# FLOOD INSURANCE STUDY

# EL PASO COUNTY, TEXAS

## AND INCORPORATED AREAS
## VOLUME 1 OF 3


| COMMUNITY NAME | COMMUNITY NUMBER |
|---|---|
| ANTHONY, TOWN OF | 480804 |
| CLINT, TOWN OF | 481260 |
| EL PASO, CITY OF | 480214 |
| EL PASO COUNTY (UNINCORPORATED AREAS) | 480212 |
| HORIZON CITY, TOWN OF* | 480322 |
| SAN ELIZARIO, CITY OF | 480561 |
| SOCORRO, CITY OF | 481658 |
| VINTON, VILLAGE OF | 481557 |
| YSLETA DEL SUR PUEBLO | 480663 |

* No Special Flood Hazards Areas Identified

**EFFECTIVE:**
**REVISED PRELIMINARY OCTOBER 24, 2014**

Federal Emergency Management Agency

**FLOOD INSURANCE STUDY NUMBER**
**48141CV001A**

## NOTICE TO

## FLOOD INSURANCE STUDY USERS

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

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

| Old Zone(s) | New Zone |
|---|---|
| Al through A30 | AE |
| VI through V30 | VE |
| B | X |
| C | X |

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

**ATTENTION:** On FIRM panels 0175, 0180, 0186, 0188, 0189, 0332, 0351, 0352, 0353, 0354, 0358, 0362, 0366, 0367, 0369, 0388, 0389, 0393, 0394, 0413, 0501, 0506, 0507, 0526, 0527, 0528, 0529, 0533, 0536, 0537, 0539, 0541, 0542, 0543, 0544, 0563, 0631, 0632, 0650, 0651, 0652, 0653, 0654, 0675, 0750, 0775, and 0800 the International Boundary Water Commission (IBWC) levees along the Rio Grande have not been demonstrated by the community or levee owner(s) to meet the requirements of Section 65.10 of the NFIP regulations in 44 CFR as it relates to the levee's capacity to provide 1-percent annual chance flood protection. The subject areas are identified on FIRM panels (with notes and bounding lines) and in the FIS report as potential areas of flood hazard data changes based on further review.

FEMA has updated levee analysis and mapping protocols. Until such time as FEMA is able to initiate a new flood risk project to apply the new protocols, the flood hazard information on the aforementioned FIRM panel(s) that are affected by the IBWC levees along the Rio Grande are being added as a snapshot of the prior effective information presented on the FIRMs and FIS reports dated February 16, 2006 for the City of El Paso; August 1, 1987 for the Town of Anthony; July 1, 1987 for the Town of Clint; June 24, 1980 for the Village of Vinton; and September 4, 1991 for the unincorporated areas of El Paso County. As indicated above, it is expected that affected flood hazard data within the subject area could be significantly revised. This may result in floodplain boundary changes, 1-percent annual chance flood elevation changes, and/or changes to flood hazard zone designations.

The effective FIRM panels (and the FIS) will again be revised to update the flood hazard information associated with the IBWC levees along the Rio Grande when FEMA is able to initiate and complete a new flood risk project to apply the new protocols.

Initial Countywide FIS Effective Date:

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# FLOOD INSURANCE STUDY

# EL PASO COUNTY, TEXAS AND INCORPORATED AREAS

## 1.0 INTRODUCTION

### 1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and supersedes the FIS reports and Flood Insurance Rate Maps (FIRMs) in the geographic area of El Paso County, Texas, including the Cities of El Paso, San Elizario, Socorro; the Towns of Anthony, Clint and Horizon City; the Village of Vinton; the Ysleta Del Sur Pueblo; and the unincorporated areas of El Paso County (referred to collectively herein as El Paso County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates. This information will also be used by El Paso County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and 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.

Please also note that FEMA has identified levees in this jurisdiction that have not been demonstrated by the community or levee owner to meet the requirements of Part 65.10 of the NFIP regulations as it relates to the levee's ability to withstand a 1-percent annual chance flood event. As such, there are temporary actions being taken until such time as FEMA is able to initiate a new flood risk project to apply new protocols. Please refer to the Notice to Flood Insurance Study Users at the front of this FIS report for more information.

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.

Please note that the on the effective date of this study the Town of Horizon City does not have any identified Special Flood Hazard Areas (SFHAs). This does not preclude future determinations of SFHAs that could be necessitated by changed conditions affecting the community (i.e. annexation of new lands) or the availability of new scientific or technical data about flood hazards.

Please note that the Cities of Mesa and La Isla are no longer incorporated. These jurisdictions are now entirely within the unincorporated areas of El Paso County.

### 1.2 Authority and Acknowledgments

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

Information on the authority and acknowledgements for each of the previously printed FIS and FIRMs for the communities within El Paso County was compiled and is shown below.

| | |
|---|---|
| City of El Paso: | Hydrologic and hydraulic flood analyses represent a revision of the original analyses prepared by the U.S. Army Corps of Engineers' (USACE's) Albuquerque District for FEMA under Interagency Agreement Ns. IAA-H-2-73, Project Order No. 2; IAA-H-19-74, Project Order No. 18; IAA-H-7-76, Project Order No. 12, Amendment Nos. 5 and 7. This work was completed in March 1979 (Reference 1). |
| City of El Paso (continued): | The hydrologic and hydraulic analyses in the first revision in the northwestern portion of El Paso were performed by the USACE's Albuquerque District for FEMA under Interagency Agreement No. EMW-E-0105, Project Order No. 2; IAA EMW-E-0105, Project Order No. 2, Amendment No. 1; and IAA EMW-E-0105, Project Order No. 2, Amendment No. 2. This work was completed in December 1981 (Reference 1).<br><br>The hydrologic and hydraulic analyses in the second City revision in the northeastern portion of El Paso were performed by Cardenas-Saledo and Associates, Inc. The revised study was completed in April 1987 (Reference 1).<br><br>The hydrologic and hydraulic analysis in the third revision in the North Hills subdivision in northeast El Paso was performed by Cardena-Saledo and Associates Inc. This work was completed in March 1990. In addition, hydrologic and hydraulic analyses were performed by Conde Inc. for the West Hills subdivision. This work was completed in June 1990 (Reference 1).<br><br>The study was revised again in 1997 to incorporate several letters of map revision issued for the City of El Paso (Reference 1).<br><br>The hydrologic and hydraulic analyses for revisions to Flow Path No. 28 Mesa Drain and Interceptor, Flow Path No. 29, Flow Path No. 30, Flow Path No. 32 and Flow Path No. 33 Middle Drain were performed by the USACE, Albuquerque District, for FEMA, under Interagency Agreement No. EMW-98-IA-0176. This work was completed October 30, 2002 (Reference 1). |
| El Paso County (Unincorporated Areas): | The original hydrologic and hydraulic analyses for this study were prepared by Bohannan-Huston, Inc. for FEMA, under Contract No. EMT-87-0147. This work was completed in September 1988 (Reference 2). |

There are no previous FIS for the Cities of San Elizario and Socorro; the Towns of Anthony, Clint, and Horizon City; the Village of Vinton; and the areas of the Pueblo of Ysleta Del Sur.

For this first time countywide FIS:

The new detailed and enhanced approximate hydrologic and hydraulic analyses for this study were performed by Mapping Alliance Partnership (MAPVI) for FEMA Region VI, under Task Order 12 and Task Order J027 of Contract No. EMT-2002-CO-0052. This study was completed in February 2007. New enhanced approximate hydrologic and hydraulic analyses for this study were performed by MAPVI for FEMA Region VI, under Task Order 30 of Contract No. EMT-2002-CO-0052. This study was completed in October 2007.

Risk Assessment and Mapping and Planning Partners (RAMPP) for FEMA under Contract No. HSFE06-12-J001, updated the FIS to include information about deaccredited levees in May 2014.

The base map information shown on this study was developed by the Texas Department of Transportation. The information was photogrammetrically compiled at a scale of 1:9,000 from aerial photography dated 2003 or later.

The projection used in the preparation of this FIRM was Texas State Plane, Central Zone (FIPSZONE 4203). The horizontal datum was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

## 1.3 Coordination

The dates of the initial and final Consultation Coordination Officer (CCO) meetings held for El Paso County and the incorporated communities within its boundaries are shown below in Table 1.

**Table 1: Initial and Final CCO Meetings**

| Community Name | Initial CCO Meeting Date | Final CCO Meeting Date |
|---|---|---|
| City of El Paso (Original Study) | May 1979 | July 1980 |
| (1st revision) | * | February 1982 |
| (2nd revision) | * | * |
| (3rd revision) | * | * |
| (4th revision) | * | * |
| (5th revision) | July 7 1998 | * |
| El Paso County (Unincorporated Areas) | October 23, 1986 | March 19, 1990 |

* Data Not Available

For this revision, the final Consultation Coordination Officer's (CCO) meeting was held on ______________, and attended by representatives of FEMA and the communities. All problems raised at that meeting have been addressed in this study.

## 2.0 AREA STUDIED

### 2.1 Scope of Study

This FIS report covers the geographic area of El Paso County, Texas, including the incorporated areas listed in Section 1.1. The areas studied by detailed and enhanced approximate methods were selected with priority given to all known flood hazards and areas of projected development.

All stream reaches previously studied by detailed methods, but not subsequently restudied, were redelineated for this countywide update. All unnumbered A-zones not subsequently studied by detailed and enhanced approximate methods were refined for this countywide update.

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 community officials.

Flooding sources studied by detailed and enhanced approximate Riverine methods along with the limits of study are shown in Table 2, "Scope of Study."

**Table 2: Scope of Study**

Table 2a: New Detailed Study Streams and Enhanced Approximate Type 1 Streams

| Stream Name | Downstream Limit | Upstream Limit |
|---|---|---|
| Flow Path No. 14 (Drainage Channel No. 2) | McCombs Street | Rushing Road |
| Flow Path No. 16 | Ft. Bliss Drainage Channel | Confluence with Flow Path 14 |
| Flow Path No. 24 (Government Hills Channel) | Montana Street at Boone Street | US Highway 54 |
| Flow Path No. 42 | Rio Grande | I-10 |
| Flow Path No. 42A | Confluence with Canutillo Arroyo | 390 Feet upstream of I-10 and Los Mochise |
| Flow Path No. 45 | Confluence with Rio Grande | 27,740 Feet Upstream of Confluence with Rio Grande |
| Flow Path No. 45A | Confluence with Flow Path 45 | 9,236 Feet Upstream of Confluence with Flow Path 45 |
| Flow Path No. 45B | Confluence with Flow Path 45 | 8,935 Feet Upstream of Confluence with Flow Path 45 |
| Flow Path No. 45C | Confluence with Flow Path 45 | 2,286 Feet Upstream of Confluence with Flow Path 45C Tributary 1 |
| Flow Path No. 45C Tributary 1 | Confluence with Flow Path 45C | 2,051 Feet Upstream of Confluence with Flow Path 45C |
| Flow Path No. 45D | Confluence with Flow Path 45B | 6,358 Feet Upstream of Confluence with Flow Path 45B |
| Stream 2 (Horizon Arroyo) | 1,600 Feet upstream of its confluence with Mesa Spur Drain | 500 feet downstream of I-10 |
| McKelligon Canyon Arroyo (Flow Path No. 17) | Downstream of Davis-Seamon Road | 10,842 feet Upstream of Davis-Seamon Road |

Table 2a: New Detailed Study Streams and Enhanced Approximate Type 1 Streams (continued)

| Stream Name | Downstream Limit | Upstream Limit |
| --- | --- | --- |
| McKelligon Canyon Arroyo Tributary 6 (Flow Path No. 17A) | Confluence with McKelligon Canyon Arroyo | 2,460 feet Upstream of Confluence with McKelligon Canyon Arroyo |
| Range Dam Outlet Channel (Joe Herrera Channel) | Range Dam | Tobin Drain |
| Northeast Pond | South side of berm at Deer Street | Dyer Street Bridge |
| San Felipe Arroyo | 550 Feet west of Alameda Avenue at irrigation channel | I-10 |

Table 2b: Redelineated Detailed Study Streams

| Stream Name | Downstream Limit | Upstream Limit |
| --- | --- | --- |
| Arroyo 1 | AT&SF Railway | 5,450 Feet upstream of diversion dike |
| Arroyo 1A | Diversion dike | 8,550 Feet upstream of diversion dike |
| Arroyo 2 | Confluence with Arroyo 3 | 4,880 Feet upstream of La Posta Drive |
| Arroyo 3 | Confluence with Montoya Drive | 1,850 Feet upstream of Bondolero Lane |
| Arroyo 3A | Confluence with Arroyo 3 | 300 Feet upstream of Pinto Reyes Lane |
| Arroyo 3B | Mesa Dam | 1,900 Feet upstream of Villa Hermosa Drive |
| Arroyo 4 | Keystone Dam | 150 Feet upstream of Broadmore Drive |
| Arroyo 5 | Keystone Dam | 600 Feet upstream of Mesa Street |
| Arroyo 8 | Oxidation Dam | 450 Feet upstream of Amelia Drive |
| Flow Path No. 11 | 200 feet upstream of southbound lane of North-South Freeway | 3,000 Feet upstream of confluence of Flow Path 11A |
| Flow Path No. 12 | Confluence with Eastern Freeway Channel | 1,500 Feet upstream of Access Road |
| Flow Path No. 12A | Confluence with Flow Path 11C | 1,350 Feet upstream of Access Road |
| Flow Path No. 13 (Drainage Channel No. 1) | 1,200 ft. downstream of Kenworthy Dr. | War Road II |
| Flow Path No. 14 (Drainage Channel No. 2) | Confluence with Flow Path 13 | McCombs Street |
| Flow Path No. 20 | Confluence with Rio Grande River | 2,000 Feet upstream of Mesa Street (US Highway 80) |
| Flow Path No. 20A | Confluence with Flow Path 20 | 2,950 Feet upstream of Mesa Street |

Table 2b: Redelineated Detailed Study Streams (continued)

| Stream Name | Downstream Limit | Upstream Limit |
|---|---|---|
| Flow Path No. 21 | 1,100 Feet downstream of Mesa Street | 600 Feet upstream of Las Vegas Drive |
| Flow Path No. 21A | Confluence with Flow Path 21 | 1,700 Feet upstream of Stanton street |
| Flow Path No. 22 | Van Buren Dam | 1,825 Feet upstream of Small Dam |
| Flow Path No. 23 | Franklin Canal | 1,100 Feet upstream of Scenic Drive |
| Flow Path No. 25 | Franklin Canal | Williams Street at Missouri |
| Flow Path No. 26 (Phelps Dodge) | Confluence with Flow Path 28, Mesa Drain and Interceptor | 850 Feet upstream of drop structure above Hawkins Boulevard |
| Flow Path No. 27 (Playa Drain) | Confluence with Flow Path 28, Mesa Drain and Interceptor | Cargill Street |
| Flow Path No. 28 (Mesa Drain and Interceptor) | Pump Station at lower end of Mesa Drain Interceptor | Vertical concrete channel upstream of Bucher Road |
| Flow Path No. 28A (Mesa Drain Below Interceptor) | Corporate limits (City of El Paso) | Confluence with Flow Path 28, Mesa Drain and Interceptor |
| Flow Path No. 29 | Confluence with Flow Path 28, Mesa Drain and Interceptor | 75 Feet upstream of Sugarberry Drive |
| Flow Path No. 30 | Confluence with Flow Path 28, Mesa Drain and Interceptor | 2,000 Feet upstream of Carolina Drive |
| Flow Path No. 31 (Jesuit Draw) | 1,900 Feet downstream from Ryland Drive | 1,000 Feet upstream of I-10 |
| Flow Path No. 32 | Confluence with Flow Path 23, Mesa Drain and Interceptor | 5,500 Feet upstream of confluence with Flow Path 32A |
| Flow Path No. 33 (Middle Drain) | Confluence with Flow Path 28, Mesa Drain and Interceptor | 1,800 Feet upstream of Zaragoza Road |
| Flow Path No. 36 | Confluence with Flow Path 28A, Mesa Drain and Interceptor | 4,000 Feet upstream of confluence with Mesa Spur Drain |
| Flow Path No. 37 (Franklin Drain) | Confluence with Flow Path 28, Mesa Drain and Interceptor | End of drain |
| Flow Path No. 38 | Desert Boulevard Northbound (East I-10 Frontage Road) | 3,560 Feet upstream of Pond 4 |
| Flow Path No. 38A | Confluence with Flow Path 38 | 5,900 Feet upstream of Pond 3 |
| Flow Path No. 38B | Confluence with Flow Path 38 | 5,900 Feet upstream of Pond 3 |
| Flow Path No. 39 | Desert Boulevard Northbound (East I-10 Frontage Road) | 1,570 Feet upstream of Resler Drive |
| Flow Path No. 40 | 900 feet upstream from Confluence with Flow Path 41 | Transmountain Road |
| Flow Path No. 41 | 105 Feet upstream of Talbot Avenue | 1,014 Feet upstream of Confluence with Flow Path 41A |

Table 2b: Redelineated Detailed Study Streams (continued)

| Stream Name | Downstream Limit | Upstream Limit |
|---|---|---|
| Flow Path No. 41A | Confluence with Flow Path 41 | 940 Feet upstream of Confluence with Flow Path 41 |
| Flow Path No. 43 | 100 Feet downstream from corporate limits | 7,725 Feet upstream of Dirt Road |
| Flow Path No. 44 | 200 Feet downstream from corporate limits | 11,950 Feet upstream of Dirt Road |
| Flow Path No. 46 | 600 Feet downstream from corporate limits | 5,550 Feet upstream of Dirt Road |
| Flow Path No. 47 | 520 Feet downstream from corporate limits | 6,880 Feet upstream of corporate limits |
| Flow Path No. 48 | 180 Feet downstream from corporate limits | 6,250 Feet upstream of Unnamed Road |
| Flow Path No. 54 | Confluence with Flow Path 11 | 11,000 Feet upstream of confluence with Flow Path 11 |
| Horizon Arroyo (Stream 2) | 1,600 Feet upstream of its confluence with Mesa Spur Drain | 1.1 Miles upstream of Doy Road |
| Stream 3 | 0.42 Mile upstream of the east frontage road of I-10 U. S. Route 80 | 1,400 Feet upstream of its confluence with Mesa Spur Drain |
| Lower Valley Area | Levee at the confluence of Montoya Drain and Rio Grande | 200 Feet upstream of Frontera Road |
| Upper Valley Area | Nemexa Drain | 1,250 Feet upstream of Montoya Lane |

Table 3, "Stream Name Changes," lists those streams where the name has changed or differs from that published in the previous FIS for El Paso County or any of the communities within.

**Table 3: Stream Name Changes**

| Old Name | New Name |
|---|---|
| Flow Path 14, Drainage Canal #2 | Flow Path 14 (Drainage Channel No. 2) |
| Flow Path 15 | Flow Path 16 |
| Flow Path 17 | McKelligon Canyon (Flow Path 17) |
| Flow Path 17A | McKelligon Canyon Tributary 4 (Flow Path 17A) |
| Flow Path 24, | Flow Path 24 (Government Hills Channel) |
| Flow Path 45 | Flow Path 45D |
| Stream 2 | Horizon Arroyo (Stream 2) |

Table 4, “Letter of Map Change's" lists those revisions that have been incorporated into this countywide update for El Paso County.

**Table 4: Letters of Map Changes**

| Case No. | Effective Date | Flooding Source | Community |
|---|---|---|---|
| 93-06-318P | 4/27/1994 | Ponding Area P15 | City of El Paso |
| 97-06-103P | 2/26/1997 | Pond N | City of El Paso |
| 97-06-477P | 1/16/1998 | Flow Path No. 20; Flow Path No. 20A | City of El Paso |
| 98-06-732P | 3/23/1998 | Arroyo 2 | City of El Paso |
| 98-06-1106P | 12/21/1998 | Arroyo 1A | City of El Paso |
| 99-06-449P | 3/26/1999 | Ponding Area P14; Vista Real Ponds P1, P2, P3, P4, P5, P6, P7, P8 | City of El Paso |
| 99-06-793P | 8/30/1999 | Ponding Area P16 | City of El Paso |
| 01-06-1394P | 10/4/2001 | Unnamed Tributary to Flow Path No. 38 | City of El Paso |
| 02-06-1543P | 11/18/2002 | Unnamed Flow to Flow Path No. 38 | City of El Paso |
| 03-06-107P | 5/2/2003 | Ponding Area P18 | City of El Paso |
| 02-06-1458P | 6/5/2003 | Arroyo 3B | City of El Paso |
| 04-06-1606P | 10/29/2004 | Arroyo 1A | City of El Paso |
| 06-06-BE34P | 8/30/2006 | Ponding Area P16 | City of El Paso |
| 06-06-B414P | 2/15/2007 | Arroyo 1 | City of El Paso |
| 06-06-B807P | 8/6/2007 | Flow Path No. 38A | City of El Paso |
| 07-06-2364P | 11/30/2007 | Arroyo 4 | City of El Paso |
| 07-06-2485P | 3/27/2008 | Flow Path No. 53 | City of El Paso |
| 09-06-0832P | 9/17/2009 | Flow Path No. 41 | City of El Paso |
| 09-06-1731P | 4/30/2010 | Cielo Vista Basin B | City of El Paso |
| 10-06-2130P | 6/8/2011 | Flow Path No. 38A | City of El Paso |
| 10-06-3638P | 5/13/2011 | Ponding Area P1B; Ponding Areas P2 | City of El Paso |
| 11-06-2150P | 8/4/2011 | Flow Path No. 39 | City of El Paso |

### 2.2 Community Description

El Paso County is located in the extreme western portion of Texas. It is bordered by the unincorporated areas of Doña Ana County, New Mexico, to the north and west; the unincorporated areas of Hudspeth County to the east; and by the State of Chihuahua, Mexico, to the south. The following incorporated communities are located within El Paso County: the Cities of El Paso, San Elizario and Socorro; the Towns of Anthony, Clint and Horizon City; and the Village of Vinton.

El Paso County has experienced rapid growth over the past two decades. Currently, the main economic sources in the county are: agricultural products, such as long-staple Egyptian cotton; manufacturing; tourism, due to the warm, dry climate and proximity to Juarez, Mexico; the military at Fort Bliss, the U.S. Army Air Defense Center; and the University of Texas at El Paso. The U.S. Census estimated the population in 2013 to be 827,718 a 3.4% increase since 2010 (Reference 3).

The City of El Paso, located at the western edge of the county, was incorporated in 1873, and is the fifth largest city in Texas. The city experienced a relatively slow growth prior to 1945, but has grown tremendously since that time. According to the U.S. Bureau of the Census, the population was 649,121 in 2010 (Reference 4).

The Rio Grande, which is controlled by Elephant Butte Reservoir in New Mexico, flows along the western edge of the county in a north-south direction. The Rio Grande, along with an extensive system of irrigation canals, provides the water for the county's agricultural industry. Except for the Rio Grande, the remaining arroyos in El Paso County are ephemeral and runoff occurs as a result of short, intense summer thunderstorms.

Arroyos in the northwestern and northeastern areas generally head on the slopes of the Franklin Mountains and flow through the City of El Paso. In most cases, the arroyos, after leaving the mountains, become poorly defined in developed areas. The arroyos in the southeastern section of the City of El Paso generally head on the mesa adjacent to the eastern corporate limits and flow southwest toward the Rio Grande.

The topography within El Paso County varies along the Rio Grande to increasing slopes in the alluvial fans at the foot of the Franklin Mountains to very steep slopes in the mountainous areas. The Franklin Mountain range is approximately 20 miles in length from north to south. The maximum width of the range is 8 miles, and the highest elevation is 7,100 feet. The sloping outwash plains are made up of surface material derived from the highlands, with the size of the material decreasing from boulders to fine sand as the distance of travel increases and slopes decrease. The depth of this material varies from shallow to great as the terrain levels off. The Rio Grande Valley on the U.S. side is a flat plain varying in width along the reach.

The climate of El Paso County is semiarid continental, characterized by moderately hot summers, mild winters, and short spring and fall seasons. The average annual temperate is 64.5ºF, with recorded extremes of 109ºF and -8ºF. El Paso County is located in the transitional zone of the Gulf of Mexico and Pacific rainfall provinces. This complex meteorological condition is further complicated by the presence of mountains. The average annual precipitation is approximately 8.81 inches.

The maximum recorded rainfall in a 24-hour period was 2.89 inches in September 1941. Severe rainfall has been reported, such as 6.5 inches in a two-hour period on July 9, 1881, and 8 inches in one day in 1863. Approximately 59 percent of the annual rainfall occurs during the period of July through October, with the greatest amounts falling during July and August when small localized thunderstorms are prevalent. Fall, winter, and spring are the dry seasons because much of the moisture in eastward circulation from the Pacific Ocean is removed as the air passes over the mountains of west Texas. In the summer, moisture-laden air from the Gulf of New Mexico enters southern El Paso County. Strong surface heating and upslope flow of the air cause brief, and often heavy, showers.

The undeveloped portions of the watersheds support only a meager growth of desert-type vegetation, while the irrigated land in the valley produces abundant agricultural crops. The native vegetation in many parts of the county has been greatly depleted by continued heavy grazing. Much of the acreage that once was desert grassland is now dominated by shrubs and annual forbs (Reference 5).

Development in the floodplains consists of single- and multifamily residences, industrial and commercial establishments, and agricultural land. New development is occurring throughout the city at a rapid pace.

The Town of Anthony is located in northwest El Paso County along the border with New Mexico along I-10. Population in the Town of Anthony in 2010 was 5,011 (Reference 4). Just south of Anthony is the Village of Vinton. Population in the Village of Vinton in 2010 was 1, 971 (Reference 4). Both communities lie between the Rio Grande and the Franklin Mountains.

City of Socorro's population in 2010 was 32,013 (Reference 4). This community is one of the older in the area, dating back to an old Spanish Mission. The city is located southeast of the City of El Paso along the Rio Grande.

City of San Elizario is the newest incorporated community in the County. It was incorporated in November 2013 and lies south of Socorro and west of Clint along the Rio Grande. In 2020 it was a Census Designated Place with a population of 13,603 (Reference 4).

Town of Clint located just east of San Elizario and South of Socorro is located on I-10. The population of the community in 2010 was 926 (Reference 4).

Town of Horizon City is located in southeastern El Paso County. The population of the community in 2010 was 5,233.

## 2.3 Principal Flood Problems

On July 5-6, 1968, rain fell generally throughout the El Paso area with peak intensities in the southeast. Flowing water damaged many streets and seriously eroded channel flow structures. Lack of capacity in existing drains caused them to overflow and inundate the low valley areas. Because there were no flow concentrations, discharges were not computed for that flood event.

More recently, in June 1995, brief but heavy rain caused a flash flood in east-central El Paso, killing three people. A 38-year-old female and her 12-year-old son were in a car that was washed off the road. In a separate nearby incident, a 23-year-old female was killed after losing her footing in a flash flood. Hail damaged many acres of cotton crops southeast of El Paso. Total estimated damages were $50 thousand.

In June 1999, thunderstorms produced heavy rains in the Sparks area just south of Horizon City. The resulting flash flooding severely damaged roads and washed mobile homes off their foundations. One car was overturned as it attempted to cross a flooded arroyo, leaving one man injured. Damage from this storm event was estimated at $50 thousand.

In July 2000, thunderstorms accompanied by 1.5 inches of rain in a short time (including one report of one inch in 15 minutes) brought extensive street flooding to the downtown, central, and eastern sections of the city. At least two lanes on Interstate 10 along with the access roads were closed, with water nearly 3 feet deep in some spots. Total damage from this storm was estimated to be $75 thousand.

On August 2, 2002, a cluster of strong to severe thunderstorms moved into central and downtown El Paso from the south, dropping 1.5 to 2 inches of rain at the range of 1 inch in 10 minutes on the southern spine of the Franklin Mountains. The excessive runoff resulted in several cars being washed off streets, and the closure of Interstate 10 for several hours. A child playing in the floodwaters was swept into a catchment basin. After being rescued, he died the following day. These storms also produced wet microbursts measured at 69 mph in two locations. An athletic dome still under construction at Cohen Stadium was severely damaged. Total damage from this storm was estimated at $200 thousand (Reference 4).

Flooding in the streams south of the City of El Paso generally occurs at the point where the runoff exits the mesa escarpment and spreads out on to the Rio Grande floodplain. References to historic floods in the study area prior to 1940 are meager. References to floods since that time are more plentiful because of the expansion of the city into areas more susceptible to flooding. Floods of major proportions occurred in 1949, 1950, 1955, 1957, 1958, 1962, 1963, 1965, 1966, 1967, 1968, and 1971. Technical data for these floods are not available and, therefore, cannot be related to any particular frequency flood.

Flooding in El Paso is generally of the flash flood type, with a high peak and a low volume. The following descriptions of the flood of August 3, 1966, were extracted from the El Paso Times and a USACE flood report (References 6 and 7). The August 1966 flood was typical of floods that occur in El Paso.

**El Paso Times**

A devastating cloudburst struck the Upper Valley Wednesday afternoon sending roaring waters from the slopes of the Franklin Mountains, tearing down homes, undermining railroad tracks, pummeling bridges and leaving more than two inches of rain in the area. No injuries were reported ... as the water flooded wide sections of the Crossroads and Coronado areas.... Two inches of water flowed through many business establishments in the Coronado area.... Doniphan was closed to traffic for a while...Doniphan would remain closed south of the Crossroads until Highway Department crews could repair damage and clear the silt and other debris.... Santa Fe Railroad...tracks were still in place, but suspended as much as two feet in the air. Water was reported standing in yards and streets in the Coronado and County Club areas, as much as a foot deep in places. Most serious flooding of homes occurred along Love, Lindberg and Sunset where 18 inches of muddy water stood in the streets and several homes.... Several automobiles were stalled by the high water...a Cadillac...was swept off of Doniphan into a ditch.... Highway patrolmen estimated that at the height of the flooding, about 2 P.M., water rushing down the arroyos and undermining Doniphan and the Santa Fe tracks was five feet deep in place.

**USACE Flood Report**

Floodwater inundated a portion of the upper valley area of El Paso from above the intersection of Mesa Road and Doniphan Drive to the El Paso Electric Company generating plant. The rain that produced the flood occurred over a small area, with its center near Coronado Hills Shopping Center on Mesa Road. The short intense storm produced as much as two inches of rainfall in 45 minutes, with a total amount of 2.40 inches. The floodwaters came down the arroyos, which approach Doniphan Drive at almost right angles. The change of slope at the road plus the barrier formed by the highway and railroad embankment caused the floodwaters to drop most of the sediment load on or adjacent to Doniphan Drive. The sediment blocked the drainage structures under the embankments and caused the water to spread to a width of approximately 3.5 miles along Doniphan Drive. Sediment depths to two to three feet were prevalent along the 3.5-mile stretch.

The size of the peak flows, one estimated at 2,500 cubic feet per second, resulted in the floodwaters ponding and overtopping the Atchison, Topeka, and Santa Fe Railway embankment. This washed out some ballast and at one location (near the Mesa Road and Doniphan Road intersection) the entire embankment was washed out for 200 feet.

As the floodwaters crossed west of the track, a low-lying valley area was flooded from Mulberry Avenue to the El Paso Electric Company generating plant. This area is a man-made catchment area that is traversed by irrigation laterals, ditches and drains, plus numerous roads. Most of these structures are perched and tend to trap the water till it reaches depths to overtop the embankments. The area is hindered further by the complete lack of interior drainage facilities to the leveed Rio Grande. Thus, the area, which is urban and suburban in development, was flooded up to depths of three feet.

There has been extensive development on the broad alluvial fans and in the foothills of the Franklin Mountains. Land developers have made massive cut and fill operations in the foothills to provide graded terraces for development. Often, these developments disregard or preempt the natural drainage courses, diverting flood flows into new and unpredictable flow paths. Some development exists in sumps where floodwaters pond during high flows. During past floods, extensive damage was caused by ponding behind and along the street, highway, and railroad embankments.

## 2.4 Flood Protection Measures

**Note:** Within this jurisdiction lie IBWC levees along the Rio Grande that have not been demonstrated by the community or levee owner to meet the requirements of NFIP regulation 65.10 as it relates to its ability to provide protection from the 1-percent annual chance flood event. Please refer to the Notice to Flood Insurance Study Users page at the front of this FIS report for more information.

The City of El Paso constructed a storm sewer system for the downtown area in the 1920s. The system consists of pumping plants and storm sewers to collect and discharge storm runoff into the Rio Grande. During 1932 to 1933, the Civilian Conservation Corps (CCC) built a series of small check dams along the southeastern slope of the Franklin Mountains to McKelligon Canyon to further improve flood control in the downtown area. In 1975, a large dam was constructed in place of McKelligon Dam No. 4.

