FLOOD INSURANCE STUDY

COLUSA COUNTY, CALIFORNIA
AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
COLUSA, CITY OF	060023
WILLIAMS, CITY OF	060024
COLUSA COUNTY, UNINCORPORATED AREAS	060022

MAY 15, 2003

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
06011CV000A

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 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 tis FIS may be revised by the Letter of Map Revision process, which does not involve republication or redistribution or th FIS. It is therefore, the responsibility of the user to consult with the community officials and to check the community repository to obtain the mose cuurent FIS components.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

Page

TABLES

EXHIBITS

FLOOD INSURANCE STUDY
COLUSA COUNTY, CALIFORNIA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Colusa County, California, including the Cities of Colusa and Williams and the unincorporated areas of Colusa County (referred to collectively herein as Colusa County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (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 studies for Colusa County and the Cities of Colusa and Williams were performed by Ensign & Buckley for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-90-C-3133. The study for Colusa County and the City of Colusa was completed in December 1996. The study for the City of Williams was completed in January 1995.

The Colusa County study was revised on May 15, 2003, to incorporate revised flood hazard information for Elk Creek, Funks Creek, North Fork Elk Creek, Salt Creek, South Maxwell Creek, Stone Corral Creek, Whiskey Creek, and local flooding sources within the unincorporated areas of Colusa County, including the Arbuckle, College City, and Maxwell areas. Detailed flood hazard information was determined for Elk Creek, Salt Creek, and Stone Corral Creek. Approximate flood hazard information was determined for the remaining flooding sources.

The hydrologic and hydraulic analyses for the restudy were performed by the U.S. Army Corps of Engineers (USACE), Sacramento District, for FEMA, under Contract No. EMW-97-IA-0140, Project Order No. 6. This work was completed in 1999.

1.3 Coordination

The following Consultation Coordination Officer (CCO) meetings were held to review and supplement the results of the original and revised studies.

City of Colusa and Colusa County (Unincorporated Areas)

The results of the study were reviewed at the CCO meeting held on May 1, 1997, and attended by representatives of FEMA, the City of Colusa, and Colusa County. All problems raised at that meeting have been addressed in this study.

The results of the restudy were reviewed at the final CCO meeting held on June 18, 2002, and attended by FEMA and the county. All problems raised at that meeting have been addressed in this study.

City of Williams

The initial CCO meeting was held on July 21, 1992, and attended by representatives of the City of Williams, FEMA, and the USACE.

The results of the study were reviewed at the final CCO meeting held on September 19, 1995, and attended by representatives of FEMA and the City of Williams. All problems raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Colusa County, including the incorporated communities listed in Section 1.1.

The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction.

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.

2.2 Community Description

Colusa County and City of Colusa

Colusa County is one of the original 27 California counties formed in 1850. The county is located along the western side of the Sacramento Valley and comprises an area of 1,152 square miles. The population of Colusa County was estimated to be 18,844 in 1999 (Reference 1). Elevations range from approximately 30 feet along the Sacramento River at the southeast corner of the county to a maximum of approximately 7,040 feet in the coastal ranges in the northwestern portion of the county (Reference 2).

Colusa County is bordered by Lake, Glenn, Butte, Sutter, and Yolo Counties to the west, north, east, and south, respectively. The county seat is located in the City of Colusa, which is located approximately 70 miles north of the State Capitol at the City of Sacramento. The City of Colusa had an estimated population of 5,825 in 1999 (Reference 1).

The primary transportation route is Interstate Highway 5 (I-5), which runs north to south through the approximate center of Colusa County, serving the Cities of Williams, Maxwell, and Arbuckle. State Highway 45, located approximately 20 miles to the west of I-5, follows the Sacramento River through the Cities of Grimes, Colusa, and Princeton. State Highway 20 (SH20) crosses the county from west to east, passing through the Cities of Williams and Colusa. A main line of the Southern Pacific Railroad crosses the middle of the county from north to south. Shallow draft boats can use the Sacramento River channel. There are small general aviation airports in the Cities of Colusa and Williams.

Agriculture is the base of the county economy. Colusa County is the State's leading producer of rice and wheat. Other significant agricultural products include almonds, sugar beets, tomatoes, prunes, and livestock. Food processing is the leading manufacturing activity in the county. Natural gas, along with aggregates, and a small amount of mercury are produced in Colusa County.

The climate in the region is characterized by hot, dry summers and cool winters. Temperatures in the City of Colusa average 45°F and 77°F in January and July, respectively (Reference 3). The average growing season is approximately 270 days. Annual precipitation averages approximately 16 inches in the City of Colusa. Flood-producing rainstorms normally occur between November and April. Peak flows in the streams, originating in the coastal ranges on the west side of the county and in the Colusa Basin Drain (the primary north-to-south drainage channel), will result from winter rainstorms. Peak flow in the Sacramento River can result from either winter rainstorms or winter and spring snowmelt.

City of Williams

The City of Williams was incorporated in May 1920. It is located in the central part of Colusa County, approximately 60 miles north of Sacramento, in the western-central portion of northern California.

In general, the temperatures in Williams are moderate, ranging from an average of 45°F in January to 78°F in July (Reference 3). Occasionally, the winter temperature may drop to approximately 36°F and the summer temperature may reach 97°F. Annual rainfall averages 16 inches in the City of Williams.

The City of Williams had an estimated population of 2,932 in 1999 (Reference 1). The city's economy is primarily based on agriculture.

2.3 Principal Flood Problems

Colusa County and City of Colusa

As a result of limited channel capacities, agricultural lands along the Colusa Basin Drain have experienced relatively frequent flooding. According to studies by the California Department of Water Resources, crop damages were incurred as the result of historic floods during 1958, 1970, 1973, 1980, 1983, and 1986 (Reference 4). Because of the predominantly rural nature of the study area, the reported damages to structures were relatively limited. However, approximately 20 homes and agricultural buildings experienced damages as a result of the 1983 flood event. Major flood events, such as those in 1983 and January 1995, resulted in overtopping and closure of SH20. No significant structural damage was reported for the January 1995 flood event.

City of Williams

The City of Williams was inundated by a flood in 1973 cause by a heavy rainstorm in the western mountains. Severe floods also occurred in 1983 and 1984.

Salt Creek, which flows outside the city limits, is the main source of flooding in the City of Williams.

2.4 Flood Protection Measures

Colusa County and City of Colusa

The main channel for the Colusa Basin Drain is an excavated earthen channel. The channel depth is approximately 10 feet to 15 feet below the original ground elevation, and the average topwidth of the excavated section is approximately 100 feet. The channel is leveed on both sides throughout most of the study area. The levee height varies to a maximum of approximately 6 feet. Additional levees in the study area are set back from the channel by distances varying from approximately 500 feet to more than 10,000 feet.

