FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 4

CITY AND COUNTY OF HONOLULU, HAWAII

COMMUNITY NAME	COMMUNITY NUMBER
CITY AND COUNTY OF HONOLULU	150001

REVISED:

June 10, 2026

FLOOD INSURANCE STUDY NUMBER
15003CV001D
Version Number 2.8.5.6

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FLOOD INSURANCE STUDY REPORT
CITY AND COUNTY OF HONOLULU, HAWAII

SECTION 1.0 – INTRODUCTION

1.1 The National Flood Insurance Program

The National Flood Insurance Program (NFIP) is a voluntary Federal program that enables property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.

For decades, the national response to flood disasters was generally limited to constructing flood-control works such as dams, levees, sea-walls, and the like, and providing disaster relief to flood victims. This approach did not reduce losses nor did it discourage unwise development. In some instances, it may have actually encouraged additional development. To compound the problem, the public generally could not buy flood coverage from insurance companies, and building techniques to reduce flood damage were often overlooked.

In the face of mounting flood losses and escalating costs of disaster relief to the general taxpayers, the U.S. Congress created the NFIP. The intent was to reduce future flood damage through community floodplain management ordinances, and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection.

The U.S. Congress established the NFIP on August 1, 1968, with the passage of the National Flood Insurance Act of 1968. The NFIP was broadened and modified with the passage of the Flood Disaster Protection Act of 1973 and other legislative measures. It was further modified by the National Flood Insurance Reform Act of 1994 and the Flood Insurance Reform Act of 2004. The NFIP is administered by the Federal Emergency Management Agency (FEMA), which is a component of the Department of Homeland Security (DHS).

Participation in the NFIP is based on an agreement between local communities and the Federal Government. If a community adopts and enforces floodplain management regulations to reduce future flood risks to new construction and substantially improved structures in Special Flood Hazard Areas (SFHAs), the Federal Government will make flood insurance available within the community as a financial protection against flood losses. The community's floodplain management regulations must meet or exceed criteria established in accordance with Title 44 Code of Federal Regulations (CFR) Part 60, *Criteria for Land Management and Use*.

SFHAs are delineated on the community's Flood Insurance Rate Maps (FIRMs). Under the NFIP, buildings that were built before the flood hazard was identified on the community's FIRMs are generally referred to as "Pre-FIRM" buildings. When the NFIP was created, the U.S. Congress recognized that insurance for Pre-FIRM buildings would be prohibitively expensive if the premiums were not subsidized by the Federal

Government. Congress also recognized that most of these floodprone buildings were built by individuals who did not have sufficient knowledge of the flood hazard to make informed decisions. The NFIP requires that full actuarial rates reflecting the complete flood risk be charged on all buildings constructed or substantially improved on or after the effective date of the initial FIRM for the community or after December 31, 1974, whichever is later. These buildings are generally referred to as “Post-FIRM” buildings.

1.2 Purpose of this Flood Insurance Study Report

This Flood Insurance Study (FIS) Report revises and updates information on the existence and severity of flood hazards for the study area. The studies described in this report developed flood hazard data to assist communities in efforts to implement sound floodplain management.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive than the minimum Federal requirements. Contact your State NFIP Coordinator to ensure that any higher State standards are included in the community’s regulations.

1.3 Jurisdictions Included in the Flood Insurance Study Project

This FIS Report covers the entire geographic area of the City and County of Honolulu, Hawaii.

The jurisdictions that are included in this project area, along with the Community Identification Number (CID) for each community and the United States Geological Survey (USGS) 8-digit Hydrologic Unit Code (HUC-8) sub-basins affecting each, are shown in Table 1. The FIRM panel numbers that affect each community are listed. If the flood hazard data for the community is not included in this FIS Report, the location of that data is identified.

Table 1: Listing of NFIP Jurisdictions

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
City and County of Honolulu	150001	20060000	15003C0010F 15003C0020G 15003C0030H 15003C0035F 15003C0040G 15003C0041J 15003C0042J 15003C0043J 15003C0044J 15003C0060G 15003C0080G 15003C0085G 15003C0090H 15003C0095G 15003C0105J 15003C0110G 15003C0115H 15003C0120G 15003C0130G 15003C0135G 15003C0140G 15003C0145F[1] 15003C0155G 15003C0165G 15003C0170F 15003C0177H 15003C0179H 15003C0183J 15003C0185H 15003C0191H 15003C0192K 15003C0194H 15003C0205G 15003C0210G 15003C0213J 15003C0215J 15003C0219G 15003C0220G 15003C0226F 15003C0227F[1] 15003C0228G 15003C0229G 15003C0235G 15003C0236H 15003C0237G	

Table 1: Listing of NFIP Jurisdictions *(continued)*

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
City and County of Honolulu	150001	20060000	15003C0238H 15003C0239H 15003C0241H 15003C0242G[1] 15003C0243J 15003C0244H 15003C0252H 15003C0254H 15003C0255H[1] 15003C0258G 15003C0259G 15003C0260G[1] 15003C0265F 15003C0266K 15003C0267K 15003C0268K[1] 15003C0269K 15003C0280F 15003C0290J 15003C0295F 15003C0301G 15003C0302F[1] 15003C0303G 15003C0304G 15003C0310H 15003C0312G 15003C0316H 15003C0317G 15003C0326H 15003C0327G 15003C0328G 15003C0329G 15003C0331H 15003C0332J 15003C0333G 15003C0334G 15003C0336G 15003C0337G[1] 15003C0341G 15003C0342G 15003C0351H 15003C0352G 15003C0353H 15003C0354H 15003C0360H 15003C0361H 15003C0362H 15003C0365G	

Table 1: Listing of NFIP Jurisdictions *(continued)*

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
City and County of Honolulu	150001	20060000	15003C0366H 15003C0367J 15003C0368G 15003C0369J 15003C0376J 15003C0377J 15003C0378J[1] 15003C0379J 15003C0381H 15003C0382H[1] 15003C0383H 15003C0384H 15003C0386H 15003C0387H 15003C0388H 15003C0389G 15003C0391G 15003C0393G 15003C0395H	

[1] Panel Not Printed

1.4 Considerations for using this Flood Insurance Study Report

The NFIP encourages State and local governments to implement sound floodplain management programs. To assist in this endeavor, each FIS Report provides floodplain data, which may include a combination of the following: 10-, 4-, 2-, 1-, and 0.2-percent annual chance flood elevations (the 1-percent-annual-chance flood elevation is also referred to as the Base Flood Elevation (BFE)); delineations of the 1-percent-annual-chance and 0.2-percent-annual-chance floodplains; and 1-percent-annual-chance floodway. This information is presented on the FIRM and/or in many components of the FIS Report, including Flood Profiles, Floodway Data tables, Summary of Non-Coastal Stillwater Elevations tables, and Coastal Transect Parameters tables (not all components may be provided for a specific FIS).

This section presents important considerations for using the information contained in this FIS Report and the FIRM, including changes in format and content. Figures 1, 2, and 3 present information that applies to using the FIRM with the FIS Report.

- Part or all of this FIS Report may be revised and republished at any time. In addition, part of this FIS Report may be revised by a Letter of Map Revision (LOMR), which does not involve republication or redistribution of the FIS Report. Refer to Section 6.5 of this FIS Report for information about the process to revise the FIS Report and/or FIRM.

It is, therefore, the responsibility of the user to consult with community officials by contacting the community repository to obtain the most current FIS Report components. Communities participating in the NFIP have established repositories of flood hazard data for floodplain management and flood insurance purposes. Community map repository addresses are provided in Table 30, "Map Repositories," within this FIS Report.

- New FIS Reports are frequently developed for multiple communities, such as entire counties. A countywide FIS Report incorporates previous FIS Reports for individual communities and the unincorporated area of the county (if not jurisdictional) into a single document and supersedes those documents for the purposes of the NFIP.

  The initial Countywide FIS Report for City and County of Honolulu, Hawaii became effective on November 20, 2000. Refer to Table 27 for information about subsequent revisions to the FIRMs.

- Selected FIRM panels for the community may contain information (such as floodways and cross sections) that was previously shown separately on the corresponding Flood Boundary and Floodway Map (FBFM) panels. In addition, former flood hazard zone designations have been changed as follows:

Old Zone	New Zone
A1 through A30	AE
V1 through V30	VE
B	X (shaded)
C	X (unshaded)

  The CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Visit the FEMA Web site at www.fema.gov/flood-insurance/rules-legislation/community-rating-system or contact your appropriate FEMA Regional Office for more information about this program.

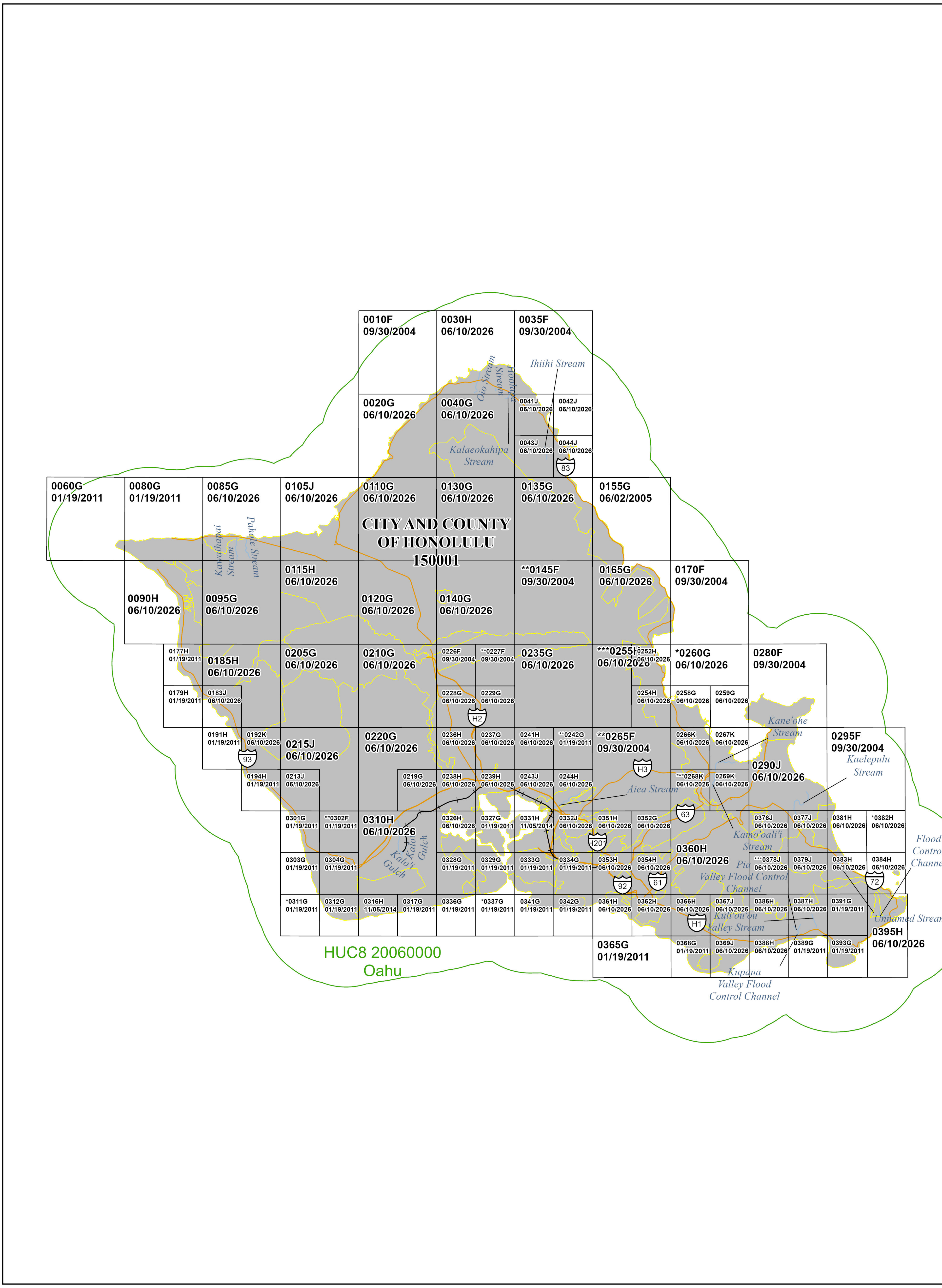
- FEMA does not design, build, inspect, operate, maintain, or certify levees. FEMA is responsible for accurately identifying flood hazards and communicating those hazards and risks to affected stakeholders. FEMA has identified one or more levee systems in this jurisdiction summarized in Table 8 of this FIS Report. For FEMA to accredit the identified levee systems, the levee systems must meet the criteria of the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10), titled "Mapping of Areas Protected by Levee Systems."

  Information on the levee systems in this jurisdiction can be obtained from the USACE National Levee Database (https://levees.sec.usace.army.mil/). For additional information, the user should contact the appropriate jurisdiction floodplain administrator and the levee owner or sponsor.

- FEMA has developed a *Guide to Flood Maps* (FEMA 258) and online tutorials to assist users in accessing the information contained on the FIRM. These include how to read panels and step-by-step instructions to obtain specific information. To obtain this guide and other assistance in using the FIRM, visit the FEMA Web site at www.fema.gov/flood-maps/tutorials.

The FIRM Index in Figure 1 shows the overall FIRM panel layout within the City and County of Honolulu, and also displays the panel number and effective date for each FIRM panel in the county. Other information shown on the FIRM Index includes community boundaries, flooding sources, watershed boundaries, and USGS HUC-8 codes.

Figure 1: FIRM Index



1 inch = 25,820 feet 1:309,844

0 10,000 20,000 40,000 60,000 feet

Map Projection:
NAD 1983 StatePlane Hawaii 3 FIPS 5103 Feet
Vertical Datum: LOCAL TIDAL DATUM

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTPS://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION

* PANEL NOT PRINTED - OPEN WATER
**PANEL NOT PRINTED - AREA IN ZONE D

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX

CITY AND COUNTY OF HONOLULU, HAWAII

PANELS PRINTED:

0010, 0020, 0030, 0035, 0040, 0041, 0042, 0043, 0044, 0060, 0080, 0085, 0090, 0095, 0105, 0110, 0115, 0120, 0130, 0135, 0140, 0155, 0165, 0170, 0177, 0179, 0183, 0185, 0191, 0192, 0194, 0205, 0210, 0213, 0215, 0219, 0220, 0226, 0228, 0229, 0235, 0236, 0237, 0238, 0239, 0241, 0243, 0244, 0252, 0254, 0258, 0259, 0266, 0267, 0269, 0280, 0290, 0295, 0301, 0303, 0304, 0310, 0312, 0316, 0317, 0326, 0327, 0328, 0329, 0331, 0332, 0333, 0334, 0336, 0341, 0342, 0351, 0352, 0353, 0354, 0360, 0361, 0362, 0365, 0366, 0367, 0368, 0369, 0376, 0377, 0379, 0381, 0383, 0384, 0386, 0387, 0388, 0389, 0391, 0393, 0395

U.S. DEPARTMENT OF HOMELAND SECURITY

FEMA

MAP NUMBER
15003CIND0E

EFFECTIVE DATE
June 10, 2026

Each FIRM panel may contain specific notes to the user that provide additional information regarding the flood hazard data shown on that map. However, the FIRM panel does not contain enough space to show all the notes that may be relevant in helping to better understand the information on the panel. Figure 2 contains the full list of these notes.

Figure 2: FIRM Notes to Users

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM including historic versions of this FIRM, how to order products, or the National Flood Insurance Program in general, please call the FEMA Mapping and Insurance eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Flood Map Service Center website or by calling the FEMA Mapping and Insurance eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates, refer to Table 27 in this FIS Report.

To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

The map is for use in administering the NFIP. It may not identify all areas subject to flooding, particularly from local drainage sources of small size. Consult the community map repository to find updated or additional flood hazard information.

BASE FLOOD ELEVATIONS: For more detailed information in areas where Base Flood Elevations (BFEs) and/or floodways have been determined, consult the Flood Profiles and Floodway Data and/or Summary of Non-Coastal Stillwater Elevations tables within this FIS Report. Use the flood elevation data within the FIS Report in conjunction with the FIRM for construction and/or floodplain management.

Coastal Base Flood Elevations shown on the map apply only landward of 0.0' Local Tidal Datum. Coastal flood elevations are also provided in the Coastal Transect Parameters table in the FIS Report for this jurisdiction. Elevations shown in the Coastal Transect Parameters table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on the FIRM.

Figure 2. FIRM Notes to Users *(continued)*

FLOODWAY INFORMATION: Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the FIS Report for this jurisdiction.

FLOOD CONTROL STRUCTURE INFORMATION: Certain areas not in Special Flood Hazard Areas may have reduced flood hazards due to flood control structures. Refer to Section 4.3 "Dams and Other Flood Hazard Reduction Measures" of this FIS Report for information on flood control structures for this jurisdiction.

PROJECTION INFORMATION: The projection used in the preparation of the map was State Plane Transverse Mercator, Hawaii 3 Zone. The horizontal datum was the North American Datum of 1983 NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

ELEVATION DATUM: Flood elevations on the FIRM are referenced to the Local Tidal Datum. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between Local Tidal Datum and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at www.ngs.noaa.gov.

Local vertical monuments may have been used to create the map. To obtain current monument information, please contact the appropriate local community listed in Table 30 of this FIS Report.

BASE MAP INFORMATION: Base map information shown on the FIRM was provided by DigitalGlobe, Inc. and Natural Resources Conservation Service at a scale of 1:12,000. For FIRM panels effective June 10, 2026, basemap information shown on the FIRM was provided in digital format by the United States Geological Survey (USGS). The basemap shown is the USGS National Map: Orthoimagery. Last refreshed October, 2020. For information about base maps, refer to Section 6.2 “Base Map” in this FIS Report.

The map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map.

Corporate limits shown on the map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after the map was published, map users should contact appropriate community officials to verify current corporate limit locations.

NOTES FOR FIRM INDEX

REVISIONS TO INDEX: As new studies are performed and FIRM panels are updated within the City and County of Honolulu, Hawaii, corresponding revisions to the FIRM Index will be incorporated within the FIS Report to reflect the effective dates of those panels. Please refer to Table 27 of this FIS Report to determine the most recent FIRM revision date for each community. The most recent FIRM panel effective date will correspond to the most recent index date.

Figure 2. FIRM Notes to Users *(continued)*

SPECIAL NOTES FOR SPECIFIC FIRM PANELS

This Notes to Users section was created specifically for the City and County of Honolulu, Hawaii, effective June 10, 2026.

ACCREDITED LEVEE SYSTEM: Check with your local community to obtain more information on the levee system(s) shown as providing flood hazard reduction on this panel. To mitigate flood hazards in residual risk areas, property owners and residents are encouraged to review the community's emergency preparedness plan and to consider flood insurance and floodproofing or other risk reduction measures. For more information on flood insurance, interested parties should visit www.fema.gov/flood-insurance.

NON-ACCREDITED LEVEE SYSTEM: This panel contains a levee system that has not been accredited and is therefore not recognized as reducing the 1-percent-annual-chance flood hazard.

FLOOD RISK REPORT: A Flood Risk Report (FRR) may be available for many of the flooding sources and communities referenced in this FIS Report. The FRR is provided to increase public awareness of flood risk by helping communities identify the areas within their jurisdictions that have the greatest risks. Although non-regulatory, the information provided within the FRR can assist communities in assessing and evaluating mitigation opportunities to reduce these risks. It can also be used by communities developing or updating flood risk mitigation plans. These plans allow communities to identify and evaluate opportunities to reduce potential loss of life and property. However, the FRR is not intended to be the final authoritative source of all flood risk data for a project area; rather, it should be used with other data sources to paint a comprehensive picture of flood risk.

Each FIRM panel contains an abbreviated legend for the features shown on the maps. However, the FIRM panel does not contain enough space to show the legend for all map features. Figure 3 shows the full legend of all map features. Note that not all of these features may appear on the FIRM panels in the City and County of Honolulu.

Figure 3: Map Legend for FIRM

SPECIAL FLOOD HAZARD AREAS: The 1% annual chance flood, also known as the base flood or 100-year flood, has a 1% chance of happening or being exceeded each year. Special Flood Hazard Areas are subject to flooding by the 1% annual chance flood. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights. See note for specific types. If the floodway is too narrow to be shown, a note is shown.

	Special Flood Hazard Areas subject to inundation by the 1% annual chance flood (Zones A, AE, AH, AO, AR, A99, V and VE)
Zone A	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. No base (1% annual chance) flood elevations (BFEs) or depths are shown within this zone.
Zone AE	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. Base flood elevations derived from the hydraulic analyses are shown within this zone.
Zone AH	The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the hydraulic analyses are shown at selected intervals within this zone.
Zone AO	The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the hydraulic analyses are shown within this zone.
Zone AR	The flood insurance rate zone that corresponds to areas that were formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
Zone A99	The flood insurance rate zone that corresponds to areas of the 1% annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or flood depths are shown within this zone.
Zone V	The flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations are not shown within this zone.
Zone VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations derived from the coastal analyses are shown within this zone as static whole-foot elevations that apply throughout the zone.
	Regulatory Floodway determined in Zone AE.

Figure 3: Map Legend for FIRM *(continued)*

OTHER AREAS OF FLOOD HAZARD	
	Shaded Zone X: Areas of 0.2% annual chance flood hazards and areas of 1% annual chance flood hazards with average depths of less than 1 foot or with drainage areas less than 1 square mile.
	Future Conditions 1% Annual Chance Flood Hazard – Zone X: The flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined based on future-conditions hydrology. No base flood elevations or flood depths are shown within this zone.
	Area with Reduced Flood Hazard due to Accredited or Provisionally Accredited Levee System: Area is shown as reduced flood hazard from the 1-percent-annual-chance or greater flood by a levee system. Overtopping or failure of any levee system is possible. See Notes to Users for important information.
	Area with Undetermined Flood Hazard due to Non-Accredited Levee System: Analysis and mapping procedures for non-accredited levee systems were applied resulting in a flood insurance rate zone where flood hazards are undetermined, but possible.
OTHER AREAS	
	Zone D (Areas of Undetermined Flood Hazard): The flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.
NO SCREEN	Unshaded Zone X: Areas of minimal flood hazard.
FLOOD HAZARD AND OTHER BOUNDARY LINES	
(ortho) (vector)	Flood Zone Boundary (white line on ortho-photography-based mapping; gray line on vector-based mapping)
	Limit of Study
	Jurisdiction Boundary
GENERAL STRUCTURES	
Aqueduct Channel Culvert Storm Sewer	Channel, Culvert, Aqueduct, or Storm Sewer
Dam Jetty Weir	Dam, Jetty, Weir
	Levee, Dike, or Floodwall
Bridge	Bridge

Figure 3: Map Legend for FIRM *(continued)*

REFERENCE MARKERS	
22.0 ●	River mile Markers
CROSS SECTION & TRANSECT INFORMATION	
B 20.2	Lettered Cross Section with Regulatory Water Surface Elevation (BFE)
5280 21.1	Numbered Cross Section with Regulatory Water Surface Elevation (BFE)
17.5	Unlettered Cross Section with Regulatory Water Surface Elevation (BFE)
8	Coastal Transect
	Profile Baseline: Indicates the modeled flow path of a stream and is shown on FIRM panels for all valid studies with profiles or otherwise established base flood elevation.
	Coastal Transect Baseline: Used in the coastal flood hazard model to represent the 0.0-foot elevation contour and the starting point for the transect and the measuring point for the coastal mapping.
513	Base Flood Elevation Line
ZONE AE (EL 16)	Static Base Flood Elevation value (shown under zone label)
ZONE AO (DEPTH 2)	Zone designation with Depth
ZONE AO (DEPTH 2) (VEL 15 FPS)	Zone designation with Depth and Velocity
BASE MAP FEATURES	
Missouri Creek	River, Stream or Other Hydrographic Feature
234	Interstate Highway
234	U.S. Highway
234	State Highway
234	County Highway
MAPLE LANE	Street, Road, Avenue Name, or Private Drive if shown on Flood Profile
RAILROAD	Railroad

Figure 3: Map Legend for FIRM *(continued)*

____________	Horizontal Reference Grid Line
__	Horizontal Reference Grid Ticks
+	Secondary Grid Crosshairs
Land Grant	Name of Land Grant
7	Section Number
R. 43 W. T. 22 N.	Range, Township Number
$\mathbf{^{42}76^{000m}E}$	Horizontal Reference Grid Coordinates (UTM)
365000 FT	Horizontal Reference Grid Coordinates (State Plane)
80° 16’ 52.5”	Corner Coordinates (Latitude, Longitude)

SECTION 2.0 – FLOODPLAIN MANAGEMENT APPLICATIONS

2.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance (500-year) flood is employed to indicate additional areas of flood hazard in the community.

Each flooding source included in the project scope has been studied and mapped using professional engineering and mapping methodologies that were agreed upon by FEMA and the City and County of Honolulu as appropriate to the risk level. Flood risk is evaluated based on factors such as known flood hazards and projected impact on the built environment. Engineering analyses were performed for each studied flooding source to calculate its 1-percent-annual-chance flood elevations; elevations corresponding to other floods (e.g. 10-, 4-, 2-, 0.2-percent annual chance, etc.) may have also been computed for certain flooding sources. Engineering models and methods are described in detail in Section 5.0 of this FIS Report. The modeled elevations at cross sections were used to delineate the floodplain boundaries on the FIRM; between cross sections, the boundaries were interpolated using elevation data from various sources. More information on specific mapping methods is provided in Section 6.0 of this FIS Report.

Depending on the accuracy of available topographic data (Table 22), study methodologies employed (Section 5.0), and flood risk, certain flooding sources may be mapped to show both the 1-percent and 0.2-percent-annual-chance floodplain boundaries, regulatory water surface elevations (BFEs), and/or a regulatory floodway. Similarly, other flooding sources may be mapped to show only the 1-percent-annual-chance floodplain boundary on the FIRM, without published water surface elevations. In cases where the 1-percent and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM. Figure 3, "Map Legend for FIRM", describes the flood zones that are used on the FIRMs to account for the varying levels of flood risk that exist along flooding sources within the project area. Table 2 and Table 3 indicate the flood zone designations for each flooding source and each community within the City and County of Honolulu, respectively.

Table 2, "Flooding Sources Included in this FIS Report," lists each flooding source, including its study limits, affected communities, mapped zone on the FIRM, and the completion date of its engineering analysis from which the flood elevations on the FIRM and in the FIS Report were derived. Descriptions and dates for the latest hydrologic and hydraulic analyses of the flooding sources are shown in Table 12. Floodplain boundaries for these flooding sources are shown on the FIRM (published separately) using the symbology described in Figure 3. On the map, the 1-percent-annual-chance floodplain corresponds to the SFHAs. The 0.2-percent-annual-chance floodplain shows areas that, although out of the regulatory floodplain, are still subject to flood hazards.

Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data. The procedures to remove these areas from the SFHA are described in Section 6.5 of this FIS Report.

