FLOOD INSURANCE STUDY

BUTTE COUNTY, CALIFORNIA AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
BIGGS, CITY OF	060437
BUTTE COUNTY (UNINCORPORATED AREAS)	060017
CHICO, CITY OF	060746
GRIDLEY, CITY OF	060019
OROVILLE, CITY OF	060020
PARADISE, TOWN OF[1]	060748

[1]No Special Flood Hazard Areas

Revised:
January 6, 2011

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
06007CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

Initial Countywide FIS Effective Date: June 8, 1998

Revised Countywide FIS Effective Date(s): April 20, 2000
January 6, 2011

TABLE OF CONTENTS

Table of Contents

FIGURES

Table of Contents, continued

TABLES

EXHIBITS

FLOOD INSURANCE STUDY
BUTTE COUNTY, CALIFORNIA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) investigates the existence and severity of flood hazards in, or revises and updates previous FIS/Flood Insurance Rate Maps (FIRMs) for the geographic area of Butte County, California, including: the Cities of Biggs, Chico, Gridley, Oroville, the Town of Paradise, and the unincorporated areas of Butte County (hereinafter referred to collectively as Butte County). The Town of Paradise is a non-floodprone community.

This FIS aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This FIS has developed flood risk data for various areas of the county that will be used to establish actuarial flood insurance rates. This information will also be used by Butte County to update existing floodplain regulations as part of the Regular Phase of the NFIP, and will also be used by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some States or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for the original June 8, 1998 study were performed for the Federal Emergency Management Agency (FEMA) by Gill & Pulver Engineers, Inc., under Contract No. EMW-85-C-1891, and was completed in February 1987; the study was also performed by Borcalli & Associates, Inc., under Contract No. EMW-91-C-3375, and was completed in April 1993. The hydrologic and hydraulic analyses were also performed by Schaaf & Wheeler, under Contract No. EMW-92-C-4071, and was completed in April 1993.

This study was revised on April 20, 2000, to incorporate approximate flood-hazard information along Dead Horse and Keefer Sloughs and Wyman Ravine in the vicinity of Butte County. This restudy incorporates the results of a study performed by Borcalli & Associates, Inc., for FEMA, under Contract No. EMF-96-CO-0097. This work was completed on November 13, 1997.

For this countywide study, MAP IX-Mainland was contracted by FEMA, under contract number EMF-2003-CO-0047, to revise the 1998 Butte Countywide FIS and DFIRM. This work was completed in May 2009.

Behind levee analyses was completed for Biggs Extension, Cherokee Canal, Comanche Creek, Dead Horse Slough, Feather River, Little Chico-Butte Creek Diversion Channel, Little Dry Creek, Main Drainage Canal, Mud Creek, Sycamore Creek, and Western Canal; the studies were performed by Nolte Associates, Inc. for FEMA, and was completed in May 2007.

Additional behind levee analyses was completed for Butte Creek, Comanche Creek, Dry Creek, Feather River, Lindo Channel, Little Chico-Butte Creek Diversion Channel, Big Chico Creek Diversion Channel, and Sycamore Creek; these studies were performed by URS Corporation for FEMA, and were completed in May 2009.

Reaches of the Upper Feather River from the mouth of Yuba River to Oroville Dam were restudied in May 2008. This countywide revision incorporates the results of the study performed by the U.S. Army Corps of Engineers (USACE) Sacramento District for FEMA (Reference 26).

Base map information shown on this FIRM was derived from multiple sources. Street centerlines and political boundaries were provided by Butte County Development Services – GIS Division. This information was derived at a scale of 1:24,000 and was adjusted to fit digital orthophotos created by Butte County Association of Governments in 2002 and 2004 respectively. Additional information was derived from FEMA FIRM maps dated 1998 or later.

The projection used in the preparation of this map was California State Plane II FIPS 402. The horizontal datum was NAD 83, GRS80 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 this FIRM.

1.3 Coordination

Consultation Coordination Officer's (CCO) meetings may be held for each jurisdiction in this countywide FIS. An initial CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to explain the nature and purpose of a FIS, and to identify the streams to be studied by detailed methods. A final CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to review the results of the study.

The dates of the initial and final CCO meetings held for the original June 8, 1998 countywide FIS and the April 20, 2000 countywide revision for Butte County and the incorporated communities within its boundaries are shown in Table 1, "Initial and Final CCO Meetings."

Table 1 – Initial and Final CCO Meetings

Community	Initial CCO Date	Final CCO Date
Butte County	December 1984	August 24, 1988[1]
and Incorporated Areas	July 1990	September 21, 1995[1]
	*	April 8, 1997[1]
	*	July 21, 1998[2]

**Data not available*

[1] June 8, 1998 initial countywide

[2] April 20, 2000 countywide revision

For this countywide revision, an initial CCO meeting was held on June 30, 2005, and was attended by representatives of FEMA, the communities, and the study contractor. The final CCO meeting was held on July 9, 2009, and was attended by representatives of FEMA, the communities, and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Butte County, California.

All or portions of the flooding sources listed in Table 2, "Flooding Sources Studied by Detailed Methods," were studied by detailed methods. Limits of detailed study area indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

Table 2 – Flooding Sources Studied by Detailed Methods

Butte Creek	Little Chico-Butte Creek Diversion Channel
Big Chico Creek	Little Dry Creek
Big Chico Creek Diversion Channel	Mud Creek
Big Chico Creek Split Flow	Palermo Tributary
Comanche Creek	Ruddy Creek
Dead Horse Slough	Ruddy Creek Tributary
Durham Slough	Sycamore Creek
Hamlin Slough	Wyman Ravine
Lindo Channel	Wyman Ravine Tributary 1
Little Chico Creek	

Numerous flooding sources in the county were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the communities.

This countywide FIS also incorporates the determination of Letter of Map Revision (LOMR) case number 04-09-0415P, dated March 31, 2005, for the City of Chico and the Unincorporated Areas of Butte County, California.

2.2 Community Description

Butte County, founded in 1850, was one of the original 27 counties in California. Gold was discovered approximately 12 miles downstream from Oroville, the county seat, in 1848.

Butte County is bounded to the west by Glenn and Colusa Counties, with the Sacramento River forming half of the western boundary; to the north and northwest by Tehama County; to the east by Plumas County; to the south by Sutter County; and to the southeast by Yuba County, with Honcut Creek forming the southeastern boundary (Reference 1).

Butte County, with an area of 1,054,320 acres or 1,680 square miles, contains a wide range of climatic and topographic conditions. The county is geographically divided into a portion that lies in the northeastern part of the Sacramento Valley and the mountainous area surrounding the valley (Reference 1). The topography of the county varies, from the relatively flat Sacramento Valley floor, with an elevation ranging from 60 to 200 feet, and associated alluvial fans; to extensive rolling foothills, with elevations ranging from 200 to 2,100 feet; and to the Cascade and Sierra Nevada Mountain Ranges, with elevations ranging from 2,100 to greater than 6,000 feet above sea level. The valley comprises 45 percent of the county, the foothills comprise 23 percent, and the mountains comprise 31 percent (Reference 2). The valley floor and foothill country encompass approximately 1,100 square miles. Much of the valley floor is alluvial deposit accumulated through time by materials washed down from the face of the Sierras (Reference 1). Soil types in the county include the deep, nearly level, very fertile valley basin and alluvial soils of the Sacramento Valley and associated alluvial fans, which support extensive agriculture; the shallow, gentle to steep sloping, less fertile residual soils of the foothill areas; and the shallow to deep, moderate to steep sloping residual soils of the mountain areas, which are suitable for rangeland, forestry, and wildlife habitat uses. High clay-content expansive soil conditions (creating shrink-swell soil characteristics) predominate the southwestern portion of the county and some of the western portion (Reference 2).

Butte County has a typical Mediterranean climate with hot, dry summers and cool, wet winters. Cooler summers and cold winters are common in the areas of higher elevation. Annual precipitation, generally in the form of rain, ranges from 18 inches along the Sacramento River to 80 inches in high elevation areas, where snow falls regularly. Easterly winds are common above 3,500 feet in elevation. Average wind speeds are less than 8 miles per hour, and prolonged calm periods are common.

Prevailing winds are generally from the southwest during half of the year and from the northwest for the remainder. Southerly winds are normally associated with approaching winter storms and are usually moisture-bearing because of their origin over the Pacific Ocean. Northerly winds are usually associated with winter and spring high pressure ridging (fair weather) and occasional summer daytime breezes. Northerly winds tend to be dry.

Butte County contains abundant and diversified vegetations types, including the non-native agricultural crops and pastures in the valley, native foothill and mountain oak and conifer forests, dryland chaparral areas and riparian and marshland areas of restricted and diminishing distribution, which have high value as wildlife habitats (Reference 2).

No large, natural lakes exist within the county's boundaries. Several artificial lakes serve as domestic water, irrigation, and power dam reservoirs and are located in the mountain and foothill areas. Some examples of these are the Oroville, Philbrook, and Madrone reservoirs (Reference 1).

State Highway 99 and the main line of the Union Pacific Railroad cross the western lowland portion of Butte County. State Highway 70 runs northeasterly from Oroville into the scenic Feather River Canyon. The Western Pacific Railroad follows a similar route. The eastern part of Butte County is very mountainous, but most parts can be reached by car. There are airports at Chico and Oroville (Reference 3).

Butte County's agricultural products include rice, almonds, seed crops, vegetables, peaches, prunes, olives, and walnuts. Livestock and livestock products are also produced. Lumber, minerals, and food processing make up a large portion of the county's economy (Reference 3).

2.3 Principal Flood Problems

A variety of conditions cause flooding in Butte County.

Butte Creek

Floods of record in Butte Creek occurred in December 1937, December 1955, December 1964, and February 1986 (Reference 4). The recurrence intervals for these flows are approximately 20 years, 30 years, 50 years, and 50 years, respectively.

Keefer Slough

Flooding along Keefer Slough is primarily due to water being diverted into Keefer Slough from Rock Creek. The frequency of flooding has historically been dependent on the debris and vegetation in Rock Creek between State Highway 99 and its confluence with Keefer Slough. Farmers in the vicinity have periodically cleared Rock Creek to reduce spills into Keefer Slough. During periods when Rock Creek has not been cleared, Keefer Slough has spilled its banks. The most notable recent flood occurred in March 1983 when Keefer Slough flooded homes in the vicinity of Keefer Road and the area southwest of State Highway 99. State Highway 99 was overtopped for 11.5 hours. These floodflows continued southwest, affecting much of the area between State Highway 99 and the Union Pacific Railroad, including the community of Nord and its vicinity (References 5 and 6).

Little Chico Creek

Flows of record measured in Little Chico Creek occurred in December 1964, March 1978, and March 1974 (Reference 7). The recurrence intervals for these three storms are approximately 10 years, 15 years, and 30 years, respectively.

Ruddy Creek and Ruddy Creek Tributary

Areas of flooding along Ruddy Creek have been at the crossings of Nelson, Tehama, and Biggs Avenues. Minor flood damage was reported after the February 1986 storm. The March 1983 storm caused the most recent widespread flooding (Reference 5).

Wyman Ravine and Tributaries

As Wyman Ravine flows out of the steep foothills, its bed slope flattens, downstream of Lincoln Boulevard. Sheetflow and shallow flooding occur every few years in the orchards west of the Western Pacific Railroad. Floodflows over Palermo Road have extended east of Wyman Ravine almost as far as Occidental Avenue. With few exceptions, the reach of Wyman Ravine between Stimpson Lane and Lone Tree Road experiences annual flooding. The storm of February 1986 produced flow over Lone Tree Road, extending 500 feet north and 1,000 feet south of the creek (Reference 5).

The area to the south of Wyman Ravine Tributary 1, between the Western Pacific Railway embankment and Melvina Avenue, experiences chronic flooding, flow historically crosses over Melina Avenue south of Wyman Ravine Tributary 1 and continues west and southwest across the farm fields. Additional flow spills to the south between the Western Pacific Railway embankment and Railroad Avenue (References 5 and 8).

Palermo Tributary floods during the 10-percent-annual-chance flood and greater discharges. Sheetflow across roads and between homes occurs between approximately once in five years (Reference 5).

2.4 Flood Protection Measures

Several small lakes or ponds are located within the watersheds contributing to the studied reaches, but none have effects on the peak discharges. The largest of these are two water supply reservoirs located at Little Butte Creek, a tributary to Butte Creek. Historically, these reservoirs have been full and spilling during the occurrence of large floods and have not had an appreciable effect on floodflows (Reference 9).

Levees have been erected along the banks of a large portion of Wyman Ravine. The levees range in height from approximately 1 foot to 4 feet. The levees extending from the lower study limits to a point approximately 45,510 feet upstream do not continuously contain the 10-percent-annual-chance flood discharges. Their effectiveness in containing the 1-percent-annual-chance flood discharges is negligible, according to the analysis done in this study. The levee extending from a point approximately 3,500 feet north of Palermo Road to approximately 2,000 feet upstream of Lincoln Boulevard is more significant.

Several levee systems have been constructed along Butte Creek, Cherokee Canal, Big Chico Creek, Hamlin Slough, the Little Chico Butte Creek Diversion Channel, Comanche Creek, and Little Chico Creek. Through hydraulic investigations, these levees were determined to provide protection from less than the 1-percent-annual-chance flood, and/or certification of the levees for 1-percent-annual-chance flood protection could not be obtained from the responsible agency. Therefore, they have been shown on the FIRM as not containing the 1-percent-annual-chance flood.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this FIS. Flood events of a magnitude, which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent 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, which equals or exceeds the 1-percent-annual-chance flood in any 50-year period is approximately 40 percent (4 in 10), and, 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 FIS. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

April 20, 2000 Countywide Analyses

Twenty years of peak flow data from the period 1959 to 1984 were available from the California Department of Water Resources (CADWR) for Little Chico Creek (Reference 7). Fifty-two years of peak flow data were available for Butte Creek at U.S. Geological Survey (USGS) gage 1139000 from the period 1931 to 1982 (Reference 4). The location of the flow measurements coincided approximately with the downstream limit of study for both creeks.

A log-Pearson Type III analysis was conducted using the computer program HECWRC (Reference 10), in accordance with the guidelines of the Water Resources Council Bulletin 17B (Reference 11). The resulting peak discharges for the 1-percent-annual-chance recurrence interval flood for Little Chico Creek and Butte Creek were 5,000 and 25,000 cubic feet per second (cfs), respectively. The 1-percent-annual-chance flood discharges presented in an unpublished USACE Office Report in 1976 (Reference 9) were 6,700 and 30,000 cfs for these respective locations. The discrepancy in discharges is because of the inclusion of additional years of record, and the application of the Water Resources Council Guidelines regarding the exclusion of extreme data points and the incorporation of a non-zero skew.

For Ruddy Creek, Wyman Ravine, and their tributaries, runoff was developed using the HEC-l computer program (Reference 12). Six-hour storms were constructed using precipitation statistics for 29 years of record from the rainfall gage at the Oroville Ranger Station. Unit hydrographs were developed using the USACE procedures, as discussed earlier in this section, and the S-curve adopted by the Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service). Loss rates were adjusted to produce a discharge for the 1-percent-annual-chance storm that agrees closely with the discharge published in the study by Cook Associates (Reference 8). The point at which the discharges were compared was the point of concentration for approximately 50 percent of the drainage of the Wyman Ravine watershed upstream of the lower study limit.

Wyman Ravine, Wyman Ravine Tributary 1, and Palermo Tributary all have reaches where some flow spills out of the channel and does not return for several thousand feet, if at all. The HEC-2 computer program has the capability of determining where water leaves the channel, but does not adequately account for the downstream effects of the flow transfers. To more accurately model the flow transfers, the hydrologic and hydraulic models were developed simultaneously. A discussion of the development of the discharges presented in Table 3, "Summary of Discharges", is presented in Section 3.2. The 1-percent-annual-chance flood peak discharge at the Stimpson Road crossing is 2,390 cfs. The only other reported discharge at this location was by Cook Associates (Reference 8), which assigns a discharge of 3,300 cfs to the same stream location. The difference is due primarily to the more detailed analysis of this study and the consideration of flow leaving the watershed before it reaches Stimpson Road.

The primary source of the peak discharge in Keefer Slough is the overflow from Rock Creek at their upstream confluence. Rock Creek is an integral part of the hydrology of Keefer Slough.

Rainfall runoff was modeled using the HEC-1 computer model. Storms each having a duration of 6 hours for different return periods were developed by obtaining 6-hour rainfall depths from the National Oceanic and Atmospheric Administration (NOAA) precipitation maps (Reference 13) and distributing the storm totals according to the statistics of 30 years of recorded precipitation in the nearby City of Chico. Unit hydrographs for the Rock Creek and Keefer Slough subbasins were developed using a method developed by the USACE. This method utilizes a dimensionless S-curve unit hydrograph in combination with a relationship that relates lag time to various physical parameters of the watershed. The USACE work for the 1975 Office File Report on Pine and Rock Creeks (Reference 14) was used as a basis for the selection of the Valley and Cottonwood S-curves and some of the parameters related to the lag time.

The hydrologic model was calibrated using the adopted peak discharges for Little Chico Creek. The drainage basin of Rock Creek upstream of Keefer Slough and that of Little Chico Creek upstream of the study limits are very similar with respect to size, orientation, topography, and ground cover. For this reason the peak discharges in Rock Creek upstream of its confluence with Keefer Slough were assumed to be the same as the discharges determined for Little Chico Creek.

Loss rates were adjusted to produce peak discharges in Rock Creek equal to the discharges of Little Chico Creek at the point of comparison. A rating curve was developed to represent the division of the Rock Creek total discharge between that portion of the discharge that is diverted into Keefer Slough and the balance of the discharge, which continues down the Rock Creek main channel. This rating was based on the normal depth computations in each channel by modeling a representative channel cross section near their confluence in a hydraulic computer program (Reference 15). The result of this rating is that approximately 44 percent of the 1-percent-annual-chance total Rock Creek discharge is diverted into Keefer Slough. This analysis increases the discharge in Keefer Slough by approximately 1,800 cfs from the original study. Due to the increase in discharge, the detailed study area between State Highway 99 and Keefer Lane was redelineated using an approximate method.

The adopted peak discharges in Keefer Slough are presented in Table 3, "Summary of Discharges." In the cases of the 1-percent and 0.2-percent-annual-chance flood events, the discharges decrease downstream between Garner Lane and State Highway 99. The channel capacity in this reach is 525 cfs. Any additional discharge spills over the left bank and flows away from Keefer Slough. The total 2-percent-, 1-percent, and 0.2-percent-annual-chance flood discharges at State Highway 99 are 760, 840, and 1,200 cfs, respectively. The difference between these discharges and those listed in Table 3 constitutes sheetflow across State Highway 99. The discharges at State Highway 99 exceed the flows presented in previous studies. The USACE (Reference 14) computed a peak discharge of 470 cfs for the 1-percent-annual-chance flood event and McCain Associates (Reference 16) published a flow of 566 cfs for the same return period. This study considered the contribution from Rock Creek and has resulted in a higher total discharge.

Rainfall-runoff modeling was performed for Butte Creek, Hamlin Slough, Comanche Creek, Little Chico-Butte Creek Diversion Channel, and Little Chico Creek, using the HEC-1 computer model. The purpose of the modeling was to estimate peak discharges for performing the floodplain analysis.

Storms having a duration of 24 hours were developed by obtaining rainfall depths from precipitation maps contained in the NOAA precipitation maps and distributing the storms in accordance with the Type lA distribution contained in the NRCS Technical Release 55 (Reference 17).

Precipitation losses were calculated based upon developed NRCS curve numbers (CN). Soil parameters were obtained from NRCS soil surveys and U.S. Forest Service soil vegetation maps. Land use characteristics are based on field investigation, aerial photos, quadrangle maps and Forest Service timber stand and vegetation maps. CN are selected according to soil type and land use, and are based on a set of CN developed by the NRCS for a watershed in Contra Costa County, California. The synthetic unit hydrographs were developed using the NRCS dimensionless unit hydrograph and channel routing was accomplished using the Muskingum and Muskingum-Cunge Methods.

A log-Pearson Type III analysis was performed for Little Chico Creek near Chico, reflecting the period of record from 1931-1988 and for Butte Creek at Durham reflecting the period of record from 1959-1981 and 1983-1990. The results of the analyses at the gages were used as the targets for adjusting the interception/infiltration losses.

The adopted peak discharges in Butte Creek, Hamlin Slough, Little Chico-Butte Creek Diversion Channel, Comanche Creek, and Little Chico Creek are shown in Table 3, "Summary of Discharges."

The USGS and CADWR streamflow gages are located on several streams in the study area; however, only the discharge determined by frequency analysis of data from USGS gage 1138400 on Big Chico Creek may be used in the FIS. The required assumption of annual peak streamflows as independent, random events is invalidated by upstream diversions for all other gage data within the study limits. Additionally, the gage on Lindo Channel was moved about 3 miles upstream in 1974, so any analysis that combines data from the two gage stations would not be valid, since heterogeneity has been introduced. Statistical analysis follows the guidelines set forth in Bulletin 17B of the Interagency Advisory Committee on Water Data (Reference 18).

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 3, "Summary of Discharges."

Table 3 – Summary of Discharges

		Peak Discharges (cfs)			
Flooding Source and Location	**Drainage Area (sq mi)**	**10-Percent-Annual-Chance**	**2-Percent-Annual-Chance**	**1-Percent-Annual-Chance**	**0.2-Percent-Annual-Chance**
BIG CHICO CREEK					
Upstream of Big Chico Creek Diversion Structure	73.65	*	*	11,000	*
Downstream of Diversion Structure (Upstream of Manzanita)	73.65	*	*	1,400	*
Road Bend At Bidwell Avenue (2.4 miles Downstream of Rose Avenue)	75.56	*	*	1,730	*
BIG CHICO CREEK DIVERSION CHANNEL[1]					
Downstream of Lindo Channel Diversion Structure	*	*	*	5,600	*
Upstream of Confluence with Sycamore Creek	4.69	*	*	6,070	*
BUTTE CREEK					
At Hamlin Slough	*	13,200	24,400	30,300	44,800
At Aquas Frias Road	*	13,600	28,000	34,900	51,100
Approximately 930 feet upstream of confluence with Little Butte Creek	117.6	10,560	17,040	20,000	27,200
At Skyway	151.4	13,200	21,300	25,000	34,000
COMANCHE CREEK					
Approximately one mile above Midway	*	300	550	6,300	16,800
Approximately 1,500 feet above Midway	*	300	550	3,000	3,000
At Midway	*	300	550	2,300	2,300

[1]*ExcessBig Chico Creek flows are diverted northerly to Lindo Channel and Sycamore Creek. Sycamore Creek merges with Mud Creek upstream of Highway 99.*

**Data not available*

Table 3 – Summary of Discharges, continued

Flooding Source and Location	Drainage Area (sq mi)	Peak Discharges (cfs) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
COMANCHE CREEK, continued					
At Union Pacific Railroad	*	400	800	2,100	2,100
Approximately 1,300 feet below Union Pacific Railroad	*	500	900	2,300	2,300
Approximately 1,500 feet above Dayton Road	*	500	900	1,600	1,600
At Lone Pine Road	*	500	900	900	900
Sacramento River Floodplain	*	500	900	1,200	1,200
DEAD HORSE SLOUGH					
At confluence with Little Chico Creek	5.36	750	1,500	1,900	*
HAMLIN SLOUGH					
North Branch at confluence	9.3	523	1,380	1,820	2,640
South Branch at confluence	10.16	741	1,710	2,300	3,290
Hamlin Canyon	33.85	2,300	4,700	6,200	8,650
Hayes Canyon	37.75	2,570	5,210	6,720	9,330
At confluence with Butte Creek	40.12	2,670	5,330	6,830	9,430
KEEFER SLOUGH[1]					
Approximately 1,125 feet downstream of Hicks Lane	0.3	130	400	560	750
Approximately 500 feet upstream of Garner Lane	2.9	275	500	680	850
At State Highway 99[2]	4.4	415	525	525	525
LINDO CHANNEL					
Upstream of confluence with Channel Slough/Sandy Gulch (0.6 miles Downstream of Highway 32)	5.25	*	*	4,600	*
Downstream of Big Chico Creek Diversion Structure	*	*	*	4,000	*
LITTLE CHICO-BUTTE CREEK DIVERSION CHANNEL					
At Diversion Structure	*	700	2,200	3,100	4,900
Approximately 1,500 feet below Warfield	*	800	2,400	3,300	5,200
Approximately 2,000 feet below Skyway	*	1,100	3,000	3,900	6,000

[1]*Drainage area only refers to Keefer Slough local drainage; diversions from Rock Creek are a major source of the listed discharges.*

[2]*See Section 3.1 for an explanation of the reduction in flow.*

**Data not available*

Table 3 – Summary of Discharges, continued

Flooding Source and Location	Drainage Area (sq mi)	Peak Discharges (cfs) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
LITTLE CHICO CREEK					
Below Diversion Structure	*	2,300	4,400	5,600	7,800
At Forest Avenue	*	1,500	2,000	2,200	2,500
At State Highway 99	*	2,100	3,400	3,700	*
Approximately 100 feet above Bruce Street	*	2,100	3,400	3,500	3,700
At Bruce Street	*	2,200	3,100	3,100	3,100
At Mills Street	*	2,200	2,800	2,800	2,800
At Crouch Road	*	2,200	2,500	2,500	2,500
Approximately 3,000 feet below Alberton	*	2,300	2,600	2,600	2,600
Sacramento River Floodplain	*	2,300	2,700	2,700	2,700
MUD CREEK					
Downstream of Confluence with Sycamore Circle	44.89[2]	*	*	10,410	*
At Nord Highway	45.44[2]	*	*	10,700	*
PALERMO TRIBUTARY					
At Baldwin Avenue	1.0	255	355	390	470
Approximately 100 feet downstream of Palermo Road	1.7	500	690	760	920
Approximately 550 feet downstream of South Villa Avenue[1]	1.7	126	126	126	126
At confluence with Wyman Ravine Tributary 1	2.1	500	690	760	920
RUDDY CREEK					
Just upstream of confluence with Ruddy Creek Tributary	0.7	255	350	380	460
Approximately 350 feet upstream of Feather River	1.9	580	790	870	1,050
Entire Reach	0.5	165	220	250	300

[1]*See Section 3.2 for an explanation of the reduction in flow.*

[2]*Includes Big Chico Creek Diversion Channel and Sycamore Creek drainage area.*

**Data not available*

Table 3 – Summary of Discharges, continued

Flooding Source and Location	Drainage Area (sq mi)	Peak Discharges (cfs) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
SYCAMORE CREEK					
Upstream of confluence with Big Chico Creek Diversion Channel	8.60	*	*	2,170	*
Downstream of confluence with Diversion	13.29[2]	*	*	7,080	*
Upstream of confluence with Mud Creek	24.99[2]	*	*	8,100	*
WYMAN RAVINE					
Approximately 220 feet downstream of Lincoln Boulevard	12.6	1,670	2,390	2,625	2,970
Approximately 90 feet downstream of Western Pacific Railroad[1]	12.6	1,660	2,200	2,310	2,465
Approximately 2,470 feet downstream of Western Pacific Railroad[1]	14.3	340	385	400	425
Approximately 690 feet downstream of Palermo Road	16.0	1,950	2,620	2,770	3,020
Approximately 200 feet upstream of confluence with Wyman Ravine Tributary 1	16.4	1,950	2,710	2,930	3,390
Approximately3,580 feet downstream of confluence with Wyman Ravine Tributary 1[1]	21.6	2,145	3,010	3,290	3,840
Approximately 6,800 feet downstream of Lone Tree Road	26.2	1,570	1,845	1,920	2,060
At Stimpson Lane	28.4	1,775	2,230	2,390	2,700
WYMAN RAVINE TRIBUTARY 1					
Approximately 60 feet upstream of Melvina Avenue	2.8	560	790	870	1,070
Approximately 950 feet downstream of Melvina Avenue[1]	2.8	80	100	100	110
At confluence with Palermo Tributary[1]	4.9	490	610	660	740
At Western Pacific Railway culvert[1]	4.9	370	430	450	480
At confluence with Wyman Ravine	5.2	440	530	550	600

[1]*See Section 3.2 for an explanation of the reduction in flow.*

[2]*Includes Big Chico Creek Diversion Channel drainage area.*

**Data not available*

2010 Countywide Revision

The drainage area for the Feather River extends from the confluence of the Feather River at the Yuba River down to the confluence of the Feather River and the Sacramento River encompassing over 26,000 square miles.

Historically, large events occurring at the Shanghai Bend have resulted from rare events occurring on the Upper Feather River (above Oroville) and also on the Yuba River, with one of these rivers having a slightly rarer event then the other. Because of the possibility that either scenario could happen, two different hypothetical storm patterns were produced. The differences in the storm patterns lies within the index locations on the Feather and Yuba Rivers.

For the seven hypothetical storms (10-, 2-, 1-, and 0.2- percent chance exceedences) no other location in the Sacramento River Basin experiences a larger flood than at Shanghai Bend and the Latitude of Verona. The distribution of storm intensity for the Upper Feather and Yuba river basins were developed. Initial exceedence frequency values were assigned to the Yuba River and Feather River index locations. Hydrographs were then constructed at these locations and routed through the system to Shanghai Bend. Duration maxima (peak 1-, 3-, 7-, 15- and 30-day) were computed for the hydrographs at Shanghai Bend and compared with the average flows from the frequency curves. The initial pattern was then increased or decreased and the comparison process was repeated until results agreed reasonably with the unregulated rain flood frequency curves.

Once this portion of the pattern was set, the same process was followed for the Latitude of Verona index location. The storm pattern for the rest of the tributary index locations were based upon the average of the Feather and Yuba River storm centerings generated for the Comprehensive Study (Reference 23). This pattern was iteratively adjusted by a fixed percentage until the duration maxima (1-, 3-, 7-, 15-, and 30-day) computed at the Latitude of Verona agreed reasonably with the unregulated rain flood frequency curve at the index locations.

Hypothetical hourly hydrographs consisting of six 5-day waves were generated based on the unregulated frequency curves obtained from the Comprehensive Study (Reference 23). No adjustments were made to any of the frequency curves except for the peak curve for Shanqhai Bend. The 1997 flood was chosen as the pattern for the five – day wave patterns. These wave patterns were constructed by adjusting regulated gage records for the 1997 flood event in accordance with changes in upstream storage.

Reservoir routing for the Feather River system was accomplished using both the HEC-5 and the ResSim modeling package produced by the Hydrologic Engineering Center (HEC). A ResSim model was used to model the Feather – Yuba system and the HEC-5 model completed as part of the Comprehensive Study (Reference 23) was used to model the Sacramento River system down to the confluence with the Feather River (Verona). Output hydrographs from both of these models were used as input into the hydraulic models, which cover the majority of the main river system.

A summary of the regulated peak discharges along the Feather River is shown on Table 4, "Regulated Peak Flows."

Table 4 – Regulated Peak Flows

% Chance Exceedence	Feather River at Oroville	North Yuba River at new Bullards Bar Dam	Yuba River at Marysville	Feather River at Shanghai Bend	Feather River at Nicolaus
10	100,000	44,400	92,400	200,000	219,000
2	150,000	50,000	150,000	293,000	323,000
1	150,000	66,100	155,000	296,000	323,000
0.2	327,000	150,000	313,000	607,000	668,000

3.2 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. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. For construction and/or floodplain management purposes, users are encouraged to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

The hydraulic analysis for this revision was based on unobstructed flow. The flood elevations shown on the flood profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are also shown on the FIRM (Exhibit 2).

April 20, 2000 Countywide Analyses

Cross sections for the detailed analyses of Keefer Slough, Butte Creek, and Wyman Ravine between the lower study limits and a point 35,480 feet upstream were obtained by field survey and extended where necessary from USGS 7.5-minute series topographic maps (Reference 19). Cross sections for the detailed analysis of Wyman Ravine Tributary 1, Palermo Tributary, and Wyman Ravine, between a point 35,480 feet upstream of Stimpson Road and Lincoln Boulevard, were obtained from topographic mapping (Reference 20). For the backwater analysis of Ruddy Creek and Ruddy Creek Tributary, cross sections were obtained from aerial photographs (Reference 21). Cross sections for all approximate method study reaches were obtained from USGS topographic maps (Reference 19). All bridges and culverts were field measured to obtain dimensions, geometry, and elevations.

Water-surface elevations of floods of the selected recurrence intervals were computed through the use the USACE HEC-2 step-backwater computer program (Reference 22).

Starting water-surface elevations for the backwater analyses of all the streams studied by detailed methods were determined by normal depth analysis. In the cases of Wyman Ravine and Keefer Slough, the detailed study started at the upstream face of constricting road crossings. In these cases the models were extended several hundred feet downstream of the structure to a location where normal depth approximations were appropriate.

The hydraulic characteristics of Wyman Ravine and its tributaries require special attention because of the existence of levees and the occurrences of low channel capacity, resulting in sheetflow breaking out of the channel and not returning for several thousand feet, if at all.

The next several paragraphs describe the major occurrences of water spilling out of the channel and the transfer of flow between channels of the Wyman Ravine system. These spills are the reason for the downstream reductions in peak discharge as presented in Table 3, "Summary of Discharges." The hydrology and hydraulic models were developed simultaneously in order to reflect all of these spills and flow transfers.

Levees have been erected along much of Wyman Ravine ranging in height from approximately 1 foot to 4 feet. The levees extending from the downstream study limit to a point approximately 45,510 feet upstream do not contain the 10-percent-annual-chance flood discharges and hence their existence does not affect the flood limits presented in this report. However, the levee that extends from a point approximately 3,500 feet north of Palermo Road to approximately 2,000 feet beyond Lincoln Boulevard restricts some of the flow from leaving the channel and affects the downstream flooding. In the analysis of Wyman Ravine, two cases of channel performance were considered. Case 1 considered the possibility of the latter levee remaining intact, and Case 2 considered the possibility of the same levee failing under flood conditions. The discharges listed in Table 3, "Summary of Discharges," and the profiles in Exhibit 1 represent Case 1, which considers the greater discharge in the channel. The associated flood boundary maps (Exhibit 2) reflect a combination of both cases. The right overbank flood limits result from the larger channel flows and the sheetflow and ponding zones indicated to the south of the ravine were determined assuming that the levee failed entirely.

It should be noted that, even in the case of the levee remaining intact, the large majority of the 1-percent-annual-chance flood streamflow spills out of the ravine before the channel bends sharply south at a point approximately 3,500 feet upstream of Palermo Road.

Some of the flow that spills out of Wyman Ravine between the Western Pacific Railroad and Lincoln Boulevard returns to Wyman Ravine after passing through a railway culvert 300 feet north of North Villa Avenue.

The reach of Wyman Ravine extending from Lone Tree Road to a point approximately 6,060 feet upstream is inadequate to contain the 10-percent-annual-chance flood discharge. Some of the flood discharge flows south and does not re-enter Wyman Ravine within the limits of the study.

The reach of Wyman Ravine Tributary 1 between the Western Pacific Railway embankment and Melvina Avenue is inadequate to contain the 10-percent-annual-chance flood discharge. The majority of the flow upstream of Melvina Avenue spills over the road south of the bridge crossing and continues westerly and southwesterly across the farm fields. Additional flow spills to the south between the Western Pacific Railway embankment and Railroad Avenue.

Palermo Tributary is inadequate to contain the 10-percent-annual-chance flood discharge. Upstream of Palermo Road the flow is confined between the high ground on the east and Lincoln Boulevard on the west. Between Palermo Road and South Villa Road the channel will not contain the 10-percent-annual-chance flood discharge. Any spill over the right bank (east bank) continues southwesterly away from the channel as sheetflow. The Western Pacific Railway embankment stops the westerly movement of the floodflow and directs the sheetflow south across South Villa and into Wyman Ravine Tributary 1. Some water that spills from Wyman Ravine upstream of the Western Pacific Railway embankment enters the Palermo drainage area but the timing of the peak discharge is such that it does not increase the peak discharge in Palermo Tributary or Wyman Ravine Tributary 1.

The approximate study portion of Wyman Ravine and Wyman Ravine Tributary 2 were analyzed using HEC-2. Little Chico Creek and the approximate study portion of Butte Creek were analyzed assuming that the flow traveled at normal depth.

The approximate study portion of Keefer Slough was modeled using HEC-2. The shallow flooding southwest of the channel was computed as normal depth flow. However, based on conversations with the County Department of Public Works, sheetflow southwest of State Highway 99 has occurred more extensively than can be simulated with normal depth approximations (Reference 5). The area is very flat with a mild slope to the southwest. Small farm levees can significantly alter the course of the overland flow. To account for this uncertainty in the path of sheetflow, and to include areas of observed flooding, the flood limits shown on the FIRM (Exhibit 2) are shown wide enough to encompass all possible paths of sheetflow.

Cross sections for detailed analysis of Butte Creek, Hamlin Slough, Little Chico-Butte Creek Diversion Channel, Comanche Creek, and Little Chico Creek were obtained by aerial and field surveys. On Butte Creek and Hamlin Slough, cross sections were extended where necessary using the topographic mapping prepared for this FIS and the USGS 7.5-minute series topographic mapping. All bridges and culverts were field measured to obtain dimensions, geometry, and elevations.

Starting water-surface elevations for the backwater analysis of the streams were determined by normal depth analysis, with the exception of Hamlin Slough and the Little Chico-Butte Creek Diversion Channel. For these streams, the starting water-surface was based upon the estimated water-surface elevation on Butte Creek that would be present at the time of the peak in the respective tributary.

The Butte Creek levee system located downstream of the Skyway could not be reflected as providing 1-percent-annual-chance flood protection in this FIS. Therefore, according to FEMA criteria, the system was evaluated for the three conditions reflecting both levees intact, the left levee failed, and the right levee failed.

The Hamlin Slough levee system located downstream of the Chico-Oroville Highway could not be reflected as providing 1-percent-annual-chance flood protection in this FIS. Therefore, according to FEMA criteria, the system was evaluated for the three conditions reflecting both levees intact, the left levee failed, and the right levee failed.

The Little Chico-Butte Creek Diversion Channel has reaches that consist of a levee along its right bank. The levee could not be reflected as providing 1-percent-annual-chance flood protection in this FIS. Therefore, according to FEMA criteria, the system was evaluated reflecting the levee intact and the levee failed.

The Little Chico-Butte Creek Diversion Channel crosses Comanche Creek. Therefore, under the failed levee scenario, the discharge in the diversion channel would flow down Comanche Creek instead of being delivered to Butte Creek. The hydraulic analysis of Comanche Creek for the 1-percent and 0.2-percent-annual-chance flood events reflects failed levee conditions on the diversion channel.

The levees located along the lower reaches of Comanche Creek could not be reflected as providing 1-percent-annual-chance flood protection in the FIS. Therefore, according to FEMA criteria, the system was evaluated for the three conditions reflecting both levees intact, the left levee failed, and the right levee failed.

The hydraulic analysis of Little Chico Creek reflects the diversion of flow into the Little Chico-Butte Creek Diversion Channel. The levees located in the lower reaches could not be reflected as providing 1-percent-annual-chance flood protection in this FIS. Therefore, according to FEMA criteria, the system was evaluated for the three conditions reflecting both levees intact, the left levee failed, and the right levee failed.

Reaches of Butte Creek downstream of the Skyway, Hamlin Slough, the Little Chico-Butte Creek Diversion Channel, Comanche Creek, and Little Chico Creek all have the occurrences of inadequate levees and/or channel capacities, resulting in flow breaking out of the channel and not returning for several thousand feet, if at all.

A detailed hydraulic analysis was prepared for Lindo Channel beginning approximately 2,000 feet downstream of the Nord Highway Bridge, upstream to its confluence with the Big Chico Creek Diversion Channel.

HEC-2 backwater analyses were run for Lindo Channel so that water surface elevations balance at bifurcations and diversions. The diversion structure is modeled using HEC-2 special culvert routines. Backwater computations were started by assuming normal depth downstream of the Nord Highway bridge. At each bridge or culvert, a 1:1 flow contraction into the opening and a 4:1 flow expansion out of the opening was modeled using encroachments.

Analysis indicates that the estimated 1-percent-annual-chance flood discharge is contained within the creek channel for the entire study reach. Downstream of Esplande, however, Lindo Channel is near bank capacity for the 1-percent-annual-chance flood discharge. Within this reach the channel is perched, so flows that overtopped the banks would tend to run away from the channel as shallow overland flooding. It should be noted that, while the estimated 1-percent-annual-chance flood discharge is significantly less than the channel's design capacity, that capacity was based on a clean channel. Vegetation growth has since reduced that capacity.

Since the estimated 1-percent-annual-chance flood discharge is contained within the channel for Lindo Channel, a floodway was not computed.

Diversion structures on Big Chico Creek and Lindo Channel affect discharges for every stream reach within the study limits, except Sycamore Creek upstream from its confluence with the Big Chico Creek Diversion Channel.

A recreational swimming pool was formed in the past at the diversion structure using temporary flashboards on the upstream faces of the culvert structures on Big Chico Creek and Lindo Channel. For the purposes of hydraulic analyses for this FIS, these flashboards are assumed to be removed prior to the flood season. While this is part of the City of Chico's operational procedure, it is not clear whether or not the flashboards have actually been removed prior to every flood season.

A detailed hydraulic analysis has been prepared for the Big Chico Creek diversion system, beginning at the Nord Highway bridge on Mud Creek. The studied river system includes Mud Creek from Nord Highway to the confluence with Sycamore Creek; Sycamore Creek from the confluence with Mud Creek to a point 1 mile above the tributary diversion canal; and the diversion canal from its outfall into Sycamore Creek to the diversion point at Big Chico Creek.

The USACE Sacramento District surveyed project levee crown elevations and found that the levees are currently at or near design grade. The USACE certifies that the levees are well maintained, do not have any known stability or foundation problems, and, with the exception of Sycamore Creek upstream from Sheep Hollow Creek, the project will pass design flows within the design water surface profile provided that adequate maintenance continues.

HEC-2 backwater analyses were run for each of the study reaches so that water-surface elevations balance at bifurcations and diversions. The ogee spillway on the Big Chico Creek Diversion Channel is modeled using a rating curve based on data found in the U.S. Bureau of Reclamation's Design of Small Dams.

For a balanced water surface with Lindo Creek, the estimated discharge over the spillway is 5,600 cfs.

Backwater computations were started by assuming normal depth downstream of the Nord Highway bridge, and normal depth in North Sycamore Creek. For freeboard determination, encroachments were placed at levee crests. At each bridge or culvert, a 1:1 flow contraction into the opening and a 4:1 flow expansion out of the opening were modeled using encroachments.

The USACE certified their project levees for grade and structural integrity. Adequate freeboard exists for all study reaches with the exception of 100 feet downstream of the Cohasset Road Bridge to just upstream of the bridge.

Following FEMA guidelines, levees without adequate freeboard are assumed not to exist when mapping flood elevations on the protected side of the levee. For this study reach, only about 100 lineal feet of right bank levee on each side of the Cohasset Road Bridge does not meet freeboard criteria. The configuration of the bridge is such that levee failure immediately upstream of the bridge merely causes water to back up into the right overbank without spilling over the road, which is on fill. Effective flow is not changed and the mapped water surface is contiguous with the main channel water surface.

Since the estimated 1-percent-annual-chance flood discharge is contained within the leveed channel for Mud Creek and the Big Chico Creek Diversion Channel, a floodway was not computed.

A detailed hydraulic analysis was prepared for North Sycamore Creek beginning at its confluence with the Big Chico Creek Diversion Channel (Sycamore Creek). North Sycamore Creek is studied for approximately 1 mile upstream of its confluence with the Big Chico Creek Diversion Channel.

North Sycamore Creek was not improved as part of the Sacramento River and Major and Minor Tributaries Project. There are no levees along the creek bank for this study reach.

A HEC-2 backwater analysis was run for North Sycamore Creek. Backwater computations were started by assuming normal depth within the reach of North Sycamore Creek just upstream of the confluence with the Big Chico Creek Diversion Channel. There are no bridges or culverts, nor channel expansions or contractions.

