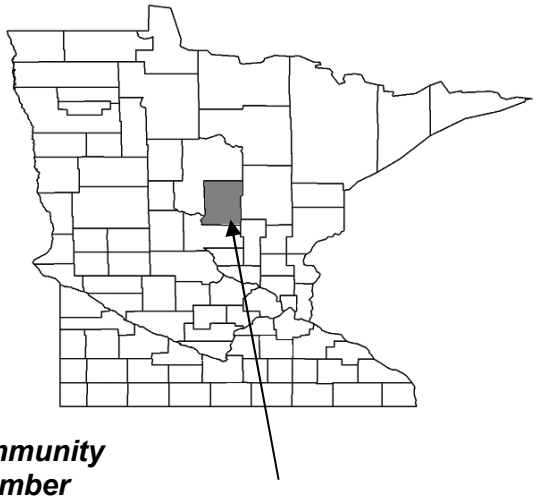
FLOOD INSURANCE STUDY



CROW WING COUNTY, MINNESOTA

AND INCORPORATED AREAS

Community Name	*Community Number*	*Community Name*	*Community Number*
BAXTER, CITY OF	270092	FIFTY LAKES, CITY OF	270096
BRAINERD, CITY OF	270093	FORT RIPLEY, CITY OF	270097
BREEZY POINT, CITY OF	270236	GARRISON, CITY OF	270913
CROSBY, CITY OF	270094	IRONTON, CITY OF	270910
CROSS LAKE, CITY OF	270095	JENKINS, CITY OF	270098
CROW WING COUNTY (UNINCORPORATED AREAS)	270091	MANHATTAN BEACH, CITY OF	270904
		NISSWA, CITY OF	270099
CUYUNA, CITY OF	270911	PEQUOT LAKES, CITY OF	270250
DEERWOOD, CITY OF	270909	RIVERTON, CITY OF	270100
EMILY, CITY OF	270254	TROMMALD, CITY OF	270912

Revised Preliminary: September 12, 2016

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
27035CV000A

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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Flood Insurance Rate Map

FLOOD INSURANCE STUDY
CROW WING COUNTY, MINNESOTA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Crow Wing County, including the Cities of Baxter, Brainerd, Breezy Point, Crosby, Cross Lake, Cuyuna, Deerwood, Emily, Fifty Lakes, Fort Ripley, Garrison, Ironton, Jenkins, Manhattan Beach, Nisswa, Pequot Lakes, Riverton, and Trommald; and the unincorporated areas of Crow Wing County (referred to collectively herein as Crow Wing County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

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

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.

Precountywide Analyses

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:

Baxter, City of:	The hydrologic and hydraulic analyses for the Mississippi River, from approximately 43,800 feet downstream of College Drive to approximately 4,350 feet downstream of College Drive, Perch Lake, Lower Whipple Lake, Red Sand Lake, Upper Whipple Lake, and White Sand Lake for the May 15, 1991, FIS report (FEMA, 1991a) were performed by the U.S. Army Corps of Engineers (USACE), St. Paul District, for FEMA, under Interagency Agreement No. EMW-87-E-2509, Project Order No. 9. The work was completed in January 1989.
Brainerd, City of:	The hydrologic and hydraulic analyses for the Mississippi River, from approximately 4,350 feet downstream of College Drive to approximately 3,800 feet upstream of State Highway 25, and Rice Lake for the March 2, 1981, FIS report, were performed by Toltz, King, Duvall, Anderson and Associates, Inc., for the Federal Insurance Administration (FIA), under Contract No. H-4706 (FIA, 1981a). The work was completed in February 1980.
Crosby, City of:	The hydrologic and hydraulic analyses for Serpent Creek and Serpent Lake for the March 2, 1981, FIS report (FIA, 1981b), were performed by Toltz, King, Duvall, Anderson and Associates, Inc., for the FIA, under Contract No. H-4706. The work was completed in November 1979.
Crow Wing County (Unincorporated Areas):	The hydrologic and hydraulic analyses for the Mississippi River, from confluence of Rabbit River to approximately 23,400 feet upstream of confluence of Mission Creek, Black Bear/Miller Lake, Little Rabbit Lake, Red Sand Lake, Rice Lake, and Serpent Lake for the May 15, 1991, FIS Report (FEMA, 1991b), were performed by the USACE, St. Paul District, for FEMA, under Interagency Agreement No. EMW-87-E-2509, Project Order No. 9. The work was completed in January 1989.

Fort Ripley, City of:	The hydrologic and hydraulic analyses for the Mississippi River, from the County Boundary to approximately 11,050 upstream of the County Boundary, for the February 15, 1991, FIS report (FEMA, 1991c), were performed by the USACE, St. Paul District, for FEMA, under Interagency Agreement No. EMW-87-E-2509, Project Order No. 9. The work was completed in January 1989.
Riverton, City of:	The hydrologic and hydraulic analyses for the Mississippi River, at confluence of Little Rabbit Lake, and Little Rabbit Lake for the March 2, 1981, FIS report (FIA, 1981c) were performed by Toltz, King, Duvall, Anderson and Associates, Inc., for the FIA, under Contract No. H-4706. The work was completed in November 1979.

The Cities of Breezy Point, Cross Lake, Cuyuna, Deerwood, Emily, Fifty Lakes, Garrison, Ironton, Jenkins, Manhattan Beach, Nisswa, Pequot Lakes, and Trommald have no previously printed FIS reports.

This Countywide FIS Report

The hydrologic and hydraulic analyses for the areas where approximate analyses were utilized for this study were performed by Atkins, for FEMA, under Contract No. HSFE05-05-D-0023, Task Order No. 029. The work was completed in July 2010.

Base map information shown on the Flood Insurance Rate Map (FIRM) was derived from the United States Department of Agriculture-Farm Serviced Agency USDA-FSA Aerial Photography Field Office produced at a scale of 1:40,000, from aerial photography dated October 2009 or later. The projection used in the preparation of this map is Universal Transverse Mercator (UTM) zone 15, and the horizontal datum used is the North American Datum of 1983 (NAD83).

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.

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

Community	FIS Date	Initial Meeting	Final Meeting
Baxter, City of	May 15, 1991	July 23, 1986	February 1, 1990
Brainerd, City of	March 2, 1981	April 1978	September 15, 1980
Crosby, City of	March 2, 1981	April 1978	September 15, 1980
Crow Wing County (Unincorporated Areas)	May 15, 1991	July 23, 1986	February 1, 1990
Fort Ripley, City of	February 15, 1991	June 12, 1986	February 1, 1990
Riverton, City of	March 2, 1981	April 1978	September 15, 1980

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.

The initial meeting was held on October 12, 2006, and attended by representatives of FEMA, Atkins, the Minnesota Department of Natural Resources (MNDNR), and the communities.

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

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Crow Wing 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.

The streams and lakes studied by detailed methods are listed in Table 1.

Table 1 - Streams and Lakes Studied by Detailed Methods

Black Bear Lake	Mississippi River	Serpent Lake
Cedar Lake	Perch Lake	Upper Whipple Lake
Little Rabbit Lake	Red Sand Lake	White Sand Lake
Lower Whipple Lake	Rice Lake	
Mille Lacs Lake	Round Lake	
Miller Lake	Serpent 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 detailed flooding sources have been redelineated for this study.

The portion of the Mississippi River, herein referred to as Mississippi River (Upper Reach), from the Crow Wing/Aitkin County boundary to approximately 5.67 miles upstream of the Crow Wing/Aitkin County boundary was studied in detail for the first time in Crow Wing County.

Cedar Lake, Mille Lacs Lake and Round Lake were studied in detail for the first time in Crow Wing County. Data for Cedar and Round Lake came from the Aitkin County, Minnesota, FIS report (FEMA, 1996), while data for Mille Lacs Lake came from the City of Isle, Minnesota FIS report (FIA, 1979).

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, are now referenced to the 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 the communities.

2.2 Community Description

Crow Wing County is in east-central Minnesota about 100 miles northwest of the City of Minneapolis, Minnesota. The county is bordered by Morrison County, Minnesota, on the south and west; Cass County, Minnesota on the north and west; and Mille Lacs and Aitkin Counties, Minnesota, on the east. The 2007 population estimate for Crow Wing County was 61,648 (U.S. Census Bureau, 2008).

The surface topography of the area ranges from level to gently rolling, consisting of a heavy mantle of glacial drift having few large boulders, overlying Precambrian granitic rock, slate and iron formation. Soils covering the region consist mainly of a mixture of brown sandy till and slightly calcareous silty clay till.

Temperatures in the county range from an average high of 81 degrees Fahrenheit (°F) to an average low of 56°F in the summer, and from an average high of 19°F

to an average low of -7°F in the winter. The average annual precipitation is 27.51 inches, with the maximum average precipitation occurring in the month of June (The Weather Channel, 2008).

2.3 Principal Flood Problems

The following tabulation presents historical peak flood data recorded at the U.S. Geological Survey (USGS) gaging stations along the Mississippi River located upstream and downstream of Crow Wing County (USGS, 2007a; USGS 2007b):

Royalton, Minnesota		Aitken, Minnesota	
Date	Estimated Flow (cfs)	Date	Estimated Flow (cfs)
1997	38,200	1950	20,000
2001	35,500	1975	14,500
1979	35,100	1969	14,400
1969	32,400	2001	14,200
1975	30,700	1965	13,400

In the City of Brainerd, some flooding problems have been experienced as a result of high water on the Mississippi River. During the 1950 flood on the Mississippi River, which affected the community from late April through the end of May, a maximum flood crest of 19.49 feet was recorded on May 20, 1950, at the City of Aitkin, in Aitkin County, Minnesota, 12 miles upstream of the Brainerd Dam (USGS, 1965). At this time, a portion of County Highway 20, along the Mississippi River was inundated, and water was reported to have overflowed East River Road between Boom Lake and the Mississippi River near West College Drive. The Brainerd Daily Dispatch newspaper reported that the rising floodwaters caused most of the floodgates and part of the superstructure of the Northwest Paper Company Dam to fail. During the 1965 flood, which had a maximum crest at Aitkin of 14.5 feet on April 18 (USGS, 1965), East River Road between Boom Lake and the Mississippi River was again flooded. According to the Brainerd Daily Dispatch, high water from the Mississippi River forced the abandonment of buildings south of the sewage treatment plant. The frequencies and estimates of damage are unknown for these storms.