Table 2: Flooding Sources Included in this FIS Report

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Ahuimanu Stream	City and County of Honolulu	Confluence with Kaneohe Bay	Approximately 800 feet upstream of Kahekili Highway	20060000	1.3	-	Y	AE	2023
	City and County of Honolulu	Approximately 800 feet upstream of Kahekili Highway	Approximately 2,020 feet upstream of Kahekili Highway	20060000	0.2	-	N	AE	2017
Ahuimanu Stream Tributary	City and County of Honolulu	Confluence with Ahuimanu Stream	Approximately 75 feet downstream of Hui Io Street	20060000	0.6	-	Y	AE	2023
Aiea Stream	City and County of Honolulu	At Moanalua Road	Approximately 0.7 miles upstream of Ulune Street	20060000	1.0	-	Y	AE	1985
Ala Wai Canal	City and County of Honolulu	At downstream Limit of Study	At upstream Limit of Study	20060000	1.9	-	Y	AE	1976
Anahulu River	City and County of Honolulu	Approximately 280 feet upstream of Kamehameha Highway	Approximately 930 feet upstream of Cane Haul Road	20060000	1.0	-	Y	AE	1976
Eku Stream	City and County of Honolulu	Confluence with Pacific Ocean	Approximately 1,450 feet upstream of Kaulawaha Road	20060000	0.8	-	Y	AE	1993
Fish Pond	City and County of Honolulu	Just upstream of Highway H1	Approximately 1,600 feet upstream of Highway H1	20060000	0.3	-	N	AE	2020
Flow Along Cane Haul Road	City and County of Honolulu	Convergence with Panakauahi Gulch	Divergence from Panakauahi Gulch	20060000	*	-	N	AE	1976

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Haiamoa Stream	City and County of Honolulu	Confluence with Kaneohe Bay	Approximately 50 feet upstream of Ahilama Road	20060000	0.4	-	Y	AE	1985
Halawa Stream	City and County of Honolulu	Confluence with East Loch	Approximately 3,250 feet upstream of Kamehameha Highway	20060000	0.9	-	N	AE	2013
Hanahimoa Stream	City and County of Honolulu	Approximately 195 feet upstream of Kamehameha Highway	Approximately 1,290 feet upstream of Kamehameha Highway	20060000	0.3	-	Y	AE	1976
Heeia Stream	City and County of Honolulu	Confluence with Kaneohe Bay	Approximately 1,700 feet upstream of Alaloa Street	20060000	1.8	-	Y	AE	1976
Helemano Stream	City and County of Honolulu	Confluence with Paukauila Stream and Opaeula Stream	Approximately 3,660 feet upstream of confluence with Paukauila Stream and Opaeula Stream	20060000	0.7	-	Y	AE	1976
Hoaeae Stream	City and County of Honolulu	Confluence with West Loch, Pearl Harbor	Approximately 940 feet upstream of Honowai Street	20060000	1.2	-	Y	AE	2023
Honouliuli Stream	City and County of Honolulu	Confluence with West Loch, Pearl Harbor	Approximately 20 feet upstream of Farrington Highway	20060000	1.4	-	Y	AE	1985
Hoolapa Stream	City and County of Honolulu	Approximately 530 feet downstream of Kamehameha Highway	Approximately 365 feet upstream of Kamehameha Highway	20060000	0.6	-	Y	AE	1976
Ihiihi Stream	City and County of Honolulu	Confluence with Kahawainui Stream	Approximately 1,225 feet upstream of confluence with Kahawainui Stream	20060000	0.2	-	Y	AE	2023

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi²) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Inoaole Stream	City and County of Honolulu	Confluence with Pacific Ocean	Approximately 30 feet downstream of Hihimanu Street	20060000	1.2	-	Y	AE	2023
Inoaole Stream Tributary	City and County of Honolulu	At Kulaiwi Street	Approximately 990 feet upstream of Hihimanu Street	20060000	0.8	-	Y	AE	2023
James Campbell Industrial Park (JCIP) Drainage Canal	City and County of Honolulu	Approximately 2,000 feet upstream of confluence with Pacific Ocean	Approximately 3,920 feet upstream of confluence with Pacific Ocean	20060000	0.4	-	N	AE	2013
Kaaawa Stream	City and County of Honolulu	At Kamehameha Highway	At conflunce with Ka'a'awa Stream	20060000	0.6	-	Y	AE	1976
Kaalaea Stream	City and County of Honolulu	Confluence with Kaneohe Bay	Approximately 380 feet upstream of Access Road	20060000	1.1	-	Y	AE	1985
Kaelepulu Stream	City and County of Honolulu	Just downstream of Kawailda Road	At upstream Limit of Study	20060000	2.7	-	N	AE	1976
Kaelepulu Stream Tributary	City and County of Honolulu	At confluence with Kaelepulu Stream	At upstream Limit of Study	20060000	*	-	N	A	1989
Kahaluu Stream	City and County of Honolulu	Confluence with Ahuimanu Stream	At Melekua Road	20060000	1.3	-	Y	AE	1985
Kahana Stream	City and County of Honolulu	At downstream Limit of Study	At upstream Limit of Study	20060000	0.9	-	Y	AE	1976
Kahauiki Stream	City and County of Honolulu	Confluence with Moanalua Stream (Lower)	Approximately 290 feet downstream of Government Road	20060000	0.3	-	Y	AE	2020
	City and County of Honolulu	Approximately 290 feet downstream of Government Road	Approximately 590 feet upstream of Moanalua Highway	20060000	0.5	-	Y	AE	2021
Kahawainui Stream	City and County of Honolulu	Confluence with Pacific Ocean	Approximately 1.3 miles upstream of confluence with Pacific Ocean	20060000	1.3	-	Y	AE	2023

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Kaipapau Stream	City and County of Honolulu	Approximately 150 feet downstream of Kamehameha Highway	Approximately 0.4 miles upstream of Kamehameha Highway	20060000	0.4	-	Y	AE	1976
Kalaeokahipa Stream	City and County of Honolulu	Confluence with Ohia Stream	Approximately 375 feet upstream of Kamehameha Highway	20060000	0.5	-	Y	AE	1976
Kalauao Stream	City and County of Honolulu	Confluence with East Loch, Pearl Harbor	At H1 Freeway	20060000	0.8	-	Y	AE	1985
Kalihi Stream	City and County of Honolulu	Confluence with Keehi Lagoon	Approximately 330 feet upstream of Likelike Highway	20060000	4.5	-	Y	AE	2023
	City and County of Honolulu	Approximately 330 feet upstream of Likelike Highway	At Kalihi Street	20060000	2.6	-	Y	AE	1976
Kaloi Gulch	City and County of Honolulu	Approximately 2,100 feet upstream of Geiger Road	Approximately 515 feet upstream of Mango Tree Road	20060000	1.2	-	Y	AE	1989
Kaluanui Stream	City and County of Honolulu	Approximately 1,460 feet upstream of Kamehameha Highway	Approximately 3,500 feet upstream of Kamehameha Highway	20060000	0.3	-	Y	AE	1976
Kamanaiki Stream	City and County of Honolulu	Confluence with Kalihi Stream	Approximately 1,440 feet upstream of Laulani Street	20060000	0.9	-	Y	AE	1989
Kamooalii Stream	City and County of Honolulu	Confluence with Kaneohe Bay	Approximately 0.6 miles upstream of Luluku Road	20060000	2.7	-	Y	AE	2023

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Kaneohe Stream	City and County of Honolulu	Confluence with Kamooalii Stream	Approximately 480 feet upstream of Lohiehu Street	20060000	1.3	-	N	AE	1976
Kapakahi Stream #1	City and County of Honolulu	Approximately 1,320 feet upstream of confluence with Pacific Ocean	Approximately 1,570 feet upstream of Halekoa Drive	20060000	4.6	-	N	AE	1976
Kapakahi Stream #2	City and County of Honolulu	Confluence With West Loch, Pearl Harbor	Approximately 2,570 feet upstream of Farrington Highway	20060000	1.3	-	Y	AE	2022
Kapalama Drainage Canal	City and County of Honolulu	At North Nimitz Highway	Approximately 70 feet downstream of Kapalama Avenue	20060000	1.3	-	Y	AE	2023
Kapalama Drainage Canal Tributary	City and County of Honolulu	Confluence with Kapalama Drainage Canal	Approximately 50 feet downstream of N School Street	20060000	0.1	-	Y	AE	2023
Kaukonahua Stream	City and County of Honolulu	Confluence with Kaika Bay	Approximately 2.5 miles upstream of confluence with Kaika Bay	20060000	2.5	-	Y	AE	1976
	City and County of Honolulu	Approximately 2.5 miles upstream of confluence with Kaika Bay	Approximately 3.5 miles upstream of confluence with Kaika Bay	20060000	1.0	-	Y	AE	2019
Kaupuni Stream	City and County of Honolulu	Confluence with Pacific Ocean	Approximately 395 feet upstream of Waianae Valley Road	20060000	3.7	-	Y	AE	2023
Kawa Stream	City and County of Honolulu	Confluence with Kaneohe Bay	Approximately 1,220 feet upstream of Namoku Street	20060000	1.7	-	Y	AE	1976

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Kawainui Stream	City and County of Honolulu	Confluence with Kaelepulu Stream	Approximately 370 upstream of Kailua Road	20060000	2.5	-	Y	AE	1985
Kawiwi Stream	City and County of Honolulu	Confluence with Kaupuni Stream	Approximately 0.6 mile upstream of Hoopuhi Street	20060000	0.7	-	Y	AE	2023
Keaahala Stream	City and County of Honolulu	Confluence with Kaneohe Bay	Approximately 50 feet downstream of Kahekili Highway	20060000	1.5	-	Y	AE	2013
Keaaulu Gulch	City and County of Honolulu	Confluence with Malaekahana Stream	Approximately 1.3 miles upstream of confluence with Malaekahana Stream	20060000	1.3	-	N	AE	2013
Kiikii Stream	City and County of Honolulu	At Kaika Bay	Confluence of Kaukonahua Stream and Poamoho Stream	20060000	1.3	-	Y	AE	1976
Kuliouou Stream	City and County of Honolulu	Confluence with Pacific Ocean	Approximately 0.5 miles upstream of Kuliouou Road	20060000	1.5	-	Y	AE	2023
Kului Stream	City and County of Honolulu	Confluence with Wailupe Stream	Approximately 1,650 feet upstream of Hind Iuka Drive	20060000	0.4	-	Y	AE	2023
Ma'ili'ili Channel	City and County of Honolulu	Confluence with Pacific Ocean	Approximately 1,425 feet upstream of Paakea Road	20060000	0.7	-	N	AE	2013
Maipalaoa Stream	City and County of Honolulu	Confluence with Pacific Ocean	Approximately 3,200 feet upstream of confluence with Pacific Ocean	20060000	0.6	-	N	AE	2013

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Makaha Stream	City and County of Honolulu	At Farrington Highway	Approximately 575 feet upstream of Huipu Drive	20060000	4.3	-	Y	AE	2012
Makaleha Stream	City and County of Honolulu	Confluence with Pacific Ocean	At Cane Haul Road	20060000	0.7	-	Y	AE	2011
	City and County of Honolulu	At Cane Haul Road	Approximately 0.9 miles upstream of Cane Haul Road	20060000	0.9	-	Y	AE	1985
Makiki Stream	City and County of Honolulu	At downstream Limit of Study	At upstream Limit of Study	20060000	*	-	N	AE	1979
Malaekahana Stream	City and County of Honolulu	Confluence with Pacific Ocean	Approximately 1.6 miles upstream of confluence of Keaaulu Gulch	20060000	2.6	-	Y	AE	2013
Manaiki Stream	City and County of Honolulu	Confluence with Moanalua Stream	Approximately 260 feet upstream of Mahole Street	20060000	1.4	-	Y	AE	1997
Manoa-Palolo Drainage Canal	City and County of Honolulu	At confluence with Ala Wai Canal	Just downstream of King Street	20060000	0.8	-	Y	AE	1979
Manoa Stream	City and County of Honolulu	Just downstream of King Street	Approximately 185 feet upstream of confluence with Luaalaea Stream	20060000	3.3	-	Y	AE	1979
Moanalua Stream (Lower)	City and County of Honolulu	Confluence with Keehi Lagoon	Approximately 535 feet downstream of confluence of Kahauiki Stream	20060000	0.9	-	Y	AE	1982
	City and County of Honolulu	Approximately 535 feet downstream of confluence of Kahauiki Stream	Approximately 180 feet upstream of Jarrett White Road	20060000	0.4	-	Y	AE	2020

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Moanalua Stream (Lower) *(continued)*	City and County of Honolulu	Approximately 180 feet upstream of Jarrett White Road	Approximately 200 feet upstream of Mahole Street	20060000	0.1	-	Y	AE	1982
Moanalua Stream (Upper)	City and County of Honolulu	Approximately 165 feet downstream of Ala Aolani Street	Approximately 465 feet upstream of Ala Aolani Street	20060000	7.0	-	Y	AE	1982
Nanakuli Stream	City and County of Honolulu	At Farrington Highway	Approximately 1.0 mile upstream of Farrington Highway	20060000	1.0	-	Y	AE	1989
Niu Stream	City and County of Honolulu	Confluence with Pacific Ocean	Approximately 0.6 miles upstream of Haleola Street	20060000	1.1	-	Y	AE	2023
Niu Tributary Stream	City and County of Honolulu	Confluence with Niu Stream	Approximately 2,000 feet upstream of Halemaumau Street	20060000	0.5	-	Y	AE	2023
North Halawa Stream	City and County of Honolulu	At Moanalua Freeway	Approximately 0.7 miles upstream of Moanalua Freeway	20060000	0.7	-	Y	AE	1989
Nuuanu Stream	City and County of Honolulu	At North Nimitz Highway	Approximately 2,250 feet upstream of Nuuanu Avenue	20060000	2.0	-	Y	AE	2023
Ohia Stream	City and County of Honolulu	Approximately 1,010 feet downstream of 1st Avenue	Approximately 480 feet upstream of Kamehameha Highway	20060000	0.3	-	Y	AE	1976
Ohia Stream (East)	City and County of Honolulu	Approximately 2,250 feet downstream of Plantation Road	Approximately 1,200 feet upstream of Kamehameha Highway	20060000	1.0	-	Y	AE	1976
Oneawa Channel	City and County of Honolulu	Confluence with Kailua Bay	Approximately 1,250 feet upstream of Oneawa Street	20060000	1.8	-	N	AE	2013

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Opaeula Stream	City and County of Honolulu	Confluence with Paukauila Stream	Approximately 2,155 feet upstream of Twin Bridge Road	20060000	12.3	-	Y	AE	1976
Overflow of Waiawa Stream	City and County of Honolulu	Confluence with Middle Loch	Approximately 560 feet upstream of Waiawa Road	20060000	0.4	-	Y	AE	1997
Pacific Ocean	City and County of Honolulu	Entire coastline of the Island of Oahu	Entire coastline of the Island of Oahu	-	227.0	-	N	AE, VE	2011
Pahipahialua Stream	City and County of Honolulu	Confluence with Pacific Ocean	Approximately 0.4 miles upstream of Kamehameha Highway	20060000	0.5	-	Y	AE	1976
Palolo Stream	City and County of Honolulu	Confluence with Manoa Stream	Approximately 330 feet upstream of Kiwila Street	20060000	2.0	-	Y	AE	2023
Panakauahi Gulch	City and County of Honolulu	Confluence with Waiawa Stream	Approximately 795 feet upstream of Cane Haul Road	20060000	5.3	-	Y	AE	1997
Paukauila Stream	City and County of Honolulu	Confluence with Kaika Bay	At confluence of Opaeula Stream and Helaman Stream	20060000	0.7	-	Y	AE	1976
Poamoho Stream	City and County of Honolulu	Confluence with Kaukonahua Stream	Approximately 600 feet upstream of Kaukonahua Road	20060000	0.6	-	Y	AE	1976
Punaluu Stream	City and County of Honolulu	At downstream Limit of Study	At upstream Limit of Study	20060000	1.0	-	Y	AE	1976
Tributary to Kawa Stream	City and County of Honolulu	Confluence with Kawa Stream	Just downstream of Mokulele Drive	20060000	0.2	-	Y	AE	1976

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Ulehawa Stream	City and County of Honolulu	Confluence with Ulehawa Channel	Approximately 60 feet upstream of Paakea Road	20060000	2.9	-	Y	AE	1989
Unnamed Stream	City and County of Honolulu	Approximately 950 feet upstream of confluence with Pacific Ocean	Approximately 800 feet upstream of Farrington Highway	20060000	1.4	-	Y	AE	1985
Waiahole Stream	City and County of Honolulu	Confluence with Pacific Ocean	Approximately 0.5 miles upstream of Kamehameha Highway	20060000	1.7	-	Y	AE	1976
Waialae-Iki Stream	City and County of Honolulu	Confluence with the Pacific Ocean	Approximately 20 feet downstream of Kalaniiki Place	20060000	0.7	-	Y	AE	2023
Waialae-Major Drain	City and County of Honolulu	Approximately 3,200 feet upstream of confluence with Pacific Ocean	Approximately 780 feet upstream of Hunakai Street	20060000	1.1	-	N	AE	1976
Waialae-Nui Stream	City and County of Honolulu	Confluence with Kapakahi Stream #1	Approximately 0.5 miles upstream of Kilauea Road	20060000	1.7	-	N	AE	2013
Waiawa Stream	City and County of Honolulu	Approximately 100 feet upstream of confluence with Middle Loch, Pearl Harbor	Approximately 2,740 feet upstream of Cane Haul Road	20060000	6.3	-	Y	AE	1997
Waihee Stream	City and County of Honolulu	Confluence with Kahaluu Pond	Approximately 7,100 feet upstream of confluence with Kahaluu Pond	20060000	1.2	-	Y	AE	1985

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi²) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Waihee Stream Tributary	City and County of Honolulu	Confluence with Waihee Stream	Approximately 55 feet upstream of Ahilama Road	20060000	0.2	-	Y	AE	1985
Waikakalua Stream	City and County of Honolulu	Approximately 220 feet upstream of Kamehameha Highway	At Interstate H2	20060000	1.3	-	Y	AE	1989
Waikane Stream	City and County of Honolulu	Confluence with Kaneohe Bay	Approximately 0.6 miles upstream of Kamehameha Highway	20060000	0.8	-	Y	AE	1976
Waikele Stream	City and County of Honolulu	Confluence with West Loch, Pearl Harbor	Approximately 0.3 miles downstream of East H1 Freeway	20060000	1.4	-	Y	AE	2022
	City and County of Honolulu	Approximately 0.3 miles downstream of East H1 Freeway	Approximately 1.1 miles upstream of E H1 Freeway	20060000	2.6	-	Y	AE	2023
Wailani Drainage Canal	City and County of Honolulu	Approximately 90 feet downstream of Waipio Access Road	Approximately 2,140 feet upstream of Waipio Access Road	20060000	0.5	-	N	AE	1993
	City and County of Honolulu	Approximately 2,140 feet upstream of Waipio Access Road	Approximately 1,195 feet upstream of Farrington Highway	20060000	0.7	-	N	AE	2022
Wailele Stream	City and County of Honolulu	Confluence with Wailele Stream Left Overbank and Right Overbank	Approximately 0.7 miles upstream of confluence with Wailele Stream Left Overbank and Right Overbank	20060000	0.7	-	N	AE	2013
Wailele Stream Left Overbank	City and County of Honolulu	Confluence with Pacific Ocean	Confluence with Wailele Stream	20060000	1.0	-	N	AE	1989
Wailele Stream Right Overbank	City and County of Honolulu	Confluence with Pacific Ocean	Confluence with Wailele Stream	20060000	0.7	-	N	AE	1989

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Wailupe Stream	City and County of Honolulu	Confluence with the Pacific Ocean	Approximately 0.6 miles upstream of the confluence of Kului Stream	20060000	1.8	-	Y	AE	2023
Waimalu Stream	City and County of Honolulu	Confluence with East Loch, Pearl Harbor	Approximately 140 feet downstream of Moanalua Road	20060000	0.8	-	N	AE	2013
	City and County of Honolulu	Approximately 140 feet downstream of Moanalua Road	Approximately 7,200 feet upstream of H1	20060000	1.4	-	Y	AE	2023
Waimanalo Stream	City and County of Honolulu	Confluence with Pacific Ocean	At upstream Limit of Study	20060000	2.5	-	Y	AE	1976
Waimanalo Stream: Inoaole Stream	City and County of Honolulu	At Hihimanu Street	Approximately 0.4 miles upstream of Hihimanu Street	20060000	0.4	-	Y	AE	1985
Waimanalo Stream: Stream A	City and County of Honolulu	Confluence with Waimanalo Stream	Approximately 195 feet upstream of Waikupanaha Street	20060000	1.6	-	Y	AE	2013
Waimanalo Stream: Stream B	City and County of Honolulu	Confluence with Waimanalo Stream: Stream A	At Waikupanaha Street	20060000	0.7	-	Y	AE	1976
Waimanalo Stream: Stream C	City and County of Honolulu	Confluence with Inoaole Stream	At Waikupanaha Street	20060000	1.2	-	Y	AE	1976

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi²) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Waimanalo Stream: Stream D	City and County of Honolulu	Confluence with Waimanalo Stream: Stream C	Approximately 50 feet downstream of Waikupanaha Street	20060000	0.9	-	Y	AE	1976
Waimea River	City and County of Honolulu	Confluence with Pacific Ocean	Approximately 0.7 miles upstream of confluence with Pacific Ocean	20060000	0.7	-	Y	AE	1976
Waipilopilo Stream	City and County of Honolulu	Confluence with Pacific Ocean	Approximately 1,290 feet upstream of confluence with Pacific Ocean	20060000	0.2	-	Y	AE	1976
Waolani Stream	City and County of Honolulu	Confluence with Nuuanu Stream	Approximately 1,575 feet upstream of North Judd Street	20060000	0.8	-	Y	AE	2023
Zone A Flood Sources	City and County of Honolulu	Various locations	Various locations	20060000	Varies	-	N	A	1976
1-D BLE Zone A Flood Sources	City and County of Honolulu	Various locations	Various locations	20060000	Varies	-	N	A	2023
2-D BLE Zone A Flood Sources	City and County of Honolulu	Various locations	Various locations	20060000	Varies	-	N	A	2023

* Data not available

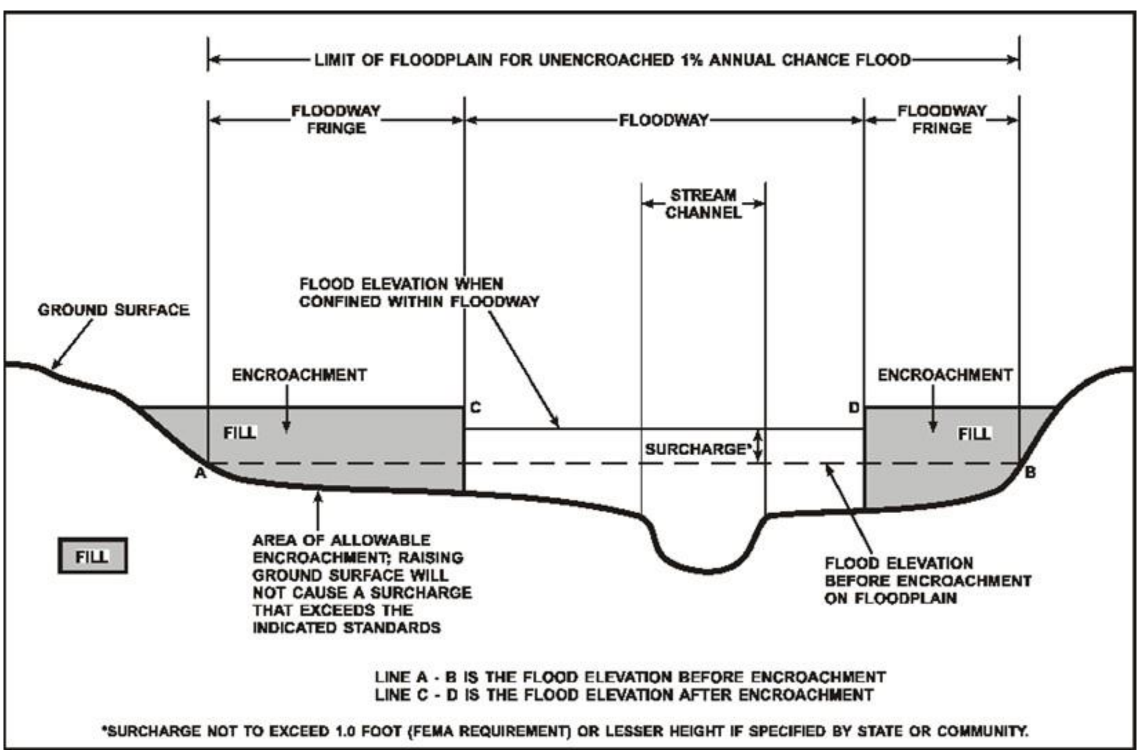
2.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard.

For purposes of the NFIP, a floodway is used as a tool to assist local communities in balancing floodplain development against increasing flood hazard. With this approach, the area of the 1-percent-annual-chance floodplain on a river is divided into a floodway and a floodway fringe based on hydraulic modeling. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment in order to carry the 1-percent-annual-chance flood. The floodway fringe is the area between the floodway and the 1-percent-annual-chance floodplain boundaries where encroachment is permitted. The floodway must be wide enough so that the floodway fringe could be completely obstructed without increasing the water surface elevation of the 1-percent-annual-chance flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 4.

To participate in the NFIP, Federal regulations require communities to limit increases caused by encroachment to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this project are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway projects.

Figure 4: Floodway Schematic



Floodway widths presented in this FIS Report and on the FIRM were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. For certain stream segments, floodways were adjusted so that the amount of floodwaters conveyed on each side of the floodplain would be reduced equally. The results of the floodway computations have been tabulated for selected cross sections and are shown in Table 23, “Floodway Data.”

All floodways that were developed for this Flood Risk Project are shown on the FIRM using the symbology described in Figure 3. In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown on the FIRM. For information about the delineation of floodways on the FIRM, refer to Section 6.3.

2.3 Base Flood Elevations

The hydraulic characteristics of flooding sources were analyzed to provide estimates of the elevations of floods of the selected recurrence intervals. The BFE is the elevation of the 1-percent-annual-chance flood. These BFEs are most commonly rounded to the whole foot, as shown on the FIRM, but in certain circumstances or locations they may be rounded to 0.1 foot. Cross section lines shown on the FIRM may also be labeled with the BFE rounded to 0.1 foot. Whole-foot BFEs derived from engineering analyses that apply to coastal areas, areas of ponding, or other static areas with little elevation change may also be shown at selected intervals on the FIRM.

Cross sections with BFEs shown on the FIRM correspond to the cross sections shown in the Floodway Data table and Flood Profiles in this FIS Report. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM. For example, the user may use the FIRM to determine the stream station of a location of interest and then use the profile to determine the 1-percent annual chance elevation at that location. Because only selected cross sections may be shown on the FIRM for riverine areas, the profile should be used to obtain the flood elevation between mapped cross sections. Additionally, for riverine areas, whole-foot elevations shown on the FIRM may not exactly reflect the elevations derived from the hydraulic analyses; therefore, elevations obtained from the profile may more accurately reflect the results of the hydraulic analysis.

2.4 Non-Encroachment Zones

This section is not applicable to this Flood Risk Project.

2.5 Coastal Flood Hazard Areas

For most areas along rivers, streams, and small lakes, BFEs and floodplain boundaries are based on the amount of water expected to enter the area during a 1-percent-annual-chance flood and the geometry of the floodplain. Floods in these areas are typically caused by storm events. However, for areas on or near ocean coasts, large rivers, or large bodies of water, BFE and floodplain boundaries may need to be based on additional components, including storm surges and waves.

Coastal flooding sources that are included in this Flood Risk Project are shown in Table 2.

2.5.1 Water Elevations and the Effects of Waves

Specific terminology is used in coastal analyses to indicate which components have been included in evaluating flood hazards.

The stillwater elevation (SWEL or still water level) is the surface of the water resulting from astronomical tides, storm surge, and freshwater inputs, but excluding wave setup contribution or the effects of waves.

- *Astronomical tides* are periodic rises and falls in large bodies of water caused by the rotation of the earth and by the gravitational forces exerted by the earth, moon and sun.
- *Storm surge* is the additional water depth that occurs during large storm events. These events can bring air pressure changes and strong winds that force water up against the shore.
- *Freshwater inputs* include rainfall that falls directly on the body of water, runoff from surfaces and overland flow, and inputs from rivers.

The 1-percent-annual-chance stillwater elevation is the stillwater elevation that has been calculated for a storm surge from a 1-percent-annual-chance storm. The 1-percent-annual-chance storm surge can be determined from analyses of tidal gage records, statistical study of regional historical storms, or other modeling approaches. Stillwater elevations for storms of other frequencies can be developed using similar approaches.

The total stillwater elevation (also referred to as the mean water level) is the stillwater elevation plus wave setup contribution but excluding the effects of waves.

- *Wave setup* is the increase in stillwater elevation at the shoreline caused by the reduction of waves in shallow water. It occurs as breaking wave momentum is transferred to the water column.

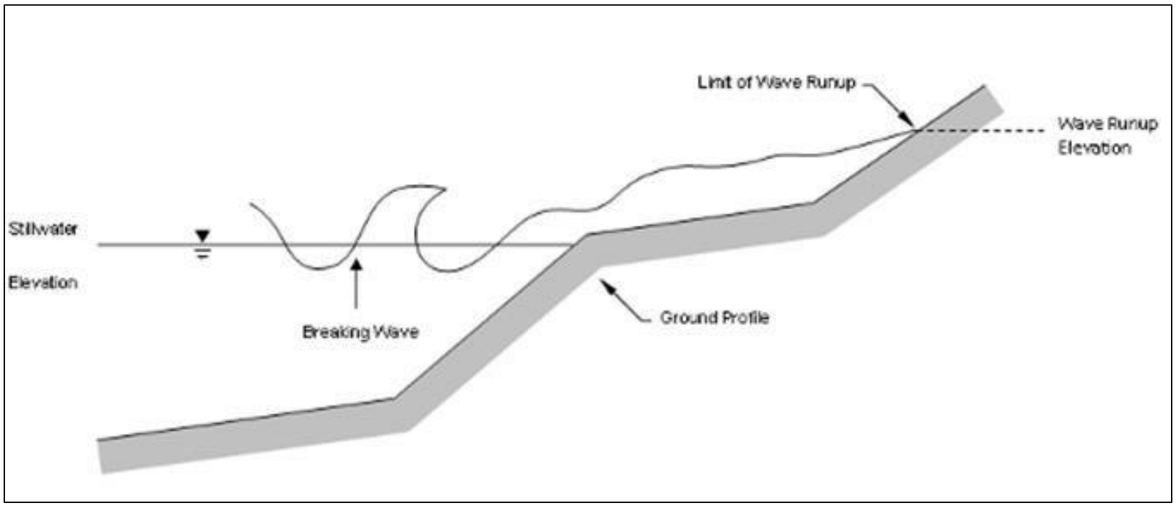
Like the stillwater elevation, the total stillwater elevation is based on a storm of a particular frequency, such as the 1-percent-annual-chance storm. Wave setup is typically estimated using standard engineering practices or calculated using models, since tidal gages are often sited in areas sheltered from wave action and do not capture this information.