A floodway was established by encroaching to the natural channel banks, and then slightly relaxing the encroachments in order to provide a smooth floodway with a fairly constant width. The floodway results in a maximum rise over the base flood elevation of 0.5 foot.

In Keefer Slough, a rating curve was developed to represent the division of the Rock Creek total discharge between that portion of the discharge that is diverted into Keefer Slough and the balance of the discharge, which continues down the Rock Creek main channel. This rating was based on the normal-depth computations in each channel by modeling a representative channel cross section near their confluence using the USACE HEC-2 computer program. The result of this rating is that approximately 44 percent of the 1-percent-annual-chance total Rock Creek discharge is diverted. This analysis increases the discharge in Keefer Slough by approximately 1,800 cfs from the original study. Due to the increase in discharge, the detailed study area between Highway 99 and Keefer Lane was redelineated using an approximate method. The approximate studies for Dead Horse and Keefer Sloughs and Wyman Ravine were based on a HEC-2 analysis. Cross sections for the studied streams were compiled using available topographic mapping, USGS quadrangle maps, and as-built information. Hydraulic structure dimensions were determined using as-built construction plans and existing HEC-2 models.

Roughness factors (Manning's "n") used in the hydraulic computations were chosen based on engineering judgment and field observations of the streams and floodplain areas. The roughness values used for the channels and overbank floodplains are shown in Table 5, "Manning's "n" Values."

Table 5 – Manning's "n" Values

Community Name	Roughness Values Channel	Overbank
Big Chico Creek	0.045 – 0.1	0.045 – 0.1
Butte Creek	0.040 – 0.054	0.036 – 0.077
Comanche Creek	0.035 – 0.058	0.040 – 0.077
Dead Horse Slough	0.040	0.060
Hamlin Slough	0.035 – 0.050	0.036 – 0.048
Keefer Slough	0.040	0.060
Lindo Channel	0.040 – 0.070	0.045
Little Chico Creek	0.035 – 0.060	0.048 – 0.080
Mud Creek	0.035	0.045
North Sycamore Creek	0.045	0.045
Palermo Tributary	0.050 – 0.060	0.060 – 0.080
Rock Creek	0.060	0.060
Ruddy Creek	0.015 – 0.060	0.050 – 0.100
Ruddy Creek Tributary	0.015 – 0.040	0.040
Wyman Ravine	0.050	0.070
Wyman Ravine Tributary 1	0.080	0.080

2010 Countywide Revision

The study for the Upper Feather model extends from the mouth of the Yuba River upstream to Oroville Dam, approximately 44 miles in length. The basis of the model is the HEC-RAS hydraulic model generated for the Yuba River Basin, California, General Re-evaluation (Yuba GRR) Study (Reference 24).

Cross sections were taken from the hydraulic model for the Yuba GRR study (Reference 24) Refinements to the existing cross sections were performed at the locations where the extents of the floodplain boundaries were uncertain and questionable, and the cross sections of the existing geometry were too far apart. For these areas, more cross sections were generated utilizing DTM surfaces of the Feather River from the Comprehensive Study topographic data (Reference 25). The developed cross sections were imported in the geometry of HEC-RAS model for a more concise definition of floodplain boundaries. Furthermore, some of the already existing cross sections, whose lengths were not sufficient enough to capture the entire floodplain extents, were further extended into the left and right overbank.

Upstream and Downstream conditions for the HEC-RAS model were taken from the Lower Feather model/Yuba GRR models. Upstream boundary conditions consist of inflow hydrographs. Downstream boundary conditions consist of rating curves.

The channel model was calibrated to the 1997 storm event. The model was calibrated by adjusting the Manning's n values to provide a reasonable fit to the observed peak stages from 1997. Extensive effort was undertaken to model the area within HEC-RAS to match the gage data, without using unrealistic Manning's n values.

The limitations associated with the HEC-RAS modeling being one dimensional necessitated the selection of the FLO-2D hydraulic program for delineating flooding in the overbank area resulting from levee failure scenarios. FLO-2D model development constituted generation of a separate left overbank model and a right overbank model.

The FLO-2D grid model for the left bank extends from Oroville wildlife area on the left bank at river mile 58.6 to RM 27 downstream of city of Marysville. The horizontal extents are from the outskirts of Brown Valley Ridge. The levees that have been modeled extend from RM 56 near Oak Grove to Honcut Creek. The other levee encompasses the Honcut area on the four sides. The other two levees consist of the levee on Highway 20 and Marysville Ring Levee. The study limits cover approximately 400 square miles of Yuba County, Sutter County, and Butte County.

The FLO-2D model on the right bank extends approximately from the downstream edge of the Thermalito After Bay at River mile 55.6 of Feather River which is the upstream limit of the grid model, while the downstream limit of the grids is approximately at the confluence of Sutter Bypass and Feather River at RM 7.775 of Feather River. The horizontal extent of the model encompasses the area around Cherokee Canal, Butte Sink, Sutter Buttes, and Sutter Bypass. The levee reaches that have been incorporated into the model are the Feather River right bank levee extending from RM 59.6 to Feather River 7.7 and the Sutter Bypass left bank levee.

Levee breach locations were determined from the levee breach analysis performed in HEC-RAS and based on the recommendations provided by the geotechnical report. Also, the FEMA based levee failure standards have been incorporated into the modeling efforts. The outflow hydrographs resulting from the channel model simulations with the breaches of the levees were utilized as flow input to the FLO-2D models.

The results from the geotechnical levee failure and FEMA based failures were merged to delineate the extent of flooding on the left and right overbanks.

Qualifying bench marks within a given jurisdiction that are cataloged by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS) as First or Second Order Vertical and have a vertical stability classification of A, B, or C are shown and labeled on the FIRM with their 6-character NSRS Permanent Identifier.

Benchmarks cataloged by the NGS and entered into the NSRS vary widely in vertical stability classification. NSRS vertical stability classifications are as follows:

- Stability A: Monuments of the most reliable nature, expected to hold position/elevation well (e.g., mounted in bedrock)
- Stability B: Monuments which generally hold their position/elevation well (e.g., concrete bridge abutment)
- Stability C: Monuments which may be affected by surface ground movements (e.g., concrete monument below frost line)
- Stability D: Mark of questionable or unknown vertical stability (e.g., concrete monument above frost line, or steel witness post)

In addition to NSRS benchmarks, the FIRM may also show vertical control monuments established by a local jurisdiction; these monuments will be shown on the FIRM with the appropriate designations. Local monuments will only be placed on the FIRM if the community has requested that they be included, and if the monuments meet the aforementioned NSRS inclusion criteria.

To obtain current elevation, description, and/or location information for benchmarks shown on the FIRM for this jurisdiction, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their Web site at www.ngs.noaa.gov.

It is important to note that temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with this FIS and FIRM. Interested individuals may contact FEMA to access this data.

Levee Hazard Analysis

Some flood hazard information presented in prior FIRMs and in prior FIS reports for Butte County and its incorporated communities was based on flood protection provided by levees. Based on the information available and the mapping standards of the NFIP at the time that the prior FISs and FIRMs were prepared, FEMA accredited the levees as providing protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year. For FEMA to continue to accredit the identified levees with providing protection from the base flood, the levees 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."

On August 22, 2005, FEMA issued Procedure Memorandum No. 34 - Interim Guidance for Studies Including Levees. The purpose of the memorandum was to help clarify the responsibility of community officials or other parties seeking recognition of a levee by providing information identified during a study/mapping project. Often, documentation regarding levee design, accreditation, and the impacts on flood hazard mapping is outdated or missing altogether. To remedy this, Procedure Memorandum No. 34 provides interim guidance on procedures to minimize delays in near-term studies/mapping projects, to help our mapping partners properly assess how to handle levee mapping issues.

While 44 CFR Section 65.10 documentation is being compiled, the release of more up-to-date FIRM panels for other parts of a community or county may be delayed. To minimize the impact of the levee recognition and certification process, FEMA issued Procedure Memorandum No. 43 - Guidelines for Identifying Provisionally Accredited Levees on March 16, 2007. These guidelines will allow issuance of preliminary and effective versions of FIRMs while the levee owners or communities are compiling the full documentation required to show compliance with 44 CFR Section 65.10. The guidelines also explain that preliminary FIRMs can be issued while providing the communities and levee owners with a specified timeframe to correct any maintenance deficiencies associated with a levee and to show compliance with 44 CFR Section 65.10.

FEMA contacted the communities within Butte County to obtain data required under 44 CFR 65.10 to continue to show the levees as providing protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year.

FEMA understood that it might take time to acquire and/or assemble the documentation necessary to fully comply with 44 CFR 65.10. Therefore, FEMA put forth a process to provide the communities with additional time to submit all the necessary documentation. For a community to avail itself of the additional time, it had to sign an agreement with FEMA. Levees for which such agreements were signed are shown on the final effective FIRM as providing protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year and labeled as a Provisionally Accredited Levee (PAL). Communities have two years from the date of FEMA's initial coordination to submit to FEMA final accreditation data for all PALs. Following receipt of final accreditation data, FEMA will revise the FIS and FIRM as warranted.

FEMA coordinated with the USACE, the local communities, and other organizations to compile a list of levees that exist within Butte County. Table 6, "List of Structures Requiring Flood Hazard Revisions," lists all levees shown on the FIRM, to include PALs, for which corresponding flood hazard revisions were made.

Approximate analyses of "behind levee" flooding were conducted for all the levees in Table 6 to indicate the extent of the "behind levee" floodplains. The methodology used in these analyses is discussed below.

The approximate levee analysis was conducted using information from existing hydraulic models (where applicable) and USGS topographic maps.

The extent of the 1-percent-annual-chance flood in the event of levee failure was determined. Normal-depth calculations were used to estimate the base flood elevation (BFE) if detailed topographic or representative cross section information was available. The remaining BFEs were estimated from effective FIRM maps. The 1-percent-annual-chance floodplain boundary was traced along the contour line representing the estimated BFE. Topographic features such as highways, railroads, and high ground were used to refine approximate floodplain boundary limits. The 1-pecent annual chance peak flow and floodplain widths and depth (assumed at 1 foot) were used to ensure the floodplain boundary was not overly conservative

Table 6 – List of Structures Requiring Flood Hazard Revisions

Community	Flood Source	Levee Inventory ID (Lat. /Long. Coordinates. ; FIRM panel)	USACE Levee
City of Chico	Butte Creek Diversion Channel	1113 (-121.78, 39.73; -121.774, 39.732 06007C0510E)	No
City of Chico	Butte Creek Diversion Channel	1131 (-121.78, 39.722; -121.78, 39.73 06007C0506E/06007C0510E)	Yes
City of Chico	Butte Creek Diversion Channel	1305 (-121.783, 39.718; -121.78, 39.722 06007C0506E/06007C0510E)	No; not a levee
City of Chico	Dead Horse Slough	1269 (-121.794, 39.744; -121.793, 39.744 06007C0506E)	No
City of Chico	Unknown	1317 (-121.849, 39.784; -121.849, 39.787 06007C0340D)	No
City of Oroville	Lake Oroville	1291 (-121.595, 39.526; -121.579, 39.531 06007C0788D/ 06007C0790D)	Dam; not a levee

Table 6 – List of Structures Requiring Flood Hazard Revisions, continued

Community	Flood Source	Levee Inventory ID (Lat. /Long. Coordinates. ; FIRM panel)	USACE Levee
Butte County (Unincorporated Areas)	Butte Creek	1301 (-121.777, 39.694; -121.774, 39.697 06007C0510E)	Yes
Butte County (Unincorporated Areas)	Butte Creek Diversion Channel	1114 (-121.779, 39.695; -121.779, 39.698 06007C0510E)	Yes
Butte County (Unincorporated Areas)	Butte Creek Diversion Channel	1281 (-121.779, 39.698; -121.779, 39.703 06007C0510E)	Yes
Butte County (Unincorporated Areas)	Cherokee Canal	1284 (-121.882, 39.355; -121.867, 39.363 06007C1075D/06007C1100D)	Yes
Butte County (Unincorporated Areas)	Comanche Creek	1081 (-121.864, 39.701; -121.844, 39.702 06007C0505D)	No
Butte County (Unincorporated Areas)	Comanche Creek	1258 (-121.921, 39.667; -121.887, 39.681 06007C0495D)	No
Butte County (Unincorporated Areas)	Drainage Canal	1012 (-121.855, 39.32; -121.855, 39.33 06007C1100D)	No
Butte County (Unincorporated Areas)	Drainage Canal	1190 (-121.85, 39.315; -121.836, 39.315 06007C1100D)	No
Butte County (Unincorporated Areas)	Drainage Canal	1226 (-121.882, 39.328; -121.846, 39.347 06007C1075D /06007C1100D)	No
Butte County (Unincorporated Areas)	Drainage Canal	1287 (-121.854, 39.315; -121.85, 39.315 06007C1100D)	No
Butte County (Unincorporated Areas)	Drainage Canal	1288 (-121.854, 39.332; -121.845, 39.336 06007C1100D)	No

Table 6 – List of Structures Requiring Flood Hazard Revisions, continued

Community	Flood Source	Levee Inventory ID (Lat. /Long. Coordinates. ; FIRM panel)	USACE Levee
Butte County (Unincorporated Areas)	Drainage Canal	1289 (-121.845, 39.336; -121.838, 39.34 06007C1100D)	No
Butte County (Unincorporated Areas)	Drainage Canal	1290 (-121.855, 39.33; -121.854, 39.332 06007C1100D)	No
Butte County (Unincorporated Areas)	Dry Creek	1314 (-121.702, 39.572; -121.701, 39.574 06007C0755D)	Yes
Butte County (Unincorporated Areas)	Feather River	1026 (-121.621, 39.423; -121.605, 39.451 06007C0960D/06007C0975D/06007C0980 D/06007C0990D)	No
Butte County (Unincorporated Areas)	Feather River	1050 (-121.627, 39.419; -121.641, 39.44 06007C0960D/06007C0975D)	No
Butte County (Unincorporated Areas)	Feather River	1053 (-121.631, 39.46; -121.609, 39.47 06007C0960D/06007C0980D)	Yes
Butte County (Unincorporated Areas)	Feather River	1055 (-121.625, 39.396; -121.641, 39.44 06007C0960D/06007C0975D)	Yes
Butte County (Unincorporated Areas)	Feather River	1060 (-121.63, 39.457; -121.595, 39.471 06007C0960D/06007C0980D)	No
Butte County (Unincorporated Areas)	Feather River	1062 (-121.593, 39.472; -121.581, 39.494 06007C0980D)	No
Butte County (Unincorporated Areas)	Feather River	1078 (-121.625, 39.396; -121.632, 39.413 06007C0975D/06007C0990D)	No
Butte County (Unincorporated Areas)	Feather River	1092 (-121.641, 39.44; -121.64, 39.458 06007C0960D)	Yes

Table 6 – List of Structures Requiring Flood Hazard Revisions, continued

Community	Flood Source	Levee Inventory ID (Lat. /Long. Coordinates. ; FIRM panel)	USACE Levee
Butte County (Unincorporated Areas)	Feather River	1184 (-121.638, 39.306; -121.637, 39.313 06007C1125D)	Yes
Butte County (Unincorporated Areas)	Feather River	1229 (-121.637, 39.313; -121.625, 39.396 06007C0975D/06007C1125D)	Yes
Butte County (Unincorporated Areas)	Feather River	1265 (-121.623, 39.422; -121.621, 39.423 06007C0975D/06007C0990D)	No
Butte County (Unincorporated Areas)	Feather River	1266 (-121.621, 39.423; -121.605, 39.425 06007C0990D)	No
Butte County (Unincorporated Areas)	Mud Creek	1241 (-121.883, 39.786; -121.876, 39.802 06007C0320E)	Yes
Butte County (Unincorporated Areas)	Sacramento River-Eddy Lake	1141 (-121.973, 39.529; -121.97, 39.534 06007C0725D)	Yes
Butte County (Unincorporated Areas)	Thermalito Afterbay	1119 (-121.686, 39.505; -121.64, 39.458 06007C0770D/06007C0960D/ 06007C0975D)	Dam; not a levee
Butte County (Unincorporated Areas)	Thermalito Afterbay	1120 (-121.639, 39.458; -121.629, 39.464 06007C0960D)	Dam; not a levee
Butte County (Unincorporated Areas)	Thermalito Afterbay	1238 (-121.686, 39.505; -121.684, 39.509 06007C0770D)	Dam; not a levee
Butte County (Unincorporated Areas)	Thermalito Forebay	1221 (-121.626, 39.514; -121.595, 39.526 06007C0770D/06007C0788D)	Dam; not a levee
Butte County (Unincorporated Areas)	Thermalito Forebay	1263 (-121.63, 39.515; -121.626, 39.514 06007C0770D)	Dam; not a levee

Table 6 – List of Structures Requiring Flood Hazard Revisions, continued

Community	Flood Source	Levee Inventory ID (Lat. /Long. Coordinates. ; FIRM panel)	USACE Levee
Butte County (Unincorporated Areas)	Unknown	1018 (-121.712, 39.523; -121.712, 39.538 06007C0765D)	No
Butte County (Unincorporated Areas)	Unknown	1037 (-121.754, 39.583; -121.748, 39.587 06007C0735D/06007C0755D)	No
Butte County (Unincorporated Areas)	Western Canal	1014 (-121.882, 39.329; -121.882, 39.355 06007C1075D)	No
Butte County (Unincorporated Areas)	Western Canal	1059 (-121.605, 39.47; -121.595, 39.471 06007C0980D)	No
Butte County (Unincorporated Areas)	Western Canal	1061 (-121.605, 39.471; -121.593, 39.472 06007C0980D)	No

Several levees within Butte County and its incorporated communities 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." Table 7, "List of Certified and Accredited Levees," lists all levees shown on the FIRM that meet the requirements of 44 CFR 65.10 and have been determined to provide protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year.

Table 7 – List of Certified and Accredited Levees

Community	Flood Source	Levee Inventory ID (Lat. /Long. Coordinates. ; FIRM panel)	USACE Levee
City of Chico	Big Chico Diversion Channel	1306 (-121.81, 39.775; -121.793, 39.762 06007C0339D/ 06007C0343D)	Yes
City of Chico	Mud Creek Diversion Channel	1308 (-121.797, 39.761; -121.793, 39.762 06007C0343D)	Yes

Table 7 – List of Certified and Accredited Levees, continued

City of Chico	Sycamore Creek	1161 (-121.852, 39.78; -121.849, 39.784 06007C0340D)	Yes
City of Chico	Sycamore Creek	1277 (-121.855, 39.779; -121.852, 39.78 06007C0340D)	Yes
City of Chico	Sycamore Creek	1300 (-121.843, 39.778; -121.841, 39.78 06007C0339D)	Yes
City of Chico	Sycamore Creek	1304 (-121.851, 39.776; -121.848, 39.775 06007C0340D)	Yes
City of Chico Butte County (Unincorporated Areas)	Mud Creek	1243 (-121.913, 39.757; -121.883, 39.785 06007C0320E)	Yes
City of Chico Butte County (Unincorporated Areas)	Sycamore Creek	1160 (-121.883, 39.786; -121.855, 39.779 06007C0320E/06007C0340D)	Yes
City of Chico Butte County (Unincorporated Areas)	Sycamore Creek	1164 (-121.883, 39.785; -121.851, 39.776 06007C0320E/06007C0340D)	Yes
City of Chico Butte County (Unincorporated Areas)	Sycamore Creek	1173 (-121.851, 39.776; -121.849, 39.774 06007C0340D)	Yes
City of Chico Butte County (Unincorporated Areas)	Sycamore Creek	1244 (-121.85, 39.777; -121.846, 39.776 06007C0340D)	Yes
City of Chico Butte County (Unincorporated Areas)	Sycamore Creek	1278 (-121.851, 39.776; -121.85, 39.777 06007C0340D)	Yes
City of Oroville	Feather River	1233 (-121.573, 39.511; -121.551, 39.516 06007C0790D/ 06007C0795D)	No
Butte County (Unincorporated Areas)	Mud Creek	1034 (-121.927, 39.741; -121.886, 39.784 06007C0320E/06007C0485D)	Yes

Table 7 – List of Certified and Accredited Levees, continued

Community	Flood Source	Levee Inventory ID (Lat. /Long. Coordinates. ; FIRM panel)	USACE Levee
Butte County (Unincorporated Areas)	Mud Creek	1256 (-121.885, 39.785; -121.876, 39.802 06007C0320E)	Yes
Butte County (Unincorporated Areas)	Mud Creek	1297 (-121.927, 39.741; -121.913, 39.757 06007C0320E/06007C0485D)	Yes
Butte County (Unincorporated Areas)	Western Canal	1090 (-121.706, 39.522; -121.686, 39.505 06007C0765D/06007C0770D)	No
Butte County (Unincorporated Areas)	Western Canal	1218 (-121.703, 39.523; -121.686, 39.505 06007C0765D/06007C0770D)	Yes

3.3 Vertical Datum

All FISs and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FISs and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD29). With the finalization of the North American Vertical Datum of 1988 (NAVD88), many FIS reports and FIRMs are being prepared using NAVD88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD88. Structure and ground elevations in the community must, therefore, be referenced to NAVD88. It is important to note that adjacent communities may be referenced to NGVD29. This may result in differences in BFEs across the corporate limits between the communities.

The conversion factor from NGVD29 to NAVD88 was 2.35 for all streams in Butte County.

As noted above, the elevations shown in the FIS report and on the FIRM for Butte County are referenced to NAVD88. Ground, structure, and flood elevations may be compared and/or referenced to NGVD29 by applying a standard conversion factor.

The BFEs shown on the FIRM represent whole-foot rounded values. For example, a BFE of 102.4 will appear as 102 on the FIRM and 102.6 will appear as 103. Therefore, users that wish to convert the elevations in this FIS to NGVD29 should apply the stated conversion factors to elevations shown on the Flood Profiles and supporting data tables in the FIS report.

For more information on NAVD88, see Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA Publication FIA-20/June 1992, or contact the Spatial Reference System Division, National Geodetic Survey, NOAA, Silver Spring Metro Center, 1315 East-West Highway, Silver Spring, Maryland 20910 (Internet address http://www.ngs.noaa.gov).

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-percent, 2-percent, 1-percent, and 0.2-percent-annual-chance flood elevations; delineations of the 1-percent and 0.2-percent-annual-chance floodplains; and 1-percent-annual-chance floodway. This information is presented on the FIRM and in components of the FIS, including Flood Profiles. Users should reference the data presented in the FIS as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For the stream studied in detail, the 1-percent and 0.2-percent-annual-chance floodplains have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale and a contour interval as shown on Table 8, "Topographic Map Information."

The 1-percent and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AH, and AO), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. 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 has been shown. 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.

For the streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM (Exhibit 2).

Table 8 – Topographic Map Information

Flooding Source	Scale	Contour Interval	Reference
Big Chico Creek	1:400	4 foot	[1]
Butte Creek	1:24,000	5 & 40 foot	19
Keefer Slough	1:24,000	5 foot	19
Little Chico Creek	1:24,000	5 & 40 foot	19
Palermo Tributary	1:2,400	2 foot	20
Ruddy Creek	1:4,800	4 foot	21
Ruddy Creek Tributary	1:4,800	4 foot	21
Wyman Ravine	1:24,000	5 foot	19
	1:2,400	2 foot	20
Wyman Ravine Tributary 1	1:2,400	2 foot	20

[1] *Data not available*

There are several locations along Wyman Ravine and its tributaries, as well as Butte Creek downstream of the Skyway, Hamlin Slough, Comanche Creek, and Little Chico Creek, where flow spills from the channel as sheetflow. The limits of this shallow flooding were determined by normal depth analysis. Only the 1-percent-annual-chance floodplain boundaries are indicated for the shallow flooding reaches. Shallow flooding occurs on Wyman Ravine between Lone Tree Road and a point approximately 8,750 feet upstream of Lone Tree Road and again between a point 1,330 feet downstream of Palermo Road and Lincoln Boulevard. Shallow flooding occurs on Wyman Ravine Tributary 1 between the Western Pacific Railroad embankment and Melvina Avenue and on Palermo Tributary between South Villa Avenue and Palermo Road.

4.2 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 this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as a minimum standard that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed for certain stream segments on the basis of equal-conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (Table 9). The computed floodways are shown on the revised FIRM (Exhibit 2). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

As discussed in Sections 3.2 and 4.1 of this report, there are several reaches of Wyman Ravine and its tributaries, as well as Butte Creek downstream of the Skyway, Hamlin Slough, Comanche Creek, and Little Chico Creek, where the overbank does not confine the flow. In these reaches some of the flow leaves the channel and becomes shallow flooding. Consequently, floodways have not been determined in these reaches.

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent-annual-chance flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1, "Floodway Schematic."

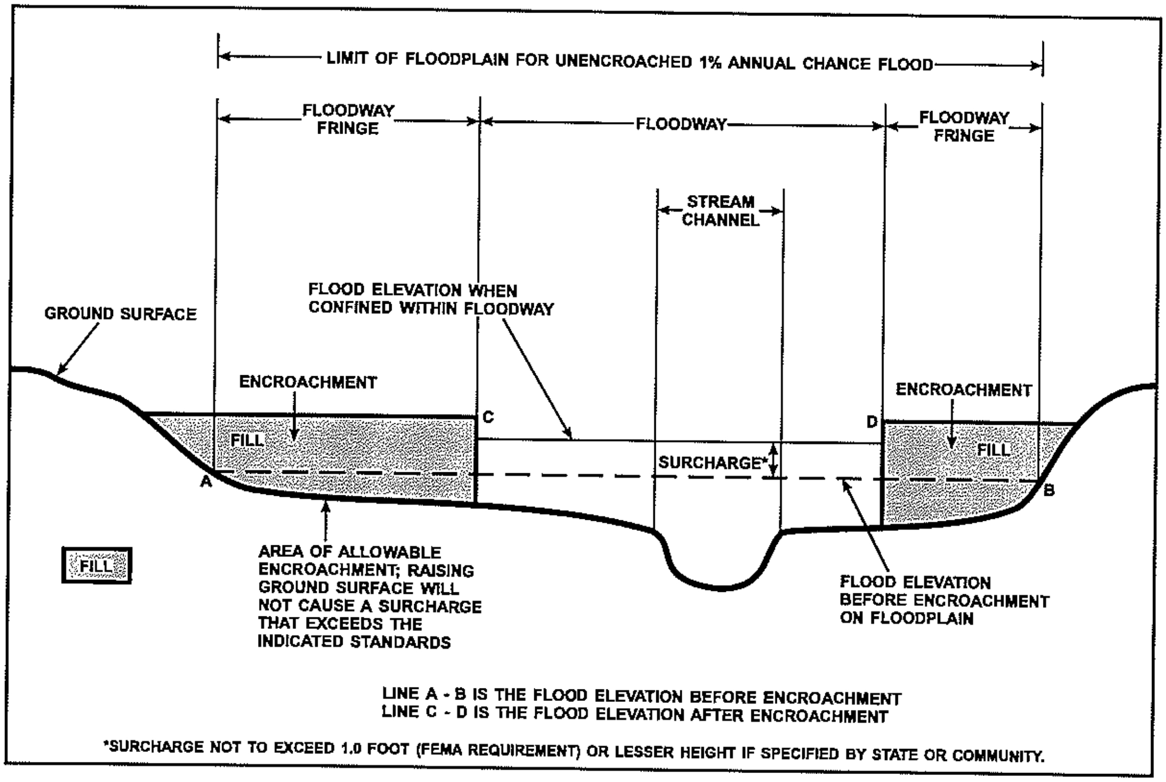

Figure 1 – Floodway Schematic

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Big Chico Creek								
A	0	40	294	5.4	160.9	160.9	161.9	1.0
B	630	57	446	3.6	163.4	163.4	163.8	0.4
C	1,170	48	334	4.8	164.7	164.7	165.0	0.3
D	1,640	38	303	5.3	166.5	166.5	166.6	0.1
E	2,260	35	311	5.1	168.8	168.8	168.8	0.0
F	2,890	44	392	4.1	170.6	170.6	170.6	0.0
G	3,445	41	330	4.8	171.9	171.9	171.9	0.0
H	4,390	47	397	4.0	174.5	174.5	174.5	0.0
I	5,610	53	428	3.7	177.0	177.0	177.0	0.0
J	6,410	57	380	4.2	178.6	178.6	178.6	0.0
K	7,060	48	357	4.5	180.4	180.4	180.4	0.0
L	8,065	61	468	3.4	183.4	183.4	183.4	0.0
M	9,335	79	602	2.7	187.0	187.0	187.0	0.0
N	10,340	66	474	3.2	190.3	190.3	190.4	0.1
O	11,367	64	486	3.1	192.3	192.3	192.8	0.5
P	11,954	130	953	1.6	193.6	193.6	194.0	0.4
Q	12,711	164	1,308	1.1	196.7	196.7	196.8	0.1
R	13,072	178	909	1.6	196.8	196.8	196.9	0.1
S	13,409	64	411	3.6	197.0	197.0	197.1	0.1
T	14,124	95	555	2.7	198.3	198.3	198.3	0.0
U	14,314	80	469	3.2	198.7	198.7	199.7	1.0
V	14,829	120	709	2.1	199.9	199.9	200.5	0.6
W	15,349	45	279	5.4	201.1	201.1	201.4	0.3
X	15,854	315	1,172	1.3	203.6	203.6	203.6	0.0
Y	16,189	110	578	2.6	203.8	203.8	203.8	0.0
Z	16,340	140	738	2.0	204.6	204.6	204.6	0.0

[1]Feet above road bend at Bidwell Avenue

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

BIG CHICO CREEK

TABLE 9

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Big Chico Creek								
AA	17,550	92	367	4.1	206.8	206.8	206.8	0.0
AB	18,248	120	750	2.0	210.1	210.1	210.2	0.1
AC	18,638	205	1,062	1.4	210.3	210.3	210.4	0.1
AD	19,568	93	265	5.7	211.9	211.9	211.9	0.0
AE	20,358	176	850	1.8	215.1	215.1	215.2	0.1
AF	20,949	160	786	1.9	218.6	218.6	219.2	0.6
AG	21,209	171	779	1.8	219.2	219.2	219.8	0.6
AH	22,209	124	656	2.1	220.7	220.7	221.4	0.7
AI	22,879	164	578	2.4	223.0	223.0	223.3	0.3
AJ	23,709	111	591	2.4	225.7	225.7	225.7	0.0
AK	24,719	112	398	3.5	229.2	229.2	229.2	0.0
AL	25,658	120	776	1.8	231.9	231.9	232.2	0.3
AM	26,598	74	218	4.2	233.2	233.2	234.0	0.8
AN	27,448	66	290	3.1	241.7	241.7	241.7	0.0
AO	27,558	124	448	2.0	242.3	242.3	242.3	0.0
AP	28,303	216	642	2.2	246.3	246.3	246.3	0.0
AQ	28,853	139	557	2.5	248.4	248.4	248.4	0.0
AR	29,963	98	498	2.8	252.3	252.3	252.4	0.1
AS	30,993	92	457	3.1	256.0	256.0	256.0	0.0
AT	32,013	109	681	2.1	258.6	258.6	258.6	0.0
AU	33,143	72	161	8.7	263.4	263.4	263.4	0.0
AV	33,778	98	582	2.4	267.0	267.0	267.1	0.1
AW	34,268	247	1,123	1.2	267.5	267.5	267.6	0.1
AX	34,883	30	161	8.7	267.7	267.7	267.8	0.1

[1]Feet above road bend at Bidwell Avenue

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

BIG CHICO CREEK

TABLE 9

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Big Chico Creek Split Flow								
AL	25,658 [1]	120	775	1.8	231.9	231.9	232.2	0.3
AM	26,598 [1]	144	102	4.8	237.7	237.7	237.7	0.0
AN	27,448 [1]	187	424	1.2	241.2	241.2	241.8	0.6
AO	27,558 [1]	244	689	0.7	241.3	241.3	241.9	0.6
Butte Creek								
P	2,050 [2]	732	5,316	4.7	249.4	249.4	250.2	0.8
Q	8,575 [2]	869	5,336	4.7	277.9	277.9	278.8	0.9
R	10,850 [2]	640	4,120	6.1	287.4	287.4	288.0	0.6
S	13,750 [2]	900	3,775	6.6	300.8	300.8	301.2	0.4
T	17,000 [2]	752	4,831	5.2	317.5	317.5	317.7	0.2
U	21,200 [2]	300	1,909	13.1	333.5	333.5	333.5	0.0
V	23,850 [2]	346	3,039	8.2	344.2	344.2	344.2	0.0
W	25,500 [2]	430	3,411	7.3	352.5	352.5	352.5	0.0
X	27,250 [2]	232	1,853	10.8	358.7	358.7	358.7	0.0

[1] Feet above road bend at Bidwell Avenue
[2] Feet above Skyway Street

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY
BUTTE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

BIG CHICO CREEK SPLIT FLOW - BUTTE CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Palermo Tributary								
A	600 [1]	208	379	2.0	150.8	150.8	151.8	1.0
B	1,100 [1]	150	329	2.3	152.1	152.1	152.9	0.8
C	3,795 [1]	300	432	1.8	161.0	161.0	161.0	0.0
D	4,835 [1]	140	166	2.3	163.8	163.8	164.3	0.5
E	5,595 [1]	120	175	2.2	166.7	166.7	167.6	0.9
F	6,415 [1]	100	232	1.7	170.2	170.2	171.1	0.9
Ruddy Creek								
A	700 [2]	119	287	3.5	155.7	155.7	156.7	1.0
B	2,100 [2]	150	339	3.0	164.1	164.1	165.1	1.0
C	3,600 [2]	130	368	2.7	168.6	168.6	169.2	0.6
D	4,570 [2]	90	339	2.6	173.0	173.0	173.9	0.9
E	5,100 [2]	111	406	2.1	174.2	174.2	175.2	1.0
F	6,700 [2]	64	245	3.6	182.0	182.0	182.6	0.6
G	8,600 [2]	60	225	3.9	186.8	186.8	187.5	0.7
H	10,250 [2]	50	166	2.3	191.7	191.7	192.2	0.5

[1]Feet above confluence with Wyman Ravine Tributary 1
[2]Feet above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY
BUTTE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

PALERMO TRIBUTARY - RUDDY CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Ruddy Creek Tributary								
A	1,100[1]	50	125	2.0	193.6	193.6	194.0	0.4
B	1,800[1]	50	304	0.8	198.0	198.0	198.7	0.7
C	3,250[1]	50	225	1.1	198.0	198.0	198.9	0.9
D	4,350[1]	90	165	1.5	198.1	198.1	199.1	1.0
Sycamore Creek								
A - J[3]								
K	14,760[2]	114	383	5.7	195.3	195.3	195.3	0.0
L	15,720[2]	78	325	6.7	201.1	201.1	201.1	0.0
M	16,870[2]	158	351	6.2	208.9	208.9	208.9	0.0
N	17,925[2]	163	397	5.5	217.1	217.1	217.3	0.2
O	19,047[2]	125	360	6.0	226.1	226.1	226.6	0.5
P	20,285[2]	144	385	5.6	236.6	236.6	236.8	0.2

[1] Feet above confluence with Ruddy Creek
[2] Feet above State Highway 99
[3] No Floodway determined

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

RUDDY CREEK TRIBUTARY - SYCAMORE CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Wyman Ravine								
A	150	1,000	3,776	0.9	97.6	97.6	98.6	1.0
B	2,200	1,300	3,439	1.0	98.0	98.0	99.0	1.0
C	4,500	1,300	3,913	0.9	98.7	98.7	99.7	1.0
D	6,400	700	1,219	2.8	100.0	100.0	100.8	0.8
E	8,270	700	2,248	1.5	102.9	102.9	103.6	0.7
F	10,580	800	3,086	1.1	104.0	104.0	104.9	0.9
G	11,910	700	2,422	1.4	104.4	104.4	105.4	1.0
H	13,430	512	1,990	1.7	105.5	105.5	106.4	0.9
I	16,170	559	1,921	1.8	107.9	107.9	108.8	0.9
J	17,570	495	1,151	2.9	109.5	109.5	110.3	0.8
K	19,810	650	2,031	1.7	111.6	111.6	112.6	1.0
L	21,640	600	1,493	2.2	114.8	114.8	115.7	0.9
M	24,030	600	1,641	2.0	117.4	117.4	118.4	1.0
N	25,880	550	1,501	2.2	119.2	119.2	120.2	1.0
O	28,000	605	1,330	2.5	122.4	122.4	123.3	0.9
P	30,570	660	1,848	1.8	126.2	126.2	126.7	0.5
Q	33,470	301	869	3.8	132.6	132.6	133.2	0.6
R	34,830	180	640	5.1	137.2	137.2	137.3	0.1
S	36,180	245	970	3.4	140.2	140.2	141.1	0.9
T	37,140	660	1,901	1.7	143.1	143.1	143.9	0.8
U	37,740	220	853	3.4	145.1	145.1	145.9	0.8
V	38,540	179	575	5.1	146.7	146.7	147.6	0.9
W	39,700	269	762	3.8	151.3	151.3	152.2	0.9
X	40,680	166	738	4.0	154.2	154.2	155.0	0.8

[1]Feet above Stimpson Road

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

WYMAN RAVINE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Wyman Ravine Tributary 1								
A	830	110	187	2.9	143.6	143.6	144.6	1.0
B	1,320	55	134	4.1	147.1	147.1	147.3	0.2
C	3,830	190	368	2.4	158.5	158.5	159.5	1.0
D	5,150	170	394	2.2	165.5	165.5	166.1	0.6
E	6,370	253	540	1.6	173.4	173.4	174.4	1.0

[1]Feet above confluence with Wyman Ravine

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

WYMAN RAVINE TRIBUTARY 1

TABLE 9

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. The zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 1-percent-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 detailed hydraulic analyses are shown within this zone.

Zone D

Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, and areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by levees. No BFEs or depths are shown within this zone.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Biggs City of	June 8, 1998	NONE	June 8, 1998	NONE
Butte, County of	September 6, 1974	December 27, 1977	September 29, 1989	NONE
Chico, City of	June 8, 1998	NONE	June 8, 1998	NONE
Gridley City of	June 8, 1998	NONE	June 8, 1998	NONE
Oroville, City of	June 7, 1974	September 19, 1975	September 24, 1984	NONE
Paradise, Town of [1]	N/A	NONE	N/A	NONE

[1] No Special Flood Hazards

FEDERAL EMERGENCY MANAGEMENT AGENCY
BUTTE COUNTY, CA
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

TABLE 10

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-annual chance floodplains. Floodways and the locations of selected cross sections used in the hydraulic analyses and floodway computations are shown where applicable.

This FIRM includes some flood hazard information that was presented separately on the Flood Boundary and Floodway Maps, where applicable. Historical data relating to the maps prepared for each community up to and including this countywide FIS are presented in Table 10, "Community Map History."

7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Butte County has been compiled into this FIS. Therefore, this FIS supersedes all previously printed FIS Reports, FHBMs, FBFMs, and FIRMs for all of the incorporated and unincorporated jurisdictions within Butte County

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this FIS can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, 1111 Broadway, Suite 1200, Oakland, California 94607-4052.