There have been no known problems with surface flooding from Serpent Lake. The lake reached its maximum recorded level on August 6, 1952 (MNDNR, 1978), as a result of a rainfall totaling 12.25 inches during a 5-day period from July 16 to July 20, 1952. At this time, Serpent Creek overflowed its banks and washed out a portion of County Road 30 according to the July 24, 1952, article in the Crosby Courier newspaper.

There have been no known problems with surface flooding from Little Rabbit Lake. During the flooding which occurred on the Mississippi River in May 1950, the lake was reported to have risen to within 15 to 20 feet of several lakefront homes. Some seepage into basements occurred. The recurrence interval of this flood was approximately a 1-percent-annual-chance event.

2.4 Flood Protection Measures

The Northwest Paper Company Dam provides a moderate degree of flood protection to the downstream reach of the Mississippi River in Brainerd. This dam was constructed in 1889 by the Mississippi Water Power and Boom Company. The Northwest Paper Company acquired the dam in 1910, constructed a paper mill near the dam site, and proceeded to rebuild the dam and powerhouse to bring the generating capacity up to the demands of the paper mill. After the flood of April 1950 severely undercut the dam and destroyed the gate sections, a second reconstruction was necessary. This brought the dam to its present condition and capacity.

The dam is a rock-filled crib structure set on timber pilings. A four to six foot thick concrete cap covers the entire crib structure. The 258-foot long L-shaped spillway is controlled by three different methods. Two 850-foot long bascule gates control 170 feet of the east-west spillway, a 20-foot long wooden tainter gate controls the remainder of the east-west spillway and five 13-foot 7-inch stoplog gates control the north-south spillway.

The powerhouse contains five generators with a capacity of 63,500 kilowatt-day. The paper mill located beside the dam normally consumes all the energy generated by the dam.

The total discharge capacity of the tainter gate, bascule gates, stoplog gates, and turbines is 25,000 cubic feet per second (cfs) at a headwater pool elevation of 1,178.5 feet NAVD. At this elevation, flows are just beginning to wash over the abutments. This is 1,400 cfs greater than the 1-percent-annual-chance discharge (Potlatch Corporation, unpublished). The dam controls the water surface elevation (WSEL) for Little Rabbit Lake, however, provides no meaningful protection against the 1-percent-annual-chance flood.

The Mississippi River dam located just downstream of confluence of the Crow Wing River is not operated for flood control purposes.

A levee system is located along the Black Bear Lake and Miller Lake. Please refer to the corresponding Flood Insurance Rate Map panels for the protection status of this levee system.

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.

Precountywide Analyses

Discharge-frequencies for the Mississippi River, for all reaches except within the City of Brainerd, from approximately 4,350 feet downstream of College Drive to approximately 3,800 feet upstream of State Highway 25 (Lower Middle Reach), were determined by applying the general relations method with uses an interpolation equation derived from a log-log plot of discharge verses drainage area. The USGS gage (no. 05227500), located on the Mississippi River at Aitkin and the USGS gage (no. 05267000), located on the Mississippi River at Royalton, with drainage areas of 6,140 square miles and 11,600 square miles respectively, were used for the interpolation. A high-flow partial record station at Fort Ripley, Minnesota was not used in this study due to its short period of record.

The USGS has developed a discharge-frequency curve at Aitkin. After updating this curve graphically to include additional years of record, and historical information, it was found that the existing USGS curve fell within acceptable confidence limits of the new graphical curve. Therefore, the curve which existed at Aitkin was adopted. The existing interagency coordinated curve at Royalton was adopted after it fell within the confidence limits of a new curve, which included additional years of record, developed using the procedures outlined in the Water Resources Council Bulletin No. 17B (Water Resource Council, 1982)

and the USACE, Hydrologic Engineering Center (HEC) computer program, HEC-2 (HEC, 1982).

Discharges for the Mississippi River, Lower Middle Reach, were obtained from a discharge-frequency analysis conducted by the USACE (Fisher, 1979). This analysis was based on regional frequency correlation studies for the Mississippi River from St. Paul to Libby, Minnesota.

The USACE conducted a discharge-frequency analysis of the Mississippi River at Brainerd, approximately eight miles downstream of the Riverton study area. The discharges obtained from this source were transferred to Riverton by using the drainage area transfer equation (Potlatch Corporation, unpublished). This equation was used to calculate discharge at an ungaged site (in this case, the City of Riverton) by adjusting a known discharge from a nearby location with a similar drainage area (Brainerd) by a factor derived from a ratio of the two drainage areas. (The drainage area for Brainerd was calculated to be 7,030 square miles; an area of 6,934 square miles was used for Riverton). The exponent with this ratio was determined based on regional frequency correlation results from records obtained at Aitkin and at Royalton.

Peak elevations for Rice Lake were determined using the hydrologic analysis of the Mississippi River upstream of State Highway 25 bridge.

Little Rabbit Lake is located at the confluence of the Mississippi River. Data from the USGS stream gage on the Rabbit River at Crosby (No. 05241500), located approximately six miles upstream of Riverton, indicate that the maximum recorded discharge on the Rabbit River is 94 cfs (USGS, 1968). The drainage area at this gage is only 8.4 square miles. From this information and from high water profiles for the Mississippi River prepared by the USACE in 1969 (USACE, 1969), it was determined that the Mississippi River has the most significant influence on the water level of Little Rabbit Lake and that the level of the Mississippi River at Riverton is controlled by the backwater from the Northwest Paper Company Dam at Brainerd. Thus, it was necessary to study the hydrology of the Mississippi River from its headwaters to the Brainerd dam.

Peak elevations for Perch Lake, Upper Whipple Lake, Lower Whipple Lake, White Sand Lake and Red Sand Lake were determined by applying a 10-day duration storm on the lake areas contributing drainage areas. Storm runoff volumes for corresponding frequencies were obtained from Soil Conservation Service (SCS), now the Natural Resource Conservation Service (NRCS) (SCS, undated). The 0.2-percent-annual-chance values were determined through extrapolation from the values determined from this guide. Runoff volumes from the contributing drainage areas were then added to the rainfall volumes applied to the lake surface areas. The rainfall volumes for corresponding frequencies were obtained from the SCS guide with the 0.2-percent-annual-chance values extrapolation from the other given frequency values (SCS, undated).

For Serpent Lake the recorded maximum lake level occurred in August 6, 1952. A newspaper article from the Crosby Courier reported that this level resulted from a total rainfall of 12.25 inches over the 5-day period from July 16, 1952, to July 20, 1952, and the maximum 48-hour precipitation experienced during this 5-day period was seven inches. This represents 107 percent of the 1-percent-annual-chance 2-day precipitation for the Crosby area as presented in U.S. Weather Bureau (USWB) Technical Paper 49 (USWB, 1964). Because of the close comparison between actual rainfall and the 1-percent-annual-chance event, the high lake level recorded on August 6, 1952, 1249 feet, NAVD, was estimated to be the 1-percent-annual-chance elevation of Serpent Lake.

For Serpent Creek, the flows through the outlet structure from Serpent Lake were computed for the various flood stage lake levels by using the SCS, equation for flow through an orifice (SCS, 1972).

This Countywide FIS Report

The 10-, 2- and 1-percent-annual-chance discharges for the Mississippi River (Upper Reach) were obtained from the published USGS discharge-frequency curve for the Mississippi River at Aitkin, Minnesota (USACE, 1973). Discharges were developed using a log-Pearson Type III statistical analysis of 29 years of flow records from a USGS continuous record gaging station (No. 05227500) at Aitkin; discharges were coordinated with more than 70 years of flow records from the USGS gaging stations on the upper Mississippi River (USACE, 1975). The 0.2-percent-annual-chance discharge at Aitkin was determined by logarithmic extrapolation.

The discharge-frequency relationship for Mille Lacs Lake was based on 44 years of gage height records for the gage on Mille Lacs Lake at Garrison, Minnesota, northwest of the Isle, Minnesota (USGS, date unavailable). A normal probability plot of elevation was made using maximum annual mean daily gage heights.

For Cedar Lake and Round Lake the USACE, HEC-1 flood hydrograph computer program was used to determine the 1-percent-annual-chance recurrence interval flood elevations. Clark's unit hydrographs, in conjunction with exponential loss rates, were used in the models to convert rainfall to runoff on the subbasins. Loss rates and baseflow parameters were incorporated into the HEC-1 models from the USACE Open Files, Mississippi River Headwaters Reservoir Regulation Manual Revision Study (USACE, 1986). Clark's unit hydrograph parameters, Tc and R, were computed using regression relations determined in the USACE study. The 1-percent-annual-chance, 10-day hypothetical precipitation was assumed to cause the 1-percent-annual-chance recurrence interval flood. The 1-percent-annual-chance, 10-day precipitation values were obtained from Technical Paper No. 40 and Technical Paper No. 49 (USWB, 1961 and 1965). A 10-day duration storm was selected to ensure that the most critical duration and volume was modeled.

The lakes were modeled with a single-ordinate unit hydrograph to return 100 percent of precipitation that falls within each time step of the model. Computed lake elevations were compared to historical data supplied by the MNDNR. The following tabulation presents historic lake elevation data for Cedar Lake and Round Lake.

Lake	Maximum Recorded Lake Elevation (feet NAVD)	Year
CEDAR LAKE	1202.85	1975
ROUND LAKE	1259.86	1991

Discharges for streams studied by approximate analyses were developed using the published USGS regional regression equations for Minnesota (USGS, 1997) or using available USGS gage record data if applicable. Drainage areas were developed from USGS 30-meter Digital Elevation Models (DEMs) (USGS, various dates).

Peak discharge-drainage area relationships for each flooding source studied in detail are shown in Table 2.

