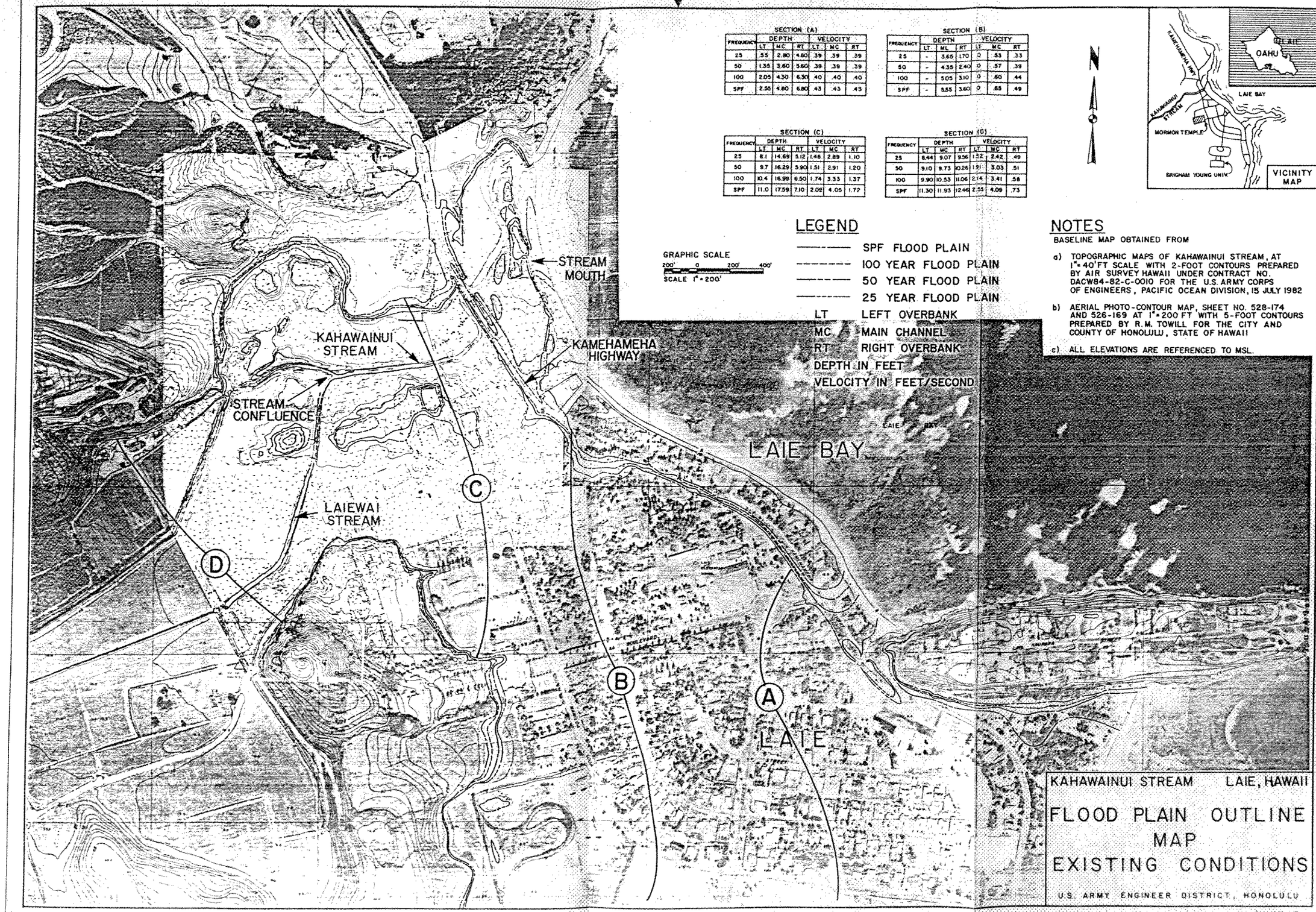

DRAINAGE AREA
DRAINAGE AREA
SUB-AREA (A) DA = 0.46 Sq. mi.
SUB-AREA (B) DA = 4.53 Sq. mi.
SUB-AREA (C) DA = 0.36 Sq. mi.
SUB-AREA (D) DA = 0.45 Sq. mi.
SUB-AREA (E) DA = 1.31 Sq. mi.
SCALE 1:24 000
1 MILE
7000 FEET
1 KILOMETER
CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL
DETAILED PROJECT REPORT
KAHAWAINUI STREAM
DRAINAGE AREA MAP
U. S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 2



SECTION (A)

FREQUENCY	DEPTH			VELOCITY		
	LT	MC	RT	LT	MC	RT
25	.55	2.80	4.60	.39	.39	.39
50	1.35	3.60	5.60	.39	.39	.39
100	2.05	4.30	6.30	.40	.40	.40
SPF	2.55	4.80	6.80	.43	.43	.43

SECTION (B)

FREQUENCY	DEPTH			VELOCITY		
	LT	MC	RT	LT	MC	RT
25	-	3.65	1.70	0	.53	.33
50	-	4.35	2.40	0	.57	.39
100	-	5.05	3.10	0	.60	.44
SPF	-	5.55	3.60	0	.65	.49

SECTION (C)

FREQUENCY	DEPTH			VELOCITY		
	LT	MC	RT	LT	MC	RT
25	8.1	14.69	5.12	1.46	2.89	1.10
50	9.7	16.29	5.90	1.51	2.91	1.20
100	10.4	16.99	6.50	1.74	3.33	1.37
SPF	11.0	17.59	7.10	2.09	4.05	1.72

SECTION (D)

FREQUENCY	DEPTH			VELOCITY		
	LT	MC	RT	LT	MC	RT
25	8.44	9.07	9.56	1.52	2.42	.49
50	9.10	9.73	10.26	1.91	3.03	.51
100	9.90	10.53	11.06	2.14	3.41	.58
SPF	11.30	11.93	12.46	2.55	4.09	.73

FIGURE 3

E. PLANNING OBJECTIVES

Based on an analysis of the problems, needs and opportunities of the study area, the following planning objectives were derived to guide the plan formulation process for flood damage reduction measures in Laie:

1. Contribute to the reduction of property damage by floodwaters from Kahawainui Stream during the 1990 to 2040 period of analysis;

2. Contribute to the efficient use of the lands consistent with land-use plans and floodplain management policy during the 1990 to 2040 period of analysis;

3. Contribute to the improvement of water quality (in terms of oxygen content) of the estuary below Laiewai Bridge; and

4. Minimize disturbance to graves in Lai'e Cemetery.

5. Protect and/or enhance the beneficial values of wetlands and other important environmental resources within the project area.

III. DESCRIPTION OF THE PROPOSED PROJECT

The proposed project is located in Laie on the northeast coast of the Island of Oahu (See Figure 1). The project will consist of channel improvements and a levee along the right bank of Kahawainui and Laiewai Streams to relieve the flooding problems in the area (See Figure 4).

The levees would be about 1,760 feet in length and would have a maximum height of about 12.6 feet. The levees would consist of compacted earth-fill with the side slope along the stream lined with concrete riprap downstream of Station 27+70 to prevent erosion of the levee by the floodflows. The backside slope and the levee crest would be grassed. A concrete I-wall would be provided between Stations 27+70 and 30+33. The levee would require that a road be raised to a maximum height of about 10.0 feet near Station 27+63 for access to cemetery areas, and that another road be raised to a maximum height of about 10.1 feet near Station 38+35.

The existing stream would be realigned upstream of Kamehameha Highway and replaced with a trapezoidal channel with 3 to 1 side slopes from the bridge to Station 21+00 for a length of about 490 feet. The channel would be concrete lined from the bridge at Station 16+40 to Station 17+50 and concrete riprap lined from Station 17+50 to Station 21+00. Two feet deep invert cut-off walls would be placed between linings. The channel invert would be V-shaped to channelize low flows. Above Station 21+00, the floodplain would be graded to concentrate low flows into a swale and to guide flows from the existing stream to the channel improvements (See Figure 5). The upstream end of the channel improvement is widened from an 80-foot base width at Station 19+00 to 150 feet at Station 21+00 to reduce flow depths and upstream right bank levee height requirements. Along the left bank, the channel would be in cut. The channel top would require fill at the design channel height along the right bank. The State-owned Laiewai Bridge on Kamehameha Highway would be modified by cleaning and excavating the stream under the bridge to an invert center-line elevation of -3.2 feet mean sea level (MSL) and the invert under the bridge would be lined with concrete riprap. The bridge abutments would be extended to Station 16+50 to form a wedge type transition to the upstream channel improvements. Bridge pier extensions would be provided to improve flow considerations and reduce debris impacts. Flows will not overtop the highway. The channel improvements would require relocation of one residential structure and three sheds which are situated on the left bank and center of the channel above Kamehameha Highway.

Flows would pass through the modified bridge and another wedge transition downstream of the Kamehameha Highway and into the existing Kahawainui Stream. Flows exceeding the stream capacity of about 400 cfs below the project limits will overflow within the park site and discharge as sheet flows to the ocean. This park area will remain in a flood hazard zone.

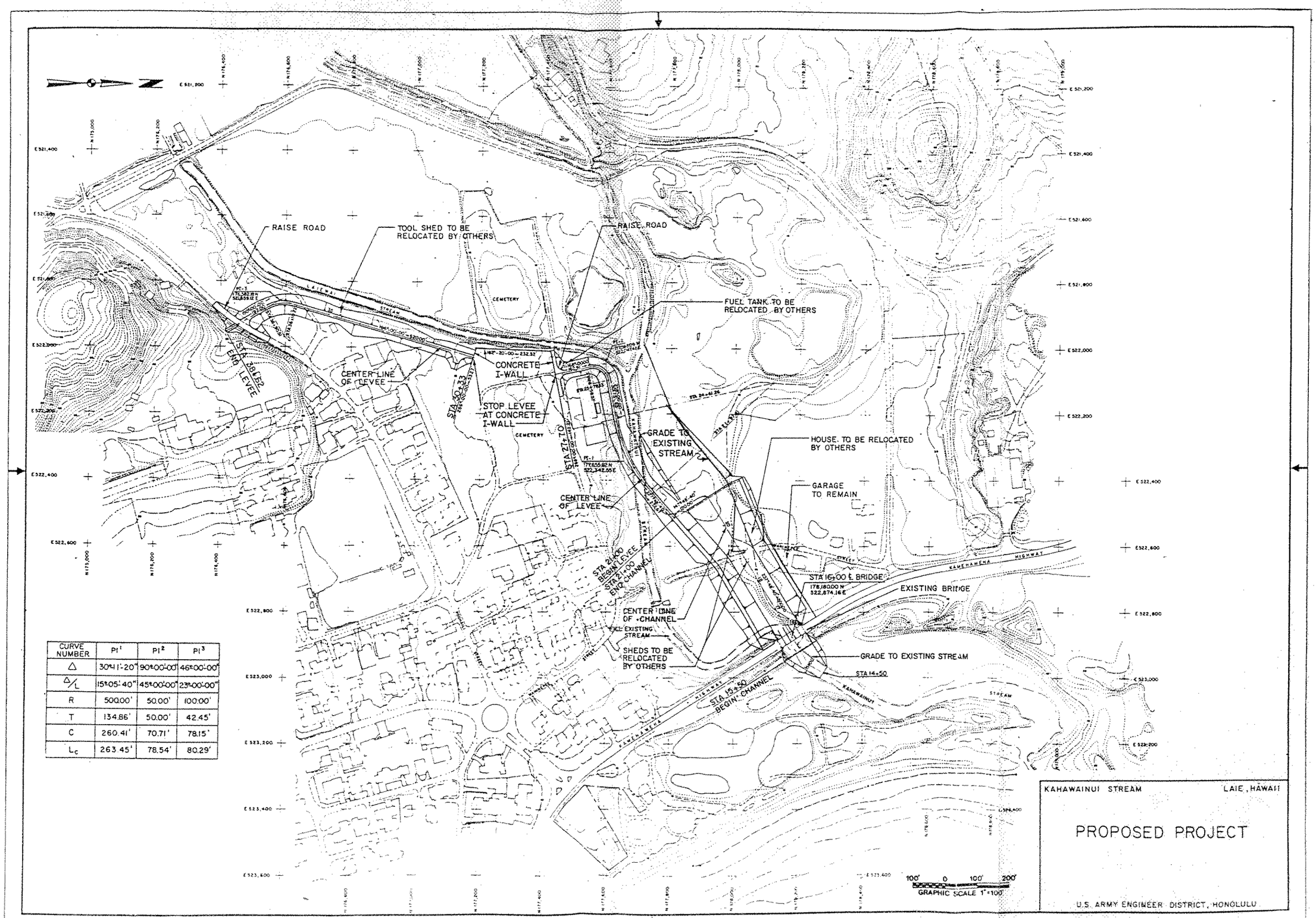
An equipment turnaround area will be provided in the upper levee area to aid in the ease of maintenance by the City and County of Honolulu. Project land and easements for the channel and levee will require about 5.3 acres of land.

Construction would require approximately 18 months to complete. Construction would be accomplished by contract through competitive bidding under the U.S. Army Corps of Engineers supervision. Starting dates will be sometime in 1988.

The total project first cost is $3,290,000. Of this cost, $2,760,000 would be borne by the Corps of Engineers, and the remaining $530,000 by the City and County of Honolulu. This apportionment of project costs is based on the traditional policy for cost sharing of Federal flood control projects.

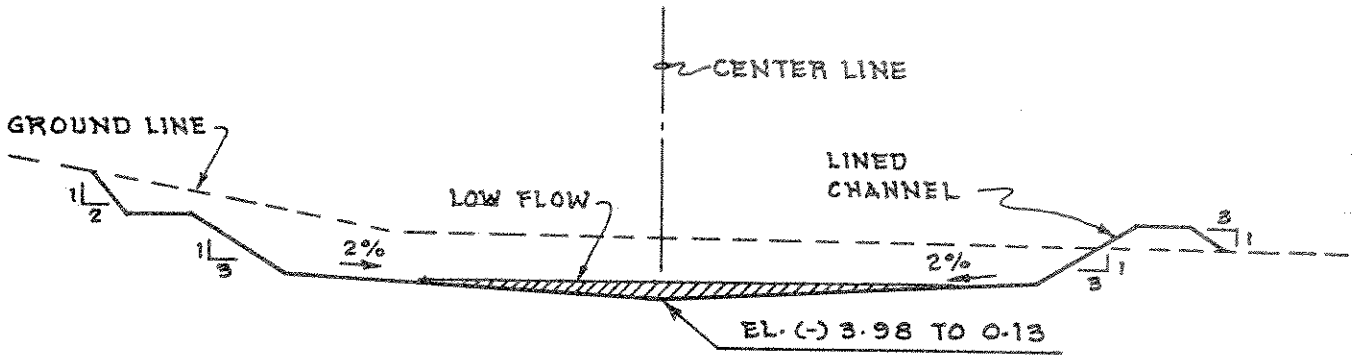
Zions Securities Corporation, the largest land owner at the project site, has also indicated that they would be willing to participate in the local share of the project cost. Zions Securities Corporation will be dedicating all of the easements and land rights required for the project, a disposal site for the disposal of the vegetation and unsuitable materials, and a borrow site to provide suitable fill and backfill material for the project.

State funds has not been appropriated for this project. However, the project will affect State lands within the Kamehameha Highway rights-of-way at the bridge crossing.



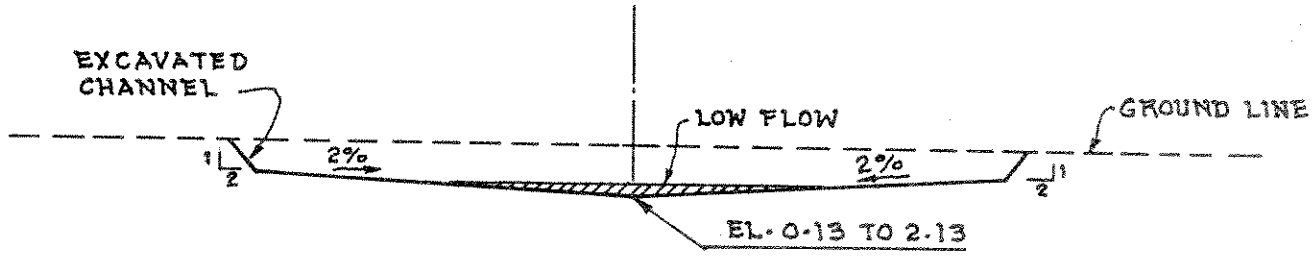
CURVE NUMBER	PI[1]	PI[2]	PI[3]
Δ	30°41'-20"	90°00'-00"	46°00'-00"
Δ/L	15°05'-40"	45°00'-00"	23°00'-00"
R	500.00'	50.00'	100.00'
T	134.86'	50.00'	42.45'
C	260.41'	70.71'	78.15'
L_c	263.45'	78.54'	80.29'

FIGURE 4



DRAINAGE CHANNEL

STA. 16+40 TO STA. 21+00



DRAINAGE SWALE

UPSTREAM OF STA. 21+00

KAHAWAINUI STREAM LAIE, HAWAII

TYPICAL SECTION

DRAINAGE CHANNEL AND DRAINAGE SWALE

FIGURE 5

IV. ALTERNATIVES

A. PRELIMINARY SCREENING OF ALTERNATIVES

A preliminary screening of feasible alternatives was conducted for Kahawainui Stream to eliminate obvious inapplicable and inappropriate measures prior to more detailed analysis.

1. Structural measures

Structural alternatives within the context of flooding are alternatives used to reduce the extent of flooding by constructing levees, dams, reservoirs, diversion works or channel modification. These measures specifically may include:

-Storing water in reservoirs or ponding areas for gradual release after the threat of flooding has passed;

-Diverting flood flows away from property by constructing a diversion channel; and

-Improving flow conditions by channel modifications so that flood stages can be reduced.

a. Upstream Reservoir. One type of structural flood control measure is temporary impoundment and controlled release of floodwaters by a dam structure and reservoir or detention pond. These structures are designed to impound floodwaters which would exceed the downstream channel capacity. These waters would then be released at a safe rate after the flood has crested. To effectively control floods, a dam and detention pond must be constructed at a site, which would control most of the runoff-produced flooding and be large enough to sufficiently store the floodwaters. A detention pond site may require clearing and/or grubbing. The reservoir area would be inundated only during floodflows.

A preliminary assessment of this alternative was conducted. Additional hydrologic analyses were developed for the individual gulches, i.e., the evaluation of each stream's floodflow contributions and peaking times, in order to estimate the required size of ponding pools and embankments. The terrain features preclude any suitable site for the location of a single dam structure. An investigation showed that a single dam structure would need to be 4,000 feet in length, which would be too long to be economical.

Instead, a system of several small detention ponds, upstream at each subdrainage area, was considered to be more practical. Development of several small upstream reservoirs at each subdrainage area would require excavation, grading, and vegetation clearing in wooded or semi-wooded areas at about the 100-foot elevation. Storage of floodwaters for gradual release would require periodic inundation of up

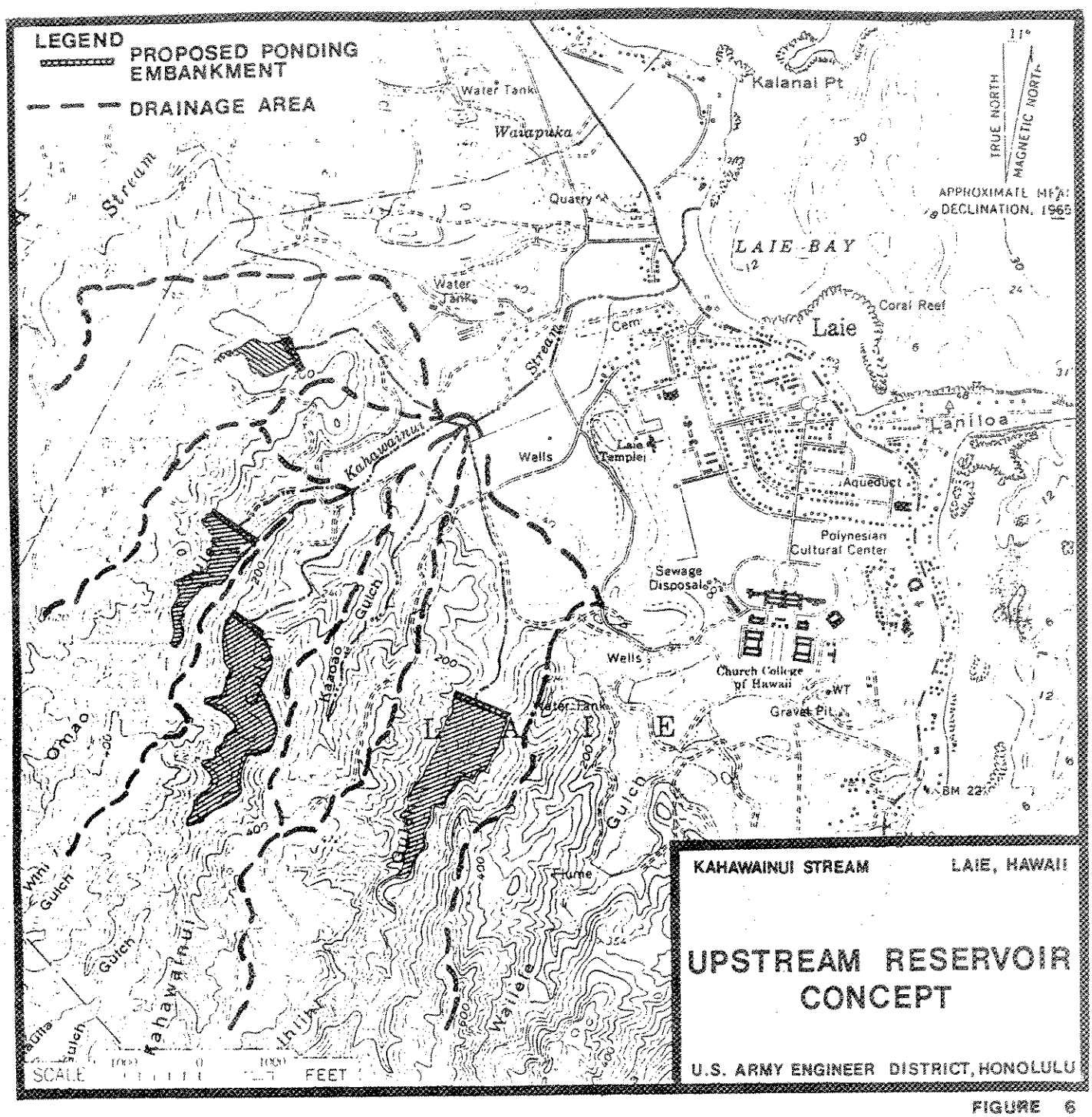


FIGURE 6

TABLE 2. Possible Preliminary Design Features of an Upstream Reservoir System Alternative

Tributary	unit	Un-named SPF	Un-named 100y	Omao SPF	Omao 100y	Kahawainui SPF	Kahawainui 100y	Ihiihi SPF	Ihiihi 100y
Drainage area at dam site	sq mi	0.32	0.32	0.50	0.50	1.70	1.70	1.19	1.19
Dam height above stream bed	ft	74	64	144	135	134	123	97	87
Crest length	ft	440	390	750	700	550	530	800	760
Spillway length	ft	300	260	510	465	490	440	310	290
Inflow	cfs	2250	1640	3020	2300	8220	6450	6180	4950
Outflow	cfs	150	140	170	140	590	530	260	340
Debris & Sed. storage	AF	4.00	3.00	5.00	2.50	20.0	10.0	11.0	7.00
Flood control pool storage	AF	302	212	426	350	1350	1060	1040	817
Debris & Sed. storage area	Ac	1.32	1.30	0.10	0.05	1.00	0.70	3.50	3.40
Flood control pool area	Ac	10.4	7.75	8.72	7.60	25.5	21.7	25.0	21.3

to 70 acres of mesic woodland dominated by guava and koa haole trees and shrubs. Paumalu badland soils located above the reservoir sites are subject to severe erosion. Thus, detention ponds would be subject to sedimentation and could require frequent maintenance dredging.

Table 2 summarizes the pertinent elements of this scheme. See Figure 6. Each ponding area was designed to minimize the need for downstream channel modifications. A tradeoff analysis was also conducted to evaluate the reduction of the ponding area by increasing the downstream channel capacity. This was not deemed economical. Based on the dimensions of the basic elements of the smaller dams and the costs associated with similar sized projects, this alternative plan would cost more than $25 million. The Kaneohe-Kailua Dam which was completed in 1981 has an embankment height of 76 feet, a crest length of 2,200 feet and a spillway with a length of 1,200 feet; it had a cost of $19 million (August 1981 price levels). This cost reflects the purchase of the flood control lands and the construction of the structures. The total combination of the separate smaller reservoirs would be similar to the Kaneohe-Kailua Dam in size.

The expected average annual costs would greatly exceed the potential average annual benefits. Consequently, an upstream reservoir plan was eliminated from further consideration.

b. Diversion Channels. This structural measure diverts floodwaters away from flood prone areas by the construction of diversion channels from flood prone streams to other streams or areas. Based on the topography of the study area, a diversion channel would need to be built at the confluence of Ihiihi, Kahawainui and an unnamed stream (see Figure 7) in order to divert floodwaters before they affect Laie. Table 3 summarizes possible diversion channels:

TABLE 3. DIVERSION CHANNEL ALTERNATIVES

Diversion Alignment		Improvements to the Re-	Estimate
To	Distance (ft)	ceiving River System (ft)	$
Wailele Stream	5,500	4,000	$7.6 M
Malaekahana Stream	6,000	6,000	$9.6 M

Diversion of floodwaters to another drainage basin would require extensive excavation through wooded areas, agricultural areas, and developed or undeveloped open lands. Approximately 5,000 to 6,000 lineal feet of land would be affected by the construction of a channel diversion to the nearest drainage basin. This alternative would also require modification of the receiving drainage basin in order to accommodate the additional flood waters. Increased flow through the new drainage basin would lower water quality in coastal receiving waters fronting the affecting stream(s).

The channel width would need to be 75 feet to accommodate approximately 11,000 cfs of flow for the 100-year flood event. Based on this size channel, a preliminary cost estimate of $800 per foot of channel appears reasonable, based on experiences with other lined channels in Hawaii. The expected average annual costs would greatly exceed the potential average annual benefits. Consequently, diversion channels were eliminated from further consideration.

c. Increasing Channel Capacity

(1) Channel Modification. These measures are designed to contain the expected flood flows within the stream channel by modifying the stream to increase its flow capacity. Typical means to increase capacity include enlarging the channel and removing constrictive points in the stream.

It appears from the topographic and hydrologic characteristics of the floodplain that flood waters overbank Kahawainui Stream above the confluences of Omao Gulch and Kahawainui Stream and at Ihiihi Gulch and Kahawainui Stream.

Consequently, channel modifications will have to extend above the lower floodplain to adequately intercept the floodwaters before they overflow the stream banks. Therefore, the channel would be modified for at least 1,600 feet (see Figure 8). At $800 per foot, a channel modification project would cost approximately $1.3 million. Detailed studies for providing stream channel improvements were considered further.

(2) Levees. Levees are used to confine floodwaters to a designated floodway. When used in combination with other flood control measures, they serve to heighten existing streambanks and to divert floodwaters into a designated channel or floodway.

The majority of the damageable property in the Kahawainui Stream floodplain is along the right streambank (looking downstream). A levee system along the right bank to confine the floodwaters is technically and economically feasible. Relocating houses would not be necessary. The topographic characteristics of the left bank indicate that a levee system may not be required on the left bank. Structures remaining in the floodplain after the construction of the levee system would need to be floodproofed or relocated. Channel improvements downstream may be used to minimize the requirement for upstream levees. Overtopping and breaching by a flood greater than the design flood are the major concerns with levees. Consequently, levees usually require greater maintenance and inspection, as well as a higher level of design than other typical flood control measures.

Three levee alternative plans were investigated: one low-cost alternative utilizing existing high ground along the right stream bank, the second, utilizing a levee system to confine the flood flow at a higher level of protection, and the third combining a levee and channel modification plan to minimize the risks associated with

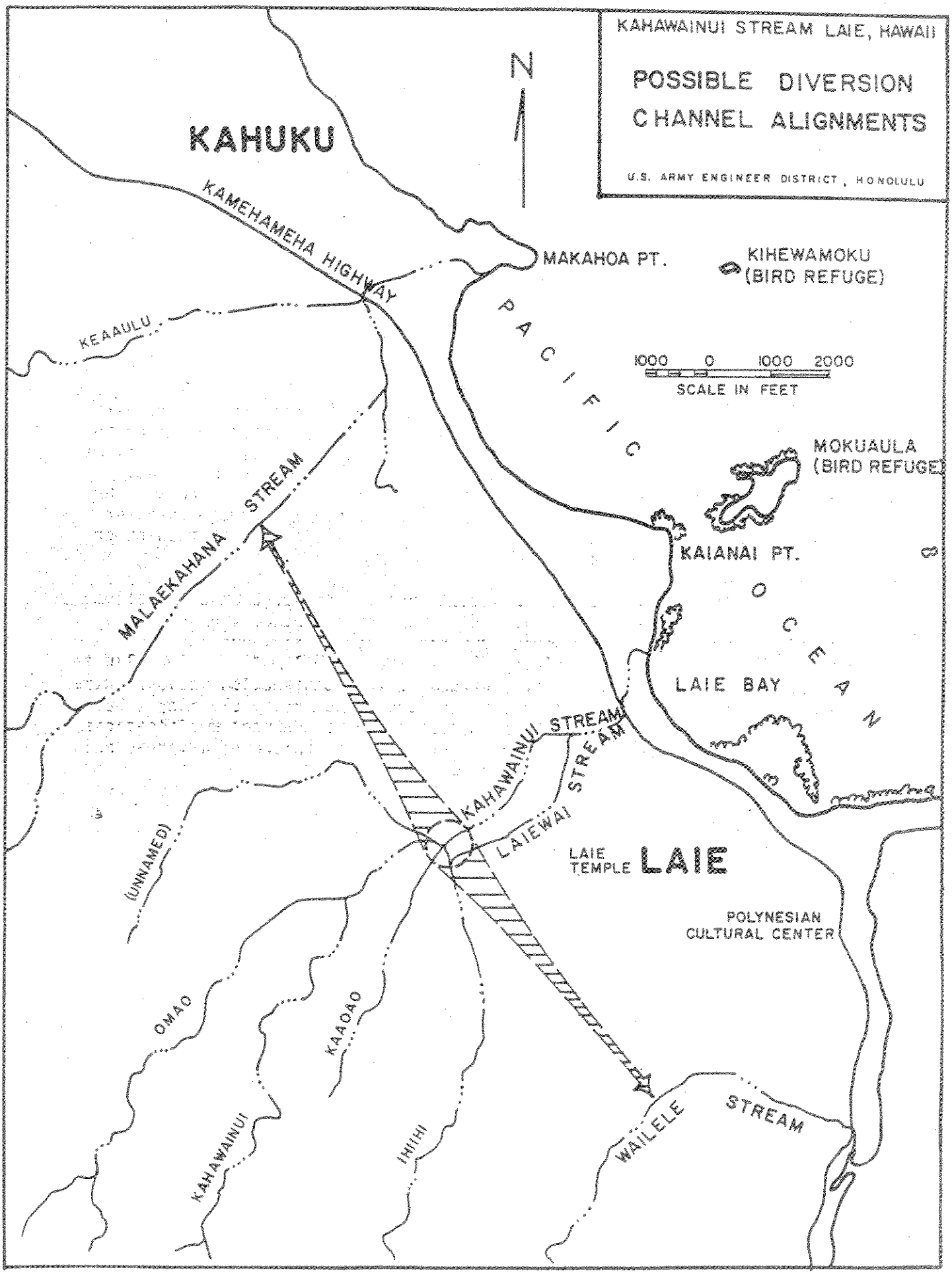

KAHAWAINUI STREAM LAIE, HAWAII
POSSIBLE DIVERSION CHANNEL ALIGNMENTS
U.S. ARMY ENGINEER DISTRICT, HONOLULU
N
KAHUKU
KAMEHAMEHA HIGHWAY
MAKAHOA PT.
KIHEWAMOKU (BIRD REFUGE)
KEAAULU
PACIFIC
1000 0 1000 2000
SCALE IN FEET
MOKUAULA (BIRD REFUGE)
MALAEKAHANA STREAM
KAIANAI PT.
OCEAN
LAIE BAY
KAHAWAINUI STREAM
LAIEWAI STREAM
(UNNAMED)
LAIE TEMPLE
LAIE
POLYNESIAN CULTURAL CENTER
OMAO
KAAOAO
KAHAWAINUI
IHIHI
WAILELE STREAM

FIGURE 7

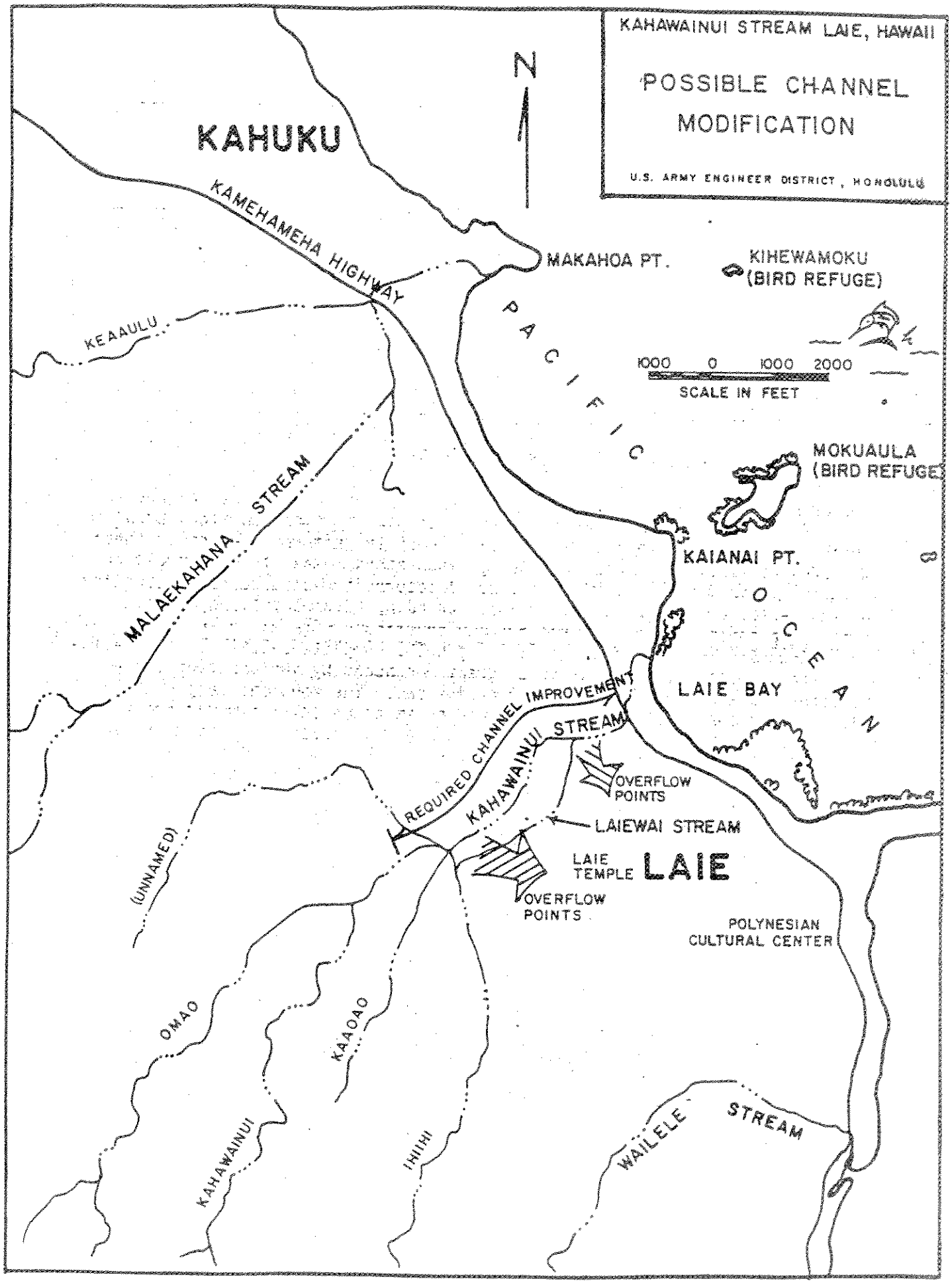

KAHAWAINUI STREAM LAIE, HAWAII
POSSIBLE CHANNEL MODIFICATION
U.S. ARMY ENGINEER DISTRICT, HONOLULU
N
KAHUKU
KAMEHAMEHA HIGHWAY
MAKAHOA PT.
KIHEWAMOKU (BIRD REFUGE)
KEAAULU
PACIFIC
1000 0 1000 2000
SCALE IN FEET
MOKUAULA (BIRD REFUGE)
MALAEKAHANA STREAM
KAIANAI PT.
OCEAN
LAIE BAY
REQUIRED CHANNEL IMPROVEMENT
KAHAWAINUI STREAM
OVERFLOW POINTS
LAIEWAI STREAM
LAIE TEMPLE
LAIE
OVERFLOW POINTS
(UNNAMED)
POLYNESIAN CULTURAL CENTER
OMAO
KAAOAO
KAHAWAINUI
IHIIHI
WAILELE STREAM

FIGURE 8

levees. Levee construction would require excavation and filling of vegetated areas, including grassy clearings, hau thickets and wetland fringes. Levees associated with channel modifications would require excavation and filling of existing hau thickets; mangrove and estuarine wetlands; robust ironwood groves; and banana plantings and ornamental escapes along Kahawainui Stream. Portions of the stream and wetlands would be left dry with a new channel alignment. Flora and fauna associated with these former wet areas would be adversely affected unless they are adaptable to mesic conditions. Preliminary analysis of these two alternative plans indicated that they may be economically feasible, and therefore, additional studies were conducted.

The low cost levee alternative utilized the high ground in the area of the cemetery into the design of the levee, i.e., constructing a levee on both sides of this high ground. It was determined that this levee could be constructed at elevation +12 feet MSL. At this elevation, protection against the 4.2-year storm event would be provided. Based on preliminary estimates, it was determined that the average annual benefits and costs would be $106,000 and $114,000, respectively, resulting in a benefit-cost ratio of 0.93. With net benefits of -$8,000, no further development of this alternative was pursued.

2. Nonstructural Alternatives

Nonstructural alternative measures do not reduce or eliminate flooding, but are intended to minimize loss and damage during floods. These alternatives do not control the flow of water, but rather remove, floodproof, or prohibit damageable property within the flood zone. Typical nonstructural measures include, but are not limited to:

-Incorporating floodplain restrictions on construction and use of lands;

-Improving maintenance and efficiency of existing flood control and drainage structures;

-Relocating the flood damageable structures to property outside the floodplains;

-Implementing flood insurance programs;

-Floodproofing existing structures; and

-Flood forecasting, warning, and evacuation systems.

Two or more of these nonstructural measures can be used together to complement each other. Nonstructural measures are possible solutions to flood problems which do not involve significant alteration of the natural elements. These measures attempt to minimize damage by floodwaters rather than controlling or reducing these waters. Options

include floodproofing structures, relocating of residents, or enforcing regulations regarding floodplain management. Although a nonstructural alternative may contribute significantly to the reduction of future flood damages, it is not a complete solution. The recovery time from floods, however, would be greatly reduced by implementing these measures, especially for commercial businesses. The inherent danger of flooding and the problems of erosion and sediment deposition would not be eliminated. Other complementary measures may also need to be incorporated to minimize the flooding hazard. These other measures include floodplain restrictions and ordinances, maintenance of the stream channel, and the use of flood warning and evacuation systems.

a. Floodplain Restrictions. Land use controls on future development within the floodplain such as zoning, subdivision regulations, building codes, development policies, and designated floodways can lessen future damaging effects of floods. The City and County of Honolulu incorporated floodplain management regulations under the auspices of the Federal Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973, through the Federal Flood Insurance Administration. The hydrologic analyses conducted for this study directly supports this policy, in that it provided a detailed flood hazard map of the Laie Bay area for the County. The preliminary flood hazard map was forwarded by the County to the Federal Emergency Management Agency for their approval. Although this policy reduces potential damages, it does not relieve the flood hazard to those who are in the floodplain. However, this measure can complement other structural or nonstructural measures.

b. Maintenance. Maintenance consists of a regularly instituted program of repairing stream channel structures, removing sediment, and clearing obstructive material (vegetation and other debris) from the channel. Maintenance alone will not significantly reduce the larger storm-generated floods, but will provide protection for the lower frequency storms. The carrying capacities and related flood frequency expected for Kahawainui Stream under three channel conditions are presented on Table 4:

TABLE 4. STREAM CONDITIONS AND CAPACITIES

Condition of Stream	Estimated Capacity (cfs) 1/	Associated Flood Frequency
Clean, well maintained, stream mouth relatively open	1200-1700	.34 exceedance (3 years)
Moderately vegetated, some debris and sediment deposition, stream mouth moderately plugged	900-1200	.61 exceedance (2 years)

Heavily vegetated, poorly maintained, high deposition of debris and sediments, stream mouth fully plugged	900	.72 exceedance (1 year)

1/ Estimated capacity between Laiewai and confluence at Kahawainui and Laiewai Stream.

If Kahawainui Stream was fully maintained, it would accommodate a flow of 1200 to 1700 cfs. Flows exceeding this capacity will cause flood damages. Regular maintenance must complement any nonstructural alternative.

c. Relocation. Relocation is the physical removal of all potentially damageable property and the conversion of these lands to uses compatible with the flood risk. The social and cultural impacts of relocation need to be evaluated since many families have lived in the area for generations. Relocation also complements the floodproofing of remaining structures.

d. Flood Forecasting, Warning and Temporary Evacuation. The effectiveness of these measures is a direct function of the reaction time to the flood warnings, coupled with a belief by the residents in the floodplain in the accuracy of forecasts and warnings. This confidence is most often based on past experience with floods.

Kahawainui Stream is characteristic of most streams in Hawaii where the time to peak discharge is only a matter of hours. Consequently, the primary aim of forecasting and warning is to save lives. Civil defense agencies, in cooperation with National Weather Service and police have established flood forecasting and warning systems for Oahu. While lives can be saved, usually little can be done to reduce the flooding of homes unless some type of floodproofing has been incorporated. Flood warnings can warn the people of possible flood hazard conditions and allow the maximum time to implement floodproofing measures to their homes or to evacuate flood hazard areas.

e. Flood Insurance. Flood insurance does not reduce flood hazard damages, but rather lessens the economic burden of flooding and encourages floodplain development restrictions. Over the long term, the land use regulation, which requires participation in the National Flood Insurance Program, should effectively reduce the amount of existing flood prone development. Again, this measure is effective when complemented with other nonstructural alternatives.

f. Floodproofing. The alteration of a structure or conditions surrounding the structure to prevent damage by floodwaters is known as floodproofing. Typical methods include: (1) raising the building above the flood level; (2) installing waterproof panels and sealing around openings; and (3) providing walls or levees around the

building. While the function of these methods is essentially the same, i.e., to preclude floodwaters from entering the building's interior, each method has different limitations. Raising a slab-on-grade structure is often uneconomical and unpractical, and the height a structure can be raised is limited because of stability considerations. Sealing and waterproofing are only applicable to buildings that can sustain the hydrostatic pressure and drag force exerted by floodwaters. Constructing walls or levees to floodproof individual property can be unsightly and expensive, and it is necessary to provide interior drainage.

Floodproofing is effective when complemented by floodplain restrictions, regular stream maintenance, and effective forecasting and warning. Floodproofing can also be effective in complementing other nonstructural measures.

Since many of the residences in the floodplain are wooden-frame, post-and-beam structures, it is economical to floodproof them by raising them above the floodplain. There are approximately 441 structures in Laie. Structures prone to flooding would need to be floodproofed or relocated, depending on the type and condition of the structure. Much of the land adjacent to the stream, which was formerly used for agriculture, is now used as pasturage for a few cattle and small agricultural plots. Flood regulation of those areas, for activities consistent with the flood hazard zone, would probably not displace many structures. Floodproofing of residential structures may result in localized disturbance to vegetation, including landscaped ornamentals near housing foundations. This is not anticipated to be significant over the long term, since vegetation can be replanted and no rare or endangered species will be affected. No adverse effects on wetlands are anticipated under this alternative. A detailed assessment of the feasibility of floodproofing was examined to determine the technical and economic potential of floodproofing or relocating structures subjected to flooding.

B. ALTERNATIVES STUDIED IN DETAIL

Based on the preliminary screening and the previous discussions and analyses, four alternatives were considered the most appropriate for Kahawainui Stream at this time, and further detailed studies were conducted.

Alternative 1: Levee Plan
Alternative 2: Levee and Channel Plan
Alternative 3: Floodproofing and Floodplain Management Plan
Alternative 4: Channel Plan

1. Alternative Plan 1 - Levee Plan

Alternative Plan 1 (see Figure 9) provides for levee protection along the right stream bank of Kahawainui Stream beginning

from Laiewai Bridge at Kamehameha Highway. The levee length and height would vary with the design level of protection:

TABLE 5. LEVEE PLAN

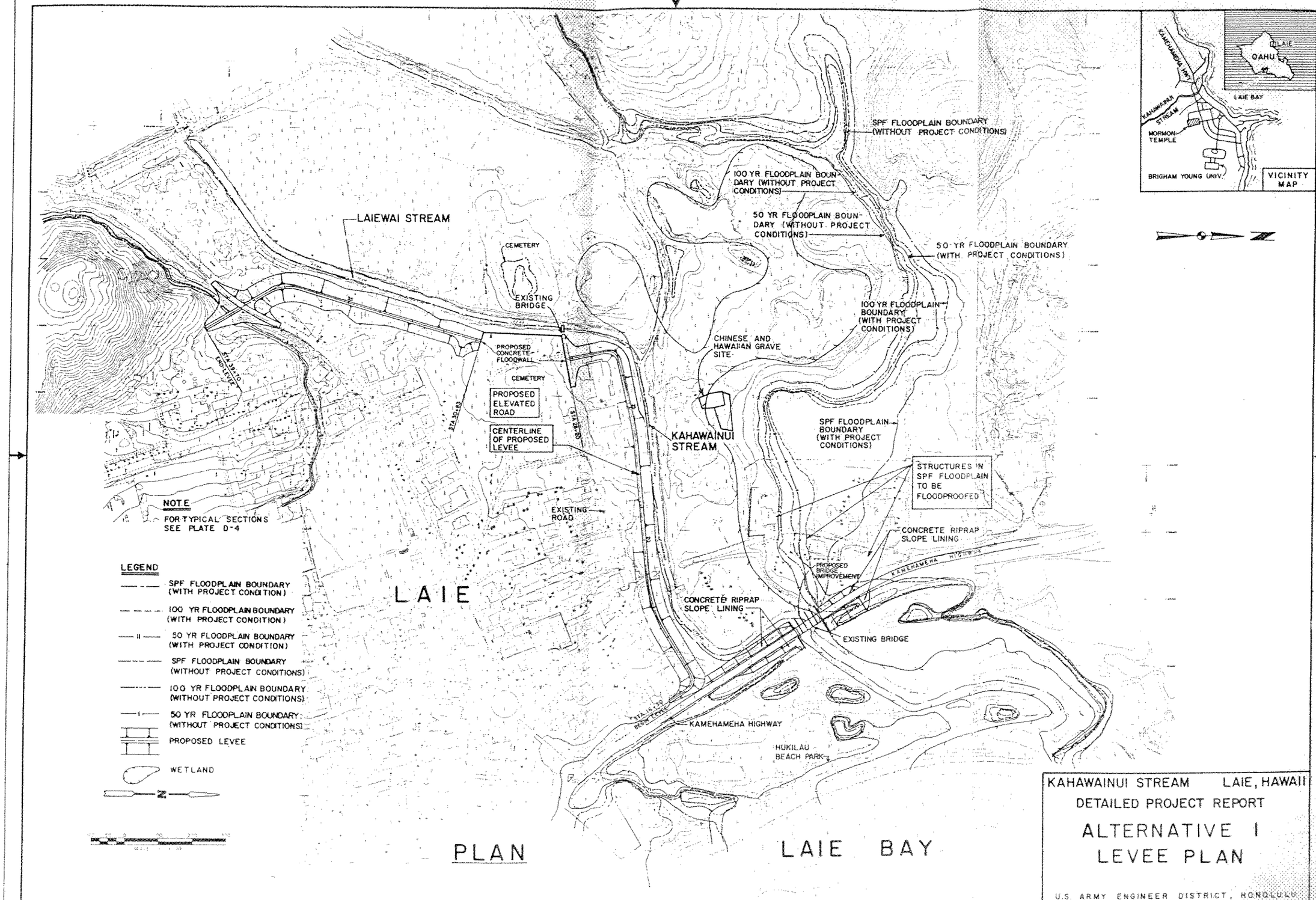
Plan	Level of Protection	Maximum Height (ft)	Levee Features Length (ft)	Levee Features Crest Width (ft)	Side Slope
1a	SPF	15.8	2,370	12.0	2-to-1
1b	100 yr	15.0	2,360	12.0	2-to-1
1c	50 yr	14.5	2,360	12.0	2-to-1

The levee would consist of compacted earth-fill with the side slope from Stations 16+30 to 28+20 lined with concrete riprap on the river side to prevent erosion of the levee by flood flows. The backside slope and the levee crest would be grassed. At Station 28+13, an existing road would be elevated a maximum height of about 12.5 feet at the levee crossing for access to an existing cemetery located along both sides of the levee. Another road would also need raising at the upstream end of the levee. A concrete I-wall supported on steel sheet piling would be located between Stations 28+20 and 30+83. This wall would extend a distance of about 430 linear feet and would avoid mass relocation of 67 graves, which otherwise would be necessary by levee construction within this reach. The levees will tie into each end of the wall. Fencing or other similar protective measures would be provided at these retaining end wall locations. The levee would continue upstream of Station 30+83 and would be grassed on both sides. A minimum freeboard allowance of 3 feet was utilized.

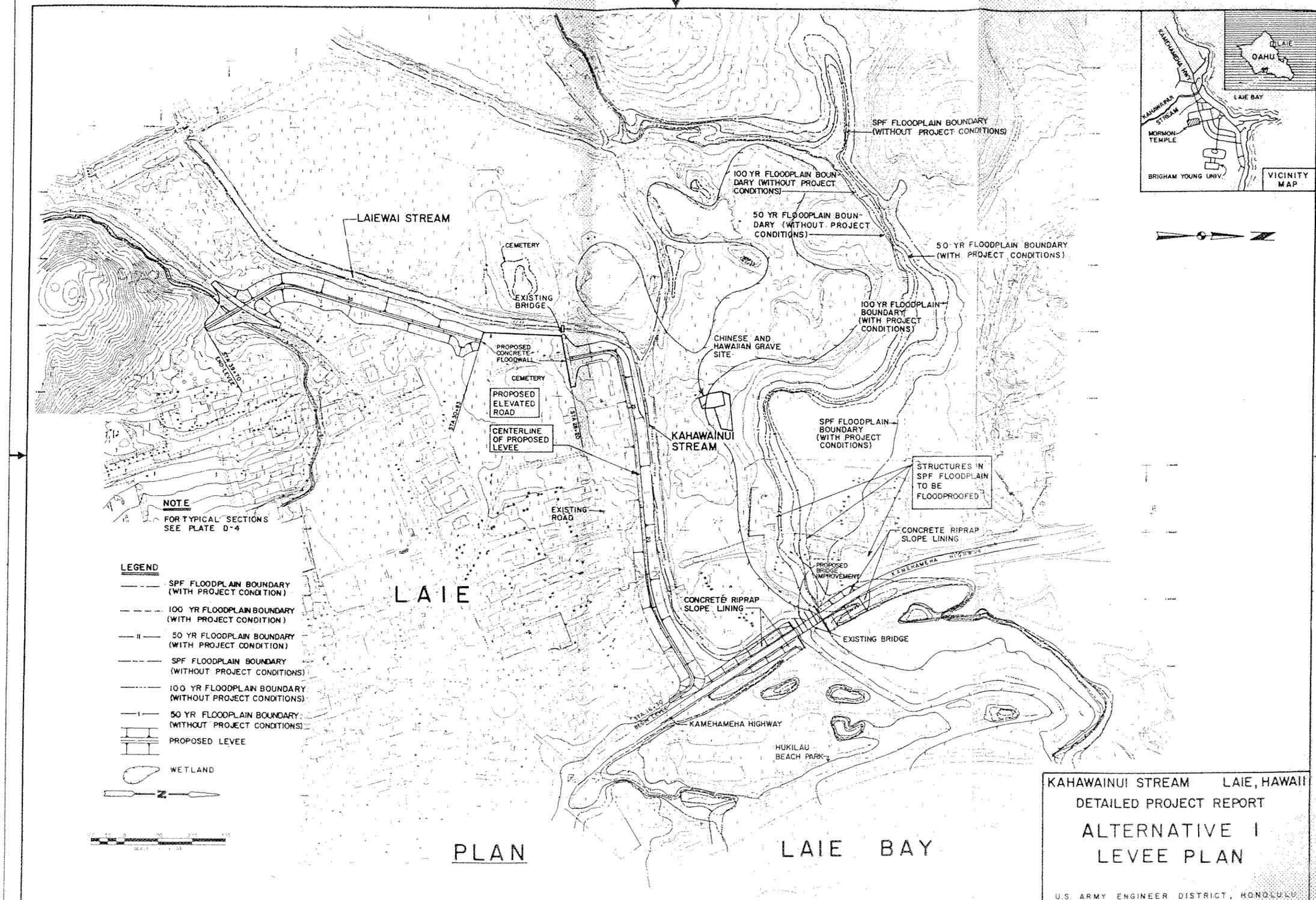
The area upstream of the levee would be subject to flooding and would need to be zoned as a flood hazard area. This area is shown on Figure 9.

At the downstream end, flows would be ponded against the Kamehameha Highway; concrete riprap paving along the highway embankment would be provided as slope protection to stabilize the highway for this purpose. The existing bridge abutments would be extended with concrete walls along the ends of the slope protection. Pier extensions would be provided at the existing bridge piers and the bridge invert would be deepened and lined with concrete riprap to increase bridge capacity and to pass flows through the bridge. Flows would not overtop the highway. The park downstream of the Kamehameha Highway would remain as a flood hazard area and would be subject to flooding by flood events greater than the 50-year frequency. Flood warning signs would be placed in the park to warn park users of potential flood hazards.

The proposed levee system would increase the extent of floodplain on the left bank upstream of Kamehameha Highway. The anticipated effects of higher flood stages on five (5) existing structures on the left bank are shown on Table 6.



LAIEWAI STREAM
CEMETERY
EXISTING BRIDGE
PROPOSED CONCRETE FLOODWALL
CEMETERY
PROPOSED ELEVATED ROAD
CENTERLINE OF PROPOSED LEVEE
STA 39+70 END LEVEE
STA 30+83
STA 28+20
EXISTING ROAD
NOTE
FOR TYPICAL SECTIONS SEE PLATE D-4
LAIE
SPF FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
100 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
50 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
50 YR FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
100 YR FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
CHINESE AND HAWAIIAN GRAVE SITE
KAHAWAINUI STREAM
SPF FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
STRUCTURES IN SPF FLOODPLAIN TO BE FLOODPROOFED
CONCRETE RIPRAP SLOPE LINING
PROPOSED BRIDGE IMPROVEMENT
KAMEHAMEHA HIGHWAY
CONCRETE RIPRAP SLOPE LINING
EXISTING BRIDGE
STA 16+30 BEGIN LEVEE
KAMEHAMEHA HIGHWAY
HUKILAU BEACH PARK
LAIE BAY
LEGEND
SPF FLOODPLAIN BOUNDARY (WITH PROJECT CONDITION)
100 YR FLOODPLAIN BOUNDARY (WITH PROJECT CONDITION)
50 YR FLOODPLAIN BOUNDARY (WITH PROJECT CONDITION)
SPF FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
100 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
50 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
PROPOSED LEVEE
WETLAND
N
PLAN
KAMEHAMEHA HWY
KAHAWAINUI STREAM
MORMON TEMPLE
BRIGHAM YOUNG UNIV.
LAIE BAY
OAHU
LAIE
VICINITY MAP
KAHAWAINUI STREAM LAIE, HAWAII
DETAILED PROJECT REPORT
ALTERNATIVE I
LEVEE PLAN
U.S. ARMY ENGINEER DISTRICT, HONOLULU
FIGURE 9



LAIEWAI STREAM
CEMETERY
EXISTING BRIDGE
PROPOSED CONCRETE FLOODWALL
CEMETERY
PROPOSED ELEVATED ROAD
CENTERLINE OF PROPOSED LEVEE
STA 39+70 END LEVEE
STA 30+83
STA 28+20
EXISTING ROAD
NOTE
FOR TYPICAL SECTIONS SEE PLATE D-4
LAIE
SPF FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
100 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
50 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
50 YR FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
100 YR FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
CHINESE AND HAWAIIAN GRAVE SITE
KAHAWAINUI STREAM
SPF FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
STRUCTURES IN SPF FLOODPLAIN TO BE FLOODPROOFED
CONCRETE RIPRAP SLOPE LINING
PROPOSED BRIDGE IMPROVEMENT
KAMEHAMEHA HIGHWAY
CONCRETE RIPRAP SLOPE LINING
EXISTING BRIDGE
STA 16+30 BEGIN LEVEE
KAMEHAMEHA HIGHWAY
HUKILAU BEACH PARK
LAIE BAY
LEGEND
SPF FLOODPLAIN BOUNDARY (WITH PROJECT CONDITION)
100 YR FLOODPLAIN BOUNDARY (WITH PROJECT CONDITION)
50 YR FLOODPLAIN BOUNDARY (WITH PROJECT CONDITION)
SPF FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
100 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
50 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
PROPOSED LEVEE
WETLAND
N
PLAN
KAMEHAMEHA HWY
KAHAWAINUI STREAM
MORMON TEMPLE
BRIGHAM YOUNG UNIV.
LAIE BAY
OAHU
LAIE
VICINITY MAP
KAHAWAINUI STREAM LAIE, HAWAII
DETAILED PROJECT REPORT
ALTERNATIVE I
LEVEE PLAN
U.S. ARMY ENGINEER DISTRICT, HONOLULU
FIGURE 9

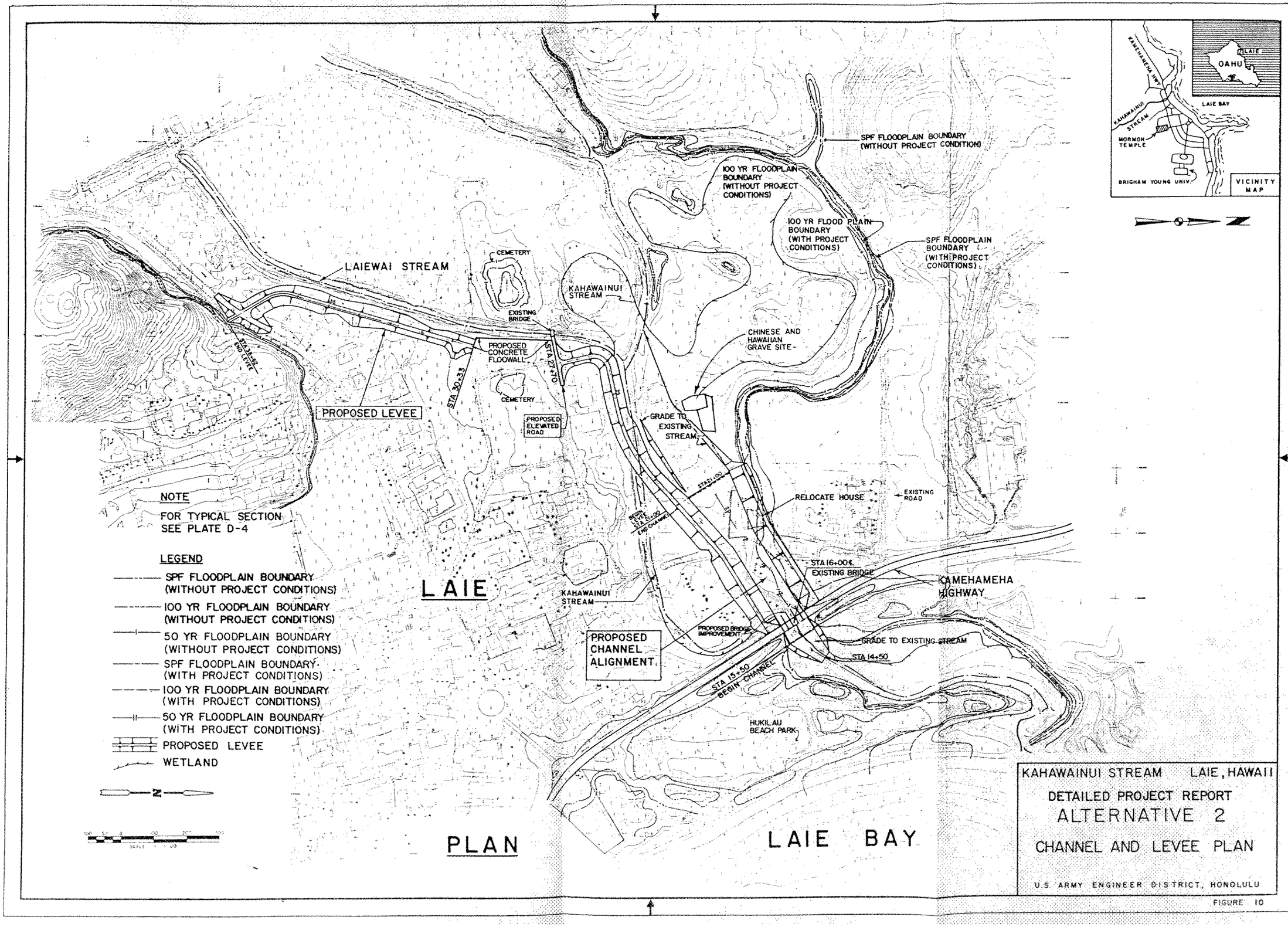

SPF FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITION)
100 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
100 YR FLOOD PLAIN BOUNDARY (WITH PROJECT CONDITIONS)
SPF FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
LAIEWAI STREAM
CEMETERY
KAHAWAINUI STREAM
EXISTING BRIDGE
PROPOSED CONCRETE FLOODWALL
STA 27+70
STA 30+33
END LEVEE
CEMETERY
PROPOSED LEVEE
PROPOSED ELEVATED ROAD
CHINESE AND HAWAIIAN GRAVE SITE
GRADE TO EXISTING STREAM
STA 21+00
RELOCATE HOUSE
EXISTING ROAD
BEGIN CHANNEL STA 21+00
END CHANNEL
STA 16+00±
EXISTING BRIDGE
KAMEHAMEHA HIGHWAY
LAIE
KAHAWAINUI STREAM
PROPOSED BRIDGE IMPROVEMENT
PROPOSED CHANNEL ALIGNMENT
GRADE TO EXISTING STREAM
STA 14+50
STA 15+50 BEGIN CHANNEL
HUKILAU BEACH PARK
LAIE BAY
NOTE
FOR TYPICAL SECTION SEE PLATE D-4
LEGEND
SPF FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
100 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
50 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
SPF FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
100 YR FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
50 YR FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
PROPOSED LEVEE
WETLAND
N
SCALE 1" = 200'
PLAN
KAMEHAMEHA HWY
KAHAWAINUI STREAM
LAIE BAY
MORMON TEMPLE
BRIGHAM YOUNG UNIV.
LAIE
OAHU
VICINITY MAP
N
KAHAWAINUI STREAM LAIE, HAWAII
DETAILED PROJECT REPORT
ALTERNATIVE 2
CHANNEL AND LEVEE PLAN
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 10

stream. The downstream project limits will end at the existing stream about 140 feet below Kamehameha Highway. This plan also optimizes net benefits at the standard project flood level. The following describes the proposed plan, based on the various design levels of protection:

TABLE 7. LEVEE AND CHANNEL PLAN

	Levee		Channel			
Level of Protection	Max Height (ft)	Length (ft)	Slope	Width (ft) (base)	Height (ft) (max)	Length (ft)
SPF	12.3	1,760	3-to-1	80-150	17.5	490
100 yr	11.0	1,760	3-to-1	80-150	16.1	490
50 yr	10.0	1,760	3-to-1	80-150	16.0	490

The levee would consist of compacted earth-fill with the side slope along the stream lined with concrete riprap downstream of Station 27+70 to prevent erosion of the levee by the floodflows. The backside slope and the levee crest would be grassed. As discussed in Alternative 1, a concrete I-wall would be provided between Stations 27+70 and 30+33 and would retain the levee at both ends and provide fencing to discourage misuse. The levee upstream of Station 30+33 would be grassed. A minimum freeboard allowance of 3 feet was utilized. As in Alternative Plan 1, the levee would require that a road be raised to a maximum height of about 10.0 feet above MSL near Station 27+63 for access to cemetery areas, and that another road be raised to a maximum height of about 10.1 feet above MSL near Station 38+35. An equipment turnaround area would be provided on the upstream end of the levee.

The existing stream would be realigned upstream of the highway and replaced with a concrete and concrete riprap lined trapezoidal channel with 3-to-1 side slopes from the bridge to Station 21+00 for a length of about 490 feet. The channel invert would be V-shaped to concentrate low flows. Above Station 21+00, the floodplain would be graded to concentrate low flows in a swale and to guide flows from the existing stream to the channel improvements. The upstream end of the channel improvement would be widened from an 80-foot base width at Station 19+00 to 150 feet at Station 21+00 to reduce flow depths and upstream right bank levee height requirements. Along the left bank, the channel would be in cut. The channel top would require fill at the design channel height along the right bank. The Laiewai Bridge would be modified by cleaning and excavating the stream under the bridge to an invert centerline elevation of -3.2 ft. MSL and the invert under the bridge would be lined with concrete riprap. The bridge abutments would be extended to Station 16+50 to form a wedge type transition to the upstream channel improvements. Bridge pier extensions would be provided to improve flow considerations and reduce debris impacts. Flows would not overtop the highway.

Flows would pass through the modified bridge under the Kamehameha Highway and into the existing Kahawainui Stream. Flows exceeding the stream capacity of about 400 cfs below the project limits would overflow the stream banks within the park site and discharge as sheet flows to the ocean. This park area would remain in a flood hazard zone. Flood-warning signs would be placed at the park to warn users of potential flood hazards.

The channel construction would destroy portions of the natural stream channel and some wetland areas. One house structure, three small storage sheds and a fuel tank would require removal or relocation by the local sponsor. The areas in the riverside portions of the levees that are subject to flooding would require flood easements and zoning regulations to insure that the project intent and operations are maintained.

3. Alternative Plan 3 - Floodproofing and Floodplain Management

a. General. This nonstructural alternative plan provides for floodproofing individual structures, relocating or replacing structures which cannot be economically floodproofed, providing a ringwall, incorporating a floodplain management plan and zoning, and providing for a flood warning system. Field surveys of all structures in the floodplain were conducted by the Corps of Engineers in 1982 and 1983 to obtain the structural condition, type, first floor height above the ground, unusual features and interviews with owners. Aerial photographs and State tax key maps were also examined. The SPF plan would affect 418 structures; the 100-year plan would provide for 409 structures; and the 50-year plan would incorporate 387 structures.

b. Floodproofing. Floodproofing measures were developed based on the existing type of structures in the floodplain. Structure types were divided into the following categories:

- Wood frame on post-and-beam
- Wood frame on concrete slab
- Wood frame on concrete block
- Concrete block or block frame on concrete slab
- Metal frame on concrete slab
- Reinforced concrete building

Based on the structure's location, type, and depth of flooding, a method of floodproofing was recommended that was considered appropriate for the flood hazard. Five (5) specific measures were identified:

- Providing temporary or permanent closures
- Relocating damageable property within the structure
- Raising the first floor elevation
- Relocating/replacing the structure
- Providing a ring wall

The SPF plan would provide for floodproofing 239 structures (excluding removal/replacement), the 100-year plan would provide for 252 structures and the 50-year plan would provide for 269 structures as shown on Table 8.

TABLE 8. FLOODPROOFING MEASURES AND AFFECTED STRUCTURES

Floodproofing Measure	Number of Structures		
	SPF	100 year	50 year
Temporary/permanent closures	60	68	96
Relocation of damageable property	7	7	6
Raising the structure	162	159	139
Providing a ring wall	10	18	28
Totals	239	252	269

Structures which could not be physically or economically floodproofed were evaluated separately for relocation or replacement as discussed below.

c. Removal/Replacement. This measure provides for removing structures, which cannot be economically floodproofed, and replacing them with new floodproofed structures. Some structures may not need to be totally removed but may require major modifications. Based on an evaluation of relocation, replacement, and in-place modification costs, the latter was found to be more beneficial. The owner's preference may ultimately determine the decision to replace, modify in-place, or relocate structures to another location. The number of structures affected by removal, replacement, or in place alterations is 179, 157, and 118 structures for the SPF, 100-year, and 50-year storms, respectively.

d. Floodplain Management. This complementary measure provides for floodplain restrictions, maintenance programs and flood warning systems. Restrictions on future development in the floodplain by land use controls zoning, subdivision regulations, building codes and standards must be enforced by the City and County of Honolulu to minimize future development within the 100-year floodplain. This would be consistent with the City and County's participation in the Federal Flood Insurance Program.

A regular maintenance and inspection program to repair existing channels and remove accumulated sediments, obstructive materials and vegetation in the Kahawainui Stream must be established to insure that the existing flood channels remain at their design capacities. Many of the secondary roads will still be prone to flooding. Backyards, road surfaces, and utilities sustaining residual damages would still require cleaning and repair after each storm. An information program could be initiated to inform the community about the benefits of this alternative.

e. Flood Warning System. An integral part of the nonstructural plan would be to establish a flood warning system, affording residents optimal time to floodproof (e.g., install floodproofing panels) structures, relocate movable damageable property (e.g., outdoor furniture), and maximize personal safety. The warning system could consist of a radio telemetric system, calibrated to activate a warning notice at certain rain and stream flow stages. Based on the topographic and hydrologic characteristic of the floodplain, minimal warning time will be available. Based on a 100-year flood event, it would take only one hour for the flood stage to peak, after an intense rainfall (5-6 inches/hour) in the upper watershed. Assuming a 1,400 cfs capacity for the lower reaches of Kahawainui Stream, it would take approximately 3 hours after the peak stage for the level of water to recede. The warning time available is estimated to be about 1 hour. Periodic exercises, testing, and community involvement programs would be part of the overall warning system.