9.0 BIBLIOGRAPHY AND REFERENCES

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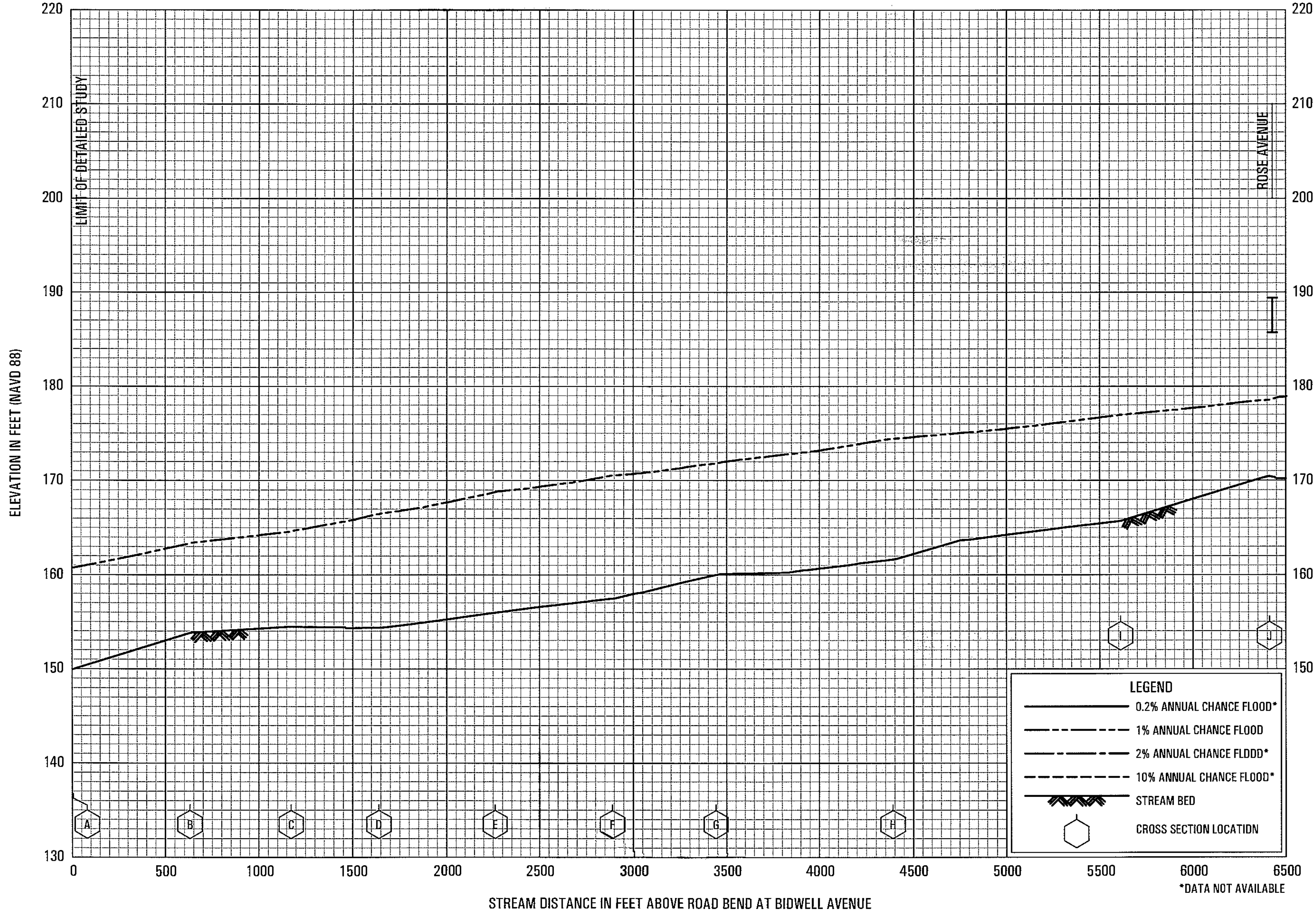


FLOOD PROFILES

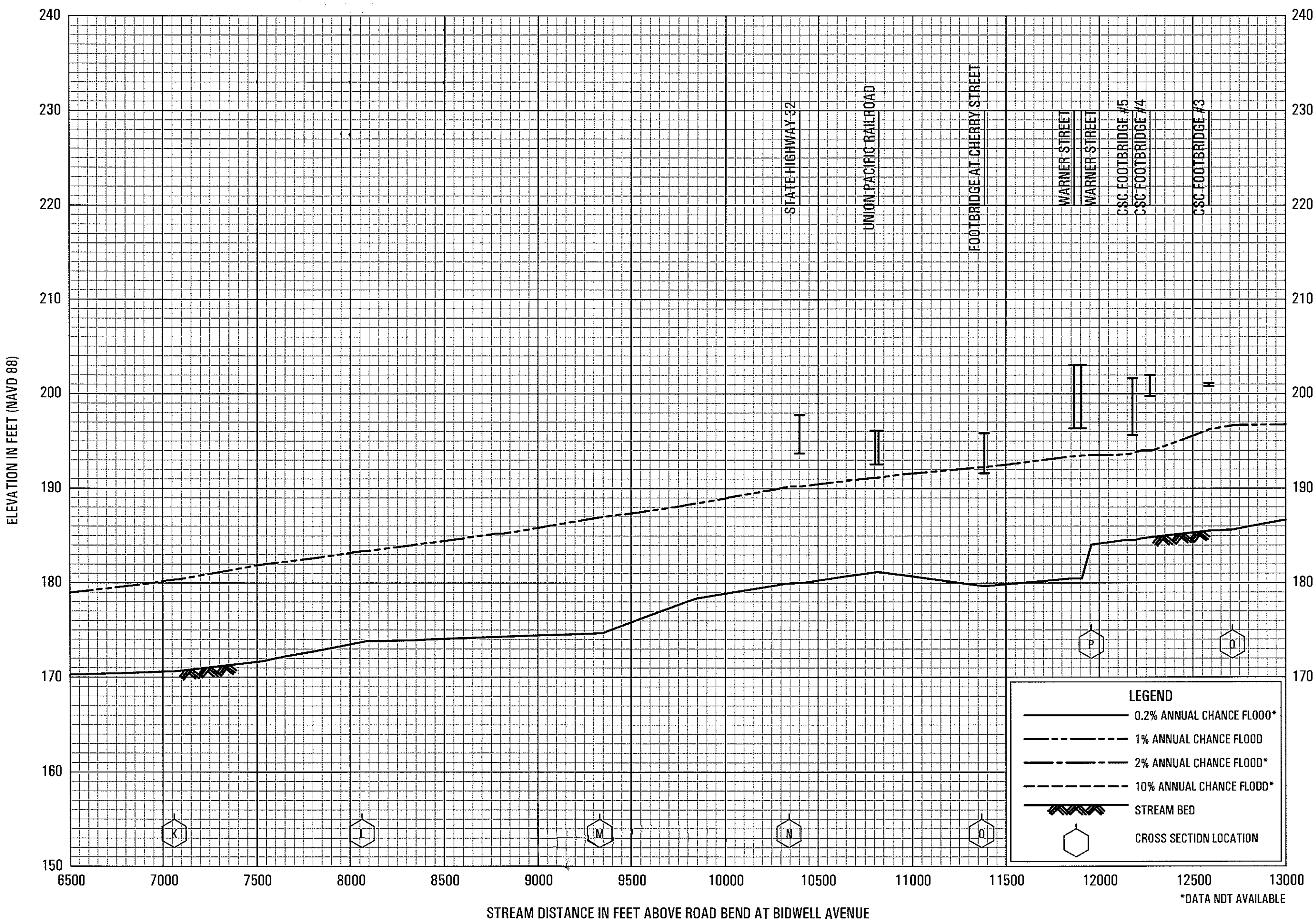
BIG CHICO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

01P



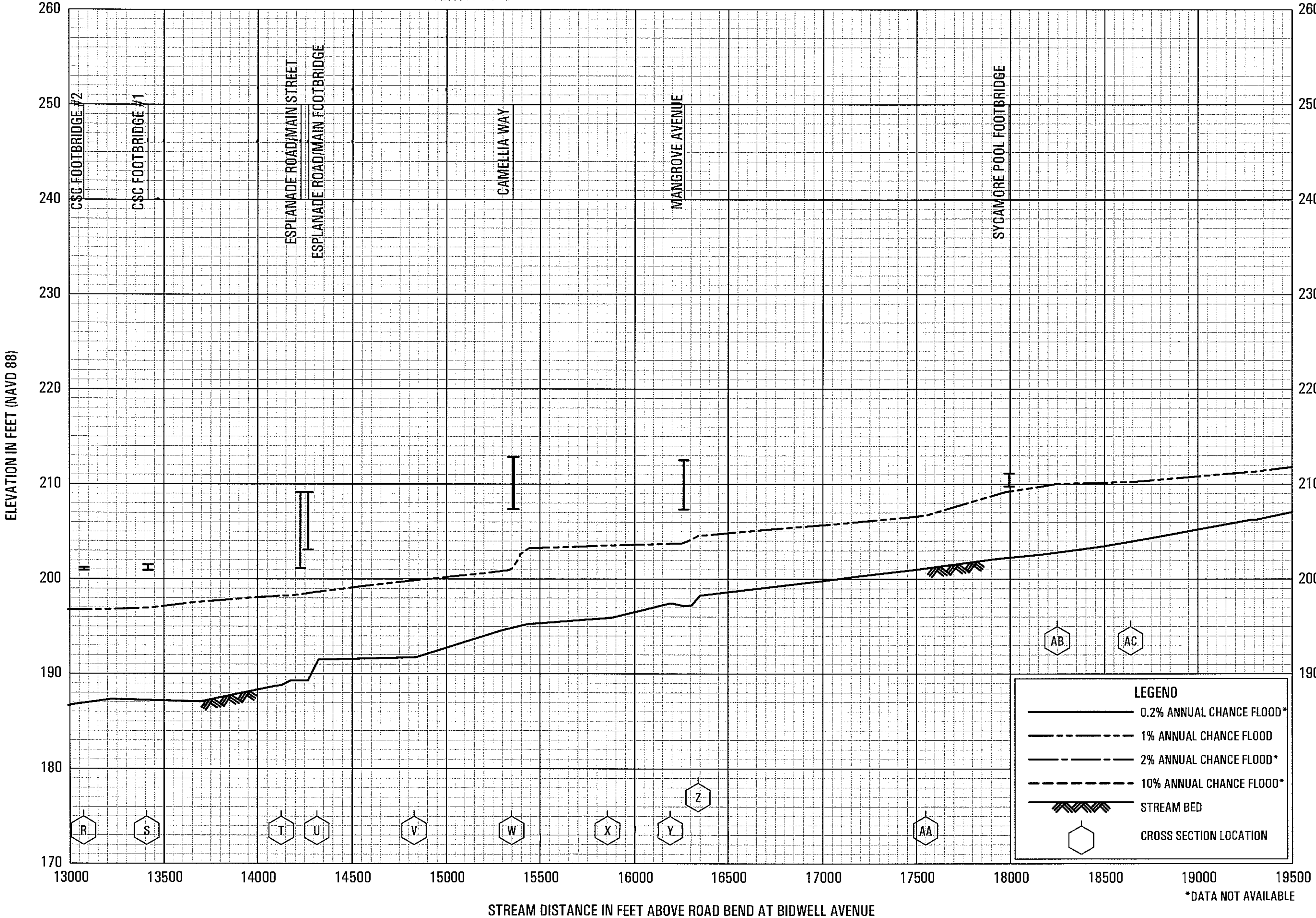
FLOOD PROFILES

BIG CHICO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



FLOOD PROFILES

BIG CHICO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

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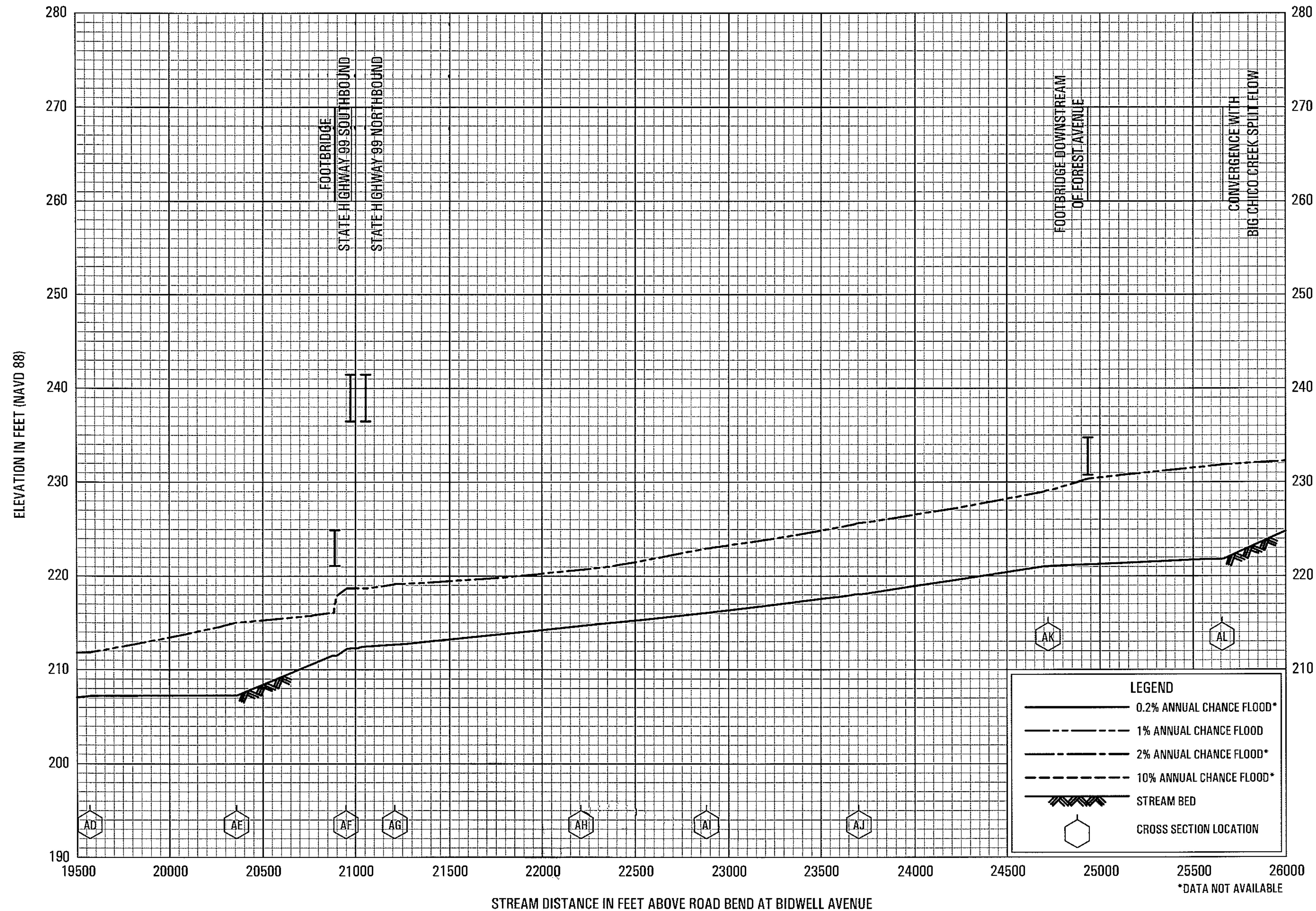

FLOOD PROFILES

BIG CHICO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

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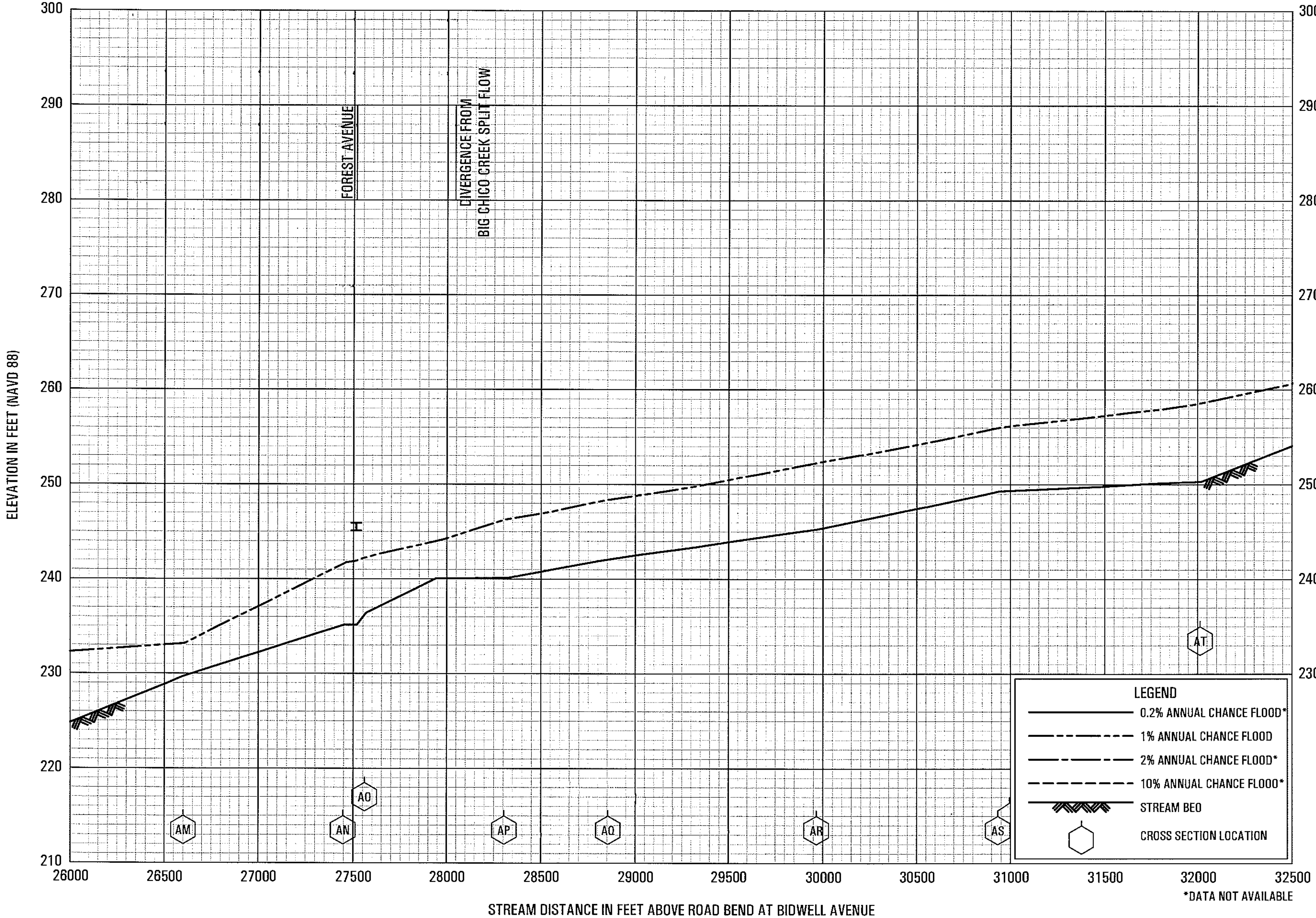

FLOOD PROFILES

BIG CHICO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

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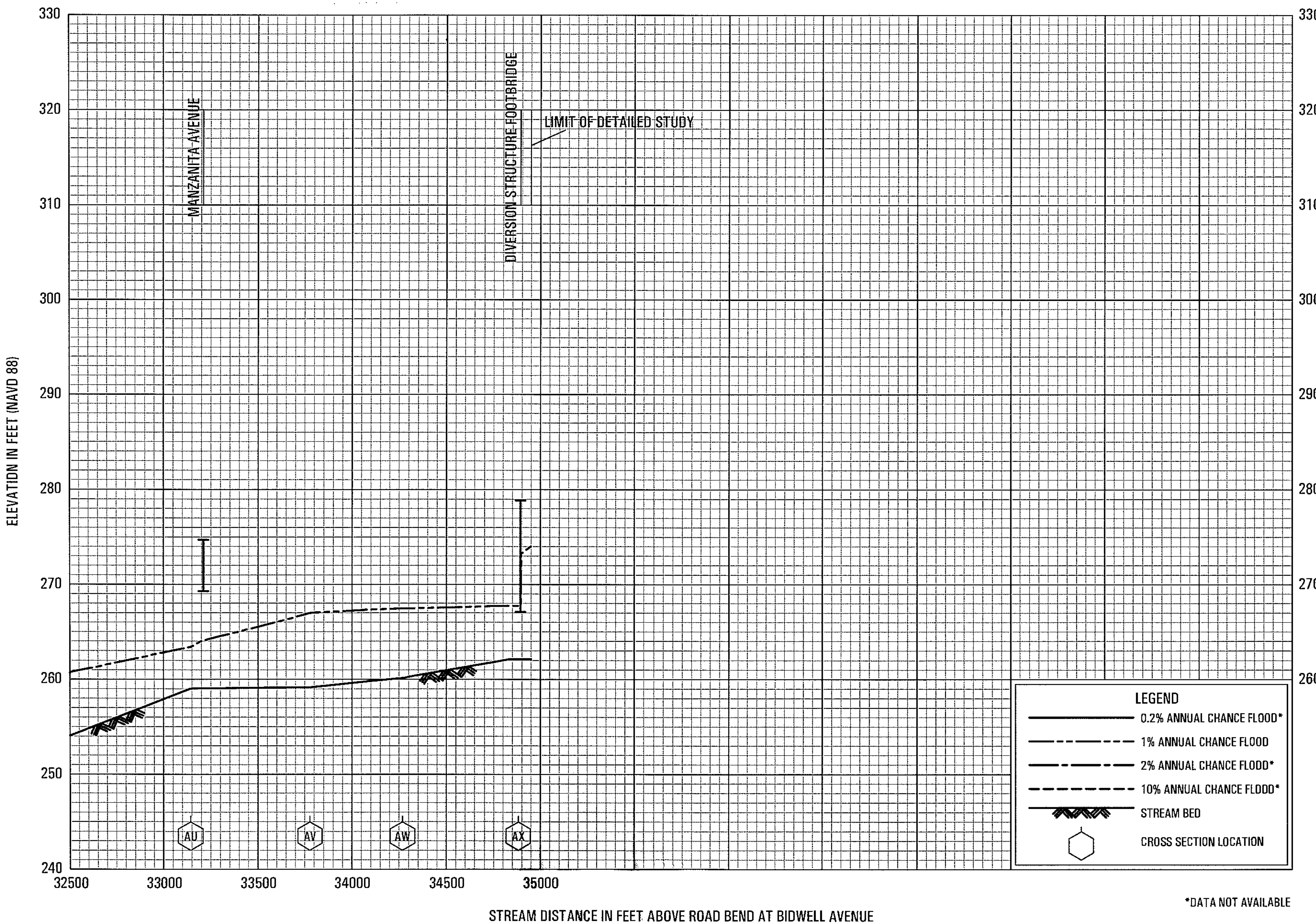


FLOOD PROFILES

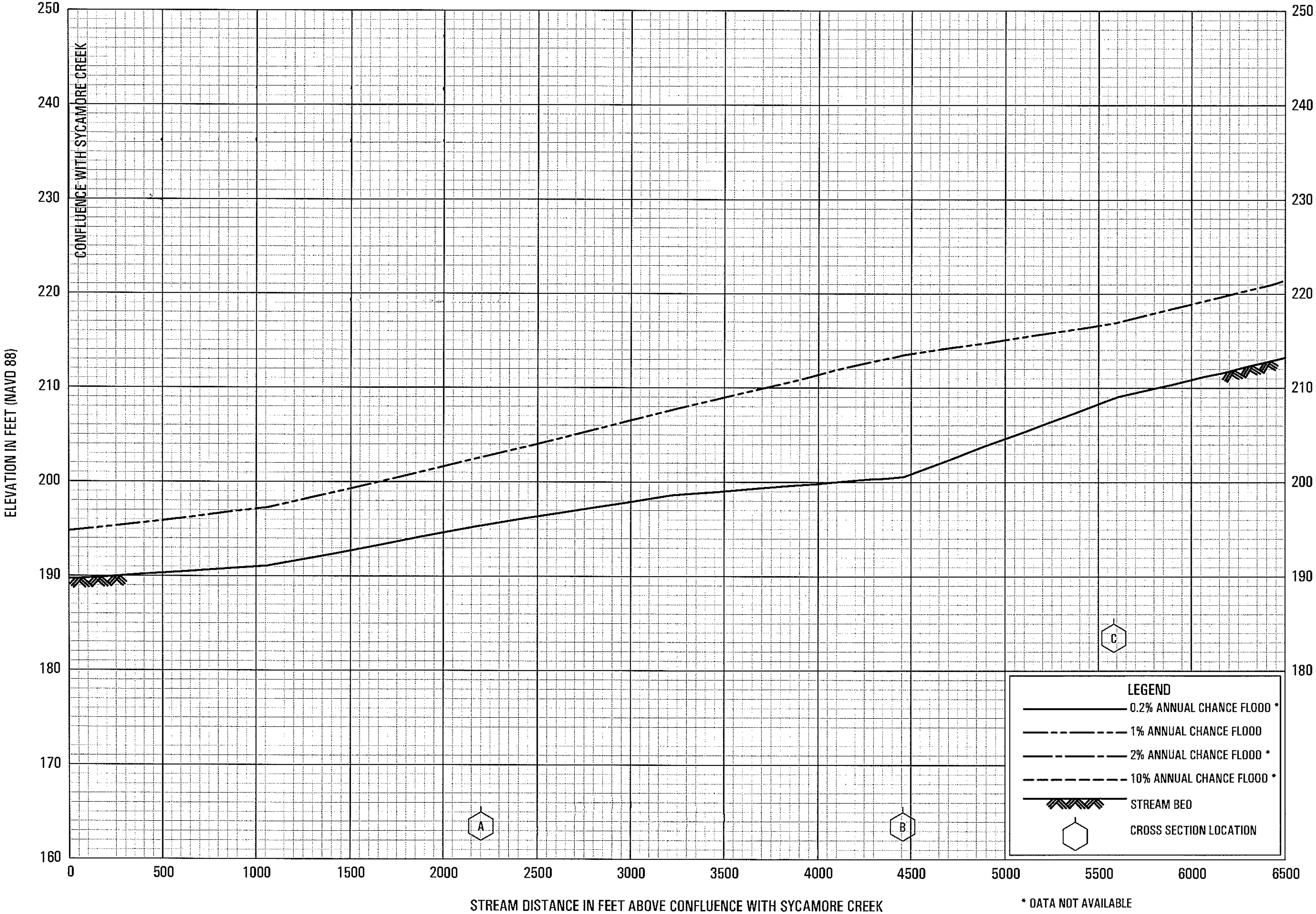
BIG CHICO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

06P



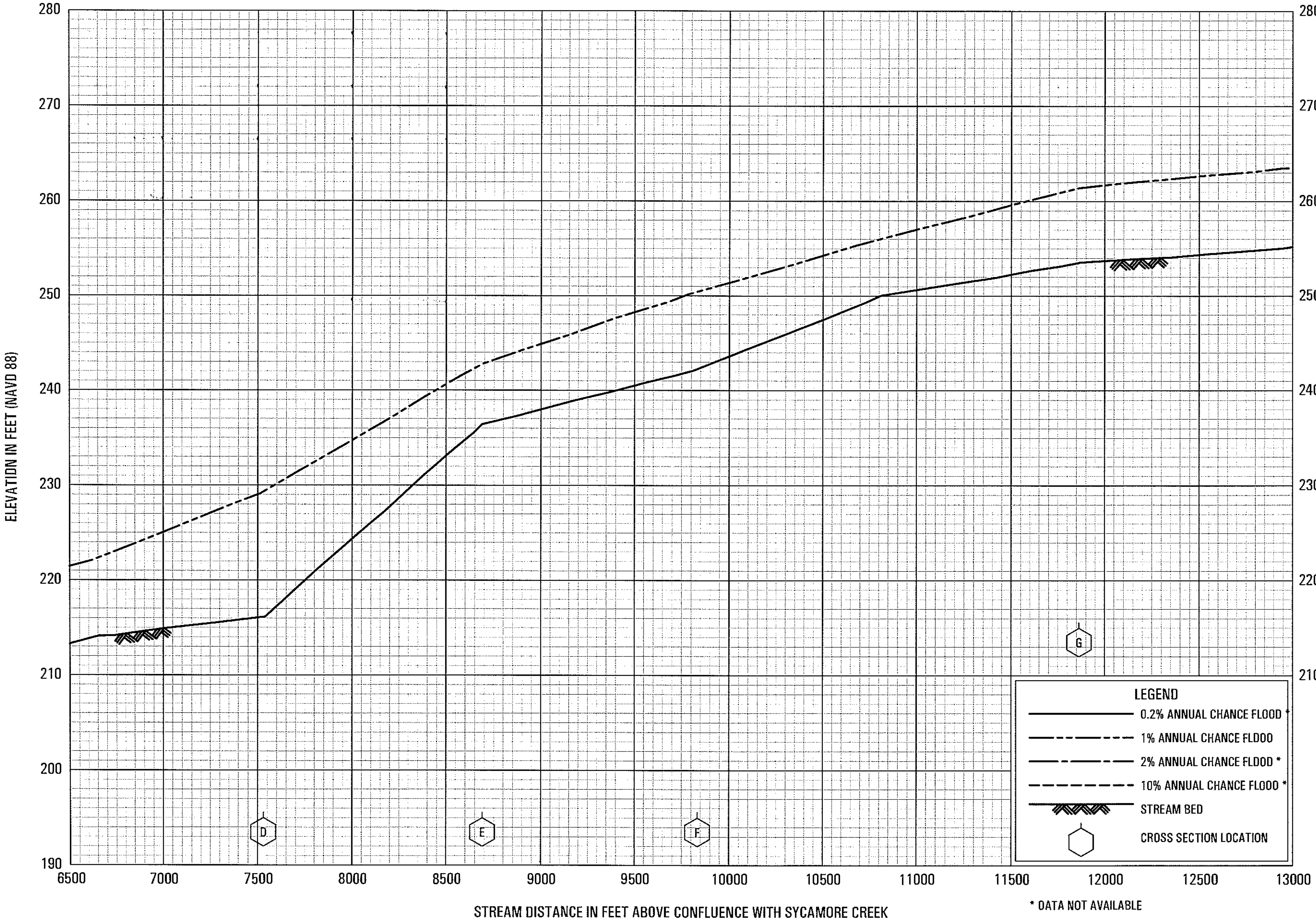
FLOOD PROFILES

BIG CHICO CREEK DIVERSION CHANNEL

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



FLOOD PROFILES

BIG CHICO CREEK DIVERSION CHANNEL

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

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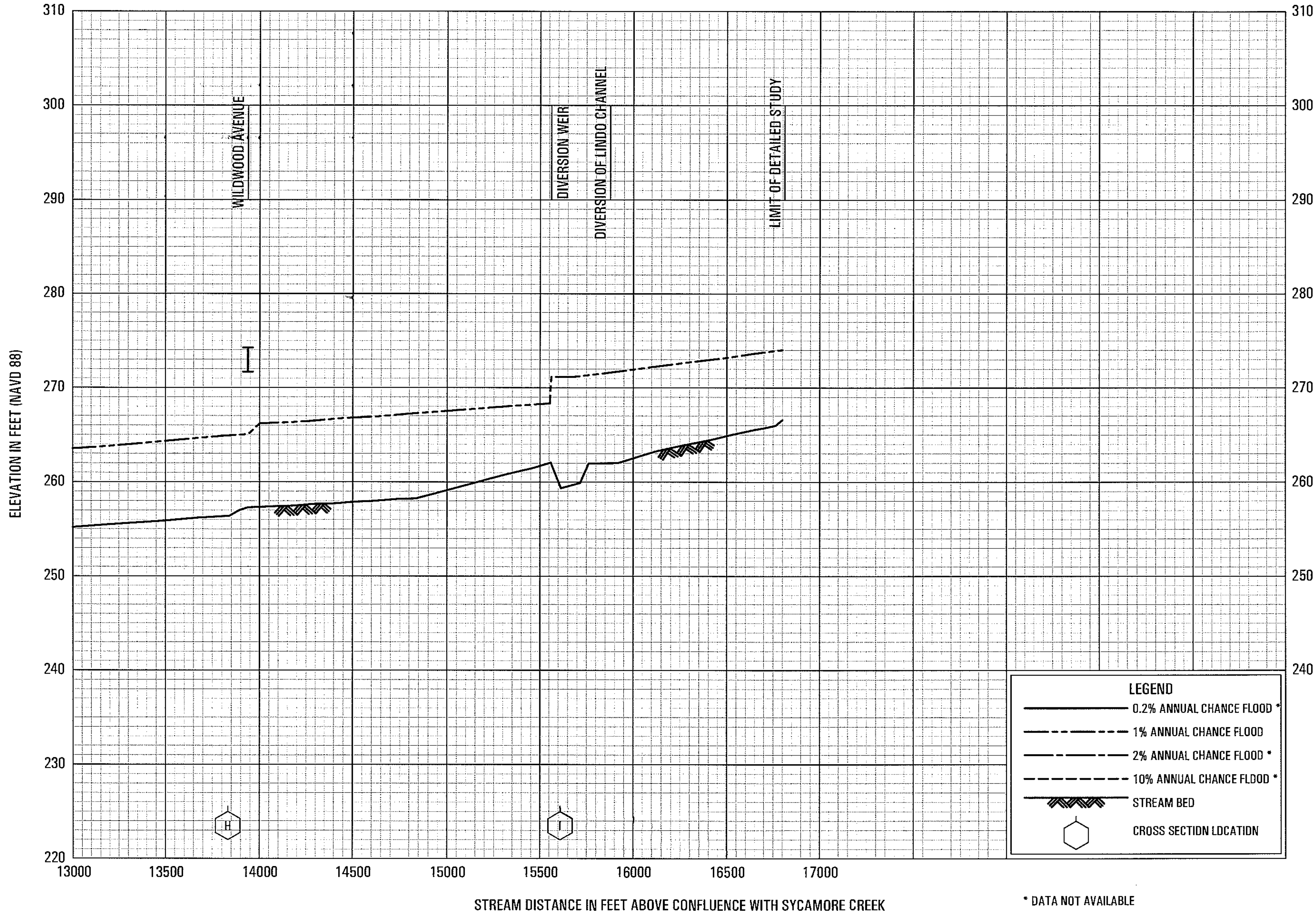

FLOOD PROFILES

BIG CHICO CREEK DIVERSION CHANNEL

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

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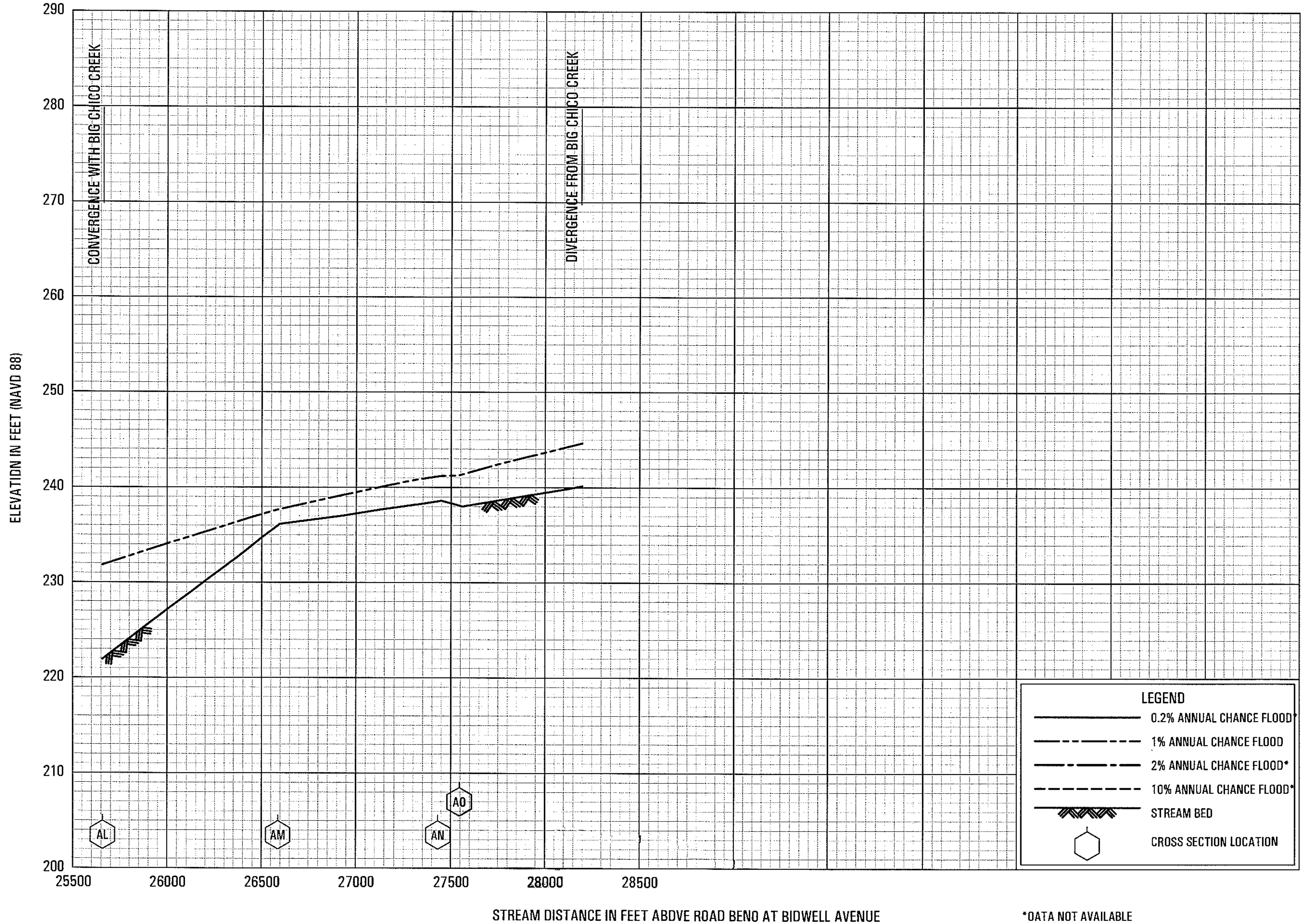

FLOOD PROFILES

BIG CHICO CREEK SPLIT FLOW

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

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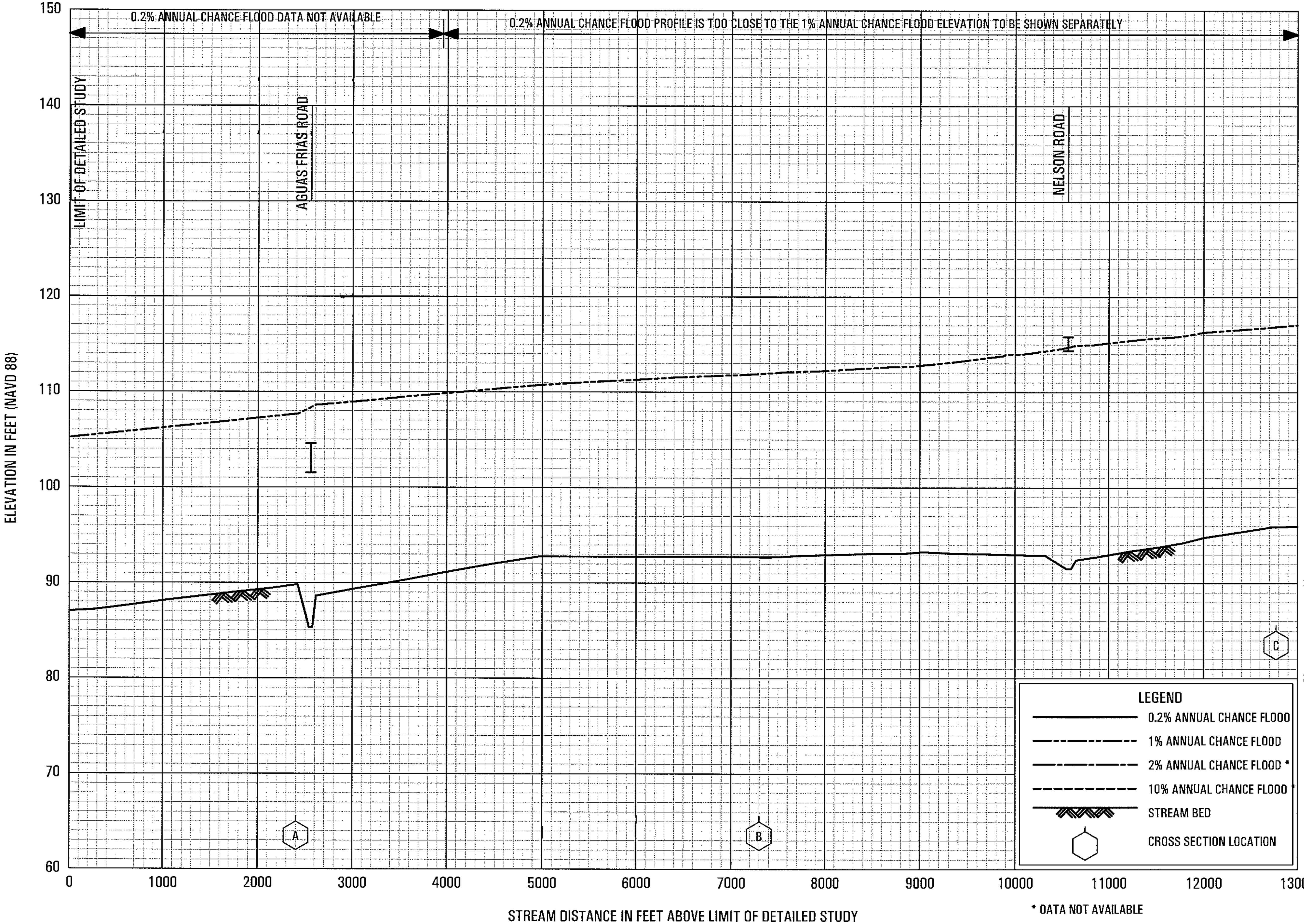

FLOOD PROFILES

BUTTE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

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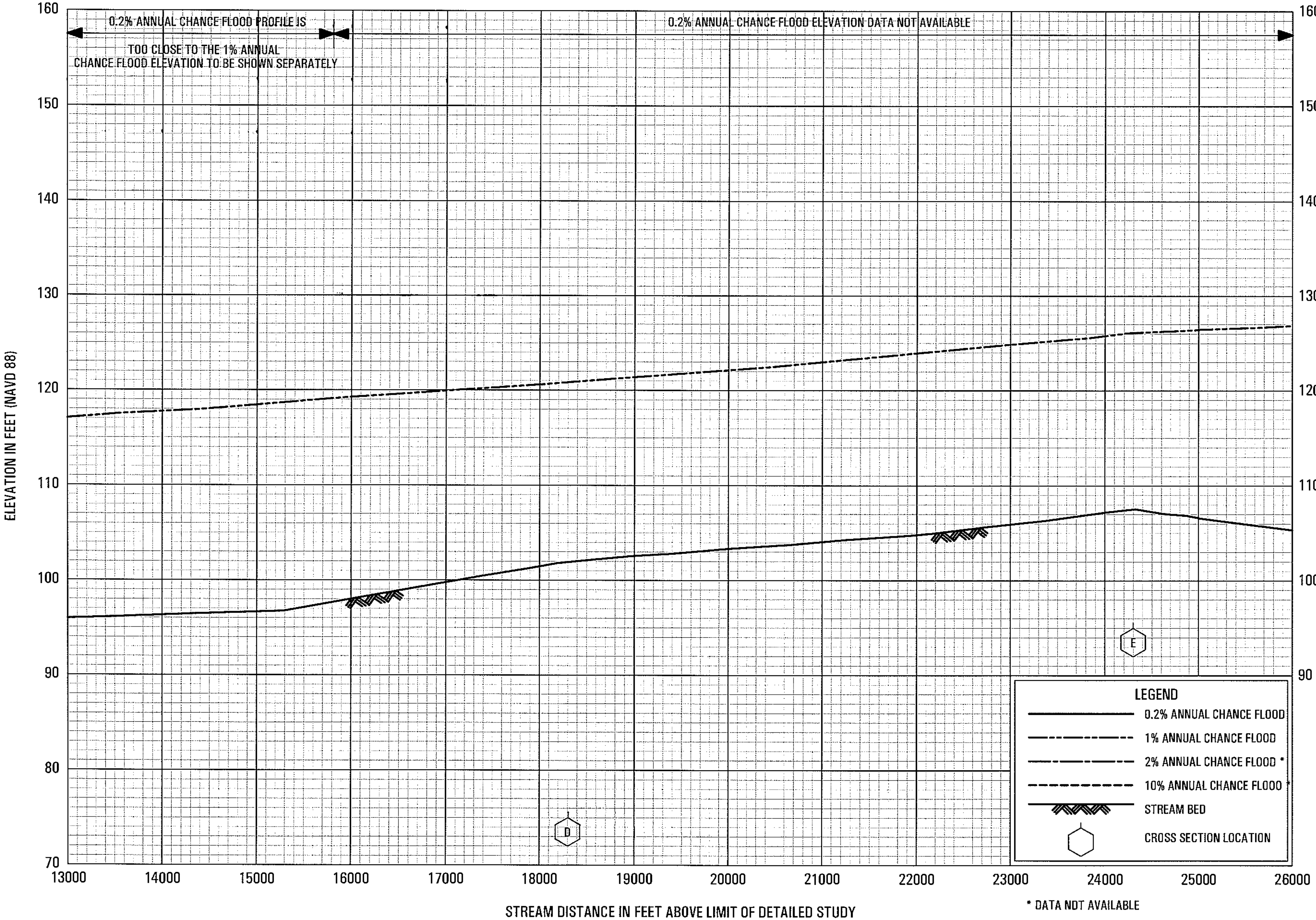

FLOOD PROFILES

BUTTE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

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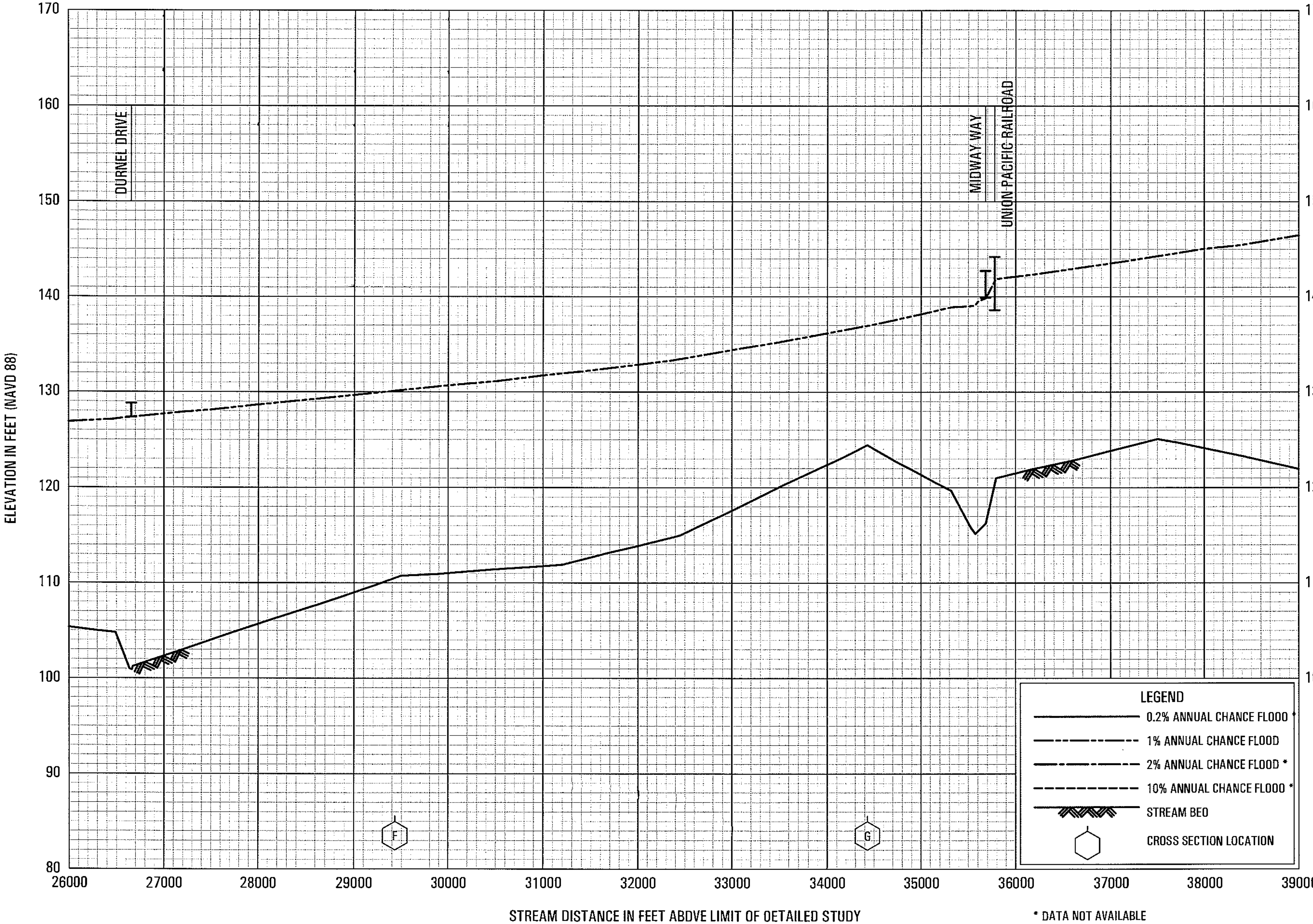


