MAIN REPORT
AND TECHNICAL APPENDIX

FLOOD PLAIN INFORMATION STUDY
HANALEI, KAUAI, HAWAII

PREPARED FOR

BOARD OF LAND AND NATURAL RESOURCES

STATE OF HAWAII

BY

U. S. ARMY ENGINEER DISTRICT, HONOLULU

CORPS OF ENGINEERS

HONOLULU, HAWAII

DECEMBER 1964

FLOOD PLAIN INFORMATION STUDY

HANALEI, KAUAI, HAWAII

MAIN REPORT

FLOOD PLAIN INFORMATION

HANALEI, KAUAI, HAWAII

MAIN REPORT

TABLE OF CONTENTS

Paragraph		Page
	I. INTRODUCTION	
1.	GENERAL	1
2.	PURPOSE OF STUDY	1
3.	USE OF REPORT	1
4.	ACKNOWLEDGMENTS	2
	II. FLOOD HISTORY	
5.	GENERAL	2
6.	RAINFALL	2
7.	FLOODS	3
8.	TSUNAMIS	6
	III. FUTURE IMPROVEMENTS IN THE FLOOD PLAIN	
9.	GENERAL	7
10.	NAVIGATION PROJECT	8
11.	PROPOSED HIGHWAY MODIFICATION	8
12.	RESORT DEVELOPMENT	8
	IV. GUIDE LINES FOR USE OF FLOOD PLAIN AND REDUCING FUTURE FLOOD LOSSES	
13.	GENERAL	9
14.	CRITERIA FOR ESTABLISHING NATURAL FLOODWAY REQUIREMENTS	9
15.	FLOOD PLAIN REGULATIONS	9
16.	METHODS TO PROTECT EXISTING IMPROVEMENTS	10
	V. CONCLUSION	
	GLOSSARY OF SELECTED TERMS	
A.	HYDROLOGIC TERMS	12
B.	REGULATORY TERMS	13

FIGURES

Number	
1.	Hanalei River - View of flood plain at State Highway No. 56 bridge. View of flood plain adjacent to Hanalei.
2.	Hanalei River - View downstream from State Highway No. 56 bridge. Hanalei River - View upstream from left bank at Ching Ma Leong's store.
3.	Waioli Stream - View downstream from State Highway No. 56 bridge. Also, view upstream from same. Waipa Stream - View upstream from State Highway No. 56 bridge. Hanalei River - Left bank flood plain near mouth of river.
4.	Site and layout of proposed boat harbor at Hanalei Bay, Kauai.

TABLE

Table		Page
1	Flood Discharge-Frequency Relationships	6

PLATES

Plate	
1	Geographic Location of Hawaiian Islands
2	Drainage Area Map
3	Hanalei Flood Plain
4	Flood Prevention Techniques
5	Example of Flood Plain Regulation
6	Example of Flood Plain Regulation

APPENDIX

Technical Appendix (Available with main report on specific request)

FLOOD PLAIN INFORMATION
HANALEI, KAUAI, HAWAII

MAIN REPORT

I. INTRODUCTION

1. GENERAL

This report has been prepared by the Corps of Engineers under the authority contained in Section 206 of the 1960 Flood Control Act in response to a request by the State of Hawaii Department of Land and Natural Resources for flood plain information in the Hanalei area. The Chief of Engineers, on April 18, 1962, approved the State's request of February 3, 1962 for this study.

2. PURPOSE OF STUDY

The basic purposes of the study are:

a. To provide information on hazards to life and property in the Hanalei flood plain caused by flooding from the Hanalei River, Waioli Stream, Waipa Stream, and tsunami.

b. To furnish information to residents and developers about potential flood, sediment and erosion damages to lands, crops, roads, and other improvements.

c. To provide a basis for local planning decisions.

d. To reduce future expenditures of the Federal Government in protecting developments that may be constructed in the flood plain in the absence of regulations or knowledge of potential hazards.

3. USE OF REPORT

The main portion of this report outlines flood problems and presents general guidelines to reduce present and future flood losses. This portion of the report is primarily intended for use by existing and prospective local land owners and residents, as well as developers, investors, realtors, governmental bodies and others with interest in the area. The technical appendix is included primarily for reviewing authorities as well as engineers or others who may find this information usable in designing or planning future improvements for the Hanalei area.

This report is not intended to extend any Federal control or jurisdiction in flood plain planning or regulation. In addition, it in no way obligates the Federal Government to further investigate planning, designing, constructing, operating and maintaining any facilities discussed or implies any intent to undertake such activities if not

authorized by Congress. The State of Hawaii Department of Land and Natural Resources and the Chief of Engineers have reviewed and approved release of the report. Copies may be obtained by contacting the Department of Land and Natural Resources, State of Hawaii or the County Engineer, County of Kauai.

4. ACKNOWLEDGMENTS

The study was coordinated with interested parties, who were very cooperative in furnishing information and contributing time and material. Some of the major contributors are:

Department of Agriculture - Soil Conservation Service
Department of Commerce - U. S. Weather Bureau
Department of Interior - Fish and Wildlife Service
- U. S. Geological Survey
- National Park Service
State of Hawaii - Department of Land and Natural Resources
- Department of Transportation
- University of Hawaii
County of Kauai, Hawaii
Newspapers - "The Garden Island," Lihue, Kauai
- "Honolulu Star-Bulletin"
- "Honolulu Advertiser"
Residents of the Hanalei area

II. FLOOD HISTORY

5. GENERAL

The flood problems of the Hanalei area are confined to the flat plain adjacent to Hanalei Bay on the northern coast of the island of Kauai, Hawaii, as shown on plate 2. The flood plain comprises about 1,850 acres, which include taro and rice fields, wooded areas, pasture land, residential and commercial buildings. Figures 1, 2, and 3 show various views of the flood plain and the streams that contribute to its flooding.

The town of Hanalei, with a population of about 370, is located between the mouths of the Hanalei River and Waioli Stream on slightly higher ground than the surrounding plain and therefore suffers less direct flood damage than the adjacent areas. The Waipa Stream, also a source of flooding, enters the Hanalei Bay about one-half mile west of the town. Floods are caused by the overflow from these three streams and by tsunamis which enter Hanalei Bay and inundate the low areas.

6. RAINFALL

Rainfall records for 18 stations (plate 2) in and near the Hanalei River basin show that the annual rainfall ranges from about 70 inches

near the coast to about 470 inches in the headwaters (at Mt. Waialeale, elevation 5,080 feet). Monthly rainfall in the higher regions averages 35 to 40 inches throughout the year and is fairly uniform. Near the coast, monthly rainfall fluctuates from 8 to 10 inches for the winter season to 4 to 6 inches during the rest of the year. Storm rainfall follows a pattern of short duration (3 to 6 hours) and high intensity. In one storm, an estimated 12 inches fell in 1 hour.

7. FLOODS

The primary cause of the frequent damaging floods in Hanalei is overflow of the Hanalei River. The Waioli and Waipa Streams also contribute, but on a smaller scale. During the past 18 years there have been 5 damaging floods. This indicates that on the average, every 3½ years the Hanalei area is subjected to property damage and agriculture losses. The two highest floods of record occurred within 2½ months of each other. The flood of January 24-25, 1956 crested just a few feet lower than the November 11-12, 1955 flood of record. The following excerpts describing past floods are from "The Garden Island," Lihue, Kauai; "Honolulu Star-Bulletin" and "Honolulu Advertiser" newspapers for selected floods.

May 9, 1868 - "Hanalei Valley was flooded and considerable damage done."

May 16, 1877 - "The storm of May 15-16 was extremely violent at Hanalei. On the 16th a thunderstorm occurred. Shortly after noon a freshet came down river and in 25 minutes the water rose 15 feet and spread over the valley, carrying off horses, mules, oxen and other animals. Princeville Plantation suffered heavy losses."

July 27, 1885 - "A very heavy storm occurred all over the island. Bridges at Waimea, Wailua, and Hanalei were carried away by freshets. The freshet at Hanalei was the highest known by any of the residents; about 4 inches higher than the freshet of 1877. Damage to lumber, rice, cane and loss of pigs occurred."

August 15, 1905 - "Few small rice patches were washed out during the night by an overflow of the river due to exceptionally heavy rains."

January 16, 1921 - "The greatest daily rain of 24.4 inches was reported at the power house near Hanalei."

April 1, 1948 - "The Hanalei River overflowed between 8 and 10:30 p.m. Chickens were killed and taro patches were flooded. Floods came during

heavy rains which drenched the north end of the island. Kilauea Sugar Plantation reported 4½ inches of rain between 6-7:30 p.m."

January 23, 1952 - "A severe 'Kona' storm struck Kauai Friday night and caused flash floods in several districts Saturday morning. Damage was confined to crops. Hanalei was probably hardest hit, although Hanapepe residents claim Saturday's flood was one of the worst the town has seen. Hanalei River rose at 11:00 p.m. Friday and did not begin to go down until shortly before noon Saturday. At its peak it was about 10 feet above normal in the section on the Kilauea side of the Ching Ma Leong store. The belt road mauka of the store was completely blocked by the water, which was 3 to 4 feet above the pavement."

November 11-12, 1955 - This is the maximum flood of record. The Kilauea Plantation office, about 4 miles east of Hanalei, recorded 19.8 inches of rain in 13.5 hours. The storm total was 26.1 inches. The entire Hanalei Valley lowlands were flooded. A one-half mile length of Highway 56 (Belt Road) was under about six feet of water and at one point the depth was about 8 feet. Traffic was paralyzed for about 12 hours, mainly due to landslides but also by the high water. Estimated losses of $20,000 were suffered when harvested rice was destroyed or spoiled. The County Engineer estimated damage to roads at $5,000. The Hanalei River stream gaging station was destroyed and no peak discharge estimate is available although fairly reliable highwater marks were reported. The limits of flooding were obtained through interviews with residents of Hanalei. These limits are on plate 3.

January 26, 1956 - "Late on the morning of 25 January water rose in the Hanalei River, rendering the highway impassable. Late in the afternoon, police reported, the water was still backed up around the Ching Ma Leong store. Telephone lines to Hanalei side were out all day. The only means of communication was police radio."

April 17, 1963 - "The Hanalei River flood, triggered by a massive cloudburst in the mountains, rose to the highest level in several years, but damages proved to be relatively light. The biggest concern was for the taro fields, but a check yesterday disclosed the actual losses were not severe. Some of the younger taro plantings probably suffered damages but the flood receded fast enough so that the older plants were little damaged. The river rose fast at 3:30 p.m. and hit the peak about 4:00 p.m. The water was so high it covered the entire stretch of the highway, even covering the road in front of the Ching Ma Leong store. The highway remained impassable until 9:00 p.m." (The flooded area is shown on plate 3.)

A study was made to determine the flood which would result from the greatest storm considered reasonably characteristic of the Hanalei region. This regional flood is called the "Standard Project Flood" by the U. S. Army Corps of Engineers. Flood routing studies show that the runoff from this storm would flood the Hanalei Valley to a depth of 9-10 feet. If the area of inundation (see plate 3) of this rare flood were used in defining the limits of flood plain regulation, flood damage risk could be very greatly reduced.

Those floods with a greater probability of occurrence than the "Standard Project Flood" are shown on plate 3 and listed in table 1. This information may serve as a guideline to determine flood plain areas in which a greater degree of flood risk may be permissible. Since floods are random in nature, frequency is only a prediction based on studies of past floods. The assignment of a 10-year frequency to a given stream flow does not mean that the flood will occur every 10 years. Instead, it is an indication that the particular peak discharge, expressed in cubic feet per second or million gallons per day, will be exceeded on an average of about once in every 10 years. This means that over an extended period of 100 years, a 10-year flood will be exceeded about 10 times. Frequency estimates for the Hanalei River are based on limited stream gaging records. Additional information will improve the reliability of the frequency data used in table 1.

Table 1. Flood Discharge-Frequency Relationships

Hanalei River (at mouth)
Drainage area = 23.1 square miles

Recurrence interval in years	Peak discharge in cubic feet per second	Remarks
10	10,000	Flood outline shown on plate 3
50	16,500	Flood outline shown on plate 3
100	20,000	Flood outline shown on plate 3
Standard Project Flood	29,000	Flood outline shown on plate 3. No frequency assigned.

Waioli Stream
Drainage area = 5.1 square miles

10	6,400	Flood outline shown on plate 3
50	10,000	Flood outline shown on plate 3
100	11,700	Flood outline shown on plate 3
Standard Project Flood	16,000	Flood outline shown on plate 3. No frequency assigned.

Waipa Stream
Drainage area = 3.2 square miles

10	4,400	Flood outline shown on plate 3
50	6,900	Flood outline shown on plate 3
100	8,000	Flood outline shown on plate 3
Standard Project Flood	11,000	Flood outline shown on plate 3. No frequency assigned.

The expected number of times that a flow will exceed a given magnitude in a selected time interval is known as the frequency of a flood.

8. TSUNAMIS

Another source of flooding is the tsunami which overflows onto the beach and into stream mouths and lowlands of the Hanalei area. The tsunami has been noted in the record of natural phenomena for at least 2,000 years. In the past 146 years, 43 tsunamis have been known to affect the Hawaiian Islands. Seven were designated very severe, 2 severe, 8 moderate, and 26 slight judged by the amount of physical damage inflicted. Although the island of Kauai has suffered great damage from these tsunamis, Hanalei has received less damage than surrounding towns. The more recent and damaging tsunamis are described in the following paragraphs to emphasize the magnitude of flooding and resulting flood losses.

Tsunami of April 1, 1946. The tsunami was generated by an earthquake centered about 70 miles southeast of Unimak Island, Alaska. It reached the northern coast of Kauai on the morning of April 1, 1946. Three major waves were recorded, traveling at the rate of 400 miles per hour and about 80 miles apart. The Hanalei area sustained damages of $5,000 to highway bridge abutments, while damages amounting to $10,000 were caused by beach and road erosion. There was no major damage to residences and no loss of life.

Tsunami of March 9, 1957. An earthquake occurred in the Aleutian chain, about 2,200 miles northeast of the Hawaiian Islands, at 4:30 a.m. The first of a series of tsunamis reached Kauai at 9:59 a.m. The most severe damages were suffered on the northern portion of the island. Hanalei reported major damage to beach front homes. This tsunami inflicted more damage than the one in 1946. The area between Anahola and Haena, which includes Hanalei, was declared a major disaster area by the Governor of Hawaii and Federal assistnace was requested. Estimated losses included $267,000 residential, $20,000 public property, and $1,550 agricultural for the Hanalei area alone. Nineteen homes were destroyed and 8 damaged. The main part of town, the beach road, and Highway 56 intersection were inundated as were some of the low spots extending to Highway 56. The advance warning system was in operation and no casualties were reported. However, two persons who were crabbing in the Hanalei River when the surge came narrowly escaped drowning when their boat capsized. They were later rescued after clinging to some trees for about three hours. The Red Cross provided shelter for about 100 people left homeless. Police, Territorial Civil Defense, Civil Air Patrol, and the Armed Forces participated in evacuation and rescue operations. The estimated area of the 1957 tsunami inundation is shown on plate 3.

Tsunami of May 23, 1960. On May 20, 1960, ten days of violent earthquakes began in Chile. At 6:47 p.m. Hawaiian Standard Time, May 23, an official warning was issued by the U. S. Coast and Geodetic Survey after receiving reports of tsunami attacks on the South American coast earlier in the day. The islands of Hawaii and Maui were hit hardest. Like the other islands, Kauai experienced the flood and ebb type of tsunami activity, but relatively little damage was reported.

III. FUTURE IMPROVEMENTS IN THE FLOOD PLAIN

9. GENERAL

The estimated limits of flooding shown on plate 3 are based on present use of the area. Future improvements that materially change the flood channel capacity in the flood plain may cause the stage and area of inundation to be modified.

Future improvements affecting the flood plain are discussed in the following paragraphs.

10. NAVIGATION PROJECT

The Corps of Engineers has recommended the construction of a light-draft boat harbor and facilities on Hanalei Bay near the mouth of the river. This proposed project includes a 1,800-foot combination entrance and main access channel that would extend from Hanalei Bay into the central portion of the peninsula which is formed by the river and the bay. A berthing area of 5.5 acres would accommodate about 180 boats. Figure 4 shows the general location and plan. The embankment section (figure 4) will be constructed to elevation of 10 feet mean sea level, which is about 1/2 foot above the standard project flood. The service dock, boat ramp and berthing area are inside this embankment. Future expansion of the project or construction of other facilities outside and adjacent to the embankment should use this design for a guide to determine the minimum elevation to afford protection against flooding from the Hanalei River.

11. PROPOSED HIGHWAY MODIFICATION

The State of Hawaii Department of Transportation is planning to improve Highway 56, the only all-weather road servicing the area. New bridges are planned for the Hanalei River and Waioli and Waipa Streams. The portions of the roadbed that lie in the flood plain will be widened and constructed to an elevation of 20 feet mean sea level, which will be above any probable future flood height. However, the highway fill would raise upstream flood heights unless adequate bridge openings are provided at the stream crossings.

12. RESORT DEVELOPMENT

The State Planning Office, together with the Department of Transportation, submitted a plan of development to the State Legislature in January 1961 entitled "The General Plan of the State of Hawaii." It was adopted and released to the Department of Planning and Economic Development for use in planning land utilization policies.

Hanalei has been designated as a tourist destination area. In connection with this, a specific plan for a small boat marina, yacht club, hotels, and commercial center is depicted in the State of Hawaii publication, "Visitor Destination Areas in Hawaii, Part 3, First Stage Plans for Public Improvements." The proposed location for the marina and four of the hotels is wholly within the flood plain. Assuming that this complex is constructed at natural ground elevation, these studies show that flow conditions approximating the Hanalei River 1955 flood would inundate the improvements to a depth of 8 feet. If this development is constructed as indicated, means to protect the facilities from flooding should be considered. Methods of protection could be flood-proofing, raising the first floor levels to about elevation 12.0 m.s.l. or building a ring levee around the entire development. Any major alteration of the existing topographic features may cause a higher flood stage with an accompanying increase in land inundation.

IV. GUIDE LINES FOR USE OF FLOOD PLAIN AND REDUCING FUTURE FLOOD LOSSES

13. GENERAL

The preceding discussion of the more disastrous flood and tsunamis that have affected Hanalei emphasizes the need for regulations to control land use in the flood plain. The enactment and enforcement of the proper laws and ordinances are the responsibility of local authorities. The following discussion assumes that part of the existing flood plain will be reserved for the free passage of flood waters with a minimum of obstruction to its flow. Methods to preserve this area are outlined under the heading of flood plain regulations. Avenues of investigation for the protection of existing improvements are also presented. Plate 4 shows suggested flood damage prevention programs.

14. CRITERIA FOR ESTABLISHING NATURAL FLOODWAY REQUIREMENTS

The estimated limits of flooding (plate 3) are intended to furnish guidelines for the establishment of a natural floodway to pass a peak discharge of the magnitude shown. The exact legal description of the land to be regarded as floodway property is the responsibility of a local governmental agency. The area immediately adjacent to the Hanalei River should be permanently restricted from future development with some form of regulation. The present sparse settlement and improvement in this area offers the opportunity to prevent future flood losses by planned development. Plates 5 and 6 show a typical flood plain with various degrees of flooding and how it can be regulated to reduce potential flood hazard.

15. FLOOD PLAIN REGULATIONS

The police powers of state and local governments to enact and enforce laws and ordinances regulating land use furnish the vehicle by which the concepts of paragraph 14 can be implemented. Included within the scope of flood plain regulation are zoning ordinances, subdivision regulations, channel and floodway encroachment statutes and building codes. The intent of these restrictions is to deny uses of the land or property in the Hanalei flood plain that would tend to multiply the loss of life and property through development without adequate consideration of the flood hazard.

a. Zoning ordinances. Zoning ordinances control the type of land use that will be permitted in an area. Ordinances may be written to provide a designated natural floodway on either side of the Hanalei River, Waioli and Waipa Streams, using a particular flood outline as the boundary. Zoning for tsunami inundation may, for example, be based on the area flooded by the 1957 tsunami. Regardless of the method used; specific instructions concerning what land use activity will be permitted within the restricted areas should be included.

b. Subdivision regulations. Proposed subdivisions in the town of Hanalei that lie in flood prone areas should have regulations that clearly define the degree of risk and extent of flooding involved. Such items as minimum lot, street or structural elevations, outline of flood plain for various frequencies of flow, and minimum surface drainage requirements should be an integral part of these regulations.

c. Channel and flood plain encroachment statutes. Encroachment statutes designate areas adjacent to bodies of water that are set aside for the passage of flood flows. Obstructions such as structures or trees should be held to a minimum in these areas. These statutes, together with applicable zoning ordinances, constitute the means for preserving a permanent floodway by permitting only such improvements as playgrounds, which offer a minimum resistance to flood flows and can withstand inundation with little damage.

d. Building codes. Building codes for flood plain development should specify (1) minimum elevation of footings, (2) minimum first floor elevations, (3) require such reinforcement to withstand high velocity flow and water pressure, (4) designate minimum requirements of flood proofing, and (5) control construction of basements.

e. Other controls. Government and private lending agencies can exercise an indirect control over flood plain development by refusing to finance improvements to be located in an existing or potential flood hazard area. Also, land fill or dumping operations should be controlled in the area designated to carry off the flood waters. The acquisition of the flood plain area by easement or in fee simple title by local or state governments for recreation or open space use would put it to uses compatible with the flood hazard.

16. METHODS TO PROTECT EXISTING IMPROVEMENTS

Control of the Hanalei River flood waters with a reservoir or by channel improvement and levees would be a solution of the flood problem. Federal participation in flood control for the Hanalei River was investigated in 1940 by the Corps of Engineers. It was learned that flood control would be economically unjustified. Likewise, a report on channel restoration made by the U. S. Army Engineer District, Honolulu, in 1959 indicated such work to be unfeasible. Since direct flood control seems unlikely at this time, two methods may give partial protection to the existing improvements that lie in the flood plain.

a. Flood proofing. Flood proofing could be used for the present structures subject to flooding and incorporated into the basic design for any future buildings planned. This involves raising vulnerable equipment such as generators, motors, and machinery above the high water profile for a given flood and emergency installations consisting of water-tight doors, windows and ground level air vent coverings. These methods would be effective only for flooding from stream flow. They would offer no protection from tsunamis because of the tremendous forces

associated with them. The University of Chicago, Department of Geography, Research Paper No. 65, "Flood Proofing: An Element in a Flood Damage Reduction Program," 1960, by John Richard Sheaffer is a comprehensive discussion of some of the flood proofing techniques that can be employed.

b. Evacuation. Temporary evacuation of movable property is effective only if coupled with an adequate flood warning system. The Kauai Civil Defense Agency has the network to warn of any impending tsunami. Presently there is no system to predict rain storm floods in the Hanalei area except the U. S. Weather Bureau's forecasts of probable heavy rains and possible flooding. Once alerted, residents can either remove their personal property to higher ground or raise it to a safe level and evacuate the area.

V. CONCLUSION

This report has defined the flood problems in Hanalei Valley, describing the past and potential limits of inundation resulting from rain related floods. Discussions on flooding at Hanalei from tsunamis also are included. However, potential limits of tsunami inundation have not been estimated because of lack of knowledge on this subject. The University of Hawaii's Institute of Geophysics has been conducting research in this field and may provide helpful information. Guidelines for the future control of damages resulting from these conditions have also been presented. Federal participation in providing flood control measures is not probable in the foreseeable future because of lack of economic justification. Likewise, protection from tsunami inundation does not seem practicable. Past experience indicates that the natural growth pattern for the Hanalei area is up the valley to either side of the river and along the beach front. In view of these facts, recognition of the danger from flooding to low areas and possible flood losses that may result is imperative at this time.

GLENN P. INGWERSEN
Lt Col, Corps of Engineers
District Engineer

GLOSSARY OF SELECTED TERMS

A. HYDROLOGIC TERMS

Channel - A natural or artificial watercourse with definite bed and banks to confine and conduct continuously or periodically flowing water.

Flood - Any temporary rise in stream flow or stage overtopping the banks that results in significant adverse effects in the vicinity.

Flood Duration - The total length of time a flood is above "flood stage."

Flood frequency - The average interval of time, based on the period of record, between floods equal to or greater than a specified discharge. Frequency is generally expressed in years.

Flood of record - Any flood for which there is reasonable reliable data useful in technical analysis. Ordinarily the term is used to refer to "maximum flood of record."

Flood peak - The highest value of stage or discharge attained by a flood.

Flood plain - The relatively flat low lands adjoining a watercourse or other body of water subject to overflow therefrom.

Flood profile - The longitudinal profile assumed by the surface of a stream of water flowing in an open channel.

Flood stage - A term used to designate that stage or depth of water at which overflow of the natural banks of the stream begins to cause damage.

Flood volume - The total volume of runoff during a flood, which is equal to the average rate of flow multiplied by the time of flood duration. The term "inches of runoff" is sometimes used to designate flood volume which means that a flood volume would cover the drainage area above the point of measurement to a uniform depth equal to the number of inches specified.

Historical flood - A known flood which occurred before systematic record keeping was begun for the stream or area under consideration.

Maximum known flood - The largest known flood which has occurred in a region whether it is an historical flood or a flood of record.

Natural floodway - The channel of a stream or body of water and that portion of the flood plain that is used to carry the flow of a flood.

Rainfall intensity - The amount of precipitation that falls in a specified time interval. It is usually referred to as inches per hour.

Standard project flood - A hypothetical flood, estimated by the Corps of Engineers, representing the critical flood runoff volume and peak discharge that may be expected from the most severe combination of meteorological and hydrologic conditions that are considered reasonably characteristic of the geographical region involved, excluding extremely rare combinations.

Tsunami - A great sea wave produced by submarine earth movement or volcanic eruption.

Watershed - The area drained by a stream or stream system.

B. REGULATORY TERMS

Building code - A collection of regulations adopted by a local governing body setting forth standards for the construction of buildings and other structures for the purpose of protecting the health, safety, and general welfare of the public.

Designated floodway - The channel of a stream and that portion of the adjoining flood plain designated by a regulatory agency to provide for reasonable passage of flood flows.

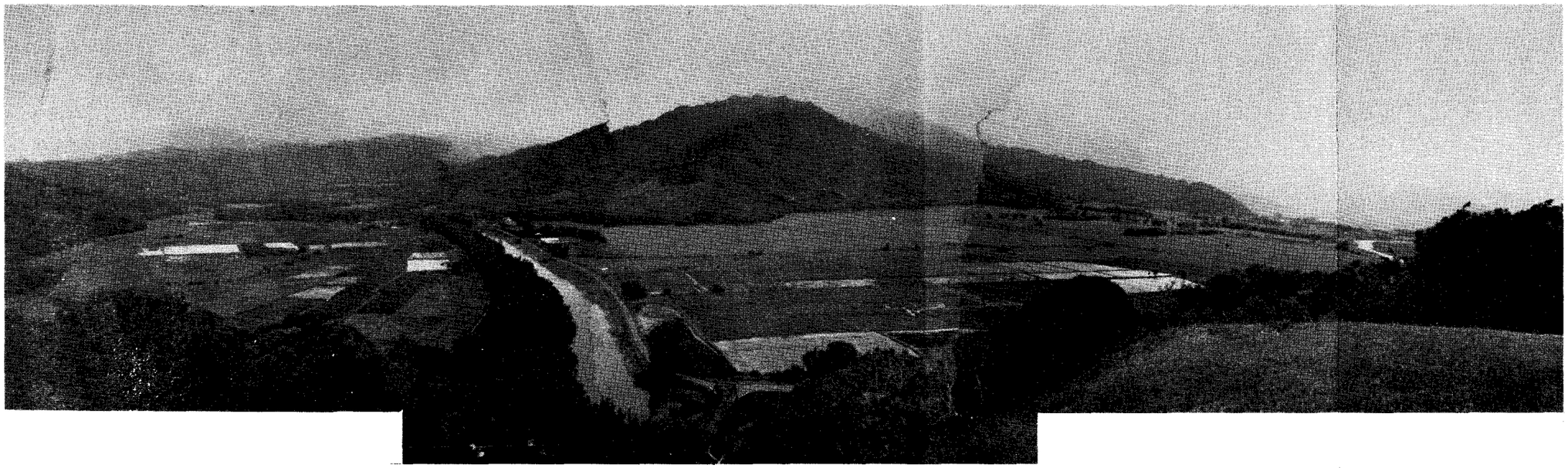
Encroachment lines - Lateral limits or lines along streams or other bodies of water, beyond which in the direction of the stream or other body of water no structure or fill may be added.

Flood plain regulations - A general term applied to the full range of codes, ordinances, and other regulations relating to the use of land and construction within flood plain areas. The term encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment laws, open area regulations, and other similar methods of control affecting the use and development of flood plain areas.

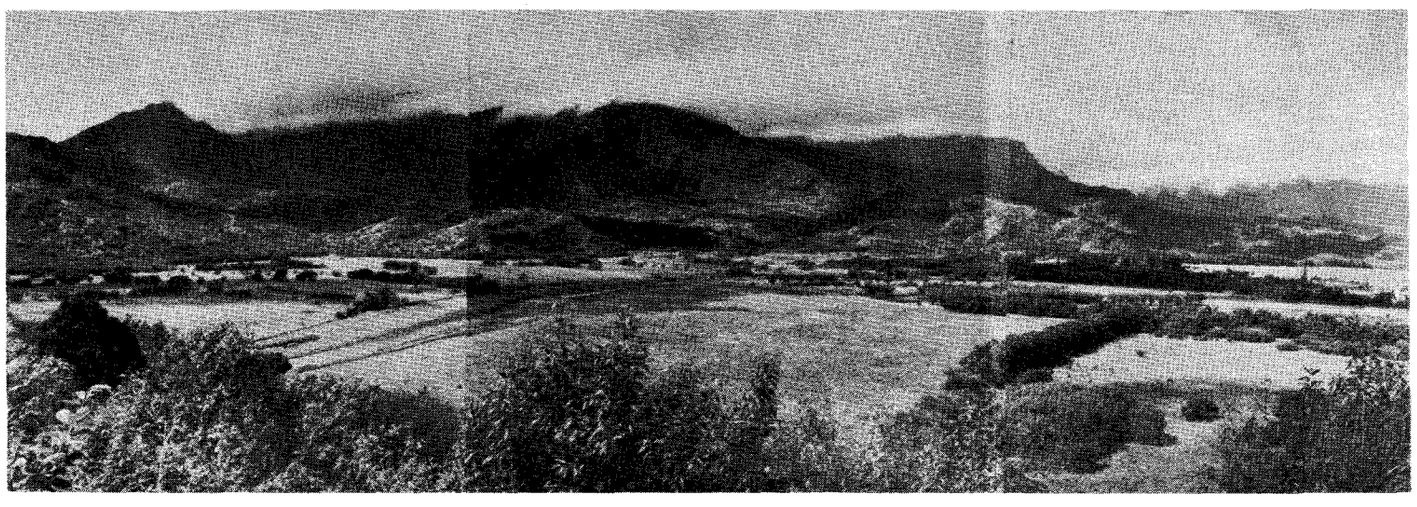
Flood proofing - A combination of structural changes and adjustments to properties subject to flooding primarily for the reduction or elimination of flood damages.

Subdivision regulations - Regulations and standards established by a local authority, generally the local planning agency, with authority from a state enabling law, for the subdivision of land in order to secure coordinated land development, including adequate building sites and land for vital community services and facilities such as streets, utilities, schools, and parks.

Zoning ordinance - An ordinance adopted by a local governing body, with authority from a state zoning enabling law, which under the police power divides an entire local government area into districts and, within each district, regulates the use of the land, the height, bulk, and use of buildings or other structures and the density of population.

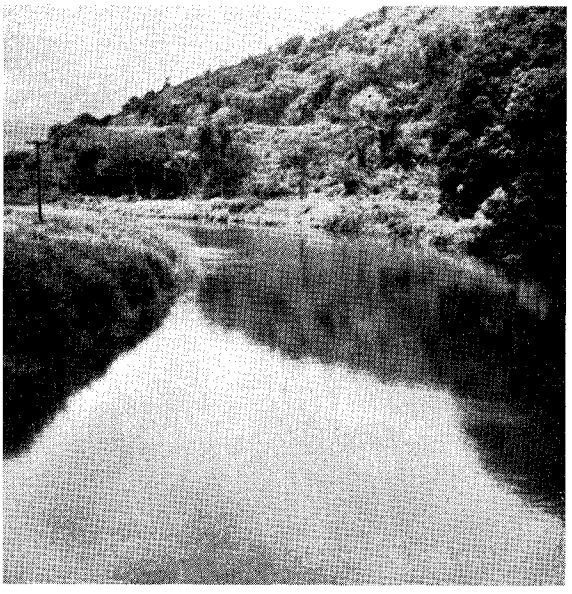


Hanalei River - View of flood plain at State Highway No. 56 bridge. Structure in center of photograph is a rice mill and storage facility. Rice, taro, vegetable fields and pasture land are included in the flood plain. Stream flow is from left to right in photograph.

