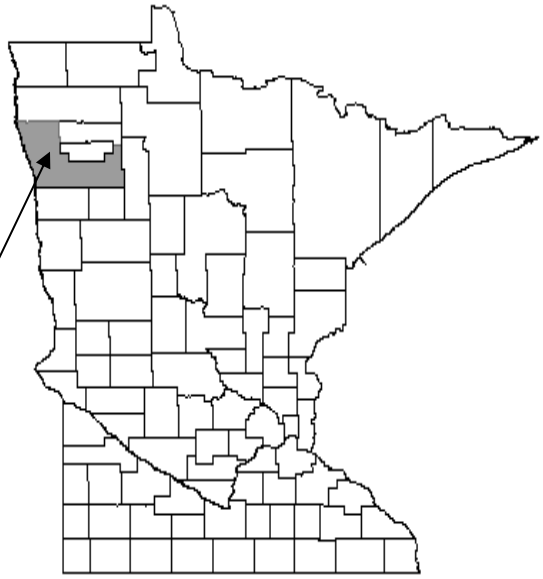
FLOOD INSURANCE STUDY

POLK COUNTY, MINNESOTA
AND INCORPORATED AREAS

Community Name	*Community Number*
BELTRAMI, CITY OF	270362
CLIMAX, CITY OF	270363
CROOKSTON, CITY OF	270364
EAST GRAND FORKS, CITY OF	275236
*ERSKINE, CITY OF	270924
FERTILE, CITY OF	270921
FISHER, CITY OF	270366
FOSSTON, CITY OF	270922
*GULLY, CITY OF	270925
*LENGBY, CITY OF	270923
MCINTOSH, CITY OF	270588
MENTOR, CITY OF	270367
NIELSVILLE, CITY OF	270590
POLK COUNTY (UNINCORPORATED AREAS)	270503
*TRAIL, CITY OF	270926
WINGER, CITY OF	270613

*No Special Flood Hazard Areas Identified



PRELIMINARY
7/4/2014

EFFECTIVE: XXXXXXXX

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
27119CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

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

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

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

Old Zone(s)	New Zone
A1 through A30	AE
B	X
C	X

Initial Countywide FIS Report Effective Date: XXXXXXX, 2015

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Exhibit 2 - Flood Insurance Rate Map Index
Flood Insurance Rate Map

FLOOD INSURANCE STUDY
POLK COUNTY, MINNESOTA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Countywide FIS revises and supersedes the FIS reports and/or Flood Insurance Rate Maps (FIRMs) in the geographic area of Polk County, Minnesota, including the incorporated communities of Beltrami, Climax, Crookston, East Grand Forks, Erskine, Fertile, Fisher, Fosston, Gully, Lengby, McIntosh, Mentor, Nielsville, Trail and Winger and unincorporated areas of Polk County (hereinafter referred to collectively as Polk County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates. This information will also be used by Polk County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

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

Please note that the City of Erskine, Gully, Lengby, and Trail have no special flood hazard areas identified within Polk County.

The Digital Flood Insurance Rate Map (DFIRM and FIS report for this countywide study has been produced in a digital format. Flood hazard information was converted to meet the Federal Emergency Management Agency (FEMA) DFIRM Database specification and Geographic Information System (GIS) format requirements. The flood hazard information was created and is provided in 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

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

Beltrami, City of:	the hydrologic and hydraulic analyses for the original FIS were performed by Edwards and Kelcey, Inc. for FEMA, under Contract No. EMW-C-0322. This study was completed in May 1981.
Crookston, City of:	the hydrologic and hydraulic analyses for the original FIS were performed by the U.S. Army Corps of Engineers, St. Paul District, for FEMA, under Inter-Agency Agreement Nos. IAA-H-16-75 and IAA-H-7-76, Project Order Nos. 21 and 1, respectively. This work, which was completed in September 1976, covered all flooding sources affective the City of Crookston.
East Grand Forks, City of:	the hydrologic and hydraulic analyses for the original FIS were performed by the Soil Conservation Service, U.S. Department of Agriculture, Bismarck, North Dakota for FEMA under Inter-Agency Agreement No. IAA-H-23-74, Project Order No. 11. This work, which was completed in November 1975, covered all flooding sources affecting the City of East Grand Forks.
Polk County (Unincorporated Areas):	the hydrologic and hydraulic analyses for the original FIS were performed by Edwards and Kelcey, Inc. for FEMA, under Contract No. EMW-C-0322. This study was completed in October 1981.

The Cities of Climax, Erskine, Fertile, Fisher, Fosston, Gully, Lengby, McIntosh, Mentor, Nielsville, Trail, and Wenger have no previously printed FIS reports.

Countywide

This FIS was prepared to include the unincorporated areas of, and incorporated communities within, Polk County in a countywide format.

The Minnesota Department of Natural Resources (MnDNR) is a Cooperating Technical Partner (CTP) with FEMA and was awarded a grant to remap the floodplains within the county and incorporate two LOMRs under CTP Mapping Activity Statement (MAS) No. 2009-01. The MnDNR awarded the grant to Red Lake Watershed District (RLWD). The RLWD contracted with Wenck Associates, Inc. (Wenck) and Wenck contracted with Michael Baker Jr., Inc (Baker) as a subconsultant in June 2010.

The base map information shown on this DFIRM was derived from the National Agriculture Imagery Program (NAIP) 1-meter Ground Sample Distance (GSD) from color aerial photography acquired in 2009. Base map GIS data was obtained from various entities. The USGS provided stream centerlines, water bodies, 7.5' Quadrangles, the Minnesota Land Management Information Center provide the Township, Range, and Section Grid, NOAA & NGS provided National Geodetic Survey benchmarks, MnDOT/MNGeo provided political boundaries, and MnDOT provided transportation features

The projection used in the preparation of this map was UTM Zone 15N. The horizontal datum was NAD 83. Differences in datum, spheroid, projection or UTM zones in the production of DFIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

1.3 Coordination

Pre-Countywide

Consultation Coordination Officer's (CCO) meetings may be held for each jurisdiction in this countywide FIS. An initial CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to explain the nature and purpose of a FIS and to identify the streams to be studied by detailed methods. A final CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to review the results of the study.

The dates of the initial and final CCO meetings held for Polk County and the incorporated communities within its boundaries are shown in Table 1.

The initial and final meeting dates for the previous FIS reports for Polk County and its communities are listed in Table 1 on the following page.

Countywide

A scoping report dated September 29, 2008 (Reference 5) describes the initial scope of work for this countywide project. MnDNR entered into an agreement to become a CTP with FEMA in February 2005 under CTP Agreement 2009-01.

The results of the study were reviewed at the final meeting held on XXXXXX, and attended by XXXXX.

Table 1 – Initial and Final CCO Meetings

Community	For FIS Dated	Initial CCO Date	Final CCO Date
Beltrami, City of	July 19, 1982	June 1979	October 6, 1981
Climax, City of	*	*	*
Crookston, City of	September 1977	January 28, 1976	August 31, 1976
East Grand Forks, City of	September 1977	December 10, 1974	September 8, 1975
Fisher, City of	*	*	*
McIntosh, City of	*	*	*
Mentor, City of	*	*	*
Nielsville, City of	*	*	*
Polk County, Unincorporated Areas	February 15, 1983	June 1979	June 25, 1982
Winger, City of	*	*	*

*Data not available

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Polk County, Minnesota, including the incorporated communities mentioned in Section 1.1.

This project included redelineation of detailed study areas, a restudy of Zone AH areas, models to generate new limited detail floodplains, and models to generate revised approximate floodplains.

Burnham Creek, Burnham Creek Tributary, Judicial Ditch 15, and the Red Lake River, from a point 6.2 miles downstream to the Western corporate limits of Crookston and from the Eastern corporate limit of Crookston to a point 5.8 miles upstream were not re-studied in this FIS. These detailed streams were redelineated as part of the countywide study.

The hydrologic and hydraulic analysis for the Sand Hill River in Beltrami was updated with new hydrologic information, overbank elevation data, and a new floodway model. The floodplain boundary was developed by Wenck-Baker as part of this study using the 1-meter DEM data derived from LiDAR produced by

the Red River Bain Mapping Initiative by the International Water Institute in Fargo, North Dakota, 2008-2010.

The hydrologic and hydraulic analyses for the Red River of the North from the northern edge of the City of East Grand Forks to the northern border with Marshall County and from 30 miles upstream from the southern edge of City of East Grand Forks to the southern border with Norman County was performed by the U.S. Army Corp of Engineers, as reported in "Regional Red River Assessment Report", dated January 2003 (Reference 6). The floodplain boundary was developed by Wenck-Baker as part of this study using the USACE hydraulic data and the 1-meter DEM.

The northwest area of the County was re-studied by detailed methods using the above referenced January 2003 USACE report, 100-year flood runoff volume and 1m DEM data as stated in the "AH Zone Delineation", August 2011 report (Reference 7).

A detailed study of the Snake River performed for the Marshall County Flood Insurance Study (Reference 8) indicated flooding from the Snake River within Polk County. The Snake River within Polk County was studied by approximate methods.

All or portions of the flooding sources studied by detailed methods are listed in Table 2. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

All or portions of the flooding sources studied by approximate methods include Burnham Creek, Clearwater River, County Ditch No. 2, County Ditch No. 2.1, County Ditch No. 7, County Ditch No. 14, County Ditch 35, County Ditch 43, Ditch No. 16, Grand Marais Creek, Grand Marais Creek 8, Hill River, Judicial Ditch No. 1, Judicial Ditch 1.11, Judicial Ditch No. 75, Kittleson Creek, Lost River, Maple Creek, Poplar River, Red River 6, Red River Tributary A, Red Lake River 3, Red Lake River 3.1, Sand Hill River, Sand Hill River Tributary 2, Sand Hill River Tributary 5, Sand Hill River Tributary 6, Sand Hill River Tributary 7, Sand Hill River Tributary 13.1, Sand Hill River Tributary 29, Snake River, Snake River 1, Snake River 5, Snake River 7, and Snake River 8. The approximate studies are shown as Zone A on the FIRM.

All or portions of the flooding sources studied by limited detailed methods include the Red Lake River outside of the LOMR limits described in Table 3. The limited detailed studies are shown as Zone A on the FIRM.

This FIS also incorporates the determination of letters issued by FEMA resulting in map changes (Letter of Map Revision (LOMR) as shown in Table 3. The LOMR for the City of Crookston revised the Red Lake River from approximately 7,600 feet downstream of Sargent Street to approximately 7,150 feet upstream of

the Burlington Northern Santa Fe Railroad. It also revised a north ponding area from approximately 150 feet north of Memorial Driver to east of U.S. Highway 75 and a south ponding area from approximately 200 feet south of Memorial Drive to approximately 400 feet east of U.S. Highway 75. This is described in the "Crookston Flood Insurance Study" (Reference 9).

The USACE report "Grand Forks, ND & East Grand Forks, MN Flood Insurance Study" dated January 2007 LOMR for the City of East Grand Forks revised the Red Lake River (upstream about 10 miles to the confluence with the RRN), Red River of the North (from 30 miles upstream of the city to 1 mile downstream of the city), Heartsville Coulee, and various ponding areas within the City of East Grand Forks and 30 miles upstream and 1 mile downstream of city limits. This study was the basis for the LOMR.

Table 2 - Flooding Sources Studied by Detailed Methods

Burnham Creek	Red Lake River
Burnham Creek Tributary	Red River of the North
Heartsville Coulee	Sand Hill River at Beltrami
Judicial Ditch 15	

Table 3 – Letters of Map Change

Community	Flooding Sources Revised	Date Issued	Type	Case No.
Crookston	Red Lake River, Various Ponding Area	01/24/2007	LOMR	07-05-1774P
East Grand Forks	Red River of the North, Red Lake River, Heartsville Coulee, Various Ponding Areas	09/12/2007	LOMR	07-05-2270P
Unincorporated Polk County	Red River of the North, Red Lake River	09/12/2007	LOMR	07-05-2270P

2.2 Community Description

Polk County covers an area of 1,970 square miles in the northwest corner of Minnesota. It is bordered by the Red River of the North and North Dakota to the west, by Marshall, Red Lake, and Pennington Counties to the north, by Clearwater County to the east, and by Norman and Mahnomen Counties on the south.