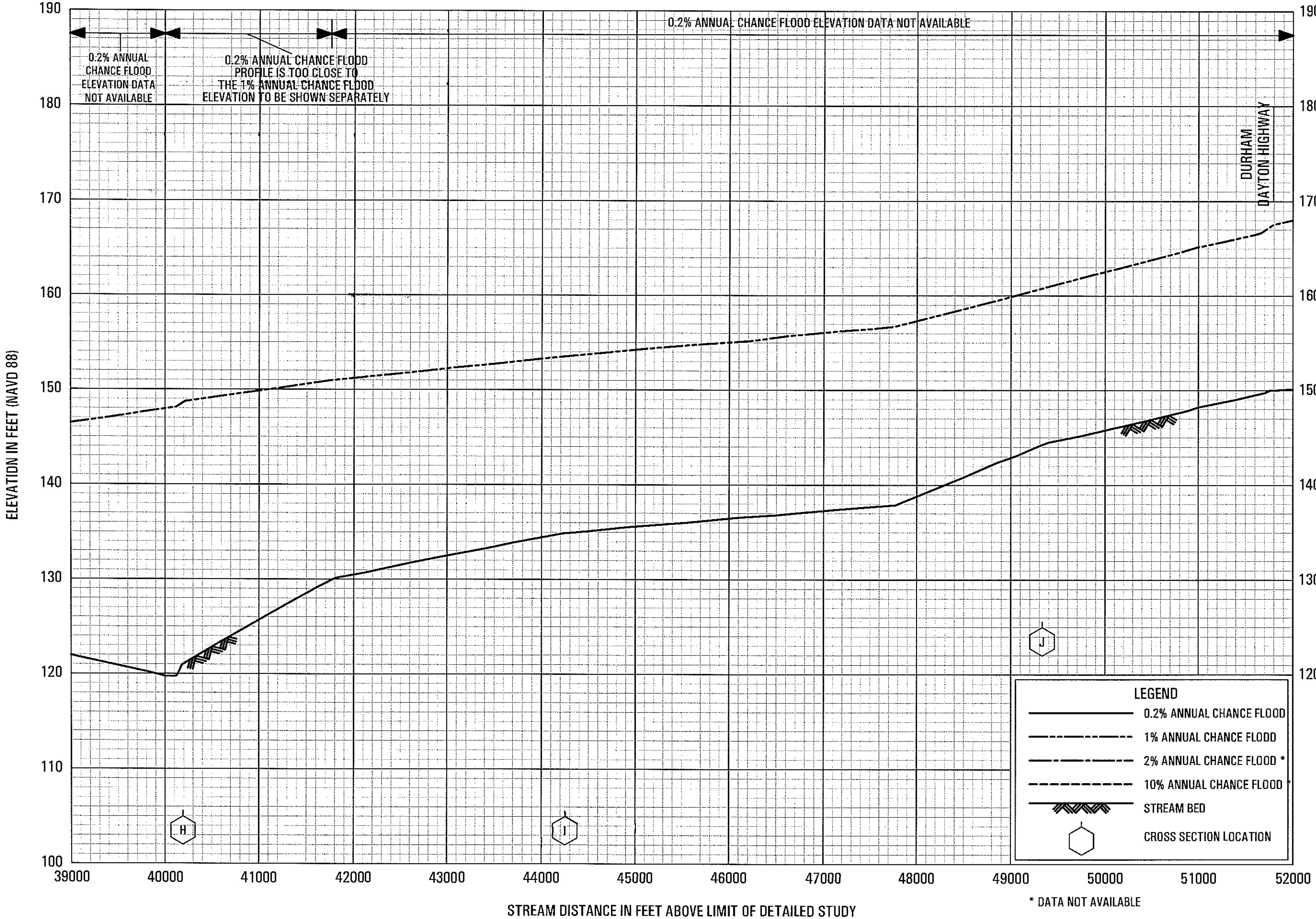
FLOOD PROFILES

BUTTE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



FLOOD PROFILES

BUTTE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

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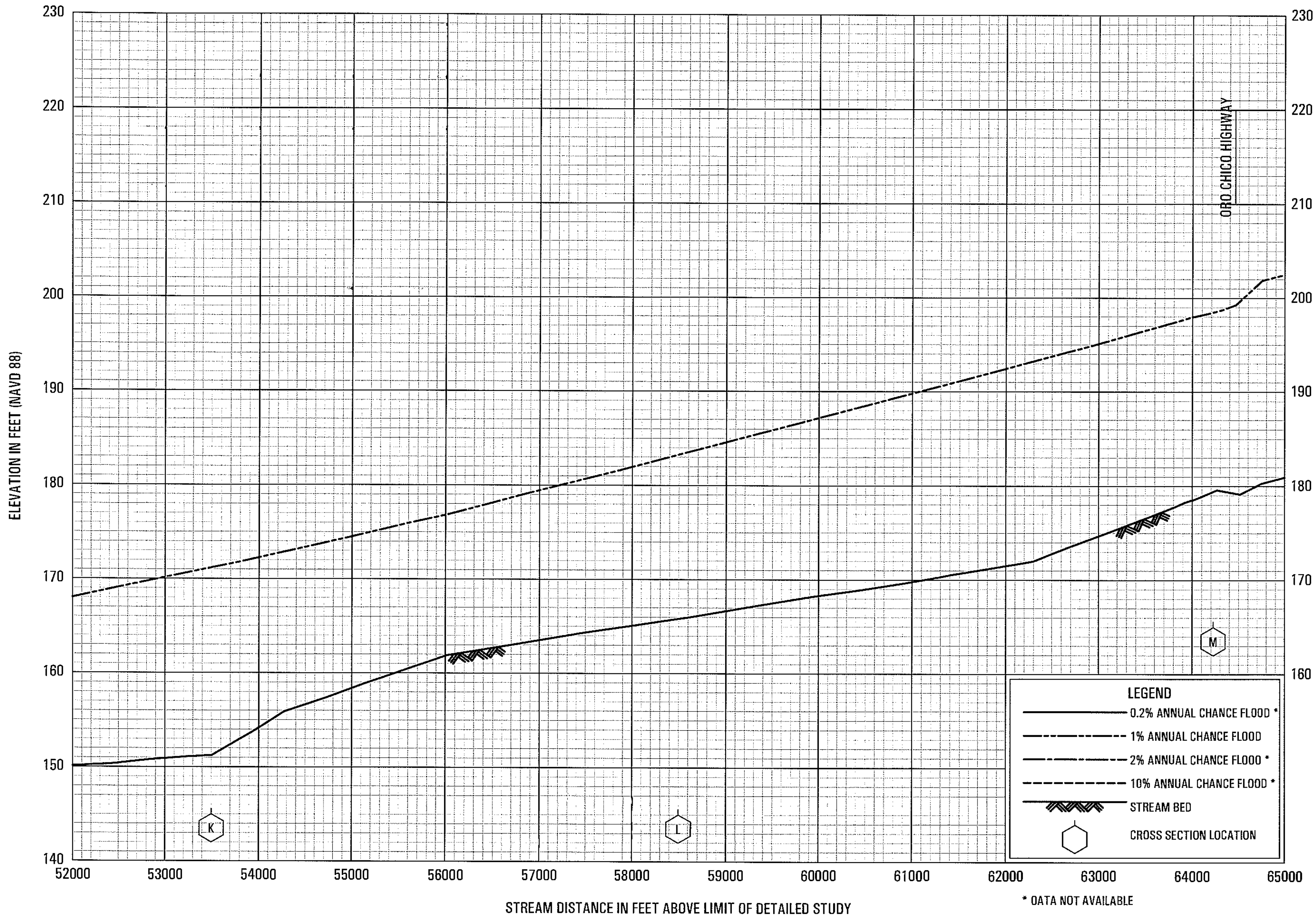

FLOOD PROFILES

BUTTE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA
AND INCORPORATED AREAS

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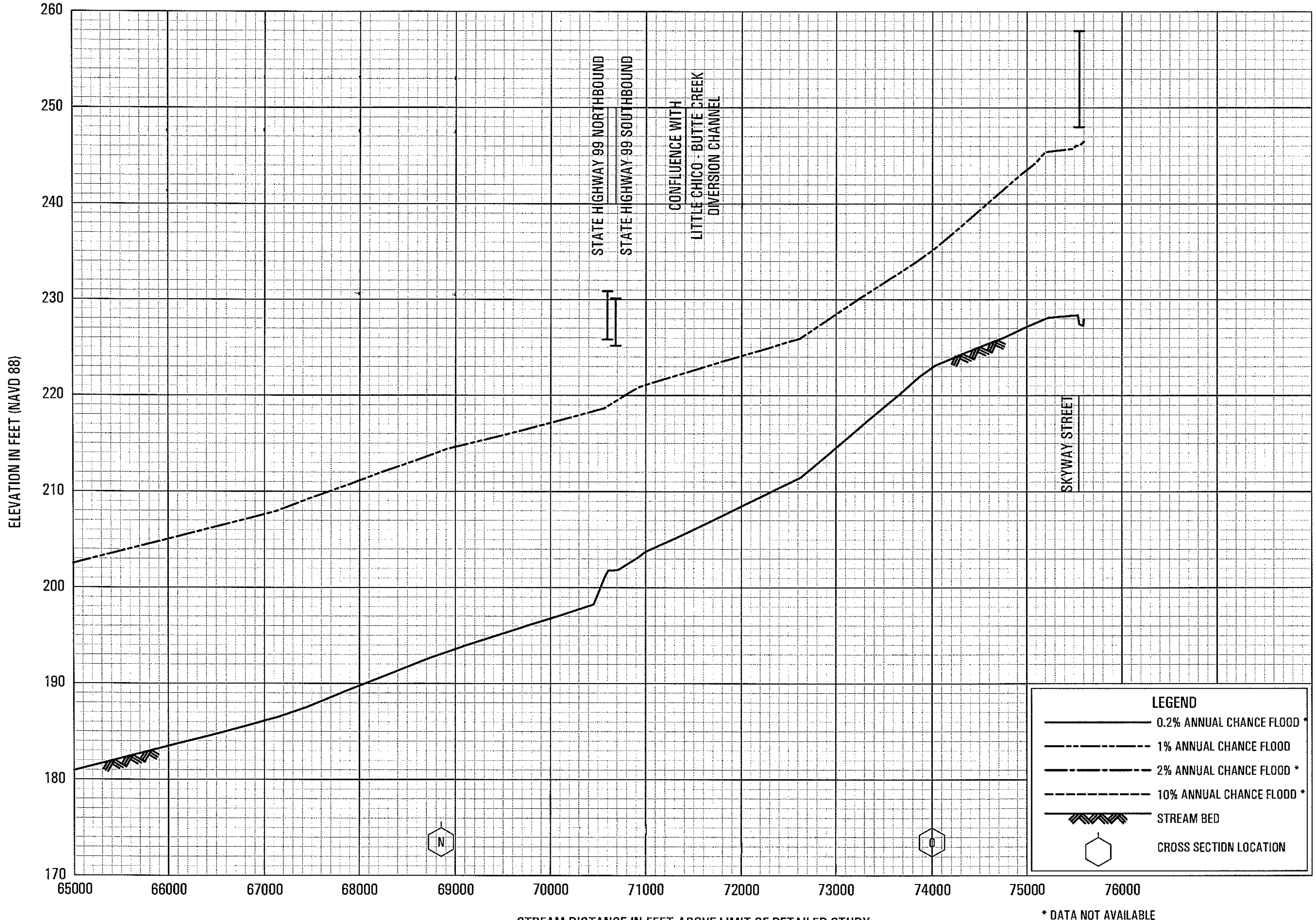

FLOOD PROFILES

BUTTE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

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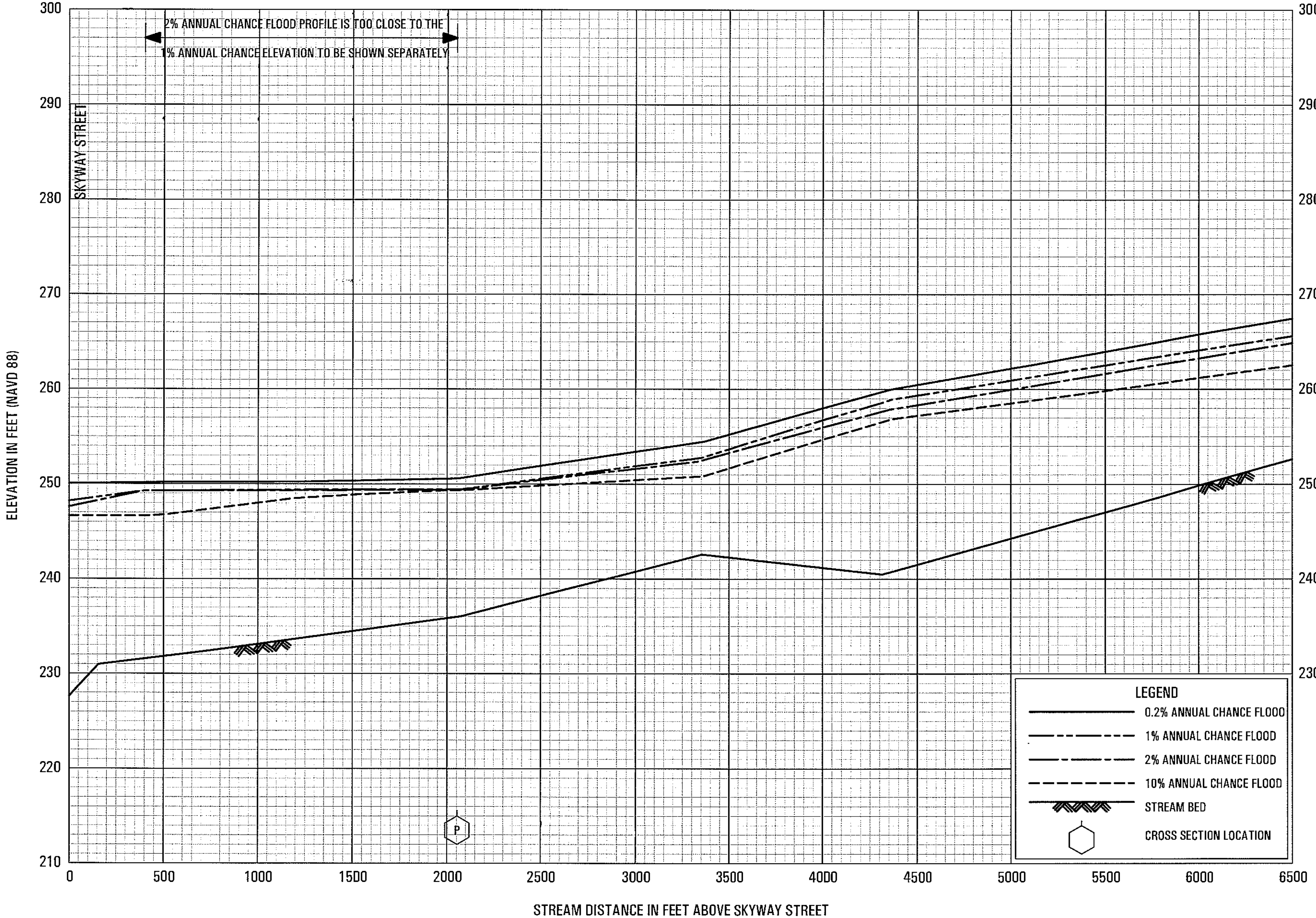


FLOOD PROFILES

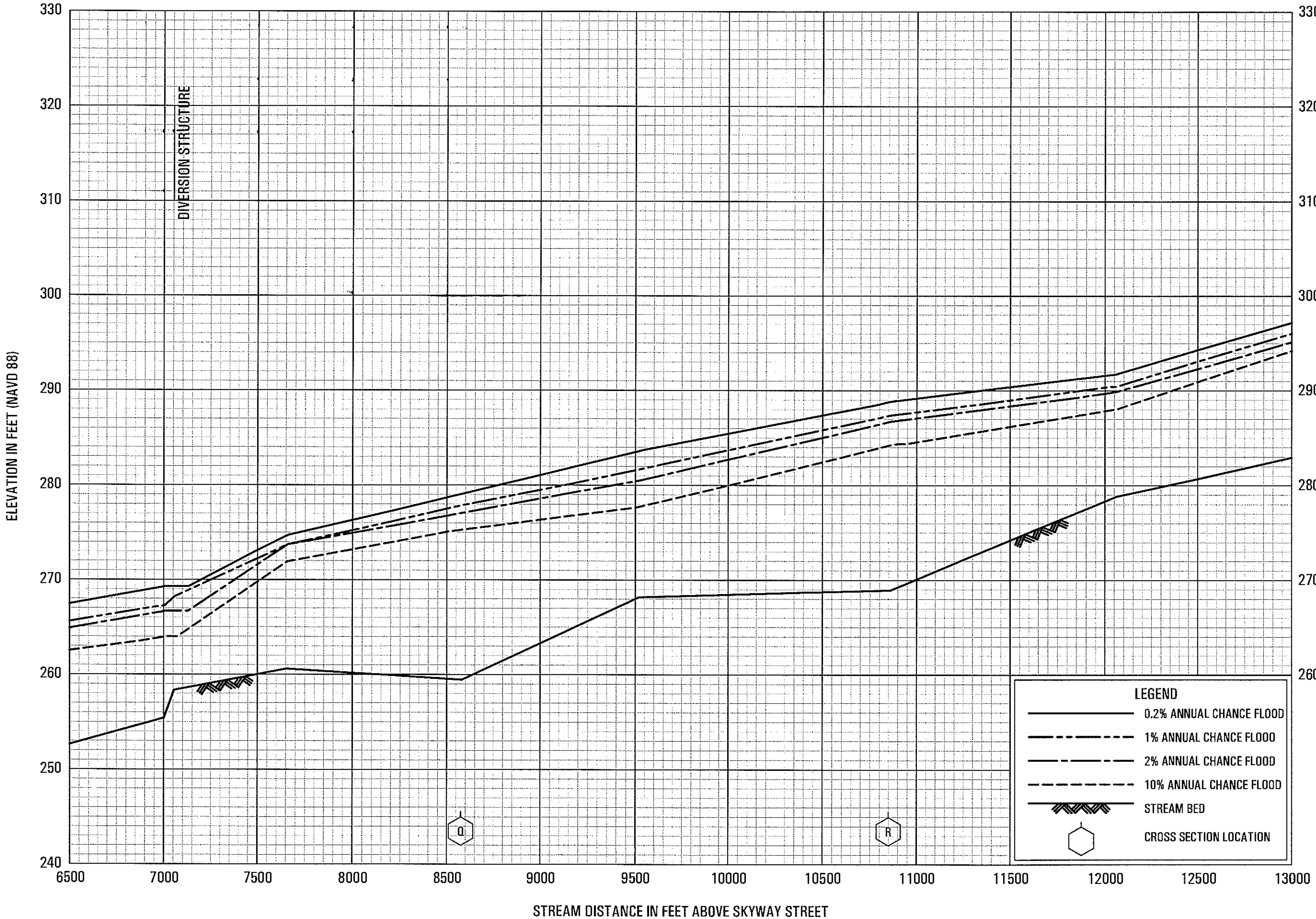
BUTTE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