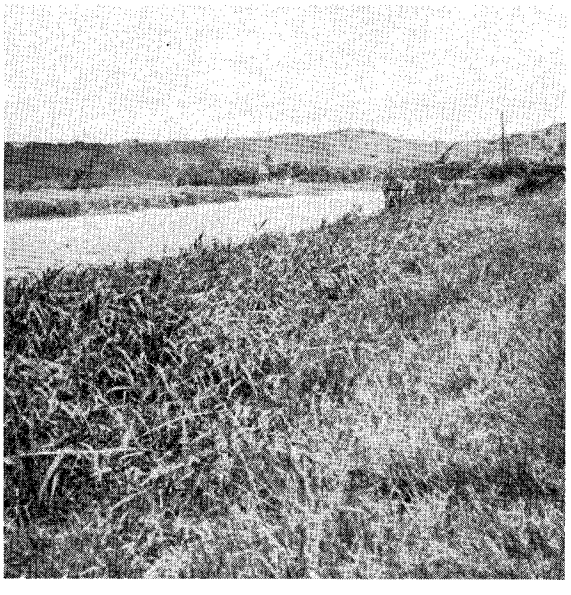


Hanalei River - View of flood plain adjacent to the town of Hanalei. The town is located in the extreme right center of the photograph. The flood plain is predominantly pasture land.

Figure 1

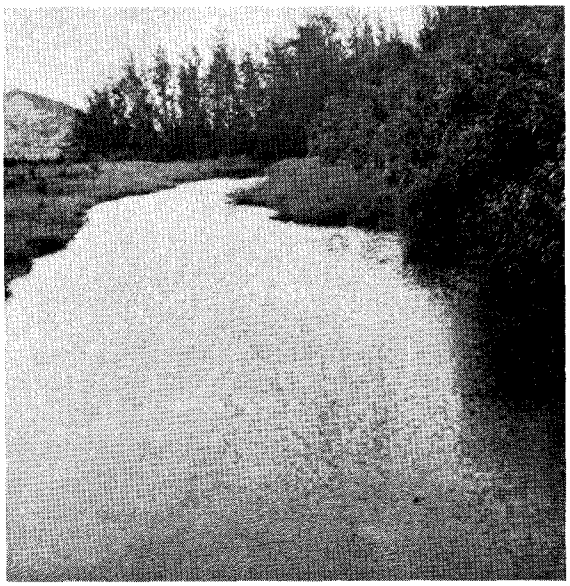


Hanalei River - View looking downstream from State Highway No. 56 bridge

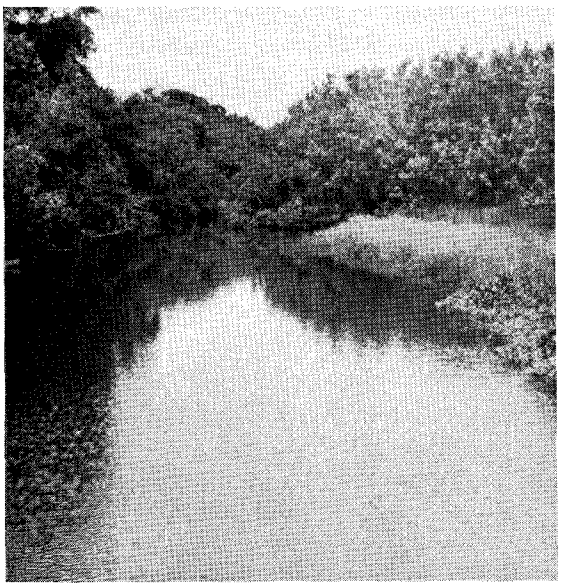


Hanalei River - View looking upstream from left bank at Ching Ma Leong's store.

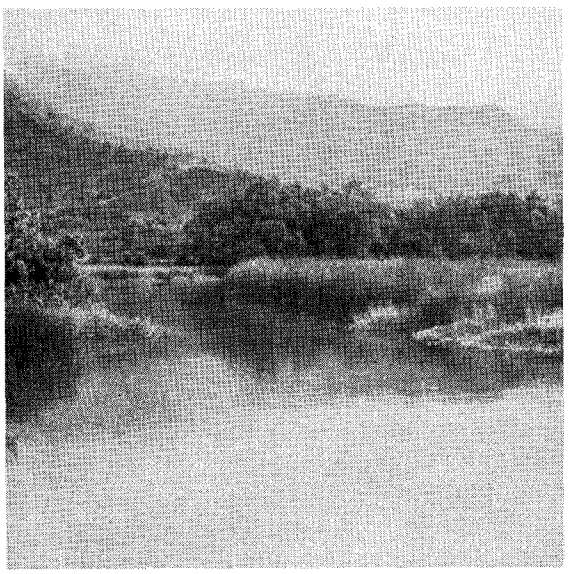
Figure 2



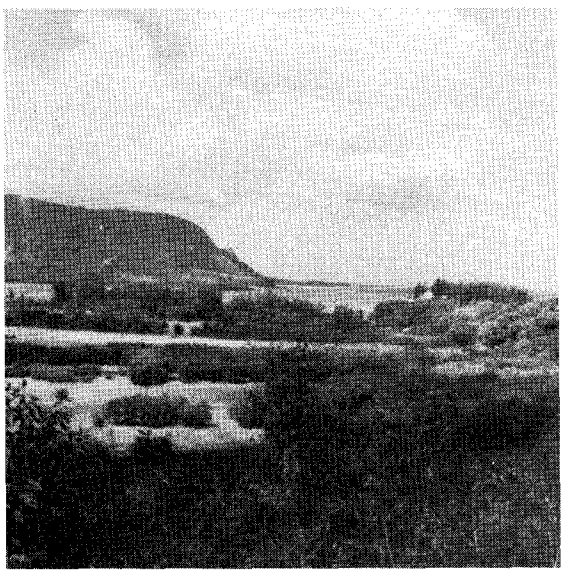
Waioli Stream - View downstream from State Highway No. 56 bridge.



Waioli Stream - View upstream from State Highway No. 56 bridge.



Waipa Stream - View upstream from State Highway No. 56 bridge.



Hanalei River - Left bank flood plai near mouth of river.

Figure 3

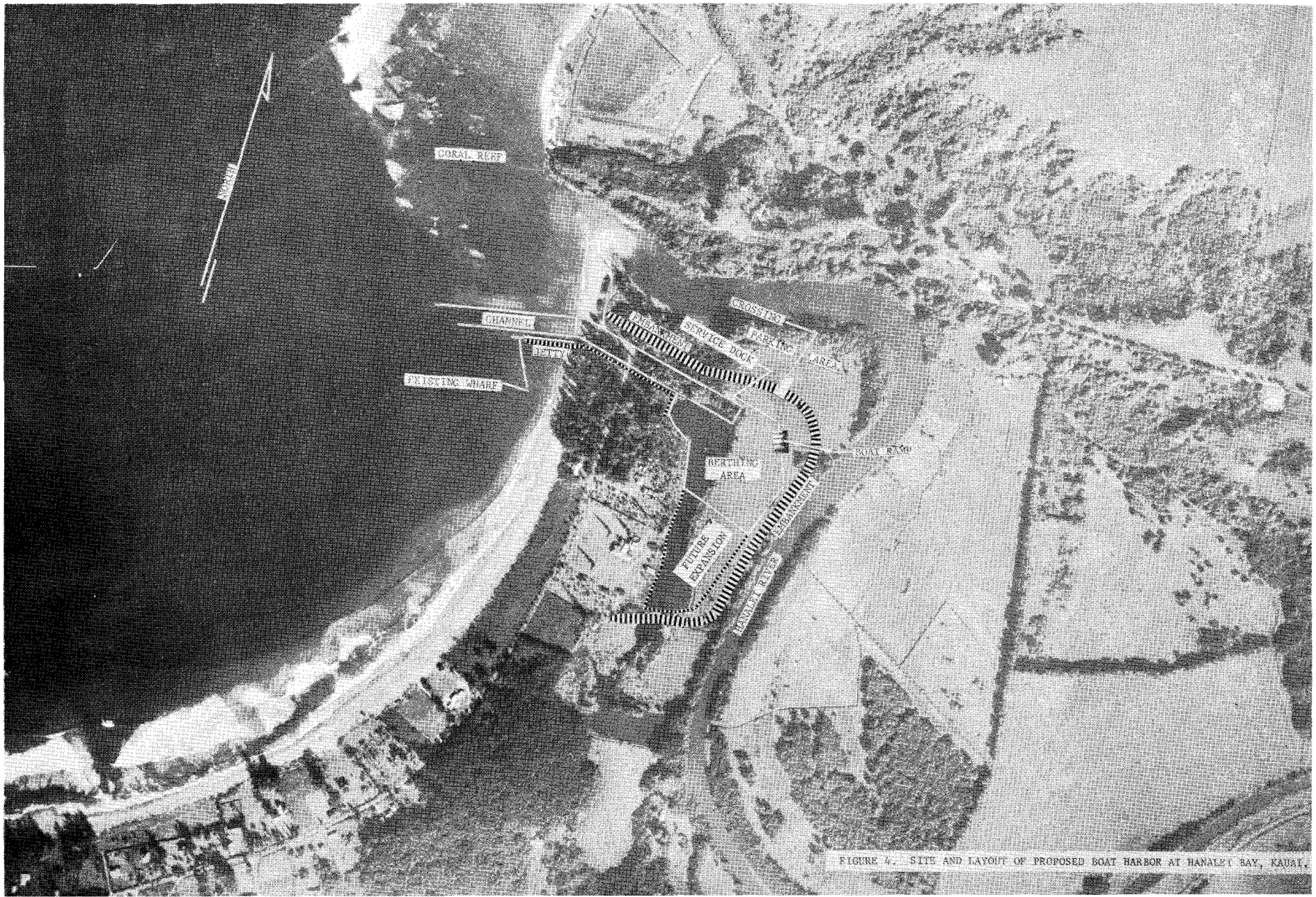


FIGURE 4. SITE AND LAYOUT OF PROPOSED BOAT HARBOR AT HANALEI BAY, KAUAI.

CORPS OF ENGINEERS

U. S. ARMY

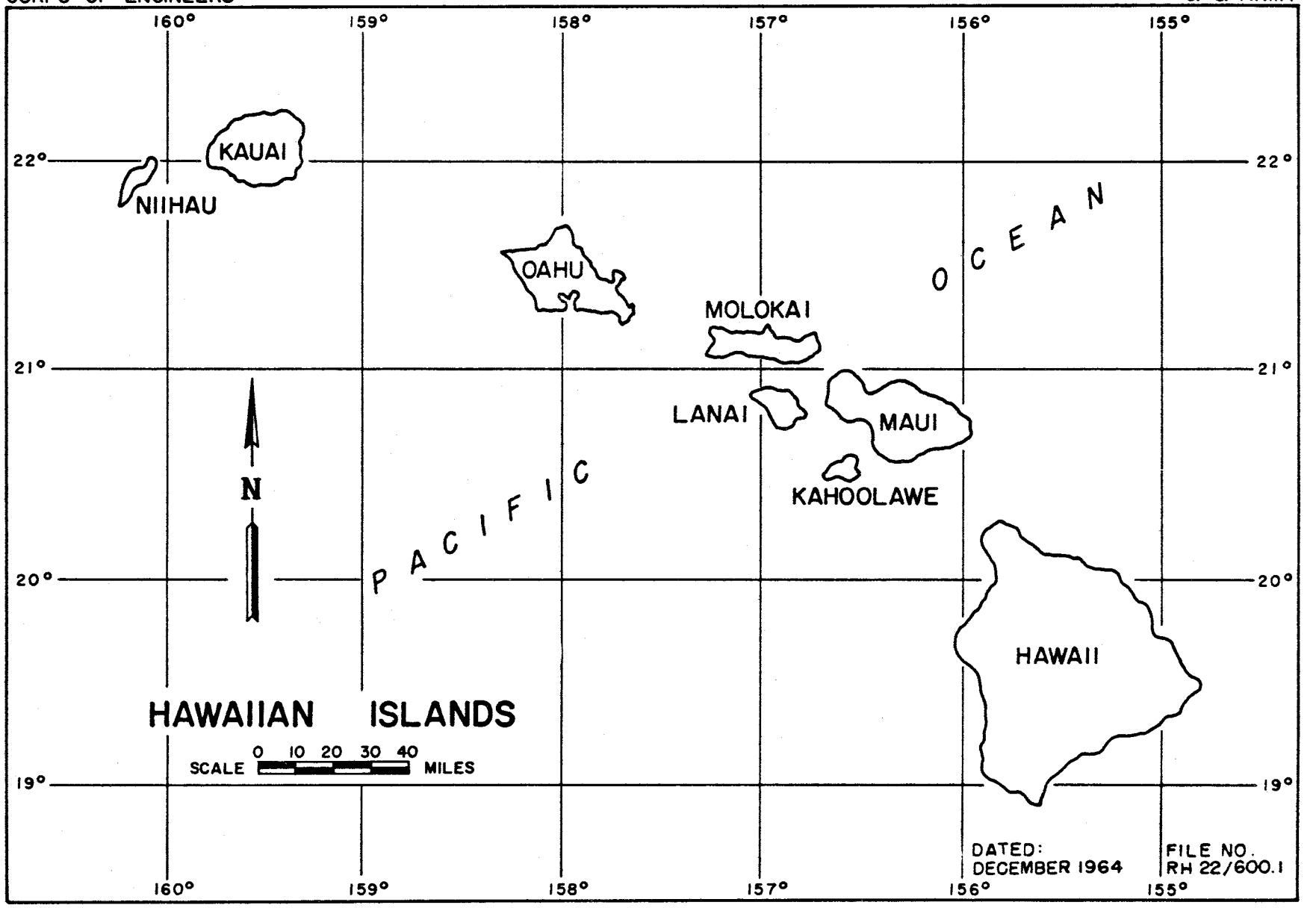
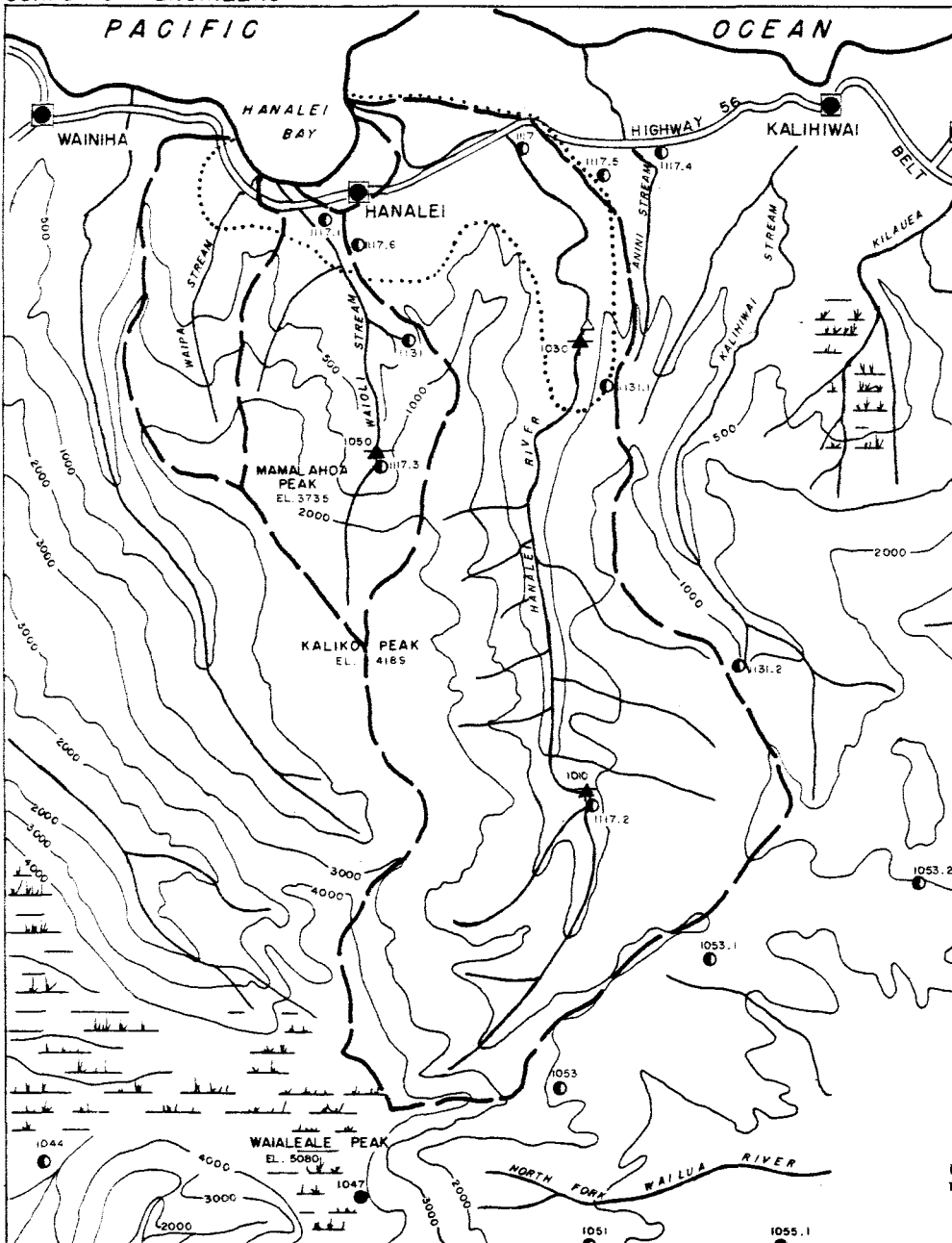
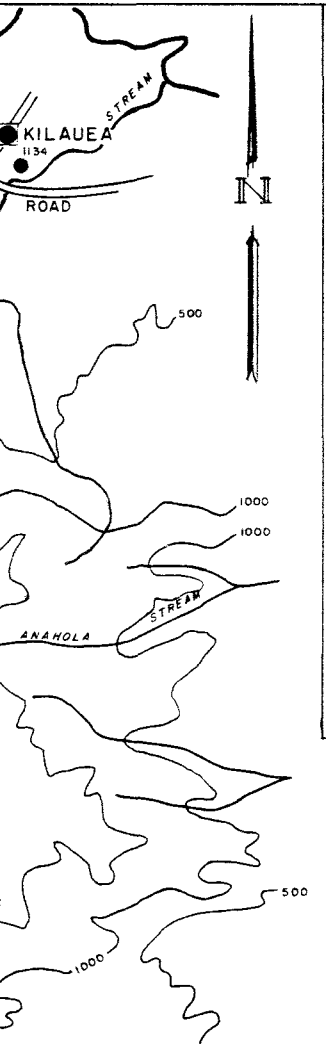
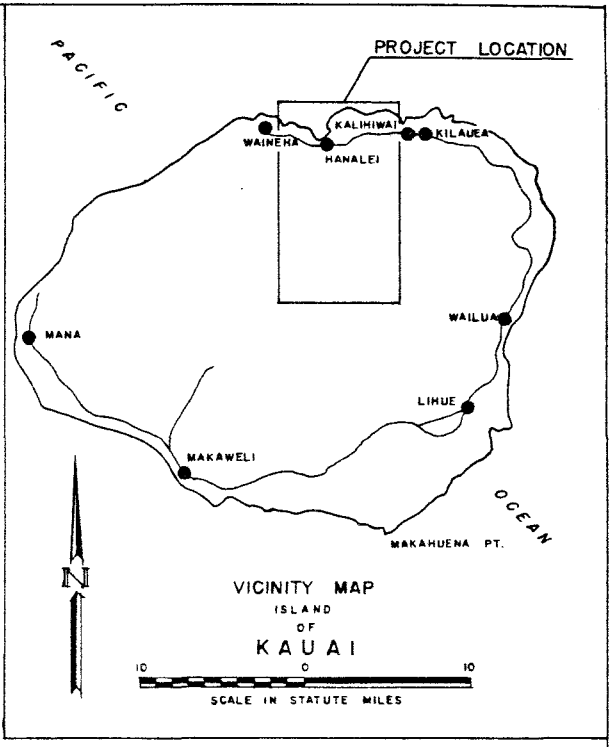


PLATE 1

CORPS OF ENGINEERS







LEGEND

- LIMIT OF DRAINAGE AREA
- BOUNDARY OF FLOOD PLAIN
- 1050 STREAM GAGING STATION AND NUMBER
- 1055 RAINFALL STATION AND NUMBER (RECORDING)
- 1053 RAINFALL STATION AND NUMBER (NON-RECORDING)

HANALEI, KAUAI HAWAII

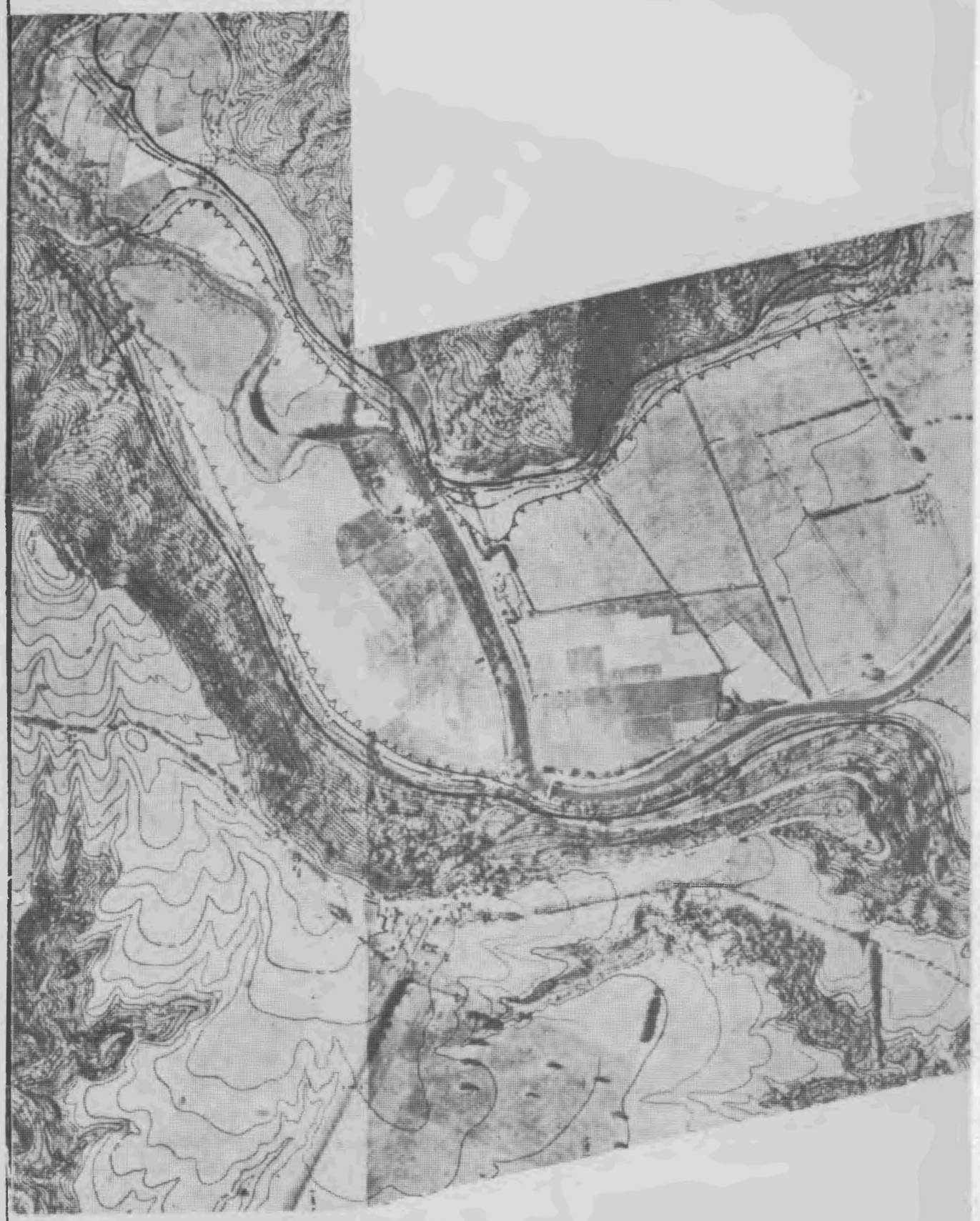
HANALEI FLOOD INFORMATION STUDY

DRAINAGE AREA MAP

U.S. ARMY ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS HONOLULU, HAWAII
TO ACCOMPANY REPORT FILE NO.
DATED: DECEMBER 1964 RH22/600.2

PLATE 2

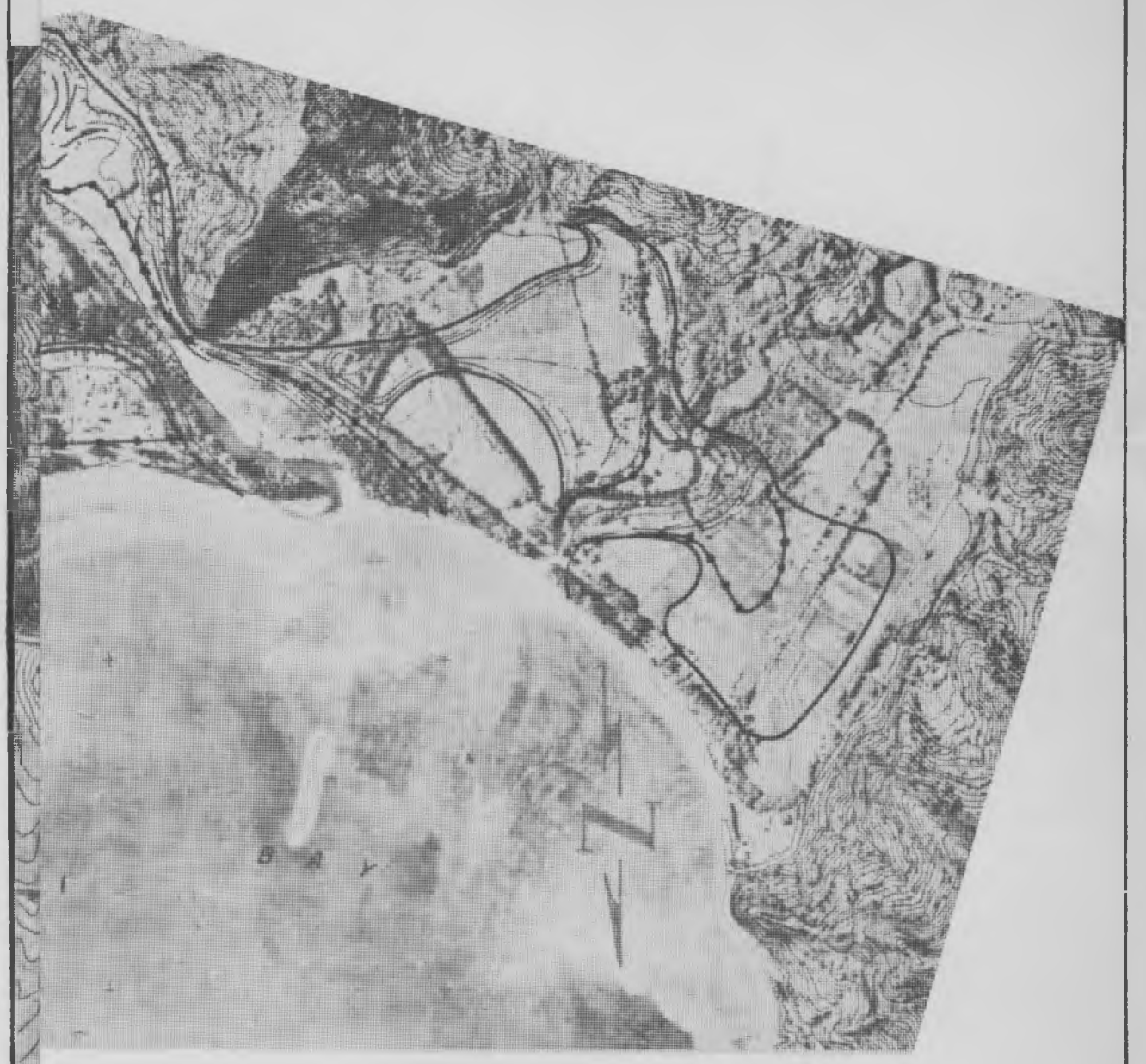
CORPS OF ENGINEERS




HANALE
500 0 500 1000
SCALE IN FEET

CO

U. S. ARMY



LEGEND

- 10 YEAR FLOOD
- 50 YEAR FLOOD
- 100 YEAR FLOOD
- STANDARD PROJECT FLOOD
- APR. 1963 FLOOD
- NOV. 1955 FLOOD
- MARCH 1957 TSUNAMI

HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

HANALEI FLOOD PLAIN

U S. ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO.
DATED: DECEMBER 1964 RH 22/600.3

PLATE 3

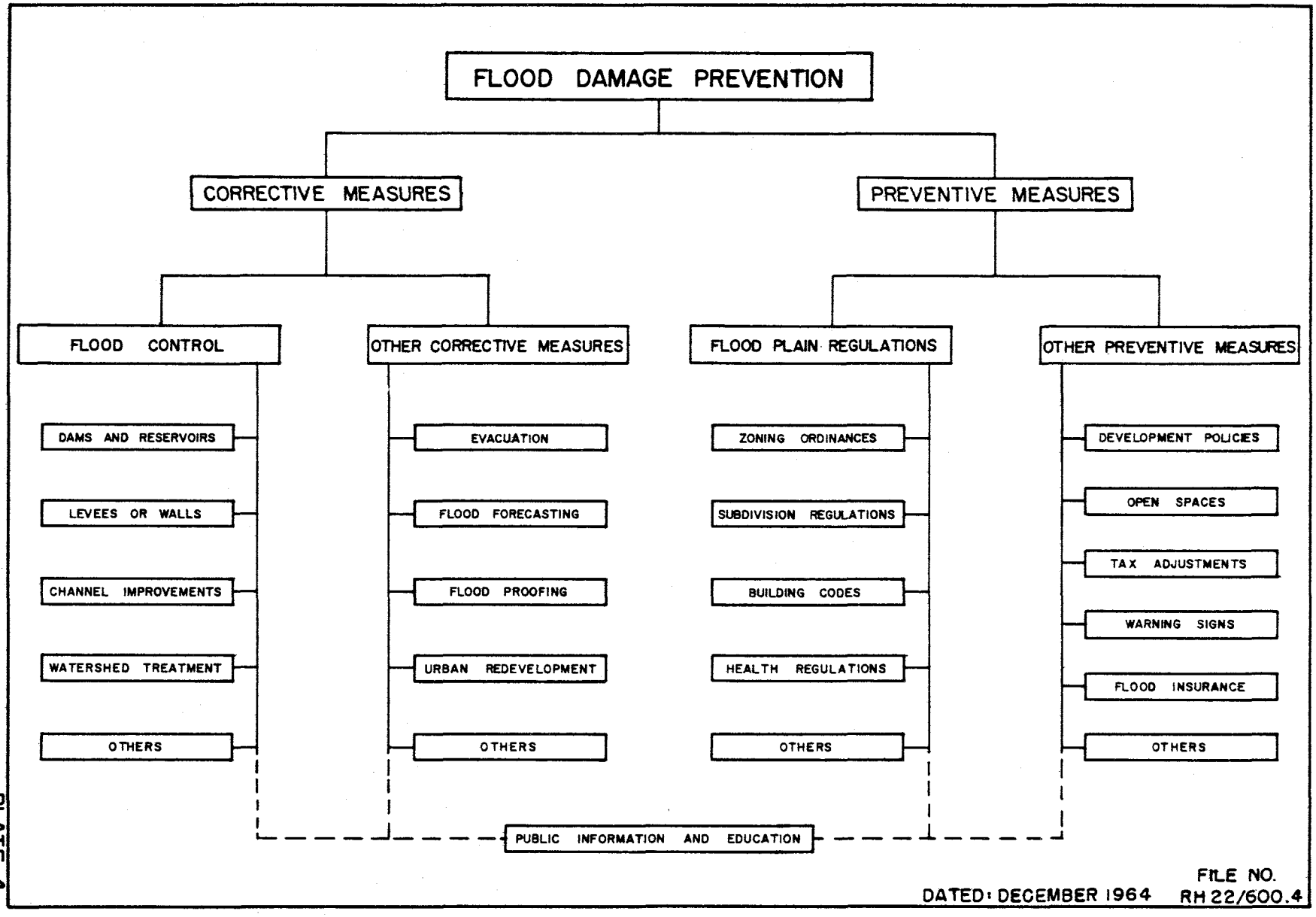
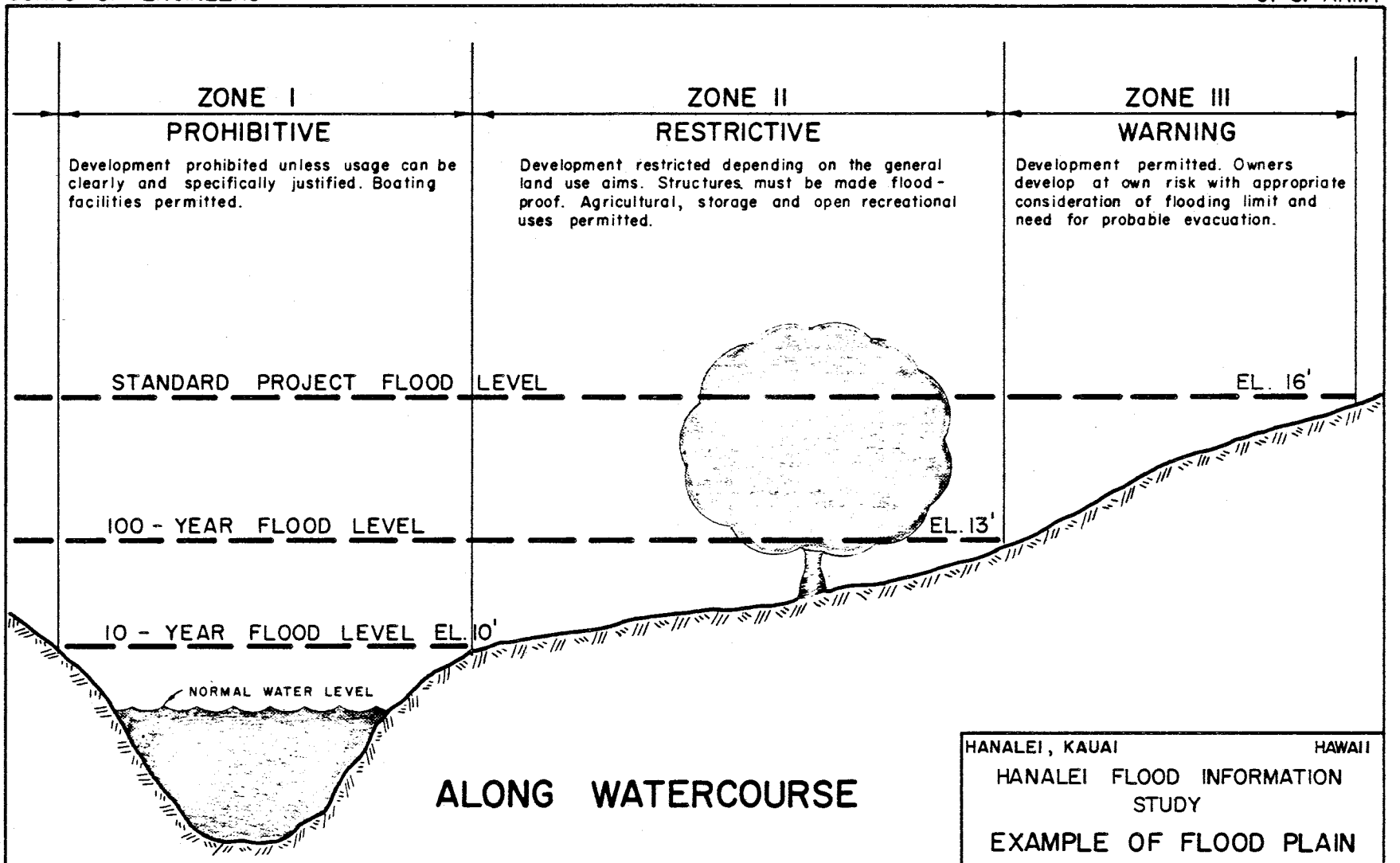


PLATE 4

DATED: DECEMBER 1964

FILE NO. RH 22/600.4

CORPS OF ENGINEERS U. S. ARMY



ALONG WATERCOURSE

HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

EXAMPLE OF FLOOD PLAIN REGULATION

U. S. ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO.
DATED DECEMBER 1964 RH 22/600.5

PLATE 5

CORPS OF ENGINEERS

ZONE I

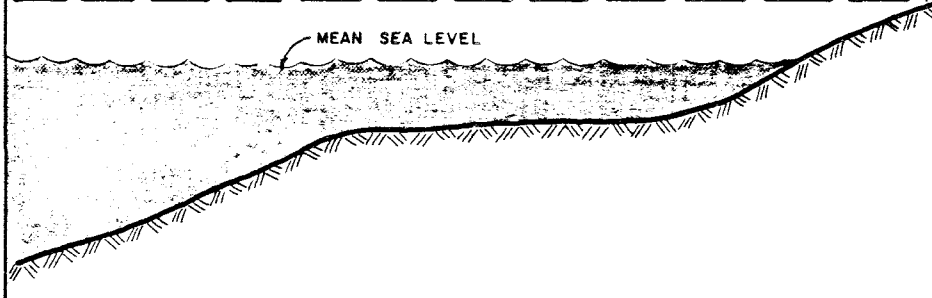
PROHIBITIVE

Development prohibited unless usage can be clearly and specifically justified. Piers, breakwaters, jetties and other marine facilities permitted.