Table 2 - 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
MISSISSIPPI RIVER					
At Crow Wing/Morrison County Boundary	11,240	25,600	37,400	42,700	55,500
Approximately 10,560 feet upstream of Crow Wing/Morrison County Boundary	11,010	25,000	36,500	41,600	53,900
Just upstream of confluence of Crow Wing River	7,420	16,800	22,600	25,100	30,700
Approximately 36,485 feet upstream of confluence of Crow Wing River	7,394	16,800	22,500	25,000	30,600
Approximately 43,800 feet downstream of West College Drive	7,030	14,700	20,800	23,600	30,000
Just upstream of confluence of Rabbit River	6,841	15,500	20,500	22,600	27,400
Approximately 23,400 feet upstream of confluence of Mission Creek	6,808	15,400	20,400	22,500	27,200
SERPENT CREEK					
At confluence with of Serpent Lake	9	40	56	60	69

Stillwater elevations for the lakes studied by detailed methods in Crow Wing County, Minnesota are shown in Table 3.

Table 3 - Summary of Stillwater Elevations

Flooding Source	Water Surface Elevations (Feet NAVD[1]) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
BLACK BEAR LAKE	1,179.8	1,180.5	1,181.4	1,182.3
CEDAR LAKE	*	*	1,203.0	*
LITTLE RABBIT LAKE	1,179.2	1,182.0	1,183.0	1,185.0
LOWER WHIPPLE LAKE	1,196.8	1,197.2	1,197.4	1,197.9
MILLE LACS LAKE	1,253.4	1,253.9	1,254.1	1,254.4
MILLER LAKE	1,179.8	1,180.5	1,181.4	1,182.3
PERCH LAKE	1,192.9	1,193.4	1,193.6	1,194.1
RED SAND LAKE	1,200.4	1,200.7	1,200.8	1,201.2
RICE LAKE	1,175.0	1,177.4	1,178.3	1,180.4
ROUND LAKE	*	*	1,260.7	*
SERPENT LAKE	1,248.4	1,249.0	1,249.2	1,249.6
UPPER WHIPPLE LAKE	1,196.7	1,197.2	1,197.4	1,197.9
WHITE SAND LAKE	1,200.4	1,200.7	1,200.8	1,201.2

*Data not available

[1] National Geodetic North American Vertical Datum of 1988

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.

Precountywide Analyses

Cross section data for the Mississippi River, for all reaches, except in the City of Brainerd from approximately 4,350 feet downstream of College Drive to approximately 3,800 feet upstream of State Highway 25, was obtained by field survey (USGS, 1989). Below-water sections for the analyses were obtained during the same field survey.

Cross section data for the Mississippi River in the City of Brainerd, from approximately 4,350 feet downstream of College Drive to approximately 3,800 feet upstream of State Highway 25, was obtained by field survey, while data on

the overbank sections was obtained by photogrammetric compilation from 1978 aerial photography (Martinez Ortho-Mapping Corporation, 1978) and from USGS topographic maps (USGS, 1973a; USGS, 1973b). Additional cross sections were obtained from the St. Paul District, USACE HEC-2 backwater model of the Mississippi River from Brainerd to Pine Knoll. All bridges, dams, and culverts were surveyed in detail to obtain elevation data and structural geometry. Bridge information was obtained from the Minnesota Department of Transportation and Burlington Northern, Inc.

Cross section data for Serpent Creek were obtained by field surveys, while data on the overbank sections were obtained by photogrammetric compilation from 1978 aerial photography (Martinez Ortho-Mapping Corporation, 1978). All bridges, dams, and culverts were surveyed in detail to obtain elevation data and structural geometry.

WSELs of floods of the selected recurrence intervals for the Mississippi River, for all reaches except in the City of Brainerd from approximately 4,350 feet downstream of College Drive to approximately 3,800 feet upstream of State Highway 25, were computed using the USACE HEC-2 step-backwater program (HEC, 1984).

WSELs of floods of the selected recurrence for the Mississippi River in the City of Brainerd, from approximately 4,350 feet downstream of College Drive to approximately 3,800 feet upstream of State Highway 25, were computed using the USACE HEC-2 step-backwater program (HEC, 1976).

WSELs of floods of the selected recurrence intervals along Serpent Creek were computed using the USACE HEC-2 step-backwater program (HEC, 1976).

Starting WSELs for the Mississippi River, from the Crow Wing/Morrison County boundary to approximately 11,050 feet upstream from the Crow Wing/Morrison County boundary and from approximately 43,800 feet downstream of College Drive in the City of Brainerd to approximately 4,350 feet downstream of College Drive, were determined by transferring the rating curve for the USGS gage no. (05261000), the Mississippi River near Fort Ripley, Minnesota, to the southern county boundary, based upon the water-surface profile slope of the 1950 and 1965 historic flood events.

Starting WSELs for the Mississippi River, from approximately 4,350 feet downstream of College Drive to the Northwest Paper Company Dam, were obtained through the use of the slope-area option of the USACE HEC-2 program (HEC, 1976).

Starting WSELs for the Mississippi River, from the Northwest Paper Company Dam to approximately 3,800 feet upstream of State Highway 25, were determined from a rating curve for the dam which was developed from historic discharge and

WSEL data provided by the Potlatch Corporation (Potlatch Corporation, unpublished).

Starting WSELs for the Mississippi River, from the confluence of Rabbit River to approximately 23,400 feet upstream of the confluence of Mission Creek, were determined from a rating curve for the Northwest Paper Company Dam which was developed from historic discharge and WSEL data provided by the Potlatch Corporation (Potlatch Corporation, unpublished). WSELs were then extended downstream using the average water-surface profile slopes of the 1950 and 1965 historic flood events.

Starting WSELs for Serpent Creek were determined using the slope-energy option from the USACE HEC-2 program (HEC, 1976).

For Perch Lake, Lower Whipple Lake, Upper Whipple Lake, Red Sand Lake and White Sand Lake, the initial lake elevations were assumed to be at the Natural Ordinary High Water elevations determined for each lake by the MNDNR.

For Rice Lake, the WSEL corresponds to the WSEL on the Mississippi River upstream of the State Highway 25 bridge.

For Little Rabbit Lake, the WSEL corresponds to the WSEL on the Mississippi River at the confluence of the river and the outlet to Little Rabbit Lake.

For Serpent Lake, the WSEL corresponds to the high lake level recorded on August 6, 1952, which was estimated to be to the 1-percent-annual-chance elevation.

This Countywide FIS Report

Cross sections on the Mississippi River (Upper Reach) were obtained from the USACE floodplain information report (USACE, 1975); all bridges, dams and culverts were field surveyed to obtain elevation data and structural geometry.

Water surface elevations of floods of the selected recurrence intervals for the Mississippi River (Upper Reach) were computed using the USACE, HEC-2 step-backwater computer program (HEC, 1991). Cross sections in the HEC-2 analyses were located at close intervals upstream and downstream of bridges to allow computation of the backwater effects of the structures. Additional cross sections were located along the river to provide a representation of the stream and valley topography.

Starting water-surface elevations for the Mississippi River (Upper Reach) were obtained from a stage-discharge relationship developed by the USACE (USACE, 1979).

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).

Roughness factor (Manning's "n") used in the hydraulic computations for the Mississippi River (Upper Reach) were estimated by calibrating the USACE HEC-2 computer model with historic flood profiles on the Mississippi River (USACE, 1969).

The Manning's "n" values for all detailed studied streams are listed in the following table:

Manning's "n" Values

Stream	Channel "n"	Overbank "n"
Mississippi River	0.02 - 0.11	0.07 - 0.10
Mississippi River (Upper Reach)	0.026-0.040	0.020-0.120
Serpent Creek	0.02 - 0.034	0.08

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 Special Flood Hazard Area.

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) VERTCON online utility (NGS, 2008). The data points used to determine the conversion are listed in Table 4.

Table 4 - Vertical Datum Conversion

Quad Name	Corner	Latitude	Longitude	Conversion from NGVD29 to NAVD88
Edna Lake	SE	46.750	-93.750	0.669
Roosevelt Lake	SE	46.750	-93.875	0.689
Mitchell Lake	SE	46.750	-94.000	0.712
Stewart Lake	SE	46.750	-94.125	0.709
Lake Ada	SE	46.750	-94.250	0.702
Mildred	SE	46.750	-94.375	0.676
Ross Lake	SE	46.625	-93.750	0.604
Emily	SE	46.625	-93.875	0.653
Cross Lake	SE	46.625	-94.000	0.679
Lower Whitefish Lake	SE	46.625	-94.125	0.682
Jenkins	SE	46.625	-94.250	0.643
Pine River	SE	46.625	-94.375	0.604
Cuyuna	SE	46.500	-93.875	0.620
Trommald	SE	46.500	-94.000	0.630
Pelican Lake	SE	46.500	-94.125	0.630
Nisswa	SE	46.500	-94.250	0.577
Crosby	SE	46.375	-93.875	0.607
Riverton	SE	46.375	-94.000	0.614
Merrifield	SE	46.375	-94.125	0.633
Gull Lake	SE	46.375	-94.250	0.610
Grave Lake	SE	46.250	-93.875	0.594
South Long Lake	SE	46.250	-94.000	0.607
Brainerd	SE	46.250	-94.125	0.607
Baxter	SE	46.250	-94.250	0.600
Pillager	SE	46.250	-94.375	0.597
Platt Lake	SE	46.125	-93.875	0.594
Shephard	SE	46.125	-94.000	0.581
Lastrup NW	SE	46.125	-94.125	0.571
Fort Ripley	SE	46.125	-94.250	0.548
Belle Prairie NW	SE	46.125	-94.375	0.531
			Average:	**0.626**

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, the boundaries were interpolated using 1-meter raster grids with an accuracy equivalent to a contour interval of 2 feet (Merrick & Company, 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. 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). 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.

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 5). 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.

At the request of Crow Wing County and the State of Minnesota Department of Natural Resources a non-model backed “Administrative” floodway was delineated along the Flood Diversion Channel on panel 27035C0360. The channel routes flood flows around the City of Aitkin and the floodway will ensure the conveyance capacity by preventing encroachment. As this floodway is non-model backed, there is no Floodway Data Table for this flooding source.