The economy of unincorporated areas of Polk County is primarily agricultural. Industry in the County is generally agricultural in nature. Floodplain

development consists mainly of farmsteads and farm outbuilding but also includes residential and commercial development near populated cities. The population of Polk County in 2010 was 31,600 (Reference 11).

The temperature range, from summer to winter, and on occasion from day to day, is large. In the winter, outbreaks of arctic air bring bitter cold. The climate in Polk County is continental, with the mean temperature ranging from 6 degrees Fahrenheit in January to 70 degrees Fahrenheit in July. The average annual precipitation is about 22 inches. The average annual snowfall is about 38 inches (The Weather Channel, 2012).

The western portion of Polk County along the Red River of the North is part of the ancient lake plain formed by glacial Lake Agassiz. The lake plain is extremely flat, slowing two to three feet per mile. Elevations vary from 800 feet to 900 feet. The central portion is intersected by the Lake Agassiz beach ridges with elevations varying from 900 feet to 1,100 feet. The eastern portion is part of the lake-washed till plain with elevations varying from 1, 1000 feet to 1,500 feet (Reference 12).

Soils in the lake plain vary from the deep black sols formed on glacial lake clay and silt to dark colored, fin sandy soils. Beach ridge soils tend to be comprised of fine sand and gravel deposits. Large areas of peat land lie within the lake-washed till plain along with dark colored calcareous till soils (Reference 13).

City of Beltrami

The City of Beltrami is a rural community located in the southwest portion of Polk County. The total land area within the corporate limits is approximately 2 square miles. The City of Beltrami is completely surrounded by unincorporated areas of Polk County. Beltrami is approximately 35 miles southeast of East Grand Forks, 18 miles south of Crookston, and 55 miles north-northwest of Moorhead. Its population was 107 in 2010.

The headwaters of the Sand Hill River are located in the prairie lakes region south of Fosston. The river flows in a natural condition westerly to a point several miles east of Beltrami, where it has been enlarged, straightened and improved from 20 miles. The Sand Hill River finally discharges to the Red River of the North 2 miles west of Climax.

The City of Beltrami is located in the western region of the watershed. The Sand Hill River drainage area at Beltrami is approximately 270 square miles. Most of the watershed tributary to the city is in agricultural usage.

Present development within the floodplain is primarily residential/commercial, and is located near the intersection of State Highway 9 and County Highway 1

north of the Sand Hill River. The remainder of the community is in agricultural usage.

City of Climax

The City of Climax is a rural community located in the southwest portion of Polk County. US Highway 75 and Minnesota Highway 220 are two of the main routes in the community. According to the United States Census Bureau, the city has a total area of 1.1 square miles, all of it land. The elevation is 866 feet (264 m) above sea level. The population was 267 at the 2010 census.

City of Crookston

The City of Crookston is a community located in the northeast portion of Polk County. The total land area within the corporate limits is approximately 5 square miles. Its population was approximately 7,890 in 2010.

The Red Lake River joins the Red River of the North approximately 30 miles northwest of Crookston. The river follows a serpentine course through the city, with the result that, in an unprotected state, substantial areas of the city are directly exposed to overflow. Within the city, development along the river is largely residential.

City of East Grand Forks

The City of East Grand Forks is a community located on the western border of Minnesota, about 70 miles south of the Canadian boundary and 298 miles upstream from the mouth of the Red River of the North. The total land area within the corporate limits is approximately 6 square miles. Its population was approximately 8,600 in 2010.

The point where the Red River of the North and the Red Lake River join was an important landmark. It served as a trading post and general rendezvous for 50 years prior to the development of the area as a permanent community. East Grand Forks was chartered as a village in 1879. During the early years of the settlement, small industry and farming was the prevalent economic base for the area. As railroads were built through the area, people began to emigrate to the fertile land of the Red River Valley and, by 1883, most of the prime land was claimed. The present economy of the area is still based primarily on agriculture and related processing industries.

City of Erskine

The City of Erskine is a community located in the southeast portion of Polk County, Northwestern Minnesota approximately 90 miles south of the Canadian border and 55 miles east of the North Dakota/Minnesota border. The city sits at

the junction of two US highways: U.S. Highway #2 and #59. In addition to the highways, Erskine sits at the junction of two major transcontinental railroads Burlington Northern Sante Fe and Canadian Pacific railways. The population was 503 at the 2010 census.

City of Fertile

The City of Fertile is a community located in the southern portion of Polk County. According to the United States Census Bureau, the city has a total area of 2.13 square miles. The area east, south, and southwest of Fertile are hilly while the areas to the north and west of Fertile are very flat and good for agriculture. Minnesota Highway 32 and Minnesota Highway 102 are two of the main routes in the community. The Agassiz Recreational Trail, a 53 mile multi-use trail built on an abandoned railroad grade passes through the city. The population was 842 at the 2010 census.

City of Fisher

The City of Fisher is a community located in the western portion of Polk County. According to the United States Census Bureau, the city has a total area of 0.43 square miles. The population was 435 at the 2010 census.

City of Fosston

The City of Fosston is a community located in the southeastern portion of Polk County. US Highway 2 serves as a main route in the city. According to the United States Census Bureau, the city has a total area of 1.71 square miles. The population was 1,527 at the 2010 census.

City of Gully

The City of Gully is a community located in the western portion of Polk County. According to the United States Census Bureau, the city has a total area of 0.26 square miles. The population was 66 at the 2010 census.

City of Lengby

The City of Lengby is a community located in the southeastern portion of Polk County. According to the United States Census Bureau, the city has a total area of 0.29 square miles. The population was 86 at the 2010 census.

City of McIntosh

The City of McIntosh is a community located in the southeastern portion of Polk County, 100 miles south of the Canadian border and 60 miles east of North Dakota. US Highway 2 serves as a main route in the city. According to the United

States Census Bureau, the city has a total area of 1.00 square mile. The population was 625 at the 2010 census.

City of Mentor

The City of Mentor is a community located in Polk County near Maple Lake. According to the United States Census Bureau, the city has a total area of 1.87 square miles. The population was 153 at the 2010 census.

City of Nielsville

The City of Nielsville is a community located in the southwestern portion of Polk County. US Highway 75 serves as the main arterial in the community. According to the United States Census Bureau, the city has a total area of 0.36 square miles. The population was 90 at the 2010 census.

City of Trail

The City of Trail is a community located in the eastern portion of Polk County. According to the United States Census Bureau, the city has a total area of 0.99 square miles. The population was 46 at the 2010 census.

City of Winger

The City of Winger is a community located in the southwestern portion of Polk County. According to the United States Census Bureau, the city has a total area of 0.44 square miles. The population was 220 at the 2010 census.

2.3 Principal Flood Problems

Flooding in Polk County occurs primarily along the Red River of the North, the Red Lake River, the Snake River, Burnham Creek, and Grand Marais River. The principal flood season in Polk County is the spring as a result of rapid snowmelt accompanied by spring rain. The region is also susceptible to flooding as a result of intense regional storms.

City of Beltrami

The floods of record occurred in 1978 and 1979. They were not directly attributable to highwater on the Sand Hill River adjacent to the town, but come from overland flow from the Sand Hill River east of Beltrami. State Highway 9 and the Burlington Northern railroad are located along parallel alignments in a north-south direction through Beltrami, and act to impound flow on the east side of the city. Restrictive culverts under the railroad, approximately 1500 feet north of the Sand Hill, cause water to remain in town for several days. Flow is generally shallow, but has caused some property damage.

City of Crookston

The City of Crookston is subject to periodic overflow from the Red Lake River. The most severe flooding occurs during and following the spring breakup. Particularly critical are periods when melting snow and heavy rains occur simultaneously. Major recent floods occurred at Crookston in 1950, 1966, 1967, 1969, 1974, 1979, 1996, 1997, 1999, 2001, 2006, 2009, 2010, and 2011. The flood of record causing the greatest damage occurred in 1997.

City of East Grand Forks

In the past, East Grand Forks has experienced considerable flooding. The Red River of the North has historically flooded in the spring due to rapid snowmelt generally accompanied by spring rains. The Red River of the North flows north, which compounds the flooding problem; the downstream reaches of the river are still frozen when the upstream reaches are beginning to flow from spring snowmelt. Run-off from tributary streams is generally synchronized with mainstream flows, increasing the resultant flood peak.

Major flooding on the Red River of the North has occurred numerous times since 1882. Dates of past major floods are the springs of 1882, 1893, 1897, 1950, 1966, 1969, 1978, 1989, 1996, 1997, 2001, 2006, 2009, 2010, and 2011. The 1997 flood on the Red River of the North had the largest flow on record at the Grand Forks USGS gage of 137,000 cfs which is higher than the 1-percent annual chance flow rate. Various reports summarize past flooding on the Red River of the North including the United States of America Corps of Engineers (USACE) report, Red River of the North Stem Hydrologic Data (Reference 14), and the Minnesota Department of Natural Resources report, Red River of the North Regional Flood Analysis (Reference 15), and the USACE Regional Red River Flood Assessment Report (Reference 6).

2.4 Flood Protection Measures

A system of earthen spoil banks adjacent to the Sand Hill River in Beltrami were created as part of the USACE's channel improvement project on the Sand Hill River. These spoil banks are not levees and do not offer protection from the 100-year flood in Beltrami.

The Flood Protection Project in East Grand Forks was completed in 2007. The project consisted of three flood control systems working together. A levee/floodwall system holds back water from the Red River of the North and the Heartsville Coulee Diversion Channel diverts flow around the east side of the city to the Red Lake River during large flood events. Additionally, a series of pumping stations to handle internal city drainage were added. The project was

also authorized to provide recreation features including 24 miles of trails and seven trailheads constructed in the new river greenway.

The Flood Protection Project in Crookston was completed in 2011. The project consists of earthen levees, concrete floodwall, pump stations and riprap erosion protection. The project included a removal of the existing emergency levee system and installation of a high-flow cutoff channel.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the county, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 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 which equals or exceeds the 100-year flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the county at the time of completion of this FIS. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for the flooding sources studied in detail affecting the county.

Hydrologic data from the various engineering reports discussed in Section 7.0 have been used extensively for the revised study of Polk County, including peak discharges and starting WSELs.

Peak discharges for the Sand Hill River in the City of Beltrami were updated from the 1982 FIS. These new discharges are based upon a weighted analysis of the years of record for the estimates obtained from the station records and on the equivalent years of record for the regression estimates.

Peak discharges for the City of East Grand Forks were updated through a new study and a LOMR and are described in the “Grand Forks, ND & East Grand Forks, MN Flood Insurance Study, January 2007 report” (Reference 10) and LOMR 07-05-2270P. These discharges were calculated for the Red River of the

North, Red Lake River and Heartsville Coulee and are shown in the table of discharges.

Peak discharges for the Red Lake River at the City of Crookston were updated through a LOMR (07-02-1774P) and are from a 1990 reconnaissance report for the Red Lake River at Crookston. Peak flow data was available through 1988 when the report was written. The gage within the city of Crookston (USGS Gage No. 05079000, D.A. = 5,280 square miles, Effective D.A. =3,300 square miles) was the primary gage used and the Grand Forks gage (USGS Gage No. 05082500, D.A. = 30,100 square miles) was used to improve the period of record statistics at Crookston. The flood of record at the Crookston gage for this report was on April 12, 1969 with a flow of 28,400 cfs with an estimated exceedance frequency of 2%. Flow rates at Crookston were developed by following the guidelines and procedures outlined in the Water Resources Council Bulletin No. 17B and the Hydrologic Engineering Center's computer programs, "Flood Frequency Analysis" and "Regional Frequency Computation". Following this study was a large flood in 1997 and a new discharge-frequency curve was developed. There was not a significant difference between the old values and new values; therefore the discharges were not changed. Since the LOMR went effective, there was a large flood in 2009 that increased the flood-frequency analysis flow to 32,810 cfs. Since this value was not significantly different than the LOMR values, these LOMR values shown in the table of discharges will remain the effective flows.

Peak discharges for Unincorporated Polk County along the Red Lake River upstream and downstream of Crookston were obtained from a discharge-frequency curve developed by the USACE for the Crookston Flood Insurance Study (Reference 2) and Flood Plain Information Report (Reference 16). A statistical analysis was performed on 67 years of historic flood data from the USGS station in Crookston in order to compute the discharge-frequency curve (Reference 16).