POTENTIAL TSUNAMI INUNDATION LEVEL

RECORDED TSUNAMI INUNDATION LEVEL

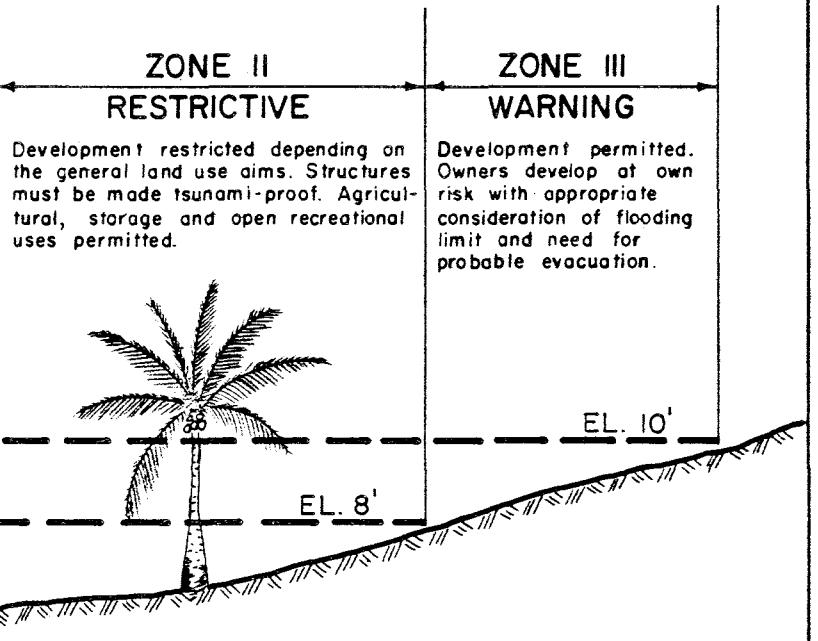
ESTIMATED HIGHEST TIDE LEVEL EL. 3'



ALONG COASTAL AREA

PLATE 6

U. S. ARMY



HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

EXAMPLE OF FLOOD PLAIN REGULATION

U. S. ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO.
DATED: DECEMBER 1964 RH22/600.6

FLOOD PLAIN INFORMATION STUDY

HANALEI, KAUAI, HAWAII

TECHNICAL APPENDIX

FLOOD PLAIN INFORMATION, HANALEI, KAUAI, HAWAII

TECHNICAL APPENDIX

TABLE OF CONTENTS

Paragraph	Description	Page
1	PURPOSE	A-1
2	AUTHORIZATION	A-1
3	COORDINATING AGENCY FOR LOCAL INTERESTS	A-1
4	SURVEYS	A-2
5	MAPPING	A-2
6	PROFILES AND CROSS SECTIONS	A-2
7	HIGH WATER MARKS	A-2
8	PHYSIOGRAPHIC CHARACTERISTICS	A-3
9	HYDROMETEOROLOGICAL CHARACTERISTICS	A-4
10	RUNOFF CHARACTERISTICS	A-4
11	EXISTING FLOOD-CONTROL STRUCTURES	A-5
12	RAINFALL RECORDS	A-5
13	RUNOFF RECORDS	A-7
14	STORMS AND FLOODS OF RECORD	A-8
15	RELATIVE MAGNITUDE OF STORMS	A-9
16	SYNTHESIS OF STANDARD PROJECT FLOOD	A-9
17	DETERMINATION OF STANDARD PROJECT STORM	A-9
18	RAINFALL-RUNOFF RELATIONSHIPS	A-9
19	DETERMINATION OF STANDARD PROJECT FLOOD	A-11
20	STANDARD PROJECT FLOOD	A-11
21	PEAK DISCHARGE FREQUENCY	A-11
22	FLOOD ROUTING	A-14
23	FLOOD PROFILES	A-14
24	ELEVATION-DISCHARGE RELATIONSHIPS	A-14
25	VELOCITIES	A-15
26	TSUNAMIS IN HAWAII	A-15
27	TSUNAMI DAMAGE	A-15
28	PROPOSED NAVIGATION PROJECT	A-15
29	FLOOD PLAIN REGULATION	A-17
30	EXCERPTS FROM ZONING ORDINANCES	A-17
31	EXCERPTS FROM SUBDIVISION REGULATIONS	A-21
32	EXCERPTS FROM ENCROACHMENT STATUTES	A-22
33	EXCERPTS FROM BUILDING CODES	A-23
34	CORRESPONDENCE FROM OTHER AGENCIES	A-25
35	SELECTED BIBLIOGRAPHY	A-26

TABLES

Tables	Description	Page
A-1	Climatological Data for Kilauea, Kauai	A-5
A-2	Precipitation Stations In and Near Hanalei Flood Plain Drainage Area	A-6
A-3	Stream Gaging Stations In and Near Hanalei Flood Plain Drainage Area	A-7
A-4	Subarea Lags and Pertinent Elements	A-10
A-5	Locations for Standard Project Flood Estimates and Peak Discharge Frequency	A-11
A-6	Seasonal Peak Discharges at Gaging Stations In and Near Hanalei Flood Plain Drainage Area	A-12
A-7	Tsunamis Affecting Hawaii	A-16

PLATES

Plates	Description
A-1	Details of Flood Plain
A-2	Hanalei River Flood Profiles
A-3	Waioli Stream Flood Profiles
A-4	Waipa Stream Flood Profiles
A-5	Drainage Area and Hydrologic Map
A-6	S-Graph
A-7	Lag Curve
A-8	Standard Project Flood Hydrograph
A-9	Envelope Curves of Peak Discharges
A-10	Frequency Curves
A-11	Hanalei River Cross Sections
A-12	Hanalei River Cross Sections
A-13	Hanalei River Cross Sections
A-14	Hanalei River Cross Sections
A-15	Waioli Stream Cross Sections
A-16	Waioli Stream Cross Sections
A-17	Waioli Stream Cross Sections
A-18	Waioli Stream Cross Sections
A-19	Waipa Stream Cross Sections
A-20	Waipa Stream Cross Sections
A-21	Waipa Stream Cross Sections
A-22	Stream Bed Profiles
A-23	Details of Light Draft Boat Harbor

EXHIBITS

Exhibits	Description
A-1	Act 148, Session Laws of Hawaii, 1963
A-2	State of Hawaii Letter of Application for Hanalei Flood Plain Study
A-3	William F. Quinn, Governor of Hawaii Letter Dated June 21, 1962
A-4	Fish and Wildlife Service, U. S. Department of Interior Letter Dated June 15, 1962
A-5	U. S. Public Health Service Letter Dated June 25, 1962
A-6	Minutes of Hanalei Community Association General Meeting (No date)

FLOOD PLAIN INFORMATION

HANALEI, KAUAI, HAWAII

TECHNICAL APPENDIX

1. PURPOSE

This technical appendix contains detailed information and data to supplement the main report. Additional details for these investigations are available for inspection in the Honolulu District office of the Corps of Engineers.

2. AUTHORIZATION

The authority for the flood plain information report was granted under the provisions of Section 206, Public Law 86-645 (Flood Control Act of 1960). Section 206 reads as follows:

> "Sec. 206 (a) That, in recognition of the increasing use and development of the flood plains of the rivers of the United States and of the need for information on flood hazards to serve as a guide to such development, and as a basis for avoiding future flood hazards by regulation of use by states and municipalities, the Secretary of the Army, through the Chief of Engineers, Department of the Army, is hereby authorized to compile and disseminate information on floods and flood damages, including identification of areas subject to inundation by floods of various magnitudes and frequencies, and general criteria for guidance in the use of flood plain areas; and to provide engineering advice to local interests for their use in planning to ameliorate the flood hazard; Provided, That the necessary surveys and studies will be made and such information and advice will provide for specific localities only upon the request of a State or a responsible local governmental agency and upon approval by the Chief of Engineers.
>
> "(b) The Secretary of the Army is hereby authorized to allot, from any appropriations hereafter made for flood control, sums not to exceed $1,000,000 in any one fiscal year for the compilation and dissemination of such information."

3. COORDINATING AGENCY FOR LOCAL INTERESTS

The Hawaii State Department of Land and Natural Resources was designated as the coordinating agency for local interests by Act 34, Session Laws of Hawaii 1961. This Act was superseded by Act 148 in 1963. Exhibit A-1 is a copy of Act 148 and Exhibit A-2 is a copy of the letter requesting the Hanalei Flood Plain study.

4. SURVEYS

Surveys were made to develop topography of the flood plain. Field surveys consisted of spot elevations in the flood plain using U. S. Geological Survey Bench Mark 1 (1927) and an unnamed bench mark on the northeast corner of the abutment on the Hanalei River belt road bridge for vertical control. Additional control elevations were obtained from a map furnished by the Hawaii Department of Land and Natural Resources. Horizontal control was established by field orientation using an advance U. S. Geological Survey Hanalei Quadrangle sheet and a 1957 aerial photograph map made by the R. M. Towill Corporation of Honolulu for the State Department of Transportation. The scales of the quadrangle sheet and aerial photograph are 1" = 2,000' and 1" = 500' respectively. Bench mark descriptions follow with their physical location shown on Plate A-1.

> U.S.G.S. Bench Mark 1 (1927) -- A standard disk cemented in the top of the coping at the northeast corner of the concrete loading platform at the outer end of the pier. The pier is on the east side of the bay and about 100 yards south of the mouth of the Hanalei River. Elevation: 8.74 feet above mean lower low water. (7.89 feet mean sea level.)
>
> Unnamed Bench Mark -- Bronze tablet top of northeast concrete abutment on Hanalei River Bridge. U.S.G.S. elevation 17.04, mean sea level datum.

5. MAPPING

The 1957 aerial photograph described in paragraph 4 and the Hanalei quadrangle sheet were used as base maps to define the physical culture and to aid in determining elevation contours in the area. Stationing, bridge and valley cross section locations shown on Plate A-1 were measured from an enlargement of the Hanalei quadrangle sheet. Additional data, presented on Plate A-1, concerning drainage structures along the belt road, pipe line crossings and elevation controls were taken from a Hawaii Department of Land and Natural Resources map of the Hanalei River downstream of the belt road crossing.

6. PROFILES AND CROSS SECTIONS

Stream bed profiles and valley sections were taken from available maps with interpolated values verified by field checks. Bridge data and channel sections were obtained through field surveys. The profiles are shown on plates A-2, A-3 and A-4.

7. HIGH WATER MARKS

High water marks and limits of inundation for known floods were obtained from interviews with local people to supplement recorded stages available from the U.S.G.S. gages. Newspapers also furnished additional information.

8. PHYSIOGRAPHIC CHARACTERISTICS

a. The flood plain which comprises about 1,850 acres is along the south shore of Hanalei Bay (plate A-5) on the northern side of the island of Kauai approximately in latitude 22° 13' north and longitude 159° 31' west. Streams tributary to the flood plain are (a) Hanalei River (drainage area about 23.1 square miles), (b) Waioli Stream (drainage area about 5.1 square miles) and (c) Waipa Stream (drainage area about 3.2 square miles).

b. Hanalei River, with a total length of about 14.5 miles, rises near Mt. Waialeale at elevation 5,050 feet above mean sea level and flows northerly down a central valley to empty into the Pacific Ocean through Hanalei Bay. The average gradient of the main stream in the upper 1.5 miles is about 1,800 feet per mile. Over the next 8 miles the average gradient is about 180 feet per mile, and over the remaining distance of about 5 miles to the mouth, the average gradient is about 10 feet per mile. The average elevation of the ridge forming the western boundary of the drainage area is about 3,500 feet varying from sea level to 5,050 feet. A less pronounced ridge with an average elevation of about 1,500 feet forms the eastern boundary of the drainage area.

c. Waioli Stream, with a total length of about 5 miles, rises on the northern slopes of Kalika peak (elevation 4,189 feet above mean sea level) and flows northerly through a narrow valley to Hanalei Bay. The gradient of the stream in the upper one mile is about 3,500 feet per mile, about 500 feet per mile in the next 2 miles and about 30 feet per mile in the remaining 2 miles. The average elevations of the ridges forming the eastern and western boundaries of the drainage area are about 2,000 and 3,000 feet above mean sea level, respectively.

d. Waipa Stream, with a total length of about 3.3 miles, rises on the northwestern slope of Mt. Mamalahoa (elevation 3,735 feet) and flows generally north to Hanalei Bay. The average gradient of the stream in the upper miles is about 3,100 feet per mile, about 500 feet per mile in the next mile and about 50 feet per mile in the remaining 1.3 miles. The average elevation of the eastern and western ridges that form the drainage boundary is about 1,500 feet.

e. Except for the area under cultivation near the mouths of the streams and a few barren spots on the steeper slopes, the area is densely covered with native or escaped vegetation. The town of Hanalei, with a population of about 370, is along the south shore of Hanalei Bay and is the only settlement within the drainage area.

f. The island of Kauai is the summit of one of the principal volcanic mountains of the Hawaiian range. Various periods of eruption, separated by intervals of erosion and decomposition combined with faulting, as well as submergent and emergent periods, have

resulted in a complex geological structure. Soils within the drainage area are mainly residual having been derived from the decomposition in situ of volcanic flows in the uplands. They vary in color from brick red in the dryer portions of the area to brown in the moist portions and are of a basaltic base. The soils in the lowlands are essentially residual laterites of varying composition. Along the coast detritus from the disintegration of the fringing reef is added to the basaltic detritus. The lower portions of the river valleys are of alluvial deposits generally in the form of black sticky mud, known locally as "taro patch clay."

9. HYDROMETEOROLOGICAL CHARACTERISTICS

a. Median seasonal rainfall for the drainage area ranges from about 70 inches near the coast to about 400 inches in the headwaters. Median seasonal isohyets based on data for the period 1933-1957 are shown on plate A-5. Rainfall in the higher regions is fairly uniform throughout the year, while near the coast most rainfall occurs during the winter months. The nearest U. S. Weather Bureau station is at Kilauea (elevation 320 feet) about 6 miles east of Hanalei. A climatological summary for this station is given in table A-1. The prevailing winds are the northeast trade winds which are maintained about 80 percent of the time. The trade winds are interrupted at intervals, mostly during the winter months, by cyclonic disturbances from the south which are known as "kona" storms. Precipitation in the form of snow has never been recorded on the island of Kauai.

b. The types or kinds of meteorological situations associated with major rainfalls of record may be classified as (1) vigorous trade wind situations; (2) easterly waves; (3) frontal passages; (4) "Kona" type storms; (5) local convective storms or thunderstorms; and (6) tropical cyclones. High flood-peak producing storms are usually severe local storms that occur in association with any of the above meteorological situations except local convective storms or thunderstorms. Usually the severe local storms are of short duration (3 to 6 hours) but produce high rainfall intensities over relatively small areas.

10. RUNOFF CHARACTERISTICS

Streams in the drainage area usually have small flows throughout the year. During high-intensity storms streamflow increases rapidly in response to effective rainfall. On one occasion the Hanalei River, at the highway bridge about 2 miles upstream from the mouth, was reported to have risen 6 feet in 15 minutes. Peak discharges in the stream usually occur within 2 to 3 hours after high intensity rainfall. The extremely dense vegetation over most of the area causes effective rain as pertains to high streamflow to occur only after there has been considerable prior rainfall (approximately 5 inches in the area.) Because of steep slopes streamflow is back to near normal within a few hours after the storm.

Table A-1

Climatological Data for Kilauea, Kauai[1/]

Month	Temperature			Precipitation		
	Maximum degrees fahrenheit	Minimum degrees fahrenheit	Mean degrees fahrenheit	Maximum inches	Minimum inches	Mean inches
January	87	49	69.3	51.10	0.73	7.15
February	87	50	69.5	18.81	0.87	5.64
March	90	50	69.6	31.95	0.83	8.10
April	90	52	70.9	20.54	0.97	5.57
May	87	55	72.8	16.25	0.70	5.04
June	90	55	74.8	9.93	0.34	3.51
July	90	57	75.6	15.74	1.85	4.63
August	94	60	76.1	11.07	1.72	4.74
September	90	58	75.9	27.30	1.34	4.39
October	92	59	75.0	13.40	1.53	5.35
November	88	55	72.6	29.59	0.96	7.01
December	88	50	70.7	21.18	1.05	7.06
Period of Record-Year	94	49	72.7	102.90	38.25	68.19

1/ Station number 1134 in accordance with State key number system.

Note: Above data from U. S. Weather Bureau Climatological Data Summaries. Temperature values are based on 45 years of record (1905-1950). Precipitation values are based on 77 years of record (1885-1962).

11. EXISTING FLOOD-CONTROL STRUCTURES

There are no flood-control structures located within the drainage area. Since 1925 relatively small flows (about 40 cubic feet per second) have been diverted from the headwaters of Hanalei River through the Hanalei tunnel for irrigation in the vicinity of Lihue. China Ditch in the lower part of Hanalei River also diverts small flows for irrigation.

12. RAINFALL RECORDS

Rainfall records are available for 18 stations in and near the drainage area. Pertinent data for these stations are given in table A-2 and locations are shown on plate A-5. Records are available during various periods since 1892. The only recording rain gage close to the drainage area is the Mt. Waialeale gage at elevation 5,075 feet near the headwaters of Hanalei River. Intermittent records are available for this gage since 1949.

Table A-2

Precipitation Stations In and Near Hanalei Flood Plain Drainage Area

Number[1]	Name[2]	Geographic Coordinates: Elevation Ft. above mean sea level	Latitude degrees and minutes	Longitude degrees and minutes	Period of record	Frequency of observations	Maintained by
1044	Keanakua	4450	22-04.4	159-32.8	1910-64	1 or 2 times yearly	US Geological Surv.
1047	Mt. Waialeale	5075	22-04.1	159-30.0	1910-64	Annually thru 1949[3]	"
1051	North Wailua Ditch	1010	22-03.6	159-27.9	1928-64	Monthly thru 1953, then daily	Lihue Plantation
1053	Hanalei Tunnel	1220	22-05.0	159-28.2	1928-64	Monthly	"
1053.1	Summit Camp	1900	22-06.1	159-26.9	1910-27	Monthly	Kauai Electric
1053.2	Kapehuala	3130	22-06.7	159-25.1	1910-11	Irregular	US Geological Surv.
1055.1	Stable Camp	740	22-03.5	159-26.7	1950-64	Continuous (recorder)	Corps of Engineers
1086	Intake, Wainiha Power Canal	700	22-09.1	159-34.2	1907-64	After rains	McBryde Sugar Co.
1115	Powerhouse-Wainiha	100	22-11.7	159-33.5	1907-64	Daily	"
1117	Princeville Ranch	295	22-12.8	159-28.5	1910-64	Daily	Princeville Ranch
1117.1	Hanalei (Deverill)	10	22-12.2	159-30.3	1892-1909	Daily	E.G.K. Deverill
1117.2	Hanalei River	625	22-07.1	159-28.0	1914-55	Several times yearly	US Geological Surv.
1117.3	Waioli	600	22-10.2	159-29.8	1921-32	Several times yearly	"
1117.4	Field P-24	275	22-12.8	159-27.3	1957-64	Monthly	Hawaiian Canneries
1117.5	Hanalei	250	22-12.6	159-27.7	1929-39	After rains	"
1117.6	Waioli (Johnson)	20	22-12	159-30	1845-46	Daily	Rev. E. Johnson
1131	Kalihiwai Reservoir	400	22-11.2	159-25.9	1930-64	Daily except weekends	Kilauea Sugar Co.
1131.1	Kapaka	635	22-10.8	159-27.7	1910-45	Daily except weekends	McBryde Sugar Co.
1131.2	Kalihiwai	700	22-08.5	159-26.6	1914-23	Several times yearly	US Geological Surv.
1134	Kilauea	315	22-12.7	159-24.6	1885-1964	Daily except weekends[4]	Kilauea Sugar Co.

1/ Station numbered in accordance with state key number system.

2/ See plate A-5 for locations except for stations 1086 and 1115 which are not shown on map.

3/ A recording gage was instalaled at this station in 1949 and has been in operation intermittently since that time.

4/ A recording gage was installed at this station in 1960.

Note: Above data obtained from U. S. Department of Commerce, Weather Bureau publication entitled. "A Key to Climatological Observations in Hawaii," printed in 1961.

13. RUNOFF RECORDS

Runoff records are available for 4 stream-gaging stations in the area. Pertinent data for these stations are given in table A-3 and locations are shown on plate A-5.

Table A-3

Stream Gaging Stations In and Near Hanalei Flood Plain Drainage Area

Number[1]	Name[2]	Elevation of gage[3] ft. above mean sea level	Geographic coordinates Latitude degrees, minutes and seconds	Geographic coordinates Longitude degrees, minutes and seconds	Drainage area square miles	Period of record
1010	Hanalei River 6.2 mi. east of Hanalei	625	22-07-10	159-28-05	7.4	1914-55
1030	Hanalei River near Hanalei	40 50	22-11-15 22-11-21	159-27-55 159-27-58	19.2 19.1	1911-19 1962[4]
1042	Hanalei River near Hanalei	[5]	22-12-39	159-28-43	21.0	1962-
1050	Waioli Stream near Hanalei	550	22-10-05	159-29-50	1.5	1914-32

1/ Station numbered in accordance with U.S. Geological Survey numbering system.

2/ See plate A-5 for location.

3/ From topographic maps.

4/ Water-stage recorder installed.

5/ Zero of gage is 7.025 m.s.l.

Note: Above data from U. S. Geological Survey water supply papers.

14. STORMS AND FLOODS OF RECORD

At least 8 storms that produced 24-hour rainfall amounts in excess of 20 inches have occurred at various locations throughout the island since fairly complete records have been maintained. Seasonal peak discharges, at U. S. Geological Survey gaging station elevation 625 on the Hanalei River, indicate that one or more floods of various magnitude occurred during the seasons of 1914-15, 1920-21, 1936-37, 1938-39, 1940-41, 1945-46, 1947-48, 1951-52, 1953-54, and 1954-55. Seasonal peak discharges greater than 6,000 cubic feet per second at the gaging station are considered flood producing flows. Storms during the seasons of 1955-56 and 1962-63 are also considered as causing flood producing flows. Those storms occurred during a period when the stream gage was not in operation. Major storms in the drainage area are described in the following paragraphs.

a. Storm and flood of November 11-12, 1955. The November 11-12, 1955 storm was a low latitude extra-tropical or "kona" storm with two centers, one in the vicinity of Kilauea, about 4 miles east of the Hanalei area, and another in the vicinity of Mt. Waialeale. The Kilauea Plantation office, near one center of the storm, had 19.8 inches of rain in 13.5 hours with a storm total of 26.1 inches. Considerable flooding occurred in the Wailua River drainage area, south of the storm center, where estimated peak discharge rates (cubic feet per second per square mile of drainage area) were the maximum of record for the island of Kauai. Excessive runoff was due, in part, to considerable rain in the area during a 3-day period prior to the main storm.

b. Storm and flood of January 24-25, 1956. A cold front from the northwest passed over Kauai bringing thunderstorms and record breaking rains over the northern portion of the island on January 24-25, 1956. Records for the Kilauea Plantation office rain gage show that 41.9 inches of rain fell within a 30-hour period on the 24th-25th. It was estimated that 6 inches fell in 30 minutes and that 12 inches fell in one hour during the storm. All of the recording rain gages (capacity 12 inches) near the storm center overflowed. The maximum 1- and 5-hour recorded rainfall amounts prior to the overflow of the Kilauea Plantation office gage were 7.5 and 9.5 inches, respectively. No appreciable rain had fallen for a period of about 6 days prior to the storm. However, runoff was quite heavy in the area near the storm center. No stream-gaging stations were in operation and no estimates of peak discharges were made in the Hanalei area.

c. Storm and flood of April 12-16, 1963. An upper level low pressure area caused light rainfall in the mountain sections of Kauai on April 12. Rainfall averaged one inch on the 13th and two inches on the 14th of April with no flooding reported for either day. The heaviest concentration of rainfall occurred between 6:00 AM and 6:00 PM on April 15. During this 12-hour period, the average rainfall was 4 inches for the island. The highest intensity recorded on Kauai was

3.20 inches in one hour and 6.0 inches in 2 hours at the Honolulu District office rain gage at Stable Camp on the eastern slope of Mount Waialeale. The two-hour rainfall of 6 inches represents a recurrence interval of about 20 years. The north Wailua Ditch rain gage had the maximum daily and total storm rainfall. The maximum daily precipitation was 14.8 inches on April 15 and the storm total was 16.7 inches for the period April 12-16, 1963. No record of stream flow was maintained for the Hanalei River between 1955-1962 but this rise was the third highest during the past 50 years.

15. RELATIVE MAGNITUDE OF STORMS

The relative magnitude of the numerous storms that have occurred in the area is difficult to determine because of inadequate recording gage records. The records show, at best, 24-hour amounts observed at various times during the storm. The storm of January 24-25, 1956 produced the greatest storm total and perhaps the greatest intensities of storms of record.

16. SYNTHESIS OF STANDARD PROJECT FLOOD

The standard project flood for the Hanalei area was developed according to criteria presented in a memorandum by the Office of the Chief of Engineers, dated September 19, 1962, subject: "Standard Project Storm Determinations, Hawaiian Islands," and instructions given in Civil Engineer Bulletin 52-8, dated March 26, 1952.

17. DETERMINATION OF STANDARD PROJECT STORM

The standard project flood is defined as an estimated or hypothetical storm that might be expected from the most severe flood-producing rainfall depth-area-duration relationship and isohyetal pattern that is considered reasonably characteristic of the geographical region involved, excluding extraordinarily rare combinations. The maximum 6-hour rainfall was computed to be 14.6 inches and the total storm rainfall about 27.5 inches for the Hanalei River watershed. The Waioli and Waipa streams had maximum 6-hour intensities of 17 and 17.8 inches with storm totals of 29 and 30 inches, respectively.

18. RAINFALL-RUNOFF RELATIONSHIPS

Available rainfall and runoff records are inadequate for an analysis of rainfall-runoff relationships in the drainage area. The rainfall-runoff relationships that were adopted for this study were determined by the application of synthetic unit hydrographs, rainfall-loss rates and base flow that were based on information from hydrologic investigations made for other flood control reports for streams mostly in the Los Angeles District. While several rainfall stations are located in or near the drainage area, observations at most

stations are made daily, or less often, which makes the records of little value for an analysis of rainfall-runoff relationships. Elements used to establish the rainfall-runoff relationships are explained in the following subparagraphs.

a. Unit hydrographs. The synthetic unit hydrographs used for this study were based on an S-graph (see plate A-6) and a lag curve (see plate A-7) developed for mountain areas in the Los Angeles District. Values of lag and pertinent elements for selected concentration points in the drainage area are given in table A-4.

Table A-4

Subarea Lags and Pertinent Elements
Hanalei Flood Plain Information Study

Subarea designation[1/]	Drainage area, square miles	L, miles	L_{ca}, miles	S, feet/mile	$\frac{L \cdot L_{ca}}{S^{\frac{1}{2}}}$	Lag[2/]
A	7.4	4.3	1.8	1005	0.24	0.68
A and B	23.1	14.5	8.2	345	6.39	2.40
C	5.1	5.0	2.5	900	.42	.84
D	3.2	3.3	1.3	1120	.13	.54

1/ See plate A-5 for location.
2/ See plate A-7 for lag curve and explanation of terms.

b. Rainfall-loss rates. Insufficient rainfall data are available for the determination of rainfall-loss rates in the drainage area. Based on an inspection of the area and a comparison of the area with areas of established loss rates, it is estimated that an average loss rate of 0.5 inch per hour varying to a minimum of 0.2 inch per hour is a reasonable rainfall-loss rate for the drainage area. Unusually high rainfall intensities during the standard project storm are such that a variation of a few tenths in loss rate is relatively unimportant. A study of storms of record indicates that high intensity rainfall of about 6 hours or less usually occurs in connection with storms of much longer durations and after considerable rainfall has occurred. Therefore sufficient prior rainfall to reasonably condition the ground for runoff was assumed.

c. Base flow. No determination of base flow for the drainage area has been made. An assumed constant base flow of 20 cubic feet per second per square mile of drainage area was used to develop the standard project flood.

19. DETERMINATION OF STANDARD PROJECT FLOOD

The standard project flood was determined at each selected concentration point in the drainage area by the following procedure: (a) determination of unit-time increments of rainfall; (b) determination of effective rainfall by subtraction of loss rate; (c) determination of surface-runoff hydrograph by application of the unit hydrograph to the effective unit-period rainfall; and (d) determination of total runoff hydrograph by addition of base flow.