17P



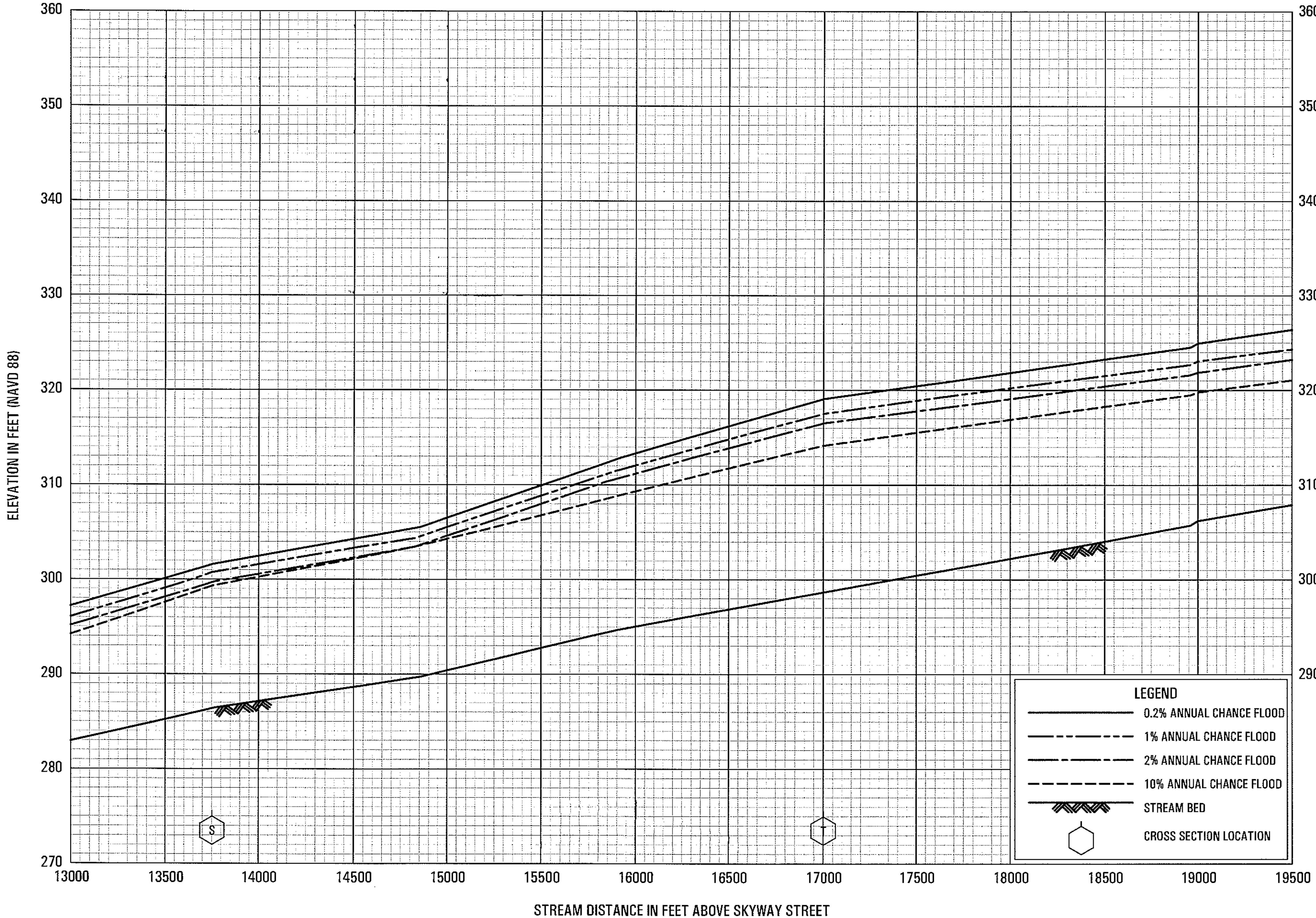
FLOOD PROFILES

BUTTE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



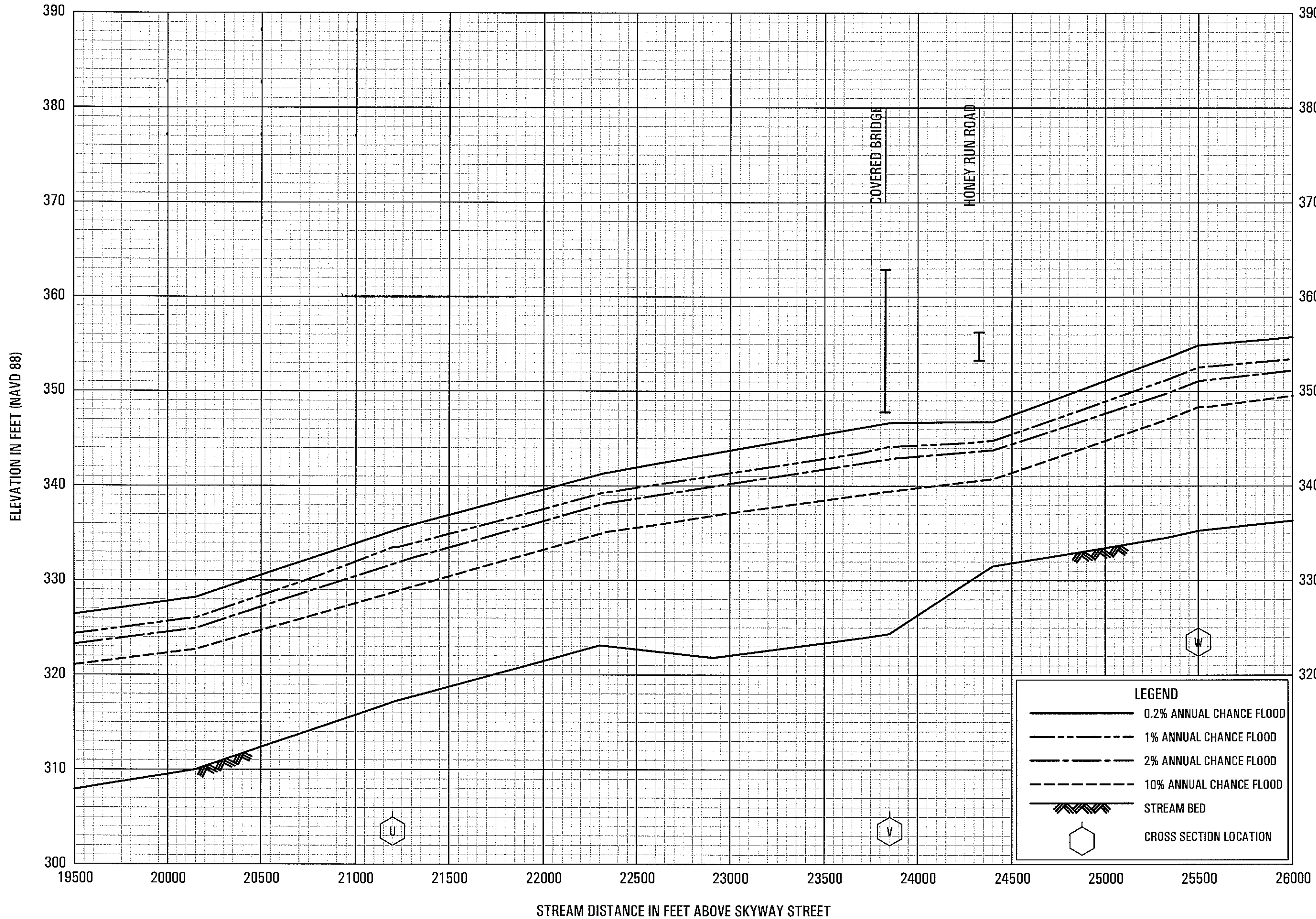
FLOOD PROFILES

BUTTE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



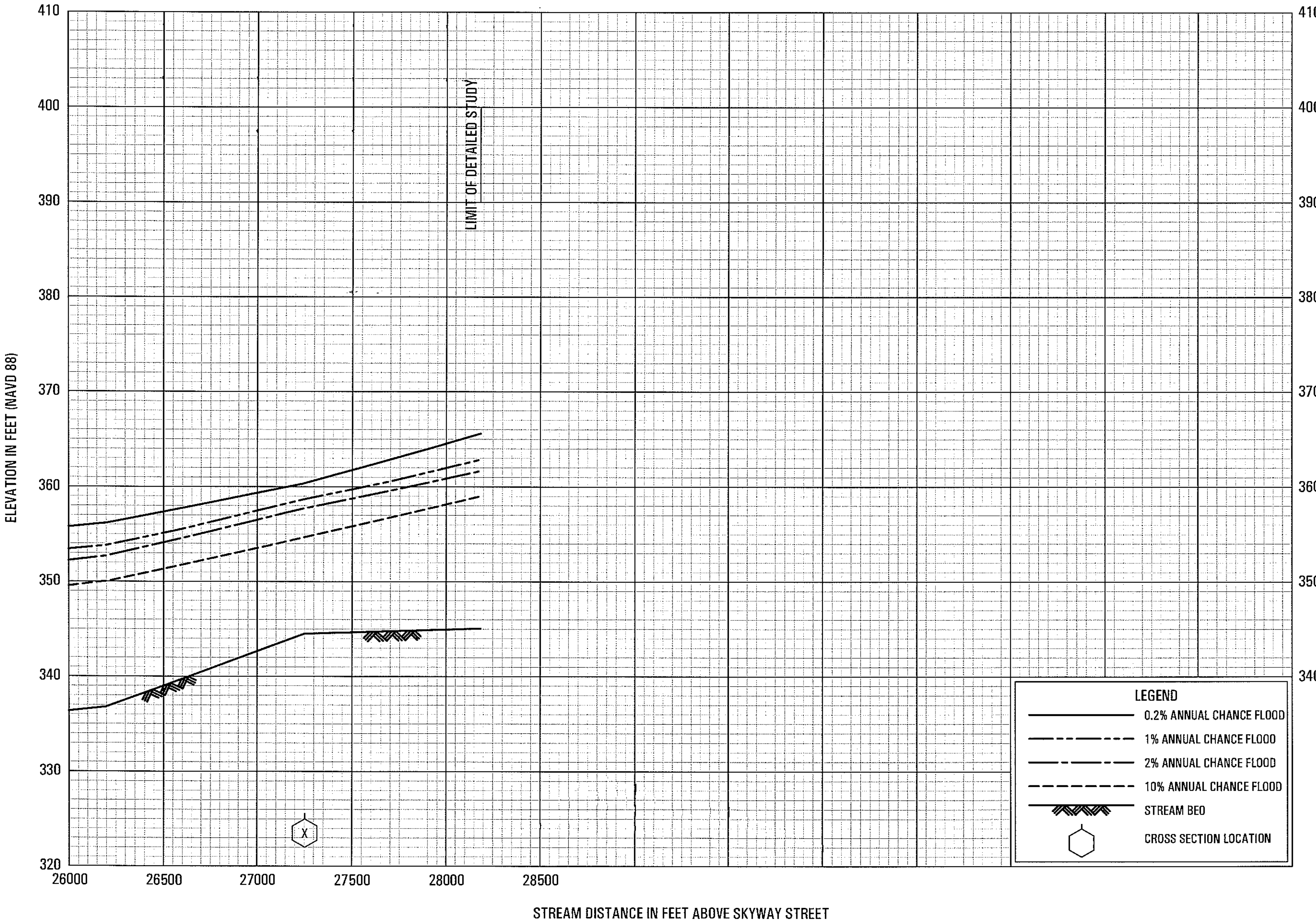
FLOOD PROFILES

BUTTE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



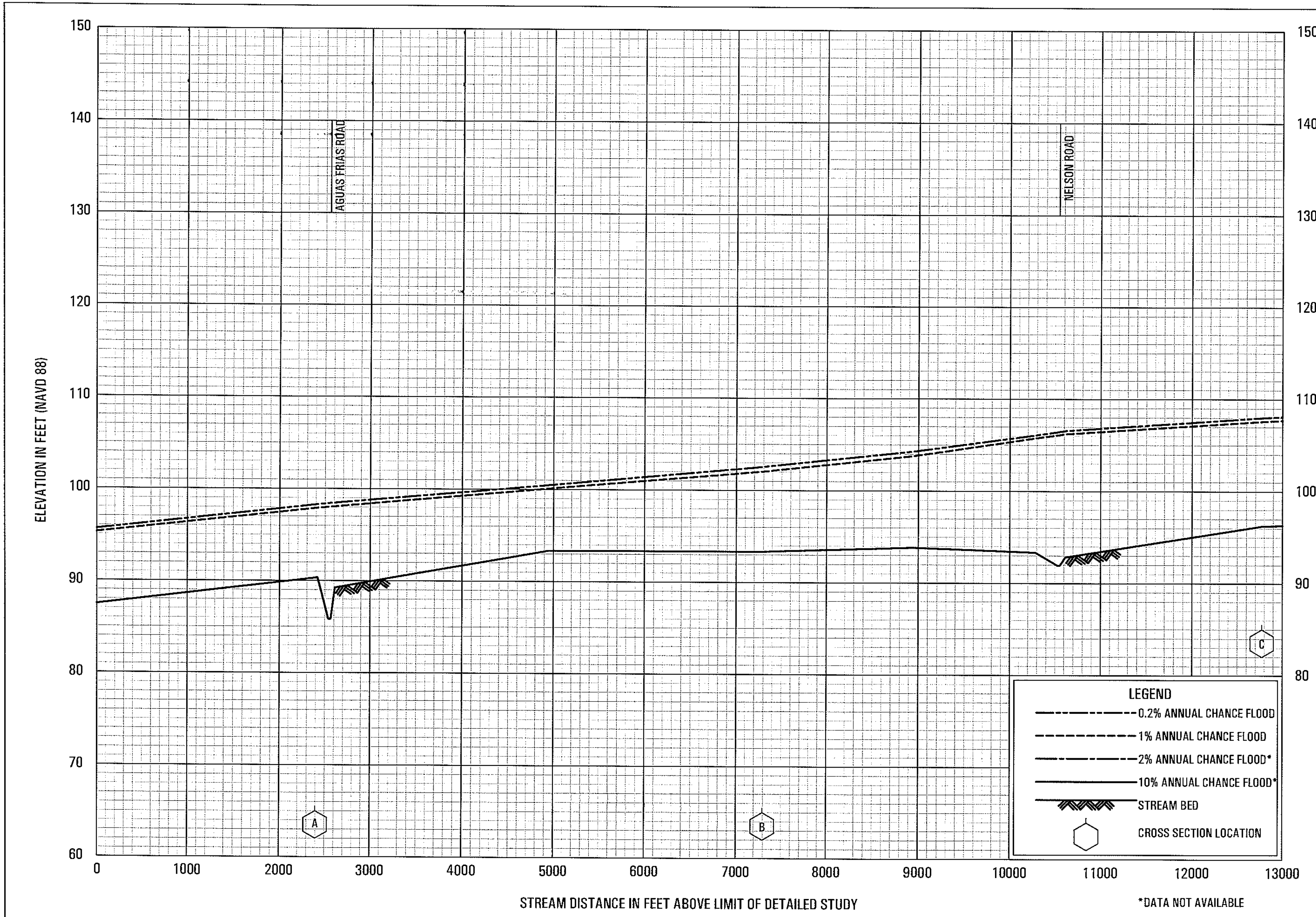
FLOOD PROFILES

BUTTE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



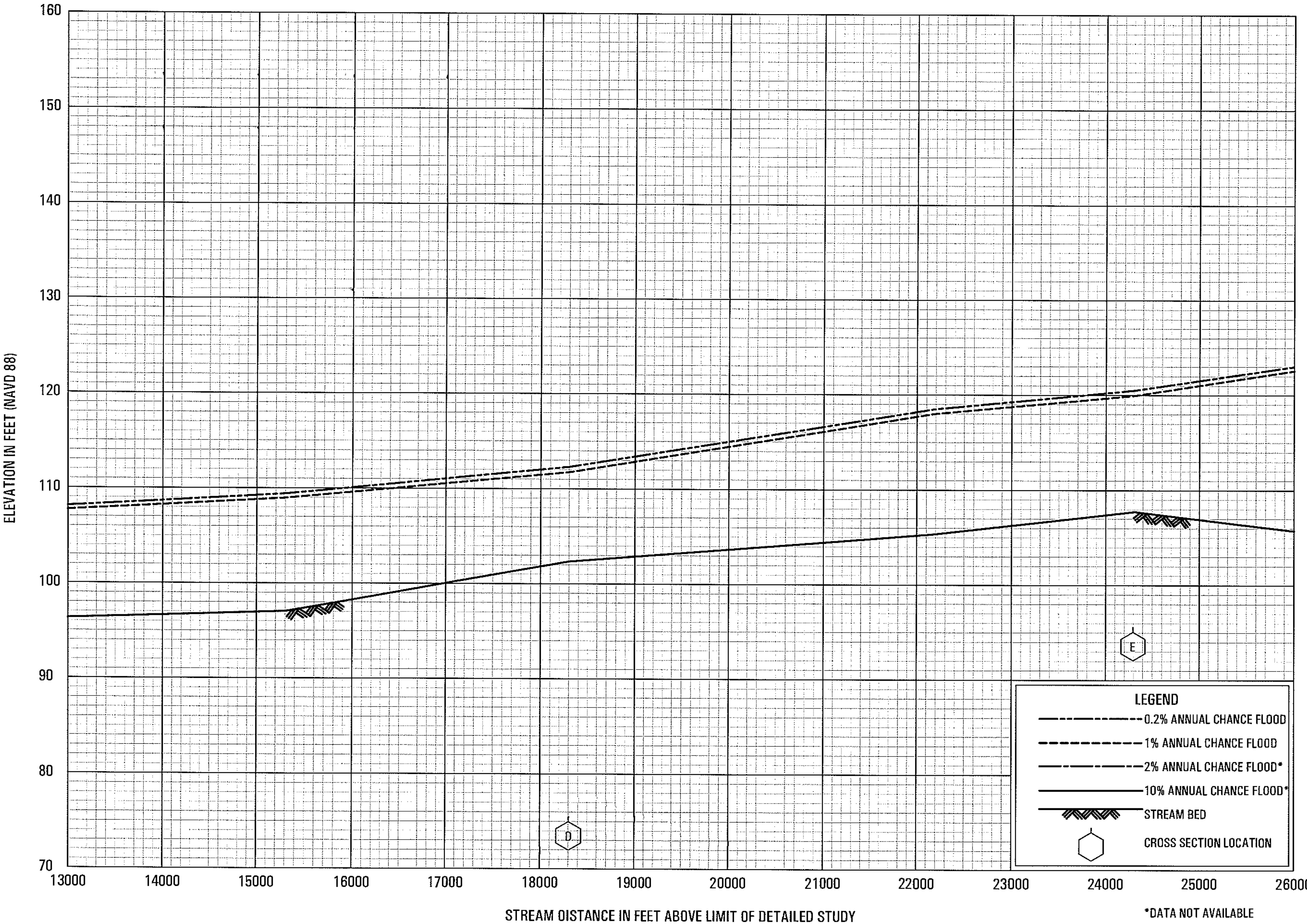
FLOOD PROFILES

BUTTE CREEK LEFT LEVEE FAILED

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



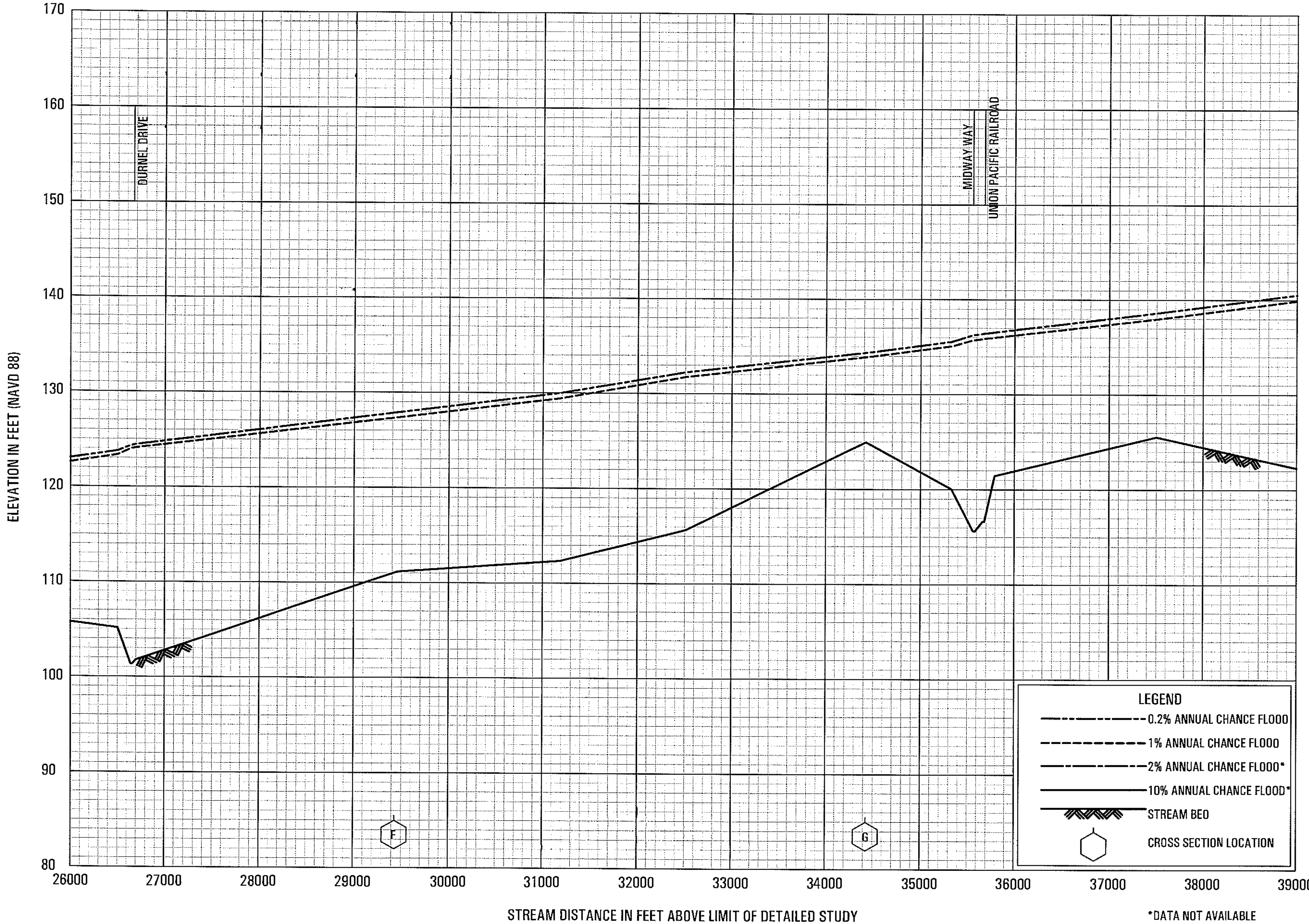
FLOOD PROFILES

BUTTE CREEK LEFT LEVEE FAILED

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

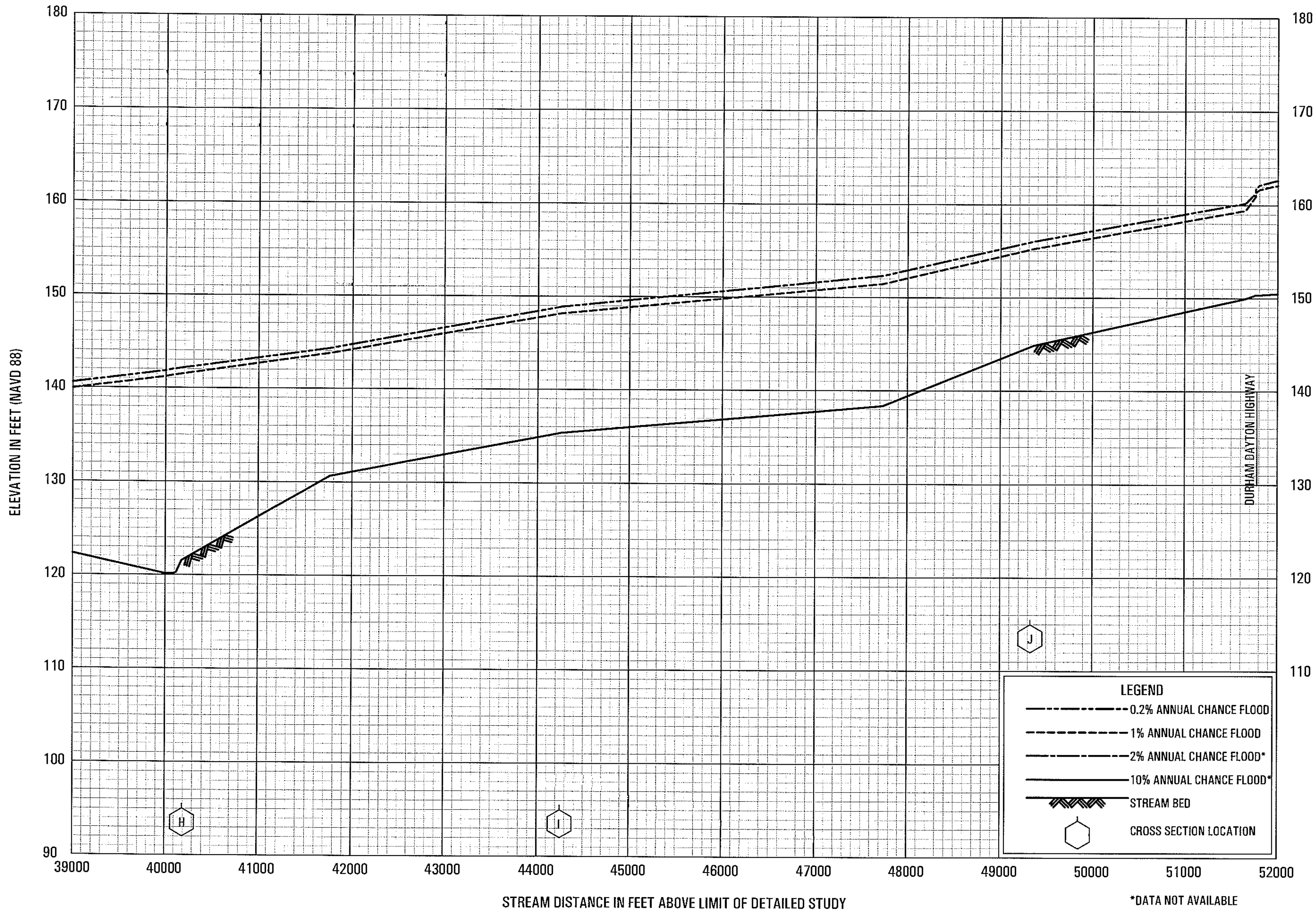


FLOOD PROFILES

BUTTE CREEK LEFT LEVEE FAILED

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA
AND INCORPORATED AREAS



FLOOD PROFILES

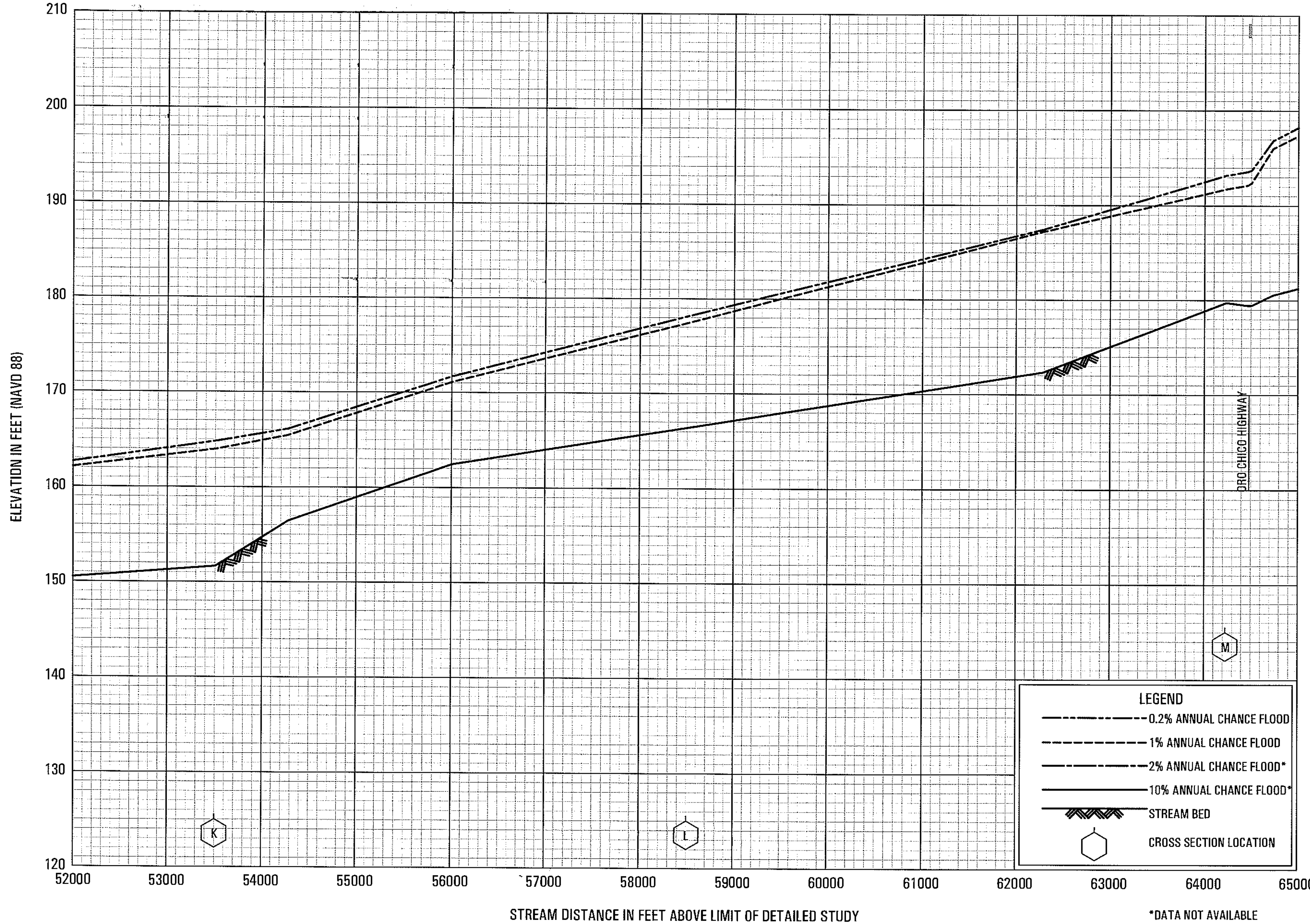
BUTTE CREEK LEFT LEVEE FAILED

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

21dP



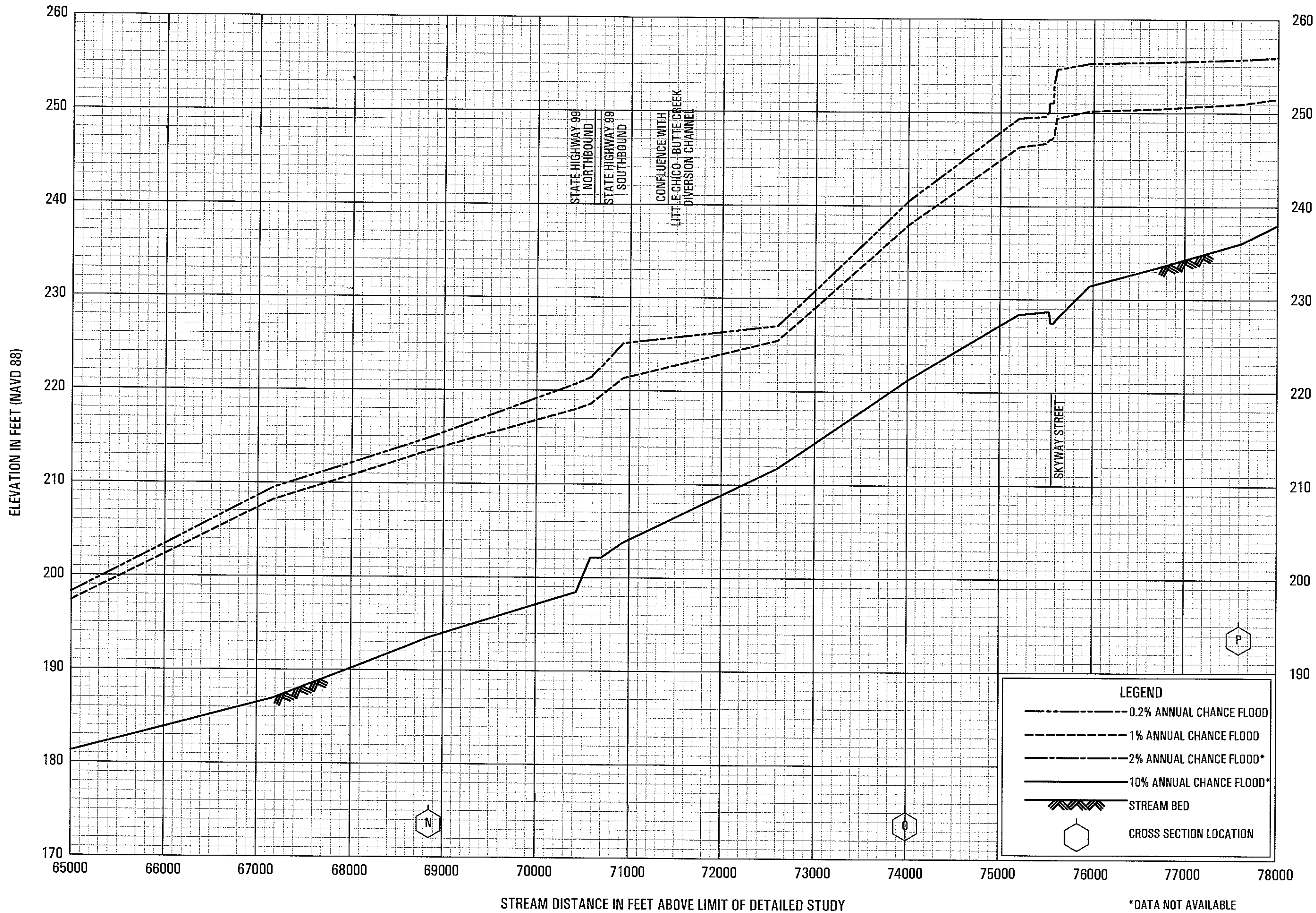
FLOOD PROFILES

BUTTE CREEK LEFT LEVEE FAILED

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE CREEK, CA

AND INCORPORATED AREAS



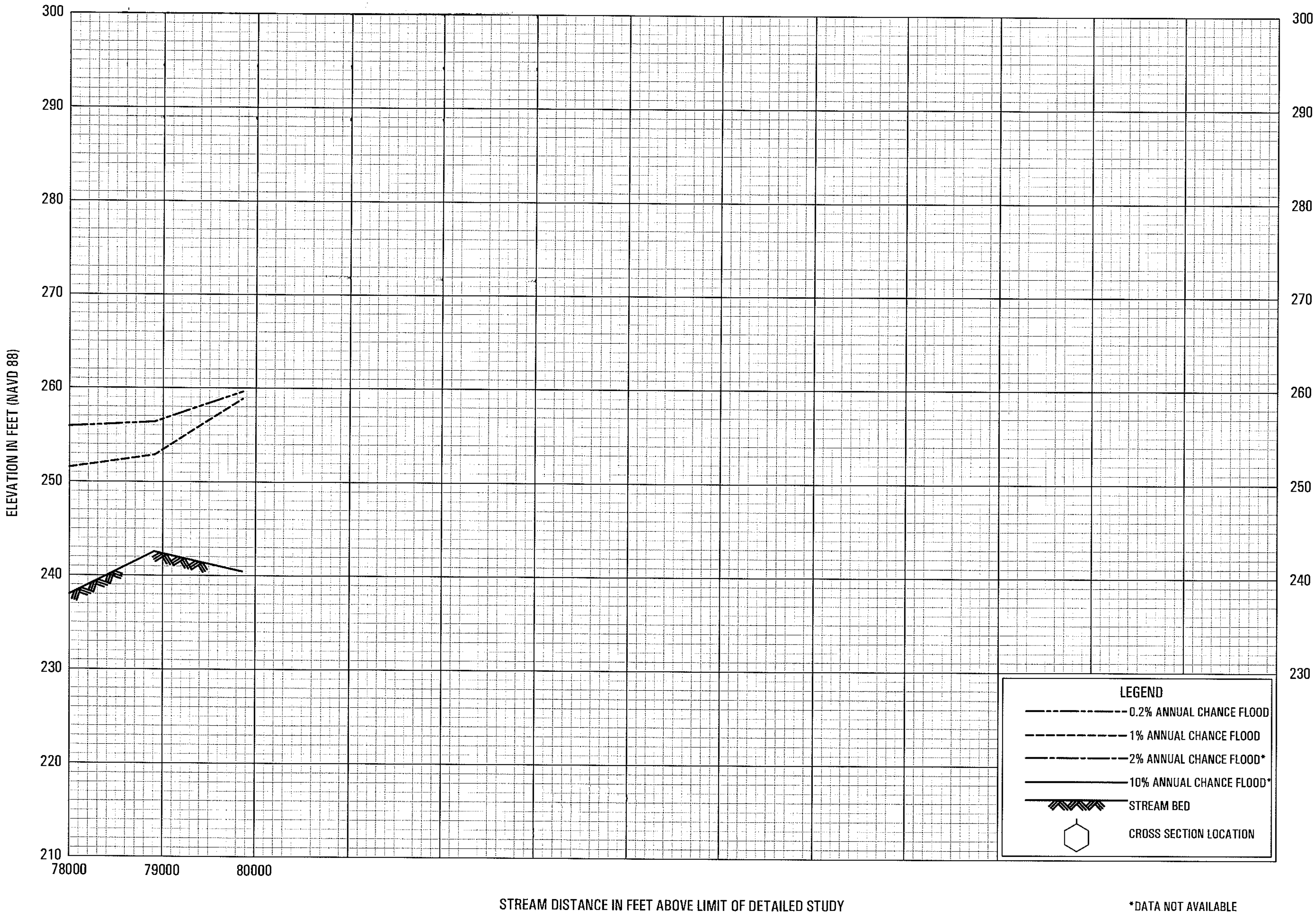
FLOOD PROFILES

BUTTE CREEK LEFT LEVEE FAILED

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



FLOOD PROFILES

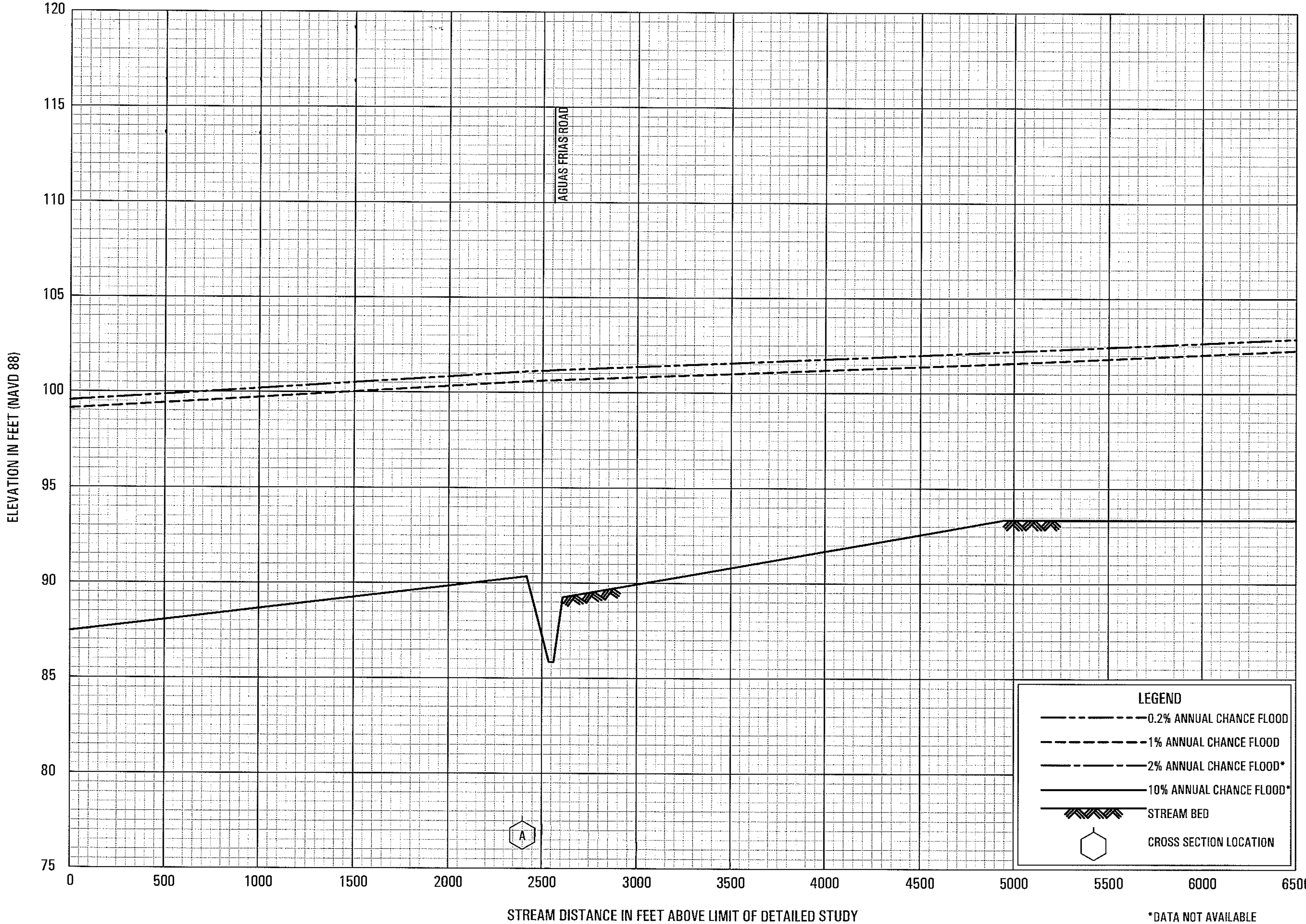
BUTTE CREEK LEFT LEVEE FAILED

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE CREEK, CA

AND INCORPORATED AREAS

21gP



FLOOD PROFILES

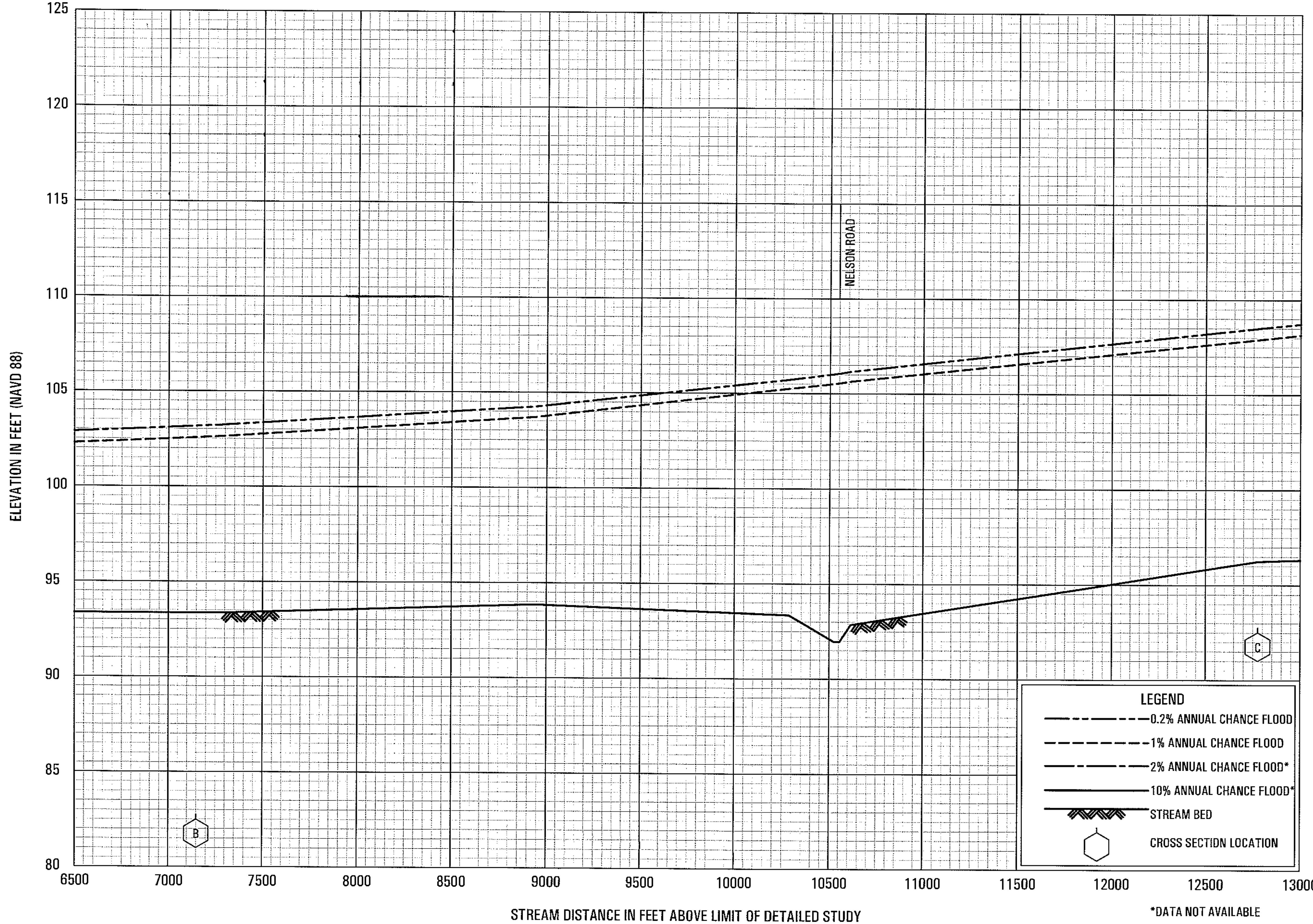
BUTTE CREEK RIGHT LEVEE FAILED - BELOW MIDWAY

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

21hP



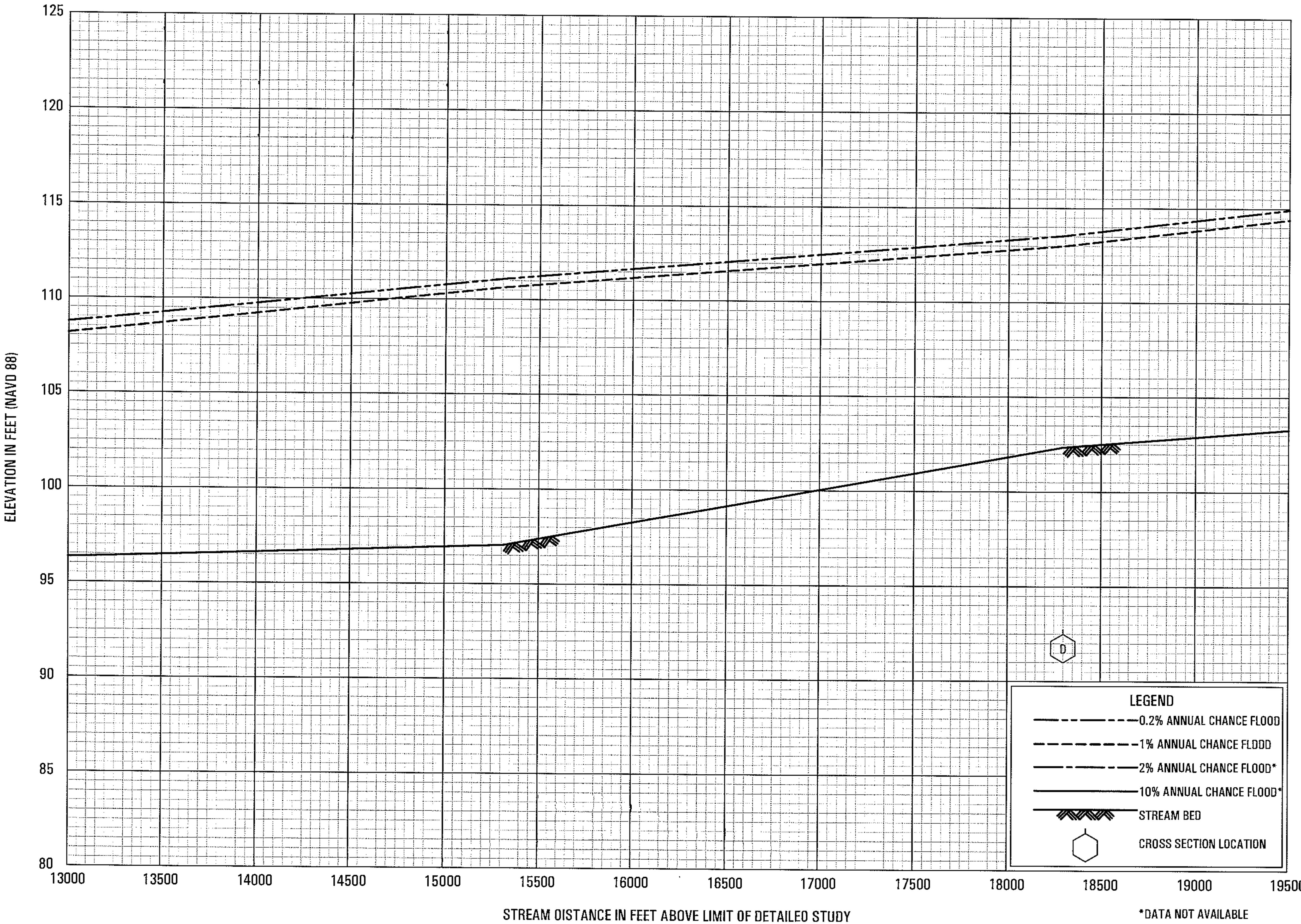
FLOOD PROFILES

BUTTE CREEK RIGHT LEVEE FAILED - BELOW MIDWAY

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



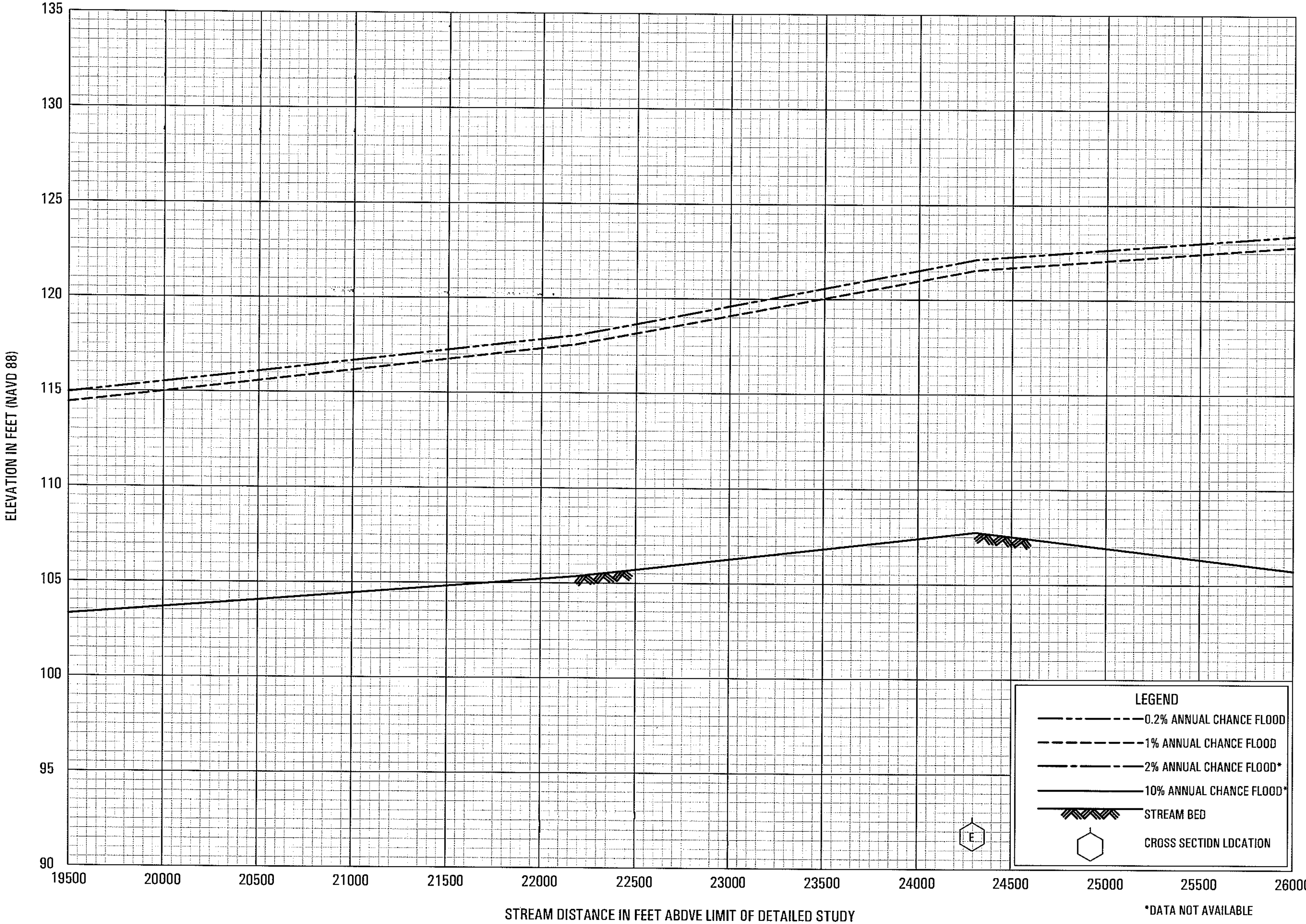
FLOOD PROFILES

BUTTE CREEK RIGHT LEVEE FAILED - BELOW MIDWAY

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



FLOOD PROFILES

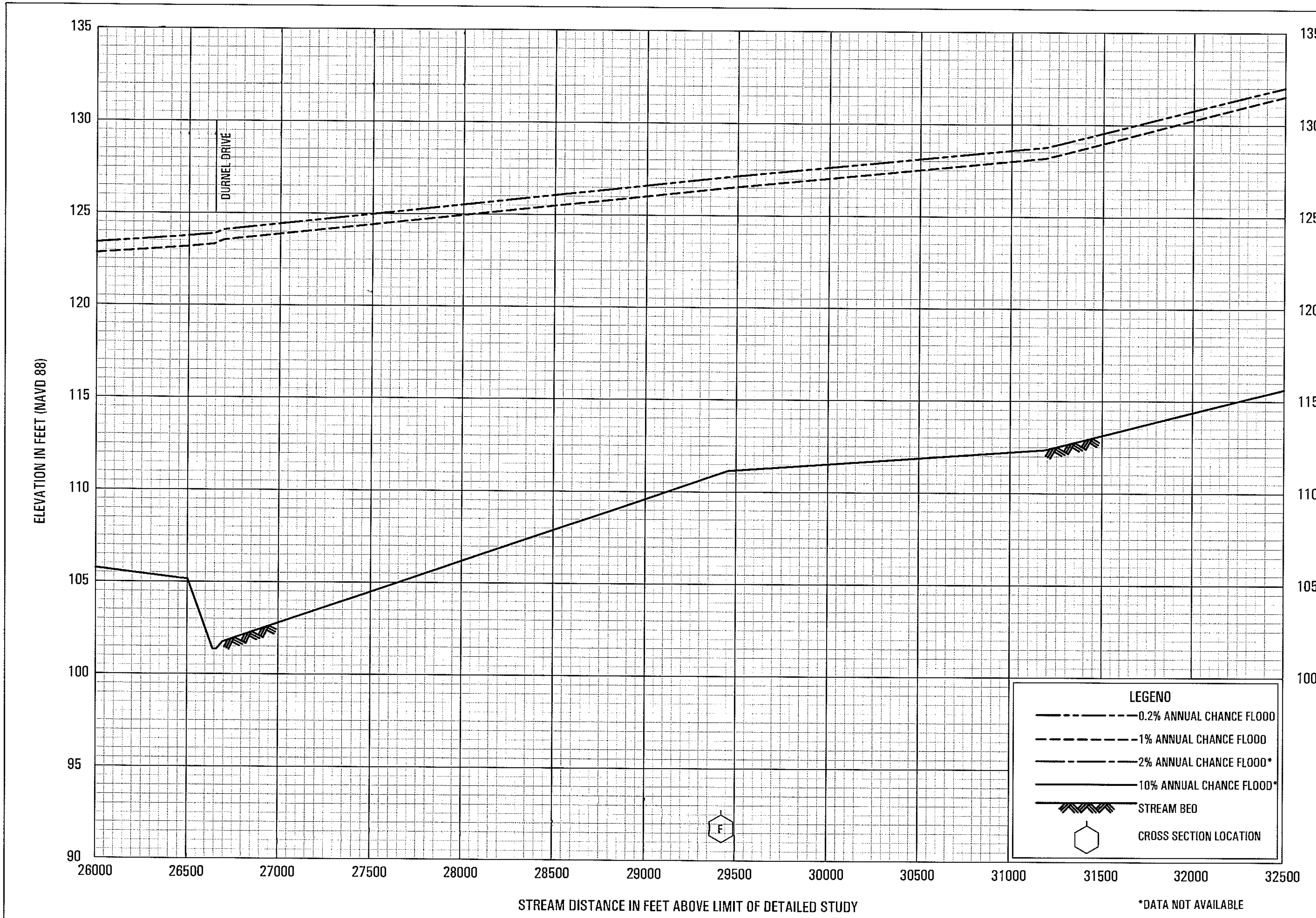
BUTTE CREEK RIGHT LEVEE FAILED - BELOW MIDWAY

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

21kP



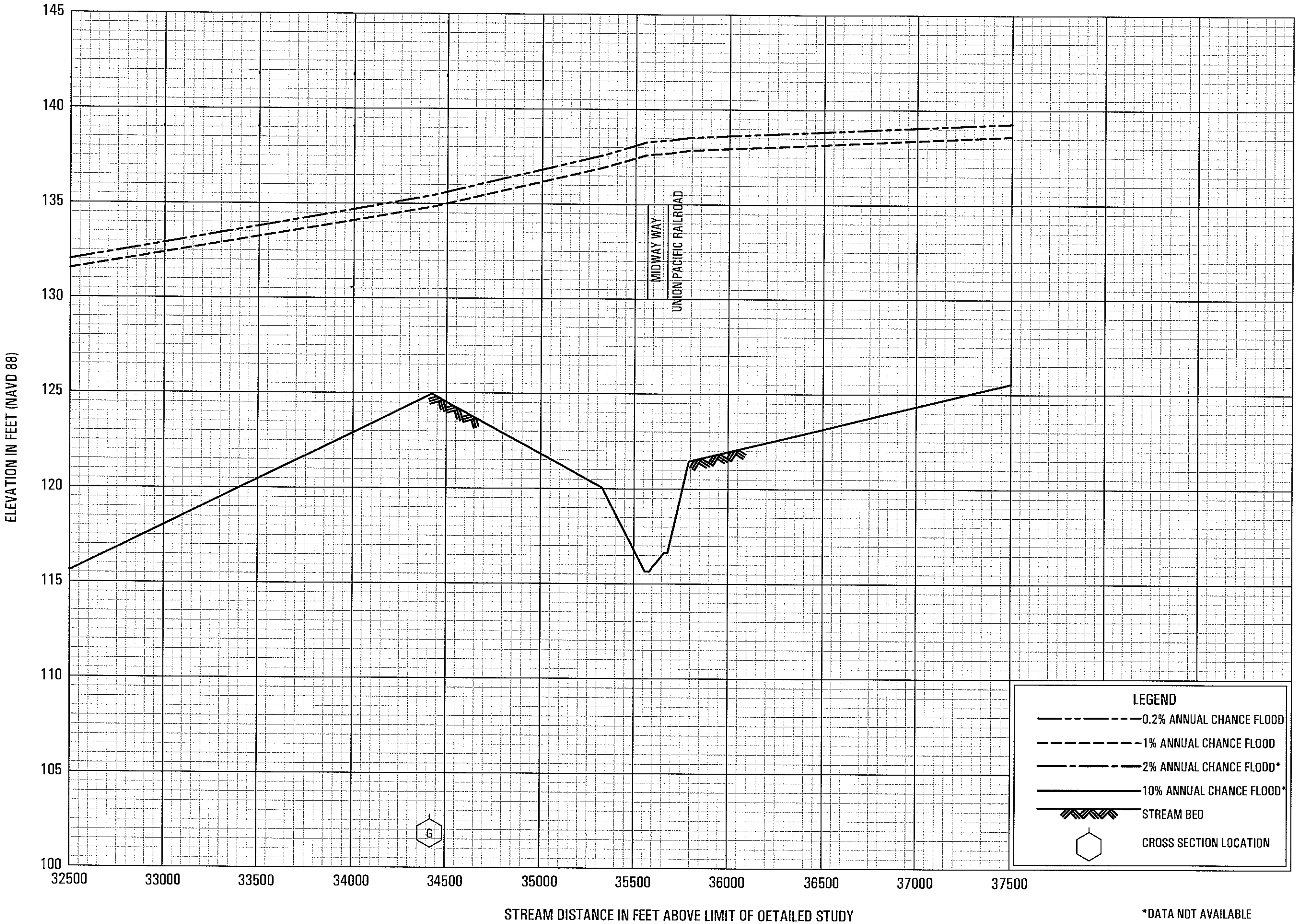
FLOOD PROFILES

BUTTE CREEK RIGHT LEVEE FAILED - BELOW MIDWAY

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



FLOOD PROFILES

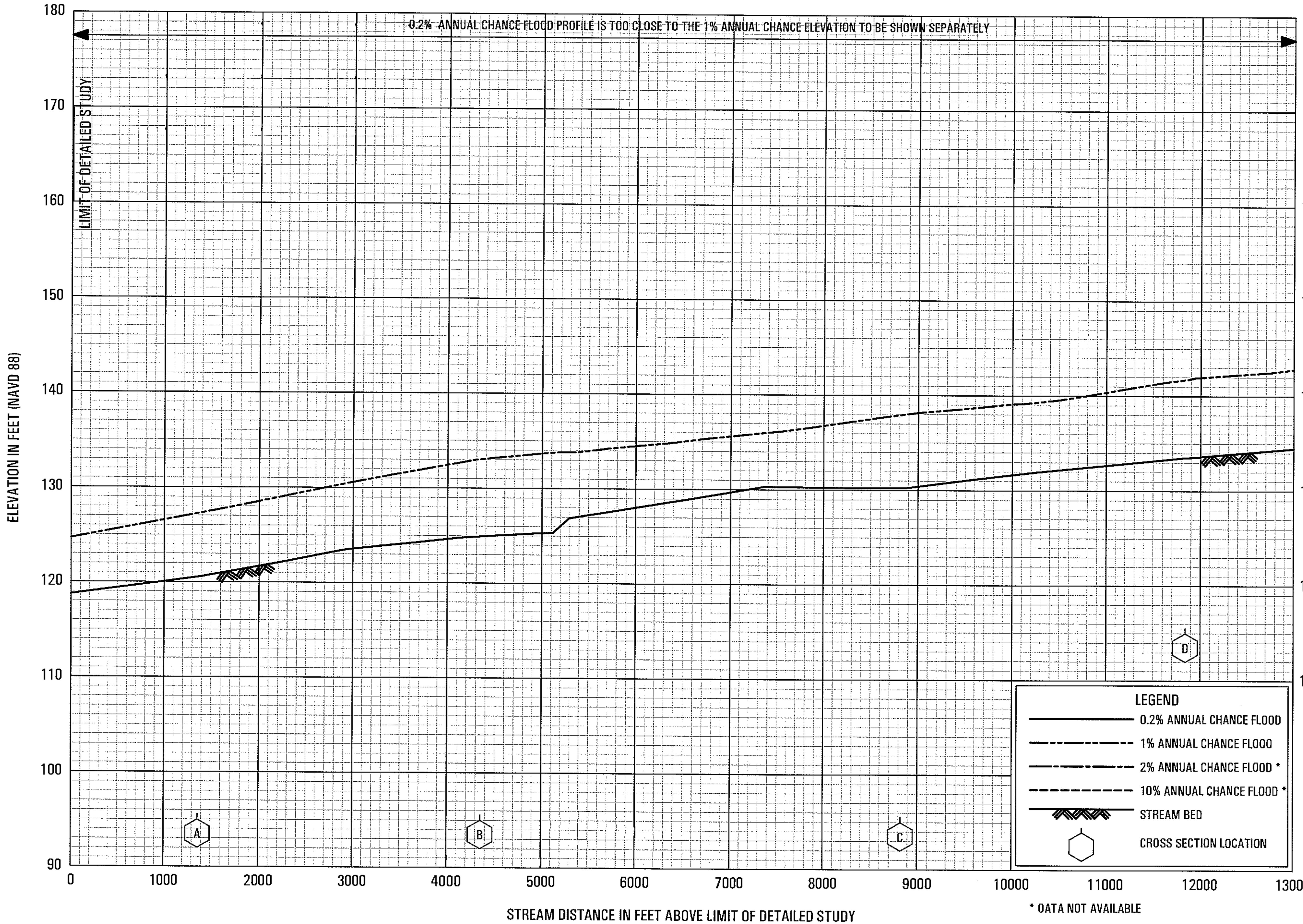
BUTTE CREEK RIGHT LEVEE FAILED - BELOW MIDWAY