Coastal analyses may examine the effects of overland waves by analyzing storm-induced erosion, overland wave propagation, wave runup, and/or wave overtopping.

- *Storm-induced erosion* is the modification of existing topography by erosion caused by a specific storm event, as opposed to general erosion that occurs at a more constant rate.
- *Overland wave propagation* describes the combined effects of variation in ground elevation, vegetation, and physical features on wave characteristics as waves move onshore.
- *Wave runup* is the uprush of water from wave action on a shore barrier. It is a function of the roughness and geometry of the shoreline at the point where the stillwater elevation intersects the land.

- *Wave overtopping* refers to wave runup that occurs when waves pass over the crest of a barrier.

Figure 5: Wave Runup Transect Schematic



2.5.2 Floodplain Boundaries and BFEs for Coastal Areas

For coastal communities along the Atlantic and Pacific Oceans, the Gulf of America, the Great Lakes, and the Caribbean Sea, flood hazards must take into account how storm surges, waves, and extreme tides interact with factors such as topography and vegetation. Storm surge and waves must also be considered in assessing flood risk for certain communities on rivers or large inland bodies of water.

Beyond areas that are affected by waves and tides, coastal communities can also have riverine floodplains with designated floodways, as described in previous sections.

Floodplain Boundaries

In many coastal areas, storm surge is the principle component of flooding. The extent of the 1-percent-annual-chance floodplain in these areas is derived from the total stillwater elevation (stillwater elevation including storm surge plus wave setup) for the 1-percent-annual-chance storm. The methods that were used for calculation of total stillwater elevations for coastal areas are described in Section 5.3 of this FIS Report. Location of total stillwater elevations for coastal areas are shown in Figure 8, “1% Annual Chance Total Stillwater Levels for Coastal Areas.”

In some areas, the 1-percent-annual-chance floodplain is determined based on the limit of wave runup or wave overtopping for the 1-percent-annual-chance storm surge. The methods that were used for calculation of wave hazards are described in Section 5.3 of this FIS Report.

Table 25 presents the types of coastal analyses that were used in mapping the 1-percent-annual-chance floodplain in coastal areas.

Coastal BFEs

Coastal BFEs are calculated as the total stillwater elevation (stillwater elevation including storm surge plus wave setup) for the 1-percent-annual-chance storm plus the additional flood hazard from overland wave effects (storm-induced erosion, overland wave propagation, wave runup and wave overtopping).

Where they apply, coastal BFEs are calculated along transects extending from offshore to the limit of coastal flooding onshore. Results of these analyses are accurate until local topography, vegetation, or development type and density within the community undergoes major changes.

Parameters that were included in calculating coastal BFEs for each transect included in this FIS Report are presented in Table 16, “Coastal Transect Parameters.” The locations of transects are shown in Figure 9, “Transect Location Map.” More detailed information about the methods used in coastal analyses and the results of intermediate steps in the coastal analyses are presented in Section 5.3 of this FIS Report. Additional information on specific mapping methods is provided in Section 6.4 of this FIS Report.

2.5.3 Coastal High Hazard Areas

Certain areas along the open coast and other areas may have higher risk of experiencing structural damage caused by wave action and/or high-velocity water during the 1-percent-annual-chance flood. These areas will be identified on the FIRM as Coastal High Hazard Areas.

- *Coastal High Hazard Area (CHHA)* is a SFHA extending from offshore to the inland limit of the primary frontal dune (PFD) or any other area subject to damages caused by wave action and/or high-velocity water during the 1-percent-annual-chance flood.

- *Primary Frontal Dune (PFD)* is a continuous or nearly continuous mound or ridge of sand with relatively steep slopes immediately landward and adjacent to the beach. The PFD is subject to erosion and overtopping from high tides and waves during major coastal storms.

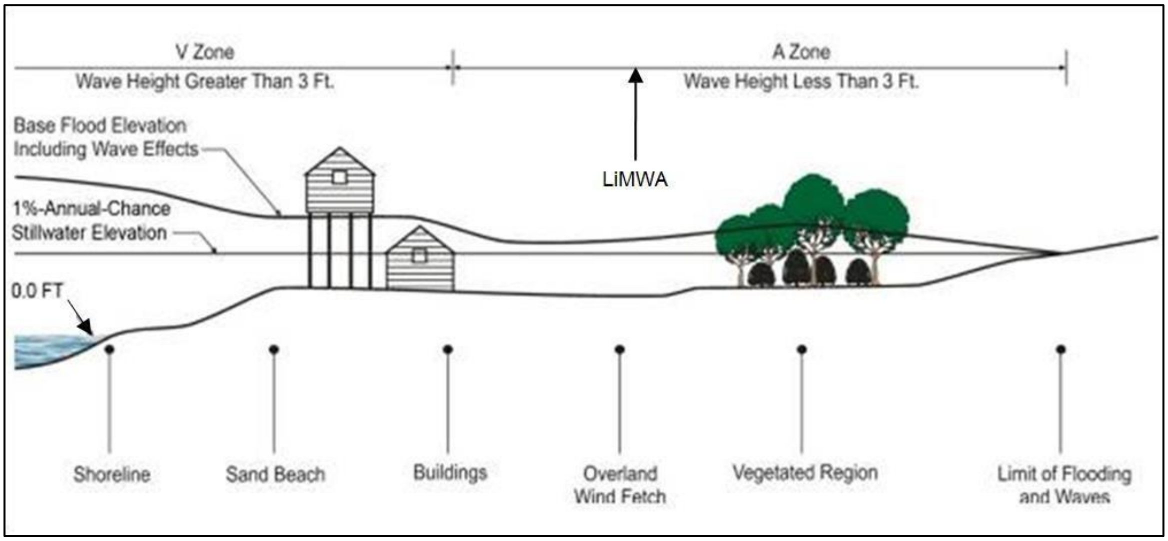
CHHAs are designated as “V” zones (for “velocity wave zones”) and are subject to more stringent regulatory requirements and a different flood insurance rate structure. The areas of greatest risk are shown as VE on the FIRM. Zone VE is further subdivided into elevation zones and shown with BFEs on the FIRM.

The landward limit of the PFD occurs at a point where there is a distinct change from a relatively steep slope to a relatively mild slope; this point represents the landward extension of Zone VE. Areas of lower risk in the CHHA are designated with Zone V on the FIRM. More detailed information about the identification and designation of Zone VE is presented in Section 6.4 of this FIS Report.

Areas that are not within the CHHA but are SFHAs may still be impacted by coastal flooding and damaging waves; these areas are shown as “A” zones on the FIRM.

Figure 6, “Coastal Transect Schematic,” illustrates the relationship between the base flood elevation, the 1-percent-annual-chance stillwater elevation, and the ground profile as well as the location of the Zone VE and Zone AE areas in an area without a PFD subject to overland wave propagation. This figure also illustrates energy dissipation and regeneration of a wave as it moves inland.

Figure 6: Coastal Transect Schematic



Methods used in coastal analyses in this Flood Risk Project are presented in Section 5.3 and mapping methods are provided in Section 6.4 of this FIS Report.

Coastal floodplains are shown on the FIRM using the symbology described in Figure 3, “Map Legend for FIRM.” In many cases, the BFE on the FIRM is higher than the stillwater elevations shown in Table 16 due to the presence of wave effects. The higher elevation should be used for construction and/or floodplain management purposes.

2.5.4 Limit of Moderate Wave Action

This section is not applicable to this Flood Risk Project.

SECTION 3.0 – INSURANCE APPLICATIONS

3.1 National Flood Insurance Program Insurance Zones

For flood insurance applications, the FIRM designates flood insurance rate zones as described in Figure 3, “Map Legend for FIRM.” Flood insurance zone designations are assigned to flooding sources based on the results of the hydraulic or coastal analyses. Insurance agents use the zones shown on the FIRM and depths and base flood elevations in this FIS Report in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

The 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (e.g. Zones A, AE, V, VE, etc.), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of additional flood hazards.

Table 3 lists the flood zones in the City and County of Honolulu, Hawaii.

Table 3: Flood Zone Designations by Community

Community	Flood Zone(s)
City and County of Honolulu	A, AE, AH, AO, D, VE, X

SECTION 4.0 – AREA STUDIED

4.1 Basin Description

Table 4 contains a description of the characteristics of the HUC-8 sub-basins within which each community falls. The table includes the main flooding sources within each basin, a brief description of the basin, and its drainage area.

Table 4: Basin Characteristics

HUC-8 Sub-Basin Name	HUC-8 Sub-Basin Number	Primary Flooding Source	Description of Affected Area	Drainage Area (square miles)
Oahu	20060000	All inland flooding sources	Inland drainage for the entire Island of Oahu, Hawaii	1,117

4.2 Principal Flood Problems

Table 5 contains a description of the principal flood problems that have been noted for the City and County of Honolulu by flooding source.

Table 5: Principal Flood Problems

Flooding Source	Description of Flood Problems
All inland flooding sources on the Island of Oahu	The island of Oahu is subject to flooding from stream overflow, tsunamis, and hurricanes. While the specific cause of tsunami and hurricane related flooding can be attributed to a single factor, the cause of flooding as a result of stream overflow may be due to various reasons. Possible flood causes include: debris-clogged streams, flash floods, undefined streamflow patterns, isolated depressions in topography, inadequate drainage facilities, and changed drainage conditions because of development. Flooding is attributable to fast-moving surface runoff from steep mountain slopes discharging onto low, flat, coastal plains. This condition causes stormwater from the highlands to overtop lowland streams and flood areas adjacent to the streams. Most flood problems on the island occur in the low-lying areas, which have largely been developed with inadequate or nonexistent flood-control measures and storm drainage systems. Excessive surface water from overland flow frequency causes flooding in poorly drained areas. Many of these problems are found in developed areas where the natural drainage patterns have been altered during development. Other factors which contribute to this type of flooding are insufficient or excessive land slopes and poor soil conditions.

Table 5: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
Ahuimanu, Haiamoa, Kaalaea, Kahaluu, and Waihee Streams	Flooding in this area can be severe, causing loss of life, crop and property damage, and soil erosion. The natural channels have low capacities due to vegetation and the topography. Thus, the streambanks are overtopped by large storms. Until recently, the area near the outlet of Kahaluu Stream had chronic flooding problems. A multi-use flood-protection and recreational project has helped to relieve this problem. There are other areas of chronic flooding such as the inadequate culvert bridge on Waihee Stream at Ahilama Road.
Aiea Flood Control Channel	The existing Aiea Flood Control Channel has alleviated flooding problems below Moanalua Road. The area above Moanalua Road is still prone to flooding, mainly from storm runoff that cannot be conveyed by the stream channel or the H-1 culvert. Vegetation growth may create obstructions to floodflows.
Ala Wai Canal	The flooding problem associated with the Ala Wai Canal is that of overtopping into the Waikiki district. During the November 1965 and December 1967 storms, the Ala Wai Canal overflowed at the confluence of Manoa-Palolo Drainage Canal. Nearly 2-foot-deep stormwaters overflowed across Ala Wai Boulevard into the adjacent hotel and apartment basements and parking lots. The Ala Wai Canal was originally constructed in the 1920s to create and protect the Waikiki district. Initially dredged to elevation of -25 feet, the capacity of the watercourse was expected to discharge floodwaters from the entire Makiki, Manoa, and Palolo drainage basins. With the increased urbanization within the drainage area, siltage, and additional drainage from Waikiki itself, the canal can no longer convey floodflows, and flooding into Waikiki has occurred.
Anahulu River, Helemano, Kaukonahua, Kiikii, Opaeula, Paukauila, and Poamoho, Streams	The most recent flood in this area, which claimed three lives and caused considerable damage, occurred on April 19, 1974. At the Helemano Stream gaging station (Stream Gaging Station No. 3430) a record discharge of 18,200 cfs was estimated. Record discharges turned in for three other gaging stations in this area are as follows: 16,300 cfs for Anahulu River near Hakilua (Stream Gaging Station No. 3500), and 6,940 cfs for Poamoho Stream at Waialua (Stream Gaging Station No. 2112). Other large floods in this area occurred on February 28, 1932 (record rainfall flood), February 1935, March and October 1939, February 1956, February 1969 and July 1974.
Eku and West Makaha Streams	Makaha Stream presently consists of three separate channels referred to as Eku Stream, West Makaha Stream and Makaha Stream. Historical flooding from these streams resulted from the inadequate capacities to convey the storm runoff. The largest flood known to have occurred since 1953 occurred on November 24, 1954. The peak discharge was estimated to be 1,700 cfs at Stream Gaging Station No. 2116. Less severe floods occurred in March 1962, December 1964, and November 1965. The tsunami of April 1, 1946, which resulted from a strong earthquake in the Aleutian Islands, had the severest effect in the Makaha coastal areas. The maximum wave runup elevation was approximately 22 feet, resulting in flooding of areas approximately 500 feet inland.

Table 5: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
Hanahimoa, Kaipapau, Kaluanui, Punaluu, Waipilopilo, and Wailele Streams	Flooding in the Hauula-Punaluu Area is caused by ponding of the low-lying areas inland of Kamehameha Highway and by the inadequate capacities of streams in this area. The most severe coastal flooding in the Hauula-Punaluu study area has been caused by tsunami, with storm surf causing only minor damage. The two most severe known tsunamis occurred in 1946 and 1957, with maximum observed elevations of 12 feet above sea level at Punaluu Beach Park and 13 feet above sea level at Hauula, respectively. A major storm event in December 2008 resulting in both State and Federal disaster declarations. Heavy flooding in the Wailele Stream area resulted in residential damages estimated at $2,000,000, $1,500,000 in damage to Brigham Young University Hawaii facilities, and $600,000 in damage to the Polynesian Cultural Center.
Heeia Stream	Heeia Stream is confined to a narrow valley until it reaches the floodplain at an elevation of approximately 40 feet. The basin topography and existing drainageway capacities are such that flooding in the Heeia area is restricted almost entirely to the low-lying area between elevation 40 feet and Kamehameha Highway. During moderate to high peak discharges, floodwater overtops the banks, inundating the low-lying swamp. Erosion and sedimentation also compound the flood problem. The impact of floods of high peak discharges originating from the mountains on the floodplain below the Kahekili Highway is reduced by the Kahekili Highway embankment. This embankment acts as a detention dam with a controlled outlet. There is no major tsunami flooding problem in the Heeia area as a result of the protection afforded by the configuration of the Kaneohe Bay estuary. Discharge records for Haiku and Lolekaa Streams date back to 1915 and 1941, respectively. The largest flood of record for Haiku Stream occurred in May 1965, with an estimated discharge of 5,740 cfs at the USGS Gage No. 2750 (drainage area of 0.97 square mile). The largest flood of record for Lolekaa Stream occurred on the same date with an estimated discharge of 797 cfs at the USGS Gage No. 2780 (drainage area of 0.29 square mile). This represents unit runoff of approximately 5,920 and 2,500 cfs per square mile for the respective drainage areas. Numerous floods have occurred since 1890; however, they were not documented.
Honouliuli Stream	The stream has a very flat slope and has a winding course through the lower plain. Thus, there are many sites where debris can collect and cause the floodwater to overflow the streambanks.
Hoolapa, Kalaeokahipa, Ohia and Ohia East Streams	Flooding in the Kahuku Area results primarily from ponding in the flat, low-lying area seaward of Kamehameha Highway. This low-lying area, which measures approximately 3.2 square miles, and is used primarily for growing sugarcane, does not have an adequate drainage system to convey floodwater to the ocean. The flooding problem is compounded by the formation of sand dunes at the outlets which prevent floodwater from discharging into the ocean. From the stream gaging station record of Oio Stream near Kahuku, the largest recorded flood occurred on April 15, 1963. No estimate of damage from this flood is available. Tsunami hazard in this area is severe. Historical data on the tsunami shoreline elevations indicate heights of 20 to 25 feet above sea level.

Table 5: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
Inoaole Stream, Waimanalo Stream, Waimanalo Stream A, Waimanalo Stream B, Waimanalo Stream C, and Waimanalo Stream D	Flooding in this area is caused by inadequate channel capacities and resultant lowland ponding. There are two stream gaging stations within this study area; one on Waimanalo Stream upstream of Kalanianaole Highway, installed in 1963, and the other on Inoaole Stream upstream of Hihimanu Street, installed in 1958. Data from these gaging stations indicate occurrences of large floods in March 1963, November 1965, December 1967, and November 1970. Records of historical tsunami occurrence within the Waimanalo Bay area indicate that they have had little effect on developments along the seaward portion of the Waimanalo area. This is because the land along the shoreline rises abruptly to elevations of 10 to 15 feet above sea level. This is higher than the wave height of the tsunami of 1946 (record elevation) which had wave heights of 8.0 feet off the shoreline of Waimanalo Bay. The December 2008 major storm event resulted in large amounts of rainfall in the Waimanalo area (estimated 5.6 inches in 12-hour period) and some reports of flooding.
JCIP Drainage Canal	Stream flooding risk in this area of Oahu, near Barbers Point, is considered moderate to low due to the arid climate of the region; particularly when compared to the other areas of Oahu. Historically, the coast has been impacted by tsunamis and hurricanes, with the 1946 Alaskan earthquake tsunami generating 12-foot-high waves at Barbers Point and incurring damages during both Hurricane Iniki (1992) and Iwa (1982).
Kaaawa Stream	The principal flooding problem in this area is the ponding of flood-water inland of Kamehameha Highway and the inadequate capacity of Kaaawa Stream to convey the larger floods. The approximate ponding limits for the April 15, 1953, flood were established from interviews with residents of that area and outlined for a portion of the Kaaawa area in the Floodplain Information Report (USACE, 1969) for Kaaawa. The tsunami of April 1, 1946, was the most destructive ever to hit the Kaaawa area. It was generated by an earthquake in the East Aleutian Islands. The highest wave, estimated at 17 feet, had a measured runup to the 11.8-foot elevation along the coastal plain between Swanzy Beach Park and Kaaawa Park. This was the most severely damaged area of the floodplain. Several homes in this area and Army barracks on the present Swanzy Beach Park site were either severely damaged or demolished. These structures and a seawall which extended a short distance south from the Army barracks diminished the force of the wave on structures further inland. However, unprotected inland homes south of the seawall were flooded by the incoming wave. In addition to riverine flooding and tsunami inundation in the coastal area of the Kaaawa floodplain, storm surf flooding occasionally occurs in low-lying areas on the inland side of Kamehameha Highway.
Kaelepulu Stream	The flooding in this area is caused by backwater from Kaelepulu Stream. The outlet of Kaelepulu Stream is often obstructed by sand dunes which cause backup of the floodflow until the sand plug is breached. Flooding of the Coconut Grove Subdivision of Kailua results from the inadequacy of the existing storm drains in that area and from the tailwater from Kaelepulu Stream. A storm drain system currently being constructed will alleviate flooding from lesser floods; however, for floods of the 50-year or greater recurrence interval flooding in this area would occur because of backwater from Kaelepulu Stream, which is the outlet channel for the Coconut Grove drainage system.

Table 5: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
Kahana Stream	Kahana Valley is under the jurisdiction of the State of Hawaii, Department of Land and Natural Resources and will eventually be developed into a State Park. Presently, the land is leased for agricultural and residential purposes. There is no significant development in this basin. The few residences in this basin are located generally above the valley floor and are free from flooding during large floods. The road serving the residents of the upper valley is flooded during large floods, however, it generally does not remain impassable for any long period. Flooding on Kahana Stream is at the lower reaches, generally from the mouth to approximately 1.5 miles upstream. Flooding at the mouth is caused by sand dunes obstructing bridges. Further upstream, flooding occurs in the overbank due to the inadequate capacity of the existing natural channel section to convey the flow.
Kahauiki, Kalihi, Kamanaiki and Lower and Upper Moanalua Streams	The principal cause of flooding of the lower reaches of Kalihi and Moanalua Streams are the restricted capacities of the numerous bridges at the mouths of the streams. The flood problems in both the Kalihi and Kamanaiki Streams are a result of limited stream channel capacities and debris which constricts flows at numerous bridge crossings. Within the study reach, Kalihi Stream flows through a relatively deep channel section and flooding primarily occurs at the bridges. The Kamanaiki Stream floods more often due to its having a shallower channel with many irregular sections, sharp bends, and abrupt transitions. Both streams have heavy vegetation and tree growth along the banks, especially in the upper reaches. On November 18, 1930, 23.5 inches of rain fell over Kalihi Valley. Storm flows, which were blocked just upstream of School Street, suddenly penetrated the debris obstruction and caused extensive damage to the areas below. The discharge recorded at USGS Stream Gage 2290 was 12,400 cfs. Many walls have been built on private property along the stream. The lower portion between King Street and the H-1 Freeway is walled on both sides, although the channel itself is not lined. Vegetation abounds in the streambed or on its banks. This vegetation may cause flooding by catching debris and forming a barrier to floodflows. The seaward portion of the coastal plain in the lower area is subject to tsunami inundation; however, such flooding is considered minor when compared to that which would occur from storm runoff, since the area is well protected from tsunami inundation by the broad coastal reef extending seaward from the Keehi Lagoon area.
Kalauao Stream	Kalauao Stream cannot carry the storm runoff downstream to the ocean within its defined channels. The bridge structures and utility crossings near the stream outlet also add to the flooding problem by catching debris and restricting flow. Vegetation growth may create obstructions to floodflows.
Kaloi Gulch	The study reach for Kaloi Gulch is situated on a gently sloping plain and is subjected to shallow sheet flooding. The stream is perched slightly higher than the overbanks and is characteristic of irrigation ditches in the area. The flow is contained within the channel by berms along both banks and flows which escape the channel are usually not able to return. No records of significant flood damage were uncovered during the literature search for Kaloi Gulch. Between 1968 and 1985, the largest floods to occur were: February 1, 1969, peak flow of 645 cfs; and January 8, 1989, 724 cfs. These flows were recorded at gage 16212450.

Table 5: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
Kamooalii, Kaneohe, Keaahala, Kawa, and Tributary to Kawa Streams	The principal flood problems in this area are caused by the inadequate capacities of these five streams which were apparent during the storms of February and November 1965 and February 1969. The February 4, 1965, storm claimed 2 lives and severely damaged approximately 30 homes in the Keapuka Subdivision. This catastrophe occurred when Kamooalii Stream overtopped its banks upstream of the Luluku Street crossing. The February 1, 1969, storm again caused damage to homes in this area; fortunately no lives were lost. Other areas flooded in this storm were the Kapunahala Subdivision, lower reaches of Kaneohe Stream, View Golf Course, and the Kahaluu Valley floodplain. Flooding in the Keapuka Subdivision was attributed to debris obstructing the opening of the Luluku Street bridge. The Kapunahala Subdivision was unexpectedly flooded by floodflows from another area. The floodwater from Keaahala Stream was unable to pass under Kahekili Highway due to culvert obstruction and, therefore, flowed southerly on Kahekili Highway and into the Kapunahala Subdivision. Other areas were flooded by the inadequate capacity of the stream to convey the floodflow. The low-lying area of the coastal Kaneohe area has experienced a large number of stream floods (over 20 since 1936). More recent storm events occurred during the December 2008 storm event, and another on June 4, 2011.
Kapakahi #1, Waialae-Iki, Waialae-Nui Streams, and Waialae Major Drain	This area is a totally developed residential area and the principal flood problem results from the inadequate capacities of the major drains to convey the floodwater from large storms. This area suffered its most severe flooding on March 5, 1958, from a storm which produced 12.5 inches of rainfall in 7.5 hours. Other storms, which caused various degrees of flooding, occurred on November 1954, February 1955, March 1955, January 1957, and on December 1967. Waialae-Nui Stream, which traverses the eastern limits of the residential area, also causes flooding during the occurrence of large floods.
Kaupuni Stream	Principal flood problems in this area are similar to those found in the adjacent Lualualei Valley and Makaha Areas. While Kaupuni Stream is an engineered flood control channel, local drainage systems are subject to flooding during heavy storm events and the coastal area has historically been impacted by tsunami and hurricane flooding events. Two recent storms, hurricanes Iwa (1982) and Iniki (1992) generated damaging high waves, and storm surges produced coastal flooding to an elevation of 11ft above msl and higher. The tsunami of April 1, 1946, which resulted from a strong earthquake in the Aleutian Islands, impacted the Waiamae area with a maximum wave runup elevation of approximately 12 feet. A tsunami in 1957 produced recorded flood inundation heights of approximately 14 feet. The largest flood known to have occurred since 1961 occurred in January 1982. The peak discharge was estimated to be 3,300 cfs at USGS Stream Gaging Station No. 1800. A large storm in November 1996 also caused extensive flooding in this area as well as the adjacent Lualualei Valley area. The December 2008 major storm event reportedly produced very large rainfall amounts over short periods of time (estimated 7.2 – 8.1 inches over a 12-hour period). Heavy winds at Waianae boat harbor and extensive flooding (up to chest high) in Wainanae were reported.

Table 5: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
Kawainui Stream	The flat topography of the study area is the main cause of the flooding problems along Kawainui Stream. The tailwater effect from Kaelepulu Canal also helps to promote the overtopping of streambanks. There are also two bridges on Kawainui Stream that tend to restrict the flow of storm runoff along Kawainui Stream to Kaelepulu Canal. There area is also moderately exposed to tsunami hazards, recording wave runup elevations of approximately 6 feet as a result of the 1946 tsunami, for example.
Kea'aulu Gulch and Malaekahana Stream	Malaekahana Stream does not have the capacity to transmit storm runoff downstream to the ocean. Kea'aulu Gulch contributes additional flows to Malaekahana Stream at their confluence upstream of the Kamehameha Highway crossing. The bridge on Kamehameha Highway cannot convey flows under the highway, thus causing the storm waters to flood the area upstream of the highway, until the water is high enough to flow over the highway.
Kului Stream	Kului Stream, which is a tributary to Wailupe Stream, also causes flooding near its confluence with Wailupe Stream due to the inadequate capacity of the Hind Iuka Drive culvert.
Ma'ili'ili Channel and Maipalaoa Stream	The principal flooding problems in the area can be generally characterized as caused by exceedance of the local drainage system capacity. Heavy rains on November 11, 13, and 14 of 1996 resulted in extensive flooding in the leeward and central portions of Oahu. In the Lualualei Valley, rainfall runoff sheet flowed from the steep faces of the surrounding mountains and across the moderately sloping open lands of the valley, and collected on the valley floor. Homes and portions of area roadways were inundated for up to seven days. A 2001 United States Army Corps of Engineers study attributed flooding problems to the absence of a storm drainage system within agricultural areas, and partially blocked existing culverts and other drainage structures in residential areas, due to their poor maintenance. The December 2008 major storm event led to reports of flooding in these same low-lying areas. Also, approximately $8,000,000 in damage to mostly coastal areas was reported due to a small tsunami in March 2011.
Makaleha and Unnamed Streams	These two streams do not have the capacity to transmit storm runoff down to the ocean. Inadequate manmade structures at road crossings, especially Farrington Highway, and the flat topography near the ocean also serve to promote the flooding problems. During Hurricane Kolohe in 1972, the portion of Farrington Highway that crosses the two streams was impassable due to flooding.
Makiki Stream	Makiki Stream between King Street and the Ala Wai Canal runs a length of 3,080 feet. Within this study limit, previous flooding has occurred at two specific locations. At the Philip Street Bridge, the bend in the stream has resulted in water overshooting into the street, causing traffic disruption and some property damage. The second location of flooding is in the block bordered by Fern, Nanea, Malanai, and Hauoli Streets. At this low point, flooding approximately 1.5 feet in depth has caused property damage and traffic congestion.