4. Alternative Plan 4 - Channel Plan

Alternative Plan 4 was developed to evaluate an all channel plan. The channel would begin at about 140 feet downstream of Kamehameha Highway and would extend upstream for about 3,850 feet to the confluence of Kahawainui Stream with Ihiihi Gulch. Terminating the channel structures below this location would necessitate the use of long containment levee and/or diversion structures below the confluence would require extensive levee improvements since the floodplain widens drastically below this confluence. However, levee ties to high grounds at the channel entrance would be needed at the upstream channel limit to preclude end run flow conditions (see Figure 11). Table 9 presents the features associated with this plan:

TABLE 9. CHANNEL PLAN

Level of Protection	Slide Slope	Modified Channel		
		Base Width (ft)	Depth (ft)	Length (ft)
SPF	3-to-1	80-180	16.0	3,850
100 year	3-to-1	80-180	14.5	3,830
50 year	3-to-1	80-180	13.0	3,810

The existing stream would be realigned in line with the existing Laiewai Bridge to provide a smoother and wider approach to the bridge. The channel would be lined with concrete riprap and would be trapezoidal in shape with a base width of 80 feet and side slopes of 3-horizontal to 1-vertical. The upstream end of the channel improvements would be widened from an 80-foot wide base at Station 48+00 to a 180-foot wide base at Station 53+00 to guide flood flows into the improved channel. The stream at the Laiewai Bridge at Kamehameha Highway would be deepened

to elevation -6.2 feet MSL, and the new invert would be lined with concrete riprap. Bridge pier and abutment extensions would be provided similar to Alternative Plan 2. Portions of the downstream park adjoining the stream will also remain as flood hazard area.

This plan is the most environmentally adverse, because it would destroy the existing wetland area and Hawaiian grave sites.

V. DESCRIPTION OF THE AFFECTED ENVIRONMENT

A. ENVIRONMENTAL CONDITIONS

1. Physical Conditions. The Kahawainui Stream watershed is located on the eroded remnants of the Koolau Shield volcano on the northeastern side of Oahu. Elevation ranges within the watershed from sea level to approximately 2,300 feet, with deeply dissected cliffs and valleys characterizing higher elevations. At lower elevations, the watershed is characterized by a broad coastal plain consisting of coral reef, dune sand, and detrital sediment deposits. Soils in the study area include beach sands and coral outcrops on the coastal plain and clays, loams, and silty clays throughout the area, with soils on steeper slopes typically subject to erosion. During times of low or no flow, a sand berm typically closes the mouth of Kahawainui Stream, preventing the stream from flowing continuously to the bay.

Rainfall ranges from 45 inches on an average annual basis along the coastal plain to over 100 inches in higher elevations of the study area. Temperatures are moderate throughout the year and winds are primarily from the northeast. Groundwater is characterized by basal water floating on salt water and by dike-confined freshwater at high elevations. Streams and gulches which dissect the study area include Kahawainui, Wailele, and Malaekahana Streams. The drainage basin of the Kahawainui watershed is approximately 5.3 square miles and encompasses the area between Omao Gulch to the north and Wailele Gulch to the south. Two ponds, the result of ground surface modifications and surface drainage, are located within the study area. In addition, seven aquaculture ponds are located within the watershed.

Kahawainui Stream is designated as a "Class 2" stream according to Chapter 11-54 of the State of Hawaii Water Quality Standards. Marine waters adjacent to the proposed project area are designated "Class A" waters. High ammonia and nitrate concentrations have been recorded for Kahawainui and Wailele Streams, possibly due to the presence of agricultural activities upstream.

Air quality in the Kahawainui project area is generally good and noise levels generally low, being influenced primarily by traffic along Kamehameha Highway and within Laie town.

2. Ecological Conditions. Vegetation in the Kahawainui study area includes strand vegetation along the coast and wetland vegetation along the ponds, streams, ditches, and in associated marshes and swamps. Open guava forest characterizes much of the watershed, with residential and agricultural developments influencing vegetation assemblages throughout the coastal plain. Terrestrial fauna occurring within the study area include common introduced species of birds and mammals. Aquatic faunal species diversity is low, due in part to the poor water quality of streams within the project area. Marine waters adjacent to the project area provide habitat for a variety of marine organisms

including corals and fishes. The Hawaiian Gallinule, an endangered species of waterbird, was observed in the pond north of Kahawainui Stream. Detailed descriptions and species lists of flora and fauna characteristic of the Kahawanui study area are provided in Appendix G.

3. Social, Cultural and Economic Conditions. Appendix F provides a synopsis of the social, cultural and economic conditions characteristic of the study area (see also paragraphs V.B.2, 3, and 4).

B. SIGNIFICANT RESOURCES

Detailed technical discussions of all significant and other resources are found in Appendix F (Cultural and Social Resources) and Appendix G (Natural Resources and Fish and Wildlife Coordination). Detailed discussion of regional social and economic statistics is found in Appendix E.

Section 122 (Public Law 91-611) Resources. Section 122 of the River and Harbor Act of 1970 supplements the provisions of the National Environmental Policy Act of 1969 requiring that all Corps projects take into consideration all possible, but at least 17 possible adverse economic, social and environmental effects relating to any proposed project, the cost of eliminating or minimizing such adverse effects, and the need for flood control, navigation and associated actions. The minimum list of 17 "effects" are desirable regional growth, employment/labor force, local governmental finance, business and industrial activity, displacement of people or farms, desirable community growth, population, public services, public facilities, aesthetic effects, community cohesion, noise, air pollution, water pollution, natural resources, and manmade resources. The most significant of these considerations for the Kahawainui Stream study are Wetlands, combining natural resources, aesthetic values and water pollution; Historic Sites and Graves, which involve manmade resources, aesthetic values and by one definition, injurious displacement of people; Desirable Community Growth/Cohesion comprising community cohesion, employment effects, property value, displacement of people, businesses and farms and desirable community and regional growth; and Agricultural Lands, dealing with employment, tax and property value, displacement of farms, and regional growth.

1. Wetlands and Endangered Species. Wetlands are considered important natural resources that contribute significant benefits to both the natural and human environment. Wetlands considered to perform functions important to the public interest include (33 CFR 320):

a. Wetlands which serve important natural biological functions, including food chain production, general habitat, and nesting, spawning, rearing and resting sites for aquatic or terrestrial wildlife species;

b. Wetlands set aside for study of the aquatic environment or as sanctuaries or refuges;

c. Wetlands, the destruction of alteration of which would affect detrimentally natural drainage characteristics, sedimentation patterns, salinity distribution, flushing characteristics, current patterns, or other environmental characteristics;

d. Wetlands which are significant in shielding other areas from wave action, erosion, or storm damage. Such wetlands are often associated with barrier beaches, islands, reefs and bars;

e. Wetlands which serve as valuable storage areas for storm and floodwaters;

f. Wetlands which are prime natural recharge areas. Prime recharge areas are locations where surface and groundwater are directly interconnected; and

g. Wetlands which through natural water filtration processes serve to purify water.

Wetlands occur within the Kahawainui floodplain. Major elements of the wetlands located within the study area include California grass marshlands and wet pastures, fringing marshes along streams and ditches, and an estuarine mangrove and hau swamp near the mouth of Kahawainui Stream (Figure 12). The approximate acreage of wetlands occurring within the study area is 17 acres. The wetlands provide limited habitat for the Hawaiian Gallinule, one of Hawaii's four endangered waterbird species, and limited habitat for other terrestrial and aquatic plant and animal species. During a survey of the project area on 9 June 1983, FWS and Corps Environmental staff observed three Hawaiian Gallinules (*Gallinula chloropus sandvicensis*) in the pond on the west bank of Kahawainui Stream. A subsequent sighting of two Gallinules within the same pond (Service survey on June 16, 1983) reconfirmed the previous observation. The Gallinule is a listed Federal endangered species (40 CFR 17.11 and 17.12). No previous sightings of this or other endangered species within the project area had occurred. It is possible that the birds are using the vegetation bordering the pond for nesting.

Several Black-crowned Night Heron (*Nycticorax nycticorax hoactli*) were sighted and/or heard in the hau and mangrove wetlands above and below the highway. One Heron was sighted at the pond where the Gallinules were observed. The presence of Herons in this area may indicate it is a nesting site, since these birds are known to be colonial breeders (Wilson, 1974). This species is indigenous to Hawaii and is resident on all main islands (except possibly Niihau and Kahoolawe). Munro in 1944 noted that they were common on Oahu; however, in recent history, populations have clearly diminished (*An Ornithological Survey of Hawaiian Wetlands*, 1977).

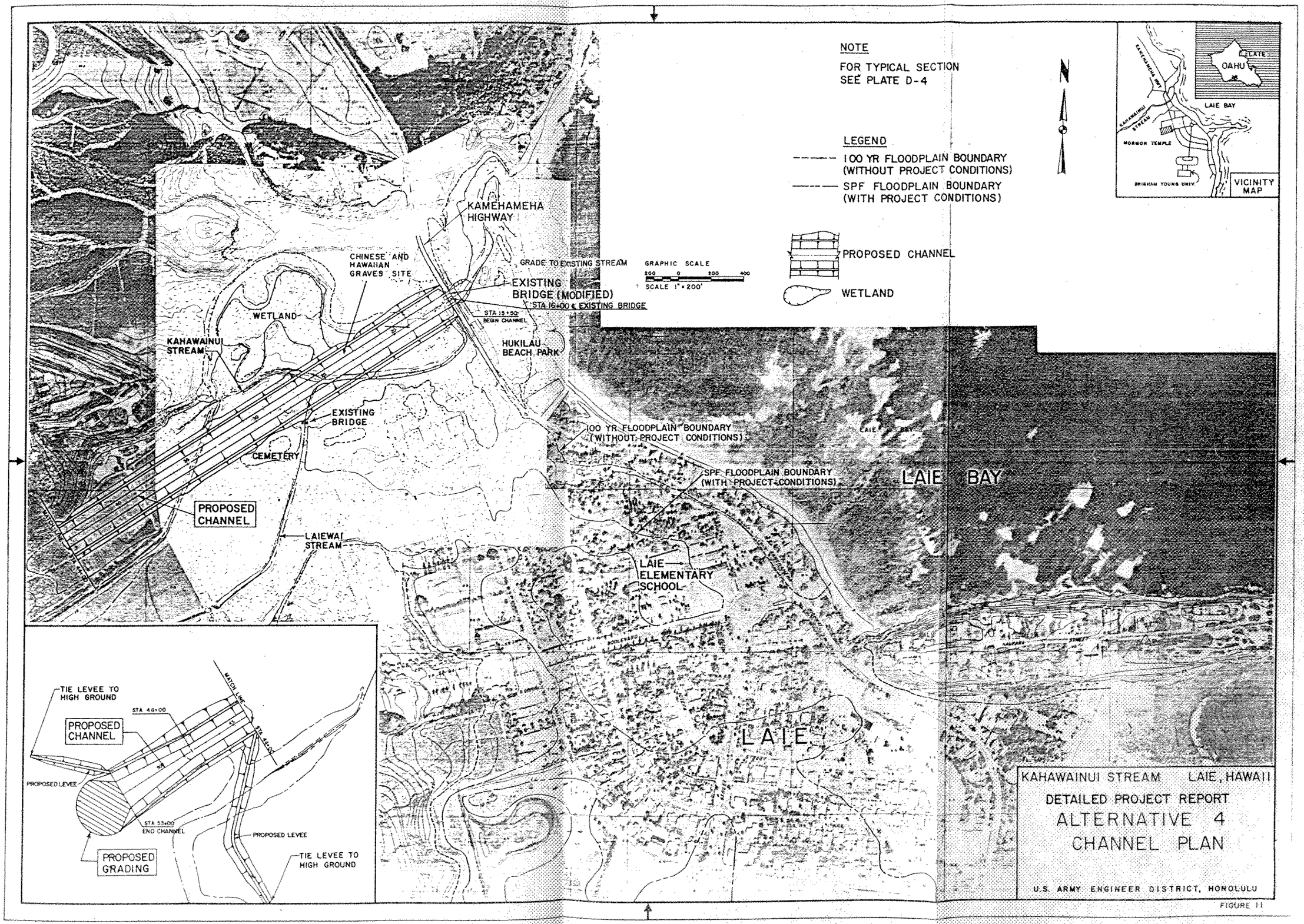

NOTE
FOR TYPICAL SECTION
SEE PLATE D-4
LEGEND
100 YR FLOODPLAIN BOUNDARY
(WITHOUT PROJECT CONDITIONS)
SPF FLOODPLAIN BOUNDARY
(WITH PROJECT CONDITIONS)
PROPOSED CHANNEL
WETLAND
GRAPHIC SCALE
200 0 200 400
SCALE 1" = 200'
VICINITY MAP
STATE
OAHU
LAIE BAY
KAMEHAMEHA HWY
KAHAWAINUI STREAM
MORMON TEMPLE
BRIGHAM YOUNG UNIV.
KAMEHAMEHA HIGHWAY
CHINESE AND HAWAIIAN GRAVES SITE
GRADE TO EXISTING STREAM
EXISTING BRIDGE (MODIFIED)
STA 16+00 ℄ EXISTING BRIDGE
STA 15+50 BEGIN CHANNEL
WETLAND
KAHAWAINUI STREAM
HUKILAU BEACH PARK
EXISTING BRIDGE
CEMETERY
100 YR FLOODPLAIN BOUNDARY
(WITHOUT PROJECT CONDITIONS)
SPF FLOODPLAIN BOUNDARY
(WITH PROJECT CONDITIONS)
LAIE BAY
PROPOSED CHANNEL
LAIEWAI STREAM
LAIE ELEMENTARY SCHOOL
LAIE
TIE LEVEE TO HIGH GROUND
STA 48+00
MATCH LINE
STA 44+00
PROPOSED CHANNEL
PROPOSED LEVEE
STA 53+00
END CHANNEL
PROPOSED LEVEE
PROPOSED GRADING
TIE LEVEE TO HIGH GROUND
KAHAWAINUI STREAM LAIE, HAWAII
DETAILED PROJECT REPORT
ALTERNATIVE 4
CHANNEL PLAN
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 11

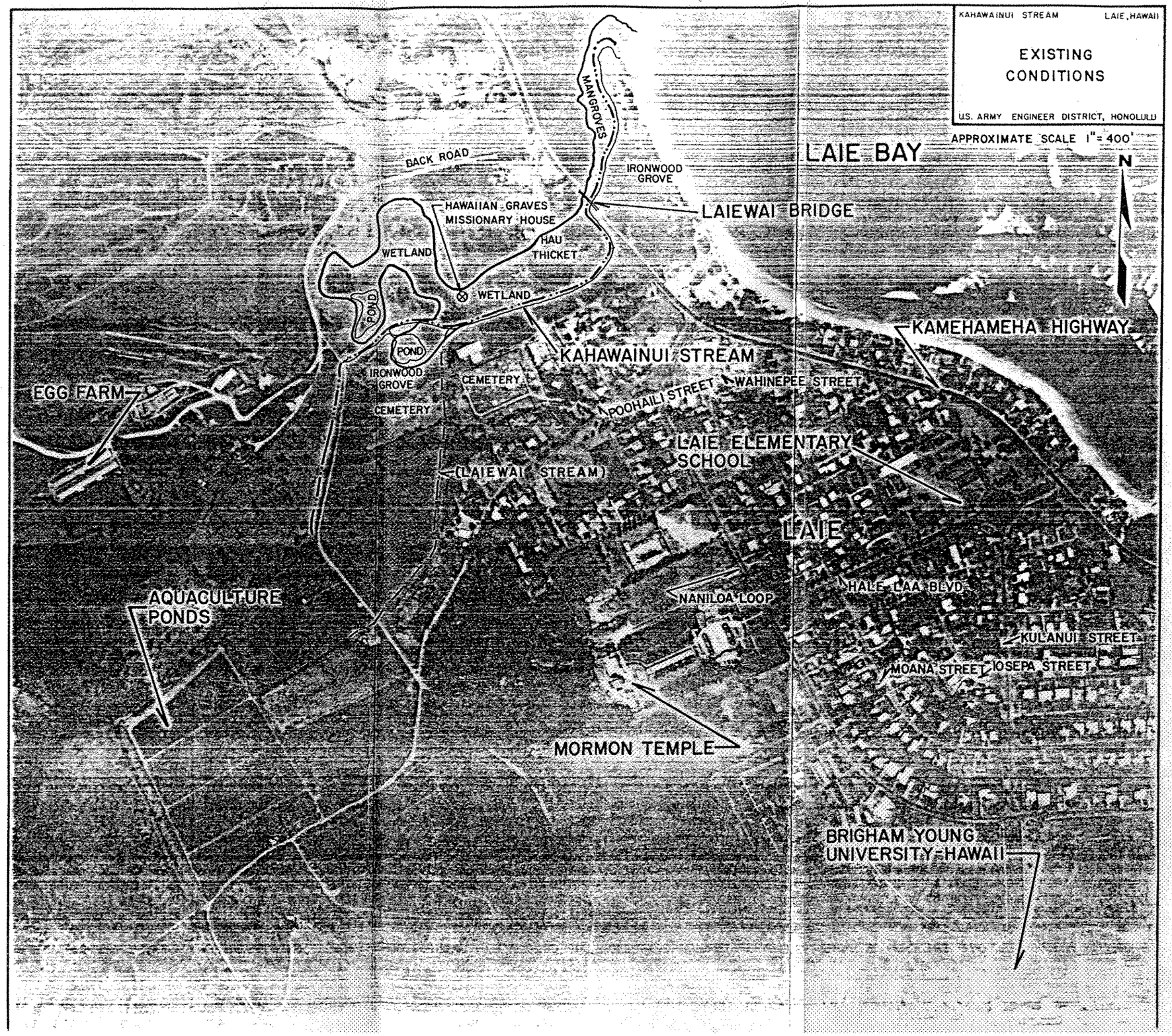

KAHAWAINUI STREAM
LAIE, HAWAII
EXISTING CONDITIONS
U.S. ARMY ENGINEER DISTRICT, HONOLULU
APPROXIMATE SCALE 1" = 400'
N
LAIE BAY
MANGROVES
IRONWOOD GROVE
BACK ROAD
LAIEWAI BRIDGE
HAWAIIAN GRAVES
MISSIONARY HOUSE
HAU THICKET
WETLAND
WETLAND
POND
POND
KAMEHAMEHA HIGHWAY
KAHAWAINUI STREET
IRONWOOD GROVE
CEMETERY
CEMETERY
POOHAILI STREET
WAHINEPEE STREET
EGG FARM
LAIE ELEMENTARY SCHOOL
(LAIEWAI STREAM)
LAIE
HALE LAA BLVD
NANILOA LOOP
AQUACULTURE PONDS
KULANUI STREET
MOANA STREET
IOSEPA STREET
MORMON TEMPLE
BRIGHAM YOUNG UNIVERSITY-HAWAII

FIGURE 12

In addition, the wetlands of the study area are natural filters of sediments, pollutants and nutrients in stream waters; buffer only in park area adjacent lands against storm waves and floods; provide limited groundwater recharge; serve as pasture for grazing animals; provide a substrate for potential wetland plant cultivation; provide recreational fishing areas; and contribute to the scenic quality of the landscape. Present views from the highway inland and toward the beach provides attractive greenery. Wetlands located in the immediate project area are delineated in Figure 11, Existing Conditions.

2. Historic Sites and Graves. The area around Kahawainui and Laiewai Streams was most certainly inhabited and environmentally exploited by prehistoric (circa. pre-A.D. 1800) Hawaiian populations. Although very little direct evidence for this is currently available, nearby localities such as Malaekahana, and similar coastal-stream valley areas on the Island of Oahu have evidence for prehistoric habitation from at least the A.D., 1200's. The interior wetland at Kahawainui comprises a former (now filled) fishpond known as Pa'eo ("full fishpond"). The 3.5-acre Laie Cemetery, most likely founded in the early 1900's, lies south of the former fishpond (Figure 11). A red concrete torii gate, the only remnant of a Shinto shrine once at the site, is located west of a bridge through the cemetery over a drainage canal. The older portion of the cemetery lies east of this canal. Likely relic, natural sand dunes are situated north of the torii gate, west of an artificial (excavated) pond. These dunes may contain in situ cultural deposits and are situated outside the project area.

Three (3) archaeological investigations have been performed within the project area including a reconnaissance survey with stratigraphic testing; a site visit-reconnaissance survey of the northeast portion of the project area by archaeologists from the Corps of Engineers and the Hawaii State Department of Land and Natural Resources; and an intensive mapping and test excavation program, also in the northeast portion (Appendix F). The latter two projects were concentrated in an area containing a lithified sand escarpment and two (2) small cemetery plots situated north of Laie Cemetery, across the former fishpond, amidst a small copse of ironwood trees. One of the cemetery plots consists of a small fenced enclosure containing at least 17 graves. Athens and Bath, archaeologists, in a 1985 report have established or strongly suggested that the cemetery referred to as being "Chinese" actually contains two segments one associated with ethnic Chinese and one with an ethnic Hawaiian community. It appears that portions of the cemetery are maintained by a local family. This is suggested by the presence of joss sticks and flower arrangements on the graves. Immediately north of the graves is a raised rectangular earthen (sand) area containing at least six (6) and probably more ethnic-Hawaiian graves (as indicated by headstone inscription) from the early 1900's.

Approximately 20 meters west of the Hawaiian cemetery is a mound which may be the remains of a late 19th century house site. An area of approximately 15 by 20 meters east of the small cemeteries to the edge of the low lithified sand escarpment contains several subsurface cultural deposits. At least two (2) distinct, possibly prehistoric,

living surfaces are present. The lithified sand, sic. limestone, escarpment was initially thought to contain several prehistoric-era rock shelters. Subsequent archaeological investigations established the presence of in situ remains only in the vicinity of the cemeteries and no rock shelters. Dense historic artifact deposits, possibly mixed with prehistoric remains, have accumulated along the escarpment base from modern bulldozing of its upper surface.

Through the archaeological investigations and studies performed in the project area and the field investigation conducted jointly by the State Department of Land and Natural Resources and the Corps of Engineers, it was determined that the historic sites and cultural resources in the vicinity of the project does not appear to qualify for inclusion on the National Register of Historic Places. This is documented in correspondences between the Hawaii State Historic Preservation Officer and the Corps of Engineers (re: letters dated February 13, 1986 and June 5, 1986, included in Appendix C). It was also determined that all of the cultural resources will not be either adversely affected by the proposed project or are not located within the project boundaries (see discussion, Appendix F).

3. Desirable Community Growth/Cohesion. Modern Laie is a Mormon community first settled in 1850 and now the home of over 4,600 people (1980 Census). Once a sugar plantation village, Laie today is the home of Brigham Young University-Hawaii (2,045 students in 1981), the tourist-serving Polynesian Culture Center (892,000 visitors in 1981). Residents are located in the floodplain seaward of a line of low hills in back of the university and the Mormon Temple. The Church-associated Zions Securities, controls the majority of lands in the floodplain except the area seaward of Kamehameha Highway. A 13-acre farmstead west of the study area alongside Kahawainui Streams, owned by the native Hawaiian Pukahi family. The 32 other native Hawaiian (Kuleana) parcels are located in the floodplain and 5 other parcels are located at the Kamehameha Highway bridge location. The community can spatially and socially be divided into three parts: the privately-owned high income shoreline residences (outside the floodplain), the exclusive Mormon Laie town south of Kahawainui and Laiewai Streams (mostly within the floodplain), and six residences north of Laiewai Stream on Wahinepee Street and three other isolated farmsteads. The latter two areas represent an older Japanese element dating from the plantation years and a native Hawaiian element, some who are contesting the property ownership with Zions Securities. At present, there is little readily developable land in Laie, existing housing stocks are more than 30 years old and 43 percent of Laie households had annual incomes of less than $10,000 in 1979. During the last decade, the population of Laie town showed a 54 percent increase compared with a 21 percent increase for Oahu as a whole. Many of the houses affected by this study are occupied by Polynesian island families, including Hawaiians, whose lifestyles fully utilize the ground level of their residential lots, both indoors and outdoors.

4. Agricultural Lands. The State of Hawaii designated lands in Hawaii according to their uniqueness and suitability for agricultural use. "Prime Agricultural Land" is defined as land which has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops economically when treated and managed according to modern farming methods. "Unique Agricultural Land" is defined as land that has the special combination of soil, quality, location, growing season, moisture supply and is used to produce sustained high quality and/or high yields of a specific crop when treated or managed according to modern farming methods. "Other Important Agricultural Land" is land other than Prime or Unique Agricultural Land that is also of Statewide or local importance for agricultural use. Both Prime and "Other Important Agricultural Lands" occur within the Kahawainui watershed. South of Kahawainui Stream less than 1 acre of "other important" agricultural lands is intensively cultivated for taro, bananas, fruit trees, and vegetable crops. A 13-acre parcel of "prime agricultural land" north of Kahawainui Stream is used for raising pigs, chicken, and calves, and also serves as pasture for grazing animals. Many other prime and other important agricultural areas within the Kahawainui floodplain are used as pasture. Near the highway an area designated as neither prime nor other important agricultural areas supports intensive banana cultivation.

5. Recreational Resources. Hukilau Park, approximately 9 acres in area, owned by Zions Securities but publicly accessible, is located within the grove of ironwood trees seaward of Kamehameha Highway and southeast of the mouth of Kahawainui Stream along the shore. Hukilau Park lies in a low-lying area, which was formerly mined for commercial sand and is now used for picnicking, camping, and recreational fishing, primarily by the Laie-Kahuku residents. Additionally, the dense mangrove area provides a pleasing aesthetic vista to the quality of the park setting. The proposed project area is bounded on the north by Malaekahana State Park, which consists of approximately 100 acres located between Kamehameha Highway and the sea. The park area nearest to the proposed project was initially developed as Phase I and consists of 74 acres.

Hukilau Park is located along the right stream bank seaward of the highway and includes ironwood trees, a scenic beach vista of the shoreline and offshore islands, Kahawainui Stream, and a mangrove area along the left bank of the stream. The scenic values of the park are considered high. Pa'eo Fishpond, near the confluence of the Kahawainui Stream and the irrigation ditch, is also considered an aesthetically pleasing area, although little used.

The City Department of Parks and Recreation has a preliminary master plan for the development of a 20+-acre community park in proximity of Station 38+62 of the proposed flood control project. The proposed park development will be subjected to and will need to conform with the floodplain management restrictions.

C. ENVIRONMENTAL EFFECTS

1. Wetlands

A detailed analysis is provided in Appendix A which covers the effects of the discharge of dredged or fill material into

waters of the United States, including wetlands for the study area. An evaluation of compliance with Presidential Executive Order 11990, Protection of Wetlands, is also provided in Appendix A.

Alternative 1 (Levee Plan) would not require excavation or filling of wetlands since the levee system under this plan is proposed for the right streambank of Kahawainui Stream beginning from Laiewai Bridge. The proposed levees under this plan would divert floodwaters away from Laie towards existing wetland and nonwetland areas north of Kahawainui Stream. This may result in more frequent flooding of wetlands and increased retention time of waters in wetland areas. The vegetation found in the wetland is typically adapted to periodic flooding and prolonged saturation. Increased staturation would, in fact, favor the continued growth of hydrophytes over the less desirable weedy mesic species of the area.

Alternative 2 (Levee and Channel Plan) would require excavation and filling of portions of the wetland. Approximately 12,000 cubic yards of material would be discharged into wetlands to facilitate construction of the levee, and channel under this alternative. This represents the loss of approximately 2 acres of wetland or 10 percent of the total wetland acreage of the project area. The visual impact of replacing lush greenery with concrete and riprap will be rather abrupt despite the implementation to grassed levees. With the realignment of the stream and channel improvements, the existing stream will be filled and the adjacent land will be graded to be compatible with the surrounding area. In addition, modification of the stream alignment, as a result of the construction of the concrete-lined channel, could reduce soil moisture in a small portion of wetland near the highway. Channelization would increase stormwater runoff into mangrove estuarine areas and may increase sediment loading of coastal receiving waters. Circulation and wave action are expected to disperse sediments in coastal waters.

Alternative 3 (Floodproofing and Floodplain Management) would not affect existing wetland areas with respect to construction. However, some of the zoning requirements which may be imposed under this alternative may involve wetland areas.

Alternative 4 (Channel Plan). This plan would affect wetland and aquatic resources in the immediate vicinity of the proposed stream channel improvements. As with Plan 2, excavation and filling of wetlands will be required. Decreased floodflow may increase sediment loading of coastal receiving waters if estuarine wetland areas are not able to filter sediments.

2. Historic Sites and Graves

Alternative 1 (Levee Plan) has been redesigned since the September 1983 Draft Interim Survey Report and EIS prepared by the Corps

of Engineers to avoid all graves in the Laie Cemetery, thus eliminating considerable anguish among surviving loves ones. No other known archaeological or cultural sites would be affected by this alternative, including the Chinese Grave Site, the newly identified Hawaiian Grave Site or the Torii Gate and former plantation camp.

Alternative 2 (Levee and Channel Plan) has the same effects or lack of effects as Alternative 1. As this is the alternative plan recommended for implementation, construction would be monitored by professional archaeologists particularly in the vicinity of Laie Cemetery and near the Hawaiian and Chinese Grave Sites.

Alternative 3 (Floodproofing and Floodplain Management). Implementation of this alternative plan would not affect any historic sites.

Alternative 4 (Channel Plan). This channel alignment would cut across the following potential cultural resources: portions of sand dunes containing possible, but yet unidentified, cultural materials; the former and now-filled Pa'eo fishpond; the Shinto torii gate and associated graves; the Pukahi Ranch, which may have once contained historic wet taro fields; an area described by a local informant as the site of an ancient Hawaiian village. The alignment of Plan 4 has not yet been investigated by archaeologists.

None of the alternatives would affect the site of the former Hanapepe Shrine and only Plan 4 would affect the Shinto torii gate. Depending upon which alternative is selected, further archaeological or historical studies would be conducted in the post-approval stage of planning to determine possible eligibility of affected sites for inclusion on the National Register of Historic Places.

3. Desirable Community Growth and Cohesion

Alternative 1 (Levee Plan)

(1) Depending on sizing, this alternative would provide protection to residents of Laie town proper from periodic flooding anticipated with the standard project (285-year) flood event, a 100-year flood event, a 50-year flood event or a 25-year flood event. It would also reduce potential public health hazards and other adverse economic impacts, and improve safe movement within the town during storms. All unprotected structures in the standard-project floodplain would be floodprooofed. Minor relocations involve a small tool shed and a small water tank, southwest of the Laie Cemetery.

(2) The levee would rise from 14.5 to 15.75 feet above stream level and would be grassed on the face toward residential areas. Due to present height of the plain above and south of the lower reaches of the stream, the levee would lie low and would be almost invisible to residents whose backyards face the streamway.

(3) In the area of the Laie Cemetery, the concrete I-wall along the ditch would rise about 7.5 to 9.5 feet above existing ground level, creating even more a sense of division between the two cemetery sections. This division would be emphasized by the levee sections and the short segment of raised road. The existing road running parallel to and joining the cemetery sections must be raised about 10.5 feet above the existing ground level to match the height of the levees and I-wall. It would be provided with a fence for safety purposes. Because the traffic load is so light, no separate sidewalk will be constructed. The concrete I-wall, levee sections, and raised road would be an intrusion into the sense of tranquility and natural greenery that now prevails at Laie Cemetery. There is no way to avoid aesthetic impacts at the cemetery while still providing the required levels of flood protection to the community as a whole at reasonable cost. Levee side slopes will be grassed to minimize visual impacts. This segment of the project for Alternative 1 and the recommended Alternative 2 has been redesigned to eliminate the severe social impacts of grave relocation, but aesthetic impacts are unavoidable.

(4) This plan and the nonstructural Plan 3 would divert floodwater from the town toward the highway bridge, however, the bridge itself is not expected to fail. If the approaches to the bridge were to erode away, cutting off access between Kahuku and Laie, fire protection services would still be available in both Hauula (2.5 miles south of Laie) and in Kahuku, just to the north of Laie. However, the only hospital in the North Shore area is located in Kahuku. Castle Memorial Hospital in Kailua is located 27 miles to the south. Use of the bridge probably could be restored within 2 or 3 days following a washout.

(5) On the whole, community growth would be encouraged under this alternative by freeing most residences from the restrictive flood insurance regulations, which limit major reconstruction or new construction of existing lots. Comparatively speaking, however, the costs of new construction in the unprotected part of the floodplain would be higher than in the protected area.

Alternative 2 (Levee and Channel)

(1) This, the recommended alternative plan, would have the same beneficial and adverse social and aesthetic effects as Alternative 1, except that none of the residents or the commercial structure along Wahinepee Street would need floodproofing. One residence currently owned by Mr. and Mrs. A. Chang, would, however, require relocation, as it lies directly in the path of the proposed left-bank channel structure. No other relocations are needed, except for three small sheds and a fuel tank. No residences in the SPF floodplain would require floodproofing.

(2) The channel portion of Alternative 2 could interfere with the proposed development of a linear park running through the lower Kahawainui/Laiewai Streamway. However, sensitive planning by the Corps

could include landscaped pathways and other park features, contributing to its multi-use as both floodway and a recreational resource. No definite plans for the park have been completed as of yet.

(3) The houses along Wahinepee Street would not be directly affected, but would experience the aesthetic intrusion of a 150-foot wide concrete riprap structure, adjoining their residential area.

Alternative 3 (Floodproofing and Floodplain Management)

(1) The specific effects of this alternative would depend on subsequent planning. Efforts should be made to avoid a hodge-podge landscape of houses on columns interpersed with slab-on-grade houses with floodproofing shields. Those families whose houses are raised would not be allowed to build new permanent structures underneath their houses, which is a common practice. Police protection will be needed to protect vacant houses during the short periods of two or three days needed to floodproof individual houses.

(2) The alternative may require the City and County to rezone portions of the lower Kahawainui/Laiewai Streams floodplain to promote uses compatible with a permanent floodplain, such as agricultural or recreational/ park uses. If the Pa'eo Low Income Housing project was to fully comply with the floodplain management aspects of this alternative, its present design may need alteration. In summary, this alternative may not support desirable community growth to the degree that the other alternatives would, but it would probably result in less dissension between informal community groups.

Alternative 4 (Channel Plan)

(1) This plan would have the same beneficial effects of other plans on future growth within Laie town proper and the adverse effects of Alternative 2 on displacement of residences (See Paragraph (5) under Alternative 1 above). No farmhouses would be displaced but the economic viability of the Pukahi farm as a commercial enterprise would be severely damaged. Existing recreational activities around the pond, near the cemetery, and along the existing stream would be eliminated. Long-range plans to develop the lower stream corridor as a parkway would not be eliminated but would be limited by implementation of this alternative plan.

4. Agricultural Lands

Alternative 1 (Levee Plan) would not require excavation or filling existing agricultural areas, although it would divert floodwaters into agricultural areas north of Kahawainui Stream and west of the irrigation ditch referred to as Laiewai Stream. Grazing areas dominated

by California grass and wetland agricultural areas are expected to tolerate periodic flooding and soil saturation. Truck crops would not tolerate these conditions as well over extended periods.

Alternative 2 (Levee and Channel Plan) would involve excavating and filling grazing areas in and near wetlands north of Kahawainui Stream. Berms associated with the proposed channel would be constructed on the fringes of an existing banana tree grove located along Kahawainui Stream near Kamehameha Highway.

Alternative 3 (Floodproofing and Floodplain Management) would not require the commitment of agricultural land resources for construction. Farmstead homes would be floodproofed under this alternative. If floodproofing is not possible due to dilapidated conditions of structures, some relocation may be required.

Alternative 4 (Channel Plan). This plan would require excavation and fill about 4.5 acres of Prime Agricultural land, amounting to 85 percent of the potential grazing land controlled by a native Hawaiian family. Such a plan would definitely aggravate existing differences between those having or seeking control of kuleana lands and the Zions Securities Corporation. Together with its floodplain management-related effects (similar to Plan 1) on the other isolated farmsteads, this plan would incur the greatest social and agricultural impacts.

5. Endangered Species

It is uncertain whether the Hawaiian Gallinules are utilizing the pond and associated wetland areas for breeding, or whether breeding areas would be adversely affected by the proposed project alternatives. Although there are some uncertainties, U.S. Fish and Wildlife Service determined that the proposed project would not jeopardize the continued existence of the species.

Based upon information available, it appears that none of the alternatives would have a significant adverse effect on the endangered Hawaiian Gallinule. Construction activities for all alternatives would avoid the pond in which this species was observed. Changes in floodflow under the structural alternatives may affect the water regime of the Gallinule's habitat. Channelization may reduce the amount of water generally available to the habitat, whereas levee construction may increase the potential for flooding of habitat and increased retention time. An evaluation cannot be precisely made at this time since the Gallinule's relationship to the existing hydrologic characteristics of the ponds is not well understood. Section 7 Consultation, pursuant to the Endangered Species Act of 1973, as amended, has been completed, and is documented in Appendix G.

6. Water Quality and Aquatic Resources

Channelization proposed in Alternatives 2 and 4 may result in increasing stream velocity during periods of storm flow. A straighter channel alignment planned in Alternative 4 would result in flow velocities faster than that of Alternative 2. High velocity flows may cause scour and erosion particularly along unlined stream banks below the channel (i.e., seaward of the highway). Over a period of time, heavy storm flow may alter the location of the lower stream reach and stream mouth, probably to the east of where it presently enters Laie Bay. Bankside plants may be removed if scour changes the stream course regularly.

Channelization may also affect water depth in upper reaches of Kahawainui and Laiewai Streams and in wetlands during periods of low flow. The improved drainage may lower stream depth or drain the stream's upper reaches. Resultant increased water temperature and changes in water chemistry (pH, dissolved oxygen) may stress fish populations and cause temporary emigration or possibly death of certain aquatic organisms in these areas. Because fishing is popular within the ponds and streams, particularly below the confluence of Kahawainui and Laiewai Streams, channelization may negatively impact the value of these areas for recreational fishing.

Levee development under Alternative 1 may be expected to divert more water to Kahawainui Stream and its associated floodplain than currently flows. Since no channel improvements are proposed under this plan, retention time for floodwaters may be expected to slightly increase within the floodplain. Increased retention time would provide opportunity for more sediment filtering by the wetland prior to drainage of floodwaters into the bay. While this may contribute to slight improvements in water quality by decreasing sediment loads, it may also contribute to accelerated sedimentation of desirable wetland pond areas unless maintenance is conducted periodically.

Short-term, construction-related impacts on water quality and aquatic resources are discussed on page 37.

7. Air Quality

No long-term adverse effects on air quality are anticipated as a result of the structural and non-structural alternatives for this project. Short-term construction-related impacts are discussed on page 37.

8. Noise

No long-term increases in noise levels are anticipated as a result of this project. Short-term construction-related increases are anticipated and are discussed on page 37.

9. Recreation

Levees constructed under Alternative Plan 1 would obstruct access to portions of Kahawainui Stream which is used for recreational fishing. Channel improvements proposed under Plans 2 and 4 would extend approximately 50 feet into the existing Hukilau Beach Park. Plan 3, the nonstructural plan, would have no effect on recreational resources.

10. Marine Resources

Laie Bay may not be susceptible to significant, long-range, adverse impact from structural alternatives. Nearshore waters are relatively deep, and predominant currents would promote dispersion and dilution of silt-laden streamwaters in the bay. Although residents have noted that a turbidity plume is visible following heavy rains, little accumulation of terrigenous material was observed during offshore surveys conducted by FWS. The nonstructural alternative would have no effect on marine resources.

11. Constructed-related Impacts

a. Impacts

Vegetation along proposed levees, channel and berms (Alternatives 1, 2, and 4) would be cleared during construction. The majority of plants within the project site are common, naturalized exotics, none of which are unique to this island or area. Of the structural alternatives, Alternative 1 would require the least area of clearing and grubbing (approximately 5 acres). Nonstructural designs (Alternative 3) would not involve any clearing of streambed or vegetation, except as required for floodproofing.

During construction, increased turbidity, noise and air pollution may result from use of heavy equipment. Dredging and disturbance of bottom sediments under Alternatives 2 and 4 would cause increased turbidity and degradation of water quality. Suspended material can interfere with the respiratory and feeding mechanisms of aquatic organisms. Turbidity effects would be most significant upon the juvenile stages and sessile organisms. Mitigation measures (see following discussion) may help to minimize stream turbidity. Noise and air pollution may temporarily disturb nearby nesting birds and residents of Laie town. Floodproofing methods would generate increased noise and cause temporary inconvenience to residents involved.

b. Mitigation

In order to minimize adverse impacts to biological resources, water quality, air quality and noise emission levels, the following mitigation measures will be incorporated for the structural alternatives based upon recommendations provided by the U.S. Fish and Wildlife Service and the State Department of Health.

(1) A low flow channel will be incorporated along the lined portion of the channel above Kamehameha Highway.

(2) As much as practical, construction activites will take place during periods of low stream flow.

(3) All construction activities within and adjacent to the water will be conducted so as to minimize turbidity and control erosion.

(4) The existing water regimes of the ponds along Kahawainui Stream will be maintained to prevent impacts upon the endangered Hawaiian Gallinule.

(5) The construction specification will require that the Contractor implement environmental protection measures to minimize turbidity and degradation of water quality during the construction of the project.

(6) All construction activities within and adjacent to the water will be conducted according to sound engineering management practices to insure that no debris, organic materials, petroleum products, or other deleterious materials be placed or allowed to fall, flow, leach or otherwise enter the water.

(7) The construction specification will require that the Contractor shall submit an environmental protection plan to comply with all Federal, State and Local Laws, Regulations and Permits including Air and Water Quality Standards.

(8) The effect of the increase in noise levels will be mitigated by ensuring compliance by the Contractor with the provisions of Title 11, Administrative Rules Chapter 43, Community Noise Control for Oahu and Title 11, Administrative Rules Chapter 42, Vehicular Noise Control for Oahu.

12. Summary of Impacts

Structural alternatives 1, 2 and 4 would result in a general loss of vegetation during construction, although levees and berms will be vegetated. Of the structural alternatives, Alternative 1 would require the least area of clearing and grubbing (approximately 5 acres). Alternative 3, the nonstructural alternative, would affect little or no vegetation. All structural alternatives would result in abrupt visual intrusions landward of Kamehameha Highway.

Alternative 1 would require relocation of two sheds and a fuel tank. Alternative 2 would require relocation of one residence, three sheds and a fuel tank. Alternative 4 would affect cultural resources possibly eligible for the National Register of Historic Places and may displace eight structures and a fuel tank.

Alternatives 2 and 4 would eliminate portions of wetlands as well as a natural streambed. Although impacts on the endangered Hawaiian Gallinule are not expected to be significant in this project, the cumulative loss of wetland habitat in Hawaii is considered a significant adverse impact on Hawaiian waterbirds.

In view of the above, Alternative Plan 3 (the nonstructural plan) appears to involve the least impacts on the cultural, physical and biological environment. However, since history indicates that the nonstructural measures of this plan may not adequately control flooding in this area, Alternative Plan 1 (Levee Plan) is concluded to be the least environmentally damaging plan which meets the objectives of this study.

Alternative Plan 2 (Levee and Channel, SPF-event protection) currently maximizes net benefits and is the recommended plan.

VI. SUMMARY COMPARISON OF ALTERNATIVE PLANS

The evaluations of the economic, social and environmental effects of each alternative plan for Kahawainui Stream are displayed in Table 10, Summary Comparison of Alternative Plans and System of Accounts. This table displays the significant contributions, the beneficial and adverse effects, and the extent to which various planning objectives and evaluation criteria are met by each alternative plan.

TABLE 10 SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS

DESCRIPTION	'WITHOUT-PROJECT' CONDITION	ALTERNATIVE 1 Levee Plan	ALTERNATIVE 2 Levee and Channel Plan	ALTERNATIVE 3 Floodproofing and Flood-plain Management Plan	ALTERNATIVE 4 Channel Plan
A. DESCRIPTION OF PROPOSED PLAN FEATURES	Most likely condition to exist in the future in the absence of any plan, but including any known changes in law or public policy.	Provides for levee on right stream bank. A concrete I-wall supported on steel sheet piling would be located in the area of the cemetery, in order to avoid the mass relocation of about 67 graves, which would be required if a levee were to be constructed.	Provides for a levee on the right stream bank with an improved channel section upstream from the bridge. A concrete I-wall supported on steel sheet piling would be located in the area of the cemetery, in order to avoid the mass relocation of about 67 graves, which would be required if a levee were to be constructed.	Floodproof individual structures, relocate or rebuilt non-flood proof-able structures and incorporate floodplain management.	Provides for modifying the existing channel by widening, straightening and lining the channel invert.
B. SIGNIFICANT IMPACTS					
1. Economic (NED Acct)					
a. Goods & Services Urban Flood Damage Reduction	Flooding would continue. Future damages will be incurred to existing properties. Land-use restrictions imposed by C&C Honolulu participation in Federal Flood Insurance Program would help to minimize increases in future damages to new structures.	Plan would reduce average annual damages by ($1,000): SPF 672 100-yr 630 50-yr 583	Plan would reduce average annual damages by ($1,000): SPF 672 100-yr 630 50-yr 583	Plan would reduce average annual damages by ($1,000): SPF 752 100-yr 715 50-yr 674	Plan would reduce average annual damages by ($1,000): SPF 672 100-yr 630 50-yr 583

TABLE 10 SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS (CONT)

DESCRIPTION	'WITHOUT-PROJECT' CONDITION	ALTERNATIVE 1 Levee Plan	ALTERNATIVE 2 Levee and Channel Plan	ALTERNATIVE 3 Floodproofing and Flood-plain Management Plan	ALTERNATIVE 4 Channel Plan
Other: Public Facility & Services	Public facilities within floodplain would continue to flood. Kamehameha Highway and park would be affected by floods exceeding aproximately the 7-year event.	Hukilau Beach Park would be subjected to inundation by floods exceeding 50-year event.	Same as Alternative 1.	If floodproofing measures were undertaken, then only minor roads, back-yards, and exposed utilities would be susceptible to flooding.	Same as Alternative 1.
Land Use	C&C Honolulu's participation in the Federal Insurance Program would impose land use restrictions regarding development in the 100-year flood limit.	Required 5 acres for project lands for levees. Flood area behind levee subject to development restrictions within 100-year floodplain and 50-year flowage easement. Left bank subject to increased flooding with project.	Requires 5 acres for project lands (levee and channel). Flood area behind levee subject to development restrictions.	Incorporate floodplain management policy regulating development within 100-year flood limit.	Requires 26 acres for project lands (channel modification). Allows greatest potential for new home construction.
Commitment of Economic Resources	Public resources in equipment, manpower and money would need to be committed for post-flood clean-up operations by private and County, State and Federal agencies.	Commitment of 47,300 cy of fill and related manpower, equipment and energy resources for construction.	Commitment of 42,200 cy of fill, construction materials and related manpower, equipment and energy resources for and energy resources for construction.	Commitment of building material (wood, concrete, etc.) to modify or reconstruct structures and other related manpower and energy resources for construction	Commitment of equipment, construction material (CRM) and energy resources for construction.
b. External Economics	Economic efficiency of Laie and surrounding area would be diminished. Housing shortage would continue for residents.	Increased economic efficiency and safety of Laie and surrounding resort, recreational, cultural and tourist areas.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.

TABLE 10 SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS (CONT)

DESCRIPTION	'WITHOUT-PROJECT' CONDITION	ALTERNATIVE 1 Levee Plan			ALTERNATIVE 2 Levee and Channel Plan			ALTERNATIVE 3 Floodproofing and Flood-plain Management Plan			ALTERNATIVE 4 Channel Plan		
c. Use of the Unemployed or Under-utilized Labor Resources	Lack of adequate economical housing and unemployment opportunities would force younger generations to other areas on the island to seek housing and employment.	Proposed project may employ local labor for construction.			Same as Alternative 1.			Same as Alternative 1.			Same as Alternative 1.		
d. National Economic Development		SPF	100-Yr	50-Yr	SPF	100-Yr	50-Yr	SPF	100-Yr	50-Yr	SPF	100-Yr	50-Yr
Average Annual Benefit	N/A	672	630	583	672	630	583	752	715	674	672	630	583
Average Annual Cost	N/A	349	324	306	319	283	262	2,081	1,829	1,452	812	777	751
Net Average Annual Benefits	N/A	323	306	277	355	347	321	-1,407	-1,174	-700	-140	-147	-168
Benefit to Cost Ratio	N/A	1.9	1.9	1.9	2.1	2.2	2.2	0.3	0.4	0.5	0.8	0.8	0.8

TABLE 10 SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS (CONT)

DESCRIPTION	'WITHOUT-PROJECT' CONDITION	ALTERNATIVE 1 Levee System Plan	ALTERNATIVE 2 Levee and Channel Plan	ALTERNATIVE 3 Floodproofing and Flood-plain Management Plan	ALTERNATIVE 4 Channel Plan
2. Environmental (EQ Account)					
a. Significant Existing EQ Resources & Attributes					
Ecological: Terrestrial Marine Water Quality Fish & Wildlife	Project area includes flora and fauna associated with residential and agricultural development; wetlands, streams; estuary; coastal embayment; and undeveloped floodplain lands. Water quality is poor in streams. Marine waters are productive. Endangered Hawaiian gallinule is found in pond and fringing wetland. Agricultural practices would continue to affect stream water quality and wetland. No significant changes in the overall terrestrial, aquatic or marine faunal composition.	Levees would require clearing and grubbing of 5 acres of land consisting of common trees, shrubs, weeds and ornamental escapes. Floodwaters would be diverted to areas north of Kahawainui Stream including wetlands.	Levee would require clearing and grubbing of 5 acres of land consisting of common trees, shrubs and ornamental escapes.	Ornamental plants around homes would be destroyed or damaged during construction, but would be replaced or repaired. No impacts on fauna, marine resources or water quality.	Channel would require clearing and grubbing of 26 acres of land consisting of common trees, shrubs, weeds and ornamental escapes. Same as Alternative 2. Potential of destroying the wetland by channeling low stream flows through the area rather than allowing ponding in the wetland.

TABLE 10 SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS (CONT)

DESCRIPTION	'WITHOUT-PROJECT' CONDITION	ALTERNATIVE 1 Levee Plan	ALTERNATIVE 2 Levee and Channel Plan	ALTERNATIVE 3 Floodproofing and Flood-plain Management Plan	ALTERNATIVE 4 Channel Plan
Cultural					
Historic/ Archaeological	Possible National Register sites. Prehistoric artifacts and possible cultural deposit and Hawaiian grave sites. Possibly prehistoric sites near filled fishpond. Some prehistoric site may be destroyed by planned housing project in 1990's.	Increased flooding in the area of prehistoric artifacts and cultural deposits. Some sites may require archaeological data recovery if justified. Excavations in beach would be monitored.	No known sites affected. Excavations in beach will be monitored.	No known sites affected.	No known sites affected. Excavations in beach will be monitored.
Recreation	Hukilau Beach Park. Recreational fishing in stream.	Levee would obstruct access to stream.	Channel would intrude slightly into beach park.	No effect on recreation.	Same as Plan 2.
Aesthetic					
Noise	Quiet, rural scene except for two-lane highway noise. Ambient noise levels should rise greater traffic & new residences from housing project.	Temporary and minor construction noise.	Same as Alternative 1, but longer duration.	Highest perceived noise levels because construction occurs within residential area.	Same as Alternative 1.

TABLE 10 SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS (CONT)

DESCRIPTION	'WITHOUT-PROJECT' CONDITION	ALTERNATIVE 1 Levee Plan	ALTERNATIVE 2 Levee and Channel Plan	ALTERNATIVE 3 Floodproofing and Flood-plain Management Plan	ALTERNATIVE 4 Channel Plan
Aesthetic (Cont)					
Visual	3,200 linear feet of stream through grassed wetland and woodland areas. Portions of grassed wetland/meadow may be filled by housing project if approved.	Levees would obstruct view of 2,370 linear feet stream area. Levee would be grassed to temper impact.	Levees would obstruct view of 1,760 linear feet of stream area: lined channel would extend up from the Laiewai Bridge nearly 500 feet. Some visual impacts can be minimized by landscaping.	Raising some houses and shielding others at ground level would create a hodge-podge landscape. Floodproofing would introduce new visual elements to homes.	New wider, straighter, 3,850-linear foot long channel with CRM lining would add new visual element.
b. Section 122 (PL 91-611)	*Items specifically required by Section 122, Public Law 96-611.				
*Air, Noise, and Water Pollution	-	Temporary increases in air and noise pollution during construction of levee.	Temporary increases in air, noise and water pollution during construction of levee and channel.	Temporary increases in air and noise pollution during floodproofing depending on construction methods used.	Temporary increases in air, noise and water pollution during construction of channel.
*Destruction or Disruption of Man-Made and Natural Resources	-	Clearing and grubbing of existing vegetation along levee alignment.	Clearing and grubbing of land along levee and channel alignments. Permanent alteration of a portion of stream course and bottom substrate.	Disruption and modification of residences during floodproofing operations.	Clearing and grubbing of of channel alignment. Permanent alteration of stream course and bottom substrate.

TABLE 10 SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS (CONT)

DESCRIPTION	'WITHOUT-PROJECT' CONDITION	ALTERNATIVE 1 Levee Plan	ALTERNATIVE 2 Levee and Channel Plan	ALTERNATIVE 3 Floodproofing and Flood-plain Management Plan	ALTERNATIVE 4 Channel Plan
Aesthetic (Cont)					
*Adverse Employment Effects & Tax & Property Value Losses	Employment dependent on tourism, services and farming. Property tax value influenced by 100-year flood hazard restrictions and flooding.	No measurable effects on employment levels. Protected areas have potential property tax value increase. No change for those in the 100-year floodplain.		Equal effects on all residences.	No measurable effects on on employment. Property tax value increases for protected areas. No change within 100-year floodplain.
*Injurious Displacement of People, Businesses & Farms		Three structures on left bank would require floodproofing. Two sheds and a fuel tank would require relocation/removal.	One residence, three sheds and a fuel tank to be relocated.	Temporary (1-3 days) displacement of residents. Alternative housing would be provided.	About 8 structures and a fuel tank to be relocated.
*Disruption of Desirable Community & Regional Growth		Portions of future housing project in floodplain will need to conform w/floodplain management restrictions. Floodplain alteration may allow development within protected areas.			
3. Regional Economic Development (RED Account)					
a. Regional Income	-	Regional economic analysis not separable.			
b. Regional Employment	-	Regional economic analysis not separable.			

TABLE 10 SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS (CONT)

DESCRIPTION	'WITHOUT-PROJECT' CONDITION	ALTERNATIVE 1 Levee Plan	ALTERNATIVE 2 Levee and Channel Plan	ALTERNATIVE 3 Floodproofing and Flood-plain Management Plan	ALTERNATIVE 4 Channel Plan
C. PLAN EVALUATION					
1. Contributions to the Planning Objectives					
a. Contribute to the Reduction of Property Damages by Flood-waters	-	Alternative plan reduces average annual damages by ($1000): SPF 672 100-yr 630 50-yr 583	Alternative plan reduces annual damages by ($1000): SPF 672 100-yr 630 50-yr 583	Alternative plan reduces annual damages by ($1000): SPF 752 100-yr 715 50-yr 674	Alternative plan reduces annual damages by ($1000): SPF 672 100-yr 630 50-yr 583
b. Contribute to the Efficient Use of the Lands Consistent with the Local Land-Use and Development Plans & Floodplain Manage-ment Policy during 1985-2085.	-	All plans implement floodplain management measure compatible with County's participation in the Federal Flood Insurance Program.			
c. Contribute to the improvement of water quality of the estuary below Laiewai Bridge	-	No effect.	No effect.	No effect.	No effect.

TABLE 10 SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS (CONT)

DESCRIPTION	'WITHOUT-PROJECT' CONDITION	ALTERNATIVE 1 Levee Plan	ALTERNATIVE 2 Levee and Channel Plan	ALTERNATIVE 3 Floodproofing and Flood-plain Management Plan	ALTERNATIVE 4 Channel Plan
C. PLAN EVALUATION (Cont)					
d. Contribute to or Maintain the Water Contact Recreational Opportunities	-	No effect on seashore water contact recreation.			
e. Protect and/or enhance the beneficial values of wetlands within the project area.	-	No significant impact	Impact on about 2 acres of wetland. Enhancement of undisturbed wetland proposed.	No effect	Similar to Plan 2.
f. Minimize land acquisition impacts to landholders.	-	Requires removal/relocation of 2 sheds and a fuel tank.	Requires removal/relocation of 1 house, 3 sheds and a fuel tank.	Requires removal/relocation of about 179 structures.	Requires removal/relocation of about 8 structures and a fuel tank.
2. RESPONSE TO CONSIDERATION OF FOUR EVALUATION TEST					
a. Completeness	-	Complete requires periodic maintenance	Complete requires periodic maintenance	Completeness depends upon flooding of roads, yards and utilities and post-flood cleanup.	Complete requires periodic maintenance
b. Effectiveness	-	Effective	Effective.	Effective, nuisance flooding still prevalent.	Effective.
c. Efficiency	-	Efficient	Most economically efficient.	Not economically efficient.	Not economically efficient.
d. Acceptability	-	Publically acceptable	Publically acceptable	Not publically acceptable	Not acceptable to Kuleana landowners.

TABLE 10 SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS (CONT)

DESCRIPTION	'WITHOUT-PROJECT' CONDITION	ALTERNATIVE 1 Levee Plan	ALTERNATIVE 2 Levee and Channel Plan	ALTERNATIVE 3 Floodproofing and Flood-plain Management Plan	ALTERNATIVE 4 Channel Plan
3. SELECTION OF CANDIDATE PLANS FOR THE NED, EQ, NONSTRUCTURAL PRIMARILY NONSTRUCTURAL PLANS					
a. Plan Designation	-	-	NED Plan (for SFP-event storm).	Non-structural plan.	-
b. Ranking between Alternatives and Contributions to Accounts.					
NED (SFP-event level of protection)	-	2	1	3	4
EQ	-	2	3	1	4
OSE	-	1	2	3	4
Net Benefits	-	2	1	4	3

TABLE 10 SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS (CONT)

DESCRIPTION	'WITHOUT-PROJECT' CONDITION	ALTERNATIVE 1 Levee Plan	ALTERNATIVE 2 Levee and Channel Plan	ALTERNATIVE 3 Floodproofing and Flood-plain Management Plan	ALTERNATIVE 4 Channel Plan
4. Other Social Effects (OSE Account)					
a. Urban & Community Impacts	-	All plans are intended to alleviate flooding problems related to Kahawainui Stream. In the long run, these should have a generally positive effect on the community at large.			
b. Life, Health & Safety	-	Would reduce likelihood of human injury, sickness or potential loss of life, except for unprotected parts of floodplain.		Likelihood of human injury or loss of life reduced only if people stay in residences or evacuate the area during flood. Risk of sickness due to standing water not eliminated.	Would reduce likelihood of human injury, sickness or loss of life except for unprotected parts of floodplain.
c. Displacement	-	Three structures must be floodproofed for safety reasons.	One home, three sheds and one fuel tank to be relocated with potential loss of land.	Temporary (1-3 days) displacement of residences. Alternative housing would be provided.	May impact on Hawaiian grave site and many structures must be removed.
d. Long-Term Productivity	-	Long-term productivity of agricultural land unaffected.	Would eliminate some wetland grazing.	No change.	Would eliminate about 20 acres of ag. use on proj lands, may encourage housing development on lands to be protected.
e. Energy Requirements and Energy Conservation	-	Petroleum fuel will be consumed during construction.	Same as Alternative 1.	Little petroleum consumption.	Same as Alternative 1.

TABLE 10 SUMMARY COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS (CONT)

DESCRIPTION	'WITHOUT-PROJECT' CONDITION	ALTERNATIVE 1 Levee Plan	ALTERNATIVE 2 Levee and Channel Plan	ALTERNATIVE 3 Floodproofing and Flood-plain Management Plan	ALTERNATIVE 4 Channel Plan
D. IMPLEMENTATION RESPONSIBILITIES					
1. Corps of Engineers	Provide emergency flood control assistance as necessary.	Provide Federal project first cost share, design and construction of structural features.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
2. City & County of Honolulu	Provide emergency flood control assistance and clean-up as necessary.	Provide non-Federal project first share and local assurances and cooperation. Maintenance responsibilities.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
3. State of Hawaii	Provide financial and emergency assistance during floods.	Support recommended plan through financial assistance to County.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.

VII. RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS, POLICIES AND CONTROLS FOR THE AFFECTED AREA

The proposed project does not conflict with any approval or proposed, State or County land use plans, policies or controls. To the extent that the project will provide protection against flooding to the existing residences in the Laie town area, the project can be said to conform with the approved land use plans for the area. The proposed project is presently not included in the current Development Plan Public Facilities (DP/PF) Map. However, the application to amend the DP/PF Map for the Koolauloa District has been submitted to the Department of General Planning and is currently being processed. The project amendment is included in the Fiscal Year 1986-87 Annual Review of the Development Plans package. It is anticipated that the adoption of the FY 1986-87 Annual Review package by the City Council will be in May 1987.

The project area is also located within the Special Management Area (SMA) and a Special Management Area Permit will be required. The application for the SMA permit is being prepared and will be submitted to the City Department of Land Utilization.

According to the Flood Insurance Rate Map prepared by the Federal Emergency Management Agency, the project area is situated within the limits of the 100-year flood hazard area and designated as Zone A. The Kahawainui Stream Flood Control project should eliminate the flood hazard designation for the existing Laie town area to be protected by the flood control project. However, the floodplain area behind the levee will be subject to development restrictions covered under Ordinance 80-62.

The proposed project is in consonance with the General Plan of the City and County of Honolulu. The applicable objectives and policies are as follows:

Natural Environment

Objective A	To protect and preserve the natural environment of Oahu.
Policy 2	Seek the restoration of environmentally damaged areas and natural resources.
Policy 3	Retain the Island's streams as scenic, aquatic and recreation resources.
Policy 6	Design surface drainage and flood control systems in a manner which will help preserve their natural settings.

Public Safety

Objective B	To protect the people of Oahu and their property against natural disasters and other emergencies, traffic and fire hazards, and unsafe conditions.
Policy 2	Require all developments in areas subject to floods and tsunamis to be located and constructed in a manner that will not create any health or safety hazards.

Culture and Recreation

Objective B	To protect Oahu's cultural, historic, architectural and archaeological resources.
Policy 2	Identify, and to the extent possible, preserve and restore buildings, sites, and areas of social, cultural, historic, architectural, and archaeological significance.

The proposed project was evaluated to determine its consistency with the Hawaii State Plan in Chapter 226, HRS, the Hawaii State Planning Act. The sections in the State Plan that are applicable to the project are Sections 226-11 through 226-13. The objectives of the applicable sections are as follows:

Section 226-11	Physical Environment - Land Based, Shoreline and Marine Resources.
Objective 226-11(a)(1)	Prudent use of Hawaii's land based, shoreline and marine resources.
Objective 226-11(a)(2)	Effective protection of Hawaii's unique and fragile environmental resources.
Section 226-12	Physical Environment - Scenic, Natural Beauty, and Historic Resources.
Objective 226-12(a)	Enhancement of Hawaii's scenic assets, natural beauty, and multi/cultural historical resources.
Section 226-13	Physical Environment - Land, Air and Water Quality.
Objective 226-13(a)(1)	Maintenance and pursuit of improved quality in Hawaii's land, air, and water resources.
Objective 226-13(a)(2)	Greater public awareness and appreciation of Hawaii's environmental resources.

Section 226-11: Physical Environment - Land Based, Shoreline and Marine Resources.

The proposed project will be consistent with the objectives and applicable policies of Section 226-11, the land based, shoreline and marine resources.

The proposed project will not have any significant, long-range, adverse impact on any land based, shoreline and marine resources. The marine resources within Laie Bay will not be susceptible to significant, long-range, adverse impact from the construction of the project. Nearshore waters are relatively deep, and predominant currents would promote dispersion and dilution of silt-laden streamwaters in the bay and along the windward coast. Although residents have noted that a turbidity plume is visible following heavy rains, it is quickly dissipated and ambient water quality is restored. Little accumulation of terrigeous material was observed during offshore surveys conducted by the Fish and Wildlife Service.

The shoreline area will not be directly affected by the project since the project will extend only 140 feet downstream of Kamehameha Highway which is approximately 300 feet upstream from the shoreline. Flows exceeding the stream capacity of about 400 cfs below the project limits would overflow the stream banks within the park site and discharge as sheet flows across the shoreline to the ocean.

The proposed project will result in the long-term loss of approximately 5 acres of agricultural, residential, public facility (cemetery) and wetlands areas for the construction of the levee and channel improvements. However, the project will provide protection to the residents in the Laie town proper from periodic flooding from the overflow of Kahawainui and Laiewai Streams. After the project is completed, future community growth would be enhanced and encouraged to proceed without sudden and severe interruptions. As mitigation for wetland loss, the remaining wetland acreage would be preserved.

The proposed project would involve excavating and filling some grazing areas north of Kahawainui Stream. Berms associated with the proposed channel would be constructed on the fringes of an existing banana tree grove located along Kahawainui Stream near Kamehameha Highway. Otherwise, agricultural use of the existing agricultural lands will not be affected by the project and may continue.

Construction of the project will provide for a wider choice of land use alternatives for the protected portion of the floodplain. However, development of the floodplain area behind the levee will be subject to floodplain restrictions as the area will not be protected from flooding.

Section 226-12: Physical Environment Scenic, Natural Beauty, and Historic Resources.

The proposed project will be consistent with the objectives and applicable policies of Section 226-12, relating to scenic assets, natural beauty, and multi/cultural historic resources.

Although construction of the levee would obscure the view of approximately 1,760 feet of the stream, some of the scenic and visual impacts will be minimized by landscaping and grassing of the levee slopes. The lined channel would extend approximately 500 feet upstream from Kamehameha Highway bridge. The invert of the lined channel will be constructed below mean sea level and will be submerged to minimize visual impact.

The private, but accessible Hukilau Beach Park of approximately 3.4 acres is located within the grove of ironwood trees seaward of Kamehameha Highway and southeast of the mouth of Kahawainui Stream. Additionally, the dense mangrove area adds a pleasing aesthetic vista to the quality of the park setting. The project will not adversely intrude into the open space and natural beauty of the park.

The project will be aligned to avoid all graves in the Laie Cemetery and all known archaeological or cultural sites including the Chinese Grave Site, the newly identified Hawaiian Grave Site, the Torii Gate and the former plantation camp.

Implementation of the recommended alternative will not foreclose public access to and use of the historic sites in the general or overall project area. As a result of the archaeological studies performed, all identified historic sites will be located outside the construction boundaries of the flood control project.

Section 226-13: Physical Environment - Land, Air and Water Quality.

The proposed project will generally be consistent with the objective and applicable policies of Section 226-13, land, air and water quality.

The recommended alternative will require the clearing and grubbing of approximately 5 acres of land. However, the proposed project would provide protection to residents of Laie town area from periodic flooding from the overflow of Kahawainui and Laiewai Streams. The project would reduce public health hazards and other adverse economic impacts and enhance community safety. Future community growth can be implemented without fear of flooding. Implementation of the project would improve the quality of the land resources within the protected area and provide for a wide range of choices in the land use plans.

There will be no long-term effects on the air quality as a result of this project. During construction, increased noise and air pollution may result from use of heavy equipment. The construction contract specifications will require that the Contractor comply with Federal, State and City laws and regulations regarding noise, air and water quality.

The channelization proposed under the recommended alternative may result in increased stream velocity during periods of storm flow. However, the project is not anticipated to adversely affect the water quality of the existing stream.

VIII. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The proposed project will result in the long-term loss of approximately 5 acres of agricultural, residential, public facility (cemetery) and wetland areas. The project will require the relocation of one residence, three sheds and a fuel tank. The project will provide protection to residents in Laie town proper from periodic flooding from the overflow of Kahawainui and Laiewai Streams. The project would reduce public health hazards and other adverse economic impacts and enhance community safety. Overall, long-term community growth would be enhanced and encouraged to proceed without sudden and severe interruptions.

IX. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The proposed project will irreversibly and irretrievably commit public and private funds, land, manpower, material and energy resources required for its design, construction and maintenance. Approximately 5 acres of land will be lost to permanent rights-of-way and easements for the levee and channel improvements.

Manpower and labor will be involved in the construction and maintenance of this flood control project; all labor expenditure will be essentially irreversible and irretrievable. Materials such as concrete, reinforcing steel, asphaltic concrete pavement, corrugated metal pipe, etc. will be required for construction, and when in place, will be irreversibly and irretrievably committed. Vegetation cleared and removed from along the proposed levees, channel and berms during construction will be irretrievably committed. However, the exposed areas and the unlined levee slopes and crest would be grassed.

The maintenance of the flood control improvements will involve mechanically and manually clearing and removing vegetation and debris from the channel and levees that normally grow and accumulate over a period of time. The maintenance work will be an irreversible commitment of energy and manpower in the future.

X. RISK AND UNCERTAINTY EVALUATION

Various levels of flood protection were evaluated for the four alternatives studied in detail. A 50-year, 100-year and standard project flood (SPF) which is approximately equal to a 285-year flood event were evaluated. A risk and uncertainty evaluation was done by the Corps of Engineers and is included in Appendix B.

Alternative Plan 2 at the SPF level of protection will be implemented based upon its maximization of net benefits and also that the plan does not have any significant adverse or unmitigative environmental impacts.

XI. AGENCIES AND ORGANIZATIONS CONSULTED PRIOR TO FILING EIS

A. FEDERAL GOVERNMENT

	DATED
U.S. Army Engineer District, Honolulu	November 6, 1986
U.S.D.I. Fish and Wildlife Service	November 7, 1986
U.S.D.A. Soil Conservation Service	November 7, 1986
U.S.G.S., Water Resources Division	None

B. STATE OF HAWAII

Department of Accounting and General Services	November 5, 1986
Department of Education	October 24, 1986
Department of Health	October 27, 1986
Department of Land and Natural Resources	January 16, 1987
Division of Fish and Game	
Division of State Parks	
Department of Planning and Economic Development	November 14, 1986
Department of Transportation	December 1, 1986
University of Hawaii	October 28, 1986
Environmental Center	
Water Resources Research Center	

C. CITY AND COUNTY OF HONOLULU

Department of General Planning	October 31, 1986
Department of Land Utilization	None
Department of Parks and Recreation	October 28, 1986
Department of Transportation Services	November 12, 1986
Koolauloa Neighborhood Board No. 28	None

D. OTHERS

Zions Securities Corporation	None
Laie Community Association	None

Letters of comments from consulted agencies and organizations, and the City responses where applicable, are appended.

865960

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

RECEIVED
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REPLY TO
ATTENTION OF:

November 6, 1986

TO _____

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RECEIVED
DIV. OF ENGINEERING
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Mr. Russell L. Smith, Jr.
Department of Public Works
City and County of Honolulu
650 S. King Street
Honolulu, Hawaii 96813

Dear Mr. Smith:

Thank you for the opportunity to review and comment on the EIS Preparation Notice for Kahawainui Stream Flood Control Project, Laie, Oahu, Hawaii.