From 1949 to 1950, the storm drainage system for the downtown area was improved and expanded to the older sections of the city. These included outlets to the Rio Grande and a new series of small detention dams constructed around the point of the Franklin Mountains to supplement those built by the CCC. The city has also constructed detention dams and established ponding areas in other parts of the city. Most of these detention dams and ponding areas do not have the storage capacity to control one-percent-annual-chance floods or larger.

The USACE investigated the arroyo flood problem in El Paso and has implemented a single-purpose flood control plan (Reference 8). It comprises a system of detention reservoirs, diversion dikes, and channels to collect, regulate, and discharge arroyo runoff into the Rio Grande. The structures completed as a part of the USACE flood control plan are located in the northeast-central and northwestern sections of El Paso. These structures will control floods up to and including the 0.2-percent-annual-chance flood. Pertinent flood control data of these and other structures are shown in Table 5, "Flood Control Data of Structures".

**Table 5: Flood Control Data of Structures**

| Structure | Storage Capacity (acre-feet) | 1-Percent-Annual-Chance Discharges | |
|---|---|---|---|
| | | Conduit | Spillway |
| Durazno Dam | 310 | 270 | 0 |
| Fusselman Dam | 595 | * | * |
| Giles Dam | 93 | * | * |
| Keltner Dam | 47 | 0 | 0 |
| Keystone Dam | 1,020 | 660 | 0 |
| McKelligon Dam No. 1 | 8 | Dam Overtopped | N/A |
| McKelligon Dam No. 2 | 38 | Dam Overtopped | N/A |
| McKelligon Canyon Dam | 1450 | * | * |
| Mesa Dam | 778 | 220 | 0 |
| Mountain Park Dam | 235 | 104 | 0 |
| Mulberry Dam | 1,113 | 230 | 0 |
| Northgate Dam | 1,038 | * | * |
| Oxidation Pond Dam | 1,462 | 130 | 0 |
| Pasotex Dam | 100+ | * | * |
| Pershing Dam | 12,000 | 350 | 0 |
| Range Dam | 908 | * | * |

## Table 5: Flood Control Data of Structures (continued)

| Structure | Storage Capacity (acre-feet) | 1-Percent-Annual-Chance Discharges | |
|---|---|---|---|
| | | Conduit | Spillway |
| Sunrise Dam | 133 | 88 | 0 |
| Thorn Dam | 723 | 220 | 0 |
| Van Buren Dam | 104 | 320 | 0 |
| North Hills Dam, Detention Basin 1 | 323 | 100 | 0 |
| North Hills Dam, Detention Basin 2 | 579 | 104 | 0 |
| Northeast Pond 1 | 4534 | N/A | N/A |
| Northeast Pond 2 | 235 | N/A | N/A |
| Northeast Pond 3 | 59 | N/A | N/A |
| Northeast Pond 4 | 66 | N/A | N/A |
| Northeast Pond 5 | 178 | N/A | N/A |
| Northeast Pond 6 | 39 | N/A | N/A |
| Piedras Downtown Ponding Area 1 | 101 | N/A | N/A |
| Piedras Downtown Ponding Area 2 | 236 | N/A | N/A |
| Piedras Downtown Ponding Area 3 | 1250 | N/A | N/A |

| Structure | Storage Capacity (acre-feet) |
|---|---|
| Buena Vista Diversion | 2960 to 5180 |
| Borderland Diversion | 560 to 5180 |
| Chapparel Park Diversion Channel and Dike | 10,500 |
| Diana Ditch | Approximately 600 |
| Electric Diversion Channel | 1820 |
| Fort Bliss Sump Outlet Conduit | 257 |
| Government Hills Ditch | Varies from 280 to 660 |
| Government Hills Outfall Channel | 364 |
| Highway Diversion | 450 to 1190 |
| Northgate Diversion Channel | 2400 |
| Northgate Interceptor Channel | 1450 |
| Northgate Outlet Channel and Dike | 950 |
| Range Outlet Channel | 121 |
| Tobin Ditch | Varies from 176 to 540 |
| War Road Channel | 1430 to 2325 |
| Western Freeway Channel | 3810 to 5350 |
| Greenbelt Levee | 20,740 (1983) |

NOTES: = * Not available; N/A = Not applicable.

In 1989, the North Hills Dam, War Road Channel, and the Western Freeway Channel were completed as part of the overall Master Drainage Plan for northeast El Paso. Two detention basins were constructed behind the North Hills Dam. These basins are separated by an earthen embankment. Overflow from Basin 1 during the one-percent-annual-chance flood enters Basin 2 through a culvert in the embankment that separates the basins. Overflow during the one-percent-annual-chance flood exits Basin 2 through an outlet pipe, which empties into War Road Channel. During the 0.2-percent-annual-chance flood, overflow exits Basins 1 and 2 over three spillways on the North Hills Dam.

The Greenbelt Levee System along Flow Path No. 11 has been accredited by FEMA to provide protection to the 1-perce annual chance flood.

Other levees, dikes and spoilbanks exist within El Paso County, however none of these structures provide protection from the 1-percent annual chance flood.

## 3.0 ENGINEERING METHODS

For the flooding sources studied by detailed and enhanced approximate Type 1 methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood-hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent-annual-chance in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

Note: Within this jurisdiction lie IBWC levees along the Rio Grande that have not been demonstrated by the community or levee owner to meet the requirements of NFIP regulation 65.10 as it relates to its ability to provide protection from the 1-percent annual chance flood event. Please refer to the Notice to Flood Insurance Study Users page at the front of this FIS report for more information.

### 3.1 Hydrologic Analyses

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

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 6, “Summary of Discharges.” In some cases, the peak flows decrease at locations due to the existence of flood attenuating structures.

A summary of the ponding values for flooding sources and locations in El Paso County is provided in Table 7, “Summary of Ponding Values.” Table 8, “Summary of Stillwater Elevations,” provides flooding sources and locations for the 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations.

**Table 6: Summary of Discharges**

| Flooding Source and Location | Drainage Area (in $mi^2$) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| ARROYO 1 | | | | | |
| Approximately 1,500 feet upstream of confluence with Arroyo 1A | 1.43 | 960 | 1,200 | 1,580 | 2,040 |
| Cross-section AE | * | 740 | 1,360 | 1,610 | 2,200 |
| Approximately 1,800 ft. upstream of Mulberry Dam | 3.35 | 2,164 | 2,570 | 3,309 | 4,232 |
| Cross-section K | * | 160 | 240 | 330 | 440 |
| Cross-section C (below Mulberry Dam) | 0.4 | 305 | 445 | 520 | 1,030 |
| ARROYO 1A | | | | | |
| Approximately 1,325 feet downstream of Franklin Crest Dr. | 1.6 | 1,264 | 1,478 | 1,928 | 2,446 |
| Just Downstream of Franklin Crest Drive | 1.4 | 1,151 | 1,344 | 1,756 | 2,222 |
| Approximately 3, 250 feet upstream of Franklin Hills Street | 0.97 | 803 | 936 | 1,227 | 1,549 |
| ARROYO 2 | | | | | |
| Station 3,590[2] | 2.49 | [3] | [3] | 2,913 | 3,629 |
| Station 7,880[2] | 2.12 | [3] | [3] | 2,225 | 2,582 |
| Station 14,360[2] | 1.61 | [3] | [3] | 1,666 | 1,945 |
| ARROYO 3 | | | | | |
| Cross-section AO | * | 520 | 860 | 1,010 | 1,310 |
| Cross-section AC | * | 350 | 535 | 680 | 869 |
| Cross-section AA | * | 590 | 911 | 975 | 975 |
| Cross-section V | * | 960 | 1,472 | 1,610 | 1,760 |
| Cross-section F | * | 210 | 440 | 465 | 620 |
| Arroyo 3A | | | | | |
| Cross-section G | * | 210 | 330 | 370 | 480 |
| Cross-section D | * | 320 | 600 | 710 | 980 |
| Cross-section A | 0.25 | 320 | 600 | 710 | 980 |
| ARROYO 3B | | | | | |
| Cross-section L | * | 1,040 | 1,680 | 1,930 | 2,450 |
| Cross-section A | 1.27 | 1,040 | 1,680 | 1,930 | 2,450 |

* Data not available

[1] Stream Distance above Interstate 10

[2] Data not determined

**Table 6: Summary of Discharges (continued)**

| Flooding Source and Location | Drainage Area (in $mi^2$) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| ARROYO 4 | | | | | |
| Upstream of Broadmoor Drive | 0.06 | 43 | 66 | 74 | 94 |
| Upstream of Westwind Drive | 0.19 | 164 | 320 | 380 | 504 |
| Cross-section P | * | 317 | 560 | 650 | 870 |
| Cross-section L | * | 240 | 315 | 350 | 400 |
| Cross-section I | * | 180 | 230 | 260 | 320 |
| Cross-section F | 0.49 | 390 | 620 | 710 | 910 |
| Cross-section D | 0.74 | 390 | 620 | 710 | 910 |
| ARROYO 5 | | | | | |
| Cross-section K | * | 410 | 620 | 710 | 910 |
| Cross-section G | 0.37 | 460 | 730 | 830 | 1,060 |
| Cross-section C | 0.74 | 460 | 730 | 830 | 1,060 |
| ARROYO 6 | | | | | |
| Cross-section D | 2.4 | 700 | 1420 | 1,820 | 2,920 |
| ARROYO 6A | | | | | |
| At mouth | 1.8 | 415 | 810 | 1,290 | 2,330 |
| ARROYO 6B | | | | | |
| At mouth | 1.0 | 320 | 605 | 745 | 1,550 |
| ARROYO 7 | | | | | |
| Cross-section D | 1.7 | 485 | 950 | 1,200 | 2,240 |
| ARROYO 8 | | | | | |
| At Amelia Drive | 0.26 | 184 | 308 | 482 | 516 |
| At Tablerock Drive | 0.33 | 221 | 384 | 573 | 617 |
| Just upstream of Mesa Street | 0.50 | 430 | 636 | 836 | 888 |
| Just upstream of School Road | 0.56 | 528 | 661 | 854 | 922 |
| Upstream of confluence of Arroyo 8B | 1.0 | 1,601 | 1,675 | 1,773 | 1,798 |
| Upstream of oxidation Pond Dam impoundment | 5.1[1] | 3,210 | 5,390 | 6,280 | 8,580 |
| ARROYO 8A | | | | | |
| Cross-section R | 0.99[2] | 320 | 450 | 610 | 690 |
| Cross-section P | * | 670 | 1,020 | 1,150 | 1,530 |
| Cross-section O | * | 1,044 | 1,730 | 1,970 | 2,565 |
| Cross-section M | * | 1,044 | 1,730 | 1,850[3] | 1,850[3] |
| Cross-section H | * | 1,044 | 1,710[3] | 1,710[3] | 1,710[3] |
| Cross-section A | * | 1,078 | 1,500[3] | 1,500[3] | 1,500[3] |

* Data not available

[1] Total Drainage Area for All Arroyo 8 systems

[2] Above Mesa Road

[3] Channel capacity-controlled by culverts or bridges. Remaining flow goes into street flow in overbank area.

**Table 6: Summary of Discharges (continued)**

| Flooding Source and Location | Drainage Area (in mi$^2$) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| ARROYO 8B | | | | | |
| Cross-section AG | * | 960 | 1,550 | 1,790 | 2,320 |
| Cross-section AD | * | 960 | 1,550 | 1,790 | 2,320 |
| Cross-section A | * | 1,150 | 1,920 | 2,220 | 2,920 |
| At station 11300[1] | * | 1,320 | 2,290 | 2,660 | 3,530 |
| At station 11190[1] | * | 1,500 | 1,500 | 1,500 | 1,500 |
| Cross-section P | 1.89[2] | 1,330 | 1,500 | 1,500 | 1,500 |
| Cross-section E | * | 1,330 | 2,320 | 3,710 | 3,550 |
| Cross-section D | * | 1,490 | 2,570 | 3,000 | 4,030 |
| Cross-section C | * | 2,500 | 4,241 | 4,950 | 6,580 |
| Cross-section B | 3.07[3] | 3,120 | 5,240 | 6,100 | 8,370 |
| ARROYO 8C | | | | | |
| Cross-section L | Approx. 0.3 | 90 | 160 | 180 | 250 |
| ARROYO 8D | | | | | |
| Cross-section F | Approx. 0.3 | 350 | 560 | 650 | 850 |
| FLOW PATH No. 11 | | | | | |
| Just upstream of confluence of Flow Path 11A | 0.23 | 230 | 302 | 353 | 410 |
| At confluence of Flow Path 11A | 1.41 | 1,272 | 1,692 | 1,959 | 2,290 |
| Approximately 0.7 mile upstream of State Route 2529 | 4.82 | 1,684 | 2,576 | 2,820 | 3,440 |
| At State Route 2529 | 8.34 | 1,958 | 3,317 | 3,541 | 4,400 |
| FLOW PATH No. 11A | | | | | |
| Approximately 1000 ft. upstream of confluence with Flow Path 11 | 0.93 | 885 | 1,177 | 1,361 | 1,595 |
| At confluence with Flow Path 11 | 1.41 | 1,272 | 1,692 | 1,959 | 2,290 |
| FLOW PATH No. 11C | | | | | |
| At confluence of Flow Path 12A | 1.08 | 667 | 949 | 1,085 | 1,229 |
| FLOW PATH No. 12 | | | | | |
| Just upstream of confluence with eastern Freeway Channel | 0.37 | 583 | 815 | 942 | 1,128 |
| FLOW PATH No. 12A | | | | | |
| Approximately 1000 ft. upstream of confluence with Flow Path 11C | 0.70 | 486 | 675 | 777 | 881 |

* Data not available

[1] Feet Above Confluence with Arroyo 8

[2] Above Mesa Road

[3] Includes drainage areas from Arroyos 8A, 8C and 8D

## Table 6: Summary of Discharges (continued)

| Flooding Source and Location | Drainage Area (in mi²) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| FLOW PATH No. 13 (Drainage Channel #1) | | | | | |
| At station 15310[1] | 2.6 | 780 | 1,630 | 1,960 | 2,770 |
| At station 9480[1] | 9.5 | 5,120 | 6,130 | 6,300 | 6,700 |
| At station 5778[1] | 11.3 | 4,000 | 4,000 | 4,000 | 4,000 |
| At station 4438[1] | 11.5 | 4,160 | 4,620 | 4,770 | 5,130 |
| At station 4402[1] | 12.0 | 4,160 | 4,400 | 4,400 | 4,400 |
| At station 2650[1] | 14.6 | 4,810 | 5,050 | 5,050 | 5,050 |
| At station 500[1] | 34.6 | 7,860 | 10,840 | 11,890 | 14,710 |
| FLOW PATH No. 13A | | | | | |
| At confluence of Flow Path No. 13B | 1.14 | 687 | 949 | 1065 | 1,255 |
| FLOW PATH No. 13B | | | | | |
| Approximately 1,000 feet upstream of confluence of Flow Path No. 13A | 0.31 | 289 | 382 | 444 | 520 |
| FLOW PATH No. 14 (Drainage Channel #2) | | | | | |
| At station 15438[2] | 1.2 | 780 | 1280 | 1490 | 1970 |
| Between MacKinaw Street and Rushing Rd | * | * | * | 2,386 | * |
| Between Alcan Street and MacKinaw St | * | * | * | 1,116 | * |
| At McCombs St | 2.6 | N/A | N/A | 246 | N/A |
| At mouth | 2.5 | 650 | 650 | 650 | 650 |
| FLOW PATH No. 16 | | | | | |
| At Intersection of Mt. Shasta Channel and Railroad Dr. | 19.6 | 2,351 | 4,342 | 4,960 | 5,746 |
| At Diana Channel and Railroad Dr. | 21.7 | 2,783 | 4,480 | 5,054 | 6,415 |
| FLOW PATH No. 18 | | | | | |
| At station 600[3] | 0.4 | 160 | 240 | 270 | 310 |
| FLOW PATH No. 19 | | | | | |
| At station 600[2] | 0.5 | 160 | 250 | 280 | 340 |
| FLOW PATH No. 20 | | | | | |
| At station 9640[2] | 0.6 | 630 | 990 | 1,130 | 1,460 |
| At station 2870[2] | 1.0 | 1,060 | 1,730 | 2,000 | 2,620 |
| At station 600[2] | 2.0 | 1,890 | 3,160 | 3,670 | 4,850 |

* Data not available

[1] Feet Above U.S. 54

[2] Feet Above Mouth

[3] Feet Above Alabama Street

**Table 6: Summary of Discharges (continued)**

| Flooding Source and Location | Drainage Area (in mi²) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| FLOW PATH No. 20A | | | | | |
| At station 11020[1] | 0.6 | 500 | 780 | 900 | 1,170 |
| At station 8160[1] | 0.9 | 690 | 1,110 | 1,280 | 1,670 |
| At station 000[1] | 1.3 | 860 | 1,460 | 1,700 | 2,260 |
| FLOW PATH No. 21 | | | | | |
| At station 6720[2] | 0.4 | 360 | 570 | 660 | 860 |
| At station 4430[2] | 1.5 | 990 | 1,650 | 1,920 | 2,550 |
| At station 2795[2] | 1.6 | 210 | 260 | 280 | 330 |
| At station 1995[2] | 2.4 | 320 | 450 | 510 | 650 |
| At station 310[2] | 2.6 | 420 | 690 | 800 | 1,070 |
| FLOW PATH No. 21A | | | | | |
| At station 8645[1] | 0.3 | 370 | 570 | 660 | 850 |
| At station 2070[1] | 0.8 | 650 | 1,060 | 1,230 | 1,610 |
| At station 000[1] | 0.8 | 120 | 150 | 170 | 200 |
| FLOW PATH No. 22 | | | | | |
| At station 4190[3] | 0.5 | 550 | 860 | 990 | 1,270 |
| At station 2340[3] | 0.9 | 990 | 1,550 | 1,780 | 2,290 |
| At station 920[3] | 1.2 | 1320 | 2,080 | 2,380 | 3,070 |
| FLOW PATH No. 23 | | | | | |
| At station 8330[4] | 1.2 | 1,070 | 1,690 | 1,950 | 2,520 |
| At station 875[4] | 1.9 | 1,170 | 1,920 | 2,220 | 2,930 |
| FLOW PATH No. 24 (Government Hills Channel) | | | | | |
| Just upstream of Durazno Basin | 0.8 | 920 | 1,683 | 1,990 | 2,575 |
| Just upstream of Manchester Ave | 0.2 | 618 | 1,039 | 1,257 | 1,564 |
| FLOW PATH No. 25 | | | | | |
| At station 2090[4] | 1.4 | 360 | 920 | 1,160 | 1,260 |
| At station 590[4] | 1.5 | 460 | 970 | 1,210 | 1,780 |
| FLOW PATH No. 26 (Phelps Dodge) | | | | | |
| At station 9240[1] | 1.3 | 700 | 1,200 | 1,400 | 2,100 |
| At station 8110[1] | 1.5 | 700 | 1,600 | 2,000 | 2,000 |
| At station 7590[1] | 1.5 | 700 | 1,600 | 2,000 | 3,000 |
| At station 5390[1] | 2.2 | 800 | 2,000 | 2,600 | 2,100 |

[1] Feet Above Mouth
[2] Feet Above Alabama Street
[3] Feet Above Rio Grande Levee
[4] Feet Above Franklin Canal

**Table 6: Summary of Discharges (continued)**

| Flooding Source and Location | Drainage Area (in mi$^2$) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| FLOW PATH No. 27 (Playa Drain) | | | | | |
| At station 54650[1] | 1.3 | 9,060 | 2,120 | 2,620 | 4,020 |
| At station 54650[1] | 1.3 | 125 | 125 | 125 | 125 |
| At station 53800[1] | 1.3 | 835 | 1,995 | 2,495 | 3,895 |
| At station 52950[1] | 1.4 | 155 | 715 | 210 | 235 |
| At station 51000[1] | 1.4 | 490 | 1,795 | 2,360 | 3,820 |
| At station 50650[1] | 1.4 | 505 | 1,820 | 2,380 | 3,855 |
| At station 50125[1] | 1.4 | 480 | 1,750 | 2,320 | 3,290 |
| At station 49310[1] | 1.4 | 470 | 1,670 | 2,270 | 3,735 |
| At station 48500[1] | 1.5 | 475 | 1,675 | 3,240 | 3,705 |
| At station 48000[1] | 1.5 | 345 | 1,210 | 1,720 | 2,910 |
| At station 46850[1] | 1.5 | 350 | 765 | 1,010 | 1,700 |
| At station 42950[1] | 1.7 | 335 | 1,100 | 1,620 | 2,755 |
| At station 42600[1] | 2.0 | 700 | 1,370 | 1,620 | 2,800 |
| At station 40150[1] | 2.0 | 470 | 1,090 | 1,620 | 2,765 |
| At station 37800[1] | 2.5 | 745 | 1,540 | 2,100 | 3,485 |
| At station 36900[1] | 2.5 | 630 | 1,495 | 2,050 | 3,400 |
| At station 36000[1] | 2.6 | 700 | 1,565 | 2,130 | 3,485 |
| At station 35100[1] | 2.7 | 0 | 30 | 223 | 1,037 |
| At station 35100[1] | 2.7 | 35 | 36 | 37 | 39 |
| At station 29380[1] | 3.3 | 45 | 555 | 130 | 650 |
| At station 23200[1] | 3.3 | 85 | 125 | 140 | 650 |
| At station 19400[1] | 3.7 | 540 | 790 | 900 | 1,210 |
| At station 17750[1] | 3.7 | 475 | 695 | 800 | 1,065 |
| At station 16950[1] | 3.8 | 500 | 730 | 840 | 1,120 |
| At station 14350[1] | 4.0 | 485 | 705 | 810 | 1,080 |
| At station 12270[1] | 4.1 | 515 | 750 | 860 | 1,140 |
| At station 8400[1] | 4.1 | 460 | 665 | 760 | 1,020 |
| At station 4600[1] | 4.2 | 10 | 10 | 20 | 610 |
| FLOW PATH No. 28 (Mesa Drain and Interceptor) | | | | | |
| Approximately 2,030 feet upstream of Bucher Road | <0.01 | 63 | 63 | 63 | 63 |
| Approximately 125 feet upstream of North Loop | 3.1 | 163 | 301 | 334 | 422 |

[1] Feet Above Mouth

**Table 6: Summary of Discharges (continued)**

| Flooding Source and Location | Drainage Area (in $mi^2$) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| FLOW PATH No. 28 (Mesa Drain and Interceptor) - continued | | | | | |
| Approximately 590 feet upstream of Juan Herrera Lateral | 7.4 | 576 | 753 | 812 | 1,048 |
| Approximately 840 feet downstream of Lee Trevino Drive | 8.9 | 723 | 1404 | 1,577 | 2,240 |
| Approximately 240 feet upstream of Le Baron Road | 14.3 | 785 | 1293 | 1,354 | 1,579 |
| Approximately 200 feet upstream of Southern Pacific Railroad[1] | 15.2 | 100 | 135 | 141 | 157 |
| At station 44800[2] | 16.1 | 820 | 1,590 | 2,800 | 5,370 |
| At station 41850[2] | 17.6 | 840 | 1,600 | 2,750 | 5,770 |
| At station 39450[2] | 20.2 | 740 | 830 | 980 | 1,300 |
| At station 38050[2] | 27.0 | 810 | 1,150 | 1,300 | 2,470 |
| At station 34500[2] | 27.3 | 860 | 1,120 | 1,270 | 2,520 |
| At station 31000[2] | 27.8 | 870 | 1,160 | 1,350 | 2,530 |
| At station 28000[2] | 28.0 | 880 | 1,200 | 1,400 | 2,510 |
| At station 25100[2] | 45.0 | 1,740[3] | 3,240[3] | 4,580[3] | 7,560[3] |
| At station 25000[2] | 45.0 | 1,290 | 1,940 | 2,400 | 5,630 |
| At station 17100[2] | 48.5 | 183 | 228 | 290 | 330 |
| At station 14000[2] | 49.0 | 183 | 185 | 200 | 200 |
| FLOW PATH No. 28A (Mesa Drain Below Interceptor) | | | | | |
| At station 1550[4] | 1.5 | 50[5] | 340[5] | 700[5] | 1,700[5] |
| At station 3000[4] | 1.6 | 130[5] | 360[5] | 770[5] | 1,770[5] |
| At station 5630[4] | 5.3 | 770 | 1,830 | 2,350 | 3,830 |
| FLOW PATH No. 29 | | | | | |
| Giles Basin Outlet | 1.0 | 21 | 27 | 29 | 201 |
| At station 12060 | 1.5 | 750 | 1,600 | 2,000 | 3,580 |
| At station 8350 | 1.5 | 20 | 405 | 1,300 | 3,500 |
| FLOW PATH No. 30 | | | | | |
| Approximately 330 feet upstream of Carolina Drive | 0.3 | 231 | 400 | 436 | 592 |

[1] Downstream of Divergence of Flow Path No. 28A Mesa Drain Below Interceptor
[2] Feet Above Pumping Station
[3] Includes inflow from Flow Path No. 32
[4] Feet Below Mesa Drain Interceptor
[5] Includes inflow from Flow Path No. 36

**Table 6: Summary of Discharges (continued)**

| Flooding Source and Location | Drainage Area (in mi²) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| FLOW PATH No. 31 (Jesuit Draw) | | | | | |
| At station 5960 | 2.1 | 240 | 370 | 430 | 1,400 |
| At station 3770 | 2.3 | 270 | 540 | 800 | 1,600 |
| At station 2210 | 2.5 | 500 | 950 | 1,200 | 1,800 |
| FLOW PATH No. 32 | | | | | |
| Approximately 40 feet downstream from Betel Drive | 0.2 | 200 | 364 | 396 | 516 |
| Approximately 575 feet upstream of Geranium Drive | 0.1 | 126 | 233 | 253 | 328 |
| At station 6600 | 5.0 | 960 | 2300 | 3000 | 6,000 |
| FLOW PATH No. 32A | | | | | |
| At station 5360 | 0.7 | 290 | 510 | 630 | 940 |
| At station 2300 | 1.0 | 400 | 740 | 920 | 1,400 |
| At station 840 | 1.4 | 440 | 1,030 | 1,300 | 2,000 |
| FLOW PATH No. 33 (Middle Drain) | | | | | |
| At station 8000 | 0.3 | 140 | 240 | 300 | 395 |
| At station 6760 | 0.3 | 130 | 220 | 270 | 360 |
| At station 5680 | 0.3 | 120 | 170 | 205 | 335 |
| At station 5000 | 0.3 | 135 | 190 | 230 | 300 |
| At station 3400 | 0.4 | 130 | 190 | 220 | 305 |
| FLOW PATH No. 34 | | | | | |
| At mouth | 0.5 | 310 | 540 | 660 | 950 |
| FLOW PATH No. 35 | | | | | |
| At mouth | 0.4 | 270 | 460 | 550 | 800 |
| FLOW PATH No. 36 | | | | | |
| At mouth | 2.5 | 640 | 1,370 | 1,740 | 2,800 |
| FLOW PATH No. 37 (Franklin Drain) | | | | | |
| At station 4220[1] | 0.2 | 45 | 80 | 90 | 170 |
| At station 2650[1] | 0.3 | 90 | 160 | 190 | 350 |
| At station 1070[1] | 0.4 | 33 | 157 | 180 | 290 |

[1] Feet Above Mesa Drain Interceptor

**Table 6: Summary of Discharges (continued)**

| Flooding Source and Location | Drainage Area (in $mi^2$) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| FLOW PATH No. 38 | | | | | |
| Just upstream of Pond 1 | 0.6 | 731 | 858 | 1,153 | 1,397 |
| Just upstream of Northwestern Drive | 3.1 | 601[1] | 662[1] | 894[1] | 2,101[1] |
| FLOW PATH No. 38A | | | | | |
| 5,200 feet upstream of Pond 4 | 1.8 | 815 | 1,260 | 1,450 | 1,910 |
| FLOW PATH No. 38B | | | | | |
| 9,500 feet upstream of Pond 4 | 0.8 | 430 | 655 | 750 | 980 |
| FLOW PATH No. 39 | | | | | |
| Cross-section B | 3.3 | 1,640 | 2,820 | 3,300 | 4,420 |
| FLOW PATH No. 39A | | | | | |
| Cross-section B | 2.8 | 1,640 | 2,820 | 3,300 | 4,420 |
| FLOW PATH No. 40 | | | | | |
| Cross-section D | 3.5 | 1,680[2] | 1,680[2] | 1,680[2] | 1,680[2] |
| FLOW PATH No. 41 | | | | | |
| Cross-section F | 1.8 | 1,050 | 1,190 | 2,250 | 3,050 |
| Cross-section C | 4.0 | 1,960 | 4,160 | 5,260 | 7,700 |
| FLOW PATH 41A | | | | | |
| Cross-section A | 1.7 | 940 | 1,700 | 2,000 | 2,700 |
| FLOW PATH No. 42 | | | | | |
| Cross-section F | 1.1 | 810 | 1,550 | 1,840 | 2,550 |
| Cross-section D | 1.9 | 810 | 1,500 | 1,840 | 2,550 |
| Just downstream of Los Mochis | 2.7 | 960 | 2,520 | 3,200 | 5,580 |
| Just downstream of confluence with FP 42A | 2.4 | 931 | 2,237 | 2,822 | 4,750 |
| Upstream Limit of detailed study | 1.9 | 822 | 2,160 | 2,710 | 4,700 |
| FLOW PATH No. 42A | | | | | |
| Upstream limit of detailed study area | 0.1 | 178 | 468 | 533 | 875 |
| Just Upstream of Los Mochis crossing. | 0.5 | 178 | 255 | 255 | 225 |
| Just Downstream of Los Mochis crossing | 0.3 | 362 | 737 | 852 | 1260 |
| At 90º Bend In Channel | 0.5 | 415 | 877 | 1,032 | 1,570 |
| FLOW PATH No. 43 | | | | | |
| Cross-section K | 0.35 | 180 | 350 | 410 | 570 |
| Cross-section D | 0.97 | 480 | 920 | 1,090 | 1,500 |

[1] Flow rate reduction due to a number of ponds upstream
[2] Channel capacity controlled by culverts and bridges; lost flow analyzed separately or added to an adjacent Flow Path

**Table 6: Summary of Discharges (continued)**

| Flooding Source and Location | Drainage Area (in mi²) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| FLOW PATH No. 44 | | | | | |
| Cross-section C | 2.12 | 1,290 | 2,310 | 2,700 | 3,640 |
| Cross-section A | 4.82 | 2,590 | 4,500 | 5,260 | 7,070 |
| FLOW PATH No. 45 | | | | | |
| Just downstream of Confluence with Flow Path 45A | 5.6 | 2,909 | 5,175 | 6,201 | 7,957 |
| Just upstream of Confluence with Flow Path 45A | 4.9 | 2,843 | 5,100 | 6,070 | 7,852 |
| Just upstream of Confluence with Flow Path 45C | 2.3 | 1,491 | 2,551 | 2,909 | 3,624 |
| Just upstream of Confluence with Flow Path 45B | 0.3 | 263 | 449 | 511 | 636 |
| FLOW PATH No. 45A | | | | | |
| Just upstream of Confluence with Flow Path 45 | 0.7 | 546 | 924 | 1,050 | 1,303 |
| Just upstream of Junction of Basins 141 and 144 on Flow Path 45A | 0.1 | 98 | 167 | 189 | 235 |
| FLOW PATH No. 45B | | | | | |
| Just upstream of Confluence with Flow Path 45 | 1.6 | 1,266 | 2,156 | 2,455 | 3,054 |
| Just upstream of Junction of Basins 148 And 149 | 1.2 | 928 | 1581 | 1,800 | 2,239 |
| FLOW PATH No. 45C | | | | | |
| Just upstream of confluence with Flow Path 45 | 2.2 | 1,483 | 2,774 | 3,331 | 4,392 |
| FLOW PATH No. 45C Tributary | | | | | |
| Just upstream of Confluence with Flow Path 45C | 0.4 | 1,052 | 1,816 | 2,075 | 2,592 |
| Just upstream of Confluence with Flow Path 45C | 0.4 | 1,052 | 1,816 | 2,075 | 2,592 |
| FLOW PATH No. 45D | | | | | |
| Just upstream of Confluence with Flow Path 45 | 0.4 | 338 | 575 | 655 | 815 |
| FLOW PATH No.46 | | | | | |
| Cross-section A | 0.5 | 320 | 600 | 710 | 980 |
| FLOW PATH No. 47 | | | | | |
| Cross-section A | 2.1 | 1,460 | 2,600 | 3,030 | 4,070 |