Table 5: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
Manaiki, and Moanalua Stream	The construction of Moanalua Road required a realignment of Moanalua Stream, resulting in a 90-degree change in direction of main flow. The existing channel capacity for both Moanalua and Manaiki Streams are inadequate, as are the road crossings. These factors, along with the peculiar bend at Moanalua Road are the primary causes of flooding in Moanalua and Manaiki Streams. Backwater resulting primarily from downstream conditions causes a high tailwater condition at Moanalua Road, adding to the flooding problem. The Moanalua Gardens Park Bridge crossing at Moanalua Stream cannot convey the 1-percent-annual-chance (100-year) flow and stream flow overtops this bridge. The existing access road crossing along Manaiki Stream consists of two 36-inch culverts which do not have adequate capacity. Stream flow backs up at the crossing and overtops the road. The Mahiole Street crossing at Manaiki Stream is also inadequate and stream flow overtops the bridge.
Manoa Stream	For Manoa Stream, there have been two known deaths due to flooding, the first during the flood of December 3, 1918, and the second during the flood of December 3, 1950. Despite these two recorded casualties, additional flood damage information is unavailable. Principal flood problems associated with Manoa Stream are due to inadequate capacities at several locations, especially at the numerous bridge crossings (twelve). At the higher areas, from Paradise Park to Manoa Elementary School, the steep, sloping channel results in shallow, rapid, supercritical flows and minimal flooding. In the lower portion, the flatter terrain causes higher-level, slower-moving, subcritical flows which, when coupled with several bridge constrictions, do create a greater flooding potential. The Woodlawn area is particularly susceptible to flooding.
Manoa-Palolo Drainage Canal and Palolo Stream	For the Manoa-Palolo Drainage Canal and Palolo Stream, no direct flood hazard is apparent. The unlined and overgrown condition of the banks create the potential for overgrowth-related flooding; hence, the entire Manoa-Palolo Drainage Canal and the unlined segment of Palolo Stream were studied in detail.
Nanakuli Stream	The Nanakuli Stream floodplain is very broad in the lower reaches and is able to contain most floods. Backwater from the 1% annual chance flood event will collect behind the Farrington Highway Bridge. Downstream, a walk bridge and an abandoned railroad bridge further restrict the flows. Localized flooding in the downstream area is primarily due to a sand bar at the stream mouth. This sand bar builds up over time from the surf and, unless cleared regularly, causes a severe obstruction to flow. Between 1968 and 1985, the largest floods recorded were: January 3, 1969, 2,070 cfs; February 7, 1976, 3,300 cfs; and October 31, 1982, 2,470 cfs.

Table 5: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
North Halawa/ Halawa Stream	Within the North Halawa study reach, flooding potential is very limited. The existing channel is relatively deep and flooding is limited to a few developments which have encroached on the lower portion of the stream. Just below the study limit, two flood-prone areas have been identified: 1) Just above the confluence of North and South Halawa Streams; 2) an area between Salt Lake Boulevard and Kamehameha Highway. Flooding in these areas would result from storms exceeding a recurrence interval of 50 years. The Halawa Stream reach was impacted by October 28, 1981 with an estimated $1,000,000 in damages; and the December 2008 major storm events, with large amounts of rainfall recorded in the upstream Koolua Mountains. Since 1930, the largest recorded floods were: November 18, 1930, 6,540 cfs; February 28, 1932, 6,650 cfs; May 14, 1963, 5,620 cfs; and March 18, 1980, 5,470 cfs.
Nuuanu and Waolani Streams	The portions of Nuuanu and Waolani Streams in the study area are not channelized with concrete, unlike the channelized lower portions of Nuuanu Stream outside the study area. The area is thus prone to flooding and erosion problems during large storms. During Hurricane Kolohe in 1972, Nuuanu Stream overflowed its banks and bank erosion occurred. Similar events have also been recorded for Waolani Stream. Certain portions of the two streams in the study area have private walls to keep out floodwater. The extensive vegetation in and on the banks of the two streams is a flood hazard. The vegetation may catch debris and constrict flow or it may become uprooted and cause flooding by collecting and blocking floodflows at manmade structures such as bridges.
Oneawa Channel	The Oneawa Channel was constructed as part of the Kawainui Marsh Levee Flood Control project and conveys flood waters from behind the Marsh levee to the Pacific Ocean. Historic floods in the Kawainui marsh and its uplands led to construction of the flood control project and subsequent large storm events, such as those that occurred in January 1988, led to further improvement of the project in order to reduce the flood risk to the Kailua area.
Pahipahialua and Paumalu Streams	The principal flood problem in this area is the lack of defined streams with capacity adequate to convey storm runoff to the ocean. Flooding in the highlands is caused by overland flow, which results from inadequate capacity of existing streams or the lack of streams. In the lowlands, the problem results from the poor drainage systems and local depressions. This area has been flooded on numerous occasions. The largest known flood, according to the Flood Plain Information report (USACE, 1968) for this area, occurred on March 13-14, 1962. Rainfall of 8.33 inches in a 24-hour period caused a wall of water to dump tons of mud, boulders, and other debris across Kamehameha Highway. The USGS estimated a peak flow of 4,000 cfs in this area. Other large floods in this area occurred in February 1956, January 1957, April 1963, and November 1965. A stream gaging station was installed on Paumalu Gulch at Sunset Beach (Stream Gaging Station No. 3180) in 1968, and the largest flood recorded occurred on April 19, 1974, with a peak discharge of 982 cfs. Other large floods occurred in March 1968 and January 1971.
Panakauahi Gulch	The flooding problem in the Panakauahi Gulch is primarily a result of limited stream channel capacities and inadequate road crossing. At the Cane Haul Road crossing, the upstream ends of the culverts are blocked with sediment, allowing no flow to pass through. Therefore, the flood waters back up at the culverts and overtop the road.

Table 5: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
Ulehawa Stream	The Ulehawa Stream faced regular flooding problems near Farrington Highway. In January 1957, a severe southerly storm (known as a "Kona Storm") occurred over the Waianae and Nanakuli area. Damages sustained in the vicinity of Maipalaoa, Moiliili, and Ulehawa Streams totaled over $350,000 and involved residential and farm losses.
Waiahole and Waikane Streams	The flooding in this area is primarily caused by the inadequate channel capacities of the three main streams and the backwater caused by the bridges and culverts at Kamehameha Highway. A major part of the inundated area is the low-lying area inland of Kamehameha Highway between Waikane and Waiahole Streams. This area receives floodflows generated within its own basin and from the overbank flows of the other streams. Flows in excess of the culvert capacities often backup and overtop Kamehameha Highway. Historic floods in this area were determined from a stream gage on Waikane Stream installed in December 1959. There were 15 annual peak discharges recorded ranging from 292 cfs to 8,800 cfs, the latter occurring on February 4, 1965. Other major floods in excess of 4,000 cfs occurred on February 1, 1969 (4,020 cfs), and on March 15, 1963 (4,560 cfs). A report entitled "Floods in Waiahole-Waikane Area, Oahu, Hawaii," prepared by the USGS (USGS, 1974) in cooperation with the Hawaii State Department of Land and Natural Resources, indicated that the floods of May 2, 1965 (3,300 cfs, Waiahole Stream Gaging Station 2949), and November 12-14, 1965 (3,230 cfs, Waiahole Stream Gaging Station 2949), caused approximately 0.76 square mile of inundation of this area.
Waiawa Stream	The flood problems for Waiawa Stream are the result of limited stream channel capacity, inadequate road crossings, and low-lying coastal plains. Waiawa Stream has a history of flooding below Kamahameha Highway. The additional discharge from the Panakauahi Gulch contributes to this flooding. During past severe storms, debris has piled up at the Kamehameha Highway and Farmington Highway crossings and stream flow overtops the road. During heavy rainfall, the low-lying area below Leeward Community College becomes inundated, flooding the watercress farms.
Waikakalaua Stream	Waikakalaua Stream meanders and cuts through a relatively deep gulch. The threat of flooding is limited to the area within the gulch where residential developments have encroached onto the floodplain. Numerous footbridges and bridge crossings for the Waipio Acres Access Road present significant restrictions to floodflows. Adverse horizontal bends, unstable streambanks, and debris accumulation aggravate the situation and render portions of residential developments prone to inundation. In the past, flood damage as the result of intense rainfall has not been significant due to the relatively low population density and an upstream irrigation storage system. However, the area has undergone considerable growth and the threat of flood damage has increased. Between 1958 and 1985, the largest floods to occur were: April 15, 1963, 4,820 cfs; November 14, 1965, 2,460 cfs; April 19, 1974, 3,130 cfs; and October 18, 1981, 2,780 cfs. These flows were recorded at gage 1212700, located just upstream of the confluence with Waikele Stream.

Table 5: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
Waikele Stream	The Waikele Stream watershed is very large and receives a large portion of the storm runoff on the island. Compounding the rainfall flooding problem are inadequate bridge openings as well as manmade and natural streamcourses that cannot convey the storm runoff within their defined channels. During large storms the stream floods what is now the Waipahu Cultural Garden Park area, depositing silt which further decreases stream capacity. Flooding problems were severe enough for the City and County of Honolulu to divert the stream away from Waipahu Town.
Wailupe Stream	The principal flood problem in this area is the inadequate channel capacity of Wailupe Stream and sheetflow flooding of an adjacent lowland residential area. Two floods large enough to cause overbank flooding have occurred since the installation of a stream gaging station on Wailupe Stream at the Ani Street Bridge. The first, occurring in March 1958, was estimated at 2,170 cfs; the second, in December 1967, was estimated at 3,600 cfs.
Waimalu Stream	Principal flooding problems tend to be the result of limited stream channel capacity, inadequate road crossing, and low-lying coastal plains. The stream also crosses below the Kamehameha Highway, an area susceptible to flooding problems. Heavy silting of the channel bottom, along with debris in the channel are also contributors to flooding during heavy rainfall events.
Waimea River	The flooding in this area is attributed to the inadequate capacity of the watercourse and the obstruction of floodflows by two bridges across the stream. The flooding problem is further aggravated by sand dunes at the outlet, obstructing flow into the ocean, and the deposition of debris in the lower watercourse from erosion in the upper reaches where the velocities are higher. The largest recorded flood at a stream gaging station on the upstream reach occurred on April 19, 1974, and had an estimated discharge of 5,610 cfs. No major flood damage was reported in the study area. Other large floods recorded at the gaging station since 1958 occurred in March 1962, April 1963, February 1965, March 1968, and February 1969.

Table 6 contains information about historic flood elevations in the communities within the City and County of Honolulu.

Table 6: Historic Flooding Elevations

[Not applicable to this Flood Risk Project]

4.3 Dams and Other Flood Hazard Reduction Measures

Table 7 contains information about non-levee flood hazard reduction measures within the City and County of Honolulu such as dams or jetties. Levee systems are addressed in Section 4.4 of this FIS Report.

Table 7: Dams and Other Flood Hazard Reduction Measures

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Ala Wai Canal	N/A	Dredging	Various locations	The dredged capacity of the canal is approximately 13,000 cfs, or equivalent to approximately a 10% annual chance flood event
Kaaawa Stream	N/A	Seawall	Swanzy Beach Park	Low-lying areas are protected from high surf
Kamooalii Stream	N/A	Dam	Headwaters of Kamooalii Stream	Flood-control dam will convey the 1% annual chance flood event flows
Keaahala Stream	N/A	Flood Control Channel	Wailele Road to 300 feet upstream of Kamehameha Highway	Flood control channel constructed by the city
Oneawa Channel	N/A	Flood Control Channel	Kawainui Swamp	Conveys floodflows from the Kawainui Swamp
Wailele Stream	N/A	Berms	Along middle portion of study reach	The berms provide limited protection but are not considered sound flood control structures.

4.4 Levee Systems

For purposes of the NFIP, FEMA only recognizes levee systems that meet, and continue to meet, minimum design, operation, and maintenance standards that are consistent with comprehensive floodplain management criteria. The Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10) describes the information needed for FEMA to determine if a levee system reduces the flood hazard from the 1-percent-annual-chance flood. This information must be supplied to FEMA by the community or other party when a flood risk study or restudy is conducted, when FIRMs are revised, or upon FEMA request. FEMA reviews the information for the purpose of establishing the appropriate flood hazard zone.

Levee systems that are determined to reduce the hazard from the 1-percent-annual-chance flood are accredited by FEMA. FEMA can also grant provisional accreditation to a levee system that was previously accredited on an effective FIRM and for which FEMA is awaiting data and/or documentation to demonstrate compliance with 44 CFR 65.10. These levee systems are referred to as Provisionally Accredited Levees, or PALs. Provisional accreditation provides communities and levee owners with a specified timeframe to obtain the necessary data to confirm the levee system’s accreditation status. Accredited levee systems and PALs are shown on the FIRM using the symbology shown in Figure 3. If the required information for a PAL is not submitted within the required timeframe, or if information indicates that a levee system no longer meets 44 CFR 65.10, FEMA will consider the levee system as non-accredited and issue an effective FIRM showing the levee-impacted area as a SFHA or Zone D.

FEMA coordinated with the USACE, the local communities, and other organizations to compile a list of levee systems that exist within the City and County of Honolulu. Table 8, “Levee Systems,” lists all accredited levee systems, PALs, and non-accredited levee systems shown on the FIRM for this FIS Report. Other categories of levees may also be included in the table. The Levee ID shown in this table may not match numbers based on other identification systems that were listed in previous FIS Reports. Levee systems identified in the table are displayed on the FIRM with notes to users to indicate their flood hazard mapping status.

Please note that the information presented in Table 8 is subject to change at any time. For that reason, the latest information regarding the levee systems presented in the table may be obtained by accessing the National Levee Database. For additional information, contact the levee owner/sponsor or the local community shown in Table 30.

Table 8: Levee Systems

Community	Flooding Source(s)	NLD Levee System ID	NLD Levee System Name	Levee System Status on Effective FIRM	FIRM Panel(s)	Levee Owner(s) / Sponsor(s)
City and County of Honolulu	Aiea Stream	N/A	N/A	Non-Accredited	15003C0243J	City and County of Honolulu
City and County of Honolulu	Kahauiki Stream	230005000000	Fort Shafter Flats Flood Mitigation Project	Accredited	15003C0353H	City and County of Honolulu
City and County of Honolulu	Kahawainui Stream	3205040802	Kahawainui Stream – RB Levee	Non-Accredited	15003C0043J 15003C0044J	USACE/City and County of Honolulu
City and County of Honolulu	Kalauao Stream	3205041303	Kalauao Stream – Right Bank	Non-Accredited	15003C0243J	USACE/City and County of Honolulu
City and County of Honolulu	Kawainui Marsh/ Oneawa Channel	3205040901	Kawainui Marsh – 6850LF Levee, Floodwall & Oneawa Channel	Accredited	15003C0290J	USACE/City and County of Honolulu
City and County of Honolulu	Kuliouou Stream	3205041102	Kuliouou Stream – Right Bank and Channel	Non-Accredited	15003C0387H	USACE/City and County of Honolulu
City and County of Honolulu	Waiawa Stream - Left and Right Banks	N/A	N/A	Non-Accredited	15003C0239H	City and County of Honolulu
City and County of Honolulu	Waimalu Stream	3205041302	Waimalu Stream – NF Debris Basin and Channel	Non-Accredited	15003C0243J	City and County of Honolulu

SECTION 5.0 – ENGINEERING METHODS

For the flooding sources in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded at least once on the average during any 10-, 25-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management. These events, commonly termed the 10-, 25-, 50-, 100-, and 500-year floods, have a 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance, respectively, of being equaled or exceeded during any year.

Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1-percent chance of annual exceedance) during the term of a 30-year mortgage is approximately 26 percent (about 3 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

The engineering analyses described here incorporate the results of previously issued Letters of Map Change (LOMCs) listed in Table 26, "Incorporated Letters of Map Change", which include Letters of Map Revision (LOMRs). For more information about LOMRs, refer to Section 6.5, "FIRM Revisions."

5.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for each flooding source studied. Hydrologic analyses are typically performed at the watershed level. Depending on factors such as watershed size and shape, land use and urbanization, and natural or man-made storage, various models or methodologies may be applied. A summary of the hydrologic methods applied to develop the discharges used in the hydraulic analyses for each stream is provided in Table 12. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

A summary of the discharges is provided in Table 9. Frequency Discharge-Drainage Area Curves used to develop the hydrologic models may also be shown in Figure 7 for selected flooding sources. A summary of stillwater elevations developed for non-coastal flooding sources is provided in Table 10. (Coastal stillwater elevations are discussed in Section 5.3 and shown in Table 16.) Stream gage information is provided in Table 11.

Table 9: Summary of Discharges

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Ahuimanu Stream	At Pacific Ocean	6.2	11,811	15,282	18,009	20,470	27,511
Ahuimanu Stream	Confluence with Kahalulu Stream	3.7	6,932	8,915	10,476	11,902	15,541
Ahuimanu Stream	Upstream of confluence with Kahalulu Stream	2.4	3,170	*	7,120	9,590	17,900
Ahuimanu Stream	At confluence with Ahuimanu Stream Tributary	1.7	2,380	*	5,400	7,300	13,700
Ahuimanu Stream	USGS Gage 16284200	1.1	2,956	3,860	4,567	5,189	7,249
Ahuimanu Stream Tributary	Upstream of confluence of Main Branch	0.4	1,620	*	3,320	4,240	6,900
Ahuimanu Stream Tributary	Near Hui Nene Street	0.3	1,370	*	2,800	3,580	5,820
Aiea Stream	At Noanalua Road	1.4	1,140	*	2,130	2,660	4,030
Aiea Stream	Near Aiea Heights	1.1	910	*	1,710	2,140	3,100
East Makaha Stream (Kaupuni Tributary)	Confluence with Kaupuni Stream	2.8	2,202	2,961	3,579	4,132	5,650
Hahakea Gulch	At mouth	4.0	1,800	*	3,600	4,600	7,500
Haiamoa Stream	At Pacific Ocean	0.6	1,280	*	2,530	3,230	5,100
Haiamoa Stream	Upstream of Ahilama Road	0.2	640	*	1,270	1,640	2,550
Halawa Stream	1,700 feet upstream of Kam-Highway	9.6	4,057	5,693	7,128	8,738	13,209
Hoaeae Stream[1]	Pacific Ocean	2.9	2,732	3,490	4,081	4,663	6,083
Hoaeae Stream	Interstate H-1	1.6	1,455	1,894	2,232	2,568	3,389
Honouliuli Stream	At Pacific Ocean	12.1	3,180	*	6,430	8,030	12,170
Honouliuli Stream	Downstream of Farrington Highway	11.0	3,060	*	6,190	7,730	11,710
Ihiihi Stream	Confluence with Kahawainui Stream	1.4	1,572	2,172	2,643	3,116	4,323
Inoaole Stream	Pacific Ocean	2.2	2,216	2,892	3,421	3,954	5,272
Inoaole Stream	Approximately 1,100 feet upstream of Kalanianaole Highway	1.6	1,971	2,546	2,990	3,434	4,534
Inoaole Stream Tributary	Kulaiwi St	0.4	287	391	473	556	762
JCIP Drainage Canal	500 feet upstream of Olai Street	2.8	826	1,490	2,175	3,049	5,938
Kaalaea Stream	At Pacific Ocean	1.6	2,690	*	5,230	6,610	10,500
Kaalaea Stream	Upstream of Pulama Road	1.0	1,890	*	3,700	4,700	7,500
Kaelepulu Stream	Downstream limit of study	0.2	*	*	*	1,404	*
Kaelepulu Stream	Upstream limit of study	0.1	*	*	*	1,120	*

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs) 10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Kahaluu Stream	Upstream of confluence of Ahuimanu Stream	1.4	1,220	*	2,630	3,530	6,550
Kahaluu Stream	At Melekula Road	1.0	980	*	2,110	2,830	5,220
Kahauiki Stream	At Fort Shafter Flat Motor Pool	1.9	1,600	*	3,000	3,800	6,100
Kahawainui & Ihiihi Stream	Pacific Ocean	5.0	4,873	6,779	8,287	9,803	13,687
Kahawainui & Ihiihi Stream	Confluence with Ihiihi Stream	4.4	4,653	6,437	7,846	9,260	12,873
Kalaiokahipa Stream	At Kamehameha Highway	1.2	410	*	1,380	4,500	*
Kalauao Stream	At Pacific Ocean	2.7	1,860	*	2,990	3,540	4,960
Kalauao Stream	Downstream of H-1 Freeway	2.5	1,780	*	2,870	3,400	4,760
Kalihi Stream	At Pacific Ocean	5.7	6,544	8,421	9,910	11,432	15,254
Kalihi Stream	Confluence with Kamanaiki Stream	4.8	6,159	7,931	9,334	10,771	14,377
Kalihi Stream	At USGS Gage 16229000	2.6	3,924	5,086	6,012	6,961	9,369
Kaloi Gulch	Downstream limit of study	5.8	*	*	*	2,425	*
Kaloi Gulch	Upstream limit of study	5.2	*	*	*	2,359	*
Kamanaiki Stream	Downstream limit of study	0.9	*	*	*	4,944	*
Kamanaiki Stream	Upstream limit of study	0.6	*	*	*	4,069	*
Kamooalii Stream[1]	At Pacific Ocean	5.7	6,780	8,754	10,228	11,813	15,652
Kamooalii Stream[1]	Confluence with Kapunahala Stream	5.1	5,666	7,369	8,647	10,016	13,335
Kapakahi Stream #2	Downstream limit of study	0.3	*	*	*	2,590[2]	*
Kapakahi Stream #2	At divergence from Waikele Stream	0.2	*	*	*	1,920[3]	*
Kapalama Drainage Canal	Pacific Ocean	2.6	3,993	4,240	4,994	5,757	7,731
Kapalama Drainage Canal	Approximately 390 feet upstream of Interstate H-1	2.0	1,579	2,052	2,444	2,843	3,872
Kaukonahua Stream	Approximately 2,300 feet upstream of Cane Haul Road	39.3	11,300	*	20,800	25,600	38,700
Kaukonahua Stream	Approximately 7,000 feet upstream of Cane Haul Road	33.8	10,600	*	19,400	23,800	35.500
Kaupuni Stream	Confluence with Kawiwi Stream	5.5	3,837	5,241	6,373	7,470	10,060
Kawainui Stream	At confluence with Kaelepulu Stream	1.0	1,150	*	1,850	2,150	3,150
Kawainui Stream	Upstream of Pali Highway	0.4	450	*	720	840	1,230
Kawiwi Stream	Confluence with Kaupuni Stream	2.8	2,202	2,961	3,579	4,132	5,650
Keaahala Stream	At mouth	1.2	2,003	2,680	3,197	3,714	4,937

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Keaahala Stream	825 feet downstream of Kahekili Highway	0.50	1,292	1,694	2,030	2,367	3,195
Keaahala Stream	Upstream of confluence with Unnamed Tributary to Keaahala Stream	0.3	680	*	1,220	1,500	2,250
Keaaulu Gulch	At confluence with Malaekahana Stream	1.4	968	1,653	2,327	3,156	5,811
Kuliouou Stream	Pacific Ocean	1.6	2,026	2,766	3,376	3,993	5,425
Kuliouou Stream	Approximately 1,750 feet upstream of Kuilouou Road	0.6	700	1,002	1,254	1,514	2,121
Kului Stream	Confluence with Wailupe Stream	0.5	1,031	1,347	1,590	1,857	2,524
Makaha Stream	Downstream limit of study	7.0	*	*	*	11,561	*
Makaha Stream	Upstream limit of study	5.3	*	*	*	7,388	*
Makaleha Stream	At Pacific Ocean	6.4	2,120	*	4,240	5,410	8,880
Makaleha Stream	Upstream of Farrington Highway	4.2	1,640	*	3,280	4,180	6,860
Ma'ili'ili Channel	1,450 feet upstream of Paakea Road	15.8	3,182	5,410	7,597	10,265	18,544
Maipalaoa Stream	At Kulaaupuni Street	2.7	800	1,444	2,107	2,956	5,760
Malaekahana Stream	At Pacific Ocean	6.5	4,467	7,340	10,202	13,702	25,031
Malaekahana Stream	Upstream of agricultural area	4.6	3,326	5,641	7,277	9,531	16,289
Manaiki Stream	Approximately 250 feet upstream of Mahole Street	2.0	*	*	*	4,900	6,080
Moanalua Stream	Approximately 250 feet downstream of Moanalua Road	7.9	*	*	*	13,500	18,200
Moanalua Stream	Approximately 180 feet upstream of Jarrett White Road	5.0	*	*	*	9,700	12,700
Nanakuli Stream	Downstream limit of study	4.1	*	*	*	7,554	*
Nanakuli Stream	Upstream limit of study	3.5	*	*	*	7,256	*
Niu Stream and Niu Tributary	Pacific Ocean	2.5	2,643	3,586	4,366	5,128	7,140
Niu Stream and Niu Tributary	Confluence with Niu Stream	2.1	2,456	3,343	4,072	4,788	6,676
Niu Tributary	Confluence with Niu Stream	1.1	1,236	1,681	2,048	2,410	3,362
North Halawa Stream	Downstream limit of study	4.2	*	*	*	9,916	*
North Halawa Stream	Upstream limit of study	4.0	*	*	*	9,794	*

Table 9: Summary of Discharges *(continued)*

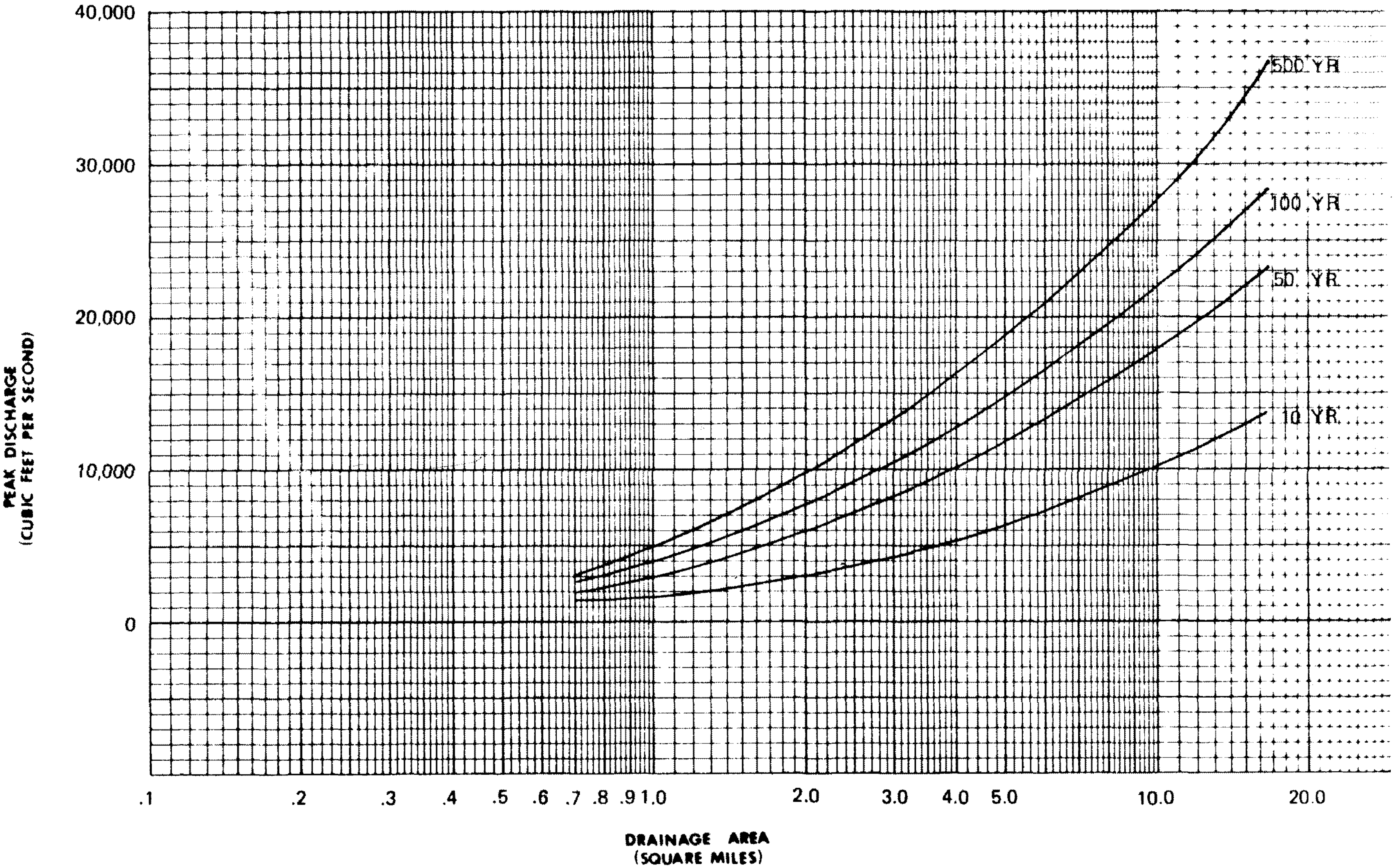
Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Nuuanu Stream and Waolani Stream	At Pacific Ocean	8.4	8,201	10,592	12,468	14,410	19,322
Nuuanu Stream and Waolani Stream	Confluence with Waolani Stream	6.0	7,967	10,284	12,110	13,988	18,748
Ohia Stream	At Kamehameha Highway	2.4	985	*	1,870	8,900	*
Ohia Stream	Approximately 500 feet upstream of Kamehameha Highway	2.4	*	*	*	4,875[4]	*
Ohia Stream (East)	At Kamehameha Highway	0.5	*	*	*	5,925[5]	*
Ohia Stream (East)	Approximately 1,200 feet upstream of Kamehameha Highway	0.5	345	*	1,720	1,900	*
Oneawa Channel[6]	At confluence with Kawainui Marsh	10.6	4,910	5,623	6,782	8,127	7,432
Palolo Stream[7]	Confluence with Manoa Stream	4.1	3,500	5,129	6,300	7,600	12,000
Palolo Stream[7]	USGS Gage 16247000	3.6	3,100	4,404	5,500	6,600	10,000
Palolo Stream[7]	Confluence of Pukele and Waiomao Streams	2.9	2,900	4,163	5,100	6,100	9,200
Panaikauahi Gulch	At confluence with Waiawa Stream	8.4	*	*	*	14,200	18,300
Panaikauahi Gulch	Approximately 800 feet upstream of Cane Haul Road	7.9	*	*	*	13,500	17,400
Ulehawa Stream	Downstream limit of study	3.5	*	*	*	3,785	*
Ulehawa Stream	Upstream limit of study	1.9	*	*	*	2,436	*
Unnamed Stream	At Pacific Ocean	3.3	1,340	*	3,160	4,300	7,750
Unnamed Stream	Upstream of Farrington Highway	2.0	940	*	2,200	2,920	5,250
Unnamed Tributary to Keaahala Stream	At confluence with Keaahala Stream	0.2	450	*	810	1,000	1,530
Waialae-Iki Stream	Pacific Ocean	0.9	1,133	1,600	1,857	2,202	3,096
Waialae-Nui Stream	At confluence with Kapakahi	1.7	1,741	2,429	2,982	3,542	5,088
Waiawa Stream	At mouth	27.3	*	*	*	34,000	43,800
Waiawa Stream	Approximately 4,380 feet upstream of confluence of Panakauahi Gulch	16.1	*	*	*	23,000	29,650
Waihee Stream	At mouth	2.3	2,380	*	4,740	6,070	10,030
Waihee Stream	Upstream of agricultural area near end of Waihee Road	0.9		*	2,350	2,990	4,980
Waihee Stream Tributary	Upstream of confluence of Main Branch	0.2	470	*	930	1,180	1,970

