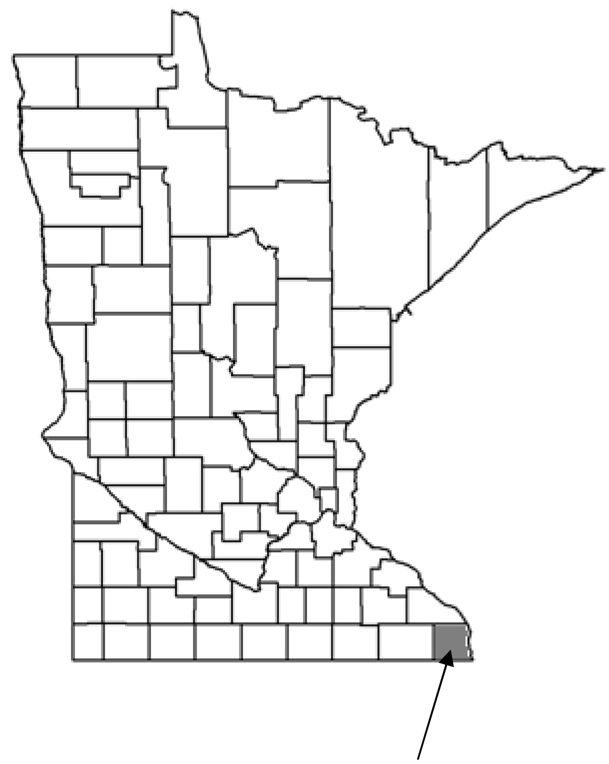
FLOOD INSURANCE STUDY

HOUSTON COUNTY, MINNESOTA

AND INCORPORATED AREAS



Houston County

Community Name	*Community Number*
BROWNSVILLE, CITY OF	270191
CALEDONIA, CITY OF	270712
*EITZEN, CITY OF	275302
HOKAH, CITY OF	270192
HOUSTON, CITY OF	270193
HOUSTON COUNTY (UNINCORPORATED AREAS)	270190
LA CRESCENT, CITY OF	275237
SPRING GROVE, CITY OF	275303

*NO SPECIAL FLOOD HAZARD AREAS IDENTIFIED

Preliminary: December 31, 2014

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
27055CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) report may not contain all data available within the Community Map Repository. Please contact the Community Map Repository for any additional data.

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS report at any time. In addition, FEMA may revise part of this FIS report by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS report. Therefore, users should consult with community officials and check the Community Map Repository to obtain the most current FIS report components.

Selected Flood Insurance Rate Map 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
B	X
C	X

Initial Countywide FIS Effective Date: To Be Determined

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1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Houston County, including the Cities of Brownsville, Caledonia, Eitzen, Hokah, Houston, La Crescent, and Spring Grove; and the unincorporated areas of Houston County (referred to collectively herein as Houston County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

Please note that the City of Eitzen has no mapped special flood hazard areas. 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 City of La Crescent is geographically located in Winona and Houston Counties. The City of La Crescent is included in its entirety in this FIS report.

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

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

1.2 Authority and Acknowledgments

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

Pre-Countywide FIS Reports

Information on the authority and acknowledgements for each jurisdiction included in this countywide FIS, as compiled from their previously printed FIS reports, is shown below:

Brownsville, City of:	The hydrologic and hydraulic analyses for the FIS report dated August 15, 1983, and the FIRM dated February 15, 1984, were performed by Edwards and Kelcey, Inc., for the Federal Emergency Management Agency (FEMA) under Contract No. H-4540, Amendment No. 2. The work was completed in March 1980 (FEMA, 1983).
Hokah, City of:	The hydrologic and hydraulic analyses for the FIS report dated September 15, 1981, and the FIRM dated March 15, 1982, were performed by Howard Needles Tammen & Bergendoff for the Federal Insurance Administration (FIA) under Contract No. H-3984. The work was completed in October 1977 (FIA, 1981b).
Houston, City of:	The hydrologic and hydraulic analyses for the FIS report dated January 1979, and the FIRM dated July 16, 1979, were performed by the U.S. Army Corps of Engineers (USACE), St. Paul District for FIA, under the Inter-Agency Agreement No. (IAA)-H-10-77, Project Order No. 15. The work was completed in August 1977 (FIA, 1979).
	The revised analyses for the FIS report and FIRM dated August 23, 2000, were performed by USACE, St. Paul District, for FEMA (FEMA, 2000).
Houston County (Unincorporated Areas):	The hydrologic and hydraulic analyses for the FIS report dated July 6, 1981, and the FIRM dated January 6, 1982, were performed by Edwards and Kelcey, Inc., for FIA under Contract No. H-4540, Amendment No. 2. The work was completed in March 1980 (FIA, 1981a).
	The revised analyses for the FIS report and the FIRM dated June 6, 2001, were performed by USACE, St. Paul District (FEMA, 2001).

La Crescent, City of: The hydrologic and hydraulic analyses for the FIS report dated November 2, 1982, and the FIRM dated May 2, 1983, were performed by Toltz, King, Duvall, Anderson, and Associates, Inc. for FEMA, under Contract No. H-4706. The work was completed in March 1981 (FIA, 1982).

The Cities of Caledonia, Eitzen, and Spring Grove have no previously printed FIS reports.

This Countywide FIS Report

The hydrologic and hydraulic analyses for this study (with the exception of the Mississippi River) were performed by the Minnesota Department of Natural Resources (MNDNR) for FEMA, under Contract No. EMC-2010-CA-7012. The hydrologic and hydraulic analyses for the Mississippi River was performed by the USACE Rock Island, St. Louis, and St. Paul Districts for FEMA, under Contract No. EMW-2002-IA-0114. The work was completed in September 2013.

Base map information shown on the FIRM was derived from the Farm Services Administration. This information was photogrammertically compiled at a scale of 1:12,000, from aerial photography dated 2010 or later. The projection used in the preparation of this map is Universal Transverse Mercator (UTM) zone 15, and the horizontal datum used is North American Datum of 1983 (NAD83), Geographic Reference System 1980 (GRS80) Spheroid.

1.3 Coordination

An initial meeting is held with representatives from FEMA, the community, and the study contractor to explain the nature and purpose of a FIS, and to identify the streams to be studied or restudied. A final meeting is held with representatives from FEMA, the community, and the study contractor to review the results of the study.

Precountywide Analyses

The initial and final meeting dates for previous FIS reports for Houston County and its communities are listed in the following table:

Community	FIS Date	Initial Meeting	Final Meeting
Brownsville, City of	August 15, 1983	***	March 21, 1983
Hokay, City of	September 15, 1981	January 1976 - March 1977*	February 4, 1981

Community	FIS Date	Initial Meeting	Final Meeting
Houston, City of	January 1979 August 23, 2000	September 10, 1976 March 23, 1999**	August 8, 1978 ***
Houston County (Unincorporated Areas)	July 6, 1981 June 6, 2001	September 8, 1976 May 13, 1999**	February 3, 1981 ***
La Crescent, City of	November 2, 1982	May 1978	May 14, 1982

*Several meetings were held during this period
**Community notified by letter
***Data not available

This Countywide FIS Report

The initial meeting was held on March 21, 2011, and attended by representatives of FEMA, MNDNR, the Root River Watershed District, the Strategic Alliance for Risk Reduction (STARR) and representatives from the communities.

The results of the study were reviewed at the final meeting held on ___________and attended by representatives of ___________________________. All issues and/or concerns raised at that meeting have been addressed.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Houston County, Minnesota, including the incorporated communities listed in Section 1.1. The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction through May 2014.

The following streams were studied by detailed methods in this FIS report:

Crooked Creek
Mississippi River
Pine Creek
Pine Creek Overflow
Root River
South Fork Root River
Thompson Creek

The limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

This Countywide FIS Report

All streams studied by approximate methods were newly studied or revised using the USACE's Hydrologic Engineering Center's (HEC) River Analysis System (RAS), computer software. Cross section data was obtained from the 3-meter resolution Light Detection and Ranging (LiDAR).

Limited detailed analyses were completed for the Root River between the Cities of Hokah and Houston detailed study reaches and from the upstream limit of the City of Houston detailed study reach to the Houston/Fillmore County boundary. HEC-RAS models were developed using HEC-GeoRAS. Overbank cross-section data was obtained from the 3-meter resolution LiDAR and the bathymetry and bridge geometry was obtained from detailed field surveys.

All streams studied by detailed methods, with the exception of the Mississippi River, were restudied using HEC-RAS models developed by the MNDNR. The Mississippi River water surface profiles were developed using the USACE's UNET computer software, which was later converted to HEC-RAS.

For this countywide FIS, the FIS report and FIRM were converted to countywide format, and the flooding information for the entire county, including both incorporated and unincorporated areas, is shown. Also, the vertical datum was converted from the National Geodetic Vertical Datum of 1929 (NGVD) to the North American Vertical Datum of 1988 (NAVD). In addition, the Universal Transverse Mercator coordinates, previously referenced to the North American Datum of 1927 (NAD 27), are now referenced to the North American Datum of 1983 (NAD83).

Approximate analyses were used to study those areas having low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by FEMA and Houston County.

2.2 Community Description

Houston County is located in the southeastern corner of Minnesota. The county is bordered on the west by Fillmore County, on the north by Winona County, on the east by the Mississippi River and the counties of La Crosse and Vernon in Wisconsin, and on the south by the counties of Allamakee and Winneshiek in Iowa. The City of Caledonia, the county seat, is approximately 55 miles southeast of the City of Rochester, Minnesota, and approximately 30 miles south of the City of Winona, Minnesota.

Houston County was established on February 23, 1854, and was named in honor of Samuel Houston, who served as the President of the Republic of Texas before its annexation to the United States. He later served as both a United States Senator and as Governor of the state of Texas (Minnesota Historical Society, 1969).

The Houston County area has a typical continental climate characterized by wide variations in temperature, little winter precipitation and normally ample summer rainfall. Temperature averages have ranged from a low of 6 degrees Fahrenheit (˚F) in January to a high of 81˚F in July. Annual precipitation in Houston County averages 36.97 inches (The Weather Channel, 2014).

According to the 2010 Census, the population for Houston County was 19,027. (U.S. Census Bureau, 2014).

The topography and geomorphology of the Root River are highly interrelated and have given the drainage system of the Root River its distinct physical characteristics. The headwaters of the Root River are located in northeastern Mower County, in an area of large spring-fed sloughs. The headwaters of Thompson Creek are located in Houston County, approximately eight miles southwest of the City of Hokah (Minnesota Department of Conservation, 1959).

The gorges of the Root River at the City of Hokah are 400 to 550 feet deep and from a quarter of a mile to one mile wide. Tributary streams flow in steep walled coulees into the major stream valley. The bedrock exposed in the valley walls is composed of sedimentary beds of limestone, dolomite, sandstone, and shale. These beds dip uniformly west-south-west at about 10 feet per mile. The Galena formation, which is predominantly limestone, is covered by only a thin mantle of glacial drift. The uplands ground water has dissolved some of the limestone and created cavities in the formation. Where the cavities have extended to the surface of the limestone, the overlying glacial drift has collapsed and sink hole topography has developed (Minnesota Department of Conservation, 1959).

Soils in the drainage basins of Thompson Creek and the Root River are complex and represent for the most part modified glacial till. Permeability characteristics of this complex soil distribution, ranging from alluvium to clay loams, will vary within a few feet. Soils in the immediate vicinity of the City of Hokah are coarse to medium textured. In the vicinity of Thompson Creek above the City of Hokah, the soils are medium textured with good to rapid surface drainage (Arneman, 1963).

The distribution of vegetation and land use in the Thompson Creek/Root River drainage basins are highly interrelated. The original vegetation was basically brushland consisting of oak openings and barrens. Portions of these basins were originally part of the "Big Woods" and "River-Bottom Forest", which were comprised of various species of oaks, elm, basswood, ash, maple, cottonwood, boxelder, aspen, and birch (U.S. Department of Agriculture, 1974).

Presently, only portions of original vegetation remain, mainly in the glacial moraines, pastures, and roughlands. The majority of the valley is under agricultural cultivation and, thereby, subject to rapid runoff from spring snowmelt and rain showers during the dormant season. The floodplains in the City of Hokah consist of some residential and commercial development.

2.3 Principal Flood Problems

Many serious floods have occurred in the Root River basin since its settlement. Flood flows in the basin are characterized by their rapid rise, short duration, and almost as rapid, subsidence. Spring floods occur regularly during the latter part of March and April, resulting from the combination of snowmelt and spring rains. Summer and early fall floods resulting from severe thunderstorm activity, although usually having a lower return frequency, have a very damaging effect on agriculture in the Houston County. Ice jams, which occur frequently during spring floods along the Root River, have caused as much as five feet of backwater. The ice effects have generally occurred during the lower frequency floods. State Highway 26 and Iowa, Chicago and Eastern Railroad crossings of the Root River floodplain, near its confluence with the Mississippi River, are particularly susceptible to ice and debris jams (USACE, 1975). A severe ice jam occurred at this location in January 1980. Although the associated discharge for this flood was relatively minor, the flood stage exceeded the 1-percent-annual-chance elevation at the City of Hokah by one foot.

Past flood problems include siltation, debris accumulation, ice jams, inundated structures, stream bank erosion, wet basements, the disruption of public and private business services, and the interruption of industrial activities. One of the principal flood-related concerns of the community is the temporary agricultural levees which are located on the Root River. In recent years (especially in the early summer of 1974), floodwaters threatened several homes and businesses in the City of Hokah. This flooding appears to be related to the construction of temporary farm levees along the riverbank upstream from the City of Hokah. The levees are significantly reducing the overland flow areas and appear to contribute to the increased flood stages for the City of Hokah. This hypothesis is supported by the 1974 summer flooding in the City of Hokah, which witnessed the recession of floodwaters quickly after the failure of an agricultural levee (USACE, 1975).

The largest flood of the Root River on record in the City of Houston occurred on April 1, 1952. This event caused extensive damages to the city and most of the lower portion of the basin. The April 1965 flood, brought on by snowmelt and substantial spring rains, caused over $5.6 million in damages within the Root River basin. More than 440 homes and 100 businesses experienced either basement or first floor flooding. Discharges and frequencies for the major flood on the Root River at the City of Houston are shown below (Watson, 1975).

Flood	Discharge (cfs)	Estimated Frequency (years)
April 1952	37,000	30
March 1961	31,400	18
March 1965	31,000	17
March 1962	29,500	14
March 1933	26,600	10
March 1950	26,200	10

Tributary streams to the Root River and the Mississippi River are well defined with little natural available floodwater storage. Most of these creeks have very steep slopes, responding readily to individual rainstorm events, often resulting in flash floods. Most severe flooding events on the creeks tributary to the Root River and the Mississippi River in Houston County are the result of high-intensity thunderstorms during the warm summer months.

2.4 Flood Protection Measures

Flood protection measures along the Root River in Houston County were first initiated in 1916. Twenty miles of the Root River were straightened from the City of Houston to the confluence with the Mississippi River. The construction shortened the river by 12 miles (USACE, 1975).

The Soil Conservation Service (SCS) prepared a Watershed Work Plan for the Crooked Creek Watershed (Root River Soil and Water Conservation District and Houston County Board of Commissioners, 1963). Various land treatment measures as well as structural measures were recommended in the report. Four floodwater-retarding structures and several thousand feet of stream bank erosion control measures were built as a result of this project. The four floodwater-retarding structures temporarily retard runoff from 56-percent of the contributing watershed at the unincorporated community of Freeburg, significantly reducing peak discharges.

The USACE, St. Paul District, has designed and constructed the City of Houston levee system. This system was designed to provide 1-percent-annual-chance flood protection from the Root River. The USACE, St. Paul District, certified that the levee system meets all NFIP criteria for 1-percent-annual-chance flood protection.

Flood protection measures in the City of Hokah are limited. In the lower part of the City of Hokah, a levee extends from State Highway 16 westward past the sewage treatment plant. However, this levee is relatively low and basically serves the purpose of funneling water through the water control structure located under State Highway 16 approximately 200 feet south of the State Highway 16 bridge over the Root River. This structure assists in controlling the amount of water entering Thompson Creek just upstream of its confluence with the Root River. There are no other existing or proposed significant flood protection measures in the City of Hokah.

3.0 ENGINEERING METHODS

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

3.1 Hydrologic Analyses

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

Pre-Countywide FIS Reports

The hydrologic analysis for Root River basin was based upon a large number of stream gage records obtained from locations varying in drainage area and geographic location.

Some of the gages used in that analyses, which are located in Houston County are listed below:

Gage	Location	Years of Record
53840	Root River near the City of Lanesboro, Minnesota	38
53850	Root River near the City of Houston	49
53855	South Fork Root River near the City of Houston, Minnesota	24

In addition to stream gage data for the Root River and its main branches, crest gages have been installed on several of the smaller tributaries. These data have been analyzed by the U.S. Geological Survey (USGS) and the USACE using techniques consistent with procedures outlined in the Water Resource Council

(WRC) Bulletin No. 17 (WRC, 1976) to obtain discharge-frequency curves for each of the gage locations (USGS, 1977).

A drainage-discharge curve for the 1-percent-annual-chance recurrence interval was developed by the USGS for the Root River basin. This curve yields a discharge-drainage area relationship using an exponent of 0.55. Using the frequency analysis information for gages within the Root River basin, a similar relationship was constructed for the 10-, 2-, and 0.2-percent-annual-chance recurrence intervals using log-Pearson Type III frequency analysis to provide a family of Drainage Area-Frequency Discharge curves for the Root River basin. Although it is generally not recommended to span this regional relationship over such a wide range of drainage areas, independent analyses by the USGS have found that the results expressed by the transfer relationship are acceptable on the lower drainage area locations.

Gaging stations on the Root River near Lanesboro, Minnesota (No. 5-3840) and below the South Fork Root River near the City of Houston, Minnesota (No. 5-3860) provided the principal source of data. The discharge-frequency relationship for the Root River near Lanesboro is based on 42 years of record (1910-1914, 1916-1917, 1940-1974) and the relationship for the Root River near Houston is based on 24 years of record (1938-1961)(USGS, 1969).

The discharge values used for Pine Creek, Root River, and Thompson Creek were obtained using the administratively-determined values and the Drainage Area-Frequency Discharge Curves. Discharge values for South Fork Root River were based on the USGS gage (No. 53855) near the City of Houston and the discharge-frequency curve it produced.

Flood magnitudes of the selected recurrence intervals for Thompson Creek were determined by utilizing the drainage area ratio equation using the values from gage No. 5-3860 assuming a power of n=0.55. The resultant values concurred with values obtained using USGS unpublished empirical equations. The flood magnitude is based on a drainage area of 37.5 square miles, channel slope of 27.2 feet per mile, and zero percentage of swamp and lake storage area.

Discharge values for Crooked Creek watershed were determined using the SCS TR-20 Hydrologic Runoff Model (SCS, 1965). Use of regional equations or drainage area-discharge curves was not considered applicable to the Crooked Creek watershed due to the large percentage of watershed drainage area controlled by the SCS floodwater-retarding structures. Storms of six and 24 hours as well as a 10-day runoff volume were used in the analysis (National Weather Service (NWS), 1961). The one-day storm proved to be critical for all recurrence intervals.

The discharge values used for the Mississippi River were obtained from the USACE "Upper Mississippi River Water-Surface Profiles" (USACE, 1979). Discharge values were computed using procedures outlined in the WRC Bulletin

No. 17 (WRC, 1976). The discharges were based on a statistical analysis of 97 years of record obtained from the Mt. Vernon Street gage (No. 3830) in the City of La Crosse.

The discharge-frequency curve at the gage was developed using the USACE, HEC computer program, Flood Frequency Analyses (HEC, 1992). Gage data through 1994 was analyzed. The skew of -0.2 was obtained from a regional map (USACE, Unknown Date (b)).

The drainage area on the landward side of the levee consists of about 1.5 square miles. The design of interior ponds was developed using both historical rainfall and the use of the NWS publications Hydro-35, TP-40, and TP-49 (NWS, 1961; NWS, 1964; NWS, 1977). The interior flood control plan consists of Interior Ponds, Outlet A-1, Outlet A-2, and Outlet B.

This Countywide FIS Report

The discharge values for the Mississippi River were obtained from the USACE's Upper Mississippi River System Flow Frequency Study, (USACE, 2004). The analysis used a log-Pearson Type III distribution for unregulated flows at gages for 100 years of record from 1898 to 1998. Discharges between gages were determined by interpolation of the mean and standard deviation for the annual flow distribution based on the drainage area and regional skew. For details on how flood control reservoirs, hydraulic impacts and historic events were included in the analysis refer to the USACE report.

Discharge frequency curves for long-term gage stations remain the basis for the detailed study reaches. Two major floods affected southeast Minnesota in 2007 and 2008. For the active gages, updated flow-frequency curves were developed using the USACE, HEC computer program, HEC-SSP, Version 2.0 with peak flow data through 2011. The computed station skews were weighted with generalized skews obtained from the USGS Water-Resources Investigations Report- 97-4089 (Lorenz, et. Al, 1997).