According to the Flood Insurance Rate Map (150001-0015A), the property identified as TMK: 5-5-9 is within the limits of the 100-year flood, designated Zone A. Base flood elevations and flood hazard factors have not been determined for this area. Our flood control project for Kahawainui Stream should eliminate the flood hazard.

Sincerely,

Kisuk Cheung
Chief, Engineering Division

865978

ENV
11/10 ENGR

United States Department of the Interior

FISH AND WILDLIFE SERVICE
300 ALA MOANA BOULEVARD
P.O. BOX 50167
HONOLULU, HAWAII 96850

RECEIVED
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TO

ES
Room 6307

NOV 7 1986

Mr. Russell L. Smith, Jr.
Director and Chief Engineer
Department of Public Works
City and County of Honolulu
650 South King Street
Honolulu, HI 96813

Re: Environmental Impact Statement (EIS) Preparation Notice, Kahawainui Flood Control Project, Laie, Oahu

Dear Mr. Smith:

We have reviewed the referenced Preparation Notice and offer the following comments for your consideration.

We understand that this proposal is identical to the project described in the Final Detailed Project Report and Environmental Impact Statement for the Kahawainui Flood Control Study (U.S. Army Corps of Engineers, 1985). The City and County of Honolulu is preparing an EIS to meet State requirements under Chapter 343, HRS.

We recommend that the following mitigation measures be made part of the project and be discussed in the EIS.

a. The mitigation measures included in the Service's Final Fish and Wildlife Coordination Act Report (January 1984) should be incorporated into the project design.

b. A channel should be constructed from Station 21+00 to the upstream point where Kahawainui Stream is to be straightened. This would provide stream habitat for and allow upstream migration of native diadromous species.

c. The small wetland isolated by the new stream alignment should be monitored for changes in water levels and wetland vegetation. If the wetland decreases in value because of the flood control improvements, we recommend that it be restored or that adjoining wetlands enhanced.

We appreciate the opportunity to comment.

Sincerely,

for Ernest Kosaka
Project Leader
Office of Environmental Services

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CONSERVE AMERICA'S ENERGY

cc: DLNR

Save Energy and You Serve America!

12-0050

February 9, 1987

Mr. Ernest Kosaka
Project Leader
Office of Environmental Services
Fish and Wildlife Service
United States Department of the Interior
P. O. Box 50167
Honolulu, Hawaii 96850

Dear Mr. Kosaka:

Subject: Your Latter ES Room 6307 dated November 7, 1986 relating to the Environmental Impact Statement Preparation Notice for the Kahawainui Stream Flood Control Project

Thank you for your comments on the environmental impact statement (EIS) preparation notice.

There have been no significant changes to the scope of the project as described in the Final Detailed Project Report and Environmental Impact Statement for the Kahawainui Stream Flood Control project prepared by the U.S. Army Corps of Engineers. This EIS is being prepared to meet the State environmental requirements under Chapter 343, HRS.

Your comments will be discussed further in the draft EIS and were referred to the U.S. Army Corps of Engineers for their consideration since they are the lead agency in the design and preparation of the project construction plans.

The Corps of Engineers has informed us that a channel will be excavated between Station 21+00 and the Kahawainui Stream. The bottom of the channel will have a V-shaped cross section. Where the existing stream being realigned will be filled, the adjacent land remnant will be graded to be compatible with the surrounding area.

The Corps also indicated that planting of shade vegetation on the levee is not permitted in the Corps standard design because the roots of large plants would increase probability of structural damages to the levee.

Very truly yours,

Vernon W. S. Ching
ALFRED J. THIEDE
FOR Acting Director and Chief Engineer

WY:CPC:pto

United States
Department of
Agriculture

Soil
Conservation
Service

P.O. Box 50006
Honolulu, HI
96850

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Mr. Russell L. Smith, Jr.
Director and Chief Engineer
Department of Public Works
City and County of Honolulu
650 South King Street
Honolulu, HI 96813

November 7, 1986
12-0306

Dear Mr. Smith:

Subject: EIS Preparation Notice for the Kahawainui Stream Flood Control Project, TMK: 5-5-9

We have reviewed the subject preparation notice and have no comments.

Thank you for the opportunity to review this document.

Sincerely,

Stratford L. Whiting

Stratford L. Whiting
District Conservationist

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GEORGE R. ARIYOSHI
GOVERNOR

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HIDEO MURAKAMI
COMPTROLLER

MIKE N. TOKUNAGA
DEPUTY COMPTROLLER

STATE OF HAWAII

DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES
DIVISION OF PUBLIC WORKS
P. O. BOX 119, HONOLULU, HAWAII 96810

LETTER NO. (P) 2033.6

NOV 5 1986

Mr. Russell L. Smith, Jr.
Director and Chief Engineer
Department of Public Works
City and County of Honolulu
Honolulu, Hawaii

Dear Mr. Smith:

Subject: Environmental Impact Statement
Preparation Notice
Kahawainui Stream Flood Control Project

We have reviewed the preparation notice and are interested in the project due to its proximity to the Laie Elementary School. Please include us on the distribution list for the Final EIS.

Thank you for providing us this opportunity to comment on this preparation notice.

Very truly yours,

TEUANE TOMINAGA
State Public Works Engineer

EM:jnt

12-0057

February 9, 1987

Mr. Teuane Tominaga
State Public Works Engineer
Division of Public Works
Department of Accounting and
General Services
State of Hawaii
P. O. Box 119
Honolulu, Hawaii 96810

Dear Mr. Tominaga:

Subject: Your Letter No. (P)2033.6 dated November 5, 1986 relating to the Environmental Impact Statement Preparation Notice for the Kahawainui Stream Flood Control Project

Thank you for your comments on the environmental impact statement preparation notice.

We will include your agency on the distribution list for the Final EIS as requested.

Very truly yours,

Vernon W. S. Ching

FOR: ALFRED J. THIEDE
Acting Director and Chief Engineer

WY:CPC:pto

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GEORGE R. ARIYOSHI
GOVERNOR

FRANCIS M. HATANAKA
SUPERINTENDENT

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TO

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STATE OF HAWAII
DEPARTMENT OF EDUCATION
P. O. BOX 2360
HONOLULU, HAWAII 96804

OFFICE OF THE SUPERINTENDENT

October 24, 1986

Mr. Russell L. Smith, Jr.
Director and Chief Engineer
Department of Public Works
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Smith:

Subject: Environmental Impact Statement Preparation Notice for the Kahawainui Stream, Flood Control Project

Thank you for the opportunity to review your EIS preparation notice. Our review indicates negligible effect on the Department of Education.

Sincerely,

Margaret Y. Oda

Francis M. Hatanaka
for Superintendent

FMH:ct

cc Windward District
OBS

AN AFFIRMATIVE ACTION AND EQUAL OPPORTUNITY EMPLOYER

865830

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

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LESLIE S. MATSUBARA
DIRECTOR OF HEALTH

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STATE OF HAWAII

DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

In reply, please refer to:
EPHSD

October 27, 1986

MEMORANDUM

To: Mr. Russell L. Smith, Jr., Director & Chief Engineer
Department of Public Works, City & County of Honolulu

From: Deputy Director for Environmental Health

Subject: Environmental Impact Statement Preparation Notice for the Kahawainui Stream Flood Control, TMK 5-5-9

In preparation of an EIS of the subject project, the following concerns must be addressed:

1. Activities associated with the construction phase must comply with the provisions of Title 11, Administrative Rules Chapter 43, Community Noise Control for Oahu.

   a. The contractor must obtain a noise permit if the noise levels from the construction activities are expected to exceed the allowable levels of the regulations.

   b. Construction equipment and on-site vehicles requiring an exhaust of gas or air must be equipped with mufflers.

   c. The contractor must comply with the conditional use of the permit as specified in the regulations and conditions issued with the permit.

2. Traffic noise from heavy vehicles travelling to and from the construction site must be minimized near existing residential areas and must comply with the provisions of Title 11, Administrative Rules Chapter 42, Vehicular Noise Control for Oahu.

3. Should there be a baseyard or stockpile area located adjacent to residences, precautions to reduce the noise in these areas, such as barriers or berms, must be implemented. Contingency plans must be developed in the event that complaints are received regarding noise emanating from these areas.

James K. Ikeda
JAMES K. IKEDA

12-0051

February 9, 1987

Mr. James K. Ikeda
Deputy Director for
Environmental Health
Department of Health
State of Hawaii
P. O. Box 3378
Honolulu, Hawaii 96801

Dear Mr. Ikeda:

Subject: Your Memorandum EPHSD dated October 27, 1986 relating to the Environmental Impact Statement Preparation Notice for the Kahawainui Stream Flood Control Project

Thank you for your comments on the environmental impact statement (EIS) preparation notice.

Your comments will be discussed further in the draft EIS. Also, since the construction contract will be administered by the U.S. Army Corps of Engineers, we have requested the Corps of Engineers to include a provision in the construction contract requiring the project contractor to comply with the provisions of Title 11, Administrative Rules Chapters 42 and 43, relating to Vehicular Noise Control for Oahu and Community Noise Control for Oahu, respectively.

The Corps of Engineers has informed us that compliance with noise control and other construction control regulations will be specified in the construction specifications.

Very truly yours,

Vernon N S Ching

ALFRED J. THIEDE
FCW Acting Director and Chief Engineer

WY:CPC:pto

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JOHN WAIHEE
GOVERNOR OF HAWAII

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WILLIAM W. PATY
BOARD OF LAND & NATURAL RESOURCES
LIBERT K. LANDGRAF
DEPUTY TO THE CHAIRMAN

DIVISIONS:
AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

JAN 16 1987

DOCUMENT NO.: 2264B

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Department of Public Works
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Gentlemen:

SUBJECT: Environmental Impact Statement (EIS) Preparation Notice, Kahawainui Flood Control Project, Laie, Oahu, TMK: 5-5-9

We have reviewed the subject Preparation Notice and offer the following comments for your consideration.

Aquatic Resources Concerns

From an aquatic resources standpoint, we have no objection to the Corps' selection of Alternative Plan 2 (levee along the right banks of the upper portions of Laiewai and Kahawainui Streams, and the realignment and channelization of the lower portion of Kahawainui Stream). Biological studies conducted in the subject area by the U.S. Fish and Wildlife Service revealed low diversity of stream/estuarine macrofauna, probably due to low water quality (high ammonia concentrations) in the Kahawainui Stream from agricultural activities. The mitigating measures addressed in the Final Environmental Impact Statement should minimize adverse impacts to the biological resources.

Forestry and Wildlife Concerns

We noticed an error on page 6 of the EIS Preparation Notice. It states that the Black-crowned night heron is a common introduced bird. This statement should be corrected as the Black-crowned night heron is a native or indigenous species. Otherwise, it appears that this EIS Preparation Notice adequately addresses our concerns. However, we will reserve further comments until we review the draft EIS and compare it to the Army Corps of Engineers' June 1985 "Draft Detailed Project Report and Environmental Impact Statement, Kahawainui Stream Flood Control Study, Laie, Oahu, Hawaii," which adequately addressed our concerns.

Water and Land Development Concerns

It is our understanding that Federal NEPA EIS requirements have been met and that the current EIS preparation notice initiates the State EIS process and is intended to satisfy State EIS requirements under Chapter 343, HRS.

The project will involve channel improvements, consisting of construction of levees and concrete and rip-rap channels along Kahawainui and Laiewai Streams. As such, a Stream Channel Alteration Permit will be required for the project in accordance with the Department's Administrative Rule, Title 13, Chapter 167 for protection of instream uses of water in Windward Oahu. The local sponsors of the project are aware of this permit requirement and will submit an application in the near future.

The draft EIS should address the existing stream environment, aquatic species and habitat and the recreational uses of the streams involved. Anticipated impacts and mitigation measures should be fully discussed.

Thank you for allowing us to review the EISPN for the proposed Kahawainui Stream Flood Control project. We hope our comments will be of help to you.

Very truly yours,

WILLIAM W. PATY, Chairperson
Board of Land and Natural Resources

12-0056

February 9, 1987

Mr. William W. Paty, Chairperson
Board of Land and Natural Resources
State of Hawaii
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Paty:

Subject: Your Letter, Document No. 2264B, dated January 16, 1987, relating to the Environmental Impact Statement (EIS) Preparation Notice for the Kahawainui Stream Flood Control Project

Thank you for your comments on the environmental impact statement preparation notice.

Your comments will be taken into consideration in the preparation of the draft EIS. We will also be submitting an application for a Stream Channel Alteration Permit which will be required for this project as soon as the EIS is accepted.

Very truly yours,

Vernon W. L. Ching
For ALFRED J. THIEDE
Acting Director and Chief Engineer

WY:CPC:pto

866171

GEORGE R. ARIYOSHI
GOVERNOR
KENT M. KEITH
DIRECTOR
MURRAY E. TOWILL
DEPUTY DIRECTOR

DEPUTY DIRECTOR

DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT

KAMAMALU BUILDING, 250 SOUTH KING ST, HONOLULU, HAWAII
MAILING ADDRESS: P.O. BOX 2359, HONOLULU, HAWAII 96804 • TELEX: 7430250 HIDPED

DIVISIONS
BUSINESS AND INDUSTRY DEVELOPMENT DIVISION
ENERGY DIVISION
335 Merchant St., Room 110, Honolulu, Hawaii 96813
FOREIGN-TRADE ZONE DIVISION
Pier 2, Honolulu, Hawaii 96813
LAND USE DIVISION
PLANNING DIVISION
RESEARCH AND ECONOMIC ANALYSIS DIVISION

OFFICES
ADMINISTRATIVE SERVICES OFFICE
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Ref. No. P-5424

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November 14, 1986

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The Honorable Russell L. Smith, Jr.
Director and Chief Engineer
Department of Public Works
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Smith:

Subject: EIS Preparation Notice for a Flood Control Project on Kahawainui Stream, Laie, Oahu

We have reviewed the subject preparation notice and offer the following comments.

We previously reviewed the proposed activity through the EIS prepared by the U. S. Army Corps of Engineers in conjunction with its Federal consistency determination. The upcoming draft EIS should indicate any change from that previous EIS.

In addressing the Hawaii Coastal Zone Management objective to reduce hazards to life and property from stream flooding, the draft EIS should discuss the adequacy of proposed flood protection. It is particularly important that the document identify the level of protection that will be provided (i.e., against the 50-year storm, the 100-year storm); describe the probable effect(s) of flooding when the proposed structures are in place; assess the potential to exceed the project's capacity (e.g., its probability of overtopping or failure within a given time interval); and estimate future residual flood damages to property or hazards to life.

The draft EIS should discuss the consistency of the proposed project to the appropriate objectives, policies and priority guidelines of the Hawaii State Plan (Chapter 226, HRS), and the policies and implementing actions of the applicable Functional Plans. This review should include the objectives and policies for the Physical Environment (Sections 226-11 through 226-13, HRS) among the relevant sections for discussion.

Thank you for this opportunity to comment on the subject document.

Very truly yours,

Murray E. Towill
for Kent M. Keith

cc: Office of Environmental Quality Control

12-0055

February 9, 1987

Mr. Roger Ulveling
Director
Department of Planning and
Economic Development
State of Hawaii
P. O. Box 2359
Honolulu, Hawaii 96804

Dear Mr. Ulveling:

Subject: Your Letter Ref. No. P-5424, dated November 14, 1986, relating to the Environmental Impact Statement Preparation Notice for the Kahawainui Stream Flood Control Project

Thank you for your comments on the environmental impact statement (EIS) preparation notice.

The upcoming draft EIS will not have any significant changes from the previous EIS prepared by the U.S. Army Corps of Engineers since there have been no significant changes in the scope of the project.

Your comments will be addressed and discussed in the draft EIS.

The Corps of Engineers is designing the project to provide for the standard project flood control (SPF) levee of protection which is approximately equal to a 285-year storm. The improvements will provide protection from riverine overflows from the Laiewai and Kahawainui Streams.

Very truly yours,

Vernon W. L. Ching

For ALFRED J. THIEDE
Acting Director and Chief Engineer

WY:CPC:pto

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GEORGE R. ARIYOSHI
GOVERNOR

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WAYNE J. YAMASAKI
DIRECTOR

DEPUTY DIRECTORS
JONATHAN K. SHIMADA, Ph.D.
WALTER T.M. HO
CHERYL D. SOON
ADAM D. VINCENT

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? How come??

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

IN REPLY REFER TO:
STP 8.1707

December 1, 1986

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TO

Mr. Russell L. Smith, Jr.
Director and Chief Engineer
Department of Public Works
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Smith:

EIS Preparation Notice
Kahawainui Stream Control Project

A review of the subject preparation notice revealed some discrepancies in the structural details of the State owned Laiewai Bridge. Therefore, the City should coordinate this project directly with our agency prior to conducting any work to the bridge or its abutment. All plans for work within the State's right-of-way should be submitted for review and approval by the State Highways Division.

We appreciate this opportunity to provide comments.

Very truly yours,

Wayne J. Yamasaki
Director of Transportation

12-0052

February 9, 1987

Mr. Edward J. Hirata, Director
Department of Transportation
State of Hawaii
869 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Hirata:

Subject: Your Leter STP 8.1707 dated December 1, 1986 relating to the Environmental Impact Statement Preparation Notice for the Kahawainui Stream Flood Control Project

Thank you for your comments on the environmental impact statement preparation notice.

The U.S. Army Corps of Engineers is preparing the project construction plans, and we have requested that the plans be submitted to the State Highways Division for review and approval prior to any work being done on the State-owned Laiewai bridge.

The Corps has informed us that they will be submitting the construction plans for review and approval by the Highways Division.

Very truly yours,

Vernon H S Ching

ALFRED J. THIEDE
For Acting Director and Chief Engineer

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ENGR

University of Hawaii at Manoa

Water Resources Research Center
Holmes Hall 283 • 2540 Dole Street
Honolulu, Hawaii 96822

28 October 1986

Mr. Russell L. Smith, Jr.
Director and Chief Engineer
Department of Public Works
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Smith:

Subject: Environmental Impact Statement Preparation Notice for the Kahawainui Stream Flood Control Project TMK: 5-5-9, October 1986

We have reviewed the subject EISPN and have no comment to offer. Thank you for the opportunity to comment. This material was reviewed by WRRC personnel.

Sincerely,

Edwin T. Murabayashi

Edwin T. Murabayashi
EIS Coordinator

ETM:jm

AN EQUAL OPPORTUNITY EMPLOYER

DEPARTMENT OF GENERAL PLANNING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

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TO

FRANK F. FASI
MAYOR

DONALD A. CLEGG
CHIEF PLANNING OFFICER

GENE CONNELL
DEPUTY CHIEF PLANNING OFFICER

JB/DGP 10/86-9848

October 31, 1986

MEMORANDUM

TO: RUSSELL L. SMITH, JR., DIRECTOR AND CHIEF ENGINEER
DEPARTMENT OF PUBLIC WORKS

FROM: DONALD A. CLEGG, CHIEF PLANNING OFFICER
DEPARTMENT OF GENERAL PLANNING

SUBJECT: KAHAWAINUI STREAM FLOOD CONTROL PROJECT
ENVIRONMENTAL IMPACT STATEMENT PREPARATION
NOTICE--YOUR LETTER DATED OCTOBER 10, 1986

We have the following comments for your consideration.

1. Your application to amend the Development Plan Public Facilities (DP/PF) Map for the Koolauloa district, which was assigned amendment number 86/KL-1001, is currently being processed via the FY 86-87 Annual Review of the Development Plans package. We anticipate adoption of the FY 1986-87 Annual Review package by City Council in May 1987. Construction of the proposed Kahawainui Stream Flood Control project may proceed as soon as this facility is depicted on the DP/PF Map.

   For information on the status of your amendment application, you may call Gary Okino of my staff at 527-6067.

2. The relationship of this project to the adopted DP/PF Map should be indicated in the draft environmental impact statement (dEIS).

3. The dEIS should provide detailed information regarding the specific need for this improvement proposal which should include the historical background of the flooding problem in this section of Laie, how long the problem has existed, the frequency of serious flooding, and how extensive was the damage to private and public property during the severe flooding?

4. Since the development site is located within the Special Management Area (SMA), the proposed project will be subject to the requirements of Ordinance No. 84-4. (See attached map.)

   The dEIS should indicate the relationship of the proposed improvement facility to the SMA Ordinance and the necessary steps that will be taken to bring the project in conformity with Ordinance No. 84-4.

   For information or details on the provisions of SMA Ordinance No. 84-4 and/or filing of the SMA application, we suggest you contact John Foster of the Department of Land Utilization (DLU) at 527-5027.

   We note that DLU will be the accepting agency, on behalf of the City and County of Honolulu government, for the EIS for this improvement project.

5. Under Chapter 176, Hawaii Revised Statutes, re Protection of Instream Uses of Water, no windward Oahu stream channel shall be altered until an application for a permit to undertake the work has been filed and a permit is issued by the Department of Land and Natural Resources.

   The dEIS should discuss what steps have been taken to comply with Chapter 176, HRS.

6. A discussion on whether or not any facilities or residents living near the flood-plain area of Kahawainui Stream will require relocation should be included in the dEIS.

   Additionally, the need for relocation of buildings and structures within the affected area, including the alterations of utilities, roadways, bridges and storm drains resulting from the proposed flood control improvement should also be addressed.

7. From maps prepared by the U.S. Fish and Wildlife Service (USF&WS), we note that considerable amounts of real property within the project site have been classified by the agency as "wetlands." (See map by the USF&WS.)

   How many acres of "wetlands" will this flood control project destroy? What are the cumulative effects on the loss of these "wetlands"?

   A detailed discussion on "wetlands" would be appropriate.

8. What estimated volume of "muck" will dredging activities remove and where will these waste materials be located?

   The potential effect of silt-laden streamwater resulting from construction and dredging activities to the marine life and to the Class "A" waters of Laie Bay should also be addressed in the dEIS.

9. What is the estimated cost of constructing the proposed Kahawainui Stream Flood Control project? How much funding will the Federal government and the City & County of Honolulu each contribute to the total cost of implementing this proposal? What is the land owner's (Zions Securities Corporation) contribution in this endeavor? We understand that Zion Securities Corporation is willing to participate in dedicating certain lands needed for the project.

   These should be discussed in the dEIS.

Thank you for allowing us to review the EISPN for the proposed Kahawainui Stream Flood Control project. We hope our comments can be of help to you.

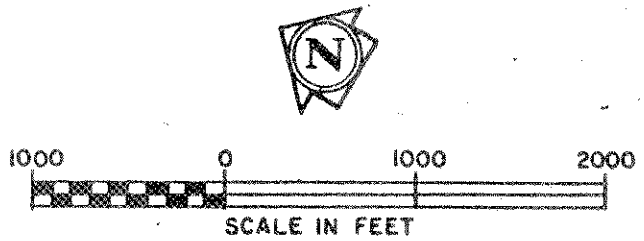
Donald Clegg

DONALD A. CLEGG
Chief Planning Officer

ORD. NO. 85-105 EFF. DATE: DEC. 2, 1985

SPECIAL MANAGEMENT AREA MAP

KOOLAULOA



Prepared by: Department of Land Utilization
City and County of Honolulu
Sept. 1980

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SMA BOUNDARY LINE

THE SMA INCLUDES:

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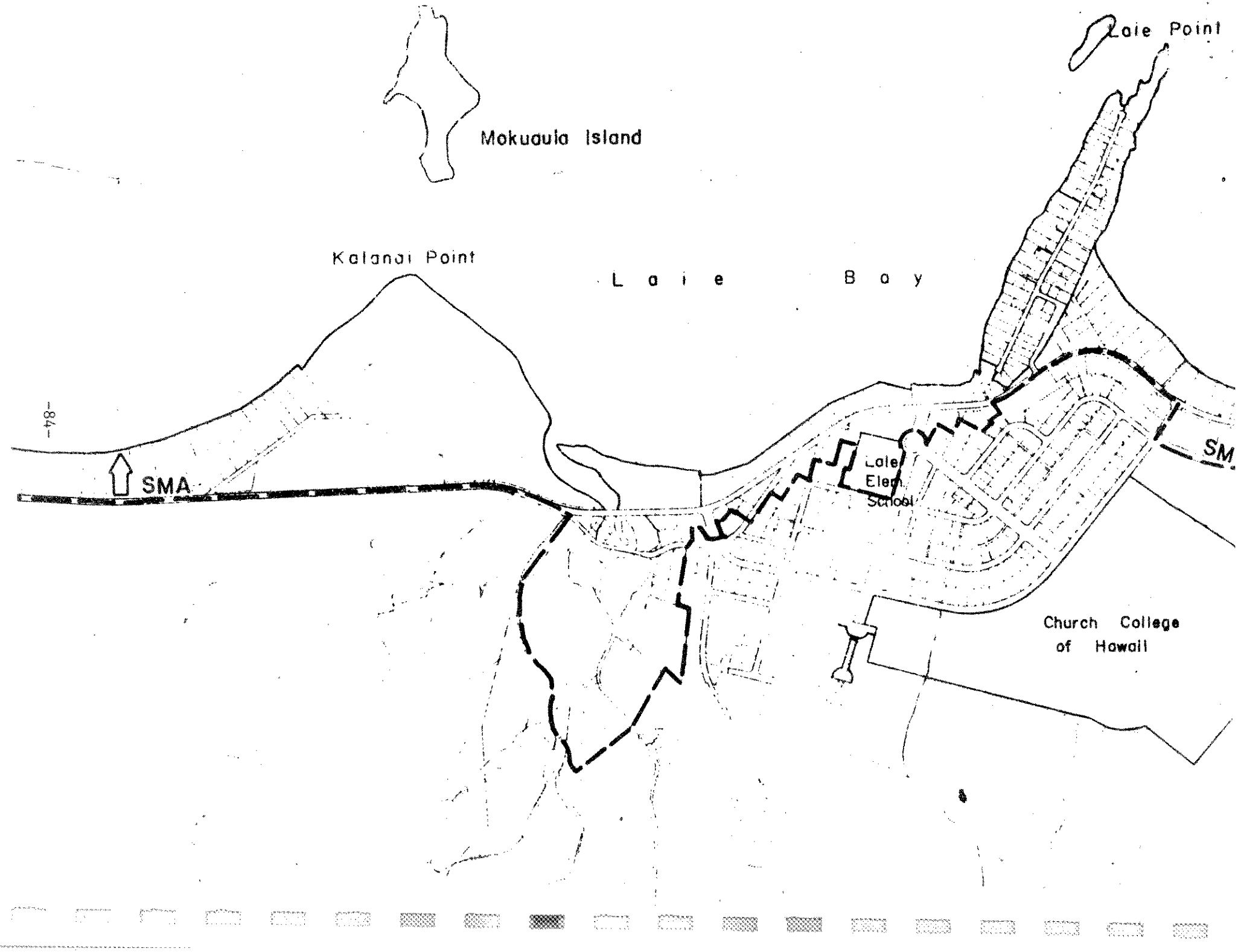
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Kalanai Point
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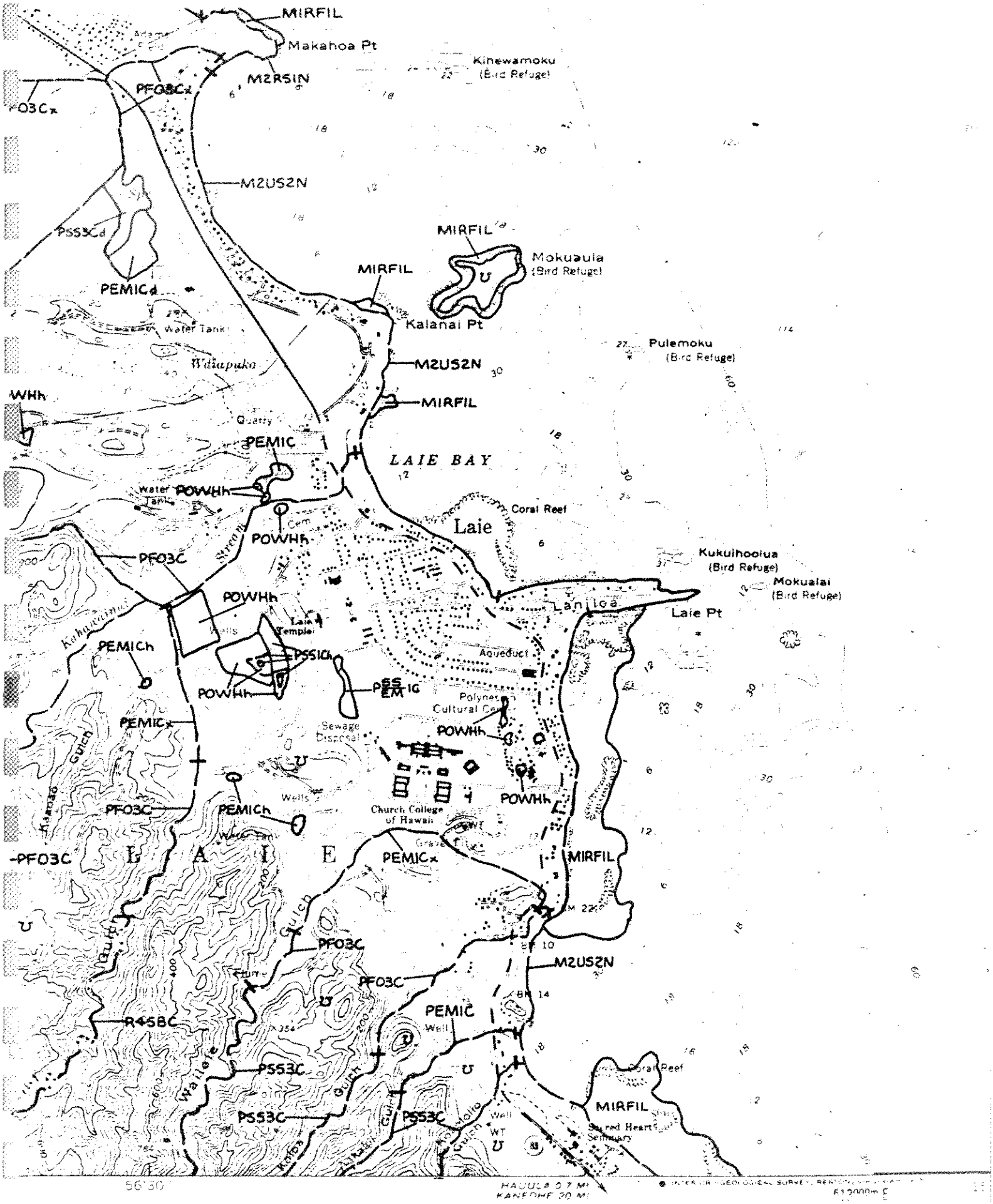
Laie Elem. School
SM
Church College of Hawaii



KAHUKU, HAWAII

12-0053

February 9, 1987

MEMORANDUM

TO: MR. DONALD A. CLEGG, CHIEF PLANNING OFFICER
DEPARTMENT OF GENERAL PLANNING

FROM: ALFRED J. THIEDE, ACTING DIRECTOR AND CHIEF ENGINEER

SUBJECT: YOUR MEMORANDUM JB/DGP 10/86-9848, DATED OCTOBER 31, 1986, RELATING TO THE ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE FOR THE KAHAWAINUI STREAM FLOOD CONTROL PROJECT

Thank you for your comments on the environmental impact statement (EIS) preparation notice. Your comments were very helpful and will be included and discussed further in the draft EIS.

Your letter was also referred to the U.S. Army Corps of Engineers for their consideration in the design and preparation of the project construction plans. The construction specifications will also require all construction activities within and adjacent to the water to be conducted so as to minimize turbidity and control erosion.

Vernon H S Ching

ALFRED J. THIEDE
Acting Director and Chief Engineer

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DEPARTMENT OF PARKS AND RECREATION

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

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TO _____

FRANK F. FASI
MAYOR

TOM T. NEKOTA
DIRECTOR

October 28, 1986

TO: RUSSELL L. SMITH, JR., DIRECTOR AND CHIEF ENGINEER
DEPARTMENT OF PUBLIC WORKS

FROM: TOM T. NEKOTA, DIRECTOR

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE FOR THE KAHAWAINUI STREAM FLOOD CONTROL PROJECT

We are proposing to develop a 20+ acre community park in proximity to Station 38+62 of the proposed flood control project. The impacts of the project on park development should be addressed.

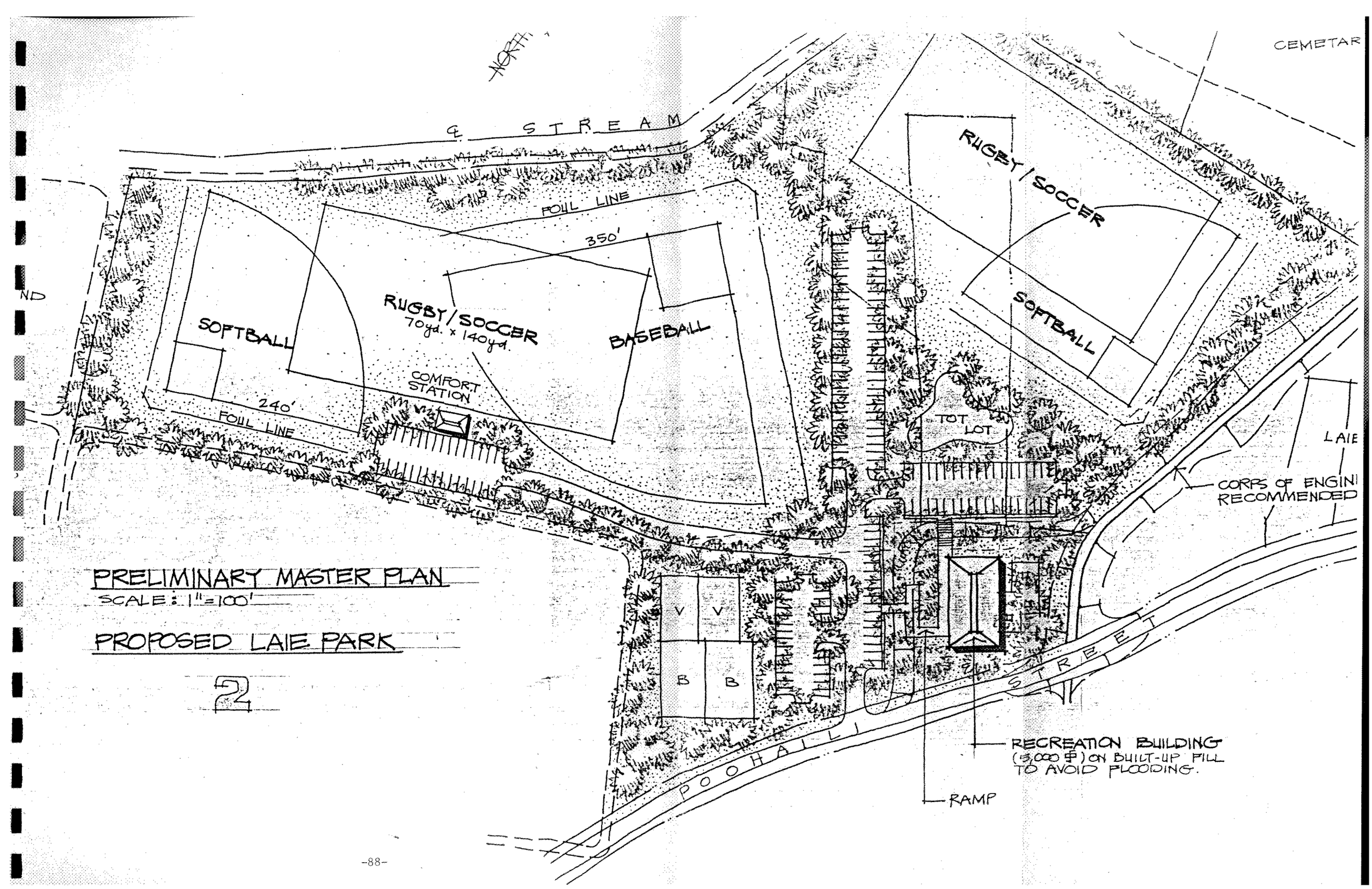
Thank you for the opportunity to review the EIS Preparation Notice.

Tom Nekota

TOM T. NEKOTA, Director

TTN:ei

Attach.


NORTH
℄ STREAM
FOUL LINE
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SOFTBALL
RUGBY/SOCCER
70yd. x 140yd.
BASEBALL
COMFORT STATION
240'
FOUL LINE
RUGBY/SOCCER
SOFTBALL
TOT LOT
CEMETAR
LAIE
CORPS OF ENGINI
RECOMMENDED
V
V
B
B
POOHAILI STREET
RECREATION BUILDING
(5,000 ☐') ON BUILT-UP FILL
TO AVOID FLOODING.
RAMP
PRELIMINARY MASTER PLAN
SCALE: 1"=100'
PROPOSED LAIE PARK
2

12-0054

February 9, 1987

MEMORANDUM

TO: MR. HIRAM K. KAMAKA, DIRECTOR
DEPARTMENT OF PARKS AND RECREATION

FROM: ALFRED J. THIEDE, ACTING DIRECTOR AND CHIEF ENGINEER

SUBJECT: YOUR MEMORANDUM DATED OCTOBER 28, 1986 RELATING TO THE ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE FOR THE KAHAWAINUI STREAM FLOOD CONTROL PROJECT

Thank you for your comments on the environmental impact statement preparation notice.

The proposed development of the 20+-acre community park in proximity of Station 38+62 of the proposed flood control project will be subjected to the floodplain development restrictions. The proposed built-up fill within the 100-year floodplain area may adversely affect the flood flows.

We recommend that consideration be given to construct the recreation building and comfort station within the protected area. All other facilities should be designed with the knowledge that they will be flooded periodically.

Vernon H S Ching

FOR ALFRED J. THIEDE
Acting Director and Chief Engineer

WY:CPC:pto

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
HONOLULU MUNICIPAL BUILDING
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

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FRANK F. FASI
MAYOR

JOHN E. HIRTEN
DIRECTOR

JOSEPH M. MAGALDI, JR.
DEPUTY DIRECTOR

TE-5753
PL 1.0477

November 12, 1986

MEMORANDUM

TO: RUSSELL L. SMITH, JR., DIRECTOR AND CHIEF ENGINEER
DEPARTMENT OF PUBLIC WORKS

FROM: JOHN E. HIRTEN, DIRECTOR

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE
FOR THE KAHAWAINUI STREAM FLOOD CONTROL PROJECT
TMK: 5-5-9

This is in response to your memorandum of October 10, 1986.

We have no comments on the subject Environmental Impact Statement Preparation Notice.

JOHN E. HIRTEN

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XII. LIST OF REFERENCES

1. Ahlo, Hamilton M. and Robert J. Honmon, An Archaeological Reconnaissance Survey of the Flood Control Study Area, Kahawainui Stream, Laie, Oahu, Hawaii, prepared for U.S. Army Engineer Division, Pacific Ocean, under Contract No. DACW84-81-C-0003, 18 May 1981.

2. Air Survey Hawaii, Topographic Map of Kahawainui Stream, Oahu prepared for the U.S. Army Corps of Engineers under Contract No. DACW84-82-C-0010, 7 Sheets, 1" - 40', 2-foot contour intervals, 10 July 1982.

3. Air Survey Hawaii, Aerial Photograph, Hawaiian Islands #1-71(0) and 1-72(0), prepared for U.S. Army Corps of Engineers under Contract No. DACW84-82-M-3098, flight altitude = 1200', focal length = 153mm, 5 December 1982.

4. Austin, Smith & Associates, Inc., Review of Drainage System for Laie Village, undated.

5. Chow, Ven Te, Open-Channel Hydraulics, McGraw-Hill Book Company, New York, 1959.

6. City and County of Honolulu, Aerial Photo-Contour Map, Sheet Numbers: 528-174, 528-168, 1' = 200', 5-foot contour intervals, Planning Department, prepared by R.M. Towill, undated.

7. Dexter, James R. et al, Social Aspects of Floodproofing, reprinted from the Proceedings of the Specialty Conference on the Legal, Institutional and Social Aspects of Irrigation and Drainage and Water Resources Planning and Management, ASCE, Blacksburg, VA, July 26-28, 1979.

8. Pace, Carl E., Tests of Brick-Veneer Walls and Closures for Resistance Flood Waters, Misc Paper C-78-16, U.S. Army Engineer Waterways Experiment Station, Dec 1978.

9. Pace, Carl E. and Roy L. Campbell, Structural Integrity of Brick-Veneer Buildings, Technical Report C-78-3, U.S. Army Engineer Waterways Experiment Station, May 1978.

10. Shaeffer, John R., Introduction to Flood Proofing, University of Chicago, The Center for Urban Studies, April 1967.

11. Synder, Tim, Fine Homebuilding, "Moving a House", No. 5, October/ November 1981.

12. U.S. Army Corps of Engineers, Hawaii Regional Inventory of the National Shoreline Study, Pacific Ocean Division, August 1971.

13. U.S. Army Corps of Engineers, Flood Proofing - Example of Raising a Private Residence, Technical Services Report, South Atlantic Division, March 1977.

14. U.S. Army Corps of Engineers, Physical and Economical Feasibility of Nonstructural Flood Plain Management Measures, Institute for Water Resources, The Hydrologic Engineering Center, March 1978.

15. U.S. Army Corps of Engineers, Hydroelectric Power Summary Report, Harbors and Rivers in Hawaii, Honolulu District, October 1978.

16. U.S. Army Corps of Enginers, The Development of Nonstructural Alternatives, A Policy Discussion, St. Paul District, May 1979.

17. U.S. Army Corps of Engineers, Reconnaissance Study for Flood Damage Reduction Measures, Kahawainui Stream, Laie, Oahu, Hawaii, Pacific Ocean Division, August 1981.

18. U.S. Army Corps of Engineers, Community Handbook on Flood Warning and Preparedness Programs, Research Report 81-R06, Engineer Institute for Water Resources, August 1981.

19. U.S. Army Corps of Engineers, Flood Insurance Map, Sheet Number 528-174, 1" = 200', 5-foot contour intervals, Pacific Ocean Division, May 1982.

20. U.S. Army Corps of Engineers, Draft Interim Survey Report and Environmental Impact Statement, Kahawainui Stream, Island of Oahu, Pacific Ocean Division, September 1983.

21. U.S. Army Corps of Engineers, Draft Detailed Project Report and Environmental Impact Statement, Kahawainui Stream, Island of Oahu, Pacific Ocean Division, June 1985.

22. U.S. Department of Commerce, Rainfall Frequency Atlas of the Hawaiian Islands, Technical Paper No. 43, Weather Bureau, 1962.

23. VIN Pacific, Laie Low Income Housing Project, Master Plan and Environmental Assessment, prepared for Zions Securities Corporation, April 1981.

24. Water Resources Council, Guidelines for Determining Floodplain Frequency, 1977.

25. U.S. Army Corps of Engineers, Final Detailed Project Report and Environmental Impact Statement, Kahawainui Stream, Island of Oahu, Honolulu District, November 1985.

APPENDIX A

KAHAWAINUI STREAM
FLOOD DAMAGE REDUCTION STUDY

SUPPLEMENTAL COMPLIANCE REPORTS

TABLE OF CONTENTS

Report	Title	Page
A	Presidental Executive Order 11988 on Floodplain Management Evaluation Report	A-1
B	Presidential Executive Order 11990 on Protection of Wetlands	A-6
C	Evaluation of the Effect of the Discharge of Dredged Materials into Waters of the United States, Using US Environmental Protection Agency (EPA) Section 404(b) Guidelines	A-8
D	Federal Coastal Zone Management (CZM) Consistency Determination	A-13

The following supplemental evaluation reports are provided in this Appendix:

A. Presidential Executive Order 11988 on Floodplain Management Evaluation Report

B. Presidential Executive Order 11990 on Protection of Wetlands

C. Evaluation of the Effect of the Discharge of Dredged Materials into waters of the U.S. using U.S. Environmental Protection Agecy (EPA) Section 404(b) Guidelines

D. Federal Coastal Zone Management (CZM) Consistency Report

A. PRESIDENTIAL EXECUTIVE ORDER 11988 ON FLOODPLAIN MANAGEMENT EVALUATION REPORT

1. PURPOSE

The purpose of this supplemental report is to present the results of additional studies in accordance with 33 CFR 239 which implements Executive Order (EO) 11988, Floodplain Management, dated 24 May 1977. The objective of EO 11988 is to avoid to the maximum extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. The Order requires Federal agencies to:

a. Avoid development in the base floodplain unless it is the only practicable alternative;

b. Reduce the hazard and risk of flood loss;

c. Minimize the impact of floods on human safety, health, and welfare; and

d. Restore and preserve the natural and beneficial floodplain values.

2. COMPLIANCE

a. It has been determined that the project is located within the base flood. The base flood is defined as the one percent (1%) exceedance frequency floodplain (100-year floodplain).

b. Practicable alternatives to locating the "action" in the base floodplain have been considered. The term "action" is defined as any Federal activity including (1) acquiring, managing, and disposing of Federal lands and facilities; (2) providing Federally undertaken, financed, or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

No practicable alternatives are available that could locate the action outside the 100-year floodplain. The only measure, which locates the action outside the floodplain, is relocating each individual structure outside the floodplain. The alternative is impractical because it involves relocating over half the community to an area outside Laie. Land requirements and potential relocation costs for 50% of Laie makes this alternative impractical.

c. Impact Assessment (Natural and Beneficial Values). Assessment of the impacts of the proposed action on the natural/beneficial values of the floodplain indicates there are no Federally listed endangered or threatened species of fauna or flora that will be affected. Structural alternatives 2 and 4 will encroach upon the wetlands. Indirect development in this area as a result of the proposed actions will be closely regulated by existing City & County building restrictions within the designated 100-year floodplain. Cultural or archaeological resources will not be affected by structural actions. Archaeological monitoring will accompany all survey activities in order to ensure the integrity of cultural resources.

d. Induced Development as a Result of the Proposed Action. A practicable alternative to the proposed actions must consider water resources; conservation; economics; aesthetics; impact of future floods on human safety; locational values with respect to housing, education and work force; functional need for locating within the floodplain, historic, fish and wildlife habitat values; endangered and threatened species; support of local, municipal infra-structure; energy conservation; cost effectiveness; and the general needs and welfare of the local community.

Structural alternatives 1, 2 and 4 will alter the 100-year floodplain limits. Alternative 1 will increase the 100-year floodplain; Alternatives 2 and 4 will decrease it. Alternative 3, which is a nonstructural proposal will not reduce or alter the 100-year floodplain.

e. Viable Methods to Minimize Adverse Impacts and to Restore and Preserve the Natural and Beneficial Values of the Floodplain.

Floodplain management measures are all an integral part of the proposed alternative plans. These measures restrict future development in the floodplain and minimize potential flood damages. Measures to minimize adverse impacts include:

(1) Floodplain management services are available from the U.S. Army Corps of Engineers under the authority of Section 206 of the River and Harbor and Flood Control Act of 1960 (Public Law 89-789). These services include providing flood hazard data, maps and technical assistance and studies.

(2) A flood insurance program is administered by the U.S. Federal Emergency Management Agency (FEMA) through the Federal Insurance Administration under the authority of the National Flood Insurance Act of 1968, as amended. The City and County of Honolulu is officially participating in the program.

(3) The U.S. Department of Housing and Urban Development (HUD) has minimum building standard requirements for Federally subsidized housing projects administered by the agency. All buildings funded by HUD requires compliance to these standards which incorporate floodplain planning requirements.

(4) Relocation assistance for persons displaced as a result of Federal and federally-assisted programs are authorized by the Uniform Relocations Assistance and Real Property Acquisition Act of 1970 (Public Law 91-646). This statute provides moving and related expenses to insure fair and equitable treatment of displaced persons.

(5) Emergency and disaster operations, when in effect are administered by FEMA. Disaster recovery assistance includes protection of life and property, damage surveys, restoration of public services, and technical assistance. This assistance was recently provided during the storm of February 1979.

f. Advise the general public.

The general public was notified of this action by public notice and was given the opportunity of voicing their concerns on this action during a formal public meeting held on 25 July 1985.

g. Recommendation of the most desirable plan.

Alternative 2 at the SPF level of protection is the recommended plan because it maximizes net economic benefits and minimizes adverse environmental impact.

TABLE A-1. EVALUATION OF ADVANTAGES AND DISADVANTAGES OF FLOODPLAIN AND NON-FLOODPLAIN SITES

FACTORS (EO11988)	ADVANTAGES OF FLOODPLAIN	DISADVANTAGES OF FLOODPLAIN
Economics	Human economic activities are currently concentraed on floodplain area.	Human economic activities are subject to periodic flooding.
Aesthetics	None.	May degrade aesthetic appeal of open floodplain.
Natural Beneficial Values	None.	May degrade existing natural and beneficial values.
Impacts of Floods on Human Safety	Reduces the impacts of flooding on human safety.	Periodic flooding damage.
Locational Advantage Relative to Availability of Housing	Reduces flooding to housing.	Periodic flooding damage.
Education	None.	School days may be lost due to periodic flooding.
Work Force	Reduces flood hazards to work force.	Work days may be lost due to periodic flooding.
Functional Need	Provides comprehensive flood control measures to Laie and surrounding areas.	None.
Cultural/Historic Values	Laie is religious and educational center. Areas include Mormon Temple, BYU Hawaii Campus and Polynesian Cultural Center.	Prehistoric cultural deposits may be affected.
Fish & Wildlife Values	None.	None.
Endangered & Threatened Species	Not applicable.	Not applicable.
Support of Municipal Infrastructure	Provides comprehensive flood control measures to reduce flood hazards for other municipal infrastructure in floodplain.	Infrastructures subject to periodic flood damage.

TABLE A-1. EVALUATION OF ADVANTAGES AND DISADVANTAGES OF FLOODPLAIN AND NON-FLOODPLAIN SITES (Cont)

FACTORS (EO11988)	ADVANTAGES OF FLOODPLAIN	DISADVANTAGES OF FLOODPLAIN
Energy Conservation	None.	None.
Cost Effectiveness	None.	None.
Enhancement of Work Opportunities for Economically disadvantaged	None.	None.
Needs and Welfare of People	Reduces the flood hazard to the community.	None.

B. FLOOD DAMAGE REDUCTION
KAHAWAINUI STREAM, OAHU
PRESIDENTIAL EXECUTIVE ORDER 11990 ON PROTECTION OF WETLANDS
EVALUATION REPORT

1. Executive Order 11990 directs the Corps to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out its Civil Works activities.

2. To insure compliance with Executive Order 11990, the following evaluations were incorporated into the plan formulation for flood damage reduction of Kahawainui Stream.

a. Procedure: Determine if wetlands are present within the study area.

Evaluation: Site inspections of soils, water and vegetation of the study area indicated the presence of wetlands along Kahawainui Stream on both sides of Kamehameha Highway. Seaward of the highway, an estuarine mangrove and hau swamp dominates the wetland. Fringing marshes and floating aquatic weeds characterize the stream and irrigation ditches. California grass marshlands and pastures (wet meadow) in the vicinity of the ponds comprise the greatest component of the wetland. Since the degree of soil saturation in the wetland varies with seasonal variations in rainfall, the outside limits of the wetland are difficult to pinpoint. Figure 12 shows the approximate boundary of the wetland based on field observations of vegetation, soils, hydrology, and microtopography; and on interpretation of aerial photographs of the area taken at different years and seasons. The area defined as wetland is approximately 17 acres.

b. Procedure: If wetlands are present, make protection and/or enhancement of the beneficial values of wetlands a planning objective.

Evaluation: Wetland protection and enhancement were considered throughout the planning process and are incorporated into the planning objectives in the Main Report.

c. Procedure: During the plan formulation process, include appropriate wetlands protection and/or enhancement measures in alternative plans.

Evaluation: Wetlands protection and enhancement were considered during the development of each of the alternative plans. The structural elements of Alternative Plan 1 (levee plan) avoid wetland areas entirely. Levee development will cause surface waters to be diverted to wetland areas at a greater frequency and duration than at present. This may help to maintain wetland conditions along some intermittently dry upper limits of the wetland area.

The structural elements of Alternative Plans 2 and 4 (levee and channel) will require excavation and filling of approximately 2 acres of wetland, or approximately 10 percent of the total wetland acreage of the project area. Although efforts were made to minimize destruction or alteration of wetlands under this alternative, overriding consideration was given to minimizing overtopping risks associated with extensive levee

development. As with Alternative Plan 1, levee construction may result in diversion of waters to wetlands including those areas which presently experience intermittent drying. The Corps would recommend preservation and enhancement of wetlands under Alternative Plans 2 and 4 to mitigate losses of wetland values and resources.

Alternative Plan 3 (floodproofing and floodplain management) would not affect wetlands in the Kahawainui floodplain. Plan 4 would destroy wetlands only in the immediate vicinity of the proposed stream channel.

d. Procedure: If the proposed Corps action would be located in wetlands, identify and evaluate practicable alternatives to wetlands location.

Evaluation: No practicable alternative to the wetland location is available outside of wetland. Floodproofing flood damageable property which does not modify the wetland is not economically feasible.

e. Procedure: Identify and evaluate adverse impacts related to the loss and degradation of beneficial values of wetlands.

Evaluation: Limited areas of wetland will be affected by Plans 2 and 4. Beneficial values associated with the wetland include nutrient filtering; buffering against erosion; food chain production; and storage of storm and floodwaters.

f. Procedure: Include appropriate measures in alternative plans to minimize unavoidable adverse impacts to beneficial wetlands and their functions.

Evaluation: Attempts were made to preserve or enhance wetlands during development of the alternative plans. Plans 1 and 3 will have no effects on wetlands. Plans 2 and 4 will affect wetlands to the minimum extent possible given the structural requirements of the project components. Coordination is in progress with State Wildlife representatives and the US Fish and Wildlife Service to develop wetland preservation/enhancement plans.

g. Procedure: Based on the above, and in close coordination with appropriate agencies and the public throughout the planning process, recommend the plan most responsive to the planning objectives and evaluation criteria.

Evaluation: This report will be distributed to the US Fish and Wildlife Service for review and comment and preparation of a FWCA Report. Plans 3 and 1 appear to be the least environmentally damaging plan in terms of wetland resources.

C. EVALUATION OF THE EFFECTS OF THE DISCHARGE OF DREDGED OR FILL MATERIAL INTO THE WATERS OF THE US USING THE US ENVIRONMENTAL PROTECTION AGENCY (EPA) SECTION 404(b) GUIDELINES

1. PROJECT DESCRIPTION

a. Location: Kahawainui Stream, Laie
Island of Oahu, Hawaii

b. General Description: The Honolulu District, US Army Corps of Engineers, has investigated public concerns and needs associated with flood damage reduction measures in the Kahawainui Stream floodplain. The impacts upon the environmental, social, cultural and economic resources of the area were also evaluated. Four alternative plans were developed and are consistent with national and local goals and the primary objective of reducing property damage by floodwaters from Kahawainui Stream. Alternative Plan 1 consists of levees and Alternative Plan 2 consists of a combination of levee and channel improvements. Alternative Plan 3 is the nonstructural plan involving flood-proofing and floodplain management. Alternative Plan 4 is a structural plan consisting of only a channel.

c. Authority and Purpose: This survey report was prepared under the authority of Section 209 of the Flood Control Act of 1962 (Public Law 87-874). This section authorizes the Secretary of the Army, through the Chief of Engineers, to study water and related resource problems and needs in the State of Hawaii. The Secretary of the Army may recommend solutions to Congress and the extent which the Federal government should participate in implementing possible flood damage reduction measures.

The purpose of this study are to identify the problems, needs and the extent to which the Federal government should participate in flood damage reduction measures in the Kahawainui Stream floodplain. This report documents the results of the Corps' planning process and is used to determine whether further Federal participation is warranted under the study authority.

d. General Descriptions of Dredged or Fill Materials:

	Alternative Plans			
	1	2	3	4
(1) General Characteristics of the Material	NA	Earth fill; concrete consisting of cement, aggregates and water with reinforcement bars; boulders	NA	Earth fill; concrete consisting of cement, aggregates and water with reinforcement bars; boulders
(2) Quantity of Material to be Discharged 2/	NA	2 Berm 9,000 CY Channel 3,000 CY TOTAL 12,000 CY	NA	24,700 CYS of concrete and boulders
(3) Source of the Material	NA	Approved existing quarries and/or approved borrow sites. Cement will be factory produced.	NA	Approved existing quarries and/or approved borrow sites. Cement will be factory produced.

e. Description of the Proposed Discharge Site:

	Alternative Plans			
	1	2	3	4
(1) Location	See Fig 9 of Main Report	See map page, Fig 10 of Main Report. Create new levee, channel, berms along Kahawainui Stream and wetlands	NA	Same as Plan 2 without a channel.
(2) Size	NA	2.0 acres	NA	4 acres
(3) Type of site	NA	Stream/wetlands	NA	Same as Plan 2
(4) Type(s) of Habitat	NA	Freshwater stream and wetlands	NA	Same as Plan 2
(5) Timing and Duration of discharge	NA	The project would probably be implemented within 3 to 4 years and would take 15 to 21 months to construct	NA	Same as Plan 2

f. Description of Disposal Method:

(1) Method of discharge	NA	Crane and dump truck	NA	Same as Plan 2

2. FACTUAL DETERMINATIONS

	Alternative Plans			
	1	2	3	4
a. Physical Substrate Determinations				
(1) Substrate elevation and slope	NA	0 to 10 feet MSL Geologic study and report prepared by the COE and filed in the Corps Final DPR and EIS.	NA	Same as Plan 2
(2) Sediment Type	NA		NA	Same as Plan 2
(3) Dredged/Fill Material Movement	NA	NA	NA	Same as Plan 2

NOTES:

1. NA: not applicable
2. Material includes concrete and bedding

a. Physical Substrate Determinations (Cont)

	Alternative Plans 1	2	3	4
(4) Physical Effects on Benthos	NA	Excavation and burial	NA	Same as Plan 2
(5) Other Effects	NA	NA	NA	Same as Plan 2
(6) Actions Taken to Minimize Impacts	NA	Avoid wetlands where feasible. Recommend preservation, enhancement of other wetland areas	NA	Same as Plan 2

b. Water Circulation, Fluctuation and Salinity Determination

	Alternative Plans 1	2	3	4
(1) Water, Effects on:				
(a) Salinity	NA	No effect	NA	Same as Plan 2
(b) Water Chemistry	NA	Temperature may increase	NA	Same as Plan 2
(c) Clarity	NA	Possible increase	NA	Same as Plan 2
(d) Color	NA	No effect	NA	Same as Plan 2
(e) Odor	NA	No effect	NA	Same as Plan 2
(f) Taste	NA	No effect	NA	Same as Plan 2
(g) Dissolved gas levels	NA	Will attempt to increase O_2	NA	Same as Plan 2
(h) Nutrients	NA	Possible increase downstream	NA	Same as Plan 2
(2) Current Patterns and Circulation	NA	Will alter course of stream	NA	Same as Plan 2
(a) Current Patterns and Flow	NA	Will alter course of stream	NA	Same as Plan 2
(b) Velocity	NA	Increase in lower reaches	NA	Same as Plan 2
(c) Stratification	NA	Wide channel will reduce depth	NA	Same as Plan 2
(d) Hydrologic Regime	NA	Less infiltration	NA	Same as Plan 2
(3) Normal Water Level Fluctuations	NA	Wetland water levels may increase during flooding. Lower reaches of stream will remain under tidal influence	NA	Same as Plan 2

b. Water Circulation, Fluctuation and Salinity Determination (Contd)

	Alternative Plans			
	1	2	3	4
(4) Salinity gradients	NA	No effect	NA	Same as Plan 2
(5) Actions that will be taken to minimize impacts	NA	Efforts will be made to improve water quality; preserve and enhance wetland	NA	Same as Plan 2
c. Suspended Particulate/Turbidity Determination				
(1) Expected changes in suspended particulate and turbidity levels in vicinity of disposal site.	NA	Temporary increase	NA	Same as Plan 2
(2) Effects (degree and duration) on Chemical and Physical Properties of the Water Column				
(a) Light Penetration	NA	Shallower water levels	NA	Same as Plan 2
(b) Dissolved Oxygen	NA	Efforts will be made to increase	NA	Same as Plan 2
(c) Toxic Metals & Organics	NA	No effect	NA	Same as Plan 2
(d) Pathogens	NA	No effect	NA	Same as Plan 2
(e) Aesthetics	NA	Natural streambed, wetlands converted	NA	Same as Plan 2
(3) Effects on Biota				
(a) Primary Production, Photosynthesis	NA	Loss of benthic habitat	NA	Same as Plan 2
(b) Suspension/Filter Feeders	NA	Shallower water levels	NA	Same as Plan 2
(c) Sight Feeders	NA	No effect	NA	Same as Plan 2
(4) Actions taken to Minimize Impacts	NA	Minimize fill; preserve and enhance wetlands	NA	Same as Plan 2
d. Contaminant Determination				
The proposed discharge is free of contaminants	NA	NA	NA	Same as Plan 2
e. Aquatic Ecosystem and Organism Determinations				
The proposed discharge is free of contaminants	NA	NA	NA	Same as Plan 2

f. Proposed Disposal Site Determinations

	Alternative Plans			
	1	2	3	4
(1) Mixing Zone Determination	NA	NA	NA	Same as Plan 2
(2) Determination of Compliance with Applicable Water Quality Standards	NA	NA	NA	Same as Plan 2
(3) Potential Effects on Human Use Characteristics	NA	Floodplain management would be required	NA	Same as Plan 2
g. Determination of Cumulative Effects on the Aquatic Ecosystems	NA	Continued channelization/ filling would adversely affect quality of habitat	NA	Same as Plan 2
h. Determination of Secondary Effects on the Aquatic Ecosystem	NA	No significant effects	NA	Same as Plan 2

D. FEDERAL COASTAL ZONE MANAGEMENT (CZM) CONSISTENCY DETERMINATION REPORT

1. PURPOSE

a. The Coastal Zone Management (CZM) Act of 1972 (Public Law 92-583) and the regulations on Federal consistency with approved Coastal Zone Management programs (15 CFR 930) provide that all Federal activities must be consistent to the maximum extent practicable with the Hawaii State Coastal Zone Management Program.

b. The Kahawainui Stream Flood Damage Reduction Study located at Laie, Island of Oahu will involve construction within the CZM area. Four alternatives were investigated in detail and include (1) levee plan, (2) levee and channel plan, (3) floodproofing and floodplain management, and (4) channel plan. This study was requested by the City and County of Honolulu. The following consistency determination summarizes the study's conformance with policies of the Hawaii State Coastal Zone Management program to the maximum extent practical.

2. The plans under consideration meet the objectives and policies of the CZM program as follows:

SECTION 205A-(b)(1), RECREATIONAL RESOURCES

Objective: Provide coastal recreational opportunities accessible to the public.

Policies:

a. Improve coordination and funding of coastal recreation planning and management.

Identifying and developing water contact recreational opportunities as part of the overall flood control project were incorporated in the planning process. The project document will recommend any coordination and funding of potential coastal recreation planning, management and opportunities.

b. Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:

(1) Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas.

(2) Requiring replacement of coastal resources having significant recreational value, including but not limited to, surfing sites and sandy beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable.

(3) Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation.

(4) Encouraging expanded public recreational use of County, State, and federally owned or controlled shoreline lands and waters having recreational value.

(5) Adopting water quality standards and regulating point and non-point sources of pollution to protect and where feasible, restore the recreational value of coastal waters.

(6) Developing new shoreline recreational opportunities, where appropriate, such as artifical reefs for surfing and fishing.

(7) Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the Land Use Commission, Board of Land and Natural Resources, county planning commissions; and crediting such dedication against the requirements of Section 46-6.

As part of the overall planning process, water-contact recreational opportunities were identified and provided. No coastal recreation opportunities were identified which can be incorporated into the proposed flood control measures. None of the proposed alternatives will adversely affect any significant coastal resources. Federal participation in the proposed project will require compliance with Federal and local environmental, land-use and water quality regulations and standards.

SECTION 205A-2(b)(2), HISTORIC RESOURCES

Objective: Protect, preserve, and, where desirable, restore those natural and man-made historic and prehistoric resources in the CZM area that are significant in Hawaiian and American history and culture.

Policies:

a. Identify and analyze significant archaeological resources.

An archaeological/cultural resources reconnaissance survey was conducted by a qualified archaeologist. The survey did not identify and analyze any potential archaeological resources in the study area. A separate survey by the State Historic Preservation Officer revealed evidence of possible other prehistoric materials which will be investigated in the subsequent stage of planning to determine potential eligibility to the National Register of Historic Places.

b. Maximize information retention through preservation of remains and artifacts or salvage operations.

Construction specifications will detail methods of maximizing preservation of any remains or artifacts identified during project planning or discovered during construction activities. No action will be made that will adversely affect the preservation of any archaeological remains or artifacts without consultation with a qualified archaeologist and coordination with the State Historic Preservation Officer.

c. Support State goals for protection, restoration, interpretation, and display of historic resources.

12-0054

February 9, 1987

MEMORANDUM

TO: MR. HIRAM K. KAMAKA, DIRECTOR
DEPARTMENT OF PARKS AND RECREATION

FROM: ALFRED J. THIEDE, ACTING DIRECTOR AND CHIEF ENGINEER

SUBJECT: YOUR MEMORANDUM DATED OCTOBER 28, 1986 RELATING TO THE ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE FOR THE KAHAWAINUI STREAM FLOOD CONTROL PROJECT

Thank you for your comments on the environmental impact statement preparation notice.

The proposed development of the 20+-acre community park in proximity of Station 38+62 of the proposed flood control project will be subjected to the floodplain development restrictions. The proposed built-up fill within the 100-year floodplain area may adversely affect the flood flows.

We recommend that consideration be given to construct the recreation building and comfort station within the protected area. All other facilities should be designed with the knowledge that they will be flooded periodically.

Vernon H S Ching

FOR ALFRED J. THIEDE
Acting Director and Chief Engineer

WY:CPC:pto

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
HONOLULU MUNICIPAL BUILDING
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

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RECEIVED
DIV. OF ENGINEERING
Nov 17 3 48 PM '86

ENV
11/17 ENGR

FRANK F. FASI
MAYOR

JOHN E. HIRTEN
DIRECTOR

JOSEPH M. MAGALDI, JR.
DEPUTY DIRECTOR

TE-5753
PL 1.0477

November 12, 1986

MEMORANDUM

TO: RUSSELL L. SMITH, JR., DIRECTOR AND CHIEF ENGINEER
DEPARTMENT OF PUBLIC WORKS

FROM: JOHN E. HIRTEN, DIRECTOR

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE
FOR THE KAHAWAINUI STREAM FLOOD CONTROL PROJECT
TMK: 5-5-9

This is in response to your memorandum of October 10, 1986.

We have no comments on the subject Environmental Impact Statement Preparation Notice.

JOHN E. HIRTEN

10 29 AM '86
DEPT OF PUBLIC WORKS
RECEIVED

XII. LIST OF REFERENCES

1. Ahlo, Hamilton M. and Robert J. Honmon, An Archaeological Reconnaissance Survey of the Flood Control Study Area, Kahawainui Stream, Laie, Oahu, Hawaii, prepared for U.S. Army Engineer Division, Pacific Ocean, under Contract No. DACW84-81-C-0003, 18 May 1981.

2. Air Survey Hawaii, Topographic Map of Kahawainui Stream, Oahu prepared for the U.S. Army Corps of Engineers under Contract No. DACW84-82-C-0010, 7 Sheets, 1" - 40', 2-foot contour intervals, 10 July 1982.

3. Air Survey Hawaii, Aerial Photograph, Hawaiian Islands #1-71(0) and 1-72(0), prepared for U.S. Army Corps of Engineers under Contract No. DACW84-82-M-3098, flight altitude = 1200', focal length = 153mm, 5 December 1982.

4. Austin, Smith & Associates, Inc., Review of Drainage System for Laie Village, undated.

5. Chow, Ven Te, Open-Channel Hydraulics, McGraw-Hill Book Company, New York, 1959.

6. City and County of Honolulu, Aerial Photo-Contour Map, Sheet Numbers: 528-174, 528-168, 1' = 200', 5-foot contour intervals, Planning Department, prepared by R.M. Towill, undated.

7. Dexter, James R. et al, Social Aspects of Floodproofing, reprinted from the Proceedings of the Specialty Conference on the Legal, Institutional and Social Aspects of Irrigation and Drainage and Water Resources Planning and Management, ASCE, Blacksburg, VA, July 26-28, 1979.

8. Pace, Carl E., Tests of Brick-Veneer Walls and Closures for Resistance Flood Waters, Misc Paper C-78-16, U.S. Army Engineer Waterways Experiment Station, Dec 1978.

9. Pace, Carl E. and Roy L. Campbell, Structural Integrity of Brick-Veneer Buildings, Technical Report C-78-3, U.S. Army Engineer Waterways Experiment Station, May 1978.

10. Shaeffer, John R., Introduction to Flood Proofing, University of Chicago, The Center for Urban Studies, April 1967.

11. Synder, Tim, Fine Homebuilding, "Moving a House", No. 5, October/ November 1981.

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13. U.S. Army Corps of Engineers, Flood Proofing - Example of Raising a Private Residence, Technical Services Report, South Atlantic Division, March 1977.

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15. U.S. Army Corps of Engineers, Hydroelectric Power Summary Report, Harbors and Rivers in Hawaii, Honolulu District, October 1978.

16. U.S. Army Corps of Enginers, The Development of Nonstructural Alternatives, A Policy Discussion, St. Paul District, May 1979.

17. U.S. Army Corps of Engineers, Reconnaissance Study for Flood Damage Reduction Measures, Kahawainui Stream, Laie, Oahu, Hawaii, Pacific Ocean Division, August 1981.

18. U.S. Army Corps of Engineers, Community Handbook on Flood Warning and Preparedness Programs, Research Report 81-R06, Engineer Institute for Water Resources, August 1981.

19. U.S. Army Corps of Engineers, Flood Insurance Map, Sheet Number 528-174, 1" = 200', 5-foot contour intervals, Pacific Ocean Division, May 1982.

20. U.S. Army Corps of Engineers, Draft Interim Survey Report and Environmental Impact Statement, Kahawainui Stream, Island of Oahu, Pacific Ocean Division, September 1983.

21. U.S. Army Corps of Engineers, Draft Detailed Project Report and Environmental Impact Statement, Kahawainui Stream, Island of Oahu, Pacific Ocean Division, June 1985.

22. U.S. Department of Commerce, Rainfall Frequency Atlas of the Hawaiian Islands, Technical Paper No. 43, Weather Bureau, 1962.

23. VIN Pacific, Laie Low Income Housing Project, Master Plan and Environmental Assessment, prepared for Zions Securities Corporation, April 1981.

24. Water Resources Council, Guidelines for Determining Floodplain Frequency, 1977.

25. U.S. Army Corps of Engineers, Final Detailed Project Report and Environmental Impact Statement, Kahawainui Stream, Island of Oahu, Honolulu District, November 1985.