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs) 10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Waihee Stream Tributary	At Ahilama Road	0.2	390	*	790	1,000	1,670
Waikakalaua Stream	Downstream limit of study	4.6	*	*	*	5,591	*
Waikakalaua Stream	Upstream limit of study	4.2	*	*	*	5,486	*
Waikele Stream	At Pacific Ocean	45.1	10,858	*	21,975	27,528	41,852
Waikele Stream	At Waipahu Street	44.9	10,450	*	20,700	26,000	40,800
Wailani Drainage Canal	Downstream of Golf Cart Bridge	2.1	*	*	*	3,468	*
Wailani Drainage Canal	Upstream limit of study	1.6	*	*	*	3,042	*
Wailele Stream (Left/Right Overbank)	Downstream limit of study	1.3	*	*	*	2,601	*
Wailele Stream (Left/Right Overbank)	Upstream limit of study	1.1	*	*	*	2,257	*
Wailele Stream	0.8 miles upstream of Cane Haul Road	1.2	1,753	2,476	3,084	3,736	5,479
Wailupe Stream and Kului Stream	At Pacific Ocean	3.2	4,303	5,823	7,047	8,325	11,575
Wailupe Stream and Kului Stream	Confluence with Kului Stream	2.4	3,248	4,454	5,431	6,444	9,081
Waimalu Stream	Approximately 1,500 feet downstream of Interstate H-1	6.2	3,170	4,438	5,392	6,555	9,297
Waimalu Stream	Approximately 1,500 feet upstream of Kulea Place	5.6	3,060	4,300	5,232	6,370	9,064
Waimanalo: Stream A	At confluence with Waimanalo Stream	1.3	1,887	2,663	3,314	4,011	5,871
Waimanalo: Stream A	Just upstream of confluence with Waimanalo Stream B	0.4	736	1,053	1,323	1,620	2,431
Waolani Stream	At confluence with Nuuanu Stream	1.6	1,842	2,337	2,740	3,139	4,139

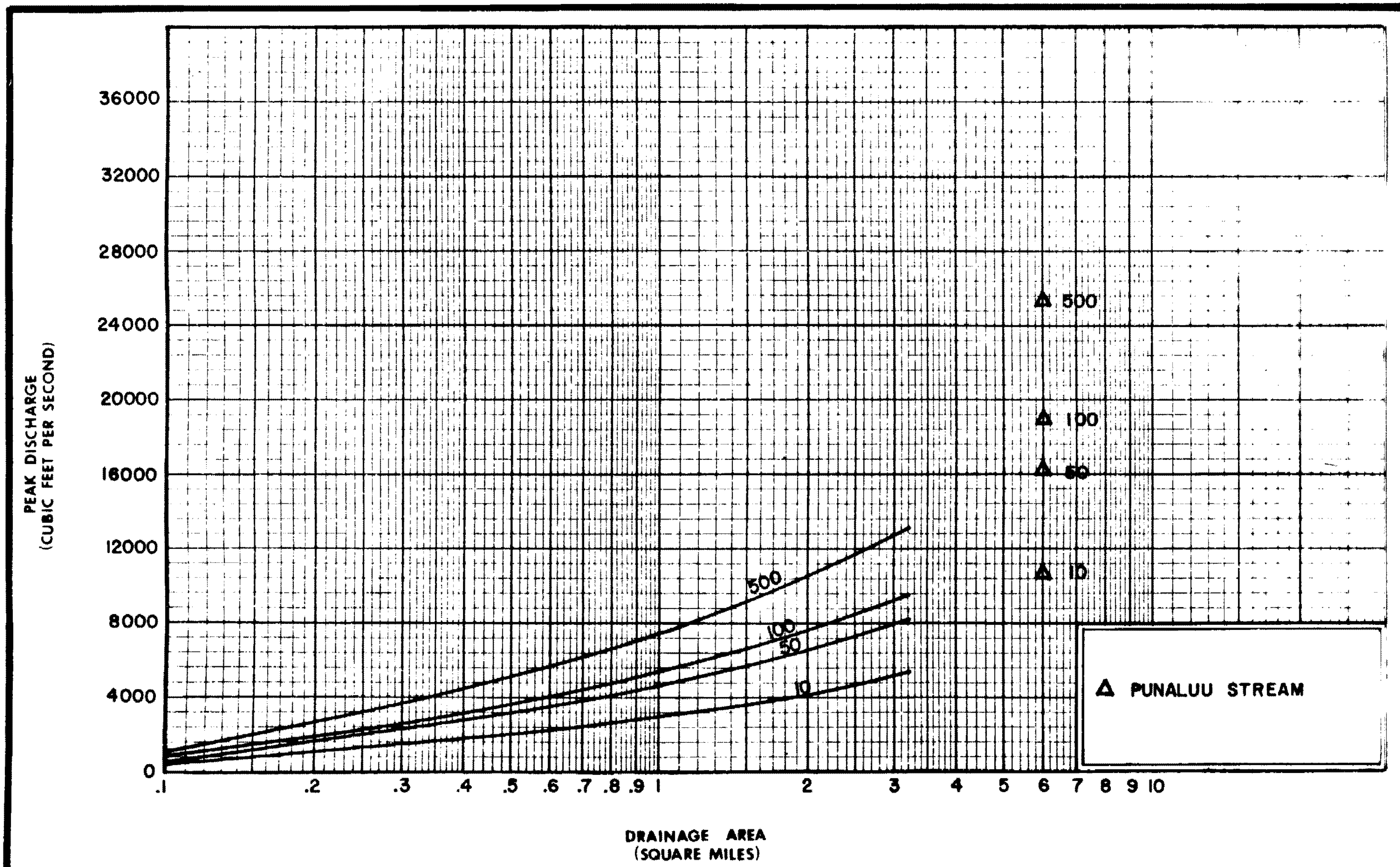
*Not calculated for this Flood Risk Project
[1]Peak discharge may change pending anticipated ground topographic survey data (2021)
[2]Includes overflow from Waikele Stream and split flow from Wailani Drainage Canal
[3]Includes overflow from Waikele Stream
[4]Excludes overflow into Ohia Stream (East)
[5]Includes overflow from Ohia Stream
[6]Represents max flow through unsteady flow modeled reach
[7]Ala Wai Canal Flood Risk Management Study, O’ahu, Hawai’I (2017)

Figure 7: Frequency Discharge - Drainage Area Curves



FEDERAL EMERGENCY MANAGEMENT AGENCY	FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES
CITY AND COUNTY OF HONOLULU, HI	ALA WAI CANAL

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY AND COUNTY OF HONOLULU, HI

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

HAUULA-PUNALUU STREAMS NEAR LAIE

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*

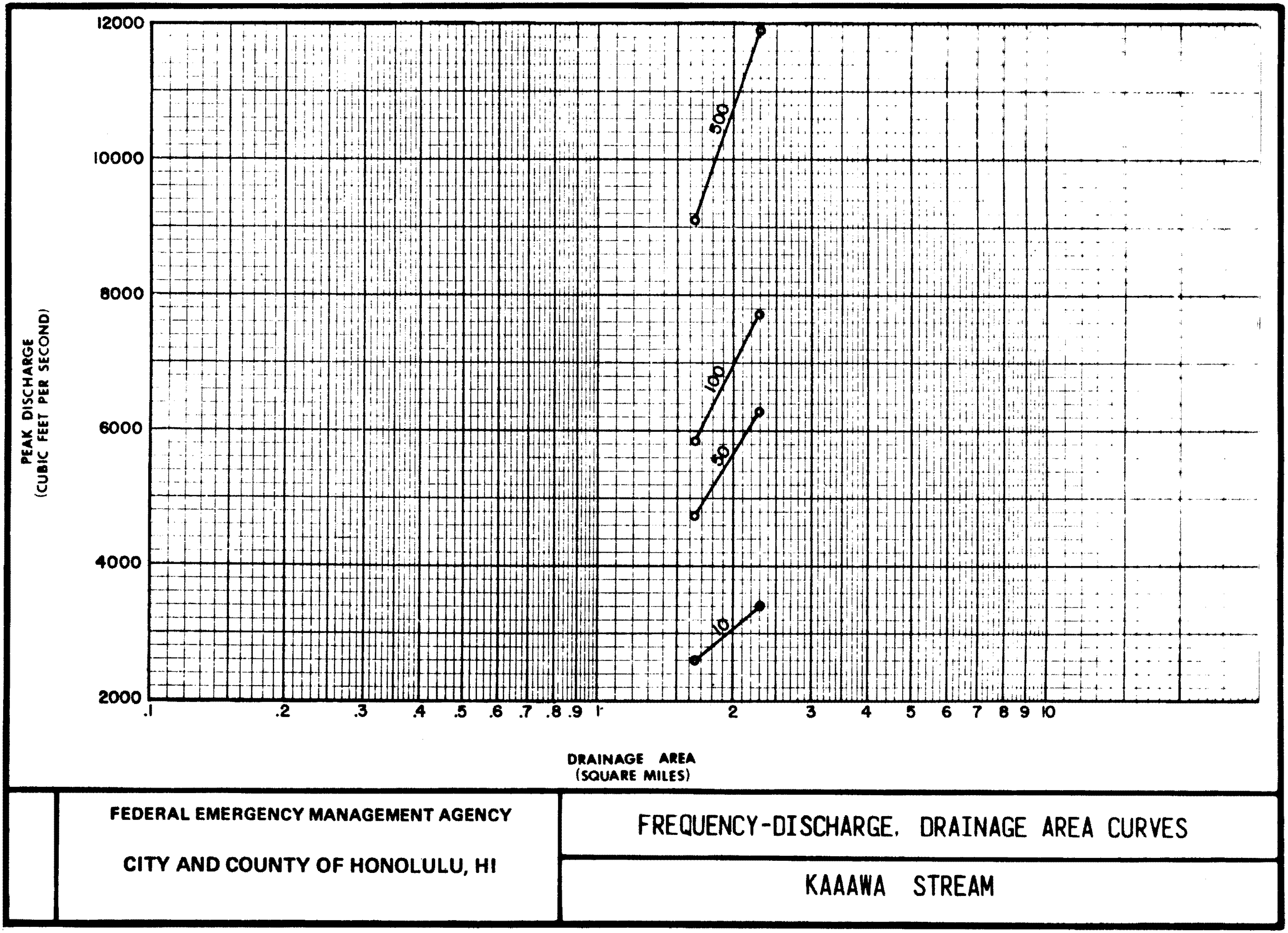
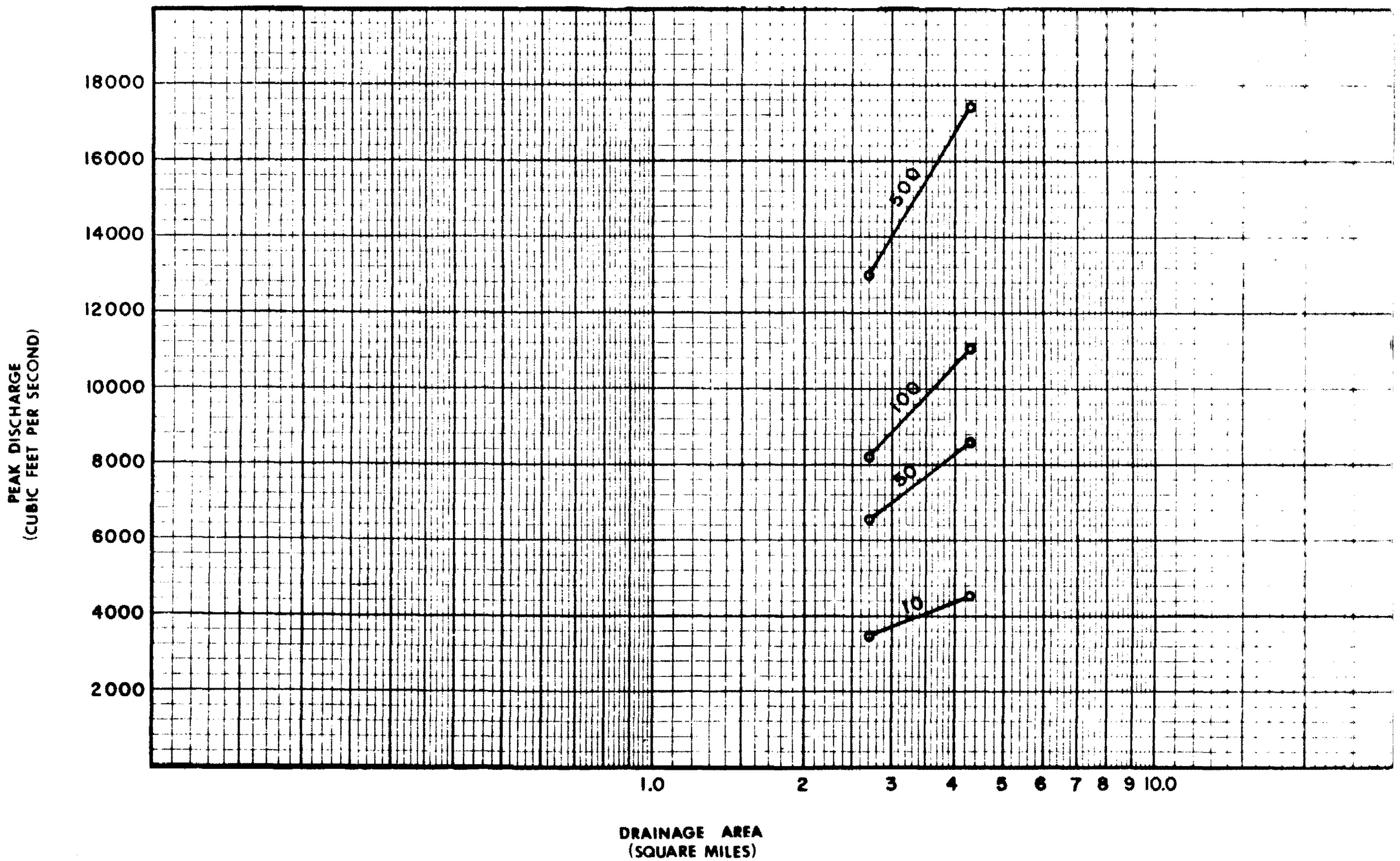
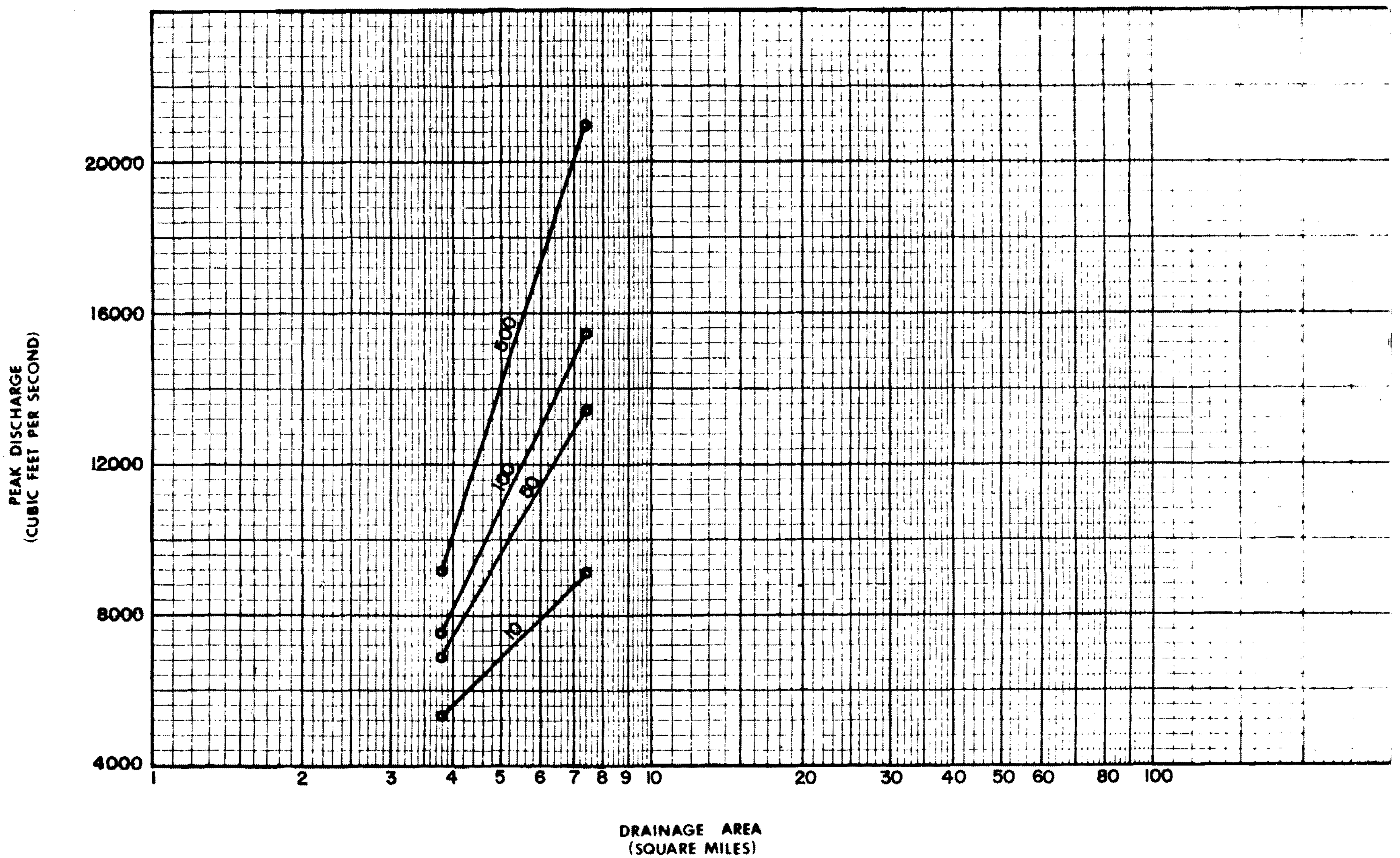


Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



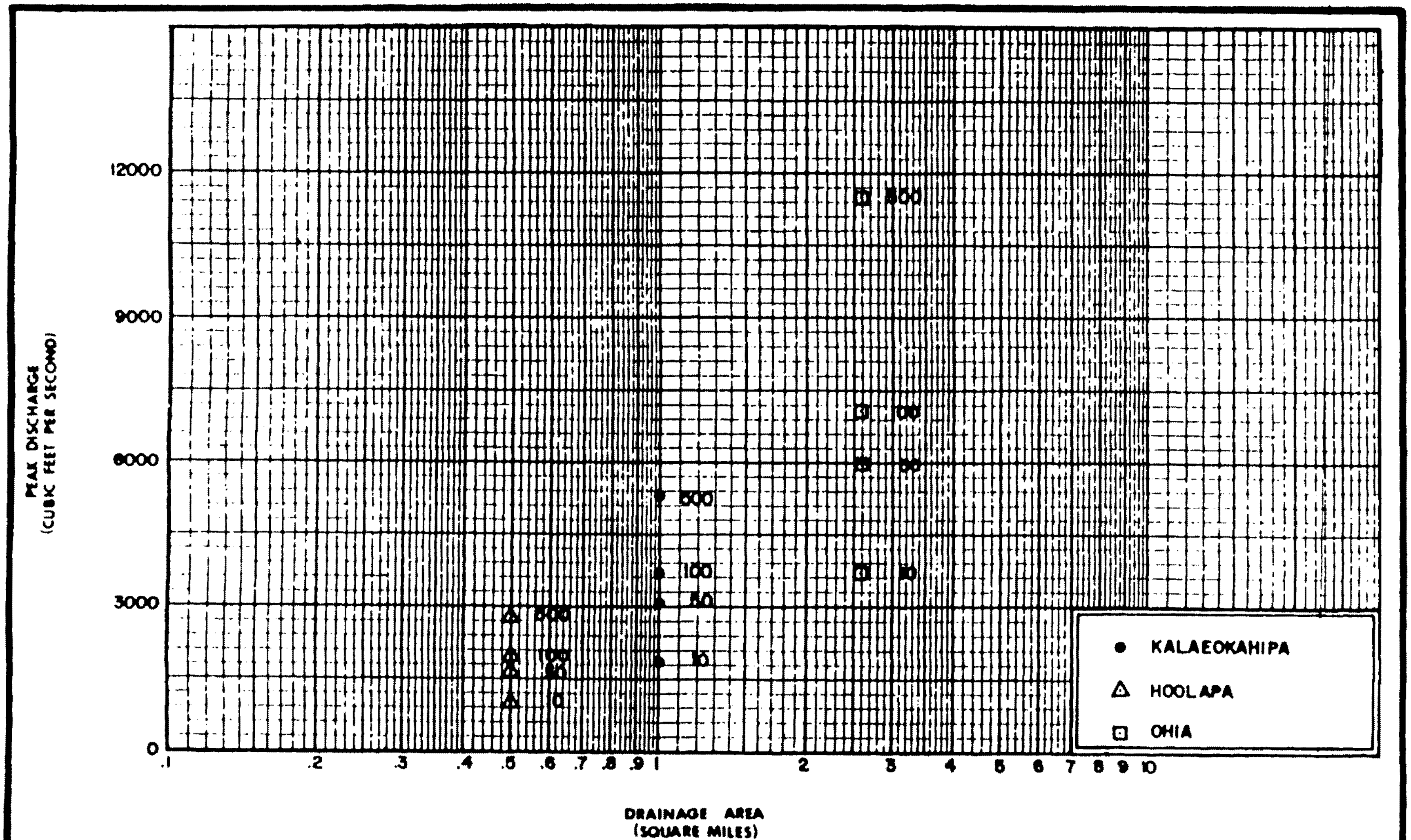
FEDERAL EMERGENCY MANAGEMENT AGENCY CITY AND COUNTY OF HONOLULU, HI	FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES KAELEPULU STREAM

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



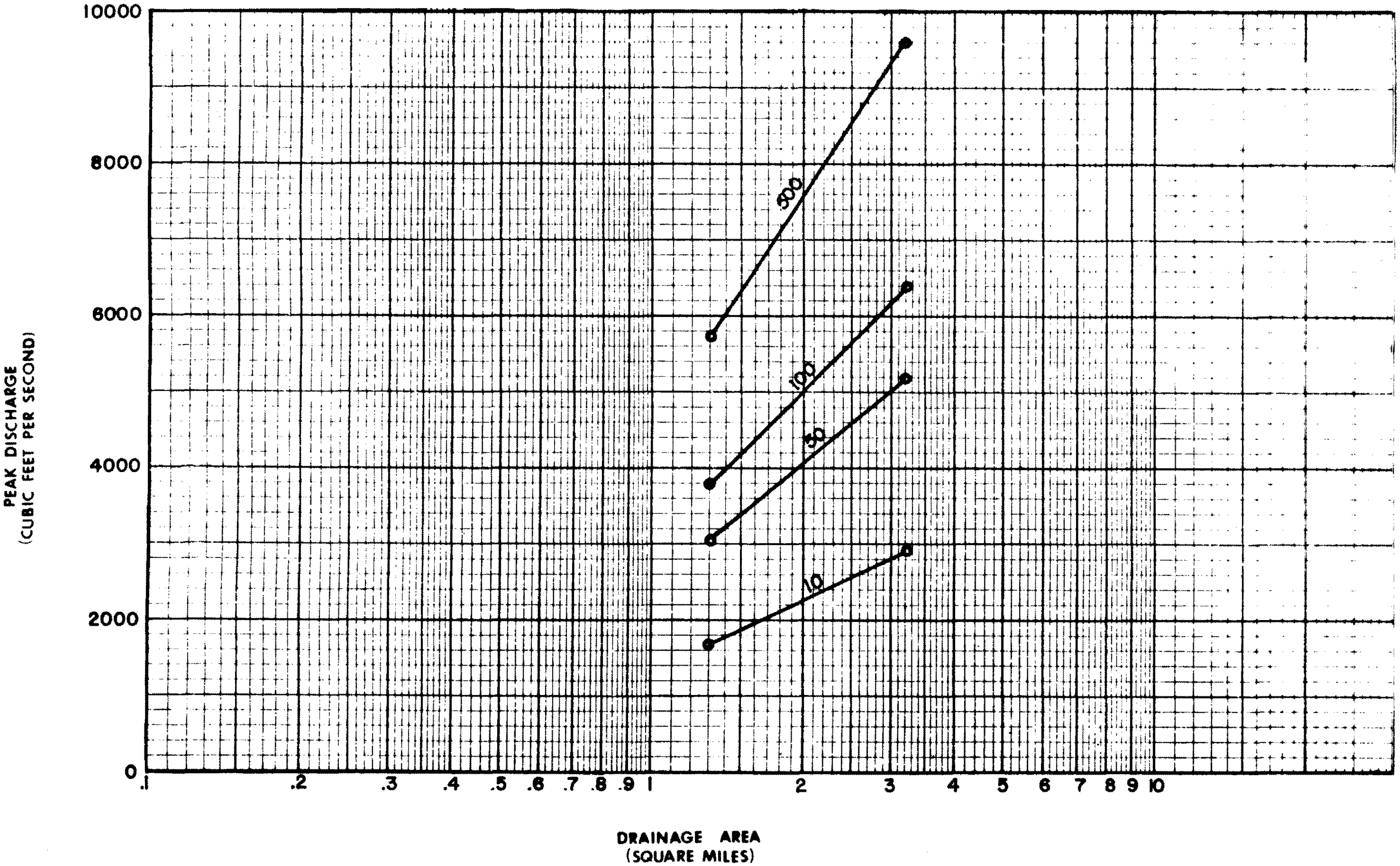
FEDERAL EMERGENCY MANAGEMENT AGENCY	FREQUENCY-DISCHARGE DRAINAGE AREA CURVES
CITY AND COUNTY OF HONOLULU, HI	KAHANA STREAM