City of Williams

No specific flood-protection structures have been built along the designated study area of the City of Williams. Some levees exist within the community, but they are not recognized as providing protection from the 100-year flood event.

Irrigation canals and structures, which were built by the Glenn Colusa Drainage District, do not provide adequate 100-year flood protection.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood-hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded 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 that equals or exceeds the 100-year flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

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

Peak discharge-drainage area relationships for the study area are shown in Table 1, "Summary of Discharges."

Colusa County and City of Colusa

The discharges outlined in the report entitled "Colusa Basin Drain Hydrologic Study," prepared by the USACE, Sacramento District (Reference 5), were used for Colusa Trough. This report was performed as part of an ongoing study by the USACE to evaluate the levees in the study area. The USACE included a statistical analysis of the California DWR streamflow gage located at SH-20. This analysis was based on 49 years of record (from 1941 to 1989). The USACE used the Weibull plotting position method as the basis of the frequency analysis of the gage.

The hydrologic analyses for the restudy were performed using the USACE's HEC-1 model. This model was used to compute the 100-year flood hydrographs. Factors were then applied to the 100-year hydrographs to determine the 10-, 50-, and 500-year flood hydrographs. The model results were compared to the flow-frequency curves developed from the gage data. This comparison showed that the model and gage results were reasonably consistent with each other. The HEC-1 results were used as part of the input into the XRATE model. This model was used to distribute the flow throughout the drainage system. The discharges used for the restudy at selected locations are included in Table 1, "Summary of Discharges."

Table 1. Summary of Discharges

Flooding Source and Location	Drainage Area (Sq. mi.)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-year	500-year
Colusa Trough					
At Colusa County	510	--[1]	--[1]	34,500	--[1]
Elk Creek					
Upstream of confluence with Salt Creek	--[1]	1,060	1,585	1,600	1,895
Upstream limit of detailed study	--[1]	1,075	1,400	1,405	1,460
Salt Creek					
Above confluence with Elk Creek	--[1]	3,190	3,985	4,010	4,445
At Business Route 5 (City of Williams)	55.0	[1]	--[1]	2,509	--[1]
At Freshwater Road	55.0	[1]	--[1]	1,133	--[1]
At Husted Road	55.8	[1]	--[1]	2,485	--[1]
At Interstate 5 (Colusa County)	--[1]	3,150	4,390	4,545	5,000
Upstream of Hillgate Road	--[1]	2,165	2,950	3,050	3,135
Salt Creek Overflow Area 1					
At Freshwater Road	--[1]	--[1]	--[1]	1,351	--[1]
Salt Creek Overflow Area 2					
At Business Route 5	--[1]	--[1]	--[1]	219	--[1]
At North Street	--[1]	--[1]	--[1]	375	--[1]
Salt Creek Overflow Area 3					
At Husted Road	--[1]	--[1]	--[1]	363	--[1]
Stone Corral Creek					
Below California Northern Railroad	--[1]	2,520	2,630	3,330	3,770
Upstream of Cemetery Road	--[1]	3,160	3,355	3,650	3,870

[1]Data not determined

City of Williams

The discharges used in this study were based on a HEC-1 model (Reference 6) developed for a previous FIS for the City of Williams (Reference 7) by the USACE, Sacramento District. The HEC-1 model was used to model the tributary watershed areas for Salt Creek and Spring Creek to a point immediately upstream of SH20. For this study, the HEC-1 model was extended to the Salt Creek crossing of Husted Road at the eastern corporate boundary of the City of Williams by adding local tributary areas to the USACE model as appropriate.

The revised HEC-1 model was based on the following data and parameters. The unit hydrograph ordinates were determined using USACE S-graph and Lag parameters. The precipitation was based on the National Oceanographic and Atmospheric Administration's isohyetal maps (Reference 8), and the USACE Sacramento Valley distribution pattern. The loss rates used were those previously established by the USACE as an initial loss rate of 0.5 inch and a uniform loss rate of 0.15 inch per hour. The Modified-Puls routing and reservoir storage methods were used for areas downstream of SH20, where significant overbank flooding and ponding can occur. Upstream of SH20, the Muskingum method was used to route the calculated hydrographs.

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 Flood Insurance Rate Map (FIRM) represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

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 was computed (Section 4.2), selected cross section locations are also shown on the FIRM (Exhibit 2).

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Colusa County and City of Colusa

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.

Colusa Trough was studied in detail from approximately 9,800 feet downstream to approximately 22,000 feet upstream of SH20.

Cross-section data were based on field surveys. The dimensions of hydraulic structures were determined using field surveys and as-built plans.

Channel roughness factors (Manning's "n" values) were selected based on field investigations and publications by Chow (1959) and the U.S. Geological Survey (USGS) (1967)

(References 9 and 10, respectively). Roughness values of 0.045 and 0.060 were used for the channel and overbanks, respectively.

The USACE HEC-2 computer program was used to calculate the water-surface elevations (WSELs) for the 100-year flood event (Reference 11).

The existing levee along Colusa Trough does not meet the minimum freeboard requirements of the FEMA levee policy. Therefore, the floodplain on the landward side of the levee was computed assuming the levee did not act as an effective flow barrier.

The revised hydraulic analyses for the main channels of Elk Creek, Salt Creek, and Stone Corral Creek were performed using the USACE's HEC-2 model. Starting WSELs were derived using the slope-area method. Cross sections for backwater analyses were located at close intervals upstream and downstream of bridges and culverts in order to establish the backwater effect of such structures in areas of or potentially subject to urban development. Additional cross sections were located at other representative locations in the study area.

The hydraulic characteristics of flow used in the restudy for the overbank areas were determined using the results of the XRATE model. The XRATE model results were used generally in two ways. First, the discharge results were plugged back into the stage-discharge rating curves that had been determined separately and included in the XRATE input. Second, the discharge results were used in Manning's equation to determine a depth of flooding. The slope and Manning's "n" value were included in the input. The flow width was generally taken to be approximately 750 feet. The approximate flood hazard information was determined based on engineering judgment during field visits.

City of Williams

The elevations of the ponding areas located west of North Street were based on the elevation of weir flow over SH20 and the canals in that area. Weir calculations were carried out using a weir coefficient of 2.6. The elevation of the ponding area west of North Street was calculated using the storage-routing routines in HEC-1. WSELs for the remaining areas studied by detailed methods were calculated using the USACE step-backwater program HEC-2 (Reference 11).

The cross sections used in the step-backwater analyses were obtained from topographic maps at a scale of 1:4,800 with a contour interval of 2 (Reference 12).