APPENDIX A

KAHAWAINUI STREAM
FLOOD DAMAGE REDUCTION STUDY

SUPPLEMENTAL COMPLIANCE REPORTS

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B	Presidential Executive Order 11990 on Protection of Wetlands	A-6
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D	Federal Coastal Zone Management (CZM) Consistency Determination	A-13

The following supplemental evaluation reports are provided in this Appendix:

A. Presidential Executive Order 11988 on Floodplain Management Evaluation Report

B. Presidential Executive Order 11990 on Protection of Wetlands

C. Evaluation of the Effect of the Discharge of Dredged Materials into waters of the U.S. using U.S. Environmental Protection Agecy (EPA) Section 404(b) Guidelines

D. Federal Coastal Zone Management (CZM) Consistency Report

A. PRESIDENTIAL EXECUTIVE ORDER 11988 ON FLOODPLAIN MANAGEMENT EVALUATION REPORT

1. PURPOSE

The purpose of this supplemental report is to present the results of additional studies in accordance with 33 CFR 239 which implements Executive Order (EO) 11988, Floodplain Management, dated 24 May 1977. The objective of EO 11988 is to avoid to the maximum extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. The Order requires Federal agencies to:

a. Avoid development in the base floodplain unless it is the only practicable alternative;

b. Reduce the hazard and risk of flood loss;

c. Minimize the impact of floods on human safety, health, and welfare; and

d. Restore and preserve the natural and beneficial floodplain values.

2. COMPLIANCE

a. It has been determined that the project is located within the base flood. The base flood is defined as the one percent (1%) exceedance frequency floodplain (100-year floodplain).

b. Practicable alternatives to locating the "action" in the base floodplain have been considered. The term "action" is defined as any Federal activity including (1) acquiring, managing, and disposing of Federal lands and facilities; (2) providing Federally undertaken, financed, or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

No practicable alternatives are available that could locate the action outside the 100-year floodplain. The only measure, which locates the action outside the floodplain, is relocating each individual structure outside the floodplain. The alternative is impractical because it involves relocating over half the community to an area outside Laie. Land requirements and potential relocation costs for 50% of Laie makes this alternative impractical.

c. Impact Assessment (Natural and Beneficial Values). Assessment of the impacts of the proposed action on the natural/beneficial values of the floodplain indicates there are no Federally listed endangered or threatened species of fauna or flora that will be affected. Structural alternatives 2 and 4 will encroach upon the wetlands. Indirect development in this area as a result of the proposed actions will be closely regulated by existing City & County building restrictions within the designated 100-year floodplain. Cultural or archaeological resources will not be affected by structural actions. Archaeological monitoring will accompany all survey activities in order to ensure the integrity of cultural resources.

d. Induced Development as a Result of the Proposed Action. A practicable alternative to the proposed actions must consider water resources; conservation; economics; aesthetics; impact of future floods on human safety; locational values with respect to housing, education and work force; functional need for locating within the floodplain, historic, fish and wildlife habitat values; endangered and threatened species; support of local, municipal infra-structure; energy conservation; cost effectiveness; and the general needs and welfare of the local community.

Structural alternatives 1, 2 and 4 will alter the 100-year floodplain limits. Alternative 1 will increase the 100-year floodplain; Alternatives 2 and 4 will decrease it. Alternative 3, which is a nonstructural proposal will not reduce or alter the 100-year floodplain.

e. Viable Methods to Minimize Adverse Impacts and to Restore and Preserve the Natural and Beneficial Values of the Floodplain.

Floodplain management measures are all an integral part of the proposed alternative plans. These measures restrict future development in the floodplain and minimize potential flood damages. Measures to minimize adverse impacts include:

(1) Floodplain management services are available from the U.S. Army Corps of Engineers under the authority of Section 206 of the River and Harbor and Flood Control Act of 1960 (Public Law 89-789). These services include providing flood hazard data, maps and technical assistance and studies.

(2) A flood insurance program is administered by the U.S. Federal Emergency Management Agency (FEMA) through the Federal Insurance Administration under the authority of the National Flood Insurance Act of 1968, as amended. The City and County of Honolulu is officially participating in the program.

(3) The U.S. Department of Housing and Urban Development (HUD) has minimum building standard requirements for Federally subsidized housing projects administered by the agency. All buildings funded by HUD requires compliance to these standards which incorporate floodplain planning requirements.

(4) Relocation assistance for persons displaced as a result of Federal and federally-assisted programs are authorized by the Uniform Relocations Assistance and Real Property Acquisition Act of 1970 (Public Law 91-646). This statute provides moving and related expenses to insure fair and equitable treatment of displaced persons.

(5) Emergency and disaster operations, when in effect are administered by FEMA. Disaster recovery assistance includes protection of life and property, damage surveys, restoration of public services, and technical assistance. This assistance was recently provided during the storm of February 1979.

f. Advise the general public.

The general public was notified of this action by public notice and was given the opportunity of voicing their concerns on this action during a formal public meeting held on 25 July 1985.

g. Recommendation of the most desirable plan.

Alternative 2 at the SPF level of protection is the recommended plan because it maximizes net economic benefits and minimizes adverse environmental impact.

TABLE A-1. EVALUATION OF ADVANTAGES AND DISADVANTAGES OF FLOODPLAIN AND NON-FLOODPLAIN SITES

FACTORS (EO11988)	ADVANTAGES OF FLOODPLAIN	DISADVANTAGES OF FLOODPLAIN
Economics	Human economic activities are currently concentraed on floodplain area.	Human economic activities are subject to periodic flooding.
Aesthetics	None.	May degrade aesthetic appeal of open floodplain.
Natural Beneficial Values	None.	May degrade existing natural and beneficial values.
Impacts of Floods on Human Safety	Reduces the impacts of flooding on human safety.	Periodic flooding damage.
Locational Advantage Relative to Availability of Housing	Reduces flooding to housing.	Periodic flooding damage.
Education	None.	School days may be lost due to periodic flooding.
Work Force	Reduces flood hazards to work force.	Work days may be lost due to periodic flooding.
Functional Need	Provides comprehensive flood control measures to Laie and surrounding areas.	None.
Cultural/Historic Values	Laie is religious and educational center. Areas include Mormon Temple, BYU Hawaii Campus and Polynesian Cultural Center.	Prehistoric cultural deposits may be affected.
Fish & Wildlife Values	None.	None.
Endangered & Threatened Species	Not applicable.	Not applicable.
Support of Municipal Infrastructure	Provides comprehensive flood control measures to reduce flood hazards for other municipal infrastructure in floodplain.	Infrastructures subject to periodic flood damage.

TABLE A-1. EVALUATION OF ADVANTAGES AND DISADVANTAGES OF FLOODPLAIN AND NON-FLOODPLAIN SITES (Cont)

FACTORS (EO11988)	ADVANTAGES OF FLOODPLAIN	DISADVANTAGES OF FLOODPLAIN
Energy Conservation	None.	None.
Cost Effectiveness	None.	None.
Enhancement of Work Opportunities for Economically disadvantaged	None.	None.
Needs and Welfare of People	Reduces the flood hazard to the community.	None.

B. FLOOD DAMAGE REDUCTION
KAHAWAINUI STREAM, OAHU
PRESIDENTIAL EXECUTIVE ORDER 11990 ON PROTECTION OF WETLANDS
EVALUATION REPORT

1. Executive Order 11990 directs the Corps to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out its Civil Works activities.

2. To insure compliance with Executive Order 11990, the following evaluations were incorporated into the plan formulation for flood damage reduction of Kahawainui Stream.

a. Procedure: Determine if wetlands are present within the study area.

Evaluation: Site inspections of soils, water and vegetation of the study area indicated the presence of wetlands along Kahawainui Stream on both sides of Kamehameha Highway. Seaward of the highway, an estuarine mangrove and hau swamp dominates the wetland. Fringing marshes and floating aquatic weeds characterize the stream and irrigation ditches. California grass marshlands and pastures (wet meadow) in the vicinity of the ponds comprise the greatest component of the wetland. Since the degree of soil saturation in the wetland varies with seasonal variations in rainfall, the outside limits of the wetland are difficult to pinpoint. Figure 12 shows the approximate boundary of the wetland based on field observations of vegetation, soils, hydrology, and microtopography; and on interpretation of aerial photographs of the area taken at different years and seasons. The area defined as wetland is approximately 17 acres.

b. Procedure: If wetlands are present, make protection and/or enhancement of the beneficial values of wetlands a planning objective.

Evaluation: Wetland protection and enhancement were considered throughout the planning process and are incorporated into the planning objectives in the Main Report.

c. Procedure: During the plan formulation process, include appropriate wetlands protection and/or enhancement measures in alternative plans.

Evaluation: Wetlands protection and enhancement were considered during the development of each of the alternative plans. The structural elements of Alternative Plan 1 (levee plan) avoid wetland areas entirely. Levee development will cause surface waters to be diverted to wetland areas at a greater frequency and duration than at present. This may help to maintain wetland conditions along some intermittently dry upper limits of the wetland area.

The structural elements of Alternative Plans 2 and 4 (levee and channel) will require excavation and filling of approximately 2 acres of wetland, or approximately 10 percent of the total wetland acreage of the project area. Although efforts were made to minimize destruction or alteration of wetlands under this alternative, overriding consideration was given to minimizing overtopping risks associated with extensive levee

development. As with Alternative Plan 1, levee construction may result in diversion of waters to wetlands including those areas which presently experience intermittent drying. The Corps would recommend preservation and enhancement of wetlands under Alternative Plans 2 and 4 to mitigate losses of wetland values and resources.

Alternative Plan 3 (floodproofing and floodplain management) would not affect wetlands in the Kahawainui floodplain. Plan 4 would destroy wetlands only in the immediate vicinity of the proposed stream channel.

d. Procedure: If the proposed Corps action would be located in wetlands, identify and evaluate practicable alternatives to wetlands location.

Evaluation: No practicable alternative to the wetland location is available outside of wetland. Floodproofing flood damageable property which does not modify the wetland is not economically feasible.

e. Procedure: Identify and evaluate adverse impacts related to the loss and degradation of beneficial values of wetlands.

Evaluation: Limited areas of wetland will be affected by Plans 2 and 4. Beneficial values associated with the wetland include nutrient filtering; buffering against erosion; food chain production; and storage of storm and floodwaters.

f. Procedure: Include appropriate measures in alternative plans to minimize unavoidable adverse impacts to beneficial wetlands and their functions.

Evaluation: Attempts were made to preserve or enhance wetlands during development of the alternative plans. Plans 1 and 3 will have no effects on wetlands. Plans 2 and 4 will affect wetlands to the minimum extent possible given the structural requirements of the project components. Coordination is in progress with State Wildlife representatives and the US Fish and Wildlife Service to develop wetland preservation/enhancement plans.

g. Procedure: Based on the above, and in close coordination with appropriate agencies and the public throughout the planning process, recommend the plan most responsive to the planning objectives and evaluation criteria.

Evaluation: This report will be distributed to the US Fish and Wildlife Service for review and comment and preparation of a FWCA Report. Plans 3 and 1 appear to be the least environmentally damaging plan in terms of wetland resources.

C. EVALUATION OF THE EFFECTS OF THE DISCHARGE OF DREDGED OR FILL MATERIAL INTO THE WATERS OF THE US USING THE US ENVIRONMENTAL PROTECTION AGENCY (EPA) SECTION 404(b) GUIDELINES

1. PROJECT DESCRIPTION

a. Location: Kahawainui Stream, Laie
Island of Oahu, Hawaii

b. General Description: The Honolulu District, US Army Corps of Engineers, has investigated public concerns and needs associated with flood damage reduction measures in the Kahawainui Stream floodplain. The impacts upon the environmental, social, cultural and economic resources of the area were also evaluated. Four alternative plans were developed and are consistent with national and local goals and the primary objective of reducing property damage by floodwaters from Kahawainui Stream. Alternative Plan 1 consists of levees and Alternative Plan 2 consists of a combination of levee and channel improvements. Alternative Plan 3 is the nonstructural plan involving flood-proofing and floodplain management. Alternative Plan 4 is a structural plan consisting of only a channel.

c. Authority and Purpose: This survey report was prepared under the authority of Section 209 of the Flood Control Act of 1962 (Public Law 87-874). This section authorizes the Secretary of the Army, through the Chief of Engineers, to study water and related resource problems and needs in the State of Hawaii. The Secretary of the Army may recommend solutions to Congress and the extent which the Federal government should participate in implementing possible flood damage reduction measures.

The purpose of this study are to identify the problems, needs and the extent to which the Federal government should participate in flood damage reduction measures in the Kahawainui Stream floodplain. This report documents the results of the Corps' planning process and is used to determine whether further Federal participation is warranted under the study authority.

d. General Descriptions of Dredged or Fill Materials:

	Alternative Plans			
	1	2	3	4
(1) General Characteristics of the Material	NA	Earth fill; concrete consisting of cement, aggregates and water with reinforcement bars; boulders	NA	Earth fill; concrete consisting of cement, aggregates and water with reinforcement bars; boulders
(2) Quantity of Material to be Discharged 2/	NA	2 Berm 9,000 CY Channel 3,000 CY TOTAL 12,000 CY	NA	24,700 CYS of concrete and boulders
(3) Source of the Material	NA	Approved existing quarries and/or approved borrow sites. Cement will be factory produced.	NA	Approved existing quarries and/or approved borrow sites. Cement will be factory produced.

e. Description of the Proposed Discharge Site:

	Alternative Plans			
	1	2	3	4
(1) Location	See Fig 9 of Main Report	See map page, Fig 10 of Main Report. Create new levee, channel, berms along Kahawainui Stream and wetlands	NA	Same as Plan 2 without a channel.
(2) Size	NA	2.0 acres	NA	4 acres
(3) Type of site	NA	Stream/wetlands	NA	Same as Plan 2
(4) Type(s) of Habitat	NA	Freshwater stream and wetlands	NA	Same as Plan 2
(5) Timing and Duration of discharge	NA	The project would probably be implemented within 3 to 4 years and would take 15 to 21 months to construct	NA	Same as Plan 2

f. Description of Disposal Method:

(1) Method of discharge	NA	Crane and dump truck	NA	Same as Plan 2

2. FACTUAL DETERMINATIONS

	Alternative Plans			
	1	2	3	4
a. Physical Substrate Determinations				
(1) Substrate elevation and slope	NA	0 to 10 feet MSL Geologic study and report prepared by the COE and filed in the Corps Final DPR and EIS.	NA	Same as Plan 2
(2) Sediment Type	NA		NA	Same as Plan 2
(3) Dredged/Fill Material Movement	NA	NA	NA	Same as Plan 2

NOTES:

1. NA: not applicable
2. Material includes concrete and bedding

a. Physical Substrate Determinations (Cont)

	Alternative Plans 1	2	3	4
(4) Physical Effects on Benthos	NA	Excavation and burial	NA	Same as Plan 2
(5) Other Effects	NA	NA	NA	Same as Plan 2
(6) Actions Taken to Minimize Impacts	NA	Avoid wetlands where feasible. Recommend preservation, enhancement of other wetland areas	NA	Same as Plan 2

b. Water Circulation, Fluctuation and Salinity Determination

	Alternative Plans 1	2	3	4
(1) Water, Effects on:				
(a) Salinity	NA	No effect	NA	Same as Plan 2
(b) Water Chemistry	NA	Temperature may increase	NA	Same as Plan 2
(c) Clarity	NA	Possible increase	NA	Same as Plan 2
(d) Color	NA	No effect	NA	Same as Plan 2
(e) Odor	NA	No effect	NA	Same as Plan 2
(f) Taste	NA	No effect	NA	Same as Plan 2
(g) Dissolved gas levels	NA	Will attempt to increase O_2	NA	Same as Plan 2
(h) Nutrients	NA	Possible increase downstream	NA	Same as Plan 2
(2) Current Patterns and Circulation	NA	Will alter course of stream	NA	Same as Plan 2
(a) Current Patterns and Flow	NA	Will alter course of stream	NA	Same as Plan 2
(b) Velocity	NA	Increase in lower reaches	NA	Same as Plan 2
(c) Stratification	NA	Wide channel will reduce depth	NA	Same as Plan 2
(d) Hydrologic Regime	NA	Less infiltration	NA	Same as Plan 2
(3) Normal Water Level Fluctuations	NA	Wetland water levels may increase during flooding. Lower reaches of stream will remain under tidal influence	NA	Same as Plan 2

b. Water Circulation, Fluctuation and Salinity Determination (Contd)

	Alternative Plans			
	1	2	3	4
(4) Salinity gradients	NA	No effect	NA	Same as Plan 2
(5) Actions that will be taken to minimize impacts	NA	Efforts will be made to improve water quality; preserve and enhance wetland	NA	Same as Plan 2
c. Suspended Particulate/Turbidity Determination				
(1) Expected changes in suspended particulate and turbidity levels in vicinity of disposal site.	NA	Temporary increase	NA	Same as Plan 2
(2) Effects (degree and duration) on Chemical and Physical Properties of the Water Column				
(a) Light Penetration	NA	Shallower water levels	NA	Same as Plan 2
(b) Dissolved Oxygen	NA	Efforts will be made to increase	NA	Same as Plan 2
(c) Toxic Metals & Organics	NA	No effect	NA	Same as Plan 2
(d) Pathogens	NA	No effect	NA	Same as Plan 2
(e) Aesthetics	NA	Natural streambed, wetlands converted	NA	Same as Plan 2
(3) Effects on Biota				
(a) Primary Production, Photosynthesis	NA	Loss of benthic habitat	NA	Same as Plan 2
(b) Suspension/Filter Feeders	NA	Shallower water levels	NA	Same as Plan 2
(c) Sight Feeders	NA	No effect	NA	Same as Plan 2
(4) Actions taken to Minimize Impacts	NA	Minimize fill; preserve and enhance wetlands	NA	Same as Plan 2
d. Contaminant Determination				
The proposed discharge is free of contaminants	NA	NA	NA	Same as Plan 2
e. Aquatic Ecosystem and Organism Determinations				
The proposed discharge is free of contaminants	NA	NA	NA	Same as Plan 2

f. Proposed Disposal Site Determinations

	Alternative Plans			
	1	2	3	4
(1) Mixing Zone Determination	NA	NA	NA	Same as Plan 2
(2) Determination of Compliance with Applicable Water Quality Standards	NA	NA	NA	Same as Plan 2
(3) Potential Effects on Human Use Characteristics	NA	Floodplain management would be required	NA	Same as Plan 2
g. Determination of Cumulative Effects on the Aquatic Ecosystems	NA	Continued channelization/ filling would adversely affect quality of habitat	NA	Same as Plan 2
h. Determination of Secondary Effects on the Aquatic Ecosystem	NA	No significant effects	NA	Same as Plan 2

D. FEDERAL COASTAL ZONE MANAGEMENT (CZM) CONSISTENCY DETERMINATION REPORT

1. PURPOSE

a. The Coastal Zone Management (CZM) Act of 1972 (Public Law 92-583) and the regulations on Federal consistency with approved Coastal Zone Management programs (15 CFR 930) provide that all Federal activities must be consistent to the maximum extent practicable with the Hawaii State Coastal Zone Management Program.

b. The Kahawainui Stream Flood Damage Reduction Study located at Laie, Island of Oahu will involve construction within the CZM area. Four alternatives were investigated in detail and include (1) levee plan, (2) levee and channel plan, (3) floodproofing and floodplain management, and (4) channel plan. This study was requested by the City and County of Honolulu. The following consistency determination summarizes the study's conformance with policies of the Hawaii State Coastal Zone Management program to the maximum extent practical.

2. The plans under consideration meet the objectives and policies of the CZM program as follows:

SECTION 205A-(b)(1), RECREATIONAL RESOURCES

Objective: Provide coastal recreational opportunities accessible to the public.

Policies:

a. Improve coordination and funding of coastal recreation planning and management.

Identifying and developing water contact recreational opportunities as part of the overall flood control project were incorporated in the planning process. The project document will recommend any coordination and funding of potential coastal recreation planning, management and opportunities.

b. Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:

(1) Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas.

(2) Requiring replacement of coastal resources having significant recreational value, including but not limited to, surfing sites and sandy beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable.

(3) Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation.

(4) Encouraging expanded public recreational use of County, State, and federally owned or controlled shoreline lands and waters having recreational value.

(5) Adopting water quality standards and regulating point and non-point sources of pollution to protect and where feasible, restore the recreational value of coastal waters.

(6) Developing new shoreline recreational opportunities, where appropriate, such as artifical reefs for surfing and fishing.

(7) Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the Land Use Commission, Board of Land and Natural Resources, county planning commissions; and crediting such dedication against the requirements of Section 46-6.

As part of the overall planning process, water-contact recreational opportunities were identified and provided. No coastal recreation opportunities were identified which can be incorporated into the proposed flood control measures. None of the proposed alternatives will adversely affect any significant coastal resources. Federal participation in the proposed project will require compliance with Federal and local environmental, land-use and water quality regulations and standards.

SECTION 205A-2(b)(2), HISTORIC RESOURCES

Objective: Protect, preserve, and, where desirable, restore those natural and man-made historic and prehistoric resources in the CZM area that are significant in Hawaiian and American history and culture.

Policies:

a. Identify and analyze significant archaeological resources.

An archaeological/cultural resources reconnaissance survey was conducted by a qualified archaeologist. The survey did not identify and analyze any potential archaeological resources in the study area. A separate survey by the State Historic Preservation Officer revealed evidence of possible other prehistoric materials which will be investigated in the subsequent stage of planning to determine potential eligibility to the National Register of Historic Places.

b. Maximize information retention through preservation of remains and artifacts or salvage operations.

Construction specifications will detail methods of maximizing preservation of any remains or artifacts identified during project planning or discovered during construction activities. No action will be made that will adversely affect the preservation of any archaeological remains or artifacts without consultation with a qualified archaeologist and coordination with the State Historic Preservation Officer.

c. Support State goals for protection, restoration, interpretation, and display of historic resources.

United States Department of the Interior
GEOLOGICAL SURVEY
Water Resources Division
P.O. Box 50166
Honolulu, Hawaii 96850

871962

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April 6, 1987

RECEIVED
DEPT OF PUBLIC WORKS
APR 8 3 20 PM '87
TO

Dr. John C. Lewin
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Lewin:

Subject: Draft Environmental Impact Statement for the Kahawainui Stream Flood Control, Laie, Oahu, Hawaii

The Hawaii District Office of the U.S. Geological Survey, Water Resources Division, has reviewed the subject DEIS and has no comments.

As requested, we are returning the Draft EIS to the State Office of Environmental Quality Control. We thank you for the opportunity to review the material.

Sincerely,

William Meyer

William Meyer
District Chief

Copy to: John P. Whalen, Dir.
Dept. of Land Util.
C & C of Honolulu
650 South King St.
Honolulu, HI 96813

Alfred J. Thiede
Director & Chief Engr.
Dept. of Public Works
C & C of Honolulu
650 South King St.
Honolulu, HI 96813

cc: A. Thiede

871963

UNITED STATES
DEPARTMENT OF
AGRICULTURE

SOIL
CONSERVATION
SERVICE

P.O.BOX 50004
HONOLULU, HAWAII
96850

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April 6, 1987 4/9/87 ENGR

Dr. John C. Lewin, Director
Office of Environmental
Quality Control
465 S. King St., Room 104
Honolulu, HI 96813

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Dear Dr. Lewin:

Subject: Draft EIS - Kahawainui Stream Flood Control, Laie, Oahu, Hawaii

We reviewed the subject draft environmental impact statement and have no comments to make.

Thank you for the opportunity to review the document.

Sincerely,

RICHARD N. DUNCAN
State Conservationist

cc:
Mr. John P. Whalen, Director
Department of Land Utilization
City and County of Honolulu
650 South King Street
Honolulu, HI 96813

Mr. Alfred J. Thiede
Director and Chief Engineer
Department of Public Works
City and County of Honolulu
650 South King Street
Honolulu, HI 96813

John Waihee
GOVERNOR

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Land - cc

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
465 SOUTH KING STREET, ROOM 104
HONOLULU, HAWAII 96813

DIRECTOR
TELEPHONE NO.
548-6915

March 10, 1987

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TO

Mr. Alfred J. Thiede
Director and Chief Engineer
Department of Public Works
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Thiede:

Subject: Draft EIS for Kahawainui Stream Flood Control, Laie, Oahu

Zion Securities Corporation is the largest land owner in Laie and they would benefit most from the proposed flood control project. However, Zion Securities' participation in the project's cost seems trifling in light of the higher property values that the corporation would enjoy as a result of this project. We question whether funds for this project could be better spent elsewhere.

Sincerely,

John C. Lewin, M.D.
Director of Health

cc: DLU

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

FRANK F. FASI
MAYOR

ALFRED J. THIEDE
DIRECTOR AND CHIEF ENGINEER

12-0171

May 26, 1987

Dr. John C. Lewin, Director of Health
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Lewin:

Subject: Your Letter Dated March 10, 1987 Relating to the Draft Environmental Impact Statement (DEIS) for the Kahawainui Stream Flood Control Project, Laie, Oahu

Although Zions Securities Corporation is presently the largest land owner in the Laie area, they are in the process or have already terminated individual leasehold properties in favor of fee simple title to the lessees. Zions Securities Corporation has also offered: to dedicate the necessary easements and land rights for the project; the fill material needed for the construction of the project; and a disposal site for the vegetation and unsuitable materials.

The Corps of Engineers' study indicated a favorable benefit to cost ratio of 2.2. A major portion of the benefits to be derived from the implementation of this project results from a reduction of damages to structures and their contents which are owned by the individual lessees. Other benefits which will be derived from this project include the elimination of emergency relief costs, and reduction in damages to public roads and utilities. The intangible benefits include lessening threats to human life and safety, and the elimination of the aggravation that damages and general nuisance of flooding bring.

We concur with the Corps' conclusion and recommendation that implementation of this project is justified.

Very truly yours,

for [signature]
ALFRED J. THIEDE
Director and Chief Engineer

WY:CPC:smi

cc: Department of Land Utilization
Army Corps of Engineers
bcc: Environmental Engineer

871860

JOHN WAIHEE
GOVERNOR

SUZANNE D. PETERSON
CHAIRPERSON, BOARD OF AGRICULTURE
TADASHI TOJO
DEPUTY TO THE CHAIRPERSON

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 So. King Street
Honolulu, Hawaii 96814-2512

Mailing Address:
P. O. Box 22159
Honolulu, Hawaii 96822-0159

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April 1, 1987

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MEMORANDUM

To: Dr. John C. Lewin
Director, Department of Health

Subject: Draft Environmental Impact Statement (DEIS) for
Kahawainui Stream Flood Control Project
Department of Public Works
City and County of Honolulu
TMK: 5-5-05: por. 18
5-5-08: various
5-5-09: various
Laie, Oahu

The Department of Agriculture has reviewed the subject DEIS and offers the following comments.

We note that the recommended project is Alternative 2 which would appear to result in minimal adverse impact upon the existing agricultural uses in the affected area. We concur with the findings of the DEIS as they relate tto agriculture.

Thank you for the opportunity to comment.

Suzanne D Peterson

SUZANNE D. PETERSON
Chairperson, Board of Agriculture

cc: Mr. John P. Whallen, DLU
Mr. Alfred J. Thiede, DPW
OEQC

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

FRANK F. FASI
MAYOR

ALFRED J. THIEDE
DIRECTOR AND CHIEF ENGINEER

12-0178

May 26, 1987

Ms. Suzanne D. Peterson, Chairperson
Board of Agriculture
Department of Agriculture
State of Hawaii
P.O. Box 22159
Honolulu, Hawaii 96822-0159

Dear Ms. Peterson:

Subject: Your Memorandum Dated April 1, 1987 Relating to the Draft Environmental Impact Statement (DEIS) for the Kahawainui Stream Flood Control Project, Laie, Oahu

Thank you for your comments on the DEIS for the Kahawainui Stream Flood Control project.

We concur that the recommended alternative will have the least adverse impact upon the existing agricultural uses in the area. Your concurrence with the findings in the DEIS as it relates to the agricultural activities in the area is noted.

Very truly yours,

for Vernon H. J. Chiang
ALFRED J. THIEDE
Director and Chief Engineer

WY:CPC:smi

cc: OEQC
DLU
Army Corps of Engineers
bcc: Environmental Engineer

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Dr. John C. Lewin
Office of Environmental
Quality Control
State of Hawaii
Honolulu, Hawaii

Mr. John P. Whalen, Director
Department of Land Utilization
City and County of Honolulu
Honolulu, Hawaii

Dear Dr. Lewin and Mr. Whalen:

Subject: Kahawainui Stream Flood Control
Draft Environmental Impact Statement

We have reviewed the subject document and have no comments to offer.

Very truly yours,

TEUANE TOMINAGA
State Public Works Engineer

/jnt
cc: Mr. Alfred J. Thiede

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HIENG

Mr. John C. Lewin
Office of Environmental
Quality Control
465 S. King St., Room 104
Honolulu, HI 96813

Mr. John P. Whalen, Director
Dept. of Land Utilization
City & County of Honolulu
650 S. King St.
Honolulu, HI 96813

Dear Mr. Lewin:

Kahawainui Stream Flood Control
Laie, Oahu

Thank you for providing us the opportunity to review the above subject project.

We have no comments to offer at this time regarding this project.

Yours truly,

Jerry M. Matsuda
Major, Hawaii Air
National Guard
Contr & Engr Officer

Enclosure

cc: Mr. Alfred J. Thiede,
Dept. of Public Works

JOHN WAIHEE
GOVERNOR

CHARLES T. TOGUCHI
SUPERINTENDENT

STATE OF HAWAII
DEPARTMENT OF EDUCATION
P. O. BOX 2360
HONOLULU, HAWAII 96804

OFFICE OF THE SUPERINTENDENT

March 20, 1987

Dr. John C. Lewin
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Lewin:

SUBJECT: Environmental Impact Statement for the
Kahawainui Stream Flood Control

We have no comments on the subject Environmental Impact Statement.

Thank you for the opportunity to review the subject project.

Sincerely,

Charles T. Toguchi

Charles T. Toguchi
Superintendent

CTT:dk (MRI)

cc Mr. Alfred J. Thiede, Director & Chief Engineer
Department of Public Works
Mr. Chris Ito, Office of Business Services

AN AFFIRMATIVE ACTION AND EQUAL OPPORTUNITY EMPLOYER

871861

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STATE OF HAWAII
OFFICE OF HAWAIIAN AFFAIRS
1600 KAPIOLANI BLVD., SUITE 1500
HONOLULU, HAWAII 96814
(808) 548-8960

April 2, 1987

RECEIVED
DEPT OF PUBLIC WORKS
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TO

Mr. John P. Whalen, Director
Department of Land Utilization
City and County of Honolulu
650 South King Street
Honolulu, HI 96813

Dear Mr. Whalen:

SUBJECT: Draft EIS, Kahawainui Stream Flood Control Project, La'ie, O'ahu. TMK: 5-5-09

Thank you for sending our office a copy of the Draft EIS, and for the opportunity to comment.

The proposed undertaking will have an impact on historical sites of interest to Hawaiians. Information about these sites are only summarized in the Draft EIS. Please send our Office complete copies of the archaeological reports referenced in the Draft EIS:

1) Ahlo & Hommon: "An archaeological reconnaissance survey of the flood control study area, Kahawainui Stream, La'ie, O'ahu, Hawaii." May 18, 1981.

2) "...a site visit-reconnaissance survey of the northeast portion of the project area by archaeologists from the Corps of Engineers and the Hawaii Department of Land and Natural Resources..."

3) Athens & Bath: "Archaeological services for survey and testing for Kahawainui Flood Control Project, La'ie, O'ahu, Hawaii." 1985.

We believe it is premature and improper for us to provide comments and recommendations regarding this project's impact on cultural resources until these three reports are read and discussed by our staff.

As a matter of standard procedure, we believe the Draft EIS should contain the comments of the State Historic Preservation Office. This Draft EIS does not.

We also believe that it is appropriate to request a formal determination of eligibility at this stage in the planning process. It makes no sense for a federal agency to design a project to avoid impact to historic sites which have not been determined eligible for the National Register, as is being done in this case.

Given the information available at this time, we recommend that the alternatives discussed in this Draft EIS tend to foreclose future options for public access to and use of historic sites in the project area. Insufficient thought has been given to improving drainage in the residential areas of La'ie and providing for a comprehensive, coordinated, storm sewer drainage system for the La'ie community and the La'ie Wai Stream watershed. We are opposed to the displacement of small landowners to be affected by this project. Other options are available.

For the record, the correct name of the stream in this portion of La'ie is La'ie Wai, not Kahawainui. Also for the record, the cemetery referred to as a Chinese cemetery on page 26 of the Draft EIS is known to be a Hawaiian cemetery. It is maintained by a Hawaiian family living in La'ie, and the descendents of the people interred in the cemetery should be contacted for their comments before the preferred alternative is chosen.

Sincerely,

Kamaki A. Kanahele, III
Administrator

KAK:EN

cc: State Historic Preservation Office (SHPO)
Advisory Council of Historic Preservation (ACHP)
Corp of Engineers (COE)
Office of Environmental Quality Control (OEQC)
Department of Public Works (DPW)

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

FRANK F. FASI
MAYOR

ALFRED J. THIEDE
DIRECTOR AND CHIEF ENGINEER

12-0172

May 26, 1987

Mr. Kamaki A. Kanahele, III
Administrator
Office of Hawaiian Affairs
State of Hawaii
1600 Kapiolani Boulevard, Suite 1500
Honolulu, Hawaii 96814

Dear Mr. Kanahele:

Subject: Your Letter Dated April 2, 1987 Relating to the Draft Environmental Impact Statement (DEIS) for the Kahawainui Stream Flood Control Project, Laie, Oahu

Thank you for your comments on the DEIS for the Kahawainui Stream Flood Control Project.

Your letter was referred to the U.S. Army Corps of Engineers since they are the lead agency for this project. The archaeological studies, planning and engineering for this project were coordinated or performed by the Corps of Engineers.

The Corps of Engineers has informed us that copies of the documents for the archaeological investigations for this project may be obtained from either the State of Hawaii Department of Land and Natural Resources, Historic Sites Section, or the U.S. Army Engineer District, Honolulu, Environmental Resources Section.

The earlier Corps prepared Federal EIS which is similar to the DEIS was fully coordinated with the State Historic Preservation Office. Attached are copies of appropriate coordination correspondences between the State Department of Land and Natural Resources and the Corps of Engineers. The coordination correspondences will also be included in the final EIS.

All appropriate historic preservation coordination is in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, and has been completed for this project by the Corps of Engineers. No significant cultural resources, eligible for inclusion to the National Register of Historic Places, were determined to be within the proposed project area.

The Corps of Engineers conducted pre-construction archaeological research for this project in order to satisfy Section 106 requirements and to gather general archaeological data for project planning. These data were used, along with other environmental and engineering data, to plan alternative alignments of structures and facilities for the project. The archaeological data were only one segment of a body of data, including public input, which were used for project planning. This planning resulted in all identified historic sites being located outside the construction boundaries of the flood control project. Construction of the recommended alternative will not foreclose public access to and use of the historic sites in the general or overall project area.

The existing roadways, drainage, water and sewer systems in the Laie town area are privately owned and therefore any roadway, drainage, water or sewer improvements needed for the area are the responsibility of the property owner.

Implementation of the recommended alternative will require the displacement of one landowner. The affected property owner testified during the July 25, 1985 public meeting held at Laie Elementary School that both she and her husband would be willing to sacrifice their home in order to protect the town of Laie from flooding. The City and County of Honolulu will be working with the property owner to ensure that they are satisfactorily compensated and relocated.

We concur that proper reference and identification of the stream as La'ie Wai is contained in all historic preservation documents for the flood control project. However, since the Kahawainui Stream is a tributary to the La'ie Wai Stream and to preclude any confusion that this may indeed be a new project, we will continue to call this project the Kahawainui Stream Flood Control project.

Athens & Bath, archaeologists, have established or strongly suggested that the cemetery referred to as being "Chinese" actually contains two segments — one associated with ethnic Chinese and one with an ethnic Hawaiian community. This finding will be noted in the final EIS. It

does appear that portions of this cemetery are maintained by a local family. The proposed flood control project has been designed not to affect this cemetery, and will, in fact, protect it from periodic flood events. Construction of the flood control project will not preclude or obstruct access to the cemetery.

Very truly yours,

for ALFRED J. THIEDE
Director and Chief Engineer

WY:CPC:smi

Attach.

cc: OEQC
DLU
State Historic Preservation Office
Advisory Council of Historic Preservation
Army Corps of Engineers
bcc: Environmental Engineer

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES
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DEPUTY TO THE CHAIRMAN
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STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

DEC 2 9 1983

DEC 30 1983

Mr. Kisuk Cheung
Chief, Engineering Division
Pacific Ocean Division
U. S. Army Corps of Engineers
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

Thank you for the opportunity to review the draft of the interim survey report and the statement of environmental impact for Kahawainui Stream. We have a number of concerns about the draft.

Flood Control

From a flood control standpoint, we have no objection to either of the preferred alternatives: Alternative 1, consisting of levee development to confine floodwaters to a designated floodway, and, Alternative 2, consisting of a combination of levee construction and channel modification to confine floodwater to a designated floodway and to enlarge the existing channel.

Aquatic Resources

From an aquatic resource standpoint, we have no objection to the four alternative plans proposed by the Corps of Engineers which are based on the results of aquatic biota surveys conducted in the project area by the U. S. Fish and Wildlife Service in 1981 and 1983. These studies revealed the presence of stagnant stream water conditions during periods of low or no flow, and a low species diversity of macrofauna, probably in response to poor water quality.

Instream Use and Stream Alteration

The Department of Land and Natural Resources will soon be implementing a new Instream Use Program authorized by the 1982 Legislature by Act 185. Title 13, Chapter 167, Administrative Rules, for protection of instream use of water, was approved by the Board of Land and Natural Resources in November 1983. We expect this rule to be in effect by early 1984. As such, a proposal requiring alteration of the stream channel will require a permit under the Instream Use Program.

We note the draft environmental impact statement does address existing stream environment as well as anticipated impacts and mitigation measures. We concur with the mitigation measures proposed.

Recreation

Malaekahana State Park borders Kahawainui (or Laiewai) stream from Kamehameha Road to the stream mouth. Any changes to this portion of the Stream, by direct channelization or by alteration in stream flow, will have an impact on the park.

Another concern is any change in water quality in the stream or in Laie Bay near the stream mouth which would impact on water recreation opportunities. In general, a flood control alternative is preferred which retains flood waters, thereby reducing stream velocity and silt/debris loading of Laie Bay.

Cultural Resources

All alternatives will have adverse effect on significant cultural resources in the floodplain area. We recommend that two especially significant areas be nominated to the National Register of Historic Places, and that mitigation measures provide for preservation and protection of these sites:

1) The wooded area containing the remains of the Japanese Shrine, unmarked graves, plantation camp, and ponds.

2) The wooded area containing the missionary house site, Hawaiian cemetery, and limestone caves.

Pursuant to 36 CFR 500, the Advisory Council on Historic Preservation should be given the opportunity to comment on the proposed undertaking.

Sincerely,

SUSUMU ONO
Chairperson
and
State Historic Preservation Officer

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES
EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN

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STATE PARKS
WATER AND LAND DEVELOPMENT

January 27, 1986

Mr. Kisuk Cheung
Chief, Engineering Division
Honolulu District
U. S. Army Corps of Engineers
Ft. Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

Thank you for the opportuinity to review the project report and environmental impact statement (EIS) covering the flood control work planned for Kahawainui Stream. We would like to offer the following comments:

Aquatic Resources

From an aquatic resources standpoint, we have no objection to the Corps' selection of Alternative Plan 2 (levee along the right banks of the upper portions of Laiewai and Kahawainui Streams, and the realignment and channelization of the lower portion of Kahawainui Stream). Biological studies conducted in the area by the U. S. Fish and Wildlife Service revealed low diversity of stream/estuarine macrofauna, probably due to low water quality (high ammonia concentrations) in the Kahawainui Stream from agricultural activities. The mitigating measures addressed in the Final Environmental Impact Statement should minimize adverse impacts to the biological resources.

Historic Sites Concerns

We concur that of the four alternatives, only alternative 4 (channel plan) would have an adverse impact to known cultural resources.

As stated in our July 20, 1983 letter to you, the following cultural resources in the project are likely to meet the criteria of eligibility for placement on the National Register of Historic Places: the Pa'eo Fishpond, the Hanapepe Shrine, the Shinto Temple ruins and cemetery, and the smaller cemetery and associated homestead ruins. The developing agency should 1) explicitly state, in a letter to our historic sites office, that it agrees that these

properties appear to meet criteria for placement in the National Register of Historic Places, or 2) submit a determination of eligibility of these resources to the Keeper of the National Register. We presume the agency will coordinate mitigative measures with our historic sites office.

Instream Use Protection

The recommended alternative number 2 involves construction of a levee and channel improvements and realignment, cleaning and excavation of portions of the existing stream channel under bridges, as well as floodplain management, including grading and construction of swales.

As such, a Stream Channel Alteration Permit will be required for the proposed project. The local sponsoring agency, the City and County of Honolulu, Department of Public Works, should contact Takeo Fujii at 548-7619 regarding permit requirements.

We note that the EIS does address impacts to stream habitat and species as well as mitigation measures, and we concur with the mitigation measures proposed.

Sincerely,

SUSUMU ONO
Chairperson
and
State Historic Preservation Officer

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
FT. SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF

February 13, 1986

Mr. Susumu Ono
Chairperson and State Historic
Preservation Officer
State of Hawaii, Department of
Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Thank you for your review responses for the project report and environmental impact statement (EIS) for proposed flood control work for Kahawainui Stream, Laie, O'ahu, Hawaii (letter of January 27, 1986). We would like to offer the following responses to your comments.

HISTORIC SITES CONCERNS

As indicated in your recent letter, a July 20, 1983, letter from your office stated that the following cultural resources in the project area are likely to meet the criteria of eligibility for placement on the National Register of Historic Places:

1. Pa'eo Fishpond
2. Hanapepe Shrine
3. Shinto Temple ruins and cemetery
4. Smaller cemetery and associated homestead remains

Since 1983, project plans have been altered for the preferred construction alternative (Alternative 2). A result, with which your office concurs, is that none of these properties will be adversely impacted through the proposed project. In addition, further archaeological research in portions of the project area have elucidated more data for evaluating the significance of these sites. As stated in your letter, the Corps should either explicitly state that there is agreement on site significance or submit determinations of eligibility for these resources to the Keeper of the National Register. As a result, we suggest that properties 1 and 2 do not

possess the criteria for inclusion to the National Register whereas properties 3 and 4 may. Further discussion is included below.

1. Pa'eo Fishpond

The exact location of this site remains unknown following several archaeological and historic record investigations. Bath (Archaeological Testing and Mapping at Kahawainui Stream in Laie, Oahu, Hawaii, 1985: 4,6,13-14) suggests several alternatives for the site including that there may have never been such a pond; a pond somewhere in the Laie area may have been out of operation by 1850 or earlier; or that there were never any visible structural remains of a fishpond but rather unaltered utilization of a natural stream oxbow. No surface nor subsurface indication of ponded sediments have been found in the project area during archaeologic and geologic testing. Although a pond in the Laie area is recorded in traditional Hawaiian legends, there are no other data available satisfying criteria for inclusion to the National Register of Historic Places.

2. Hanapepe Shrine

Although this site is also mentioned in traditional Hawaiian legendary accounts, no physical evidence for the site was found during archaeological surveys and historic research (Ahlo and Hommon 1981; Bath 1985). Bath (ibid: 6) infers that the shrine may have been situated atop the escarpment north of the Hawaiian-Chinese cemetery, among several locational alternatives. This area had been extensively modified during historic times through buldozing and/or chain dragging. Virtually no sediment, aside from a thin O-horizon, is present for several meters north of the escarpment edge. A few indigeneous basalt artifacts were recovered in this area, however, which may have once been associated with the shrine. Property 4 (described below) also may have been functionally related to this site.

3. Shinto Temple ruins and cemetery

This site is situated well outside the proposed flood control project and will not be adversely affected. It consists of a torii which may be of sufficient

importance to satisfy criteria for placement on the National Register. This may be the last visible remnant of a largely ethnic Japanese plantation camp established in the area probably during the 1st quarter of the 20th Century (Ahlo and Hommon, 1981). No other surveys have been performed in the Laie area, however, in order to identify historic remains from this era so this determination is tentative. The associated "cemetery" includes graves with headstones bearing predominantly Japanese surnames now incorporated into the large Laie Cemetery.

4. Smaller cemetery and associated homestead ruins

No evidence for an associated homestead ruin(s) was identifed in this area during intensive archaeological investigations (Bath, 1985). The "smaller cemetery" was also identified as being composed of two segments--a probable ethnic Chinese portion in active use today, and a probable ethnic Hawaiian one in use for a considerable period of time. An area measuring approximately 10-32 meters long (north-south) by 15-46 meters wide (east-west) includes the cemeteries and intact prehistoric cultural deposit (A.D. 1400-1600's). This deposit may be eligible for the National Register as an isolated remnant of the prehistoric use of the Laie area. Much more extensive and dense deposits exist at nearby Malaekahana Beach Park, however, and other similar deposits may be present elsewhere in the Laie area but no systematic archaeological surveys have been performed.

In order to verify these suggestions, a Corps of Engineers representative and a member of your staff can field-visit the proposed Kahawainui Stream flood control project area at your convenience. Our staff will also closely coordinate mitigative measures with the historic site office prior to construction so as to ensure that no adverse effect to historic properties is perpetrated. Construction for this project is not anticipated to begin until summer 1987, at the soonest.

INSTREAM USE PROTECTION

We have contacted the local sponsoring agency, the City and County of Honolulu, Department of Public Works, about the need for obtaining a Stream Channel Alteration Permit from the State of Hawaii.

Sincerely,

Kisuk Cheung
Chief, Engineering Division

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES
EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN

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WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

April 3, 1986

Mr. Kisuk Cheung, Chief
Engineering Division
Army Engineering District, Honolulu
Department of the Army
Fort Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

SUBJECT: Request for Staff Field Inspection
Kahawainui Stream Flood Control Project
Laie, Koolauloa, Oahu
TMK: 5-5-05, 07, 08, 09:various

Thank you for your letter of February 13, 1986, expressing your agency's comments on the cultural resources located within the project area and their eligibility for listing on the National Register of Historic Places.

We do concur with your suggestion of having a field inspection of the cultural resources to verify your comments regarding their eligibility and also assess any proposed mitigative measures. Please be advised that Wendell Kam, staff archaeologist, will be contacting members of your staff to coordinate the field inspection.

Sincerely,

SUSUMU ONO
Chairperson and State Historic
Preservation Officer

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES

EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN

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- STATE PARKS
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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF STATE PARKS
P. O. BOX 621
HONOLULU, HAWAII 96809

June 5, 1986

Mr. Kisuk Cheung, Chief
Engineering Division
Army Engineering District, Honolulu
Department of the Army
Fort Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

SUBJECT: Staff Field Inspection Report
Kahawainui Stream Flood Control Project
Laie, Koolauloa, Oahu
TMK: 5-5-05, 07, 08, 09:various

On April 17, 1986, Mr. Wendell Kam, Staff Archaeologist and Mr. Charles Streck, Archaeologist with your agency, conducted a field inspection of the project area. The purpose of the inspection was to determine if the subject project will have any impact to the known cultural resources.

The field inspection resulted in our determination that the project will not impact any of the known cultural resources, specifically, the concrete torii and the plantation camp cemetery. Further, it does not appear that these two features qualify for inclusion on the National Register of Historic Places.

We do recommend that in the event that any previously unidentified sites or remains such as artifacts, shell, bone, or charcoal deposits, human burials, rock or coral alignments, pavings, or walls are encountered during the course of any construction activity, please stop work and contact our office at 548-7460, immediately. Work in the immediate area should be stopped until our office is able to assess the impact and make further recommendations for mitigative activity, if warranted.

Sincerely yours,

RALSTON H. NAGATA
State Parks Administrator

C. Streck
1f/3-2264

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858

June 27, 1986

REPLY TO
ATTENTION OF:

Maragos
PDOED-PV

Dr. Robert Fink
Chief, Western Division of Project Review
Advisory Council on Historic Preservations
730 Simms Street, Room 450
Golden, Colorado 80401

Pelowski
PODED-P

Dear Dr. Fink:

FUJII
PODED-Z

Thank you for your review responses dated 31 January 1986 on the Final Detailed Project Report and Environmental Impact Statement for the Kahawainui Stream Flood Control Study, Laie, Island of Oahu, Hawaii. As you have recommended, we have initiated and completed consultation pursuant to Section 106 of the National Historic Preservation Act with the Hawaii State Historic Preservation Officer (H.P.O) (Encl 1, 2, 3 and 4). The Corps of Engineers and the Hawaii H.P.O agree that no adverse effect will be incurred by this proposed project to any properties listed in or eligible for inclusion to the National Register of Historic Places. We would at this time, like the further concurrence on this matter by the Advisory Council on Historic Preservation.

Cheung
PODED

M & R

Thank you for your recommendation on disclosure of site location maps in accordance with 32CFR229 Section 18 and for your actions on the above matter.

PODED-PV
Files

If you have any further questions, please contact Mr. Chuck Streck, Archaeologist, at (808) 438-2264.

Sincerely,

Kisuk Cheung
Chief, Engineering Division

Enclosures

Hr. cert

871862

JOHN WAIHEE
GOVERNOR OF HAWAII

DISTRICT OFFICES

WEST HAWAII OFFICE
P. O. BOX 125
KAMUELA, HAWAII 96743

EAST HAWAII OFFICE
160 BAKER STREET
HILO, HAWAII 96720

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STATE OF HAWAII
DEPARTMENT OF HAWAIIAN HOME LANDS
P. O. BOX 1879
HONOLULU, HAWAII 96805

DISTRICT OFFICES

MAUI OFFICE
P. O. BOX 22
KAHULUI, MAUI 96732

MOLOKAI OFFICE
P. O. BOX 198
HOOLEHUA, MOLOKAI 96729

KAUAI OFFICE
P. O. BOX 332
LIHUE, KAUAI 96766

April 2, 1987

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Dr. John D. Lewin
Office of Environmental Quality Control
456 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Lewin:

Thank you for the opportunity to comment on the Environmental Impact Statement for Kahawainui Stream Flood Control.

The trust lands of the Hawaiian Homes Commission are not affected by this proposal. The Department of Hawaiian Home Lands has no comment.

Sincerely,

Ilima A. Piianaia, Chairman
Hawaiian Homes Commission

IAP:RF:CI:eh

cc: City and County Department of Land Utilization
Alfred Thiede, Director & Chief Engineer,
City and County Department of Public Works

John Waihee
GOVERNOR OF HAWAII

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STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

John C. Lewin, M.D.
DIRECTOR OF HEALTH

87-1695
ENV-ec
ENGR

In reply, please refer to:
EPHSD

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TO

March 19, 1987

MEMORANDUM

To: Director
Office of Environmental Quality Control

From: Director of Health

Subject: Kahawainui Stream Flood Control, Laie, Oahu

Thank you for allowing us to review and comment on the subject draft EIS. We provide the following comments:

Water Pollution

The EIS for the proposed activity (Alternative 2, selected) should include or address the following:

1. The work activity shall be conducted according to good engineering management practices that will provide reasonable assurance that the applicable Water Quality Standards will not be violated.

2. The City and County shall insure that the material to be placed shall be free of waste metal products, organic material, unsightly debris and any pollutants at toxic concentrations to aquatic life.

3. The draft EIS (page A-8) indicates that 12,000 cy of material will be placed from the existing quarries. On page F-2 (Item No. 3), the draft EIS indicates that during World War II, refuse from an Army training camp was dumped in the area and the City and County continued to use the dump site. It is recommended that refuse material of this type, if uncovered at the quarries, should not be used as the placement material.

4. The City and County should apply for a 401 Water Quality Certification if one is required in conjunction with obtaining a federal permit or license.

Noise

Concerns toward this proposed project, regarding construction noise impact and regulatory provisions, were addressed in our previous comments to the EIS Preparation Notice (October 27, 1986). While the Draft EIS has indicated an increase in noise during the construction phase of the project, mitigative measures or provisions for compliance with regulations are not included. These concerns must be addressed in the final EIS.

JOHN C. LEWIN, M.D.

cc: Mr. Alfred J. Thiede

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

FRANK F. FASI
MAYOR

ALFRED J. THIEDE
DIRECTOR AND CHIEF ENGINEER

12-0176

May 26, 1987

Dr. John C. Lewin, M.D.
Director of Health
State of Hawaii
P.O. Box 3378
Honolulu, Hawaii 96801

Dear Dr. Lewin:

Subject: Your Letter EPHSD Dated March 19, 1987 Relating to the Draft Environmental Impact Statement (DEIS) for the Kahawainui Stream Flood Control Project, Laie, Oahu

Thank you for your comments on the DEIS for the Kahawainui Stream Flood Control Project.

We offer the following responses to your comments:

1. This is a cooperative project between the U.S. Army Corps of Engineers and the City and County of Honolulu. The Corps of Engineers is the lead agency for this project and will be responsible for the design and preparation of the construction plans and administration of the construction contract.

2. To assure that the applicable Water Quality Standards will not be violated, the following mitigative measures will be incorporated.

   A. Construction activities will take place during periods of low stream flow insofar as it is practical.

   B. All construction activities within and adjacent to the water will be conducted with care so as to minimize gross turbidity and control erosion.

   C. The construction specification will require that the Contractor shall submit an environmental protection plan to comply with all Federal, State and Local Laws, Regulations and Permits including the applicable Water Quality Standards.

3. The Corps construction specification will require that all fill and backfill material comply with the American Society for Testing and Materials (ASTM) standards. Extreme care will be taken to insure that the fill material shall be free of any waste metal products, organic material, unsightly debris and any pollutants at toxic concentrations to aquatic life.

4. The fill material needed for this project will be obtained from approved quarries and/or approved borrow sites. The fill material will need to meet ASTM standards.

   The abandoned dump site used by the Army and City will not be affected by the project. Material from the dump site is not acceptable and will not be used for fill or backfill material for the project.

5. The Corps of Engineers, the lead agency for this project, has submitted an application for a 401 Water Quality Certification by letter dated March 19, 1987.

6. The concerns regarding construction noise impact and regulatory provisions including the mitigative measures or provisions regarding compliance with the regulations will be included in the final EIS. As we indicated in our earlier response, compliance with State noise control provisions and other construction control regulations will be specified in the Corps of Engineers construction specifications, which are legally binding upon the Contractor.

Very truly yours,

for Norman H. Lichtig
ALFRED J. THIEDE
Director and Chief Engineer

WY:CPC:smi

cc: OEQC
DLU
Army Corps of Engineers
bcc: Environmental Engineer

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

LIBERT K. LANDGRAF
DEPUTY

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

APR 7 1986

DOC. NO.: 2856B
FILE NO.: 87-79

Dr. John C. Lewin, Director
Office of Environmental Quality Control
465 So. King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Lewin:

SUBJECT: Draft Environmental Impact Statement (EIS) - Kahawainui Flood Control Project - Section 106 Compliance, National Historic Preservation Act
Laie, Koolauloa, Oahu
TMK: 5-5-09

Thank you for the opportunity to review the draft EIS cited above. We offer the following comments:

Aquatic Resources Concerns

Since the project is identical to that addressed in the Corps Final Detailed Project Report and EIS, the following comments (dated January 13, 1986) remain applicable:

> From an aquatic resources standpoint, we have no objection to the Corps' selection of Alternative Plan 2 (levee along the right banks of the upper portions of Laiewai and Kahawainui Streams, and the realignment and channelization of the lower portion of Kahawainui Stream). Biological studies conducted in the subject area by the U.S. Fish and Wildlife Service revealed low diversity of stream/estuarine macrofauna, probably due to low water quality (high ammonia concentrations) in the Kahawainui Stream from agricultural activities. The mitigating measures addressed in the Final EIS should minimize adverse impacts to biological resources.

Historic Sites Concerns

On May 5, 1985, our office wrote a letter regarding a Final EIS for this project to Mr. Kisuk Cheung of the Corps of Engineers, concurring with their determination of "no effect" to significant historic sites, providing that the alternative selected was Alternative 2.

Assuming this is the same project, we still believe there will be "no effect" to significant historic sites.

Recreation Concerns

A small portion of the subject project area makai of Kamehameha Highway adjoins Malaekahana State Park, but no significant impact on the park is anticipated.

Water and Land Development Concerns

The draft EIS addresses the existing stream and wetland environment, aquatic species and habitat, and the recreational use of the streams involved. Anticipated impacts and mitigation measures are addressed.

The proposing agency has notified the Department that they will be submitting an application for a stream channel alteration permit to the Department of Land and Natural Resources in order to fully comply with HRS Chapter 176D, the Hawaii Instream Use Protection Act.

Thank you for your consideration of our concerns.

Very truly yours,

WILLIAM W. PATY, Chairperson
Board of Land and Natural Resources
State Historic Preservation Officer

cc: Hon. Alfred J. Thiede

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

FRANK F. FASI
MAYOR

ALFRED J. THIEDE
DIRECTOR AND CHIEF ENGINEER

12-0179

May 26, 1987

Mr. William W. Paty, Chairperson
Board of Land and Natural Resources
State Historic Preservation Officer
Department of Land and Natural Resources
State of Hawaii
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Paty:

Subject: Your Letter Doc. No. 2857B, File No. 87-79 Dated April 7, 1987 Relating to the Draft Environmental Impact Statement (DEIS) for the Kahawainui Stream Flood Control Project, Laie, Oahu

Thank you for your comments on the DEIS for the Kahawainui Stream Flood Control Project.

As indicated, this project is identical to the project that was addressed by the U.S. Army Corps of Engineers in their Final Detailed Project Report and Environmental Impact Statement. Alternative 2 is still the recommended plan of improvement.

The City will be submitting an application for a stream channel alteration permit in order to comply with HRS Chapter 176D, the Hawaii Instream Use Protection Act.

Very truly yours,

for Kenneth H. Ching
ALFRED J. THIEDE
Director and Chief Engineer

WY:CPC:smi

cc: OEQC
DLU
Army Corps of Engineers
bcc: Environmental Engineer

871873

DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT

KAMAMALU BUILDING, 250 SOUTH KING ST., HONOLULU, HAWAII
MAILING ADDRESS: P.O. BOX 2359, HONOLULU, HAWAII 96804 • TELEX: 7430250 HIDPED

JOHN WAIHEE
GOVERNOR
ROGER A. ULVELING
DIRECTOR
MURRAY E. TOWILL
DEPUTY DIRECTOR
BARBARA KIM STANTON
DEPUTY DIRECTOR

DIVISIONS
BUSINESS AND INDUSTRY DEVELOPMENT DIVISION
ENERGY DIVISION
335 Merchant St. Room 110 Honolulu, Hawaii 96813
FOREIGN-TRADE ZONE DIVISION
Pier 2, Honolulu, Hawaii 96813
LAND USE DIVISION
PLANNING DIVISION
RESEARCH AND ECONOMIC ANALYSIS DIVISION

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Ref. No. P-6209

April 1, 1987

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MEMORANDUM

TO: The Honorable John C. Lewin, Director
Department of Health

FROM: Roger A. Ulveling

SUBJECT: DEIS for Kahawainui Stream Flood Control, Laie, Oahu

We have reviewed the subject draft environmental impact statement (DEIS) and find that the DEIS has not discussed the consistency of the proposed project to the Hawaii State Plan as requested in our letter of November 14, 1986, on the preparation notice.

Thank you for the opportunity to review the subject document.

Murray E. Towill
for Director

cc: Office of Environmental Quality Control
Mr. Alfred J. Thiede, Director and Chief Engineer
Department of Public Works, City and County of Honolulu

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

FRANK F. FASI
MAYOR

ALFRED J. THIEDE
DIRECTOR AND CHIEF ENGINEER

12-0180

May 27, 1987

Mr. Roger A. Ulveling, Director
Department of Planning
and Economic Development
State of Hawaii
P.O. Box 2359
Honolulu, Hawaii 96804

Dear Mr. Ulveling:

Subject: Your Letter Ref. No. P-6209 Dated April 1, 1987 Relating to the Draft Environmental Impact Statement (DEIS) for the Kahawainui Stream Flood Control Project, Laie, Oahu

Thank you for your comments on the DEIS for the Kahawainui Stream Flood Control project.

Although the DEIS did not specifically discuss the consistency of the proposed project to the State Plans, many applicable items are discussed in the DEIS.

The final environmental impact statement will include a discussion on the consistency of the proposed project to Sections 226-11 through 226-13 of the Hawaii State Plan.

Very truly yours,

for ALFRED J. THIEDE
Director and Chief Engineer

WY:CPC:smi

cc: OEQC
DLU
Army Corps of Engineers
bcc: Environmental Engineer

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March 25, 1987

RECEIVED
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TO

Dr. John C. Lewin
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Lewin:

Draft EIS - Kahawainui Stream Flood Control Project
Laie, Oahu

We have no additional comments beyond those submitted earlier during the EIS Preparation Notice stage. These earlier comments have been reproduced and are presented under Section XI of the subject draft EIS.

Thank you for this opportunity to provide comments.

Very truly yours,

Edward Y. Hirata
Director of Transportation

DT:ko

cc: HWY, STP(dt)
Alfred Thiede, DPW

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University of Hawaii at Manoa

ENV 4
4/9/87 ENGR

Environmental Center
Crawford 317 • 2550 Campus Road
Honolulu, Hawaii 96822
Telephone (808) 948-7361

April 6, 1987

RE:0463

RECEIVED
DEPT OF PUBLIC WORKS
APR 8 3 20 PM '87
TO

Dr. John C. Lewin
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Mr. John P. Whalen
Director
Department of Land Utilization
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Gentlemen:

Draft Environmental Impact Statement
Kahawainui Stream Flood Control
Laie, Oahu

The above cited document discusses four alternatives to alleviate flood damage in Laie, Oahu. The alternatives range from building channels and levees, to flood proofing individual properties. The second alternative, which intends to use a combination of levees and a channel, is the project recommended in the Draft EIS. It will provide for a Standard Project Flood (SPF) level of protection which is approximately equal to a 285-year flood event. This review was prepared with the assistance of Sheila Conant, General Science; Yu-Si Fok, Civil Engineering; Michael Graves, Anthropology; Pamela Bahnsen and Steven Armann, Environmental Center.

It is our understanding that Federal NEPA EIS requirements were met with the 1985 EIS and that the current EIS is intended to satisfy State EIS requirements under Chapter 343, HRS.

Design

With respect to the various amounts of debris in Kahawainui Stream, we note (p. 13, Table 4) that the estimated carrying capacities in cubic feet per second (cfs) under three channel conditions are provided. Similiar information would be useful regarding the four proposed flood control alternatives. An assessment of the four alternatives and their carrying

AN EQUAL OPPORTUNITY EMPLOYER
A Unit of Water Resources Research Center

capacities in cfs would be helpful in evaluating the adequacy of each alternative.

Relocation of Existing Structures

Whose responsibility will it be to relocate the various existing structures? We note (Figure 4) that these structures are to be relocated by "others".

Wetlands

We believe that the proposed project will not significantly impact wetland wildlife habitat in the area. Other ponds exist in the locality which provide a generally higher quality habitat for wetland wildlife.

Archaeology

It appears that the proposed locations of Alternatives 1, 2, and 3 will not significantly impact known historical resources. We do note, however, that the Department of Public Works will be responsible for initiating any further archaeological surveys that may prove to be necessary depending on the chosen Alternative and will also monitor indirect impacts once the project begins. We note, in particular, that should Alternative 2 be selected "construction would be monitored by professional archaeologists" and that "the alignment of Plan 4 has not yet been investigated by archaeologists" but would be investigated "in the post-approval stage of planning" should this plan be selected (p. 30). If Plan 4 is selected, further archaeological studies should then be immediately initiated.

We appreciate the opportunity to comment on this Draft EIS and hope you will find our comments useful in the preparation of the final document.

Yours truly,

Jacquelin N. Miller

Jacquelin N. Miller
Acting Associate
Environmental Coordinator

cc: Alfred J. Thiede
Stephen Lau
Sheila Conant
Yu-Si Fok
Michael Graves
Pamela Bahnsen
Steven Armann

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

FRANK F. FASI
MAYOR

ALFRED J. THIEDE
DIRECTOR AND CHIEF ENGINEER

12-0173

May 27, 1987

Ms. Jacquelin N. Miller
Acting Associate Environmental Coordinator
Environmental Center
University of Hawaii at Manoa
Crawford 317
2550 Campus Road
Honolulu, Hawaii 96822

Dear Ms. Miller:

Subject: Your Letter RE:0463 Dated April 6, 1987 Relating to the Draft Environmental Impact Statement (DEIS) for the Kahawainui Stream Flood Control Project, Laie, Oahu

Thank you for your comments on the DEIS for the Kahawainui Stream Flood Control project.

We offer the following responses to your comments:

The Federal NEPA environmental impact statement (EIS) requirements were met in 1985 with the preparation of the Final Detailed Project Report and Environmental Impact Statement by the U.S. Army Corps of Engineers. This EIS is intended to satisfy State EIS requirements under Chapter 343, HRS. There have been no changes in the scope of the project since NEPA requirements were met by the Corps Final EIS in 1985.

The carrying capacity in cubic feet per second (CFS) of Alternatives 1, 2 and 4 will be the design discharge for the Standard Project Flood (SPF) or approximately for a 285-year flood event. The project under Alternatives 1, 2 and 4 will be designed to provide for a 285-year level of protection which is approximately 18,500 CFS. A maintenance program will be established to maintain the designed level of protection.

Alternative 3 is a nonstructural alternative which provides for floodproofing individual structures; relocating or replacing structures which cannot be economically floodproofed; providing a ringwall; incorporating a floodplain management plan; and providing a flood warning system. Under this Alternative, a regular maintenance and inspection program will be adopted to maintain the carrying capacity of the existing channels.

As the local sponsor for the project, the City and County is responsible for the acquisition of the land rights and relocation of existing improvements. We plan to negotiate and have the property owners relocate or salvage the existing structures.

The U.S. Army Corps of Engineers is the lead agency for this project and will be responsible for initiating further archaeological surveys. The Corps has indicated that the construction specifications would require the archaeological monitoring of any construction excavation activities in the sand dune area downstream of Kamehameha Highway, and in the vicinity of the historic cemeteries, and along the excavated channel upstream of the historic cemeteries.

Alternative 2 is the recommended plan of improvements since it maximizes net benefits and displays no significant, adverse, or unmitigative environmental impacts. The selection of Alternative 4 would require the initiation of further archaeological studies. However, the implementation of Alternative 4 is highly unlikely because of the low benefit to cost ratio of 0.8 and it is the most environmentally adverse, because it would destroy the existing wetland area and the Hawaiian grave sites.

Very truly yours,

for ALFRED J. THIEDE
Director and Chief Engineer

WY:CPC:smi

cc: OEQC
DLU
Army Corps of Engineers
bcc: Environmental Engineer

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University of Hawaii at Manoa

Water Resources Research Center
Holmes Hall 283 • 2540 Dole Street
Honolulu, Hawaii 96822

17 March 1987

Dr. John C. Lewin
Office of Environmental
Quality Control
465 S. King St., Rm. 104
Honolulu, HI 96813

Mr. John P. Whalen, Director
Dept. of Land Utilization
City and County of Honolulu
650 S. King Street
Honolulu, HI 96813

Gentlemen:

Subject: Draft Environmental Impact Statement for the Kahawainui Stream Flood Control, Laie, Oahu, Hawaii

We have reviewed the subject DEIS and offer the following comments. Please indicate:

1. The acreage of wetland to be altered.

2. The design 285 yrs flood discharge in cfs.

3. How much state funds is involved.

Thank you for the opportunity to comment. This material was reviewed by WRRC personnel.

Sincerely,

Edwin T. Murabayashi

Edwin T. Murabayashi
EIS Coordinator

ETM:jm

cc: A.J. Thiede, DPW, C&C of Honolulu

AN EQUAL OPPORTUNITY EMPLOYER

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

FRANK F. FASI
MAYOR

ALFRED J. THIEDE
DIRECTOR AND CHIEF ENGINEER

12-0181

May 28, 1987

Mr. Edwin T. Murabayashi
EIS Coordinator
Water Resources Research Center
University of Hawaii at Manoa
Holmes Hall 283
2540 Dole Street
Honolulu, Hawaii 96822

Dear Mr. Murabayashi:

Subject: Your Letter Dated March 17, 1987 Relating to the Draft Environmental Impact Statement (DEIS) for the Kahawainui Stream Flood Control Project, Laie, Oahu

Thank you for your comments on the DEIS for the Kahawainui Stream Flood Control project.

We offer the following responses to your comments:

1. Under the recommended plan, Alternative 2, approximately 2 acres of wetland or 10 percent of the total wetland acreage at the project area will be affected. This is discussed under Section V.C.1 "Wetlands" page 29, paragraph 3 and under Table 10 "Summary Comparison of Alternative Plans and System of Accounts" page 46 Section C.1.e.

2. The 285-year or Standard Project Flood (SPF) design discharge value at the confluence of La'ie Wai and Kahawainui Streams is 18,500 cfs. This information will also be included in the EIS.

3. State funds have not been appropriated for this project. However, State lands under the Kamehameha Highway bridge right-of-way will be affected.

Very truly yours,

ALFRED J. THIEDE
Director and Chief Engineer

WY:CPC:smi

cc: OEQC
DLU
Army Corps of Engineers
bcc: Environmental Engineer

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

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March 13, 1987

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TO

Dr. John C. Lewin
Office of Environment Quality
Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Lewin:

Subject: Draft Environmental Impact Statement for Kahawainui Stream Flood Control, TMK: 5-5-09

Thank you for the opportunity to review the environmental document for the proposed improvements to Kahawainui Stream.

The project is not anticipated to have adverse impacts to ground water resources in the area.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Alfred J. Thiede, DPW

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March 16, 1987

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TO

Dr. John C. Lewin
Office of Environmental
Quality Control
465 S. King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Lewin:

Subject: Draft Environmental Impact Statement
Kahawainui Stream Flood Control
TMK: 5-5-9
Laie, Oahu, Hawaii

Thank you for the opportunity to review the draft Environmental Impact Statement for the Kahawainui Stream Flood Control project.

We have no comments on the documents.

Very truly yours,

Herbert K. Muraoka

HERBERT K. MURAOKA
Director and Building Superintendent

TH:jo
cc: J. Harada
Public Works Dept.

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813
PHONE 523-4161

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TO _____

FRANK F. FASI
MAYOR

MIKE MOON
DIRECTOR

ROBERT MIYASATO
DEPUTY DIRECTOR

ENV 04
4/8 ENGR

April 2, 1987

Dr. John C. Lewin
Office of Environmental Quality
Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Lewin:

Subject: EIS - Kahawainui Stream Flood Control

Thank you for the opportunity to review and comment on the EIS report for the Kahawainui Stream Flood Control project in Laie, Oahu.