Flow-frequency values for the Root River gages having watershed areas greater than 100 square miles, except for the short-term station at the City of Lanesboro, were plotted against the drainage area. These data were very consistent except for the Root River at Rushford station.

The discharges for the Rush Creek near the City of Rushford and the Crooked Creek at the City of Freeburg were developed by the USGS using the Expected Moments Algorithm method. USGS recommended this methodology because the USGS' "Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005," Scientific Investigations Report 2009-5250 identified these two gaging stations as having "left-censored" peak-flow data (peak flows below the minimum flow that could be quantified at these partial record high-flow stations.) (Lorenz, Sanocki, and Kocian, 2010)

For the Root River at the City of Rushford and the South Fork Root River in Houston County, discharges were based on the USACE report Hydrologic Analyses Rush Creek and the Root River in the Vicinity of Rushford and Houston, Minnesota, (USACE, 2008). For this report, the USACE completed a flow frequency analysis for the Rush Creek near Rushford and the Root River at Houston stream gages. The analyses included peak flow data through water year 2007. The Root River at Houston analysis was based on 84 systematic events with a weighted skew. The Rush River near Rushford gage analysis was based on a two-station comparison using the longer record station at Houston. A comparison of same event flow data indicated that the peak flow on the Root River at Rushford is often higher than the peak flow at the downstream city of Houston gage. Contributing factors are attenuation of peak flows due to floodplain storage, gage height affected by backwater and distribution of rainfall within the large Root River watershed. The flood flow frequency data from the Houston gage was used for the Root River to the upstream Houston County boundary.

The discharges for Thompson Creek at Hokah and Pine Creek and Pine Creek Overflow at the City of La Crescent for the previous FIS studies used a regional frequency analysis. These discharges were updated by using the USGS StreamStats online application (http://water.usgs.gov/osw/streamstats/minnesota.html). This applies the regression most recently developed by the USGS for this region.

Flood discharge values for all approximate study reaches in Houston County were determined using the USGS StreamStats online application (http://water.usgs.gov/osw/streamstats/minnesota.html). Discharge values were typically obtained at the mouth of each tributary, at locations of significant change in drainage area, and many road crossings.

Peak discharge-drainage area relationships for each flooding source studied in detail are shown in Table 1.

Table 1 - Summary of Discharges

		Peak Discharges (cubic feet per second)			
Flooding Source and Location	Drainage Area (square miles)	10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
CROOKED CREEK					
Approximately 2,655 feet downstream of County Road 259	44.7	1,660	3,460	4,440	7,190
Approximately 1,600 feet downstream of Freeburg Ridge Road	38.6	1,500	3,120	3,990	6,490

Table 1 - Summary of Discharges *(continued)*

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
MISSISSIPPI RIVER					
At Lock and Dam No. 8	64,700	164,500	223,000	248,000	306,500
Just upstream of confluence of Root River	*	181,000	220,000	245,000	304,000
Just upstream of confluence of LaCrosse River	*	160,000	219,000	244,000	303,000
PINE CREEK					
At the I&M Rail Link, LLC	56	4,700	7,500	9,300	12,200
PINE CREEK OVERFLOW	*	*	*	*	*
ROOT RIVER					
At LaCrosse County/Houston County Boundary	1,270	23,200	36,800	43,100	58,700
Approximately 8,725 feet downstream of State Highway 76	1,560	28,900	46,500	55,500	76,000
At State Highway 16	1,630	31,000	48,500	57,000	78,000
SOUTH FORK ROOT RIVER					
At confluence with Root River	275	7,320	14,700	18,700	30,600
THOMPSON CREEK					
At confluence with Root River	37	3,470	6,720	8,440	13,200
At Butterfield Valley Road	27	2,910	5,710	7,210	11,400

*Data not available

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data Table 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 report in conjunction with the data shown on the FIRM.

Pre-Countywide FIS Reports

Profiles for the Mississippi River in the City of Brownsville were obtained from the USACE study (UASCE, 1979). Flood profiles were drawn showing the computed water-surface elevations for floods of the selected recurrence intervals.

Cross section data for Thompson Creek in the City of Hokah were obtained to estimate the significant backwater effect of the bridges and to reflect the significant variations in stream valley topography. Data from the cross sections and bridge profiles were obtained from field surveys conducted by the Study Contactor in the fall of 1976. Starting water-surface elevations for Thompson Creek were obtained be performing hydraulic analyses for the Root River at the mouth Thompson Creek and hydrologic analyses at Thompson Creek.

For the Thompson Creek analyses, the total discharge was assumed to be confined to that area east of State Highway 44 and 16. This necessitated the use of an effective area option in HEC-2. In the analyses, a vertical obstruction was assumed to exist along the west edge of State Highway 16 which would prevent minor Thompson Creek flows from crossing State Highway 16 and entering the Root River though the lower area of the City of Hokah. However, this area will flood such that a weir will form across State Highway 44 with the water flowing from Thompson Creek into Root River flow.

Valley and channel cross section data for Root River in the City of Houston were obtained from USACE surveys made in 1972, 1987, and 1990. Topographic maps at a scale of 1:100, with a contour interval of 2 feet, were developed from the 1987 survey data. State Route 76 bridge data were obtained from the Minnesota Department of Transportation (MnDOT) (MnDOT, 1955).

Starting water-surface elevations for the Root River and Pine Creek at the Chicago, Milwaukee, St. Paul, and Pacific Railroad were obtained from a USACE profile for the Mississippi River (USACE, 1979), since the Mississippi River controls flooding up to this point on both streams. A normal depth analysis was used to determine starting water-surface elevations for the remaining streams studied in detail except the Mississippi River.

An overflow channel for Pine Creek near the confluence with the Mississippi River conveys approximately 70 percent of the total flow in the stream. A separate hydraulic model was developed for this overflow channel. Adjustments to the discharge split between the main channel and the overflow channel were made until agreement of water-surface elevations was reached at an upstream cross-section location near the bifurcation point. The flood delineation for the detailed study along the Mississippi River used elevations from the USACE profile (USACE, 1979).

Cross sections for the Unincorporated Areas of Houston County were obtained from field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Channel alignment and geometry were obtained by photogrammetric and stadia field methods (Mark Hurd, 1978). Cross sections for the backwater analyses were field surveyed and were located at close intervals above and below bridges in order to compute significant backwater effects in the developing area (USACE, Unknown Date (a)).

Water-surface profiles for the various frequency floods for the stream reaches studied in detail were computed using the USACE, HEC, computer program, HEC-2 (HEC, 1973).

This Countywide FIS Report

The hydraulic analysis for the Mississippi River was updated in the USACE's "Upper Mississippi River System Flow Frequency Study," January 2004 (USACE, 2004). UNET models were developed for the Upper Mississippi River from Cairo, Illinois to St. Paul, Minnesota. Floodways were determined for the reach in Minnesota by importing the UNET data for the 1-percent-annual-chance event into HEC-RAS. Three floodways were analyzed: the Wisconsin floodway surcharge of 0.01 feet determined the east bank floodway, the Minnesota floodway surcharge of 0.5 feet determined the west bank floodway, and a combined floodway analysis using the east and west bank floodway stations from the first two analyses. Cross section data was obtained using the 3-meter resolution LiDAR data.

New HEC-RAS models were developed for Crooked Creek, Pine Creek, Pine Creek Overflow, Root River, South Fork Root River, and Thompson Creek using the USACE, HEC computer program, HEC-RAS, Version 4.1.0. Cross section data was obtained from 3-meter resolution LiDAR with the bathymetry obtained from the existing HEC-2 models. Bridge geometry was updated from bridge as-built plans.

The USACE developed a HEC-2 model for the Root River near the City of Houston as part of the 2000 flood control project. The model was converted to HEC-RAS, Version 4.1.0 and the overbank geometry checked, and where merited revised, using the 3-meter resolution LiDAR data.

The USACE, HEC computer program, HEC-RAS, Version 4.1.0 was used in computing the starting WSELs estimated as normal depth, for all detailed streams.

Limited detailed analyses were completed for the Root River between the Cities of Hokah and Houston detailed study reaches and from the upstream limit of the Houston detailed study reach to the Houston/Fillmore County boundary. HEC-RAS models were developed using HEC-GeoRAS. Overbank cross-section data was obtained from the 3-meter resolution LiDAR and the bathymetry and bridge geometry was obtained from detailed field surveys.

HEC-RAS, Version 4.1.0 models were developed for the approximate reaches. Cross section data was obtained from the 3 meter resolution LiDAR. The area below the water surface was ignored in the cross-section geometry. The analyses included road crossings with high embankments, substantial bridge openings or with bridge details readily available from the Minnesota Department of Transportation hydraulic data site.

Channel roughness factors (Mannings "n") used in the hydraulic computations were chosen by MNDNR. The Manning's "n" values for all detailed studied streams are listed in the following tabulation:

Manning's "n" Values

Stream	Channel "n"	Overbank "n"
Crooked Creek	0.015-0.050	0.030-0.150
Mississippi River	0.021- 0.038	0.026- 0.150
Pine Creek	0.015-0.050	0.030-0.150
Pine Creek Overflow	*	*
Root River	0.030-0.040	0.040-0.130
South Fork Root River	0.040	0.045-0.060
Thompson Creek	0.015-0.050	0.030-0.150

*Data Not Available

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

The profile baselines depicted on the FIRM represent the hydraulic modeling baselines that match the flood profiles on this FIS report. As a result of improved topographic data, the profile baseline, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

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.

3.3 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 in use for newly created or revised FIS reports and FIRMs was NGVD. With the finalization of NAVD, many FIS reports and FIRMs are being prepared using NAVD as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD. Structure and ground elevations in the community must, therefore, be referenced to NAVD. It is important to note that adjacent communities may be referenced to NGVD. This may result in differences in Base Flood Elevations (BFEs) across the corporate limits between the communities. Some of the data used in this study were taken from the prior effective FIS reports and adjusted to NAVD. The average conversion factor that was used to convert the data in this FIS report to NAVD was calculated using the National Geodetic Survey's (NGS) VDatum software utility (NGS, 2012). The data points used to determine the conversion are listed in Table 2.

Table 2 – Vertical Datum Conversion

Quad Name	Corner	Latitude	Longitude	Conversion from NGVD29 to NAVD88
New Albin	NE	43.500	-91.250	-0.152
Waukon NW	NE	43.500	-91.375	-0.082
Dorchester	NE	43.500	-91.500	-0.100
Highlandville	NE	43.500	-91.625	-0.088
Burr Oak	NE	43.500	-91.750	-0.054
Bratsberg	NE	43.750	-91.750	0.025
Brownsville	NE	43.750	-91.250	-0.077
Caledonia	NE	43.750	-91.375	-0.145
Eitzen	NE	43.625	-91.375	-0.079
Houston	NE	43.875	-91.500	0.002
Mabel	NE	43.625	-91.750	-0.049
Mound Prairie	NE	43.875	-91.375	-0.038
Reno	NE	43.625	-91.250	-0.093
Rushford East	NE	43.875	-91.625	0.000
Rushford West	NE	43.875	-91.750	0.042
Sheldon	NE	43.750	-91.500	-0.091
Spring Grove	NE	43.625	-91.625	-0.052
Wilmington	NE	43.625	-91.500	-0.058
Yucatan	NE	43.750	-91.625	-0.051
			Average:	**-0.060**

BFEs and profile elevations reported in the Upper Mississippi River System Flow Frequency Study (USACE, 2004) were incorporated into this FIS report and associated DFIRM. This information was converted from NGVD to NAVD based on data presented in Table 3. The conversion factor for each cross section was used to prepare the Mississippi River Floodway Data Tables, Flood Profiles, and DFIRM.

Table 3 – Mississippi River Vertical Datum Conversions

Cross Section ID	NGVD Base Flood Elevation (feet)	NAVD Base Flood Elevation (feet)	NGVD to NAVD Elevation Change (feet)
674.127	634.2	634.1	-0.14
674.747	634.4	634.3	-0.13
675.100	634.5	634.4	-0.13
675.600	634.7	634.5	-0.12
676.150	634.8	634.7	-0.12
677.070	635.1	635.0	-0.12
677.587	635.5	635.4	-0.11
678.096	635.7	635.6	-0.11
678.518	635.8	635.7	-0.11
678.937	635.9	635.8	-0.11
679.390	636.7	636.6	-0.11
679.689	636.8	636.7	-0.10
679.948	636.9	636.8	-0.10
680.895	637.1	637.0	-0.10
681.229	637.2	637.1	-0.10
682.013	637.3	637.2	-0.10
683.037	637.4	637.3	-0.08
684.008	637.5	637.4	-0.07
684.794	637.6	637.6	-0.07
685.282	637.7	637.6	-0.06
685.825	637.8	637.7	-0.06
686.420	637.8	637.8	-0.06
686.833	637.9	637.8	-0.06
687.568	638.0	637.9	-0.06
688.602	638.1	638.1	-0.06
689.756	638.3	638.2	-0.06
690.167	638.4	638.4	-0.06
690.562	638.6	638.5	-0.06
691.000	638.7	638.7	-0.06
691.304	638.9	638.8	-0.06
691.424	639.0	638.9	-0.07
691.811	639.1	639.0	-0.07
692.218	639.2	639.2	-0.07

Table 3 – Mississippi River Vertical Datum Conversions *(continued)*

Cross Section ID	NGVD Base Flood Elevation (feet)	NAVD Base Flood Elevation (feet)	NGVD to NAVD Elevation Change (feet)
692.636	639.4	639.3	-0.07
692.955	639.6	639.5	-0.07
693.239	639.7	639.6	-0.07
693.532	639.8	639.7	-0.07
693.987	640.0	639.9	-0.07
694.323	640.2	640.2	-0.07
694.735	640.5	640.4	-0.07
695.118	640.7	640.7	-0.07
695.611	640.9	640.9	-0.07
696.940	641.2	641.1	-0.07
697.217	642.3	642.2	-0.07
697.376	642.5	642.4	-0.08
697.422	642.6	642.5	-0.08
697.471	642.7	642.6	-0.08
697.521	642.7	642.7	-0.08
698.373	642.8	642.7	-0.07
699.058	643.6	643.6	-0.07
699.360	644.1	644.0	-0.07
699.738	644.3	644.3	-0.08
699.800	644.4	644.3	-0.07
700.056	644.4	644.4	-0.07
700.168	644.6	644.6	-0.07
700.224	644.7	644.6	-0.07
700.366	644.7	644.6	-0.07
700.851	644.8	644.8	-0.06

For additional information regarding conversion between NGVD and NAVD, visit the NGS website at www.ngs.noaa.gov, or contact the NGS at the following address:

Vertical Network Branch, N/CG13
National Geodetic Survey, NOAA
Silver Spring Metro Center 3
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191

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.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each FIS provides 1-percent-annual-chance (100-year) flood elevations and delineations of the 1- and 0.2-percent-annual-chance (500-year) floodplain boundaries and 1-percent-annual-chance floodway to assist communities in developing floodplain management measures. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data Table, and Summary of Stillwater Elevations Table. Users should reference the data presented in the FIS report as well as additional information that may be available at the local 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 on the detailed streams, the boundaries were interpolated using LiDAR based topographic data which includes 3-meter resolution DEMs and two-foot contours derived from the MNDNR (MNDNR, 2008).

For approximate streams between cross sections, the 1-percent-annual-chance boundaries were interpolated using LiDAR based topography using 3-meter raster grids with an accuracy equivalent to a contour interval of 2 feet (Aero-metric of Sheyboygan, WI, 2008).

Limited detailed analyses were completed for the Root River between the Cities of Hokah and Houston detailed study reaches and from the upstream limit of the Houston detailed study reach to the Houston/Fillmore County boundary. The floodplain boundaries were interpolated using 3-meter resolution LiDAR (MNDNR, 2008).

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

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

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 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. In Minnesota, however, floodplain encroachment is limited by Minnesota Regulations to that which would cause a 0.5-foot increase in flood heights above pre-floodway conditions at any point (MNDNR, 1977). Floodways having no more than 0.5-foot surcharge were delineated for this FIS. The floodway can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this FIS report and on the FIRM were computed for certain stream segments on the basis of equal-conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations have been tabulated for selected cross sections (Table 4). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CROOKED CREEK								
A	32,260	675	1,470	3.2	668.8	668.8	668.9	0.1
B	32,980	677	1,805	2.5	669.9	669.9	670.1	0.2
C	33,973	518	2,969	1.5	673.7	673.7	673.9	0.2
D	34,420	803	3,405	1.3	673.8	673.8	674.1	0.3
E	35,343	430	1,495	3.0	674.2	674.2	674.4	0.2
F	36,891	307	979	4.1	676.7	676.7	676.7	0.0
G	37,490	257	836	4.8	679.2	679.2	679.2	0.0
H	37,918	185	622	6.4	681.6	681.6	681.7	0.1
I	38,596	259	705	5.7	684.0	684.0	684.0	0.0
J	38,922	127	458	8.7	685.6	685.6	685.9	0.3
K	39,863	307	1,048	3.8	691.3	691.3	691.6	0.3

[1]Feet above confluence with Mississippi River

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS

FLOODWAY DATA

CROOKED CREEK

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
MISSISSIPPI RIVER								
A	674.292	16,598/15,614	211,007	1.2	634.1	634.1	634.1	0.0
B	674.938	17,092/16,194	225,096	1.1	634.3	634.3	634.3	0.0
C	675.388	16,378/14,462	216,871	1.1	634.4	634.4	634.4	0.0
D	675.863	15,348/12,574	196,205	1.3	634.5	634.5	634.5	0.0
E	676.333	14,624/12,082	200,403	1.2	634.7	634.7	634.7	0.0
F	677.252	13,978/9,942	190,591	1.3	635.0	635.0	635.0	0.0
G	677.772	12,423/9,551	167,453	1.5	635.4	635.4	635.4	0.0
H	678.281	12,237/10,890	171,544	1.5	635.6	635.6	635.6	0.0
I	678.709	12,889/12,258	167,777	1.5	635.7	635.7	635.7	0.0
J	679.116	*	*	*	635.8	635.8	*	*
K	679.459	*	*	*	636.6	636.6	*	*
L	679.810	*	*	*	636.7	636.7	*	*
M	680.108	*	*	*	636.8	636.8	*	*
N	681.063	*	*	*	637.0	637.0	*	*
O	681.381	*	*	*	637.1	637.1	*	*
P	682.114	12,780/1,429	176,061	1.4	637.2	637.2	637.2	0.0
Q	683.088	12,888/730	163,646	1.5	637.3	637.3	637.3	0.0
R	684.074	14,242/2,244	171,096	1.5	637.4	637.4	637.4	0.0
S	684.855	12,681/3,050	154,279	1.6	637.6	637.6	637.6	0.0
T	685.326	13,668/3,121	159,544	1.6	637.6	637.6	637.6	0.0
U	685.844	14,087/1,034	174,385	1.4	637.7	637.7	637.7	0.0
V	686.413	15,511/609	180,446	1.4	637.8	637.8	637.8	0.0

[1]Miles above confluence with Ohio River
[2]Total width/width within county boundary
*The floodway width shown has been modified on the FIRM for administrative purposes

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS

FLOODWAY DATA

MISSISSIPPI RIVER

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
MISSISSIPPI RIVER (CONTINUED)								
W	686.849	14,967/896	172,776	1.4	637.8	637.8	637.8	0.0
X	687.591	14,877/1,223	164,836	1.5	637.9	637.9	637.9	0.0
Y	688.614	13,917/661	165,407	1.6	638.1	638.1	638.1	0.0
Z	689.348	14,131/531	152,095	1.6	638.2	638.2	638.2	0.0
AA	689.754	14,847/450	143,648	1.7	638.4	638.4	638.4	0.0
AB	690.171	15,294/1,034	158,188	1.6	638.5	638.5	638.5	0.0
AC	690.586	16,925/2,384	173,375	1.4	638.7	638.7	638.7	0.0
AD	691.061	18,513/4,001	159,656	1.6	638.8	638.8	638.8	0.0
AE	691.370	18,177/4,072	160,179	1.6	638.9	638.9	638.9	0.0
AF	691.498	17,995/4,157	158,903	1.6	639.0	639.0	639.0	0.0
AG	691.891	18,526/4,389	167,548	1.5	639.2	639.2	639.2	0.0
AH	692.294	18,808/5,033	169,643	1.5	639.3	639.3	639.3	0.0
AI	692.710	20,382/6,508	183,464	1.4	639.5	639.5	639.5	0.0
AJ	693.014	20,038/7,121	186,301	1.3	639.6	639.6	639.6	0.0
AK	693.306	19,486/7,564	179,558	1.4	639.7	639.7	639.7	0.0
AL	693.603	18,766/8,077	163,177	1.5	639.9	639.9	639.9	0.0
AM	694.051	18,633/10,389	153,697	1.6	640.2	640.2	640.2	0.0
AN	694.367	18,316/12,199	157,733	1.6	640.4	640.4	640.4	0.0
AO	694.754	16,966/12,963	146,087	1.7	640.7	640.7	640.7	0.0
AP	695.108	15,083/12,316	142,811	1.7	640.9	640.9	640.9	0.0
AQ	695.600	13,174/11,621	133,806	1.8	641.1	641.1	641.1	0.0

