Alenaio Stream, Island of Hawaii
Harbors and Rivers in Hawaii

FINAL

Survey Report and
Environmental Impact Statement

US Army Corps of Engineers
Honolulu District

JULY 1982

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

HARBORS AND RIVERS IN HAWAII

ALENAIO STREAM

ISLAND OF HAWAII, HAWAII

INTERIM
SURVEY REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT

July 1982

FINAL
SURVEY REPORT AND
ENVIRONMENTAL IMPACT STATEMENT
ALENAIO STREAM, ISLAND OF HAWAII, HAWAII

SYLLABUS

The purposes of this study were to identify the problems, needs and the extent to which the Federal government should participate in flood-damage reduction measures. A variety of preliminary plans were evaluated where many were eliminated from further study because of their high costs compared with expected benefits and/or technical inapplicability to the study area. Three (3) alternatives were studied in further detail. They included:

Plan 1: Modifying the Existing Stream Channel
Plan 2: A Diversion Channel into the Wailuku River
Plan 3: Floodproofing Individual Structures, Relocation and Floodplain Management Practices.

A public meeting was held on 12 May 1982 to discuss the draft report and the recommended plan. A public notice was circulated prior to the scheduled meeting notifying the public of the time and place. All comments received on the draft report is documented in the Final Report and Environmental Impact Statement.

Alternative Plan 1 is recommended because the combined beneficial National Economic Development (NED) and Environmental Quality (EQ) qualities exceed the other two (2) alternative plans. Alternative Plan 1 has an estimated project first cost of $7,983,000 with an expected benefit-to-cost ratio of 2.3 for the Standard Project Flood level of protection. The most significant adverse environmental impact for this plan is the requirement to relocate six (6) residential structures and one (1) public (fire station) administration building. The major features of Plan 1 are:

(1) A 1640-foot rectangular concrete-lined channel, 35 to 40 feet wide between Kilauea Avenue and Kapiolani Street,

(2) Floodproofing 11 individual structures, and

(3) Incorporating floodplain management regulations.

July 1982
Honolulu, Hawaii

Final
Survey Report
and
Environmental Impact Statement
Alenaio Stream, Island of Hawaii, Hawaii

Table of Contents

Table of Contents (Cont)

List of Appendices

List of Figures

List of Tables

List of Tables (Cont)

List of Photographs

LIST OF ABBREVIATIONS AND SYMBOLS

ac-ft	acre feet
BERH	Board of Engineers for Rivers and Harbors
CFR	Code of Federal Regulations
cfs	cubic feet per second
CT	Census Tracts
DA	Drainage Area or Department of the Army
EIS	Environmental Impact Statement
EM	Engineer Manual
ER	Engineer Regulation
ETL	Engineer Technical Letter
EQ	Environmental Quality
FWS	Fish and Wildlife Service
i	interest rate
HACS	Hilo Area Comprehensive Study
HEC	Hydrologic Engineering Center
hr	hour
KW	Kilowatt
MFR	Memorandum for Record
m	meter(s)
mgd	million gallons per day
MOA	Memorandum of Agreement
n	Manning roughness coefficient or amortization period
NED	National Economic Development
NER	North East Rift Zone
OCE	Office of the Chief of Engineers
OSE	Other Social Effects
PAL	Planning Aid Letter
PL	Public Law
POS	Plan of Study
P&S	Principles and Standards
RED	Regional Economic Development
SCS	Soil Conservation Service
SPF	Standard Project Flood
Sq Mi	Square Miles
USGS	U.S. Geological Survey

HARBORS AND RIVERS IN HAWAII

ALENAIO STREAM

ISLAND OF HAWAII, HAWAII

MAIN REPORT

TABLE 1. PRIOR STUDIES (Cont)

STUDY TITLE	DATE	AGENCY/AUTHORITY	CONCLUSIONS
Preliminary Flood Boundary and Flooding Map, Alenaio Stream	1979	US FEDERAL Emergency Management Agency, Federal Insurance Administration, National Flood Insurance Program	Provides technical data on existing flood hazards
County			
Hilo Drainage and Flood Control	1967	County of Hawaii, prepared by Wilson, Okamoto & Associates	Recommended various flood control and drainage measures, partially implemented by County.
Alenaio Stream, Flood Control Improvements	undated	County of Hawaii, prepared by Neighbor Island Consultants	Designed possible channel improvements to Alenaio Stream, not implemented by County.

6. REPORT PREPARATION

This document consists of a Main Report and a series of appendices. The Main Report is a self-contained document which describes the planning process and includes the Environmental Impact Statement. The appendices contain technical and detailed information and background data to support the information contained in the Main Report. A list of symbols and abbreviations used in this report is presented as part of the Table of Contents.

Appendix A, Plan Formulation Criteria and Compliance Documents, contains general and specific information regarding the study authority, legislative requirements, planning criteria and constraints, local cooperation and cost sharing requirements that contribute to the plan formulation process of the study. Also included in this appendix are the compliance evaluation reports required by Executive Order 11988, Section 404 of the Clean Water Act and the Coastal Zone Management Act.

Appendix B, Public Involvement, describes the public involvement program and contains pertinent correspondence, public comments received and the Corps responses to these comments during the study and evaluation period.

Appendix C, Geology, Foundations and Materials, contains the analyses and data relevant to the geologic, soils and foundation design assumptions.

Appendix D, Hydrologic and Hydraulic Engineering Investigations and Design, documents the engineering analyses and data pertinent to the development of the hydrologic assumptions, hydraulic design and construction costs.

Appendix E, Economic Benefit Analysis, contains the economic background data and analyses for determining the benefits associated with each alternative plan.

Appendix F, Social and Cultural Resources, contains background information and impact evaluations on the recreational, social, cultural and archaeological resources within the affected study area.

Appendix G, Natural Resources, contains information on the natural resources of the study area and the US Fish and Wildlife Service reports and coordination actions made by the Corps of Engineers.

II. PROBLEM IDENTIFICATION

1. PURPOSE

The purpose of problem identification is to define the study area and the objectives and problems to be addressed in the study. This includes describing the base conditions, identifying public concerns, establishing planning criteria and analyzing the problems. Public concerns which relate to water and related land resource problems are identified and then refined based on national and local policies and the study authority.

National planning policies are provided by the Water Resources Council's Principles and Standards of 1980 (18 CFR 711 et seq dtd 29 Sep 1980), the National Environmental Policy Act of 1969 (PL 91-190), Section 122 of the River and Harbor and Flood Control Act of 1970 (PL 91-611), the Water Resources Development Act of 1974 (PL 93-251), the Clean Water Act of 1977 (PL 95-217), and the Corps of Engineers' Policy Guidelines (ER's). The Water Resources Council's Principles and Standards furnishes guidelines for managing the nation's water and related land resources. The Principles provide a broad policy framework for planning activities and include the conceptual basis for planning the management and use of these resources, while the standards outline how this policy framework should be implemented by detailing uniform, consistent methods of measuring the beneficial or adverse effects of alternative plans.

To help determine the resource management1/ problems the base condition of the study area is first defined. The base condition comprises the existing economic, social, and environmental characteristics of the area. Future conditions are then projected and analyzed to determine the "most probable future"2/ which would prevail over the area without any changes to existing resource management plans. This analysis describes the "without condition" criterion. Planning objectives3/ are then formulated based on the problems and needs of the area related to the "without condition" criterion.

1/ "Resource management" involves the development, conservation, enhancement, preservation, or maintenance of water and related land resources to achieve the goals of society expressed nationally and locally.

2/ "Most probable future" is the projection of basic demographic, economic, social, and environmental parameters, which is used as the basis for defining the "without condition" and the planning objectives for a particular study.

3/ "Planning objectives" are the national, state, and local water and related land resource management needs (opportunities and problems) specific to a given study area that can be addressed to enhance National Economic Development or Environmental Quality.

2. NATIONAL OBJECTIVES

The Principles and Standards (P&S) for Planning Water and Related Land Resources seek to further two specific objectives: the promotion of national economic development and the preservation of environmental quality. The national objectives provide the basis for formulation and analysis of alternative plans. The National Economic Development (NED) objective is achieved by increasing the value of the nation's output of goods and services and improving national economic efficiency.

The Environmental Quality (EQ) objective provides for the management, conservation, preservation or improvement of the quality of certain natural and cultural resources and ecological systems in the study area. During the formulation of alternative plans the NED and EQ contributions are evaluated on an equal basis; however, for any plan to be recommended, the benefits accruing from the project must exceed the total adverse impacts of the project. Although a proposal to eliminate the Environmental Quality (EQ) objective from the planning framework is under consideration, this proposal will not affect the principles of maximizing the conservation, enhancement or preservation of environmental resources in the development of any plan in this study. P&S also require that the impacts of a proposed action be measured in terms of Regional Economic Development (RED) and Other Social Effects (OSE). Contributions to the RED account are determined by establishing a proposal's effects on a region's income, employment, population, economic base, environment, and social development. Contributions to the OSE account are determined by establishing a proposal's effects on security of life, health and safety, urban and community impacts, emergency preparedness, displacement, long term productivity and energy.

3. WATER USES AND DEVELOPMENT

Because water is a precious resource, it is important that it be utilized to the fullest extent possible. Although the primary purpose of this study is to investigate flood damage reduction or flood control measures, the multiple uses of water have also been considered. Sometimes however, different uses of water are not compatible, and compromises between uses may be necessary and must be identified based on needs and economic efficiency. Other primary uses or concerns for water that were considered include:

a. Urban water supply and conservation,

b. Agricultural irrigation,

c. Power generation (Hydropower),

d. Recreation,

e. Water quality/pollution control,

f. Navigation, and

g. Fish and wildlife enhancement.

4. STUDY AREA

The Alenaio watershed is in the South Hilo District (see Figure 1) which is on the northeastern side of the island of Hawaii, the largest island of the Hawaiian Archipelago. The island comprises the County of Hawaii, where Hilo, the County seat and principal urban center, is located in the lower portion of the watershed.

There are four main tributary areas in the South Hilo District, the Waiakea-Uka Stream, the Wailuku River, the Alenaio Stream, and the Palai/Four Mile Creek. Alenaio Stream includes several connecting waterways, the Kaluiike and Waipahoehoe Streams in the upper areas, and the Waiolama Canal along the coast. The Waiolama Canal discharges into the Wailoa River which empties into Hilo Bay.

Alenaio Stream originates approximately 11 miles southwest of the City of Hilo at an elevation of about 2,550 feet on the slopes of the Mauna Loa volcano. The Alenaio drainage basin (see Figure 2) is approximately 8.53 square miles in area. The study area for this report is the drainage (watershed) area from Chong's Bridge to Hilo Bay. The area above Chong's Bridge is under study by the Soil Conservation Service. The Kaluiiki Branch joins Waipahoehoe Stream above Chong's Bridge. The stream then becomes undefined in the flood plain below Chong's Bridge in the lava-covered land area. As the flow disappears in the lava land area, part of the flow reappears above Komohana Road where it forms Alenaio Stream. Alenaio Stream then flows downstream with bridge crossings at Kapiolani, Ululani, and Kinoole Streets and Kilauea Avenue. Downstream of Kilauea, the Alenaio Stream flows into the Waiolama Canal and into Wailoa River which discharges into Hilo Bay. All the streams in the Alenaio watershed are ephemeral. Figure 3 shows the major features of the study area.

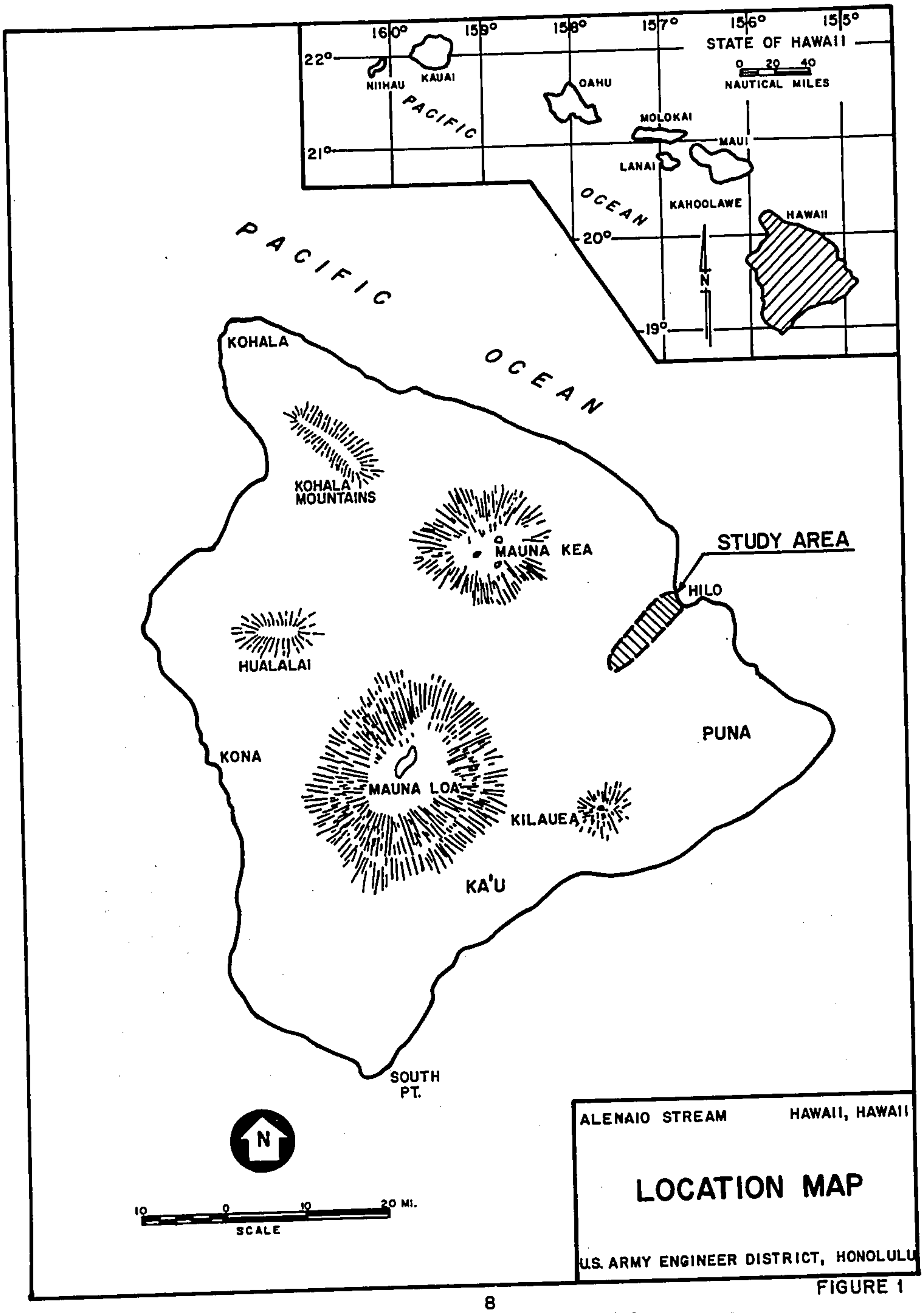
5. PROFILE OF EXISTING BASE CONDITIONS

The social, physical, environmental and economic characteristics are briefly described to provide the reader with a general background of the study area. More detailed and specific descriptions are provided in the appendices.

a. Social Resources.

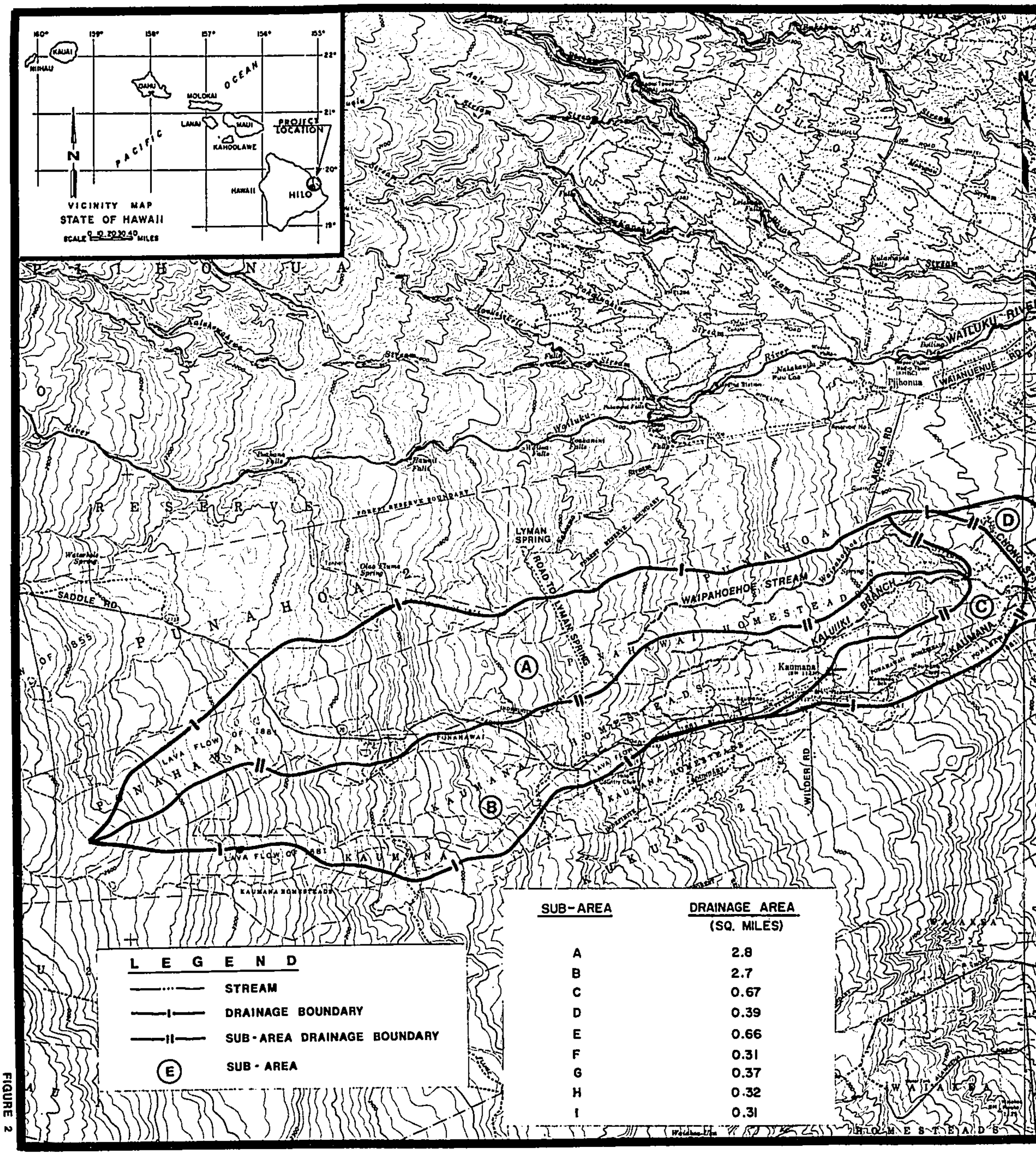
History and Culture. The historical background of the study area revolves around the events and changes that took place in the area that is now the City of Hilo. Hilo's position on the bay made it well suited for attracting ships which helped it to dominate the flow of goods and people along the windward coast of the island of Hawaii. It was believed that there were originally several Hawaiian settlements within the boundaries of Hilo. Hawaiian legends indicate that Kamehameha determined his destiny at Hilo, where at the Pinao Temple, he overturned the Naha Stone, a sign that he would rise to power and eventually conquer and rule the Hawaiian island chain. The significance of the City's name has disappeared but some believe it refers to the crescent shaped bay and its similarity to the crescent phase of the moon as Hilo means crescent moon in the Hawaiian language.

The first written reports of the area came from Captain James Cook in 1778. After the explorers came the fur traders and seamen who found the island an ideal spot for provisioning and spending the winter months. Christian missionaries arrived in 1820. By the end of 1837, two-thirds of the



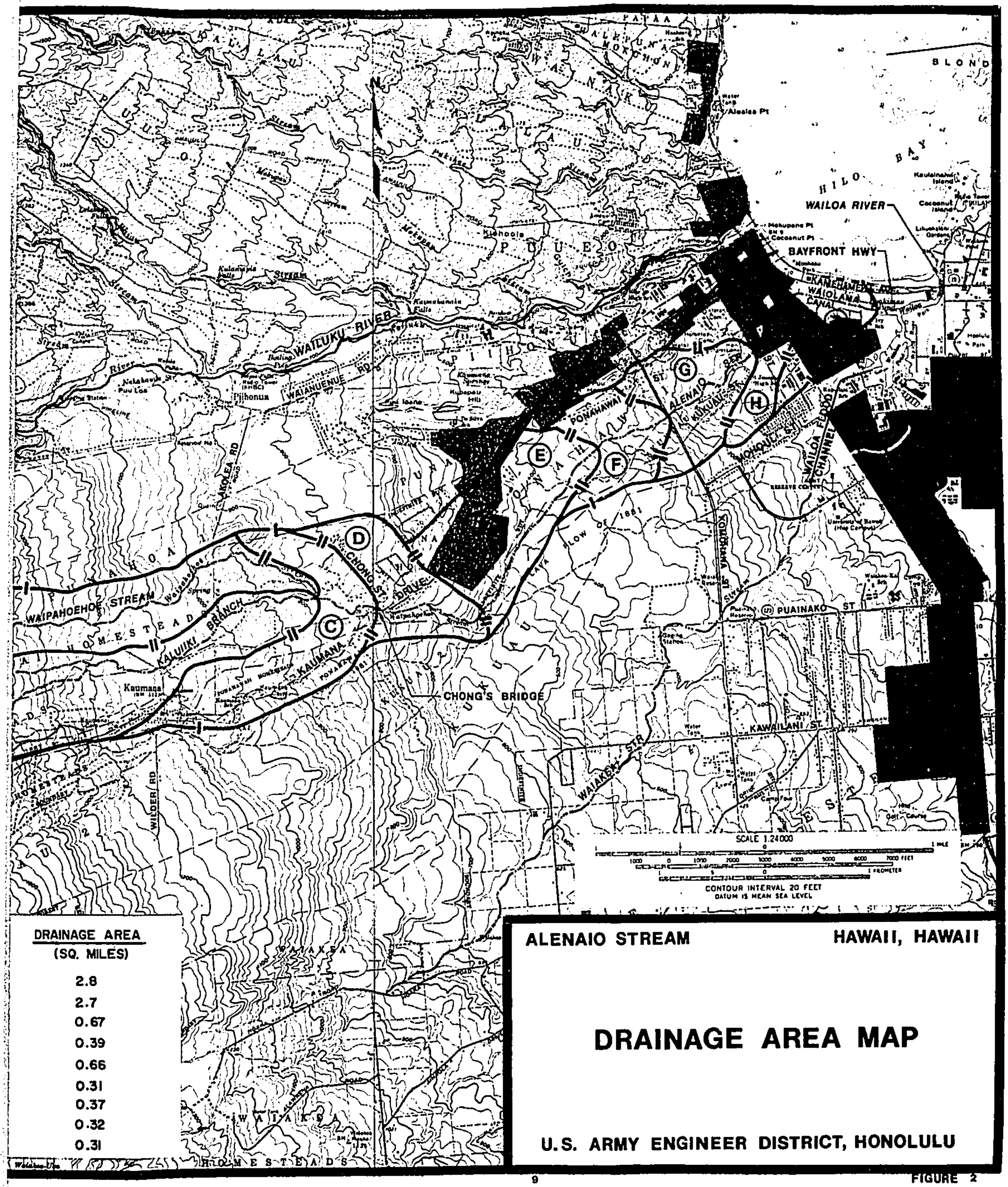
STATE OF HAWAII
160°
159°
158°
157°
156°
155°
22°
21°
20°
19°
0 20 40
NAUTICAL MILES
NIIHAU
KAUAI
OAHU
MOLOKAI
MAUI
LANAI
KAHOOLAWE
HAWAII
PACIFIC
OCEAN
N
PACIFIC
OCEAN
KOHALA
KOHALA MOUNTAINS
MAUNA KEA
STUDY AREA
HILO
HUALALAI
KONA
MAUNA LOA
KILAUEA
PUNA
KA'U
SOUTH PT.
N
10 0 10 20 MI.
SCALE
ALENAIO STREAM
HAWAII, HAWAII
LOCATION MAP
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 1



SUB-AREA	DRAINAGE AREA (SQ. MILES)
A	2.8
B	2.7
C	0.67
D	0.39
E	0.66
F	0.31
G	0.37
H	0.32
I	0.31

FIGURE 2



ALENAIO STREAM **HAWAII, HAWAII**

DRAINAGE AREA MAP

U.S. ARMY ENGINEER DISTRICT, HONOLULU

DRAINAGE AREA (SQ. MILES)
2.8
2.7
0.67
0.39
0.66
0.31
0.37
0.32
0.31

FIGURE 2

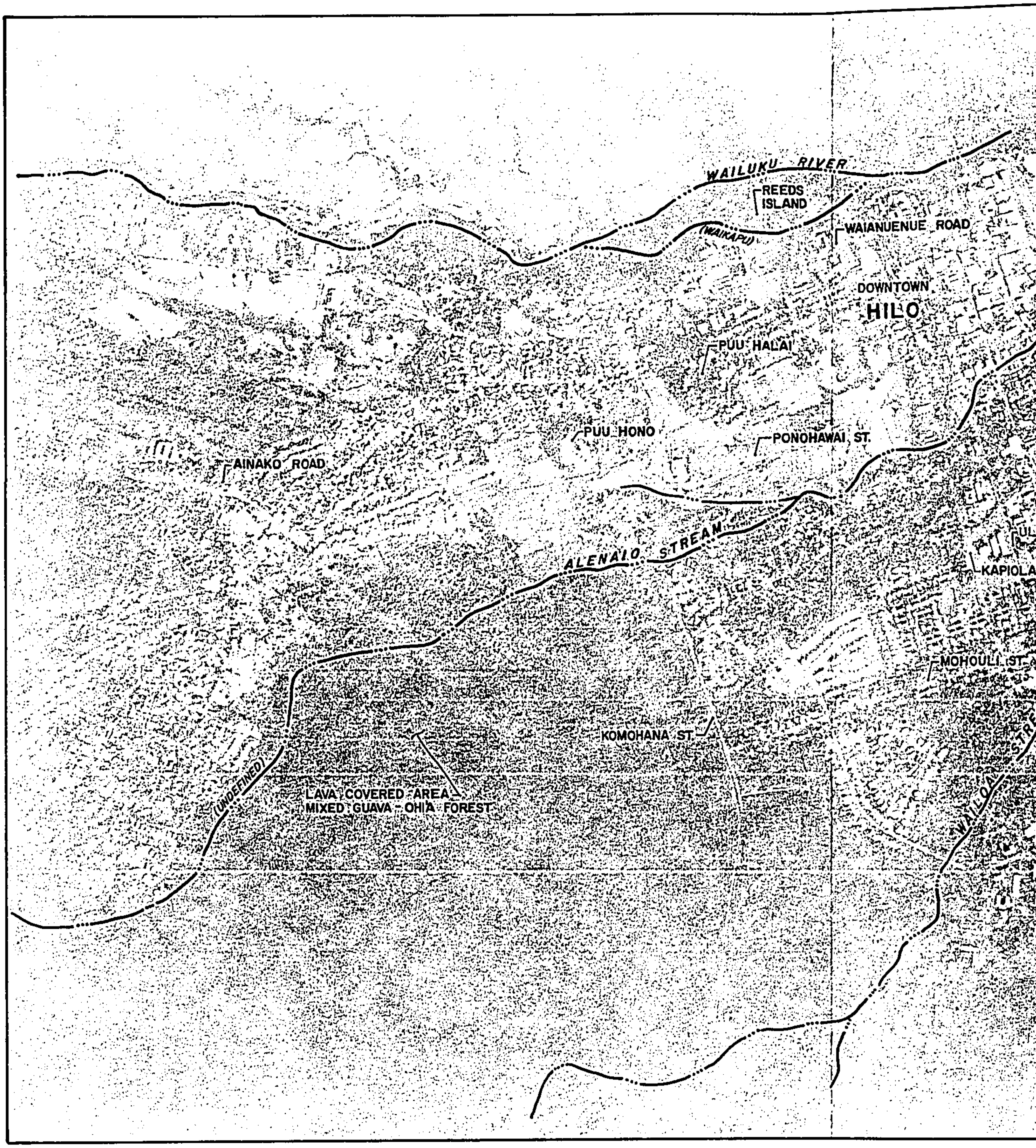

WAILUKU RIVER
REEDS ISLAND
(WAIKAPU)
WAIANUENUE ROAD
DOWNTOWN
HILO
PUU HALAI
PUU HONO
PONOHAWAI ST.
AINAKO ROAD
ALENAIO STREAM
KAPIOLA
MOHOULI ST.
KOMOHANA ST.
LAVA COVERED AREA
MIXED GUAVA - OHIA FOREST
(UNDEFINED)
WAILOA STRE

FIGURE 3


N
RIVER
WAIANUENUE ROAD
HILO BAY
DOWNTOWN
HILO
BAYFRONT HIGHWAY
KAMEHAMEHA AVE
WAIOLAMA CANAL
KILAUEA AVE
HONOHAWAI ST.
KINOOLE ST.
WAIAKEA POND
ULULANI ST.
KAPIOLANI ST.
WAILOA FLOOD CONTROL PROJECT
MOHOULI ST.
WAILOA STREAM
GRAPHIC SCALE
1000 0 500 1000
SCALE IN FEET
ALENAIO STREAM
HAWAII
EXISTING CONDITIONS
US ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 3

surrounding population had moved into Hilo to join the religion's great revival. By 1857, the impact of introduced diseases left, only 1,500 out of 10,000 Hawaiians remaining in Hilo.

After petroleum was discovered in Pennsylvania, the need for whale oil dramatically declined and the importance of Hilo was lost. However, a reciprocity treaty with the US in 1875, assuring no duty on Hawaiian sugar, produced a sugar-prosperous Hilo at the close of the century. The economic prosperity and the need for labor attracted immigrants from the Orient.

After a depression in 1904, major moves were made to stimulate the local economy. Two major actions were implemented; the construction of a breakwater to provide an all-weather deep-draft harbor and the extension of the railroad to the Hamakua Coast to link the outlying plantations with the city. In 1905, Hilo became the seat of government for the County of Hawaii. The two world wars brought prosperity into the county with higher sugar prices.

Historic land and water uses. Many active natural phenomena have affected and will continue to affect the Alenaio Stream floodplain. Lava flows in and around Hilo have significantly affected surface run-off and spring flows. Mauna Loa and Kilauea are still active, having last erupted in 1975 and 1979, respectively. Severe tsunamis in 1946 and 1960 caused major destruction along the bay front. This resulted in a major redevelopment plan for downtown Hilo, where a policy of incorporating open spaces along the bay to reduce the potential of future tsunami damage changed the urban form to what it is today.

Many man-made changes have also been made, most notably the construction of the Waiolama Canal from 1912-1917. Approximately 600,000 cubic yards of material dredged from the beaches of Hilo Bay were utilized in filling the marsh land area along the Waiolama Canal. The Waiolama Stream area was used during the pre-contact period for self-sufficient agriculture (taro) and aquaculture (fishponds). Today the Waiolama Stream is a canal that drains water from the Alenaio Stream into the Wailoa River.

Various culverts and local drainage systems were also constructed. The most significant project was the Ponahawai relief box culvert which originates between Ululani and Kinoole Streets and diverts part of the water flow directly into Hilo Bay through a diversion culvert running east of Punahawai Street. This system was constructed in 1924 by local businessmen to help alleviate flooding in the Punahawai area. Over-flows are carried by a diversion weir into the Waiolama Canal.

The surrounding and upper watershed areas were utilized for sugarcane plantations. Sugarcane growing has influenced the expansion of Hilo and incorporated many land-use changes. The construction of a railroad system to the outlying plantations and harbor improvements (most notably the offshore breakwater) were major construction projects to stimulate the sugar cane industry.

b. Physical Resources.

Climatology. Hawaii has a subtropical climate. Hilo's mean temperature is 73.4°F. Relatively uniform temperatures and day lengths provide a 12-month growing season with slight growth reduction from October to April.

The mean annual rainfall increases from 100 inches or more along the coasts to a maximum of over 300 inches between elevations 2,000 to 3,000 feet and then declines to about 15 inches at the summits of Mauna Kea and Mauna Loa. Hilo receives about 130 inches. Monthly average rainfall varies enough to provide wet and dry seasons which affect stream flow volume. Underground water may also be affected by monthly rainfall variation because the basal lavas are porous. Mauna Loa and Mauna Kea are usually snowcapped from December through February but do not affect stream flows.

Topography. The most prominent topographic landmark in Hilo is Puu Halai. Mauna Kea at 13,796 MSL and Mauna Loa (Long Mountain) at 13,653 MSL provide a dramatic backdrop for the Hilo community. Mauna Loa and Kilauea are active volcanoes, both erupting during this decade. The commercial and civic center of South Hilo is bounded by the Waiakea Stream, the Wailuku River and Hilo Bay. Other major urban centers are Kailua-Kona about 100 miles from Hilo and Waimea, approximately 55 miles from Hilo.

Geology/Mineral Resources. The island of Hawaii is the largest and youngest of the Hawaiian island archipelago. The island is the result of the coalescence of the lava flows of five volcanoes. The oldest, Kohala, has not erupted in the last 60,000 years, however, the two younger volcanos, Mauna Loa and Kilauea are very active. The slopes above Hilo are built as a shield volcano by thin lava flows, both pahoehoe and aa. The flows dip 4o to 6o to the northeast and consist of permeable highly zesicular and scoriaceous lava-basalt. Cooling cracks, lava tubes, intra-flow clinker layers, jointing and fracturing and other openings are channels through which heavy rainfall flows through the ground to the ocean.

The 1881 lava flows in and around the Waiakea estuary influence surface runoff, infiltration, location and size of springs and other physical factors affecting groundwater movement above Hilo. Springs flowing into the Waiakea estuary from groundwater range from 100 to more than 200 cubic feet per second, volumes equal to some of the largest springs in the world.

The Alenaio Stream flows in a channel defined by the margins of three pahoehoe flows (1881, Kulaloa and Punahoa flows); water movement into the Alenaio Stream area is influenced by the characteristics of these lava flows.

There is also a potential danger to the City of Hilo and the surrounding community from volcanic lava flows originating in the northeast rift zone of Mauna Loa. Historic lava flows are shown in Figure 4. Studies have been made by the Corps of Engineers in cooperation with the State (Ref. 43) to develop possible plans for implementation in the event that an eruption endangers Hilo. This study recommended that a fully prepared Emergency Barrier plan be implemented only when it has been determined that an eruption will affect the city of Hilo.

There are no known mineral resources of commercial value in the study area. However, lava rocks are commonly used for decorative and masonry wall material by local residents.

c. Environmental Resources.

(1) Flora.

Terrestrial vegetation in the Waiolama Canal region, located within the Hilo Bay front park, includes predominantly exotic ornamental species such as

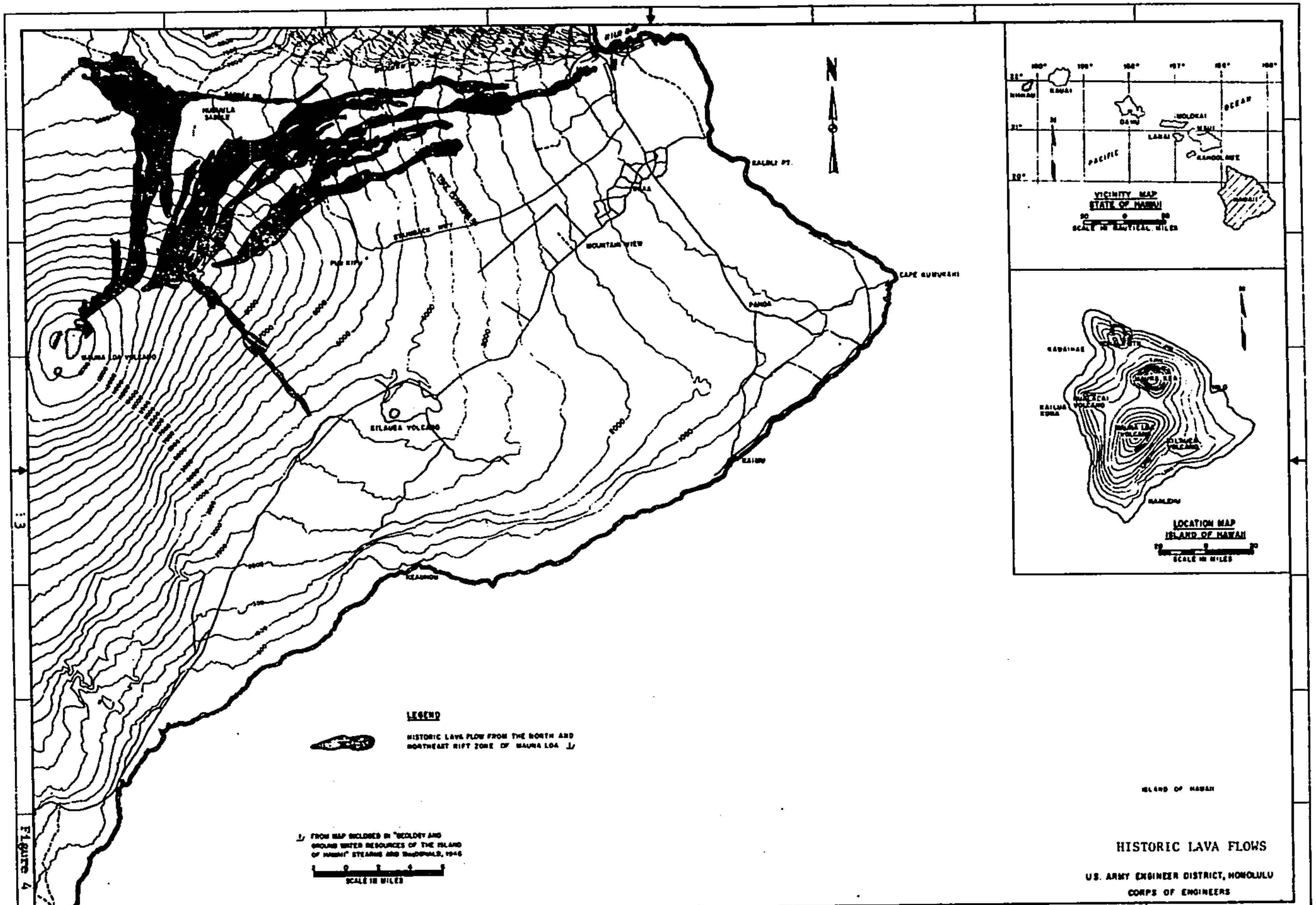


FIGURE 4

Figure 4

coconut palms, livistona palms, African tulip trees, monkey pod, banyan and bamboo. Exotic weeds are also common, as well as a variety of native and exotic grasses.

Aquatic flora within the canal is comprised of hydrophytes including waterweed, parrot feather and water lily. Emergent grasses such as seashore paspalum, California grass and quackgrass are common. Riparian vegetation growing within and adjacent to the canal consists of California grass, honohono, primrose willow, sourbush and Spanish clover.

From Kilauea Avenue to Komohana Street, vegetation consists primarily of guava, ginger, banana, umbrella tree, swamp mahogany, ti, mango, papaya, various palms, kukui, African tulip tree, and other ornamentals. Aquatic vegetation is limited to emergent grasses, such as California grass.

The forested area between Komohana and Chong Streets can be characterized as a mixed guava - ohi'a forest. In addition, hala, swordfern, strawberry guava, banana, ginger, kukui, coconut palms, and African tulip trees are common in more heavily forested areas. In clearings, grasses and low-growing shrubs prevail, including California grass, quackgrass, sugarcane, sourbush, sleeping grass, and morning glory.

The reach above Chong Street includes both forest reserve lands and agricultural lands devoted to the cultivation of sugarcane. Native ohi'a - koa forest predominates above the 1600-foot elevation. Other common flora include guava, strawberry guava, ginger, sourbush, primrose willow, tree ferns, false staghorn fern, wild orchids, and a variety of grasses and sedges.

On agricultural lands and uncultivated peripheral lands, sugarcane, guava, strawberry guava, ohi'a, and ginger are common. Banana, swamp mahogany, sourbush, wild orchids, sleeping grass, California grass, quackgrass, Jamaica vervain, and melastome are also found on uncultivated lands adjacent to stream channels.

(2) Terrestrial Fauna

Waiakea Pond located at the seaward end of Waiolama Canal provides habitat for a variety of resident and migratory bird species. Native resident species such as the black-crowned night heron and the endangered Hawaiian coot are known to frequent the area. The coot also nests in Mohouli Pond, which is adjacent and connected to Waiakea Pond. Regular visitors to the pond include the mallard, pintail, shoveler, Americana widgeon, and lesser scaup. Occasional or infrequent visitors include the canvasback, white-fronted goose, Canada goose, bufflehead, and glaucous-winged gull.

Two species of migratory shorebirds have been observed in Hilo Bayfront Park, the golden plover and the wandering tattler. So-called "urban" species are widely distributed throughout the main islands and are frequently sighted in the project area. These exotic species include the barred dove, lace-necked dove, common mynah, Japanese white-eye, ricebird, house sparrow, house finch, and red-crested cardinal.

Mammals in the Alenaio project area most likely include non-game species typically found in urban environments throughout Hawaii. These include the house mouse, roof rat, Norway rat, Polynesian rat, Indian mongoose, domestic dog, and the domestic cat. The only land mammal endemic to Hawaii is the Hawaiian hoary bat, an endangered species. Although this species has been observed in the Hilo area in the past, little is known of its life history or specific habitat requirements.

(3) Aquatic Fauna

Sixty-one percent of the aquatic species observed or reported in Alenaio Stream and Waiakea Pond are considered native (endemic or indigenous) to Hawaii. These include euryhaline marine species, such as maiko, manini, papio, milkfish, mullet and aholehole. All of these species occur in the lower Alenaio (Waiolama Canal, Waiakea Pond) subject to tidal influence.

Native diadromous species found in the Waiakea Pond - Waiolama Canal reach include the gobioid fishes o'opu okuhe, o'opu naniha, and o'opu nakea, as well as the decapod crustacean opae oeha'a. Other native invertebrates included the Hawaiian crab, dragonfly larvae and adults, and a polychaete bristleworm. Exotic macrofauna which have been reported from Waiakea Pond include tilapia, carp, guppies, and mosquito fish.

Guppies are common throughout Alenaio Stream. Larvae and adults of the bullfrog and the giant marine toad are also abundant in all stream reaches. The weatherfish or dojo is occasionally found in Alenaio Stream and the Waipahoehoe Branch. Crayfish are also found in the Waipahoehoe Branch, and the Tahitian prawn has been observed by local residents in several of the deeper perennial pools.

d. Economic Resources.

General. The basic elements of the economy of Hawaii County are tourism, agriculture and fishing, manufacturing, and scientific research. Hilo is the principal urban area of the County and is the second largest city in the State. The city site, which has been inhabited since early Hawaiian times, fronts Hilo Bay, the only sheltered bay along the eastern coast of the Island of Hawaii. Hilo is the center of government and is the only metropolitan area in the County. The city serves as the center for trade, distribution, and services.

Population. The population of Hawaii County declined from 1930 to 1960. County population has experienced a continued growth from 1970 through 1978, with growth rates significantly exceeding those for the State throughout this period. Population estimates for South Hilo District and the Hilo urban area since 1960 indicate that the Hilo area has shared in this growth. Table 2 shows historical population growth for the State of Hawaii, Hawaii County, South Hilo District and the Hilo urban area for selected years.

TABLE 2: HISTORICAL POPULATION OF HAWAII, HAWAII COUNTY, AND HILO

	STATE OF HAWAII		HAWAII COUNTY		SOUTH HILO DISTRICT		HILO	
YEAR	POPULATION	AVERAGE ANNUAL GROWTH RATE	POPULATION	AVERAGE ANNUAL GROWTH RATE	POPULATION	AVERAGE ANNUAL GROWTH RATE	POPULATION	AVERAGE ANNUAL GROWTH RATE
1910	191,874		55,382					
1920	255,881	2.9%	64,895	1.6%				
1930	368,300	3.7%	73,325	1.2%				
1940	422,770	1.4%	73,276	-.01%				
1950	499,794	1.7%	68,350	-.69%				
1960	632,772	2.4%	61,332	-1.1%	31,553		25,996	
1970	769,913	2.0%	63,468	.34%	33,915	.72%	26,353	.14%
1975	867,900	2.4%	75,300	3.5%			31,969	3.9%
1976	883,500	1.8%	76,600	1.7%	40,200	2.9%		
1977	891,400	.89%	79,200	3.4%	40,500	.75%		
1978	896,600	.58%	80,900	2.1%	41,000	1.2%		

SOURCE: Through 1970 from U.S. Census of Population; estimates since 1970 by Hawaii Department of Planning and Economic Development.

Despite the relatively rapid population growth in recent years, the County remains comparatively uncrowded with an average 1978 density of 21 persons per square mile, as compared to Oahu's 1232 persons per square mile, and 142 persons per square mile for the entire State. Growth in the visitor industry and other sectors of the economy will probably continue to influence population increases on the island.

The Alenaio watershed boundaries coincide roughly with 1970 Census Tracts 204 and 208 in Hilo. Estimates of the population, number of housing units, and average housing unit values are shown in Table 3 for these areas.

TABLE 3.
ESTIMATES OF WATERSHED POPULATION AND HOUSING DATA
1970

	Census Tract 204	Census Tract 208	Total
Population	3,531	4,865	8,396
Housing Units1/	994	1,332	2,326
Average Housing Unit Value2/	$27,600	$31,500	$30,6003/

1/ Housing units intended for year-round use, both occupied and vacant.
2/ Owner-estimated market value for owner-occupied units.
3/ 308 owner-occupied units in Census Tract 204 and 1026 owner-occupied units in Census Tract 208.

Source: U.S. Census of Housing, 1970, Block Statistics, Selected Areas in Hawaii

The watershed boundaries also coincide approximately with planning areas 1, 5, 6, 7, 22 and 23, as delineated in the Hilo Community Development Plan (County of Hawaii, 21 May 1975). Estimated 1972 population of these areas was 8,470 projected to reach 11,240 to 13,280 by 1980. This represents an increase in housing units from 2,490 in 1972 to a range of 3,420 to 4,150 by 1980-1985. These estimated 1980-1985 housing unit projections amount to about 25 to 31 percent of the planned upper limit capacity, or zoning saturation, for the six planning areas. The flood plain area itself is only a small part of the overall watershed, and most of the hazard area is already developed, and not likely to undergo significant change during the course of the planning period.

Labor Force and Employment. The civilian labor force within the County increased from 23,740 in 1960 to 30,120 in 1970, and to 35,550 in 1978. Civilian employment in the County was 33,050 in 1977 and 31,950 in 1978. Unemployment was 9.2% in 1977 and 10.2% in 1978, and ranked highest among the four counties in the State. Civilian labor force and employment status for Hawaii County and the rest of the State of Hawaii are shown for 1977 and 1978 in Table 4.

TABLE 4: CIVILIAN LABOR FORCE AND EMPLOYMENT

COUNTY	CIVILIAN LABOR FORCE 1977	CIVILIAN LABOR FORCE 1978	CIVILIAN EMPLOYMENT 1977	CIVILIAN EMPLOYMENT 1978	UNEMPLOYMENT RATE(%) 1977	UNEMPLOYMENT RATE(%) 1978
Hawaii	36,400	35,550	33,050	31,950	9.2	10.2
Oahu	317,850	313,900	294,650	290,100	7.3	7.6
Kauai	17,850	17,450	16,650	16,250	6.5	6.9
Maui	30,900	31,100	28,650	28,700	7.4	7.6
State Total	403,000	398,000	373,000	367,000	7.4	7.8

SOURCE: State of Hawaii Data Book, 1979, Department of Planning and Economic Development.

The long-term trend has been one of continued growth, although growth rates have been declining in recent years, with actual decreases in employment and labor force in 1978. The greatest increase over the last two decades was in hotel employment, followed by retail trade. The largest decrease was in the sugar industry, where labor requirements for harvesting and processing have declined due to mechanization. While prospects exist for continued long-term growth for the State and the County, the immediate future will likely be adversely affected by national economic conditions. Hawaii enters the 1980's facing tight money and credit conditions, accompanied by high interest and inflation rates. Economic conditions in the U.S. are further complicated by international problems dealing with the value of the dollar in foreign exchange markets and those related to the supply and prices of foreign oil. These external effects tend to aggravate difficulties within the U.S., affecting the balance of payments and fiscal and monetary policies. All of these factors have effects on the opportunities for employment growth in the local economy. This is particularly true of the tourist industry, whose health depends on the general well-being of the national economy, and is also dependent to a large degree on stability in the flow and price of oil.

A breakdown of jobs, by industry, is shown in Table 5 for 1978 for Hawaii County and for the State. The data in Table 5 show generally that the job market breakdown in both Hilo and Hawaii County are similar to the pattern for the State as a whole. The comparatively agrarian nature of the County economy is evident in the difference between County and State percentages of employment in agricultural work. While non-agricultural employment is over 96 percent of total employment in the State, it is only about 82 percent for the County. Non-agricultural employment for the City of Hilo, on the other hand, is about the same in proportion to its total employment (97 percent) as for the State.

TABLE 5: JOBCOUNT BY INDUSTRY

Industry	State of Hawaii 3/		Hawaii County 3/		Hilo 4/
	Jobcount	Percent of Total	Jobcount	Percent of Total	Percent of Total
Nonagriculture, wage, and salary	373,600	90.4	26,050	74.7	63.9
Contract construction	20,400	4.9	1,250	3.6	7.0
Manufacturing	23,550	5.7	2,750	7.9	7.0
Durable goods	4,700	1.1	250	.7	
Nondurable goods	18,850	4.6	2,450	7.0	
Food processing	11,750	2.8	2,150	6.2	
Textile, apparel	3,250	.8	(NS)		
Printing, publishing	2,700	.7	(NS)		
Other nondurables	1,250	.3	(NS)		
Transportation, communication, utilities	28,550	6.9	1,900	5.5	7.7
Transportation	19,700	4.8	(NS)		
Communication	6,350	1.5	(NS)		
Utilities	2,500	.6	(NS)		
Trade	96,150	23.3	6,500	18.7	23.0
Wholesale	17,000	4.1	1,050	3.0	
Retail	79,150	19.1	5,500	15.8	
Finance, insurance, real estate	28,500	6.9	950	2.7	4.2
Services and miscellaneous	89,350	21.6	6,450	18.5	16.8
Hotels	23,050	5.6	3,250	9.3	
Other services, miscellaneous	66,300	16.0	3,200	9.2	
Government	87,050	21.1	6,250	17.9	18.2
Federal	29,350	7.1	450	1.3	
State	43,350	10.5	3,950	11.3	
Local	14,350	3.5	1,850	5.3	
Agriculture, wage, and salary	11,600	2.8	3,550	10.2	1.4
Sugar	4,950	1.2	1,450	4.2	
Pineapple	2,550	.6	-	-	
Other	4,100	1.0	2,100	6.0	
Nonagriculture, self-employed 1/	23,500	5.7	2,400	6.9	13.3
Agriculture, self-employed 2/	4,700	1.1	2,850	8.2	1.4

NS Not shown separately.
1/ Includes unpaid family workers and domestics.
2/ Includes unpaid family workers.
3/ 1978 data from "State of Hawaii Data Book, 1979," Department of Planning and Economic Development.
4/ 1970 data from "Hilo Community Development Plan," May 21, 1975.

6. EXISTING CONDITIONS

a. Existing Flood Control Improvements.

In conjunction with the U.S. Soil Conservation Service (SCS), a watershed work plan for the Wailuku-Alenaio watershed was prepared by the Mauna Kea and Waiakea Soil and Water Conservation Districts and the County of Hawaii under the authority of the Watershed Protection and Flood Prevention Act (PL 566). This study investigated the possibility of preventing flood, sediment and erosion damages, maintaining wildlife habitats in the floodplain and reducing sediment pollution of the streams and of Hilo Bay.

Their plan recommended the construction of a series of stream channel works and diversion structures in the upper watershed areas. Although their plan investigated possible measures below Chong's Bridge, it was recommended that the Corps of Engineers implement the measures in that area because of its urban character and the benefits associated with urbanized areas. SCS investigative authorities and justifications are more applicable to agricultural and soil conservation improvements.

The SCS plan (see Figure 5) will protect the agricultural areas from a 4 percent recurrence (25 year) flood while the urban areas of Kaumana, Chongmanville and Ainako will be protected from a 1 percent recurrence (100 year) flood. The diversion channel at Ainako (SCS structure number 4) was completed in 1980 and extended by 1,160 feet in October 1981. Construction of a diversion channel, wall and channelization works for the Chongmanville area (SCS structure number 3) was scheduled to begin in the fall of 1981 but has been deferred due to budget priorities. The completion of the watershed plan is expected to take approximately 10 years.

b. Existing County Improvements.

Table 6 summarizes the existing County improvements that have been constructed on Alenaio Stream. All of these systems have been known to overflow during past storms. Figure 6 shows their locations on the Alenaio Stream.

TABLE 6. SUMMARY OF EXISTING COUNTY IMPROVEMENTS ON ALENAIO STREAM

Location	Description	Opening Dimensions (approximate width x height)	Remarks
Komohana St	Corrugated pipe-arch culvert	16'-7" x 10'-1" (max dimension)	Damaged by flooding and replaced in 1980
Kapiolani St	Concrete box culvert	12' x 10'	
Ululani St	Concrete box culvert	12' x 10'	
Ponohawai Storm drain system	Concrete box diversion culvert and diversion weir	10' x 5' (diversion culvert)	Built in 1926

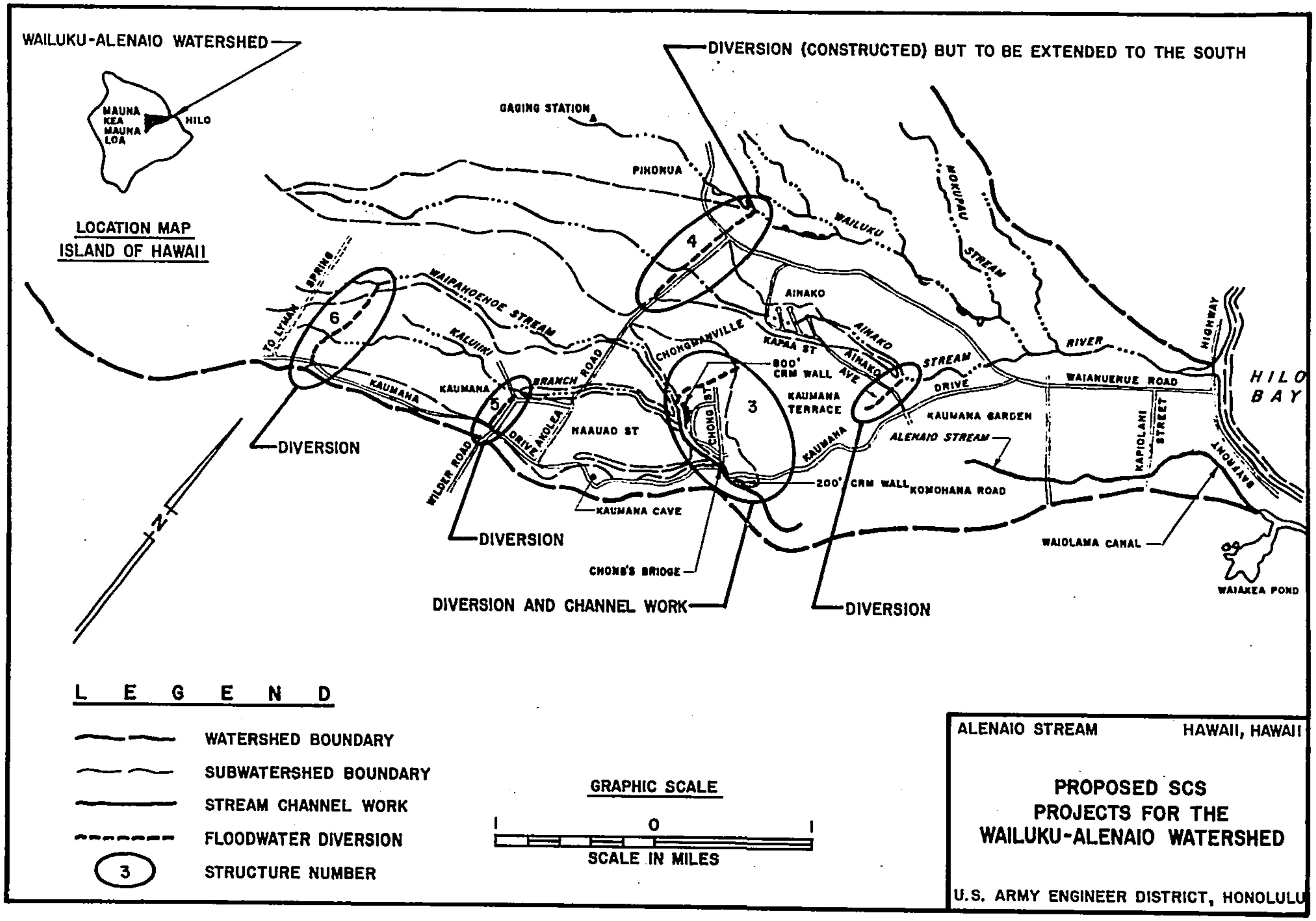


FIGURE 5

FIGURE 5

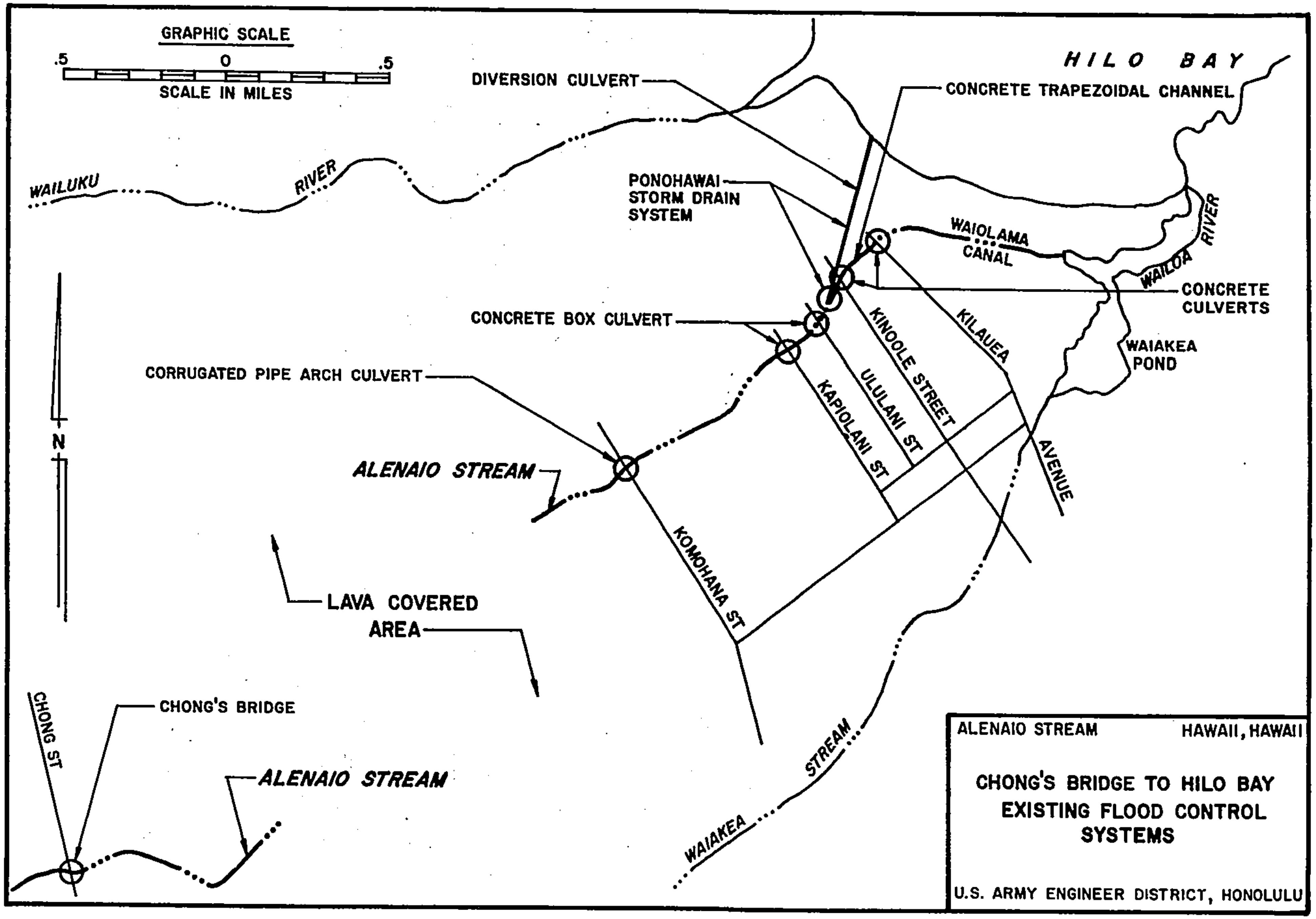


FIGURE 6

FIGURE 6

TABLE 6. SUMMARY OF EXISTING COUNTY IMPROVEMENTS ON ALENAIO STREAM (Contd)

Location	Description	Opening Dimensions	Remarks
Kinoole St	Concrete box culvert	13' x 8'	
Alenaio Channel	Concrete trapezoidal channel	14' x 10' (average dimension)	
Kilauea Avenue	Upstream opening: Concrete arch culvert Downstream opening: two (2) box culverts	21'- 8"x10'- 8" 2 @ 10'- 6"x8'-6"	
Waiolama Canal	Unimproved trapezoidal channel	24' x 5'	built during 1912-1917

These major conduit systems are supplemented by pipe drains on Shipman, Waianuenue, Haili, Mamo, Ponohawai and Ululani Streets.

c. Related Water Resources Development Projects and Studies

Power Generation (Hydropower). There are four (4) existing hydroelectric plants on the island of Hawaii, two (2) owned by the Hawaiian Electric Light Company and two (2) by local sugar plantations. The total 1975 generating rate was 20.4 kw-hr. None are in the Alenaio Stream watershed. A summary report (Ref. 42) addressing the potential of hydroelectric power in the State of Hawaii was completed under Section 209 of the Flood Control Act of 1962. At the time of its completion, this study indicated that the physical resources of the drainage areas in the County of Hawaii are insufficient for cost effective hydropower production.

Dam Safety. The National Dam Inspection Act of 1972 (PL 92-367) provided for the Corps of Engineers to inventory all dams 25 feet or more in height or impounding 50 or more acre-feet of water. Six (6) dams have been noted as having high or significant hazard potential based upon downstream populations on the island of Hawaii. None are within the study area.

Flood Control Improvements. There are no existing Corps of Engineers flood control improvements in the Alenaio Stream watershed. The only constructed Corps of Engineers flood control project in the South Hilo District is on the Wailoa Stream. This project was authorized by the Flood Control Act of 1954 and completed in August 1965.

Navigation. There are no navigational projects on Alenaio Stream. The only constructed Corps of Engineers navigation project in the South Hilo District is at Hilo Harbor. The entrance channel, turning basin and breakwater were constructed under the authority of the River and Harbor Acts of 1907, 1916 and 1925.

Hilo Area Comprehensive Study (HACS). The HACS is concentrating on the problems of ship motion at the Hilo docks, the undersized deep-draft turning basin, inadequate small craft berthings, erosion of the Hilo bayfront black sand beach, and the water quality of Hilo Bay and tributary streams. This study is nearing completion (Ref. 41), and a draft report has been circulated for review.

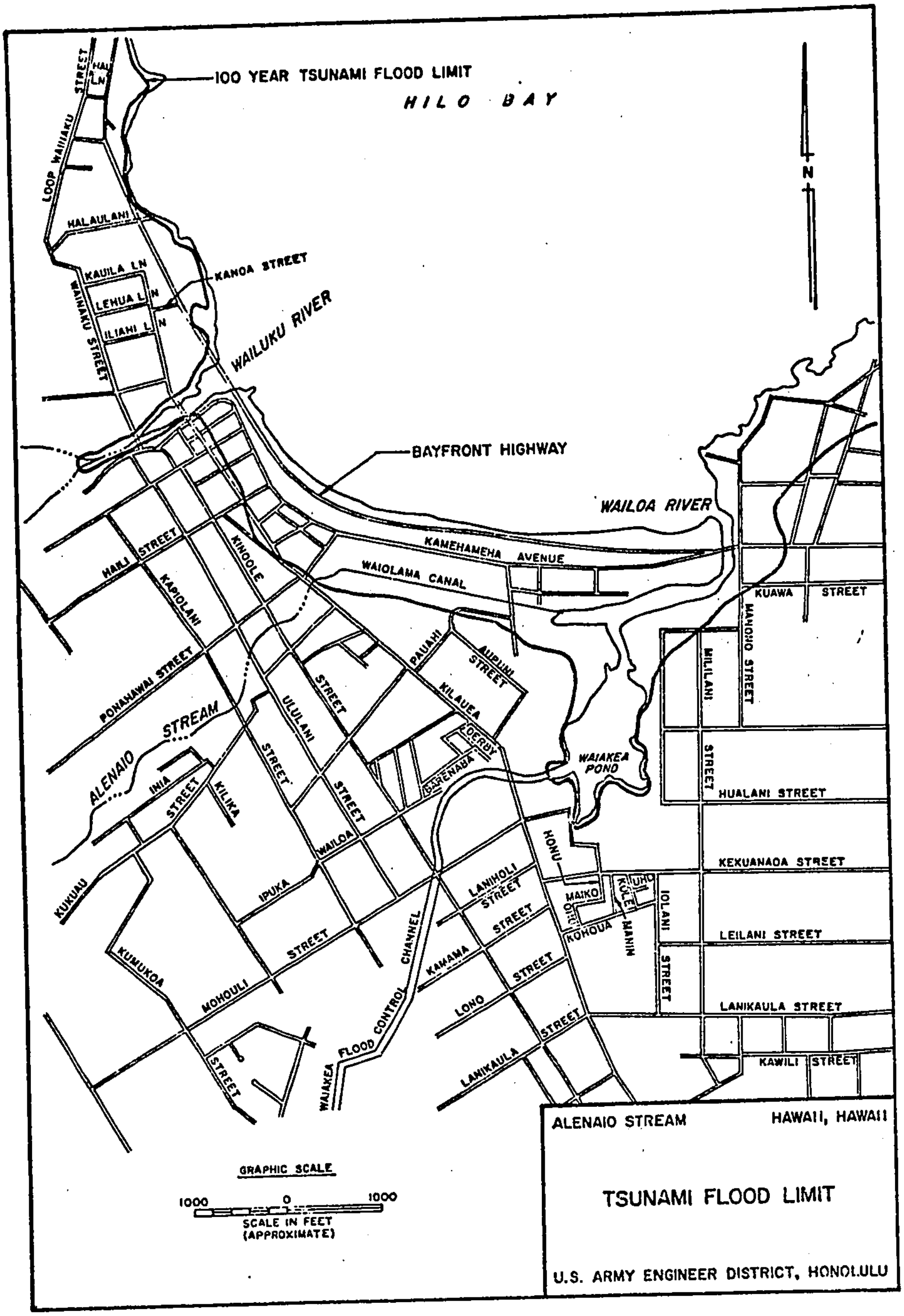
Lava Flow Control Study. Although the study is not directly water resources related, its implementation may affect water runoff or drainage patterns and is consequently included in this section. The potential threat of lava flow should be a consideration to planning for Alenaio Stream and its possible impacts as well as its compatibility with the recommended plan of action should be addressed.

A Final Report and Environmental Impact Statement was completed in May 1980 (Ref. 43). This study evaluated and assessed possible non-structural and structural measures in an attempt to formulate a long-range protective plan for combating lava flows. Based on the results of the study, it was considered that the most appropriate plan is a fully prepared emergency barrier plan to be implemented only when an eruption endangers Hilo.

d. Tsunami

Hilo is highly susceptable to tsunami inundation. Major tsunami have caused considerable damage in the past. Since 1837, Hilo has experienced about thirty (30) tsunamis, an average of about one every four years.

The Corps of Engineers has performed studies to evaluate and assess possible tsunami protection systems. The Tsunami Barrier Study in 1967 recommended a $60 million improvement consisting of barriers and levees to protect Hilo. The local cost share was estimated at $10 million. The local government declined to implement this plan because of its costs and the project was deauthorized in 1977. The County is presently implementing a non-structural approach of incorporating open-space in tsunami-prone areas. Figure 7 shows the 100-year tsunami flood limit.



ALENAIO STREAM HAWAII, HAWAII

TSUNAMI FLOOD LIMIT

U.S. ARMY ENGINEER DISTRICT, HONOLULU

Figure 7

e. Land Use.

Table 7 shows a breakdown of land ownership use for Hawaii, Hawaii County and South Hilo District. Land use distribution for all three areas follows a similar pattern, with unused open space and agriculture the largest categories, with space devoted to recreation, services, and residential use following.

TABLE 7. LAND OWNERSHIP BY COUNTY AND STATE 1/

	State of Hawaii 2/		Hawaii County 2/	
	Acres	Percent of Total	Acres	Percent of Total
All Owners	4,045,931	100.0	2,516,979	100.0
Federal	296,765	7.3	200,995	8.0
State	1,399,839	34.6	985,269	39.1
County	2,327	.1	839	.1
Private	2,346,999	58.0	1,329,876	52.8

1/ Because of the omission of public thoroughfares and for other reasons, totals may vary considerably from area data in Table 8.

2/ Survey date is 1971 for Hawaii County. Survey dates are different for other counties, and the State total is the sum of averages for the counties.

Source: The State of Hawaii Data Book, 1979, Department of Planning and Economic Development.

Table 8 shows a breakdown of land use for the County and the State. The majority of the land (over 50 percent) is privately owned. State-held land is the next largest category, followed by Federally owned land. A relatively negligible amount of land is owned by County government.

The City of Hilo is by far the largest on the island in terms of land area (35,929 acres). Originally, the City was defined by boundaries delineated for statistical purposes to include a total of 187,136 acres. Since this area included large amounts of basically uninhabited forest reserve land, unsuitable for statistical use, the boundaries were revised in 1969.

Land use in the Alenaio Watershed includes open barren lava and cinder land in the upper reaches, agricultural uses further downstream, and medium to high density urban development in the immediate vicinity of the Hilo Bay area. Most of the land is in private ownership, although there is some publicly owned land in the watershed. The present land use distribution in the watershed is described in Table 9 (the Wailuku River and the Alenaio Stream are two major drainageways for the watershed).

Land within the 100-year flood plain is used for agricultural and residential purposes, and also as a natural drainageway. In the immediate vicinity of the drainageway, land uses include sugarcane fields, cemeteries, pasture land, gardens, single family dwellings, apartment houses and commercial businesses.

TABLE 8 : LAND USE 1/

Land Use	State of Hawaii Acres	State of Hawaii Percent of Total	Hawaii County Acres	Hawaii County Percent of Total	South Hilo District Acres	South Hilo District Percent of Total
All uses 2/	4,046,902	100.0	2,520,906	100.0	249,350	100.0
Residential	65,494	1.6	11,975	.48	4,132	1.7
Manufacturing	3,769	.1	619	.02	366	.1
Manufacturing Services .	11,076	.3	1,586	.06	646	.3
Commercial	2,299	.1	435	.02	199	.1
Services	125,023	3.1	37,823	1.50	8,960	3.6
Social and cultural	7,734	.2	1,844	.07	1,133	.5
Recreation	273,311	6.8	243,324	9.65	460	.2
Agriculture	1,356,195	33.5	819,249	32.50	46,904	18.8
Transportation	5,343	.1	1,417	.06	1,111	.4
Unused open spaces	2,196,659	54.3	1,402,635	55.64	185,439	74.4

1/ Totals may not add due to rounding.
2/ Excludes public streets and highways.

SOURCE: "The State of Hawaii Data Book, 1979," Department of Planning and Economic Development; and "County of Hawaii Data Book, 1978," Department of Research and Development, Hawaii County.

TABLE 9. LAND USE IN THE WAILUKU-ALENAIO WATERSHED

Land Use	Acreage	Percent of Total
Cultivated Crops	3,880	2.5
Pasture		
Improved pasture	3,740	2.2
Grassland	30,110	18.0
Woodland		
Forest Reserve (general use)	10,500	6.2
" " (closed watershed)	45,500	27.8
" " (game reserve)	6,500	3.8
" " (public hunting - game mgmt. area)	5,500	3.2
Outside Reserve - not grazed	4,500	2.6
- grazed	5,000	2.9
Barren lava and Cinderland	50,000	29.8
Urban and Industrial	1,770	1.0
	167,000	100.0

Source: Final Environmental Impact Statement, Wailuku-Alenaio Watershed, March 1976, Soil Conservation Service.

About 93 percent of the land within the watershed (155,000 acres) is State-owned. Of this, 35,000 acres are controlled by the Hawaiian Homes Commission. Most of the State land is within the Hilo Forest Reserve, and the Hawaiian Homes Commission land is leased for pasture and cropland. Nearly half of the cropland in the watershed is leased to the Mauna Kea Sugar Company.

About 7 percent of the watershed land (12,000 acres) is privately owned. Approximately one-third of the privately-owned land is within the forest reserve. The reserve is zoned as "closed watershed," used to provide domestic water to Hilo. The remaining 8,000 acres of private land are located near the Hilo urban area. Nine major landowners hold parcels in the 100 acre to 2,600 acre range. The rest of this land is held in small pieces.

Agricultural land was valued at about $.30/square foot in cropland, pasture, and wooded areas, in 1976. At that time average residential area land was valued at about $1.50/square foot.

f. Projected Future (Without) Conditions[1]

Downtown Hilo has traditionally served as the center of commercial activity for Hawaii County. Although downtown Hilo has experienced during the past years a deterioration and decline that has afflicted many American cities, downtown Hilo still remains the center for financial and professional office activities for the County. A number of studies and plans have been made to improve and revitalize the downtown Hilo area. The Hilo Downtown Development Plan (Ref 3) adopted by the County Council on 21 August 1974 includes some of the following recommendations for implementation:

"Encourage the development of a major retail anchor in the block surrounded by Kilauea, Ponahawai, Kamehameha and Mamo Streets"

"Encourage the intensification of the office and civic center core in the Waianuenue-Keawe Street area ..."

"Encourage a high level of design for new public and private development"

"Continue to utilize the area between Kinoole and Ululani Streets for convenience and secondary shopper's goods outlet"

The Hilo Community Development plan (Ref 4) adopted 21 May 1975 expects that Hilo will remain as the principal urban center of the County and reconfirms the implementation of the Hilo Downtown Development Plan. Employment opportunities, housing needs and commercial urban development areas are expected to be the major concerns in the next 5 to 10 years. The County made two studies regarding the flooding and drainage problems for Hilo. These studies dealt mainly with interior drainage and flooding for a low level of protection (channel capacity of 2400 cfs). The County General Plan adopted 15 December 1971 recommended the implementation of the Hilo Drainage and Flood Control Report and that "a program of acquisition of easements for drainage on flood control purpose shall be initiated." No specific plan however, is expected to be implemented by the County on the Alenaio Stream within the near future. The County is waiting for the recommendations of this report before implementing any final action.

Science, energy and mining research are expected to be the lead sectors where the economy will probably expand. Science research in the fields of volcanology, astronomy, meteorology and cloud physics is expected to contribute in the expansion of observatory and telescope facilities. Energy research in alternate energy sources such as geothermal and ocean thermal energy conversion (OTEC) are expected to continue as a $20 million appropriation has just been passed by Congress to continue OTEC research and the development of a pilot plant. The mining and the industrial processing of manganese nodules from the ocean floor are new areas where great economic potential may exist as some of the richest deposits are situated in the north Pacific area, making Hilo a geographically ideal port.

1/ The without-project condition is the most likely condition expected to exist over the planning period in the absence of a plan, including any known change in law or public policy (P&S § 713.805).

Sugar, macadamia nuts, diversified agriculture, anthuriums and orchids the traditional major economic sectors will probably continue at relatively the same level. Hilo is not noted as a tourist destination area in Hawaii but rather as a point of entry and termination for the rest of the islands; consequently, no major changes are expected in the near future in this sector. Hilo Harbor is one of the major ports serving the County. Cargo volume averages approximately one million tons annually and will probably remain constant unless significant changes to the existing economic development occurs.

7. PROBLEMS, NEEDS AND OPPORTUNITIES.

The purpose of identifying the problems and possible needs of the study area is to develop the range of water and related land resources opportunities that could be addressed within the study authority. The description of the existing project conditions given in the previous section provides a basic understanding of existing conditions and potential problems.

a. Flooding Problems.

Historical accounts indicate that many major floods have occurred in the past 20 years causing significant damages. During the storm of 16-19 March 1980, Hilo Airport recorded 25.36 inches of rainfall in 72 hours with the highest one hour rainfall of 2.16 inches. Floodwaters washed away the Komohana Street culvert and downtown Hilo was flooded. The Bayfront Highway was inundated by 1 foot of water. The storm of 17-20 February 1979 broke nearly every rainfall record kept by the National Weather Service for the Hilo area. Hilo Airport recorded 3.08 inches of rainfall in 1 hour, 4.78 inches in 3 hours and 30.9 inches in 72 hours. The President declared the County of Hawaii a major disaster area. The storm of 25 July 1966 was probably the most severe where water rose to 2 feet in downtown stores. Thirty-four (34) persons were evacuated, three persons were injured and one policeman narrowly escaped death when he was swept downstream during rescue operations. Other major recorded floods have occurred in 1959, 1954, 1939 and 1921. Appendix D provides more detailed descriptions of these floods.

Flooding has been a recurrent problem for the residents of the Alenaio and Hilo area. Floods in the Alenaio area result from heavy rainfall over the basin. Below Chong's Bridge to Komohana Street in the lava area, the stream is undefined in most instances and floodwaters inundate the lowlands. From Komohana Street to the mouth, flood problems are exacerbated by poor stream and bridge capacities and obstructions from debris accumulation and blockage of bridge openings. Downstream of Kilauea Avenue, floodwaters enter into the man-made Waiolama Canal which has a very low capacity because of its flat gradient. Floodwaters inundate the low-lying area from the canal to the Bay front and downtown Hilo. The lower reach below Kilauea Avenue is also subject to tsunami flooding. Flooding seems to also be related to lava tubes. Water might be transported through subsurface lava tubes which then flood areas where they outcrop the surface. Houses at Ponahawai (meaning springs) have experienced this type of flooding. The extent of this type of flooding cannot be accurately determined. Historical flood information did not differentiate the cause or type of flooding (surface flow or springs).

The volcanic geologic make-up of the Alenaio Stream watershed poses a unique geohydrologic problem. Many subterranean conduits exist naturally as pahoehoe lava forms tubes as the molten lava cools. Lava tubes are only created in pahoehoe flows. Springs which are prevalent in the area are one direct result of these tubes. Springs or subsurface waterflow can unexpectedly develop in areas of pahoehoe outcrop, especially near the distal ends of flows and when the water table has risen from heavy rains and floods. Near the ends of the Kulaloa flow between Alenaio Stream and Mohaule Street, lava tube springs have caused flood damages. In identifying the study problems and needs, it was determined that the influences of lava tubes and flows should be evaluated for its effects on geohydrologic assumptions and hydraulic design. The US Geologic Survey (USGS) at the Hawaiian Volcano Observatory (Dr. John Lockwood) was asked to assist the Corps of Engineers in evaluating this aspect of the

Photograph #1   25 July 1966 Flood at
Kinoole Street

Photo by L Kadooka, Hilo Tribune

Photograph #2   25 July 1966 Flood
Damage at Osorio Lane

Photo by Hilo Ace Photo

Photograph #3 25 July 1966 Flood at Kamehameha Avenue

Photo by L Kadooka, Hilo Tribune

Photograph #4 25 July 1966 Flood Damage along Stream

Photo by L Kadooka, Hilo Tribune

1979 Flood Damage at Kilauea Avenue

Photo by L Kadooka, Hilo Tribune

Photograph #5

1979 Flooding of Hilo Bayfront

Photo by L Kadooka, Hilo Tribune

Photograph #6

problem. The USGS conducted field investigations and tests in the watershed area. The results of their studies are discussed in Appendix C. This study indicated a need to map the complex lava tube systems in order to fully evaluate the impacts of this phenomena on any recommended plan. However, technology and analytical techniques have not been adequately developed to accurately and cost-effectively map these lava tube systems. Further analysis concluded that it is a reasonable assumption that subsurface flows would not exacerbate the flooding situation under the "with project" (structural) conditions; and that additional detailed subsurface geologic studies are not cost effective since the usefulness of the obtained data is uncertain in applying the results to specific design parameters. Design parameters will rely on existing geohydrologic information and data. It is envisioned that areas experiencing flood conditions by subsurface flow will need to be addressed on a case-by-case basis by the County with possible technical assistance by POD. If lava tubes are encountered during construction, certain design modifications would probably be incorporated with any proposed improvements to insure that water flowing in these tubes will be diverted into the channel to avoid undesirable impacts caused by the interruption of these flows. Since these flows peak at a considerable time lag behind the surface runoff, significant impact on the design peak discharge is not expected. Consequently analysis and design will deal primarily with surface run-off flooding.

b. Existing Hydrology

Detailed hydrologic analyses were conducted and are provided in Appendix D. These hydrologic values contribute to the determination of the flooding problem, the level of protection and the feasibility of alternatives that will be investigated.

The following peak floodflows under existing conditions were determined at selected concentration points.

Concentration Point	Est Capacity1/ (cfs)	Expected Peaks Floodflows for Associated Frequency Flood2/ 2-yr	5-yr	10-yr	50-yr	100-yr	SPF
Kapiolani Br	2800	1,100	2,060	2,900	5,500	7,000	12,200
Ululani Br3/	2800	-	-	-	-	-	-
Kinoole Br3/	900	-	-	-	-	-	-
Kilauea Br	1500	1,120	2,090	2,960	5,580	7,050	12,300
Waiolama Canal	500	1,130	2,100	2,970	5,600	7,100	12,500

1/ Estimated from "backwater profiles - HEC-2"
2/ Refer to Appendix D for analysis
3/ Not calculated at these locations

Flood inundation limits for various selected floods were determined for evaluating potential flood damages for the benefit analyses. The depths of flow and flood limits were determined by using a computer program developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, California. Flood outlines for the standard project flood (SPF) and the 100-year (1% frequency) event flood are shown in Figure 8.

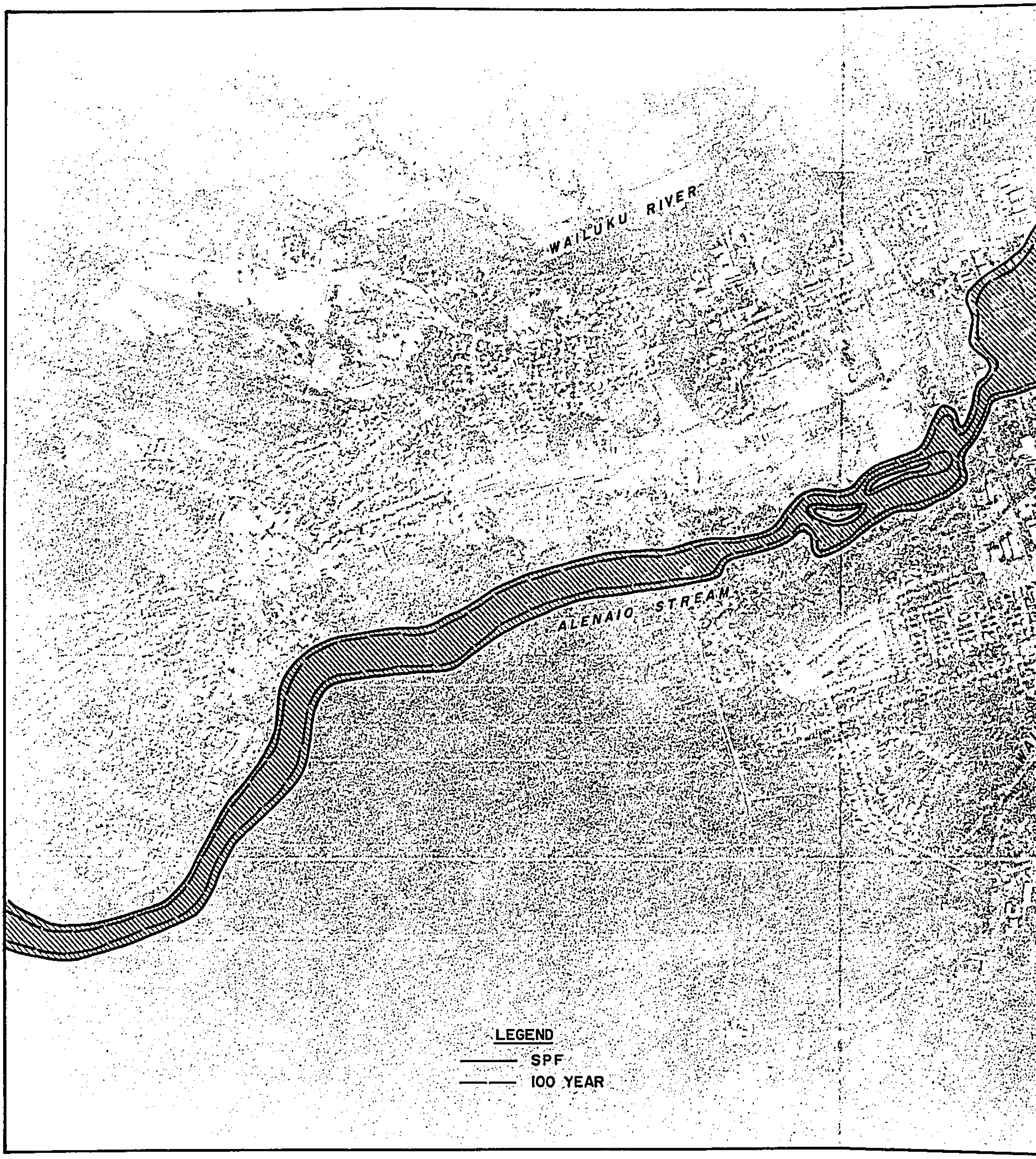


FIGURE 8

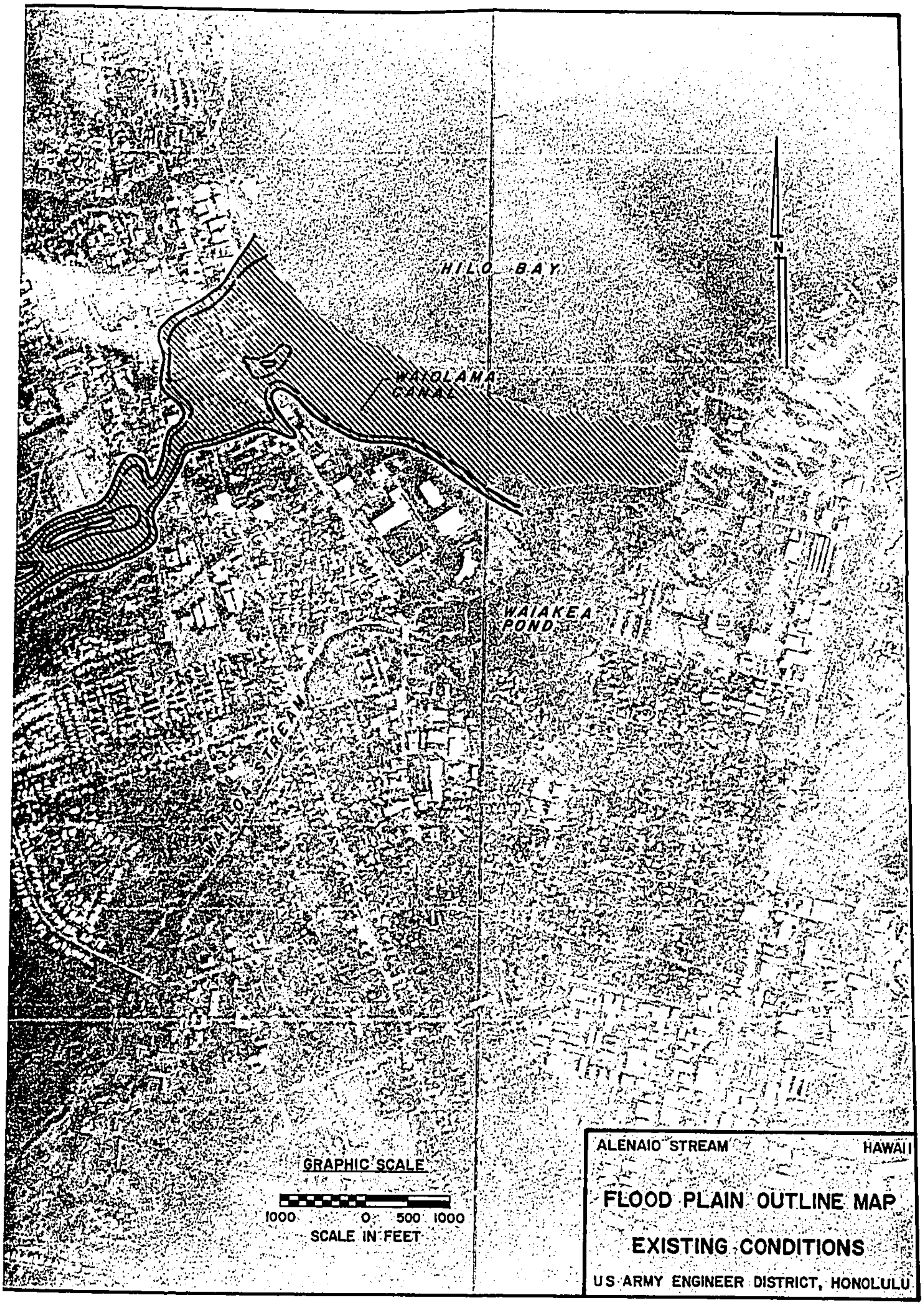

HILO BAY
N
WAIOLAMA CANAL
WAIAKEA POND
WAILOA STREAM
GRAPHIC SCALE
1000 0 500 1000
SCALE IN FEET
ALENAIO STREAM HAWAII
FLOOD PLAIN OUTLINE MAP
EXISTING CONDITIONS
US ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 8

c. Public Input. A public meeting was held on 4 June 1980 and an informal public workshop was held on 10 December 1980 to obtain the public's views regarding the flood problem, possible solutions and the community concerns. A transcript of the public meeting is provided in Appendix B. Many of the residents stated that a major flood problem exists and recounted their personal experiences with property damage and flooding. Testimonies both written and oral were given concerning their flooding problems. No one expressed opposition to the study.

d. Institutional Policies. The U.S. Army Corps of Engineers regulations define certain conditions for which urban flood damage reduction measures may be accomplished under its existing authorities. These conditions include:

(1) Eligible Improvements. The Corps of Engineers may implement flood damage reduction works through land use changes and facilities designed to reduce flood damages resulting from storm generated overflow or backwater from natural streams or modified natural waterways. These adjustments may include structural and nonstructural measures. Storm drainage and related facilities (such as pipes, culverts, manholes, sewers) are a local responsibility and are not eligible for Federal participation. Storm drainage facilities are designed to collect local flows resulting from overland sheetflows, ponding and similar runoff and to convey these waters to natural or modified waterways.

(2) Magnitude of Discharge. The discharge at the upstream point of improvement must exceed 800 cubic feet per second (cfs) for the 10 percent (%) frequency flood (one chance in ten of being equalled or exceeded in any given year). Alenaio Stream meets this criterion; the 10 percent flood is 2,650 cfs at Chong's Bridge.

(3) Size of Drainage Area. The drainage area under consideration should normally exceed 1.5 square miles. The Alenaio Stream also meets this criterion, with a total drainage area of 8.53 square miles.

(4) Local Assurances. Letters of intent to support the project and to comply with providing local assurances will be required to accompany the feasibility report. A formal agreement must be executed by authorized representatives of the County of Hawaii and the Department of the Army in accordance with Section 221 of the River and Harbor Act of 1970 (PL 91-611) prior to initiation of construction.

(5) Level of Protection. The maximum quantity of water at design conditions which can be safely carried by the system is the measure of level of protection. The greater the flow (often interpreted in terms of flood frequency), the greater the protection provided the community. The level of protection is based on the type of improvements, the relative hazard, the tangible economic benefits, and the environmental or social considerations in connection with the planning objectives. Various types of measures to achieve different levels of protection must be formulated and considered. The alternative should remain economically feasible, considering damages resulting from floods exceeding the design flood. For potential measures in high density urban areas and high velocity channels subject to potential catastrophic effects, the Standard Project Flood (SPF), the hypothetical flood that would occur assuming a severe combination of hydrometeorological conditions, excluding extremely rare combinations, is the desired goal for

the level of protection. Lower levels of protection may be recommended for urban areas not subject to catastrophic damages resulting from floods exceeding the design flood.

e. Other Related Water Resources Opportunities.

Water Supply and Conservation.

The Hawaii County Department of Water Supply obtains most of its domestic water for Hilo from the Wailuku River basin. Intakes on Wailuku River are at altitudes 1,370 feet and 1,150 feet and on Kahoama Stream (tributary to Wailuku River) at 1,256 feet. During the period 1930 to 1963, diversion averaged 3.86 mgd. The Waiakea Stream supplies between 0.1 and 0.2 mgd to the Hilo domestic water supply. Drilled wells and a shaft tap the basal aquifer. The total output of wells is 15 to 20 mgd, mostly for industrial use.

Three water supply issues have been focused on in the "Hilo Area Comprehensive Study". The first is that new Federal drinking water standards require less turbidity than is possible from existing surface sources. The County is switching from a proportion of 1/3 groundwater and 2/3 surface water to 2/3 groundwater to comply with the standards. The switch will increase costs due to well drilling and pumping charges. The second problem is that cesspool seepage and injection well disposals may pollute underground waters. The third problem concerns the effects on surface water and groundwater of the "dieback" of the native ohia forest. The ohia forest is "dying back" due to poorly understood and complex factors. Effects on water supply could include increased surface water turbidity and volume due to the major loss of vegetation.

Alenaio Stream's ephemeral water flow makes it a poor source for water supply development.

Irrigation (Agriculture).

Due to the ephemeral nature of Alenaio Stream and the urbanized surrounding area, there is poor irrigation potential for agriculture. Much of the agricultural lands are upstream where flood control and related resource measures are being implemented under the SCS watershed plan.

Hydroelectric Power.

There is no potential for the development of hydroelectric power because the streams are ephemeral and dry most of the time.

Water Contact Recreation.

There is presently no water contact recreation in the drainage basin except at Hilo Bay. The potential development of water related recreation will need to be evaluated based on specific proposed alternatives. The immediate adjacent banks can be landscaped for hiking paths and nature trails. The possibility of complementing flood control measures with recreational areas and facilities can be evaluated on an individual alternative basis.

Water Quality, Erosion and Sedimentation Influences.

The SCS estimates that most soil loss in the watershed is from sheet and rill erosion. Road-bank erosion is not a significant problem but unsurfaced roads in cultivated fields tend to concentrate runoff and induce sheet and gully erosion. Streambank erosion is not a serious problem because most streams are contained in bedrock or in well-vegetated streambanks. The SCS estimates that the average annual sediment yield is 0.23 acre feet per square mile. Sediment can cause turbidity and discoloring of the water which eventually flows into Hilo Bay.

Structurally oriented flood control measures have the potential to reduce sedimentation through structures such as debris basins. However, these basins are usually designed only for flood-oriented sedimentation and hydraulic efficiency. The Corps of Engineers under its Hilo Area Comprehensive Study is addressing the issues of water quality in Hilo Bay and surrounding streams.

Navigation.

Due to the size and ephemeral nature of Alenaio Stream, there is no economic potential for commercial or light draft navigational development.

Fish and Wildlife Enhancement.

Coordination with the U.S. Fish and Wildlife Service can best address fish and wildlife enhancement potentials. Formal coordination and negotiation agreements were initiated at the intermediate stage planning to aid in the development and assessment of potential solutions to the planning objectives and/or constraints. A planning aid letter was provided and is included in Appendix G.

Ground Water Supply Cycle.

Methods to enhance the ground water were investigated, especially in light of the geohydrologic properties of the study area. Specific possibilities include recharging the water lens by retention ponds where water is ponded to increase seepage time into the ground or by injection wells where water is diverted directly into the ground through wells drilled into the ground. The feasibility of incorporating these measures is dependent on their technical applicability and expected economic benefits to be accrued. Based on preliminary analysis the ability to adequately evaluate these alternatives is beyond the scope of this study. Possible impacts on the geohydrologic properties of the study area will need to be evaluated on an individual alternative basis.

8. Planning Objectives

Planning objectives are established in order to guide the formulation of possible solutions identified in the previous sections. By identifying specific problems and needs, planning objectives, consistent with national and local goals, can be developed to solve the problems of the community. These objectives were subject to periodic review and modifications during the planning process.

The planning objectives established for this study are to:

a. Contribute to the reduction of property damage by floodwaters from Alenaio Stream from Chong's Bridge to Hilo Bay during the 1985 to 2085 period of analysis.

b. Contribute to the efficient use of the lands consistent with the local land use and development plans and floodplain management policy during the 1985 to 2085 period of analysis; and

c. Contribute to the understanding of the complex lava tube system and spring characteristics and of measures to minimize its impacts on flood damages.

III. FORMULATION OF PRELIMINARY PLANS

1. RATIONALE

Plan formulation is the process of developing a system of management and planning measures to remedy the defined problems. This process is a multi-disciplinary evaluation and assessment involving an examination of the environmental impacts, technical adequacy, economic efficiency and social acceptability of possible solutions within the framework of national and local planning objectives. Significant adverse impacts of any of the major components without an acceptable resolution may terminate further study of that alternative. Elimination of infeasible or undesirable plans will narrow the field of potential alternatives until an acceptable plan is developed. A preliminary screening of possible alternatives will eliminate obviously inappropriate plans prior to detailed analyses. Those considered to be the most feasible will be carried into detailed planning and design. Greater detail may be applied during the preliminary screening stage to those plans that appear infeasible to insure that the elimination of those plans from further consideration is justified.

2. PLANNING CONSTRAINTS.

There are no major planning constraints due to resource limitations, competitive use of resources or legislation which can affect the desired levels of output or environmental amenities.

3. CATEGORIES OF POSSIBLE MEASURES.

In accordance with Corps of Engineers' planning policies and regulations, various types of management measures must be examined for applicability and feasibility, depending on the study area and problem. These measures are not limited to the institutional capability of the Corps. Each management measure has its appropriate place in flood damage reduction. They may also be used in a combination of ways to complement each other. Local desires may also dictate the possible utilization of various measures as one measure may be more desirable by one community or individual homeowner. Management measures are usually classified as either nonstructural or structural. The purpose of this study is to find the most appropriate measure or combination of measures for each specific flood hazard and various community desires.

4. STRUCTURAL AND NONSTRUCTURAL ALTERNATIVES

Structural alternatives within the context of flooding are alternatives used to alleviate or reduce the extent of flooding by the construction of such structures as levees, dams, reservoirs, diversion works or channel modifications. These measures specifically can include:

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

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

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

-Reducing the rate of run-off by water-shed treatment.

Nonstructural alternatives have usually been described as utilizing measures other than structural ones described above. These alternatives do not control the flow of water but rather remove, floodproof or prohibit specific damageable property within the flooding zone. Typical measures which have been termed nonstructural 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 flood damageable structures or property outside the floodplains;

-utilizing flood forecasting and warning for evacuation;

-implementing flood insurance programs; and

-floodproofing existing structures.

P&S requires that at least one non-structural plan be carried into the final array of plans. The primary consideration in selecting particular types of nonstructrual measures is its effectiveness in reducing flood damages and in deciding if the proposed actions or measures should be induced by incentives or mandated through legislation. Incentives to inhibit development in the flood hazard areas can be offered through higher taxes or higher flood insurance premiums. Prohibiting development can also be mandated by regulation through zoning or building codes. Each particular measure has its associated institutional and social impacts. Structural and nonstructural measures can also be used together to complement each other.

A flood damage reduction plan should include positive contributions to both the NED and EQ objectives, providing a desirable mix of the two. The NED or EQ objectives are not intended to be polarized solutions; but the emphasis should be clear as to the primary intent and component. The planning objectives, hydraulic engineering analysis and professional judgment combined with defined public input will guide the best mix of the features and the number of alternatives considered for detailed examination. P&S specifies certain types of evaluations and comparisons that must be coordinated for each possible alternative plan.

5. PRELIMINARY SCREENING OF POSSIBLE SOLUTIONS

An initial screening of possible solutions was conducted and a preliminary elimination of alternatives was made on the basis that some plans were:

-technically inapplicable
-obviously too costly

Structural Measures

a. Storing floodwaters in an upstream retention basin

Preliminary Concept.

The temporary storage of floodwaters by an upstream retention basin or reservoir can reduce the threat of flooding by gradually releasing the stored water after the peak stage of the flood has passed. The stored water can then be released at a controlled rate within the capacity of the downstream channel.

To effectively control the floodwaters, a dam and retention pool must be constructed at a site which would control and collect most of the flood producing run-off and be large enough to sufficiently store these waters. Based on the characteristics of the Alenaio Stream watershed the primary objective of the retention basin would be to temporarily store floodwaters and not to permanently store water for multi-purpose uses such as water supply and recreation. Due to the ephemeral nature of the stream, a permanent ponding area will tend to become stagnant because the volume and exchange of water would be largely dependent on waters derived from storms. This would not provide enough water circulation. Usually a minimum of 5 cfs is desirable to provide environmental enhancement and/or to derive vendible project benefits. The basin pool will essentially be empty during nonflood periods. Normal low stream flows (nonflood) can be allowed downstream unaffected by the basin pool for fish and wildlife purposes.

In developing this alternative, an area approximately 1,000 feet above Komohana Street was considered the most suitable site for a retention pond (see Figure 9). The area is essentially undeveloped and is in a position to collect most of the floodwaters before it reaches downtown Hilo. Preliminary design features were developed in order to obtain an "order of magnitude" in expected costs in pursuing this alternative. The following features would be associated with this plan for a SPF level of protection:

Retention embankment	
maximum height and elevation	70 ft, 360 ft MSL
length	5,000 ft
design freeboard	5 ft
Ponding surface area	
flood stage (SPF)	90 ac
nonflood	0 ac
drainage area	7.53 sq mi
Storage	
flood capacity	2,500 ac-ft
emergency spillway	12,000 cfs (300'W x 10'H)
Project land requirements	130 acres

The most efficient plan would also incorporate downstream improvements to increase its capacity to accommodate a standard project storm which can occur below the proposed point of collection at the retention basin. Downstream improvements would require modifying the stream channel between Kinoole Street and Kilauea Avenue.

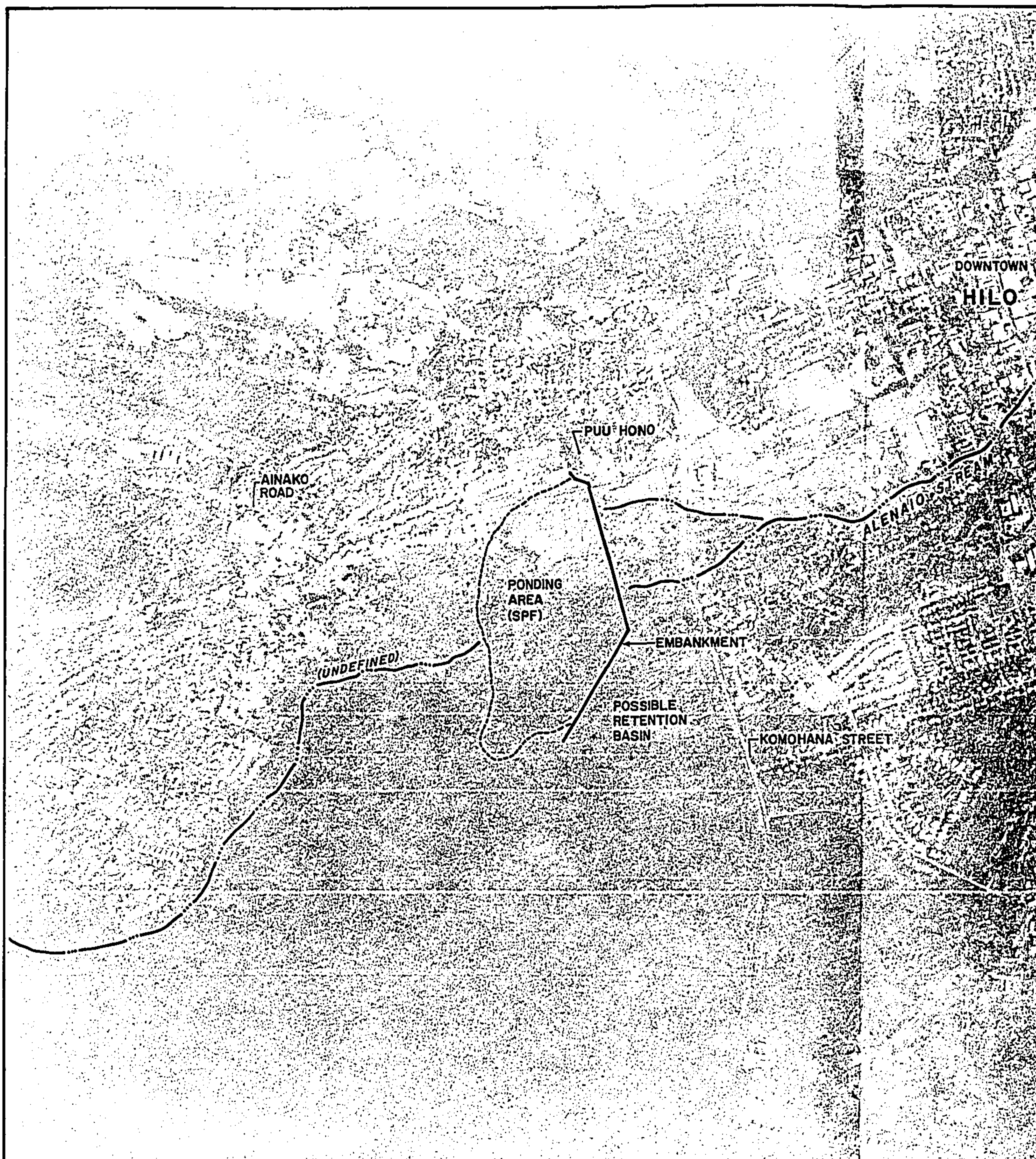

DOWNTOWN
HILO
PUU HONO
AINAKO ROAD
ALENAIO STREAM
PONDING AREA (SPF)
EMBANKMENT
(UNDEFINED)
POSSIBLE RETENTION BASIN
KOMOHANA STREET

FIGURE 9

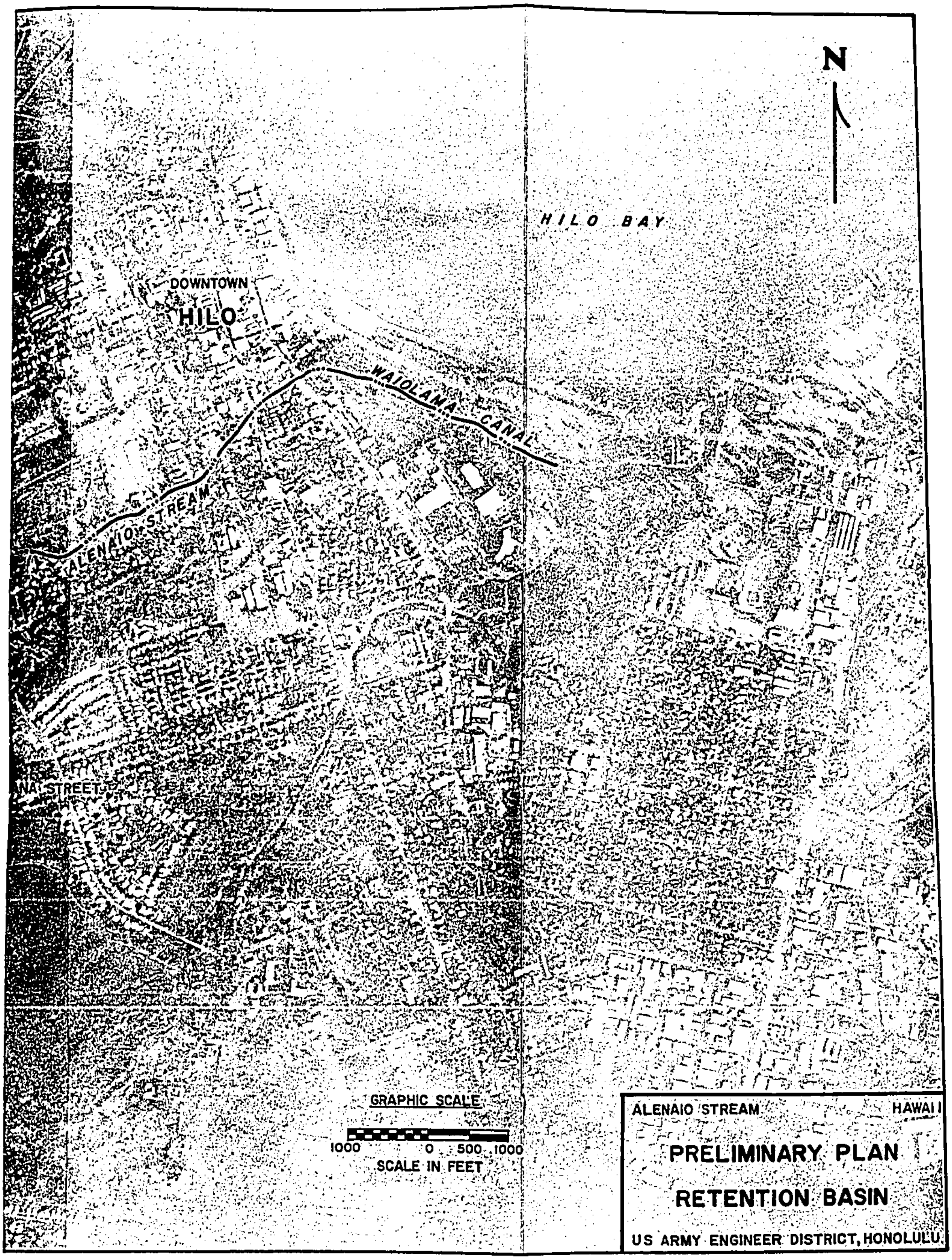

N
HILO BAY
DOWNTOWN
HILO
WAIOLAMA CANAL
ALENAIO STREAM
STREET
GRAPHIC SCALE
1000 0 500 1000
SCALE IN FEET
ALENAIO STREAM
HAWAII
PRELIMINARY PLAN
RETENTION BASIN
US ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 9

It would be desirable to have an unlined ponding area to allow the stored water to recharge the water table through natural seepage. However, the magnitude and location of lava tubes which can undesirably transport water elsewhere are not known at this time. Based on field observations of the prevalence of such features, the need for a lining is likely for an effective project. However, uplift pressure due to springs can cause cracking and stability problems for the lining. This issue will need to be resolved if further studies are warranted.

An evacuation plan and warning system will need to be developed for the downstream areas in the unlikely event of the floodwaters exceeding the capacity of the basin or a break in the retaining walls during the peak stages of the flood. During other times the pond will be empty. It is estimated that during a SPF event flood the pond will take approximately 6 hours to fill (peak elevation) and about 11 hours to empty thereafter. An emergency spillway is incorporated into the plan in the event the low flow outlet becomes inoperable.

Environmental Concerns.

A proposed retention basin alternative would consist of clearing approximately 130 acres of land above Komohana Street. The proposed site comprises of existing agricultural land and mixed ohia-guava forests in roughly equal proportions. The loss of forest land is considered a significant adverse impact by the USFWS. Because the basin would retain floodwaters for short periods of time, it would not provide suitable habitats for aquatic fauna and waterbirds. Social impacts associated with the structure would be the required removal of houses located within the proposed ponding area and the visual impact of the 70-foot-high earthen embankment to retain floodwaters. Archeological sites, if any, could be disturbed or destroyed during the clearing of vegetation from the basin.

Summary.

Based on the preliminary design features developed, the estimated cost of this plan would be approximately $30 million.1/ This cost appears to far exceed the expected benefits to be accrued. In addition many factors that affect projects costs are subject to many unresolved concerns.

These concerns include the:

(i) Effects of lava tubes in the project ponding area and their relationship to outlets in other flood damageable areas, and the

(ii) Need, design and cost for a lined ponding area due to effects of seepage and uplift through lava tubes and springs.

1/ Does not include cost of lining the retention basin.

The risks associated with these unknown factors are difficult to evaluate because, as expressed earlier, measuring techniques are not cost effective nor reliable at this time. Based on the high expected costs, low expected benefits compared to the probable costs and undeterminable risks associated with the technical effectiveness, this alternative was not considered suitable for further detailed studies and consequently eliminated from further consideration in lieu of more viable solutions.

b. Diverting the Floodflows

Preliminary Concept.

Floodflows can be diverted away from the existing stream into a diversion channel which can carry these waters to streams which can better accommodate their flows. In developing possible diversion plans, three (3) diversion alignments were investigated. Two (2) plans were studied to divert floodwaters into the Wailuku River and one (1) into the Wailoa Stream. The initial concern in evaluating these schemes is the impact of diverting the additional water into these other riverine systems. The preliminary criteria for selecting alignments were to minimize excavation, to provide a suitable hydraulic slope and to avoid or minimize the removal of homes or businesses.

(1) Diversion into the Wailoa Stream. The County recommended a possible diversion alignment into the Wailoa Stream. Their alignment (see Figure 10) proposal would divert floodflows along the proposed Mohauli Road extension along Ainako Road and across Komohana Street into the ditch behind the University Heights subdivision then into the Wailoa Stream. The major planning concern is the ability of the Wailoa Stream to handle the increased flow during coincidental flood conditions on both streams. Based on the expected water surface profiles from the design flood event, the additional diverted water (11,600 cfs, DA = 7.22 sq mi) would raise the Wailoa Stream water level approximately three (3) feet above the existing embankments. Diverting Alenaio's floodwaters into the Wailoa Stream would require a diversion channel approximately 8,000 feet long and improving the Wailoa Stream for 4,000 feet by raising its embankments about 5 feet (3 feet rise in water plus 2 feet assumed freeboard allowance).[1/]

(2) Diversion into the Wailuku River at Komohana Street. Based on topographic cross-sections of the Wailuku River, detailed hydraulic studies to determine the impacts of diversion on the water surface elevation were conducted by the Pacific Ocean Division and the State Department of Transportation (DOT). The State DOT is planning to modify and improve the Bayfront Highway by constructing another bridge over the Wailuku River. Plans at this time call for constructing a new bridge adjacent to the existing Bayfront Bridge. Their primary concern is the possibility that the additional flow may cause overtopping of the bridges. The Corps' planning concern is the possibility of this additional flow overtopping the Wailuku's banks and causing undesirable flooding. Based on the hydraulic evaluation, no adverse impacts such as overtopping the existing bridges or bank are anticipated. The detailed analysis is provided in Appendix D.

1/ Base-line data and design criteria for the Wailoa Stream were obtained from Ref 36.

Two alignments were investigated for the diversion plan into the Wailuku River, one alignment (No. A) (see Figure 10) starts approximately 500 feet upstream of Komohana Street. The second alignment (No. B) (see Figure 10) which was suggested by the County also starts above Komohana Street but runs generally between Komohana and Kapiolani Street. Alignment B would require approximately 1,800 feet of additional channel. Both channels will pass near private homes and businesses. Alignments A and B may require the relocation of some houses. Detailed design analysis will be needed to determine the exact number of homes affected.

Both plans will divert flood flows into the Wailuku River. The existing Alenaio Stream will probably be modified to carry approximately 2800 cfs by enlarging the culvert openings at Kilauea Ave and Kinoole Street and by modifying the channel between Kinoole Street and Ululani Street in order to accommodate a Standard Project Storm occurring below the point of diversion.

The diversion channel will need to be fenced for safety because of the high velocity (super-critical) flows associated with the expected floodflows. The curved sections of the channel will need to be banked to reduce or eliminate the super-elevation and cross-wave disturbance patterns in the channel.

Environmental Concerns.

The diversion alignment easement for Alignment A will require approximately 10 acres of land, and Alignment B will require 11 acres, most of which is presently in agricultural use. These agricultural lands will have to be converted to flood control purposes, however, the impacts to the surrounding agricultural lands would be minimal. Social impacts would occur where the channel alignment impinges on private residences. Although the channel would be aligned to avoid relocation of homes and possibly be covered in residential areas, temporary adverse impacts during construction would occur. The diversion channel will create a new visual element in the community and on the Wailuku River.

Environmental concerns and potential adverse effects for Diversion Alignment A are essentially the same as for Diversion Alignment B. The diversion Alignment B traverses an area designated for future park use in the Hawaii County land use plan. The proposed seven acre neighborhood park would be located at the base of Puu Halai. The exact site of the park will depend on future residential development in the area. County officials foresee no adverse impacts to the park resulting from the proposed Diversion Alignment B.

SUMMARY OF POSSIBLE DIVERSION ALIGNMENTS AT KOMOHANA STREET

Alignment	Proposed Diversion Channel Length	Length of Channel to be Improved on the Receiving River System
Diversion into the Wailoa River	8,000'	4,000'
Diversion into the Wailuku River		
Alignment A	4,200'	0
Alignment B	6,000'	0


WAILUKU RIVER
(WAIKAPU)
DOWNTOWN
HILO
ALIGNMENT A
ALIGNMENT B
AINAKO ROAD
POSSIBLE DIVERSION CHANNEL INTO THE WAILUKU RIVER
ALENAIO STREAM
(UNDEFINED)
KOMOHANA STREET
POSSIBLE DIVERSION CHANNEL ALIGNMENT INTO THE WAILOA STREAM
WAILOA

FIGURE 10

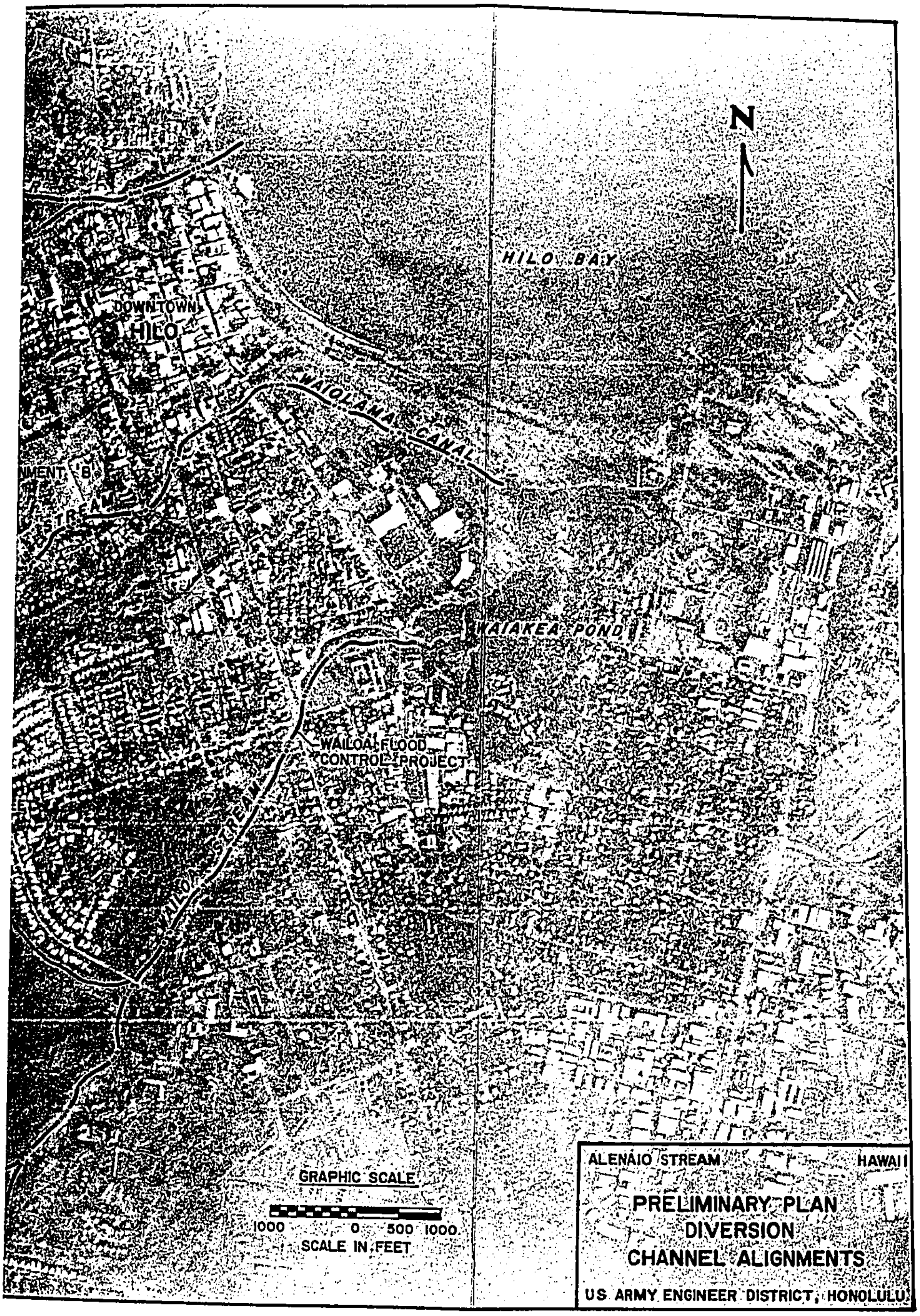

N
HILO BAY
DOWNTOWN HILO
WAIOLAMA CANAL
WAIAKEA POND
WAILOA FLOOD CONTROL PROJECT
GRAPHIC SCALE
1000 0 500 1000
SCALE IN FEET
ALENAIO STREAM
HAWAII
PRELIMINARY PLAN
DIVERSION
CHANNEL ALIGNMENTS
US ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 10

Summary.

Based on the preliminary screening, it appears that the diversion alignment plan into the Wailoa River would be substantially more costly by the longer diversion channel length and additional improvements required for the Wailoa River. Alignments A and B for the diversion plan into the Wailuku River are essentially the same in concept and potential impacts. However, based on the preliminary evaluation, Alignment A appears more suitable. The shorter alignment of A would be less expensive to construct. The alignment of A is also relatively smoother, requiring less severe curves in its alignment. There is no special advantage of alignment of B over A. Consequently, Alignment A will be further investigated in detail during the next stage and the other two alignments will be deleted from further considerations.

(3) Diversion into the Wailuku River along Akolea Road utilizing the existing SCS diversion channel. A diversion channel from Kaluiiki and Waipahoehoe Streams along Akolea Road utilizing the existing SCS diversion channel was investigated for its feasibility (see figure 11). The SCS project at Akolea Road is an unlined 5,210 ft. trapezoidal channel with a design capacity of 1,120 cfs (100-year frequency flood) for a drainage area of 1.15 sq. miles in the Wailuku watershed. A diversion channel from Kaluiiki and Waipahoehoe Streams would require diverting 5,860 cfs (DA = 5.15 square miles) for the 100-year frequency flood. The existing SCS channel would need to be lengthened by 3,000 feet and enlarged for the existing 5,210 feet to accommodate the additional water flow. The proposed channel at Akolea Road will require a channel approximately twice (8,210 vs 4,200) as long as with the proposed channel at Komohana Street as described previously. The following summarizes the difference between the two diversion channels.

Diversion Plan	Length of Channel (ft)	Quantity of water to be diverted (cfs)
Diversion at Komohana Street	4,200	6,950
Diversion at Akolea Road	8,210 (3,000 new) (5,210 enlarging the exist SCS channel)	5,860 (1,120 exist SCS channel)

Summary.

It appears that the diversion plan along Akolea Road will be twice as costly as the proposed Komohana Street diversion based on its channel length and width requirements even with the existing SCS channel. The SCS channel was only designed for 1,120 cfs capacity for a drainage area of 1.15 square miles in the Wailuku watershed. The existing channel would need to be lengthened by 3,000 feet and enlarged for 5,210 feet. This would not be less expensive compared to the cost of a new 4,200-foot channel at Komohana Street. Both diversion plans would still need downstream improvements below the point of diversion to accommodate a localized storm. Due to the expected cost of at least twice as much, this diversion plan was deleted from further consideration.

c. Increasing channel capacities by modifying the existing channel.

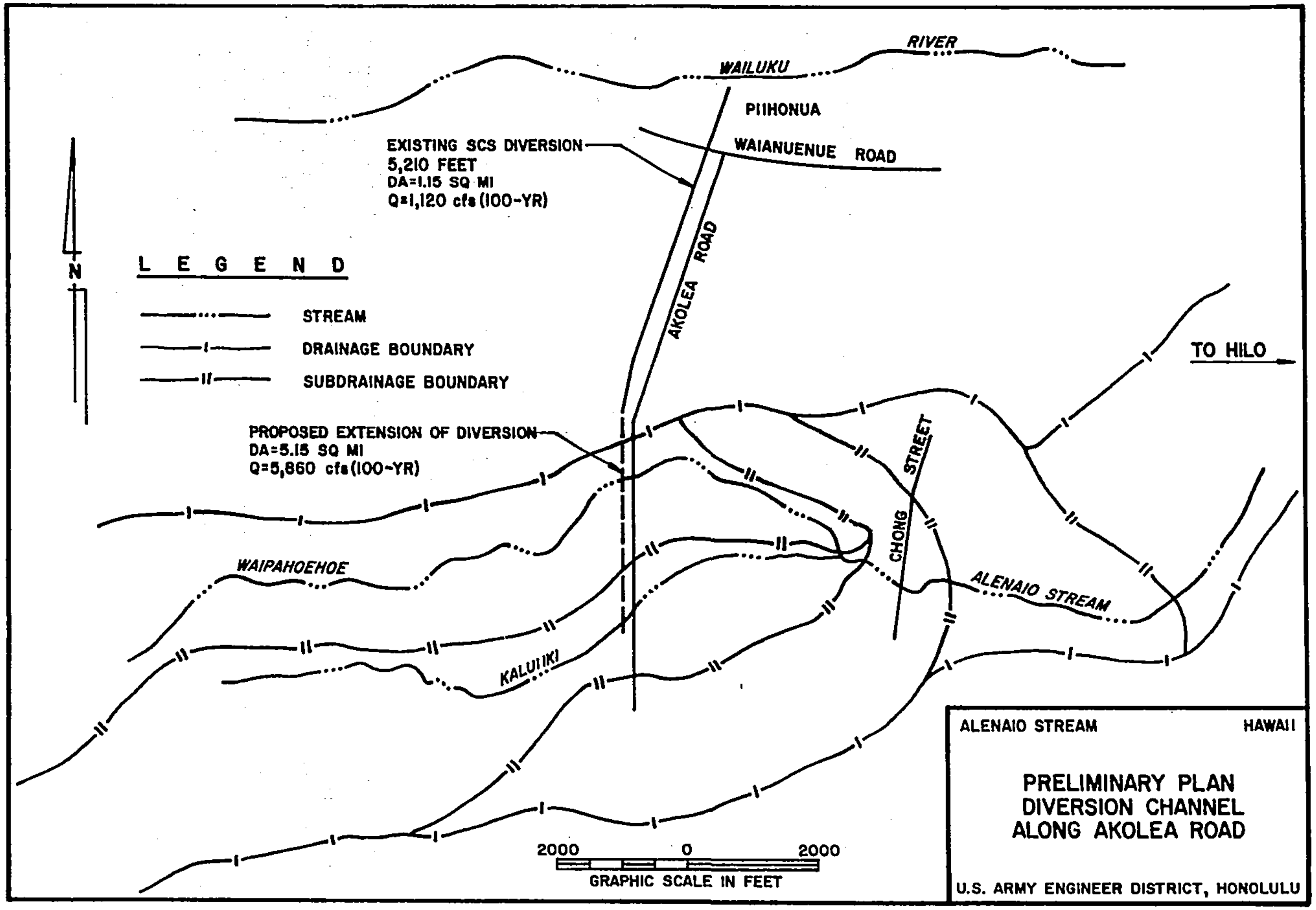


FIGURE 11

50

FIGURE 11

Preliminary Concept.

Modifications can be made to the existing stream to increase the channel capacity to accommodate the design level of the SPF event flood. In analyzing the possibility of increasing the existing channel capacity, it became apparent that many of the bridge openings and culverts on the existing stream channel would need to be modified. There is considerable development within the floodplain for some reaches of the Alenaio Stream. Stream modifications especially between Kilauea Avenue and Kapiolani Street are highly restricted as enlarging any portion will probably require the removal of some homes and businesses along the stream bank. The stream channel is also the narrowest (13' wide) in these areas. The SPF level protection would require a channel approximately 40 feet wide. The Ponahawai diversion culvert was assumed to have a capacity of approximately 800 cfs. However, for design purposes, it was also assumed that no flow would be diverted by this culvert.

Environmental Concerns.

Channel modifications would require concrete lining because of the expected velocities. Some natural streambed may be destroyed by the modifications unless these changes occur on previously modified portions. The enlargement and/or realignment of the channel may require the relocation of some residential/commercial buildings.

Summary.

Possible channel alignments and modifications will be analyzed to fully evaluate their impacts. Potential channel modifications can basically be divided into four (4) geographic areas; between Chong's Bridge and Komohana Street; between Komohana Street and Kapiolani Street; between Kapiolani Street and Kilauea Avenue; and below Kilauea Avenue and Hilo Bay. The majority of damageable property is between Kapiolani Street and Kilauea Avenue. Modifications to the other three areas should be evaluated on a cost effective basis.

d. Reducing the Rate of Run-off by Watershed Treatment.

Preliminary Concept.

Watershed treatment involves the treatment of lands to increase the soil's capacity to absorb and retain greater excess rainfall until flood heights of the streams have receded. Watershed treatment is generally applied to a small watershed area.

Summary.

The upper watershed which is primarily agricultural and forest areas is being treated by the U.S. Soil Conservation Service as part of their watershed treatment plan. Their plan will reduce runoff, protect the soil, maintain favorable soil conditions and productivity and maintain vegetative cover for soil protection. These measures will enhance the ability of the ground to retain rainfall.

Applying watershed treatment to the lower watershed would not be effective as this area is essentially urban. Consequently, consideration of this measure was eliminated by the Corps of Engineers.

e. Diverting Floodflows by Lava Tubes.

Preliminary Concept.

A unique possibility was investigated to utilize the presence of large lava tubes as natural diversion channels. These tubes which can be 6 to 12 feet in diameter have the potential to be used as 'pipelines' to the ocean by diverting floodflows into their openings. The major difficulty is in finding the lava tube window and tracing the outlets. This concept is currently being used for interior drainage at Akolea Road where a 6-foot-diameter lava tube is being used as a drainage system. However, the exact outlet and impacts of this diversion are not known. Detection tests by induction and plane wave geophysical techniques were conducted by the USGS (ref 19) for the Corps of Engineers to test detection feasibility. By profiling a known lava tube (Thurston lava tube) 3m high by 4m wide, it appeared that the resulting anomaly signatures could not unequivocally identify the location with enough confidence for our engineering needs. Other remote sensing techniques such as ground radar were recommended as possible effective systems but their costs would be prohibitive based on the scope of this study. Other studies by local A-E firms tried to use dye tracing techniques which also proved ineffective.

Summary.

Although the use of lava tubes is an unique and potentially a very economical possibility for flood control in Hilo, their utilization and confidence is based on the future ability to technically and economically locate and trace them. Consequently this alternative plan was not pursued further.

Nonstructural Measures

Floodplain Restrictions. Restriction of future development in the floodplain by land use controls such as zoning, subdivision regulation, building codes, development policies and designated floodways can lessen future damaging effects of floods. The County of Hawaii will be incorporating floodplain management regulations under the Federal Insurance Administration's programs.

Much of the land above Komohana Street is undeveloped, and plans for subdividing this area for single family housing have been proposed by developers.1/ Concerns were brought up by the Pacific Ocean Division with regard to its impacts on the Alenaio floodplain. As indicated earlier, the area is unique in that the stream becomes undefined for approximately 5,000 feet, then reappears approximately 2,000 feet before the Komohana Street intersection.

POD's concerns are that to insure that adequate floodplain management measures and practices are being incorporated to minimize future flood problems and that no development will adversely affect alternatives under consideration by this study. Consequently, it was recommended to the County of Hawaii that a

1/ See Ref 27

flood control area or easement between Komohana Street and Chong's Bridge be established by the County or City of Hilo. This area or easement will help insure that:

(1) future development will not adversely encroach on the floodplain thereby minimizing future damage potential and need for flood control improvements;

(2) developers will provide a suitable floodway in the absence of a definable stream;

(3) the effects of any proposed development on drainage patterns of surrounding areas are adequately reviewed;

(4) adequate project and construction easements are provided in the event that additional flood control works are necessitated by unforeseen changes in floodplain drainage characteristics due to development;

(5) any proposed work will be consistent with the flood control alternatives under consideration for the area below Komohana Street; and

(6) the limits of concern for possible DA permit actions are defined to potential developers.

It is recognized that because of lava tubes and other geologic features which are prevalent in the area, drainage patterns and flowages are complex and difficult to understand. The dense vegetation and rough terrain make it difficult to trace the stream on aerial photographs and do not easily accommodate field observation and surveying. A very extensive area mauka of Komohana Street is subject to flooding, because the ancestral Alenaio Stream has been blocked by the 1881 flow, and during times of high runoff the carrying capacity of the stream is exceeded at numerous chokepoints and water is diverted to the south, to a broad basin where standing water eventually percolates into subsurface lava tubes. This problem was discussed in the USGS report to POD (ref 21). According to the USGS, the relatively flat area between 360 and 420 feet elevation is particularly subject to flooding.

It is financially beyond the scope of this report to determine the exact boundaries of this area. A "false confidence" to a prospective developer or planning agencies by portrayal of a "200-foot minimum flowage easement" is not intended. The 200-foot minimum easement is not to depict the extent of flooding but to indicate a minimum flowage area that can be adequately utilized as a drainage system for possible future conditions based on expected flows. Flooding may well occur outside this easement. Development in this area will need to be regulated by the county taking into account the community development needs but recognizing the geohydrologic impacts. Floodproofing and floodplain management practices should be an integral part in designing homes, commercial buildings and utilities systems in this area. Developers and prospective buyers should be adequately informed of the floodplain.

In regard to the DA permit program, (Section 404 of the Clean Water Act), any proposed work which deposits fill or dredged material within this easement will be evaluated by POD to determine if it falls in the waters of the United States, thus requiring permit action. Any proposed work outside the waters of the United States but inside the easement will fall under the purview of the County. It is recommended that only activities consistent with the flood hazard be allowed in this area. Although this policy will reduce potential damages, it will not relieve the flood hazard for those who are in the floodplain. This measure can however complement other structural or nonstructural measures. Floodplain restrictions will be evaluated in conjunction with other alternatives.

Maintenance. Maintenance is a regularly instituted program of repairing stream channel structures and removing sediment, obstructive material and other debris from the channel. Maintenance alone will not significantly reduce damages from the larger storms and floods, but will provide protection from the lower frequency storms. The expected carrying capacities and related flood frequencies for Alenaio Stream under three channel conditions are as follows:

Condition of Stream	Estimated Capacity (cfs)1/	Associated Flood Frequency	
Clean, well maintained	2000	5-yr	(20%)
Moderately vegetated, some debris and sediment deposition	1500	3-yr	(33%)
Heavy vegetated, poorly maintained, high deposition of debris and sediments	1100	2-yr	(50%)

It is expected that if the stream were fully maintained Alenaio Stream would probably provide protection for 1100 to 2000 cfs of flow. Flows exceeding this capacity will cause flooding in downtown Hilo. Regular maintenance and repair would be recommended to complement any structural or nonstructural alternative.

Relocation. Relocation is the physical removal of all damageable property and the conversion of these lands to uses compatible with the flood risk. Relocation was analyzed in conjuction with floodproofing where structures which cannot be floodproofed economically are proposed to be relocated.

Flood Forecasting, Warning and Temporary Evacuation. The effectiveness of these measures is a direct function of the reaction time coupled with floodplain residents' confidence in the accuracy of the forecast or warning. This confidence is most often based on past experience with floods.

Alenaio Stream is characteristic of most streams in Hawaii where the time from the initial stages of the storm to the peak discharge in the stream is only a matter of hours. Consequently, the primary aim of forecasting and warning is

1/ at Kilauea Avenue

to save lives. Civil defense agencies, in cooperation with National Weather Service and police have established flood forecasting and warning systems for the County of Hawaii. While lives can be saved, little can usually 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 provide time to implement floodproofing measures to their homes.

Flood Insurance. This nonstructural measure does not reduce the flood hazard or associated damages but rather lessens the economic burden of flooding and encourages floodplain restrictions. Over the long term the land use regulation required for 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 structural or nonstructural alternatives.

Floodproofing. The alteration of a structure or conditions surrounding the structure to prevent damage by floodwaters is known as floodproofing. Typical methods are (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, to preclude floodwaters from entering the building's interior, each one has different limitations. Raising the structure is often uneconomical and impractical for structures constructed on a slab. Raising structures is also limited to a maximum raising height because of stability. Sealing and waterproofing are only applicable to buildings that can sustain the hydrostatic pressure and the drag force exerted by floodwaters. Using walls or levees to floodproof an individual property can be unsightly and expensive due to the necessity of providing interior drainage. Floodproofing is effective when complemented by incorporating floodplain restrictions, providing regular maintenance of the stream and implementing effective forecasting and warning. Floodproofing can also be effective in complementing structural measures.

An inventory of the number, type and condition of structures in the Alenaio watershed was made during January-February 1981. This inventory was used in evaluating the potential of floodproofing individual structures. Floodproofing appears to be the most viable nonstructural plan. One hundred and thirty-one (131) structures1/ are in the SPF floodplain. Many of the structures are wooden structures on post and beam which can be economically floodproofed.

6. SUMMARY OF SCREENING THE PRELIMINARY ALTERNATIVES

Based on the preliminary screening, the analyses indicate that many alternatives can be eliminated from further study because of technical inapplicability and/or because the cost would obviously exceed the expected benefits. In summary, the following table indicates those measures which have potential for detailed study.

1/ Many structures contain more than one damage unit where a number of commercial stores may be housed in one structure.

Structural measures	Measures warranting further detailed studies	Measures warranting studies to complement other measures	Further studies not warranted
Upstream retention basin			X
Diversion channel (Alignment A) into the Wailuku River	X		
Diversion channel (Alignment B) into the Wailuku River			X
Diversion channel into the Wailoa River			X
Modifications to the existing stream	X		
Nonstructural measures			
Floodproofing/relocation	X		
Floodplain management		X	
Maintenance program		X	
Flood warning, temporary evacuation		X	
Flood insurance		X	

TABLE 10. SUMMARY OF POTENTIAL IMPACTS AND MAJOR CONCERNS

● Major Concern
◐ Moderate Concern
○ Minimal or No Concern

CONCERN	RETENTION BASIN	DIVERSION CHANNEL (WAILOA)	DIVERSION CHANNEL (WAILUKU)	MODIFYING EXISTING CHANNEL	FLOOD PROOFING
1. LAND-USE POLICY					
A. Compatible with Local Land-Use Planning	◐ Existing land zoned as agricultural; owner requesting rezoning for subdivision development; privately-zoned lands required.	◐ Channel traverses areas zoned as agricultural. Privately-zoned lands required.	● Channel traverses areas zoned as agricultural. Privately-zoned lands required.	◐ Alternative is compatible with the Downtown Hilo Redevelopment plans. Privately-zoned lands may be required.	○ Alternative is compatible with existing land use planning and laws.
B. Possible Community Impacts	● Approximately 190 acres must be dedicated for flood control project and easements.	◐ Approximately 10 to 12acres must be dedicated for flood control project and easements.	◐ Approximately 9 to 10acres must be dedicated for flood control project and easements.	○ Modifications may alter existing appearance of Downtown Hilo.	○ Alterations may change the existing appearance of the Community.
2. ENVIRONMENTAL RESOURCES					
A. Significant Adverse Effects	◐ Loss of 130 acres of native ohia-guave forests.	○ Stream flows will be diverted from Alenaio Stream into the Wailoa Stream.	○ Stream flows will be diverted from Alenaio Stream into the Wailuku River.	◐ Modifications may result in loss of natural streambed unless modifications occur in previously concrete-lined portions.	○ No adverse ecological effects anticipated. Some ornamental plants and shrubs may be damaged during floodproofing/relocation operations.
B. Social Impacts	● May require the removal of residential buildings.	○ Diversion channel represents a new visual element in communities not affected by flooding from Alenaio Stream.	● Alignment may require the removal of residential/commercial buildings. Diversion channel represents a new visual element in communities not affected by flooding from Alenaio Stream.	● Enlargement and/or realignment may require the removal of residential/commercial buildings.	● Structures not economically feasible to be flood proofed may need to be relocated or replaced with a new structure.
3. ARCHAEOLOGICAL/ HISTORICAL RESOURCES	○ No effect on known resources.	○ No effect on known resources.	◐ Alignment may traverse old sugar cane flumes. Determination of significance of flumes pending.	○ No effect on known resources.	○ No effect on known resources; alterations will be compatible to existing architectural style of community.
4. TECHNICAL CONCERNS					
A. Prevalence of Lava Tube Formations	● Proposed area is in pahoehoe type lava.	● Proposed area is in pahoehoe type lava.	● Proposed area is in pahoehoe type lava.	◐ Modifications are in Homelani ash.	○ Alternative does not involve significant subsurface excavation.
B. Risks of Flood Exceeds Design Parameters	● Possible embankment failure will cause catastrophic flooding if during peak storage.	● Diversion channel will have potential to overtop Wailoa Stream and flood surrounding community.	◐ Diversion channel will have potential to overtop Wailuku River and flood surrounding community.	● Downtown Hilo urban area will be flooded.	◐ Flood elevations will overtop floodproofing measures.

IV. DEVELOPMENT OF DETAILED PLANS

1. GENERAL

This section of the report is directed toward the development of detailed design and evaluation for analyzing specific plans and configurations. The formulation of design plans was guided by specific technical, economic and environmental criteria which are documented in the supporting appendices.

Based upon the preliminary evaluation and screening, three basic alternative plans were considered the most feasible at this stage and were further developed in greater detail. They include:

Alternative Plan 1	Modifying the existing stream channel
Alternative Plan 2	A diversion channel into the Wailuku River
Alternative Plan 3	Floodproofing, relocating structures and incorporating a floodplain management practices

2. DESIGN ASSUMPTIONS

Design assumptions and data are provided in Appendix D. Existing conditions were determined from topographic surveys conducted by the Corps of Engineers, County of Hawaii and the State of Hawaii. Hydrologic and hydraulic analyses and computations were assisted by US Army Hydrologic Engineering Center (HEC) computer program systems1/. Two design levels of protection were evaluated for each alternative, the Standard Project Flood (SPF) and the 100-year flood events (1% frequency).

3. ALTERNATIVE PLAN 1, MODIFYING THE EXISTING STREAM CHANNEL

In developing this alternative the study area was divided into four (4) reaches. These four reaches include (see Figure 12):

Reach	Area
4	Chong's Bridge to Komohana Street
3	Komohana Street to Kapiolani Street
2	Kapiolani Street to Kilauea Avenue
1	Kilauea Avenue to Hilo Bay

Reach 4. The majority of the area between Chong's Bridge and Komohana Street, except at the northwest portion which has considerable single family housing, is essentially undeveloped but subject to possible development by private owners. Alternative 1 incorporates a floodplain management plan for future development in order to minimize future flooding problems and to insure that future development will not adversely affect the plans under study. A minimum 200-foot flood control easement is proposed along the best known stream alignment (see figure 12). The 200-foot minimum easement is based on an area

1/ Documentation of the HEC computer system utilzed is provided in the following publication: HEC-2 Water Surface Profiles, Users Manual, US Army Hydrologic Engineering Center, Davis, CA 95616.