**Table 6: Summary of Discharges (continued)**

| Flooding Source and Location | Drainage Area (in $mi^2$) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| FLOW PATH No. 48 | | | | | |
| Cross-section A | 2.6 | 1,790 | 3,050 | 3,550 | 4,740 |
| FLOW PATH No. 49 | | | | | |
| At station 12400[1] | 1.2 | 859 | 1,167 | 1,329 | 1,560 |
| FLOW PATH No. 49B | | | | | |
| At station 6000[1] | 1.1 | 864 | 1,165 | 1,334 | 1,560 |
| At station 5000[1] | 2.1 | 1,639 | 2,212 | 2,531 | 2,980 |
| FLOW PATH No. 49C | | | | | |
| At station 1000[1] | 1.0 | 787 | 1,061 | 1,214 | 1,420 |
| FLOW PATH No. 53 | | | | | |
| At station 5000[1] | 0.3 | 197 | 270 | 309 | 365 |
| FLOW PATH No. 54 | | | | | |
| At confluence with Flow Path No. 11 | 2.2 | 901 | 1,289 | 1,441 | 1,720 |
| FLOW PATH No. 55 | | | | | |
| Approximately 400 ft. upstream of confluence of Flow Path 55A | 3.0 | 1,574 | 2,220 | 2,472 | 2,950 |
| Approximately 900 ft. downstream of confluence of Flow Path 55A | 3.8 | 1,816 | 2,601 | 2,875 | 3,440 |
| Approximately 2.5 miles upstream of El Paso county boundary | 4.5 | 2,030 | 2,984 | 3,299 | 3,950 |
| Approximately 0.4 mile upstream of confluence of Flow Path 56 | 7.3 | 2,620 | 3,854 | 4,224 | 5,100 |
| At El Paso County boundary | 7.8 | 2,929 | 4,092 | 4,408 | 5,450 |
| FLOW PATH No. 55A | | | | | |
| Approximately 500 ft. upstream of confluence with Flow Path 55 | 0.8 | 752 | 989 | 1,155 | 1,340 |

[1] Feet Above Mouth

**Table 6: Summary of Discharges (continued)**

| Flooding Source and Location | Drainage Area (in $mi^2$) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| FLOW PATH No. 56 | | | | | |
| Approximately 100 ft. upstream of confluence of Flow Path 56A | 0.3 | 233 | 312 | 359 | 415 |
| Approximately 800 ft. downstream from confluence of Flow Path 56A | 0.5 | 424 | 568 | 654 | 770 |
| Approximately 1.1 miles upstream of Flow Path 55 | 1.0 | 692 | 941 | 1,074 | 1,260 |
| Approximately 1300 ft. upstream of confluence with Flow Path 55 | 1.4 | 957 | 1,351 | 1,542 | 1,835 |
| FLOW PATH No. 56A | | | | | |
| Approximately 500 ft. upstream of confluence with Flow Path 56 | 0.2 | 191 | 256 | 295 | 346 |
| HORIZON ARROYO (Stream 2) | 16.9 | 2280 | 5980 | 8010 | 14,500 |
| McKELLIGON CANYON ARROYO (Flow Path 17) | | | | | |
| 9,200 Feet Upstream of Davis-Seamon Rd | 1.4 | 1,077 | 2,049 | 3,292 | 3,567 |
| 11,460 Feet Upstream of Davis-Seamon Rd | 0.4 | 413 | 796 | 877 | 1,136 |
| MCKELLIGON CANYON Tributary 6 (FLOW PATH 17A) | 0.4 | 509 | 914 | 1,042 | 1,302 |
| RANGE DAM OUTLET CHANNEL | | | | | |
| At Dyer Street | 11.3 | 0 | 95 | 99 | 163 |
| 800 feet Downstream of Dyer Street | 12.1 | 0 | 104 | 241 | 711 |
| SAN FELIPE ARROYO | 24.1 | N/A | N/A | 1,965 | N/A |
| STREAM 1 | | | | | |
| At a point approximately 4,290 ft. downstream from Interstate 10/US Highway 80 | 6.9 | * | * | 3,728 | * |

* Data not available

**Table 6: Summary of Discharges (continued)**

| Flooding Source and Location | Drainage Area (in $mi^2$) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| STREAM 3 | | | | | |
| At a point approximately 3,180 ft. downstream from Interstate 10/US Highway 80 | 1.3 | * | * | 1,250 | * |
| STREAM 4 | | | | | |
| At a point approximately 3,060 ft. downstream from Interstate 10/US Highway 80 | 3.8 | * | * | 2,248 | * |
| STREAM 5 | | | | | |
| At a point approximately 3,270 ft. downstream from Interstate 10/US Highway 80 | 1.0 | * | * | 950 | * |
| STREAM 6 | | | | | |
| At a point approximately 3,510 ft. downstream from Interstate 10/US Highway 80 | 1.1 | * | * | 1,050 | * |
| STREAM 7 | | | | | |
| At a point approximately 3300 ft. downstream from Interstate 10/US Highway 80 | 2.6 | * | * | 1,688 | * |
| STREAM 8 | | | | | |
| At a point approximately 4110 ft. downstream from Interstate 10/US Highway 80 | 1.1 | * | * | 950 | * |
| STREAM 9 | | | | | |
| At is confluence with Salatral Lateral | 1.8 | * | * | 1,266 | * |
| STREAM 10 | | | | | |
| At its confluence with Stream 9 | 3.4 | * | * | 2,677 | * |
| STREAM 11 | | | | | |
| At its confluence with Stream 9 | 0.3 | * | * | 377 | * |
| STREAM 12 | | | | | |
| At its confluence with Stream 13 | 0.8 | * | * | 850 | * |
| At its confluence with Salateral Lateral | 0.8 | * | * | 919 | * |

* Data not available

**Table 6: Summary of Discharges (continued)**

| Flooding Source and Location | Drainage Area (in $mi^2$) | PEAK DISCHARGES (cfs) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| STREAM 13 | | | | | |
| At its confluence with Stream 12 | 0.4 | * | * | 543 | * |
| LOWER VALLEY AREA | | | | | |
| At corporate limits (City of El Paso) | 1.3 | 1,200 | 1,900 | 2,200 | 2,900 |
| UPPER VALLEY AREA | | | | | |
| At lower limit of study | 2.2 | 1,400 | 2,300 | 2,700 | 3,500 |
| WAR ROAD CHANNEL | | | | | |
| Approximately 0.6 mile upstream of confluence with Western Freeway Channel | 0.2 | * | 282 | 330 | 396 |
| Approximately 700 ft. upstream of confluence with Western Freeway Channel | 6.3 | * | 740 | 848 | 1,002 |
| At confluence with Western Freeway Channel | 6.4 | * | 909 | 1,046 | 1,241 |
| WESTERN FREEWAY CHANNEL | | | | | |
| Approximately 50 ft. downstream from confluence with War Road Channel | 7.2 | * | 1,542 | 1,742 | 2,126 |
| Approximately 0.4 mile downstream from confluence with War Road Channel | 7.6 | * | 2,131 | 2,415 | 2,943 |
| Approximately 0.7 mile downstream from confluence with War Road Channel | 7.7 | * | 2,259 | 2,566 | 3,131 |
| Approximately 0.9 mile downstream from confluence with War Road Channel | 8.0 | * | 2,581 | 2,932 | 3,582 |

**Table 7: Summary of Ponding Values**

| Flooding Source and Location | Drainage Area (in mi²) | PEAK VOLUME (acre-feet) | | | |
|---|---|---|---|---|---|
| | | 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
| McKelligon Canyon Arroyo Dam | 2.2 | 94.5 | 160 | 184 | 229 |
| North Hills Dam Detention Basin 1 | 2.50 | * | 310 | 334 | 365 |
| North Hills Dam Detention Basin 2 | 5.84 | * | 461[1] | 510[1] | 616[1] |
| Northeast Pond – Pond 1 | 37.7 | * | * | 2,959 | * |
| Northeast Pond – Pond 2 | 3.8 | * | * | 234 | * |
| Northeast Pond – Pond 3 | 0.2 | * | * | 15.6 | * |
| Northeast Pond – Pond 4 | 0.5 | * | * | 19.2 | * |
| Northeast Pond – Pond 5 | 1.4 | * | * | 80.9 | * |
| Northeast Pond – Pond 6 | 0.2 | * | * | 19.8 | * |
| P1B | 13.98 | 556 | 712 | 731 | 934 |
| P2 | 2.00 | 167 | 224 | 229 | 303 |
| P3 (Scotsdale Pond) | 1.00 | 34 | 103 | 151 | 321 |
| P4 | 0.24 | 8 | 24 | 36 | 75 |
| P5 | 0.47 | 13 | 38 | 67 | 122 |
| P6 | 1.10 | 36 | 105 | 155 | 310 |
| P7 | 0.15 | 5 | 15 | 23 | 47 |
| P8 | 0.52 | 18 | 50 | 75 | 160 |
| P9 | 0.15 | 5 | 15 | 22 | 48 |
| P10 (Parkwood Basin) | 2.31 | 79[2] | 335[2] | 561[2] | 1,470[2] |
| P11 | 0.90 | 30 | 88 | 131 | 272 |
| P12 | 0.80 | 26 | 76 | 113 | 240 |
| P13 | 0.70 | 24 | 71 | 108 | 220 |
| P14 | 2.27 | 64 | 212 | 304 | 692 |
| P16 | 1.00 | 32 | 95 | 136 | 300 |
| P16a | 0.19 | 10 | 16 | 18 | 23 |
| P16b | 0.05 | 2 | 2 | 2 | 2 |
| P16c | 0.03 | 4 | 4 | 5 | 6 |
| P17 | 0.19 | * | * | * | * |
| P18 | 0.13 | 10 | 13 | 16 | 18 |
| A | 0.25 | 24 | * | 36 | 45 |
| B | 0.10 | 10 | * | 15 | 19 |
| C | 0.35 | 33 | * | 49 | 62 |
| D | 0.25 | 23 | * | 35 | 44 |
| E | 0.17 | 16 | * | 23 | 30 |
| F | 0.36 | 20 | * | 33 | 44 |
| F1 | 0.19 | 1 | 1 | 1 | [2] |

[1]Includes contributions from North Hills Dam and Detention Basin 1.
[2]Includes contributions from Ponding Areas P8, P9, P11, P12, and P13.
*Data not determined.

**Table 7: Summary of Ponding Values (continued)**

| Flooding Source and Location | Drainage Area (in $mi^2$) | PEAK VOLUME (acre-feet) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|---|
| G | 0.35 | 29 | * | 45 | 58 |
| L | 0.17 | 16 | * | 24 | 30 |
| NA | 0.15 | 14 | 16 | 20 | [2] |
| NB | 0.35 | 28 | 33 | 42 | [2] |
| NC | 0.29 | 21 | 25 | 33 | [2] |
| N2 | 0.26 | 17 | 20 | 27 | [2] |

[1]Includes contributions from North Hills Dam and Detention Basin 1.
[2]Includes contributions from Ponding Areas P8, P9, P11, P12, and P13.
*Data not determined.

**Table 8: Summary of Stillwater Elevations**

| Flooding Source and Location | ELEVATION (NAVD88 ft.) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|
| McKelligon Canyon Arroyo Dam | 4,379.7 | 4,387.0 | 4,388.5 | 4,392.6 |
| North Hills Dam, Detention Basin 1 (approximate center) | * | 4,224.8 | 4,226.1 | 4,227.6 |
| North Hills Dam, Detention Basin 2 (approximate center) | * | 4,213.9 | 4,215.4 | 4,218.6 |
| Northeast Pond – Pond 1 | * | * | 3,918.9 | * |
| Northeast Pond – Pond 2 | * | * | 3,923.0 | * |
| Northeast Pond – Pond 3 | * | * | 3,909.1 | * |
| Northeast Pond – Pond 4 | * | * | 3,912.6 | * |
| Northeast Pond – Pond 5 | * | * | 3,908.9 | * |
| Northeast Pond – Pond 6 | * | * | 3,909.3 | * |
| Ponding Area P1B (approximate center) | 3,932.3 | 3,932.9 | 3,933.0 | 3,933.9 |
| Ponding Area P2 (approximate center) | 3,936.4 | 3,936.9 | 3,936.9 | 3,937.5 |
| Ponding Area P3 (approximate center) | 3,931.5 | 3,938.7 | 3,938.9 | 3,940.2 |
| Ponding Area P4 (approximate center) | 3,958.8 | 3,965.0 | 3,966.9 | 3,970.6 |
| Ponding Area P5 (approximate center) | 3,958.9 | 3,964.2 | 3,967.9 | 3,971.9 |
| Ponding Area P6 (approximate center) | 3,942.7 | 3,945.6 | 3,946.9 | 3,949.2 |
| Ponding Area P7 (approximate center) | 3,957.0 | 3,965.4 | 3,966.9 | 3,969.1 |
| Ponding Area P8 (approximate center) | 3,960.9 | 3,967.7 | 3,970.9 | 3,972.1 |
| Ponding Area P9 (approximate center) | 3,963.8 | 3,965.7 | 3,965.9 | 3,966.3 |
| Ponding Area P10 (approximate center) | 3,932.0 | 3,943.7 | 3,946.9 | 3,953.0 |
| Ponding Area P11 (approximate center) | 3,966.1 | 3,966.7 | 3,966.9 | 3,967.0 |
| Ponding Area P12 (approximate center) | 3,967.1 | 3,968.7 | 3,968.9 | 3,969.1 |
| Ponding Area P13 (approximate center) | 3,958.6 | 3,964.1 | 3,964.9 | 3,966.2 |
| Ponding Area P14 (approximate center) | 3,983.2 | 3,984.9 | 3,984.9 | 3,984.9 |

*Data not determined.

## Table 8: Summary of Stillwater Elevations (continued)

| Flooding Source and Location | ELEVATION (NAVD88 ft.) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|
| Ponding Area P16 | 3,982.9 | 3,986.2 | 3,988.3 | 3,993.4 |
| Ponding Area P16a | 3,985.8 | 3,990.5 | 3,991.6 | 3,994.7 |
| Ponding Area P16b | 3,998.0 | 3,998.4 | 3,998.6 | 3,999.0 |
| Ponding Area P16c | 3,994.6 | 3,995.8 | 3,996.5 | 3,997.3 |
| Ponding Area P18 (approximate center) | * | * | 3,968.9 | * |
| Ponding Area A | 3,954.4 | * | 3,960.8 | 3,965.0 |
| Ponding Area B | 3,968.3 | * | 3,974.2 | 3,978.1 |
| Ponding Area C | 3,962.1 | * | 3,969.6 | 3,974.8 |
| Ponding Area D | 3,972.7 | * | 3,978.9 | 3,983.2 |
| Ponding Area E | 3,980.5 | * | 3,985.0 | 3,989.0 |
| Ponding Area F | 3,990.4 | * | 3,998.3 | 4,005.2 |
| Ponding Area F1 | 4,010.6 | 4,010.6 | 4,010.7 | * |
| Ponding Area G | 3,964.0 | * | 3,969.8 | 3,973.6 |
| Ponding Area L | 3,988.0 | * | 3,992.5 | 3,995.4 |
| Pond NA | 3,972.7 | 3,974.2 | 3,977.4 | * |
| Pond NB | 3,955.0 | 3,956.6 | 3,959.4 | * |
| Pond NC | 3,987.6 | 3,989.8 | 3,993.9 | * |
| Pond N2 | 3,948.7 | 3,949.3 | 3,950.4 | * |
| FLOW PATH No. 27A | | | | |
| (Left bank lateral street flow of Flow Path No. 27) at Valencia Place | * | * | 3,698.9 | * |
| FLOW PATH No. 38 | | | | |
| Pond 1 | 4,214.0 | 4,219.4 | 4,222.8 | 4,223.9 |
| Pond 2 | 4,131.0 | 4,132.8 | 4,135.9 | 4,140.1 |
| Pond 3 | 4,075.3 | 4,075.3 | 4,075.8 | 4,076.1 |
| Pond 4 | 3,942.0 | 3,942.2 | 3,942.2 | 3,942.4 |
| Pond 5 | 4,082.7 | 4,085.0 | 4,087.9 | 4,089.9 |
| OVERLAND Flooding | | | | |
| Northwest of Arroyo 1 and North of Mulberry Avenue | 3,747.4 | 3,749.7 | 3,750.9 | 3,752.7 |
| LOMALAND BASIN | | | | |
| East Bank of Juan de Herrera Lateral Branch A and Lomita Drive | 3,679.4 | 3,682.9 | 3,684.9 | 3,687.9 |

*Data not determined.

**Table 8: Summary of Stillwater Elevations (continued)**

| Flooding Source and Location | ELEVATION (NAVD88 ft.) 10%-Annual-Chance | 2%-Annual-Chance | 1%-Annual-Chance | 0.2%-Annual-Chance |
|---|---|---|---|---|
| SHALLOW FLOODING | | | | |
| Between Juan de Herrera Lateral Branch B between Interstate 10 and Flow Path No. 28 (Mesa Drain Interceptor) | * | * | 3,669.9 | * |
| West bank of Ysleta Lateral at Americas Avenue | * | * | 3,666.9 | * |
| West of Flow Path No. 28 (Mesa Drain and Interceptor – Franklin Drive at Oro Verde) | * | * | 3,665.9 | * |
| MIDDLE DRAIN (below Interceptor) | | | | |
| Ponding Area 1 Inglewood Drive | * | * | 3666.9 | * |
| Ponding Area 2 (approximate center) | * | * | 3665.9 | * |
| PLAYA LATERAL | | | | |
| Approximately 300 feet southeast of Zaragosa Road | 3,663.1 | 3,663.8 | 3,663.9 | 3,665.3 |
| Shallow flooding west of Flow Path 27 at Knights Drive | * | * | 3,678.9 | * |
| Vista Real Pond P1 | 3,970.0 | 3,972.4 | 3,974.4 | 3,978.2 |
| Vista Real Pond P2 | 3,984.9 | 3,987.3 | 3,989.2 | 3,992.8 |
| Vista Real Pond P3 | 3,991.7 | 3,994.2 | 3,996.3 | 4,000.0 |
| Vista Real Pond P4 | 3,972.7 | 3,975.7 | 3,978.0 | 3,982.1 |
| Vista Real Pond P5 | 3,971.0 | 3,974.0 | 3,976.3 | 3,980.5 |
| Vista Real Pond P6 | 3,978.5 | 3,982.2 | 3,985.2 | 3,990.4 |
| Vista Real Pond P7 | 3,978.6 | 3,982.0 | 3,984.6 | 3,988.4 |
| Vista Real Pond P8 | 3,994.9 | 3,997.4 | 3,999.6 | 4,003.5 |

*Data not determined.

### 3.1.1 New Detailed Study Streams and Enhanced Approximate Type 1 Streams

The discharges for the new Detailed and Enhanced Approximate Studied streams were calculated using the region of influence regression model or a rainfall-runoff model. The hydrologic analysis performed as part of the Enhanced Approximate Study Type I is similar to the Detailed Study in every way, except that only flow rates for the 1-percent-annual-chance storm event are calculated as opposed to the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events for the Detailed Study. Regional Regression Equations are only applicable for two (2) study reaches due to engineered storage facilities, concrete lined channels, or development in the study reach watersheds. All other study reaches require a rainfall-runoff model.

Table 9, “Stream Hydrologic Methods Used,” lists the study reaches included in this re-study, the type of study performed for each reach, and the hydrologic modeling methodology selected.

**Table 9: Stream Hydrologic Methods Used**

| Study Stream Name | Study Type | Hydrologic Method Used |
|---|---|---|
| Flow Path 16, Flow Path 14 (El Paso Drainage Channel #2), and Range Dam – Outlet Channel | Detailed Study | Rainfall Runoff Model – HEC-HMS (NRCS Method) |
| Flow Path 24 (Government Hills Channel) | Detailed Study with Floodway | Rainfall Runoff Model– Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) (NRCS Method) |
| Flow Path 42 and Flow Path 42A | Detailed Study with Floodway | USGS Regression Equation – Region 16 Southwestern United States Equation (Reference 9) |
| Flow Paths 45, 45A, 45B, 45C, 45D and 45C Tributary | Enhanced Approximate Study Type I | Rainfall Runoff Model – HEC-HMS (NRCS Method) |
| Horizon Arroyo (Stream 2) | Detailed Study with Floodway | USGS Regression Equation – Region 16 Southwestern United States Equation |
| McKelligon Canyon Arroyo and McKelligon Canyon Arroyo Tributary 6 (Flow Path 17 and Flow Path 17A) | Detailed Study with Floodway | Rainfall Runoff Model – HEC-HMS (NRCS Method) |
| Northeast Pond | Enhanced Approximate Study Type I | Rainfall Runoff Model – HEC-HMS (NRCS Method) |
| San Felipe Arroyo | Enhanced Approximate Study Type I | Rainfall Runoff Model – HEC-HMS (NRCS Method) |

### 3.1.2 Flow Path No. 28 (Mesa Drain and Interceptor), Flow Path No. 29, Flow Path No. 30, Flow Path No. 32 and Flow Path No. 33 (Middle Drain) Revision

The City of El Paso contracted with Surdex Corporation in 1997 to generate aerial photography, aerotriangulation and ground control survey data, including establishment of elevation reference marks, for the entire city. Surdex Corporation produced the mapping to a scale of 1” = 100 feet with two-foot topographic contour intervals. Surdex Corporation compiled the digital mapping on meet ASPRS Standards for Class 2 map accuracy. The mapping is geo-referenced and incorporates the Texas State Plane Coordinate System Central Zone, the North American Horizontal Datum of 1983 (NAD 83), and the North American Vertical Datum of 1988 (NAVD 88). The digital orthophotographic data files can be joined seamlessly without overlap or gaps adjoining the files. Surdex Corporation provided the mapping as MicroStation Version SE design files. The metadata files meet Federal Geographic Data Committee metadata standards and are generated in CorpsMET95 format. Surdex Corporation also produced 354 mylars displaying the orthophotography and topographic contour interval for the southeast portion of the City.

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

The USACE used the HEC-1 "Flood Hydrograph Package" computer program, developed by the USACE Hydrologic Engineering Center, to model the southeast El Paso watershed to determine the 10-, 2-, 1-, and 0.2-percent-annual-chance flood discharges at selected locations within the watersheds. The USACE developed HEC-1 models for Flow Paths 26, 28, 29, 30, 31, and 32.

Snyder's synthetic unit hydrograph method was used in the hydrologic model. Snyder's method draws a relationship between measurable physical characteristics of a drainage basin and the basin's unit hydrograph. The USACE engineering manual EM-1110-2-9021, Flood Runoff Analysis, and dated October 11, 1991 (Reference 10) describes Snyder's unit hydrograph method and provides the following equation to compute the time to peak of the unit hydrograph (tp):

$tp = Ct * (L*Lca)\ 0.3$

tp = Time to peak (hours)

L = Length of the main watercourse from headwater to outlet (feet)

Lca = Travel length to the centroid of the basin (feet)

Ct = Time to peak coefficient

The basin lags and stream slope measurements were extracted from the digital topographic maps. The USACE, Albuquerque District used the Ct-versus-equivalent-slope curve, for urbanized areas in El Paso, Texas, to develop the Ct coefficient and the Cp (peaking) coefficient.

The frequency rainfall was obtained using the design rainfall for the Southeast Area flood control projects, as part of the USACE El Paso Local Protection Project (Reference 11). The frequency point rainfall amounts for the 10-, 2-, 1-, and 0.2-percent-annual-chance storms are based on Technical Paper No. 40 (Reference 12). The frequency point rainfall is reduced for the southeast watershed area in accordance with the area-depth curves presented in Technical Paper 40. The 0.2-percent-annual-chance rainfall was extrapolated from a plot of the 10-, 2-, and 1-percent-annual-chance rainfall. The USACE used 6-hour storm duration for the design of the Southeast Area flood control structures, as authorized by the El Paso Local Protection Project. The HEC-1 Flood Hydrograph computer program applied the six-hour storm precipitation to each sub-area within the watersheds.

In the design of the southeast area flood control projects, the USACE design hydrology specified an initial infiltration of 0.60 inches with a constant infiltration of 0.30 in/hr. for the mesa sub-areas, and an initial infiltration of 0.80 inches with a constant infiltration of 0.40 in/hr., for the valley sub-areas. For this FIS, an initial infiltration of 0.80 inch and constant infiltration of 0.40 inch/hour were used for both valley and mesa sub-areas based on the NRCS Soil Survey Report for El Paso County, Texas, dated November 1971 (Reference 13). The NRCS report explains that the mesa soils have higher infiltration rates than the valley areas, based on soil classification. An initial infiltration of 1.00 inch is used for a number of valley sub-areas to account for numerous small ponds. The land use and percent of urbanization for each sub-area was determined through field reconnaissance and inspection of the orthophotos.

For the steeply sloping mesa area, hydrographs were routed using either the Muskingum-Cunge or kinematic wave channel methods. The routing reaches along Flow Paths 29, 30, 31, 32, and 32A were modeled as either simple geometric shapes or an eight-point cross section.

For hydrograph routing along Flow Path 28 (Mesa Drain) in the low-gradient valley, storage-discharge tables were imported into the HEC-1 model. The storage discharge tables were developed from volume-discharge tables generated by a multiple profile HEC-RAS hydraulic model of Mesa Drain and the overbanks. The roughness coefficients (Manning's "n" values) for the channel routing were based on field reconnaissance.

The City of El Paso and urban developers have constructed numerous retention and detention ponds in the southeast area watershed for flood control. Using the current orthotopographic mapping, the storage capacity and the spillway discharge for these ponds were determined, and included in the hydrologic models at the request of the City of El Paso.

Mesa Drain bisects the flat southeast valley of El Paso, and floodwaters pond in low-lying areas. City of El Paso officials report that yards and fields in the valley contain the water that contributes directly, creating numerous local pools of water following heavy rainstorms. To account for flood storage in the valley area, digital orthotopographic mapping was used to identify ponding areas and extract elevation-storage data for the designated ponds. The watershed was subdivided in HEC-1 to compute the hydrographs that contribute to each pond. Using the storage-elevation data, the hydrographs were routed through the individual ponds, accounting for valley storage and more accurately representing the contribution to Mesa Drain.

Mesa Drain flows into Feather Lake and New Feather Lake near the downstream terminus. The storage elevation data for Feather Lake was extracted from the digital terrain model (DTM). The starting storage elevation for Feather Lake is set at 3658.0, which is the water surface elevation existing in Feather Lake at the time that the orthotopographic mapping was flown. The storage elevation table for Feather Lake was manually derived and based on a proposed plan, dated May 1998, that was provided by the City of El Paso. The plan uses an unknown datum. By comparison of spot elevations on the plan to spot elevations from the DTM, a conversion of +12 feet was used to convert plan elevations to NGVD and subsequently converted to NAVD88. New Feather Lake was assumed to be empty at the start of the flood.

### 3.1.3 Redelineation MHIP Case 1

For all other flooding sources previously studied, the following hydrologic analyses methodology was taken from the prior FIS for El Paso County. Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the county.

The Snyder hydrologic method, used in USACE studies for this area, was used in developing the hydrology for this study (Reference 14). Runoff records of sufficient length were not available to perform peak frequency analysis on any of the streams studied. Insufficient correlation exists between runoff records and rainfall to enable an evaluation of the rainfall-runoff relationship; consequently, natural unit hydrographs could not be developed. Therefore, the HEC-1 flood hydrograph computer program was used in developing hydrologic models (Reference 15). Rainfall data were developed using U.S. Weather Bureau Technical Paper No. 40 (Reference 16). The point rainfall was used to adjust the rainfall hyetograph by the "realistic ordering" storm distribution method, which places the peak intensity at 45 minutes into the six-hour storm.

The City of El Paso was divided into three separate areas for hydrologic analyses: northwest, northeast-central, and southeast. The basic hydrology for these areas was developed by the USACE for the El Paso Local Protection Project (References 17, 18, and 19).

In the absence of stream gaging stations and associated data in the northwestern and southeastern areas, regional frequency curves for peak discharges and flood volumes were constructed using Snyder's synthetic unit hydrograph procedures and rainfall-frequency-duration data (References 20 and 21). This analysis followed recommended procedures outlined by the Water Resources Council (Reference 22). Two dams in the northwestern area, Mulberry and Thorn, affected flow analyses; therefore, outflows were routed using the Modified Puls method (Reference 23).

The USACE HEC-1 computer program was used to develop discharge rates for the northeast-central area (Reference 24). Rainfall data used for this program were developed from reports prepared by the National Weather Service and the NRCS (References 21 and 25). Discharge rates computed by the HEC-1 program were plotted-on log probability paper to develop frequency curves.

In this revision, the USACE HEC-1 computer program was also used to develop discharge rates for the North Hills subdivision in northeast El Paso (Reference 24). Rainfall data used for this program were developed from reports prepared by the National Weather Service (References 16 and 21). In addition, the discharge rates for West Hills subdivision were developed using the USACE HEC-1 computer program (Reference 24). The rainfall data were taken from a report by Espey, Huston & Associates, Inc. (Reference 26).

For these analyses, if the maximum flood storage elevation in a flood control structure not designed or operated by the USACE rose to within two feet of the top of the dam; it was assumed that there was no dam. Discharges for the 0.2-percent-annual-chance flood were determined by straight-line extrapolation of a single-log graph of flood discharges computed for frequencies up to 100 years.

Please note that during the redelineation process, portions of several flooding sources that had been previous studied by detailed methods were reverted to Zone A with the concurrence of El Paso County and the City of El Paso. This was done as the historic models, and historic base flood elevations did not match the new topographic data. Discharges for these streams were are maintained in Table 6 “Summary of Discharges.”

## 3.2 Hydraulics Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the Flood Insurance Rate Map (FIRM) represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

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

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

### 3.2.1 Detailed and Enhanced Approximate Type 1 Study Streams

For streams studied under new detailed analysis, water surface elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance-flood was computed using the USACE's HEC-RAS version 3.1.2 step-backwater computer program (Reference 27). For streams studied under enhanced approximate type 1 analysis, only the 1 percent annual chance floods were computed. These streams were identified in Section 2.1. Hydrologic Modeling System (HEC-HMS) software was used to compute the maximum water surface elevation based on hydrograph routing.

Photogrammetric survey obtained from the Texas Department of Transportation was used to create a Triangular Irregular Network (TIN) of El Paso County (Reference 28). The TIN, in conjunction with field survey data, was used within the Watershed Concepts, Inc. WISE software platform (Reference 29) to obtain all cross-section information. Cross-sections were placed with the goal of approximate 500-foot spacing.

For detailed study hydraulic analyses, profiles of the 10-, 2-, 1-, and 0.2-percent-annual-chance-flood events were generated.

Cross-sections were also placed at all crossing structures. Each structure cross-section is categorized as a top-of-road (TOR) cross-section. WISE relates the TOR cross-section to the closest survey structure. Culverts and bridge structures require an additional cross-section to be placed upstream of the structure just outside the toe of any road fill that is related to the structure. Dam structures require a cross-section placed upstream, as described above for culverts, as well as a cross-section placed downstream just outside the toe of the dam embankment. WISE uses these cross-sections to develop the upstream and downstream channel configurations necessary for HEC-RAS modeling. Typically, these cross-sections are not provided as a final cross-section on the FIRM as they are used to model structures and not to provide flood depths along the channel.

Additional cross-sections were placed to account for significant profile inflection points (profile breaks). Cross-sections at profile breaks are critical for accuracy in the development of BFEs.

Table 10, “Stream Hydraulic Methodology,” shows the type of study that was performed for each stream and the methodology selected.

Roughness coefficients were estimated based on field inspection of stream channels and floodplain areas for El Paso County. GIS coverage of floodplain and channel n-values was developed. This GIS coverage consists of “bands” of Manning’s n-values. These bands were developed using the field reconnaissance and orthophotos. The purpose of the n-value “band” coverage is to allow the consistent application of Manning’s n-value estimates. Additional cross sections can be added to the models based on the same n-value assessments. The n-value bands also allow for the global increase or decrease of n-values for a stream reach or entire stream for historical calibration and verification.

The channel and overbank “n” values used to model detailed and enhanced approximate Type 1 study streams are shown in Table 10, “Summary of Roughness Coefficients.”

An AutoCAD .dxf file containing the floodplain boundaries for the modeled study reaches was generated in WISE. The .dxf file was then revised using topology commands within AutoCAD Map and shapefiles were created from the AutoCAD polylines. The floodplain shapefile is in agreement with the modeling results for all study reaches. Any deviations of the floodplain shapefile from the modeling results are discussed in detail below.