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
MISSISSIPPI RIVER								
A	0[1]	696/292[3]	7,956	5.4	1,149.5	1,149.5	1,150.0	0.5
B	1,860[1]	1,213/928[3]	12,463	3.4	1,150.2	1,150.2	1,150.6	0.4
C	3,590[1]	1,792/1166[3]	16,521	2.6	1,150.5	1,150.5	1,150.9	0.4
D	5,000[1]	1,581/1302[3]	14,795	2.9	1,150.6	1,150.6	1,151.0	0.4
E	6,030[1]	1,443/1145[3]	14,296	3.0	1,150.8	1,150.8	1,151.2	0.4
F	9,540[1]	724/201[3]	7,311	5.7	1,151.3	1,151.3	1,151.6	0.3
G	10,560[1]	900/480[3]	13,524	3.1	1,152.1	1,152.1	1,152.4	0.3
H	11,328[2]	284	4,777	5.3	1,158.3	1,158.3	1,158.7	0.4
I	13,345[2]	234	4,330	5.8	1,158.8	1,158.8	1,159.2	0.4
J	16,685[2]	681	8,016	3.1	1,159.8	1,159.8	1,160.2	0.4
K	18,260[2]	296	4,956	5.1	1,159.9	1,159.9	1,160.3	0.4
L	21,502[2]	432	6,663	3.8	1,160.6	1,160.6	1,161.0	0.4
M	24,184[2]	243	4,008	6.3	1,160.9	1,160.9	1,161.3	0.4
N	25,698[2]	258	4,592	5.5	1,161.5	1,161.5	1,161.9	0.4
O	27,893[2]	267	5,129	4.9	1,162.1	1,162.1	1,162.5	0.4
P	30,448[2]	257	4,695	5.3	1,162.5	1,162.5	1,162.9	0.4
Q	33,846[2]	407	6,915	3.6	1,163.3	1,163.3	1,163.6	0.3
R	36,065[2]	473	7,854	3.2	1,163.6	1,163.6	1,163.9	0.3
S	37,994[2]	566	9,208	2.7	1,163.8	1,163.8	1,164.1	0.3
T	39,900[2]	482	8,287	3.0	1,163.9	1,163.9	1,164.2	0.3
U	42,322[2]	241	4,872	5.1	1,164.0	1,164.0	1,164.3	0.3

[1]Feet above County Boundary
[2]Feet above Confluence of Crow Wing River
[3]Total width/Width within Crow Wing County

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CROW WING COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

MISSISSIPPI RIVER

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)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
MISSISSIPPI RIVER (CONTINUED)								
V	44,222	1,085	11,107	2.1	1,164.4	1,164.4	1,164.9	0.5
W	46,277	1,205	13,791	1.7	1,164.7	1,164.7	1,165.2	0.5
X	49,022	1,450	15,652	1.5	1,164.9	1,164.9	1,165.4	0.5
Y	50,397	1,426	14,020	1.7	1,165.0	1,165.0	1,165.5	0.5
Z	51,627	465	7,121	3.3	1,165.0	1,165.0	1,165.5	0.5
AA	52,962	429	7,132	3.3	1,165.2	1,165.2	1,165.7	0.5
AB	53,312	450	6,848	3.4	1,165.4	1,165.4	1,165.9	0.5
AC	54,262	315	5,208	4.5	1,165.8	1,165.8	1,166.3	0.5
AD	55,737	363	7,329	3.2	1,165.9	1,165.9	1,166.4	0.5
AE	56,232	424	8,841	2.7	1,166.0	1,166.0	1,166.5	0.5
AF	56,692	391	7,418	3.2	1,166.1	1,166.1	1,166.6	0.5
AG	57,252	333	6,596	3.6	1,166.3	1,166.3	1,166.8	0.5
AH	57,692	281	5,849	4.0	1,166.3	1,166.3	1,166.8	0.5
AI	59,282	525	9,668	2.4	1,166.7	1,166.7	1,167.2	0.5
AJ	61,312	633	10,304	2.3	1,166.8	1,166.8	1,167.3	0.5
AK	63,012	1,285	15,490	1.5	1,166.9	1,166.9	1,167.4	0.5
AL	64,842	1,412	16,423	1.4	1,167.1	1,167.1	1,167.6	0.5
AM	66,642	664	10,422	2.3	1,167.2	1,167.2	1,167.7	0.5
AN	68,262	740	15,535	1.5	1,167.3	1,167.3	1,167.8	0.5
AO	68,997	409	8,337	2.8	1,178.0	1,178.0	1,178.5	0.5

[1]Feet above Confluence of Crow Wing River

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CROW WING COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

MISSISSIPPI RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
MISSISSIPPI RIVER (CONTINUED)								
AP	70,907[1]	922	15,547	1.5	1,178.2	1,178.2	1,178.7	0.5
AQ	71,537[1]	1,018	20,791	1.1	1,178.3	1,178.3	1,178.8	0.5
AR	72,862[1]	1,149	20,799	1.1	1,178.3	1,178.3	1,178.8	0.5
AS	0[2]	1,152	14,680	1.6	1,182.9	1,182.9	1,182.9	0.0
AT	1,900[2]	458	7,136	3.2	1,183.1	1,183.1	1,183.1	0.0
AU	3,783[2]	320	6,520	3.5	1,183.3	1,183.3	1,183.3	0.0
AV	5,087[2]	408	6,998	3.2	1,183.5	1,183.5	1,183.5	0.0
AW	10,287[2]	340	5,928	3.8	1,184.3	1,184.3	1,184.4	0.1
AX	12,389[2]	358	6,734	3.4	1,184.7	1,184.7	1,184.8	0.1
AY	14,352[2]	451	7,800	2.9	1,185.0	1,185.0	1,185.1	0.1
AZ	17,175[2]	1,237	14,182	1.6	1,185.3	1,185.3	1,185.4	0.1
BA	19,466[2]	405	6,512	3.5	1,185.4	1,185.4	1,185.5	0.1
BB	29,851[2]	2,313	23,666	1.0	1,186.4	1,186.4	1,186.6	0.2
BC	32,487[2]	2,163	21,450	1.1	1,186.6	1,186.6	1,186.8	0.2
BD	39,741[2]	691	9,249	2.4	1,187.3	1,187.3	1,187.6	0.3
BE	42,053[2]	667	8,303	2.7	1,187.5	1,187.5	1,187.8	0.3
BF	45,207[2]	383	5,761	3.9	1,187.9	1,187.9	1,188.2	0.3
BG	47,763[2]	239	4,626	4.9	1,188.5	1,188.5	1,188.9	0.4
BH	230[3]	496/166[4]	9,515	2.1[6]	1,201.9	1,201.9	1,202.1	0.2
BI	3,270[3]	581/341[4]	5,378[5]	3.7[6]	1,202.1	1,202.1	1,202.4	0.3

[1]Feet above Confluence of Crow Wing River
[2]Feet above Confluence of Little Rabbit Lake
[3]Feet above county boundary
[4]Total width/width within county boundary
[5]Area is an approximation
[6]Velocity is an approximation

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CROW WING COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

MISSISSIPPI RIVER

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)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SERPENT CREEK								
A	1,139	56	35	1.7	1,237.4	1,237.4	1,237.9	0.5
B	1,329	20	52	1.2	1,240.7	1,240.7	1,240.7	0.0
C	2,359	11	12	5.2	1,244.9	1,244.9	1,244.9	0.0
D	2,589	16	31	2.0	1,246.8	1,246.8	1,246.8	0.0
E	3,084	20	53	1.1	1,247.2	1,247.2	1,247.2	0.0
F	3,294	20	51	1.2	1,247.5	1,247.5	1,247.5	0.0
G	3,734	19	46	1.3	1,247.8	1,247.8	1,247.8	0.0

[1]Feet above Confluence with Armour No. 2 Mine

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CROW WING COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SERPENT 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 WSEL 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.

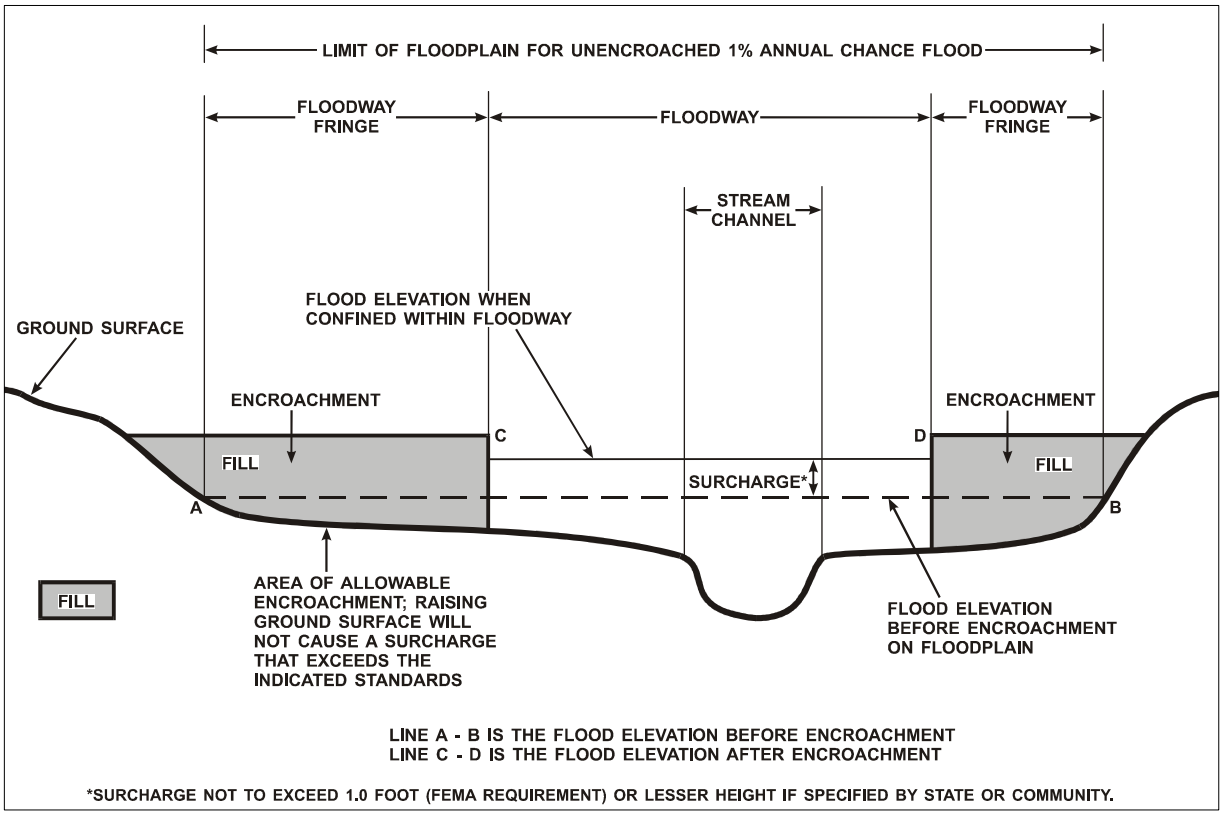

Figure 1 - Floodway Schematic

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 Crow Wing County. Previously, FIRMs were prepared for each incorporated community and the unincorporated areas of the County identified as flood-prone. This countywide FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps, where applicable. Historical data relating to the maps prepared for each community are presented in Table 6.