[1]Miles above confluence with Ohio River
[2]Total width/width within county boundary

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS

FLOODWAY DATA

MISSISSIPPI RIVER

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
MISSISSIPPI RIVER (CONTINUED)								
AR	696.873	*	*	*	642.2	642.2	*	*
AS	697.181	*	*	*	642.4	642.4	*	*
AT	697.366	*	*	*	642.5	642.5	*	*
AU	697.420	*	*	*	642.6	642.6	*	*
AV	697.477	*	*	*	642.7	642.7	*	*
AW	697.530	*	*	*	642.7	642.7	*	*
AX	698.231	*	*	*	643.6	643.6	*	*
AY	698.917	*	*	*	644.0	644.0	*	*
AZ	699.195	*	*	*	644.3	644.3	*	*
BA	699.541	*	*	*	644.3	644.3	*	*
BB	699.583	*	*	*	644.4	644.4	*	*
BC	699.761	5,582/2,427	115,239	2.3	644.6	644.6	644.6	0.0
BD	699.904	6,157/2,574	116,534	2.2	644.6	644.6	644.6	0.0
BE	699.967	6,424/2,646	116,376	2.1	644.6	644.6	644.6	0.0
BF	700.102	7,451/2,880	123,861	1.9	644.8	644.8	644.8	0.0
BG	700.565	7,766/2,397	119,171	1.8	645.0	645.0	645.0	0.0

[1]Miles above confluence with Ohio River
[2]Total width/width within county boundary
*The floodway width shown has been modified on the FIRM for administrative purposes

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS

FLOODWAY DATA

MISSISSIPPI RIVER

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
PINE CREEK								
A	24	69	1,330	4.6	646.0	646.0	646.0	0.0
B	488	170	912	2.2	648.4	648.4	648.4	0.0
C	1,740	315	1,233	1.6	648.9	648.9	648.9	0.0
D	2,604	276	2,719	6.5	650.4	650.4	650.4	0.0
E	5,296	1,212	16,115	0.8	657.4	657.4	657.4	0.0
F	6,773	711	5,837	1.7	658.0	658.0	658.0	0.0
G	7,872	448	3,718	2.6	658.2	658.2	658.2	0.0
H	9,041	638	4,648	2.0	658.8	658.8	658.8	0.0
I	10,218	426	2,504	3.7	659.2	659.2	659.2	0.0
PINE CREEK OVERFLOW								
A	658	263	1,773	6.4	648.9	648.9	648.9	0.0

[1]Feet above I & M Rail Link, LLC

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS

FLOODWAY DATA

PINE CREEK/PINE CREEK OVERFLOW

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
ROOT RIVER								
A	16,990	7,128	48,116	3.4	643.5	643.5	643.5	0.0
B	17,589	7,146	41,824	3.3	644.3	644.3	644.3	0.0
C	18,833	6,219	38,843	2.6	645.1	645.1	645.1	0.0
D	20,140	5,993	36,990	1.9	645.6	645.6	645.6	0.0
E	22,927	8,153	47,942	1.2	646.1	646.1	646.1	0.0
F	25,391	6,595	30,269	2.0	647.1	647.1	647.1	0.0
G	27,006	4,800	22,155	2.6	648.0	648.0	648.0	0.0
H	29,031	5,259	30,162	1.9	648.8	648.8	648.8	0.0
I	31,668	6,296	40,256	1.8	651.1	651.1	651.1	0.0
J	32,126	6,134	35,580	1.8	651.4	651.4	651.4	0.0
K	32,984	6,299	36,636	1.6	651.6	651.6	651.6	0.0
L	34,916	5,289	27,358	2.1	652.3	652.3	652.3	0.0
M	37,072	4,166	22,477	2.5	653.6	653.6	653.6	0.0
N	38,902	4,289	24,190	2.4	654.4	654.4	654.4	0.0
O	40,224	4,049	21,592	2.6	655.0	655.0	655.0	0.0
P	41,892	4,031	22,727	2.5	655.8	655.8	655.8	0.0
Q	43,323	4,410	23,060	2.5	656.5	656.5	656.5	0.0
R	45,574	4,132	18,320	3.1	657.4	657.4	657.4	0.0
S	46,937	4,900	23,961	2.6	658.6	658.6	658.6	0.0
T	48,102	3,794	19,776	4.3	659.1	659.1	659.1	0.0
U	50,386	3,458	24,147	3.4	662.0	662.0	662.0	0.0

[1]Feet above LaCrosse County, Wisconsin / Houston County, Minnesota County Boundary

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS

FLOODWAY DATA

ROOT RIVER

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
ROOT RIVER (CONTINUED)								
V	51,869	3,290	23,921	3.2	662.9	662.9	662.9	0.0
W	54,141	2,176	16,027	3.7	664.0	664.0	664.0	0.0
X	56,201	4,210	34,248	2.8	665.3	665.3	665.3	0.0
Y	60,161	3,022	22,385	2.8	667.1	667.1	667.1	0.0
Z	65,650	3,011	22,387	2.5	677.6	677.6	677.6	0.0
AA	69,220	4,903	27,003	2.1	678.4	678.4	678.4	0.0
AB	76,606	2,915	15,599	2.8	681.5	681.5	681.5	0.0
AC	77,826	2,906	11,728	3.7	681.8	681.8	681.8	0.0
AD	78,526	2,395	9,658	4.5	682.1	682.1	682.1	0.0
AE	79,326	1,983	11,035	3.9	683.0	683.0	683.0	0.0
AF	80,556	1,451	7,465	5.8	683.4	683.4	683.4	0.0
AG	81,106	675	5,207	8.3	683.8	683.8	683.8	0.0
AH	81,251	345	4,512	9.6	683.9	683.9	683.9	0.0
AI	81,886	1,249	8,087	5.3	685.2	685.2	685.2	0.0
AJ	82,556	1,298	8,426	5.1	685.6	685.6	685.6	0.0
AK	83,746	2,145	13,274	3.3	686.6	686.6	686.6	0.0
AL	84,346	1,950	10,254	4.2	686.7	686.7	686.7	0.0
AM	84,806	1,792	9,250	4.7	686.8	686.8	686.8	0.0
AN	85,396	1,648	12,616	3.4	687.6	687.6	687.6	0.0
AO	87,046	1,892	13,561	3.2	688.3	688.3	688.3	0.0
AP	87,616	2,308	14,417	3.0	688.4	688.4	688.4	0.0
AQ	92,891	2,798	10,138	4.3	690.7	690.7	690.7	0.0

[1]Feet above LaCrosse County, Wisconsin / Houston County, Minnesota County Boundary

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS

FLOODWAY DATA

ROOT RIVER

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
SOUTH FORK ROOT RIVER								
A	2,871	5,973	24,599	2.4	680.4	680.4	680.4	0.0
B	5,120	5,623	22,096	0.9	680.9	680.9	680.9	0.0
C	6,596	5,214	16,219	1.2	681.1	681.1	681.1	0.0
D	7,667	5,164	17,711	1.1	681.3	681.3	681.3	0.0
E	9,129	4,704	12,627	3.5	681.8	681.8	681.8	0.0
F	9,938	4,262	11,303	3.2	683.0	683.0	683.0	0.0
G	11,166	3,082	9,816	2.4	684.9	684.9	684.9	0.0
H	12,877	2,274	6,363	2.9	686.5	686.5	686.5	0.0
I	14,102	1,682	6,430	2.9	688.3	688.3	688.3	0.0
J	15,661	2,606	9,078	2.1	689.2	689.2	689.3	0.1
K	18,015	2,464	6,786	2.8	690.3	690.3	690.4	0.1
L	18,915	2,801	8,070	2.3	691.4	691.4	691.4	0.0

[1]Feet above confluence with Root River

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS

FLOODWAY DATA

SOUTH FORK ROOT RIVER

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
THOMPSON CREEK								
A	494	366	1,710	4.9	655.8	655.8	655.8	0.0
B	1,230	265	1,831	7.0	657.2	657.2	657.3	0.1
C	1,437	250	1,815	7.5	657.5	657.5	657.6	0.1
D	1,481	270	1,753	7.5	657.5	657.5	657.6	0.1
E	1,968	170	1,596	8.2	658.4	658.4	658.6	0.2
F	2,567	148	1,529	7.8	659.4	659.4	659.5	0.1
G	2,841	605	2,822	6.9	671.4	671.4	671.4	0.0
H	3,140	623	2,914	6.0	671.9	671.9	671.9	0.0
I	3,690	359	1,712	8.9	672.5	672.5	672.5	0.0
J	4,166	160	1,377	7.3	675.0	675.0	675.0	0.0
K	4,835	529	3,425	4.5	676.3	676.3	676.3	0.0
L	5,162	482	2,992	5.0	676.5	676.5	676.5	0.0
M	6,202	380	2,734	5.1	677.7	677.7	677.7	0.0
N	7,175	542	3,086	4.8	678.4	678.4	678.4	0.0
O	7,599	518	2,923	4.3	678.8	678.8	678.8	0.0
P	8,660	560	2,452	4.8	679.5	679.5	679.5	0.0
Q	9,426	112	699	10.7	680.9	680.9	680.9	0.0

[1]Feet above confluence with Root River

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS

FLOODWAY DATA

THOMPSON CREEK

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water surface elevation of the 1-percent-annual-chance flood more than 1 foot at any point.

Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1.

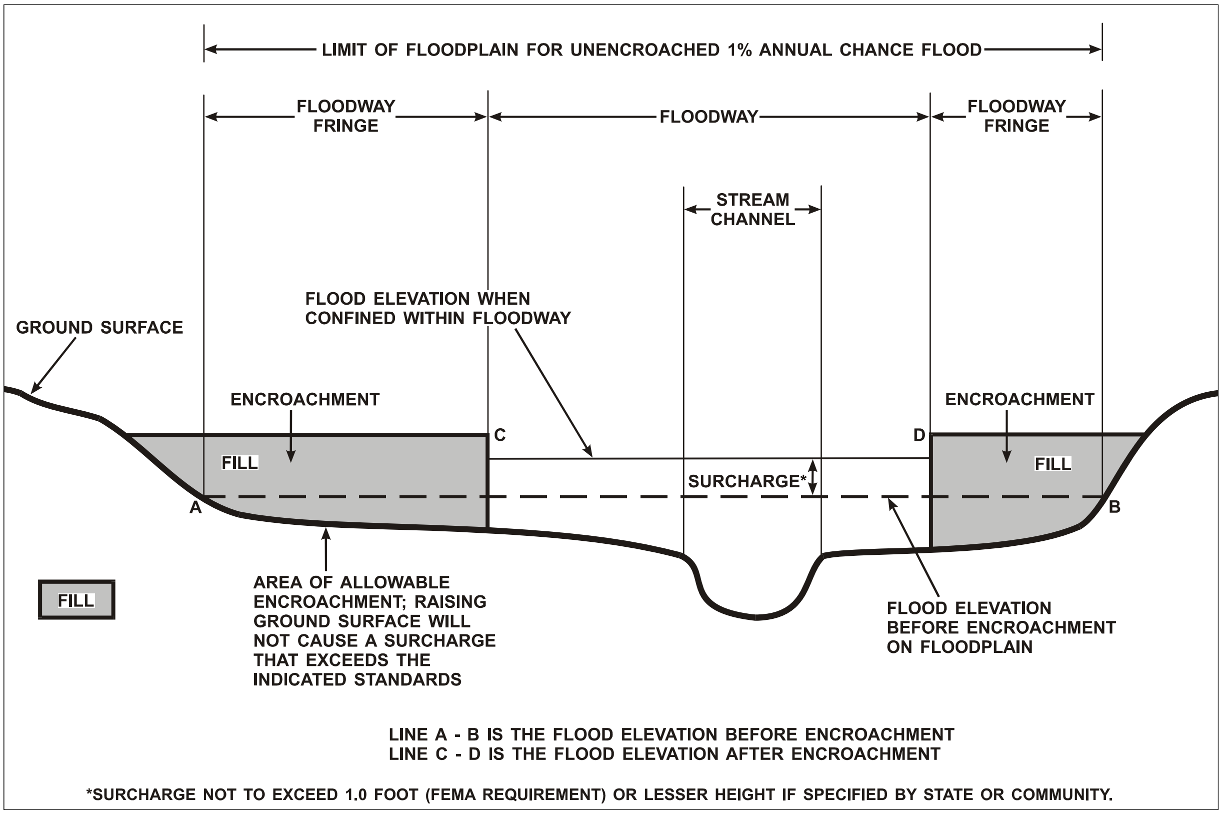

Figure 1 - Floodway Schematic

5.0 INSURANCE APPLICATIONS

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

Zone A

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

Zone AE

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

Zone X

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

6.0 FLOOD INSURANCE RATE MAP

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

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

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

The countywide FIRM presents flooding information for the entire geographic area of Houston County. Previously, FIRMs were prepared for each incorporated community and the unincorporated areas of the County identified as flood-prone. Historical data relating to the maps prepared for each community are presented in Table 5.

7.0 OTHER STUDIES

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

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, 536 South Clark Street, Sixth Floor, Chicago, Illinois 60605.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Brownsville, City of	October 18, 1974	July 2, 1976 June 8, 1979	February 15, 1984	None
Caledonia, City of	October 13, 1978	None	N/A	None
Eitzen, City of[1,2]	N/A	N/A	N/A	N/A
Hokah, City of	March 8, 1974	June 4, 1976	March 15, 1982	None
Houston, City of	May 24, 1974	March 26, 1976	July 16, 1979	December 4, 1981 August 23, 2000
Houston County (Unincorporated Areas)	January 6, 1978	None	January 6, 1982	June 6, 2001
La Crescent, City of	July 20, 1973	None	July 20, 1973	July 1, 1974 November 28, 1975 May 2, 1983
Spring Grove, City of[1]	N/A	N/A	N/A	N/A

[1]This community does not have map history prior to the first countywide mapping.
[2]No Special Flood Hazard Areas Identified

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

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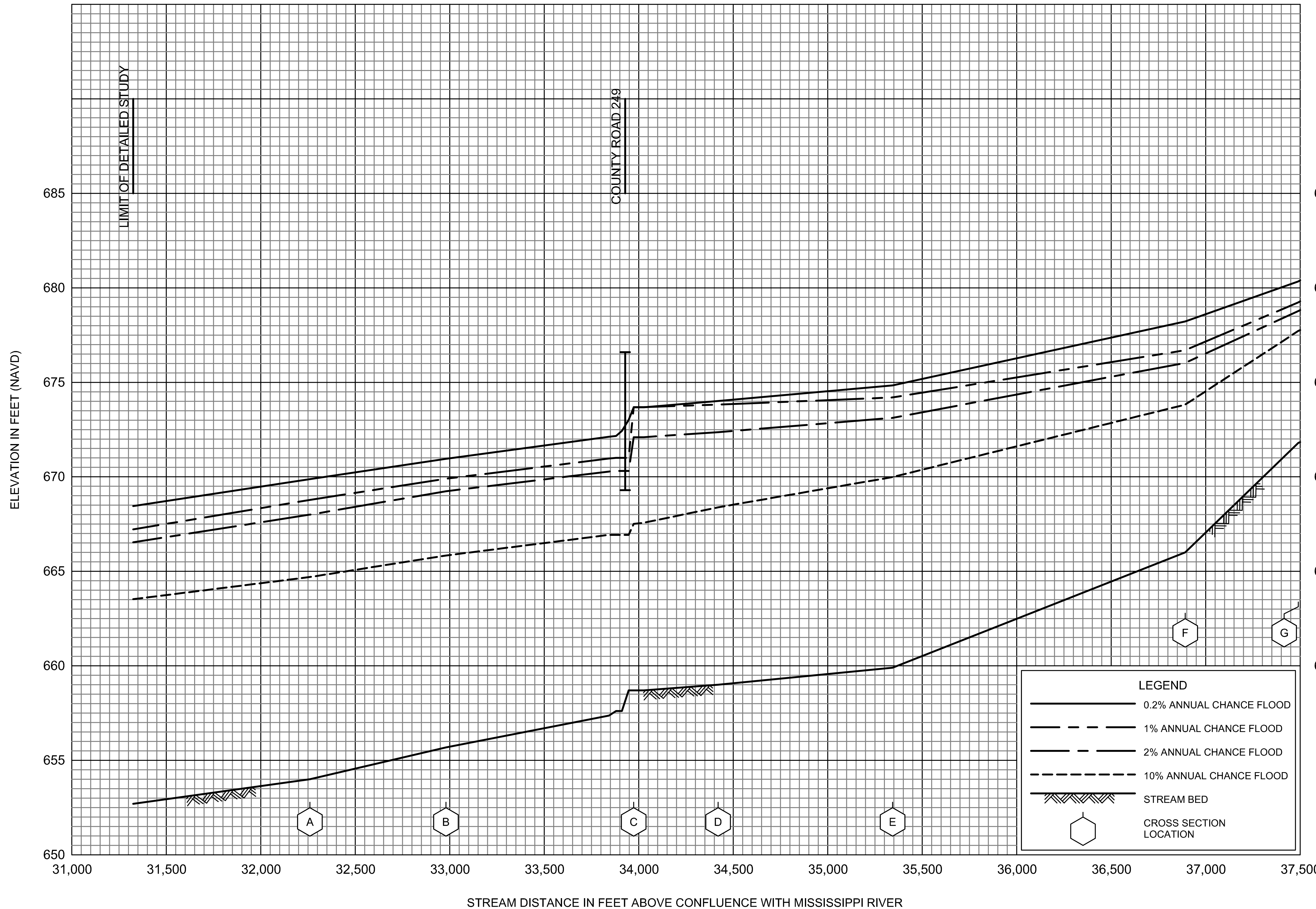


FLOOD PROFILES

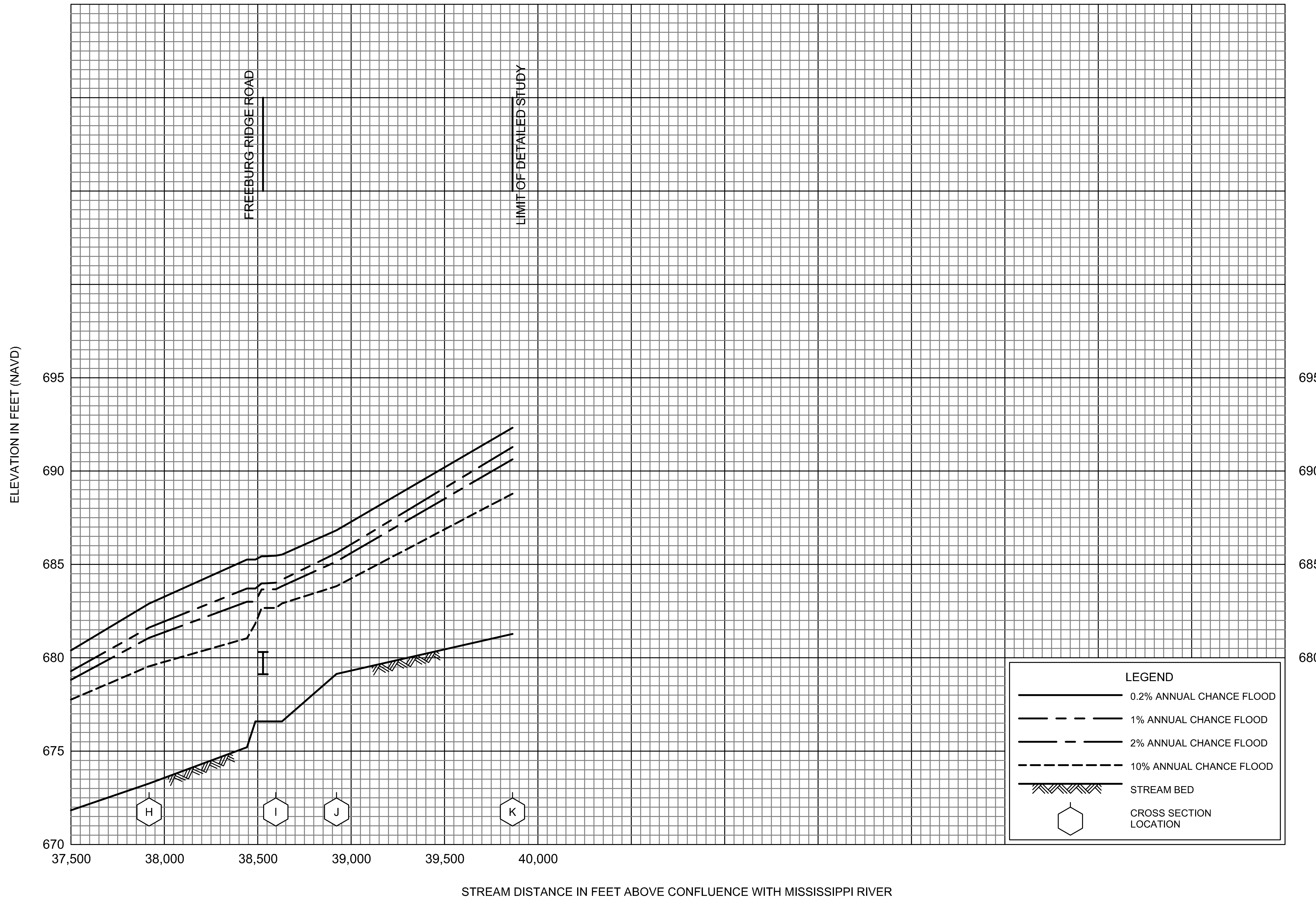
CROOKED CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS

01P



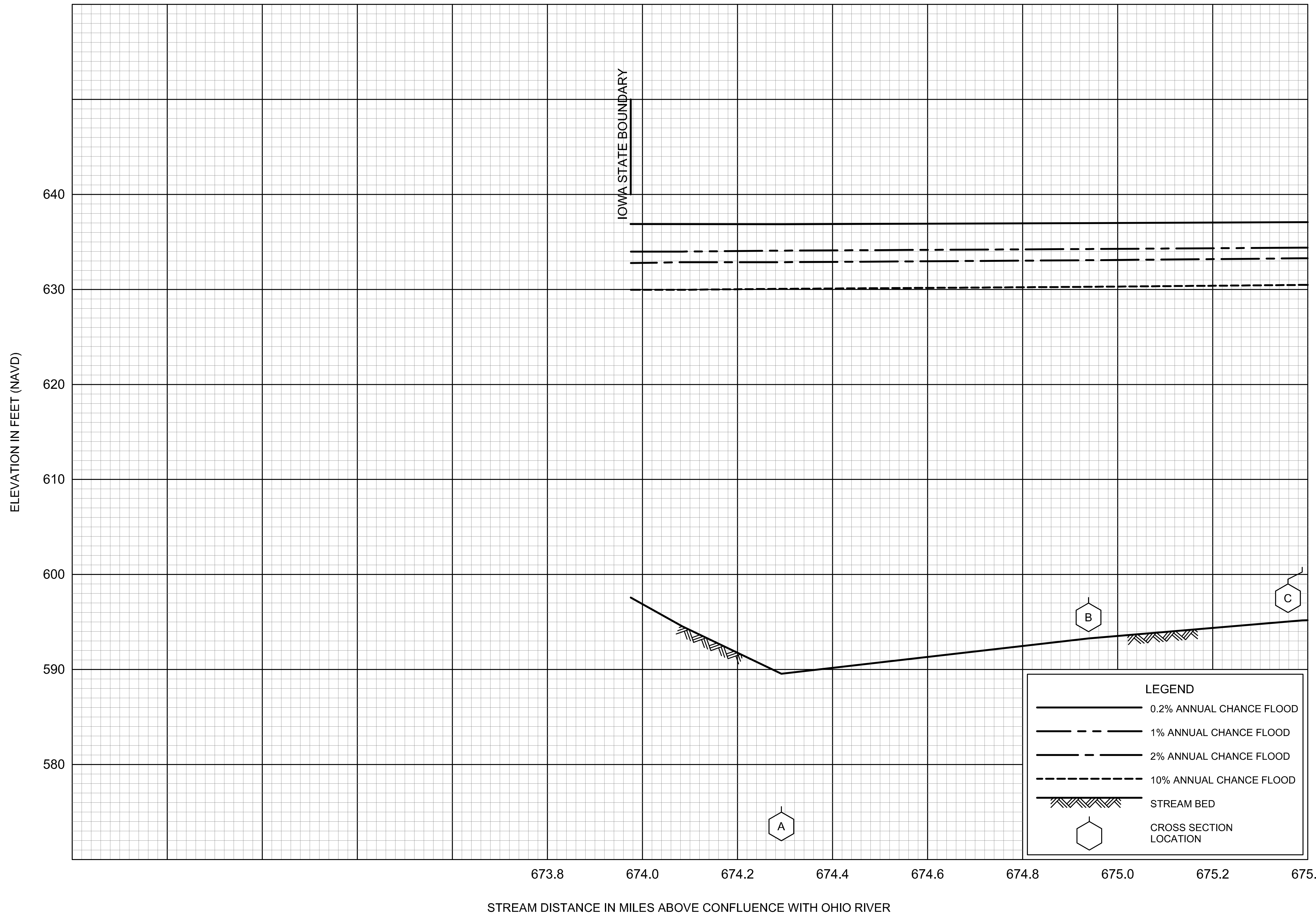
FLOOD PROFILES

CROOKED CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



FLOOD PROFILES

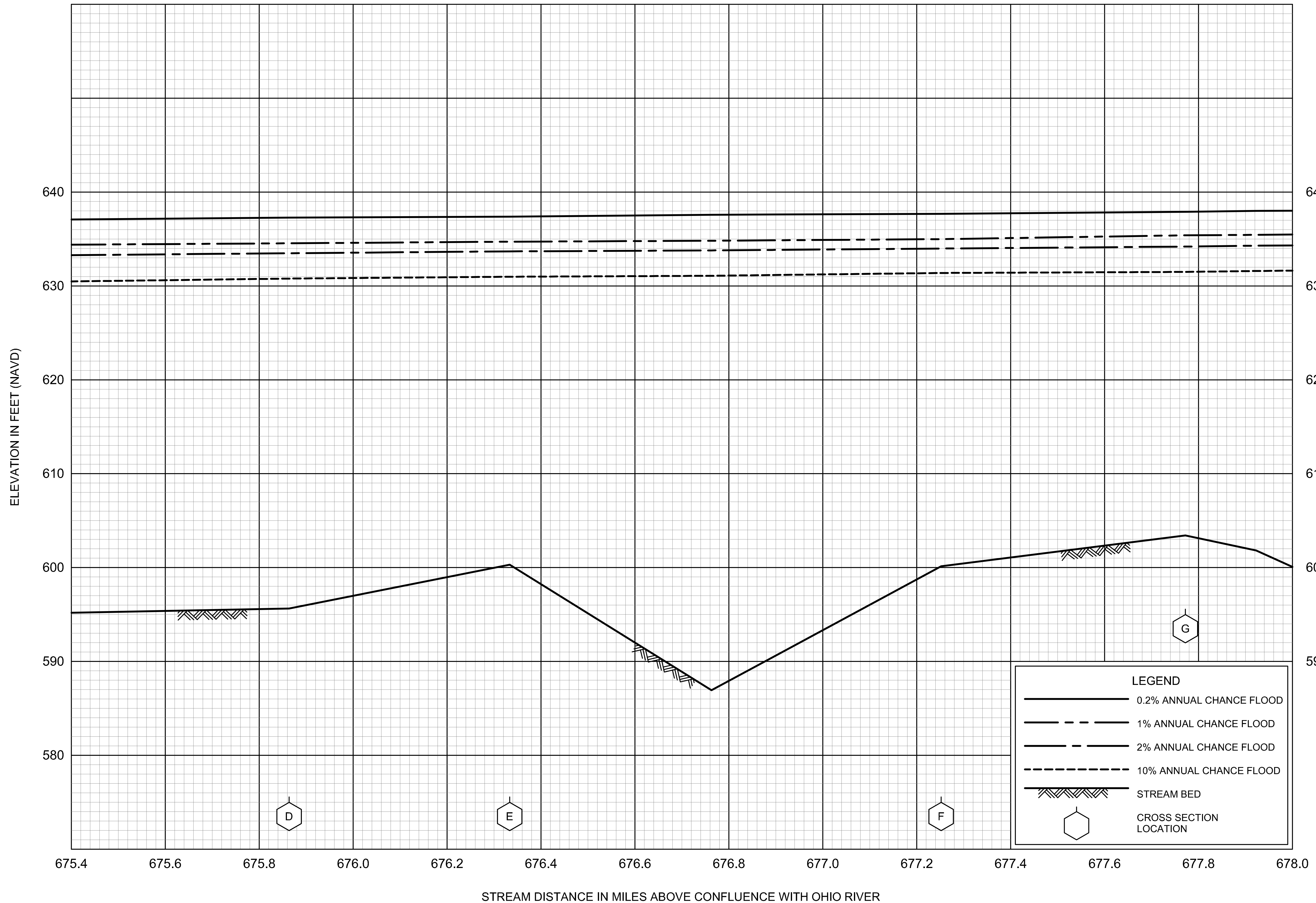
MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS

03P



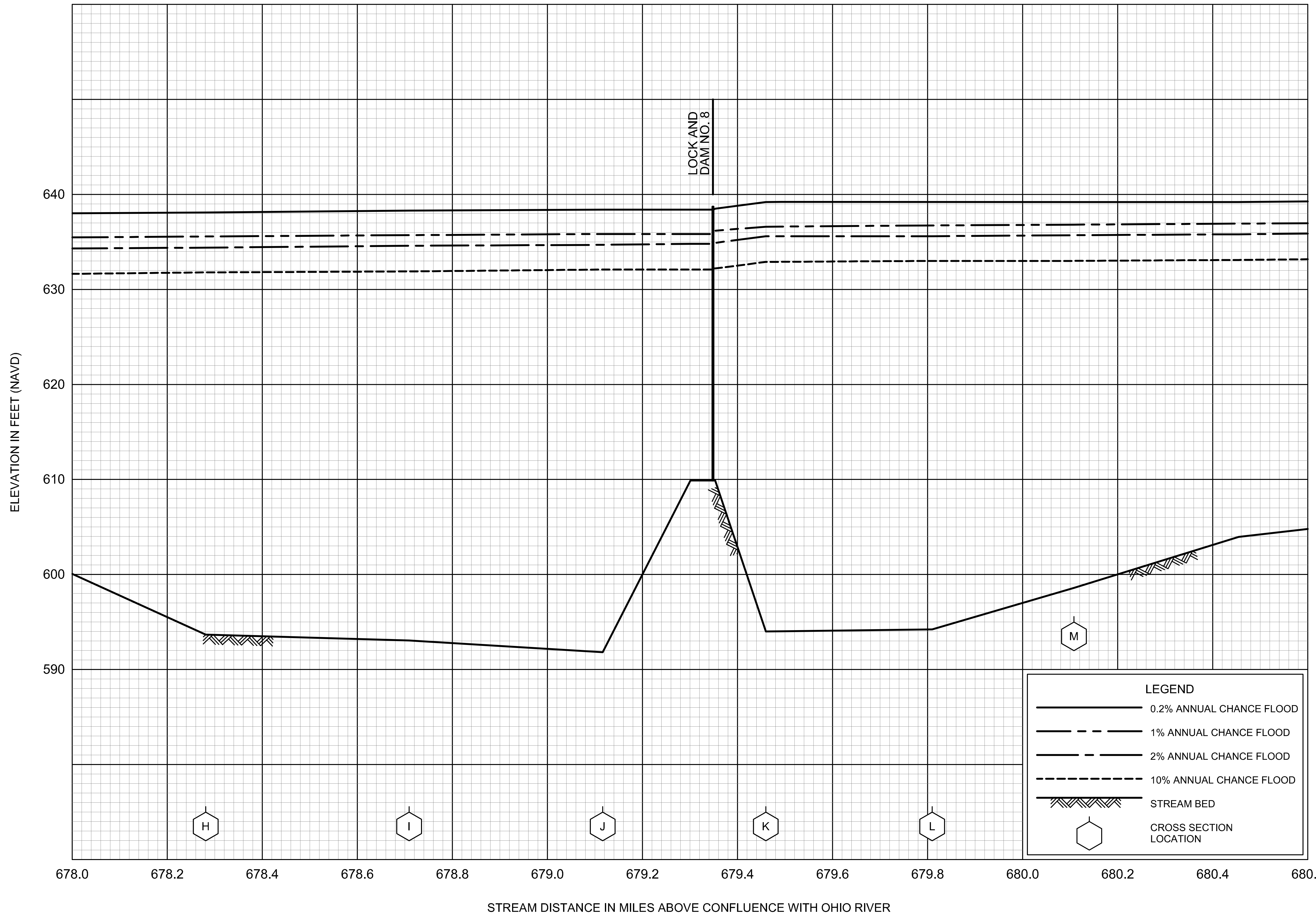
FLOOD PROFILES

MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



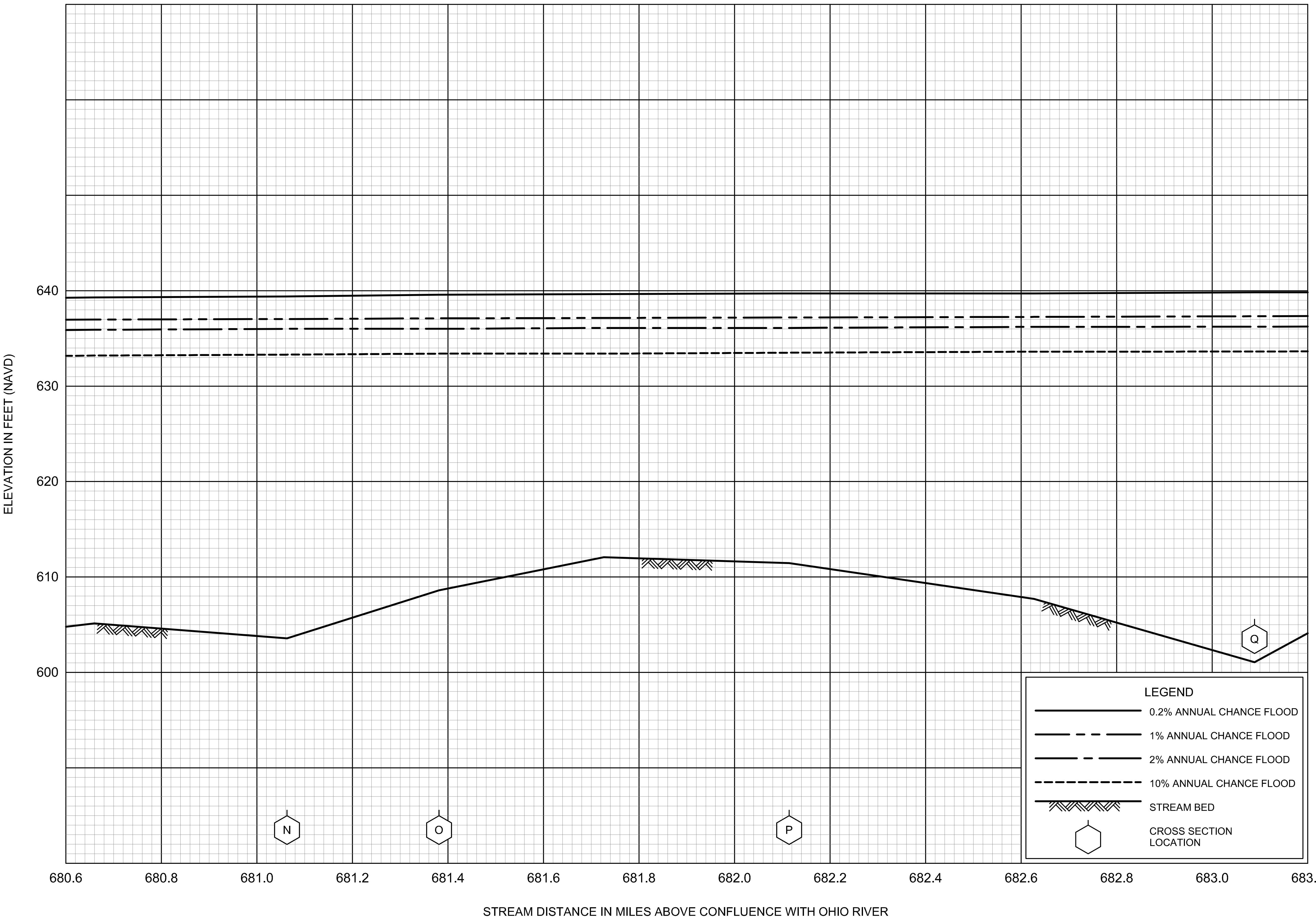
FLOOD PROFILES

MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



FLOOD PROFILES

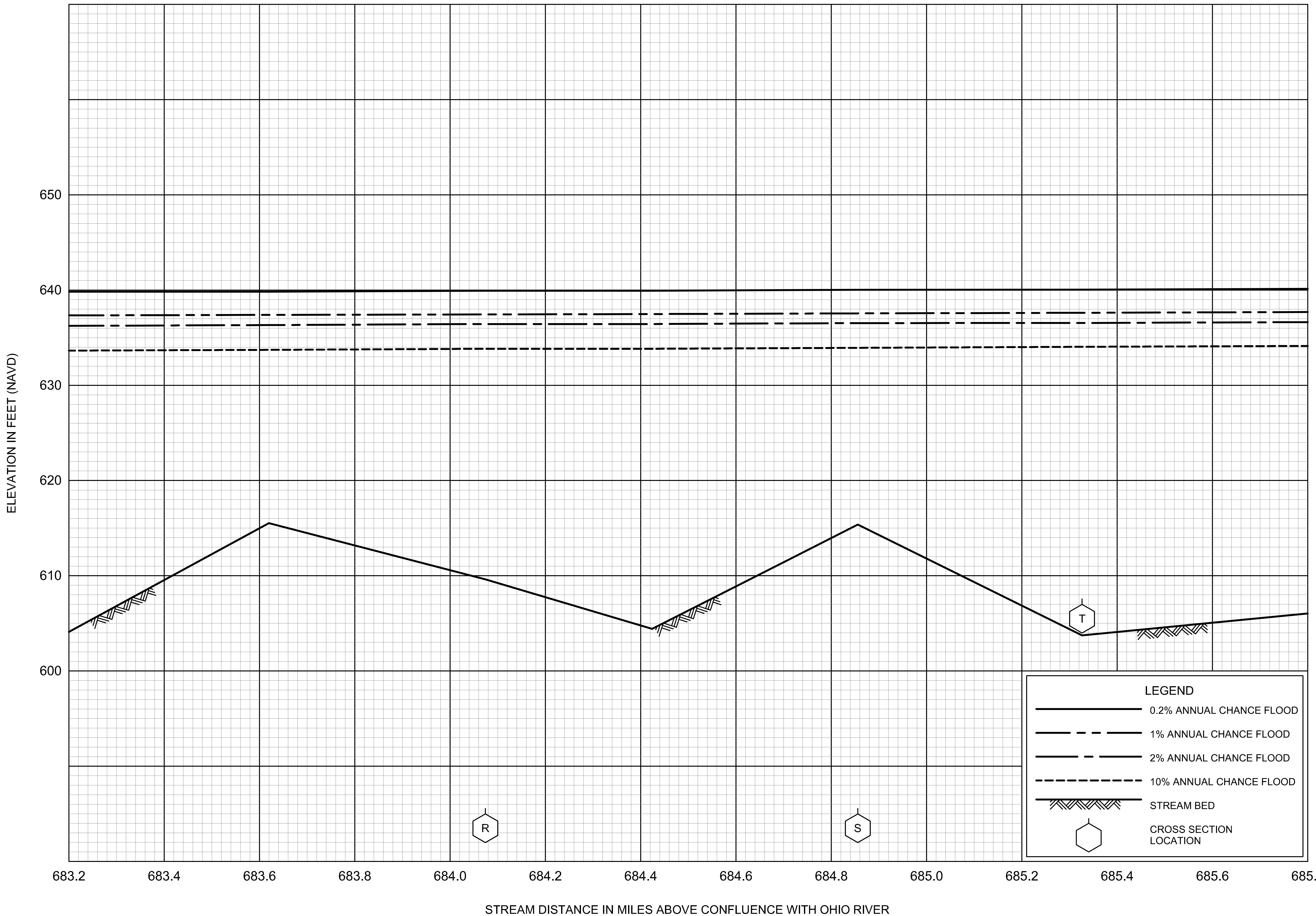
MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS

06P



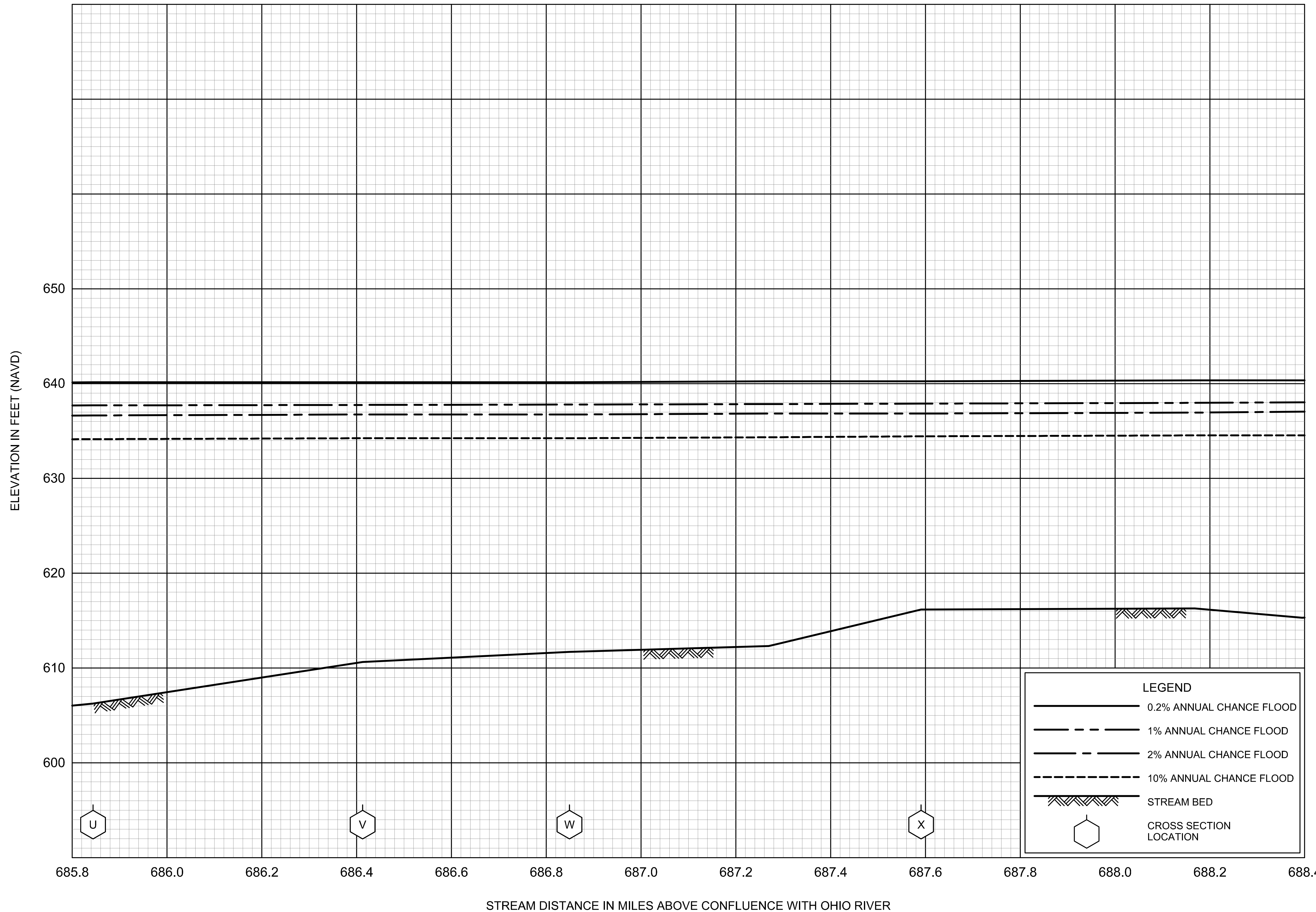
FLOOD PROFILES

MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



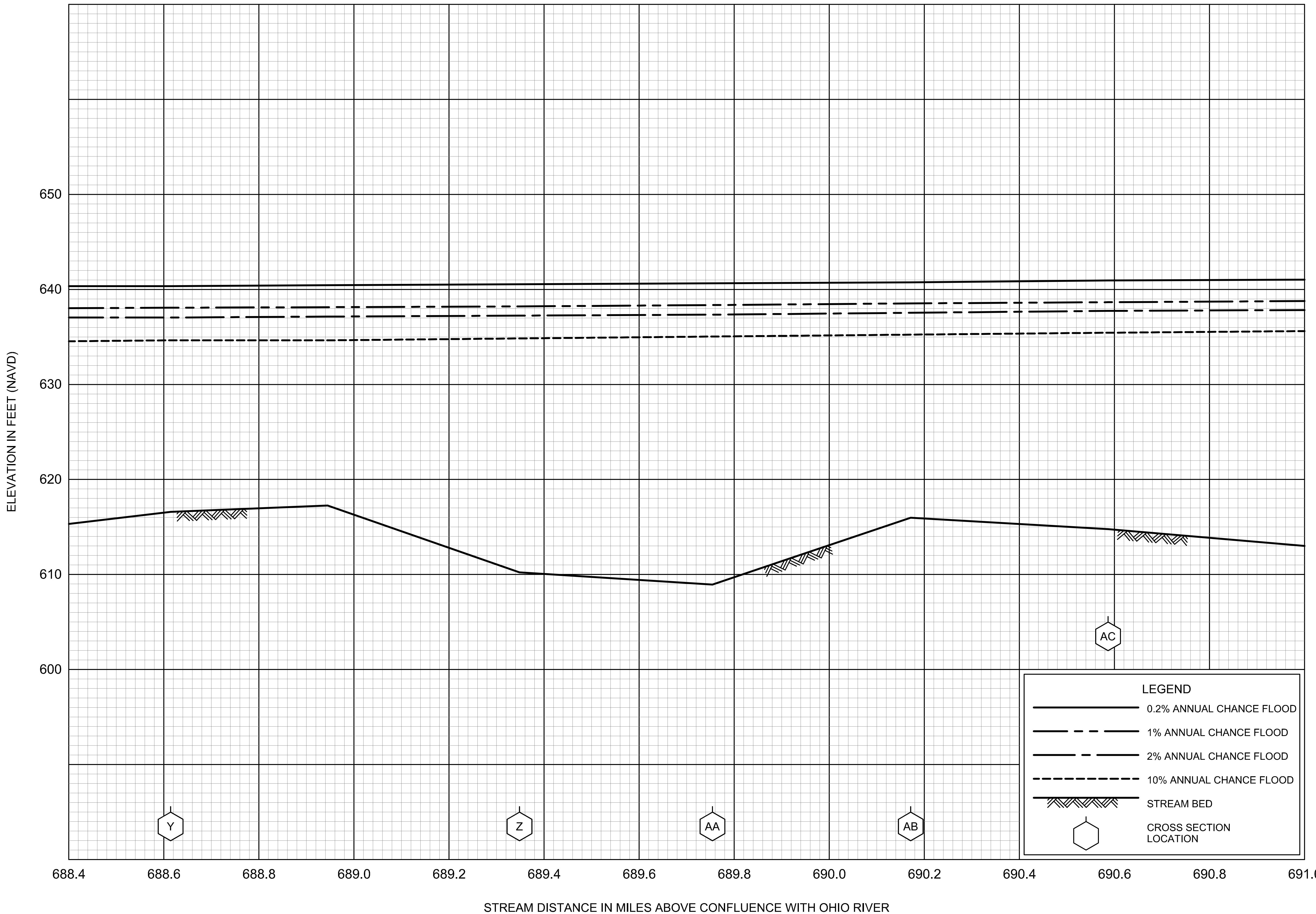
FLOOD PROFILES

MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



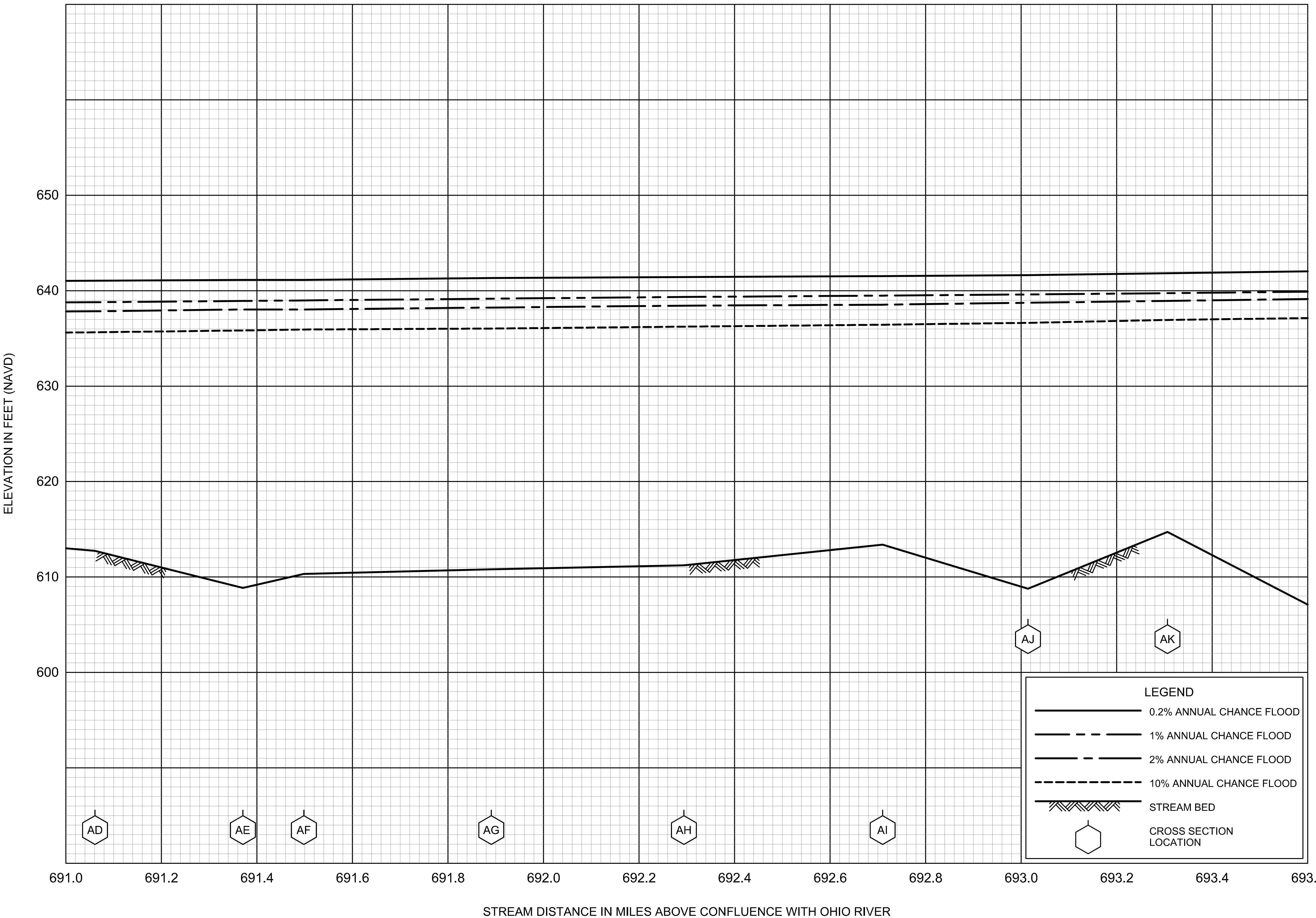
FLOOD PROFILES

MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



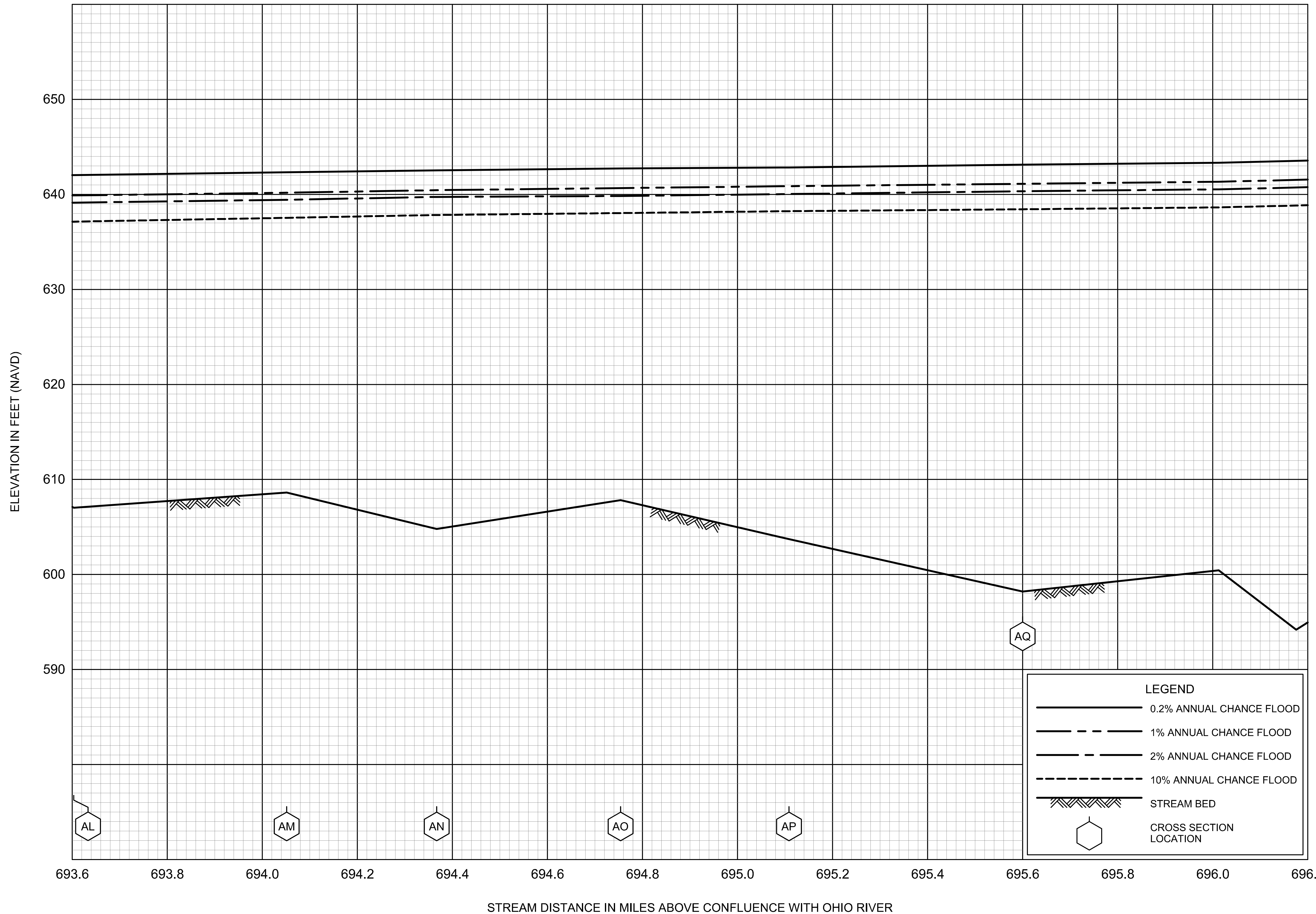
FLOOD PROFILES

MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



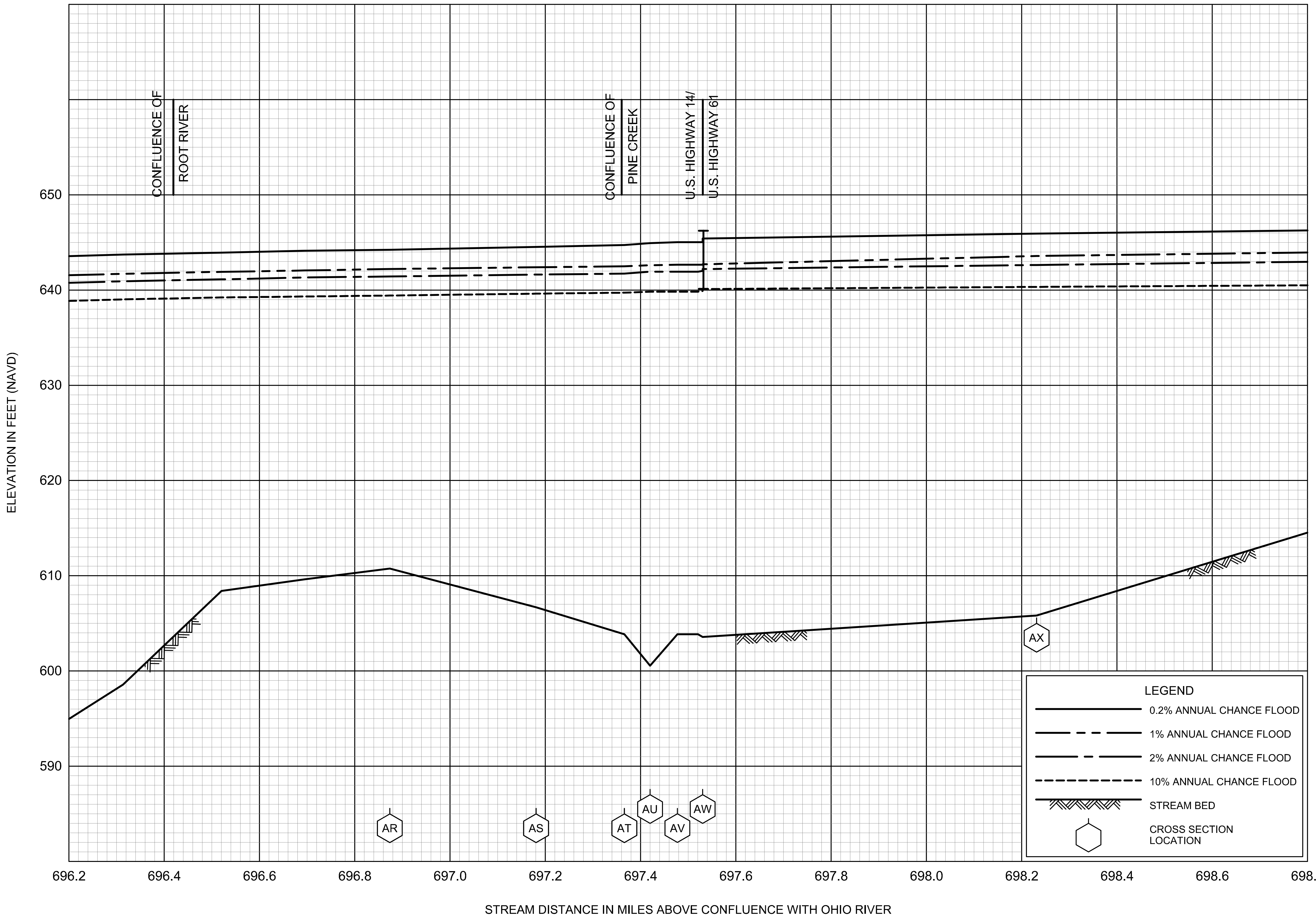
FLOOD PROFILES

MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



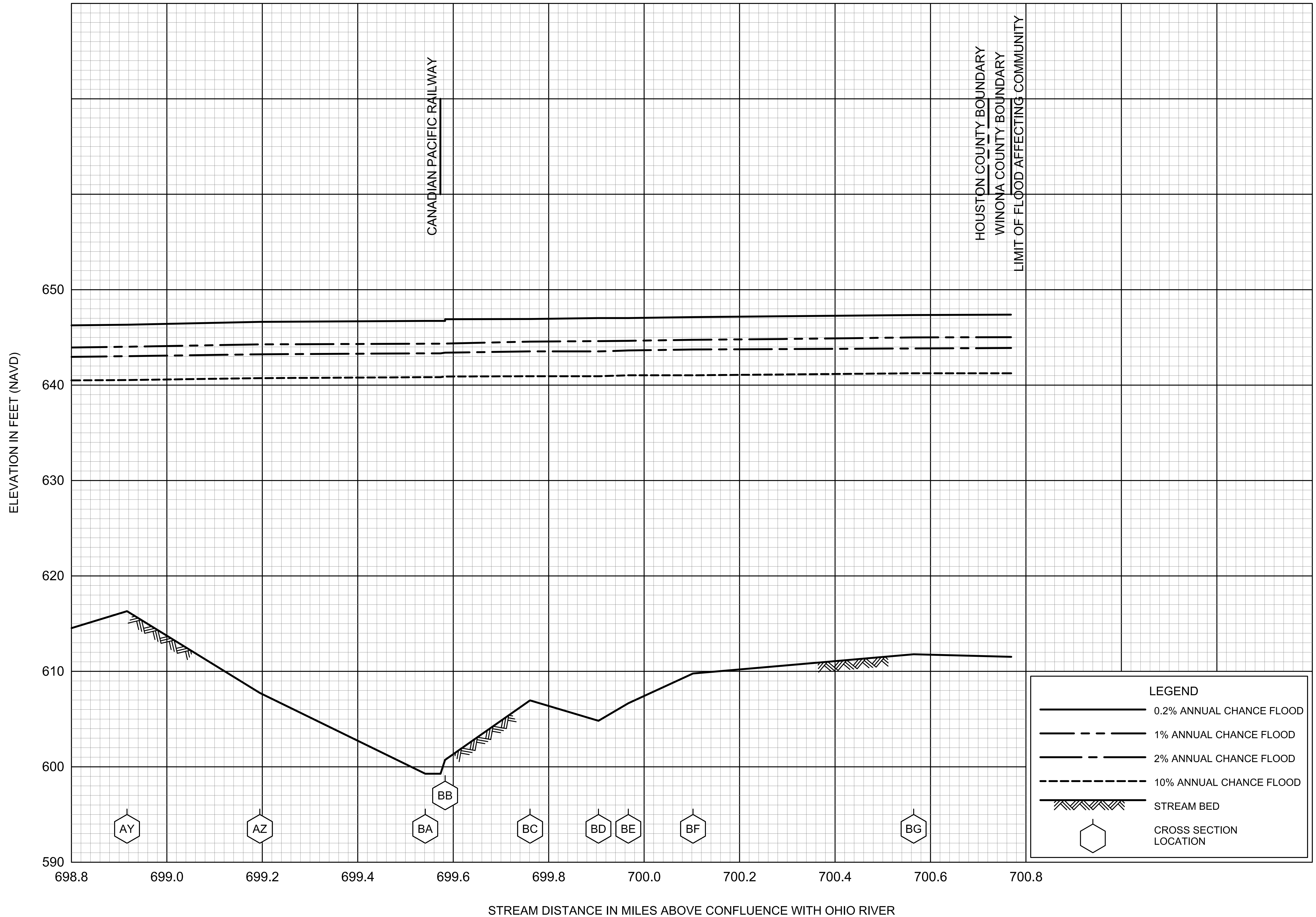
FLOOD PROFILES

MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