Manning's roughness coefficients ("n" values) were based on field observations and on guidelines published by the USGS (Reference 10). The channel roughness values varied from 0.020 to 0.065. Values of 0.060 to 0.065 were used for the overbanks.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks (ERMs) and their descriptions are shown on the maps. ERMs shown on the FIRM represent those used during the preparation of this and previous FISs. The elevations associated with each ERM were obtained and/or developed during FIS production to establish vertical control for determination of flood elevations and floodplain boundaries shown on the FIRM. Users should be aware that these ERMs may have changed since the publication of this FIS. To obtain up-to-date elevation information on National Geodetic Survey (NGS) ERMs shown on this map, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their website at www.ngs.noaa.gov. Map users

should seek verification of non-NGS ERM monument elevations when using these elevations for construction or floodplain management purposes.

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 100-year floodplain data, which may include a combination of the following: 10-, 50-, 100-, and 500-year flood elevations; delineations of the 100-year and 500-year floodplains; and 100-year floodway. This information is presented on the FIRM and in many components of the FIS, including Flood Profiles, Floodway Data tables and Summary of Stillwater Elevation tables. 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 (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated within Colusa County and the City of Colusa using topographic maps at a scale of 1:24,000 with a contour interval of 5 feet (Reference 13), and within the City of Williams at a scale of 1:4,800 with a contour interval of 2 feet (Reference 12).

The topographic data used in the restudy were taken from topographic maps at a scale of 1:24,000, with a contour interval of 5 feet (Reference 13).

The 100- and 500-year floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AH, and AO), and the 500-year floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year 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 100-year floodplain boundary is shown on the FIRM (Exhibit 2).

Approximate 100-year floodplain boundaries in some portions of the study area were taken directly from the FIRM for the unincorporated areas of Colusa County, California, dated June 5, 1989 (Reference 14).

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 100-year 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 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

No floodways were computed for this FIS report because they were not included in the study scope.

5.0 INSURANCE APPLICATION

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

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base (100-year) Flood Elevations (BFEs) or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the FIS by detailed methods. 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 100-year 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 100-year 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 X

Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No BFEs or depths 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.

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 100-year 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 100- and 500-year floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

The countywide FIRM presents flooding information for the entire geographic area of Colusa County, California. Previously, FIRMs were prepared for each incorporated community and the unincorporated areas of the county identified as flood-prone. This countywide FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps, where applicable. Historical data relating to the maps prepared for each community are presented in Table 2, "Community Map History."

7.0 OTHER STUDIES

FISs were prepared for the City of Colusa and for the unincorporated areas of Colusa County, California, on August 3, 1998 (References 15 and 16, respectively). An FIS was prepared for the City of Williams on November 20, 1996 (Reference 7).

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the NFIP.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Federal Emergency Management Agency, Region IX, Federal Insurance and Mitigation Administration, 1111 Broadway, Suite 1200, Oakland, California 94607-4052.

9.0 REFERENCES AND BIBLIOGRAPHY

1. U.S. Census Bureau, Population Estimates, July 1999, http://www.census.gov/population/www/estimates/popest.html

2. Sacramento Bee, *California – Past, Present, and Future*, 1971

3. Weatherbase, Weather Records and Averages, February 2001, http://www.weatherbase.com/

4. California Department of Water Resources, *Colusa Basin Appraisal*, May 1990

5. U.S. Department of the Army, Corps of Engineers, Sacramento District, *Colusa Basin Drain Hydrologic Study*, August 1990

6. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, *HEC-1, Flood Hydrograph Package*, September 1990

7. Federal Emergency Management Agency, *Flood Insurance Study, City of Williams, California*, September 6, 1989

8. National Oceanographic and Atmospheric Administration, *Precipitation Frequency Maps for California*, December 1992

9. Chow, Ven Te, *Open-Channel Hydraulics*, McGraw-Hill Book Company, 1959

10. U.S. Geological Survey, Water Supply Paper 1849, *Roughness Characteristics of Natural Channels*, 1967

11. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, *HEC-2, Water-Surface Profiles, Generalized Computer Program, User's Manual*, September 1990

12. Geonex, Inc., Williams Topographic Map, Scale 1:4,800, Contour Interval 2 feet, Photo Date May 14, 1993

13. U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 5 feet: Colusa, California, 1952, Photorevised 1973; Williams, California, 1952, Photorevised 1973

14. Federal Emergency Management Agency, Flood Insurance Rate Map, Colusa County, California, Unincorporated Areas, June 5, 1989

15. Federal Emergency Management Agency, *Flood Insurance Study, City of Colusa, California*, August 3, 1998

16. Federal Emergency Management Agency, *Flood Insurance Study, Colusa County, Unincorporated Areas, California*, August 3, 1998

Table 2. Community Map History

Community Name	Initial Identification Date	Flood Hazard Boundary Map Revision Date(s)	FIRM Effective Date	FIRM Revision Date(s)
Colusa County	October 25, 1974	September 6, 1977	September 18, 1985	June 5, 1989
Colusa, City of	November 16, 1973	--	August 3, 1998	--
Williams, City of	March 29, 1974	October 10, 1975 September 12, 1978	April 22, 1980	September 6, 1989 November 20, 1996

ELEVATION IN FEET (NGVD)