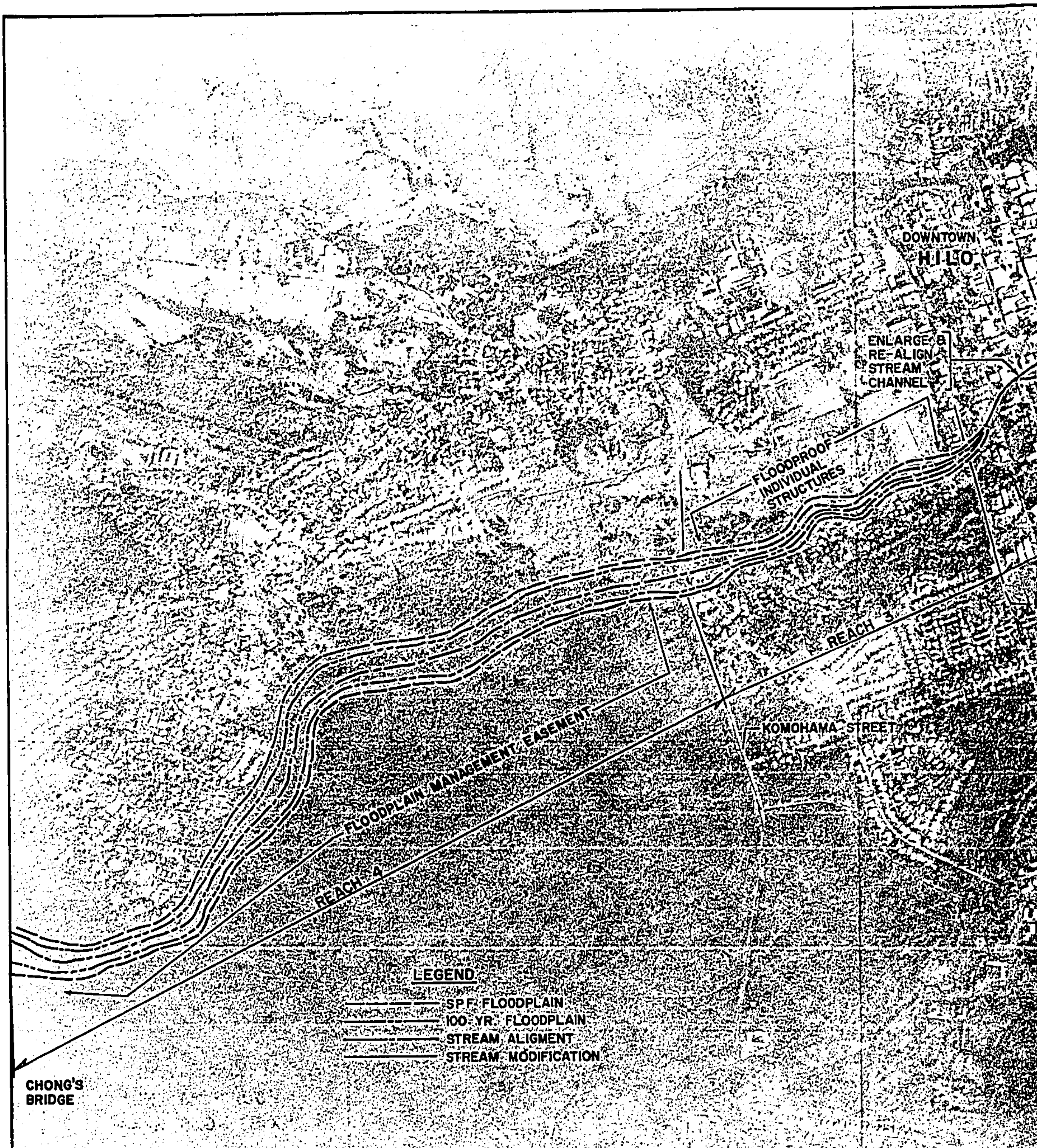

DOWNTOWN
HILO
ENLARGE & RE-ALIGN STREAM CHANNEL
FLOODPROOF INDIVIDUAL STRUCTURES
REACH 5
KOMOHAMA STREET
FLOODPLAIN MANAGEMENT EASEMENT
REACH 4
LEGEND
SPF FLOODPLAIN
100 YR. FLOODPLAIN
STREAM ALIGMENT
STREAM MODIFICATION
CHONG'S BRIDGE

FIGURE 12

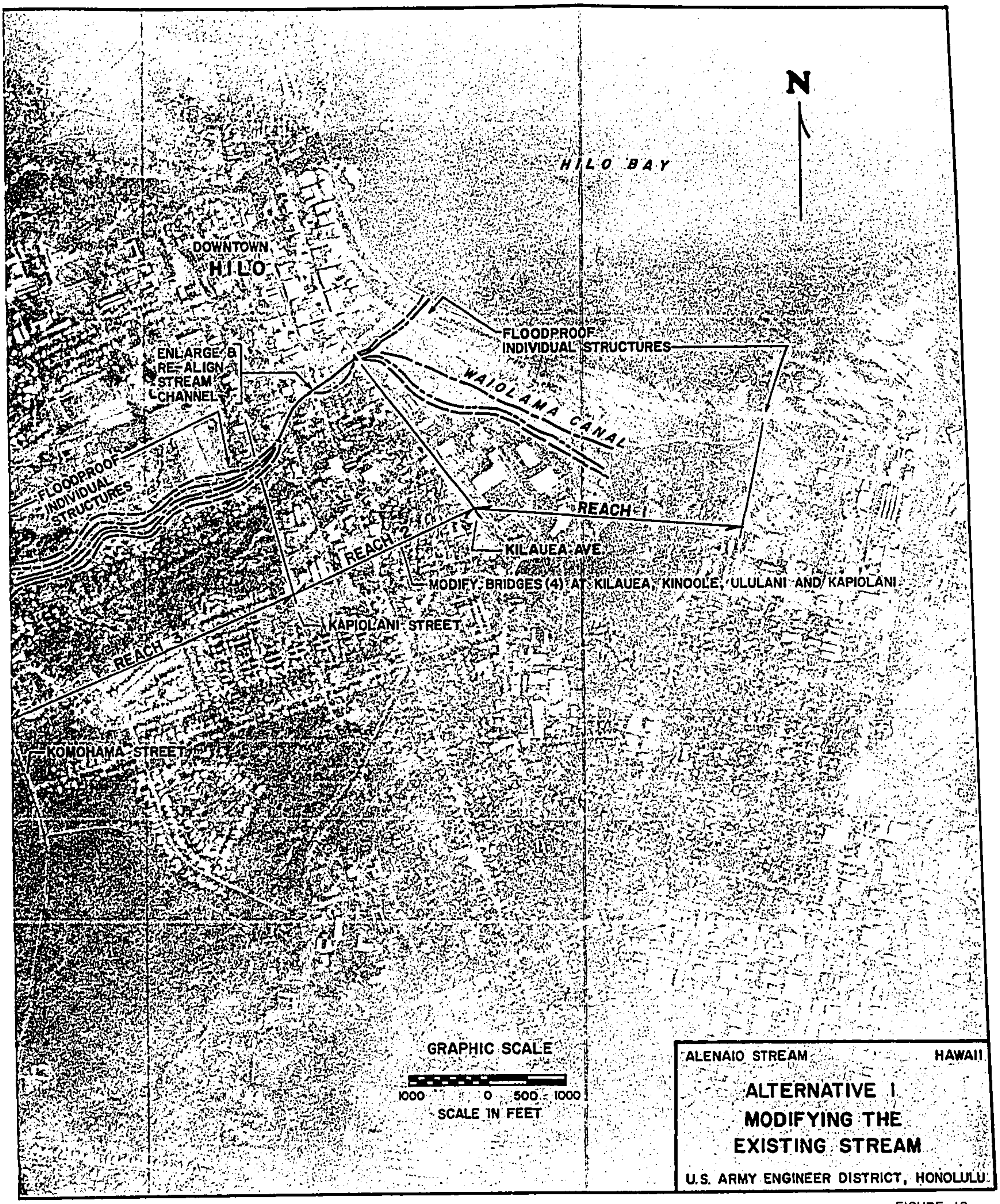

N
HILO BAY
DOWNTOWN
HILO
FLOODPROOF
INDIVIDUAL STRUCTURES
ENLARGE &
RE-ALIGN
STREAM
CHANNEL
WAIOLAMA CANAL
FLOODPROOF
INDIVIDUAL
STRUCTURES
REACH 1
REACH 2
REACH 3
KILAUEA AVE
MODIFY BRIDGES (4) AT KILAUEA, KINOOLE, ULULANI AND KAPIOLANI
KAPIOLANI STREET
KOMOHAMA STREET
GRAPHIC SCALE
1000 0 500 1000
SCALE IN FEET
ALENAIO STREAM HAWAII
ALTERNATIVE I
MODIFYING THE
EXISTING STREAM
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 12

that can be adequately utilized as a drainage system based on possible flood flows. It does not depict the extent of flooding. This proposed easement would be recommended for both the SPF and 100-year plans. The minimum 200-foot easement is being proposed for the SPF plan in order to minimize land-use restrictions and to leave the major decision making process on development policy and planning in this area to the County. The Corps' major concerns are to insure that potential future flood damages are minimzed and land-use changes to the watershed will not adversely affect the design conditions for the alternative plans being considered.

Komohana Investors who owns approximately 200 acres of land in this area is requesting a rezoning of this area from Agricultural (A-1a) and Open (O) to Residential and Commercial (RS-15, RS-10, RS-7.5, CN-10 and O). They propose to incorporate a 200-foot open space along Alenaio Stream for floodplain management and to incorporate channel improvements, detention ponds and sediment basin as not to adversely change the Corps of Engineers design parameters as a result of their development.

A debris/sediment basin was not considered necessary in this reach. Debris basins are usually built in the headwaters of flood control channels in order to trap bed-load debris before it enters the main channel. This prevents aggradation of downstream channels and deposition of large quantities of sediment at the stream mouth. Based on the drainage basin characteristics and the US Soil Conservation Service plans for a watershed protection project, minimal soil erosion is expected. Past flooding did not result in significant turbidity of the floodwaters or debris accumulation along the stream channel. Consequently, a debris/sediment basin will not be economically effective. Periodic maintenance, however, will be needed along the stream to minimize degradation of the stream channel from long-term debris accumulation.

Reach 3. The stream between Komohana Street and Kapiolani Street is approximately 4400 feet long with 5 structures in the 100-year floodplain and 9 structures in the SPF floodplain. Evaluations indicate that it is not cost effective to modify this portion of the stream. Floodproofing1/ is the most appropriate measure for this reach due to the scattered distribution of structures in the reach.

Reach 2. Alenaio Stream between Kapiolani Street and Kilauea Avenue is approximately 1900 feet long with 123 structures in the SPF floodplain. The stream is at its narrowest in this reach. This alternative provides for the

1/ Structure types and appropriate floodproofing measures are detailed in Appendix D. Within the context of this study, relocation or removal will mean the total replacement (or major alteration) of the structure in its original place. The owner can have the option to relocate outside the floodplain to another site.

realignment and enlargement of this portion of the stream. The stream will need to be realigned in order to try to provide a degree of curvature which will maintain as steady flow conditions during flood discharge. When the flow becomes unstable due to sharp curves in the channel, theoretically predicting flow behavior is difficult, and physical modeling will then become necessary to adequately design the channel. Model tests during the Advance Engineering & Design (AE&D) stage is proposed because of the high velocity flows and channel curvatures required in order to confirm the design. The channel will be modified as follows:

Channel Modifications (Rectangular Concrete)

Channel Dimensions	100 Year	SPF
Width	25'	40' for 415' 35' for 1225'
Design flood depth	8' to 12'	8' to 9.5'
Length	1,640'	1,640'

The maximum velocity was computed to be 42 fps for the SPF flood and 38 fps for the 100 year frequency flood. The bridges at Kapiolani Street, Ululani Street, Kinoole Street and Kilauea Avenue will also need to be replaced.

Seven (7) structures will need to be relocated, one public building (fire department office) and six residential buildings along the new alignment. The old channel will be filled and landscaped. A pleasant walkway can be incorporated along the old alignment landscaped with shading trees, benches and shrubbery.

On the downstream side of Kilauea Avenue Bridge a 250-foot-long concrete wall and energy dissipators will need to be provided to prevent channel erosion. The velocity at this point is estimated at 40 fps.

Reach 1. This reach consists of the stream below Kilauea Avenue and south of Ponahawai Street until it enters Hilo Bay. Within this reach are only two (2) structures subject to flooding. The most critical activity affected by flooding is traffic on the Bayfront Highway and Kamehameha Avenue. The SPF and 1% frequency event floods will overtop the Bayfront Highway by 3.5 feet and 2.5 feet, respectively. The Bayfront Highway is under planning for modification by the State Department of Transportation. The major issue in providing protection below Kilauea Avenue is the impact of flooding on the highway route, resulting in unsafe driving conditions and possible closure. The highway is one of the main roads to northern areas of the county. Two issues are critical:

a. Does the closing of these highways due to floods constitute a critical or major emergency for the county transportation system and/or

b. Do expected tangible benefits accrued from floodfree transportation routes exceed the cost of providing the associated flood control improvements in reach 1.

It is felt that temporarily closing this portion of the highway due to flooding will cause an inconvenience but not a catastrophic or emergency condition. If a major storm occurs, it would probably be over a large portion of Hilo and the surrounding area. Consequently, other portions of the highway not protected by the Alenaio project and outside the study area may become impassable. Protecting the Bayfront Highway section while having other portions of the highway system impassable would probably isolate the bay front section and may defeat the purpose of providing flood control measures for the highway. Major emergency centers such as hospitals, schools and civil defense offices are not along this highway nor are major accesses to these facilities dependent on the Bayfront Highway or Kamehameha Avenue. Other secondary roads are available which can access areas near the Bayfront Highway and Kamehameha Avenue. Consequently, providing flood control measures for reach 1 would be dependent on expected flood damage reduction benefits. Evaluation of benefits for this reach are then based on

- reducing damages and maintenance cost to the highway features and utility systems

- reducing losses due to time delays from flooding

- reducing additional costs to circumvent the flooded area

Five (5) sub-plans were evaluated for this area. They include:

a. no structural action/floodproofing existing structures

b. enlarging the capacity of the Waiolama Canal

c. constructing a levee along Kamehameha Avenue

d. constructing a new diversion channel outlet into Hilo Bay

e. raising the Bayfront Highway

No structural action/floodproofing. This measure leaves reach 1 in its current condition. No substantial measures would be provided except incorporating flood warning signs along the Bayfront Highway and Kamehameha Avenue to warn drivers of dangerous driving conditions. This is consistent with the open space land-use zoning of the area where no development is allowed because of tsunamis. Most of the water would be ponded in the Wailoa park area. Flooding in the park would result from the occurrence of a 2-year frequency flood. The three existing structures (service stations) would be affected by a 5-year flood frequency, and the highway would be inundated by a 10-year frequency flood. The three service stations will be floodproofed by providing a flood wall surrounding the stations and/or by elevating damageable property above the expected flood heights (3.5 feet for the SPF event).

Enlarging the Capacity of the Waiolama Canal. This measure confines the floodwaters within the limits of the Wailoa park by enlarging the capacity of the Waiolama Canal. Due to the mild hydraulic gradient, the Waiolama Canal would need to be enlarged to a width of 350 feet for the SPF flood (175 feet for the 100 year flood) with a rip-rap trapezoidal channel with 2H to 1V sideslopes. The Pauohi Avenue crossing and foot bridges along the canal will need to be modified accordingly. The maximum channel velocity is 6 feet per second.

Levee System along the Highway. This measure provides a 2,800-foot-long earthen levee at a height of 8 feet for the SPF flood (7 ft for the 100 year flood) with sideslopes of 2.5H to 1V and a crest width of 10 feet. At Pauohi Street the levee would be cut and a manually operated flood gate will be inserted. The levee would tie into the three service stations and provide protection to the stations and Kamehameha and Bayfront Highways. No interior drainage structures would be required. The ponded water on the canal side of the levee will flow into the normal course of the canal into Hilo Bay. The water on the bay side of the levee will flow directly into the bay.

New Diversion Channel into Hilo Bay. The SPF measure extends the channel in reach 2 into Hilo Bay by running parallel to Ponahawai Avenue. The proposed channel would be 35 feet wide at Kilauea Avenue and enlarged to 45 feet through a 100-foot transition. The channel would be 1,300 feet long with a flow depth between 7 and 10 feet. The maximum velocity in the channel is 41 fps with a velocity of 28 feet per second at the bay. Two new bridges would be required, one at Kamehameha Avenue and one at Hilo Bayfront Highway. Utilities will also need to be modified as existing lines parallel the Hilo Bayfront Highway and Wailoa Park. The 100 year level protection would have a 30-foot-wide channel with a maximum flow velocity of 37 fps in the channel and 24 fps at the bay.

Raising the Highway. The State DOT has the option of raising Bayfront Highway by a minimum of 2.5 feet for the 100-year frequency flood. The Corps of Engineers cannot directly contribute to this plan but the State DOT has the option to incorporate this measure in their modification of the Bayfront Highway. The State DOT is currently investigating the feasibility of raising the highway but has not made any decision at this time.

Economic evaluations were made to determine the best features for reach 1. Based on this evaluation and the State DOT plans, subplan "a" was considered the most appropriate measure for Reach 1 and is included as part of the recommended measures for Alternative Plan 1.

4. ALTERNATIVE PLAN 2, A DIVERSION CHANNEL INTO THE WAILUKU RIVER

Design Plans.

This alternative provides for a channel diversion from approximately 500 feet above Komohana Street extending into the Wailuku River (see Figure 13). The alignment generally runs parallel to Komohana Street and Hale Street. Two levels of protection, the SPF and the 100 year flood frequency were developed. The plan provides for a 4,200 feet diversion channel consisting of a trapezoidal channel at the point of diversion for 1,850 feet, a transition section of 100 feet and a rectangular channel for 2,250 feet. The following summarizes the pertinent sections of the proposed channel:

	100-Yr		SPF	
	Trapezoidal (1850')	Rectangular (2250')	Trapezoidal (1850')	Rectangular (2250')
Bottom width	15'	25'	25'	35'
depth	8-10'	8-11'	8-10'	8-12.5'
side slope	1.5H to 1V	NA	1.5H to 1V	NA
velocity (max)	30 fps	50 fps	30 fps	50 fps

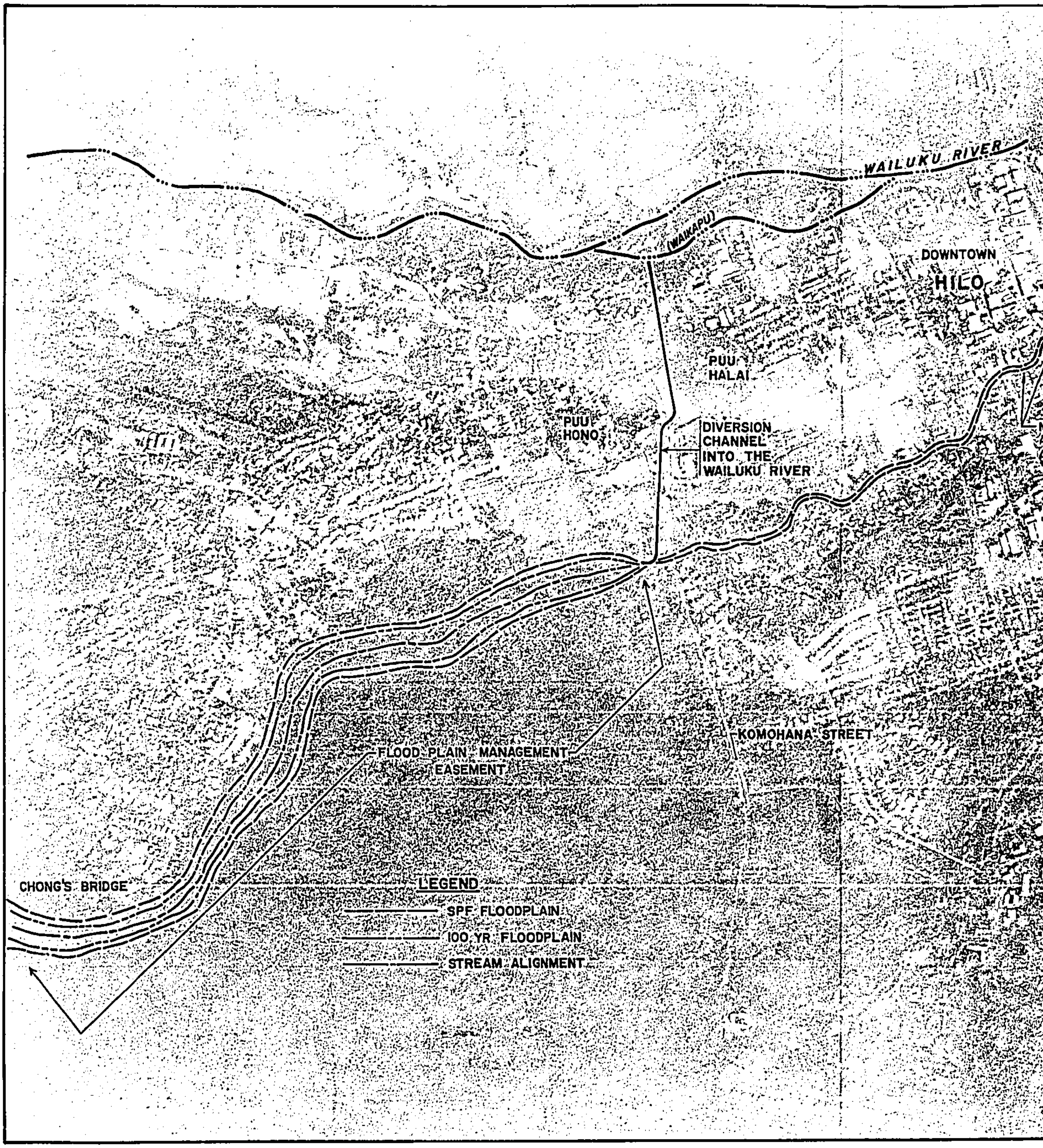

WAILUKU RIVER
(WAIKAPU)
DOWNTOWN
HILO
PUU
HALAI
PUU
HONO
DIVERSION
CHANNEL
INTO THE
WAILUKU RIVER
KOMOHANA STREET
FLOOD PLAIN MANAGEMENT
EASEMENT
CHONG'S BRIDGE
LEGEND
SPF FLOODPLAIN
100 YR. FLOODPLAIN
STREAM ALIGNMENT

FIGURE 13

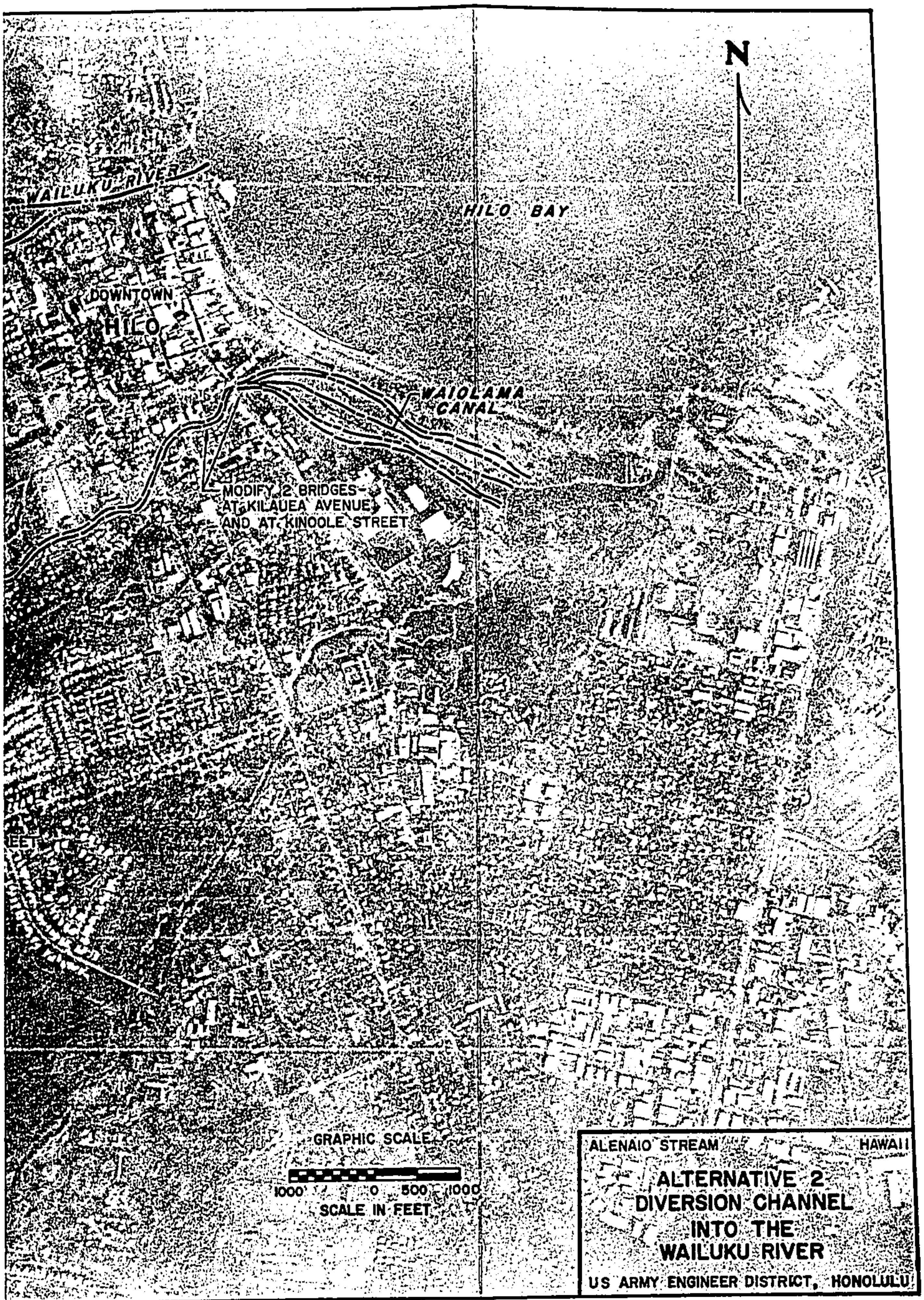

N
WAILUKU RIVER
HILO BAY
DOWNTOWN
HILO
WAIOLAMA
CANAL
MODIFY 2 BRIDGES
AT KILAUEA AVENUE
AND AT KINOOLE STREET
GRAPHIC SCALE
1000 0 500 1000
SCALE IN FEET
ALENAIO STREAM
HAWAII
ALTERNATIVE 2
DIVERSION CHANNEL
INTO THE
WAILUKU RIVER
US ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 13

The outlet at the Wailuku River will consist of a drop structure and stilling basin. New bridges will also be needed at Komohana (18'H x 35'W) and Punahele (12'H x 35'W). Since the velocity of flows in the channel will be 30 to 50 fps a safety fence will be provided along the channel. Model tests will be made during the Advance Engineering & Design stage (AE&D) to confirm and refine design aspects of the channel.

The existing downstream portion of Alenaio will also be modified in order to be able to accommodate a Standard Project Storm (SPS) occurring below the proposed point of diversion. The following structures will be modified as indicated.

Culvert/Bridge Openings	100-Yr	SPF
Kinoole Street	18'W x 10'H	20'W x 10'H
Kilauea Avenue	18'W x 10'H	20'W x 10'H

Floodplain management measures are also part of overall plan for the area between Chong's Bridge and the point of diversion in order to minimize development impacts on the diversion channel. The same flood control easement as developed for Alternative Plan 1 where a minimum 200 feet zone along the stream would be provided and the diversion levee at Luana Way are also being proposed as part of the overall plan for Alternative Plan 2.

Other Features.

Outlet structure. The drop structure and stilling basin at the Waikapu River, a portion of the Wailuku River, will be designed to appear as a natural waterfall as practical. The concrete structures can be cosmetically covered with rock. For example, the concrete baffles in the stilling basin can be replaced with natural rock of approximate equal size anchored to the stream bottom where a natural stream appearance can be developed.

Covered channel. A covered channel is proposed for 650 feet of the diversion channel along Hale Street. If an open channel is incorporated, two houses would need to be removed, walkways over the channel would need to be provided to existing structures and Hale street would need to be realigned to accommodate vehicular traffic. Safety, access, and aesthetics can be best served with a covered channel in this area. Comparing the cost of providing the open channel and appurtenant structures and providing a cover channel, the covered channel would cost an additional $898,600 for the SPF plan. The covered channel would actually be $451,200 less expensive for the 100-year plan. Any additional costs associated with the covered channel will have to be borne by the local sponsor.

5. ALTERNATIVE PLAN 3, FLOODPROOFING, REMOVING/REPLACEMENT AND FLOODPLAIN MANAGEMENT POLICY.

This nonstructural alternative provides for floodproofing individual structures, relocating or replacing structures which cannot be economically floodproofed and incorporating a floodplain management plan. Two levels of protection were evaluated, the Standard Project Flood (SPF) and the 100-year (1% frequency) flood frequency event.

Floodproofing. Floodproofing measures were developed based on the existing type of structures in the floodplain. An inventory of structures and their contents was obtained from field surveys conducted during January to February 1981, aerial photographs and State tax key maps. Structure types were divided into 6 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 the depth of flooding a method of floodproofing was incorporated 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[1]
- providing a ring wall

Appendix D provides the design assumptions and identifies the specific structure location and appropriate floodproofing measure to be incorporated. The SPF plan provides for floodproofing 78 structures and the 100-year plan provides for 63 structures.

Floodproofing Measure	Number of Structures	
	100-year	SPF
Temporary/permanent closures	19	18
Relocation of damageable property	14	14
Raising the structure	25	41
Providing a ring wall	5	5

Structures which could not technically or economically employ the floodproofing measures described above were evaluated separately for relocation or replacement.

Removal/Replacement. This measure provides for removing structures which cannot be economically floodproofed and replacing them with new floodproofed structure. Some structures may not need to be totally removed but may require major modifications. Based on an evaluation of relocation and replacement in-place modification costs, the latter was found to be more beneficial. Most of the structures that fall under this category are commercial businesses in the main business area. Relocating these business activities to another site within the downtown business area would be expensive as sites are already limited by the tsunami hazard zone which incorporates much of the downtown Hilo area. Removing thriving businesses outside the downtown Hilo area was not considered beneficial to the overall economic plan by the County of Hawaii

1/ The structure will be replaced with a new structure at its original location for this analysis but the owner can have the option to relocate to another site outside the floodplain.

who wished to revitalize this area. No significant cost savings are also anticipated by relocating these activities outside the downtown area as additional costs for real estate acquisition will tend to offset the additional costs for reconstruction in-place. Any replacement and/or major modification will be compatible with the Hilo Downtown Redevelopment plan and the local architectural style.

	Number of structures 100-year	SPF
Removal/Replacement or major alterations	31	53

Floodplain Management. This measure provides for floodplain restrictions, maintenance programs and flood warning systems. Restrictions to future development in the floodplain by land use controls through zoning, subdivision regulations, building codes and standards will need to be enforced by the County of Hawaii to minimize future development within the 100-year floodplain. This measure would be consistent with the County's participation in the Federal Flood Insurance Program. The open area between Chong's Bridge and Komohana Street which is subject to major development would need to have a recommended 200 foot minimum easement to minimize future flooding problems.

A regularly instituted maintenance and inspection program of repairing existing channels and removing accumulated sediments, obstructive materials and vegetation will need to be established to insure that the existing flood channels remain at their design capacities. Many of the secondary roads and the Bayfront area will still be prone to flooding. Residual backyard, road-surface and utility damages will still occur and will need to be cleaned and repaired after each storm.

An effective forecasting and flood warning system will need to be established to allow residents time to implement temporary floodproofing measure and to warn them of hazardous conditions. Flood warning lights along the Bayfront highway would be installed to advise drivers of dangerous driving conditions.

6. OTHER PLANNING CONSIDERATIONS.

a. Effects on the Hydrologic Water-Cycle. The P&S recognizes the unity of the total hydrologic cycle or the conjunctive relationship of groundwater with surface water. As indicated previously, significant efforts to investigate this impact were undertaken by the USGS. Based on their preliminary findings, the three alternatives should minimally affect the geohydrologic characteristics of the watershed. Alternative 1 basically only modifies 1,640 feet of existing stream between Kinoole Street and Kilauea Avenue where the stream channel will be enlarged and re-aligned. Based on the geologic map, the subsurface in this area is mostly Homelani ash. The Homelani Ash bordering the stream is only a few feet thick. In the stream channel to the west, it has been eroded and the underlying unit, the picrite of Alenaio Stream (A1), is exposed. This unit is quite vesicular and there is undoubtedly seepage of water into A1. A similar situation may exist between Kinoole Street and Kilauea Avenue. These outcrops are too small to be shown at the scale of the map (see Figure C-1). Lava tube formations do not occur in Homelani ash, consequently few adverse impacts are anticipated on the geohydrology in this area as a result of this modification.

Alternative 2 has the most potential to disrupt underground waterflow by the interception of lava tubes along the proposed alignment. The proposed diversion alignment crosses pahoehoe lava flows where the formation of lava tubes are prevalent. The diversion channel has the potential to intercept these tubes within its proposed channel depths. If provisions are not made to divert the water flowing in these tubes into the proposed channel, the concrete diversion channel can act as a barrier which can cause the water to either back-up and reappear at weak points in the surface or be directed to other lava tube systems possibly causing undesirable flooding elsewhere. This potential problem can be minimized by having any lava tube encountered diverted directly into the new channel. Pre-determining their locations is not possible as discussed earlier in the report. The additional contribution of these flows should not affect the design peak discharge of the channel as these water flows occur at a significant time lag behind the surface runoff. It is not technically feasible at this time to accurately predict the discharge of water contributed by tubes encountered as it is impossible to trace their origins and watershed sources. It is expected that the new channel would only intercept a few tubes near the surface. It is not expected that the proposed diversion will significantly affect any perched dikes of water or geohydrologic water cycle due to its relatively shallow channel depth.

Alternative Plan 3 will not require any subsurface modifications, consequently no impacts are anticipated by the implementation of this plan.

b. Water Conservation. Water conservation measures are defined as actions that will (1) reduce the demand for water; (2) improve efficiency in use and reduce losses and waste; and (3) conserve water. Also included in the water conservation directive is emphasis on the management of water resources and the balance of water use with supply. As indicated in the evaluation of the potential water resources needs and opportunities of the study area, there is little economic opportunity to exploit water resources development due to the hydrologic characteristics of the stream. Single purpose flood control projects may appear to be an inefficient use of water because these alternatives tend to increase the flow of water into the ocean rather than to incorporate the retainment and use of these large amounts of flood waters for other more profitable purposes. The ephemeral nature of the stream and the relatively small watershed, coupled with high intensity rainfall within a short period of time causing flash-type floods create (hydraulic) difficulties in economically developing more efficient and multi-purpose water systems. Measures to reduce the demand for and losses of water are being investigated under the Hilo Comprehensive Study.

c. Mitigation. Mitigation is a planned measure to moderate, minimize or eliminate adverse impact that may result from the proposed alternatives. The following are proposed measures to mitigate expected impacts.

Ecological. No major ecological impacts are expected due to the implementation of any of the three alternatives. None of the plans destroy new streambed areas, significant habitats or ecologically significant areas. Consequently no mitigative actions were considered necessary for implementation to offset possible ecological losses. The US Fish and Wildlife Service's recommendations to minimize adverse impacts will be implemented. The USFWS will have the opportunity to comment on the construction plans and specifications.

Cultural/archaeological. Past studies indicate that no significant historical, cultural or archaeological resources will be affected by any of the proposed alternatives. Field surveys along the alignment were made by a qualified archaeologist to ascertain any possible impacts. The results of this study will be coordinated with the State Historic Preservation Officer and the Advisory Council on Historic Preservation. The final report will recommend any mitigative actions required after this coordination.

Social. The removal, relocation, modification of structures will be required for implementing any of the three proposed alternatives. The Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970 (PL 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 replacemnt 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.

d. Plan Implementation.

Construction. The Corps of Engineers will coordinate, design, prepare the plans and specifications and construct by contract the structural features of the alternative. The Corps constructs Federal civil works improvements by contracting with private construction firms through competitive bidding procedures.

Operation and Maintenance. The County of Hawaii will operate and maintain all features of the completed project. The Corps of Engineers will prepare an operations and maintenance (O&M) manual which will detail the O&M requirements and safe operations of the project. The County of Hawaii must also enforce all floodplain regulations and assurances associated with the project.

Real Estate requirements. No construction contract will be awarded until a valid right of possession has been obtained for the entire project area. This includes fee title or permanent easements and adequate access for channel rectification, walls, permanent structures and permit or temporary easement for work and borrow areas required during construction. The County of Hawaii is responsible for obtaining these requirements.

Local assurances. The County of Hawaii must execute a formal cooperation agreement prior to the initiation of the plans and specifications stage in accordance with section 221 of the River and Harbor Act of 1970.

Compliance Documents and Certificates. All necessary Federal certificates for consistency and conformance to environmental (water quality, discharge, etc.) and land-use regulations that must be completed prior to any construction will be obtained by the Corps of Engineers. All local and State certificates must be obtained by the County of Hawaii.

Federal Funding. Allocation of the Federal share of project costs in accordance with the current Federal cost-sharing policy enumerated by the President of the United States or Congress. Federal funding is based on this approval, authorization and appropriation by Congress and the allocation of funds by the Office of Management and the Budget (OMB).

7. SUMMARY DESCRIPTION OF DETAILED PLANS.

Table 11 presents a summary description of the three alternative plans previously described. The next step is to assess these specific alternatives to evaluate which alternative best meets the planning objectives, national and local objectives and the community desires. P&S provides guidelines on how these evaluations are to be made, detailing uniform methods of measurement.

TABLE 11. SUMMARY PLAN DESCRIPTION OF ALTERNATIVES

ALTERNATIVE	STANDARD PROJECT FLOOD (SPF)	100-YEAR (1% FREQUENCY EVENT)
1. Modifying the existing channel.		
Reach 1: Kilauea Avenue to Hilo Bay	-Incorporates no structural actions except flood proofing 3 structures along Kamehameha Ave. Plan also provides for flood hazard warning signs along the Bay Front to indicate when hazardous driving conditions exist.	-Incorporates no structural actions except flood-proofing 3 structures along Kamehameha Ave. Plan also provides for flood hazard warning signs along the Bay Front to indicate when hazardous driving conditions exist.
Reach 2: Kapiolani Street to Kilauea Avenue	-Modifies by realigning and enlarging existing channel for 1,640 ft by 40 and 35 ft. Requires removing 6 residential and 1 public structure. Old channel to be filled and landscaped as a walking mall. A 250-ft concrete wall and energy dissipators will be provided downstream of Kilauea Ave to prevent channel erosion from high velocity flows.	-Modifies by realigning and enlarging existing channel for 1,640 ft by 25 ft. Requires removing 6 residential and 1 public structure. Old channel alignment to be filled and landscaped as a walking mall. A 250-ft concrete wall and energy dissipators will be provided downstream of Kilauea Ave to prevent channel erosion from high velocity flows.
Reach 3: Komohana Street to Kapiolani Street	-Incorporates flood proofing 9 structures.	-Incorporates flood proofing 5 structures.
Reach 4: Chong's Bridge to Komohana Street	-Incorporates floodplain management by providing a minimum 200-ft flood easement along stream.	-Incorporates floodplain management by providing a minimum 200-ft flood easement along stream.
2. Diversion Channel into the Wailuku River	-Incorporates a 4,200-ft diversion channel from 500 ft above Komohana St extending into the Wailuku River. The channel will vary from a 25-ft wide, 1,850-ft long trapezoidal channel to a (with a 100-ft transition channel) 35-ft wide, 2,250-ft long rectangular channel. The last 650 ft of channel will be covered. The outlet at the Wailuku River will consist of a drop structure and stilling basin. Two new bridges will also be needed at Komohana & Punahele Streets. -Area between Chong's Bridge to Konohana St will incorporate a 200-ft floodplain easement similar to alternative 1 for reach 4.	-Incorporates a 4,200-ft diversion channel from 500 ft above Komohana St extending into the Wailuku River. The channel will vary from a 15-ft wide, 1,850-ft long trapezoidal channel to a (with a 100-ft transition channel) 25-ft wide, 2,250-ft long rectangular channel. The last 650 ft of channel will be covered. The outlet at the Wailuku River will consist of a drop structure and stilling basin. Two new bridges will also be needed at Komohana and Punahele Streets. -Area between Chong's Bridge to Komohana St will incorporate a 200-ft floodplain easement similar to alternative 1 for reach 4.
3. Flood proofing, relocations, and flood plain management	-The plan incorporates the following: (No. of Structures) temporary/perm closures 18 relocation of damageable property 14 raising the structure 41 providing a ring wall 5 removal/major alterations 53 -Area between Chong's Bridge to Komohana St to incorporate a 200-ft flood easement flood plain management.	-The plan incorporates the following: (No. of Structures) temporary/perm closures 19 relocation of damageable property 14 raising the structure 25 providing a ring wall 5 removal/major alterations 31 -Area between Chong's Bridge to Komohana St to incorporate a 200-ft flood easement flood plain management.

V. ASSESSMENT AND EVALUATION OF ALTERNATIVE PLANS

1. ESTIMATED BENEFITS AND COSTS

a. Benefit Analysis

Benefits accruing from each alternative were derived by estimating damages prevented from flooding to structures and contents and a reduction in emergency relief costs and damages to public property and utilities. Economic evaluations were conducted in accordance with procedures and standards prescribed by the Water Resources Council and the Corps of Engineers' policy. Detailed analyses are provided in Appendix E. Also included in this appendix are evaluations regarding optimization, risk and sensitivity.

b. Costs

Estimated project first costs were developed from September 1982 price levels and assumptions based on the prevailing physical conditions and construction methods suitable to the project area. The determination of the average annual cost for the purposes of the benefit to cost comparisons includes interest (7-5/8%) and amortization (100-years) of the project first costs and the estimated annual maintenance costs associated with maintaining the project features, repairing structural elements and administering an operations and maintenance (O&M) program. Detailed cost breakdowns and estimating assumptions are provided in Appendix C.

c. Benefit to Cost Comparison

Table 12 presents a summary of the estimated costs and benefits associated with each plan. The benefit to cost comparisons or ratios (B/C) are the arithmetic proportions of the average annual benefits to average annual costs insofar as these factors can be expressed in monetary terms. The comparisons represent the degree of tangible economic justification for each alternative plan.

TABLE 12. Benefits and Cost Summary ($1,000)
(September 1982 price levels)

	Alternative Plans					
	1		2		3	
Item	100-yr	SPF	100-Yr	SPF	100-Yr	SPF
Total estimated Project First Cost1/	6,675	7,983	12,184	15,678	13,102	17,935
Est. average annual Cost2/	539	642	989	1,271	1,082	1,463
Est. average annual benefit	1,438	1,471	1,456	1,458	518	786
Est. Benefit to Cost Ratio (B/C)	2.7	2.3	1.5	1.15	0.48	0.54

1/ Project First Cost includes cost of construction, real estate, supervision and administration costs.

2/ Average annual cost based on interest rate of 7-5/8% amortized over 100-years and includes annual operations and maintenance costs.

2. COST APPORTIONMENT

Flood damage reduction works must conform to regulations on cost sharing between Federal and non-Federal interests. These requirements apply to project costs which include construction first costs, acquisition of lands, easements and rights-of-way, relocations including utilities and bridges, and engineering and administrative costs. The Federal government, under Corps of Engineers civil works traditional cost sharing, will fund all work (as limited by statutory requirements) except for acquisition of lands, easements and rights-of-way, relocations, drainage structures and associated administrative costs which will be funded by the non-Federal sponsoring agency. The traditional Federal policy on cost sharing for flood damage reduction projects is that the Federal government will bear the project costs for construction and design and the non-Federal sponsor will bear the project costs for lands, easements and relocations. Table 13 summarizes the cost sharing requirements under current guidelines.

TABLE 13. Cost Apportionment (Traditional)
($1,000)

	Alternative Plans					
	1		2		3	
Item	100-yr	SPF	100-Yr	SPF	100-Yr	SPF
Total Project First Cost	6,675	7,983	12,184	15,678	13,102	17,935
Corps of Engineer First Cost Share	4,579	5,506	11,293	14,692	10,481	14,348
Non-Federal First Cost Share	2,096	2,477	891	986	2,620	3,587

3. RISK AND UNCERTAINTY EVALUATION

Many of the technical analysis and economic evaluation factors such as the expectant flooding frequencies and heights and flood damage estimates can be described in a probability distribution by common statistical methods. The level of confidence in expected damages was increased by collecting extensive field data and inventories. A field survey of damageable property was conducted in January and February 1981. Technical analaysis assumptions were made with considerable consultation with other governmental agencies such as the US Geological Survey, Soil Conservation Service and the Hawaii County Department of Public Works. Safety factors in analysis and design were incorporated where appropriate.

1/ Risks are defined as those factors for which the potential outcome can be described in reasonably well known probability distribution such as the probability of particular flood events.

Uncertainty is defined as those factors for which potential outcome cannot be described in objectively known probability distribution. (P&S §711.21)

The concept of risk is applicable in describing the potential hazards where a flood event can exceed the level of protection being provided. This is important in understanding the level of protection associated with each proposed alternative. For example, although a project designed for a 100-year flood event may provide protection for a flood which has a one percent chance in any year during a 100 year period there is a 63(%) percent chance that this level of flood protection will be exceeded one or more times in the 100 year period. Similarly, during a 30 year period, a 100 year flood event level of protection has a 26(%) percent chance that it will be exceeded within the 30 years. For the Alenaio Stream the SPF is approximately equivalent to the 500 year (.2% exceedance frequency). The relationship of the period of time and the chance an event will be exceeded is shown in the following tabulation:

Period of Time (In Years)	Chance of One or More Overtopping Events (in %) for selected Exceedance Frequencies 1/			
	50-yr 2%	100-yr 1%	200-yr 0.5%	500-yr 0.2%
30	45	26	14	6
50	64	39	22	10
70	76	51	30	13
100	87	63	39	18

1/ U.S. Water Resources Council, Guidelines for Determining Flood Flow Frequency, Bulletin 17A, June 1977.

Of course the impacts of these exceedance frequencies is dependent on the physical occurrence of these flood events estimated by the assumed technical analysis parameters. The impacts of exceeding the design level can also be described in terms of 'residual' damages. This is the average annual damages expected with the project based on the exceedance frequencies. If residual damages are catastrophic, causing loss of life and/or crippling vital services in an area, a higher level of protection may be necessary regardless of economic efficiency. The estimated residual damages for each alternatives is shown in the following tabulation:

AVERAGE ANNUAL RESIDUAL DAMAGES
($) (1,000)

Level of Protection	Alternative Plans 1	2	3
100 Yr (1% exceedance)	45	28	531
SPF	11	26	199

The concept of uncertainty as defined in the study (and P&S) can be associated with the lava tubes. As indicated earlier the potential occurrence, impacts and evaluation of lava tubes cannot be described in a known probability distribution. Their impacts were hypothesized from various studies conducted by the USGS and by evaluating projects implemented by the SCS in the upper reaches of the watershed.

4. SUMMARY COMPARISION OF ALTERNATIVE PLANS

The evaluation of the economic, social and environmental effects of each alternative plan is displayed in Table 14 (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. The environmental evaluation is provided as part of the Environmental Impact Statement.

5. TRADE-OFF ANALYSIS

Trade-off possibilities between economic efficiency (NED account) and environmental quality (EQ and OSE accounts) are not apparent because none of the plans enhance or significantly degrade environmental quality. There were no appreciable differences between individual plans or levels of protection within each plan and environmental quality.

Trade-off possibilities between project costs and expected benefits are based on the premise of trying to maximize the returns on investments or providing the maximum reduction of damages in proportion to the investment required. Three factors become important:

a. maximization of net benefits

b. benefit to cost ratio

c. residual damages.

It is apparent that a plan that maximizes net benefits may not always have the best benefit-to-cost ratio and vice versa. Other factors may need to be incorporated such as the impacts of residual damages, catastrophic flooding and professional judgment to determine the best overall plan. Table 15 summarizes the evaluation for the three alternatives for the 100-year and SPF levels of protection.

TABLE 15. Summary of Economic Analysis ($1,000)

	1		2		3	
	100-Yr	SPF 1/	100-Yr	SPF	100-Yr	SPF
Avg annual benefit	1,438	1,471	1,456	1,458	518	786
Avg annual cost	539	642	989	1,271	1,082	1,463
Avg annual residual damage	45	11	28	26	531	199
Net benefit	899	829	467	187	-564	-677
Benefit-to-cost ratio	2.7	2.3	1.5	1.15	0.48	0.54

1/ The SPF is approximately equivalent to the 500-year frequency flood for this watershed area.

TABLE 14. SUMMARY COMPARISON OF ALTERNATIVES PLANS AND SYSTEM OF ACCOUNTS

DESCRIPTION	'WITHOUT' CONDITION	BASE CONDITION (Most Probable Alternative Future) (1985-1990)	ALTERNATIVE 1 Modifying the Existing Channel - (SPF and 100-Yr Level of Protection)	ALTERNATIVE 2 Diversion Channel Into the Wailuku River (SPF & 100-Yr Level of Protection)	ALTERNATIVE 3 Floodproofing, Relocation, and Floodplain Management (SPF & 100-Yr Level of Prot.)
A. DESCRIPTION OF PROPOSED PLAN FEATURES	No action.	No action.	Reach 4: Floodplain management. Reach 3: Floodproofing. Reach 2: Modify 1,640 ft of channel. Reach 1: No structural action/floodproofing.	4,200' diversion channel into Wailuku River from Komohana Street.	Floodproof individual structures, relocate non-flood proofable structures and incorporate flood plain management.
B. SIGNIFICANT IMPACTS					
1. Economic (NED Acct)					
a. Goods & Services Urban Flood Damage Reduction	Existing structures will continue to flood; future damages expected to be relatively constant due to land use restrictions imposed by County of Hawaii's participation in the Federal Flood Insurance Program.	Same as 'Without' Condition.	Reduces average annual damages by: ($1000) $ 1,438 100-Year $ 1,471 SPF	Reduces average annual damages by: ($1000) $ 1,456 100-Year $ 1,458 SPF	Reduces average annual damages by: ($1000) $ 518 100-Year $ 786 SPF
Other: Public Facility & Services	Public facilities within floodplain will continue to flood when channel capacity is exceeded. Public services will be required for clean-up after flood.	Same as 'Without' Condition.	Portion of Fire Dept Bldg (Admin Sec) would need to be relocated. Bay Front Hwy will continue to be inundated by floods exceeding 10-year event.	No anticipated effects.	Bay Front Highway will continue to be inundated by floods exceeding 10-year event. Regional flooding of secondary roads, yards, & community will occur.
Land Use	County of Hawaii's participation in the Federal Insurance Program will incorporate land use/construction regulations regarding development in the 100-yr flood limit.	Same as 'Without' Condition.	Incorporates flood control/flood management policy for Reaches 1 & 4.	Requires 9-10 acres of agricultural/residential lands to be dedicated for flood control easements and for the diversion channel.	Incorporates floodplain management policy.
Commitment of Economic Resources	Manpower & public economic resources will need to be committed for post flood clean-up operations.	Same as 'Without' Condition.	Commitment of 5,820 cy (4,780 100-yr) of concrete and related manpower and energy resources.	Commitment of 19,130 cy (12,840 100-yr) of concrete and related manpower and energy resources.	Commitment of building material to modify and/or related manpower and energy resources.

Table 14. (Continued)

DESCRIPTION	'WITHOUT' CONDITION	BASE CONDITION	ALTERNATIVE 1		ALTERNATIVE 2		ALTERNATIVE 3	
b. External Economics	Re-vitalization of historic downtown Hilo will be diminished as community will continue to suffer from flood damages. Economic efficiencies of commercial businesses in downtown Hilo will be decreased due to recurring floods.	Same as 'Without' Condition.	Increase economic efficiency of commercial businesses by reducing recurring flooding and post flood clean-up.		Same as Alternative 1.		Same as Alternative 1.	
c. Use of the Unemployed of Underutilized Harbor Resources	No effects anticipated.	Same as 'Without' Condition.	No effects anticipated.		No effects anticipated.		No effects anticipated.	
d. National Economic Development			SPF	100-Yr	SPF	100-Yr	SPF	100-Yr
Average Annual Benefits	-	-	1,471	1,438	1,458	1,456	786	518
Average Annual Cost	-	-	642	539	1,271	989	1,463	1,082
Net Average Annual Benefits	-	-	829	899	187	467	-677	-564
Benefit to Cost Ratio	-	-	2.3	2.7	1.15	1.5	0.48	0.54
2. Environmental (EQ Account) (711-62)								
a. Significant EQ Resources & Attributes								
Ecological: Terrestrial Marine Water Quality Fish & Wildlife	Project area largely disturbed by agricultural and urban usage. Exotic trees & shrubs dominate riparian stream vegetation. Stream is ephemeral and usually dry. Pools of standing water support a limited aquatic fauna when stream is not flowing. Waiolama Canal is under tidal influence and supports an estuarine aquatic community.	Same as 'Without' condition.	Loss of 920 ft of natural streambed by concrete channel.		Approx 9-10 acres of agricultural land converted to flood control channel. No change from base condition in marine environment, water quality, or fish and wildlife resources.		No change from base condition.	

Table 14. (Continued)

DESCRIPTION	'WITHOUT' CONDITION	BASE CONDITION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Cultural					
Historic/ Archaeo- logical	No known significant sites. Possible subsurface features along Alt 1.	Same as 'Without' Condition.	No known beneficial effects.	Same as Plan 1.	Same as Plan 1.
Recreation	Because the stream is usually dry & devoid of game or tablefish, recreational usage and value low.	Same as 'Without' Condition.	No change from existing condition.	No change from base condition.	No change from base condition.
Aesthetic					
Noise	Noise levels are typical of a small rural urban/suburban community including aircraft noise from a nearby airport facility.	Same as 'Without' Condition.	Temporary increase in noise levels during construction of new channel segment.	Same as Plan 1.	Same as Plan 1.
Visual	One part of Hilo town w/in the project area has the appearance of a typical older rural town. The upper reaches include open areas, agricultural land and forested areas.	Same as 'Without' Condition.	Provides scenic mall over old stream.	No effects.	More open area along stream channel where buildings have been removed.
b. Significant Adverse Effects 1/	Not applicable.	Not applicable.	No significant adverse effects anticipated.	No significant adverse effects anticipated.	No significant adverse effects anticipated.
Ecological					
Terrestrial	Not applicable.	Not applicable.	No effect.	No effect.	No effect.
Marine	Not applicable.	Not applicable.	No effect.	No effect.	No effect.
Water Quality	Not applicable.	Not applicable.	No effect.	No effect.	No effect.
Fish & Wildlife	Not applicable.	Not applicable.	No effect.	No effect.	No effect.
Cultural					
Historical/ Archaeological	Not applicable.	Not applicable.	Possible effects on subsurface urban features in Reach 3 (1, 5, 9).	Possible effects on subsurface remnant historic irrigation flumes (1, 4, 9).	No effect.
Recreation	Not applicable.	Not applicable.	No effect.	No effect.	No effect.

Table 14. (Continued)

DESCRIPTION	'WITHOUT' CONDITION	BASE CONDITION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Aesthetic					
Noise	Not applicable.	Not applicable.	Temporary noise during construction (1, 6, 9).	No significant adverse effects.	No effect.
Visual	Not applicable.	Not applicable.	Visual intrusion of new 1,640' concrete channel (1, 5, 9).	4,200' diversion channel would create new visual elements in an area that is predominantly open, fallow agricultural land.	No effect.
c. Sec 122 (PL 91-611)					
* Air, Noise, and Water Pollution	Not applicable.	Not applicable.	No significant long-term adverse effects.	Same as Plan 1.	Same as plan 1.
* Destruction or Disruption of Man-Made and Natural Resources	Not applicable.	Not applicable.	1,640' of riprap channel would be filled in. Four bridges would be replaced. Six residential structures and 1 govt building would be destroyed.	Approx 9-10 acres of fallow agricultural land would be converted to use as a diversion channel. 2-4 residential buildings would be relocated.	30 to 53 commercial and residential structures would be removed or replaced. Raising of the 1st floor elevation would be required for 23 to 41 structures.
* Adverse Employment Effects & Tax & Property Value Losses	Not applicable.	Not applicable.	No significant long-term adverse effects.	Same as Plan 1.	Same as Plan 1.
* Injurious Displacement of People, Businesses & Farms	Not applicable.	Not applicable.	Possible, unknown significant effects. Displaced people would be relocated and fully compensated. (1,5,9).	Same as Plan 1.	No long-term relocations.
* Disruption of Desirable Community & Regional Growth	Not applicable.	Not applicable.	No significant adverse effects. Temporary traffic disruptions (1, 4, 9).	Same as Plan 1.	No adverse effects.
3. <u>Regional Economic Development</u> (RED Account) (711.63)					
a. Regional Income	-	-	REGIONAL ECONOMIC ANALYSIS NOT SEPARABLE.		
b. Regional Employment	-	-	REGIONAL ECONOMIC ANALYSIS NOT SEPARABLE.		

Table 14. (Continued)

DESCRIPTION	'WITHOUT' CONDITION	BASE CONDITION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
4. Other Social Effects (OSE Account) (711.64)					
a. Urban & Community Impacts	No significant impacts.	Same as 'Without' Condition.	No substantial change from base levels or trends expected.	Same as Plan 1.	Same as Plan 1.
b. Life, Health & Safety	Recurring flood hazards will jeopardize life, health, and safety of residents.	Same as 'Without' Condition.	Life, health, & safety of people & property will be enhanced (3,4,8,9).	Same as Plan 1.	Same as Plan 1.
c. Displacement	None.	None.	Families and merchants from structures will be displaced. Relocation compensation will be provided but the foreknowledge of possible displacements may induce short-term (5-yr) anxiety & indecision.	Same as Plan 1. Temporary displacement from from residences to be flood-proofed.	Same as Plan 1. Temporary displacement of individuals from structures to be flood-proofed.
d. Long-Term Productivity	Undesignated USDA agricultural land - adjacent to uncultivated prime agricultural lands.	Private owners of agricultural lands request to change land-use zone to residential.	Minimal effect on agricultural lands or future residential development.	Minimal significant impact on former sugar cane lands or future residential development.	Minimal effect.
e. Energy Requirements and Energy Conservation	No effects.	No effects.	No impacts on energy conservation.	Same as Plan 1.	Same as Plan 1.
C. PLAN EVALUATION					
1. Contributions to the Planning Objectives (711.30)					
a. Contribute to the Reduction of Property Damage by Floodwaters from Alenaio Stream from Chong's Bridge to Hilo Bay during 1985-2085.			($1000) Alternative plan reduces average annual damages by: $ 1,438 100-Year $ 1,471 SPF	($1000) Alternative plan reduces average annual damages by: $ 1,456 100-Year $ 1,458 SPF	($1000) Alternative plan reduces average annual damages by: $ 518 100-Year $ 786 SPF
b. Contribute to the Efficient Use of the Lands Consistent with the Local Land-Use and Development Plans & Floodplain Mgmt Policy During 1985-2085.			ALL PLANS IMPLEMENT FLOOD PLAIN MANAGEMENT COMPATIBLE WITH COUNTY'S PARTICIPATION WITH THE FEDERAL FLOOD INSURANCE PROGRAM AND LATEST HILO DEVELOPMENT PLANS.		

Table 14. (Continued)

DESCRIPTION	'WITHOUT' CONDITION	BASE CONDITION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
c. Contribute to the Understanding of the Complex Lava Tube System & Spring Characteristics and Effects to Minimize Its Impacts on Flood Damages	Not Applicable.	Not Applicable.	INITIAL STUDIES AND REPORT BY USGS WILL HELP TO ESTABLISH BASIC UNDERSTINDING OF PHENOMENA AND ITS POTENTIAL IMPACTS ON FUTURE WATER RESOURCE PLANNING STUDIES IN HILO.		
2. RESPONSE TO CONSIDERATION OF FOUR EVALUATION TEST 711.51 (c)					
a. Completeness	-	-	Complete as described except for periodic maintenance.	Complete as described except for periodic maintenance.	Complete as described except for residual flooding of roads, utilities and yards.
b. Effectiveness	-	-	Effective.	Effective.	Effective.
c. Efficiency	-	-	Highly efficient.	Efficient	Not efficient.
d. Acceptability	-	-	Support of a specific plan was divided among the public and governmental agencies. The County of Hawaii supports alternative 1.		
3. SELECTION OF CANDIDATE PLANS FOR THE NED, EQ, NONSTRUCTURAL PRIMARILY NONSTRUCTURAL PLANS 711.52					
a. Plan Designation	-	-	NED Plan.	-	LED Plan.
b. Ranking of Contribution					
NED			1	2	3
EQ			2	3	1
OSE			2	3	1
Net Benefits			1	2	3
D. IMPLEMENTATION RESPONSIBILITIES					
1. Corps of Engineers	Provide emergency flood control assistance as necessary.	Same as 'Without' Condition.	Provide estimated project first cost share of $5,506,000 (SPF) or $4,579,000 (100-Yr); design & construction of the structural features.	Provide estimated project first cost share of $14,692,000 (SPF) or $11,293,000 (100-Yr); design & construction of the structural features.	Provide estimated project first cost share of $14,348,000 (SPF) or $10,481,000 (100-Yr); design & construction of the structural features.
2. County of Hawaii	Provide emergency flood control assistance and clean-up as necessary.	Same as 'Without' Condition.	Provide estimated project first cost share of $2,477,000 (SPF) or $2,096,000 (100-Yr) and local assurances and cooperation.	Provide estimated project first cost share of $986,000 (SPF) or $891,000 (100-Yr) and local assurances and cooperation.	Provide estimated project first cost share of $3,587,000 (SPF) or $2,620,000 (100-Yr) and local assurances and cooperation.
3. State of Hawaii	Provide financial and emergency assistance during floods.	Same as 'Without' Condition.	Support recommended plan through financial assistance.	Same as Alternative 1.	Same as Alternative 1.

Table 14. (Continued)

INDEX TO FOOTNOTES

1/ (*) Item specifically required by Section 122, Public Law 91-611 and ER 1105-2-30 (App B).

TIMING
1. Impact is expected to occur prior to or during implementation of the plan.
2. Impact is expected within 15 years following plan implementation.
3. Impact is expected in a longer time frame (15 or more years following implementation).

UNCERTAINTY
4. The uncertainty associated with impact is 50% or more.
5. The uncertainty is between 10% and 50%.
6. The uncertainty is less than 10%.

EXCLUSIVITY
7. Overlapping entry: Fully monetized in NED Account.
8. Overlapping entry: Not fully monetized in NED Account.

ACTUALITY
9. Impact will occur with implementation.
10. Impact will occur only when specific additional actions are carried out during implementation.
11. Impact will not occur because necessary additional actions are lacking.

6. DESIGNATION OF NED AND EQ PLANS

Alternative Plan 1 maximizes economic efficiency based on its least cost and greatest benefit to cost comparison. Consequently, Alternative Plan 1 is designated as the National Economic Development (NED) Plan.

None of the plans make net positive contributions to the environmental, social or cultural resources in the study areas. Alternative Plan 3 is considered to be the least environmentally damaging plan because it involves the least modification, shortest construction time and minimizes adverse impacts upon existing ecological habitats and the overall ecological systems in Hilo. A major social impact involves the removal of 7 structures along the new alignments of Alternative Plan 1 The reaction of the community at the public meeting will help determine the impact assessment of this requirement.

7. CANDIDATE PLAN FOR THE RECOMMENDED PLAN

It is recommended that Alternative Plan 1 be implemented based upon its economic efficiency and minimal environmental damaging effects. The combined beneficial NED and EQ effects of this Alternative Plan 1 outweigh the combined adverse NED and EQ effects of the other two plans.

8. CONDITIONS OF LOCAL COOPERATION

In addition to the costs indicated, the local sponsoring agency must agree to certain conditions prior to initiation of construction. At preconstruction stages, letters of intent to comply with the conditions will be required for reporting and authorization procedures. These conditions for flood damage reduction projects are as follows:

(1) Provide, without cost to the United States, all lands, easements and rights-of-way necessary for the construction of the project; including spoil disposal and borrow and access thereto required for construction and maintenance.

(2) Hold and save the United States free from damages due to the construction, operation, and maintenance of the project except where such damages are due to the fault or negligence of the United States or its contractors.

(3) Maintain and operate the project, or integral parts thereof, in accordance with regulations prescribed by the Secretary of the Army.

(4) Accomplish without cost to the United States all alterations and relocations of buildings, streets, storm drains, utilities, highway bridges, and other structures made necessary by the construction. Provide the non-Federal share, in kind or cash, of the total project first costs.

(5) Prescribe and enforce the floodplain management regulations for the floodplain.

(6) Maintain eligibility under the National Flood Insurance Program.

(7) Comply with the provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (PL 91-646).

(8) Comply with Title VI of the Civil Rights Act of 1964 (PL 88-352).

9. COMPLIANCE AND COORDINATION REQUIREMENTS

a. A public meeting was held on 12 May 1982 at the County Council Room in Hilo. Public notices were distributed to the general public and media as well as to Federal, State and County. The draft report was made available to the public for review prior to the meeting at the Hilo public library, County Department of Public Works and the Corps office. The meeting gave the public the opportunity to express their views concerning the proposed alternatives as well as on the effects of "discharge of fill material in the navigable waters of the US" and the "development of Federal activities within the base floodplain" under Section 404 of the Clean Water Act of 1977 and Executive Order 11988 (Floodplain Management, dated 24 May 1977), respectively. Additional evaluation reports required by these acts were provided in the draft report. A transcript of the public meeting is provided in Appendix B.

b. The Draft Environmental Impact Statement (DEIS) was filed with the US Environmental Protection Agency (EPA). The EPA classified the DEIS as LO-1 indicating lack of objections.

c. In accordance with the Fish and Wildlife Coordination Act of 1946 as amended, the US Fish and Wildlife Service provided a Final Coordination Act Report dated 18 June 1982. A copy of this report is provided in Appendix G.

d. The State Historic Preservation Officer (SHPO), the Interagency Archaeological Service, the Council on Historic Preservation were afforded the opportunity to review the adequacy of our cultural resources studies and findings under the National Historic Preservation Act of 1966. No adverse comments on the cultural resources studies and findings were received by SHPO.

e. The State Department of Health was requested to evaluate the effects of the discharge of dredged or fill material into the stream to determine its impacts on water quality and health in accordance with the Clean Water Act. The State Department of Health had no objections at this time to the project proposals as indicated in their letter of 25 May 1982.

f. The State Coastal Zone Management (CZM) program coordinator was requested to review the draft for consistency with their CZM program under the CZM Act of 1972 (PL 92-583). The State Department of Planning and Economic Development by letter dated 27 May 1982 (ref No. 5877) indicated that "...we concur with your recommendation for alternative 1 and find that the activity is consistent with the relevant provisions of our management program (Coastal Zone Management)."

10. PUBLIC INPUT

Appendix B summarizes all the comments received from the Draft Survey Report and Environmental Impact Statements. Actual letters received and written testimony presented at the public meeting are also documented in this appendix. Governmental agencies and individuals who provided comments are shown in Table 16.

TABLE 16. SUMMARY OF THOSE COMMENTS RECEIVED ON THE DRAFT REPORT AND ENVIRONMENTAL IMPACT STATEMENT

Agency/Organization/Individual	Comment (Documented in Appendix B) No	Yes	Remarks
FEDERAL			
US Department of Agriculture			
Soil Conservation Service	X		
US Department of Commerce			
National Oceanic and Atmospheric Administration			
National Marine Fisheries Service (SW Region)		X	
US Environmental Protection Agency			LO-1
US Department of Housing and Urban Development	X		
US Department of the Interior			
Fish and Wildlife Service		X	Response provided.
Geological Survey - Hawaiian Volcano Observatory		X	
Water Resources Division		X	
Office of the Secretary, Pacific SW Region		X	Response provided.
STATE			
Department of Agriculture	X		
Department of Defense			
Civil Defense	X		
Department of Health		X	Public health regulation compliance.
Department of Land and Natural Resources		X	
State Historic Preservation Officer	X		SHPO compliance.
Department of Planning & Economic Development			
Department of Transportation, Hawaii Division		X	Response provided
Office of Environmental Quality Control		X	CZM compliance.
University of Hawaii at Manoa			
Environmental Center		X	Response provided.
Water Resources Research Center	X		
COUNTY			
Department of Water Supply	X		
Planning Department	X		
Office of the Mayor			Letter of Assurance.
PRIVATE INTERESTS			
Mr. Edward Fujimoto			Written testimony at Public Meeting.
Mr. J.W. Hanley, Cutler-Hanley JV			Response provided.
Mr. Gary Neko			Written testimony at Public Meeting.
Food Fair Super Markets			Written testimony at Public Meeting.
Mr. J. Walter Silver			Response provided.
Mr. and Mrs. Thomas Yamashiro			Response provided.
COMMUNITY GROUPS			
Residents along Waianuenue Avenue, Hale Street and the vicinity of the proposed diversion channel			Written testimony at Public Meeting.
Residents of Luana Way			Written testimony at Public Meeting.

VI. THE SELECTED PLAN

1. RATIONALE FOR SELECTION

Alternative Plan 1 was considered the best overall plan based on the NED and EQ objectives. Plan 1 has the greatest net benefits and benefit to cost comparison of any of the other two alternatives. In addition, the combined NED and EQ attributes exceeded the combined NED and EQ attributes of the other two alternative plans.

Certain minor modifications were made to Alternative Plan 1 based on comments received during the review of the draft survey report. The alignment of the new proposed channel at the intersection of Kilauea Avenue and Alenaio Stream was slightly modified as an option to result in relocating the structure on TMK 2-2-08-046 rather than portions of the service station on TMK 2-2-008-023. Comments from the owner of the service station indicated that the proposed alignment would eliminate his underground gas storage tanks and their access to Kilauea Avenue constituting a major and irreplaceable loss to his business. Since the condition of the other structure is believed to be unsound and appears to be unsafe it may be more cost effective to replace that building instead. As a result, another alignment was made which was hydraulically comparable as a viable option to the county. Since the County of Hawaii is responsible for acquiring the necessary lands and easements for construction, they may decide to choose this optional alignment based on greater economic benefits pending a response from the owner of TMK 2-2-008-046. This option can be resolved during Advance Engineering and Design where other mitigative design features may be identified which may satisfy both owners.

The community at Luana Way indicated that their community suffers from flooding and should be included in the proposed project. After closer examination, it was observed that our original contention where much of their flood problem dealt with interior drainage and sheet flow from Ainako Avenue (see Figure 14) and, consequently, was under the purview of the local government. A small drainage ditch was built as part of the subdivision development paralleling Alenaio Stream and intercepting Alenaio Stream approximately 2,500 feet upstream from Luana Way. It appears that this drainage ditch adversely diverts floodflows from the main Alenaio channel. This diverted floodflow exceeds the capacity of the drainage ditch causing flooding to the adjacent property. It is the Corps' contention that this man-made drainage ditch is not part of Alenaio Stream. The major stream channel is approximately 100 to 200 feet beyond this ditch. However, in order to alleviate the flood problem due to the overbanking of this ditch, a diversion weir to divert the floodflows back into the main stream is proposed to be incorporated as a feature in Reach 4. Its cost is minimal.

The SPF-level of protection was selected in lieu of the 100-year level even though the SPF protection is not incrementally justified on an economic basis. Factors overriding the lack of incremental economic justification are related to the potential for a catastrophe due to floods exceeding the 100-year level of protection. These factors include very high velocity overflows (45 fps), the urbanized character of the project area, and the flashy nature of peak flows in the area which would result in practically no warning time. The following considerations were considered in the overall evaluation:

a. Overtopping by an SPF occurrence of the 100-year protection channel in Reach 2, the most critical area in the floodplain, would result in 1.9 feet (average) to 4.1 feet (maximum) of overflow water at velocity approximately 42 feet/second along the channel banks. It would take only about 10 hours for the total flood hydrograph to past and only 4 hours for the flood hydrograph to peak.

b. The overtopping below Kinoole Street would affect mostly older, retired (60 to 70 years old) persons in the Kinoole-Ponahawai-Kilauea-Kukuau block. Houses in this area are mostly older wooden structures on posts in the range of 50-75 years of age. These structures are located adjacent to the stream. In the event of an SPF flood, the likelihood of significant structural damages to these homes are great as depicted on the photographs on page 31, 32 and 33. Further, many of the older residents are not mobile and, consequently, the likelihood of injury and possible loss of life to these residents are great. The danger is even greater should the flood event occur at night.

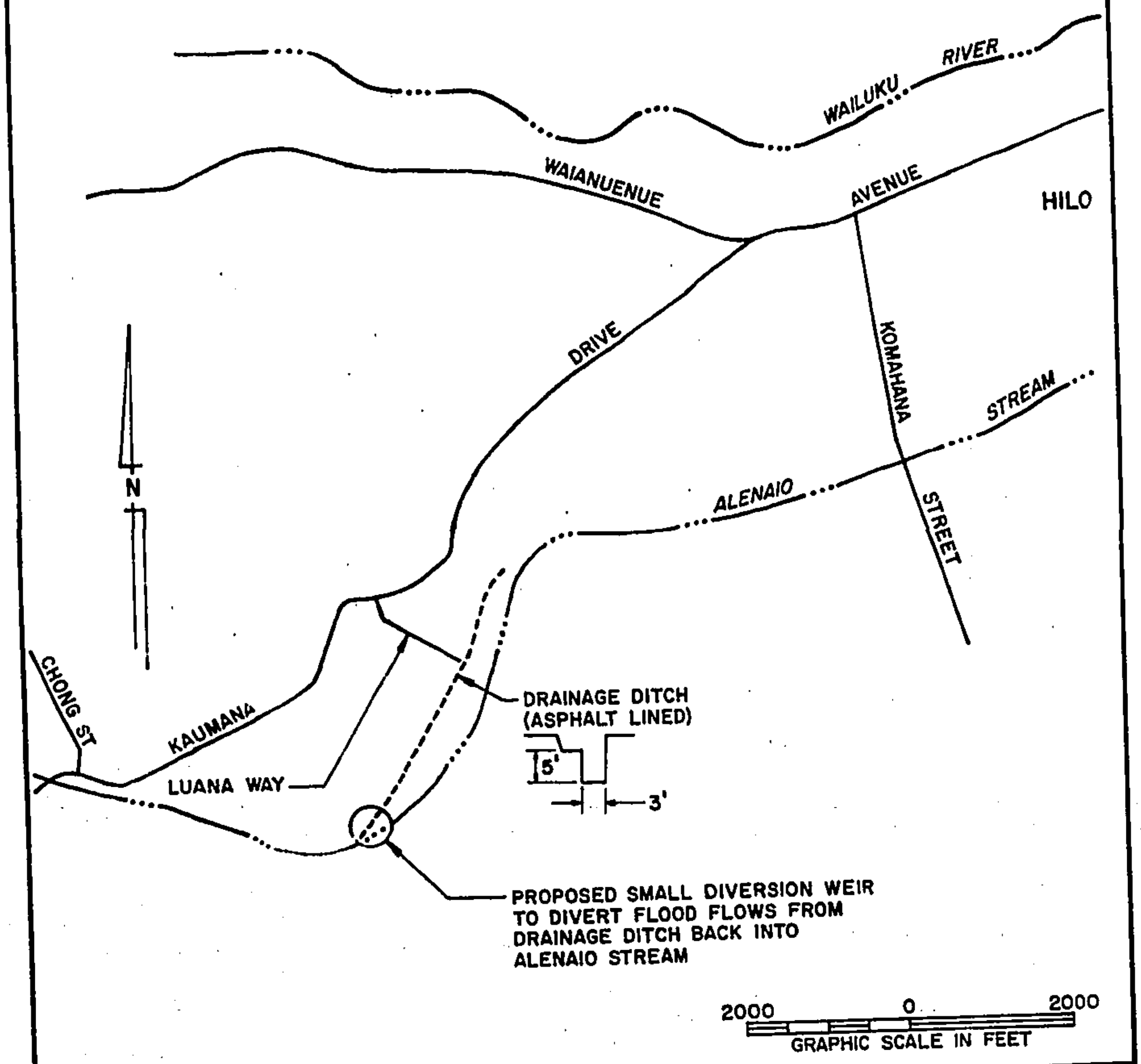
c. The near future (5-15 years) land-use of the area with or without the project will likely be the development of a commercial and/or mix of multi-family-commercial use. New multi-family housing would attract younger couples with young children. Given such a scenario, the effects of overtopping of the 100-year level project would be even higher in residual damages, risks, and personal injury or death.

d. The SPF frequency approximates the 500-year event. The chance of one or more overtopping events in percent for a given time period are as follows:

Period of Time	100-Year (1%)	200-Year (.5%)	500-Year (.2%)
30 (years)	26	14	6
50	39	22	10
70	51	30	13
100	63	39	18

Consequently, the probability of one or more floods exceeding the 100-year (1%) frequency for the life of the project (100 years) is 63%.

Because the potential adverse impacts of a flood exceeding the 100-year protection can cause catastrophic consequences which include the possible loss of life, and that the 100-year level of protection may cause a false sense of security to the residents, the SPF level of protection is strongly recommended regardless of economic optimization below the SPF level of protection.



ALENAIO STREAM HAWAII

PROPOSED
DIVERSION WEIR
IN REACH 4

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 14

The required relocation of six residential structures and their rental occupants would be minimized by the time prospectus of the project. Construction is unlikely to begin until 5 to 10 years. The provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970, which provides equitable treatment of all relocated persons will help to minimize the impacts of being relocated. All efforts to minimize or mitigate any adverse impacts of the proposed project will be made to those affected with the interests of the community on a whole.

2. PLAN DESCRIPTION

a. General Plan.

The proposed plan for Alternative 1 divides the project area into four (4) reaches. Reach 1 between Hilo Bay and Kilauea Avenue incorporates no structural action except floodproofing three gas stations and incorporating flood hazard warning signs along the Bayfront Highway to indicate when hazardous driving conditions exist. The Waiolama Canal and Bayfront area will be subject to flooding up to 2.5 feet for the 100-year frequency flood and 3.5 feet for the SPF flood. The State Department of Transportation is investigating the feasibility to modify the highway along the Bayfront by raising the new road above the 100-year flood surface elevation. This would help to mitigate transportation problems associated with flooding in this area.

Reach 2 between Kilauea Avenue and Kapiolani Street will consist of 1,640 feet of channel modification and realignment. The channel will be realigned to accommodate a better radius of curvature thereby requiring a smaller channel width than would be needed if the original path of the stream was utilized.

The channel will be 40 feet wide at Kapiolani Street for 415 feet transitioning to 35 feet for the remaining 1,225 feet. The channel will be concrete lined to maximize the efficiency (thereby minimizing the size) of the channel and to accommodate the expected velocities of the water to prevent channel erosion. The end of the channel at Kilauea will have a guide wall and energy dissipaters to minimize erosion problems in the Waiolama Canal. The reach between Kapiolani Street and Komohana Street will incorporate floodproofing the nine structures subjected to flooding in an SPF flood area. Preliminary analysis indicates that this will consist of providing a ring wall to two houses, raising two houses above the floodwater elevation and providing temporary/permanent closures to the remaining five houses.

Reach 4 between Komohana Street and Chong's Bridge incorporates floodplain management regulations and a small diversion weir. As previously indicated in detail, this area is geohydrologically complex and subject to extensive flooding. It is proposed to incorporate a minimal 200-foot easement to accommodate possible flowages associated with a 100-year/SPF flood event by an improved channel. This 200-foot easement is not a depiction of the limits of flooding. Future development in this area should incorporate floodproofing measures as an integral design of all proposed structures in this area. Adverse grading and its impacts on the drainage characteristics should be carefully considered by the County prior to approving grading and building permits. The hydrologic design analyses and design parameters utilized for the proposed channel incorporates an assumption that the drainage characteristics will change due to development.

Alternative Plan 2 was not chosen because of its marginal benefit to cost comparison and total costs compared to the benefits to be accrued. Although this plan has a lower non-Federal share based on the traditional cost-sharing policy, this consideration was not the primary concern especially in meeting the overall NED objectives. No other environmental, social or technical, concern was paramount which would override the NED objective.

Alternative Plan 3 was not economically justified as indicated by a benefit to cost comparison of 0.48 (100-year protection). This plan would be the most socially disruptive by requiring extensive relocations in the community.

b. Apportionment of Costs.

General legislation authorizing implementation of water resources projects generally contains local cooperation requirements established by enactment of various laws. This survey report contains information based on the application of these traditional cost-sharing requirements. The current administration is reviewing project cost-sharing and financing across the entire spectrum of water resource development functions. Specific policies applicable for this particular project have not yet been established. The following summarizes the possible cost-sharing and financing arrangements based on the traditional cost-sharing policy subject to being satisfactory to the President and Congress.

		($1000)	
	Total	Federal	Non-Federal
Traditional cost-sharing policy	$7,983	$5,506	$2,477

c. Plans and Specifications.

Construction plans and specifications will be made by the Corps of Engineers after Congress authorizes the project and appropriates funds for Advance Engineering and Design under the Department of the Army Civil Works Programs.

d. Fish and Wildlife Measures.

In the Preliminary Coordination Act Report, the US Fish and Wildlife Service (USFWS) of the Department of the Interior provided certain recommendations to minimize fish and wildlife impacts. The Corps of Engineers response to each recommendation in accordance with the USFWS, region policy adopted 1 October 1981 is as follows:

(1) Natural streambed be maintained in all reaches of the stream affected by realignment and channelization.

Alternative Plan 1 will channelize and realign 1,640 feet of stream of which 720 feet was previously modified by a concrete channel. The 920 feet of natural streambed will need to be channelized by concrete in order to prevent channel erosion and to maximize the efficiency of the channel in order to minimize the required channel width and depth. The natural streambed will be maintained above the proposed channel modification above Kapiolani Avenue. Some floodproofing techniques, which are being proposed to individual homes, may require a short floodwall fronting the house. At this time only one wall is anticipated directly below Komohana Street.

(2) Streamside vegetation be maintained or replanted, as necessary, to provide shading for the stream.

All streamside vegetation affected by construction will be replanted and maintained to the existing condition to the maximum extent practical.

(3) Realigned and channelized sections incorporate a low-flow channel to concentrate flows and take advantage of natural shading.

A low-flow channel does not appear economically justified based on the cost of providing a low-flow channel and the potential benefits to the existing aquatic resources. The stream is ephemeral and the channel will be concrete lined, consequently providing poor environmental enhancement potential where the stream will be modified.

(4) Bridge culverts should be minimal in length and installed in such a way that the downstream terminus will not be above stream level.

All bridge culverts will be minimal to the maximum extent practical. The downstream terminus will not be above stream level.

(5) The channel between Kilauea Avenue and Kinoole Street be restored to a natural (unlined) streambed or incorporate a low-flow channel to concentrate flows.

The channel between Kilauea Avenue and Kinoole Street cannot economically be restored to a natural (unlined) streambed. A concrete channel is proposed to accommodate the design channel velocity and to maximize the channel capacity in order to minimize the channel width and depth thereby minimizing necessary relocation of homes and businesses along the stream.

(6) If practicable, the weir above Kinoole Street be modified to permit a greater volume of low to moderate instream flows to discharge into Waiolama Canal.

The weir above Kinoole Street is proposed to be removed thereby allowing all low to moderate instream flows to discharge into the Waiolama Canal.

(7) Construction methods should minimize streambed and bank disturbance and prevent excessive sedimentation of downstream habitat.

Sedimentation and turbidity controls will be included in the construction plans and specifications to limit the spread of turbid water outside the construction area. As a consequence the contractor will opt for the use of mitigative measures to control sedimentation.

3. PLAN IMPLEMENTATION

a. Construction Schedule.

The initiation of work for the preparation of the construction plans and specifications during the Advance Engineering and Design phase (post-authorized studies) is dependent on the study being approved at various levels of independent review, being specifically authorized by Congress and monies being appropriated for post-authorized studies. Construction would be accomplished by contract to a privately-owned construction firm through competitive bidding under Corps of Engineers supervision. Construction will require approximately 30 months to complete and will be initiated when Congress appropriates construction funds.

b. Operation and Maintenance.

The County of Hawaii will be responsible for operating and maintaining the completed project. An operations manual will be prepared by the Corps of Engineers for the County of Hawaii. Other local responsibilities to make the project complete and effective will be detailed in the local assurance agreement.

c. Local Assurances.

The County of Hawaii must execute a formal local cooperation agreement in accordance with Section 221 of the River and Harbor Act of 1970 prior to the initiation of construction. At present, a letter supporting the selected plan has been received from the County of Hawaii.

d. Compliance Documents and Certificates.

All necessary Federal and local certificates for consistency, appropriateness and conformance to environmental and land-use regulations must be completed prior to any construction. The Corps of Engineers will obtain the necessary Federal documents and the County of Hawaii will be responsible in obtaining the local requirements.

e. Real Estate Requirements, Rights-of-Way and Easements.

The County of Hawaii will be required to obtain all lands, easements and rights-of-way for construction and in implementing floodplain restrictions and regulations.

f. Disposal Site.

An existing landfill area near the airport has been identified as a suitable disposal site by the Department of Public Works. This site is within two miles from the project area and is capable to handle the expected 60,400 cubic yards of excess excavated material. No adverse impacts on environmental or cultural resources are expected. The excess excavated material to be disposed is expected to be free of contaminates with relatively small amounts of silts. The material is expected to be trucked from the project area to the disposal site.

VII. CONCLUSIONS AND RECOMMENDATIONS

Conclusions.

The purpose of this report is to identify the problems, needs and the extent to which the Federal government should participate in flood damage reduction measures in the Alenaio Stream floodplain. Based upon the flooding problem, technical parameters, economic evaluations and the environmental assessment of various alternatives investigated, Alternative Plan 1 best meets the planning objectives and the NED and EQ national objectives. Alternative Plan 1 (SPF protection) provides for a 1,640-foot realigned and modified channel, floodproofing 11 individual structures and incorporates floodplain management regulations to minimize future potential flood damages.

The proposed alternative plan is economically justified as demonstrated by a benefit to cost comparison at 7-5/8% interest of 2.3 and 1.8 for a 10% interest rate. The estimated project first cost is $7,983,000. The County of Hawaii has tentatively agreed to the necessary local cooperation agreements and is aware of the current administration's proposed cost-sharing policies.

Recommendations.

In light of the overall public interest, I have evaluated the pertinent information and the stated views of other government agencies and the concerned public on the various practical alternatives for alleviating the flood problem in the Alenaio Stream drainage basin. The alternatives considered and consequences of each were examined for economic, environmental, and social effects and for engineering feasibility. Other factors considered were the specifically stated desires of local government officials and citizens. Based on my evaluation, I find that no alternative plan considered would fulfill the study objectives and the needs as effectively as Alternative Plan 1. I therefore, recommend that the project plan selected herein for flood damage reduction be authorized for implementation as a Federal project, with such modifications as in the discretion of the Chief of Engineering may be advisable; at a total first cost presently estimated at $7,983,000, and with annual operation, maintenance and replacement costs to non-Federal interests presently estimated at $33,000; provided that, prior to project implementation, local interests provide assurances satisfactorily to the Secretary of the Army that they will:

(1) Provide, without cost to the United States, all lands, easements and rights-of-way necessary for the construction of the project; including spoil disposal and borrow and access thereto required for construction and maintenance.

(2) Hold and save the United States free from damages due to the construction, operation, and maintenance of the project except where such damages are due to the fault or negligence of the United States or its contractors.

(3) Maintain and operate the project, or integral parts thereof, in accordance with regulations prescribed by the Secretary of the Army.

(4) Accomplish, without cost to the United States, all alterations and relocations of buildings, streets, storm drains, utilities, highway bridges, and other structures made necessary by the construction. Provide the non-Federal share, in kind or cash, of the total project first costs.

In summary I, recommend that the project plan for Alternative Plan 1 as presented in this report be authorized and to implement the project subject to the cost-sharing and financing arrangements which are satisfactory to the President and Congress and to the local cooperation requirements.

KENNETH E. SPRAGUE
Lt Col, Corps of Engineers
District Engineer

VIII. LIST OF REFERENCES

1. Baldwin, E.D.; "Notes on the 1880-81 Lava Flow from Mauna Loa," The Volcano Letter, U.S. Geological Survey, published by the University of Hawaii, April-June 1953.

2. Bank of Hawaii, Hawaii 1979 Annual Economic Review, Honolulu, Hawaii, August 1979.

3. Belt, Collins & Associates, Ltd., Hilo Downtown Development Plan, prepared for the County of Hawaii, 1974.

4. Belt, Collins & Associates, Ltd., Hilo Community Development Plan. Prepared for the County of Hawaii, 1975.

5. Berger, Andrew U.; Hawaiian Birdlife; University Press of Hawaii, 1972.

6. Bernice P. Bishop Museum, Archaeological and Historical Literature Search and Research Design, Lava Flow Control Study, Hilo, Hawaii, prepared for U.S. Army Engineer Division, Pacific Ocean, Contract DACW84-77-C-0019, Mod. P00017, May 1979.

7. Brock, E.E.; Handbook of Hawaiian Birds; 1954.

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

9. County of Hawaii, County of Hawaii Data Book 1978, Department of Research and Development, 1979.

10. County of Hawaii, Water Master Plan, Island of Hawaii, Department of Water Supply 1971.

11. Dan and George Yamanaga, Preliminary Report of the Hilo-Puna Area, Hawaii-Circular C45, prepared by the USGS, April 1968.

12. 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.

13. Federal Emergency Management Agency, Preliminary Flood Profiles for Alenaio Stream, Federal Insurance Administration, National Insurance Program, 1979.

14. Federal Emergency Management Agency, Preliminary Flood Insurance Rate Map (FIRM), Alenaio Stream, Federal Insurance Administration, National Insurance Program, 1979.

15. Federal Emergency Management Agency, Preliminary Flood Boundary and Flooding Map, Alenaio Stream, Federal Insurance Administration, National Insurance Program, 1979.

16. First Hawaiian Bank, Economic Indicators, Honolulu, Hawaii, September 1979.

17. George S. Walters, Landscape Architects, Environments and Urban Design Proposals, East Hawaii Project/City of Hilo; prepared for the Hawaii State Foundation on Culture and the Arts, 24 April 1969.

18. Haraguchi, Paul, Post Flood Report, Storm of November 16-18 1979, Island of Hawaii, Circular C82, Consulting Meteorologist, Pacific Weather Inc., prepared for the State of Hawaii, Dept of Land and Natural Resources, April 1980.

19. Jackson, Dallas, Memorandum, Subject: Detection of Empty Lava Tubes with Induction and Plane Wave Geophysical Techniques, prepared for U.S. Army Corps of Engineers, Honolulu District, by U.S. Geological Survey, 5 December 1980.

20. Kelly et al., Historical Research of Land and Water Use in the Hilo Bay Area Since 1775, Island of Hawaii, prepared for U.S. Army Engineer Division, Pacific Ocean by Bernice P. Bishop Museum, 22 September 1980.

21. Lockwood, J.P. and J.M. Buchanan - Banks, Preliminary Geologic Report, Alenaio Stream Flood Damage Reduction Study Area, Hilo, Hawaii, prepared for the U.S. Army Corps of Engineers, Honolulu District, by the U.S. Geologic Survey, September 1980, revised March 1981.

22. M&E, Pacific, Inc. (formerly Sunn, Low, Tom and Hara, Inc.), Hilo Harbor First Spring Season Environmental Studies - 1977, prepared for U.S. Army Engineer District, Honolulu, August 1977.

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

24. Moberly, Ralph, Sr. and Theodore Chamberlain, Hawaiian Beach Systems; HIG-64-2, University of Hawaii, Hawaii Institute of Geophysics, May 1964.

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

26. 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.

27. Philip Yoshimura, Inc. and Hiroshi Kasamoto Inc., A Proposal For Rezoning To Single-Family Residential (RS-15; RS-20); Multi-Family Residential (RM-4); Neighborhood Commercial (CN-10) Open (0), Ponahawai Lands, South Hilo, Hawaii, prepared for Komohana Investors, undated.

28. R.M. Towill, Preliminary Engineering Studies for Peakalika Subdivision at Hilo, Hawaii, prepared for Nippon Shinpan Pacific, Inc., June 1974.

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

30. Sea Engineering Inc., Circulation and Sediment Transport Study, Hilo Bayfront Beach, Hilo, Hawaii, prepared for the U.S. Army Corps of Engineers, Pacific Ocean Division, September 1981.

31. State of Hawaii, The State of Hawaii Data Book 1979, Department of Planning and Economic Development, 1980.

32. State of Hawaii, Hawaii Water Resources Plan, Hawaii Water Resources Regional Study, Honolulu, Hawaii, January 1979.

33. Stearns, H.T. and G. MacDonald, Geology and Ground-Water Resources of the Island of Hawaii, Division of Hydrology Bulletin No. 9, 1946.

34. U.S. Department of Agriculture, Wailuku-Alenaio Watershed Work Plan, Hawaii County, Hawaii, Soil Conservation Service, March 1976.

35. U.S. Army Corps of Engineers, Waterborne Commerce of the United States, 1978.

36. U.S. Army Corps of Engineers, General Design Memorandum, Wailoa Stream and Its Tributaries, Hilo, Hawaii, Corps of Engineers, Honolulu District, December 1961.

37. U.S.Army Corps of Engineers, Hilo Harbor Baseline Environmental Investigation, prepared by Neighbor Island Consultants for the Honolulu District, March 1973.

38. U.S. Army Corps of Engineers, Preliminary Planning for Small Craft Facilities in East Hawaii, Hilo Comprehensive Study, prepared by Aotani and Associates, Inc., Honolulu, for the Honolulu District, 1977.

39. U.S. Army Corps of Engineers, Hilo Comprehensive Study, Plan of Study, Honolulu District, December 1977.

40. U.S. Army Corps of Engineers, Hilo Comprehensive Study, Stage 2 Report, Honolulu District, September 1980.

41. U.S. Army Corps of Engineers, Hilo Area Comprehensive Study, Draft Navigation Report, Honolulu District, August 1981.

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

43. U.S. Army Corps of Engineers, Hilo Lava Flow Control, Review Report and Environmental Impact Statement, Honolulu District, May 1980.

44. U.S. Army Corps of Engineers, Physical and Economic Feasibility of Nonstructural Floodplain Management Measures, Hydrologic Engineering Center, Institute for Water Resources, March 1978.

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

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

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

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

49. U.S. Department of Commerce, U.S. Census of Housing, 1970, Block Statistics, Selected Areas in Hawaii, Bureau of the Census, Washington, D. C. 1970.

50. U.S. Department of the Interior, The Geological Resources of the Hilo Study Area, Hawaii, Hawaii, an Overview for the Hilo Area Comprehensive Study, Fish and Wildlife Services, Honolulu, September 1978.

51. U.S. Department of the Interior, Planning Aid Letter (PAL), Alenaio Stream Flood Damage Reduction, Hilo, Hawaii, prepared by the Fish and Wildlife Services, Honolulu, 10 December 1980.

52. U.S. Department of the Interior, Flood of February 20, 1979 in Hilo, Kau and Puna Districts, Island of Hawaii, Circular 81, Geological Survey in cooperation with the Division of Water and Land Development, Department of Land and Natural Resources, State of Hawaii, March 1980.

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

54. Wilson, Okamoto & Associates, Inc., Hilo Drainage and Flood Control, prepared for the County of Hawaii, 1967.

55. Wilson, Okamoto & Associates, Inc., Waiakea-Uka Flood Control Study, prepared for the Department of Public Works, July 1970.

FINAL
IX. ENVIRONMENTAL IMPACT STATEMENT
ALENAIO STREAM FLOOD CONTROL
HILO, HAWAII

The responsible lead agency is the U.S. Army Corps of Engineers, Honolulu District. The responsible cooperating agency is the U.S. Fish and Wildlife Service, Pacific Islands Office.

Abstract: The Alenaio watershed is in the South Hilo District, which is on the northeastern side of the island of Hawaii. The island comprises the County of Hawaii, where Hilo, the County seat and principal urban center is located in the lower portion of the watershed. The Honolulu District, U.S. Army Corps of Engineers, has investigated public concerns and needs associated with flood damage reduction measures in the Alenaio Stream floodplain, and impacts upon the environmental, social, cultural and economic resources of the area. Three alternative plans have been developed, consistent with national and local goals and the primary objective of reducing property damage by floodwaters from Alenaio Stream. Alternative Plan 1, the recommended plan, consists of both structural and nonstructural measures: floodplain management, floodproofing and modification of 1640 feet of existing stream between Kapiolani Street and Kilauea Avenue. Alternative Plan 2 specifies a 4200 foot concrete lined diversion channel from Alenaio Stream above Komohana Street to Waikapu Gulch and the Wailuku River. Alternative Plan 3 is the non-structural plan involving floodproofing and relocation. The SPF alternative plan would affect 131 structures and the 100 year alternative plan would affect 94 structures. Fifty-three and thirty-one (100 year) structures would be removed or relocated. None of the plans would have significant adverse effects on important environmental or known archaeological resources. Adverse social effects involving displacement/relocation of people and businesses, and the possible decrease in property values would result from implementation of any of the 3 alternative plans.

Further technical information concerning the statement may be obtained from:

Dr. James E. Maragos
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, HI 96858
Telephone: (808) 438-2263/64

Note: Information, displays, maps, etc. discussed in the main report are incorporated by reference in the EIS.

FINAL

ENVIRONMENTAL IMPACT STATEMENT

TABLE OF CONTENTS

LIST OF TABLES

THE FOLLOWING PEOPLE WERE PRIMARILY RESPONSIBLE FOR PREPARING THIS ENVIRONMENTAL IMPACT STATEMENT:

LIST OF PREPARERS

NAME	DISCIPLINE/EXPERTISE	EXPERIENCE	ROLE IN PREPARING EIS
James K. Ligh	Hydraulic Engineer/Civil Engineering and Water Resources Planning	BS, Civil Engineering MS, Ocean Engineering MS, Management 2 years Civil Engineering 3 years Civil/Hydraulic Engineering with the US Army Corps of Engineers	Study Manager
James E. Maragos	Supervisory Environmental Biologist/ Marine Ecology	BS, Zoology, Ph D, Oceanography 2 years Post-Doctoral Research 9 years Environmental Consultant 7 years EIS studies with the US Army Corps of Engineers	EIS Coordinator
Robert Moncrief	Ecologist/Marine Biology	BA, Zoology 7 years Biologist with the US National Marine Fisheries Service 4 years Biologist with the US Navy 4 years EIS studies with the US Army Corps of Engineers	EIS Preparer
David G. Sox	Social Environmental Specialist/ Historical and Cultural Geography	BA, MA, Geography 6 years research 7 years EIS studies with the US Army Corps of Engineers	Social and Cultural Resource Assessment
Gerry Roehm	US Fish and Wildlife Fishery Biologist/Biology	BS, Biology 3 years Environmental Toxicology 3 years Fishery Biologist with the US Fish and Wildlife Service	Fish and Wildlife Assessment
John I. Ford	US Fish and Wildlife Fishery Biologist/Limnology	BS, MS, Zoology 6 years research 4 years EIS studies with the US Army Corps of Engineers 1 year with US Fish and Wildlife Service.	Fish and Wildlife Assessment
James D. Emerson	Hydraulic Engineer/Hydraulic Engineering and Design	BS, Civil Engineering 1 year Civil Engineering with the State Department of Highways 5 years Hydraulic Engineering with the US Army Corps of Engineers	Hydraulic Engineering and Design

1. Summary

a. Major Conclusion and Findings: The alternative plans are described in detail in Section IV and Appendix D of the report. All three alternative plans meet the primary objectives of reduction of property damage by floodwaters from Alenaio Stream and efficient use of lands consistent with the local land use and development plans and floodplain management policy. Based on a maximization of net benefits, Alternative Plan 1 has been designated as the National Economic Development (NED) plan. None of the plans result in net positive contributions to the environmental resources of the study area, which is the criterion for designation of an Environmental Quality (EQ) plan. Alternative Plan 3, the non-structural plan, is considered to be the least environmentally damaging plan because it requires the least modification of the stream and other natural environment. An evaluation of the discharge of fill material under Section 404 of the Clean Water Act of 1977 indicates that the site and fill material are suitable for this purpose. No threatened or endangered species or their critical habitat would be affected by any of the proposed alternative plans. No known cultural resources eligible for or listed on the National Register of Historic Places would be affected by the proposed alternative plans. Alternative Plan 1 is being recommended based on NED criteria and the lack of significant adverse environmental effects associated with it.

b. Areas of Controversy: None.

c. Unresolved Issues: None.

d. Relationship to Environmental Requirements

The relationship of the alternative plans to Federal and State environmental laws and regulations affecting this study are presented in Table EIS-1.

Table EIS-1.
Relationship of Plans to Environmental Requirements

Federal Statutes

National Environmental Policy Act (NEPA)	In full compliance.
Prime Agricultural Lands	Not applicable
National Historic Preservation Act	In full compliance.
National Landmarks	Not applicable
Fish and Wildlife Coordination Act of 1958	In full compliance.
Endangered Species Act of 1973, as amended	In full compliance.
Migratory Bird Treaty Act of 1918	Not applicable

Table EIS-1.
Relationship of Plans to Environmental Requirements (Contd)

Federal Statutes Contd	
Marine Mammal Protection Act of 1972	Not applicable
Marine Protection, Research and Sanctuaries Act	Not applicable
Federal Water Project Recreation Act of 1965	Not applicable
Coastal Zone Management Act	In full compliance.
Scenic and Wild River Act	Not applicable
Water Resources Planning Act	In full compliance
Clean Water Act of 1977	
Section 404 - Dredged or Fill Materials	In full compliance.
Executive Orders, Memoranda, Etc.	
E.O. 11593 - Protection and Enhancement of the Cultural Environment	In full compliance.
E.O. 11990- Protection of Wetlands	Not applicable
E.O. 11987 - Exotic Organisms	Not applicable
E.O. 11988- Floodplain Management	In full compliance
State and Local Laws	
Chapter 343, HRS: State EIS Law, State CZMA	In full compliance.

Rev 26 Sep 80.

2. Need For and Objectives of Actions

a. Study Authority

This 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 to Congress solutions to the problems and the extent the Federal government should participate in implementing possible flood damage reduction measures.

b. Public Concern

Alenaio Stream possesses a long history of flooding. Flood events causing significant damages to property and, in some cases bodily injury, have occurred since at least 1906. Recent storms (17-20 February 1979 and 16-19 March 1980) have underscored the gravity of the flood problem along the downstream reach of the Alenaio. Recently during the 1980 flood, the Komohana Street culvert was washed away and considerable flooding occurred in downtown Hilo. Concern has been expressed with respect to the unabated flood problem and the need to increase the capacity of the existing drainage system.

c. Planning Objectives

Based on an analysis of social, economic and environmental aspects of the study area, the following planning objectives were developed to guide the formulation and evaluation of alternative plans and to provide flood protection for the community of Hilo:

(1) Contribute to the reduction of property damages by flooding, from Chong's Bridge to the Waiolama Canal, during the 1985-2085 period of analysis;

(2) Contribute to the efficient use of the lands consistent with the local land use and development plans and floodplain management policy during the 1985-2085 period of analysis;

(3) Contribute to the understanding of the complex lava tube system and spring characteristics and of measures to minimize its impact on flood damages.

3. Alternatives Considered

a. Plans Eliminated from Further Study

(1) Retention Basin. The temporary storage of floodwaters by an upstream retention basin was considered. A site approximately 1000 feet above Komohana Street was selected as the most suitable location for the basin (see Figure 9). The area is situated such that a retention basin would collect most of the flood producing runoff and is large enough to accommodate the storage of these floodwaters. Land requirements for this alternative would be approximately 130 acres including ponding area and earthen embankments. The 90 acre basin was initially conceived as an unlined structure to promote recharge of the water table through percolation. However, the prevalence of lava tubes as a geological feature of the area indicates that the basin would need to be lined to prevent undesirable transportation of water through these tubes to commercial and residential areas in Hilo.

Based on the preliminary design features developed (not including lining the detention basin) the estimated cost of this plan is $30 million. This cost far exceeds the expected benefits of the projects. Based on the high expected costs when compared with the low expected benefits and undetermined risk associated with technical effectiveness, this alternative was not considered feasible for further detailed studies.

(2) Diversion into the Wailoa Stream. The County recommended a possible diversion alignment into the Wailoa Stream. This alignment (see Figure 10) would divert floodflows along the proposed Mohauli Road extension along Ainako and across Komohana Street into the ditch behind the University heights subdivision, then into the Wailoa Stream. The major planning concern was the capacity of the Wailoa Stream to handle the increased flow during coincidental

flood conditions on both streams. Based on the expected water surface profiles from the design flood event, the additional diverted water would raise the Wailoa Stream water level approximately three (3) feet above the existing embankments. Diverting the floodwaters into the Wailoa Stream would require a diversion channel approximately 8000 ft long. In addition, improvements to 4000 feet of the Wailoa Stream by raising its embankments about 5 feet would be required.

Because the diversion channel into Wailoa Stream would be approximately twice as long as the proposed diversion channel into the Wailuku River and require additional downstream improvements to Wailoa Stream, this alternative would be far more costly to implement than the Wailuku River diversion. It was, therefore, not considered for further detailed studies.

(3) Diversion into the Wailuku River. Two diversion alignments were initially investigated for this alternative. Alignment A starts approximately 500 feet upstream of Komohana Street, intersecting and running roughly parallel to it (see Figure 10). Alignment B, which was suggested by the County, begins above Komohana Street. Instead of running parallel to Komohana Street after their intersection it continues NE toward Hilo Bay and then swings north in a wide arc (see Figure 10). Alignment B would require approximately 1800 feet of additional channel.

Both plans will divert potential flood flows from the existing Alenaio Stream. *The stream will also be modified to carry 2800 cfs at its mouth by* enlarging the culvert openings at Kilauea Ave and Kinoole Street. The existing weir at Ponohawai can be removed without affecting the proposed project to allow low flows downstream.

Alignments A and B are essentially the same in concept. However, based on the preliminary evaluation, Alignment A would be approximately $2 million less expensive to construct and is relatively straight, requiring fewer and less severe curves. The two alignments are comparable in other respects. Consequently, Alignment A has been selected for detailed feasibility study and Alignment B was deleted from further consideration.

b. Without Condition (No Action)

Flooding would continue to be a recurrent problem within the Alenaio Stream flood hazard zone. Lowlands between Chong's Bridge and Komohana Street would be inundated by floodwaters during storm conditions. Because of the inadequate carrying capacity of the stream below Komohana Street, floodflows exceeding the 10-year storm event would continue to overtop the stream banks and flood adjacent areas, damaging residential and commercial property.

c. Plans Considered in Detail

(1) Nonstructural Measures. Nonstructural alternatives do not control the flow of water but instead remove, floodproof or prohibit specific damageable property within the the zone of flooding. Floodplain restrictions, improved maintenance and efficiency of existing flood control structures, flood forecasting warning and temporary evacuation, implementation of flood insurance programs, and floodproofing/relocation were evaluated during initial

plan formulation. These measures are described in some detail in Section V of the Survey Report. Of the measures enumerated above, floodproofing/relocation is considered the only nonstructural solution which would provide adequate protection to structures from damage by floodwater during a 100-year flood event. The remaining nonstructural measures can be effective when implemented in conjunction with floodproofing or appropriate structural measures.

Alternative 3, the floodproofing plan for Alenaio Stream, would affect 131 (SPF) and 94 (100-year) structures.

	SPF	100-Yr
Temporary/perm closures	18	19
Relocation of damageable property	14	14
Raising the structure	41	25
Providing a ring wall	5	5
Removal/major alterations	53	31

(2) Structural Measures. Two alternative plan layouts were analyzed for flood control measures on Alenaio Stream. Alternative Plan 1 incorporates floodplain management, floodproofing and modifying the existing stream (Figure 12). Alternative Plan 2 incorporates floodplain management, a diversion channel and modification of the existing stream (Figure 13). Both alternatives are evaluated to the same level of protection and treated in detail in Section IV of the Survey Report.

Alternative Plan 1: This alternative would consist of floodplain management from Chong's Bridge to Komohana Street (Reach 4), floodproofing from Komohana Street to Kapiolani Street (Reach 3), and modifying the existing stream from Kapiolani Street to Kilauea Avenue (Reach 2). From Kilauea Avenue to Hilo Bay (Reach 1), no change from existing condition would occur. Two levels of protection were investigated, the Standard Project Flood (SPF) and the 100-year flood frequency.

The nonstructural plan for the stream reach between Komohana and Kapiolani Streets would be to raise four homes that are wood frame on post and beam, provide temporary and permanent closures around one home, and to relocate or replace in the same location three homes that would have flood depths greater than two feet and could not be raised.

The structural alternative for the Kapiolani Street - Kilauea Avenue reach would consist of a channel alignment following the existing alignment from Kapiolani Street to Kinoole Street and then diverging from the existing channel to Kilauea Avenue. The existing channel would be filled in from Kinoole Street to Kilauea Avenue to provide access to the buildings between the proposed and existing alignments.

The proposed channel would be a 1640-foot long rectangular concrete conduit. The channel width would be 40 feet for the first 415 feet and then transition to a 35 foot width in a distance of 50 feet for the remainder of the channel length. Four existing bridges would need to be replaced. They are located at

Kapiolani Street, Ululani Street, Kinoole Street and Kilauea Avenue. Seven structures within this reach would require relocation; one public service building and six residential buildings. The public service building houses the administrative offices of the County Fire Department at Kinoole Street.

The reach between Kilauea Avenue and Hilo Bay would remain unchanged except in the vicinity of Kilauea Avenue where the downstream end of channel modification would transition into the existing surroundings.

This alternative was also developed for the 100-year flood following the same design and assumptions. The main difference between this and the SPF is in the channel size, due to the difference in flows. The channel width would be 25 feet throughout the entire 1640 foot length rather than the 40 and 35 foot widths required for the SPF design.

Alternative Plan 2: This alternative consists of floodplain management along reaches 1, 2 and 4 of the stream. Reach 3 would require the replacement of bridges at Kilauea Avenue and Kinoole Street. No additional structural modifications to the existing channel would be necessary. The diversion channel would intercept Alenaio Stream approximately 500 feet upstream of Komohana Street, intersecting and continuing roughly parallel to it. The diversion channel would be 4200 feet in length and entirely concrete lined. The initial segment of the diversion channel would be a trapezoidal channel with 1.5H to 1V sideslopes and bottom width of 25 feet. This segment would be approximately 1850 feet long and would transition into a 2250 foot long rectangular channel with a bottom width of 35 feet. The terminus of the diversion channel would include a drop structure and stilling basin where it discharges into Waikapu Gulch. Where the channel traverses a residential neighborhood along Waianuenue Avenue, as an option it may be covered to lessen its obtrusiveness and potential as an attractive nuisance. From two to four residences would be relocated as part of this alternative depending on whether the latter traverse was covered or not.

d. Comparative Impacts of Alternatives

Comparative impacts of the three plans are presented in Table EIS-2 and additional comparison of alternative plans is contained in Table EIS-3.

4. <u>Affected Environment</u>

Environmental Conditions

a. Physical Features. The Alenaio-Wailuku watershed is in the South Hilo District which is on the northeastern side of the island of Hawaii, the largest island of the Hawaiian Archipelago. The island comprises the County of Hawaii where Hilo, the County seat and principal urban center, is located in the lower portion of the watershed. The watershed is roughly triangular in shape with Hilo, Mauna Kea and Mauna Loa volcanoes are boundary points.

Elevation in the watershed ranges from sea level at Hilo Bay to 13,796 feet at the summit of Mauna Kea. The general slope of the land is toward the east. The Wailuku River and Alenaio Stream are the two major drainage systems for the watershed. The streams that comprise the Alenaio Stream drainage are Kaluiiki Branch, Waipahoehoe Stream, and Alenaio Stream. Kaluiiki and Waipahoehoe Streams originate below the road to Lyman Springs.

TABLE EIS-2.
COMPARATIVE IMPACTS OF ALTERNATIVES ON SIGNIFICANT RESOURCES

BASE CONDITION AND ALTERNATIVES	ENDANGERED SPECIES	SCENIC RESOURCES	PRIME AGRICULTURAL LANDS	RESIDENTIAL DEVELOPMENT	CULTURAL RESOURCES
Base Condition	Project area may provide peripheral habitat for the Hawaiian hoary bat and Hawaiian hawk.	Much of the project area is rural in character, possessing large areas of open space, fallow agricultural lands, wooded and densely vegetated areas and some older residential and commercial buildings.	An area of approximately 100 acres surrounding Puu Hono cinder cone, extending south to Alenaio Stream is designated prime agricultural land by the State Department of Agriculture.	The major portion of the Alenaio floodplain lies within downtown Hilo. It is presently a mix of single family and apartment residential dwellings and commercial and public buildings. Most of the structures were built before 1950 and contribute to the rural flavor of the town.	Possible unmarked graves indicated to exist between Hilo Chinese Cemetary and Alenaio streambed.
Without Condition	No substantial change. Some increase in residential housing development may diminish the existing agriculturally-zoned lands within the project area.	No immediate change. Continued residential and commercial growth of Hilo town may eventually encroach on existing open space and forested lands.	The prime agricultural lands in the vicinity of Alenaio Stream were formerly used for sugarcane cultivation, but have been fallow for several years. As Hilo expands, eventual demand for developable lands may result in rezoning and conversion to other uses.	No substantial change in upper floodplain. Eventual (5-15 yrs) renovation or replacement of older structures within the project area in lower floodplain.	Continual flooding could erode away graves.
Plan 1	No effect.	Upper 800 feet of concrete channel changes a natural rocky cascade into impersonal concrete.	No effect.	Six residential structures and one public building would be demolished as a result of channel redevelopment.	Direct effect on possible graves. Graves could be relocated.
Plan 2	No effect.	The 4,200-foot long concrete diversion channel including a chain link fence for human safety, would create a man-made visual element in an area that will be predominantly residential land in 10+ years.	Approx 9 to 10 acres of agricultural land would be converted to use as a flood control channel. The proposed channel alignment skirts the eastern boundary of the prime agricultural lands. None of the agricultural lands in the area including the prime lands are currently in cultivation.	The channel alignment would necessitate relocation of between 2-4 residential structures.	No effect.
Plan 3	No effect.	Initial removal of structures would be intrusive but land scaping could soften impact. Permanent closure would be intrusive.	No effect.	31 (100-Yr) to 53 (SPF) commercial and residential structures would be removed or replaced. 25 (100-Yr) to 41 (SPF) structures would be modified by raising the 1st floor elevation; 19 (100-Yr) to 18 (SPF) structures would require the construction of temporary or permanent closures.	No effect.

TABLE EIS-3
ANALYSIS OF IMPACTS ON RESOURCES AND VALUES IDENTIFIED IN SECTION 122 OF PUBLIC LAW 91-611 AND OTHER RESOURCES IN THE PROJECT AREA

DESCRIPTION	BASE CONDITION	ALTERNATIVE 1 Modifying the Existing Channel.	ALTERNATIVE 2 Diversion Channel Into the Wailuku River.	ALTERNATIVE 3 Floodproofing, Relocation, and Floodplain Management
A. DESCRIPTION OF PROPOSED PLAN FEATURES	No action.	Reach 4: Floodplain management. Reach 3: Floodproofing. Reach 2: Modify 1,640 ft of channel. Reach 1: No structural action/floodproofing.	4,200' diversion channel into Wailuku River from Komohana Street.	Floodproof individual structures, relocate nonflood proofable structures and incorporate floodplain management.
B. PROJECT IMPACTS				
1. Economic				
a. Goods & Services Urban Flood Damage Reduction	Existing structures will continue to flood; future damages expected to be relatively constant due to land use restrictions imposed by County of Hawaii's participation in the Federal Flood Insurance Program.	Reduces average annual damages by: ($1000) $ 1,438 100-Year $ 1,471 SPF	Reduces average annual damages by: ($1000) $ 1,456 100-Year $ 1,458 SPF	Reduces average annual damages by: ($1000) $ 518 100-Year $ 786 SPF
Public Facility and Services	Public facilities within floodplain will continue to flood when channel capacity is exceeded. Public services will be required for clean-up after flood.	Portion of Fire Department Building (Admin Sec) would need to be relocated. Bay Front Highway will continue to be inundated by floods exceeding 10-year event.	County Jail would need new access roads to parking and maintenance area.	Bay Front Highway will continue to be inundated by floods exceeding 100-year event. Regional flooding of secondary roads, yards, and community will occur.
Land Use	County of Hawaii's participation in the Federal Insurance Program will incorporate land use/construction regulations regarding development in the 100-year flood limit.	Incorporates flood control/flood management policy for Reaches 1 and 4.	Requires 9-10 acres of agricultural/residential lands to be dedicated for flood control easements and for the diversion channel. Small scale irrigation water intercepted.	Incorporates floodplain management policy.
Commitment of Economic Resources	Manpower and public economic resources will need to be committed for post flood clean-up operations.	Commitment of 5,820 cy (4,780 100-Yr) of concrete and related manpower and energy resources.	Commitment of 19,130 cy (12,840 100-Yr) of concrete and related manpower and energy resources.	Commitment of building material to modify and/or related manpower and energy resources.
b. External Economics	Re-vitalization of historic downtown Hilo will be diminished as community will continue to suffer from flood damages. Economic efficiencies of commercial businesses in downtown Hilo will be decreased due to recurring floods.	Increase economic efficiency of commercial businesses by reducing recurring flooding and post flood clean-up.	Same as Alternative 1.	Same as Alternative 1.

Table EIS-3. (Continued)

DESCRIPTION	BASE CONDITION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
2. Environmental				
a. Significant EQ Resources and Attributes				
Ecological: Terrestrial Marine Water Quality Fish and Wildlife	Project area largely disturbed by agricultural and urban usage. Exotic trees and shrubs dominate riparian stream vegetation. Stream is ephemeral and usually dry. Pools of standing water support a limited aquatic fauna when stream is not flowing. Waiolana Canal is under tidal influence and supports an estuarine aquatic community.	Upper 920 ft new concrete channel would destroy the existing ephemeral aquatic fauna in this currently natural rock environment.	Approximately 9-10 acres of agricultural land converted to flood control channel. No change from base condition in marine environment, water quality, or fish and wildlife resources.	No change from base condition.
Cultural:				
History/Historic/Archaeological	No National/State-listed or eligible site in SPF flood plain. No sites recommended in Hilo Comm Dev Plan. Potential subsurface burials.	Potential burials in upper 600 ft of concrete channel affected. Any burials would be relocated. May affect other subsurface urban features in Reaches 1 and 2.	May affect subsurface agricultural features.	No effect on any previously identified historic buildings.
Recreation	Because the stream is usually dry and devoid of game or tablefish, recreational usage and value low.	No change from existing condition.	No change from base condition.	No change from base condition.
Aesthetic:				
Noise	Noise levels are typical of a small rural urban/suburban community including aircraft noise from a nearby airport facility.	Temporary increase in noise levels during construction of new channel segment.	Same as Alternative 1.	Same as Alternative 1.
Visual	One part of Hilo town within the project area has the appearance of a typical older rural town. The upper reaches include open areas, agricultural land and forested areas.	Provides scenic mall over old stream. New channel segment results in visual impacts associated with concrete channels.	4,200' diversion channel would create new visual elements in an area that will be predominantly residential within 10+ years.	More open area along stream channel where buildings have been removed.
b. Section 122 (Public Law 91-611)				
Air, Noise, and Water Pollution	Not applicable.	No significant long-term adverse effects.	Same as Alternative 1.	Same as Alternative 1.

Kaluiiki Branch joins Waipahoehoe Stream above Chong's Bridge south of the Wailuku River. The stream then becomes undefined in the wide floodplain below Chong's Bridge, where much of the flow percolates into the ground. It again becomes defined above Komohana Road where it forms Alenaio Stream. The three streams are ephemeral and flow for several days after heavy rains. Alenaio Stream becomes Waiolama Canal which enters the Wailoa River and discharges into Hilo Bay.

Many man-made changes have occurred in the Hilo area during the past century. Construction of the Waiolama Canal from 1889-1917 was a notable example. Approximately 600,000 cubic yards of fill dredged from the beaches of Hilo Bay was utilized filling in the marshland area along the Waiolama Canal. The canal extends 3000 feet west from the Wailoa River to the Kilauea Avenue bridge culvert, which marks the downstream terminus of Alenaio Stream and the upper limit of tidal action. This reach is entirely within the Bayfront Park occupying the former bayfront business district which was devastated by the 1960 tsunami.

Various culverts and local drainage system were constructed in the lower Alenaio Stream over the years. The most significant of these was the Ponohawai relief box culvert which originates between Ululani and Kinoole Streets and diverts water flow directly into Hilo Bay through a diversion culvert running east of Ponohawai Street. This system was constructed in 1924 by local businessmen to help alleviate flooding in the Ponohawai area. The remainder follows a concrete lined channel from Kinoole Street to Kilauea Avenue where it enters Waiolama Canal.

b. Geological Features

The course of Alenaio Stream is presently defined by three different pahoehoe flows from the NERJ the flow of 1881, the Kulaloa flow (1100-1400 years old), and the Punahoa flow (3000-4000 years old). The Waipahoehoe Branch is bounded on the north by the Punahoa flow. Below its confluence with the Kaluiiki Branch, the stream is defined by the flow of 1881 to the south, while the Kulaloa flow defines its southern margin in the reach below 250 feet elevation (USGS, 1980).

The streambed consists mainly of pahoehoe lavas which are relatively resistant to erosion. These younger lavas are interspersed with sand and gravel-filled potholes eroded in older, underlying weathered clays. Transitions between strata are generally marked by "stairstep" cascades or near-vertical drops in the streambed.

Between Chong Street and Komohana Street, the stream passes through a heavily forested area with a relatively flat gradient. The stream channel is poorly defined in this area, and a large volume of water is lost from the main stem of Alenaio Stream, probably due to seepage into the underlying Punahoa lava flow (USGS, 1980).

A significant portion of low to moderate stream flows percolates into small lava tubes, fractures, and voids between strata. However, during periods of heavy rainfall these subterranean conduits may be filled to capacity and surface runoff can occur. Historically, flooding in the Alenaio watershed has resulted from overbank flows during peak surface flows, as well as from springs which unexpectedly develop in areas of pahoehoe outcrop, especially near the distal ends of lava flows, and from the transient elevation of the basal freshwater lens. The basal groundwater lens underlying the proposed diversion channel from Alenaio Stream to the Wailuku River is relatively thick. However, there are no wells below the downgrade from this channel.

c. Vegetation

Grasses, ferns and associated herbs generally occupy the streambed and lower banks of Alenaio Stream. Shrubs and small trees grow on the banks and the taller plants comprise the overstory growth on the higher banks and lands adjacent to the stream. In some areas, there is no overstory of trees and shrubs; grasses and associated low herbs completely dominate the stream. In other areas, there is a dense tree canopy and the understory is relatively bare. A large number of the plants found in the study area are exotic. These include escaped horticultural species as well as weeds accidentally introduced to Hawaii. Some species are common throughout the entire study area, others dominate only in certain limited areas. A list of flora observed in the study area is provided in the US Fish and Wildlife Coordination Report (Appendix G).

d. Wildlife Resources

Mammals in the Alenaio project area are non-game species typically found in urban environments throughout Hawaii. These include the house mouse, roof rat, Norway rat, Polynesian rat, Indian mongoose as well as domestic animals and livestock. Feral pigs, sheep and goats are found in the upper watershed. Pigs occupy primarily the rain forests and higher elevation forests at timberline. Sheep and goats occupy the more isolated habitats, open and scrub forests on the higher mountain slopes.

Bird species observed in the Alenaio Stream project area include the barred dove, lace-necked dove, common myna, Japanese white-eye, ricebird, house sparrow, house finch, and red-crested cardinal. In addition, two species of migratory shorebirds were observed in Hilo Bayfront Park during the USFWS survey--the golden plover and the wandering tattler. The Waiakea Pond wetland provides habitat for a variety of resident and migratory bird species. Native resident species such as the black-crowned night heron and the endangered Hawaiian coot are known to frequent the area. The coot also nests in Mohouli Pond, which is adjacent and connected to Waiakea Pond.

e. Aquatic Resources

Alenaio Stream is ephemeral, flowing only during and a few days after heavy rains. During periods of low rainfall or drought most of the pools within the streambed dry up, leaving minimal aquatic habitat to support stream organisms. In the existing channelized stream reach between Kinoole and Kilauea Avenue no ponding of residual water occurs after flows have ceased. Consequently, stream fauna is largely absent and poorly developed above Kilauea Avenue where the upper limit of Waiolama Canal occurs. The Waiolama Canal is tidally influenced and provides an estuarine habitat for euryhaline marine fishes, native diadromous stream fishes, and several crustaceans. Aholehole, mullet, papio, milkfish, maiko, and three species of native gobies are relatively common in the canal. Pools in the upper reaches of the Alenaio support populations of guppies, mosquito fish and dojo, crayfish, bullfrogs, toads and insect larvae. A list of aquatic and wildlife species observed or reported from the study area is provided in the Fish and Wildlife Coordination Report (Appendix G).

f. Water Quality

Streams in the Alenaio-Wailuku watershed are Class 2 waters under the classification of water uses for inland waters, Chapter 37-A, Water Quality Standards, State of Hawaii, Department of Public Health. The uses to be protected for this class of water are recreation, propagation of fish and other aquatic life and agricultural and industrial water supply.

Alenaio Stream flows intermittently and, except for occasional shallow pools, is dry during periods of low rainfall. When it is flowing, dissolved oxygen levels are near or at saturation and turbidity is moderate.

g. Cultural and Historical Resources

There are no historic or archaeological sites listed on or eligible for either the National or Hawaii Registers of Historic Places within the floodplain or in the vicinity of either the Alternative Plan 1 or Plan 2 alignments. The only historic sites within the floodplain lie near the Hilo Bay shoreline: the Downtown Bandstand in Mooheau park and the Old False Front Stores on Kamehameha Avenue, both local sites recognized in the Hilo Community Development Plan of 1975. Adjacent to the floodplain to the south of Kilauea Street is the Hongwanji Temple which was listed as "Marginal" on the Hawaii Register. Another historic site just south of the floodplain on Kukuau Street is the Serrao Winery. The historic County Jail, which does not house inmates but is still used as a correctional facility, is located about 250 feet southwest of Alternative 2 at the corner of Waianuenue Avenue and Komohana Street. Archaeological and historical studies of the study area were conducted by Bishop Museum in the Spring 1982. The urban lands in Reach 2 of Alenaio Stream between the Central Fire Station at Kinoole Street and Kilauea Street may contain subsurface remains of early historic or prehistoric Hilo. Sediments lying below the sandfill of Wailoa River State Recreation Area immediately northeast of Kilauea Street probably contain archaeological information about the formation of prehistoric taro lands or fishponds. The western streamway within the Hilo Chinese Cemetery Association property has no surface indications of burials but an Association official indicated that this sloping area once contained unmarked graves of children which to his knowledge had not been relocated. Lands along Komohana Street may contain subsurface early historic or prehistoric agricultural features below the plow zone. Likewise, the present-day swale between Punahele Street and Waianuenue Avenue probably contains prehistoric subsurface remnants of irrigated agriculture.

h. Recreational Resources

There are no National parks in the study area. Wailoa River State Recreation Area lies at the mouth of Alenaio Stream paralleling the Waiolama Canal and provides 145 acres of open space and water features. The other Bayfront parks (Mooheau and Bayfront parks) lie makai of Bayfront Highway are also within the floodplain. The 3.3-acre Lincoln Park Neighborhood facility is one of the principal downtown outdoor recreational resources lying about 250 feet northwest of Alenaio Stream. Bike routes are planned for Kilauea and Kinoole in the short-term future and later along Komohana Street and Waianuenue Avenue. The Wailuku River State Park borders the lower reach of the Wailuku River but does not extend southeast into the discharge point for Alternative 2. As an intermittent stream, Alenaio is not recognized as a formal recreational opportunity area as other streams in the Hilo urban area, but during the rainy season it is undoubtedly frequented by neighborhood residents for recreational fishing. Likewise in the dry season, its dry rocky cascades also probably attract adventurous neighborhood children. Illegal skate-boarding is also recognized to occur in the lower portion of the existing concrete channel just above Kilauea Street.

i. Development and Economy

(1) The basic elements of the economy of Hawaii County are tourism, agriculture and fishing, manufacturing, and scientific research. Hilo is the principal urban area of the County and is the fourth largest city in the State. The city site, which has been inhabited since early Hawaiian times, fronts Hilo Bay, the only sheltered bay along the eastern coast of the Island of Hawaii. Hilo is the center of government and is the only metropolitan area in the County. The city serves as the center for trade, distribution, and services.

(2) Hawaii County population has experienced a continued growth from 1960 through 1980, with growth rates significantly exceeding those for the State only for the 1970-1980 period. Population estimates for South Hilo District and the Hilo urban area since 1960 indicate that the Hilo area has shared in this growth. Table 2 shows historical population growth for the State of Hawaii, Hawaii County, South Hilo District and the Hilo urban area for selected years. In 1980 the census tract areas most closely approximating the study area (CT 203, 204, and 208) had a population of 15,312, up 22.7 percent from 1970 but with most of the growth occurring above Komohana Street. No other socioeconomic indicators at the census tract level of the study area are yet available from the 1980 Census. The 1970 Census indicators are found in Appendix F. Based on limited interviews and observation, the residents of the lower Alenaio Stream floodplain, particularly the Kinoole-Ponahawai-Kilauea-Kukuau Street block appear to be mostly older couples, many retired and on fixed incomes having occupied their present residences for 15 years or longer. Ethnicity varies with few Caucasian (except Portuguese) and many Japanese. Residents along the alignment of Alternative Plan 2 appear to be upper-middle class with attractive homes. Most are employed but two residences adjacent to the alignment contained retired couples. Most have occupied their homes for over 20 years.

Significant Resources

a. <u>Endangered Species</u>. The Hawaiian hoary bat (<u>Lasierus cinerus semotus</u>) has been observed in the Hilo area in the past. However, it is unlikely that the project area provides more than a peripheral habitat for this species. The Hawaiian hawk habitat (<u>Buteo solitarius</u>) overlaps the project. It is not known what importance, if any, the project area has for this endangered species.

b. Scenic Resources. Much of the Alenaio Stream project area is now rural in character, possessing large areas of open space, fallow agricultural lands, wooded and densely vegetated areas and old residential areas. The principal scenic resources of the wooded glade between Punahele Street and Waianuenue Avenue and the open rural character of the surrounding area, the cascading Alenaio Stream course through Hilo to the Central Fire Station, and the old, downtown residences and wooden storefronts are considered of intrinsic value to the community.

c. Prime Agricultural Lands. Prime agricultural lands are defined as those which have soil quality, growing season and moisture needed to produce sustained high yields of crops economically managed in accordance with modern farm techniques. An area of approximately one hundred acres surrounding Puu Hono cinder cone, extending south to Alenaio Stream is designated as prime agricultural land by the State Department of Agriculture. This land and adjacent agricultural lands were formerly cultivated in sugarcane but are currently fallow. In August 1980, all this prime land was redesignated Urban from Agriculture by the State Land Use Commission. County zoning for the Ponahawai Lands Subdivision to Residential and Commercial uses is pending for the Ponahawai Lands Subdivision.

d. Commercial and Residential Development. The major portion of the Alenaio floodplain lies within downtown Hilo and has been developed as single family and apartment residential dwellings and commercial and public buildings. Most of the structures were built before 1950 and contribute to the rural flavor of Hilo town. The old residences of the Kinoole-Ponahawai-Kilauea-Kukuau block are mostly under the control of one property-owner whose holdings are currently divided by the Alenaio Stream. Many of the residents are older, retired and on fixed incomes. The entire block is zoned by the County as General Commercial for future development. Curently, agriculturally-fallow lands beside Komohana Street north of Alenaio Stream are planned for residential and commercial development in the short- to medium-term (1-15 year) future.

e. Cultural Resources. The most significant known cultural resource in the study area is the strong probability of unmarked children's graves between the Alenaio Stream course and the marked graves of the Hilo Chinese Cemetery. These potential cultural resources are more socially significant than historically significant. Other significant subsurface remains of early historic or prehistoric Hilo may also be found.

f. Resources and Values Identified in Section 122 of Public Law 91-611. The following resources and environmental values have been fully considered with respect to possible adverse economic social and environmental effects resulting from implementation of the proposed project. They are treated in Table 14, Summary Comparison of Alternative Plans and System of Accounts; Table EIS-3 and Section 5 of the EIS:

(1) Air, Noise and Water Pollution

(2) Man-made or natural resources, aesthetic values, community cohesion and availability of public facilities and service.

(3) Employment effects and tax and property value.

(4) Injurious displacement of people, businesses and farms.

5. Environmental Effects

a. Endangered Species. The U.S. Fish and Wildlife Service, Office of Endangered Species, indicated that the project area might provide peripheral habitat for the endangered Hawaiian hoary bat and Hawaiian hawk. None of the proposed alternatives would have an effect on the areas that might be used by these species.

b. Scenic Resources. Alternatives Plans 1 and 3 would minimally affect the rural and scenic resources in the project area. Alternative Plan 1 would provide a trade-off by covering and landscaping one portion of the present Alenaio Stream course and creating a new channelized stretch which had been partially channelized before. The possible modification of 31 (100 yr) to 53 (SPF) structures under Alternative 3 would initially create a possible blemish on the landscape but with landscaping, the modified area could be minimized. Construction of a 4,200-foot-long concrete diversion channel with a 6-foot chain-link safety fence under Alternative Plan 2 would be a major intrusive visual element in the present residential area between Punahele Street and Waianuenue Avenue but community adjustment to the channel by the planned residential development above Komohana Street and north of Alenaio Stream would be considerably easier. Planting of appropriate shrubbery along the fences for both structural alternatives would diminish the visual impact of the structures.

c. Prime Agricultural Lands. Alternative Plans 1 and 3 would have no effect on prime agricultural lands within the flood control study area. The proposed diversion channel alignment of Alternative Plan 2 may impinge slightly upon the eastern boundary of the area designated as prime agricultural lands, which is part of a larger area formerly under sugar cultivation. The impact is real but also illusory since the State has redesignated the Prime agricultural land for future Urban uses. Nine to ten additional acres of former sugarcane land would also be eliminated by the flood control channel. Old, surface irrigation canals which still serve small agriculture east of Halai Hill would be intercepted, but provision could be made not to interfere with their flow.

d. Commercial and Residential Development.

(1) Under Alternative Plan 1, demolition of the County Fire Department administrative offices would be preceded by an orderly move into temporary or new permanent facilities, the provision of which would be the responsibility of the local sponsor. No disruption of the Fire Department services will be experienced. Approximately 30 residents in ten housing units (six structures) would be displaced if not already displaced by commercial development planned by two property owners in the medium term (5-15 year) future. Anticipation of a potential Corps project may delay or modify plans for the commercial development to two parcels (TMK 3-2-2-8:13 and 3-2-2-8:18). Development on the former parcel would be entirely precluded and limited on the latter, but opportunities may exist to modify the design of the concrete channel to meet

the needs of individual property developers during Advanced Engineering and Design. One new optional alignment of the proposed modified channel at the lower portion of Kilauea Avenue could preclude effective use of TMK 2-2-8:23 as a gasoline station by cutting off its direct access to Kilauea Avenue. The contrasting option at that portion of the reach would necessitate relocation or destruction of an old two-story, wooden building used now for several small commercial concerns. The single major landowner in the Kinoole-Ponahawai-Kilauea-Kukuau block (TMK 3-2-2-8:5,21,30,38,39, and 40) controls 49 percent of the currently usable area in mostly old and small single-family residences. Assuming that this landowning has not been commercially developed by the time Alternative Plan 1 is implemented, the filling in of the present stream course with landscaping would both enhance the residential attractiveness of the total parcel and may socially unite the two residential communities which had been previously divided by the stream. The park-like corridor, being dedicated to public use, could also, however, attract urban crime. Since the block has long been zoned by the County for General Commercial uses and new commercial developments are planned or underway both within and adjacent to the now predminantly residential block, the commercial value of the now divided, singly-owned parcel should greatly increase by the creation of fast land between the two sides. Commercial development of the block is, however, not dependent on the flood control project. Nevertheless, anticipated implementation of Alternative Plan 1, whether or not it occurs, may stimulate development sooner than it would occur without project planning.

(2) Under Alternative Plan 2, one residence currently occupied by an elderly couple on a fixed income would need to be relocated on the same lot and one other homeowner's carport would probably need to be relocated. Access to residences and a townhouse complex along Hale Street would be severely affected during construction. Alternative routes would have to be developed by the local sponsor or access permitted through the construction area. Normal access would return following completion of the covered channel in this portion of the alignment. The planned residential and commercial (supermarket) development by the Ponahawai Lands Subdivision would need to take the proposed alignment into consideration in designing its lot and road pattern.

(3) Residents or occupants of commercial buildings subject to flood-proofing or relocation under Alternative Plan 3 would experience temporary inconvenience and possible temporary relocation to other quarters during construction. The modified commercial buildings should not experience any significant decline in business due to construction activities. All people affected by the demolation or relocation of residential structures under Alternative Plans 1, 2, or 3, whether tenants or property owners, are covered under the Uniform Relocations Assistance and Real Property Acquisition Act of 1970 (P.L. 91-646) as described in Para. 5f(4).

e. Cultural Resources

Alternative Plan 1 may affect unmarked children's graves immediately above the Ululani Street Bridge and yet unknown subsurface remains of early historic or prehistoric Hilo where the proposed channel heads outside the existing stream channel. Likewise Alternative Plan 1 may affect subsurface remains of early historic or prehistoric agricultural activities. No significant surface sites will be affected and no historic sites listed or now eligible for listing on the National or State Registers of Historic Places will be affected. A cultural reconnaissance surface survey of the two structural alignments has been completed by Bishop Museum accompanied by an intensive historical analysis to determine areas of likely subsurface remains. The results of this study have been coordinated with the State Historic Preservation Officer. The final report recommends further studies and mitigative actions including test excavations near the old jail under Alternative Plan 2 and immediately northeast of Kilauea Avenue under Alternative 1. Intensive test excavations need also be performed in the areas of suspected unmarked children's burials. Any such excavations would be conducted with the full cooperation of the Hilo Chinese Cemetery Association.

f. Resources and Values Identified in Section 122 of Public Law 91-611. Project related impacts on the environmental resources and values identified in Section 122 of P.L. 91-611 have been fully considered (see Table EIS-3). Potential adverse impacts upon these resources resulting from project implementation are summarized below:

(1) Air, Noise and Water Pollution. Air, noise and water pollution would be temporary impacts during construction of flood control improvements. Some sedimentation of the stream resulting from implementation of Alternative Plans 1 and 2 would be anticipated. Sedimentation in both cases would involve only the extremities of the newly constructed flood control channels. Most of the excavation and concrete lining of the channels would be completed prior to tying in to the existing stream and the Wailuku River (Alternative 2). Siltation would only occur when the channels are tied-in and the sediment source would be limited in area. Minimization of these impacts would be effected by employment of construction methods that do not create excessive or unnecessary dust, hydrocarbon emmission, noise or turbidity. Environmental protection procedures and controls would be included in the project plans and specifications to insure compliance with applicable air, noise and water pollution regulations during construction operations. Construction noise and air pollution may have severe localized effects on particular individuals residing or working immediately adjacent (within 25 feet) to the project construction work area. These effects may have to be individually dealt with by special protective or preventative measures.

(2) Man-made or natural resources, aesthetic values, community cohesion and availability of public facilities and services: Destruction or disruption of the above resources as a consequence of project implementation would be minimal except as previously discussed and are not considered significant. Alternative Plan 1 would realign an existing channelized segment of the stream and would have no effect on stream habitat, aquatic or wildlife resources. There is a possibility that construction activities would result in a temporary increase in suspended sediment in the lower reach of the stream and Waiolama Canal. Adverse effects to aquatic biota in Waiolama Canal from this source are not anticipated. Alternative Plan 2 would provide a diversion channel from Alenaio Stream to the Wailuku River. A limited area of streambed would be disturbed at the site of the diversion. Because the stream is ephemeral, aquatic biota are limited. The species that do occur in the stream are predominantly introduced species. Stream flows below the diversion during periods of high rainfall would be sufficient to sustain the existing aquatic community. Siltation resulting from project construction activities would be temporary and would not adversely affect aquatic resources in Alenaio Stream or Wailua River. Alternative Plan 3 does not involve stream modification and would have no effect on aquatic or wildlife resources.

(3) Employment effects and tax and property value. Adverse employment effects and tax value losses would not result from implementation of the project. Property value losses and gains may both result from implementation of Alternatives 1 and 2, particularly Alternative Plan 2 as noted in Para. 5d. Residential property abutting the diversion channel may decrease or increase in value and marketability.

(4) Displacement of people, businesses and farms. The removal, relocation or modification of structures will be required with implementation of any of the three proposed alternatives. The Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970 (PL 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. No injurious displacement of currently operating farms will result from any of the project alternatives.

6. Public Involvement

a. Public Involvement Program. Government officials and agencies were notified by letter on 2 July 1979 of the initiation of flood damage reduction studies.

A formal public meeting was held on 4 June 1980 to give the public an opportunity to express their views and comments on the direction of the study. A transcript of this meeting is provided in Appendix B.

A notice of intent to prepare a Draft Environmental Impact Statement for this study was published in the Federal Register in 1980 to notify those interested in contributing to the preparation of the DEIS.

An informal public workshop was held on 10 December 1980 to inform and discuss with the public the current planning status. The public was given the opportunity to comment on the plan formulation process and tentative plans being carried into further detail.

The Draft Environmental Impact Statement was filed with the US Environmental Protection Agency and a notice of availability was published in the Federal Register on 7 May 1982. A minimum forty-five (45)-day comment period from the date of publication in the Federal Register was made available to those who desired to review and comment. The Draft Survey Report and Environmental Impact Statement was circulated to Federal and local governmental agencies and interested citizens. The report was made available to the general community through the Hawaii Public Library and County Department of Public Works.

A public meeting was held on 12 June 1982 at the County Council Room in Hilo where the public was given the opportunity to comment on the Draft Environmental Impact Statement and the final array of alternatives prior to formally selecting and recommending a plan. A transcript of this meeting is provided in Section II of the Survey Report. All public comments from the draft report are documented in Section III of the report.

The Final Survey Report and Environmental Impact Statement will be forwarded to the Board of Engineers and Harbors (BERH) for its review. The BERH is an independent review agency of the US Army Corps of Engineers. A public notice will be circulated upon completion of the final report informing the public of the recommended plan. Further comments or statements should be mailed directly to the Board of Engineers for Rivers and Harbors, Kingman Building, Fort Belvoir, VA 22060.

b. Required Coordination.

(1) Coordination was initiated with the U.S Fish and Wildlife Service at the inception of the study to fulfill the requirements of the Fish and Wildlife Coordination Act. A preliminary report was submitted by FWS on 26 November 1980 describing fish and wildlife resources in the project area, and was utilized as a planning aid during the study. A draft FWCA report was submitted in Dec 1981 which evaluated impacts of various alternatives and made recommendations on mitigation and reducing impacts. The final FWCA report was submitted to the Corps on 18 June 1982 (Appendix G). Report recommendations are as follows:

(a) Natural streambed be maintained in all reaches of the stream affected by realignment and channelization.

(b) Streamside vegetation be maintained or replanted, as necessary, to provide shading for the stream.

(c) Realigned and channelized sections incorporate a low-flow channel to concentrate flows and take advantage of natural shading.

(d) Bridge culverts should be minimal in length and installed in such a way that the downstream terminus will not be above stream level.

(e) The channel between Kilauea Avenue and Kinoole Street be restored to a natural (unlined) streambed or incorporate a low-flow channel to concentrate flows.

(f) If practicable, the weir above Kinoole Street be modified to permit a greater volume of low to moderate instream flows to discharge into Waialama Canal.

(g) Construction methods should minimize streambed and bank disturbance and prevent excessive sedimentation of downstream habitat.

Recommendations (b), (d), (f), and (g) will be incorporated in the environmental protection guidelines of the construction specifications during the Advance Engineering and Design phase. Recommendations (a), (c), and (e) cannot be accepted for the following reasons:

(a) The natural streambed will need to be channelized with concrete in order to prevent erosion and undermining of the channel walls and to maximize the efficiency of the channel in order to minimize the required channel width and depth.

(c) A low-flow channel would have little if any value in reach of stream affected by the proposed channelization. The stream is ephemeral and flows in the affected reach only during periods of relatively high rainfall. Aquatic fauna throughout the stream are poorly developed as a consequence. The increased cost of providing a low-flow channel would not be justified in this case.

(e) The channel between Kilauea Avenue and Kinoole Street cannot economically be restored to a natural (unlined) streambed. A concrete channel is proposed to accommodate the design channel velocity and to maximize the channel capacity in order to minimize the channel width and depth thereby minimizing necessary relocatio n of homes and businesses along the stream.

(2) Endangered species coordination with the FWS Endangered Species Office was completed in August 1980.

(3) The State Historic Preservation Officer (SHPO) was given an opportunity to review both the draft report and EIS and also the Bishop Museum Archaeological and Historical Studies report. The SHPO made no adverse comments about the DEIS and verbal communication with SHPO staff indicates that the SHPO fully concurs with the conclusions and recommendations of the Bishop Museum report. No formal written review was received.