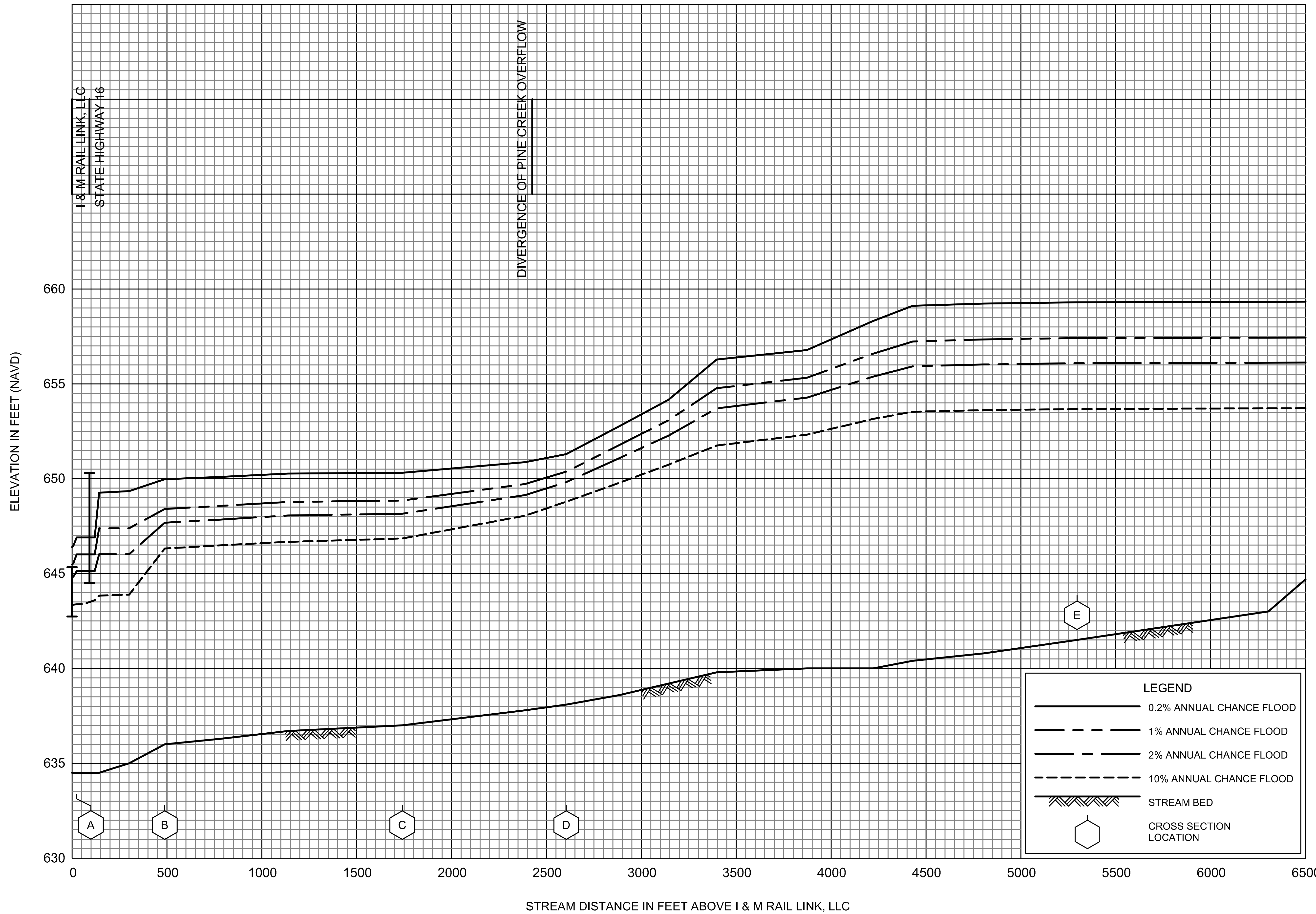
FLOOD PROFILES

MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



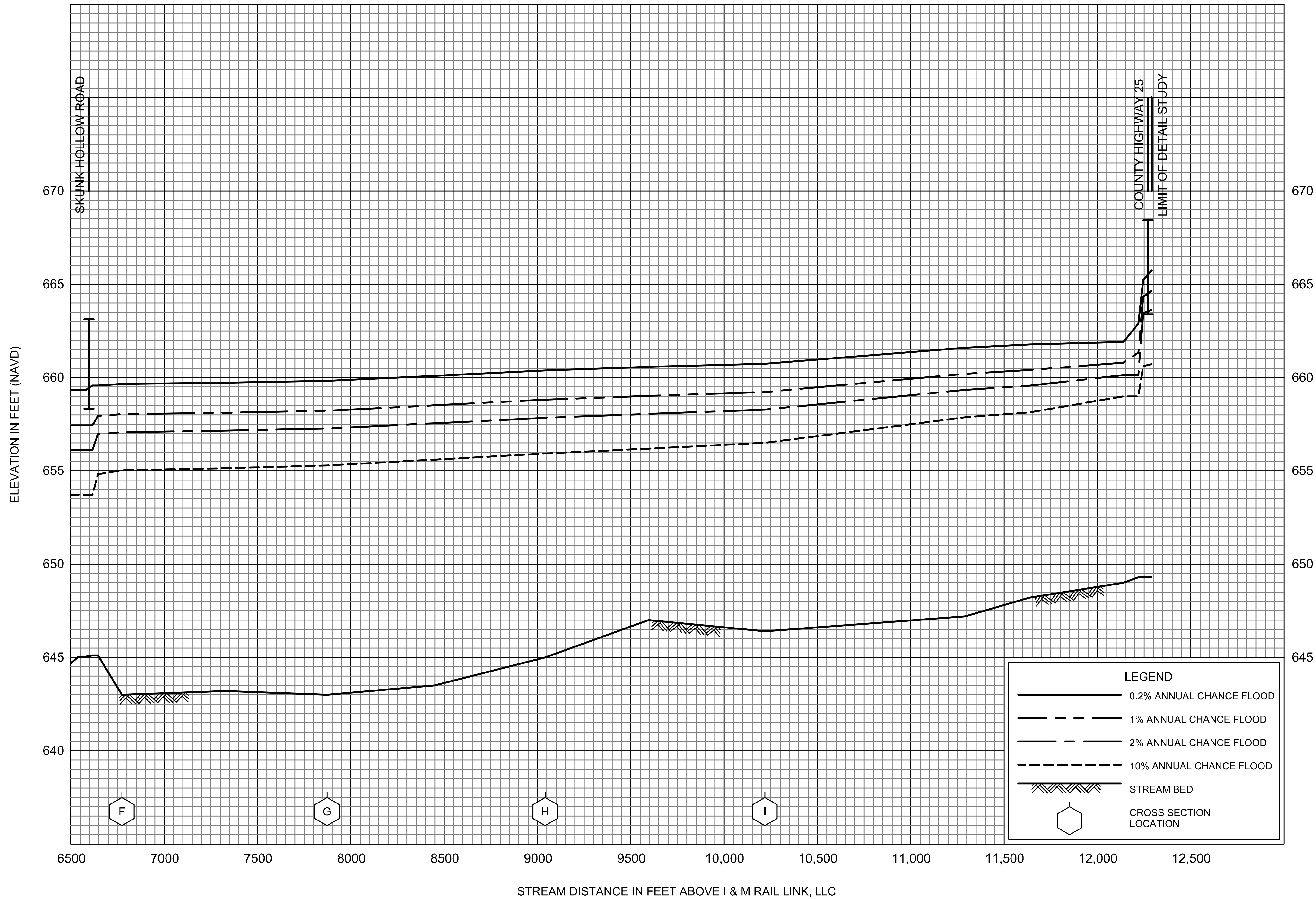
FLOOD PROFILES

PINE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



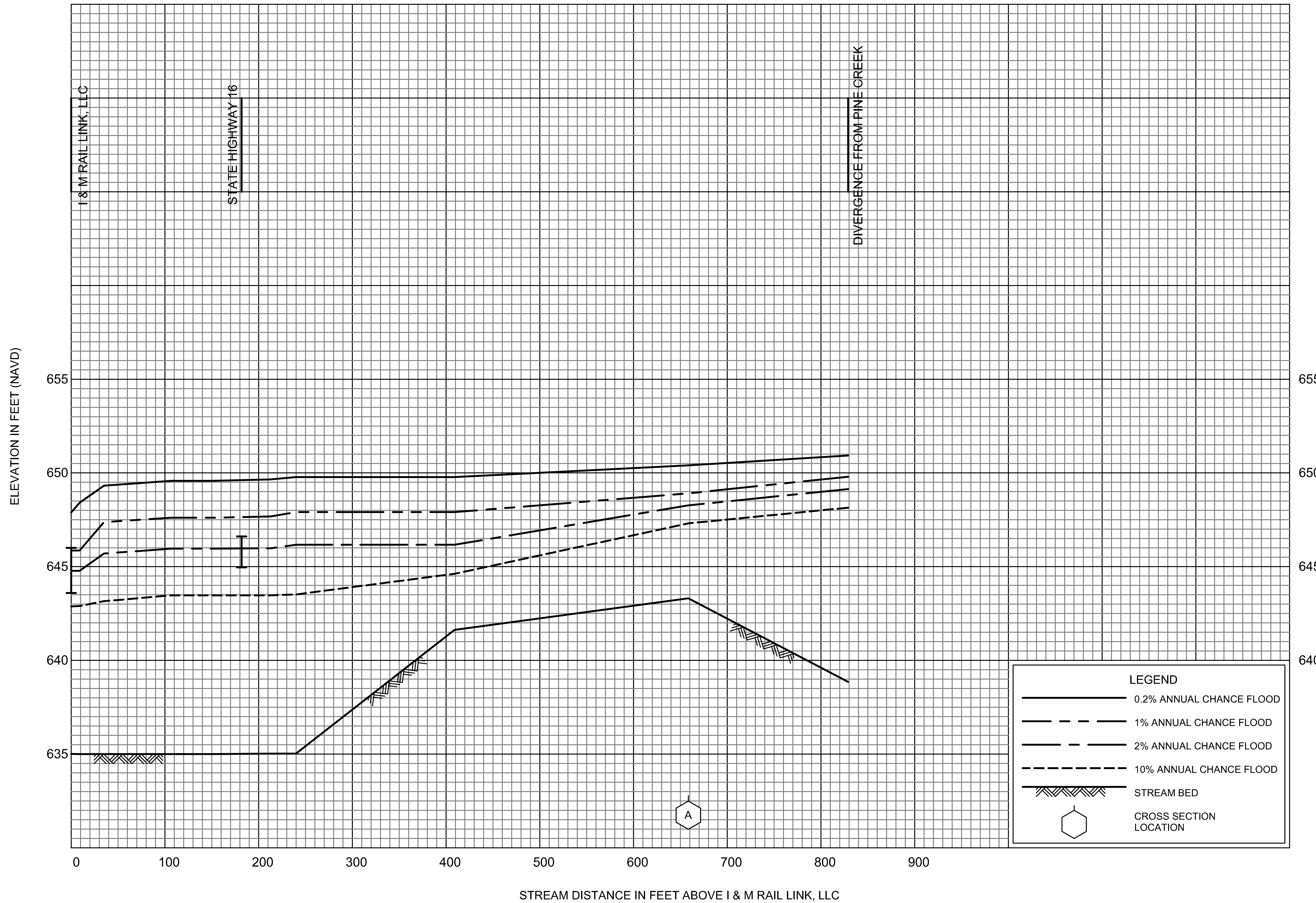
FLOOD PROFILES

PINE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



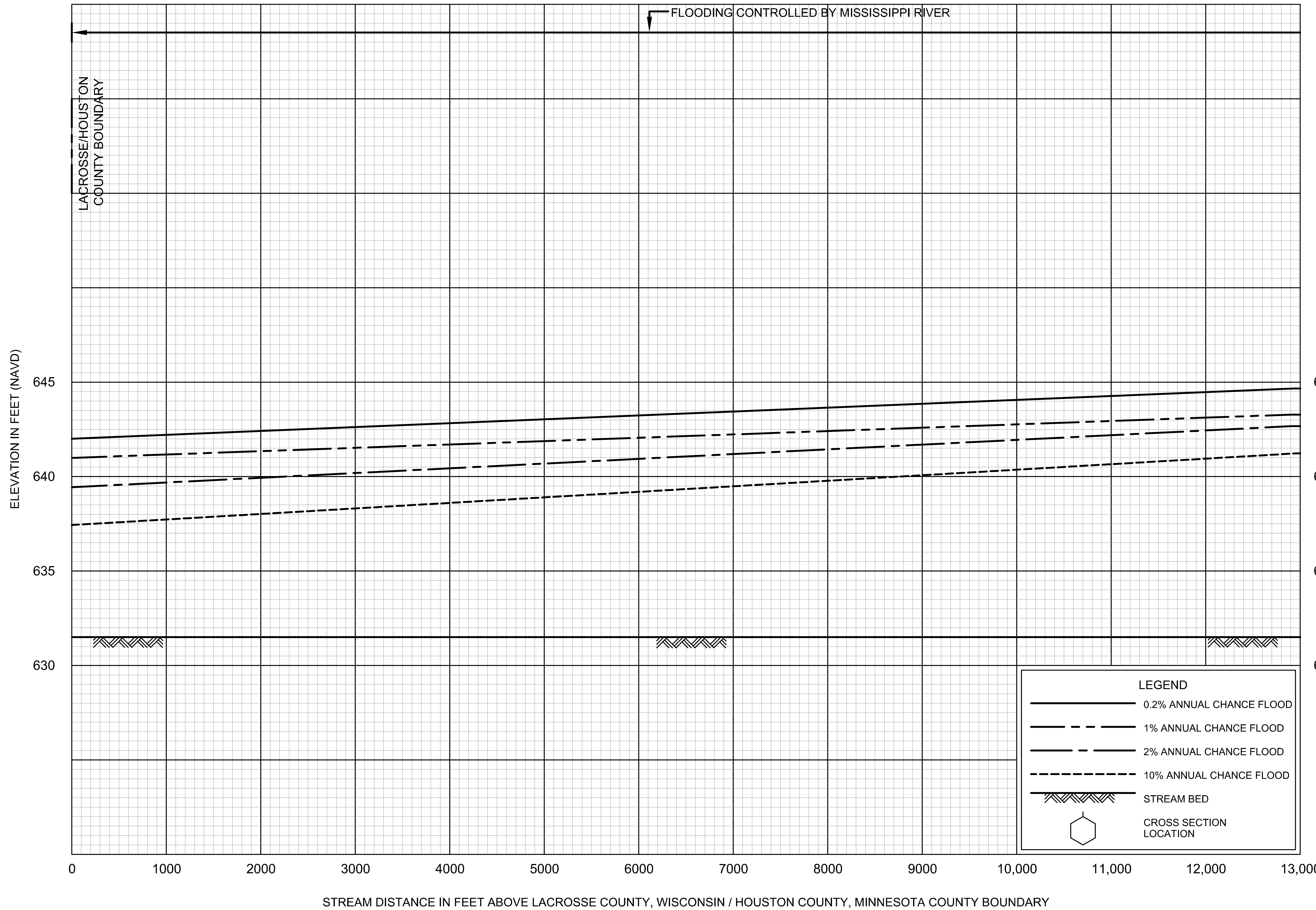
FLOOD PROFILES

PINE CREEK OVERFLOW

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



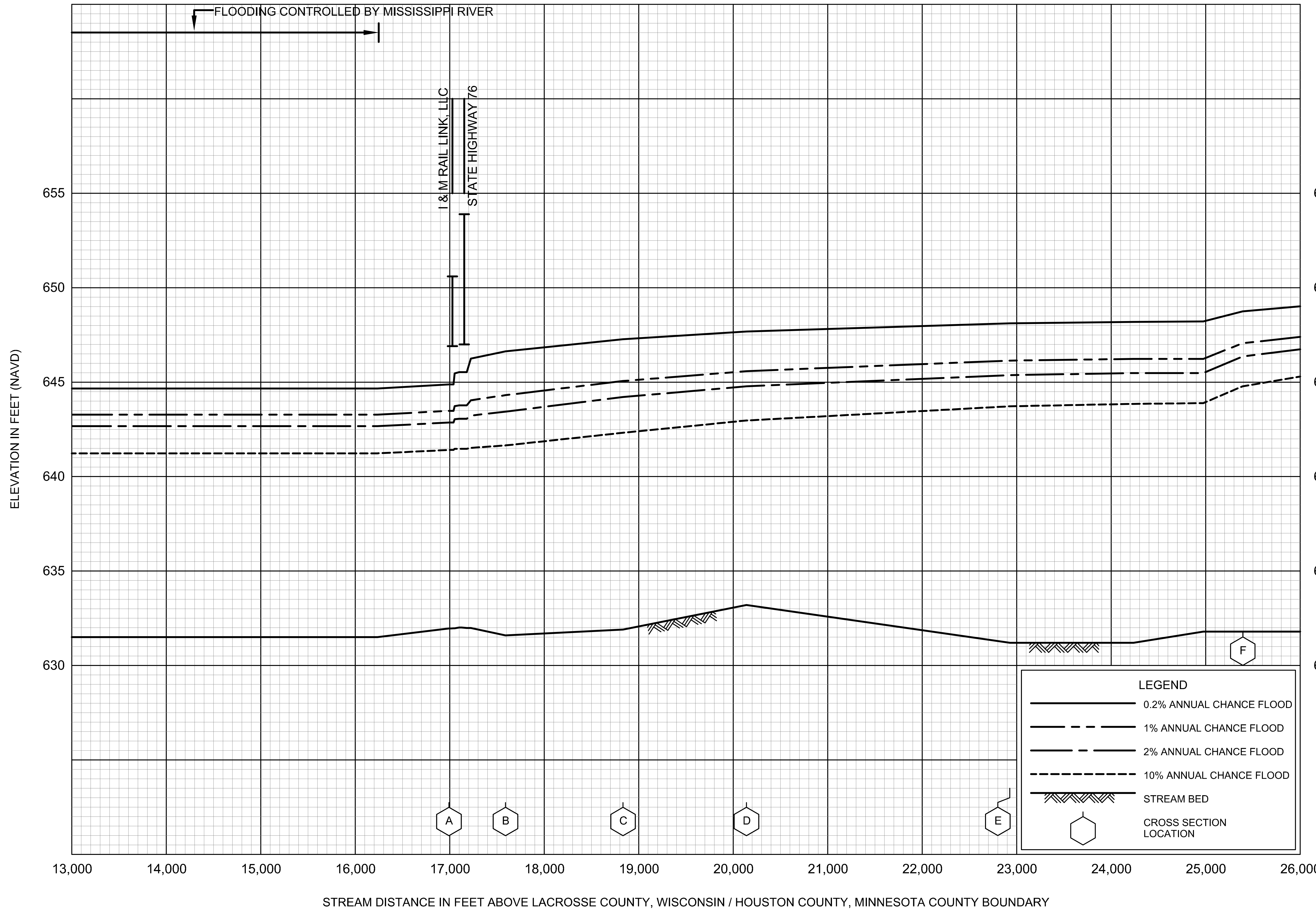
FLOOD PROFILES

ROOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



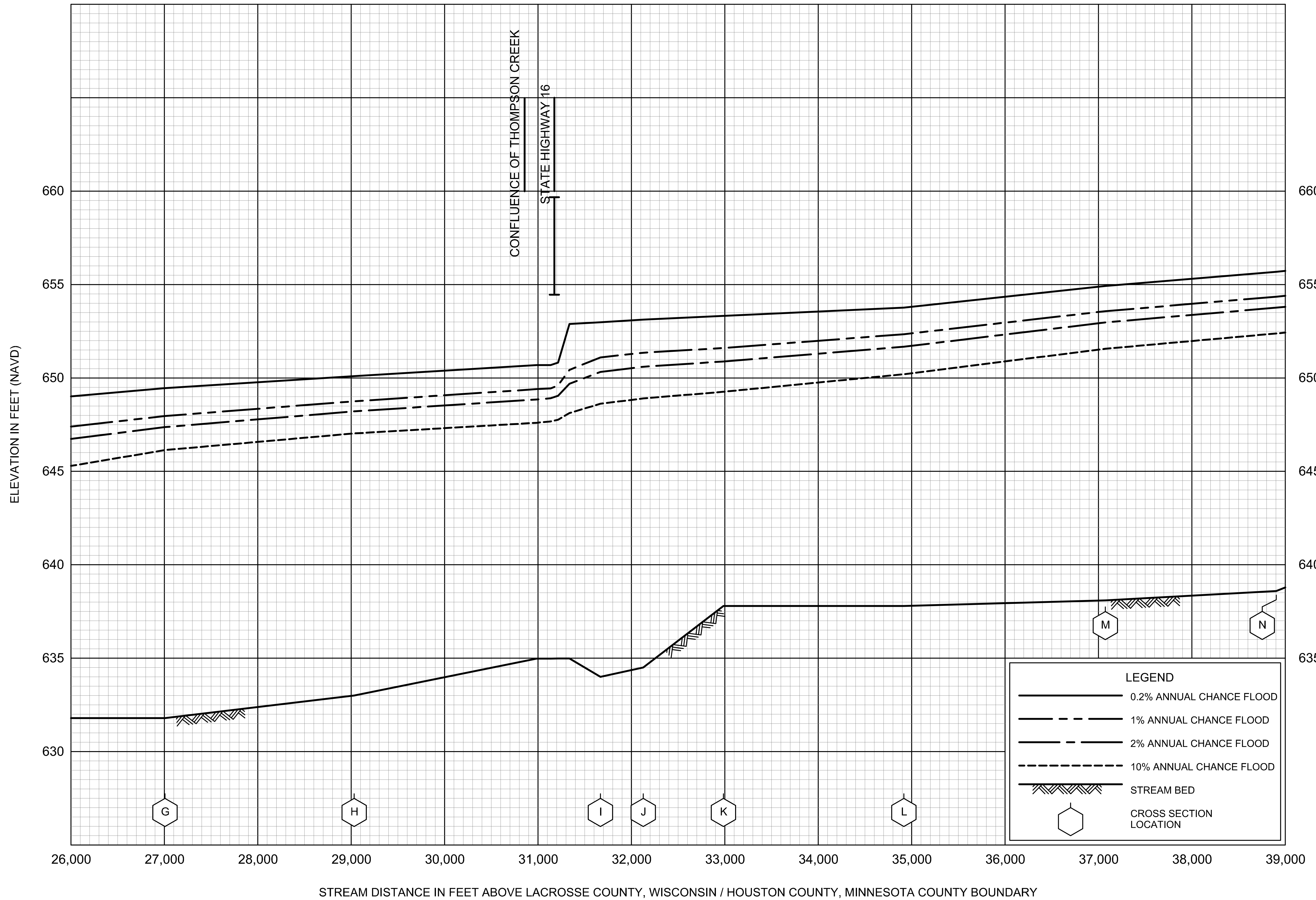
FLOOD PROFILES

ROOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