20. STANDARD PROJECT FLOOD

The standard project flood hydrograph for Hanalei River at cross section No. 8 (see plate A-1) is shown on plate A-8. Standard project flood peak discharges in cubic feet per second at each selected concentration point are (a) Hanalei River cross section No. 8, 35,000; (b) Hanalei River at elevation 625, 21,000; (c) Waioli Stream at mouth, 16,000; and (d) Waipa Stream at mouth, 11,000. Table A-5 shows the locations for these estimates of peak discharge.

Table A-5

Locations for Standard Project Flood Estimates and Peak Discharge Frequency

Concentration Point No.	Stream	Location	Drainage area
			sq. mi.
1[1/]	Hanalei River	Elevation 625[2/]	7.4
2[4/]	Hanalei River	Cross-sec No. 8[3/]	23.1
3[1/]	Waioli Stream	Mouth	5.1
4[1/]	Waipa Stream	Mouth	3.2

1/ See plate A-5 for location.
2/ Standard-project-flood peak discharge estimated at this location for use only in the peak discharge frequency analysis for the area.
3/ See plate A-8 for hydrograph at this location.
4/ See plate A-1 for location.

21. PEAK DISCHARGE FREQUENCY

Peak discharge frequency curves were developed from recorded seaonal (July to June, inclusive) peak discharges for 6 stream-gaging stations in the general region with records varying from 15 to 41 years (see table A-6).

Table A-6

Seasonal Peak Discharges at Gaging Stations In and Near Hanalei Flood Plain Drainage Area

Season[1]	Seasonal peak discharge[2]					
	Hanalei River 6.2 miles southeast of Hanalei Sta.No.1010 DA = 7.4 sq. miles	Kalalau Stream near Hanalei Station No.1170 DA = 1.6 sq.miles	Hanakapiai Stream near Hanalei Station No. 1150 DA = 2.1 sq.miles	Hanakoa Stream near Hanalei Station No.1160 DA=1.1 sq.miles	Waioli Stream near Hanalei Station No.1050 DA=1.5 sq.miles	Lunahai Stream near Hanalei Station No.1060 DA=7.5 sq.miles
	Cu ft/sec.	Cu ft/sec	Cu ft/sec	Cu ft/sec	Cu ft/sec	Cu ft/sec
1914-15	8,280				1,700	4,020
1915-16	5,720				1,160	1,470
1916-17	3,950				1,480	7,120
1917-18	2,550				852	NR
1918-19	2,480				534	NR
1919-20	4,830				727	NR
1920-21	6,220				1,360	NR
1921-22	1,870				913	3,480
1922-23	4,180				1,320	11,900
1923-24	3,470				990	4,490
1924-25	3,030				696	3,250
1925-26	2,100				362	1,780
1926-27	4,600				1,160	4,950
1927-28	5,030				854	4,300
1928-29	3,030				1,420	5,880
1929-30	2,480				1,020	4,950
1930-31	2,100				927	7,150
1931-32	3,470				1,370	6,160
1932-33	2,660	198	1,040	447		6,650
1933-34	2,100	313	2,290	685		
1934-35	1,950	282	788	447		
1935-36	2,100	254	2,750	438		
1936-37	8,320	260	2,070	639		
1937-38	2,750	354	4,150	880		
1938-39	9,520	68	399	235		
1939-40	3,140	523	2,600	812		
1940-41	6,840	234	842	577		
1941-42	1,950	114	684	322		
1942-43	5,650	472	1,480	591		
1943-44	4,730	114	588	396		
1944-45	4,600	291	925	515		
1945-46	6,330	195	746	456		

Table A-6 (Cont'd)

Seasonal Peak Discharges at Gaging Stations In and Near Hanalei Flood Plain Drainage Area

Season[1]	Seasonal peak discharge[2]					
	Hanalei River 6.2 miles southeast of Hanalei Sta.No.1010 DA = 7.4 sq. miles	Kalalau Stream near Hanalei Station No.1170 DA=1.6 sq.miles	Hanakapiai Stream near Hanalei Station No.1150 DA=2.1 sq.miles	Hanakoa Stream near Hanalei Station No.1160 DA=1.0 sq.miles	Waioli Stream near Hanalei Station No.1050 DA=1.5 sq.miles	Lunahai Stream near Hanalei Station No.1060 DA=7.5 sq.miles
	Cu ft/sec.	Cu ft/sec	Cu ft/sec	Cu ft/sec	Cu ft/sec	Cu ft/sec
1946-47	5,490	870	1,840	1,060		
1947-48	9,750	464	897	418		
1948-49	5,650	959	1,550	362		
1949-50	4,730	314	1,830	633		
1950-51	9,190	1,030	2,520	1,700		
1951-52	14,200	588	2,600	1,070		
1952-53	1,470	696				
1953-54	7,550	237				
1954-55	6,500	828				

1/ Season July to June, inclusive.
2/ See plate A-5 for locations.
NR = No record.

Note: Above data from U. S. Geological Survey water supply papers. The enveloping curves of peak discharge for streams in the Hanalei area are shown on plate A-9. A study of the 6 frequency curves indicates that the slope of the curve for the Hanalei River gaging station with a 41-year record is reasonably representative of the region and was therefore used as a guide to develop frequency curves at selected locations in the area. The standard-project-flood peak for the Hanalei River gaging station at elevation 625 was computed and the indicated frequency of the standard project flood peak at this location together with the average regional slope were used to develop required frequency curves for the area. Frequency determinations were made using methods outlined in the revised edition of "Statistical Methods in Hydrology" published under Civil Works Investigations Project CW-151 by the Sacramento District in January 1962. Curves thus developed are shown on plate A-10.

22. FLOOD ROUTING

Methods in the Corps of Engineers Engineering Manual 1110-2-1408, "Routing of Floods Through River Channels," 1 March 1960, were used to reflect storage influence in reducing the peak discharges through the reach from cross section No. 8 (plate A-1) to the mouth of the Hanalei River. The peak discharges for the frequencies as shown on plate A-10 were assumed to be effective at cross section No. 8 (see plate A-1). The discharges as a result of this routing are shown on plate A-2.

23. FLOOD PROFILES

The water surface profiles for the derived floods shown on plates A-2 through A-4 were developed by backwater computations, using methods based on Manning's friction formula. The controlling elevation at the mouth was assumed to be for high tide conditions. Manning's formula is:

$$Q = \frac{1.486}{n} AR^{2/3} S^{\frac{1}{2}}$$

where Q = discharge in cubic feet per second
A = cross sectional flow area in square feet
R = hydraulic radius (ratio of area to wetted perimeter)
S = slope of hydraulic gradient in foot per foot
n = channel roughness coefficient

Hanalei River:	channel	n = .03
	overbank	n = .04
Waioli Stream:	channel	n = .03
	overbank	n = .04
Waipa Stream:	channel	n = .03
	overbank	n = .05

The November 1955 flood peak on the Hanalei River entered Hanalei Bay at low tide. High tide occurred about 3 hours prior to the maximum peak of the April 1963 flood. Profiles for these floods are shown on plate A-2 for two different conditions. One profile reflects what would occur when high tide controls the backwater at the mouth of the river. The other shows the water surface established by field observation and interviews with residents of Hanalei.

24. ELEVATION-DISCHARGE RELATIONSHIPS

The computed elevations at selected cross sections and bridge sections are shown on plates A-11 through A-21. These cross sections, when oriented in accordance with the plan view shown on plate A-1, illustrate the depth and limit of flooding in the flood plain.

25. VELOCITIES

The stream gradient of the three flood producing tributaries are relatively steep and flood flow velocities can be expected to be high. Backwater computations reveal maximum channel and overbank velocities of 13 and 3 feet per second respectively with average velocities of 7 and 2 feet per second. Although this range of velocity removes the silt deposited in the stream and aids runoff conditions, it also contributes to erosive action affecting the banks and adjacent cultivated fields. Plate A-22 shows the approximate stream bed profiles for the tributaries involved.

26. TSUNAMIS IN HAWAII

The frequency of tsunamis in the Pacific Ocean is exemplified by the record of 43 damaging occurrences in Hawaii over the past 146 years. Pertinent information is given in table A-7, which does not include those tsunamis manifesting their presence by only slight variations in water surface. The dearth of data recorded by instrumentation and the marked variation in activity even within extremely short distances along a coast preclude the assignment of height to the largest wave in each phenomenon. Then, too, eye witness accounts and data provided by post-tsunami examination of areas subjected to violent attack can be misleading, since it is difficult to differentiate between a solid mass of water and run up or spray. In the case of water marks on objects, run up, which varies with the shape of the obstruction and environmental factors, contributes immensely to distortion of the true picture. Wave height determination by refraction analysis was considered, but wave characteristics, such as length, and other factors preclude determination by this procedure. Besides, much data relative to deep water characteristics are lacking.

27. TSUNAMI DAMAGE

Since no correlation of occurrences by wave height could be made, comparison was effected on the basis of severity of damage. Each event was classified into one of four categories, namely, very severe, severe, moderate and slight. Difficulty was encountered even in this relatively simple approach to the problem because data pertaining to early occurrences is limited. Of the 43 listings 7 were designated very severe, 2 severe, 8 moderate and 26 slight. The more recent damaging tsunamis and their effects at Hanalei are described in the main report. The estimated area of the 1957 tsunami inundation is shown on plate A-1.

28. PROPOSED NAVIGATION PROJECT

The recommended plan for development of a light-draft harbor at Hanalei Bay is shown on plate A-23. It provides for a harbor basin to be constructed within the land area comprising the north end of

Table A-7

Tsunamis Affecting Hawaii

Date	Source	Wave period (minutes)	Damage
Apr 12, 1819	Chile	11	Slight
Feb 20, 1835	Chile	-	Severe
Nov 7, 1837	Chile	28	Very severe
May 17, 1841	Kamchatka	40	Moderate
Apr 2, 1868	Hawaii	-	Very severe
Aug 13, 1868	Peru and Bolivia	-	Very severe
Jul 25, 1869	South America	-	Severe
Aug 23, 1872	Hawaii	6	Moderate
May 10, 1877	Chile	20	Very severe
Jan 20, 1878	-	-	Slight
Aug 27, 1883	-	-	Moderate
Jun 15, 1896	Japan	-	Slight
Aug 9, 1901	Japan	-	Slight
Jan 31, 1906	Colombia	-	Slight
Aug 16, 1906	Chile	-	Moderate
Oct 11, 1913	New Guinea	-	Slight
May 26, 1914	New Guinea	-	Slight
May 1, 1917	Kermadea Islands	-	Slight
Jun 25, 1917	Samoan Islands	-	Slight
Aug 15, 1918	Philippine Islands	-	Slight
Sep 7, 1918	Kurile Islands	-	Moderate
Apr 30, 1919	Tonga Islands	90	Slight
Nov 11, 1922	Chile	-	Slight
Feb 3, 1923	Kamchatka	15	Very severe
Apr 13, 1923	Kamchatka	-	Slight
Nov 4, 1927	California	-	Slight
Dec 28, 1927	Kamchatka	-	Slight
Jun 16, 1928	Mexico	-	Slight
Mar 6, 1929	Aleutian Islands	-	Slight
Oct 3, 1931	Solomon Islands	15	Slight
Jun 3, 1932	Mexico	-	Slight
Mar 2, 1933	Japan	-	Moderate
Nov 10, 1938	Alaska	-	Slight
Apr 6, 1943	Chile	-	Slight
Dec 7, 1944	Japan	-	Slight
Apr 1, 1946	Aleutian Islands	1 5	Very slight
Dec 20, 1946	Japan	-	Slight
Aug 21, 1951	Hawaii	-	Slight
Nov 4, 1952	Kamchatka	38	Moderate
Mar 9, 1957	Aleutian Islands	18	Moderate
May 23, 1960	Chile	33	Very severe
Oct 19, 1963	Japan	-	Slight
Mar 27, 1964	Alaska	22	Slight

the peninsula between the bayshore and the river estuary. A combination entrance and main access channel would extend from Hanalei Bay into the middle portion of the peninsula to serve a berthing area of approximately 5.5 acres which would accommodate about 180 boats. The total length of the channel would be 1,800 feet. The 950 feet of channel inside the existing shoreline would be 100 feet wide and dredged to a depth of 12 feet.1/ The entrance channel would extend 850 feet offshore to the existing 15-foot depth contour of the bay floor. The shoreward 200 feet of this outer channel would be 120 feet wide and 12 feet deep while the seaward 650-foot portion would be the same width but have a depth of 15 feet. Channel side slopes within the peninsula would require 1,450 linear feet of revetment to prevent erosion by minor wave action. Dredged material from the channel and basin would be spoiled to provide a surrounding fill to an elevation of 11 feet, except on the south side of the channel where the elevation would be 6 feet. The wider portions of this fill at the northeast corner of the project would be developed for shoreside facilities. An additional 150-foot section of revetment would be necessary to protect the fill on the south side of the access portion of the channel adjacent to the beach from storm waves. A jetty on the south side of the entrance channel located immediately adjacent to the existing pier, would be a rubblemound structure 380 feet long and armored with 1-ton stone; the crest elevation would vary from 5 to 6 feet.

29. FLOOD PLAIN REGULATION

Flood plain land use regulation has been accomplished by other states and municipalities using various combinations of regulatory powers available to them. Excerpts of laws and ordinances dealing with flood plain regulation are given in the following paragraphs to demonstrate their importance in a well planned community development program.

30. EXCERPTS FROM ZONING ORDINANCES

Kingsport

(From Kingsport, Tennessee, Ordinance No. 1563, adopted 22 July 1957)

* * *

F-1 Floodway channel district regulations:

Within the F-1 Floodway channel districts, as shown on the Zoning map, the following regulations shall apply:

1/ All depths or elevations cited in paragraph 28 are referenced to mean lower low water (MLLW) datum.

(a) Uses permitted.

Any use permitted in the nearest adjacent zoning district on the same side of Reedy Creek.

(b) Uses and improvements prohibited.

1. No building or structure shall be constructed, altered, or extended in said flood area, and no building or structure shall be moved within or into the F-1 district.

2. No landfill or dumping shall be permitted in said flood area.

3. No permanent storage of materials or equipment shall be permitted in said zone.

SECTION VI. Be it further ordained by the City of Kingsport, Tennessee, that the Zoning Map of the City of Kingsport, adopted and enacted as part of Zoning Ordinance No. 894, the same being Chapter 34 of the 1949 City Code, as the same has been heretofore amended, be further amended so as to provide that the area and territory hereinafter described under this section be declared to be and the same shall be designated as an F-1 Floodway Channel District, and which said area is located in the City of Kingsport, and the 11th Civil District of Sullivan County, Tennessee, and being described and bounded as follows, to-wit:

Beginning at a point on the corporate limits line, said point being forty (40) feet from and radial or perpendicular to the centerline of Reedy Creek and approximately two hundred (200) feet south of the center of the Clinchfield Railroad Bridge, measured along said corporate limits line; thence on a line meandering easterly and northeasterly forty (40) feet from and parallel with the centerline of said creek for a distance of about 2,200 feet to a point 2,000 feet upstream from the center of the Clinchfield Railroad bridge, measured along said centerline; thence on a line radial or perpendicular to the centerline of said creek for a distance of 25 feet to a point 65 feet from said centerline; thence on a line meandering in a generally northeasterly direction 65 feet from and parallel with the centerline of said creek ... thence southerly along said corporate limits line to the point of beginning.

* * *

Tehama County

(From Tehama County, California, Ordinance No. 302, adopted 5 September 1961)

* * *

SECTION 24-A. "PF" PRIMARY FLOOD PLAIN DISTRICTS

Sec. 24-A-1.--This district classification is intended to be applied by the County to properties which lie within a primary floodway, which for the purposes of this ordinance shall be construed to be a stream channel and the portions of the adjacent flood plain as are required to efficiently carry the flood flow of the stream, and on which properties special regulations are necessary for the minimum protection of the public health and safety, and of property and improvements from hazards and damage resulting from flood waters.

The following specific regulations and the general rules set forth in Section 31 shall apply in all "PF" Districts.

Sec. 24-A.2. Uses Permitted:

(a) Crop and tree farming, truck gardening, viticulture, livestock grazing, and other agricultural uses which are of the same or a closely similar nature.

(b) Public utility wire and pipe lines for transmission and local distribution purposes.

Sec. 24-A.3. Uses Permitted Upon The Issuance of Use Permits:

(a) The following uses, buildings and structures when it is found by the Planning Commission that such buildings and structures will be so constructed or placed, or will be so protected by levees or other flood proofing that they will not be appreciably damaged by flooding, will offer a minimum obstruction to flood flow, and will resist flotation:

1. Buildings and structures accessory to agricultural uses for the storage of goods and equipment and the shelter of animals and fowl, but not including dwellings or buildings for human occupancy.

2. Public utility buildings and structures other than wire and pipe lines.

3. Public parks and recreation areas and facilities, including boat ramps, docks, parking areas, picnic tables and fireplaces, private and commercial recreation developments and facilities, camp grounds and trailer parks, provided that rest room facilities shall be located and constructed in accordance with Health Department requirements.

(b) Commercial excavation of natural materials, filling of land areas; construction of levees, dikes or other structures designed to divert or obstruct the flow of flood waters.

(c) Single family residences and multiple family residences when it is found by the Planning Commission that such buildings and structures will be so constructed or placed, or will be so protected by levees or other flood proofing that they will not be damaged by flooding or constitute obstructions to flood flow or hazards to life or property.

D. By the addition thereto of a new Section to be designated Section 24-B, and to read as follows:

SECTION 24-B, "SF" SECONDARY FLOOD PLAIN DISTRICTS.

Sec. 24-B.1. This district classification is intended to be applied to properties which lie within areas inundated by overflow waters during the historical flood of 1958 of the Sacramento River and its tributaries, excluding areas within established "PF" Districts, which properties are subject to occasional flooding or inundation by overflow flood waters, and so require special regulations for the protection of such properties and their improvements from hazards and damage which may result from flood waters.

The following regulations and the general rules set forth in Section 31 shall apply to all "SF" Districts.

Sec. 24-B-2. Uses Permitted:

(a) Uses as permitted in "PF" Districts, (Sec. 24-A.2 and Sec. 24-A.3).

(b) Single-family dwellings and accessory residential and agricultural structures located on agricultural properties of three or more acres, provided that the ground floor level of such dwellings shall be above the level of the 1958 flood waters upon the particular property.

(c) Residential subdivision improvements and dwellings, as defined herein, within subdivisions approved and recorded in Tehama County after the fourth day of March, 1957, and subject to conditions to such approval and to ground floor level as specified in Sec. 24-B.2 (b) above.

Sec. 24-B.3. Uses Permitted Upon the Granting of Use Permits:

(a) Improvements, buildings and structures listed in Sec. 24-B.2 (a) and (b) above which may not meet the ground floor level specified, but which will otherwise be adequately protected by levees or other acceptable flood proofing.

(b) Single family dwellings, motels, multiple family dwelling.

(c) Local service commercial uses and structures.

(d) Uses and structures for the storage, distribution and processing of agricultural products, supplies and equipment.

(e) Public and private schools, churches, libraries, organization meeting halls and other similar places of public assembly.

* * *

31. EXCERPTS FROM SUBDIVISION REGULATIONS

Clinton

(From Clinton, Tennessee, Subdivision Regulations, adopted December 1957)

* * *

Land which the planning commission has found to be unsuitable for subdivision due to flooding, bad drainage, steep slopes, rock formation, or other features likely to be harmful to the safety, health, and general welfare of the future residents shall not be subdivided unless adequate methods approved by the city engineer are formulated by the developer for meeting the problems created by the subdivision of such land.

Land within the Floodway shall not be platted for residential occupancy or building sites. Other land subject to flooding may be platted for residential occupancy or for such other uses which will not increase the danger to health, life, and property. Fill may not be used to raise land in the Floodway areas. In other areas subject to flood, fill may be used providing the proposed fill does not restrict the flow of water and unduly increase flood heights.

In applying this provision land below the elevation of the 50,000 cfs Flood shall be considered subject to flood. The elevation of the 50,000 cfs Flood shall be determined from the chart "High Water Profiles, Clinch River, Vicinity of Clinton, Tennessee" (Tennessee Valley Authority, November 1957), which chart is made a part of these regulations. Areas included in the Floodway are as shown on the Zoning Map of Clinton, Tennessee.

* * *

No street shall be approved unless it is at an elevation within two feet of the elevation of the 50,000 cfs Flood. The planning commission may require where necessary profiles and elevations of streets for areas subject to flood. Fill may be used for streets provided such fill does not unduly increase flood heights. Drainage openings shall be so designed as to not restrict the flow of water and unduly increase flood heights.

* * *

For each lot in a subdivision that does not contain a flood-free building site as defined by these regulations, the subdivider must fill to the required elevation and meet other requirements concerning fills as specified in the introduction to Article II or include in the deed the restriction that the lower floor of any structure be built at an elevation not lower than that of the 50,000 cfs Flood referred to in the introduction to Article II.

* * *

If any portion of the land being subdivided is subject to flood, as defined in the introduction to Article II, the limits of such land shall be shown on the final plat as recorded.

* * *

32. EXCERPTS FROM ENCROACHMENT STATUTES

Connecticut

(From Connecticut Public Act 364, as contained in Statutes Pertaining to the Water Resources Commission Hartford, Connecticut, compiled 1957)

* * *

Section 9, Powers (c).--Said commission shall establish, by order after a public hearing and in accordance with sound engineering principles, on any waterway under consideration for stream clearance, channel improvement or any form of flood control or protection work, lines beyond which, in the direction of the waterway, no obstruction or encroachment shall be placed by any person, firm or corporation, public or private, unless specifically authorized by the commission. The provisions of this section shall not affect the provisions of section 25 of number 13 of the public acts of 1957 authorizing any town, city or borough to establish such lines within its jurisdiction prior to the establishment of lines by the commission, provided the commission may alter any lines, however established, upon finding such alterations necessary to effectuate the purpose of this section and section N 209. Notice of any such order of the commission establishing or altering any such line shall be given by mailing notice thereof to all persons known to be affected thereby and by publishing such notice three times in a newspaper having a general circulation in the area involved. Any person aggrieved by any order of the commission as to the location of any such line may appeal from such order to the court of common pleas within thirty days of the giving of such notice. Service of notice of appeal shall be made upon the chairman of the commission. Whenever the commission shall find that existing encroachments within lines established or to be established constitute a hazard to life and property in the event of flood, it is empowered to take land as provided by chapter 360.

Whenever the commission finds that the regulation and use of flood control measures at dams and reservoirs will constitute an effective part of a flood control program it may negotiate and enter into agreements with the owners of such dams and reservoirs to carry out the purpose of this section and section N209 with due regard to water supply needs and reserves of communities in drought periods.

Section N192, Study of Conditions Relating to Flood Control.--Said commission shall make a comprehensive study of all conditions, wherever located, in any way relating to: (a) the control of flood waters, the establishment of encroachment limits along waterways to provide reasonable flood discharge capacity, the flood control features of existing and future dams and reservoirs, the removal of stream obstructions caused by flood waters, the extent of damage caused by flood waters to property of the state, its political subdivision, industry and agriculture and any necessary means or method by which such damage may be repaired or provided against in case of future floods; (b) river and harbor improvements, obstructions or encroachments in any of the navigable waters or tributaries within the state; and (c) any matters kindred thereto.

* * *

New Jersey

(From New Jersey Revised Statutes (1929) C.1 Title 58)

* * *

Encroachments on Streams

58:1-26.--Construction and maintenance of structures within streams regulated; penalty for violation. No structure within the natural and ordinary high water mark of any stream shall be made by any public authority or private person or corporation without notice to the commission, and in no case without complying with such conditions as the commission may prescribe for preserving the channel and providing for the flow of water therein to safeguard the public against danger from the water impounded or affected by such structure, and this prohibition shall apply to any renewal of existing structures. No such approval by the commission shall impair or affect any property rights, otherwise existing, which might be invaded by the construction or maintenance of any structure.

* * *

33. EXCERPTS FROM BUILDING CODES

Los Angeles County

(The Los Angeles County, California, Uniform Building Code of 1956 contains the following statement concerning construction in flood areas.)

* * *

A permit shall not be issued for a group A, B, C, D, H, or I occupancy in an area which is subject to flood hazards by reason of inundation, overflow, or erosion, and is so determined to be by the County Engineer unless such hazard is eliminated to the satisfaction of the County Engineer by providing adequate drainage facilities, by protective wall, by suitable fill, by raising floor level of the building, by a combination of these methods, or by other means.

* * *

National Building Code

(From National Building Code, Recommended by the National Board of Fire Underwriters, New York: 1955.)

* * *

Sills shall be anchored to the foundation walls at intervals not exceeding 6 feet by anchors equivalent to bolts not less than one-half inch in diameter with proper washers, embedded at least 7 inches in the foundation.

* * *

Basic Building Code

(From Basic Building Code, 1955 Edition-Chicago: Building Officials Conference of America, Inc., 1955.)

* * *

Section 874.3 Foundations.--Exterior walls below grade and the cellar floors of all buildings for institutional and residential uses (use groups H and L) enclosing habitable or occupiable rooms or spaces below grade shall be made watertight, and when necessary shall be reinforced to withstand water pressure as prescribed in sections 710 and 871. The basement walls of buildings in the residential use groups and the walls of all habitable and occupiable rooms and spaces below grade shall be protected with not less than a one-coat application of approved waterproofing paint, or a one-half (1/2) inch pargeting coat of portland cement mortar or other approved damproof-covering.

* * *

Wrightsville Beach

(From Wrightsville Beach, North Carolina, Ordinance of 17 January 1955 amending the Building Code of the Town of Wrightsville Beach.)

* * *

(5) Girders resting on masonry foundation walls or piers shall be anchored thereto with not less than 1/2 inch bolts embedded at least 6 inches in the masonry.

(6) Wooden columns and posts shall be securely anchored to their foundations and to the members which they support.

* * *

All new structures and all structures rebuilt or repaired where the structure required a new foundation or where rebuilding or relocating a building on existing foundations is necessary, shall be built upon piles in accordance with the following requirements.

(1) Height. Piles shall not be less than eight (8) feet in height measured from the "Building Line" of the Town of Wrightsville Beach as established by the North Carolina General Assembly and as shown on the map of the Town of Wrightsville Beach dated September 4, 1941. The height of the piles measured from the mean high water mark if established by competent authority may be used in lieu of the "Building Line" in measuring the required pile height. The average elevation of the building lot may be obtained by averaging the known elevations measured at the corners of such lot.

(2) Type of Pile .....

(3) Required Depth of Piles. Piles shall be sunk or buried to a depth of not less than 100% of the required height of the pile.

(4) Size of Wood Piles .....

(5) Spacing of Wood Piles. The maximum center-to-center spacing of wood piles shall not be more than eight (8) feet on centers under weight bearing sills. However, for two story or larger buildings or where the load bearing requirements demand it, piles may be required to be spaced closer together by the building inspector.

(6) Tieing and Bracing of Wood Piles. Wood piles shall be tied to the structure with bolts or galvanized strips at least four inches wide with galvanized nails, or tied in some other approved manner. Each pile shall be properly braced in an approved manner and when timber braces are used the recommended size shall be 4" x 4".

* * *

34. CORRESPONDENCE FROM OTHER AGENCIES

Exhibits A-3 through A-6 contain comments by interested parties, State agencies and other Federal agencies concerning their interest and responsibility in the Hanalei Flood Plain study.

35. SELECTED BIBLIOGRAPHY

The following list is a sampling of the papers and publications dealing with floods and flood plain information:

Corps of Engineers, U. S. Army Engineer District, Sacramento, California, Statistical Methods in Hydrology, 1962.

Corps of Engineers, U. S. Army Engineering and Design Manual EM 1110-2-1405, Flood Hydrograph Analysis and Computations, 1959.

Corps of Engineers, U. S. Army Engineering and Design Manual EM 1110-2-1408, Routing of Floods Through River Channels, 1960.

Corps of Engineers, U. S. Army Engineering and Design Manual EM 1110-2-1409, Backwater Curves in River Channels, 1959.

Corps of Engineers, U. S. Army Engineering and Design Manual EM 1165-2-111, Flood Plain Information Studies, 1961.

Corps of Engineers, Honolulu District, Final Post Flood Report, The Tsunami of 23 May 1960 in Hawaii, 1962.

Hawaii Department of Land and Natural Resources, Flood Control and Flood Water Conservation in Hawaii, Volumes I and II.

Tennessee Valley Authority, Flood Damage Prevention, An Indexed Bibliography, Knoxville: 1963.1/

University of Hawaii, Hawaii Institute of Geophysics Report No. 14, Potential Tsunami Inundation Areas in Hawaii, Doak C. Cox, undated.

U. S. Coast and Geodetic Survey Preliminary Report, The Tsunami of May 22, 1960 as Recorded at Tide Stations, J. M. Symons and B. D. Zetler, undated.

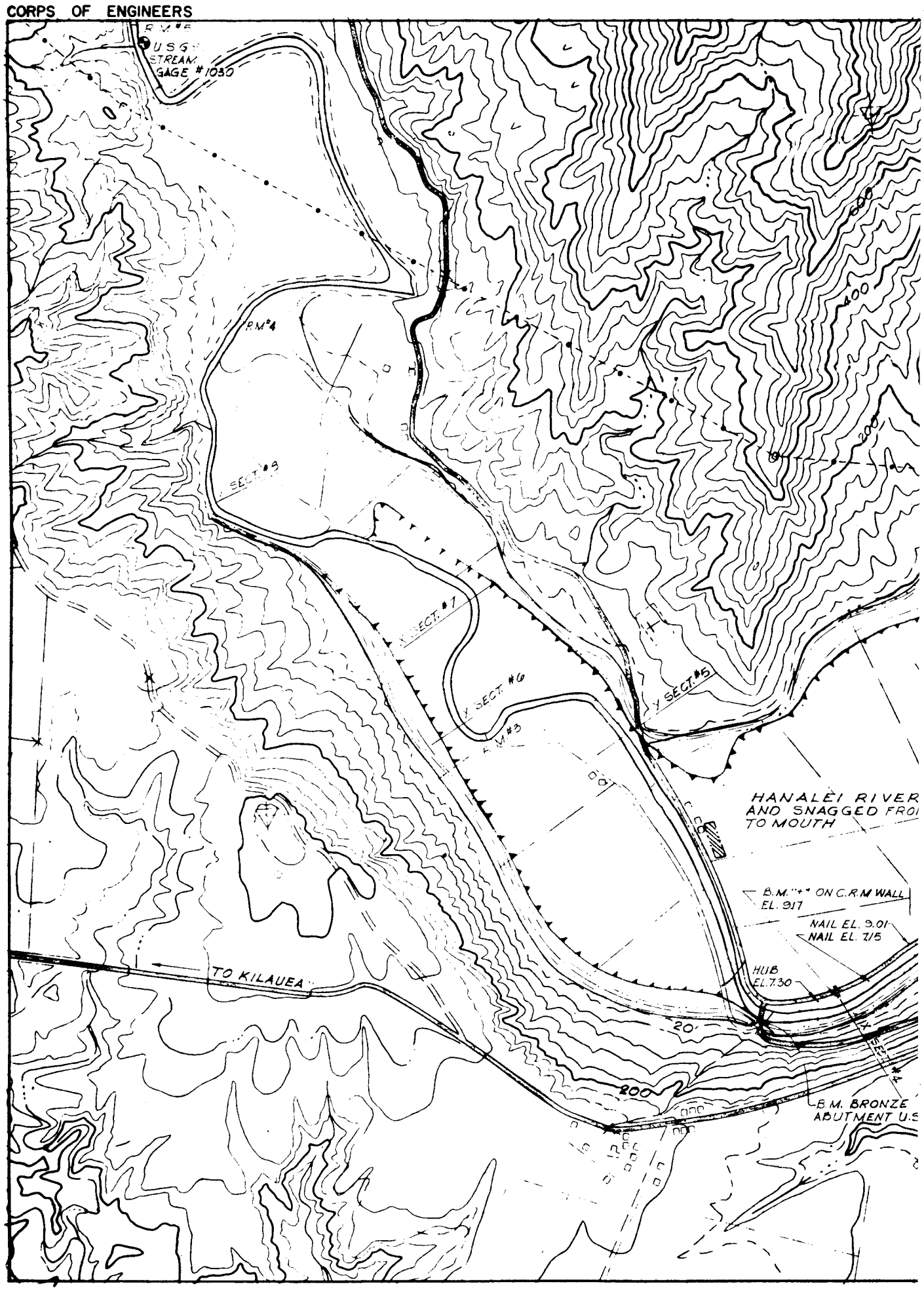
U. S. Geological Survey Progress Report No. 5, An Investigation of Floods in Hawaii, 1963.