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



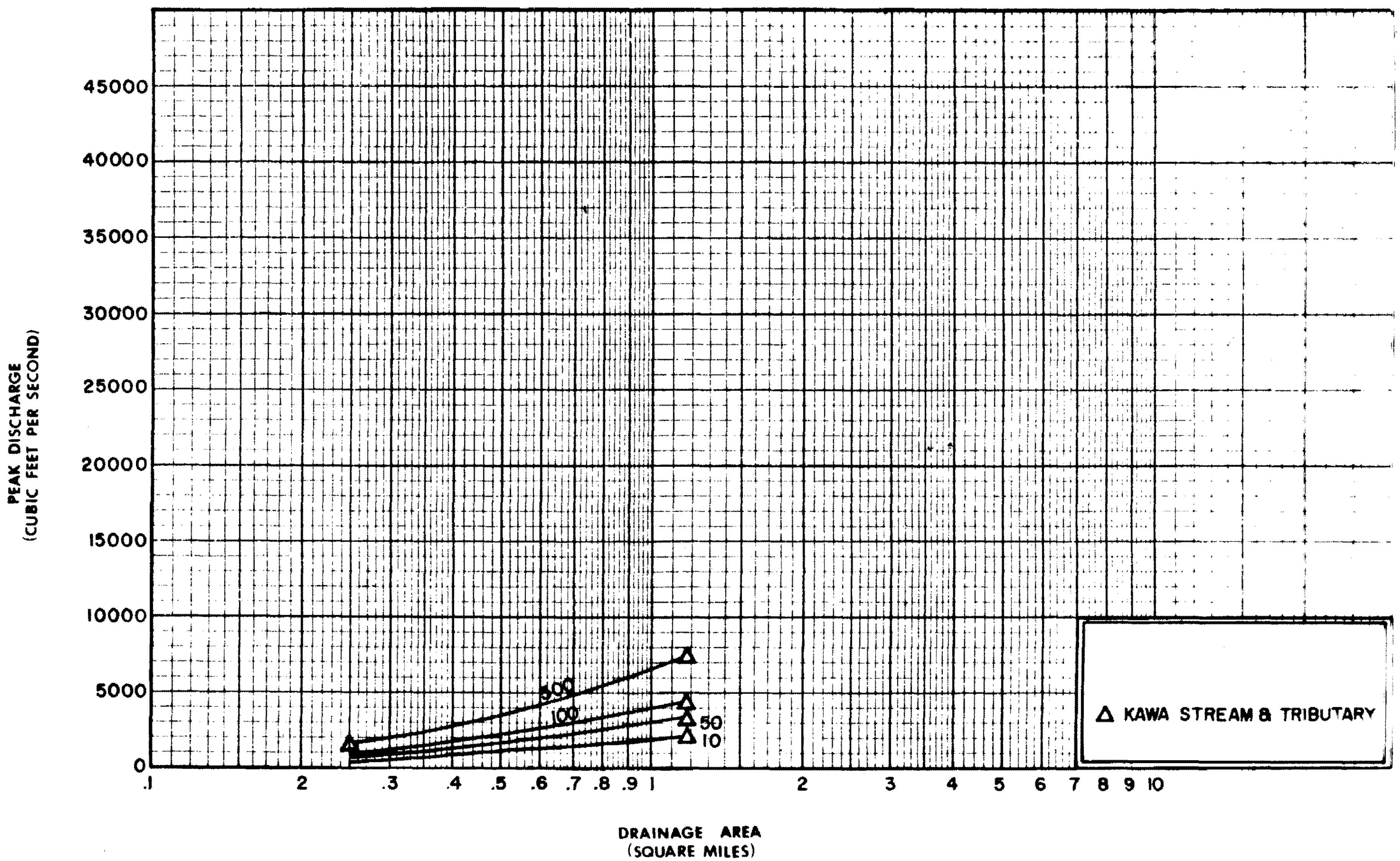
FEDERAL EMERGENCY MANAGEMENT AGENCY CITY AND COUNTY OF HONOLULU, HI	FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES KAHUKU STREAMS

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



FEDERAL EMERGENCY MANAGEMENT AGENCY	FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES
CITY AND COUNTY OF HONOLULU, HI	**KAPAKAHI STREAM # 1**

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



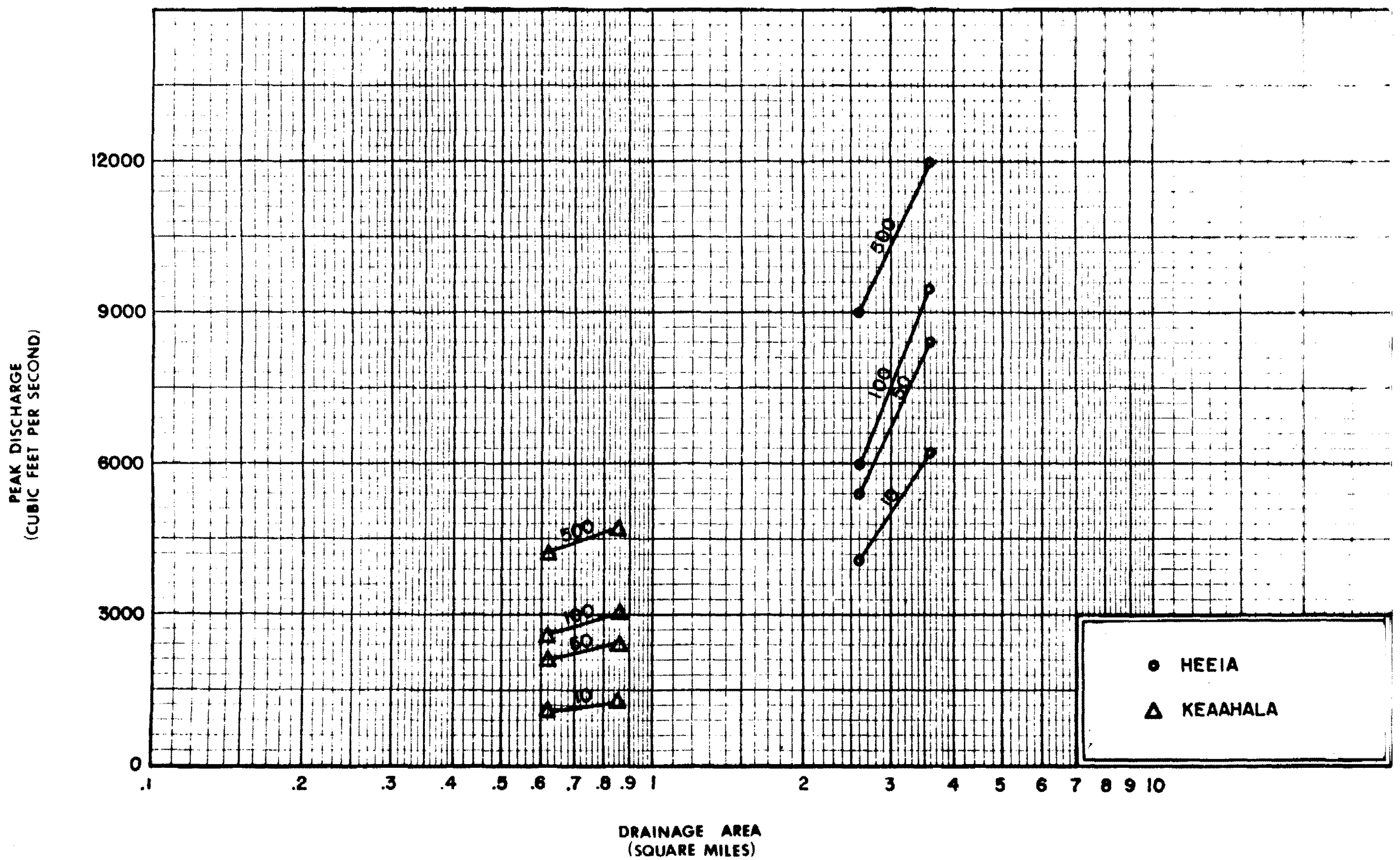
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY AND COUNTY OF HONOLULU, HI

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

KAWA STREAM

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



FEDERAL EMERGENCY MANAGEMENT AGENCY CITY AND COUNTY OF HONOLULU, HI	FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES KEAAHALA & HEEIA STREAMS

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*

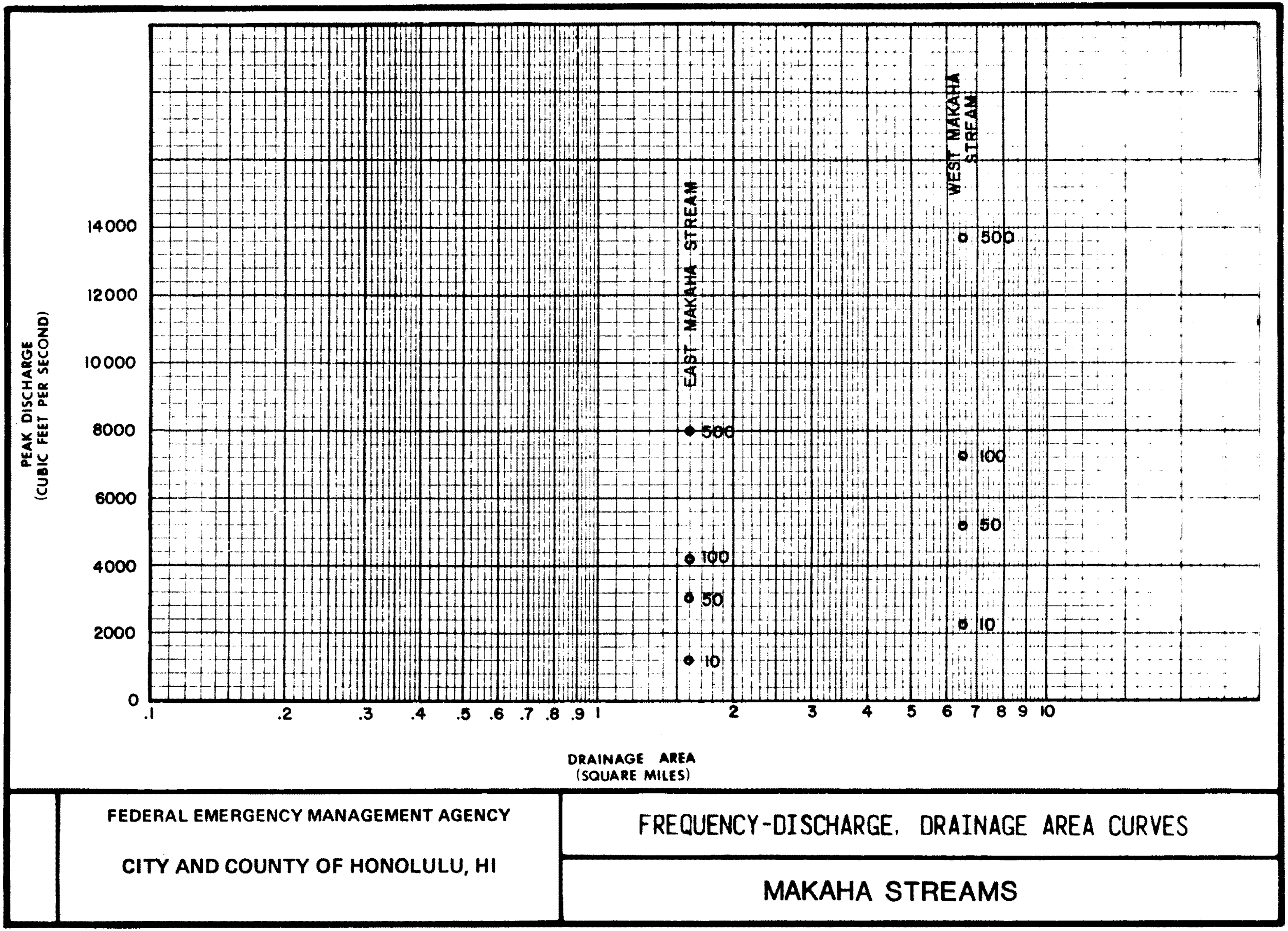
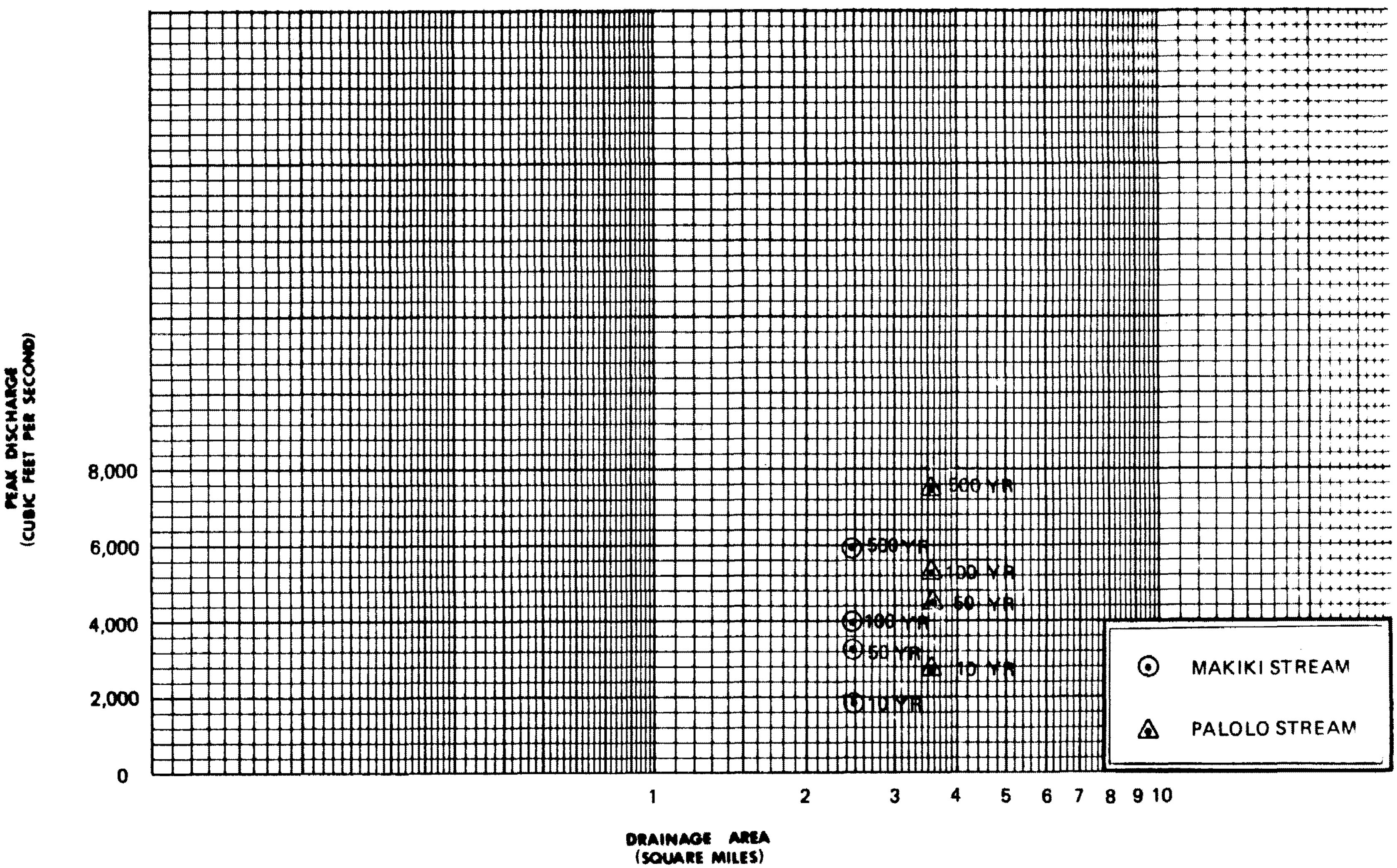
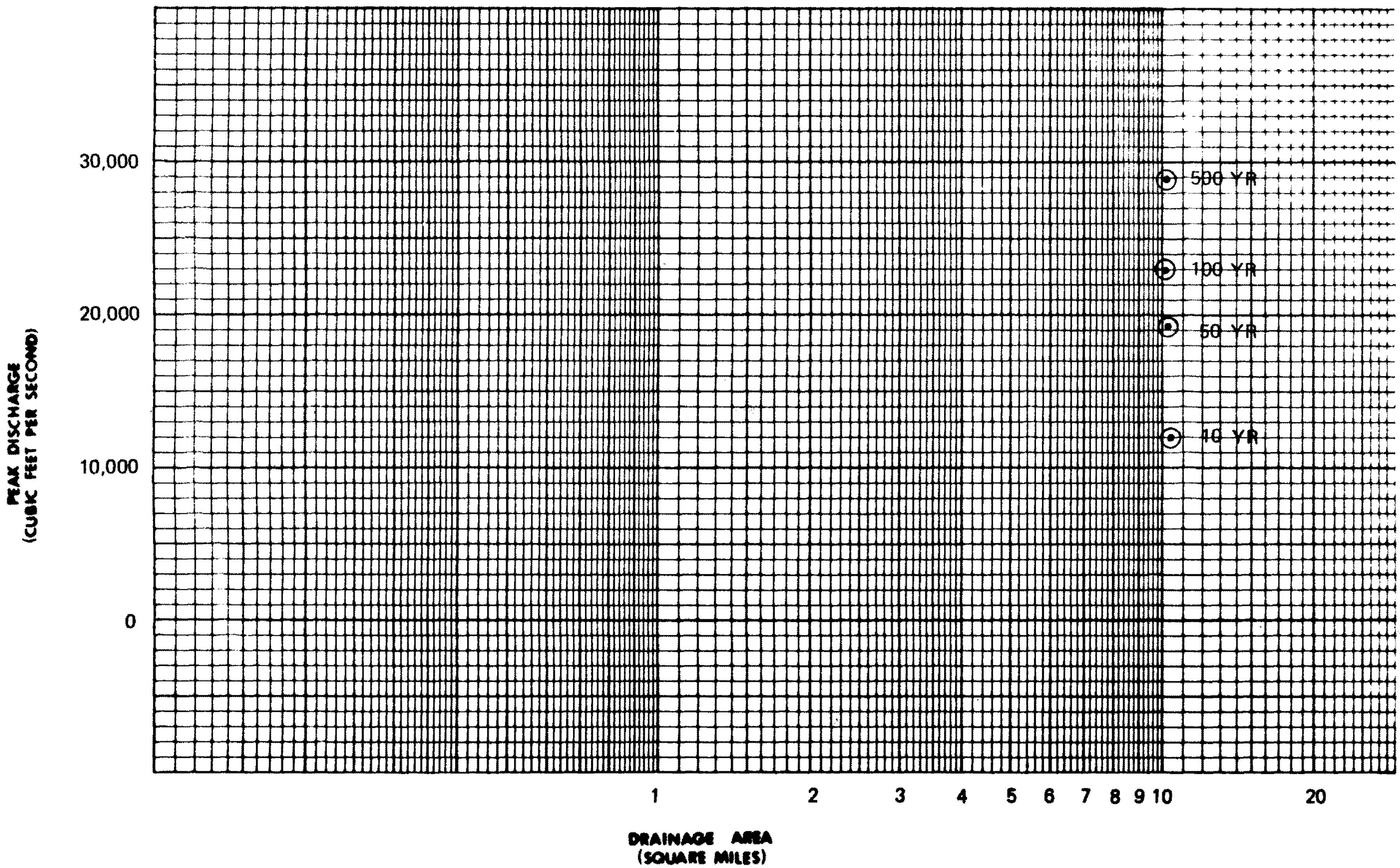


Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



FEDERAL EMERGENCY MANAGEMENT AGENCY CITY AND COUNTY OF HONOLULU, HI	FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES MAKIKI STREAM AND PALOLO STREAM



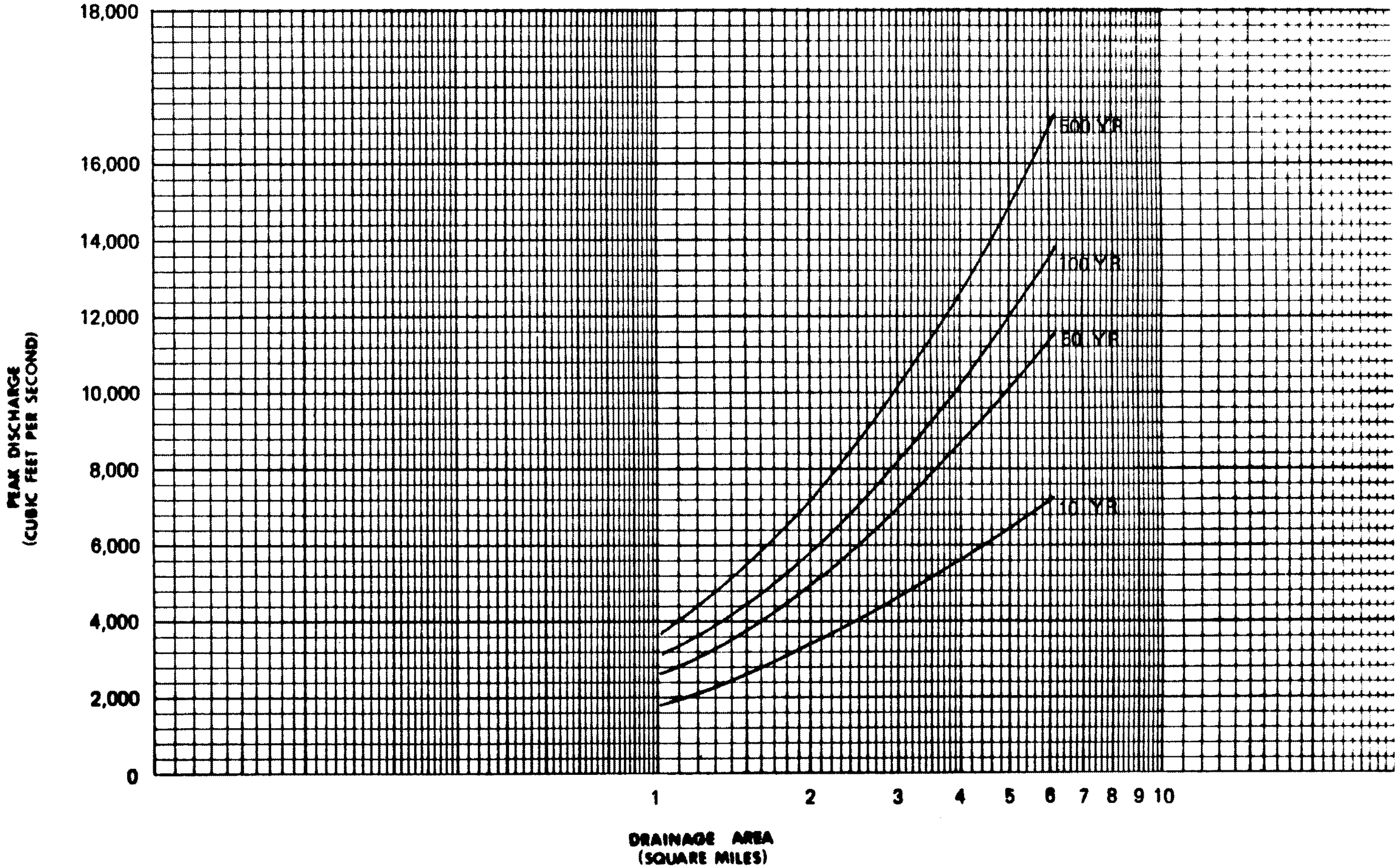
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY AND COUNTY OF HONOLULU, HI

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

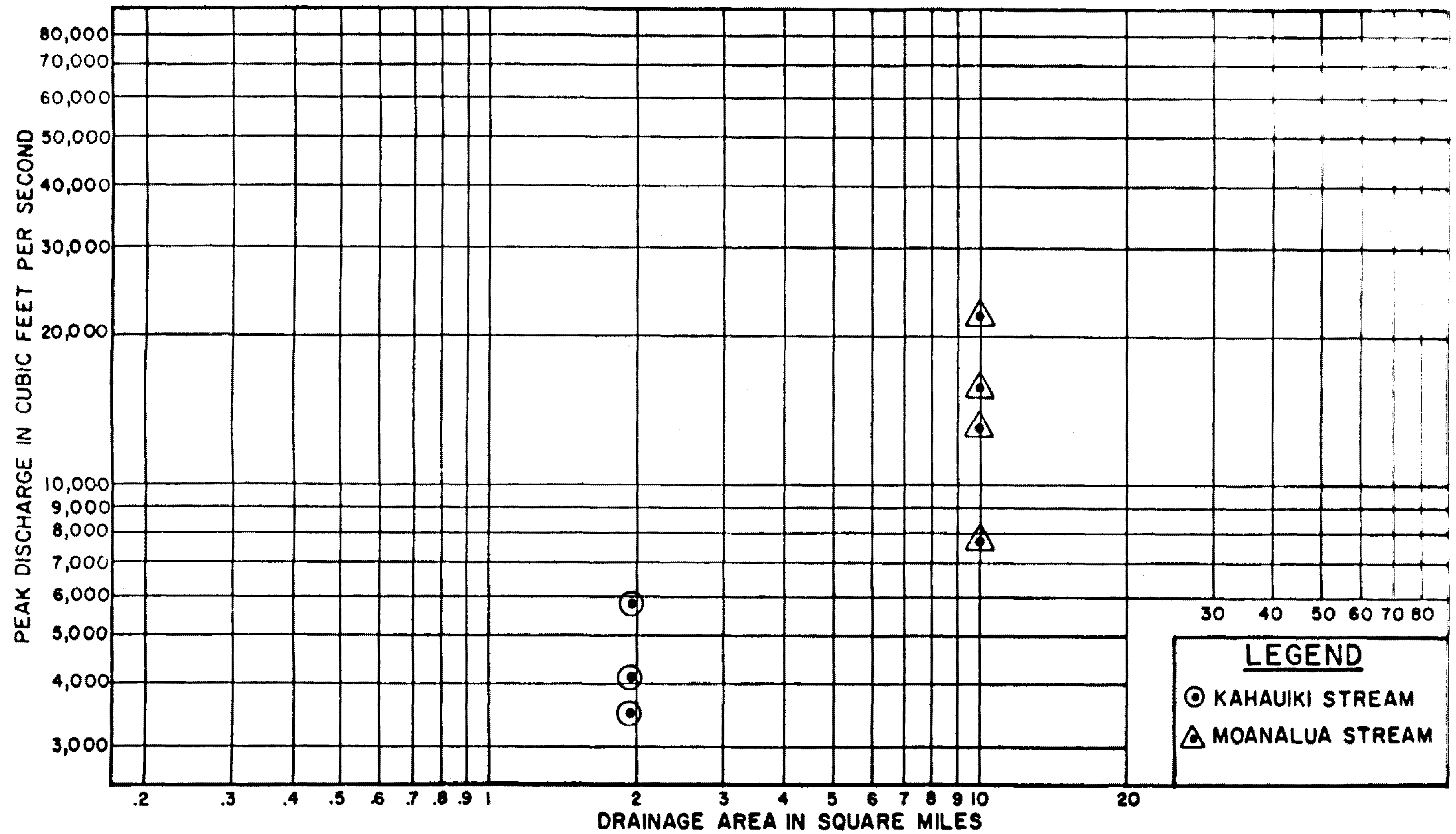
MANOA - PALOLO DRAINAGE CANAL

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



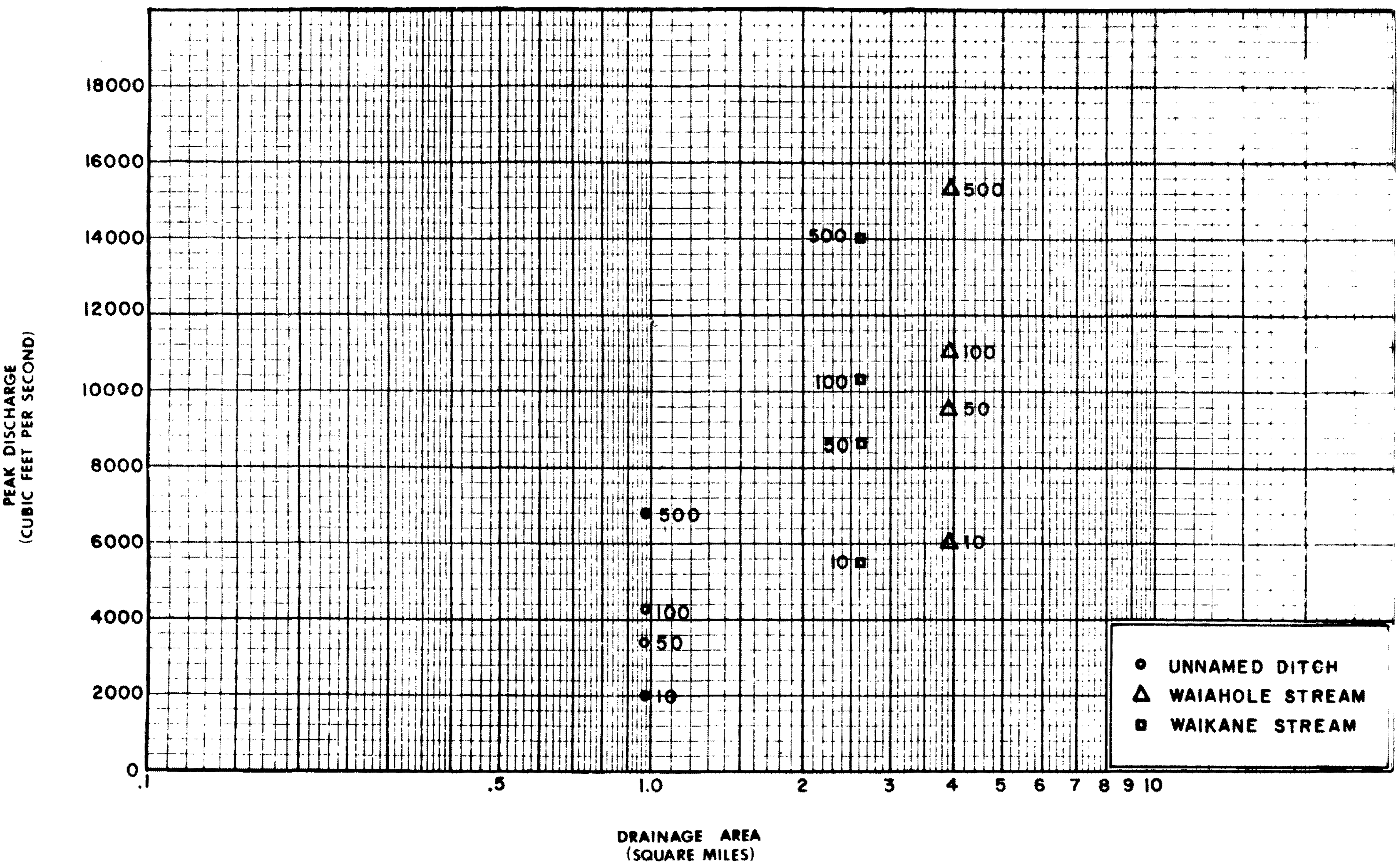
FEDERAL EMERGENCY MANAGEMENT AGENCY	FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES
CITY AND COUNTY OF HONOLULU, HI	MANOA STREAM