**Table 10: Stream Hydraulic Methodology**

| Study Stream Name | Study Type | Hydrologic Method Used |
|---|---|---|
| Flow Path 16, Flow Path 14 (El Paso Drainage Channel #2), and Range Dam – Outlet Channel | Detailed Study without Floodway | HEC-HMS<br>HEC-RAS<br>StormCAD (Reference 30) |
| Flow Path 24<br>(Government Hills Channel) | Detailed Study without Floodway | HEC-RAS<br>StormCAD |
| Flow Path 42 and Flow Path 42A) | Detailed Study with Floodway | HEC-RAS |
| Flow Paths 45, 45A, 45B, 45C, 45D and 45C Tributary | Enhanced Approximate Study Type I | HEC-RAS |
| Horizon Arroyo<br>(Stream 2) | Detailed Study with Floodway | HEC-RAS |
| McKelligon Canyon Arroyo and McKelligon Canyon Arroyo Tributary 6 (Flow Path 17, 17A) | Detailed Study with Floodway | HEC-HMS<br>HEC-RAS |
| Northeast Pond | Enhanced Approximate Study Type I | HEC-HMS |
| San Felipe Arroyo | Enhanced Approximate Study Type I | HEC-RAS |

BFEs were developed using WISE software tools and AutoCAD batch processing. The BFEs were then refined to match the floodplain boundaries and contour data. The resulting floodplains consist of Zone AE polygons with BFEs.

All models were run at subcritical depth per the FEMA *Guidelines and Specifications* (Reference 31). For cases where models indicated critical depth or supercritical depth, the critical depth results were reported.

**Table 11: Manning's Roughness Coefficients**

| Detailed Study Stream Name | Channel "n" Value | Overbank "n" Value |
|---|---|---|
| Flow Path 14 (El Paso Drainage Channel #2) | 0.016 – 0.03 | 0.1 |
| Flow Path 16 (includes Alcan Storm Drain, Diana Channel, Mt. Shasta Channel, and Tobin Drain) | 0.016 – 0.033 | 0.05 – 0.10 |
| Flow Path 24 (Government Hills Channel) | 0.016 – 0.1 | 0.1 |
| Flow Paths 42 and Flow Path 42A | 0.01 – 0.07 | 0.025 – 0.1 |
| Flow Path 45 and Flow Path 45A | 0.035 – 0.8 | 0.033 – 0.15 |
| Flow Paths 45B, 45C, 45C-Tributary 1, and 45D | 0.045 | 0.05 |
| McKelligon Canyon Arroyo (Flow Path 17) and McKelligon Canyon Arroyo Tributary 6 (Flow Path 17A) | 0.04 – 0.15 | 0.04 – 0.2 |
| Range Dam – Outlet Channel | 0.016 – 0.033 | 0.04 – 0.20 |
| Stream 2 (Horizon Arroyo) | 0.017 – 0.08 | 0.035 – 0.15 |
| San Felipe Arroyo | 0.025 - 0.035 | 0.03 – 0.1 |

With the exception of McKelligon Canyon Arroyo (Flow Path 17) and Dam, Flow Path 14(El Paso Drainage Channel #2), and the Range Dam Outlet Channel the normal depth method was used to calculate starting water surface elevations with backwater effects considered at confluences. For McKelligon Canyon Arroyo (Flow Path 17) the tie-in starting water surface elevations for multiple events were obtained from the proposed redelineation for McKelligon Canyon Arroyo (Flow Path 17). At the McKelligon Canyon Dam, the starting water surface elevations for use in the HEC-RAS model were developed as part of the dam hydraulics in HEC-HMS. For Flow Path 14 (El Paso Drainage Channel #2) the model starting water surface elevation was set at 3944.8 feet based on the downstream tie in from a previous study. For Range Dam Outlet Channel, the starting water surface used within the model was obtained from the closest cross-section (RD 24.75) water surface elevation generated as part of the main channel model.

### 3.1.2 Flow Path No. 28 (Mesa Drain and Interceptor), Flow Path No. 29, Flow Path No. 30, Flow Path No. 32 and Flow Path No. 33 (Middle Drain) Revision

The hydraulic analysis was performed using the USACE Hydrologic Engineering Center River System Analysis System (HEC-RAS) version 3.0, dated April 2001 (Reference 32). HEC-RAS is designed to perform one-dimensional hydraulic calculations for natural and constructed channels. The HEC-RAS program computes water surface elevations at locations of interest for given flood-discharge values. Cross sections for the hydraulic analyses were obtained from the topographic mapping and DTMs. The following paragraphs describe the assumptions that were made for modeling the reaches in this study including Flow Path No. 28 Mesa Drain and Interceptor, Flow Path No. 29, Flow Path No. 30, Flow Path No. 32, and Flow Path No. 33 Middle Drain Revision

<u>Manning’s “n” Value:</u> Channel roughness factors (Manning’s “n” values) ranged from 0.013 for concrete-lined channels to 0.030 for earth-lined channels. Roughness coefficients used in the overbank areas ranged from 0.035 to 0.045 for undeveloped areas, 0.030 to 0.035 for yards and developed areas, and 0.017 to 0.022 for streets. The roughness coefficients selected were 0.017 for reinforced concrete pipes and 0.022 for corrugated metal pipes.

<u>Expansion and Contraction Coefficients:</u> Expansion and contraction coefficients of 0.1 and 0.3, respectively, were used for gradual transitions between channel cross sections. Expansion and contraction coefficients of 0.3 and 0.5 were used for bridge sections.

The scope of work for this revision was to analyze Flow Paths Nos. 28 (Mesa Drain), 29, 30, 31 (Jesuit Draw), 32 and 32A as presented in the effective FIS. Construction of retention and detention basins in the watershed and development of detailed topographic mapping have indicated the need for adjustments to the flow paths since publication of the prior FIS and FIRMs. The flow paths with the necessary adjustments are described in the following paragraphs.

<u>Flow Path No. 28 Mesa Drain and Interceptor:</u> The hydraulic analysis for Flow Path No. 28 Mesa Drain and Interceptor extended from the upstream drop structure to downstream of the Southern Pacific Railroad.

The Mesa Drain Interceptor Channel passes under the Southern Pacific Railroad tracks by way of two 60-inch-diameter reinforced concrete pipes. Because of the limited capacity of the pipes and the elevated nature of the railway embankment, flood flows do not overtop the railroad, but instead back up a considerable distance upstream. Flows overtop the left overbank upstream of Feather Lake and travel overland in a southeast direction. The embankment of the Juan de Herrera Lateral impedes flows traveling in this direction. For larger floods, some flow continues southeast over the North Loop siphon. The multiple-rating-curve method was used to determine the amount of flow that continues down the Mesa Drain Interceptor Channel versus the amount of flow that leaves the system by flowing southeast. First, a rating curve for the Mesa Drain Interceptor Channel was developed by incorporating multiple discharges into a HEC-RAS model of the Mesa Drain Interceptor Channel. Similarly, a multiple profile HEC-RAS model for flow over the North Loop Siphon of the Juan de Herrera Lateral was created. Rating tables were combined to create a rating table of total flow. The rating tables were incorporated into the HEC-1 model, and flow over siphon was modeled as a diversion.

Flow Path No. 29: Flow Path No. 29 begins at Eastwood Basin, flows south to Giles Basin, then east along Phoenix Drive and south to Mesa Drain. Flood flow from the 10-, 2-, 1-, and 0.2-percent-annual-chance flood events are contained within the system upstream of Giles Basin; therefore a flow path does not exist between Eastwood Basin and Giles Basin. Giles Basin contains the 10-, 2-, and 1-percent-annual-chance-flood events that originate in the watershed downstream of Eastwood Basin. During the 0.2-percent-annual-chance flood, approximately 240 cfs spills, via the Giles Basin spillway, into the park below the dam and onto Phoenix Drive. Phoenix Drive has the capacity to convey 210 cfs, which allows approximately 30 cfs to flow overland through yards and streets. The soil between Phoenix Drive and Mesa Drain is highly permeable; therefore, very little of the water will reach Mesa Drain.

Hunter Drive and Puerto Rico Street intersect Phoenix Drive and deduct flow from Phoenix Drive. At the Hunter Drive and Puerto Rico Street intersections, additional flow will enter the system from the watershed that exists north of Phoenix Drive. Consequently, Phoenix Drive maintains an almost constant flow of approximately 210 cfs. Flows greater than 210 cfs will overtop Phoenix Drive and exit the system as overland flow on the south side of Phoenix Drive.

At the intersection of Phoenix Drive and Del Monte Street, Phoenix Drive turns to the Northwest, and the grade flattens. Lacking any significant obstruction, the majority of the flow turns to the southwest and enters the El Paso Community College campus and parking lot. A portion of the flow travels south along Del Monte Drive; however, the majority of flow spreads over a wide non-residential area in depths less than one foot. As a result, Flow Path No. 29 exists only along Phoenix Drive between Giles Basin and Del Monte Drive.

Flow Path No. 30: The construction of the Carolina Basin has altered Flow Path No. 30 (Reference 33). Flow upstream of the intersection of Glendale Avenue and Lafayette Drive now contributes to Carolina Basin, and the project reduces the flow along Yarbrough Drive by diverting flow from the northern portion of the watershed into the modified Carolina Basin. Along Flow Path No. 30, downstream of Carolina Basin and near the intersection of Yarbrough Drive and Lafayette Drive, a portion of the flow is diverted to two retention ponds west of Yarbrough Drive. Flow from the remaining drainage area downstream of Glendale Avenue contributes to Flow Path No. 30 and is conveyed to Mesa Drain.

Flow Path No. 31 (Jesuit Draw): Jesuit Draw Basin, located on the west side of Lee Trevino Drive and north of Interstate 10, has a capacity of 275 acre feet, which is sufficient to contain the 1-, and 0.2-percent-annual-chance storm runoff from the contributing watershed upstream of the basin. The runoff from the areas between Jesuit Draw Basin and Interstate 10 is directed under the highway by means of three 24-inch reinforced concrete pipes, four 36-inch reinforced concrete pipes, and a battery of ten 36-inch reinforced concrete pipes. Runoff from the three 24-inch and four 36-inch pipes spills on the south side of Interstate 10 and flows along the streets to Jesuit Draw. Hydraulic runoff indicates that the culverts will pass the 1-, and 0.2-percent-annual-chance storm runoff under the highway.

An existing 10 foot by 4 foot reinforced box culvert extends from the downstream end of the ten 36-inch reinforced concrete pipes and travels approximately 800 feet south from Interstate 10 to Burnham Drive. At Burnham Drive, the system enters a newly-constructed 10 foot by 5 foot reinforced box culvert that leads to the recently enlarged Lomaland Basin (Reference 34). The additional watershed area on the south side of Interstate 10 increases the runoff sufficiently that the 10 foot by 5 foot box culvert cannot convey the entire 0.2-percent-annual-chance-flood. The flow that is not conveyed by the box culvert will travel along the backfill over the culvert. In the HEC-RAS model for Flow Path No. 31, the thalweg was approximated for this channel by assuming a minimum cover of three feet over the new culvert. The cross sections were modified from the digital orthotopographic maps accordingly. As a result, the floodplain delineation and profile were produced for the 0.2-percent-annual-chance flood for Flow Path No. 31. Floodplains do not exist for the 1-percent-annual-chance flood because the flow is contained within the box culvert.

<u>Flow Path No. 32 and Flow Path No. 32A:</u> Bluff Channel intercepts Flow Path Nos. 32 and 32A and transports the floodwater to Americas Basin. Flow from the area north of Interstate 10, formerly designated Flow Path No. 32A, no longer flows into the Warnock Channel. Development in the area upstream of Bluff Channel and Americas Basin has eliminated the section of Flow Path No. 32 and all of Flow Path No. 32A; therefore, Flow Paths Nos. 32 and 32A were not plotted above Bluff Channel (Reference 34). The section of Flow Path No. 32 analyzed in the current study extends from the confluence with Mesa Drain upstream to Bluff Channel.

Storage in the numerous detention and retention ponds constructed by the City of El Paso and developers in the watershed upstream of Bluff Channel and Americas Dam has reduced the flood peaks that enter Bluff Channel and Americas Basin. Detailed analysis, incorporating storage-elevations data for each of the ponds, reveals that Bluff Channel and Americas Basin now contain the 0.2-percent-annual-chance flood. As a result, the floodplain along Bluff Channel was not plotted.

### 3.2.3 Redelineation MHIP Case 1 Study Streams

Flooding sources that had an existing study and were not restudied under the current effort underwent a redelineation process. The redelineation process consists of the floodplains and profiles being updated based on the most current topographic data and the datum converted to NAVD 88. New hydrologic and hydraulic analyses were not performed on the redelineated flooding sources.

Locations of selected cross-sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1) and the Flood Insurance Rate Map where applicable.

Please note that during the redelineation process, portions of several flooding sources that had been previous studied by detailed methods were reverted to Zone A with the concurrence of El Paso County and the City of El Paso. This was done as the historic models; historic base flood elevations did not match the new topographic data.

<u>El Paso County Unincorporated Areas:</u> For the flooding sources previously studied, the following hydraulic analyses methodology was taken from the prior FIS for El Paso County (Reference 2).

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross-section data for arroyos south of El Paso were obtained by field surveys that were performed in March and June 1988.

Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (Reference 35). Starting water-surface elevations for the streams studied by detailed methods were determined using normal depth calculations. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and were based on field observations of the stream and floodplain areas. The channel "n" value for the streams studied by detailed methods was 0.035, and the overbank "n" value was 0.050.

Alluvial fan analyses were performed on Streams 3, 4, 6, 7, 8, and 9 using the FEMA alluvial fan methodology (Reference 36). This methodology assumes that floodwaters will be confined within a single channel at any particular time during the flood event and that this channel is formed by the flow itself. Further assuming that the channel can occur at random locations across the surface, the probability of a point being flooded in a given event decreases as one moves downfan, due to an increase in the area susceptible to flooding. Therefore, all one-percent-annual-chance depths and velocities determined by the FEMA methodology incorporate both the probability of distribution of the flood discharges at the fan apex and the probable effects of the changing widths of the flood-prone surface in moving downfan.

City of El Paso: For the flooding sources previously studied, the following hydraulic analyses methodology was taken from the prior Flood Insurance Study for the City of El Paso (Reference 1).

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Digitized cross-sections were obtained from topographic maps compiled in August 1973, March 1976, and May 1980 (References 37, 38, and 39). Additional cross sections were obtained during field surveys. Elevation data and structural geometry of dams, bridges, and culverts were obtained from field surveys, USACE publications, the Texas Highway Department, and the City of El Paso.

Generally, water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step backwater computer program (Reference 40). Exceptions to this are mentioned in succeeding paragraphs. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Flow conditions in the arroyos in the northwestern area of El Paso are in the unstable range and often vary from the subcritical to supercritical range. These conditions are typified by standing waves, hydraulic jumps, and variable velocities. Channels are natural, non-uniform, and often cross alluvial fans. A typical flow may follow any of numerous new paths after sedimentation.

Starting water-surface elevations for each sub-basin in the northwestern valley area were established by a rating curve using the appropriate control section such as streets, railroads, and levees. Subsequent elevations were obtained by the Modified Puls method to route hydrographs through ponding areas, and the hydrographs were lagged for the short flow reaches using Manning equations. Water-surface elevations in the individual arroyos were started using the elevations established by routing procedures or critical depth, whichever controlled. The Montoya Drain gates are assumed closed for this study. The starting water-surface elevations for the revised flow paths in the northeastern section were obtained using the coincident peak method except for Flow Paths 11, 49, 50, and 55, where the slope/area method was used.

Initial computation indicated that none of the channels in the northeastern area would carry flows of the magnitude considered in this study. Cultural development and street alignment were considered in this study and often dictated the direction and severity of flooding. Of particular significance is the extensive use of stone wall fencing throughout the northeastern area. A stone wall was considered effective to 40 percent of its height in areas where flow impinged directly on the wall and 60 percent where flow was parallel.

In this revision, the Western Freeway Channel and War Road Channel, both concrete lined channels in the North Hills subdivision, are designed to carry the 0.2-percent-annual-chance peak discharges within their channel banks. In the West Hills subdivision, a portion of Arroyo 2 was channelized to carry the 0.2-percent-annual-chance peak discharge upstream of Thorn Dam.

The interchange of significant quantities of flow between flow paths alters the hydrologic characteristics of the total drainage system. The inflow and outflow locations were so numerous and the problem of routing and balancing flows so complex that it became necessary to adopt a simplified procedure to adjust the flow balance. Backwater computations, based on the HEC-2 program, were made for each independent flow path using a random range of enveloping discharges. At the point of flow separation, rating curves were constructed and added to obtain a composite rating. This procedure provided a method to proportion flows in each flow path. The HEC-1 computer runs used to formulate the hydrology were examined and revised to account for the adjusted contributing sub-areas and relocation of concentration points. Primarily, the revised methodology consists of adjusting peak flows by adding or deducting flow gains or losses between flow paths.

Roughness factors generally ranged from 0.050 to 0.070 in undeveloped areas. Channel "n" values averaged 0.035. Streets and yards combined were assigned values varying from 0.025 to 0.040, dependent on the proportionate widths of paving and degree of vegetation and obstructions. For the northwestern area, roughness factors (Manning's "n") varied from 0.015 to 0.060 for channel areas and from 0.040 to 0.060 for overbank areas. The roughness factor used in the northeastern section was 0.040 for channel and overbank areas. The channelized portion of Arroyo 2 had roughness factors varying from 0.013 to 0.022 for the channel and 0.018 to 0.022 for the overbank areas. For War Road Channel and Western Freeway Channel, roughness factor of 0.015 was used for the channel and 0.040 was used for the overbank areas.

Water-surface elevations in closed ponding areas were established by applying runoff to volume-stage relationships. Starting water surface elevations for the southernmost stream system of the northeastern area were established by normal depth computations. Subsequent elevations were obtained using the HEC-2 computer program. Due to steep slopes and loss of control, water-surface elevations on other streams were started using critical depth as established by the HEC-2 program. Where flow divided at tributaries or at overflow areas, starting water-surface elevations were established using the composite rating curve technique.

The study in the central portion of El Paso included channel and street flows. These two phenomena were analyzed separately because of critical flow conditions along all streets, although the upper reaches of the channel systems also exhibited a tendency toward critical flow. In all cases, profiles along channel flow segments were determined using the HEC-2 computer program. For street flow reaches (where flow is confined largely to streets), profiles were determined from representative cross sections to reach segments. Based on field data and verification of aerial photographs, the sidewalk widths were selected and added onto each side of the street. All remaining sections of the cross-section were blocked out because of walls or structures that would obstruct flows. Roughness factors used in the central area ranged from 0.060 for street flow to 0.035 for channel flow.

Starting water-surface elevations were determined from reservoir routing results, whenever a flow detention area was encountered, and from normal depth if the channel discharge was unobstructed. Critical depth was used for starting conditions whenever slopes equal to or greater than critical prevailed.

In some instances along the alluvial fan, there existed the potential for flow losses to side streets and eventual dispersion down the fan. Since no definitive method for analysis of this phenomenon is possible, it was assumed that no accounting for these losses would be attempted, and no reduction in flows would be utilized.

For those areas along Franklin Canal and downstream of Interstate 10, it was assumed that the storm sewers would be flowing near capacity. Consequently, the entire flow hydrograph routed to the Franklin Canal was stored in depressions that are prevalent throughout that area of central El Paso, and flooding was determined for standing, rather than flowing, water.

The southeastern portion of El Paso can be broken into three distinct geographical-hydraulic sub-areas - closed basins, bluff line, and valley. Floods generated in the closed basins do not enter any surface water system. Flow from the bluff line system originates north of Interstate 10 and intersects the freeway along southwesterly-oriented courses. The streams lose definition after leaving the escarpment and entering the system. Some intermediate storage basins are located throughout the stream system. The valley area is located below the escarpment and north of the Rio Grande River. It contains well-defined drains that direct combined local flow and flow from the escarpment to the south-southeast.

In the closed basin areas, the volume of runoff generated by a particular drainage area was determined from generalized relations of flood volume generated versus drainage area for the El Paso area. A family of curves was developed using runoff hydrograph data from the hydrologic investigation. Curves were constructed for each of the 10-, 2-, 1-, and 0.2-percent-annual-chance floods for undeveloped areas, medium-density areas, and basins with a high degree of development.

The streams flowing southwest toward the bluff line cross under or over a number of obstructions along their flow paths. Hydrographs were calculated at various points along each stream. These hydrographs were routed downstream and combined, passing through detention basins, culverts, or other restrictions until floodwaters reached the valley area where the flows integrated into the valley system.

The combining and routing option of the HEC-1 computer program was used exclusively for the hydrologic analysis on all streams in the valley area. At all obstructions, water-surface elevations as a result of ponding controlled until backwater calculations exceeded the ponding depths. All elevations of floodwaters upstream of all conduits were rated by Modified Puls using the HEC-1 program.

Roughness factors generally ranged from 0.050 to 0.070 in undeveloped areas. Channel "n" values averaged 0.035. Streets and yards combined were assigned values varying from 0.025 to 0.040, dependent on the proportionate widths of paving and degree of vegetation and obstructions.

Starting water-surface elevations were determined from reservoir routing results whenever a detention area was encountered, and normal depth for unobstructed channel reaches. Critical depth ratings, established using normal manual computations, were used for slopes equal to or greater than critical.

Shallow flooding areas covered a large part of the City. When shallow flooding is associated with arroyos or flow paths, they are presented in this study with flood profiles. Although several flood profiles for these shallow flooding areas indicate that the base flood elevations are more than 3 feet above the streambed, the actual flooding affecting these areas meet the shallow flooding criteria because most of the channels are narrow and, in some cases, not very well defined. Also, the overbank areas are of higher elevations, making the actual water depths 3 feet or less.

For the areas studied by approximate methods, the extent of the 1-percent-annual-chance flood was determined from topographic maps and aerial photographs (References 37, 38, 41, 42, and 43). Depths of flow and flood boundaries were determined by obtaining representative sections and limiting the width based on probable recent flow paths identified from aerial photography and by examining and comparing to an alluvial fan studied by detailed methods.

### 3.3 Vertical Datum

All FIS reports 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 used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD29). With the completion of the North American Vertical Datum of 1988 (NAVD88), many FIS reports and FIRMs are now prepared using NAVD as the referenced vertical datum.

Flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. The datum conversion factor from NGVD29 to NAVD88 in El Paso County is +1.94 feet. For information regarding conversion between the NGVD29 and NAVD88, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey, SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

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 the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

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

## 3.4 Refinement

All Zone A Special Flood Hazard Areas that were not restudied underwent refinement. The refinement was based on the orthophotography, which was provided by Texas Department of Transportation and is the base map for the FIRMs. Refinement does not take into account changes to the ground surfaces since orthophotos were taken. Potential surface changes may include development and alluvial changes to the river systems.

# 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 a 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

## 4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross-section. Between cross-sections, the boundaries in the City of El Paso were originally interpolated using topographic maps with a contour interval of 2 feet (Reference 38, 39, 40). In some areas the floodplain boundaries were originally interpolated using topographic maps with a contour interval of 4, 5 and 10 feet (References 39, 42 and 43). Floodplain boundaries for areas studied in the 2006 revision of the City of El Paso were delineated against the Surdex data as described in section 3.1.2 For El Paso County floodplain boundaries were originally interpolated using topographic maps with a contour interval of 4, 5 and 10 feet (Reference 44).

Flooding sources that had an existing study and were not restudied under the current effort underwent a redelineation process. The redelineation process consists of the floodplains and profiles being updated based on the most current topographic data and the datum converted to NAVD 88. These flooding sources were redelineated against TXDOT photogrammetric survey and orthophotography data dated 2004 (Reference 28). Please note that during the redelineation process, portions of several flooding sources that had been previous studied by detailed methods were reverted to Zone A with the concurrence of El Paso County and the City of El Paso. This was done as the historic models, and historic base flood elevations did not match the new topographic data.

Within this jurisdiction lie IBWC levees along the Rio Grande that have not been demonstrated by the community or levee owner to meet the requirements of NFIP regulation 65.10 regarding its ability to provide protection from the 1-percent annual chance flood event. As such, the floodplain boundaries in this area are subject to change. Please refer to the Notice to Flood Insurance Study Users page at the front of this FIS report for more information on how this may affect the floodplain boundaries shown on this FIRM.

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

### 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 base flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to l foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies. Floodway analysis was not possible for some reaches in the steeply sloped portions of El Paso County. Increasing encroachments were minimal (only feasible at a few cross-sections) or resulted in a drop in water surface elevation and a resulting increase in velocity. Therefore, the encroachments were set to zero and floodway boundaries and floodway widths were set to those of the 1-percent annual chance floodplain.

The area between the floodway and the 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 (WSEL) of the base flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown on Figure 1, “Floodway Schematic.”

Table 12, provides floodway data for Flow Path 42, Flow Path 42A, Horizon Arroyo, McKelligon Canyon Arroyo, and McKelligon Canyon Arroyo Tributary 6. No floodways were computed for this communities in El Paso County prior to this study.

**Table 12: Floodway Data Table**

| FLOODING SOURCE | | FLOODWAY | | | 1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY (FEET NAVD)[2] | WITHOUT FLOODWAY (FEET NAVD)[2] | WITH FLOODWAY (FEET NAVD)[2] | INCREASE (FEET)[2] |
| FLOW PATH NO. 42 | | | | | | | | |
| A | 171 | 719.4 | 4,762.0 | 3.3 | 3,772.4 | 3,772.4 | 3,772.4 | 0 |
| B | 2,874 | 51.9 | 255.3 | 12.5 | 3,807.5 | 3,807.5 | 3,807.5 | 0 |
| C | 5,500 | 63.8 | 251.9 | 11.2 | 3,851.7 | 3,851.7 | 3,851.7 | 0 |
| D | 7,000 | 92.0 | 274.7 | 9.9 | 3,882.0 | 3,882.0 | 3,882.0 | 0 |

[1] Feet above confluence with the Rio Grande
[2] Floodway coincident with floodplain

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

**EL PASO COUNTY, TEXAS**

**AND INCORPORATED AREAS**

**FLOODWAY DATA**

**FLOW PATH NO. 42**

| FLOODING SOURCE | | FLOODWAY | | | 1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY (FEET NAVD)[2] | WITHOUT FLOODWAY (FEET NAVD)[2] | WITH FLOODWAY (FEET NAVD)[2] | INCREASE (FEET)[2] |
| FLOW PATH NO. 42A | | | | | | | | |
| A | 41 | 49.3 | 117.2 | 8.8 | 3,869.7 | 3,869.7 | 3,869.7 | 0 |
| B | 1,793 | 26.8 | 84.0 | 10.4 | 2,909.5 | 3,909.5 | 3,909.5 | 0 |

[1] Feet above confluence with Flow Path No. 42
[2] Flooding contained in channel.

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

**EL PASO COUNTY, TEXAS**

**AND INCORPORATED AREAS**

**FLOODWAY DATA**

**FLOW PATH NO. 42A**

| FLOODING SOURCE | | FLOODWAY | | | 1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY (FEET NAVD)[2] | WITHOUT FLOODWAY (FEET NAVD)[2] | WITH FLOODWAY (FEET NAVD)[2] | INCREASE (FEET)[2] |
| HORIZON ARROYO (Stream 2) | | | | | | | | |
| A | 243 | 130.3 | 652.6 | 14.3 | 3,658.4 | 3,658.5 | 3,658.5 | 0 |
| B | 1,472 | 134.0 | 660.96 | 14.0 | 3,697.7 | 3,697.7 | 3,697.7 | 0 |
| C | 2,587 | 349.6 | 1,138.9 | 13.6 | 3,628.8 | 3,728.8 | 3,728.8 | 0 |
| D | 3,436 | 135.9 | 649.7 | 12.6 | 3,747.2 | 3,747.2 | 3,747.2 | 0 |

[1] Feet above confluence with Mesa Spur Drain
[2] Floodway coincident with floodplain

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

**EL PASO COUNTY, TEXAS**

**AND INCORPORATED AREAS**

**FLOODWAY DATA**

**HORIZON ARROYO (Stream 2)**

| FLOODING SOURCE | | FLOODWAY | | | 1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY (FEET NAVD)[2] | WITHOUT FLOODWAY (FEET NAVD)[2] | WITH FLOODWAY (FEET NAVD)[2] | INCREASE (FEET)[2] |
| McKELLIGON CANYON ARROYO | | | | | | | | |
| A | 969 | 355.0 | 1,986.2 | 0.2 | 4,265.8 | 4,265.8 | 4,265.8 | 0 |
| B | 1,469 | 86.6 | 173.9 | 2.2 | 4,278.8 | 4,278.8 | 4,278.8 | 0 |
| C | 1,943 | 78.7 | 69.6 | 5.4 | 4,295.2 | 4,295.2 | 4,295.2 | 0 |
| D | 2,221 | 63.6 | 162.8 | 2.3 | 4,304.3 | 4,304.3 | 4,304.3 | 0 |
| E | 2,721 | 69.5 | 336.9 | 1.1 | 4,333.6 | 4,333.6 | 4,333.6 | 0 |
| F | 3,971 | 278.1 | 2,993.4 | 1.1 | 4,388.6 | 4,388.6 | 4,388.6 | 0 |
| G | 4,471 | 83.4 | 306.1 | 10.8 | 4,393.8 | 4,393.8 | 4,393.8 | 0 |
| H | 4,721 | 123.3 | 348.4 | 9.6 | 4,404.2 | 4,404.2 | 4,404.2 | 0 |
| I | 5,203 | 109.3 | 338.8 | 9.7 | 4,431.9 | 4,431.9 | 4,431.9 | 0 |
| J | 5,470 | 152.1 | 380.1 | 8.7 | 4,448.9 | 4,448.9 | 4,448.9 | 0 |
| K | 5,721 | 104.2 | 328.9 | 10.0 | 4,460.8 | 4,460.8 | 4,460.8 | 0 |
| L | 6,221 | 87.0 | 308.2 | 10.7 | 4,483.9 | 4,483.9 | 4,483.9 | 0 |
| M | 6,721 | 87.7 | 335.3 | 9.8 | 4,505.7 | 4,505.7 | 4,505.7 | 0 |
| N | 7,159 | 152.4 | 464.0 | 7.1 | 4,531.5 | 4,531.5 | 4,531.5 | 0 |
| O | 7,179 | 138.7 | 364.6 | 9.0 | 4,532.0 | 4,532.0 | 4,532.0 | 0 |

[1]Feet above confluence with the Rio Grande

[2]Floodway coincident with floodplain

TABLE 12

**FEDERAL EMERGENCY MANAGEMENT AGENCY**

**EL PASO COUNTY, TEXAS**

**AND INCORPORATED AREAS**

**FLOODWAY DATA**

**McKELLIGON CANYON ARROYO (Flow Path 17)**

| FLOODING SOURCE | | FLOODWAY | | | 1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY (FEET NAVD)[2] | WITHOUT FLOODWAY (FEET NAVD)[2] | WITH FLOODWAY (FEET NAVD)[2] | INCREASE (FEET)[2] |
| McKELLIGON CANYON ARROYO (continued) | | | | | | | | |
| P | 7,471 | 252.0 | 440.3 | 7.5 | 4,541.0 | 4,543.0 | 4,542.0 | 0 |
| Q | 7,769 | 253.4 | 437.3 | 7.5 | 4,552.8 | 4,552.8 | 4,552.8 | 0 |
| R | 7,971 | 148.9 | 378.3 | 8.7 | 4,563.7 | 4,563.7 | 4,563.7 | 0 |
| S | 8,341 | 207.9 | 411.5 | 8.0 | 4,582.1 | 4,582.1 | 4,582.1 | 0 |
| T | 8,368 | 153.0 | 373.1 | 8.8 | 4,584.9 | 4,584.9 | 4,584.9 | 0 |
| U | 8,721 | 117.2 | 334.2 | 9.9 | 4,604.1 | 4,604.1 | 4,604.1 | 0 |
| V | 9,221 | 136.7 | 357.6 | 9.2 | 4,628.0 | 4,628.0 | 4,628.0 | 0 |
| W | 9,471 | 82.7 | 125.2 | 7.0 | 4,641.0 | 4,641.0 | 4,641.0 | 0 |
| X | 9,721 | 41.6 | 100.0 | 8.8 | 4,658.0 | 4,658.0 | 4,658.0 | 0 |
| Y | 10,221 | 37.1 | 95.3 | 9.2 | 4,686.0 | 4,686.0 | 4,686.0 | 0 |
| Z | 10,704 | 24.7 | 82.3 | 10.7 | 4,715.5 | 4,715.5 | 4,715.5 | 0 |
| AA | 10,971 | 25.5 | 83.7 | 10.5 | 4,731.5 | 4,731.5 | 4,731.5 | 0 |
| AB | 11,471 | 40.3 | 99.0 | 9.0 | 4,769.9 | 4,769.9 | 4,769.9 | 0 |