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.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Baxter, City of	September 13, 1974	September 10, 1976	May 15, 1991	None
Brainerd, City of	June 21, 1974	May 7, 1976	September 2, 1981	None
Breezy Point, City of	To Be Determined	None	To Be Determined	None
Crosby, City of	June 28, 1974	August 6, 1976	September 2, 1981	None
Cross Lake, City of	September 13, 1974	December 26, 1975	July 2, 1987	None
Crow Wing County (Unincorporated Areas)	January 13, 1978	None	May 15, 1991	None
Cuyuna, City of	To Be Determined	None	To Be Determined	None
Deerwood, City of	To Be Determined	None	To Be Determined	None
Emily, City of	To Be Determined	None	To Be Determined	None
Fifty Lakes, City of	To Be Determined	None	To Be Determined	None
Fort Ripley, City of	January 24, 1975	None	February 15, 1991	None
Garrison, City of	To Be Determined	None	To Be Determined	None
Ironton, City of	To Be Determined	None	To Be Determined	None

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CROW WING COUNTY, MN
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Jenkins, City of	August 23, 1974	July 9, 1976	To Be Determined	None
Manhattan Beach, City of	To Be Determined	None	To Be Determined	None
Nisswa, City of	To Be Determined	None	To Be Determined	None
Pequot Lakes, City of	To Be Determined	None	To Be Determined	None
Riverton, City of	June 28, 1974	May 28, 1976	September 2, 1981	None
Trommald, City of	To Be Determined	None	To Be Determined	None

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CROW WING COUNTY, MN
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 FEMA, Federal Insurance and Mitigation Division, 536 South Clark Street, Sixth Floor, Chicago, Illinois 60605.

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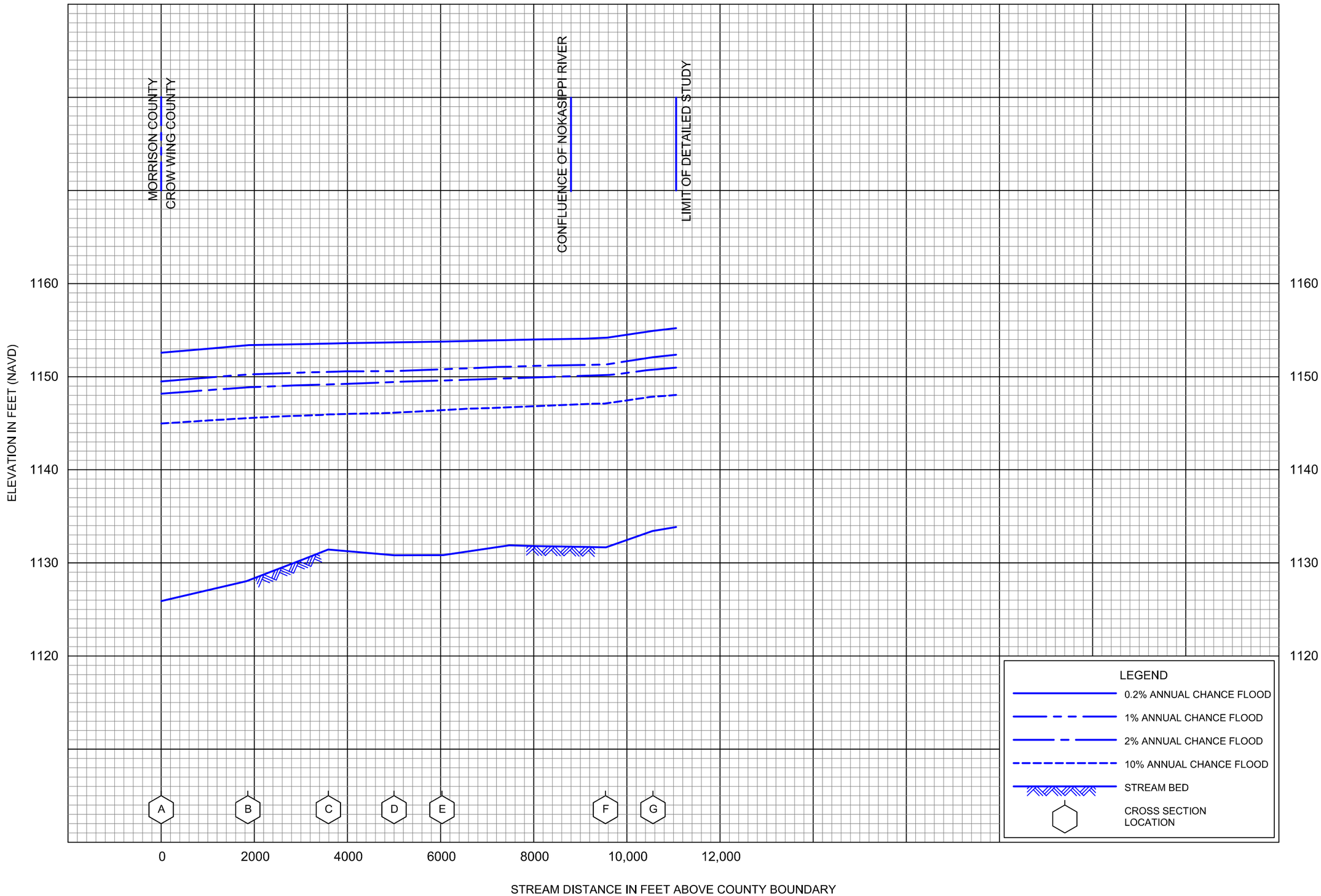

FLOOD PROFILES

MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CROW WING COUNTY, MN

AND INCORPORATED AREAS

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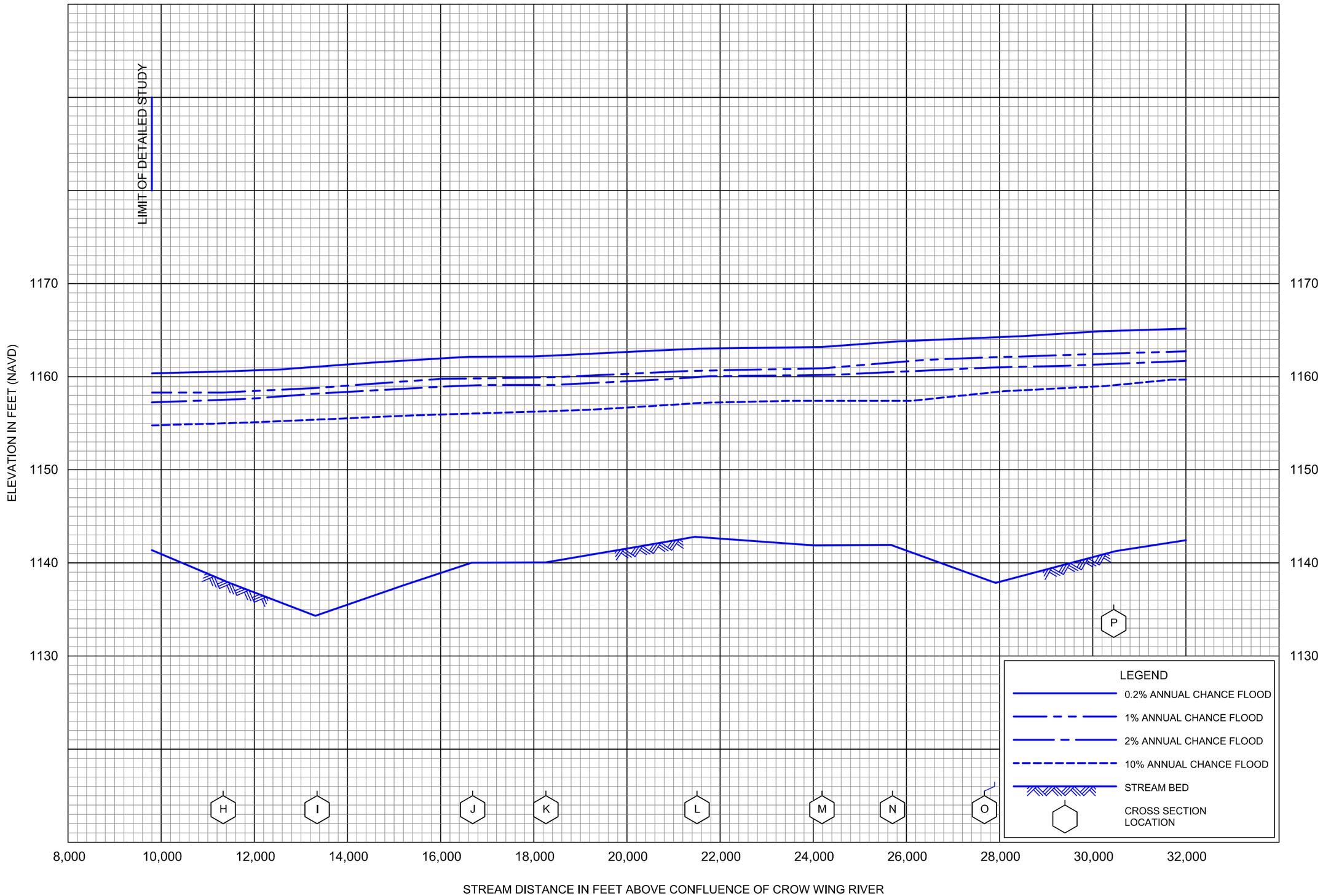