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



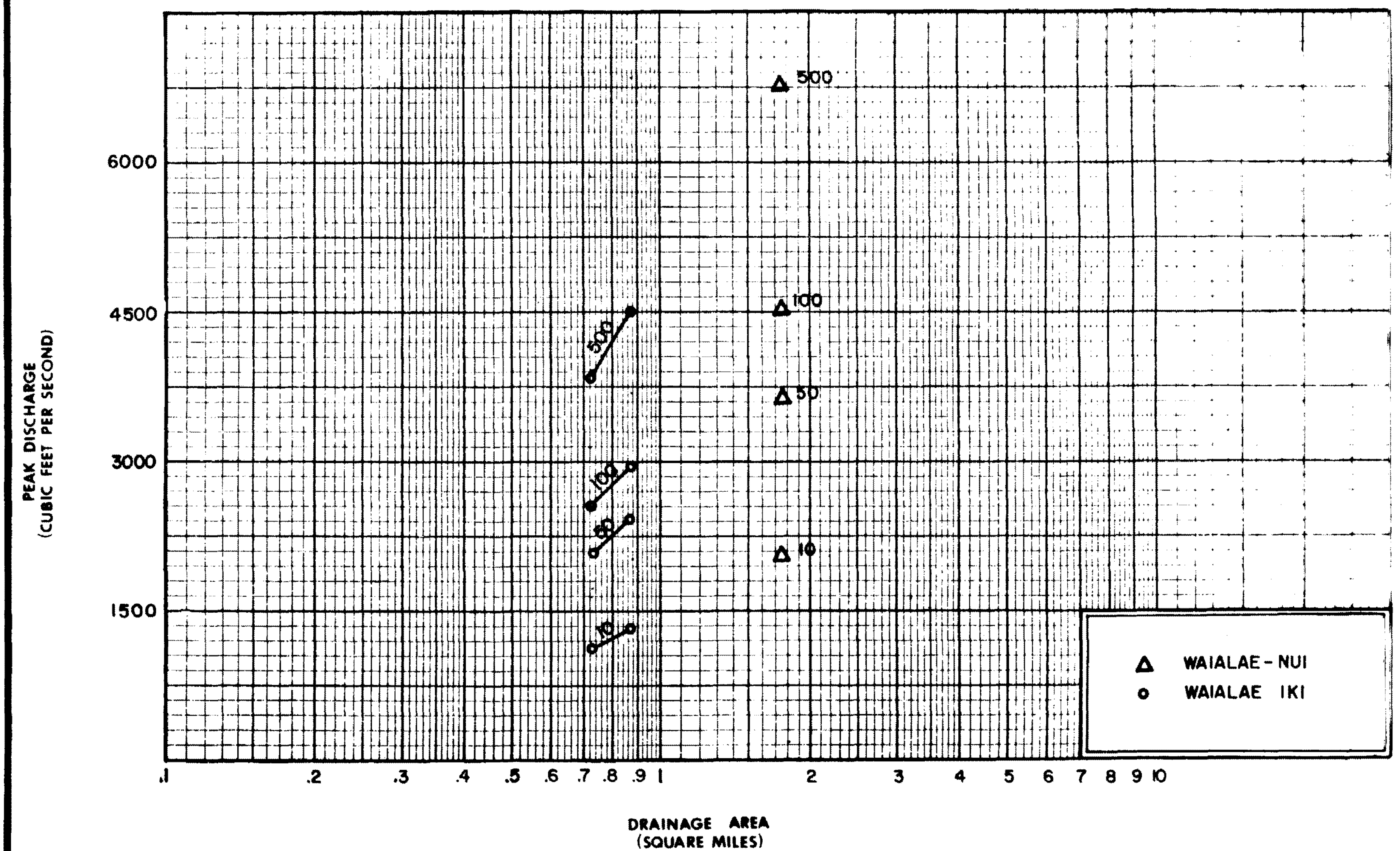
FEDERAL EMERGENCY MANAGEMENT AGENCY CITY AND COUNTY OF HONOLULU, HI	FREQUENCY-DISCHARGE VS. DRAINAGE AREA MOANALUA AND KAHAUIKI STREAMS

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



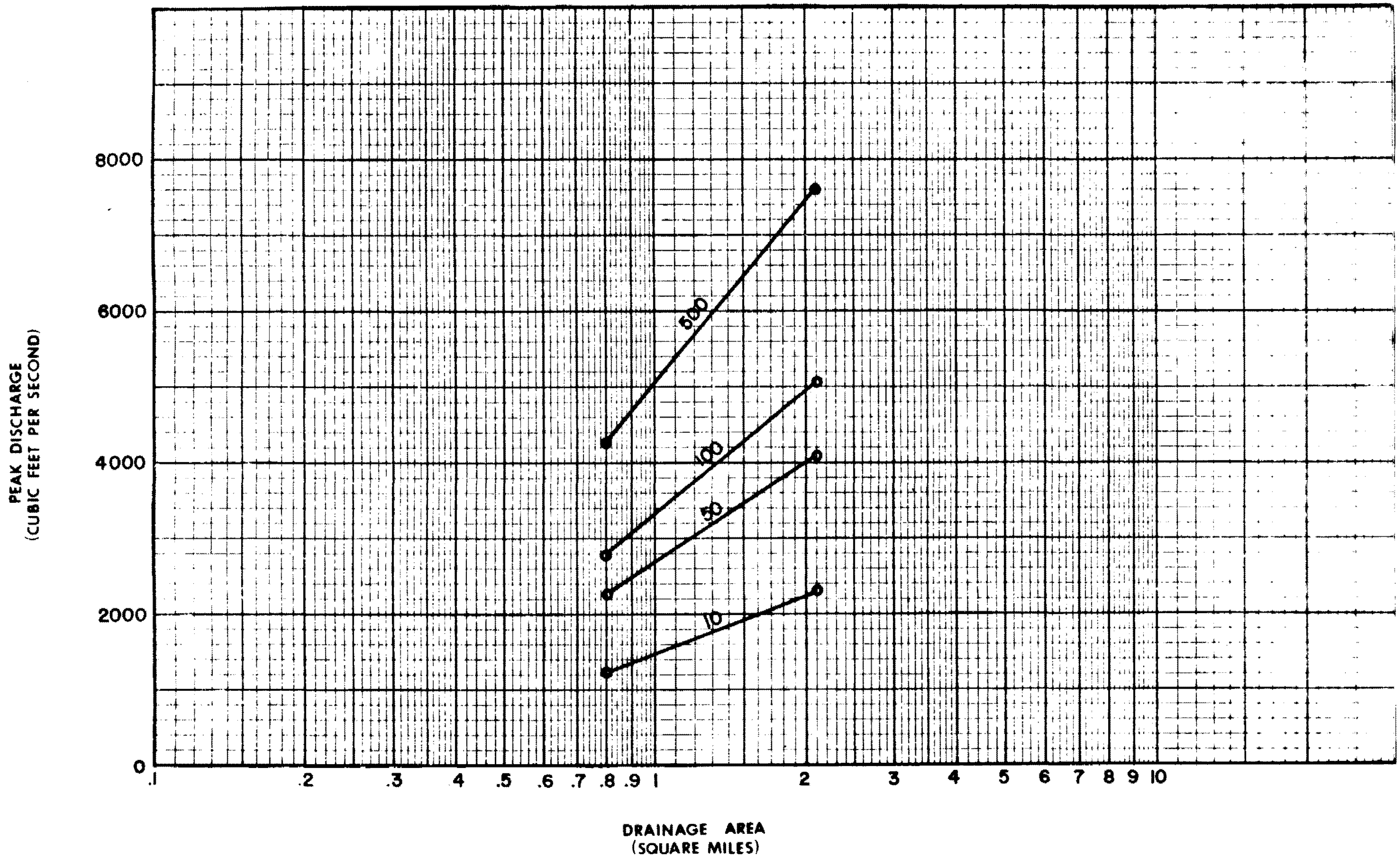
FEDERAL EMERGENCY MANAGEMENT AGENCY CITY AND COUNTY OF HONOLULU, HI	FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES WAIKANE & WAIAHOLE STREAMS

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



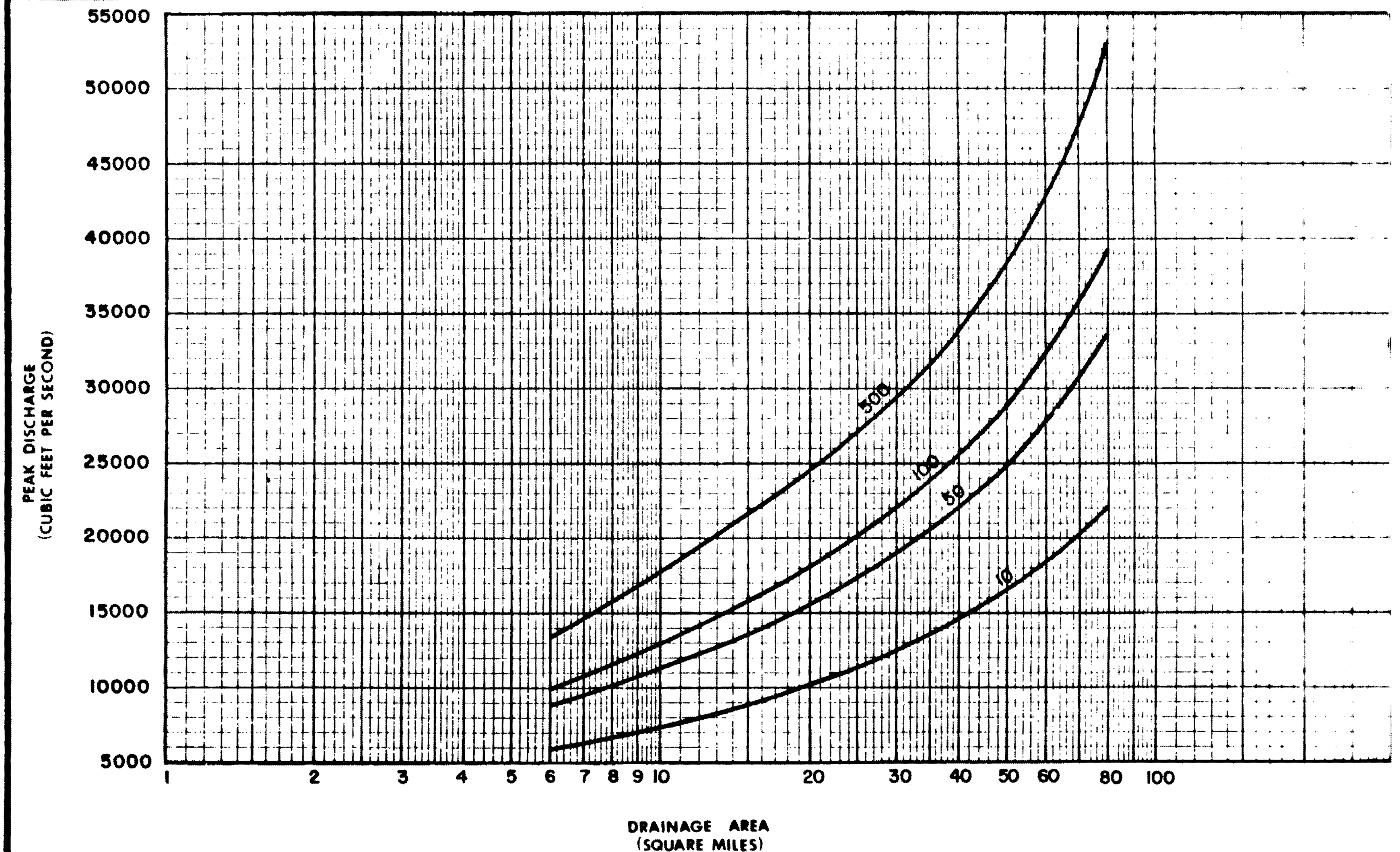
FEDERAL EMERGENCY MANAGEMENT AGENCY CITY AND COUNTY OF HONOLULU, HI	FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES **WAIALAE IKI & WAIALAE NUI STREAMS**

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



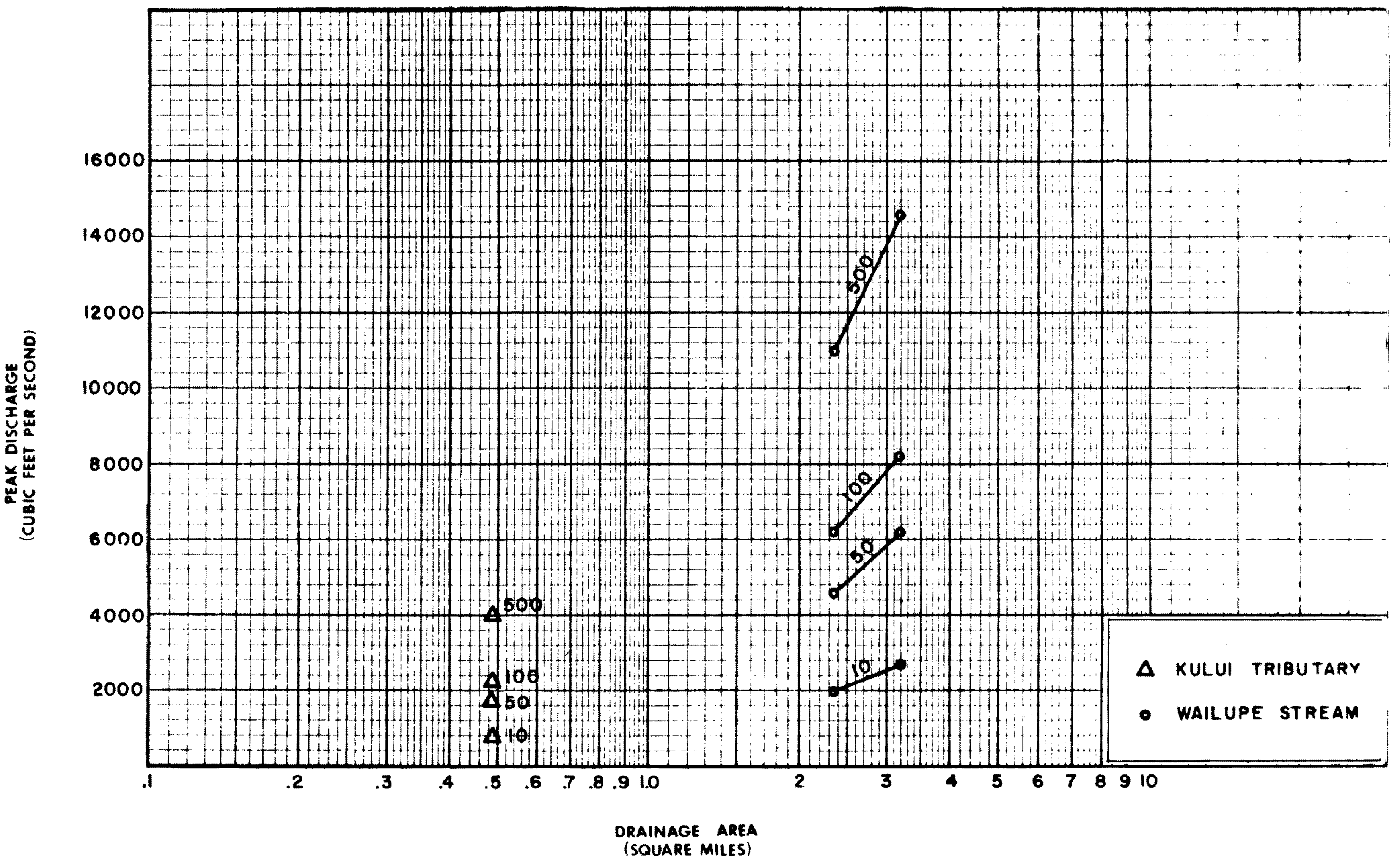
FEDERAL EMERGENCY MANAGEMENT AGENCY CITY AND COUNTY OF HONOLULU, HI	FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES
	WAIALAE MAJOR DRAIN

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



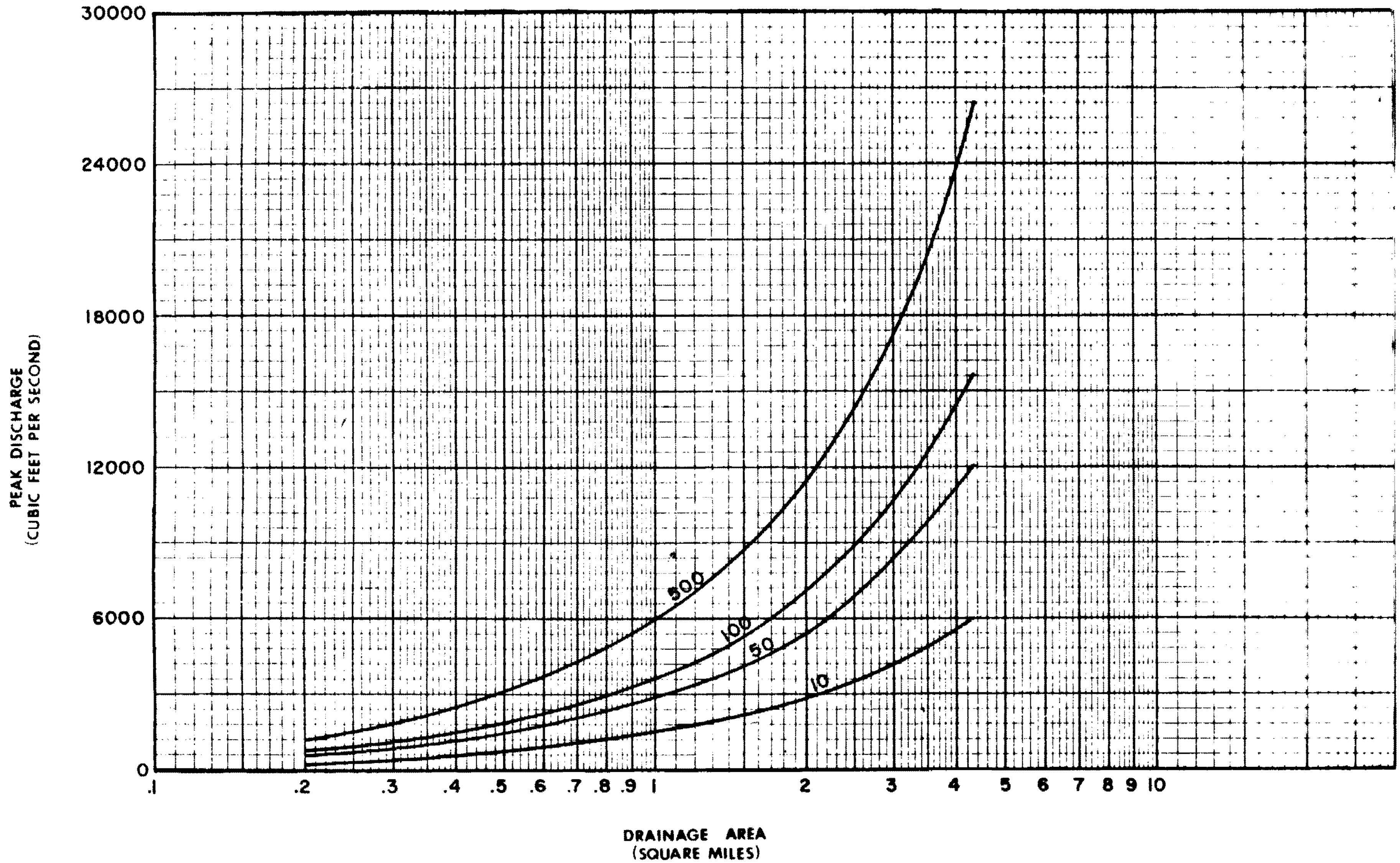
FEDERAL EMERGENCY MANAGEMENT AGENCY CITY AND COUNTY OF HONOLULU, HI	FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES WAIALUA - HALEIWA STREAMS

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



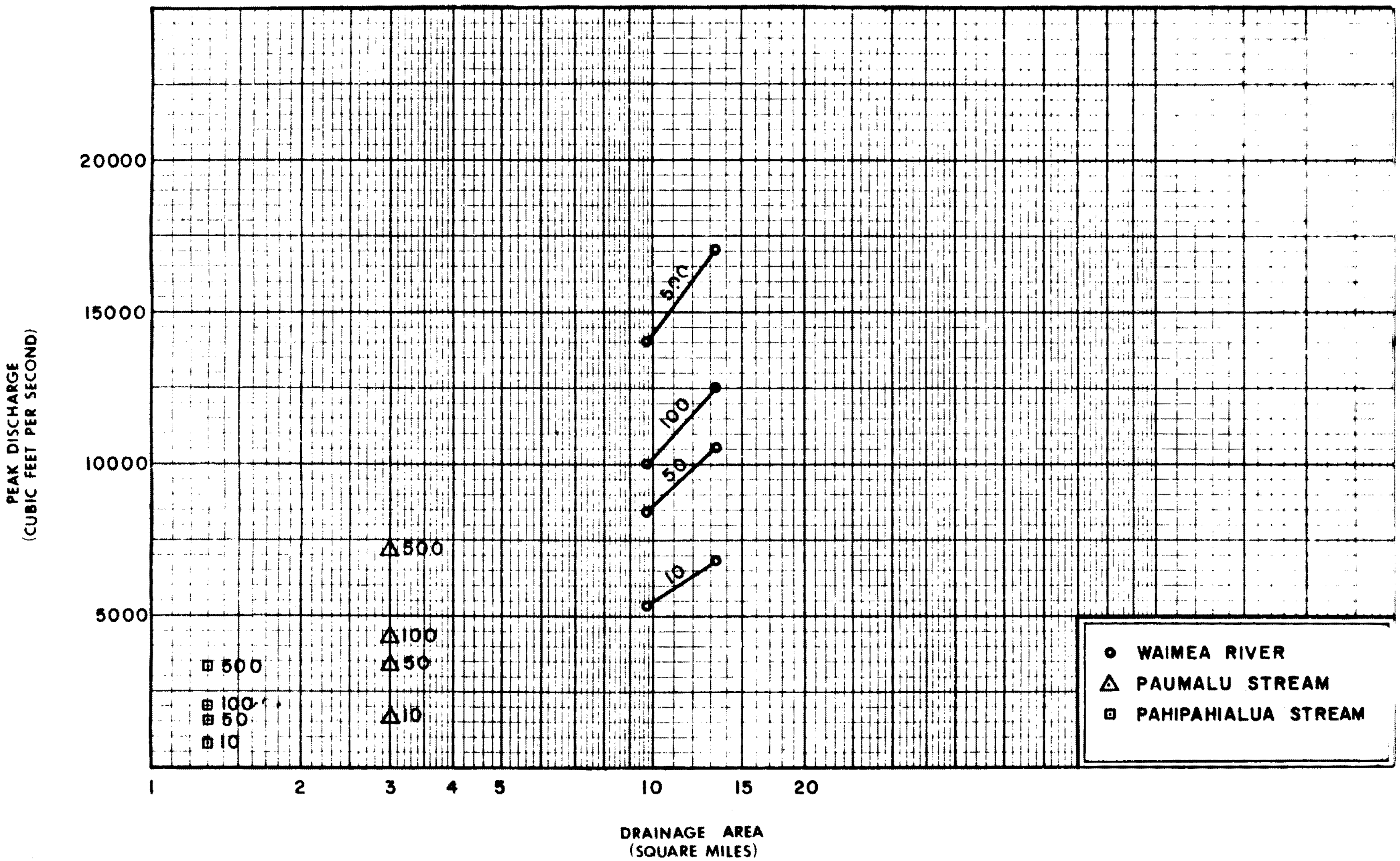
FEDERAL EMERGENCY MANAGEMENT AGENCY CITY AND COUNTY OF HONOLULU, HI	FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES WAILUPE STREAM & KULUI TRIBUTARY

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



FEDERAL EMERGENCY MANAGEMENT AGENCY CITY AND COUNTY OF HONOLULU, HI	FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES WAIMANALO STREAMS

Figure 7: Frequency Discharge - Drainage Area Curves *(continued)*



FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY AND COUNTY OF HONOLULU, HI

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

WAIMEA RIVER, PAUMALU & PAHIPAHIALUA STREAMS

Table 10: Summary of Non-Coastal Stillwater Elevations
[Not applicable to this Flood Risk Project]

Table 11: Stream Gage Information used to Determine Discharges

Flooding Source	Gage Identifier	Agency that Maintains Gage	Site Name	Drainage Area (Square Miles)	Period of Record	
					From	To
Kalihi Stream	16229000	USGS	Kalihi Stream near Honolulu, Oahu HI	2.6	1917	2018
Kalihi Stream	16229300	USGS	Kalihi Stream near Kalihi, Oahu HI	5.2	*	*
Keaahala Stream	16274499	USGS	Keaahala Stream at Kamehameha Highway, Kanohe, Oahu, HI	0.8	*	*
Kuliouou Stream	16247900	USGS	Kuliouou Valley at Kuliouou, Oahu, HI	1.3	1970	2020
Makaha Stream	16211600	USGS	Makaha Stream near Makaha, Oahu, HI	2.1	1960	2023
Makaha Stream	16211700	USGS	Makaha Stream near Makaha, Oahu, HI	5.2	*	*
Nanahuli Stream	16212300	USGS	Nankuli Stream at Nankuli, Oahu, HI	4.0	*	*
Palolo Stream	16247000	USGS	Palolo Stream near Honolulu, Oahu, HI	3.7	1953	2007
Pukele Stream	16244000	USGS	Pukele Stream near Honolulu, Oahu, HI	1.2	1927	2004
Waiawa Stream	16216000	USGS	Waiawa Stream near Pearl City, Oahu, HI	25.2	*	*
Waihee Stream	16284200	USGS	Waihee Stream near Kahaluu, Oahu, HI	1.0	1974	2019
Waikele Stream	16213000	USGS	Waikele Stream near Waipahu, Oahu, HI	45.1	1951	2018
Waiomao Stream	16246000	USGS	Waiomao Stream near Honolulu, Oahu, HI	1.1	1927	1971

* Data not available

5.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Base flood elevations on the FIRM represent the elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report. Rounded whole-foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static base flood elevations. These whole-foot elevations may not exactly reflect the elevations derived from the hydraulic analyses. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM. The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

For streams for which hydraulic analyses were based on cross sections, locations of selected cross sections are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 6.3), selected cross sections are also listed in Table 23, "Floodway Data."