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

21mP



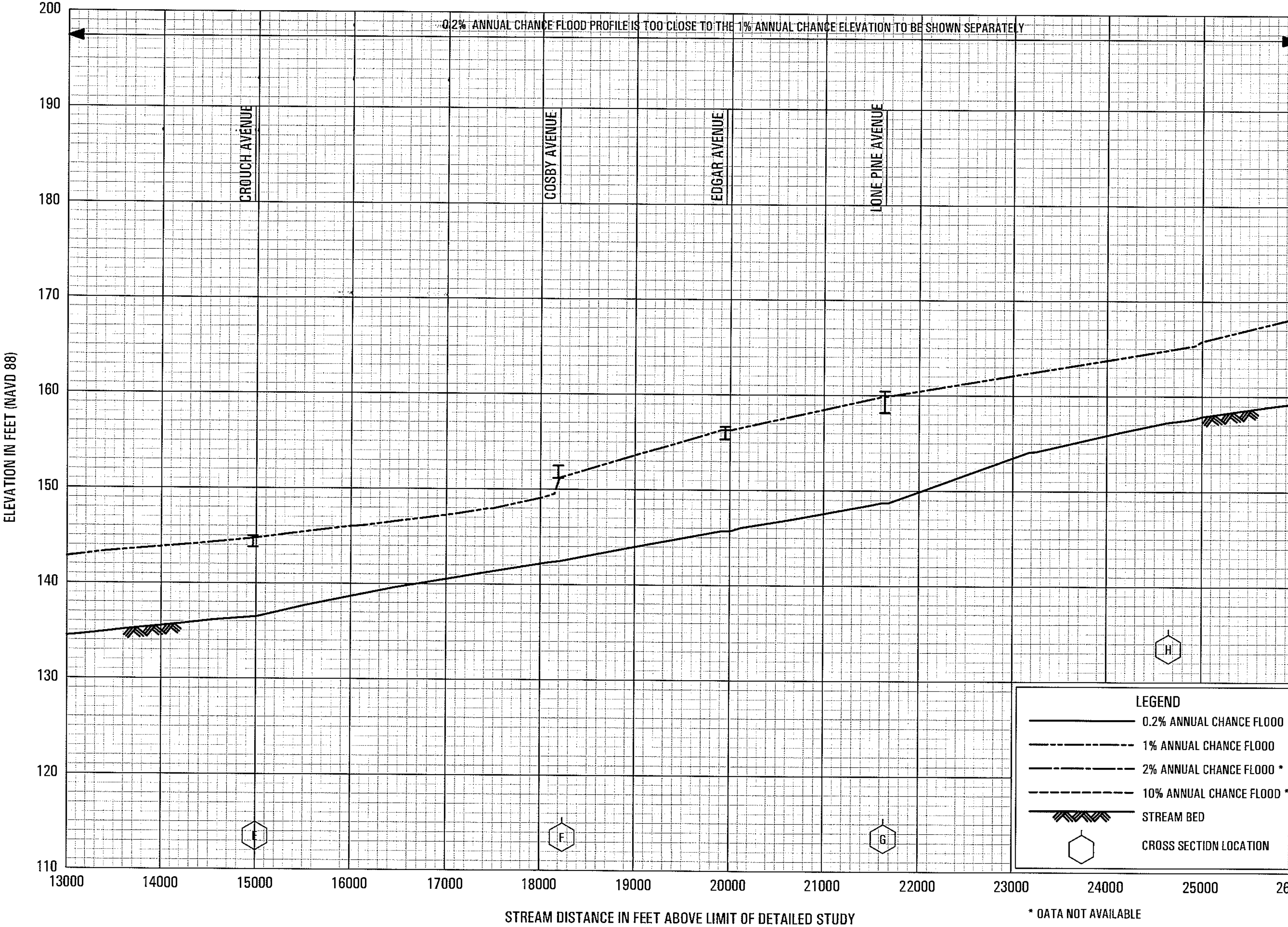
FLOOD PROFILES

COMANCHE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORORATED AREAS



FLOOD PROFILES

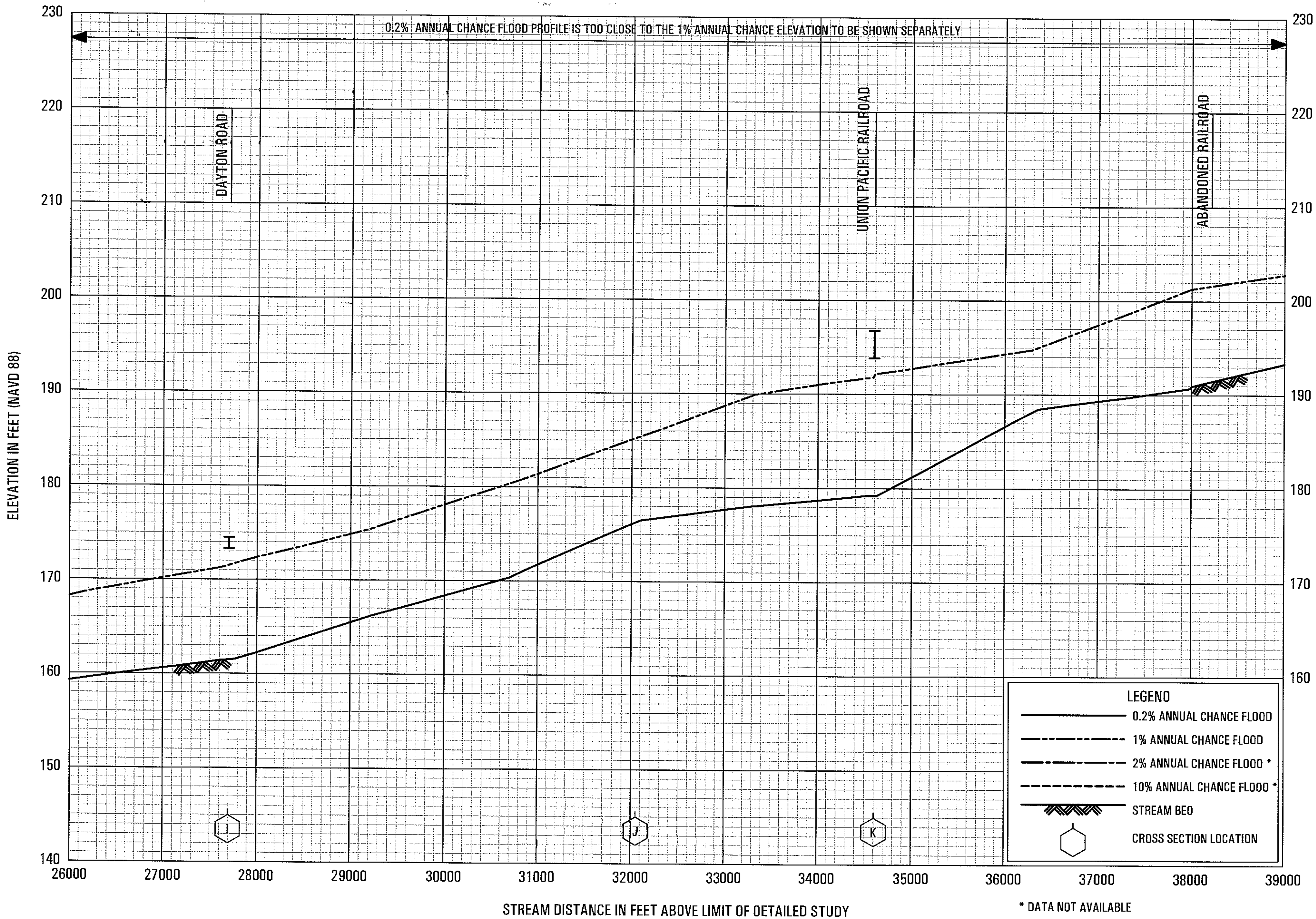
COMANCHE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

23P



FLOOD PROFILES

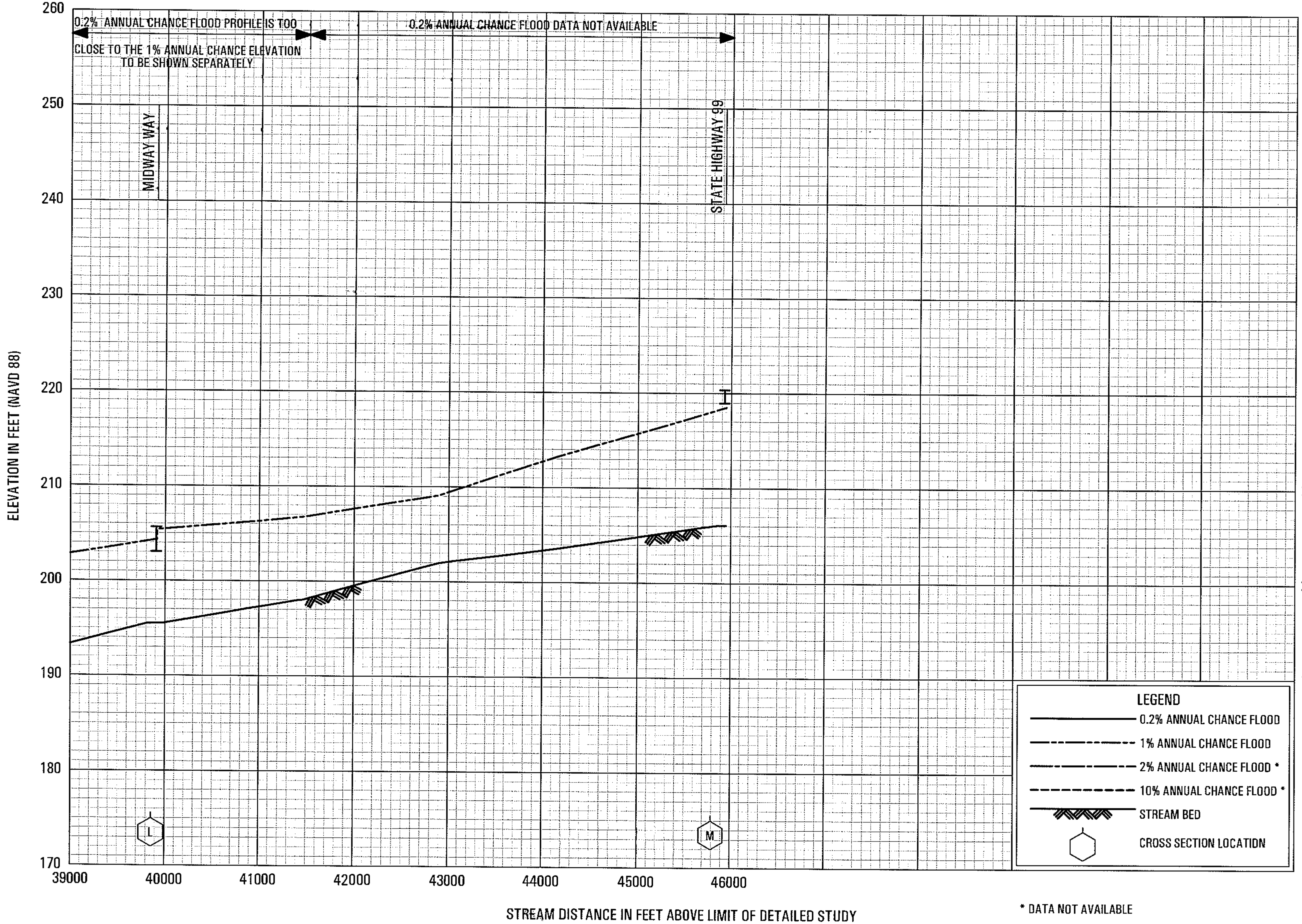
COMANCHE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

24P



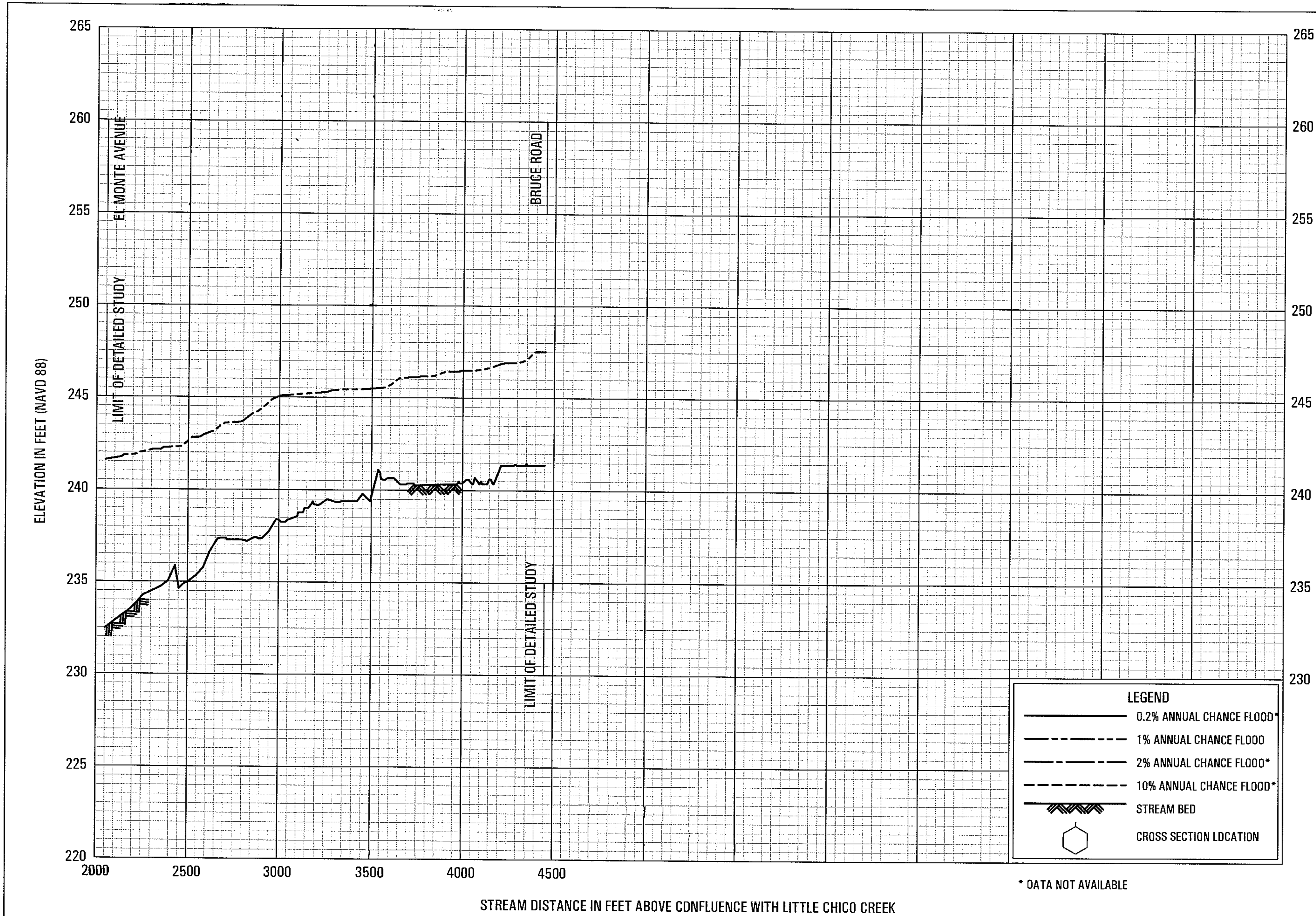
FLOOD PROFILES

COMANCHE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORORATED AREAS



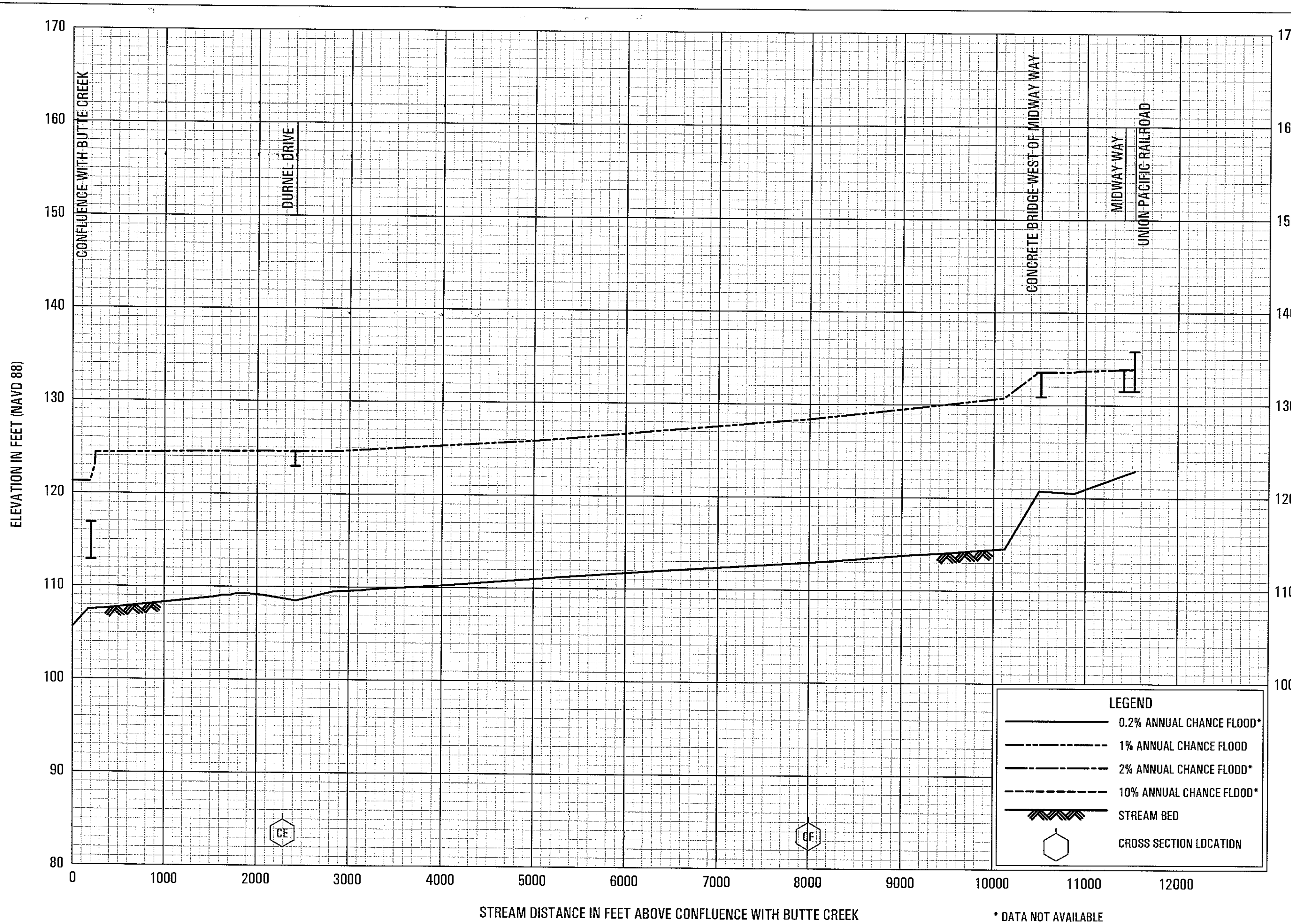
FLOOD PROFILES

DEAD HORSE SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



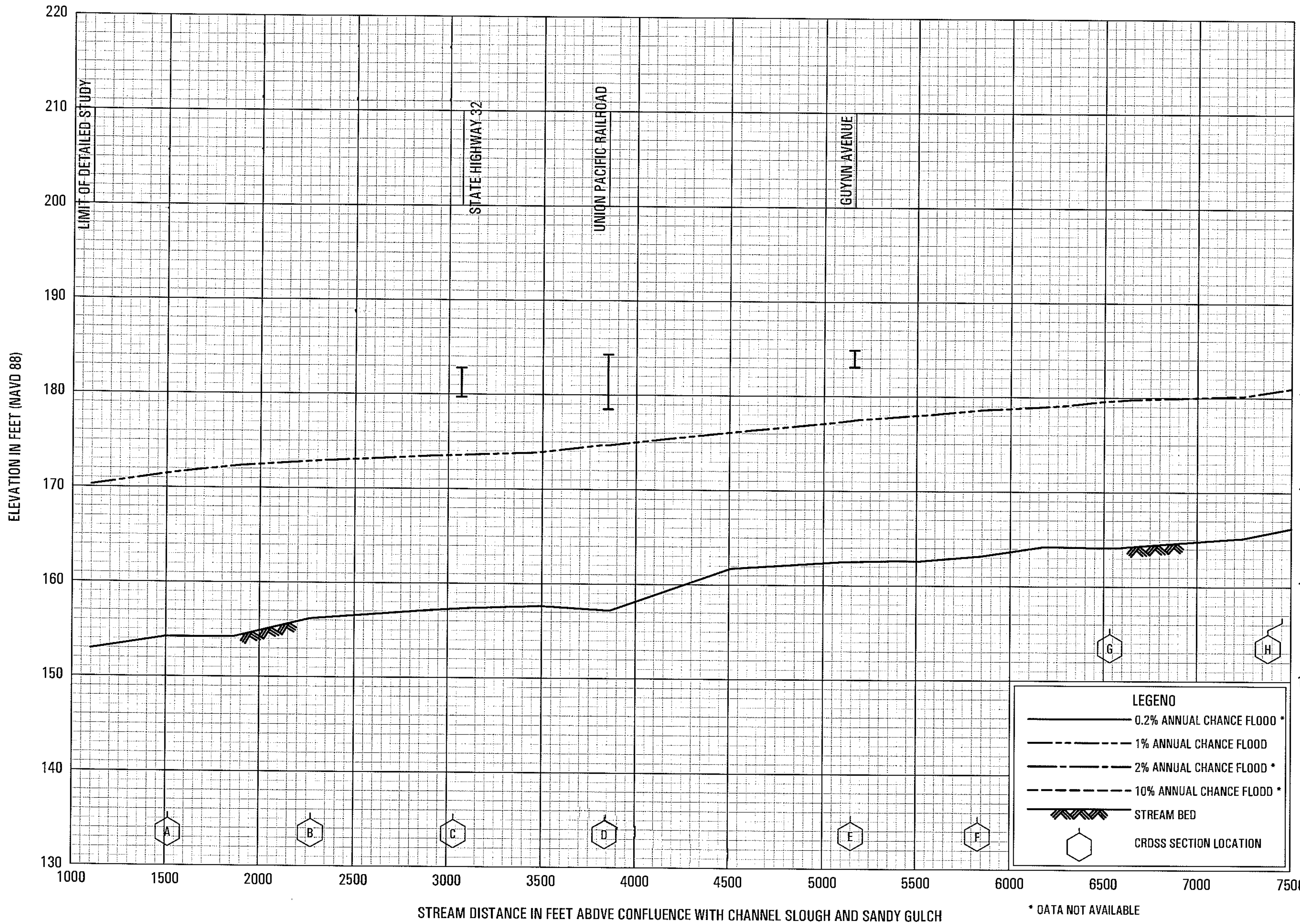
FLOOD PROFILES

HAMLIN SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



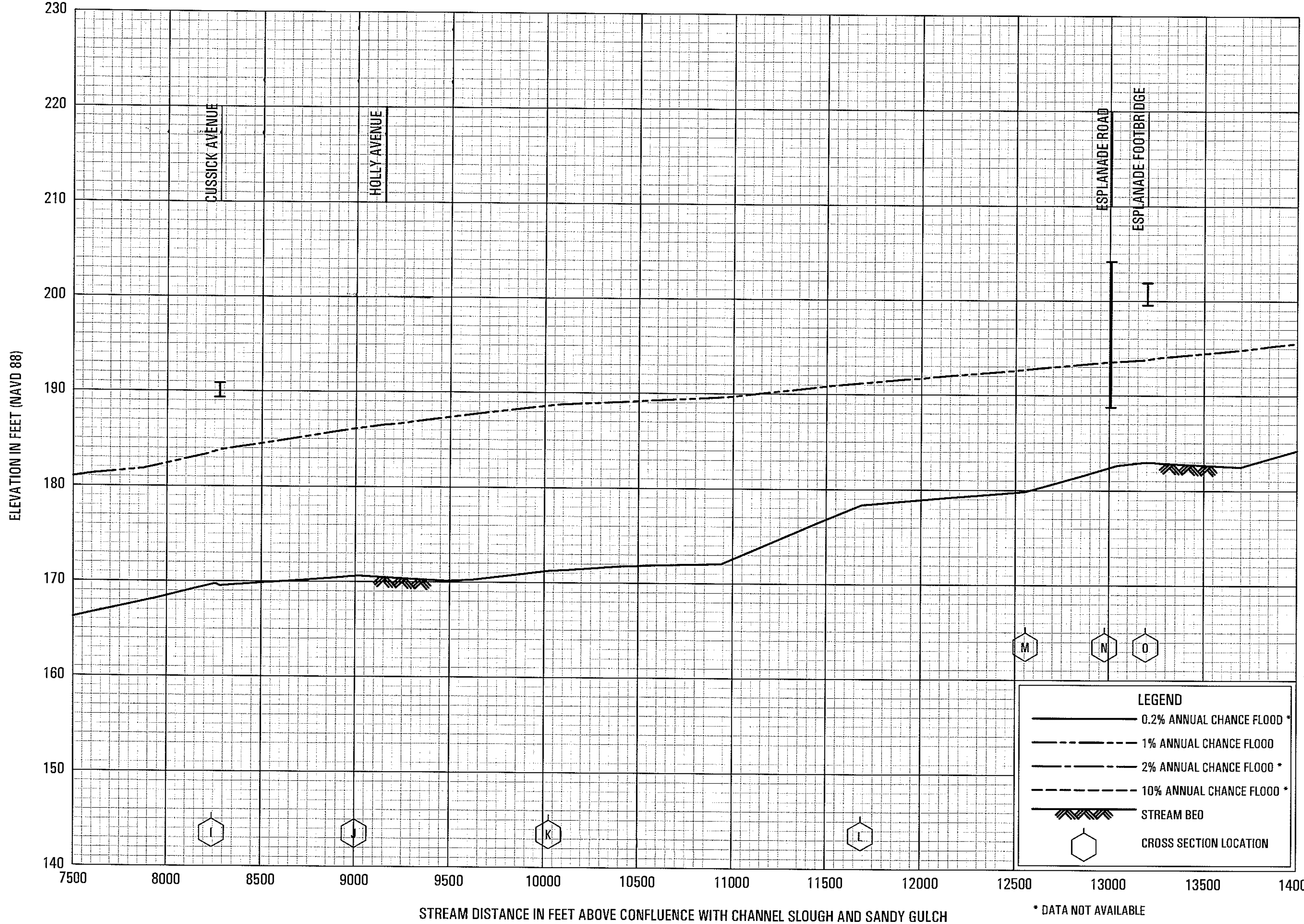
FLOOD PROFILES

LINDO CHANNEL

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



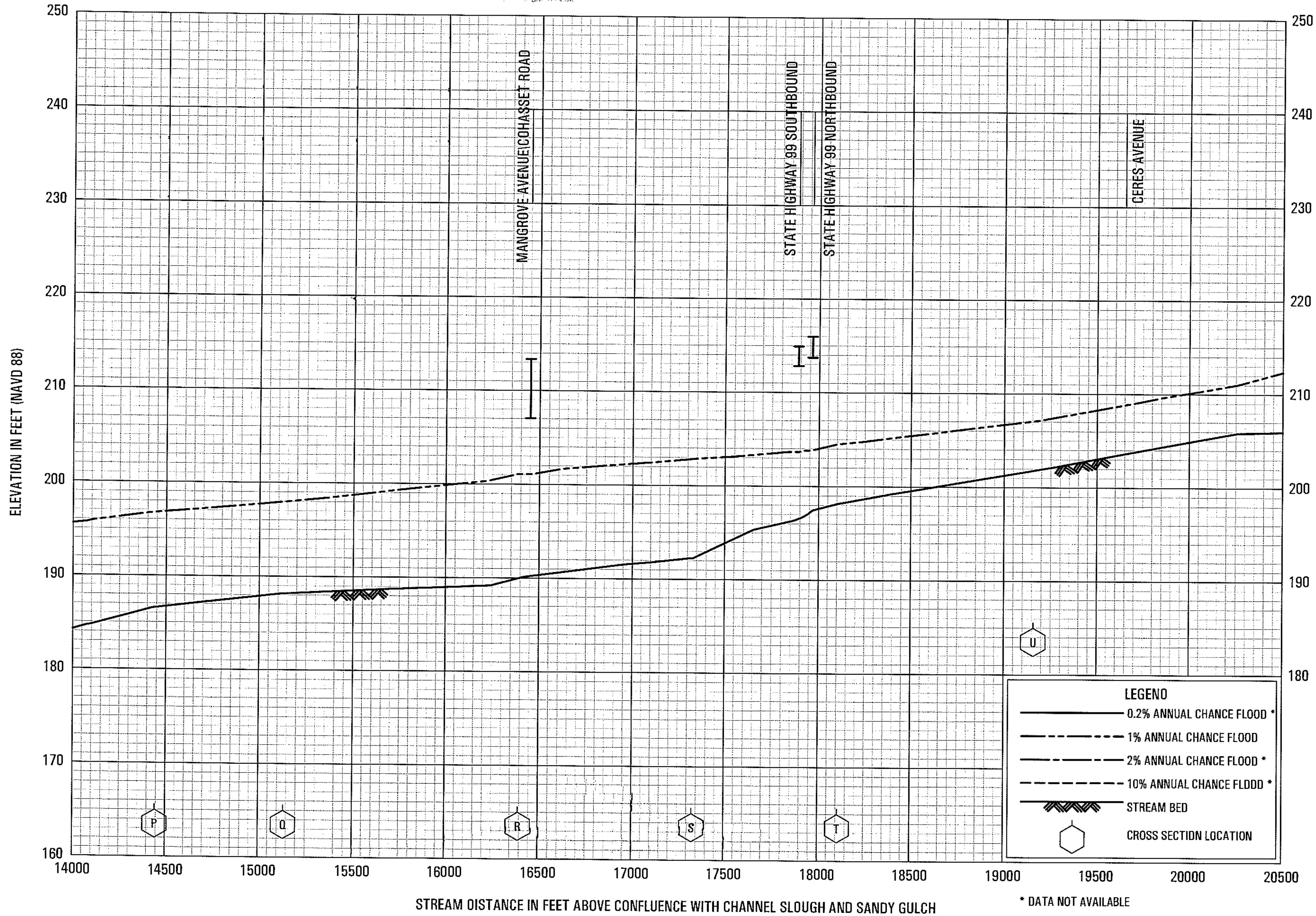
FLOOD PROFILES

LINDO CHANNEL

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



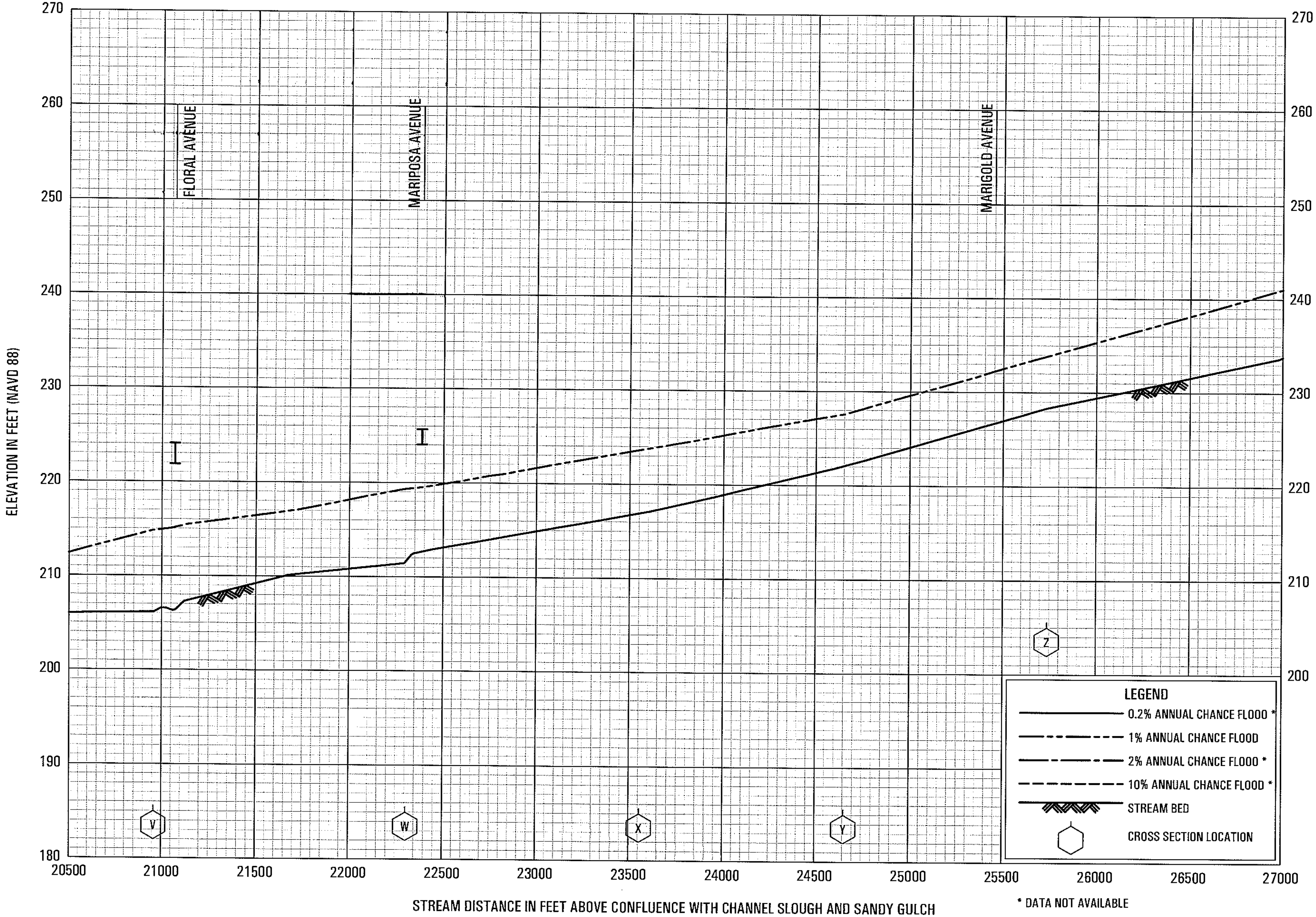
FLOOD PROFILES

LINDO CHANNEL

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



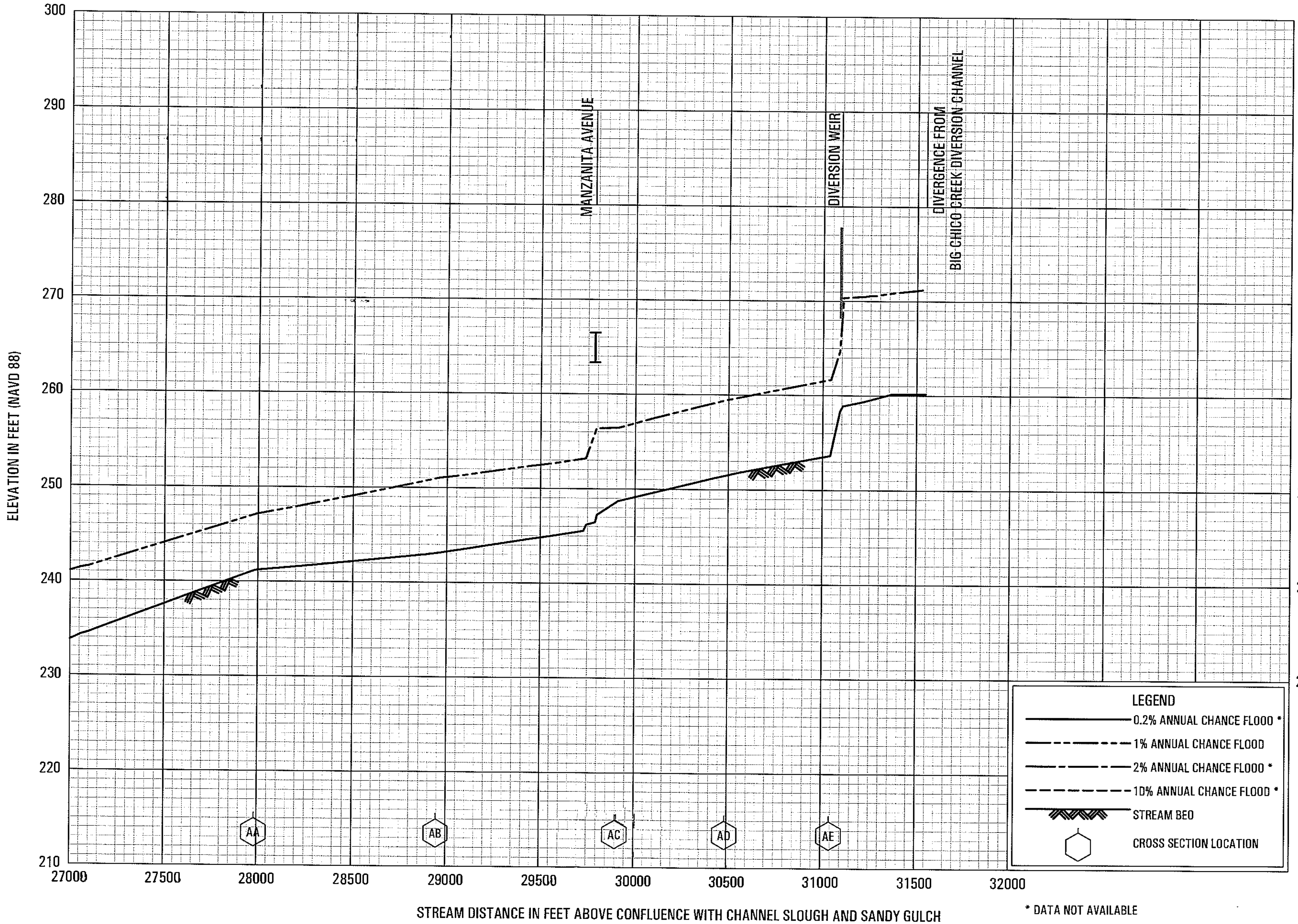
FLOOD PROFILES

LINDO CHANNEL

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



FLOOD PROFILES

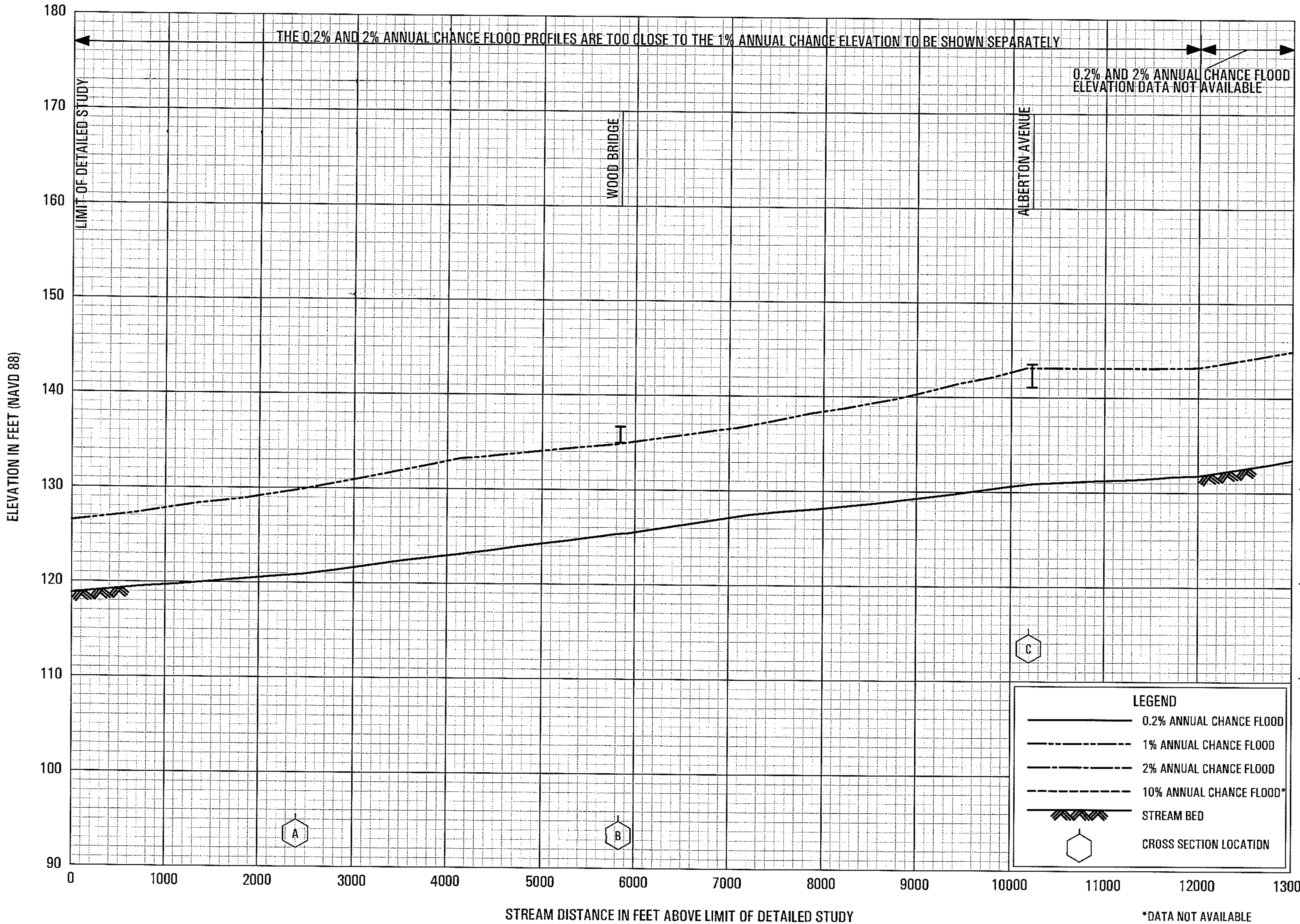
LINDO CHANNEL

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

32P



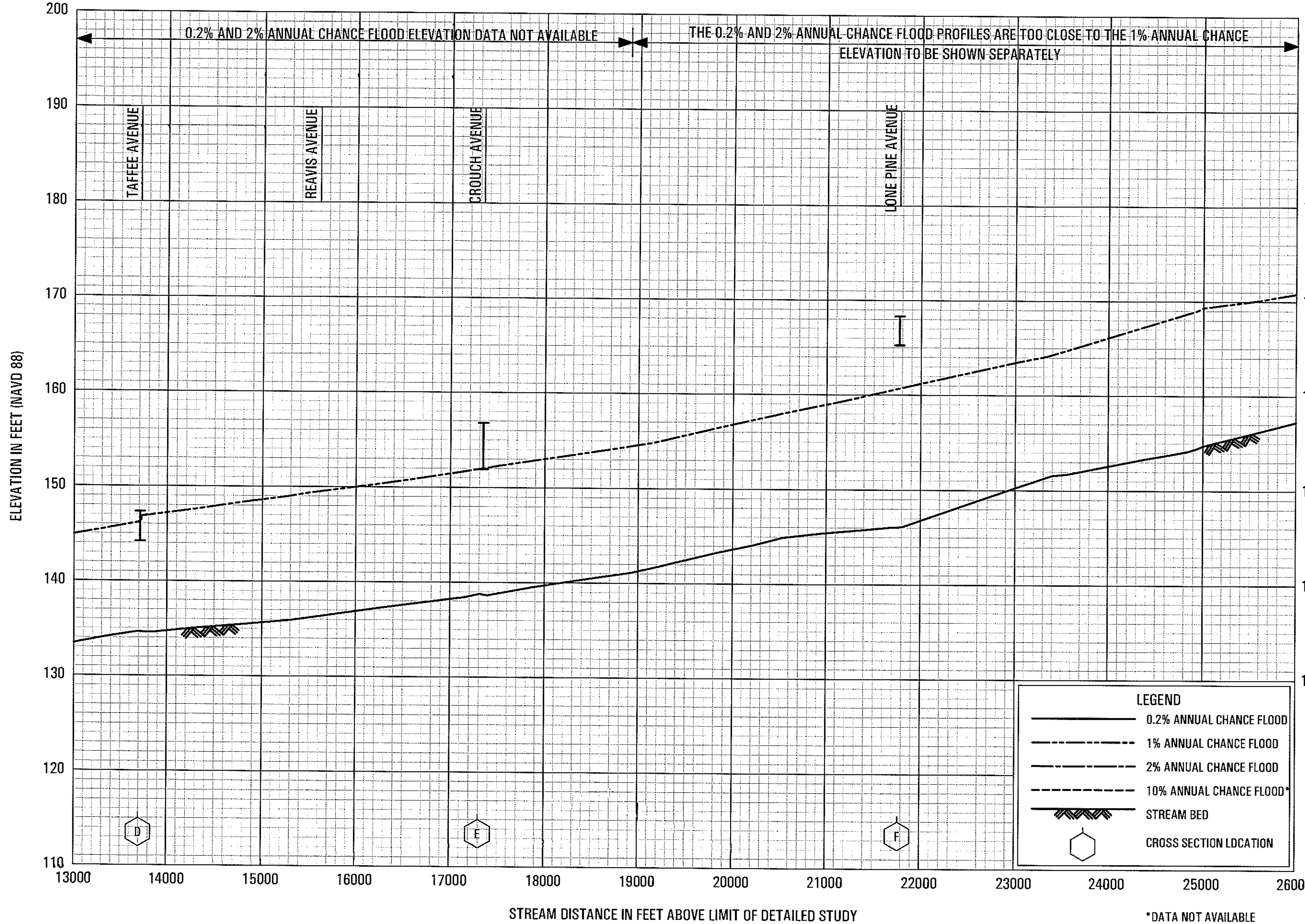
FLOOD PROFILES

LITTLE CHICO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

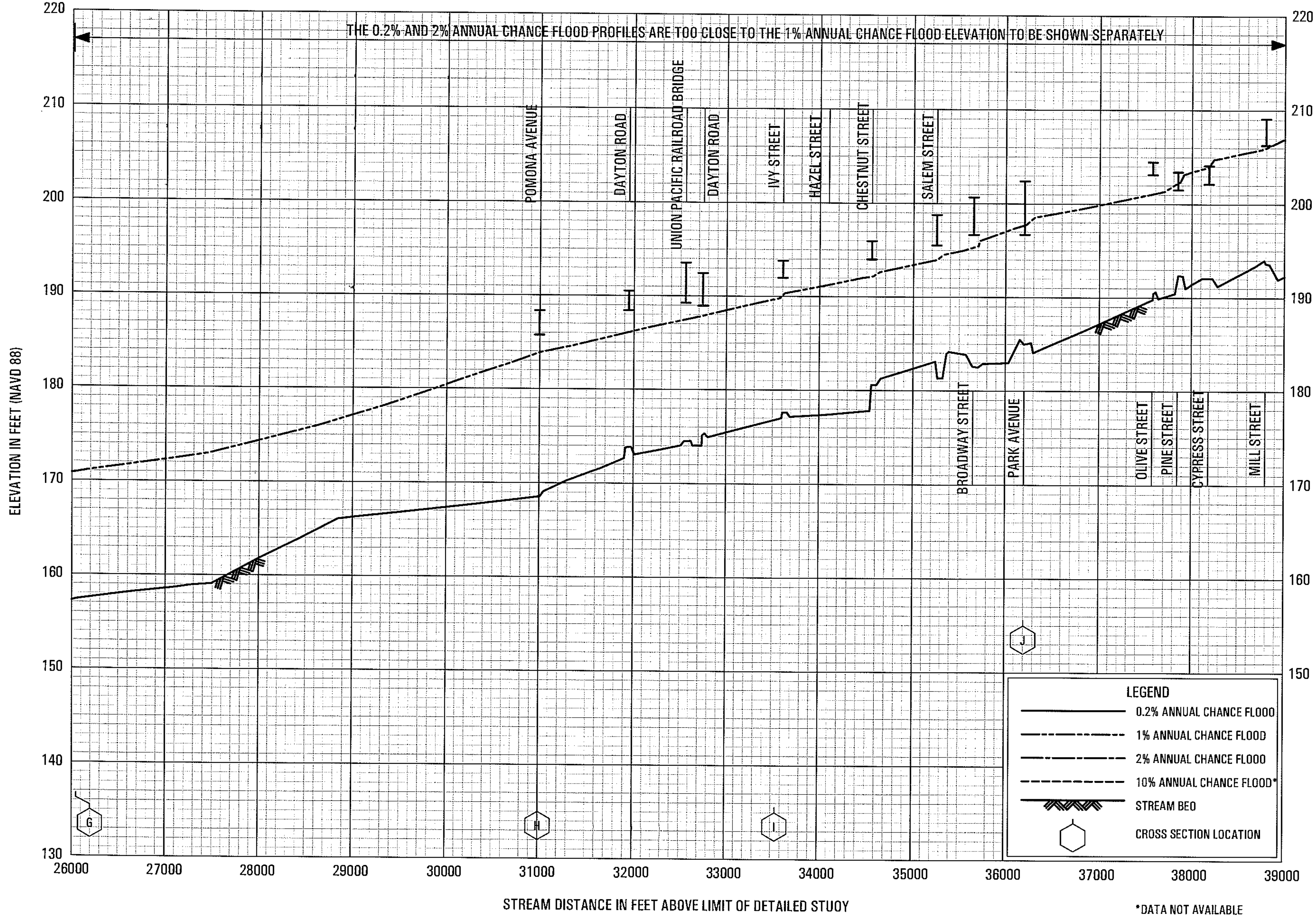


FLOOD PROFILES

LITTLE CHICO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA
AND INCORPORATED AREAS



