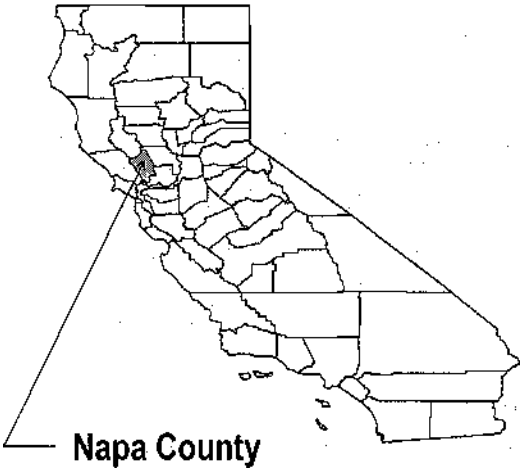
# FLOOD INSURANCE STUDY

# NAPA COUNTY, CALIFORNIA
## AND INCORPORATED AREAS




| Community Name | Community Number |
|---|---|
| AMERICAN CANYON, CITY OF | 060755 |
| CALISTOGA, CITY OF | 060206 |
| NAPA, CITY OF | 060207 |
| NAPA COUNTY (UNINCORPORATED AREAS) | 060205 |
| ST. HELENA, CITY OF | 060208 |
| YOUNTVILLE, TOWN OF | 060209 |

**PRELIMINARY**

**DECEMBER 19, 2014**

REVISED
Month Day, Year

## Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
06055CV000C

**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.

This FIS report was revised on <date>. Users should refer to Section 10.0, Revisions Description, for further information. Section 10.0 is intended to present the most up-to-date information for specific portions of this FIS report. Therefore, users of this FIS report should be aware that the information presented in Section 10.0 supersedes information in Sections 1.0 through 9.0 of this FIS report.

Initial Countywide FIS Effective Date: September 26, 2008

First Revised Countywide FIS Date: September 29, 2010

Second Revised Countywide FIS Date: Month xx, 201x

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**FLOOD INSURANCE STUDY**

**NAPA 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 FISs/Flood Insurance Rate Maps (FIRMs) for the geographic area of Napa County, California, including: the Cities of American Canyon, Calistoga, Napa, St. Helena, and the Town of Yountville, and the unincorporated areas of Napa County (hereinafter referred to collectively as Napa County).

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 Napa County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (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.

The Digital Flood Insurance Rate Map (DFIRM) and FIS report for this countywide study have been produced in digital format. Flood hazard information was converted to meet the Federal Emergency Management Agency (FEMA) DFIRM database specifications and Geographic Information System (GIS) format requirements. The flood hazard information was created and is provided in a digital format so that it can be incorporated into a local GIS and be accessed more easily by the community.

## 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.

This FIS was prepared to include the unincorporated areas of, and incorporated communities within, Napa County in a countywide FIS. Information on the authority and acknowledgments for each jurisdiction included in this countywide FIS, as compiled from their previously printed FIS reports, is shown below.

Calistoga, City of: The hydrologic and hydraulic analyses from the FIS report dated March 28, 1979, were performed by Dames & Moore, for the Federal Insurance Administration (FIA), under Contract No. H3952. That work, which was completed in June 1977, covered all significant flooding sources affecting the City of Calistoga.

Napa, City of: The hydrologic and hydraulic analyses shown in the previous FIS reports were performed by Dames & Moore for FEMA under Contract No. H-3952. The revised study was performed by Gill & Pulver Engineers, Inc., under Contract No. EMW-85-C-1891. That study was completed in December 1977 and revised in April 1986.

The hydrologic and hydraulic analyses for the January 19, 2000, restudy were performed by Ensign & Buckley, for FEMA, under Contract No. EMW-90-C-4151. This study was revised to incorporate flood hazard data for Napa Creek, from its confluence with the Napa River to approximately 200 feet upstream of State Highway 29, a length of approximately 1.5 miles. This restudy was completed on September 19, 1997.

The hydrologic and hydraulic analyses for the September 29, 2010, restudy for Salvador Creek, Salvador Creek North Branch, and Salvador Creek South Branch were performed by DHI Water and Environment, Inc., for The Napa County Flood Control and Water Conservation District and the City of Napa. This restudy was completed in December 2007 and revised in April 2008. The hydrologic and hydraulic analyses for Napa Creek, Napa River, Napa River Oxbow Overflow, and Tulucay Creek were performed by West Consultants, Inc., for the Peter A and Vemice H. Gasser Foundation. This restudy was completed in April 2008.

The detailed coastal analyses for the <date>, restudy were performed by NHC via BakerAECOM, for FEMA, under Contract No. HSFEHQ-09-D-0368. This work, which was completed on <date>, incorporates regional-scale wave and hydrodynamic modeling performed by DHI Water & Environment, and covers the portions of the City of Napa affected by coastal flood hazard processes from the North San Francisco Bay (San Pablo Bay) shoreline.

Napa County (Unincorporated Areas): The hydrologic and hydraulic analyses shown in the previous FIS reports were prepared by the U.S. Army Corps of Engineers (USACE) for the Federal Emergency

Management Agency (FEMA) (FEMA, 1979). The analyses for the 1977 study were prepared under Interagency Agreement No. IAA-H-8-71, Project Order 16, and IAA-H-19-74, Project Order 2. This study was an expansion of a March 1974 study and was completed in 1977.

The non-floodway and floodway portions of the 1977 study were originally prepared by George S. Nolte and Associates, Civil Engineers, of San Jose, California, for the USACE, San Francisco District.

This study was revised on September 28, 1990, to reflect a hydraulic reanalysis, by Gill & Pulver Engineers, Inc., of a 3.9-mile reach of the Napa River floodplain, based on a March 1987 aerial topographic map of a portion of unincorporated Napa County adjacent to the Town of Yountville.

The hydrologic and hydraulic analyses for the September 29, 2010, restudy for Salvador Creek, Salvador Creek North Branch, and Salvador Creek South Branch were performed by DHI Water and Environment, Inc., for The Napa County Flood Control and Water Conservation District and the City of Napa. This restudy was completed in December 2007 and revised in April 2008. The hydrologic and hydraulic analyses for Napa Creek, Napa River, Napa River Oxbow Overflow, and Tulucay Creek were performed by West Consultants, Inc., for the Peter A and Vemice H. Gasser Foundation. This restudy was completed in April 2008.

The detailed coastal analyses for the <date>, restudy were performed by NHC via BakerAECOM, for FEMA, under Contract No. HSFEHQ-09-D-0368. This work, which was completed on <date>, incorporates regional-scale wave and hydrodynamic modeling performed by DHI Water & Environment, and covers the portions of the City of Napa affected by coastal flood hazard processes from the North San Francisco Bay (San Pablo Bay) shoreline.

St. Helena, City of:

The hydrologic and hydraulic analyses shown in the previous FIS reports were prepared by Dames & Moore for the FIA under Contract No. H-3952. That work, which was completed in July 1977, covered all significant flooding sources in the City of St. Helena.

The hydrologic and hydraulic analyses for the January 7, 1998, revision were performed for FEMA by Ensign &

Buckley Consulting Engineers, under Contract No. EMW-90-C-9133, to show modifications to flood hazards along an approximate 1.4-mile reach of Sulphur Creek. The creek was studied from its confluence with the Napa River upstream to approximately 300 feet upstream of Valley View Street. Included in this restudy is an approximate 0.5-mile reach of Sulphur Creek Tributary. Study limits for Sulphur Creek Tributary are from its confluence with Sulphur Creek upstream to approximately 300 feet upstream of Spring Street.

Yountville, Town of: The hydrologic and hydraulic analyses shown in the previous FIS reports were performed by Dames & Moore, for FEMA, under Contract No. H-3952. That work, which was completed in July 1977, covered all significant flooding sources affecting the Town of Yountville.

The City of American Canyon did not have a previous FIS report prior to the September 26, 2008, countywide because it was previously part of the unincorporated areas of Napa County.

As part previous revisions to this FIS, the tidal flooding on the Napa River caused by San Pablo Bay was revised to be in agreement with the USACE's "San Francisco Bay Tidal Stage vs. Frequency Study" dated October 1984 (USACE, 1984). This data has been superseded by this PMR. Users should refer to Section 10.0, Revisions Description, for further information on this PMR.

Base map information shown on the September 26, 2008 and September 29, 2010 FIRMs was derived from Napa County digital orthophotos produced at a scale of 1:4,800 with 1-foot ground sample distance from photography dated April 2002. These data were provided in digital format by the Napa County Information Technology Services Department. Users of this FIRM should be aware that minor adjustments may have been made to specific base map features.

Base map information shown on the FIRMs for this revision was derived from Coastal California LiDAR and Digital Imagery dated 2011. USDA NAIP 2012 imagery is used in areas not covered by the Coastal California imagery. The coordinate system used for the production of this FIRM is State Plane II Zone, North American Datum of 1983 (NAD 83), GRS 80. Corner coordinates in the FIRM are in latitude and longitude. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on the 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 Napa 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 Name | For FIS Dated | Initial CCO Date | Final CCO Date |
|---|---|---|---|
| American Canyon, City of | * | * | * |
| Calistoga, City of | March 28, 1979 | Late 1976 | December 21, 1977 |
| | September 28, 1979 | | |
| Napa, City of | * | Late 1976 | December 6, 1977 |
| | * | December 3, 1984 | May 1, 1986 |
| | January 19, 2000 | * | January 13, 1998 |
| Napa County | February 1, 1980 | * | December 6, 1977 |
| (Unincorporated Areas) | September 28, 1990 | December 3, 1984 | November 4, 1988 |
| St. Helena, City of | * | Late 1976 | December 6, 1977 |
| | September 4, 1987 | * | * |
| | January 7, 1988 | * | September 27, 1996 |
| Yountville, Town of | * | Late 1976 | September 12, 1978 |
| | September 28, 1990 | * | |

*Data not available

September 26, 2008 Countywide Revision

On October 18, 2007, the final CCO meeting for the Napa County countywide DFIRM and FIS was held. Attending the meeting were representatives of FEMA Region IX, MAPIX-Mainland (Dewberry) the study contractor, Napa County, Town of Yountville, Cities of American Canyon, Napa, Calistoga, and St. Helena.

September 29, 2010, Revision

The initial meeting was held on September 12, 2007, and attended by representatives of FEMA, Army Corps of Engineers, the City of Napa, Napa County, and the study contractor.

The results of the study were reviewed at the final meeting held on May 27, 2009, and attended by representatives Napa County, the City of Napa, FEMA, and the study contractor. All problems raised at that meeting have been addressed.

<date>, Revision

To be added.

## 2.0 AREA STUDIED

### 2.1 Scope of Study

This FIS covers the geographic area of Napa 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 are indicated on the Flood Profiles (Exhibit 1) and on the FIRMs (Exhibit 2).

**Table 2: Flooding Sources Studied by Detailed Methods**

| | | |
|---|---|---|
| Blossom Creek | Milliken Creek | Sarco Creek |
| Carneros Creek | Napa Creek | Sheehy Creek |
| Charter Oak Avenue Split Flow | Napa River | Soda Creek |
| Conn Creek | Redwood Creek | Sulphur Creek |
| Cyrus Creek | Salvador Creek | Sulphur Creek Tributary |
| Garnett Creek | Salvador Creek North Branch | Suscol Creek |
| Hopper Creek | Salvador Creek South Branch | Tulucay Creek |

**Table 3: Flooding Sources Revised by September 29, 2010 Restudy**

| Flooding Source | Revised Reach |
|---|---|
| Napa Creek | From confluence with Napa River to approximately 200 feet upstream of Jefferson Street |
| Napa River | From approximately 11,000 feet downstream of lmola Avenue to approximately 1,000 feet downstream of the confluence of Soda Creek |
| Napa River Oxbow Overflow | From the confluence with Tulucay Creek to 5,300 feet upstream of the confluence with Tulucay Creek |
| Tulucay Creek | From the confluence with the Napa River to approximately 600 feet upstream of Shurtleff Avenue |
| Salvador Creek | From the confluence with Napa River to State Highway 291 Byway East |
| Salvador Creek North Branch | From confluence with Salvador Creek Lower to 4,200 feet above confluence with Salvador Creek Lower |
| Salvador Creek South Branch | From confluence with Salvador Creek Lower to 1,350 feet above confluence with Salvador Creek Lower |

This PMR covers the geographic area inside Napa County affected by coastal flood hazard processes from the North San Francisco Bay (San Pablo Bay) shoreline, from the Napa-Alameda county boundary to the Napa-Solano county boundary.

No new LOMRs were recorded for the September 29, 2010 revision.

LOMR case 10-09-0235P is superseded by this PMR. LOMR cases 11-09-3313P, 12-09-2084P, 12-09-0871P, and 14-09-2231P are outside this PMR's study area and remain effective.

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

All or portions of 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 Napa County.

## 2.2 Community Description

Napa County is located in northern California. The county is bordered on the south by San Pablo Bay, on the east by Solano County, on the east and north by Yolo County and Lake County, and on the west by Sonoma County.

Napa County was one of California's original 27 counties. The valley and county were named for the Indian tribe that once occupied the area. The first expedition was in 1823 by Francisco Castro and Father Jose Altimira, who were looking for a site for the mission San Francisco Solano (Hoover, Reusch and Abeloe, Historic Spots in California).

The City of Napa is the county seat. It is located approximately 36 miles northeast of the City of San Francisco.

The total population of Napa County, as of 2008, was 133,433. The county, excluding the City of Napa, is agricultural in character. The most prominent agricultural commodity of the valley is high-quality, dry, wine grapes. Practically all medium and heavy industries (excluding wineries) are located in or between the communities of Napa and Vallejo (the latter is in Solano County). An efficient network of Federal, state, and county highways covers the Napa River basin. Approximately 10,000 acres in the county are devoted to public and reserved uses.

The county has many old-style stone and brick homes and buildings. The growth rate is expected to be rapid due to the scenic attractiveness of the valley and its proximity and accessibility to the bay area.

The western topography of Napa County consists of foothills and mountainous areas, the highest of which is over 4,300 feet at Mount St. Helena. Most of the development and urbanization has occurred in the Napa Valley in the western portion of the county. Napa

Valley is bordered on the west by a series of foothills that rise to elevations of over 2,700 feet in adjacent Sonoma County. The ground surface elevation in the Napa Valley varies from 0 feet at San Pablo Bay and 365 feet at Calistoga, to 440 feet at the termination of the Napa River floodplain.

The Napa River drainage basin is approximately 50 miles long (north to south) and approximately 10 miles wide, comprising an area of approximately 426 square miles. The Napa River winds through the county, is joined by numerous tributaries from adjacent foothills, and ends in broad tidal sloughs approximately 9 miles north of San Pablo Bay. The channel dimensions of the Napa River are highly irregular, especially above the head of navigation at Third Street in the City of Napa. In the upper valley, the existing channel varies from 50 to 300 feet in width and from 10 to 20 feet in depth. A few miles south of the Town of Yountville, the river diverges into two smaller streams for a distance of approximately 1 mile. Tributary channel sections vary greatly, but are essentially narrow and deep due to the mountainous and hilly areas traversed.

Temperatures range from 17 degrees Fahrenheit (°F) to 100°F. The annual mean minimum and maximum daily temperatures are 45°F and 71 °F, respectively. Annual rainfall varies from 10 to 18 inches.

## 2.3 Principal Flood Problems

Streamflow of flood-producing magnitude is the result of storms causing precipitation over the entire Napa River basin for periods in excess of approximately 12 hours. After the periods of most intense rainfall (December, January, and February), maximum river stages and discharges can be expected at the following elapsed times:

| | |
|---|---|
| City of St. Helena | 4 Hours |
| Oak Knoll Avenue | 10 Hours |
| City of Napa | 13-14 Hours |

Flooding occurs when the discharge exceeds approximately 7,000 cubic feet per second (CFS) at the City of St. Helena, or 15,000 CFS at Oak Knoll Avenue. Duration of flooding in some places has lasted as long as several weeks due to inadequate drainage of ponded floodwater. The duration of flooding within the agricultural area between Oak Knoll Avenue and the City of Napa is normally from 1 to 3 days.

The floor of Napa Valley has been subject to frequent flooding, resulting in severe damage to agriculture and urban development. Many damaging floods have been recorded since 1862. The most recent flood that occurred in February 1986, had an estimated recurrence interval of 50 years. All lands adjacent to the Napa River through the City of Napa are subject to flooding. Damages throughout Napa county resulting from the 1986 flooding were estimated to be approximately $100 million. The devastating flood left 3 people dead, 27 injured, 250 homes destroyed, and another 2,500 residences damaged countywide. Other floods that have caused great damage in the Napa River watershed occurred in 1940, 1941, 1942, 1950, 1952, 1955, 1958, 1960, 1963, 1965, 1967, 1973, 1978, 1982, and 1983. Furhter damage-causing floods occurred in 1986,

1997, and 2005 (Courtney, Kevin, 2005).

The Town of Yountville experiences flooding in some places due to inadequate drainage of ponded floodwater. Duration of flooding has been as long as several weeks.

## 2.4 Flood Protection Measures

The U.S. Soil Conservation Service has completed numerous small projects in the area and has others, including a project on Napa Creek, under consideration. Conn Creek, with a water-storage dam upstream, is well controlled by dikes in the lower reaches. The Napa River is only traversed by discontinuous dikes, except for the tidal reaches.

As a flood protection measure in Napa County, all developers are required to upgrade channels as far upstream and downstream as is necessary to convey the 1-percent annual chance flood without flooding their developments. As a result of this requirement, a few improvements have been made on short sections of Salvador Creek and American Canyon Creek.

To further implement the city's existing floodplain ordinance, a "Floodway Development Checklist" has been prepared by the city which presents the details of analysis to be considered in the evaluation or proposed development in the Napa River floodway.

The following are major flood protection measures on Conn Creek, Tulucay Creek, and Sheehy Creek:

1. On Conn Creek, from State Highway 128, east of Rutherford, downstream to approximately 1.25 miles below Oakville crossroads, levees, riprap, and three inlet structures with flap gates have been constructed to convey the 1-percent annual chance flood.

2. Tulucay Creek has been straightened, impounded, and leveed up to 3,000 feet above State Highway 121 to convey the 1-percent annual chance flood.

3. Sheehy Creek was channelized for 400 yards south of Napa, east of the airport, upstream of State Highway 29 to convey the 1-percent annual chance flood.

Levees have been built along the Napa River to provide protection from flooding. These levees were investigated for their ability to provide protection from the 1-percent annual chance flood.

FEMA specifies that all levees must have a minimum of 3-foot freeboard against 1-percent annual chance flooding to be considered a safe flood protection structure. Consequently, the reach of Lakepark levee, the right bank levee (oriented facing

downstream) that begins at a point where the extension of Pueblo Avenue would intersect the Napa River and extends downstream to a point approximately 1,000 feet southeast of the Central Avenue-Soscol Avenue intersection, is considered to fail by overtopping.

## 3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the county, 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-, 2-, 1-, and 0.2-percent annual chance 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 100-year flood (1-percent chance of annual exceedence) 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 county 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 the flooding sources studied in detail affecting the county.

**Precountywide Analyses**

For each community within Napa County that had a previously printed FIS report, the hydrologic analyses described in those reports have been compiled and are summarized below.

In the lower reach of the Napa River, stream gage data are not available in the river at Imola Avenue and Bull Island; therefore, it was decided to use a rainfall-runoff approach to develop a complete hydrologic picture of the Napa River Basin. A HEC-1 computer model (USACE, 1973) was constructed in accordance with USACE procedures dated September 1975. The HEC-1 model is designed to simulate the surface runoff response of a river basin to precipitation by representing the basin as an interconnected system of hydrologic and hydraulic components.

The Muskingum routing procedure was used to simulate flood wave movement through the river reach. Loss rates used are derived from the USACE September 1975 analysis with the exception of the constant loss rate in the Napa River local area between Oak

Knoll and Imola Avenue. A constant loss of 0.06 was selected for this area to account for the increased development in and around the City of Napa. A range of loss rates tested demonstrates that further reduction in this constant loss has insignificant effects on the peak discharges in the Napa River.

Two types of storms were analyzed: a short-duration cloudburst storm of 3 hours and a long-duration general storm of 96 hours. The long-duration general storm developed higher peak flows and produced more volume. The rainfall distribution was based on the USACE standard project rainfall, confirmed with precipitation data from gages in the Napa River Basin.

The USACE hydrologic computer program, HEC-1, was used to compute storm hydrographs and peak discharges using unit hydrographs, rainfall distributions, and loss rates previously discussed.

Peak discharge data (USACE, 1975) were statistically analyzed, using methods in Statistical Methods in Hydrology by L. R. Beard (USACE, 1962), to develop peak discharge-frequency curves for the Napa River.

For the upper reach of the Napa River, floodflow frequency data were based on a statistical analysis of stage-discharge records covering a 38-year period at gaging stations operated by the USGS. This analysis followed the standard log-Pearson Type III method as outlined by the U.S. Water Resources Council (U.S. Water Resources Council, 1973).

The frequencies of flood stages in the various tributaries to the Napa River included in the study were developed from hydrographs. Discharges for the 0.2-percent annual chance floods of all streams were determined by straight-log graph extrapolation of flood discharges computed for frequencies up to 100 years.

All computed approximate 1-percent annual chance discharges were calculated using rainfall-runoff curves in conjunction with topographic maps (U.S. Department of the Interior, 1958 et cetera), which were used to determine drainage areas and cross-section data.

Information on the methods used to determine peak discharge-frequency relationships for the streams restudied as part of this countywide FIS is shown below.

The peak discharges used in this restudy were determined using the USACE HEC-1 computer program (USACE, 1990) and are summarized in Table 4, "Summary of Discharges." The procedures and parameters used in this restudy are consistent with those developed and used by the USACE for General Design Memorandum No. 1 and Appendix A, "Hydrologic and Hydraulic Analyses: Napa River Flood Control Project" (USACE, 1975). Sulphur Creek is a tributary to the Napa River.

The USACE studies included the evaluation of historical floods and available streamflow data as a verification of the modeling parameters. The basic data and parameters were:

Watershed areas were determined using USGS quadrangle mapping (U.S. Department of the Interior, 1980 et cetera). The watershed was divided into subbasins. Land uses were defined based on the USGS quadrangle maps and field observations. Watershed soil types were determined from Natural Resources Conservation Service (formerly the Soil Conservation Service) soil survey maps (U.S. Department of Agriculture, 1978). The land use and soil conditions were reviewed for consistency with the overall Napa watershed included in the USACE study (USACE, 1975). A 6-hour-duration storm event was determined to be critical for the watershed and was adopted for this restudy. The total storm precipitation and distribution of rainfall were determined based on statistics for Department of Water Resources publication "Short-Duration Precipitation Frequency Data" (California Department of Water Resources, 1976). A USACE-developed storm distribution with 15-minute intervals was used. Precipitation ranged from 0.57 inch for the most intense 15-minute period to 4.29 inches for the 6-hour storm event. Based on the USACE Napa watershed study, a constant infiltration loss rate of 0.1 inch per hour was used. Based on review of available precipitation information, it was concluded that the intense 6-hour duration would occur following a longer duration period of rainfall. This preceding rainfall would use the initial infiltration loss capacity of the soil. Therefore, a zero initial loss was used. The unit hydrographs for each subbasin were developed using a method developed by the USACE. This method utilized a dimensionless S-curve unit hydrograph in combination with a relationship that relates lag time to various physical parameters of the watershed. The S-curve hydrograph used was one that the USACE had developed for the Dry Creek watershed near Napa. Lag times were determined by the USACE formula:

$$\text{Lag} = 24n \left(\frac{LL_{ca}}{\sqrt{s}}\right)^{0.38}$$

Where:

Lag = Time from beginning of excess rainfall to 50 percent of ultimate discharge, in hours

n = Water shed roughness coefficient

L = Total Stream length of watershed

$L_{ca}$ = Distance to centroid of area along primary watercourse, in miles

$\sqrt{s}$ = Average slope of primary watercourse, in feet per mile

Channel routing was performed using the HEC-1 Muskingum method. A Muskingum coefficient of 0.4 was used to reflect relatively small channel storage, based on field observations and the USACE studies. The routing travel times were estimated based on the estimated channel slopes and the USACE studies. The discharges as determined by the HEC-1 analyses are summarized in Table 5, "Summary of Discharges."

Water-surface elevations were computed through the use of the USACE HEC-2 computer program (USACE, 1990). Bank-to-bank channel and overbank cross sections were field

surveyed. Overbank flow areas were modeled based on topographic mapping provided by the City of St. Helena (Geonex, Inc., 1993).

**September 29, 2010, Revised Analysis**

For the Napa Creek study reach, the effective FEMA FIS only includes the 1-percent annual chance discharge (4,300 cfs). This value is consistent with the 4,280 cfs peak discharge computed by the USACE. The FEMA discharge was used for the hydraulic analysis.

The USACE developed two HEC-1 hydrologic models for the Napa River watershed - one upstream and one downstream of Oak Knoll A venue-in order to compute flood hydrographs and route discharges to key concentration points. The HEC-1 model results were used in conjunction with flood-frequency analyses of observed stream gage data for the Napa River, Napa Creek, and other Napa River tributaries.

The peak discharges for the Salvador Creek watershed were obtained using HECHMS, a software program developed by the USACE Hydrologic Engineering Center for rainfall-runoff modeling projects. The SCS hypothetical storm was selected as the meteorological model, for which the inputs are SCS temporal distribution type and rainfall depth. The SCS Type IA rainfall distribution was found to be appropriate for the study region. Using the coordinates of the centroids of the sub basins, and the NOAA Atlas 2 website located at http://www.nws.noaa.gov/oh/hdsc/noaaatlas2.htm, the 1-percent-annual-chance 24-hour rainfall depth for each sub basin was obtained. The results of HEC-HMS watershed runoff analysis of the Salvador Creek watershed are presented in Summary of Discharges table.

The Napa County Resource Conservation District (Napa County RCD) performed hydrologic modeling for Tulucay Creek using the HEC-HMS (Hydrologic Modeling System) computer program.

A summary of the drainage area-peak discharge relationships for all the streams studied by detailed methods is shown in Table 4, "Summary of Discharges."

**Table 4: Summary of Discharges**

| Flooding Source and Location | Drainage Area (Square miles) | Peak Discharges (Cubic Feet per Second) 10-percent | 2-percent | 1-percent | 0.2-percent |
|---|---|---|---|---|---|
| BLOSSOM CREEK | | | | | |
| At confluence with Napa River | 3.4 | 1,000 | N/A | 1,700 | 2,000 |
| CYRUS CREEK | | | | | |
| At confluence with Napa River | 2.9 | 900 | N/A | 1,500 | 1,900 |
| GARNETT CREEK | | | | | |
| At confluence with Napa River | 6.9 | 1,900 | N/A | 3,200 | 3,900 |
| NAPA CREEK | | | | | |
| At mouth | 14.9 | * | * | 4,300 | * |
| At the City of Napa corporate limits | 14.9 | 2,200 | * | 3,500 | 4,500 |
| NAPA RIVER | | | | | |
| Upstream of Bull Island | 324.0 | 25,500 | 38,900 | 45,200 | 69,000 |
| Upstream of Imola Avenue | 300.0 | 26,770 | 39,200 | 44,390 | 53,450 |
| Upstream of confluence of Tulucay Creek | * | 25,810 | 38,010 | 42,720 | 51,260 |
| Upstream of confluence of Napa Creek | * | 24,040 | 35,600 | 40,100 | 48,300 |
| Upstream of Trancas Street | * | 22,750 | 33,430 | 39,000 | 44,540 |
| Near the City of Napa (Oak Knoll Avenue) | 281.0 | 18,500 | * | 33,000 | 46,000 |
| Upstream of Oak Knoll Avenue | 218.0 | 18,400 | 28,100 | 32,700 | 50,300 |
| Near the City of St. Helena (Zinfandel Lane) | 81.4 | 13,000 | * | 21,000 | 25,000 |
| At Dunweal lane | 23.0 | 7,800 | N/A | 12,500 | 15,000 |
| At State Highway 29 | 21.6 | 7,400 | N/A | 12,000 | 14,500 |
| At upstream corporate limits | 5.4 | 3,300 | N/A | 5,100 | 6,400 |
| SALVADOR CREEK | | | | | |
| At confluence with Napa River | * | * | * | 3,910 | * |
| At Big Branch Road | 1.8 | * | * | 3,213 | * |

*Data not available

**Table 4: Summary of Discharges (continued)**

| Flooding Source and Location | Drainage Area (Square miles) | Peak Discharges (Cubic Feet per Second) 10-percent | 2-percent | 1-percent | 0.2-percent |
|---|---|---|---|---|---|
| SULPHUR CREEK | | | | | |
| At confluence with Napa River to Sulphur Creek Tributary | 9.2 | * | * | 3,330[1] | * |
| Upstream of Sulphur Creek Tributary | 7.6 | * | * | 3,110 | * |
| SULPHUR CREEK TRIBUTARY | | | | | |
| At confluence with Sulphur Creek | 1.1 | * | * | 500 | * |
| TULUCAY CREEK | | | | | |
| At Soscol Avenue | * | 2,880 | * | 4,530 | 5,500 |
| Upstream of Camille Creek | * | 2,050 | * | 3,250 | 4,050 |

*Data not available
[1]Flow rate reduction due to capacity restriction

Tidal elevations for the 10-, 2-, 1-, and 0.2-percent annual chance tidal floods for San Pablo Bay were taken from the USACE's "San Francisco Bay Tidal Stage vs. Frequency Study," dated October 1984 (USACE, 1984). The stillwater elevation in the vicinity of Bull Island was determined by an analysis of the difference between mean higher high water (MHHW) elevations at tide gages along the Napa River. The difference between the MHHW elevations between the Bull Island and Mare Island Strait gages is 1 foot. This was added to the Mare Island 1-percent annual chance stillwater elevation determined by the USACE to obtain the 1-percent annual chance elevation at Bull Island.