Peak discharges for Unincorporated Polk County were previously calculated for Burnham Creek, Burnham Creek Tributary, and Judicial Ditch 15 in the FIS (Reference 4) using regional regression equations developed for this area by the USGS. Regional flood-frequency equations for ungaged sites are derived from multiple regression analyses of data obtained from gaged sites within the basin. These values will remain effective for the countywide study

Peak discharges for the northern shallow flooding area of Polk County were studied considering runoff volume. The peak storage volume of this area, excluding the area controlled by the Red River, is equivalent to 2.3-inches of runoff over the 256 square mile watershed and is described in the report "AH Zone Delineation", August 2011.

Peak discharges for stream studied by approximate methods used USGS Scientific Investigations report 2009-5250 for regression equation analysis (Reference 17),

USGS National Streamflow Statistics Program (Reference 18), and Bulletin 17B (Reference 19).

Peak discharge values for the limited detail study along the Red Lake River were estimated using a straight line equation of the discharges at the Thief River Falls, Crooks, and East Grand Forks gages. This relationship is:

$$Q = 7.9596 * (DA) - 10349$$

Peak discharge values for the Snake River were previously taken from the Marshall County Flood Insurance Study (Reference 8). These values will remain effective for this countywide Study.

Peak discharges for the Red River of the North were obtained from the Corps of Engineers report, “Regional Red River Flood Assessment Report” (Reference 6). The current Corps of Engineers Regional Red River Flood Analysis included floods of record on the main stem and other large events that occurred since the 1971 curves were computed. The report was prepared in cooperation with technical experts from the Minnesota Department of Natural Resources, the North Dakota State Water Commission, U.S. Geological Survey (North Dakota District), FEMA Regions V and VIII (Chicago and Denver), and FEMA Headquarters. The methods used to generate the discharge-frequency relationships were in accordance with guidelines provided by FEMA in its Publication No. 37, “Guidelines and Specifications for Study Contractors” and in accordance with the Interagency Advisory Committee on Water Data’s Bulletin No. 17B, “Guidelines for Determining Flood Flow Frequency” and other Corps of Engineers criteria.

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

Table 4 – Summary of Discharges

Flooding Source and Location	Drainage Area (sq. miles)	Peak Discharges (Cubic Feet per Second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Burnham Creek					
At Downstream Limit	139	1,570	2,640	3,180	4,500
At County Road 217	126	1,480	2,490	2,990	4,300
About 2000' Downstream of County Road 14	106	1,330	2,230	2,680	3,850
At County Road 45	75	1,070	1,800	2,170	3,150
Burnham Creek Tributary					
At Confluence with Burnham Creek	12.7	360	600	720	1,030
At County Road 45	10.8	320	540	650	950
Heartsville Coulee	33	800	1600	6810	19322
Judicial Ditch 15					
At confluence with Burnham Creek	27.1	570	960	1,150	1,650
Red Lake River					
At East Grand Forks	5,660	14,500	23,700	34,600	58,420
At 310th Street	5,640	*	*	34,500	*
At Crookston	5,280	18,100	27,800	31,800	40,700
At 150th Avenue	5,233	*	*	31,400	*
Red River of the North					
Immediately Downstream of confluence with Red Lake River	30,100	47,700	87,600	108,000	161,000
Immediately Upstream of confluence with Red Lake River	24,439	33,200	63,900	73,400	102,600
Immediately Upstream of Heartsville Coulee Breakout	*	33,200	63,900	80,200	121,900
Sand Hill River					
At Beltrami	270	2,720	5,235	6,545	10,140

*Data not available

Table 5 – Summary of Stillwater Elevations

Flooding Source and Location	Elevation (Feet NAVD) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Heartsville Coulee Ponding Area L8	*	*	822.1	*
Red Lake River at Crookston				
North Ponding Area	*	*	850.1	851.1
South Ponding Area	*	*	849.4	850.0
Red River of the North				
Ponding Area K7 – River Heights Park	*	*	822.6	*
Ponding Area K10 – Sherlock Park	*	*	825.5	*
Ponding Area K3- Valley Golf Course	*	*	828.8	*
Ponding Area L6- Laurel Drive	*	*	830.1	*

*Data not available

3.2 Hydraulic Analyses

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

Hydraulic data from the various engineering reports discussed in Section 7.0 have been used extensively for the revised study of Polk County.

Cross sections for the Sand Hill River at Beltrami analyses were field surveyed and were located at close intervals above and below bridges in order to compute significant backwater effects. Analyses of the hydraulic characteristics of the flooding sources studied in detail were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of these flood sources. The model from the 1982 FIS was updated to include updated hydrologic

analysis and overbank elevations. For the original model, channel alignment and geometry was obtained by photogrammetric and stadia field methods.

Roughness coefficients were selected using field inspection data and engineering judgment. Roughness values are 0.035 for the main channel and range from 0.037 to 0.042 for the overbanks of the Sand Hill River.

The original HEC-2 model was converted to HEC-RAS model and any errors at bridges were updated. The updated HEC-RAS model also includes a datum conversion from NGVD29 to NAVD88. Starting water surface elevations were based upon the upstream water surface elevations of the approximate model for the Sand Hill River downstream of Beltrami.

Cross sections for Burnham Creek, Burnham Creek Tributary, Judicial Ditch 15, and the Red Lake River (upstream and downstream of Crookston), were located at close intervals upstream and downstream of bridges, culverts and other obstructions in order to compute significant backwater effects of these structures. Other cross sections were located along the watercourses in a manner that would provide a representation typical of the stream valley topography. Photogrammetric methods were used to obtain data for the overbank portions of the cross sections; channel portion of the cross section, bridge dimensions, and other structures were field surveyed during May through August, 1980.

Loss coefficients for bridges and other channel obstructions, as well as channel and overbank roughness coefficients were initially estimated by field inspection. Adjustments were made in the coefficients until the computed water-surface profiles approximated historic flooding events. Roughness values for the Red Lake River at Crookston vary from 0.020 to 0.042 for the main channel to 0.05 to 0.20 for the overbanks. Roughness values for Burnham Creek, Burnham Creek Tributary and Judicial Ditch 15 vary from 0.025 to 0.04 for the main channel to 0.035 to 0.084 for the overbanks.

Starting water surface profiles for Burnham Creek and the Red Lake River (upstream and downstream of Crookston), were computed using the USACE HEC-2 step-backwater model. Starting water surface elevations were computed using the HEC-2 slope-area method. Water-surface elevations for Burnham Creek were computed using the HEC-2 slope-area method.

Starting water surface profiles for Burnham Creek Tributary and Judicial Ditch 15 were computed using the USACE HEC-2 step-backwater model. Starting water surface elevations were computed from the water surface profiles computed for Burnham Creek. Coincident 100-year floods were assumed due to their relatively small drainage area compared to Burnham Creek.

Cross sections for the Red Lake River in Crookston were located at close intervals upstream and downstream of bridges and other hydraulic structures to allow

computation of the significant backwater effect of these structures. Other cross sections were located along the river to provide a typical representation of the river valley topography. Locations of cross sections used in the hydraulic analysis are shown on the flood profiles.

Roughness coefficients (Manning's "n" values) ranged from 0.0207 to 0.042 for the channel and from 0.090 to 0.150 for the overbank areas. Contraction coefficients ranged from 0.1 to 0.3, and expansion coefficients ranged from 0.3 to 0.5. The roughness coefficients have been updated during calibration to high water marks from 1969 and 1997 floods

The hydraulic program used for this study was HEC-2 and HEC-RAS version 3.1.3. The original hydraulic model for this area was a HEC-2 model from the 1974 “Flood Plain Information, Red Lake River, Crookston, Minnesota” report, which was updated in 1990 with new bridge plans, future cut-off channels, and new topographic mapping for cross section overbank areas. This model used in conjunction with HEC-2 models of cut-off channels downstream of Crookston with divided flow analysis at the cut-offs and main channel until the elevations matched; these elevations are the new starting water surface at cross section 9.2, which is the downstream city limit. The new HEC-RAS model combined these HEC-2 models and optimizes flow through the cutoff channels, along with new bridge, dam and overbank data.

Cross section for the Red River of the North, Heartsville Coulee, and Red Lake River were taken from one-foot bathymetry and topography available within the City of East Grand Forks. For the Red River of the North upstream of the City, surveyed cross sections were available with limited overbank data. The cross section data in the overbanks was modified based on the best available data, which include 30-meter DEM data, 1:24,000 scale DRG’s, and 1997 flood aerials.

Roughness coefficients (Manning’s “n” values) for the Red River of the North were based on engineering judgment and the model calibration. The “n” values for the Red River of the North channel varied from 0.035 to 0.041. For overbank areas with open fields the “n” values varied from 0.06 to 0.07. The “n” values for the overbank areas with less dense trees and brush, overbank areas with dense trees, and overbank areas with residential development were 0.09, 0.12, and 0.15, respectively. The Heartsville Coulee Manning’s “n” value was based upon calibration efforts based upon the indirect measurement of the Heartsville Coulee breakout flow after the 1997 flood. A value of 0.028 for the channel and 0.039 for open fields were selected and agreed upon.

Water surface profiles for the Red River of the North, Heartsville Coulee and Red Lake River were developed using the USACE HEC-RAS backwater computer program. For the Heartsville Coulee low tailwater conditions were modeled in HEC-RAS. The interior ponding elevations were incorporated from the interior flood control analysis completed for the flood control project.

Water surface elevations were calculated for the Red River of the North from the northern edge of the City of East Grand Forks to the northern border with Marshall County and from approximately 30 miles upstream of the southern border with the City of East Grand Forks to the southern border with Norman County. These elevations were obtained from the USACE as reported in "Regional Red River Assessment Report," dated January 2003 (Reference 6). These elevations were used to map a Zone AE floodplain using the 1m DEM topography.

The elevations for the shallow AH flooding in the area of northern Polk County were based upon historic flood elevations and 1m DEM data.

Cross-sections for approximate studies were cut along the study reaches with a spacing of 2000 feet using 1m DEM data. Hydraulic analyses for streams were calculated using the USACE HEC-RAS computer program. Starting water surface elevations for the streams were calculated using the normal water surface elevation. The banks and ineffective flow areas were established manually with use of aerial photography. The floodplain analysis did not consider the backwater effects caused by bridges, culverts, and other structures located within the floodplain.

Limited Detail studies with floodway were developed for the Red Lake River outside of the LOMR limits in Crookston and East Grand Forks. Cross-sections were cut along the study reaches with a spacing of 500-750 feet using 1m DEM data. Select cross sections were developed using surveyed data for channel elevations and all other cross section channel data was interpolated. Starting water surface elevations for the streams were calculated using the normal water surface elevation. The banks and ineffective flow areas were established manually. The floodplain analysis considered the backwater effects caused by bridges, culverts, and other structures located within the floodplain.

Aerial photography and a land use data for approximate and limited detail studies were used to estimate the Manning's roughness coefficient ("n" value) based on land use types in the overbank areas. For the main channel, coefficients of 0.035 and 0.045 were used and incorporated in the HEC-RAS model.

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

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

All topographic mapping used to determine cross sections are referenced in Section 4.1.

3.3 Vertical Datum

All FISs and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FISs and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the finalization of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs are being prepared using NAVD 88 as the referenced vertical datum.

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

For this revision, a vertical datum conversion was completed for the entire county. The Profile Panel and FWDT conversion from NGVD29 to NAVD88 was carried out in accordance to the procedure outlined in the FEMA document Map Modernization – Guidelines and Specifications for Flood Hazard Mapping Partners Appendix B: Guidance for Converting to the North American Vertical Datum of 1988. The datum conversion from NGVD29 to NAVD88 for Polk County is 1.1 feet.

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

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 this data.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent annual chance flood elevations; delineations of the 1- and 0.2-percent annual

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

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance 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 county. For the streams studied in detail, the 1- and 0.2-percent annual chance floodplain boundaries have been delineated using the flood elevations determined at each cross section.

Floodplain boundaries for the Red River of the North, Heartsville Coulee, and Red Lake River per the LOMR were delineated from one-foot bathymetry and topography available within the City of East Grand Forks. For the Red River of the North upstream of the City of East Grand forks, the floodplains were delineated from the best available data, which included 30-meter DEM data, 1:24,000 scale DRG's, and 1997 aerials.