FLOOD PROFILES

MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CROW WING COUNTY, MN

AND INCORPORATED AREAS

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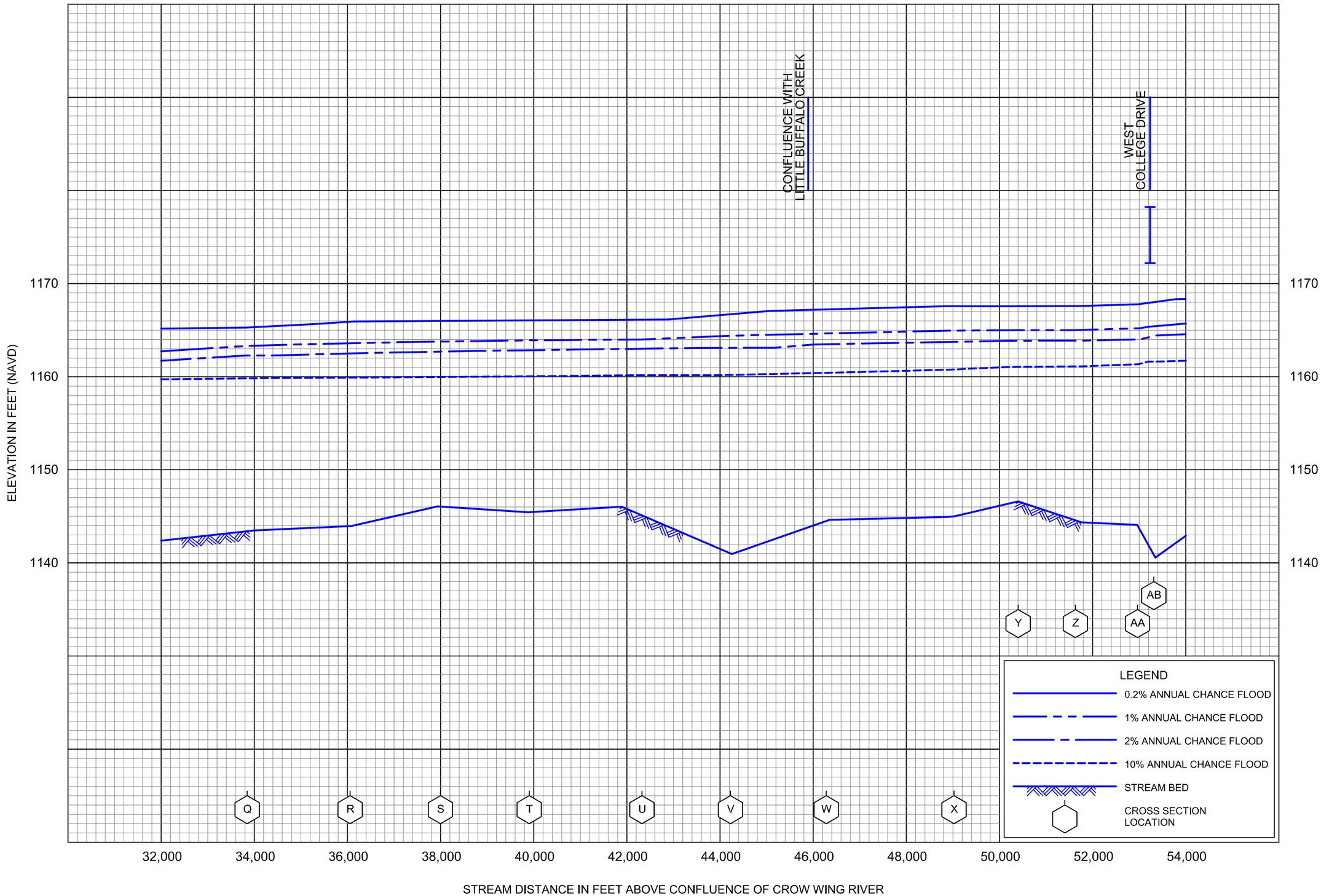

FLOOD PROFILES

MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CROW WING COUNTY, MN

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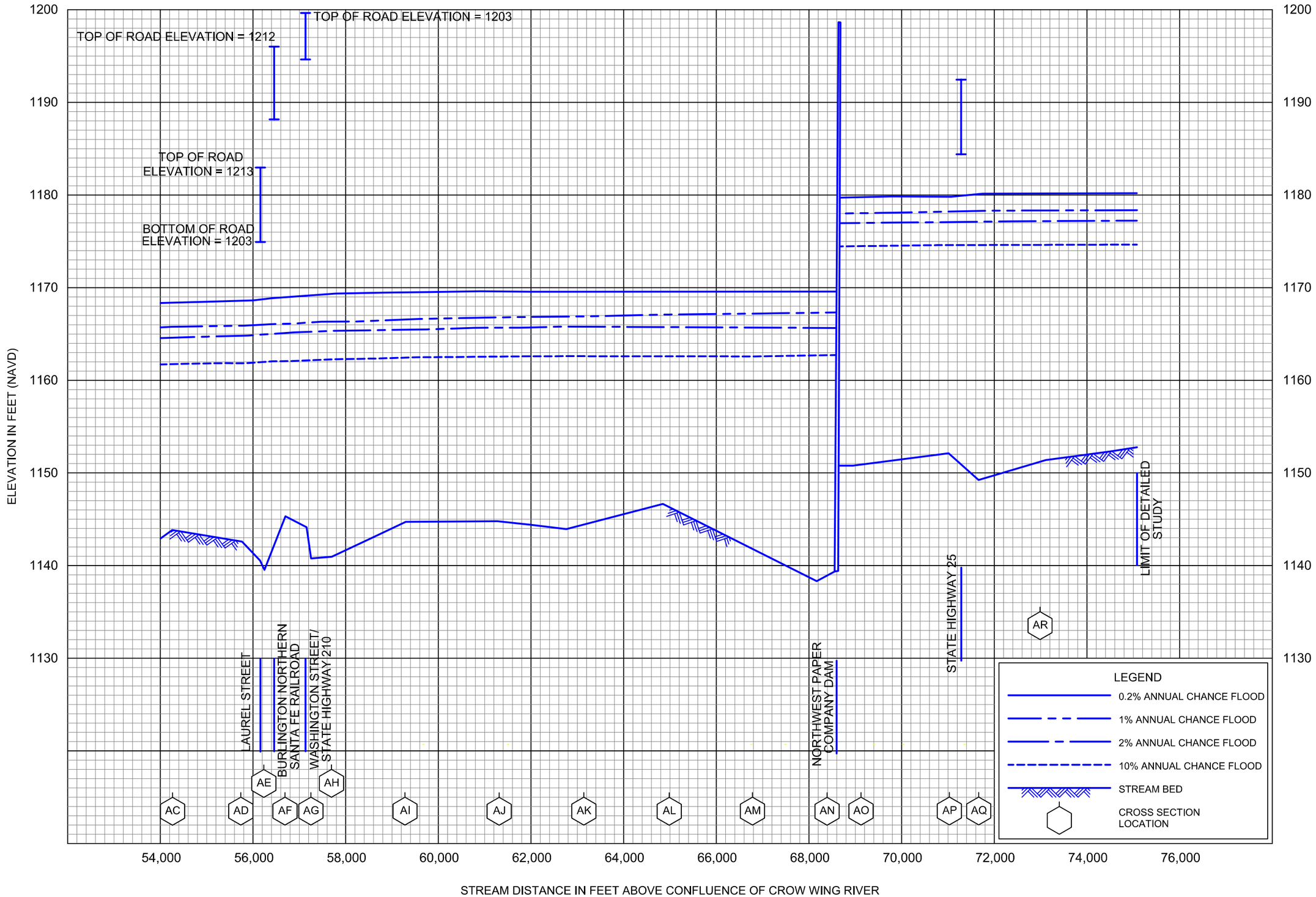

FLOOD PROFILES

MISSISSIPPI RIVER

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CROW WING COUNTY, MN

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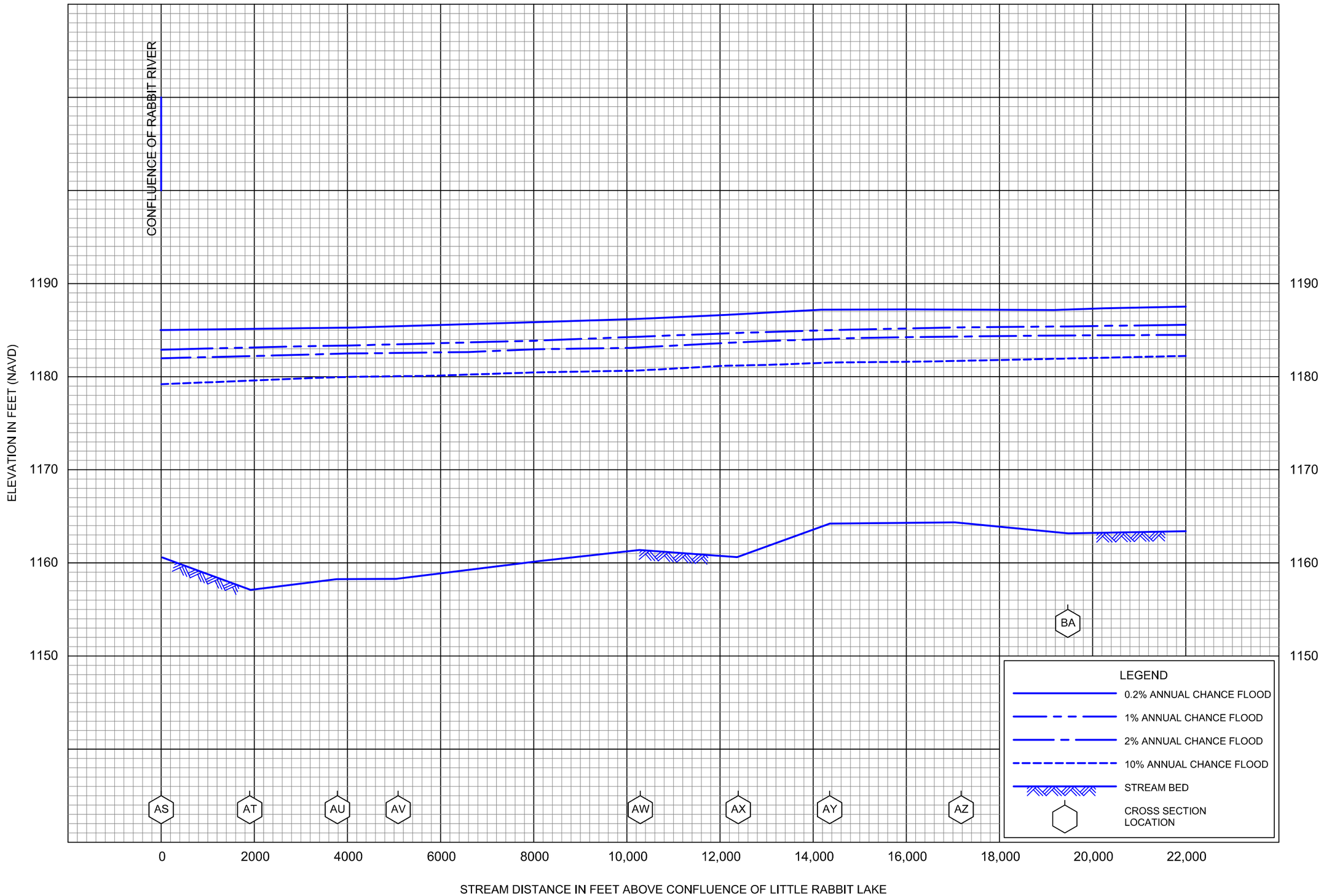