(4) A coastal zone consistency determination report is provided in Appendix A of the Detailed Project Report and has been submitted for review by the State Coastal Zone Management Office. The consistency evaluation summarizes the project's conformance with the policies of the Hawaii State Coastal Zone Management Program. A letter of concurrence was received from the State CZM office.

(5) The U.S. Environmental Protection Agency and the State Department of Health have had the opportunity to review and comment on the Draft Survey Report and Draft Environmental Impact Statement (DEIS) to evaluate the effects of the project on water, air and noise quality. The State Department of Health had provided a water quality certification in accordance with Section 404(r) of the Clean Water Act of 1977.

c. Statement Recipients. A list of agencies, groups and individuals who will receive copies of the combined Draft Environmental Impact Statement and Draft Survey Report for review is provided in Appendix B of the report.

d. Public Views and Responses. During a public meeting presided by the Deputy District Engineer, held 4 June 1980 at the Hawaii County Council Room, the preponderance of public testimony supported the need for flood control measures within the Alenaio Stream floodplain to reduce property damage by flood waters from Alenaio Stream. An informal public workshop was held on 10 December 1980 during which the public was given the opportunity to comment on the progress of plan formulation activities and the tentative plans being carried into more detailed evaluation.

A public meeting was held on 12 June 1982 at the County Council Room in Hilo to obtain the public's views on the alternative plans provided in the draft report and EIS. Public views and concerns expressed at that meeting and written comments received during the review period were given due consideration in the selection of the recommended flood control plan.

7. INDEX TO REFERENCES & APPENDICES

TABLE EIS-4. Index to References & Appendices
ALENAIO STREAM FLOOD CONTROL
HILO, HAWAII

ALENAIO STREAM

Plan Formulation Criteria and Compliance Reports Appendix

APPENDIX A

APPENDIX A

ALENAIO STREAM
FLOOD DAMAGE REDUCTION STUDY

PLAN FORMULATION CRITERIA AND
COMPLIANCE REPORTS APPENDIX

TABLE OF CONTENTS

LIST OF TABLES

I. PLAN FORMULATION CRITERIA

A. STUDY (LEGISLATURE) AUTHORITY

This study was prepared under the authority of Section 209 of the Flood Control Act of 1962 (Public Law 87-874) which states:

"The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the following named localities:

Provided, That after the regular or formal reports made on any survey are submitted to Congress, no supplemental or additional report or estimate shall be made unless authorized by law except that the Secretary of the Army may cause a review of any examination or survey to be made and a report thereon submitted to Congress, if such review is required by the national defense or by changed physical or economic conditions: Provided further, That the Government shall not be deemed to have entered upon any project for the improvement of any waterway or harbor mentioned in this title until the project for the proposed work shall have been adopted by law:

.... Harbors and rivers in Hawaii, with a view to determining the advisability of improvements in the interest of navigation, flood control, hydroelectric power development, water supply, and other beneficial water uses, and related land resources ...."

B. ASSURANCE OF LOCAL COOPERATION

Section 221 of the River and Harbor and Flood Control Act of 1970 (Public Law 91-611) provides that the construction of any water resources project by the Corps shall not be commenced until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project. Federal participation in the proposed project is subject to the condition that local interest would:

(1) Provide, without cost to the United States, all lands, easements and rights-of-way necessary for the construction of the project; including spoil disposal and borrow and access thereto required for construction and maintenance.

(2) Hold and save the United States free from damages due to the construction, operation, and maintenance of the project except where such damages are due to the fault or negligence of the United States or its contractors.

(3) Maintain and operate the project, or integral parts thereof, in accordance with regulations prescribed by the Secretary of the Army.

(4) Accomplish without cost to the United States all alterations and relocations of buildings, streets, storm drains, utilities, highway bridges, and other structures made necessary by the construction.

(5) Prescribe and enforce the floodplain management regulations for the floodplain.

(6) Maintain eligibility under the National Flood Insurance Program.

(7) Comply with the provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (PL 91-646).

(8) Comply with Title VI of the Civil Rights Act of 1964 (PL 88-352).

C. PLANNING CRITERIA AND CONTRAINTS

Institutional Policies. Several institutional policies of the Federal government affect the design and decisions for local and Federal participation. Executive policies are issued through the Office of Management and Budget (OMB), the Water Resources Council (WRC) and the Council of Environmental Quality (CEQ). Legislative policies are expressed by various legislative enactments of Congress which has developed a body of laws establishing national concerns regarding the nation's natural resources. The Principles and Standards of 1980 (18 CFR 711 et seq dtd 29 Sep 1980) provides the basic framework for Federal agencies in formulating and evaluating alternative plans for Level C implementation studies. Level C implementation studies are defined as project feasibility studies which are expected to result in project authorization. The Corps of Engineers regulations (ER) are specific guidelines to implement the P&S as well as other legislative laws (i.e., NEPA) within the Corps' civil works programs.

Design/Benefit Criteria. In developing justification for Federal participation, technical and economic evaluation policies, standards, principles, and procedures are established in determining a benefit to cost comparison. All projects must have a benefit to cost comparison. A recommended plan must usually have a combined beneficial NED and EQ effects that outweigh combined adverse NED and EQ effects for Federal participation.

Regulatory/Environmental Requirements. A number of statutory and regulatory requirements of the Federal government must be complied with during the planning process. These requirements largely relate to the assessment and evaluation of possible impacts on the environmental resources of the project area. The major requirements include:

National Environmental Policy Act of 1969 (Public Law 91-190). The National Environmental Policy Act (NEPA) requires an environmental statement in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment.

Clean Water Act of 1977 (Public Law 95-217). This act was formerly known as the Federal Water Pollution Control Act Amendments of 1972. The requirement is to evaluate discharge effects of dredged or fill materials into waters of the United States.

Coastal Zone Management Act of 1972 (Public Law 92-583). This act requires that the project must comply with the Federal law as well as be consistent with the Coastal Management Program for the State of Hawaii.

Endangered Species Act of 1973 (Public Law 93-205). The implementing agency shall coordinate with the appropriate Federal wildlfe agency to determine the presence of listed endangered or threatened species or their critical habitat may be present in the area of proposed action. The results of the assessment shall be contained in the EIS.

Fish and Wildlife Coordination Act of 1958 (Public Law 85-624). This act requires any Federal agency proposing to impound, divert, or modify the channel of any stream or other body of water to consult with the Department of Interior, U.S. Fish and Wildlife Service (USFWS) and the head of the State or Territorial agency exercising control over fish and wildlife resources, concerning the impacts of such action. The USFWS shall prepare a report on compliance with Section 2(b) of this act, a report recommending methods to mitigate impacts of the proposed action and to conserve fish and wildlife resources.

Marine Protection, Research, and Sanctuaries Act of 1972 (Public Law 92-532). This act regulates the evaluation of the need and transportation of dredged material for the purpose of dumping in ocean waters. In the case of this project, there is no specific need to provide an ocean dump site for excess construction materials.

National Historic Preservation Act of 1966 (Public Law 89-635). Section 106 of this act requires that Federal agencies shall, prior to the approval of the expenditure of any funds on an undertaking, or prior to the issuance of any license, as the case may be, take into account the effect of the undertaking on any property included in, or eligible for inclusion in the National Register and shall afford the Advisory Council on Historic Preservation and appropriate State agency a reasonable opportunity to comment with regard to such undertaking.

Executive Order on Floodplain Management (EO 11988). This order requires that agencies avoid the base floodplain unless it is the only practicable alternative. For potential action in the floodplain, an evaluation of effects on floodplain values, a description of other practicable alternative actions outside the floodplain, and adequate dissemination of the action to the public must be undertaken.

Executive Order on Protection of Wetland (EO 11990). This order requires the agency to analyze potential impacts of existing wetlands and associated values and to give the public early public review of proposed actions.

Wild and Scenic Rivers Act of 1968 (Public Law 90-542). This act requires agencies to identify potential impacts to designated wild and scenic rivers and to coordinate action and obtain concurrence with the U.S. Department of the Interior.

II. COMPLIANCE REPORTS

The following supplemental evaluation reports are provided:

Presidential Executive Order 11988 on Floodplain Management Evaluation Report

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

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. PROCEDURE

The basic determinations necessary to implement EO 11988 are stated in Section 2 of the EO and are summarized in the following paragrahs:

a. Determine whether the proposed action is in the base floodplain. The base floodplain is defined in Section 6 of EO 11988 as the area inundated by a flood with a 1 percent chance of occurrence in any given year.

b. Determine whether there is a practicable alternative to locating the action in the base floodplain. The "action" is 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.

c. Identify adverse impacts due to the action and any induced development and identify losses of natural and beneficial values of the floodplain.

d. If the proposed action induces development in the base floodplain, determine if there is a practicable alternative to the development. The decision on whether a practicable alternative exists is to be based on the advantages and disadvantages of floodplain and non-floodplain sites. Factors to be considered include water resources; conservation; economics; aesthetics, natural and beneficial values served by the floodplains; impacts of floods on human safety; locational advantage relative to availability of housing, education, and work force; the functional need for locating the development in the floodplain; historic values; fish and wildlife habitat values; endangered and threatened species; support of municipal infrastructure; energy conservation; cost effectiveness; enhancement of work opportunities for economically disadvantaged minorities; and in general the needs and welfare of the people.

e. Determine viable methods to minimize the adverse impacts of the action and any induced development and methods to restore and preserve the natural and beneficial values of the floodplain.

f. Advise the general public if the proposed action will be located in the floodplain.

g. Recommend the most desirable plan responsive to the established planning objectives and consistent with the requirements of the Executive Order.

3. COMPLIANCE

a. Proposed Location. The proposed action for the Alenaio Stream study area is located within the base flood. The base flood is defined as the one percent (1%) exceedance frequency floodplain.

b. Other practical alternatives to locating the action in the base floodplain.

A broad spectrum of measures were investigated where three (3) alternatives were carried into detailed studies. The only practical effective measure which locates the action outside the floodplain is relocating/floodproofing each individual structure. This however will not remove the inherent nature and danger of flooding within the community, as the community will still continue to be inundated by floodwaters requiring cleanup activities during the post-flood period. The very nature and purpose of flood control measures often places many practical and effective measures within the floodplain. Consequently, developing feasible alternatives located outside the base floodplain at times becomes difficult and impractical.

c. Identify impacts due to the proposed action, any induced development and losses of natural and beneficial values of the floodplain.

Ecological. Minimum ecological impacts are expected as no significant habitats, existing streambeds, or ecologically significant areas will be lost or jeopardized as a result of the implementation of any of the three alternatives.

Historical/Archaeological. No cultural or archaeological resources are expected to be impacted by the three alternatives based on historical research of the area and field surveys by our Contractor, Bishop Museum. Coordination with the State Historic Preservation Officer indicated concurrence with our assessment.

Social. All the alternatives require some alteration or relocation of individual residential or commercial structures. Temporary impacts, such as restriction of vehicular traffic, will occur during construction activities.

d. If the proposed action induces development in the base floodplain, determine if there is a practical alternative to the development.

Structural Alternatives 1 and 2 will essentially reduce the base floodplain (1% exceedance frequency) to within the Alenaio Stream channel. Alternative 2 will confine the floodplain to within its stream channel while Alternative 1 will create a floodplain below Kilauea Avenue along the Hilo Bay front. Current land-use regulations however, prohibits development of this area as it is zoned as open-space due to tsunami hazards. Alternative 3 will not reduce the 100-year floodplain but will control future development through compliance with the floodplain management policies being incorporated with this alternative and through the participation in the Federal Flood Insurance Program requirements. All three proposed alternatives will prohibit future development within the 100-year base floodplain thereby minimizing induced development.

e. Determine viable methods to minimize adverse impacts and methods to restore and preserve the natural and beneficial values of the floodplain.

Floodplain management measures will be an integral part of all three proposed alternative plans which will prohibit future development and will minimize adverse impacts in the 100-year floodplain. The US Fish and Wildlife Service will in their Section 2(b) report recommend measures which will minimize, avoid or mitigate adverse fish and wildlife impacts due to any of the three alternatives. Coordination with the State Historic Preservation Officer will insure that no alternative will adversely affect any existing or potentially eligible historic property or that adequate mitigation measures are implemented. Other measures that will help to minimize adverse impacts include the following:

(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 County of Hawaii is officially participating into the program as of May 1982.

(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 incorporates 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 had the opportunity to address and comment on this action during a formal public meeting held on 12 May 1982. All public comments are documented in the Final Report and Environmental Statement (Appendix B).

g. Recommendation of the most desirable plan.

Alternative 1 is the recommended plan because it maximizes net benefits and minimizes adverse environmental impacts.

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

FACTORS (EO11988)	ADVANTAGES OF FLOODPLAIN	DISADVANTAGES OF FLOODPLAIN
Water Resources	None.	None.
Conservation	None.	None.
Economics	Human economic activities are currently concentrated on floodplain area.	Human economic activities are subject to periodic flooding.
Aesthetics	None.	May degrade aesthetic appeal of open floodplain.
Natural and 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 downtown Hilo and surrounding areas.	None.
Historic Values	Downtown Hilo has historically been the center of Government, finance, and business for County.	None.
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.
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. 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

I. Project Description

a. Location: Alenaio Stream, Hilo
Island of Hawaii

b. General Description: The Honolulu District, U.S. Army Corps of Engineers, has investigated public concerns and needs associated with flood damage reduction measures in the Alenaio Stream floodplain, and impacts upon the environmental, social, cultural and economic resources of the area. Three alternative plans have been developed, consistent with national and local goals and the primary objective of reducing property damage by floodwaters from Alenaio Stream. Alternative Plan 1, the recommended plan, consists of both structural and nonstructural measures: floodplain management, floodproofing and modification of 1640 feet of existing stream between Kapiolani Street and Kilauea Avenue. Alternative Plan 2 specifies a 4200 foot concrete lined diversion channel from Alenaio Stream above Komohana Street to Waikapu Gulch and the Wailuku River. Alternative Plan 3 is the non-structural plan involving floodproofing and relocation.

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 to Congress solutions to the problems 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 Alenaio Stream floodplain. This report documents the results of the US Army Corps of Engineers' planning process and is used to determined whether further Federal participation is warranted under the study authority.

d. General Descriptions of Dredged or Fill Materials:

	Alternatives 1	2	3
(1) General Characteristics of the Material.	Concrete consisting of cement, aggregates and water with reinforcements bars.		NA 1/
(2) Quantity of Material to be Discharged 2/	11,950 CY (SPF) 9,330 CY (100 yr)	32,070 CY (SPF) 24,540 CY (100 yr)	NA
(3) Source of the Material	Aggregates will probably come from existing quarries in the vicinity of Hilo. Cement will be factory produced.		NA

	Alternatives 1	2	3
e. Description of the proposed discharge site:			
(1) Location (See map pp 59 and 64 of Main Report)	Create new aligned channel between Kapiolani St. and Kilauea Ave. for 1640'.	Create new diversion channel from Komohana St. into the Wailuku River for 4400'.	NA
(2) Size (acres)	10 Acres	15 Acres	NA
(3) Type of site	Confined	Confined	
(4) Type(s) of Habitat	Ephemeral stream and urban area.	Ephemeral stream and agricultural lands.	NA
(5) Timing and Duration of discharge	The project will probably be implemented within 5 to 8 years. Alt. 1 and 2 will take 24 to 30 months to construct.		NA
f. Description of Disposal Method:			
(1) Method of discharge.	Material will be used to construct channel wall at the discharge site. Material will be placed by crane into form work along new channel.		NA

1/ NA: not applicable

2/ Material includes concrete and bedding

II. Factual Determinations

a. Physical Substrate Determinations

(1) Substrate elevation & slope	0 to 30' MSL	240' to 220' MSL	NA
(2) Sediment Type	(pp. C-11-19)		NA
(3) Dredged/Fill Material Movement	NA	NA	NA
(4) Physical Effects on Benthos	burial	burial	NA
(5) Other Effects	NA	NA	NA
(6) Actions Taken to Minimize Impacts	NA	NA	NA

b. Water Circulation, Fluctuation and Salinity Determination

	Alternatives 1	2	3
(1) Water, Effects on:			
(a) Salinity	No effect	No effect	NA
(b) Water Chemistry	No effect	No effect	NA
(c) Clarity	Possible increased	clarity	NA
(d) Color	No effect	No effect	NA
(e) Odor	No effect	No effect	NA
(f) Taste	No effect	No effect	NA
(g) Dissolved gas levels	Possible slight reduction		NA
(h) Nutrients	No effect	No effect	NA
(2) Current Patterns and Circulation			
(a) Current Patterns and Flow	No effect	New diversion channel will divert floodflows into Wailuku River.	NA
(b) Velocity	Increased in lower stream reach	Increased in lower stream reach	NA
(c) Stratification	No effect	No effect	NA
(d) Hydrologic Regime	No effect	No effect	NA
(3) Normal Water Level Fluctuations	No effect	No effect	NA

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

	Alternatives 1	2	3
(4) Salinity gradients	No effect	No effect	NA
(5) Actions that will be taken to minimize impacts	NA	NA	NA
c. Suspended Particulate/Turbidity Determination			
(1) Expected changes in suspended particulate and turbidity levels in vicinity of disposal site.	No effect	No effect	NA
(2) Effects (degree and duration) on Chemical and Physical Properties of the Water Column			
(a) Light Penetration	No effect	No effect	NA
(b) Dissolved Oxygen	No effect	No effect	NA
(c) Toxic Metals and Organics	No effect	No effect	NA
(d) Pathogens	No effect	No effect	NA
(e) Aesthetics	Natural streambed converted to concrete channels		
(3) Effects on Biota			
(a) Primary Production, Photosynthesis	No effect	No effect	NA
(b) Suspension/Filter Feeders	No effect	No effect	NA
(c) Sight Feeders	No effect	No effect	NA
(4) Actions taken to Minimize Impacts	NA	NA	NA
d. Contaminant Determination The proposed discharge is free of contaminants	NA	NA	NA
			NA
e. Aquatic Ecosystem and Organism Determinations The proposed discharge is free of contaminants			NA
f. Proposed Disposal Site Determinations			
(1) Mixing Zone Determination	NA	NA	NA
(2) Determination of Compliance with Applicable Water Quality Standards	NA	NA	NA
(3) Potential Effects on Human Use Characteristics	No effect	No effect	NA

		Alternatives		
		1	2	3
g.	Determination of Cumulative Effects on the Aquatic Ecosystems	No effect	No effect	NA
h.	Determination of Secondary Effects on the Aquatic Ecosystem	No effect	No effect	NA

Finding of Compliance
for
Alenaio Stream Flood Control Study

1. No significant adaptations of the guidelines were made relative to this evaluation.

2. The discharge (concrete) is necessary to construct channel walls and invest for proposed comprehensive flood control measures for Alenaio Stream. The discharge site is project specific; there are no practicable alternatives to the proposed discharge site that would achieve the desired project purpose. The discharge will not result in significant adverse impacts on the aquatic ecosystem.

3. The discharge of concrete material at the site would not violate any applicable State Water Quality Standards. Nor would it violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

4. The discharge of fill material at the proposed site will not harm any endangered species or their critical habitat.

5. The proposed discharge will not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic life and other wildlife will not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic and economic values will not occur.

6. On the basis of the quidelines, the proposed site for the discharge of fill material is specified as complying with the requirements of these guidelines.

11/9/82
Date

ALFRED J. THIEDE
Colonel, Corps of Engineers
District Engineer

C. FEDERAL COASTAL ZONE MANAGEMENT (CZM) CONSISTENCY EVALUATION 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 Alenaio Stream Flood Damage Reduction Study located at Hilo, Island of Hawaii will involve construction within the CZM area. Three alternatives were investigated in detail and include (1) modifying the existing stream, (2) constructing a diversion channel into the Wailuku River and (3) incorporating floodproofing or relocating individual structures outside the floodplain. This study was requested by the County of Hawaii. 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 meets 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, identifying and providing water-contact recreational opportunities were evaluated. 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 will be conducted by a qualified archaeologist which will identify and analyze any potential archaeological resources in the study area. Construction specifications will detail procedures for avoiding or mitigating potential impacts on any existing archaeological resource and with any others discovered during project construction.

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.

All proposed actions dealing with the identification, protection, restoration, interpretation and display of historic resources will be coordinated with the State Historic Preservation Officer for their review and concurrence.

SECTION 205A-2(b)(3), SCENIC AND OPEN SPACE RESOURCES

Objective: Protect, preserve and, where desirable, restore or improve the quality of coastal scenic and open space resources.

Policies:

a. Identify valued scenic resources in the CZM area.

No significant, valued scenic resources or open space will be affected by the proposed alternatives. The diversion into the Wailuku River is not situated near the scenic portions of the river (Rainbow Falls).

b. Insure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural land forms and existing public views to and along the shoreline.

Alternative 1 will require enlarging and realigning the original concrete channel of approximately 1640' and the removal of existing structures along the new alignment. The old alignment will be landscaped with trees and shrubbery to minimize visual impacts. Alternative 2 will create a new visual element of a concrete channel approximately 25' wide from Alenaio Stream into the Wailuku River. The outlet into the Wailuku River will be designed to appear as a natural waterfall to minimize visual impacts. Alternative 3 will require the alteration of individual structures. The alterations can be made consistent with the architectural style of the community.

c. Preserve, maintain and, where desirable, improve and restore shoreline open space and scenic resources.

Alternative 2 will provide a new visual element into the landscape and on the Wailuku River. Alternatives 1 and 3 will not degrade any open space or scenic resources.

d. Encourage those developments which are not coastal dependent to locate in inland areas.

Federal participation into the proposed alternatives will require compliance with various Federal regulations, programs and policies which encourages developments which are not coastal dependent to be located outside the coastal and flood zone.

SECTION 205A-2(b)(4), COASTAL ECOSYSTEMS

Objective: Protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems.

Policies:

a. Improve the technical basis for natural resource management.

Fish and wildlife base line inventories and studies were performed with the US Fish and Wildlife Service, Department of the Interior, to provide the technical basis of potential ecological impacts. Geotechnical investigations conducted by the USGS will improve subsurface technical knowledge regarding lava tubes and springs prevalent in the study area.

b. Preserve valuable coastal ecosystems of significant biological or economic importance.

The proposed alternatives will not affect any valuable coastal ecosystem of economic or biological importance.

c. Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs.

The US Fish and Wildlife Service will provide in their Section 2(b) report their assessment and evaluation on the impacts of the selected plan upon fish and wildlife resources and recommendations to minimize, mitigate or avoid adverse effects. Federal implementation is dependent on the compliance of State and local water quality and discharge standards and certification requirements.

d. Promote water quantity and quality planning and management practices which reflect the tolerance of fresh water and marine ecosystems and prohibit land and water uses which violate State water quality standards.

Federal participation requires compliance with all State water quality standards. Construction specification will require maintaining water quality standards to the maximum extent practicable.

SECTION 205A-2(b)(5), ECONOMIC USES

Objective: Provide public or private facilities and improvements important to the State's economy in suitable locations.

Policies:

a. Concentrate in appropriate areas the location of coastal dependent development necessary to the States's economy.

The proposed flood control improvements will benefit the community of Hilo, especially the downtown commercial area by reducing the potential of flood damages and the cost of post-flood cleanup and repair activities.

b. Insure that coastal dependent development such as harbors and ports, visitor industry facilities, and energy generating facilities are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the CZM area.

Coordination with other Federal and State governmental planning agencies and special interest groups will help identify and establish social values to avoid, minimize or mitigate possible adverse impacts.

c. Direct the location and expansion of coastal dependent developments to areas presently designated and used for such development and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:

(1) Utilization of presently designated locations is not feasible.

(2) Adverse environmental effects are minimized.

(3) Important to the State's economy.

The proposed alternatives will not directly induce coastal dependent developments as these alternatives will not reduce the threat of tsunami hazards, storm waves or coastal flooding. The coastal area of the watershed is zone "O," used for open space, park and recreation (Ordinance No. 187, Section 7.29).

SECTION 205A-2(b)(6), COASTAL HAZARDS

Objective: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, and subsidence.

Policies:

a. Develop and communicate adequate information on storm wave, tsunami, flood, erosion, and subsidence hazard.

Detailed hydrologic and hydraulic studies will provide information on the flood hazards and will produce a floodplain outline map. Public workshops and meetings, the project document and the review process will provide mechanisms in communicating this information to the general public and governmental planning agencies.

b. Control development in areas subject to storm wave, tsunami, flood, erosion, and subsidence hazard.

Federal participation of any proposed plan will require compliance to:

(1) the Federal Flood Insurance Program which will require restrictions in developing the base floodplain;

(2) Executive Order 11988 on floodplain management which requires that all Federal activities avoid developing the base floodplain unless it is the only practical alternative; and

(3) Floodplain management measures which are being incorporated into the overall proposed alternatives.

The compliance to these requirements will contribute in controlling development in areas subject to flood hazards.

c. Ensure that developments comply with requirements of the Federal Flood Insurance Program.

Federal participation in any project will require compliance with the Federal Flood Insurance Program.

d. Prevent coastal flooding from inland projects.

The proposed alternatives will not change existing coastal flooding patterns.

SECTION 205A-2(b)(7), MANAGING DEVELOPMENT

Objective: Improve the development review process, communication, and public participation in the management of coastal resources and hazards.

Policies:

a. Effectively utilize and implement existing law to the maximum extent possible in managing present and future coastal zone development.

The project planning process utilizes and implements existing Federal, State, and County laws and ordinances as well as existing Federal and US Army Corps of Engineers regulations.

b. Facilitate timely processing of application for development permits and resolve conflicting permit requirements.

The implementation of project planning facilitates timely processing of permit applications to the maximum extent practicable.

c. Communicate the potential short- and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the general public to facilitate public participation in the planning and review process.

The report document and environmental impact statement discuss all potential short- and long-term impacts relative to the project. Significant impacts was discussed at a public meeting where the general public had the opportunity to formally document their concerns and comments. The report document was circulated for review to governmental agencies and the interested public prior to the public meeting. A public notice will be distributed to the general public notifying them of the final recommendations of the project report.

ALENAIO STREAM

PUBLIC INVOLVEMENT PROGRAM APPENDIX

APPENDIX B

APPENDIX B

ALENAIO STREAM
FLOOD DAMAGE REDUCTION STUDY

PUBLIC INVOLVEMENT PROGRAM APPENDIX

TABLE OF CONTENTS

I. PUBLIC INVOLVEMENT PROGRAM

OBJECTIVES

To insure that the desires and needs of the public were identified and considered, a public involvement program was developed. The public, as broadly interpreted by the U.S. Army Corps of Engineers, is any affected or interested non-Corps of Engineers entity; other Federal and Territorial government entities and officials; public and private organizations, and individuals. The public participation program is directed to maintaining information flow, achieving a mutual understanding and acceptance of the problems and opportunities, and attainment of interest level for proper decision making.

The objectives of the public participation program are:

a. To inform citizens of the current Corps of Engineers planning process and direction.

b. To surface key planning issues and concerns so that they are given full consideration.

c. To help formulate and review potential plans and improvement.

d. To offer technical, historical, and localized information pertinent to the study.

e. To provide a communicative forum between the Corps, local agencies, advocacy groups, and interested citizens on the subject plan and problems.

TECHNIQUES

The types of public participation forums in this study are small meetings, workshops, and formal meetings:

a. Informal Meetings.

These meetings are of less than 10 persons with specific invited agency personnel, group representatives, or citizens. These meetings are undertaken at various intervals throughout the study to help the planners obtain information and address certain issues.

b. Workshops.

These meetings are informal exchange sessions open to the general public and usually numbering from 10 to 50 persons. The purpose is to promote the full airing of various views in recognition of current Corps' planning efforts. Public information notices and fact sheets are issued to all interested parties prior to the meeting.

c. Public Meeting.

A formal public meeting will be held at key points in the study effort. The purpose is to notify all interested parties of the planning effort to date and to obtain specific views on various items of the agenda. The meeting, conducted by the District Engineer, will include a summary of findings to date, an informal question and answer period, a presentation of formal statements by others, and tentative conclusions. A public notice of the meeting is issued to the media and the general public invited. All information and statements are documented as part of the planning record.

ACTIVITIES CONDUCTED

Government officials and agencies were notified by letter on 2 July 1979 of the initiation of flood damage reduction studies.

A formal public meeting was held on 4 June 1980 to give the public an opportunity to express their views and comments on the direction of the study. A transcript of this meeting is provided in Section II.

A notice of intent to prepare a Draft Environmental Impact Statement for this study was published in the Federal Register to notify those interested in contributing to the preparation of the DEIS.

An informal public workshop was held on 10 December 1980 to inform and discuss with the public the stage 2 planning status. The public was given the opportunity to comment on the plan formulation process and tentative plans being carried into further detail.

The Draft Environmental Impact Statement was filed with the US Environmental Protection Agency and a notice of availability was published in the Federal Register on 7 May 1982. A minimum forty-five (45) day comment period from the date of publication in the Federal Register was made available to those who wish to review and comment. The Draft Survey Report and Environmental Impact Statement was circulated to Federal and local governmental agencies and interested citizens. The report was made available to the general community through the Hawaii Public Library and County Department of Public Works.

A public meeting was held on 12 June 1982 at the County Council Room in Hilo where the public was given the opportunity to comment on the Draft Environmental Impact Statement and the final array of alternatives prior to formally selecting and recommending a plan. A transcript of this meeting is provided in Section II. All public comments from the draft report are documented in Section III.

FUTURE COORDINATION

The Final Survey Report and Environmental Impact Statement will be forwarded to the Board of Engineers and Harbors (BERH) for its review. The BERH is an independent review agency of the US Army Corps of Engineers.

A public notice will be circulated upon completion of the final report informing the public of the recommended plan. Further comments or statements should be mailed directly to the Board of Engineers for Rivers and Harbors, Kingman Building, Fort Belvoir, VA 22060.

Should the Board contemplate action different from the recommendations of the District Engineer, appropriate notice to that effect will be furnished to local interests, inviting their views and comments prior to final action by the Board.

After the Board completes its independent review and makes its recommendations on the final report, the authorization process will continue to the Office of the Chief of Engineers, Secretary of the Army and Congress.

II. PUBLIC MEETINGS

Public meetings presided by the (Deputy) District Engineer were held on 4 June 1980 and 12 June 1982 at the Hawaii County Council Room. Public notices were mailed to the general public, governmental agencies, the media and interested parties. The following are transcripts of these meetings.

PUBLIC MEETING HELD ON 4 JUNE 1980

LIST OF ATTENDEES

Federal - Corps of Engineers
Lt Col Kenneth E. Sprague, District Engineer
James Ligh
William Hunt
Frank Rezac
Sue Kim

Federal - Other Agencies
Robert D. Doty, U.S. Forest Service
Warren Kanai, Soil Conservation Service
Larry Soenen, Soil Conservation Service

County of Hawaii - Elected
Merle K. Lai, Hawaii County Council

County of Hawaii - Other Agencies
Arthur Isemoto, Deputy Chief Engineer, Department of Public Works
Masayoshi Onuma, Planning Department
Mel Ozeki, County of Council (Analyst)
Ted Tanaka, County of Hawaii

Individuals
Michaele Aiona
William T. Aiona
Sherry Amundson
Patricia G. Engelhard
Patricia G. Forbes
R. Gregg Hall
Hiroshi Hashimoto
I. Hashimoto
Hiro Hayashi
Susan Irvine

Individuals (contd)
Manuel Jardine
Herbert A. Kai
Yasuko Kameda
Kumio Kihara
Yoshie Kihara
Duane Kanuha
Hiroko Kawaoka
Morris Kihara
Asawo Kodani
Orlando H. Lyman
Robert Mishima
Etsuro Murakami
Fumie Nakamichi
Tadashi Nakamoto
T. Nakayama

PUBLIC MEETING HELD ON 12 MAY 1982

LIST OF ATTENDEES

Federal - Corps of Engineers
Major Edmund Thal, Deputy District Engineer
James Ligh
Elsie Smith
Sue Kim

Federal - Other Agencies
Larry Soenen, Soil Conservation Service
Warren Kanai, Soil Conservation Service
John Lockwood, USGS

State
Albert Ching, DLNR

County of Hawaii
Arthur Isemoto, Deputy Chief Engineer, Department of Public Works
Robert Yanabu, Department of Public Works
Lawrence Capellas, Hawaii Redevelopment Agency

Individuals
John Alicuben
Lulu Alicuben
Valta Cook
Mabel Damasco
Reverend Ralph Douglas, Hilo Church of God
Patrick Falias
Ed Fujimoto
Roy Fujimoto
Ken Fujiyama
J.W. Hanley
Glenn S. Hara
Janet Hara
Stanley Hara

Individuals (contd)
Gordon Inaba
Yoshio Inaba
Manuel Jardine
Eijiro Kaneshiro
Hiroko Kawaoka
Lloyd Kawaoka
Morris Kihara
Asawo Kodani
Susumu Maeda
Clyde Matsunaga
Ernest Mattos
Etsuro Murakami
Louise Murakami
Tadushi Nakamichi
Alva K. Nakamura
Gary Nako
John Nelson
Don Pakele
Timothy Rodriguera
Doris Sasaki
Lloyd Shimada
Takeo Shimada
Lee Straumietis
T. Myles Tamanaha
Takako Tokuuka
Earl Toma
Maricio Valera, Hawaii Electric Light Co.
Herbert Wegner
Thelma Wegner
Rodney Wong
Dale Yamamoto
Dennis Yamamoto
Mackay Yamamoto
Harry Yoda
Philip Yoshimura

TRANSCRIPT OF PUBLIC MEETING
ALENAIO STREAM FLOOD DAMAGE REDUCTION STUDY
HILO, HAWAII
4 June 1980

Mr. Isemoto: Good evening. Welcome to the public meeting on Alenaio Stream. I would like to say a few words. The Corps had made a reconnaissance report back in March 1973 under the authority of Section 205 of the 1948 Flood Control Act as amended. At that time, the federal share was limited to $1 million, and the total project cost came out to an estimated $3.8 million, which meant the County's share was $2.8 million. The County was not able to authorize such a large sum of money for further study; therefore, the additional study was not able to be accomplished at that time. In October of 1978, the County had submitted a list of possible Corps oriented projects to its Flood Plain Management Section, and Alenaio Stream was one of the possible projects that we wished the Corps would undertake. They reported back to us in November of that year that the federal share had been raised to $2 million but because of the intervening period where the construction cost is escalated, the total project, as you can understand, had increased also which made the project beyond our reach.

Last year, around July, the County was informed by the Corps of Engineers that they received authorization to initiate a flood damage reduction study for Alenaio Stream watershed under authorization of Section 209 of the Flood Control Act of 1962. This study was an appropriate one for the County in light of the recent storms. As you have been apprised by the public meeting notice issued by the Corps of Engineers, the Corps will explain its initial study and will receive comments.

At this time, it is my pleasure to introduce to you Lt Colonel Kenneth E. Sprague, Deputy Honolulu District Engineer, of the U.S. Army Corps of Engineers. He can introduce his staff with him tonight. Thank you.

Lt Col Sprague: Good evening. I'm Ken Sprague, Deputy District Engineer, for the Honolulu District. This is our emblem for the Pacific Ocean Division of which we are a part; General Hatch commands the Pacific Ocean Division which is also located in Honolulu. This public meeting tonight is for the Alenaio Stream Flood Reduction Damage study. The purpose of tonight's meeting is to present our planning efforts to date and to obtain your reactions, your opinions, and your comments concerning possible flood damage reduction measures in the Alenaio Stream floodplain.

Many of you may wonder why the Department of the Army is involved in flood control activities. The major reason is rooted in our country's history. When our country was first established, the majority of the engineers in America was from the Army. In fact, the first engineering school in the country was the United States Military Academy at West Point. Consequently, the U.S. Congress turned to the Army engineers to help develop the nation's coastal fortifications, harbors and waterways. After a severe flood in the Mississippi River in 1927, which left 200 dead and over $1 billion in 1927 dollars in damage, the U.S. Congress turned to the Department of Army and the

U.S. Corps of Engineers to study and construct flood control measures. The Army's role in such activities as flood control, navigation, and other water resources related development is known as our Civil Works program. We keep this role today. We, of course, also support the regular Army forces in our military program. Our office is in Honolulu at Fort Shafter. Our Civil Works authority stretches from Hawaii out to the Northern Marianas and Guam and south of the equator to American Samoa. We are also presently supporting the Republic of Korea through our Han River Study on possible navigational flood control measures there.

This flood damage reduction study was initiated at the request of the County of Hawaii. We are authorized to conduct studies for possible flood control measures in Hawaii under the authority of Section 209 of the Flood Control Act of 1962. We may recommend to the U.S. Congress solutions to the problem and the extent the federal government should participate in implementing the possible measures.

I would now like to cover some administrative items. At the information table, various items are available for your information and convenience. Extra copies of the public notice, brochures, and pencil and paper are available. If you would like to leave a written statement, you may hand it to me or put it on the table as you depart or give it to Mr. Frank Rezac. Also, there are some self-addressed envelopes; actually they are not self-addressed, the return address is on there. These are government envelopes and all you have to do is put the same address, and you don't even have to pay to mail it in. So, after we get done with the meeting, and many of us have our best thoughts after we've left someplace, just jot it down and send them in. We would be pleased to receive them.

We asked you to fill out a blue card so that we have a complete record of everyone who attended the meeting and to determine who would like to make an oral statement. If you have not been able to complete a blue card, please raise your hand and we will provide you with one.

Our agenda this evening is to first introduce elected officials, federal, state, and county officials who may be present, and then present our planning concepts of the study. Then we will call on anyone who wishes to make an oral statement. Finally, we will have the question and answer period. If you decide during the meeting that you have changed your mind and would like to make a statement, there will be an opportunity to do so.

We would like for you to use the microphone although you may not feel comfortable with it, but we do make a verbatim record. We want to make sure that your opinions count and the only way we can do that is to put it on tape and transcribe it, and it will become part of the official report. So, when it comes time to make statements, we have a microphone here that we will hand out to you. We would ask that you speak into it so that we can hear it over the speaker system so that our microphone for the tape recorder can pick it up. Also, please clearly state your name.

At this time I would like to recognize Councilwoman Merle Lai who I think is the only elected official here tonight. Merle? Then, we also have from the County of Hawaii, Ted Tanaka. A couple of our federal agencies are also represented: Larry Soenen from the Soil Conservation Service, and Robert Doty from the U.S. Forest Service. Do we have any other officials present tonight?

At this time I would like to introduce the members of my staff. First is Jimmy Ligh who is the project engineer and who will be presenting the project information; Mr. Frank Rezac is our Public Affairs Officer, and the one who does most of the work here is Sue Kim, our recorder. We also have another member of our staff here, Bill Hunt, who is an economist.

As part of this public meeting, we will take all comments received tonight and those we receive in the mail and include them in preparing our official reconnaissance report. This reconnaissance report will include a three-stage planning effort. This report will make a recommendation if further study is warranted. You can see the three stages up there. Stage I on the left primarily deals with project identification and what the problems really are. Now, as you go across to the second stage, you can see that that top block gets smaller and smaller. Then we look at the various alternatives and you can see that that block gets fairly large in the second stage. So right now, we are not as interested in the alternatives as we are in defining what the problem is. I'm sure that many of you will be able to help us in that tonight.

This Stage I reconnaissance report will make a recommendation if further study is warranted. Stages II and III findings will be of sufficient detail to be able to select a plan. It will also include our environmental assessment and impacts because before we can recommend Stage II findings, our preliminary reconnaissance report must show that general benefits accruing from any possible measures exceed the expected cost. Once again, you would be a great help here from your historical knowledge of what has transpired in previous flooding as to exactly what damages occurred. Before any plan is selected, a letter of assurance from the County of Hawaii must be obtained. Now, this is really a gentlemen's agreement that says, yes, the County is also interested in this. The letter indicates that the County of Hawaii supports the selected or recommended plan and will provide the local, non-federal obligations. These obligations include but are not limited to providing the necessary lands, easements, maintenance afterwards, all arrangements and relocation of utilities, buildings, etc. and its non-federal share of the project's first cost. This letter does not financially commit the County of Hawaii to the proposed project but assures the federal government that it supports and acknowledges the general plan and responsibilities of the proposed project. A contractual commitment will be necessary only after completion of detailed design just prior to construction. So, if this goes on to a recommended plan, the County of Hawaii will be asked to indicate that they do support it. We've had some misunderstandings with public officials in other areas where they think that they are signing on the dotted line which means County resources, and all we want before we spend more money on our study is an indication of what the people really want, both the people in the area and the County officials as the local sponsor. This is a statement of intent, nothing more.

This entire study process, before a contract comes out, is approximately 3 to 4 years. Now, those of you who have expectations that this winter's flooding is going to be a thing of the past, we're not going to be able to accomplish it in that time frame. One reason for the longer period is so

that all interests can be met. If we go based upon what we think are a few local interests, proceed and start on something, in the past it has been found that this is not the optimal. So the process is geared to be methodical and go through many iterations; we look at it and then we go back and look at it again to make sure that we haven't overlooked some alternative that wouldn't have been as costly, would not cause as much inconvenience and would not cause as much impact on the environment. So, this protects the environment, the interests of the people and we try to come up with the best plan we can, and it takes time.

At this time, I am going to turn the meeting over to Jimmy Ligh. Jim?

Mr. Ligh: Thank you, Colonel Sprague. This meeting is a rather informal meeting so if you have any questions on anything I have said or anything you see on the screen, please feel free to raise your hand and we will be more than happy to expound or explain in more detail. Basically, what I want to do tonight is to cover our concepts of what the problem is right now. Based on what you say tonight, we'll determine if what we have done so far is indeed correct or not and if we indeed have overlooked things that we should have looked at during the last couple of months. I'm going to cover some of the background material for the study and try to describe the floodplain and most of the floodplain talk that the technical engineering people talk about; it usually gets confusing in written form.

The first thing I want to cover is what area are we talking about, which is kind of a cue thing. This map here shows basically the drainage area, namely, where does the water come from that hits into the Alenaio Stream. The basin actually covers 11 miles up to part of the mountains and the volcanoes. The drainage basin is approximately 8.5 square miles. Unfortunately, the stream is quite ephemeral, namely, it's dry most of the time. The outline here we are talking about is the black line that you see there; that's the drainage area.

Now, as you know from this past flood, the Soils Conservation Service has been doing studies in the watershed, especially in the upper areas above Chong's bridge. They were authorized by the Department of Agriculture with their own authority, which is similar to ours, to conduct flood control studies. Their studies mostly have to do with agricultural lands so that's why they pretty much take the area above Chong's bridge. By agreement with them, we decided to take the area below Chong's bridge, approximately from here down, because the Corps of Engineers usually handles urbanized residential areas. We can justify a project more easily (in urbanized areas) than if it's farm and agricultural.

We did some preliminary analysis of what the floodplain would look like, namely, if it rained, what areas would be inundated with water. We came up with what we call a Standard Project Flood limit. The red that you see is the area that would be inundated with water; the outline that you see up there is what we call the Standard Project Flood. The Standard Project Flood is sort of a technical term that tells us what happens when there's different combinations such as high tide, maximum rainfall from past history which has accumulated, debris that would accumulate in the channel, and a couple of other hypothetical things that can happen at one time. What we came up with is this type of red outline. Now, this is only preliminary based on our analysis to date. This, of course, would be refined if we get into the next stages with more detailed studies and from analysis that we get from you to determine if this indeed is what happens. So, our initial studies are based on this type of outline.

Also, as you know, the Hilo area is subjected to tsunami floods. The outline that we have here is the 100-year tsunami; the 100-year is a definition of the probability or the chance of a tsunami occurring in the Hilo area in a hundred years.

I want to go over some of the existing conditions; I guess many of you who live there know exactly what the stream looks like. As you know, especially in the lower areas, below Komohana Street, there are a lot of culverts and there are a lot of bridge crossings. We analyzed the problem and determined that the flood problem is basically caused by the limited capacity of Alenaio Stream. We estimate that the carrying capacity of this stream is only approximately 500 cubic feet per second. That may not mean anything to you, but we are talking about magnitudes of the Standard Project Flood that we talked about or possibly 9,000 cubic feet per second. If the carrying capacity of the stream is only 500, you can see why floods occur. The excess water has to go somewhere and it overrides the banks.

Just to give you a little background on some of the drainage systems: the one that crosses Komohana which was destroyed this past 16-18 March and was replaced recently by the County of Hawaii--I believe that's what it looked like before; this is not the most recent picture. Of course, this is the second one that we are talking about, the Ululani Street culvert. This one here--it was difficult to get into the culvert area because of the high growth, but this is the one at the Kapiolani Street. This is what they call the relief concrete box drain at the Ponohawai area. This was constructed, I believe, in the late 1920's or 1930's by the local residents here or by the County. We're not sure, based on our records, when it was built to divert some of the water from the Alenaio Stream directly into Hilo Bay. The carrying capacity of this is only approximately 800 cfs. This was a wier that was put on the Alenaio Stream to somehow try to control the water. I think at that time, they had a lot of problems with localized flooding in that particular area. This is another channel; it's I believe at Kinoole Street. This is the trapezoidal concrete channel that was put in between Kinoole Street and Kilauea Avenue. This is one of the bridge openings that somehow constricts water; this one is at Kilauea Avenue. This is the upstream side and this is the downstream side. This is the Waiakea Canal. The carrying capacity of this is also quite small; engineering-wise it is not the size of a channel but the ability of it to transport water. This has a very flat slope, so the ability of it to transport water over a particular time is very small. This is one of the typical bridges that crosses the Waiakea Canal.

I particularly wanted to show some of these drainage structures to give you an idea of the problems that we're having in terms of analyzing some of the problems of constriction of the Alenaio Stream--the bridges, the many structures that exist there that prevents water from going from the drainage basin into the Hilo Bay. So far, we have identified that this is the problem. So we decided to look at possible solutions to solve some of these problems.

We basically divide solutions into two categories: structural and nonstructural. Structural are those solutions that you are probably familiar with; those are things that we build such as levees to increase the embankments of the channel so that the water won't flow into your homes. I think the typical example of that is along the Wailoa Channel which was built by the Corps of Engineers back in the 1960's. Another thing is the channel improvements, namely, we try to increase the capacity of the stream, make it deeper, make it wider, have a better capacity for it to transport water. Another one is a diversion channel, namely, to divert the water somewhere else, not along the stream. Before it gets to the stream, we can divert it into a channel or river that could take the water; for example, diverting some of the water that drains into the Alenaio Stream into the Wailuku River. Another way is to perhaps hold the water like a dam or reservoir or detention area which would hold the water first, and then when the rain subsides, release it at a controlled rate which the stream could take. All this, of course, takes detailed engineering and your ideas to determine the landscape, etc.

Nonstructural plans. Nonstructural plans are what we consider not controlling the flow of water but controlling what gets damaged. For example, floodproofing a home; I guess many of you have done that already. If water gets to your home, you protect your home by, maybe, sealing all the entrances to your houses, building a floodwall around your home, or raising your house up a couple of feet above the water level that you experienced in the past. We usually call this floodproofing.

Another plan is what we call flood zones--the County or the government prohibits the development of buildings in that particular area, period. We prohibit any buildings, let's say, within the red line that I showed on the other slide. Another idea, of course, is insurance, namely, everybody has an insurance policy and you get reimbursed everytime it floods. These are what we call nonstructural plans.

We looked at every possibility to get the least cost to reduce the flood as much as possible. We looked at the nonstructural ideas and we felt that, since many of you have homes there, it is very difficult to relocate; you have to decide among yourselves. This is your home, you don't want to move, and we are talking about many political issues. Then we looked at floodproofing, how much it would cost you to floodproof your house. Well, we don't know at this time. If the report goes into further stages, we would go on a house-to-house basis. We would inventory the houses and determine the cost estimate of how much it would cost to floodproof individual houses.

So, we decided to look into structural ideas. What could we do structurally for you, what could be built? We talked to the County Department of Public Works, and they recommended that we look at two diversion channels that you see up there. The one on the left is one typical plan and the other one is one that was recommended by the Department of Public Works. We had a cursory look at this in terms of what would be the feasibility of building something like this. Diverting the water into the Wailuku River which has a tremendous capacity--we looked into this--and then we felt that it would be a viable solution. Another plan that we were thinking about was building a water detention system along here--maybe a small reservoir--and hold the water before it reaches Hilo, and release it, as I said before, at a more controlled rate. This would be done between Chong's bridge and Komohana Street.

Another idea, of course, would be to improve the channel, the carrying capacity of the whole channel, especially around the built-up areas. The problem that I mentioned before is that you have many structures already that inhibits the flow of water--the culverts, the bridge openings, etc. It costs a lot of money to rebuild bridges; it costs a lot of money to reconstruct conduits, etc., so that would have to be looked at after other solutions.

We looked at all these different plans and we decided to have this public meeting tonight to get perhaps your opinion and maybe some ideas that we overlooked in terms of investigating possible flood damage reduction. Of course, you being residents here would know best of what you feel the problem is and what the solutions are. As Colonel Sprague mentioned, we would take this and it would be documented, and it would be one of our single criteria in terms of determining what would be the most viable solution. Then from this we would go on and make very detailed studies of all these possible plans and determine the effects in terms of cost, effects on the environment, etc.

The thing I wanted to point out is that the federal government, the way the Corps of Engineers works, is restricted by legislation. The United States Congress dictates to us what we can do and what we cannot do. One thing I must point out is that we can modify or change or do things on the Alenaio Stream. We are not authorized to build an auxiliary system, namely manholes, pipes, etc. that drains the water, it's what we call interior drainage, into the Alenaio Stream. That would have to be a nonfederal or County obligation cost.

We have to have what we call a benefit-to-cost ratio. Now, what's a benefit-to-cost ratio? On one side of the column, we try to add up all the benefits associated with a certain plan. We would put down how much property would be saved, how many homes would be saved from flooding, loss of life, etc. We weigh all these things and weigh it against how much it costs. We try to put it in monetary terms; how much would we save and how much it would cost. And for us to be able to send a recommended plan to Congress, the benefits should outweigh the cost. That's one part I have to make clear--we do have to determine the benefit-to-cost ratio.

We also have to write an environmental impact statement, which I guess many of you already know. It evaluates your concerns, social, environmental, biological, water quality, etc. This would be addressed in extreme detail.

That concludes my presentation. I wanted to basically give you the background of what we've been doing and what happens in a flood control study. If you have any questions, please feel free to write them down on a piece of paper or ask them during our question and answer period. I'd be more than happy to clarify or try to answer some of your concerns. If you do send me a letter, I'll make sure that I answer it to the best of my ability to satisfy you. Thank you very much.

Lt Col Sprague: Thank you, Jimmy. We have a number of people who have expressed an interest in speaking at this time. You can either come up here or we have the same microphone that Jimmy used and we can pass it back. The first name I have here is Asawo Kodani.

Mr. Kodani: My name is Asawo Kodani. This letter was sent to Colonel Sprague. Roy Kodani is my son. So, I will read it.

"Kenneth E. Sprague, Lt. Colonel, Corps of Engineers, Deputy District Engineer, Department of the Army, U.S. Army Engineer District, Honolulu, Building 230, Fort Shafter, HI, regarding Alenaio Stream Flood Damage Reduction.

"Dear Colonel Sprague: This is with respect to the public meeting to be held in Hilo, Hawaii, on June 4, 1980, relative to the Alenaio Stream Flood Damage Reduction Study being conducted by the Honolulu District U.S. Army Corps of Engineers.

"Please be informed that my parents, Mr. and Mrs. Asawo Kodani, reside at 466 Kukuau Street, Hilo, Hawaii, which is approximately 300 feet to 500 feet from Alenaio Stream. They have resided at the said address since January 1957, and during the past 23 years, they have experienced four floods, which have caused extensive damage to their property.

"As my parents become older, I am deeply concerned that since the flood waters swirl through the basement of my parents' home, the flood water may injure my parents or cause something worse. According to them, one of the recent floods reached a height of about 18 inches in the basement. This is a serious problem.

"If more information is needed, please do not hesitate to contact my father in Hilo or the undersigned in Honolulu.

"Very truly yours, Roy M. Kodani."

Lt Col Sprague: Thank you, Mr. Kodani. Next individual is Hiroko Kawaoka.

Mrs. Kawaoka: Thank you very much for the opportunity to present my testimony on the overflow of the Alenaio Stream and its effect on my personal property. My name is Mrs. Kawaoka; I have resided at 466-A Kukuau Street for the last 35 years. During the past 20 years, I have experienced various magnitudes of flooding; however, they weren't as bad as the 1979 and 1980 flooding. On March 22, 1979, I received a letter from the Mayor's Administrative Aid stating that proposal had been made in the past to apply the stream easement and improvement made to the area. However, this was considered a Capital Improvement project which would require the necessary funding. At present, there is no funding, especially for increasing austerity that the Capital Improvement funding is faced. Because the County lacks the appropriate funding, we must turn to the federal government for assistance.

I was disappointed to see the County workers come to our community after the flooding subsided and cleared out. I felt the government personnel were not fully aware of the extent of the damages left by the flooding and therefore did not address our problems or do anything for us. During the past years, I have had to extensively renovate my house because of serious water damages to my basement. For example, I had to have my kitchen moved upstairs. In 1979, after clearing and cleaning up the damages left by the February flooding, I was completely exhausted, both physically and mentally, thus causing an accident which fractured my leg. I was in a cast for six weeks and was unable to work. Because the Alenaio Stream overflow has not been corrected, every heavy rainfall has caused me unnecessary worries, sleepless nights and undue pressures to protect my house and property. I also have had to take emergency vacations over the past years for two to four days in order to clean out my property. I am a licensed practical nurse at Hilo Hospital.

I would like to recommend that the Alenaio Stream be cleaned and deepened and that retaining walls be constructed along the stream from Komohana Stream down. Thank you very much.

Lt Col Sprague: Thank you. The next name I have is Kumio Kihara. (Mrs. Kihara did not wish to speak.) Mrs. Helen Pastushin? (Mrs. Pastushin requested to wait to speak.) Yuriko Ohye?

Mrs. Ohye: Thank you. My name is Yuriko Ohye and I live at 180 Inia Lane which is directly next door to Mrs. Kawaoka and across the way from Mr. Kodani. I grew up in this neighborhood and know through personal experience that the flooding in Alenaio Stream has increased in severity and frequency over the past few years. My neighbor's basements have been flooded and foundations of their homes weakened. My other neighbor's home has been completely surrounded because of the flood waters. I have noticed that the level of water collecting in my yard is rising and coming nearer the house each time. During the heavy rains in March, the flood waters were just 5 feet from my house and so whenever it begins to rain heavily, the uppermost thought in my mind is whether I am going to be flooded out like my neighbors. We need immediate action to protect the residents of this neighborhood, and it is my hope that appropriate actions can be taken soon to alleviate this problem.

Now, I have been asked by my neighbor, Mr. Tadashi Nakamichi to read his testimony, and I would like to do so at this time. The following is Mr. Nakamichi's testimony.

"I have resided at 518 Kukuau Street since 1937. Alenaio Stream runs along the rear of my property. The flood in March was very bad. The worst I recall, however, occurred about two years ago. I would like to request your office to immediately begin doing something to reduce the threat of flooding to the people who live along Alenaio Stream. We realize that we cannot stop urban growth and development and we are not against it. The future development, such as the Komohana subdivision, will undoubtedly increase the volume of water in Alenaio Stream because more housing developments will cause greater surface runoff. Although the cost for something substantial like the concrete drainage channel behind Kapiolani School might be too costly, we would like to ask that you really assist us as well as the County as much as possible. Councilwoman Merle Lai saw for herself the damage the last flooding caused, but she explained to us and we understand, that Capital improvements such as the concrete drainage channel cost millions of dollars and the County does not seem to have the money to do it. Because my house is situated on a slope, I have suffered only a few hundred dollars loss during each of the big floods. These have been limited primarily to my vegetable crops and ornamental plants, but please realize that almost everyone else downstream is not quite as fortunate--the Kawaoka's, Yamasato's and Jardine's, for example, suffer very heavy losses. Our plea is that you

please do something to help us as soon as possible. Each passing year makes a threat for a massive and devastating flood more real. Please do something before homes and lives are lost. Thank you."

Lt Col Sprague; Thank you, Mrs. Ohye. Manuel Jardine?

Mr. Jardine: Thank you. My name is Manuel Jardine; I live at 446 Kukuau Street. Thank you very much for having this public meeting tonight. I hope this meeting will be to some understanding that our problems be considered and that action to correct this flooding problem will begin this year.

The residents in the lower Kukuau Street area really took a beating from the flooding in March. Many of us suffered through the heavy losses because we can't afford to buy flood insurance protection. So our loss is like really throwing our life and money down the drain. But we still think that if the government will help build a better drainage channel through Alenaio, we might still have some loss, but it wouldn't be that bad. Councilwoman Merle Lai came a number of times, in the rain and all, and nobody else came. It's too bad the others couldn't come at least once.

I suffered about $7,300 loss from last year's flood; this was in 1979. This year was not as high because most of our things were moved upstairs. It is very unfortunate to experience a heavy rainstorm that we had the past two years. In a few hours, Alenaio Stream began to overflow and there is no drain and nothing you can do about it except hope that it's not worse than the last flood. We need help by your office because the County just doesn't have enough money.

Alenaio never used to overflow like it does now. All the development mauka of it is causing it. There is nothing on the roof to catch the rain. The more intensive the flowing would be for us. That is why please get something going soon. Thank you.

Lt Col Sprague: Thank you, Mr. Jardine. Those of you who have read your remarks, to make sure that our back-up for modern technology works, if you would like to leave a copy, we'd be glad to have them. As you leave and you would like to leave a copy with me, please do, or send them in; maybe you want to add something to it.

The next name I have is Morris Kihara. (Mr. Kihara: I think the speakers have covered everything I wanted to say.)

OK, Mr. Kihara, later if you decide to say something, please do. I believe that's all the cards I have that indicated the desire to speak. Would anyone else like to make a comment at this time?

Mr. Kai: My name is Herbert Kai. For your information, about 1,375 billion gallons of water fall on east Hawaii each year. Our output is 14 million as compared to Oahu, say which is 1,600,000. So, water is a commodity of which we have plenty of.

I think the best solution is to have holding reservoirs rather than shooting them down in drainage canals in accelerating speeds and causing damages further down. I think all the natural courses ought to be fairly mapped out to prevent encroachment by real estate brokers. By putting in upland lakes, we would eliminate the temptation; subdivide it. Upland lakes would provide many diversions, recreation, like fishing. I understand that the Wahiawa Reservoir has about six different species of fish--you have a lot of fun and you get a lot of food. It would be a natural habitat for mainland birds which come down here every year. You would have water for irrigation, aquaculture, agriculture, raising of shrimps, and things like that.

I live off Kamana Street and there is a peculiar geological feature there. The lava must have come down in a tube which is higher than the surrounding drain so the water that goes down the river is higher than most of the houses, and I would advise all of the homeowners to get insurance--plenty of insurance. I think that close to 50 or more houses are below road level, and I don't know what your requirements are for a 100-year flood--whether you are supposed to have the floor of the house 18 inches over the highest flood water.

The Soenen experience of Soil Conservation people in establishing drainage canals show that there's more damage caused by flooding because the water runs unrestrained down the mountainside. They have concluded that it's best to have holding ponds. I think that holding ponds would be wonderful.

Lt Col Sprague: Thank you very much. Mrs. Pastushin?

Mrs. Pastushin: I'm Mrs. Pastushin, and it was my home that the culvert from Komohana plowed into our stonewall that we had built. It was only the stonewall that kept the culvert from falling right through my bedroom. I have a complete record of the stream, but why they would give permission to have a subdivision up there, I don't know. I was there today, and they very quickly pushed stones; they had covered the stream in subdividing the property. This is what is coming under the culvert right now.

I live less than 75 feet from the culvert, but what is disgusting is the way the culvert was put back in. It wasn't fastened in; it's only a cosmetic finish to the culvert. It looks beautiful but I stopped there today in the full rain and saw that all the new subdivision mauka of Komohana, they have put in drainage ditches, metal drainage ditches into the stream. It's going to put more water in there.

Where the water came in at my place, it used to be six feet deep; it was almost a lake. I've lived here just only one year and everybody said that we were very foolish to put this stonewall in, but it saved my life and it saved the other houses downstream from me, because as the culvert came out, the water was so swift. I got the full force of the river or the stream. It came over my wall. It was around 10 o'clock when the culvert went out. I was the one that called the police that the bridge was gone. It was four o'clock the next day before the river stopped. I haven't anything left in my yard; it came up to the second step of my house, over the stonewall until they were able to pull the culvert on the side. The stream now is so full of just this; that's what they put around the culvert before they put just a thin layer of stone. But, as I said, I went back today to see what had happened.

They have cemented the turn, but as the stream comes into our little circle, which is Huali Way, it comes in almost at a 35 degree angle, and that culvert is going to go out again in the next rain we have. Right now the water is going under the culvert and that's why we have all this black mess that's in the stream now. But what is disgusting is the time spent of putting that culvert back and working days and days and days with it destroying the effect of the whole stream. It's made it flat. On the other side now, it will flood right back and not turn around and take all the homes that's around mine.

My husband has a shop in Los Angeles; he was raised here and he wanted to retire here in Hilo. And so we bought this house after the storm of last year. We knew it had been damaged; that's why we put the stonewall in. The stonewall held fine until the culvert actually plowed in and under the stonewall. They didn't even straighten that out, and my wall is cracked in five places. We have been able to get no results from anyone as to what they are going to do to clean out the stream.

It would be a good place to put a pond, as you say, because it's wide and it was deep, but it isn't anymore. But I did see that they put sand bags on the stream to cut the flow down before it hits the culvert. Why, I don't know. But coming in on that angle, and when they subdivided to get more lots, they plowed into the stream, but in three days after the rain, this last one, they were up there bulldozing and making the stream back again, and, as I said, putting in these metal things that will feed right into the stream. It is a very childish system of what stones they have used and what little bit of cement, but it will not hold when even that big stonewall of mine held as well as it did until the culvert came down.

In taking the culvert out, they took a lot of my property, without any asking or anything, they plowed out a whole corner of my property. I think that my husband is writing a letter. It was supposed to be arriving today for me to present, but it did not arrive. Merle Lai came over to my place twice to see the damage. I felt that half of Hilo was standing on my terrace, and I'm sure you all saw the pictures which one insurance company is still using. My house is in an ad. As I said, I'm very new here; I have friends I have known for over 35 years here in Hilo, and I've lived in Honolulu and Maui. So, I don't feel that I'm quite the coast haole that some have accused me of. That's all I have to say.

Lt Col Sprague: Thank you, Mrs. Pastushin. Do we have anyone else who wanted to make a statement at this time?

Mrs. Ohye: After what she said, all I want to say is that area is the area that we used to swim in when we were children.

Lt Col Sprague: Would anyone else like to make a statement? How about questions?

Mr. Kai: From the President of the Mauna Kea Soil Conservation organization--I spoke to him in connection with the drainage project that was put in for Alenaio. All we have to do is put in gates. When there's too much rain, you open the gates to the ponds. We have perched springs in Kaumana and in Waikea and they increase in volume when it rains and I think we should plug up all the holes. I think Woolworth's must get all the water from up mauka; those poor fellows have to pump for days. I think if we plug up the hole, the businessmen don't have to worry about being flooded out.

Lt Col Sprague: Thank you.

Mr. Rogers: I have just one question. When you mentioned the possible alternative for diverting the flood water, one was to build these lakes. I had this vision of a wall of water waiting to come down like a dam, and with some minor eruption or earthquake, we all must be at the mercy of that. I would hope that in planning alternatives, you consider the risk factor.

Lt Col Sprague: Thank you, Mr. Rogers. To respond to that, yes, the Corps has been in the dam design business for a long time. We are doing a risk analysis of high hazard dams throughout the State--nonfederal dams that have been produced by a variety of agencies, not by the federal government. We have our own dam safety law of federal dams. We don't have problems of federal dams failing but a lot of the smaller dams back on the mainland have. So we are going through a safety analysis chartered by Congress to do this. That's part of our business; we do it very well, and that will be taken into consideration, absolutely.

Mr. Kai: I forgot to add that the holding pond would give us another advantage as a lava barrier. If the lava flows come down, you could change the course of the lava, and if that doesn't help, the pond would quench the fire. If that doesn't stop it, the lower wall will stop it.

Lt Col Sprague: That's certainly a possibility. Other questions?

Mr. Wong: I'm Rodney Wong, resident of Huali Way across the street from Mrs. Pastushin. Sir, is there anybody from the County that can answer a question? An official representative of the County? First of all, in a year the culvert gave two times. This time it plowed into Mrs. Pastushin's wall. I understand that she was looking for some kind of reimbursement to have the wall repaired and she was told that it's an act of God. Now, if that same culvert goes back, and it gives again and plows into her wall or plows into her house, can the County again slop that off as an act of God and not accept the responsibility?

Mr. Tanaka: I'm not a man of legal opinion; this has to come from the County Attorney's office on this type of matters. The culvert that we put back is a temporary measure. If we had the funds, we would put in a permanent structure, a bridge.

Mrs. Pastushin: But if you are going to put it in, put it in so that it can take at least one rain; this is not even going to take one rain. Even what little bit we had today, it was still running underneath the culvert.

Mr. Tanaka: We cemented the upper end; it shouldn't run underneath. As I told you, the County put it in temporarily; it's not permanent.

Mr. Wong: How long is temporary? Does the County know when the next big rain is coming?

Mr. Tanaka: That we cannot answer. For a permanent structure, we have to get it under the CIP, and if they don't give funds, that's all we can do--wait.

Mr. Wong: I know the day of the flood, I was told by someone from the Engineering Department that if federal funds are used, then you only can replace. So then, if there are no funds, it will be temporary forever then?

Lt Col Sprague: I empathyze with the problem of the culvert, and we are looking to be able to reduce damages.

Mrs. Pastushin: Why did they give permission for a subdivision when there was no allotment made to take care of the water?

Lt Col Sprague: OK, once again, we are in a matter of local concern, and I don't mean to belittle you at all because it's a very urgent thing to the people that are involved and the issues are brought up because we do have representatives of the County. But, the purpose of our meeting is not to discuss that further. OK? I don't think it's productive at this point and time. The people you have here are not the ones who can answer the questions. Our purpose here is to try and provide a long-term solution. Our position is that if we go beyond the reconnaissance stage of where we are right now, it will take three or four years.

Mr. Nathaniel: Years back, they were supposed to have State/County at Lanikaula Kilauea Avenue where the tree nursery is--that's where the whole State/County building, Police Department, Fire Department supposed to be there. But it changed right after the tsunami. As a young boy, we swam out here, there's a lot of area--the Kukuau area. We are talking about legends of Hawaiiana way back, but today it's modernized. I was living at Kumuhana Heights; there's a lot of water.

Lt Col Sprague: Thank you very much.

Mr. Tan: I'm John Tan, and I'm from the Kawailani area. Hilo is going to grow very much, but the thing is they are not doing it the right way. Now, you folks are the engineers and come from the federal department, but I do not know whether you folks have the authority or right to use the Kaumana tubes that nature has made. I would say that by using the tubes when the river recedes, use color to divert that water running through the tube to test where the color come out exposed in the lower area so that you know whether they will break out some stream or uprising springs or so. On that status, I would say that I guess you will solve the situation.

See, nature has made two or three plateaus over there coming down towards Hilo. And what they are doing today is the same thing they are doing on the mainland--concrete the whole place. We're using concrete culverts; we're using metal culverts instead of using what nature made with the lava--drainage. I would say that where the base is cinders, put concrete on the walls but leave the bottom open; don't cement the bottom. You cannot carry water so far down because the water will be much bigger than what it is at the top.

In Hawaii over here, on this lava section, I have noticed that all the streambeds, as the water starts receding, there's drainage. The dry well right there, blast the bottom when you finish about the depth you want, leave the rocks there but put the top so you can go in there and dig it out again. Clean it out when the water is off. That's the thing I want to see in Hilo, but I see they are doing concrete all over the area which is very bad. Concrete you cannot sweep the water down. I noted that because I saw so many dry wells and I went through blue rocks and everything until I went down to the base of it, and I tell you that water went underneath that base fast. That's right where the tree nursery was. So, I hope you folks do that instead of culverts. Thank you.

Lt Col Sprague: Thank you for your comments.

Mr. Strout: My name is Ronald Strout. I think my home is just outside the stream area. What I'm wondering is, you are just handling this area. What would be the effects on the surrounding areas? It could cause terrific flooding, maybe, three blocks away. These things kind of worry me because I've been here a lot of years and it seems that the flooding changes year by year. Thank you.

Lt Col Sprague: Thank you; you are right. The last several times in talking about urbanization of the areas will in fact change the drainage patterns and rate in which the water accumulates. This is only one of eight problems we have looked at. Any of these flood projects, we look at nonstructural types solutions as well. When you are urbanizing an area, that's sometimes not very popular because your flood zone management where you tell people you just can't build there anymore and one of the alternatives is to move the homes out. That's a possibility.

In some areas in the mainland, the federal government has paid the cost of the house time and time again after the floods, and when you get down to it, those are all of our tax dollars. We talk about federal aid here and we are talking about using tax dollars to assist you good folks and that's our intent. We will look at nonstructural alternatives; we are required to do that, as the County is also your agent in these matters to look at those types of things to help alleviate the problems. Yes, nonstructural solutions are definitely going to be a consideration.

Things like allowing the natural drainage is very important to some areas but it's like a pipe that's a two-way street. Sometimes the water runs out that pipe and depending where the water is recovered in the system, it comes back out the same place. It's coming out in your place and going into somebody else's; that can cause problems. These things have to be looked at very carefully. And, that's one reason why it takes three to four years; it takes time for us to look at these. Then when we come up with a plan, we have to look at all the possible consequences of that and then we have to go back through the process again. We could have, you know, come out here tonight and say, OK, here's what we think you ought to do and see if the people supported it and then go on and get federal support; it may not have been the best thing for you. In fact, probably, it would not have been; it's like throwing darts and being lucky at the bull's eye. So all your comments are very well made and are very helpful to us.

15

Mr. Ligh: Colonel, I would like to add that by policy we have to investigate a nonstructural plan to the very end. By law and policy, we will do that.

Lt Col Sprague: We were criticized in the past for just looking at structural solutions because environmentally, the structural solution may not be the best. We have the best economic plan and the best environmental quality plan; those two are not generally the same thing.

Mr. Takata: My name is Howard Takata and I live on Akolea Road. I think that some of the water that probably came from across the street mauka of my place ended up in Kukuau Street. My question is, to what degree will there be a coordinated effort between the SCS and the Army Corps? I think you mentioned that above Akolea Road is SCS and below Chong's Street, the Corps would be working.

Mr. Ligh: The SCS is the Soils Conservation Service of the Department of Agriculture. I already called their office and they already know about the project. I believe I coordinated with every department except Larry Soenen which was my purpose today to meet him. They have the opportunity as well as all federal agencies, state agencies, and county agencies to review any documents that we put in, and they have the same opportunity as you to make comments; and we must address their comments.

Mr. Kai: The late Bill Chun, former County Engineer, created a reservoir in Kahaluu. He poured some kind of chalk down the stream and he followed the chalk to see where it went. In that way, he discovered all the cracks. The big holes, he filled up with cement; the little cracks he eventually filled up with charcoal, cement or gunnite.

Lt Col Sprague: Thank you. Any other comments or questions?

Mr. Jardine: I'm Manuel Jardine again. I live up Kukuau Street for 64 years now. Mr. Nakayama live up there 75 years, and we never did see that Alenaio Stream overflow because the stream was clear. You never had trees; it was wide open right down. The one under the fire station, that one you only see the opening, but the outlet the tidal wave cover the wall. So that brings all the water back. But it's only lately that the stream overflow because we had the farm right there, right on the side of the river. But after they let the trees, the guavas and all the plum trees grow up on the river, that went bring the water all back. That's why we get problems.

Lt Col Sprague: That's very true. It's also the cyclic nature of flooding. On Maui, we have the Iao Stream project, and a lot of people said, I don't understand why you are building this large structure because it just doesn't flood that much. Then, this year alone, even though the structure is not complete, we saved about a million dollars worth of damage with that structure put in over there, because we design up to the 100-year storm. Now, it doesn't mean that it happens once every hundred years; it means that the probability is that it will happen on a 100-year frequency. It may happen next week, or it may have happened twenty years ago or it may have happened a hundred years ago. So people's memory help establish the patterns and so forth, and fortunately, Alenaio Stream is an ungaged stream, which means that we don't have good flow records on it. We have some estimates at certain

16

flood times when people come down and get an estimate which helps us to compare with other streams in the area to model it a little bit. But, yes, during this three or four years that the study process will take, we can go on with it, and additional information will be generated about the stream capacity and the probability of flooding. But you are right, putting vegetation in the stream will cause some difficulty. When we build structures, the County has responsibility for maintenance. We inspect them as well with the County to insure that they are being maintained. Then if any damage to those structures accrues due to a flood at some later time, then they can call on the federal government to repair the flood structures. But they need to maintain them, and we work very closely with them to show them what needs to be done.

Mr. Tan: Long ago that area used to be caneland; used to be the Portuguese Hill. Then afterwards, all this area here was swamp; then they built a canal, the Wailoa Canal. Wonderful canal they have built, but man have come around and changed it again. What I want to say is that when you have improvement, when you have buildings, when you have roads, you stop trees over there from the area. What's going to happen--you are going to have water. When man try to change, they supposed to be ready to accompany that change by getting the protection, and they are not doing it. And nature says this, if you are not going to do what you take away from me, I'm coming forward. Thank you.

Lt Col Sprague: Thank you. It's getting sort of late, towards 9 o'clock here and it's been running a long time. We'll take anymore questions we have and I'd like to once again remind you of the opportunity afforded to you to submit written comments to us.

Mr. Wong: I thank you for this opportunity. I hate to question the County through your hearing, but my neighbors and I don't have the opportunity to say anything, so can I ask a question of the County representative again. I don't think my question was answered. If the culvert gives again, officially the County will not be responsible for any damage then?

Mr. Tanaka: As I told you, this is a legal problem, so the County attorneys can answer that.

Mr. Wong: Can we get an answer then?

Mr. Tanaka: We probably could write them a letter to get an opinion.

Mr. Wong: OK, so who do I get in touch with? Mr. Isemoto?

Mr. Isemoto: Conceptually, we are thinking about a bridge there. The cost of that is quite high so we are not able to get a handle on it right now. So, we'll be working closely to see if any kind of source of funding can be appropriated to us in order to at least start planning for this. But in order to get the traffic moving, we had to put the culvert there temporarily; so, we do say temporarily. We cannot assure you at this time how long it will take. To the best of our ability, we will try to make the structure stable so if anything does happen, then at that time implications we have will have to be solved.

Mr. Wong: How long will it take for me to get an answer to the question of whether the County will be responsible for any damages caused by the culvert if it goes again?

Mr. Isemoto: Well, we did protect the culvert.

Mr. Wong: I'm not questioning the stability of the culvert. I'm no engineer; I don't know if it's going to give again or not. But I've seen it give twice in the last year, and I assume the second time it was put back.

Ms. Merle Lai: Let me do this; I will do the follow-up. Let me just say this. Since the flooding, the public works people have been notified; we've asked them for their kokua. We have asked them to clear up the debris. Arthur is trying to get the rights to go into the stream. I will follow-up on the question and also take care of the legal response.

Mr. Isemoto: Maybe I can explain what Councilwoman Lai just mentioned. Under the emergency, we are able to go ahead and clean up the Aleanio Stream area. This Alenaio Stream is a private stream because the property line runs to the centerline of the stream. So we have no authority other than during the emergency to go into that area. We haven't gotten all the rights-of-entry yet, but with the rights-of-entry given to us, then we can go in and at least clear the debris in there so that you have a clearer flowage. As you mentioned earlier, many of the problems are because of the overgrowth within the stream area and the debris that comes out of the mouth of the area down. All of these are cumulative things that add to the problems; I don't think we can say that it is any one thing. If the stream within the project area can be kept fairly clear of brushes, then maybe flowage can be made faster. As Councilwoman Lai said, we are committed to go in there and do some cleaning up. Thank you.

Ms. Rogers: Is there any damage recovered for the culvert hitting my neighbor's retaining wall now that the wall is cracked and unstable?

Mr. Isemoto: Well, all I can say is that under the County laws, there is a provision that states if there are any claims to be made, the claims can be made through the County Clerk.

Lt Col Sprague: I'd like to thank all of you for coming tonight. This is a real fine turn out. I would also like to thank the public officials that are here, both elected and appointed. In other public meetings, we have had very little presence from these people, so your presence here in support of the project is very much appreciated. Remember to keep those cards and letters coming if you have any comments because it is a public involvement process, and it will continue to be as long as we are pursuing it. You will have an opportunity to make your wants and needs known.

I'm going to change pace here for a moment. I am in the Army and I am a Corps of Engineers Officer. We talked about civil works tonight, and although it may not seem to be appropriate to a certain extent, I'd like to remind you all to support your recruiters over here and support the armed forces. Remember the country you save may be your own. Thank you.

TRANSCRIPT OF PUBLIC MEETING
ALENAIO STREAM FLOOD DAMAGE REDUCTION STUDY
HILO, HAWAII
12 May 1982

Mr. Isemoto: Good evening. My name is Arthur Isemoto and I'm the Deputy Chief Engineer of the County Department of Public Works. Welcome to the public meeting on the tentative alternative plans developed by the Corps of Engineers. As you recall, the Corps of Engineers held a public meeting on June 4, 1980 on the initial capability study of the flood reduction measures, and they also held an informal public workshop meeting on December 10, 1980. Tonight the Corps will seek public input on their presentation on technical, economic, social and environmental studies developed by them for the alternative plans. At this time, it is my pleasure to introduce to you Major Edmund Thal, Deputy District Engineer, of the US Army Corps of Engineers. He will introduce his staff who are with him tonight. Before that, may I introduce to you Mr. Robert Yanabu who is the head of the County Department of Public Works Bureau of Planning. May I now call on Major Thal.

Major Thal: Welcome to the public meeting tonight. Art, thank you for the introduction. My name is Major Thal; I'm the Deputy District Engineer from the Honolulu District. May I introduce my staff that came with me tonight: Jim Ligh who is the project engineer; Elsie Smith who is from the Public Affairs Office; and Sue Kim, our recorder tonight, from the Planning Branch.

The purpose of this public meeting tonight is to tell you about the proposals we've been working on and also to obtain your comments. Your comments will be incorporated into the final report on the Alenaio Stream which we hope will be submitted to Washington in July of this year. Tonight your comments will be recorded on the tape recorder which we have set up over here. We do not plan on using the microphone in the audience; if the recorder does not pick up your voice, then we'll go to the microphone in the audience. Your oral comments are important to us and those will be incorporated with the final report, as I said. I have your cards of the ones who wanted to make an oral comment tonight. Is there anyone who does not have a blue card? Please raise your hand and we will get you a card. Also your written comments are important to us. If you have written comments, please give them to us tonight. If you want to submit written comments after tonight, we have self-addressed envelopes on the table. We also have on the table some additional information that you may use. Please submit your comments to us either tonight or by 4 June. We'd like all the comments by 4 June so that we can incorporate them into the final report.

Let me introduce some of the other Federal, State and County individuals who are here tonight representing their agencies. First, John Lockwood from the US Geological Survey; Larry Soenen from the Soil Conservation Service. From the State, Al Ching, from the Department of Land and Natural Resources; and everyone knows Art Isemoto and Bob Yanabu. The reason I introduce these individuals is to let you know who is here so that if you have questions pertaining to those agencies, they are here to answer those questions for you.

As mentioned previously, the last workshop was on 10 December 1980. Since that time, we have gathered data and have been working on them. Tonight we are going to show you three proposed alternatives to get your comments and your feelings on these different alternatives. Hopefully after tonight and the 4th of June, we will get a concensus on which alternative is best and at which time in July we will submit the final report to Congress.

Also, after the meeting, we will be around for questions, if you want to talk to us individually. If you don't feel like standing up and making a comment, please see us afterwards and we'll be here as long as anyone wants us to stay.

After Jim presents the alternatives, then I'll call on the individuals who want to make a statement, and I'll just go by the cards I have which are not in any particular order. After that, we will give ample opportunity to anyone else who wants to speak at that time. I will now turn you over to Jim Ligh who will brief you on the three proposed alternatives. Jim?

Mr. Ligh: Good evening. I think I met many of you the last time at the public meeting. I got to hear many of your problems and hopefully we can solve some of them tonight and I hope we can give you a basic understanding of what we're trying to do.

We prepared a draft survey report and environmental impact statement; we have some on the front desk. If you want an individual copy, you can write to us and we'll send you a copy in the mail right away. Also, we have some information that are pertinent, basically the ones that show the alternative plans and the existing conditions, so if you don't have the big volume book that we have, you can grab some of the sheets there and look at the maps and see what we're trying to describe this evening. I will try to describe them to you the best I can; some of the problems may be difficult to describe in this one evening, so if you have any questions, please free to ask.

The document, as I said, is available to anyone who wishes to have one. It's quite long; I don't know if everyone will have the opportunity to read the whole thing, but everything you want to know is in here basically. We hope to complete the final report after tonight, as was indicated. We will make a verbatim transcript of what occurs tonight and all the comments we receive to finalize the report. This will then go to Washington, DC for authorization.

Tonight we will cover basically four things. First, I will provide an overview of what we've done; second, I'm going to discuss the alternatives in detail; next, I'm going to discuss the future coordination, where we are going from here; and last of all, I will discuss the conclusions of what we plan to do.

We've been on this study for the last two years and I guess many of you feel that it's too long, but it takes time to do all the basic studies that we are required to do for a project of this magnitude. As indicated, we held a public meeting on 4 June 1980 and held an informal workshop on 10 December 1980. On the basis of the problems that were depicted during those two meetings, we were able to come up with your flood problems and we proceeded to try to develop the plans that we have.

I'm not going to go over in detail all the plans that we eliminated. They are documented quite well in the report. Just to go over some quick ones, we investigated a dam and retention pond above Komohana Street; we investigated a diversion channel into the Wailoa River; we also investigated using the existing SCS channel along Ainako Avenue. We eliminated those plans from future study because the cost was just too much and we had some other technical problems. These that we present tonight are the ones that fell out and the ones we thought were the best plans based on the problems, needs and the comments that we received within the last couple of weeks. I have had many phone calls during the past week on some of the proposals because we were proposing to relocate some structures. We want to set some things straight and try to get some misconceptions out tonight so that you know that we're not going out tomorrow and bulldozing people's houses and things like that. We have a formality, a process that we go through to make sure that every person here has their say.

I guess you all know the community, but just to go over--this is Hilo Bay; Alenaio Stream goes from Hilo Bay up to Waiakea Pond up to here, so it makes an S-shape through the downtown community. It crosses the street through Kilauea and Kapiolani and Komohana Street, and up along here, up above Komohana Street, the stream disappears and reappears somewhat below Chong's Bridge. Basically our study is from Hilo Bay covering the whole watershed up to Chong's Bridge. We left the area above Chong's Bridge alone because we feel that SCS will have its project completed to solve the flooding there. Let's go to our first alternatiave. Alternative 1, which we call modifying the existing stream. The first alternative has four major components. The most major component is incorporating a concrete channel and realigning portions of the channel; floodproofing certain individual structures; removing six residences and part of the fire administration building; and providing floodplain management practices. I'll go over each of these in detail, but these are the four major features of this plan. I think the best thing to do is start from the top and go to the bottom; starting above Komohana Street.

I think there is a major concern by the residents above Komohana Street that development in that area may cause further flooding problems, especially where the stream is undefined. Above Komohana Street, we are proposing floodplain management practices. We are proposing that no development be made within 200 feet of the stream. This is to prevent encroaching upon the floodplain and to prevent future damages. The 200 feet is not arbitrary; it is what we thought would be the 100-year minimum flood problem. In other words, our 1% frequency flood, this would be the extent the water would go in these areas. So the proposal would be that any future construction should be above the water height or outside the water area, above Komohana Street.

The next portion is through Komohana Street and Kapiolani. This area is quite long and there are approximately 10 to 12 residences there that actually experienced flooding. In this area, we are proposing floodproofing, namely, the government will help put walls and other structures in front of these individual houses to prevent flooding to those houses. We'll look into either raising the structure or putting a small floodwall in front of those structures. The most obvious one is the one right makai of Komohana Street; those houses there flood quite frequently, so we would propose putting a concrete wall in front of those houses and so on, until all the individual houses between Komohana Street and Kapiolani are floodproofed. That's floodproofing. Basically, what we do in the next stages are identify those houses, meet with those people and describe what they think they would like to have in those areas.

3

The major aspect that I would like to get into now is the concrete channel. On this particular map we have here, Hilo Bay is along here, upstream is along here. Alenaio Stream is depicted in red. This Kilauea Avenue, Konoole Street and Kapiolani Street. This area tends to get bottlenecked, and the stream in this area narrows down to 13 feet where it is S-shaped. So what we are proposing is to realign and widen the channel 1,640 feet. It's depicted in yellow. Unfortunately, along the new alignment, there are 6 residences that we are proposing to relocate. The reasoning for this is that we needed a better curve for the water to get into Hilo Bay. Because of this new alignment, we were able to provide a smaller channel. If you were to use the existing channel and to get the desired flood capacity, where we are proposing the standard project flood; we would have to enlarge this existing channel considerably up to 60 feet. With this new alignment which we have depicted in yellow, we would only need a 35-foot channel. This is the reason why we wanted to realign the channel. The water would have a much smoother flow. Unfortunately as indicated, it's in the path of some houses. We had to look at the economic benefit to cost. Providing a 60-foot channel would require moving houses anyway. The channel can be 40 feet at the entrance, narrowed down to 35 along the stream. We couldn't deepen the channel any deeper because we would have to deepen the whole channel from here all the way to the Hilo Bay and it is quite expensive. So basically, this is Alternative 1. There are 4 major aspects: floodplain management of the Komohana Street area; floodproofing; creating a 1,640-foot concrete rectangular channel; and to remove 6 residences. We really hesitated to do that as I indicated. Our social scientist came out to investigate who will be affected, how they would be affected, etc.

Any relocation of people is mitigated by what we call the Relocation Assistance Act by the Federal Government. The Federal Government will assist the people in moving by paying the moving expenses. The County will have to buy the land, reimburse them on the value of the land, and in addition to that, we would pay the tenants approximately $4,000 for the inconvenience of moving. Now as indicated, we are not going in tomorrow, the process may take five years, so we have a lot of time to think about it. The County will be the major consultant on the moving of these people. Most of the people that live in this area, as I understand it, are tenants so they rent the houses; they do not own the houses. These are the four features of Alternative 1. This is the plan that the Corps recommends as far as the cost goes.

I would like to now go to Alternative 2. Alternative 2 has three major features: a 4,200-foot concrete channel; the removal or relocation of one structure; and floodplain management. If you look again at this map, Komohana Street runs across here, Wailuku River is along here, the existing Alenaio Stream is in red, Hilo Bay is down here, Komohana Street runs across along here. Waiānuenue Avenue is right along here. Our proposal basically is 1,000 feet above Komohana Street in diverting the water--just about paralleling Komohana Street into the Wailuku River. It's basically a trapezoidal channel here and gradually transforming into a rectangular channel. We wanted a trapezoidal channel here because it did not affect any houses and we decided to go into a rectangular channel here because of the houses. We will possibly have to relocate just one house. We found that one house that we had to relocate, they could perhaps pick up the whole building and just move it 20 feet over.

4

The critical portion of floodplain management again is the land above Komohana Street along here where we want a floodplain management policy again. I believe the County is now participating in the Flood Insurance Program which primarily prohibits construction within the 100-year floodplain. So we selected this portion here to jive with the Federal Insurance Plan.

The third plan is what we call a nonstructural plan. We are required to come up with a nonstructural plan where there are no modifications to the stream, no levees, no dams, no new channels. Nonstructural is usually relocation and floodproofing. Every house that is in the floodplain is raised above the flood limit. Those that cannot be floodproofed will be relocated outside the floodplain. We don't say that that is the best or most desirable plan, but we must look at it because Congress says we must look at it. With that plan, we would have to relocate almost 53 houses; it's in the report.

I will now go into comparison of the three plans, in terms of benefit cost, average cost, and things like that. We tried to analyze each of the three plans on the project cost, the average annual cost, the benefits and what we call the benefit-to-cost ratio. The average annual cost is--we take the whole project cost and average how much we would have to pay in interest. Its similar if you mortgage a house, what would be the yearly cost at today's interest rate. So this would be almost like a yearly mortgage rate--what the cost would be over a 50-year period. The benefits is what we think just how much this flood control project will prevent in damages per year. Obviously, we would like to have the benefits exceed the cost, and all this is based on interest rates. So we based it on 7-5/8% interest rate which is dictated by Federal laws and took it over a 50-year period. We had a SPF protection. SPF is the level of protection we are talking about; in other words, what we call the Standard Project Flood. Engineers and scientists try to put things in probability and what we call a 100-year flood is a probability that a flood will occur--it has a 1% probability in any year that a flood will occur. A 100-year flood for Alenaio Stream at this point here would be approximately 7,000 cfs of water coming down Komohana Street. For Standard Project Flood, it would be approximately 12,000 cfs. We don't say that it will happen tomorrow or the next year but it can happen over the life of the project. Two could happen tomorrow or none could happen for the next ten years; it's a probability. We base that on taking rain gages in upper areas, historical records and things like that.

Let's go into some of the project costs. We are recommending the Standard Project Flood protection. The project cost is $7.9 million. That has an average annual cost of $642,000 a year, but we feel it will prevent approximately $1,452,000 worth of damages. So the cost benefit ratio is 2.3.

Alternative 2, which is the diversion into Wailuku River, cost $15 million. It has an average annual cost of $1.2 million. It will reduce, we feel $1,458,000 worth of damages, and it has a benefit-to-cost ratio of 1.1.

The third plan, which is the relocation plan, will cost $17.9 million. The average annual cost is $1,463,000. Now this benefit here, we have is $358,000 and you're probably wondering why it's only $358,000. It has to be reduced because if you just remove people and say that you're going to save them, you're not saving them because you're moving them out. You remove everybody, you're going to save everybody, but there's a concept that if you destroy a house, would you save them, which is not really true. So we had to reduce the damages because by destroying the house, you are not fully benefiting because you lost your home. This plan has a benefit-to-cost ratio of 0.24.

Based on the benefit-to-cost ratio, the least cost, Alternative 1 is the recommended plan. Environmentally, it is the best plan because it does not impact on any endangered species, habitats, ecological items, nothing of real value. The only problem we felt was the social problem where we had to relocate some poeple. I would now like to go over the costs. Obviously, the Federal Government will share in some of these costs. President Reagan is implementing a different policy--he believes that the local government should pick up more of the price tags, etc. We have two types of cost sharing: the traditional and the proposed. Under the traditional, the price tag that we put on projects if the President decides to take no action; this has been around a while if nobody changes anything, it's going to be that way. Under the traditional cost sharing, we will pay for all construction; 100% of the construction. The non-Federal, or the County, must pay for the lands, easements, and rights-of-way, and the reconstruction of bridges.

On Alternative 1, we have to reconstruct 4 bridges. As you can see, we have bridge crossings on Kapiolani, Ululani, Kinoole and Kilauea. These openings are bottlenecks. What we would like to have is a nice channel and when it comes to a bridge, these will have to be modified in proportion to the new channel. And that's what we call the non-Federal cost where the County will have to pay either in cash or they do the work. Under that concept, for the first plan, the Federal Government will pick up $5.5 million; the County or the State, whatever the agreement, will pick up $2.4 million. Now that $2.4 million is a very conservative estimate; the County may verify these estimates based upon their experiences.

For Alternative 2, it would be $14 million. It's kind of funny here; you're saying, why is the non-Federal share not lower for a $14 million project. Because on a traditional basis, the non-Federal Government will only pay for the real estate, so basically, the real estate is a lot cheaper because it's mostly undeveloped land.

For the Federal share, the floodproofing or the nonstructural plan, the government says that we will pay 80% and the non-Federal 20%. That turns out to be $14 million Federal, $3 million non-Federal; that turns out to be $17.9 million.

Now let's go back to the new cost-sharing policy that is coming up. Secretary Gianelli, Assistant Secretary of the Army for Civil Works, has turned out a new proposed plan called cost sharing. He's proposing that we put the whole price tag together, the Federal Government will pick up 65% and the non-Federal Government must pick up 35%. Lo and behold, the County comes out better on this deal because lands are the major contributing costs. On the mainland, construction costs are tremendous compared to the land. Here, we are talking about smaller projects and higher land costs. Land costs in Hawaii are much more costly than costs in the mainland. If Secretary Gianelli comes in with his new proposal, the Federal share would be $5.9 million or $6 million and the non-Federal share would be about $1.9 million.

For Plan 2, the Federal cost would be $11.7 and the non-Federal would jump up to $3.9. This does not affect the nonstructural plan.

Again, those are the two different types of cost sharing. Unfortunately, we cannot promise you that it's going to be like this.

The last thing I would like to cover is what we are going to do from now. What we have now is a draft report. I have checked off what we have done so far. We just finished the draft report. We circulated the reports to the interested public and we are holding this public meeting. What we have now is the 45-day review period. We give the public an opportunity of 45 days to comment so that we can document it in the report. All Federal, State and local agencies may comment. That's approximately 4 June; we'd like to get your comments by 4 June so we can get the thing moving.

After that we will prepare a final report which will give our final recommendation. Before we can prepare a final report, we must have a letter of assurance from the County. The Mayor must sign a letter saying to the Federal Government that you indorse Plan 1 and you will agree sometime in the future that you will follow through. It does not legally bind the County; they can stop anytime after that but it gives us assurances that we are on the right track. This is the plan we are going for and this is the plan that we will ultimately reach at that time where we can award a contract. So that is the local assurance we must get. After we finish the final report, we can publish a public notice to the general public with our conclusions. We're going to say, the County and the Corps of Engineers are recommending this plan, and this is what we are going to do. Then we will give a 30-day notice again for anybody who wants to comment on that final recommendation. Then we are going to submit the report to Washington DC. Once we send it to the Office of Chief of Engineers, our higher headquarters, they will give it to the Secretary of Army, who will then give it to Congress, who will then say, yes or no. Once the project is authorized, they appropriate funds. This is done by the Office of Management and Budget. Then they will allocate the money and after that we will do what we call Advance Engineering and Design of plans and specifications where we actually make the blue prints for construction of this project. At that point in time, we will take care of all the little details. Then Congress appropriates construction money. We do not build the projects. We send out bids to private construction firms and they look at the drawings and they bid for the project and we get the low bidder. Now, all this does not occur within a year or two, unfortunately. We may take 3 to 5 years if we get to that point depending on Congress, how fast they act, depending on whether there are any snafus along the line.

I would now like to review what I just presented. We have provided an overview of the study to date; I tried to describe the three plans that we have; I indicated that we recommend Alternative 1 because the benefit-to-cost ratio is the highest, the cost is the lowest, and we have the least environmental impact. We feel that this alternative is best for the community in the long run. Next, I discussed the future course of actions of what we are going to do. The final report will be submitted to Washington DC we hope by July of this year, so we are talking about 2 or 3 months from now. We will keep you informed by periodic public notices of what is going on. When we get to this stage here, we will have one more public meeting before we actually send the project out for bids. Again we are recommending Alternative 1.

At this time, I would like to turn the meeting back to Major Thal.

Major Thal: Thank you, Jim. It seems like a long process. If you remember, Congress does fund all the money so all the projects throughout the United States when they are submitted to Congress after we go through this process

are really in competition. So that's the reasons sometimes that the higher the benefit-to-cost ratio, the better chance you have of getting your project through Congress. We always consider the intangibles; people have to be moved and you can't put a price tag on some of these items and those are considered in the final recommendation.

I would now like to call on the individuals that indicated that they wanted to speak tonight. After that, we will open up for questions. If you want to ask a question, please identify yourself and if you represent an organization, please so indicate for our records.

The first person is Reverend Ralph Douglas.

Reverend Douglas: Alternative 2 looks like it is going to take a slice out of my bedroom. I'm wondering how much of our property is going to be taken out and how ugly it's going to be when it's finished.

Mr. Ligh: Is this the area you are talking about? (Yes) We think we avoided the houses.

Reverend Douglas: Well that's good news. How close to the house is it? It looks like you are right inside my bedroom.

Mr. Ligh: Well, pretty close. Well, we really didn't look into it because we are recommending Plan 1, but we thought we would miss it by about 5 feet.

Major Thal: If you can't see, I know it's kind of difficult to see, please feel free to move and after the public meeting, all these charts will be available for everyone to look at.

Edward Fujimoto?

Mr. Fujimoto: I wonder if I could use the chalkboard. We have some copies of what I will be discussing. We'd like to hand it out to our community members as much as possible, but I would like to have some of these passed out. I will try to refer to this very rough sketch here. We'd like to address the missing portion of the Alenaio Stream that mainly affects our area. We didn't have a chance to come to the public hearing in 1980, so we'd like to take this opportunity to more or less catch up what is happening here.

OK, I have a written statement here, and I'll read it to you to save us some time. My name is Edward Fujimoto, and I'm a resident of Luana Way. Due to the constant flooding problems that we have experienced in our neighborhood, the upper sources of water flowing into the Luana Way drainage channel were traced.

As indicated in the attached diagram, there are at least three major sources of water from the Kaumana Terrace Drive area that converge into the Luana Way drainage channel. Now, this is one, this is two, and there is three here.

The area designated "3" on the diagram feeds into the Luana Way Subdivision via Kaumana Terrace, Piiaaloha and Ualehua Streets and flows through the private drainage channel at the bottom of Luana Way.

The sources marked "1" and "2" flow through the Kaumana Terrace Drive complex, crosses Piilaloha Street, and enters the Luana Way Subdivision, flowing down Luana Way and also across this street into Mr. Ernest Mattos' pasture, and converges with the drainage channel water at the bottom of Luana Way.

The volume of water, then, which is absorbed by our subdivision from the Kaumana Terrace area, is tremendous. This is not all. A major finger of water from the Alenaio Stream which can be traced to Chong Street converges with the Luana Way drainage channel, compounding the volume. Also underground water from broken lava tubes is also surfacing to add to the total volume of water. A great ponding effect then takes place at the bottom of Mr. Ernest Mattos' property, and the water--clearly identifiable--flows down toward Komohana Street.

We contend, therefore, that the Alenaio Stream is clearly defined and is located near the bottom of our subdivision. If not the stream itself, a major finger of the stream is evident and should be recorded and described in your study. This we feel, as residents of this community, is very, very important. Thank you.

Major Thal: Thank you, Edward. Gary Neko?

Mr. Neko: As most of our residents in the community were not aware of the Alenaio FC study, we were not able to make early input. At this hearing, we would definitely want to have included in our public hearing input, the precarious conditions which exist with the floodwaters of the Alenaio Stream which joins the drainage system of our subdivision to create a definite waterflow which our community is keenly aware of and have subsequently brought to your attention.

I am hereby submitting a petition that was signed by the residents and individuals who are aware of the flooding problems at the end of Luana Way, who are not in favor of the proposed HCEOC project which will affect the floodplain areas just below Luana Way by diverting more water in the well-defined flood stream, and which will bring subterranean water to the surface heretofore drained via underground lave tubes.

The Alenaio Stream does flow from Chong Street and converges with the waters of our drainage channel and can be identified on flooding days as a definite finger above and below Komohana Street, a finger which flows directly below Luana Way.

The petition covers our major concerns, and is definitely linked with the Alenaio Stream. The contentions presented, therefore, should be indicated in your study.

Major Thal: Thank you, Gary. Mr. Mattos?

Mr. Mattos: My name is Ernest Mattos. (Tape was not clear to decipher Mr. Mattos' statement. Mr. Mattos basically indicated that his property is consistently flooded by Alenaio Stream.)

Major Thal: Don Pakele?

Mr. Pakele: I put down myself as far as representing myself, but I'm with the Kumiai, and I think my responsibility tonight is to go into greater detail on what is happening. We are concerned because of the OEO project, the farming project which is going to be adjacent to the lower open area, as they describe it, and they want access to our community. There are many problems that come up. As I look around the room, I think it was a very important thing for OEO to be here and I think that it is indicative of their style of approach that nobody is here. I think it's a very important part of their program and it is very indicative of the type of hearing they will have for it's all one-sided. The only think we could get out from them was, well, you are not listening, and I hope that people will listen to what we have to say tonight.

Getting back to some of the proposals, I think we are in total agreement that things have to be done in Alenaio. I don't think we are against the idea of improvements, I don't think we are against the idea of future developments, but I think what we will have to do is to put the mule before the cart instead of the cart before the mule. For all the departments concerned, what's happening is that we are going to allow 57 acres below us to be bulldozed and this is right within the area where we say Alenaio is undefined. I have to disagree with the statement that Alenaio from Komohana to Chong Street is undefined because there is an area from Chong Street down to Mattos' property which is right here. I think it is clearly defined. There's some areas in there where the water is, to say the least, this area if you want to call it a stream, that you can stand there and it's 12 to 15 feet high. So, I have to disagree that it is undefined. From behind our subdivision on down, what happens is that it flows into a channel area. The County was much concerned when our subdivision was built because we made the developer put in a 10-foot-deep by 20-foot wide storage area, and they cut it into the natural rock to prevent the flooding of homes. And it's a definitely defined area; the water is channeled within an area of about 50 feet. It does disappear in some areas over here. However, if you go up in a helicopter or plane, you will find areas of green vegetation and trees and goes all the way down to Komohana. There is a lot of California grass so you really cannot define the path of the water. I have been in the area at times when the water is flowing deeply and I would challenge anybody that would stand in the middle of what we call an undefined river. About a week after, in some areas you might be able to walk in that spot, but it is flowing tremendously, like the last two or three floods, some places are as much as 8 to 11 feet deep. I don't think that can be called an undefined area. There are many other problems associated with this. The County Water Department has a water pipe that goes through that area.

We are really questioning the idea of the State awarding the OEO the contract to use this 57 acres for agriculture purposes. I think in the study, I was reading that the area, and I'm not positive if your study is same in area, behind Komohana, up into that area, 1,000 or 2,000 yards was converted from agriculture to urban, and if it is, we are allowing an agricultural theme to go into the area.

The other thing is that if it's an undefined stream, how are we going to designate the 200 feet as an undesigned area or undefined area? I think it would be difficult, because that 57 acres that OEO is proposing to develop is right in the middle of that 200 feet.

I think our question now to the Corps would be, and I'm going to ask these questions later on, is that how is this going to affect the specific project and also how are we going to be affected by whatever is allowed by the State or by the County? I will save my questions for later.

Mr. Ligh: I would like to make a response to the problems that were specified here. I think I met with Mr. Fujimoto and the community couple of months ago about this whole problem here, about this land, etc. I think we met for a couple of hours and met with the community and talked to them about the problems they have here. What we felt was that this was more of a County local problem, the Federal Government tries not to dictate what we can do to the properties. You indicated that this area is undefined. We had to make some assumptions and that's how we got the 200 feet; we assumed that the stream was undefined. We felt that assumptions is better than saying we can't do anything because we don't know what's going on out there, and that's what we tried to do. As indicated, we held the two public meetings and nobody from that community came out at that time, and the main issue at that time was that they were against this bridge that was going to cross some of that drainage area because they felt that it was a nuisance to the community. We indicated that the Federal Government has no vested interest only if it's a matter within Navigable Waters of the US. And that's another part that we had to determine. Here we are talking about a stream that we couldn't define and what is navigable waters when you get to that point? We recognize the flooding problem, but what we had to do was determine--the Corps of Engineers can only do flood control measures for a specific type of flooding. Namely, when the major drainage overtops the banks of the stream, that's under the purview of the Corps of Engineers and considered by Congress. I think you have indicated that a lot of the water comes down the roads because it is quite steep there; that usually comes under the purview of what we call interior drainage and the Corps cannot touch interior drainage. Unfortunately, we can't because Congress says we can't. The issue you talked about is very difficult because we have a lot of hypothetical questions and it's really difficult in that area; it is highly vegetated, rocky, and the issue is really a County issue.

Mr. Pakele: May I interject a point here. I don't think we are saying that the Corps shouldn't get involved with the flooding problems that already exist. I think we were merely trying to point out that there is a heavy volume of water coming from the upper section which compounds with the water coming down from Chong Street to the Alenaio. With that kind of volume, we contend that there is no way in which the stream can be mysteriously gone. We contend that with that much water, you must have a defineable path, an identifiable path that can be depicted from where we are down to Komohana Street. Your report indicates that it mysteriously vanishes. We contend that it is there, and if it is there, then we feel that there is a strong argument that there is a floodplain right below our community.

Major Thal: Thank you. Dr. Cook?

Dr. Cook: I represent the Pacific Hawaiian, Ltd. Food Fair Super Markets. We support your Alternative 1. We would like to point out, however, that if Alternative 2 were to be selected, our parcel is basically something like that, then it would virtually destroy any usability of that particular parcel. We would also point out that, if I heard you correctly, you are saying that you would require the County as part of this assurance that there would be no development within 200 feet of the stream.

Jim Ligh: That's along the original stream. We are saying within the 200-year flood limit, so it extends along here.

Dr. Cook: OK. I thought you were saying that you require that 200 feet and you will have a lot of what I consider inverse condemnation.

Jim Ligh: No, because that 200 feet is where there is existing flooding.

Dr. Cook: We have a written statement in support of Alternative 1 and we will transmit it for the record.

Major Thal: Thank you very much. J. W. Hanley?

Mr. Hanley: Thank you very much. I have two parcels of property that are I think involved only in Alternative 1. One is at Kam Avenue at Punahawai, tax map key 2.2.006.027, which is below where the map goes here. The other one is at Kilauea and Punahawai, this property here, tax map key 2.2.008.023. It is my understanding that the property at Kam Avenue is affected only if it is threatened and that there will be a diversion wall put out to the property. The indication I received on the property on Punahawai and Kilauea is that all of the widening of the stream would come off my property--none off the adjacent property; there is a gas tank stuck in the ground there somewhere and there is a driveway that is a minimum distance from the corner extending toward the stream. The widening of the stream at that point to 35 feet would take about 20 feet of the frontage on this property and would remove the gas tanks from the ground. It would eliminate all access to Kilauea Avenue and would destroy the usefulness of the property. I can't quite see your rationale at that point taking a piece of property that has never been one of the properties that suffered damage and taking away from it.

Immediately across the stream from the Puna side, the property has suffered repeated damage which means that's where the water wants to go, and to take this property which has never suffered damage and virtually destroy its usefulness in order to protect this piece of property which repeatedly suffers damages, it seems to me if the stream is going to be widened at this point, it should be widened in the direction of the property that has suffered the damages which is where the water wants to go, and not in the direction of this property. I think the main point I wanted to make basically is for the County and that is it would be our contention that if the stream is widened in that direction of our property that they would have to totally condemn and purchase the property because the usefulness of the property would be destroyed. I'd like to point out also for the benefit of the County that property on Kam Avenue, we are currently contemplating a major development on the property and if in fact there is any talk of other than floodproofing it, it would be well to get it well set before we spend several hundred thousand dollars.

James Ligh: On the lower portion down here, we are not going to be proposing anything below Kilauea. We will recommend that if there is any construction here, we would have to go to the Corps of Engineers for a floodplain analysis and we would make a recommendation. At that point in time, we can tell you what the impacts would be on your particular plan. We are not proposing any structures down below besides this wall here.

This property up here, we were at the point where we were planning, we were trying to do what we could with minimum construction. We felt at that time that this whole structure here is a pretty big structure.

Mr. Hanley: I would say that this termite-eaten structure here is of less value than several tens of thousands of gas tanks.

James Ligh: Well, it that's the case, it would be no problem for us to realign the proposed channel.

Mr. Hanley: I don't know exactly where the gas tanks are but I would guess they are not more than 50 feet; I would guess they are within 5 feet of the protective walls. But actually neither one of these properties have suffered any damages and I can't see causing them any expense or even discomfort to protect other properties.

James Ligh: If you give us the property limits and the gas tanks, then we can modify it.

Mr. Hanley: I think they are very close.

Major Thal: That's the type of information that we need and please send us that data so that we can program it into our study. Toshio Inaba?

Mr. Inaba: I have a petition here signed by few of the residents affected by Alternative 2. Most of the people are located here, north of Waianuenue Avenue.

I have a few questions to ask Major Thal. Seashore Properties is primarily set on Alenaio Stream. Waipahoehoe Stream is cut down; it's an extension of Alenaio Stream, although it disappears in the lava flow. We have the same petition on the Waiakea Stream where it crosses Komohana Street and disappears in the same lava flow and it comes down the University, although we have a flood control project there now. But prior to that, the floodwater always go down and cross Komohana Street, and cross the nursery, and then it disappeared into the old lava flows just parallel to Kilauea Avenue. After several days of heavy rain, then it used to cross ____?____ Street. But my question is this. I made a sketch here. On Wilder Avenue, the County put the flood control project--the County and the Corps. (No, it was the Soil Conservation.) We have quite a few streams coming down here and the main one is Waipahoehoe Stream which comes down and crosses by Bill Wisses (?) home. This is the one that dissipates and eventually comes into Alenaio Stream. There are other streams in here, and when there is heavy rains, there is always flooding in this area. But if you like divert these two streams and bring them in here, I was wondering what effect that would have on your flood control project.

J. Ligh: SCS has an existing diversion channel and Mr. Inaba wanted to know why we can't extend the diversion channel into the Waipahoehoe. Here is the problem. The area that this diversion handles is this area above here that is approximately 1.15 square miles. I believe the SCS designed it for a 100-year event or 1,120 cfs. Our estimate is, at this point along here, the drainage flow area is approximately 5.15 square miles and has approximately 6,000 cfs. Now, for us to divert these two streams into the SCS diversion, we would have

to upgrade the existing SCS from 1,120 to 6,000, plus add the additional 9,240 feet compared with our diversion and also we would have to enlarge this one, plus create two more. Plus, at this point here, the remaining flow has an existing 2.3 square miles of drainage area, that's this to here, which would on a 100-year event still have 4,250 cfs. Now, the existing stream channel here will still be inadequate so we still have to upgrade it for 1,000 cfs plus of flow. So if we had a diversion here, we still would have to take care of this flow in addition to upgrading the SCS channel.

Mr. Inaba: Where is Kaumana Road--no, Saddle Road. This has to extend across the road.

Mr. Ligh: But that's super expensive.

Mr. Inaba: But it covers more area.

Mr. Ligh: And it's going to cost three times as much.

Major Thal: We did look into that and there are some adverse impacts. Back to the question on Soil Conservation Service, Larry, do you have any comments?

Mr. Soenen: I suspect your question is what plans we may have for extending our channel. The extension that was made this past year is the extent of what we plan to do. We have no plans to extend it beyond what it is now. There are plans to construct smaller intercept ditches at other locations but we would not intercept any of the water in the Kauiki and Waipahoehoe Stream. So we would not be intercepting any of those flows.

Major Thal: Thank you, Larry. That is all the cards that I have. Is there anyone else who would like to make a statement?

Mr. Herb Wegner: I am also from the Luana Way/Alapaki area. You folks say that you are close to wrapping this up hoping to send it in by July. I'm actually concerned about my area, but I'm also thinking about the downstream, Komohana and below. You folks are considering wrapping it up and still going with the miles and miles of areas that you are calling undefined. In other words, you are saying that you are going to be doing this multi-million project and leave that thing up there undefined. Is that correct?

Mr. Ligh: Pretty much. We don't know what we can do up there. We can dredge out the whole channel, but we don't know what we can do out there. We're going to have to look at individual floodproofing because it would be lot cheaper than dredging or cutting all the way from Chong's Bridge to Komohana. It is such a controversial area and we have a lot of technical problems. If you feel that there is a stream there, then how does it flood?

Mr. Wegner: We know it's there because we live there and we know it's going to affect people farther down the river. In fact it's going to affect the people downtown because what they do in the back of our area is starting to affect us already. You are talking about 200 feet in your concept of floodplain management. They bulldozed within 15 feet of my house and the river is only 15 feet in the back of my house. And the water is coming in faster now than it did before.

Mr. Ligh: It's such a critical issue and we felt that at least let's protect the people who live in the lower portions and solve their problem. In the upper portions, nobody has the answers. We tried to work with the USGS to see what's happening up there.

Mr. Pakele: The problem is with the 57 acres behind our houses; they are going right into the river area which is clearly defined and what we are saying is that there is no way, and I think you are saying in your report that you are planning to withdraw the undefined area, that 200 feet clause. Is that right?

Mr. Ligh: We're going to work with the County and based on people who know the area where the main stream goes through. We know it's difficult; it's going to be plus or minus. We don't like to force the County to do things. What they do upstream there is going to affect what's going to happen downstream, but that's their judgment on drainage, etc. We're saying that there is a lot of controversy now. The Corps provides permits--when anybody wants to go in and dredge or fill navigable waters. They have to come to the Corps of Engineers to get a permit. And we're having problems in saying--when a person wants to build something on this location, where is that stream, so perhaps the best thing we could do is to delineate where we think the stream is and in the future development, everybody gears to that. That's the stream that has been recorded and then when people come in the future to develop, they have to make sure that they provide an adequate channel in there where the water will come down, and that they are not going to build all along here and only put a 10-foot channel in. They would have to come in and spend the money and put in a say, 50-foot channel all the way down--a prerequisite of any future development.

Major Thal: If you think we should consider something, give us the information and data and we will look at it.

Mr. Wegner: I just feel that it's really being unfair to us to go ahead and spend all this money and kind of leave us in the lurch, so to speak, which is what it really sounds like.

Mr. Ligh: As I said, unfortunately, the issue is not clear. We don't know if it's a political or management problem versus a flood problem or even if the Corps can go in there because it's an interior drainage problem versus an Alenaio flood problem. Unfortunately, no one came to the first two public meetings that we had; we looked at it and based on information we had--what would you recommend we do?

Mr. Wegner: Take the time to find out what's happening because if you come up there anytime that it's raining, I think the Alenaio Stream is very visible; it's right there. There's no question.

Mr. Ligh: Is it the Alenaio Stream or is it a finger? The stream is 500 feet back; you tell me it's over here, but I could say it's 500 feet back and the water is coming down that way and maybe this is one of the overbanking that has occurred and it looks like it's high.

Mr. Wegner: Well, it's clearly a major portion of the stream.

Mr. Ligh: Do you have flood damages because that water is overflowed and going into your house or is it coming from the street above?

Mr. Wegner: No, no, no. I live on the inside of the street; I'm not affected by the water coming down. I'm affected by the water which comes out not only from the main opening in the course but it also runs all along the back of the stream. It's solid water.

Mr. Ligh: Do you think a higher wall would help?

Mr. Wegner: I think it would certainly help because as I said, it may help us, but again until it's kind of defined what's happening back there.

Mr. Ligh: As I said, it's beyond technology right now. What we did in our design was assume so much development and incorporated it into our design. We don't say this is it, we add another 20-30% on that back there. We plan for a 50-year life so we assume so much development will occur and we add an extra factor.

Mr. Wegner: Then if I could talk for myself instead of the whole down river area, I would like to see something seriously considered.

Major Thal: You can be sure once we go ahead, your concerns will be taken care of. We are not going to neglect that area because we haven't considered it so far. We definitely will look into it.

Mr. Ligh: I notice that a lot of people look at it as a general drainage problem, which may help define the drainage problems. I think we are trying to give assistance to the County on that, right?

Major Thal: So you might just give your information to the County and also to the Hilo Comprehensive Study.

Major Thal: Your concerns will be taken into consideration.

Mr. Ligh: Leave me your name and address and I can call you when a decision is made.

Major Thal: Would you like to identify yourself?

Mack Yamamoto: I have a question on the definition on what you said about the water going down one way. The water really doesn't go down one way until it reaches my place. My place it actually cuts across; there's a drainage canal and when it floods a lot that canal goes into my property and wets my house and that starts to overflow and goes on.

Mr. Ligh: So that's why we're saying that it might be a drainage problem; if that canal were wider, it would intercept that water, which is what we consider a local problem. It's not a Federal flood problem.

Mr. Yamamoto: When I talked to the County Engineer, he told me that this flooding had already occurred. So what does that mean--that the flood has already occurred?

Mr. Ligh: It means that flooding could be from interior drainage. You have to define the type of flooding. If it's flooding from interior drainage, we cannot touch that at all.

Major Thal: If it's a local drainage problem, the County would get involved; the Federal would not. It has to be defined whether it's a local drainage problem or whether in fact it's part of the overall problem of the stream itself.

Mr. Sasaki: My name is Doris Sasaki and I live on the corner of Kilialoha and Kaumana, so that's my property. I can answer the problem for Mr. Wegner and Mr. Fujimoto if you put the Alenaio Stream into my property. When I got this property four years ago, they didn't know that we would get flooded and I got flooded out four times. Instead of floodproofing my property and I think you should consider putting that stream into my land and buy it because I'm the culprit. The first house on Kilialoha Street. The water comes down into my property from Kaumana Drive and I live in the first house. I talked to Mr. Yanabu and Civil Defense and the County and told them that the culvert was too small.

Mr. Ligh: This is where you're saying that Alenaio is?

Mrs. Sakaki: That's the thing--it's a culvert problem.

Mr. Ligh: You see, that's the question we have to determine. Is it because of inadequate drainage structure along here or is it because Alenaio Stream there's so much water coming down here? Is it because water is coming along here and it's raining and it's pouring into the land and going along the roads and everything? We put that under the purview of drainage.

Mrs. Sakaki: No, not drainage--flooding. Why don't you come to my lot and look at it because Mr. Yanabu knows.

Mr. Yanabu: Doris, I was at your place when this problem occurred. It is an interior problem; it's a County problem. I know you have a problem, we are aware of it, but it's a matter of funding. So, if you can let Jim off this time, we'll get together again.

Audience: You know between Reach 3 between Komohana and Kilauea--Kapiolani--you mentioned structures. Have these structures been specified? Is that information available?

Mr. Ligh: It's in the report.

Audience: I want to know if one is my house. I live whcre the culvert gave way twice.

Mr. Ligh: Komohana Street?

Audience: Kuapoani Way.

Mr. Ligh: If you have the tax key number, it tells you what we think the flood type is for that structure and next to it it has what we think we should do. I think it's in Appendix C. We are providing a floodwall here; as a matter of fact, we will probably go to your house and ask you what you think. There are six houses.

Audience: Another question. About a month ago, there was some surveying. Do you have anything to do with the bridge?

Mr. Yanabu: The reason we did the survey was because we designed the bridge, and we applied for Federal funds. That has nothing to do with the Corps.

Mr. Pakele: I would like to go back to Alenaio Stream again, please. The question that I have, there are two questions--you do have jurisdiction of Alenaio Stream up to the point where it is defined, right?

Mr. Ligh: All the way to Chong's Bridge.

Mr. Pakele: My second questions is, in your report, there was a proposal to delineate that 200 feet in the undefined area, right?

Mr. Ligh: Yes. As a matter of fact, we tried to delineate it. We based it on topo maps and field observations. We tried to survey the area but the cost to send a survey crew over to Chong's Bridge and Komohana Street was really expensive. So we thought that at this point in time it was not cost effective.

Mr. Pakele: The reason why I'm asking this is to get a thorough understanding because if it is that undefined area that you're taking out that 200 feet, then clearly we have no concern to raise with you. The question becomes, is it the County? That's what I'm trying to determine now.

Mr. Ligh: We are recommending to the County on this plan that they zone that area, and that they do not provide permits to develop. That's all we can do--make the recommendations; it's up to the County. When they provide us the local assurances, they will say how they intend to take the recommendation. We're recommending that minimum 200 feet of area not be developed without proper permit actions.

Mr. Pakele: I'm getting a hard time following your rationale because if you tell me that you have jurisdiction all the way up to Chong's Bridge, why can't you provide flood control measures to the whole area.

Mr. Ligh: But that jurisdiction is only for a small area pertaining to navigable waters of the U.S.

Mr. Pakele: That'w what I wanted to hear.

Mr. Ligh: You see, there's two different types of jurisdictions--jurisdiction to study or jurisdiction to study to implement Federal projects and jurisdiction to prevent people from doing things. We have authority to study but we have no authority to build anything for the whole area. We have authority between Chong's Bridge and Hilo Bay to prevent construction in navigable waters and that authority we have legally. I cannot go into the Wailuku area and start studying there because we do not have the authority.

Major Thal: Under the Clean Water Act, Section 404, we have permit authority, regulatory authority. In other words, you build in the wetlands or lands that are controlled by the waterways of the United States, then we issue a permit.

So, we have a regulatory authority in that area. We do not have authority in local interests. We are not in the business of telling you or the County what you ought to use the land for. So therefore perhaps I think your first source of information should be with the County.

Mr. Pakele: There's just one clarification I would like to have made. Ed said that we did meet with the Corps; we had made several proposals to them that we would be willing to walk through the areas but nobody took us up on it. Your study says that there's an undefined area from Chong Street (?) down and we have to adamantly disagree with you because from Chong Street to behind our subdivision is a mile and a half to two miles and it is definitely a defined area.

Mr. Ligh: You said that it's defined. How would that impact on changing our recommendations?

Mr. Wegner: I would say that it would put you into your legal position of not issuing a permit within 200 feet of that river.

Mr. Ligh: No, we don't have that. We said only navigable waters of the U.S. But right now we only have authority within that water which may be only 5 feet or 10 feet. We have it on the map, the US Geological Survey map. The map makers delineated it. We have to transpose that location to what's out there and you people agree that that's the actual site. But then if you walk in there how do I know--I have no reference. So, that is a real touchy issue here and we felt that the County would perhaps be the best people to solve what they want to do in that area. We recognize your problems and we are not trying to push you off. We just feel that you have a stronger argument with the County rather than with us.

Mr. Fujiyama: I have a question on design for capacity instead of location. You said that you allowed for 20-30% for the design. Design for what? Because between Kaumana and Waiakea there's total open area all the way up. The Alenaio Stream is the main channel that will handle all future development, so what is the density or surface runoff from future developments?

Mr. Ligh: We had our experts in hydrology do that, and I think on this particular project, they assumed that--as you know, water either goes into the ground or goes into stream when the ground is saturated. Obviously where they have concrete, it probably doesn't saturate as much. In this particular case, we assumed that 50 years from now, 50% of the drainage area will be impervious.

Mr. Fujiyama: From where to where?

Mr. Ligh: The whole stream from the bottom all the way to Chong's Bridge. We put a factor in there and in certain years, it would be impervious.

Mr. Fujiyama: So the design below Komohana to the ocean can handle that capacity.

Mr. Ligh: Yes. I want to mention that Standard Project Flood is the most extreme conditions that would happen.

Major Thal: There's always a question on the 100-year flood and the Standard Project Flood. On the 100-year flood, there's a 1% chance, 1 out of a 100 chance of that size storm occurring in one year. Which means that you could have two or three in one year. The Standard Project Flood normally are 1 out of 500. In other words, there's a 1 out of 500 chance of that size storm occurring in any particular year. We design for the Standard Project Flood which is a larger storm than the 100-year flood.

Mr. Fujiyama: But does it take into account maximum development?

Mr. Ligh: Yes, it's in there. It's what we call impervious factors.

Major Thal: If you look at the report, it shows what factors we used, what percentage of development. Obviously, if you have any open area and you rake away the grass and put concrete then you are going to get more runoff. It's not going to percolate into the ground. So, those factors are all in the report and we project the best information for 50 years.

Mr. Pakele: I have one more statement. Mr. Inaba's proposal has a lot of merit. If we look at the Wailua Flood Control Area, there are certain areas that they had to concrete, but if anybody knows that area, from Kinoole all the way up to Komohana, what Mr. Inaba was proposing in terms of digging up the area, it handled the water very well because it cuts through the university cut off, and it made all that area developable. I think there's a lot of merit into looking at something like that for Alenaio Stream. I think that Mr. Inaba's proposal in terms of looking at the type of channel or diversion or even taking the undefined area, like how we did with the Wailoa project from Kinoole all the way up to Komohana, would have a lot of merit because a lot of that land would then be able to be developed to confine that undefined stream into one area.

Mr. Ligh: But down here, we already know that the stream is inadequate. We would be spending a lot of money dredging along here to let the water out.

Mr. Pakele: But isn't the question still the same, what are you going to do with that water after you improve the area that you want to improve?

Mr. Ligh: But the output would continue out to Hilo Bay.

Mr. Pakele: And flood downtown.

Mr. Ligh: But there's nothing downtown; there's nothing below Kilauea Avenue, there's no development.

Mr. Pakele: Through the present canal that's there down to Wailoa River. It seems like we're putting a band-aid on something.

Mr. Ligh: But why should we provide protection?

Mr. Pakele: Wouldn't it be easier to run from Punahawai and Kilauea--run a straight channel right up to the bridge area?

Major Thal: Cost is one factor. Remember, we're in a cost-sharing program. If the Federal Government approves it, then it will be a 35% to a 55%. This type of concrete channel is very expensive and what you try to do is optimize the cost. In this case, you can see the benefits derived are very small compared to the cost which is derived from the cost ratio.

Mr. Pakele: The reason why I bring that out is because we have had two major floods. The whole downtown area was flooded, Komohana was washed out and people could not move.

Mr. Fujiyama: You are looking for recommendations. What is the County's position of Alternative 1, 2 or 3?

Mr. Yanabu: We don't have a recommendation at this time.

Mr. Fujiyama: What is the County's stand on OEO, whether they are going to be allowed to go through with their 57 acres?

Mr. Fujiyama: Because the top of that comes right smack down.

Mr. Inaba: In the second channel, wouldn't that diversion of the water benefit the whole area?

Mr. Ligh: Why would that be better?

Mr. Inaba: Because the future is going to develop.

Mr. Ligh: You want the Corps to spend twice the amount of money to help you develop the property?

Mr. Pakele: If you are looking at cost ratio factor based upon just what you're doing and what we wanted to hear, but when you look at the total Alenaio Stream, it's going to be maybe three times what we would spend to do this extension here. Inevitably the Corps is going to come back and be involved again; and I'm not against your first proposal, as a matter of fact, I'm for it. But what I'm saying is if you do that....

Mr. Ligh: You're saying that if we do this, we're going to solve the whole problem of flooding?

Mr. Pakele: I'm not saying that you are going to be solving the whole problem, but you are going to take away a heck of a lot and maybe by taking away that, the present type of system that we have could handle what comes down.

Mr. Ligh: I'm saying that even if this diversion here, we still would have 4,450 feet of at this point here. And the existing capacity below Komohana is only approximately 2,000 so we still have a surplus of 2,450 cfs which we still have to figure out what we're going to do.

Mr. Pakele: But it's more now with all of that. I think you are missing out on what I'm saying.

Mr. Ligh: I understand what you are trying to say, but we still have to make improvements anyway. We're trying to make improvements along here and down here which is 9,240 feet and plus the additional to wherever this 4,450 feet we have to incorporate.

Major Thal: Remember now, it has to solve the problem. Jim is saying that by putting a diversion channel here, it is not going to solve the problem. What Jim is saying is that under his alternative, that will solve the problem. You

are talking about a tremendous increase in cost. It is not cost effective to do that and do this when you have another alternative at much less the cost which will solve the same problem. Again, we are not in the land development business. We will not put a structure here with the idea that in the future this will be developed. We are looking at the situation trying to solve a flood control problem.

Mr. Matsunaga: Do you work in conjunction with Soil Conservation?

Mr. Ligh: Yes.

Mr. Matsunaga: Right now, are you aware of their projects; I mean future projects? Are your projects coordinated?

Mr. Ligh: Yes. We send them a copy.

Mr. Matsunaga: It's just that you are different departments.

Mr. Ligh: I think on page 20 of the report, I have a diagram that shows all the proposed SCS projects. Every time I come here, I visit with Larry Soenen.

Mr. Hara: If I'm hearing you right, what you are saying is that even if we downgrade the engineering, you're going to get some benefits out of it? What happens along here?

Mr. Ligh: Well, there's no houses along here. Chong's Bridge is along here.

Mr. Hara: Oh, I see, you're not looking at anything above Chong's Bridge.

Mr. Ligh: They may have some along Chong's Bridge; they don't get flooded.

Mr. Hara: Concrete is further down.

Mr. Ligh: But they indicated that they do not get flooded.

Mr. Hara: So if we put that in, we're not going to get any benefits. What you are saying is that even if you reduce the capacity of the channel, it just doesn't cancel out.

Major Thal: Any more questions?

Mr. Kihara: I am very disappointed that nothing is being done between Kapiolani and Komohana. In the last flood I had water over my property.

Mr. Ligh: We're not saying that nothing is being done on the top. What we are saying is that there are about 12 houses in that stretch. That stretch is about 2,000 feet and we felt that improving the channel 2,000 feet for 12 houses is not cost effective. And we thought that floodproofing houses individually is easier than doing the whole stream.

Mr. Kihara: My land is level with the Alenaio Stream so I thought maybe you were going to raise that stream. Surveyors came to survey the area and they told me that they would have a 40-foot channel, so I'm very disappointed that nothing is going to be done. I'm still going to get flooded. In fact, I lost some property in that last flood; I never saw one flood that big. Guava trees growing for 50 years were washed out. And you folks going do nothing about that. You're doing only piecemeal. Fifty years from now we're going to have the same problem; maybe we have to widen the channel again. I lived there 50 years and look what happened. In the next 50 years, what's going to happen.

Mr. Ligh: Where do you live?

Mr. Kihara: Well, fortunately my home is about 20 feet above the bridge. My home is this one right here.

Audience: Am I correct in understanding that Alternative 1 because widening the channel that it will prevent flooding in Reach 3?

Mr. Ligh: Yes, you can say that. The channel down there will prevent flooding from Kaipolani down all the way. Reach 3 between Kapiolani and Komohana will prevent flooding to individual structures.

Audience: Why does the bridge has to be high if the area is all block? In the area you are talking about, it's almost solid ground. What if they just excavate?

Audience: Which is what they did right near our house; they went down 10 feet.

Audience: It's hard lava on one side. On the Puna side it's solid rock.

Major Thal: Any other questions? OK, once again, if you want to write us, we have some self-addressed envelopes. Please put your comments in by 4 June and thank you very much for coming tonight.

written testimony provided at the
12 May 1982 Public Meeting in Hilo

My name is Gary Neko, and I am a resident of Luana Way.

Since most of the residents of our community were not aware of the Alenaio Stream Flood Damage Study that the Corps of Engineers was preparing, we were not able to make earlier input.

At this hearing, we would definitely want to have included in our public hearing input, the precarious conditions which exist with the flood waters of the Alenaio Stream which joins the drainage system of our subdivision to create a definite water flow which our community is keenly aware of and have subsequently brought to your attention.

I am hereby submitting a petition that was signed by the residents and individuals who are aware of the flooding problems at the end of Luana Way, who are not in favor of the proposed HCEOC project which will affect the flood plains area just below Luana Way by diverting more water in the well-defined flood stream, and which will bring subterranean water to the surface heretofore drained via underground lava tubes.

The Alenaio Stream does flow from Chong Street and converges with the waters of our drainage channel and can be identified on flooding days as a definite finger above and below Komohana Street--a finger which flows directly below Luana Way.

The petition covers our major concerns, and is definitely linked with the Alenaio Stream. The contentions presented, therefore, should be indicated in your study.

My name is Edward Fujimoto, and I am a resident of Luana Way.

Due to the constant flooding problems that we have experienced in our neighborhood, the upper sources of water flowing into the Luana Way drainage channel were traced.

As indicated in the attached diagram, there are at least three major sources of water from the Kaumana Terrace Drive area that converge into the Luana Way drainage channel.

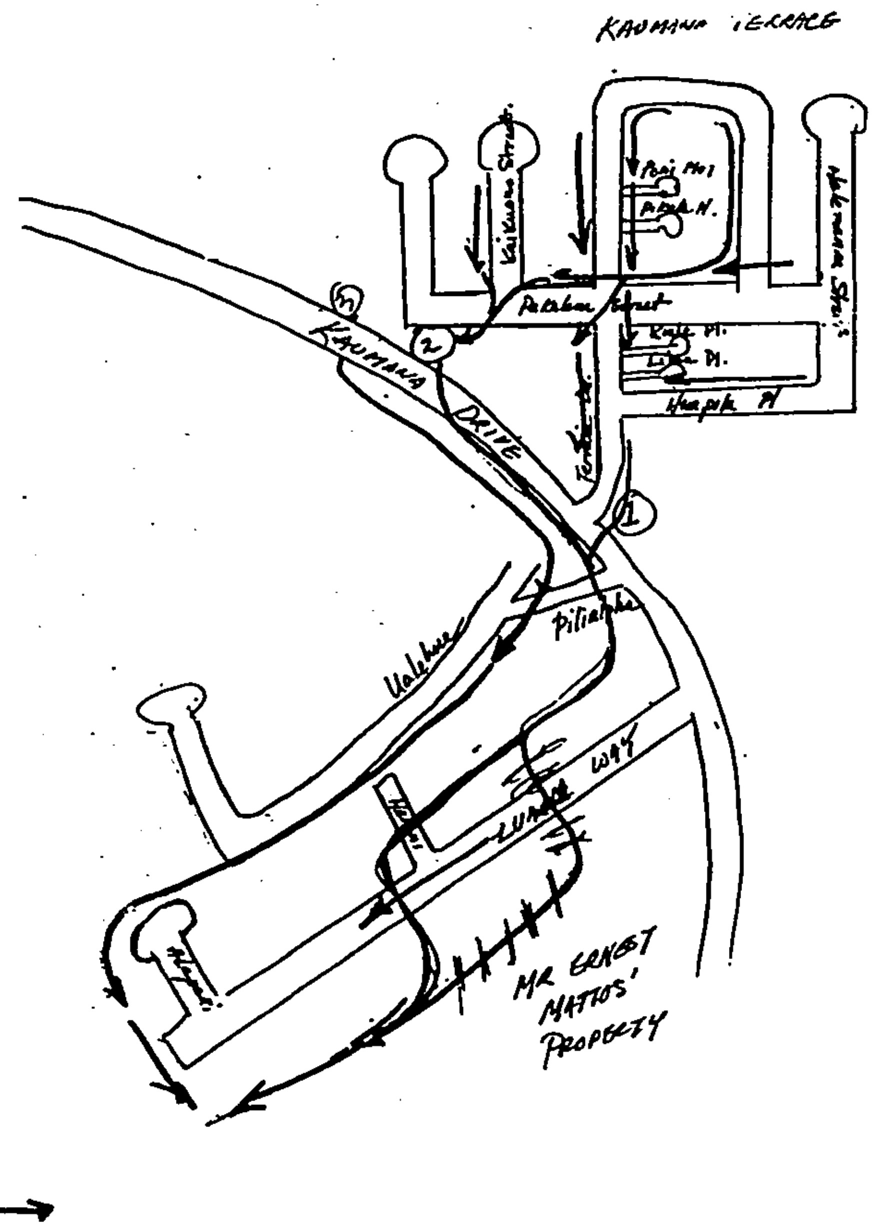
The area designated "3" on the diagram feeds into the Luana Way subdivision via Kaumana Terrace, Pilialoha and Ualehua Streets, and flows through the private drainage channel at the bottom of Luana Way.

The sources marked "1" and "2" flow through the Kaumana Terrace Drive complex, crosses Pilialoha Street, and enters the Luana Way Subdivision flowing down Luana Way and also across this street into Mr. Ernest Mattos' pasture, and converges with the drainage channel water at the bottom of Luana Way.

The volume of water, then, which is absorbed by our subdivision from the Kaumana Terrace area, is tremendous. This is not all. A major finger of water from the Alenaio Stream which can be traced to Chong Street converges with the Luana Way drainage channel--compounding the volume. Also underground water from broken lava tubes is also surfacing to add to the total volume of water. A great ponding effect then takes place at the bottom of Mr. Ernest Mattos' property, and the water--clearly identifiable--flows down toward Komohana Street.

We contend, therefore, that the Alenaio Stream is clearly defined and is located near the bottom of our subdivision.

If not the stream itself, a major finger of the stream is evident and should be recorded and described in your study.



LUANA WAY PETITION

WHEREAS, inasmuch as we are in favor of the program being proposed by the Hawaii County Economic Opportunity Council (HCEOC), we are on the same note, opposed to creating a hazardous traffic condition for the children and residents living on or near Luana Way; and

WHEREAS, the Corps of Engineers is now conducting a flooding study which encompasses the area from Chong Street to Kukuau Street and includes the area at the end of the Luana Way street; and

WHEREAS, the Corps of Engineers' study will determine whether or not any development or structure is possible in the flooding area studied; and

WHEREAS, the HCEOC is proposing to create a bridge to gain access into the 59 acres that they are leasing from the Department of Land and Natural Resources (DLNR) which will be a possible barrier to the free flow of water in the private drainage ditch of Luana Way, to the free flow of water which drains on Luana Way and into the private drainage channel, and to the general area considered a flooding area; and

WHEREAS, if such a structure as a bridge is erected in a flooding area it must be of such standard as to meet the requirements of a 100 years flood; and

WHEREAS, if such a structure as a bridge is erected, it will require widening and deepening throughout and at the end of the Luana Way drainage channel to prevent blockage that may take place at the bridge and near the end of that channel; and

WHEREAS, if a bridge is constructed at the end of Luana Way, it will enhance the development of a through-street on Luana Way which will in turn add to the already hazardous condition at the junction of Luana Way and Kaumana Drive; and

WHEREAS, the peaceful and safe characteristics of a dead-end street community will be disrupted when there is additional traffic into the 59 acres and other possible traffic if Luana Way should become a through-street; and

WHEREAS, there is a less expensive, more conducive access into the 59 acres being contemplated for the HCEOC project, through the Ainako extension being proposed for the new subdivision in this area which will provide urban zoning and automatic access into the 59 acres; and

WHEREAS, there are other possible accesses into the 59 acres to be utilized by the HCEOC project such as through the Ken Fujiyama Sunrise Subdivision near Kukuau Street, the Richardson Estate, and other areas abutting the proposed land area including the Ainako extension already mentioned, which would be less expensive,

NOW, THEREFORE, WE THE UNDERSIGNED, are against the creation of a bridge, and the utilization of the Luana Way access, and urgently request HCEOC to consider the selection of an alternate access into the 59 acres that will be used for their agricultural

NAME	ADDRESS
1. Linda H. Nako	121 Luana Way - Hilo
2. [illegible]	55 Luana Way Hilo
3. [illegible]	55 Luana Way Hilo
4. Bob [illegible]	71 Luana Way Hilo
5. [illegible] Nako	121 LUANA WAY
6. [illegible]	50 Luana Way Hilo
7. Clive K. Honaki	" " " "
8. [illegible]	639 Luana Way Hilo
9. [illegible]	" " " "
10- [illegible]	31 - Luana Way
11. [illegible]	19 Luana Way
12 [illegible]	570 Kaumana Dr. / Hilo
13 Nancy Mariyama	
14 [illegible]	24 [illegible] Place Hilo
15 [illegible]	24 [illegible] Place, Hilo
16 [illegible]	28 Ikena Pl, Hilo
17 Darrell Yoshida	28 Ikena Pl, Hilo
18. [illegible]	603 Ikena Pl. Hilo
19 [illegible] Yoshida	221 Box 208 Papaikou, Hawaii
Albert C. Rezentes, Jr.	21 IKENA PL.
Emily Sakaguchi	603 Kaumana Dr.
Mae Costa	624 Kaumana Dr.
Elaine Sugai	640 Kaumana Dr.
[illegible] K. Sugai	640 Kaumana Dr.
[illegible]	31 Luana Way
[illegible]	632 Kaumana Dr.
[illegible]	685 [illegible]
[illegible]	176 [illegible] St
[illegible]	84 Ainako Ave

NAME	ADDRESS
[illegible] Q. Damasco	129 Luana Way Hilo, Hi
Mabel B. Damasco	129 Luana Way Hilo, Hi
Joseph C. Lucas	105 Haihai St. Hilo, Hi
[illegible] M. Lucas	105 Haihai St. Hilo, Hi
Karen Lucas	105 Haihai St. Hilo, Hi
[illegible]	206 [illegible] Hilo, Hi
[illegible]	146 Kalanai St.
[illegible]	191 [illegible] St.
Noreen Luiz	PO Box 116 Papaikou, Hi
Ezekiel Luiz	P.O. Box 116 Papaikou, Hi
Helen L. Luiz	P.O. Box 116 Pepeekeo, Hi. 9678
Theresa L. Rapoza	65 Akala Rd Hilo, Hi. 96720
Manuel S. Rapoza	65 Akala rd Hilo Hi 96720
[illegible]	193 Manulele St. Hilo Hi 96720
[illegible]	193 Manulele St. Hilo Hi
M. [illegible]	199 Manulele St. Hilo
Mr & Mrs Gil K. [illegible]	7 Luana Way
Mr & Mrs. S. [illegible]	16 Luana Way
Mr. Errol Tomita	480 Kaumana Dr.
Amy S. Fujimoto	113 Luana Way Hilo
Edward K. Fujimoto	113 Luana Way Hilo, Hawaii

NAME	ADDRESS
Melani S. [illegible]	105 Luana Way
Annette K. [illegible]	105 Luana Way
Carol Shimizu	18-A Helani Place
Gloria Shimizu	" "
[illegible] Goto	18-Helani Place
Haruko Goto	18 Helani Place
Ruby K. Kahalepa	18 Helani Place
[illegible] Kahaapea	18 Helani Place
[illegible]	21 Helani Place
[illegible]	21 Helani Place
[illegible]	21 Helani Place
[illegible]	21 Helani Place
Lynn C. del Rosario	21 Helani Place
[illegible] M. Yamamoto	7 Helani Pl.
Dale K. Yamamoto	7 Helani Place
Richard Salas	8 Helani Place
[illegible] Ohigashi	81 Luana Wy.
[illegible]	81 Luana Way
[illegible]	88 Luana Way
[illegible]	106 Luana Way
[illegible]	106 Luana Way
[illegible]	81 Luana Way
[illegible] N. Ohigashi	81 Luana Way
Phyllis [illegible]	55 [illegible] St.
[illegible]	30 Helani Pl
[illegible]	30 Helani Pl
Mrs. Mrs. Masayoshi Tomita	480 Kaumana Dr
Roy A. [illegible]	154 Manulele St

NAME	ADDRESS
Ernest A. Mattos	563 Kaumana Dr.
Virginia R Mattos	563 Kaumana Dr
Albert A Mattos	579 Kaumana Dr
Ernest M. Mattos	579 Kaumana Dr.
Raymond N. Ajima	11 LILINOE ST.
Michele Ono	545 KAUMANA DR.
[illegible]	" " "
[illegible] Bomley	537 Kaumana Dr. Hilo 967
Mr & Mrs. Y. Oakano	525 Kaumana Dr.
M/M Richard Nakamura	499 Kaumana DR.
M/M Gilbert P. Aguiar	526 Kaumana Dr.
M. [illegible] Amaral	513 Kaumana Dr.
Howard Mattos	530 Kaumana Dr.
Delores L. Mattos	530 Kaumana Dr.
Sebastian Mattos	530 Kaumana Dr.
Louie A. Mattos	530 Kaumana dr.
Edward K. Bright	538 Kaumana Dr
Cecelia Bright	538 Kaumana Dr.
[illegible]	566 Kaumana Dr.
[illegible]	585 Kaumana Dr
Mrs. Jo S. Aguerros	586 Kaumana Dr.
[illegible]	585 Kaumana Dr
[illegible]	24 Luana Way
[illegible]	24 Luana Way

NAME	
[illegible] Okada	702 [illegible] Ave. Hilo
Hiroko [illegible]	704 Kilauea Ave Hilo
Laverne Amey	1525 Kilohi St. Hilo
[illegible]	1498 MAILANI ST Hilo
[illegible]	[illegible]
[illegible] Machado	170 [illegible] St Hilo
[illegible]	[illegible]
[illegible] Okada	97 [illegible] St. Hilo
[illegible]	[illegible]
[illegible] M. [illegible]	P.O. Box 204 Kurtistown
Reynaldo M. [illegible]	261 [illegible] St
[illegible]	1571 Alae St.
Audrey Cabatbat	P.O. Box 498 Papaikou, Hi 967:
Isaac J. [illegible]	Kaia . Papaikou
John Garcia	74 Mikioi St.
Gary D. [illegible]	146 Uluwai St. Hilo
Stanley S. Yoshimoto	10 Ululani St
[illegible]	786 Kahaopea St
[illegible]	1540 Kilohi St.
Harold [illegible]	P.O. Box 155 Kurtistown
Gilbert [illegible]	375 Noe St Hilo, Hawaii
[illegible]	66 Wainaku St. Hilo, Hawaii
[illegible] T. Okazaki	126 Uluwai St. Hilo Hawaii
[illegible] T. [illegible]	172-B Kekela Hilo
[illegible] T [illegible]	2451 Waianuenue Hilo Hawaii
Richard [illegible]	504 HOOKUNI ST. Hilo
Delbert S. S. Lau	S.R. C-23B KEAAU
[illegible] Matsunaga	22 [illegible] Pl.
[illegible]	92 UHALA

NAME	ADDRESS
[illegible] Hall	118 Alapaki Pl
[illegible]	118 Alapaki Place.
Mark L. Varize	118 Alapaki Place
[illegible] Bowen	112 Alapaki Place
Carol Ann Bowen	112 Alapaki Place.
[illegible]	125 ALAPAKI PLACE
[illegible]	125 Alapaki Road

NAME	TEL:	ADDRESS
Mrs. Lurne K. Miyasato	(935-6456)	597 Kalanikoa St. Hilo, HI 96720
Terry C. Aliceben	966-7039	mailing address: 130 Luana Way
Mrs. Jacklyn A. Spencer	#961-3945	663 Waianuenue Ave. Hilo 96720
Mrs. Pearl H. Kailimai	(959-1835)	430 Kehaulani St. Hilo 96720
John Aliceben	961-6130	130 Luana Way Hilo
Gerry Kahelewai	961-3871	242 Hilinai St. Hilo
Karl K. Kekela	964-5115	Papaikou HI.
Eddie Pavao	935-7555	48 Mooke St.
John Moon	959-9403	1188 Komohana St.
[illegible]	959 5757	1559 Kione St
Rudolph Spencer	961-3945	663 Waianuenue Ave
Terry C. Aliceben	964-1660	P.O. Box 116 Papaikou, HI. 96781
Lily A. Aliceben	964-1660	P.O. Box 116 Papaikou, Hi 96781
Donald Aliceben	935-3139	69 Pakalana St. Hilo 96720
Marietta Aliceben	935-3139	69 Pakalana St. Hilo 96720
Lulu Aliceben	961-6130	130 Luana Way Hilo 96720

NAME	ADDRESS	NAME	ADDRESS
1) April Cazimero	124 Alapaki Pl.	[illegible]	111 Alapaki Pl. Hilo
2) Caroline K. Cazimero	126 Alapaki Pl	Arthur M. [illegible]	132 Alapaki Pl. Hilo
3) Wm K Cazimero	126 Alapaki Pl	[illegible]	132 Alapaki Pl. Hilo
4) Janet L Matsuno	233 Ameda Street	[illegible]	138 Alapaki Pl.
5)		[illegible]	128 Alapaki Pl. Hilo
6)		[illegible]	117 Alapaki Pl. Hilo
7)		[illegible]	131 Alapaki Pl Hilo
8)		[illegible]	131 Alapaki Pl. Hilo
9)		Laura A. Pilo	137 Alapaki Place, Hilo
10)		[illegible]	117 Alapaki Place - Hilo
11)			
12)			
13)			
14)			
15)			
16)			
17)			
18)			
19)			
20)			

NAME	ADDRESS
Ayako Shiro	2110 B. Waianuenue Ave.
Jeanette B. Siuzi	P.O. Box 1518 Pahoa, HI 96778
Lorna Uyehara	44 Alnako Ave. Hilo 96720
Bob Miguel	77 Laukona St. Hilo, Hi.
Lynette S. Brown	144 Kaumaloa St Hilo, HI

NAME	ADDRESS
Harvey T. [illegible]	322 [illegible] Drive
[illegible] Matsushima	1327 Laune St.
Julie [illegible]	1327 Laune St.
Mary Ann Miyahara	1414 Mailani St.
Paul M. Miyahara	1414 Mailani St
Sally Abramson	138 Anela Dr.
Jimmy [illegible]	138 Anela St.