10 20 30 40 50 60 70 80 90

20 30 40 50 60 70 80 90

LIMIT OF DETAILED STUDY

COLUSA NATIONAL WILDLIFE REFUGE
COLUSA COUNTY

US HIGHWAY 20

EAST LEVEE FAILED

A

B

LEGEND

100 YEAR FLOOD

STREAM BED

CROSS SECTION LOCATION

STREAM DISTANCE IN FEET UPSTREAM OF US HIGHWAY 20

-10000 -9000 -8000 -7000 -6000 -5000 -4000 -3000 -2000 -1000 0 1000 2000 3000

FEDERAL EMERGENCY MANAGEMENT AGENCY

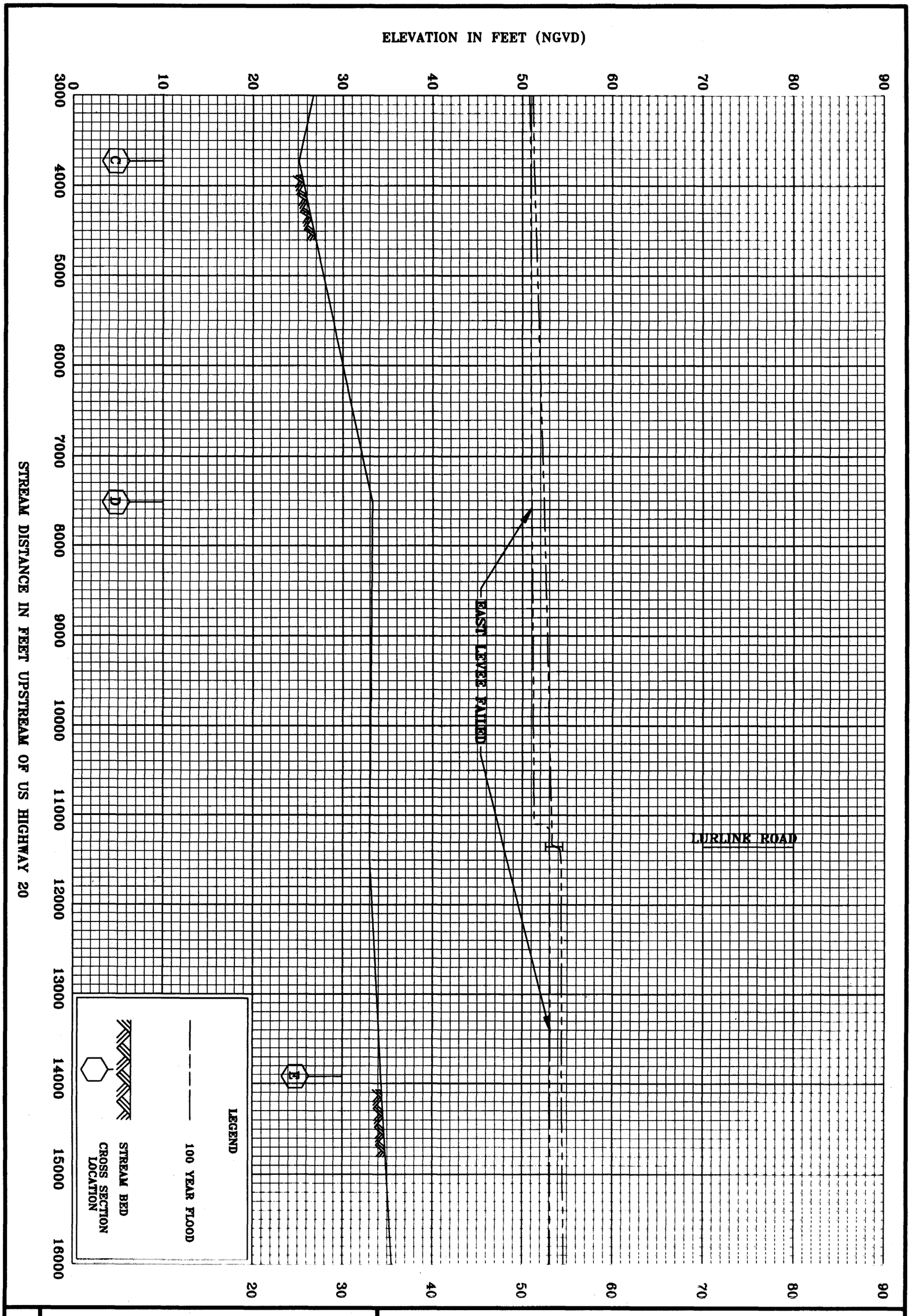
COLUSA COUNTY CA

AND INCORPORATED AREAS

FLOOD PROFILES

COLUSA TROUGH

01P



02P	FEDERAL EMERGENCY MANAGEMENT AGENCY COLUSA COUNTY CA AND INCORPORATED AREAS	FLOOD PROFILES COLUSA TROUGH

ELEVATION IN FEET (NGVD)