We have no objections to your recommended flood control measures of channel improvements at Kahawainui Stream. Approximately 12 damaging floods have occurred in the Laie area since 1879. The overbank flooding problem on Kahawainui Stream is attributed to its inadequate channel capacity and is probably compounded by the accumulation of vegetation and debris in the stream channel and mouth. The recommended improvements will resolve all the problems.

Sincerely,

MIKE MOON
Director

87-1729

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DEPARTMENT OF GENERAL PLANNING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

DONALD A. CLEGG
CHIEF PLANNING OFFICER

GENE CONNELL
DEPUTY CHIEF PLANNING OFFICER

WM/DGP 3/87-798

March 27, 1987

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Dr. John C. Lewin, Director
Office of Environmental Quality Control
State of Hawaii
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Lewin:

Kahawainui Stream Flood Control Project
Draft Environmental Impact Statement (DEIS)

The Department of General Planning has reviewed the subject project and offers the following comments:

1. The project requires an amendment to the Development Plan Public Facilities Map. A request for such an amendment is currently being processed as a part of the FY 1986-87 Development Plan Annual Amendment Review (amendment number 86/KL-1001).

2. According to Figure F-4: Archaeology Site Locations, grading in the area adjacent to the north level would have a direct impact on the Chinese cemetery and the "prehistoric cultural deposit."

   This is in apparent conflict to the text of Appendix F: Cultural and Social Resources which states on page F-8 that "[all] . . . grading shall be oriented south, towards Kahawainui Stream, of these sites."

   In addition, the locations of the Chinese and Hawaiian grave sites as indicated in Figures 8 and 9 in the main body of the DEIS are inconsistent with the findings of the archaeological report contained in Appendix F (see Figures F-2 and F-4).

Thank you for the opportunity to review this document. Should you have any questions, please contact Bill Medeiros of my staff at 523-4485.

Sincerely,

Donald Clegg

DONALD A. CLEGG
Chief Planning Officer

cc: Alfred J. Thiede, Director and Chief Engineer
Department of Public Works

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

FRANK F. FASI
MAYOR

ALFRED J. THIEDE
DIRECTOR AND CHIEF ENGINEER

12-0174

May 27, 1987

MEMORANDUM

TO: MR. DONALD A. CLEGG, CHIEF PLANNING OFFICER
DEPARTMENT OF GENERAL PLANNING

FROM: ALFRED J. THIEDE, DIRECTOR AND CHIEF ENGINEER
DEPARTMENT OF PUBLIC WORKS

SUBJECT: YOUR LETTER WM/DGP 3/87-798 DATED MARCH 27, 1987 TO DR. JOHN C. LEWIN RELATING TO THE KAHAWAINUI STREAM FLOOD CONTROL PROJECT DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

Thank you for your comments on the DEIS for the Kahawainui Stream Flood Control Project.

We offer the following responses to your comments:

The text in Appendix F, on page F-8 "[all]...grading shall be oriented south, towards Kahawainui Stream, of these sites." is correct. Figure F-4 will be revised to show the correct extent of grading work to be done. It was always the intent of the project to avoid any significant adverse impacts to existing archaeological sites.

Figures 8 and 9 in the main body of the DEIS will also be revised to show the correct locations of the Chinese and Hawaiian grave sites in the final EIS to be consistent with the findings of the archaeological report.

for Norman H. Libby
ALFRED J. THIEDE
Director and Chief Engineer

WY:CPC:smi

cc: OEQC
DLU
Army Corps of Engineers
bcc: Environmental Engineer

DEPARTMENT OF LAND UTILIZATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813 • (808) 523-4432

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FRANK F. FASI
MAYOR

ENV
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JOHN P. WHALEN
DIRECTOR

87/SMA-24(BWM)
87/SV-10

April 6, 1987

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TO

Director of Health
John C. Lewin, MD.
c/o Office of Environmental Quality Control
State of Hawaii
Kekuanaoa Building, Room 104
465 South King Street
Honolulu, Hawaii 96813

Dear Dr. Lewin:

Kahawainui Stream Flood Control
Draft Environmental Impact Statement (DEIS)
Laie, Oahu--Tax Map Key 5-5-09

We have reviewed the DEIS and have the following comments to make:

1. A Shoreline Setback Variance (SSV) may be required if portions of the project occur within the 40-foot shoreline setback. This should be noted in Table 1, "Statutes, Permits, Approvals, and Other Environmental Requirements."

   A certified shoreline survey will be required as part of the SSV application.

2. The extent of participation in the funding of the project by Zion Securities Corporation should be specified in more detail.

If you have any questions, please contact Bennett Mark of our staff at 527-5038.

Very truly yours,

for Loretta Chee

JOHN P. WHALEN
Director of Land Utilization

JPW:sl
0875B

cc: Mr. Alfred Thiede, DPW

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

FRANK F. FASI
MAYOR

ALFRED J. THIEDE
DIRECTOR AND CHIEF ENGINEER

12-0183

May 28, 1987

MEMORANDUM

TO: MR. JOHN P. WHALEN, DIRECTOR
DEPARTMENT OF LAND UTILIZATION

FROM: ALFRED J. THIEDE, DIRECTOR AND CHIEF ENGINEER
DEPARTMENT OF PUBLIC WORKS

SUBJECT: YOUR LETTER 87/SMA-24(BWM) 87/SV-10 DATED APRIL 6, 1987 TO DR. JOHN C. LEWIN RELATING TO THE KAHAWAINUI STREAM FLOOD CONTROL PROJECT DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS), LAIE, OAHU

Thank you for your comments on the DEIS for the Kahawainui Stream Flood Control Project.

We offer the following responses to your comments:

1. The permitting of the Shoreline Setback Variance (SSV) will be included in Table 1, "Statutes, Permits, Approvals, and Other Environmental Requirements."

   A request for a Shoreline Setback Variance will be made if portions of the project intrude into the 40-foot shoreline setback area. A shoreline certification survey is being conducted to determine whether the project is within the 40-foot shoreline setback area.

2. Zions Securities Corporation will be dedicating all of the easements and land rights required for the project. In addition, a disposal site for the disposal of the vegetation and unsuitable materials, and a borrow site to provide suitable fill and backfill material will be provided for the project. This will also be noted in the final environmental impact statement.

for Vernon H. Lehman
ALFRED J. THIEDE
Director and Chief Engineer

WY:CPC:smi

cc: OEQC
Army Corps of Engineers
bcc: Environmental Engineer

DEPARTMENT OF PARKS AND RECREATION

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

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FRANK F. FASI
MAYOR

ENVCU
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HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

April 6, 1987

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TO

Dr. John C. Lewin
Office of Environmental Quality Control
State of Hawaii
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Lewin:

Subject: Kahawainui Street Flood Control - Laie, Oahu, Hawaii

The future 17-acre Poohaili Street park will be situated near Station 38-62 of the proposed flood control levee. This levee will not protect the park from periodic flooding from an overflowing Laiewai Stream so the park will have to be designed with this in mind.

The park area will still lie within a 100-year floodplain area and future construction will have to be coordinated with the Department of Public Works to insure that the future comfort station and recreation building will be protected from possible flood damage.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:ei

cc: Dept. of Land Utilization
Dept. of Public Works

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

FRANK F. FASI
MAYOR

ALFRED J. THIEDE
DIRECTOR AND CHIEF ENGINEER

12-0182

May 28, 1987

MEMORANDUM

TO: MR. HIRAM KAMAKA, DIRECTOR
DEPARTMENT OF PARKS AND RECREATION

FROM: ALFRED J. THIEDE, DIRECTOR AND CHIEF ENGINEER
DEPARTMENT OF PUBLIC WORKS

SUBJECT: YOUR LETTER DATED APRIL 6, 1987 RELATING TO THE DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS) FOR THE KAHAWAINUI STREAM FLOOD CONTROL PROJECT, LAIE, OAHU

Thank you for your comments on the DEIS for the Kahawainui Stream Flood Control project.

As indicated, the future 17-acre Poohaili Street park will be situated on the west side of the proposed levee alignment and will therefore be within the floodplain area. The proposed levee will not provide protection against flooding to the future park area. For that reason, any proposed park facilities should be designed with the knowledge that the area could be periodically inundated.

We recommend that the proposed comfort station and recreation building be constructed within the protected area.

for ALFRED J. THIEDE
Director and Chief Engineer

WX:CPC:smi

cc: OEQC
DLU
Army Corps of Engineers
bcc: Environmental Engineer

871674

DEPARTMENT OF TRANSPORTATION SERVICES

CITY AND COUNTY OF HONOLULU

HONOLULU MUNICIPAL BUILDING
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

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FRANK F. FASI
MAYOR

TO _____

JOHN E. HIRTEN
DIRECTOR

JOSEPH M. MAGALDI, JR.
DEPUTY DIRECTOR

PL 1.0603
TE-1402

March 19, 1987

MEMORANDUM

TO: JOHN P. WHALEN, DIRECTOR
DEPARTMENT OF LAND UTILIZATION

FROM: JOHN E. HIRTEN, DIRECTOR

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT
KAHAWAINUI STREAM FLOOD CONTROL
LAIE, OAHU, HAWAII
TMK: 5-5-9

This is in response to the Office of Environmental Quality Control's letter dated March 6, 1987.

We have reviewed the subject document and have no comments to offer.

JOHN E. HIRTEN

cc: Dr. John C. Lewin
Department of Public Works

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FIRE DEPARTMENT

CITY AND COUNTY OF HONOLULU

1455 S. BERETANIA STREET, ROOM 305
HONOLULU, HAWAII 96814

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FRANK F. FASI
MAYOR

FRANK K. KAHOOHANOHANO
FIRE CHIEF

LIONEL E. CAMARA
DEPUTY FIRE CHIEF

April 14, 1987

Dr. John C. Lewin
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813
and
Mr. John P. Whalen, Director
Department of Land Utilization
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

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Dear Dr. Lewin and Mr. Whalen:

Subject: Environmental Impact Statement
Kahawainui Stream Flood Control
Laie, Oahu

We have reviewed the subject EIS and agree the project will enhance community safety for the area. The project will have a positive effect on existing fire protection facilities by reducing service calls for flooded conditions.

We apologize for the tardiness of our response and hope it has not caused any difficulties. Should you have any questions, please contact Battalion Chief Kenneth A. Word at 943-3838.

Very truly yours,

Frank K. Kahoohanohano

FRANK K. KAHOOHANOHANO
Fire Chief

FKK:KAW:lm

cc: Mr. Alfred J. Thiede, Department of Public Works
City and County of Honolulu

871499

POLICE DEPARTMENT

CITY AND COUNTY OF HONOLULU

1455 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96814 · AREA CODE (808) 943-3111

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FRANK F. FASI
MAYOR

DOUGLAS G. GIBB
CHIEF

WARREN FERREIRA
DEPUTY CHIEF

ENGR

OUR REFERENCE DI-LK

March 13, 1987

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DEPT OF PUBLIC WORKS
MAR 17 11 37 AM '87

Dr. John C. Lewin
Office of Environmental
Quality Control
465 South King Street
Room 104
Honolulu, Hawaii 96813

Dear Dr. Lewin:

Subject: DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE KAHAWAINUI STREAM FLOOD CONTROL, LAIE, OAHU, HAWAII

We have reviewed the material on Kahawainui Stream flood control and do not have any objections to the proposed project.

Sincerely

DOUGLAS G. GIBB
Chief of Police

cc: Mr. Alfred J. Thiede

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TO _____

HEI

April 1, 1987

Brenner Munger, Ph.D., P.E.
Manager
Environmental Department
(808) 548-6880

Dr. John C. Lewin
Office of Environmental Quality Control
465 S. King Street, Room 104
Honolulu, HI 96813

Dear Dr. Lewin:

Subject: Draft Environmental Impact Statement (EIS) for the Kahawainui Stream Flood Control, Laie

We have reviewed the above EIS and have the following comments.

1. The proposed project will require the relocation of HECO facilities. The developer shall be responsible for coordinating all relocation work with HECO and for performing the actual work. In addition, the following notes shall be included as part of the final construction plans:

   * The Contractor is to exercise extreme caution when the excavation and construction crosses or is in close proximity of HECO lines and is to maintain 13'-0" clearance for his equipment while close to and/or under the overhead facilities.

   * When trench excavation is adjacent to or under existing structures or facilities, the Contractor is responsible for properly sheeting and bracing the excavation and stabilizing the existing ground to render it safe and secure from possible slides, cave-ins and settlement, and for properly supporting existing structures and facilities with beams, struts or underpinning to fully protect it from damage.

   * If field conditions and/or construction procedures require that poles be braced to facilitate construction, the Contractor shall contact the Koolau District Superintendent a minimum of 72 hours in advance at 262-5454 or 262-5043.

   * The Contractor shall be liable for any damage to HECO's facilities.

* The Contractor shall report any damage to HECO's facilities to the HECO trouble dispatch at 548-7961.

2. The proposed project will require the relocation of HECO electric distribution facilities in the area. This will include raising the height of several poles to maintain ground clearance requirements where our lines pass over the proposed project.

Sincerely,

Brenner Munger

cc: Mr. John P. Whalen, Director
Dept. of Land Utilization

Mr. Alfred J. Thiede,
Director and Chief Engineer
Dept. of Public Works

HEI

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

FRANK F. FASI
MAYOR

ALFRED J. THIEDE
DIRECTOR AND CHIEF ENGINEER

12-0177

May 27, 1987

Dr. Brenner Munger, Ph.D., P.E.
Manager
Environmental Department
Hawaiian Electric Company, Inc.
P.O. Box 2750
Honolulu, Hawaii 96840-0001

Dear Dr. Munger:

Subject: Your Letter ENV 2-1 JA/G Dated April 1, 1987 Relating to the Draft Environmental Impact Statement (DEIS) for the Kahawainui Stream Flood Control Project, Laie, Oahu

Thank you for your comments on the DEIS for the Kahawainui Stream Flood Control project.

Although the U.S. Army Corps of Engineers will be responsible for the preparation of the construction plans and administration of the construction contract, the City and County will be coordinating the review and relocation of HECO facilities with your Distribution Engineering Department.

Your letter was referred to the Corps of Engineers in order that the applicable notes may be incorporated in the construction plans.

Very truly yours,

for ALFRED J. THIEDE
Director and Chief Engineer

WY:CPC:smi

cc: OEQC
DLU
Army Corps of Engineers
bcc: Environmental Engineer

APPENDIX E

KAHAWAINUI STREAM
FLOOD DAMAGE REDUCTION STUDY

ECONOMIC EVALUATION

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GENERAL

Floodplain management, including flood control and prevention, can contribute to the National Economic Development (NED) objective by improving the net productivity of flood-prone land resources. This occurs by an increase in output of goods and services and/or by reducing the cost of using the land resources (improvements in economic efficiency). The benefit standard is the willingness of users (benefitting activities) to pay for each increment of output from a plan.

The two economic principles governing the selection of an alternative are economic justification and optimality. Project economic benefits should exceed project costs, and there should be no other alternative with greater net benefits (benefits less costs). Non-economic considerations, such as risks and uncertainty, may require deviation from these principles.

Estimated project benefits result from a reduction in damages to structures and their contents, elimination of emergency relief costs, and reduction in damages to roads and utilities. Estimated project costs are discussed in Appendix D. These costs include all goods and services used in project construction, operation and maintenance. Both costs and benefits are expressed in terms of estimated April 1985 price levels. Costs and benefits occurring at different times are converted to an average annual equivalent basis over the 50-year period of analysis for comparison using the Federal discount rate prescribed for water resource projects. This rate is currently set at 8-3/8%.

BENEFITS

Introduction

Benefits are the measured difference between conditions with and without a flood prevention plan. Damages to structures and contents are the primary source of major flood-associated costs, which can be assigned dollar values, in evaluating floodplain management plans for the Kahawainui Stream floodplain in Laie, Oahu, Hawaii. Benefits resulting from the alternatives considered include reduction of damages to structures and their contents, elimination of emergency relief costs, reduction in damages to public roads and utilities, elimination of the threat to human safety, and elimination of the aggravation that the damages and general nuisance of flooding bring.

Damageable Property Inventory

Almost all of the damage units in the Kahawainui Stream floodplain are residential. An inventory of flood-damageable property, conducted during 1982 and 1983, provided the information for development of a damage data base for use in evaluating damage reduction alternatives. There are 441 units in the floodplain, of which 434 are residential. The number of structures is about 10% less than the number of units, since there exist some multi-unit structures in the floodplain (e.g., two or more commercial establishments in the same building, or more than one dwelling unit in a residential structure). The

7 non-residential units consist of a school, a church, and some commercial establishments (a restaurant, a gas station, and some food stores). Approximately one half of the structures in the floodplain are of wood frame on post-and-beam construction, and the remainder are concrete masonry or wood frame on slab-on-grade. First floor elevation data for nearly all (87%) of the damageable units in the floodplain were collected in the field survey. Further analysis since this original survey confirms the reliability of this data. Content value data for residential properties are based on a recent study relating value of contents to value of structure for residential properties in Hilo, Hawaii. The character of the Laie, Oahu, properties is sufficiently similar to warrant the use of the Hilo data relationship findings. Market values of structures for all properties are based on data from the Hawaii State Department of Taxation. Tax record data reflects assessed value, which is converted to market value in the analysis. The calculations upon which this analysis is based initially were done in 1982 and 1983, using tax record data reflecting estimated price levels as of April 1981. Since that time, more recent data has become available which reflects estimated market values as of April 1984. (Eighteenth Edition, Published 1984, Real Estate Atlas of Hawaii, 1st Tax Division, City and County of Honolulu, Real Estate Handbook, Volume 5, Zones 5-8, by Real Estate Data, Inc.) This is the most recent readily available data. A complete review of over 80% of the properties in the floodplain in this updated data base shows that the estimated April 1984 market values of structures are 27% higher than they were according to the 1981 source. Since this feasibility study reflects constant dollar analysis in April 1985 price levels, adjustment from 1984 to 1985 is based on a general price level adjustment (using the consumer price index, April 1984 to April 1985) of 3.7%. This results in an increase of 32% (1.27 x 1.037 = 1.32). In this evaluation, the original data is shown, and it is then updated to reflect values in the more recent data base and April 1985 estimated price levels, using this update factor of 1.32. Table E-1 displays the inventory of properties in the Kahawainui Stream floodplain.

TABLE E-1

DAMAGEABLE PROPERTY INVENTORY

Use 1/	Stream Station Number 2/	Damage Code 3/	First Floor Elevation 4/	Building Type 5/	Assessed Value of Structure ($1,000's) 6/
R	1600	S	10.2	25	38.92
R	2000	S	14.0	10	13.85
R	1650	S	10.1	25	47.81
R	1600	S	13.6	10	13.12
R	1600	S	10.4	25	55.71
R	1600	S	13.5	10	13.12
R	1600	S	13.6	10	13.12
R	1650	S	10.5	10	10.96
R	1600	S	13.5	10	13.12
R	1650	S	10.8	10	10.96
R	1650	S	10.5	10	10.96
R	1700	S	7.7	25	34.98
R	1650	S	10.8	10	10.96
R	2150	S	20.6	15	19.21

NOTE: Refer to page E-11 for footnotes.

TABLE E-1 (CONT)

DAMAGEABLE PROPERTY INVENTORY

Use 1/	Stream Station Number 2/	Damage Code 3/	First Floor Elevation 4/	Building Type 5/	Assessed Value of Structure ($1,000's) 6/
R	1700	S	9.7	25	32.79
R	1800	S	11.4	10	26.61
R	1800	S	11.6	10	26.61
R	1750	S	9.6	25	18.67
R	1750	S	9.9	25	18.67
R	1700	S	12.0	10	18.60
R	1750	S	13.0	25	29.26
R	1750	S	14.1	25	29.26
R	2400	S	15.0	10	5.12
R	1000	S	7.5	25	16.32
R	500	S	9.6	15	31.98
R	500	S	9.6	15	24.42
R	500	S	11.8	10	24.42
R	500	S	10.3	25	35.95
R	1200	S	9.1	25	38.00
R	800	S	7.3	25	35.52
R	600	S	9.2	25	22.30
R	700	S	9.2	25	34.40
R	500	S	9.7	25	29.43
R	600	S	11.8	10	5.88
R	700	S	7.4	15	40.33
R	800	S	7.4	25	29.02
R	900	S	7.0	25	41.10
R	1000	S	7.7	25	34.68
R	1000	S	7.7	25	52.74
R	900	S	7.7	10	10.72
R	1000	S	7.0	25	35.90
R	1100	S	7.7	25	38.44
R	1100	S	7.6	25	39.85
R	1200	S	6.8	25	25.84
R	1200	S	7.5	25	27.24
R	1300	S	7.4	25	33.22
R	1300	S	7.3	15	25.97
R	1200	S	7.3	25	27.06
R	1200	S	7.3	25	27.06
R	1300	S	9.0	10	22.37
R	1200	S	7.4	15	20.58
R	1200	S	8.7	15	47.03
R	1100	S	7.6	25	16.32
R	1100	S	7.2	25	23.34
R	1200	S	7.5	25	16.32
R	1100	S	7.7	25	23.34
R	1100	S	7.6	25	16.32
R	1000	S	7.5	25	23.34

TABLE E-1 (CONT)

DAMAGEABLE PROPERTY INVENTORY

Use 1/	Stream Station Number 2/	Damage Code 3/	First Floor Elevation 4/	Building Type 5/	Assessed Value of Structure ($1,000's) 6/
R	1000	S	7.6	25	23.34
R	900	S	8.3	25	24.66
R	1200	S	8.5	15	38.52
R	500	S	10.7	25	48.26
R	700	S	8.9	25	34.38
R	900	S	7.8	25	16.32
R	1000	S	7.8	25	16.32
R	900	S	7.9	25	23.34
R	1000	S	7.8	25	16.32
R	900	S	8.0	25	23.34
R	900	S	7.8	25	16.32
R	800	S	7.7	25	23.34
R	800	S	7.8	25	23.34
R	800	S	8.5	25	16.32
R	700	S	8.6	25	23.34
R	800	S	8.1	25	16.32
R	800	S	8.1	25	23.34
R	700	S	8.8	25	41.85
R	700	S	9.4	25	25.47
R	600	S	9.8	25	29.43
R	400	S	9.8	25	24.42
R	500	S	10.7	25	21.14
R	600	S	10.1	25	25.21
R	700	S	9.4	25	41.34
R	600	S	10.3	25	25.47
R	600	S	10.1	25	25.21
R	500	S	10.7	25	21.14
R	400	S	7.4	25	28.06
R	400	S	9.5	25	28.06
R	500	S	9.6	25	21.42
R	500	S	9.6	25	21.42
R	400	S	9.6	25	73.76
R	400	S	9.7	25	32.21
R	600	S	9.6	25	33.52
R	800	S	9.6	25	25.63
R	700	S	9.6	25	29.93
R	600	S	9.6	25	21.28
R	600	S	9.6	25	17.07
R	500	S	9.6	25	25.08
R	500	S	9.6	25	25.08
R	600	S	9.6	25	17.07
R	700	S	9.6	25	29.93
R	700	S	10.0	25	25.05
R	700	S	10.2	25	29.28

TABLE E-1 (CONT)

DAMAGEABLE PROPERTY INVENTORY

Use 1/	Stream Station Number 2/	Damage Code 3/	First Floor Elevation 4/	Building Type 5/	Assessed Value of Structure ($1,000's) 6/
R	700	S	9.8	25	41.09
R	600	S	10.0	25	23.99
R	600	S	10.0	25	23.99
R	800	S	9.9	25	25.51
R	800	S	9.9	25	39.44
R	900	S	8.9	25	26.14
R	1100	S	8.1	25	28.45
R	1000	S	8.7	25	26.90
R	900	S	10.1	15	24.23
R	900	S	8.7	25	25.95
R	800	S	8.7	25	54.89
R	1000	S	9.0	10	30.39
R	1000	S	7.9	25	29.32
R	1000	S	8.7	15	18.98
R	1000	S	8.3	15	19.82
R	1000	S	8.3	15	19.82
R	1100	S	7.9	25	16.05
R	1100	S	7.9	25	16.05
R	1100	S	9.1	10	22.67
R	1100	S	8.8	10	24.42
R	1200	S	8.5	15	38.52
R	2200	S	7.2	25	26.71
R	700	S	8.3	25	58.57
R	900	S	10.9	10	24.42
R	1000	S	8.5	10	32.07
R	900	S	11.2	10	7.32
R	1200	S	7.6	10	13.40
R	1100	S	9.6	10	24.42
R	1000	S	10.6	10	6.01
R	900	S	11.1	10	7.26
R	900	S	10.2	10	2.54
R	800	S	8.3	25	46.67
R	800	S	7.6	25	18.51
R	900	S	10.0	10	2.54
R	900	S	8.8	15	19.37
R	800	S	9.3	10	18.51
R	700	S	9.4	10	3.79
R	800	S	10.7	10	3.79
R	900	S	10.1	10	24.81
R	800	S	10.9	10	13.24
R	700	S	7.6	15	45.09
R	800	S	8.3	10	18.11
R	800	S	8.1	25	20.31
R	700	S	9.2	25	35.61

TABLE E-1 (CONT)

DAMAGEABLE PROPERTY INVENTORY

Use 1/	Stream Station Number 2/	Damage Code 3/	First Floor Elevation 4/	Building Type 5/	Assessed Value of Structure ($1,000's) 6/
R	700	S	9.0	25	35.61
R	1400	S	9.6	10	11.49
R	1900	S	6.6	10	26.04
R	2000	S	8.1	10	14.22
R	1300	S	8.6	10	12.03
R	1800	S	6.9	25	36.86
R	2100	S	6.5	25	26.38
R	2100	S	6.5	25	26.38
R	2300	S	8.0	15	8.96
R	2700	S	7.5	15	38.03
R	2600	S	5.3	25	24.09
R	2500	S	8.7	10	12.68
R	2600	S	7.3	25	63.55
R	2400	S	8.9	10	7.98
R	2500	S	9.2	10	9.05
R	2600	S	6.3	25	21.89
R	2600	S	4.2	10	5.57
R	2600	S	6.0	25	29.13
R	2700	S	7.2	15	21.50
R	2700	S	10.1	10	8.37
R	2700	S	7.9	10	5.00
R	2700	S	7.8	25	16.26
R	2700	S	10.1	10	8.37
R	2700	S	9.1	25	26.50
R	2600	S	9.9	15	.89
R	2600	S	7.2	10	12.17
R	2100	S	9.1	10	16.62
R	2100	S	9.9	10	16.62
R	2500	S	11.0	10	74.02
R	2300	S	9.3	15	14.14
R	2600	S	8.8	10	5.03
R	2600	S	10.6	10	12.17
R	2600	S	20.0	10	22.44
R	2500	S	7.0	15	26.85
R	700	S	9.4	10	13.21
R	2500	S	20.0	10	25.02
R	2600	S	7.6	25	20.80
R	900	S	9.0	25	46.78
R	900	S	9.6	25	24.66
R	900	S	10.6	25	23.54
R	1700	S	7.8	10	12.22
R	2300	S	10.6	10	12.72
R	1100	S	9.0	25	53.93
R	700	S	10.5	10	11.88

TABLE E-1 (CONT)

DAMAGEABLE PROPERTY INVENTORY

Use 1/	Stream Station Number 2/	Damage Code 3/	First Floor Elevation 4/	Building Type 5/	Assessed Value of Structure ($1,000's) 6/
R	900	S	8.5	25	24.66
R	800	S	11.8	10	4.73
R	800	S	9.4	15	23.54
R	800	S	11.6	10	23.54
R	800	S	11.0	25	4.73
R	800	S	8.5	25	24.66
R	800	S	7.8	25	24.66
R	1900	S	10.0	25	44.58
R	1400	S	19.1	25	25.04
R	1600	S	10.3	25	7.98
R	1700	S	10.9	25	23.79
R	1300	S	10.7	10	10.29
R	1300	S	8.0	15	10.29
R	1200	S	10.1	10	4.11
R	2300	S	11.5	10	29.32
R	1300	S	8.0	25	42.61
R	1400	S	10.5	10	20.31
R	1200	S	10.3	10	13.33
R	1300	S	9.0	25	38.55
R	1700	S	9.0	25	27.14
R	2000	S	9.0	25	30.03
R	2500	S	9.0	25	44.27
R	2300	S	14.5	10	28.47
R	2300	S	11.1	10	16.39
R	2400	S	10.3	25	18.92
R	2400	S	11.3	10	17.47
R	2300	S	10.0	25	18.44
R	2300	S	11.3	10	12.72
R	2300	S	10.5	10	2.45
R	1900	S	8.7	25	37.65
R	2200	S	9.1	10	11.30
R	2200	S	7.0	10	98.05
R	2200	S	10.7	10	11.21
R	2300	S	8.0	15	25.51
R	2300	S	8.8	10	19.82
R	2200	S	10.7	10	11.21
R	2100	S	11.0	10	1.81
R	2200	S	9.1	10	11.30
R	2000	S	8.3	15	19.05
R	2200	S	8.1	10	18.26
R	2100	S	9.4	25	21.81
R	2200	S	8.1	25	35.47
R	2200	S	7.9	25	33.06
R	2000	S	9.8	10	22.85

TABLE E-1 (CONT)

DAMAGEABLE PROPERTY INVENTORY

Use 1/	Stream Station Number 2/	Damage Code 3/	First Floor Elevation 4/	Building Type 5/	Assessed Value of Structure ($1,000's) 6/
R	2100	S	9.3	15	20.48
R	1900	S	8.9	10	10.03
R	2000	S	9.8	10	22.82
R	2000	S	8.0	25	22.82
R	2100	S	10.1	10	18.09
R	1900	S	10.8	10	17.75
R	1800	S	7.3	25	20.01
R	1800	S	7.3	25	20.01
R	1900	S	7.3	25	10.03
R	1700	S	5.8	10	12.22
R	1700	S	7.5	10	12.22
R	1800	S	11.5	10	8.74
R	1800	S	12.7	10	23.49
R	1700	S	8.4	10	12.22
R	1700	S	8.4	10	12.22
R	1700	S	7.5	10	12.22
R	2700	S	7.5	15	21.12
R	2600	S	10.1	10	17.22
R	2500	S	10.0	10	20.33
R	1600	S	9.3	10	19.98
R	1600	S	10.0	10	19.98
R	1700	S	7.5	10	12.22
R	1700	S	7.6	10	17.95
R	1500	S	10.5	10	18.89
R	1500	S	9.6	10	18.89
R	2600	S	4.0	25	33.37
R	2600	S	10.7	10	8.84
R	2600	S	11.7	10	5.86
R	2600	S	4.0	25	33.37
R	2600	S	14.5	10	17.08
R	2600	S	6.9	25	8.77
R	2600	S	11.3	10	17.22
R	2600	S	9.0	25	6.91
R	2700	S	7.1	25	36.13
R	2600	S	8.5	10	9.66
R	2700	S	7.0	25	36.13
R	2600	S	9.0	25	6.91
R	2600	S	9.5	10	9.66
R	2700	S	7.0	25	36.13
R	2700	S	7.1	25	44.12
R	2700	S	7.1	25	36.13
R	2700	S	8.9	10	18.16
R	2700	S	7.8	25	23.17
R	2700	S	6.2	25	41.00

TABLE E-1 (CONT)

DAMAGEABLE PROPERTY INVENTORY

Use 1/	Stream Station Number 2/	Damage Code 3/	First Floor Elevation 4/	Building Type 5/	Assessed Value of Structure ($1,000's) 6/
R	2700	S	6.0	25	23.51
R	2700	S	10.7	15	22.59
R	2700	S	8.3	10	16.72
R	2700	S	9.5	10	24.17
R	2500	S	9.0	10	8.91
R	2600	S	7.3	10	12.85
R	2750	S	8.0	25	50.55
R	2800	S	10.2	10	15.16
R	2600	S	8.0	25	32.23
R	2700	S	7.6	25	28.39
R	2700	S	9.3	10	9.06
R	2700	S	7.6	25	50.56
R	2500	S	9.6	10	12.85
R	2500	S	6.2	25	34.48
R	2600	S	6.4	25	45.05
R	2500	S	8.9	10	12.85
R	2650	S	8.7	15	50.56
R	2500	S	8.0	10	25.93
R	2600	S	5.9	25	29.48
R	2300	S	8.9	10	8.91
R	2100	S	8.0	25	20.77
R	2400	S	8.3	10	15.00
R	2200	S	14.0	10	25.00
R	2350	S	9.9	10	8.91
R	2400	S	6.1	25	36.00
R	2200	S	7.5	25	25.00
R	2200	S	9.0	10	22.84
R	2000	S	10.1	10	19.29
R	2000	S	9.9	25	6.08
R	2100	S	13.0	10	9.71
R	1900	S	12.0	10	17.74
R	2000	S	12.0	10	17.74
R	2100	S	12.8	10	9.71
R	2300	S	14.3	10	13.10
R	2400	S	13.8	10	13.93
R	3600	S	11.8	10	26.89
R	2850	S	7.4	25	12.20
R	3100	S	12.8	10	9.98
R	2600	S	9.0	15	28.33
R	2500	S	11.5	15	28.33
R	2600	S	8.5	25	28.33
R	2400	S	13.0	10	24.89
R	2500	S	11.5	10	20.87
R	2700	S	10.6	25	28.33

TABLE E-1 (CONT)

DAMAGEABLE PROPERTY INVENTORY

Use 1/	Stream Station Number 2/	Damage Code 3/	First Floor Elevation 4/	Building Type 5/	Assessed Value of Structure ($1,000's) 6/
R	2700	S	9.5	25	28.33
R	2600	S	9.0	15	28.33
R	3300	S	8.5	25	26.13
R	3200	S	8.4	25	35.78
R	2500	S	10.5	15	22.82
R	2500	S	12.0	10	14.87
R	3150	S	8.3	25	27.08
R	3100	S	12.8	25	9.98
R	2900	S	9.9	10	17.20
R	3050	S	12.1	10	20.32
R	3000	S	7.7	10	40.67
R	3050	S	8.4	25	40.67
R	3000	S	7.7	25	37.25
R	3000	S	8.3	10	21.04
R	3100	S	9.4	10	5.42
R	3200	S	10.9	10	23.10
R	2900	S	11.3	10	21.30
R	2900	S	13.1	10	20.03
R	2900	S	8.1	10	18.72
R	2950	S	11.5	10	19.90
R	2900	S	17.6	15	33.84
R	2850	S	8.3	10	19.20
R	2850	S	9.8	10	12.20
R	2850	S	7.1	25	12.20
R	3550	S	13.2	10	18.00
R	3800	S	12.7	10	13.96
R	3500	S	12.7	10	3.47
R	3500	S	9.5	10	7.42
R	3600	S	10.8	10	7.42
R	3600	S	13.2	10	21.97
R	3650	S	9.0	10	15.06
R	3850	S	9.9	10	26.22
R	3500	S	11.5	25	13.96
R	3700	S	9.6	10	9.37
R	3650	S	9.0	10	12.73
R	3750	S	10.7	10	3.81
R	3800	S	13.0	10	3.81
R	3650	S	9.0	10	12.73
R	3600	S	10.3	15	8.30
R	3400	S	12.3	10	12.98
R	2900	S	13.1	10	9.00
R	3300	S	12.7	10	22.03
R	3000	S	11.8	25	29.63
R	3550	S	19.3	15	12.98

TABLE E-1 (CONT)

DAMAGEABLE PROPERTY INVENTORY

Use 1/	Stream Station Number 2/	Damage Code 3/	First Floor Elevation 4/	Building Type 5/	Assessed Value of Structure ($1,000's) 6/	Market Value of Contents ($1,000's) 7/
R	3200	S	9.4	15	24.87	
R	3100	S	10.3	25	23.12	
R	3100	S	10.3	25	23.12	
R	2950	S	11.6	10	9.00	
R	3400	S	18.3	10	14.59	
R	3500	S	14.0	10	9.90	
R	3000	S	13.6	10	19.81	
R	3100	S	18.3	10	14.59	
R	3550	S	13.1	10	9.90	
R	3550	S	16.4	10	6.93	
R	500	S	11.8	55	293.24	100
R	2600	S	9.2	15	12.85	25
R	1400	S	9.5	55	400.73	400
R	1700	S	7.7	55	459.25	400
R	200	S	7.5	25	31.00	60
R	200	S	6.5	25	7.44	50
R	2700	S	7.3	15	3.26	20

1/ R = residential; C = non-residential.
2/ Stream station number coincides with hydrology analysis.
3/ S = low velocity flow damage zone; V = high velocity.
4/ In feet MSL.
5/ 10 = wood on post and beam
15 = wood on slab
25, 55 = brick or block on slab.
6/ Assessed value of structure in $1000's (approximately .6 of market value); April 1981 price levels.
7/ Market value of contents of non-residential units in $1000's

NOTE: This listing excludes 58 residential units in the floodplain which were not covered in the inventory of damageable property.

The analysis of damages and damage reduction benefits assumes that no significant change in the nature of the floodplain development is likely to occur during the period of analysis with the exception of some increase in the real value of the contents of residential structures.

Inundation Damage Reduction

Stage-damage-frequency relationships were developed based on the property inventory data base, hydrology water surface profile data, and standardized depth-damage relationships relating damage, as a percent of total market value, to total value. The standardized depth-damage curves used are based on previous studies, experience in POD, and type of construction, as well as engineering judgment. The depth-damage relationships reflect a very low velocity flood-flow environment, typical of the Kahawainui floodplain. These relationships are outlined in Table E-2.

TABLE E-2

STANDARDIZED DEPTH-DAMAGE RELATIONSHIPS

Feet of Flooding 1/	Damage As A Percent of Total Market Value 2/	
	Structures	Contents
0	0	0
1	18	26
2	25	40
3	30	51
4	34	61
5	37	67
6	39	72
7	41	76
8	43	79
9	45	81
10	47	83

1/ Over first floor.
2/ For residential units only. Different relationships apply for non-residential properties.

Recognizing that this flood problem exists in a very small area, and that small deviations from such standardized relationships are a distinct possibility, specific relationships were observed for individual structures in the floodplain. A number of structures flooded in recent years were covered in this observation, with the result that the contents relationship in Table E-2 appears to be a very good average approximation to be used in this methodological approach. The structure data was less conclusive, with decidedly more variation, but the variation was fairly evenly balanced, both above and below the data in Table E-2. On balance, this data for the structural depth-damage relationship also appears to be a reasonable assumption upon which to build further analysis. Actual flood verification data for this same sample of structures was also checked for height of flooding. Flood depths which actually occurred compared favorably with flood heights generated by the damage calculation model used in this analysis.

Water surface profile data for five different floodflows were used to estimate damages from the different levels of flooding. Most of the calculations were performed using a POD-developed computer program which calculates damages for each damage unit, for each flood flow, sums the damage probability

data for the entire floodplain, by structures and contents, and integrates this summed damage probability data to arrive at an expected value average annual damage estimate for the floodplain.

To arrive at inundation damage reduction benefits for the structural plans embodied in Alternatives 1, 2, and 4, the exercise described above was first performed for the without-project condition. The general methodological approach used in calculating with-project damages is based on the assumption that damages are a function of stream discharge in excess of stream capacity to carry water within its banks. Using without-project damage vs. exceedance probability data, along with associated average discharge-frequency data from hydrologic analysis, overbank discharge (Qo) was calculated for different frequencies for the various levels of protection, along with the estimated resulting damage. The damage probability data, resulting from these calculations, as well as for the without condition, is displayed in Table E-3. The damage data reflecting with-project conditions, shown in Table E-3, does not include interior drainage flooding and resulting ponding. Table E-4 shows the estimated damage probability data reflecting this interior drainage flooding.

Integration of the data in Table E-3 and E-4 results in average annual inundation damage estimates both with and without protection for Alternatives 1, 2, and 4. This average annual damage information, as well as resulting benefits, is displayed in Tables E-5 and E-6. Average annual damages were first figured for the without condition. These calculations include all flooding, including that from interior drainage. The average annual damages were calculated for each level of protection for the structural (stream flow modification) alternatives, assuming that no interior drainage flooding takes place. Then the effect of this interior drainage flooding, shown in Table 4, was added to the with-project condition, since this flooding will still occur even with a project in place. Recognizing that these data sets in a strict sense are not exactly additive, the overall residual effect may be slightly in error, but the significance of this error is minute and was not given further consideration.

Included in Table E-5 is the effect of the increasing real value of contents throughout the period of analysis. Growth in the real value of contents and in the average annual damages to contents is assumed to parallel growth in real per capita income expected to occur in the future. The OBERS 1980 BEA Regional Projections (U.S. Department of Commerce, Bureau of Economic Analysis, 1981) for per capita income in the NON-SMSA (outside of Honolulu) portion of Hawaii are equivalent to about 2.0% per year from 1980-2030. Water resources planning regulatory guidelines allow for the effect of increasing real value of contents to be incorporated into damage calculation analysis subject to the constraint that projected real value of the contents does not exceed 75% of the real value of the structure. As of 1983, the estimated average market value of contents was about 28% of the average market value of the structure. At an average annual growth of 2.0% per year, the average real value of contents will be 75% of the real value of the structure after about 50 years, or about 2033 (i.e., $1.02^{50} \times .28 = .75$). Since the estimated first year of project life is 1988, the estimated real value of contents and content damages in 1988 will be 10% higher than at 1983 levels (5 years of growth at 2.0% per year = $1.02^{5} = 1.10$). Growth from 1988 to 2033 at 2.0% per year, with no further growth through the end of the period of analysis, results in an average annual equivalent factor of 1.30 as shown in the following calculation:

Average annual equivalent factor - (A/P, 8-3/8%, 50)

$$\times \left(\left(\sum_{n=1}^{45} (1.02/1.08375)^{n} \right) + (1.02)^{45} \times (P/A,\ 8\text{-}3/8\%,\ 5) \times (P/F,\ 8\text{-}3/8\%,\ 45) \right) = (.0853)\ (14.95 + .26) = 1.30$$

Where the notation (A/P, i, n) signifies the factor for the annual equivalent of periodic amounts at interest rate i/period for n periods, P/A = the present worth of an annual amount, and P/F = the present worth of a future amount.

Multiplying estimated average annual contents inundation damages in 1988 by this factor of 1.30 results in estimated average annual equivalent contents inundation damages for the 50-year period of analysis.

For Alternative 3, the inundation damage reduction benefits result from floodproofing of individual structures, and other floodplain management measures, including a flood warning system. Estimated damage-probability data for conditions with Alternative 3 implemented is displayed in Table E-7 for 50-Year, 100-Year, and SPF design levels of protection. The levels of damage with Alternative 3 reflect the fact that not as much of the effects of flooding are reduced as when the flooding itself is reduced or eliminated (as with levee/channel systems). Nuisance flooding still occurs, to a greater extent than the interior drainage flooding occurring with Alternatives 1, 2, and 4.

Tables E-8 and E-9 contain estimates of average annual inundation damages with and without the three levels of protection, as well as estimated benefits for each design level of protection, for Alternative 3.

Other Benefits

There have in the past been emergency relief efforts during flood conditions throughout the windward Oahu area. Available data on emergency relief costs specific to Kahawainui Stream flood problems are not available. Although some records and reports are made by the Civil Defense, and police and fire departments, the data is usually for large areas covering many floodplains. Also, such information usually includes items not specifically associated with stream flooding. Since there are such costs, however, an estimate has been included as shown in Table E-10. The data in Table E-10 translates into an average annual equivalent cost of about $2,250.

Estimated emergency relief cost reduction benefits for Alternatives 1, 2, and 4 are based on the concept that such costs are reduced roughly in proportion to the extent of reduction in flooding of structures and contents. This translates into benefits for Alternatives 1, 2, and 4 in this category as outlined in Table E-11.

Estimated emergency relief cost reduction benefits for Alternative 3 are based on the concept that some reductions in these costs will occur even without physically controlling flooding. Benefit estimates assume a reduction in these costs of at least 50% on the basis of warning system availability. This results in estimated annual benefits for the primarily nonstructural alternative of approximately $1,125 in this category.

No data suggesting significant measurable damages to public roads and utilities from flooding is available at this time. Although some such damages most likely occur, no benefit is claimed for this category for Alternatives 1, 2, and 4. Likewise, the floodproofing of individual structures in the floodplain in Alternative 3 would not alleviate these damages and therefore no benefits in this category are estimated for the primarily nonstructural alternative. The Kamehameha Highway bridge over Kahawainui Stream and the highway to each side of the bridge will be overtopped with a 50-year or greater storm and will be impassable for about 4 hours. This highway is the only link between the leeward coast and the north shore area of Oahu without having to go through the City of Honolulu some 40 miles to the south. However, only about 14,000 people live within 8 or 9 miles of this bridge. If one-fourth of these people travel this road to or from work and each car averages one and one-half occupants, this would generate some 5,000 trips per day. If there are again as many trips generated from outside this area for business, tourist sightseeing and recreation, there would be some 10,000 trips per day. This would be some 400 trips per hour. During a 4-hour blockage of the highway, there would be an average of probably less than 2,000 autos affected or some 3,000 persons. Assuming the average time delay is 2 hours, then there would be 6,000 hours of lost time for these travelers. At minimum wages of about $4.00 per hour, the average annual loss of time would be about (6,000 x 4 x1602) $480. This is considered quantitatively negligible and is not shown as a benefit item for those plans that would eliminate this problem.

In addition to emergency relief costs and damage to public property, flooding along Kahawainui Stream poses a threat to human safety. While basicially impossible to measure in quantifiable economic terms, this aspect of Kahawainui Stream flooding is nontheless very real. Perhaps the most important effects of flooding and the threat of flooding are disruption of community activity, health hazard, general aggravation, and the danger of loss of human life. Preventing the likelihood of these effects occurring is a major consideration in proposing a flood control alternative.

Benefit Summary

A summary of average annual benefits for each of the three alternatives is tabulated in Table E-12.

It should be recognized that an analysis of this nature is subject to limitations due to data availability and the fact that this is a relatively small floodplain. However, the application of the flood reduction model utilizes a set of assumptions which are basically internally consistent throughout the computations. This helps to avoid a tendency toward the bias which can be introduced to the assessment of flood damages and flood damage reduction benefits by the use of arbitrary calculations.

TABLE E-3. ALTERNATIVES 1, 2, AND 4 ESTIMATED INUNDATION DAMAGE-PROBABILITY DATA

($1,000's) 1/

Condition 2/	Annual Exceedance Probability	Qo 3/	Inundation Damage: Residential Structures	Residential Contents	Residential Total	Non-Residential Structures	Non-Residential Contents	Non-Residential Total	TOTAL
Without Protection:	.1000	4	2551	1017	3568	61	236	297	3865
	.0400	7	3442	1424	4868	81	354	435	5301
	.0200	9.6	4158	1793	5951	110	519	629	6580
	.0100	12.3	4683	2078	6761	124	623	747	7508
	.0035 (SPF)	16.7	5062	2293	7355	146	687	833	8188
2-Year Design:	.1000	3	1914	763	2677	46	177	223	2900
	.0400	6	3117	1289	4406	13	321	394	4800
	.0200	8.6	3855	1662	5517	102	481	583	6100
	.0100	11.3	4553	2020	6573	121	606	727	7300
	.0035 (SPF)	15.7	4946	2240	7186	143	671	814	8000
10-Year Design:	.1000	0	0	0	0	0	0	0	0
	.0400	3	1883	779	2662	44	194	238	2900
	.0200	5.6	2907	1253	4160	77	363	440	4600
	.0100	8.3	3680	1633	5313	97	490	587	5900
	.0035 (SPF)	12.7	4760	2156	6916	137	646	783	7700
25-Year Design:	.1000	0	0	0	0	0	0	0	0
	.0400	0	0	0	0	0	0	0	0
	.0200	2.6	1580	681	2261	42	197	239	2500
	.0100	5.3	2807	1246	4053	74	373	447	4500
	.0035 (SPF)	9.7	4080	1848	5928	118	554	672	6600

NOTE: Refer to page E-17 for footnotes.

TABLE E-3. ALTERNATIVES 1, 2, AND 4 ESTIMATED INUNDATION DAMAGE-PROBABILITY DATA ($1,000's) 1/

Condition 2/	Annual Exceedance Probability	Qo 3/	Inundation Damage: Residential Structures	Residential Contents	Residential Total	Non-Residential Structures	Non-Residential Contents	Non-Residential Total	TOTAL
50-Year Design:	.1000	0	0	0	0	0	0	0	0
	.0400	0	0	0	0	0	0	0	0
	.0200	0	0	0	0	0	0	0	0
	.0100	2.7	1627	722	2349	43	216	259	2608
	.0035 (SPF)	7.1	3308	1498	4806	95	449	544	5350
100-Year Design:	.1000	0	0	0	0	0	0	0	0
	.0400	0	0	0	0	0	0	0	0
	.0200	0	0	0	0	0	0	0	0
	.0100	0	0	0	0	0	0	0	0
	.0035 (SPF)	4.4	2508	1136	3644	72	340	412	4056
SPF Design:	(Flooding with the SPF design level of protection is measurably insignificant, for purposes of project economic evaluation, resulting in a negligible average annual equivalent effect.)								

1/ April 1981 price levels.
2/ Damages without the project as shown in this tabulation include the effect of both overbank streamflow as well as local drainage not from the stream. Damages with project as shown in this tabulation exclude the effect of interior drainage flooding, shown in Table E-4. Breakdown of damages by structure, contents, residential and non-residential, for with-project conditions are assumed to be in the same proportion as for without-project conditions.
3/ Overbank discharge in CFS (1,000's).

TABLE E-4. ALTERNATIVES 1, 2 AND 4 ESTIMATED DAMAGE-PROBABILITY DATA FOR INTERIOR DRAINAGE FLOODING ($1,000's)

Annual Exceedence Probability	Inundation Damage 1/					
	Residential			Non-Residential		
	Structures	Contents	Total	Structures	Contents	Total
.1000	0	0	0	0	0	0
.0400	126	312	438	27	180	207
.0200	315	780	1095	68	360	428
.0100	567	1404	1971	122	540	622
.0035 (SPF)	801	2148	2949	172	800	972
Average Annual Equivalent 2/	27	70	97	5	32	37

1/ April 1981 price levels.
2/ April 1985 price levels (April 1981 prices + 32%, based on an assessment of estimated market value data for April 1984, reflecting the most recent readily available data from State tax records, and based on consumer price index change from April 1984 to April 1985). Calculation of average annual equivalent is based on expected value of damages annually, using trapezoidal integration method, assuming damages can occur with equal probability at any time during the year. Conversion to annual equivalent employs end-of-year convention.

TABLE E-5

ALTERNATIVES 1, 2, AND 4 ESTIMATED AVERAGE ANNUAL INUNDATION DAMAGES AND INUNDATION DAMAGE REDUCTION BENEFITS FOR RESIDENTIAL PROPERTIES 1/
($1,000's)

	Structures 2/	Contents 1983 2/	Contents 1988 3/	Contents 1988-2038 4/	Total Structure and Contents Damage 5/	Average 6/ Annual Inundation Damage Reduction Benefits
W/O Proj:	480	202	222	289	769	-
W/Proj:						
2-Yr	454	190	209	272	726	43
10-Yr	276	177	195	253	529	240
25-Yr	129	106	117	152	281	488
50-Yr	76	92	101	132	208	561
100-Yr.	50	80	89	115	165	604
SPF	27	70	77	100	127	642

1/ April 1985 price levels, 8-3/8% interest rate, and 50-year period of analysis, 1988-2038. April 1985 price level = April 1981 price level + 32%.

2/ From integration of damage-probability data in Tables E-3 and E-4, including price level adjustment reflecting change from April 1981 to April 1985. Annualization is based on expected value concept, with damages occurring with equal probability throughout the year, and employs end-of-year convention capital recovery factor in calculation of annual equivalent.

3/ From multiplying 1983 figure by 1.10 to account for five years of real growth at 2.0% per year.

4/ From multiplying 1988 figure by 1.30 to account for increasing real value of contents during period of analysis.

5/ Structure figure plus contents figure for 1988-2038.

6/ Benefit equals damage without alternative less damage with alternative. Damage with alternative equals sum of damages from stream overflow flooding and interior drainage flooding.

TABLE E-6

ALTERNATIVES 1, 2, AND 4 ESTIMATED AVERAGE ANNUAL INUNDATION DAMAGES AND INUNDATION DAMAGE REDUCTION BENEFITS FOR NON-RESIDENTIAL PROPERTIES 1/
($1,000's)

	Average Annual Damages			
	Structures	Contents	Total	Average Annual Benefits 2/
Without Project:	12	53	65	-
With Project:				
10-Year Design 3/	3/	3/	3/	0 3/
25-Year Design	8	45	53	12
50-Year Design	6	39	45	20
100-Year Design	6	35	41	24
SPF Design	5	32	37	28

1/ From integration of damage probability data in Tables E-3 and E-4, adjusted to reflect April 1985 price levels. April 1985 price level = April 1981 price level +32%. Annualization is based on expected value concept, with damages occurring with equal probability throughout the year, and employs end-of-year convention capital recovery factor in calculation of annual equivalent.

2/ Damages without alternative less damages with alternative. Damage with alternative equals sum of damages from stream overflow flooding and interior drainage flooding.

3/ With-project damages set equal to without-project damages for 10-year design since approximation method of summing interior drainage damages and residual stream overtopping damages to arrive at total with-project damages results in a residual which is greater than without-project damages. Estimated benefit for this and lesser levels of protection for non-residential properties is for all practical purposes negligible.

TABLE E-7. ALTERNATIVE 3 ESTIMATED INUNDATION DAMAGE-PROBABILITY DATA ($1,000's)

Condition	Annual Exceedence Probability	Inundation Damage 1/						
		Residential 2/			Non-Residential 3/			
		Structures	Contents	Total	Structures	Contents	Total	TOTAL
50-Year Design:	.1000	255	101	356	6	24	30	386
	.0400	344	142	486	8	35	43	529
	.0200	416	179	595	11	52	63	658
	.0100	2341	1039	3380	111	561	672	4052
	.0035 (SPF)	2532	1146	3676	131	618	749	4425
100-Year Design:	.1000	255	101	356	6	24	30	386
	.0400	344	142	486	8	35	43	529
	.0200	416	179	595	11	52	63	658
	.0100	468	208	676	12	63	75	751
	.0035 (SPF)	2532	1146	3676	131	618	749	4425
SPF Design:	.1000	255	101	356	6	24	30	386
	.0400	344	142	486	8	35	43	529
	.0200	416	179	595	11	52	63	658
	.0100	468	208	676	12	63	75	751
	.0035 (SPF)	506	229	735	15	69	84	819

1/ These residual damages at or below the design level of protection are an estimated 10% of without-project damages, reflecting the fact that flooding still occurs, resulting in damages to property other than individually floodproofed structures (lawns, cars, etc.). April 1981 price levels.

2/ For flooding above the design level of protection, damage estimates for residential units reflect the fact that structures which will have been raised will have minimal flooding, whereas structures floodproofed with closures or ring walls will be subject to a major ovetopping effect.

3/ For non-residential damage units, flooding above the design level of protection reflects the fact that major overtopping effects occur. None of these units will have been floodproofed by raising the structure.

TABLE E-8

ALTERNATIVE 3 ESTIMATED AVERAGE ANNUAL INUNDATION DAMAGES AND INUNDATION DAMAGE REDUCTION BENEFITS FOR RESIDENTIAL PROPERTIES ($1,000's) 1/

	Structures 2/	Contents 1983 2/	Contents 1988 3/	Contents 1988-2038 4/	Total Structures and Contents 5/	Average 6/ Annual Inundation Damage Reduction Benefits
W/O Proj:	480	202	222	289	769	-
W/Proj:						
50-Year Design	88	38	42	54	142	627
100-Year Design	67	29	32	41	108	661
SPF Design	48	20	22	29	77	692

1/ April 1985 price levels, 8-3/8% interest rate, and 50-year period of analysis, 1988-2038. April 1985 price level = April 1981 price level +32%.

2/ From integration of damage-probability data in Tables E-3 and E-4, including price level adjustment reflecting change from April 1981 to April 1985. Annualization is based on expected value concept, with damages occurring with equal probability throughout the year, and employs end-of-year convention capital recovery factor in calculation of annual equivalent.

3/ From multiplying 1983 figure by 1.10 to account for five years of real growth at 2.0% per year.

4/ From multiplying 1988 figure by 1.30 to account for increasing real value of contents during period of analysis.

5/ Structure figure plus contents figure for 1988-2038.

6/ Benefit equals damage without alternative less damage with alternative. Damage with alternative equals sum of damages from stream overflow flooding and interior drainage flooding.

TABLE E-9

ALTERNATIVE 3 ESTIMATED AVERAGE ANNUAL INUNDATION DAMAGES AND INUNDATION DAMAGE REDUCTION BENEFITS FOR NON-RESIDENTIAL PROPERTIES ($1,000's)

	Structures	Contents	Total Structures and Contents	Average 3/ Annual Inundation Damage Reduction Benefits
Without Project: 1/	12	53	65	-
With Project: 2/				
50-Yr. Design	3	16	19	46
100-Yr. Design	2	10	12	53
SPF Design	1	5	6	59

1/ From Table E-6.

2/ From integration of damage probability data in Table E-7. April 1985 price levels. Annualization is based on expected value concept, with damages occurring with equal probability throughout the year, and employs end-of-year convention capital recovery factor in calculation of annual equivalent.

3/ Damage without alternative less damage with alternative.

TABLE E-10. Estimated Emergency Relief Costs
($1,000's)

Exceedence Probability of Flood Event	Emergency Relief Costs 1/
.1000	15
.0400	21
.0200	27
.0100	30
.0035 (SPF)	33

1/ $75 per damage unit affected in the SPF flood event, and for lower levels of flooding in proportion to damages from stage damage relationships for the floodplain. Based on experience in other floodplains within jurisdiction of Pacific Ocean Division, Corps of Engineers.

TABLE E-11. Alternatives 1, 2, and 4 Estimated Emergency Relief Cost Reduction Benefits ($1,000's)

Condition	Average Annual Amount Costs	Average Annual Amount Benefits
W/O Project: 1/	2.25	-
W/Project: 2/		
2-Yr. Design	3/	0
10-Yr. + 25-Yr Design	.50 4/	1.75
50-Yr. Design	.45	1.80
100-Yr. Design	.44	1.81
SPF Design	.42	1.83

1/ From Integration of data in Table E-10. Annualization is based on expected value concept, with damages occurring with equal probability throughout the year, and employs end-of-year convention capital recovery factor in calculation of annual equivalent.

2/ In proportion to estimated damage probability data for structures and contents.

3/ While some flood reduction effect occurs, such effect is believed to be negligibly measurable, and therefore the estimated benefit amount is zero.

4/ Estimate based on concept that while these levels of protection would still entail significant costs, there would still be some reduction, and therefore a benefit effect.

TABLE E-12. (713.533-1) 1/
SUMMARY OF ANNUALIZED NED BENEFITS AND COSTS FOR
ALTERNATIVES 1, 2, 3 AND 4 ($1,000's)

	Alternative 1, 2, and 4							Alternative 3		
	2-Yr 4/	10-Yr	25-Yr	50-Yr	100-Yr	SPF	50-Yr	100-Yr	SPF	
Flood Hazard Reduction Benefits 2/										
Residential										
Structures	26	204	351	404	430	453	392	413	432	
Contents	17	31	36	137	157	174	189	235	248	260
Non-Residential										
Structures	0 5/	0	4	6	6	7	9	10	11	
Contents	0 5/	0	8	14	18	21	37	43	48	
Emergency	0 5/	2	2	2	2	2	1	1	1	
Public Property 3/	-	-	-	-	-	-	0	0	0	
Human Safety 3/	-	-	-	-	-	-	-	-	-	
Total Project Benefits (B)	43	242	502	583	630	672	674	715	752	

1/ Table 713.533-1 is required by Federal Regulations to be displayed. See Federal Register Vol. 44, No. 242, Rules and Regulations, 14 December 1979 (Water Resources Council Procedures for Evaluation of National Economic Development Benefits and Costs in Water Resources Planning). April 1985 price levels.

2/ From Tables E-5, E-6, E-8, E-9, and E-11.

3/ While these effects will most likely occur, no credit is included due to measurement problems.

4/ Alternative 1 only. This low-level-of-protection levee project is examined since it involves low-cost levee construction utilizing existing topographical features as a part of the protection.

5/ Negligible effect.

TABLE E-12. (713.533-1) 1/
SUMMARY OF ANNUALIZED NED BENEFITS AND COSTS FOR
ALTERNATIVES 1, 2, 3 AND ($1,000's)

Design Level of Protection	Alternative	B 6/	C 6/	B/C 6/	B-C 6/
2-Year	1	43	97	.44	-54
10-Year	1	242	259	.93	-17
	2	242	211	1.15	31
	4	242	700	.35	-458
25-Year	1	502	279	1.80	223
	2	502	240	2.09	285
	4	502	750	.66	-248
50-Year	1	583	300	1.94	283
	2	583	262	2.23	321
	3	674	1,464	.46	-790
	4	583	769	.76	-186
100-Year	1	630	318	1.98	312
	2	630	283	2.23	347
	3	715	1,890	.38	-1175
	4	630	796	.79	-166
SPF 7/	1	672	342	1.96	330
	2	672	317	2.12	355
	3	752	2,059	.37	-1307
	4	672	831	.81	-159

6/ B = average annual benefit, C = average annual cost, B/C = benefit - cost ratio, B-C = net benefits.
7/ For purposes of economic evaluation, providing 500-year design level of protection is not significantly measurably different from SPF level of protection.

Required Tables

U.S. water resource planning guidance requires the display of four specific information tables in flood control study reports conducted by Federal agencies. One of these displays is in Table E-12. Tables E-13 through 15 are the other three, and contain information on residual damages, without-project damages and number of structures in the floodplain.

SENSITIVITY ANALYSIS

Sensitivity of project feasibility to varying assumptions can be useful in revealing which areas of the analysis may require further detailed study in post authorization planning, should a plan be authorized for implementation. One of the factors which has a bearing on project feasibility is the discount rate, or interest rate, used to convert benefit and cost items occurring at different points in time to a comparable basis. In this analysis, the interest rate has an insignificant effect on benefits, since it applies only in the calculations of the affluence factor, used to account for the effect of increases in the real value of residential property contents. Since this component of the benefits as presently evaluated amounts to a very small portion of the total, the effect of using different discount rates is negligible. The interest rate does, however, affect costs. As presently calculated, average annual costs are based on an 8-3/8% interest rate. Higher rates result in higher average annual costs, and lower rates reduce average annual costs. Roughly, for those alternatives with BC ratios in close to 2.0, the discount rate would have to be approximately 17% or greater in order to reduce the BC ratio to below 1.0. For a BC ratio close to 1.2, the discount rate would have to be approximately 10% or greater.

If the damage estimates are either high or somewhat conservative, average annual damage and benefit calculations are higher or lower, respectively, than they should be. Similarly, varying assumptions about market value data for structures and contents can have an effect on benefits. Structure market value data is derived from estimates obtained from the State Department of Taxation. Contents valuation for residential structures are in turn based on an estimated relationship between content and structure values. Since depth-damage curves are expressed in terms of percentage of market value, changing estimated market values would affect benefits. The analysis used in this report carries the stated assumption that no significant change is expected in the character of flood plain development during the life of the project. If flooding continues to be a significant nuisance in future years without the project, it is possible that there might as a result be some market ramifications. If market values were to decline in response to this condition, benefits would in turn be lower.

For those plans having BC ratios in the 1.8 to 2.2 range, the compound average annual change in market values would have to be -6%/yr. to -9.5%/yr., respectively in order to reduce benefits enough to make the respective BC ratios fall below 1.0, making the alternatives infeasible. At the end of a 50-year period the real value of the damageable property will have decreased by nearly 99% with such rates of change. This is not likely. For a BC ratio of 1.15 (Plan 2, 10 yr. design level), the change would have to be -1.53%/yr., resulting in a decrease in market value of over 95% after 50 years. This is not likely, either.

Accuracy of elevation data for both damage units and water surface profiles and location of properties relative to stream station number reference points can also have an impact on damage and benefit estimates. Benefits were re-calculated assuming consistent elevation errors throughout the floodplain, of ± 1 foot, and ± 0.5 foot. The results of this sensitivity test are displayed in Table E-17. As shown in Table E-17, elevation data is a key element in arriving at reliable average annual benefit estimates. Consistent error of only plus or minus one foot can change benefits by 39 percent. That is, if all structures were assumed to be 1 foot higher than estimated (or if all water surface profiles are assumed to be 1 foot lower than estimated), benefits would be 39 percent less than estimated. With this in mind, elevation data was generated with consistent procedures for all structures in the floodplain, using the same reference data sources used for the hydrologic analysis.

Another sensitivity concern regarding elevation data is freeboard designed into each project. In the case of Kahawainui flood control alternatives, freeboard, the vertical difference in distance between design water surface and the top of the channel wall or levee is generally about 4 feet. Existing policy (EP 1105-2-45, Change 2, page 1-9, paragraph 1-8.b.) provides for benefits attributable to freeboard. Such benefits are to be based on informed judgement and in the absence of better data, are comprised of one-half of the area under the frequency-damage curve between the design level of protection and the largest flood which might be carried within the freeboard. No such benefits have been included in this analysis. Including freeboard benefits based on this "one-half" approach would have a negligible effect on SPF protection plans. However, it would add roughly $20,000 in average annual net benefits to 50- and 100-year protection plans, and approximately $35,000 to 10- and 25-year plans. Including such effects in the feasibility analysis would result in a shift to the 100 year level of protection as an optimization point. This would also make the 25-year plan more economically attractive, in terms of optimality. For lower levels of protection, the freeboard benefit effect has not been calculated, but it would most likely be significantly greater, although such plans would still be far less attractive than the larger levels of protection, from the NED accounting stance. While including so-called freeboard benefits might change the recommendation to a lower level of protection, there is not sufficient confidence in the level of precision in the benefit measurement to warrant including them.

As construction takes place, the flood reduction effect grows gradually. Theoretically, there is a concommitant growth in benefits. Such benefits during construction (BDC) have not been calculated. Including them would have the effect of increasing net benefits marginally for all plans.

TABLE E-13. (713.533-2) 1/
AVERAGE ANNUAL RESIDUAL FLOOD DAMAGES BY DECADE ($1,000's)

Applicable Discount Rate: 8-3/8%

Project	Time Period 2/						
	P0	P10	P20	P30	P40	P50	AAE 3/
Alternatives 1, 2, & 4:							
2-Year Design 4/	730	776	832	900	982	1031	793
10-Year Design	538	581	633	696	774	818	594
25-Year Design	299	325	356	394	440	467	334
50-Year Design	222	244	271	304	344	365	253
100-Year Design	180	199	223	252	288	308	206
SPF Design	141	158	178	203	234	252	164
Alternative 3:							
50-Year Design	150	159	170	184	201	210	162
100-Year Design	112	119	128	138	151	158	121
SPF Design	77	82	88	95	104	109	84

1/ U.S. water resource planning guidance required table designation. April 1985 prices.
2/ P10, P20, etc., denote the 10th and 20th years of project life, respectively (P0 = 1988).
3/ Growth is due to growth in contents damages through P45. AAE = average annual equivalent.
4/ 2-year applies for Plan 1 (levee) only.

TABLE E-14. (713.533-3) 1/

AVERAGE ANNUAL FLOOD DAMAGES BY DECADE WITHOUT PROJECT ($1,000's)

Applicable Discount Rate: 8-3/8%

		Time Period 2/						
	1983	P0	P10	P20	P30	P40	P50	AAE 3/
Residential								
Structures	480	480	480	480	480	480	480	480
Contents	202	222	271	330	402	490	541	289
Non-Residential								
Structures	12	12	12	12	12	12	12	12
Contents	53	53	53	53	53	53	53	53
Emergency	2	2	2	2	2	2	2	2
TOTAL	749	769	818	877	949	1037	1088	836

1/ U.S. water resource planning guidance required table designation. Table excludes non-quantified damages. April 1985 prices.

2/ P10, P20, etc., denote the 10th and 20th years of project life, respectively (P0 = 1988).

3/ Growth is due to growth in contents damages through P45. AAE = average annual equivalent.

TABLE E-15. (713.533-4) [1/]

NUMBER OF STRUCTURES IN FLOODPLAIN

Condition	Existing	Time Period [2/]					
		P0	P10	P20	P30	P40	P50
Without Project [3/]	413	413	413	413	413	413	413
With Project [3/]							
Alternatives 2, 3	413	413	413	413	413	413	413
Alternatives 1, 4	418	418	418	418	418	418	418

1/ U.S. water resource planning guidance required table designation. April 1985 prices.
2/ P10, P20, etc., denote 10th and 20th years of project life, respectively.
3/ Number of structures differs from number of damage units since there are a number of multi-unit structures in the floodplain.

TABLE E-16. SENSITIVITY OF BENEFITS TO ELEVATION DATA

Change in Elevation Data 1/	Change in Benefits
+/-1.0 ft.	+/-39%
+/-0.5 ft.	+/-19%

1/ Water surface data.

APPENDIX F

KAHAWAINUI STREAM
FLOOD DAMAGE REDUCTION STUDY

CULTURAL AND SOCIAL RESOURCES

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I. INTRODUCTION

1. Section II-IV of Appendix F summarize those prehistoric and historic era sites or other cultural resources in the study area identified by the Corps of Engineers. Identification of historic sites is required by the Reservoir Salvage Act of 1960, as amended, Section 110 of the National Historic Preservation Act of 1966, and the Executive Order 11593 (1971). The Federal agency must evaluate the significance of the sites in order to determine possible eligibility for the National Register of Historic Places. If any sites in the project area are determined eligible for or already listed on the National Register, they would be protected by Federal law and regulation to the extent that the Federal agency must consult with the State Historic Preservation Officer and the US Advisory Council on Historic Preservation to determine the effect of the Federal project and to identify measures to either avoid or mitigate any adverse effects.

2. Section V and VI summarize pertinent socioeconomic profile data on the study area and assess the social well-being components of the four (4) alternative plans. The "Other Social Effects" component analysis derives from the Water Resources Council's "Economic and Environmental Principles and Guidelines for Water and Related Land Resources," 3 February 1983. The "Other Social Effects" components is not required by the new P&G, but encompasses the social well-being elements that are legally required by Section 122 of the Flood Control Act of 1970 (P.L. 91-611, 84 Stat. 1823) to be addressed in water resources studies. This "OSE" account consists of (a) urban and community impacts such as income, employment and population distribution and composition; the fiscal condition of the local government, and the quality of community life; (b) life, health and safety; (c) displacement of people, businesses, and farms; (d) long-term productivity involving renewable resources; and (e) energy requirements and conservation both during construction and operation of facilities.