FOOD FAIR SUPER MARKETS

PACIFIC-HAWAIIAN, LTD.

DOWNTOWN STORE
194 KILAUEA AVENUE
HILO, HAWAII 96720
PHONE: 935-0862

Mailing Address:
1990 KINOOLE STREET
HILO, HAWAII 96720
PHONE: 959-9126

May 12, 1982

Kenneth E. Sprague
Lt. Colonel
Corps of Engineers
District Engineer
Department of the Army
U.S. Army Engineer District
Honolulu
Ft. Shaftner, Hawaii 96858

Re: Alenaio Stream Flood Damage Reduction Study

Dear Lt. Colonel Sprague:

Pacific Hawaiian, Ltd. owns an 8 acre parcel of property included in the area covered by the flood damage reduction study, being Tax Map Key: 2-3-37:01, and physically located near the intersection of Komohana and Ponahawai Streets, Hilo, Hawaii. As president of Pacific Hawaiian, Ltd., I received the public meeting notice dated April 16, 1982, which requested comments from all interested parties concerning the flood damage reduction study and the recommendations. This letter will serve as my formal comments concerning the study and the Corps of Engineer's recommendations.

Of the three alternative plans studied by the Corps of Engineers, I strongly support Alternative No. 1. The draft survey report and environmental impact statement has been reviewed and it seems clear that Alternative Plan No. 1 is, in almost all respects, the prefereable alternative. Tables 10 and 14 of the study set out very succintly the advantages and disadvantages of the various alternative plans. A review of those tables can lead to but one conclusion: Alternative No. 1, modifying the existing channel, is much preferable to any of the other alternatives.

The main reasons I favor Alternative No. 1 are as follows:

I. Cost. The initial cost of carrying out Alternative No. 1 is estimated to be (SPF) $7,985,000, whereas the initial cost of Alternative No. 2 is (SPF) $15,678, 000. The initial cost then, for Alternative No. 2,

is approximately double the cost of Alternative No. 1. As a property owner and tax payer, I can see no justification, at least from a cost standpoint, of selecting Alternative No. 2 over Alternative No. 1.

II. Practicality. I believe it is much preferable to modify the existing channel rather than attempt to divert the flow of the waters into a completely new channel as suggested by Alternative No. 2. Aesthetically, it certainly makes more sense to follow the existing channel and, from a layman's standpoint, I would think that the chance of success in achieving the overall goal of reducing future flooding would be greater by following the natural flow of the stream.

III. Effect of Alternative No. 1 and 2 on other property. Alternative No. 1 would require much less condemnation of agricultural and residential property. If Alternative No. 2 were to be selected, it would require nine to ten acres of agricultural/residential lands to be condemned for flood control easements and for the diversion channel. Alternative No. 2 would require 19,130 (cy) of concrete and related man power and energy resources versus only 5,820 (cy) of concrete and related man power and energy resources for Alternative No. 1. Further, from a personal standpoint, Alternative No. 2, Alignment A, would substantially reduce the usefulness of Tax Map Key: 2-3-37:01 for any type of developmental purposes.

IV. Environmental. Alternative Plan No. 1 will have minimal environmental damaging effects.

In summary, I strongly urge the U.S. Corps of Engineers to adopt Alternative No. 1 and to develop the flood control plan set out under that alternative. Thank you for your consideration.

Yours very truly,

PACIFIC HAWAIIAN, LTD.

Eijiro Kaneshiro
EIJIRO KANESHIRO
President

EK/nlb

August 10, 1981

Department of the Army
Pacific Ocean Division
Corps of Engineers
Building 230
Fort Shafter, Hawaii 96858

Attention: M. Tanimoto, Chief Real Estate Division

Re: Alenaio Stream Flood Control Project.
Hilo, Hawaii

Gentlemen:

We are residents along Waianuenue Avenue, Hale Street and the vicinity of the proposed diversion Alenaio Stream flood control project. We will be directly and indirectly affected by the flood control project and wish to direct your attention to the following:

1. The Alenaio Stream Flood Control Project should follow it's present stream course. The cost of the project will be least expensive and will not alter other improved areas.

2. The proposed diversion flood control project to Wailuku River will cause more damages to the improvements, property and enviroment than the actual flood damages caused by Alenaio Stream. It will deprive the residents from a peaceful existance.

3. The flood diversion channel should be constructed mauka of Chong Street or Kaumana School or near Akolea Road where it will serve its best use:

NAME	TAX MAP KEY	RESIDENT
[illegible]	2-3-15:02	Yes
[illegible]	2-3-15:29	Yes
[illegible]	2-3-26:15	[illegible]
[illegible]	2-3-26:14	Yes
[illegible]	2-3-26:24	Yes.
[illegible]	2-3-26:57	[illegible]
[illegible]	2-3-26-46	Yes
[illegible]	2-3-26-21	Yes
Bernice Kawamoto	2-3-26-23	Yes

III. SUMMARY OF COMMENTS RECEIVED

The following is a summary of comments (other than typographic errors or rewording) received during the review period and the Corps of Engineers response to each comment if applicable. All letters received and transmitted in response to the comments are provided in Section IV, Pertinent Correspondence.

Federal Agencies

US Department of the Interior
Fish and Wildlife Service

Comment: As of October 1, 1981, the Fish and Wildlife Service, Region 1, has adopted a new policy with respect to the preparation and coordination of "2(b)" Coordination Act Reports. Your Environmental Resources Section staff was informed of the specific objectives and requirements of this new policy during our meeting of September 11, 1981. At that time, we informed your staff that we expect the Corps to formally approve or reject each Service mitigation recommendation which appears in our reports. The statement in the second sentence of this paragraph on page 57 that "These concerns were incorporated whenever possible provided that the effectiveness of the proposed alternative would not be adversely affected" does not adequately demonstrate how each individual recommendation has been or will be incorporated into the design of development plans. We therefore ask that this matter be clarified in the survey report, and that future Corps reports include detailed statement(s) addressing specific Fish and Wildlife Service recommendations.

Response: Both of your comments have been incorporated in the Final Survey Report and Environmental Impact Statement. We are aware of the US Fish and Wildlife Service, Region 1, policy regarding the preparation and coordination of Fish and Wildlife Coordination Act (FWCA) reports, which requires the Corps to formally approve or reject each Service mitigation recommendation. However, we would like to point out that the appropriate time to accomplish this is after we have formally determined a recommended plan in concurrence with the local sponsor. Our evaluation of the Service recommendations would then be addressed in the Final Survey Report and Environmental Impacts Statement as is the case with this study.

Geological Survey, Water Resources Division

Comment: The existence of a thick basal groundwater lens underlying the proposed diversion channel from Alenaio Stream to the Wailuku River should be pointed out in the EIS. There are no existing wells below or downgradient from this channel--this can also be pointed out. Adverse effects will probably be minimal, but should be mentioned.

Response: Your comment will be included in the EIS.

State Agencies

Office of Environmental Quality Control

Comment: P. 15. The population data should reflect the most recent 1980 population figures. Such data can be obtained from the State of Hawaii Data Books, 1980 and 1981.

P. 16. Again, there should be more recent data reflected for housing.

Response: The population and housing data will be updated.

Comment: Since this is a joint project, we wish to point out that the County of Hawaii may have to meet the requirements of Chapter 343, Hawaii Revised Statutes, the state EIS law. On future joint projects, consideration should be given to preparing one document to meet both the National Environmental Policy Act of 1969 and the State EIS law.

Response: Consideration will be given to preparing one document to meet both NEPA and State EIS law during the Post-authorization/advance Engineering and Design phase.

University of Hawaii at Manoa, Environmental Center

Comment: Part 2a of Table 14 on page 76 states that Alternative 1 would result in *"no change from the base condition"* in relation to the environmental quality of the project site. What is the basis of this conclusion? Alternative 1 would include construction of a rectangular concrete channel. The impact of stream channelization on the freshwater biota depends largely on the condition of the streambed. While a minimal amount of damage would occur if the bottom is left in the natural state, a flat, 35-40 foot wide concrete bottom would significantly alter and impact the physical-biological habitat. A low-flow channel would mitigate some of the impacts of a channelized bottom. The final EIS should elaborate on the specific design which will be considered for the channelization alternatives. This information would result in a more complete assessment of the three alternatives by reducing the uncertainty surrounding the impact on aquatic fauna.

Response: We agree that implementation of alternative plan 1 would affect the "base conditions" within the stream. An additional 920 feet of natural streambed would be eliminated by construction of the proposed concrete channel. This information has been incorproated in Table 14 of the main report.

Comment: A flat, concrete floor would inhibit upstream migration of aquatic species. The drop structure (waterfall) proposed in Alternative 2 would completely restrict upstream migration. We urge that the mitigative measures recommended by the Fish and Wildlife Service on pages 23-24 of their December 1981 letter be incorporated into the Corps of Engineers' design of the stream channel.

Response: Recommendations 2, 4, 6 and 7 will be incorporated in the environmental protection guidelines of the construction specifications during the advance Engineering and Design phase. Recommendations 1, 3 and 5 were rejected for the following reasons:

Recommendations 1. The natural streambed will need to be channelized with concrete to prevent erosion and undermining of the channel walls and to maximize the efficiency of the channel to minimize the required channel width and depth. A wider channel would necessitate the removal of additional residential structures and displacements of its occupants.

Recommendation 3. Alenaio Steam is ephemeral, flowery only during times of moderately high rainfall. During dry periods the aquatic habitat is reduced to scattered small pools. High mortality of aquatic species occur as a consequence, stream fauna is rather poorly developed and is dominated by more hardy exotic species such as mosquito fish, dojo and crayfish. Provisions of a low-flow channel to accommodate migration of mainly exotic species within a stream that is often dry cannot be justified in view of the substantial increase in project costs associated with it.

Recommendation 5. The channel between Kilauea Avenue and Kinoole Street cannot economically be restored to a natural (unlined) streambed. A concrete channel is proposed to accommodate the design channel velocity and to maximize the channel capacity in order to minimize the channel width and depth thereby minimizing necessary relocation of homes and businesses along the stream.

Department of Land and Natural Resources

Comment: The project could have possible impact on Waiolama Canal which adjoins Wailoa River State Recreation Area. We note that Subplan 1a leaves Waiolama Canal in its current condition. While preferable to other four subplans, still another alternative might be considered. Under normal conditions, water movement in Waiolama Canal is sluggish and the canal is an unattractive ditch. We suggest the opportunity exists to make the canal more attractive without destroying the surrounding open space.

Response: The Waiolama Canal is primarily influenced by tidal flow. Since Alenaio Stream is ephemeral, little opportunity exist to help circulation and flushing characteristics. Possible environmental enhancements will be considered during post-authorization/advance Engineering and Design phase.

Private Interests

Cutler-Hanley Joint Venture

Comment: Regarding our property at Kilauea and Ponahawai (TMK 2-2-008-023), we would like to point out that we totally oppose the stated intent to widen the stream at the makai reach of our property to 35' with the entire acquisition coming from our property. This widening would require replacement of our gasoline storage tanks and would eliminate our access to Kilauea Avenue. This degree of loss of use would constitute constructive condemnation of the entire parcel and we would expect the condemning authority to replace this property with comparable property (located within one block of the ocean with unobstructed view to the ocean and zoned identically to the current property). From a practical standpoint we fail to see the rationale of widening this stream at the expense of our property (which has not been subject to flood damage). Immediately to the Puna side of this stream adjacent to our property is a parcel of property which lies in the preferred flow patch of the stream. This other property has been a repeated flood casualty of the stream and is occupied only by a dilapidated, aged, wood frame building which fails to meet all current building standards and, in fact, could well be a hazard to the neighborhood.

Response: Based on your comments we are providing an optional alignment of the proposed modification to Alenaio Stream at the lower portion at Kilauea Avenue. This optional alignment will widen and realign the channel through the structure at TMK 2-2-008-046.

When the project becomes authorized by Congress and funds are appropriated to prepare advance engineering and design plans, the economic merits of which you indicated in your letter between the two alignments will be fully evaluated with the County of Hawaii. Since the County of Hawaii is responsible for acquiring the necessary lands and easements for construction, they may accept your economic rationale pending the response from the owner of TMK 2-2-008-046. Other mitigative design features may also be identified during the Advance Engineering and Design phase which may satisfy both you and/or the owner of TMK 2-2-008-046.

Mr. J. Walter Silver

Comment: "For what my two cents is worth, on this several million dollars of you're proposed plan, Alternative 2, Diversion Channel, at the (4,200) feet elevation, my suggestion is to extend the present Diversion Channel, that has just about eliminated all our flooding problems in the Ainako Residential Area, so extend the present diversion channel thru to catch all flood waters of the Alenaio Stream, and remove half of the water going down the Komohana Street area...So before going into millions of dollars expense try my suggestion, and possibly save this money."

Response: We did investigate this alternative and found the alternative to be economically inferior to the other plans based on the comparative length and size of the channels. The SCS project has a design capacity of 1,120 cfs (100-year flood frequency) for a drainage area (DA) of 1.15 square miles in the Wailuku watershed. The combined Waipahoehoe and Kaluiiki Streams in the Alenaio watershed have a 100-year frequency flood of 5,860 cfs (DA = 5.15 square miles) at Akolea Road. To divert this flow, the SCS diversion will need to be lengthened by approximately 3,000 feet and enlarged for 5,210 feet to accommodate approximately six times the existing capacity for the 100-year level of protection. Even with this Akolea Road diversion, the 100-year frequency flood flow at Komohana Street will be 2,700 cfs (DA = 2.38 square miles). The Alenaio Stream channel downstream of Komohana Street has an existing capacity of approximately 2,000 cfs; consequently, the lower portion would still need to be improved to handle the additional 700 cfs. The proposed diversion channel (Alternative 2) at Komohana Street, as described in the report, will require a shorter diversion channel (4,200 feet) and less downstream improvements. Alternative 1, which proposes to modify the existing channel between Kilauea Avenue and Kapiolani Street, will require the relocation of six families but will require only 1,640 feet of channel modification.

The following agencies had no substantial comments regarding the Draft Survey Report and Environmental Impact Statement.

US Department of Housing and Urban Development

US Department of Transportation, Federal Highway Administration, Region Nine

US Department of the Interiof, National Park Service

US Department of Commerce, National Oceanic and Atmosphic Administration

US Department of Agriculturre, Soil Conservation Service

Hawaii State Department of Agriculture

Hawaii State Department of Defense, Office of Civil Defense

University of Hawaii at Manoa, Water Resources Research Center

Hawaii State Department of Planning and Economic Development

County of Hawaii Department of Water Supply

County of Hawaii Planning Department

VI. PERTINENT CORRESPONDENCE

List of Letters. Letters are either compiled chronologically or grouped together to provide a logical sequence of events, comments and responses.

Date	Subject	Initiating Agency	Page No.
Federal			
undated	Endangered Species	US Fish & Wildlife Service	B-50
25 Feb 82	DLNR Concurrence	US Fish & Wildlife Service	B-51
05 May 82	DEIS Review	US EPA, Region IX - Pacific Islands Office	B-51
05 May 82	Official Filing of the EIS	US EPA, Washington, DC	B-52
29 Apr 82	DEIS Review	US Fish & Wildlife Service	B-53
12 May 82	DEIS Review	US National Marine Fisheries Service	B-55
18 May 82	DEIS Review	National Park Service	B-55
18 May 82	DEIS Review	US Department of Housing & Urban Development	B-52
20 May 82	DEIS Review	National Oceanic and Atmospheric Administration	B-56
25 May 82	DEIS Review	Federal Highway Administration Region Nine	B-56
25 May 82	DEIS Review	Geological Survey, Hawaii Volcano Observatory	B-57
27 May 82	DEIS Review	US Soil Conservation Service	B-59
01 Jun 82	DEIS Review	Geological Survey, Water Resources Division	B-59
03 Jun 82	DEIS Review	US Department of the Interior, Office of the Secretary, Pacific SW Region	B-60
16 Jun 82	DEIS Review	US EPA, Region IX	B-61
18 Jun 82	DEIS Review	Advisory Council on Historic Preservation	B-61
State			
22 Feb 82	USFWS Preliminary Coordination Report	Department of Land and Natural Resources	B-62
03 May 82	DEIS Review	DLNR, Division of State Parks	B-63

Date	Subject	Initiating Agency	Page No.
State (contd)			
06 May 82	Draft Survey Report	Governor of Hawaii	B-63
12 May 82	DEIS Review	Department of Defense, Office of of the Director of Civil Defense	B-64
25 May 82	DEIS Review	Department of Health	B-64
27 May 82	DEIS Review	Department of Agriculture	B-65
27 May 82	DEIS Review	Department of Planning & Economic Development	B-65
28 May 82	DEIS Review	Department of Land & Natural Resources	B-66
02 Jun 82	DEIS Review	Office of Environmental Quality	B-67
04 Jun 82	DEIS Review	University of Hawaii, Water Resources Research Center	B-70
07 Jun 82	DEIS Review	University of Hawaii, Environmental Center	B-68
18 Jun82	DEIS Review	Department of Transportation Highways Division, Hawaii District	B-70
County			
28 Apr 82	DEIS Review	Department of Water Supply	B-71
3 May 82	DEIS Review	Planning Department	B-72
8 Jun 82	Letter of Support	Office of the Mayor	B-73
Private Interests/Individuals			
08 May 82	Draft Survey Report	Mr. Thomas & Mrs. Marion Yamashiro	B-74
11 Jun 82	Response to Mr./Mrs. Yamashiro	Corps of Engineers	B-75
13 May 82	Public meeting	Cutler-Hanley Joint Venture	B-75
11 Jun 82	Response to Mr. J. Hanley	Corps of Engineers	B-76
Undated	Diversion channel at Akolea Road	Mr. J.W. Silver	B-77
	Response to Mr. Silver	Corps of Engineers	B-77
01 Jun 82	Draft Survey Report	P. Yoshimura, Inc	B-78

Federal

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:
AFA-SE 1-2-80-SP-132

Mr. Kisuk Cheung
Chief, Engineering Division
U. S. Army Engineering Division
Building 230
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

This is in response to your letter of August 5, 1980, for information on Endangered Species (listed, proposed, or candidates for listing) which may be present in the U.S. Army Corps of Engineers' proposed Alenaio Stream Flood Control Project Area in Hilo, Hawaii.

To the best of our knowledge no proposed species occur within the area. However, one listed species, the Hawaiian hoary bat (Lasiurus cinereus semotus) does exist peripherally. It flies to and from feeding areas along Hilo Bay.

No listed plants would be expected to occur in the project area. However, one candidate plant, the grass Ischaemum byrone did grow along the bay but has not been noted in that area for many years. It probably did not go inland as far as the project boundaries so it would not pose any problems with the project. This species is presently being reviewed by this Service for consideration to propose and list it as endangered or threatened. It should be noted that this candidate species has no protection under the Endangered Species Act, but is included in the letter to alert you to the possibility that it could become a formal proposal and be listed during the construction project.

Should you have any additional questions, please feel free to contact me again. Thank you for your interest in endangered species.

Sincerely yours,

Robert Shallenberger

ACTING Pacific Islands Administrator

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

FEB 25 1982

Mr. Kisuk Cheung
Chief, Engineering Division
U.S. Army Engineering Division, Honolulu
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

The Hawaii Department of Land and Natural Resources' letter of concurrence pertaining to our Preliminary Coordination Act Report for the Alenaio Stream Flood Damage Reduction Study (dated December 28, 1981) is enclosed for your information. This letter will also be appended to our final coordination act report in accordance with U.S. Fish and Wildlife Service policy.

Sincerely yours,

Ernest Kosaka
ACTING Pacific Islands Administrator

Enclosure

Save Energy and You Serve America!

ENVIRONMENTAL PROTECTION AGENCY
REGION IX — PACIFIC ISLANDS OFFICE
P.O. Box 50003
Honolulu, Hawaii 96850

May 5, 1982

Mr. Kisuk Cheung
Chief, Engineering Division
Department of the Army
US Army Engineer District, Honolulu
Fort Shafter, HI 96858

Dear Mr. Cheung:

We have received your letter requesting EPA review and comments on the Alenaio Stream Draft Survey Report and EIS. I have forwarded your letter and statement to Ms. Loretta Barsamian, EIS Coordinator for EPA, Region IX, who will coordinate this effort.

The Pacific Islands Contact Office serves as an information/contact-liaison office and is not staffed to perform this function. Since the EIS reviews are done in the Regional Office, it would be more efficient to send the statements and notices directly to Ms. Barsamian (Mail Stop OPRM); EPA-Region IX; 215 Fremont Street; San Francisco, California 94105.

If you have any questions on this matter, feel free to call me at 546-8910.

Sincerely,

Vicki H. Tsuhako
Vicki H. Tsuhako
Manager, Pacific Islands
Contact Office

cc: Ms. Barsamian
w/enclosures

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF THE ADMINISTRATOR

MAY 5 1982

Dear Dr. Maragos:

I am writing to verify the official filing of the EIS entitled:

Draft: Alenaio Stream Flood Control, Hilo, Hawaii County, Hawaii (#820287)

This EIS was received by the Office of Federal Activities on April 26, 1982. It has been determined the above document meets the requirements for filing an EIS as set forth under Section 1506.9 of the CEQ Regulations. Accordingly, EPA has scheduled publication of the Notice of Availability in the Federal Register dated May 7, 1982 and the public review period is scheduled to terminate on June 21, 1982.

If you have any questions or concerns relating to this matter, please do not hesitate to contact me or Ms. Jan Lott of my staff on 245-3006.

Sincerely,

Kathi L. Wilson
Management Analyst
Office of Federal Activities (A-104)

Dr. James E. Maragos
Honolulu District
US Army Corps of Engineers
Building 230
Fort Shafter, Hawaii 96858

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
HONOLULU AREA OFFICE
300 ALA MOANA BLVD., RM. 3318, P.O. BOX 50007
HONOLULU, HAWAII 96850

REGION IX

IN REPLY REFER TO:

May 18, 1982

Mr. Kisuk Cheung, Chief
Engineering Division
Department of the Army
U.S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

Subject: Alenaio Stream Draft Survey Report and Environmental Impact Statement

The Honolulu Area Office reviewed the subject report that investigates methods to reduce damage caused by floods and the potential use or concerns for water in the Alenaio watershed.

We find that this action does not impact on any HUD project in the area. We do not have any substantive comments at this time but would appreciate receiving a copy of the final report and EIS.

Sincerely,

Calvin Lew
Acting Area Manager, 9.1S

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

APR 29 1982

Mr. Kisuk Cheung
Chief, Engineering Division
U.S. Army Engineering District, Honolulu
Building 230
Ft. Shafter, Hawaii 96858

Re: Alenaio Stream Draft Survey Report and EIS, Island of Hawaii

Dear Mr. Cheung:

We have reviewed the Alenaio Stream Draft Survey Report and Environmental Impact Statement prepared by your office in April 1982, and offer the following comments for your consideration:

1. Main Report, page 57, paragraph 2, first sentence. The words "planning aid letter" should read: "Preliminary Coordination Act Report."

2. Main Report, page 57, paragraph 2, second sentence. As of October 1, 1981, the Fish and Wildlife Service, Region 1, has adopted a new policy with respect to the preparation and coordination of "2(b)" Coordination Act Reports. Your Environmental Resources Section staff was informed of the specific objectives and requirements of this new policy during our meeting of September 11, 1981. At that time, we informed your staff that we expect the Corps to formally approve or reject each Service mitigation recommendation which appears in our reports. The statement in the second sentence of this paragraph on page 57 that "These concerns were incorporated whenever possible provided that the effectiveness of the proposed alternative would not be adversely affected" does not adequately demonstrate how each individual recommendation has been or will be incorporated into the design of development plans. We therefore ask that this matter be clarified in the survey report, and that future Corps reports include

Save Energy and You Serve America!

detailed statement(s) addressing specific Fish and Wildlife Service recommendations.

We appreciate this opportunity to comment.

Sincerely yours,

for Ernest Kosaka
Project Leader
Office of Environmental Services

cc: NMFS - WPPO
HDF&G
EPA, San Francisco

PODED-PV

24 June 1982

Ms. Patricia Sanderson Port
Regional Environmental Officer
Office of the Secretary
US Department of the Interior
Pacific Southwest Region
450 Golden Gate Ave., Box 36098
San Francisco, CA 94102

Dear Ms. Port:

This is in response to your letter dated 3 June 1982 commenting on our Draft Survey Report and Environmental Impact Statement, Alenaio Stream, Island of Hawaii. Both of your comments have been incorporated in the Final Survey Report and EIS. We are aware of the Fish and Wildlife Service, Region 1, policy regarding the preparation and coordination of Fish and Wildlife Coordination Act (FWCA) reports, which requires the Corps to formally approve or reject each service mitigation recommendation. However, we would like to point out that the appropriate time to accomplish this is after we have formally determined a recommended plan in concurrence with the local sponsor. Our evaluation of the Service recommendations would then be addressed in the Final Survey report and Environmental Impact Statement as is the case with this study.

Sincerely,

KISUK CHEUNG
Chief, Engineering Division

CF:
Mr. Ernest Kosaka, Project Leader
Fish and Wildlife Service
US Department of the Interior
300 Ala Moana Blvd.
Honolulu, HI 96850

United States Department of the Interior

NATIONAL PARK SERVICE
WASHINGTON, D.C. 20240

IN REPLY REFER TO:

MAR 18 1982

Kisuk Cheung, Chief
Engineering Division
Department of the Army
U.S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

We received the copy of your draft report "Archeological and Historical Studies for the Alenaio Stream Flood Damage Reduction Study, Hilo, Hawaii." We have forwarded the report to our regional office in San Francisco. They will be providing the professional review and comments directly to you.

Sincerely,

Bennie C. Keel
Departmental Consulting
Archeologist

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
Western Pacific Program Office
P. O. Box 3830
Honolulu, Hawaii 96812

May 12, 1982 F/SWR1:JJN

Colonel Kenneth E. Sprague
District Engineer
Honolulu District
U.S. Army Corps of Engineers
Building 230
Fort Shafter, Hawaii 96858

Dear Colonel Sprague:

The National Marine Fisheries Service (NMFS) has received and reviewed the draft environmental impact statement (DEIS) and survey report for Alenaio Stream, Island of Hawaii. The following comments are offered for your consideration.

General Comments.

The proposed action described in the subject DEIS should not significantl affect resources for which NMFS has a responsibility. There may be temporary impacts on estuarine and marine resources in Hilo Bay from increased turbidity during construction activities within Alenaio Stream, however they will be short-term and relatively insignificant in nature.

NMFS recommends the selection of Alternative 3 (floodproofing, relocating structures and flood plan management) since this non-structural alternative represents the least environmentally damaging alternative. If structural measures are considered necessary, we recommend no construction take place within Waiolama Canal or the Wailoa River as they both contain important habitat for native estuarine and diadromous species.

Sincerely yours,

John J. Naughton
Acting Administrator

cc: F/SWR, Terminal Is. CA
F/HP, Washington, D.C.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20230
OFFICE OF THE ADMINISTRATOR

May 20, 1982

PP/EC:DC

Colonel Kenneth E. Sprague
District Engineer
Honolulu District
U.S. Army Corps of Engineers
Building 230
Fort Shafter, Hawaii 96858

Dear Colonel Sprague:

This is in reference to your draft environmental impact statement and survey report entitled, "Alenaio Stream, Island of Hawaii." The enclosed comments from the National Oceanic and Atmospheric Administration are forwarded for your consideration.

Thank you for giving us an opportunity to provide comments, which we hope will be of assistance to you. We would appreciate receiving two copies of the final environmental impact statement.

Sincerely,

Joyce Wood

Joyce M. Wood
Director
Office of Ecology and Conservation

Enclosure

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION NINE
Hawaii Division
Box 50206
Honolulu, Hawaii 96850

Mr. Kisuk Cheung, Chief
Engineering Division
Department of the Army
Fort Shafter, HI 96858

Dear Mr. Cheung:

Subject: Alenaio Stream Draft Report and Environmental Impact Statement

Thank you for the opportunity to review the subject document transmitted by your letter, PODED-PJ, dated 20 April 1982. We have no comments.

Sincerely yours,

H. Kusumoto
Division Administrator

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Hawaiian Volcano Observatory Hawaii Volcanoes National Park, Hawaii

May 25, 1982

Kisuk Cheung
Chief, Engineering Division
U. S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Thank you for sending the draft E.I.S. for the Alenaio Stream flood control project.

This is an excellent comprehensive report that very well addresses the flooding problem along the Alenaio system, and which forms a firm basis for decision making.

We have some corrections and comments to offer, which you may wish to consider:

Page.	Col.	Parag.	Line	
11		5	2,4,6	Ponahawai Street
12		3	3,4	volcanoes
		4	1	The 1881 lava flow...influences plans for possible implementation rather than "...possible plans for implementation..."
30		3	13	Ponahawai Street
		4	8	Is the street referred to here Mohouli Street? Simplifying the opening sentences of this paragraph might improve the clarity. For example: The geologic make-up of the Alenaio Stream watershed poses a unique geohydrologic problem. Lava tubes formed in the pahoehoe flows can carry subsurface water which in times of heavy rains can cause flooding in unexpected places especially near the distal end of the flows. In identifying the study problems..."
38		3	8	"...the effects on surface water and..."
			10	"...due to [not-well] poorly understood..."
49		2	11	Ponahawai Street
52		9	4	The dense vegetation and rough terrain do not mask the aerial photography but do "...make it difficult to trace the stream course on aerial photographs..."

Page.	Col.	Parag.	Line	
53 Plate D-1				Your Alternative 1 is geologically reasonable, but contains a serious error in design assumptions for Reach 4. In Reach 4 you depict and discuss a rather narrow floodplain for both 100 year and SPF floods. You recommend a "minimum 200-foot floodplain easement" to allow for such floods. Clearly this figure is inadequate. A very extensive area mauka of Komohana Street is subject to flooding, because the ancestral Alenaio Stream has been blocked by the 1881 flow, and during times of high runoff the carrying capacity of the stream is exceeded at numerous chokepoints and water is diverted to the south, to a broad basin where standing water eventually percolates into subsurface lava tubes. This problem was discussed in the USGS report to the COE(Lockwood, J.P., and Buchanan-Banks, J.M., 1981, p. 6, figs. 4, 5, 6) and should perhaps be alluded to in the final EIS. The exact dimensions of this floodplain have not been determined, but from personal observation extends at least 400-500 m south of the Alenaio Stream floodplain as depicted for Reach 4 in Plate D-1. The relatively flat area between 360 and 420 feet elevation is particularly subject to flooding. It is apparently beyond the scope of the EIS to determine the axact boundaries of this area, but I recommend that the final report at least allude to this extensive floodplain, and not give a "false confidence" to a prospective developer or planning agencies by portrayal of a "200-foot minimum floodplain management easement".
58		2	1	"The area between Chong's Bridge and Komohana Street is essentially undeveloped..." is not an accurate statement. Between Chong's Bridge eastward to Luana Way there has been substantial development of single-family dwellings. From Luana Way eastward to Komohana Street, where the stream channel is poorly defined, there has been little development.
similarly: 67		1	7	
F-4		4	6	
61		2	2	Ponahawai Street
		5	6,7	impassable
62		3	5	Pauahi [Avenue] Street
similarly D-53		4	3	
		6	5	
		7	4	
D-55	3	5	5	
62		5	2	Ponahawai Street
67		4	8	"Based on the geologic map, the subsurface...is mostly Homelani Ash." The Homelani Ash bordering the stream is only a few feet thick. In the stream channel to the west, it has been eroded and the underlying unit, the picrite of Alenaio Stream (Al), is exposed. This unit is quite vesicular and there is undoubtedly seepage of water into Al. A similar situation may exist between Kinoole Street and Kilauea Avenue. These outcrops are too small to be shown at the scale of the map.

70	2	5	13	Komohana Street
87	Ref. 19		1	"...Empty Lava Tubes..."
C-3		2	4	"...Komohana Street and [Cheng-Street-Bridge] Luana Way." A well-defined stream channel does exist from Chong Street Bridge to the east as far as Luana Way. From Luana Way further northeast their is no well-defined channel.
C-5				J. P. Lockwood should be shown as the first author and J. Buchanan-Banks as second.
C-7		4		This section states that "...lava contacts are marked by great irregularity occassioned by...". This sentence is confusing and not true; we recommend deletion.
		5	1	Suggest altering first sentence to read "The surface of aa flows are rough and difficult to traverse..." They really are not as "impossible" to cross as suggested by the present wording.
		5	11	"Thin (5 feet to 15 feet thick) surface deposits... generally cover recent lavas." Such deposits are much thinner than this, and are almost everywhere less than 2-3 feet thick.
C-8				We would recommend deletion of this entire section because the units listed do not show all those represented on the geologic map. Also, the units are already described on pages C-5 and 6.
C-9		4	2	"...and flows in a stream bed where the picritic basalt of Alenaio Stream (Al) is exposed for almost the..." The stream channel is cut into the Homelani Ash and the underlying lavas are exposed.
		2,3,4		There are references to stations along the river in these paragraphs. I could not locate a map showing these stations. If one is included in the report, a reference to it should be noted in paragraph 2. If no map is included, perhaps they stations could be identified by street names.
C-11		2		It is stated in this section that water from the Ola'a Flume Spring is currently not used. This is not true Water from this spring is transported by a large diameter pipe and supplies Hilo with an average of 1,000,000 gals. of water per day.
D-11		7	5	Ponahawai Street
12		2	11,13 16,17	" "
			15	Waiolama Canal
D-52		1	3	Ponahawai Street
56		1	8	"For designd purposes..."
Plate D-6, 7, 8, 9				Pauahi [Avenue] Street
F-3		1	7	"...(eastern) side of the Halai Hills..."
F-4		4	8	[Sunridge] Sunrise Ridge Subdivision
F-5		1	4	Pu'u Halai
		2	1	" "
C-3		2	7	Delete sentence starting "In times of normal rainfall. ..Chong Street Bridge." The water does not completely disappear into a lava tube. Move the next sentence (Yet, despite the lack... period of drought." to follow "Between Waipahoehoe and Alenaio Streams, the ["missing"]water is lost...

in the underlying rocks."

Although this letter is long, most of the items are simple corrections to minor spelling errors that have crept into the report. We hope that the comments on the geology will be of help to you.

Again, congratulations on a very thorough report.

Sincerely,

J. P. Lockwood Jane Buchanan-Banks

J. P. Lockwood and J. M. Buchanan-Banks
Geologists

cc: J. P. Lockwood
J. M. Buchanan-Banks

United States Department of Agriculture — Soil Conservation Service

P.O. Box 50004
Honolulu, Hawaii
96850

May 27, 1982

Mr. Kisuk Cheung
Chief, Engineering Division
U.S. Army Engineer District, Honolulu
Department of the Army
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Subject: Harbors and Rivers in Hawaii
Alenaio Stream, Island of Hawaii, Hawaii

We reviewed subject environmental impact statement and find it contains adequate information on alternatives to alleviating the flooding of Alenaio Stream.

We would like to point out that the Wailuku-Alenaio Watershed project, which was planned and is being installed under the authority of PL-566, does not protect the downtown area being flooded by Alenaio Stream. The EIS for the Wailuku-Alenaio Watershed states, "In downtown Hilo, the County of Hawaii has plans for flood control. When these flood control measures are installed, the flood damage from a 100-year storm will be greatly reduced."

We support the concept of a mutually acceptable plan providing flood control to the downtown area along Alenaio Stream.

Thank you for the opportunity to comment on this draft EIS.

Sincerely,

FRANCIS C.H. LUM
State Conservationist

The Soil Conservation Service is an agency of the Department of Agriculture

SCS-AS-1
10-79

United States Department of the Interior

GEOLOGICAL SURVEY
Water Resources Division
P. O. Box 50166
Honolulu, Hawaii 96850

June 1, 1982

Kisuk Cheung
Chief, Engineering Division
Department of The Army
U.S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858

Dear Sir:

The existence of a thick basal ground-water lens underlying the proposed diversion channel from Alenaio Stream to the Wailuku River should be pointed out in the EIS. There are no existing wells below or downgradient from this channel--this can also be pointed out. Adverse effects will probably be minimal, but should be mentioned.

Thank you for letting us comment on the Alenaio Stream Draft Survey Report and Environmental Impact Statement.

Sincerely,

Ben Jones
District Chief

Enclosure

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
PACIFIC SOUTHWEST REGION
BOX 36098 • 450 GOLDEN GATE AVENUE
SAN FRANCISCO, CALIFORNIA 94102
(415) 556-8200

June 3, 1982

ER 82/721

Brigadier General Henry J. Hatch
Division Engineer
U. S. Army, Corps of Engineers
Building 230
Fort Shafter, Hawaii 96857

Dear General Hatch:

The Department of the Interior has reviewed the draft environmental statement and draft Survey Report (Combined), Harbors and Rivers in Hawaii, Alenaio Stream, Island of Hawaii, and offer the following comments.

Specific Comments

Main Report, page 57, para. 2, first sentence

The words "planning aid letter" should read, "Preliminary Coordination Act Report."

Main Report, page 57, para. 2, second sentence

As of October 1, 1981, the Fish and Wildlife Service (FWS), Region 1, has adopted a new policy with respect to the preparation and coordination of "2(b)" Coordination Act Reports. The Corps of Engineers' Environmental Resources Section staff was informed of the specific objectives and requirements of this new policy during a FWS meeting of Spetember 11, 1981. At that time, your staff was informed that the Corps was expected to formally approve or reject each Service mitigation recommendation which appears in the FWS reports. The statement in the second sentence of this paragraph on page 57 stating that "These concerns were incorporated whenever possible provided that the effectiveness of the proposed alternative would not be adversely affected", does not adequately demonstrate how each individual recommendation has been or will be incorporated into the design of development plans. This matter should be clarified in the survey report, and future Corps reports include detailed statement(s) addressing specific FWS recommendations.

The Department appreciates this opportunity to comment.

Sincerely,

Patricia Sanderson Port
Regional Environmental Officer

cc: Director, OEPR (w/copy incoming)
Director, Fish and Wildlife Service
Director, National Park Service
Director, Geological Survey
Director, Bureau of Mines
Director, Minerals Management Service
Reg. Dir., FWS
Reg. Dir., NPS
Reg. Dir., GS
Reg. Dir., BM
Reg. Dir., MMS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
215 Fremont Street
San Francisco, Ca. 94105

JUN 16 1982

Mr. Kisuk Cheung
Chief, Engineering Division
Department of the Army
U.S. Army Engineering District, Honolulu
Port Shafter, HI 96858

Dear Mr. Cheung:

The Environmental Protection Agency (EPA) has received and reviewed the Draft Environmental Impact Statement (DEIS) titled ALENAIO STREAM DRAFT SURVEY REPORT AND ENVIRONMENTAL IMPACT STATEMENT.

EPA's comments on the DEIS have been classified as Category LO-1. Definitions of the categories are provided by the enclosure. The classification and the date of the EPA's comments will be published in the Federal Register in accordance with our responsibility to inform the public of our views on proposed federal actions under Section 309 of the Clean Air Act. Our procedure is to categorize our comments on both the environmental consequences of the proposed action and the adequacy of the environmental statement.

EPA appreciates the opportunity to comment on this DEIS and requests three copies of the Final Environmental Impact Statement when available.

If you have any questions regarding our comments, please contact Loretta Kahn Barsamian, Chief, EIS Review Section, at (415) 974-8188 or FTS 454-8188.

Sincerely yours,

for William Anning
John Wise
Acting Director
Office of Policy, Technical, and Resources Management

Enclosures (2)

Advisory Council On Historic Preservation

JUN 23 1982

1522 K Street, NW
Washington, DC 20005

Reply to: ~~Lake Plaza South, Suite 616~~
~~44 Union Boulevard~~
~~Lakewood, CO 80228~~
730 Simms Street, Room 450
Golden, Colorado 80401

June 16, 1982

Mr. Kisuk Cheung
Chief, Engineering Division
Corps of Engineers, Honolulu District
Department of the Army
Ft. Shafter, HI 96858

Dear Mr. Cheung:

This letter is to acknowledge receipt of your letter and enclosures of May 5, 1982 about historic properties in the areas of potential environmental impact of Alenaio Stream flood damage reduction measures.

Note is made of the Corps' concurrence with the recommendations of the report "Archeological and Historical Studies for Alenaio Stream Flood Damage Reduction Study, Hilo, Hawaii" for further studies of historic properties.

This office looks forward to participating as appropriate once historic properties have been identified and a determination of effect has been made in consultation with the Hawaii State Historic Preservation Officer.

Sincerely,

Louis S. Wall
Chief, Western Division of Project Review

RECEIVED 23 JUN 1982 PLANNING BR.

State of Hawaii

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

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

February 22, 1982

Mr. Dale T. Coggeshall
Pacific Islands Administrator
Fish and Wildlife Service
P.O. Box 50167
Honolulu, Hawaii 96850

Dear Mr. Coggeshall:

Alenaio Stream Flood Damage Study (ES 6307)

Thank you for extending us this opportunity to comment on the Fish and Wildlife Services' preliminary coordination report of the Corps of Engineers' Alenaio Stream Flood Damage Reduction Study.

The report addresses flora and fauna very comprehensively. We are particularly pleased with the assessment of aquatic faunas. Of the three flood damage reduction plans considered, alternative 1 appears to be the most viable since alternatives 2 and 3 are adverse to the stream ecosystem and very expensive to implement. We also endorse the seven mitigation measures recommended for inclusion in the project design for alternative 1.

Very truly yours,

SUSUMU ONO
Chairman of the Board

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

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

DIVISIONS:
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FISH AND GAME
FORESTRY
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

May 3, 1982

Mr. Kisuk Cheung, Chief
Engineering Division
Department of the Army
U. S. Army Engineer District,
Honolulu
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

SUBJECT: Review of Draft Survey Report and EIS
Alenaio Stream Flood Control Project
South Hilo, Hawaii, TMK: Zone 2

Thank you for the opportunity to review the subject document.

Please be advised that our division's response will be incorporated in our departmental response which is forthcoming.

Sincerely yours,

Roy K. C. Sue
State Parks Administrator

EXECUTIVE CHAMBERS
HONOLULU

GEORGE R. ARIYOSHI
GOVERNOR

May 6, 1982

Lieutenant Colonel Kenneth E. Sprague
District Engineer
Corps of Engineers
U.S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858

Dear Colonel Sprague:

Thank you for the draft survey report and environmental impact statement for the Alenaio Stream flood damage reduction study.

I realize that this study phase has to be undertaken as the first step in resolving the perennial flooding problems plaguing the citizens of Hilo. I do hope, however, that each required phase will be expeditiously resolved and executed.

If the state can be of any assistance in this matter, please do not hesitate to call on us.

With warm personal regards, I remain,

Yours very truly,

George R. Ariyoshi

GEORGE R. ARIYOSHI
GOVERNOR

ARTHUR U. ISHIMOTO
DIRECTOR OF CIVIL DEFENSE

JIM COREY
VICE DIRECTOR OF CIVIL DEFENSE

STATE OF HAWAII
DEPARTMENT OF DEFENSE
OFFICE OF THE DIRECTOR OF CIVIL DEFENSE
3949 DIAMOND HEAD ROAD
HONOLULU, HAWAII 96816

PHONE (808) 734-2161

May 12, 1982

HICDPO

U.S. Army Engineer
District/PODED-PJ
Department of the Army
Fort Shafter, Hawaii 96858

Gentlemen:

Alenaio Stream Draft Survey Report and
Environmental Impactment Statement

The Civil Defense Division has no comment on the subject plan other than to say it appears to be very complete with adequate attention to pertinent details. We look forward to reviewing your Final Report.

Sincerely,

Jim Corey

JIM COREY
Vice Director of
Civil Defense

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

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

GEORGE A. L. YUEN
DIRECTOR OF HEALTH

JOHN F. CHALMERS, M.D.
DEPUTY DIRECTOR OF HEALTH

HENRY N. THOMPSON, M.A.
DEPUTY DIRECTOR OF HEALTH

MELVIN K. KOIZUMI
DEPUTY DIRECTOR OF HEALTH

ABELINA MADRID SHAW, M.A., J.D.
DEPUTY DIRECTOR OF HEALTH

May 25, 1982

In reply, please refer to:
File: EPHSD-SS

MEMORANDUM

To: Mr. Kisuk Cheung, Chief, Engineering Division

From: Deputy Director for Environmental Health

Subject: Environmental Impact Statement (EIS) for Alenaio Stream, Island of Hawaii, Harbors and Rivers in Hawaii

Thank you for allowing us to review and comment on the subject EIS. On the basis that the project will comply with all applicable Public Health Regulations, please be informed that we do not have any objections to this project.

We realize that the statements are general in nature due to preliminary plans being the sole source of discussion. We, therefore, reserve the right to impose future environmental restrictions on the project at the time final plans are submitted to this office for review.

for MELVIN K. KOIZUMI

BC:kk

cc: Office of Environmental Quality Control

GEORGE R. ARIYOSHI
GOVERNOR

JACK K. SUWA
CHAIRMAN, BOARD OF AGRICULTURE

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 So. King Street
P.O. Box 22159
Honolulu, Hawaii 96822

May 27, 1982

Mr. Kisuk Cheung, Chief
Engineering Division
U. S. Army Engineer District, Honolulu
Department of the Army
Ft. Shafter, Hawaii 96858

Dear Mr. Kisuk Cheung:

The Department of Agriculture has reviewed the Alenaio Stream Draft Survey Report and Environmental Impact Statement and does not have any comments to offer at this time.

Thank you for the opportunity to comment.

Sincerely,

JACK K. SUWA
Chairman, Board of Agriculture

"Support Hawaiian Agricultural Products"

DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT

Kamamalu Building 250 South King St. Honolulu, Hawaii • Mailing Address: P.O. Box 2359 Honolulu, Hawaii 96804

GEORGE R. ARIYOSHI

HIDETO KONO

FRANK SKRIVANEK

May 27, 1982

Ref. No. 5877

Mr. Kisuk Cheung, Chief
Engineering Division
Department of the Army
U.S. Army Engineer District, Honolulu
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Subject: Alenaio Stream Flood Reduction Project

We have reviewed your analysis of the proposed activity's consistency with Hawaii's Coastal Zone Management (CZM) Program as contained in your April, 1982, "Alenaio Stream, Island of Hawaii, Draft Survey Report and Environmental Impact Statement." Based on this review, we concur with your recommendation for Alternative 1 and find that the activity is consistent with the relevant provisions of our management program.

Your assistance and cooperation in complying with the substantive and procedural requirements of the CZM Program are very much appreciated.

Sincerely,

Frank Skrivanek
for Hideto Kono

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

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

MAY 28 1982

Your: PODED-PJ

Mr. Kisuk Cheung
Chief, Engineering Division
U. S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

Thank you for your letter of April 20, 1982, and the opportunity to comment on the survey report and environmental impact statement for the Alenaio Stream flood control project.

Assuming a change in the cost-sharing policy as proposed by Secretary Gianelli (p. 72), we favor Alternative Plan 1 (Modification of the Existing Channel), Subplan A, as being least costly and least damaging to the environment.

If there is no change in the cost-sharing policy, we would like to see Alternative Plan 2 be reevaluated and reconsidered prior to finalizing recommendations for this project. Although Alternative 2 will have the greatest impact on natural resources, reevaluation may be warranted if, under the present policy, it would be least costly to local sponsors.

With respect to Alternative 1, our records do not indicate the presence or absence of historical, cultural, architectural, and/or archaeological resources in the project area. If, however, you become aware of any cultural resources during this survey, please notify our historic sites office (Phone 548-6408).

The project could have possible impact on Waiolama Canal which adjoins Wailoa River State Recreation Area. We note that Subplan 1a leaves Waiolama Canal in its current condition. While preferable to other four subplans, still another alternative might be considered. Under normal conditions, water movement in Waiolama Canal is sluggish and the canal is an unattractive ditch. We suggest the opportunity exists to make the canal more attractive without destroying the surrounding open space.

Please be advised that any work in a Conservation District will require the prior approval of the Board of Land and Natural Resources.

Sincerely,

SUSUMU ONO, Chairman
Board of Land and Natural Resources
and
State Historic Preservation Officer

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
550 HALEKAUWILA ST.
ROOM 301
HONOLULU, HAWAII 96813

Jacqueline Parnell
DIRECTOR

TELEPHONE NO.
548-6915

June 2, 1982

Mr. Kisuk Cheung
U.S. Army Corps of Engineers
Building 230
Fort Shafter, Hawaii 96858

SUBJECT: Draft Survey Report and Environmental Impact Statement Alenaio Stream, Island of Hawaii Harbors and Rivers in Hawaii

Dear Mr. Cheung:

This Office has reviewed the subject document and offers the following comments for your consideration:

1. P. 15. The term "o'oepu nakea" is misspelled and should read, "o'opu nakea."

2. P. 15. The population data should reflect the most recent 1980 population figures. Such data can be obtained from the State of Hawaii Data Books, 1980 and 1981.

3. P. 16. Again, there should be more recent data reflected for housing.

4. Since this is a joint project, we wish to point out that the County of Hawaii may have to meet the requirements of Chapter 343, Hawaii Revised Statutes, the state EIS law. On future joint projects, consideration should be given to preparing one document to meet both the National Environmental Policy Act of 1969 and the State EIS law.

We trust that these comments will be helpful to you in preparing the final document. We would like to have 22 copies of the final EIS for implementation in our EIS data base system. We thank you for the opportunity to review the EIS and look forward to the final document.

Sincerely,

Jacqueline Parnell
Director

University of Hawaii at Manoa

Environmental Center
Crawford 317 • 2550 Campus Road
Honolulu, Hawaii 96822
Telephone (808) 948-7361

Office of the Director

June 7, 1982

RE:0353

Mr. Kisuk Cheung
Chief, Engineering Division
U.S. Army Engineering Division, Honolulu
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Draft Survey Report and
Environmental Impact Statement
Alenaio Stream, South Hilo, Hawaii

The Environmental Center has reviewed the above cited document with the aid of several members of the University community with expertise relative to stream-flood control projects. Participating in our review process were Paul Ekern, Agronomy and Soils; James Parrish, Hawaii Cooperative Fishery Research Unit; and Jacquelin Miller and Garret Kawamura, Environmental Center.

The Draft Survey Report is a detailed, well-documented, report and provides vital information to the draft EIS. Our concern focuses on sections in the draft EIS which reflect the studies presented in the Appendicies.

Part 2a of Table 14 on page 76 states that Alternative 1 would result in "no change from the base condition" in relation to the environmental quality of the project site. What is the basis of this conclusion? Alternative 1 would include construction of a rectangular concrete channel. The impact of stream channelization on the freshwater biota depends largely on the condition of the stream bed. While a minimal amount of damage would occur if the bottom is left in the natural state, a flat, 35-40 foot wide concrete bottom would significantly alter and impact the physical-biological habitat. A low-flow channel would mitigate some of the impacts of a channelized bottom. The final EIS should elaborate on the specific design which will be considered for the channelization alternatives. This information would result in a more complete assessment of the three alternatives by reducing the uncertainty surrounding the impact on aquatic fauna.

Appendix G of the Survey Report contains a detailed and comprehensive discussion of fish and wildlife concerns. Page 23 of the letter prepared by the Fish and Wildlife Service (December 28, 1981) states that "no long-term significant impacts to fish and wildlife resources in the project area are anticipated provided that our recommended mitigative measures are included in plans and specifications for the project" (our emphasis added). The validity of this statement rests upon the channel design discussed earlier.

A flat, concrete floor would inhibit upstream migration of aquatic species. The drop structure (waterfall) proposed in Alternative 2 would completely restrict upstream migration. We urge that the mitigative measures recommended by the Fish and Wildlife Service on pages 23-24 of their December 1981 letter be incorporated into the Corps of Engineers' design of the stream channel.

We appreciate the opportunity to comment on the Draft Survey Report and Environmental Impact Statement for the Alenaio Stream Project and the extension of your response due date from Friday June 4, to Monday June 7, 1982.

Sincerely,

Doak C. Cox
Director

cc: Office of Environmental Quality Control
Paul Ekern
James Parrish
Garret Kawamura
Jacquelin Miller

CORRECTION

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

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
550 HALEKAUWILA ST.
ROOM 301
HONOLULU, HAWAII 96813

Jacqueline Parnell
DIRECTOR

TELEPHONE NO.
548-6915

June 2, 1982

Mr. Kisuk Cheung
U.S. Army Corps of Engineers
Building 230
Fort Shafter, Hawaii 96858

SUBJECT: Draft Survey Report and Environmental Impact Statement Alenaio Stream, Island of Hawaii Harbors and Rivers in Hawaii

Dear Mr. Cheung:

This Office has reviewed the subject document and offers the following comments for your consideration:

1. P. 15. The term "o'oepu nakea" is misspelled and should read, "o'opu nakea."

2. P. 15. The population data should reflect the most recent 1980 population figures. Such data can be obtained from the State of Hawaii Data Books, 1980 and 1981.

3. P. 16. Again, there should be more recent data reflected for housing.

4. Since this is a joint project, we wish to point out that the County of Hawaii may have to meet the requirements of Chapter 343, Hawaii Revised Statutes, the state EIS law. On future joint projects, consideration should be given to preparing one document to meet both the National Environmental Policy Act of 1969 and the State EIS law.

We trust that these comments will be helpful to you in preparing the final document. We would like to have 22 copies of the final EIS for implementation in our EIS data base system. We thank you for the opportunity to review the EIS and look forward to the final document.

Sincerely,

Jacqueline Parnell
Director

University of Hawaii at Manoa

Environmental Center
Crawford 317 • 2550 Campus Road
Honolulu, Hawaii 96822
Telephone (808) 948-7361

Office of the Director

June 7, 1982

RE:0353

Mr. Kisuk Cheung
Chief, Engineering Division
U.S. Army Engineering Division, Honolulu
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Draft Survey Report and
Environmental Impact Statement
Alenaio Stream, South Hilo, Hawaii

The Environmental Center has reviewed the above cited document with the aid of several members of the University community with expertise relative to stream-flood control projects. Participating in our review process were Paul Ekern, Agronomy and Soils; James Parrish, Hawaii Cooperative Fishery Research Unit; and Jacquelin Miller and Garret Kawamura, Environmental Center.

The Draft Survey Report is a detailed, well-documented, report and provides vital information to the draft EIS. Our concern focuses on sections in the draft EIS which reflect the studies presented in the Appendicies.

Part 2a of Table 14 on page 76 states that Alternative 1 would result in "no change from the base condition" in relation to the environmental quality of the project site. What is the basis of this conclusion? Alternative 1 would include construction of a rectangular concrete channel. The impact of stream channelization on the freshwater biota depends largely on the condition of the stream bed. While a minimal amount of damage would occur if the bottom is left in the natural state, a flat, 35-40 foot wide concrete bottom would significantly alter and impact the physical-biological habitat. A low-flow channel would mitigate some of the impacts of a channelized bottom. The final EIS should elaborate on the specific design which will be considered for the channelization alternatives. This information would result in a more complete assessment of the three alternatives by reducing the uncertainty surrounding the impact on aquatic fauna.

Appendix G of the Survey Report contains a detailed and comprehensive discussion of fish and wildlife concerns. Page 23 of the letter prepared by the Fish and Wildlife Service (December 28, 1981) states that "no long-term significant impacts to fish and wildlife resources in the project area are anticipated provided that our recommended mitigative measures are included in plans and specifications for the project" (our emphasis added). The validity of this statement rests upon the channel design discussed earlier.

A flat, concrete floor would inhibit upstream migration of aquatic species. The drop structure (waterfall) proposed in Alternative 2 would completely restrict upstream migration. We urge that the mitigative measures recommended by the Fish and Wildlife Service on pages 23-24 of their December 1981 letter be incorporated into the Corps of Engineers' design of the stream channel.

We appreciate the opportunity to comment on the Draft Survey Report and Environmental Impact Statement for the Alenaio Stream Project and the extension of your response due date from Friday June 4, to Monday June 7, 1982.

Sincerely,

Doak C. Cox
Director

cc: Office of Environmental Quality Control
Paul Ekern
James Parrish
Garret Kawamura
Jacquelin Miller

PODED-PV

25 June 1982

Dr. Doak C. Cox, Director
University of Hawaii at Manoa
Environmental Center
Crawford 317
2550 Campus Road
Honolulu, HI 96822

Dear Dr. Cox:

Thank you for your letter of 7 June 1982 commenting on our Draft Survey Report and Environmental Impact Statement (EIS), Alenaio Stream, Island of Hawaii. We agree that implementation of Alternative Plan 1 would affect the "base condition" within the stream. An additional 920 feet of natural streambed would be eliminated by construction of the proposed concrete channel. This information has been incorporated in Table 14 of the Main Report.

Alternative Plan 1 has been designated as the recommended plan of improvement in concurrence with our local sponsor. The Final EIS includes a general description of the recommended plan. For detailed design information refer to Appendix D of the Survey Report.

Our Final Fish and Wildlife Coordination Act (FWCA) Report dated 18 June 1982 contains a list of recommended mitigative measures specifically addressing Alternative Plan 1. These recommendations and their disposition are provided below:

1. Natural streambed be maintained in all reaches of the stream affected by realignment and channelization.

2. Streamside vegetation be maintained or replanted, as necessary, to provide shading for the stream.

3. Realigned and channelized sections incorporate a low-flow channel to concentrate flows and take advantage of natural shading.

4. Bridge culverts should be minimal in length and installed in such a way that the downstream terminus will not be above stream level.

5. The channel between Kilauea Avenue and Kinoole Street be restored to a natural (unlined) streambed or incorporate a low-flow channel to concentrate flows.

6. If practicable, the weir above Kinoole Street be modified to permit a greater volume of low to moderate instream flows to discharge into Waiakea Canal.

7. Construction methods should minimize streambed and bank disturbance and prevent excessive sedimentation of downstream habitat.

Recommendations 2, 4, 6, and 7 will be incorporated in the environmental protection guidelines of the construction specifications during the Advance Engineering and Design phase. Recommendations 1, 3, and 5 were rejected for the following reasons:

Recommendation 1. The natural streambed will need to be channelized with concrete to prevent erosion and undermining of the channel walls and to maximize the efficiency of the channel in order to minimize the required channel width and depth. A wider channel would necessitate the removal of additional residential structures and displacement of the occupants.

Recommendation 3. Alenaio Stream is ephemeral, flowing only during times of moderately high to high rainfall. During dry periods the aquatic habitat is reduced to scattered small pools. High mortality of aquatic species occurs. As a consequence, stream fauna is rather poorly developed and is dominated by more hardy exotic species such as mosquito fish, dojo and crayfish. Provision of a low-flow channel to accomodate migration of mainly exotic species within a stream that is often dry, cannot be justified in view of the substantial increase in project costs associated with it.

Recommendation 5. The channel between Kilauea Avenue and Kinoole Street cannot economically be restored to a natural (unlined) streambed. A concrete channel is proposed to accommodate the design channel velocity and to maximize the channel capacity in order to minimize the channel width and depth thereby minimizing necessary relocation of homes and businesses along the stream.

Sincerely,

KISUK CHEUNG
Chief, Engineering Division

University of Hawaii at Manoa

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

4 June 1982

Mr. Kisuk Cheung
Chief, Engineering Division
U.S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

Subject: Draft Survey Report and Environmental Impact Statement Alenaio Stream, Island of Hawaii, Hawaii, April 16, 1982

We have reviewed the subject Draft Survey Report and EIS, and have no comment to offer at this time. Thank you for the opportunity to comment. This material was reviewed by WRRC personnel.

Sincerely,

Edwin T. Murabayashi
EIS Coordinator

ETM:jm

cc: H. Gee
Y.S. Fok

AN EQUAL OPPORTUNITY EMPLOYER

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
HAWAII DISTRICT
50 MAKAALA STREET
P. O. BOX 4277
HILO, HAWAII 96720-0710

RYOKICHI HIGASHIONNA, PH.D.
DIRECTOR

DEPUTY DIRECTORS
JAMES B. McCORMICK
Jonathan K. Shimada
Wayne J. Yamasaki

IN REPLY REFER TO

HWY-H 82-2.531

June 9, 1982

Mr. Kisuk Cheung, Chief
Engineering Division
Department of the Army
U.S. Army Engineer District
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

This is to acknowledge receipt of the Alenaio Stream Draft Survey Report and Environmental Impact Statement.

Your report indicated that the State Department of Transportation has tentatively indicated that they will raise the highway elevation as part of their overall modification plan for the Bayfront Highway. As information to you, realignment of the Bayfront Highway is also under study and that may impact upon your final recommendation.

Very truly yours,

ALVAH T. MIYAMOTO
District Engineer

AM:jts

County of Hawaii

DEPARTMENT OF WATER SUPPLY • COUNTY OF HAWAII
25 AUPUNI STREET • HILO, HAWAII 96720

April 28, 1982

Mr. Kisuk Cheung, Chief
Engineering Division
U. S. Army Engineer District
Department of the Army
Ft. Shafter, HI 96858

ALENAIO STREAM STUDY
SOUTH HILO

Thank you for giving us the opportunity to comment on the Draft Survey Report and Environmental Impact Statements. We have no comments at this time.

William Sewake

H. William Sewake
Manager

CS

...Water brings progress...

COUNTY OF HAWAII

PLANNING DEPARTMENT

25 AUPUNI STREET • HILO, HAWAII 96720

HERBERT T. MATAYOSHI
Mayor

SIDNEY M. FUKE
Director

DUANE KANUHA
Deputy Director

May 3, 1982

Mr. Kisuk Cheung, Chief
Engineering Division
Department of the Army
U. S. Army Engineering
District, Honolulu
Fort Shafter, HI 96858

Dear Mr. Cheung:

Draft Survey Report and EIS
<u>Alenaio Stream-Flood Control Project</u>

Thank you for the opportunity to review this draft Survey Report and EIS. We concur with the recommended alternative Plan 1.

Plan 1's Reach 2 (between Kapiolani Street and Kilauea Avenue) includes lands zoned for Multiple Family Residential (RM-1) and Commercial (CG-7.5) development.

Most of the parcels abutting the existing and proposed alignment have yet to be developed to the maximum allowed by zoning. As you note in this document, the Hilo Downtown Development Plan and the Hilo Community Development Plan both recommend the future development of Hilo which would be consistent with the present zoning. The implementation of this project would encourage this development.

The Hilo Redevelopment Agency (HRA) was recently reactivated by the Hawaii County Council to formulate a program for the development of the downtown urban area. HRA's focus includes lands adjoining Reach 1 and Reach 2 (Altenative Plan 1). As such, by a copy of this letter, we are sending them a copy of this report.

Again thank you for the opportunity to review this document.

Sincerely,

SIDNEY FUKE
Planning Director

RN:lrp

cc: Mayor Herbert Matayoshi
Dept. of Public Works
Hawaii Redevelopment
Agency (w/report)

HERBERT T. MATAYOSHI
MAYOR

Office of the Mayor

June 8, 1982

Lt. Col. Kenneth E. Sprague
District Engineer
US Army Engineer District, Honolulu
Building 230
Fort Shafter, HI 96858

SUBJECT: Alenaio Stream Flood Damage Reduction Project

We are providing our intent to support Alternative Plan 1 - Modifying Existing Channel for the Alenaio Stream Flood Damage Reduction Project pursuant to the local cooperation requirements. The County of Hawaii does hereby declare its intention to:

a. Provide, without cost to the United States, all lands, easements, and rights-of-way necessary for the construction of the project; including spoil disposal and borrow and access thereto required for construction and maintenance.

b. Hold and save the United States free from damages due to the construction, operation, and maintenance of the project except where such damages are due to the fault or negligence of the United States or its contractors.

c. Maintain and operate the project, or integral parts thereof, in accordance with regulations prescribed by the Secretary of the Army.

d. Accomplish without cost to the United States all alterations and relocations of buildings, streets, storm drains, utilities, highway bridges, and other structures made necessary by the construction.

e. Prescribe and enforce the floodplain management regulations for the floodplain.

f. Maintain eligibility under the National Flood Insurance Program.

g. Comply with the provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (PL 91-646).

h. Comply with Title VI of the Civil Rights Act of 1964 (PL 88-352).

COUNTY OF HAWAII • HILO, HAWAII 96720

i. Contribute in cash or in-kind the non-Federal share based on traditional Federal cost-sharing policy. Based on September 1982 price levels, the estimated cost sharing is $5,506,000 Federal and $2,477,000 non-Federal.

The County is also aware that the new cost-sharing policies are under consideration. Should such policies be adopted, we intend to evaluate the implications fully at that time to determine the extent to which the County can participate.

We understand that this letter expresses the intent of the County of Hawaii and does not legally bind us to the above agreement. We also understand that this agreement must be formally executed in accordance with Section 221 of the River and Harbor Act of 1970, prior to commencement of construction of the project.

HERBERT T. MATAYOSHI
Mayor

cc: Chief Engineer

May 8, 1982

Dept of the Army
Alenaio Stream Flood Damage Reduction Study
Hilo, Hawaii

Re: Public Meeting May 12 1982

Dear Sirs:

We are the owners of the property 542 Kinoole St, Hilo, Hawaii. My Parents Mr & Mrs Bunji Murakami, 92 & 88 yrs, have been residing there for approximately 47 yrs. There were no flooding problems on their property. So to insure that tranquility I am writing to you today. Please do not make any changes in your plans to include that piece of property in your flood control plans.

Since we cannot be there to vote in person, we are voting in writing for plan 4. That would divert any flooding problems from the busy Hilo downtown area. Thank you for your attention.

Phone 408-245-2906 Homer & Naomi Yamashiro
1418 Kelowna Ct
Sunnyvale, Calif 94087

Private Interests/
Individuals

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

PODED-PJ

11 June 1982

Ms. Marion Yamashiro
1418 Kelowna Ct
Sunnydale, CA 94807

Dear Ms. Yamashiro:

We are responding to your letter of 8 May 1982 regarding your concern of the possible impacts of our Alenaio Stream Flood Damage Reduction Project on your property at 542 Kinoole Street, Hilo, Hawaii. Based on our proposed alternative (Plan 1) which we will be recommending, no impacts on your property, TMK 2-3-18-58 (see attached map, Incl 1) are anticipated. The recommended plan 1 proposes to enlarge and realign Alenaio Stream between Kapiolani Street and Kilauea Avenue. Within the project area near your property, Alenaio Stream will be enlarged to 35 feet and realigned toward the Hilo Fire Station at TMK 2-3-18-33.

We appreciate your concern for your parents who reside on your property. Please be assured that we are sensitive to the concerns of all those who will be impacted by the proposed project. We will make every effort to minimize or mitigate any adverse impacts.

Sincerely,

KISUK CHEUNG
Chief, Engineering Division

1 Incl
As stated

CUTLER·HANLEY JOINT VENTURE
P. O BOX 706 • HILO, HAWAII 96720 • PHONE 935-1191

May 13, 1982

Department of the Army
Honolulu District, Corps of Engineers
Building 230
Ft. Shafter, Hawaii 96858

Re: Alenaio Stream Flood Damage Reduction Study

Gentlemen:

I would like to re-iterate my testimony at your May 12, 1982, public hearing on alternative flood control plans for Alenaio Stream.

Regarding our property located at Kam Avenue and Ponahawai (TMK 2-2-006-027), we have no question as long as the current plan to floodproof only is not changed.

Regarding our property at Kilauea and Ponahawai (TMK 2-2-008-023), we would like to point out that we totally oppose the stated intent to widen the stream at the makai reach of our property to 35' with the entire acquisition coming from our property. This widening would require replacement of our gasoline storage tanks and would eliminate our access to Kilauea Avenue. This degree of loss of use would constitute constructive condemnation of the entire parcel and we would expect the condemning authority to replace this property with comparable property (located within one block of the ocean with unobstructed view to the ocean and zoned identically to the current property). From a practical standpoint we fail to see the rationale of widening this stream at the expense of our property (which has not been subject to flood damage). Immediately to the Puna side of this stream adjacent to our property is a parcel of property which lies in the preferred flow patch of the stream. This other property has been a repeated flood casualty of the stream and is occupied only by a dilapidated, aged, wood frame building which fails to meet all current building standards and, in fact, could well be a hazard to the neighborhood.

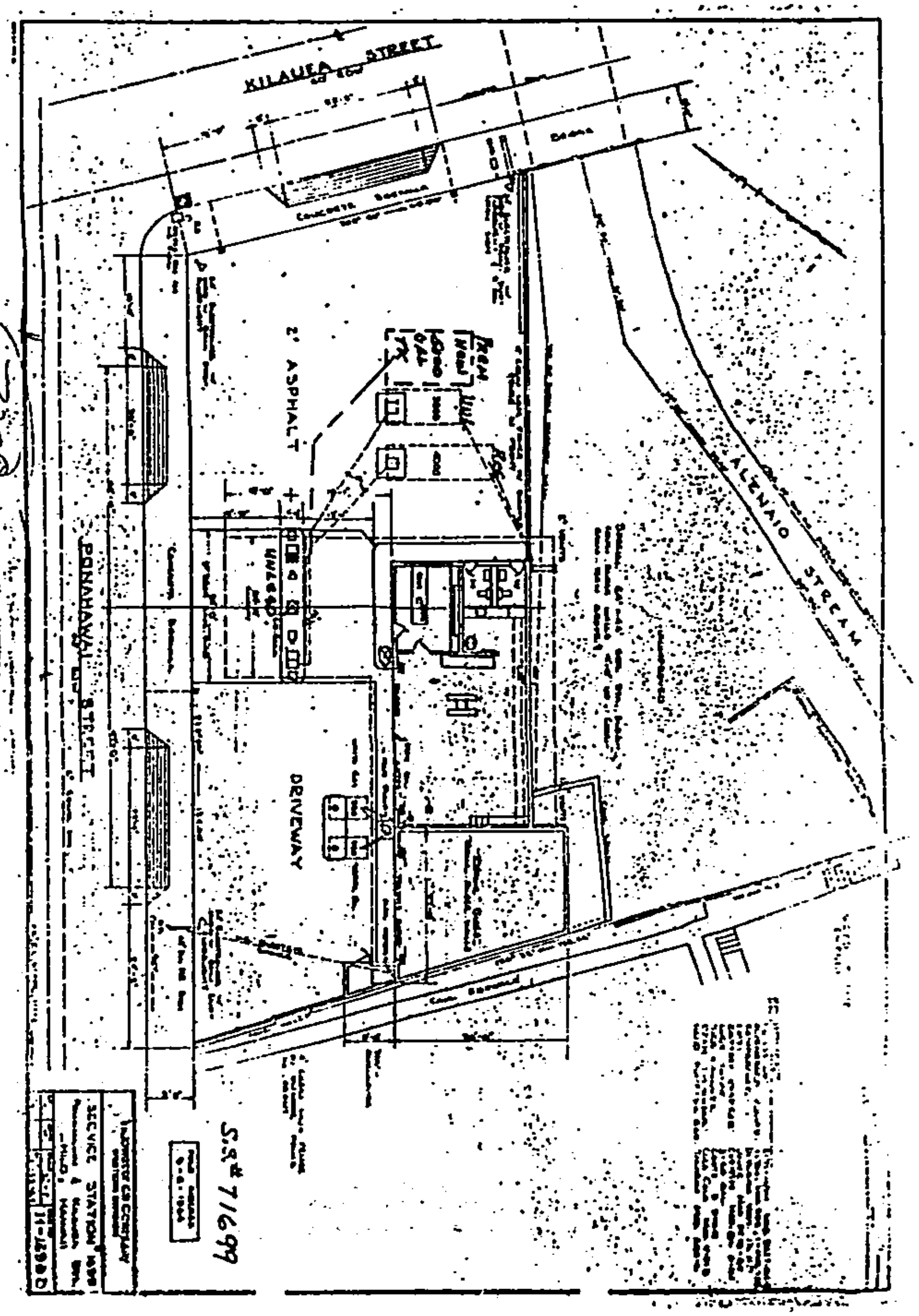
The above comments relate to Alternative 1 only since this is the recommended project. We would appreciate specific notice of any change to emphasis of either other alternatives as neither Alternative 2 or Alternative 3 were analyzed in detail. We are enclosing a sketch showing the approximate location of the tanks on TMK 2-2-008-023.

Yours very truly,

CUTLER-HANDLY JOINT VENTURE

J. W. Hanley

enclosure



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

PODED-PJ

11 June 1982

Mr. J. W. Hanley
Cutler-Hanley Joint Venture
PO Box 706
Hilo, HI 96720

Dear Mr. Hanley:

We are responding to your letter dated 13 May 1982 regarding the Alenaio Stream Flood Damage Reduction Study. We will be recommending with the concurrence of the County Alternative Plan 1. However, based on your comments we are providing an optional alignment of the proposed modification to Alenaio Stream at the lower portion at Kilauea Avenue. This option will avoid your property at TMK 2-2-008-023. The optional alignment will widen and realign the channel through the structure at TMK 2-2-008-046 (see attached map, Incl 1).

When the project becomes authorized by Congress and funds are appropriated to prepare advance engineering and design plans, the economic merits of which you indicated in your letter between the two alignments will be fully evaluated with the County of Hawaii. Since the County of Hawaii is responsible for acquiring the necessary lands and easements for construction, they may accept your economic rationale pending the response from the owner of TMK 2-2-008-046. Other mitigative design features may also be identified during the Advance Engineering and Design phase which may satisfy both you and/or the owner of TMK 2-2-008-046.

We appreciate your concerns on the impacts of this proposed plan on your property. We will make every effort to minimize or mitigate any adverse impacts of the proposed project with the County of Hawaii in the best interest to the community.

Sincerely,

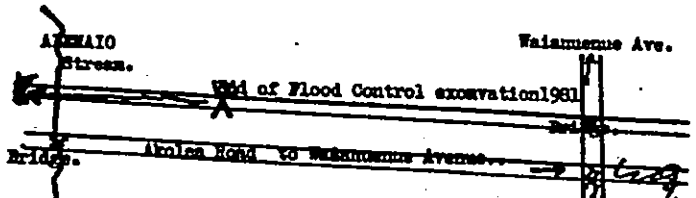
KISUK CHEUNG
Chief, Engineering Division

1 Incl
As stated

CF: w/o incl
Mr. Edward Harada
Dept of Public Works
County of Hawaii
25 Aupuni St
Hilo, HI 96720

FOR NOTES

Lt. Col, Corp of Engineers.
District Engineer. Kenneth E. Sprague.



Note: Lt. Col. Kenneth E. Sprague & Honorable Engineers:

For what my two cents is worth, on this several million dollars of you're proposed plant, Alternative 2, Diversion Channel, at the (4,200) feet elvation, my suggestion is to extend the present Diversion Channel, that has just about eliminated all our flooding problems in the Ainako Residential Area, so extent the present diversion channel thru to catch all flood waters of the Alenaio Stream and remove half of the water going down the Komohana Street area...So before going into millions of dollars expense, try my suggestion, and possibly save this money..sure?

Much Aloha,

J. Walter Silver. Hilo.

Hilo, Hawaii....5/20/82....Thursday: 11:26AM...#1692882....

****

Aloha Lt. Colonel Kenneth E. Sprague & Honorable Staffers:

A Big and Warm Aloha from the Big Island of Hawaii Nei, to y'all at Fort Shafter!!

Colonel, I sent you a few suggestions, about the project, or the Diversion channel to take the waters out of the Komohana Area, by using the present diversion channel that runs parallel to the Akolea Road, in the Alenio-Piihonua Area, I thought it would be a lot cheaper, than you're 6.2 million dollar project to move some 6 families, etc, in the Komohana Area!!but you have not replied to my suggestion, so please do so at you're earliest convenience!!

Much Aloha,

PODED-PJ

1 June 1982

Mr. James Silver
1029 Ainako Avenue
Hilo, HI 96720

Dear Mr. Silver:

We are responding to your suggestion of diverting the Alenaio Stream flood waters into the present Soil Conservation Service (SCS) diversion channel that runs along Akolea Road.

We did investigate this alternative and found the alternative to be economically inferior to the other plans based on the comparative length and size of the channels. The SCS project has a design capacity of 1,120 cfs (100-year flood frequency) for a drainage area (DA) of 1.15 square miles in the Wailuku watershed. The combined Waipahoehoe and Kaluiiki Streams in the Alenaio watershed have a 100-year frequency flood of 5,860 cfs (DA = 5.15 square miles) at Akolea Road. To divert this flow, the SCS diversion will need to be lengthened by approximately 3,000 feet and enlarged for 5,210 feet to accommodate approximately six times the existing capacity for the 100-year level of protection. Even with this Akolea Road diversion, the 100-year frequency flood flow at Komohana Street will be 2,700 cfs (DA = 2.38 square miles). The Alenaio Stream channel downstream of Komohana Street has an existing capacity of approximately 2,000 cfs; consequently, the lower portion would still need to be improved to handle the additional 700 cfs. The proposed diversion channel (Alternative 2) at Komohana Street, as described in the report, will require a shorter diversion channel (4,200 feet) and less downstream improvements. Alternative 1, which proposes to modify the existing channel between Kilauea Avenue and Kapiolani Street, will require the relocation of six families but will require only 1,640 feet of channel modification.

Inclosure 1 summarizes the differences of each alternative. We appreciate your concerns and interest in this study.

Sincerely,

KENNETH E. SPRAGUE
Lt Col, Corps of Engineers
District Engineer

1 Incl
As stated

ALTERNATIVE PLAN COMPARISON 1/

PLAN	LENGTH OF IMPROVEMENT (Ft)		DESIGN DISCHARGE (cfs)	OTHER REQUIRED IMPROVEMENTS	ESTIMATED COST ($000)
Alternative 1, Modifying the Existing Channel	1,640		10,400 - 12,300	Modify 4 bridges; relocation of 6 residences	$ 7,983
Alternative 2, Diversion Channel at Komohana Street	4,200		6,950	Modify 2 bridges below Komohana Street to handle 2,800 cfs for localized storm occurring below Komohana Street; relocation of 1 resident.	$15,678
Diversion Channel at Akolea Road	8,210	3,000 new channel. 5,210 enlarging the existing SCS channel.	5,860 1,120 existing SCS channel.	Modify stream channel below Komohana Street to handle 2800 cfs for localized storm occurring below Komohana Street.	Not determined, but channel is much longer than alternatives 1 and 2.

1/ 100-year level of protection is shown for the purposes of comparison. The Standard Project Flood is the recommended level of protection.

P. YOSHIMURA, INC. ENGINEERING & PLANNING
290 AINAKO AVE. • HILO, HAWAII 96720

June 1, 1982

Mr. James Ligh, Project Engineer
U.S. Army Engineer District, Honolulu
Department of Army
Ft. Shafter, Hawaii 96858

Subject: Alenaio Stream Project

We have reviewed your EIS report and have attended the recent public meeting held in Hilo for the Alenaio Stream project.

Our comments are as follows:

1. In discussing the matter with Mr. Chiaki Matsuo of Komohana Investors, he is in agreement with the Corps of Engineers' recommendation of improving the stream according to Alternate 1.

2. Also, we concur with your recommendation of keeping a 200-foot wide strip along Alenaio Stream for flood plain management between Chong Bridge and Komohana Street. The attached revised rezoning application submitted to the County show this 200-foot wide strip in Komohana Investors land.

In closing, we appreciate your comments on our drainage design as part of the rezoning request submitted to the County. More specifically, not only on the flood control measures, but also on the timing; whether the Komohana Investor's project can go before government start their improvements on Alenaio downstream.

Philip Yoshimura, P.E.

cc: Mr. Chiaki Matsuo, Komohana Investors
Department of Public Works, County of Hawaii w/o Revised Rezoning Application

attachment

ALEE00300XXXXD01F01

HONORABLE DANIEL K. INOUYE
UNITED STATES SENATE
105 RUSSELL SENATE OFFICE BLDG
WASHINGTON, DC 20510

ALEE00302XXXXD01F01

HONORABLE SPARK M. MATSUNAGA
UNITED STATES SENATE
5121 DIRKSEN BLDG
WASHINGTON, DC 20510

ALEE00304XXXXD01F01

HONORABLE DANIEL K. AKAKA
HOUSE OF REPRESENTATIVES
1510 LONGWORTH HOUSE OFC BLDG
WASHINGTON, DC 20515

ALEE00306XXXXD01F01

HONORABLE CEC HEFTEL
HOUSE OF REPRESENTATIVES
1030 LONGWORTH HOUSE OFC BLDG
WASHINGTON, DC 20515

ALEE00488XXXXD01F01

COUNCILMAN FRANK DE LUZ, III
HAWAII COUNTY COUNCIL
25 AUPUNI ST
HILO, HI 96720

ALEE00486XXXXD01F01
MR. STEPHEN K. YAMASHIRO
CHAIRMAN
HAWAII COUNTY COUNCIL
25 AUPUNI ST
HILO, HI 96720

ALEE00490XXXXD01F01

COUNCILMAN TOMIO FUJII
HAWAII COUNTY COUNCIL
25 AUPUNI ST
HILO, HI 96720

ALEE00494XXXXD01F01

COUNCILWOMAN HELENE H. HALE
HAWAII COUNTY COUNCIL
25 AUPUNI ST
HILO, HI 96720

ALEE00489XXXXD01F01

COUNCILMAN TAKASHI DOMINGO
HAWAII COUNTY COUNCIL
25 AUPUNI ST
HILO, HI 96720

ALEE00493XXXXD01F01

COUNCILWOMAN MERLE K. LAI
HAWAII COUNTY COUNCIL
25 AUPUNI ST
HILO, HI 96720

ALEE00491XXXXD01F01
MR. SPENCER KALANI SCHUTTE
VICE-CHAIRMAN
HAWAII COUNTY COUNCIL
25 AUPUNI ST
HILO, HI 96720

ALEE00492XXXXD01F01

COUNCILMAN WILLIAM S. KAWAHARA
HAWAII COUNTY COUNCIL
25 AUPUNI ST
HILO, HI 96720

ALEE00487XXXXD01F01

COUNCILMAN JAMES DAHLBERG
HAWAII COUNTY COUNCIL
25 AUPUNI ST
HILO, HI 96720

ALEE00485XXXXD01F01

HONORABLE HERBERT T. MATAYOSHI
MAYOR OF THE COUNTY OF HAWAII
25 AUPUNI ST
HILO, HI 96720

ALEE00377XXXXD01F01

HONORABLE YOSHITO TAKAMINE
HAWAII HOUSE OF REPRESENTATIVE
HONOLULU, HI 96813

ALEE00374XXXXD01F01

HONORABLE HERBERT A. SEGAWA
HAWAII HOUSE OF REPRESENTATIVE
HONOLULU, HI 96813

ALEE00313XXXXD01F01

HONORABLE DANTE K. CARPENTER
HAWAII SENATE
HONOLULU, HI 96813

ALEE00359XXXXD01F01

HONORABLE ANDY LEVIN
HAWAII HOUSE OF REPRESENTATIVE
HONOLULU, HI 96813

ALEE00328XXXXD01F01

HONORABLE JOHN T. USHIJIMA
HAWAII SENATE
HONOLULU, HI 96813

ALEE00362XXXXD01F01

HONORABLE RICHARD MATSUURA
HAWAII HOUSE OF REPRESENTATIVE
HONOLULU, HI 96813

ALEE00317XXXXD01F01

HONORABLE RICHARD HENDERSON
HAWAII SENATE, ROOM 217
HONOLULU, HI 96813

ALEE00308XXXXD01F01

HONORABLE GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII
HONOLULU, HI 96813

ALEE00351XXXXD01F01

HONORABLE VIRGINIA ISBELL
HAWAII HOUSE OF REPRESENTATIVE
HONOLULU, HI 96813

ALEE00301XXXXD01F01

HONORABLE DANIEL K. INOUYE
UNITED STATES SENATOR
300 ALA MOANA BLVD, ROOM 6104
HONOLULU, HI 96850

ALEE00305XXXXD01F01

HONORABLE DANIEL K. AKAKA
REPRESENTATIVE IN CONGRESS
300 ALA MOANA BLVD, ROOM 5104
HONOLULU, HI 96850

ALEE00303XXXXD01F01

HONORABLE SPARK M. MATSUNAGA
UNITED STATES SENATOR
P.O. BOX 50124
HONOLULU, HI 96850

ALEE00307XXXXD01F01

HONORABLE CEC HEFTEL
REPRESENTATIVE IN CONGRESS
300 ALA MOANA BLVD, ROOM 4104
HONOLULU, HI 96850

ALEG00201XXXXD08F08

DEPUTY ASSISTANT SECRETARY FOR
ENVIRONMENTAL AFFAIRS
US DEPT OF COMMERCE
WASHINGTON, DC 20230

ALEG00204XXXXD05F05
DIRECTOR
OFC OF ENVIRON REVIEW (A-104)
US ENVIRON PROTECTION AGENCY
401 M ST, SW
WASHINGTON, DC 20460

ALEG00209XXXXD01F01
REGIONAL DIRECTOR, SW REGION
NAT MARINE FISHERIES SVC, NOAA
US DEPARTMENT OF COMMERCE
300 SOUTH FERRY STREET
TERMINAL ISLAND, CA 90731

ALEG00215XXXXD01F01
DIRECTOR, PAC SW REGION
NATL PARK SERVICE
US DEPT OF THE INTERIOR
P.O. BOX 36063
SAN FRANCISCO, CA 94102

ALEG00210XXXXD05F05

ADMINISTRATOR, REGION IX
US ENVIRON PROTECTION AGENCY
215 FREMONT ST
SAN FRANCISCO, CA 94105

ALEG00178XXXXD01F01
MR. DALLAS JACKSON
GEOLOGICAL SURVEY
DEPT OF THE INTERIOR
HAWAII VOLCANO OBSERVATORY
HI VOLCANO NAT PARK, HI 96718

ALEG00418XXXXD01F01
DISTRICT CONSERVATIONIST
US DEPT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. BOX 1361
HILO, HI 96720

ALEG00203XXXXD20F05
ASST SECRETARY, PROGRAM POLICY
OFC OF ENVIRONMENTAL PROJECT
REVIEW
US DEPARTMENT OF THE INTERIOR
WASHINGTON, DC 20240

ALEG00222XXXXD05F05

DIVISION OF NEPA AFFAIRS
US DEPT OF ENERGY
MAIL STATION E-201, GTN
WASHINGTON, DC 20545

ALEG00217XXXXD01F01
SECRETARY'S FIELD REP
PACIFIC SOUTHWEST REGION
US DEPT OF THE INTERIOR
450 GOLDEN GATE AVE, BOX 36098
SAN FRANCISCO, CA 94102

ALEG00211XXXXD01F01
REGIONAL ADMINISTRATOR
US DEPT OF HEALTH
AND HUMAN SERVICES
50 FULTON ST
SAN FRANCISCO, CA 94102

ALEG00236XXXXD02F02
REGIONAL ADMINISTRATOR
FED HWY ADMIN, REGION IX
US DEPT OF TRANSPORTATION
2 EMBARCADERO CTR, SUITE 530
SAN FRANCISCO, CA 94111

ALEG00416XXXXD01F01
SCIENTIST IN CHARGE
US GEOLOGICAL SURVEY
VOLCANO OBSERVATORY
HAWAII VOLCANO NATIONAL PARK
HAWAII, HI 96718

ALEG00405XXXXD01F01
HAWAII DISTRICT ENGINEER
HIGHWAYS DIVISION
DOT, STATE OF HAWAII
50 MAKAALA ST
HILO, HI 96720

ALEG00220XXXXD01F01
DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
COORDINATOR, ENVIRONMENTAL
QUALITY ACTIVITIES
WASHINGTON, DC 20250

ALEG00206XXXXD01F01
CHIEF, WESTERN PROJECT REVIEW
ADV COUNCIL ON HIST PRESERV
LAKE PLAZA-SOUTH, SUITE 616
44 UNION BLVD
LAKEWOOD, CO 80228

ALEG00214XXXXD01F01

ADMINISTRATOR, REGION IX
US DEPT OF HOUSING & URBAN DEV
450 GOLDEN GATE AVE, BOX 36003
SAN FRANCISCO, CA 94102

ALEG00212XXXXD01F01
CHIEF
INTERAGENCY ARCHEOL SERVICE
NATIONAL PARK SERVICE
450 GOLDEN GATE AVE, BOX 36065
SAN FRANCISCO, CA 94102

ALEG00175XXXXD01F01
DR. JOHN P. LOCKWOOD
GEOLOGICAL SURVEY
DEPT OF THE INTERIOR
HAWAII VOLCANO OBSERVATORY
HI VOL NAT PARK, HI 96718

ALEG01595XXXXD01F01

MS JANE BUCHANAN-BANKS
US DEPT OF INTERIOR, GEOLOGICA
HAWAIIAN VOLCANO OBSERVATORY
HI NATIONAL PARK, HI 96718

ALEG00409XXXXD01F01

HAWAII DISTRICT FORESTER
STATE OFFICE BUILDING
HILO, HI 96720

ALEG00411XXXXD02F02
DIRECTOR
DEPT OF PLANNING
COUNTY OF HAWAII
25 AUPUNI ST
HILO, HI 96720

ALEG00400XXXXD01F01

HAWAII DISTRICT LAND AGENT
LAND MANAGEMENT DIVISION
DLNR, STATE OF HAWAII
HILO, HI 96720

ALEG01831XXXXD02F02

SERIALS DEPARTMENT
UNIV OF HI AT HILO LIBRARY
1400 KAPIOLANI STREET
HILO, HI 96720

ALEG00146XXXXD01F01
DIRECTOR
DEPT OF HAWAIIAN HOME LANDS
STATE OF HAWAII
P.O. BOX 1879
HONOLULU, HI 96805

ALEG00110XXXXD01F01
ADMINISTRATOR
DIVISION OF STATE PARKS
DLNR, STATE OF HAWAII
P.O. BOX 621
HONOLULU, HI 96809

ALEG00100XXXXD01F01
ADMINISTRATOR, SW REGION, WEST
PACIFIC PROG OFC, NAT MARINE
FISHERIES SVC, US DEPT OF COM
P.O. BOX 3830
HONOLULU, HI 96812

ALEG00120XXXXD01F01
DIRECTOR
INST OF PAC ISLS FORESTRY
FOREST SVC, US DEPT OF AGRCLTR
1151 PUNCHBOWL ST, RM 323
HONOLULU, HI 96813

ALEG00413XXXXD05F05
CHIEF ENGINEER
DEPT OF PUBLIC WORKS
COUNTY OF HAWAII
25 AUPUNI ST
HILO, HI 96720

ALEG00420XXXXD02F02
DIRECTOR
DEPT OF CIVIL DEFENSE
COUNTY OF HAWAII
25 AUPUNI ST
HILO, HI 96720

ALEG00154XXXXD01F01

DIRECTOR, STATE CLEARINGHOUSE
DEPT OF PLNG & ECON DEV
P.O. BOX 2359
HONOLULU, HI 96804

ALEG00114XXXXD01F01

CHAIRMAN
STATE BD OF LAND & NAT RESRS
P.O. BOX 621
HONOLULU, HI 96809

ALEG00113XXXXD01F01
ADMINISTRATOR
LAND MANAGEMENT DIV
DLNR, STATE OF HAWAII
P.O. BOX 621
HONOLULU, HI 96809

ALEG00112XXXXD01F01
STATE FORESTER
FORESTRY & WILDLIFE DIV
DLNR, STATE OF HAWAII
1151 PUNCHBOWL ST
HONOLULU, HI 96813

ALEG00111XXXXD01F01
DIRECTOR
DIV OF AQUATIC RESOURCES
DLNR, STATE OF HAWAII
1151 PUNCHBOWL ST
HONOLULU, HI 96813

ALEG00415XXXXD02F02
MANAGING ENGINEER
DEPT OF WATER SUPPLY
COUNTY OF HAWAII
25 AUPUNI ST
HILO, HI 96720

ALEG00410XXXXD02F02
DIRECTOR
DEPT OF PARKS & RECREATION
COUNTY OF HAWAII
25 AUPUNI ST
HILO, HI 96720

ALEG00118XXXXD01F01
DIRECTOR
DEPT OF PLANNING & ECONOMIC
DEVELOPMENT, STATE OF HAWAII
P.O. BOX 2359
HONOLULU, HI 96804

ALEG00115XXXXD01F01
MANAGER-CHIEF ENGINEER
WATER & LAND DIV
DLNR, STATE OF HAWAII
P.O. BOX 373
HONOLULU, HI 96809

ALEG00116XXXXD01F01

STATE HISTORIC PRSVN OFFICER
DLNR, STATE OF HAWAII
P.O. BOX 621
HONOLULU, HI 96809

ALEG00108XXXXD60F20
DIRECTOR
OFC OF ENVIRONMENTAL QUALITY
CONTROL, STATE OF HAWAII
550 HALEKAUWILA ST
HONOLULU, HI 96813

ALEG00150XXXXD01F01
DIRECTOR
DEPARTMENT OF TRANSPORTATION
STATE OF HAWAII
869 PUNCHBOWL ST
HONOLULU, HI 96813

ALEG00109XXXXD01F01
DIRECTOR
DEPARTMENT OF HEALTH
STATE OF HAWAII
1250 PUNCHBOWL ST
HONOLULU, HI 96813

ALEG00131XXXXD01F01
CHAIRMAN
BOARD OF AGRICULTURE
STATE OF HAWAII
1428 SOUTH KING ST
HONOLULU, HI 96814

ALEG00132XXXXD01F01
MG VALENTINE A. SIEFERMANN
ADJ GEN & DIR OF CIV DEFENSE
NATIONAL GUARD FORT RUGER
3949 DIAMOND HEAD ROAD
HONOLULU HI 96816

ALEG00176XXXXD01F01
OFFICER-IN-CHARGE
CTR FOR DISEASE CONTROL
US PUB HEALTH QUARANTINE STN
P.O. BOX 29300
HONOLULU, HI 96820

ALEG00141XXXXD01F01
DIRECTOR
WATER RESOURCES CENTER
UNIVERSITY OF HAWAII
2444 DOLE ST
HONOLULU, HI 96822

ALEG00177XXXXD01F01
DIRECTOR
HI INSTITUTE OF GEOPHYSICS
UNIVERSITY OF HAWAII
2525 CORREA ROAD
HONOLULU, HI 96822

ALEG00104XXXXD01F01

MANAGER, PACIFIC ISLANDS OFC
US ENVIRON PROTECTION AGENCY
300 ALA MOANA BLVD, ROOM 1302
HONOLULU, HI 96850

ALEG00106XXXXD01F01
HAWAII ADMINISTRATOR
FISH & WILDLIFE SERVICE
US DEPT OF THE INTERIOR
300 ALA MOANA BLVD, BOX 50167
HONOLULU, HI 96850

ALEG00107XXXXD01F01
DIRECTOR, NATL PARK SERVICE
HAWAII STATE OFFICE
US DEPT OF THE INTERIOR
300 ALA MOANA BLVD, RM 6305
HONOLULU, HI 96850

ALEG00124XXXXD01F01

MANAGER, HONOLULU AREA OFFICE
US DEPT OF HOUSING & URBAN DEV
300 ALA MOANA BLVD, BOX 50007
HONOLULU, HI 96850

ALEG00121XXXXD01F01
STATE CONSERVATIONIST
SOIL CONSERVATION SERVICE
US DEPT OF AGRICULTURE
300 ALA MOANA BLVD, BOX 50004
HONOLULU, HI 96850

ALEG00122XXXXD01F01

DIRECTOR
US DEPARTMENT OF ENERGY
300 ALA MOANA BLVD, BOX 50168
HONOLULU, HI 96850

ALEG00123XXXXD01F01
ADMINISTRATOR, HAWAII DIVISION
FEDERAL HIGHWAY ADMINISTRATION
US DEPT OF TRANSPORTATION
300 ALA MOANA BLVD, BOX 50206
HONOLULU, HI 96850

ALEG00103XXXXD01F01
DIRECTOR, PACIFIC REGION
NATIONAL WEATHER SERVICE, NOAA
US DEPARTMENT OF COMMERCE
300 ALA MOANA, BOX 50027
HONOLULU, HI 96850

ALEG00125XXXXD01F01
DISTRICT CHIEF
GEOLOGICAL SURVEY
US DEPT OF THE INTERIOR
300 ALA MOANA BLVD, RM 6110
HONOLULU, HI 96850

ALEG0012XXXXD1F01

COMMANDER
FOURTEENTH COAST GUARD DIST
300 ALA MOANA BLVD, 9TH FLR
HONOLULU, HI 96850

ALEG0021XXXXD1F01
REGIONAL DIRECTOR, REGION IX
US FISH & WILDLIFE SERVICE
LLOYD 500 BLDG, SUITE 1692
500 NE MULTNOMAH STREET
PORTLAND, OR 97232

ALES00165XXXXD01F01

HAWAII AUDUBON SOCIETY
P.O. BOX 22832
HONOLULU HI 96822

R-80

Additional Letters

The following letters arrived at the Honolulu District after 21 June 1982 (45-day review period) and could not be incorporated into the appendix text because of prior submittal for printing of the Final Report.

These letters are provided as an addendum to the appendix.

Date	Agency
18 June 82	State Department of Transportation
8 July 82	Corps of Engineers
21 June 82	State Department of Land and Natural Resources, State Historic Preservation Officer
17 Aug 82	State Department of Land and Natural Resources, 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

DIVISIONS:
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FISH AND GAME
FORESTRY
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

JUN 21 1982

Mr. Kisuk Cheung, Chief
Engineering Division
U. S. Army Engineer District,
Honolulu
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

SUBJECT: Review of Draft EIS and Draft Archaeological and Historical Studies, Alenaio Stream Flood Control Project, Hilo, Hawaii
TMK 2-2-various, 2-3-various
Your: PODED-PJ

This is to amend our comments of May 28, 1982, as it relates to historic sites concerns by replacement with the following:

We concur with the recommendations of the consulting archaeologist, as stated in the Cultural Resources Reconnaissance (May 1982). These recommendations are:

Alternative No. 1

Selection of this alternative would require a determination of where the unmarked infant and/or child burials are located. Therefore, a qualified archaeologist should be commissioned for this task and all activities be carried out in conformance with the wishes of the Chinese Cemetery Association.

Alternative No. 2

The presence of a large number of basalt cobbles on the knoll suggests the possibility that the remains of an early historic or prehistoric Hawaiian site could be present at this location.

It is therefore recommended that the knoll be archaeologically tested by means of the excavation of several backhoe trenches. Pending the results of this work, further recommendations may be made by our office.

A similar program of archaeological testing is also recommended for the area north of the Old Hilo Jail because of the possibility that prehistoric or early historic Hawaiian agricultural remains may exist at this location.

Sincerely yours,

Susumu Ono
Chairman and
State Historic Preservation
Officer

cc: Mr. Gordon Soh, DLNR Planning Office

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

DIVISIONS:
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FISH AND GAME
FORESTRY
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

AUG 17 1982

Mr. Kisuk Cheung, Chief
Engineering Division
Department of the Army
U. S. Army Engineer District,
Honolulu
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

SUBJECT: Review of the Final Report on "Archaeological and Historic Studies for the Alenaio Stream Flood Damage Reduction Study"
U.S. Army Corps of Engineers
Hilo, Hawaii, TMK 2-2-var., 2-3-var.

Thank you for your letter of July 14, 1982, requesting our comments and recommendations on the subject document.

We concur with your decision to recommend for approval and Congressional authorization, Alternative Plan 1 which will involve the following mitigative actions prior to construction (Subject Document, 1982:10-11).

1. Determination, by a professional archaeologist, of the location of the unmarked burials along the slope of the Chinese cemetery. Exhumation and reburial shall be carried out in conformance to the wishes of the Chinese Cemetery Association.

2. Archaeological testing shall be undertaken at the extreme makai end of Alternative No. 1.

3. The excavation of several backhoe trenches for the drawing of soil profiles and the collection of archaeological samples for the determination of the presence or absence of cultural remains. Recommendations for possible further excavations or other mitigative measures could then be made with this information.

Your compliance with the above recommendations would conform to the mitigative procedures set forth in 36 CFR 800 (Advisory Council on Historic Preservation's Procedures for the Protection of Historic and Cultural Properties).

If there are any questions, please contact Wendell Kam, Staff Archaeologist, at 548-7460.

Sincerely yours,

Susumu Ono
Chairman and
State Historic Preservation
Officer

GEORGE R. ARIYOSHI
GOVERNOR

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

RYOKICHI HIGASHIONNA, Ph.D.
DIRECTOR

DEPUTY DIRECTORS
WAYNE J. YAMASAKI
JAMES R. CARRAS
JAMES B. McCORMICK
JONATHAN K. SHIMADA, Ph.D.

IN REPLY REFER TO

STP 6.8313

June 18, 1982

Mr. Kisuk Cheung
U.S. Army Engineer District, Honolulu
Department of the Army
Building 230
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

ALENAIO STREAM DRAFT SURVEY AND EIS

Thank you for the opportunity to review and comment on the subject EIS.

We have reviewed the documents and offer the following comments. The statement on page 62 that DOT will raise the highway is not accurate. Raising the highway is only a consideration in our planning studies and no decision has been made yet. Consequently, Alternate Plans 1 and 3 should consider the cost of raising the Hilo Bayfront Highway to prevent inundation by storms greater than a 10-year flood in their cost analysis. Hilo Bayfront Highway as a Federal-aid project is subject to cost sharing with Federal funds. Therefore, a savings in Federal funds for Alenaio Stream project may result in higher Federal expenditures for the Hilo Bayfront project.

In addition to the increase in capital costs, other factors of consideration in elevating the highway are the impacts to businesses and the effects on highway user delay costs incurred from rerouting of vehicles during times of flooding.

The Department would appreciate reassurances (i.c.Ch. III, 5, b(2) page 46) whereby, no adverse impacts such as overtopping of either the Wailuku or Wailoa River Bridges or flooding of our facilities are anticipated due to changes or action taken by the Corps.

Very truly yours,

Ryokichi Higashionna

Ryokichi Higashionna
Director of Transportation

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

PODED-PJ

Dr. Ryokichi Higashionna, Director
Department of Transportation
869 Punchbowl Street
Honolulu, HI 96813

Dear Dr. Higashionna:

We are responding to your letter (STP 6.8313) regarding the Alenaio Stream Flood Damage Reduction Study. We understand and appreciate your views on cost factors for certain plans, and each plan's ultimate cost with the inclusion of the cost of raising Hilo Bayfront Highway.

Based on our analyses, the economic merits of the alternatives rely heavily on urban flood damage reduction of property and contents. Transportation enhancement benefits were considered and included in the evaluation; however, since the estimated transportation benefits add very little to the total benefit estimation, we concluded raising the highway to prevent flood inundation is not justifiable for a flood control project under our guidelines. Accordingly, we feel the cost of raising the Hilo Bayfront Highway should not be included in the economic analysis.

In regard to your concern of our proposed project's impacts on the Wailuku River, we anticipate no adverse impacts as a result of our project. Alternative Plan 1 will not divert any floodwaters into the Wailuku River. Our hydrologic studies for Plan 2, which proposed to divert floodwaters in the Wailuku River but will not be recommended, were previously sent to your office and coordinated with your A-E consultant, Wilson Okamoto and Associates.

We also changed the statement on page 62 in the Final Report to indicate that raising the highway is only being considered by your office at this time. If you desire additional information please feel free to call Mr. James Ligh at 438-9526.

Sincerely,

KISUK CHEUNG
Chief, Engineering Division

CF:
Mr. Henry Hoshide, Director
Wilson Okamoto and Associates
P. O. Box 3530
Honolulu, HI 96811

ALENAIO STREAM

GEOLOGY, FOUNDATIONS AND MATERIALS APPENDIX

APPENDIX C

APPENDIX C

ALENAIO STREAM
FLOOD DAMAGE REDUCTION STUDY

GEOLOGY, FOUNDATIONS, AND MATERIALS APPENDIX

TABLE OF CONTENTS

LIST OF FIGURES (Plates)

I. GEOLOGY AND HYDROGEOLOGY

1. Introduction

The size of the watershed draining into Hilo Bay above Hilo on the slopes of Mauna Loa ranges from an estimated 950 square miles[1/] to 400 square miles as measured from topographic sheets. The slopes are composed of young, highly permeable lava flows that are virtually untouched by weathering and soil formation. Three channels or streams drain the area, the Wailuku River, Alenaio-Waipahoehoe Stream and Waiakea-Wailoa Stream.

Responsibility for flood control in the upper reaches of the Alenaio-Waipahoehoe Stream was assumed by the Soils Conservation Service (SCS), U.S. Department of Agriculture, with construction (1980) of a diversion channel near elevations 900 feet above sea level along Akolea Road to connect Waipahoehoe Stream with the Wailuku River.

The Corps of Engineers' concern is with the 1.5 miles of Alenaio Stream from the ocean to near elevation 300 feet above sea level. The Corps of Engineers became associated with flooding in Hilo with the Wailoa Stream Flood Control Project in 1964.

Prior to 1979 most of the Waiakea-Wailoa Stream flow escaped into two large lava tubes near the University of Hawaii, Hilo Campus. The tubes apparently became plugged during the 15-year interval (1964 to 1979) and were unable to carry the flooding waters via underground channels to the ocean.

No investigations have been made of the hydrogeological conditions above Hilo to measure features such as: the number, size or location of lava tubes, conduits and passageways for groundwater on the lower slopes above Hilo; for the elevations and characteristics for perched groundwater and dike-held waters, the rates of permeability, transmissibility, and the hydraulic properties of ground-water cells and similar other hydrogeological problems.

Surface flooding by groundwater is a phenomena which is vaguely understood. The extraordinary event results from a combination of rare natural features: heavy and continuous rainfall on tropical vegetation, highly permeable and recent lava-basalt, basal ground-water lens obeying the Ghyben-Herzberg law and perched (dike held) water table(s). The phenomena is demonstrated and manifested by the enormous volume of fresh water emerging as springs at sea level and reported by the USGS in "Fresh-Water Springs of Hawaii from Infrared Images" (Atlas HA.218, W.A. Fischer, USGS, 1966).

2. Problem Analysis

Although rainfall is great on the slopes of Mauna Loa above Hilo (120 inches to 200 inches per year), little surface flow reaches the ocean. Rainfalls on highly permeable lava infiltrates and rapidly reaches the basal water table near sea level. A part of the infiltrated waters is intercepted by impermeable

---

1/ Preliminary Report on the Water Resources of the Hilo-Puna Area, Hawaii Circular C45 by the U.S. Geological Survey in cooperation with DWLD, DLNR, State of Hawaii, 1968.

interbedded layers of weathered ash or residual soil, or by dense lava flows and returns to the ground surfaces as high-level springs where the layers crop out or where the slope intercepts the perched water table. Numerous perched springs rise from lava flows on the slopes of Mauna Loa, the volume of water flow is proportional to the duration and rate of rainfall. In the Hilo area, the springs mainly discharge in two zones at elevations between 400 and 500 feet and near sea level. Local rainfall is trapped in swamps.

Most springs and swamps are in or just below (in elevation) the rainy zones on the higher slopes of Mauna Loa, where they maintain a low flow to the Waiakea and Waipahoehoe Streams. The latter stream has no defined channel between Komohana Street and Luana Way. Substantial surface water travels directly from Waipahoehoe Stream to Alenaio Stream only during periods of very heavy and sustained rainfall (at least 5 inches in 12 hours and continuing for 48 hours). In times of normal rainfall, water carried in the Waipahoehoe Stream at the Chong Street Bridge disappears into a lava tube 3,500 feet downstream from Chong Street Bridge. Yet, despite the lack of a surface water supply, water continues to flow in the middle and lower reaches of the Alenaio Stream except during periods of drought. Between Waipahoehoe and Alenaio Streams, the water is lost by seepage into fractures and lava tubes in the underlying rocks. During periods of low flow, water is lost directly into the bed of Waipahoehoe Stream. There are numerous narrows or "chokepoints" in the Punahoa and 1881 pahoehoe lava flows. During periods of high runoff, the carrying capacity of the channel is exceeded, and excess water is diverted into poorly defined flood channels that conduct the water southward, over the 1881 pahoehoe flow. Some of these flood channels lead directly to large lava tube openings. Other channels lead to the relatively flat area above Komohana Street, an area underlain by the 1881 and Kulaloa pahoehoe flows. Floodwaters accumulate in the flat area during periods of high rainfall up to several feet depth, and much of the water seeps into the underlying rocks. Numerous small holes were observed in this area; holes through which water percolates downward. It is assumed that most of this water eventually reaches lava tubes within the 1881 and Kulaloa flows. Some of this water continues to percolate downward beneath these flows, but much is transported laterally towards the central Hilo areas. The answer to the Alenaio-Waipahoehoe Stream "enigma", lies in the fact that the area between the two streams is entirely underlain by relatively young pahoehoe flows. Surface water percolates into these lavas and is transported laterally by subsurface flow, beneath the anomalous "missing" connection between the two streams.

Layering within individual flows and between flows has made a stepped and sloping surface below the swampy flats above Komohana Street. Deep water-filled pot holes and springs are found along the Alenaio Stream Channel after prolonged rainfall. Information is lacking for hydrogeological features such as: the number and location of the major opening (tubes, cavities, faults, etc.), size and location of major springs (before and after heavy rainfall), the groundwater hydrology (storage constants for the various cells, hydraulic head, static water levels with rainfaill, etc.).

3. Regional Geology

Hilo's location, between the massifs of Mauna Loa and Mauna Kea, makes it the natural focal point for lava flows erupted between 5,000 and 12,000 feet on Mauna Loa's Northeast Rift Zone (NER). Depending on the location of their eruptive vents on the NER, flows can take many paths, but if they flow far enough, most will eventually focus on Hilo Bay. Lava from the NER has repeatedly entered the area of Hilo in the past; these flows are the principal factor controlling the patterns of both surface and subsurface water runoff in the central Hilo area today, and an understanding of their distribution and effects is essential to any viable flood control system.

Surface water runoff within the area of present-day central Hilo probably has been channeled by ephemeral streams for tens of thousands of years, but these streams have been repeatedly shifted laterally as major lava flows from the NER entered the Hilo area. These flows often displace the preexisting surface streams by burying parts of the old streams, and by forcing the blocked streams to shift laterally, usually to the margins of the new flows.

Both pahoehoe and aa lava flows2/ are common on the slopes of Mauna Loa with a preponderance of aa found at lower elevations. Heavy "rain forest" vegetation with thick undergrowth covers and conceals the land surface except for cleared and developed areas. Because all flows are erupted first in the pahoehoe form, the upland parts near the fissure or crater exhibit a larger preponderance of pahoehoe. With distance down the flanks of Mauna Loa, pahoehoe flows become aa and a greater volume of aa can be expected at lower elevations.

The contact of lava flows is marked by irregularity, occasioned by the broken character of the preexisting surface and by the chilling and increase in viscosity of the advancing lava. Pahoehoe flows are distinguished by relatively smooth, billowy, ropy, or entrail-like surfaces. When the viscosity of the molten lava increases and the slope of the terrain decreases, tumuli or pressure domes develop. Transition of pahoehoe to aa goes through a stage called slabby pahoehoe.

The surface of aa flows are rough and difficult to traverse especially if covered by thick vegetation. The surface is often hidden by moss, lichen, and ferns. The upper part of aa consists of clinker and loose scoriaceous basalt pieces which are generally weathered and produce a soil-rock mixture when excavated. The loose clastic surface layer of aa is open and porous and hence decay has created a residual sediment suitable for embankment and level construction. Dense, hard basalt underlies the clinker-scoriaceous, strippable layer in aa flows which requires ripping to excavate. The hard layer varies in depth below the surface anywhere from 1 to 15 feet. No discernible surface feature has been found that would differentiate thick strippable clastic aa layers. Thin (2 feet to 15 feet thick) surface deposits of soil, ash, and weathered residual rock generally cover recent lavas.

2/ The terms pahoehoe and aa are Hawaiian terms to classify the surface and structure of lava flows.

4. Geologic Map Units

The units are described by the U.S. Geological Survey in their report "Alenaio Stream Flood Damage Reduction Study Area, Hilo, Hawaii," dated March 1981, J. P. Lockwood and J. M. Buchanan-Banks. Unit names are highly informal, and subject to change.

1881 Flow Tube-Fed Pahoehoe. Typically contains 2-3% plagioclase and 3-4% olivine phenocrysts crystals visible by unaided eye set in a microcrystalline matrix. The abundant vesicles (gas bubbles) are usually spherical and of uniform size. This flow can be recognized by the presence of fresh, black, volcanic glass on all undisturbed surfaces.

1856 Flow. Tube-fed pahoehoe similar to the 1881 flow, but with less common olivine, slightly more weathered surface glass, and more mature vegetation.

Kulaloa Flow. Tube-fed pahoehoe contains abundant fine plagioclase laths and may contain up to 2% olivine. The abundant vesicles are perfectly spherical in most localities and are of uniform size. Deeply weathered glass is present on many fresh, undisturbed surfaces. ^{14}C age: 1,100 to 1,400 years. Named after Kulaloa (long field) Road in Waiakea-Uka.

Punahoa Flow Tube-Fed Pahoehoe. Contains abundant fine plagioclase, but rarely olivine. Surface is usually deeply weathered and surface glass is found at only a few localities. The vesicles are normally subrounded in shape and variable in size. ^{14}C age: 3,000 to 4,000 years. Named after Punahoa (Companion Spring) Ahupua'a. This flow covers a large surface area in Humu'ulu Saddle region and in the lower rain forest and forms outcrops to at least 5,800 feet above Hilo. This flow is characterized by numerous lava tubes which transport a great volume of groundwater in Hilo. Over 90% of Hilo's spring-derived drinking water is obtained from lava tubes in this unit (County of Hawaii, 1971).

Kino'ole Flow Dense aa. Contains 5-8% sugary olivine and 5-7% plagioclase, mostly intergrown with olivine. The flow has a rubbly surface, but a dense interior. Estimated age: 5,000 to 7,000 years. Named after poor exposures on Kino'ole Street.

Wailuku Flow Very Dense aa. Typically contains 8-12% clear, angular olivine and minor, very fine plagioclase. This flow is tough, flinty "Bluestone" throughout, except in a few outcrops of undisturbed surfaces near flow margins. Estimated age: 7,000 to 10,000 years. It flowed down the Wailuku River channel, and forms much of the present day Wailuku riverbed.

Homelani Ash. Deep yellow and orange-brown volcanic ash. Loose and friable in top 3 to 4 feet, but lower portions are well indurated and fairly impervious to water. The thickness is variable but averages about 10 feet. Its age is generally in excess of 10,000 years. Younger ash units, such as that which overlies the Punahoa flow in places, also overlies the Homelani ash. Named after the Homelani Cemetery (Heavenly Home). All of Hilo's graveyards are located on this easy-to-excavate unit.

Halai Hills Spatter. Olivine-rich, partially welded spatter. Chemical analysis shows this spatter was derived from an ancient Mauna Loa eruptive vent. The age and relationship of this spatter to the Homelani Ash is not known.

5. Site Geology

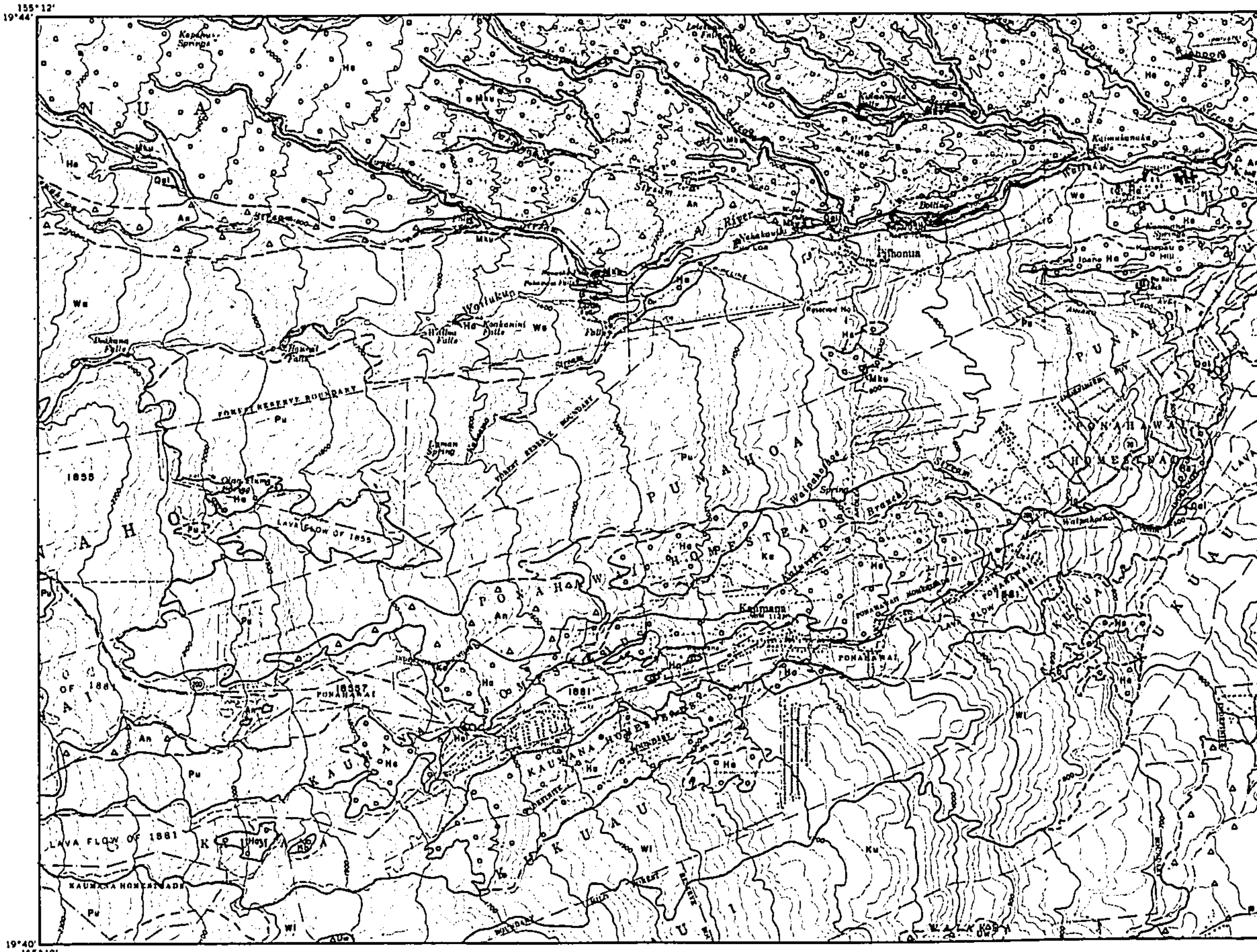
a. Alenaio Stream - The present Alenaio Stream flows in a channel controlled by the margins of three different pahoehoe flows--the flow of 1881, the "Kulaloa" flow and the "Punahoa" flow. The Waipahoehoe branch of Alenaio Stream is bound by the Punahoa flow in its upper reaches, and by the 1881 flow in the area below Chong's Bridge.

A portion of the Alenaio Stream channel mauka of Komohana Street consists of thin to moderately thick marsh-like soils, overlying lava basalt of the Punahoa flow. This section is characterized by a gently sloping and poorly defined channel with frequent outcrops of the flow rock which have water-filled depressions (pot holes scoured by the stream). Lava basalt is exposed in the channel bottom for 2,000 feet makai of Komohana Street. The stream gradient (average 7.5 degree slope) is greatest here and is responsible for exposing the bedrock. Alenaio Stream in the vicinity discussed thus far was formed at the contact of two lava flows: the Punahoa flow on the north side (the older) and the Kulaloa flow on the south. Identifying the individual lava flows in the stream channel was not possible; however, Figure C-1 suggests the lava is the older Punahoa flow. The margin of the younger Kulaloa flow is assumed to overlap at least part of the older Punahoa flow. The higher gradient of this portion of the stream perhaps is also responsible for a more pronounced (but far from prominent) channel. The stream bottom here is rugged with numerous ledges of flow rock, cascades, pot holes, and rock protrusions between Kapiolani Street and Kilauea Street. Alenaio Stream exposes sections of the Homelani Ash and the Kulaloa lava flow. The channel sides are frequently lined with silty clays to sands (weathered ash), gravels, cobbles, and boulders. Sorting and gradation changes in the materials occur as the channel gradient decreases from 7.5 degrees to 2 degrees slope. The Homelani Ash deposits are north of Alenaio Stream and have a lower topographic expression than the adjacent Kulaloa flow (south of Alenaio Stream).

Alenaio Stream departs the margin of the Kulaloa flow at about station 44+00[3] and flows across thin Homelani ash and lava basalt for almost the remainder of the project area. Unconsolidated marine sediments are known to exist along the landward perimeter of Hilo Bay. The thickness of the Homelani ash has been measured up to 13 feet in the Hilo area. Alenaio Stream has cut a well defined channel exposing the underlying, older lavas from station 63+00 to station 44+00. Channel lining and cultural development precluded thorough examination of surface materials for the remainder of the study area.

b. Alenaio Stream - Wailuku River Diversion Ditch: The site for a diversion ditch and cut-and-cover conduit extends from the Alenaio Stream to the Wailuku River. At Alenaio Stream, diversion structures will be located in lava basalts of the Punahoa flow. The alignment is straddled by the Halai Hills spatter cones along Komohana Street. Very thin Homelani ash deposits

3/ See plates D-5 and D-10 for references to stationing along Alenaio Stream and the diversion alignment.



NOTES: GEOLOGY BY J.P. LOCKWOOD AND J. BUCHANAN-BANKS
OF THE USGS
LEGEND OF SYMBOLS ON REVERSE SIDE

GRAPHIC SCALE

0 .5 1 mile

SCALE: 1:24,000

ALENAIO STREAM	HAWAII
GEOLOGIC MAP	
U.S. ARMY ENGINEER DISTRICT, HONOLULU	

FIGURE C-1

PRELIMINARY LEGEND (for Figure C-1)

Geologic Map of the Alenaio-Waipahoehoe Stream lower drainage area
by
John P Lockwood & Jane Buchanan-Banks

Qal	Quaternary alluvium	Unconsolidated sand, gravel, and conglomerate deposits along major streams.
1881	1881 flow	Dense, tube-fed pahoehoe characterized by fresh black surface glass.
1856	1856 flow	Dense, tube-fed pahoehoe similar to the 1881 flow, but with less olivine.
Ku	Pahoehoe of Kulaloa Road	Dense, tube-fed pahoehoe characterized by sparse glass on undisturbed surfaces. Age approx. 1,350 yrs.
Uw	A'a of Upper Waiakea Forest Reserve	Dense a'a characterized by abundant fine plagioclase. Exposed on southern margin of map area. Age approx 1,700 yrs.
Pf	Picrite of Panaewa Forest	Mixed a'a and pahoehoe characterized by abundant olivine and plagioclase. Densely forested. Age approx. 2,900 yrs.
Pu	Pahoehoe of Punahoa Ahupua'a	Dense, tube-fed pahoehoe, characterized by abundant fine plagioclase and sparse olivine. Surface glass rare. Age approx. 3,500 yrs.
Wi	Pahoehoe of Wilder Road	Dense, tube-fed aphanitic pahoehoe. Glass found only on basal surface. Age approx. 4,300 yrs.
Wh	Pahoehoe of Waiakea Homesteads	Plagioclase-rich pahoehoe. Age approx. 9,000 yrs.
Ph	Picrite of Pu'u Hoakalei	Dense, olivine-rich a'a and pahoehoe, characterized by sparse plagioclase. Estimated age pending ^{14}C date 9,500 yrs.

An	A'a of Anuenue Falls	Very dense, flinty a'a which largely fills the ancestral Wailuku River channel. Contains conspicuous olivine. Age approx. 10,500 yrs.
Ki	A'a of Kino'ole Street	Dense a'a, loose on surface, characterized by both olivine and plagioclase. Est. age 11,000 yrs.
Wa	Pahoehoe of Waianuenue Road	Dense, aphanitic, tube-fed pahoehoe characterized by a deeply weathered orange surface where protected from erosion. Age approx. 14,000 yrs.
Ka	Pahoehoe of Kaluiiki Stream	Dense, aphanitic, tube-fed pahoehoe. May be a lobe of the pahoehoe of Waianuenue Road. ^{14}C age pending.
Ha	Homelani Ash	Deep yellow and orange-brown vitric ash. Loose in upper parts, but well-indurated at base. Age >14,000 yrs.
Hh	Spatter of Halai Hills	Partially welded olivine-rich spatter. Overlain by Homelani Ash. Age > 14,000 yrs.
Al	Picrite of Alenaio Stream	Deeply weathered olivine-rich pahoehoe. This is probably a flow from the Halai Hills.
MKu	Lavas of Mauna Kea, undivided	Consists of many different, deeply-weathered pahoehoe flows, commonly with abundant plagioclase and pyroxene. Age est. > 20,000 yrs.

Overprint symbols:

Pahoehoe

A'a

Ash

were encountered at this location. The alignment bisects a lobe or "finger flow" of Punahoa lava from station 17+00 to 11+00. The remainder of the diversion alignment will encounter lavas of the Wailuku flow. The diversion generally follows Komohana Street, mauka of the street from station 50+00 to 32+00 and makai of the street throughout the remainder. Waianuenue Street is crossed at station 16+50. The ground surface along the alignment undulates very gently and bisects minor drainage tributaries at stations 40+00 and 18+00.

6. Groundwater

The basal ground-water table rises from sea level at the average rate of 3 feet per mile and is between 12 and 18 feet above sea level 5 to 6 miles inland. The greatest flow of basal water on the island of Hawaii is around Hilo Bay and the largest visible concentrations of flow are in the Waiakea Pond area. Here, large basal springs discharge into Waiakea Pond which empties into Hilo Bay through the Wailoa River and is the main source of flow in the river. Groundwater flow via springs in and around Waiakea Pond has been conservatively estimated at 200 to 400 cubic feet per second rising to much higher rates following heavy rainfall.

As mentioned earlier, knowledge of the groundwater conditions along Alenaio Stream and its watershed is limited. During the subsurface investigations for this study, the groundwater was measured to be 10 feet below the ground surface (at elevation 5) inthe lower reach of the stream (below sta. 37+00). Here, the high water table results from the low topography and close proximity to the shoreline. At all other locations, groundwater was below the bottom depth of boring or was not measured.

7. Subsurface Flooding

Each of the pahoehoe flows contains complex lava tube systems. The lava tubes can be seen at some places, for example, at Kaumana Cave in the 1881 flow, or at the openings to large springs in the Punahoa flow. In other places they can be inferred where artesian water mysteriously issues from pahoehoe lava, as for example, immediately makai of Akolea Road. The shape of lava tubes seen above the Alenaio Stream area varies from circular to lenticular in cross section, and their diameters from less than a foot to 20 feet. Water is normally carried below the surface in some of these tubes, even in times of drought. During periods of heavy rainfall in the uplands mauka of Hilo, most of these tubes carry water. This water normally flows to sea-level springs without causing problems, but in times of exceptionally heavy rainfall, as for example, in February 1979 and March 1980, the carrying capacity of these subterranean conduits may be exceeded, and springs can unexpectedly develop in areas of pahoehoe outcrop, especially near the distal ends of flows. A great deal of flood damage has been caused by ephemeral lava tube springs located near the ends of the Kulaloa flow between Alenaio Stream and Mohouli Street. These springs usually develop 2-3 days after the heaviest rainfall, showing that the water must travel a significant distance underground, likely from rain forest catchment areas outside the topographic drainage basin of Alenaio Stream as depicted by Figure 2 of the Main Report.

Surface water runoff has been deliberately channeled into open lava tubes mauka of Hilo. Although this alleviates surface flooding in these upland areas, it may amplify subterranean flooding problems in makai Hilo.

8. Springs

The upper limits for known springs are around 3,000 feet above sea level. Several high-level springs rise from Mauna Loa rock above Hilo. The largest of these are Olaa Flume Spring at an altitude of 1,960 feet, Lyman Spring at 1,620 feet, and Kaumana Springs at 410 feet. These springs have been used as sources for domestic water. Water from Lyman, Kaumana, and Olaa Flume Springs is still used to supply residential areas in the upper part of Hilo.

The Hawaii County Board of Water Supply obtains most of its domestic water for Hilo from the Wailuku River basin. Intakes are on the river at altitudes of 1,370 feet and 1,150 feet and on Kahoma Stream at 1,256 feet.

Flow from tunnels bored to concentrate the flow of Middle Flume Spring, together with water diverted from Olaa Flume Spring, has been used for domestic purposes and for fluming to sugarcane fields near Keaau (formerly Olaa) and Mountain View. Fluming of water to the canefields was discontinued about 1944. The county maintains the flume below Middle Flume Sring, using it to transport water to the Keaau-Mountain View area for domestic use. Water flows down the stream channel and, after flowing for a short distance, disappears into the streambed. The Board of Water Supply obtains a part of the domestic water used in the Hilo area from springs and tunnels along Waiakea Stream at an altitude of about 1,500 feet.

9. *Seismicity*

The strongest recorded earthquake in the islands occurred April 2, 1868 and was centered along the south coast of the island of Hawaii. This earthquake had a Richter magnitude of about 7.5 on the island of Hawaii. Practically all earthquakes on the islands of Hawaii and Maui are associated with intermittent volcanic activity. However, potential earthquakes in the islands can also be caused by deep-seated tectonic forces and not from the indirect action of volcanic activity. A Richter magnitude 7 shock on January 23, 1938 had an epicenter 25 miles north of Pauwela Point on the north shore of Haleakala, Maui. Recent explorations by geophysical methods show that faults and rift zones cut through the major islands and that these faults are branches of a gigantic fracture system known as the Molokai Fracture Zone. The Army Technical Manual 5-809-10 (Feb 1982) assigns a zone four seismic risk rating for the project area.

The magnitude of Hawaiian earthquakes was not routinely determined locally until 1958. Prior to that, magnitudes of large earthquakes were measured by seismograph stations on the continental United States, usually by those at the California Institute of Technology, University of California at Berkeley and Columbia University.

II. SUBSURFACE INVESTIGATIONS

1. General

Investigation proposals have been made to meet two basic needs for this project. The first need is to develop geologic and hydrogeologic information necessary for properly understanding the causes of flooding at and adjacent to the site. The other need is to obtain subsurface information for cost estimating and designing of flood control structures. The latter need is relatively simple engineering practice, i.e., borings and laboratory tests made for proposed structures. By contrast, the former need requires time-consuming, expensive, state-of-the-art studies with a scope of work of unlimited posibilities. Furthermore, it cannot presently be determined that such an investigation will satisfy the immediate project objectives or justify the costs.

2. Lava Tube Detection Program

USGS Proposal: In a letter dated February 1981 to the U.S. Army Engineer District, the US Geologic Survey presented a detailed and comprehensive lava tube detection program that would cost $752,400 plus other costs by POD. Its objectives were to detect lava tubes by geophysical methods such as ground probing radar, microgravity, seismic refraction, etc., to initiate detailed underground surveys of lava tube distribution, and to provide subsurface by exploratory drilling. Many of the tasks proposed are in the nature of research and, while being beneficial in the future, the tasks have no direct design application to the Alenaio Stream Flood Control Project.

3. Alternative Proposals

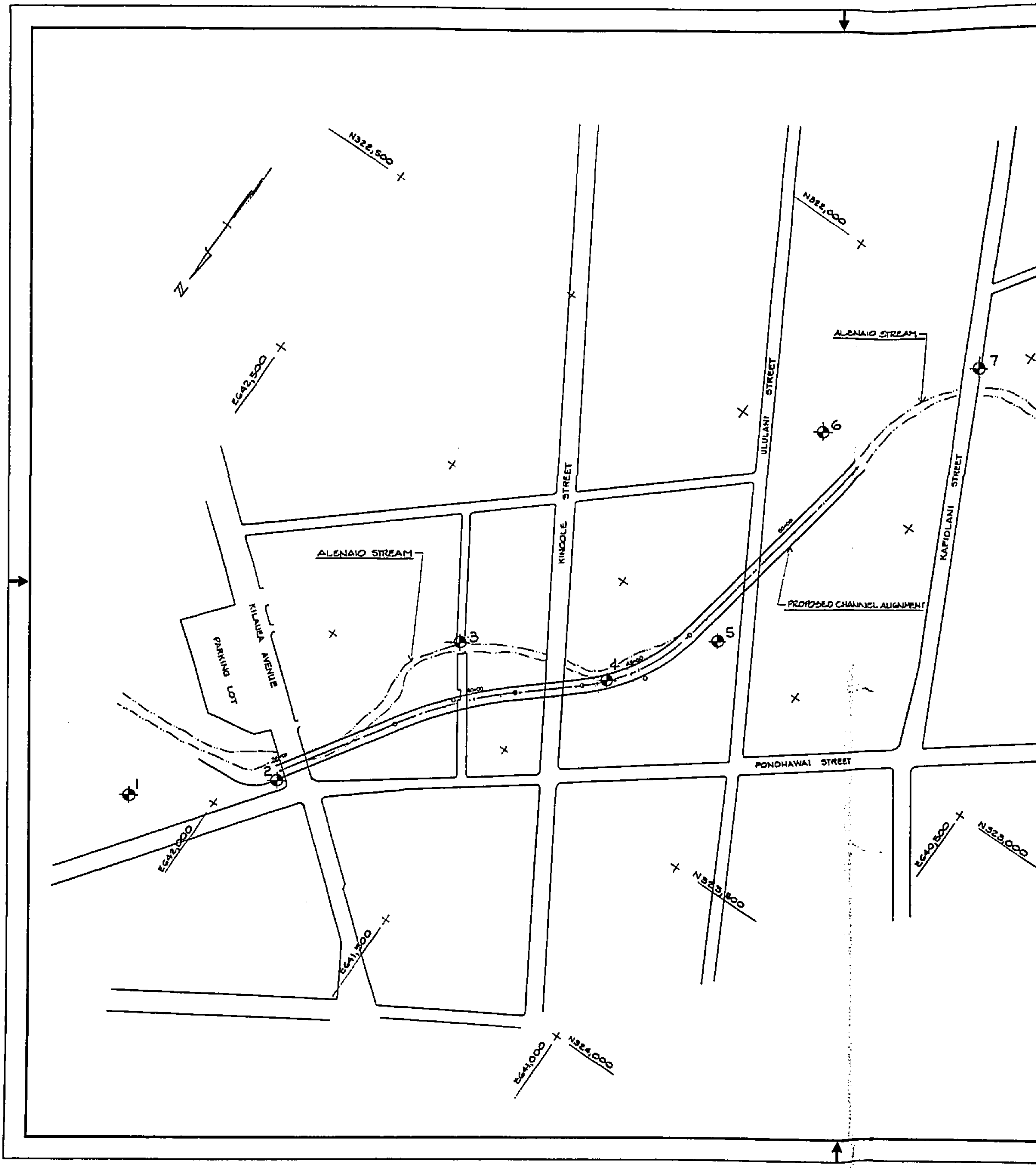
During the preliminary planning stages, several schemes were developed which consisted of combinations of flood water injection well systems, flood control (dry) reservoirs, debris basins, diversions, and channel improvements. Cost estimates for geotechnical investigations (including hydrogeological surveys) for the preliminary alternatives ranged from $120,000 to $258,000 in addition to the USGS cost for a lava tube detection program. The alternatives with injection well systems and reservoirs featured high costs with a substantial degree of uncertainty for resolving the flooding problem. In addition, the groundwater enhancement plan (injection wells) presented the potential for adverse groundwater impacts in the Hilo area. Such proposals are tabled for future use.

4. Present Subsurface Investigations

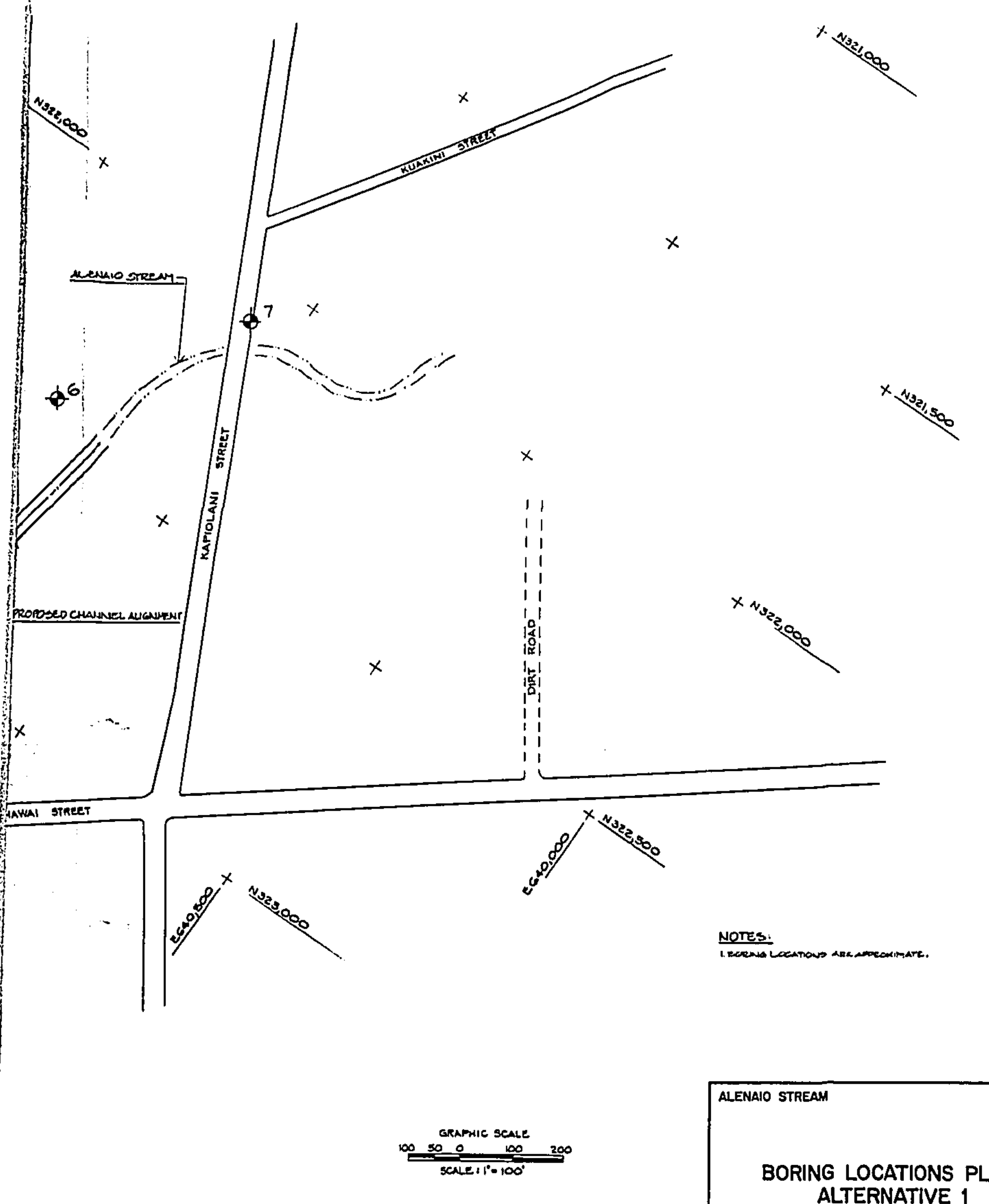
The scope for subsurface investigations was reduced to provide preliminary data for design and cost estimation of the flood control structures, eliminating research type geologic and hydrogeologic studies. Subsurface materials within the reaches of proposed improvements were generally explored during February 1982 by means of 12 borings. Boring location maps are presented as Plates C-2 and C-3.

a. Alternative 1. - Along Alenaio Stream between stations 30+00 and 60+00, the overburden soils are predominantly silty clays, sand, and clayey gravel, 10 to 20 feet deep. The silty clay is yellow to orange in color, slightly plastic, and has varying percentags of basalt cinder and gravel content, up to 50%. The gravel layers are basaltic, with grain sizes from sand to cobbles. Silt and clay fill the voids in the gravel layers. Standard penetration resistance is low to medium, N-values range from 2 to 28 blows per foot. Natural groundwater was encountered only in borings 1 and 2 at the lower end of the project reach, at approximately elevation 5 feet.

Underlying the soils is a moderately hard lava basalt. It is fractured and broken to the depths investigated; low core recovery in some locations resulted from the basalt breaking into gravel-sized pieces under drill pressure and washing out. See Plate C-4 for a profile and logs of the borings.