[1] Feet above confluence with the Rio Grande [2] Floodway coincident with floodplain

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

**EL PASO COUNTY, TEXAS**

**AND INCORPORATED AREAS**

**FLOODWAY DATA**

**McKELLIGON CANYON ARROYO (Flow Path 17)**

| FLOODING SOURCE | | FLOODWAY | | | 1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY (FEET NAVD)[2] | WITHOUT FLOODWAY (FEET NAVD)[2] | WITH FLOODWAY (FEET NAVD)[2] | INCREASE (FEET)[2] |
| McKELLIGON CANYON ARROYO Tributary 6 | | | | | | | | |
| A | 31 | 108.8 | 155.5 | 6.7 | 4,637.5 | 4,637.5 | 4,637.5 | 0 |
| B | 87 | 142.9 | 169.2 | 6.2 | 4,645.5 | 4,645.5 | 4,645.5 | 0 |
| C | 480 | 184.4 | 210.3 | 5.0 | 4,665.2 | 4,665.2 | 4,665.2 | 0 |
| D | 750 | 217.4 | 191.8 | 5.4 | 4,682.6 | 4,682.6 | 4,682.6 | 0 |
| E | 1,240 | 57.0 | 122.9 | 8.5 | 4,704.4 | 4,704.4 | 4,704.4 | 0 |
| F | 1,447 | 107.8 | 152.8 | 6.8 | 4,717.0 | 4,717.0 | 4,717.0 | 0 |
| G | 1,750 | 63.2 | 128.0 | 8.1 | 4,737.7 | 4,737.7 | 4,737.7 | 0 |
| H | 2,012 | 75.5 | 138.1 | 7.5 | 4,752.3 | 4,752.3 | 4,752.3 | 0 |
| I | 2,287 | 34.6 | 103.8 | 10.0 | 4,763.9 | 4,763.9 | 4,763.9 | 0 |
| J | 2,399 | 89.5 | 144.4 | 7.2 | 4,781.9 | 4,781.9 | 4,781.9 | 0 |

[1] Feet above confluence with McKelligon Canyon Arroyo
[2] Floodway coincident with floodplain

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

**EL PASO COUNTY, TEXAS**

**AND INCORPORATED AREAS**

**FLOODWAY DATA**

**McKELLIGON CANYON ARROYO TRIBUTARY 6**

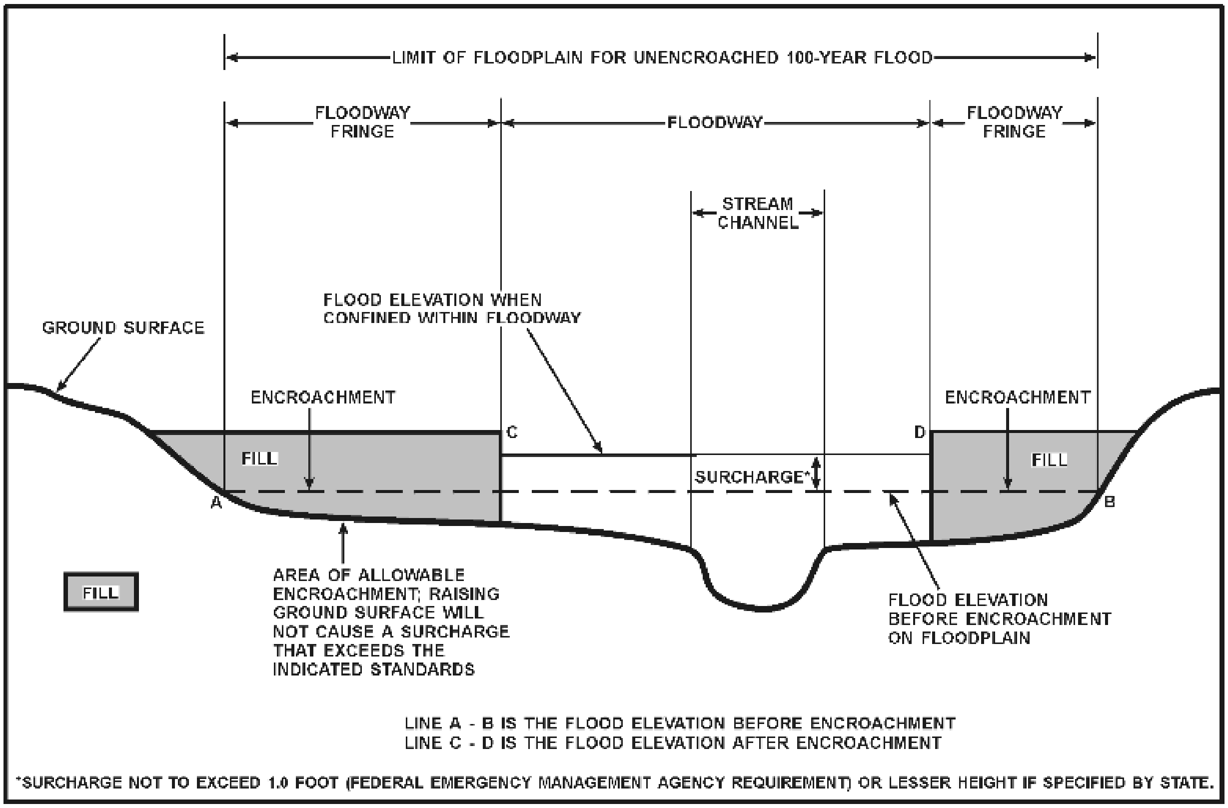


**Figure 1: Floodway Schematic**

## 5.0 INSURANCE APPLICATION

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

Zone A

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

Zone AE

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

Zone AH

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

Zone AO

Zone AO is the flood insurance rate zone that corresponds to 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 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 one 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.

## 6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map (FIRM) is designed for flood insurance and floodplain management applications.

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

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

The current FIRM presents flooding information for the entire geographic area of El Paso County. Previously, separate FIRMs were prepared for each identified floodprone incorporated community and for the unincorporated areas of the county. Historical data relating to the maps prepared for each community are presented in Table 13 “Community Map History.”

Within this jurisdiction lie IBWC levees along the Rio Grande that have not been demonstrated by the community or levee owner to meet the requirements of NFIP regulation 65.10 regarding its ability to provide protection from the 1-percent annual chance flood event. Please refer to the Notice to Flood Insurance Study Users page at the front of this FIS report for more information on how this may affect the FIRM.

## 7.0 OTHER STUDIES

This FIS report either supersedes or is compatible with all previous studies (References 1 and 2) published on streams studied in this report and should be considered authoritative for the purposes of the NFIP.

This is a multi-volume FIS. Each volume may be revised separately, in which case it supersedes the previously printed volume. Users should refer to the Table of Contents in Volume 1 for the current effective date of each volume; volumes bearing these dates contain the most up-to-date flood hazard data.

**Table 13: Community Map History Table**

| COMMUNITY NAME | INITIAL IDENTIFICATION | FLOOD HAZARD BOUNDARY MAP REVISIONS DATE | FIRM EFFECTIVE DATE | FIRM REVISONS DATE |
|---|---|---|---|---|
| Anthony, Town of | January 24, 1975 | None | August 1, 1987 | |
| Clint, Town of | November 19, 1976 | None | July 1, 1987 | |
| El Paso, City of | November 29, 1977 | None | October 15, 1982 | February 5, 1986<br>June 15, 1988<br>August 5, 1991<br>January 3, 1997<br>February 16, 2006 |
| El Paso County (Unincorporated Areas) | September 13, 1974 | July 19, 1977 | September 4, 1991 | |
| Horizon City, Town of[1]* | September 13, 1974 | July 19, 1977 | September 4, 1991 | |
| San Elizario, City of* | September 13, 1974 | July 19, 1977 | September 4, 1991 | |
| Socorro, City of* | September 13, 1974 | July 19, 1977 | September 4, 1991 | |
| Vinton, Village of | June 24, 1980 | None | None | |
| Ysleta Del Sur Pueblo† | November 29, 1977 | None | October 15, 1982 | February 5, 1986<br>June 15, 1988<br>August 5, 1991<br>January 3, 1997<br>February 16, 2006 |

* All dates taken from the Unincorporated Areas of El Paso County
† All dates taken from City of El Paso
[1] No Special Flood Hazards Areas identified.

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

**EL PASO COUNTY, TEXAS**
**AND INCORPORATED AREAS**

**COMMUNITY MAP HISTORY**

## 8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting:

Federal Insurance and Mitigation Division,

FEMA Region VI, Federal Insurance and Mitigation Division,

800 North Loop 288,

Denton, Texas 76209

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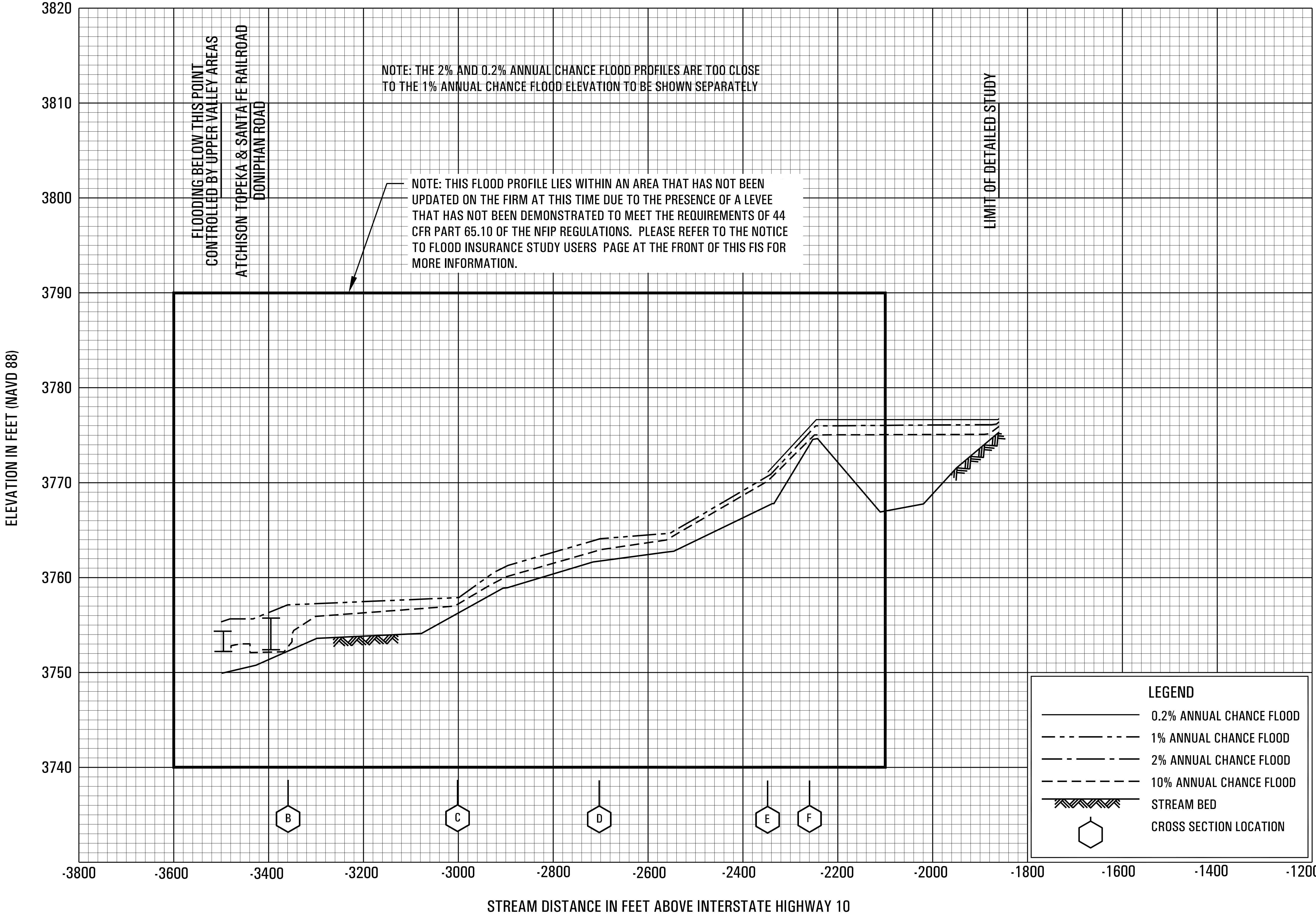


FLOOD PROFILES

ARROYO 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, TX

AND INCORPORATED AREAS

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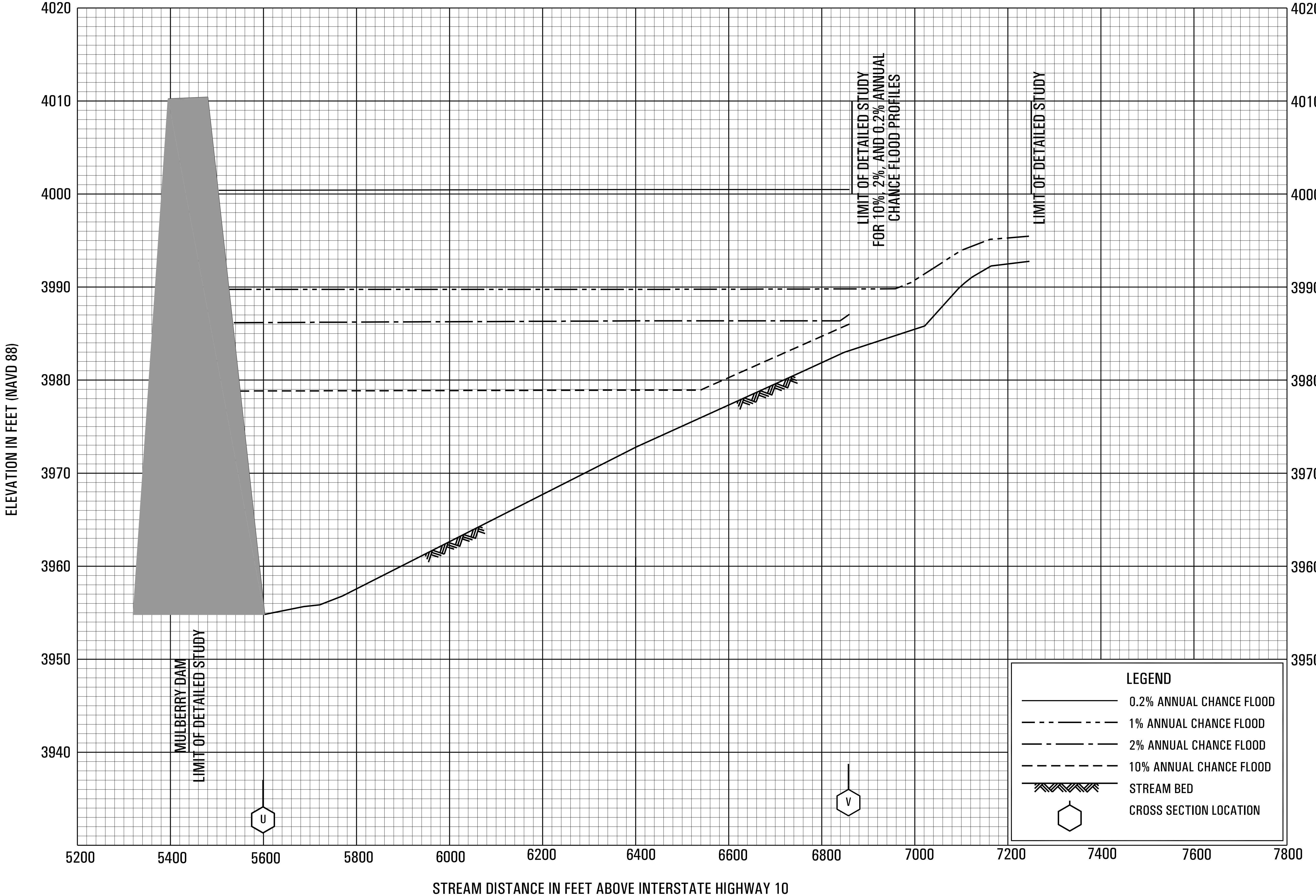


# FLOOD PROFILES

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FEDERAL EMERGENCY MANAGEMENT AGENCY

## EL PASO COUNTY, TX
AND INCORPORATED AREAS

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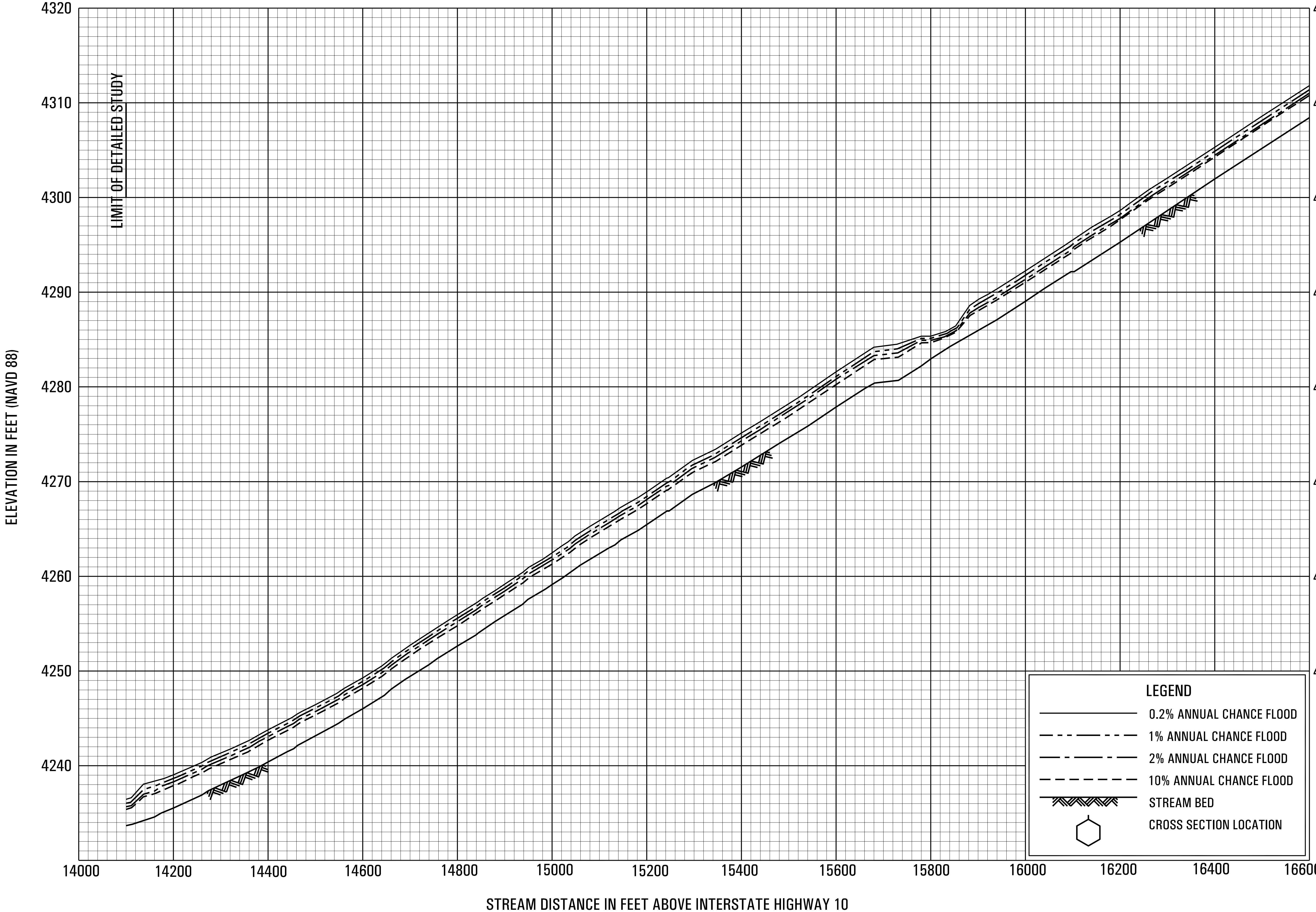


FLOOD PROFILES

ARROYO 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, TX

AND INCORPORATED AREAS

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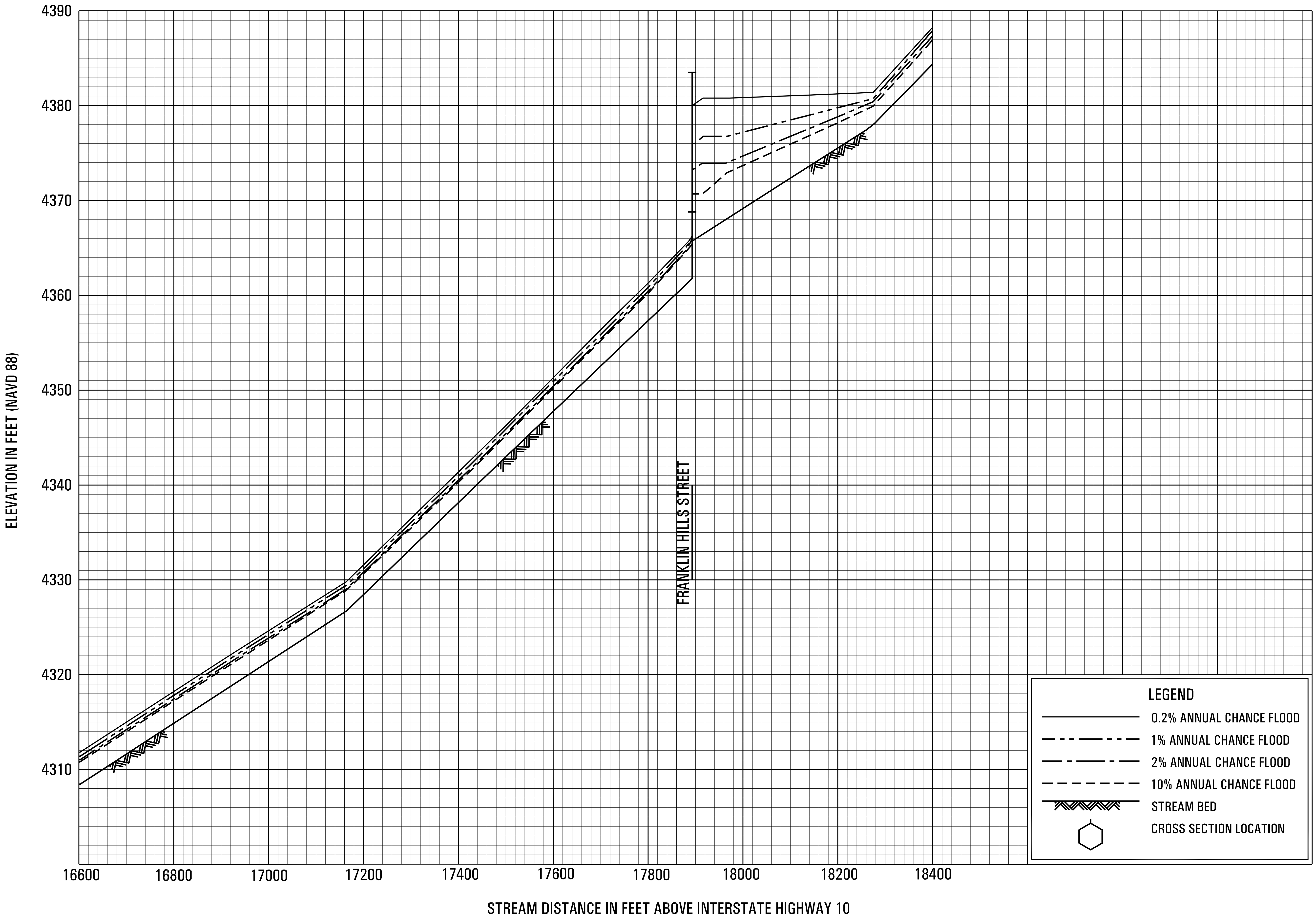


# FLOOD PROFILES

## ARROYO 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

## EL PASO COUNTY, TX

AND INCORPORATED AREAS

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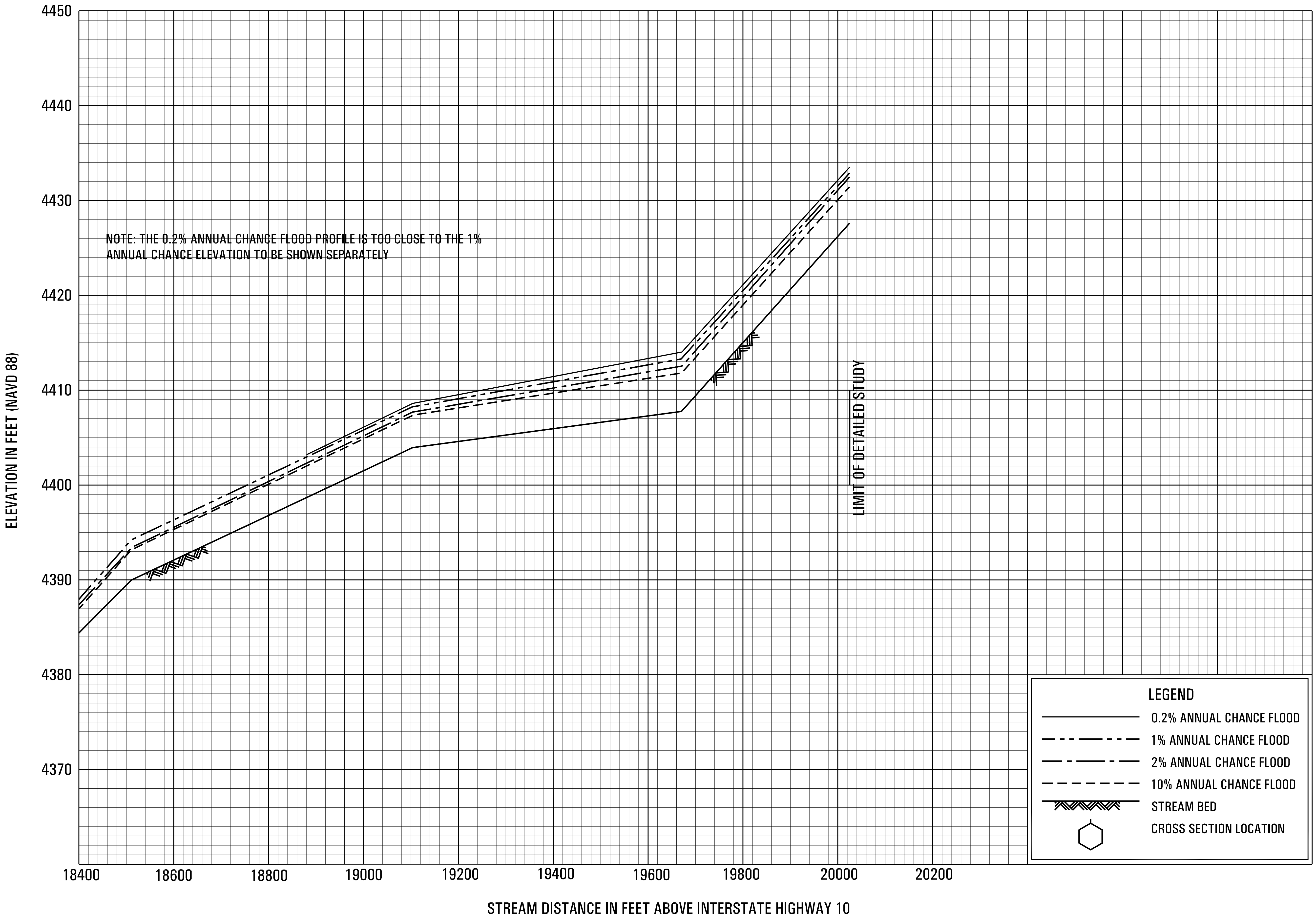


# FLOOD PROFILES

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FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, TX
AND INCORPORATED AREAS

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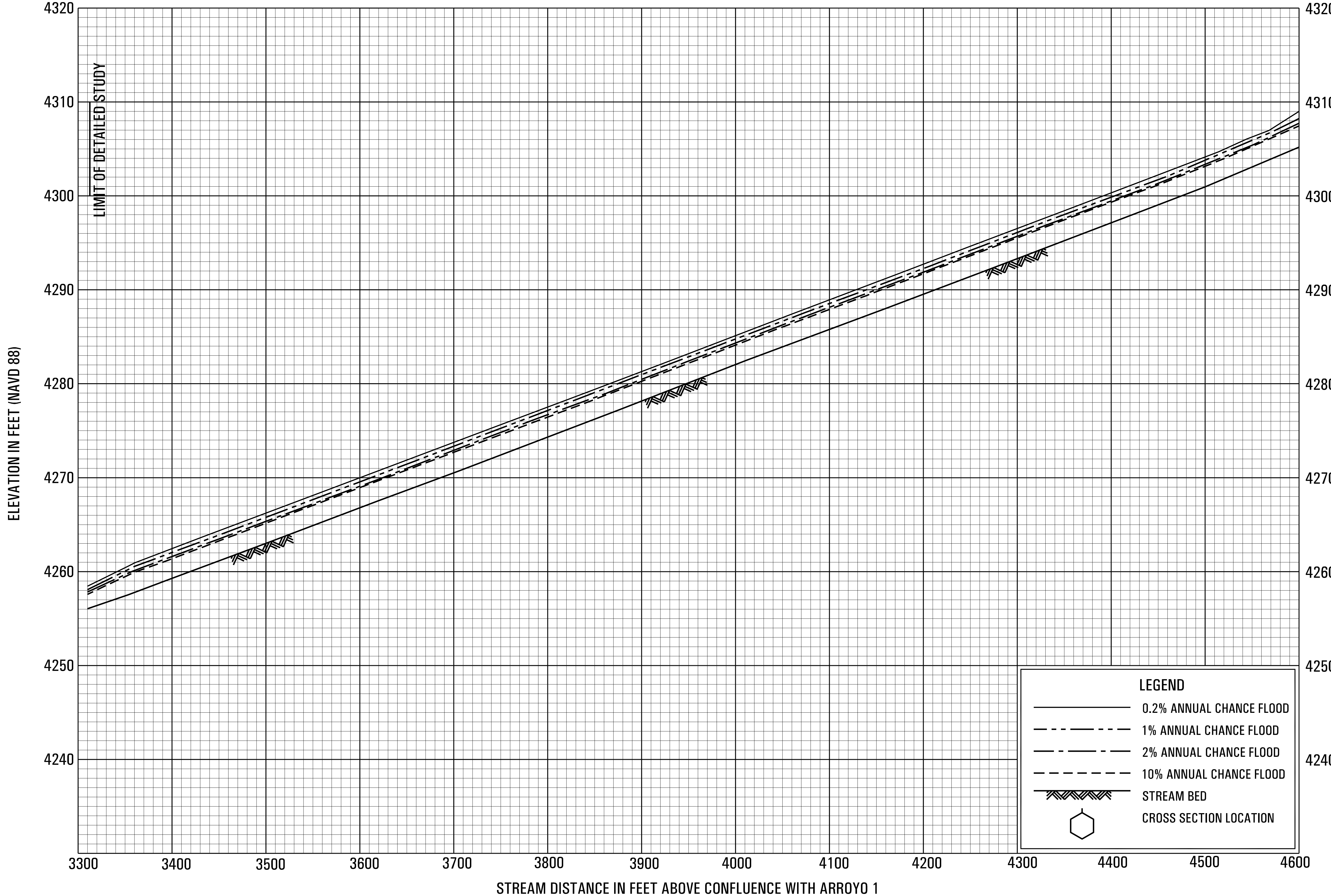