The stillwater elevations have been determined for the 10-, 2-, 1-, and 0.2-percent annual chance floods for the flooding sources studied by detailed methods and are summarized in Table 5, "Summary of Stillwater Elevations."

**Table 5: Summary of Stillwater Elevations**

| | Elevation (feet NAVD[1]) | | | |
|---|---|---|---|---|
| **Flooding Source and Location** | **10-Percent** | **2-Percent** | **1-Percent** | **0.2-Percent** |
| SAN PABLO BAY / NAPA RIVER | | | | |
| Mare Island Strait | 8.6 | * | 9.1 | 9.4 |
| Bull Island | 9.6 | * | 10.1 | 10.4 |

[1]North American Vertical Datum of 1988
*Data not available

## 3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the source 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.

Cross sections for the flooding sources studied by detailed methods were determined from topographic maps and field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. All topographic mapping used to determine cross sections are referenced in Section 4.1.

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

**Precountywide Analyses**

Each incorporated community within, and the unincorporated areas of, Napa County, has a previously printed FIS report. The hydraulic analyses described in those reports have been compiled and are summarized below.

Cross sections for the backwater analyses of the Napa River were obtained from aerial photographs flown in August of 1984, at a map scale of 1:1,200 with a 2-foot contour interval (Cartwright Aerial Surveys, Inc., 1984). All cross sections taken from areas not covered by the 1:1,200 scale mapping were obtained from the Cuttings Wharf and Napa USGS quadrangles, with a 5-foot contour interval (U.S. Department of the Interior, 1980 et cetera). The below-water cross sections were obtained by field measurement. All bridges and culverts were field surveyed to obtain elevation data and structural geometry.

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and based on field observations of the stream and floodplain areas. Roughness values for the floodplain and channels are given in Table 6, “Manning’s “n” Values.” Overbank roughness values through urbanized areas were determined using the technique defined in a publication entitled "A Method for Adjusting Values of Manning's Roughness Coefficient for Flooded Urban Areas," by H. R. Hejl, Jr. (U.S. Department of the Interior, 1977).

The revised hydraulic analyses for the Napa River were initially developed on the assumption that Lakepark levee, the right bank levee, would provide protection from the 1-percent annual chance flood. With all flow contained inside the levee, it was discovered that the freeboard was inadequate, which means that the levee crown was not a minimum of 3 feet above the 1-percent annual chance water-surface elevation. Subsequently, flooding was modeled with flow on both sides of the levee. Profiles have been presented for both cases, because elevations inside the levee will be highest just prior to overtopping. The "without levee" profiles show elevations outside the levee—on the right overbank.

Water-surface elevations of floods of the selected recurrence intervals were computed through the use of the USACE HEC-2 step-backwater computer program (USACE, 1973). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Starting water-surface elevations for Napa River were set at MHHW based upon tidal elevations.

Analyses of the cross-section information and computed water-surface elevations for Cyrus, Sheehy, Suscol, Cameros, Soda, Blossom, and Garnett Creeks has shown that the floods having recurrence intervals of 10-, 1-, and 0.2-percent annual chance are contained in the channel and, therefore, no profiles are presented for these watercourses.

On Hopper Creek, the flooding is completely controlled by the Napa River; therefore, a flood profile is not presented.

For the City of Calistoga, starting water-surface elevations for Napa River were determined from mean low water at San Pablo Bay. Starting water-surface elevations for Cyrus, Blossom, and Garnett Creeks were determined by the HEC-2 step-backwater computer program (USACE, 1973).

Starting elevations for the Napa River were determined from mean low water at San Pablo Bay for the City of St. Helena.

Information on the methods used to determine peak discharge-frequency relationships for the streams restudied as part of this countywide FIS is shown below.

The topographic map was prepared by Charles W. Shinnamon and Associates, Inc., at a scale of 1"-200', with a contour interval of 1 foot, based on a March 1987 aerial topographic map of a portion of unincorporated Napa County adjacent to the Town of Yountville.

Contraction and expansion coefficients of 0.1 and 0.3 were used for the open-channel section in accordance with USACE HEC-2 guidelines.

HEC-2 special and normal bridge routines and the special culvert routine were used to model the existing road crossings and culverts. Expansion and contraction coefficients were based on HEC-2 guidelines and ranged from 0.3 to 0.5 and 0.4 to 1.0, respectively, depending on the structure configurations. A weir coefficient of 2.6 was used. The bridges and culverts were assumed to be unobstructed.

Downstream starting water-surface elevations were determined using the HEC-2 slope/area method. The downstream limits of the models were at the stream confluences. However, due to the large differences in the watershed areas and lengths, the peak discharges were not coincident.

HEC-2 split routines were used to determine the discharge that would overflow and leave the stream in areas where adjacent ground slopes away from the channel. The split flows were based either on a weir coefficient of 2.6 or an estimated slope of the energy grade in the overflow areas.

Subcritical analyses were conducted to determine base flood elevations (BFEs) for all stream reaches.

Floodway analyses were conducted using HEC-1 embankment routines. Where possible, the floodway analyses were based on equal-conveyance reduction of each side of the channel. The floodway analyses were based on containing all split-flow discharges.

In areas of potential supercritical flow conditions, the encroachment analyses performed to determine floodway boundaries were based on limiting both the increases in water-surface elevation and energy grade lines to a maximum of 1 foot.

Divided channel overflows can occur at several locations. The estimated overflows were determined by HEC-2 split-flow analyses. HEC-2 modeling and manual calculations were used to determine the water-surface elevations and/or depths in the overflow areas. The split-flow areas are:

> Sulphur Creek, upstream of the confluence with Sulphur Creek Tributary, discharge = 690 CFS to Charter Oak Avenue; upstream of the Pope Street Crossing, discharge = 255 CFS to Pope Street
>
> Sulphur Creek Tributary, upstream of Spring Street, discharge = 145 CFS to Hudson Street; along Spring Street, upstream and downstream of North Crane Avenue, total discharge = 115 CFS to North Crane and adjacent areas.

The floodplain and floodway boundaries, as determined by the hydrologic and hydraulic analyses, have been delineated on City of St. Helena topographic mapping at a horizontal scale of 1"=200', with a contour interval of 2 feet, for the study area (USACE, 1975).

A storm event on January 28, 1993, resulted in flooding along Napa Creek from approximately 500 feet upstream of Behrens Street to Soscal Avenue and the Southern Pacific Railroad, between Pearle and Yount Streets to the north and south, respectively. According to a City of Napa survey, the interiors of 12 dwellings were flooded. The maximum estimated flood depths were 2 feet in a residence and 3 feet above existing ground at the lowest flooded areas. Flooding experienced in January 1995 was similar to the 1993 event. The City of Napa has indicated that there was significant debris accumulation at the Behrens Street bridge that probably contributed to the extent of the flooding for both the 1993 and 1995 flood events (City of Napa, 1993; City of Napa, 1995).

The peak discharge for the restudy was based on USACE, Sacramento District, General Design Memorandum Studies for the proposed Napa Flood Control Project (USACE, 1994).

The USACE performed flow-frequency analyses using the HEC-WRC program (USACE, 1985), which uses the log-Pearson Type III method as outlined in U.S. Water Resources Council Bulletin No. 17B, "Guidelines for Determining Flood Flow Frequency" (U.S. Department of the Interior, 1980). The analyses were based on annual peak flow measurements for the years 1971 through 1983 and 1986. These estimated values were supplemented by annual peaks for 1959 through 1970, estimated by a correlation with the gage readings for the major tributary to Napa Creek, Redwood Creek. This resulted in the following data being used:

- Recorded or Estimated Peaks from 1959 through 1983 and 1986 (26 Years)
- Maximum Annual Peak of 3,190 CFS in 1982
- Minimum Annual Peak of 83 CFS in 1976

Peak discharge-drainage area relationships for Napa Creek are shown in Table 4, “Summary of Discharges”. Due to the relatively small changes in drainage area, this discharge was used over the entire length of the restudy.

Water-surface elevations were computed using the USACE HEC-2 computer program (USACE, 1990) and manual calculations.

Channel and overbank cross sections and bridge and culvert models were based on City of Napa orthophoto topographic mapping (City of Napa and Cartwright Aerial Survey, 1991), USACE topographic mapping (USACE, GPM Orthophoto Topographic Mapping), USACE existing bridge-survey data (USACE, May 1990), the USACE HEC-2 model (USACE, 1991), City of Napa survey data and a hydraulic model for the California Boulevard bridge (City of Napa, California Boulevard Survey and Topography and City of Napa and Coriener, Inc., 1989), and supplemental channel field-survey data using City of Napa survey monuments (City of Napa, 1992).

The downstream starting water-surface elevation was determined using the HEC-2 slope/area method. The Napa Creek and River peak discharges will not be coincident.

Due to the relatively flat slopes in some areas, it was determined that the HEC-2 normal-depth split-flow option was used with slopes estimated from topographic maps and roughness estimated as discussed above.

Bridges were modeled using standard HEC-2 normal and special bridge routines. All channel sections were assumed to be clear of blockage caused by debris. A weir coefficient of 2.6 was used for the special bridge routine.

The floodplain limits and BFEs, as determined by the hydraulic analyses, were plotted on City of Napa orthophoto topographic mapping at a scale of 1"=100', with 2-foot contour intervals.

Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

**September 29, 2010 Revised Analysis**

Hydraulic modeling for Napa Creek, Napa River, and Tulucay Creek was performed using the HEC-RAS (River Analysis System), Version 4.0 Beta, computer program (HEC, 2006).

The Manning's roughness values for the Napa Creek channel and overbanks were taken from USACE model.

For the channel, the Napa River Manning's roughness ("n") values developed by the USACE and listed in the General Design Memorandum (Corps of Engineers, 1998) were used in the hydraulic model. For overbanks, the roughness coefficient values that were used in the hydraulic model were based on field observations and aerial photography.

Hydraulic modeling for Salvador Creek was performed using MIKE 11 for confined channel systems and MIKE21 for overland two-dimensional flows. These two models were dynamically linked using MIKE Flood, which allows flow to pass from one model domain to the other based on relative water-surface elevations and local topography.

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and were based on field observations of the streams and floodplain areas. Roughness factors for all streams studied by detailed methods are shown in Table 6, "Manning's "n" Values."

**Table 6: Manning's "n" Values**

| Stream | Channel "n" | Overbank "n" |
|---|---|---|
| Blossom Creek | 0.040 | 0.050 |
| Cyrus Creek | 0.040 | 0.050 |
| Garnett Creek | 0.040 | 0.050 |
| Napa Creek | 0.035 – 0.080 | 0.025 – 0.100 |
| Napa Creek | 0.06 | 0.07 |
| Napa River (City of Calistoga) | 0.030 – 0.090 | 0.040 – 0.120 |
| Napa River (City of Napa) | * | 0.060 |
| Napa River (Napa County) | 0.015 – 0.075 | 0.040 – 0.110 |
| Napa River (City of St. Helena) | 0.021 – 0.040 | 0.040 – 0.060 |
| Napa River (Town of Yountville) | 0.050 – 0.119 | 0.050 – 0.123 |
| Salvador Creek | 0.045 – 0.100 | * |
| Sulphur Creek | 0.035 – 0.090 | 0.030 – 0.100 |
| Tulucay Creek | 0.040 – 0.045 | * |

Behind-Levee Analyses

Some flood hazard information presented in prior FIRMs and in prior FIS reports for Napa County and its incorporated communities was based on flood protection provided by levees. Based on the information available and the mapping standards of the National Flood Insurance Program (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 annual 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 documentation related to 44 CFR 65.10 is being compiled, the release of a more up-to-date FIRM 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 allow issuance of the FIS and FIRM while levee owners or communities compile full documentation required to show compliance with 44 CFR 65.10. The guidelines also explain that a FIRM 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 65.10.

FEMA contacted the communities within Napa 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 annual chance of being equaled or exceeded in any given year.

FEMA understood that it may 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 annual 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 Napa County. Table 7 lists all levees shown on the FIRM, to include PALs, for which corresponding flood hazard revisions were made.

**Table 7: List of Levees**

| Community | Flood Source | Levee Inventory Identification Number | USACE Levee |
|---|---|---|---|
| Napa County (Unincorporated Areas) | Napa River and Conn Creek | 98 and 99 | No |

Approximate analyses of "behind levee" flooding were conducted for the levees in Table 7 to indicate the extent of the "behind levee" floodplains. The methodology used in these analyses is discussed below.

Levees 98 and 99 are located along the Napa River and Conn Creek. Based upon the FIS and topographic information from the USGS, an approximate area of 1-percent annual chance flooding in the event of failure of the levees was determined based on engineering judgment and designated as such as no accreditation data were provided.

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.

Bench marks 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 bench marks, 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 bench marks 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.

## 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 (NGVD 29). With the finalization of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs are being prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD 88. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. It is important to note that adjacent communities may be referenced to NGVD 29. This may result in differences in base flood elevations across the corporate limits between the communities.

For more information on NAVD 88, see Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA Publication FIA20/June 1992, or contact the Vertical Network Branch, National Geodetic Survey, Coast and Geodetic Survey, National Oceanic and Atmospheric Administration, Rockville, Maryland 20910 (Internet address http://www.ngs.noaa.gov).

The riverine vertical datum conversion factors used to convert pre-countywide data to NAVD 88 for the September 26, 2008, countywide revision are shown in the tabulation below:

| Stream | Conversion Factor (ft) |
|---|---|
| Charter Oak Avenue Split Flow | 2.79 |
| Conn Creek | 2.74 |
| Milliken Creek | 2.61 |
| Napa Creek | 2.58 |
| Napa River (downstream of confluence with Conn Creek) | 2.55 |
| Napa River (upstream of confluence with Conn Creek) | 2.78 |
| Redwood Creek | 2.62 |
| Sarco Creek | 2.62 |
| Sulphur Creek | 2.79 |
| Sulphur Creek Tributary | 2.80 |
| Tulucay Creek | 2.58 |

The non-riverine vertical datum conversion factors applied in revisions prior to this PMR are shown below:

| Flooding Source and Location | 1-percent Annual Chance Elevation (NGVD 29) | Conversion Factor | 1-percent Annual Chance Elevation (NAVD 88) |
|---|---|---|---|
| SAN PABLO BAY/NAPA RIVER | | | |
| Mare island Straight | 6.5 | 2.6 | 9.1 |
| Bull Island | 7.5 | 2.6 | 10.1 |
| SULPHUR CREEK | | | |
| At intersection of State Highway 29 and Pope Street[1] | 236 | 2.8 | 239 |

[1]only whole-foot value available

## 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-, 2-, 1-, and 0.2-percent annual chance flood elevations; delineations of the 1- and 0.2-percent annual chance floodplains; and 1-percent annual chance 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 county. For the streams studied in detail, 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 using topographic maps at a scale of 1:1,200 with a contour interval of 2 (Cartwright Aerial Surveys, Inc., 1984), 7.5-Minute USGS topographic maps with a contour interval of 5 feet (U.S. Department of the Interior, 1980 et cetera), topographic maps at a scale of 1:24,000, with a contour interval of 20 feet (U.S. Department of the

Interior, 1958), topographic maps at a scale of 1:1,200 and 1:2,400 with contour intervals of 1 and 20 feet, respectively (Town of Yountville, 1987 and U.S. Department of the Interior, 1951). All delineated flood limits on the Napa River within the City of Napa were compared with high water marks obtained by the City of Napa after the flood of February 1986.

Methods used to delineate approximate 1-percent annual chance floodplain boundaries included incorporating existing USGS Flood-Prone Area Maps (U.S. Department of the Interior, 1973), and using high-water marks and calculated discharges. For the latter method, USGS topographic quadrangle sheets (U.S. Department of the Interior, 1958 et cetera) were used to delineate floodplain boundaries.

Floodplain boundaries have been defined based on the BFEs as determined by subcritical flow analyses. In channel reaches where supercritical flow conditions could occur, the BFEs were based on critical depth. The floodplain boundaries were plotted in accordance with the surveyed cross sections and topographic mapping.

In the City of Napa, downstream of Coombs Street, the maximum floodplain limits and BFEs are based on backwater from the 1-percent annual chance floodplain for the Napa River as shown in the previous FIS report. The floodplain was adjusted based on the detailed topographic mapping used for this restudy.

For the flooding sources studied by approximate methods, the boundaries of the 1-percent annual chance floodplains were delineated using topographic maps taken from the previously printed FIS reports, FHBMs, and/or FIRMs for all of the incorporated and unincorporated jurisdictions within Napa County.

The 1- 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 and AE), and the 0.2-percent annual chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- 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).

## 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 FIS 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.

The floodways presented in this FIS 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 8). The computed floodways are shown on the 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.

Separate floodway models were developed for the reach of the Napa River along Lakepark levee between cross sections J and M (i.e., along the levee downstream of Trancas Street) to account for flooding just before overtopping ("with levee") and after overtopping of the levee ("without levee"). Table 8 presents the results of floodway computations for both cases. It should be noted that the total widths presented in Table 8 include the levee itself.

For the reach of the Napa River upstream of the City of Napa the floodways for this study were computed on the basis of equal conveyance reduction from each side of the floodplain. Hazardous velocities were nominally defined as those in excess of 5 feet per second. This velocity constraint frequently required that the floodway be defined such that the increase in water-surface elevation was less than 1 foot. In many areas along the floodway, this velocity is exceeded, usually in those reaches confined to the natural bank or in areas of unstable flow. The equal conveyance procedure was not used in the reach of the Napa River just downstream of the Town of Yountville corporate limits. Because of the unusual alignment of Hopper Creek, formerly known as Yountville Creek, the Napa River floodway in this area was determined by encroachment in the west overbank only.

The floodways for Sheehy Creek, Suscol Creek, Cameros Creek, Soda Creek, Cyrus Creek, Garnett Creek, and Blossom Creek are all contained in the channel; therefore, no floodway boundaries are shown for these watercourses.

Floodway limits for Napa Creek cannot be defined downstream of Behrens Street because a greater than 1-foot rise in water-surface elevation would occur if the split flows that occur at that location are contained.

During the statutory 90-day appeal period for the 2010 restudy, the City of Napa submitted high-water mark data for the area around Behrens Street. At the community's request, the submitted data were considered during the final determination of the flood hazard for Napa Creek. Based on the submitted data, the flood hazard information for

Napa Creek from its confluence with the Napa River to Jefferson Street was modified. In this reach, the BFEs were not revised. The floodplain boundary delineation was modified to include all locations where the high-water marks were recorded in 1995. Due to the complexity of the flooding in this area, floodway limits could not be defined downstream of Jefferson Street.

In the City of St. Helena, a floodway cannot be established for Sulphur Creek Tributary between Spring Street and the confluence with Sulphur Creek due to the significant overflows caused by lack of channel and capacity across and along Spring Street. It was determined that if the entire 1-percent annual chance discharge was contained, the calculated rise in water-surface elevation would exceed 1 foot if the conveyance area were limited to the Zone AE floodway boundary.

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 9, "Floodway Data." In order to reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

| 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 |
| **Conn Creek** | | | | | | | | |
| A | 22,704 | 200 | 910 | 8.8 | 159.0 | 159.0 | 159.0 | 0.0 |
| B | 25,872 | 350 | 1,770 | 4.5 | 165.6 | 165.6 | 165.8 | 0.2 |
| C | 27,984 | 350 | 1,250 | 6.4 | 170.7 | 170.7 | 171.4 | 0.7 |
| D | 30,888 | 500 | 1,450 | 5.5 | 183.5 | 183.5 | 184.0 | 0.5 |
| **Milliken Creek** | | | | | | | | |
| A | 5,800 | 535 | 1,880 | 2.4 | 35.7 | 35.7 | 36.7 | 1.0 |
| B | 8,000 | 105 | 760 | 5.9 | 44.4 | 44.4 | 44.4 | 0.0 |
| C | 8,700 | 135 | 510 | 8.9 | 50.7 | 50.7 | 51.6 | 0.9 |
| D | 10,500 | 125 | 880 | 5.1 | 63.2 | 63.2 | 63.3 | 0.1 |
| **Napa Creek** | | | | | | | | |
| A | 4,490 | 59 | 728 | 5.9 | 36.0 | 36.0 | 36.6 | 0.6 |
| B | 4,810 | 110 | 1,097 | 3.9 | 36.9 | 36.9 | 37.7 | 0.8 |
| C | 5,310 | 68 | 817 | 5.3 | 37.9 | 37.9 | 38.8 | 0.9 |
| D | 5,880 | 81[2] | 757 | 5.7 | 40.4 | 40.4 | 40.9 | 0.5 |
| E | 6,425 | 92[2] | 739 | 5.8 | 42.8 | 42.8 | 43.1 | 0.3 |
| F | 7,050 | 103[2] | 805 | 5.3 | 44.9 | 44.9 | 45.0 | 0.1 |
| G | 7,490 | 104[2] | 782 | 5.5 | 47.5 | 47.5 | 47.6 | 0.1 |
| H | 8,070 | 94[2] | 738 | 5.8 | 48.8 | 48.8 | 48.9 | 0.1 |
| I | 9,965 | -[3] | 610 | 5.7 | 55.1 | 55.1 | 55.1 | 0.0 |
| J | 13,672 | -[3] | 140 | 7.9 | 94.4 | 94.4 | 94.4 | 0.0 |

[1] Feet above confluence with Napa River
[2] Bank-to-bank width, flood contained in channel
[3] Computed floodway is inside channel banks

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**NAPA COUNTY, CA**

AND INCORPORATED AREAS

**FLOODWAY DATA**

**CONN CREEK - MILLIKEN CREEK - NAPA 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 |
| **Napa River** | | | | | | | | |
| A | 31,200 | 397 | 5,552 | 8.1 | * | 7.1[2] | 8.0 | 0.9 |
| B | 35,060 | 410 | 5,891 | 7.7 | * | 8.2[2] | 8.9 | 0.7 |
| C | 38,500 | 515 | 5,860 | 7.7 | * | 9.5[2] | 10.0 | 0.5 |
| D | 42,710 | 2,870 | 26,830 | 1.7 | 11.3 | 11.3 | 12.1 | 0.8 |
| E | 47,750 | 3,277 | 25,424 | 1.8 | 11.8 | 11.8 | 12.6 | 0.8 |
| F | 51,120 | 1,686 | 14,561 | 3.8 | 12.0 | 12.0 | 12.7 | 0.7 |
| G | 54,050 | 792 | 8,558 | 5.3 | 13.7 | 13.7 | 14.2 | 0.5 |
| H | 56,440 | 737 | 8,349 | 5.1 | 14.7 | 14.7 | 15.1 | 0.4 |
| I | 58,930 | 449 | 5,807 | 7.4 | 15.5 | 15.5 | 15.8 | 0.3 |
| J | 63,070 | 1,464 | 10,385 | 4.2 | 22.0 | 22.0 | 22.0 | 0.0 |
| K | 66,440 | 1,818 | 12,677 | 3.2 | 24.4 | 24.4 | 24.7 | 0.3 |
| L | 67,890 | 1,878 | 12,677 | 3.7 | 25.3 | 25.3 | 25.6 | 0.3 |
| M | 69,780 | 433 | 13,377 | 6.4 | 27.1 | 27.1 | 27.3 | 0.2 |
| N | 71,630 | 1,523 | 19,920 | 2.5 | 29.4 | 29.4 | 29.6 | 0.2 |
| O | 73,460 | 2,383 | 17,206 | 2.3 | 29.8 | 29.8 | 30.0 | 0.2 |
| P | 74,890 | 2,824 | 14,138 | 2.8 | 30.4 | 30.4 | 30.6 | 0.2 |
| Q | 79,310 | 1,424 | 9,673 | 4.0 | 36.7 | 36.7 | 37.6 | 0.9 |
| R | 82,850 | 1,966 | 11,920 | 3.3 | 42.4 | 42.4 | 42.7 | 0.3 |
| S | 85,570 | 1,136 | 10,644 | 3.7 | 46.4 | 46.4 | 47.2 | 0.8 |
| T | 89,232 | 865 | 13,880 | 2.4 | 52.6 | 52.6 | 53.6 | 1.0 |
| U | 92,400 | 800 | 12,340 | 2.7 | 56.1 | 56.1 | 57.1 | 1.0 |
| V | 95,357 | 590 | 8,880 | 3.7 | 62.0 | 62.0 | 63.0 | 1.0 |
| W | 98,208 | 1,200 | 10,280 | 3.0 | 64.8 | 64.8 | 65.8 | 1.0 |
| X | 101,904 | 2,650 | 14,500 | 2.1 | 68.7 | 68.7 | 69.3 | 0.6 |
| Y | 107,712 | 2,600 | 13,100 | 2.4 | 79.9 | 79.9 | 80.5 | 0.6 |
| Z | 110,880 | 1,476 | 7,933 | 3.9 | 84.7 | 84.7 | 85.7 | 1.0 |

[1] Feet above county boundary

[2] Elevation computed without consideration of backwater effects from San Pablo Bay

* Controlled by coastal flooding – see Flood Insurance Rate Map for regulatory base flood elevation