N
N322,500
N322,000
EG42,500
ALENAIO STREAM
ALENAIO STREAM
KINOOLE STREET
ULULANI STREET
KAPIOLANI STREET
PROPOSED CHANNEL ALIGNMENT
KILAUEA AVENUE
PARKING LOT
PONOHAWAI STREET
EG42,000
EG41,500
EG41,000
N324,000
N323,500
EG40,500
N323,000


N
N322,500
N322,000
EG42,500
ALENAIO STREAM
ALENAIO STREAM
KINOOLE STREET
ULULANI STREET
KAPIOLANI STREET
KILAUEA AVENUE
PARKING LOT
PROPOSED CHANNEL ALIGNMENT
PONOHAWAI STREET
1
2
3
4
5
6
7
EG42,000
EG41,500
N323,500
EG40,500
N324,000

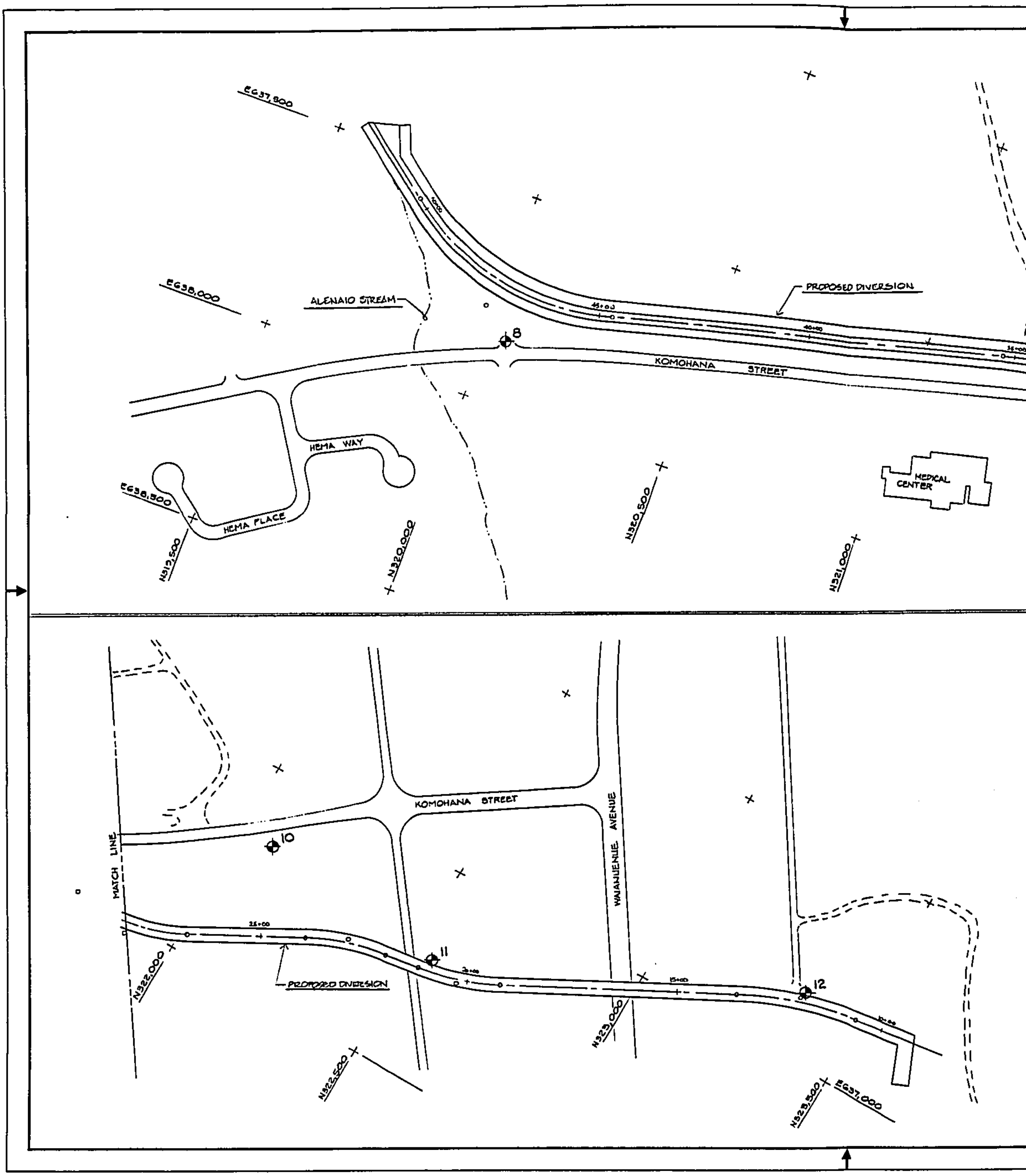


NOTES:
1. BORING LOCATIONS ARE APPROXIMATE.

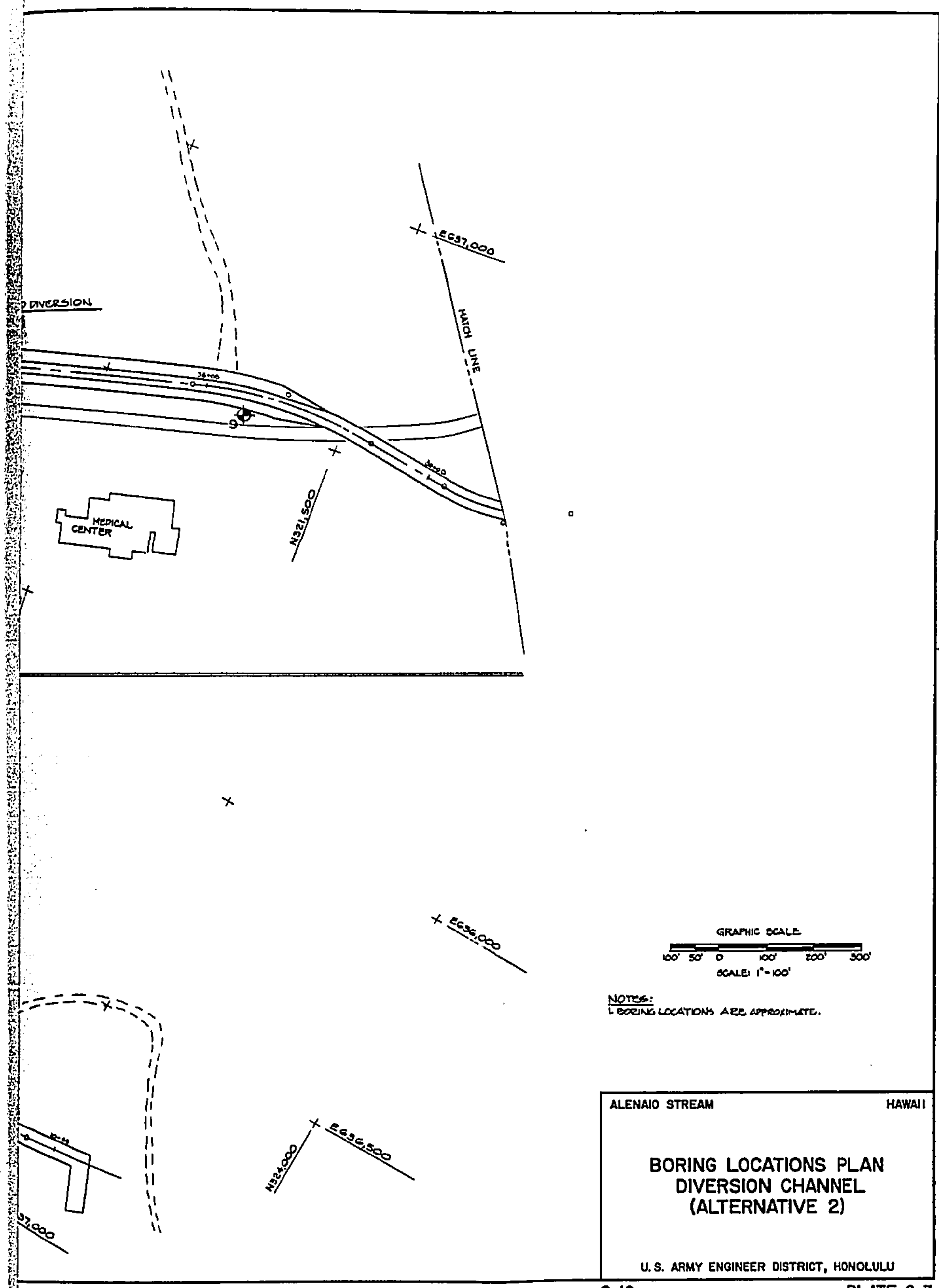
ALENAIO STREAM HAWAII

BORING LOCATIONS PLAN
ALTERNATIVE 1

U. S. ARMY ENGINEER DISTRICT, HONOLULU



E637,500
E638,000
E638,500
N319,500
N320,000
N320,500
N321,000
ALENAIO STREAM
PROPOSED DIVERSION
KOMOHANA STREET
HEMA WAY
HEMA PLACE
MEDICAL CENTER
8
10
11
12
MATCH LINE
KOMOHANA STREET
WAIANUENUE AVENUE
N322,000
N322,500
N323,000
N323,500
E637,000
PROPOSED DIVERSION

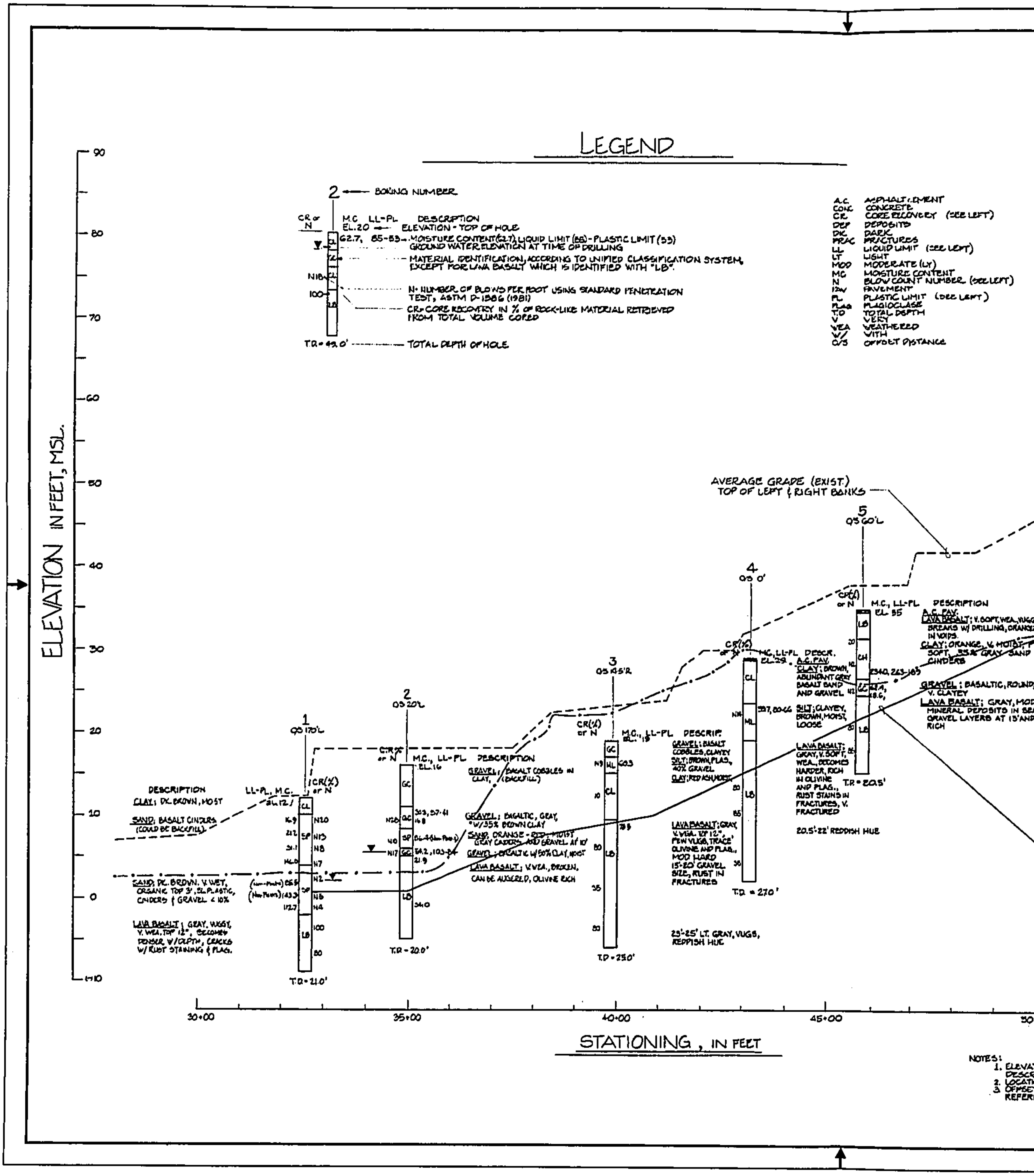


ALENAIO STREAM HAWAII

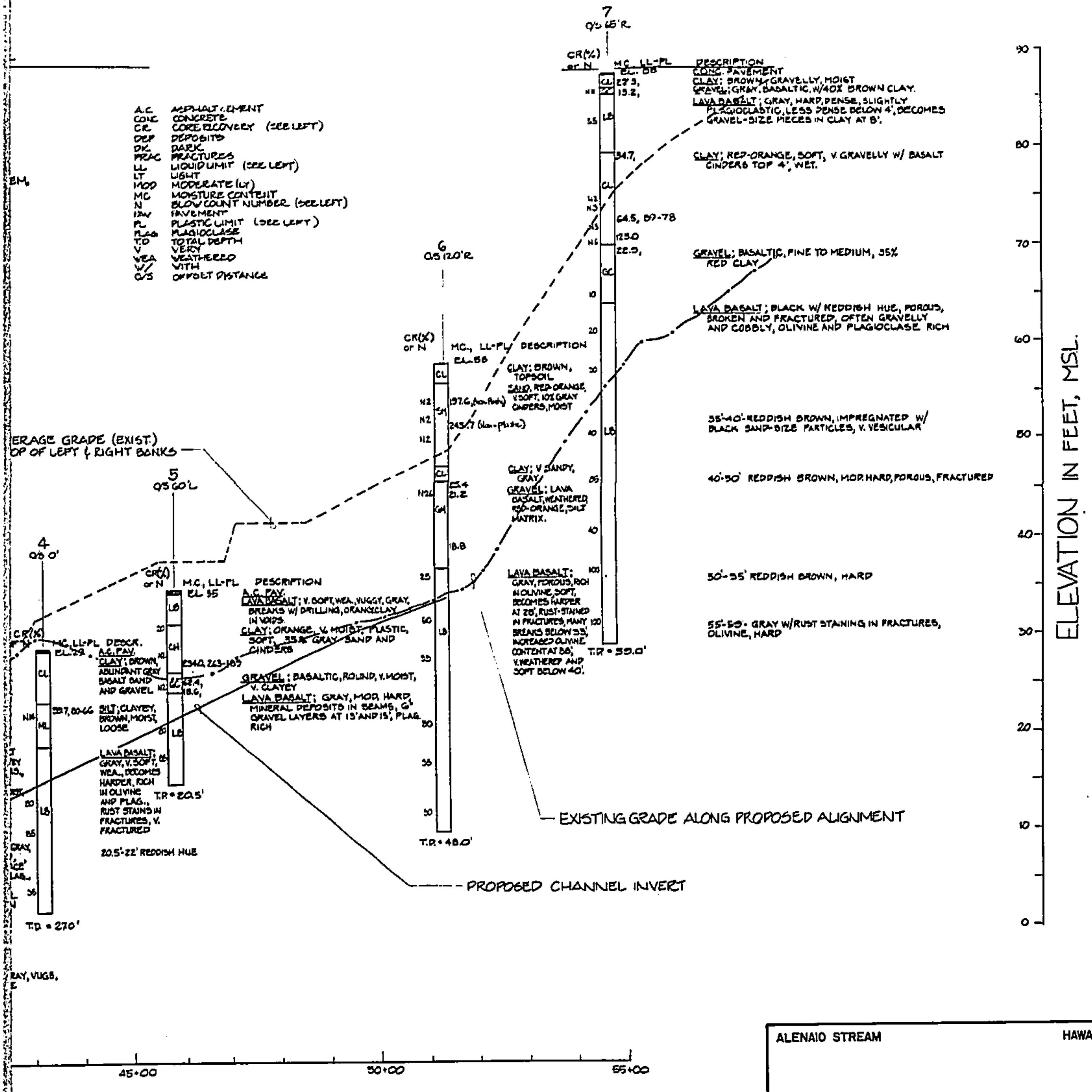
BORING LOCATIONS PLAN DIVERSION CHANNEL (ALTERNATIVE 2)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-3



LEGEND
2 ← BORING NUMBER
CR or N
M.C LL-PL DESCRIPTION
EL.20 → ELEVATION - TOP OF HOLE
62.7, 85-53 → MOISTURE CONTENT (62.7), LIQUID LIMIT (85) - PLASTIC LIMIT (53)
GROUND WATER ELEVATION AT TIME OF DRILLING
MATERIAL IDENTIFICATION, ACCORDING TO UNIFIED CLASSIFICATION SYSTEM, EXCEPT FOR LAVA BASALT WHICH IS IDENTIFIED WITH "LB".
N = NUMBER OF BLOWS PER FOOT USING STANDARD PENETRATION TEST, ASTM D-1586 (1981)
CR = CORE RECOVERY IN % OF ROCK-LIKE MATERIAL RETRIEVED FROM TOTAL VOLUME CORED
T.D. = 42.0' —— TOTAL DEPTH OF HOLE
A.C. ASPHALT CEMENT
CONC CONCRETE
CR CORE RECOVERY (SEE LEFT)
DEP DEPOSITS
DK DARK
FRAC FRACTURES
LL LIQUID LIMIT (SEE LEFT)
LT LIGHT
MOD MODERATE (LY)
MC MOISTURE CONTENT
N BLOW COUNT NUMBER (SEE LEFT)
PAV PAVEMENT
PL PLASTIC LIMIT (SEE LEFT)
PLAG PLAGIOCLASE
T.D TOTAL DEPTH
V VERY
VEA WEATHERED
W/ WITH
O/S OFFSET DISTANCE
ELEVATION IN FEET, MSL.
90
80
70
60
50
40
30
20
10
0
-10
AVERAGE GRADE (EXIST.) TOP OF LEFT & RIGHT BANKS
1
O/S 170'L
DESCRIPTION
CLAY: DK. BROWN, MOIST
SAND: BASALT CINDERS (COULD BE BACKFILL)
SAND: DK. BROWN, V. WET, ORGANIC TOP 3', SL. PLASTIC, CINDERS & GRAVEL < 10%
LAVA BASALT: GRAY, VUGGY, V. WEA. TOP 12", BECOMES DENSER W/DEPTH, CRACKS W/ RUST STAINING & PLAG.
LL-PL, M.C.
CR(%) or N
T.D. = 21.0'
2
O/S 20'L
CR(%) or N
M.C., LL-PL DESCRIPTION
EL.16
GRAVEL: BASALT COBBLES IN CLAY (BACKFILL)
GRAVEL: BASALTIC, GRAY, W/35% BROWN CLAY
SAND: ORANGE - RED - MOIST GRAY CINDERS AND GRAVEL AT 10'
GRAVEL: BASALTIC W/50% CLAY, MOIST
LAVA BASALT: V. WEA., BROKEN, CAN BE AUGERED, OLIVINE RICH
T.D. = 20.0'
3
O/S 45'R
CR(%) or N
M.C., LL-PL DESCRIP.
EL.19
GRAVEL: BASALT COBBLES, CLAYEY
SILT: BROWN, PLAS., 40% GRAVEL
CLAY: RED ASH, MOIST
LAVA BASALT: GRAY, V. WEA. TOP 12", FEW VUGS, TRACE OLIVINE AND PLAG., MOD HARD 15-20' GRAVEL SIZE, RUST IN FRACTURES
23'-25' LT. GRAY, VUGS, REDDISH HUE
T.D. = 25.0'
4
O/S 0'
CR(%) or N
MC, LL-PL DESCR.
EL.29
A.C. PAV.
CLAY: BROWN, ABUNDANT GREY BASALT SAND AND GRAVEL
SILT: CLAYEY, BROWN, MOIST, LOOSE
LAVA BASALT: GRAY, V. SOFT, WEA., BECOMES HARDER, RICH IN OLIVINE AND PLAG., RUST STAINS IN FRACTURES, V. FRACTURED
20.5'-22' REDDISH HUE
T.D. = 27.0'
5
O/S 60'L
CR(%) or N
M.C., LL-PL DESCRIPTION
EL.35
A.C. PAV.
LAVA BASALT: V. SOFT, WEA., VUGS BREAKS W/ DRILLING, ORANGE IN VOIDS
CLAY: ORANGE, V. MOIST, SOFT, 35% GRAY SAND CINDERS
GRAVEL: BASALTIC, ROUND V. CLAYEY
LAVA BASALT: GRAY, MOD MINERAL DEPOSITS IN SEA GRAVEL LAYERS AT 13' AND RICH
T.D. = 20.5'
30+00
35+00
40+00
45+00
STATIONING, IN FEET
NOTES:
1. ELEVA DESCR
2. LOCATI
3. OFFSET REFER



NOTES:
1. ELEVATIONS OF TOP OF BORINGS ARE APPROXIMATE. ALL DEPTHS IN DESCRIPTION ARE REFERENCED TO TOP OF BORING.
2. LOCATIONS OF BORINGS IN PLAN ARE SHOWN ON PLATE C-2.
3. OFFSET DISTANCES, LEFT & RIGHT, ASSUME DOWNSTREAM VIEWING REFERENCE.

ALENAIO STREAM HAWAII

PROFILE OF BORINGS (ALTERNATIVE 1)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

b. Alternative 2. - Subsurface materials for the proposed diversion channel to the Wailuku River consist of a thin overburden (5 to 8 feet thick) of clayey sands and gravels, and gravelly clay. See Plate C-7 for the field logs of borings 8 through 12. Only boring 11 revealed soil to the full depth of boring (15 feet). The soils are moderately soft, with N-values of 2 to 16, on the average. No ground water was encountered in any of the borings of this reach.

The soils are underlain by gray, weathered basalt. At the shallow depths of these borings, the basalt typically displayed a great degree of weathering, breaking up easily with auger drilling. Competent basalt was also encountered, although fractured somewhat.

5. Laboratory Testing

a. Alternative 1. - Testing of the overburden soils along the proposed channel realignment consisted of identification and moisture tests for selected representative samples. The overburden is largely silty clay and gravel of low or no plasticity, with the exception of one highly plastic sample 8 feet deep in boring 5. Moisture contents vary as expected with a few samples showing very high in-situ moisture (100-250%). This is common among the weathered unconsolidated volcanic deposits (Homelani ash) of the islands. All samples tested exhibit low plasticity regardless of moisture content (with the one exception as noted, boring 5), indicating non-swelling materials. See Plates C-5 and C-6 for a summary of laboratory testing. The following preliminary soil parameters may be used for design purposes:

	In-place Soils	Granular Backfill
Angle of internal friction,	20°	30°
Cohesion, C	0.3 tsf	0 tsf
Moist unit weight	100 pcf	120 pcf

Intact lava basalt samples were selected for unconfined compressive strength testing. Resulting strengths range from 2030 psi to 16630 psi, with a median value of about 4100 psi. Allowable bearing pressure of the basalt for preliminary design purposes is 20 tsf for weathered basalt and 100 tsf for unweathered basalt.

b. Alternative 2. - Testing of the overburden soils of Alternative 2 resulted in a wide variation of moisture and plasticity values. Moisture contents range from 16% to 281%. The plasticity of the soils varies from non-plastic to highly plastic (up to a plasticity index of 91). Soils high in moisture content and plasticity tend to be naturally deposited volcanic materials, as the Homelani ash, and are subject to swelling and shrinking characteristics with changes in moisture contents. Soils with lower values are generally man-made fills placed as grading around structures and roadways over the more active natural soils, as is verified by the boring logs. The preliminary soils design values and basalt bearing strength given above apply to Alternative 2.

TEST DATA SUMMARY

BORING NO.	SAM. NO.	DEPTH OR ELEV. OF SAMPLE	LABORATORY CLASSIFICATION (VISUAL I.D.)	MECHANICAL ANALYSIS GRAVEL %	SAND %	FINES %	D_{10}	ATTERBERG LIMITS LL	PL	ORGANIC CONTENT %	NAT. WATER CONT. %	UNCONFINED COMPRES. (psi)
1	18	3^5-7^0	(SP)	1	85	14	.07				21.2	
	20	7^0-9^0	(")								146.0	
	21	9^0-11^0	(")					NON-	PLASTIC	5.1	85.5	
	22	11^0-12^0	(")					NON-	PLASTIC	8.5	143.3	
	23	12^0-14^0	(")								112.6	
	R-2	16^0-21^0	LAVA BASALT									5230
2	24	5^0-7^0	(GC)					57	41		30.3	
	26	8^0-10^0	(SP)					NON-PL	ASTIC		56.4	
		10^0-11^0	(GC)					103	84		54.2	
3	31	2^0-3^5	(ML)								69.3	
	32	9^0-10^0	(GP)								78.5	
	R-2	10^0-15^0	LAVA BASALT									2030
	R-3	15^0-20^0	LAVA BASALT									4700
4	30	5^5-7^5	ML	1	41	58		80	66		59.7	
	R-1	12^0-17^0	LAVA BASALT									6290
	R-2	17^0-22^0	LAVA BASALT									2490
5	14	6^5-8^5	(CH)					263	189		234.0	
	15	8^5-10^5	(CH)								62.4	
6	39	2^0-5^0	(SM)					NON-	PLASTIC		197.6	
	40	5^0-7^0	SM	0	87	13	.06	NON-	PLASTIC		245.7	
	41	12^0-13^0	(GM)	39	46	15	.04				25.4	
	42	13^0-13^5	(GM)								21.2	
	43	18^0-19^5	(GM)								18.8	
7	33	1^0-1^5	(CL)								27.3	
	34	1^5-2^0	(GC)								13.2	
	35	7-12^5	(CL)								34.7	
	36	14^5-16^0	(CL)					89	78		64.6	
	37	16^0-17^5	(CL)								125.0	
	38	17^5-18^0	(GC)								22.9	
	R-1	1^5-6^0	LAVA BASALT									16630

ENG FORM 2088 1 JAN 73 EDITION OF 1 MAR 58 IS OBSOLETE.

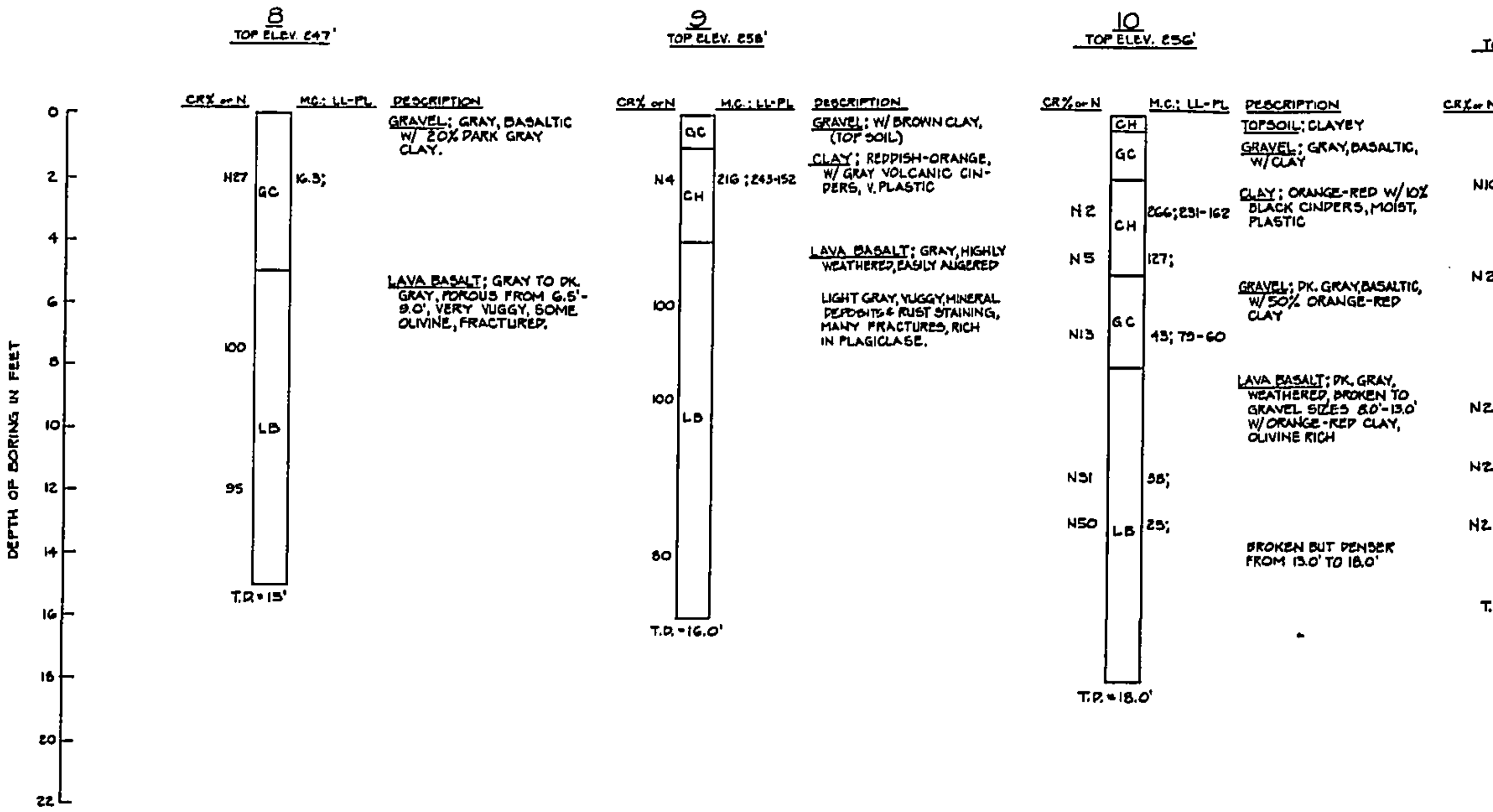
PLATE C-5

TEST DATA SUMMARY

BORING NO.	SAM. NO.	DEPTH OR ELEV. OF SAMPLE	LABORATORY CLASSIFICATION	MECHANICAL ANALYSIS GRAVEL %	SAND %	FINES %	D_{10}	ATTERBERG LIMITS LL	PL	SPECIFIC GRAVITY G	NAT. WATER CONT. %	UNCONFINED COMPRES. (p.s.i.)	M
8	3	1^0-2^5	(GC)	50	40	10	.07				16.3		
	R-2	12^0-12^5	LAVA BASALT									7510	
9	1	1^0-2^5	(CH)					243	152		216.0		
	2	5^5-6^0	(GC)								10.1		
	R-2	6^0-11^0	LAVA BASALT									4190	
	R-3	11^0-16^0	LAVA BASALT									4340	
10	4	2^0-3^5	(CH)					231	162		266.2		
	5	4^0-5^0	(CH)								126.9		
	6	6^5-8^0	(GC)					79	60		42.6		
	7	10^0-12^0	(GC)								38.5		
	8	12^0-13^3	(GC)	50	41	9	.08				22.9		
11	9	1^0-2^5	(GC)					52	40		24.9		
	10	4^0-5^5	(SM)					NON-PLASTIC			170.7		
	11	8^0-11^0	SW-SM	0	90	10	.07	NON-PLASTIC			280.7		
	12	11^0-12^0	(SM)					NON-PLASTIC			238.9		
	13	12^0-14^0	ML	0	36	64		133	106		107.9		
12	R-1	2^5-7^5	LAVA BASALT									4140	
	R-2	7^5-12^5	LAVA BASALT									5240	
	R-4	17^5-21^0	LAVA BASALT									4000	

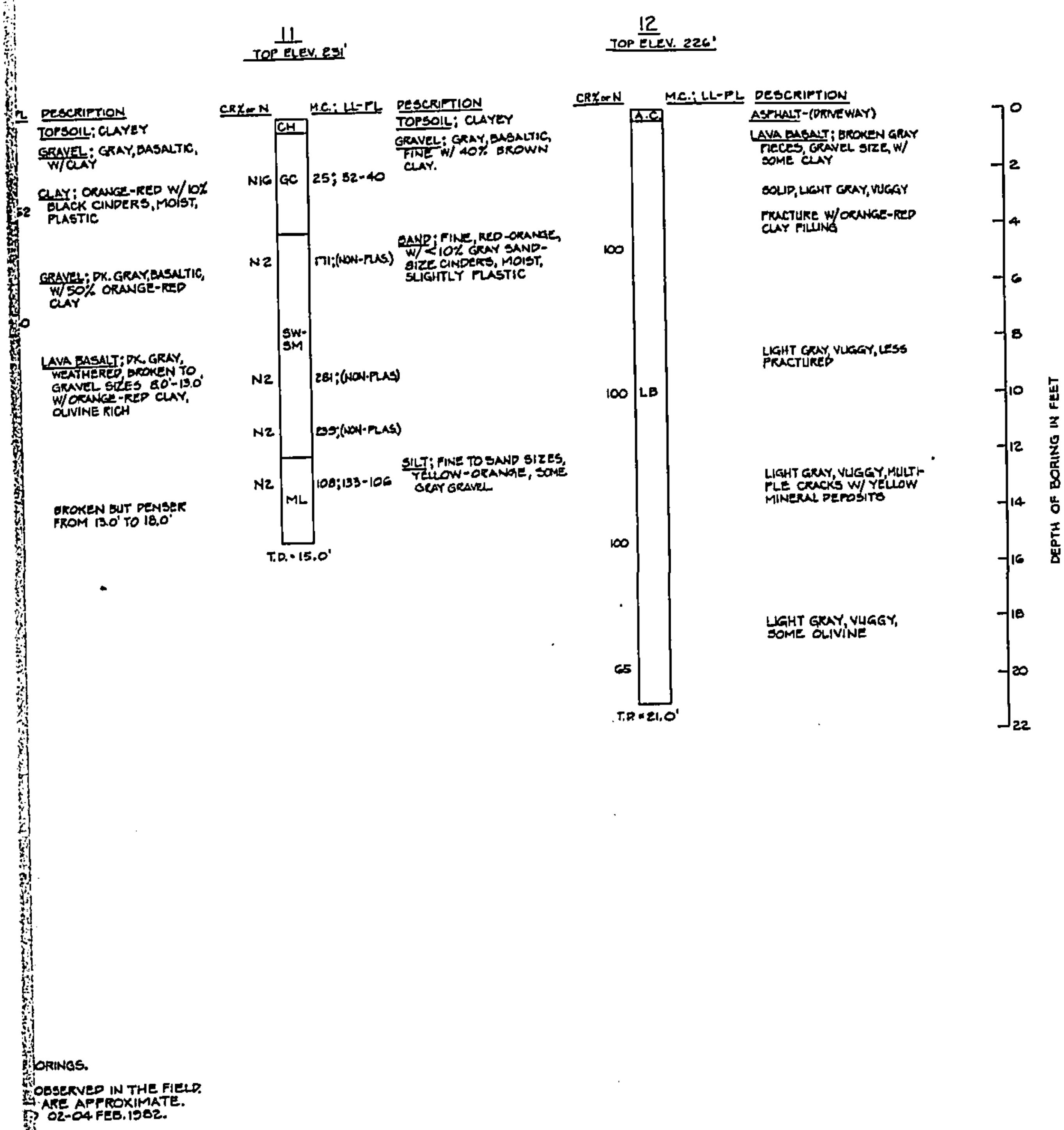
ENG FORM 2086 1 JAN 73 EDITION OF 1 MAR 58 IS OBSOLETE.

PLATE C-6



NOTES:

1. SEE PLATE C-3 FOR PLAN OF BORINGS.
2. SEE PLATE C-4 FOR LEGEND.
3. MATERIAL DESCRIPTIONS ARE AS OBSERVED IN THE FIELD.
4. ELEVATIONS OF TOP OF BORINGS ARE APPROXIMATE.
5. BORINGS 8 THRU 12 WERE DRILLED 02-04 FEB. 1962.



ALENAIO STREAM — HAWAII

LOGS OF BORINGS ALONG DIVERSION CHANNEL (ALTERNATIVE 2)

U. S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-7

III. DESIGN CONSIDERATIONS

1. Availability of Construction Materials

a. Fill. Fine-grained material for topsoil and impervious fill is not available in large quantities in the Hilo area. Such material, if required, may be imported from the Hamakua District northwest of Hilo.

Foundation materials consist predominantly of lava basalt with a relatively thin soil overburden. Most of the material recovered from the required excavations will be in the form of silt, sand, and gravel to boulder-size pieces of lava basalt, often in slabby shapes. This material will be utilized for fill and backfill (except for the CH clays) in lieu of hauling it away and bringing in material from outside sources.

b. Bedding and Filter Material. Crushed aggregate for use as bedding and filter material is available from commercial quarries in Hilo.

c. Concrete Materials. Compressive strength concrete of 4,000 psi will be required for construction of the channel improvements and is available through Hilo-based contractors. The completed structures will not be subjected to any severe or unusual climatic conditions.

2. Diversion Channel and Stream Realignment Alternatives.

a. Although lava basalt is found at poirtions of the proposed channel invert elevation, lining of the channel invert would prevent natural infiltration of water into the porous basalt, reducing undergrond seepage which can be transferred to downstream reaches causing damage to homes. Lining of the invert will require a sufficient number of weepholes in the invert slab to relieve excess hydrostatic pressures. Reverse seepage of channel water through the weepholes into the underground seepage system for the short duration storms is considered minimal.

b. A subdrainage system consisting of 6 inches perforated pipe with outlets into the channel at 10'-0" or closer on centers will be required behind channel walls. In conjunction with the subdrainage system, bedding material will be provided in thicknesses of 9 inches minimum beneath invert slabs and 18 inches behind channel walls. An 18-inch thick cap of impervious material will be provided at the top of the backfill to preclude surface flows from entering the subdrainage system and overtaxing its capacity.

c. In accordance with ETL 1110-2-236, the concrete channel invert will be designed as continuously reinforced, without transverse and longitudinal joints except construction joints placed at the end of each day's concrete pour between adjacent paving lanes, or where concrete placement is interrupted for 45 minutes or longer. Vertical contraction joints will be provided at intervals of 40 to 50 feet for floodwalls and walls of rectangular channels.

d. Concrete channel structures will be subjected to water velocities in excess of 40 feet per second. In order to satisfy the durability requirements specified in EM 1110-2-2000, concrete with a maximum water-cement ratio of 0.45 by weight and a maximum aggregate size of 1-1/3 inches (1-inch nominal size) will be used. Concrete compressive strength of 4,000 psi will be used for structural design in keeping with the 0.45 water-cement ratio required for durability.

e. Rock Excavation. Excavation into basalt rock is required for this project. Some of the rock materials can be excavated with a bulldozer equipped with a ripper. However, drilling and blasting or methods of comparable effort should be anticipated for removal of the harder rock layers. In view of the proximity of residential structures along the various alternative alignments, blasting will be performed under carefully controlled conditions.

f. Cut and Fill Slopes. Cut and fill slopes of 1V on 1.5H will be adequate, except for construction along Waiolama Canal where a slope of 1V on 2H is recommended.

g. Subgrade Preparation and Fill Compaction. Areas to receive fill will be cleared of vegetation, grubbed and stripped to remove soft organic surface soils, large roots and other organic debris. Pockets of unusually soft or compressible soils should be removed. Fills will be placed in lifts no thicker than 8 inches, moisture conditioned and compacted to minimum 95 percent maximum density for cohesionless material and to minimum 90 percent of maximum density for cohesive material, according to ASTM D1557(D). Rock fills will be placed on 24-inch lifts and compacted by bulldozer.

h. Topsoil and Ground Cover. Use of topsoil on this project will be held to a minimum in view of its scarcity in the Hilo area. Creeping type ground covers (vines) tolerant of rocky, soil-scarce ground conditions will be used in lieu of grass. However, existing lawn surfaces disturbed by construction operations will be restored with topsoil and grass to match preconstruction conditions.

ALENAIO STREAM

HYDROLOGY AND HYDRAULIC ENGINEERING
ANALYSES AND DESIGN APPENDIX

APPENDIX D

APPENDIX D

ALENAIO STREAM
FLOOD DAMAGE REDUCTION STUDY

Hydrology and Hydraulic Engineering
Analyses and Design Appendix

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont)

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF PLATES (CONT)

I. HYDROLOGY

1. BASIN DESCRIPTION

Alenaio Stream is located on the northeastern side of the island of Hawaii, in the city of Hilo. The Alenaio drainage basin is 8.53 square miles in area and extends over 11 miles from Hilo bay to its headwaters at elevation 2550 feet (see Fig. D-1). Kaluiiki Branch joins Waipahoehoe Stream above Chong's Bridge. The stream then becomes undefined in the floodplain below Chong's Bridge in the lava land area. As the flow disappears in the lava land area, part of the flow reappears above Komohana Street where it forms Alenaio Stream. Alenaio Stream then flows easterly with stream crossings at Kapiolani, Ululani, and Kinoole Streets and Kilauea Avenue. Downstream of Kilauea, the Alenaio Stream flows into the Waialama Canal which empties into the Wailoa River which discharges into Hilo Bay. All the streams in the Alenaio watershed are ephemeral. Stream slopes are steep except in the Waialama Canal area (see Fig. D-2). This study concentrates on Alenaio Stream in the reach below Chong's Bridge.

2. CLIMATE

Hawaii enjoys a subtropical climate. The climate of the island is greatly influenced by terrain. The outstanding features are the marked variations in rainfall with elevation, and the northeasterly tradewinds. The island's topography is dominated by the great volcanic masses of Mauna Loa and Mauna Kea, both of which exceed 13,600 feet in elevation. Over the island's windward slopes, rainfall occurs principally in the form of showers. Mean annual rainfall increases from 100 inches or more along the coasts to a maximum of over 300 inches between elevations 2,000 to 3,000 feet, and then declines to about 15 inches at the summits of Mauna Kea and Mauna Loa. In general, leeward (southern and western) areas are topographically sheltered from the trades and are therefore drier. The average rainfall in the study area varies from about 130 inches a year near the shore to about 220 inches at the headwaters. The wettest part of the island, with a mean annual rainfall of about 300 inches, lies about 6 miles upslope from Hilo. Hilo's mean temperature is 73.4°F. The highest temperature of record at Hilo Airport is 94°F and the lowest, 53°F. A summary of climatological data at Hilo Airport is shown in Table D-1 and rainfall stations in and near the Alenaio Basin are Shown in Fig. D-3 and listed in Table D-2.

FOR FIGURE D-1 SEE

FIGURE 2 IN THE MAIN REPORT

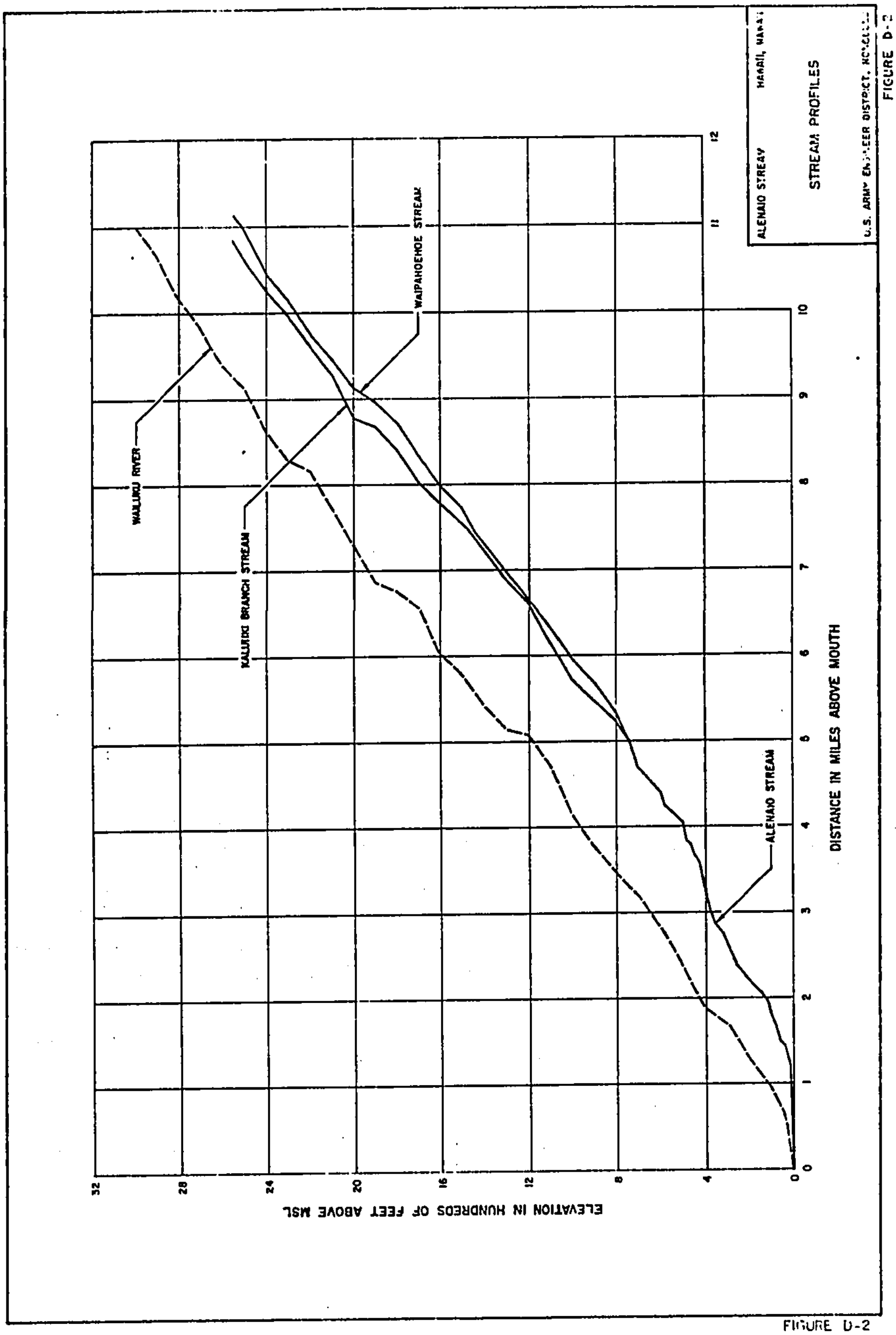

ALENAIO STREAM
STREAM PROFILES
FIGURE D-2
WAILUKU RIVER
KALUIKI BRANCH STREAM
WAIPAHOEHOE STREAM
ALENAIO STREAM
DISTANCE IN MILES ABOVE MOUTH
ELEVATION IN HUNDREDS OF FEET ABOVE MSL
0
1
2
3
4
5
6
7
8
9
10
11
12
4
8
12
16
20
24
28
32

FIGURE D-2

TABLE D-1
SUMMARY OF CLIMATOLOGICAL DATA AT HILO AIRPORT 1/
(1940 - 1979)

Month	Temperature in Fahrenheit Mean Monthly	Record Highest	Record Lowest	Rainfall in Inches Mean Monthly	Maximum Monthly	Minimum Monthly
Jan	71.2	91	54	10.05	32.24	0.36
Feb	71.1	92	53	13.23	45.55	1.70
Mar	71.3	93	54	12.68	31.91	0.88
Apr	72.2	89	56	13.07	31.94	2.93
May	73.3	94	58	9.12	25.01	1.18
Jun	74.6	90	60	6.17	15.50	2.46
Jul	75.3	89	62	8.95	14.89	3.83
Aug	75.9	93	63	9.76	26.42	2.66
Sep	75.7	92	61	6.53	13.63	1.59
Oct	75.2	91	62	10.0	26.10	2.40
Nov	73.5	88	58	14.56	27.03	3.74
Dec	71.7	91	55	14.73	50.82	0.77
	73.4 2/			128.85 3/		

1/ From Local Climatological Data, Annual Summary with Comparative Data, Hilo, Hawaii, 1979.
2/ *Mean Annual Temperature.*
3/ Mean Annual Precipitation.

Four types of storms produce heavy precipitation in the Alenaio drainage basin: Winter storms, "Kona" storms, convective-type thunderstorms, and hurricanes or tropical storms. A brief description of each storm type is given in the following subparagraphs:

a. Winter storms or cold-front storms usually occur during the period from December through March. They originate over the Pacific Ocean as a result of the interaction between polar Pacific and tropical Pacific airmasses and move eastward over the islands. These storms reflect orographic influences and are accompanied by widespread precipitation.

b. "Kona" storms are migratory low-pressure areas found at the surface and/or aloft and are accompanied in the Hawaiian area by widespread heavy rain and southerly winds.

c. Convective-type thunderstorms can occur at any time of the year. However, they are most common during periods of relatively high humidity and unstable air conditions. These storms cover comparatively small areas and result in high-intensity precipitation of short duration.

d. Hurricanes or tropical storms occur in Hawaii, and cause heavy rains and high winds. A storm is classified as a hurricane when the wind speeds exceed 74 miles per hour.

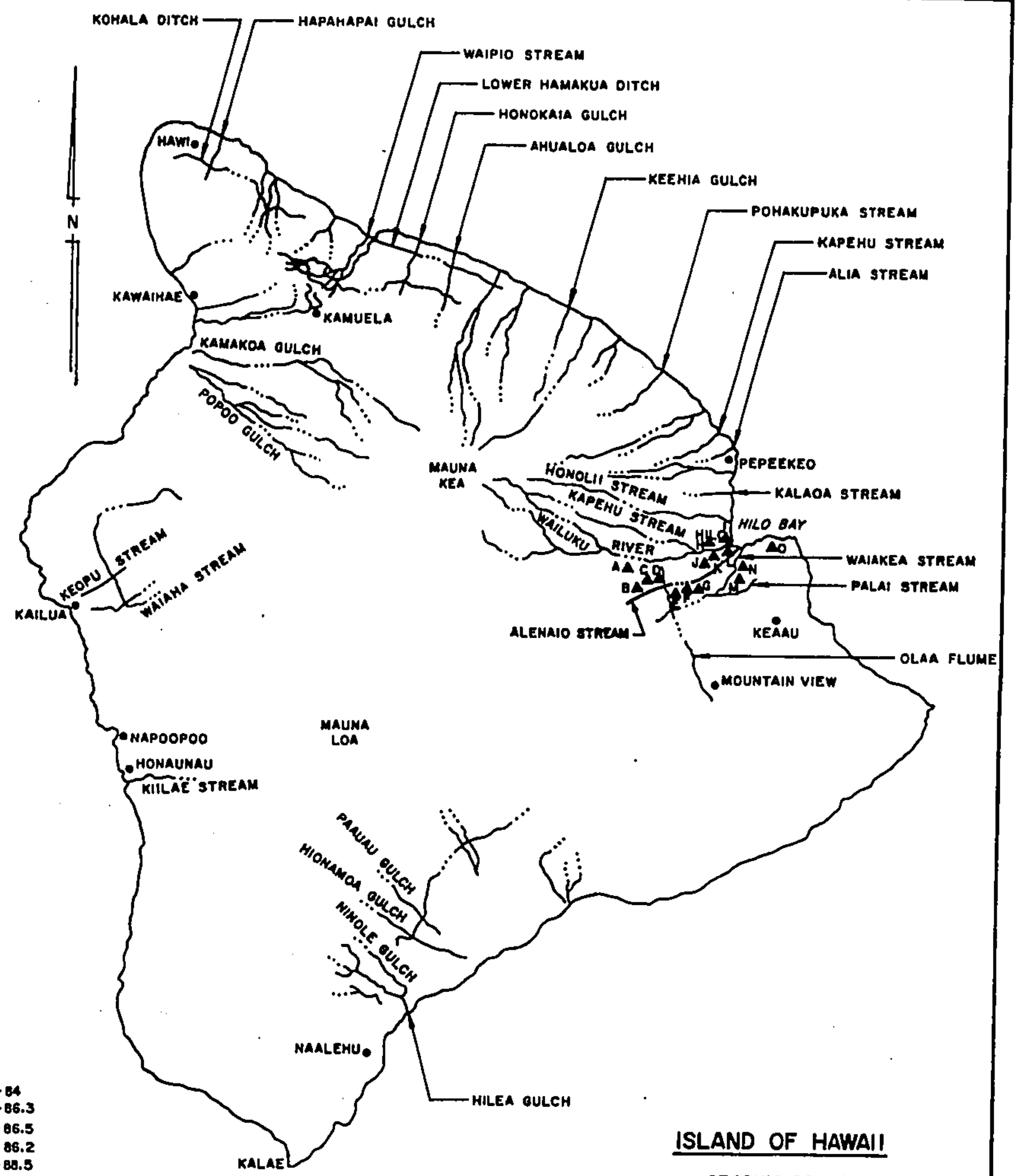
TABLE D-2

RAINFALL STATIONS IN AND NEAR ALENAIO BASIN

State Key Number	Station Name	Elevation Above MSL (Feet)	Latitude Deg-Min-Sec	Longitude Deg-Min-Sec	Period of Record	Frequency of Observations	Observer
84	Saddle Road	2,340	19-41-48	155-12-12	1948-date	Weekly	BWS
85	Hilo A&F	35	19-42-30	155-04-30	1926-date	Daily	State Div of FTRY
86.1	Hilo	40	19-43-42	155-05-24	1880-date	Daily	Individual
86.2	Kaumana 1960	1,960	19-41-00	155-11-00	1921-1947	After rain	Puna Sugar
86.3	Ponahawai	2,150	19-41-12	155-11-18	1950-1951	Monthly	State Div of FTRY
86.5	Kaumana	2,200	19-41-06	155-11-06	1950-1951	Weekly	USDA Fruit Fly Lab
86.6	Hilo Country Club	1,520	19-40-52	155-09-41	1970-date	Daily	Individual
87	Hilo Airport	30	19-43-24	155-03-36	1939-date	Recorder1/	USWB
87.1	Waiakea Mill	50	19-42-54	155-04-42	1891-1948	Daily	Waiakea Mill Co.
88.1	Kaumana	1,125	19-41-12	155-08-36	1896-1970	After rain	Hilo Sugar
88.5	Kaumana 2	1,720	19-40-24	155-10-00	1932-1939	Daily	Hilo Country Club
89.3	Mauka Amauula C4	450	19-43-42	155-06-42	1932-1948	After rain	Hilo Sugar
90.1	Hawaii Sub Off	220	19-43-48	155-05-54	1934-date	Daily	HSPA
94.2	Kaumana	500	19-42-00	155-06-54	1905-1940	Daily	Individual
94.4	Kinney Heights	570	19-42-06	155-06-58	1968-date	Daily	Individual

NOTE: Above data from "Climatologic Stations in Hawaii," Report R42, State of Hawaii, January 1973

1/ Recorder installed in 1950



A — 84
B — 86.3
C — 86.5
D — 86.2
E — 88.5
F — 86.6
G — 88.1
H — 89.3
I — 90.1
J — 94.4
K — 94.2
L — 86.1
M — 85
N — 87.1
O — 87

LEGEND
A▲ 84 RAINAGE NUMBER

NOTE
REFER TO TABLE
FOR STATION INFORMATION

ISLAND OF HAWAII

GRAPHIC SCALE

0 5 10 15 20 25

SCALE IN MILES

ALENAIO STREAM HAWAII, HAWAII

RAINFALL STATIONS LOCATION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-3

3. GEOLOGY

Hilo is located where the lower slopes of Mauna Loa and Mauna Kea merge and was created by the Hamakua volcanic series of Mauna Kea and the Ka'u volcanic series of Mauna Loa. The area north of Wailuku River consists of the Mauna Kea's Hamakua volcanic series. This series is a permeable basalt, enveloped by an overlying Pahala ash layer. The surface rocks of the Ka'u volcanic series is of recent origin and is extremely permeable basalt overlying a layer of Pahala ash. Beneath the ash is the initial Mauna Loa basalt formation, the Kahuku series, also very permeable. The result is a permeable surface and subsurface, with a strata of ash in between, conducive to high infiltration rates.

4. STORMS AND FLOODS OF RECORD

Historical accounts indicate that the study area is flood prone. The following is a brief description of major storms and the accompanying floods.

16-17 January 1921. This storm which set a record of 13.3 inches in 24 hours was at that time proclaimed the worst storm in Hilo's history since 1906. The lower Kamehameha Avenue area was completely flooded.

2-3 March 1939. Thunderstorms on 2-3 March 1939, caused flooding in downtown Hilo and damage to many homes and businesses. A 19.2" rainfall set a new 24-hour record for Hilo which was not exceeded until the recent February 1979 storm.

7-15 December 1954. The December 1954 monthly rainfall total of 50.8" is the record rainfall for all months at the Hilo Airport gage site. The storm generated many thunderstorms, but produced only one daily rainfall in excess of 7.87". Downtown Hilo was flooded.

31-October - 2 November 1959. Heavy rains caused flooding in Hilo. The rain gage at Hilo Airport recorded 15.59 inches in 24 hours, 18.58 inches in 48 hours and 23.35 inches in 72 hours.

25 July 1966. This flood was probably the most severe in the study area. Residence and business establishments in the downtown Hilo area had heavy damages. Crops, roadways, irrigation systems, culverts and public utilities were also affected by flooding. Four homes were demolished and 15 others severely damaged. Business establishments in the Kinoole, Ponohawai, Kilauea, and Kamehameha areas were damaged as water rose to as high as 2 feet in the downtown stores. Homes demolished by the rampaging waters were jammed against the upstream face of Kilauea Bridge. This resulted in water backing up into the upper reaches of the stream, causing overflowing which extended across downtown streets. Thirty-four (34) persons were evacuated. Three persons were injured and one policeman narrowly escaped death when he was swept downstream during rescue operations.

Thunderstorms were associated with this short duration localized storm. A rain gage in Kaumana recorded 9 inches in 3-1/2 hours and 17.2 inches in 24 hours. The USGS estimated the peak floodflow on Alenaio Stream at Kapiolani Street to be 2,800 cfs.

28 January - 3 February 1969. The rain gage at Hilo Airport recorded 15.7" in 24 hours, 18.86" in 48 hours and 26.2" in 72 hours. Thunderstorms were absent during this 1969 storm. This storm caused flooding in downtown Hilo.

17 - 20 February 1979. Rainfall during the storm of 17-20 February exceeded nearly every rainfall record kept by the National Weather Service for Hilo, however, damages were not as severe as the 1966 flood. The rain gage at Hilo Airport recorded rainfall amounts of 3.08 inches in 1 hour, 4.78 inches in 3 hours, 22.3 inches in 24 hours, 28.64 inches in 48 hours and 30.8 inches in 72 hours. This storm, which occurred without any thunderstorm activity, produced heavy, continuous rain over a large area on Hawaii. The hardest hit areas were North and South Hilo, Puna and Ka'u. The President declared the County of Hawaii a major disaster area. The USGS estimated the peak flow on Alenaio Stream at Komohana Street to be 1,280 cfs. A commercial building near the corner of Kilauea Avenue and Ponohawai Street was damaged extensively when Alenaio Stream overflowed its banks and filled the basement of the building. Water backed up in a conduit under Ponohawai Street and caused the pavement of the street to bulge. Water overflowed the Waialama Canal, turning bayfront parklands into a huge lake and flooding Kamehameha Avenue. Komohana Street, between Kukuau and Ponohawai Streets and the downtown intersection at Kilauea and Ponohawai, were closed. Akolea road in the upper Kaumana area was also closed.

16 - 19 March 1980. Hilo Airport had 25.36" of rainfall in 72 hours. The highest one hour rainfall was 2.16". Ainako, an area about two miles above Hilo, had 37.03" in 72 hours. Floodwaters washed away the Komohana Street culvert. Approximately 15 to 20 businesses were flooded in downtown Hilo. Mooheau Park and the downtown parking lot between Kamehameha Avenue and Bayfront Highway were inundated.

5. RUNOFF CHARACTERISTICS

The Alenaio watershed does not have any stream gages. All streams in the basin are ephemeral, flowing only in direct response to heavy rainfall. During storms, some runoff enters underground lava tubes and may reappear as springs in the downstream areas. Usually, these springs develop 2-3 days after the heaviest rainfall and do not have a significant impact on peak flows. Floodflows on Alenaio Stream and its tributaries are characterized by sharp rises of relatively short duration, followed by sharp recessions. The sharp rises are the result of intense rainfall over the watershed. Peak discharges generally occur within 2 hours after the end of heavy rainfall and are of short duration, generally lasting under 6 hours.

6. UNIT HYDROGRAPH ANALYSIS

A unit hydrograph is a hydrograph resulting from 1-inch of direct runoff from a rainfall of a specific unit duration and areal distribution.

The unit hydrograph concept is a useful tool in that it provides a linear description of runoff from a watershed and facilitates the generation of synthetic flood hydrographs for basins which are ungaged. The procedure used by the Pacific Ocean Division for determination of synthetic unit hydrographs was derived from Snyder's unit hydrograph relations outlined in EM 1110-2-1405 (Flood-Hydrograph Analyses and Computations).

7. DETERMINATION OF RAINFALL-RUNOFF RELATIONSHIPS

a. The Alenaio drainage basin does not have any stream gages as stated previously. Therefore, the USGS stream gaging station No. 7018, Wailuku River near Kaumana, was used to derive basic unit hydrographs for this study. The Wailuku River basin is adjacent to the Alenaio watershed and both have similar drainage basin characteristics. Note the similar stream profiles shown on Figure D-2. Station 7018 also has a recording tipping bucket rain gage located at the stream gage site. Reconstitution of two observed flood events from Station 7018 was accomplished to determine applicable relationships between rainfall and runoff for use in computing hypothetical flood hydrographs. The HEC-1 Flood Hydrograph Package computer program was used to develop unit hydrographs and perform loss rate study in order to derive rainfall-runoff relationships.

b. HEC-1 has the capability to automatically determine a unit hydrograph and loss rate parameters that "best" reconstitute an observed runoff event for a basin given the basin average rainfall, the drainage area, and a few runoff hydrograph parameter values for starting flow and base flow recession computations. The "best" reconstitution is considered to be that which minimizes the weighted square deviations between the observed hydrograph and a reconstituted hydrograph.

c. The runoff hydrograph variables that are not automatically derived and thus must be determined by evaluating the characteristics of observed flood hydrographs in a drainage basin are:

<u>Runoff Hydrograph Variables</u>

QRCSN	-	The discharge at which recession flow begins, may be a function of peak discharge, precipitation intensity, drainage area, or other watershed characteristics.
STRTQ	-	Recession flow for antecedent runoff, the discharge at the beginning of the first period of reconstitution, a selected value.
RTIOR	-	Recession coefficient that is the ratio of flow at time t to that 10 computational periods ($t+10\Delta t$) later during recession, may be a function of soil type, land use, water table level, soil profile and permeability. RTIOR is applied to both STRTQ and the runoff hydrograph when the flow is less than or equal to QRCSN.

d. The runoff computation variables that can have values derived automatically include Clark unit hydrograph variables:

<u>Clark Unit Hydrograph Variables</u>

TC	-	Clark unit hydrograph time of concentration, in hours (may vary somewhat from storm to storm).

R - Clark unit hydrograph storage coefficient, in hours (may vary somewhat from storm to storm).

To reduce the interdependency between TC and R, in their automatic derivation, the variables are regrouped into two new variables as follows:

TC+R - Sum of time of concentration and storage coefficient. Variable used in HEC-1 for optimizing unit hydrograph parameters.

R/(TC+R) - Ratio of storage coefficient to sum of time concentration and storage coefficient. Variable used in HEC-1 for optimizing unit hydrograph parameters.

e. The loss rate variables that can have values derived automatically are listed below. A graphical representation of these parameters is illustrated in Figure D-4.

<u>Loss Rate Parameters</u>

DLTKR - Amount of initial accumulated rain loss during which the loss rate coefficient is increased. This parameter is considered to be a function primarily of antecedent soil moisture deficiency and is usually different for different storms.

STRKR - Starting value of loss coefficient on exponential recession curve for rain losses (snow-free-ground). The starting value is considered a function of infiltration capacity and thus depends on such basin characteristics as soil type, land use, and vegetal cover.

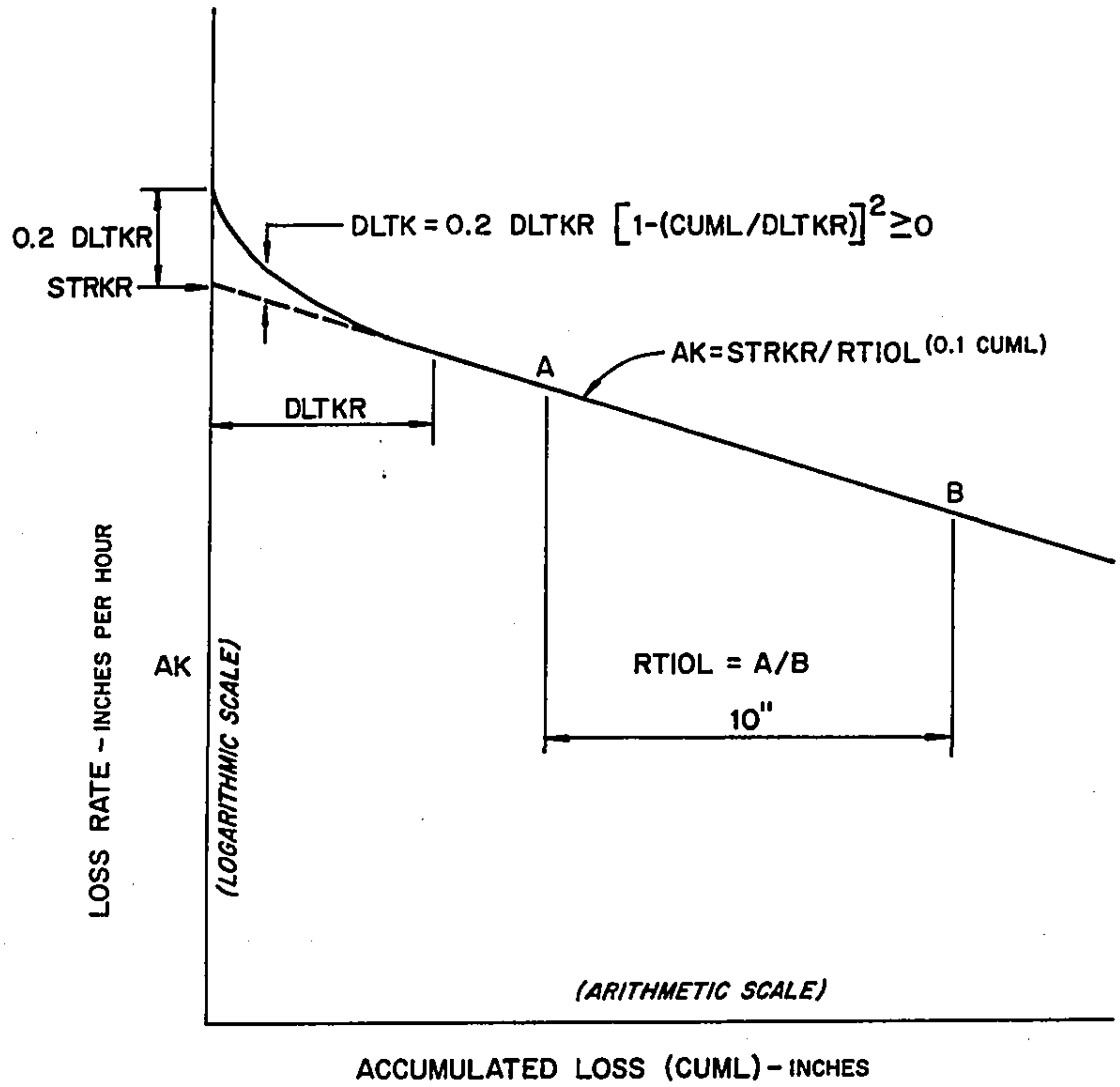
RTIOL - Ratio of rain loss coefficient on exponential loss curve to that corresponding to 10 inches more of accumulated loss. This variable may be considered a function of the ability of the surface of a basin to absorb precipitation and should be reasonably constant for large and rather homogeneous areas.

ERAIN - Exponent of precipitation for rain loss function

$ALOSS = (AK + DLTK)\ PRCP^{ERAIN}$

that reflects the influence of precipitation rate on basin loss characteristics. It reflects the manner in which storms occur within an area and may be considered a characteristic of a particular region. Varies from 0.0 to 1.0. The terms in the equation are defined as:

ALOSS = Loss rate for particular time interval in inches per hour.



$$ALOSS = (AK + DLTK)\ PRCP^{ERAIN}$$

NOTE:
DEFINITIONS OF VARIABLES GIVEN IN TEXT

ALENAIO STREAM — HAWAII, HAWAII

H.E.C. LOSS RATE FUNCTION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-4

AK	=	Loss rate coefficient at beginning of time interval, value on STRKR exponential loss curve.
PRCP	=	Rainfall intensity in inches per hour.
DLTK	=	Incremental increase in loss rate coefficient. DLTK is assumed to be a parabolic function of the accumulated loss for DLTKR amount of accumulated loss. DLTK is a maximum of 0.2 DLTKR initially, reducing to zero when the accumulated loss equals DLTKR.

f. Flood reconstitution for Wailuku River near Kaumana for the storms of 26 August 1970 and 23 January 1979 is presented graphically on Figures D-5 and D-6, respectively. Table D-3 presents a summary of "best-fit" unit hydrograph and rainfall loss rate parameters determined for each reconstitution.

TABLE D-3. "BEST-FIT" LOSS RATE AND UNIT HYDROGRAPH PARAMETERS FOR FLOOD RECONSTITUTIONS

		*HEC LOSS FUNCTIONS				**CLARK UNITGRAPH PARAMETERS			
GAGE	DATE	STRKR	ERAIN	DLTKR	RTIOL	TC	R	LAG (hrs)	C_p
Wailuku River near Kaumana (7018)	26Aug70	1.13	.45	2.7	2.0	1.12	2.30	1.3	.41
	23Jan79	.69	.59	.59	1.44	2.09	2.69	1.98	.49

* The HEC loss function parameters represents a purely mathematical, function as defined in the text.

** The Clark Unit Hydrograph parameters are time of concentration (TC) and the storage coefficient (R).

8. DETERMINATION OF BASIC UNIT HYDROGRAPHS

The two Wailuku River unit hydrographs that were derived from the floods of 26 August 1970 and 23 January 1979 are shown on Figure D-7. Based on EM 1110-2-1405, the peak discharges of these unit hydrographs were increased to represent a higher concentration of runoff near the peak. A 50 percent increase was used to represent mountain areas and a 25 percent increase for valley areas. A composite unit hydrograph was then derived from the peaked 50 percent unit hydrographs for 26 August 1970 and 23 January 1979. Similarly, a composite unit hydrograph was derived for the peaked 25 percent

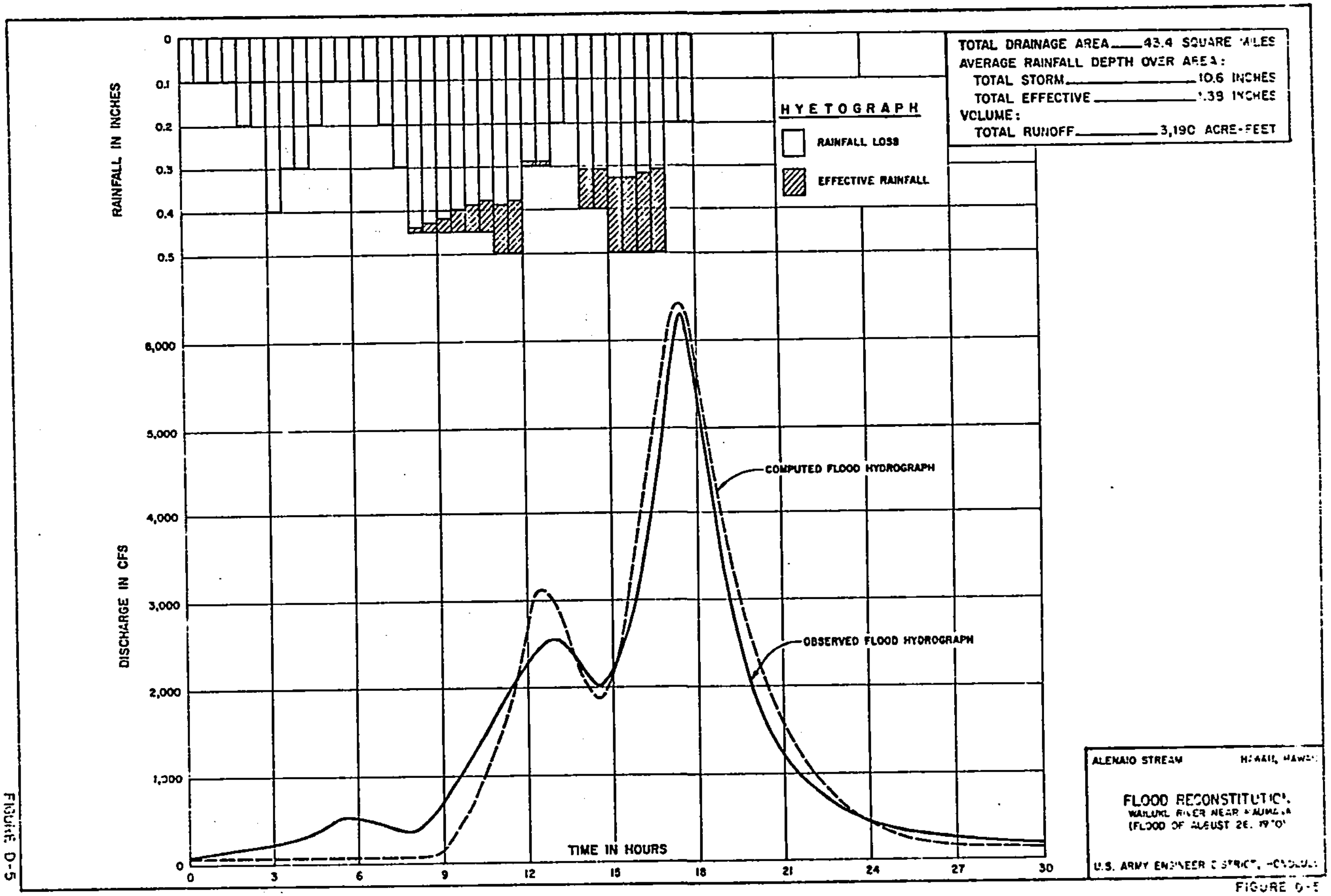

TOTAL DRAINAGE AREA 43.4 SQUARE MILES
AVERAGE RAINFALL DEPTH OVER AREA:
TOTAL STORM 10.6 INCHES
TOTAL EFFECTIVE 1.39 INCHES
VOLUME:
TOTAL RUNOFF 3,190 ACRE-FEET
HYETOGRAPH
RAINFALL LOSS
EFFECTIVE RAINFALL
RAINFALL IN INCHES
DISCHARGE IN CFS
COMPUTED FLOOD HYDROGRAPH
OBSERVED FLOOD HYDROGRAPH
TIME IN HOURS
ALENAIO STREAM
FLOOD RECONSTITUTION

FIGURE D-5

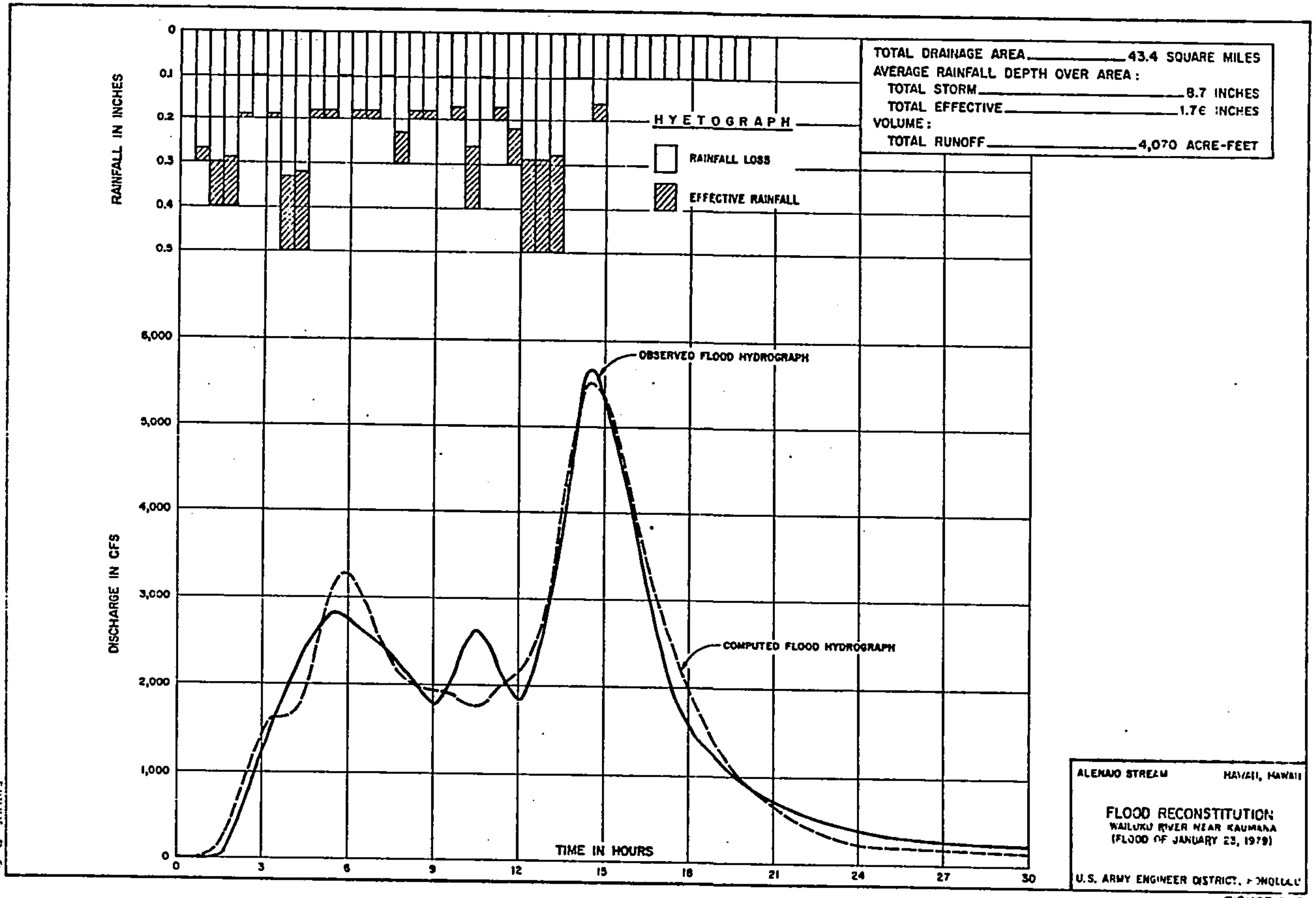
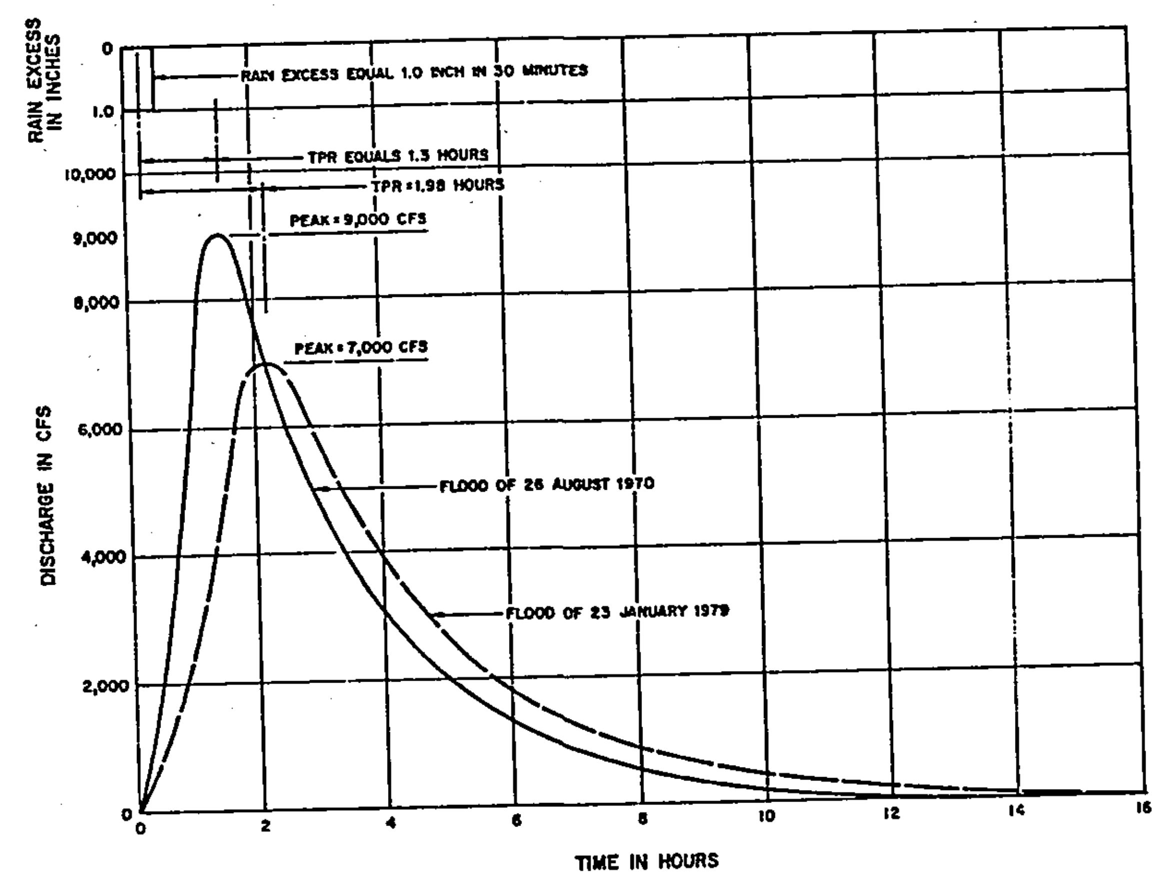

TOTAL DRAINAGE AREA 43.4 SQUARE MILES
AVERAGE RAINFALL DEPTH OVER AREA:
TOTAL STORM 8.7 INCHES
TOTAL EFFECTIVE 1.76 INCHES
VOLUME:
TOTAL RUNOFF 4,070 ACRE-FEET
HYETOGRAPH
RAINFALL LOSS
EFFECTIVE RAINFALL
RAINFALL IN INCHES
DISCHARGE IN CFS
OBSERVED FLOOD HYDROGRAPH
COMPUTED FLOOD HYDROGRAPH
TIME IN HOURS
ALENAIO STREAM
HAWAII, HAWAII
FLOOD RECONSTITUTION
WAILUKU RIVER NEAR KAUMANA
(FLOOD OF JANUARY 23, 1979)
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-6



ALENAIO STREAM HAWAI'I, HAWAII

UNIT HYDROGRAPHS
(WAILUKU STREAM NEAR KAUMANA)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-7

hydrographs. These two composite peaked unit hydrographs representing the mountain and valley areas are shown on Figure D-8. Pertinent data for the unit hydrograph development are shown in Table D-4.

TABLE D-4. UNIT HYDROGRAPH ADJUSTMENT
WAILUKU RIVER NEAR KAUMANA - GAGE 7018

DATE	DRAINAGE AREA (sq mi)	LAG t_p (HRS)	C_p	UNIT HYDRO-GRAPH PEAK (cfs)	PERCENT PEAKED FOR MAJOR FLOODS	ADJUSTED PEAK (cfs)	ADJUSTED LAG t_{PR} (HRS)
26 Aug 70	43.4	1.3	.41	9,000	50	13,500	.84
23 Jan 79	43.4	1.98	.49	7,000	50	10,500	1.30
26 Aug 70	43.4	1.3	.41	9,000	25	11,250	1.01
23 Jan 79	43.4	1.98	.49	7,000	25	8,750	1.55
Basic Unit-Hydrograph							
Mountain			.45		50	11,600	1.08
Valley			.45		25	10,000	1.25

9. UNIT HYDROGRAPH ADJUSTMENT

The basic unit hydrographs were adjusted to the drainage subareas of Alenaio using Synder's synthetic relationships as outlined in EM 1110-2-1405. Subdividing a watershed into subareas permits better description of the runoff process, as variation in topography, rainfall, channel shape and slope may be incorporated into the hydrologic description of the basin. The unit hydrographs derived for the Alenaio subareas are shown on Figures D-9 and D-10.

10. VERIFICATION OF UNIT HYDROGRAPH

For verification, the flood of July 25, 1966 was used. The peak flow was estimated to be 2,800 cfs at Kapiolani Street by USGS slope area calculations. This is the highest peak flow recorded in the study area. No flood hydrograph is available. A unit hydrograph was derived for the Kapiolani Street area. The rainfall for the July 25, 1966 storm at Kaumana rain gage was used. This rainfall was adjusted to reflect the difference in location between the Kaumana rain gage and Kapiolani Street. Variable loss rate parameters from the flood of 26 August 1970 were used. The flood hydrograph peak calculated was very close to 2,800 cfs. Verification of the flood outline was not possible because of the numerous blockages of structures in the stream which caused unknown amounts of overflow.

11. SYNTHESIS OF STANDARD PROJECT FLOOD

a. General. The standard project flood (SPF) represents the flood that would result from the most severe combination of meteorologic and hydrologic conditions considered reasonably characteristic of the region. It normally is

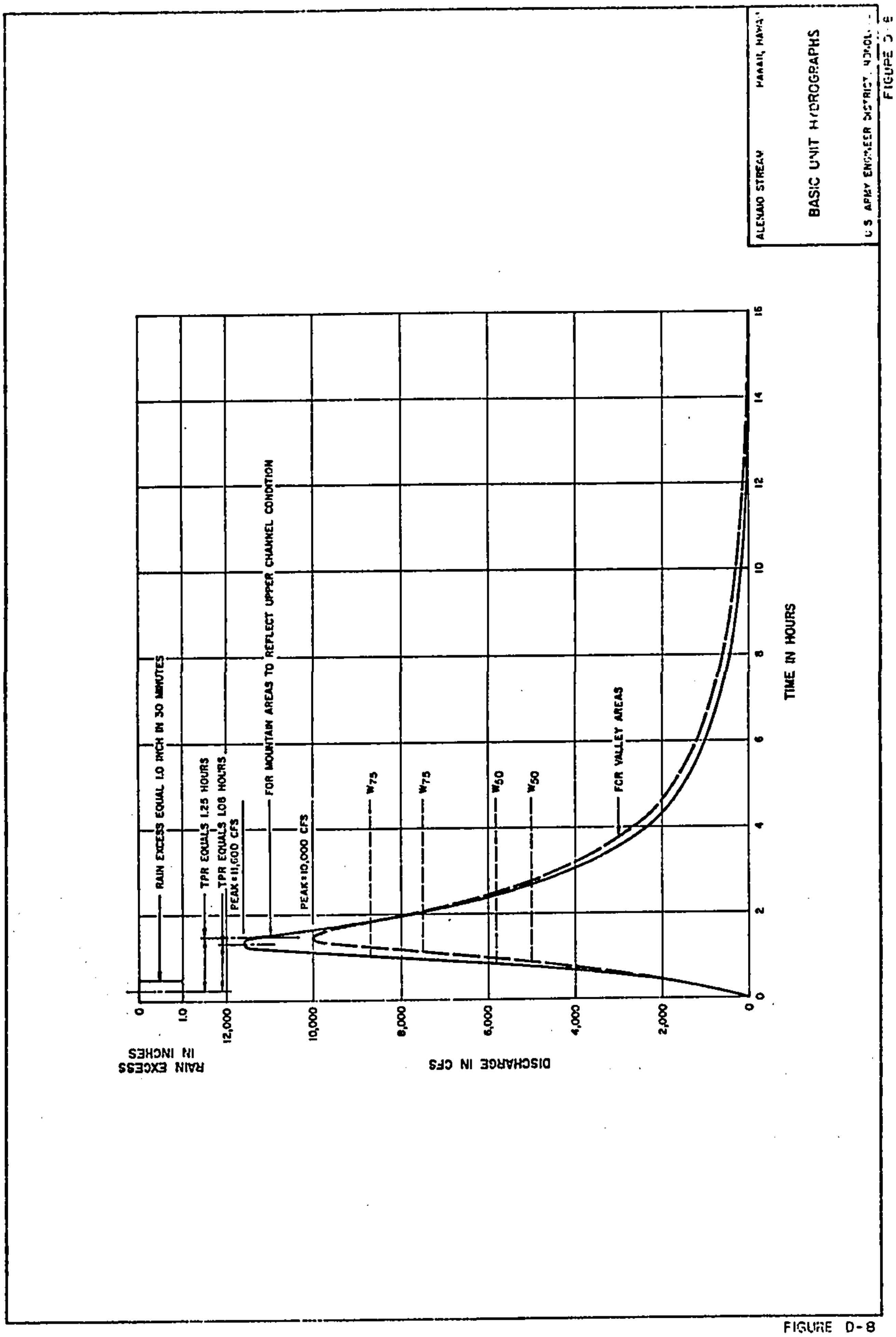
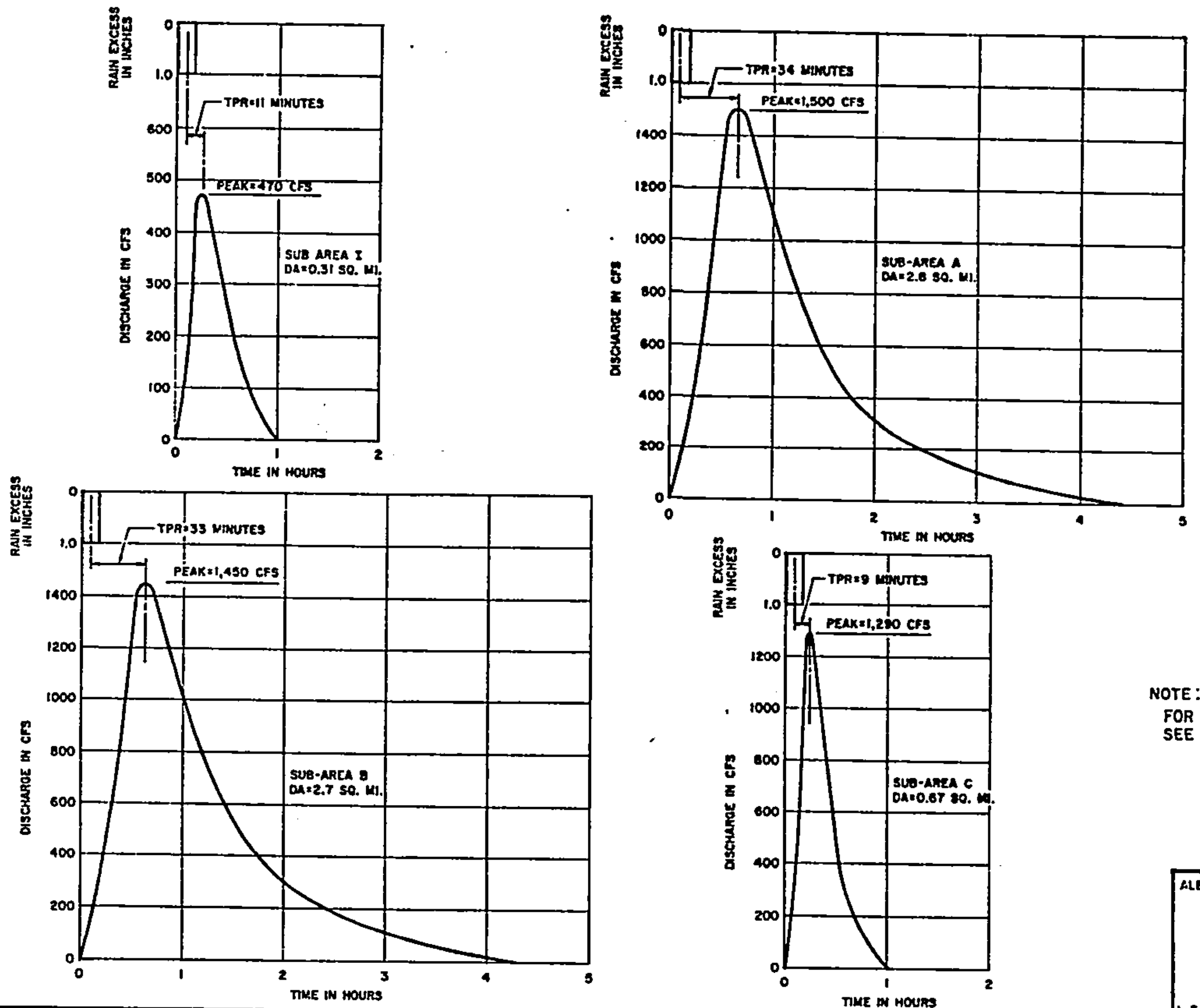

ALENAIO STREAM
HAWAII, HAWAII
BASIC UNIT HYDROGRAPHS
U.S. ARMY ENGINEER DISTRICT, HONOLULU
RAIN EXCESS EQUAL 1.0 INCH IN 30 MINUTES
TPR EQUALS 1.25 HOURS
TPR EQUALS 1.08 HOURS
PEAK=11,600 CFS
FOR MOUNTAIN AREAS TO REFLECT UPPER CHANNEL CONDITION
PEAK=10,000 CFS
W75
W75
W50
W50
FOR VALLEY AREAS
RAIN EXCESS IN INCHES
0
1.0
DISCHARGE IN CFS
12,000
10,000
8,000
6,000
4,000
2,000
0
TIME IN HOURS
0
2
4
6
8
10
12
14
16

FIGURE D-8



NOTE:
FOR LOCATION OF SUBAREAS, SEE FIGURE 2

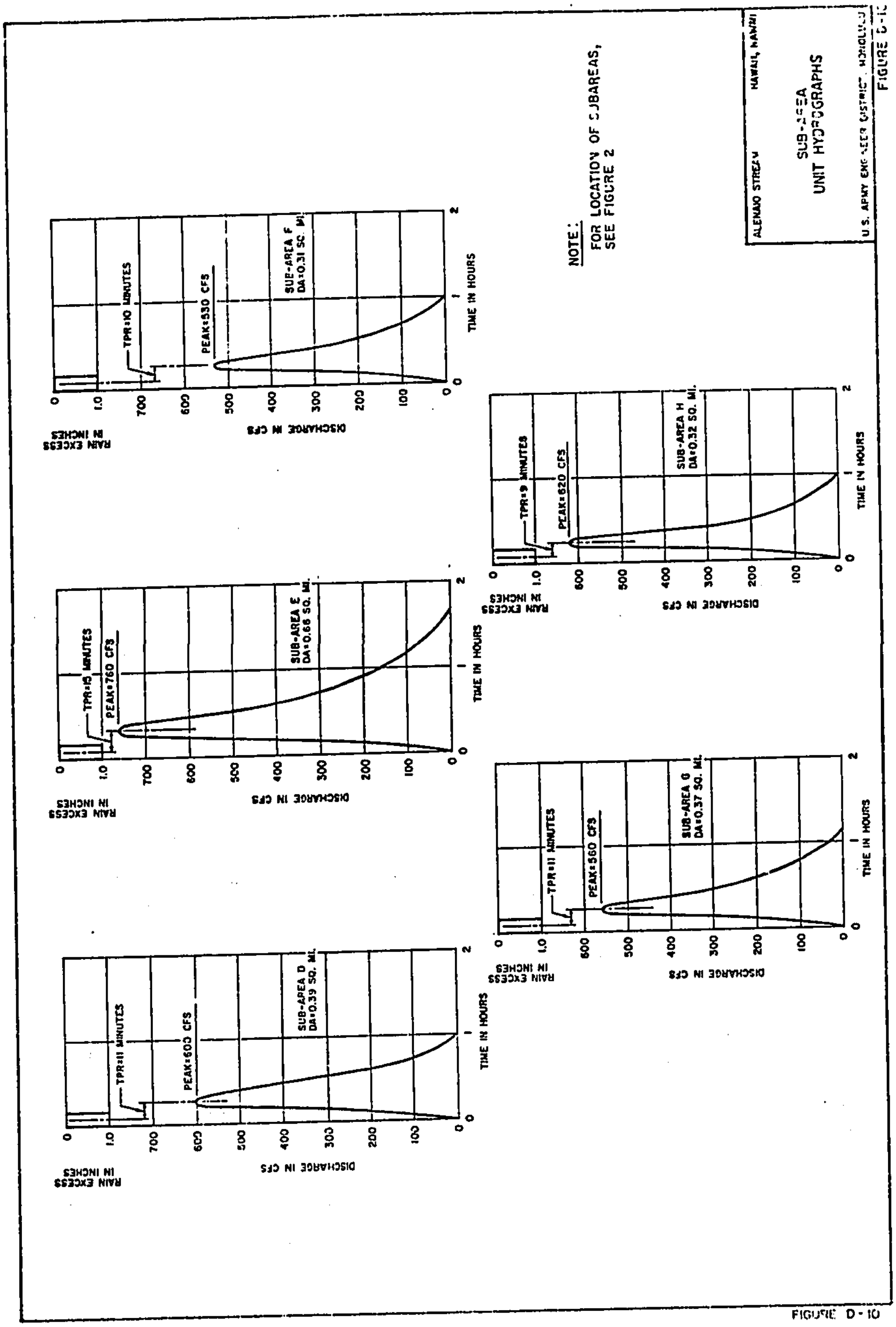
ALENAIO STREAM — HAAAII, HAWA.

SUB-AREA
UNIT HYDROGRAPHS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-9

FIGURE D-9



NOTE: FOR LOCATION OF SUBAREAS, SEE FIGURE 2
UNIT HYDROGRAPHS
FIGURE D-10
TPR=10 MINUTES
PEAK=530 CFS
SUB-AREA F
DA=0.31 SQ. MI.
TPR=15 MINUTES
PEAK=760 CFS
SUB-AREA E
DA=0.66 SQ. MI.
TPR=11 MINUTES
PEAK=600 CFS
SUB-AREA D
DA=0.39 SQ. MI.
TPR=9 MINUTES
PEAK=620 CFS
SUB-AREA H
DA=0.32 SQ. MI.
TPR=11 MINUTES
PEAK=560 CFS
SUB-AREA G
DA=0.37 SQ. MI.
RAIN EXCESS IN INCHES
DISCHARGE IN CFS
TIME IN HOURS

FIGURE D-10

larger than any past recorded flood in the area, and can be expected to be exceeded in magnitude only on rare occasions. It thus constitutes a standard for design that will provide a high degree of flood protection. Preparation of standard project flood estimates in this report were made in accordance with EM 1110-2-1411 (Standard Project Flood Determinations).

b. Standard Project Storm (SPS). The SPS rainfall was obtained from OCE Memorandum for Record, "Standard Project Storm Determinations, Hawaiian Islands", 19 September 1962. The index rainfall for the Alenaio basin is 21.2 inches in 24 hours. Rainfall depth values were computed by applying percentages extracted from the above memorandum based on drainage area and storm period to the rainfall index. A rainfall depth-duration curve was computed and is shown in Figure D-11. This curve was used exclusively to extract values from different concentration points in the basin because there was very little variation in the depth-duration curves for different drainage area sizes. A unit-time interval of 10 minutes was considered the most practical for storm computations to adequately define the computed hydrograph. The rainfall-intensity pattern is shown on Figure D-13.

c. Loss Rates and Base Flow. The study area is in very porous lava terrain. The most recent lava flow in the study area occurred in 1881. Large losses can be expected in lava terrain. Table D-3 shows the variable loss rate parameters derived from the flood reconstitution for the Wailuku River for the storms of 26 August 1970 and 23 January 1979. The use of either set of loss rate parameters was acceptable. For this study, the variable loss rate parameters from the flood of 26 August 1970 was used because it produced larger losses more characteristic of the drainage basin. The variables used were:

STRKR = 1.13   DLTKR = 2.70   RTIOL = 2.0   ERAIN = 0.45

A graphical representation of this loss rate function is shown on Figure D-4. Base flow was considered negligible for the Alenaio area, as runoff occurs only as a direct response to high intensity rainfall.

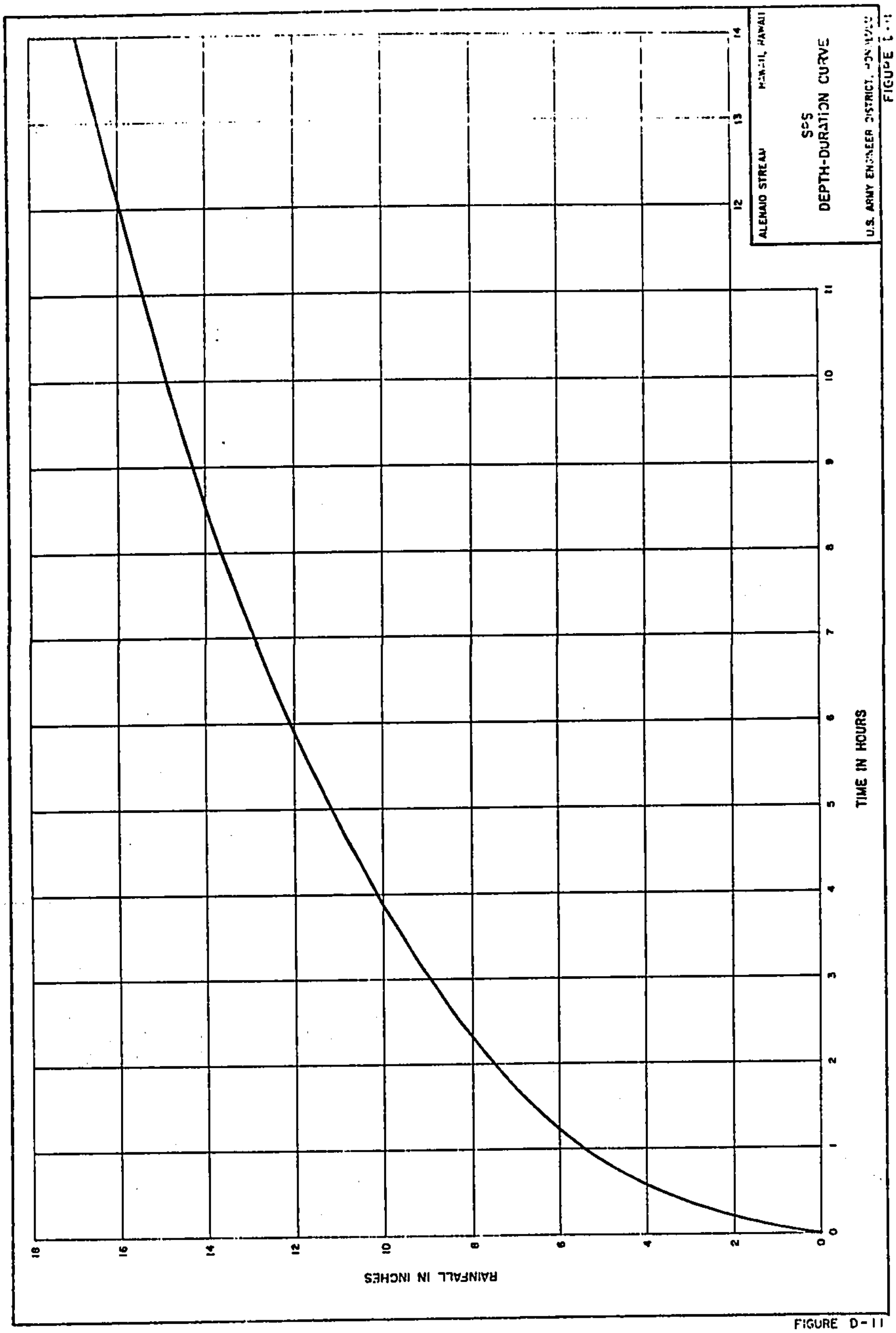
d. Flood Routing. Flood routing was accomplished by the combined use of HEC-2 and the modified Puls method. The outflow discharge-storage relationships were developed from data obtained from HEC-2 water surface profile computer runs. This data was then used in the HEC-1 stream system analysis program to route and combine the standard project flood hydrographs downstream.

12. DETERMINATION OF STANDARD PROJECT FLOOD

a. Stream System Analysis.

(1) The HEC-1 program was used for stream system analysis. The study area was divided into subbasins. Subdividing a watershed into subbasins permits more accurate modeling of the runoff process. Flood hydrographs generated from each subbasin were routed and combined to determine the design flood at a desired downstream concentration point.

(2) Standard project flood is computed by centering the standard project precipitation in the most critical flood producing manner. Application of the rainfall loss rate function described previously to standard project precipitation enables determination of the rainfall excess hyetograph. The rainfall



ALENAIO STREAM
SPS
DEPTH-DURATION CURVE
TIME IN HOURS
RAINFALL IN INCHES
0
2
4
6
8
10
12
14
16
18
1
3
5
7
9
11
13

FIGURE D-11

excess hyetograph is then applied to the subbasin unit hydrograph to produce the subbasin flood hydrograph. Routing and combining of all subbasin flood hydrographs to the desired concentration point completes the computation of standard project flood.

b. Standard Project Flood Discharges. Standard project flood peak discharges are tabulated in Table D-5 and concentration points are shown on Figure D-12. The standard project flood at the mouth is shown on Figure D-13. Standard project floods at other concentration points have similar hydrograph shapes.

TABLE D-5. PEAK FLOOD FLOWS UNDER EXISTING CONDITIONS

Concentration Point	Q_2 cfs	Q_5 cfs	Q_{10} cfs	Q_{50} cfs	Q_{100} cfs	SPF cfs	Q_{500} cfs
Confluence of Kaluiiki & Waipahoehoe DA = 5.5 sq mi	910	1,760	2,530	4,950	6,300	9,500	11,000
Chong's Bridge DA = 6.17 sq mi	960	1,850	2,650	5,100	6,500	10,400	11,300
Lava Land Area Start DA = 6.56 sq mi	1,000	1,900	2,720	5,200	6,630	10,900	11,400
Alenaio Stream Begin DA = 7.22 sq mi	1,050	2,000	2,840	5,400	6,900	11,600	11,800
Komohana Street DA = 7.53 sq mi	1,060	2,020	2,870	5,450	6,950	12,000	11,900
Kapiolani Street DA = 7.9 sq mi	1,100	2,060	2,900	5,500	7,000	12,200	12,000
Kilauea Avenue DA = 8.22 sq mi	1,120	2,090	2,960	5,580	7,050	12,300	12,100
Mouth DA = 8.53 sq mi	1,130	2,100	2,970	5,600	7,100	12,500	12,300

13. DISCHARGE FREQUENCY ANALYSIS

a. General. As stated previously, the Alenaio watershed does not have any stream gages. Two methods were used to estimate discharge frequency relationship: One was a regional analysis using 12 gages near the study area and the other, a multiple regression technique. Of the two methods, the regional analysis method was selected.

b. Regional Analysis. A regional analysis relating discharge to drainage area was employed in accordance with "Statistical Methods in Hydrology," U.S. Army Engineer District, Sacramento, Jan 1962. Twelve stream gaging stations in the region were used (see Figure D-14). Individual discharge frequency curves for these stations were calculated following

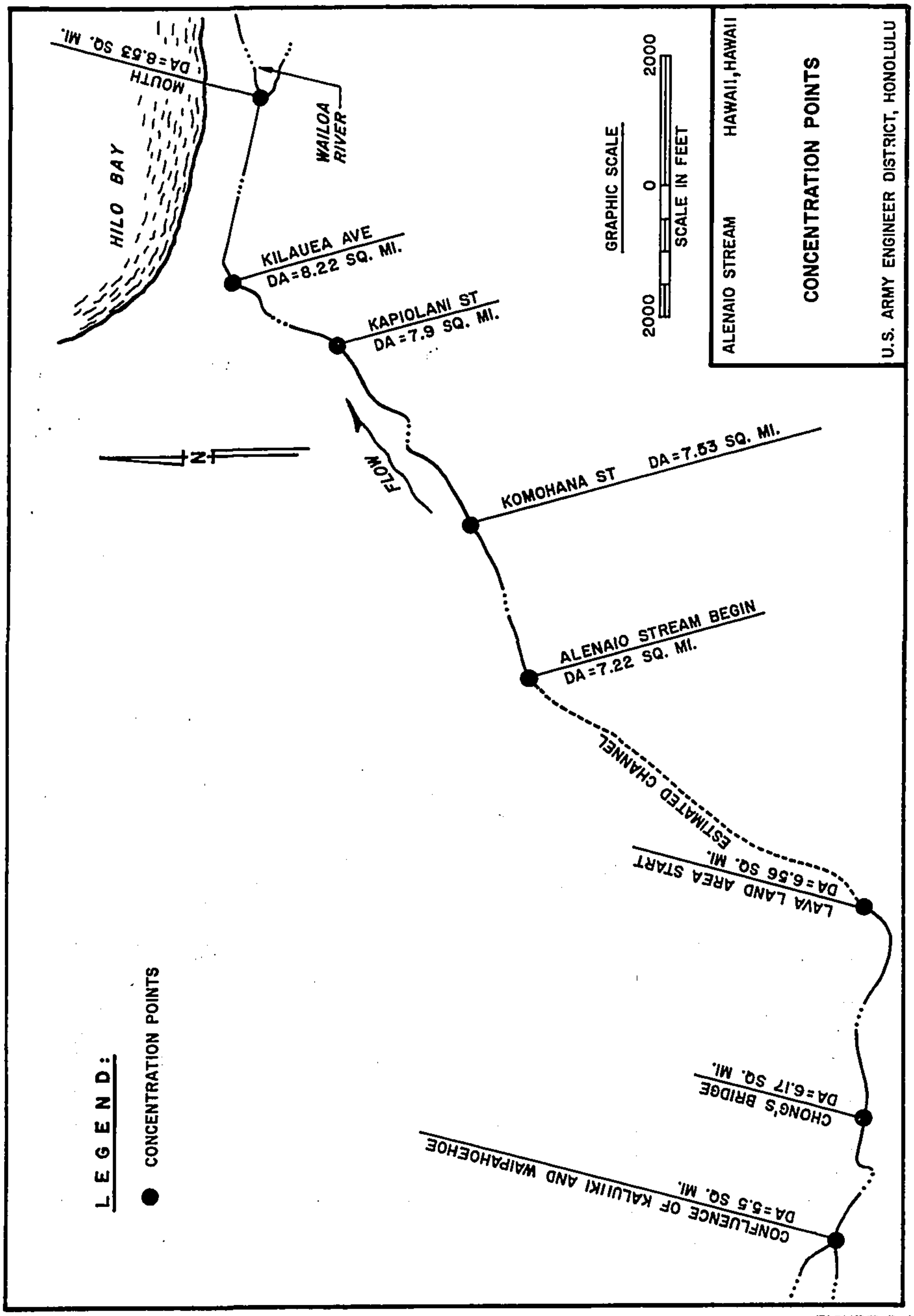


FIGURE D-12

FIGURE D-12

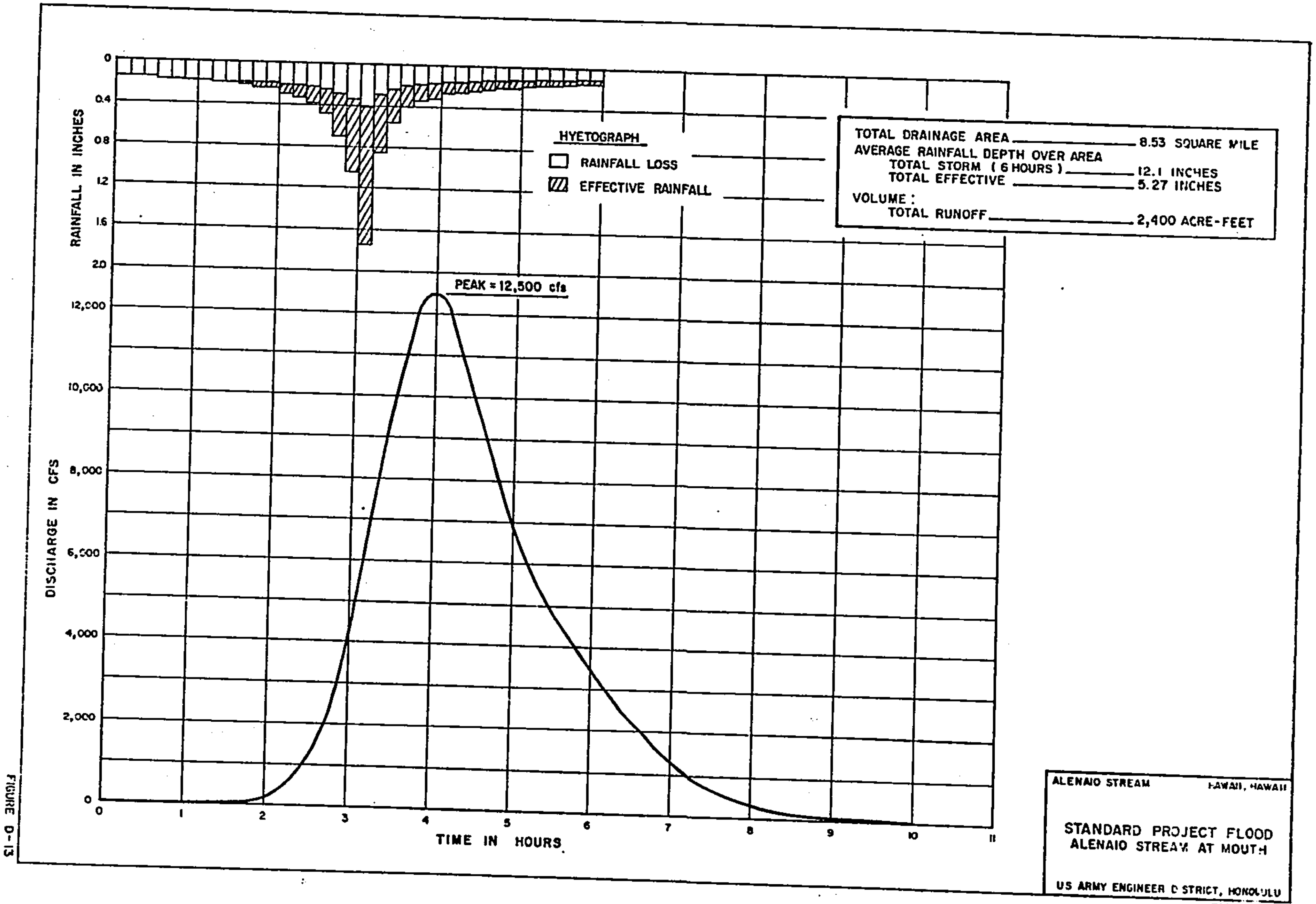
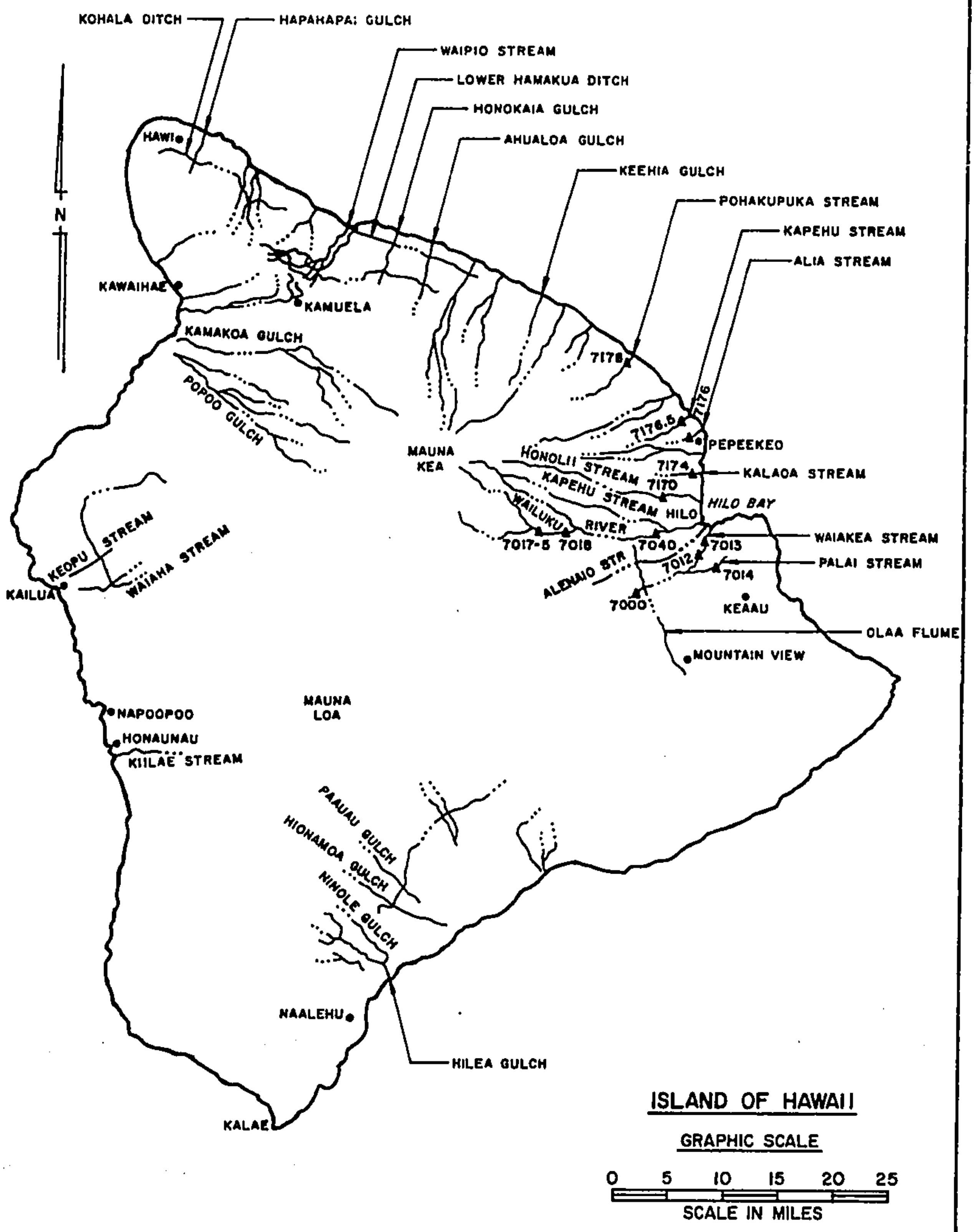

RAINFALL IN INCHES
DISCHARGE IN CFS
TIME IN HOURS
HYETOGRAPH
RAINFALL LOSS
EFFECTIVE RAINFALL
PEAK = 12,500 cfs
TOTAL DRAINAGE AREA — 8.53 SQUARE MILE
AVERAGE RAINFALL DEPTH OVER AREA
TOTAL STORM (6 HOURS) — 12.1 INCHES
TOTAL EFFECTIVE — 5.27 INCHES
VOLUME:
TOTAL RUNOFF — 2,400 ACRE-FEET
ALENAIO STREAM
HAWAII, HAWAII
STANDARD PROJECT FLOOD
ALENAIO STREAM AT MOUTH
US ARMY ENGINEER DISTRICT, HONOLULU
FIGURE D-13

FIGURE D-13



LEGEND

▲7014 GAGING STATION AND NUMBER

ALENAIO STREAM	HAWAII, HAWAII

LOCATION OF GAGING STATIONS USED IN REGIONAL ANALYSIS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-14

procedures based on the U.S. Water Resources Council's publication "Guidelines for Determining Flood Flow Frequency," Bulletin No. 17A, 1977. The 50%, 10%, 2%, and 1% discharges were plotted against their respective areas (see Figures D-15 and D-16 for typical floodflow relationship) to determine a regional discharge versus drainage area relationship. Table D-6 shows the stream gage stations utilized in the analysis and the computed peak discharges at various selected frequencies. The derived maximum likelihood frequency curve was then adjusted for expected probability as required in Civil Works Engineer Letter 63-5, dated 6 May 1963. The expected probability adjustment was based on 21 years, the average length of record for the 12 gaging stations. Final discharge frequency values are summarized in Table D-5 for selected concentration points at selected frequencies. A frequency curve for Alenaio Stream at the mouth is exhibited on Figure D-17 to show the Log Pearson Type III appearance of the curve.

c. Multiple Regression Technique. All gaging station records for the island of Hawaii were examined for possible use in this study. The examination yielded 35 stations with adequate records. The records ranged in length from 10 to 47 years, with only three stations having records of 25 years or longer. The station flood-frequency curves for the 35 stations were determined following the procedures outlined in the Water Resources Council Bulletin No. 17A, "Guidelines for Determining Flood Flow Frequency," June 1977. Multiple linear correlation studies of the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year flood (dependent variable) to the physiographic and meteorological characteristics (independent variables) of the drainage basin at each station were made. The following independent variables were used:

(1) Drainage Area (DA) - in square miles.

(2) Main Channel Slope (CS) - in feet per miles.

(3) Main Channel Length (CL) - miles.

(4) Mean Annual Precipitation (PA) - in hundreds of inches.

(5) Forest Cover (FC) - percent.

(6) Basin Mean Elevation (EL) - feet.

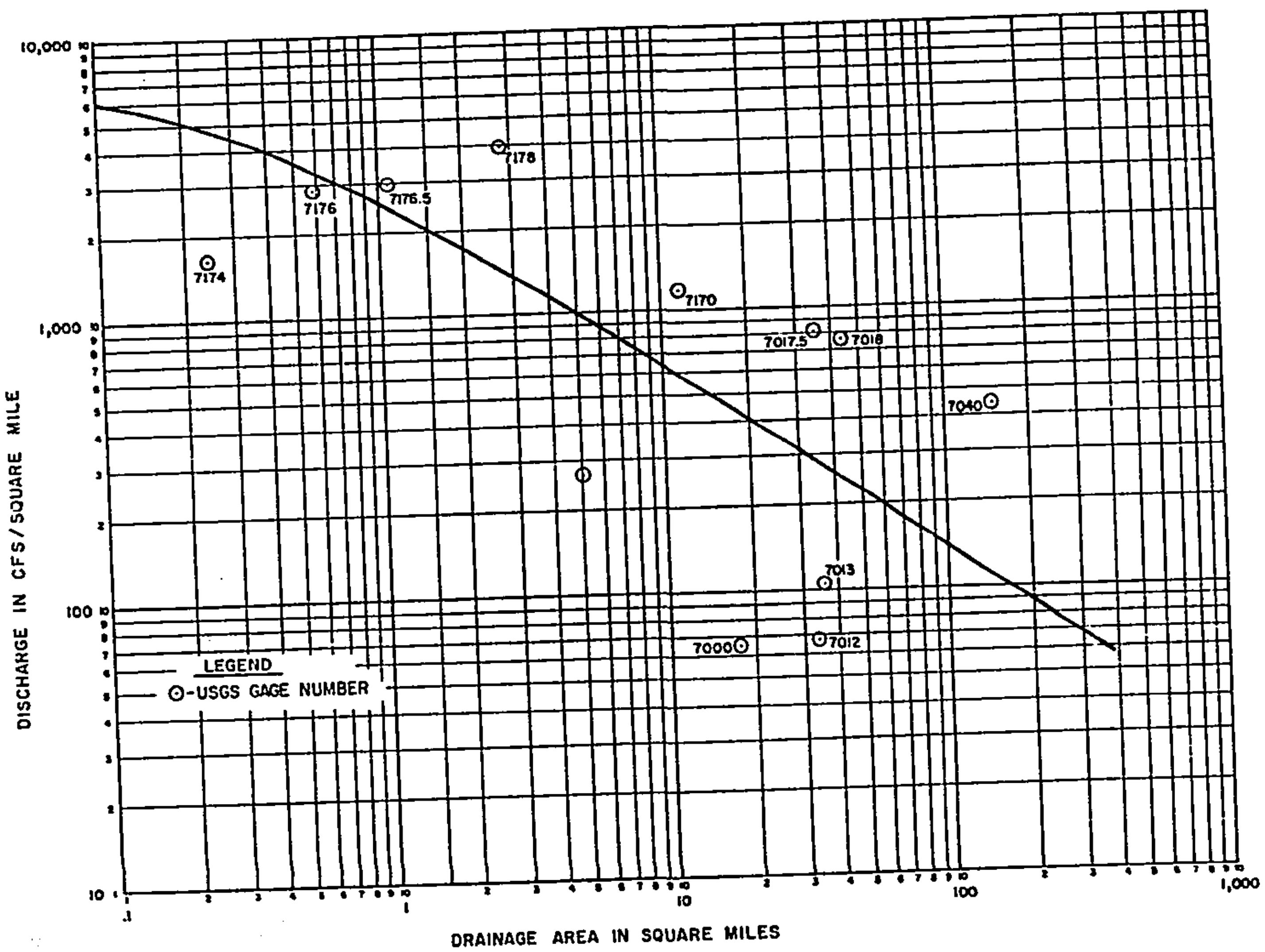
(7) 2-year 24-hour Precipitation (P2-24) - in inches.

The regression equation used in the correlation studies was of the following form:

$$Q = C_p DA^a CS^b CL^c PA^d FC^e EL^f P2\text{-}24^g$$

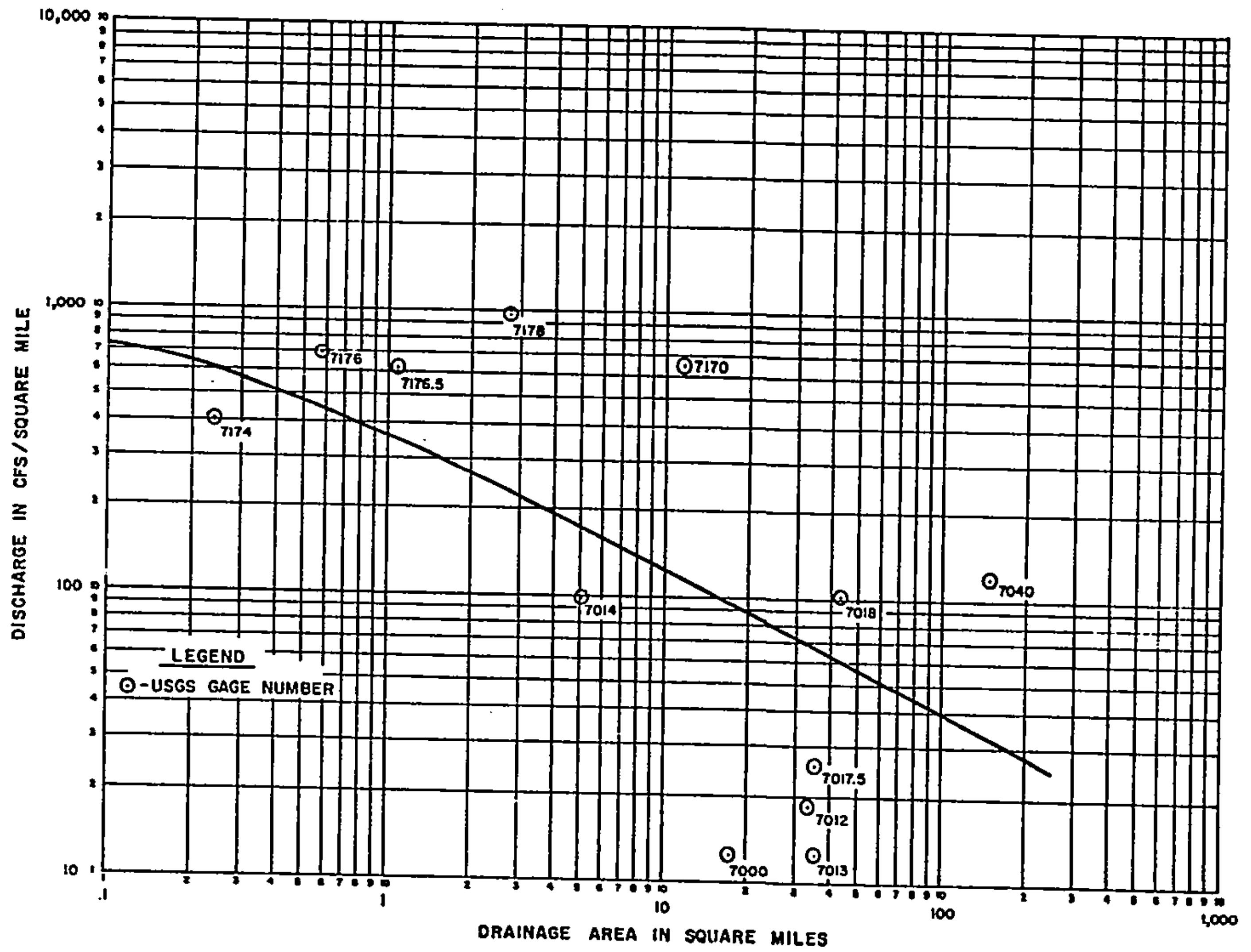
where Q is the 2-, 5-, 10-, 25-, 50-, 100- and 500-year flood peak discharge, C_p is the peak discharge coefficient: a, b, c, d, e, f, and g are constants.

Using HEC computer program "Multiple Linear Regression," independent variables having least significance were eliminated one at a time on the basis of partial determination coefficients. The multiple regression analysis was made using the records for the entire island of Hawaii and separating the records



ALENAIO STREAM	HAWAII, HAWAII
RELATIONSHIP OF 1% CHANCE FLOOD (100-YEAR) TO DRAINAGE AREA	
US ARMY ENGINEER DISTRICT, HONOLULU	

FIGURE D-15



ALENAIO STREAM — HAWAII, HAWAII

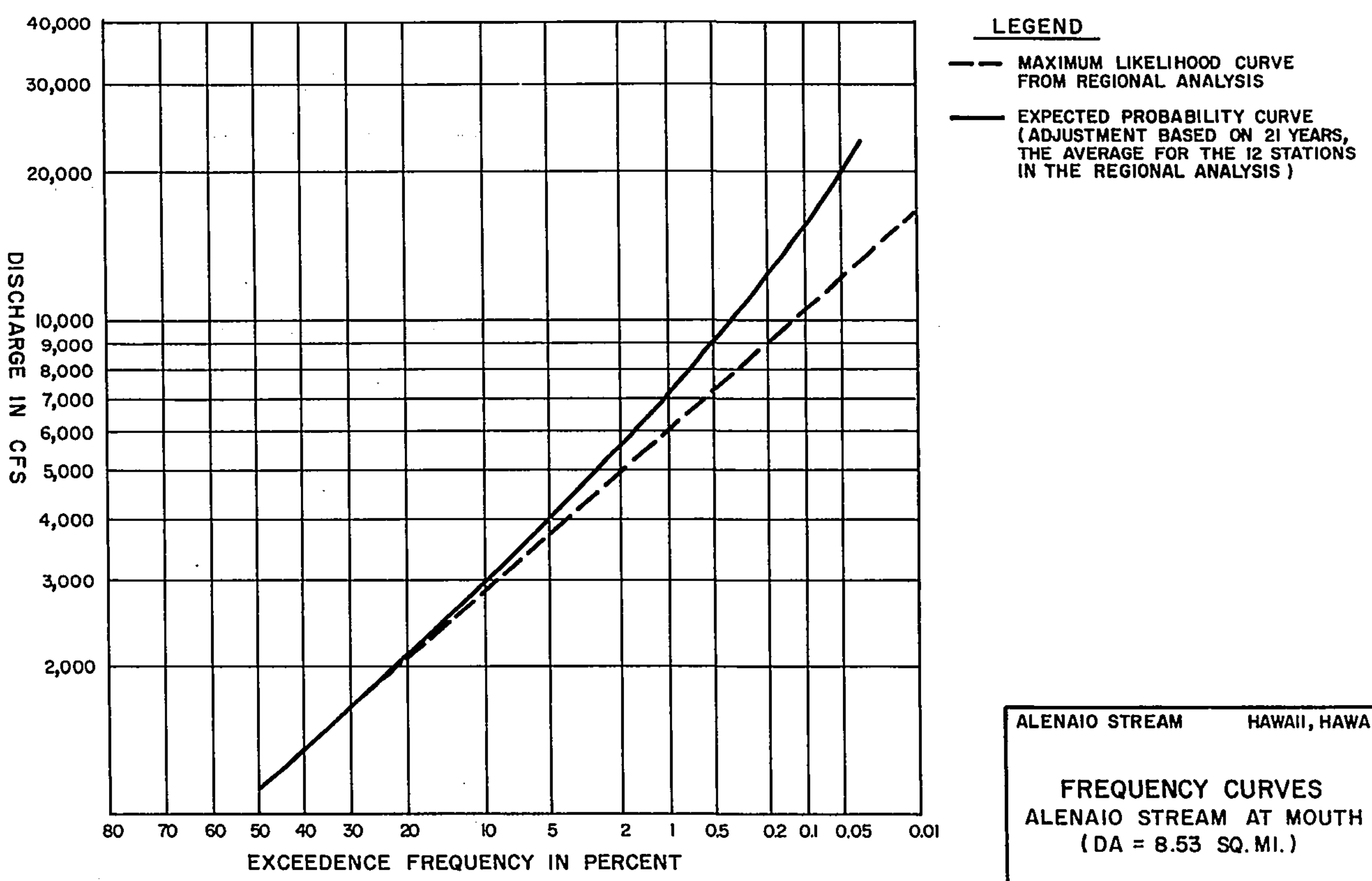
RELATIONSHIP OF 50% CHANCE FLOOD (2-YEAR) TO DRAINAGE AREA

US ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-16

TABLE D-6. STREAM GAGING STATIONS USED IN REGIONAL FLOOD FREQUENCY ANALYSIS

USGS Gage No.	Stream Name	D. A. Sq Mi	N Years of Record	Peak Discharge at Various Frequencies Cubic Feet Per Second 50%	10%	2%	1%
7000	Waiakea Stream Near Mountain View	17.4	49	218	548	937	1,130
7012	Waiakea Stream Near Hilo	33.6	11	624	1,270	1,940	2,250
7013	Waiakea Stream at Hilo	35.8	12	460	1,500	2,960	3,790
7014	Palai Stream at Hilo	5.08	16	498	866	1,210	1,360
7017.5	Wailuku River Near Humuula	34.8	15	899	5,980	18,700	28,000
7018	Wailuku River Near Kaumana	43.4	14	4,410	13,300	25,800	32,700
7040	Wailuku River at Piihonua	149	52	17,700	36,000	56,100	65,800
7170	Honolii Stream Near Papaikou	11.6	14	7,550	10,500	12,800	13,700
7174	Kalaoa Mauka Stream Near Hilo	0.24	18	97	211	337	398
7176	Alia Stream Near Hilo	0.58	18	404	874	1,390	1,640
7176.5	Kapehu Stream Near Pepeekeo	1.09	18	664	1,590	2,700	3,250
7178	Pohakupuka Stream Near Papaaloa	2.76	18	2,670	5,760	9,150	10,800



ALENAIO STREAM HAWAII, HAWAII

FREQUENCY CURVES
ALENAIO STREAM AT MOUTH
(DA = 8.53 SQ. MI.)

US ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-17

FIGURE D-17

into the windward and leeward group (Figure D-18). The best relationships in terms of standard error and multiple correlation was found using the windward and leeward split. The Alenaio basin is in the windward region.

The most significant basin and climatological characteristics for the windward area of Hawaii were found to be drainage area (DA) and the mean annual precipitation (PA). The regression equations, standard error, and correlation coefficients, which were computed for the discharges at selected recurrence intervals, are listed in Table D-7.

Table D-7. REGRESSION EQUATIONS, STANDARD ERRORS, AND MULTIPLE CORRELATION COEFFICIENTS FOR WINDWARD HAWAII GROUPING

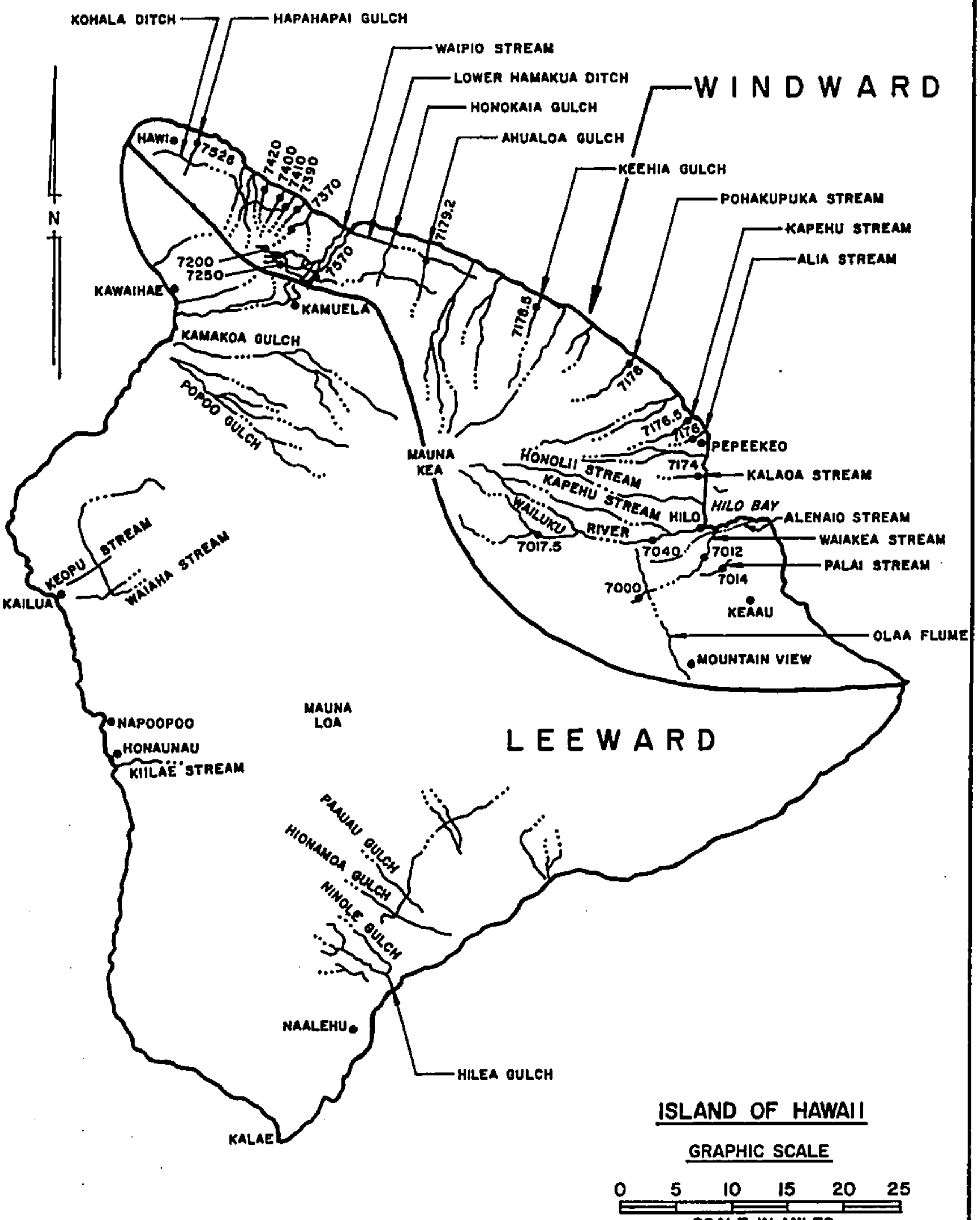
Regression equation	Standard error (percent)	Multiple correlation coefficient
$Q_2 = 93\ DA^{0.71}\ PA^{2.24}$	105	0.79
$Q_5 = 207\ DA^{0.68}\ PA^{1.60}$	102	0.80
$Q_{10} = 313\ DA^{0.67}\ PA^{1.27}$	102	0.80
$Q_{25} = 484\ DA^{0.65}\ PA^{0.92}$	102	0.80
$Q_{50} = 641\ DA^{0.64}\ PA^{0.70}$	102	0.80
$Q_{100} = 822\ DA^{0.64}\ PA^{0.50}$	105	0.80
$Q_{500} = 1361\ DA^{0.62}\ PA^{0.10}$	106	0.80

It is noted that the standard errors for the equations are over 100 percent. This does not indicate confidence in the regression equations. Hence, the equations were not used. The frequency curve based on the regional analysis was used (Figure D-18) instead. The frequency curve for Alenaio Stream using the regression method is shown on Figure D-19 for comparison purposes.

14. HYDROLOGY WITH PROJECT CONDITIONS

<u>ALTERNATIVE 1</u>. The proposed improvements in Alternative 1 do not alter the discharges from the existing condition. The affects of modifying the existing stream from Kapiolani Street to Kilauea Avenue and the subalternatives of improvements below Kilauea were analyzed. To account for the channel improvements, the effective loss rate was reduced in direct proportion to the percent impervious cover. Therefore, the loss rate for the reach between Kapiolani Street and Kilauea Avenue was reduced 5 percent to account for channel improvements and 2 percent for the reach below Kilauea Avenue, with negligible changes resulting. Therefore, design discharges used were the same as for the existing condition.

<u>ALTERNATIVE 2</u>. The diversion channel will divert all of the flows near Komohana Street to the Wailuku River basin. As a result, the changes to the flows remaining below Komohana Street, and the impact to the Wailuku River basin required evaluation.



LEGEND

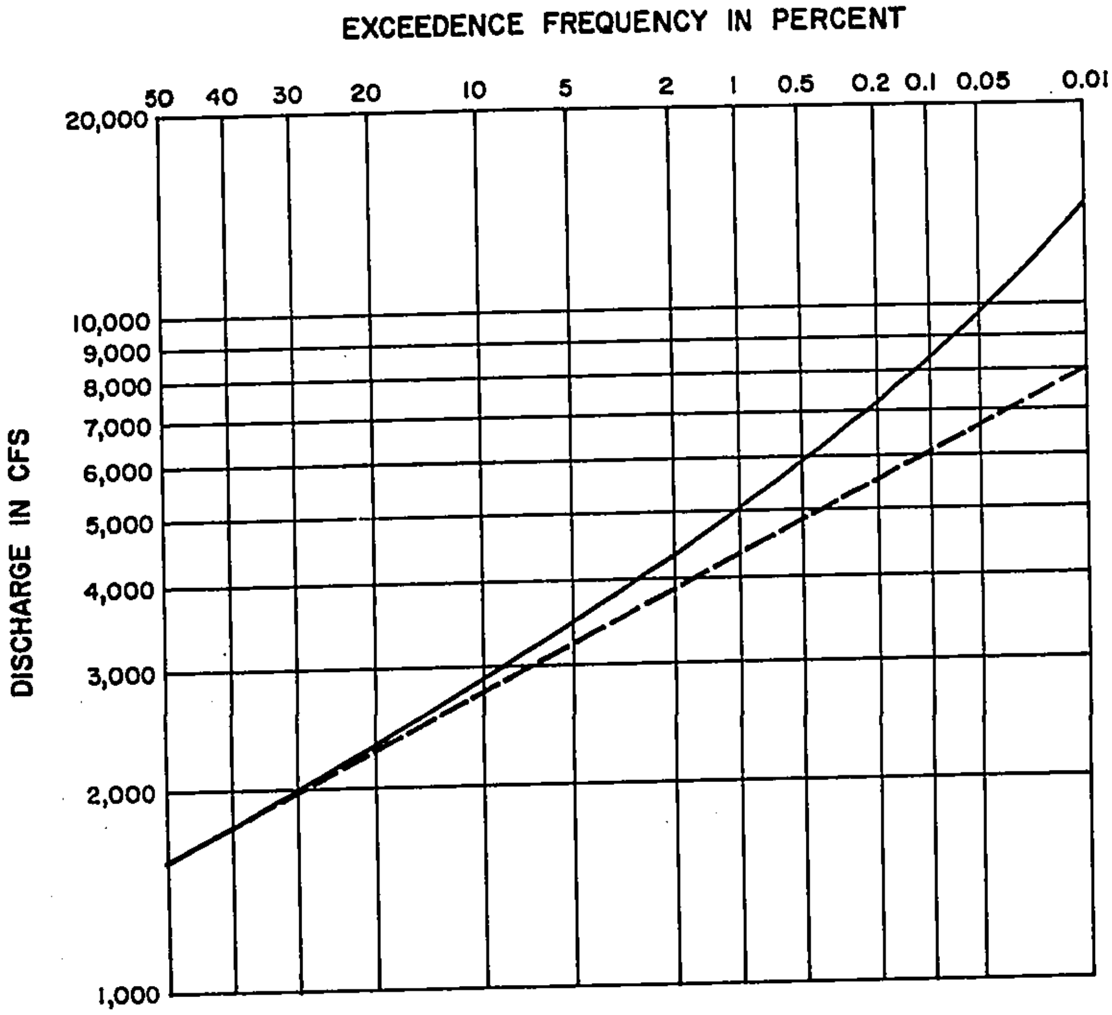
• 7174 GAGING STATION AND NUMBER

ALENAIO STREAM — HAWAII, HAWAII

DIVISION OF ISLAND WINDWARD AND LEEWARD

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-18



LEGEND

- - - - - FROM REGRESSION STUDY

——— EXPECTED PROBABILITY CURVE (ADJUSTMENT BASED ON 16 YEARS WHICH IS THE AVERAGE FOR THE WINDWARD GROUP STATIONS).

ALENAIO STREAM HAWAII, HAWAII

FREQUENCY CURVES
ALENAIO STREAM AT MOUTH
(DA = 8.53 SQUARE MILES)

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-19

Standard Project Floods were calculated below Komohana Street for the remaining subareas, routed, and combined at the outlet. Techniques used were similar to those used in developing the existing condition hydrology. The 100-year peak flows were determined by taking ratios to the Standard Project Flood peaks. Table D-8 presents the 100-year and SPF design peak discharges for the various concentration points in this area.