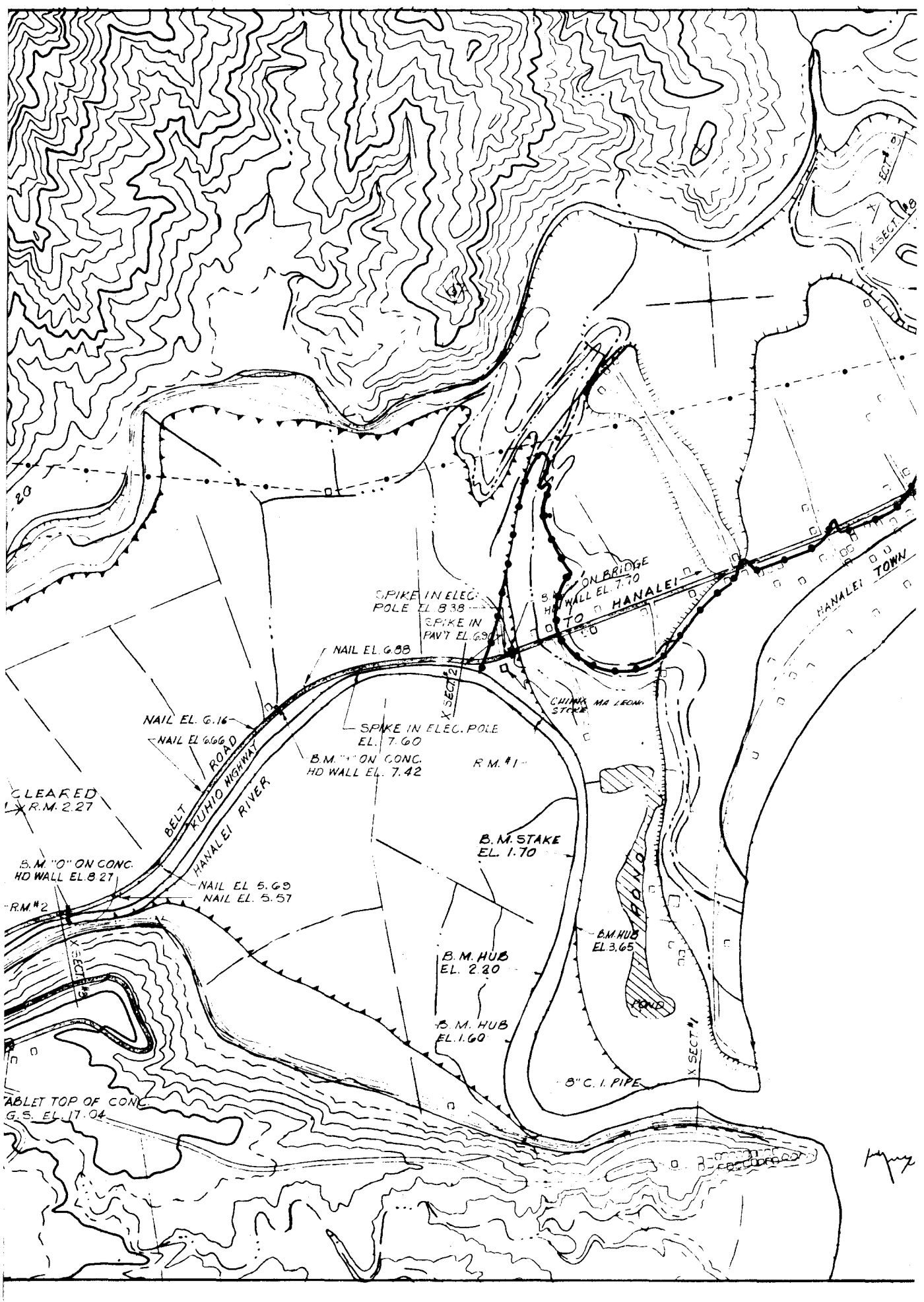
U. S. Geological Survey, Flood Plain Mapping Activities of the United States Geological Survey, Tate Dalrymple, 1963.

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

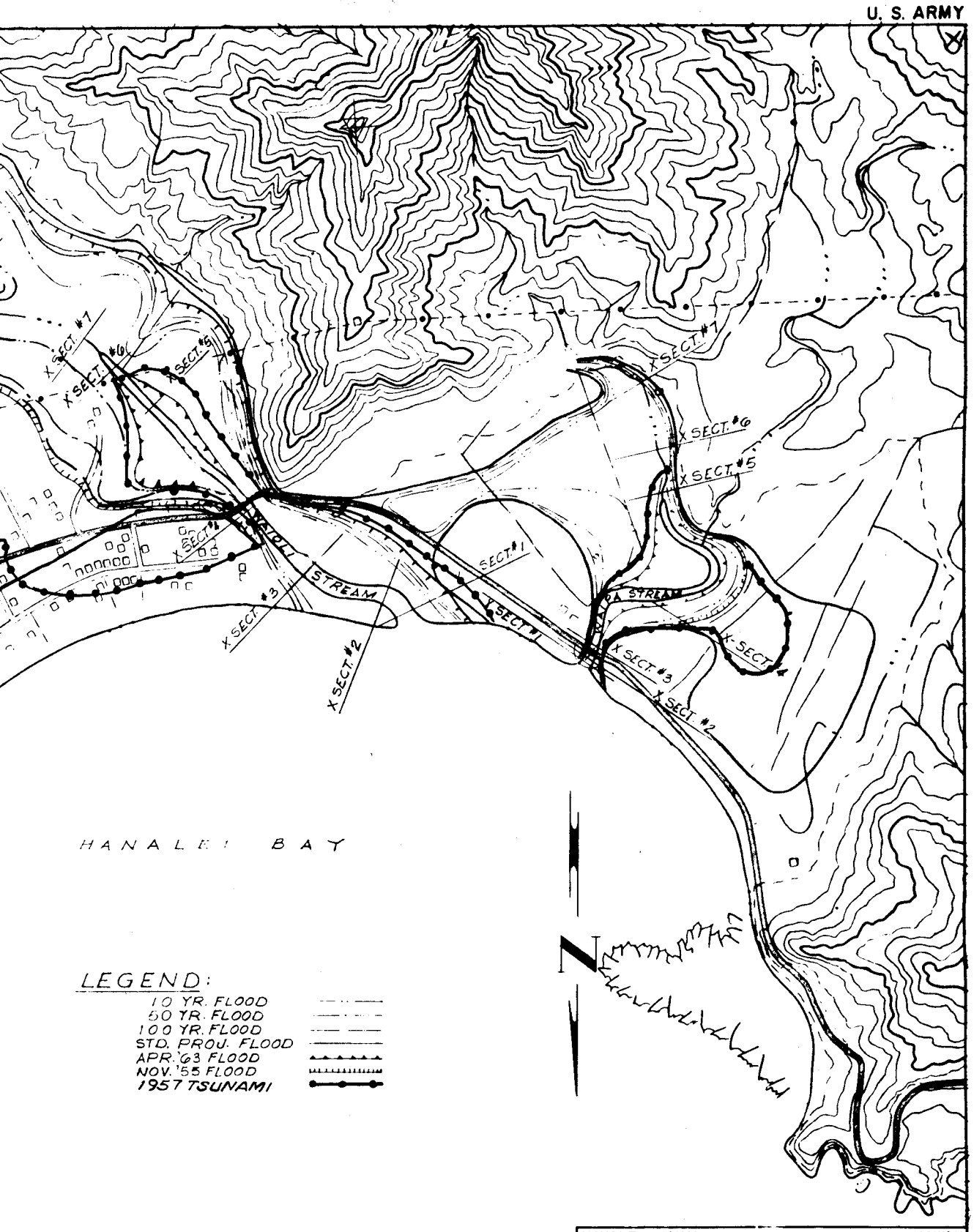
1/ Contains 238 listings of references pertaining to flood damage prevention and flood plain regulation, with only selected items concerned with flood control.

CORPS OF ENGINEERS




SPIKE IN ELEC. POLE EL. 8.38
SPIKE IN PAV'T EL. 6.90
NAIL EL. 6.88
ON BRIDGE
HD WALL EL. 7.70
TO HANALEI
HANALEI TOWN
X SECT #2
CHINK MA LEONG STORE
NAIL EL. 6.16
NAIL EL. 6.66
ROAD
KUHIO HIGHWAY
BELT
HANALEI RIVER
SPIKE IN ELEC. POLE EL. 7.60
B.M. "1" ON CONC. HD WALL EL. 7.42
R.M. #1
CLEARED
R.M. 2.27
B.M. STAKE EL. 1.70
B.M. "0" ON CONC. HD WALL EL. 8.27
NAIL EL. 5.69
NAIL EL. 5.57
R.M. #2
X SECT #3
B.M. HUB EL. 2.20
B.M. HUB EL. 1.60
B.M. HUB EL. 3.65
POND
X SECT #1
8" C.I. PIPE
TABLET TOP OF CONC. G.S. EL. 17.04

U. S. ARMY



HANALEI, KAUAI HAWAII

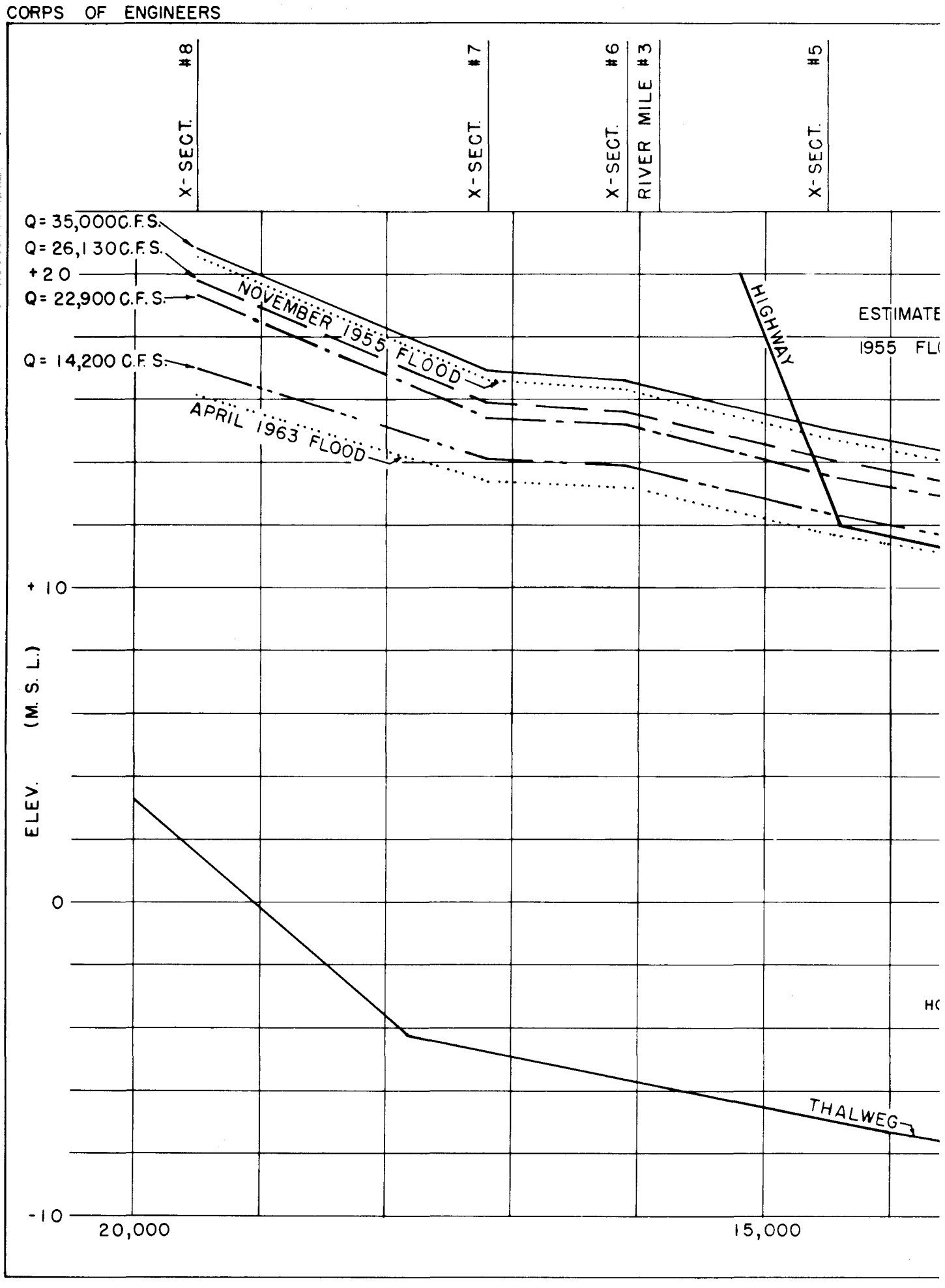
HANALEI FLOOD INFORMATION STUDY

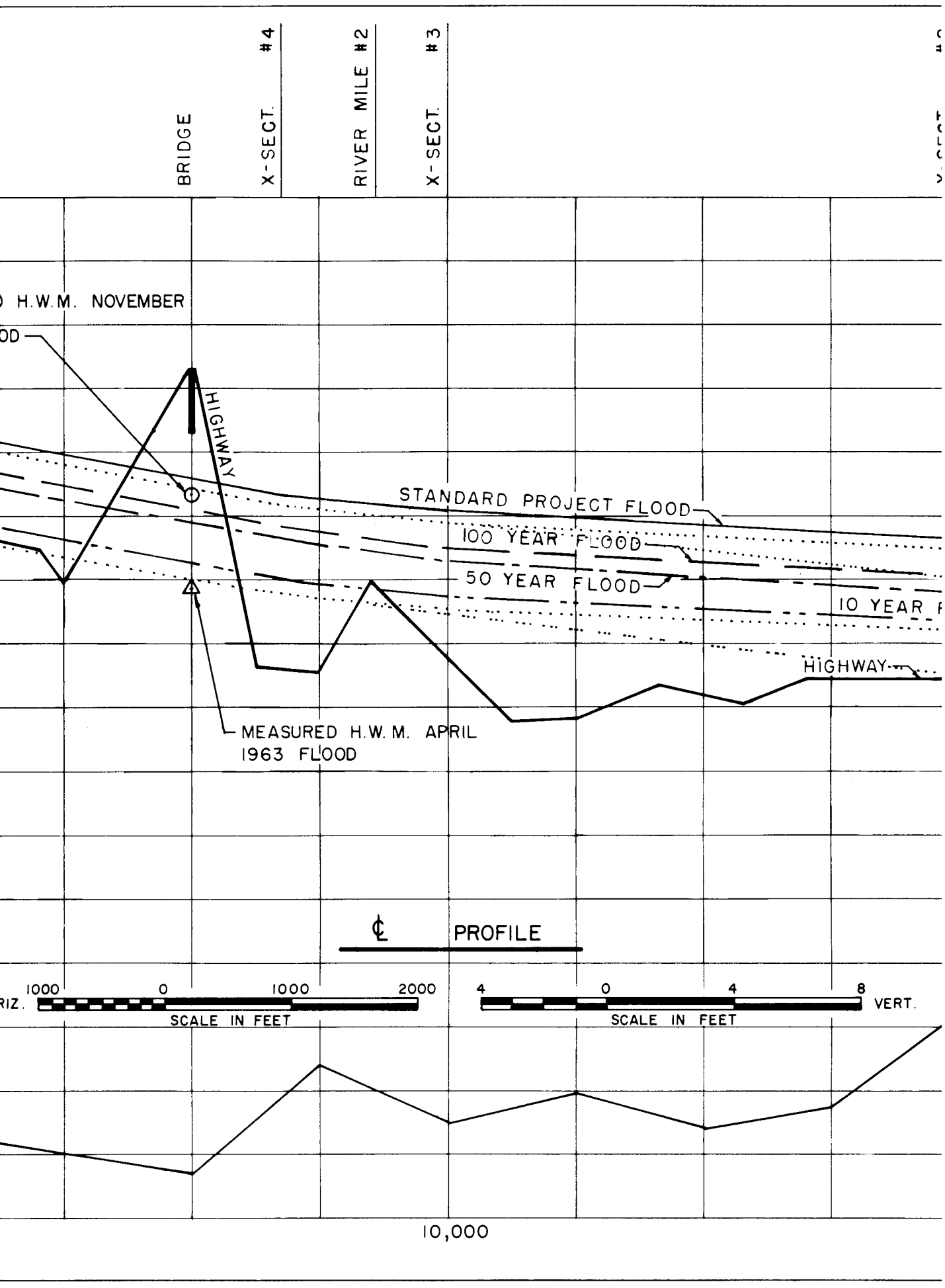
DETAILS OF FLOOD PLAIN

U.S. ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO.
DATED: DECEMBER 1964 RH 22/600.7

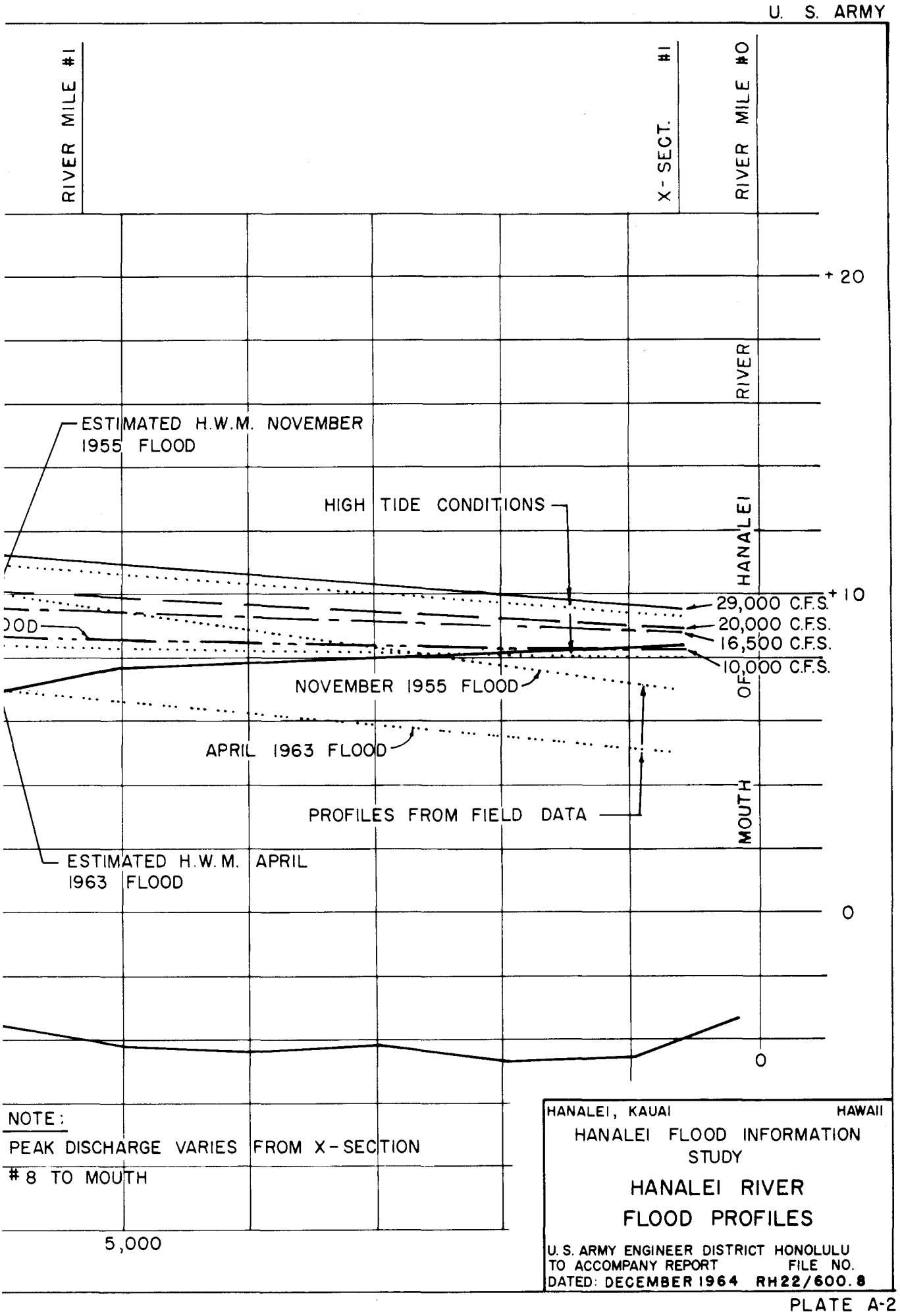
PLATE A-1

CORPS OF ENGINEERS




BRIDGE
X-SECT. #4
RIVER MILE #2
X-SECT. #3
H.W.M. NOVEMBER
OD
HIGHWAY
STANDARD PROJECT FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR F
HIGHWAY
MEASURED H.W.M. APRIL
1963 FLOOD
℄ PROFILE
1000 0 1000 2000
RIZ.
SCALE IN FEET
4 0 4 8
VERT.
SCALE IN FEET
10,000

U. S. ARMY



NOTE:
PEAK DISCHARGE VARIES FROM X-SECTION #8 TO MOUTH

HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

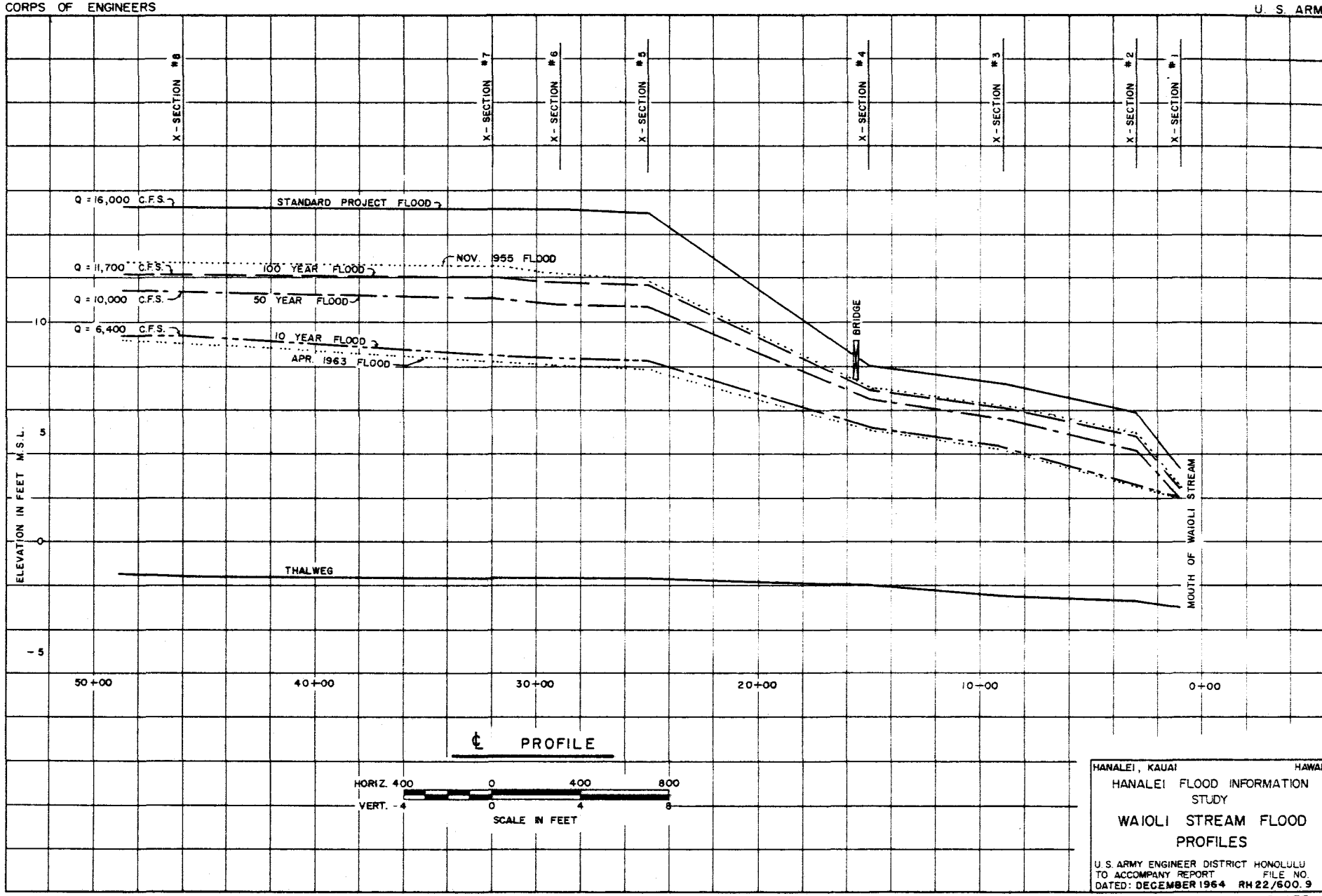
HANALEI RIVER FLOOD PROFILES

U. S. ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO.
DATED: DECEMBER 1964 RH22/600.8

PLATE A-2

CORPS OF ENGINEERS

U. S. ARMY



HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

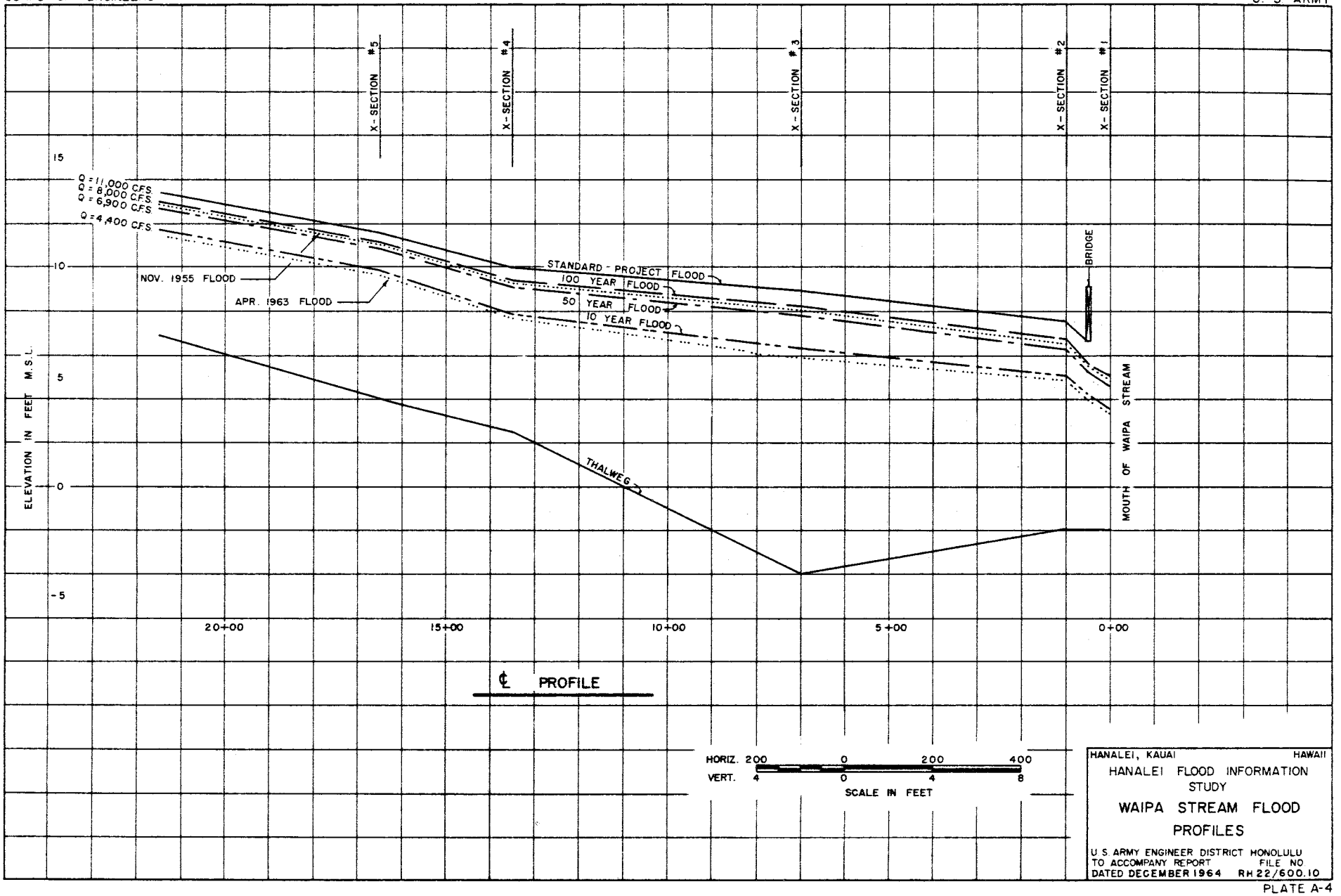
WAIOLI STREAM FLOOD PROFILES

U.S. ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO.
DATED: DECEMBER 1964 RH 22/600.9

PLATE A-3

CORPS OF ENGINEERS

U. S ARMY



HANALEI, KAUAI HAWAII

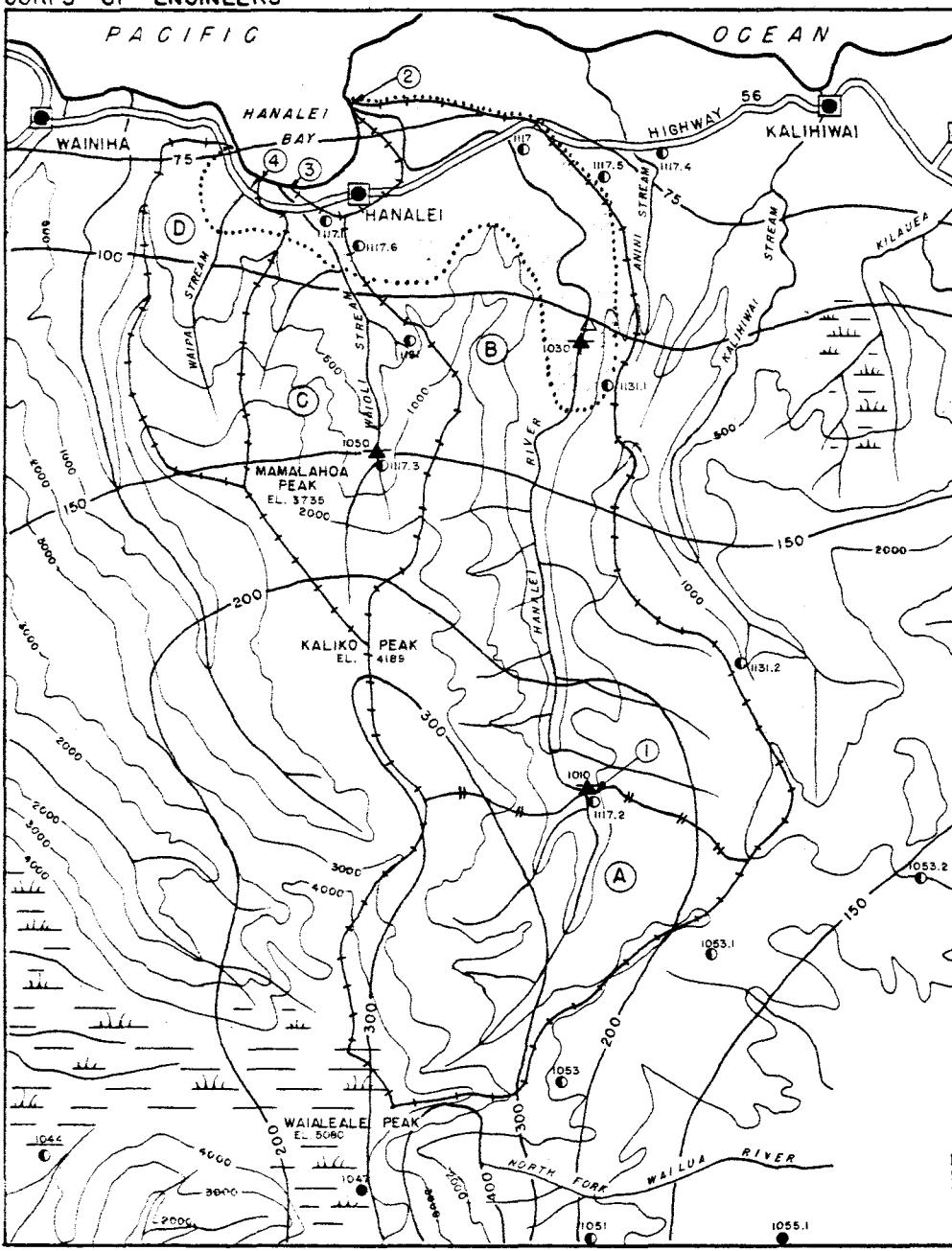
HANALEI FLOOD INFORMATION STUDY

WAIPA STREAM FLOOD PROFILES

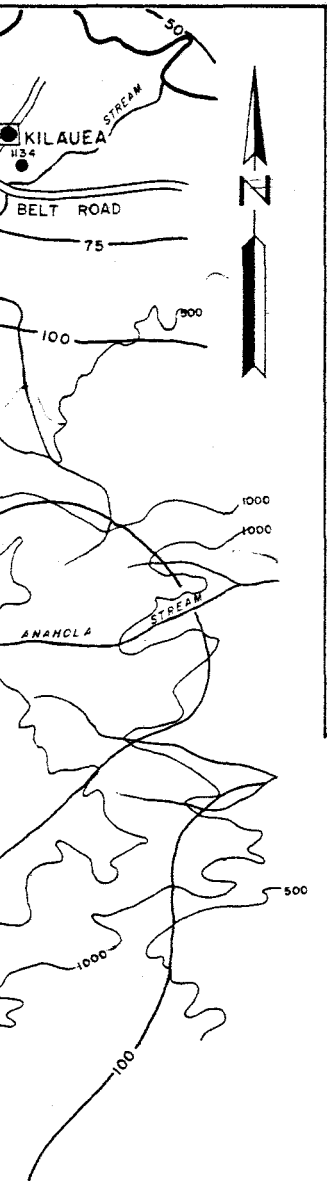
U.S. ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO
DATED DECEMBER 1964 RH 22/600.10