10 20 30 40 50 60 70 80 90 100

16000 17000 18000 19000 20000 21000 22000 23000

STREAM DISTANCE IN FEET UPSTREAM OF US HIGHWAY 20

EAST LEVEE FAILED

LIMIT OF DETAILED STUDY

LEGEND

100 YEAR FLOOD

STREAM BED

CROSS SECTION LOCATION

30 40 50 60 70 80 90 100

FEDERAL EMERGENCY MANAGEMENT AGENCY

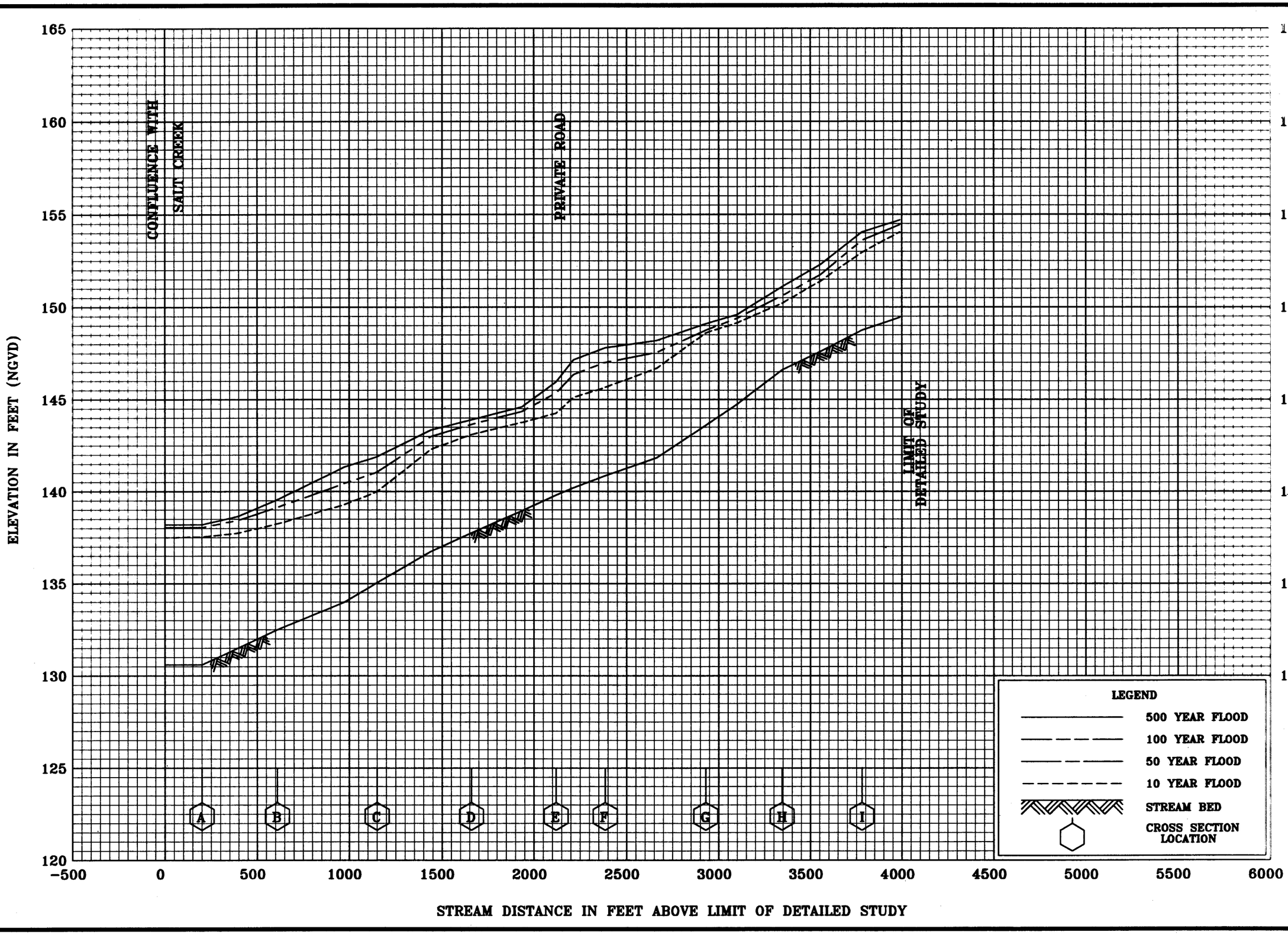
COLUSA COUNTY, CA

AND INCORPORATED AREAS

FLOOD PROFILES

COLUSA TROUGH

03P



FLOOD PROFILES

ELK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

COLUSA COUNTY, CA

AND INCORPORATED AREAS

04P

ELEVATION IN FEET (NGVD)