II. HISTORICAL BACKGROUND

1. GENERAL. The history of the Laie area is not well documented in the published literature. The prehistoric era is best summarized in a Corps-sponsored achaeological reconnaissance survey conducted in 1981 (Ahlo, and Homon 1981). This analysis was supplemented in 1983 by a one-day field reconnaissance by Mr. David W. Cox, Corps of Engineers, Pacific Ocean Division archaeological technician, and Mr. Earl Neller, State of Hawaii, Historic Sites Division staff archaeologist. As a result of these previous investigations, an intensive survey and subsurface testing project was performed in 1985 (Athens and Bath 1985), in portions of the project area. The Mormon-era history of Laie (c. 1865 to present) is derived from a summary prepared by VTN Pacific for Zion Securities Corporation in 1981 (VTN Pacific 1981).

2. LEGENDS. The Laie land division was named for a beautiful legendary princess. La'ie-i-ka-wai, who was said to have been raised in the district. Many princes of the realm attempted to win La'ie, who was guarded from the eyes of mortal men. To assure her seclusion, she was often hidden in the secret chamber of a freshwater pool in La'ie. The pool, Waipuka can still be seen in the vicinity of the La'ie dump (north of study area). Until about 1900, it was still possible to reach the hidden chamber by swimming through an underwater entrance, but mud and other debris have long since filled much of the pool, closing off access to the cave. La'ie's name is a shortened form of the two words lau'ie, the "'ie" vine leaf," and La'ie-i-ka-wai, her full title means "La'ie of the water (Clark,1977).

3. KNOWN HISTORIC SITES. The study area, particularly on the shoreward (east) section below the confluence of Kahawainui Stream and the drainage canal, is known as Laiewai (Pukui, et. al. 1974), or the "wet" portion of Laie (Figure 12; F-1). Both the wet and dry areas of Laie had a population of about 450 in the 1830's to 1850's (Schmitt 1973; Coulter 1931) and the areas were almost certainly used prehistorically. Cultivation in the area included numerous taro patches fed by streams and springs (mauka or west of the Temple), and an inland fishpond (named Pa'eo) near Kahawainui Stream. It was reported that there was a "place of refuge" at Laie, and two heiaus of which little remains (McAllister, 1933). McAllister also noted several prehistoric sites within and adjacent to the project area including Pa'eo fishpond. The fishpond probably occupied the low lying area inland of Kamehameha Highway and north of Kahawainui Stream. No trace of the fishpond is currently visible nor discernible from subsurface samples (Athens and Bath, 1985). The productivity of this fishpond may be reflected in its name, which can be translated "full fishpond" (VTN Pacific 1981). Pa'eo was "famous for the size of its fish," but by 1930 was "dry and overgrown with weeds" (McAllister 1933). During World War II, refuse from an army training camp was dumped in this area, filling in what remained of the fishpond. Later, the City and County of Honolulu continued to use the site as a dump until the early 1970s. This activity raised the ground level in some areas by 5 to 10 feet as indicated by soil borings (VTN Pacific, 1981). The two ephemeral ponds in the general vicinity result from recent ground surface modification and should not be confused with Pa'eo Fishpond (Ahlo & Hommon, 1981).

4. Two additional sites in the study area are the Waiku'uku'u Crevice (just south of Waiapuka pool), and the Hanapepe Shrine (Figure F-2). McAllister (1933:157) notes that the crevice has since been filled and is probably the site of an existing sewage seepage pit operated by the City and County of Honolulu and currently marked by a manhole (VTN Pacific, 1981). It is located well outside the project area. The Hanapepe shrine described by McAllister (1933:157) was a "very sacred place where the akua stone (a stone representing a supernatural being), Kemehaikana, was worshipped. This is said to have been a female fish god and the first fish were brought as an offering" (ibid.). The shrine was said to have been located on an elevated area near the "first bridge on the Kahuku side of Laie" (ibid.).

5. An inspection of the site files in the Historic Sites Section of the Department of Land and Natural Resources by Ahlo and Hommon (1981) revealed only three sites near the project area, two of which were noted by McAllister. The third is a cave site (State Historic Site Number 50-80-02-1039) approximately 1,800 feet (500 meters) north of Kahawainui Stream near the ridge where the Cackle Fresh Egg Farm is today. It was a large (10 by 20-meter) cave that contained a retaining wall. No midden was noted. Mr. Walter Tashiro of Laie noted to Ahlo and Hommon (1981) that he found human skeletal material eroding out of the beach berm near the project area about 50 years ago. In addition, he recalled an akua stone at which offerings and fish were left after a day's fishing also at the beach. The stone disappeared and no substantial material has apparently been found in the area since.

6. HISTORY. Information dealing with the period between contact and the arrival of the Mormons in Laie could not be found by Ahlo and Hommon (1981) in available published sources. The formative role of the Church of Jesus of Latter Day Saints in Laie began in 1850 when ten Mormon missionaires first settled there. By 1865 the Church had purchased 6,000 acres in the area (reportedly the entire ahupua'a) for a total of $14,000 (VTN Pacific, 1981). This price included a number of buildings and over 1,200 head of livestock. At the time, about 1,500 acres was arable ranch land while the rest was either mountainous or lacked a means of water supply (ibid). Mormon colonists for the new settlement were recruited in Utah and Hawaii, and new arrivals were given leaseholds to build housing and grow crops. Beginning in 1868, sugar cane was raised to provide employment. Since surface water was not sufficient to sustain consistent yields, Church members at Laie experienced considerable hardship, and financial aid from the Church General Authority at Salt Lake proved necessary on several occasions. In 1898, the first large pump was installed on a artesian well and solved Laie's water problems. Additional wells and pumps made crops possible, and soon the capacity of Laie's small sugar mill was exceeded. Excess sugar acreage was leased to Kahuku Plantation and arable land leased to pineapple growers. Other smaller businesses began, such as livestock and dairy management.

7. The first quarter of the 20th century saw an era of growth and prosperity. It was probably in this period that a plantation camp was reported by Mr. Walter Tashiro, a longtime Laie resident, to have been established in the vicinity of the eastern portion of the present Laie Cemetery and adjacent lands. The only present-day remmants of this camp are the large numbers of Japanese family names among the older gravestones (in a community of mostly mainland Caucasians and Polynesians) and a small, red torii gate near the present-day pond (Figure F-2). The concrete torii is the only a reminder of a Shinto temple that once stood on the site (Ahlo and Hommon, 1981).

8. During the mid-1920's, the Laie Plantation went into deep debt and in 1927, a large strip of beach frontage was sold in fee simple to reduce the debt (VTN Pacific, 1981). By 1931, the plantation closed and all sugar acreage was leased to the Kahuku Plantation. Many Laie residents were disheartened by the economic and social decline and moved away. In spite of these problems, the importance of Laie in the fulfillment of Church goals did not decline. In 1916, ground was broken for the now famous Laie Temple. The Temple was dedicated in 1919, and subsequent landscaping and buildings have made it a landmark structure. Because of the importance of the Temple in Mormon doctrine, it became the spiritual center of the Church in the Pacific Basin.

9. During World War II, new jobs at nearby military installations resulted in growth of the Laie population, and an upsurge in housing construction. It is unknown what areas near Laie were taken over by the Army (other than Kahuku Army Airfield and Kahuku Training Area), but Mr. Fred Proby of VTN Pacific reports finding Army pillboxes and other concrete structures in the grove of ironwood trees southwest of the cemetery adjacent to the drainage canal.

III. ARCHAEOLOGICAL FIELD INVESTIGATION

1. Archaeological field investigations were performed in March 1981, February 1983, and May 1985 within the project area in order to identify the presence and assess the importance of any historic properties which may be adversely impacted by the proposed flood control measures. The most extensive investigation was an on-foot survey and limited subsurface testing program performed from 12-21 March 1981 (Ahlo and Hommon 1981). The most consistently identified characteristics within the survey area was the great degree of disturbance of the landscape. Virtually all the land upland of Brigham Young University and the aquacultural ponds (ibid:Area C) was once used as sugar cane and/or pineapple fields and remmant stands of cane are numerous. The entire area has been thoroughly plowed and contains numerous roads and irrigation ditches. In general, the complete disturbance of the ground surface common with commercial sugarcane and pineapple cultivation is widespread throughout the project area. Aerial photographs from the first quarter of the 20th century (Mr. Fred Proby, VTN Pacific, personal communication) confirms that all of this portion of the project area (Area C) and portions of the area between the aquacultural facilities and Kamehameha Highway (Ahlo and Hommon 1981: Area B) were planted in sugar cane. No cultural resources were identified during this archaeological survey within this area.

2. That portion of the project area situated between the aquacultural facilities and Kamehameha Highway (Ahlo and Hommon 1981: Area B) was also greatly disturbed through modern activities. The area directly north and across Kahawainui Stream from the cemetery was used as a Honolulu City and County fill for many years and, when the landfill was closed, the entire area was covered with sand. An existing sand "dune" situated within the pasture in this area is apparently a portion of the material brought in to cover the dump site. Further inland (west), aquaculture construction, agriculture, and livestock grazing have further modified the ground surface. Two distinct areas containing cultural material are situated within this portion of the proposed project area. One is a concrete torii located on the west side of a small body of standing water near the intersection of Kahawainui Stream and a canal built by Kahuku Plantation to channel stream flow. This is the only remmant of a Shinto temple that once stood on the site. According to Ahlo and Hommon (1981), the torii appears to have no special architectural nor social merit. They did not adjudge it to possess the qualities inherent for inclusion to the National Register of Historic Places (ibid). Immediately north of the torii to the south banks of Kahawainui Stream is an area containing probable natural and culturally modified sand dunes. Eroding faces along some of these sand dunes contain evidence of possible prehistoric cultural sediments containing dense marine mollusk shell midden (P. Price-Beggerly, personal communication; C. Streck, Corps of Engineers Archaeologist, site visit, 1984).

3. An area north of Kahawainui Stream, northeast of the torii, was identified as a fenced enclosure containing six (6) or more grave sites adjacent to a limestone escarpment during the initial survey of the project area (Ahlo and Hommon 1981; Figure F-2). The ages of the graves could not be determined at that time but they were thought to have been associated with a plantation camp that existed nearby in the early 1900's (Mr. Walter Tashiro, personal communication). This site was described as having three (3) graves marked by cement slabs or headstones with the remainder marked by rock alignment. Glass jars of recent manufacture were found on two (2) of the graves as flower-holders, indicating occassional recent visits to the site. The single grave with a headstone was apparently inscribed at one time but weathering had obscured the inscription (ibid).

4. A one-day field check of the study area was made in February 1983 at the request of the Hawaii State Historic Preservation Officer. Mr. David Cox, archaeological technician, US Army Corps of Engineers, and Mr. Earl Neller, Staff Archaeologist, Hawaii State Historic Sites Division, further investigated the graveyard enclosure and limestone escarpment area. They concluded that a prehistoric-early historic (pre A.D. 1800 to mid 1800's) house platform comprised a portion of the fenced enclosure area. In addition, the limestone escarpment north of the enclosure may contain evidence from prehistorically utilized rock shelters. Historic glass bottle fragments collected from the ground surface near the enclosure appeared to derive from the mid-19th century.

5. A deposit of historic trash (presumably associated with the plantation camp mentioned above) was identified at the foot of the limestone escarpment immediately north of the graves (Ahlo-Hommon 1981). The trash contained material that indicated it was used until very recently. The deposit had been extensively disturbed, probably by bottle hunters (there were no intact older bottles or ceramics present in the deposit though fragments of such bottles abound). An initial conclusion was that although significant, the trash deposit was not likely eligible for inclusion to the National Register of Historic Places (ibid). The remmants of an old bridge that connected Wahinepe'e Street to Naniloa Loop is also situated approximately 100 meters east-southeast of the grave sites (Figure F-2).

6. The graveyard and limestone escarpment areas were intensively investigated through an archaeological mapping and subsurface testing program 13-19 May 1985 (Athens and Bath 1985). This project included mapping of the graveyard(s) site and approximately 90-100 meters of the exposed limestone escarpment, as well as controlled excavation of five (5) test pits. In addition, one (1) stratigraphic trench was excavated and 12 auger tests were procured (Figure F-3). A previously unidentified cultural feature consisting of a mound containing dense subsurface deposit of historic debris was recorded west of the cemetery enclosure.

7. Observations on excavated material from test units 1, 2 and 3 indicates that the area around the graveyards is relatively undisturbed by recent activities. Upper layers contain historic materials which were dumped onto and over the escarpment in historic times. The lower levels of TU-1 contained several firepits which may be prehistoric, as a marked lack of historic material was found in association with them. Midden shell was found in these layers which suggests an indigenous dietary regime. Two of these firepits yielded ample charcoal for radiocarbon analysis. Radiocarbon C-14 and C-13 ages of AD 1415-1645 and AD 1630-1950 firmly establish this cultural deposit within the prehistoric era in Hawaii. Along the eastern extent of the escarpment face, testing (test units 4, 5 and 6) indicates that recent bulldozing activity has pushed modern debris and heavy clay soils to the foot of the escarpment. Underlying sedimentary layers were of culturally sterile beach sands.

8. Identified sites include two graveyards, one of which is still tended and therefore assumed to be modern. Joss sticks and flowers were noted on these graves (at least 17) which indicates a Chinese or Chinese-Hawaiian ethnic affiliation. This graveyard was not tested. The other, which has one headstone with an inscription in Hawaiian, contains six graves marked with cement grave coverings. A stratigraphic trench unit excavated into the edge of this graveyard uncovered a coffin, over a meter below present surface, for which there was no surface indication. The strata exposed by the excavation

indicate that this burial was dug into a previous ground surface which has now been covered by up to 30 centimeters of more recent deposition. This recent deposit is associated with the visible graves on the mound. Thus it seems reasonable to suggest that this mound has served as a cemetery for a lengthy span during the historic period, and multiple burials may be found at random depths throughout the mound. As a result of encountering this burial, lower levels within the mound remain untested. No assessment can therefore be made as to the presence or absence of prehistoric burials. The upper level of more recent deposition, which dates back to at least 1920 (on the evidence of the marked tombstone), contains sparse historic material, but seemingly not enough to indicate that the mound ever served as a house foundation.

9. Two auger holes placed in the mound to the east of the graveyard provided ample evidence that the mound is not a dune, as suspected, but either a trash mound or a historic-era house site. The density of broken sherds of ceramic, glass and metal prevented augering beyond a depth of 30 centimeters.

10. One feature (Feature C) is a rock alignment enclosing a space of approximately $3m^2$ (31 ft^2) along the base of the escarpment. No definite rock shelters were found along the escarpment face. Feature D (Figure F-3) however, is a small solution cave in the escarpment associated with a rock alignment and possible cultural sediments. On the top of the escarpment, several indigenous artifacts were recovered during mapping. This discovery suggests at least the possibility that indigenous sites may exist further north upon the top of the escarpment, and that prior to land altering activities in this area more intensive archaeological investigation should be undertaken. The geology of the area suggests that the escarpment, in prehistoric times, may have been a coastline above an estuary and then later a riverbank, and thus could have been a locus of prehistoric settlement.

11. The intensive archaeological investigations suggested that the prior site of the Pa'eo Fishpond may have been situated within the relict stream oxbow north-northwest of the project area (Figure F-4). The area apparently has been altered in recent times through both natural alluvial and cultural filling activities.

12. The area seaward of Kamehameha Highway (Ahlo and Hommon 1981: Area A) was initially considered to have the highest potential for yielding <u>in situ</u> archaeological remains. A surface survey for Hanapepe Shrine was performed but no remmants were observed (ibid). Though there was no evidence for the presence of <u>in situ</u> cultural deposits on either the surface or on wave-cut beach faces, four (4) test units were investigated in these areas (Figure F-2). These stratigraphic units were excavated through use of a backhoe to water table (30-350 cm below ground surface). No indication of cultural deposit was found in any of the test units. Subsequent data obtained from local residents indicate that the area was once a sand mine. It is highly probable that archaeological deposits were once present in the area but have been subsequently destroyed by the mining operation.

13. On July 20, 1983, a letter from the Hawaii State Historic Preservation Officer informed the Corps that a State-prepared archaeological reconnaissance report on the February 1983 joint Corps-State survey will be provided in the near future but was never received. The SHPO also suggested the following cultural resources in the "project" area are likely to meet the criteria of eligibility for the National Register: The Pa'eo Fishpond, Hanapepe Shrine, the possible Shinto Temple ruins and cemetery, and a small cemetery and associated homestead ruins. The SHPO letter also mentioned the possible prehistoric deposits (rock shelters) as previously noted.

IV. IMPACTS ON HISTORIC SITES

1. The favored Alternative 2, channel and levee plan, will not adversely impact any identified cultural resources. A levee would be constructed paralleling portions of the lithified sand escarpment north of Kahawainui Stream which has been archaeologically tested. No in situ nor significant cultural resources were identified within this area. Archaeological monitoring shall be performed during Alternative 2 surveying, levee construction, and grading to ensure that there is no adverse impact to the Hawaiian and Chinese cemeteries, possible historic housesite, and in situ prehistoric deposits. All levee construction and grading shall be oriented south, towards Kahawainui Stream, of these sites. Alternative 1, the levee plan, will not adversely impact any of the aforementioned cultural resources for no construction is planned for those areas. Intensive archaeological monitoring shall accompany all south-bank (Kahawainui Stream) construction, however. Alternative Plan 3, floodproofing and floodplain management, is a nonstructural plan which would not impact archaeological resources. Alternative 4, the channel plan, would, without modification, adversely impact all of the aforementioned cultural resources as well as the Shinto shrine and sand-dune areas. If this plan is selected, an archaeological data recovery program will precede construction. Intensive archaeological monitoring would accompany the construction activities.

2. Redesign of Alternative 2 (Figure F-4) has eliminated the necessity of grave relocation at Laie Cemetery as initially anticipated. Therefore no significant impact to the cemetery is expected from the planned flood control alternative.

3. Alternative plans 2 and 4 would include channeling into the sand-dune area seaward (makai) of Kamehameha Highway. Although unlikely, this could conceivably impact unidentified cultural deposits. Therefore archaeological monitoring of the dune area excavations shall be performed (as recommended by Ahlo and Hommon 1981).

4. Alternative plans 2 and 4 would require some excavation and/or grading in the possible former location of Pa'eo fishpond (Figure F-4). Depending upon the extent and depth of excavation, archaeological subsurface testing may be performed prior to construction in order to ascertain the presence/absence of the feature. This will be contingent upon the type of construction activity, i.e., depth of excavation, planned for the area. Archaeological monitoring of such activities shall be performed, however, if warranted.

5. None of the alternative plans encroach into the area where the Hanapepe Shrine was probably once located. Therefore, no further identification or location studies will be conducted for that cultural feature. Likewise, there is no anticipated adverse impact to the Shinto torii gate nor the possible cultural deposits present in its vicinity from the alternative flood control plans.

6. The north levee alignment contained within alternative plan 2 will not impact any in situ significant cultural features along the limestone escarpment. Archaeological survey and testing has established that there are no likely prehistoric or historic rockshelters nor cultural deposits within the proposed project boundaries in this area. Therefore, archaeological monitoring

of subsurface disturbance is not recommended. Archaeological survey shall be performed along the affected portions of the escarpment upper surface in order to identify extant cultural resources.

7. All archaeological mitigative measures performed for this project shall be closely coordinated with the Hawaii State Historic Preservation Office. Determination of the historic significance of sites present in the vicinity of the Hawaiian graves (cemetery) site is currently in progress. If these sites are determined to possess attributes sufficient for inclusion to the National Register of Historic Places close coordination with the Advisory Council on Historic Preservation shall be performed prior to the construction project.

V. URBAN AND COMMUNITY CHARACTERISTICS

1. General. The most accurate picture of the people and land-use in the Kahawainui Stream study area appears in the Zions Securities Corporation's "Laie Low Income Housing: Master Plan and Environmental Assessement" by VTN Pacific, April 1981. This information is supplemented by recent 1980 Census income data, although the latter covers a much larger area (Census Tract 102.02) surrounding Laie, including a portion of Hauula and the Malaekahana Bay residential area. The analysis of the area's institutional issues is drawn in part from Corps staff observations and the public involvement program during the past five years.

2. Land Use. Laie is located on a gently sloping coastal plain between the shore and the Koolau Mountains. Most of the community and floodplain is at an elevation of 6 to 12 feet above sea level (MLLW). Present-day residential patterns are a result of the history of the area as a one-crop plantation, requiring housing to be concentrated in one zone to allow efficient cultivation and harvesting of the sugarcane. The town of Laie is congregated around the Laie Temple, the Brigham Young University-Laie Campus, and the Polynesian Cultural Center. It is a community in Hawaii, having a "unique sense of identity and purpose as a religious, educational, and cultural center for Mormons throughout the Pacific" (VTN Pacific, 1981).

The aquacultural ponds are operated by the University. The Cackle-Fresh Egg Farm is on land controlled by Zions Securities Corporation, but is privately owned. The fertile silty basaltic soils inland of the hills west of Laie Temple and in the Kahawainui River Valley provide a rich agricultural resource and much of it has been designated Prime Agricultural land by the State Department of Agriculture. Zion and Brigham Young University recognize the value of this resource and plan to retain most of these lands in agricultural uses according to their Long-Range Laie LDS (Latter Day Saints) Land Use Plan (VTN Pacific, 1981). Most other lands suitable for agriculture lying within the floodplain either lay fallow or are extensively grazed by horses or cattle. Such grazing occurs in the wetlands north of Kahawainui Stream in the former Pa'eo Fishpond.

There are four farmsteads in the Standard Project Flood (SPF) floodplain. One small farm consists of a patch of banana trees immediately mauka (mountainward) of Kamehameha Highway. A large 13-acre parcel is owned by the Pukahi family who raise calves, pigs and chickens on a very small scale. Mrs. Pukahi mentioned at one of the study's public workshops that her farm is frequently subjected to floods, often to a depth of 4 feet and occasionally drowning cattle, pigs or chickens. Two other isolated parcels are located about 750 to 1,000 feet east of the northern aquacultural plots. One comprises less than an acre of very intensively cultivated taro, banana and other truck crops. The other is engaged in calf-raising on a small scale. The ownership of the first parcel is contested between the Church and a native Hawaiian family. There are also other isolated kuleana lands within these zones of prime and other important agricultural lands of the floodplain. The ownership of some of these lands is reportedly contested. The concerns of these land claimants are represented locally by the Kuleana Hui Malama Aina O Laie (kuleana group which loves the land of Laie).

Many of the local Hawaiian's concerns arise from their desire to retain or reclaim (depending on one's viewpoint) the lands their ancestors once worked. They may also be concerned about a 1973 Laie General Plan, prepared in 1972 by William L. Pereira Associates for Zions Securities Corporation which foresaw the long-range conversion of much of the floodplain agricultural lands into commercial and multi-family residences. According to Mr. Marvin Stone, Manager for Zions Securities at Laie, this plan is no longer considered to officially represent the long-range planning goals for the Church of Laie. Rather, the VTN Pacific long-range Laie LDS Land Use Plan is now considered by the Church to informally represent its present views on the future of its landholdings.

3. Other Land Use Policies. Use of the floodplain lands controlled by Zions Securities Corporation and others is regulated by State land use designations and County zoning. The Federal project may not require any changes in land use designations or zoning but these policies affect the nature of impacts that could conceivably arise as a result of flood protection. The Federal project will, however, be required to be consistent with the State Coastal Zone Management policies and may require a County Special Management Area permit. Approximately 3 to 4 acres of designated Urban land remains undeveloped within the 100-year floodplain, except for narrow strips of land on both sides of the western portion of Laie Cemetery. One of the two undeveloped urban areas lies makai of Kamehameha Highway on the Malaekahana side of Kahawainui Stream; and the other immediately westward of the isolated residential neighborhood of five homes on Wahinepe'e Street. On the County's Detailed Land Use Map, the entire floodplain north of Kahawainui Stream from Kamehameha Highway inland for 1,500 feet is zoned industrial. The rationale behind this is because the floodplain portion of the industrial zone was used as a county landfill/dump until the early 1970's. The remaining parts of the study area zoned residential and agricultural conform to present-day land uses.

The Detailed Land Use Map (DLUP) has been revised to conform with the new City and County General Plan by preparation of a development plan specific to the Koolauloa planning district. The adopted plan (May 10, 1984) zones the currently residential area makai of the highway to Park use since it now lies within and adjacent to the Malaekahana State Beach Park and changed all of the formerly industrially zoned floodplain north of Kahawainui Stream to Agriculture. Zions Securities Corporation is opposed to the latter change because it wishes to develop the floodplain and adjacent high ground (limestone hill) as an industrial subdivision. (The housing project shown on Figure F-5 is no longer planned.)

4. Recreational Activities. The private, but accessible Hukilau Beach Park of approximately 3.4 acres, is located on land owned by Zions Securities. It is located witin the grove of ironwood trees seaward of Kamehameha Highway and southeast of the mouth of Kahawainui Stream. The undeveloped park lies within a depression which was formerly mined for commercial sand and is now used for picnicking, camping, and recreational fishing primarily by residents of the Laie-Kahuku region. Additionally, the dense mangrove area adds a pleasing aesthetic vista to the quality of the park setting. The proposed project area is bounded on the north by Malaekahana State Park which consists of approximately 151 acres located between Kamehameha Highway and the sea. The park area nearest to the proposed project has been developed initially as Phase I and consists of 74 acres. Both Kahawainui Stream and the sand mining pond (at the confluence of the stream and drainage ditch) support fish (tilapia, mosquito

fish, and guppies) and other aquatic animals (bullfrogs and crayfish) (VTN Pacific, 1981). A random conversation with a couple of young lads near the pond indicated that the freshwaters of the pond and the stream, particularly below the confluence, are popular recreation fishery among the neighborhood residents.

The Laie Master Plan (Figure F-5) shows a park area along the stream landscaped and provided with walkways, benches, and a comfort station linked with Hukilau Beach Park. The park at the project site would eventually be extended to the Laie side of Kahawainui Stream to incorporate the other pond left over from sand mining. Zions hopes that the stream can be restored to a more natural state by removing the steep earth banks and forming a more accessible channel.

5. Community Characteristics. There are three communities in the Laie area. The Hukilau Bay community (including Laie Point) is outside the floodplain and not within the study area. Its residents generally have moderately high incomes and are predominately Caucasian. The other two communities within the floodplain consist of those in Mormon Laie town and those few residences north of Kahawainui Stream and isolated farmsteads. Table F-1 summarizes the socio-economic characteristics of Laie Town (the shoreline and inland communities) compared with the County as a whole (VTN Pacific, 1981). The basis of the table is a household survey conducted in 1979 which does not include the five households north of Kahawainui Stream along Wahinepe'e Stream nor the two isolated farmsteads described above. Based on personal observation, the latter seven households are either Japanese or Hawaiian or part-Hawaiian. These households generally represent a community apart from the LDS Church-dominated Laie community. The Hawaiian element of this small community claim to be descendents of the original inhabitants of the Laie ahupua'a. It is not believed that the Hawaiian elements of the Mormon community share this same cultural tie to this particular ahupa'a.

Recent population growth resulted in increased crowding of resident housing in Laie town. Nine percent of Laie households contained two or more families in 1979 as compared to 3 percent for Oahu as a whole. Because there is likely to be continued rapid growth in Laie employment and population, this trend will probably continue to worsen unless new low and moderate cost housing is provided (VTN Pacific, 1981). According to the US Census, the resident population of the Laie Census Area increased from 3,009 in April 1970 to 4,643 in April 1980. This represents a 54 percent increase versus a 21 percent increase for Oahu as a whole. During the same period, the number of dwelling units in the Laie Census Area increased from 478 to 924. The 1970 Census found that approximately 62 percent of the homes in Laie (Census Tract 102.02) were constructed in the 1950's or earlier. Extending this data to the present, it can be concluded that at least one-third of the homes in Laie are 30 years old or more. A drive through the community gives the impression that most of the houses, though in good repair, are from the "World War II Era," and will soon be reaching the end of their serviceable life.

The 1979 survey of Laie by BYU-Hawaii (VTN Pacific, 1981) compiles some very useful information on the demographics of the community. In general, it revealed that Laie households tend to be large (mean = 5.87 persons), crowded (9 percent contain 2 or more families), young (41 percent of household members are 19 years or less), and enthically Polynesian (62 percent are either wholly

or part Hawaiian, Samoan, or Tongan). By comparison, for Oahu as a whole, households tend to be smaller (mean = 3.25), relatively uncrowded (3 percent contain 2 or more families), older (34 percent of household members are 19 years or less), and more Oriental (40 percent are either Japanese, Chinese, or Filipino).

One important characteristic of Laie of primary importance is the large percentage of low income families. The 1979 BYU-Hawaii survey found that 43 percent of the Laie households had a gross annual income of $10,000 or less, and that 20 percent lived on less than $5,000 per year. The comparable figures for Oahu as a whole are 22 percent and 3 percent, respectively. Based on 1979 income and poverty thresholds of families surveyed by the US Census in April 1980, the entire Census Tract No. 102.02 (from Malaekahana to upper Hauula) consisted of 1,012 families who exhibited about 19 percent below poverty and another 14 percent within 100 to 124 percent of poverty (State Department of Planning and Economic Development, Unpublished Computer Tabulation of the 1980 Census, Table 88a).

6. Community Concerns. Laie is a church town. In the words of then LDS President David O. McKay (in 1955): "This must be a moral town with no hatred, no back biting, no fault finding, that you may love and live in peace so the people who enter this village will feel that there is something different here from any other town they have ever visited" (Pereira Associates, 1972). The VTN Pacific planning document echoes this theme, commenting on the strong sense of community cohesiveness. According to VTN Pacific, community leaders share many common goals, including:

- Ownership of a home on fee simple land.
- Full employment.
- New housing and jobs so that the children of Laie families can remain in Laie.
- Productive use of agricultural land.
- Universal education.
- Preservation of the cultural heritage of Laie.

In 1978, the City Department of General Planning contracted SMS Research, Inc., to survey public opinion on land-use issues in various areas of Oahu. Based on 400 in-person interviews with adults in randomly selected households between Kaaawa and Kahuku, SMS concluded that residents are most concerned about two issues: Saving prime agricultural land from development and providing affordable housing. Residents are also concerned about preserving their rural life style and the area's natural and scenic resources. There is a strong opposition to constructing of high-rise buildings and large-scale housing projects in windward Oahu.

During the three years of public involvement activities for this flood control study, many of the "common goals" expressed above reflected considerable disagreement about whether the Laie floodplain should be developed or not. There is the Kuleana Hui Malama Aina O Laie of predominantly native Hawaiian families contesting control of kuleana lands with Zions Securities Corporation

and BYU on the one hand, and the frustrations of the Laie Town residents who as leaseholders complain that the lessor, Zions Securities is not providing all of the services (water supply, sewer system, drainage canal and stream clearance) the residents believe it should. Some residents indicated their concerns that any flood control projects will induce further developments of Laie consequently creating adverse social changes. An analysis of socio-economic indicators among the residents of Laie Town proper reveals a real need for new housing, particularly housing aimed at those with low incomes. A poll of a sample of Koolauloa District residents indicates strong support for more less expensive housing, although not at the expense of reducing agricultural lands. Both the Koolauloa Neighborhood Board and Laie Community Association endorsed the development of low and moderate income housing by Zions Securities Corporation.

VI. SOCIOECONOMIC IMPACTS

1. Identification and evaluation of impacts of the alternatives in relation to land-use activities and policies, demographic characteristics and community concerns must be done in the knowledge that the Federal planning and political process is lengthy. Flood-damage reduction improvements may be authorized and funded for construction in about 1986.

2. Alternative 1. Levee System. This alternative would provide flood protection to the Laie residents. In addition, potential public health hazards and adverse economic impacts generated by periodic flooding would be reduced and the safety of the community would be enhanced. The levee system would allow unobstructed access to the lower Kahawainui Stream floodway for recreational and park development.

3. The levees would provide a new visual element in the area averaging 10 feet in height, but their placement in the depressed channel/floodway would minimize obstruction of residents' open view along the levee. Grassing the levee slopes would further minimize aesthetic impacts. Fencing the levees could be an obstruction to easy access to the streamway for recreational fishing and other play activities. No residential structures are anticipated to have to be relocated by this levee alternative, but some nonresidential sheds may be affected, west of the cemetery. The intensive cultivation of bananas near the Kamehameha Highway may also be adversely affected.

In the area of the Laie Cemetery, the concrete I-wall along the ditch will rise about 7.5 to 9.5 feet above existing ground level, creating even more a sense of division between the two cemetery sections. This division will be emphasized by the levee sections and the short segment of raised road. The existing road running parallel to and joining the cemetery sections must be raised about 10.5 feet above the existing ground level to match the height of the levees and I-wall. It will be provided with guardrails or a fence for safety purposes. Because the traffic load is so light, no separate sidewalk will be constructed. The concrete I-wall, levee sections and raised road will be a dramatic intrusion into the sense of tranquility and naturally greenery that now prevails at Laie Cemetery. There is no way to avoid such aesthetic impacts at the cemetery while still providing the required levels of flood protection to the community as a whole at reasonable cost. This segment of the project for Alternative 1 and the recommended Alternative 2 has been redesigned to eliminate the severe social impacts of grave relocation, but adverse aesthetic impacts are unavoidable.

4. Alternative 1 will involve a levee which will result in an expansion of the 100-year and SPF floodplain boundaries to the north, encompassing a residence which now lies partially outside the 100-year floodplain and a residence which now is completely outside any floodplain. This imposition of Federal and County flood insurance regulations on these two residences is a direct adverse social impact and would be mitigated by providing some sort of floodproofing to the two residences such as floodwalls, flood shields, raising of the houses, or complete removal of the structures from the floodplain. The area of the planned Pa'eo Low-Income Housing project that would need to be filled to raise it above the floodplain would also increase, resulting in possibly higher construction costs for that project.

5. The removal, relocation or modification of structures will be required with implementation of any of the four proposed alternatives. The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L 91-646) provides for uniform and equitable treatment of all persons displaced from their homes and businesses as a result of land acquisition for Federal and Federally-assisted projects. The term "relocation" includes raising and lowering, altering, adjusting or protecting as well as changing its location. The Act authorizes reimbursement for actual moving expenses and losses resulting from moving, or an alternative payment in lieu of actual expenses of about $500 for a home and $2,500 to $10,000 for a business or farm operation. A replacement housing payment is also provided to enable the displaced person to be relocated in a decent, safe, and sanitary home comparable to his former home. This payment (up to $4,000 for tenants and $15,000 for homeowners) is in addition to the purchase price paid for the property acquired by the Government. The Government must assure the availability of adequate replacement housing before obtaining possession. As a last resort, the Government can build or arrange loans for building replacement housing to assure its availability to displaced persons.

6. Alternative 2. Levee and Channel Improvements. The levee would have the same adverse and beneficial social and aesthetic effects as Alternative Plan 1.

7. The channel portion of Alternative 2 would not significantly intrude into the back (mauka) part of Hukilau Bay Beach Park. One local family residence on Wahinepe'e Street would require relocation or alternative, the family would be reimbursed for constructing a similar structure elsewhere, in accordance with the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970.

8. Alternative 3. Floodproofing/Floodplain Management. The specific nature of floodproofing by house is not available at this time, but will vary according to the type of construction and/or condition of the house affected. There may result a hodge-podge of structural modifications with scattered houses on columns and others with shields, disrupting the present landscape. An exemption from the proposed County zoning restriction in residential area for a maximum building height of 25 feet may need to be sought. Those whose houses are raised need to be warned that the County regulations accompanying the Flood Insurance Program will prohibit construction of any new permanent structures underneath the raised house. This may inconvenience certain Polynesian or other Pacific islanders living there for whom it is may be culturally acceptable to fully utilize the space below a raised house.

9. Construction for floodproofing of any particular house, except in the case of severely delapidated houses, should take no longer than two or three days, during which the family will be temporarily housed in the vicinity at Government expense. This may cause inconvenience to some families or individuals. During that period of construction, police protection will need to be increased in the construction zone to prevent any losses of property due to burglary. Those few individuals or families occupying dilapidated structures requiring major repairs or rebuilding prior to floodproofing will be subject to lengthy displacement. Some of these structures may even need to be relocated to high ground.

10. This alternative may require the County to rezone certain areas of the lower Kahawainui Stream floodplain to promote uses compatible with the floodplain such as grazing, agricultural or park. The present planning configuration of the Zions Securities Corporation Pa'eo low-income housing project may also be needed to be redesigned to be comptabile with the associated floodplain management measures.

11. Alternative Plan 4 would have social effects similar to the downstream channelized portion of Alternative Plan 2, except that its upstream channel portion would traverse directly through the middle of a (the Pukahi) farm. Approximately 4.5 acres would be destroyed, or about 85 percent of the potentially grazable land. If this alternative were to be implemented, the Corps is authorized to compensate property owners for their losses by purchase of their land at a fair and reasonable price.

12. None of the proposed alternatives, except potentially Alternative 4, should affect riparian water rights of those kuleana owners or claimants. However, the concerns of these and other Laie residents over urbanization of agriculturally suitable lands may not be totally satisfied, except to the degree that floodplain management measures will likely limit any residential or commercial construction within the 100-year floodplain, which corresponds generally with Prime or Other Important Agricultural lands. Under this alternative, no one group of residents will have any advantage over the other in terms of cost of new construction in the floodplain.

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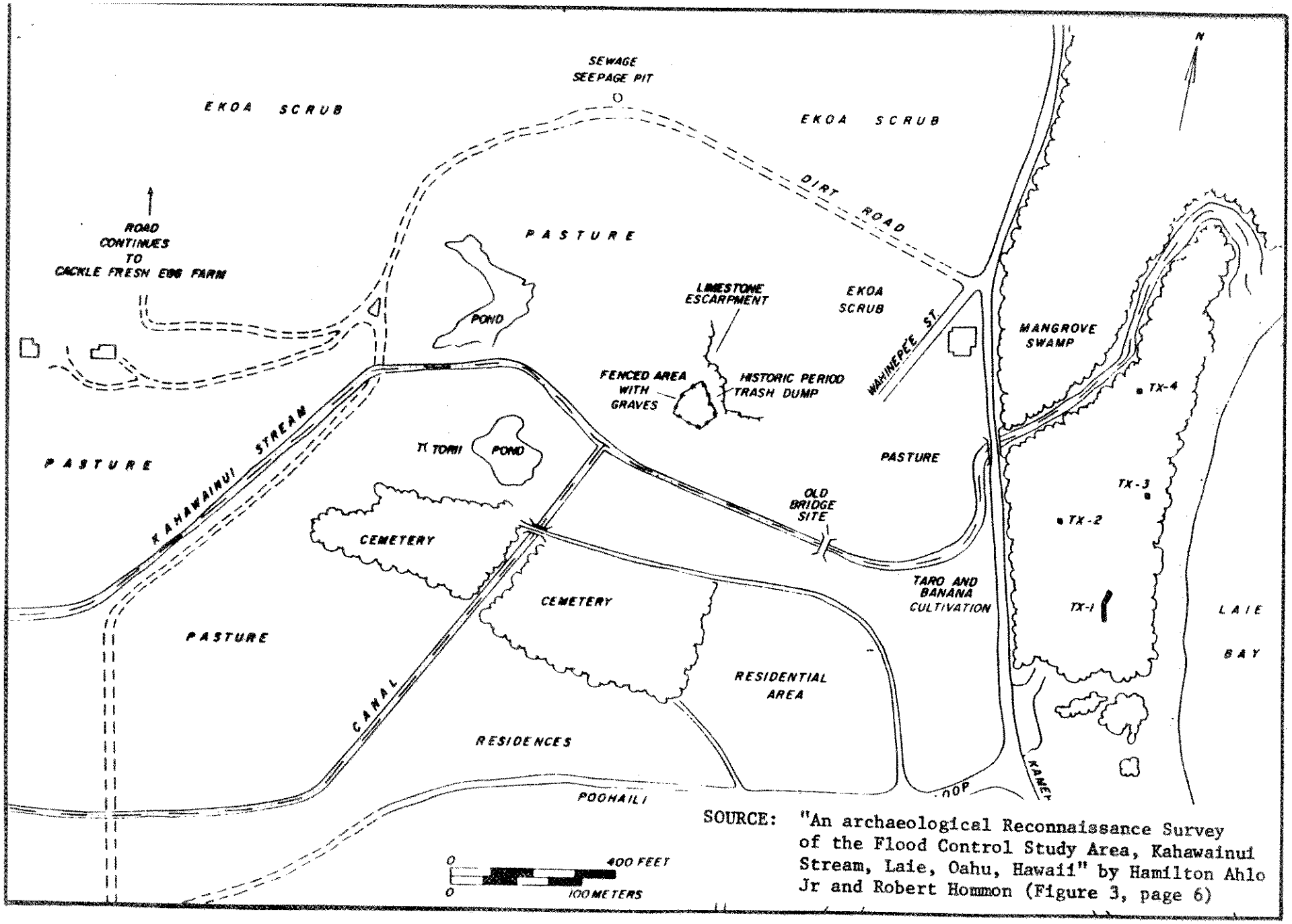
STUDY AREA
(see figure 12)

Figure F-1



SOURCE: "An archaeological Reconnaissance Survey of the Flood Control Study Area, Kahawainui Stream, Laie, Oahu, Hawaii" by Hamilton Ahlo Jr and Robert Hommon (Figure 3, page 6)

FIGURE F-2

CULTURAL RESOURCES IN THE STUDY AREA

FIGURE F-2

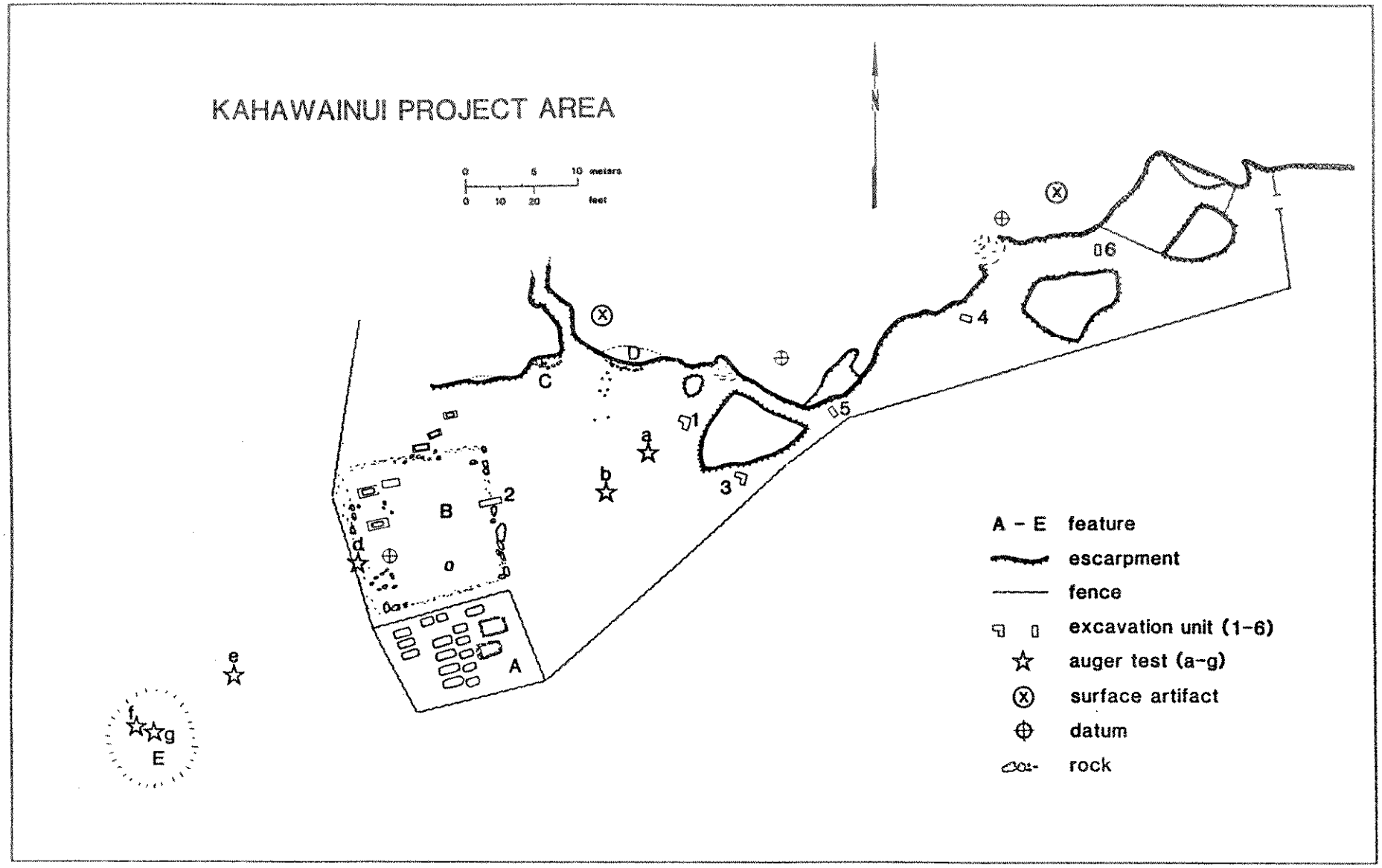


FIGURE F-3. ARCHAEOLOGICAL TEST AREA

RAISE ROAD

TOOL SHED TO BE RELOCATED BY OTHERS

RAISE ROAD

POSSIBLE SITE PA'EO FISHPOND

CEMETERY

FUEL TANK TO BE RELOCATED BY OTHERS

POSSIBLE HISTORIC HOUSE SITE

HAWAIIAN CEMETERY

PREHISTORIC CULTURAL DEPOSIT

STA 38+50 END LEVEE

CENTER LINE OF LEVEE

STA 30+33

CONCRETE I-WALL

STOP LEVEE AT CONCRETE I-WALL

CEMETERY

CHINESE CEMETERY

GRADE TO EXISTING STREAM

HOUSE TO BE RELOCATED BY OTHERS

STA 27+70

CENTER LINE OF LEVEE

GARAGE TO REMAIN

STA 21+00 BEGIN LEVEE

STA 21+00 END CHANNEL

STA 16+00 ℄ BRIDGE

178,180.00 N
522,874.16 E

KAMEHAMEHA HIGHWAY

EXISTING BRIDGE

CENTER LINE OF CHANNEL

FILL EXISTING STREAM

SHEDS TO BE RELOCATED BY OTHERS

GRADE TO EXISTING STREAM

STA 14+50

STA 15+50 BEGIN CHANNEL

KAMEHAMEHA HIGHWAY

STREAM

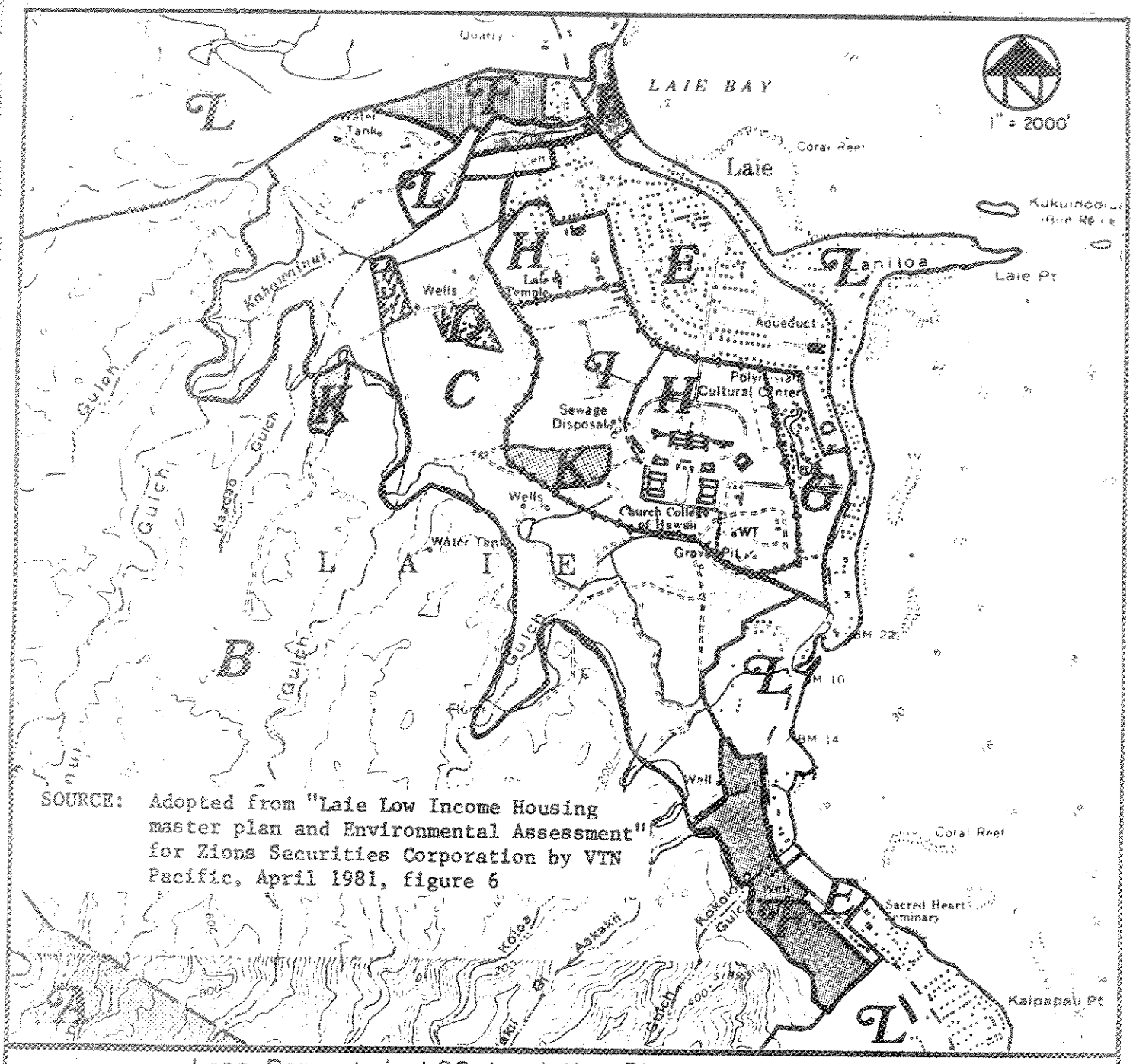
CURVE NUMBER	PI[1]	PI[2]	PI[3]
Δ	30°11'-20"	90°00'-00"	46°00'-00"
Δ/L	15°05'-40"	45°00'-00"	23°00'-00"
R	500.00'	50.00'	100.00'
T	134.86'	50.00'	42.45'
C	260.41'	70.71'	78.15'
L_c	263.45'	78.54'	80.29'

100' 0 100' 200'
GRAPHIC SCALE 1" = 100'

KAHAWAINUI STREAM LAIE, HAWAII

DETAILED PROJECT REPORT
ARCHAEOLOGY
SITE LOCATIONS

U.S. ARMY ENGINEER DISTRICT, HONOLULU



SOURCE: Adopted from "Laie Low Income Housing master plan and Environmental Assessment" for Zions Securities Corporation by VTN Pacific, April 1981, figure 6

Long-Range Laie LDS Land Use Plan

LEGEND

- A — Forest Reserve
- B — Grazing / Watershed
- C — Agriculture
- BYU Aquaculture
- E — Residential / Commercial
- F — Proposed Low Income Housing Projects
- G — Polynesian Cultural Center
- H — Spiritual / Educational
- I — BYU - Hawaii Reserve
- Park
- K — Quarry and Borrow Pit
- L — Other Ownership

TABLE F-1

Demographic Characteristics of Laie
as compared to Oahu in 1979

	Laie[1]	Oahu[2]
Household Size[a]		
Median	6	3
Mean	5.87	3.25
Only One Person	1%	12%
2-4 Persons	32%	68%
5-7 Persons	41%	18%
8 or More Persons	26%	2%
Number of Families in Household		
Only 1 Family	91%	97%
2 or More Families	9%	3%
Age of Population		
19 Years or Less	41%	34%
20-59 Years	53%	55%
60 Years or Over	6%	11%
Ethnicity of Population		
Caucasian	23%	27%
Japanese	2%	25%
Part or All Hawaiian	21%	18%
Filipino	---	10%
Chinese	2%	5%
Samoan	28%	2%
Tongan	13%	---
Other	11%	13%
Home Ownership		
% of Families Which Are Buying or Own Their Home[b]	34%	45%[3]
% of Owner Occupied Housing Units on Fee Simple Land	9%	65%[3]
% of Owner Occupied Housing Units on Leased Land	91%	34%[3]
Family Income		
Median	$12,000-14,999	$15,000-19,999
Under $5,000	20%	3%
$ 5,000 - $ 9,999	23%	19%
$10,000 - $14,999	15%	20%
$15,000 - $19,999	9%	16%
$20,000 - $24,999	12%	13%
$25,000 or More	21%	28%

Notes:

a. Both Laie and Oahu data are based on household surveys which excluded all persons living on military bases and all persons living in group quarters such as dormitories. In addition, Laie data excluded all single BYU-Hawaii students who were not living with their parents and included residents in married student apartments on the BYU-Hawaii campus. 540 households were interviewed in Laie and 2,690 households were interviewed on Oahu.

b. Data about Oahu home ownership is a 100% count of all housing units on Oahu including rental housing on military bases. Data about Laie home ownership is based on a household survey described above.

Sources:

1. Robertson, Dale & Stanton, Max. Unpublished Computer Tabulation from a Household Survey of Laie Residents. Brigham Young University, Hawaii Campus, August 6, 1980.

2. Hawaii State Department of Health, Research and Statistics Officer, Health Surveillance Program. Unpublished Computer Tabulation of Data form the State Health Surveillance Survey, prepared at the request of VTN Pacific, Honolulu, November 1979.

3. Hawaii, State Depatment of Planning and Economic Development. The State of Hawaii Data Book 1979. Honolulu, November 1979.

APPENDIX G

KAHAWAINUI STREAM
FLOOD DAMAGE REDUCTION STUDY

NATURAL RESOURCES
AND
US FISH AND WILDLIFE SERVICE COORDINATION

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I. NATURAL RESOURCES

A. Geology and Physiography

The Kahawainui Stream watershed is located on the windward (northeastern) side of Oahu and is characterized primarily by the eroded remnants of the Koolau shield volcano, one of two major shield volcanoes which comprise the island. Topography within the watershed ranges from sea level to an approximate 2300-foot elevation, with higher elevations hosting deeply dissected cliffs and valleys. At lower elevations, the watershed is characterized by a broad coastal plain which includes coral reef, dune sand and detrital sediment deposits. The Laie dunes physiographic unit occurs in the study area (Armstrong, 1973) and provides a distinct component of the coastal landscape. Laie Bay directly offshore from the project area is characterized by a sand bottom from the mouth of Kahawainui Stream north to Kalanai Point. The substrate is more solid, consisting of lithified dune or ancient reef.

B. Soils

A number of different soil types and associations occur within the Kahawainui Stream watershed. Beach sand and coral outcrops are common along the shoreline, with coral outcrops extending inland onto the coastal plain. Jaucas sand occurs commonly throughout Laie town. Other soils occurring within the coastal plain include Mokuleia loam; Haleiwa silty clay; Keeau clay; Kaloko clay; Kawaihapai clay loam; and Lahaina silty clays. Paumalu silty clays occur in the foothills and in upper portions of the coastal plain. Erosion hazard is moderate to severe for these soils where slopes are greater than 15%. The uppermost portions of the Kahawainui watershed are characterized by Paumalu-Badland soils with 10-70% slope and Kapaa silty clays with 40-100% slope. On these soils, runoff is rapid and erosion hazard is very severe (SCS, 1972).

C. Climate

Because of its location, the Kahawainui watershed is subject to the prevailing northeasterly trade winds throughout most of the year. Rainfall on an average annual basis ranges from 45 inches along the coastal plain to over 100 inches in higher elevations of the study area. Most of the rainfall occurs during October and April although trade wind showers occur commonly throughout the year in upper portions of the study area. Temperatures are moderate throughout the year with the warmest occurring during "Kona weather," when northeasterly trade winds fail and air tends to stagnate over the area (Armstrong, 1973).

D. Hydrology

Ground water hydrology in the area is characterized primarily by basal water floating on salt water at lower elevations and, in mountainous areas, by dike-confined freshwater. Numerous streams and gulches dissect upper portions of the study area, with Kahawainui, Wailele, and Malaekahana Streams draining into the Pacific Ocean. Two small ponds are located within the study area. One pond, north of Kahawainui Stream includes remnants of Pa'eo Fishpond. The second pond, south of Kahawainui Stream is the result of recent ground surface modifications as well as natural surface drainage. Drainage ditches associated with past and present agricultural activities are located throughout the study rea. Seven ponds developed for aquaculture are at the base of the foothills above Laie town. These ponds draw primarily from ground water sources, but eventually drain into Kahawainui Stream. Poor surface drainage characterizes much of the Kahawainui study area.

The estuarine reaches of Kahawainui Stream are characterized by wetland plant species including mangrove (Rhizophora mangle); hau; pluchea (Pluchea spp.); beach dropseed; California grass (Brachiaria mutica); and water hyacinth (Eichornia crassipes). Mangrove trees are confined primarily to the northern edge of the stream. Hau trees and shrubs and ironwood trees occur in association with the mangrove, but extend beyond the mangrove into drier areas above the stream. California grass and water hyacinth are primarily found in and along the stream on the mauka side of the bridge as opposed to the makai side where salinity is greater. California grass is a fast-growing, agressive weed which tends to form dense mats in wet areas.

Much of the floodplain and low-lying areas of the Kahawainui watershed is characterized by urban/residential, or agricultural development. Vegetation associated with these areas is typically comprised of landscape ornamentals, crop plants, and ornamental escapes or weedy species. Plants commonly found in the immediate vicinity of residences in the floodplain include those listed in Table G-1.

A freshwater marsh resembling a pasture occurs on the northern side of Kahawainui Stream and includes the small pond remnants of Pa'eo Fishpond. Both wetland and non-wetland vegetation found in this area which is characterized primarily by dense growths of California grass and occasional patches of water hyssop (Bacopa monnieria), honohono (Commelina diffusa), primrose willow (Ludwigia octivalvis), pluchea (Pluchea indica; P. odorata and P. xfosbergii), castor bean (Ricinus communis), bermuda grass (Cynodon dactylon), and Kikuyu grass (Pennisetum clandestinum). Banana (Musa paradisiaca) is grown in intermittently drier portions of the marsh. Ironwood trees and some coconut trees (Cocos nucifera) occur in the immediate vicinity of the ponds, rendering a scenic, park-like setting to the area.

Marshlands above the floodplain, near the aquaculture ponds, host similar vegetation as the lower elevation marshlands. In addition to California grass and other facultative wetland species, cultivated wetland plant species are found as well Taro (Colocasia esculenta) is the most common of these.

Roadsides and undeveloped portions of the project area are characterized by occasional large trees and extensive growths of weedy, exotic plant species. Java plum (Eugenia cumini); ironwood; African tulip (Spathodea campanulata) and guava (Psidium guajava) typically occur in the tree layer while Koa haole (Leucaena leucocephala); Christmas berry (Schinus terebinthifolius); lantana (Lantana camara); guava; hau; pluchea; and castor bean, among others, typically occur in the shrub layer. Pastures and abandoned cane fields occur throughout the watershed. These are characterized primarily by California grass and sugar cane (Saccharum officinarum). Cultivated fields throughout the project area host a number of different food plants. Banana and papaya (Carica papaya) are among the more popular cultivated species.

TABLE G-1

CHECKLIST OF PLANT SPECIES COMMONLY FOUND IN RESIDENTIAL AREAS, LAIE, OAHU, HAWAII

The following plant species are common in the residential areas of the Kahawainui Stream floodplain. The list includes those species most commonly observed near residences and is not intended to be a comprehensive checklist of ornamental and non-ornamental garden plants for Laie. The plant species listed are representative of those which may be temporarily disturbed or affected by floodproofing activities. Nomenclature generally follows St. John, 1973.

FILICINAE	
POLYPODIACEAE	
Microsorium scolopendia	Maile - scented fern
GYMNOSPERMAE	
ARAUCARIACEAE - Araucaria Family	
Araucaria heterophylla	Norfolk Island pine
MONOCOTYLEDONAE	
AMARYLLIDACEAE - Amaryllis Family	
Crinum asiaticum	Spider lily
ARACEAE - Arum Family	
Monstera deliciosa	Taro vine
Alocasia macrorrhiza	'ape
GRAMINEAE - Grass Family	
Saccharum officinarum	Sugarcane
LILIACEAE - Lily Family	
Cordyline terminalis	Ti
MUSACEAE - Banana Family	
Musa paradisiaca	Banana
PALMAE - Palm Family	
Cocos nucifera	Coconut
PANDANACEAE - Screw Pine Family	
Pandanus odoratissimus	Hala
DICOTYLEDONEAE	
ANACARDIACEAE - Mango Family	
Mangifera indica	Mango
DICOTYLEDONEAE (Cont)	
APOCYNACEAE - Periwinkle Family	
Plumeria spp.	Plumeria
ARALIACEAE - Ginseng Family	
Brassaia actinophylla	Octopus tree
BALSAMINACEAE - Balsam Family	
Impatiens sultani	Impatiens
CARICACEAE - Papaya Family	
Carica papaya	Papaya
COMPOSITAE - Sunflower Family	
Wedelia trilobata	Wedelia
EUPHORBIACEAE - Spurge Family	
Cordiaeum variegatum	Croton
LEGUMINOSAE - Pea Family	
Leucaena leucocephala	Koa haole
MALVACEAE - Mallow Family	
Hibiscus spp.	Hibiscus
MORACEAE - Mulberry Family	
Artocarpus altilis	Breadfruit
NYCTAGINACEAE - Four o'clock Family	
Bougainvillea spp.	Bougainvillea
RUTACEAE - Rue Family	
Murraya paniculata	Mock orange

G. Wetlands

Three major types of wetlands occurring within the Kahawainui watershed include California grass marshlands and wet pastures; frining marshes and aquatic beds along streams and ditches; and an estuarine mangrove/hau swamp located near the mouth of Kahawainui Stream. Portions of these wetlands provide limited habitat for the Hawaiian gallinule (Gallinula chloropus sandvicensis an endangered Hawaiian waterbird within the Kahawainui watershed. In addition, the wetlands serve a number of other important functions by providing food and shelter for avian, terrestrial and aquatic fauna; serving as natural filters of sediments, pollutants and nutrients in stream waters; buffering lands against storm waves and floodwaters; providing limited groundwater recharge; serving as pasture for grazing animals; providing a substrate for wetland agriculture; providing recreational fishing areas; and contributing to the scenic quality of the landscape.

Uncontrolled wetland vegetation growth within the confines of the streambanks and irrigation ditches impedes water flow and may contribute to flooding. Potential productive uses of wetlands within the project area include developing agriculture, recreational fishing, and parks; and improving the aquatic habitat. However, productive use is limited by the quality of the substrate (former landfill) underlying much of the wetland area.

H. Terrestrial Fauna

Most of the Kahawainui study area has been modified by urban or agricultural development. Birds and mammals characteristic of the area are typically exotic, introduced species. Of the mammals, dogs; cats; rats (Rattus spp.); mice (Mus musculus domesticus) and mongoose (Herpestes auropunctatus) are common. Of the birds, the Common Mynah (Acridotheres tristis tristis); Red-crested Cardinal (Paroaria coronata); Barred Dove (Geopelia striata striata) Spotted Dove (Streptopelia chinensis chinensis) and Japanese White-eye (Zosterops japonica japonica) occur throughout the project area. The Black-Crowned Night Heron (Nycticorax nycticorax hoactli) an indigenous waterbird is commonly found roosting in mangrove and hau trees in the vicinity of the estuarine wetland. The Cattle Egret (Bubulcus ibis), an introduced waterbird, occurs throughout the project area in wetlands, patures and garbage-ridden areas. Several species of shorebirds frequent the estuarine area of Kahawainui Stream.

I. Aquatic Fauna

Kahawainui Stream does not appear to have a diverse aquatic faunal community. This may be due in part to the poor water quality of the stream; particularly the high levels of ammonia which is generally toxic to freshwater organisms. Limited surveys by the US Fish and Wildlife Service revealed many schools of large tilapia and a few poeciliids within the stream mauka of Kamehameha Highway. No invertebrates were observed. Near the mouth of the stream juvenile mullet, poecillids, and several large tilapia were observed. Many tilapia appeared to be under stress in areas of the stream where oxygen levels were particularly low.

J. Marine Fauna

On May 4, 1981 US Fish and Wildlife Service (FWS) biologists conducted a marine biological reconnaissance of Laie Bay in the vicinity of the project area. No fish or other macrofauna were observed in the Basy directly offshore from the project area between the shore and approximately 300 yards offshore. From the mouth of Kahawainui Stream north to Kalanai Point the more solid substrate was found to provide habitat for a variety of organisms. Occasional heads of Pocillopora meandrina and encrusting patches of Porites lobata were observed although coral cover overall was limited. The most conspicuous benthic organism observed was the coralline alga Porolithon sp., which occurred as "heads" reaching 12 inches or more in diameter, with a density of approximately $1/m^2$ over much of the area. A healthy fish population was observed in this area, with some specimens being larger than usual for their species in shallow (10-20 feet) water. A list of macrofauna observed in the area is provided as Table 2 of the FWS Supplement to the Planning Aid Letter included in this Appendix.

K. Endangered Species

Many wetlands in Hawaii are known to provide habitat for endangered waterbird species. The endangered Hawaiian gallinule was recently observed in the pond/wetland area north of Kahawainui Stream. No other listed, proposed or candidate endangered or threatened species of animals were observed within the Kahawainui study area although a candidate endangered or threatened plant species, Capparis sandwichana var. sandwichiana, is known to occur at Pounders Beach outside the project area, several hundred feet away from the mouth of Wailele Stream.

L. Prime Agricultural Lands

The State of Hawaii has designated lands in Hawaii according to their uniqueness and suitability for agricultural use. "Prime Agricultural Land" is defined as land which has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops economically when treated and managed according to modern farming methods. "Unique Agricultural Land" is defined as land that has the special combination of soil quality, location, growing season, moisture supply and is used to produce sustained high quality and/or high yields of a specific crop when treated or managed according to modern farming methods. "Other Important Agricultural Land" is land other than Prime or Unique Agricultural Land that is also of statewide or local importance for agricultural use. Both Prime and Other Important Agricultural Lands Occur within the Kahawainui Watershed.

M. Wildlife Refuges

No State, Local or National Wildlife Refuges occur within the Kahawainui study area. However, offshore, between Laie Point and Makahoa Point a number of rock islands have been designated as wildlife sanctuaries under Chapter 125, Title 13, Hawaii Revised Statutes. Mokualai Island; Kukuihoolua Island; Pulemoku Rock, Mokuauia Island; and Kihewamoku Island are all included in the Hawaii State Seabird Sanctuary.

N. Migratory Birds

No breeding or nesting habitat for migratory birds occur within the study area.

O. Scenic and Wild Rivers

No rivers designated or potentially designated as wild, scenic or recreational pursuant to the Wild and Scenic Rivers Act occur within the project area.

P. National Trails

No National Trails are located within or near the project area.

Q. National Shorelines, Parks or Beaches

No National Shorelines, Parks or Beaches occur within or near the project area. Malaekahana State Park is located north of the project area.

R. Coastal Resources

Excerpts from US Army Corps of Engineers Coastal Resource Studies at Laie are provided at the end of the appendix.

II. US FISH AND WILDLIFE COORDINATION

A. Fish and Wildlife Coordination Act of 1958

The Fish and Wildlife Coordination Act of 1958 (FWCA) requires that fish and wildlife conservation receive equal consideration with other project purposes and be coordinated with other features of water resource development. All pre-authorization and post-authorization planning or project development must be coordinated with the FWS; National Marine Fisheries Service (NMFS) as appropriate; and the agency administering fish and wildlife resources of the State wherein the construction is contemplated.

Pursuant to the FWCA, the Corps formally contacted the FWS and received a Planning Aid Letter (PAL); a Supplement to the PAL; and a final FWCA report. The documents are reproduced in Section II.C. below.

B. Endangered Species Act

The Endangered Species Act of 1973, as amended, requires that all Federal agencies, in consultation with the Secretary of the Interior, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for conservation of endangered and threatened species listed and protected by this Act. Section 7 requires that each Federal agency insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat.

Section 7(c) of the amended Act requires the Corps to request of the FWS information regarding species listed or proposed to be listed that may occur in the proposed project area. If the FWS advise that listed species may occur, the Corps must conduct a biological assessment to identify any listed species likely to be affected by the project.

By letter of May 29, 1981, the Corps requested information on endangered species, listed or proposed, which may be present at the site of the proposed Kahawainui project area. By letter of June 15, 1981 the FWS advised the Corps that no species listed or proposed as endangered or threatened are present in the project area, thus fulfilling the requirements of the Endangerd Species Act. In July 1983, two endangered Hawaiian gallinule were observed in the project area by Corps and FWS personnel. By letter of September 28, 1983 the Corps requested initiation of formal Section 7 Consultation, and received a biological opinion from FWS in November 1983 stating that "likely no jeopardy" to the species would occur.

C. Coordination Documents

Following are reproductions of the FWS Planning Aid Letter (PAL); Supplement to the PAL; Endangered Species Coordination; and final FWCA Report.