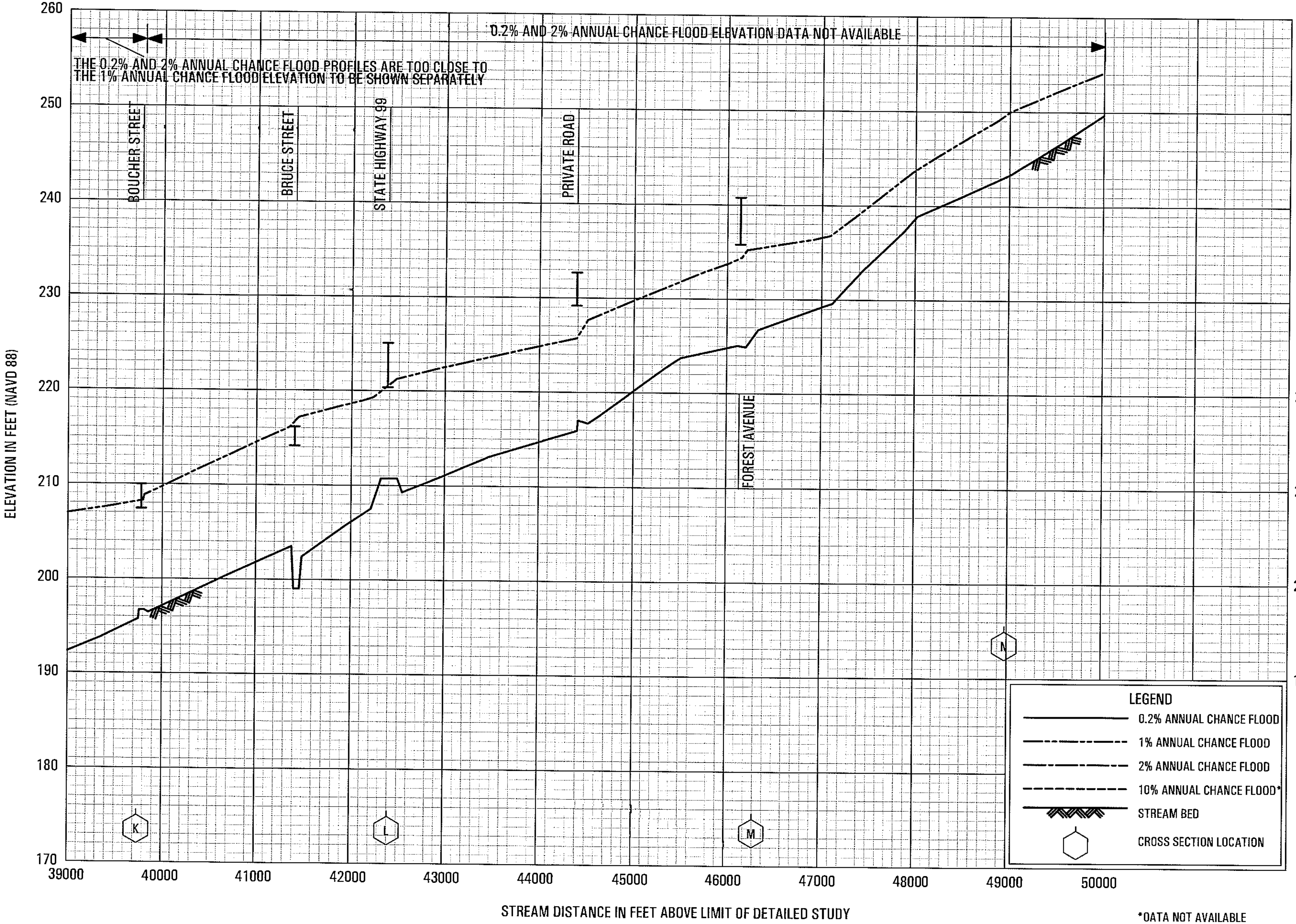
FLOOD PROFILES

LITTLE CHICO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



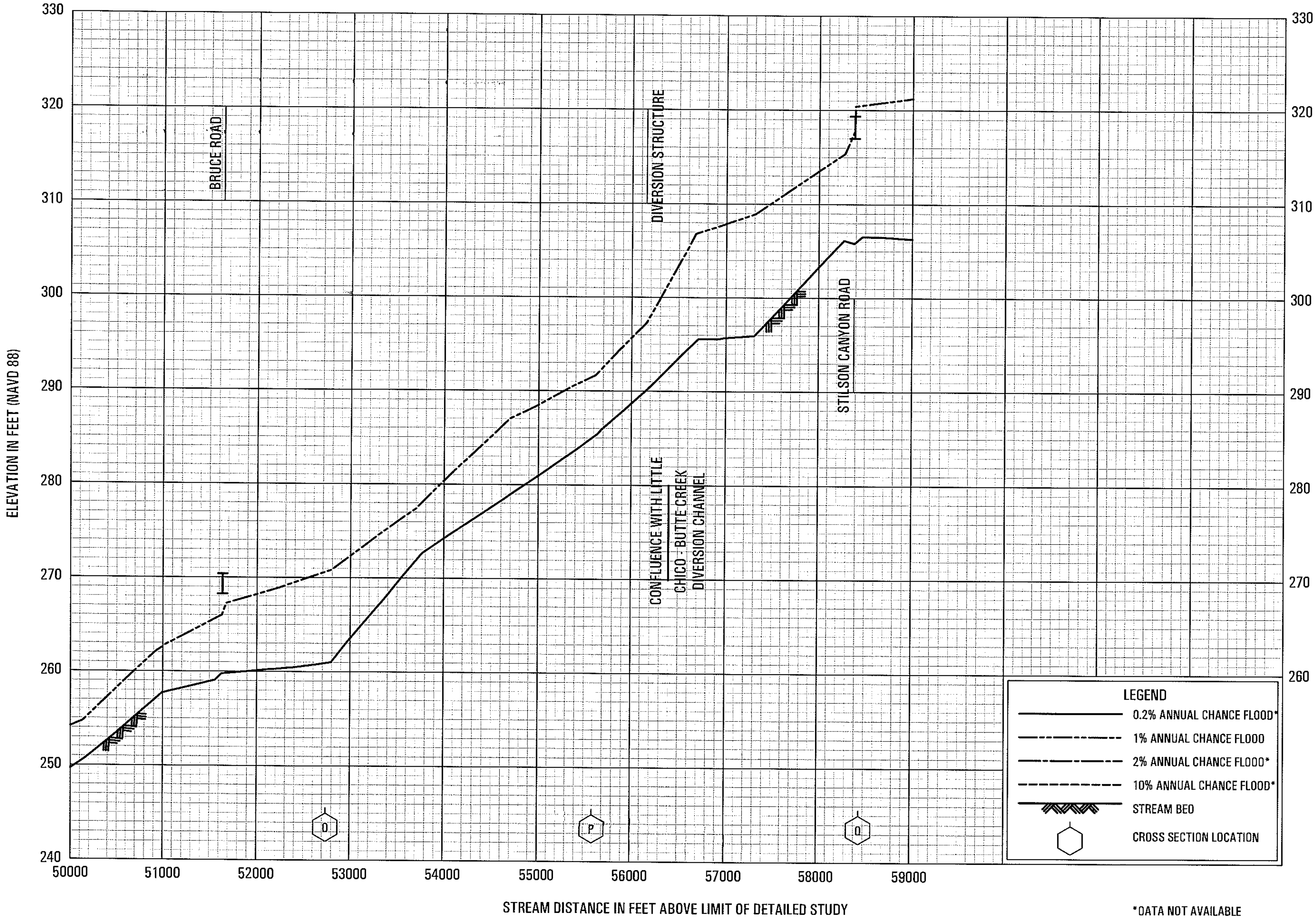
FLOOD PROFILES

LITTLE CHICO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



FLOOD PROFILES

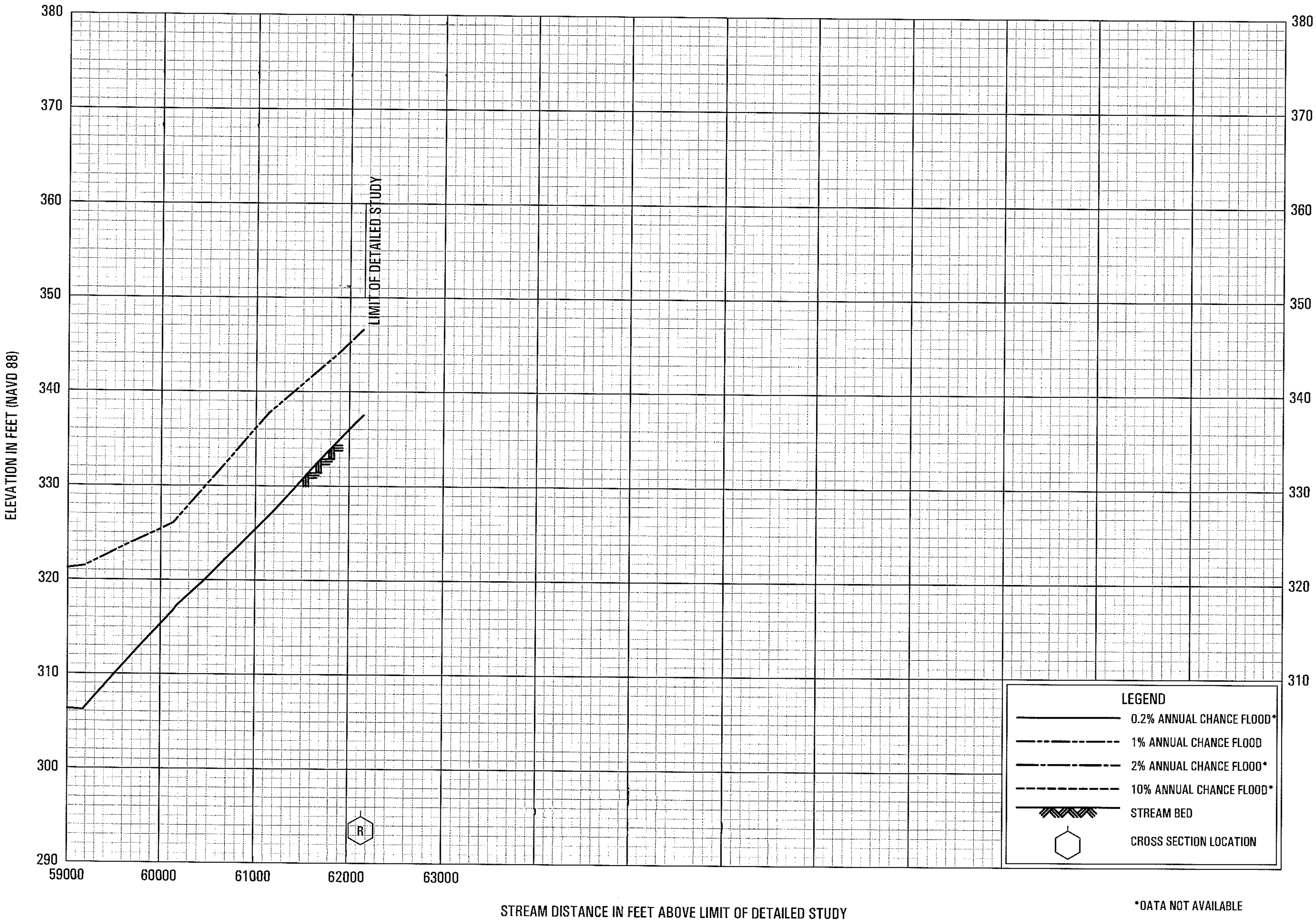
LITTLE CHICO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

37P



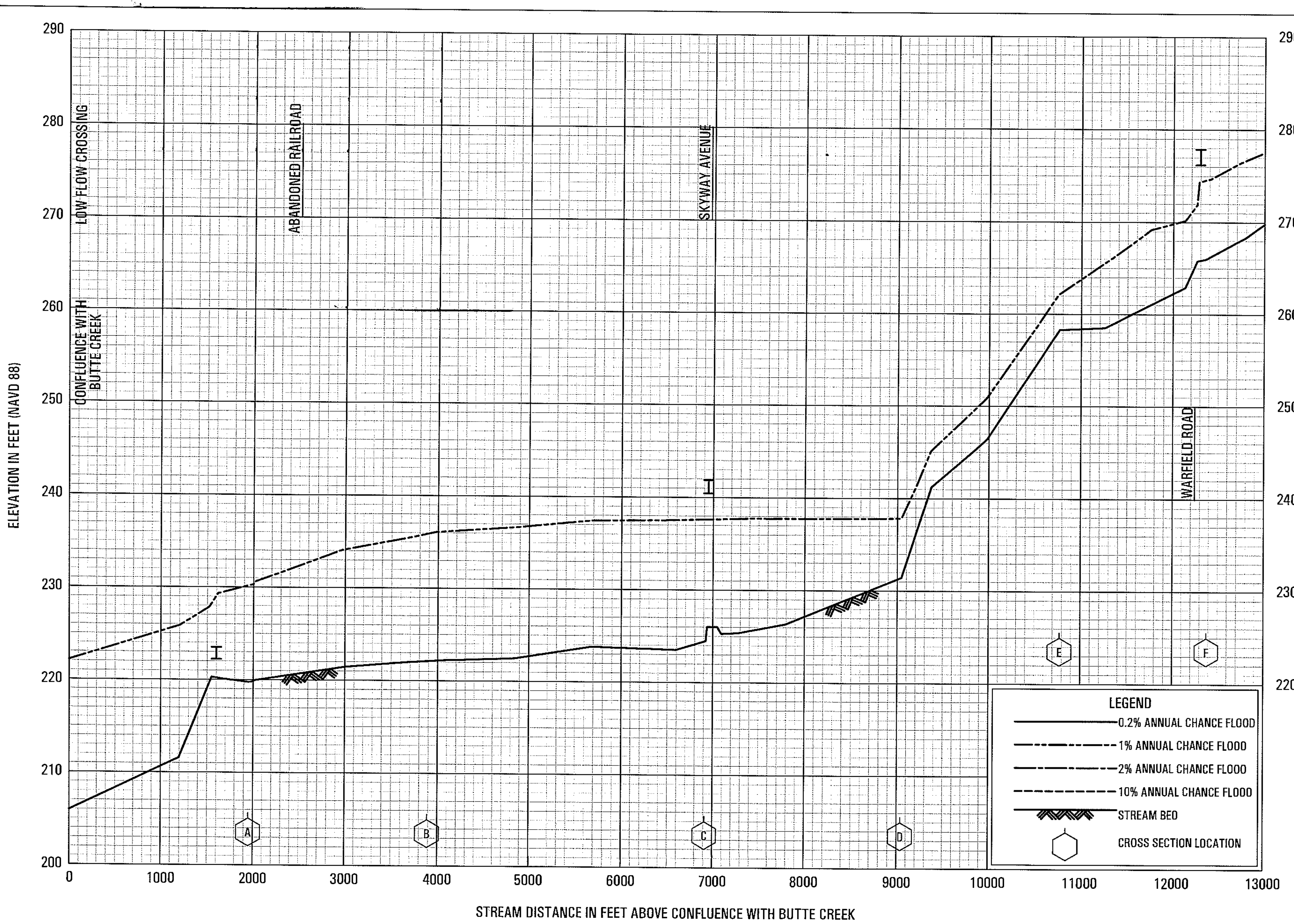
FLOOD PROFILES

LITTLE CHICO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA
AND INCORPORATED AREAS