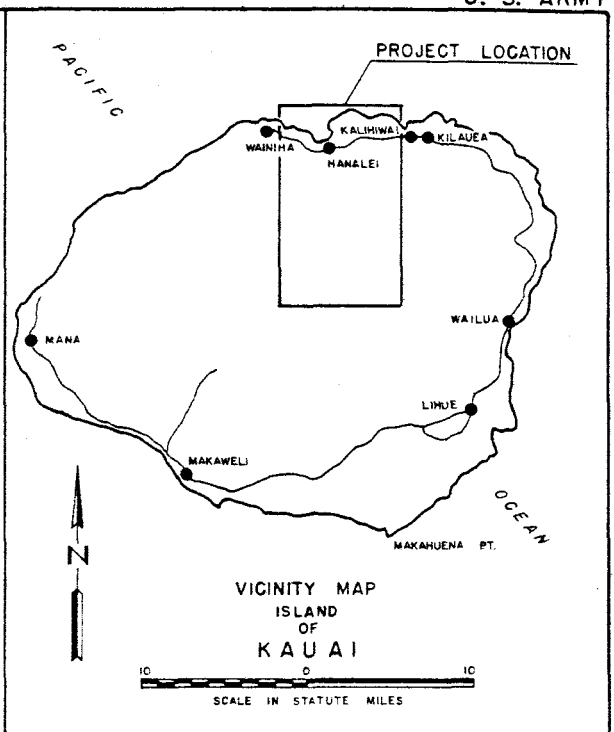
PLATE A-4

CORPS OF ENGINEERS



U. S. ARMY





LEGEND

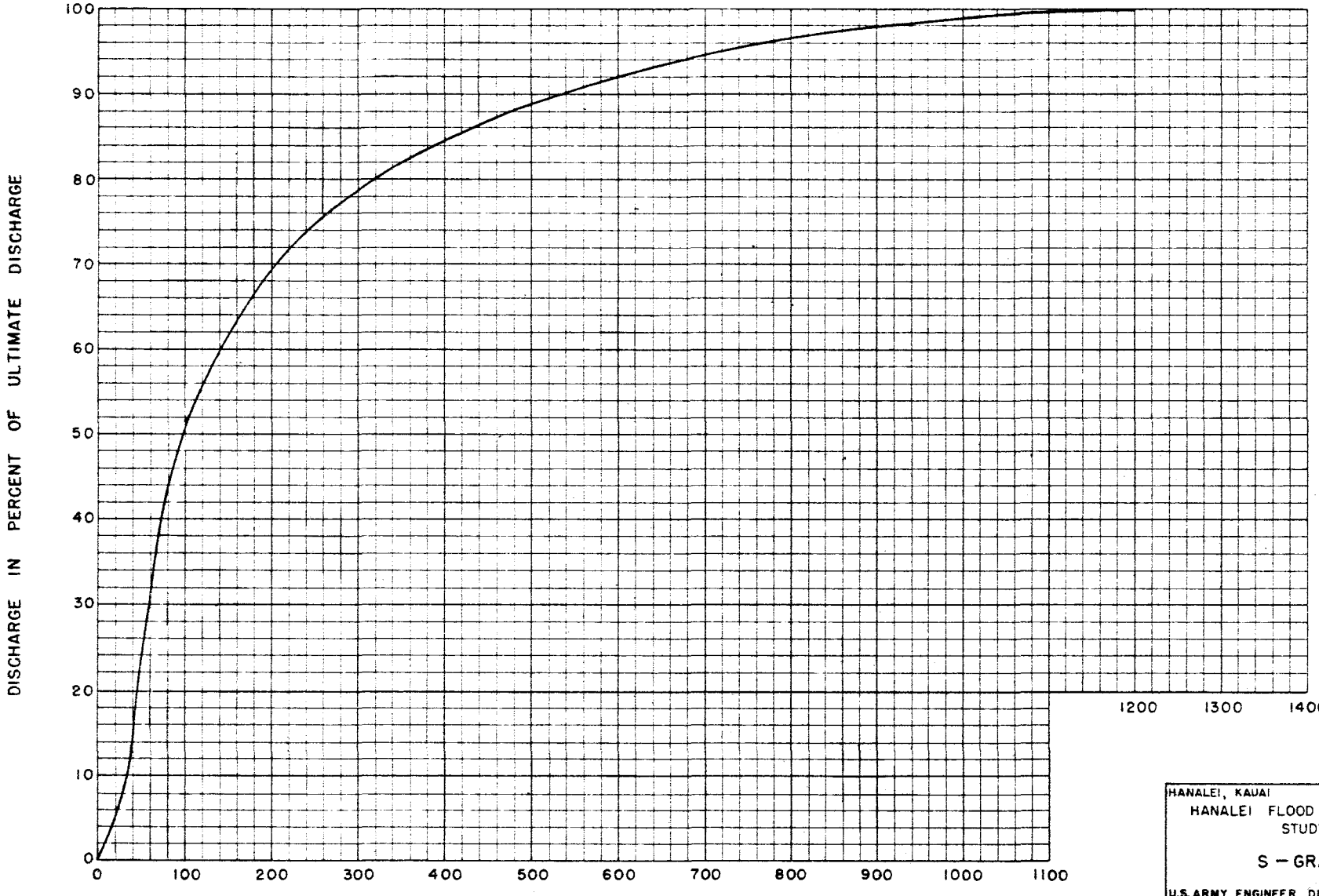
- LIMIT OF DRAINAGE AREA
- LIMIT OF DRAINAGE SUB-AREA
- BOUNDARY OF FLOOD PLAIN
- —150— LINE OF EQUAL MEAN SEASONAL RAINFALL (25 YEARS 1933 TO 1957 INCLUSIVE)
- (A) SUB-AREA DESIGNATION
- (1) POINT OF CONCENTRATION
- 1050 STREAM GAGING STATION AND NUMBER (DISCONTINUED)
- ●1055.1 RAINFALL STATION AND NUMBER (RECORDING)
- ◐1055.1 RAINFALL STATION AND NUMBER (NON-RECORDING)
- △1042 STREAM GAGING STATION (RECENT CONSTRUCTION)

HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

DRAINAGE AREA AND HYDROLOGIC MAP

U.S. ARMY ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS HONOLULU, HAWAII
TO ACCOMPANY REPORT FILE NO.
DATED: DECEMBER 1964 RH22/600.11



HANALEI, KAUAI HAWAII
HANALEI FLOOD INFORMATION STUDY

S – GRAPH

U.S. ARMY ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS HONOLULU, HAWAII
TO ACCOMPANY REPORT FILE NO.
DATED: DECEMBER 1964 RH 22/600.12

PLATE A-6

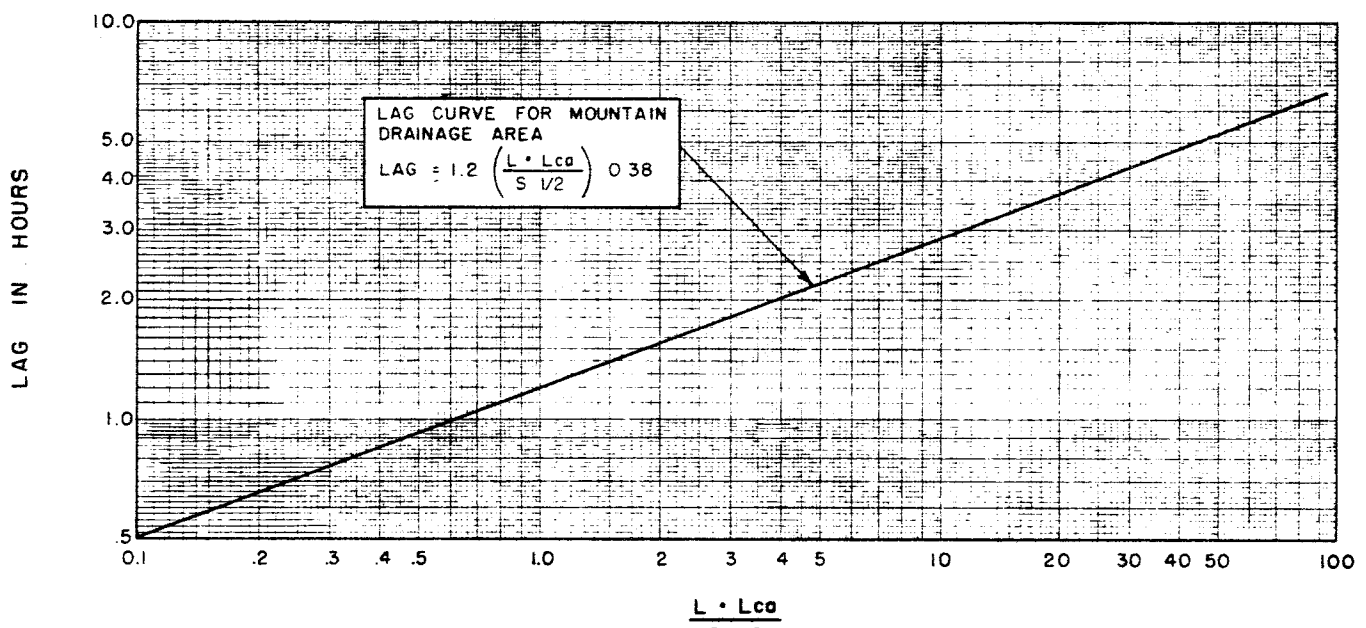
TERMINOLOGY

L = LENGTH OF LONGEST WATER COURSE, IN MILES

Lca = LENGTH ALONG LONGEST WATER COURSE, MEASURED UPSTREAM TO POINT OPPOSITE CENTER OF AREA, IN MILES

S = OVER-ALL SLOPE OF DRAINAGE AREA BETWEEN HEADWATERS AND COLLECTION POINT (Ft. PER MILE)

LAG= ELAPSED TIME FROM BEGINNING OF UNIT RAINFALL TO INSTANT THAT SUMMATION HYDROGRAPH REACHES 50 % OF ULTIMATE DISCHARGE, IN HOURS



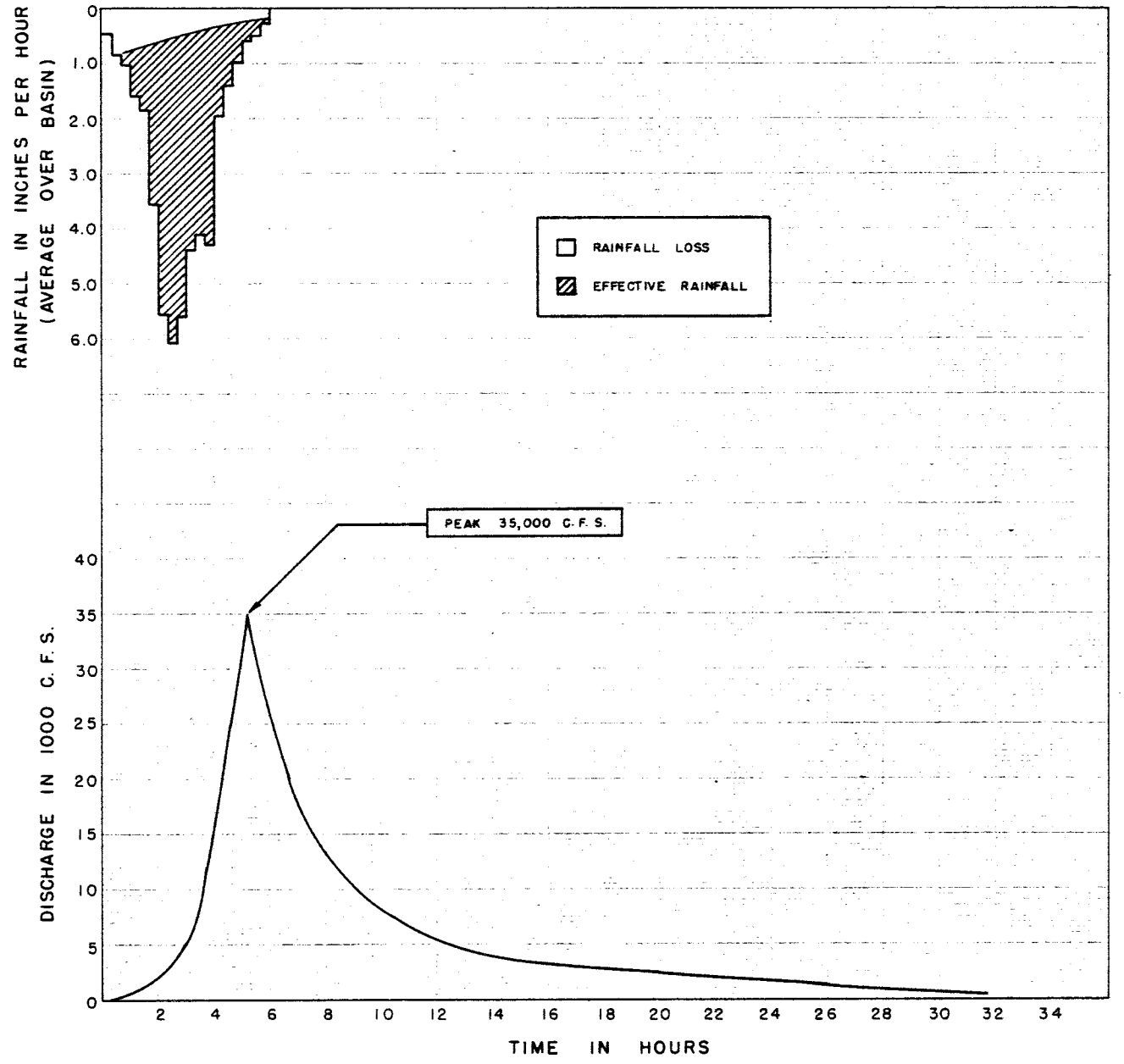
HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

LAG CURVE

U.S. ARMY ENGINEER DISTRICT, HONOLULU.
CORPS OF ENGINEERS HONOLULU, HAWAII
TO ACCOMPANY REPORT FILE NO.
DATED: DECEMBER 1964 RH 22/600.13

PLATE A-7



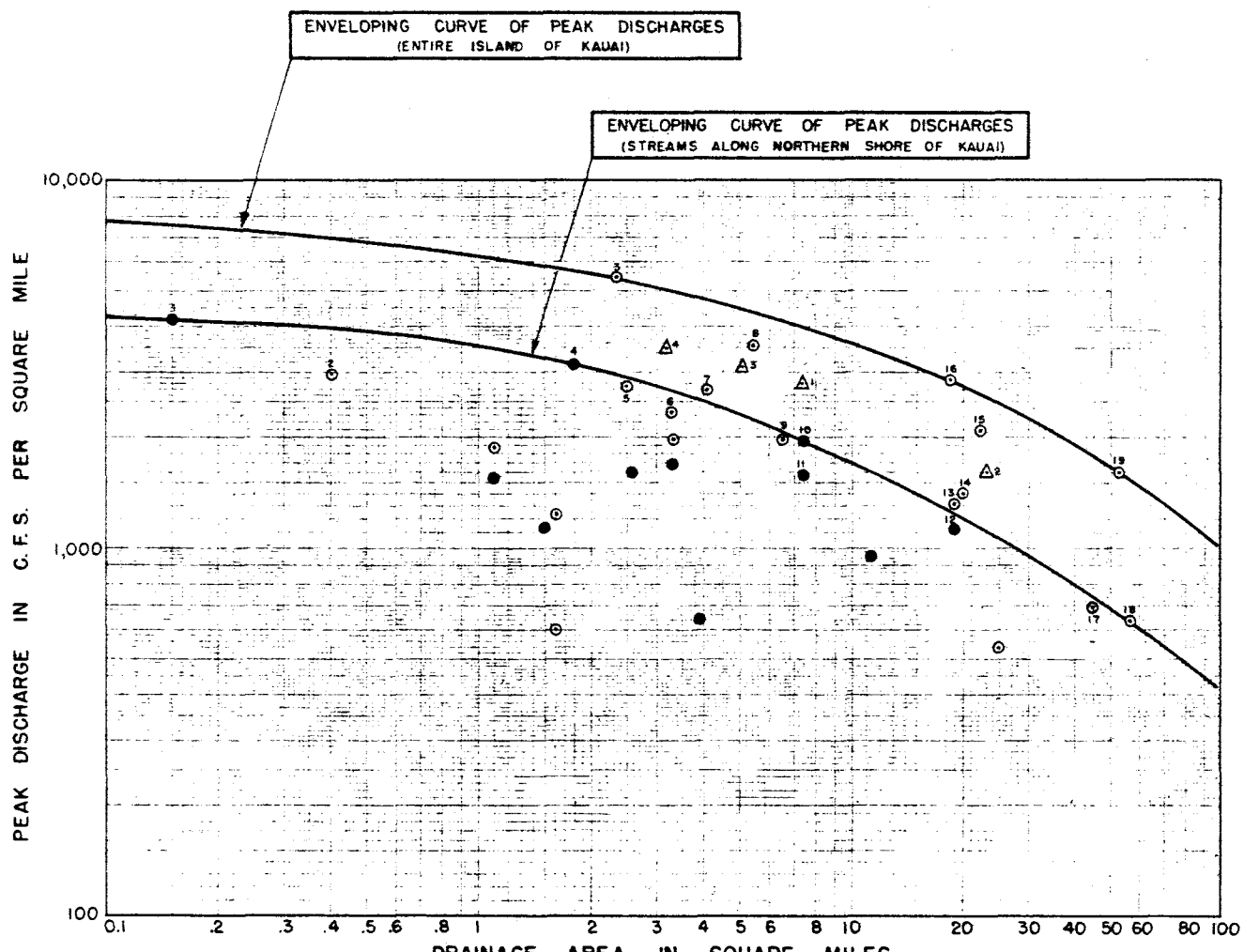
TOTAL DRAINAGE AREA	23.1 SQ. MI.
AVERAGE RAINFALL DEPTH OVER AREA:	
MAXIMUM 6 HOURS	14.6 INCHES
TOTAL STORM	14.6 INCHES
EFFECTIVE TOTAL (SURFACE RUNOFF)	12.1 INCHES
RUNOFF:	
TOTAL FOR PERIOD OF SURFACE RUNOFF	14,900 AC.FT.
(NOT INCLUDING BASE FLOW)	12.1 INCHES

HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

STANDARD PROJECT FLOOD
HANALEI RIVER AT X-SEC #8

U.S. ARMY ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS HONOLULU, HAWAII
TO ACCOMPANY REPORT FILE NO
DATED: DECEMBER 1964 RH 22/600.14



NO.	STREAM	LOCATION	DATE OF FLOOD
1.	HANAULANA STREAM	NEAR KILAUEA	31 MAR. 1923.
2.	KUIA STREAM	NEAR KOLOA	12 AUG. 1940
3.	WAHIAWA STREAM	ALEXANDER DAM	12 FEB. 1931
4.	POHAKUHONU STREAM	NEAR KILAUEA	24 JAN. 1956
5.	WAIALAE STREAM	NEAR WAIMEA	16 JAN. 1921
6.	KAPAA STREAM	NEAR KAPAA	25 JAN. 1956
7.	KAWAIKOI STREAM	NEAR WAIMEA	18 DEC. 1916
8.	ANAHOLA STREAM	NEAR KEALIA	25 JAN. 1956
9.	N.F. WAILUA RIVER	NEAR LIHUE	11 DEC. 1955
10.	HANALEI RIVER	AT ELEV. 625	3 JAN. 1952
11.	LUMANAI RIVER	NEAR HANALEI	11 SEPT. 1922
12.	HANALEI RIVER	NEAR HANALEI	26 SEPT. 1914
13.	HANAPEPE RIVER	NEAR ELEELE	17 DEC. 1949
14.	WAIMEA RIVER	NEAR WAIMEA	17 AUG. 1950
15.	S.F. WAILUA RIVER	NEAR LIHUE	12 NOV. 1955
16.	N.F. WAILUA RIVER	NEAR KAPAA	12 NOV. 1955
17.	WAIMEA RIVER	NEAR WAIMEA	17 AUG. 1950
18.	WAIMEA RIVER	NEAR WAIMEA	7 FEB. 1949
19.	WAILUA RIVER	NEAR MOUTH	12 NOV. 1955

NOTE :

ABOVE DATA FROM U.S.G.S. WATER SUPPLY PAPERS EXCEPT FOR NOS. 3 AND 19.

LEGEND

- ● RECORDED OR ESTIMATED PEAK DISCHARGES FOR STREAMS ALONG NORTHERN SHORE OF KAUAI.
- ⊙ RECORDED OR ESTIMATED PEAK DISCHARGES FOR ENTIRE ISLAND OF KAUAI. EXCEPT NORTHERN SHORE.
- △ STANDARD PROJECT FLOOD PEAK DISCHARGE AT CONCENTRATION POINTS 1 THROUGH 4, INCLUSIVE (SEE PLATE A-5.)

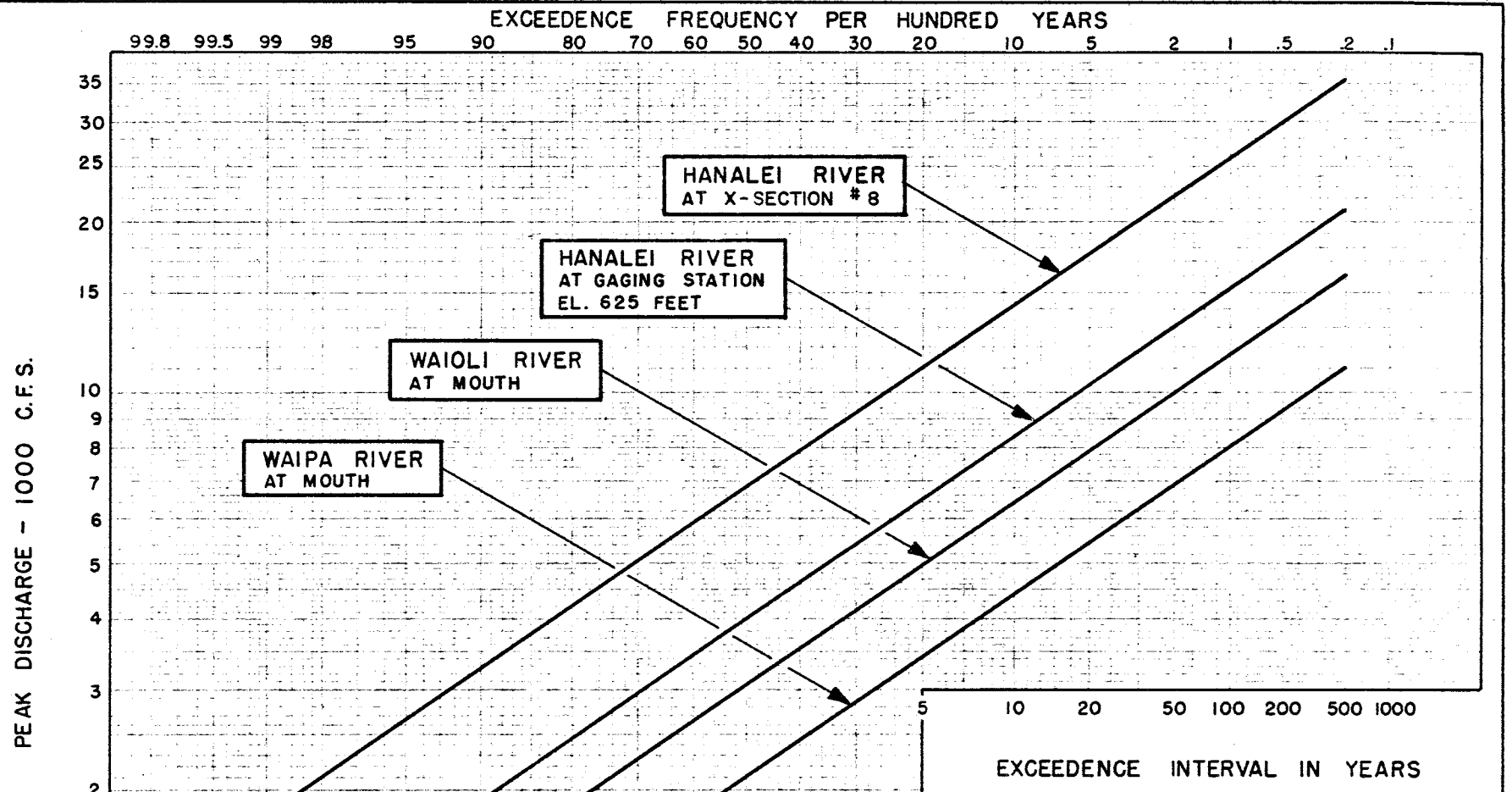
HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

ENVELOPING CURVES OF PEAK DISCHARGES

U.S.ARMY ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS HONOLULU, HAWAII
TO ACCOMPANY REPORT FILE NO.
DATED: DECEMBER 1964 RH22/600.15

CORPS OF ENGINEERS U. S. ARMY



HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

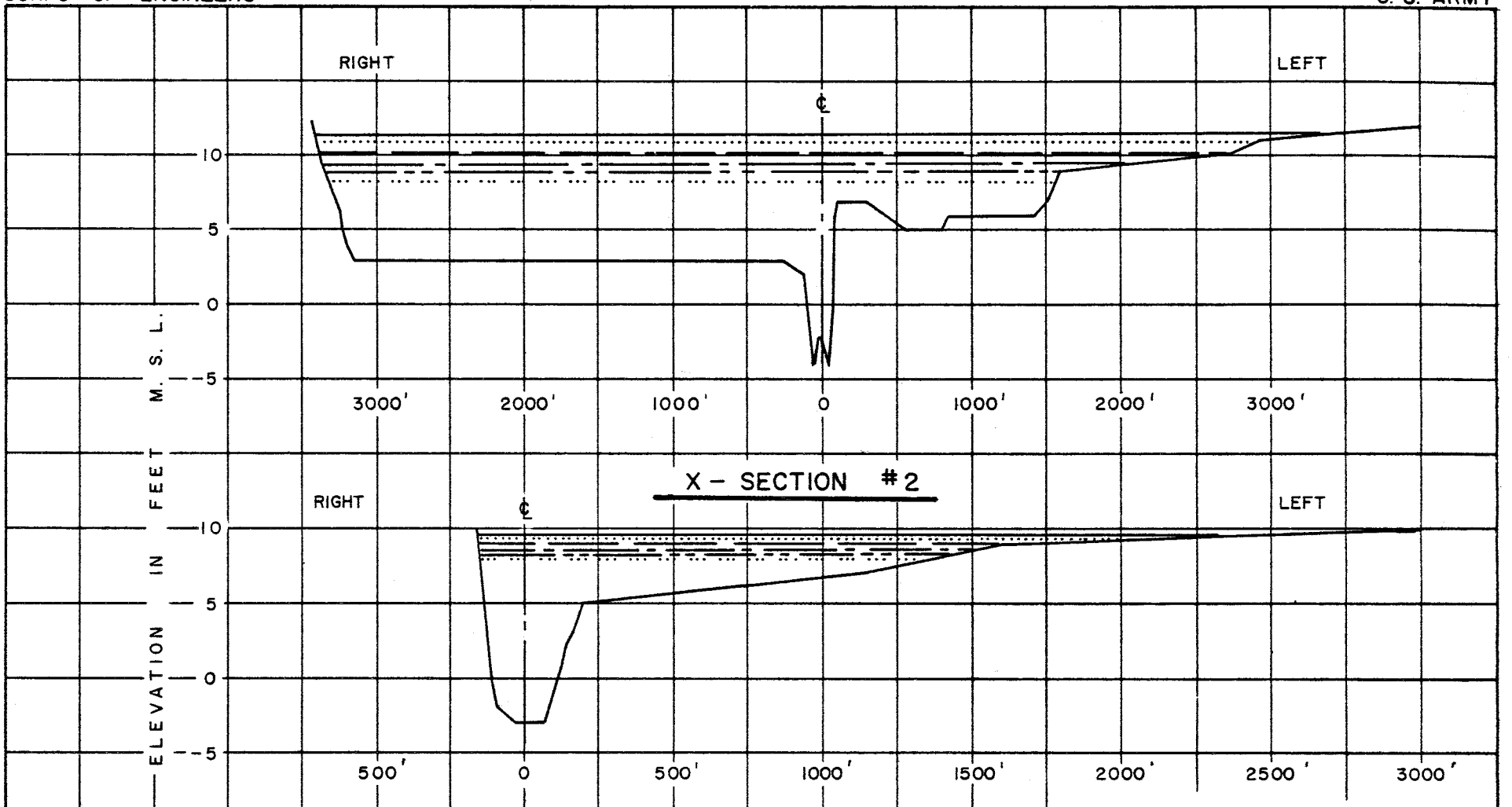
FREQUENCY CURVES

U.S. ARMY ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS HONOLULU, HAWAII
TO ACCOMPANY REPORT FILE NO.
DATED: DECEMBER 1964 RH 22/600.16

PLATE A-10

CORPS OF ENGINEERS

U. S. ARMY



HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

HANALEI RIVER

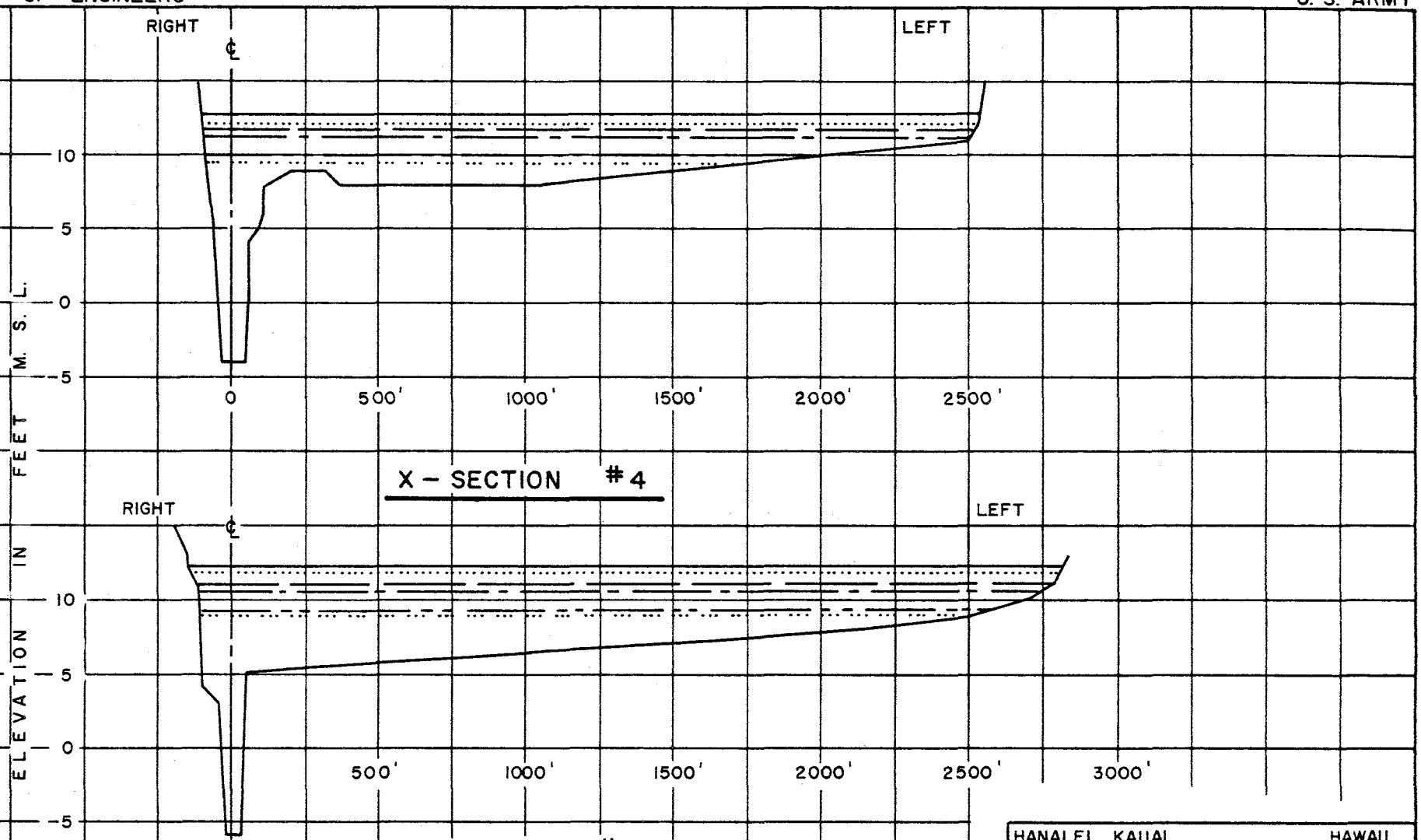
X - SECTIONS

U S ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO
DATED: DECEMBER 1964 RH 22/600.17