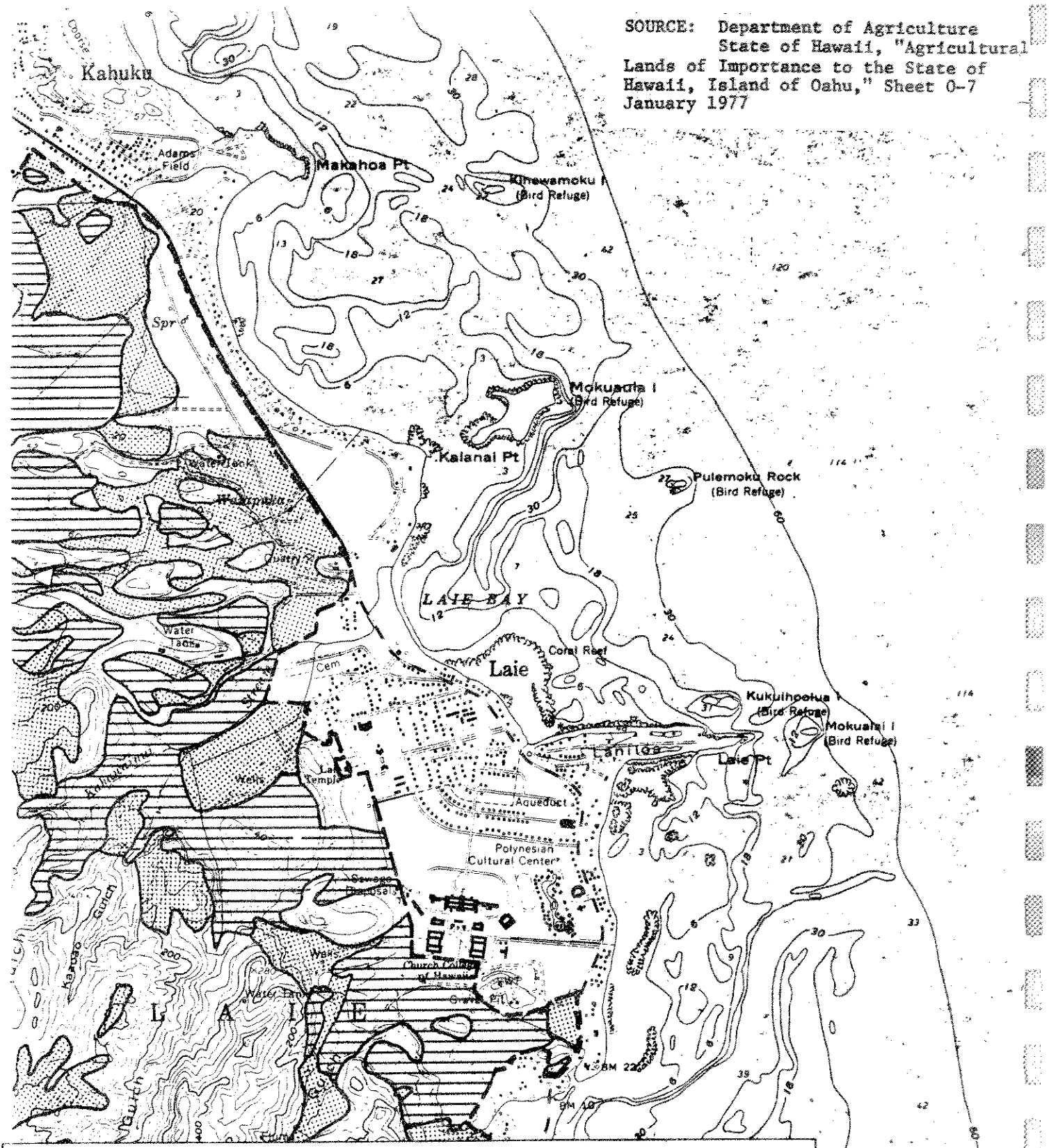
The following are excerpts from various US Army Corps of Engineers Coastal Resources Studies and State of Hawaii reports:

1. Agricultural Lands of Importance to the State of Hawaii, Island of Oahu, Sheet O-7, Department of Agriculture, State of Hawaii, Jan 1977.

2. Oahu Coastal Zone Atlas prepared by AECOS, Inc., for the US Army Corps of Engineers, 1981.

3. Oahu Coral Reef Inventory, Part B prepared by AECOS, Inc., for the US Army Corps of Engineers, July 1979.

SOURCE: Department of Agriculture State of Hawaii, "Agricultural Lands of Importance to the State of Hawaii, Island of Oahu," Sheet O-7 January 1977



LEGEND:

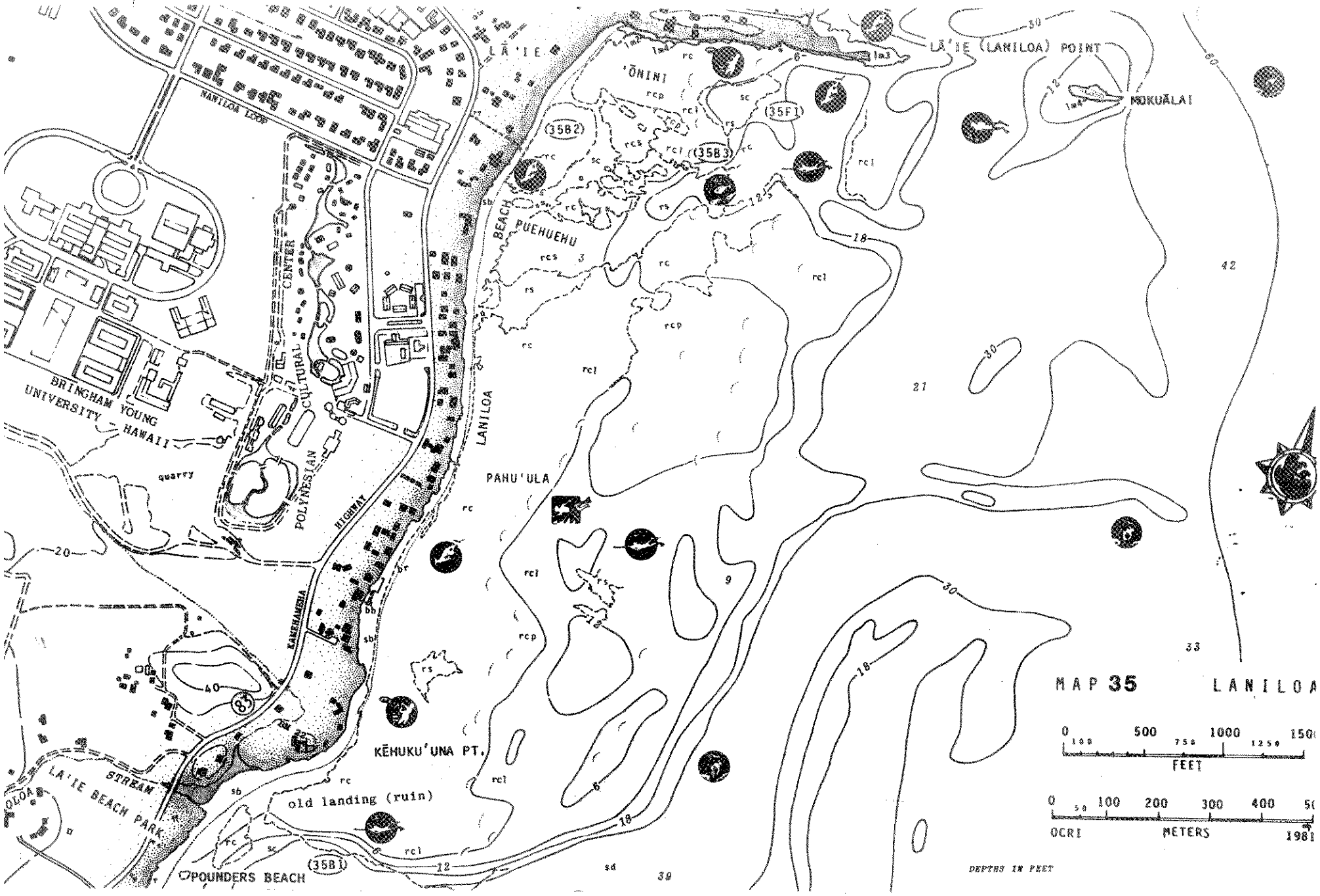
PRIME AGRICULTURAL LAND - Land which has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops economically when treated and managed according to modern farming methods.

UNIQUE AGRICULTURAL LAND - Land that has the special combination of soil quality, location, growing season, moisture supply, and is used to produce sustained high quality and or high yields of a specific crop when treated and managed according to modern farming methods.

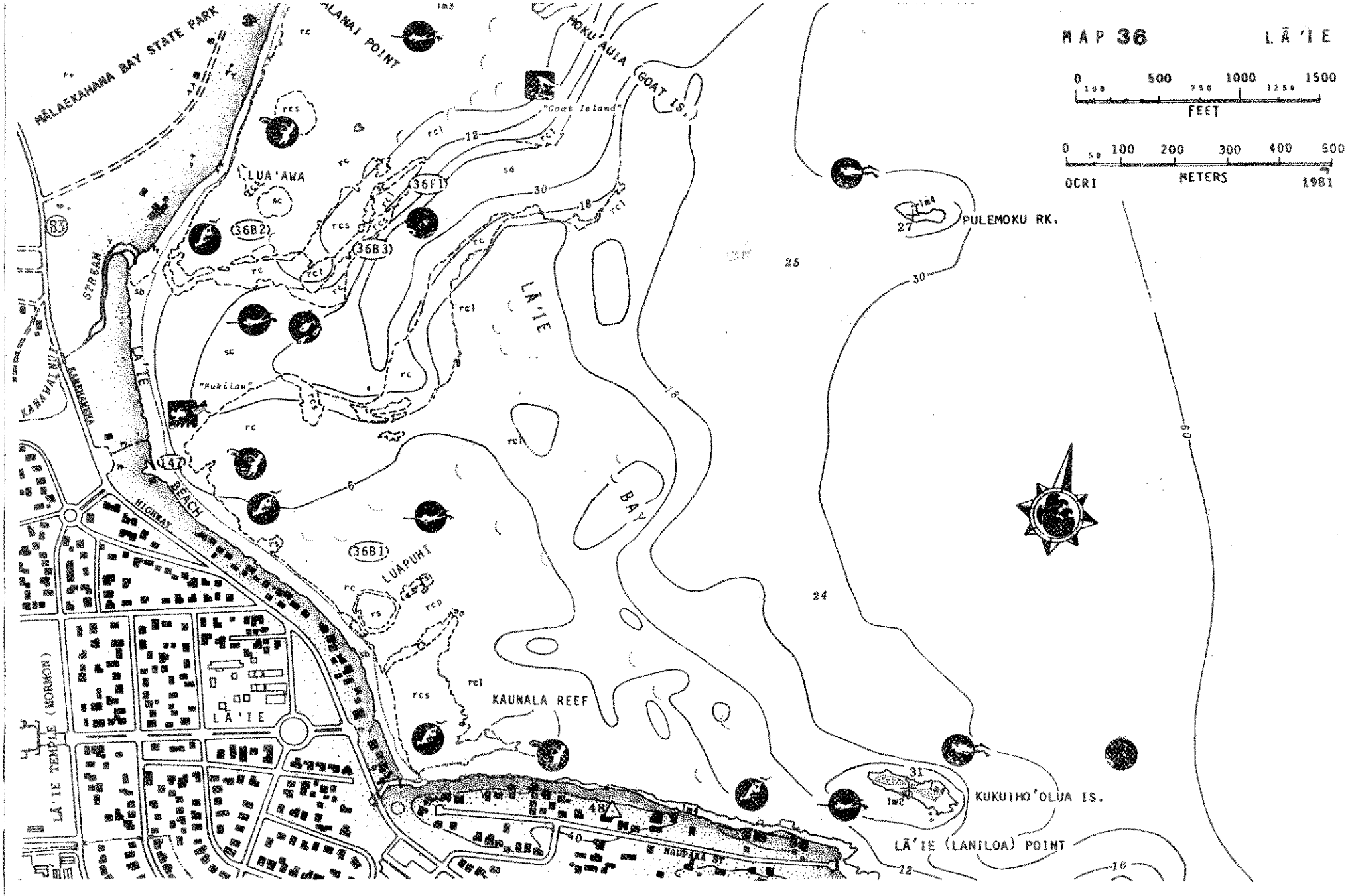
OTHER IMPORTANT AGRICULTURAL LAND - Land other than Prime or Unique Agricultural Land that is also of statewide or local importance for agricultural use.

EXISTING URBAN DEVELOPMENT - Land which has been developed for urban type use.

U.S. GOVERNMENT - Land which is currently under the jurisdiction of the U.S. Government.



ource: Oahu Coastal Zone Atlas, epresenting the Hawaii Coral Reef nventory Island of Oahu, Part C, repared by AECOS Inc. for the US rmy Corps of Engineers, 1981.



Source: Oahu Coastal Zone Atlas, Representing the Hawaii Coral Reef Inventory Island of Oahu, Part C, prepared by AECOS Inc. for the US Army Corps of Engineers, 1981.

Map Legend

coastline

The coastline is represented by two lines: a vegetation line and a shoreline (see Figure A). The vegetation line is usually a solid line with stipling grading inland from dense to light. This line is dotted or broken and light stipling is used where the vegetation is sparse (and hence, the position of the vegetation line uncertain). The line may be absent on recent lava flows where the vegetation is too sparse to be seen on the aerial photographs.

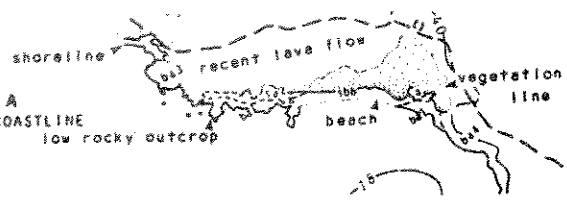


Fig. A
LOW COASTLINE

The water line or shoreline is drawn as a solid line on rocky shores where its actual position (at the scale of the maps) is unchanged by tidal fluctuations. The shoreline is a dotted line on depositional shores (beaches) and on low rock outcrops where the position is uncertain or likely to change dependent on the state of the sea or tide.

Shoreline types are indicated by appropriately placed letter codes (see Figures A & B). These fall into three basic categories:

1) Volcanic rock shores (ba)
2) Beaches (sa or sb)
3) Man-made shoreline structures (bb or bc)

Various letters or numbers added as a third "digit" modify or subdivide these basic categories. All types used on the Maui maps are defined below.

VOLCANIC ROCK SHORES (ba)

- ba1 - Low outcrop (under 3 feet or 1 m in height above sea level); abrasion ramp; or bench.
- ba2 - Talus (boulders) at the base of a cliff.
- ba3 - Low outcrop to low cliff, 3 to 10 feet (1 to 3 m) in height (access to water generally not difficult).
- ba4 - Sea cliff rising generally between 10 and 30 feet (3 to 10 m) above sea level (access to waterline difficult).
- ba5 - Sea cliff rising generally more than 30 feet (10 m) above sea level (access to the waterline generally dangerous to impossible).

Note that types ba4 and ba5 may combine with other types (including beach types) where these other types occur along a shore at the base of a seacliff (Figure B).

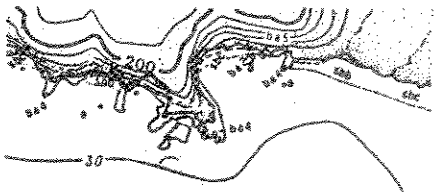


Fig. B
HIGH COASTLINE

DEPOSITIONAL SHORES (BEACHES)(s)

- sa - Storm beach; sand and boulders deposited behind rocky shore types above the high water line.
- sb - Sand beach of predominantly calcareous (reef rock) material.
- sbi - Sand beach of predominantly detrital sediments.
- sbb - Boulder beach (differs in processes operating from ba2 type although these types are not always readily distinguishable in aerial photographs).
- sbc - Cobble and shingle ('ili'ili) beaches
- sbr - Poorly sorted deposits of rubble, gravel, and sand usually associated with either protected shores behind a fringing reef or with deposits at a stream mouth.

MAN-MADE SHORELINE STRUCTURES

- bb - Boulder revetment, usually basalt "blue rock".
- bc - Cement substratum; revetment, seawall, or pier.

offshore bottom types

Differentiation from aerial photographs of offshore bottom types is highly dependent on factors of depth, water clarity, water surface smoothness, and light level and angle. One or more of these factors will obscure to a greater or lesser degree some or all of the bottom in any aerial photograph of the marine realm. To the extent possible with the available photographs, the boundaries between bottom types are designated by a dashed line (see Figure C). Bottom types are differentiated into three basic categories: rb - hard bottom; sc or sd - soft bottom (sediments); and rc - mixed bottom types associated with (usually) shallow reef formations. Subtypes are indicated by additional letter codes (e.g., rbb, rci). Where clearly demarcated, dashed lines may separate sub-types, although in many instances substratum gradients occur which do not allow an unambiguous line to be drawn.

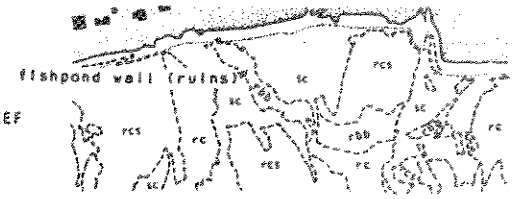


Fig. C
SHALLOW REEF

HARD BOTTOM AND DEEP REEF BOTTOM TYPES (rb)

rb - A solid or hard bottom; a massive rock surface.
rbb - Submerged field of large to massive boulders; underwater extension of sbb and ba2 shore types.
rbc - Cobbles or small boulders; generally found off sbb and sbc shore types, or off a stream mouth.
rbs - Hard bottom with sand pockets, the latter comprising generally less than 50% of the area of the designated formation;
rs - Hard bottom with sand pockets comprising 50% or more of the formation; or hard bottom with extensive sand cover; or predominantly sand bottom with numerous scattered outcrops of rock.

SHALLOW REEF BOTTOM TYPES

rc - Complex reef bottom type consisting of a mixture of limestone boulders and outcrops, and sand; hard bottom, rubble, or boulders predominate.
rcl - Predominantly consolidated limestone surface.
rcs - Complex reef bottom type consisting of a mixture of limestone rubble and (mostly) sand.
rs - Sand pocket with scattered outcrops of limestone and/or limestone boulders.
sc - Areas of sand bottom without significant proportion of limestone rock.

SOFT BOTTOM TYPES

sc - Sand channel or large sand patch in water 30 feet (10 m) deep or less; without outcrops of hard bottom or admixture of boulders.
sd - Same as sc only in water greater than 30 feet (10 m) deep (note that at depths greater than 30 feet [10 m] small outcrops of rock bottom may not be apparent in aerial photographs).
rs - Soft bottom with scattered boulders or small outcrops of rock.

special designations

Both along the shore and offshore, special features are indicated by codes, symbols, or abbreviations as indicated below.

- Position of wave break as seen in aerial photographs (assumes typical conditions were prevailing at the time of the fly-over).
arch - A natural arch cut by waves in a rocky shore.
br - Beachrock formations.
co - Live coral cover (as indicated in field surveys) exceeding 50% cover of the bottom.
ramp - Public or private boat ramp along the shore.
tp - Prominent tide pool or pools.
- Public right-of-way to shore; state or county park.

use symbols

The following symbols are used to designate uses and activities identified as commonly occuring along and off the coast. The placement of a use symbol indicates a general location for the particular activity.

Uses related to nearshore biota (e.g., coral communities).

Pole-and-line fishing

Gill-netting

Throw-netting

Spearfishing

Torching

Trapping

Lobster

Sea urchin (wana)

Octopus (he'e)

Baitfish

Aquarium fish collecting

Seaweed (limu)

Sport-diving

Shell collecting

Shoreline and deep-water fishing activities:

Crabbing (kona,'a'ama, swimming crab)

Limpet (opihi)

Trolling, bottom-fishing

Specialized fisheries (type indicated)

Uses not related to biota:

Board surfing

Body Surfing

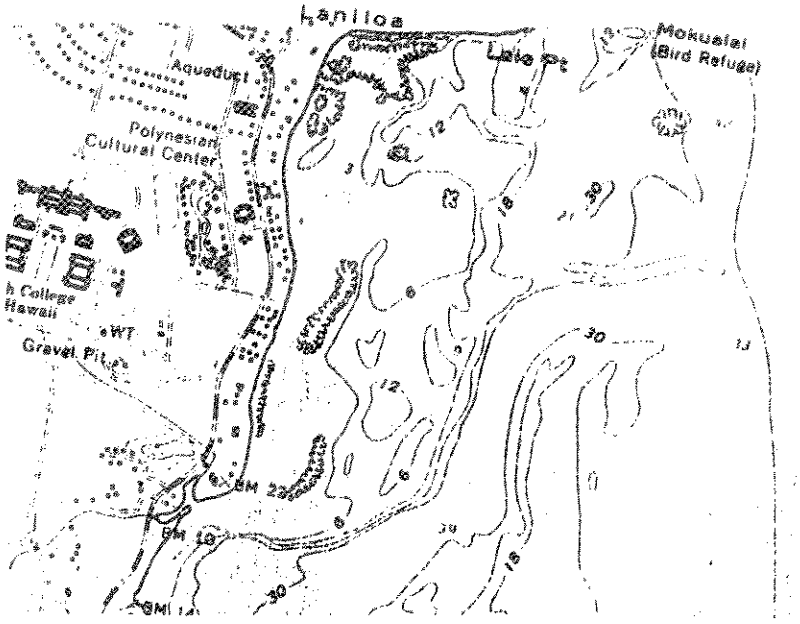
Canoe paddling

Sailing

Aquatic recreation (smallcraft sailing, wind-surfing)

Excursion boat

Anchorage



MAP 35 LANILOA

(LA'IE, LA'IE POINT, LANILOA BEACH, POUNDERS BEACH, MOKUALAI, KOLOA STREAM)

- Kahuku Quadrangle
- POD, 1:6000 BW, 2:

PHYSIOGRAPHY

LA'IE - KOLOA STREAM

La'ie is situated on a plain of inactive dunes and beach ridges -- accumulations of sand now lithified. (Also MAP 36). Although flow in Koloa Stream is intermittant, a relatively large muliwai forms behind Pounders Beach immediately south of Kehuku'una Point where the stream empties into the sea.

POUNDERS BEACH - OFF KEHUKU'UNA POINT

The sand shoreline between the points of Kehuku'una and Pali Kilo I'a (MAP 34) was once known as Pahumoa, but today goes by the name "Pounders" -- a reference to the crushing shorebreak (39). A steep-walled sand channel runs nearly parallel to shore off La'ie south of La'ie Point, turning into shore off Kehuku'una Point. This channel broadens into a sand shelf off Pounders and Kokololio (MAP 34) Beaches. A small ledge of consolidated limestone off Pali Kilo I'a Point separates Pounders Beach from Kokololio Beach. A similar ledge, at a depth of about 6 feet (2 m) occurs off Kehuku'una Point, rising up to the reef flat north of the point and dropping off into deeper water of the sand channel offshore (OCRI-35B1).

Source: Oahu Coral Reef Inventory, Part B, prepared by AECOS, Inc. for the US Army Corps of Engineers, July 1979.

LA'IE POINT

La'ie (Laniloa) Point is the most prominant of a series of limestone points that jut out from the coast between La'ie and Kahuku (see MAP 38). (See MAP 36).

LANILOA BEACH

To the south of Laniloa Point is a stretch of beach over one mile (1.6 km) long, ending at Kehuku'una Point. Beachrock is present as thin, seaward dipping beds in the wave-wash zone (327). Extending offshore is a shallow, fringing reef. A 10-foot (3 m) deep, sand-bottom channel runs across this reef near the north end, dividing into two branches that terminate in sand pockets at the beach. The southern part of the beach has been severely eroded (39). The 1946 tsunami caused runup to heights of 9 to 14 feet (3 to 4 m) above sea level at Laniloa Beach (329).

MOKUALAI ISLAND

A small island off La'ie Point is the top of an old sand dune (now mostly under water) that has turned to stone (lithified)(Also MAP 36).

FLORA AND FAUNA

OFF POUNDERS BEACH AND KEHUKU'UNA POINT

Few corals occur along the reef margin to the north of Pounders Beach. The most prominent forms of benthic life are seaweeds. Algal cover is less than 5% on shallow rubble near shore, increasing to 80% of the bottom on the outer reef flat. The dominant algae are Hypnea sp. and Galaxaura oblongata (OCRI-35B1).

Several species of sea cucumbers are present on the sand bottom. Fishes are most prevalent along the margins of the deep sand channel. The most common of 15 species recorded are Stethojulis balteata, Sufflamen bursa, Thalassoma duperreyi, Acanthurus nigrofuscus, A. triostegus, Parupeneus pleurostigma, and P. porphyreus (OCRI-35B1).

OFF LANILOA BEACH

Coral cover is sparse (not exceeding 3%) on the shallow reef flat and reef slope off Laniloa Beach. Porites lobata is the predominant coral. Algal cover, on the other hand, is high in these areas, reaching 90% of the bottom in some places (OCRI-35B2). Directly south of La'ie Point, Porolithon sp. and Asparagopsis taxiformis are abundant. Coral cover reaches 20% near the breaker zone. Montipora flabellata is the dominant species, followed in abundance by Porites lobata (OCRI-35B3).

Abudefduf abdominalis is common on the reef flat (OCRI-35B2). In deeper water (-5 to -15 feet, -2 to -3 m) of the reef front at least 27 species of fish are recorded. However, none can be

considered common in occurrence (OCRI-35F1).

WATER QUALITY

NEARSHORE WATERS

Nearshore waters are classified as open coastal class "A" by the Department of Health (189). Nonpoint source runoff and stream discharges are significant, and coastal waters are generally discolored by red sediment after heavy rains. Underwater visibility is generally about 20 feet, reducing to around 10 feet in areas of wave turbulence (OCRI).

HISTORICAL AND ARCHAEOLOGICAL SITES

LA'IE LANDING

The remnants of an old landing pier, where interisland ships once called, are seen at Pounders Beach. In times past, two elevated points that bound Pounders were used for fish spotting to direct net fishermen (39).

KEHUKU'UNA

A few stones on Laniloa Beach are all that remain of a fishing shrine (also Kaihuku'una) near Kehuku'una Point (215).

USES

LITHIFIED DUNES

Lithified dunes on the coastal plain are quarried and crushed for a source of commercial sand (208).

POUNDERS BEACH

Pounders Beach is fairly wide and steep and is one of the more popular spots on O'ahu for shorebreak bodysurfing. The area is privately owned but open to the public. Camping is not permitted. The part of the beach near Kehuku'una Point is protected by a reef and generally safe for swimming. The south end of the beach receives a pounding shorebreak in the winter months and nearshore currents can be dangerous. The sand bottom extending from the beach drops off rapidly to a deep sand channel, which is another potential hazard (39). The shoreline tends to accumulate driftwood and is excellent for beachcombing. Shorecasting and pole fishing for moi, 'o'io, papio, and sand-bottom fishes occur along this shoreline. Some oama fishing takes place adjacent to Kehuku'una Point, but water depth and sea conditions are usually not suitable for this activity. Throw-netting is common off the Point (OCRI;39).

MOKUALAI

Both Mokualai and nearby Kukuiho'olua (MAP 36) islets are

State Bird Sancturies. Human activities on the islets are restricted (326). The waters around the islets make fascinating recreational diving, but this activity is limited to summer months when the ocean is calm.

LANILOA BEACH - LA'IE POINT

Laniloa (La'ie) Point and adjacent areas of the coast are moderately fished by sport and subsistence fishermen. Surf conditions determine entry points and fishing methods. Generally, pole and throw-net fishing for reef fishes is commonest along La'ie Point. Spearfishing, pole fishing, and net laying occur primarily off the beaches south of the Point. Trapping offshore is infrequent due to rough seas. (Also MAP 36).

Access to Laniloa Beach by a public right-of-way from Kamehameha Highway. Off nearly the entire shoreline is a platform of limestone, broken by two sand pockets formed where channels cross the shelf to the south of Laniloa Point. Although the waters are well protected, the two sand pockets are the only good swimming spots. Strong currents are generated by storm waves (39). Board surfers visit the area when surf is large.

STUDIES AND SURVEYS

16 - Bathen (1978): fig.s 7,8,19,20. Compilation and analysis of offshore water circulation data.

360 - Pottratz (1968): Grain size analysis of beachrock samples from south of La'ie Point. Grain size analysis and dip measurements of inland lithified sand dunes.

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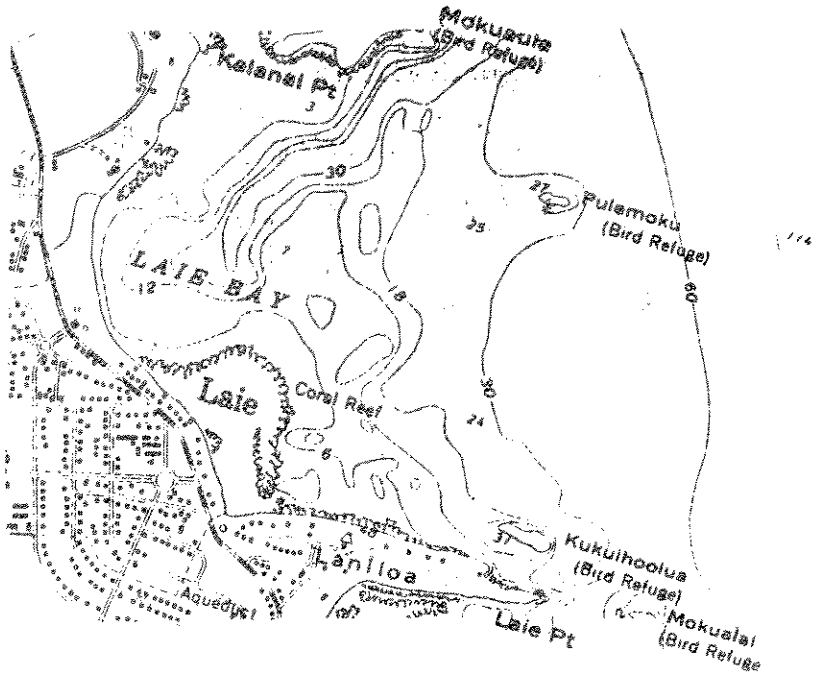

MAP 36 LA'IE

(LA'IE, LA'IE BAY, LA'IE POINT, KALANAI POINT, MOKU'AUIA, PULEMOKU ROCK, KUKUIHO'OLUA ISLET, MOKUALAI (ISLET), KAHAWAINUI STREAM)

- Kahuku Quadrangle
- POD, 1:6000 BW, 2:

PHYSIOGRAPHY

LA'IE - KAHAWAINUI STREAM

La'ie is situated on a broad plain of lithified sand. Most of the old dunes on this plain have been leveled (39). Lithified sand overlying reef limestone 70 feet (21 m) above sea level is considered evidence of a previous stand of the sea (La'ie Stand) at this elevation (128). Kahawainui Stream is continuously flowing, unchannelized and undiverted (223).

LA'IE POINT

La'ie (or Laniloa) Point is the most prominent of a series of points that jut out from the coast between La'ie and Kawela (MAP 41). La'ie Point is a well-defined ridge of lithified dune sand extending below sea level and overlying a raised reef. A conspicuous nip has been cut into the limestone shore by waves (128). Percolating freshwater has developed internal caverns, some collapsed as sinkholes (209). This coast is subject to high surf and tsunami flooding (88). The tsunami of 1946 caused runup to a height of 13 feet (4 m) at La'ie Point (20;329).

LA'IE BAY

Like Malaekahana Bay (MAP 37) to the north, La'ie Bay lies between two points of consolidated limestone: La'ie Point on the south and Kalanai Point on the north. The northern margin of the Bay is further defined by Moku'auia (Goat Island) directly off Kalanai Point. Shallow, limestone shelves lie along portions of the shore, although a broad sand channel extends into the Bay, terminating at La'ie Beach. The sand channel runs seaward close to Moku'auia Island.

South of Kalanai Point is a shallow, reef shelf, with a 15 to 20 foot (5 to 6 m) deep, circular, sand-bottom pocket (named Lua-'awa). Large sand pockets occur on the reef slopes (OCRI-36B2,B3). The shallow reef flat south of the channel also has a circular, sand-bottomed pocket (named Luapuhi) a short distance off shore. The latter shelf extends seaward as a submerged reef along the southern side of the 30-foot (9 m) deep sand-channel entering La'ie Bay (OCRI-36B1).

LA'IE BEACH

La'ie Beach curves southward from Kalanai Point for 1.5 miles (2.5 km) to near the landward end of the lithified dune ridge forming La'ie Point. Because of the wide sand channel running offshore, the middle section of the steep-sloping beach is exposed to ocean swell. This coast is subject to high surf and tsunami flooding (88).

MOKU'AUIA (GOAT ISLAND)

Moku'auia (Goat Island) is composed of old, lithified dunes and is separated from Kalanai Point by a shallow reef flat. A pebble beach occurs on the side facing the open ocean (39). (Also MAP 37).

PULEMOKU ROCK, KUKUIHO'OLUA ISLET, MOKUALAI (ISLET)

In addition to Moku'auia, four smaller islets composed of lithified sand are found off the coast: Kihewamoku off Makahoa Point (MAP 37), Pulemoku Rock offshore of La'ie Bay, and Kukuiho'olua and Mokualai islets off La'ie Point. The tsunami of 1946 broke through a cave on the outer face of Kukuiho'olua and formed a sea arch in this tiny islet (39).

FLORA AND FAUNA

LA'IE BAY

Few corals occur on the scoured, sand-veneered surface of the nearshore limestone shelf off the southern shore of La'ie Bay. Algal cover approaches 50% on the shallow flat, with Asparagopsis taxiformis, Halimeda discoidea, Martensia sp., and Galaxaura sp. most prevalent (OCRI-36B1).

The small limestone shelf south of Kalanai Point is nearly

devoid of corals and fishes. Seaweeds are abundant, covering 80% of the hard bottom nearshore, decreasing considerably towards the sand channel. Nearshore, Acanthophora spicifera, Asparagopsis taxiformis, and Halimeda discoidea are the most abundant forms, with Porolithon gardineri common (OCRI-36B2). At the margin of the sand channel, Dictyopteris sp., Jania sp., and Codium sp., are the principal algal species. Only a few corals are present (mostly Pocillopora damicornis and Porites lobata) and cover does not exceed 1% of the bottom (OCRI-36B3).

Only six species of fish are recorded from the inner part of La'ie Bay of which the most common are Acanthurus triostegus, Abudefduf abdominalis, and Thalassoma duperreyi (OCRI-36B1,B2). Along the sides of the sand channel, the fauna is more diverse (18 species recorded). Here, the most commonly encountered fishes are Thalassoma duperreyi, and Plectroglyphidodon imparipennis (OCRI- 36F1).

MOKU'AUIA (GOAT ISLAND)

(See MAP 37).

WATER QUALITY

LA'IE BAY

Nearshore waters are classified open coastal "A" by the Department of Health (189). Discharge from Kahawainui Stream discolors the water during and after heavy rains. Underwater visibility is 20 feet, decreasing to 10 feet in areas of wave turbulence (OCRI). In the late 1950's, the blue-green alga, Lyngbya majuscula, caused an epidemic of swimmer's itch at La'ie (12). There are cesspools behind the shoreline (186), and the sewage treatment plant at La'ie discharges approximately 0.133 mgd of essentially untreated sewage into the Bay. This discharge is the only significant artificial, point source discharge into nearshore waters between Kane'ohe Bay and Hale'iwa (309).

KAHAWAINUI STREAM

The quality of Kahawainui Stream is rated III: moderate to low natural values and/or water quality (223).

HISTORICAL AND ARCHAEOLOGICAL SITES

KUKUIHO'OLUA AND MOKUALAI (ISLETS)

In Hawaiian legend, the tiny islets off La'ie Point are said to be the carcasses of two mo'o (lizards) that once guarded this section of the coastline until slain by Hawaiian demigods (39).

USES

LA'IE POINT

La'ie (Laniloa) Point and adjacent areas of the coast are

moderately fished by subsistence and sport fishermen. Surf conditions restrict access and fishing methods. Generally, pole and throw-net fishing for reef species is common around the Point. La'ie Point illustrates several different stands of the sea and is a scenic landmark as well as an interesting geological feature (101; 210).

LA'IE BEACH

The shallow limestone shelf (Kaunala reef) extending from the shoreline inside La'ie Point protects inshore waters at the southern end of La'ie Beach, although the best swimming is not over this rocky bottom, but opposite the sand channel at the middle of the beach. Breaking waves and longshore currents, particularly in winter, can be dangerous off the section unprotected by fringing reef (39). When large surf strikes the coast, currents running seaward in the channel can be strong (OCRI). The beach attracts body surfers who ride the small shorebreak (39). Winter waves attract board surfers to the area as well, creating potential conflicts with body surfers. When trade winds blow steadily, Portuguese man-of-war may drift into the Bay. Shark-sightings are occasionally reported by surfers (86).

Thrownetting, and pole and shorecasting for goatfish, papio, and ulua are popular activities. Until 1970, La'ie Beach was renowned for hukilau style fishing. The beach can be reached by two public rights-of-way with parking and grassy-areas at the north and south ends of the beach.

MOKU'AUIA, PULEMOKU, KUKUIHO'OLUA, AND MOKUALAI (ISLETS)

The offshore islets are State Bird Sanctuaries, with strict limitations on access and activities (326). A shallow, sand beach in the lee of Moku'auia Island is well protected from waves and safe for swimming. The Island can be reached by wading across a narrow shelf of limestone from Kalanai Point. The crossing is easiest at low tide during calm seas but is possible even during high tide and high seas (39). The Island offers outstanding scenic vistas.

Board surfing is often excellent during the winter months on the windward side of Goat Island, but the long paddle and strong currents on this exposed side of the Island discourage use. A shallow bottom and shark-sightings are other potential hazards (86). The waters surrounding Moku'auia, Pulemoku Rock, Kukuiho'olua, and Mokualai are popular destinations for diving enthusiasts during summer months of calm seas.

STUDIES AND SURVEYS

16 - Bathen (1978): figs. 7, 19. Compilation and analysis of offshore water circulation data.

147 - Moberly and Chamberlain (1964): p. 62-3, fig. 34. Compositon and sorting of La'ie Beach sand and seasonal changes in beach profile.

360 - Pottratz (1968): Grain size and dip of the lithified dunes at La'ie Point.

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
300 ALA MOANA BOULEVARD
P.O. BOX 50167
HONOLULU, HAWAII 96850

IN REPLY REFER TO:
ES
Room 6307

MAR 1981

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DDE
ASE
SLA

March 26, 1981

Colonel Alfred J. Thiede
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858

Re: (PAL) Kahawainui Stream
Flood Damage Reduction Study
Oahu, Hawaii

Dear Colonel Thiede:

This is the U.S. Fish and Wildlife Service's Planning Aid Letter (PAL) regarding plans by the Honolulu District of the U.S. Army Corps of Engineers to reduce flood damage in the Kahawainui Stream drainage basin, Oahu, Hawaii. These comments are preliminary in nature and do not constitute the report of the Secretary of the Interior on the project within the meaning of Section 2(b) of the Fish and Wildlife Coordination Act. When a final construction plan is selected and provided to the Service, a Section 2(b) report will be prepared.

This document has been prepared using various reports provided by the Corps, a survey of the project site by Service biologists, and other relevant data. Due to high surf conditions in the project area, Service field work has not been completed. When additional investigations have been completed, a supplemental PAL will be provided. We hope to provide the supplement before April 15, 1981.

DESCRIPTION OF THE AREA

Kahawainui Stream drainage basin is located on the northern edge of the town of Laie and drains an area of approximately 5.3 square miles. During some flow conditions the stream empties into Laie Bay after passing through a small mangrove swamp. During other times, a beach sand berm closes the mouth and prevents flow into the bay. Wailele Stream forms the southern boundary of the project area. It was dry during our site inspection.

CONSERVE AMERICA'S ENERGY

Save Energy and You Serve America!

Flora

The vegetation at the mouths of the streams is comprised primarily of exotic species as mangrove, pluchea, and ironwood. Included, however, are remnants of the native strand vegetation as beach morning glory, beach dropseed grass, hau, and others. There are no listed or candidate threatened or endangered plant species in the project area.

Moving inland from the beach, the waterways pass through highly disturbed areas: pasture land and abandoned cane fields. The vegetation of these areas consists almost exclusively of common, exotic, weedy grasses, forbs, shrubs and an occasional tree. Dominant species include California grass, kikuyu grass, koa haole, castor bean and pluchea. Few native plants were encountered, and these were some of the most common, indigenous species.

Fauna

The project area is essentially urban and contains the usual exotic and introduced species of birds and mammals. Dogs, cats, rats, and mongoose are common. During our site inspection common introduced birds observed were the Common Mynah, Red-crested Cardinal, Cattle Egret, Black-crowned Night Heron, Barred Dove, Spotted Dove, and Japanese White-eye. Additionally, several species of shore birds were seen in the estuarine area of Kahawainui Stream. There are no listed or candidate threatened or endangered species of animals in the area.

Near the mouth of the stream some juvenile mullet, poeciliids, and several large tilapia were observed. Further up stream, between sampling stations 3 & 4 (Figure 1), there were many schools of large tilapia as well as a few poeciliids. No invertebrates were observed in the stream; however, sampling is not yet complete.

Water Quality

In many places the stream bottom has several feet of soft, black, silty muck, which gave off a faint hydrogen sulfide odor. Some physical and chemical properties of the water were measured at four locations (Table 2). More stations will be sampled at a later date.

DISCUSSION

All of the vegetation along the waterways will be completely and permanently destroyed by the proposed stream channelization. The majority of these plant species are common, naturalized exotics. None are unique to this island, nor are any of the trees to be considered candidates for the County Arboriest Committees' exceptional tree list. The same can be

said of the few native species seen during the survey: none are exceptional specimens of the species, none are restricted to the Laie area, none are candidate threatened or endangered species, and no association of species seen is unique to the Laie area. The Service does not believe the construction of the proposed project would have a significant impact on the total island population of any of the species involved.

A candidate endangered or threatened species, Capparis sandwichiana var. sandwichiana, grows at Pounder's Beach. As this is several hundred feet away from the mouth of Wailele Stream, no impact due to the proposed project on this species is anticipated.

Kahawainui Stream water contains fairly high concentrations of ammonia and does not appear to have a diverse faunal community. This may be due to the generally toxic effect ammonia has on fresh water organisms. As long as small agricultural plots remain in the area and drain into the stream, the ammonia levels will probably remain high. Channelizing the stream should not have a significant adverse impact on the populations of tilapia or poeciliids, although they may be displaced during construction. Long-range plans indicate more development for the Laie area which could result in less agricultural chemicals entering the stream. This change in water chemistry might permit recolonization by endemic stream organisms in the future.

The estuarine/swamp area between the beach and Kamehameha Highway is used for recreational fishing by local residents. Additionally, the dense mangrove area adds a pleasing vista to the park setting.

RECOMMENDATIONS

The U.S. Fish and Wildlife Service recommends that the lined portion of the channel above Kamehameha Highway incorporate a "low flow" channel and that vegetation be planted along the sides of the channel. This will prevent severe temperature elevation of the water, thereby making the stream more attractive to endemic organisms. For the area between Kamehameha Highway and the beach, the Service recommends normal flows all be directed into the existing stream channel/mangrove swamp, and only flows large enough to create flooding be directed through the new riprap channel. This action will preserve the character of the park while allowing rapid movement of flood potential waters.

Sincerely yours,

William B. Lerman
for Ernest Kosaka
Project Leader for
Environmental Services

Location of 4 Sampling Stations on Kahawainui Stream

(Map adapted from Hawaii Tax Map # 5-5-09)

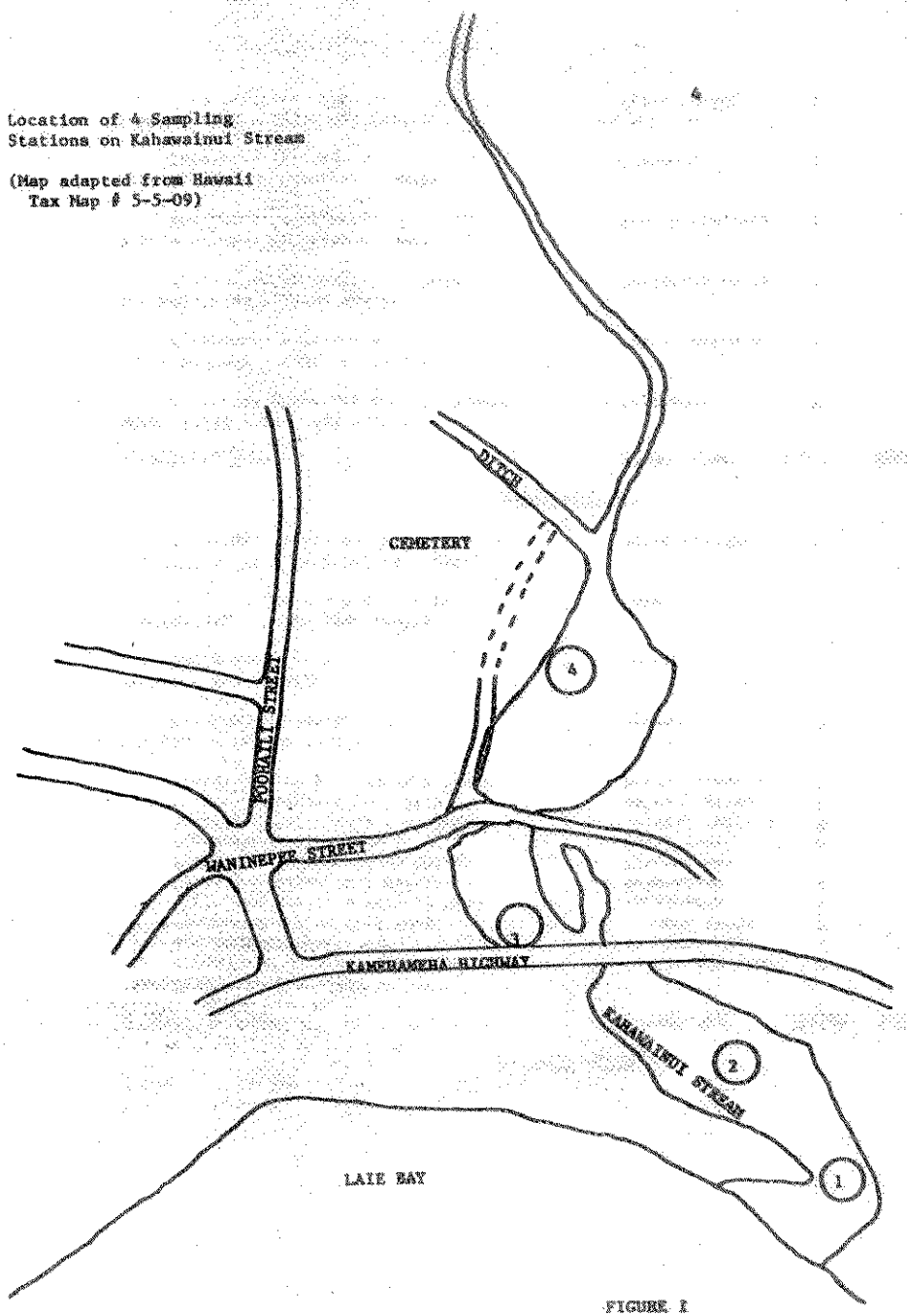

FIGURE I

TABLE 1
CHECKLIST OF THE PLANTS OF THE PROPOSED
KAHAWAINUI FLOOD CONTROL PROJECT SITE, OAHU

The following list is based entirely upon observations made February 10, 1981. As the primary objective of the study was to make a preliminary botanical survey of the proposed study site and to sample the various plant associations, rather than compile a comprehensive species list for the area, the list is not to be considered complete.

The following information is included for each entry:

1) Scientific name.
2) Common or Hawaiian name, when known.
3) Distributional range of the species. The terms used are as defined:

   I = Indigenous--native to the Hawaiian Islands, but also occurring naturally (without the aide of man) elsewhere.
   P = Polynesian introduction--a plant brought by Polynesian immigrants pre Captain Cook.
   X = Exotic--taxon of deliberate or accidental introduction after the Western discovery of the islands.

5) Relative abundance and approximate distribution within the study site. A subjective five-point scale is used to record this information. A species which was seen less than six times is ranked "rare." At the other extreme, the few most common species are ranked "abundant." The progression of the scale is as follows: rare--uncommon--occasional--common--abudant. The rank is based entirely upon a comparison of the frequency with which a species occurs, as compared to all other species, within a biotope of the study area. It does not necessarily denote the abundance of that particular species in the Hawaiian Islands.

MONOCOTYLEDONEAE

Scientific Name	Common Name	Status	Abundance
AMARYLLIDACEAE - Amaryllis family			
Crinum sp.	Spider lily	X	O
COMMELINACEAE - Spiderwort family			
Commelina diffusa Burm. f.	Honohono	X	O

Table 1 - Continued

MONOCOTYLEDONEAE

Scientific Name	Common Name	Status	Abundance
GRAMINEAE - Grass family			
Brachiaria mutica (Forsk.) Stapf	California grass	X	A
Cenchrus echinatus L.	Sandbur	X	O
Cynodon dactylon (L.) Pers.	Bermuda grass	X	O
Digitaria pruriens (Trin.) Buse	Kukaipua'a	X	U
Eleusine indica (L.) Gaertn.	Goosegrass	X	C
Pennisetum clandestinum Chiov.	Kikuyugrass	X	C
Saccharum officinarum L.	Sugar cane	P	O
Setaria verticillata (L.) Beauv.	Bristly foxtail	X	U
Sorghum halepense (L.) Pers.	Johnson grass	X	R
Sporobolus virginicus (L.) Kunth	Beach dropseed	I	O
MUSACEAE - Banana family			
Musa xparadisiaca L.	Banana	P	Cultivate
PALMAE - Palm family			
Cocos nucifera L.	Coconut	P	Cultivate
PANDANACEAE - Screw pine family			
Pandanus odoratissimus L.f.	Hala	I	U
PONTEDERIACEAE - Pickerelweed family			
Eichornia crassipes (Mart.) Solms	Water hyacinth	X	O

DICOTYLEDONEAE

Scientific Name	Common Name	Status	Abundance
ACANTHACEAE - Acanthus family			
Asystasia gangetica (L.) T. Anders.	Asystasia	X	C
AMARANTHACEAE - Amaranth family			
Amaranthus spinosus L.	Spiny amaranth	X	U
ANACARDIACEAE - Mango family			
Schinus terebinthifolius Raddi	Christmas berry	X	O
BORAGINACEAE - Heliotrope family			
Tournefortia argentea L. f.	Tree heliotrope	X	U
CASUARINACEAE - Casuarina family			
Casuarina litorea L.	Ironwood	X	C
COMBRETACEAE - Terminala family			
Terminalia catappa L.	False kamani	X	O

ble 1 - Continued

DICOTYLEDONEAE

ientific Name	Common Name	Status	Abundance
MPOSITAE - Sunflower family			
Bidens alba (L.) DC.		X	U
Pluchea xfosbergii Cooperrider & Galang	Fosberg's pluchea	X	O
P. indica (L.) Less.	Indian pluchea	X	O
P. odorota (L.) Cass.	Shrubby fleabone	X	O
Sonchus oleraceus L.	Sow thistle	X	U
Wedelia trilobata (L.) Hitchc.	Wedelia	X	U
NVOLVULACEAE - Morning glory family			
Ipomoea alba L.	Moon flower	X	R
I. indica (Burm.) Merr.	Koali-'awania	I	O
I. ochracea G. Don		X	U
I. pes-caprae (L.) R. Br.	Beach morning glory	I	O
PHORBIACEAE - Spurge family			
Euphorbia glomerifera (Millsp.) L.C. Wheeler		X	O
Macaranga tanarius (Stickm.) Muell.-Arg.		X	U
Ricinus communis L.	Castor bean	X	C
ODENIACEAE - Naupaka family			
Scaevola taccada (Gaertn.) Roxb.	Naupaka - kahakai	I	O
GUMINOSAE - Pea family			
Acacia confusa Merr.	Formosan koa	X	R
Canavalia cathartica Thouars	Mauna - loa	X	O
Cassia leschenaultiana DC.	Partridge pea	X	U
Desmanthus virgatus (L.) Willd.	Virgate mimosa	X	O
Leucaena leucocephala (Lam.) de Wit	Koa-haole	X	C
Mimosa pudica L.	Sensitive plant	X	O
LVACEAE - Hibiscus family			
Hibiscus tiliaceus L.	Hau	I	C
RTACEAE - Myrtle family			
Eugenia cumini (L.) Druce	Java plum	X	O
Psidium guajava L.	Guava	X	O
AGRACEAE - Evening primrose family			
Ludwigia octivalvis (Jacq.) Raven	Primrose willow	X	O
ASSIFLORACEAE - Passion flower family			
Passiflora edulis Sims	Liliko'i	X	R
P. foetida L.	Scarlet-fruited passionflower	X	O
P. suberosa L.	Huehue-haole	X	U

Table 1 - Continued

DICOTYLEDONEAE

Scientific Name	Common Name	Status	Abundance
PLANTAGINACEAE - Plantain family			
Plantago lanceolata L.	Buckthorn plantain	X	O
POLYGONACEAE - Buckwheat family			
Coccoloba uvifera (L.) L.	Sea grape	X	Cultivated
PORTULACACEAE - Purslane family			
Portulaca oleracea L.	Purslane	X	O
RHIZOPHORACEAE - Mangrove family			
Rhizophora mangle L.	American mangrove	X	C
SCROPHULARIACEAE - Figwort family			
Bacopa monnieria (L.) Wettst.	Water hyssop	I	O
VERBENACEAE - Verbena family			
Lantana camara L.	Lantana	X	O
Vitex trifolia L.	Polinalina	X	Cultivated

TABLE 2

Some physical and chemical properties of the water at four sample stations on Kahawainui Stream

STATION	1	2	3	4
Temperature C°	26°	26°	25°	26°
Salinity $^{o}/_{oo}$	1.5	2.0	1.0	<1
Conductance umhos	2500	3300	1350	650
pH	6.5	6.5	6.5	6.5
Ammonia mg/l	1.89	2.07	2.44	1.71
Nitrate mg/l	0	<1	<1	<1

References Used or Cited

Edmondson, C.E. 1929. Hawaiian Atyidae. Bernice P. Bishop Museum Bulletin 66, Bishop Museum, Honolulu, HI.

Norton, S.E. 1977. A Comparative Study of Fish and Crustacean Populations in Altered and Unaltered Hawaiian Streams. MS Thesis, University of Hawaii, Honolulu, HI

Thurston, R.V., R.C. Russo, C.M. Fetterolf, Jr., T.A. Edsall, and Y.M. Barber, Jr. (Eds.) 1979. A Review of the EPA Red Book: Quality Criteria for Water. Water Quality Section, American Fisheries Society, Bethesda, MD. 313 pp.

Timbol, A.S. and J.A. Maciolek. 1978. Stream Channel Modifications in Hawaii. Part A: Statewide Inventory of Streams, Habitat Factors and Associated Biota. FWS/OBS #78/16. U.S. Fish and Wildlife Service, Washington, D.C.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
300 ALA MOANA BOULEVARD
P. O. BOX 50167
HONOLULU, HAWAII 96850

IN REPLY REFER TO:
ES
Room 6307

MAY 7 1981

Colonel Alfred J. Thiede
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858

Re: (Supplemental PAL)
Kahawainui Stream
Flood Damage Reduction
Study, Oahu, Hawaii

Dear Colonel Thiede:

This is a supplement to the U.S. Fish & Wildlife Service's Planning Aid Letter (PAL) submitted to you on March 26, 1981. These comments are preliminary in nature and do not constitute the report of the Secretary of the Interior on the project within the meaning of Section 2(b) of the Fish & Wildlife Coordination Act.

On April 3, 1981, several more water samples were taken from Kahawainui and Wailele Streams (Table 1, Figure 1). On May 4, 1981 Service biologists made a reconnaissance survey of Laie Bay in the vicinity of the project area. A more comprehensive survey will be made after receipt of corps plans and prior to completion of the Section 2(b) report.

DESCRIPTION OF THE PROJECT AREA

Laie Bay directly off-shore from the project area has a sand bottom. Water depth was greater than 15 feet throughout the area surveyed, except within a few yards of shore. The prevailing longshore current is generally to the south, but according to the fishermen questioned, it sometimes changes direction depending on wind and tide. No fish or other macrofauna were observed in this zone during approximately 45 minutes of snorkeling between the shore and 300 yards out.

From the mouth of Kahawainui Stream north to Kalanai Point the substrate is more solid, probably lithified dune or ancient reef, and provides habitat for a variety of organisms. Several spear fishermen were observed with a large stringer of fish, eels and octopus. They indicated fishing was good when the water conditions were not too severe. There was very little coral cover, but occasional heads of Pocillapora meandrina were seen and encrusting patches of Porites lobata. The most conspicuous benthic organism was the coraline alga Porolithon sp., which occurred as "heads" reaching 12 inches or more in diameter, and a density of approximately $1/m^2$ over much of the area. This

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area also supports a healthy fish population, with some specimens being larger than is usual for their species in shallow (10-20 feet) water. Species observ are listed in Table 2.

DISCUSSION

When the 4 original water quality samples were taken from Kahawainui Stream on March 23, 1981, the water level was low, and there was no water in Wailele Stream. On April 3, 1981 when 4 additional samples were taken, the water level was 1-2 feet higher. These samples showed a high level of ammonia, although not as high as the previous 4. Samples #7 and 8 were taken from Wailele Stream, but no aquatic organisms were observed.

On a return survey to Wailele Stream on April 14, 1981, the stream was again dry. The oxygen level at sampling stations #5 and 6 was very low, and the schools of large Tilapia mentioned in our previous report were observed at the surface with mouths "gasping".

The portion of Laie Bay off-shore of the project area appears to be less susceptible to significant, long-range, adverse impact from stream channelization than many other areas in Hawaii. The water is relatively deep, the current carries stream effluent away from the biologically productive area to the north, and there is usually strong wave action to promote mixing of fresh water with oceanic water. Although residents say a noticeable plume of silt is visible from the stream mouth after very heavy rains, the silt must be rapidly scoured from the area, since no terrigenous material was observed off-shore during our survey. Adverse impacts during construction can be minimized by good construction practices.

RECOMMENDATIONS

In addition to the one contained in our PAL dated March 26, 1981, the Service recommends the following:

1. Construction activities take place during the summer, when stream flow is at a minimum.
2. The new outlet channel be dug and lined "in the dry".
3. Extreme care will be taken to insure that no debris, petroleum products, or other deleterious materials will be allowed to fall, flow, leach or otherwise enter the water.
4. All construction activities within and adjacent to the water be conducted so as to minimize turbidity and control erosion.

Sincerely yours,

ACTING Robert Shallenberger
Pacific Islands Administrator

Table 1

Some physical and chemical properties of the water at sample stations on Kahawainui and Wailele Streams

Station	Temperature C	Salinity %	Conductivity umhos	pH	Ammonia mg/	Nitrate mg/	Nitrite mg/	Oxygen mg/
5	23	1	410	5.2	.73	2.0	0.2	1.8
6	23	1	410	5.5	.85	2.0	0.2	1.6
7	21	1	90	5.2	.98	1.0	0.1	6.1
8	23	1	80	4.9	.98	1.0	0	9.0

Location of 4 additional sampling stations on Kahawainui and Wailele Streams

(Adapted from Tax Key Map #5-5-05)

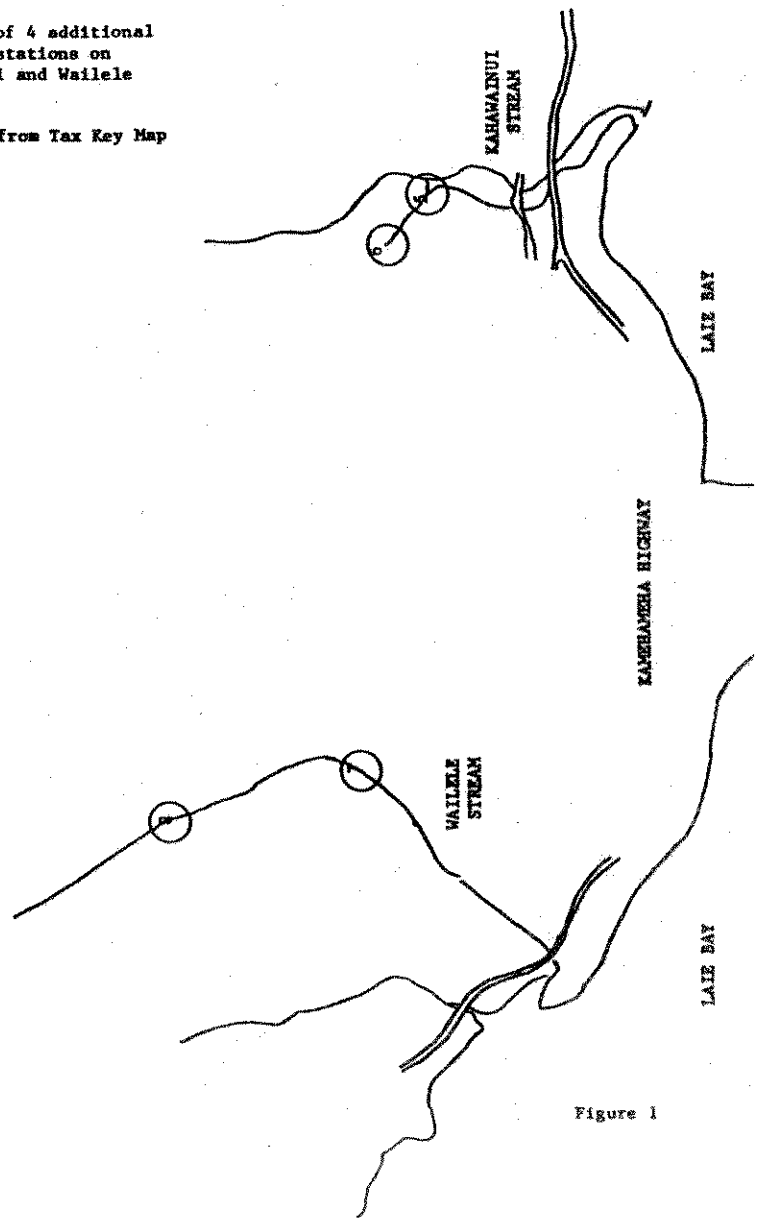

Figure 1

Table 2

Macrofauna observed in Laie Bay

CHORDATA

Acanthurus sandvicensis Streets
A. nigroris Cuvier and Valenciennes
Naso Unicornis (Forskal)
Chaetodon fremblii Bennett
C. miliaris Quoy and Gaimard
Zanclus cornutus Linnaeus
Abudefduf abdominalis (Quoy and Gaimard)
A. sordidus (Forskal)
Adioryx xantherythrus (Jordan and Evermann)
Thalassoma duperrey Quoy and Gaimard
Coris gaimardi (Quoy and Gaimard)
Labroides phthirophagus Randall
Rhinecanthus rectangulus (Bloch and Schneider)
Pervagor spilosoma (Lay and Bennett)
Unidentified wrasse, sp. 1
Unidentified wrasse, sp. 2
Parupeneus multifasciatus (Quoy and Gaimard)
Unidentified blenny
Unidentified Moray eel, sp. 1
Unidentified Moray eel, sp. 2
Unidentified Moray eel, sp. 3

MOLLUSCA

Polypus marmoratus (Hoyle)

ECHINODERMATA

Echinothrix diadima (Linnaeus)
Tripneustes gratilla (Linnaeus)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
300 ALA MOANA BOULEVARD
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HONOLULU HAWAII 96850

IN REPLY REFER TO: ES 6307
1-2-84-F-001

NOV 7 1983

Colonel Michael M. Jenks
District Engineer
U.S. Army Engineer District, Honolulu
Fort Shafter, Hawaii 96858

Dear Colonel Jenks:

This responds to your September 28, 1983 request for consultation under Section 7 of the Endangered Species Act of 1973, 16 U.S.C. 1531, et seq. (ESA). At issue are the possible effects of modifications to the Kahawainui Stream watershed on the endangered Hawaiian gallinule (Gallinula chloropus sandvicensis). The watershed is located on the north coast of Oahu, Hawaii (Figures 1 and 2).

This letter represents the biological opinion of the U.S. Fish and Wildlife Service (FWS) as directed by Section 7 of the ESA, "Interagency Cooperation Regulations" (50 CFR 402, 43 FR 870), on the proposed modifications.

On November 3, 1983 we completed our review of the information provided by you along with other related information in our files. We also contacted some of those familiar with the biology, management, and recovery of the species involved. Copies of pertinent materials and documentation are contained in an administrative record maintained in this office. Our reference number for this consultation is 1-2-84-F-001.

BIOLOGICAL OPINION

It is our biological opinion that none of the proposals suggested by you as alternatives in the Kahawainui Stream Flood Control Project is likely to jeopardize the continued existence of the Hawaiian gallinule.

Background information on the proposals and biological information on the species at issue in this determination follow.

PROJECT DESCRIPTION AND BACKGROUND INFORMATION

The Kahawainui Stream watershed is located on the north coast of Oahu, Hawaii. The stream itself is intermittent, and skirts the northwestern edge of Laie, the principal urban center in the watershed. The drainage basin is approximately 5.3 square miles and encompasses the area between Omao Gulch on the north and Wailele Gulch on the south. Two ponds located just above the confluence of Kahawainui and Laiewai Streams are in pastures on opposite banks of Kahawainui Stream.

Approximately 12 documented floods have occurred in Laie since 1879. From 1963 to 1972, five storms have caused extensive damage to the community. Flood problems result from stormwaters exceeding the channel capacity of Kahawainui Stream and overflowing into the Laie community. Inadequate drainage for sheetflow within the community compounds this problem. You have developed 4 major alternative flood control measures which involve various combinations of levee construction, channel modification, and other floodproofing construction including land clearing.

During surveys of the study area in June of this year conducted by Service and Corps of Engineers environmental staff, three Hawaiian gallinule were observed in the pond on the west bank of Kahawainui Stream. A subsequent sighting of two gallinule within the same pond later that month reconfirmed the previous observation. Three gallinule were observed in this pond, and one other was seen in the pond adjacent to the cemetery, during a joint Service-State Division of Forestry and Wildlife field reconnaissance on October 13, 1983. No previous sightings of this or other endangered or threatened species within the project area are known. The possibility exists that the birds use the vegetation bordering the pond for nesting during the spring.

SPECIES ACCOUNT

Hawaiian gallinules are known to exist only on the islands of Kauai and Oahu, although one was seen on Molokai in 1971. Estimates on total gallinule have varied between approximately 300 and 1,000 in recent years. Reliable population indices, however, are difficult to obtain due to the secretive nature of the species, the heavily vegetated habitat in which it lives, and the lack of adequate manpower to conduct comprehensive censuses. Although "censused" annually, the population estimates above are based on "best judgment." Artificial freshwater impoundments, to which gallinule have adapted, have measurably contributed to their survival.

Habitat for gallinule consists of thickly vegetated marsh interspersed with freshwater ponds, taro patches, lagoons, reedy margins of water courses (streams, irregation ditches, etc.), reservoirs, and wet pastures. Nesting, feeding, and loafing sites are generally found in the same area. Floating vegetation is characteristic of their favorite habitat. Gallinule require relatively dense marginal vegetation and are seldom found in deep, open water. Their habitat is usually found below 400 feet in elevation. This species prefers to remain close to cover, although it may be seen in open, small ponds in taro patches.

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As with the endangered Hawaiian stilt and Hawaiian coot, predation is probably the most important cause of mortality; in fact, it may be more pronounced for the gallinule because of the nature of its habitat. It reportedly is preyed upon by mongooses, dogs, cats, rats, bullfrogs and black-crowned night herons. Mongooses, dogs, and cats are probably the most important predators, poaching and harassment by humans being of secondary impact. The effect of pollutants including pesticides has not been determined, and disease is an unknown factor. As stated previously, there have been only three and two gallinules sighted in the project area during the two surveys conducted. Although no nesting was observed, nests may exist in the area.

ANALYSIS OF IMPACTS

The following can be considered as general impacts of the alternatives which might affect the Hawaiian gallinule:

1. Levee placement may change flooding patterns. Areas flooded during heavy rains may be expected to retain water for a longer or shorter period of time dependent on the location of levees. Water replenishment of wetlands above the highway may be impeded, resulting in their subsequent dewaterment. Rapid increases in water levels could force abandonment of gallinule nests due to flooding or, if water levels are decreased, nests may be more exposed to predation. Habitat value for the Hawaiian gallinule would generally be reduced.

2. During construction, turbidity, noise and air impacts may result from the use of heavy equipment and vegetation removal. Dredging and disturbance of bottom sediments would cause increased turbidity and degradation of water quality. Noise of construction and direct harassment of the gallinule may disrupt nesting, feeding, and loafing.

3. Clearing of vegetation along streams and the general disruption of vegetative cover may disturb the gall rule.

Overall, it appears that the proposed project will affect the Hawaiian gallinules within the project area in a negative way. However, items 1 and 2 above will cause only temporary impacts on the birds. It is expected that the vegetation now occurring will quickly become reestablished and will once again provide shelter for the species. Changes in water patterns on the land, however, will last, that, of course, being the purpose of the project. The flooding of nests due to rapidly rising water and the exposure of nests to predators due to lower water elevations appear to be the only two major impacts of the project on the species. However, the low counts of gallinule in the area (a maximum of three observed during any census trip) would indicate that the project site is not of major value to the species as a whole for nesting. Likewise, the flooding and rapid dewaterment of the areas under consideration would be expected to occur only during extreme weather conditions.

In consideration of the above, it is our biological opinion that the implementation of any of the alternatives expressed by the Corps of Engineers would not be likely to jeopardize the continued existence of the Hawaiian gallinule.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Endangered Species Act also requires federal agencies in consultation with this Service to utilize their authorities to carry out programs for the conservation of listed species. We believe the Corps of Engineers has the opportunity to comply with this directive in relation to its activities involving the Kahawainui Stream Flood Control Project by incorporating the following into the overall project plan:

1. If it is discovered that nesting Hawaiian gallinule are to be directly impacted by construction activities (e.g. land clearing), those specific activities should be stopped until consultation with this office has been initiated and resolved.

2. Habitat for the Hawaiian gallinule would be enhanced by the creation of additional open water areas and water edge within the floodplain. This may benefit other species of endangered Hawaiian waterbirds as well. The Service, through coordination with the Hawaii Division of Forestry and Wildlife, can provide your engineering staff with the appropriate technical expertise to develop effective pond designs for this purpose.

This concludes formal consultation on this action. Should any significant changes be made in the proposed actions, or should

species be listed which are not addressed in this letter which may be affected by the action, you must reinitiate consultation with this office.