65 70 75 80 85 90 95 100 105 110

STREAM DISTANCE IN FEET ABOVE LIMIT OF DETAILED STUDY

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000

LIMIT OF DETAILED STUDY

SOUTHERN PACIFIC

U.S. HIGHWAY 99

A B C D E F G H I J K

LEGEND

500 YEAR FLOOD

100 YEAR FLOOD

50 YEAR FLOOD

10 YEAR FLOOD

STREAM BED

CROSS SECTION LOCATION

FEDERAL EMERGENCY MANAGEMENT AGENCY

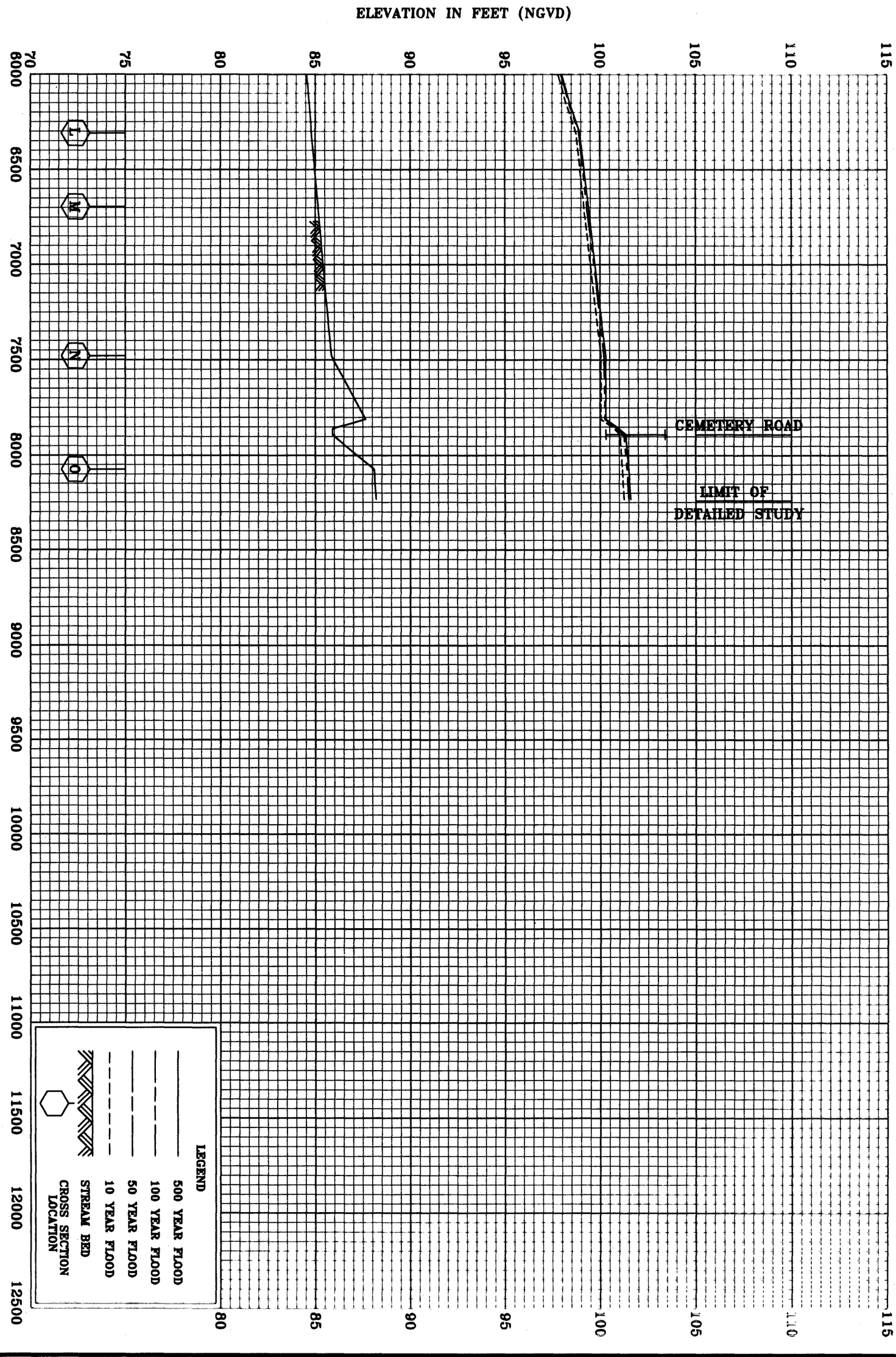
COLUSA COUNTY CA

AND INCORPORATED AREAS

FLOOD PROFILES

STONE CORRAL CREEK

05P



FEDERAL EMERGENCY MANAGEMENT AGENCY

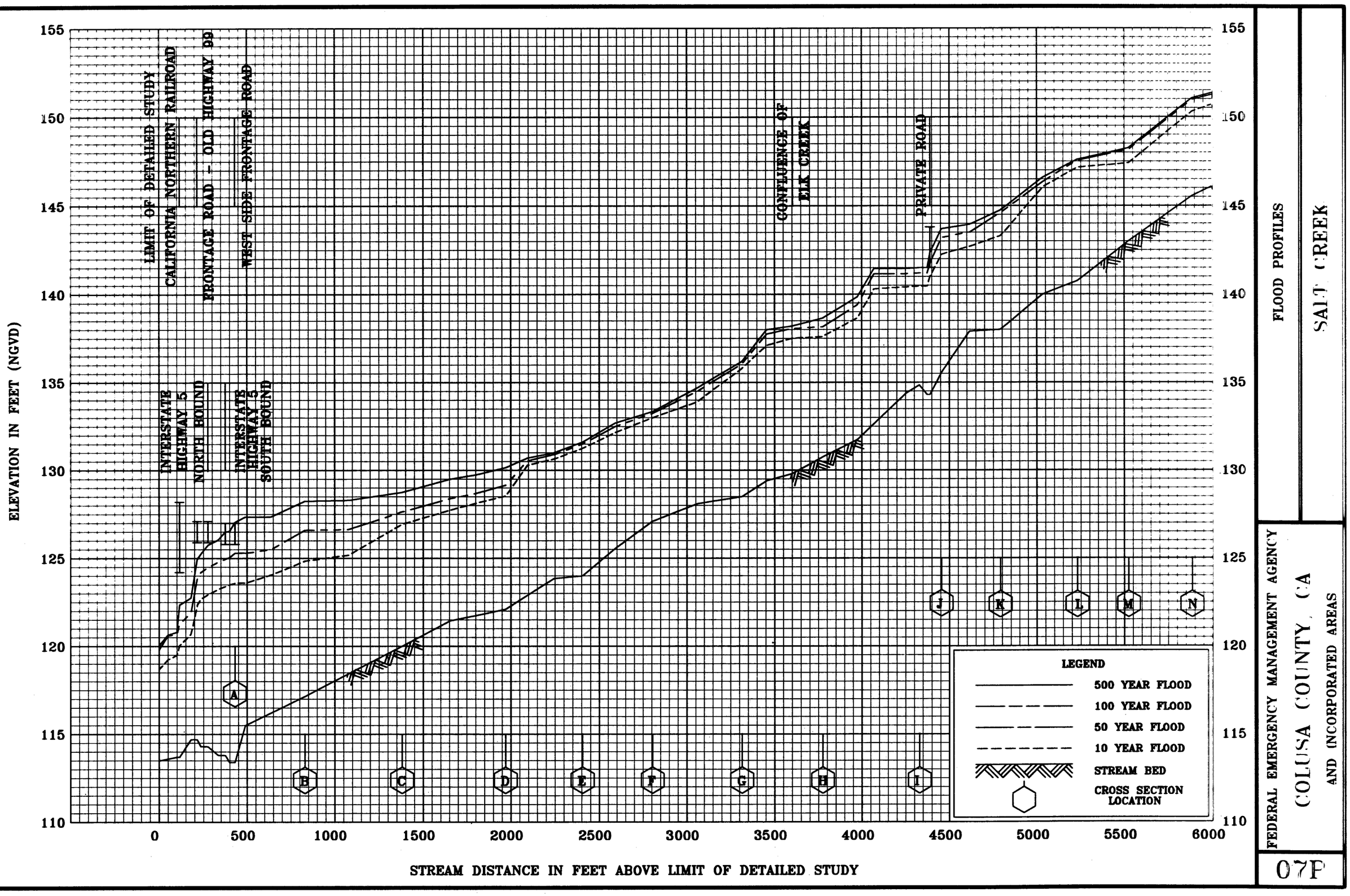
COLUSA COUNTY CA

AND INCORPORATED AREAS

FLOOD PROFILES

STONE CORRAL CREEK

06P



FLOOD PROFILES

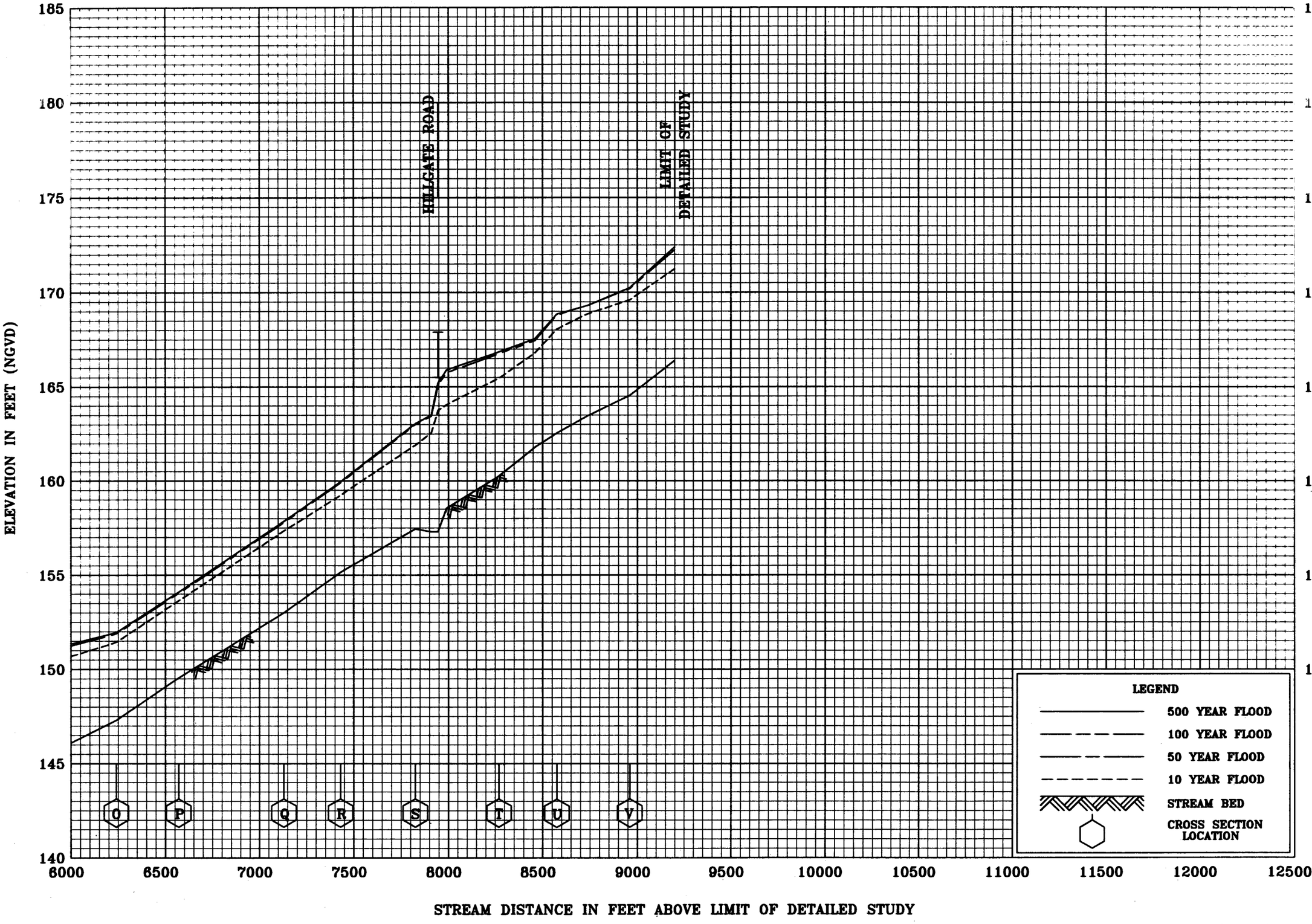
SALT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