PLATE A-11

CORPS OF ENGINEERS

U. S. ARMY



X - SECTION #4

X - SECTION #3

NOTE :

SEE PLATE A-11 FOR LEGEND

HANALEI , KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

HANALEI RIVER

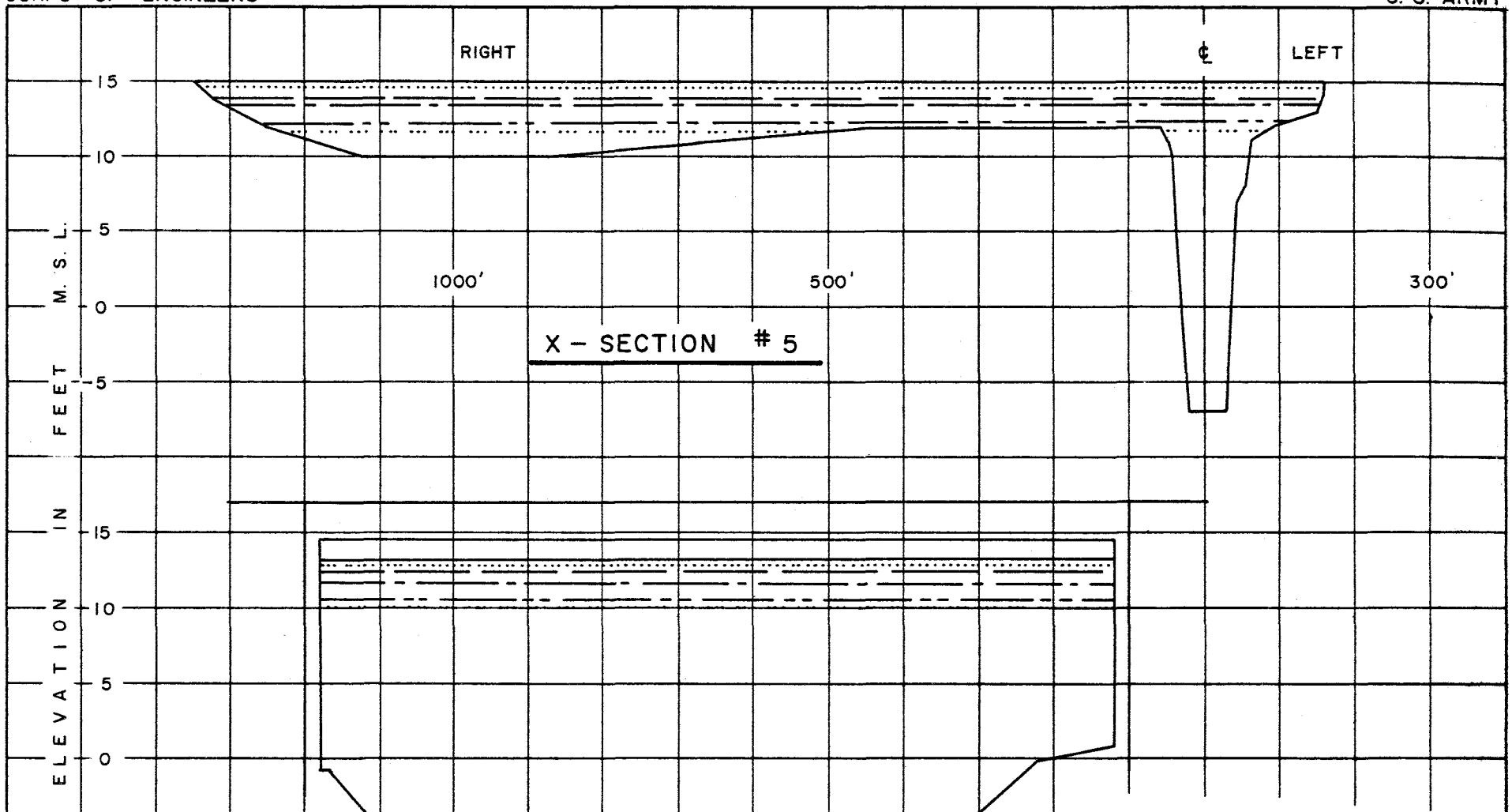
X - SECTIONS

U S ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO
DATED: DECEMBER 1964 RH22/600 18

PLATE A-12

CORPS OF ENGINEERS

U. S. ARMY



NOTE:

SEE PLATE A-11 FOR LEGEND

HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

HANALEI RIVER

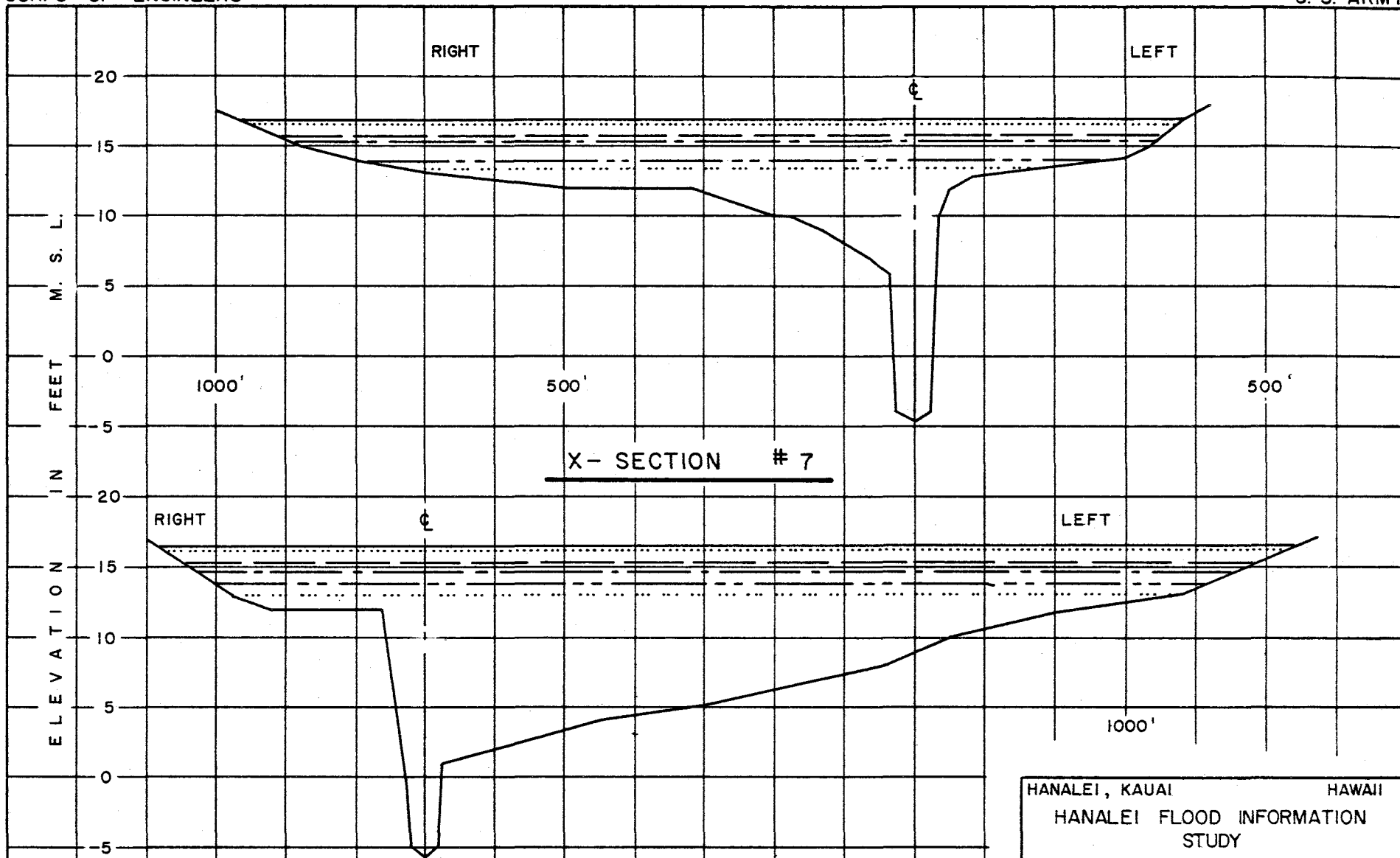
X - SECTIONS

U S ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO
DATED: DECEMBER 1964 PH 23/600 19

PLATE A-13

CORPS OF ENGINEERS

U. S. ARMY



NOTE:

SEE PLATE A-II FOR LEGEND

HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

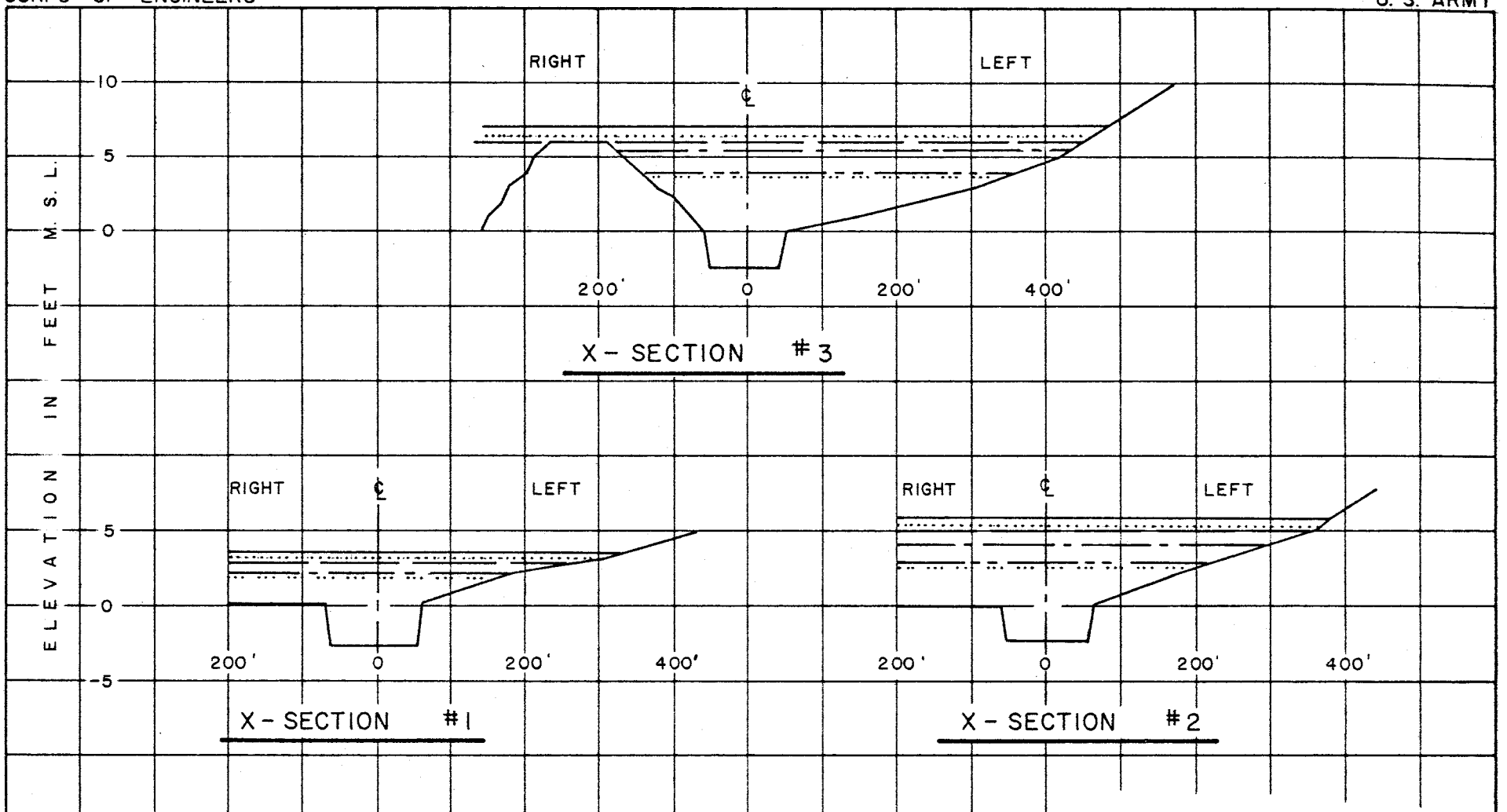
HANALEI RIVER X - SECTIONS

U S ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO
DATED: DECEMBER 1964 BH 32 (302.02)

PLATE A-14

CORPS OF ENGINEERS

U. S. ARMY



NOTE:

SEE PLATE A-II FOR LEGEND

HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

WAIOLI STREAM

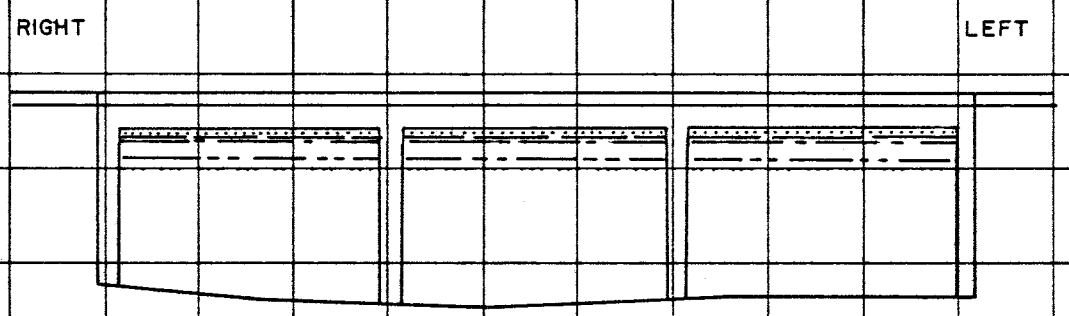
X - SECTIONS

U S ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO
DATED: DECEMBER 1964 RH 22/600.21

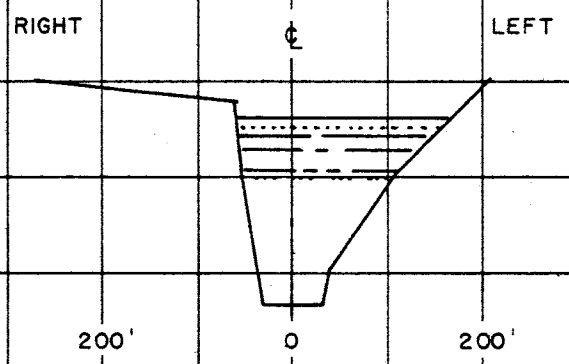
PLATE A-15

CORPS OF ENGINEERS

U. S. ARMY



BRIDGE SECTION



X-SECTION #4

NOTE:

SEE PLATE A-II FOR LEGEND

HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

WAIOLI STREAM

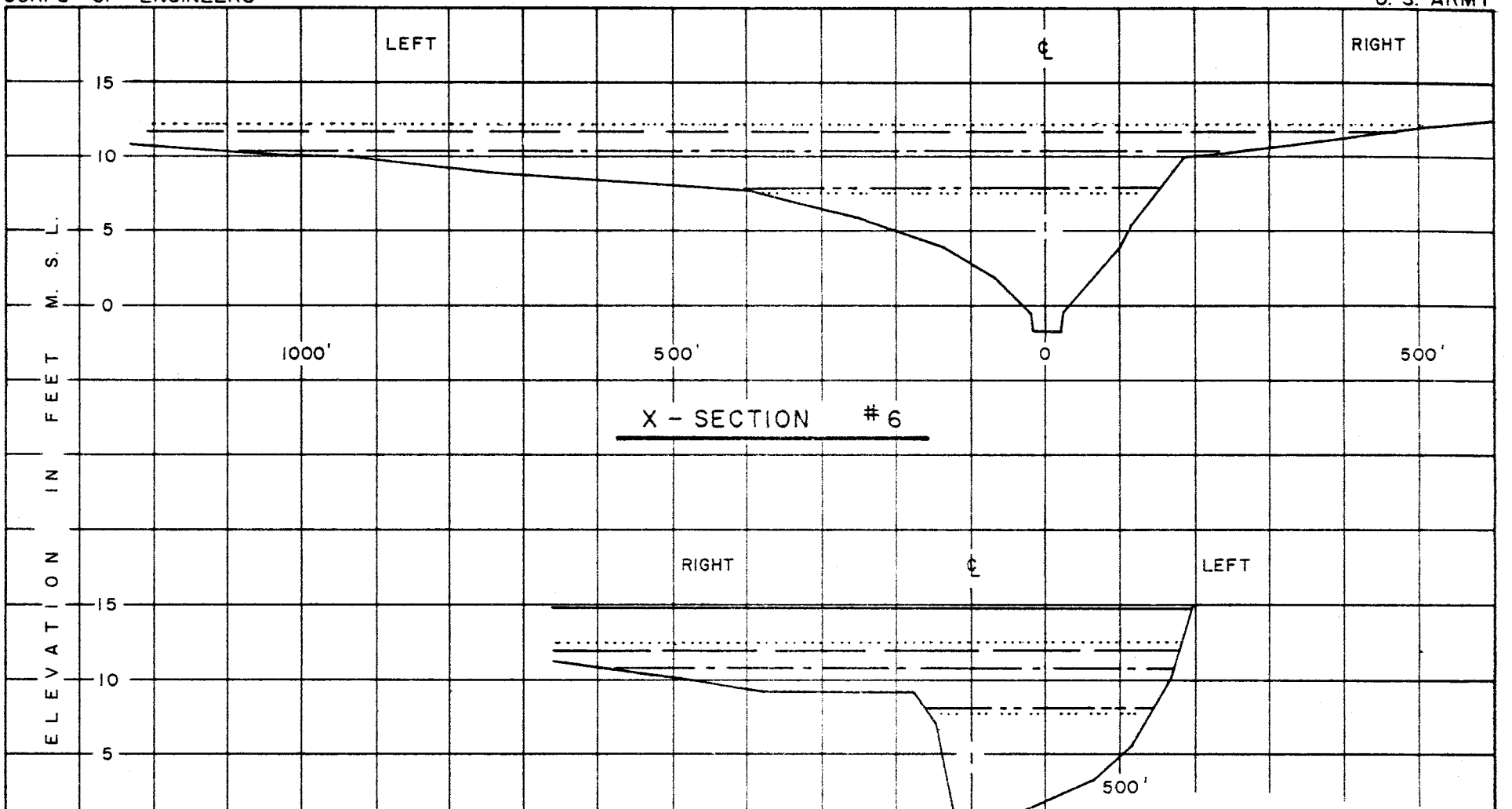
X - SECTIONS

U S ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO
DATED: DECEMBER 1964 PH 32/600.22

PLATE A-16

CORPS OF ENGINEERS

U. S. ARMY



NOTE:

SEE PLATE A-11 FOR LEGEND

HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

WAIOLI STREAM

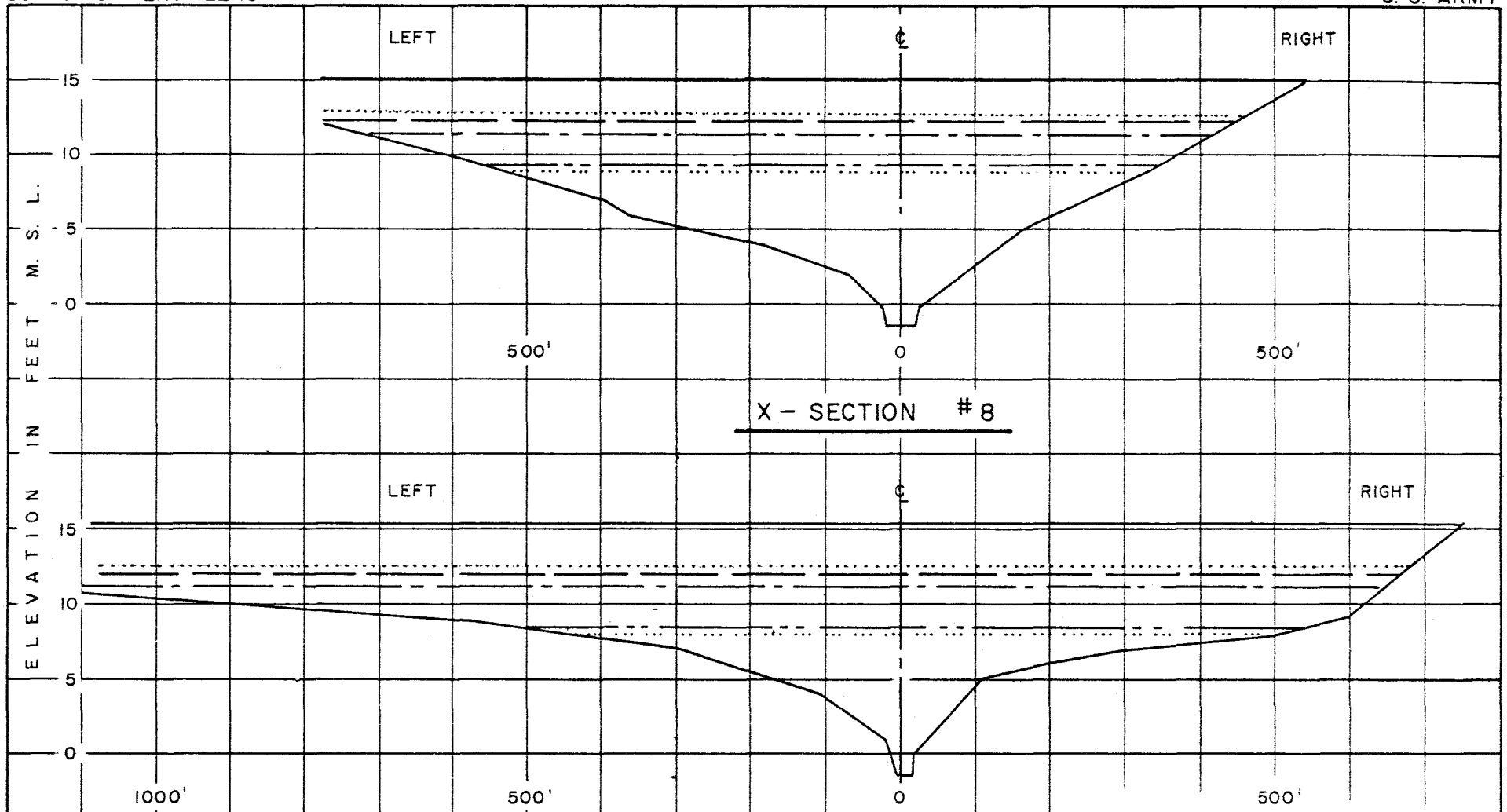
X - SECTIONS

U S ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO
DATED: DECEMBER 1964 RH 22/600.23

PLATE A-17

CORPS OF ENGINEERS

U. S. ARMY



NOTE:

SEE PLATE A-11 FOR LEGEND

HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

WAIOLI STREAM

X - SECTIONS

U S ARMY ENGINEER DISTRICT HONOLULU

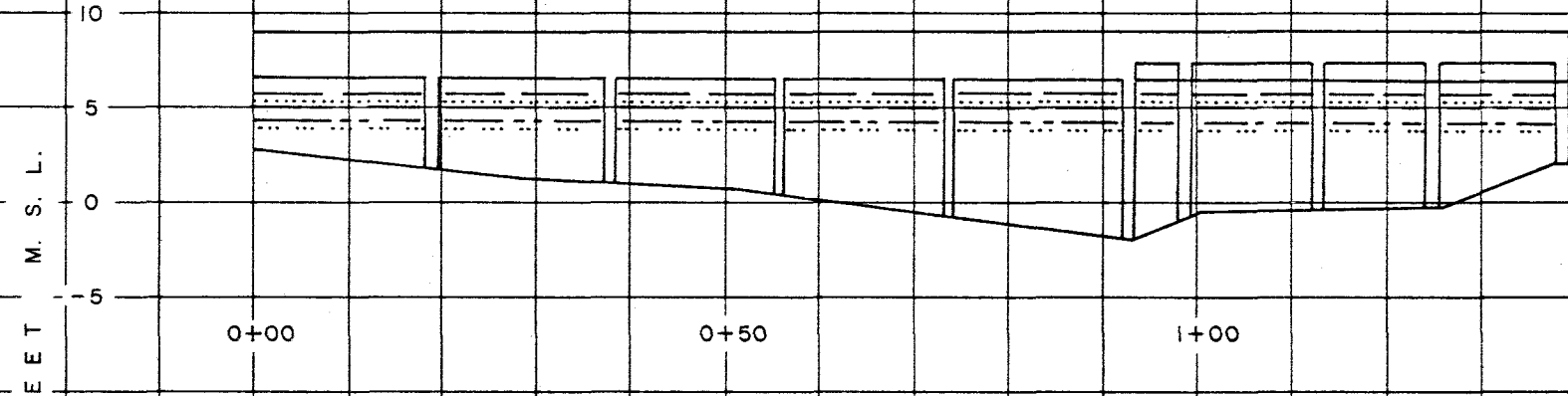
TO ACCOMPANY REPORT FILE NO

DATED: SEPTEMBER 1964

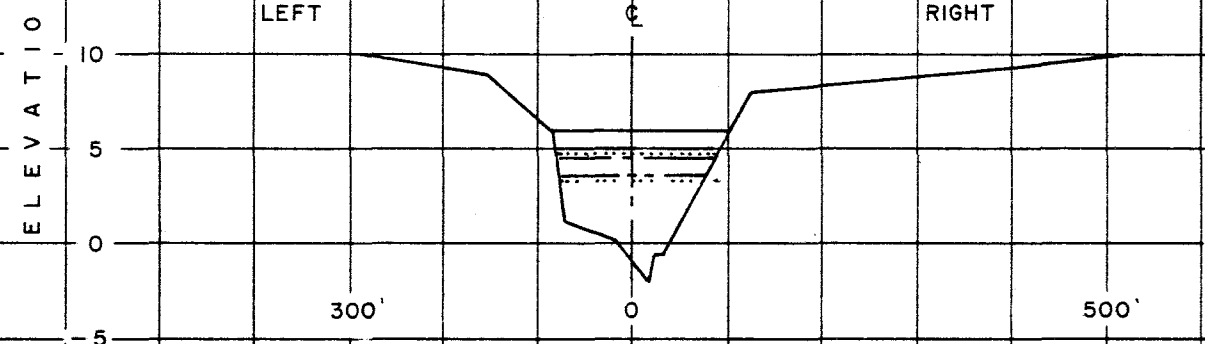
PLATE A-10

CORPS OF ENGINEERS

U. S. ARMY



BRIDGE SECTION



X - SECTION #1

NOTE:

SEE PLATE A-11 FOR LEGEND

HANALEI , KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

WAIPA STREAM

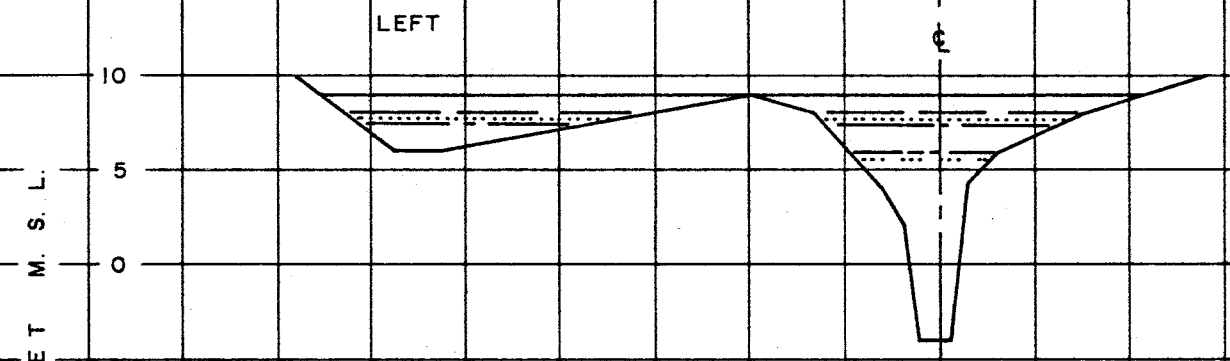
X - SECTIONS

U S ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO
DATED: DECEMBER 1964 PH22/600.25

PLATE A-19

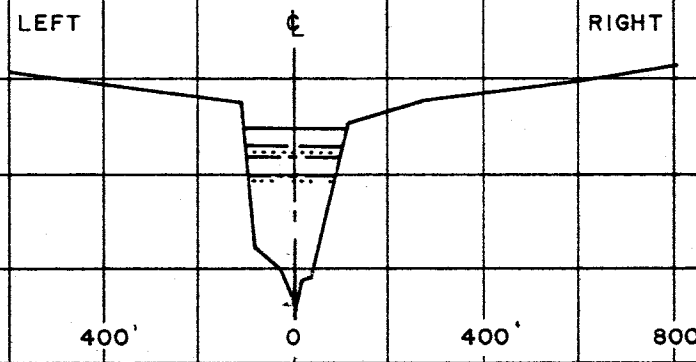
CORPS OF ENGINEERS

U. S. ARMY



X – SECTION #3

ELEVATION IN FEET M. S. L.