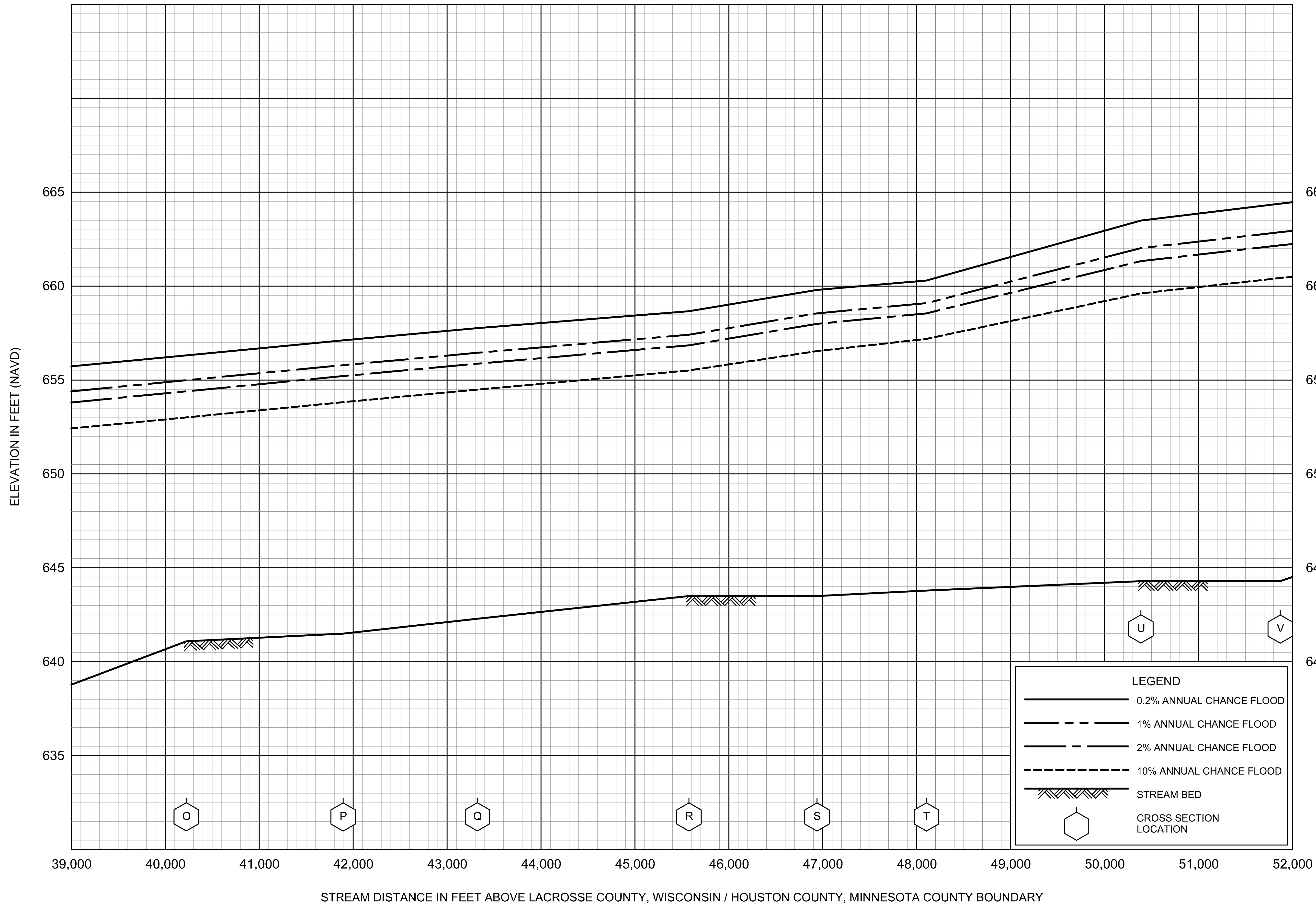
FLOOD PROFILES

ROOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



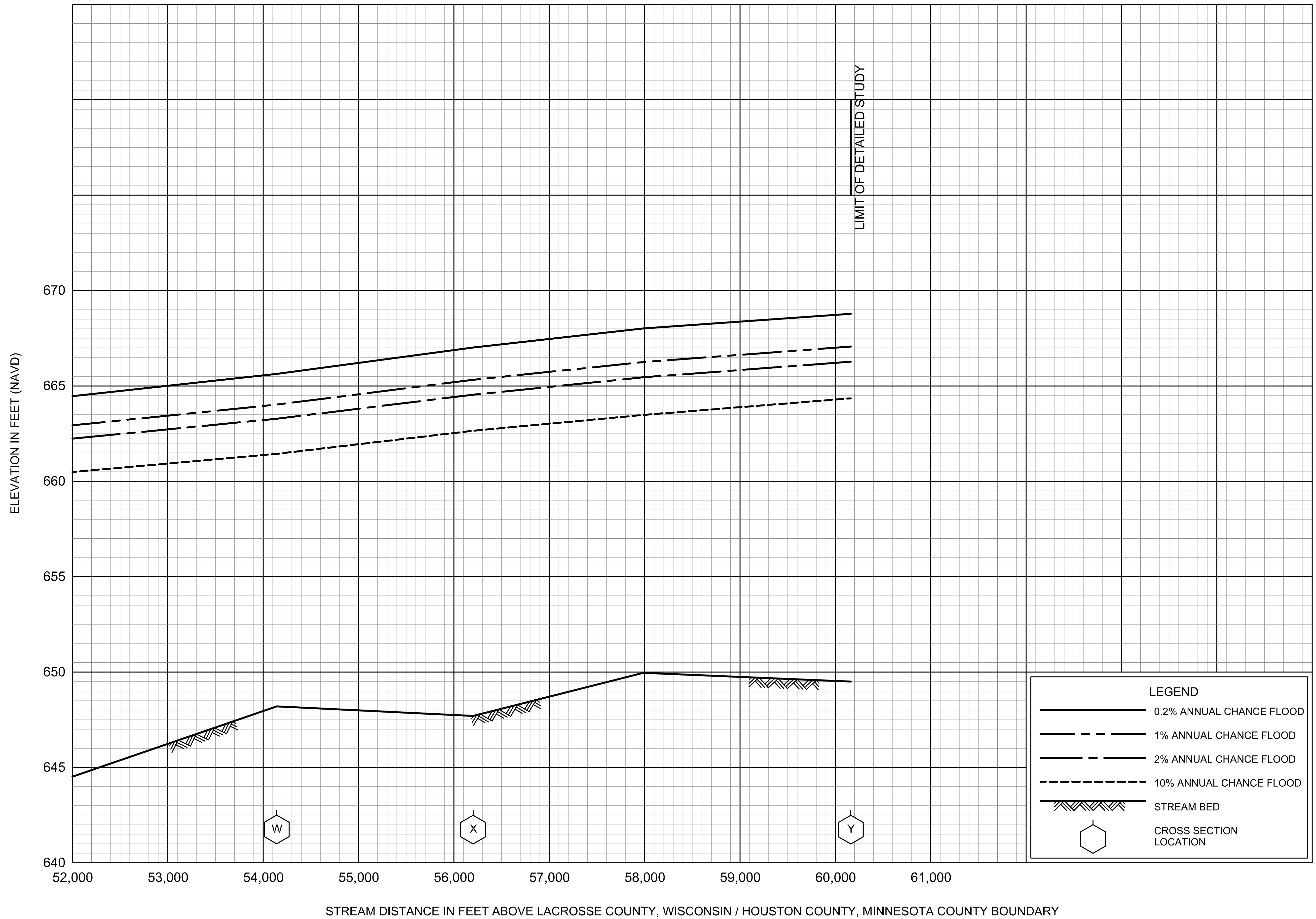
FLOOD PROFILES

ROOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



FLOOD PROFILES

ROOT RIVER

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HOUSTON COUNTY, MN

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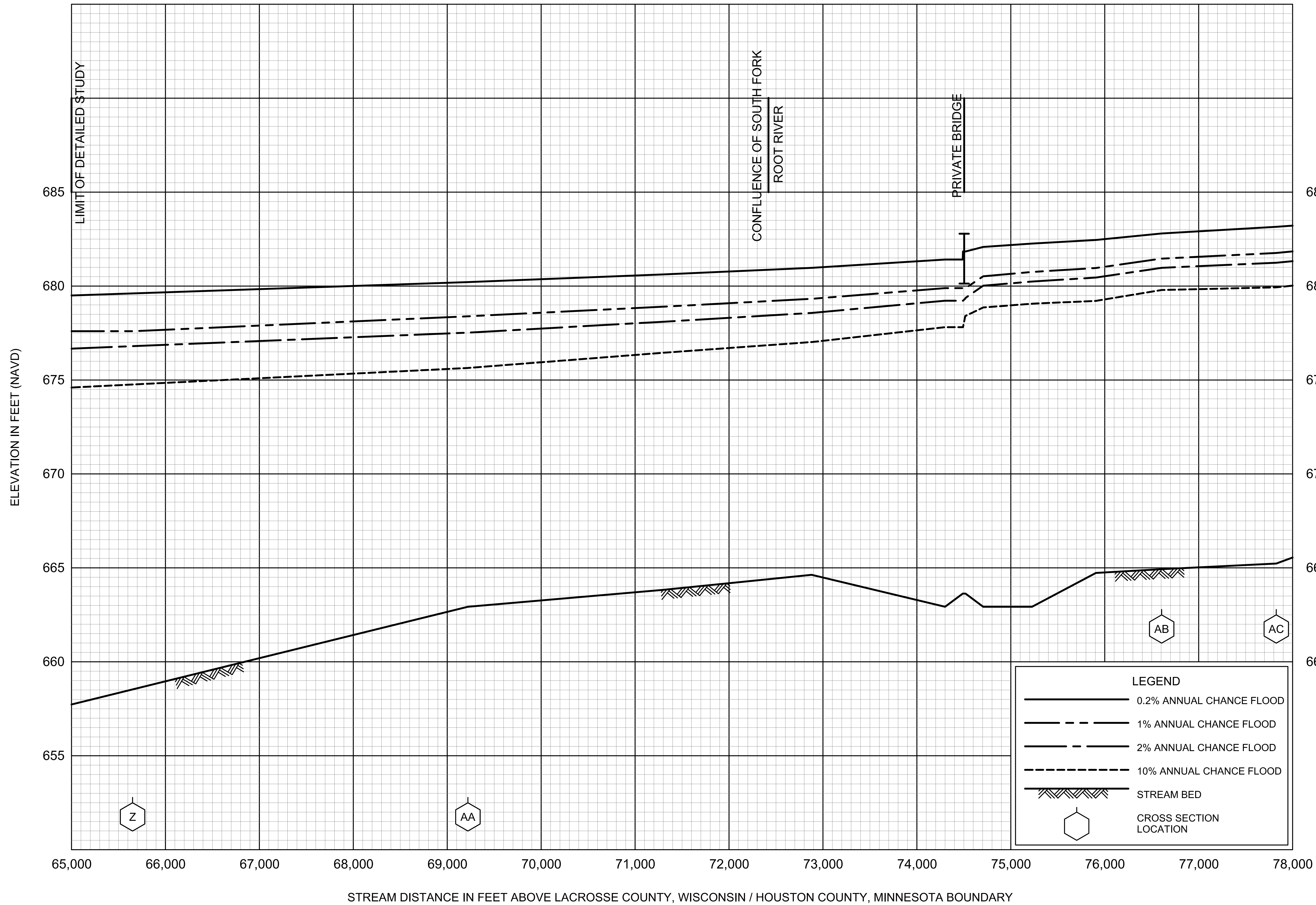


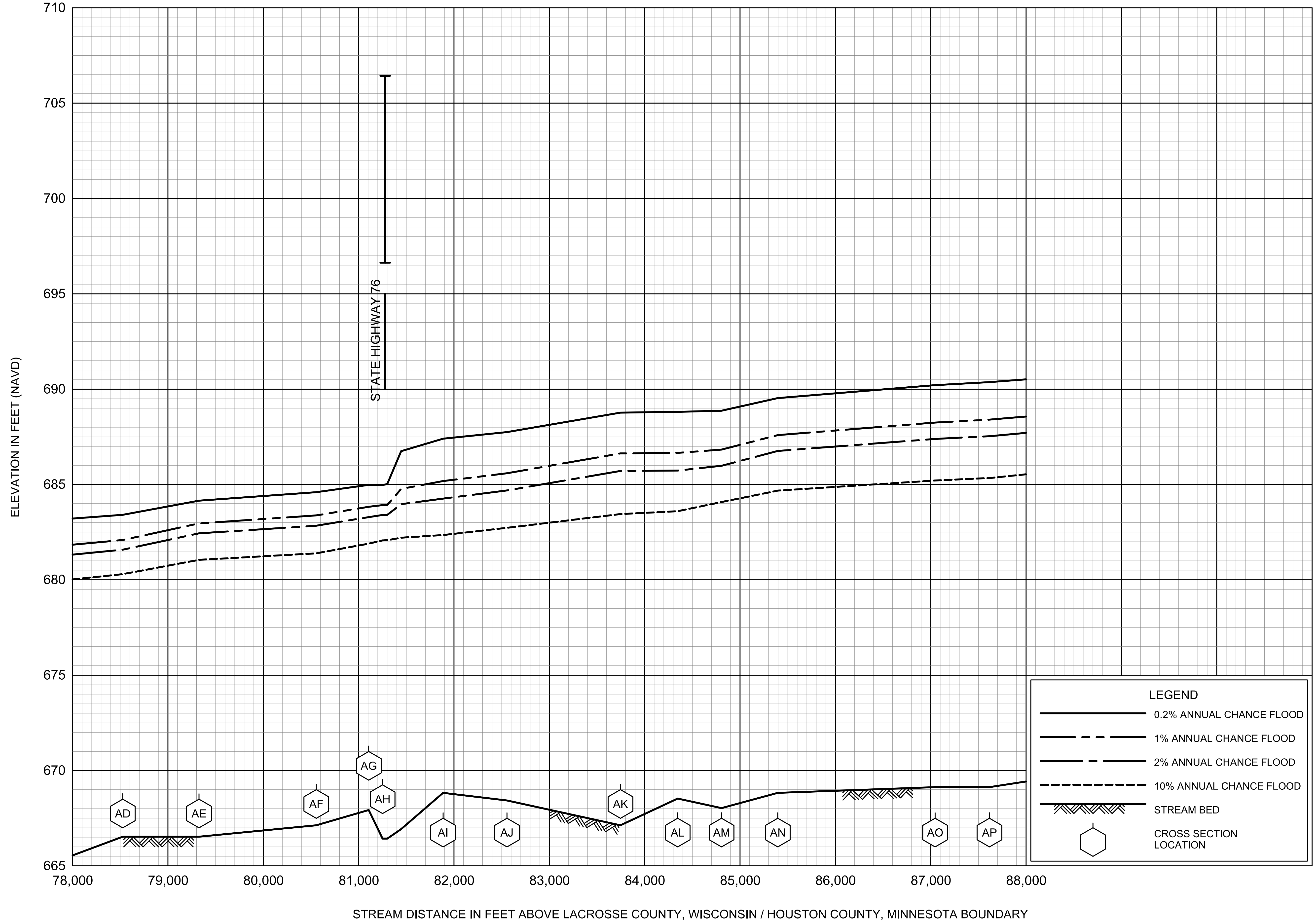
FLOOD PROFILES

ROOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



FLOOD PROFILES

ROOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

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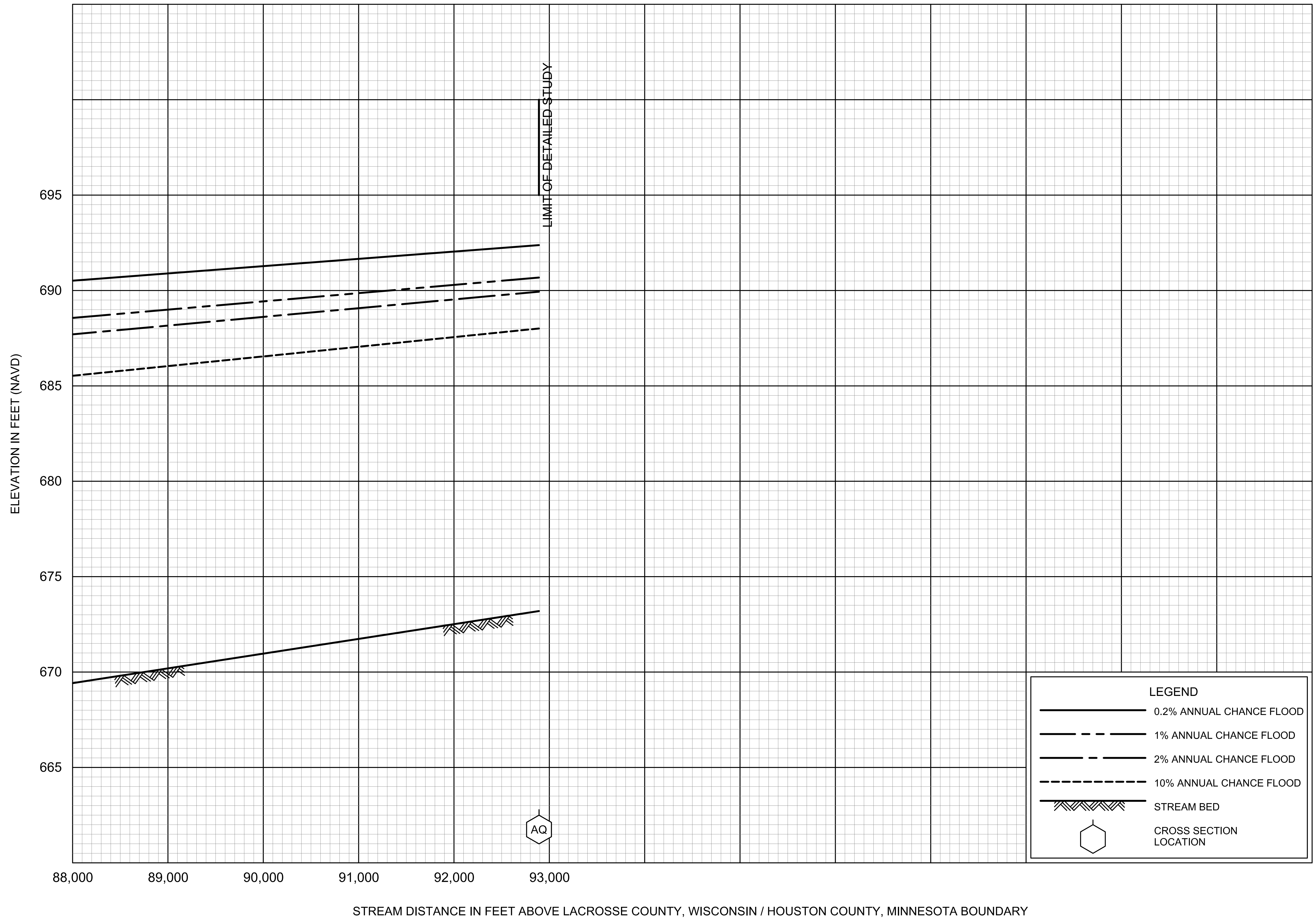