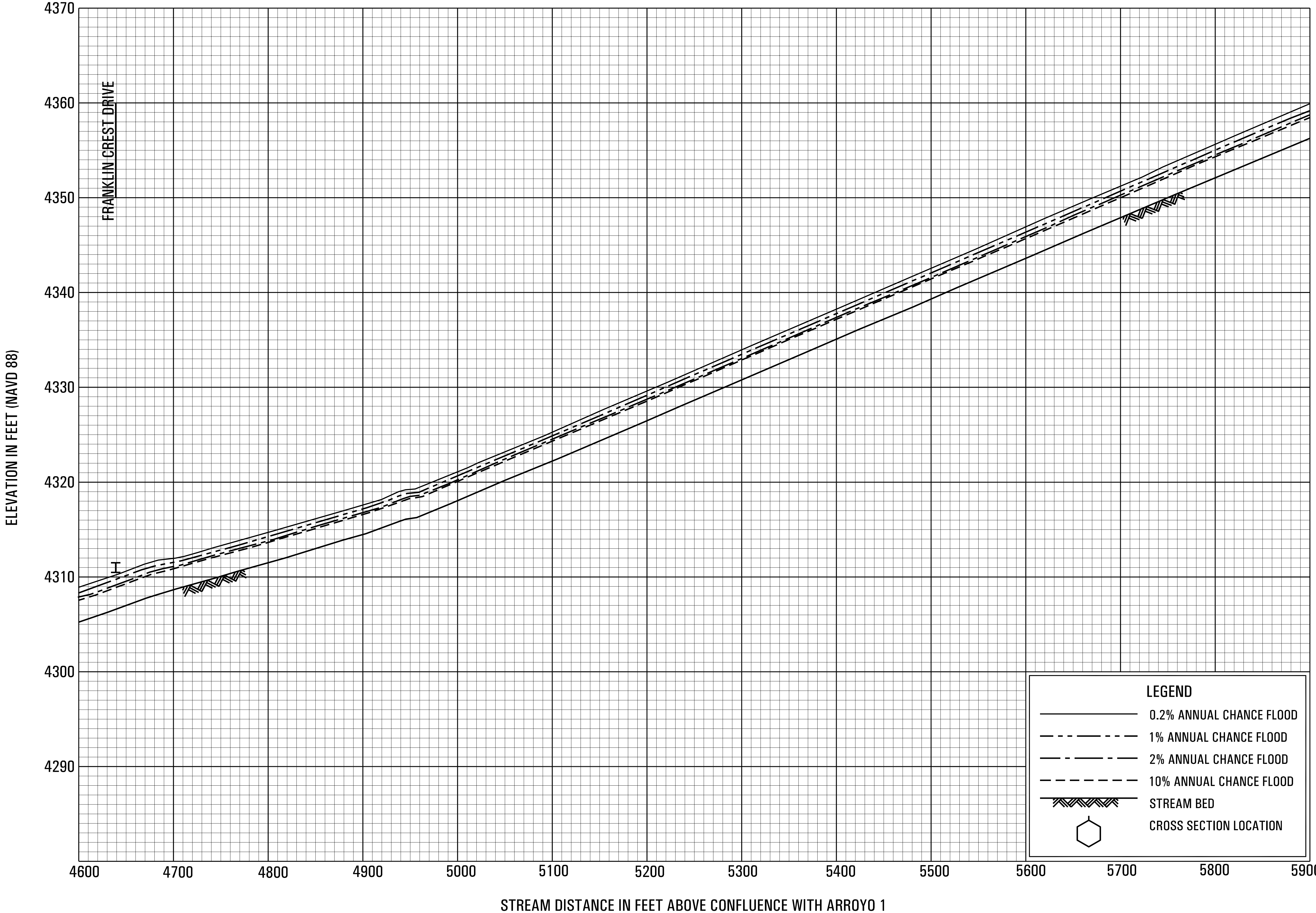

FLOOD PROFILES

ARROYO 1A

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, TX

AND INCORPORATED AREAS

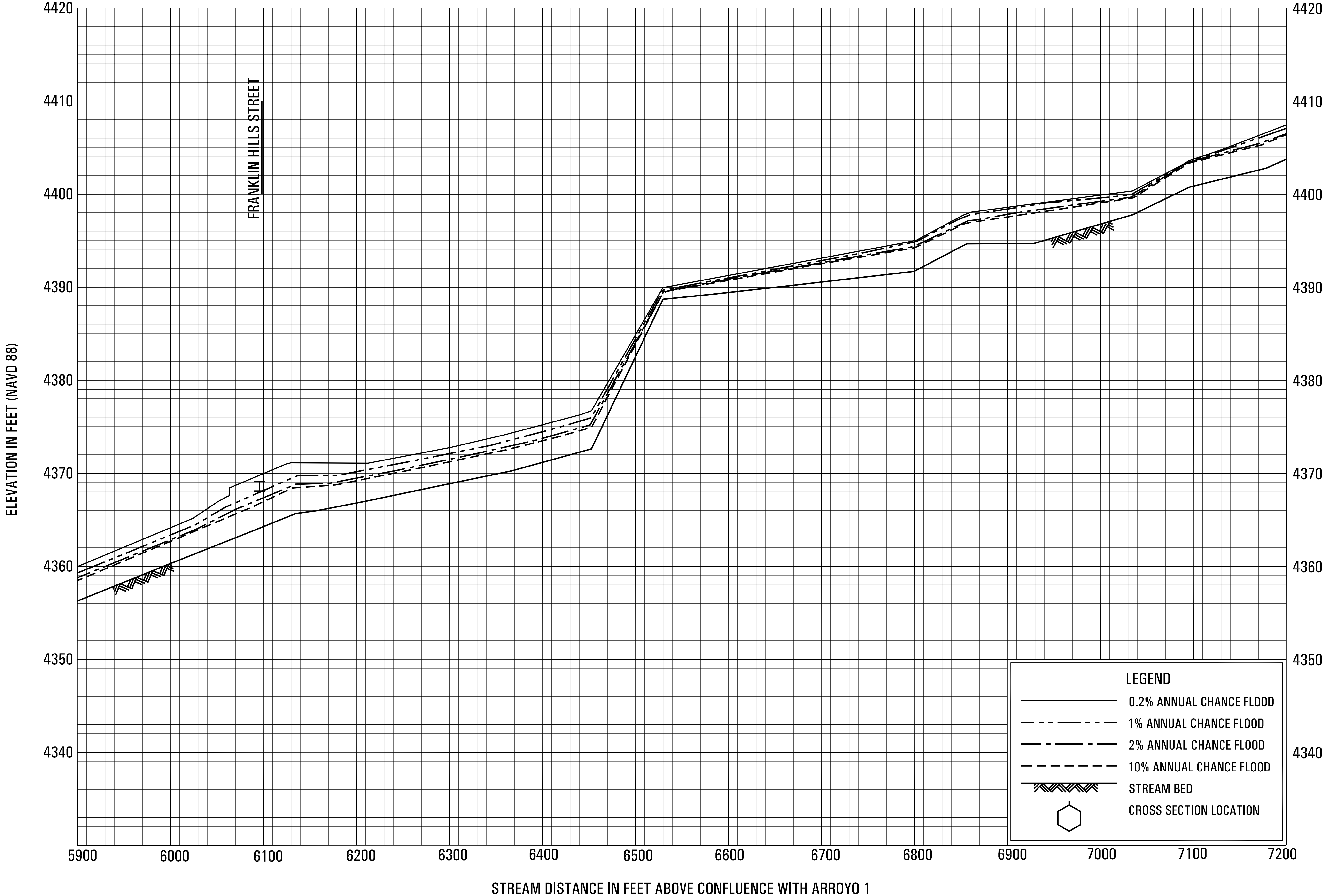



FLOOD PROFILES

ARROYO 1A

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, TX
AND INCORPORATED AREAS




FLOOD PROFILES

ARROYO 1A

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, TX

AND INCORPORATED AREAS

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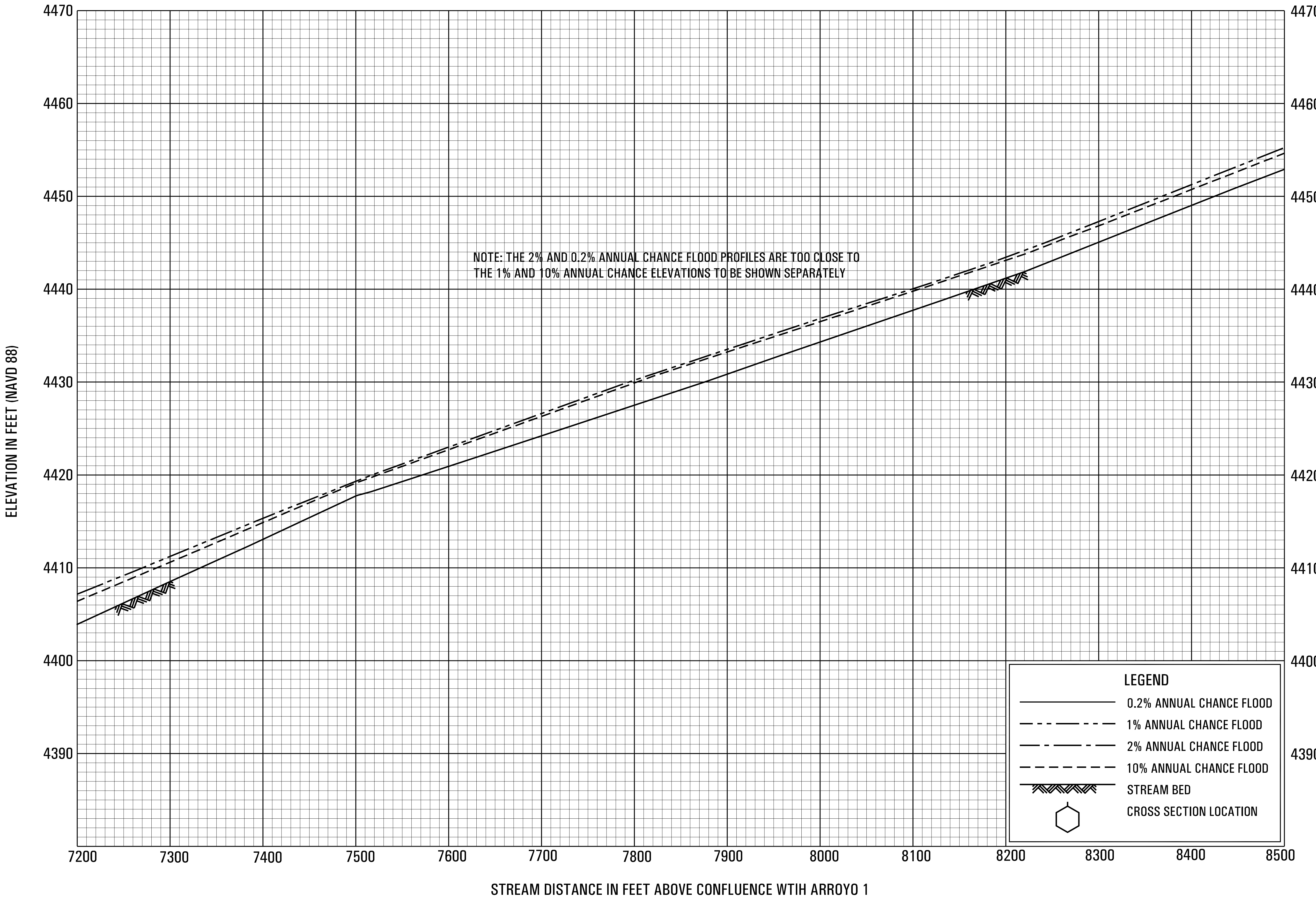


FLOOD PROFILES

ARROYO 1A

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, TX

AND INCORPORATED AREAS

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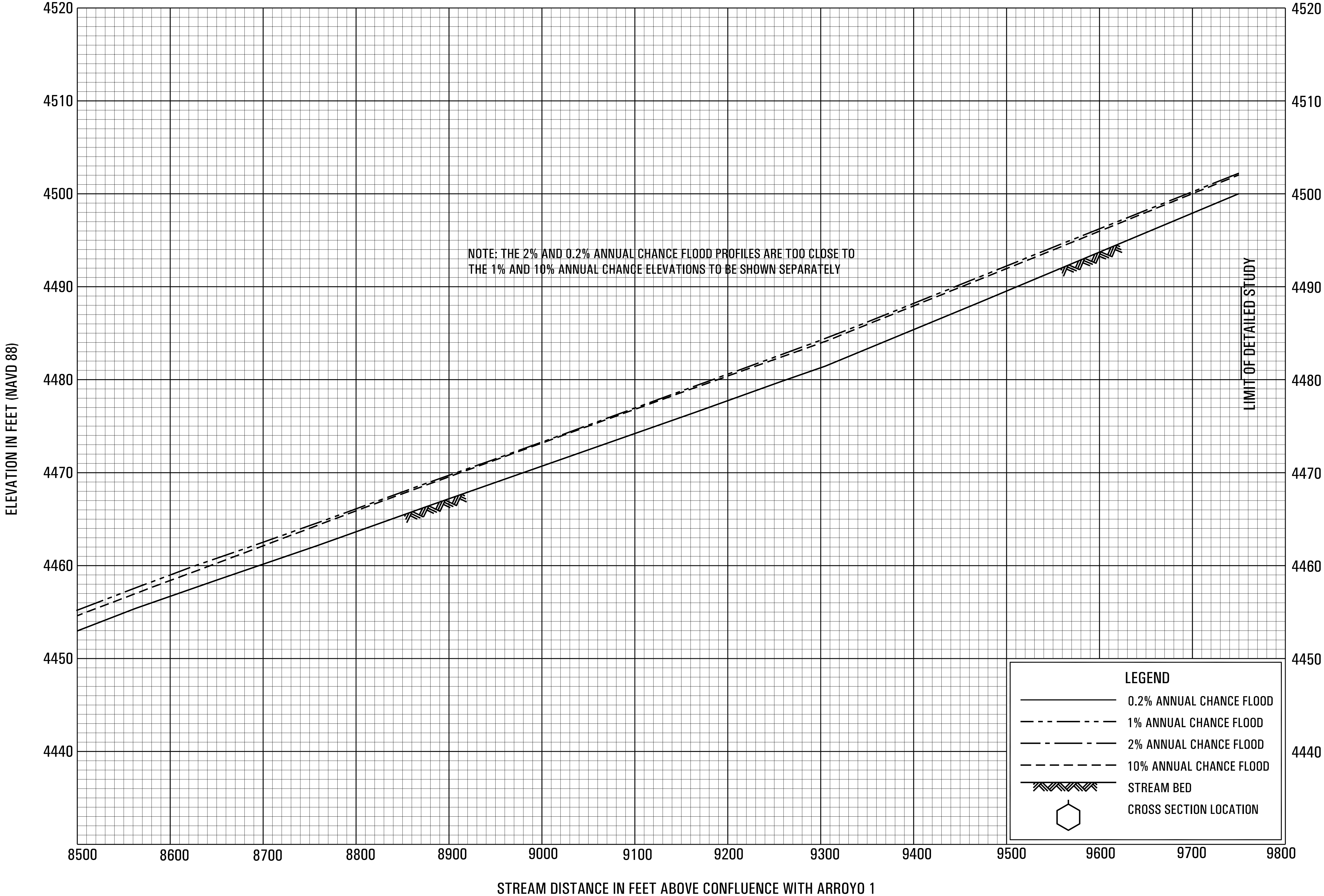


FLOOD PROFILES

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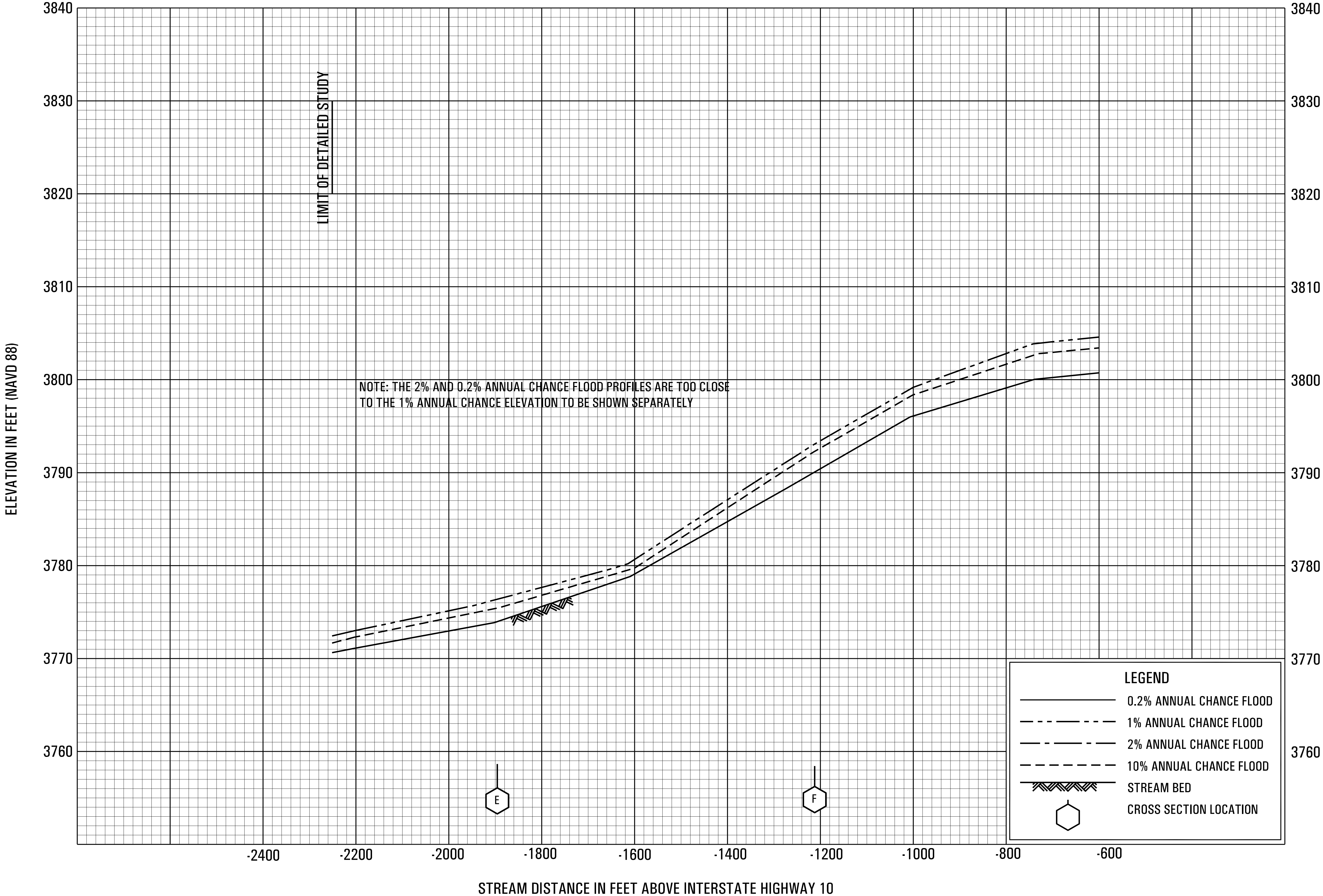
FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, TX
AND INCORPORATED AREAS



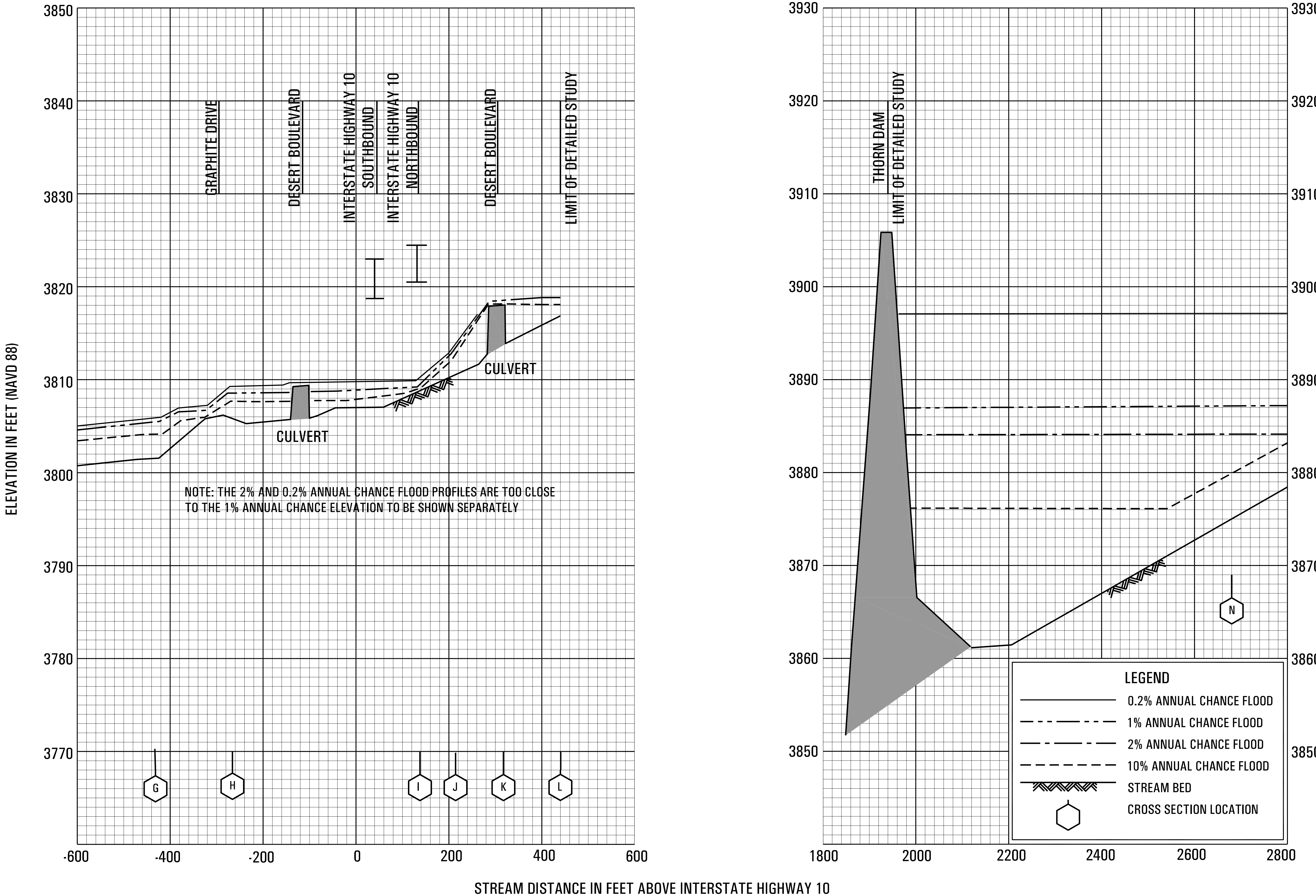

FLOOD PROFILES

ARROYO 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, TX

AND INCORPORATED AREAS




# FLOOD PROFILES

ARROYO 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, TX

AND INCORPORATED AREAS

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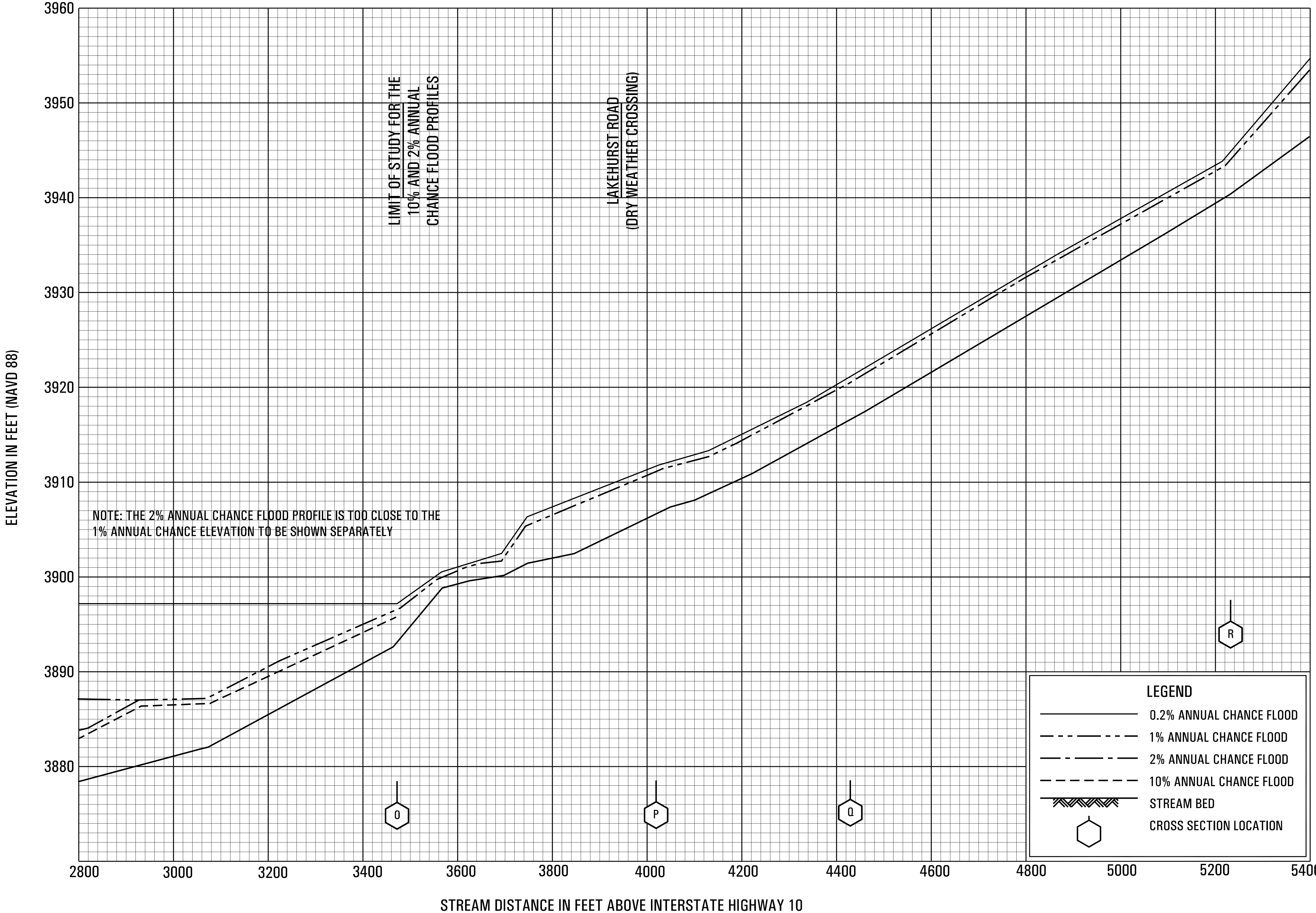


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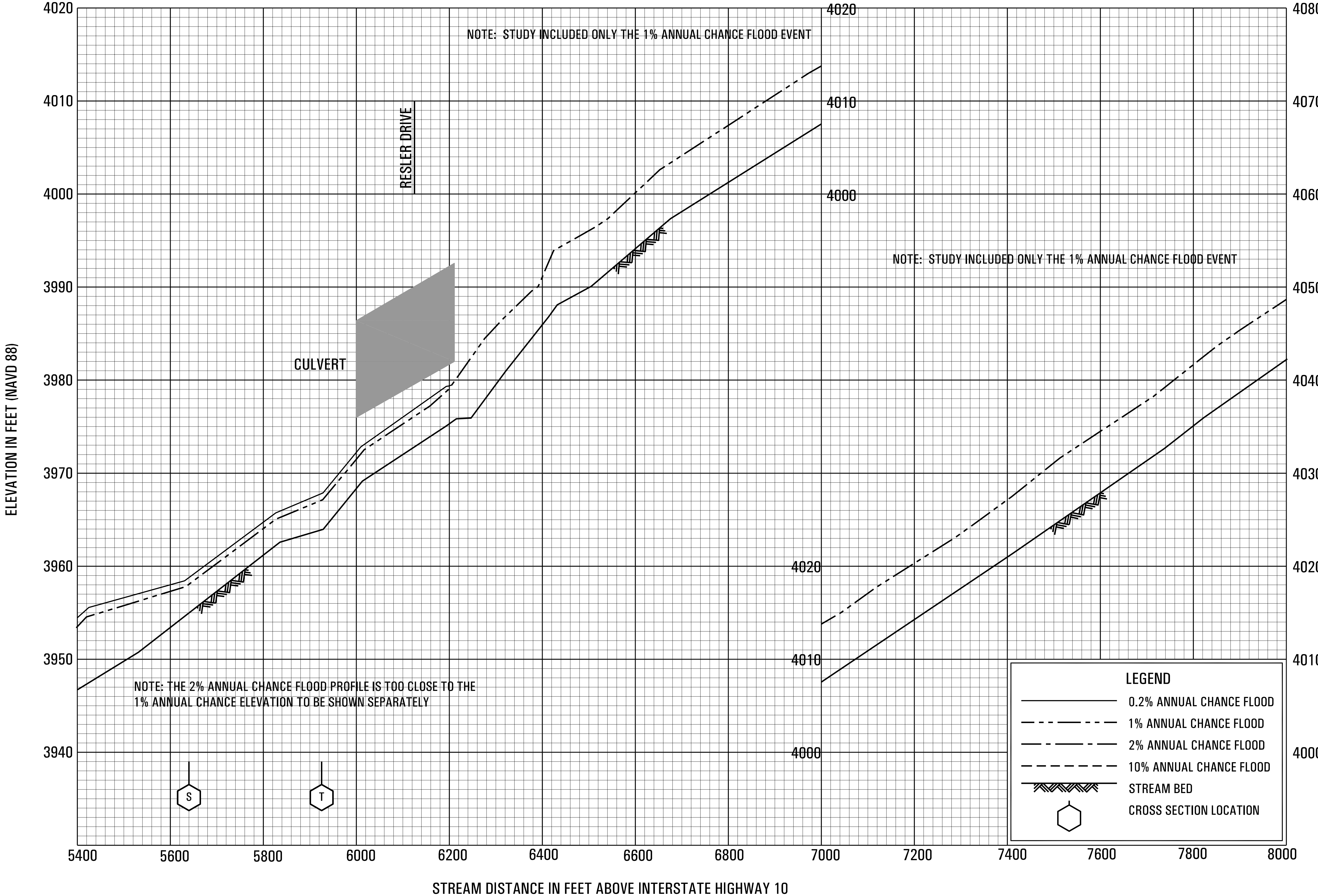
EL PASO COUNTY, TX

AND INCORPORATED AREAS

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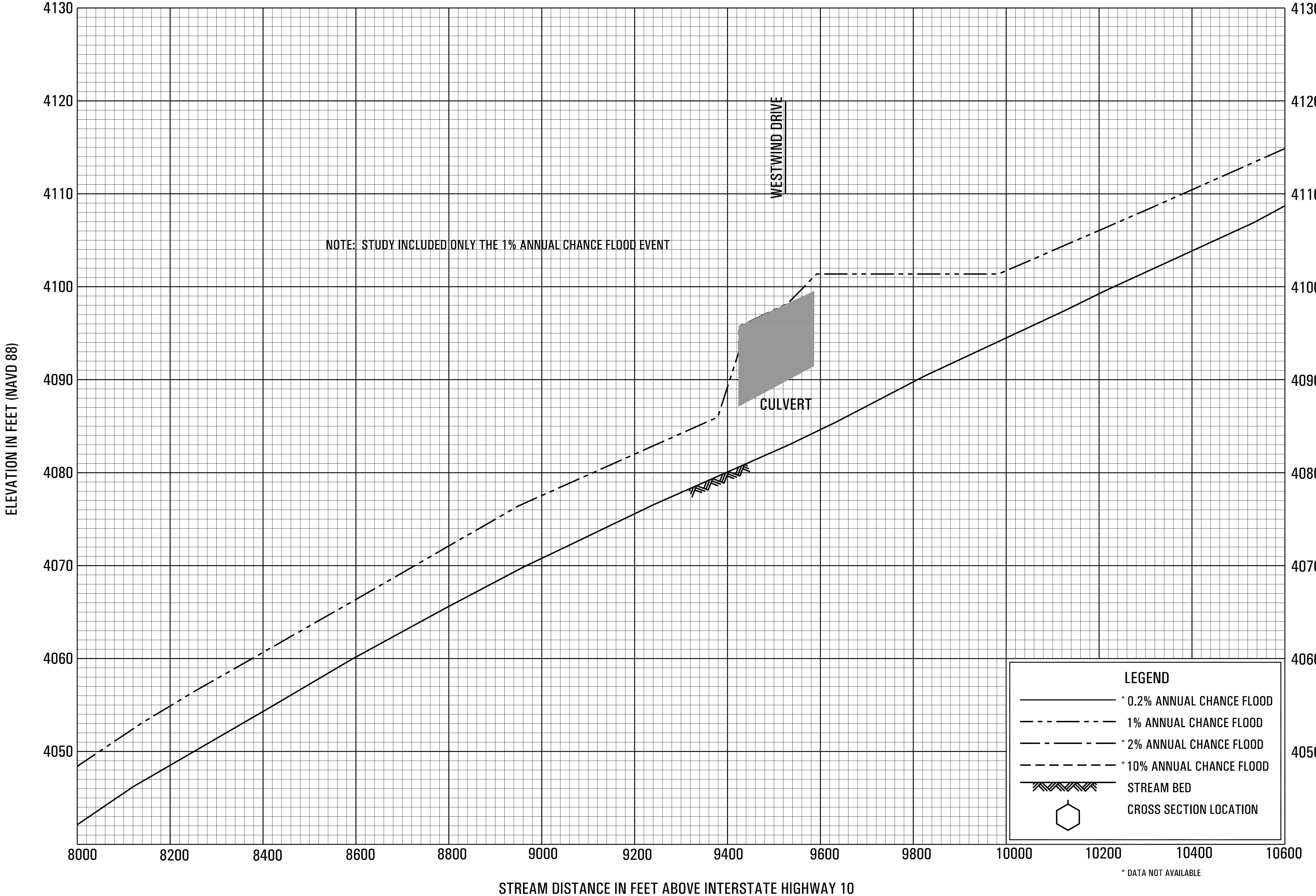
EL PASO COUNTY, TX
AND INCORPORATED AREAS