1-meter DEM data was provided by the International Water Institute's Red River Basin Mapping Initiative 2008-2010.

For the Red River of the North (upstream and downstream of the City of East Grand Forks data), the Red Lake River (limited detail areas), and the flooding sources studied by approximate methods, the floodplains were delineated from the 1m DEM data.

Floodplain boundaries for the Red Lake River were delineated from one-foot topography available within the City of Crookston.

For the shallow flooding in northern Polk County, 1m DEM data was used to delineate the floodplain. Flood elevations were kept within 1 foot of the low point in the road grade.

Burnham Creek, Burnham Creek Tributary, Judicial Ditch 15, and the Red Lake River (upstream and downstream of Crookston) were redelineated using the 1m DEM data.

The 1- and 0.2-percent annual chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE), and the 0.2-percent annual chance floodplain boundary corresponds to the

boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent annual chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

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

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. 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 a 0.5-foot surcharge were delineated for this study, with the exception of the Red River of the North, which has no more than a 0.8-foot surcharge. The floodways in this FIS are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

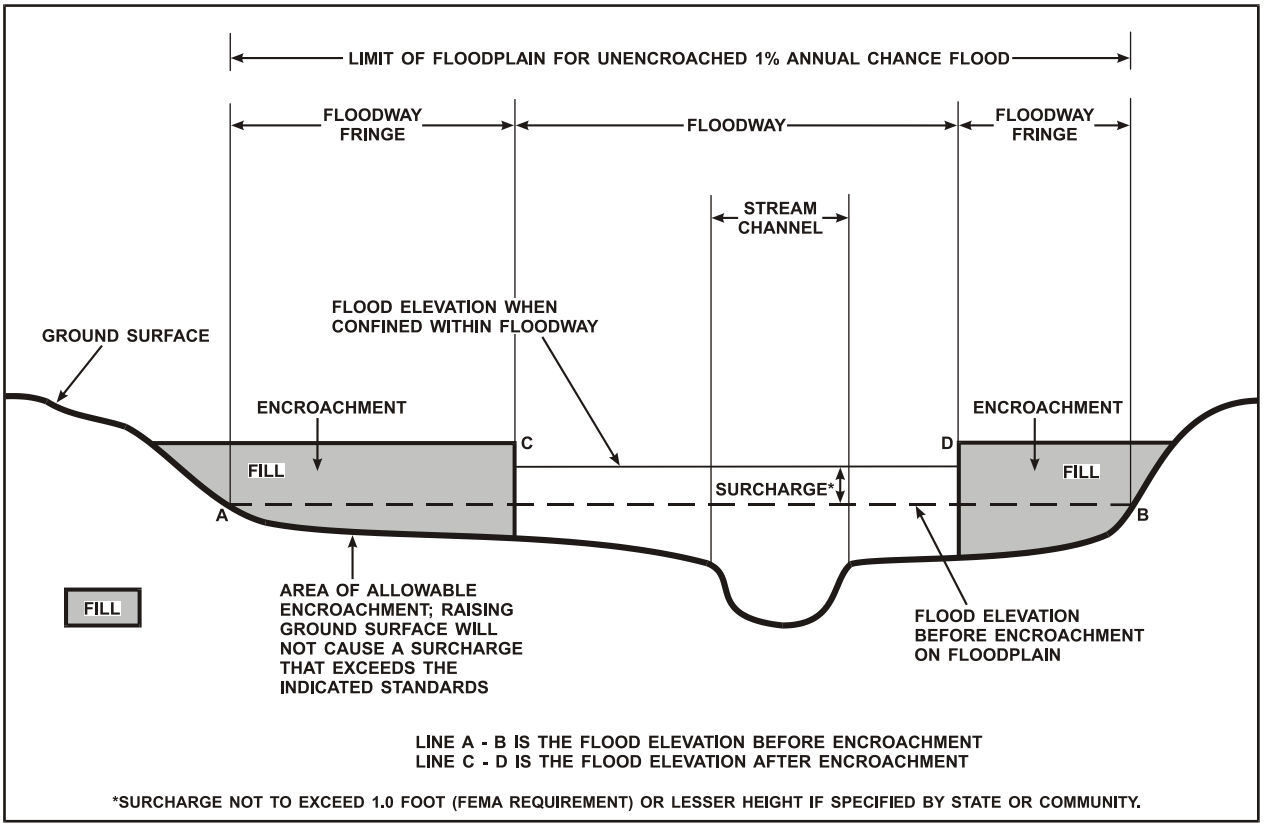
The floodways presented in this FIS were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (Table 6). The computed floodways are shown on the FIRM. In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

A floodway was computed for the Red River of the North, Heartsville Coulee, Red Lake River near East Grand Forks and Crookston, and the Sand Hill River at Beltrami. Floodway encroachment was not computed for cross-sections A through M or for cross-sections AW through BF for the Red River of the North.

An administrative, non-regulatory floodway was computed for the limited detail study along the Red Lake River. This delineation is available in the TSDN.

The floodway for Burnham Creek, Burnham Creek Tributary, and Judicial Ditch 15 were not revised for this study.

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent-annual-chance flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1.



FLOODWAY SCHEMATIC
Figure 1

5.0 INSURANCE APPLICATIONS

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

Zone A

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	UPDATED WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Burnham Creek									
A	11,330	124	130	984	3.0	863.3	863.3	863.7	0.4
B	14,460	134	200	1,113	2.7	865.1	865.1	865.4	0.3
C	22,610	230	N/A	1,560	1.9	868.8	868.8	869.2	0.4
D	33,450	97	132	828	3.2	873.7	873.7	874.1	0.4
E	40,100	200	284	1,175	2.3	877.6	877.6	877.8	0.2
F	46,450	107	76	434	5.0	880.9	880.9	881.1	0.2
G	50,530	98	98	514	4.2	884.2	884.2	884.4	0.2
H	61,390	52	N/A	373	5.8	891.0	891.0	891.1	0.1

[1] Stream distance in feet above limit of detailed study.

[2] New width based on redelineation

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

BURNHAM CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	UPDATED WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
BURNHAM CREEK TRIBUTARY									
A	800	205	N/A	1,422	0.5	859.9	859.9	860.4	0.5
B	7,560	123	N/A	624	1.2	863.1	863.1	863.2	0.1
C	11,960	120	136	984	0.7	866.5	866.5	866.6	0.1
D	15,500	110	130	622	1.2	866.7	866.7	866.9	0.2
E	20,860	98	110	519	1.4	870.6	870.6	870.7	0.1
F	26,780	125	231	737	0.9	874.6	874.6	874.7	0.1
G	31,830	48	N/A	249	2.6	875.8	875.8	875.9	0.1

[1] Stream distance in feet above confluence with Burnham Creek

[2] New width based on redelineation

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

BURNHAM CREEK TRIBUTARY

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)
HEARTSVILLE COULEE								
A	1,700	335	5,267	1.4	834.9	834.9	835.3	0.4
B	4,500	308	4,389	1.7	835.0	835.0	835.4	0.4
C	7,463	465	4,583	1.6	835.1	835.1	835.5	0.4
D	13,314	534	5,306	1.4	835.6	835.6	836.0	0.4
E	19,415	460	4,265	1.7	835.9	835.9	836.3	0.4
F	26,079	335	3,885	1.9	836.4	836.4	836.7	0.4
G	36,626	315	4,106	1.8	839.2	839.2	839.6	0.4
H	43,584	330	4,539	1.6	843.3	843.3	843.6	0.3
I	49,645	270	3,551	2.1	843.6	843.6	843.9	0.4
J	53,688	240	2,948	2.5	844.1	844.1	844.5	0.4

[1] Feet above Confluence with the Red Lake River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

HEARTSVILLE COULEE

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	UPDATED WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
JUDICIAL DITCH 15									
A	2,230	285	136	1,047	1.1	881.7	881.7	881.9	0.2
B	4,750	92	132	324	3.6	882.7	882.7	883.1	0.4
C	8,390	84	112	357	3.2	885.8	885.8	886.1	0.3

[1] Stream distance in feet above confluence with Burnham Creek

[2] New width based on redelineation

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

JUDICIAL DITCH 15

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)
Red Lake River								
A	25,891	2,489	30,350	1.1	834.1	834.1	834.6	0.5
B	33,361	2,112	34,471	1.0	834.2	834.2	834.7	0.5
C	54,751	1,262	27,558	1.3	834.2	834.2	834.7	0.5
D	123,171	1,169	29,569	1.2	834.4	834.4	834.8	0.4
E	188,121	2,135	34,015	1.0	834.5	834.5	834.9	0.4
F	238,721	1,088	24,998	1.4	834.6	834.6	835.0	0.4
G	289,431	1,092	21,796	1.3	834.8	834.8	835.2	0.4
H	382,521	1,595	29,794	0.9	835.2	835.2	835.6	0.4
I	481,391	3,071	53,913	0.5	835.8	835.8	836.2	0.4
J	565,171	1,818	33,554	0.8	835.9	835.9	836.3	0.4
K	250[2]	2,615	19,655	1.6	849.0	849.0	849.5	0.5
L	81,502	2,060	17,980	1.7	853.0	853.0	853.4	0.4
M	124,002	666	8,340	3.7	854.2	854.2	854.7	0.5
N	308,502	3,010	17,460	1.8	857.7	857.7	858.2	0.5
O	351,772	655	8,069	5.1	858.4	858.4	858.8	0.4
P	378,632	224	4,588	6.9	859.0	859.0	859.3	0.3
Q	386,522	399	6,633	5.6	859.5	859.5	859.9	0.4
R	398,402	308	4,826	7.0	859.8	859.8	860.1	0.3
S	419,712	225	4,623	7.5	860.5	860.5	860.8	0.3
T	425,272	237	5,109	3.0	861.0	861.0	861.4	0.4

[1] Stream distance in feet above mouth

[2] Stream distance in feet above limit of detailed study

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

RED LAKE 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)
Red Lake River								
U	43,926	412	5,145	6.2	861.7	861.7	862.0	0.3
V	44,974	330	5,520	6.7	862.4	862.4	862.6	0.2
W	45,450	244	4,712	7.1	862.6	862.6	862.9	0.3
X	45,825	336	5,753	6.4	863.0	863.0	863.3	0.3
Y	46,200	353	5,925	5.8	863.3	863.3	863.5	0.2
Z	48,575	515	7,410	5.4	864.6	864.6	864.8	0.2
AA	49,938	517	8,415	4.9	865.1	865.1	865.3	0.2
AB	51,238	595	9,712	4.3	865.6	865.6	865.7	0.1
AC	54,470	395	6,143	5.5	866.3	866.3	866.5	0.2
AD	55,271	702	10,156	5.1	866.8	866.8	867.3	0.5
AE	58,234	1,795	23,739	2.9	867.5	867.5	868.0	0.5
AF	59,866	1,353	17,157	4.1	867.6	867.6	868.7	0.5
AG	63,966	1,100	17,990	1.7	869.1	869.1	869.6	0.5
AH	64,330	1,100	17,990	1.7	869.1	869.1	869.6	0.5
AI	74,030	5,120	30,000	1.0	870.0	870.0	870.5	0.5
AJ	80,730	3,650	18,390	1.7	870.6	870.6	871.1	0.5
AK	93,080	755	9,010	3.4	874.8	874.8	875.3	0.5