X – SECTION #2

NOTE:

SEE PLATE A-11 FOR LEGEND

HANALEI , KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

WAIPA STREAM

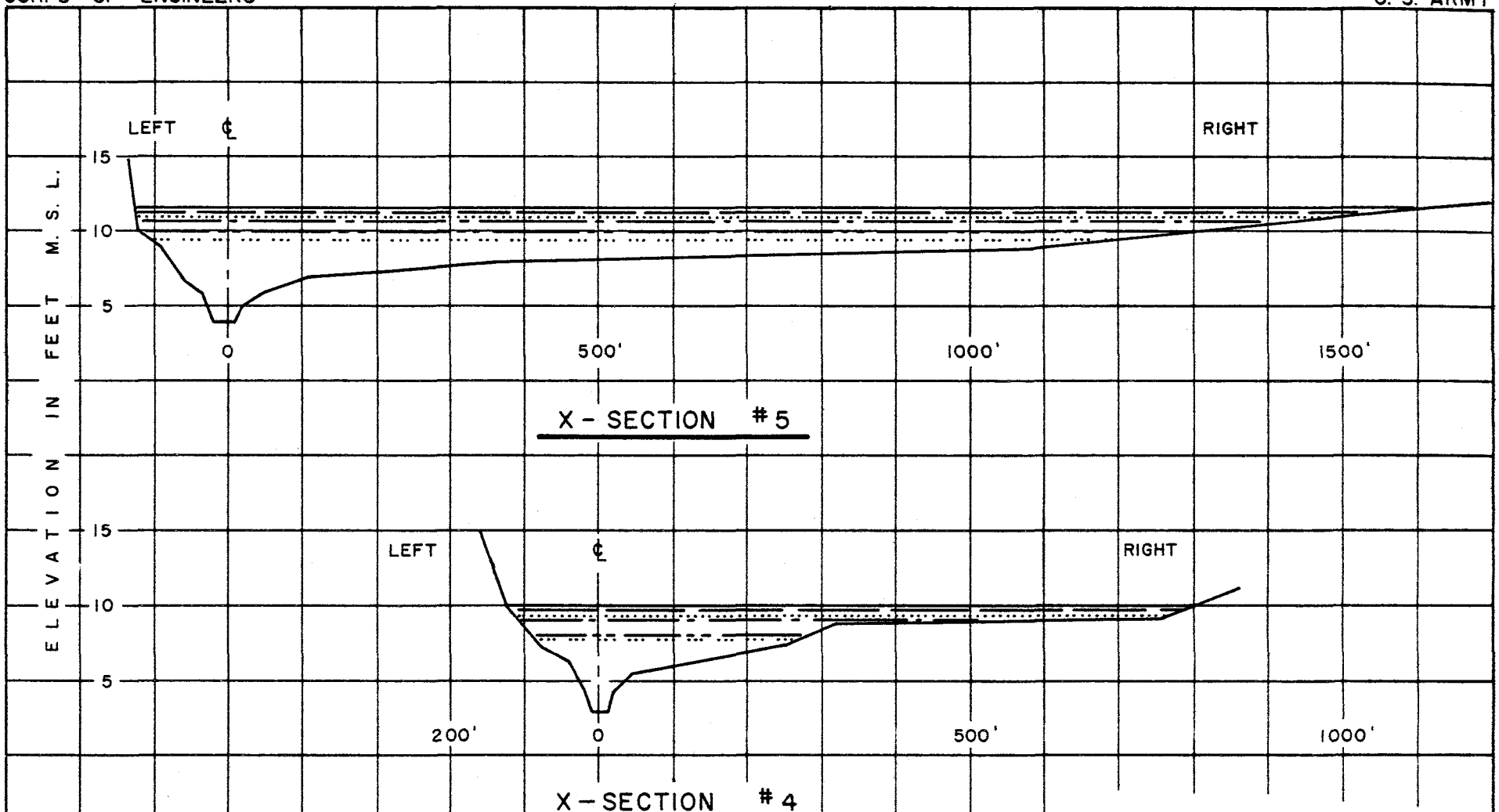
X – SECTIONS

U S ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO
DATED: DECEMBER 1964 RH22/600.26

PLATE A-2

CORPS OF ENGINEERS

U. S. ARMY



X - SECTION #5

X - SECTION #4

NOTE:

SEE PLATE A-11 FOR LEGEND

HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

WAIPA STREAM

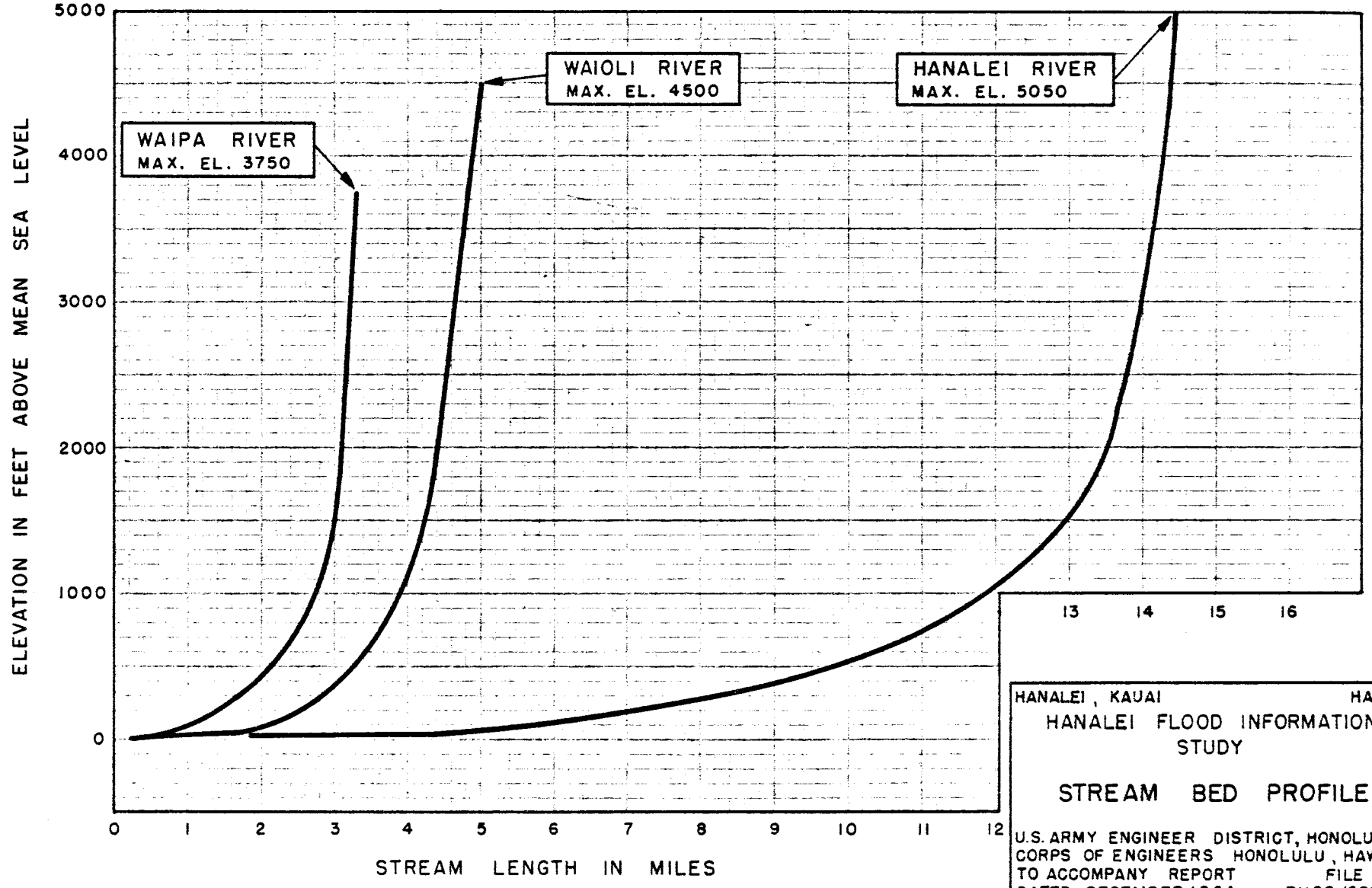
X - SECTIONS

U S ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO
DATED: DECEMBER 1964 RH 22/600.27

PLATE A-2

CORPS OF ENGINEERS

U. S. ARMY



HANALEI , KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

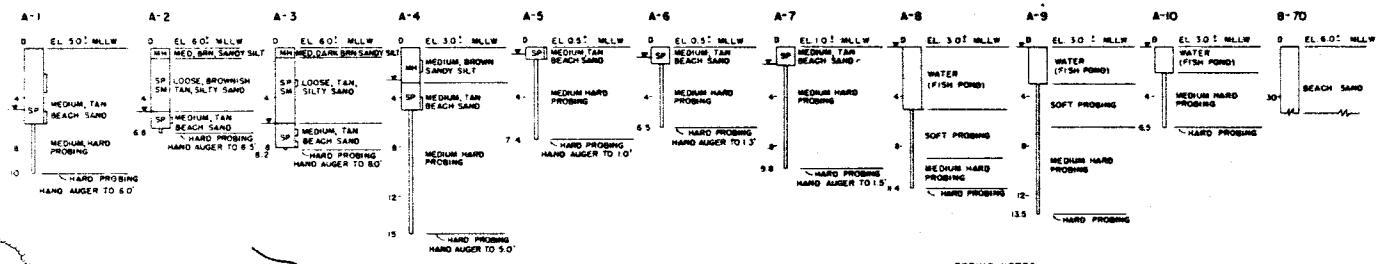
STREAM BED PROFILE

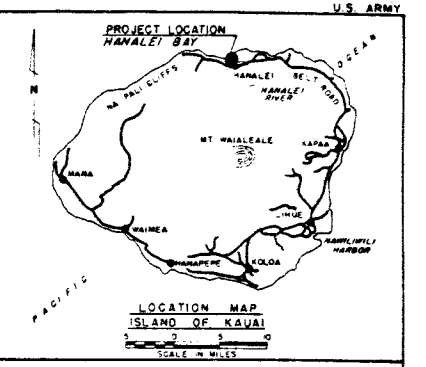
U.S. ARMY ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS HONOLULU , HAWAII
TO ACCOMPANY REPORT FILE NO.
DATED: DECEMBER 1964 RH22/600.28

PLATE A-22

CORPS OF ENGINEERS

U.S. ARMY

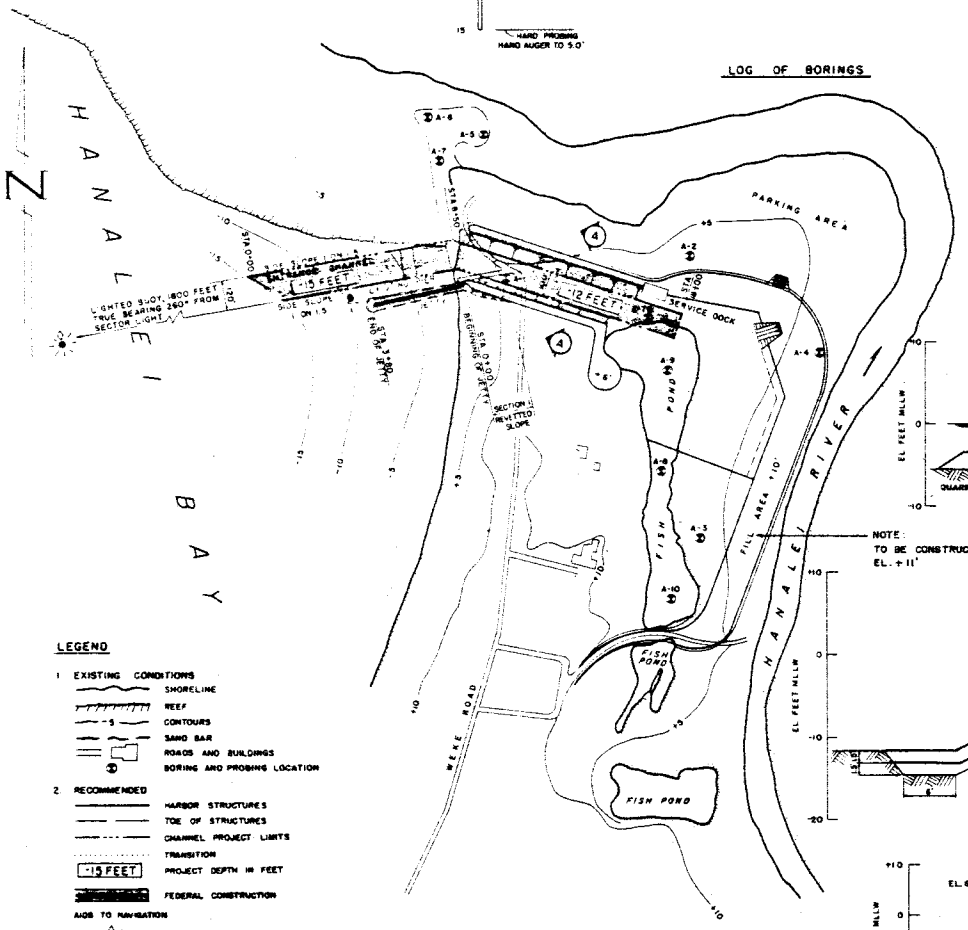




LOG OF BORINGS

BORING NOTES:

1. SP= POORLY GRADED SAND (BEACH SAND)
2. SP-SM= POORLY GRADED SILTY SAND (BEACH SAND)
3. MH=PLASTIC SILT
4. D=DEPTH OF BORING AND PROBING IN FEET
5. BORINGS AND PROBINGS A-1 TO A-10 MADE BY HONOLULU DISTRICT, CORPS OF ENGINEERS, 29-30 OCT. 1962; BORING B-70 MADE BY LOCAL INTREST APRIL 1940
6. ▯ DISTURBED JAR SAMPLES
7. ▽=WATER LEVEL ON DATE BORING WAS MADE
8. BORINGS A-1 TO A-10 + PROBING WAS ACCOMPLISHED BY MANUALLY STRIKING A 3/4" DIAMETER TAPERED STEEL ROD WITH A 5LB SLEDGE HAMMER TO REFUSAL OR REQUIRED DEPTH
9. BORING B-70 + ARTESIAN WELL BORING BULLETIN 13, HAWAII DIVISION OF HYDROGRAPHY, 1960. "GEOLOGY AND GROUND-WATER RESOURCES OF THE ISLAND OF KAUAI, HAWAII"



LEGEND

1. EXISTING CONDITIONS
   - SHORELINE
   - REEF
   - -5 CONTOURS
   - SAND BAR
   - ROADS AND BUILDINGS
   - BORING AND PROBING LOCATION
2. RECOMMENDED
   - HARBOR STRUCTURES
   - TOE OF STRUCTURES
   - CHANNEL PROJECT LIMITS
   - TRANSITION
   - -15 FEET PROJECT DEPTH IN FEET
   - FEDERAL CONSTRUCTION

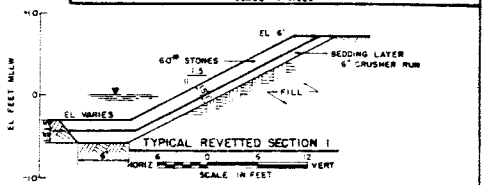
AIDS TO NAVIGATION

- LIGHTED BUOY
- PIER LIGHT

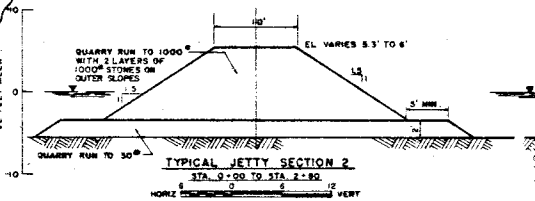
200 0 200 400
SCALE IN FEET

ELEVATIONS AND DEPTHS BASED ON MEAN LOWER LOW WATER DATUM.

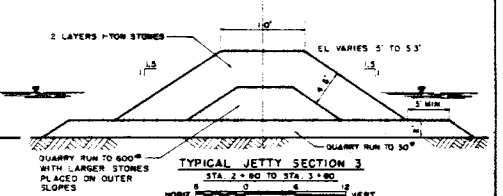
NOTE:
MLLW DATUM IS AT -.85' MSL



TYPICAL REVETTED SECTION 1

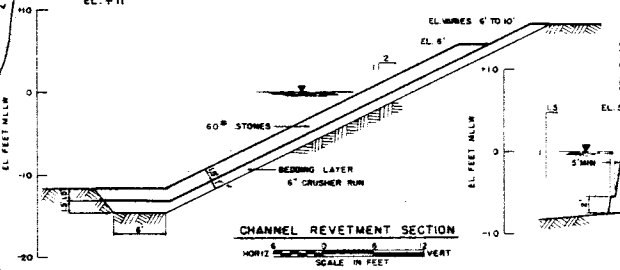


TYPICAL JETTY SECTION 2
STA. 0+00 TO STA. 2+80

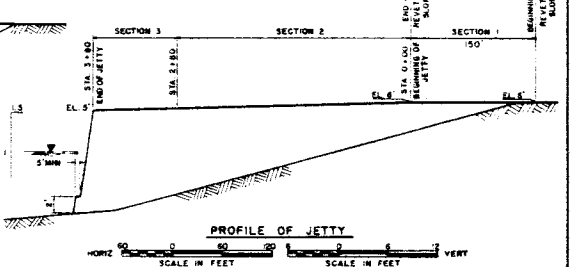


TYPICAL JETTY SECTION 3
STA. 2+80 TO STA. 3+80

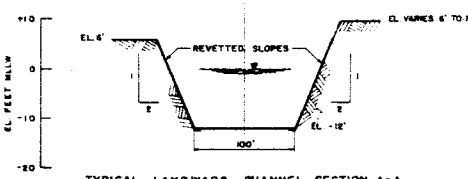
NOTE:
TO BE CONSTRUCTED TO EL. +11'



CHANNEL REVETMENT SECTION



PROFILE OF JETTY



TYPICAL LANDWARD CHANNEL SECTION A-A

NOTE: ARMOR STONE WEIGHTS ARE MINIMUM REQUIRED.

HANALEI, KAUAI HAWAII

HANALEI FLOOD INFORMATION STUDY

LIGHT-DRAFT BOAT HARBOR

U.S. ARMY ENGINEER DISTRICT HONOLULU
TO ACCOMPANY REPORT FILE NO.

ACT 148 H. B. NO. 80

A B I L L F O R A N A C T

RELATING TO FLOOD CONTROL AND AMENDING CHAPTER 87C, REVISED LAWS OF HAWAII 1955, AS AMENDED.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF HAWAII:

SECTION 1. Chapter 87C, Revised Laws of Hawaii 1955, as amended, is hereby further amended to read as follows:

"Sec. 87C-1. Declaration of Purpose. It is hereby declared:

(a) That floods caused by heavy rainstorms and abnormal tidal action are detrimental to the health, safety, and general welfare of the people of the state, resulting in jeopardy to and the loss of life and property, disruption of commerce, and interruption of transportation and communications; that the reduction of flood damage is therefore of primary importance to the people of the state; and the conservation and beneficial use of flood water is an essential adjunct to rainfall drainage and flood control.

(b) It is the purpose of this Act to provide for the coordination by the state of all federal and state flood control projects undertaken in Hawaii and for such technical and/or financial assistance to its political subdivisions as may be desirable or necessary to assure maximum benefits to the people of the state from the expenditure of state funds for flood control purposes.

(c) Nothing in this chapter shall prevent any political subdivision through its proper officials from requesting federal aid on its own initiative and at its own expense without having to secure State approval.

Sec. 87C-2. Definitions. The following terms, whenever used and referred to in this Act, shall have the following respective meanings, unless a different meaning clearly appears in the context:

'Abnormal tidal action' shall include high seas or surf, hurricane floods, and tsunamis or seismic waves.

EXHIBIT A-1

'Board' shall mean the board of land and natural resources.

'Department' shall mean the department of land and natural resources.

'Drainage' shall mean the collection and conveyance of surface or sub-surface water, storm runoff, or any other water to a disposal area, or into a watercourse or standing body of water to reduce damage to lands which are not necessarily adjacent to such watercourse or standing body of water, or to reclaim lands for beneficial use.

'Drainage facilities' shall mean any man-made construction undertaken for drainage purposes and shall include conduits, ditches, canals, dikes, embankments, dams, reservoirs, and other appropriate facilities.

'Drainage measures' shall include drainage facilities, land treatment, statutory and building code requirements relating to drainage, and any other measures intended to accomplish drainage purposes.

'Flood' shall mean the temporary inundation of usable lands caused by the overflow of an adjacent natural watercourse or standing body of water.

'Flood control,' 'flood water control,' and 'flood prevention,' shall mean the minimizing of flood damage by appropriate protective, preventive, and corrective measures.

'Flood control measures' shall include flood control works, land treatment, master planning and zoning to establish encroachment zones along watercourses and adjacent to standihg bodies of water, training of flood fighting units, flood disaster plans and operations, and any other measures relating to flood control, flood water conservation, and flood damage.

'Flood Control Plan,' 'General Flood Control Plan,' and 'Plan' shall mean the report entitled General Flood Control Plan for Hawaii (Volume II of Flood Control and Flood Water Conservation in Hawaii), published by the Board in January 1963.

'Flood control program' when referring to a specific watershed or sub-watershed, shall mean all existing or planned flood control measures relating to such area; when referring to the statewide flood control program shall mean the General Flood Control Plan and all activities of the Board and Department pursuant to the provisions of this Act.

'Flood control project,' 'federal flood control project,' and 'state flood control project' shall mean, respectively: (1) specific flood control works which comprise all or a portion of the works needed to complete a specific flood control program; (2) a flood control project authorized and implemented pursuant to the Federal Flood Control Act of 1936 or the Watershed Protection and Flood Prevention Act of 1958, as amended or supplemented, and (3) a flood control project sponsored and financed by the State and authorized and implemented pursuant to Section C-4(c) of this Act.

'Flood control works,' 'works of improvement,' 'works,' or 'flood control facilities' shall mean any man-made construction undertaken to confine storm runoff within a natural watercourse, conserve such runoff, or lessen the energy and effect of abnormal tidal action, and shall include conduits, ditches, canals, levees, dikes, embankments, dams, reservoirs, breakwaters, groins, seawalls, and other appropriate facilities.

'Flood water conservation' shall mean the confinement, storage and beneficial utilization of storm runoff by the construction, operation, maintenance, and supervision of drainage and flood control facilities.

'Political subdivision' shall mean any of the several counties under existence in the state by virtue of the laws of Hawaii or any legally organized district or political incorporation thereof.

'Watercourse' or 'natural watercourse' shall mean any river, stream, gulch, gully, valley floor, or any other naturally formed channel having a bed and sides or banks in which water flows either perennially or intermittently. 'Natural watercourse' shall also include a drainage ditch in existence after seven years from installation but shall not include

a ravine, swale, or similar depression within which water flows only during rainfall.

'Standing body of water' shall mean a fresh water pond, lake, or reservoir, or the Pacific Ocean along an extended shoreline or a tidal inlet such as a bay, harbor, pond, or estuary.

'United States' shall mean the United States of America, including the agencies, instrumentalities, officers, agents, or employees thereof.

Sec. 87C-3. Statewide Flood Control Agency and Program.

(a) The board of land and natural resources, whose functions include under the existing laws of Hawaii, the management and administration of water resources of the state, is hereby designated as the state agency responsible for the accomplishment of the purposes of this act.

(b) All flood control and flood water conservation and related activities, and any attendant powers and duties, heretofore assigned to other state departments or agencies, but not including flood disaster operations, shall be transferred to the Board upon the enactment of this law.

(c) It is declared that the General Flood Control Plan is to be regarded as a general guide for the orderly and coordinated implementation of a statewide flood control program and the specific existing and planned flood control programs and the specific existing and planned flood control programs comprising the Plan to be financed by State funds. This declaration is not to be construed so as to constitute approval of the specific flood control programs included in the Plan Nor shall this declaration be construed so as to prohibit the development of lands bordering watercourses or standing bodies of water. The Board may, from time to time, modify the Plan to the extent that it finds such to be necessary or desirable.

Sec. 87C-4. Powers, Duties and Jurisdiction of the Board. In addition to those powers and responsibilities of the Board established by existing law, the Board is authorized to implement the declared purposes of this act with regard to flood control and flood water conservation in the following manner:

(a) Coordinate the programs and activities of all agencies of the state, in conformance with the objectives of the statewide flood control program.

(b) Compile, evaluate, interpret, and disseminate information for technical use and for the general information and education of the people of the state.

(c) Render technical assistance to the political subdivisions and other agencies of the state only upon request of the affected agencies in matters of master planning, zoning, qualifying for and constructing federal and state flood control projects, the training of flood fighting units, and related flood control activities.

(d) With regard to federal flood control projects: (1) review plans submitted by federal agencies for state approval and make appropriate recommendations to the Governor; (2) formulate and recommend to the Legislature of a general policy for state participation with the political subdivisions in the assurances of local cooperation required by federal flood control acts; (3) review requests from political subdivisions for financial assistance in meeting local participation requirements and make appropriate recommendations to the Legislature; and (4) execute and administer agreements with political subdivision to implement state assurances of participation in federal flood control projects.

(e) For meritorious proposed projects which do not meet feasibility standards for federal flood control projects: (1) formulate state feasibility criteria and project funding procedures; (2) study, evaluate, and determine the feasibility of proposed projects in accordance with established criteria and make recommendations to the Legislature; (3) execute and administer agreements with political subdivisions to assure compliance with the conditions of state projects; and (4) design, prepare plans and specifications, obtain bids, let contracts, and supervise the construction of state flood control works.

(f) With regard to projects initiated and financed entirely by political subdivisions, render coordination and aid only if requested by the respective agencies."

SECTION 2. Existing Laws and Severability. All laws or parts of laws which are held to be inconsistent with this Act are hereby amended to conform with the provisions of this Act. The provisions of this Act a re declared to be severable, and if any portion of this Act or the application thereof to any person, circumstance, or property is held to be invalid for any reason, the validity of the remainder of this Act or the application of such portion to other persons, circumstances or property shall not be affected thereby.

SECTION 3. This Act shall take effect upon its approval.

APPROVED this 3rd day of June, 1963

/s/ John A. Burns

GOVERNOR OF THE STATE OF HAWAII

EXHIBIT A-1

February 8, 1962

District Engineer
U. S. Army Engineer District, Honolulu
Corps of Engineers
Building 96, Fort Armstrong
Honolulu 13, Hawaii

Dear Sir:

This Department has been designated by Act 34, Session Laws of Hawaii 1961, as the State agency responsible for assisting political subdivisions in obtaining the benefits of Federal funds for flood control and flood water conservation projects (copy of authorizing law is attached). Under authority of Section 206, Public Law 86-645, approved July 14, 1960, we hereby apply for flood plain information study of the following area:

1. Hanalei River Area, Island of Kauai

2. Kaumana-Punahoa Area, Island of Hawaii

Hanalei River Area, Island of Kauai

The local objective is to further develop the area so that possible flood, sediment and erosion damages to lands, crops, roads, and other improvements can be prevented or controlled. On several occasions during the past five years this area has been isolated due to flooding of the only ingress and egress highway.

The flood plain area is approximately 1,850 acres and is situated in the north central coastline portion of the island of Kauai (see Plate 1). This contributory drainage basin or watershed area extends from an approximate elevation of 4500 feet to the sea.

Present land use consists primarily of residential areas, schools, vacation beach cottages, commercial establishments, and wet land farming (rice and taro) and grazing areas. Much of the flood plain is still in wilderness growth capable of being developed further. This fact has been recognized by the State Planning Office when the Hanalei area was considered in the First Stage Plan for Public Improvements, an action program for further development.

Planned land use will be generally centered on resort hotel developments with supporting facilities. The future plans also include the development of an all weather marina and expansion of residential, commercial and wet land farming uses.

EXHIBIT A-2

A proposed public works action plan titled "First Stage Plans for Public Improvements" has been prepared for the State Planning Office for use as a guide in the development of the tourist industry on Kauai. The information collected under the flood plain information studies will be of great value in making local planning decisions during the implementation of the action plan in the Summer of 1963.

Kaumana-Punahoa Area, Island of Hawaii

The local objective is to develop this area so that possible flood, sediment and erosion damage to lands, roads, and improvements can be prevented or controlled. This area is in a rapid transition stage from open and grazing land to agricultural and residential areas. The rainfall in this area is very high. The median annual rainfall ranges from 150 to 300 inches.

The flood plain area to be studied is approximately 3,500 acres and is located on the southwesterly portion of the city of Hilo, the County Seat (see Plate 2). The city of Hilo is located on the eastern coast of the island of Hawaii, the southernmost island in the State.

Presently, the outer extremes of the area is largely vacant land. In the central portion the land is used for grazing and agriculture. Strips of residences border both sides of the main government road which runs through the central portion of the area. These strips increase in width toward the lower end of the flood plain area.

The planned use of this area will be diversified agriculture at the upper and outer regions and essential and residential agriculture, single family residences, schools and parks in the central portion. The last three uses will be predominant in the lower area of the flood plain.

The planning report titled "A Plan for the Metropolitan Area of Hilo" has been prepared and submitted to the County of Hawaii in October, 1961. The information obtained from the flood plain study of this area will be of great value in local planning decisions during the implementation of this plan in the Summer of 1963.

Maps of existing land use, streets, utilities and planning data are available for both areas and will be furnished without cost. The County or State, as a part of the local cooperation, can also provide the following mapping, data gathering and other services:

1. Parcel maps
2. Existing and future land use maps
3. Rainfall and other climatological data
4. Aerial photographs
5. Contour maps
6. Flood plain maps showing extent of flooding
7. Stream profiles and cross-sections

The Counties of Kauai and Hawaii or the State of Hawaii will be responsible for providing the following local cooperation:

1. Publicize the information report in the Hanalei and Kaumana-Punahoa communities; Lihue,Kauai and Hilo, Hawaii County Seats; and the city of Honolulu, the State Capitol. Copies will be made available for use or inspection by all interested parties and individuals.

2. Zoning and other regulatory, development and planning agencies, and public information media will be provided with the flood plain information for their guidance and appropriate action.

3. Survey markers, monuments, etc., established in any Federal surveys in the area concerned, will be preserved and safeguarded.

Our Department is also studying other areas which will require flood plain information studies. Applications for these areas will follow as soon as necessary background data are gathered.

Very truly yours,

E. H. COOK
Director

Enc.

C O P Y

EXHIBIT A-2

WILLIAM F. QUINN
GOVERNOR

STATE OF HAWAII
EXECUTIVE CHAMBERS
HONOLULU

JUN 21 1962

Colonel D. G. Williams
District Engineer
U.S. Army Engineer District, Honolulu
Building 96, Fort Armstrong
Honolulu 13, Hawaii

Dear Colonel Williams:

Thank you for your letter of May 28, 1962 concerning the initiation of flood plain information studies for the Hanalei River, Kauai and the Kaumana-Punahoa area, Hawaii.

If we can be of any assistance to you on these projects, please do not hesitate to call upon our Department of Land and Natural Resources. I have referred your letter to this department and they stand ready to cooperate with you in any way that they can.

Sincerely,

William F. Quinn

WILLIAM F. QUINN
GOVERNOR OF HAWAII

cc Land & Nat. Res.
Plan. & Res.

EXHIBIT A-3

CABLE ADDRESS
FISHWILD

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES
P. O. Box 3830, Honolulu 12, Hawaii

HAWAII AREA

ADDRESS ONLY
THE AREA DIRECTOR

June 15, 1962

District Engineer
U.S. Army Engineer District, Honolulu
Corps of Engineers
Building 96, Ft. Armstrong
Honolulu 13, Hawaii

Reference: POHGP

Dear Sir:

Not knowing what flood control measures might be adopted for the Hanalei flood plain area, it is only possible to comment at this time that Hanalei Bay provides about one percent of the State's catch of tuna live bait (nēhu) and that Hanalei River is one of the most accessible and most popular streams in the State for recreational fishing for oopu. We do not have additional information, pertinent to our interests, to provide you for your flood plain information studies of the Hanalei River, island of Kauai, and the Kaumana-Punahoa area, island of Hawaii.

Sincerely yours,

John C. Marr
Area Director

EXHIBIT A-4

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE

PUBLIC HEALTH SERVICE

447 Federal Office Building
San Francisco 2, California

June 25, 1962

AIR MAIL

Colonel D. G. Williams
District Engineer
U. S. Army Engineer District, Honolulu
Corps of Engineers
Building 96, Ft. Armstrong
Honolulu 13, Hawaii

Dear Colonel Williams: Re: POHGP

We are in receipt of your letter of May 29, 1962, requesting information relative to initiated flood plain studies of the Hanalei River, Island of Kauai, and Kaumana-Punahoa area, Island of Hawaii, Hawaii.

No available data from this office are directly applicable to the Kaumana-Punahoa area; however, information on water supply facilities for the City of Hanalei, Hanalei flood plain, is described herein. Hanalei Village, a community with an approximately population of 500 people, obtains its domestic water supply from the East Branch, Waioli Stream. No treatment is provided these waters.

We would appreciate four copies of your findings and conclusions for future reference and action, if so indicated.

Sincerely yours,

William B. Schreeder
Chief, Water Resources Development
Section, DWS&PC, PHS, Region IX

cc: M. B. Rainey
B. J. McMorrow
Dr. E. W. Norris

EXHIBIT A-5

Hanalei Community Association

General Meeting

The flooding of Hanalei stream during periods of heavy rain is as obvious as the sun rising daily from the eastern horizon. People of Hanalei have long suffered from its damaging effects in one way or another. School children as well as teachers have missed many school days, all transportation forced to a standstill for hours, disrupting important mail schedule as well as endangering lives of those who seek emergency medical care.

Farmers, ranchers, merchants have suffered substantial damages and losses to property, crops, animals, merchandise, soil, etc., and these losses and inconveniences will continue to mount and persist unless a speedy remedy to this problem is planned and carried out as soon as possible through proper government service channels.

Parallel problems of flood control have already been licked and solved at Waimea and Hanapepe.

A $175,000 appropriation by the 1957 Legislative session meant for use in the Hanalei stream flood control was spent for some west side project, I was told. Rather than argue or question this short-changing, let's simply make our stand and wishes known to our Board and Legislators and prevail upon them for favorable action.

Attached are comprehensible data covering damages and losses to property, crop, animal, and merchandise suffered by a number of parties living along the bank of the Hanalei stream. The committee hopes that this partial overview of the situation as it now exists will help in some small measure to enlighten the minds of the totally unfamiliar to the pertinence of a solution to this grave community problem.

Upon acceptance of this committee report, I strongly urge the following follow-up step:

1. Call a general meeting in early part of Dec., 1960, to which every member of our County Board and Legislators will be invited--preferably a pay dinner meeting.

2. Present this Flood Control proposal to the Board and Legislators present.

3. Request their views on it.

4. Prevail on Legislators right there and then to father a joint bill for necessary appropriation to carry out project.

Respectfully submitted:

Jack N. Nishimoto, Chairman
Legislative Committee
Hanalei Community Association

Members: Harold Kobayashi
George Kodama
Blakeslee Conant

C O P Y

EXHIBIT A-6

Data on Flood Losses Reported by Farmers and Merchant Established Along Hanalei Stream

	1956			1957			1959		
	Taro	Rice	Property	Taro	Rice	Property	Taro	Rice	Property
Wm. Tuck Wong	$1,000.00	$	$ 150.00	$	$	$	$1,200.00	$ 600.00	$ 200.00
A. Marcelo		100.00						900.00	
A. Diego							1,200.00		
Haraguchi Farm	250.00	2,250.00	1,825.00	525.00	850.00	1,225.00		714.00	1,578.51
S. Takenaka							6,000.00		
Mateo							3,000.00		
D. Rosal	1,700.00						800.00		
Sub-totals	$2,950.00	$2,350.00	$1,975.00	$525.00	$850.00	$1,225.00	$12,200.00	$2,214.00	$1,778.51

Ching Ma Leong Store: 1956: Merchandise loss $1,423.37
Property Loss 126.98
Total $1,550.35

Princeville Ranch	1955	1956	1959
Cattle:	$1,350.00	$5,000.00	$225.00

TOTAL: $6,575.00

EXHIBIT A-6

Hanalei Community Ass'n,
Page 2

Sub-totals by Items and Years:

Year	Taro	Rice	Property	Merchandise	Cattle
1955	$	$	$	$	$1,350.00
1956	2,950.00	2,350.00	2,101.98	1,423.37	5,000.00
1957	525.00	850.00	1,225.00		
1958					
1959	12,200.00	2,214.00	1,778.51		225.00
TOTALS	$15,675.00	$5,414.00	$5,105.49	$1,423.37	$6,575.00

Grand Total by Items:

Taro $15,675.00
Rice 5,414.00
Property 5,105.49
Merchandise 1,423.37
Cattle 6,575.00

GRAND TOTAL $34,192.86

Late report not included above: Haraguchi Farm, 1955 flood damage:

Rice $4,200.00
Property 826.00

NEW GRAND TOTAL: $39,218.86