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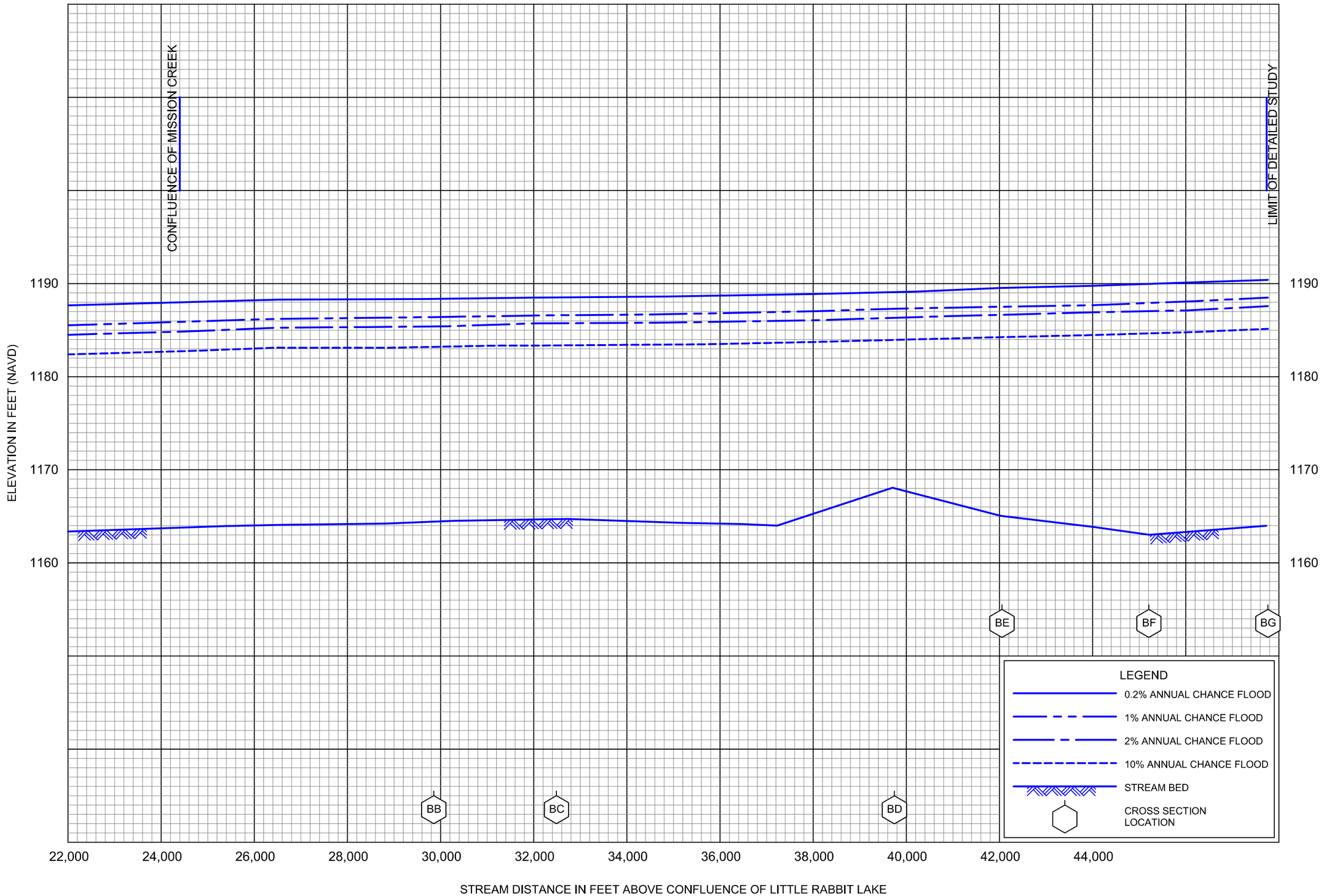

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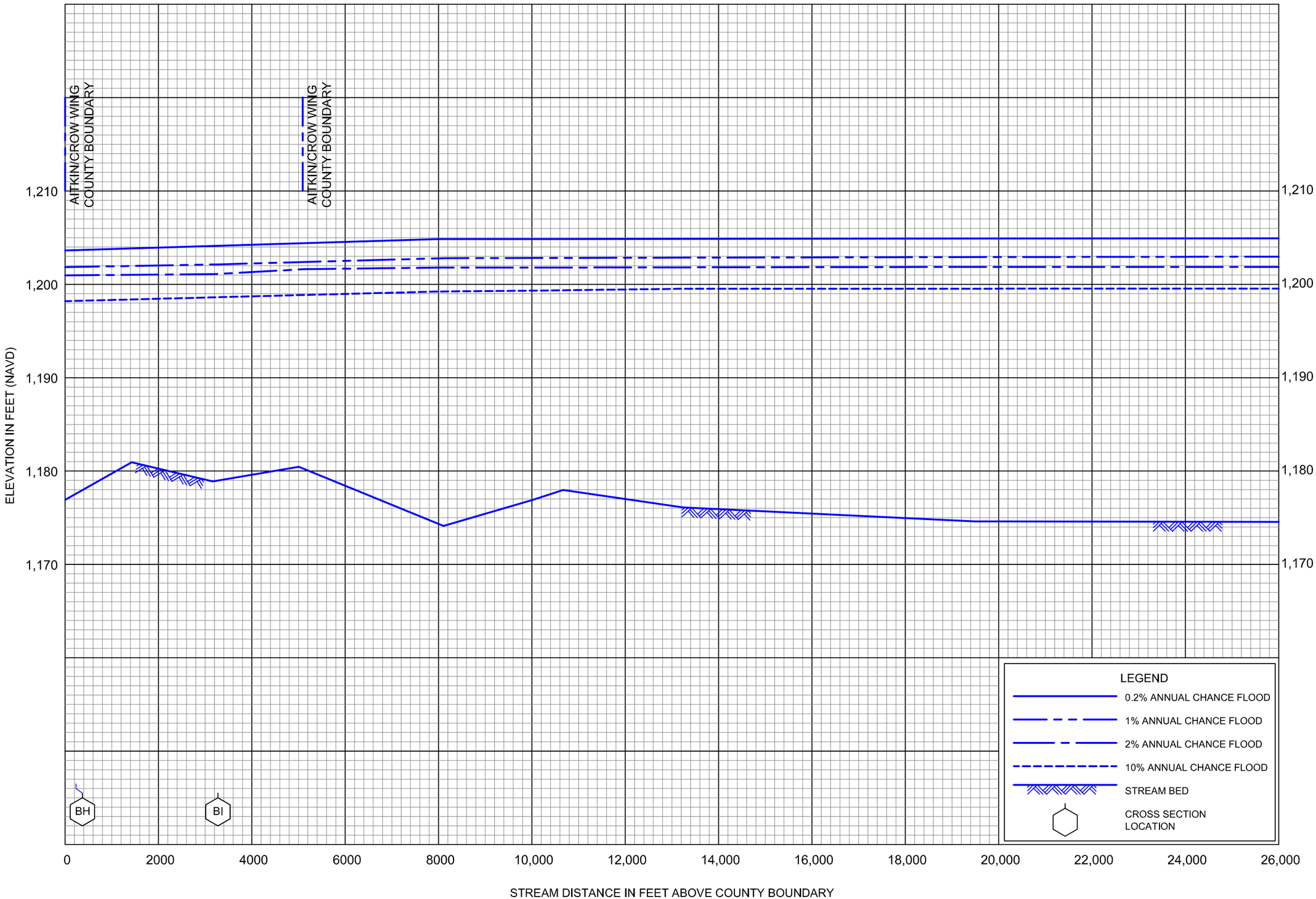