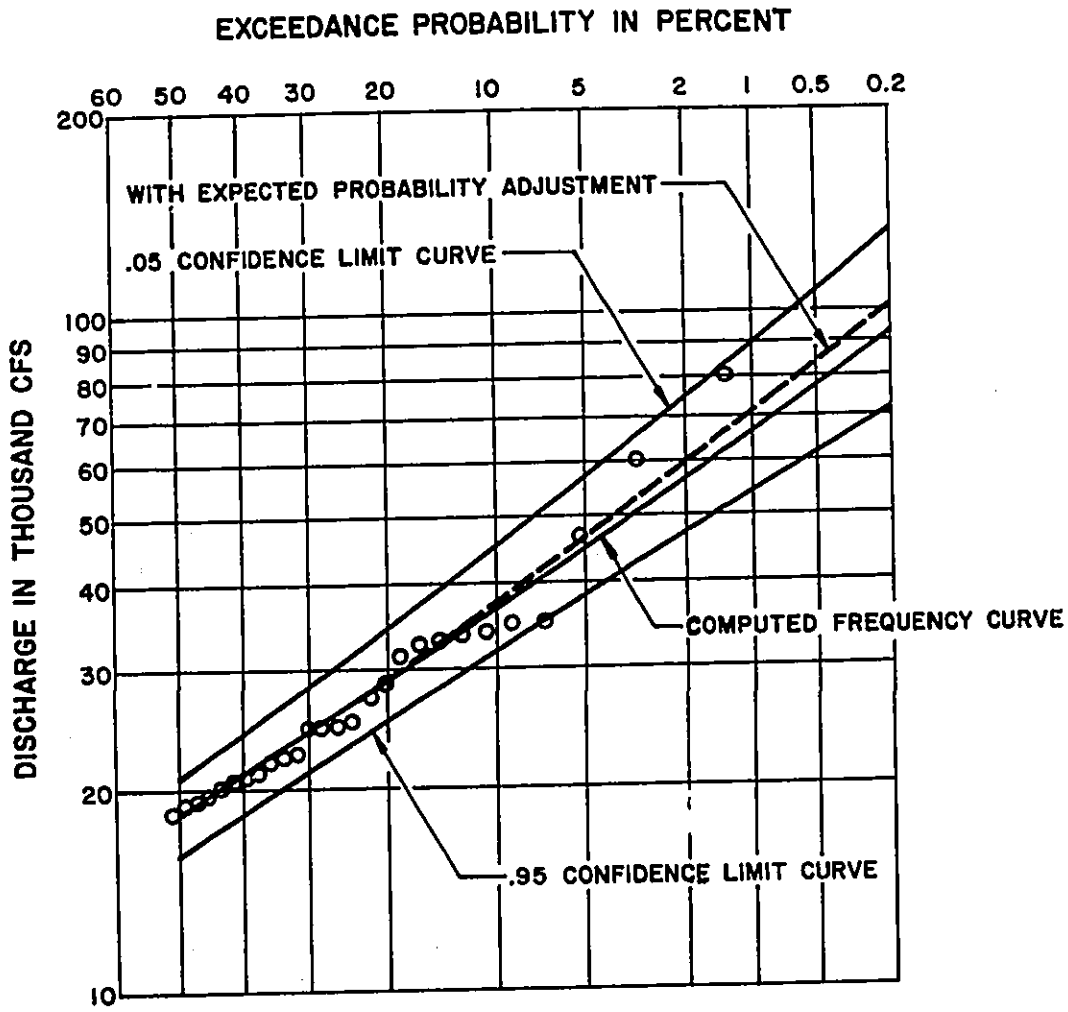
TABLE D-8

Alternative 2, Flows Below Komohana Street

Concentration Point	1% Chance Flood (cfs)	Standard Project Flood (cfs)
Kapiolani	670	1,170
Kilauea	1,280	2,250
Mouth	1,600	2,800

To evaluate the effects of the diversion, the hydrology for the Wailuku River basin had to be developed. The Wailuku River basin stream gaging stations are listed on Table D-6. In addition, limited data is available for Station 7130, Wailuku River at Hilo, because the station was established in March 1977 and destroyed by the flood of November 17, 1979. The Station 7130 effective drainage area is 175 square miles. Flood discharge frequency curves for the lower Wailuku River were estimated using data from Stations 7040 and 7130. Flood flow frequency curves for Station 7040, which has 52 years of records, are shown on Figure D-20. The November 17, 1979 flood had peak flows of 65,500 and 60,200 cfs at Stations 7130 and 7140, respectively. Using these two peak flows and the drainage areas of 175 and 149 square miles for Stations 7130 and 7040 respectively, the exponent of the ratio of the drainage areas was 0.524. This exponent of the ratio of the drainage areas was used to determine the peak flows for selected frequencies at Station 7130 by the following relationship:

$$Q_{Sta.\ 7130} = \left(\frac{175\ Mi^2}{149\ Mi^2}\right)^{0.524} Q_{Sta.\ 7040}$$



o = OBSERVED ANNUAL PEAKS

NOTE: ONLY THE TOP HALF OF THE CURVES ARE SHOWN

ALENAIO STREAM HAWAII, HAWAII

FLOOD FLOW FREQUENCY CURVES
WAILUKU RIVER
(STATION 7040)
DA = 149 SQ MI

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-20

Expected probability discharges for selected frequencies are tabulated for Stations 7040 and 7130 in Table D-9.

Table D-9

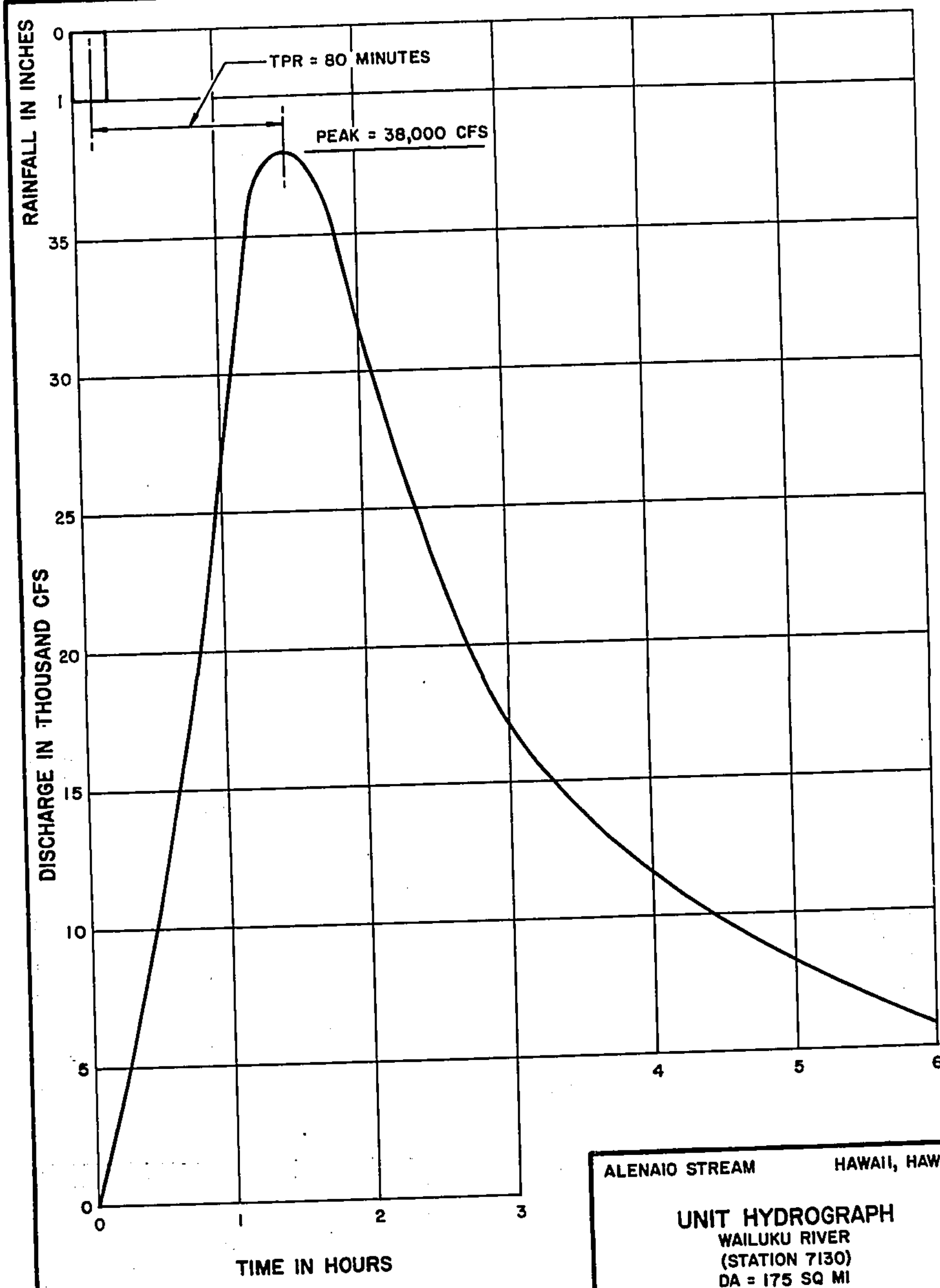
Selected Discharges for Stations 7040 and 7130

Frequency	Stations 7040 Discharge cfs	Station 7130 Discharge cfs
2 year	18,000	19,800
10 year	37,400	40,700
50 year	59,500	64,700
100 year	70,700	76,900
500 year	102,000	111,000

A Standard Project Flood of 91,000 cfs was calculated for Station 7130. The basic unit hydrograph from the mountain area of the watershed as shown on Figure D-8, was transferred to Station 7130 using Snyder's unit hydrograph relationship. The unit hydrograph for Station 7130 is shown on Figure D-21. The SPF index rainfall was determined to be 15.6 inches in 24 hours for the Wailuku basin at Station 7130. Rainfall depth values were computed by applying percentages extracted from OCE Memorandum for Record, "Standard Project Storm Determinations, Hawaii Islands," based on drainage area and storm period to the rainfall index. A rainfall depth-duration curve was computed and is shown in Figure D-22. A unit-time interval of 15 minutes was considered the most practical for storm computations to adequately define the computed hydrograph. The rainfall-intensity pattern and standard project flood is shown on Figure D-23. Loss rates were determined using the variable loss rate function.

To determine the design discharge in the lower Wailuku River, coincidental peaks were assumed between Alenaio Stream and the Wailuku River to give the worst conditions. The 100-year and standard project floods of 6,950 cfs and 12,000 cfs respectively for Alenaio Stream were added to 76,900 cfs and 91,000 cfs for Wailuku River. The combined discharges for the 100-year and standard project flood were 83,850 cfs and 103,000 cfs, respectively. The Wailuku River SPF and 100-year peak water surface elevations would increase by approximately 1.5 and 1.0 feet respectively with the additional diverted flow from Alenaio Stream. Based on water surface elevation computations, this would still be 1.8 and 4.3 feet below the low chord of the Hilo Waterfront Highway Bridge for the SPF and 100-year floods respectively.

15. WATER SURFACE DETERMINATION. Water surface elevations were determined by using the HEC-2 computer program, "Water Surface Profiles." Profiles of the 2 percent, one percent and standard project floods are shown on Figures D-24 and D-25. The inundation limits of the 100-year and Standard Project Flood are shown on Figure D-26. The 500-year was not shown because it is almost identical to the Standard Project Flood. The Ponohawai storm drain was assumed to have no effect on the discharges, based on past floods which rendered the drain ineffective because of debris blockages at and within the drain.

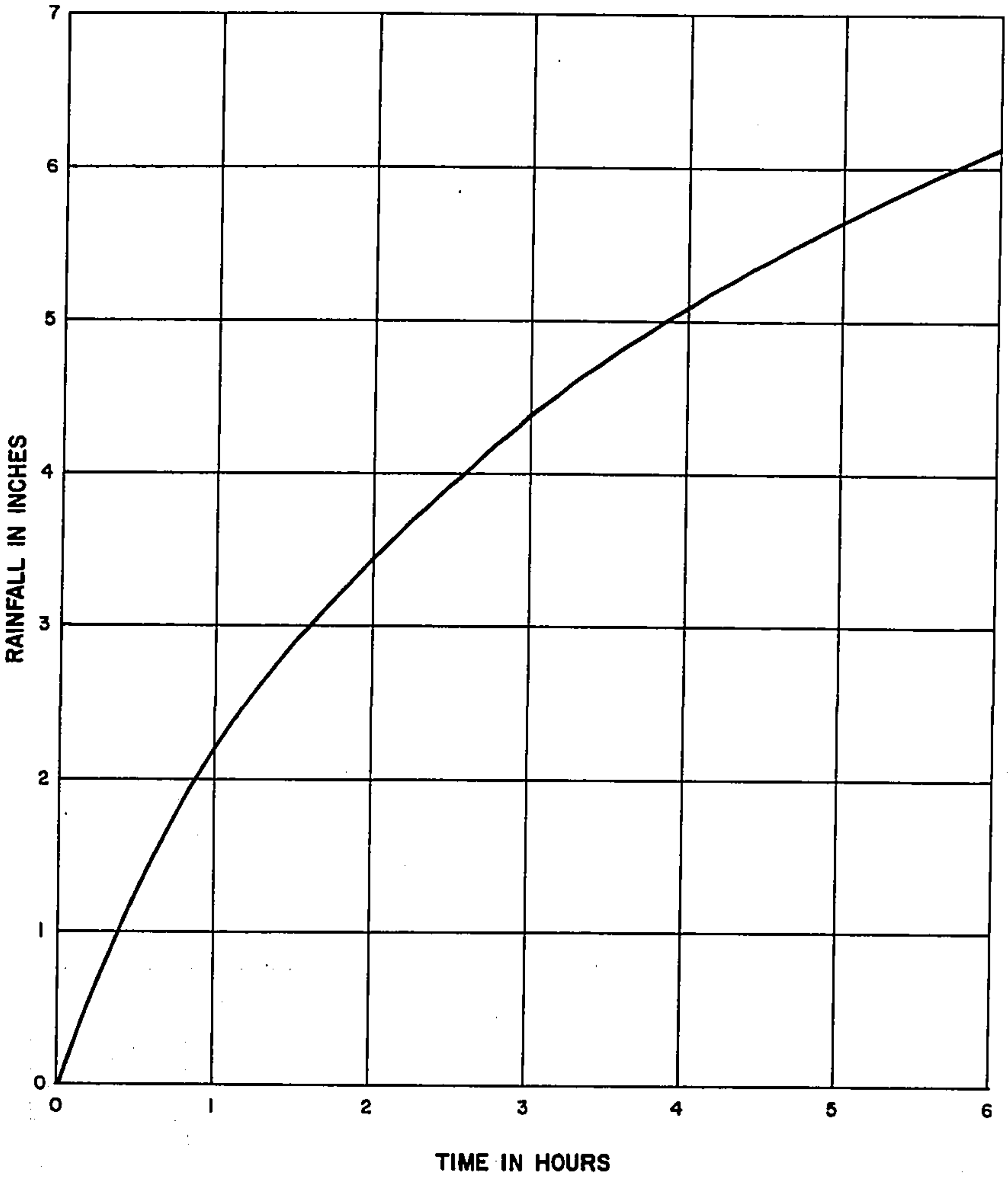


ALENAIO STREAM HAWAII, HAWAII

UNIT HYDROGRAPH
WAILUKU RIVER
(STATION 7130)
DA = 175 SQ MI

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-21



ALENAIO STREAM HAWAII, HAWAII

DEPTH-DURATION-CURVE
STANDARD PROJECT STORM
WAILUKU RIVER

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-22

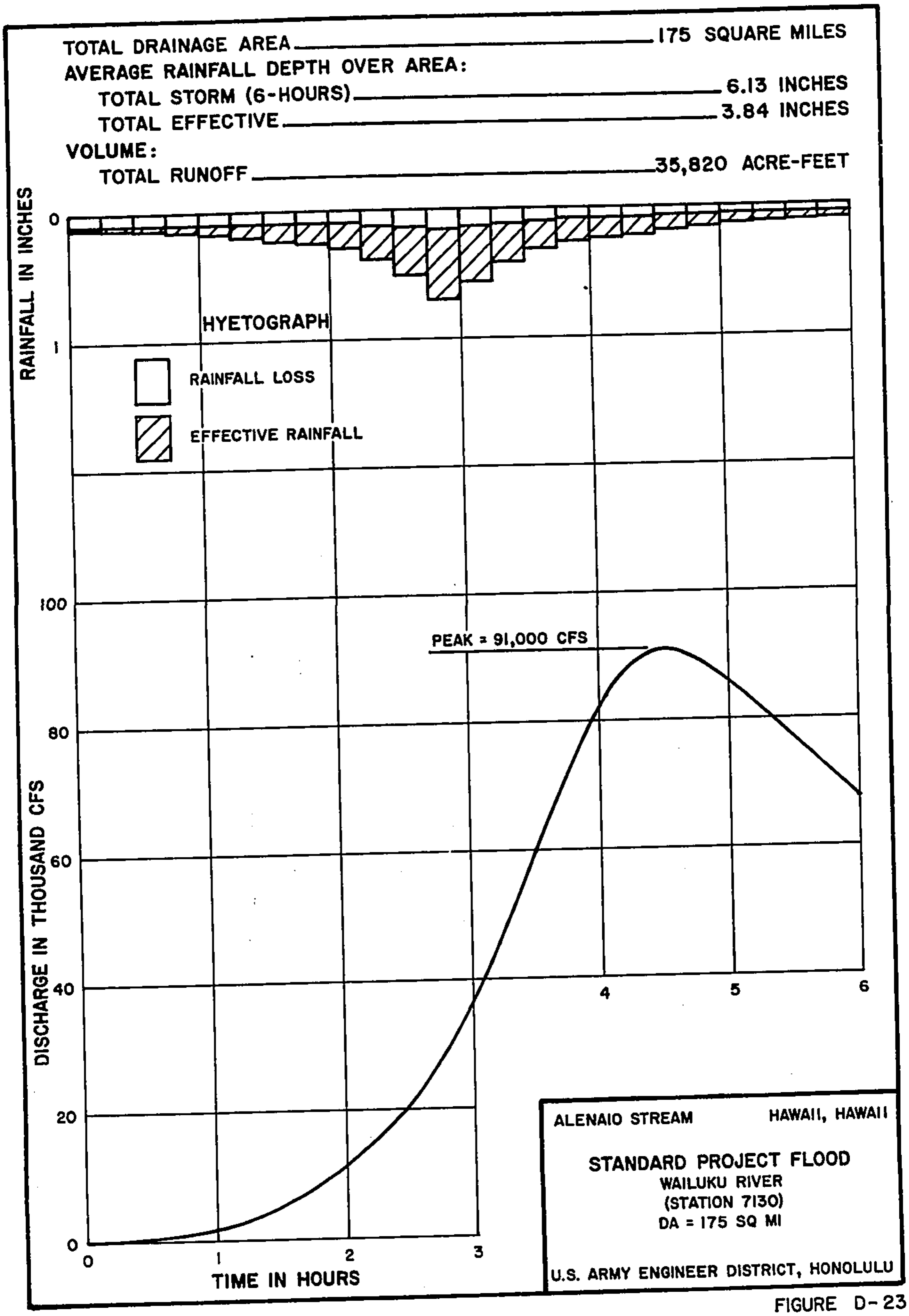

TOTAL DRAINAGE AREA 175 SQUARE MILES
AVERAGE RAINFALL DEPTH OVER AREA:
TOTAL STORM (6-HOURS) 6.13 INCHES
TOTAL EFFECTIVE 3.84 INCHES
VOLUME:
TOTAL RUNOFF 35,820 ACRE-FEET
RAINFALL IN INCHES
HYETOGRAPH
RAINFALL LOSS
EFFECTIVE RAINFALL
PEAK = 91,000 CFS
DISCHARGE IN THOUSAND CFS
TIME IN HOURS
ALENAIO STREAM HAWAII, HAWAII
STANDARD PROJECT FLOOD
WAILUKU RIVER
(STATION 7130)
DA = 175 SQ MI
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-23

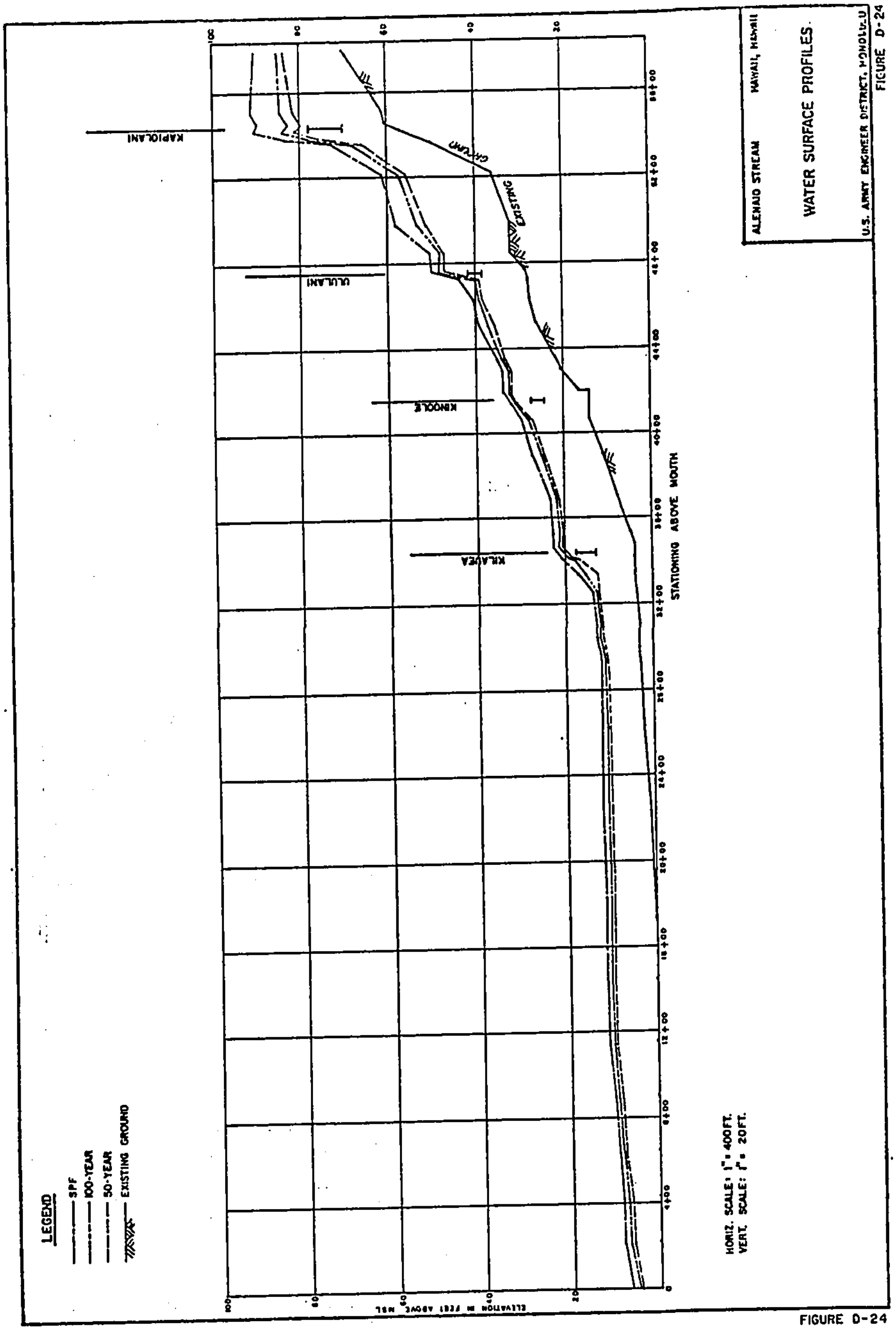

LEGEND
SPF
100-YEAR
50-YEAR
EXISTING GROUND
HORIZ. SCALE: 1" = 400FT.
VERT. SCALE: 1" = 20FT.
ALENAIO STREAM
HAWAII, HAWAII
WATER SURFACE PROFILES
U.S. ARMY ENGINEER DISTRICT, HONOLULU
FIGURE D-24
STATIONING ABOVE MOUTH
ELEVATION IN FEET ABOVE MSL
KAPIOLANI
ULULANI
KINOOLE
KILAUEA
EXISTING
CHANNEL

FIGURE D-24

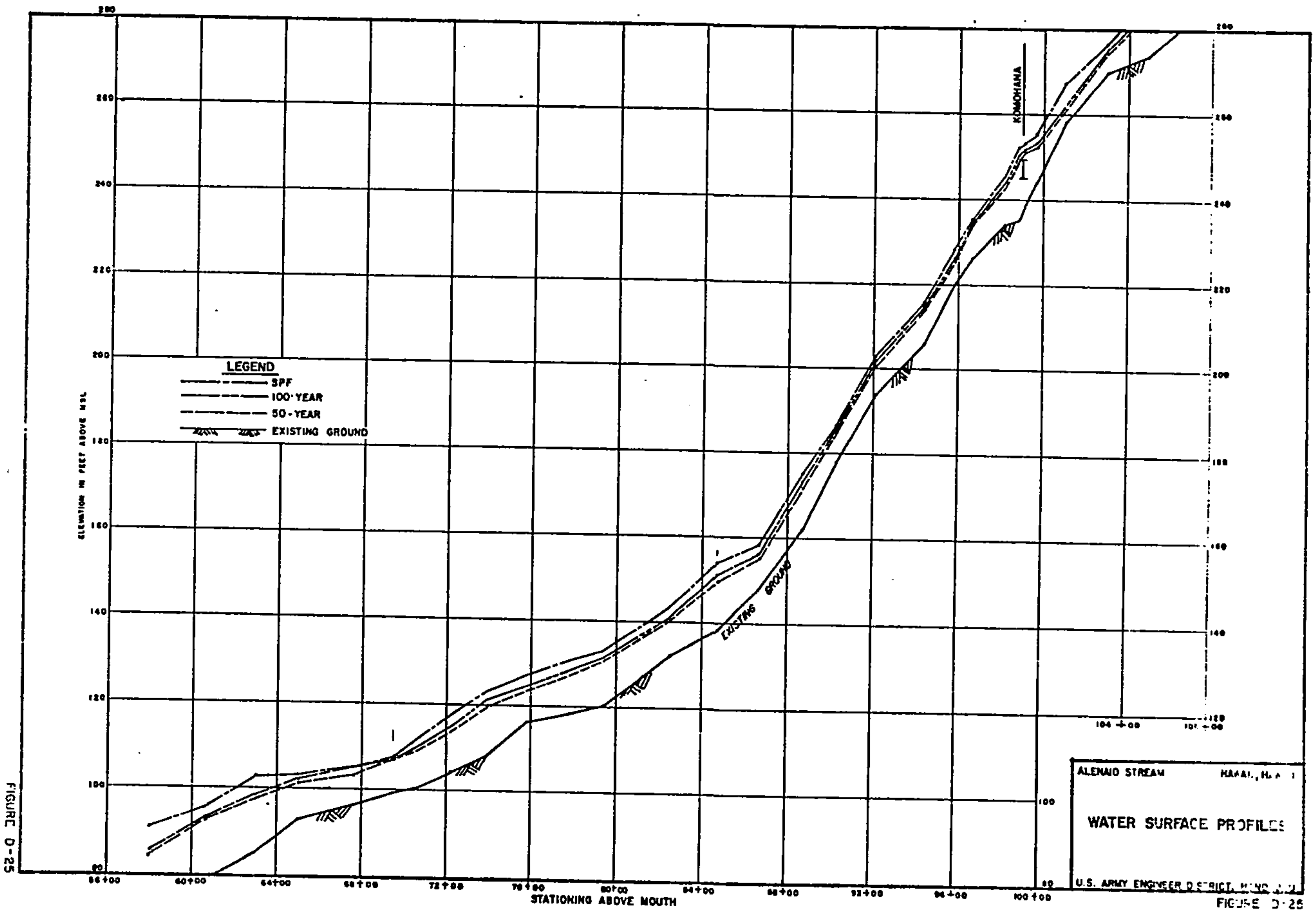

LEGEND
SPF
100-YEAR
50-YEAR
EXISTING GROUND
KOMOHANA
EXISTING GROUND
ELEVATION IN FEET ABOVE MSL
STATIONING ABOVE MOUTH
ALENAIO STREAM
WATER SURFACE PROFILES
FIGURE D-25

FIGURE D-25

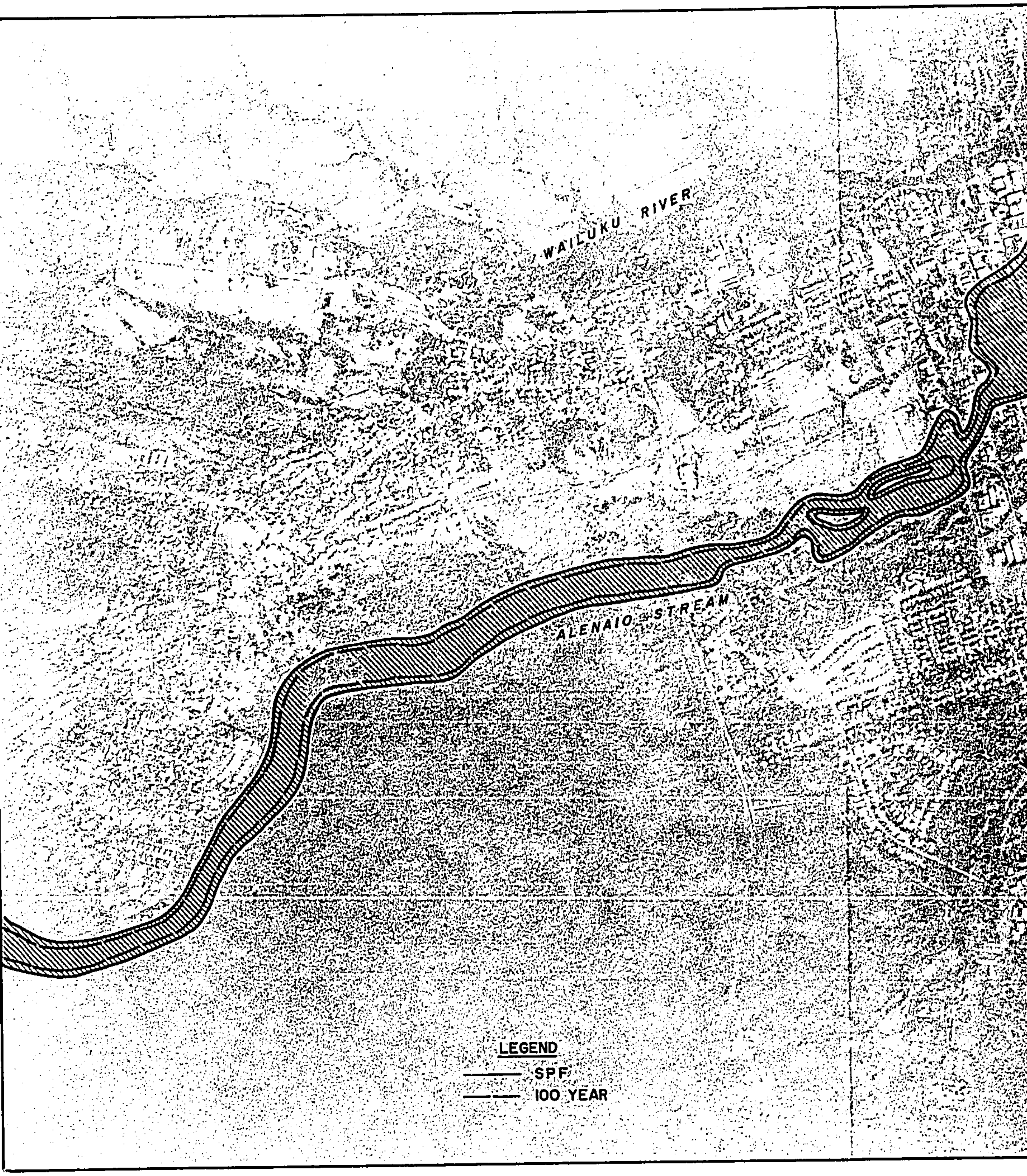


FIGURE D-26

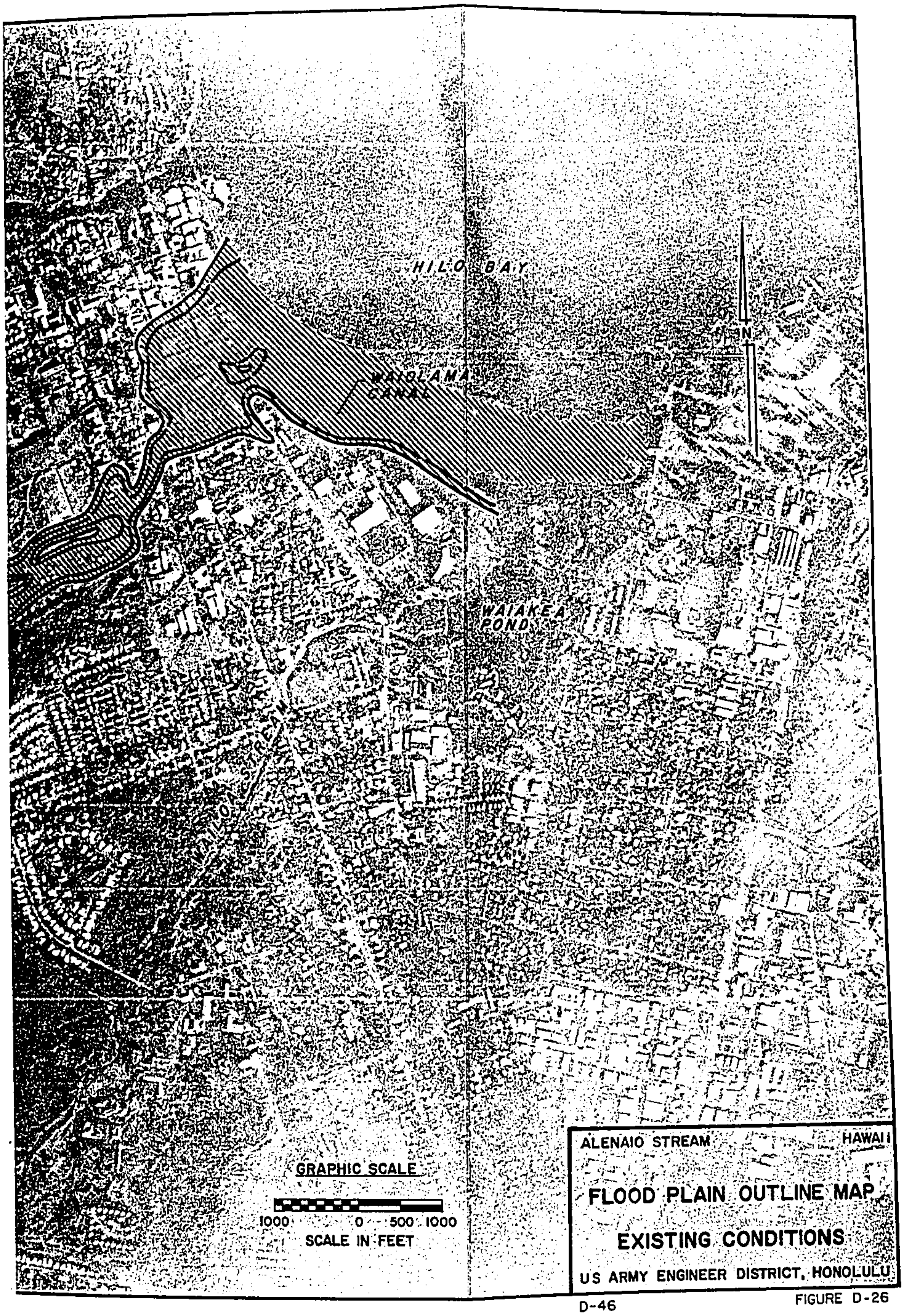

HILO BAY
N
WAIOLAMA CANAL
WAIAKEA POND
GRAPHIC SCALE
1000 0 500 1000
SCALE IN FEET
ALENAIO STREAM
HAWAII
FLOOD PLAIN OUTLINE MAP
EXISTING CONDITIONS
US ARMY ENGINEER DISTRICT, HONOLULU

FIGURE D-26

16. MANNING'S "n" and TRANSITION LOSS COEFFICIENTS

Manning's roughness coefficients, ranging from 0.013 to 0.045 for the river channel and 0.03 to 0.1 for the overbank areas, were used in the evaluation. The roughness coefficients were determined by field inspection. Contraction and expansion coefficients for transition losses ranged from 0.1 to 0.5 and 0.5 to 0.9, respectively. The contraction and expansion coefficients are consistent with recommendations by OCE for the Moanalua Stream flood control study. (Reference: 1st Indorsement, DAEN-CWP-W (6 Mar 79); Incl 2, Subject: Moanalua Stream, Oahu, Hawaii, Draft Reconnaissance Report.)

II. HYDRAULIC DESIGN

1. General.

Two structural alternative plans and one non-structural plan were analyzed for flood control measures on Alenaio Stream. Each plan was evaluated for two levels of protection, the 100-year (1% exceedance frequency) and the standard project flood (SPF). The scope of the engineering investigations was made in sufficient detail to estimate costs and evaluate the effects of the alternative plans on the environment.

Alternative 1 incorporates floodplain management, floodproofing, and modifications to the existing stream (Plate D-1). Alternative 2 incorporates floodplain management, a diversion channel, and modifications to the existing stream (Plate D-2). Alternative 3 incorporates floodproofing, relocation of individual structures, and floodplain management.

2. Design Guides.

The hydraulic designs follow the US Army Corps of Engineers Engineering Manual, EM 1110-2-1601, "Hydraulic Design of Flood Control Channels," dated 1 July 1970. This discussion, in general, follows the information specified in ETL 1110-2-230, "Hydrologic and Hydraulic Engineering for Survey Investigations," dated 15 May 1978.

3. Channel Stability.

As discussed in Appendix C, Geology, Foundations and Materials, the banks of the Alenaio Stream between Kapiolani and Ululani Streets generally consist of the highly erodible Homelani Ash and the Kuloaloa lava from volcanic eruptions. The existing channel downstream of Ululani Street is a man-made concrete channel.

The vegetation growing on the ash slopes offers protection against flows of 10 feet per second or less, however, flows exceeding this, such as anticipated in this design stage, will cause serious erosion of the slope materials despite the brush cover. The stream floor is hard lava basalt capable of withstanding the velocities of the SPF and 100-year flow. Accordingly, the portions of the channel between Kapiolani and Ululani Streets susceptible to erosion by the SPF and 100-year flows will be concrete lined.

4. Freeboard.

Freeboard is the computed, vertical distance between the design water surface to the top of channel wall or embankment. The freeboard computed for the flood control alternatives is 3.5 feet, which is based on allowances of 2.0 feet for a rectangular concrete channel, 1.0 feet for rapid flow in an urban area, and 0.5 feet for air entrainment. The final design freeboard will be selected in conjunction with model studies during AE & D.

5. Water Surface Profiles.

Water surface profiles for the 50-year, 100-year, and SPF were computed for each alternative. The 500-year profile was not computed because it is approximately equivalent to the SPF. The Bernoulli energy and Manning open channel equations were applied in the analysis. The computational procedure generally followed Method 1, Engineering Manual EM 1110-2-1409, "Backwater Curves in River Channels," dated 7 December 1959. The actual computations were performed utilizing the computer program "HEC-2, Water Surface Profiles," dated November 1976 (updated April 1980), developed by the Corps' Hydrologic Engineering Center. The following parameters were selected:

a. Manning's roughness coefficient - concrete .015
b. Contraction coefficient .1
c. Expansion coefficient .3

The contraction and expansion coefficients are consistent with the Hydrologic Engineering Center's recommendation for uniform channels with gradual transitions in supercritical flow. The Manning's roughness assumes a float finished concrete-lined channel. During the proposed model tests the Manning's 'n' will be varied to develop the final design.

6. Superelevation.

The flow in the channel is rapid for each alternative with a range in velocities from 30 to 45 feet per second. The computed difference in water surface between a theoretical level water surface at the centerline and outside wall water surface elevation in a channel is greater than 0.5 feet as determined using the equation below. Therefore, superelevation would be required.

$$\Delta y = C \frac{V^2 W}{gr}$$ (Change in water surface elevation)

C = coefficient = 0.5 (rectangular banked)

V = mean channel velocity = 40 fps

W = channel width = 35 ft

g = acceleration of gravity = 32.2 ft/sec^2

r = radius of channel centerline curvature = 425 ft

The maximum · y calculated was 2.0 feet. Super-elevation (Banking) is accomplished by rotating the channel invert around the channel centerline to maintain a constant average centerline grade throughout the curve.

7. Limiting Curvature.

Large waves are generated by rapid flow in curved channels. Therefore, a smaller rate of change of curvature is required than for tranquil flow. The recommended minimum radius of curvature for rapid flow is:

$$r_{min} = \frac{4\, V^2 W}{gy}$$

r_{min} = radius of channel curve

V = mean channel velocity

W = channel width

y = flow depth

In some locations, the radius of curvature is less than the recommended minimum radius of curvature in order to reduce the number of relocations required. In these urban locations, an additional 1.0 feet of freeboard was provided as indicated in paragraph 4.

8. Debris Basin.

A debris basin is not included in the design of the proposed alternatives. A debris basin is recommended at the upstream end of a flood control channel when the drainage basin above the flood control channel has a severe erosion problem. Alenaio Stream is mainly located in an area of highly permeable lava flows with a thin covering of soil. The upper portion of the drainage basin is located in an agricultural area where the U.S. Soil Conservation Service (SCS) has implemented a watershed protection project to minimize erosion. Based on this project, field observations, and reports that during floods on Alenaio Stream the water is neither turbid nor debris-laden; a debris basin to retain non-organic material is not included in formulation of improvement plans.

9. Hydraulic Model Studies.

Hydraulic model studies will be conducted during AE & D to determine the optimal design features of the selected alternative plan. The model will indicate the occurrence of standing waves or other hydraulic disturbances in supercritical flow through transition structures, alignment curvature, and stilling basins. In addition, the studies will indicate the most economical construction and operational features of the proposed design. In particular, the following will be examined:

a. The design of an energy dissipation structure downstream of Kilauea Avenue.

b. The effect of air entrainment and channel alignment upon design freeboard.

c. The effect of supercritical flows on the topography upstream and downstream of the proposed channel.

10. Baseline Conditions. Elevations are based upon mean sea level datum (MSL). The physical baseline conditions were determined from the following topographic surveys:

a. Plan and Profile, Alenaio Stream Flood Control Improvements by Neighbor Island Consultants for the County of Hawaii, Department of Public Works, 22 sheets, March 1976.

b. Reeds Island Bridge Improvements Plan, County of Hawaii, Department of Public Works, 2 sheets, Feb. 7, 1972.

c. Aerial Photo Contour Maps, Alenaio Stream Flood Control Project by R.M. Towill Corporation for US Army Corps of Engineers, Pacific Ocean Division, 12 sheets, 10-ft. contour interval, 1" = 200', Sept. 13, 1979.

d. Aerial Photo Contour Maps, Alenaio Stream Flood Control Project by R.M. Towill Corporation for US Army Corps of Engineers, Pacific Ocean Division, 9 sheets, 2-ft. contour interval, 1" = 100', Sept. 13, 1979.

e. Cross-sections of Alenaio Stream and Wailuku River, Alenaio Stream Flood Damage Reduction Study by Sam O. Hirota, Inc. for US Army Corps of Engineers, Pacific Ocean Division, 13 sheets, Sept. 1981.

f. Topographic and Hydrographic Surveys of Wailuku River, Hilo Bayfront Highway, Project No. 19L-02-79 by Hawaii State Department of Transportation, 1" = 50', Feb. 1979.

Table D-10 Alternative 1, Subalternatives

No structural action/floodproofing.	This measure leaves reach 1 in its current condition. No substantial measures would be provided except incorporating flood warning signs along the Bayfront Highway and Kamehameha Avenue to warn drivers of dangerous driving conditions. This is consistent with the open space land-use zoning of the area where no development is allowed because of tsunamis. Most of the water would be ponded in the Wailoa park area. Flooding in the park would result from the occurrence of a 2-year frequency flood. The three existing structures (service stations) would be affected by a 5-year flood frequency, and the highway would be inundated by a 10-year frequency flood. The three service stations will be floodproofed by providing a flood wall surrounding the stations and/or by elevating damageable property above the expected flood heights (3.5 feet for the SPF event).
Enlarging the Capacity of the Waiolama Canal.	This measure confines the floodwaters within the limits of the Wailoa park by enlarging the capacity of the Waiolama Canal. Due to the mild hydraulic gradient, the Waiolama Canal would need to be enlarged to a width of 350 feet for the SPF flood (175 feet for the 100-year flood) with a rip-rap trapezoidal channel with 2H to 1V slideslopes. The Pauohi Avenue crossing and foot bridges along the canal will need to be modified accordingly. The maximum channel velocity is 6 feet per second.
Levee System along the Highway.	This measure provides a 2,800-foot long earthen levee at a height of 8 feet for the SPF flood (7 feet for the 100-year flood) with sideslopes of 2.5H to 1V and a crest width of 10 feet. At Pauohi Avenue the levee would be cut and a manually operated flood gate will be inserted. The levee would tie into the two service stations and provide protection to the stations and Kamehameha and Bayfront Highways. No interior drainage structures would be required. The ponded water on the canal side of the levee will flow into the normal course of the canal into Hilo Bay. The water on the bay side of the levee will flow directly into the bay.
New Diversion Channel into Hilo Bay.	The SPF measure extends the channel in reach 2 into Hilo Bay by running parallel to Ponohawai Avenue. The proposed channel would be 35 feet wide at Kilauea Avenue and enlarged to 45 feet through a 100-foot transition. The channel would be 1,300 feet long with a flow depth between 7 and 10 feet. The maximum velocity in the channel is 41 fps with a velocity of 28 feet per second at the bay. Two new bridges would be required, one at Kamehameha Avenue and one at Hilo Bayfront Highway. Utilities will also need to be modified as existing lines parallel the Hilo Bayfront Highway and Wailoa Park. The 100-year level protection would have a 30-foot wide channel with a maximum flow velocity of 37 fps in the channel and 24 fps at the bay.

11. Flood Control Alternatives.

Alternative 1

SPF Protection

This alternative consists of floodplain management from Chong's Bridge to Komohana Street (Reach 4), floodproofing from Komohana Street to Kapiolani Street (Reach 3), and modifications to the existing stream from Kapiolani Street to Kilauea Avenue (Reach 2). From Kilauea Avenue to Hilo Bay (Reach 1), four subalternatives were evaluated: (a) no action, (b) enlarging Waiolama Canal, (c) levee along Kamehameha Avenue, and (d) diversion channel. Table D-10 shows a comparison summary of these four subalternatives. The SPF design discharge varies from 12,500 cfs at Hilo Bay, to 12,300 cfs at Kilauea Avenue, to 12,200 cfs at Kapiolani Street, to 12,000 cfs at Komohana Street, and 10,400 cfs at Chong's Bridge. For design purposes the Ponohawai diversion system is considered to be inoperative and have no effect on the design discharge during floods. Plates D-3 and D-9 show the water surface profiles and typical sections. The channel alignment is based on several factors: (a) to minimize the amount of existing channel disturbance, (b) to minimize the number of relocations, and (c) to make the channel hydraulically efficient.

(1) Reach 4. Reach 4 is located between Chong's Bridge and Komohana Street. This area is virtually undeveloped but is planned for future residential and some commercial development. A structural alternative was found to be economically infeasible in this reach, and at this stage of residential development, floodplain management is the most appropriate alternative. With proper floodplain management, future flood damages could be minimized in the area.

(2). Reach 3. Reach 3 is located between Komohana and Kapiolani Streets. The development in this reach of stream is mainly residential; with the majority of the development located in the stream's right overbank. Nine buildings, all residential, would be flooded by a SPF event on Alenaio Stream. The buildings are scattered throughout this 4,400-foot reach, thereby making a structural plan economically infeasible. The nonstructural plan will include the following:

Type of Structure	Depth of Flooding (ft) 100-Yr	SPF	Nonstructural Measure 100-Yr	SPF
25R (56+50)	1.8	5.0	temp/perm closure	same as 100-Yr
25R (56+50)	-	3.0	-	temp/perm closure
25R (56+50)	-	1.0	-	temp/perm closures
10R (59+00)	-	0.9	-	raise 2'
30R (59+00)	-	2.0	-	flood insurance
10R (60+65)	3.1	5.3	raise 4'	raise 6'
10R (78+00)	1.8	3.3	raise 3'	raise 4'
20R (97+20)	0.6	1.7	provide floodwall	
10R (97+70)	0.6	2.0	provide floodwall	

(3). Reach 2. Reach 2 is located between Kapiolani Street and Kilauea Avenue. The development in this reach is a mixture of residential and commercial buildings. A structural alternative was analyzed for this reach with a channel alignment following the existing alignment from Kapiolani

Street to Kinoole Street and then diverging from the existing channel to Kilauea Avenue. The existing channel will be filled from Kinoole Street to Kilauea Avenue to provide access to the buildings between the proposed and existing alignments. The proposed realigned channel will meet design standards to maintain stable flow in a high velocity channel. If the standards were not met, a hazardous condition would result, should the flow become unstable and escape the channel.

The proposed channel is a 1,640-foot-long, rectangular channel, lined with concrete to prevent scouring of the banks from the high velocities and to create a smooth invert surface for efficient flow. The channel would require widening by 15 feet if the invert was not lined because a rock invert, although resistant to the velocities, would be rough and inefficient. The channel is rectangular to reduce the land acquisition and relocation costs in this dense, urban area. The channel width is 40 feet for the first 415 feet, then transitions to a 35-foot wide channel in 50 feet for the remainder of the channel length. The flood depth ranges between 8.0 and 9.5 feet. The slope of the invert varies between 1.0% and 2.5% to minimize the amount of excavation. The maximum velocity in the channel was computed to be 42 feet per second. Plate D-5 shows the plan view with an alternate alignment between Kilauea Avenue and Kinoole Street.

Bridges are selected over culverts for two reasons: (a) the narrow right-of-way available, and (b) the width required for the culverts to compensate for pier losses in rapid-flow conditions. The four existing bridges at Kapiolani Street, Ululani Street, Kinoole Street, and Kilauea Avenue require replacement. Kapiolani and Ululani Streets require a 40-foot span, whereas, the other two require a 35-foot span.

Seven relocations are required in this reach: one public service building and six residential buildings. The public service building houses the fire department offices at Kinoole Street.

Reach 1. Reach 1 is located between Kilauea Avenue and Hilo Bay. Part of this area is classified as a Coastal High Hazard Area because possibility of tsunami inundation. No new development is allowed in this area, and the existing development is commercial. An energy dissipation structure will be required downstream of Kilauea Avenue. The design of this will be made in conjunction with model studies during AE & D. Plan views for each subalternative are indicated in Plates D-6 through D-9.

Subalternative a. This subalternative leaves this area in its existing condition except in the vicinity of Kilauea Avenue, where Reach 2 alternative would blend into the existing surroundings. By leaving this area in its existing condition, a park, three service stations, Kamehameha Avenue, and Hilo Bayfront Highway would be flooded. Flooding would begin in the park from an occurrence of a two-year flood. The three service stations would receive flooding from a five-year flood. Kamehameha Avenue would receive flooding from a ten-year flood and portions would be inundated by 2.5 feet and 3.5 feet for the 100-year flood and SPF, respectively.

Subalternative b. This subalternative enlarges Waiolama Canal to protect Kamehameha Avenue and the three service stations; the park would still be flooded. Due to the mild hydraulic gradient, Waiolama Canal is enlarged to a 350-foot wide trapezoidal channel with 2H to 1V sideslopes. The channel has a length of 3,000 feet and will be lined with riprap. The Pauahi Avenue crossing is modified to cross the channel. The maximum channel velocity calculated is 6 feet per second.

Subalternative c. This subalternative consists of a levee along Kamehameha Avenue. The levee is earthen with a maximum height of 8 feet with sideslopes of 2.5H to 1V. The length of the levee is 2,800 feet with a crest width of 10 feet. At Pauahi Avenue, the levee is broken and a manually operated flood gate inserted.

The levee provides protection to Kamehameha Avenue and the three service stations from the SPF. The park would be used as part of the floodplain and would be flooded by a two-year flood.

No interior drainage structures are required. Kamehameha Avenue acts naturally as a small ridge between Waiolama Canal and Hilo Bay. Therefore, water on the canal side of the levee flows into the canal and eventually into the bay, while water on the bay side of the levee flows directly to the bay.

Subalternative d. This subalternative extends the channel in Reach 2 to Hilo Bay, creating a new outlet in the bay. The channel is enlarged from 35 feet wide at Kilauea Avenue to 45 feet through a 100-foot transition. The length of the channel is 1,300 feet with a flow depth between 7.0 and 10.0 feet. The maximum velocity in the channel was computed to be 41 feet per second with a velocity of 28 feet per second at the bay.

A weir would be constructed in the channel to divert low flow into Waiolama Canal. Flow in Waiolama Canal is due to tidal influence, with no flow from Alenaio Stream except during floods. The diverting of low flow into the canal would serve to reduce the stagnation of the water by creating a flushing condition. New bridges would be required at Kamehameha Avenue and at Hilo Bayfront Highway, both requiring 45-foot spans.

The discharge would provide an additional source of littoral materials for nourishment of the Bayfront shore. However, the open channel would act as a temporary trap for longshore transport. The outlet into Hilo Bay would have a tendency to shoal due to littoral transport along the Bayfront Beach, and would require periodic cleaning to maintain positive flow. The velocities during high runoff would self-clean the entrance.

100-Year Protection

This alternative follows the same design and assumptions as Alternative 1 - SPF Protection, but differs in channel size because of the lower design flows. The design discharges are 7,100 cfs at Hilo Bay, 7,050 cfs at Kilauea Avenue, 7,000 cfs at Kapiolani Street, 6,950 cfs at Komohana Street, and 6,500 cfs at Chong's Bridge. Table D-11 shows the pertinent data for Alternative 1 - 100-Year Protection.

Table D-11. Alternative 1 - 100-Year Protection, Pertinent Data

Reach	Alternative	Description
4	Non-Structural	Floodplain Management
3	Non-Structural	Floodproofing. Five homes involved: raise two, temporary/permanent closures around one and provide floodwall for two.
2	Structural	Rectangular concrete channel. Length - 1,640 ft.; Width - 25 ft.; Flood Depth - 8.0 to 12.0 ft. Invert Slope - 1.0% to 2.5% Maximum Velocity - 38 fps Bridges - 4, span = 25 ft. (Kapiolani, Ululani, and Kinoole Streets and Kilauea Avenue) Relocations - 7 (6 residential; 1 public service)
1	(a) Non-Structural	Existing Conditions.
	(b) Structural	Enlarge Waiolama Canal Length - 3,000 ft.; Width - 175 ft. Trapezoidal Channel Riprap. Sideslopes - 2H to 1V Bridges - 1 (Pauahi Avenue) Maximum Velocity = 6 fps
	(c) Structural	Levee along Kamehameha Avenue Length - 2,800 ft.; Height - 3-7 ft. Crest Width - 10 ft. Type - Earth, grassed Sideslopes - 2.5H to 1V
	(d) Structural	Diversion Channel Rectangular Concrete Length - 1,300 ft.; Width - 30 ft. Flood Depth - 7.0 to 10.0 ft. Maximum Velocity - 37 fps Velocity at Bay - 24 fps Bridges - 2, span = 30 ft. (new, Kamehameha Avenue and Hilo Bayfront Highway)

Alternative 2

SPF Protection

This alternative consists of floodplain management from Chong's Bridge to Kapiolani Street, a diversion channel from Komohana Street to Waikapu Stream, a tributary of Wailuku River, modifications to the existing channel from Kapiolani Street to Kilauea Avenue, and floodplain management from Kilauea Avenue to Hilo Bay. The SPF design discharge for the diversion channel is 12,000 cfs and the SPF discharge for the existing channel varies from 2,800 cfs at Hilo Bay to 2,250 cfs at Kilauea Avenue, to 1,170 cfs at Kapiolani Street. For designn purposes the Ponohawai diversion system is considered to be inoperative and have no effect on the design discharge. Plate D-4 shows the typical sections.

The proposed diversion channel alignment is based on several factors; (a) to make the channel hydraulically efficient, (b) to minimize the number of road crossings, (c) to minimize any adverse impacts in residential areas, (d) to minimize the amount of excavation, and (e) to minimize the disturbance of any area proposed for future development.

Floodplain Management. Floodplain management would be instituted in Reaches 1, 3, and 4. Reach 4 is located between Chong's Bridge and Komohana Street in a virtually undeveloped area proposed for future development. Floodplain management during the early stages of development would help to minimize future flood damage in this reach.

Reach 3 is located between Komohana and Kapiolani Streets. The existing development in this reach is mainly residential and would not be prone to flood damage by the design flood below Komohana Street after the diversion channel has been constructed. For any future development in this reach, floodplain management could be utilized to minimize future flood damage.

Reach 1 is located between Kilauea Avenue and Hilo Bay. Part of this area is classified as a Coastal High Hazard Area due to the possibility of tsunami inundation in this area. Floodplain management is currently being utilized and providing it continues, future flood damage would be minimized.

Diversion Channel. The diversion channel (see Plate D-10) is located in Reaches 3 and 4 and diverts the flood flows above Komohana Street into Waikapu Stream, a tributary of Wailuku River. The alignment begins approximately 500 feet upstream of Komohana Street and run north along Komohana Street for approximately 1,200 feet (Reach 4). The alignment then crosses Komohana Street north of Ka Waena Lapa'au Medical Center into Reach 3. It then runs northeast on the west side of Halai Cinder Cone and crosses Punahele Street immediately east of the County Jail. It continues northeast to Waianuenue Avenue and then into the Waikapu Stream. A covered channel and an open channel are possible alternatives for the reach between Waianuenue Avenue and Waikapu Stream. Table D-12 shows the comparison between the two channels.

A diversion entrance structure will be designed to direct up to the 12,000 cfs flow of the SPF into the proposed diversion channel. An overflow structure will be provided to pass up to 2,800 cfs additional flow into the existing Alenaio Stream. The modifications to the existing stream discussed below will be adequate for passing this flow.

The proposed diversion channel has a total length of 4,200 feet and is concrete lined to prevent scouring of the banks from the high velocities. The initial 1,850 feet is a trapezoidal channel with a bottom width of 25 feet and sideslopes of 1.5H to 1V. The channel then transitions to a 35-foot wide

TABLE D-12. ALTERNATIVE 2, DIVERSION CHANNEL COMPARISON

	LEVEL OF PROTECTION			
	100-YEAR		SPF	
	Trapezoidal (1,850')	Rectangular (2,250')	Trapezoidal (1,850')	Rectangular (2,250')
Bottom Width	15'	25'	25'	35'
Depth	8-10'	8-11'	8-10'	8-12.5'
Side Slope	1.5H to 1V	NA	1.5H to 1V	NA
Velocity (max)	30 fps	50 fps	30 fps	50 fps

rectangular channel in 100 feet. The channel remains 35-feet wide for 1,600 feet to Waianuenue Avenue. From Waianuenue Avenue to Waikapu Stream, as mentioned earlier, two channels were evaluated. If the channel is an open channel, then it will be a 35-foot wide rectangular channel. If the channel is a covered channel, then it will be a double cell structure with dimensions for each cell being 14.5'H by 18'W. The flood depth ranges between 8.0 and 12.5 feet. The slope of the invert varies between 0.5% and 4.0% to minimize the amount of excavation. The maximum velocity in the channel is computed to be 45 feet per second.

Bridges are selected over culverts for two reasons: (a) the narrow right-of-way available, and (b) the width required for the culverts to compensate for pier losses in rapid-flow conditions. New bridges are required at Komohana and Punahele Streets and Waianuenue Avenue. The structures at Komohana and Punahele Streets are single 35-foot spans. The structure at Waianuenue Avenue depends upon the type of channel is chosen, open or covered. The structure will be a single 35-foot span for the open channel and a twin 14.5'H by 18'W cell for the covered channel.

The number of relocations required varies depending on the type of channel chosen below Waianuenue Avenue. Two residential buildings need to be relocated for the covered channel; whereas, four residential buildings need to be relocated for the open channel. The additional two relocations required for the open channel are needed because of the sideslopes and berm required for channel stability and maintenance for the depth of cut below Waianuenue Avenue.

An outlet structure consisting of a drop structure and stilling basin is required where the diversion channel empties into Waikapu Stream, to dissipate the energy and to protect the banks of Waikapu Stream. The design of the outlet structure is based on EM 1110-2-1603, "Hydraulic Design of Spillways," dated 31 March 1965. Design of the drop channel to lower the invert level of the diversion channel to the stilling basin floor assumes a parabolic trajectory, based on the following equation:

$$Y = X \tan\theta + gx^2/(2V^2\cos^2\theta)$$

Water surface computations in the outlet structure are based on Bakhmeteff's method. The drop structure is 35 feet wide, 42 feet long and has a vertical drop of 14 feet. The stilling basin is 40 feet wide and 85 feet long with a vertical end sill four feet high. A row of three baffles at 40 feet from the end of the stilling basin is provided. Plate D-11 shows the typical sections for the drop structure and stilling basin.

As discussed in the Hydrology Section, the proposed diversion channel diverts flood flows from the Alenaio Basin into the Wailuku Basin. To determine the effects this would have on the Wailuku River flood peaks, the SPF water surface profile was computed using HEC-2 with a discharge of 103,000 cfs, 91,000 cfs for Wailuku and 12,000 cfs for Alenaio. The Wailuku River SPF peak water surface elevation would be increased by approximately 2 feet with the additional flow, but it would still be approximately 2 feet below the existing bridge superstructures.

Modifying the Existing Stream. The existing stream can accommodate the reduced flows, provided the channel is maintained and the Kilauea Avenue and Kinoole Street bridges are modified. Both would require minimum openings of 20'W by 10'H.

100-Year Protection

This alternative follows the same design and assumptions as Alternative 2 - SPF Protection, but differs in a reduced diversion channel size due to the lower flows. The design discharge for the diversion channel is 6,950 cfs and the discharge for the existing channel varies from 1,600 cfs at Hilo Bay to 1,280 cfs at Kilauea Avenue, to 670 cfs at Kapiolani Street. Table D-13 shows the pertinent data for Alternative 2 - 100-Year Protection.

TABLE D-13. Alternative 2 - 100-Year Protection
Pertinent Data

Diversion Channel	Concrete Channel Trapezoidal - length = 1,850 ft. Bottom Width = 15 ft. Slideslopes - 1.5H to 1.0V Flood Depth - 8.0 to 10.0 ft. Maximum Velocity - 30 fps Transition - Length = 100 ft. Rectangular - Length = 2,250 ft. Width - 25 ft. Flood Depth - 8.0 to 11.0 ft. Maximum Velocity - 50 fps 650 ft of Rectangular would either be an open or covered channel. If open, same as above. Covered Twin Cell - 14.5H by 13W Drop Structure Width = 25 ft. Length = 42 ft. Vertical Drop = 14 ft. Stilling Basin Length = 85 ft. Width = 40 ft. 1 Row of baffles, 40 ft from end. Bridges - 3, span = 25 ft. (Komohana and Punahele Streets and Waianuenue Avenue)
Modifying Existing Stream	Bridges - 2 Kilauea Ave - 18'W x 10'H Kinoole St - 18'W x 10'H

Alternative 3

The nonstructural plan for Alenaio Stream provides protection for both the 100-year flood event and the SPF. This plan affects 131 structures for the SPF plan and 94 structures for the 100-year level of protection. Many structures contain more than one damage unit especially in commercial structures where many different stores may occupy one building structure. A breakdown of nonstructural methods and number of structures involved is as follows:

Method	Number of Structures	
	100-yr	SPF
Temporary or Permanent Closures	19	18
Relocate damageable items	14	14
Raise the first floor elevation	25	41
Remove the structure	31	53
Ring Walls	5	5
	94	131

The main types of structures in the study area are:

Wood frame on post and beam
Wood frame on concrete slab
Concrete block on a concrete slab

In determining the nonstructural plan for Alenaio, the following assumptions were made:

a. Wood frame on post and beam structures are easy to raise; and can be raised up to 9 feet above existing grade.

b. Concrete block or a concrete slab structure can resist a hydrostatic head up to 2.0 feet.

c. The relocating of damageable goods within a structure is a viable alternative until the 1% flood elevation is 2 feet above a structure's first floor.

d. A wood frame on concrete slab structure, with a 2-foot difference between the 1% event elevation and the first floor, will be removed.

e. Metal buildings on a concrete slab will be treated as a wood on concrete structure.

f. Wood frame on concrete block structures are assumed to behave identically to wood frame on post and beam structures.

Tables D-14 and D-15 are the nonstructural plan by reach by level of protection for Alenaio Stream. This should be considered as a minimum plan, as a closer inspection of the individual structures and personal desires of the owner may require the use of a different specific floodproofing technique. For this study, removal is considered to be the demolition of the old structure, and the construction of a new floodproofed structure on the same site. Relocating the structure on a new site was not considered due to the magnitude of commercial enterprise involved. Also, this type of removal and allocations are not of a nature which may cause removed businesses to suffer economically, if they were relocated away from the main business areas. The structural codes used in Tables D-14 and D-15 are listed below:

Code	Explanation
10	Wood frame on post and beam
15	Wood frame on concrete slab
20	Wood frame on concrete block
25	Concrete block or brick on concrete slab
30	Metal frame on concrete slab
35	Reinforced concrete
c	Commercial
R	Residential
d	Duplex

Table D-14. ALENAIO STREAM
1% Event (100-Year)
Reach Number 1

Location of Structure		Range	Type of Structure	Depth of Flooding	Method
3-2-2-4:25	1	1300	25c	1.6'	Ring wall
3-2-2-4:60	1	1500	25c	1.8'	Ring wall
3-2-2-6:27	1	2950	25c	.2'	Ring wall

Table D-14. ALENAIO STREAM
1% Event (100-Year)
Reach Number 2

Location of Structure		Range	Type of Structure	Depth of Flooding	Method
3-2-3-8:29	1	2960	15c d	2.5'	Remove
3-2-3-8:19	1	2970	25c	1.2'	Temp. & Perm. Closures
3-2-3-8:18	1	2980	25c	3.4'	Remove
3-2-3-9:14	1	3000	20c	.4'	Raise 2'
3-2-3-8:16	1	3020	25c	.6'	Temp. & Perm. Closures
3-2-3-8:15	1	3030	15c	2.3'	Remove
3-2-3-8:14	1	3030	15c	1.9'	Relocate Goods
3-2-3-8:13	1	3040	15c	2.1'	Remove
3-2-3-8:12	2	3040	25c	1.3'	Temp. & Perm. Closures
3-2-3-8:18	2	3070	25c	.4'	Temp. & Perm. Closures
3-2-3-9:35	1	3070	10c	.4'	Raise 2'
3-2-3-8:12	1	3100	25c d	.3'	Temp. & Perm. Closures
3-2-3-8:29	2	3120	25c	.8'	Temp. & Perm. Closures
3-2-3-8:27	1	3120	15c d	.5'	Relocate Goods
3-2-3-9:11	1	3120	25c	1.0'	Temp. & Perm. Closures
3-2-3-9:11	1	3140	25c	1.2'	Temp. & Perm. Closures
3-2-3-8:35	1	3160	15c d	.7'	Relocate Goods
3-2-3-8:29	3	3180	25c d	1.8'	Temp. & Perm. Closures
3-2-3-9:5	1	3220	10c	.1'	Raise 1'
3-2-3-8:1	1	3250	15c d	3.0'	Remove
3-2-3-8:25	2	3250	25c	1.6'	Temp. & Perm. Closures
3-2-3-8:1	1	3250	15c d	3.0'	Remove
3-2-3-8:25	2	3250	25c	1.0'	Temp. & Perm. Closures
3-2-3-9:6	1	3260	15c d	1.2'	Relocate Goods
3-2-3-8:6	1	3270	20c	3.0'	Raise 4'
3-2-3-8:25	1	3270	25c	1.3'	Temp. & Perm. Closures
3-2-3-7:21	1	3280	25c	1.0'	Temp. & Perm. Closures
3-2-3-8:2	1	3290	10c	1.3'	Raise 3'
3-2-3-24:2	1	3290	15c	.7'	Relocate Goods
3-2-3-9:7	1	3300	15c	.9'	Relocate Goods
3-2-3-8:24	1	3310	25c	.1'	Temp. & Perm. Closures
3-2-3-9:9	5	3310	15c d	3.3'	Remove
3-2-3-9:9	4	3320	15c d	3.2'	Remove
3-2-3-9:8	1	3330	15c d	.4'	Relocate Goods
3-2-3-8:21	1	3350	10c d	.8'	Raise 2'
3-2-3-8:22	1	3350	10c d	.4'	Raise 2'
3-2-3-8:22	2	3350	10c d	.1'	Raise 1'
3-2-3-8:33	1	3350	10c d	2.3'	Raise 4'
3-2-3-8:3	1	3350	10c	1.5'	Raise 3'
3-2-3-11:15	1	3440	25c d	.9'	Temp. & Perm. Closures
3-2-3-11:13	3	3460	10c d	2.4'	Raise 4'
3-2-3-11:17	2	3460	15c d	4.3'	Remove
3-2-3-11:11	2	3460	25c d	3.3'	Remove
3-2-3-9:9	1	3470	15c d	2.7'	Remove
3-2-3-11:16	1	3470	15c	4.2'	Remove
3-2-3-9:9	3	3470	15c	4.2'	Remove
3-2-3-9:9	2	3470	15c d	3.3'	Remove

Table D-14. ALENAIO STREAM
1% Event (100-Year)
Reach Number 2 (Cont)

Location of Structure		Range	Type of Structure	Depth of Flooding	Method
3-2-3-6:9	1	3480	30c	.1'	Temp. & Perm. Closures
3-2-2-8:5	1	3481	10c d	1.6'	Raise 3'
3-2-2-8:48	1	3485	15c d	.8'	Relocate Goods
3-2-2-8:46	1	3485	15c	1.1'	Relocate Goods
3-2-3-10:5	6	3485	15c d	4.9'	Remove
3-2-3-10:6	4	3490	15c	4.7'	Remove
3-2-3-10:6	5	3490	15c	4.5'	Remove
3-2-3-10:7	1	3510	15c	3.7'	Remove
3-2-3-10:13	1	3530	25c	4.2'	Remove
3-2-3-11:19	2	3535	15c	.8'	Relocate Goods
3-2-3-10:10	1	3535	25c	2.1'	Temp. & Perm. Closures
3-2-3-11:17	1	3535	15c	4.0'	Remove
3-2-3-10:6	2	3540	10R	2.7'	Raise 4'
3-2-3-10:6	3	3540	10R	2.7'	Raise 4'
3-2-2-8:23	3	3540	25c	1.2'	Temp. & Perm. Closures
3-2-3-10:5	5	3580	10R	4.8'	Raise 6'
3-2-3-10:5	4	3580	10R	.8'	Raise 2'
3-2-3-10:6	1	3580	10R	.8'	Raise 2'
3-2-2-8:5	2	3610	10R	4.9'	Raise 6'
3-2-3-10:8	1	3630	25c	3.5'	Remove
3-2-3-10:5	3	3630	10R	1.0'	Raise 2'
3-2-3-10:5	1	3660	10R	1.1'	Raise 2'
3-2-3-10:5	2	3660	10R	1.1'	Raise 2'
3-2-3-11:19	1	3660	15c d	1.0'	Relocate Goods
3-2-3-10:4	1	3690	15c d	.2'	Relocate Goods
3-2-2-8:21	1	3840	30c	3.6'	Remove
3-2-2-8:5	8	3870	10R	.2'	Raise 2'
3-2-3-11:1	1	3900	15c d	2.7'	Remove
3-2-2-8:14	1	4070	15c d	5.9'	Remove
3-2-2-8:15	1	4090	15c	2.8'	Remove
3-2-3-18:48	1	4220	15c d	2.8'	Remove
3-2-3-18:33	2	4220	15c	3.5'	Remove
3-2-3-18:33	3	4220	25c	3.4'	Remove
3-2-3-12:58	1	4230	25c	3.7'	Remove
3-2-3-12:56	1	4230	25c	3.7'	Remove
3-2-3-18:55	1	4230	15c d	1.8'	Relocate Goods
3-2-3-12:41	1	4240	25c	.2'	Temp. & Perm. Closures
3-2-3-12:49	1	4260	15c d	1.5'	Relocate Goods
3-2-3-12:54	1	4290	25c	5.2'	Remove
3-2-3-18:29	4	4450	10R	1.3'	Raise 3'
3-2-3-18:29	3	4490	10R	1.5'	Raise 3'

Table D-14. ALENAIO STREAM
1% Event (100-Year)
Reach Number 3

Location of Structure		Range	Type of Structure	Depth of Flooding	Method
3-2-3-19:16	1	5650	25R	1.8'	Temp. & Perm. Closures
3-2-3-36:12	1	6065	10R	3.1'	Raise 4'
3-2-3-48:19	1	9720	20R	.6'	Raise 2'
3-2-3-48:18	1	9770	10R	.6'	Raise 2'

Table D-15 is the same as Table D-14 except that the flood being considered is the Standard Project Flood (SPF). The nonstructural plan for the SPF includes the following:

Table D-15. ALENAIO STREAM
SPF Event
Reach Number 1

Location of Structure		Range	Type of Structure	Depth of Flooding	Method
3-2-2-4:25	1	1300	25c	2.6	Ring Wall
3-2-2-4:60	1	1500	25c	2.9	Ring Wall
3-2-2-6:27	1	2950	25c	1.4	Ring Wall

Table D-15. ALENAIO STREAM
SPF Event
Reach Number 2

Location of Structure		Range	Type of Structure	Depth of Flooding	Method
3-2-3-8:29	1	2960	15c d	3.7'	Remove
3-2-3-8:19	1	2970	25c	2.4'	Remove
3-2-3-8:18	1	2980	25c	4.6'	Remove
3-2-3-9:1	1	2980	25c	0.8'	Temp. & Perm. Closures
3-2-3-8:41	1	2980	15c	0.4'	Relocate Goods
3-2-3-8:28	1	2990	15c	2.5'	Remove
3-2-3-9:14	1	3000	20c	1.6'	Raise 3'

Table D-15. ALENAIO STREAM
SPF Event
Reach Number 2 (cont)

Location of Structure		Range	Type of Structure	Depth of Flooding	Method
3-2-3-8:16	1	3020	25c	1.8'	Temp. & Perm. Closures
3-2-3-8:15	1	3030	15c	3.5'	Remove
3-2-3-8:14	1	3030	15c	3.1'	Remove
3-2-3-9:39	1	3030	25c	0.6'	Temp. & Perm. Closures
3-2-3-8:13	1	3040	15c	3.3'	Remove
3-2-3-8:12	2	3040	25c	2.5'	Remove
3-2-3-8:18	2	3070	25c	1.6'	Temp. & Perm. Closures
3-2-3-9:35	1	3070	10c	1.6'	Raise 3'
3-2-3-7:16	1	3070	15c	0.1'	Relocate Goods
3-2-3-7:17	1	3080	25c	0.1'	Relocate Goods
3-2-3-8:16	1	3090	25c	0.7'	Temp. & Perm. Closures
3-2-3-8:12	1	3100	25c d	1.5'	Temp. & Perm. Closures
3-2-3-9:11	1	3120	25c	2.2'	Remove
3-2-3-8:29	2	3120	25c	2.0'	Remove
3-2-3-8:27	1	3120	15c d	1.7'	Relocate Goods
3-2-3-7:19	1	3120	15c	0.5'	Relocate Goods
3-2-3-8:11	1	3140	25c	2.2'	Remove
3-2-3-8:35	1	3160	15c d	1.7'	Relocate Goods
3-2-3-9:4	1	3170	10c	0.2'	Relocate Goods
3-2-3-8:29	3	3180	25c d	2.7'	Remove
3-2-3-7:19	2	3190	15c	0.7'	Relocate Goods
3-2-3-9:5	1	3220	10c	0.9'	Raise 2'
3-2-3-8:1	1	3250	15c d	3.6'	Remove
3-2-3-8:25	2	3250	25c	2.2'	Remove
3-2-3-9:6	1	3260	15c d	1.8'	Relocate Goods
3-2-3-8:6	1	3270	20c	3.5'	Raise 5'
3-2-3-8:25	1	3270	25c	1.8'	Temp. & Perm. Closures
3-2-3-7:21	1	3280	25c	1.6'	Temp. & Perm. Closures
3-2-3-9:10	1	3280	10R	0.2'	Raise 2'
3-2-3-8:2	1	3290	10c	1.8'	Raise 3'
3-2-3-8:2.4	2	3290	15c	1.2'	Relocate Goods
3-2-3-9:7	1	3300	15c	1.3'	Relocate Goods
3-2-3-9:9	5	3310	15c	3.8'	Remove
3-2-3-8:24	1	3310	25c	0.6'	Temp. & Perm. Closures
3-2-3-9:9	4	3320	15c d	3.6'	Remove
3-2-3-9:8	1	3330	15c d	0.7'	Relocate Goods
3-2-3-8:33	1	3350	10c d	2.6'	Raise 4'
3-2-3-8:3	1	3350	10c	1.8'	Raise 3'
3-2-3-8:21	1	3350	10c d	1.1'	Raise 2'
3-2-3-8:22	1	3350	10c d	0.7'	Raise 2'
3-2-3-8:22	2	3350	10c d	0.4'	Raise 2'
3-2-3-11:17	2	3460	15c d	5.5'	Remove
3-2-3-11:11	2	3460	25c d	4.5'	Remove
3-2-3-11:13	3	3460	10c d	3.6'	Remove
3-2-3-11:16	1	3470	15c	5.4'	Remove
3-2-3-9:9	3	3470	15c d	5.4'	Remove
3-2-3-9:9	2	3470	15c d	4.5'	Remove

Table D-15. ALENAIO STREAM
SPF Event
Reach Number 2 (cont)

Location of Structure		Range	Type of Structure	Depth of Flooding	Method
3-2-3-9:9	1	3470	15c d	3.9'	Remove
3-2-3-6:9	1	3480	30c	1.3'	Relocate Goods
3-2-2-8:5	1	3481	10c d	2.8'	Raise 4'
3-2-3-10:5	6	3485	15c d	6.1'	Remove
3-2-2-8:46	1	3485	15c	2.3'	Remove
3-2-2-8:48	1	3485	15c d	2.0'	Remove
3-2-3-10:6	4	3490	15c	5.9'	Remove
3-2-3-10:6	5	3490	15c	5.7'	Remove
3-2-2-8:26	1	3490	25c	1.1'	Temp. & Perm. Closures
3-2-2-8:1	1	3490	15c	0.6'	Relocate Goods
3-2-3-10:7	1	3510	15c	4.9'	Remove
3-2-3-10:13	1	3530	25c	5.5'	Remove
3-2-3-11:17	1	3535	15c	5.3'	Remove
3-2-3-10:10	1	3535	25c	3.4'	Remove
3-2-3-10:19	2	3535	15c	2.1'	Remove
3-2-3-10:6	2	3540	10R	4.0'	Raise 5'
3-2-3-10:6	3	3540	10R	4.0'	Raise 5'
3-2-3-8:23	1	3540	25c	2.5'	Remove
3-2-3-11:11	1	3540	10R	0.5'	Raise 2'
3-2-3-10:5	5	3580	10R	6.2'	Raise 7'
3-2-3-10:5	4	3580	10R	2.2'	Raise 3'
3-2-3-10:6	1	3580	10R	2.2'	Raise 3'
3-2-3-11:13	2	3590	10R	0.3'	Raise 2'
3-2-2-8:5	2	3610	10c	6.4'	Raise 8'
3-2-3-10:8	1	3630	25c	5.0'	Remove
3-2-3-10:5	3	3630	10R	2.5'	Raise 4'
3-2-3-10:5	1	3660	10R	2.6'	Raise 4'
3-2-3-10:5	2	3660	10R	2.6'	Raise 4'
3-2-3-11:19	1	3660	15c	2.5'	Remove
3-2-3-10:4	1	3690	15c	1.8'	Relocate Goods
3-2-2-8:5	4	3710	10R	1.0'	Raise 2'
3-2-2-8:40	1	3740	10R	1.6'	Raise 3'
3-2-2-8:5	6	3810	10R	0.1'	Raise 1'
3-2-2-8:5	5	3830	10R	1.5'	Raise 3'
3-2-2-8:21	1	3840	30c	5.7'	Remove
3-2-2-8:5	8	3870	10R	2.4'	Raise 4'
3-2-2-8:5	9	3870	10R	0.4'	Raise 2'
3-2-3-10:3	1	3890	25c	1.0'	Temp. & Perm. Closures
3-2-3-11:1	1	3900	15c	5.0'	Remove
3-2-3-10:1	1	3910	25c	0.2'	Temp. & Perm. Closures
3-2-2-8:5	13	3920	10R	2.3'	Raise 4'
3-2-2-8:5	14	3920	10R	1.3'	Raise 3'
3-2-2-8:5	15	3920	10R	0.3'	Raise 2'
3-2-2-8:16	1	3940	25c	1.4'	Temp. & Perm. Closures
3-2-2-8:30	1	4000	10R	1.6'	Raise 3'
3-2-2-8:30	2	4000	10R	0.6'	Raise 2'
3-2-2-8:14	1	4070	15c	8.1'	Remove

Table D-15. ALENAIO STREAM
SPF Event
Reach Number 2 (cont)

Location of Structure		Range	Type of Structure	Depth of Flooding	Method
3-2-2-8:12	1	4070	10R	1.8'	Raise 3'
3-2-2-8:15	1	4090	15c	4.8'	Remove
3-2-2-8:30	5	4100	10R	0.2'	Raise 1'
3-2-3-18:33	2	4220	15c	4.9'	Remove
3-2-3-18:33	3	4220	25c	4.8'	Remove
3-2-3-18:48	1	4220	15c	4.2'	Remove
3-2-3-12:58	1	4230	25c	5.1'	Remove
3-2-3-12:56	1	4230	25c	5.1'	Remove
3-2-3-18:55	1	4230	15c	3.2'	Remove
3-2-3-12:41	1	4240	25c	1.5'	Temp. & Perm. Closures
3-2-3-12:49	1	4260	15c	2.7'	Remove
3-2-3-12:54	1	4290	25c	6.1'	Remove
3-2-3-12:34	1	4330	25c	0.8'	Temp. & Perm. Closures
3-2-3-18:29	4	4450	10R	4.3'	Raise 6'
3-2-3-12:26	1	4450	25c	1.3'	Temp. & Perm. Closures
3-2-3-18:29	3	4490	10R	5.2'	Raise 6'
3-2-3-18:29	2	4520	10R	3.9'	Raise 5'
3-2-3-19:38	2	5500	15R	3.9'	Remove

Table D-15. ALENAIO STREAM
SPF Event
Reach Number 3

Location of Structure		Range	Type of Structure	Depth of Flooding	Method
3-2-3-19:16	1	5650	25R	5.0'	Remove
3-2-3-19:38	1	5650	25R	3.0'	Remove
3-2-3-19:37	1	5650	25R	1.0'	Temp. & Perm. Closures
3-2-3-36:12	3	5900	10R	0.9'	Raise 2'
3-2-3-36:12	2	5940	30R	2.0'	Remove
3-2-3-36:12	1	6065	10R	5.3'	Raise 7'
3-2-3-48:19	1	9720	20R	1.7'	Raise 3'
3-2-3-48:18	1	9770	10R	2.0'	Raise 3'

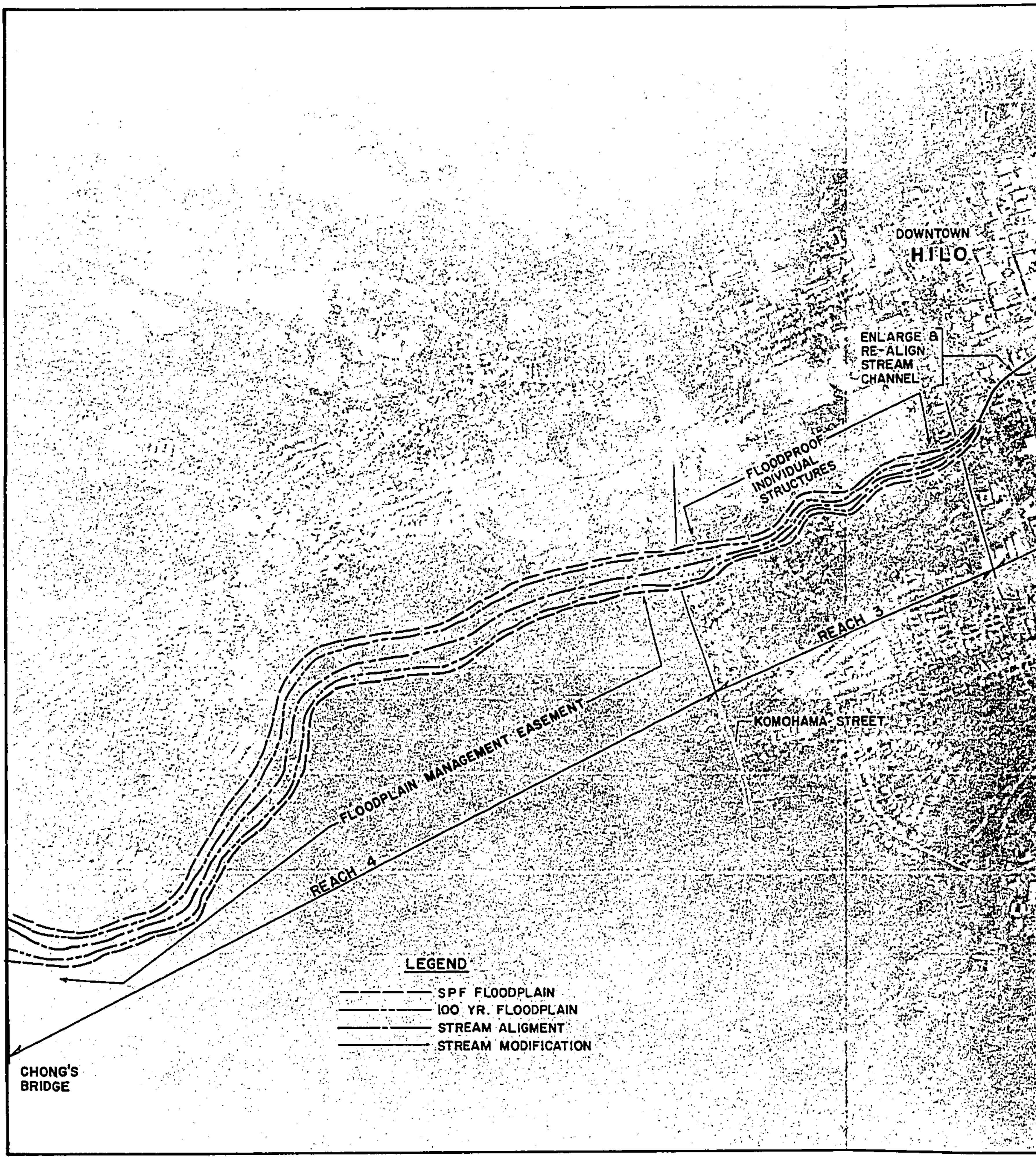
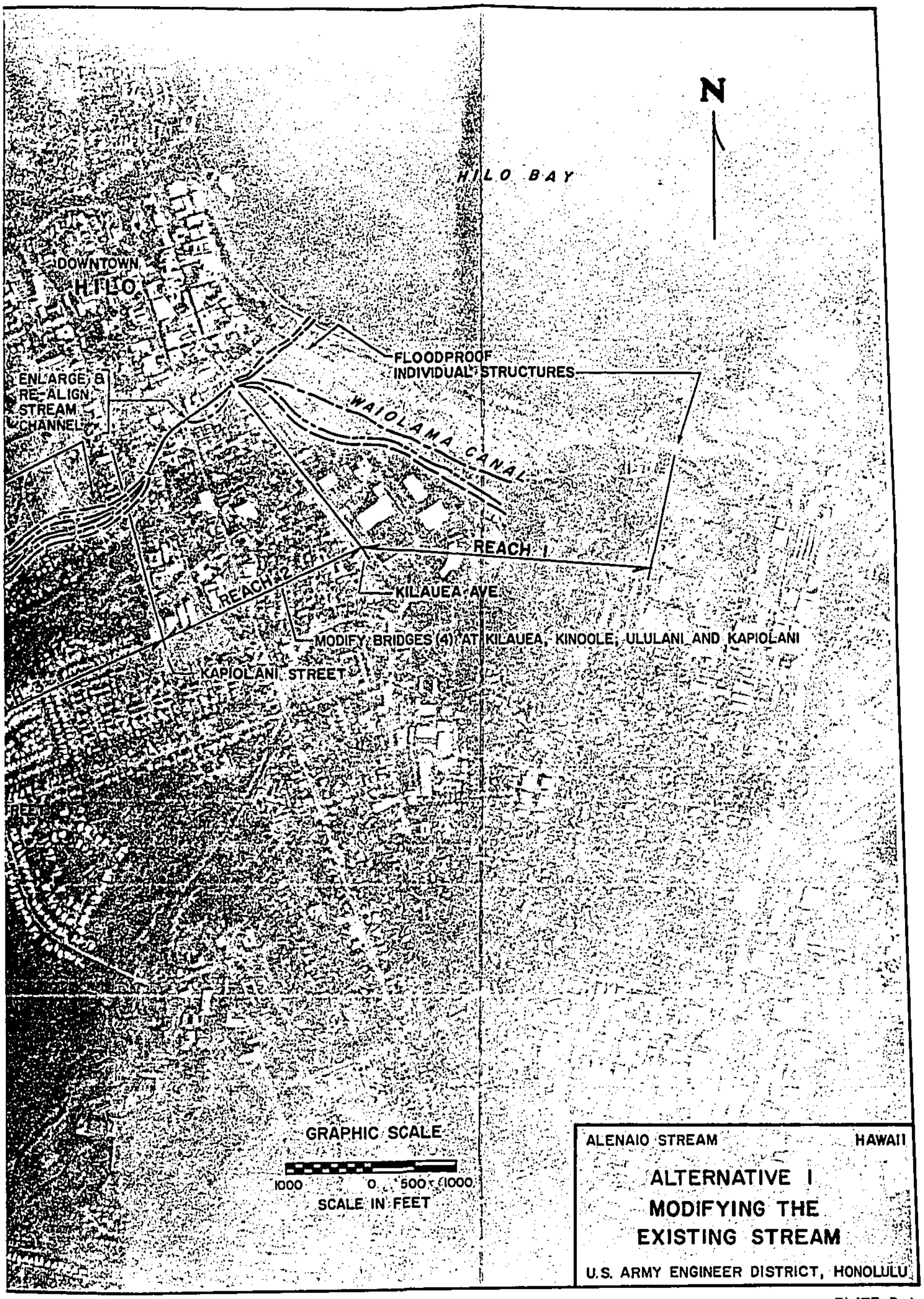

DOWNTOWN
HILO
ENLARGE & RE-ALIGN STREAM CHANNEL
FLOODPROOF INDIVIDUAL STRUCTURES
REACH 3
KOMOHAMA STREET
FLOODPLAIN MANAGEMENT EASEMENT
REACH 4
LEGEND
SPF FLOODPLAIN
100 YR. FLOODPLAIN
STREAM ALIGMENT
STREAM MODIFICATION
CHONG'S BRIDGE

PLATE D-1


N
HILO BAY
DOWNTOWN
HILO
ENLARGE &
RE-ALIGN
STREAM
CHANNEL
FLOODPROOF
INDIVIDUAL STRUCTURES
WAIOLAMA CANAL
REACH 1
REACH 2
KILAUEA AVE
MODIFY BRIDGES (4) AT KILAUEA, KINOOLE, ULULANI AND KAPIOLANI
KAPIOLANI STREET
GRAPHIC SCALE
1000 0 500 1000
SCALE IN FEET
ALENAIO STREAM HAWAII
ALTERNATIVE I
MODIFYING THE
EXISTING STREAM
U.S. ARMY ENGINEER DISTRICT, HONOLULU

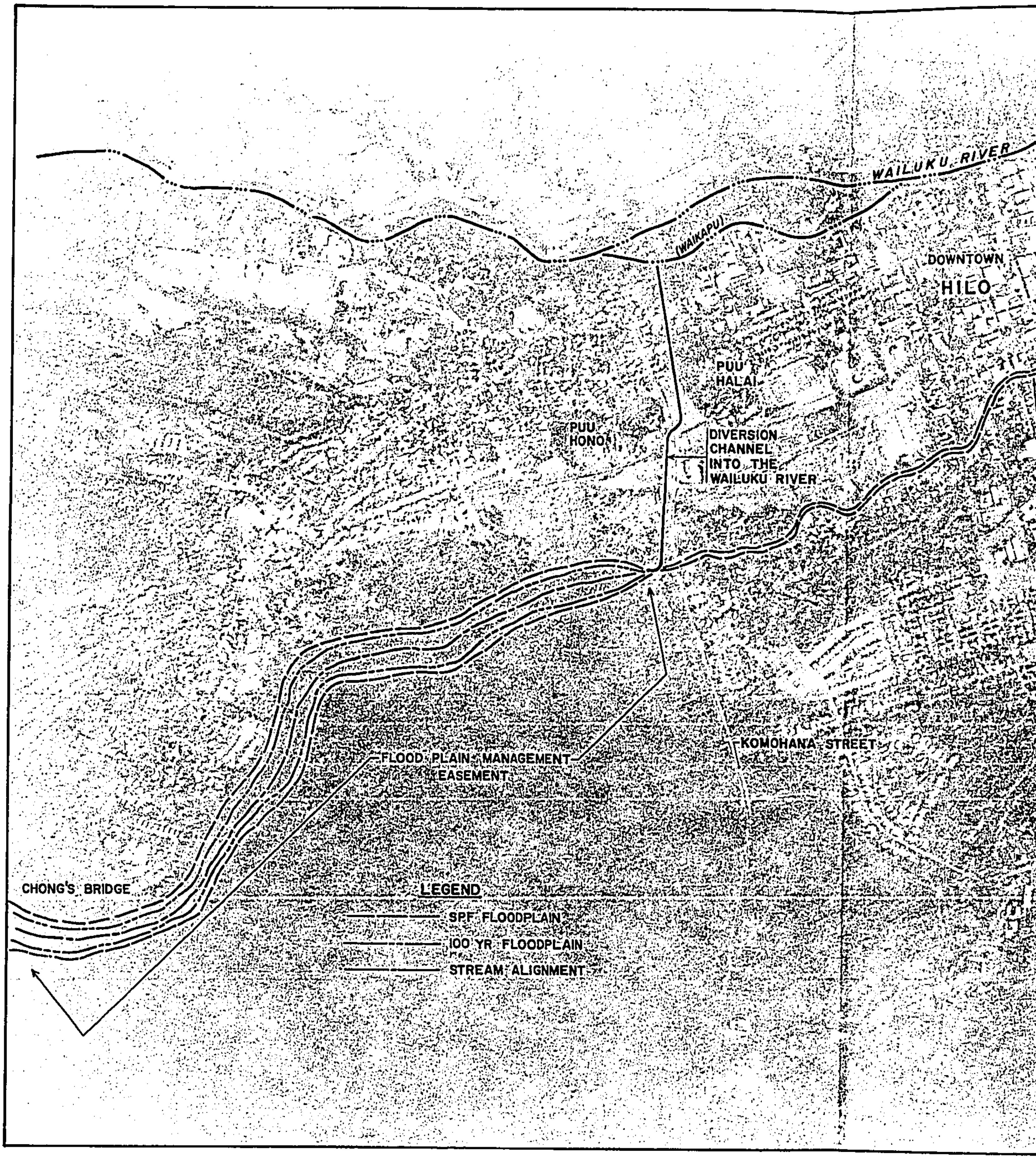
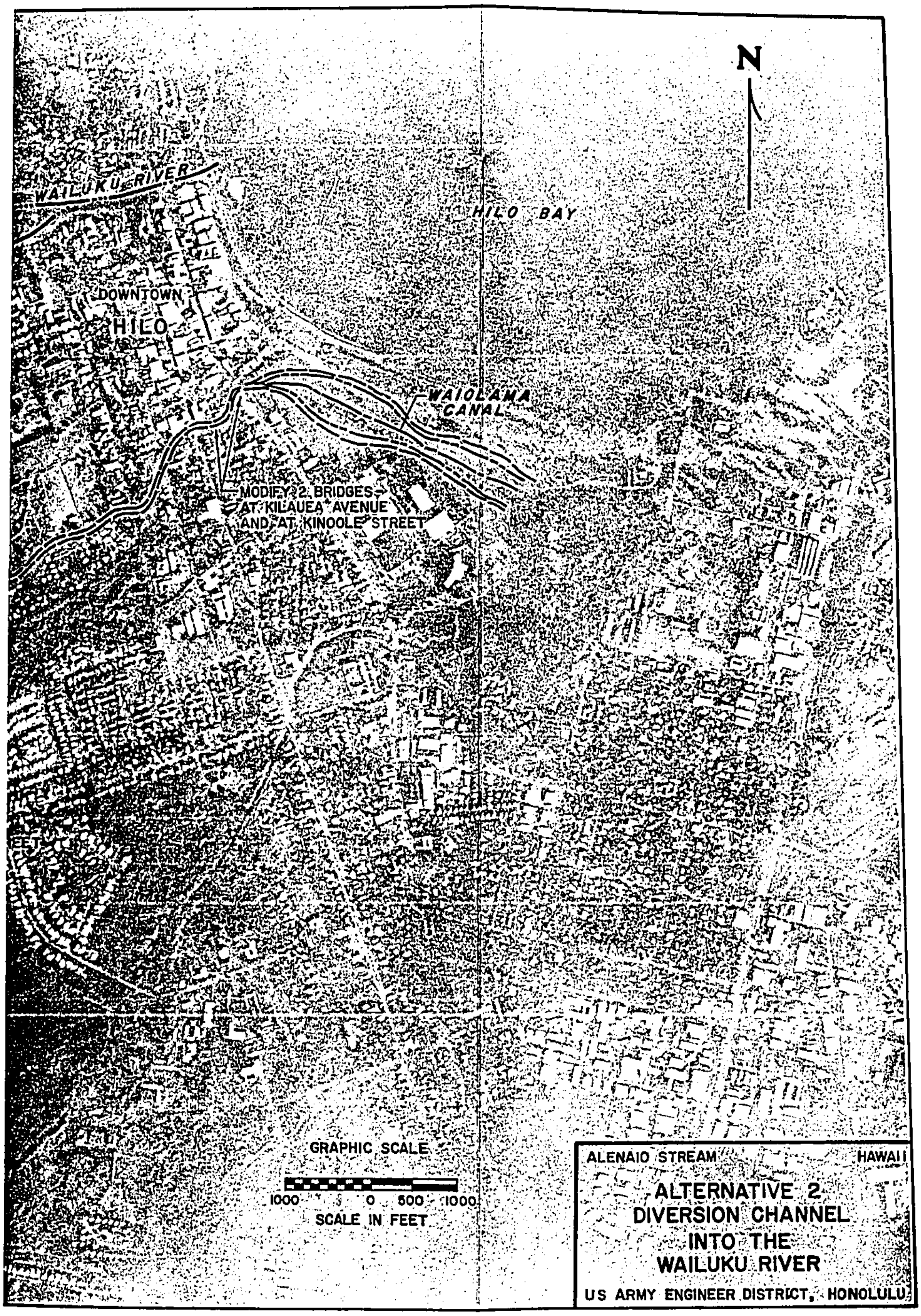
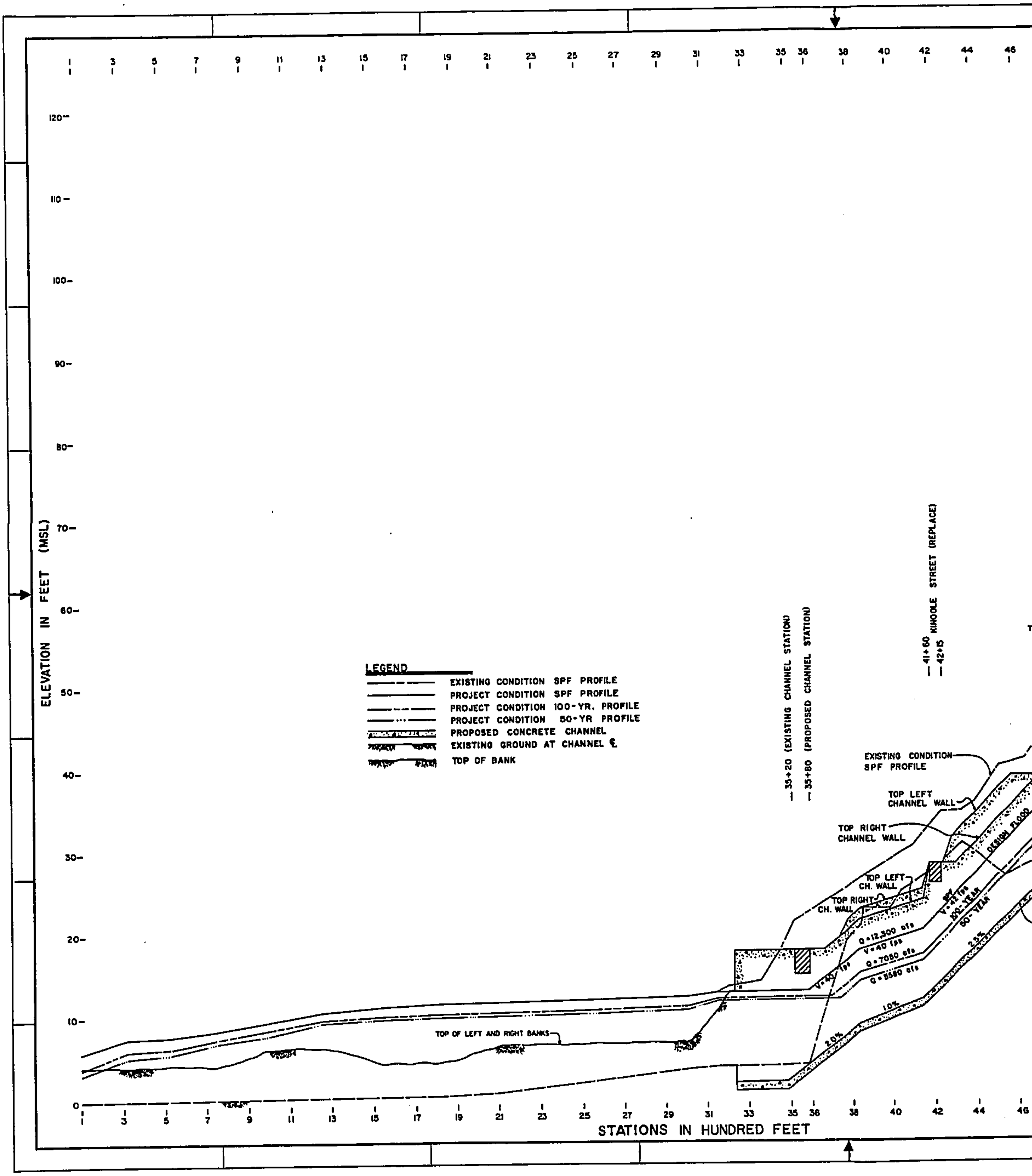
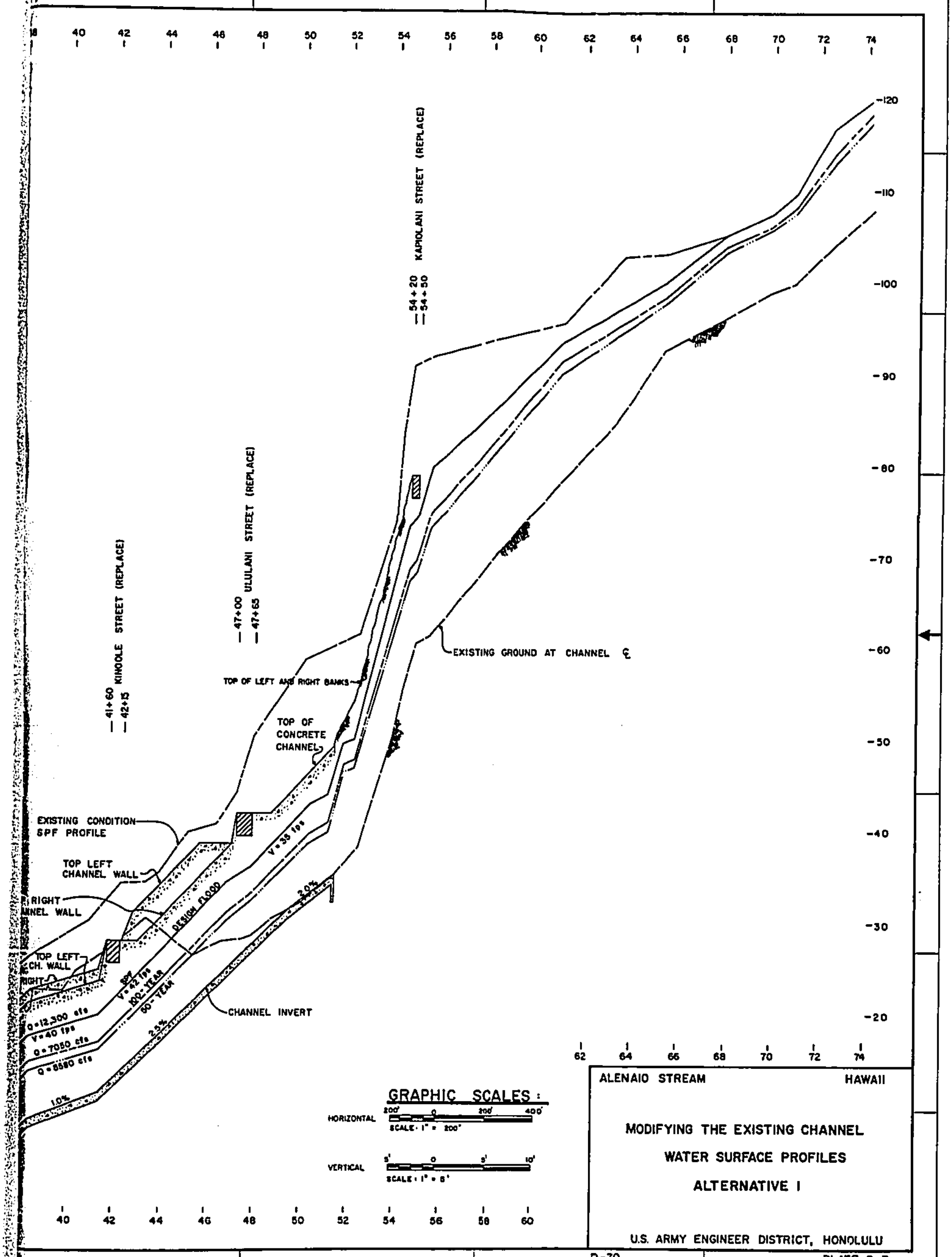

WAILUKU RIVER
(WAIKAPU)
DOWNTOWN
HILO
PUU
HALAI
PUU
HONO
DIVERSION
CHANNEL
INTO THE
WAILUKU RIVER
KOMOHANA STREET
FLOOD PLAIN MANAGEMENT
EASEMENT
CHONG'S BRIDGE
LEGEND
SPF FLOODPLAIN
100 YR FLOODPLAIN
STREAM ALIGNMENT

PLATE D-2


N
WAILUKU RIVER
HILO BAY
DOWNTOWN
HILO
WAIOLAMA
CANAL
MODIFY 2 BRIDGES
AT KILAUEA AVENUE
AND AT KINOOLE STREET
GRAPHIC SCALE
1000 0 500 1000
SCALE IN FEET
ALENAIO STREAM
HAWAII
ALTERNATIVE 2
DIVERSION CHANNEL
INTO THE
WAILUKU RIVER
US ARMY ENGINEER DISTRICT, HONOLULU



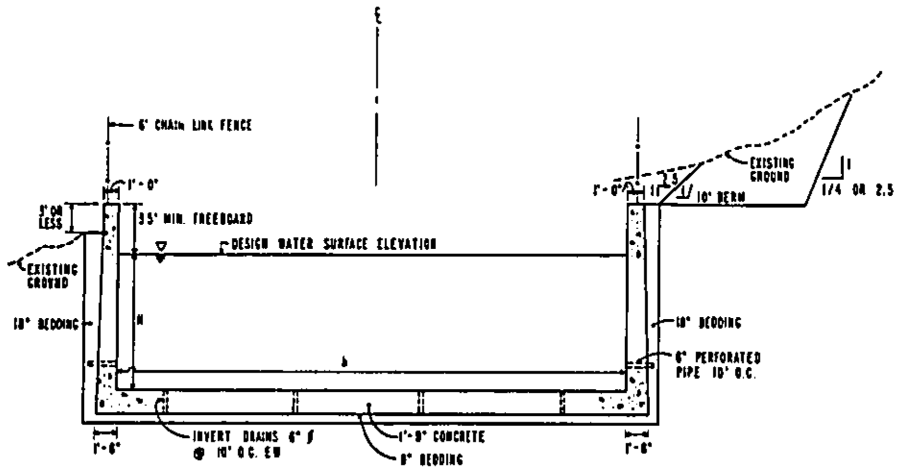
ELEVATION IN FEET (MSL)
STATIONS IN HUNDRED FEET
LEGEND
EXISTING CONDITION SPF PROFILE
PROJECT CONDITION SPF PROFILE
PROJECT CONDITION 100-YR. PROFILE
PROJECT CONDITION 50-YR PROFILE
PROPOSED CONCRETE CHANNEL
EXISTING GROUND AT CHANNEL ℄
TOP OF BANK
35+20 (EXISTING CHANNEL STATION)
35+80 (PROPOSED CHANNEL STATION)
41+60
42+15 KINOOLE STREET (REPLACE)
EXISTING CONDITION SPF PROFILE
TOP LEFT CHANNEL WALL
TOP RIGHT CHANNEL WALL
TOP LEFT CH. WALL
TOP RIGHT CH. WALL
TOP OF LEFT AND RIGHT BANKS
DESIGN FLOOD
SPF
100-YEAR
50-YEAR
Q=12,300 cfs
V=40 fps
Q=7050 cfs
Q=5580 cfs
2.0%
10%
2.5%



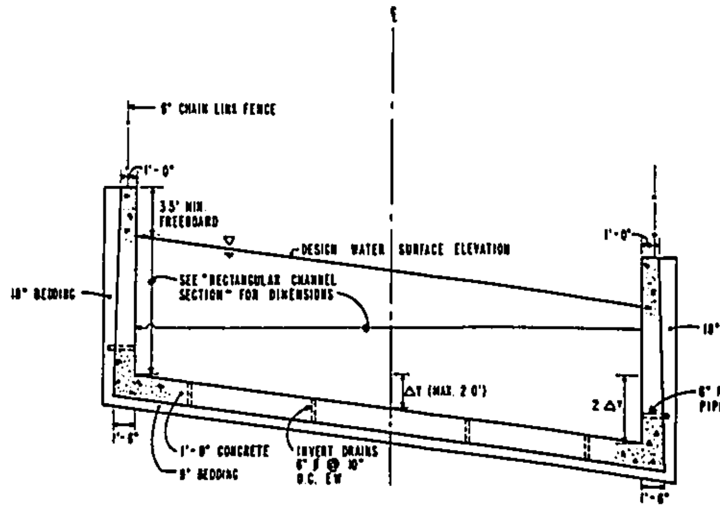
ALENAIO STREAM — HAWAII

MODIFYING THE EXISTING CHANNEL
WATER SURFACE PROFILES
ALTERNATIVE I

U.S. ARMY ENGINEER DISTRICT, HONOLULU



1/ IF GREATER THAN 2 FT., WALL WOULD NOT BE EXTENDED ABOVE REQ'D FREEBOARD HEIGHT A 10 FT WIDE BERM WOULD BE CONSTRUCTED, AND THEN A SIDESLOPE OF 1/4 H: 1V FOR ROCK OR 2.5: 1V FOR EARTH TO EXISTING GROUND APPLIES TO ALTERNATIVE 2



NOTE: BANKING WOULD BE INTRODUCED BY ROTATING THE BOTTOM IN TRANSVERSE SECTIONS ABOUT THE CHANNEL INVERT GRADE ON THE INNER SIDE OF THE CURVE.

RECTANGULAR CHANNEL SECTION

SCALE: 1" = 5'-0"

SUPERELEVATED CHANNEL

SCALE: 1" = 5'-0"

ALTERNATIVE 1 - SPF

	b FT.	H FT.
STA. 35+00 TO STA. 46+75	35	8
STA. 46+75 TO STA. 47+25	35 - 40	8 - 9.5
STA. 47+25 TO STA. 51+40	40	9.5

ALTERNATIVE 1 - 100 YEAR

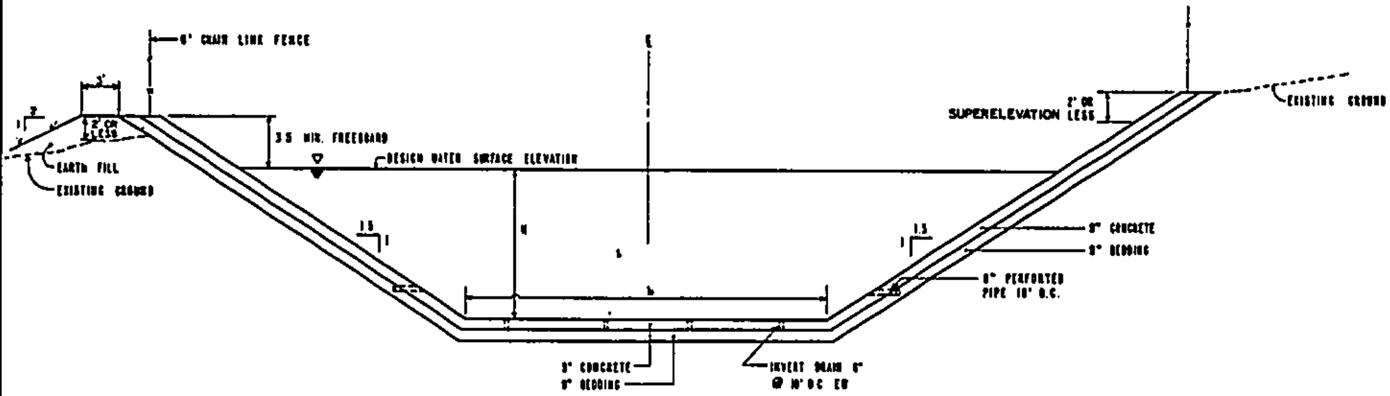
	b FT.	H FT.
STA. 35+00 TO STA. 46+50	25	8
STA. 46+50 TO STA. 51+40	25	8 - 12

ALTERNATIVE 2 - SPF

	b FT.	H FT.
STA. 10+00 TO STA. 16+50	35	10
STA. 16+50 TO STA. 28+50	35	8 - 10
STA. 28+50 TO STA. 32+50	35	10 - 12.5

ALTERNATIVE 2 - 100 YEAR

	b FT.	H FT.
STA. 10+00 TO STA. 16+50	25	11
STA. 16+50 TO STA. 28+50	25	8 - 11
STA. 28+50 TO STA. 32+50	25	11



TRAPEZOIDAL CHANNEL SECTION

SCALE: 1" = 5'-0"

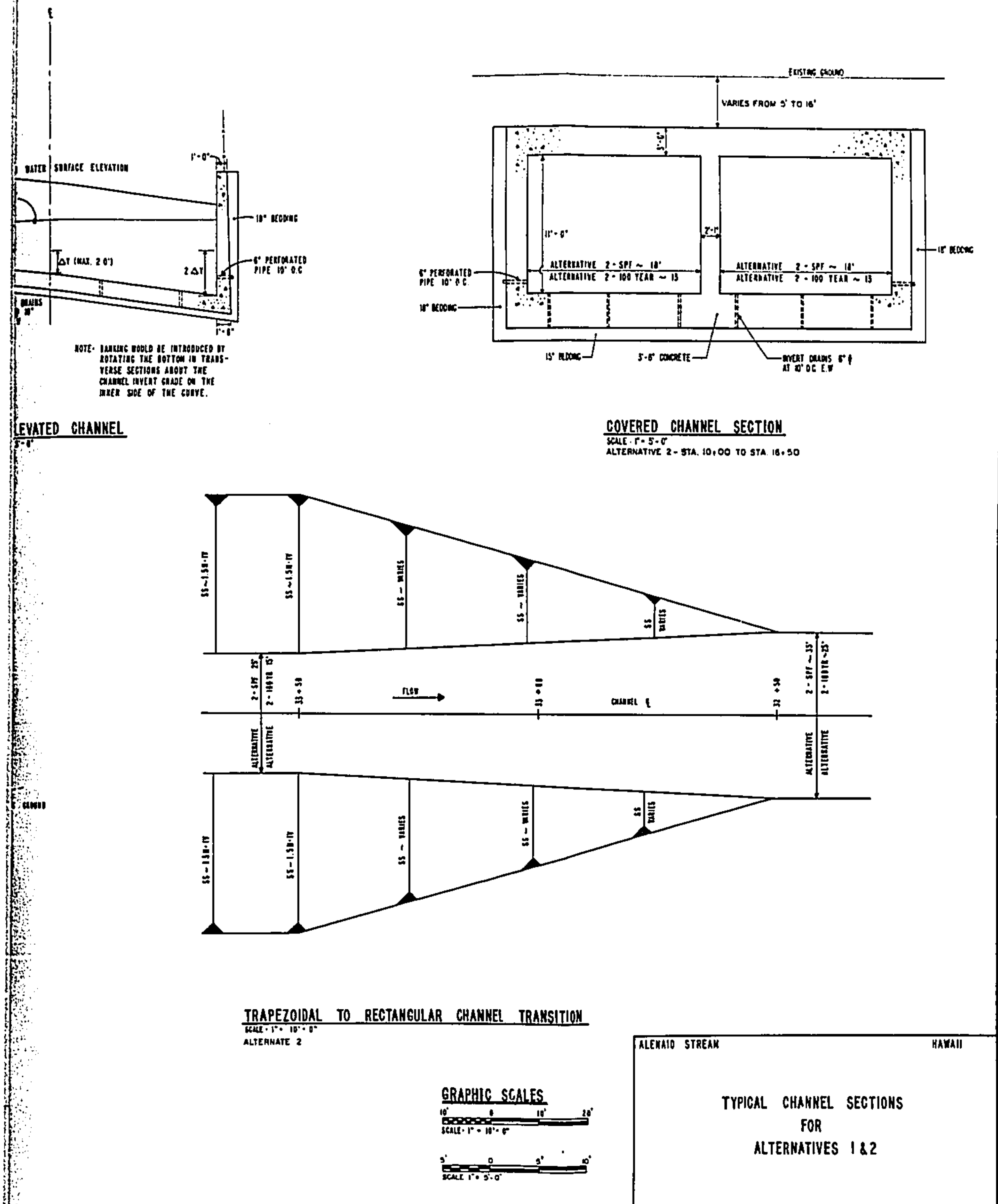
ALTERNATIVE 2 - SPF

	b FT.	H FT.
STA. 33+50 TO STA. 45+00	25	8 - 10
STA. 45+00 TO STA. 52+00	25	8

ALTERNATIVE 2 - 100 YEAR

	b FT.	H FT.
STA. 33+50 TO STA. 45+00	15	8 - 10
STA. 45+00 TO STA. 52+00	15	8

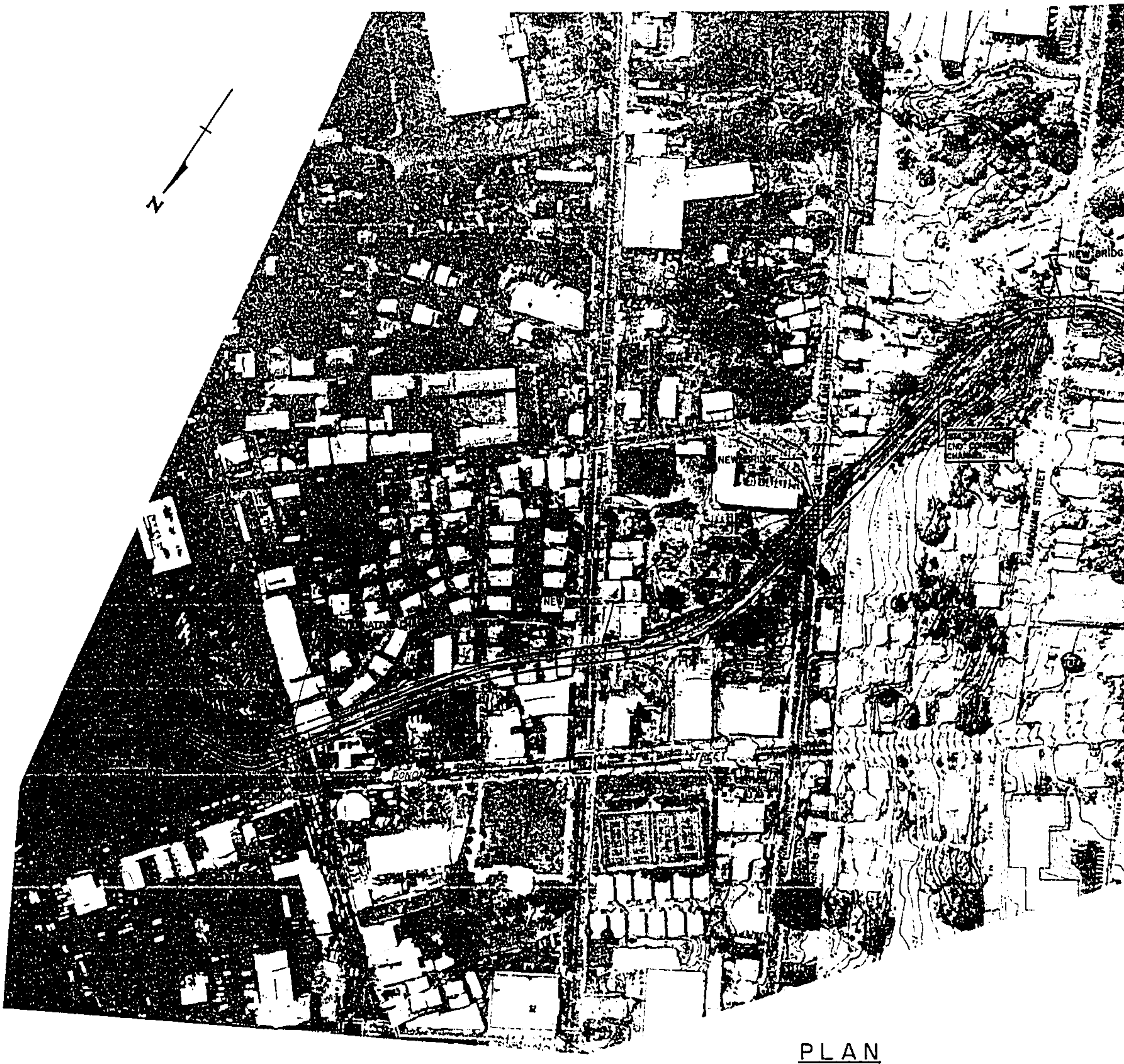
TRAP
ALTERN



ALENAIO STREAM HAWAII

TYPICAL CHANNEL SECTIONS
FOR
ALTERNATIVES 1 & 2

U.S. ARMY ENGINEER DISTRICT, HONOLULU



PLAN

NOTE: FOR TYPICAL SECTIONS SEE PLATE D-4

GRAPHIC SCALE

100' 0 100' 200'

SCALE: 1" = 100'

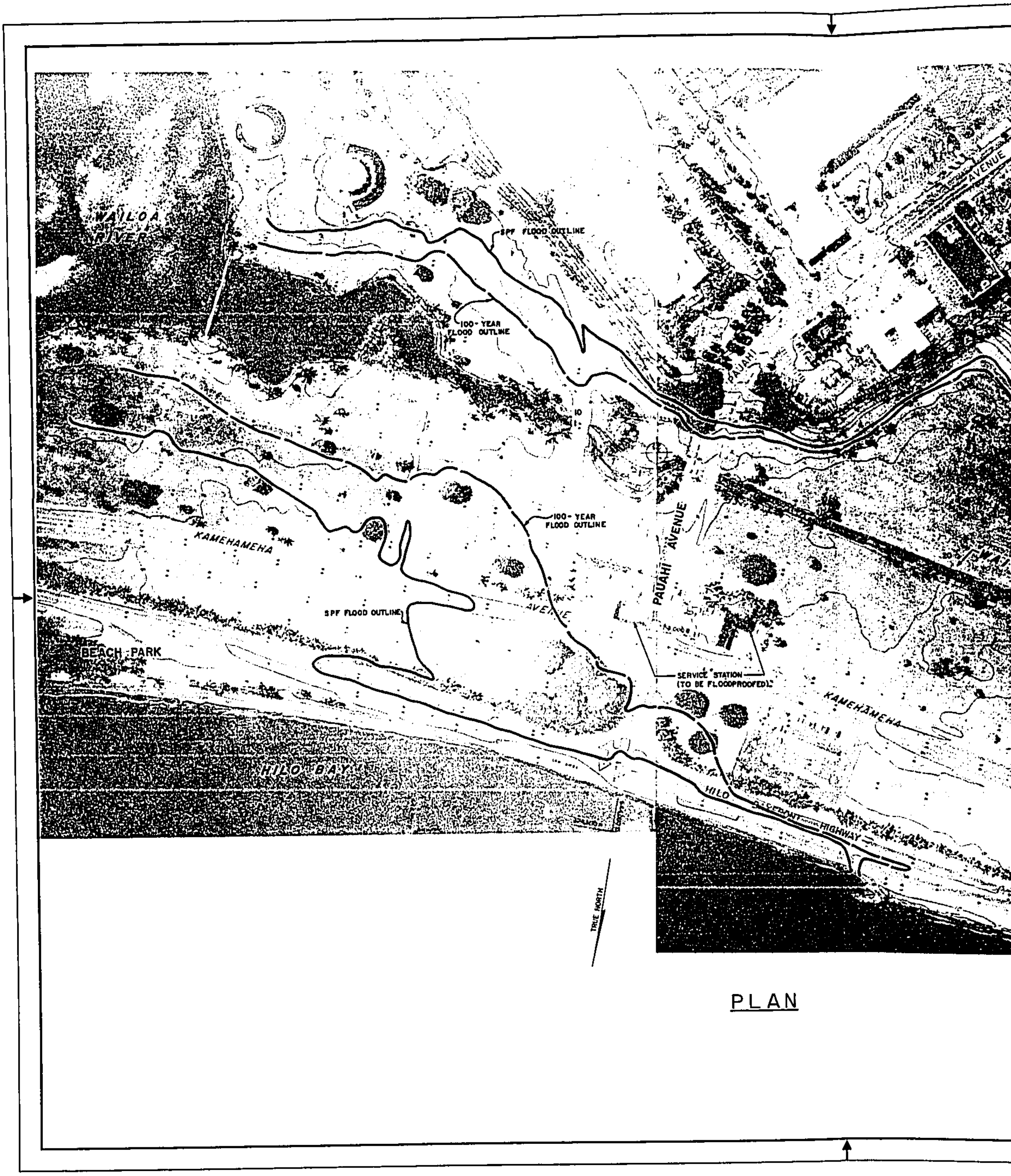
CONTOUR INTERVAL = 2'

ALENAIO STREAM HAWAII

ALTERNATIVE I ALIGNMENT (REACH 2)

MODIFYING THE EXISTING STREAM CHANNEL

U.S. ARMY ENGINEER DISTRICT, HONOLULU

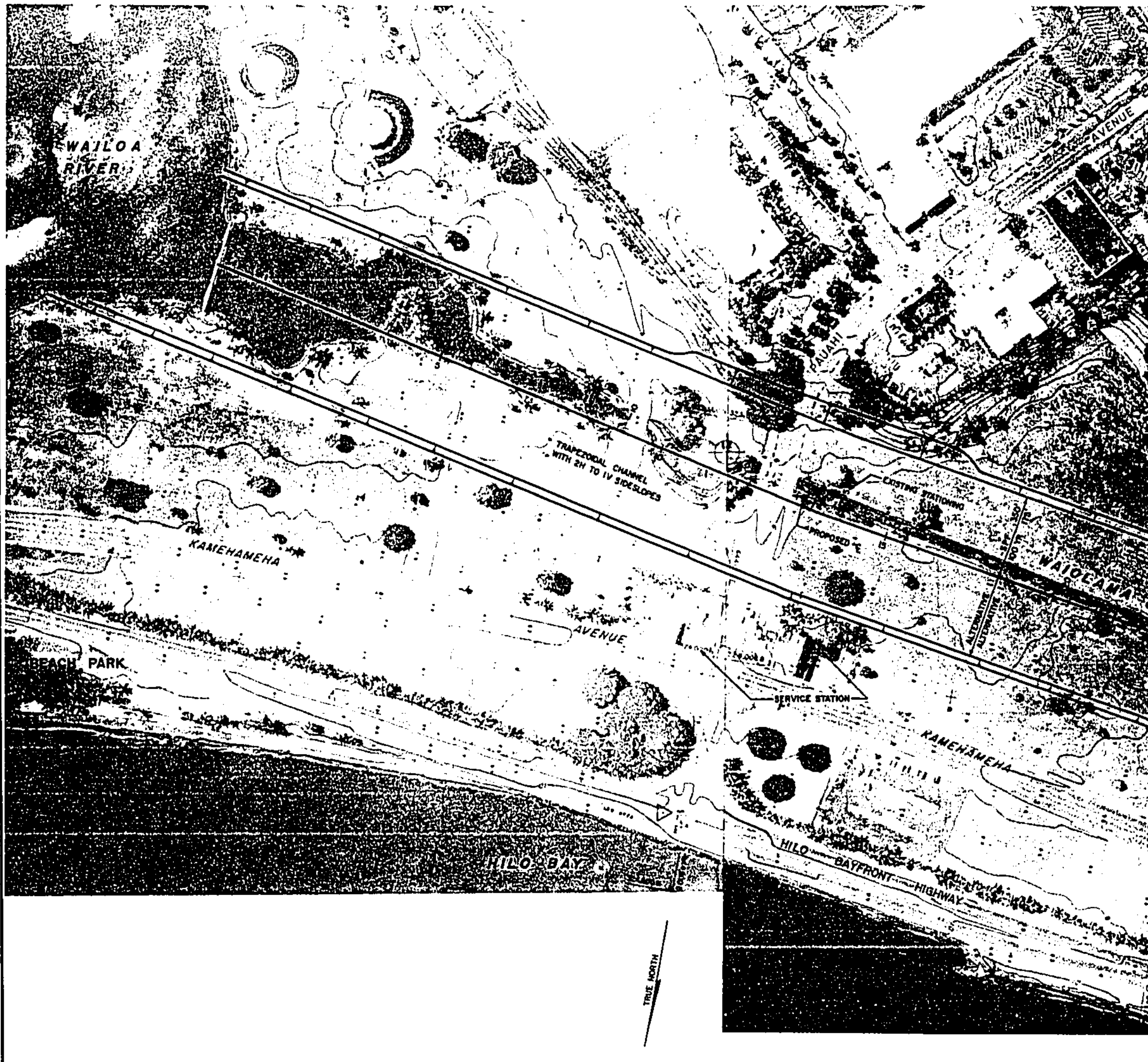

WAILOA RIVER
SPF FLOOD OUTLINE
100-YEAR FLOOD OUTLINE
100-YEAR FLOOD OUTLINE
SPF FLOOD OUTLINE
KAMEHAMEHA AVENUE
PAUAHI AVENUE
PAUAHI
SERVICE STATION (TO BE FLOODPROOFED)
BEACH PARK
HILO BAY
HILO BAYFRONT HIGHWAY
KAMEHAMEHA
AVENUE
TRUE NORTH

PLAN

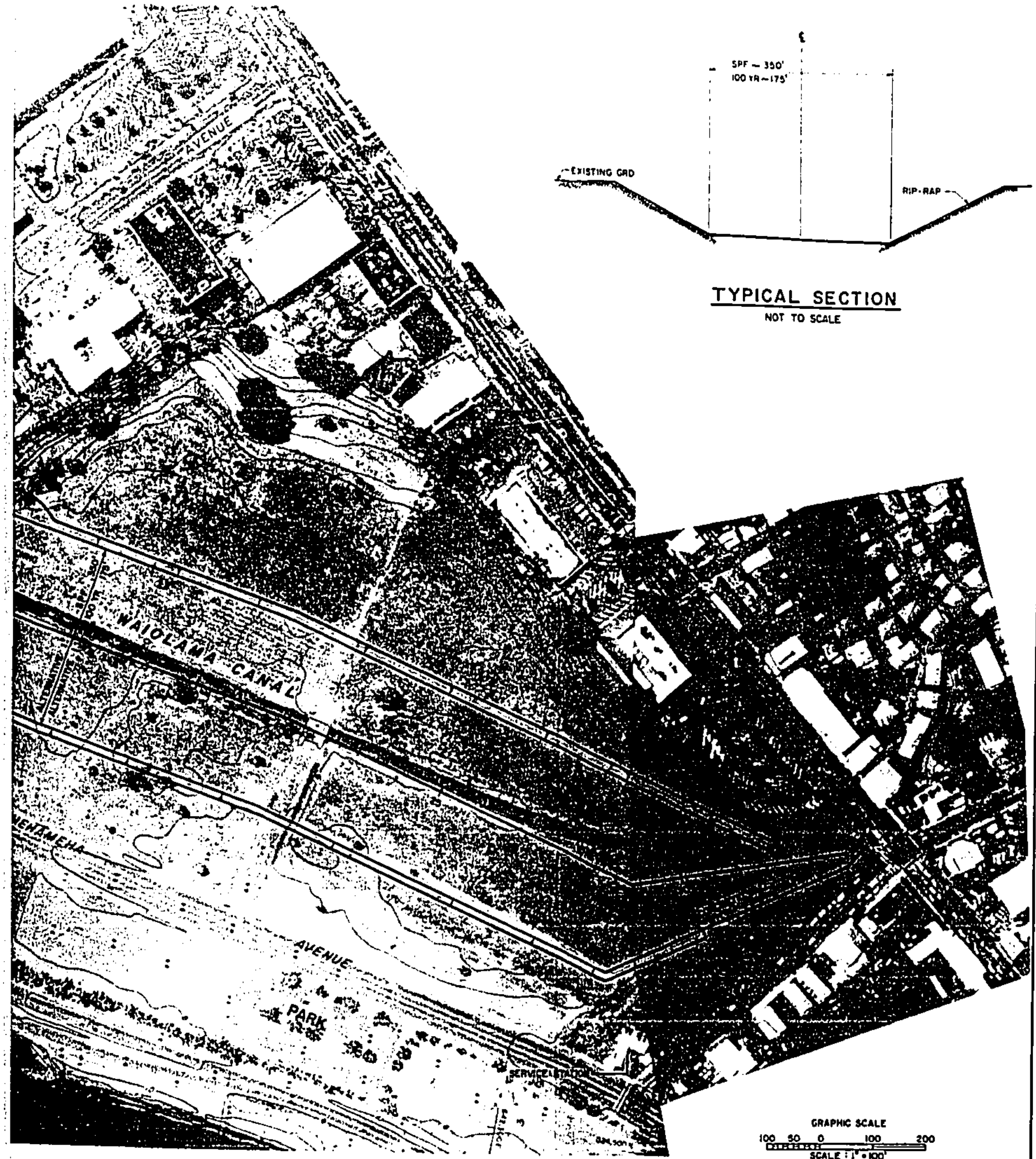
ALENAIO STREAM HAWAII

ALTERNATE I (REACH I)
FLOOD OUTLINE
NO STRUCTURAL ACTION OPTION
SUBALTERNATIVE a

U.S. ARMY ENGINEER DISTRICT, HONOLULU


WAILOA RIVER
TRAPEZOIDAL CHANNEL WITH 2H TO 1V SIDESLOPES
KAMEHAMEHA
AVENUE
BEACH PARK
HILO BAY
EXISTING STATIONING
PROPOSED
SERVICE STATION
KAMEHAMEHA
HILO BAYFRONT HIGHWAY
PAUAHI
AVENUE
TRUE NORTH

PLAN



TYPICAL SECTION

NOT TO SCALE

GRAPHIC SCALE

100 50 0 100 200

SCALE: 1" = 100'

CONTOUR INTERVAL = 2'

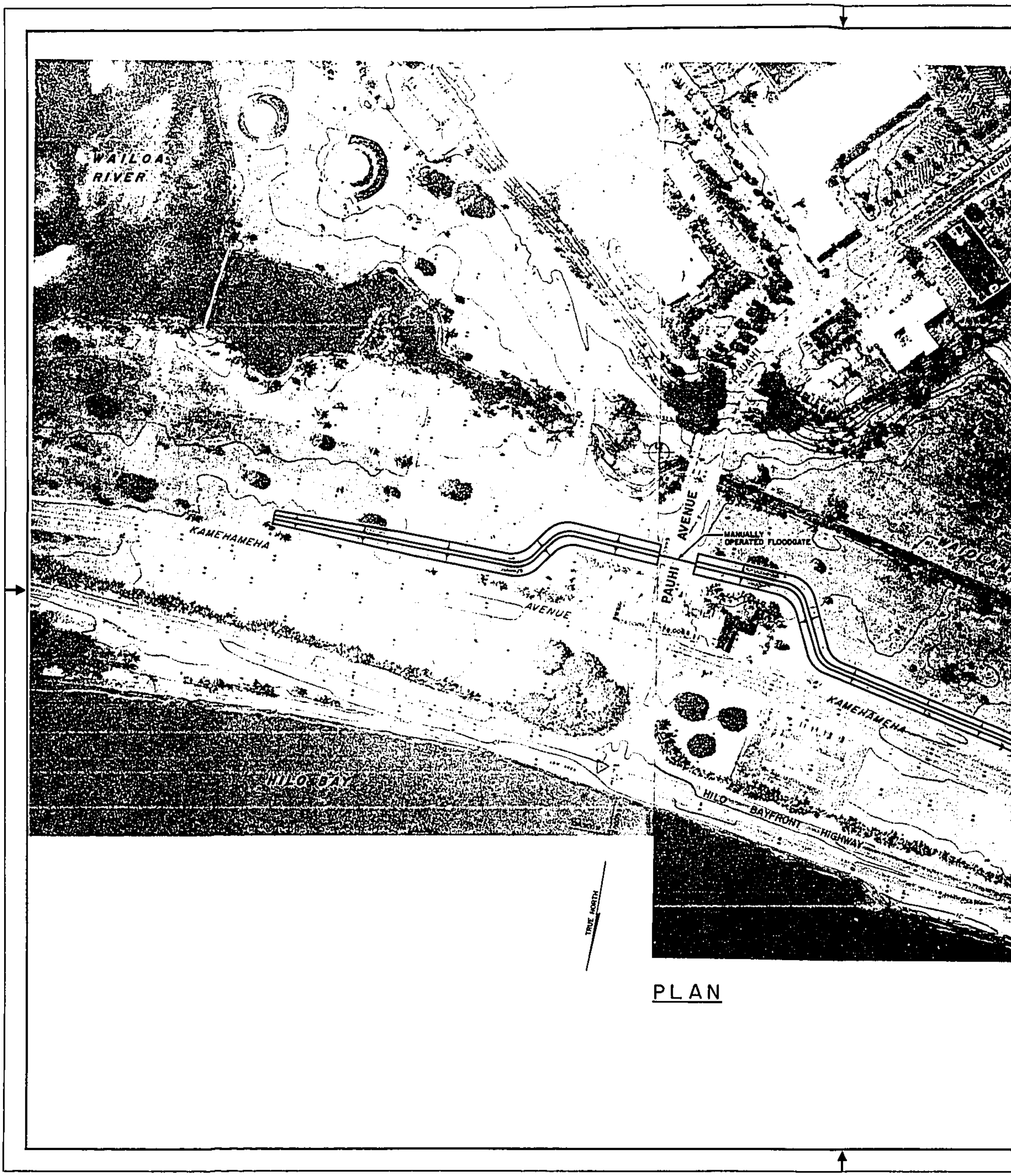
ALENAIO STREAM HAWAII

ALTERNATIVE I (REACH I)

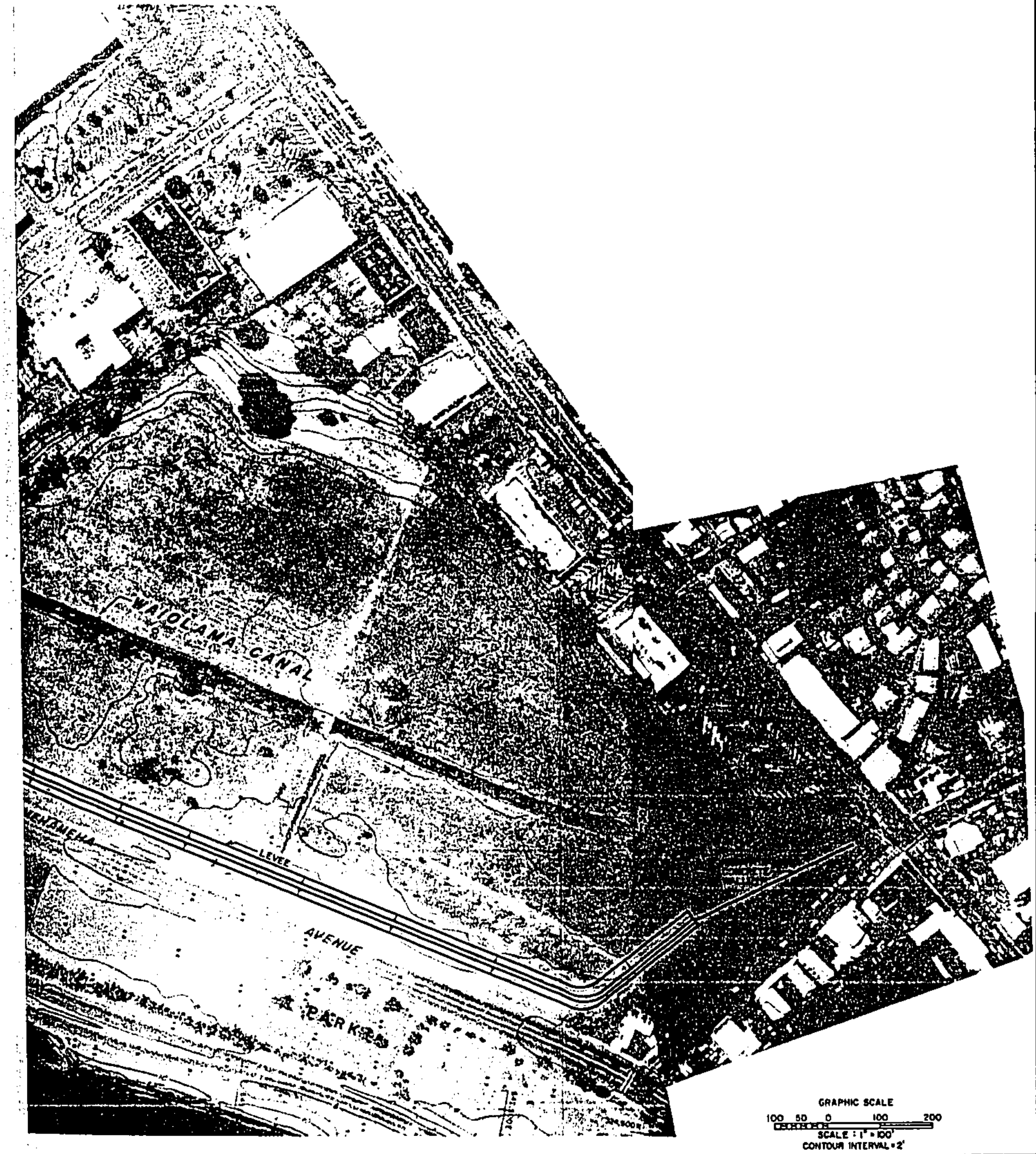
ENLARGING THE WAIOLAMA CANAL OPTION

SUBALTERNATIVE b

U.S. ARMY ENGINEER DISTRICT, HONOLULU


WAILOA
RIVER
KAMEHAMEHA
AVENUE
PAUHI
AVENUE
MANUALLY
OPERATED FLOODGATE
PAUAHI
KAMEHAMEHA
HILO BAY
HILO BAYFRONT HIGHWAY
TRUE NORTH