A summary of the methods used in hydraulic analyses performed for this project is provided in Table 12. Roughness coefficients are provided in Table 13. Roughness coefficients are values representing the frictional resistance water experiences when passing overland or through a channel. They are used in the calculations to determine water surface elevations. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

Table 12: Summary of Hydrologic and Hydraulic Analyses

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Ahuimanu Stream	Confluence with Kaneohe Bay	Approximately 800 feet upstream of Kahekili Highway	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
	Approximately 800 feet upstream of Kahekili Highway	Approximately 2,020 feet upstream of Kahekili Highway	*	*	09/08/2017	AE	LOMR 16-09-2530P
Ahuimanu Stream Tributary	Confluence with Ahuimanu Stream	Approximately 75 feet downstream of Hui Io Street	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Aiea Stream	At Moanalua Road	Approximately 0.7 miles upstream of Ulune Street	Log-Pearson Type III	HEC-2	04/01/1985	AE w/ Floodway	Discharges were based on a statistical report by the USGS (DOI 1979).
Ala Wai Canal	At downstream Limit of Study	At upstream Limit of Study	SCS Hydrograph	HEC-2	08/01/1976	AE w/ Floodway	The SCS hydrograph method of analysis was used to determine peak discharges for floods of selected recurrence intervals (USDA 1972).
Anahulu River	Approximately 280 feet upstream of Kamehameha Highway	Approximately 930 feet upstream of Cane Haul Road	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in the analyses were updated from previous USACE reports (HUD 1971, USACE 1970).
Eku Stream	Confluence with Pacific Ocean	Approximately 1,450 feet upstream of Kaulawaha Road	Log-Pearson Type III	HEC-2	07/01/1993	AE w/ Floodway	
Fish Pond	Just upstream of Highway H1	Approximately 1,600 feet upstream of Highway H1	*	*	01/24/2020	AE	LOMR 20-09-0413P

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Flow Along Cane Haul Road	Convergence with Panakauahi Gulch	Divergence from Panakauahi Gulch	Flood Frequency	HEC-2	08/01/1976	AE	
Haiamoa Stream	Confluence with Kaneohe Bay	Approximately 50 feet upstream of Ahilama Road	Log-Pearson Type III	HEC-2	04/01/1985	AE w/ Floodway	The discharges were based on a statistical study done by the USGS (DOI 1979).
Halawa Stream	Confluence with East Loch	Approximately 3,250 feet upstream of Kamehameha Highway	Regional Regression Equations	HEC-RAS 4.1	08/01/2013	AE	Analyzed using the Regional Regression equations that were developed and referenced in the Flood-Frequency Estimates for Streams on Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i, State of Hawai'i, Scientific Investigations Report 2010-5035 (USGS 2010).
Hanahimoa Stream	Approximately 195 feet upstream of Kamehameha Highway	Approximately 1,290 feet upstream of Kamehameha Highway	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The discharges were updated from a regional flood frequency report developed by the USACE (USDA 1973).
Heeia Stream	Confluence with Kaneohe Bay	Approximately 1,700 feet upstream of Alaloa Road	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in the analysis were updated from a previous report by the USACE (USDA 1973 (a)).
Helemano Stream	Confluence with Paukauila Stream and Opaeula Stream	Approximately 3,660 feet upstream of confluence with Paukauila Stream and Opaeula Stream	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in the analyses were updated from previous USACE reports (HUD 1971, USACE 1970).
Honouliuli Stream	Confluence with West Loch, Pearl Harbor	Approximately 20 feet upstream of Farrington Highway	Log-Pearson Type III	HEC-2	04/01/1985	AE w/ Floodway	The analysis of stream discharges was performed using the standard log-Pearson Type III method as outlined by the Water Resources Council (WRC 1977).
Hoaeae Stream	Confluence with West Loch, Pearl Harbor	Approximately 940 feet upstream of Honowai Street	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Hoolapa Stream	Approximately 530 feet downstream of Kamehameha Highway	Approximately 365 feet upstream of Kamehameha Highway	Flood Frequency	HEC-2	1976	AE w/ Floodway	The hydrologic data and hydraulic computations used in the analysis were updated from a previous flood frequency report prepared by the USACE (USACE 1971).
Ihiihi Stream	Confluence with Kahawainui Stream	Approximately 1,225 feet upstream of confluence with Kahawainui Stream	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Inoaole Stream	Confluence with Pacific Ocean	Approximately 30 feet downstream of Hihimanu Street	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Inoaole Stream Tributary	At Kulaiwi Street	Approximately 990 feet upstream of Hihimanu Street	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	
James Campbell Industrial Park (JCIP) Drainage Canal	Approximately 2,000 feet upstream of confluence with Pacific Ocean	Approximately 3,920 feet upstream of confluence with Pacific Ocean	Regional Regression Equations	HEC-RAS 4.1	08/01/2013	AE	Analyzed using the Regional Regression equations that were developed and referenced in the Flood-Frequency Estimates for Streams on Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i, State of Hawai'i, Scientific Investigations Report 2010-5035 (USGS 2010).
Kaaawa Stream	At Kamehameha Highway	At conflunce with Ka'a'awa Stream	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in this study were updated from the USACE Floodplain Information Report on Kaawa Stream (USACE 1969).
Kaalaea Stream	Confluence with Kaneohe Bay	Approximately 380 feet upstream of Access Road	Log-Pearson Type III	HEC-2	04/01/1985	AE w/ Floodway	The discharges were based on a statistical study done by the USGS (DOI 1979).
Kaelepulu Stream	Just downstream of Kawailda Road	At upstream Limit of Study	Flood Frequency	HEC-2	08/01/1976	AE	The technical data were updated from a previous FIS developed for the Federal Insurance Administration (HUD 1971 (a)).

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Kaelepulu Stream Tributary	At confluence with Kaelepulu Stream	At upstream Limit of Study	*	*	03/01/1989	A	
Kahaluu Stream	Confluence with Ahuimanu Stream	At Melekua Road	Log-Pearson Type III	HEC-2	04/01/1985	AE w/ Floodway	The analyses of stream discharges were performed using the standard log-Pearson Type III method as outlined by the Water Resources Council (WRC 1977).
Kahana Stream	At downstream Limit of Study	At upstream Limit of Study	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The hydrologic data used in evaluating this stream were obtained from a letter report prepared by the USACE (USACE 1973). In computing the water-surface profile upstream of Kamehameha Highway, the northern bridge, which was obstructed by a sand dune during field review, was assumed to be breached in the hydraulic computations.
Kahauiki Stream	Confluence with Moanalua Stream (Lower)	Approximately 290 feet downstream of Government Road	*	*	01/24/2020	AE w/ Floodway	LOMR 20-09-0413P
	Approximately 290 feet downstream of Government Road	Approximately 590 feet upstream of Moanalua Highway	*	*	01/04/2021	AE w/ Floodway	LOMR 20-09-0544P
Kahawainui Stream	Confluence with Pacific Ocean	Approximately 1.3 miles upstream of confluence with Pacific Ocean	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Kaipapau Stream	Approximately 150 feet downstream of Kamehameha Highway	Approximately 0.4 miles upstream of Kamehameha Highway	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The discharges were updated from a regional flood frequency report developed by the USACE (USDA 1973).
Kalaeokahipa Stream	Confluence with Ohia Stream	Approximately 375 feet upstream of Kamehameha Highway	Flood Frequency Curves	HEC-2	08/01/1976	AE w/ Floodway	The hydrologic data and hydraulic computations used in the analysis were updated from a previous flood frequency report prepared by the USACE (1971).
Kalauao Stream	Confluence with East Loch, Pearl Harbor	At H1 Freeway	Log-Pearson Type III	HEC-2	04/01/1985	AE w/ Floodway	The hydrologic analysis was performed using the standard log-Pearson Type III method as outlined by the Water Resources Council (WRC 1977).
Kalihi Stream	Confluence with Keehi Lagoon	Approximately 330 feet upstream of Likelike Highway	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Kalihi Stream *(continued)*	Approximately 330 feet upstream of Likelike Highway	At Kalihi Street	Log-Pearson Type III	HEC-2	08/01/1976	AE w/ Floodway	
Kaloi Gulch	Approximately 2,100 feet upstream of Geiger Road	Approximately 515 feet upstream of Mango Tree Road	Log-Pearson Type III	HEC-2	03/01/1989	AE w/ Floodway	Calculation of 1-percent annual chance flood magnitudes were made in accordance with procedures contained in Bulletin No. 17B (WRC 1981).
Kaluanui Stream	Approximately 1,460 feet upstream of Kamehameha Highway	Approximately 3,500 feet upstream of Kamehameha Highway	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The discharges were updated from a regional flood frequency report developed by the USACE (USDA 1973).
Kamanaiki Stream	Confluence with Kalihi Stream	Approximately 1,440 feet upstream of Laulani Street	Log-Pearson Type III	HEC-2	05/01/1989	AE w/ Floodway	The hydrologic data used in this study were developed by the USACE and were in part updated from previous reports by the USACE (USACE 1972). The upstream flow frequencies were based on statistical analysis of USGS gage data, performed in accordance with the procedures given in Bulletin No. 17B (WRC 1981).
Kamooalii Stream	Confluence with Kaneohe Bay	Approximately 0.6 miles upstream of Luluku Road	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Kaneohe Stream	Confluence with Kamooalii Stream	Approximately 480 feet upstream of Lohiehu Street	*	*	08/01/1976	AE	
Kapakahi Stream #1	Approximately 1,320 feet upstream of confluence with Pacific Ocean	Approximately 1,570 feet upstream of Halekoa Drive	Flood Frequency	HEC-2	08/01/1976	AE	The technical data used for this study were updated from a previous report developed by the USACE (USACE 1972 (a)).

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Kapakahi Stream #2	Confluence With West Loch, Pearl Harbor	Approximately 2,570 feet upstream of Farrington Highway	Log-Pearson Type III	HEC-2	12/06/2022	AE w/ Floodway	LOMR 21-09-0747P
Kapalama Drainage Canal	At North Nimitz Highway	Approximately 70 feet downstream of Kapalama Avenue	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Kapalama Drainage Canal Tributary	Confluence with Kapalama Drainage Canal	Approximately 50 feet downstream of N School Street	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Kaukonahua Stream	Confluence with Kaika Bay	Approximately 2.5 miles upstream of confluence with Kaika Bay	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in the analyses were updated from previous USACE reports (HUD 1971, USACE 1970).
	Approximately 2.5 miles upstream of confluence with Kaika Bay	Approximately 3.5 miles upstream of confluence with Kaika Bay	*	*	11/25/2019	AE w/ Floodway	LOMR 18-09-2230P
Kaupuni Stream	Confluence with Pacific Ocean	Approximately 395 feet upstream of Waianae Valley Road	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Kawa Stream	Confluence with Kaneohe Bay	Approximately 1,220 feet upstream of Namoku Street	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	Combined floodway with Kamooalii Stream 2D modeling
Kawainui Stream	Confluence with Kaelepulu Stream	Approximately 370 upstream of Kailua Road	SCS TR-55	HEC-2	04/01/1985	AE w/ Floodway	Stream discharges were based on the SCS TR-55 method (WRC 1981).
Kawiwi Stream	Confluence with Kaupuni Stream	Approximately 0.6 miles upstream of Hoopuhi Street	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Keaahala Stream	Confluence with Kaneohe Bay	Approximately 50 feet downstream of Kahekili Highway	HEC-HMS	HEC-RAS 4.1	08/01/2013	AE w/ Floodway	
Kea'aulu Gulch	Confluence with Malaekahana Stream	Approximately 1.3 miles upstream of confluence with Malaekahana Stream	HEC-HMS, Flood Frequency Analysis, and Regional Regression Equations	HEC-RAS	08/01/2013	AE	Flood discharges were developed through a detailed statistical analysis of several discharge calculation and estimation methods performed by the USACE in their January 2010 report Flood Hazard Evaluation Malaekahana Stream, Oahu, Hawaii.
Kiikii Stream	At Kaika Bay	Confluence of Kaukonahua Stream and Poamoho Stream	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in the analyses were updated from previous USACE reports (HUD 1971, USACE 1970).
Kuliouou Stream	Confluence with Pacific Ocean	Approximately 0.5 miles upstream of Kuliouou Road	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Kului Stream	Confluence with Wailupe Stream	Approximately 1,650 feet upstream of Hind Iuka Drive	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Ma'ili'ili Channel	Confluence with Pacific Ocean	Approximately 1,425 feet upstream of Paakea Road	Regional Regression Equations	HEC-RAS 4.1	08/01/2013	AE	Analyzed using the Regional Regression equations that were developed and referenced in the Flood-Frequency Estimates for Streams on Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i, State of Hawai'i, Scientific Investigations Report 2010-5035 (SIR).

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Maipalaoa Stream	Confluence with Pacific Ocean	Approximately 3,200 feet upstream of confluence with Pacific Ocean	Regional Regression Equations	HEC-RAS 4.1	08/01/2013	AE	Analyzed using the Regional Regression equations that were developed and referenced in the Flood-Frequency Estimates for Streams on Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i, State of Hawai'i, Scientific Investigations Report 2010-5035 (SIR).
Makaha Stream	At Farrington Highway	Approximately 575 feet upstream of Huipu Drive	Log-Pearson Type III	HEC-2	11/12/2012	AE w/ Floodway	LOMR 12-09-1556P
Makaleha Stream	Confluence with Pacific Ocean	At Cane Haul Road	*	*	03/21/2011	AE w/ Floodway	LOMR 11-09-0171P
	At Cane Haul Road	Approximately 0.9 mile upstream of Cane Haul Road	Log-Pearson Type III	HEC-2	04/01/1985	AE w/ Floodway	The analysis of stream discharges was performed using the standard log-Pearson Type III method as outlined by the Water Resources Council (WRC 1977).
Makiki Stream	At downstream Limit of Study	At upstream Limit of Study	USGS Regression Equations	*	02/01/1979	AE	
Malaekahana Stream	Confluence with Pacific Ocean	Approximately 1.6 miles upstream of confluence of Kea'aulu Gulch	HEC-HMS, Flood Frequency Analysis, and Regional Regression Equations	HEC-RAS	08/01/2013	AE w/ Floodway	Flood discharges were developed through a detailed statistical analysis of several discharge calculation and estimation methods performed by the USACE in their January 2010 report Flood Hazard Evaluation Malaekahana Stream, Oahu, Hawaii.
Manaiki Stream	Confluence with Moanalua Stream	Approximately 260 feet upstream of Mahole Street	Plate 6	HEC-2	05/01/1997	AE w/ Floodway	Peak discharges were determined using Plate 6 of the City and County of Honolulu's Storm Drainage Standards (City and County of Honolulu 1988).
Manoa-Palolo Drainage Canal	At confluence with Ala Wai Canal	Just downstream of King Street	SCS Hydrograph	HEC-2	02/01/1979	AE w/ Floodway	The SCS hydrograph method of analysis was used to determine peak discharges for flood of the selected recurrence intervals (USDA 1972).
Manoa Stream	Just downstream of King Street	Approximately 185 feet upstream of confluence with Luaalaea Stream	SCS Hydrograph	HEC-2	02/01/1979	AE w/ Floodway	The SCS hydrograph method of analysis was used to determine peak discharges for flood of the selected recurrence intervals (USDA 1972).

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Moanalua Stream (Lower)	Confluence with Keehi Lagoon	Approximately 535 feet upstream of confluence of Kahauiki Stream	Log-Pearson Type III	HEC-2	1982	AE w/ Floodway	
	Approximately 535 feet upstream of confluence of Kahauiki Stream	Approximately 180 feet upstream of Jarrett White Road	*	*	01/24/2020	AE w/ floodway	LOMR 20-09-0413P
	Approximately 180 feet upstream of Jarrett White Road	Approximately 200 feet upstream of Mahole Street	Log-Pearson Type III	HEC-2	1982	AE w/ Floodway	
Moanalua Stream (Upper)	Approximately 165 feet downstream of Ala Aolani Street	Approximately 465 feet upstream of Ala Aolani Street	Log-Pearson Type III	HEC-2	1982	AE w/ Floodway	The hydrologic data used in this study were developed by the USACE and were in part updated from previous reports by the USACE (USACE 1972). For the lower reaches the hydrologic data from 27 gages were used. Frequency curves were calculated following procedures from “Guidelines for Determining Flood Flow Frequency” (WRC 1977).
Nanakuli Stream	At Farrington Highway	Approximately 1.0 mile upstream of Farrington Highway	Log-Pearson Type III	HEC-2	03/01/1989	AE w/ Floodway	Calculation of 1-percent annual chance flood magnitudes from gaged data were made in accordance with procedures contained in Bulletin No. 17B (WRC 1981).
Niu Stream	Confluence with Pacific Ocean	Approximately 0.6 miles upstream of Haleola Street	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Niu Tributary Stream	Confluence with Niu Stream	Approximately 2,000 feet upstream of Halemaumau Street	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
North Halawa Stream	At Moanalua Freeway	Approximately 0.7 miles upstream of Moanalua Freeway	Log-Pearson Type III	HEC-2	03/01/1989	AE w/ Floodway	Calculation of 1-percent annual chance flood magnitudes were made in accordance with procedures contained in Bulletin No. 17B (WRC 1981).
Nuuanu Stream	At North Nimitz Highway	Approximately 2,250 feet upstream of Nuuanu Avenue	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Ohia Stream	Approximately 1,010 feet downstream of 1st Avenue	Approximately 480 feet upstream of Kamehameha Highway	Flood Frequency Curves	HEC-2	08/01/1976	AE w/ Floodway	The hydrologic data used in the analysis were updated from a previous flood frequency report prepared by the USACE (1971). They hydraulic analysis found that seaward of Kamehameha Highway splits into two separate flows due to a low right overbank and the existence of a levee or berm. The split for the four different study floods was independently evaluated.
Ohia Stream (East)	Approximately 2,250 feet downstream of Plantation Road	Approximately 1,200 feet upstream of Kamehameha Highway	Flood Frequency Curves	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in the analyses were updated from a previous flood frequency report prepared by the USACE (1971).
Oneawa Channel	Confluence with Kailua Bay	Approximately 1,250 feet upstream of Oneawa Street	HEC-RAS	HEC-RAS	01/01/2013	AE	The analysis was performed as described in the October 2012 report Levee System Evaluation Report, Kawainui Marsh Flood Control Project, Oahu, Hawaii and the USACE's Kawainui Marsh Flood Control Project Final Detailed Project Report dated July 1992.
Opaeula Stream	Confluence with Paukauila Stream	Approximately 2,155 feet upstream of Twin Bridge Road	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in the analyses were updated from previous USACE reports (HUD 1971, USACE 1970).
Overflow of Waiawa Stream	Confluence with Middle Loch	Approximately 560 feet upstream of Waiawa Road	Plate 6	HEC-2	05/01/1997	AE w/ Floodway	Peak discharges were determined using Plate 6 of the City and County of Honolulu's Storm Drainage Standards (City and County of Honolulu 1988).

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Pahipahialua Stream	Confluence with Pacific Ocean	Approximately 0.4 miles upstream of Kamehameha Highway	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in the analyses were updated from a previous report prepared by the USACE (USACE 1968).
Palolo Stream	Confluence with Manoa Stream	Approximately 330 feet upstream of Kiwila Street	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Panakauahi Gulch	Confluence with Waiawa Stream	Approximately 795 feet upstream of Cane Haul Road	Plate 6	HEC-2	05/01/1997	AE w/ Floodway	Peak discharges were determined using Plate 6 of the City and County of Honolulu's Storm Drainage Standards (City and County of Honolulu 1988).
Paukauila Stream	Confluence with Kaika Bay	At confluence of Opaeula Stream and Helaman Stream	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in the analyses were updated from previous USACE reports (HUD 1971, USACE 1970).
Poamoho Stream	Confluence with Kaukonahua Stream	Approximately 600 feet upstream of Kaukonahua Road	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in the analyses were updated from previous USACE reports (HUD 1971, USACE 1970).
Punaluu Stream	At downstream Limit of Study	At upstream Limit of Study	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The discharges were updated from a regional flood frequency report developed by the USACE (USDA 1973).
Tributary to Kawa Stream	Confluence with Kawa Stream	Just downstream of Mokulele Drive	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data were updated from a previous FIS (HUD 1971 (b)).
Ulehawa Stream	Confluence with Ulehawa Channel	Approximately 60 feet upstream of Paakea Road	Log-Pearson Type III	HEC-2	03/01/1989	AE w/ Floodway	The 1-percent annual discharge was computed in accordance with the procedures outlined in the USGS report WRI 80-45 (DOI 1979).
Unnamed Stream	Approximately 950 feet upstream of confluence with Pacific Ocean	Approximately 800 feet upstream of Farrington Highway	Log-Pearson Type III	HEC-2	04/01/1985	AE w/ Floodway	The analyses of stream discharges were based on a statistical study done by the USGS (DOI 1979).

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Waiahole Stream	Confluence with Pacific Ocean	Approximately 0.5 miles upstream of Kamehameha Highway	Regional Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in this study were updated from a regional flood frequency report developed by the USACE (USDA 1973 (b)).
Waialae-Iki Stream	Confluence with the Pacific Ocean	Approximately 20 feet downstream of Kalaniiki Place	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Waialae-Major Drain	Approximately 3,200 feet upstream of confluence with Pacific Ocean	Approximately 780 feet upstream of Hunakai Street	Flood Frequency	HEC-2	08/01/1976	AE	The technical data used for this study were updated from a previous report developed by the USACE (USACE 1972 (a)).
Waialae-Nui Stream	Confluence with Kapakahi Stream #1	Approximately 0.5 miles upstream of Kilauea Road	HEC-HMS	HEC-RAS 4.1	08/01/2013	AE	
Waiawa Stream	Approximately 100 feet upstream of confluence with Middle Loch, Pearl Harbor	Approximately 2,740 feet upstream of Cane Haul Road	Plate 6	HEC-2	05/01/1997	AE w/ Floodway	Peak discharges were determined using Plate 6 of the City and County of Honolulu's Storm Drainage Standards (City and County of Honolulu 1988).
Waihee Stream	Confluence with Kahaluu Pond	Approximately 7,100 feet upstream of confluence with Kahaluu Pond	Log-Pearson Type III	HEC-2	04/01/1985	AE w/ Floodway	The analyses of stream discharges were performed using the standard log-Pearson Type III method as outlined by the Water Resources Council (WRC 1977).
Waihee Stream Tributary	Confluence with Waihee Stream	Approximately 55 feet upstream of Ahilama Road	Log-Pearson Type III	HEC-2	04/01/1985	AE w/ Floodway	
Waikakalua Stream	Approximately 220 feet upstream of Kamehameha Hwy	At Interstate H2	Log-Pearson Type III	HEC-2	03/01/1989	AE w/ Floodway	Calculation of 1-percent annual chance flood magnitudes were made in accordance with procedures contained in Bulletin No. 17B (WRC 1981).

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Waikane Stream	Confluence with Kaneohe Bay	Approximately 0.6 miles upstream of Kamehameha Highway	Regional Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in this study were updated from a regional flood frequency report developed by the USACE (USDA 1973 (b)).
Waikele Stream	Confluence with West Loch, Pearl Harbor	Approximately 50 feet upstream of East H1 Freeway	*	*	12/06/2022	AE w/ Floodway	LOMR 21-09-0747P
Waikele Stream	Approximately 0.3 miles downstream of East H1 Freeway	Approximately 1.1 miles upstream of E H1 Freeway	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Wailani Drainage Canal	Approximately 90 feet downstream of Waipio Access Road	Approximately 2,140 feet upstream of Waipio Access Road	Log-Pearson Type III	HEC-2	07/01/1993	AE	
Wailani Drainage Canal	Approximately 2,140 feet upstream of Waipio Access Road	Approximately 1,195 feet upstream of Farrington Highway	*	*	12/06/2022	AE	LOMR 21-09-0747P
Wailele Stream	Confluence with Wailele Stream Left Overbank and Right Overbank	Approximately 0.7 miles upstream of confluence with Wailele Stream Left Overbank and Right Overbank	Regional Regression Equations	HEC-RAS 4.1	08/01/2013	AE	Analyzed using the Regional Regression equations that were developed and referenced in the Flood-Frequency Estimates for Streams on Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i, State of Hawai'i, Scientific Investigations Report 2010-5035 (SIR).
Wailele Stream Left Overbank	Confluence with Pacific Ocean	Confluence with Wailele Stream	Log-Pearson Type III	HEC-2	1989	AE	The 100yr discharge was computed in accordance with the procedures contained in the USGS Report WRI 80-45 (DOI 1979).
Wailele Stream Right Overbank	Confluence with Pacific Ocean	Confluence with Wailele Stream	Log-Pearson Type III	HEC-2	1989	AE	The 100yr discharge was computed in accordance with the procedures contained in the USGS Report WRI 80-45 (DOI 1979).

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Wailupe Stream	Confluence with the Pacific Ocean	Approximately 0.6 miles upstream of the confluence of Kului Stream	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Waimalu Stream	Confluence with East Loch, Pearl Harbor	Approximately 140 feet downstream of Moanalua Road	Regional Regression Equations	HEC-RAS 4.1	08/01/2013	AE w/ Floodway	Analyzed using the Regional Regression equations that were developed and referenced in the Flood-Frequency Estimates for Streams on Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i, State of Hawai'i, Scientific Investigations Report 2010-5035 (SIR).
	Approximately 140 feet downstream of Moanalua Road	Approximately 7,200 feet upstream of H1	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Waimanalo Stream	Confluence with Pacific Ocean	At upstream Limit of Study	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical analyses were updated from a previous FIS developed for the FIA (HUD 1971 (c)).
Waimanalo Stream: Inoaole Stream	At Hihimanu Street	Approximately 0.4 miles upstream of Hihimanu Street	Flood Frequency	HEC-2	04/01/1985	AE w/ Floodway	The technical analyses were updated from a previous FIS developed for the FIA (HUD 1971 (c)).
Waimanalo Stream: Stream A	Confluence with Waimanalo Stream	Approximately 195 feet upstream of Waikupanaha Street	Regional Regression Equations	HEC-RAS 4.1	08/01/2013	AE w/ Floodway	Analyzed using the Regional Regression equations that were developed and referenced in the Flood-Frequency Estimates for Streams on Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i, State of Hawai'i, Scientific Investigations Report 2010-5035 (SIR).
Waimanalo Stream: Stream B	Confluence with Waimanalo Stream: Stream A	At Waikupanaha Street	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical analyses were updated from a previous FIS developed for the FIA (HUD 1971 (c)).
Waimanalo Stream: Stream C	Confluence with Inoaole Stream	At Waikupanaha Street	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical analyses were updated from a previous FIS developed for the FIA (HUD 1971 (c)).

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Waimanalo Stream: Stream D	Confluence with Waimanalo Stream: Stream C	Approximately 50 feet downstream of Waikupanaha Street	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical analyses were updated from a previous FIS developed for the FIA (HUD 1971 (c)).
Waimea River	Confluence with Pacific Ocean	Approximately 0.7 miles upstream of confluence with Pacific Ocean	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The technical data used in the analysis were updated from a previous report prepared by the USACE (USACE 1972 (b)). The hydraulic computations were conducted assuming scouring at the mouth of the Waimea River.
Waipilopilo Stream	Confluence with Pacific Ocean	Approximately 1,290 feet upstream of confluence with Pacific Ocean	Flood Frequency	HEC-2	08/01/1976	AE w/ Floodway	The discharges were updated from a regional flood frequency report developed by the USACE (USDA 1973).
Waolani Stream	Confluence with Nuuanu Stream	Approximately 1,575 feet upstream of North Judd Street	HEC-HMS	HEC-RAS 6.0.0	03/31/2023	AE w/ Floodway	For model stability and accuracy the entire study area was modeled as 2D flow areas. This allowed any water that escaped into the overbanks to spread out and follow natural flow paths over the floodplain and eventually rejoin the primary system or flow to ocean.
Zone A Flood Sources	Various locations	Various locations	*	HEC-2	1976	A	
1-D BLE Zone A Flood Sources	Various locations	Various locations	*	HEC-RAS	2023	A	1-D BLE
2-D BLE Zone A Flood Sources	Various locations	Various locations	*	HEC-RAS	2023	A	2-D BLE

* Data not available