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MISSISSIPPI RIVER

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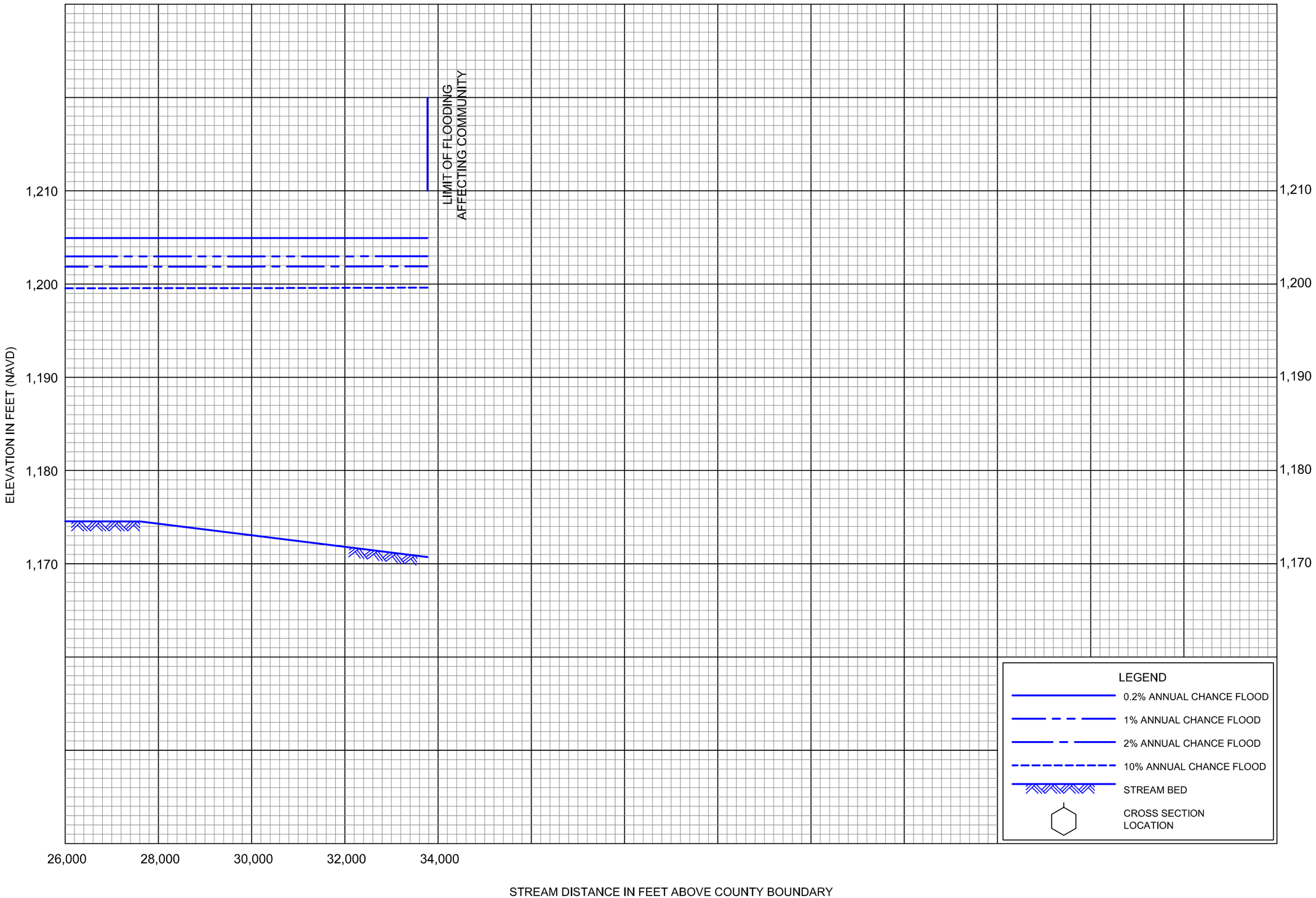

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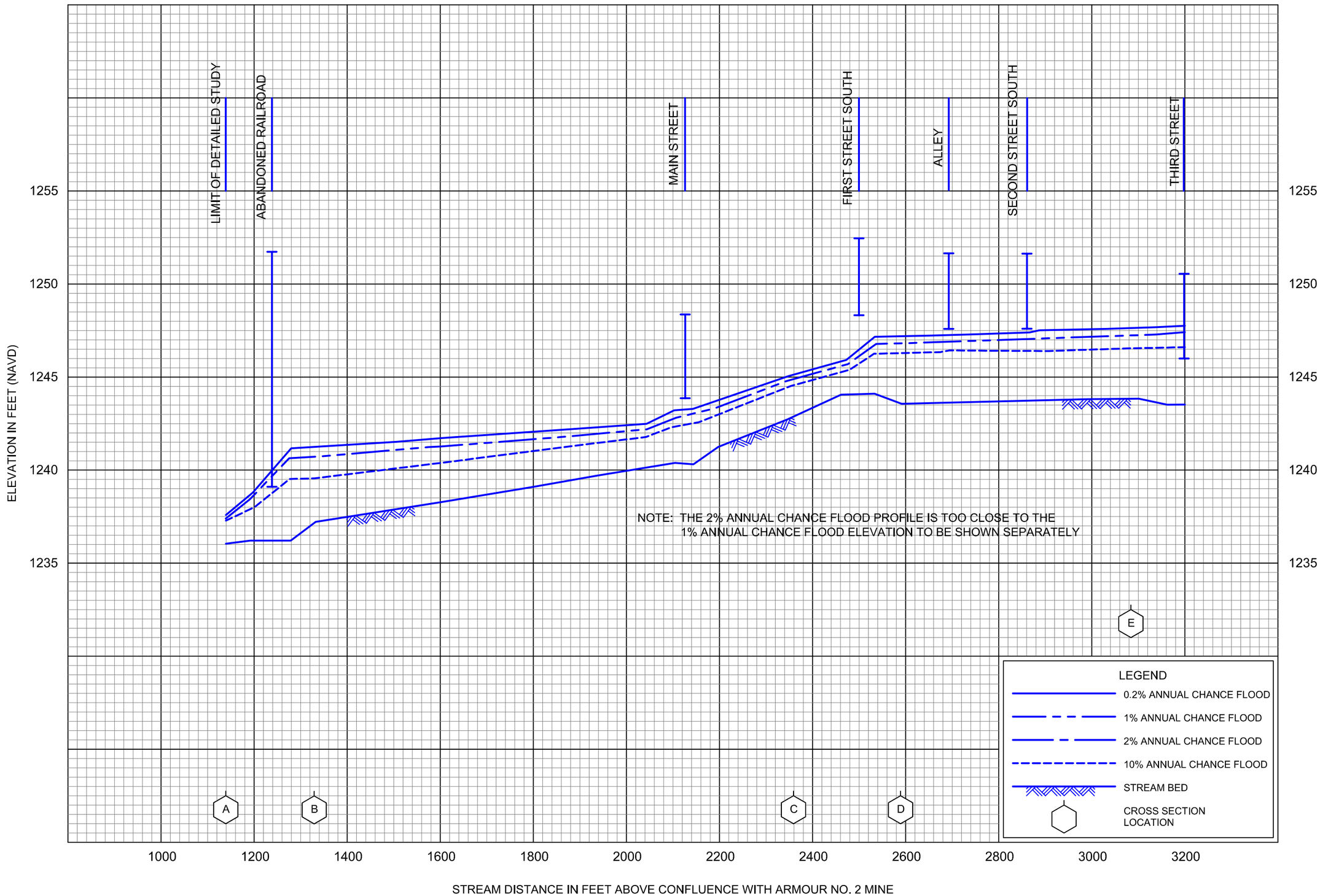

FLOOD PROFILES

SERPENT CREEK

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CROW WING COUNTY, MN

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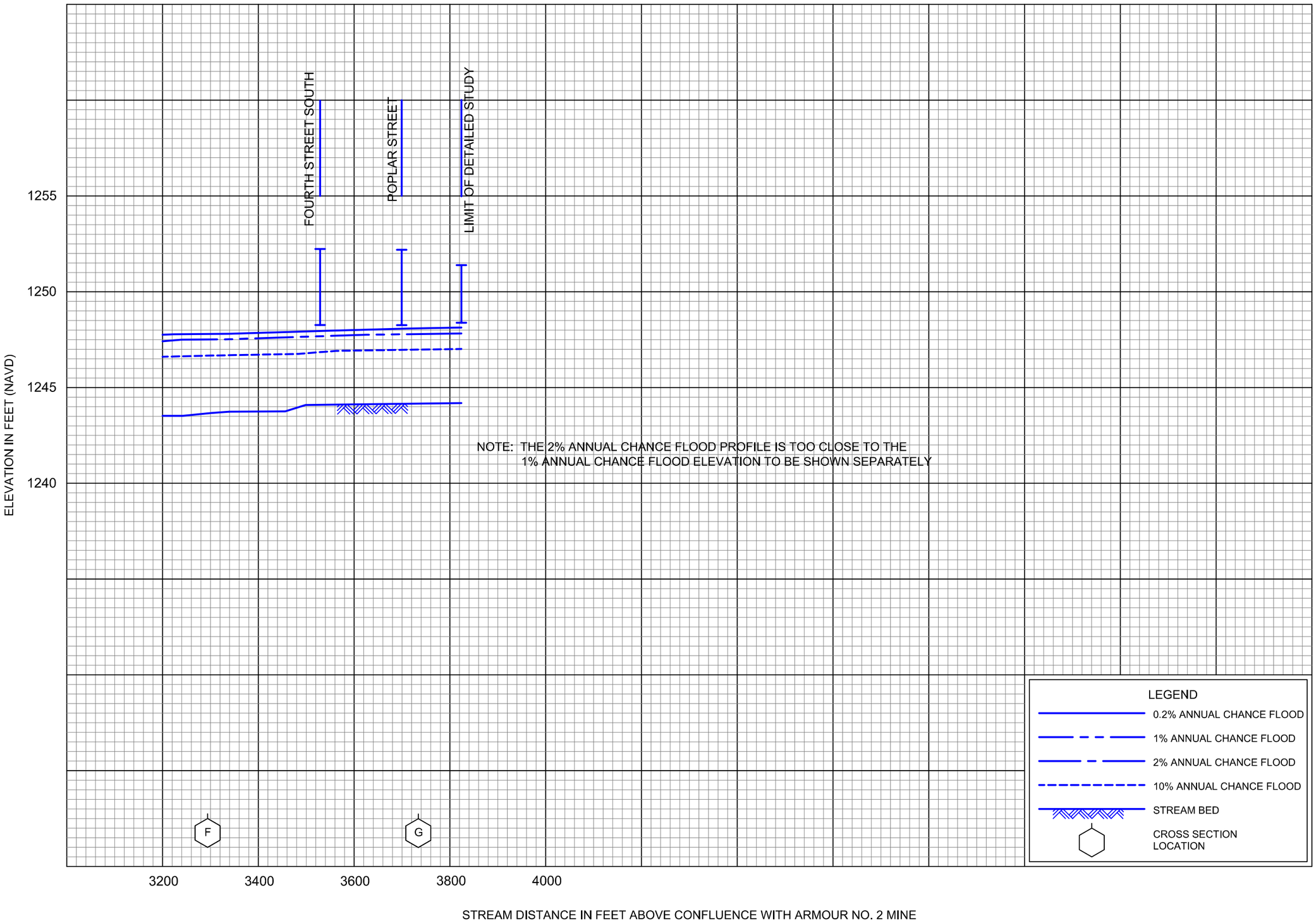

FLOOD PROFILES

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