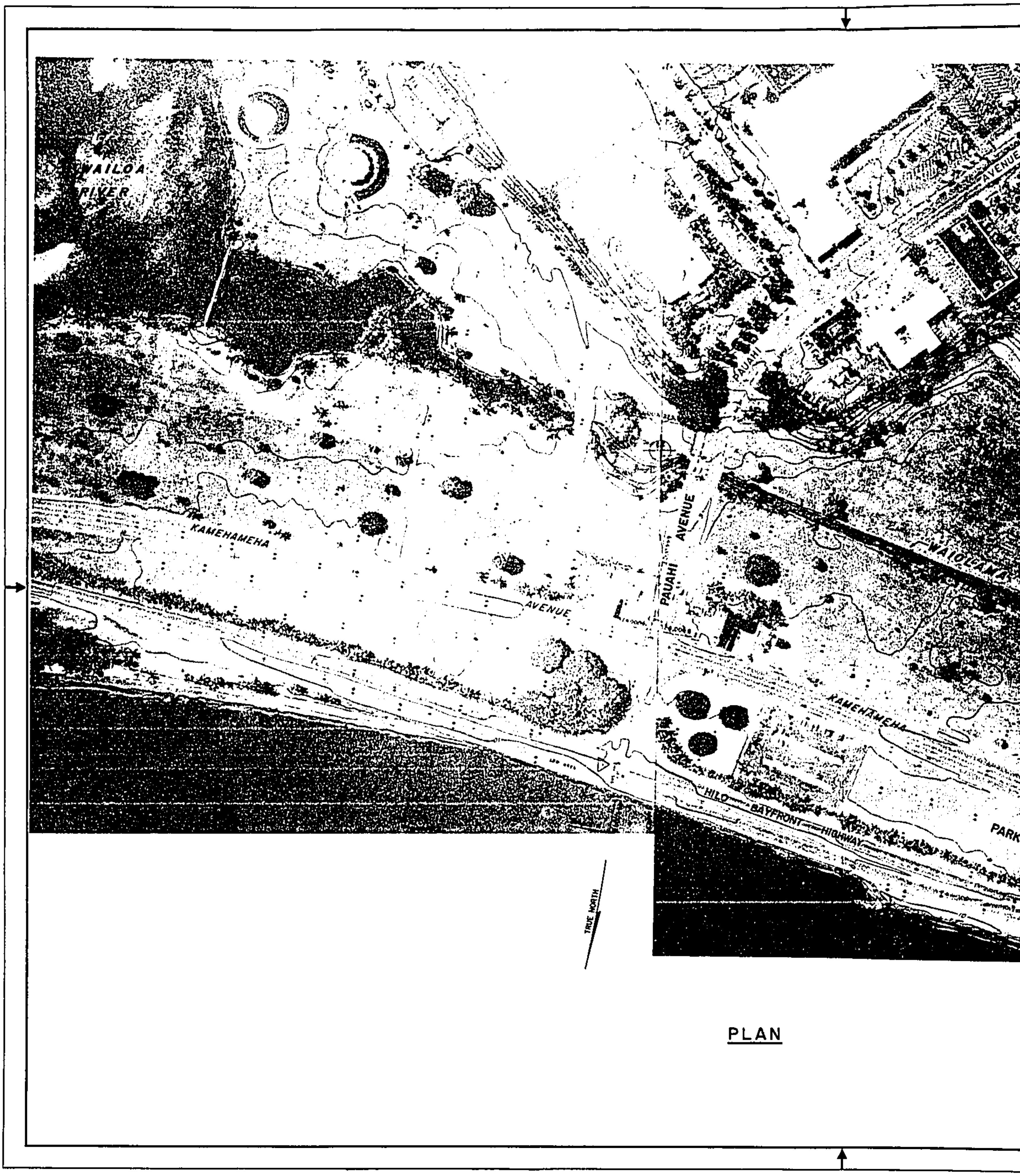
PLAN



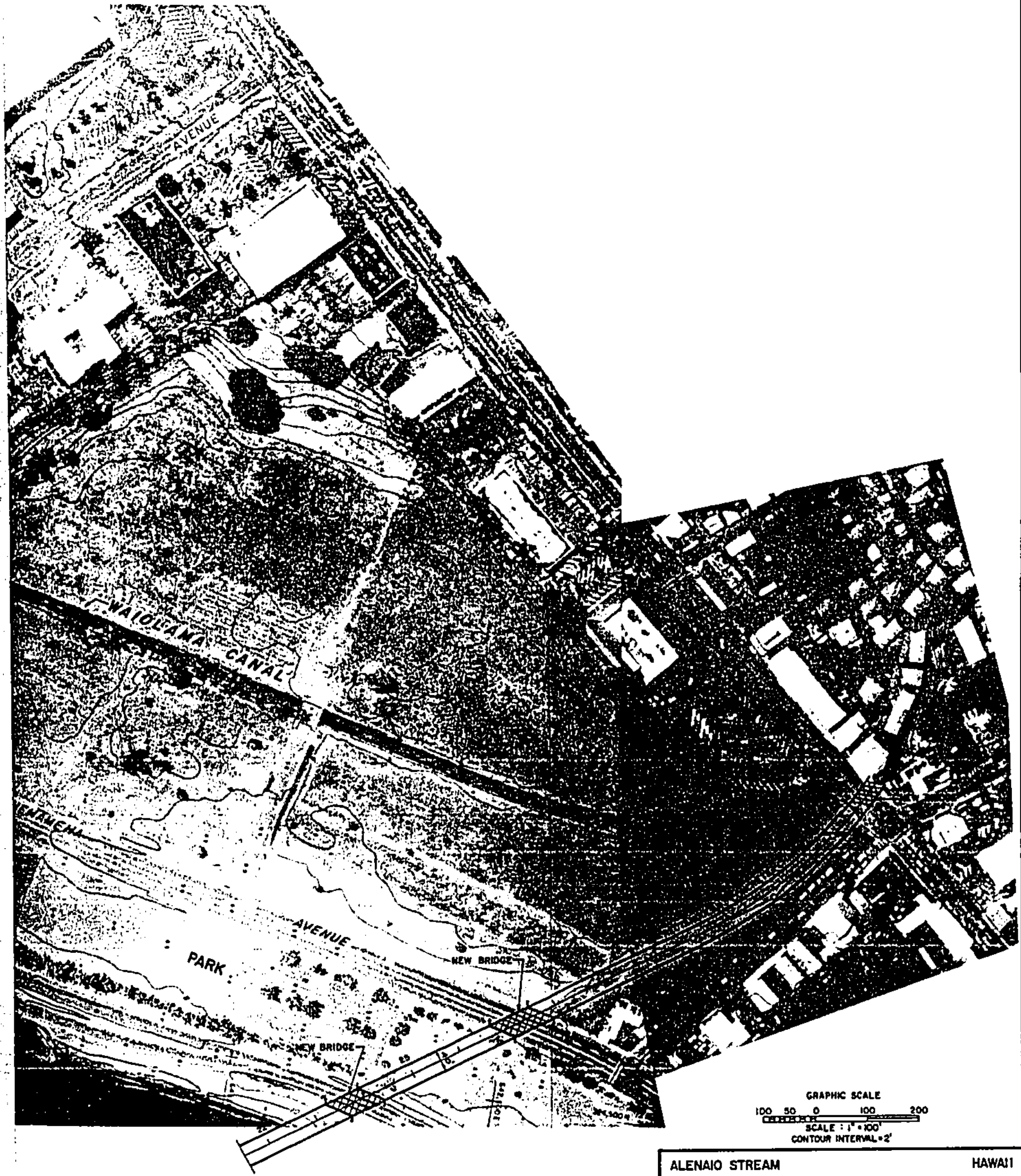
ALENAIO STREAM HAWAII

ALTERNATIVE I (REACH I)
LEVEE ALONG KAMEHAMEHA AVENUE OPTION
SUBALTERNATIVE c

U.S. ARMY ENGINEER DISTRICT, HONOLULU


WAILOA RIVER
KAMEHAMEHA
AVENUE
PAUAHI AVENUE
PAUAHI
WAIOLAMA
KAMEHAMEHA
HILO BAYFRONT HIGHWAY
PARK
TRUE NORTH

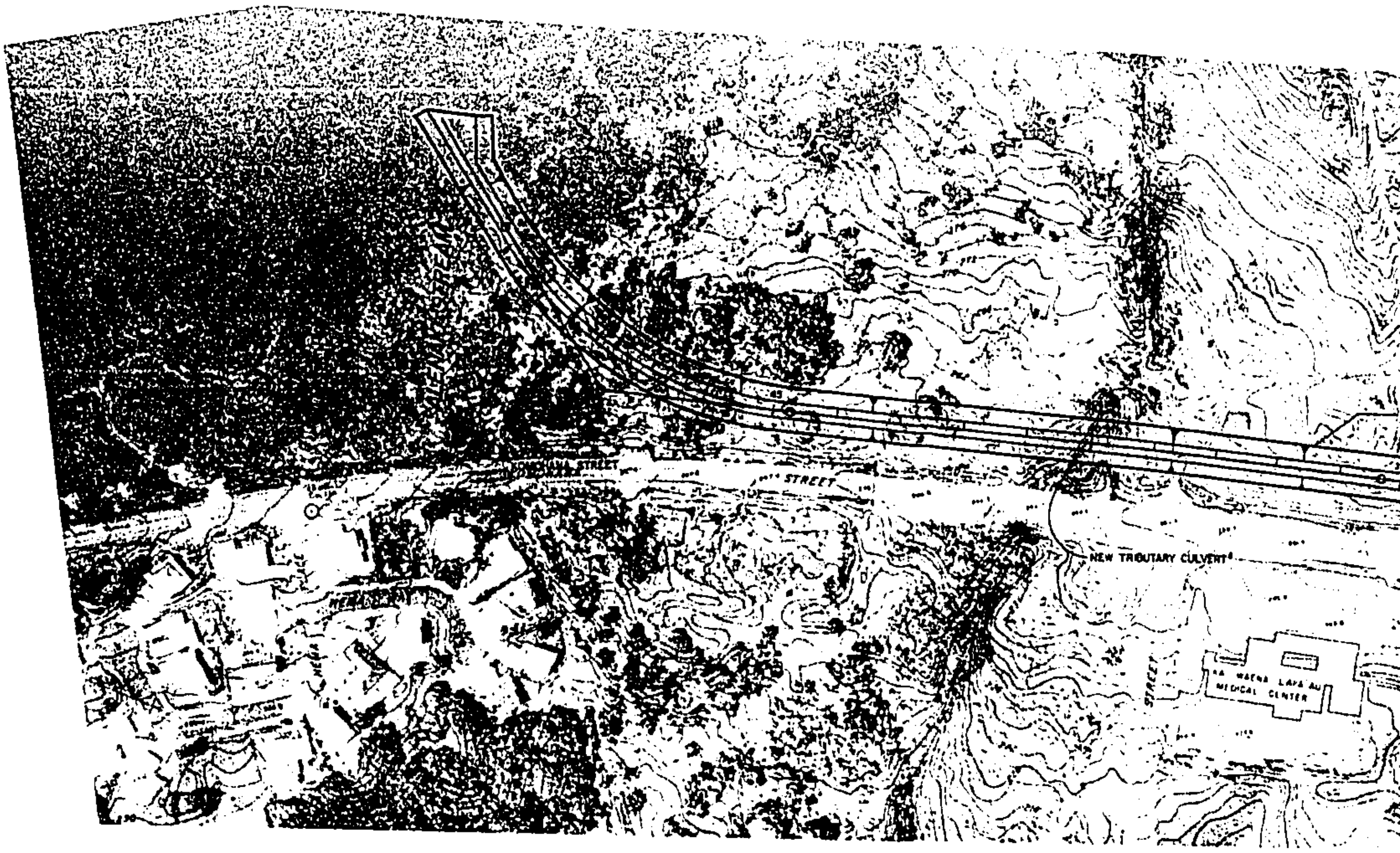
PLAN



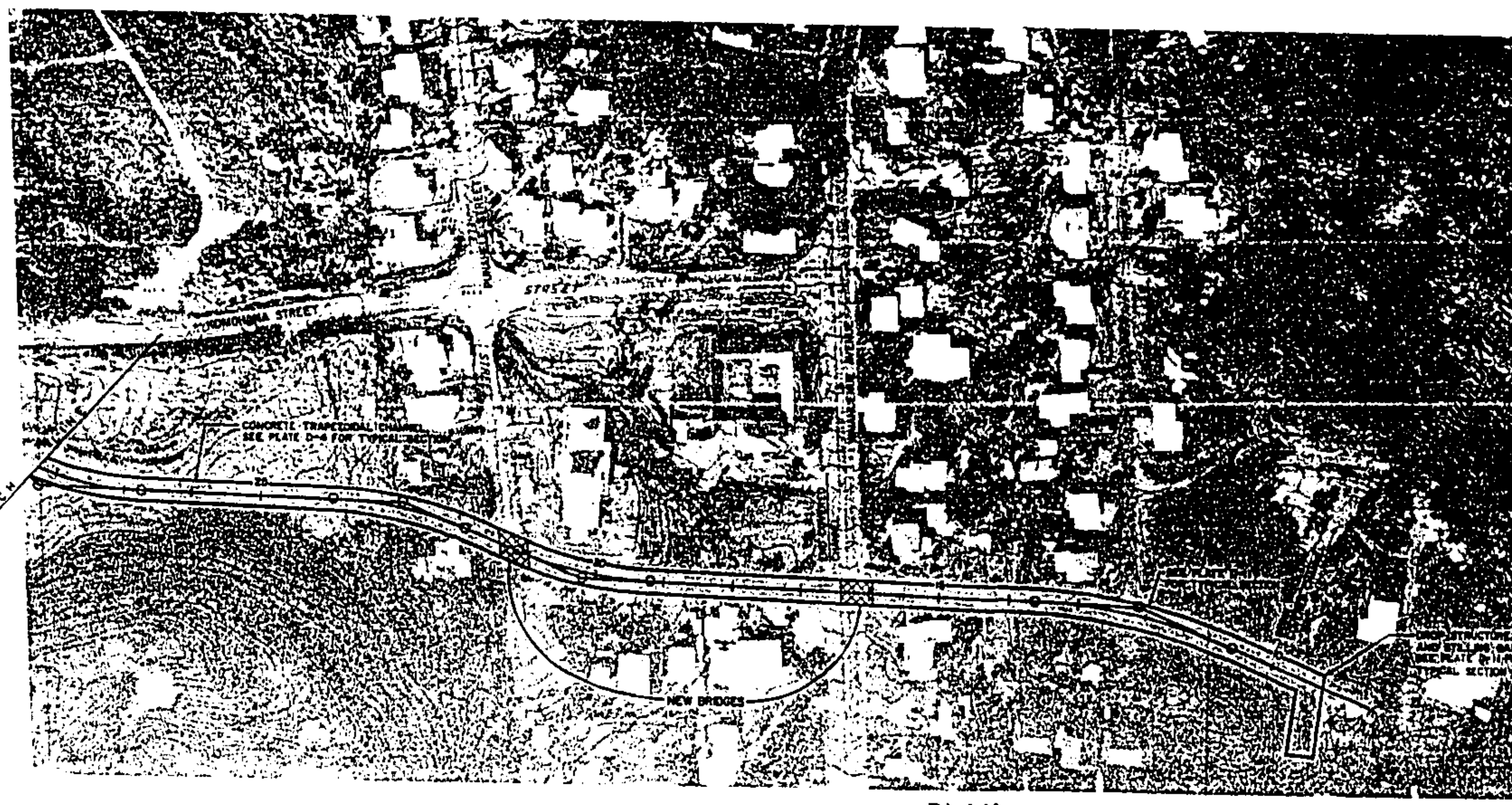
ALENAIO STREAM HAWAII

ALTERNATIVE I (REACH I)
DIVERSION CHANNEL OPTION
SUBALTERNATIVE d

U.S. ARMY ENGINEER DISTRICT, HONOLULU

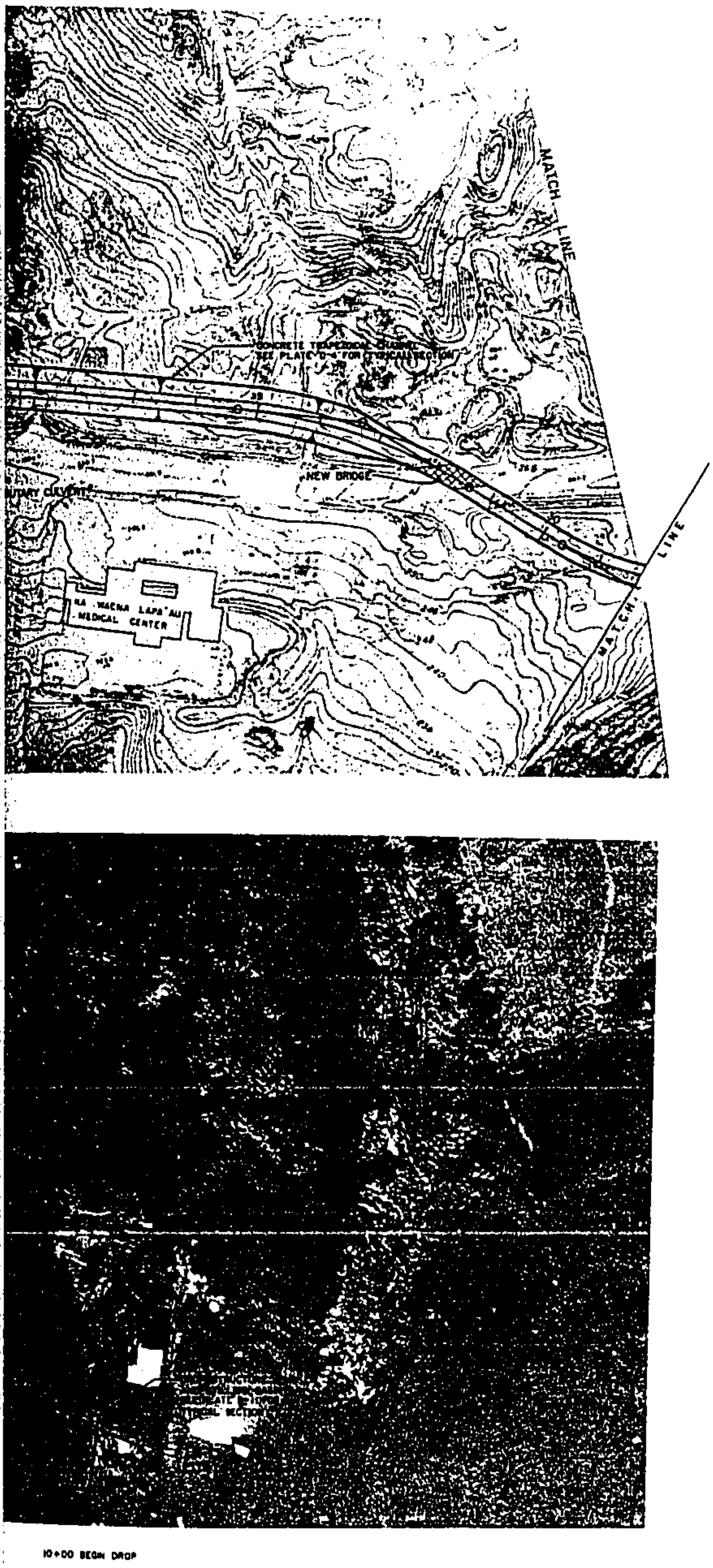


PLAN



PLAN

10+00 BEGIN DROP



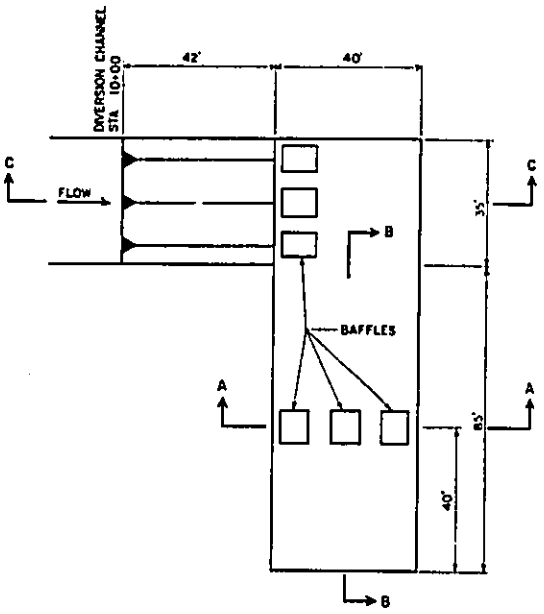
N

GRAPHIC SCALE
100' 0 100' 200'
SCALE: 1" = 100'
CONTOUR INTERVAL = 2'

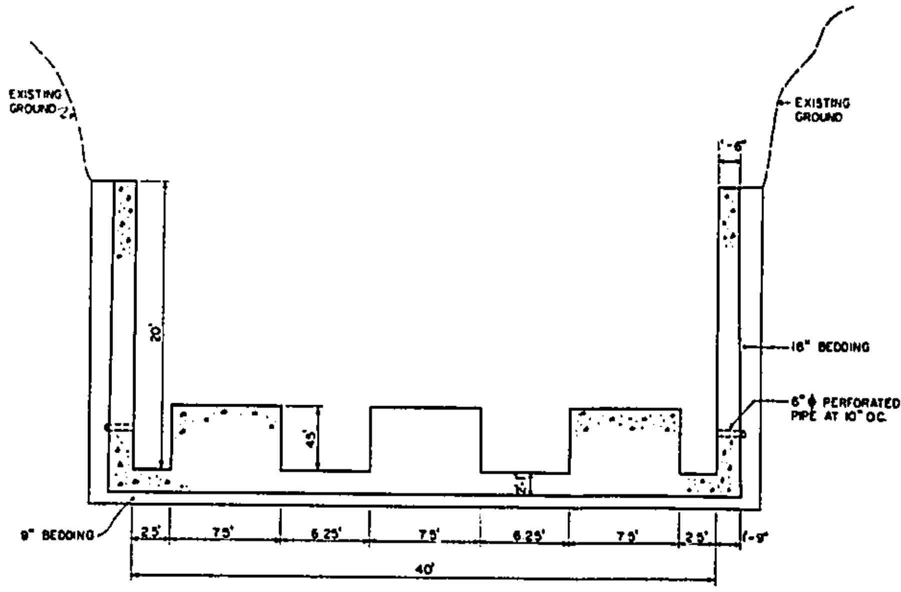
ALENAIO STREAM HAWAII

ALTERNATIVE 2
DIVERSION CHANNEL
INTO THE
WAILUKU RIVER

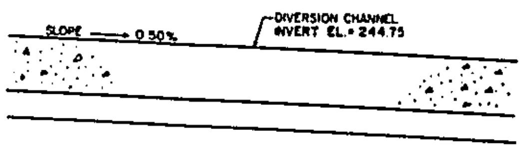
U.S. ARMY ENGINEER DISTRICT, HONOLULU

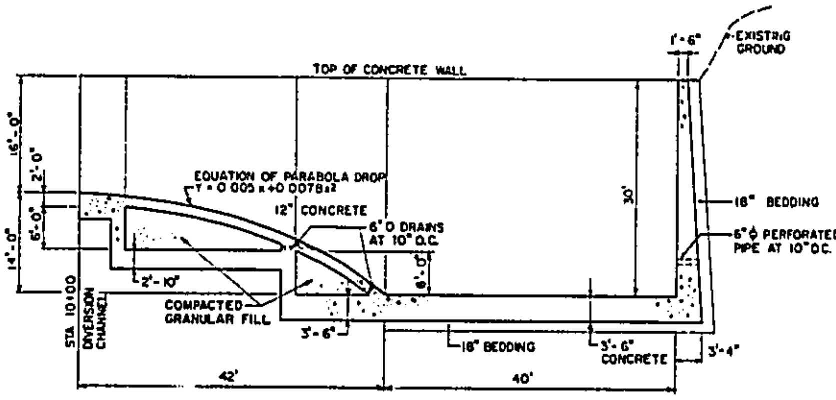


DROP STRUCTURE & STILLING BASIN
PLAN VIEW
SCALE : 1" = 20'-0"

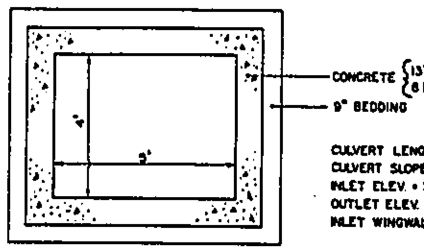


SECTION A-A
SCALE : 1" = 5'-0"

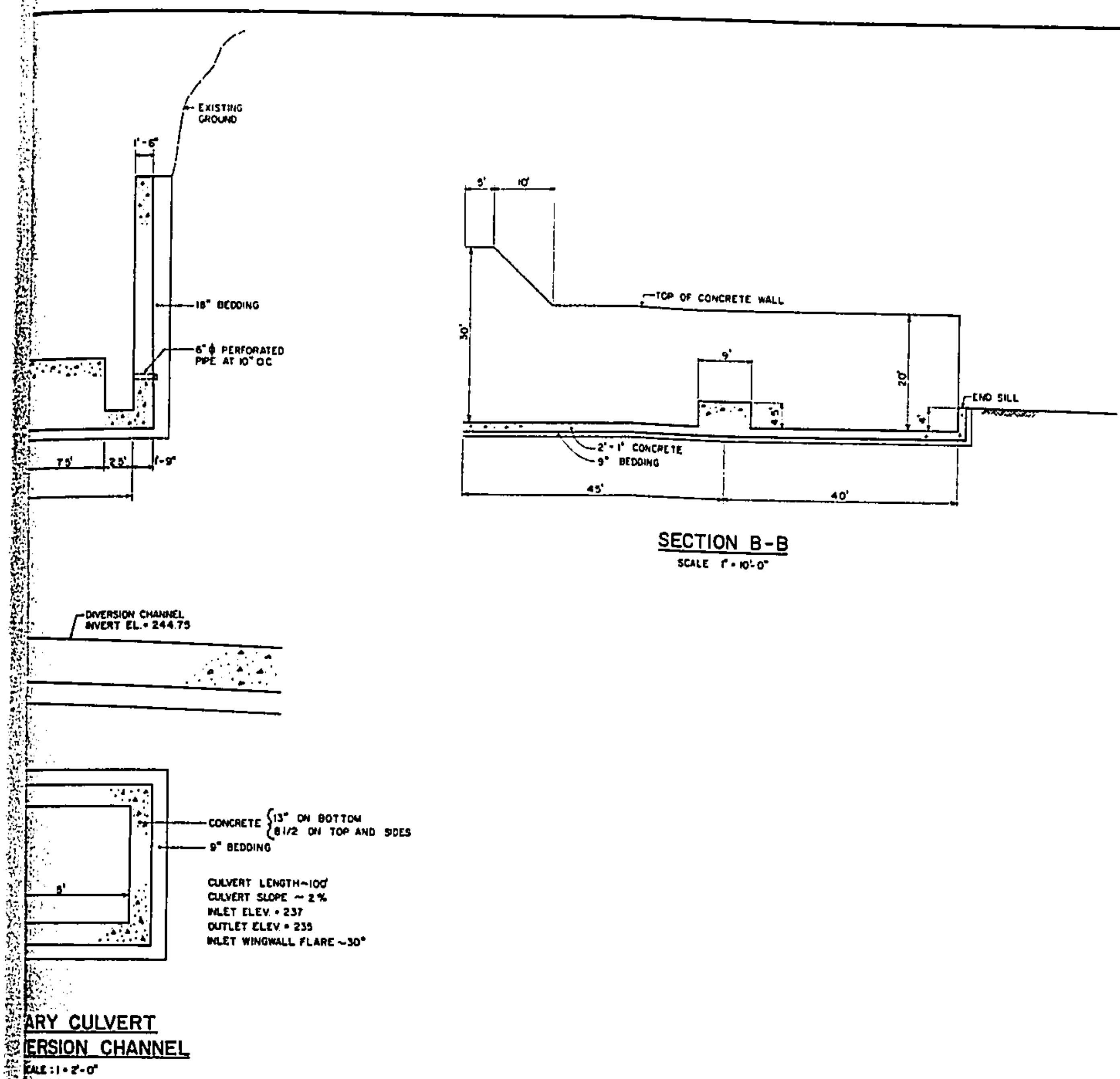




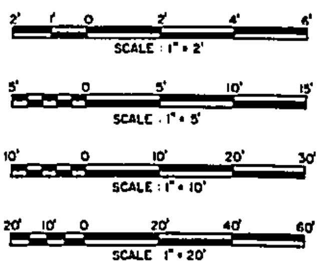
SECTION C-C
SCALE : 1" = 10'-0"



TRIBUTARY CULVERT
UNDER DIVERSION CHANNEL
SCALE : 1" = 2'-0"



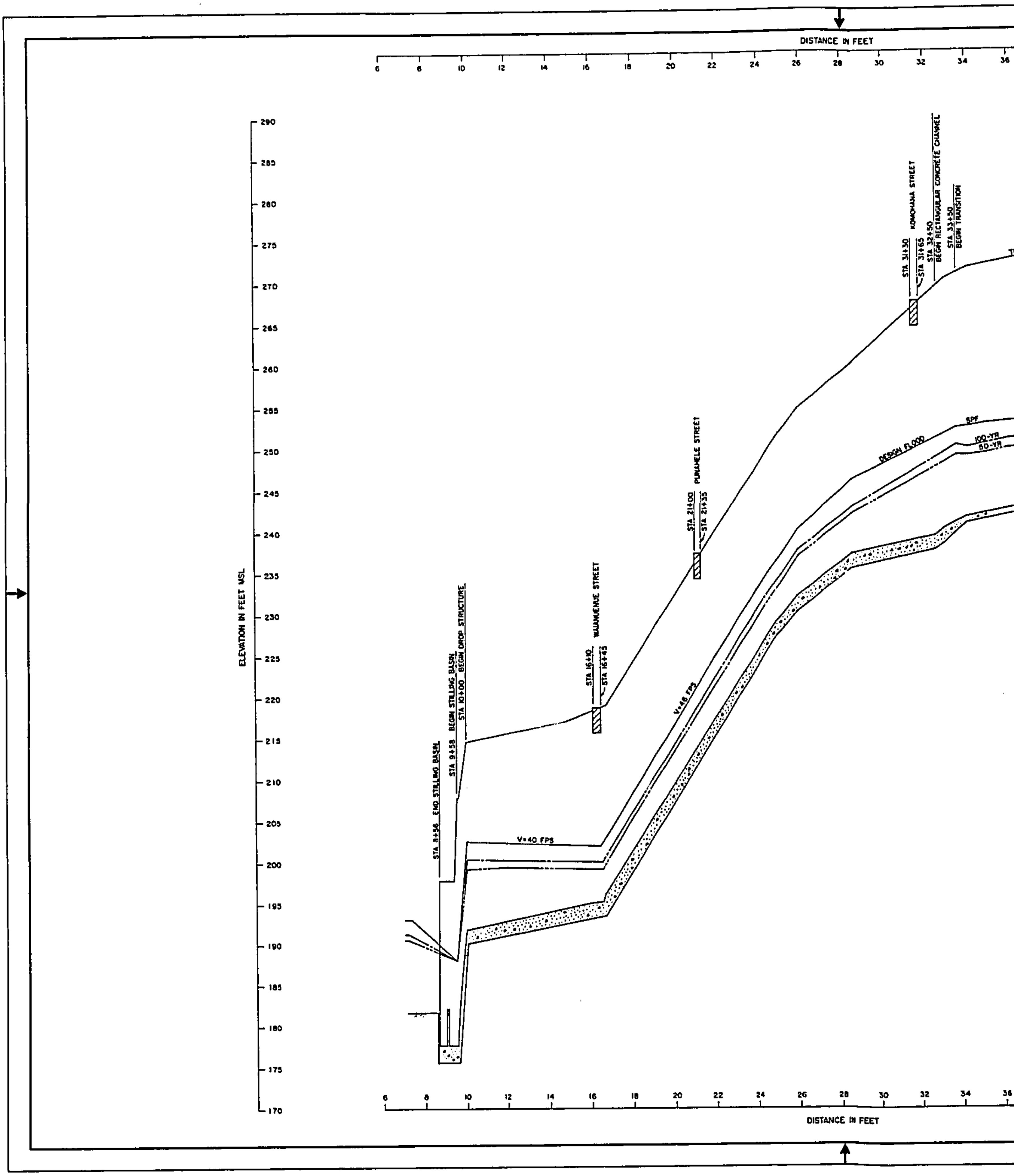
GRAPHIC SCALES



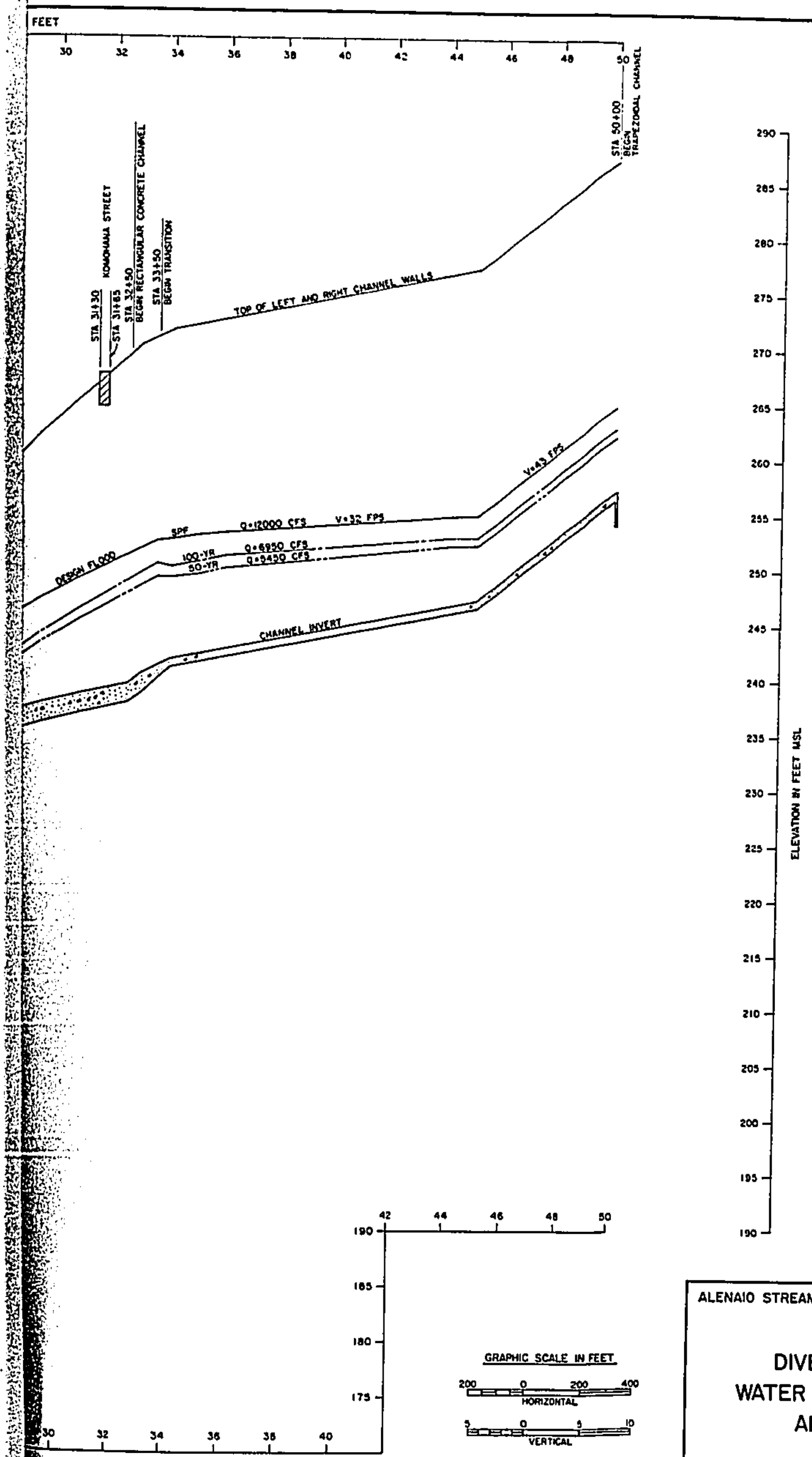
ALENAIO STREAM — HAWAII

ALTERNATE 2 DIVERSION CHANNEL
DROP STRUCTURE, STILLING BASIN,
AND TRIBUTARY CULVERT DETAILS

U.S. ARMY ENGINEER DISTRICT, HONOLULU



DISTANCE IN FEET
ELEVATION IN FEET MSL
STA 8+56 END STILLING BASIN
STA 9+58 BEGIN STILLING BASIN
STA 10+00 BEGIN DROP STRUCTURE
STA 16+10
STA 16+43
WAIAKEA STREET
STA 21+00
STA 21+35
PUNAHELE STREET
STA 31+30
STA 31+65
KOMOHANA STREET
STA 32+50
BEGIN RECTANGULAR CONCRETE CHANNEL
STA 33+50
BEGIN TRANSITION
DESIGN FLOOD
SPF
100-YR
50-YR
V=40 FPS
V=46 FPS



ALENAIO STREAM HAWAII

DIVERSION CHANNEL
WATER SURFACE PROFILES
ALTERNATIVE 2

U. S. ARMY ENGINEER DISTRICT, HONOLULU

III. STRUCTURAL DESIGN

1. CONCRETE CHANNEL

The structural design of the reinforced concrete channels will be based on EM 1110-2-2501, "Flood Wall Design," January 1948, and EM 1110-2-2502, "Retaining Walls," 29 May 1961. The design loadings are as follows:

RECTANGULAR AND TRAPEZOIDAL SECTIONS

a. Loading No. 1

(1) Channel empty

(2) Two feet surcharge on backfill

(3) Backfill saturated to midway between drain elevation and design stage

b. Loading No. 2

(1) Channel empty

(2) Backfill saturated to elevation of drains

(3) Seismic loads

Box culverts

a. Loading No. 1

(1) Culvert empty

(2) Vertical loads on roof due to fill and surcharge

(3) Lateral loads on both exterior walls due to fill and surcharge

b. Loading No. 2

(1) Culvert empty

(2) Vertical loads on roof due to fill and surcharge

(3) Lateral loads on one exterior wall due to fill and surcharge; no lateral load on other exterior wall

2. SOIL PARAMETERS

a. Rectangular and Trapezoidal Concrete Channels (Assume cohesionless backfill):

(1) Moist unit weight of soil: γm = 100 PCF

(2) Angle of internal friction: $\phi = 20°$

(3) Cohesion: C = 0

(4) Allowable soil bearing capacity (With bedding layer thicknesses recommended in paragraph: Design Considerations) — $q = 1{,}000$ PSF

b. Box Culverts and Stilling Basin (including approach channels):

(1) Moist unit weight of soil — $\gamma_m = 120$ pcf

(2) Angle of internal friction — $\phi = 30°$

(3) Cohesion — $C = 0$

(4) Allowable soil bearing capacity — $q = 20$ TSF

3. OTHER DESIGN FACTORS

Design Stresses. The structural design will be in accordance with EM 1110-1-2101, "Working Stresses for Structural Design," 1 November 1963.

a. Concrete (28-day compressive strength, f'_c):

(1) Concrete exposed to action of moving water — $f'_c = 4{,}000$ PSI

(2) All others: — $f'_c = 3{,}000$ PSI

b. *Reinforcing steel:* — $f_y = 40{,}000$ PSI

Concrete Cover over Reinforcing Steel. The concrete cover for hydraulic structures will be in accordance with EM 1110-2-2103, "Details of Reinforcement - Hydraulic Structures," 21 May 1971.

Wind. The peak gust velocity is 80 miles per hour.

Seismic Zone. The seismic zone is Zone IV.

IV. COST ESTIMATION

1. BASIS OF ESTIMATE

The following assumptions were utilized in estimating construction costs for Alternatives 1 and 2:

a. Estimated quantities were based on existing topographic maps and surveys and typical plans and sections.

b. The cost estimates are based on September 1982 price levels.

c. Eighty percent of the subsoil material will need to be blasted except in the Waiolama Canal area.

d. Dewatering costs were included.

e. Operations of construction were assumed to be an 8-hour day and 6 days per week.

f. A local contractor will bid for the job.

g. The disposal area will be designated within 10 miles of the project site.

h. A construction period of 24 to 30 months.

i. Engineering and design costs.[1/]

j. Supervision and administration costs during construction.

k. A 25% contingency cost allowance.

1/ Engineering and design costs reflect the hydraulic model tests for the structural plans during the Advance Engineering & Design Stage. Model tests will provide data to verify the empherical evaluations for the high velocity channels that are required for this flood control project.

2. COST ESTIMATES

A. Alternative 1

Construction Costs	Alternative 1 (SPF Protection) Quantity	($) Unit Cost	($) Amount	Alternative 1 (100-Year Protection) Quantity	($) Unit Cost	($) Amount
Federal Costs						
Mobilization & Demobilization	LS	-	30,000	LS	-	30,000
Clearing & Grubbing	4 AC	1,400.00	5,600	4 AC	1,400.00	5,600
Excavation	43,000 CY	5.30	227,900	32,700 CY	5.30	173,300
Blasting of Hard Material	32,800 CY	5.00	164,000	26,200 CY	5.00	131,000
Backfill	14,600 CY	6.10	89,100	19,000 CY	6.10	115,900
Concrete (Invert)	3,600 CY	245.00	882,000	2,560 CY	245.00	627,200
Concrete (wall)	1,850 CY	402.00	743,700	1,850 CY	402.00	742,700
Bedding Material	6,130 CY	26.00	159,400	4,550 CY	26.00	118,300
Subdrainage System	1,760 LF	27.00	47,500	1,760 LF	27.00	47,500
Dewatering	LS	-	60,000	LS	-	60,000
Topsoil	2,270 CY	27.00	61,300	2,400 CY	27.00	64,800
Grass	122,000 SF	.25	30,500	129,000 SF	.25	32,300
Fence	3,570 LF	15.60	55,700	3,570 LF	15.60	55,700
Concrete Retaining Wall	370 CY	383.00	141,700	370 CY	383.00	141,700
Floodproofing (Reaches 3 and 1)1/	11 Structures	-	664,800	7 Structures	-	375,200
Contingency Allowance (25%)	-	-	840,800	-	-	680,300
Sub-Total			4,204,000			3,401,500
Non-Federal Costs						
Demolition of 4 Bridges	4,200 SF	10.00	42,000	4,200 SF	10.00	42,000
Construction of 4 New Bridges	8,000 SF	100.00	800,000	6,000 SF	100.00	600,000
Restoring AC Pavement	600 SY	20.00	12,000	600 SY	20.00	12,000
Utilities Relocation	LS	-	48,000	LS	-	40,000
Lands, Easements, & Rights-of-Way1/	LS	-	750,000	LS	-	750,000
Floodproofing (Reaches 3 and 1) 1/	11 Structures	-	166,200	-	-	93,800
Contingency Allowance (25%)	-	-	454,500			385,000
Sub-Total			2,272,700			1,922,800
Total Direct Cost (Jan 1982 Price Level)			6,476,700			5,324,300
Adjustment for Sep 1982 Price Level (9%)			7,059,600			5,803,500
Engineering and Design Costs						
Post Authorization Studies 1/			400,000			400,000
Plans and Specifications			100,000			100,000
Engineering During Construction			50,000			50,000
Sub-Total			$ 550,000			$ 550,000
Supervision and Administration Costs			$ 374,000			$ 322,000
Total Project Costs			$7,983,600			$6,675,500

1/ Cost Sharing at 80% Federal, 20% Non-Federal
2/ Includes the possible costs for modeling studies

(b) Enlarging the Capacity of the Waiolama Canal

Construction Costs	Sub-Alternative (SPF Protection) Quantity	($) Unit Cost	($) Amount	Sub-Alternative (100-Year Protection) Quantity	($) Unit Cost	($) Amount
Federal Costs						
Clearing & Grubbing	25 AC	1,400.00	35,000	25 AC	1,400.00	35,000
Excavation	225,900 CY	5.30	1,197,300	225,900 CY	5.30	1,197,300
Backfill	1,300 CY	6.10	8,000	1,400 CY	6.10	8,500
Bedding Material	110 CY	26.00	2,900	140 CY	26.00	3,700
Sub-drainage System	90 LF	27.00	2,500	90 LF	27.00	2,500
Topsoil	4,600 CY	27.00	124.200	1,300 CY	27.00	35,100
Grass	247,000 SF	.25	61,800	101,000 SF	.25	25,300
Dewatering	LS	-	10,000	LS	-	10,000
Retaining Wall	260 CY	383.00	99,900	160 CY	383.00	61,300
Contingency Allowance (25%)	-	-	385,400	-	-	344,700
Sub-Total			$1,927,000			$1,723,400
Non-Federal Costs						
Demolition of 1 Bridge	4,200 SF	10.00	420,000	4,200 SF	10.00	420,000
Construction of 1 Bridge	18,000 SF	100.00	1,800,000	9,000 SF	100.00	900,000
Restore AC Pavement	900 SF	20.00	18,000	900 SF	20.00	18,000
Replant Trees	150 EA	250.00	30,000	150 EA	250.00	30,000
Contingency Allowance (25%)	-	-	567,000	-	-	342,000
Sub-Total			$2,835,000			$1,710,000
Total Direct Cost (Jan 1982 Price Level)			$4,762,000			$3,433,400
Adjustment for Sep 1982 Price Level (9%)			$5,190,600			$3,742,400

(c) Constructing a Levee Along Kamehameha Avenue

Construction Costs	Sub-Alternative (SPF Protection) Quantity	($) Unit Cost	($) Amount	Sub-Alternative (100-Year Protection) Quantity	($) Unit Cost	($) Amount
Federal Costs						
Clearing & Grubbing	3 AC	1,400.00	4,200	3 AC	1,400.00	4,200
Excavation	1,600 CY	5.30	8,500	1,600 CY	5.30	8,500
Structural Backfill & Embankments	9,000 CY	6.10	54.900	8,400 CY	6.10	51,300
Retaining Wall	280 CY	383.00	107,300	270 CY	383.00	103,500
Bedding Material	130 CY	26.00	3,400	140 CY	26.00	3,700
Sub-drainage System	90 LF	27.00	2,500	90 LF	27.00	2,500
Topsoil	1,300 CY	.25	35,100	1,300 CY	27.00	35,100
Grass	101,000 SF	-	25,300	101,000 SF	.25	25,300
Dewatering	LS	-	10,000	LS	-	10,000
Contingency Allowance (25%)	-		62,800	-	-	61,000
Sub-Total			$ 314,000			$ 305,100
Non-Federal Costs						
Restore AC Pavement	600 SF	20.00	12,000	600 SF	20.00	12,000
Raising Pauhai Avenue	400 LF	210.00	84,000	400 LF	210.00	84,000
Contingency Allowances (25%)	-	-	24,000	-	-	24,000
Sub-Total			$ 120,000			$ 120,000
Total Direct Costs (Jan 1982 Price Level)			$ 434,000			$ 425,100
Adjustment for Sep 1982 Price Level (9%)			$ 473,000			$ 463,400

(d) Constructing a New Diversion Channel Outlet Into Hilo Bay

Construction Costs	Sub-Alternative (SPF Protection) Quantity	($) Unit Cost	($) Amount	Sub-Alternative (100-Year Protection) Quantity	($) Unit Cost	($) Amount
Federal Costs						
Clearing & Grubbing	2 AC	1,400.00	2,800	1 AC	1,400.00	1,400
Excavation	32,600 CY	5.30	172,800	25,000 CY	5.30	132,500
Blasting of Hard Materials	10,400 CY	5.00	52,000	6,500 CY	5.00	32,500
Structural Backfill	3,000 CY	6.10	18,300	3,100 CY	6.10	18,900
Concrete (invert)	2,680 CY	245.00	656,600	1,970 CY	245.00	482,700
Concrete (wall)	1,460 CY	402.00	587,000	1,330 CY	402.00	534,700
Bedding Material	3,390 CY	26.00	88,200	2,770 CY	26.00	72,000
Sub-drainage System	1,180 LF	27.00	31,900	1,040 CY	27.00	28,100
Topsoil	410 CY	27.00	11,100	400 CY	27.00	10,800
Grass	23,000 SF	.25	5,800	23,000 SF	.25	5,800
Dewatering	LS	-	50,000	LS	-	50,000
Fence	2,000 LF	15.60	31,200	2,000 LF	15.60	31,200
Contingency Allowance (25%)	-	-	426,900	-		350,200
Sub-Total			$2,134,600			$1,750,800
Non-Federal Costs						
Construction of 2 Bridges	5,600 SF	100.00	560,000	3,900 SF	100.00	390,000
Restore AC Pavement	50 SY	20.00	1,000	50 SY	20.00	1,000
Utilities Relocation	LS	-	12,000	LS	-	12,000
Contingency Allowance (25%)	-	-	144,000	-	-	100,800
Sub-Total			$ 717,000			$ 503,800
Total Direct Costs (Jan 1982 Price Level)			$2,851,600			$2,254,000
Adjustment for Sep 1982 Price Level (9%)			$3,108,300			$2,457,600

B. Alternative 2

Construction Costs	Alternative 2 (SPF Protection) Quantity (A) 1/	Quantity (B) 1/	($) Unit Cost	($) Amount (A)	($) Amount (B)	Alternative 2 (100-Year Protection) Quantity (A)	Quantity (B)	($) Unit Cost	($) Amount (A)	($) Amount (B)
Federal Costs										
Mobilization & Demobilization	LS	LS	-	30,000	30,000	LS	LS	-	30,000	30,000
Clearing & Grubbing	10 AC	10 AC	1,400.00	14,000	14,000	9 AC	9 AC	1,400.00	12,600	12,600
Excavation	184,400 CY	191,400 CY	5.30	977,300	1,014,400	52,400 CY	156,000 CY	5.30	807,200	826,800
Blasting of Hard Materials	147,300 CY	153,100 CY	5.00	736,500	765,500	21,600 CY	124,800 CY	5.00	608,000	624,000
Fill Embankment	23,000 CY	34,000 CY	6.10	140,300	207,400	22,900 CY	32,800 CY	6.10	139,700	200,100
Concrete (invert)	6,810 CY	4,080 CY	245.00	1,668,500	999,600	5,070 CY	3,020 CY	245.00	1,242,200	739,900
Concrete (wall)	4,670 CY	2,230 CY	402.00	1,877,300	896,500	4,700 CY	2,250 CY	402.00	1,889,400	904,500
Concrete Transition Section	270 CY	270 CY	257.00	69,400	69,400	220 CY	220 CY	257.00	56,500	56,500
Concrete Trapezoidal Lining	3,720 CY	3,720 CY	218.00	811,000	811,000	2,300 CY	2,300 CY	218.00	501,400	501,400
Concrete (culverts)	90 CY	8,830 CY	383.00	34,500	3,381,900	90 CY	5,050 CY	383.00	34,500	1,934,200
Bedding	12,040 CY	10,400 CY	26.00	313,000	270,400	10,660 CY	9,160 CY	26.00	277,200	238,200
Sub-drainage System	4,200 LF	4,200 LF	27.00	113,400	113,400	4,200 LF	4,200 LF	27.00	113,400	113,400
Topsoil	4,450 CY	5,100 CY	27.00	120,200	137,700	4,450 CY	5,340 CY	27.00	120,200	144,200
Grass	238,000 SF	276,000 SF	.25	59,500	69,000	241,000 SF	261,000 SF	.25	60,300	65,300
Fence	8,000 LF	6,880 LF	15.60	124,800	107,300	8,000 LF	6,880 LF	15.60	124,800	107,300
Dewatering	LS	LS	-	30,000	30,000	LS	LS	-	30,000	30,000
Stilling Basin	-	-	-	740,400	740,400	-	-	-	740,400	740,400
Contingency Allowance (25%)	-	-	-	1,965,000	2,415,000	-	-	-	1,697,000	1,817,000
Sub-Total				$ 9,825,000	$12,073,000				$ 8,485,000	$ 9,086,000
Non-Federal Costs										
Build 4 (2) New Bridges	8,000 SF	4,400 SF	100.00	800,000	440,000	6,000 SF	3,300 SF	100.00	600,000	330,000
Restore AC Pavement	600 SY	1,700 SY	20.00	12,000	34,000	600 SY	1,700 SY	20.00	12,000	34,000
Utilities Relocation	LS	LS		50,000	50,000	LS	-	-	40,000	40,000
Roadway/Walkways Over Channel	4,200 SF	-	60.00	252,000	-	2,250 SF	-	60.00	135,000	-
Enlarge Hale Street	1,500 SF	-	210.00	315,000	-	1,000 SF	-	210.00	210,000	-
Lands, Easements, & Rights-of-Way	-	-	-	500,000	200,000	-	-	-	500,000	250,000
Contingency Allowance (25%)	-	-	-	482,500	181,000	-	-	-	374,300	163,500
Sub-Total				$ 2,411,500	$ 905,000				$ 1,871,300	$ 817,500
Total Direct Costs (Jan 1982 Price Level)				$12,236,500	$12,978,000				$10,356,300	$ 9,903,500
Adjustment for Sep 1982 Price Level (9%)				$13,337,800	$14,146,000				$11,298,400	$10,794,800
Engineering and Design Costs										
Post Authorization Studies 2/				400,000	400,000				400,000	400,000
Plans and Specifications				125,000	125,000				125,000	125,000
Engineering During Construction				75,000	75,000				75,000	75,000
Sub-Total				$ 600,000	$ 600,000				$ 600,000	$ 600,000
Supervision and Administration Costs				$ 842,500	$ 932,900				$ 747,600	$ 750,000
Total Project Costs				$14,780,300	$15,678,900				$12,636,000	$12,144,800

1/ (A) = Estimated Cost for Alternative with Open Channel; (B) = Estimated Cost for Alternative for 650-Foot Covered Channel.
2/ Includes the possible costs for model studies.

c. Alternative 3 (nonstructural)

COST ANALYSIS ASSUMPTIONS

The cost of building the following nonstructural protection measures was based upon prevailing construction unit costs, in the area, as of September 1982. The costs, either given or graphically derived, reflect the average construction costs within the design constraints and assumptions given. The specific construction costs for any single structure may vary from the average overall values because of a unique location or condition of a structure.

Raising Structures. The total cost for raising structures is a sum of the component costs of the different operations involved. Table D-16 is a tabulation of typical unit costs.

TABLE D-16. ESTIMATED UNIT COSTS FOR RAISING A STRUCTURE

Component/Description	Unit	Cost($)/Unit
Raising operation		
Low lift (1-2 feet)	SF	1.60
Each additional foot	SF	0.40
Utility alteration	EA	2,400
Disconnecting and reconnecting overhead electrical and telephone lines		
Installing vertical extensions to water and sewer lines		
Carpentry alterations		
Installing new posts with painting	LF (Board)	4.80
Installing new braces	LF (Board)	2.40
New concrete landing	EA	40.00
Installing slats peripheral to posts exterior painting, and damage to existing area	SF	0.32
Condition of structure		
Additional costs for poor condition	SF	4.00
Additional costs for very poor condition	SF	10.40
Additional costs for dilapidated condition	SF	16.80

Providing Closures. The cost of providing cover panels is based on shop fabrication of components from standard aluminum sheets and shapes. Units would be prefabricated and then fitted at the jobsite. The cost for this work, complete, is estimated to be $72 per square foot of panel surface. The cost for a building is derived by adding up the door and window areas to one foot above the design water surface elevation and multiplying this figure by $72 to arrive at the total average cost.

C. Alternative 3

	Alternative 3 (SPF Protection)		Alternative 3 (100-Year Protection)	
Construction Costs	Number of Structures	Amount	Number of Structures	Amount
Method				
Temporary/Permanent Closures	18	202,000	19	164,000
Raise the Structure	41	450,000	27	300,000
Removal/Relocation	53	11,600,000	31	8,200,000
Providing Ring Walls	35	407,000	5	373,000
Relocating Damageable Property Above Flood Heights	14	308,000	14	308,000
Contingency Allowance (25%)	-	3,242,000	-	2,336,000
Total Direct Costs (September 1982)		$16,209,000		$11,681,000
Engineering and Design Costs				
Post-Authorization Studies		400,000		400,000
Plans and Specifications		100,000		100,000
Engineering During Construction		50,000		50,000
Sub-Total		$ 550,000		$ 550,000
Supervision and Administration Costs		1,176,400		871,000
Total Project Costs		$17,935,400		$13,102,000

Replace Structure. The cost to replace a structure is based on wooden post-and-beam construction of an average priced new home on the Big Island. It is estimated that the costs for this alternative will be $65.00 per square foot of floor area, which includes $3.20 per square foot for the removal of the existing structure. Structures are assumed to be replaced in the same location.

Ring Walls. In building ring walls, the cost for a poured concrete wall is estimated to be $400/cubic yard. Additional costs for ring wall construction would be: surveyor's cost, excavation, closures, and a pump for interior drainage.

Relocating Goods. The relocation of goods is the permanent placement of flood damageable items above the estimated flood elevation and is generally applicable for commercial structures. Some items of work included in this relocation could be:

(1) Redesigning shelves.

(2) Relocating compressors or electric motors to a higher elevation.

(3) Relocating power outlets to a higher elevation.

(4) Redesigning of electrical controls to allow a cutoff switch of the low power outlets.

It is estimated that the cost for this work would be $10/sq ft of building floor area.

3. ESTIMATED AVERAGE ANNUAL COSTS

The average annual cost for the purposes of the benefit-to-cost comparisons include interests, amortization, annual maintenance and the development and incorporation of a flood warning and floodplain management enforcement system.

Interest and Amortization. An interest rate (i) of 7-5/8% and an amortization period (n) of 100 years were assumed. The amortization period is equivalent to the project life of the project. The project life of 100 years is consistent with Corps of Engineers policy on concrete flood control projects in urban areas.

Annual Maintenance. Annual maintenance consists of a regularly instituted program of insuring that debris and refuse accumulations do not adversely affect the flood control structures or its appurtenance and minor repair to the structural features (i.e., channels) that may be damaged. Annual maintenance and repair costs were estimated by taking 1% of the initial cost of the concrete channel for Alternatives 1 and 2. Maintenance and repair costs for Alternative 3 were based on the costs for post-flood clean-up activities and minor repairs to utilities and roads. This cost was estimated by taking .25% of the initial cost of improvements.

Flood Warning System and Floodplain Management Enforcement. The administrative cost of incorporating and sustaining supportive elements such as an adequate flood warning system, floodplain management enforcement and other items specified in the local assurances are included as annual costs. The County of Hawaii already possesses the organizational structure through the Office of the Mayor, Department of Public Works and Civil Defense to implement and coordinate many of these support elements. An annual cost of $15,000 (1/2 man-year of effort) was assumed.

Summary. Based on the prior assumptions, the following annual maintenance costs were developed:

TABLE D-17. AVERAGE ANNUAL MAINTENANCE COSTS ($1,000)

	Alternative Plans					
	1		2		3	
	100 Yr	SPF	100 Yr	SPF	100 Yr	SPF
Maintenance & Repair 40	15	18	45	60	68 1/	80 1/
Administration Costs of Incorporating Local Assurances	15	15	15	15	15	15
TOTAL AVG ANNUAL COSTS	30	33	60	75	83	95

The following is a summary of the average annual costs for determining the benefit-to-cost comparisons.

TABLE D-18. AVERAGE ANNUAL COSTS ($1,000)

	Alternative Plans					
	1		2		3	
	100-Yr	SPF	100-Yr 2/	SPF	100-Yr	SPF
Total Project Cost	6,675	7,983	12,184	15,678	13,102	17,935
Average Annual First Cost (CRF = .076299)	509	609	929	1,196	999	1,368
Average Annual Maintenance Cost	30	33	60	75	83	95
TOTAL AVG ANNUAL COST	539	642	989	1,271	1,082	1,463

1/ Higher maintenance costs were provided to maintain the floodproofing features for an expected life of 100 years.
2/ Alternative 2 cost estimate includes the covered channel.

4. APPORTIONMENT OF COSTS

The apportionment or sharing of project costs is based on current general Federal cost-sharing policy. Local interests are required to provide all lands, easements, and rights-of-way and all alterations and relocations of utilities, streets, highways, bridges, buildings, storm drains, and other structures and improvements; hold and save the United States free from damages due to the construction works; and assume operation and maintenance of the works after completion in accordance with regulations prescribed by the Secretary of the Army (33 CFR 208.10). These requirements are known as the "a-b-c" requirements of local cooperation from their general description in Section 3 of the 1936 Flood Control Act. Buildings, improvements, or other property which local interests desire to save must be removed by local interests at their expense. Buildings or other improvements which local interests desire to abandon may be turned over to the United States for disposal at Federal expense. Whenever the cost of required lands, easements and rights-of-way and all necessary alterations and relocations exceed the remaining construction cost of the project, local interests may be reimbursed one-half of the excess cost.

When a nonstructural measure is recommended, non-Federal participation is 20% of the measure's costs allocated to flood damage reduction pursuant to Section 73 of PL 93-251. Operation and maintenance costs are the responsibility of local interests. Nonstructural costs eligible for cost sharing include the cost of acquiring improvements, land or interests in land, the cost of floodproofing existing structures and the cost of relocation or removal of existing structures (including costs incurred under the Uniform Relocation Assistance and the Real Property Acquisition Policy Act of 1970 even though these costs are not considered NED costs). Eligible costs also include the cost of reestablishing existing public facilities in the case of relocation plans, e.g., building a new firehouse to replace one located in the floodplain. In these cases, purchase of existing public properties or facilities in the floodplain (e.g., the old firehouse) or reimbursement or credit for remaining indebtedness for these existing facilities are not costs which may be included, except that credit will be allowed for salvage value of public facilities.

When flood warning and/or temporary evacuation are elements of the adopted plan, the cost of equipment exclusively devoted to flood warning systems and/or temporary evacuation will require a 20% local contribution.

THE FOLLOWING IS A SUMMARY OF THE REQUIRED SHARING OF THE PROJECT FIRST COSTS BASED ON TRADITIONAL COST SHARING

TABLE D-19 APPORTIONMENT OF COSTS

ALTERNATIVE PLANS ($1000)

	SPF 1/	100-Year	SPF 1/	100-Year	SPF 2/	100-Year
Corps of Engineers Share	5,506	4,579	14,692	11,293	14,348	10,481
Non-Federal Share	2,477	2,096	986	891	3,587	2,620
Total Project First Cost	$7,983	$6,675	$14,678	$17,984	$17,935	$13,102

1/ Apportionment of costs based on traditional cost-sharing policy

2/ Nonstructural cost-sharing are based on 80% Federal, 20% non-Federal

ALENAIO STREAM

ECONOMIC EVALUATION APPENDIX

APPENDIX E

APPENDIX E

ALENAIO STREAM

FLOOD DAMAGE REDUCTION STUDY

ECONOMIC EVALUATION APPENDIX

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (Cont)

I. 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 (improvement in economic efficiency). The benefit standard is the willingness of users (benefiting 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 must exceed project costs, and there should be no other alternative with greater net benefits (benefits less costs). Non-economic considerations 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, and are the costs of all goods and services used in project construction, operation and maintenance. Both costs and benefits are expressed in terms of estimated September 1982 price levels. Costs and benefits occurring at different points in time are converted to an average annual equivalent basis over the 100-year period of analysis for comparison using the Federal discount rate prescribed for water resource projects. This rate is currently set at 7-5/8%.

II. BENEFITS

1. 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 Alenaio Stream floodplain in Hilo, Hawaii. Benefits resulting from the three alternatives include reduction of damages to structures and their contents, elimination of emergency relief costs, reduction in damages to public roads and utilities, and elimination of the threat to human safety.

2. DAMAGEABLE PROPERTY INVENTORY

Over half of the damage units in the Alenaio Stream floodplain are commercial. An inventory of flood-damageable property conducted in January and February 1981 provided the information for development of a damage data base for use in evaluating damage reduction alternatives. There are 509 first floor damage units in the floodplain, of which 286, or about 56%, are commercial, and 223 residential. There are three public buildings in the flood plain belonging to the Hawaii County Fire Department. Eighty damage units, or about 16% of the total, are located in the high-velocity flow damage zone (i.e., located adjacent to or very near the stream banks). Most of these are residential units Most of the commercial damage units, and many of the residential damage units. are located in multi-unit structures. About 26% of the residential damage units. and only about 8% of the non-residential units. are located in the high-velocity damage zone. Table E-1 contains a full breakdown of this information. The lower portions of the floodplain are almost entirely

TABLE E-1. DAMAGEABLE PROPERTY SUMMARY

	Number of Damage Units		
	Residential	Non-Residential 1/	Total
Located Near Stream Banks	58	22	80
Other	165	264	429
Total	223	286	509

1/ Includes 3 public structures

commercial and the upstream portion is all residential. The majority of the floodplain damage units. approximately 90%, are located in reaches 1 and 2, with the remainder in reach 3. Most of the structures in the floodplain, and nearly all of the residential structures, are wood on post and beam construction.

A field survey of floodplain properties was conducted during January and February 1981, and involved 6 man-weeks of effort by 5 POD staff members. The basic data items collected during the survey were first-floor elevations and depth-damage data. First-floor elevation estimates were made for all structures in the floodplain, both residential and nonresidential. The procedure involved the use of a surveyor's hand level in conjunction with elevation data for reference points throughout the floodplain from the office of the Division of Land and Surveys, and with topographic elevation data used in conducting the hydrologic analysis. The two data sources proved to be comparable, insuring consistency between damage estimates and water surface elevation estimates from hydrology studies. In addition to elevation data, the field survey involved interviews with owners/managers of nonresidential properties to determine specific depth-damage relationships for the contents of each nonresidential unit in the floodplain. 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. Structure values for all properties are based on data from the Hawaii State Department of Taxation.

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. Similarly except for the contents of residential structures, no significant increases in the real value of the stock of damageable assets have been forecast for the foreseeable future.

3. 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. Different standardized depth-damage curves were used for properties in the high-velocity damage zone than for those in the low velocity damage zone. Depth-damage data from the inventory of floodplain properties were used for non-residential contents damage estimates.

The calculations were done using a Pacific Ocean Division-developed computer program which uses the aforementioned data base information as input. The program calculates for each property a damage-frequency schedule, and integrates the aggregated damage-frequency data to arrive at expected value average annual amounts for the entire floodplain under various conditions and assumptions.

After damages for each flood are estimated, the data for all of the structures are summed to arrive at an array of estimated damage-probability data. Integration of this data results in estimated average annual flood damage for the without-project condition, and for each of the three alternatives under consideration. Historical flood experience shows that even with floods of fairly low frequency, flood damage can be significant, as indicated in photographs taken during the floods in 1966 and 1979 (see photographs #1-6, Main Report).

Damage probability data for structures and contents in the Alenaio Stream floodplain are displayed in Tables E-2 through E-6 for calculation of inundation damage reduction benefits. Data in these tables exclude properties to be relocated. Benefits for relocation of properties are treated separately as discussed later in this appendix. Further data tabulation reflecting this has been withheld in the interest of avoiding burdensome listings of numbers and the resulting confusion they would likely generate. Without-project data for all structures and contents (including those involved in relocation plans) are shown in the tables for Alternative 2.

Integration of the data in Tables E-2 through E-6 results in average annual inundation damage estimates for each of the three alternatives, for the two levels of protection considered. Tables E-7 through E-12 show average annual inundation damages for these various conditions, as well as inundation damage reduction benefits. Included in Tables E-7 through E-9 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 resource 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 contents does not exceed 75% of the real value of the structure.

Presently, the estimated average market value of contents is about 40% 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 in about 30 years from now, or about 2012 (i.e., 1.0230 x .40 = .72). Since the estimated first year of project life is 1987, the estimated real value of contents and content damages in 1987 will be 10% higher than at present (five years of growth at 2.0% per year = 1.025 = 1.104). Growth from 1987 to 2012 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 1.28, as shown in the following calcuation:

$$\text{Average annual equivalent factor} - (A/P,\ 7\text{-}5/8\%,\ 100)$$

$$\times \left(\left(\sum_{n=1}^{25} (1.02/1.07625)^{n}\right) + (1.02)^{25} \times (P/A,\ 7\text{-}5/8\%,\ 75).\right.$$

$$\left. \times\ (P/F,\ 7\text{-}5/8\%,\ 25)\right) = (.0763)\ (13.39 + 3.41) = 1.28,$$

Where the notation (A/P, i, n) signifies the factor for the annual equivalent of periodic amounts at interest rate i per period and 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 1987 by this factor of 1.28 results in estimated average annual equivalent contents inundation damages for the 100-year period of analysis.

TABLE E-2.

ESTIMATED DAMAGE PROBABILITY DATA, ALTERNATIVE 1 - 100-YEAR DESIGN 1/

($1,000's)

		Exceedence Probability	Residential Damage Structures	Residential Damage Contents	Residential Damage Total	Non-Residential Damage Structures	Non-Residential Damage Contents	Non-Residential Damage Total
Reach 1:	Without Project	.667	(No residential development in Reach 1)			0	0	0
		.500				0	0	0
		.200				0	0	0
		.100				0	0	0
		.020				34	5	39
		.010				42	19	61
		.002 (SPF)				62	36	98
	With Project	(Zero damage in Reach 1 With Project)						
Reach 2:	Without Project (Excludes properties to be relocated)	.667	0	0	0	0	0	0
		.500	10	1	11	11	788	799
		.200	21	2	23	342	1,509	1,851
		.100	56	18	74	735	3,292	4,027
		.020	126	68	194	1,392	5,198	6,590
		.010	149	106	255	1,665	6,193	7,858
		.002 (SPF)	206	185	391	2,210	8,658	10,868
	With Project	.667	0	0	0	0	0	0
		.500	0	0	0	0	0	0
		.200	0	0	0	0	0	0
		.100	0	0	0	0	0	0
		.020	0	0	0	0	0	0
		.010	0	0	0	0	0	0
		.002 (SPF)	66	24	90	882	3,537	4,419
Reach 3:	Without Project (Excludes properties to be relocated)	.667	0	0	0	(Residential development only in Reach 3)		
		.500	11	1	12			
		.200	51	2	53			
		.100	78	5	83			
		.020	154	48	202			
		.010	280	96	376			
		.002 (SPF)	502	214	716			
	With Project	.667	0	0	0	(Residential development only in Reach 3)		
		.500	4	0	4			
		.200	11	0	11			
		.100	23	1	24			
		.020	73	3	76			
		.010	113	7	120			
		.002 (SPF)	267	59	326			

1/ Alternative 1 involves channel realignment in Reach 2, and channelization. It also includes floodproofing for Reach 1 and Reach 3. The data in this table exclude structures slated for relocation, for which benefits are evaluated separately.

TABLE E-3.

ESTIMATED DAMAGE-PROBABILITY DATA, ALTERNATIVE 1 - SPF DESIGN 1/

($1,000's)

		Exceedence Probability	Residential Damage Structures	Residential Damage Contents	Residential Damage Total	Non-Residential Damage Structures	Non-Residential Damage Contents	Non-Residential Damage Total
Reach 1:	Without Project	.667	(No residential development in Reach 1)			0	0	0
		.500				0	0	0
		.200				0	0	0
		.100				0	0	0
		.020				34	5	39
		.010				42	19	61
		.002 (SPF)				62	36	98
	With Project	(Zero damage in Reach 1 With Project)						
Reach 2:	Without Project	.667	0	0	0	0	0	0
	(Excludes properties to be relocated)	.500	10	1	11	11	788	799
		.200	21	2	23	342	1,509	1,851
		.100	56	18	74	735	3,292	4,027
		.020	126	68	194	1,392	5,198	6,590
		.010	149	106	255	1,665	6,193	7,858
		.002 (SPF)	206	185	391	2,210	8,658	10,868
	With Project	(Zero damage in Reach 2 With Project)						
Reach 3:	Without Project	.667	0	0	0	(Residential development only in Reach 3)		
	(Excludes properties to be relocated)	.500	11	1	12			
		.200	51	1	53			
		.100	78	5	83			
		.020	136	38	174			
		.010	253	79	332			
		.002 (SPF)	461	187	648			
	With Project	.667	0	0	0	(Residential development only in Reach 3)		
		.500	0	0	0			
		.200	8	0	8			
		.100	21	1	22			
		.020	29	2	31			
		.010	77	3	80			
		.002 (SPF)	231	37	268			

1/ See Footnote 1, Table E-2.

TABLE E-4
ESTIMATED DAMAGE-PROBABILITY DATA, ALTERNATIVE 2 1/
($1,000's)

		Exceedence Probability	Residential Damage			Non-Residential Damage		
			Structures	Contents	Total	Structures	Contents	Total
Reach 1:	Without Project	.667	(No residential development in Reach 1)			0	0	0
		.500				0	0	0
		.200				0	0	0
		.100				0	0	0
		.020				34	5	39
		.010				42	19	61
		.002 (SPF)				62	36	98
	With Project	(Zero damage in Reach 1 with either 100-Year or SPF design level of protection)						
Reach 2:	Without Project	.667	0	0	0	0	0	0
		.500	10	1	11	11	788	799
		.200	21	2	23	392	1,522	1,914
		.100	56	18	74	758	3,310	4,108
		.020	126	68	194	1,482	5,226	6,708
		.010	149	106	255	1,766	6,227	7,993
		.002 (SPF)	206	187	393	2,322	8,706	11,028
	With 100-Year Design Level Protection	.010	0	0	0	0	0	0
		.002 (SPF)	66	24	90	882	3,537	4,419
	With SPF Design Protection	.010	0	0	0	0	0	0
		.002 (SPF)	56	18	74	798	3,310	4,108
Reach 3:	Without Protection	.667	0	0	0	(Residential development only in Reach 3)		
		.500	11	1	12			
		.200	51	1	52			
		.100	78	5	83			
		.020	154	48	202			
		.010	280	96	376			
		.002 (SPF)	502	214	716			
	With 100-Year and SPF Design Level Protection	.010	0	0	0	(Residential development only in Reach 3)		
		.002 (SPF)	51	2	53			

1/ Alternative 2 consists of a diversion channel upstream of Reach 3, and bridge modifications at Kinoole and Kilauea Streets. Since there are no properties to be relocated in this alternative, without-project data fully reflect without-project inundation damages for structures and contents.

TABLE E-5.
ESTIMATED DAMAGE-PROBABILITY DATA, ALTERNATIVE 3 - 100-YEAR DESIGN 1/
($1,000's)

		Exceedence Probability	Residential Damage			Non-Residential Damage		
			Structures	Contents	Total	Structures	Contents	Total
Reach 1:	Without Project	.100	(No residential development in Reach 1)			0	0	0
		.020				34	5	35
		.010				42	19	61
		.002 (SPF)				62	36	98
	With Project	(Zero damage in Reach 1 with project)						
Reach 2:	Without Project	.667	0	0	0	0	0	0
	(Excludes properties to be relocated)	.500	10	1	11	5	751	756
		.200	21	2	23	147	1,324	1,470
		.100	56	18	74	286	2,060	2,346
		.020	126	68	194	708	3,125	3,833
		.010	149	106	255	941	3,969	4,910
		.002 (SPF)	206	187	393	1,405	6,299	7,704
	With Project	.667	0	0	0	0	0	0
		.500	3	0	3	5	751	756
		.200	5	0	5	140	1,315	1,455
		.100	21	4	25	230	1,964	2,194
		.020	82	39	121	511	2,464	2,975
		.010	117	76	193	679	3,051	3,730
		.002 (SPF)	198	164	362	1,091	5,081	6,172
Reach 3:	Without Project	.667	0	0	0	(Residential development only in Reach 3)		
	(Excludes properties to be relocated)	.500	11	1	12			
		.200	51	1	52			
		.100	78	5	83			
		.020	154	48	202			
		.010	280	96	376			
		.002 (SPF)	502	214	716			
	With Project	.667	0	0	0	(Residential development only in Reach 3)		
		.500	4	0	4			
		.200	11	0	11			
		.100	23	1	24			
		.020	121	27	148			
		.010	257	74	331			
		.002 (SPF)	484	205	689			

1/ Alternative 3 consists entirely of floodproofing and relocation of structures. Data in this table exclude structures slated for relocation, for which benefits are calculated separately.

TABLE E-6.
ESTIMATED DAMAGE-PROBABILITY DATA, ALTERNATIVE 3 - SPF DESIGN 1/
($1,000's)

		Exceedence Probability	Residential Damage Structures	Residential Damage Contents	Residential Damage Total	Non-Residential Damage Structures	Non-Residential Damage Contents	Non-Residential Damage Total
Reach 1:	Without Project	.667	(No residential development in Reach 1)			0	0	0
		.500				0	0	0
		.200				0	0	0
		.100				0	0	0
		.020				34	5	39
		.010				42	19	61
		.002 (SPF)				62	36	98
	With Project	(Zero damage in Reach 1 with project)						
Reach 2:	Without Project (Excludes properties to be relocated)	.667	0	0	0	0	0	0
		.500	10	1	11	5	751	756
		.200	21	2	23	129	1,311	1,439
		.100	56	18	74	210	1,995	2,205
		.020	126	68	194	454	2,783	3,237
		.010	149	106	255	654	3,549	4,203
		.002 (SPF)	206	187	393	1,046	5,716	6,762
	With Project	.667	0	0	0	0	0	0
		.500	0	0	0	0	733	733
		.200	0	0	0	14	837	851
		.100	6	1	7	118	1,043	1,161
		.020	30	12	42	319	2,300	2,619
		.010	45	21	66	389	2,501	2,890
		.002 (SPF)	141	103	244	583	3,542	4,125
Reach 3:	Without Project (Excludes properties to be relocated)	.667	0	0	0	(Residential development only in Reach 3)		
		.500	11	1	12			
		.200	51	2	53			
		.100	78	5	83			
		.020	136	38	174			
		.010	253	79	332			
		.002 (SPF)	461	187	648			
	With Project	.667	0	0	0	(Residential development only in Reach 3)		
		.500	0	0	0			
		.200	8	0	8			
		.100	21	1	22			
		.020	68	20	88			
		.010	176	54	230			
		.002 (SPF)	434	164	598			

1/ See footnote 1, Table E-5.

TABLE E-7. AVERAGE ANNUAL INUNDATION DAMAGES AND INUNDATION DAMAGE REDUCTION BENEFITS FOR RESIDENTIAL PROPERTIES, ALTERNATIVE 1 1/
($1,000's)

	Average Annual Damages					
		Contents				
	Structures 2/	1982 2/	1987 3/	1987-2087 4/	Total Structures and Contents 5/	Average Annual Damage Inundation Reduction Benefits 6/
100-Yr Design						
Without Project						
Reach 2	20	7	7.7	10	30	
Reach 3	32	5	5.5	7	39	
TOTAL	52	12	13.2	17	69	
With Project						
Reach 2	1	0	0	0	1	29
Reach 3	11	1	1.1	1	12	27
TOTAL	12	1	1.1	1	13	56
SPF Design						
Without Project						
Reach 2	20	7	7.7	10	30	
Reach 3	31	5	5.5	7	38	
TOTAL	51	12	13.2	17	68	
With Project						
Reach 2	0	0	0	0	0	30
Reach 3	6	1	1.1	1	7	31
TOTAL	6	1	1.1	1	7	61

1/ September 1982 prices, 7-5/8% interest rate, and 100-year period of analysis, 1987-2087.
2/ From integration of damage-probability data in Tables E-2 and E-3.
3/ From multiplying 1982 figure by 1.10 to account for five years of real growth at 2.0% per year.
4/ From multiplying 1987 figure by 1.28 to account for the effect of increasing real value of contents during period of analysis.
5/ Structure figure plus contents figure for 1987-2087.
6/ Benefit equals damage without alternative less damage with alternative.

NOTE: Data for without-project condition exclude properties to be relocated.

TABLE E-8. AVERAGE ANNUAL INUNDATION DAMAGES AND INUNDATION DAMAGE REDUCTION BENEFITS FOR RESIDENTIAL PROPERTIES, ALTERNATIVE 2[1]
($1,000's)

	Average Annual Damages					
		Contents				
	Structures[2]	1982[2]	1987[3]	1987-2087[4]	Total Structures and Contents[5]	Average Annual Damage Inundation Reduction Benefits[6]
Without Project						
Reach 2	20	7	7.7	10	30	
Reach 3	32	5	5.5	7	39	
TOTAL	52	12	13.2	17	69	
With Project						
Both 100-Yr and SPF Design						
Reach 2	1	0	0	0	1	29
Reach 3	0	0	0	0	0	39
TOTAL	1	0	0	0	1	68

1/-6/ Footnotes from Table E-7 apply, except that average annual amounts are from integration of damage-probability data in Table E-4.

NOTE: Since there are no properties to be relocated in this alternative, without-project data fully reflect without-project inundation damages for structures and contents.

TABLE E-9. AVERAGE ANNUAL INUNDATION DAMAGES AND INUNDATION DAMAGE REDUCTION BENEFITS FOR RESIDENTIAL PROPERTIES, ALTERNATIVE 3[1/]
($1,000's)

	Average Annual Damages					
		Contents				
	Structures[2/]	1982[2/]	1987[3/]	1987-2087[4/]	Total Structures and Contents[5/]	Average Annual Damage Inundation Reduction Benefits[6/]
100-Yr Design						
Without Project						
Reach 2	20	7	7.7	10	30	
Reach 3	32	5	5.5	7	39	
TOTAL	52	12	13.2	17	69	
With Project						
Reach 2	10	4	4.4	6	16	14
Reach 3	16	3	3.3	4	20	19
TOTAL	26	7	7.7	10	36	33
SPF Design						
Without Project						
Reach 2	20	7	7.7	10	30	
Reach 3	31	4	4.4	5	36	
TOTAL	51	11	12.1	15	66	
With Project						
Reach 2	3	2	2.2	3	6	24
Reach 3	11	2	2.2	3	14	22
TOTAL	14	4	4.4	6	20	46

1/-6/ Footnotes from Table E-7 apply except that average annual amounts are from integration of damage-probability data in Tables E-5 and E-6.

NOTE: Data for without-project condition exclude properties to be relocated.

TABLE E-10. AVERAGE ANNUAL INUNDATION DAMAGES AND INUNDATION DAMAGE REDUCTION BENEFITS FOR NON-RESIDENTIAL PROPERTIES, ALTERNATIVE 1
($1,000's)

	Average Annual Damages 1/			Average Annual Benefits 2/
	Structures	Contents	Total	
Without Project				
Reach 1	2	1	3	
Reach 2	228	1124	1352	
TOTAL	230	1125	1355	
With Project				
100-Yr Design				
Reach 1	0	0	0	3
Reach 2	6	21	27	1325
TOTAL	6	21	27	1328
SPF Design				
Reach 1	0	0	0	3
Reach 2	0	0	0	1352
TOTAL	0	0	0	1355

1/ From integration of damage-probability data in Tables E-2 and E-3.
2/ Damages without project less damages with project.

NOTE: Data for without-project condition exclude properties to be relocated.

TABLE E-11. AVERAGE ANNUAL INUNDATION DAMAGES AND INUNDATION DAMAGE REDUCTION BENEFITS FOR NON-RESIDENTIAL PROPERTIES, ALTERNATIVE 2
($1,000's)

	Average Annual Damages1/			Average Annual Benefits2/
	Structures	Contents	Total	
Without Project				
Reach 1	2	1	3	
Reach 2	250	1130	1380	
TOTAL	252	1131	1383	
With Project				
100-Yr Design				
Reach 1	0	0	0	3
Reach 2	6	21	27	1353
TOTAL	6	21	27	1356
SPF Design				
Reach 1	0	0	0	3
Reach 2	5	20	25	1355
TOTAL	5	20	25	1358

1/-2/ Footnotes in Table E-10 apply, except that average annual amounts are from integration of damage-probability data in Table E-4.

NOTE: Since there are no properties to be relocated in this alternative, without-project data fully reflect without-project inundation damages for structures and contents.

TABLE E-12. AVERAGE ANNUAL INUNDATION DAMAGES AND INUNDATION DAMAGE REDUCTION BENEFITS FOR NON-RESIDENTIAL PROPERTIES, ALTERNATIVE 3

	Average Annual Damages1/ Structures	Contents	Total	Average Annual Benefits2/
100-Yr Design				
Without Project				
Reach 1	2	1	3	
Reach 2	105	840	945	
TOTAL	107	841	948	
With Project				
Reach 1	0	0	0	3
Reach 2	85	784	869	76
TOTAL	85	784	869	79
SPF Design				
Without Project				
Reach 1	2	1	3	
Reach 2	78	809	887	
TOTAL	80	810	890	
With Project				
Reach 1	0	0	0	3
Reach 2	35	579	614	273
TOTAL	35	579	614	276

1/-2/ Footnotes in Table E-10 apply, except that average annual amounts are from integration of damage-probability data in Tables E-5 and E-6.

NOTE: Data for without-project condition exclude properties to be relocated.

4. RELOCATION BENEFITS

Alternative 3, the primarily non-structural plan, consists of a floodproofing component and a relocation-evacuation component. Alternative 1 also includes these measures for Reach 2, in connection with properties which must be relocated in order to complete the channel realignment component for both the 100-yr and the SPF design levels of protection, and for Reach 3. Table E-13 summarizes numbers of structures to be relocated in Alternatives 1 and 3.

TABLE 13. SUMMARY OF NUMBER OF STRUCTURES INCLUDED IN RELOCATION COMPONENTS

	Alternative			
	1		3	
	100-Yr	SPF	100-Yr	SPF
Reach 1	0	0	0	0
Reach 2	6 1/	6 1/	30 2/	50 3/
Reach 3	0	3 4/	0	3 4/
TOTAL	6	9	30	53

1/ 4 residential, 2 non-residential
2/ all non-residential
3/ 1 residential, 49 non-residential
4/ all residential

Relocation benefits consist of the elimination of flood damages not borne by floodplain users. Damages borne by floodplain users are accounted for in the fair market value of floodplain property. Flood damages borne by the rest of the nation result from the federally subsidized Flood Insurance Administration (FIA) program insuring floodplain users. The amount by which average annual damages exceed the FIA rates charged floodplain users is the NED benefit. Utilizing the principle of economic rationality, relocation benefits are estimated assuming that all floodplain residents are insured in the without condition. Average annual relocation benefits are the sum of externalized flood damages (inundation damage net of insurance premiums and deductibles), and emergency damages and public property damages associated with the structures targeted for relocation. The relocation benefits are outlined in Table E-14 for Alternatives 1 and 3.

TABLE E-14
AVERAGE ANNUAL
RELOCATION BENEFITS, ALTERNATIVES 1 and 3
($1,000's)

	Alternative 1		Alternative 3	
	100 yr. Design	SPF Design	100 yr. Design	SPF Design
Reduction of Externalized Flood Damages				
Structures	22	23	145	173
Contents	6	6	290	323
Subtotal 1/	28	29	435	496
Deductions 2/	-2	-2	-34	-39
Subtotal	26	27	401	457
Reduction of Emergency Costs 3/	- 4/	- 4/	- 4/	1
Reduction of Public Property Damages	- 4/	- 4/	2	3
Total Relocation Benefits	26	27	403	461

1/ Includes estimated without-condition damages for those structures targeted for relocation.
2/ Deductions include insurance premiums and deductible amounts per flood event for each unit.
3/ Assumed to be in proportion to number of units to be relocated; benefits are in addition to emergency relief cost reduction benefits shown in Table E-16, and are calculated from data in Tables E-13, E-15, and E-16.
4/ Negligible (less than $500)
5/ Assumed to be in proportion to number of relocations; benefits are in addition to public property inundation reduction benefits shown in Table E-17.

5. OTHER BENEFITS

There have in the past been emergency relief efforts during flood conditions throughout the Hilo Coast area, and specifically in the immediate vicinity of Hilo. Available data on emergency relief costs specific to Alenaio Stream flooding problems are not available and 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-15. The data in Table E-15 translates into an average annual equivalent cost of about $6,000.

TABLE E-15. ESTIMATED EMERGENCY RELIEF COSTS
($1,000's)

Exceedence Probability of Flood Event	Emergency Relief Costs1/
.667	0
.500	5
.200	8
.100	18
.020	30
.010	50
.002 (SPF)	50

1/ $100 per damage unit affected in the 100-yr and SPF flood events, and for lower levels of flooding in proportion to damages from stage damage relationships for floodplain. Based on experience in other floodplains within jurisdiction of Pacific Ocean Division, Corps of Engineers.

Table E-16 shows an estimated breakdown by reach, estimated average annual estimates for each alternative, and resulting benefits.

TABLE E-16. ESTIMATED EMERGENCY RELIEF COST REDUCTION BENEFITS5/
($1,000's)

	Average Annual Cost Reach 1	Reach 2	Reach 3	Total	Average1/ Annual Benefit
Without Project2/	-- 3/	4	2	6	
Alternative 1					
100-yr Design	-- 3/	0	14/	1	5
SPF Design	-- 3/	0	14/	1	5
Alternative 2					
100-yr Design	-- 3/	-- 3/	-- 3/	-- 3/	6
SPF Design	0	0	0	0	6
Alternative 3					
100-yr Design	-- 3/	24/	14/	3	3
SPF Design	-- 3/	24/	14/	3	3

1/ Difference between costs without project and costs with project.
2/ From Table E-15. Breakdown roughly in proportion to distribution of damage units throughout reaches.
3/ Negligible
4/ Assume approximately a 50% reduction due to the effect of non-structural measures and probable heightened public awareness of precautionary actions to take during times of immediate flood threat.
5/ Excludes benefits assocated with relocation properties.

The related effect of transportation delays along Bayfront Highway is of concern in the analysis of protection for Reach 1, Alternative 1. Four of the sub-plans for Reach 1 involve significant structural measures to reduce flooding. Aside from inundation damage reduction to property in Reach 1 (there are three structures in the reach), the structural plans would alleviate to a very small degree the transportation delays encountered by motorists wishing to drive through the area during flooding. Other transportation problems would still exist in the region. Assuming 1,000 vehicles are delayed during floods of magnitudes which equal or exceed the 2-year event, and using a 10-mile detour as a proxy measure for this delay, the average annual cost of this effect is an estimated $1,000 (at $.20 per mile). Since the cost of alleviating this problem with one of the major structural subplans envisioned as possibilities for Reach 1 would exceed an annual equivalent of $1,000, a major structural component for the reach is not feasible. The damage reduction calculations have assumed that Reach 1 structures would be floodproofed individually.

Estimated benefits resulting from a reduction of damages to public roads and utilities within the Alenaio Stream floodplain are based on estimates for past flood events, updated to reflect current price levels. Assuming no significant damage in this category for floods less than the 5-year event, $10,000 worth of damage with the 5-year event, and $170,000 with the 10-year event and greater, (estimated from historical flood experience) the average annual equivalent damage amounts to about $26,000.

Benefits are based on the assumption that virtually all of this effect is eliminated with alternative 2, about 90 percent is eliminated with alternative 1 since there is no protection in Reach 3, and none is eliminated with alternative 3, the primarily nonstructural plan, except for relocation properties (see Table E-14). Reduction of damages to public roads and utilities is outlined in Table E-17.

TABLE E-17. ESTIMATED DAMAGE REDUCTION BENEFITS FOR PUBLIC ROADS AND UTILITIES 1/
($1,000's)

	Average Annual Damage	Average Annual Benefit
Without Project	26	—
With:		
Alternative 1	3	23
Alternative 2	0	26
Alternative 3	26	0

1/ Excludes benefits associated with relocation properties.

In addition to loss of land, emergency relief costs and damage to public property, flooding along Alenaio Stream poses a significant threat to human safety. While basically impossible to measure in quantifiable economic terms within the national economic development accounting framework, this aspect of the Alenaio flood problem remains very real. Perhaps the most important effects of flooding and the threat of flooding are disruption of community activity, health hazard, and the danger of loss of human life. High velocity flows carrying debris could result in serious personal injury, in addition to devastating destruction to property along the stream. Preventing the likelihood of these effects occurring is a major consideration in proposing a flood control alternative.

III. BENEFIT-COST SUMMARY

A summary of benefits by reach for the three alternatives is shown in Tables E-18 through E-20.

A summary of average annual benefits, costs and two measures of feasibility, the B/C ratio and net benefits, are tabulated in Table E-21.

TABLE E-18.
BENEFIT SUMMARY BY REACH - ALTERNATIVE 1
($1,000's)

	Average Annual Benefit							
	100-Year Design				SPF Design			
	Reach 1	Reach 2	Reach 3	Total	Reach 1	Reach 2	Reach 3	Total
Inundation Reduction								
Residential								
Structures	0	19	21	40	0	20	25	45
Contents	0	10	6	16	0	10	6	16
Non-Residential								
Structures	2	222	0	224	2	228	0	230
Contents	1	1,103	0	1,104	1	1,124	0	1,125
Emergency	0	4	1	5	0	4	1	5
Public Property 1/	8	8	7	23	8	8	7	23
Relocation	0	26	0	26	0	26	1	27
Human Safety 2/	-	-	-	-	-	-	-	-
TOTAL	11	1,392	35	1,438	11	1,420	40	1,471

1/ Arbitrarily distributed evenly among the reaches, on the basis of the concept that the entire community benefits from these effects.
2/ While these effects will most likely occur, no credit is included due to measurement problems.

TABLE E-19.
BENEFIT SUMMARY BY REACH - ALTERNATIVE 2
($1,000's)

	Average Annual Benefit							
	100-Year Design				SPF Design			
	Reach 1	Reach 2	Reach 3	Total	Reach 1	Reach 2	Reach 3	Total
Inundation Reduction								
Residential								
Structures	0	19	32	51	0	19	32	51
Contents	0	10	7	17	0	10	7	17
Non-Residential								
Structures	2	244	0	246	2	245	0	247
Contents	1	1,109	0	1,110	1	1,110	0	1,111
Emergency	0	4	2	6	0	4	2	6
Public Property 1/	9	9	8	26	9	9	8	26
Relocation	0	0	0	0	0	0	0	0
Human Safety 2/	-	-	-	-	-	-	-	-
TOTAL	12	1,395	49	1,456	12	1,397	49	1,458

1/ Arbitrarily distributed evenly among the reaches, on the basis of the concept that the entire community benefits from these effects.
2/ While these effects will most likely occur, no credit is included due to measurement problems.

TABLE E-20.
BENEFIT SUMMARY BY REACH - ALTERNATIVE 3
($1,000's)

	Average Annual Benefit							
	100-Year Design				SPF Design			
	Reach 1	Reach 2	Reach 3	Total	Reach 1	Reach 2	Reach 3	Total
Inundation Reduction								
Residential								
Structures	0	10	16	26	0	17	20	37
Contents	0	4	3	7	0	7	2	9
Non-Residential								
Structures	2	20	0	22	2	43	0	45
Contents	1	56	0	57	1	230	0	231
Emergency	0	2	1	3	0	2	1	3
Public Property	0	0	0	0	0	0	0	0
Relocation	0	403	0	403	0	458	3	461
Human Safety 1/	-	-	-	-	-	-	-	-
TOTAL	3	495	20	518	3	757	26	786

1/ While these effects will most likely occur, no credit is included due to measurement problems.

TABLE E-21 (713.533-1)[1/] SUMMARY OF ANNUALIZED NED BENEFITS AND COSTS FOR ALTERNATIVES 1, 2 AND 3 ($1,000)

Applicable Discount Rate: 7-5/8%

	Alternative 1		Alternative 2		Alternative 3	
	100 Yr.	SPF	100 Yr.	SPF	100 Yr	SPF
Flood Hazard Reduction Benefits						
Inundation						
Residential						
Structures	40	45	51	51	26	37
Contents	16	16	17	17	7	9
Non-Residential						
Structures	224	230	246	247	22	45
Contents	1104	1125	1110	1111	57	231
Emergency	5	5	6	6	3	3
Public Property	23	23	26	26	0	0
Relocation	26	27	0	0	403	461
Human Safety[2/]	-	-	-	-	-	-
Total Benefits (B)	1438	1471	1456	1458	518	786
Project Costs (C)	539	642	989	1271	1082	1463
B/C Ratio	2.7	2.3	1.5	1.15	.48	.54
Net Benefits	899	829	467	187	-564	-677

1/ Table 713.533-1 is required by Federal Regulations to be displayed. See Federal Register, Vol. 44, No. 242, Rules and Regulations, 14 Dec 79 (Water Resources Council Procedures for Evaluation of National Economic Development Benefits and Costs in Water Resources Planning).

2/ While these effects will most likely occur, no credit is included due to measurement problems.

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 internally consistent throughout the computations, so that arbitrary calculations are absent from the assessment of flood damages and flood damage reduction benefits.

IV. REQUIRED TABLES

U.S. Water Resources Council procedures require the display of four specific information tables in flood control study reports conducted by federal agencies. One of these displays is in Table E-21. Tables E-22 through E-24 below are the other three, and contain information on residual damages (damages with a project in place), damages without a project, and number of structures in the floodplain without a project and with each of the three alternatives.

TABLE E-22 (713.533.2).[1] AVERAGE ANNUAL RESIDUAL FLOOD DAMAGES BY DECADE ($1,000)

BY DECADE WITHOUT PROJECT ($1,000)

Applicable Discount Rate: 7-5/8%

Project	Time Period[2]							
	P0	P10	P20	P30	P40	P50	P100	AAE[3]
Alternative 1								
100-Yr. Design	45	45	45	45	45	45	45	45
SPF Design	11	11	11	11	11	11	11	11
Alternative 2								
100-Yr. Design	28	28	28	28	28	28	28	28
SPF Design	26	26	26	26	26	26	26	26
Alternative 3								
100-Yr. Design	529	531	533	534	534	534	534	531
SPF Design	197	198	199	200	200	200	200	199

1/ Water Resources Council (WRC) procedures required table designation.
2/ P10, P20, etc., denote the 10th and 20th years of project life, respectively.
3/ Growth is due to growth in contents damages through P25. AAE = average annual equivalent..

TABLE E-23(713.533-3) [1] AVERAGE ANNUAL FLOOD DAMAGES BY DECADE WITHOUT PROJECT ($1,000)

Applicable Discount Rate: 7-5/8%

Property Type	Existing	Time Period[2]							
		P0	P10	P20	P30	P40	P50	P100	AAE[3]
Residential									
Structures	52	52	52	52	52	52	52	52	52
Contents	12	13	16	20	22	22	22	22	17
Non-Residential									
Structures	252	252	252	252	252	252	252	252	252
Contents[4]	1131	1131	1131	1131	1131	1131	1131	1131	1131
Emergency	6	6	6	6	6	6	6	6	6
Public	26	26	26	26	26	26	26	26	26
Total	1479	1480	1483	1487	1489	1489	1489	1489	1484

1/ WRC procedures required table designation.
2/ P10, P20 denote the 10th and 20th years of project life, respectively.
3/ AAE = average annual equivalent.
4/ Growth is due to growth in contents damages through P25.

TABLE E-24 (713.533-4).[1] NUMBER OF STRUCTURES IN FLOODPLAIN

Condition	Structures[2]							
		Time Period[3]						
	Existing	P0	P10	P20	P30	P40	P50	P100
Without Project	324	324	324	324	324	324	324	324
Alternative 1 100-Yr.	324	318	318	318	318	318	318	318
Alternative 1 SPF	324	315	315	315	315	315	315	315
Alternative 2	324	324	324	324	324	324	324	324
Alternative 3 100-Yr.	324	294	294	294	294	294	294	294
Alternative 3 SPF	324	271	271	271	271	271	271	271

1/ WRC procedures required table designation.
2/ Floodplain fully developed, and reduced number for Alternatives 1 and 3 reflect relocation plans. Approximately 56% of the structures are commercial, with the remainder residential, except for three public structures. Most of the structures slated for relocation in Alternative 1 are residential, and in Alternative 3 are non-residential.
3/ P10, P20, etc., denote the 10th and 20th years of project life, respectively.

V. SENSITIVITY

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 calculation 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 less than one percent 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 a 7-5/8% interest rate. Higher rates result in higher average annual costs, and lower rates reduce average annual costs. Table E-25 shows for each of the alternatives under consideration what the interest rate would have to be in order for costs to be equal to benefits.

TABLE E-25. SENSITIVITY OF PROJECT FEASIBILITY TO THE INTEREST RATE

Alternative	Interest Rate[1/]
1, 100-Yr.	21.09%
1, SPF	18.01%
2, 100-Yr.	11.46%
2, SPF	8.82%
3, 100-Yr.	3.17%
3, SPF	3.76%

1/ For costs to equal benefits.

Another factor which has an impact on the measure of project feasibility is the depth-damage relationship used in calculating damage from different levels of flooding, from which annualized damages and benefits are derived. In the Alenaio floodplain, the majority of project damage-inundation reduction benefits accrue to floodplain activities in Reach 2. The damage calculations use two different sets of standardized depth-damage relationships for residential structures and contents and for non-residential structures, one for high velocity damage zone properties (located near or very near to the streambanks), and one for the rest of the properties. A check on benefit sensitivity to the use of these different curves revealed that for Reach 2, benefits for alternative 1, SPF protection, are about 4% lower for structures and contents when the low velocity depth-damage curves only are used, and about 23% higher when the high velocity curves only are used throughout the reach, instead of just for the high velocity zone damage units. For non-residential contents damage reduction benefits, no standardized curves are used. Instead, interview data obtained during the damageable property inventory are the basis for the depth-damage relationship.

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 affect on benefits. Structure market value data is derived from assessed valuation figures obtained from the State Department of Taxation, which based on studies made by the Tax Office are assumed to equal approximately 0.6 of the market value. 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. 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. Again using Reach 2 as an example, benefits were calculated assuming consistent elevation errors throughout the reach, of +/- 1 foot, and +/- 0.5 foot. The results of this sensitivity test are displayed in Table E-26.

TABLE E-26. SENSITIVITY OF BENEFITS TO ELEVATION DATA

Change in Elevation Data 1/	Change in Benefits 2/
+1.0 Ft.	-28%
+0.5 Ft.	-15%
-0.5 Ft.	+18%
-1.0 Ft.	+39%

1/ + means all structures assumed to be higher (or all water surface profiles are lower).
2/ Change from benefits as formulated in report for Reach 2, for structures and contents, Alternative 1, SPF design.

As shown in Table E-26, 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 30 to 40 percent. 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.

ALENAIO STREAM

CULTURAL AND SOCIAL RESOURCES

APPENDIX F

APPENDIX F

ALENAIO STREAM
FLOOD DAMAGE REDUCTION STUDY

CULTURAL AND SOCIAL RESOURCES APPENDIX

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

1. Sections II and III of Appendix F summarizes the findings of the Corps in identifying prehistoric sites, historic structures, or other cultural resources in the study area. 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 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 for any adverse effects.

2. Section IV of the cultural and social resources appendix summarizes pertinent socioeconomic profile data on the study area and assesses the social well-being components of the three alternative plans. The Other Social Effects component analysis derives from the Water Resources Council's "Principles and Standards for Planning Water and Related Land Resources - Level C" (P&S), 45 Federal Register 64366-64400, 29 September 1980. The Other Social Effects components now required by P&S consist of (a) Urban and community impacts such as income distribution, employment distribution, population distribution and composition, the fiscal condition of the local government, and the quality of community life; (b) Life, health and safety; (c) Displacement including people, businesses, and farms; (d) Long-term productivity involving renewable resources; and (e) Energy requirements and energy conservation both during construction and operation of facilities.

II. HISTORICAL BACKGROUND

1. The history of Hilo is described in detailed narrative pictures, and maps in Hilo Bay: A Chronological History - Land and Water Use in the Hilo Bay Area, Island of Hawai'i by Marion Kelly, Barry Nakamura, and Dorothy B. Barrere of the Bishop Museum (US Army Engineer District, Honolulu, March 1981). The history of the study area was examined in detail by Marion Kelly as Report 1 of Archaeological and Historical Studies for the Alenaio Stream Flood Damage Reduction Study, Hilo, Hawaii which was prepared under contract with the US Army Corps of Engineers (June 1982). The combined report will be made available upon request. Prehistoric Hilo may date back many centuries, but traditional oral histories believed to date from the 16th century, first mention Hilo in reference to the residence of chiefs at Waiakea. Virtually no archaeological studies have been conducted in Hilo proper. By the late 16th or early 17th century, land sections called *ahupua'a*, which theoretically ran from the sea to the high mountains, are believed to have been portioned off. Alenaio Stream courses in its lower reach (approximately below the present Komohana Street) between the two *ahupua'a* of Ponahawai to the northwest and Kukuau I and II to the southeast. The alignment for Alternative Plan 2 crosses the *ahupua'a* of Ponahawai, Punahoa I and II, and the large, extensive *ahupua'a* of Pi'ihonua. Upon the death of the first unifying King Kamehameha I in 1819, the King's personally held Hilo lands, including Pi'ihonua and

Punahoa descended to Liholiho, his son and heir. The two Kukuau went, respectively, to his haole (white) chiefs, John Young and Isaac Davis, and Ponahawai was apparently given to Keawe-a-Heulu, one of his warrior chiefs. Subsequent ahupua'a transactions are described in Kelly and others (1981).

2. In late prehistoric or early historic times, McEldowney (1979) describes in general terms, the Upland Agricultural Zone (around Komohana Street area) as an expanse of unwooded grassland, possibly created by slash-and-burn or swidden horticulture which is known to have been practised by the early Hawaiians. Dryland taro and bananas may have been numerous as well as sugarcane and other crops. By 1839 the Island Governor, Kuakini, had a sugar plantation and mill on Ponahawai lands, with cane planted on the Puna (eastern) side of the Hala'i hills as far seaward as the present location of Kilauea Avenue (Peggy Kai, 1974 in Kelly and others, 1981). It is not known where this mill was located, but in the late 1880's the Hawaii Mill was erected in Kukuau II alongside the Alenaio Stream, now within and to the northeast of the present-day channelized stream immediately downstream of the Kinoole Street Bridge.

3. In prehistoric and historic times through the 19th century, the Ponahawai and Waiolama Stream areas were marshlands at their lower ends and were ideal for marsh and agriculture (wet taro) and fishponds (see Figure F-1). An 1825 map shows many agricultural gardens around and above the Waiolama-Ponahawai area (Figure 5 in Kelly and others, 1981). Ellis, in 1825, described the three streams, Wailuku, Waiolama and Wailoa which emptied into Hilo Bay.

> "One on the western angle called Wairuku... Two others called Wairama and Waiakea, rise in springs, boiling up through the hollows of the lava, at a short distance from the shore, fill several large fish-ponds, and afterwards empty themselves into the sea" (Ellis, 1977 in Kelly and others, 1981)

An 1891 map of Hilo shows a spring near the present location of a large banyan tree, just seaward of the Kilauea Street Bridge over Alenaio Stream. Following floods in late 1901 and early 1902, apparently in part from Alenaio Stream waters backing up in the Ponahawai-Waiolama marsh, a popular movement began to fill in these taro-lands and fishponds. The present Waiolama Canal was constructed and the land seaward of Kilauea Street filled between 1915-1923. It was subsequently occupied by commercial buildings and residences until the 1946 tidal wave (tsunami).

4. In 1880-1881, lava flow from Mauna Loa threatened Hilo. By August 1881, the lava was moving down both the Kukuao gulches which then led into the Waiolama Stream. As reported primarily by the contemporary Sara Lyman in letters (in Kelly and others, 1981), the high chiefess and old governess of Hawaii Ruth Ke'elikolani journeyed from by steamer to Hilo on the 3d and 4th of August 1881 where she was supposed to have camped the night on the third hill (Puu Hono, just above Komohana Street). During the night of August 9, 1881, she reportedly traveled to the very edge of the lava flow and by morning, after having performed various incantations, the lava flow had stopped. One might speculate that the lava flow to which she journeyed and "successfully" halted was the northwestern prong which at its lowest point ends at the site of the proposed diversion inlet under Alternative Plan 2. It seems more likely, however, that the old ali'i went instead to the southern lava prong, which had reached closer to Hilo and Waiakea Pond, and according to the letters of Sara Lyman, was still apparently active after August 4 when the northern prong had already quieted.

III. ARCHAEOLOGICAL AND HISTORICAL INVESTIGATIONS

1. During the week of 22-26 March 1982, a team of archaeologists and historians from Bernice P. Bishop Museum conducted a reconnaissance-level archaeological survey of the proposed structural alignments and an intensive historical analysis of the same study area to determine whether any surface sites were present and the likelihood of subsurface remains. The results of this survey are summarized below. Copies of the final archaeological report will be made available to all interested parties and will be formally submitted to appropriate agencies.

2. The 1982 Museum report investigated the historical land-use in and present evidence of archaeological sites in the alignments of Alternative Plans 1 and 2 (Figure F-1). Previous in-house analysis found that none of the buildings proposed for flood-proofing or relocation were of historical or architectural significance. Studies by Museum historians confirmed earlier Corps findings that now-unmarked infant and children's graves were located in the lower, eastern slope or streamway between Alenaio Stream and the Hilo Chinese Cemetery (Figure F-2). The density or number of burials could not be ascertained either through interviews with the president of the Cemetery Association, Mr. C. F. Tong, or by the walk-through reconnaissance. Further studies failed to confirm the use of the slopes of Alenaio Stream below Ululani Street for Japanese children's graves. It was determined that the Japanese Christian School, originally built in 1919 had first been located on the eastern side of Alenaio Stream below Ululani Street within the proposed Alternative Plan 1 alignment but was subsequently moved across the stream to its present location in 1939. No evidence of the school's first site was found. The ground examination of the lower end of the Alternative Plan 1 alignment also failed to reveal any surface evidence of possible subsurface remains of Hawaiian agricultural activities. No other historic properties were identified along the Alternative Plan 1 alignment.

3. Pre-survey historical research of the Alternative Plan 2 alignment revealed the possible presence of remnants of the old Hilo Boarding School Ditch in the area north of Punahele Street. Hilo Boarding School was reportedly the first industrial training school in the United States, established in 1836. After 1894, the ditch water was used to generate electricity at the Boarding School and also an ice-plant. An early map shows the construction of the ditch dating from at least 1813, but oral testimony of Solomon P. Kaleioholani, taken in 1915, indicates that the original ditch (auwai) was dug under the guidance of the Hilo Chief "I" sometime prior to Kamehameha I (prior to the 1790's) and ran on the northern edge of Puu Honu (and Hala'i Hill) straight down to the foot of Waianuenue Street. A branch of the original "I" Ditch was dug by Kanuha under Governor Adams Kuakini in 1841. According to Kaleioholani, the Hilo Boarding School drew water from the Kanuha auwai, but the undated map reproduced as Figures 11-13 in Marion Kelly's study (Athens and Kelly, 1982) also designates the "original" alignment of "I" Ditch north of the Hala'i Hills as the "Hilo Boarding School and Old Mission Ditch constructed in 1813." Kelly also suggests that prehistoric agriculture, perhaps by taro pondfields, may have been practiced in a small, rectangular plot of land immediately north of and below the old Hilo Jail, near where the Plan 2 alignment would cross Waianuenue Avenue. U.S. Army Corps of Engineers independent analysis of Figures 12-13 in Kelly (1982) suggests that the Kanuha auwai may have crossed Komohana Street in the vicinity of Ponahawai Street.

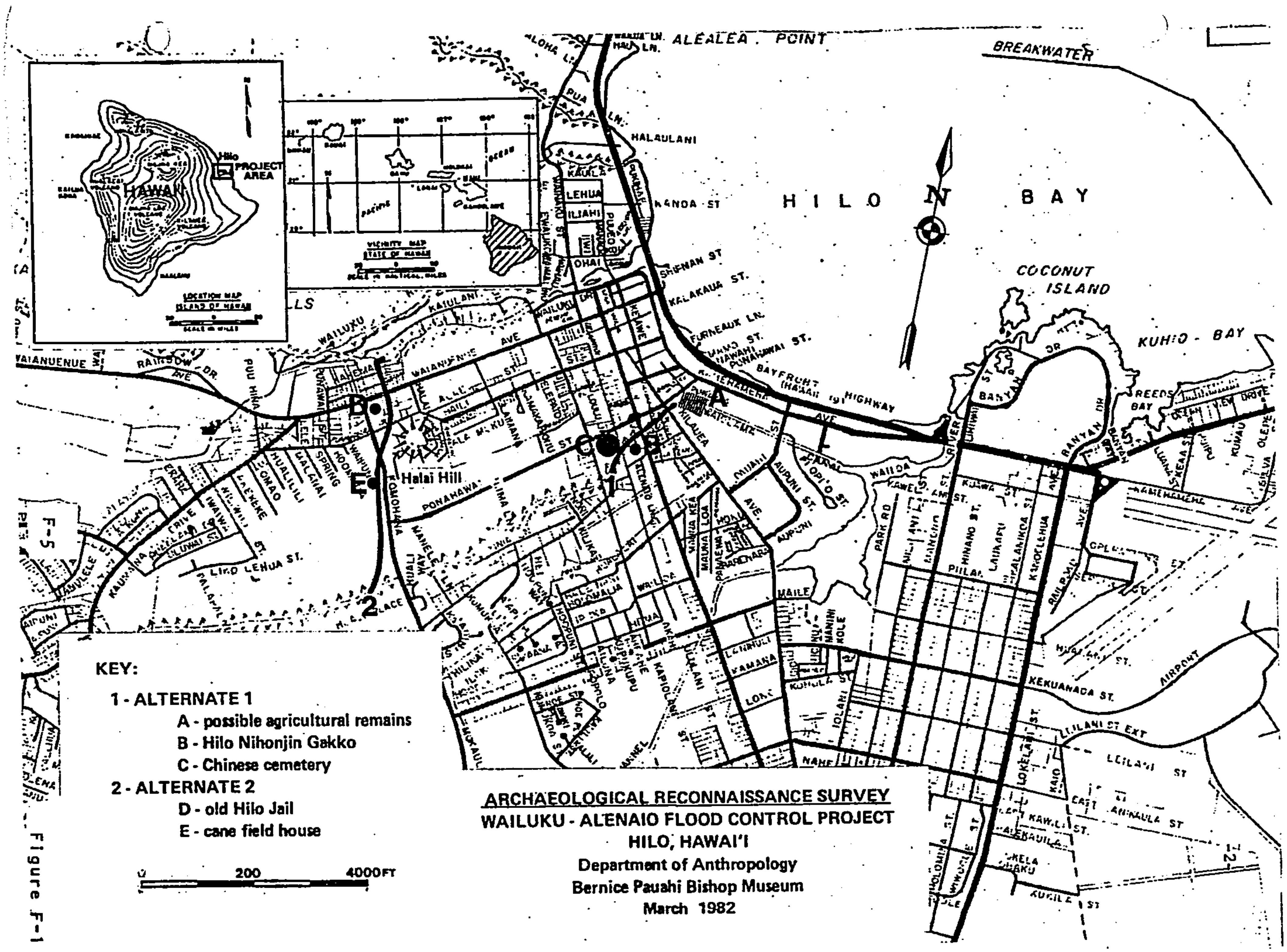


Fig. 1. MAP OF HILO SHOWING LOCATION OF ALTERNATIVES NO. 1 and NO. 2, AND FEATURES MENTIONED IN TEXT. Base Map taken from *Street Map* City of Hilo, Department of Public Works, County of Hawaii. Revised 1981.

Figure F-1

Fig. 8. THE EASTERN BORDER OF THE CHINESE CEMETERY, SHOWING GRAVE MARKERS ON THE SLOPE NEAR ALENAIO STREAM. C. F. Tong is standing at right; the Cemetery's community building is on the left. March 24, 1982. Infant and child graves are said to be located in the cleared area.

Photograph obtained from Archaeological and Historical Studies for the Alenaio Stream Flood Damage Reduction Study, Hilo, Hawaii by Marion Kelly and J. Stephen Athens, Dept of Anthropology, Bernice P Bishop Museum, June 1982, prepared for the US Army Engineer Division, Pacific Ocean under contract DACW84-82-M-0165, figure 8, page 14

Figure F-2

4. Archaeological fieldwork along the alignment of Plan 2 revealed no remnants of any branches of the Hilo Boarding School Ditch (or I Ditch), but north of the alignment along Punahele Street, evidence of the ditch could be traced around the base of Hala'i Hill. A canefield house and associated farm buildings were found on top of a small knoll overlooking Komohana Street above the Ka Waena Lapa'au Medical Center. Nothing from the historic era was considered significant by the Museum archaeologists but a dense layer of basalt cobbles on the surface suggested the possibility of an earlier, Hawaiian structure.

5. In summary, archaeological investigations along Alternative Plans 1 and 2 revealed no definite prehistoric or historic Hawaiian sites. However, the northernmost makai (seaward) portion of Plan 1, below the Kilauea Street Bridge has the potential for subsurface remains of prehistoric pond-field agriculture. Likewise the small rectangular parcel of land immediately below the old Hilo Jail, where the Plan 2 alignment would cross Waianuenue Avenue, could also have subsurface evidence of prehistoric pond-field agriculture. Subsurface remnants of an early Hawaiian structure may also be found beneath the historic-era canefield house in the Plan 2 alignment overlooking Komohana Street. Finally, there is strong indication of the presence of now-unmarked graves containing the remains of infants and children within the construction easement of Plan 1 between the Hilo Chinese Cemetery and Alenaio Stream.

6. The US Army Corps of Engineers concurs with the following Bishop Museum recommendations. Recommendations for both Alternative Plans 1 and 2 are presented, but because only Alternative Plan 1 is recommended, only those recommendations for Plan 1 will be implemented upon approval of the final report and final environmental impact statement.

a. Plan 1.

(1) Professional archaeologists should determine the location of unmarked burials adjacent to the Hilo Chinese Cemetery and a mortuary undertake actual removal and reburial of any human remains that may be encountered. Close coordination with the Hilo Chinese Cemetery Association should be maintained.

(2) Subsurface testing be conducted to determine the presence or absence of cultural (agricultural) remains at the extreme makai end of proposed Alenaio Stream modified channel. Draw soil profiles and collect archaeological samples. Recommendations for possible further excavations or other mitigative measures to be based on this information.

b. Plan 2.

(1) The canefield house does not appear to merit any mitigative action for historic preservation. Perform test excavations by several backhoe trenches to determine presence or absence of subsurface evidence of Hawaiian structures and the need for any further analysis.

(2) Perform subsurface testing of the rectangular plot north of old Hilo Jail to determine presence or absence of subsurface prehistoric cultural (agricultural) remains and need for any further analysis.

IV. URBAN AND COMMUNITY CHARACTERISTICS

1. Census tract-level socioeconomic information from the 1970 census provide the most accurate picture of the people living in the Alenaio Stream floodplain and area affected by Alternative Plan 2. The 1980 Census figures are available only for population at the census tract level. The census data is supplemented by personal observations of the affected area by Army Corps of Engineers planners and reference to other sources.

2. The study area slopes gently from about the 700-foot altitude at Chong's Bridge to about 275 feet where the inlet structure under Alternative Plan 2 would be constructed. It continues down to the 40-foot level at the Hilo Chinese Cemetery, just above the lower Hilo Bay plain, where the proposed new channelization of Alenaio Stream would begin under Alternative Plan 1. Immediately adjacent to and northwest of the floodplain below Chong's Bridge to Luana Way is an area developed in single-family dwellings. From Luana Way eastward to about 2,000 feet above Komohana Street, where the stream channel is undefined and probably flows through lava tubes, there has been little development except for sugarcane north of the channel. Recent lava flows east of the floodplain above Komohana are now being developed as the Sunridge Subdivision. The area west of the floodplain is planned for the large 230-acre Ponahawai Lands residential and commercial subdivision. About 1,200 feet of the proposed flood control channel under Alternative Plan 2 would run through the lower portion of this subdivision. Komohana Investors, Ltd., its developer, has been able to upzone over 100 acres of prime agricultural land to urban use, according to officials of the County Department of Planning. County zoning for much of that area had been Ala (agricultural, one-acre minimum lot size). A separate neighborhood is planned for development on a parcel directly above and opposite the Ka Waena Lapa'au Medical Center. It is anticipated that these developments would be fully operational within the medium-term (5-15 year) future. Currently fallow, former sugarcane fields below Komohana Street just west of the Alenaio Stream floodplains (which have conditional County zoning of RS-7.5 (single-family residential, 7,500 square feet minimal lot size), are also reportedly under consideration for future development. Undeveloped lands between Komohana Street and Pu'u Hala'i, formerly in sugarcane, were proposed by the Hui Six property owners in the early 1970's as a multi-family residential project, but the effort was unsuccessful. Once zoned for multifamily residential by the County, the zoning recommended in the Hilo Community Development Plan was to be open (open, park and recreation). However, current conditional zoning remains RM-4 (Multi-Family Residential, 4,000 square feet minimum). The County Department of Planning is not aware of any development planned for that 7.76 acre parcel in the near term future. It can be anticipated, however, that in the medium-term (5-15 year) future, the land may be developed.

3. The area west of Pu'u (Hill) Hala'i was cultivated, according to a long-time resident, Mrs. Grace Kailipaka, who also reported that an elevated irrigation flume once ran across the swale between Punahele Street and Waianuenue Avenue toward Wailuku River. Houses in this area were generally constructed as early as the 1930's but a series of houses on the eastern side of Punahele Street appear less than 15 years old. One parcel remains in wild sugarcane; it is that parcel which would be trenched for the Alternative Plan 2 channel. Based on interviews and observation, residents appear to range from retired fixed income to managerial/professional level families. Ethnicity is mixed. This portion of the study area makes up a very small part of Census Tract 203.

4. The Kukuau Street residential area was developed originally in the 1920's as a small-scale agricultural zone and most of the houses in the floodplain date from this era. Some farming continues. This area and the lower Hilo plain encompassing the urban and commercial area around the Alternative Plan 1 channel make up a substantial portion of Census Tract 204. The lower area is a mix of densely-packed single-family residences, apartment houses, businesses and public structures. The structures that will be directly or indirectly affected by the proposed Alternative Plan 1 channel are all at least 50 years old and perhaps over 75 years of age. Based on personal observations and an interview with one tenant and one property-owner, Mr. Achong Young (TMK 3-2-2-8:13), the residents of the Kinoole-Ponahawai-Kilauea-Kukuau block are mostly older, retired couples or singles on fixed incomes who have occupied their rented homes for 15 years or longer. Ethnicity varies but Japanese seem to predominate. There are five residential buildings directly affected by the Alternative Plan 2 alignment containing ten residential units. Only two are single-family structures. At present only about 15 people reside in these old buildings. Since the project would not be constructed for another 5 to 10 years, an average figure of about 3 persons per household was used to determine the impact on numbers of residents (3 persons x 10 units = 30 residents). Although the Corps project would not be implemented in the short-term future, the tenants, many elderly, may fully comprehend this. Thus some anxiety may result from the flood damage prevention study process in advance of actual construction. The property owners may also experience some difficulty in renting their units. However, the age structure of residents at the time of construction should be substantially different than at present, conceivably consisting of younger individuals or families with greater mobility. Notwithstanding, it is anticipated that many of the existing buildings and residents may be able to be relocated ouside the project area.

5. At least two of the affected property owners plan some change in the status of their land holdings. Mr. Young seeks to eventually develop a small office building on his parcel, possible within a ten-year period. Another 0.8 acre parcel on Ponahawai Street (TMK 3-2-2-08:18) owned by a hui of three investors (including Mr. Yukio Takeya and Mr. Lawrence N.C. Ing) is currently undeveloped. According to Mr. Takeya, a local real estate agent, a six-story office building is planned for the parcel. The County Department of Planning reports that essentially all land-use permits have been secured, but according to Takeya, the high cost of financing has held up initiation of construction. He also noted that the one large building may be divided into two smaller ones for easier financing. Sixty-five parking stalls are planned for the rear portion of the lot. The proposed alignment of the flood channel would cut through the planned parking area. One other parcel (TMK 3-2-2-08:23) now owned by Cutler Hanely Joint Venture on the corner of Ponahawai and Kilauea and leased to Miller Gasoline Co. would also be directly affected, but the existing facilities probably could be avoided.

6. Forty-nine percent of the Kinoole-Ponahawai-Kilauea-Kukuau block (4.1 acres) is controlled by Mr. Tristan E.M. Osorio (TMK 3-2-2-08:5,21,30,38,39 and 40) Osorio's property sustained the most flood damage in recent years. Forty-two residential structures are located on the Osorio property plus two commercial buildings and one warehouse. Eight of the residences and the warehouse are located on the western, Ponahawai Street side of Alenaio Stream and as

currently designed, the flood channel would require the relocation or displacement of two of three residences (two of the ten noted above in Paragraph 12) and one six-stall parking structure constructed of corrugated iron. The warehouse could possibly also be affected. County zoning for this residential parcel has long been GC-10 (General Commercial, 7,500 square feet minimum lot size). Sources in the County Department of Planning indicated that Osorio has no known development plans for his property. Surrounding blocks are already predominantly in commercial use and new commercial projects are in the active planning stage. One may speculate that the medium term ((5-15 year) future of this Osorio parcel, now divided by Alenaio Stream, would be a transformation from residential to commercial or at least of mix of multi-family residential and commercial. The effect of constructing a new flood channel on the western periphery of Osorio's property and filling and landscaping the existing stream channel will be to make Osorio's holdings contiguous. Not only could the implementation and construction of Alternative Plan 2 affect the value Osorio's property, but the planning process may have similar effects. It may be speculated therefore, that changes in land use of this city block without the project may be stimulated merely by the planning process and more certainly by a constructed project.

7. The following tables summarize the socioeconomic characteristics for the three census tracts encompassing the Alenaio Stream floodplain and areas of potential environmental effect. Hilo's population growth can be attributed to a migration of people from the rural to the urban area and an influx of people from out of the County. Persons of Japanese ancestry form the dominant ethnic group in the area, but the Caucasian population increased about 50% from 1950 to 1970, forming the second dominant ethnic group in Hilo. The number of persons of other ethnic groups declined. The diversity of interests, education backgrounds and ethnic ancestry diffuse community cohesion, which is based principally on common community history and interests, ethnic backgrounds, and length of residences in the County. Most persons feel a strong tie to the County in which they live because of their preference for the geographical location.

TABLE F-1. POPULATION CHARACTERISTICS

	Hawaii County	Hilo City	Census Tract 203	Census Tract 204	Census Tract 208
Population					
1960 1/	61,332	31,553			
1970 1/	63,468	26,353	3,435	3,531	4,865
1980 1/	92,053	35,278	4,292	4,003	7,017
1990 2/	105,100	Data not available			
2000	123,300	Data not available			
% Ethnic Composition 3/					
1970					
Japanese	37.5	43.4	33.8	41.1	49.1
Caucasian	28.8	28.0	40.0	26.8	31.2
Hawaiian	12.3	11.5	7.5	16.7	6.3
Others	21.4	17.1	18.7	15.4	15.4
Age of Residents (% Over 65 Years) 3/					
1970	9.2	7.8	12.4	9.0	6.2

Data adapted from:

1/ State of Hawaii, Department of Planning and Economic Development. "The Population of Hawaii, 1980: Final Census Results, "Statistical Report 143, March 18, 1981.
2/ State of Hawaii, Department of Planning and Economic Development. Revised Population and Economic Projections, 1975-2000, March 1, 1978.
3/ County of Hawaii Department of Research and Development. Data Book 1980, December 1980.

TABLE F-2. INCOME AND EMPLOYMENT CHARACTERISTICS

	Hawaii County	Hilo
Median Income 1/	$12,028	$10,610-15,740

County Employment (1980) Distribution 2/	Total Labor Force	Japanese	Caucasian	Hawaiian 3/	Others
Employed	32,550	11,380	8,704	8,891	3,575
Unemployed	2,850	Unavailable			

Sources:

1/ County of Hawaii, Department of Research and Development, County of Hawaii Data Book 1980, Table 27, Hilo, Hawaii, December 1980.
2/ State of Hawaii, Department of Planning and Economic Development, Data Book 1980. A Statistical Abstract, 1981, Honolulu, Hawaii, 1981.
3/ Hawaiian and Part-Hawaiian.

V. BIBLIOGRAPHY

Belt, Collins & Associates, Ltd. Hilo Community Development Plan, Prepared for County of Hawaii, Adopted May 21, 1975, Honolulu, Hawaii: August 31, 1975.

County of Hawaii, Department of Research and Development, County of Hawaii Data Book 1980, Hilo, Hawaii, December 1980.

Kailipaka, Mrs. Grace W.S. (Retired), Personal Communication, 16 March 1982.

Kasamoto, Hiroshi, Inc., & P. Yoshimura, Inc., A Proposal for Rezoning to Single-Family Residential (RS-15; RS-20); Multi-Family Residential (RM-4); Neighborhood Commercial (CN-10) and Open (O) Ponahawai Lands, South Hilo, Hawaii, TMK 2-3-37:4 and 2-3-44: Portion of 9, 202+ Acres, Prepared for Owner: Komohana Investors, Hilo, Hawaii.

Kelly, Marion et al., (Department of Anthropology, Bernice P. Bishop Museum), Hilo Bay: A Chronological History. Land and Water Use in the Hilo Bay Area, Island of Hawaii. Prepared for US Army Engineer District, Honolulu, under Contract No. DACW84-80-C-0015, March 1981.

Kelly, Marion and J. Stephen Athens (Department of Anthropology, Bernice P. Bishop Museum), Archaeological and Historical Studies for the Alenaio Stream Flood Damage Reduction Study, Hilo, Hawaii, Prepared for US Army Engineer Division, Pacific Ocean, under Contract No. DACW84-82-M-0165, June 1982.

McEldowney, Holly (Department of Anthropology, Bernice P. Bishop Museum), Archaeological and Historical Literature Search and Research Design, Lava Flow Control Study, Hilo, Hawaii, Prepared for US Army Engineer Division, Pacific Ocean, under Contract No. DACW84-77-C-0019, Mod. No. P00017, May 1979.

Onuma, Mr. Masayoshi (Chief, Land Use Controls Division, County of Hawaii Plan-Planning Department), Personal Communication, 17 March 1982.

State of Hawaii Department of Planning and Economic Development, Data Book 1980. A Statistical Abstract, Honolulu, Hawaii, 1981.

State of Hawaii Department of Planning and Economic Development, Revised Population and Economic Projections, 1975-2000, Honolulu, Hawaii 1978.

State of Hawaii Department of Planning and Economic Development, "The Population of Hawaii, 1980: Final Census Results", Statistical Report No. 143, March 18, 1981.

Takeya, Mr. Yukio (Ala Kai Realty, Inc.), Personal Communication, 16 March 1982.

Tong, Mr. C.S. (President, Hilo Chinese Cemetery Association), Personal Communication, 17 March 1982.

Young, Mr. Achong (Retired), Personal Communication, 17 March 1982.

ALENAIO STREAM

NATURAL RESOURCES
AND
US FISH AND WILDLIFE SERVICES COORDINATION

APPENDIX G

APPENDIX G

ALENAIO STREAM
FLOOD DAMAGE REDUCTION STUDY

NATURAL RESOURCES
AND
US FISH AND WILDLIFE SERVICES COORDINATION
APPENDIX

TABLE OF CONTENTS

LIST OF FIGURE

I. NATURAL RESOURCES

A. Vegetation.

The predominant native tree species in the watershed are ohia (Metrosideros collina) and koa (Acacia koa). Understory trees and shrubs include tree fern (Cibotium spp.), guava (Psidium gujava), melastoma (Melastoma malabathricum), kolea (Myrsine spp.), kopiko (Straussia spp.), manono (Gouldia spp.), and false staghorn fern (Dicranopteris linearis). The higher elevation tree and shrub types include mamani (Sophora chrysophylla), naio (Myoporum sandwicense), and pukeawe (Styphelia tameiameiae). About 200 acres of planted eucalyptus (Eucalyptus robusta) forests are located along the lower boundary of the Hilo Forest Reserve and in isolated stands outside the reserve.

Grasses and herbs in pasture and wildlife lands between 5000 and 8000 feet elevation include sweet vernal grass (Anthoxanthum odorantum), yorkshire fog (Holcus lanatus), kikuyugrass (Pennisetum clandestinum), white clover (Trifolium repens), and several species of bromegrass (Bromus spp.). Grasses in lower elevations around the Hilo residential areas include carpetgrass (Axonopus affinis), hilograss (Paspalum conjugatum), wainakugrass (Panicum repens), and foxtail (Setaria spp.).

Grasses, ferns, and associated herbs generally occupy the streambed and lower banks of Alenaio Stream. Shrubs and small trees grow on the banks and the taller plants comprise the overstory growth on the higher banks and lands adjacent to the stream. In some areas, there is no overstory of trees and shrubs grasses and associated low herbs completely dominate the stream. In other areas, there is a dense tree canopy and the understory is relatively bare.

A large number of the plants found in the study area are exotic. These include escaped horticultural species as well as weeds accidentally introduced to Hawaii. Some species are common throughout the entire study area, others dominate only in certain limited areas.

Although only one species of Hawaiian plant has been officially listed on the Federal list of Endangered Threatened Species, approximately 900 plants which are known to be rare or possibly extinct are presently under consideration for this list. Recent biological surveys by the Fish and Wildlife Service (FWS) within the Hilo area (primarily between 2000-6000 feet) have documented the presence of several species of rare plants although the status of most of these is uncertain because of insufficient coverage of habitat.

B. Wildlife.

Feral pigs, sheep, and goats are found in the watershed. Pigs occupy primarily the rain forests and the higher elevation forests at treeline. Sheep and goats occupy the more isolated habitats, open and scrub forests on the higher mountain slopes.

All four species of introduced rodents (black rat, Norway rat, Polynesian rat, and house mouse) are known from the study area and throughout the islands. Of these, the black rat and the house mouse are best adapted to higher elevation forests, but all four species are found in lower elevation exotic forests, agricultural lands, and urban areas.

Other mammals known in the study area included the mongoose, feral dog, and feral cat. The mongoose has been reported as high as 10,000 feet in elevation, but is most common in low elevation lands altered by human use, including urban areas. Rain forests of higher elevations in the project area provide only marginal habitat for feral dogs and cats.

Thirty-six species of birds were recorded during the 1977 FWS survey that ranged from Hamakua to Olaa Forest Reserve, principally between 2000-6000 feet. This list included 16 native and 20 exotic species. The range of many exotic species observed in this survey extends into low elevation land including the exotic forest, agricultural lands, and developed areas near Hilo. Ten of the exotic bird species recorded on the FWS survey are game species. In addition, several species of waterbirds (endemic, indigenous, exotic, and migratory) inhabit wetlands in the Hilo and Kapoho areas.

C. Aquatic Biota.

The Alenaio Stream drainage comprises the Kaluiiki Branch, Waipahoehoe Stream and Alenaio Stream. The three streams are ephemeral and flow for several days after heavy rains. The aquatic community of lower Alenaio Stream is comprised primarily of exotic organisms. Dragonfly nymphs and Louisiana crayfish and dominant invertebrate forms in the lower reaches of the stream. Guppies and mosquito fish are common in the streambed pools as are tadpoles of the marine toad. Aquatic biota occurring above the point at which the stream becomes undefined consist of Tahitian prawns, crayfish, guppies, dojo, toads, and insect larvae.

The Wailuku River is the largest stream in the State by drainage area, length and mean annual discharge. From its headwater, the Wailuku flows 19 miles through the Hilo Forest Reserve to Hilo Bay. It possesses a well-defined channel with some sections 80 feet deep and others 250 feet wide. Plunge pools and waterfalls, carved out of lava rocks, are outstanding features of the stream and lower reaches. The stream system is comprised of many small tributaries with similar characteristics. Perennial tributaries, totaling about 80 miles in length, begin at the 5000- to 6000-foot elevation.

Few aquatic species are found in the Wailuku River. The stream community is dominated by exotic species of fishes and invertebrates which have been introduced since the turn of the century. No reference to stream biota prior to 1940 can be found in historic record. It is possible that these introductions have led to the elimination of many endemic species. Perhaps the most conspicuous exotic is a small caddis fly which was introduced as food for trout in the late 1950's. Its aquatic larvae are found under rocks throughout the stream course. Other exotic species abundant in the Wailuku include the Louisiana crayfish (*Procambarus clarkii*) a guppy (*Lebistes reticulatus*), and the loach or "dojo." Two amphibians, the giant toad (*Bufo marinus*) and bull frog (Rana catesbiena) are exotic omnivores present in Wailuku River. A number of Tahitian prawns (Macrobrachium lar) have been observed in lower Wailuku as early as 1968. The State Division of Fish and Game observed numerous small endemic gobies in the lower and middle reaches of the stream in 1969. However, the most recent reconnaissance survey conducted by the FWS did not discover any gobiid fishes. The most abundant native species found throughout the stream is the mountain opae (Atya bisculata). Populations were recently observed at midstream stations by the FWS.

There are no aquatic species officially listed as endangered by the Department of the Interior. Although an endemic goby has been recommended for inclusion on the Federal list, no populations of the species have been identified in the Wailuku drainage.

D. Marine Biota.

Hilo Bay supports a variety of fish species. A survey made by Neighbor Islands Consultants in 1972 identified 72 species of fish found in the Bay. According to the report, some of the more abundant species are manini (Acanthurus sandvicensis), palani (Acanthurus dussumieri), nehu (Stolephorus purpureus), weke (Mulloidichthys samoensis), butterfly fishes (Chaetodon sp.), 'o'io (Albula vulpes), mullet (Mugil cephalus), kupipi (Abudefduf sordidus), papio (Caranx ignobilis) and aholehole (Kuhlia sandvicensis). Portunid crab (Portunus sanguinolentus) and red crab (Podopthalmus vigil) are also abundant.

Nearshore areas of sandy substrate in Hilo Bay appear to be poor in species number due to periodic inundation with freshwater, siltation, and wave scour. Sediments in the central harbor may not present a suitable habitat for many of the more common nearshore benthic organisms.

Phyto- and zooplankton levels within the harbor are high, however, some live corals appear to thrive along the inner edges of the breakwater and Blonde Reef. In contrast, deteriorating water quality has been blamed for the death of large coral colonies along the shoreward portion of the eastern harbor.

Recent studies have concluded that the Bay is not as productive in terms of pelagic fishery resources as other areas of east Hawaii. The commercial baitfish (nehu) catch has declined in recent years despite a relatively stable fishing effort. Overharvesting, removal of juveniles by bait fishermen, pollution from sugar mills, and inadequate enforcement of existing fishing regulations are blamed for declining fishery resources in the Bay.

E. Endangered Species.

The only terrestrial mammal endemic to the islands is the Hawaiian bat (Lasiurus cinereus semotus) and it is most common on the island of Hawaii. Bats were observed within the upper Waiakea Forest Reserve and elsewhere during recent FWS surveys. They have also been recorded regularly from the Hilo Bay area, where they seek food. This species is listed by State and Federal law as endangered because of its apparent low numbers, but little is known of its biology.

Six of the forest birds observed on surveys within the greater Hilo area are presently on the State and Federal lists of endangered species: Hawaiian goose (Branta sandvicensis), Hawaiian hawk (Buteo solitarius), Hawaii creeper (Loxops maculata mana), Hawaii akepa (Loxops coccinea coccinea), akiapola'au (Hemignathus wilsoni), and 'o'u (Psittirostra psittacea). With the exception of the Hawaiian hawk and the Hawaiian goose, these species were confined in distribution of the most part between 3000-6000 feet, although it was apparent that their range probably extends higher where suitable forest is present. The only endangered bird species found within the lower elevation lands in the vicinity of Hilo are the Hawaiian hawk and the Hawaiian coot (Fulica americana alai). The coot is confined to wetlands within Hilo and near Keaau.

F. Water Quality.

The Wailuku River is fed by several perennial tributaries beginning between 5000-6000 feet elevation. Streams in the Wailuku-Alenaio watershed are Class 2 waters under the State Water Quality Standards, except Wailuku River tributaries which provide Hilo's water supply and are Class 1. The river experiences periodic significant increases in turbidity during storm runoff. Recent studies conducted by the US Geological Survey (USGS) indicate that virtually all sediment discharged by Wailuku River is transported during less than 2 percent of the entire year. Water quality data gathered by USGS indicates that most dissolved solids are at background levels, dissolved oxygen is close to saturation and fecal coliforms show a pattern of decreasing value with elevation.

Hilo Bay and adjacent coastal waters are classified as Class A under the State Water Quality Standards, although a limited area next to the pier facilities is Class B. Recent studies indicate that nutrient levels in the harbor generally exceed the State Water Quality Standards for total phosphorus and total nitrogen for Class A and B waters. The nutrient levels exhibit an apparent seasonal variation, probably related to surface runoff. However, nutrient levels are generally high enough so that they are not likely to be a factor limiting phytoplankton growth rate. Suspended solids and turbidity measurements show the large influences of seasonally high surface runoff and the more localized effects of shore erosion. Dissolved oxygen levels indicate locally excessive organic loading, probably the combined result of organic materials in stream discharges and waste discharge from domestic, industrial, and agricultural sources. Bacteriological analyses show highest levels of fecal coliform and fecal strep in areas influenced by discharges from Wailuku River, Wailoa River, and Reeds Bay. Generally, low coliform levels recorded in recent studies when compared to earlier data recorded prior to discontinuance of many point discharges in the bay, substantiate a significant decrease in coliform levels.

G. Air Quality.

Existing air pollution within the study area is confined to the urban and suburban areas of Hilo and associated communities. Cane burning activities in low elevation land create temporary, but significant, sources of objectionable air pollution, particularly under conditions of low wind. Exhaust pollution, particularly that produced by large trucks, is aggravated on the Saddle Road by increasing grade. However, the impact of this pollution is localized and quickly dissipated. The State Air Quality Monitoring Station on the island is located within Hilo. This station monitors particulates and sulfur dioxide. During the period January 1976 to December 1980, State Air Quality Standards were not exceeded for either parameter.

H. Wetlands.

Waiakea Pond is an estuarine pond near the mouth of Wailoa River in Hilo, Hawaii. An extensive rock wall lines most of the shoreline at this pond. Extensive lawns cover the surrounding land, most of which is included within a State park facility. Hotel developments also border the pond on both east and west sides. Wailoa Stream has been channelized for flood and tsunami control where it runs into Waiakea Pond. A 1963 topographic map shows a separate pond (Mohouli) on the southwest edge of Waiakea Pond. Mohouli pond now connects with the larger pond via a narrow channel.

The primary water source for Waiakea Pond is the Wailoa River, but the pond may fluctuate more than a foot with tidal influence. Although the pond may be several feet deep in the center region, the bottom slopes slowly from the shoreline, where it is generally less than 2 feet in depth. Mohouli pond is considerably shallower than Waiakea. Much of the bottom is covered with a dense algal mat, some of which floats to the surface throughout the pond. Azolla and filamentous algae form a thick surface mat over much of the channelized stream entrance, and within Mohouli pond. An extensive growth of emergent California grass, waterweed, and small patches of bulrush and umbrella sedge lines both shores of the peninsula that separates Mohouli and Waiakea ponds.

I. Wildlife Refuges.

No national or local wildlife refuges occur within the project area.

J. Migratory Birds.

No migratory bird breeding or nesting habitat occurs within the project area.

K. Scenic and Wild Rivers.

None are present in the project area.

L. National Trails.

None are located in the project area.

M. National Shoreline, Parks or Beaches.

None are located in the project area.

II. US FISH AND WILDLIFE SERVICE COORDINATION

A. Fish and Wildlife Coordination Act of 1958.

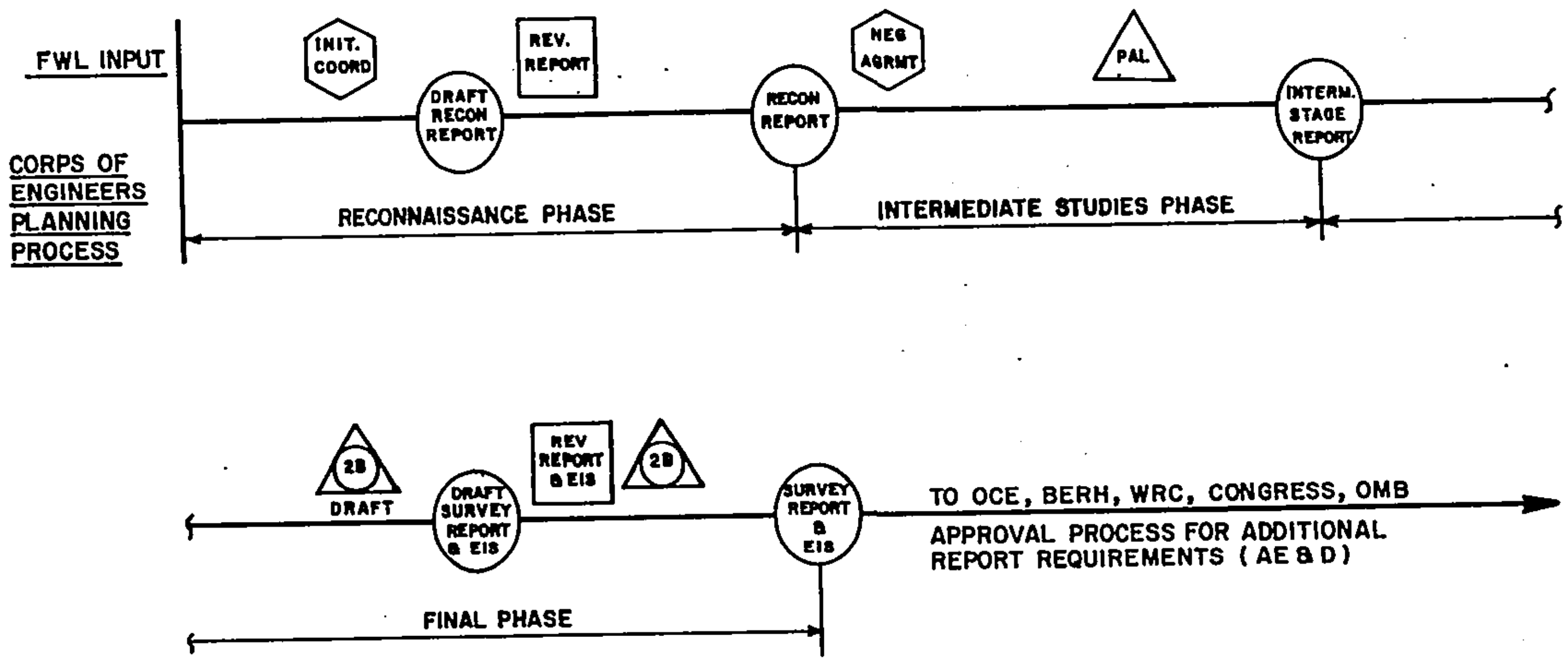
In accordance with the Fish and Wildlife Coordination Act of 1958 (P.L. 85-624) the US Fish and Wildlife Service was officially consulted. Figure G-1 indicates the Fish and Wildlife coordination input requirements at the various stages of the study.