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**NAPA COUNTY, CA**

AND INCORPORATED AREAS

**FLOODWAY DATA**

**NAPA RIVER**

| 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 |
| **Napa River (continued)** | | | | | | | | |
| AA | 112,280 | 1,982 | 11,815 | 2.6 | 87.5 | 87.5 | 88.4 | 0.9 |
| AB | 112,980 | 2,314 | 16,279 | 1.9 | 87.9 | 87.9 | 88.8 | 0.9 |
| AC | 113,480 | 1,984 | 13,820 | 2.2 | 88.1 | 88.1 | 89.0 | 0.9 |
| AD | 114,180 | 2,319 | 13,677 | 2.2 | 88.3 | 88.3 | 89.3 | 1.0 |
| AE | 116,180 | 1,667 | 8,632 | 3.5 | 89.5 | 89.5 | 90.4 | 0.9 |
| AF | 116,780 | 1,607 | 8,394 | 3.6 | 90.5 | 90.5 | 91.4 | 0.9 |
| AG | 119,780 | 1,864 | 9,842 | 3.0 | 94.1 | 94.1 | 94.8 | 0.7 |
| AH | 121,280 | 1,266 | 7,341 | 4.1 | 95.6 | 95.6 | 96.4 | 0.8 |
| AI | 122,080 | 1,202 | 6,550 | 4.6 | 98.8 | 98.8 | 99.2 | 0.4 |
| AJ | 127,580 | 1,900 | 9,228 | 3.3 | 114.2 | 114.2 | 114.7 | 0.5 |
| AK | 129,980 | 1,868 | 9,060 | 3.1 | 119.2 | 119.2 | 119.4 | 0.2 |
| AL | 134,112 | 3,000 | 4,777 | 5.9 | 121.6 | 121.6 | 122.6 | 1.0 |
| AM | 137,808 | 3,250 | 6,282 | 4.5 | 128.0 | 128.0 | 128.5 | 0.5 |
| AN | 141,504 | 2,890 | 7,313 | 3.8 | 135.8 | 135.8 | 136.7 | 0.9 |
| AO | 147,312 | 1,100 | 5,020 | 4.6 | 149.5 | 149.5 | 150.0 | 0.5 |
| AP | 150,480 | 1,200 | 3,800 | 6.1 | 156.1 | 156.1 | 156.7 | 0.6 |
| AQ | 154,176 | 2,800 | 7,490 | 3.1 | 162.9 | 162.9 | 163.9 | 1.0 |
| AR | 158,928 | 670 | 5,540 | 3.8 | 177.1 | 177.1 | 178.1 | 1.0 |
| AS | 163,680 | 2,610 | 6,770 | 3.1 | 188.8 | 188.8 | 189.8 | 1.0 |
| AT | 167,376 | 950 | 5,160 | 4.1 | 198.8 | 198.8 | 199.4 | 0.6 |
| AU | 172,128 | 240 | 2,930 | 7.0 | 211.8 | 211.8 | 211.8 | 0.0 |
| AV | 172,528 | 122 | 2,296 | 9.0 | 213.1 | 213.1 | 214.1 | 1.0 |
| AW | 173,028 | 148 | 2,782 | 7.4 | 214.8 | 214.8 | 215.8 | 1.0 |
| AX | 173,628 | 193 | 3,595 | 5.7 | 216.2 | 216.2 | 217.1 | 0.9 |
| AY | 173,930 | 290 | 5,125 | 4.0 | 217.1 | 217.1 | 218.0 | 0.9 |
| AZ | 174,530 | 1,644 | 14,396 | 1.4 | 217.6 | 217.6 | 218.4 | 0.8 |

[1] Feet above county boundary

| 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 |
| **Napa River (continued)** | | | | | | | | |
| BA | 175,030 | 925 | 12,830 | 1.4 | 217.8 | 217.8 | 218.5 | 0.7 |
| BB | 175,530 | 525 | 6,522 | 2.9 | 217.8 | 217.8 | 218.6 | 0.8 |
| BC | 176,930 | 915 | 2,634 | 7.1 | 220.0 | 220.0 | 220.6 | 0.6 |
| BD | 181,930 | 429 | 4,006 | 4.4 | 232.0 | 232.0 | 232.0 | 0.0 |
| BE | 187,440 | 390 | 2,480 | 7.1 | 242.4 | 242.4 | 242.6 | 0.2 |
| BF | 190,080 | 680 | 4,440 | 4.0 | 249.6 | 249.6 | 250.6 | 1.0 |
| BG | 192,720 | 360 | 3,050 | 5.1 | 258.2 | 258.2 | 258.5 | 0.3 |
| BH | 197,472 | 1,425 | 7,110 | 2.2 | 270.6 | 270.6 | 271.6 | 1.0 |
| BI | 200,112 | 1,000 | 3,080 | 4.9 | 275.6 | 275.6 | 275.7 | 0.1 |
| BJ | 203,808 | 575 | 2,470 | 6.1 | 290.6 | 290.6 | 290.6 | 0.0 |
| BK | 204,864 | 1,155 | 5,030 | 3.0 | 294.9 | 294.9 | 295.1 | 0.2 |
| BL | 208,560 | 1,550 | 6,590 | 1.9 | 302.7 | 302.7 | 303.2 | 0.5 |
| BM | 212,784 | 680 | 2,120 | 5.9 | 316.3 | 316.3 | 316.5 | 0.2 |
| BN | 215,424 | 660 | 3,490 | 3.6 | 326.3 | 326.3 | 326.3 | 0.0 |
| BO | 216,124 | 880 | 3,898 | 3.2 | 327.4 | 327.4 | 327.5 | 0.1 |
| BP | 219,024 | 885 | 2,664 | 4.5 | 337.1 | 337.1 | 337.6 | 0.5 |
| BQ | 219,824 | 859 | 3,726 | 3.2 | 340.2 | 340.2 | 340.9 | 0.7 |
| BR | 220,524 | 473 | 1,559 | 7.7 | 341.8 | 341.8 | 342.3 | 0.5 |
| BS | 221,424 | 561 | 2,280 | 5.3 | 345.4 | 345.4 | 346.3 | 0.9 |
| BT | 221,724 | 169 | 1,530 | 6.3 | 346.6 | 346.6 | 347.4 | 0.8 |
| BU | 222,524 | 79 | 840 | 11.4 | 349.4 | 349.4 | 349.6 | 0.2 |
| BV | 222,674 | 55 | 955 | 10.0 | 350.5 | 350.5 | 350.6 | 0.1 |
| BW | 223,624 | 783 | 2,776 | 3.5 | 356.0 | 356.0 | 356.5 | 0.5 |
| BX | 223,744 | 837 | 2,077 | 4.6 | 356.1 | 356.1 | 356.7 | 0.6 |
| BY | 224,124 | 83 | 1,084 | 8.8 | 357.5 | 357.5 | 357.7 | 0.2 |
| BZ | 224,824 | 87 | 1,293 | 7.4 | 359.3 | 359.3 | 359.7 | 0.4 |

[1] Feet above county boundary

| 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 |
| **Napa River (continued)** | | | | | | | | |
| CA | 225,424 | 95 | 918 | 10.5 | 360.9 | 360.9 | 361.1 | 0.2 |
| CB | 226,824 | 95 | 945 | 8.7 | 366.9 | 366.9 | 366.9 | 0.0 |
| CC | 229,024 | 108 | 780 | 6.5 | 373.5 | 373.5 | 373.5 | 0.0 |
| CD | 229,824 | 91 | 701 | 7.3 | 375.8 | 375.8 | 375.8 | 0.0 |
| CE | 232,848 | 126 | 710 | 4.9 | 398.5 | 398.5 | 399.2 | 0.7 |

[1] Feet above county boundary

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**NAPA COUNTY, CA**

AND INCORPORATED AREAS

**FLOODWAY DATA**

**NAPA RIVER**

| 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 |
| **Napa River (without Levee)** | | | | | | | | |
| M | 69,780 | 1,619 | 13,119 | 3.1 | 26.6 | 26.6 | 27.2 | 0.6 |
| N | 71,630 | 2,015 | 16,663 | 2.4 | 27.5 | 27.5 | 28.0 | 0.5 |

[*] Cross-section data shown on Napa River

[1] Feet above county boundary

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**NAPA COUNTY, CA**

AND INCORPORATED AREAS

**FLOODWAY DATA**

**NAPA RIVER (WITHOUT LEVEE)**

| 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 |
| **Redwood Creek** | | | | | | | | |
| A | 15,840[1] | -[4] | 680 | 3.8 | 185.6 | 185.6 | 185.7 | 0.1 |
| **Sarco Creek** | | | | | | | | |
| A | 53[2] | 500 | 2,550 | 0.8 | 32.0 | 32.0 | 33.0 | 1.0 |
| B | 3,168[2] | 138 | 600 | 3.1 | 40.7 | 40.7 | 40.7 | 0.0 |
| **Sulphur Creek** | | | | | | | | |
| A | 230[3] | 56 | 538 | 6.8 | 217.6 | 212.8[5] | 213.7[5] | 0.9 |
| B | 395[3] | 56 | 575 | 6.4 | 217.6 | 214.7[5] | 215.4[5] | 0.7 |
| C | 800[3] | 53 | 493 | 7.5 | 217.6 | 216.0[5] | 216.7[5] | 0.7 |
| D | 1,060[3] | 50 | 435 | 8.4 | 217.7 | 217.7 | 218.4 | 0.7 |
| E | 1,490[3] | 46 | 478 | 7.7 | 219.9 | 219.9 | 220.6 | 0.7 |
| F | 1,780[3] | 36 | 355 | 10.3 | 221.9 | 221.9 | 222.6 | 0.7 |
| G | 2,200[3] | 45 | 471 | 7.8 | 226.3 | 226.3 | 227.1 | 0.8 |
| H | 2,560[3] | 78 | 733 | 5.0 | 228.3 | 228.3 | 229.1 | 0.8 |
| I | 2,960[3] | 72 | 601 | 6.1 | 229.6 | 229.6 | 230.3 | 0.7 |
| J | 3,170[3] | 90 | 554 | 6.6 | 230.8 | 230.8 | 231.8 | 1.0 |
| K | 3,540[3] | 170 | 711 | 5.2 | 233.4 | 233.4 | 234.0 | 0.6 |
| L | 3,830[3] | 170 | 951 | 3.9 | 234.3 | 234.3 | 235.3 | 1.0 |
| M | 4,130[3] | 89 | 695 | 5.3 | 234.7 | 234.7 | 235.7 | 1.0 |
| N | 4,425[3] | 264 | 1,238 | 3.0 | 239.5 | 239.5 | 240.3 | 0.8 |
| O | 4,800[3] | 302 | 1,162 | 3.2 | 240.2 | 240.2 | 241.1 | 0.9 |
| P | 5,045[3] | 150 | 714 | 5.1 | 240.9 | 240.9 | 241.9 | 1.0 |

[1] Feet above confluence with Napa Creek
[2] Feet above confluence with Milliken Creek
[3] Feet above confluence with Napa River
[4] Computed floodway is in channel banks
[5] Elevation computed without consideration of backwater effects

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**NAPA COUNTY, CA**

AND INCORPORATED AREAS

**FLOODWAY DATA**

**REDWOOD CREEK – SARCO CREEK – SULPHUR CREEK**

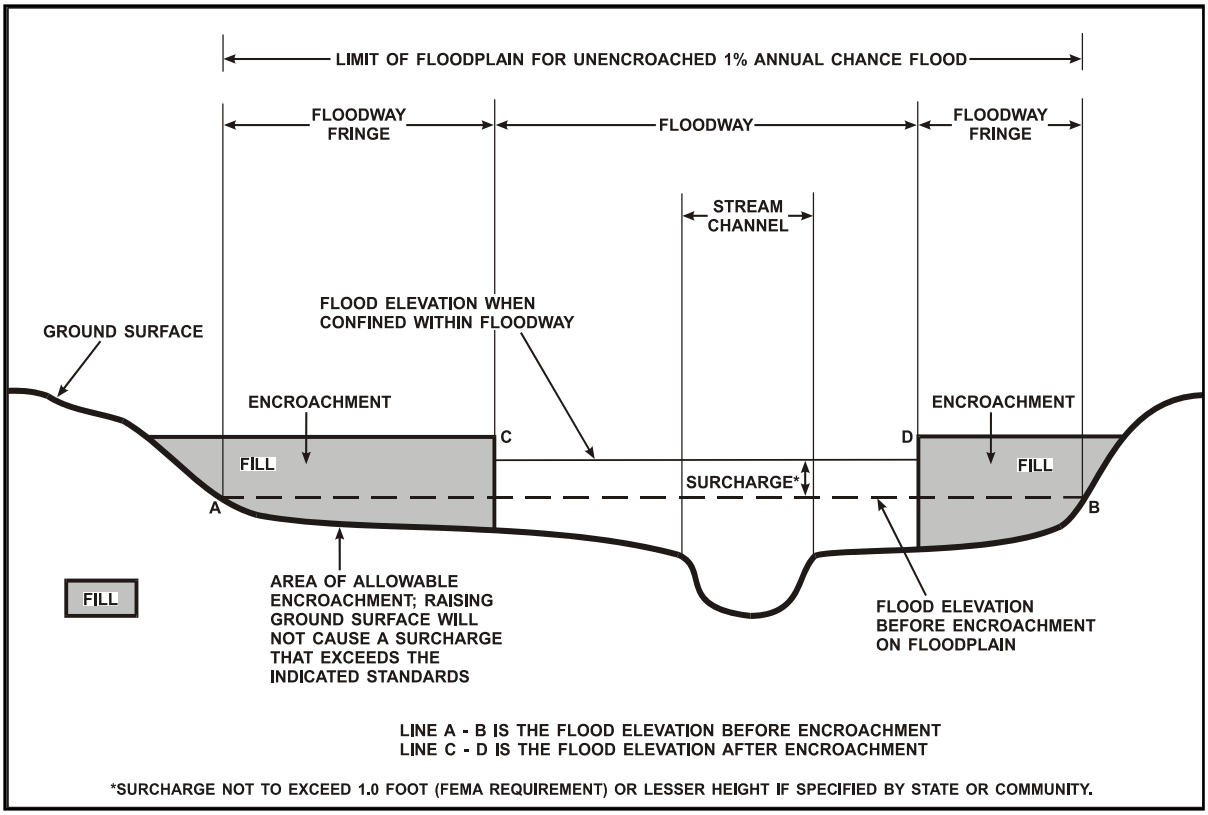
| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| **Sulphur Creek (continued)** | | | | | | | | |
| Q | 5,420[1] | 150 | 562 | 5.5 | 243.8 | 243.8 | 244.5 | 0.7 |
| R | 5,870[1] | 200 | 969 | 3.2 | 245.9 | 245.9 | 246.6 | 0.7 |
| S | 6,270[1] | 250 | 1,269 | 2.5 | 246.6 | 246.6 | 247.4 | 0.8 |
| T | 6,600[1] | 165 | 733 | 4.2 | 246.9 | 246.9 | 247.8 | 0.9 |
| U | 6,790[1] | 106 | 464 | 6.7 | 247.6 | 247.6 | 248.1 | 0.5 |
| V | 7,270[1] | 67 | 272 | 11.4 | 251.2 | 251.2 | 251.2 | 0.0 |
| W | 7,500[1] | 80 | 470 | 6.6 | 254.1 | 254.1 | 254.2 | 0.1 |
| X | 7,740[1] | 150 | 1,114 | 2.8 | 257.5 | 257.5 | 257.8 | 0.3 |
| Y | 7,960[1] | 157 | 865 | 3.6 | 257.6 | 257.6 | 258.0 | 0.4 |
| **Sulphur Creek Tributary** | | | | | | | | |
| A | 2,570[2] | 70 | 122 | 4.1 | 263.5 | 263.5 | 264.2 | 0.7 |
| B | 2,870[2] | 22 | 124 | 4.0 | 266.4 | 266.4 | 266.8 | 0.4 |
| **Tulucay Creek** | | | | | | | | |
| A | 8,448[1] | 165 | 700 | 3.4 | 54.4 | 54.4 | 54.4 | 0.0 |
| B | 13,200[1] | 130 | 290 | 7.6 | 97.0 | 97.0 | 97.0 | 0.0 |
| C | 14,784[1] | 110 | 270 | 7.8 | 125.1 | 125.1 | 125.1 | 0.0 |

[1] Feet above confluence with Napa Creek

[2] Feet above confluence with Sulphur Creek

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**




## 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 base flood elevations 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 base flood elevations 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 base flood elevations 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 AR

Area of special flood hazard formerly protected from the 1-percent annual chance flood event by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1-percent annual chance or greater flood event.

Zone A99

Zone A99 is the flood insurance rate zone that corresponds to areas of the 1-percent annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or depths are shown within this zone.

Zone V

Zone V is the flood insurance rate zone that corresponds to the 1-percent annual chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no base flood elevations are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 1-percent annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

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 to 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 base flood elevations 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 1-percent annual chance floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations 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-percent annual chance floodplains. Floodways and the locations of selected cross sections used in the hydraulic analyses and floodway computations are shown where applicable.

The current FIRM presents flooding information for the entire geographic area of Napa County. Previously, separate Flood Hazard Boundary Maps and/or FIRMs were prepared for each identified flood-prone incorporated community and the unincorporated areas of the county. This countywide FIRM also includes flood hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community, up to and including this countywide FIS, are presented in Table 9, "Community Map History."

| COMMUNITY NAME | INITIAL IDENTIFICATION | FLOOD HAZARD BOUNDARY MAP REVISIONS DATE | FIRM EFFECTIVE DATE | FIRM REVISIONS DATE |
|---|---|---|---|---|
| American Canyon, City of [1] | January 29, 1971 | None | February 1, 1980 | September 15, 1989<br>September 28, 1990<br>September 26, 2008<br><date> |
| Calistoga, City of | May 10, 1974 | September 12, 1975 | September 28, 1979 | September 26, 2008 |
| Napa, City of | March 22, 1974 | November 28, 1975 | September 5, 1979 | March 16, 1998<br>January 19, 2000<br>September 26, 2008<br>September 29, 2010<br><date> |
| Napa County (Unincorporated Areas) | January 29, 1971 | None | February 1, 1980 | September 15, 1989<br>September 28, 1990<br>September 26, 2008<br>September 29, 2010<br><date> |
| St. Helena, City of | May 31, 1974 | October 3, 1975 | May 1, 1980 | September 4, 1987<br>January 7, 1998<br>September 26, 2008 |
| Yountville, Town of | March 1, 1974 | December 20, 1974 | March 28, 1980 | September 28, 1990<br>September 26, 2008 |

[1]This community did not have its own FIRM prior to the September 26, 2008, countywide FIS. The land area for this community was previously shown on the FIRM for the unincorporated areas of Napa County, but was no identified as a separate NFIP community. Therefore, the dates for this community were taken from the FIRM for Napa County.

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

**NAPA COUNTY, CA**
AND INCORPORATED AREAS

**COMMUNITY MAP HISTORY**

## 7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Napa 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 Napa 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, 111 Broadway, Suite 1200, Oakland, California 94607-4052.

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## 10.0 REVISION DESCRIPTIONS

This section has been added to provide information regarding significant revisions made since the original FIS was printed. Future revisions may be made that do not result in the republishing of the FIS report. To assure that the user is aware of all revisions, it is advisable to contact the community repository of flood-hazard data.

### 10.1 San Francisco Bay Coastal Physical Map Revision (Revised <date>)

Coastal Hazard Analyses

For San Francisco Bay, storm surge, swell-wave and wind-waves were modeled at a regional scale using numerical models to deterministically predict water levels and wave conditions in the bay (DHI, 2011). Coastal flooding hazards were then evaluated with

one-dimensional (1D) transect-based models. The MIKE 21 Flow Model (HD) and MIKE 21 Spectral Wave (SW) model developed by DHI Water & Environment were used for the regional surge and wave modeling. The hydrodynamic model included the effects of tide, storm surge, and riverine discharge. The wave modeling was performed in two separate models, one for locally developing wind-waves and one for Pacific Ocean swell propagating into San Francisco Bay through the Golden Gate. The models synthesized water level and wave condition information for the 31 year period from 1973 to 2004. The frequency and magnitude of storm surge and wave heights was derived statistically from the synthesized 31 year record.

Water level and wave information from the regional hydrodynamic and wave models was used as input to the 1D flood hazard analyses. Wave setup, runup, overtopping, and overland wave propagation were analyzed at representative transects. Transects are shown on the FIRM panels and depicted in the Transect Location Map (Figure 2). Transect profile elevations were based on the National Oceanic and Atmospheric Administration (NOAA) 2010 Northern San Francisco Bay Area LiDAR, collected February to April, 2010. Bathymetric information was derived from USACE dredging surveys and NOAA/National Ocean Service (NOS) Geophysical Data System (GEODAS) bathymetric data. In areas where the two datasets overlapped, the USACE data was given priority.

Overland wave propagation modeling, using FEMA's Wave Height Analysis for Flood Insurance Studies (WHAFIS) model, Version 4 (FEMA, 1988; Divoky, 2007), was performed for transects with gently sloping profiles where the prevailing ground is inundated by the stillwater flood level alone. WHAFIS solves the wave action conservation equation and incorporates wind-generated wave growth and dissipation by marsh grasses, rigid vegetation, and buildings. Site specific vegetation roughness and drag parameters were developed by NHC for application to San Francisco Bay.

Wave runup was calculated for transects with coastal armoring or steeply sloping ground profiles in the vicinity of the flooded shoreline. Runup was calculated using one of three methods, depending on shoreline characteristics. The Direct Integration Method (FEMA, 2005) was used to calculate runup for transects with natural, gently sloping ($m < 0.125$) profiles. The Technical Advisory Committee for Water Retaining Structures (TAW) (van der Meer 2002) method was used for shorelines with shore protection structures and steeply sloping ($m \geq 0.125$) natural shorelines. The Shore Protection Manual (SPM) method (USACE 1984) was used to calculate wave runup on vertical walls. The total runup elevation is also referred to as the total water level (TWL). Annual TWL maxima were selected from the 31 years (1973-2003) of hindcast data, and the generalized extreme value (GEV) distribution was employed to determine the 1-percent-annual-chance TWL from the annual maxima at each transect. Wave overtopping was evaluated for transects where the runup elevation exceeded the structure or bluff crest.

For this PMR study, bench marks will not be shown on the FIRM per the FEMA RiskMap FIRM Panel Technical Reference standards from August 2013. All other FIRM panels outside of the PMR study area will remain effective under the previous standard with benchmarks shown and labeled with their 6-character NRS Permanent Identifier.

Floodplain Boundaries

For this revision, new flood zones were developed and mapped for the updated San Francisco Bay coastal hazard analysis described in Section 3.3. Detailed flood hazard boundaries along San Francisco Bay were delineated using the NOAA 2010 Northern San Francisco Bay Area LiDAR, collected February to April (NOAA, 2010).

Areas inundated by stillwater flooding with minimal wave hazard effects were mapped as Zone AE and the flood hazard boundary is located at the point where the ground elevation equals the BFE Stillwater elevation. In areas subject to wave runup, the flood hazard boundary is located at the point where the ground elevation equals the runup elevation, or where overtopping occurs, the boundary is located at the inland extent of overtopping. The Base Flood Elevation (BFE) in these areas is rounded to the nearest whole-foot, though the boundary is mapped using precision to the tenth of a foot. Inundation flooding is mapped inland to the point where it meets continuous high ground or encounters flooding from another flooding source. Salt marsh berms and non certified agricultural berms are not considered barriers to flood inundation regardless of height or continuity.

Per FEMA Procedure Memorandum No. 50—Policy and Procedures for Identifying and Mapping Areas Subject to Wave Heights Greater than 1.5 feet as an Informational Layer on Flood Insurance Rate Maps (FIRMs), the Limit of Moderate Wave Action (LiMWA) is not delineated for Napa County. The LiMWA delineates the 1.5 foot wave height contour, separating areas with wave heights greater than 1.5 feet from areas with wave heights less than 1.5 feet. It is mapped only in areas of overland wave propagation where VE Zones are mapped based on wave heights. Per recent guidance developed by FEMA Headquarters, the LiMWA is not mapped if VE Zone conditions do not exist. It is also not mapped in areas where wave runup is the dominant flood hazard. Due to marshy conditions and lack of structures in the study area, the LiMWA is not represented on the Napa County FIRMs.

**Table 10: Transect Data Table**

| Transect | XY Coordinates[2] (Longitude/Latitude) | | Stillwater Elevation (feet NAVD 88)[1] | | | | Zone | BFE |
|---|---|---|---|---|---|---|---|---|
| | | | 10% Annual Chance | 2% Annual Chance | 1% Annual Chance | 0.2% Annual Chance | | |
| 1 | -122.396096 | 38.14349 | 8.7 | 9.6 | 10.0 | 11.3 | AE | 10-11 |
| 2 | -122.393831 | 38.142965 | 8.7 | 9.6 | 10.0 | 11.3 | AE | 10-11 |
| 3 | -122.375493 | 38.137624 | 8.7 | 9.6 | 10.0 | 11.3 | AE | 10-12 |
| 4 | -122.365491 | 38.134133 | 8.7 | 9.6 | 10.0 | 11.2 | AE | 10-11 |
| 5 | -122.353464 | 38.128532 | 8.7 | 9.6 | 10.0 | 11.2 | AE | 10-11 |
| 6 | -122.34739 | 38.126315 | 8.7 | 9.6 | 10.0 | 11.2 | AE | 10-12 |
| 7 | -122.334673 | 38.125001 | 8.7 | 9.5 | 10.0 | 11.1 | AE | 10-12 |
| 8 | -122.319737 | 38.125001 | 8.7 | 9.5 | 9.9 | 11.1 | AE | 10-11 |
| 9 | -122.304521 | 38.125001 | 8.6 | 9.5 | 9.9 | 11.0 | AE | 10 |

[1]North American Vertical Datum 1988

[2]Starting wave conditions are associated with the offshore transect baseline 0.0' station in San Pablo Bay/Solano County