Sincerely yours,

Robert Shallenberger

Robert J. Shallenberger, Ph.D.
Acting Pacific Islands Administrator

Enclosures (2)

cc: Regional Director, FWS, Portland, OR (AFA-SE)

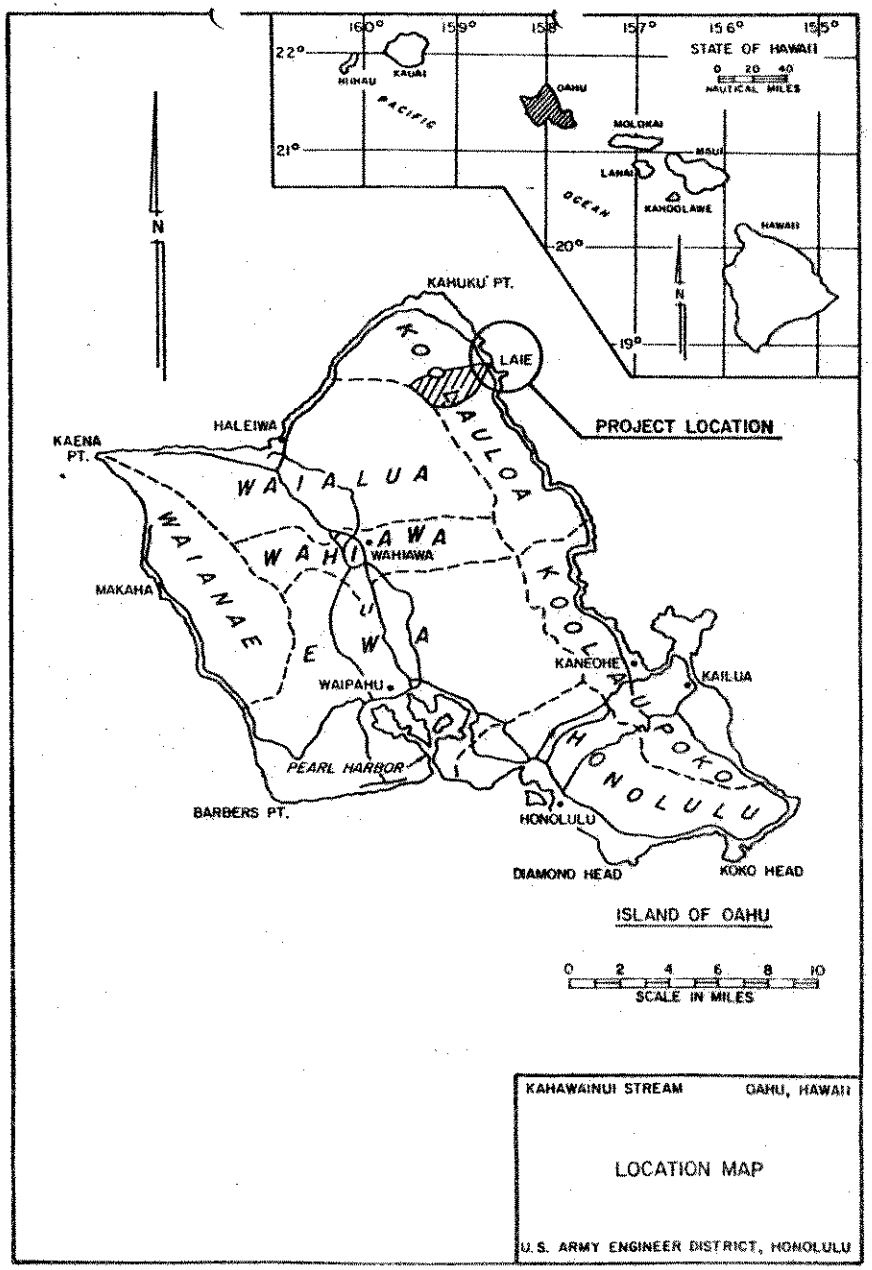
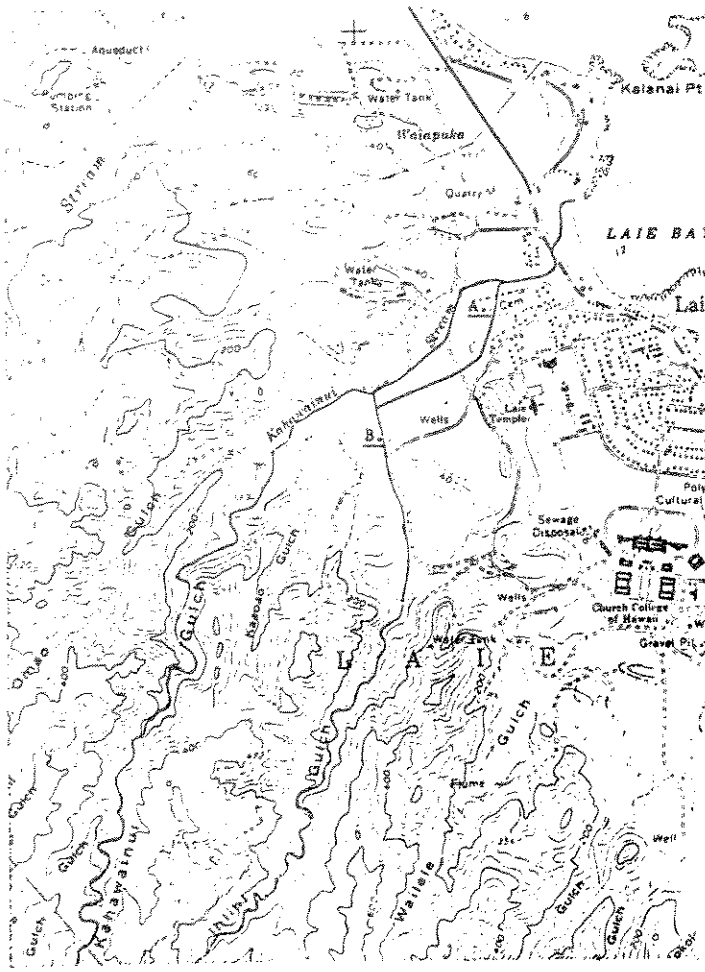


FIGURE 1

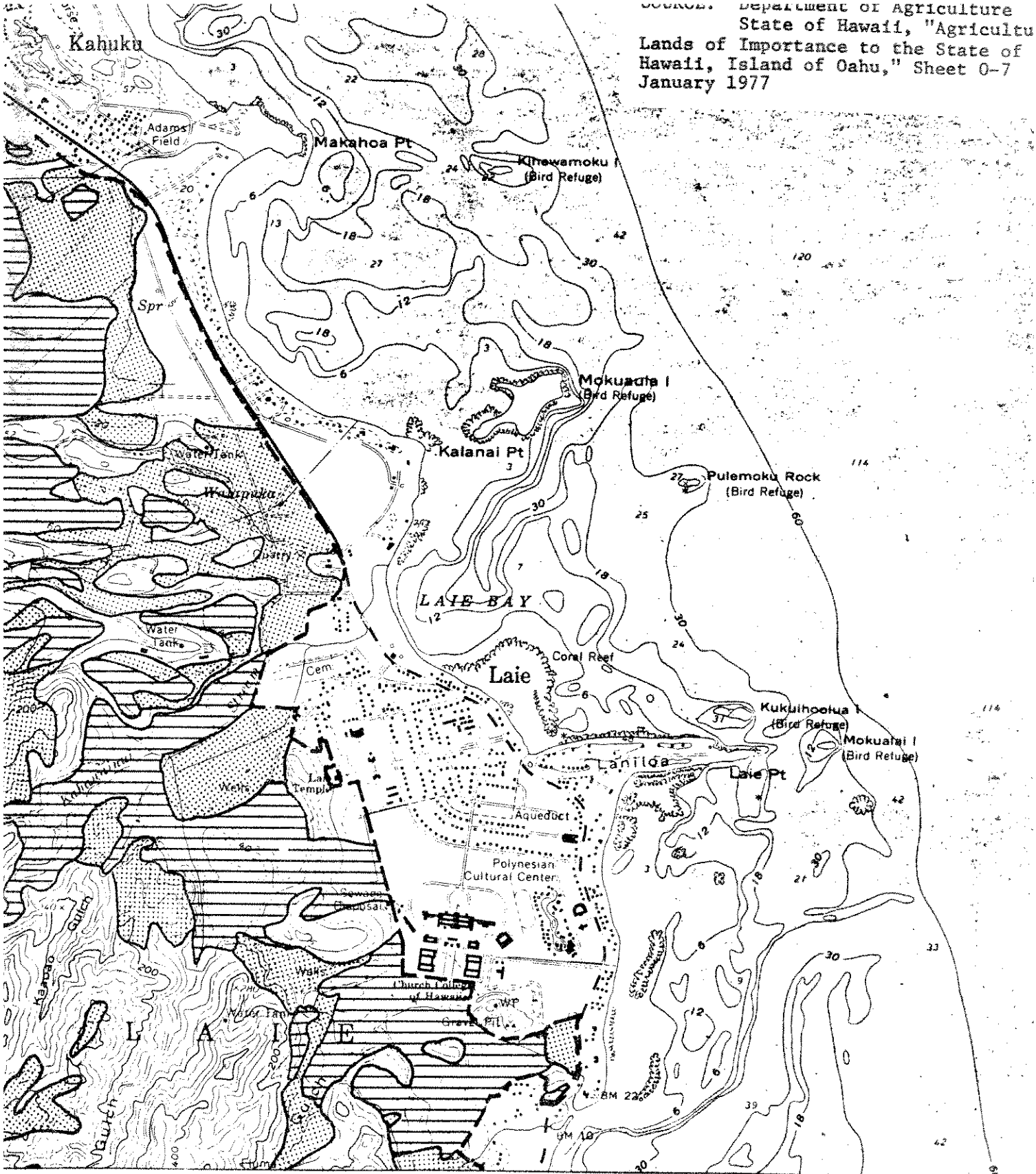


KAHAWAINUI WATERSHED LAIE, HAWAII

FIGURE 2. EXISTING STREAMS
A. Laiewai Stream
B. Ihiihi Stream

U. S. Fish & Wildlife Service, Honolulu

SOURCE: Department of Agriculture State of Hawaii, "Agricultu Lands of Importance to the State of Hawaii, Island of Oahu," Sheet 0-7 January 1977



LEGEND:

PRIME AGRICULTURAL LAND - Land which has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops economically when treated and managed according to modern farming methods.

UNIQUE AGRICULTURAL LAND - Land that has the special combination of soil quality, location, growing season, moisture supply, and is used to produce sustained high quality and/or high yields of a specific crop when treated and managed according to modern farming methods.

OTHER IMPORTANT AGRICULTURAL LAND - Land other than Prime or Unique Agricultural Land that is also of statewide or local importance for agricultural use.

EXISTING URBAN DEVELOPMENT - Land which has been developed for urban type use.

U.S. GOVERNMENT - Land which is currently under the jurisdiction of the U.S. Government.

Rec'd 9 Fe. 84

FINAL COORDINATION ACT REPORT

KAHAWAINUI STREAM FLOOD CONTROL STUDY

LAIE, OAHU, HAWAII

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

HONOLULU FIELD OFFICE

JANUARY 1984

Prepared for the Honolulu District,
U.S. Army Corps of Engineers, Honolulu, Hawaii

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GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES
EDGAR A. HAYASHI
DEPUTY TO THE CHAIRMAN

DIVISIONS:
AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND RESOURCES ENFORCEMENT
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FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

December 22, 1983

Dr. Allan Marmelstein, Ph. D.
Pacific Islands Administrator
Fish and Wildlife Service
300 Ala Moana Blvd.
P. O. Box 50167
Honolulu, Hawaii 96850

Dear Dr. Marmelstein:

In response to your request of September 27, 1983 for our review of the U. S. Fish and Wildlife Services draft report on the Kahawainui Stream Flood Control Study, staff from both our offices have had several meetings to discuss the alternatives, impacts, and recommendations. These meetings included discussions with the project engineers and environmental specialists of the U. S. Army Corps of Engineers. An on-site field inspection of the project area was also conducted.

Subsequent to all previous discussions and field study the following comments and recommendations were mutually agreed upon:

1. Flood control should be accomplished without channelizing; however;

   a) If channelizing is necessary, it should be minimized and unlined.

   b) If channelizing with lining is required, it should be designed so it provides for ponding where aquatic life such as fishes and frogs can survive. Shade producing vegetation should be planted along the channel berm. Since channelizing will destroy wetlands, it is recommended that the pond in the pasture on the

west side of Kahawainui be enlarged and an island or islands built within the pond. It was also recommended that the ponds on the east and west side of Kahawainui be planted with vegetation that provides food and shelter for waterbirds.

2. If Alternate 4 is selected as a flood control method, it is recommended that appropriate new ponds be constructed and vegetated at an off-site location.

The Division of Aquatic Resources and Division of Water and Land Development concerns were adequately covered by the draft report.

Very truly yours,

SUSUMU ONO
Chairperson

RSS:ers

PREFACE

This report has been prepared by Yvonne Ching and John Ford using available literature, results of joint-agency field surveys and current engineering information. Field surveys were conducted by Marge Elliot (of your environmental staff) (COE) and by William Lennan, Derral Herbst, John Ford and Yvonne Ching (FWS). An additional survey was conducted with Ralph Saito and Marie Morin of the State Department of Land and Natural Resources, Division of Forestry and Wildlife (HDF&W). Maps, drawings, project engineering and design information were provided by Jim Ligh and Lise Ditzel (of your planning staff). Additional design information was obtained from the Kahawainui Stream Draft Interim Survey Report and Environmental Impact Statement (Reference 12). Previous FWS reports on Kahawainui Stream include References 14, 15 and 16.

DESCRIPTION OF THE PROJECT AREA

The Kahawainui Stream watershed is located on the north coast of Oahu, Hawaii (Fig. 1). Studies focus on this intermittent stream which skirts the northwestern edge of Laie, the principal urban center in the Kahawainui watershed. The drainage basin is approximately 5.3 square miles and encompasses the area between Omao Gulch on the north and Wailele Gulch on the south (Fig. 2). Ihiihi and Laiewai Streams are tributaries which feed into Kahawainui Stream approximately 1 and .4 miles (respectively) from the stream mouth. Two ponds located just above the confluence of Kahawainui and Laiewai Streams are in pastures on opposite banks of Kahawainui Stream.

During flow conditions, the stream empties into Laie Bay. However, during periods of low or no flow, a sand berm impounds this terminal reach and prevents the stream from flowing continuously to the bay (Fig. 3). Flow conditions are influenced by rainfall and the amount of sheetflow and groundwater seepage into Kahawainui.

Approximately 12 documented floods have occurred in Laie since 1879 (Reference 13). From 1963 to 1972, five storms have caused extensive damage to the community. Flood problems result from stormwaters exceeding the channel capacity of Kahawainui Stream and overflowing into the Laie community (Fig. 4). Inadequate drainage for sheetflow within the community compounds this problem.

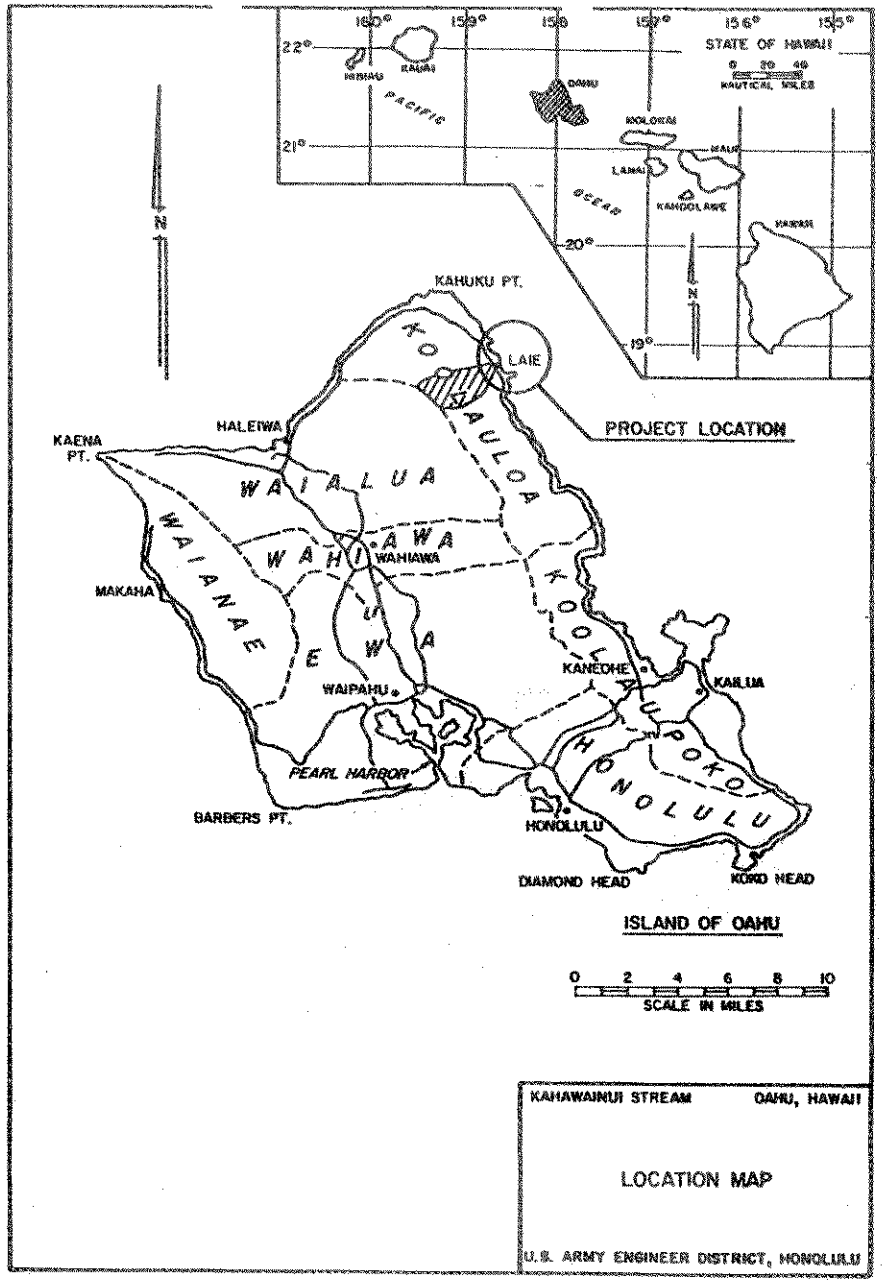


FIGURE 1

FIGURE 3. The terminal reach of Kahawainui Stream is seasonally impounded by beach sands. This sand berm is breached by freshet discharge, thus allowing the migration of indigenous species between the sea and the stream.

FIGURE 2. EXISTING STREAMS
A. Laiewai Stream
B. Ihiihi Stream

U. S. Fish & Wildlife Service, Honolulu

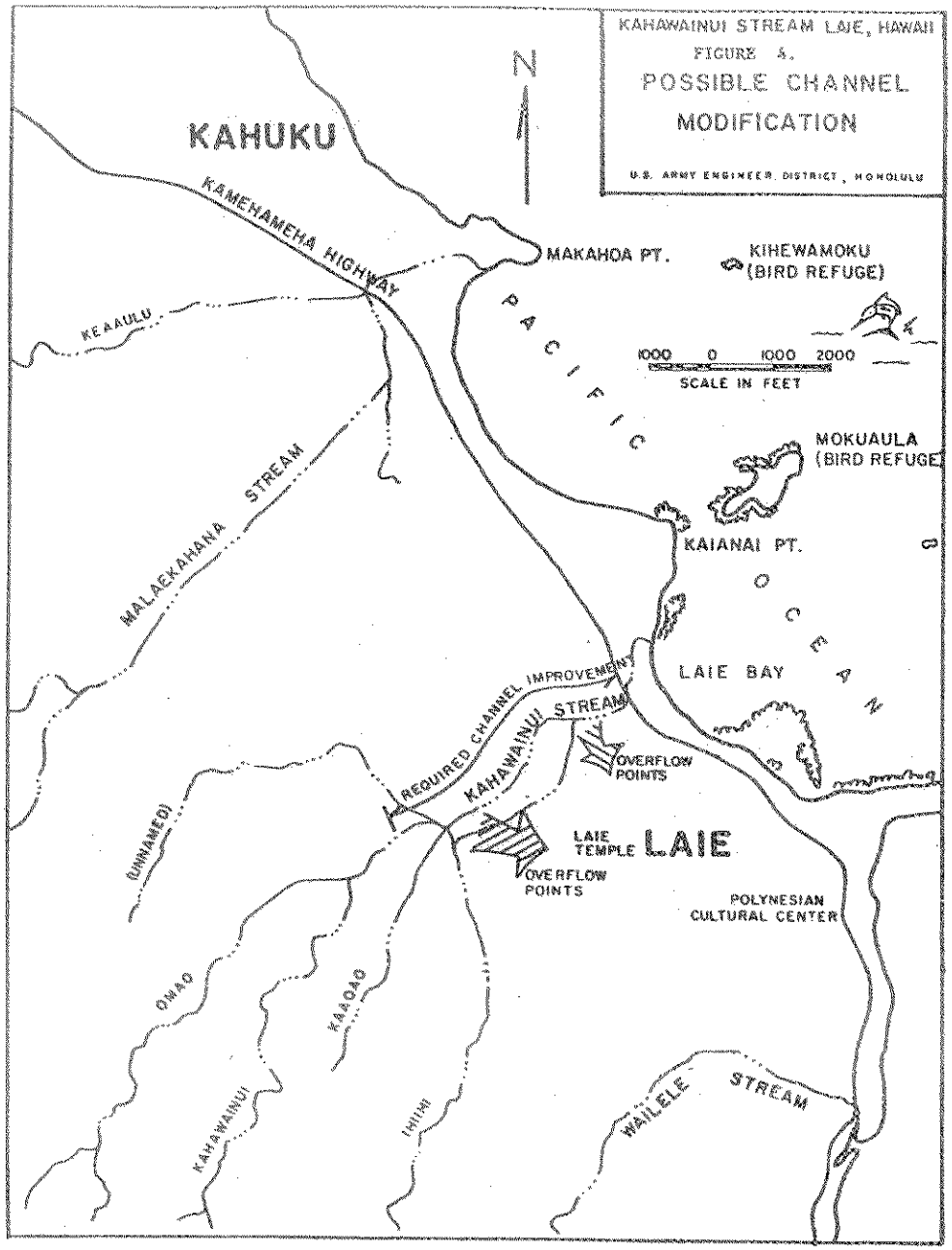


FIGURE 4

TERRESTRIAL AND AQUATIC RESOURCES WITHOUT THE PROJECT

Plant species observed within the project area are listed in Appendix 1, (see also Figs. 3, 5 - 9). Vegetation at the mouth of Kahawainui Stream is comprised primarily of a mangrove (Rhizophora mangle) and hau (Hibiscus tiliaceus) wetland. Ironwood (Casaurina litorea), pluchea (Pluchea spp.), beach morning glory (Ipomoea pes-caprae), beach dropseed grass (Sporobolus virginicus) and hala (Pandanus odoratissimus) were also common.

No threatened, endangered or candidate threatened/endangered plant species were observed in the immediate project area. However, a candidate endangered/threatened species of native caper, Capparis sandwichiana var. sandwichiana (pua pilo) was located, growing at Pounder's beach, several hundred feet east of the Wailele Stream mouth (on the southern boundary of the watershed).

A hau and mangrove wetland occupies the west bank of Kahawainui Stream along reaches below and above Kamehameha Highway. Banana has been cultivated along the drier areas adjacent to the upstream wetland. Proceeding inland, where Kahawainui Stream parallels the Laie housing community (Figs. 5 and 6), uncontrolled aquatic vegetation, mainly water hyacinth (Eichornia crassipes) and California grass (Brachiaria mutica), fill portions of the stream channel along this reach and impede water flow.

Further inland, waterways pass through pasture land and abandoned cane (Saccharum officinarum) fields. Two pasture ponds and the the hau and mangrove wetland constitute the majority of the estimated 17 acre wetland present in the project area. The dominant vegetation of the pasture areas include California grass, kikuyugrass (Pennisetum clandestinum), virgate mimosa (Desmanthus virgatus), koa-haole (Leucaena leucocephala), ironwood, castor bean (Ricinus communis) and pluchea (Fig. 7 and 9). The few native Hawaiian plants observed were common, indigenous species.

Fauna observed within the project area are listed in Appendix 2. During a survey of the project area on June 9, 1983, Service and COE environmental staff observed three Hawaiian Gallinule (Gallinula chloropus sandvicensis) in the pond on the west bank of Kahawainui Stream (Fig. 8). Subsequent sightings of two Hawaiian Gallinule within the same pond during a Service survey on June 16, 1983 and of four Hawaiian Gallinule (three within the west bank pond and one in the east bank pond) during a joint agency FWS-HDF&W survey on October 13, 1983 reconfirmed previous sightings. Another siting occurred at the west bank pond on January 23, 1984. The Hawaiian Gallinule is a listed Federal endangered species (40 CFR 17.11 and 17.12). No previous

FIGURE 5. Exotic grasses and water hyacinth have overgrown portions of the main stream channel in the lower reaches of the project area. Few waterbirds were observed in this marginal habitat during our surveys.

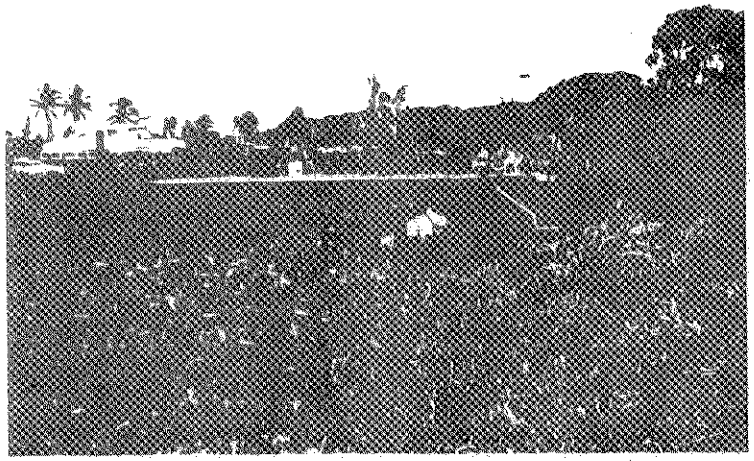


FIGURE 6. Recreational fishing appears to be a popular activity amongst the very young and elderly within this neighborhood. The main channel above the first confluence has been previously channelized (realigned), and exotic grasses have overgrown the stream banks.

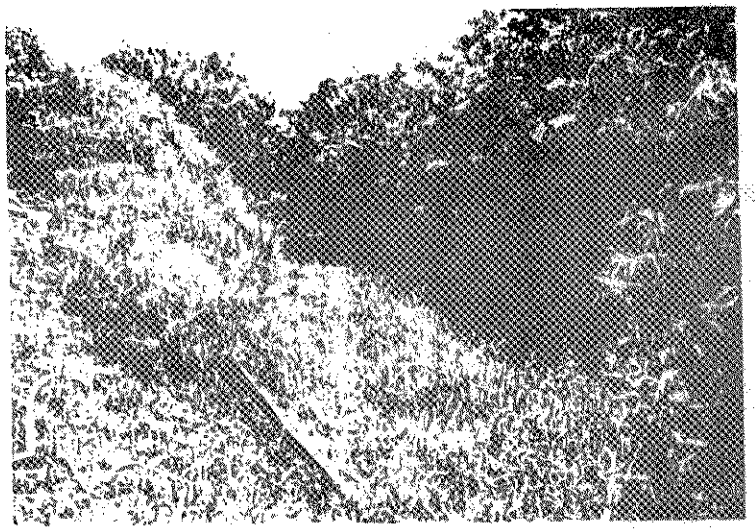


FIGURE 7. Laiewai Stream is virtually choked with California grass and koa-haole. Nevertheless, open water pools and riffles along this reach provide resting and feeding habitat for Black-crowned Night Heron.

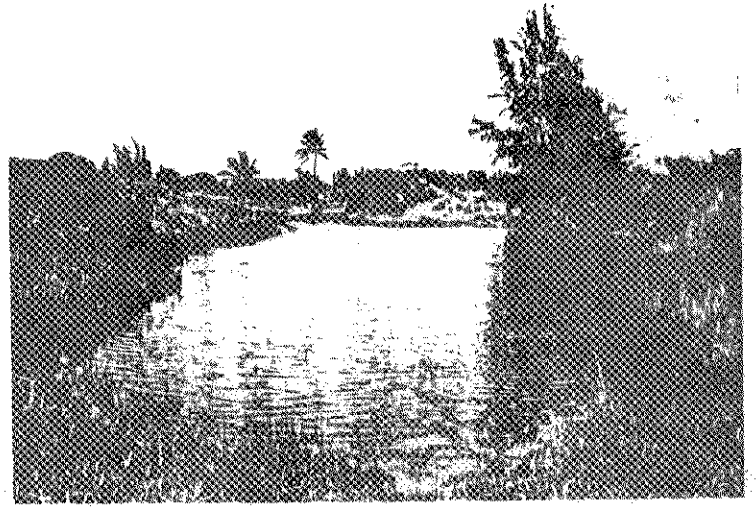


FIGURE 8. This pond on the west bank of Kahawainui Stream supports at least two Hawaiian gallinule, a listed endangere species. Some of the proposed flood control features may alter the water regime of the pond and may affect these bird

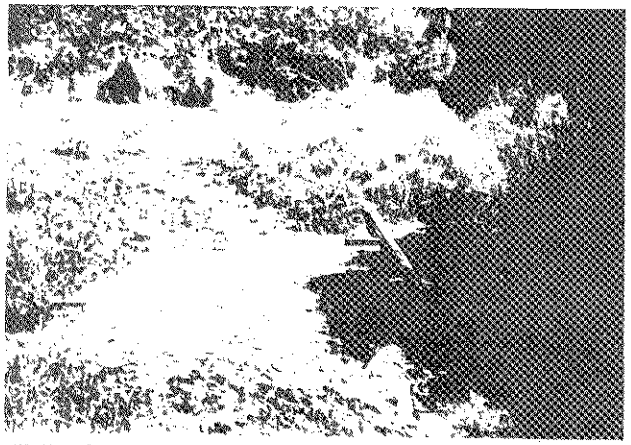


FIGURE 9. A cattle crossing on Kahawainui Stream above the gallinule pond (Figure 8). The stream does not drain into the pond, but rather flows past the pond and into the main stem. A man-made fill berm separates the pond from this drainage.

sightings of this or other endangered species within the project area had occurred. It is likely that the birds are using the vegetation bordering the pond for nesting.

During the June 16 survey, several Black-crowned Night Heron ('Auku'u) (Nycticorax nycticorax hoactli) were sighted and/or heard in the hau and mangrove wetlands above and below the highway. One 'Auku'u was sighted at the east bank pond, where the Hawaiian Gallinules were observed. The presence of 'Auku'u in the hau mangrove wetland may indicate that it is used as a roosting or nesting site, since these birds are thought to be colonial breeders (Reference 18). This species is indigenous to Hawaii and is resident on all main islands (except possibly Niihau and Kahoolawe). Munro in 1944 (Reference 7) noted that they were common on Oahū; however, in recent history, populations have clearly diminished (Reference 1).

Exotic birds observed within the study area included the Zebra Dove (Geopelia striata), Red-crested Cardinal (Paroaria coronata), Cattle Egret (Bubulcus ibis), Common Myna (Acridotheres tristis), Japanese White-eye (Zosterops japonicus) and Spotted Dove (Steptopelia chinensis). Two migratory birds observed were the Lesser Golden Plover (Pluvialis dominica fulva) and Wandering Tattler (Heteroscelus incanus).

Dogs, cats, rats and mongooses were also observed in the area. These common introduced species are often associated with urban development and human habitation.

Few stream animals were observed within the planning area. Juvenile mullet, poeciliids and tilapia were found in the estuary. Poeciliids, tilapia and juvenile bullfrogs were also commonly observed further upstream. In many places, the stream bottom consisted of soft, black muck, which had a faint smell of hydrogen sulfide (indicating anoxic conditions).

Physical and chemical water properties (Appendix 4) measured in March and April of 1981 showed relatively higher concentrations of ammonia along the lower reaches of Kahawainui Stream. Oxygen sampled at Laiewai Stream was comparably lower (1.7 mg/l) than that of Wailele Stream (6.1 to 9.0 mg/l).

During a March 1981 survey, large tilapia observed at Kahawainui Stream stations 5 and 6 appeared to be gulping air at the water's surface. This evidence further suggests that near anoxic conditions develop periodically. Much of the observed high ammonia and reduced oxygen levels may originate from cattle along and wading within the stream (Fig. 9). Another possible source may be the seepage from a nearby sewer pit operated by the City and County of Honolulu (Reference 17).

Kahawainui Stream enters Laie Bay from the northwest across a sandy beach (Fig. 3). Water depth was greater than 15 feet throughout most of the area surveyed, except within a few yards of shore. A longshore, southerly current apparently prevailed. According to local fishermen, the current changed direction depending on wind and tide. No fish or other macrofauna were observed in this zone during our snorkeling survey within 300 yards of shore.

From the mouth of Kahawainui Stream north to Kalanai Point, the substrate observed was principally consolidated reef or lithified dune. Coral cover was sparse with occasional heads of Pocillopora meandrina and Porites lobata. The coraline alga, Porolithon sp., was the most conspicuous benthic organism observed, often reaching 12 inches or more in diameter and having an approximate density of 1 colony per square meter over much of this area.

Fishes observed are listed in Appendix 3. Several spear fishermen with a large stringer of fishes, eels and octopi stated that fishing was good in the area when water conditions were not too severe.

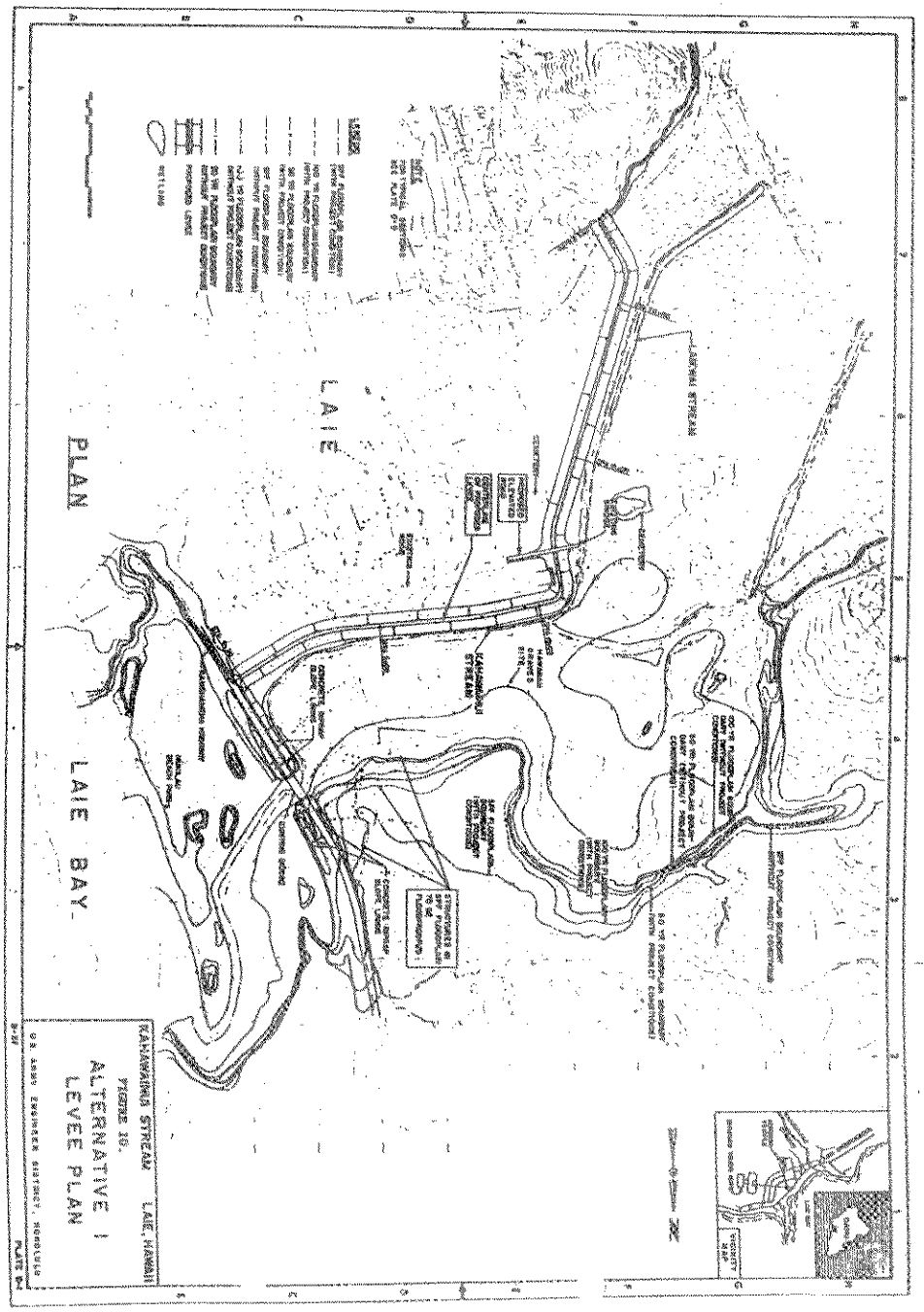
PROJECT DESCRIPTION

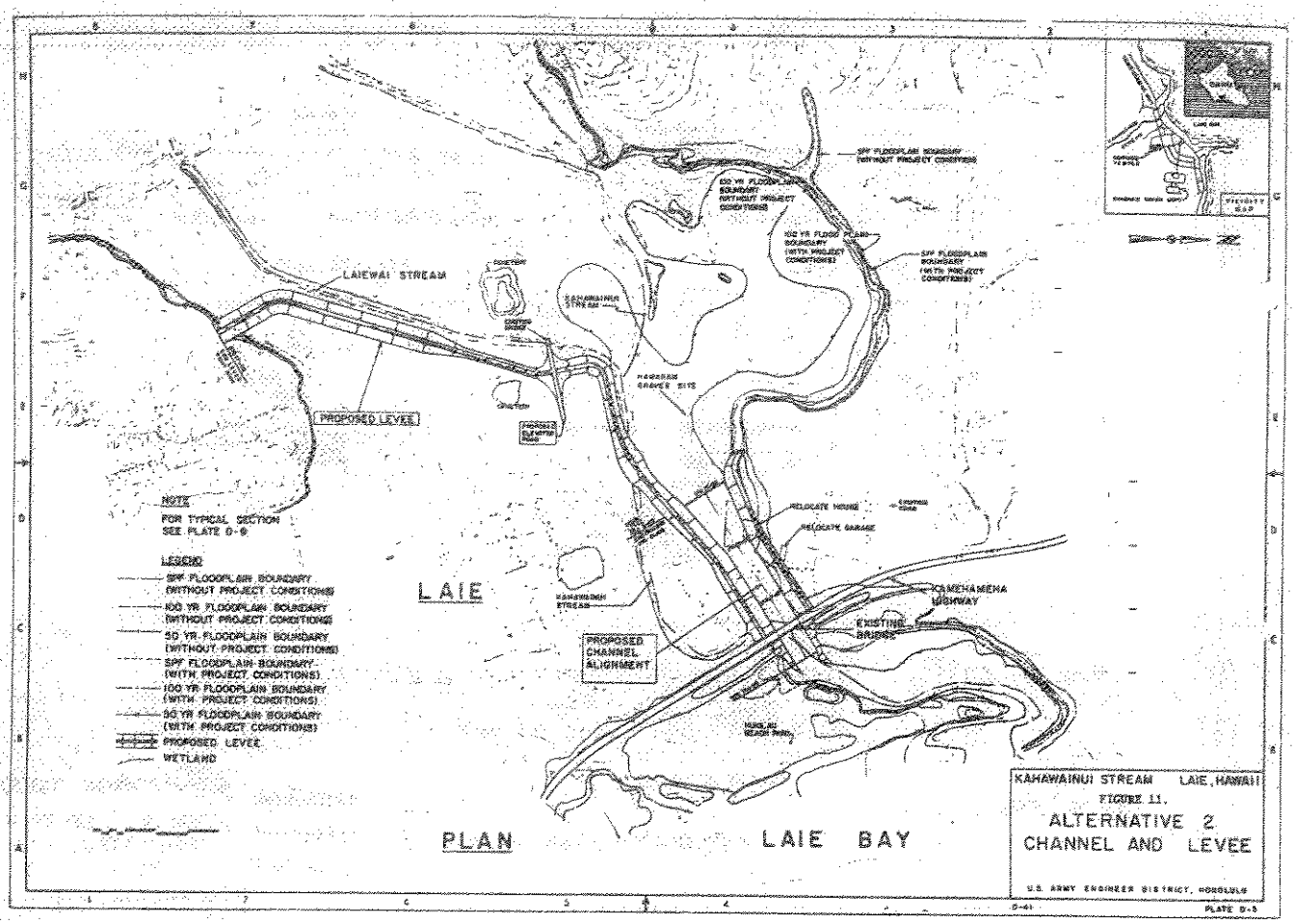
Four alternative flood reduction measures were proposed for Kahawainui (Reference 12).

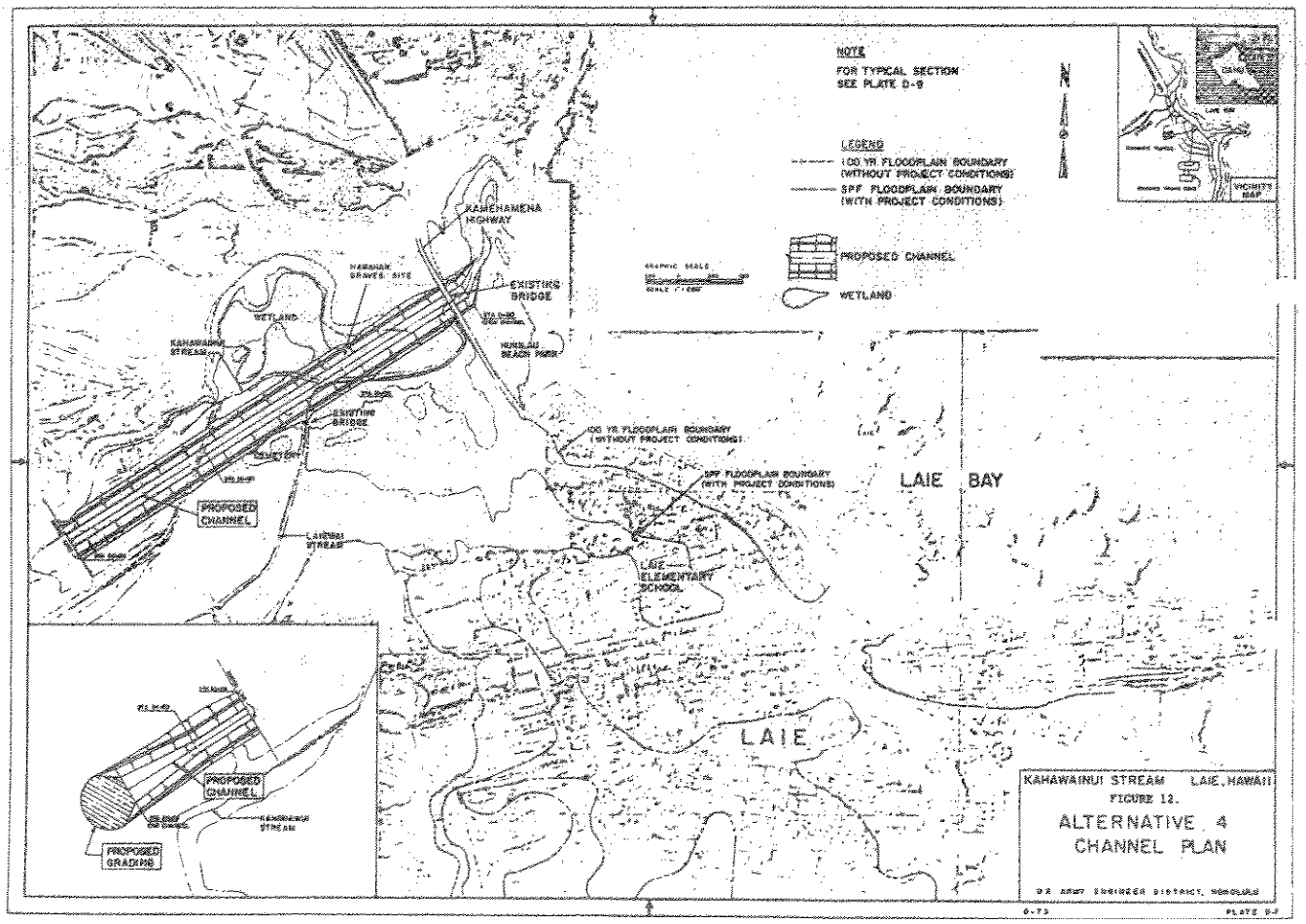
- Alternative 1: Levee System Plan (Fig. 10)
- Alternative 2: Levee and Channel Modification Plan (Selected plan) (Fig. 11)
- Alternative 3: Floodproofing and Floodplain Management Plan
- Alternative 4: Channel Modification Plan (Fig. 12)

Alternative 2 was selected as the project plan for 50 year flood protection. This plan "currently maximizes net benefits and has the highest benefit to cost ratio" (Reference 12, EIS-20).

The Selected Plan. Levee and Channel System. This plan provides for construction of a 1,760-foot levee on the east bank and a 514-foot channel along a partially realigned stream (Fig. 11).




SPF FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
100 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
100 YR FLOOD PLAIN BOUNDARY (WITH PROJECT CONDITIONS)
SPF FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
LAIEWAI STREAM
KAHAWAINUI STREAM
HAWAIIAN GRAVES SITE
PROPOSED LEVEE
PROPOSED ELEVATED ROAD
NOTE
FOR TYPICAL SECTION SEE PLATE D-9
LEGEND
SPF FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
100 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
50 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
SPF FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
100 YR FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
50 YR FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
PROPOSED LEVEE
WETLAND
LAIE
RELOCATE HOUSE
RELOCATE GARAGE
KAMEHAMEHA HIGHWAY
EXISTING BRIDGE
PROPOSED CHANNEL ALIGNMENT
PLAN
LAIE BAY
KAHAWAINUI STREAM LAIE, HAWAII
FIGURE 11.
ALTERNATIVE 2
CHANNEL AND LEVEE
U.S. ARMY ENGINEER DISTRICT, HONOLULU
D-41
PLATE D-8


NOTE
FOR TYPICAL SECTION SEE PLATE D-9
LEGEND
100 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
SPF FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
PROPOSED CHANNEL
WETLAND
KAMEHAMEHA HIGHWAY
HAWAIIAN GRAVES SITE
EXISTING BRIDGE
WETLAND
KAHAWAINUI STREAM
HUKILAU BEACH PARK
EXISTING BRIDGE
PROPOSED CHANNEL
LAIEWAI STREAM
100 YR FLOODPLAIN BOUNDARY (WITHOUT PROJECT CONDITIONS)
SPF FLOODPLAIN BOUNDARY (WITH PROJECT CONDITIONS)
LAIE BAY
LAIE ELEMENTARY SCHOOL
LAIE
PROPOSED CHANNEL
KAHAWAINUI STREAM
PROPOSED GRADING
KAHAWAINUI STREAM LAIE, HAWAII
FIGURE 12.
ALTERNATIVE 4
CHANNEL PLAN
U.S. ARMY ENGINEER DISTRICT, HONOLULU
D-73
PLATE D-7

Based on the design level of protection, the levee and channel would have the following dimensions:

Level of Protection	Levee Max Height (ft)	Levee Length (ft)	Channel Base width (ft)	Channel Max Height (ft)	Channel Length (ft)
SPF	16'-0	1,762	80-150	13.8	514
100-yr	14'-6"	1,760	80-150	12.4	514
50-yr	13'-6"	1,756	80-150	12.3	514

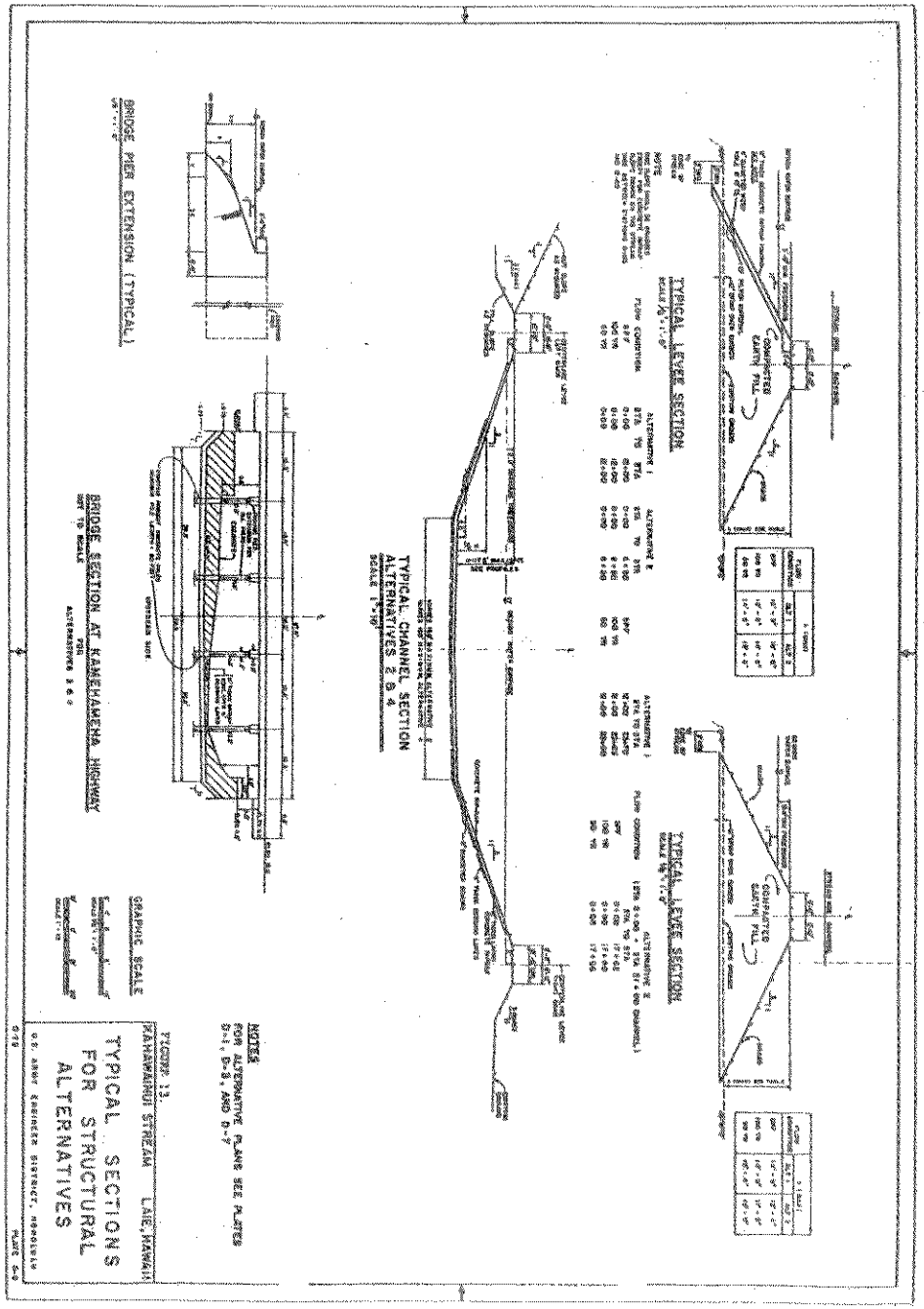
Stream realignment from Laiewai Bridge to Station 25+00 would involve excavating portions of the wetland above the bridge. Channel portions will be lined with concrete riprap and topped on both sides with a berm (levee), 2.5 to 4 feet in height (Fig. 13). Hand placement of stones in the grout may be required to assure close contact between stones of riprap. Slopes will be underlain by a 6-inch thick blanket of sand-size granular material for drainage purposes. Seepage gathered by the drainage blanket will discharge through a 6-inch drainpipe and weepholes at the base of the drainage blanket.

The berm would consist of compacted earth-fill. Stream side slopes downstream from station 27+50 will be lined with concrete riprap while backside slopes and crest will be grassed. The upstream end of the channel will be widened from an 80-foot base width at Station 19+00 to 150 feet at Station 21+00. Along the west bank, the channel will be excavated or filled to provide the required channel depths.

The levee (Station 21+00 to 7+56) will consist of compacted earth-fill and will be lined with concrete riprap on the stream side slope, downstream of Station 6+60. Stream side slopes above station 6+60, all back side levee slopes and crests will be grassed. A minimum freeboard allowance of 3 feet will be used.

The stream under Laiewai Bridge will be cleared and excavated to an invert centerline elevation of -3.2 feet MSL. The stream will also be lined with concrete riprap in this area. Bridge pier extensions will be provided to improve flow considerations and to reduce debris impacts.

Approximately 9 acres of the project site will be cleared and grubbed. An estimated 25,208 cubic yards of fill will be discharged into 2.5 acres of wetland. Excavated material will be disposed of at an approved disposal site located approximately 5 miles from the project. Additional plans require constructing a road across the levee at station 12+08 and relocating 2 structures and 67 graves.



TERRESTRIAL AND AQUATIC RESOURCES WITH THE PROJECT

During construction, turbidity, noise and air impacts may result from use of heavy equipment. Dredging and disturbance of bottom sediments will cause increased turbidity and degradation of water quality. Heavy rain during construction may cause runoff and siltation within the stream. Suspended material may interfere with the respiratory and feeding mechanisms of aquatic organisms. Turbidity effects would be most significant upon the juvenile stages and sessile organisms (Reference 6). Mitigation measures (see Recommendations) may help to minimize stream turbidity. Noise and air pollution may temporarily disturb nearby nesting birds.

The selected plan will require removal of vegetation along the proposed channel, levees and berms. Although the majority of plants within the project site are common, naturalized exotics and none are particularly unique to this island or area, they do provide food, roosting, nesting and protection for birds and other fauna. Nine acres (which will include 2.5 acres of wetland) must be cleared and grubbed. Although the destruction of wetland within the project area is small, the cumulative loss of Hawaiian wetlands can be considered a significant adverse impact on native waterbirds. Revegetating with grass and upper canopy cover would aid in restoring habitat for fish and birds and to prevent further erosion within the project area.

Realignment of the stream for channel construction will destroy the lower reaches of the natural streambed, vegetated stream banks and portions of surrounding wetland areas. Realignment of the stream would destroy approximately 15% (2.5 acres) of the hau and mangrove wetland within the project area. Channel construction below the water table has potential to drain adjacent wetlands unless lined with impervious material. Channelization will result in increased water velocity during periods of storm flow. High velocity flows will scour and erode the unlined stream banks below the channel (i.e. seaward of the highway). Over a period of time, heavy storm flow may alter the location of the lower stream reach and stream mouth, eastward of where it presently enters Laie Bay. Riparian plants may be removed if scour changes the stream course regularly.

Channelization may also lower water depth in upper reaches of Kahawainui Stream during periods of low-flow, which may also decrease areas of pooling. The subsequent increase in water temperature will reduce habitat value for native aquatic organisms and will favor certain exotic species (i.e. poeciliid fishes). Because fishing is popular within the streams (Fig. 6), particularly below the confluence of Kahawainui and Laiewai, channelization is expected to reduce or eliminate the value of these areas for recreational fishing.

The Endangered Hawaiian Gallinule nesting in the pasture ponds would be susceptible to a 100-year flood regardless of flood control improvements. The addition of a levee on the east side of Kahawainui Stream would direct flood waters to the stream, temporarily increasing flood elevations in the west pond.

Laie Bay does not appear to be susceptible to significant, long-range, adverse impact from stream channelization. Nearshore waters are relatively deep, and predominant currents would promote dispersion and dilution of silt-laden streamwaters in the bay. Although residents have noted that a turbidity plume is visible following heavy rains, little accumulation of terrigenous material was observed during offshore surveys.

FISH AND WILDLIFE SERVICE MITIGATION POLICY

The Service's Mitigation Policy (46 FR 7644-7663, January 23, 1981) was formulated with the intent to "...protect and conserve the most important and valuable fish and wildlife resources while facilitating balanced development of the Nation's natural resources." The policy outlines internal guidance for Service staff and complements our participation under the Fish and Wildlife Coordination Act and National Environmental Policy Act. The Mitigation Policy does not apply to threatened or endangered species; specific requirements for these resources are covered in the Endangered Species Act of 1973 (50 CFR 17, 402 and 424).

The policy focuses on the mitigation of habitat value, and on impacts to fish and wildlife populations. Our recommendations for mitigation/compensation are based upon the habitat values adversely affected by the project, and not by loss of acreage alone. Our habitat evaluations and recommendations are based upon thorough consideration of all relevant biological data.

In accordance with the Mitigation Policy and based upon available data, the Service considers the wetland habitats at Kahawainui as Resource Category 4: the habitat(s) to be affected are of relatively low value to evaluation species. The mitigation goal of this category is to minimize loss of habitat value. Aquatic species of recreational fishing value including Louisiana crayfish, Tahitian prawn, native o'opu and tilapia may be considered as evaluation species.

SERVICE RECOMMENDATIONS

The Service has given careful consideration to the potential resource benefits involved in expanding the existing Kahawainui pond(s), or in creating more ponds, to provide habitat for Hawaiian waterbirds as mitigation for loss of riparian wetland habitat. Several important criteria for successful propagation of these species cannot be met or developed at Kahawainui without the commitment of substantial funds and staff effort.

These considerations include lack of information on water source and volume; lack of protection from predators (feral dogs); close proximity of dwellings and probable future encroachment of urban activities; potential presence of toxic substances in the wetland (site of previous dump); and lack of sufficient funding and program base for management of the area. The Service believes that possible marginal benefits in waterbird production would not justify the probable high cost of development and operation of these ponds.

The Service recommends that the following measures be implemented to minimize adverse impacts to biological resources within the project area:

1. Shade vegetation consisting of indigenous Hawaiian plants be planted as soon as practicable along the channelized stream banks after construction.

2. Existing water regimes of the two ponds along Kahawainui Stream should be maintained to protect existing habitat utilized by waterbirds and the Endangered Hawaiian Gallinulo.

3. All construction activities should be scheduled and conducted so as to avoid soil erosion and subsequent sedimentation of the stream and Laie Bay.

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Appendix I

CHECKLIST OF THE PLANTS OF THE PROPOSED KAHAWAINUI FLOOD CONTROL PROJECT SITE, OAHU

The following list is based entirely upon observations made on February 10, 1981. As the primary objective of the study was to make a preliminary botanical survey of the proposed study site and to sample the various plant associations rather than compile a comprehensive species list for the area, the list is not to be considered complete.

The following information is included for each entry:

1) Scientific name.
2) Common or Hawaiian name, when known.
3) Distributional range of the species. The terms used are as defined:

   I = Indigenous--native to the Hawaiian Islands, but also occurring naturally (without the aid of man) elsewhere.
   P = Polynesian introduction--a plant brought by Polynesian immigrants pre-Captain Cook.
   X = Exotic--taxon of deliberate or accidental introduction after the Western discovery of the islands.

5) Relative abundance and approximate distribution within the study site. A subjective five-point scale is used to record this information. A species which was seen less than six times is ranked "rare." At the other extreme, the few most common species are ranked "abundant." The progression of the scale is as follows: rare--uncommon--occasional--common--abundant. The rank is based entirely upon a comparison of the frequency with which a species occurs, as compared to all other species, within a biotope of the study area. It does not necessarily denote the abundance of that particular species in the Hawaiian Islands.

MONOCOTYLEDONEAE

Scientific Name	Common Name	Status	Abundance
AMARYLLIDACEAE - Amaryllis family			
Crinum sp.	Spider lily	X	O
COMMELINACEAE - Spiderwort family			
Commelina diffusa Burm. f.	Honohono	X	O

MONOCOTYLEDONEAE

Scientific Name	Common Name	Status	Abundance
GRAMINEAE - Grass family			
Brachiaria mutica (Forsk.) Stapf	California grass	X	A
Cenchrus echinatus L.	Sandbur	X	O
Cynodon dactylon (L.) Pers.	Bermuda grass	X	O
Digitaria pruriens (Trin.) Buse	Kukaipua'a	X	U
Eleusine indica (L.) Gaertn.	Goosegrass	X	C
Pennisetum clandestinum Chiov.	Kikuyugrass	X	C
Saccharum officinarum L.	Sugar cane	P	O
Setaria verticillata (L.) Beauv.	Bristly foxtail	X	U
Sorghum halepense (L.) Pers.	Johnson grass	X	R
Sporobolus virginicus (L.) Kunth	Beach dropseed	I	O
MUSACEAE - Banana family			
Musa xparadisiaca L.	Banana	P	Cultivated
PALMAE - Palm family			
Cocos nucifera L.	Coconut	P	Cultivated
PANDANACEAE - Screw pine family			
Pandanus odoratissimus L.f.	Hala	I	U
PONTEDERIACEAE - Pickerelweed family			
Eichornia crassipes (Mart.) Solms	Water hyacinth	X	O

DICOTYLEDONEAE

Scientific Name	Common Name	Status	Abundance
ACANTHACEAE - Acanthus family			
Asystasia gangetica (L.) T. Anders.	Asystasia	X	C
AMARANTHACEAE - Amaranth family			
Amaranthus spinosus L.	Spiny amaranth	X	U
ANACARDIACEAE - Mango family			
Schinus terebinthifolius Raddi	Christmas berry	X	O
BORAGINACEAE - Heliotrope family			
Tournefortia argentea L. f.	Tree heliotrope	X	U
CASUARINACEAE - Casuarina family			
Casuarina litorea L.	Ironwood	X	C
COMBRETACEAE - Terminala family			
Terminalia catappa L.	False kamani	X	O

DICOTYLEDONEAE

Scientific Name	Common Name	Status	Abundance
COMPOSITAE - Sunflower family			
Bidens alba (L.) DC.		X	U
Pluchea fosbergii Cooperrider & Galang	Fosberg's pluchea	X	O
P. indica (L.) Less.	Indian pluchea	X	O
P. odorota (L.) Cass.	Shrubby fleabone	X	O
Sonchus oleraceus L.	Sow thistle	X	U
Wedelia trilobata (L.) Hitchc.	Wedelia	X	U
CONVOLVULACEAE - Morning glory family			
Ipomoea alba L.	Moon flower	X	R
I. indica (Burm.) Merr.	Koali-'awania	I	O
I. ochracea G. Don		X	U
I. pes-caprae (L.) R. Br.	Beach morning glory	I	O
EUPHORBIACEAE - Spurge family			
Euphorbia glomerifera (Millsp.) L.C. Wheeler		X	O
Macaranga tanarius (Stickm.) Muell.-Arg.		X	U
Ricinus communis L.	Castor bean	X	C
GOODENIACEAE - Naupaka family			
Scaevola taccada (Gaertn.) Roxb.	Naupaka - kahakai	I	O
LEGUMINOSAE - Pea family			
Acacia confusa Merr.	Formosan koa	X	R
Canavalia cathartica Thouars	Mauna - loa	X	O
Cassia leschenaultiana DC.	Partridge pea	X	U
Desmanthus virgatus (L.) Willd.	Virgate mimosa	X	O
Leucaena leucocephala (Lam.) de Wit	Koa-haole	X	C
Mimosa pudica L.	Sensitive plant	X	O
MALVACEAE - Hibiscus family			
Hibiscus tiliaceus L.	Hau	I	C
MYRTACEAE - Myrtle family			
Eugenia cumini (L.) Druce	Java plum	X	O
Psidium guajava L.	Guava	X	O
ONAGRACEAE - Evening primrose family			
Ludwigia octivalvis (Jacq.) Raven	Primrose willow	X	O
PASSIFLORACEAE - Passion flower family			
Passiflora edulis Sims	Liliko'i	X	R
P. foetida L.	Scarlet-fruited passionflower	X	O
P. suberosa L.	Huehue-haole	X	U

DICOTYLEDONEAE

Scientific Name	Common Name	Status	Abundance
PLANTAGINACEAE - Plantain family			
Plantago lanceolata L.	Buckthorn plantain	X	O
POLYGONACEAE - Buckwheat family			
Coccoloba uvifera (L.) L.	Sea grape	X	Cultivated
PORTULACACEAE - Purslane family			
Portulaca oleracea L.	Purslane	X	O
RHIZOPHORACEAE - Mangrove family			
Rhizophora mangle L.	American mangrove	X	C
SCROPHULARIACEAE - Figwort family			
Bacopa monnieria (L.) Wettst.	Water hyssop	I	O
VERBENACEAE - Verbena family			
Lantana camara L.	Lantana	X	O
Vitex trifolia L.	Polinalina	X	Cultivated

Appendix 2. Terrestrial and freshwater fauna observed along Kahawainui Stream during 1981-1983 Service surveys. Taxonomy is based upon References 2, 3, 5 and 9.

AVIFAUNA	COMMON NAME
NATIVE BIRDS	
Gallinula chloropus sandvicensis	Hawaiian Gallinule
Nycticorax nycticorax hoactli	Black-crowned Night Heron
INTRODUCED BIRDS	
Acridotheres tristis	Common Myna
Bubulcus ibis	Cattle Egret
Geopelia striata	Zebra Dove
Paroaria coronata	Red-crested Cardinal
Streptopelia chinensis	Spotted Dove
Zosterops japonicus	Japanese White-eye
MIGRATORY SEABIRDS	
Heteroscelus incanus	Wandering Tattler
Pluvialis dominica fulva	Lesser Golden Plover
MAMMALS	
Canis familiaris	Dog
Felis catus	Cat
Herpestes auropunctatus	Mongoose
Rattus spp.	Rat
AMPHIBIANS	
Rana catesbeiana	Bullfrog
FISHES	
Cichlidae	Tilapia
Mugil cephalus	Mullet
Poeciliidae	Poeciliid

Appendix 3. Checklist of the macrofauna observed in Laie Bay during 1981 Service surveys. Fish Taxonomy based on Reference 5.

CHORDATA

Acanthurus triostegus Streets
A. nigroris Cuvier and Valenciennes
Naso unicornis (Forskal)
Chaetodon fremblii Bennett
C. miliaris Quoy and Gaimard
Zanclus cornutus Linnaeus
Abudefduf abdominalis (Quoy and Gaimard)
A. sordidus (Forskal)
Adioryx xantherythrus (Jordan and Evermann)
Thalassoma duperrey Quoy and Gaimard
Coris gaimardi (Quoy and Gaimard)
Labroides phthirophagus Randall
Rhinecanthus rectangulus (Bloch and Schneider)
Pervagor spilosoma (Lay and Bennett)
Unidentified wrasse, sp. 1
Unidentified wrasse, sp. 2
Parupeneus multifasciatus (Quoy and Gaimard)
Unidentified blenny
Unidentified Moray eel, sp. 1
Unidentified Moray eel, sp. 2
Unidentified Moray eel, sp. 3

MOLLUSCA

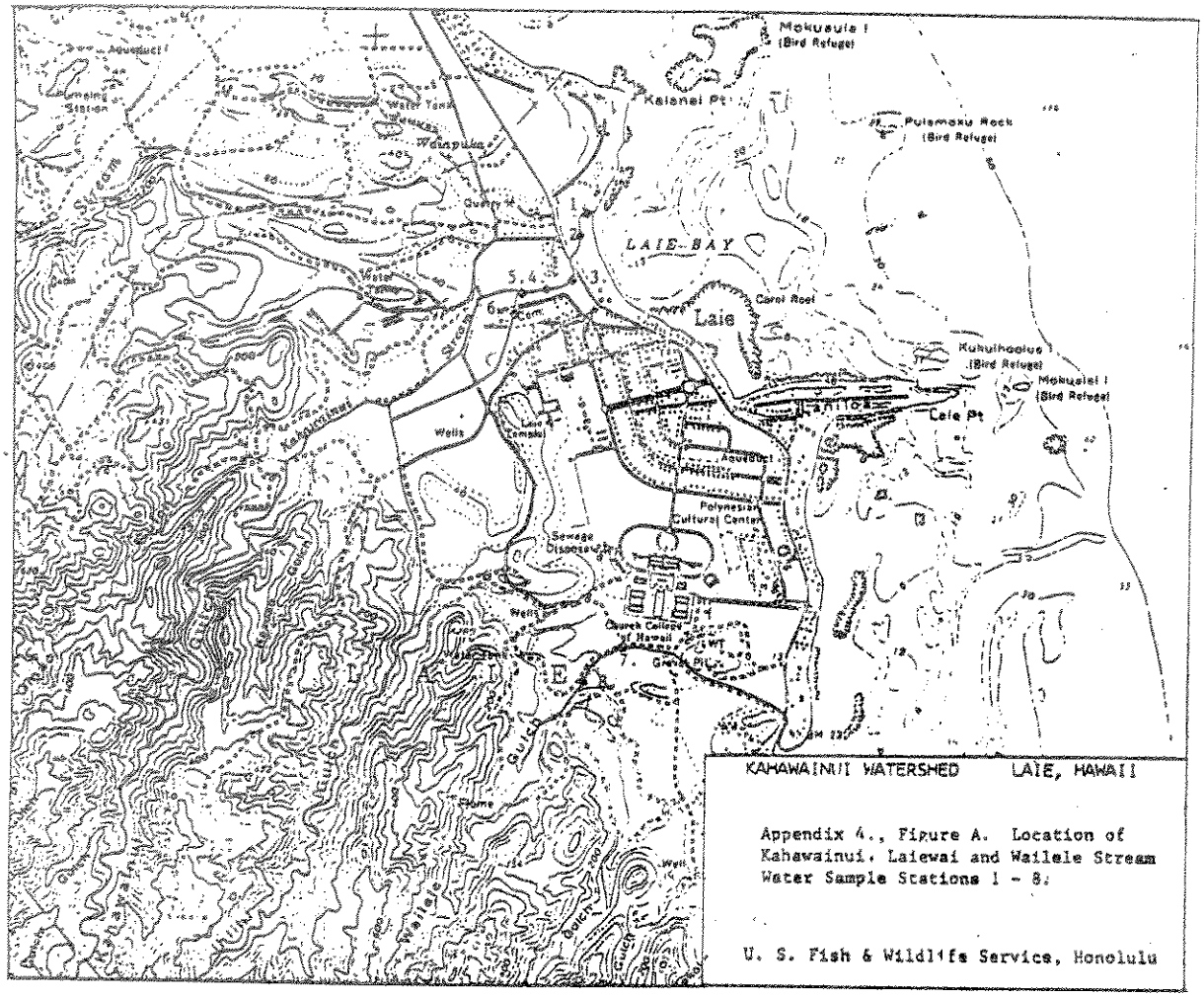
Polypus marmoratus (Hoyle)

ECHINODERMATA

Echinothrix diadima (Linnaeus)
Tripneustes gratilla (Linnaeus)

Appendix 4. Results of preliminary physical and chemical analysis of water samples obtained from six stations along Kahawainui, Laiewai and Maileie Streams by PWS staff, Bill Lennan. Stations 1-4 (from Kahawainui Stream) were sampled on March 23, 1981, while stations 5-6 (Laiewai Stream) were sampled on April 14, 1981 and stations 7-8 (Maileie Stream) were sampled on April 3, 1981. Locations of sampling stations are shown in Fig. A. Note: Stations 1-4 were not sampled for oxygen.

Station No.	Temperature C	Salinity %	Conductivity umhos	pH	Ammonia mg/l	Nitrate mg/l	Oxygen mg/l
1	26	1.5	2500	6.5	1.89	0	
2	26	2.0	3300	6.5	2.07	<1.0	
3	26	1.0	1350	6.5	2.44	<1.0	
4	26	1.0	650	6.5	1.71	<1.0	
5	23	1.0	410	5.2	.73	2.0	1.8
6	23	1.0	410	5.5	.85	2.0	1.6
7	21	1.0	90	5.2	.98	1.0	6.1
8	23	1.0	80	4.9	.98	1.0	9.0



KAHAWAINUI WATERSHED LAIE, HAWAII

Appendix 4., Figure A. Location of Kahawainui, Laiewai and Wailele Stream Water Sample Stations 1 - 8.

U. S. Fish & Wildlife Service, Honolulu

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COUNTY COUNSEL