38P



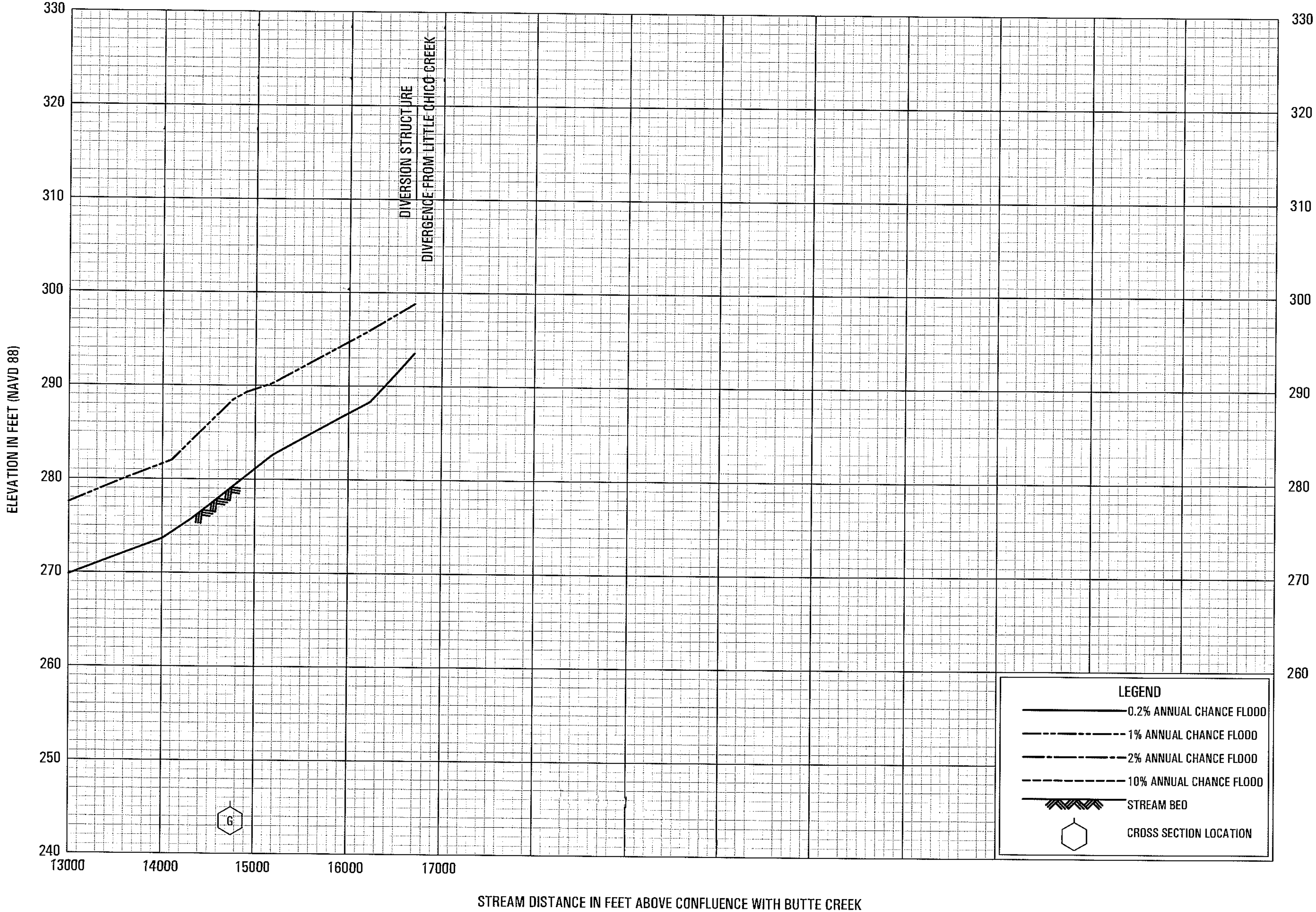
FLOOD PROFILES

LITTLE CHICO-BUTTE CREEK DIVERSION CHANNEL

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



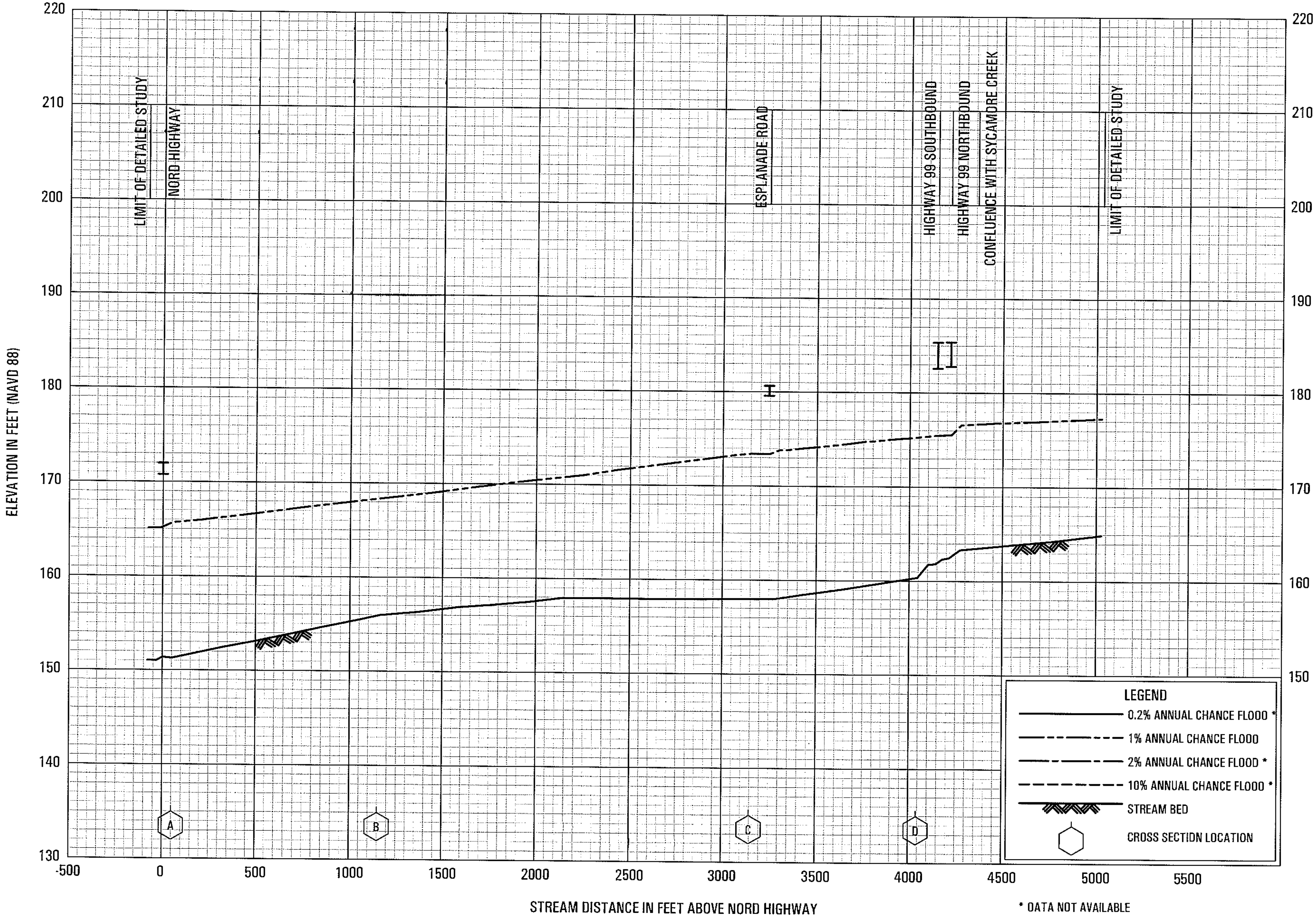
FLOOD PROFILES

LITTLE CHICO-BUTTE CREEK DIVERSION CHANNEL

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



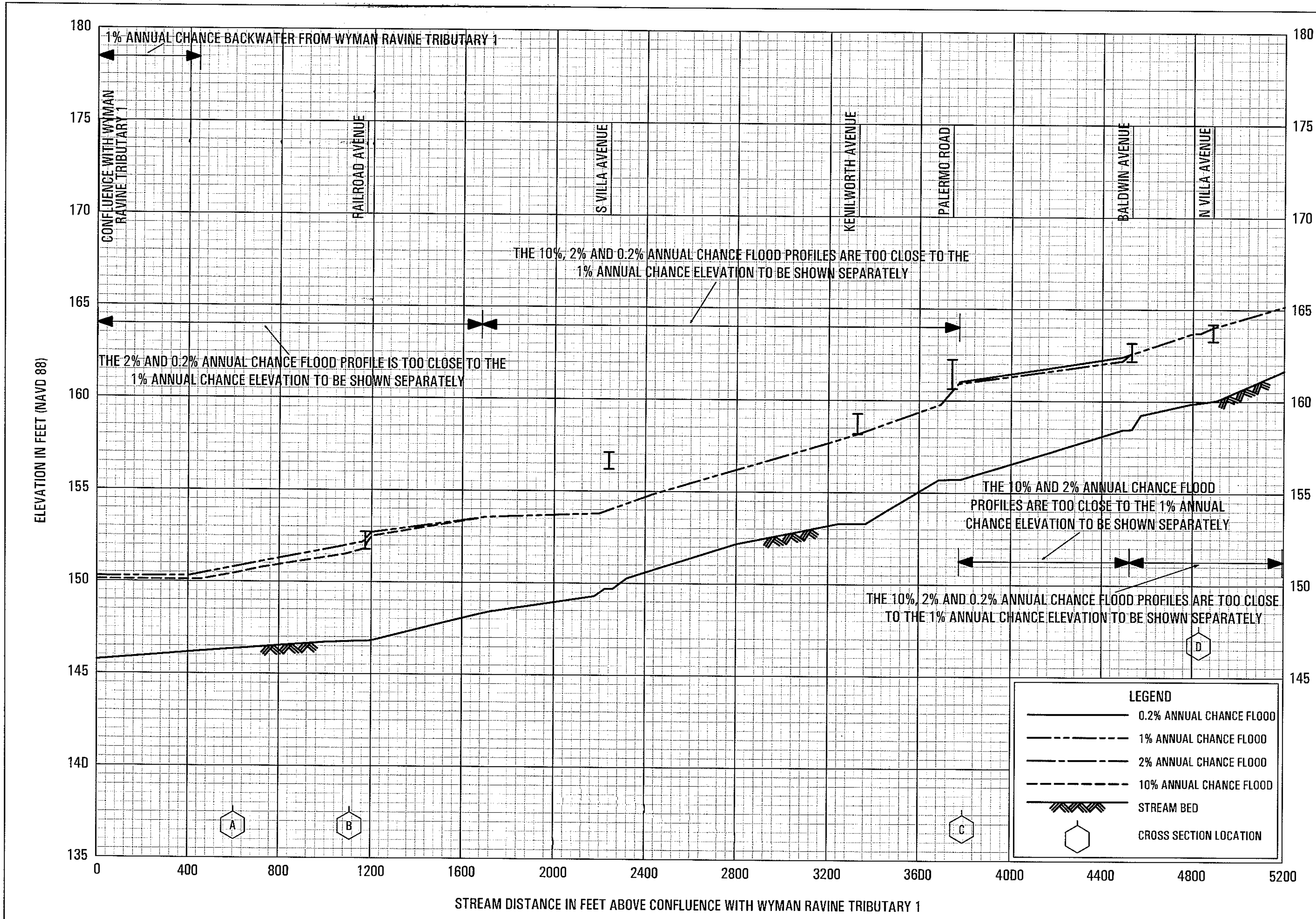
FLOOD PROFILES

MUD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



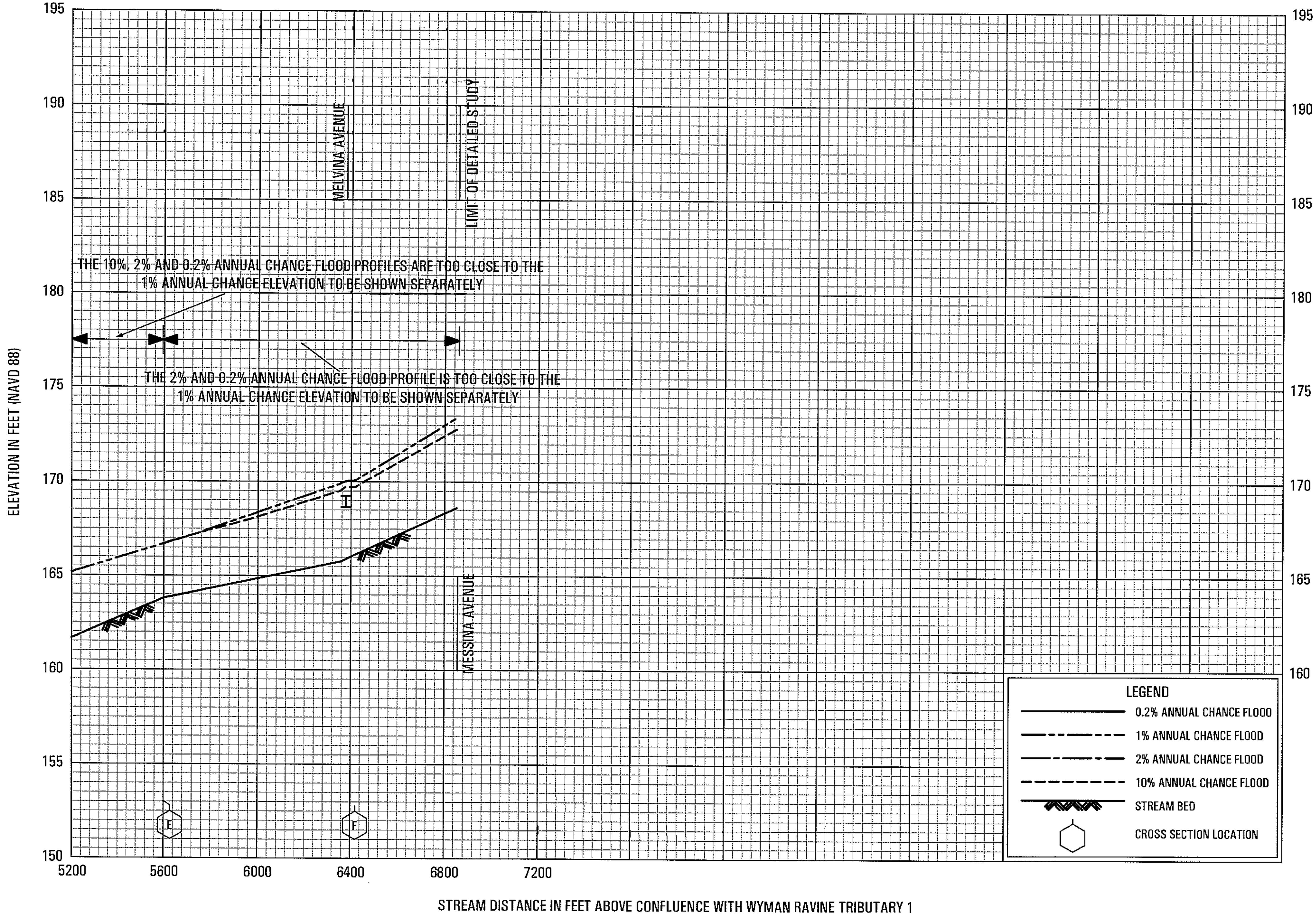
FLOOD PROFILES

PALERMO TRIBUTARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



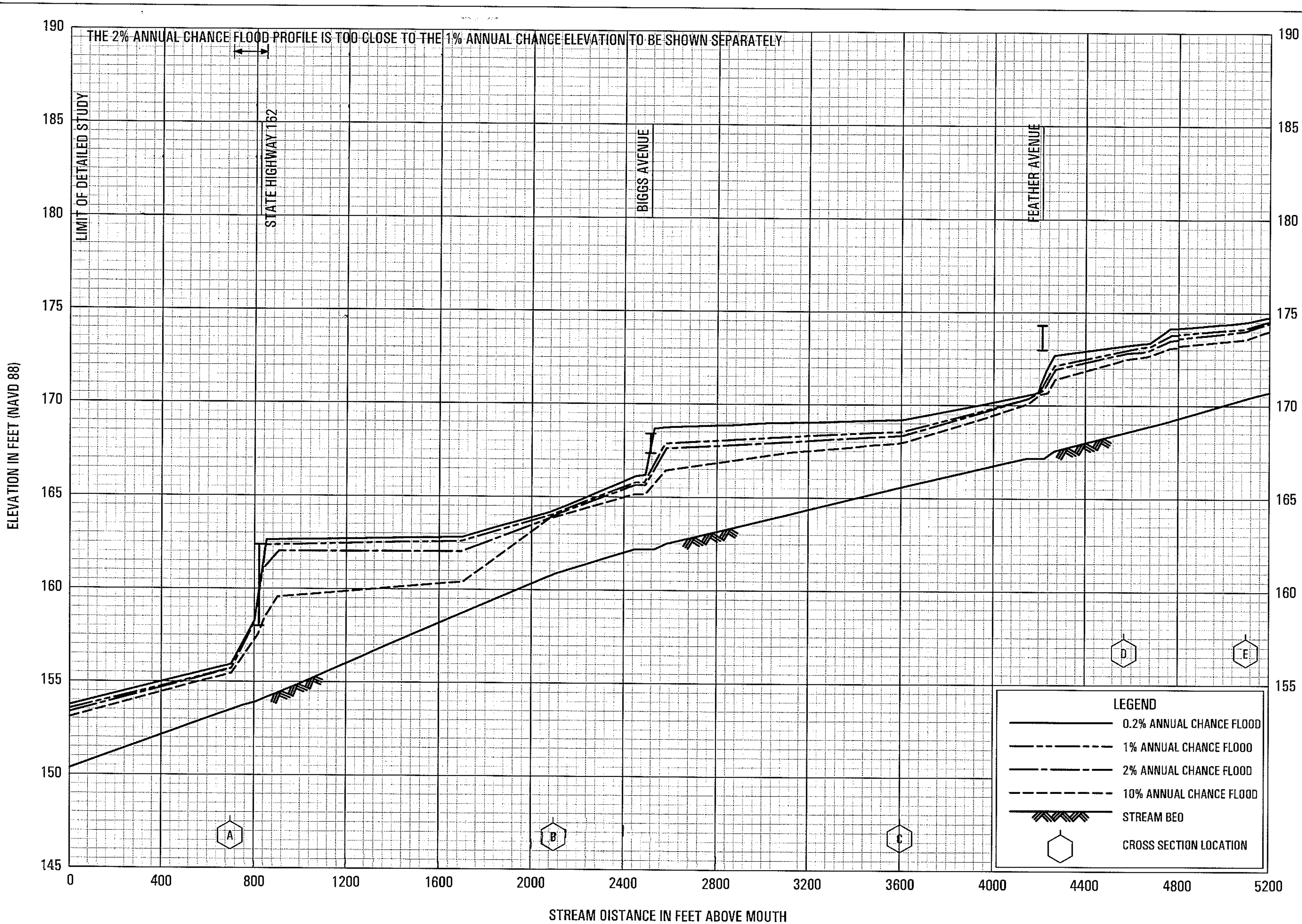
FLOOD PROFILES

PALERMO TRIBUTARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



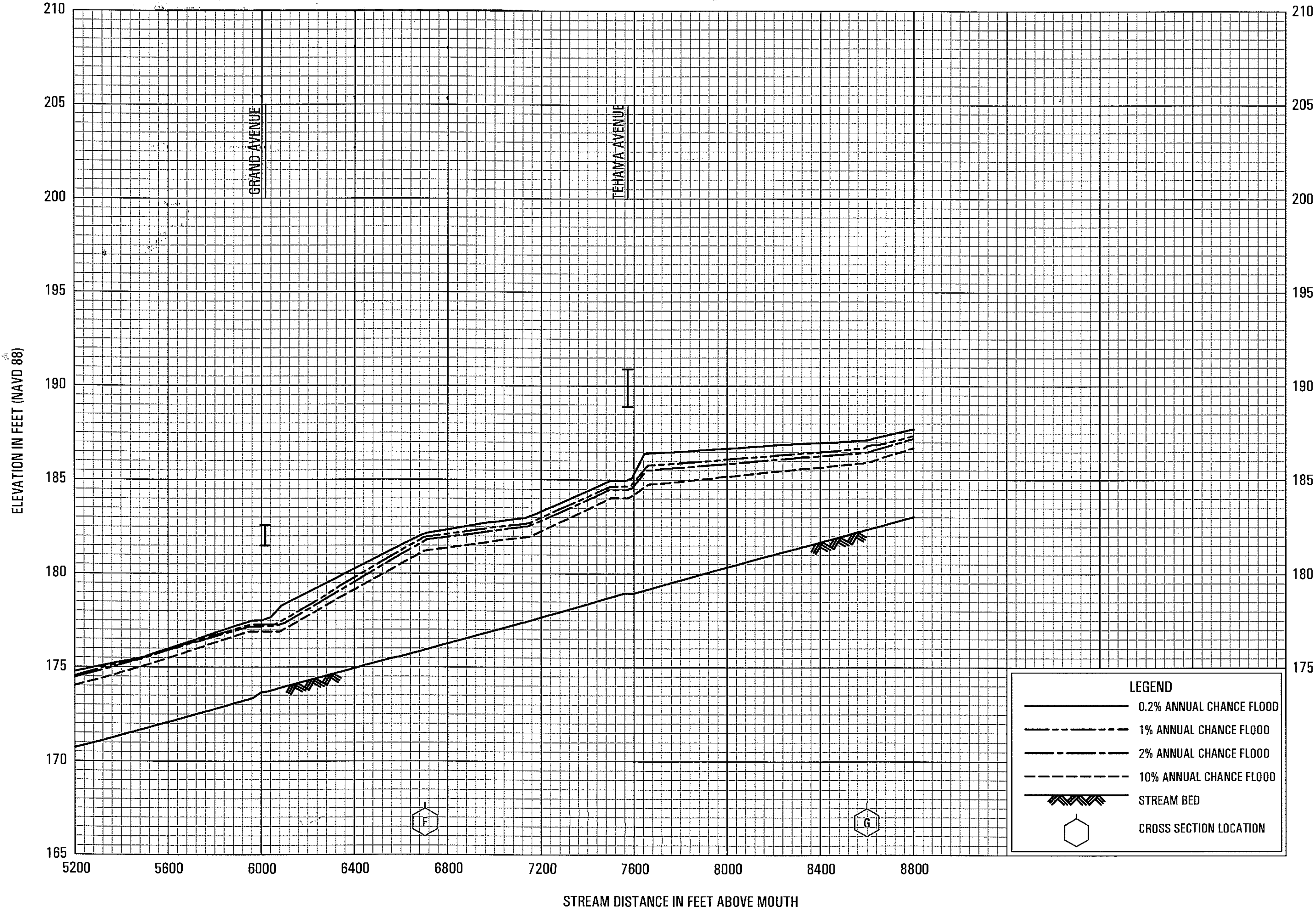
FLOOD PROFILES

RUDDY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



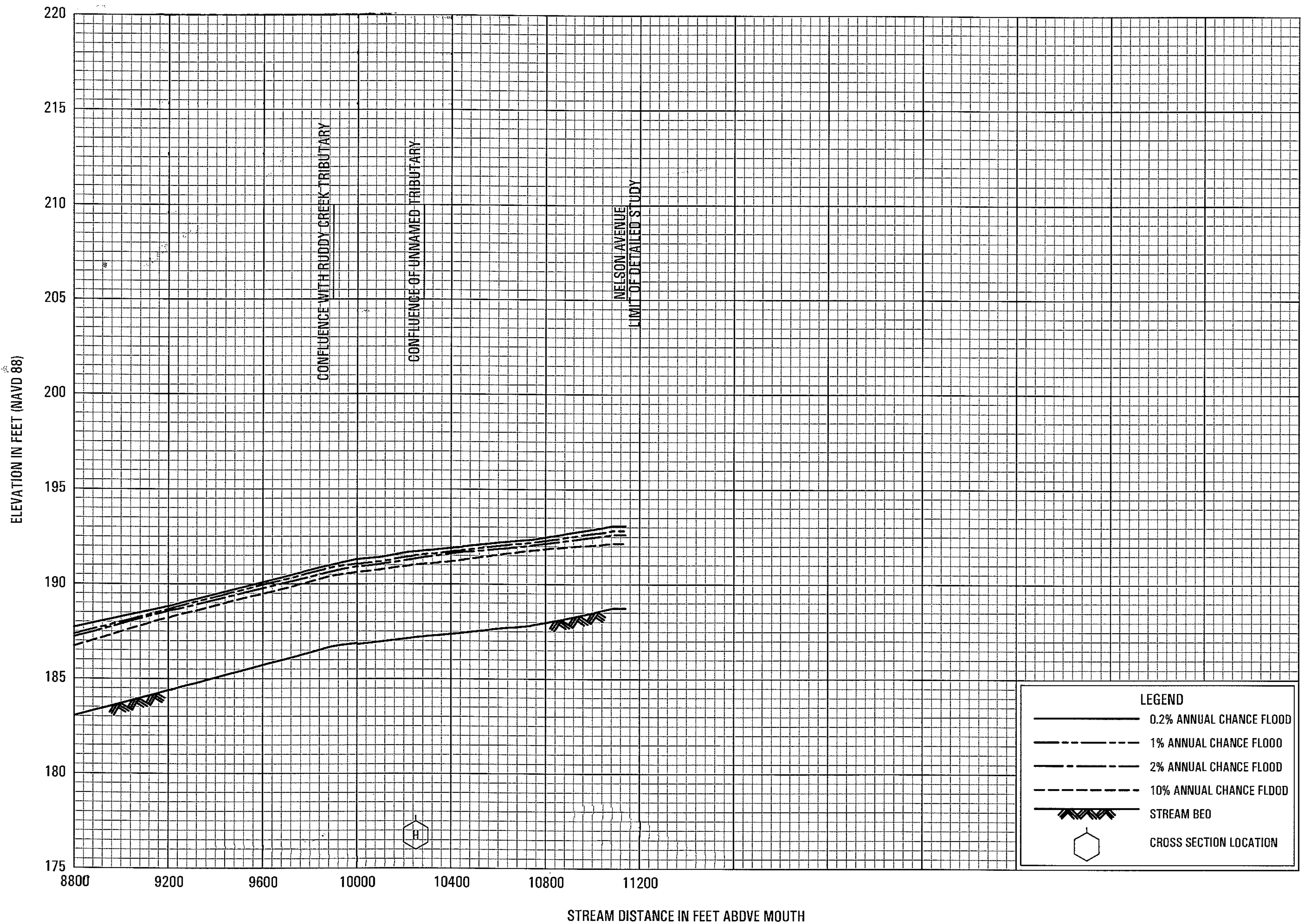
FLOOD PROFILES

RUDDY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



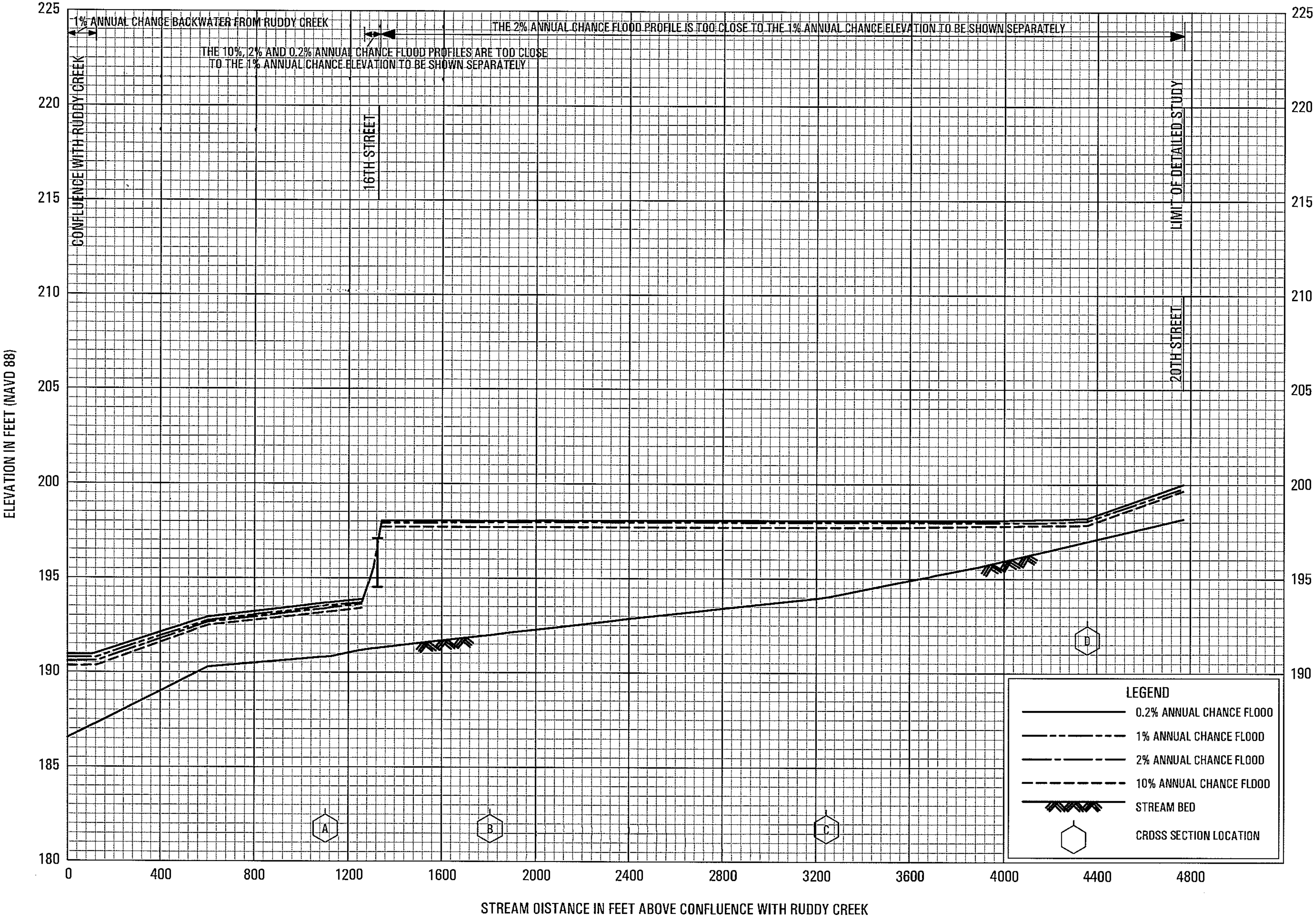
FLOOD PROFILES

RUDDY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPDRATED AREAS



FLOOD PROFILES

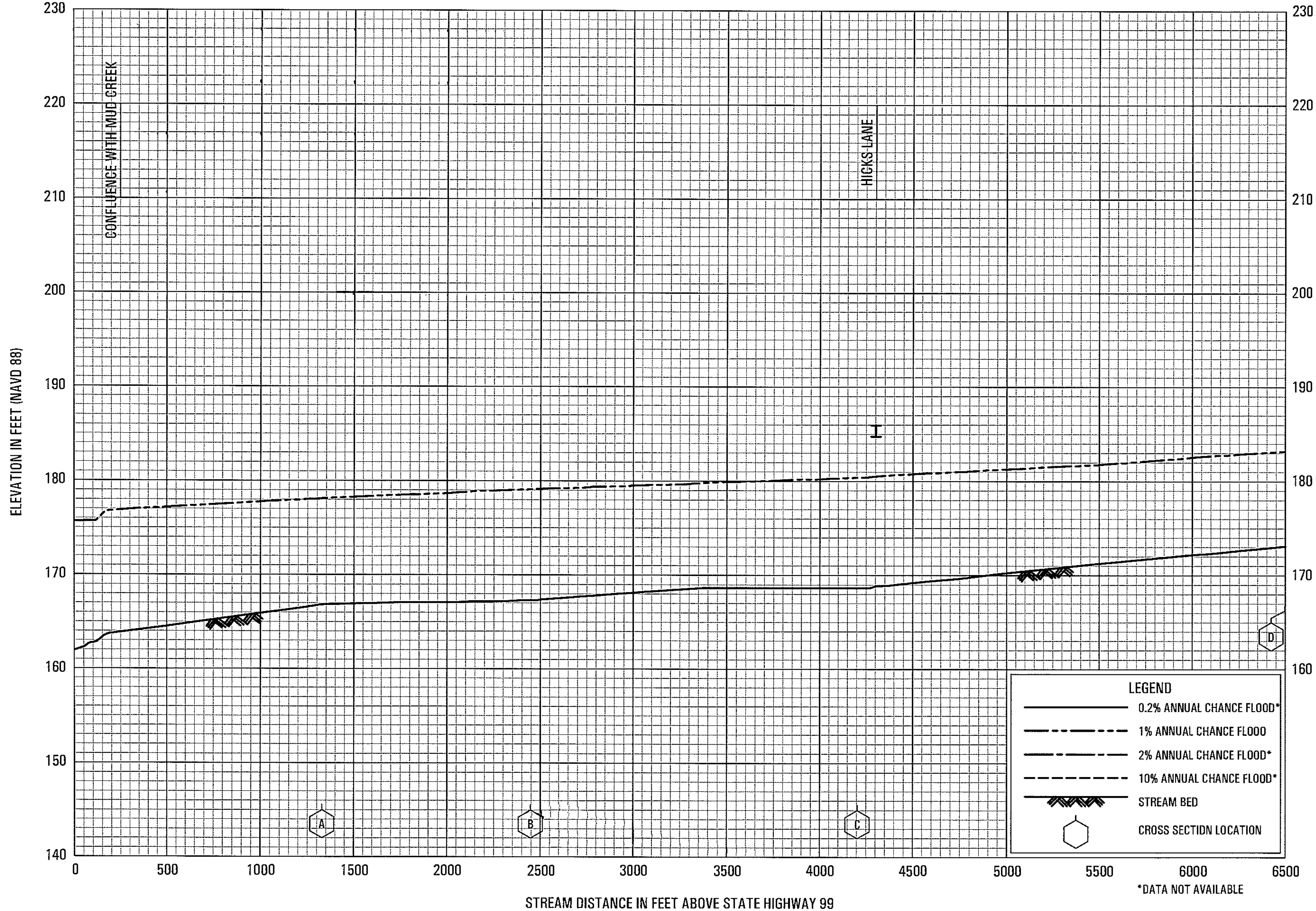
RUDDY CREEK TRIBUTARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

47P



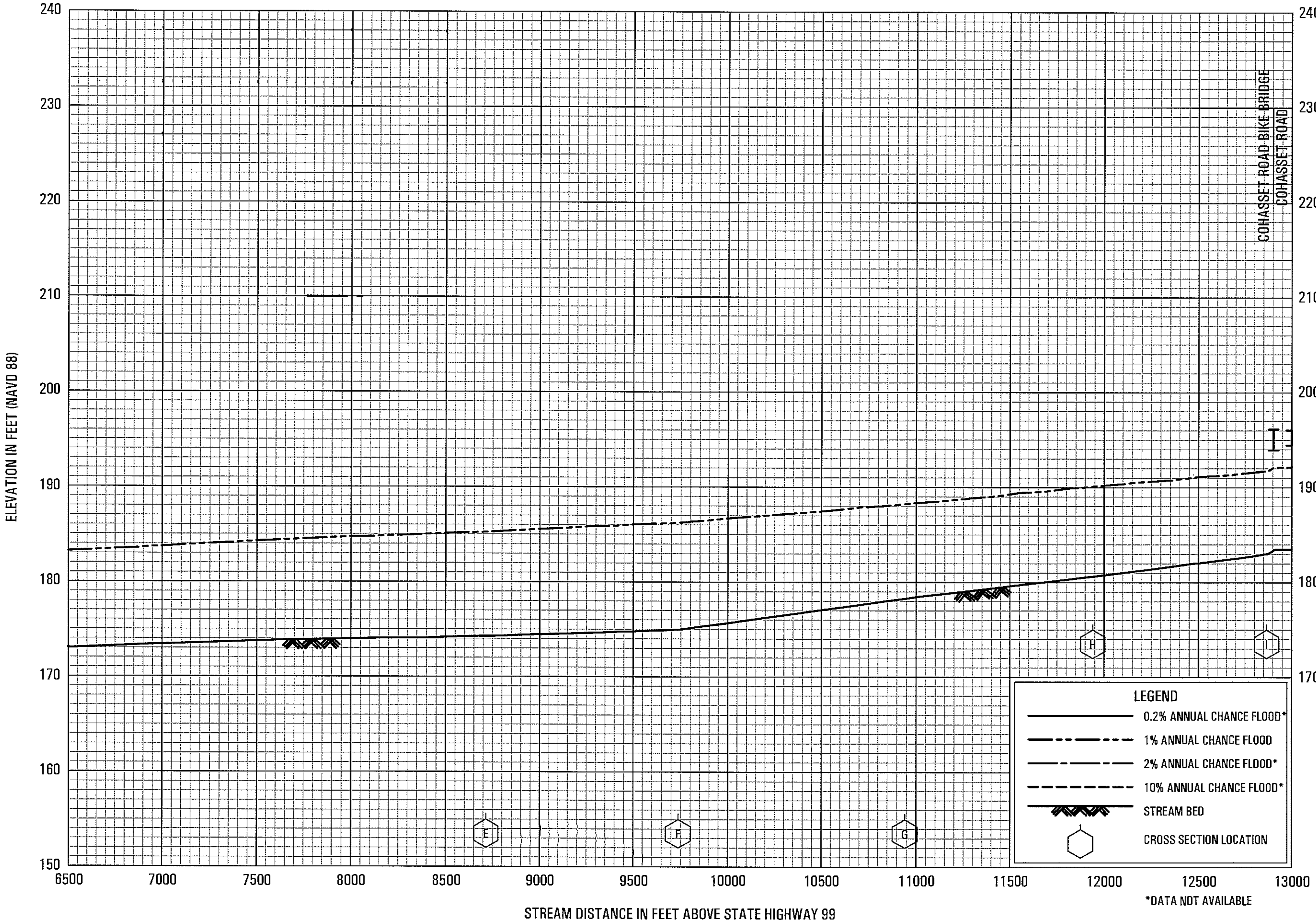
FLOOD PROFILES

SYCAMORE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



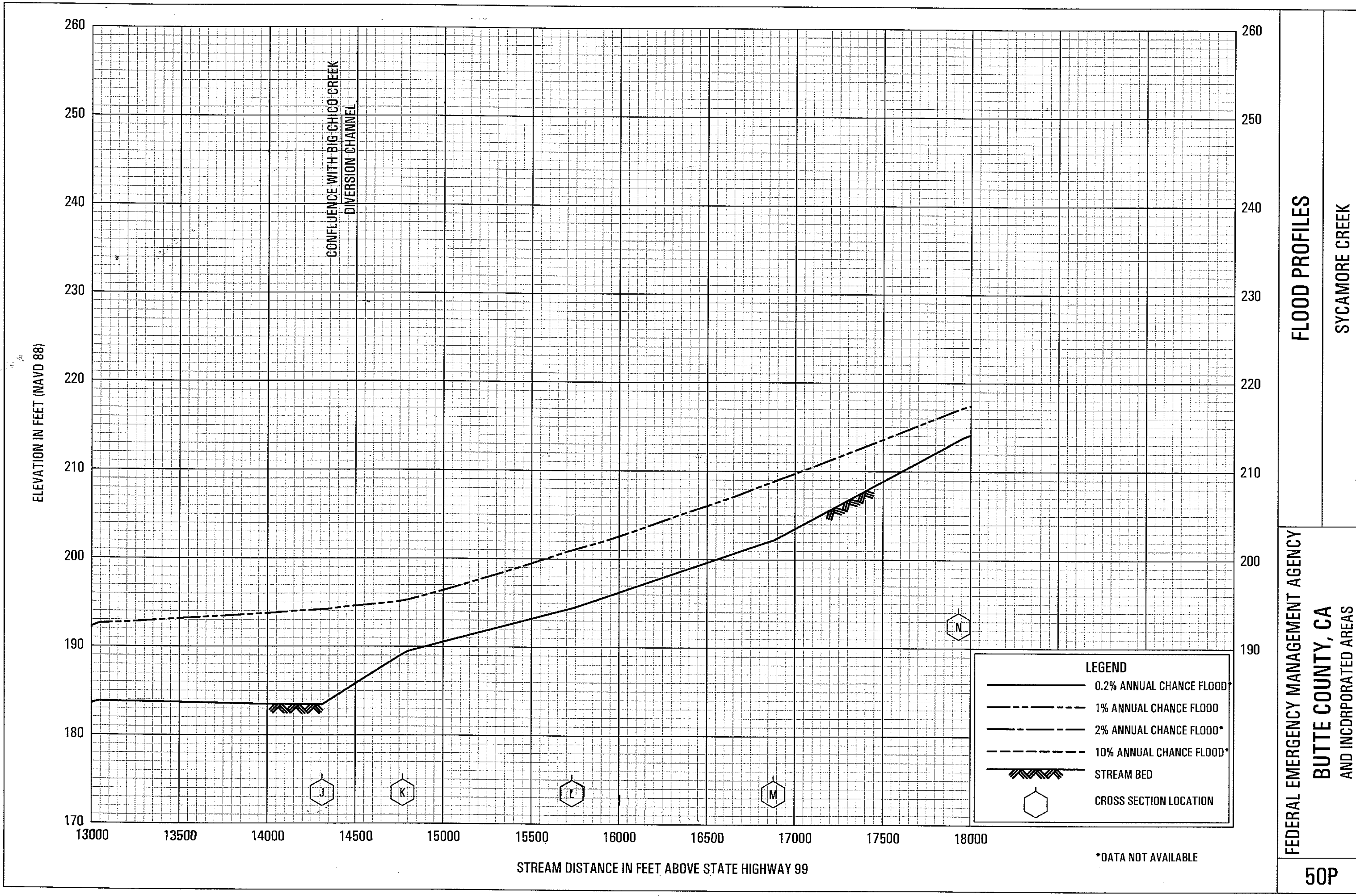
FLOOD PROFILES

SYCAMORE CREEK

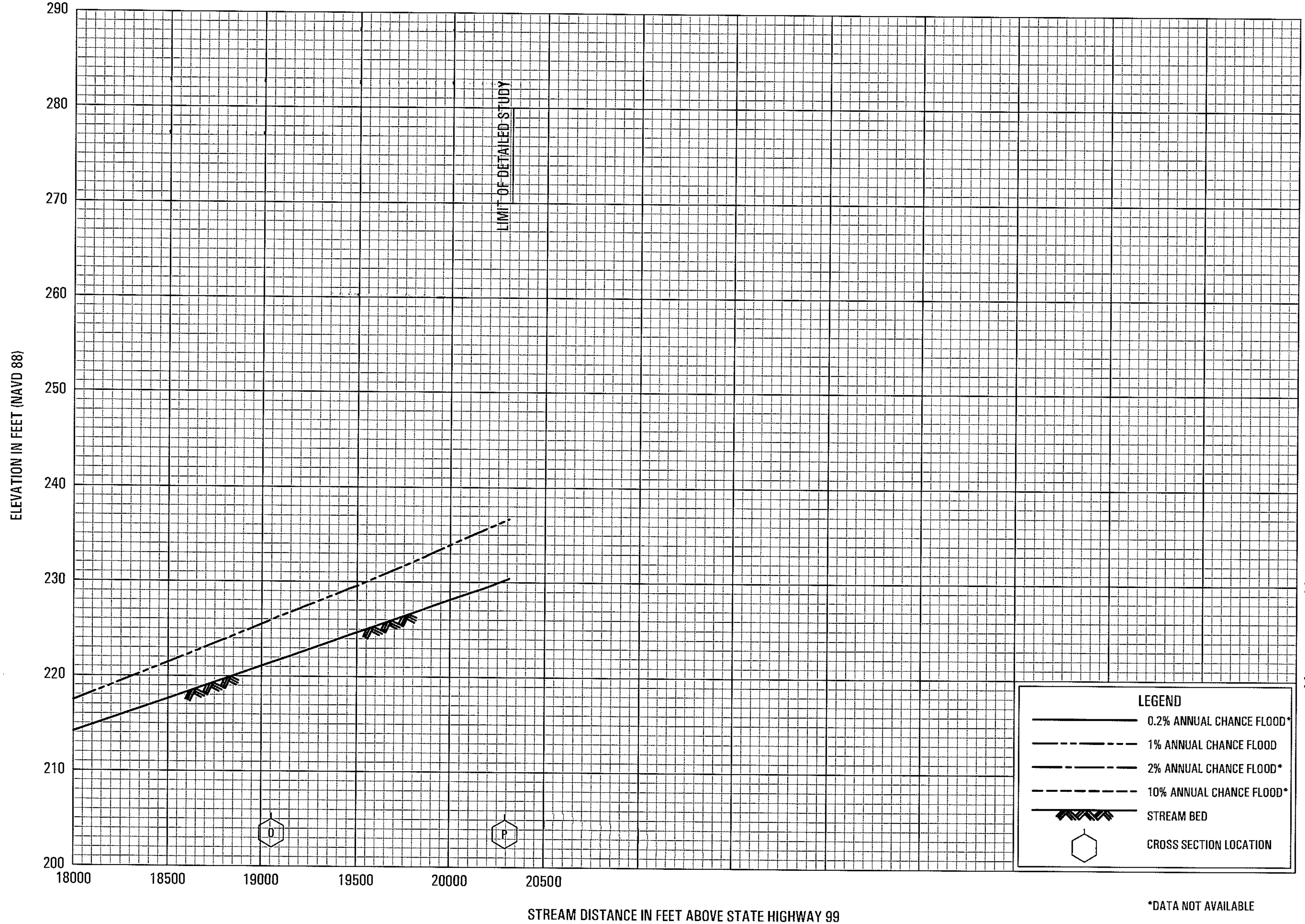
FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



ELEVATION IN FEET (NAVD 88)
260
250
240
230
220
210
200
190
180
170
13000
13500
14000
14500
15000
15500
16000
16500
17000
17500
18000
STREAM DISTANCE IN FEET ABOVE STATE HIGHWAY 99
CONFLUENCE WITH BIG CHICO CREEK DIVERSION CHANNEL
J
K
L
M
N
LEGEND
0.2% ANNUAL CHANCE FLOOD*
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD*
10% ANNUAL CHANCE FLOOD*
STREAM BED
CROSS SECTION LOCATION
*DATA NOT AVAILABLE
FLOOD PROFILES
SYCAMORE CREEK
FEDERAL EMERGENCY MANAGEMENT AGENCY
BUTTE COUNTY, CA
AND INCORPORATED AREAS
50P



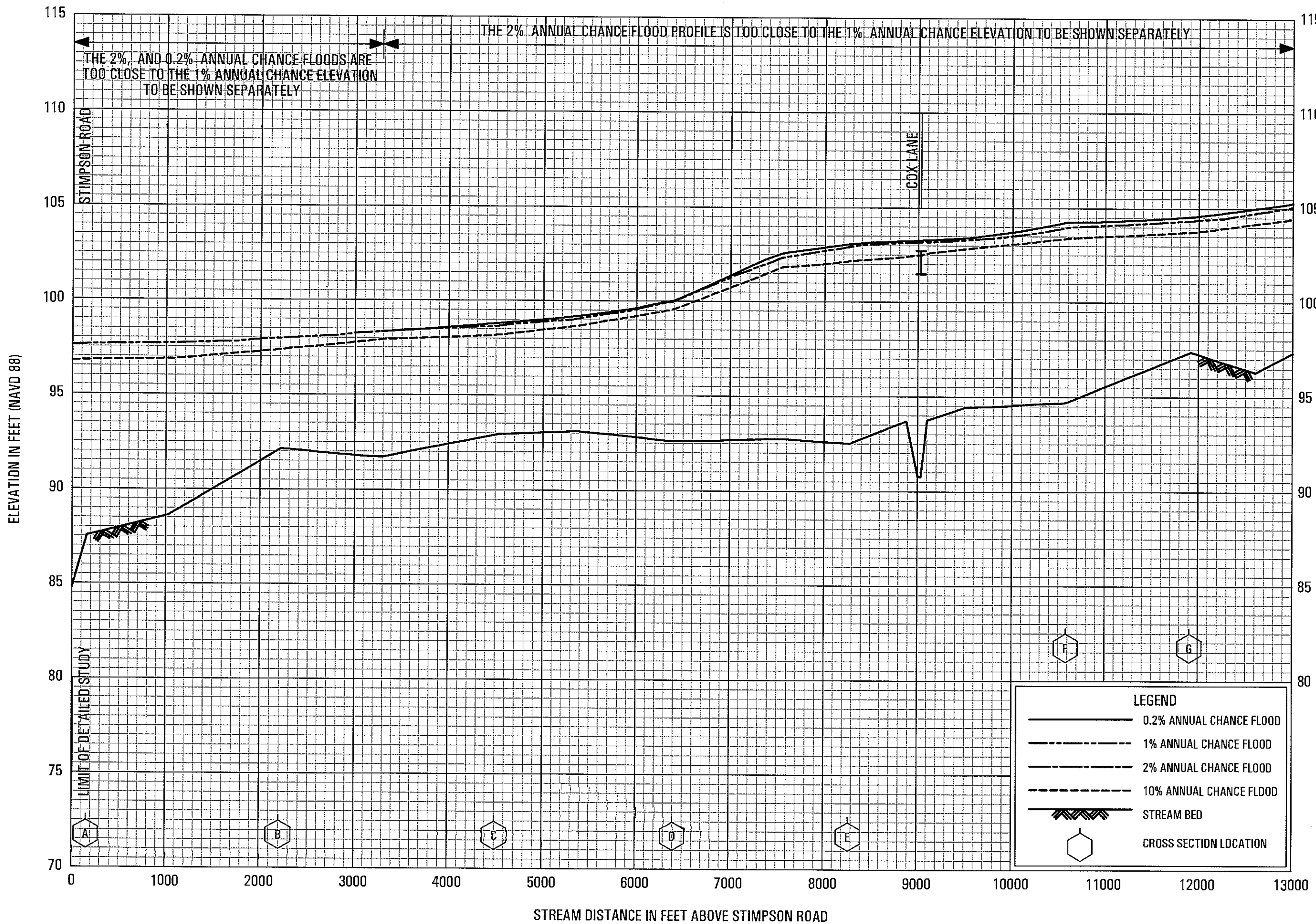
FLOOD PROFILES

SYCAMORE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



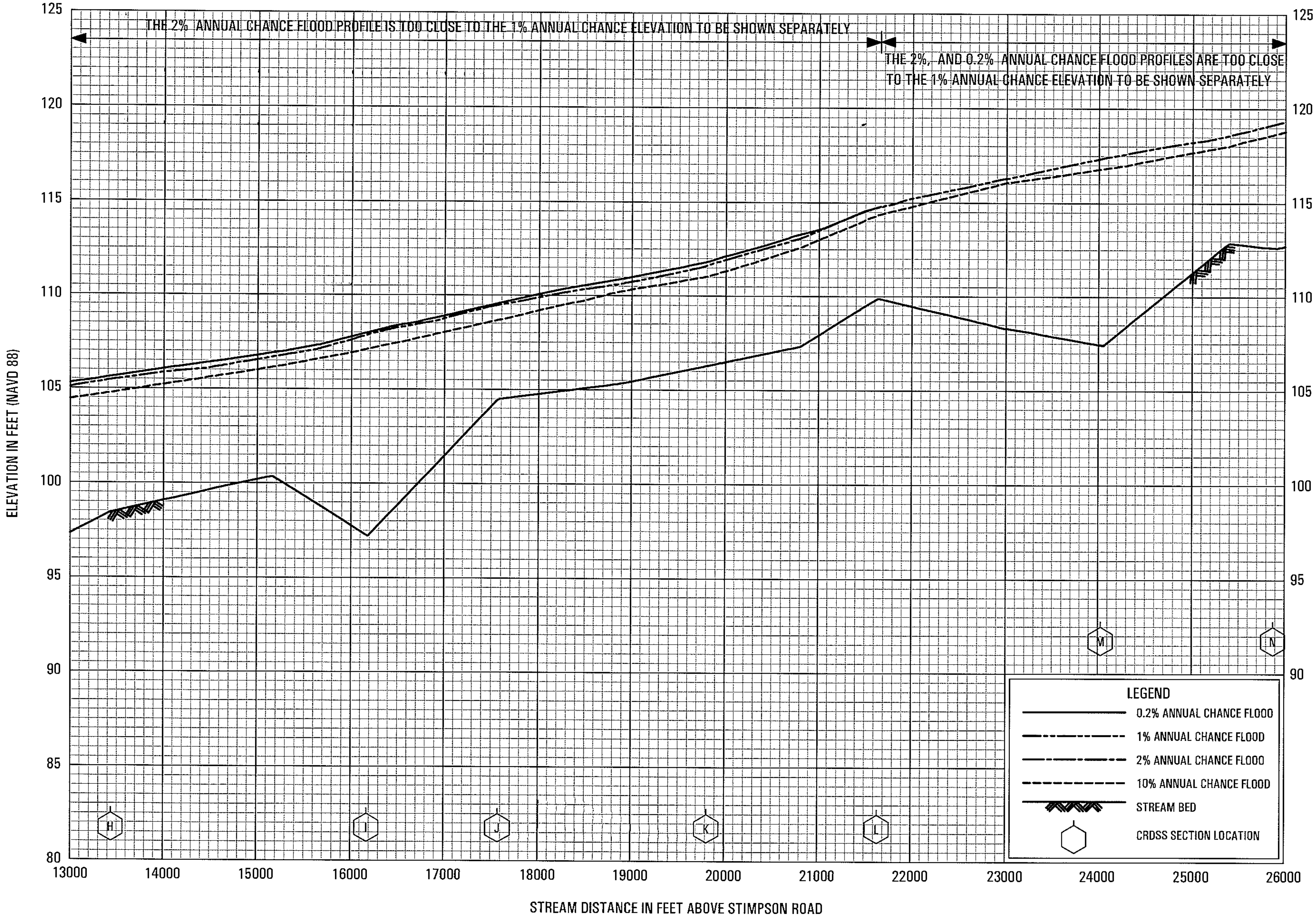
FLOOD PROFILES

WYMAN RAVINE

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



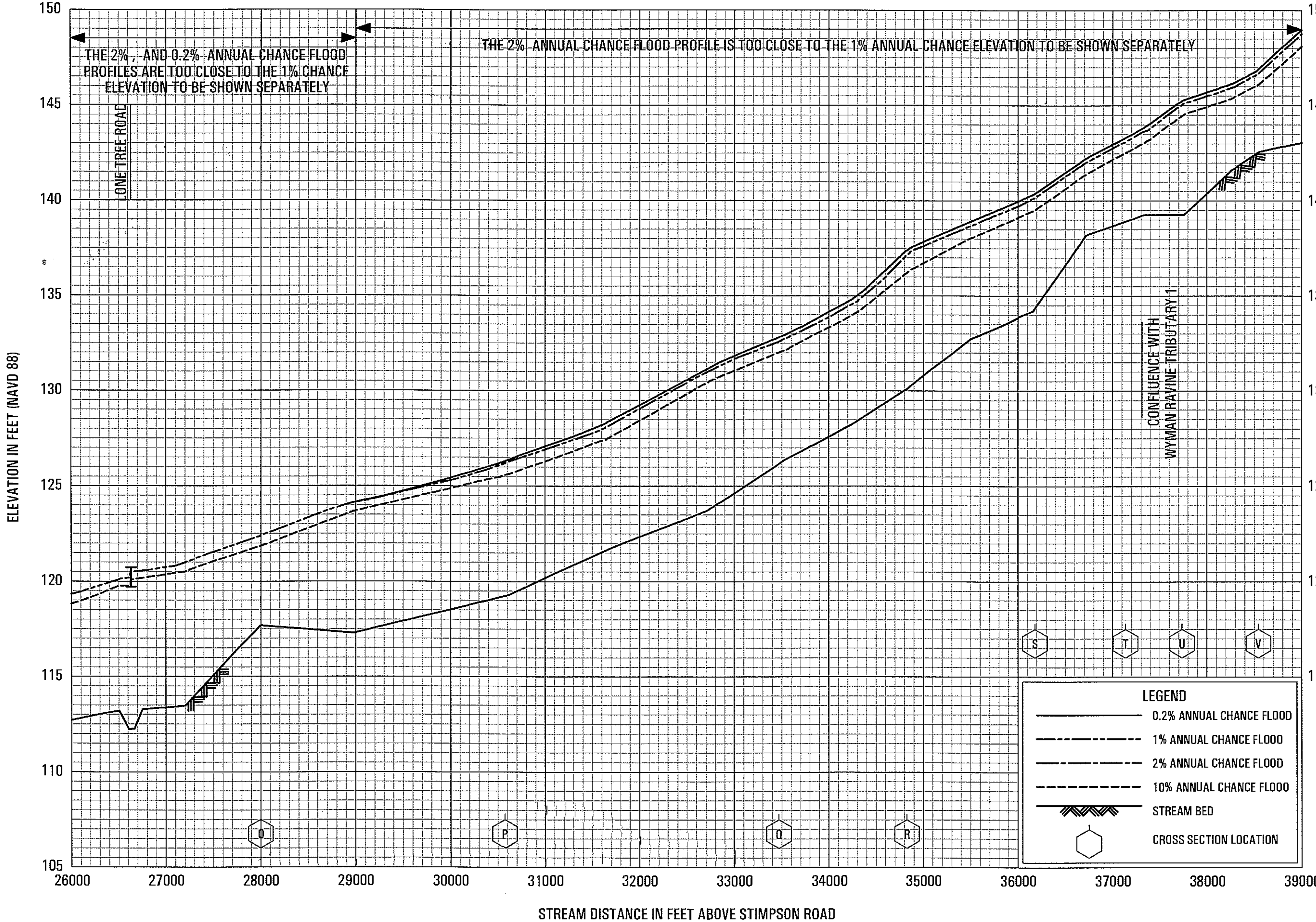
FLOOD PROFILES

WYMAN RAVINE

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS



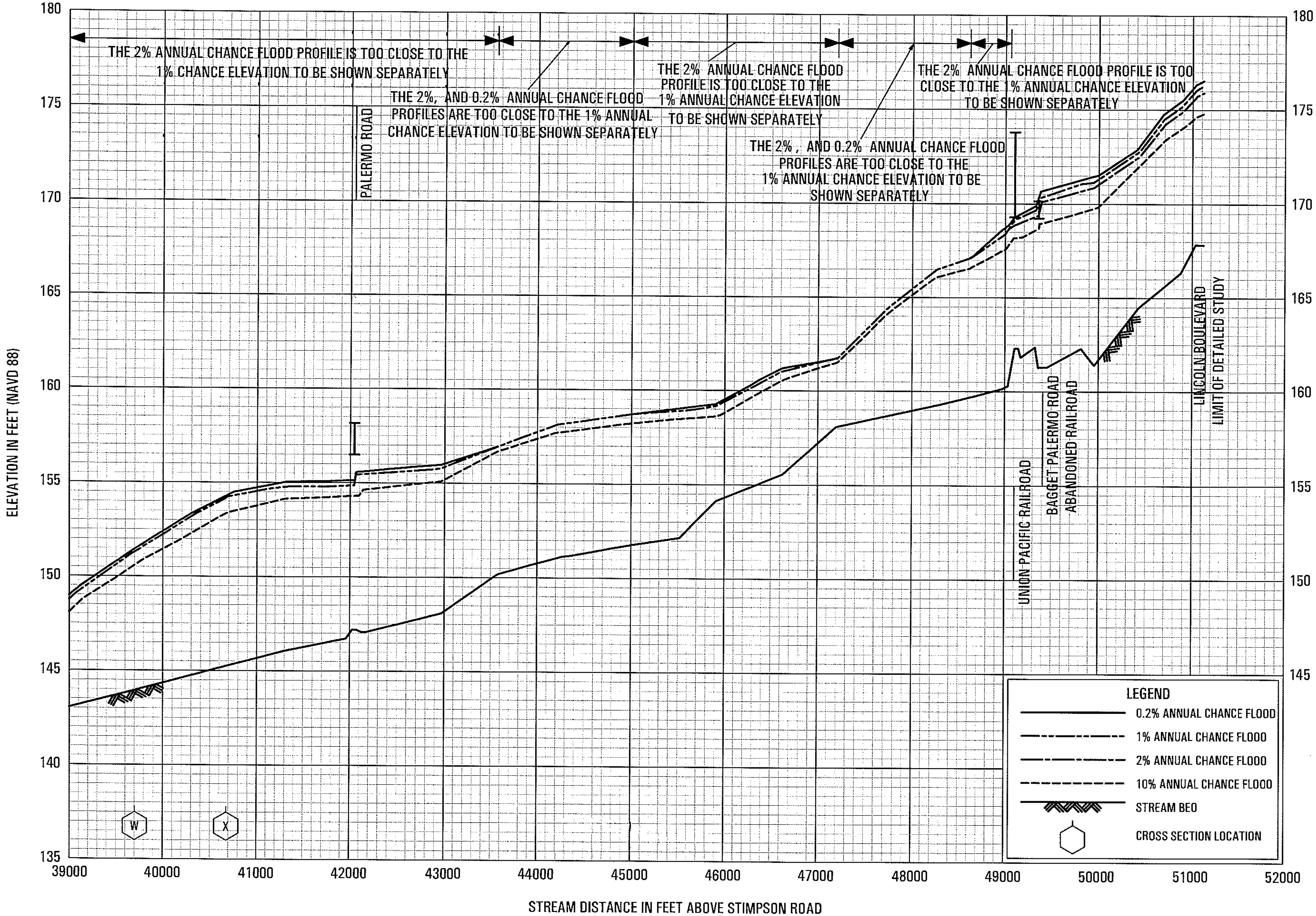
FLOOD PROFILES

WYMAN RAVINE

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

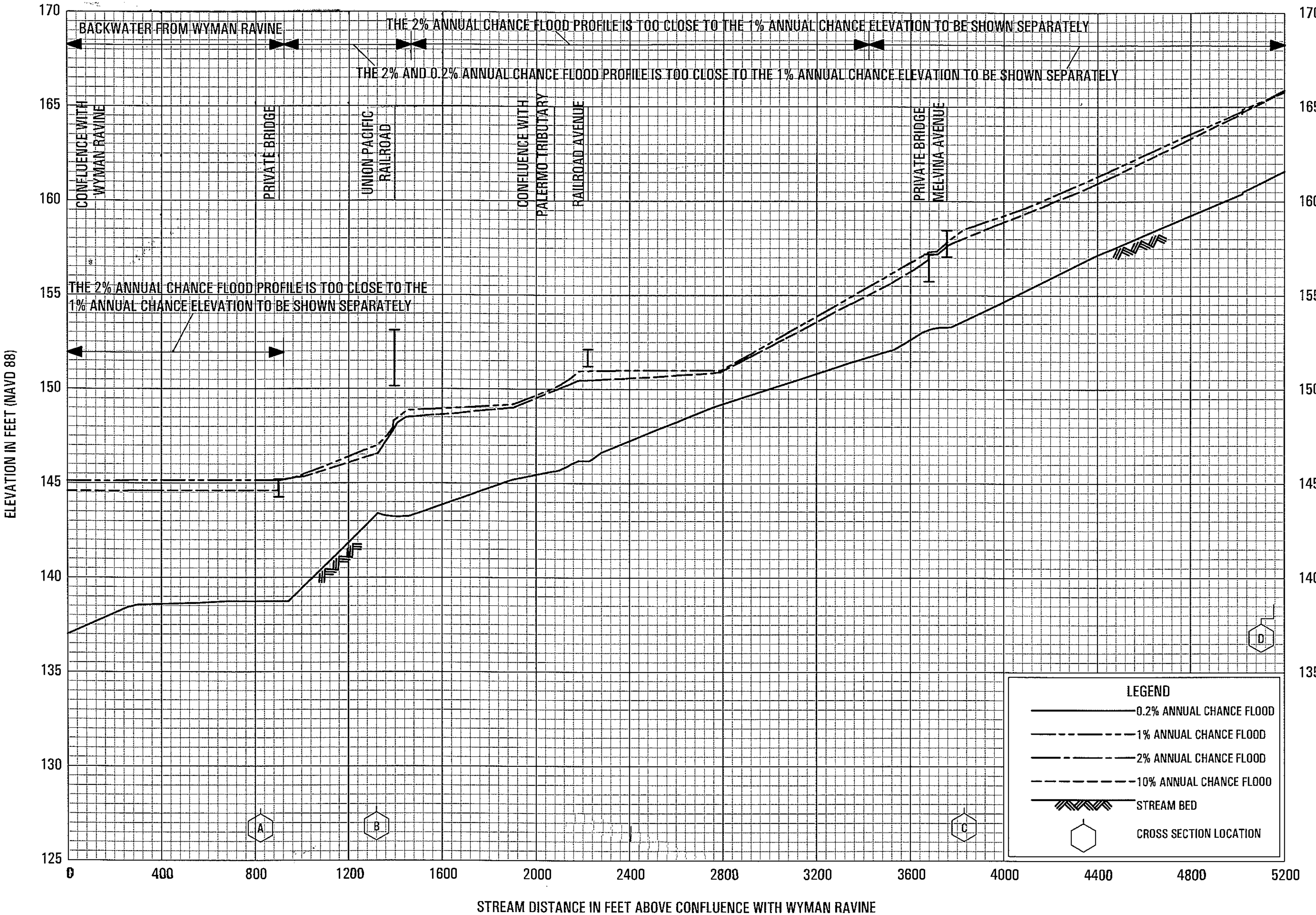


FLOOD PROFILES

WYMAN RAVINE

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA
AND INCORPORATED AREAS



FLOOD PROFILES

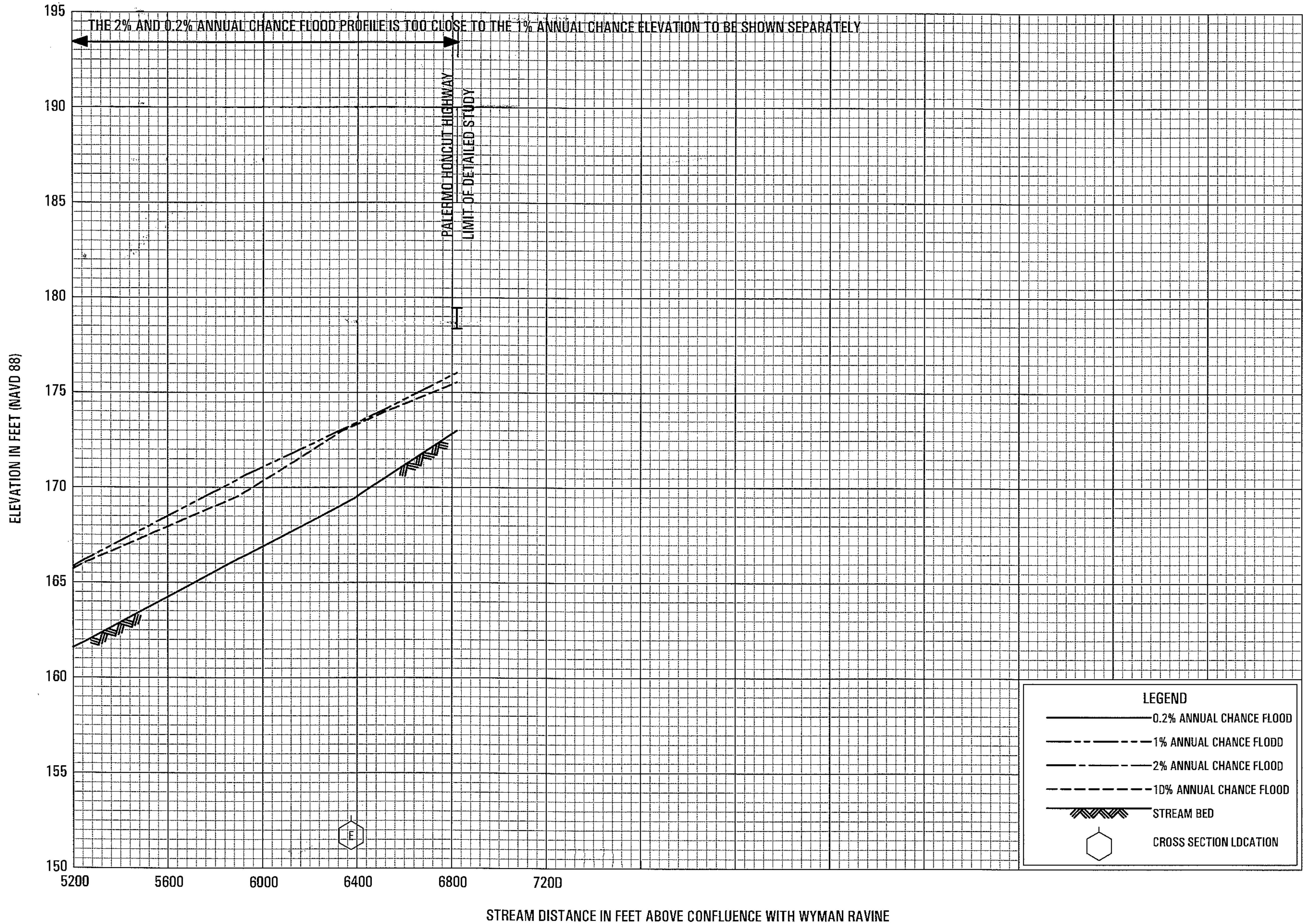
WYMAN RAVINE TRIBUTARY 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS

56P



FLOOD PROFILES

WYMAN RAVINE TRIBUTARY 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUTTE COUNTY, CA

AND INCORPORATED AREAS