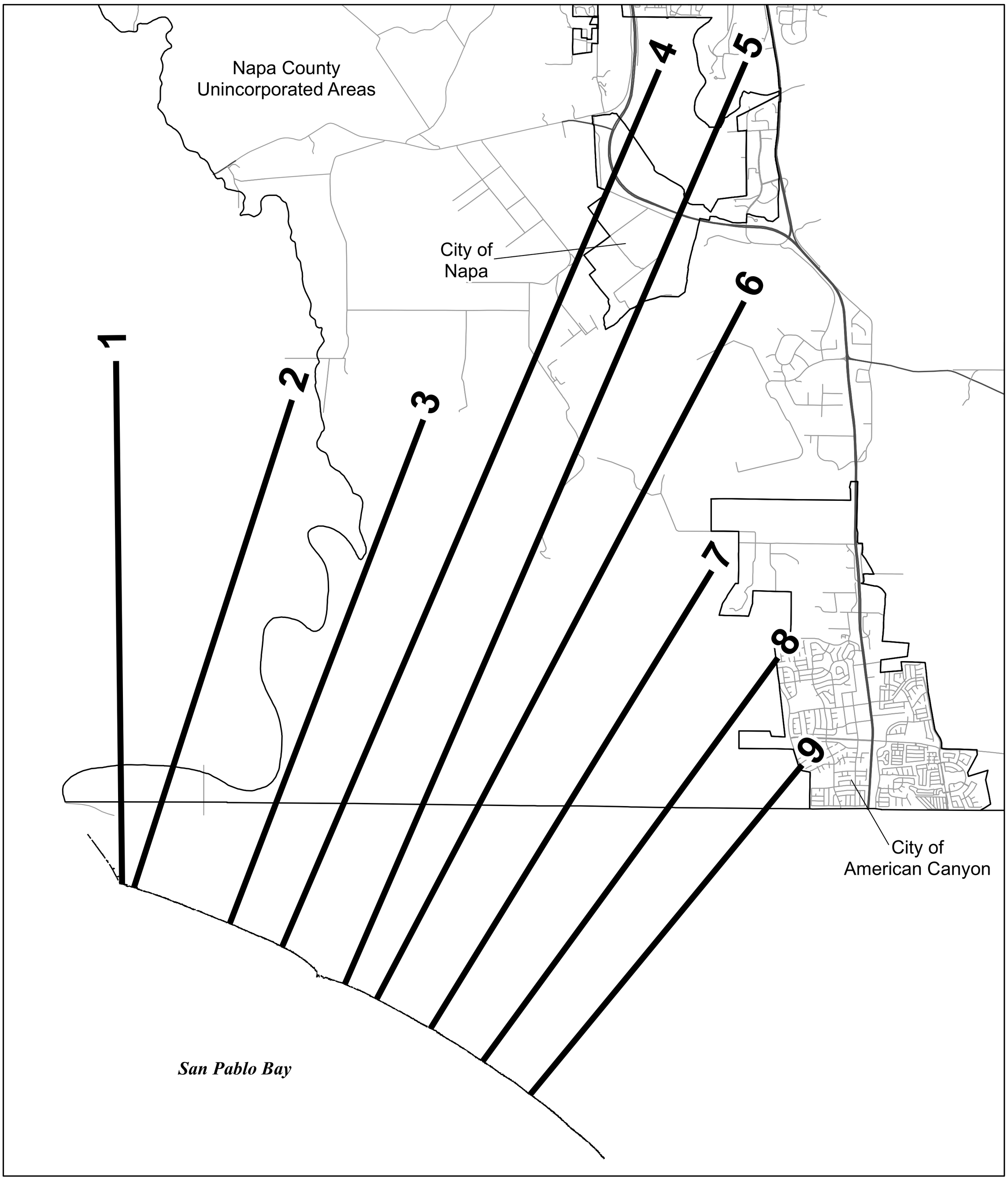



FIGURE 2

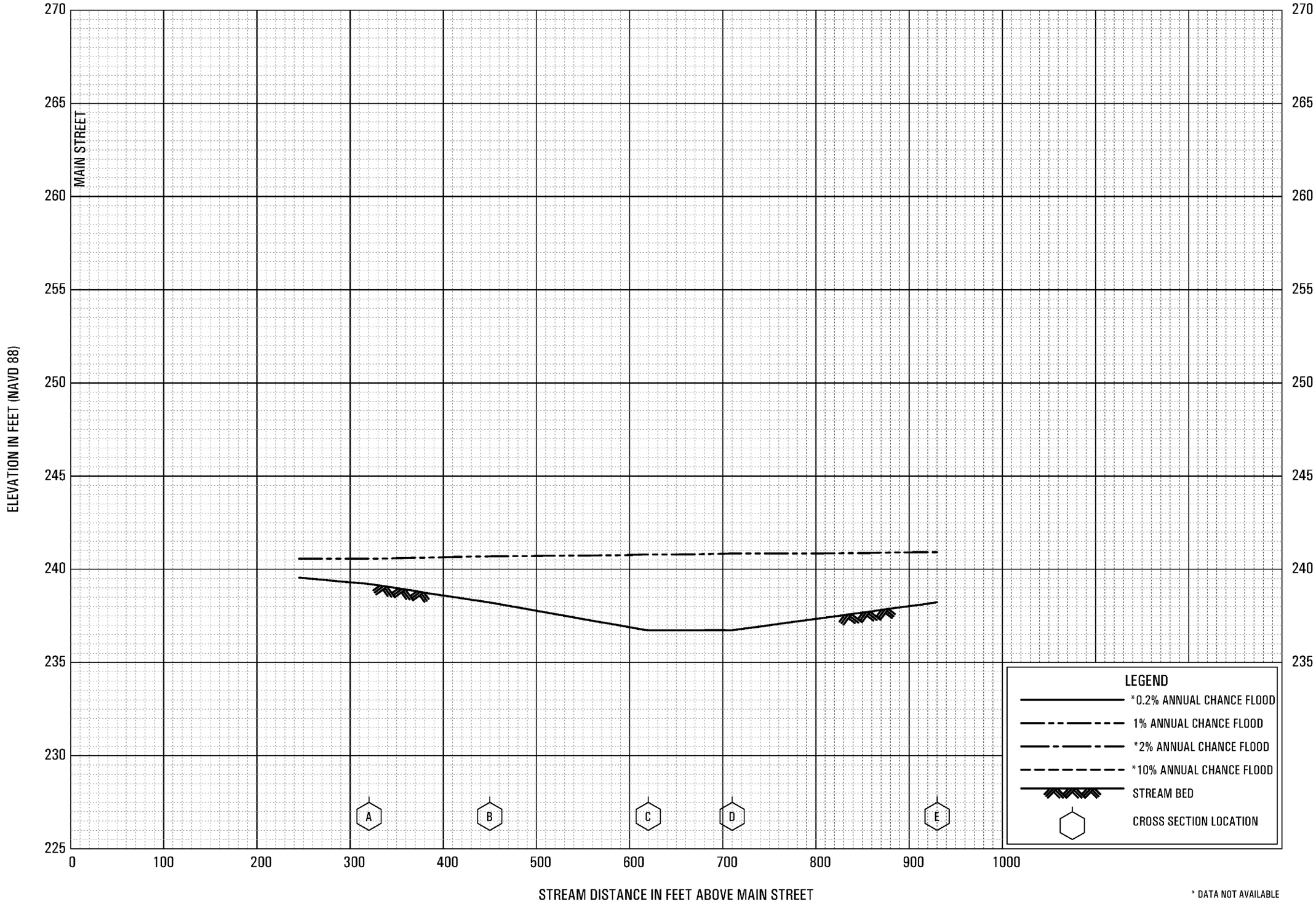
FEDERAL EMERGENCY MANAGEMENT AGENCY

**NAPA COUNTY, CALIFORNIA**
**AND INCORPORATED AREAS**

0 0.5 1 2 3 Miles

N

TRANSECT LOCATION MAP




* DATA NOT AVAILABLE

FLOOD PROFILES

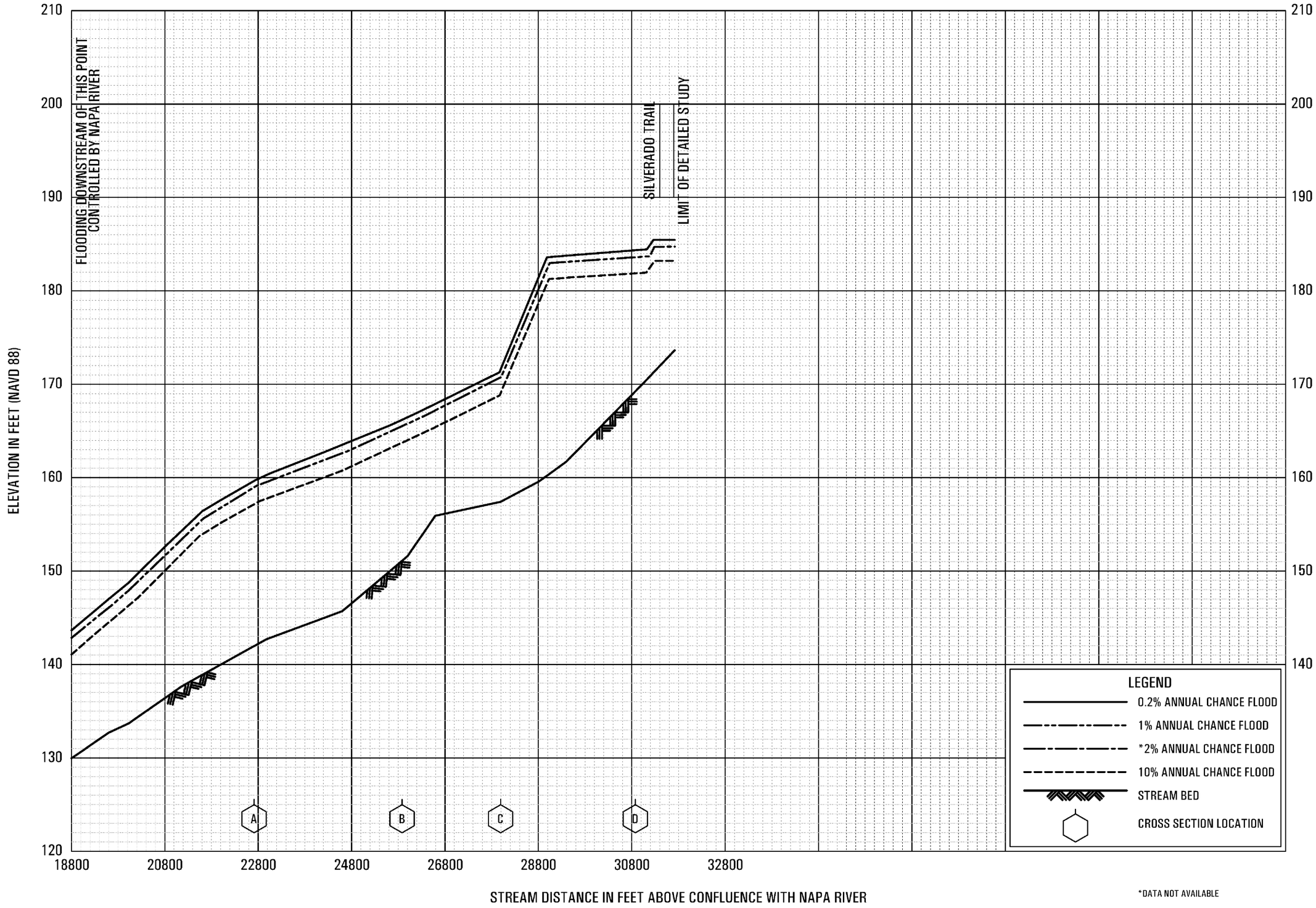
CHARTER OAK AVENUE SPLIT FLOW

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS

01P




FLOOD PROFILES

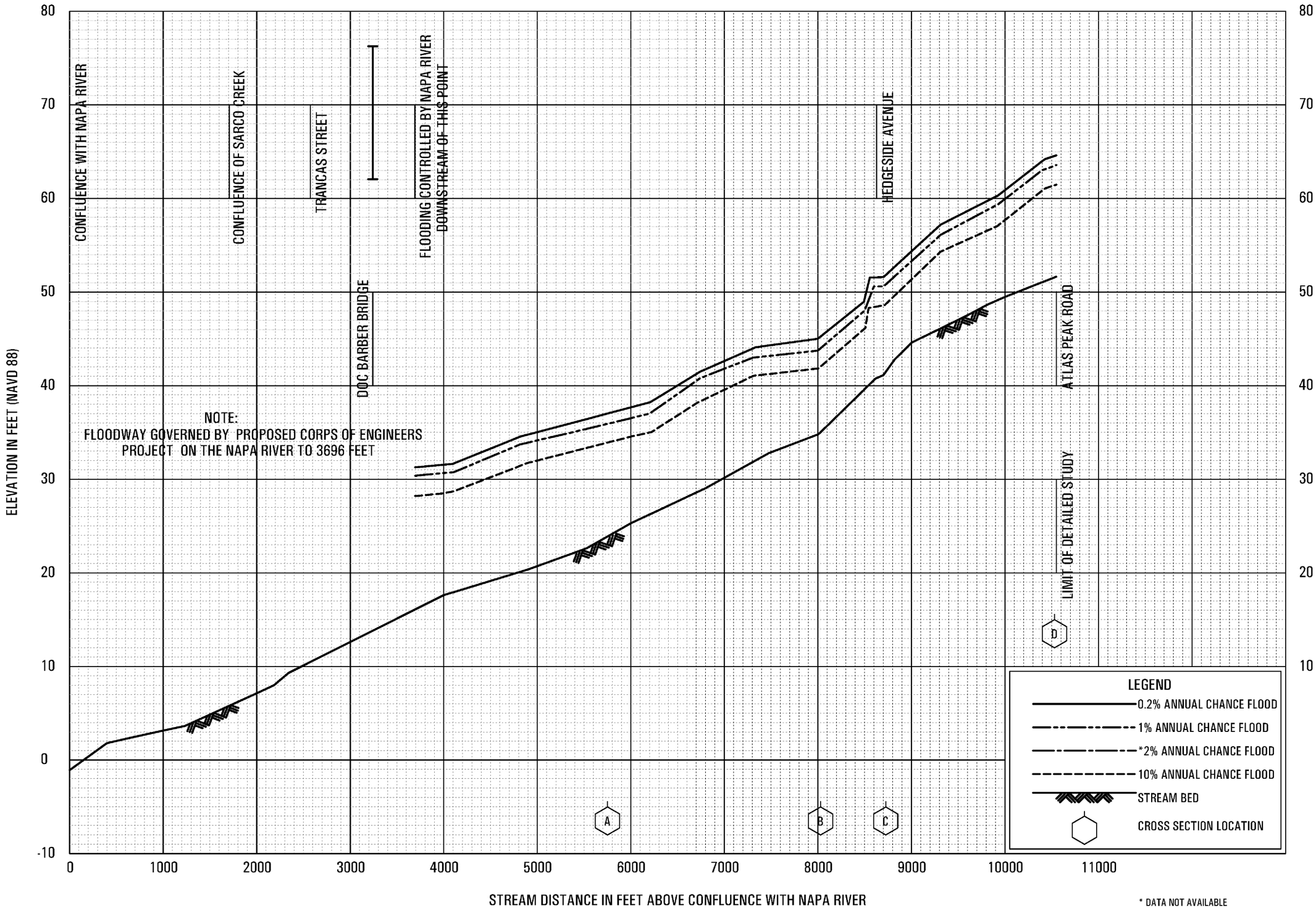
CONN CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS

02P




FLOOD PROFILES

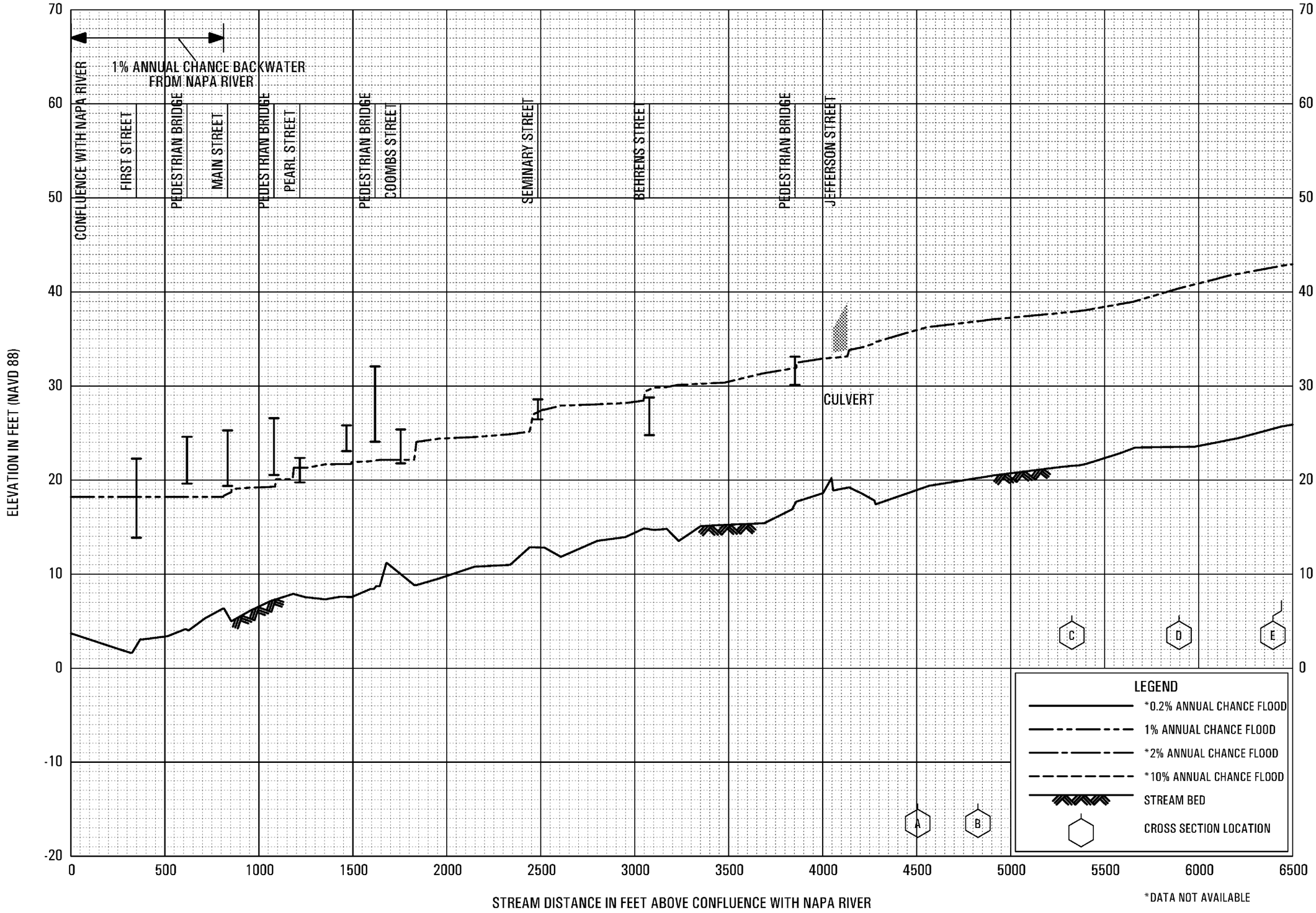
MILLIKEN CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS

03P




FLOOD PROFILES

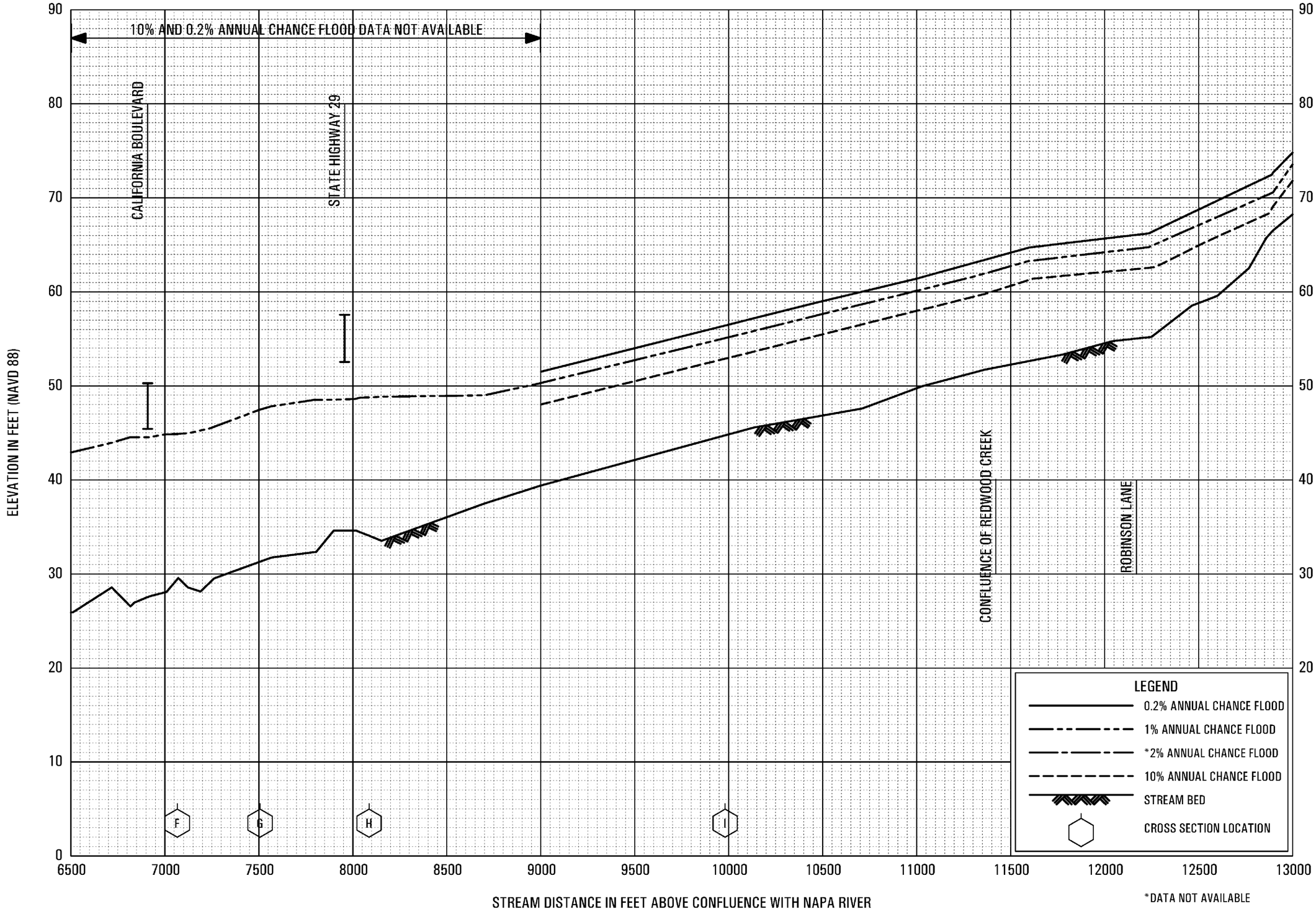
NAPA CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS

04P




FLOOD PROFILES

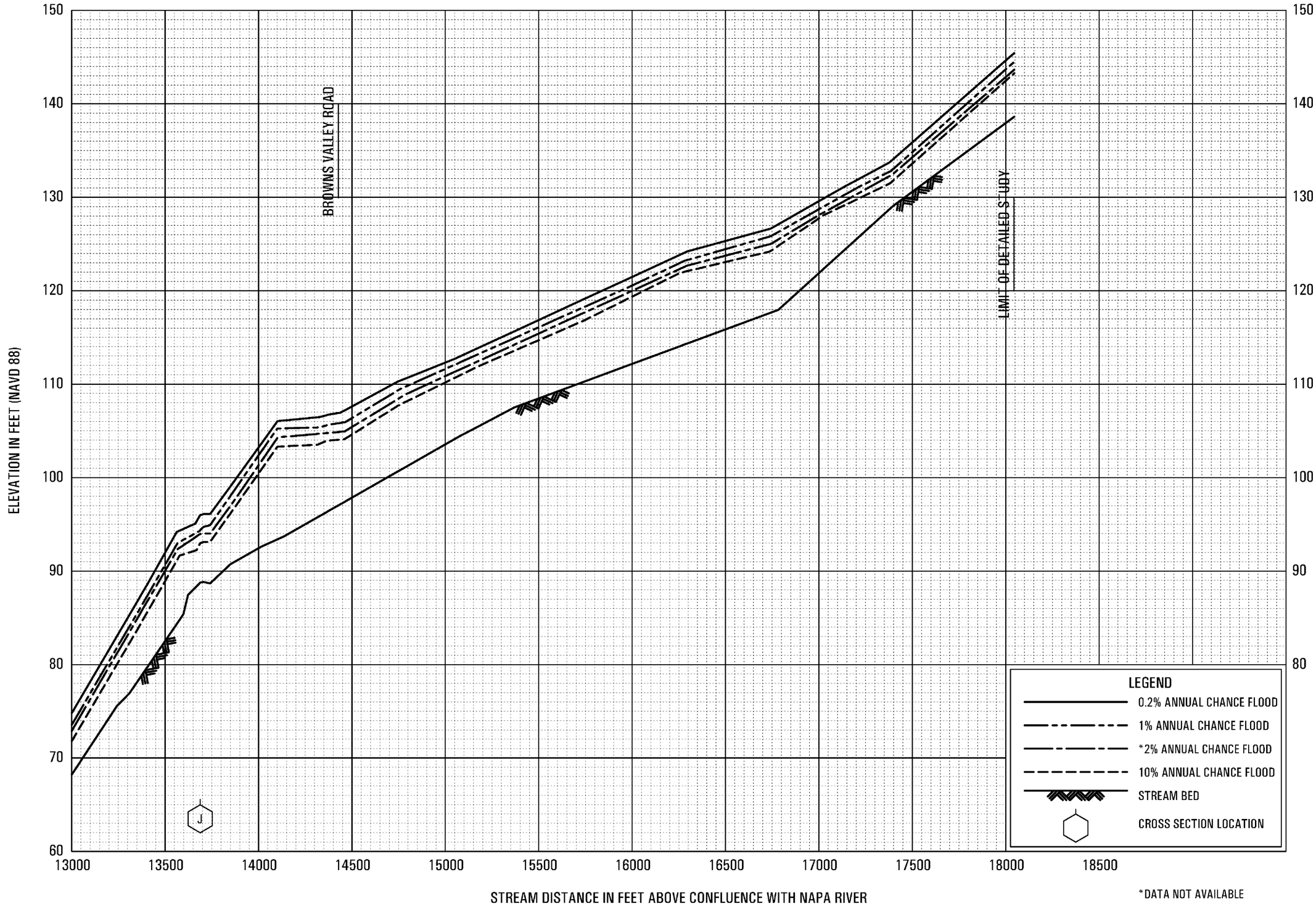
NAPA CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS

05P




*DATA NOT AVAILABLE

FLOOD PROFILES

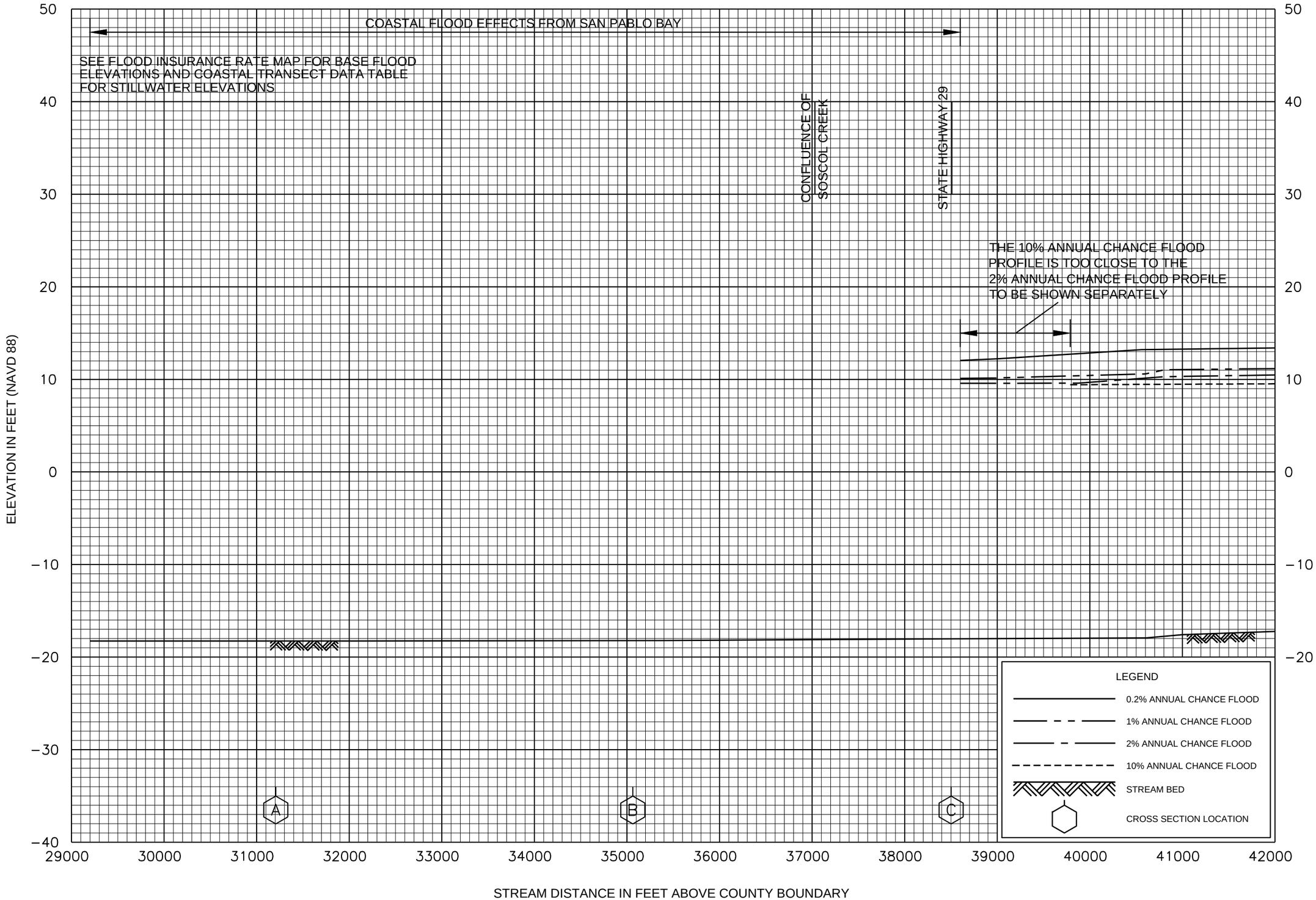
NAPA CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS

06P



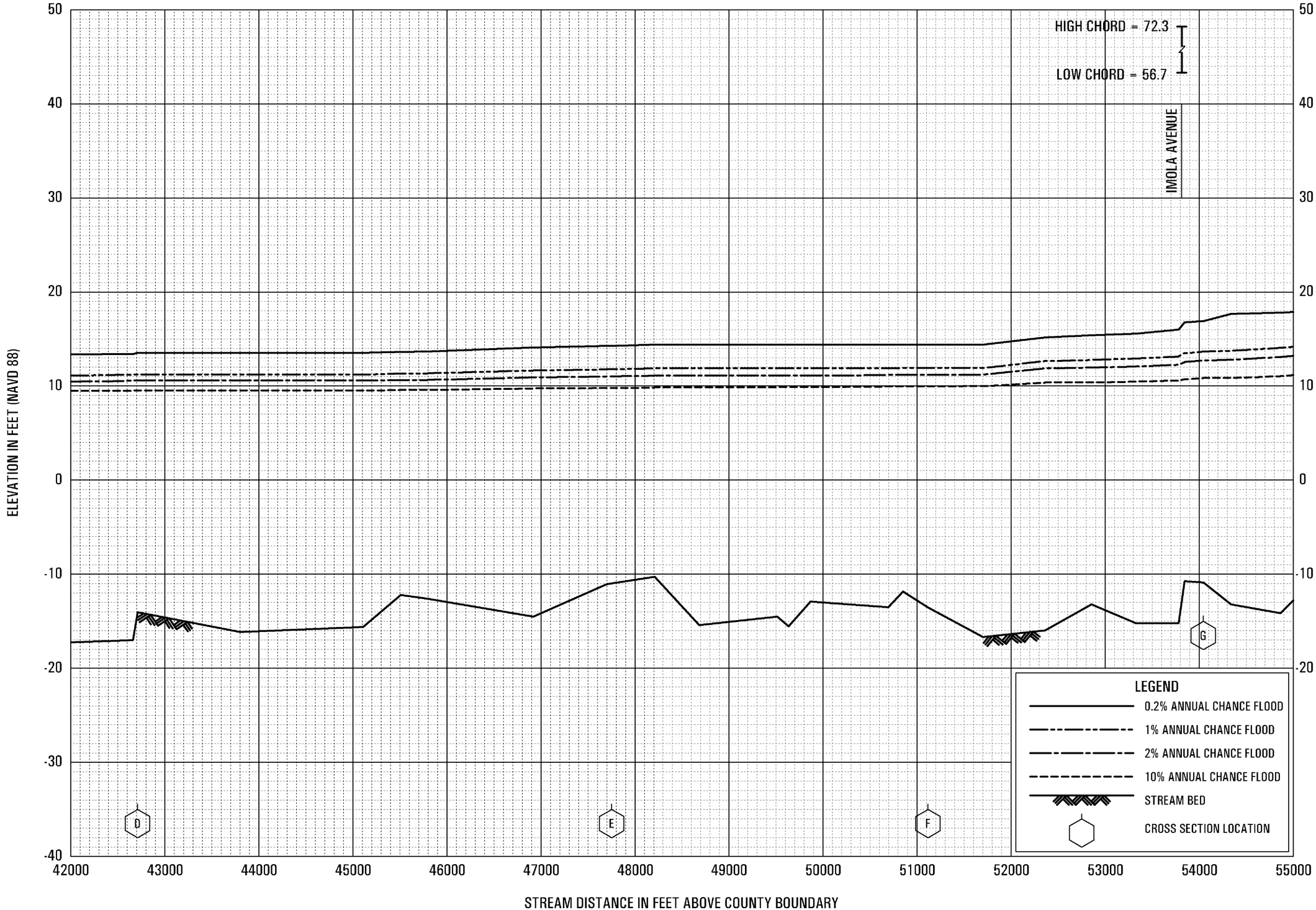

FLOOD PROFILES

NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA
AND INCORPORATED AREAS

07P




FLOOD PROFILES

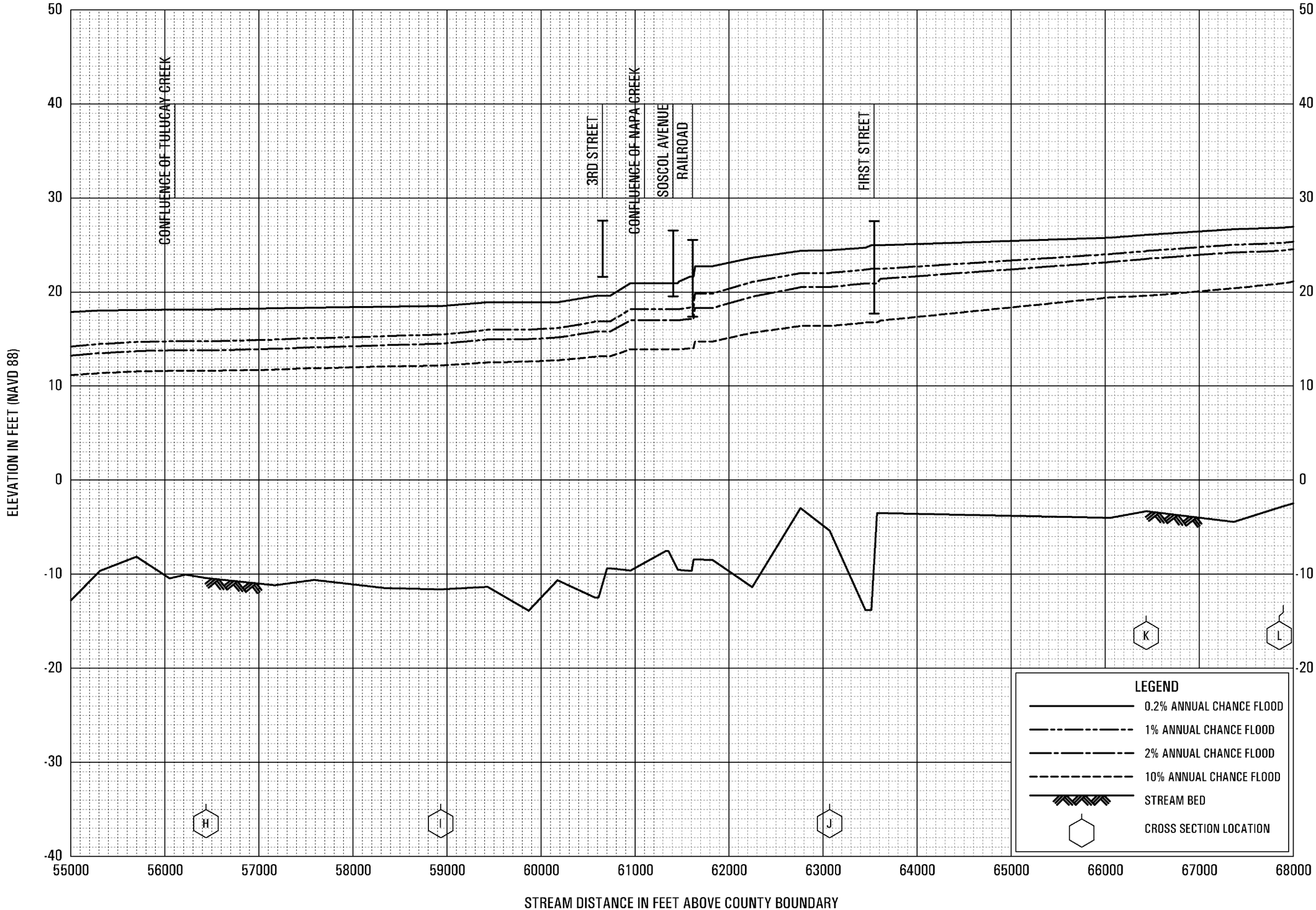
NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS

08P




FLOOD PROFILES

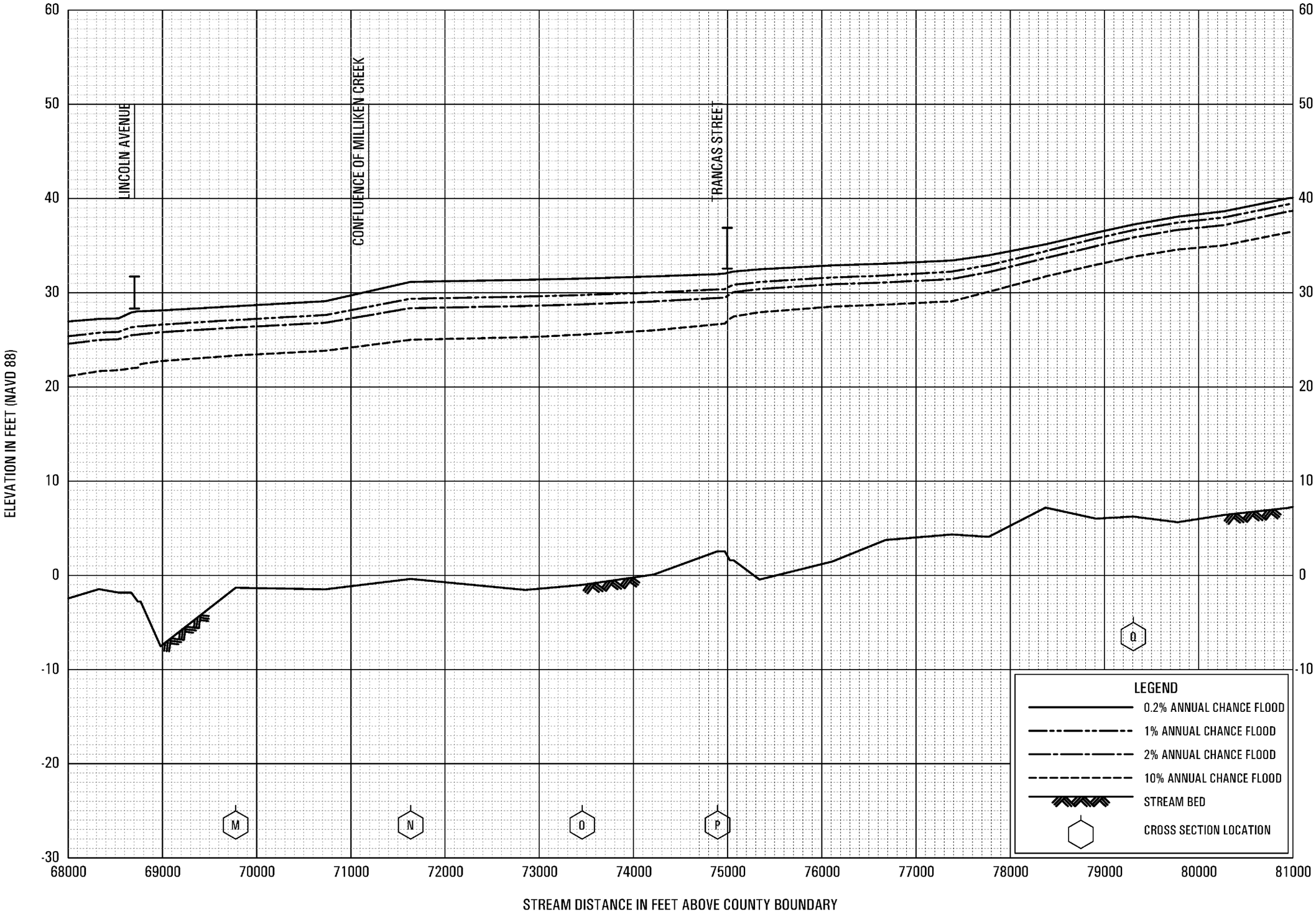
NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS

09P



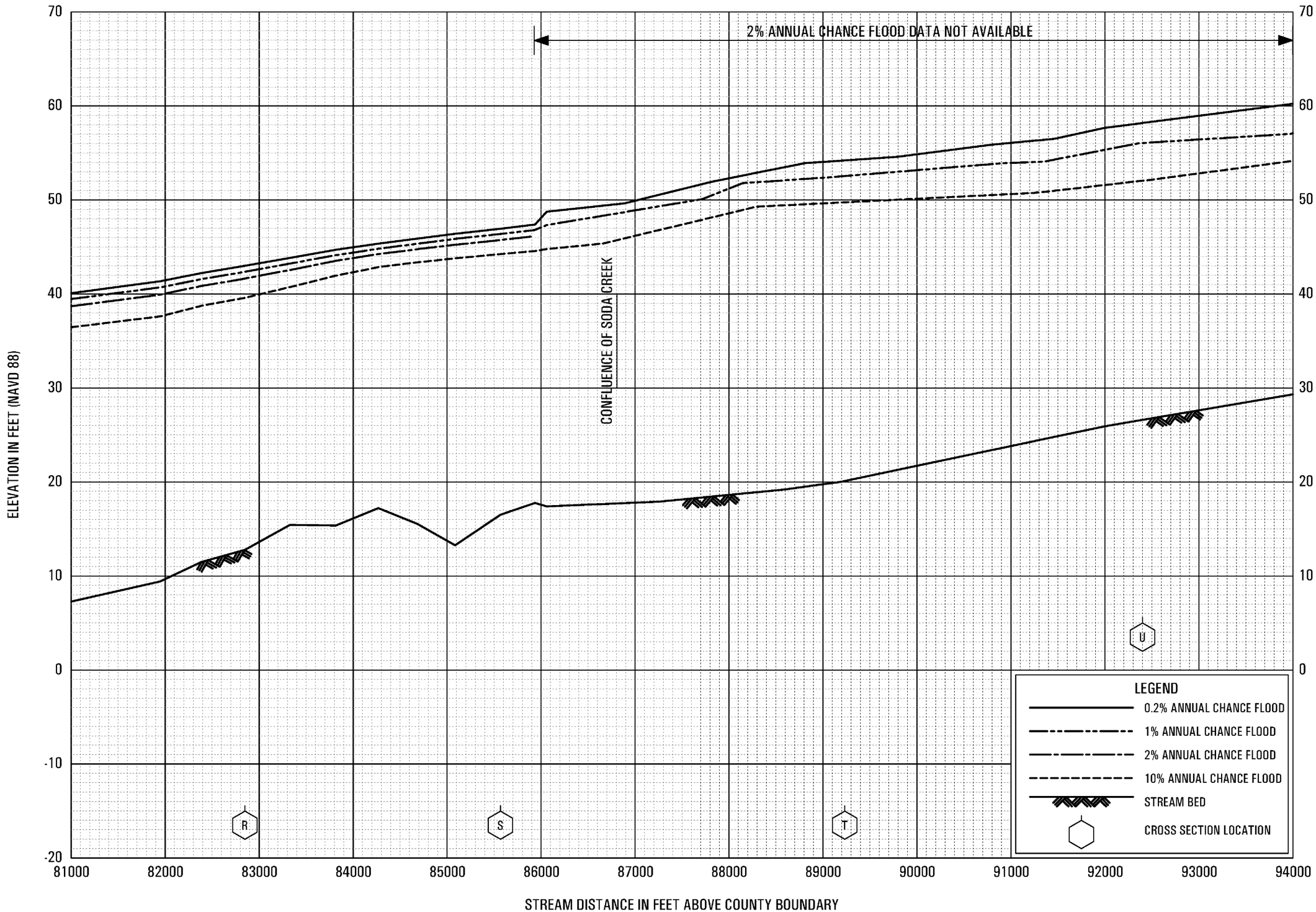

FLOOD PROFILES

NAPA RIVER (WITH LEVEE)