FLOOD PROFILES

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EL PASO COUNTY, TX

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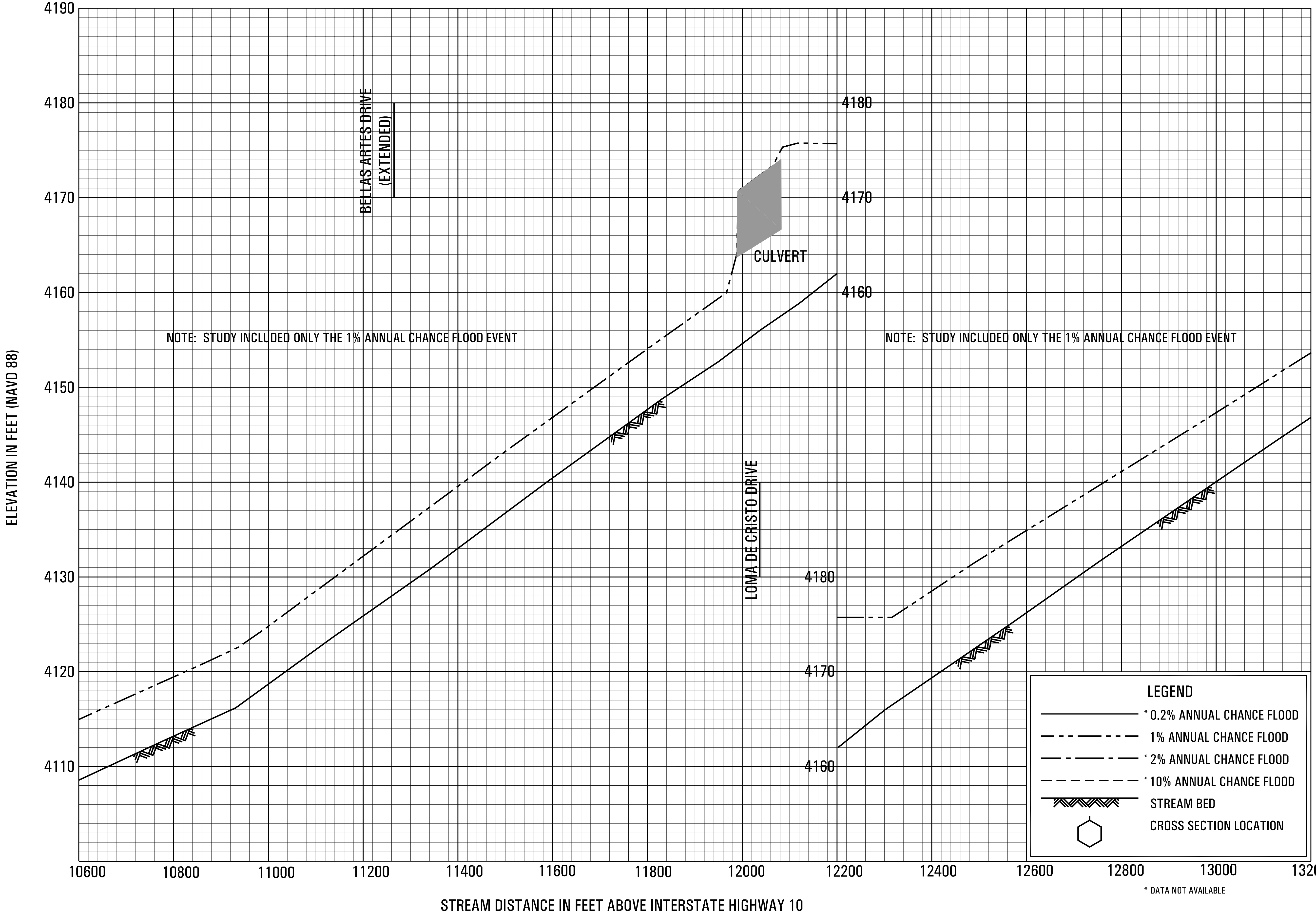


FLOOD PROFILES

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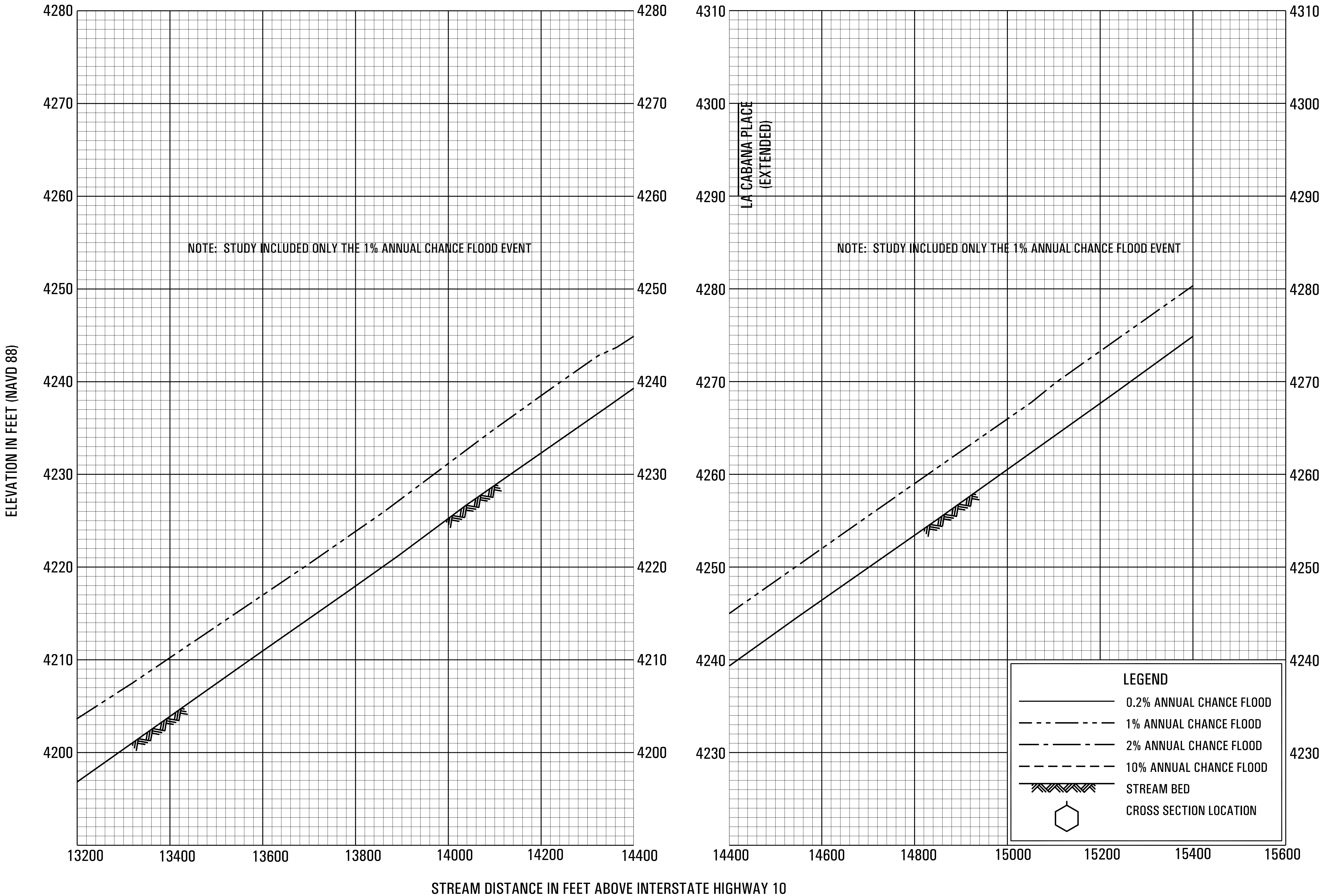


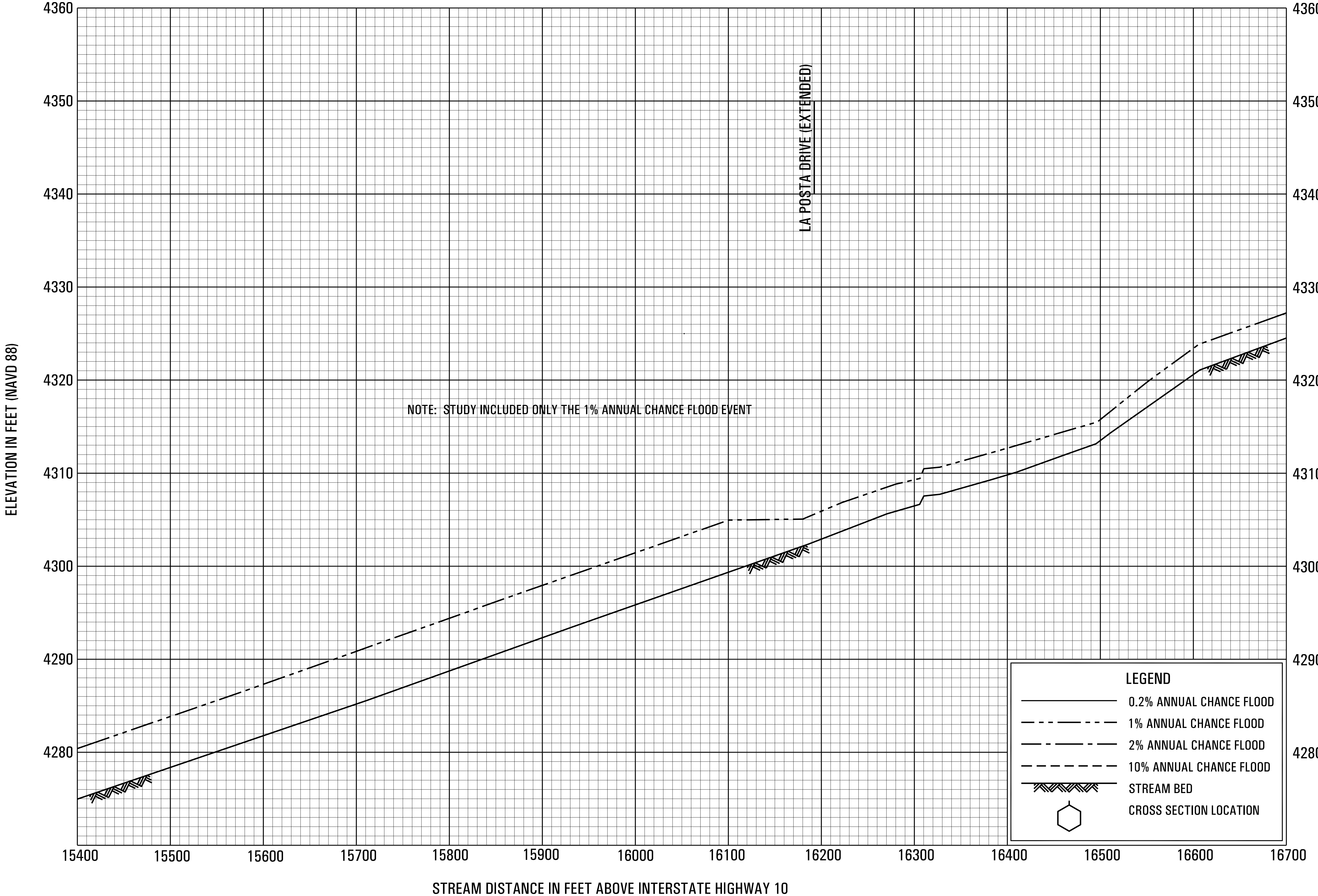

# FLOOD PROFILES

## ARROYO 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

## EL PASO COUNTY, TX

AND INCORPORATED AREAS



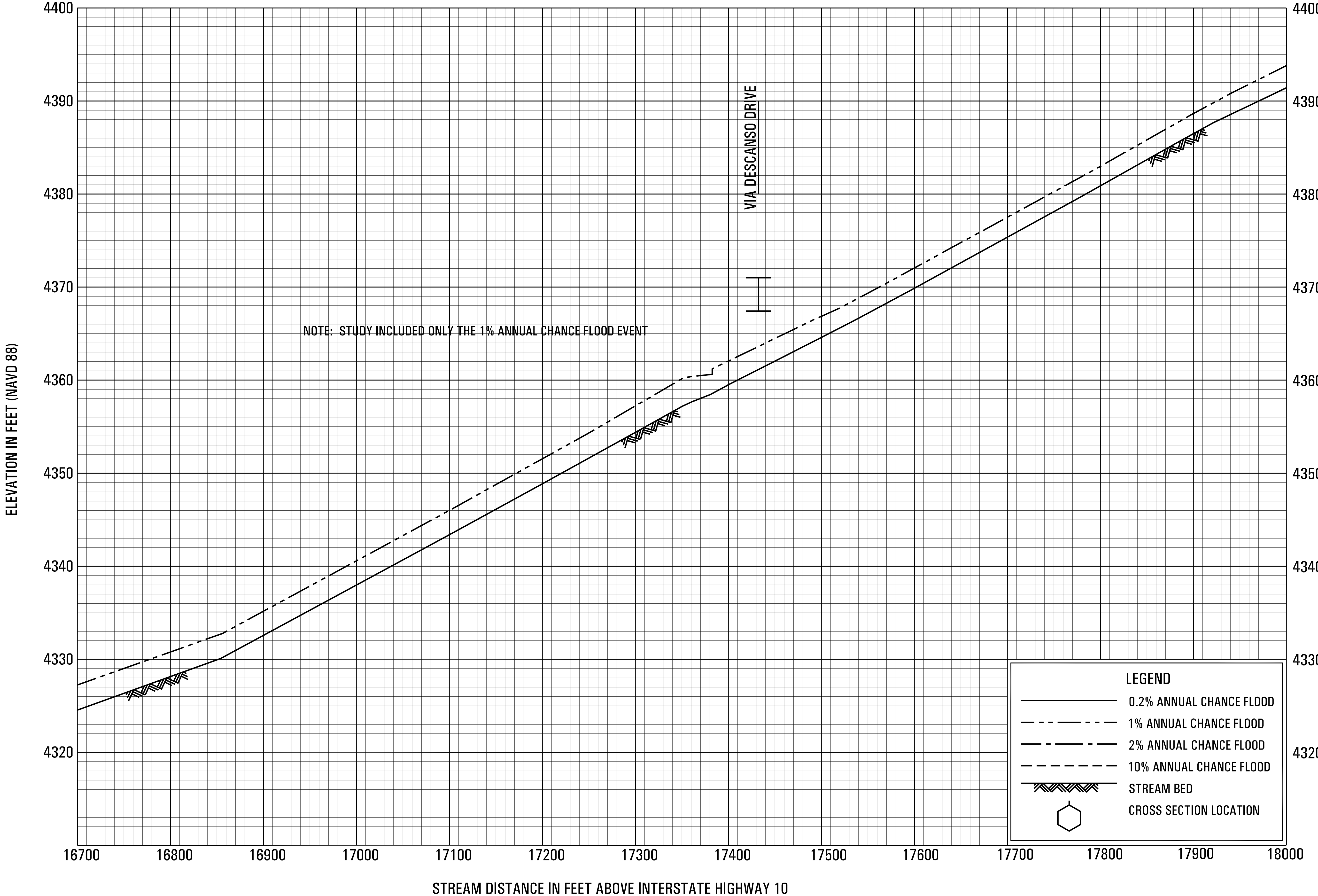

FLOOD PROFILES

ARROYO 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, TX

AND INCORPORATED AREAS




FLOOD PROFILES

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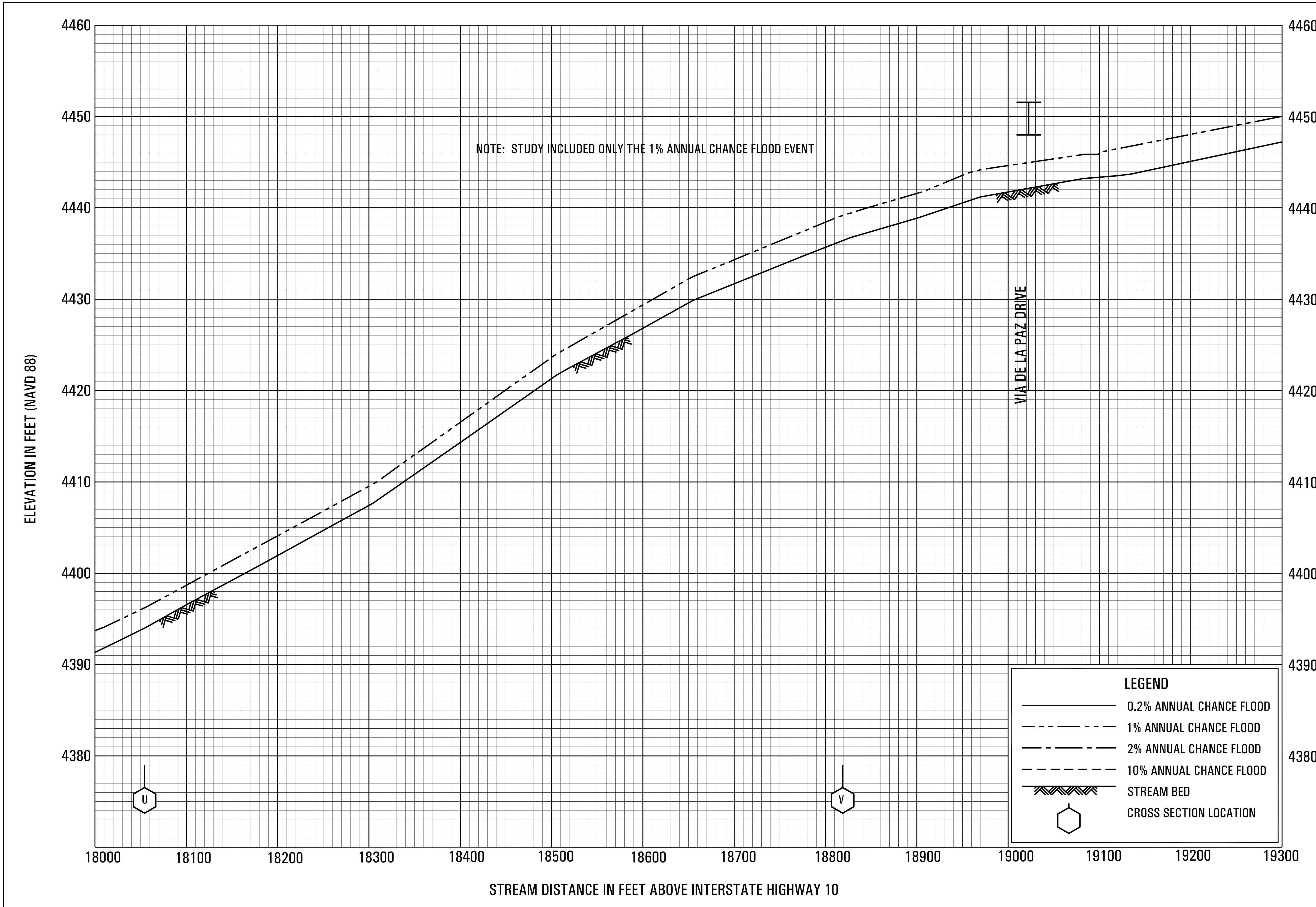
EL PASO COUNTY, TX

AND INCORPORATED AREAS



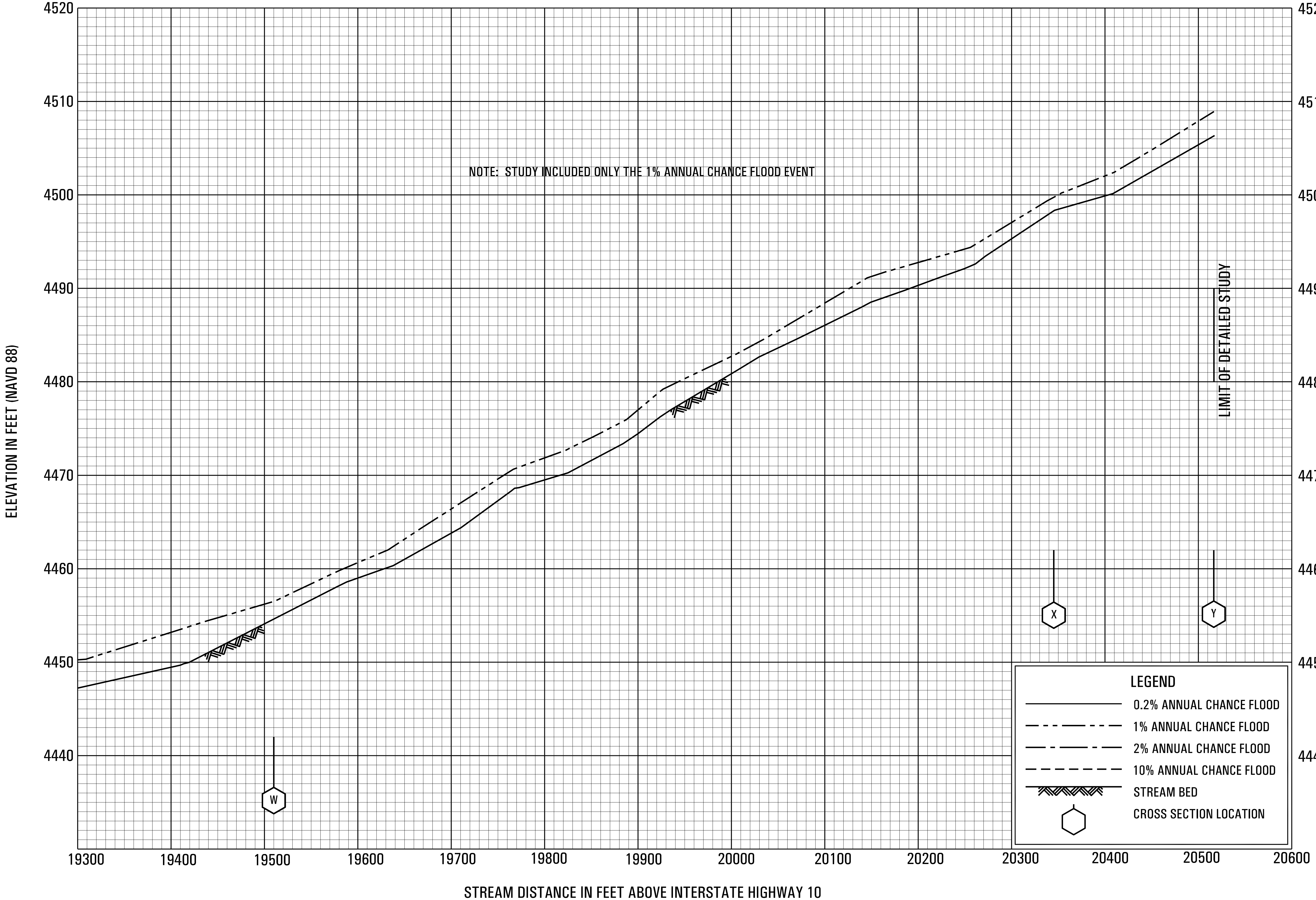

FLOOD PROFILES

ARROYO 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, TX

AND INCORPORATED AREAS

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ARROYO 2

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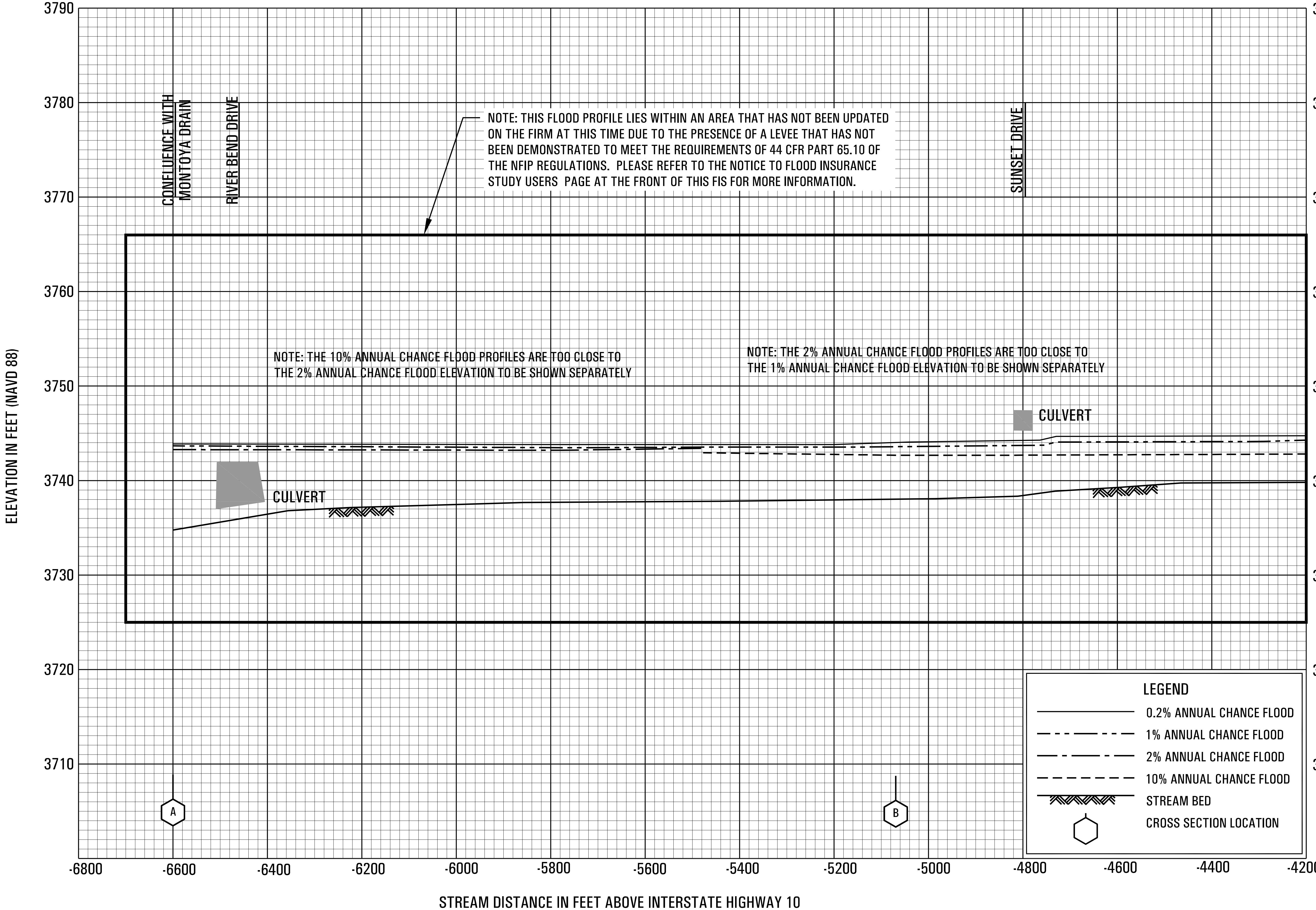
AND INCORPORATED AREAS

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ARROYO 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

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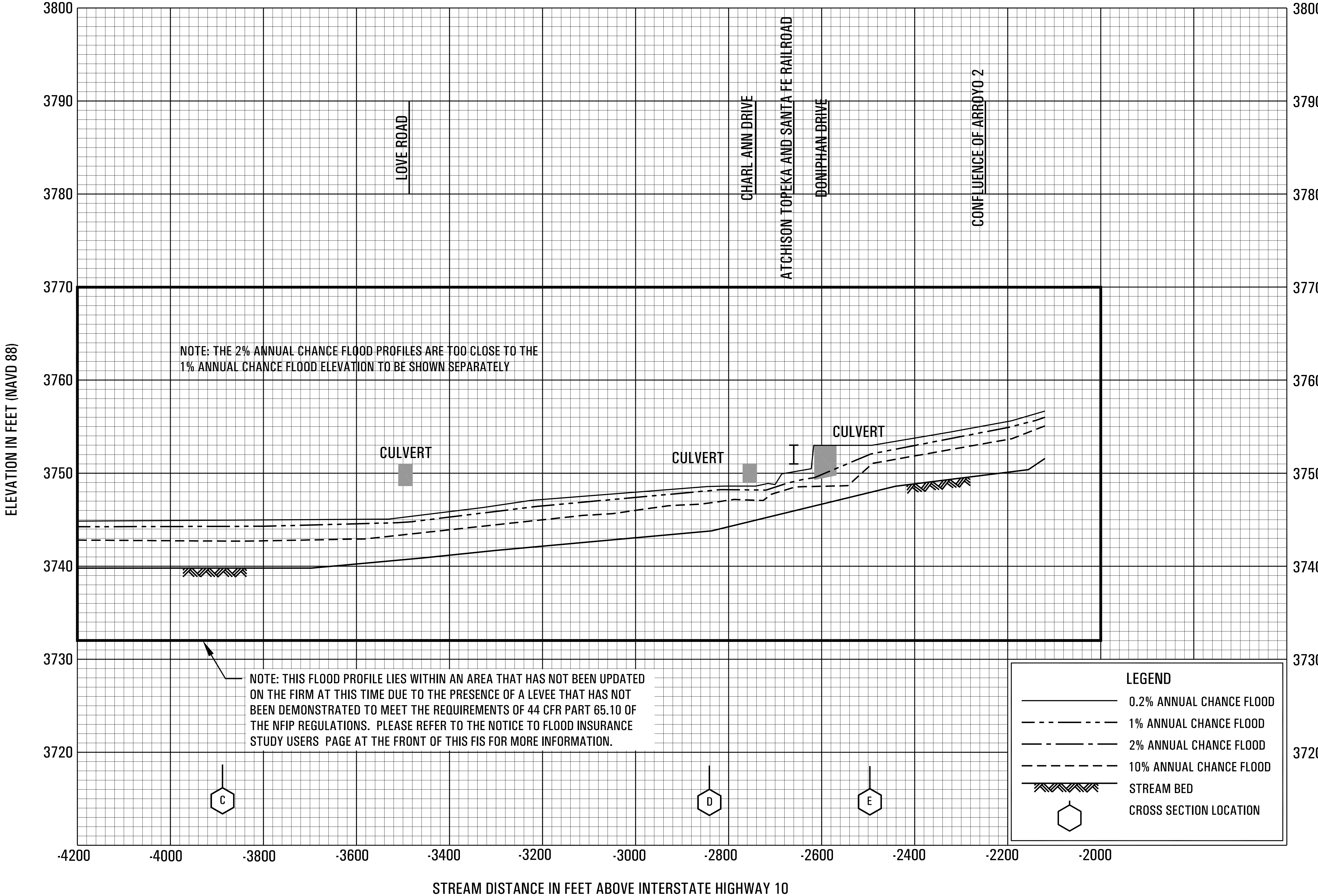