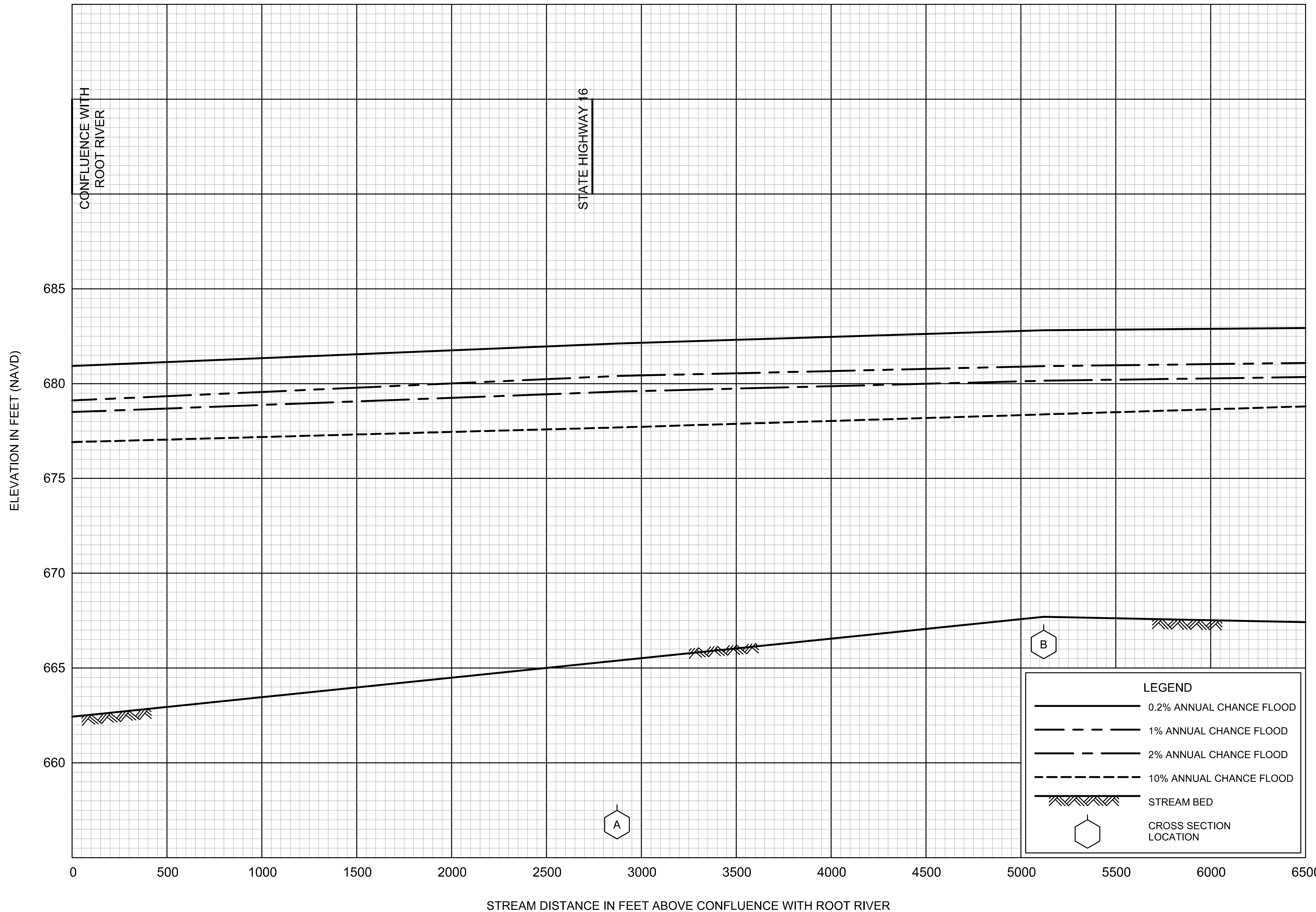
FLOOD PROFILES

ROOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



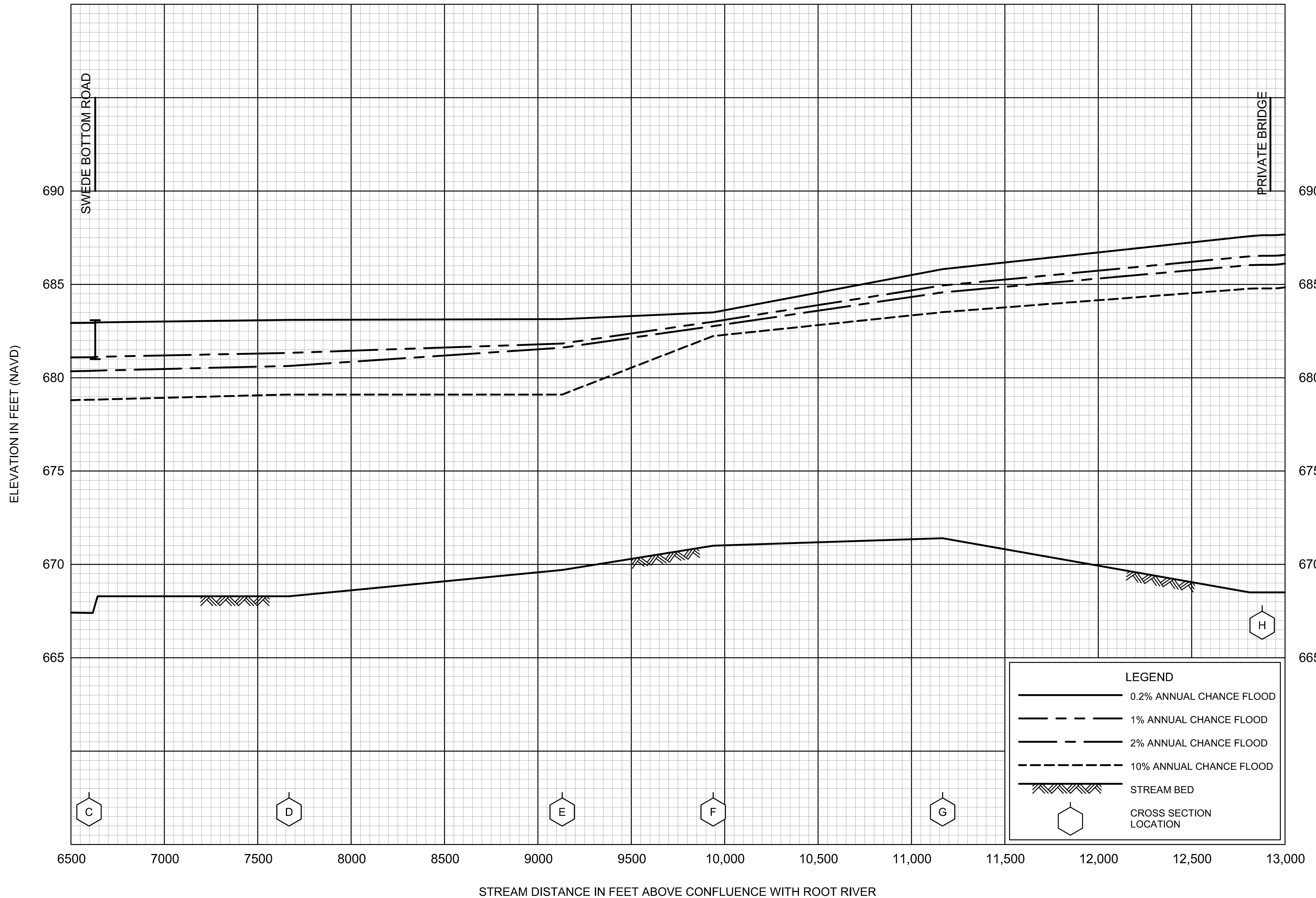
FLOOD PROFILES

SOUTH FORK ROOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



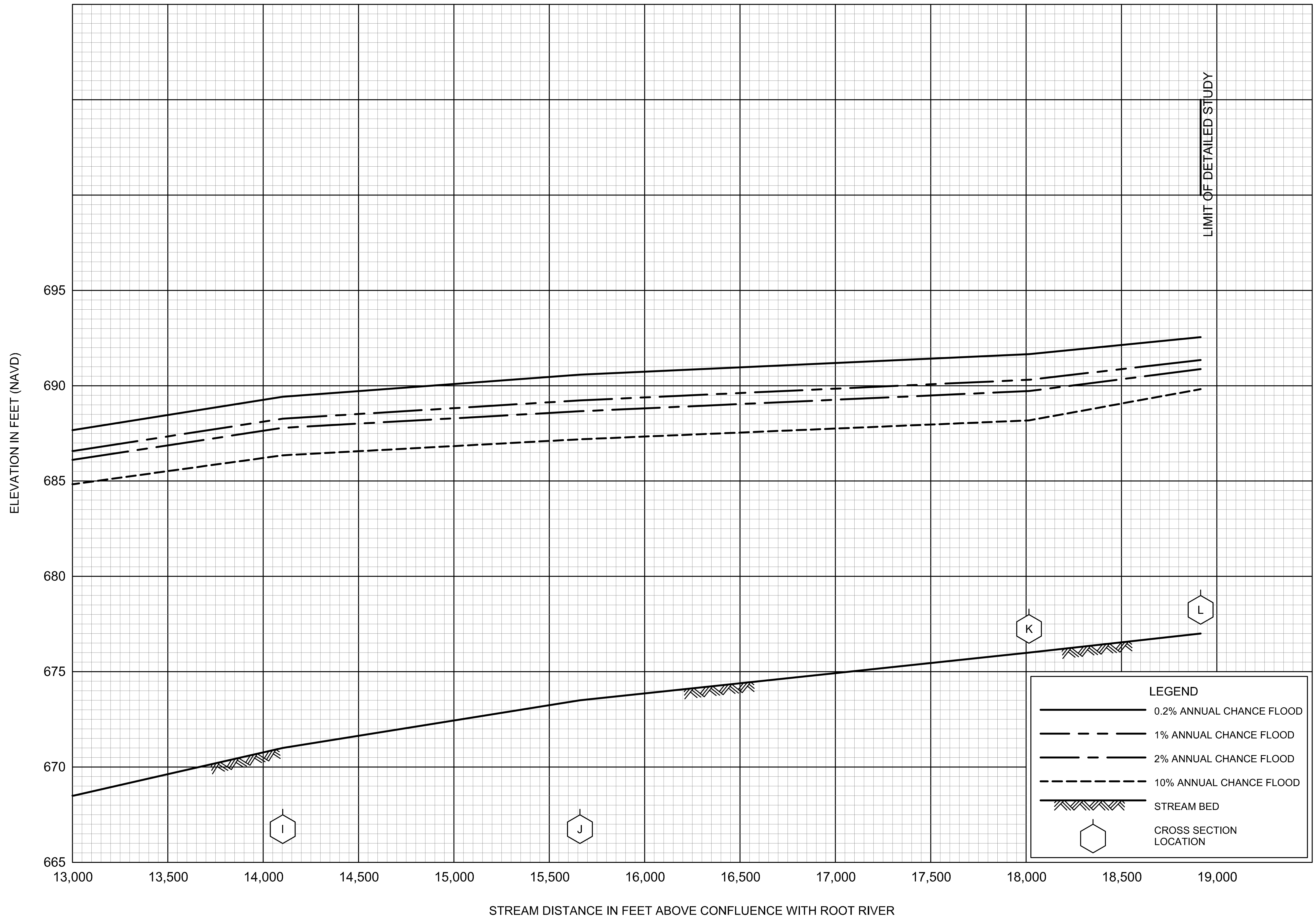
FLOOD PROFILES

SOUTH FORK ROOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



FLOOD PROFILES

SOUTH FORK ROOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

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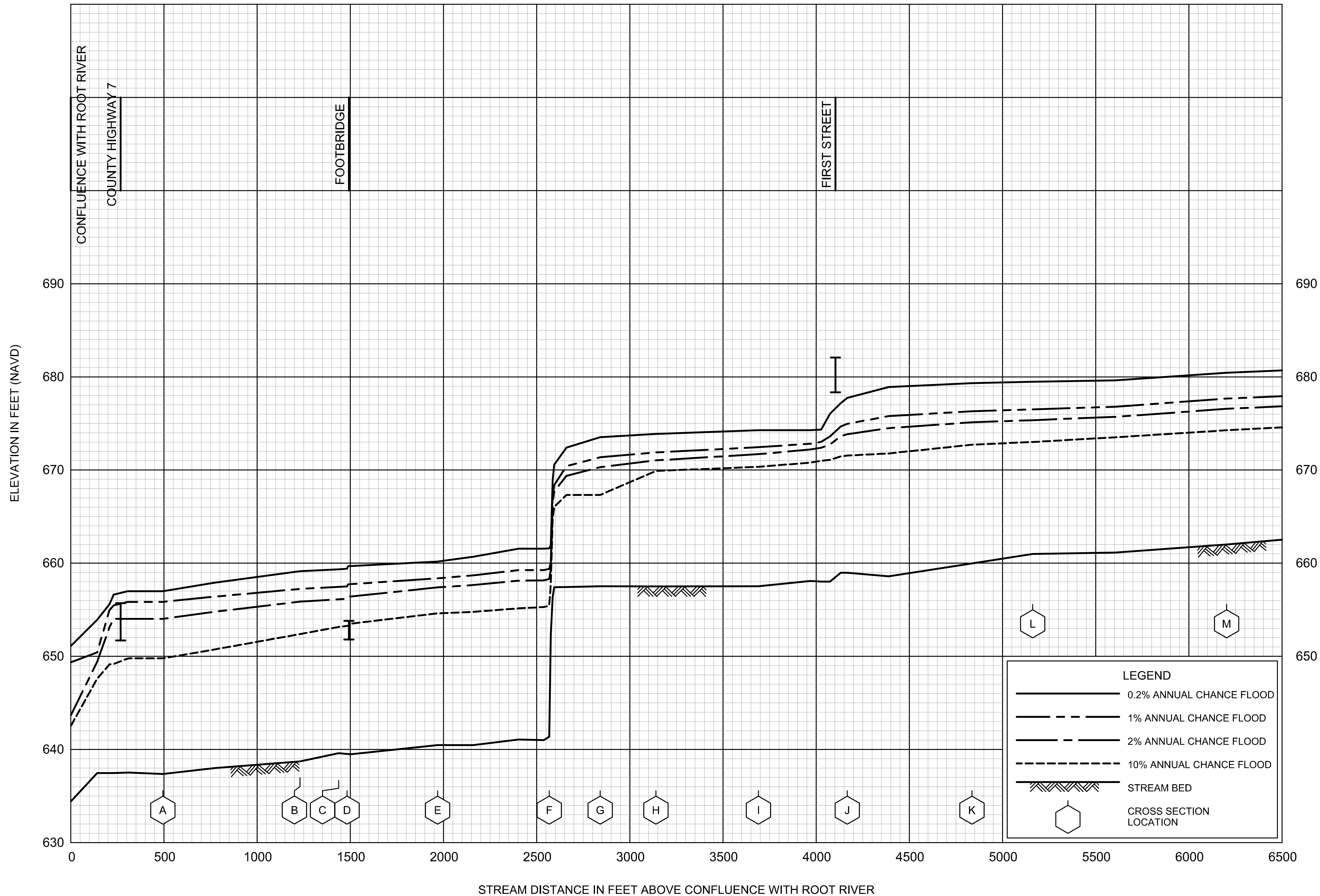


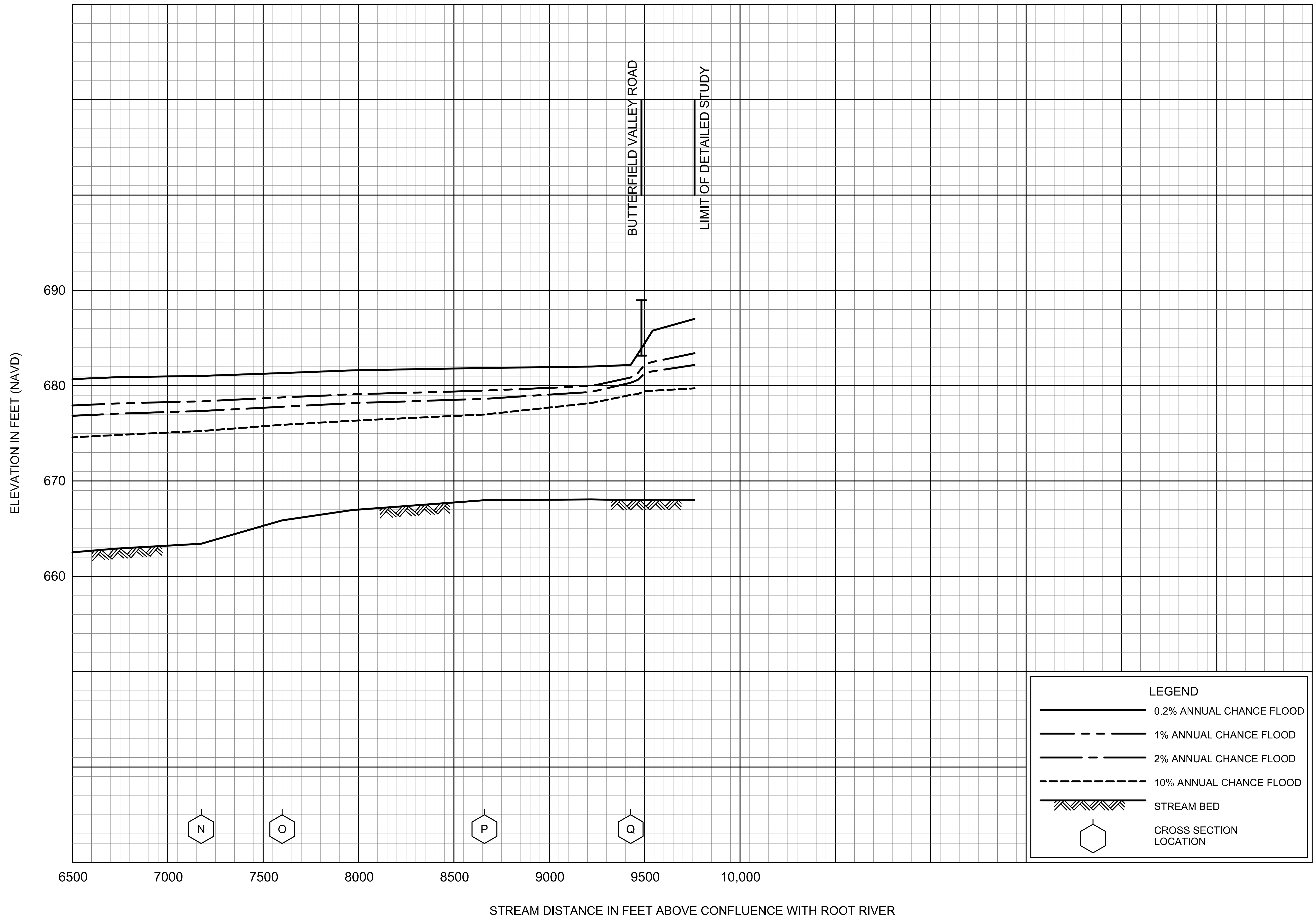
FLOOD PROFILES

THOMPSON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS



FLOOD PROFILES

THOMPSON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HOUSTON COUNTY, MN

AND INCORPORATED AREAS