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



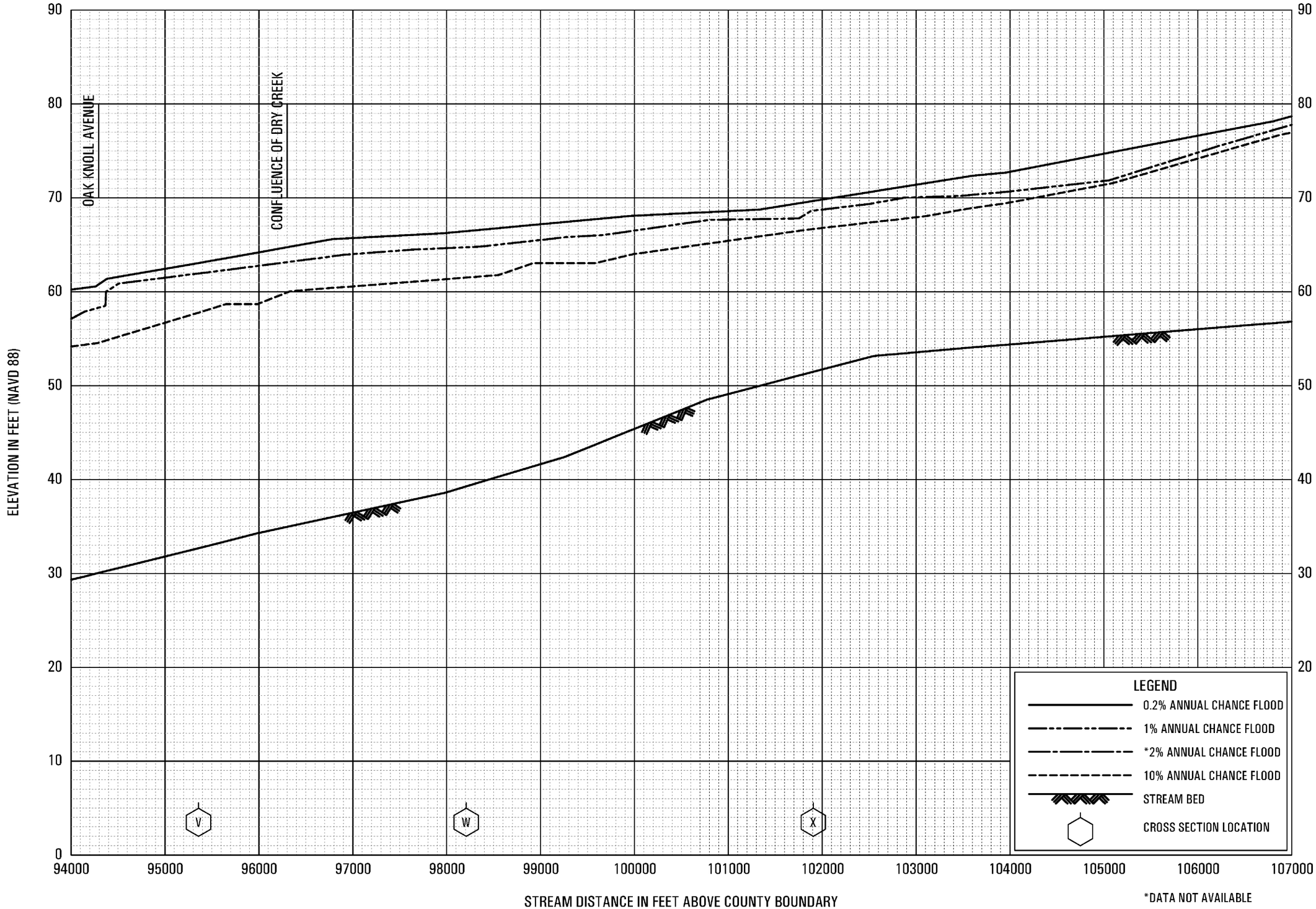

FLOOD PROFILES

NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



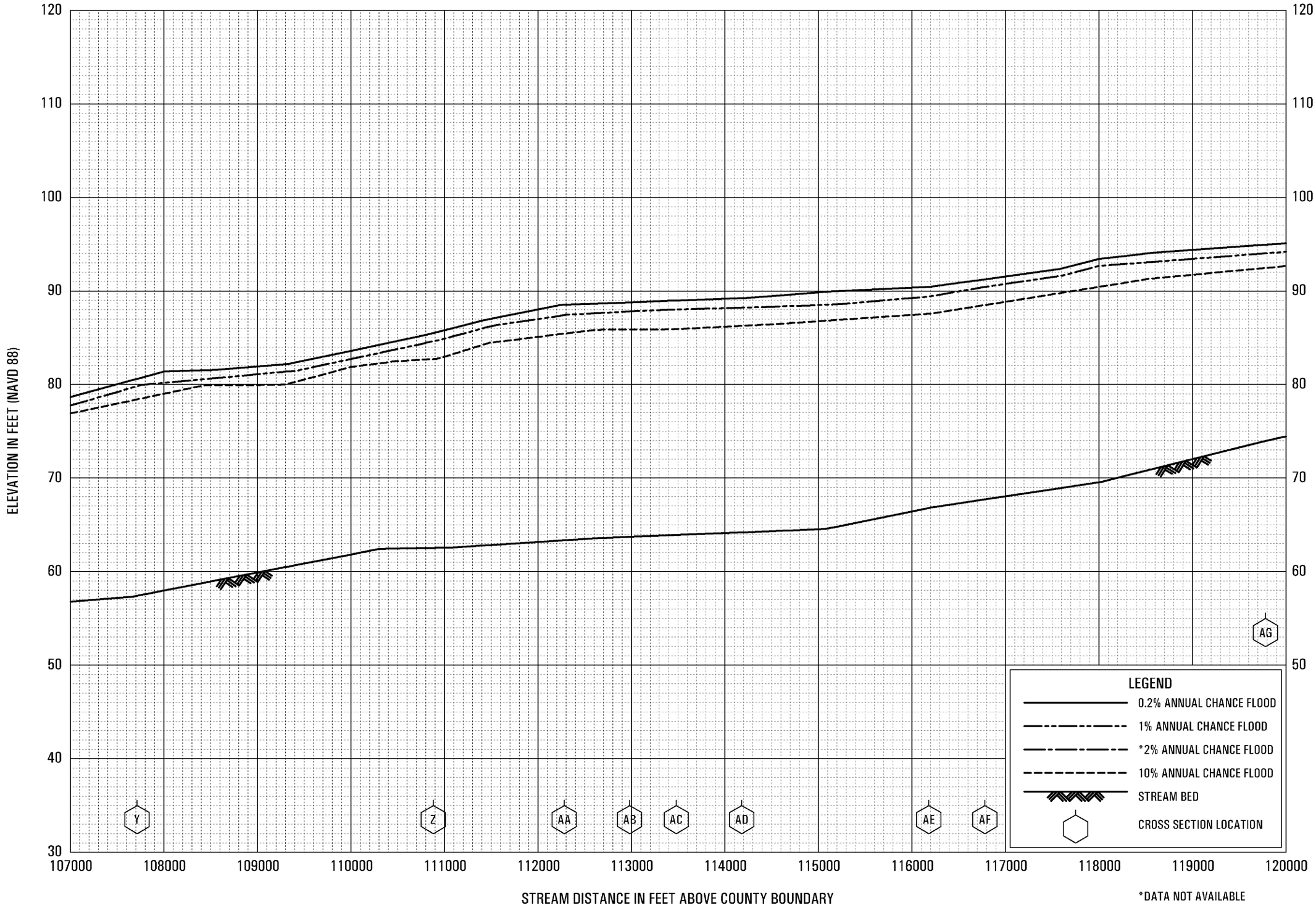

FLOOD PROFILES

NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



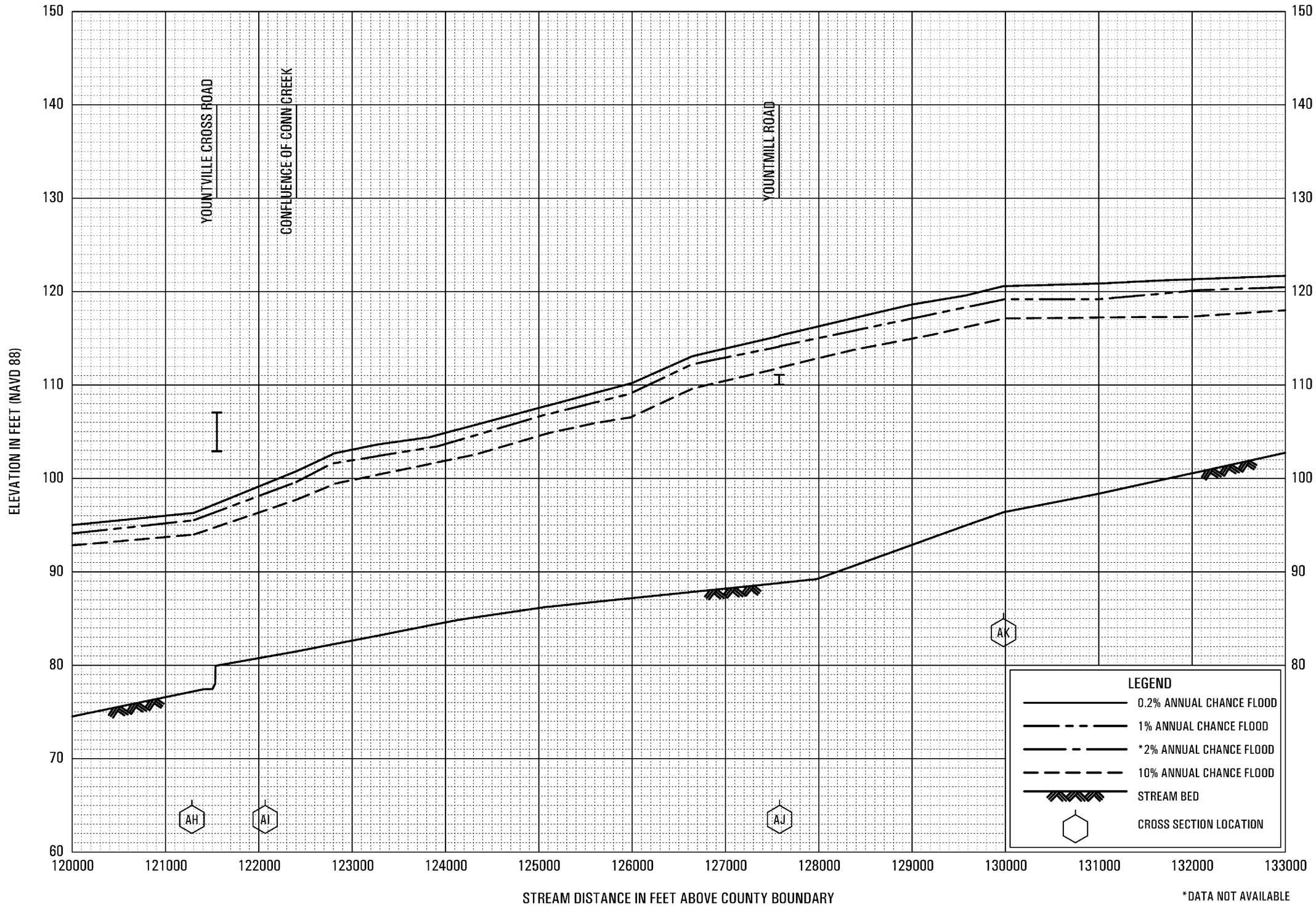

FLOOD PROFILES

NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



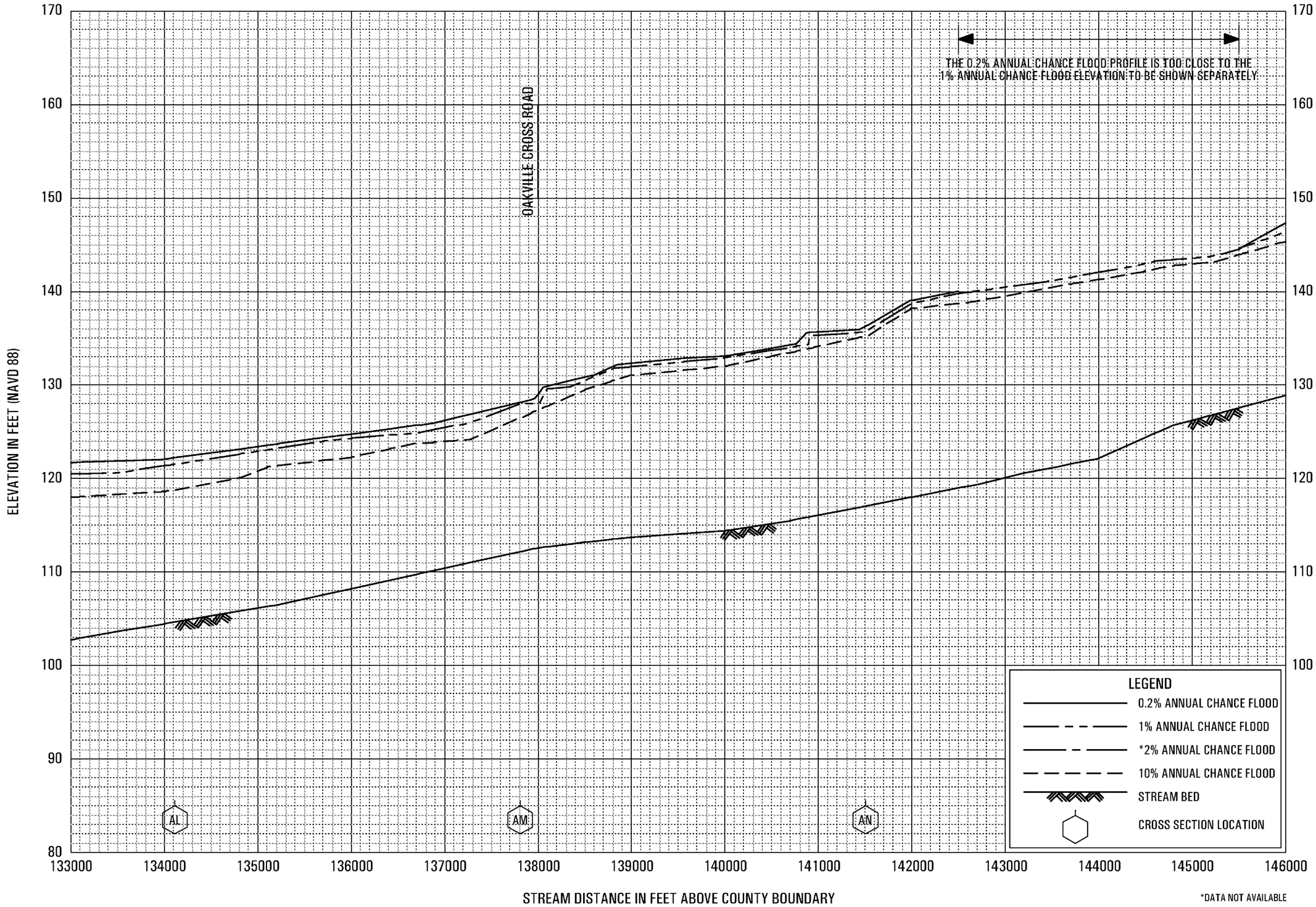

FLOOD PROFILES

NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



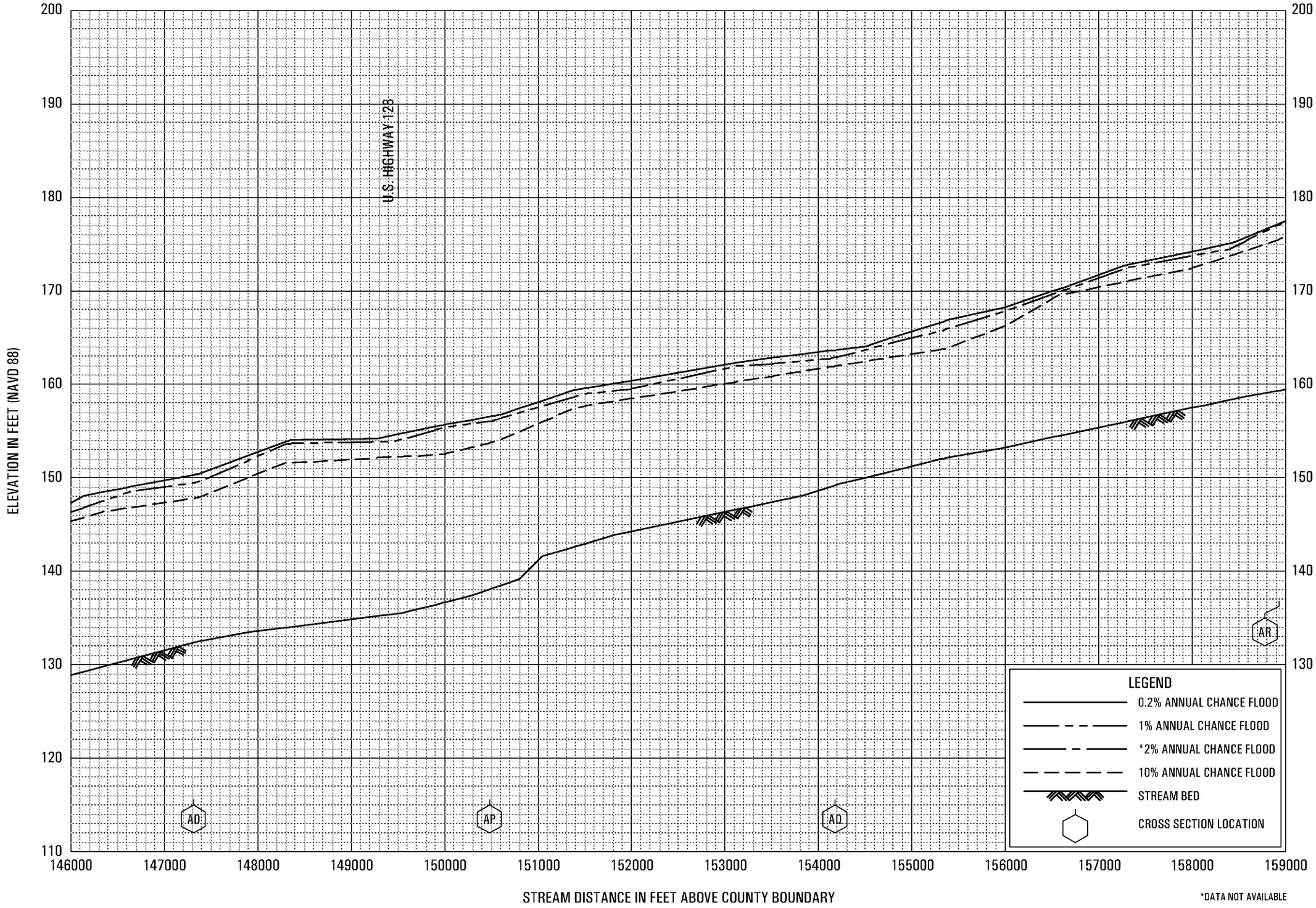

FLOOD PROFILES

NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



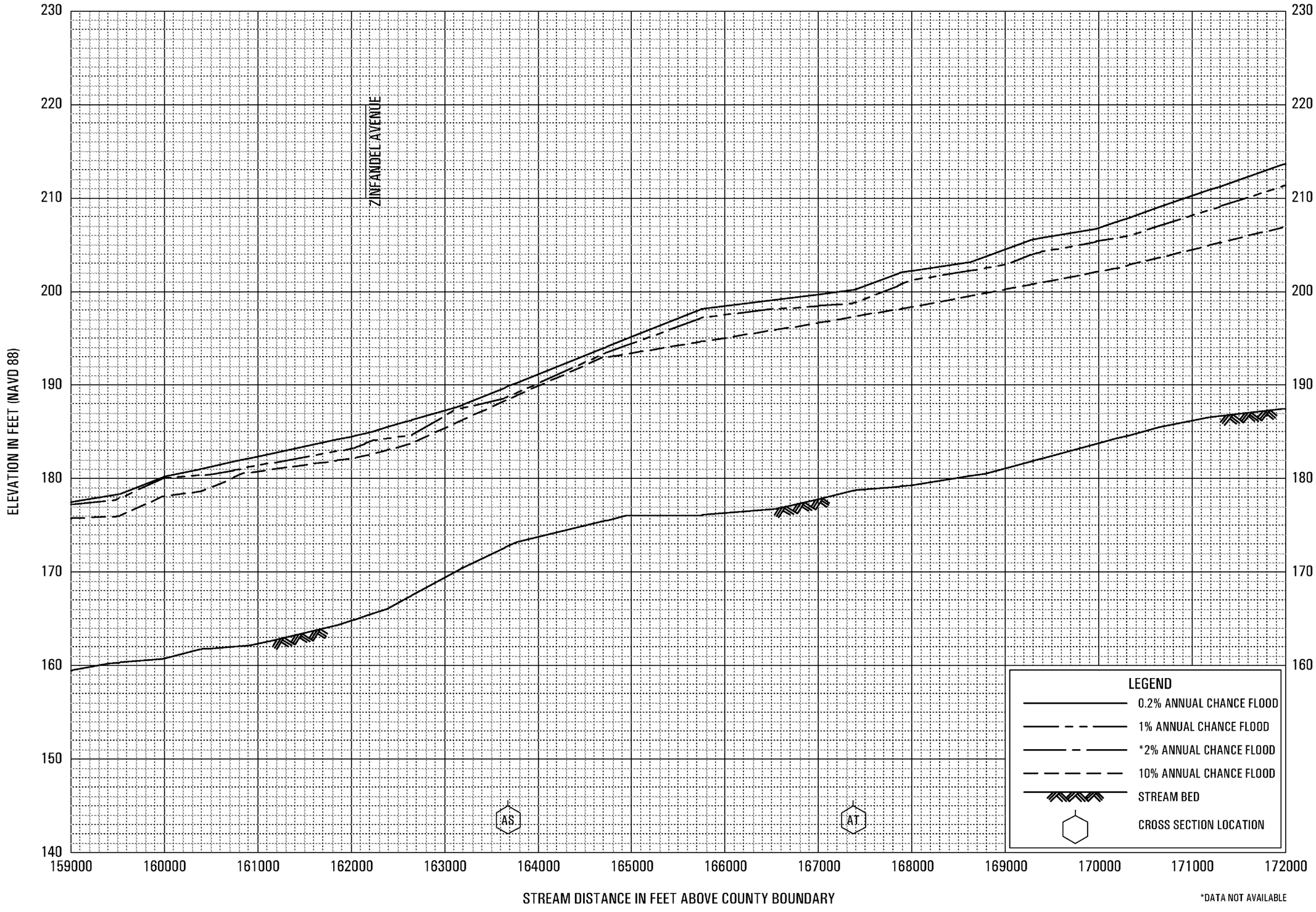

FLOOD PROFILES

NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



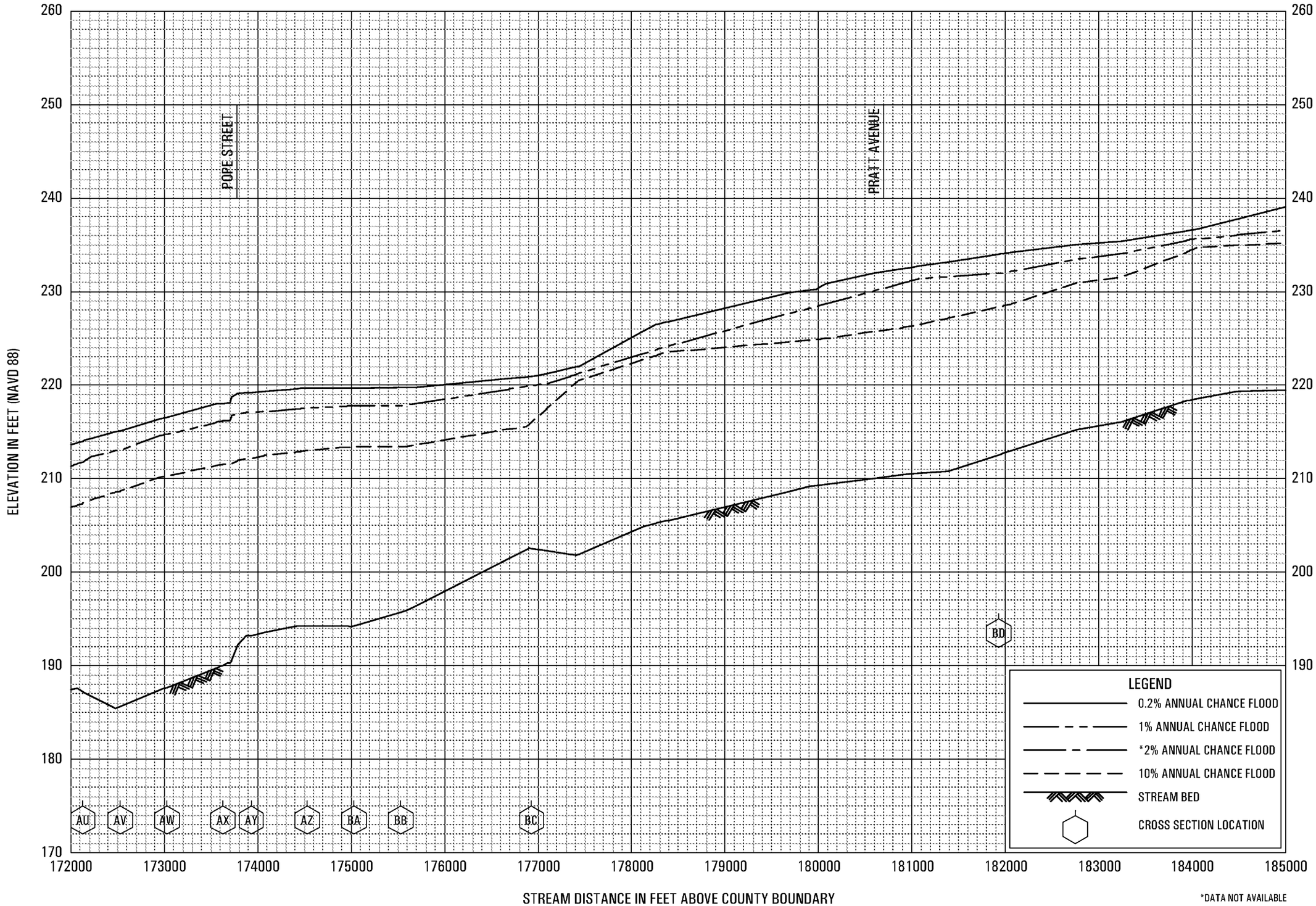

FLOOD PROFILES

NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



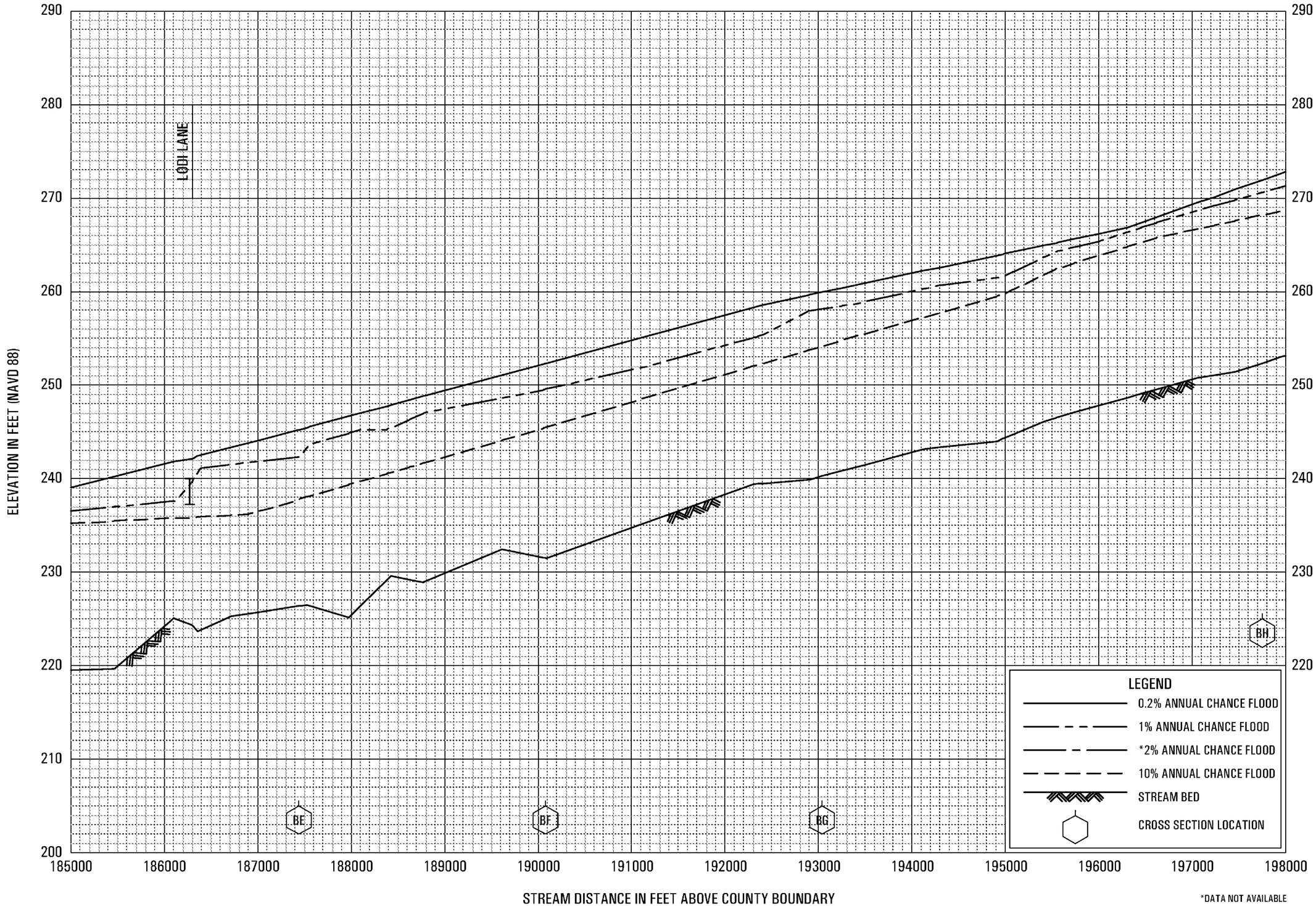

FLOOD PROFILES

NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS

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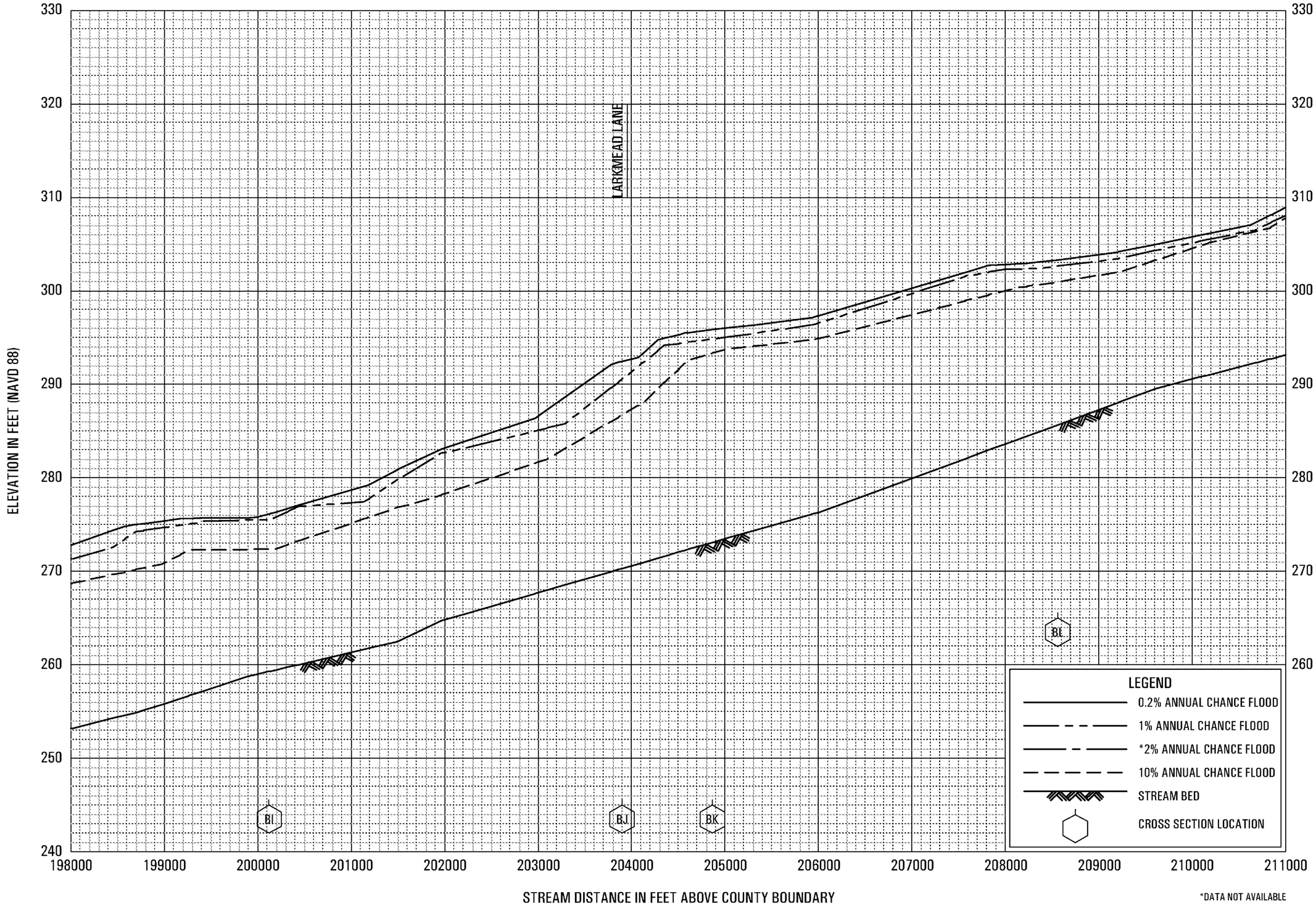
FLOOD PROFILES

NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



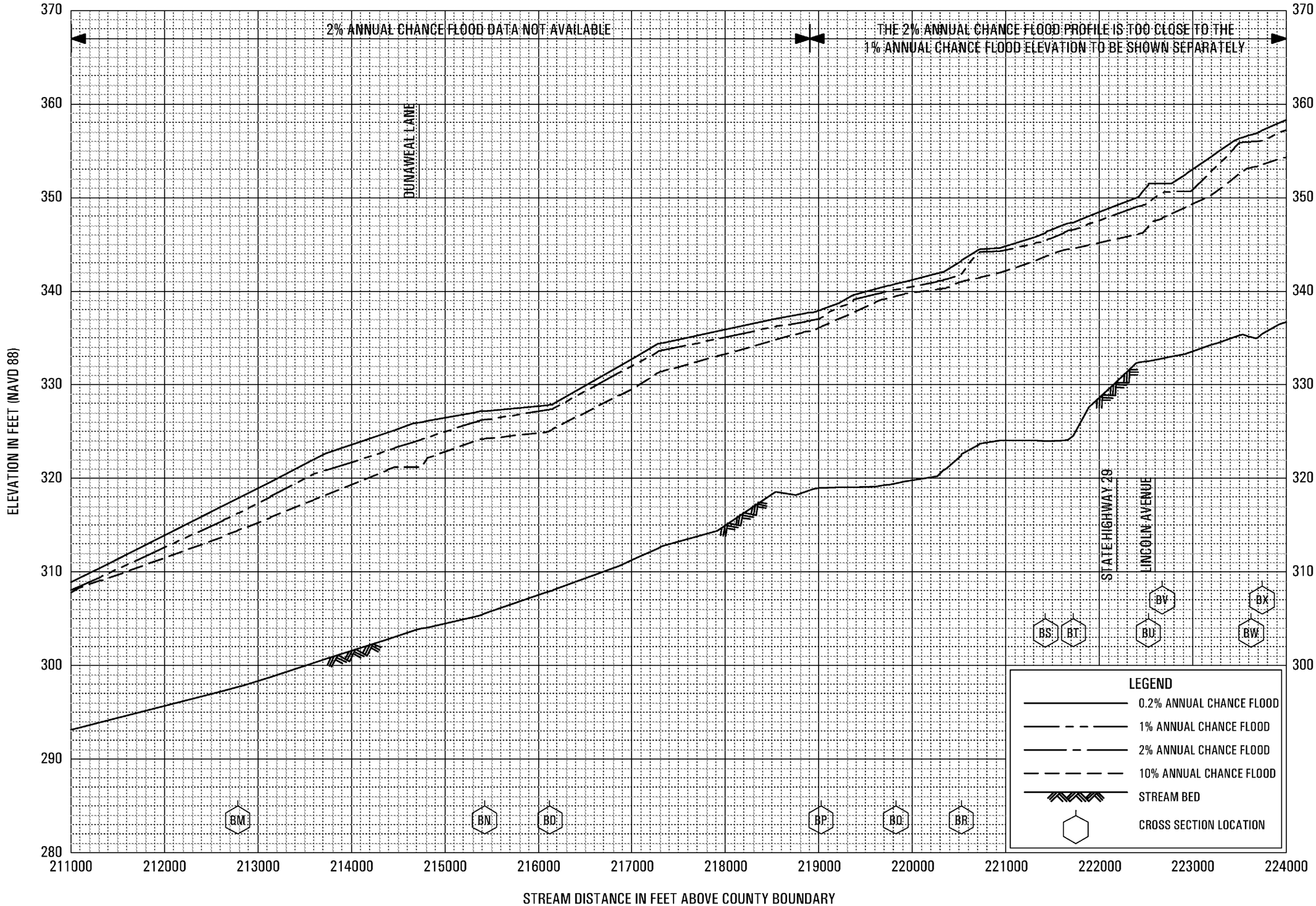

FLOOD PROFILES

NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



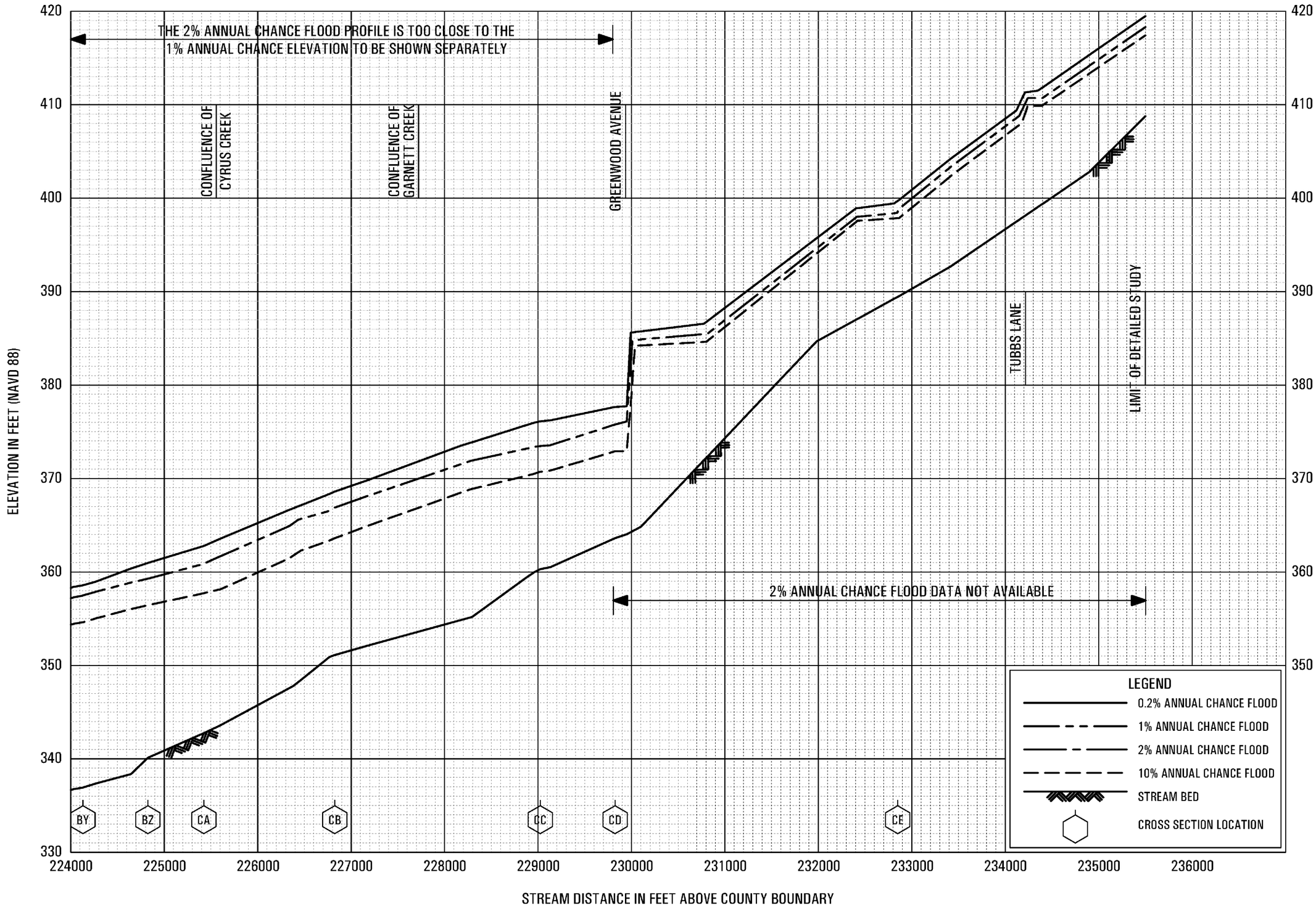

FLOOD PROFILES

NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



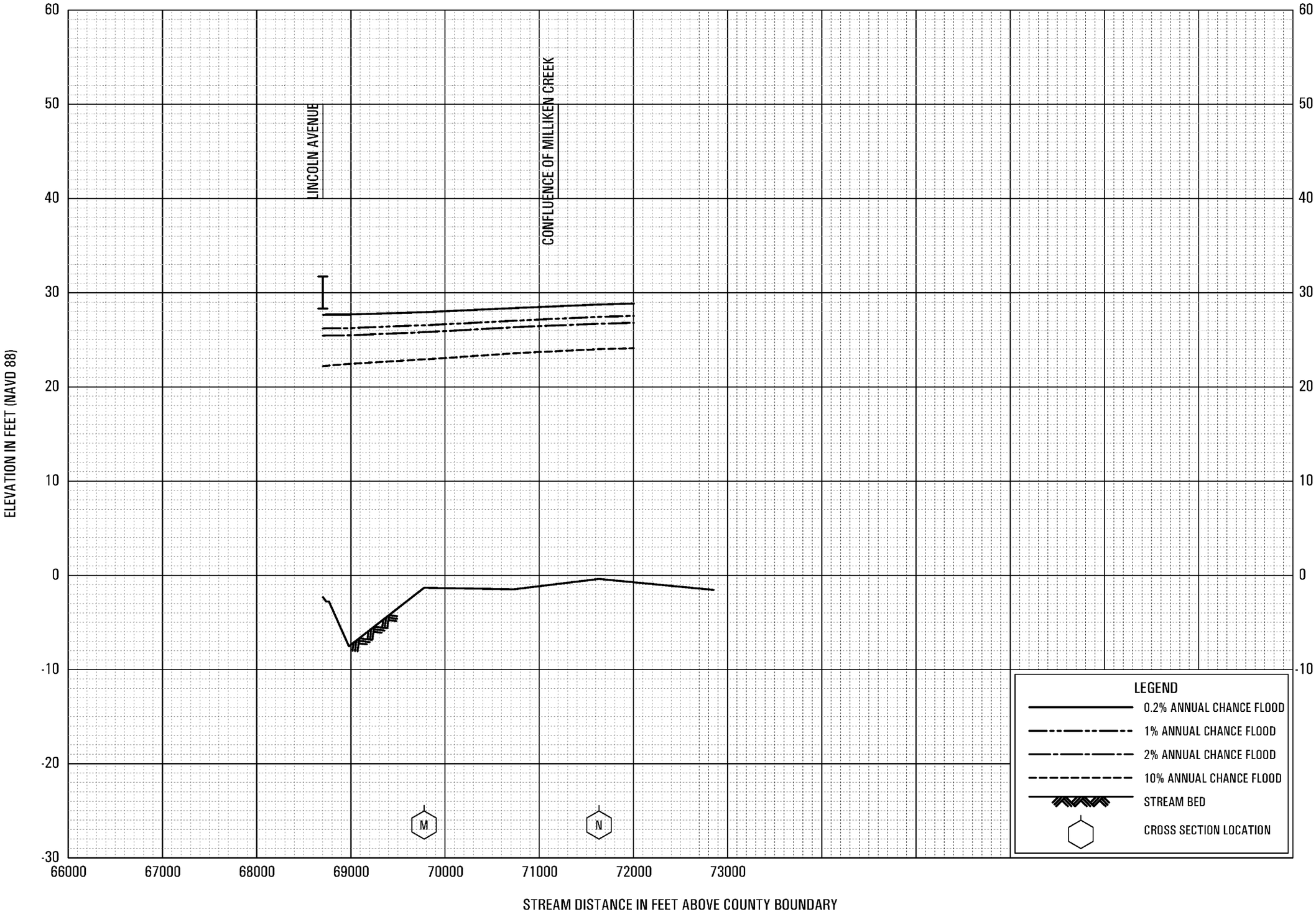

FLOOD PROFILES

NAPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



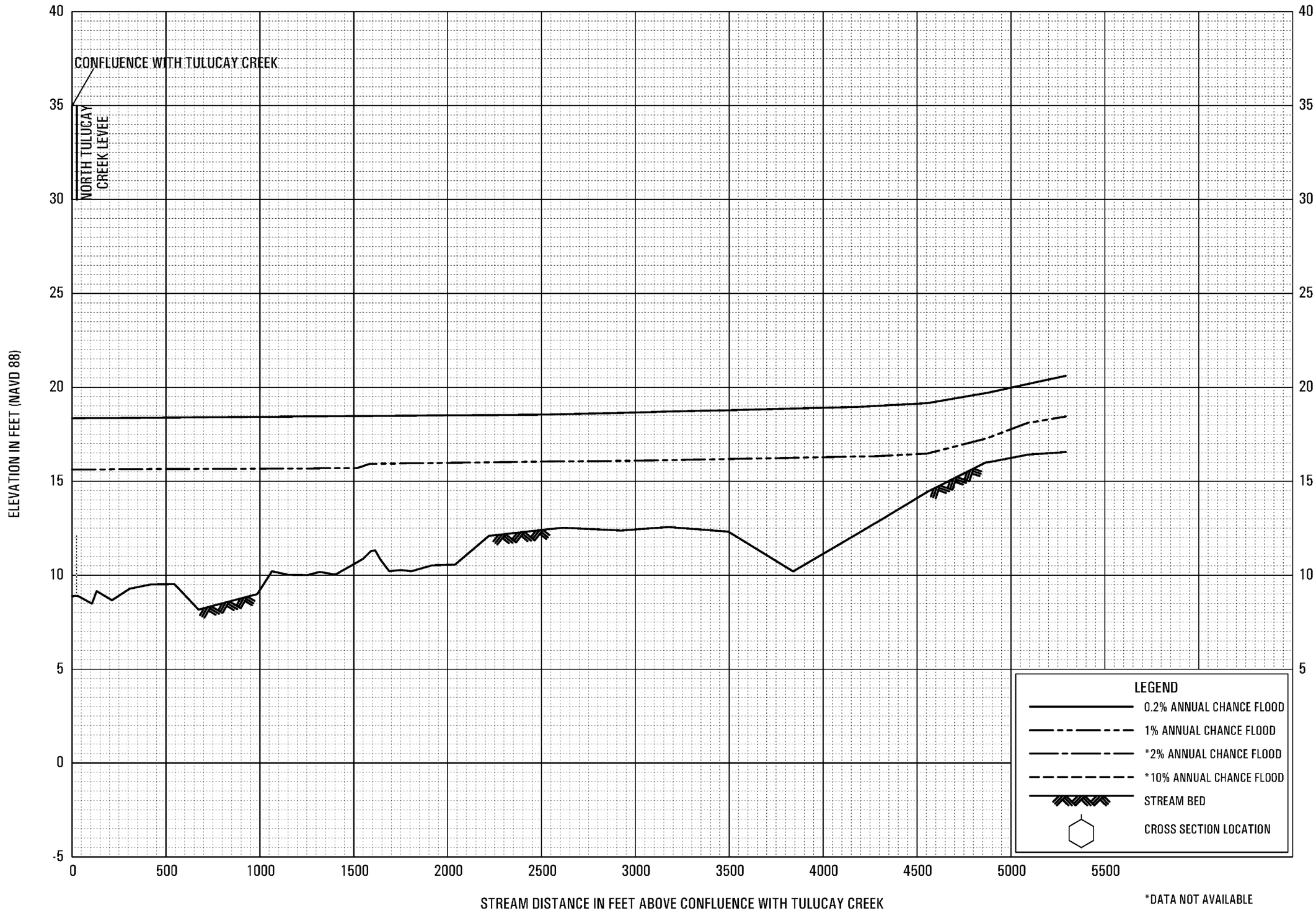

FLOOD PROFILES

NAPA RIVER (WITHOUT LEVEE)