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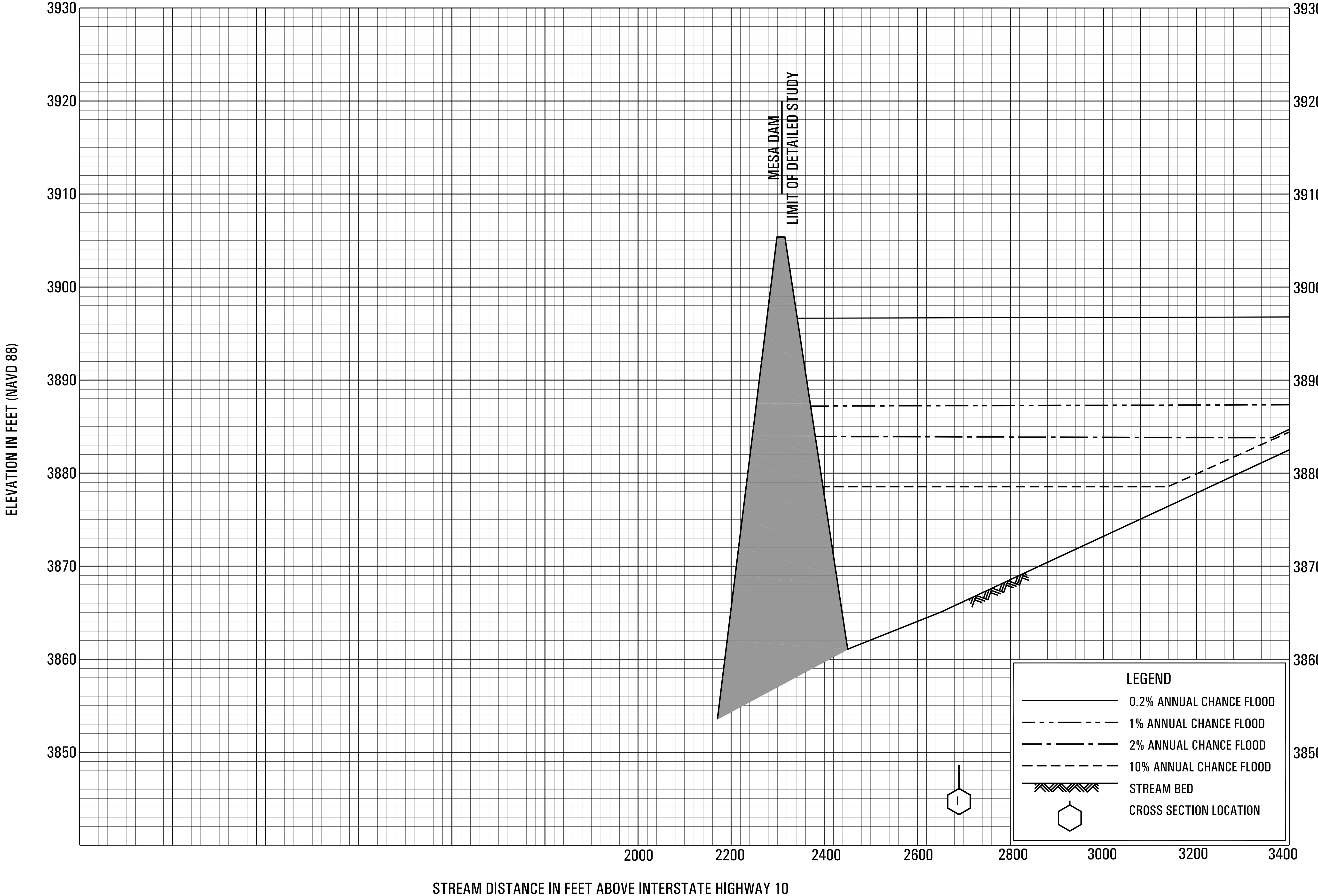


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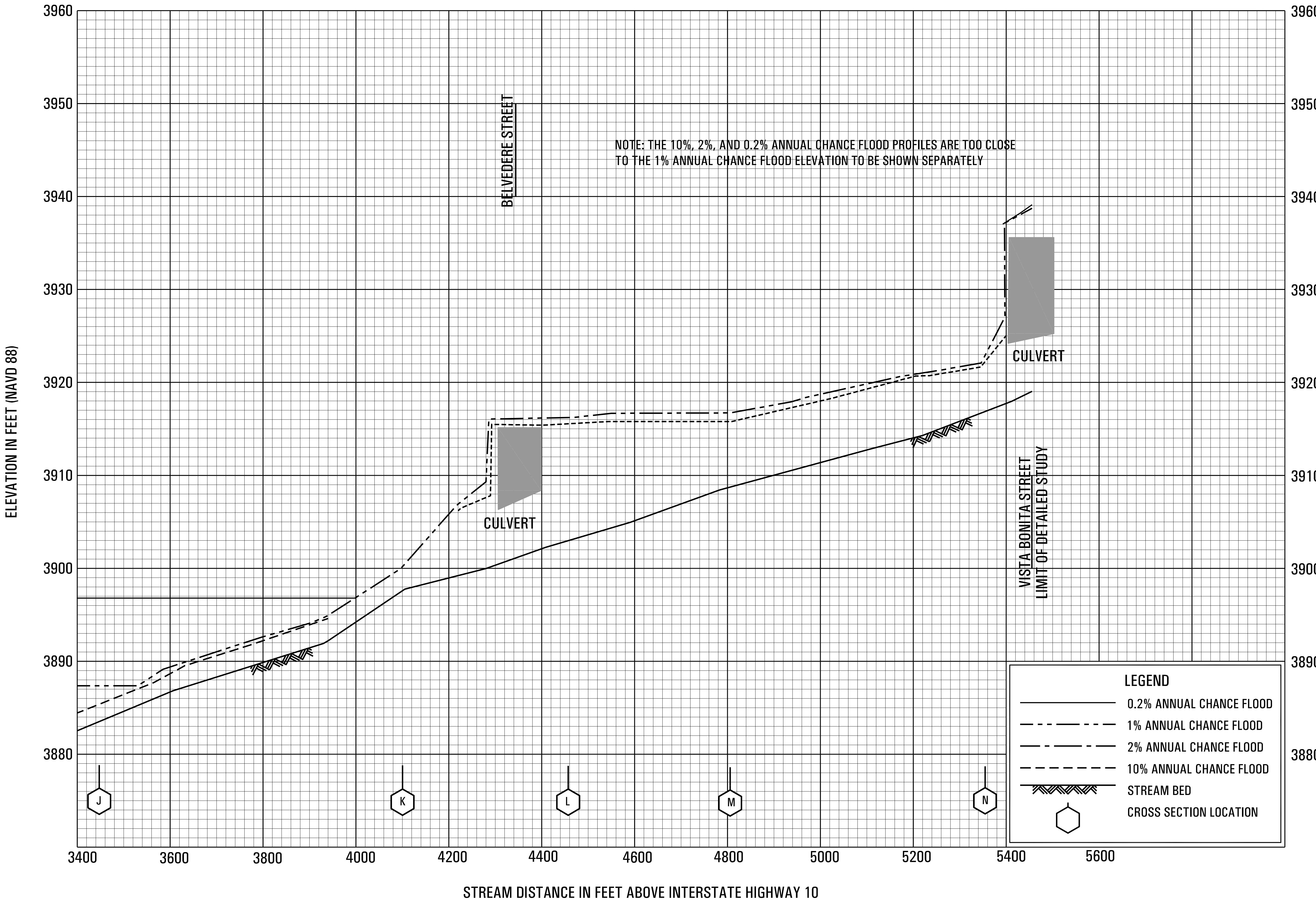


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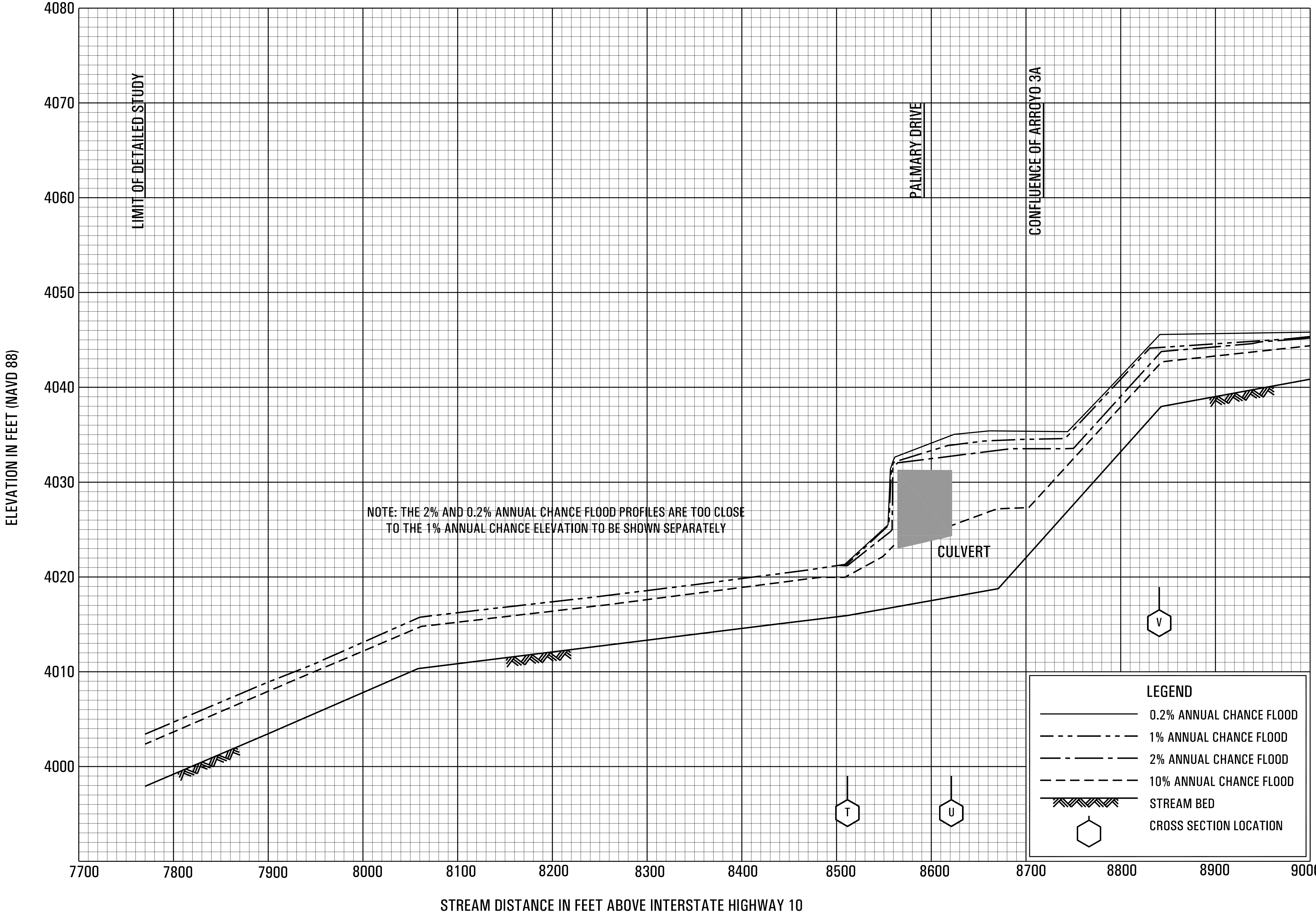


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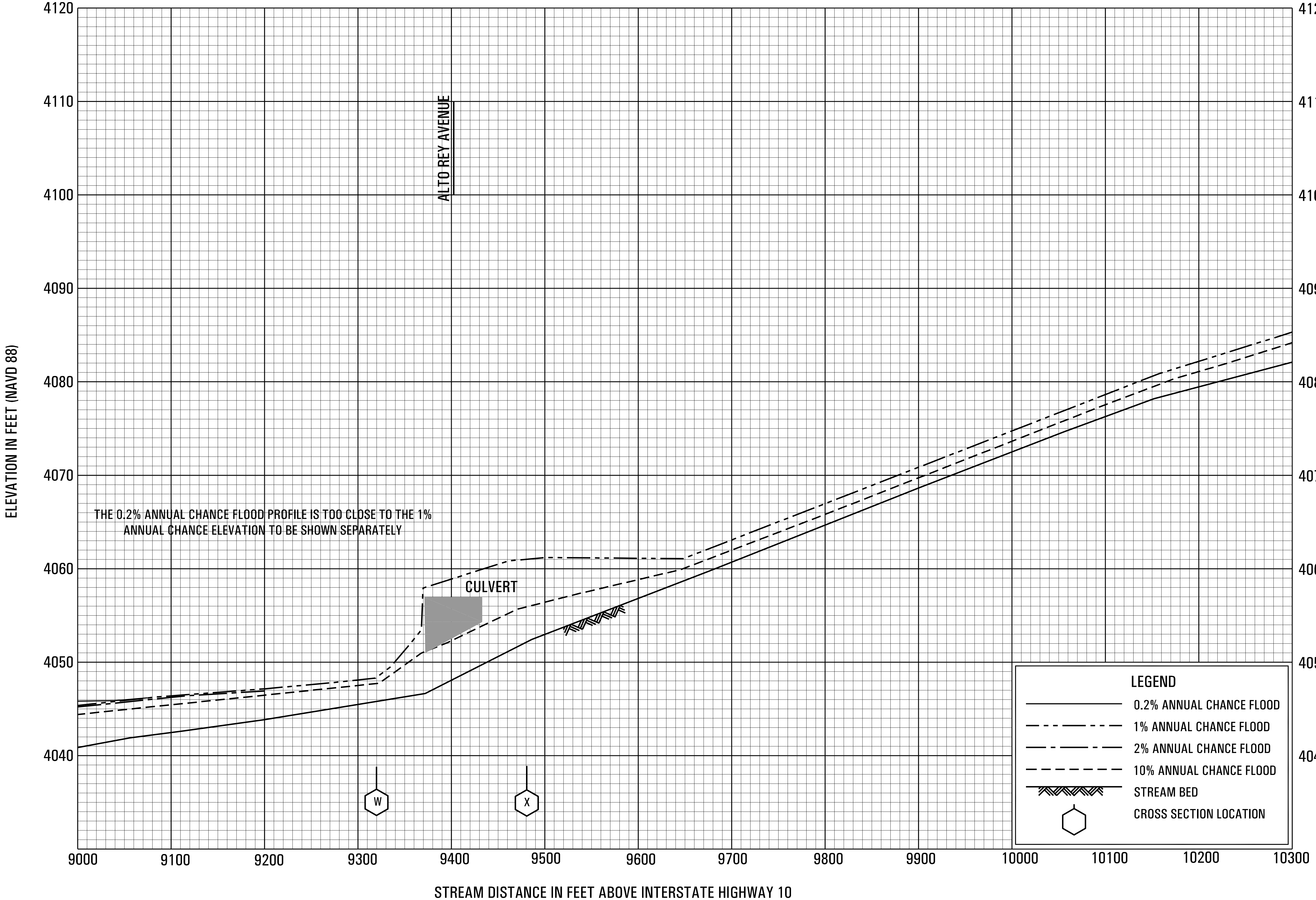


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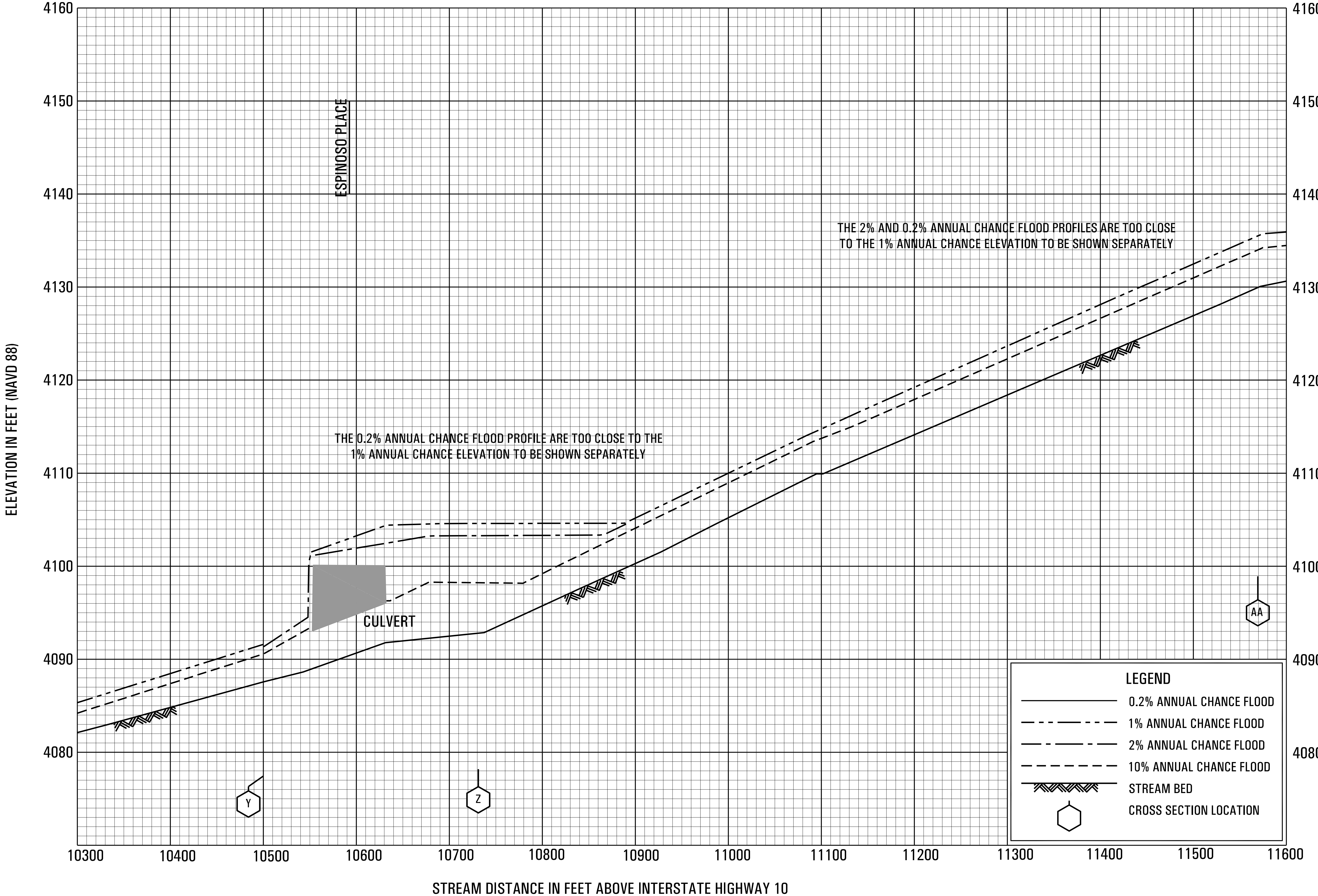


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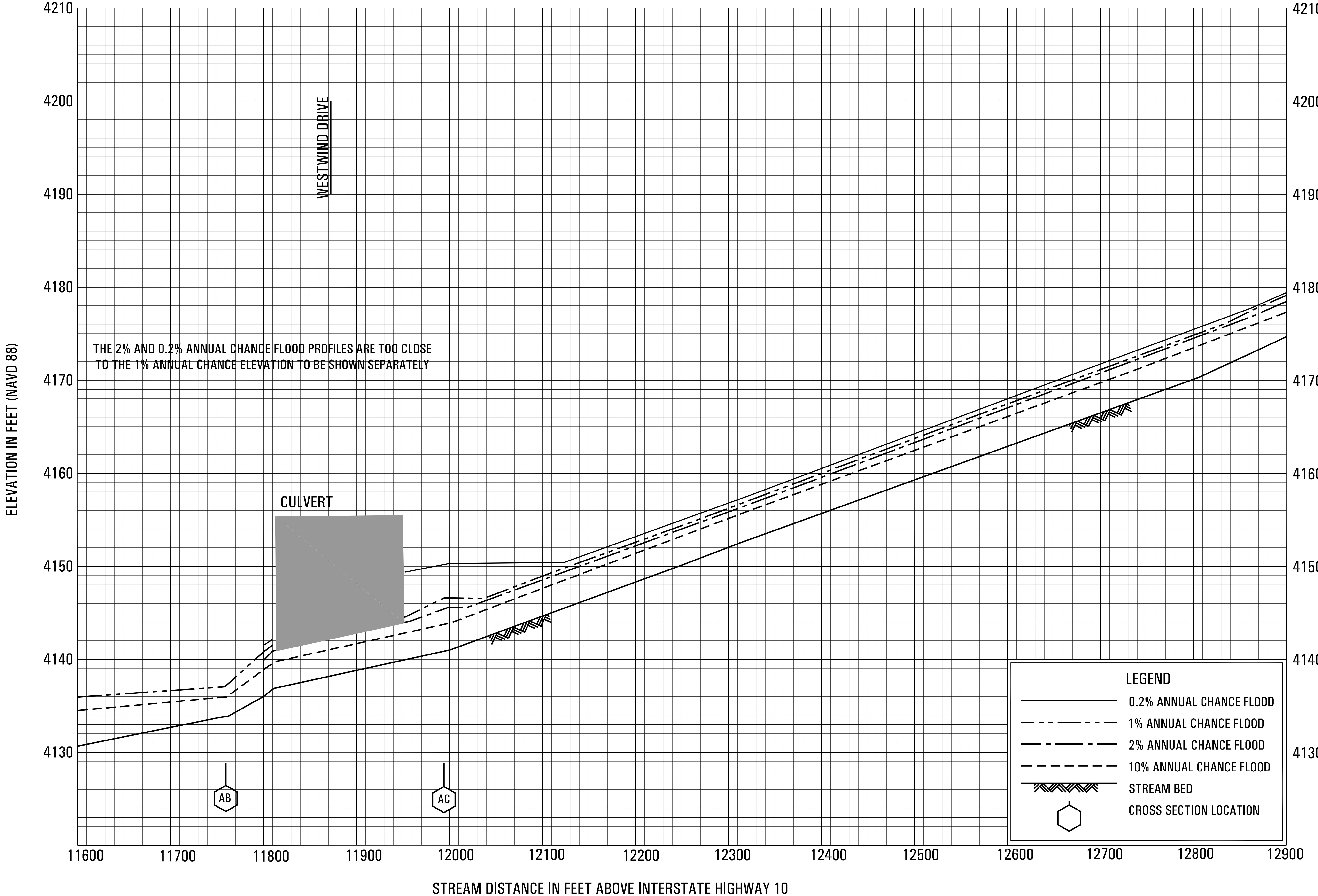


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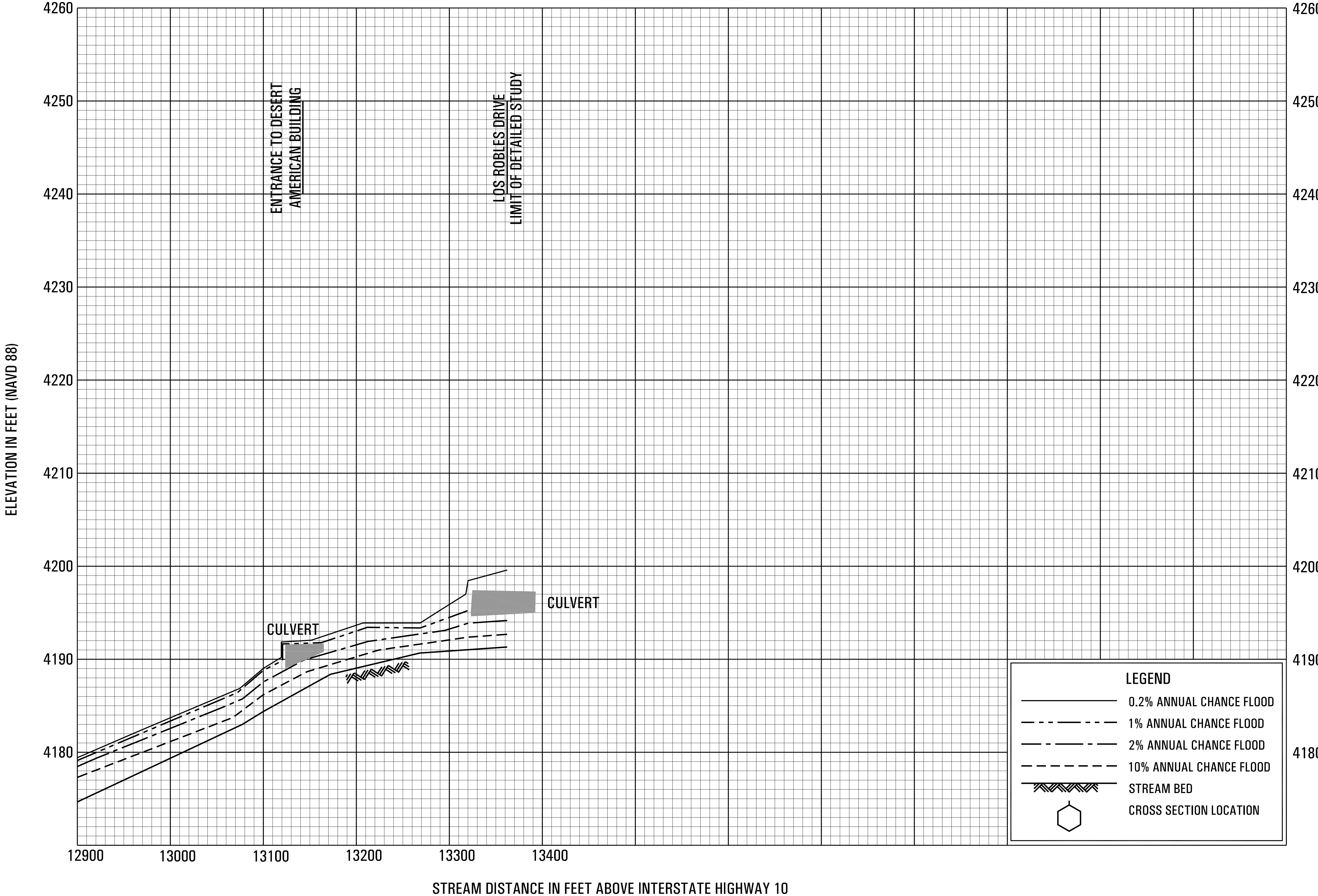


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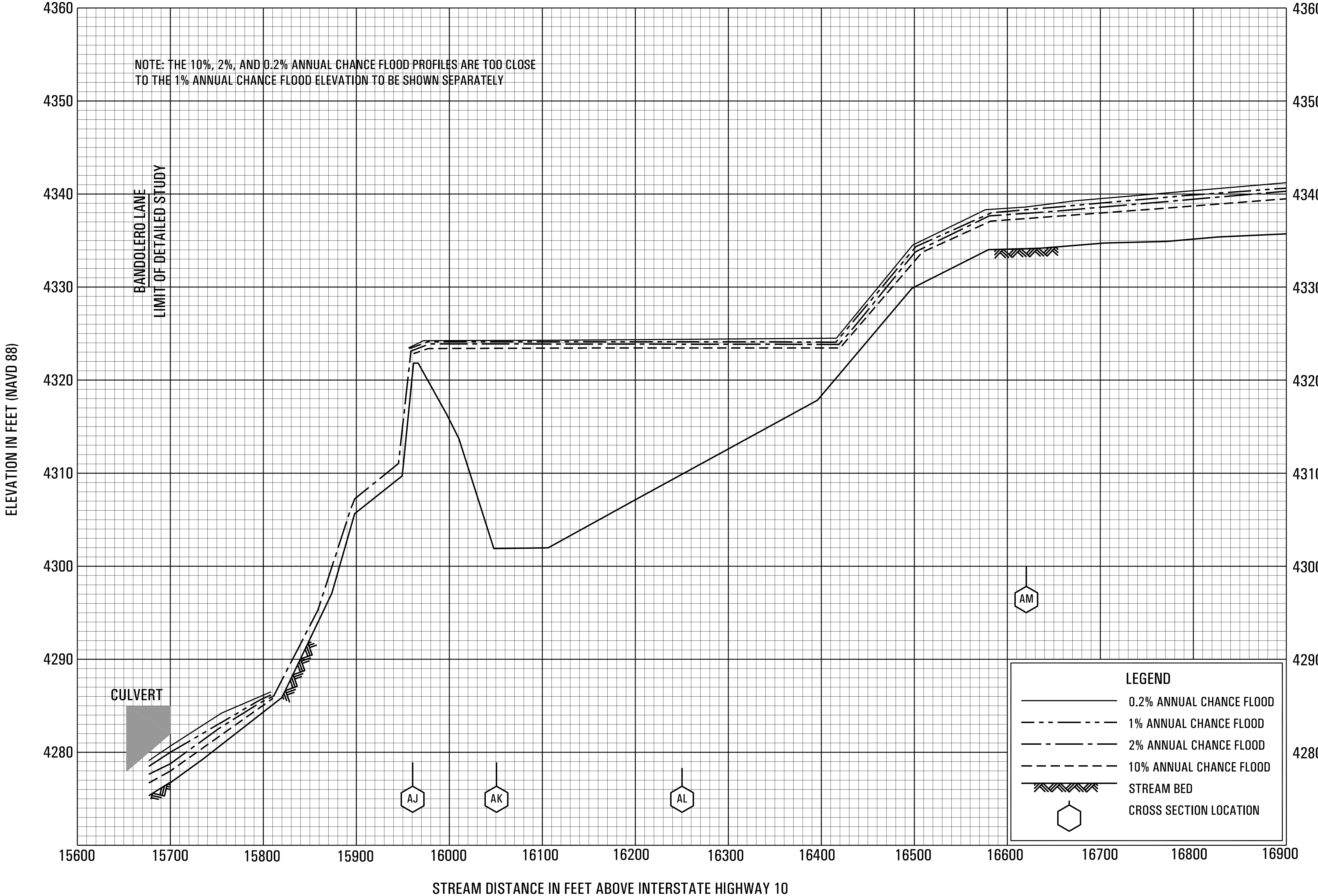


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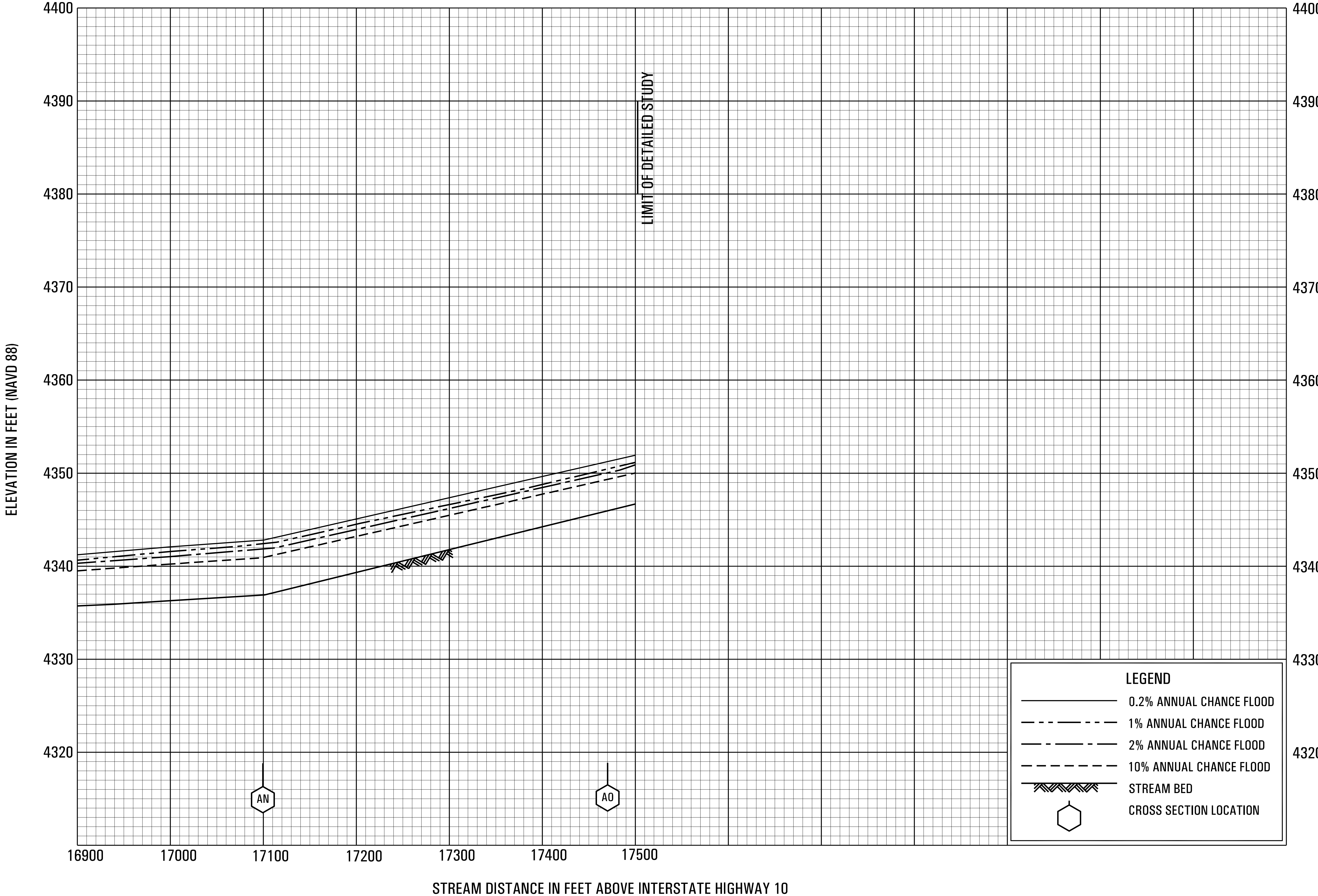


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