COLUSA COUNTY, CA

AND INCORPORATED AREAS

07P



FLOOD PROFILES

SALT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

COLUSA COUNTY, CA

AND INCORPORATED AREAS

08P

ELEVATION IN FEET (NGVD)

40 50 60 70 80 90 100 110 120 130

STREAM DISTANCE IN FEET ABOVE HUSTED ROAD

6500 6500 7000 7500 8000 8500 9000 9500 10000 10500 11000 11500 12000 12500

COLUSA COUNTY
CITY OF WILLIAMS

FRESHWATER ROAD

INTERSTATE 5

SOUTHERN PACIFIC RAILROAD

BUSINESS ROUTE 5

CORPORATE LIMITS

A

B

C

LEGEND

100 YEAR FLOOD

STREAM BED

CROSS SECTION LOCATION

60 70 80 90 100 110 120 130

09P

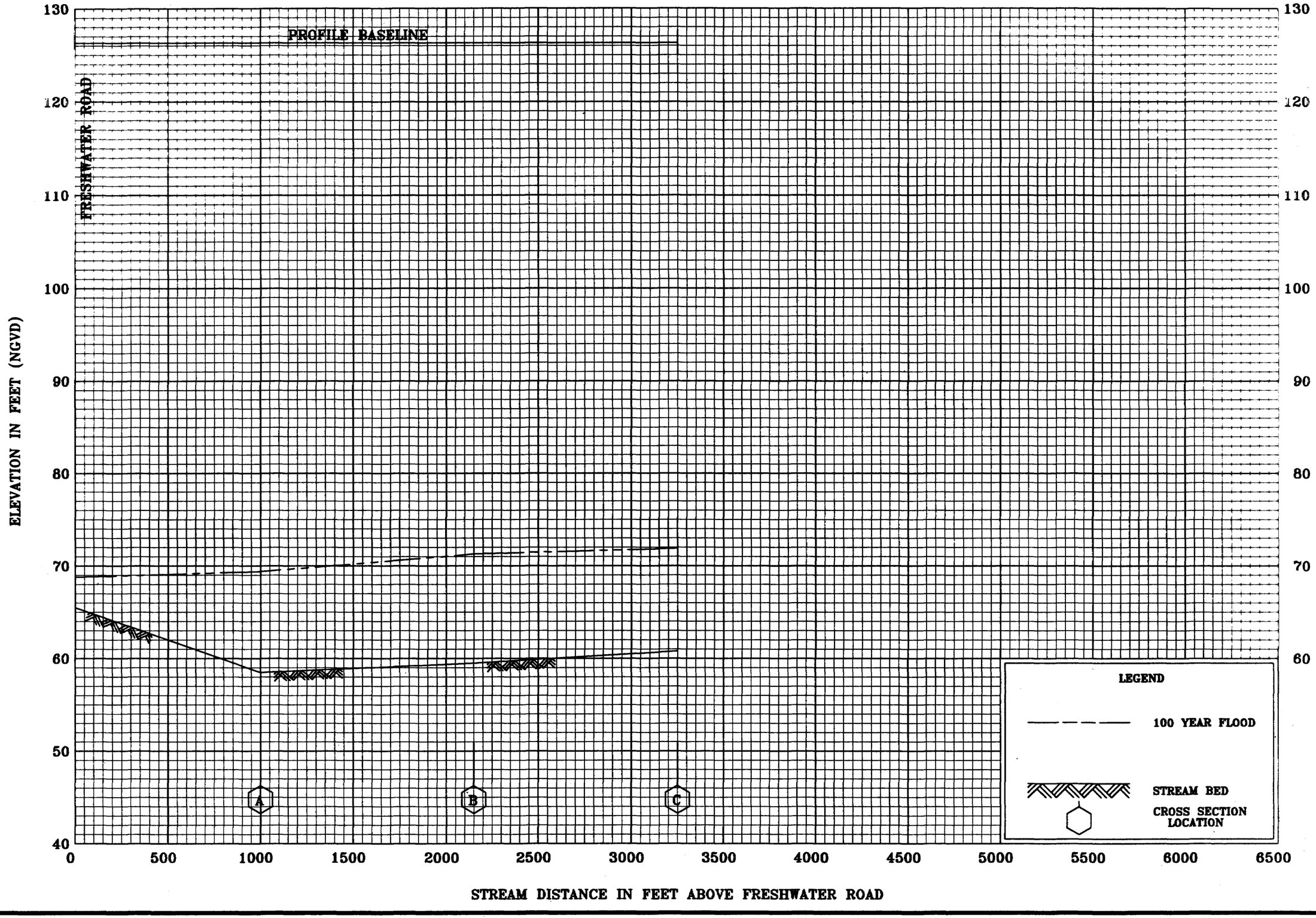
FEDERAL EMERGENCY MANAGEMENT AGENCY

COLUSA COUNTY, CA

AND INCORPORATED AREAS

FLOOD PROFILES

SALT CREEK (IN THE CITY OF WILLIAMS)