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



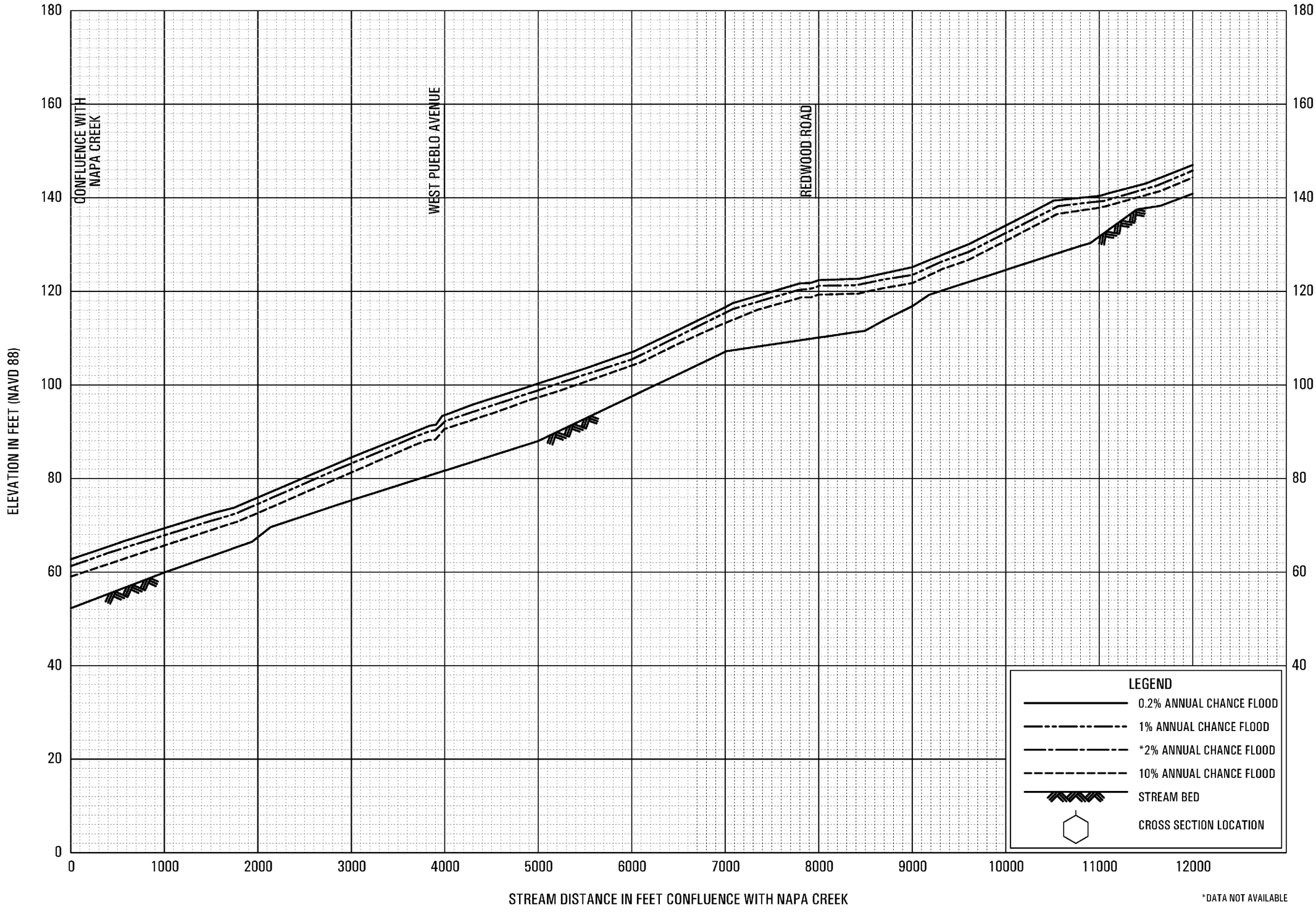

FLOOD PROFILES

NAPA RIVER OXBOW OVERFLOW

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



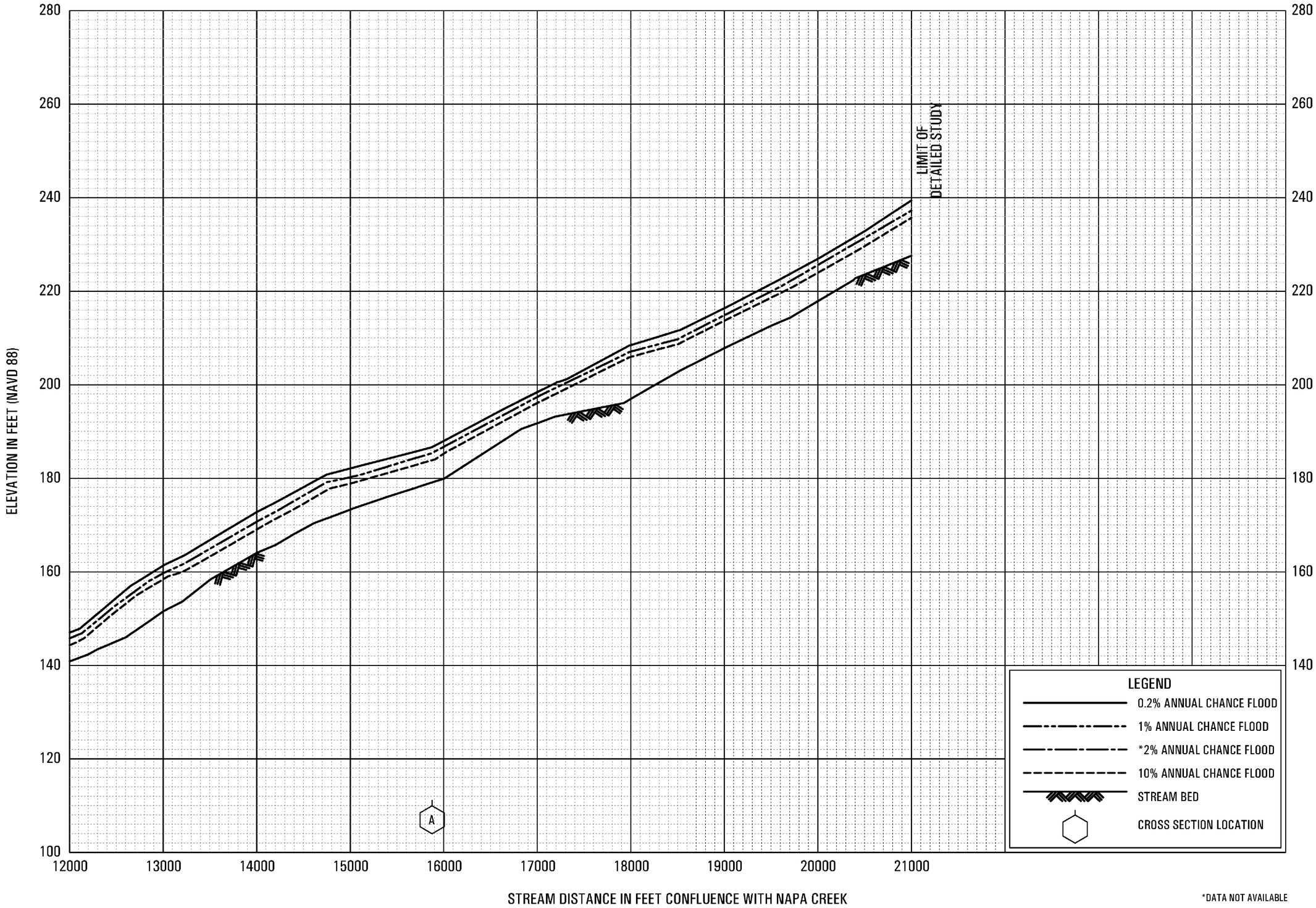

FLOOD PROFILES

REDWOOD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



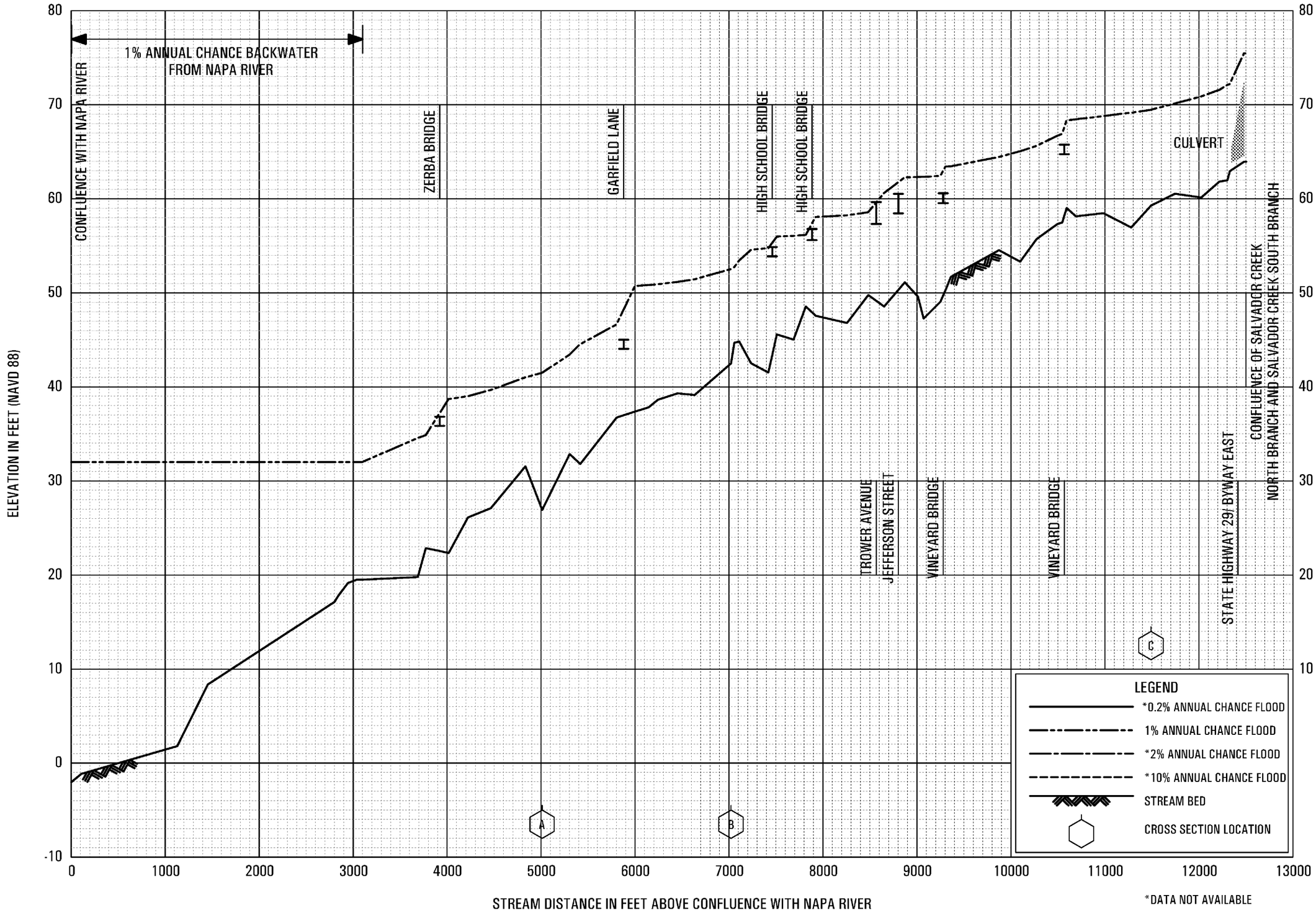

FLOOD PROFILES

REDWOOD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



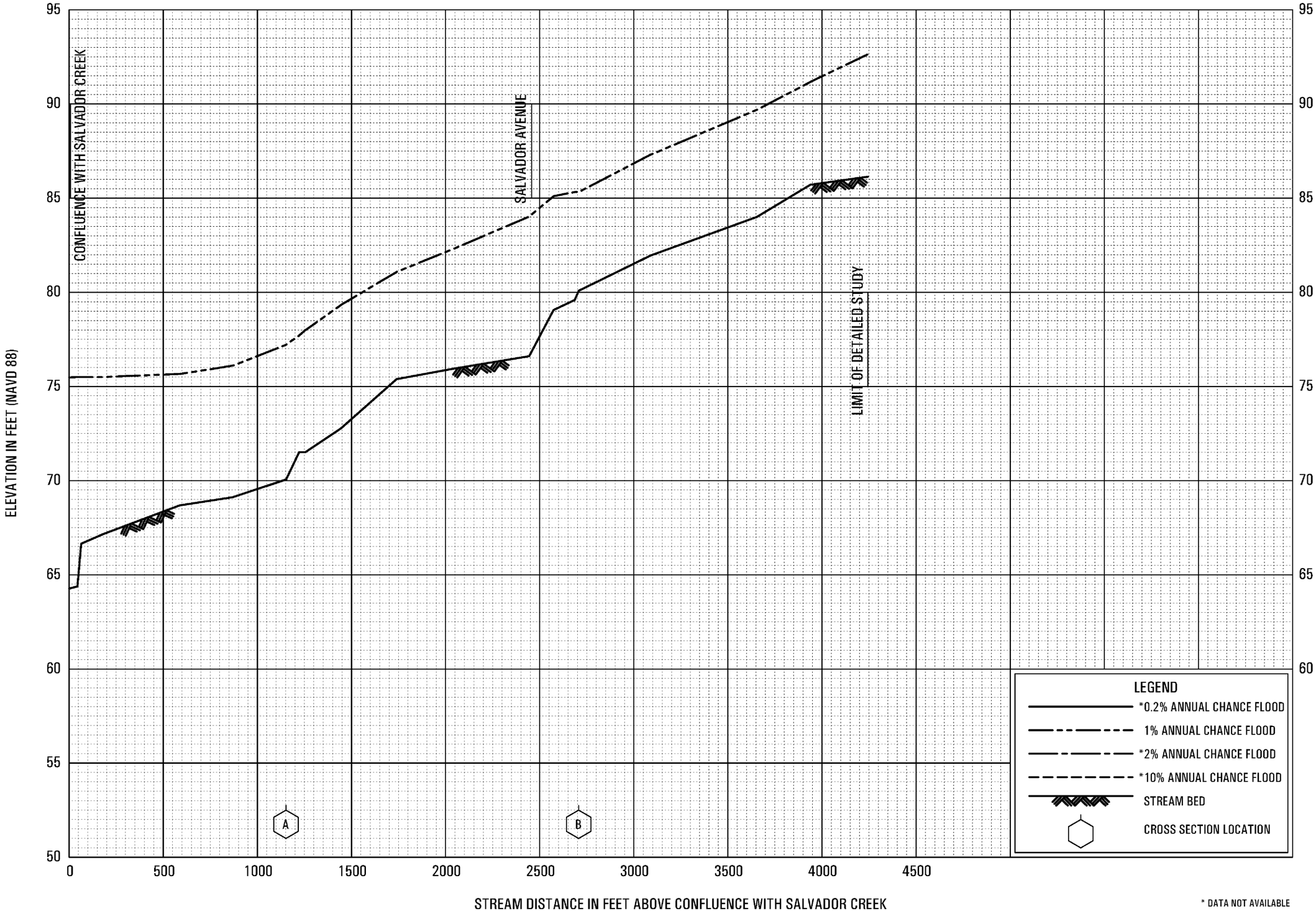

FLOOD PROFILES

SALVADOR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



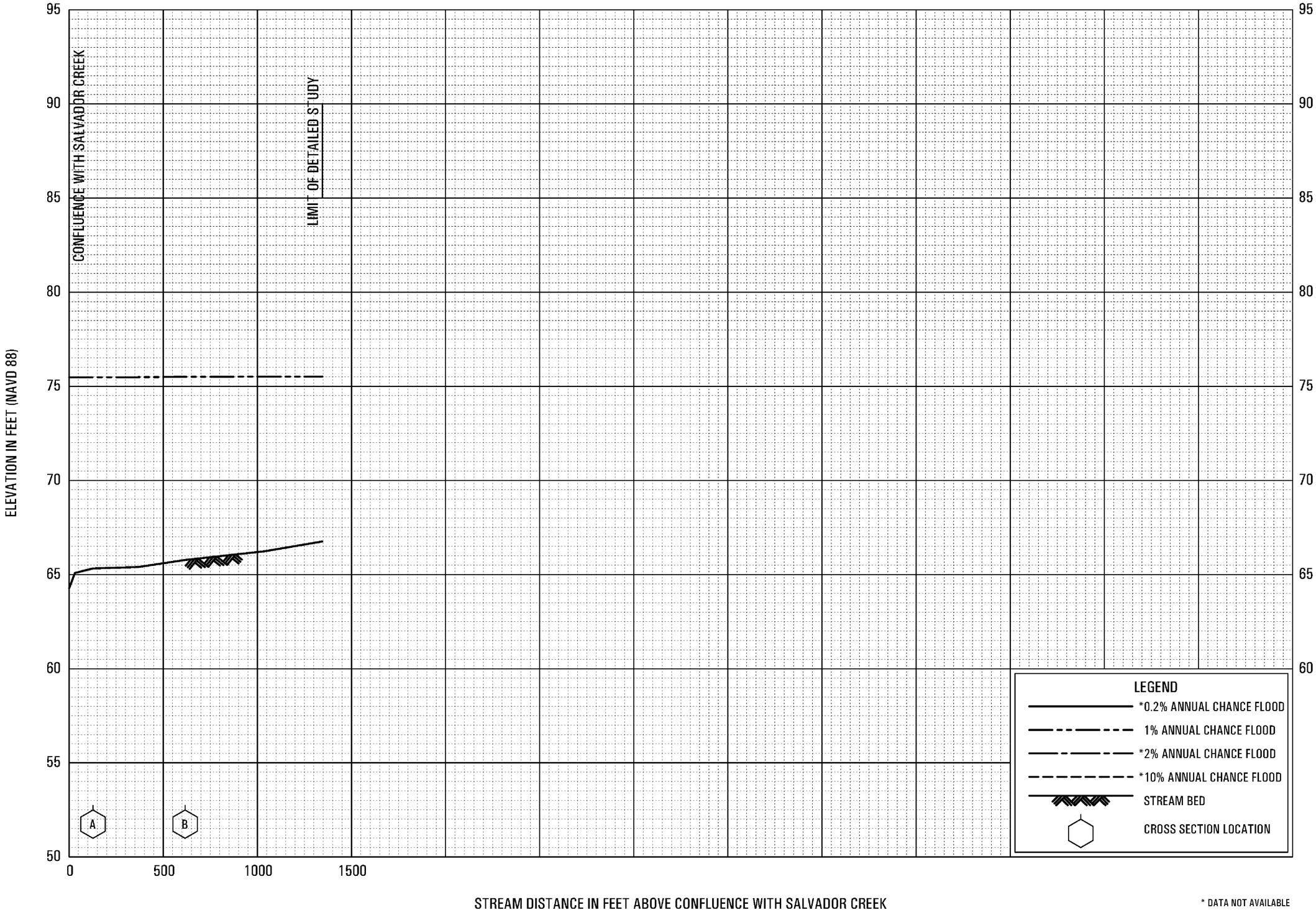

FLOOD PROFILES

SALVADOR CREEK NORTH BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



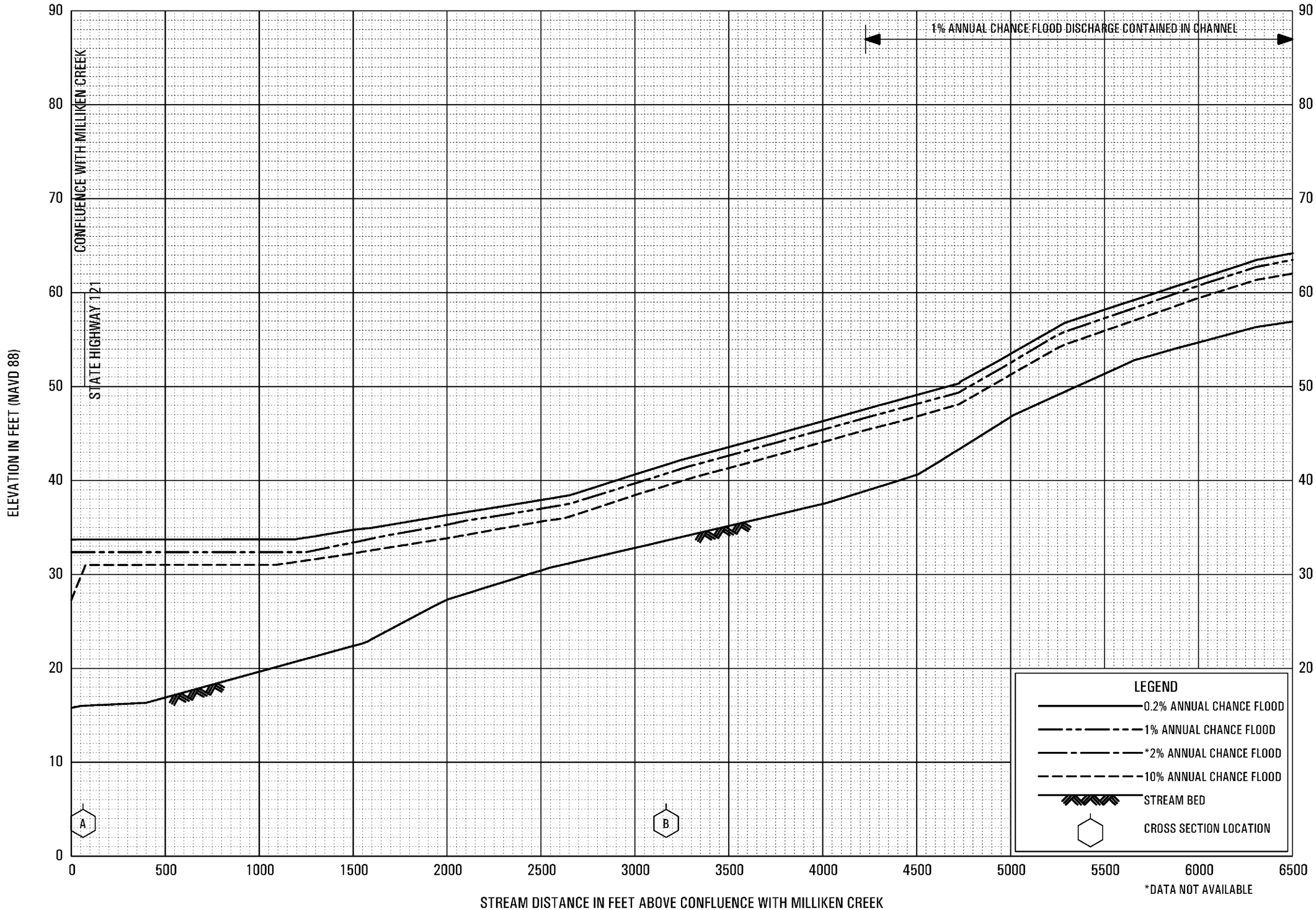

FLOOD PROFILES

SALVADOR CREEK SOUTH BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



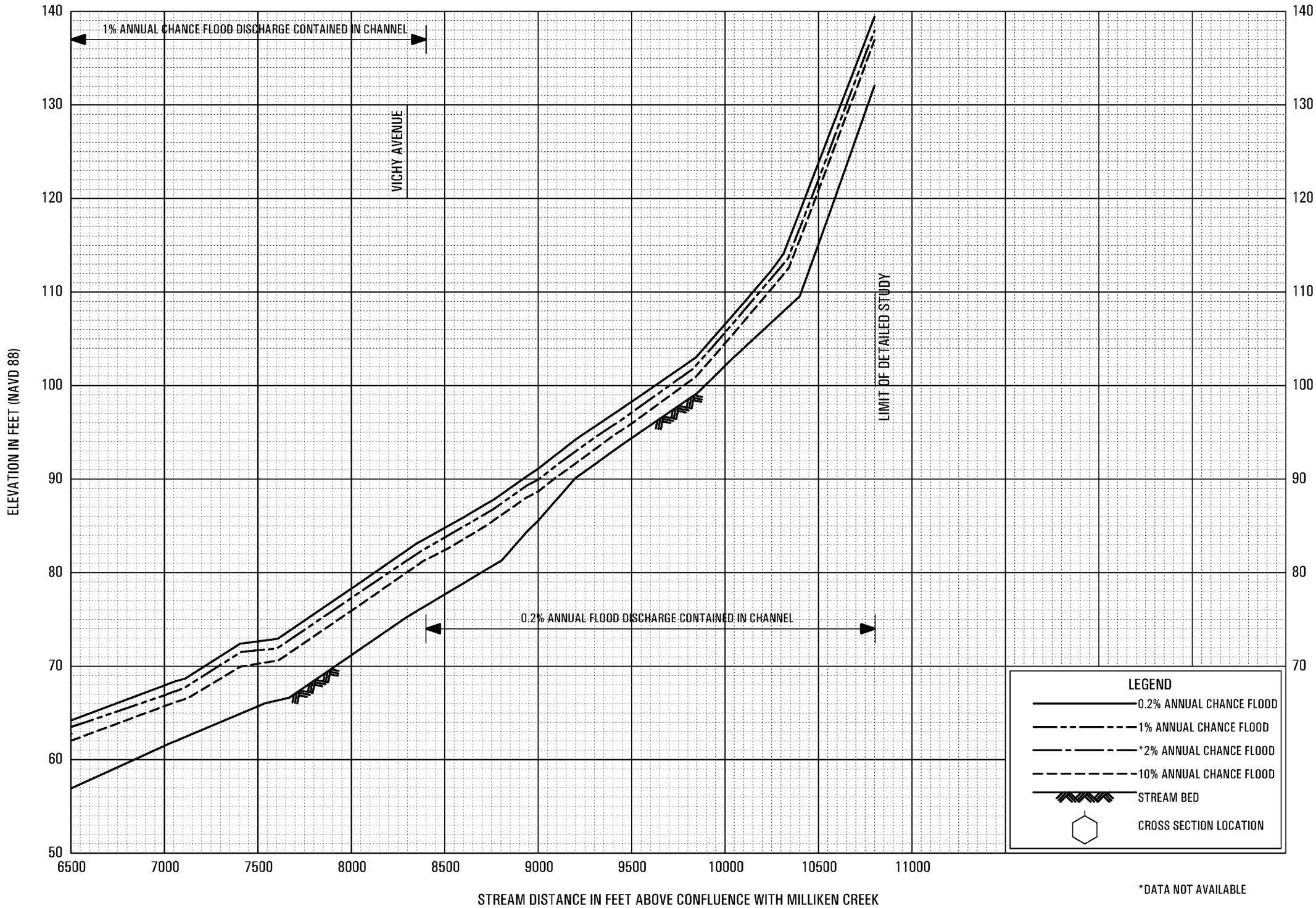

FLOOD PROFILES

SARCO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



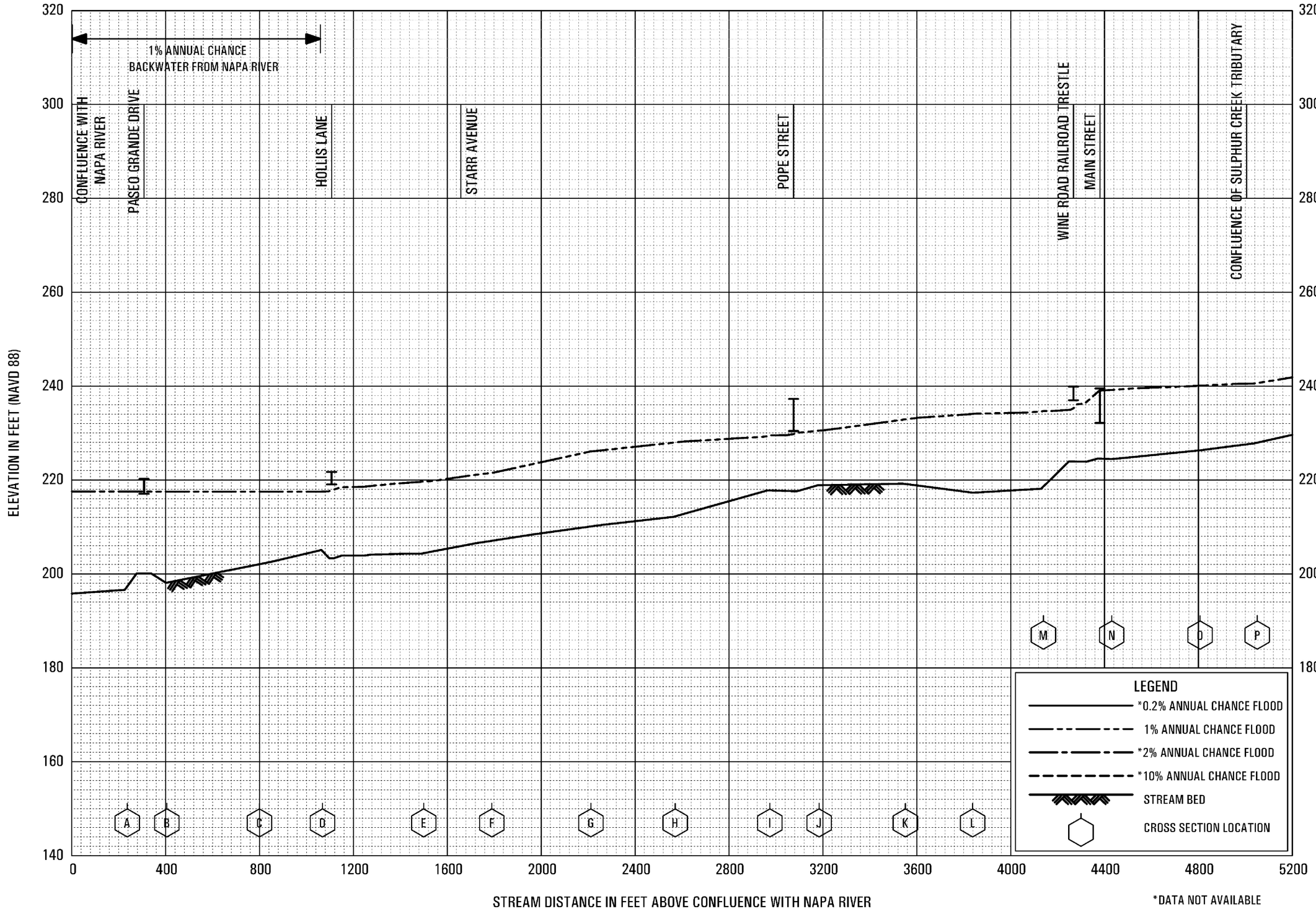

FLOOD PROFILES

SARCO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



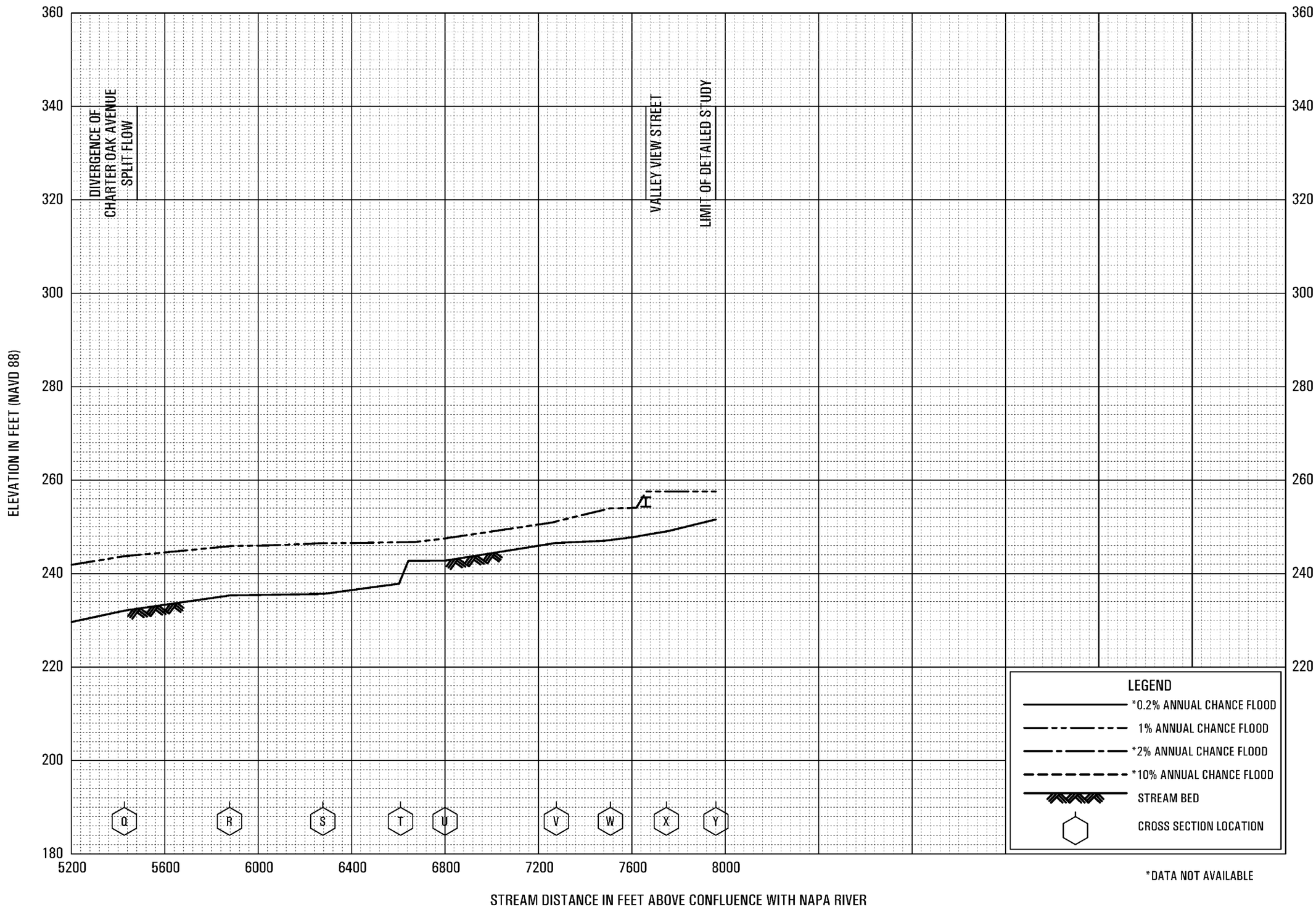

FLOOD PROFILES

SULPHUR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



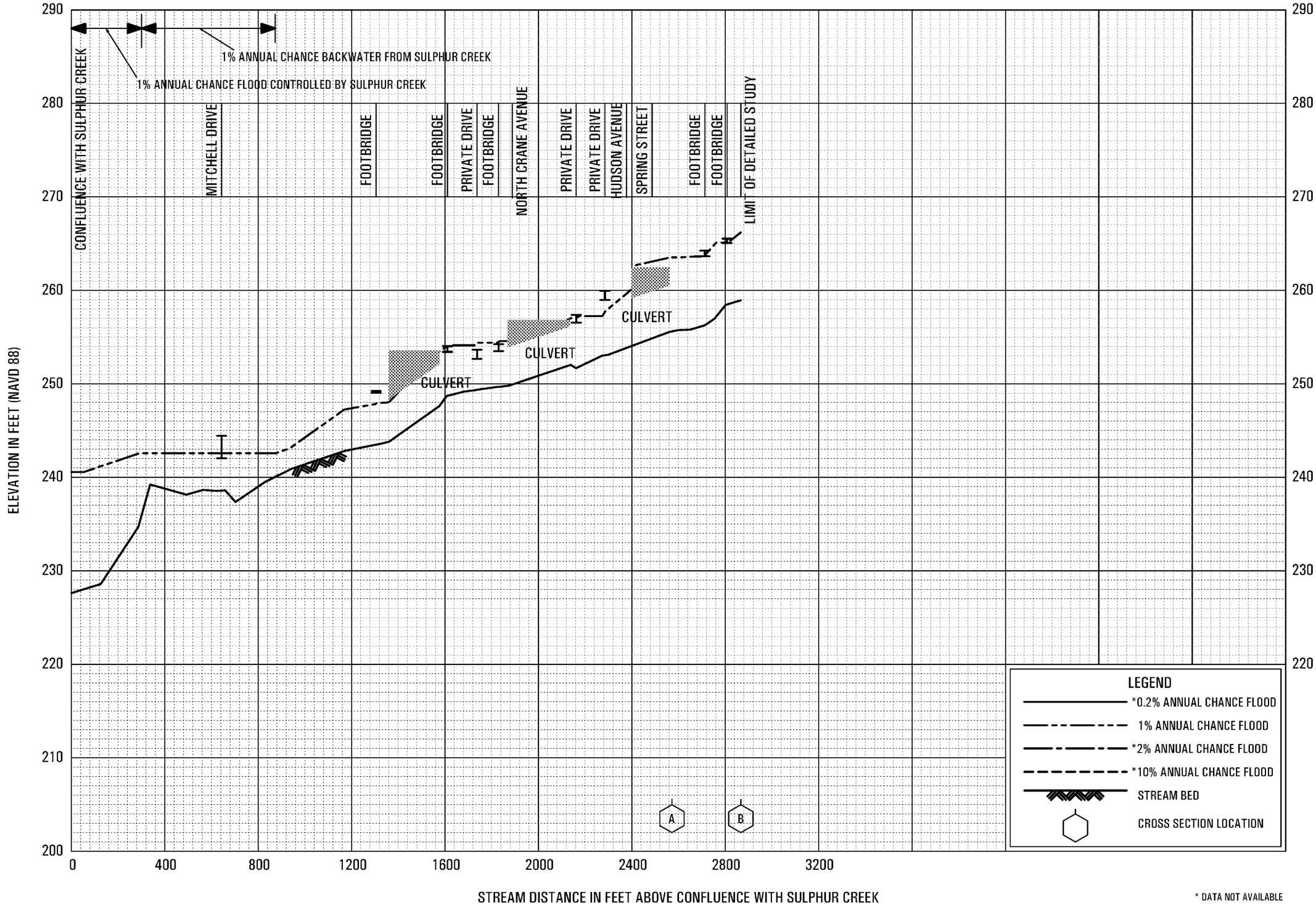

FLOOD PROFILES

SULPHUR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



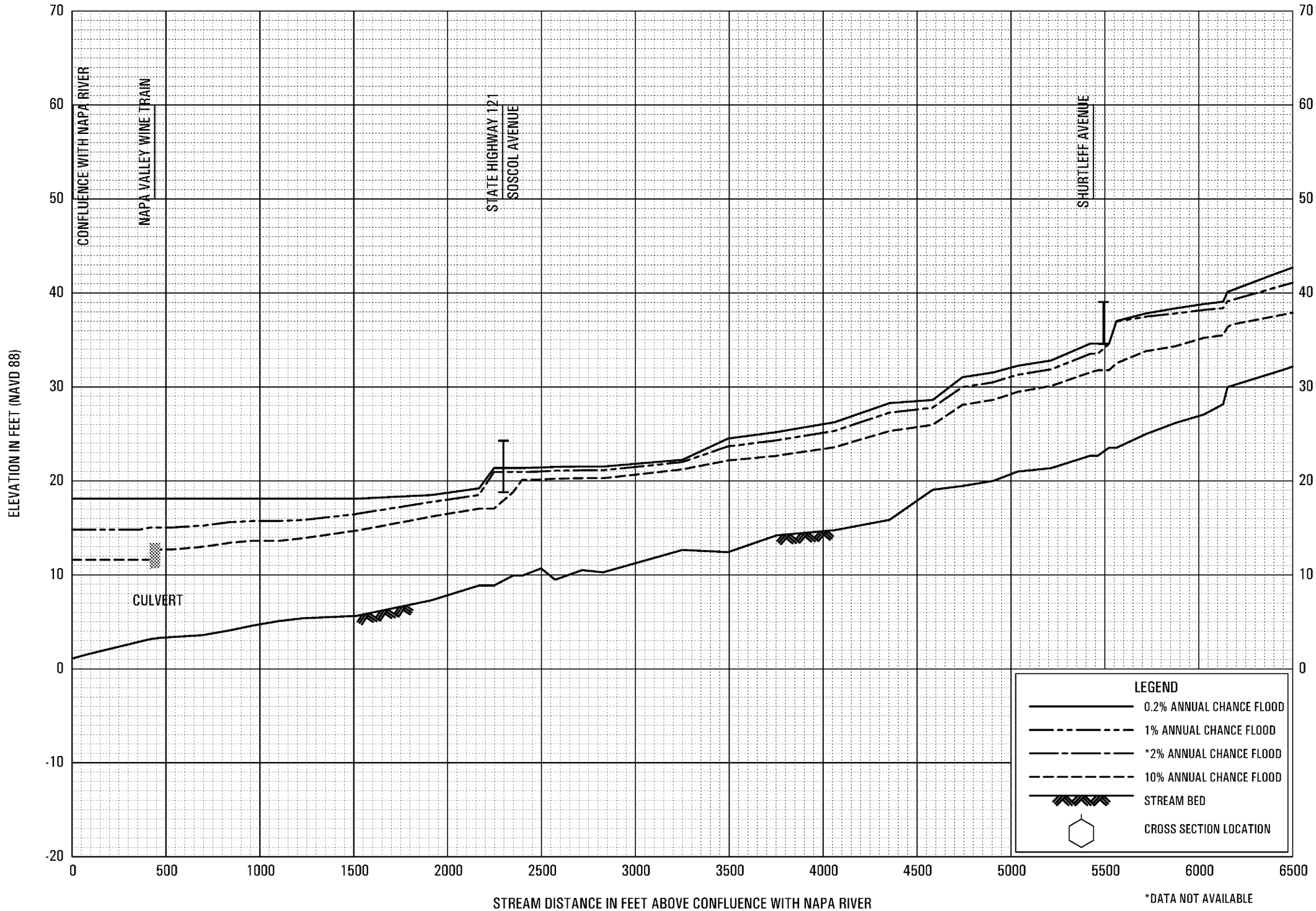

FLOOD PROFILES

SULPHUR CREEK TRIBUTARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS



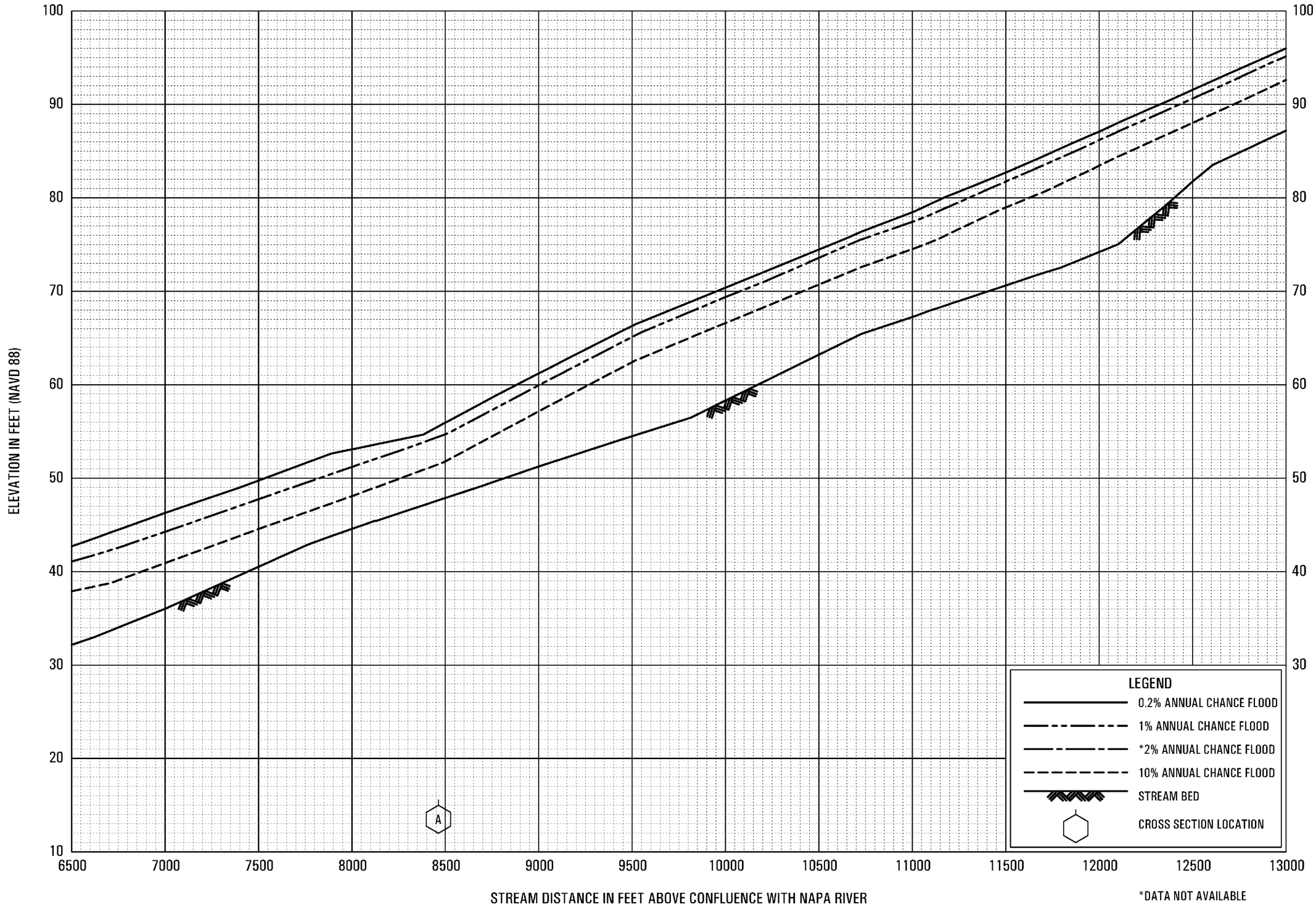

FLOOD PROFILES

TULUCAY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS




*DATA NOT AVAILABLE

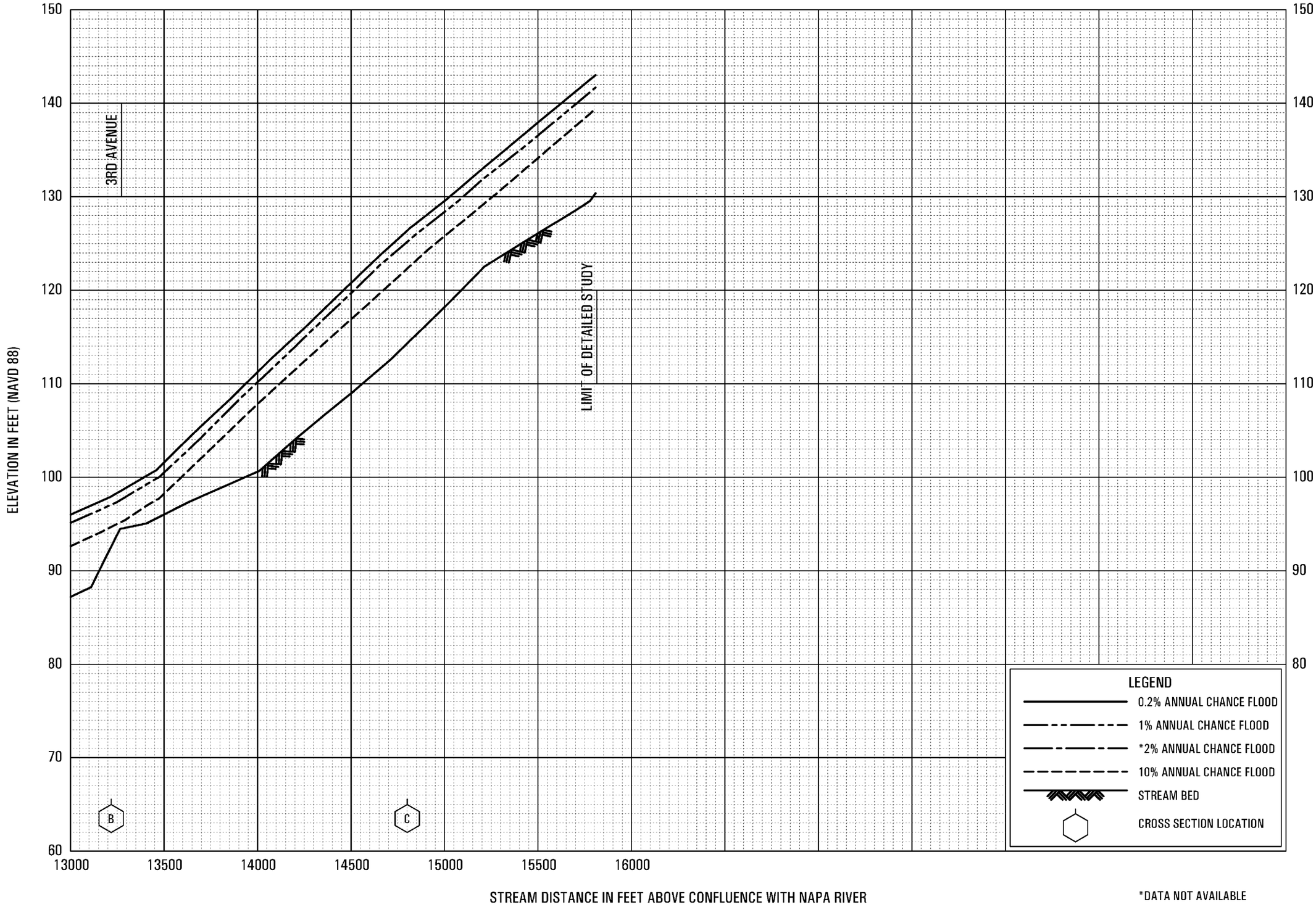
FLOOD PROFILES

TULUCAY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS




*DATA NOT AVAILABLE

FLOOD PROFILES

TULUCAY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

NAPA COUNTY, CA

AND INCORPORATED AREAS