[1] Stream distance in feet above limit of detailed study

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

RED LAKE RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Red River of the North								
A	275.3	N/A[3]	N/A[3]	N/A[3]	814.4	N/A[3]	N/A[3]	N/A[3]
B	276.7	N/A[3]	N/A[3]	N/A[3]	815.2	N/A[3]	N/A[3]	N/A[3]
C	279.4	N/A[3]	N/A[3]	N/A[3]	816.8	N/A[3]	N/A[3]	N/A[3]
D	281.5	N/A[3]	N/A[3]	N/A[3]	818.3	N/A[3]	N/A[3]	N/A[3]
E	282.9	N/A[3]	N/A[3]	N/A[3]	819.7	N/A[3]	N/A[3]	N/A[3]
F	284.3	N/A[3]	N/A[3]	N/A[3]	820.2	N/A[3]	N/A[3]	N/A[3]
G	285.5	N/A[3]	N/A[3]	N/A[3]	821.1	N/A[3]	N/A[3]	N/A[3]
H	286.3	N/A[3]	N/A[3]	N/A[3]	821.6	N/A[3]	N/A[3]	N/A[3]
I	287.6	N/A[3]	N/A[3]	N/A[3]	822.6	N/A[3]	N/A[3]	N/A[3]
J	288.8	N/A[3]	N/A[3]	N/A[3]	823.7	N/A[3]	N/A[3]	N/A[3]
K	290.6	N/A[3]	N/A[3]	N/A[3]	825.1	N/A[3]	N/A[3]	N/A[3]
L	292.1	N/A[3]	N/A[3]	N/A[3]	826.6	N/A[3]	N/A[3]	N/A[3]
M	292.9	N/A[3]	N/A[3]	N/A[3]	827.9	N/A[3]	N/A[3]	N/A[3]
N	294.4	3,674	56,016	2	829.6	829.6	830.3	0.7
O	294.9	4,751	37,819	3	829.8	829.8	830.5	0.7
P	295.7	1,787	31,658	3	830.7	830.7	831.3	0.6
Q	296.0	1,133	28,379	4	831.3	831.3	831.9	0.6
R	296.4	2,087	37,477	3	831.8	831.8	832.4	0.5
S	297.1	2,792	48,572	3	832.5	832.5	833.1	0.5
T	297.4	2,418	41,444	4	832.7	832.7	833.2	0.5

[1] Miles above Mouth

[2] Width of entire floodway into North Dakota

[3] Floodway was not computed for this cross-section

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

RED RIVER OF THE NORTH

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Red River of the North								
U	297.7	982	22,862	4.7	833.3	833.3	833.8	0.5
V	297.9	1,895	41,779	2.6	834.1	834.1	834.6	0.5
W	298.6	2,225	49,840	1.5	834.6	834.6	835.0	0.4
X	298.7	2,352	60,774	1.2	834.6	834.6	835.1	0.4
Y	299.1	2,896	39,043	1.9	834.6	834.6	835.1	0.5
Z	299.4	2,869	36,420	2.0	834.8	834.8	835.3	0.4
AA	299.8	4,059	42,941	1.7	835.1	835.1	835.5	0.4
AB	300.3	3,479	62,753	1.2	835.3	835.3	835.7	0.4
AC	300.7	2,635	41,361	1.8	835.5	835.5	835.9	0.4
AD	301.2	2,689	42,024	1.7	835.7	835.7	836.1	0.4
AE	301.7	2,589	41,133	1.8	835.9	835.9	836.3	0.4
AF	302.2	4,264	49,657	1.5	836.2	836.2	836.6	0.4
AG	302.5	3,904	44,932	1.6	836.3	836.3	836.6	0.3
AH	303.0	3,104	29,270	2.5	836.5	836.5	836.8	0.3
AI	304.0	4,810	79,697	0.9	836.9	836.9	837.3	0.4
AJ	305.0	1,148	23,618	3.1	837.5	837.5	837.9	0.4
AK	306.1	1,428	35,381	2.1	838.3	838.3	838.7	0.4
AL	307.7	1,292	30,829	2.4	838.8	838.8	839.3	0.4
AM	310.0	5,317	33,573	2.2	839.9	839.9	840.3	0.4
AN	312.7	6,436	27,301	2.7	841.6	841.6	841.9	0.3

[1] Miles above Mouth

[2] Width of entire floodway into North Dakota

[3] Floodway was not computed for this cross-section

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

RED RIVER OF THE NORTH

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Red River of the North								
AO	314.5	6,213	37,225	2.0	843.0	843.0	843.3	0.3
AP	318.2	1,494	28,439	2.8	846.7	846.7	846.9	0.1
AQ	320.2	942	27,417	2.9	848.8	848.8	849.1	0.3
AR	321.4	989	30,559	2.6	849.8	849.8	850.2	0.4
AS	324.3	1,122	28,376	2.8	852.1	852.1	852.7	0.7
AT	326.3	906	27,235	3.0	852.9	852.9	853.6	0.7
AU	328.0	1,489	32,358	2.5	853.9	853.9	854.6	0.6
AV	330.1	1,057	31,963	2.5	855.3	855.3	855.9	0.6
AW	331.3	N/A[3]	N/A[3]	N/A[3]	856.0	N/A[3]	N/A[3]	N/A[3]
AX	332.9	N/A[3]	N/A[3]	N/A[3]	856.7	N/A[3]	N/A[3]	N/A[3]
AY	335.5	N/A[3]	N/A[3]	N/A[3]	858.3	N/A[3]	N/A[3]	N/A[3]
AZ	336.9	N/A[3]	N/A[3]	N/A[3]	859.1	N/A[3]	N/A[3]	N/A[3]
BA	338.5	N/A[3]	N/A[3]	N/A[3]	859.9	N/A[3]	N/A[3]	N/A[3]
BB	339.8	N/A[3]	N/A[3]	N/A[3]	860.4	N/A[3]	N/A[3]	N/A[3]
BC	343.6	N/A[3]	N/A[3]	N/A[3]	861.1	N/A[3]	N/A[3]	N/A[3]
BD	335.1	N/A[3]	N/A[3]	N/A[3]	861.4	N/A[3]	N/A[3]	N/A[3]
BE	348.8	N/A[3]	N/A[3]	N/A[3]	862.2	N/A[3]	N/A[3]	N/A[3]
BF	351.6	N/A[3]	N/A[3]	N/A[3]	862.6	N/A[3]	N/A[3]	N/A[3]

[1] Miles above Mouth

[2] Width of entire floodway into North Dakota

[3] Floodway was not computed for this cross-section

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

RED RIVER OF THE NORTH

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)
Sand Hill River								
A	565	322	1,478	2.7	901.2	901.2	901.6	0.4
B	2,058	83	634	6.4	903.6	903.6	903.6	0.0
C	4,918	90	763	5.3	906.3	906.3	906.5	0.2

[1] Stream distance in feet above corporate limits.

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SAND HILL RIVER

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

Zone AE

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

Zone AH

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

Zone X

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

6.0 FLOOD INSURANCE RATE MAP

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

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent annual chance floodplains that were studied by detailed methods, shows selected whole-foot 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 Polk County. Previously, FIRMs were prepared for each incorporated community and the

unincorporated areas of the county identified as floodprone. 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 7, "Community Map History."

7.0 OTHER STUDIES

The hydrologic and hydraulic analyses for the Red River of the North from the northern edge of the City of East Grand Forks to the northern border with Marshall County and from 30 miles upstream from the southern edge of City of East Grand Forks to the southern border with Norman County was performed by the USACE, as reported in “Regional Red River Assessment Report” dated January 2003 (Reference 6). The floodplain boundary was developed by Wenck-Baker as part of this study using the USACE hydraulic data and 1-meter DEM.

The hydrologic and hydraulic analyses for the Red River of the North, Heartsville Coulee, Red Lake River, and Ponding Areas were performed by the USACE, as reported in the Grand Forks, ND & East Grand Forks, MN Flood Insurance Study”, dated January 2007. This study was the basis for LOMR 07-05-2270P.

The hydrologic and hydraulic analyses for the Red Lake River in the City of Crookston revised the Red Lake River from approximately 7,600 feet downstream of Sargent Street to approximately 7,150 feet upstream of the Burlington Northern Santa Fe Railroad. It also revised a north ponding area from approximately 150 feet north of Memorial Driver to east of U.S. Highway 75 and a south ponding area from approximately 200 feet south of Memorial Drive to approximately 400 feet east of U.S. Highway 75. This is described in the “Crookston Flood Insurance Study” (Reference 9). This study was the basis for LOMR 07-05-1774P

The USACE, St. Paul District, published a Flood Plain Information Study for Grand Forks, North Dakota, and East Grand Forks, Minnesota, in November 1971 (Reference 20). This study is superseded by the new USACE study dated January 2007.

The USACE, St. Paul District, published a Flood Plain Information Report (Reference 16) for Crookston, Minnesota. This study is superseded by the new USACE study within the city limits.

This FIS 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 REVISIONS DATE(S)	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE(S)
Beltrami, City of	August 23, 1974	October 17, 1975, September 1, 1978	January 19, 1983	None
Climax, City of	September 20, 1974	June 11, 1976	N/A	None
Crookston, City of	July 27, 1973	June 4, 1976	September 1, 1977	None
East Grand Forks, City of	September 13, 1974	July 23, 1976	September 15, 1977	July 20, 1979
Erskine, City of[1,2]	N/A	N/A	N/A	
Fertile, City of[2]	N/A	N/A	N/A	None
Fisher, City of	August 2, 1974	April 16, 1976	September 1, 1987	None
Fosston, City of[2]	N/A	N/A	N/A	None
Gully, City of[1,2]	N/A	N/A	N/A	
Lengby, City of[1,2]	N/A	N/A	N/A	
McIntosh, City of	November 29, 1974	None	N/A	None
Mentor, City of	December 20, 1974	July 2, 1976	N/A	None

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

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Nielsville, City of	November 1, 1974	None	N/A	None
Polk County (Unincorporated Areas)	December 30, 1977	None	August 15, 1983	None
Trail, City of[1,2]	N/A	N/A	N/A	
Winger, City of	January 31, 1975	None	N/A	None

*No Special Flood Hazards Identified

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK 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.

The primary hydraulic and hydrologic data for the Red River of the North are on file with the USACE, St. Paul District, and the U.S. Geological Survey, Water Resources Division, St. Paul Minnesota.

9.0 BIBLIOGRAPHY AND REFERENCES

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2. Federal Emergency Management Agency, Flood Insurance Study, City of Crookston, Minnesota, Polk County, 1977.

3. Federal Emergency Management Agency, Flood Insurance Study, City of East Grand Forks, Minnesota, Polk County, 1977.

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6. U.S. Department of the Army, Corps of Engineers, Regional Red River Flood Assessment Report – Whapeton, ND/Breckenridge, MN to Emerson, Manitoba, January 2003.

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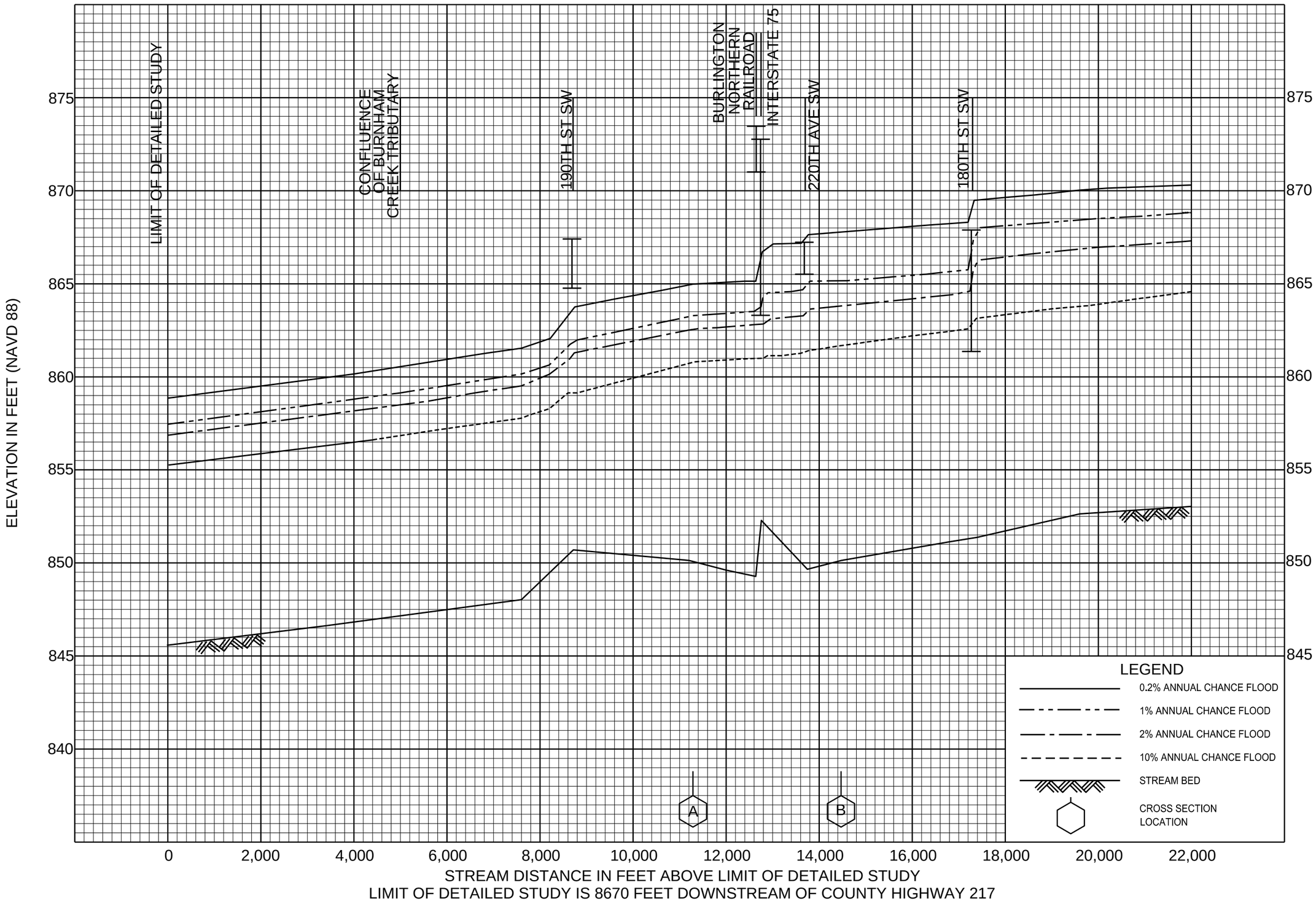