FLOOD PROFILES

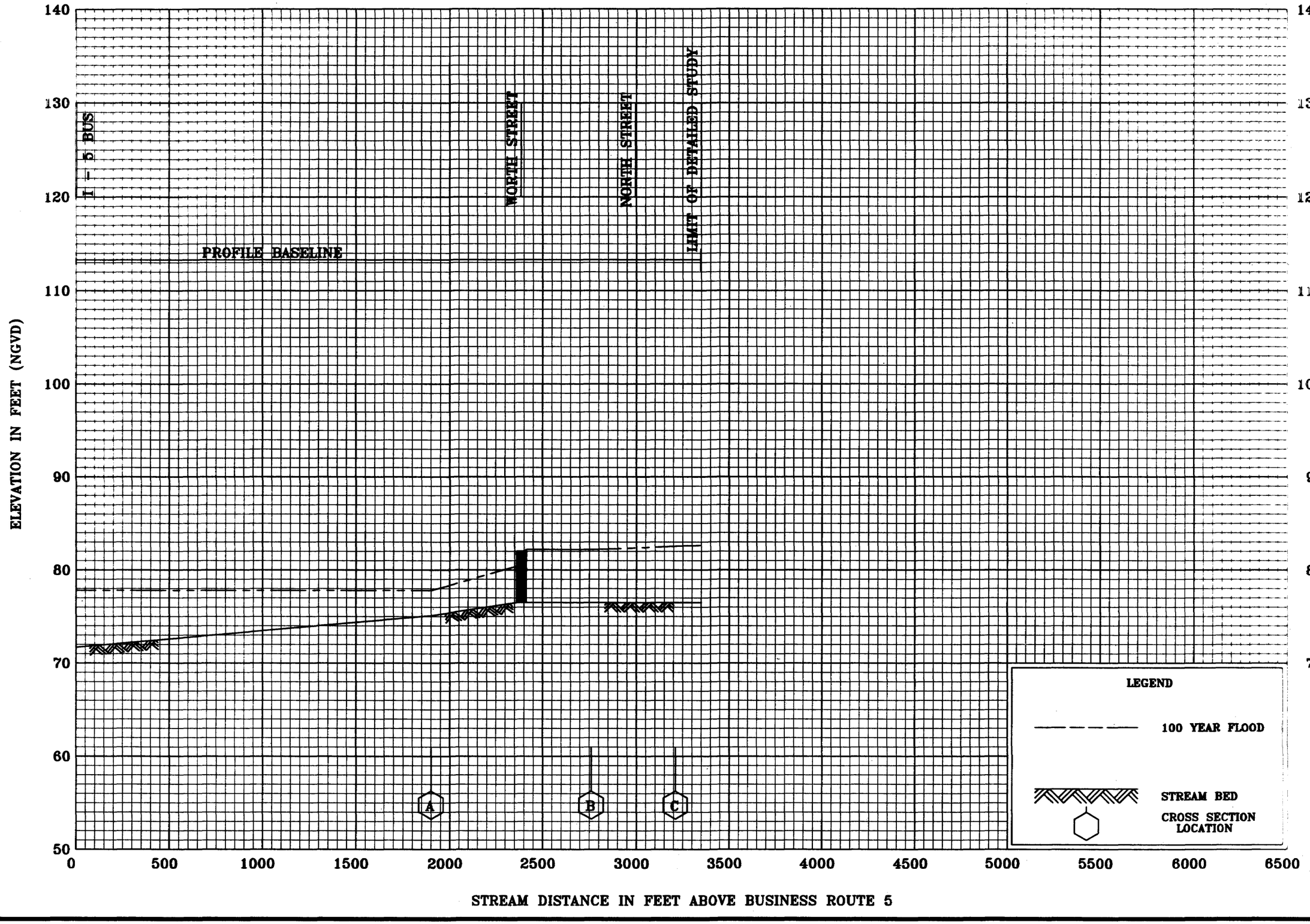
SALT CREEK OVERFLOW AREA 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

COLUSA COUNTY, CA

AND INCORPORATED AREAS

10P



FLOOD PROFILES

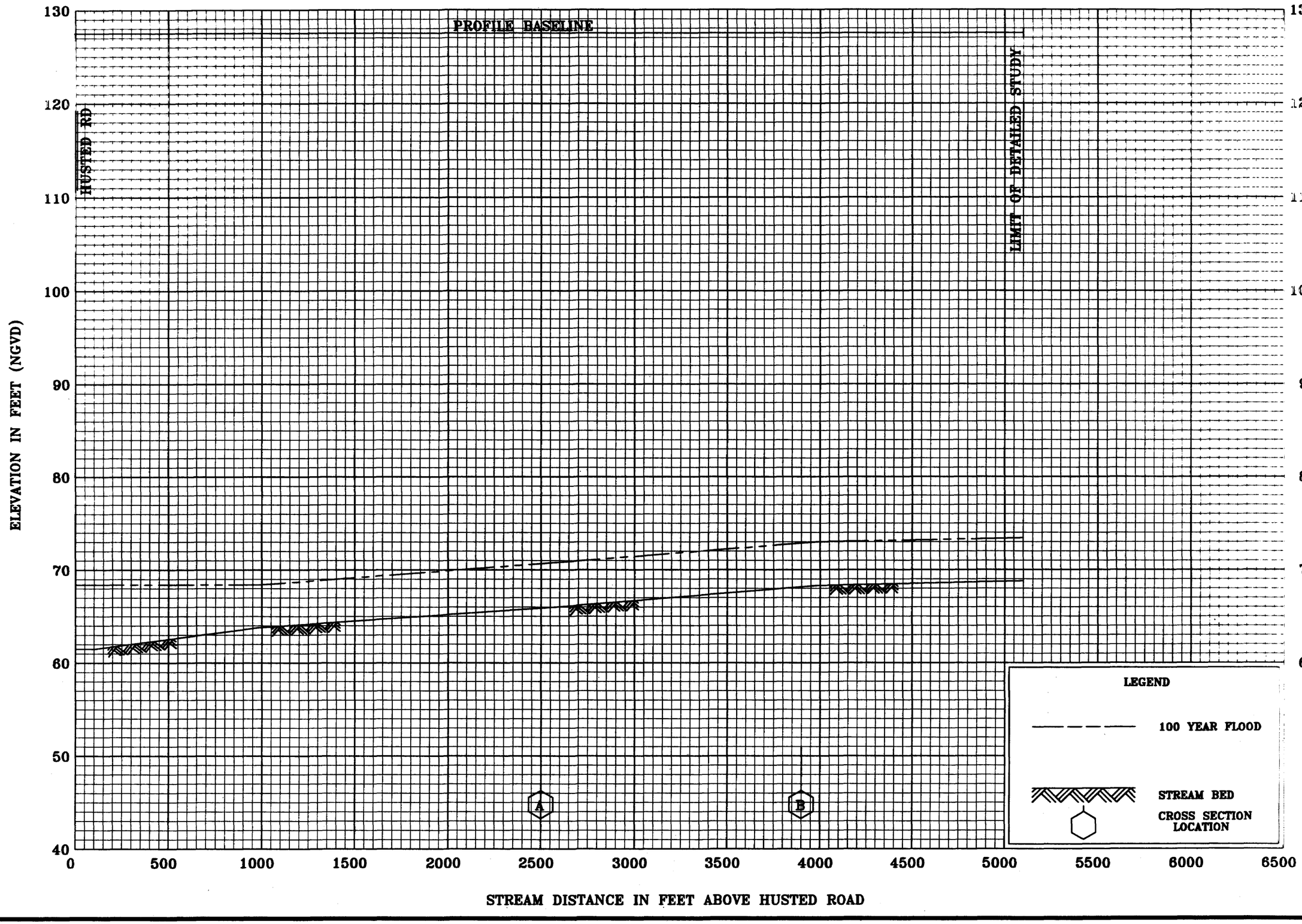
SAIT CREEK OVERFLOW AREA 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

COLUSA COUNTY, CA

AND INCORPORATED AREAS

11P



FLOOD PROFILES

SALT CREEK OVERFLOW AREA 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

COLUSA COUNTY, CA

AND INCORPORATED AREAS

12P