A planning aid letter (PAL) report was provided on 10 December 1980, a Preliminary Coordination Act report was provided on 28 December 1981, and a Final Coordination Act report was provided on 18 June 1982. All are included in this appendix.

B. Summary of Requirements.

FWL Input	Time Table
PAL	Completed 10 December 1980
Preliminary Coordination Act report	Completed 28 December 1981
Review of Draft Survey report and EIS	Completed 29 April 1982
Final Coordination Act report	Completed 18 June 1982

SURVEY STUDIES



LEGEND:

2B	FISH AND WILDLIFE 2B REPORT
AE & D	ADVANCE ENGINEERING & DESIGN
BERH	BOARD OF ENGINEERS FOR RIVERS AND HARBORS
DOC REPORT	DOCUMENTATION REPORT (INTERNAL AND SELECTED DISTRIBUTION ONLY)
EIS	ENVIRONMENTAL IMPACT STATEMENT
FWL	FISH AND WILDLIFE SERVICE
NEG AGRMT	NEGOTIATE AGREEMENT (MEMORADUM OF AGREEMENT)
OCE	OFFICE OF THE CHIEF OF ENGINEERS
OMB	OFFICE OF MANAGEMENT AND BUDGET
PAL	PLANNING AID LETTERS
RECON	RECONNAISSANCE REPORT (SURVEY STUDY)
REV REPORT	REVIEW REPORT
WRC	WATER RESOURCES COUNCIL

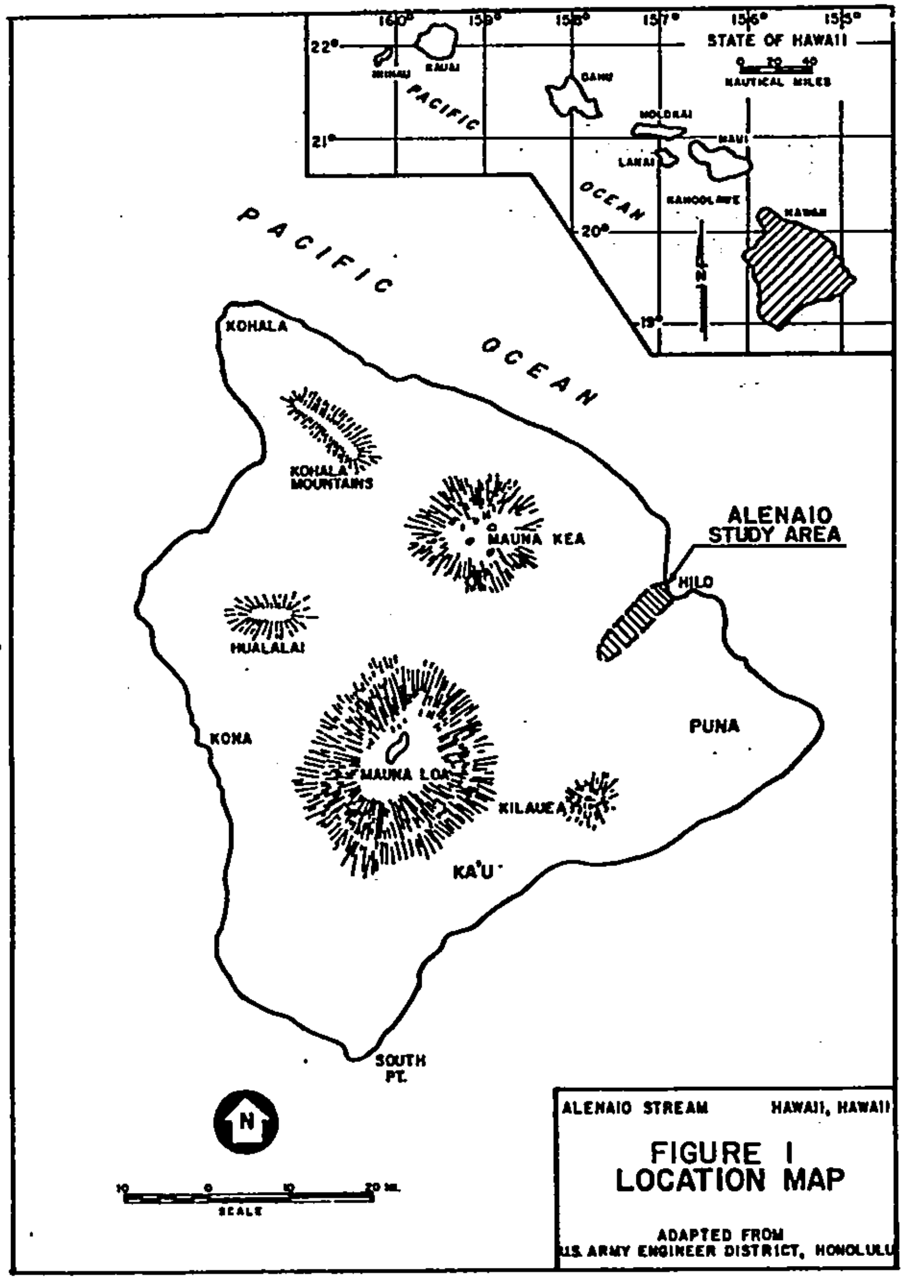
ALENAIO STREAM HAWAII

FISH AND WILDLIFE COORDINATION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE G-1

FIGURE G-1



ALENAIO STREAM HAWAII, HAWAII

FIGURE I
LOCATION MAP

ADAPTED FROM
U.S. ARMY ENGINEER DISTRICT, HONOLULU

G-5

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

December 10, 1980

Colonel Alfred J. Thiede
U.S. Army Engineer District Honolulu
Building 230
Fort Shafter, Hawaii 96858

Re: Planning Aid Letter (PAL)
Alenaio Stream Flood
Damage Reduction
Hilo, Hawaii

Dear Sir:

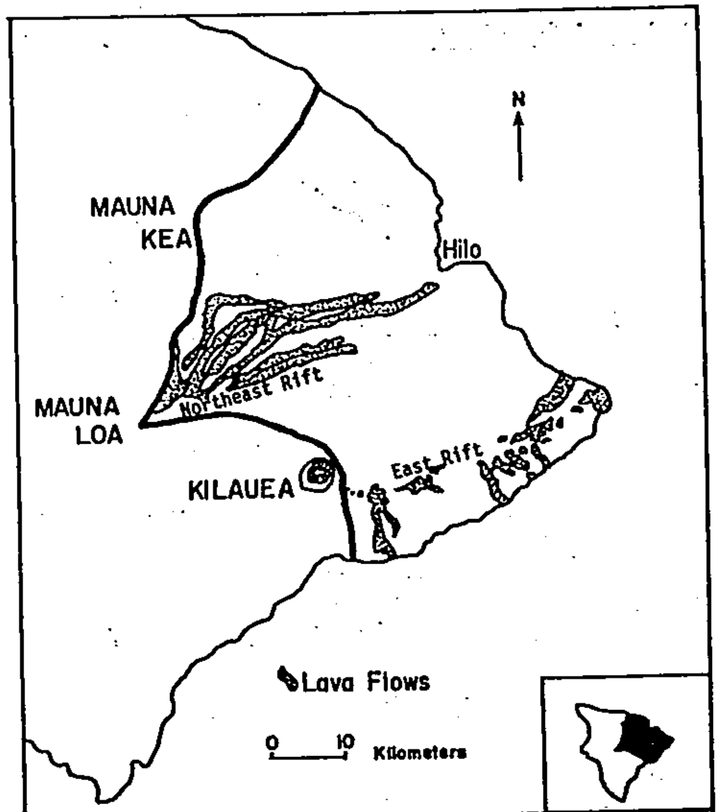
This is the Planning Aid Letter of the U.S. Fish and Wildlife Service for the Alenaio Stream Flood Damage Reduction Study, Hilo, Hawaii. The Honolulu District of the U.S. Army Corps of Engineers is undertaking this study to determine the feasibility of various alternatives for flood damage reduction in the Alenaio study area.

This report has been prepared under the authority of and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and other authorities mandating Department of the Interior concern for environmental values. It is also consistent with the intent of the National Environmental Policy Act.

The analysis and recommendations herein are based on information contained in the Corps' Reconnaissance Report for Flood Damage Reduction--Alenaio Stream (1980) and survey reports of the U.S. Geological Survey (1980). Biological information was obtained from a field investigation conducted by Fish and Wildlife Service biologists and from a review of pertinent scientific literature.

Introduction

The Alenaio study area is located on the northeast flank of Mauna Loa volcano, within the town of Hilo on the Island of Hawaii (Figure 1). Hawaii is the largest of the Hawaiian Islands in land area (4038 square miles) which is almost twice the combined area of the other islands. Like the rest of the Hawaiian Archipelago, Hawaii is volcanic in origin, formed by the coalescence of five distinct volcanic massifs--Kohala, Hualalai, Mauna Kea, Mauna Loa, and Kilauea. Of these, only Hualalai, Mauna Loa, and Kilauea have erupted historically--Kilauea as recently as November 1979.



ALENAIO STREAM HILO, HAWAII

FIGURE 2
HISTORIC LAVA FLOWS

US FISH & WILDLIFE HONOLULU

The town of Hilo is located between the two largest massifs, Mauna Kea (elevation 13,796 feet) and Mauna Loa (elevation 13,677 feet), making Hilo a natural focal point for lava flows originating along Mauna Loa's active Northeast Rift Zone (Figure 2). Lava flows from the Northeast Rift (NER) affect not only surface drainage patterns, but subsurface flows as well. Lava tube-fed pahoehoe flows in the Hilo area are characterized by horizontal layering, numerous fractures and sub-horizontal voids, which act as subterranean conduits for storm runoff. Subsurface runoff is not confined to a topographically-defined drainage basin, but may be imported from rain forest catchment areas through a plexus of small lava tubes in pahoehoe flows originating along the NER. The U.S. Geological Survey (1980) estimates that the effective drainage area of Alenaio Stream may be 5-10 times larger than its topographically-defined watershed.

Alenaio Stream is part of a larger drainage system which discharges via the Wailoa River into Hilo Bay (Figure 3). The Wailoa River receives water from Alenaio Stream and Waiakea Pond, which in turn is fed by Waiakea Stream via the Wailoa Flood Channel and by basal springs. The Wailoa River also receives freshwater directly from basal springs. Because Alenaio and Waiakea Streams are ephemeral in nature, these springs account for most of the dry-weather discharge of the Wailoa River, which is the greatest of any stream in the State of Hawaii. Average river flow exceeds 100 million gallons per day (mgd) (USGS, 1968).

The lower reach of the Waiakea-Wailoa complex is estuarine and subject to tidal fluctuation. The large influx of freshwater from basal springs depresses the salinity and temperature within the estuary. At the inlet to Waiakea Pond, salinity may vary from several parts per thousand on the incoming tide to less than one part per thousand on the outgoing tide (USGS, 1968). The estuary is entirely surrounded by commercial, light industrial, and park land uses. The Hilo-Bayfront Park, which occupies most of the adjacent lands, was set aside following the destructive tsunami of 1960 to provide a protective buffer zone for the central business district Hilo. The park is totally within the tsunami inundation zone.

Waialama Canal extends 3000 feet west from the Wailoa River to the Kilauea Avenue bridge culvert, which marks the downstream terminus of Alenaio Stream and the upper limit of tidal action. This reach is entirely within the Bayfront Park and has been channelized for approximately 2000 feet — a remnant of the bayfront business district which was devastated by the 1960 tsunami.

The Alenaio "watershed" originates above 2500 feet elevation, where the stream consists of two branches—the Waipahoehoe Branch and the Kaluiiki Branch. These tributary streams flow in roughly parallel channels and merge at approximately 750 feet elevation.

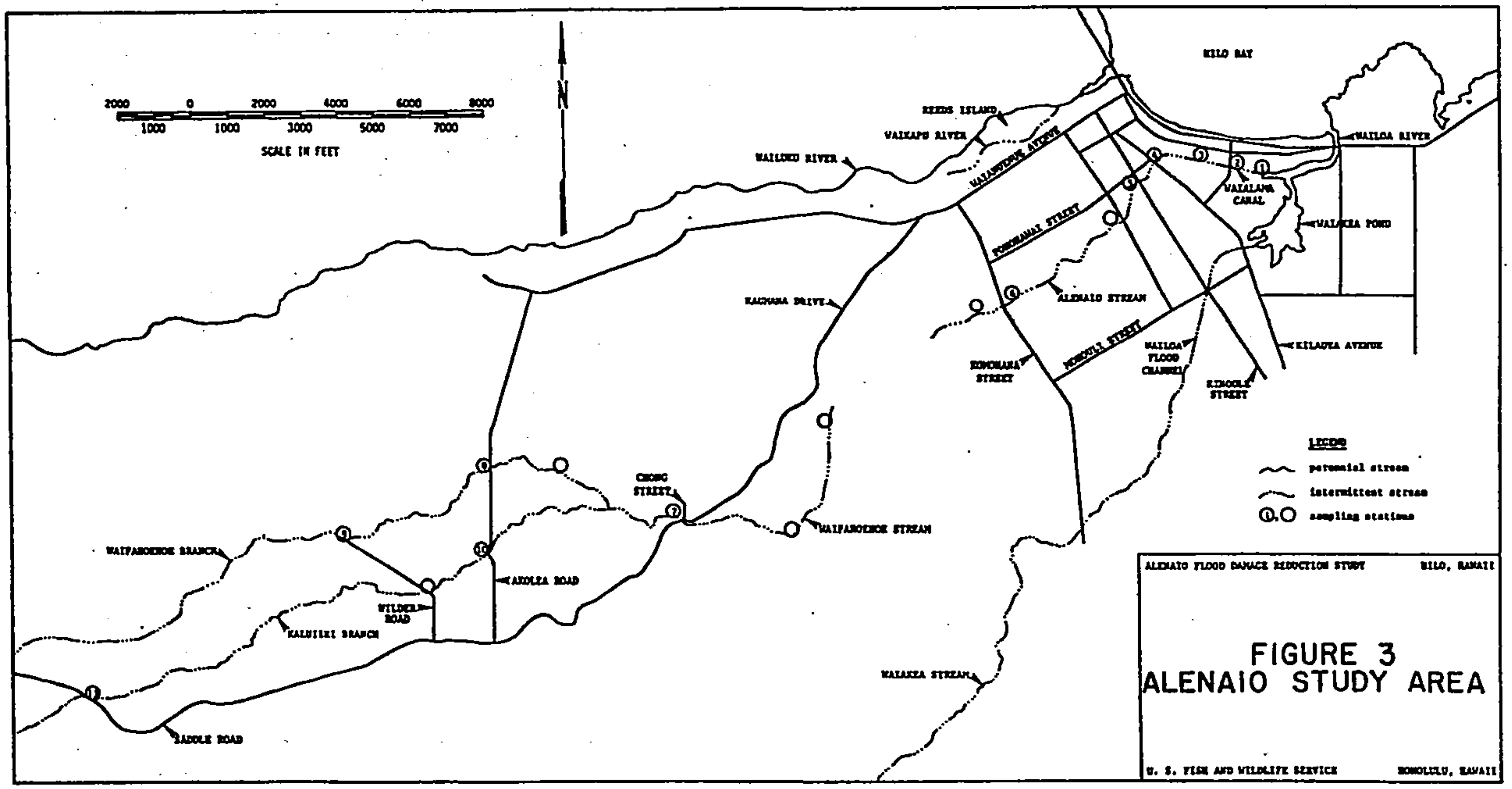


FIGURE 3
ALENAIO STUDY AREA

The course of Alenaio Stream is presently defined by three different pahoehoe flows from the NER--the flow of 1881, the Kulaloa flow (1100-1400 years old), and the Punahoa flow (3000-4000 years old). The Waipahoehoe Branch is bounded on the north by the Punahoa flow. Below its confluence with the Kaluiiki Branch, the stream is defined by the flow of 1881 to the south, while the Kulaloa flow defines its southern margin in the reach below 250 feet elevation (USGS, 1980).

The streambed consists mainly of pahoehoe lavas which are relatively resistant to erosion. These younger lavas are interspersed with sand and gravel-filled potholes eroded in older, underlying weathered clays. Transitions between strata are generally marked by "stairstep" cascades or near-vertical drops in the streambed.

Between Chong Street and Komohana Street, the stream passes through a heavily forested area with a relatively flat gradient. The stream channel is poorly defined in this area, and a large volume of water is lost from the mainstem of Alenaio Stream, probably due to seepage into the underlying Punahoa lava flow (USGS, 1980). The Fish and Wildlife Service estimates that as much as 80-90 percent of the stream flows observed at Chong Street were "lost" to percolation.

Below Komohana Street stream flows are confined within a well defined channel which reaches depths of 20-30 feet below adjacent ground contours. Above Kinoole Street a concrete weir diverts a portion of stream flows into a culvert which empties directly into Hilo Bay. The remainder follows a concrete-lined invert from Kinoole Street to Kilauea Avenue where it enters Waialama Canal.

A significant portion of low to moderate stream flows percolates into small lava tubes, fractures, and voids between strata. However, during periods of heavy rainfall these subterranean conduits may be filled to capacity and surface runoff can occur. Historically, flooding in the Alenaio watershed has resulted from overbank flows during peak surface flows, as well as from springs which unexpectedly develop in areas of pahoehoe outcrop, especially near the distal ends of lava flows, and from the transient elevation of the basal freshwater lens. Deliberate attempts have been made to control mauka flooding due to surface runoff by diverting surface flows into natural lava tubes; however, this practice may only aggravate flooding problems downslope (USGS, 1980).

Description of Alternatives

The U.S. Army Engineer District Honolulu (1980) is considering both structural and non-structural alternatives to alleviate flood damages in the Alenaio study area.

Non-structural Measures:

1) Floodplain Restrictions - restrictions on future development within the floodplain.

2) Channel Maintenance - periodic removal of sediment and debris to maintain hydraulic capacity; maintenance or repair of existing flood control structures.

3) Relocation - physical removal and relocation of damageable structures outside the floodplain; conversion to land uses compatible with flood risk.

4) Flood Forecasting - early warning and evacuation of potentially affected areas. May be used in conjunction with other non-structural measures.

5) Flood Insurance - lessen economic hardship on floodplain occupants by underwriting losses due to flooding. Regulations required for participation in such a program would effectively limit floodplain development.

6) Floodproofing - alteration of structures or their immediate environs to provide increased flood resistance or otherwise reduce flood damages. These include elevation of structures above flood level, installation of waterproof panels, and construction of floodwalls or levees around buildings.

The feasibility of non-structural measures will be evaluated in greater detail during Stage 2 of the Corps planning process.

Structural Measures:

1) Dam and Reservoir:

This measure provides for the impoundment and controlled release of floodwaters. Structural modification of the downstream channel may be necessary, if maximum release rates exceed the hydraulic capacity of the channel.

The Corps has determined that the only feasible location for such a structure is the forested area above Komohana Street. Because of the low gradient of this area, however, a long and high embankment would be necessary to impound flood flows. Furthermore, because of the high porosity and geological complexity of underlying lava flows, an impoundment at this site could aggravate flooding in Hilo due to subsurface drainage.

2) Levees:

Levees can be used to confine or divert floodwaters to a designated floodway. They can be used in conjunction with other measures to control flooding. As a complete solution, however, levees are only effective where development has not encroached on the floodplain.

3) Channel Modifications and Diversion Channels:

These include realignment of the existing stream channel to remove restrictive bends or obstructions, enlargement of the stream channel and/or bridge culverts to increase hydraulic capacity, lining of stream banks and invert, or construction of diversion channels to redirect floodwaters away from damageable property.

The Corps is considering two alternative alignments of a diversion channel which would shunt flood flows from Alenaio Stream near Komohana Street to the Waikapu River:

a) Diversion Alignment Plan 1:

This diversion plan starts approximately 1000 feet upstream of Komohana Street and runs generally along Komohana Street a distance of 4400 feet to the head of the Waikapu River, a tributary of the Wailuku River. Collection levees would be built downstream from the debris basin to collect the floodwaters.

b) Diversion Alignment Plan 2:

This diversion plan starts approximately 500 feet downstream from Komohana Street and runs generally between Komohana and Kapiolani Street, a distance of 4200 feet. Collection levees would be built downstream from the debris basin to collect the floodwaters. A branch channel would be provided for a tributary stream. This diversion alignment would discharge into the Waikapu River at a point downstream from Plan 1.

A drop channel and stilling basin may be required for one or both of these plans to minimize erosion at the point of discharge.

Environmental Setting Without the Project

Survey Methodology:

The U.S. Fish and Wildlife Service conducted a field survey of the Alenaio study area on September 22-26, 1980. The purpose of the survey was to inventory fish and wildlife resources and dominant terrestrial and aquatic flora in the study area, identify significant biological resources, and generally characterize Alenaio Stream and the estuarine environment.

Water quality data were measured at eleven stations on Alenaio Stream and its tributaries (Figure 3). These data included water temperature, salinity, specific conductance, pH, dissolved oxygen, and stream flow. Temperature data were recorded in the field using a mercury thermometer. Flow data were determined by timing a small float over a measured distance and multiplying by the cross-sectional area of the stream. Dissolved oxygen samples were chemically fixed in the field, transferred to plastic specimen jars and returned to the laboratory for analysis. In the laboratory 5.8-milliliter aliquots of each sample were analyzed using the Winkler-Azide titration method as described in the HACH Methods Manual. A single sample was taken at each sample depth for salinity, conductivity, and pH. A YSI Model 33 S-C-T meter was used to measure the first two parameters, while an AMI Model 107 pH meter was used to measure the latter. In the field, values of salinity were determined using an AO refractometer in order to determine the upper limits of the estuary. Water quality data is tabulated in Table 1.

Flora and fauna were observed and/or collected at each of the eleven water quality stations. Additional observations were made at other points along Alenaio Stream to better characterize the biological resources of the study area.

Survey Results:

Terrestrial and aquatic flora were identified in the field whenever possible. Unidentified vegetation was identified in the laboratory from dried specimens and photographs. A partial flora for the Alenaio study area is included in Table 2.

Terrestrial fauna were observed and identified in the field. A list of avifauna observed or reported from the study area has been included in Table 3.

Aquatic macrofauna were observed and identified in the field or captured with dipnets and baited minnow traps. Captured specimens were identified and released or preserved for later identification and study. Table 4 provides a listing of aquatic species observed or reported from the study area.

There was no measurable rainfall in Hilo during the course of our survey. However, heavy rains had swollen local streams several days earlier and flood warnings had been issued for the Hilo area. Though subsiding, moderate stream flows continued throughout the survey period. At Chong Street, flows subsided from approximately 100 cubic feet per second (cfs) to 50 cfs over a three-day span.

TABLE 1
WATER QUALITY DATA FOR ALENAIO STREAM
SOUTH HILO DISTRICT, HAWAII

STREAM	STATION	ELEVATION	FLOW REGIME*	SAMPLE DEPTH	T°C	S°/oo	C(umhos)	D.O.	pH
Waialama Canal	1	0	tidal	0' 2'	22.7 21.7	0.5 3.2	1170 5500	6.5 6.5	7.6 7.2
	2	0	tidal	0' 2'	22.2 22.2	0.5 0.3	1220 1040	7.0 6.5	7.8 7.6
	3	0	tidal	1'	25.0	0	64	6.0	8.2
Alenaio Stream	4	0	1	0' 2'	25.6 25.6	0 0	50 50	7.5 6.5	7.6 7.7
	5	26'	2	0'	25.0	0	52	7.5	8.0
	6	200'	2	0'	23.3	0	52	7.0	7.8
Waipahoehoe Stream	7	710'	3	1'	22.2	0	48	7.5	7.6
	8	950'	3	1'	20.0	0	50	-	7.5
	9	1200'	2	-	-	-	-	-	-
Kaluiiki Branch	10	1030'	2	0'	22.2	0	45	-	8.0
	11	1620'	0	-	-	-	-	-	-

* 0 = 0 cfs
1 = greater than 0 cfs, less than 1 cfs
2 = greater than 1 cfs, less than 10 cfs
3 = greater than 10 cfs, less than 100 cfs

TABLE 2
PARTIAL FLORA FROM THE
ALENAIO STUDY AREA
SOUTH HILO DISTRICT, HAWAII

FILICINAE

GLEICHENIACEAE
Dicranopteris linearis (Burm.) Underw. — false staghorn fern

DICKSONIACEAE
Cibotium spp. — tree fern, hapu'u

POLYPODIACEAE
Nephrolepis exaltata (L.) Schott — swordfern
Sadleria cyatheoides Kaulf. — tree fern, ama'uma'u

SALVINIACEAE
Azolla filiculoides Lam. — waterfern

ANGIOSPERMAE

MONOCOTYLEDONAE

PANDANACEAE
Pandanus odoratissimus L.f. — pandanus, hala

ELODEACEAE
Egeria densa Planch. — waterweed

RUPPIACEAE
Ruppia maritima L. — widgeon grass

GRAMINEAE
Bambusa vulgaris Wendl. — feathery bamboo
Brachiaria mutica (Forsk.) Stapf — California grass
Panicum repens L. — quackgrass
Paspalum vaginatum Sw. — seashore paspalum
Saccharum officinarum L. — sugarcane

CYPERACEAE
Cyperus spp. — sedges
Scirpus validus Vahl — great bulrush

CARICACEAE	
Carica papaya L.	papaya
MYRTACEAE	
Eucalyptus robusta Sm.	swamp mahogany
Metrosideros collina subsp. *polymorpha* (Gaud.) Rock	'ohi'a lehua
Psidium cattleianum Sabine	strawberry guava
P. guajava L.	guava
MELASTOMATACEAE	
Melastoma malabathricum L.	melastoma
ONAGRACEAE	
Ludwigia octivalvis (Jacq.) Raven	primose willow
HALORAGACEAE	
Myriophyllum brasiliense Cambess.	parrotfeather
UMBELLIFERAE	
Hydrocotyle verticullata Thunb.	whorled marsh pennywort
ARALIACEAE	
Brassaia actinophylla Endl.	umbrella tree
CONVOLVULACEAE	
Ipomoea spp.	morning glory
VERBENACEAE	
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, oi
BIGNONIACEAE	
Spathodea campanulata Beauv.	African tuliptree
GOODENIACEAE	
Scaevola taccada (Gaertn.) Roxb.	beach naupaka
COMPOSITAE	
Pluchea odorata (L.) Cass.	pluchea
Bidens pilosa L.	beggars tick
PALMAE	
Archontophoenix alexandrae (F. Muell) Wendl. & Drude	Alexandra palm
Cocos nucifera L.	coconut palm
Livistona rotundifolia (Lam.) Mart.	Livistona palm
ARACEAE	
Philodendron spp.	philodendron
COMMELINACEAE	
Commelina diffusa Burm.f.	honohono
LILIACEAE	
Cordyline terminalis (L.) Kunth	ti
MUSACEAE	
Musa x *paradisiaca* L.	banana
ZINGIBERACEAE	
Alpinia purpurata (Vieill.) K. Schum.	red ginger
Hedychium coronarium Koenig	white ginger
H. flavescens Carey	yellow ginger
ORCHIDACEAE	
Arundina bambusaefolia (Roxb.) Lindl.	bamboo orchid
Spathoglottis plicata Bl.	wind orchid
DICOTYLEDONAE	
MORACEAE	
Ficus spp.	banyan
NYMPHAEACEAE	
Nymphaea sp.	waterlily
LEGUMINOSAE	
Acacia koa Gray	koa
Desmodium uncinatum (Jacq.) DC.	Spanish clover
Mimosa pudica L.	sleeping grass
Samanea saman (Jacq.) Merr.	monkeypod
EUPHORBIACEAE	
Aleurites moluccana (L.) Willd.	kukui
ANACARDIACEAE	
Mangifera indica L.	mango

TABLE 4
DOMINANT AQUATIC MACROFAUNA OF
ALENAIO STREAM AND ESTUARY
SOUTH HILO DISTRICT, HAWAII

PHYLUM / CLASS / Genus/species	Common Name	Status
ANNELIDA		
POLYCHAETA		
Namalycastis abiuma	bristle worm	indigenous
ARTHROPODA		
INSECTA		
Anax strenuus	dragonfly (adult)	endemic
Pantala flavescens	dragonfly (larva)	indigenous
CRUSTACEA		
Grapsus grapsus tenuicrustatus	a'ama/crab	endemic
Macrobrachium lar	Tahitian prawn	introduced
M. grandimanus	opae oeha'a	endemic
Procambarus clarkii	crayfish	introduced
VERTEBRATA		
PISCES		
Acanthurus nigroris	maiko	indigenous
A. triostegus sandvicensis	convict tang/manini	endemic
Awaous genivittatus	o'opu naniha	indigenous
A. stamineus	o'opu nakea	endemic
Caranx ignobilis	papio	indigenous
Chanos chanos	milkfish, awa	indigenous
Cyprinus carpio	carp, koi	introduced
Eleotris sandwicensis	o'opu okuhe	endemic
Gambusia affinis	mosquitofish	introduced
Kuhlia sandvicensis	aholehole	endemic
Misgurnus anguillicaudatus	weatherfish/dojo	introduced
Mugil cephalus	mullet/ama'ama	indigenous
Poecilia reticulata	guppy	introduced
Sarotherodon (Tilapia) mossambica	tilapia	introduced
AMPHIBIA		
Rana catesbeiana	bullfrog	introduced
Bufo marinus	marine toad	introduced

TABLE 3
PARTIAL AVIFAUNA FROM THE
ALENAIO STUDY AREA
SOUTH HILO DISTRICT, HAWAII

FAMILY / Genus/species	Common Name	Status*
ARDEIDAE		
Bubulcus ibis	cattle egret	Fr
Nycticorax nycticorax hoactli	black-crowned night heron	Ri
ANATIDAE		
Anas acuta	pintail	Vr
A. americana	American widgeon	Vr
A. clypeata	nothern shoveler	Vr
A. platyrhynchos	mallard	Vr
Anser albifrons	white-fronted goose	Vs
Aythya affinis	lesser scaup	Vr
A. valisineria	canvasback	Vs
Branta canadensis	Canada goose	Vo
Bucephala albeola	bufflehead	Vo
ACCIPITRIDAE		
Buteo solitarius (E)	Hawaiian hawk, 'io	Re
RALLIDAE		
Fulica americana alai (E)	Hawaiian coot 'alae ke'oke'o	Ris
CHARADRIIDAE		
Pluvialis dominica fulva	golden plover	Vr (B)
SCOLOPACIDAE		
Heteroscelus incanus	wandering tattler	Vr
Numenius tahitiensis	bristle-thighed curlew	Vr

As previously stated, an estimated 80-90 percent of instream flows were lost between Chong Street and Komohana Street. There was no evidence of water loss from Komohana Street to the weir above Kinoole Street. During our survey, approximately half of the instream flows were diverted at this point with the remainder passing through a "window" in the weir and then down a concrete-lined channel to Waialama Canal.

In the lower portion of Waialama Canal, flows were influenced more by tide and surge than by stream flows. This was evident by frequent, periodic reversals of flow at Station 2 and perceptible changes in stream velocity at Station 3. Though under tidal influence, the upper portion of the canal (Station 4) was not subject to such transient changes in water level. These shorter period pertubations were undoubtedly damped out by the dense vegetative growth in the canal above Station 2. The upper portion of the canal, therefore, is dependent on stream flow for maintenance of a viable aquatic environment.

Stream Morphology:

Based on stream morphology, Alenaio Stream can be divided into four reaches:

1) Waialama Canal extends about 3000 feet from the Waiakea-Wailoa estuary to Kilauea Avenue. The entire length of the canal is subject to tidal influence. About 2000 feet of the canal is lined with vertical grouted riprap walls. The invert is unlined and heavily overgrown with grasses and aquatic vegetation.

2) Alenaio Stream proper extends about 6000 feet upstream from Kilauea Avenue (elevation 0 feet) to Komohana Street (elevation 250 feet). The stream channel in this reach is well defined with predominantly unlined banks and invert. Adjacent land use is commercial and residential.

3) From Komohana Street to Chong Street (elevation 700 feet) the channel is poorly defined and a substantial volume of water is apparently lost to percolation into underlying pahoehoe strata. Heavy forestation restricted our investigation of the area to a few points of access.

4) Above Chong Street the stream is fed by two parallel tributaries—the Waipahoehoe Branch and the Kaluiiki Branch—which originate on forest reserve lands above 2500 feet elevation and pass through agricultural lands enroute to their confluence at 750 feet elevation.

Biological information will be presented with reference to these relatively homogenous stream reaches.

LARIDAE		
Larus glaucescens	glaucous-winged gull	Vo
COLUMBIDAE		
Geopelia striata striata	barred dove	Fl
Streptopelia chinensis chinensis	lace-necked dove	Fl
ZOSTEROPIDAE		
Zosterops japonica	white-eye, mejiro	Fl
STURNIDAE		
Acridotheres tristis	common myna	Fl
PLOCEIDAE		
Lonchura punctulata	spotted munia, ricebird	Fl
Passer domesticus	house sparrow	Fl
FRINGILLIDAE		
Carpodacus mexicanus frontalis	house finch	Fl
Paroaria coronata	red-crested cardinal	Fl

(E) = Endangered Species

*Pyle, 1977.

Flora

1) Because Waialama Canal is entirely within Hilo Bayfront Park, terrestrial vegetation is predominantly exotic ornamental species such as coconut palms (Cocos nucifera), Livistona palms (Livistona rotundifolia), Alexandra palms (Archontophoenix alexandrae), African tuliptrees (Spathodea campanulata), candlenut (kukui) trees (Aleurites moluccana), monkeypod (Samanea saman), bamboo (Bambusa vulgaris), and banyan (Ficus spp.). Exotic weeds are also common, including Spanish clover (Desmodium uncinatum), sleeping grass (Mimosa pudica), and beggars tick (Bidens pilosa).

Although the entire length of the canal is subject to tidal influence, during the period of our survey the upper limit of the estuary was defined at Station 2. This also appears to be the lower limit of aquatic vegetation. Below Station 2 the bottom is relatively devoid of vegetation and consists mainly of soft, silty sand and large lava cobbles. Above Station 2 the channel is clogged with both emergent and submergent forms of vegetation.

Hydrophytes such as waterweed (Egeria densa), parrotfeather (Myriophyllum brasiliense), and waterlily (Nymphaea sp.) are abundant in this reach. Emergent grasses, such as seashore paspalum (Paspalum vaginatum), California grass (Brachiaria mutica), and quackgrass (Panicum repens) are common. Riparian vegetation consisting of California grass, honohono (Commelina diffusa), primrose willow (Ludwigia octivalvis), sourbrush (Pluchea odorata), Spanish clover, sleeping grass, and beggars tick grow within, and adjacent to, the lined channel.

2) From Kilauea Avenue to Komohana Street vegetation consists primarily of guava (Psidium guajava), ginger (Hedychium spp.), banana (Musa x paradisiaca), umbrella tree (Brassaia actinophylla), swamp mahogany (Eucalyptus robusta), ti (Cordyline terminalis), mango (Mangifera indica), papaya (Carica papaya), various palms, kukui, African tuliptree, and other ornamentals. Aquatic vegetation is limited to emergent grasses, such as California grass.

3) The forested area between Komohana and Chong Streets can be characterized as a mixed guava - ohi'a (Metrosideros collina polymorpha) forest. In addition, hala (Pandanus odoratissimus), swordfern (Nephrolepis exaltata), strawberry guava (Psidium cattleianum), banana, ginger, kukui, coconut palms, and African tuliptrees are common in more heavily forested areas. In clearings, grasses and low-growing shrubs prevail, including California grass, quackgrass, sugarcane (Saccharum officinarum), sourbush, sleeping grass, and morning glory (Ipomoea sp.).

4) The reach above Chong Street includes both forest reserve lands and agricultural lands devoted to the cultivation of sugarcane. Native ohi'a - koa (Acacia koa) forest predominates above 1600 feet elevation. Other common plants include guava, strawberry guava, ginger, sourbush, primrose willow, tree ferns (Cibotium sp. and Sadleria cyatheoides), false staghorn fern (Dicranopteris linearis), wild orchids (Arundina bambusaefolia and Spathoglottis plicata), and a variety of grasses and sedges.

On agricultural lands and uncultivated peripheral lands, sugarcane, guava, strawberry guava, ohi'a, and ginger are common. Banana, swamp mahogany, sourbush, wild orchids, sleeping grass, California grass, quackgrass, Jamaica vervain (Stachytarpheta jamaicensis), and melastome (Melastoma malabathricum) are also found on uncultivated lands adjacent to stream channels.

Terrestrial Fauna

Table 3 lists avifauna observed or reported in the study area, including Waiakea Pond. This wetland provides habitat for a variety of resident and migratory bird species. Native resident species such as the black-crowned night heron (Nycticorax nycticorax hoactli) and the endangered Hawaiian coot (Fulica americana alai) are known to frequent the area. The coot also nests in Mohouli Pond, which is adjacent and connected to Waiakea Pond (Ahuimanu Productions, 1977).

Regular visitors to the pond include the mallard (Anas platyrhynchos), pintail (A. acuta), shoveler (A. clypeata), Americana widgeon (A. americana), and lesser scaup (Aythya affinis). Occasional or infrequent visitors include the canvasback (Aythya valisineria), white-fronted goose (Anser albifrons), Canada goose (Branta canadensis), bufflehead (Bucephala albeola), and glaucous-winged gull (Larus glaucescens) (Ahuimanu Productions, 1977).

Though closely related to the Canada goose, the endangered Hawaiian goose or nene (Branta sandvicensis) is an upland bird whose range is restricted to higher elevations on Mauna Loa, Mauna Kea, and Haleakala (Maui), and is not likely to be found in the study area. The known range of the Hawaiian hawk or 'io (Buteo solitarius) overlaps the study area; however, it is not known what importance, if any, the study area has for this endangered species (USFWS, 1979).

Two species of migratory shorebirds were observed in Hilo Bayfront Park during our survey--the golden plover (Pluvialis dominica fulva) and the wandering tattler (Heteroscelus incanus).

So-called "urban" birds are widely distributed throughout the main islands and were frequently sighted during the September 1980 survey. These exotic species include the barred dove (Geopelia striata striata), lace-necked dove (Streptopelia chinensis chinensis), common myna (Acridotheres tristis), Japanese white-eye (Zosterops japonica), ricebird (Lonchura punctulata), house sparrow (Passer domesticus), house finch (Carpodacus mexicanus frontalis), and red-crested cardinal (Paroaria coronata).

Mammals in the Alenaio study area are non-game species typically found in urban environments throughout Hawaii. These include the house mouse (Mus musculus), roof rat (Rattus rattus), Norway rat (Rattus norvegicus), Polynesian rat (Rattus exulans), and Indian mongoose (Herpestes auropunctatus), as well as domestic animals and livestock.

The only land mammal endemic to Hawaii is the Hawaiian hoary bat (Lasiurus cinereus semotus), an endangered species. Although this species has been observed in the Hilo area in the past, little is known of its life history or specific habitat requirements. However, it is unlikely the study area provides more than peripheral habitat for this species.

Aquatic Fauna:

Sixty-one percent of the aquatic species observed or reported in Alenaio Stream and Waiakea Pond are considered native (endemic or indigenous) to Hawaii (Table 4). These include euryhaline marine species, such as maiko (Acanthurus nigroris), manini (A. triostegus sandvicensis), papio (Caranx ignobilis), milkfish (Chanos chanos), and mullet (Mugil cephalus).

Aholehole (Kuhlia sandvicensis) were the most abundant native fish in Alenaio Stream and were most abundant of any species found in the lower stream reach. Mullet were also common in this reach.

Native diadromous species found in this reach include the gobioid fishes o'opu okuhe (Eleotris sandvicensis), o'opu naniha (Awaous genivittatus), and o'opu nakea (Awaous stamineus), as well as the decapod crustacean opae oeha'a (Macrobrachium grandimanus).

Other native invertebrates included the Hawaiian crab (Grapsus grapsus tenuicrustatus), dragonfly larvae and adults (Pantala flavescens and Anax strenuus), and a polychaete bristleworm (Namalycastis abiuma).

Exotic macrofauna which have been reported from Waiakea Pond include tilapia (Sarotherodon mossambica), carp (Cyprinus carpio), guppies (Poecilia reticulata), and mosquitofish (Gambusia affinis) (Ahuimanu Productions, 1977). During our survey, only tilapia were observed in the lower stream reach.

O'opu okuhe had dropped out of the fish fauna observed at Station 4. Naniha and nakea were present. Okuhe and naniha are generally more common in lower stream reaches and are absent from the upper reaches. Nakea is generally more widely distributed throughout the length of a stream, and its relative abundance in Waialama Canal may be due to the coincidence of the survey period with the spawning season of this species, during which time it congregates in lower stream reaches to mate and spawn. This fact may be responsible for the absence of the species in any samples taken above Station 4.

Guppies and mosquitofish were common at Station 4. In fact, guppies were common at virtually every upstream sample site. The larvae (tadpoles) and adults of the bullfrog (Rana catesbeiana) and the giant (marine) toad (Bufo marinus) were common to abundant in all stream reaches. The weatherfish or dojo (Misgurnus anguillicaudatus) was found occasionally in Alenaio Stream and the Waipahoehoe Branch. Crayfish (Procambarus clarkii) were also found in the Waipahoehoe Branch, but they did not appear to be common. The Tahitian prawn (Macrobrachium lar) had been observed by local residents in several of the deeper perennial pools; however, this species was not seen during our survey.

Environmental Impact With The Project

Non-structural Measures:

Non-structural measure should have little, if any adverse impact on fish and wildlife resources in the Alenaio study area. No permanent alterations would be made in the stream channel and stream flow would be unchanged. Impacts due to periodic channel maintenance should be minor and of short duration, provided that removal of riparian vegetation is minimized.

Beneficial impacts could result indirectly due to floodplain restrictions or other measures which effectively restrict future development in the Alenaio floodplain.

Structural Measures:

1. Dam and Reservoir:

   Aside from the prohibitive economic costs and uncertain hydrology of the proposed site above Komohana Street, the construction of a dam and creation of a flood control reservoir would have significant adverse impacts on a mixed ohi'a-guava forest at this location. An unspecified area of the forest would be cleared and intermittently inundated. The reservoir created thereby would not provide suitable habitat for aquatic fauna or waterbirds due to ephemeral nature of

Alenaio Stream and high permeability of underlying strata. Temporary impoundment of floodwaters should not adversely affect aquatic habitat downstream, however, provided that minimum instream flows are maintained.

2. Levees:

As a complete solution, levees are impractical for that portion of Alenaio Stream where flood damage is most severe. The use of levees in conjunction with other structural measures will be discussed with those measures.

3. Channel Modifications and Diversion Channels:

Measures such as realignment, enlargement, and lining of stream channels are highly deleterious to native stream fauna. In Hawaii in general, the proportion of exotic stream fauna varies with the extent of stream alteration -- i.e. more highly altered streams have a larger proportion of exotics than do streams in a relatively "pristine" condition. Stream channelization undoubtedly confers a competitive advantage to the exotics which are more tolerant of highly altered environments.

Removal of riparian vegetation and lining of channels exposes stream waters to insolation and increases thermal stress. In addition, channelization removes places of concealment for aquatic fauna and exposes them to predation.

Diversion of stream waters into special channels or floodways can adversely affect the downstream environment as well, unless adequate provision is made for minimum instream flow. Inadequate flows could result in thermal stress, stagnation, oxygen depletion, and saltwater intrusion in lower reaches.

In addition to instream impacts, the proposed alternative alignments would have short-term construction-related impacts along the rights-of-way. The proposed rights-of-way traverse lands devoted to agriculture and residential development. Except for the vicinity of the diversion site for Alternative Plan 1, little of the ohi'a-guava forest above Komohana Street would be involved. However, construction-related impacts in this area should be relatively minor and short-term.

Some adverse impact may be expected to occur to the points of discharge. These are located in a wooded gulch between Hilo proper and Reeds Island. Vegetation is predominantly exotic. The Waikapu River which flows through the gulch is a short tributary of the Wailuku River which receives most of its water from runoff directed into it by several storm sewer culverts. The proposed input from Alenaio Stream should significantly increase the volume of discharge from

the Waikapu River and may aggravate erosion both at the point of discharge and downstream. Impacts to native stream fauna, if any, should be minor, considering the short length and ephemeral nature of the river. Installation of a drop channel and stilling basin, if necessary, should provide adequate protection from erosion at the discharge site.

Discussion and Recommendations

According to Parrish et al. (1978), channelization in its various forms 1) increases turbidity, 2) destroys natural substrate habitat, 3) creates wide, shallow, unnatural flows, 4) causes excessive illumination, water temperatures, and pH levels, and 5) creates topographical difficulties for upstream migration of diadromous species. Present channelization practices appear to be damaging the quality of stream habitat for native species and contributing to their replacement by hardy exotics. In general, altered streams have fewer native species than do unaltered streams, and these species represent a smaller proportion of the total stream fauna.

Parrish et al. (1978) recommends that mitigation include: 1) minimizing channelization projects, 2) maintaining the natural length of channels, 3) maintaining or replanting the vegetative canopy, 4) maintaining natural bottom material wherever possible, 5) using intermittent sections of natural bottom between minimum sections where a lined channel is unavoidable, 6) building a narrow, low-flow channel into flat lined inverts, and 7) installing minimum length culverts in ways that will avoid downstream elevations above stream level (waterfalls).

Furthermore, measures which would impound or divert stream flows may dewater the natural stream channel and thereby aggravate adverse impacts due to channelization. Instream flows are essential for the maintenance of a viable aquatic habitat. Therefore, maintenance of instream flows must be a primary objective of any planned impoundment or diversion work.

Although approximately one-third of the mainstem of Alenaio Stream (including Waialama Canal) has been channelized, native stream species are relatively abundant in its lower reaches. High water quality, due in part to basal springs which discharge directly to the stream and estuary, may be partially responsible for this apparent anomaly. Geologically recent, erosion-resistant lavas contribute little to the sediment load and dissolved solids in surface waters and probably account for the clarity and overall quality of the stream.

The absence of native diadromous stream fauna above Kilauea Avenue was unexpected, based on the stream conditions which were encountered during our survey. Considering its relative abundance in Waialama Canal, the absence of o'opu nakea from the mid and upper reaches of Alenaio Stream is particularly noteworthy. Whether its absence was due to environmental factors or merely an artifact of its seasonal distribution could not be determined in a single survey. The Service requests that funds be made available to collect additional survey data at a date to be determined.

The absence of the diadromous atyid shrimp opae kalaole (Atya bisculata) was not unexpected, however. This species is commonly found in the upper reaches of swift-flowing perennial streams; however, Timbol and Maciolek (1978) found it to be absent from altered streams (including Alenaio) on the island of Hawaii.

Several factors may be operating to inhibit upstream migration of diadromous fauna:

1) The reach between Kilauea Avenue and Kinoole Street is lined with concrete and exposed to insolation. Compounding this problem is the diversion of one half or more of instream flows by a weir above Kinoole Street. Diverted waters discharge via an enclosed culvert directly into Hilo Bay.

2) Alenaio Stream is ephemeral and subject to extremes in flow. Alternate scouring by high flows and drying during periods of low flow create a harsh environment for native stream fauna. Furthermore, all or part of low stream flows may be captured by subsurface drainage above Komohana Street.

Depending on which, if any, structural alternative(s) is(are) selected for development, project impacts on Alenaio Stream would vary both in kind and severity. Stream channelization can degrade water quality, increase turbidity, illumination, temperature, and pH. Impoundment or diversion of floodwaters could reduce low to moderate instream flows, unless the project design allows for the maintenance of these flows. Construction of a dam, levees, and/or diversion channels would eliminate an unspecified area of wildlife habitat, including a portion of the densely forested ohi'a-guava forest above Komohana Drive.

Native forestbirds are known to inhabit montane rainforests primarily between 3000 and 6000 feet elevation on the slopes of Mauna Kea and Mauna Loa; however, the normal range of some species may extend within the study area where suitable habitat exists. However, the Service's Office of Environmental Services (Endangered Species Unit), Honolulu, has determined that the proposed flood damage reduction project is unlikely to affect endangered species.

The U.S. Fish and Wildlife Service concurs with the recommendations of Parrish et al. concerning measures to mitigation adverse impacts due to stream channelization. Furthermore, the Service recommends that maintenance of instream flows be made an objective of the Corps' flood damage reduction study.

Each of the structural measures under consideration would have adverse impacts on stream habitat. Channelization alternatives are particularly deleterious for reasons already mentioned. Dams and diversions can adversely affect stream biota as well by dewatering the downstream reach. These measures should be considered for development only after other (non-structural) alternatives have been given due consideration. If structural measures are proven to be the only feasible solution to flood damage reduction in the Alenaio study area, project objectives should be achieved using the minimum stream alteration. Furthermore, the Service recommends that the following measures be included in the project design in order to mitigate adverse impacts on fish and wildlife resources.

1) Stream channelization, if necessary, be minimized.

2) Natural streambed be maintained wherever possible, using intermittent sections of natural bottom between minimum sections where a lined channel is unavoidable.

3) Streamside vegetation be maintained or replanted, as necessary, to provide shading for the stream.

4) Channelized sections incorporate a low-flow channel along the southern side of the invert to concentrate flows and take advantage of natural shading.

5) Replacement of bridge culverts: culverts should be minimal in length and installed in such a way that the downstream terminus will not be above stream level.

6) Dams, levees, or diversion structures be designed in such a way that less-than-flood flows remain within the natural stream channel.

7) Controlled release of floodwaters at a dam or diversion site be done so as to prolong the period of discharge into the natural stream channel.

8) The channel between Kilauea Avenue and Kinoole Street be restored to a natural (unlined) streambed or incorporate a low-flow channel to concentrate flows.

9) The weir above Kinoole Street be modified to permit a greater volume of low to moderate instream flows to discharge into Waialama Canal.

We appreciate this opportunity to comment.

Sincerely yours,

Nevin D. Holmberg
Deputy Project Leader for
Environmental Services

Literature Cited

Ahuimanu Productions. 1977. An Ornithological Survey of Hawaiian Wetlands, Volume 2. Prepared for U.S. Army Engineer District Honolulu.

Lockwood, J.P. and Buchanan-Banks, J.M. 1980. Preliminary Geologic Report on the Alenaio Stream Flood Damage Reduction Study Area, Hilo, Hawaii. U.S. Geological Survey. Prepared for U.S. Army Engineer District Honolulu.

Parrish, J.D., J.A. Maciolek, A.S. Timbol, C.B. Hathaway, and S.E. Norton. 1978. Stream Channel Modification in Hawaii, Part D: Summary Report. U.S. Fish and Wildlife Service Contract No. 14-16-0008-1199.

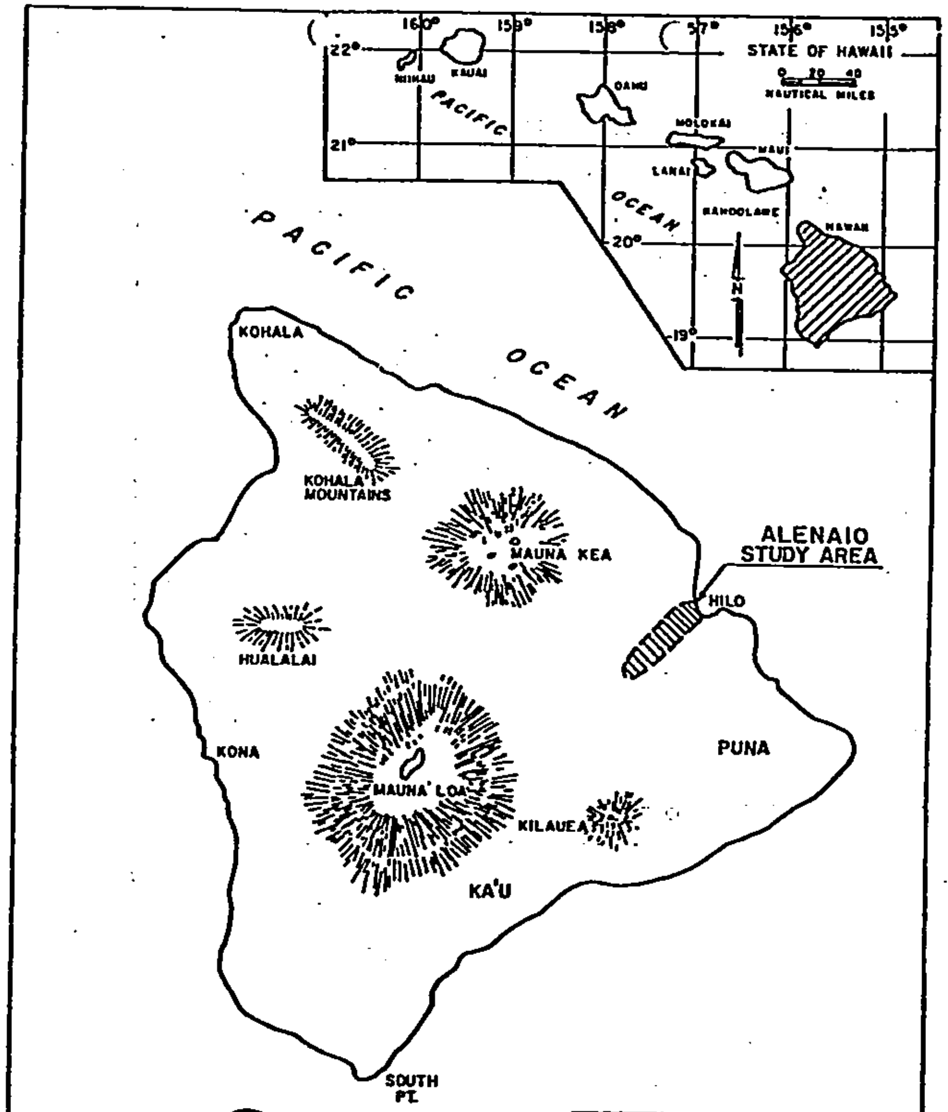
Pyle, R.L. 1977. Preliminary List of the Birds of Hawaii. _'Elepaio_ 37(10) p. 110-121.

Timbol, A.S. and J.A. Maciolek. 1978. Stream Channel Modification in Hawaii, Part A: Statewide Inventory of Streams; Habitat Factors and Associated Biota. U.S. Fish and Wildlife Service Contract No. 14-16-0008-1199.

U.S. Army Engineer District Honolulu. 1980. Reconnaissance Report for Flood Damage Reduction, Alenaio Stream, Hawaii.

U.S. Fish and Wildlife Service. 1979. Hilo Area Comprehensive Study. Prepared for U.S. Army Engineer District Honolulu.

U.S. Geological Survey. 1968. Preliminary Report on the Water Resources of the Hilo-Puna Area, Hawaii. Prepared in Cooperation with Division of Water and Land Development, Department of Land and Natural Resources, State of Hawaii.



ALENAIO STREAM HAWAII, HAWAII

FIGURE 1
LOCATION MAP

ADAPTED FROM
U.S. ARMY ENGINEER DISTRICT, HONOLULU

2

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

DEC 28 1981

LTC Kenneth E. Sprague
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858

Re: Preliminary Coordination
Act Report, Alenaio
Stream Flood Damage
Reduction, Hilo, Hawaii

Dear Colonel Sprague:

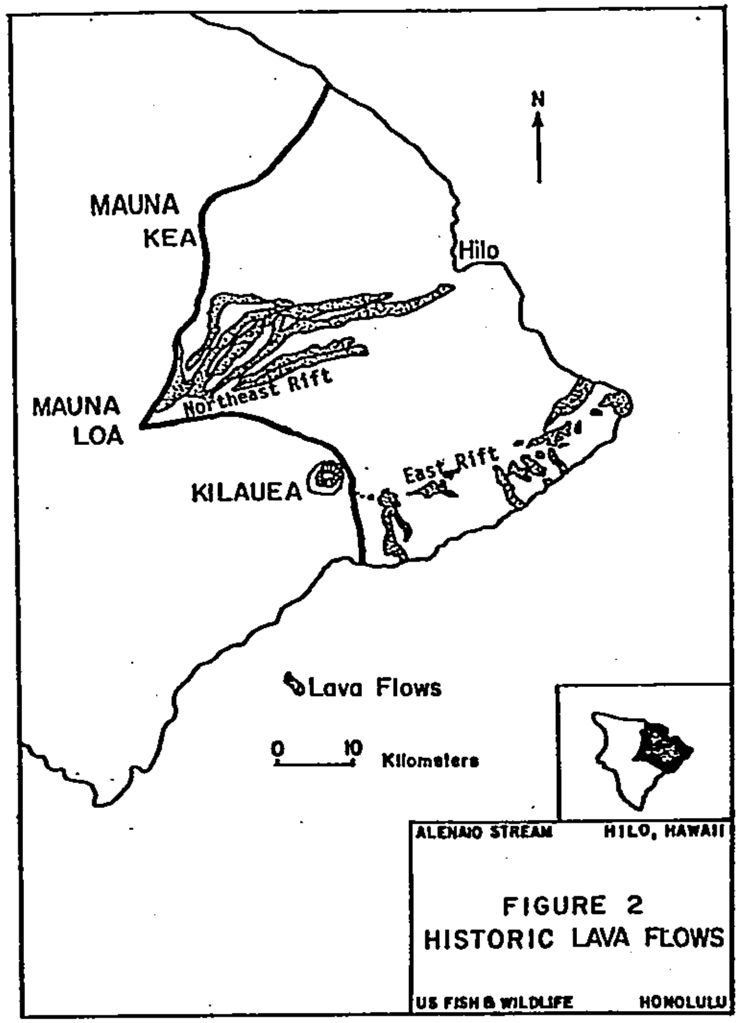
This is the Preliminary Coordination Act Report of the U.S. Fish and Wildlife Service for the Alenaio Stream Flood Damage Reduction Study, Hilo, Hawaii. The Honolulu District of the U.S. Army Corps of Engineers is undertaking this study to determine the feasibility of various alternatives for flood damage reduction in the Alenaio study area.

This report has been prepared under the authority of and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and other authorities mandating Department of the Interior concern for environmental values. It is also consistent with the intent of the National Environmental Policy Act.

The analysis and recommendations herein are based on recent project information provided by Mr. James K. Ligh (Project Engineer) and survey reports of the U.S. Geological Survey (1980). Biological information was obtained from a field investigation conducted by Fish and Wildlife Service biologist Gerald Koehm and from a review of pertinent scientific literature. This report was prepared by John I. Ford and supercedes our Planning Aid Letter (PAL) of 10 December 1980.

Description of the Planning Area

The Alenaio study area is located on the northeast flank of Mauna Loa volcano, within the town of Hilo on the Island of Hawaii (Figure 1). Hawaii is the largest of the Hawaiian Islands in land area (4038 square miles) which is almost twice the combined area of the other islands. Like the rest of the Hawaiian Archipelago, Hawaii is volcanic in origin, formed by the coalescence of five distinct volcanic massifs—Kohala, Hualalai, Mauna Kea, Mauna Loa, and Kilauea. Of these, only Hualalai, Mauna Loa, and Kilauea have erupted historically—Kilauea as recently as November 1979.



ALENAIO STREAM HILO, HAWAII

FIGURE 2
HISTORIC LAVA FLOWS

US FISH & WILDLIFE HONOLULU

The town of Hilo is located between the two largest mountains, Mauna Kea (elevation 13,796 feet) and Mauna Loa (elevation 13,677 feet), making Hilo a natural focal point for lava flows originating along Mauna Loa's active Northeast Rift Zone (Figure 2). Lava flows from the Northeast Rift (NER) affect not only surface drainage patterns, but subsurface flows as well. Lava tube-fed pahoehoe flows in the Hilo area are characterized by horizontal layering, numerous fractures and sub-horizontal voids, which act as subterranean conduits for storm runoff. Subsurface runoff is not confined to a topographically-defined drainage basin, but may be imported from rain forest catchment areas through a plexus of small lava tubes in pahoehoe flows originating along the NER. The U.S. Geological Survey (1980) estimates that the effective drainage area of Alenaio Stream may be 5-10 times larger than its topographically-defined watershed.

Alenaio Stream is part of a larger drainage system which discharges via the Wailoa River into Hilo Bay (Figure 3). The Wailoa River receives water from Alenaio Stream and Waiakea Pond, which in turn is fed by Waiakea Stream via the Wailoa Flood Channel and by basal springs. The Wailoa River also receives freshwater directly from basal springs. Because Alenaio and Waiakea Streams are ephemeral in nature, these springs account for most of the dry-weather discharge of the Wailoa River, which is the greatest of any stream in the State of Hawaii. Average river flow exceeds 100 million gallons per day (mgd) (USGS, 1968).

The lower reach of the Waiakea-Wailoa complex is estuarine and subject to tidal fluctuation. The large influx of freshwater from basal springs depresses the salinity and temperature within the estuary. At the inlet to Waiakea Pond, salinity may vary from several parts per thousand on the incoming tide to less than one part per thousand on the outgoing tide (USGS, 1968). The estuary is entirely surrounded by commercial, light industrial, and park land uses. The Hilo Bayfront Park, which occupies most of the adjacent lands, was set aside following the destructive tsunami of 1960 to provide a protective buffer zone for the central business district of Hilo. The park is totally within the tsunami inundation zone.

Waialama Canal extends 3000 feet west from the Wailoa River to the Kilauea Avenue bridge culvert, which marks the downstream terminus of Alenaio Stream and the upper limit of tidal action. This reach is entirely within the Bayfront Park and has been channelized for approximately 2000 feet — a remnant of the bayfront business district which was devastated by the 1960 tsunami.

The Alenaio "watershed" originates above 2500 feet elevation, where the stream consists of two branches—the Waipahoehoe Branch and the Kaluiiki Branch. These tributary streams flow in roughly parallel channels and merge at approximately 750 feet elevation.

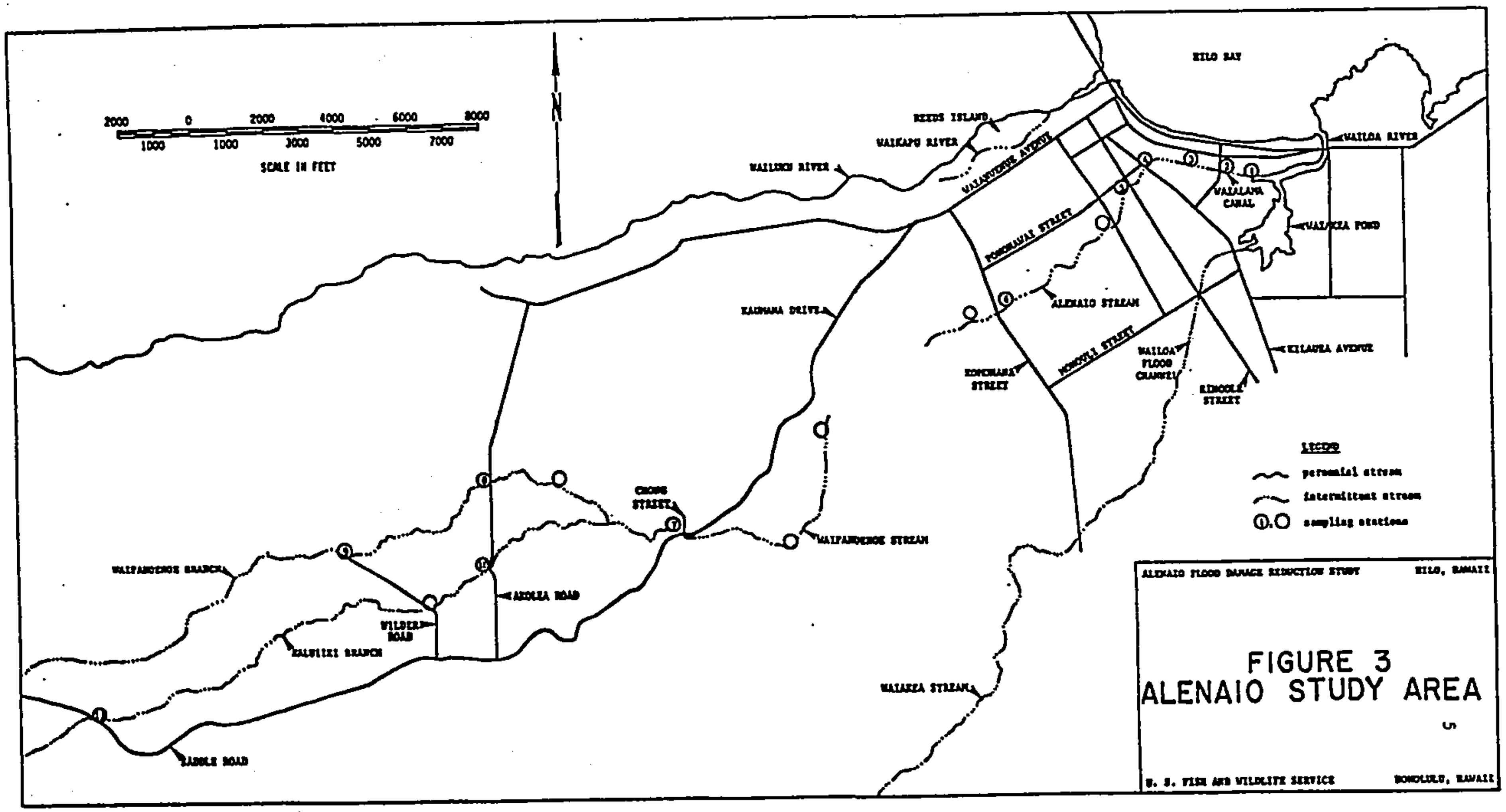


FIGURE 3
ALENAIO STUDY AREA

The course of Alenaio Stream is presently defined by three different pahoehoe flows from the NER--the flow of 1881, the Kulaloa flow (1100-1400 years old), and the Punahoa flow (3000-4000 years old). The Waipahoehoe Branch is bounded on the north by the Punahoa flow. Below its confluence with the Kaluiiki Branch, the stream is defined by the flow of 1881 to the south, while the Kulaloa flow defines its southern margin in the reach below 250 feet elevation (USGS, 1980).

The streambed consists mainly of pahoehoe lavas which are relatively resistant to erosion. These younger lavas are interspersed with sand and gravel-filled potholes eroded in older, underlying weathered clays. Transitions between strata are generally marked by "stairstep" cascades or near-vertical drops in the streambed.

Between Chong Street and Komohana Street, the stream passes through a heavily forested area with a relatively flat gradient. The stream channel is poorly defined in this area, and a large volume of water is lost from the mainstem of Alenaio Stream, probably due to seepage into the underlying Punahoa lava flow (USGS, 1980). The Fish and Wildlife Service estimates that as much as 80-90 percent of the stream flows observed at Chong Street were "lost" to percolation.

Below Komohana Street stream flows are confined within a well defined channel which reaches depths of 20-30 feet below adjacent ground contours. Above Kinoole Street a concrete weir diverts a portion of stream flows into a culvert which empties directly into Hilo Bay. The remainder follows a concrete-lined invert from Kinoole Street to Kilauea Avenue where it enters Waialama Canal.

A significant portion of low to moderate stream flows percolates into small lava tubes, fractures, and voids between strata. However, during periods of heavy rainfall these subterranean conduits may be filled to capacity and surface runoff can occur. Historically, flooding in the Alenaio watershed has resulted from overbank flows during peak surface flows, as well as from springs which unexpectedly develop in areas of pahoehoe outcrop, especially near the distal ends of lava flows, and from the transient elevation of the basal freshwater lens. Deliberate attempts have been made to control mauka flooding due to surface runoff by diverting surface flows into natural lava tubes; however, this practice may only aggravate flooding problems downslope (USGS, 1980).

There was no measurable rainfall in Hilo during the course of our survey. However, heavy rains had swollen local streams several days earlier and flood warnings had been issued for the Hilo area. Though subsiding, moderate stream flows continued throughout the survey period. At Chong Street, flows subsided from approximately 100 cubic feet per second (cfs) to 50 cfs over a three-day span.

As previously stated, an estimated 80-90 percent of instream flows were lost between Chong Street and Komohana Street. There was no evidence of water loss from Komohana Street to the weir above Kinoole Street. During our survey, approximately half of the instream flows were diverted at this point with the remainder passing through a "window" in the weir and then down a concrete-lined channel to Waialama Canal.

In the lower portion of Waialama Canal, flows were influenced more by tide and surge than by stream flows. This was evident by frequent, periodic reversals of flow at Station 2 and perceptible changes in stream velocity at Station 3. Though under tidal influence, the upper portion of the canal (Station 4) was not subject to such transient changes in water level. These shorter period pertubations were undoubtedly damped out by the dense vegetative growth in the canal above Station 2. The upper portion of the canal, therefore, is dependent on stream flow for maintenance of a viable aquatic environment.

Detailed Plan Description

The U.S. Army Engineer District Honolulu is currently considering three basic alternatives to alleviate flood damages in the Alenaio study area:

Alternative 1 - Modifying the existing stream channel (selected plan).
Alternative 2 - A diversion channel into the Wailuku River.
Alternative 3 - Floodproofing, relocating structures and incorporating a floodplain management policy.

ALTERNATIVE 1

In developing this alternative the Corps has divided the study area into four reaches:

Reach	Area
4	Chong's Bridge to Komohana Street
3	Komohana Street to Kapiolani Street
2	Kapiolani Street to Kilauea Avenue
1	Kilauca Avenue to Hilo Bay

Reach 4. The area between Chong's Bridge and Komohana Street is undeveloped but subject to future development by private owners. Alternative 1 incorporates a floodplain management plan in order to minimize future flooding problems. A minimum 200-foot flood control easement is proposed along the stream alignment. The 200-foot minimum easement is based on the maximum theoretical extent of the 100-year event flood for this area. This proposed easement would be recommended for both the SPF and 100-year plans. Periodic maintenance will be needed along the stream to minimize degradation of the stream channel from debris.

Reach 3. The stream between Komohana Street and Kapiolani Street is approximately 4400 feet long with 4 structures in the 100-year floodplain and 8 structures in the SPF floodplain. Floodproofing is the proposed measure for this reach due to the scattered distribution of structures. Structures that cannot be floodproofed would be removed or left in their current condition.

Reach 2. Alenaio Stream between Kapiolani Street and Kilauea Avenue is approximately 1900 feet long with approximately 124 structures in the SPF floodplain. The stream is at its narrowest in this reach. This alternative provides for the realignment of this portion in order to provide the minimum recommended curvature which will keep the floodwaters behaving as steady flow. The channel will be modified as follows:

Channel Modifications (Rectangular Concrete)

Channel Dimensions	100 Year	SPF
Width	25'	40' for 415' 35' for 1225'
Design flood depth	8' to 12'	8' to 9.5'
Length	1,640	1,640

The maximum velocity was computed to be 42 fps for the SPF flood and 38 fps for the 100 year frequency flood. The bridges at Kapiolani Street, Ululani Street, Kinoole Street and Kilauea Avenue will also be replaced. Seven (7) structures will be relocated, and the old channel will be filled and landscaped.

On the downstream side of Kilauea Avenue Bridge a 250-foot-long concrete wall will be provided on the left bank to prevent channel erosion as the floodflows negotiate the curved section in the Waiolama Canal. The velocity at this point is estimated at 40 fps.

Reach 1. This reach consists of the stream below Kilauea Avenue and south of Ponohawai Street until it enters Hilo Bay. Within this reach are only two (2) structures subject to flooding. The most critical activity affected by flooding is traffic on the Bayfront Highway and Kamehameha Avenue. The SPF and 1% frequency event floods will overtop the Bayfront Highway by 3.5 feet and 2.5 feet, respectively. The selected plan for this reach is floodproofing. No structural actions are proposed.

ALTERNATIVE 2

This alternative provides for a channel diversion from approximately 500 feet above Komohana Street extending into the Wailuku River. The alignment

generally runs parallel to Komohana Street and Hale Street. Two levels of protection, the SPF and the 100 year flood frequency were developed. The plan provides for a 4200 feet diversion channel consisting of a trapezoidal channel at the point of diversion for 1850 feet, a transition section of 100 feet and a rectangular channel for 2250 feet. The following summarizes the pertinent sections of the proposed channel:

	Trapezoidal	Rectangular	Trapezoidal	Rectangular
	(1850')	(2250')	(1850')	(2250')
Bottom width	15'	25'	25'	35'
depth	8-10'	8-11'	8-10'	8-12.5'
side slope	1.5H to 1V	.NA	1.5H to 1V	NA
velocity (max)	30 fps	50 fps	30 fps	50 fps

This outlet at the Wailuku River would consist of a drop structure and stilling basin. New bridges would also be needed at Komohana and Punahele streets.

The existing downstream portion of Alenaio will also be modified in order to be able to accommodate a Standard Project Storm (SPS) occurring below the proposed point of diversion. The following structures will be modified as indicated.

Culvert Bridge Openings	100 Yr	SPF
Kinoole Street	18'W x 10'H	20'W x 10'H
Kilauea Avenue	18'W x 10'H	20'W x 10'H

Floodplan management measures are also part of overall plan for the area between Chong's Bridge and the point of diversion in order to minimize development impacts on the diversion channel. The drop structure and stilling basin at the Waikapu River would be designed to appear as a natural waterfall. A covered channel is proposed for a long 650 feet of the diversion channel along Hale Street.

ALTERNATIVE 3

This non-structural alternative provides for floodproofing individual structures, relocating or replacing structures which cannot be economically floodproofed and incorporating a floodplain management plan. Two levels of protection were evaluated, the Standard Project Flood (SPF) and the 100-year (1% frequency) flood frequency event.

Environmental Setting Without the Project

Survey Methodology:

The U.S. Fish and Wildlife Service conducted a field survey of the Alenaio study area on September 22-26, 1980. The purpose of the survey was to inventory fish and wildlife resources and dominant terrestrial and aquatic flora in the study area, identify significant biological resources, and generally characterize Alenaio Stream and the estuarine environment.

Water quality data were measured at eleven stations on Alenaio Stream and its tributaries (Figure 3). These data included water temperature, salinity, specific conductance, pH, dissolved oxygen, and stream flow. Temperature data were recorded in the field using a mercury thermometer. Flow data were determined by timing a small float over a measured distance and multiplying by the cross-sectional area of the stream. Dissolved oxygen samples were chemically fixed in the field, transferred to plastic specimen jars and returned to the laboratory for analysis. In the laboratory 5.8-milliliter aliquots of each sample were analyzed using the Winkler-Azide titration method as described in the HACH Methods Manual. A single sample was taken at each sample depth for salinity, conductivity, and pH. A YSI Model 33 S-C-T meter was used to measure the first two parameters, and an AMI Model 107 pH meter was used to measure the latter. In the field, salinity values were determined using an AO refractometer. Water quality data is tabulated in Table 1.

Flora and fauna were observed and/or collected at each of the eleven water quality stations. Additional observations were made at other points along Alenaio Stream to better characterize the biological resources of the study area.

Survey Results:

A partial flora for the Alenaio study area is included in Table 2. A list of avifauna observed or reported from the study area has been included in Table 3. Table 4 provides a listing of aquatic species observed or reported from the study area.

Flora

1) Because Waialama Canal is entirely within Hilo Bayfront Park, terrestrial vegetation is predominantly exotic ornamental species such as coconut palms (Cocos nucifera), Livistona palms (Livistona rotundifolia), Alexandra palms (Archontophoenix alexandrae), African tuliptrees

TABLE 1
WATER QUALITY DATA FOR ALENAIO STREAM
SOUTH HILO DISTRICT, HAWAII

STREAM	STATION	ELEVATION	FLOW REGIME*	SAMPLE DEPTH	T°C	S°/oo	C(umhos)	D.O.	pH
Waialama Canal	1	0	tidal	0' 2'	22.7 21.7	0.5 3.2	1170 5500	6.5 6.5	7.6 7.2
	2	0	tidal	0' 2'	22.2 22.2	0.5 0.3	1220 1040	7.0 6.5	7.8 7.6
	3	0	tidal	1'	25.0	0	64	6.0	8.2
	4	0	1	0' 2'	25.6 25.6	0 0	50 50	7.5 6.5	7.6 7.7
Alenaio Stream	5	26'	2	0'	25.0	0	52	7.5	8.0
	6	200'	2	0'	23.3	0	52	7.0	7.8
	7	710'	3	1'	22.2	0	48	7.5	7.6
Waipahoehoe Stream	8	950'	3	1'	20.0	0	50	-	7.5
	9	1200'	2	-	-	-	-	-	-
	10	1030'	2	0'	22.2	0	45	-	8.0
Kaluiiki Branch	11	1620'	0	-	-	-	-	-	-

*0 = 0 cfs
1 = greater than 0 cfs, less than 1 cfs
2 = greater than 1 cfs, less than 10 cfs
3 = greater than 10 cfs, less than 100 cfs

TABLE 2
PARTIAL FLORA FROM THE
ALENAIO STUDY AREA
SOUTH HILO DISTRICT, HAWAII

FILICINAE	
GLEICHENIACEAE	
Dicranopteris linearis (Burm.) Underw.	false staghorn fern
DICKSONIACEAE	
Cibotium spp.	tree fern, hapu'u
POLYPODIACEAE	
Nephrolepis exaltata (L.) Schott	swordfern
Sadleria cyatheoides Kaulf.	tree fern, ama'uma'u
SALVINIACEAE	
Azolla filiculoides Lam.	waterfern
ANGIOSPERMAE	
MONOCOTYLEDONAE	
PANDANACEAE	
Pandanus odoratissimus L.f.	pandanus, hala
ELODEACEAE	
Egeria densa Planch.	waterweed
RUPPIACEAE	
Ruppia maritima L.	widgeon grass
GRAMINEAE	
Bambusa vulgaris Wendl.	feathery bamboo
Brachiaria mutica (Forsk.) Stapf	California grass
Panicum repens L.	quackgrass
Paspalum vaginatum Sw.	seashore paspalum
Saccharum officinarum L.	sugarcane
CYPERACEAE	
Cyperus spp.	sedges
Scirpus validus Vahl	great bulrush
PALMAE	
Archontophoenix alexandrae (F. Muell) Wendl. & Drude	Alexandra palm
Cocos nucifera L.	coconut palm
Livistona rotundifolia (Lam.) Mart.	Livistona palm

ARACEAE	
Philodendron spp.	philodendron
COMMELINACEAE	
Commelina diffusa Burm. f.	honohono
LILIACEAE	
Cordyline terminalis (L.) Kunth	ti
MUSACEAE	
Musa xparadisiaca L.	banana
ZINGIBERACEAE	
Alpinia purpurata (Vieill.) K. Schum.	red ginger
Hedychium coronarium Koenig	white ginger
H. flavescens Carey	yellow ginger
ORCHIDACEAE	
Arundina bambusaefolia (Roxb.) Lindl.	bamboo orchid
Spathoglottis plicata Bl.	wind orchid
DICOTYLEDONAE	
MORACEAE	
Ficus spp.	banyan
NYMPHAEACEAE	
Nymphaea sp.	waterlily
LEGUMINOSAE	
Acacia koa Gray	koa
Desmodium uncinatum (Jacq.) DC.	Spanish clover
Mimosa pudica L.	sleeping grass
Samanea saman (Jacq.) Merr.	monkeypod
EUPHORBIACEAE	
Aleurites moluccana (L.) Willd.	kukui
ANACARDIACEAE	
Mangifera indica L.	mango
CARICACEAE	
Carica papaya L.	papaya
MYRTACEAE	
Eucalyptus robusta Sm.	swamp mahogany
Metrosideros collina subsp. *polymorpha* (Gaud.) Rock	'ohi'a lehua

TABLE 3
PARTIAL AVIFAUNA FROM THE
ALENAIO STUDY AREA
SOUTH HILO DISTRICT, HAWAII

FAMILY / Genus/species	Common Name	Status*
ARDEIDAE		
Bubulcus ibis	cattle egret	Fr
Nycticorax nycticorax hoactli	black-crowned night heron	Ri
ANATIDAE		
Anas acuta	pintail	Vr
A. americana	American widgeon	Vr
A. clypeata	northern shoveler	Vr
A. platyrhynchos	mallard	Vr
Anser albifrons	white-fronted goose	Vs
Aythya affinis	lesser scaup	Vr
A. valisineria	canvasback	Vs
Branta canadensis	Canada goose	Vo
Bucephala albeola	bufflehead	Vo
ACCIPITRIDAE		
Buteo solitarius (E)	Hawaiian hawk, 'io	Re
RALLIDAE		
Fulica americana alai (E)	Hawaiian coot 'alae ke'oke'o	Ris
CHARADRIIDAE		
Pluvialis dominica fulva	golden plover	Vr (B)
SCOLOPACIDAE		
Heteroscelus incanus	wandering tattler	Vr
Numenius tahitiensis	bristle-thighed curlew	Vr
LARIDAE		
Larus glaucescens	glaucous-winged gull	Vo
COLUMBIDAE		
Geopelia striata striata	barred dove	Fl
Streptopelia chinensis chinensis	lace-necked dove	Fl

Psidium cattleianum Sabine	strawberry guava
P. guajava L.	guava
MELASTOMATACEAE	
Melastoma malabathricum L.	melastome
ONAGRACEAE	
Ludwigia octivalvis (Jacq.) Raven	primose willow
HALORAGACEAE	
Myriophyllum brasiliense Cambess.	parrotfeather
UMBELLIFERAE	
Hydrocotyle verticillata Thunb.	whorled marsh pennywort
ARALIACEAE	
Brassaia actinophylla Endl.	umbrella tree
CONVOLVULACEAE	
Ipomoea spp.	morning glory
VERBENACEAE	
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, oi
BIGNONIACEAE	
Spathodea campanulata Beauv.	African tuliptree
GOODENIACEAE	
Scaevola taccada (Gaertn.) Roxb.	beach naupaka
COMPOSITAE	
Pluchea odorata (L.) Cass.	pluchea
Bidens pilosa L.	beggars tick

ZOSTEROPIDAE		
<u>Zosterops japonica</u>	white-eye, mejiro	Fl
STURNIDAE		
<u>Acridotheres tristis</u>	common myna	Fl
PLOCEIDAE		
<u>Lonchura punctulata</u>	spotted munia, ricebird	Fl
<u>Passer domesticus</u>	house sparrow	Fl
FRINGILLIDAE		
<u>Carpodacus mexicanus frontalis</u>	house finch	Fl
<u>Paroaria coronata</u>	red-crested cardinal	Fl

(E) = Endangered Species

*Pyle, 1977.

TABLE 4
DOMINANT AQUATIC MACROFAUNA OF
ALENAIO STREAM AND ESTUARY
SOUTH HILO DISTRICT, HAWAII

PHYLUM CLASS <u>Genus/species</u>	<u>Common Name</u>	<u>Status</u>
ANNELIDA		
POLYCHAETA		
<u>Namalycastis abiuma</u>	bristle worm	indigenous
ARTHROPODA		
INSECTA		
<u>Anax strenuus</u>	dragonfly (adult)	endemic
<u>Pantala flavescens</u>	dragonfly (larva)	indigenous
CRUSTACEA		
<u>Grapsus grapsus tenuicrustatus</u>	a'ama/crab	endemic
<u>Macrobrachium lar</u>	Tahitian prawn	introduced
<u>M. grandimanus</u>	opae oeha'a	endemic
<u>Procambarus clarkii</u>	crayfish	introduced
VERTEBRATA		
PISCES		
<u>Acanthurus nigroris</u>	maiko	indigenous
<u>A. triostegus sandvicensis</u>	convict tang/manini	endemic
<u>Awaous genivittatus</u>	o'opu naniha	indigenous
<u>A. stamineus</u>	o'opu nakea	endemic
<u>Caranx ignobilis</u>	papio	indigenous
<u>Chanos chanos</u>	milkfish, awa	indigenous
<u>Cyprinus carpio</u>	carp, koi	introduced
<u>Eleotris sandwicensis</u>	o'opu okuhe	endemic
<u>Gambusia affinis</u>	mosquitofish	introduced
<u>Kuhlia sandvicensis</u>	aholehole	endemic
<u>Misgurnus anguillicaudatus</u>	weatherfish/dojo	introduced
<u>Mugil cephalus</u>	mullet/ama'ama	indigenous
<u>Poecilia reticulata</u>	guppy	introduced
<u>Sarotherodon (Tilapia) mossambica</u>	tilapia	introduced
AMPHIBIA		
<u>Rana catesbeiana</u>	bullfrog	introduced

(Spathodea campanulata), candlenut (kukui) trees (Aleurites moluccana), monkeypod (Samanea saman), bamboo (Bambusa vulgaris), and banyan (Ficus spp.). Exotic weeds are also common, including Spanish clover (Desmodium uncinatum), sleeping grass (Mimosa pudica), and beggars tick (Bidens pilosa).

Although the entire length of the canal is subject to tidal influence, during the period of our survey the upper limit of the estuary was defined at Station 2. This also appears to be the lower limit of aquatic vegetation. Below Station 2 the bottom is relatively devoid of vegetation and consists mainly of soft, silty sand and large lava cobbles. Above Station 2 the channel is clogged with both emergent and submergent forms of vegetation.

Hydrophytes such as waterweed (Egeria densa), parrotfeather (Myriophyllum brasiliense), and waterlily (Nymphaea sp.) are abundant in this reach. Emergent grasses, such as seashore paspalum (Paspalum vaginatum), California grass (Brachiaria mutica), and quackgrass (Panicum repens) are common. Riparian vegetation consisting of California grass, honohono (Commelina diffusa), primrose willow (Ludwigia octivalvis), sourbrush (Pluchea odorata), Spanish clover, sleeping grass, and beggars tick grow within, and adjacent to, the lined channel.

2) From Kilauea Avenue to Komohana Street vegetation consists primarily of guava (Psidium guajava), ginger (Hedychium spp.), banana (Musa x paradisiaca), umbrella tree (Brassaia actinophylla), swamp mahogany (Eucalyptus robusta), ti (Cordyline terminalis), mango (Mangifera indica), papaya (Carica papaya), various palms, kukui, African tuliptree, and other ornamentals. Aquatic vegetation is limited to emergent grasses, such as California grass.

3) The forested area between Komohana and Chong Streets can be characterized as a mixed guava - 'ohi'a (Metrosideros collina subsp. polymorpha) forest. In addition, hala (Pandanus odoratissimus), swordfern (Nephrolepis exaltata), strawberry guava (Psidium cattleianum), banana, ginger, kukui, coconut palms, and African tuliptrees are common in more heavily forested areas. In clearings, grasses and low-growing shrubs prevail, including California grass, quackgrass, sugarcane (Saccharum officinarum), sourbush, sleeping grass, and morning glory (Ipomoea sp.).

4) The reach above Chong Street includes both forest reserve lands and agricultural lands devoted to the cultivation of sugarcane. Native 'ohi'a - koa (Acacia koa) forest predominates above 1600 feet elevation. Other common plants include guava, strawberry guava, ginger, sourbush, primrose willow, tree ferns (Cibotium spp. and Sadleria cyatheoides), false staghorn fern (Dicranopteris linearis), wild orchids (Arundina

bambusaefolia and Spathoglottis plicata), and a variety of grasses and sedges.

On agricultural lands and uncultivated peripheral lands, sugarcane, guava, strawberry guava, ohi'a, and ginger are common. Banana, swamp mahogany, sourbush, wild orchids, sleeping grass, California grass, quackgrass, Jamaica vervain (Stachytarpheta jamaicensis), and melastome (Melastoma malabathricum) are also found on uncultivated lands adjacent to stream channels.

Terrestrial Fauna

The Waiakea Pond wetland provides habitat for a variety of resident and migratory bird species. Native resident species such as the black-crowned night heron (Nycticorax nycticorax hoactli) and the endangered Hawaiian coot (Fulica americana alai) are known to frequent the area. The coot also nests in Mohouli Pond, which is adjacent and connected to Waiakea Pond (Ahuimanu Productions, 1977).

Regular visitors to the pond include the mallard (Anas platyrhynchos), pintail (A. acuta), shoveler (A. clypeata), Americana widgeon (A. americana), and lesser scaup (Aythya affinis). Occasional or infrequent visitors include the canvasback (Aythya valisineria); white-fronted goose (Anser albifrons); Canada goose (Branta canadensis); bufflehead (Bucephala albeola), and glaucous-winged gull (Larus glaucescens) (Ahuimanu Productions, 1977).

Though closely related to the Canada goose, the endangered Hawaiian goose or nene (Branta sandvicensis) is an upland bird whose range is restricted to higher elevations on Mauna Loa, Mauna Kea, and Haleakala (Maui), and is not likely to be found in the study area. The known range of the Hawaiian hawk or 'io (Buteo solitarius) overlaps the study area; however, it is not known what importance, if any, the study area has for this endangered species (USFWS, 1979).

Two species of migratory shorebirds were observed in Hilo Bayfront Park during our survey--the golden plover (Pluvialis dominica fulva) and the wandering tattler (Heteroscelus incanus).

So-called "urban" birds are widely distributed throughout the main islands and were frequently sighted during the September 1980 survey. These exotic species include the barred dove (Geopelia striata striata), lace-necked dove (Streptopelia chinensis chinensis), common myna (Acridotheres tristis), Japanese white-eye (Zosterops japonica), ricebird (Lonchura punctulata), house sparrow (Passer domesticus), house finch (Carpodacus mexicanus frontalis), and red-crested cardinal (Paroaria coronata).

Mammals in the Alenaio study area are non-game species typically found in urban environments throughout Hawaii. These include the house mouse (Mus musculus), roof rat (Rattus rattus), Norway rat (Rattus norvegicus), Polynesian rat (Rattus exulans), and Indian mongoose (Herpestes auropunctatus), as well as domestic animals and livestock.

The only land mammal endemic to Hawaii is the Hawaiian hoary bat (Lasiurus cinereus semotus), an endangered species. Although this species has been observed in the Hilo area in the past, little is known of its life history or specific habitat requirements. However, it is unlikely the study area provides more than peripheral habitat for this species.

Aquatic Fauna:

Sixty-one percent of the aquatic species observed or reported in Alenaio Stream and Waiakea Pond are considered native (endemic or indigenous) to Hawaii (Table 4). These include euryhaline marine species, such as maiko (Acanthurus nigroris), manini (A. triostegus sandvicensis), papio (Caranx ignobilis), milkfish (Chanos chanos), and mullet (Mugil cephalus).

Aholehole (Kuhlia sandvicensis) were the most abundant native fish in Alenaio Stream and were most abundant of any species found in the lower stream reach. Mullet were also common in this reach. Native diadromous species found in this reach include the gobioid fishes o'opu okuhe (Eleotris sandwicensis), o'opu naniha (Awaous genivittatus), and o'opu nakea (Awaous stamineus), as well as the decapod crustacean opae oeha's (Macrobrachium grandimanus).

Other native invertebrates found here included the Hawaiian crab (Grapsus grapsus tenuicrustatus), dragonfly larvae and adults (Pantala flavescens and Anax strenuus), and a polychaete bristleworm (Namalycastis abiuma).

Exotic macrofauna which have been reported from Waiakea Pond include tilapia (Sarotherodon mossambica), carp (Cyprinus carpio), guppies (Poecilia reticulata), and mosquitofish (Gambusia affinis) (Ahuimanu Productions, 1977). During our survey, only tilapia were observed in the lower stream reach.

O'opu okuhe was not represented in the fish fauna above Station 4. Naniha and nakea were present. Okuhe and naniha are generally more common in lower stream reaches and are absent from the upper reaches. Nakea is generally more widely distributed throughout the length of a stream, and its relative abundance in Waialama Canal may be due to the coincidence of the survey period with the spawning season of this species, during which time it congregates in lower stream reaches to mate and spawn. This fact may be responsible for the absence of the species in any samples taken above Station 4.

Guppies and mosquitofish were common at Station 4. In fact, guppies were common at virtually every upstream sample site. The larvae (tadpoles)

and adults of the bullfrog (Rana catesbeiana) and the giant (marine) toad (Bufo marinus) were common to abundant in all stream reaches. The weatherfish or dojo (Misgurnus anguillicaudatus) was found occasionally in Alenaio Stream and the Waipahoehoe Branch. Crayfish (Procambarus clarkii) were also found in the Waipahoehoe Branch, but they did not appear to be common. The Tahitian prawn (Macrobrachium lar) had been observed by local residents in several of the deeper perennial pools; however, this species was not seen during our survey.

Environmental Impact With the Project

Non-structural Measures:

Floodproofing, Structure Relocation and Floodplain Management (Alternative 3)

This alternative should have little, if any adverse impact on fish and wildlife resources in the Alenaio study area. No permanent alterations would be made in the stream channel and stream flow would be unchanged. Impacts due to periodic channel maintenance should be minor and of short duration, provided that removal of riparian vegetation is minimized.

Beneficial impacts could result through implementation of floodplain management practices or other measures which effectively restrict future development in the Alenaio floodplain and upper watershed.

Structural Measures:

Diversion Channel (Alternative 2).

Impacts of diversion structure construction in Alenaio Stream above Komohana Street, and downstream culvert modification will include substantial sedimentation of aquatic habitat and diversion of flows around construction activities. Of these, the most significant will be disturbance of aquatic habitat and subsequent elimination of cover and spawning habitat due to sedimentation. The deleterious effects of suspended silt may extend to the Waialama Canal during construction. Related effects include thermal stress, stagnation and lowered dissolved oxygen concentrations. Diversion of flows from Alenaio Stream will result in greater salt water penetration into the Waialama Canal, unless there is sufficient flow of freshwater from local spring sources.

The synergistic effects of stream bed sedimentation and low (or no) flow are expected to gradually eliminate indigenous aquatic species from the stream, and favor exotic species adapted to warm, stagnant waters. Riparian vegetation may gradually invade the dry stream bed and ultimately compound flooding problems.

Some adverse impact may be expected to occur at the points of discharge. The Waikapu River which flows through the gulch is a short tributary of the Wailuku River which receives most of its water from runoff directed into it by several storm sewer culverts. The proposed input from Alenaio Stream should significantly increase the volume of discharge from the Waikapu River and may aggravate erosion both at the point of discharge and downstream. Impacts to native stream fauna, if any, should be minor, considering the short length and ephemeral nature of the river. Installation of a drop channel and stilling basin, if necessary, should provide adequate protection from erosion at the discharge site.

Except for the vicinity of the diversion site for Alternative Plan 1, little of the ohi'a-guava forest above Komohana Street would be involved. However, construction-related impacts in this area should be relatively minor and short-term.

Modifying the Existing Stream Channel (Alternative 1).

No changes in the structure of the stream channel, bed or riparian lands are anticipated above Kapiolani Street. Channel realignment between Kapiolani Street and Kilauea Avenue will result in disruption of the stream bed and channel, and riparian vegetation. Realignment and the construction of a 250-foot-long wall along the left bank of the stream immediately below Kilauea Avenue will result in sedimentation of downstream habitat over the course of construction activities. Sedimentation and destruction of aquatic habitat will be exaggerated during the reconstruction of road crossings at Kapiolani Street, Ululani Street, Kinoole Street and Kilauea Avenue. Construction activities are expected to temporarily prevent migration of indigenous fauna below Kapiolani Street. The effects of sedimentation are also expected to extend to the Waialama Canal and the Wailoa River, although no significant impacts to marine resources of Hilo Bay are anticipated. No long-term adverse effects to aquatic fauna in the upper reaches of the stream are anticipated.

Increased velocity of flood waters entering the head of the Waialama Canal after project completion is not expected to result in any significant, long-term adverse impacts on the aquatic fauna of the canal or of the Wailoa River. Freshet discharge will purge sediments from the stream bed after project construction.

<u>Discussion and Recommendations</u>

According to Parrish, <u>et al</u>, (1978), channelization in its various forms 1) increases turbidity, 2) destroys natural substrate habitat, 3) creates wide, shallow, unnatural flows, 4) causes excessive illumination, water temperatures, and pH levels, and 5) creates topographical difficulties for upstream migration of diadromous species. Channelization practices on Oahu appear to be damaging the quality of stream habitat for native

species and contributing to their replacement by hardy exotics. In general, altered streams have fewer native species than do unaltered streams, and these species represent a smaller proportion of the total stream fauna.

Although approximately one-third of the mainstem of Alenaio Stream (including Waialama Canal) has been channelized, native stream species are relatively abundant in its lower reaches. High water quality, due in part to basal springs which discharge directly to the stream and estuary, may be partially responsible for this apparent anomaly. The absence of native diadromous stream fauna above Kilauea Avenue is probably due to a combination of factors, including: partial channelization between Kilauea Avenue and Kinoole Street, partial dewaterment by a weir above Kinoole Street, and intermittent streamflow below Komohana Street.

The Waialama Canal and Wailoa River represent the best habitat for the native, diadromous aquatic animals in the lower Alenaio Stream system, and Waiakea Pond is a State-managed public fishery. Therefore these environments should be protected to the maximum extent practicable.

<u>Summary of Impacts and Recommended Mitigation</u>

Alternative 3 (Floodproofing, Relocating Structures, and Floodplain Management) represents the least environmentally damaging alternative, and would result in little or no effects upon fish and wildlife resources within the planning area. Alternative 2 (Diversion Channel) would be most disruptive to the aquatic and terrestrial environments. Long-term significant impacts associated with this alternative include blocking natural migrations of native, diadromous species, loss of lowland forest habitat, and excessive sedimentation of downstream habitat in Alenaio Stream. We recommend that this alternative be excluded from further consideration. Alternative 1 (Channel Modification) will have moderate temporary impacts during construction; however, no long-term significant impacts to fish and wildlife resources in the project area are anticipated provided that our recommended mitigation measures are included in Plans and Specifications for the project. The Fish and Wildlife Service is pleased to note that planning considerations recommended in our PAL were incorporated into the analysis which led to the identification of the three alternatives currently under consideration.

The Service recommends that the following measures be included in the project design (Alternative 1) in order to mitigate adverse impacts on fish and wildlife resources.

1) Natural streambed be maintained in all reaches of the stream affected by realignment and channelization.

2) Streamside vegetation be maintained or replanted, as necessary, to provide shading for the stream.

3) Realigned and channelized sections incorporate a low-flow channel to concentrate flows and take advantage of natural shading.

4) Bridge culverts should be minimal in length and installed in such a way that the downstream terminus will not be above stream level.

5) The channel between Kilauea Avenue and Kinoole Street be restored to a natural (unlined) streambed or incorporate a low-flow channel to concentrate flows.

6) If practicable, the weir above Kinoole Street be modified to permit a greater volume of low to moderate instream flows to discharge into Waialama Canal.

7) Construction methods should minimize stream bed and bank disturbance and prevent excessive sedimentation of downstream habitat.

We appreciate this opportunity to comment.

Sincerely yours,

Ernest Kosaka

ACTING Pacific Islands Administrator

Enclosure

Literature Cited

Ahuimanu Productions. 1977. An Ornithological Survey of Hawaiian Wetlands, Volume 2. Prepared for U.S. Army Engineer District Honolulu.

Lockwood, J.P. and Buchanan-Banks, J.M. 1980. Preliminary Geologic Report on the Alenaio Stream Flood Damage Reduction Study Area, Hilo, Hawaii. U.S. Geological Survey. Prepared for U.S. Army Engineer District Honolulu.

Parrish, J.D., J.A. Maciolek, A.S. Timbol, C.B. Hathaway, and S.E. Norton. 1978. Stream Channel Modification in Hawaii, Part D: Summary Report. U.S. Fish and Wildlife Service Contract No. 14-16-0008-1199.

Pyle, R.L. 1977. Preliminary List of the Birds of Hawaii. 'Elepaio 37(10) p. 110-121.

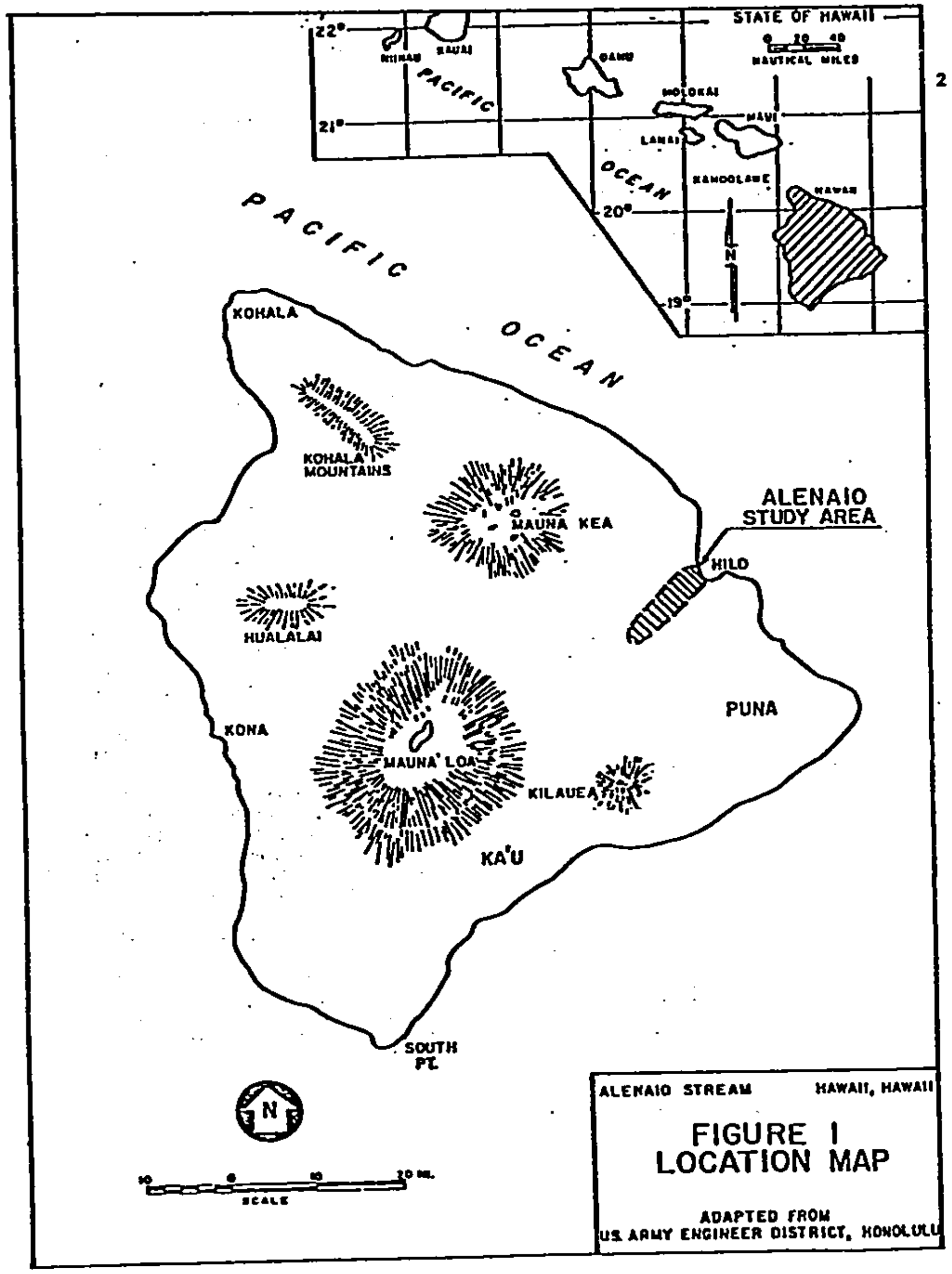
Timbol, A.S. and J.A. Maciolek. 1978. Stream Channel Modification in Hawaii, Part A: Statewide Inventory of Streams; Habitat Factors and Associated Biota. U.S. Fish and Wildlife Service Contract No. 14-16-0008-1199.

U.S. Army Engineer District Honolulu. 1980. Reconnaissance Report for Flood Damage Reduction, Alenaio Stream, Hawaii.

U.S. Fish and Wildlife Service. 1979. Hilo Area Comprehensive Study. Prepared for U.S. Army Engineer District Honolulu.

U.S. Geological Survey. 1968. Preliminary Report on the Water Resources of the Hilo-Puna Area, Hawaii. Prepared in Cooperation with Division of Water and Land Development, Department of Land and Natural Resources, State of Hawaii.

Enclosure



ALENAIO STREAM HAWAII, HAWAII

FIGURE I
LOCATION MAP

ADAPTED FROM
US ARMY ENGINEER DISTRICT, HONOLULU

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

June 18, 1982

LTC Kenneth E. Sprague
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858

Re: Final Coordination Act Report,
Alenaio Stream Flood Damage
Reduction, Hilo, Hawaii

Dear Colonel Sprague:

This is the Final Coordination Act Report of the U.S. Fish and Wildlife Service for the Alenaio Stream Flood Damage Reduction Study, Hilo, Hawaii. The Honolulu District of the U.S. Army Corps of Engineers is undertaking this study to determine the feasibility of various alternatives for flood damage reduction in the Alenaio study area.

This report has been prepared under the authority of and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and other authorities mandating Department of the Interior concern for environmental values. It is also consistent with the intent of the National Environmental Policy Act.

The analysis and recommendations herein are based on recent project information provided by Mr. Robert Moncrief (Ecologist), U.S. Army Corps of Engineers, Honolulu District. Biological information was obtained from a field investigation conducted by Fish and Wildlife Service biologist Gerald Roehm and from a review of pertinent scientific literature. This report was prepared by John I. Ford and supersedes our Preliminary Coordination Act Report of December 28, 1981.

Description of the Planning Area

The Alenaio study area is located on the northeast flank of Mauna Loa volcano, within the town of Hilo on the Island of Hawaii (Figure 1). Hawaii is the largest of the Hawaiian Islands in land area (4,038 square miles) which is almost twice the combined area of the other islands. Like the rest of the Hawaiian Archipelago, Hawaii is volcanic in origin, formed by the coalescence of five distinct volcanic massifs--Kohala, Hualalai, Mauna Kea, Mauna Loa, and Kilauea. Of these, only Hualalai, Mauna Loa, and Kilauea have erupted historically--Kilauea as recently as November 1979.

The town of Hilo is located between the two largest mountains, Mauna Kea (elevation 13,796 feet) and Mauna Loa (elevation 13,677 feet), making Hilo a natural focal point for lava flows originating along Mauna Loa's active Northeast Rift Zone (Figure 2). Lava flows from the Northeast Rift (NER) affect not only surface drainage patterns, but subsurface flows as well. Lava tube-fed pahoehoe flows in the Hilo area are characterized by horizontal layering, numerous fractures and sub-horizontal voids, which act as subterranean conduits for storm runoff. Subsurface runoff is not confined to a topographically-defined drainage basin, but may be imported from rain forest catchment areas through a plexus of small lava tubes in pahoehoe flows originating along the NER. The U.S. Geological Survey (1980) estimates that the effective drainage area of Alenaio Stream may be 5-10 times larger than its topographically-defined watershed.

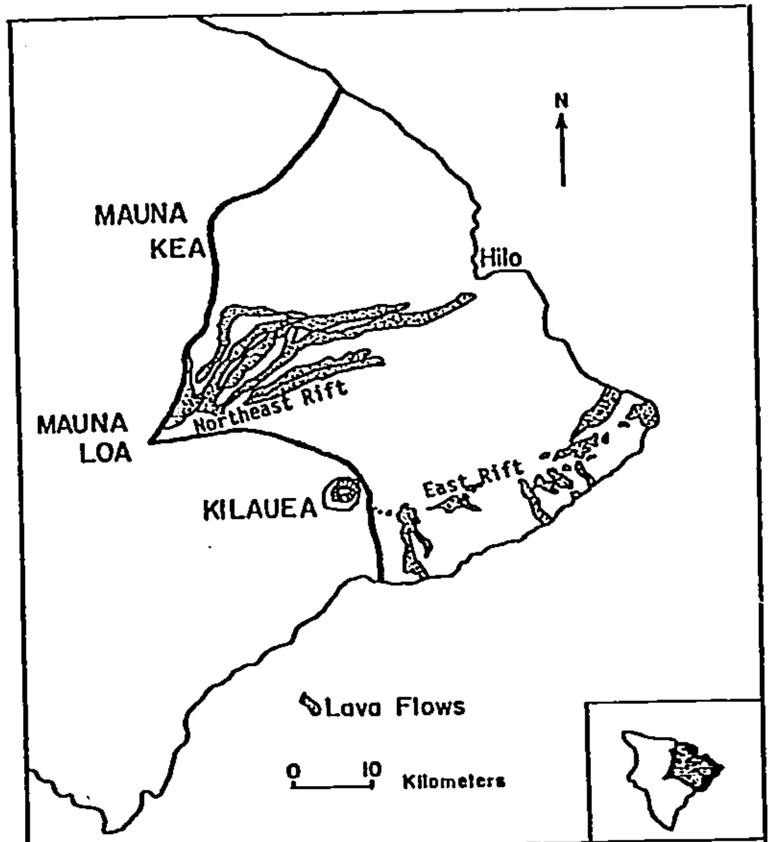
Alenaio Stream is part of a larger drainage system which discharges via the Wailoa River into Hilo Bay (Figure 3). The Wailoa River receives water from Alenaio Stream and Waiakea Pond, which in turn is fed by Waiakea Stream via the Wailoa Flood Channel and by basal springs. The Wailoa River also receives freshwater directly from basal springs. Because Alenaio and Waiakea Streams are ephemeral in nature, these springs account for most of the dry-weather discharge of the Wailoa River, which is the greatest of any stream in the State of Hawaii. Average river flow exceeds 100 million gallons per day (mgd) (USGS 1968).

The lower reach of the Waiakea-Wailoa complex is estuarine and subject to tidal fluctuation. The large influx of freshwater from basal springs depresses the salinity and temperature within the estuary. At the inlet to Waiakea Pond, salinity may vary from several parts per thousand on the incoming tide to less than one part per thousand on the outgoing tide (USGS 1968). The estuary is entirely surrounded by commercial, light industrial, and park land uses. The Hilo Bayfront Park, which occupies most of the adjacent lands, was set aside following the destructive tsunami of 1960 to provide a protective buffer zone for the central business district of Hilo. The park is totally within the tsunami inundation zone.

Waialama Canal extends 3,000 feet west from the Wailoa River to the Kilauea Avenue bridge culvert, which marks the downstream terminus of Alenaio Stream and the upper limit of tidal action. This reach is entirely within the Bayfront Park and has been channelized for approximately 2,000 feet--a remnant of the bayfront business district which was devastated by the 1960 tsunami.

The Alenaio "watershed" originates above 2500 feet elevation, where the stream consists of two branches--the Waipahoehoe Branch and the Kaluiiki Branch. These tributary streams flow in roughly parallel channels and merge at approximately 750 feet elevation.

The course of Alenaio Stream is presently defined by three different pahoehoe flows from the NER--the flow of 1881, the Kulaloa flow (1,100-1,400 years old), and the Punahoa flow (3,000-4,000 years old). The Waipahoehoe Branch is bounded on the north by the Punahoa flow. Below its confluence with the Kaluiiki Branch, the stream is defined by the flow of 1881 to the south, while the Kulaloa flow defines its southern margin in the reach below 250 feet elevation (USGS 1980).



ALENAIO STREAM HILO, HAWAII

FIGURE 2
HISTORIC LAVA FLOWS

US FISH & WILDLIFE HONOLULU

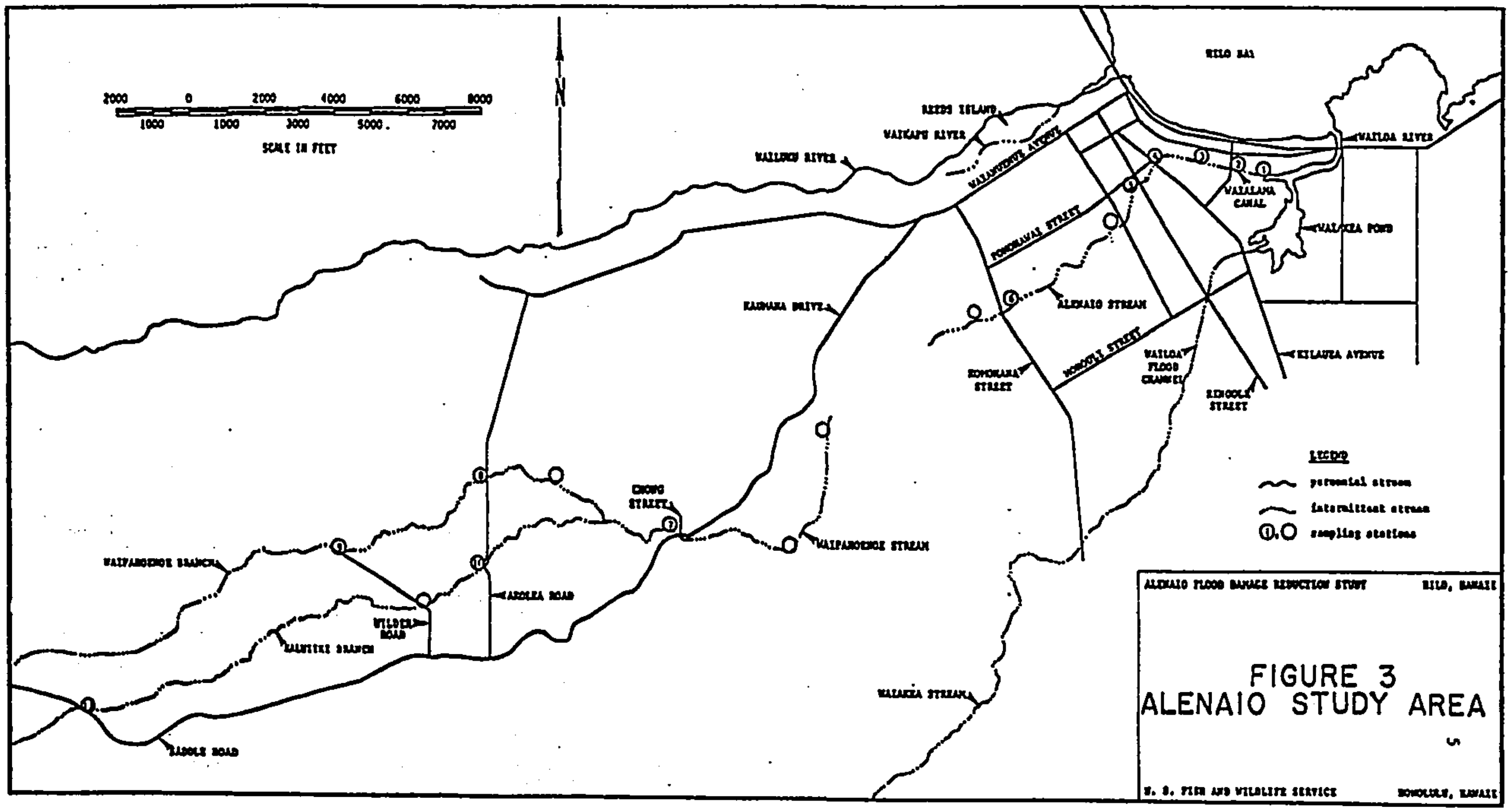


FIGURE 3
ALENAIO STUDY AREA

The streambed consists mainly of pahoehoe lavas which are relatively resistant to erosion. These younger lavas are interspersed with sand and gravel-filled potholes eroded in older, underlying, weathered clays. Transitions between strata are generally marked by "stairstep" cascades or near-vertical drops in the streambed.

Between Chong Street and Komohana Street, the stream passes through a heavily forested area with a relatively flat gradient. The stream channel is poorly defined in this area, and a large volume of water is lost from the mainstem of Alenaio Stream, probably due to seepage into the underlying Punahoa lava flow (USGS 1980). The Fish and Wildlife Service estimates that as much as 80-90 percent of the stream flows observed at Chong Street were "lost" to percolation.

Below Komohana Street stream flows are confined within a well defined channel which reaches depths of 20-30 feet below adjacent ground contours. Above Kinoole Street a concrete weir diverts a portion of stream flows into a culvert which empties directly into Hilo Bay. The remainder follows a concrete-lined invert from Kinoole Street to Kilauea Avenue where it enters Waialama Canal.

A significant portion of low to moderate stream flows percolates into small lava tubes, fractures, and voids between strata. However, during periods of heavy rainfall these subterranean conduits may be filled to capacity and surface runoff can occur. Historically, flooding in the Alenaio watershed has resulted from overbank flows during peak surface flows, as well as from springs which unexpectedly develop in areas of pahoehoe outcrop, especially near the distal ends of lava flows, and from the transient elevation of the basal freshwater lens. Deliberate attempts have been made to control mauka flooding due to surface runoff by diverting surface flows into natural lava tubes; however, this practice may only aggravate flooding problems downslope (USGS 1980).

There was no measurable rainfall in Hilo during the course of our survey. However, heavy rains had swollen local streams several days earlier and flood warnings had been issued for the Hilo area. Though subsiding, moderate stream flows continued throughout the survey period. At Chong Street, flows subsided from approximately 100 cubic feet per second (cfs) to 50 cfs over a three-day span.

As previously stated, an estimated 80-90 percent of instream flows were lost between Chong Street and Komohana Street. There was no evidence of water loss from Komohana Street to the weir above Kinoole Street. During our survey, approximately half of the instream flows were diverted at this point with the remainder passing through a "window" in the weir and then down a concrete-lined channel to Waialama Canal.

In the lower portion of Waialama Canal, flows were influenced more by tide and surge than by stream flows. This was evident by frequent, periodic reversals of flow at Station 2 and perceptible changes in stream velocity at Station 3. Though under tidal influence, the upper portion of the canal (Station 4) was not subject to such transient changes in water level. These shorter period perturbations were undoubtedly damped out by the dense vegetative growth in

the canal above Station 2. The upper portion of the canal, therefore, is dependent on stream flow for maintenance of a viable aquatic environment.

Detailed Plan Description

The U.S. Army Engineer District, Honolulu has identified a selected plan to alleviate flood damages in the Alenaio study area which involves modifying the existing stream channel. This plan was one of three principal alternative plans considered in detail during the planning process.

SELECTED PLAN

In developing this plan the Corps has divided the study area into four reaches:

Reach	Area
4	Chong's Bridge to Komohana Street
3	Komohana Street to Kapiolani Street
2	Kapiolani Street to Kilauea Avenue
1	Kilauea Avenue to Hilo Bay.

Reach 4. The area between Chong's Bridge and Komohana Street is undeveloped but subject to future development by private owners. This plan incorporates a floodplain management plan in order to minimize future flooding problems. A minimum 200-foot flood control easement is proposed along the stream alignment. Periodic maintenance will be needed along the stream to minimize degradation of the stream channel from debris.

Reach 3. The stream between Komohana Street and Kapiolani Street is approximately 4,400 feet long with 4 structures in the 100-year floodplain and 9 structures in the SPF floodplain. Floodproofing is the proposed measure for this reach due to the scattered distribution of structures.

Reach 2. Alenaio Stream between Kapiolani Street and Kilauea Avenue is approximately 1,900 feet long with approximately 123 structures in the SPF floodplain. The stream is at its narrowest in this reach. This alternative provides for the realignment of this portion in order to provide the minimum recommended curvature which will maintain steady flow conditions during flood discharge. The channel will be modified as follows:

Channel Modifications (Rectangular Concrete)

Channel Dimensions	100-Year	SPF
Width	25'	40' for 415' 35' for 1225'
Design flood depth	8' to 12'	8' to 9.5'
Length	1,640	1,640

The maximum velocity was computed to be 42 fps for the SPF flood and 38 fps for the 100-year frequency flood. The bridges at Kapiolani Street, Ululani Street, Kinoole Street and Kilauea Avenue will also be replaced. Seven (7) structures will be relocated, and the old channel will be filled and landscaped.

On the downstream side of Kilauea Avenue Bridge a 250-foot-long, concrete wall and energy dissipaters will be provided to prevent channel erosion as the floodflows negotiate the curved section in the Waiolama Canal. The velocity at this point is estimated at 40 fps.

Reach 1. This reach consists of the stream below Kilauea Avenue and south of Ponohawai Street until it enters Hilo Bay. Within this reach are only three (3) structures subject to flooding. The most critical activity affected by flooding is traffic on the Bayfront Highway and Kamehameha Avenue. The SPF and 1% frequency event floods will overtop the Bayfront Highway by 3.5 feet and 2.5 feet, respectively. The selected plan for this reach is flood-proofing of individual structures. No structural actions are proposed.

Environmental Setting Without the Project

Survey Methodology:

The U.S. Fish and Wildlife Service conducted a field survey of the Alenaio study area on September 22-26, 1980. The purpose of the survey was to inventory fish and wildlife resources and dominant terrestrial and aquatic flora in the study area, identify significant biological resources, and generally characterize Alenaio Stream and the estuarine environment.

Water quality data were measured at eleven stations on Alenaio Stream and its tributaries (Figure 3). These data included water temperature, salinity, specific conductance, pH, dissolved oxygen, and stream flow. Temperature data were recorded in the field using a mercury thermometer. Flow data were determined by timing a small float over a measured distance and multiplying by the cross-sectional area of the stream. Dissolved oxygen samples were chemically fixed in the field, transferred to plastic specimen jars and returned to the laboratory for analysis. In the laboratory 5.8-milliliter aliquots of each sample were analyzed using the Winkler-Azide titration method as described in the HACH Methods Manual. A single sample was taken at each sample depth for salinity, conductivity, and pH. A YSI Model 33 S-C-T meter was used to measure the first two parameters, and an AMI Model 107 pH meter was used to measure the latter. In the field, salinity values were determined using an AO refractometer. Water quality data is tabulated in Table 1.

Flora and fauna were observed and/or collected at each of the eleven water quality stations. Additional observations were made at other points along Alenaio Stream to better characterize the biological resources of the study area.

TABLE 1
WATER QUALITY DATA FOR ALENAIO STREAM
SOUTH HILO DISTRICT, HAWAII

STREAM	STATION	ELEVATION	FLOW REGIME*	SAMPLE DEPTH	T°C	S°/oo	C(umhos)	D.O.	pH
	1	0	tidal	0' 2'	22.7 21.7	0.5 3.2	1170 5500	6.5 6.5	7.6 7.2
Waialama Canal	2	0	tidal	0' 2'	22.2 22.2	0.5 0.3	1220 1040	7.0 6.5	7.8 7.6
	3	0	tidal	1'	25.0	0	64	6.0	8.2
	4	0	1	0' 2'	25.6 25.6	0 0	50 50	7.5 6.5	7.6 7.7
Alenaio Stream	5	26'	2	0'	25.0	0	52	7.5	8.0
	6	200'	2	0'	23.3	0	52	7.0	7.8
	7	710'	3	1'	22.2	0	48	7.5	7.6
Waipahoehoe Stream	8	950'	3	1'	20.0	0	50	-	7.5
	9	1200'	2	-	-	-	-	-	-
	10	1030'	2	0'	22.2	0	45	-	8.0
Kaluiiki Branch	11	1620'	0	-	-	-	-	-	-

*0 = 0 cfs
1 = greater than 0 cfs, less than 1 cfs
2 = greater than 1 cfs, less than 10 cfs
3 = greater than 10 cfs, less than 100 cfs

Survey Results:

A partial flora list for the Alenaio study area is included in Table 2. A list of avifauna observed or reported from the study area has been included in Table 3. Table 4 provides a listing of aquatic species observed or reported from the study area.

Flora

1) Because Waiakea Canal is entirely within Hilo Bayfront Park, terrestrial vegetation is predominantly exotic ornamental species such as coconut palms (Cocos nucifera), Livistona palms (Livistona rotundifolia), Alexandra palms (Archontophoenix alexandrae), African tulip trees (Spathodea campanulata), candlenut (kukui) trees (Aleurites moluccana), monkeypod (Samanea saman), bamboo (Bambusa vulgaris), and banyan (Ficus spp.). Exotic weeds are also common, including Spanish clover (Desmodium uncinatum), sleeping grass (Mimosa pudica), and beggars tick (Bidens pilosa).

   Although the entire length of the canal is subject to tidal influence, during the period of our survey the upper limit of the estuary was defined at Station 2. This also appears to be the lower limit of aquatic vegetation. Below Station 2 the bottom is relatively devoid of vegetation and consists mainly of soft, silty sand and large lava cobbles. Above Station 2 the channel is clogged with both emergent and submergent forms of vegetation.

   Hydrophytes such as waterweed (Egeria densa), parrotfeather (Myriophyllum brasiliense), and waterlily (Nymphaea sp.) are abundant in this reach. Emergent grasses such as seashore paspalum (Paspalum vaginatum), California grass (Brachiaria mutica), and quackgrass (Panicum repens) are common. Riparian vegetation consisting of California grass, honohono (Commelina diffusa), primrose willow (Ludwigia octivalvis), sourbrush (Pluchea odorata), Spanish clover, sleeping grass, and beggars tick grows within, and adjacent to, the lined channel.

2) From Kilauea Avenue to Komohana Street vegetation consists primarily of guava (Psidium guajava), ginger (Hedychium spp.), banana (Musa x paradisiaca), umbrella tree (Brassaia actinophylla), swamp mahogany (Eucalyptus robusta), ti (Cordyline terminalis), mango (Mangifera indica), papaya (Carica papaya), various palms, kukui, African tulip tree, and other ornamentals. Aquatic vegetation is limited to emergent grasses, such as California grass.

3) The forested area between Komohana and Chong Streets can be characterized as a mixed guava-'ohi'a (Metrosideros collina subsp. polymorpha) forest. In addition, hala (Pandanus odoratissimus), swordfern (Nephrolepis exaltata), strawberry guava (Psidium cattleianum), banana, ginger, kukui, coconut palms, and African tulip trees are common in more heavily forested areas. In clearings, grasses and low-growing shrubs prevail, including California grass, quackgrass, sugarcane

TABLE 2
PARTIAL FLORA FROM THE
ALENAIO STUDY AREA
SOUTH HILO DISTRICT, HAWAII

FILICINAE	
GLEICHENIACEAE	
Dicranopteris linearis (Burm.) Underw.	false staghorn fern
DICKSONIACEAE	
Cibotium spp.	tree fern, hapu'u
POLYPODIACEAE	
Nephrolepis exaltata (L.) Schott	swordfern
Sadleria cyatheoides Kaulf.	tree fern, ama'uma'u
SALVINIACEAE	
Azolla filiculoides Lam.	waterfern
ANGIOSPERMAE	
MONOCOTYLEDONAE	
PANDANACEAE	
Pandanus odoratissimus L.f.	pandanus, hala
ELODEACEAE	
Egeria densa Planch.	waterweed
RUPPIACEAE	
Ruppia maritima L.	widgeon grass
GRAMINEAE	
Bambusa vulgaris Wendl.	feathery bamboo
Brachiaria mutica (Forsk.) Stapf	California grass
Panicum repens L.	quackgrass
Paspalum vaginatum Sw.	seashore paspalum
Saccharum officinarum L.	sugarcane
CYPERACEAE	
Cyperus spp.	sedges
Scirpus validus Vahl	great bulrush
PALMAE	
Archontophoenix alexandrae (F. Muell) Wendl. & Drude	Alexandra palm
Cocos nucifera L.	coconut palm
Livistona rotundifolia (Lam.) Mart.	Livistona palm

ARACEAE	
Philodendron spp.	philodendron
COMMELINACEAE	
Commelina diffusa Burm. f.	honohono
LILIACEAE	
Cordyline terminalis (L.) Kunth	ti
MUSACEAE	
Musa xparadisiaca L.	banana
ZINGIBERACEAE	
Alpinia purpurata (Vieill.) K. Schum.	red ginger
Hedychium coronarium Koenig	white ginger
H. flavescens Carey	yellow ginger
ORCHIDACEAE	
Arundina bambusaefolia (Roxb.) Lindl.	bamboo orchid
Spathoglottis plicata Bl.	wind orchid
DICOTYLEDONAE	
MORACEAE	
Ficus spp.	banyan
NYMPHAEACEAE	
Nymphaea sp.	waterlily
LEGUMINOSAE	
Acacia koa Gray	koa
Desmodium uncinatum (Jacq.) DC.	Spanish clover
Mimosa pudica L.	sleeping grass
Samanea saman (Jacq.) Merr.	monkeypod
EUPHORBIACEAE	
Aleurites moluccana (L.) Willd.	kukui
ANACARDIACEAE	
Mangifera indica L.	mango
CARICACEAE	
Carica papaya L.	papaya
MYRTACEAE	
Eucalyptus robusta Sm.	swamp mahogany
Metrosideros collina subsp. *polymorpha* (Gaud.) Rock	'ohi'a lehua
Psidium cattleianum Sabine	strawberry guava
P. guajava L.	guava

MELASTOMATACEAE	
Melastoma malabathricum L.	melastome
ONAGRACEAE	
Ludwigia octivalvis (Jacq.) Raven	primose willow
HALORAGACEAE	
Myriophyllum brasiliense Cambess.	parrotfeather
UMBELLIFERAE	
Hydrocotyle verticillata Thunb.	whorled marsh pennywort
ARALIACEAE	
Brassaia actinophylla Endl.	umbrella tree
CONVOLVULACEAE	
Ipomoea spp.	morning glory
VERBENACEAE	
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, oi
BIGNONIACEAE	
Spathodea campanulata Beauv.	African tulip tree
GOODENIACEAE	
Scaevola taccada (Gaertn.) Roxb.	beach naupaka
COMPOSITAE	
Pluchea odorata (L.) Cass.	pluchea
Bidens pilosa L.	beggars tick

TABLE 3
PARTIAL AVIFAUNA FROM THE
ALENAIO STUDY AREA
SOUTH HILO DISTRICT, HAWAII

FAMILY Genus/species	Common Name	Status*
ARDEIDAE		
Bubulcus ibis	cattle egret	Fr
Nycticorax nycticorax hoactli	black-crowned night heron	Ri
ANATIDAE		
Anas acuta	pintail	Vr
A. americana	American widgeon	Vr
A. clypeata	northern shoveler	Vr
A. platyrhynchos	mallard	Vr
Anser albifrons	white-fronted goose	Vs
Aythya affinis	lesser scaup	Vr
A. valisineria	canvasback	Vs
Branta canadensis	Canada goose	Vo
Bucephala albeola	bufflehead	Vo
ACCIPITRIDAE		
Buteo solitarius (E)	Hawaiian hawk, 'io	Re
RALLIDAE		
Fulica americana alai (E)	Hawaiian coot 'alae ke'oke'o	Ris
CHARADRIIDAE		
Pluvialis dominica fulva	golden plover	Vr (B)
SCOLOPACIDAE		
Heteroscelus incanus	wandering tattler	Vr
Numenius tahitiensis	bristle-thighed curlew	Vr
LARIDAE		
Larus glaucescens	glaucous-winged gull	Vo
COLUMBIDAE		
Geopelia striata striata	barred dove	Fl
Streptopelia chinensis chinensis	lace-necked dove	Fl
ZOSTEROPIDAE		
Zosterops japonica	white-eye, mejiro	Fl
STURNIDAE		
Acridotheres tristis	common myna	Fl

PLOCEIDAE		
Lonchura punctulata	spotted munia, ricebird	Fl
Passer domesticus	house sparrow	Fl
FRINGILLIDAE		
Carpodacus mexicanus frontalis	house finch	Fl
Paroaria coronata	red-crested cardinal	Fl

(E) = Endangered Species

*Pyle, 1977.

TABLE 4
DOMINANT AQUATIC MACROFAUNA OF
ALENAIO STREAM AND ESTUARY
SOUTH HILO DISTRICT, HAWAII

PHYLUM / CLASS / Genus/species	Common Name	Status
ANNELIDA		
POLYCHAETA		
Namalycastis abiuma	bristle worm	indigenous
ARTHROPODA		
INSECTA		
Anax strenuus	dragonfly (adult)	endemic
Pantala flavescens	dragonfly (larva)	indigenous
CRUSTACEA		
Grapsus grapsus tenuicrustatus	a'ama/crab	endemic
Macrobrachium lar	Tahitian prawn	introduced
M. grandimanus	opae oeha'a	endemic
Procambarus clarkii	crayfish	introduced
VERTEBRATA		
PISCES		
Acanthurus nigroris	maiko	indigenous
A. triostegus sandvicensis	convict tang/manini	endemic
Awaous genivittatus	o'opu naniha	indigenous
A. stamineus	o'opu nakea	endemic
Caranx ignobilis	papio	indigenous
Chanos chanos	milkfish, awa	indigenous
Cyprinus carpio	carp, koi	introduced
Eleotris sandwicensis	o'opu okuhe	endemic
Gambusia affinis	mosquitofish	introduced
Kuhlia sandvicensis	aholehole	endemic
Misgurnus anguillicaudatus	weatherfish/dojo	introduced
Mugil cephalus	mullet/ama'ama	indigenous
Poecilia reticulata	guppy	introduced
Sarotherodon (Tilapia) mossambica	tilapia	introduced
AMPHIBIA		
Rana catesbeiana	bullfrog	introduced

(Saccharum officinarum), sourbush, sleeping grass, and morning glory (Ipomoea sp.).

4) The reach above Chong Street includes both forest reserve lands and agricultural lands devoted to the cultivation of sugarcane. Native 'ohi'a-koa (Acacia koa) forest predominates above 1,600 feet elevation. Other common plants include guava, strawberry guava, ginger, sourbush, primrose willow, tree ferns (Cibotium spp. and Sadleria cyatheoides), false staghorn fern (Dicranopteris linearis), wild orchids (Arundina bambusaefolia and Spathoglottis plicata), and a variety of grasses and sedges.

On agricultural lands and uncultivated peripheral lands, sugarcane, guava, strawberry guava, ohi'a, and ginger are common. Banana, swamp mahogany, sourbush, wild orchids, sleeping grass, California grass, quackgrass, Jamaica vervain (Stachytarpheta jamaicensis), and melastome (Melastoma malabathricum) are also found on uncultivated lands adjacent to stream channels.

Terrestrial Fauna

The Waiakea Pond wetland provides habitat for a variety of resident and migratory bird species. Native resident species such as the black-crowned night heron (Nycticorax nycticorax hoactli) and the endangered Hawaiian coot (Fulica americana alai) are known to frequent the area. The coot also nests in Mohouli Pond, which is adjacent and connected to Waiakea Pond (Ahuimanu Productions 1977).

Regular visitors to the pond include the mallard (Anas platyrhynchos), pintail (A. acuta), shoveler (A. clypeata), Americana widgeon (A. americana), and lesser scaup (Aythya affinis). Occasional or infrequent visitors include the canvasback (Aythya valisineria), white-fronted goose (Anser albifrons), Canada goose (Branta canadensis), bufflehead (Bucephala albeola), and glaucous-winged gull (Larus glaucescens) (Ahuimanu Productions 1977).

Though closely related to the Canada goose, the endangered Hawaiian goose or nene (Branta sandvicensis) is an upland bird whose range is restricted to higher elevations on Mauna Loa, Mauna Kea, and Haleakala (Maui), and is not likely to be found in the study area. The known range of the Hawaiian hawk or 'io (Buteo solitarius) overlaps the study area; however, it is not known what importance, if any, the study area has for this endangered species (USFWS 1979).

Two species of migratory shorebirds were observed in Hilo Bayfront Park during our survey—the golden plover (Pluvialis dominica fulva) and the wandering tattler (Heteroscelus incanus).

So-called "urban" birds are widely distributed throughout the main islands and were frequently sighted during the September 1980 survey. These exotic species include the barred dove (Geopelia striata striata), lace-necked dove (Streptopelia chinensis chinensis), common myna (Acridotheres tristis), Japanese white-eye (Zosterops japonica), ricebird (Lonchura punctulata), house sparrow (Passer domesticus), house finch (Carpodacus mexicanus frontalis), and red-crested cardinal (Paroaria coronata).

Mammals in the Alenaio study area are non-game species typically found in urban environments throughout Hawaii. These include the house mouse (Mus musculus), roof rat (Rattus rattus), Norway rat (Rattus norvegicus), Polynesian rat (Rattus exulans), and Indian mongoose (Herpestes auropunctatus), as well as domestic animals and livestock.

The only land mammal endemic to Hawaii is the Hawaiian hoary bat (Lasiurus cinereus semotus), an endangered species. Although this species has been observed in the Hilo area in the past, little is known of its life history or specific habitat requirements. However, it is unlikely the study area provides more than peripheral habitat for this species.

Aquatic Fauna:

Sixty-one percent of the aquatic species observed or reported in Alenaio Stream and Waiakea Pond are considered native (endemic or indigenous) to Hawaii (Table 4). These include euryhaline marine species, such as maiko (Acanthurus nigroris), manini (A. triostegus sandvicensis), papio (Caranx ignobilis), milkfish (Chanos chanos), and mullet (Mugil cephalus).

Aholehole (Kuhlia sandvicensis) were the most abundant native fish in Alenaio Stream and were most abundant of any species found in the lower stream reach. Mullet were also common in this reach. Native diadromous species found in this reach include the gobioid fishes o'opu okuhe (Eleotris sandvicensis), o'opu naniha (Awaous genivittatus), and o'opu nakea (Awaous stamineus), as well as the decapod crustacean opae oeha'a (Macrobrachium grandimanus).

Other native invertebrates found here included the Hawaiian crab (Grapsus grapsus tenuicrustatus), dragonfly larvae and adults (Pantala flavescens and Anax strenuus), and a polychaete bristleworm (Namalycastis abiuma).

Exotic macrofauna which have been reported from Waiakea Pond include tilapia (Sarotherodon mossambica), carp (Cyprinus carpio), guppies (Poecilia reticulata), and mosquitofish (Gambusia affinis) (Ahuimanu Productions 1977). During our survey, only tilapia were observed in the lower stream reach.

O'opu okuhe was not represented in the fish fauna above Station 4. Nanihа and nakea were present. Okuhe and nanihа are generally more common in lower stream reaches and are absent from the upper reaches. Nakea is generally more widely distributed throughout the length of a stream, and its relative abundance in Waialama Canal may be due to the coincidence of the survey period with the spawning season of this species, during which time it congregates in lower stream reaches to mate and spawn. This fact may be responsible for the absence of the species in any samples taken above Station 4.

Guppies and mosquitofish were common at Station 4. In fact, guppies were common at virtually every upstream sample site. The larvae (tadpoles) and adults of the bullfrog (Rana catesbeiana) and the giant (marine) toad (Bufo

marinus) were common to abundant in all stream reaches. The weatherfish or dojo (Misgurnus anguillicaudatus) was found occasionally in Alenaio Stream and the Waipahoehoe Branch. Crayfish (Procambarus clarkii) were also found in the Waipahoehoe Branch, but they did not appear to be common. The Tahitian prawn (Macrobrachium lar) had been observed by local residents in several of the deeper perennial pools; however, this species was not seen during our survey.

Environmental Impact With the Project

Modifying the Existing Stream Channel (Selected Plan).

No changes in the structure of the stream channel, bed or riparian lands are anticipated above Kapiolani Street. Channel realigment between Kapiolani Street and Kilauea Avenue will result in disruption of the stream bed and channel, and riparian vegetation. Realignment and the construction of a 250-foot-long wall along the left bank of the stream immediately below Kilauea Avenue will result in sedimentation of downstream habitat over the course of construction activities. Sedimentation and destruction of aquatic habitat will be exaggerated during the reconstruction of road crossings at Kapiolani Street, Ululani Street, Kinoole Street and Kilauea Avenue. Construction activities are expected to temporarily prevent migration of indigenous fauna below Kapiolani Street. The effects of sedimentation are also expected to extend to the Waialama Canal and the Wailoa River, although no significant impacts to marine resources of Hilo Bay are anticipated. No long-term adverse effects to aquatic fauna in the upper reaches of the stream are anticipated.

Increased velocity of flood waters entering the head of the Waialama Canal after project completion is not expected to result in any significant, long-term adverse impacts on the aquatic fauna of the canal or of the Wailoa River. Freshet discharge will purge sediments from the stream bed after project construction.

Discussion and Recommendations

According to Parrish, et al (1978), channelization in its various forms: 1) increases turbidity, 2) destroys natural substrate habitat, 3) creates wide, shallow, unnatural flows, 4) causes excessive illumination, water temperatures, and pH levels, and 5) creates topographical difficulties for upstream migration of diadromous species. Channelization practices on Oahu appear to be damaging the quality of stream habitat for native species and contributing to their replacement by hardy exotics. In general, altered streams have fewer native species than do unaltered streams, and these species represent a smaller proportion of the total stream fauna.

Although approximately one-third of the main stem of Alenaio Stream (including Waialama Canal) has been channelized, native stream species are relatively abundant in its lower reaches. High water quality, due in part to basal springs which discharge directly to the stream and estuary, may be partially responsible for this apparent anomaly. The absence of native diadromous stream fauna above Kilauea Avenue is probably due to a combination of factors, including: partial channelization between Kilauea Avenue and Kinoole Street, partial dewaterment by a weir above Kinoole Street, and intermittent streamflow below Komohana Street.

The Waialama Canal and Wailoa River represent the best habitat for the native, diadromous aquatic animals in the lower Alenaio Stream system, and Waiakea Pond is a State-managed public fishery. Therefore, these environments should be protected to the maximum extent practicable.

Summary of Impacts and Recommended Mitigation

Alternative 1 (Channel Modification) will have moderate temporary impacts during construction; however, no long-term, significant impacts to fish and wildlife resources in the project area are anticipated provided that our recommended mitigation measures are included in Plans and Specifications for the project.

The Service recommends that the following measures be included in the project design (Alternative 1) in order to mitigate adverse impacts on fish and wildlife resources.

1) Natural streambed be maintained in all reaches of the stream affected by realignment and channelization.

2) Streamside vegetation be maintained or replanted, as necessary, to provide shading for the stream.

3) Realigned and channelized sections incorporate a low-flow channel to concentrate flows and take advantage of natural shading.

4) Bridge culverts should be minimal in length and installed in such a way that the downstream terminus will not be above stream level.

5) The channel between Kilauea Avenue and Kinoole Street be restored to a natural (unlined) streambed or incorporate a low-flow channel to concentrate flows.

6) If practicable, the weir above Kinoole Street be modified to permit a greater volume of low to moderate instream flows to discharge into Waialama Canal.

7) Construction methods should minimize stream bed and bank disturbance and prevent excessive sedimentation of downstream habitat.

We appreciate this opportunity to comment.

Sincerely yours,

Pacific Islands Administrator

Enclosure:
Literature Cited

Literature Cited

Ahuimanu Productions. 1977. An Ornithological Survey of Hawaiian Wetlands, Volume 2. Prepared for U.S. Army Engineer District Honolulu.

Lockwood, J.P. and J.M. Buchanan-Banks. 1980. Preliminary Geologic Report on the Alenaio Stream Flood Damage Reduction Study Area, Hilo, Hawaii. U.S. Geological Survey. Prepared for U.S. Army Engineer District, Honolulu.

Parrish, J.D., J.A. Maciolek, A.S. Timbol, C.B. Hathaway, and S.E. Norton. 1978. Stream Channel Modification in Hawaii, Part D: Summary Report. U.S. Fish and Wildlife Service Contract No. 14-16-0008-1199.

Pyle, R.L. 1977. Preliminary List of the Birds of Hawaii. 'Elepaio 37(10) p. 110-121.

Timbol, A.S. and J.A. Maciolek. 1978. Stream Channel Modification in Hawaii, Part A: Statewide Inventory of Streams; Habitat Factors and Associated Biota. U.S. Fish and Wildlife Service Contract No. 14-16-0008-1199.

U.S. Army Engineer District, Honolulu. 1980. Reconnaissance Report for Flood Damage Reduction, Alenaio Stream, Hawaii.

U.S. Fish and Wildlife Service. 1979. Hilo Area Comprehensive Study. Prepared for U.S. Army Engineer District, Honolulu.

U.S. Geological Survey. 1968. Preliminary Report on the Water Resources of the Hilo-Puna Area, Hawaii. Prepared in Cooperation with Division of Water and Land Development, Department of Land and Natural Resources, State of Hawaii.

Enclosure