FLOOD PROFILES

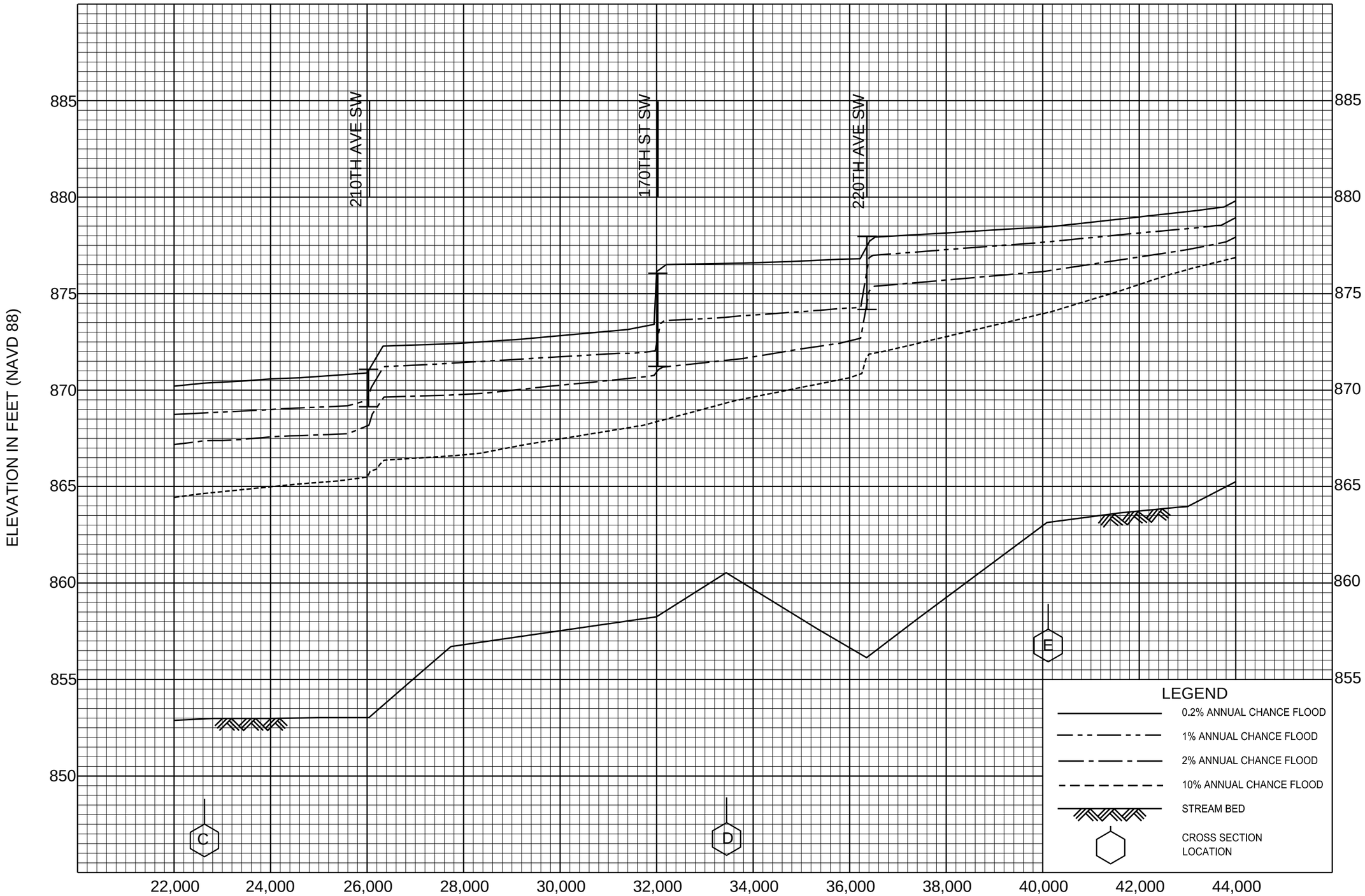
BURNHAM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS

01P



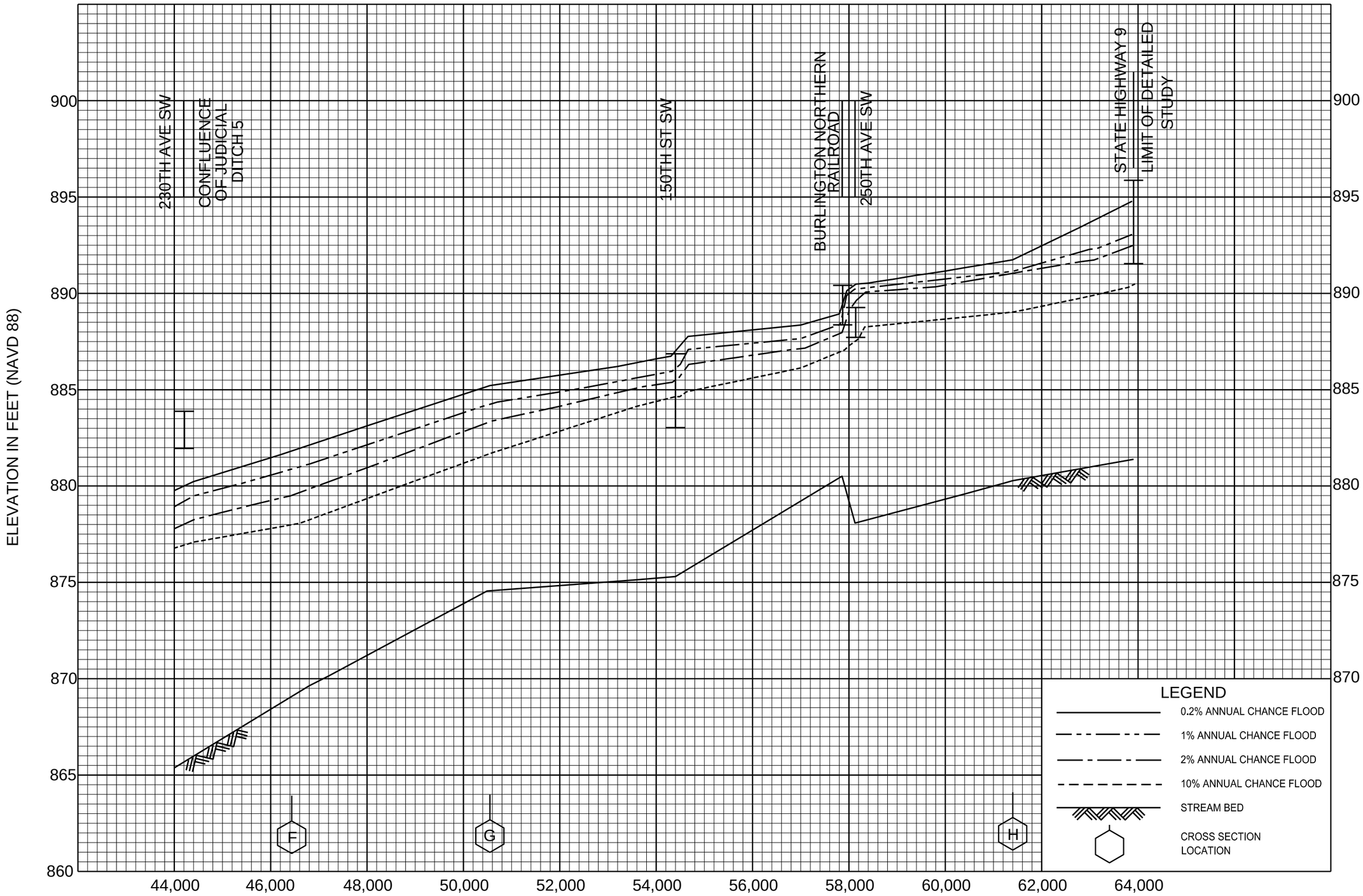
FLOOD PROFILES

BURNHAM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS



LIMIT OF DETAILED STUDY IS 8670 FEET DOWNSTREAM OF COUNTY HIGHWAY 217

FLOOD PROFILES

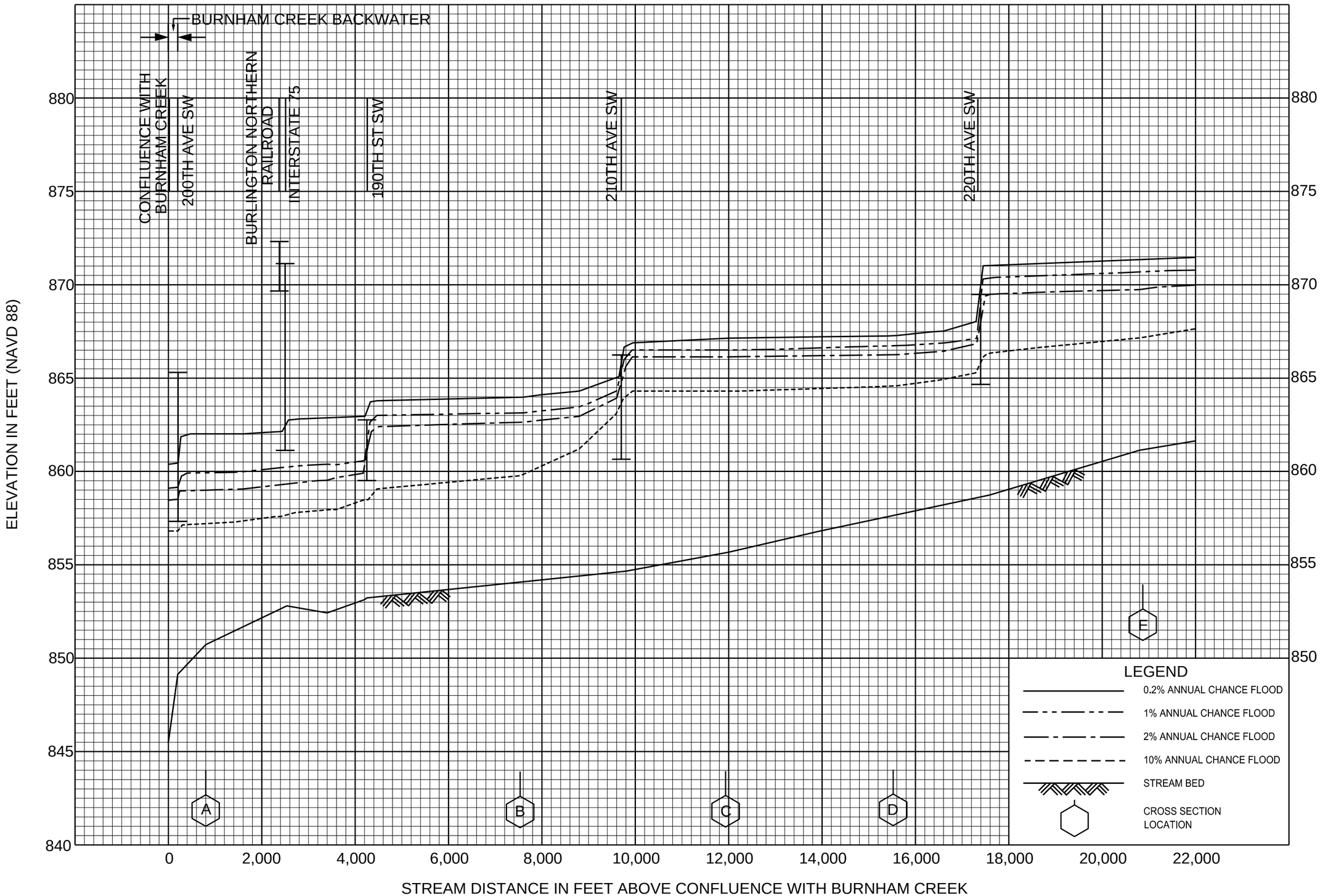
BURNHAM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS

03P



FLOOD PROFILES

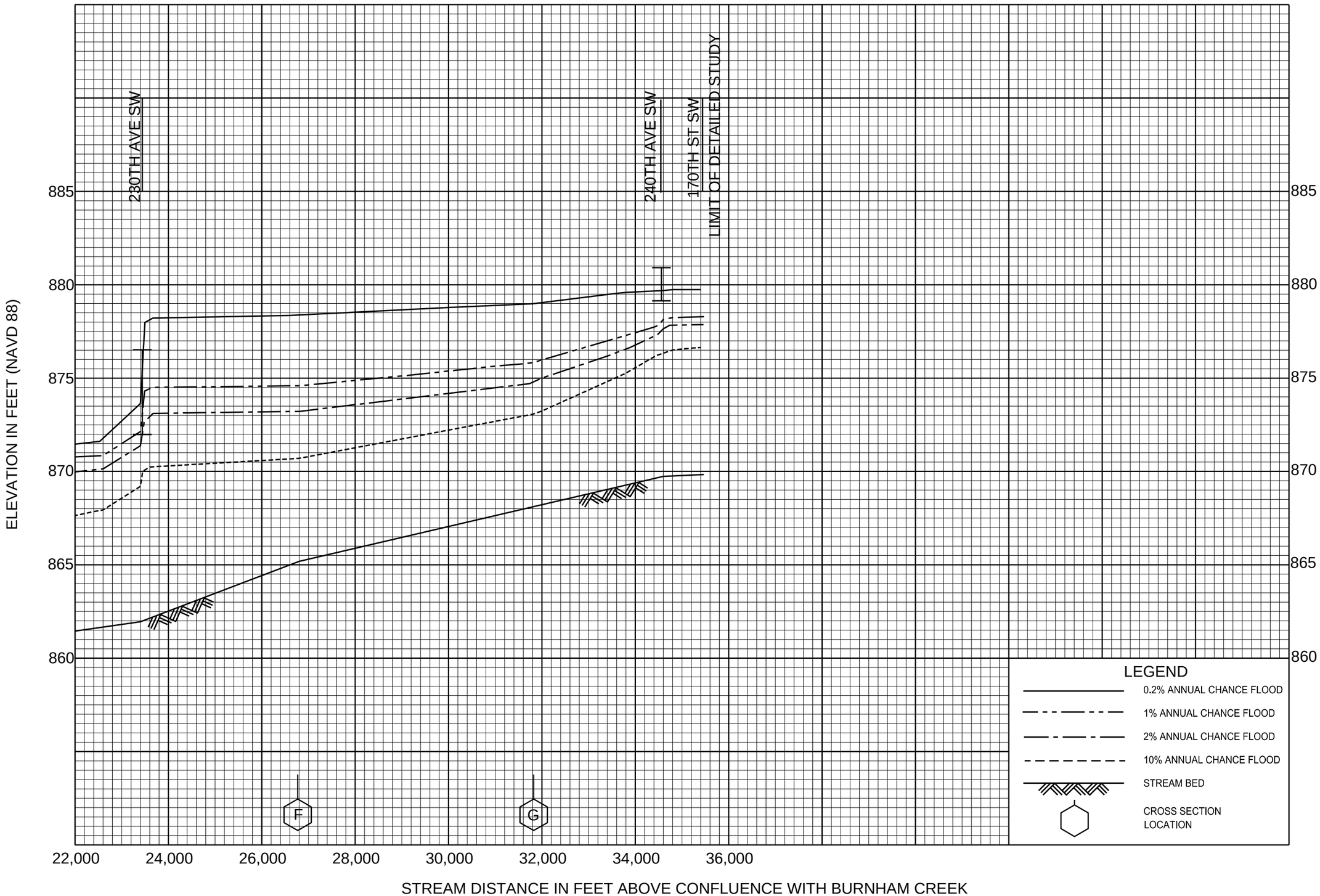
BURNHAM CREEK TRIBUTARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS

04P



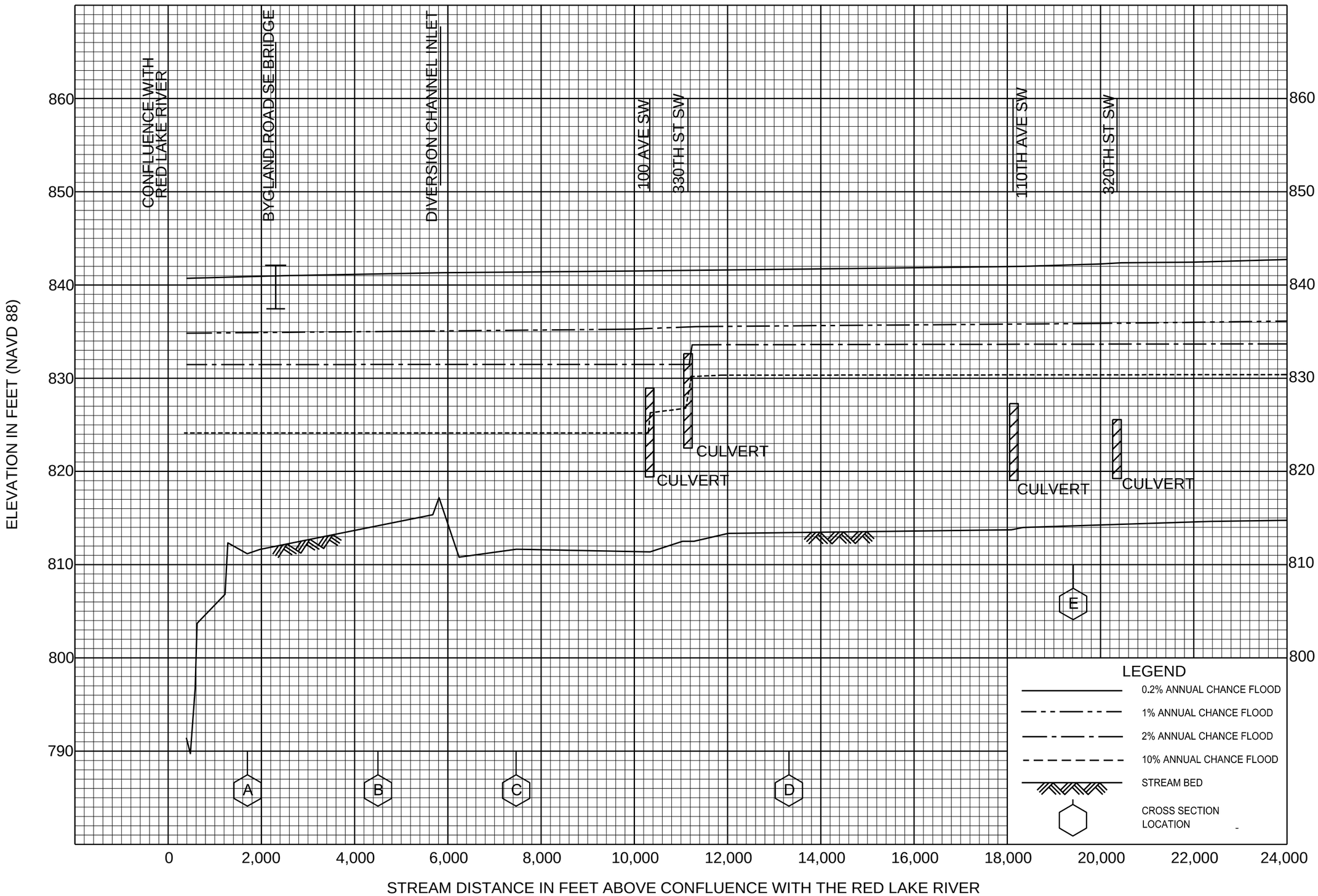
FLOOD PROFILES

BURNHAM CREEK TRIBUTARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS



FLOOD PROFILES

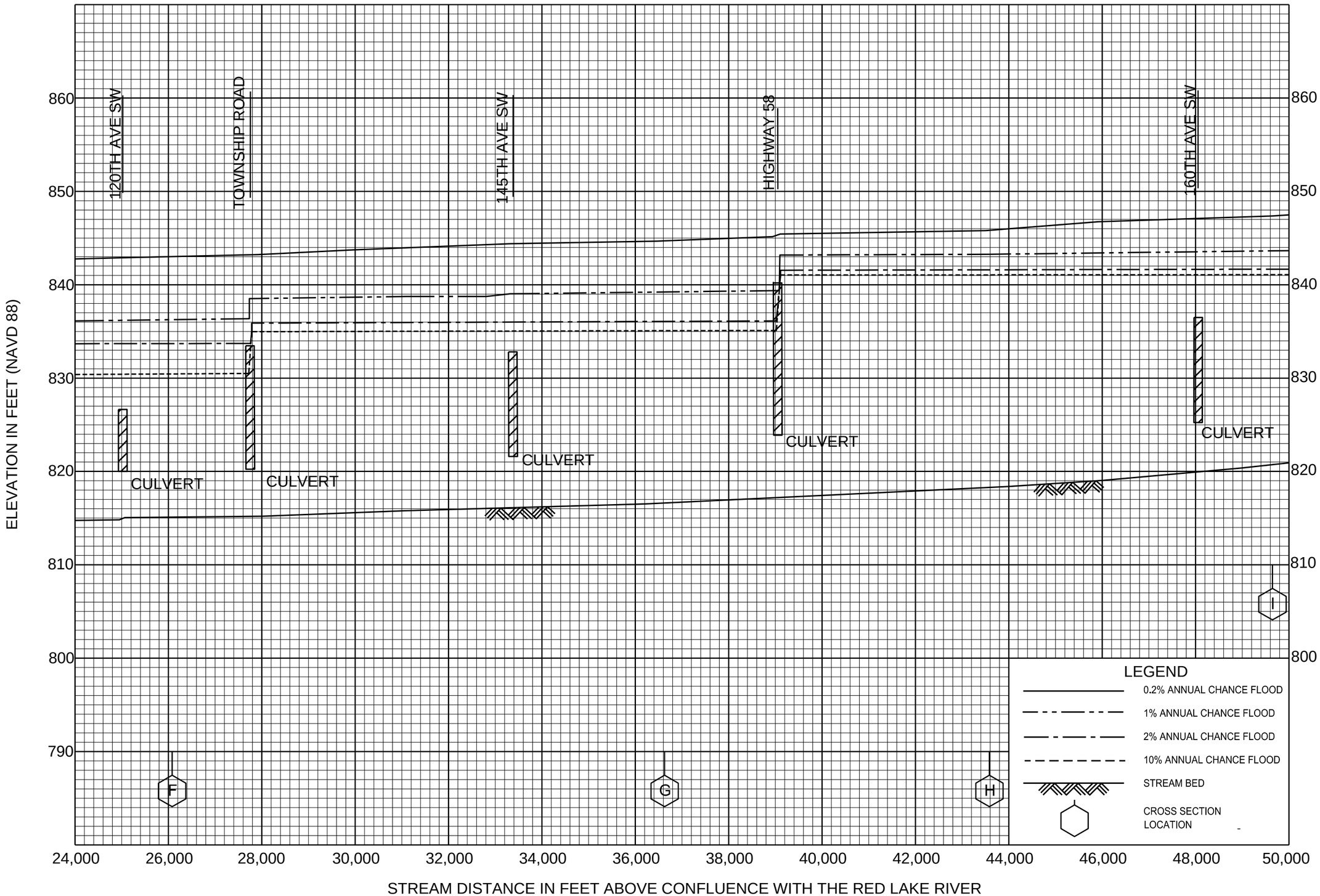
HEARTSVILLE COULEE

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS

06P



FLOOD PROFILES

HEARTSVILLE COULEE

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS

FLOOD PROFILES

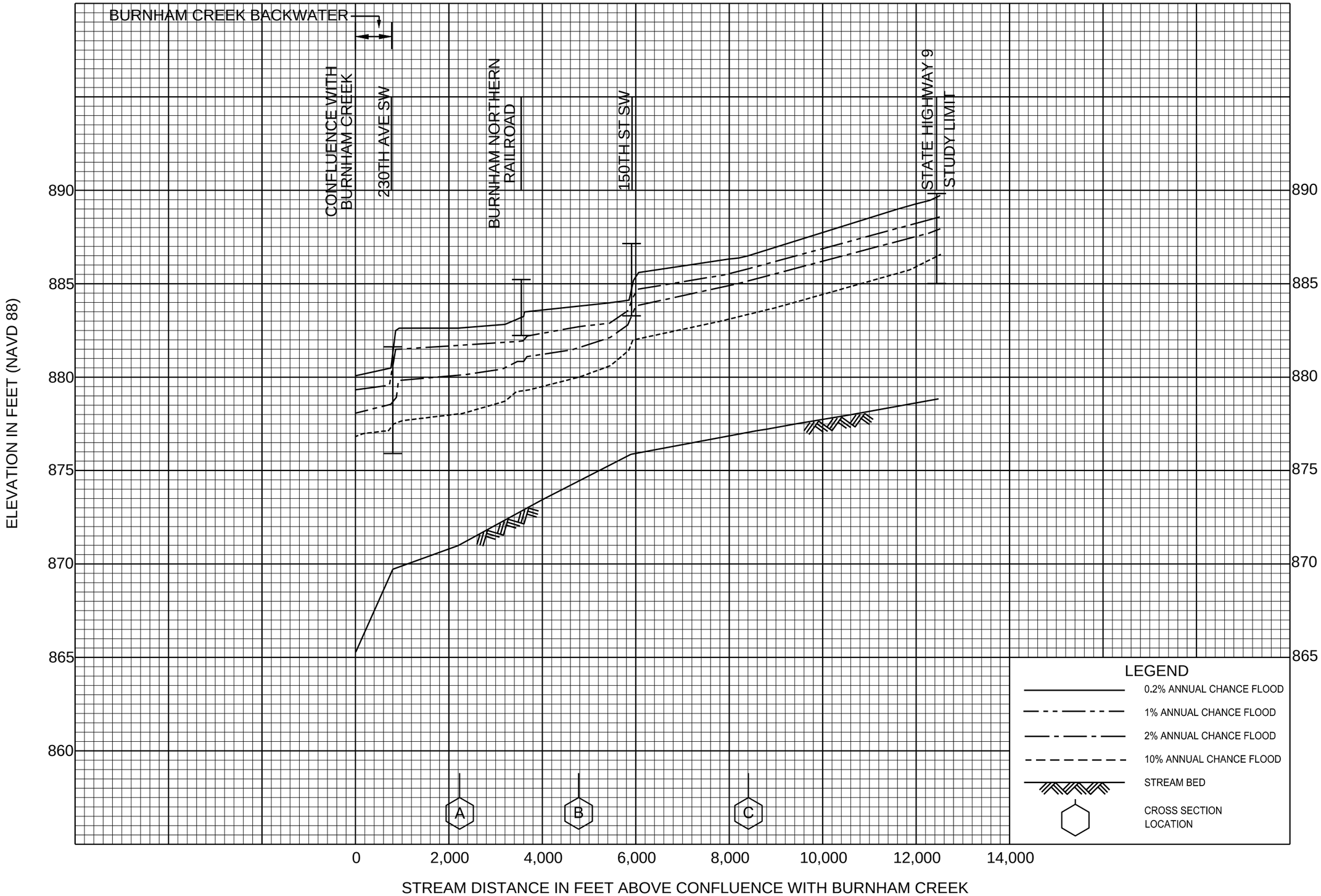
HEARTSVILLE COULEE

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS

08P



FLOOD PROFILES

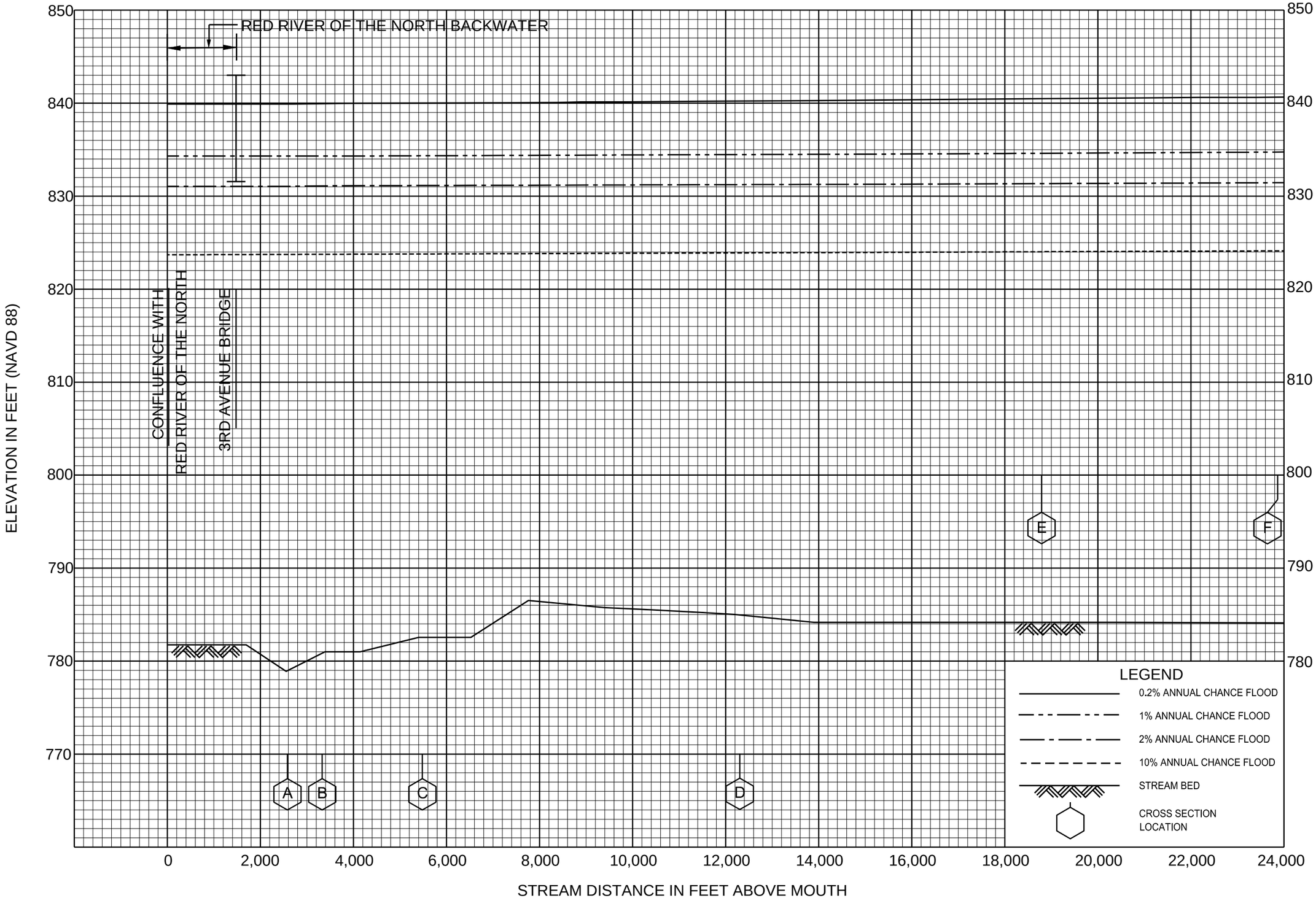
JUDICIAL DITCH 15

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS

09P



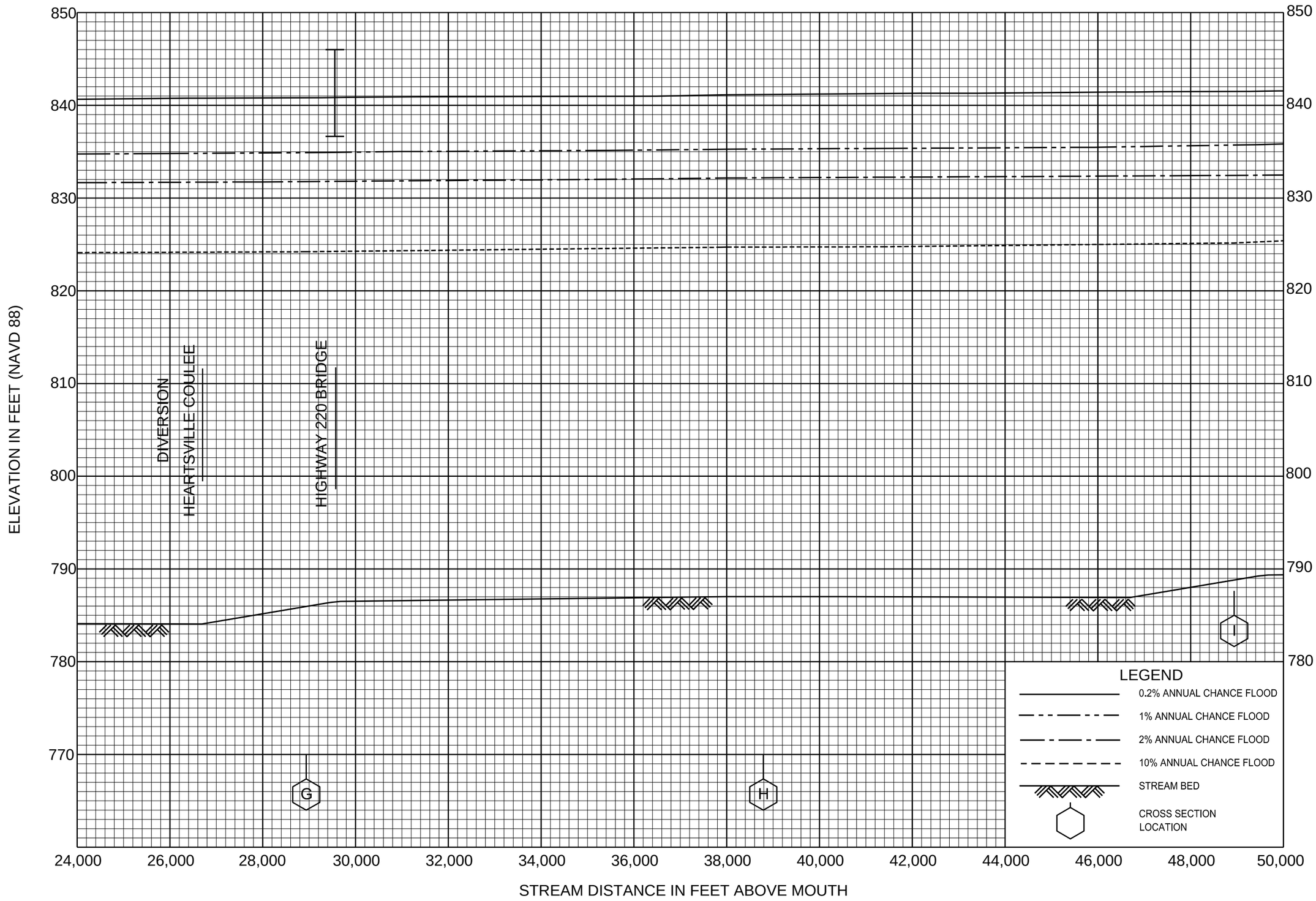
FLOOD PROFILES

RED LAKE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS



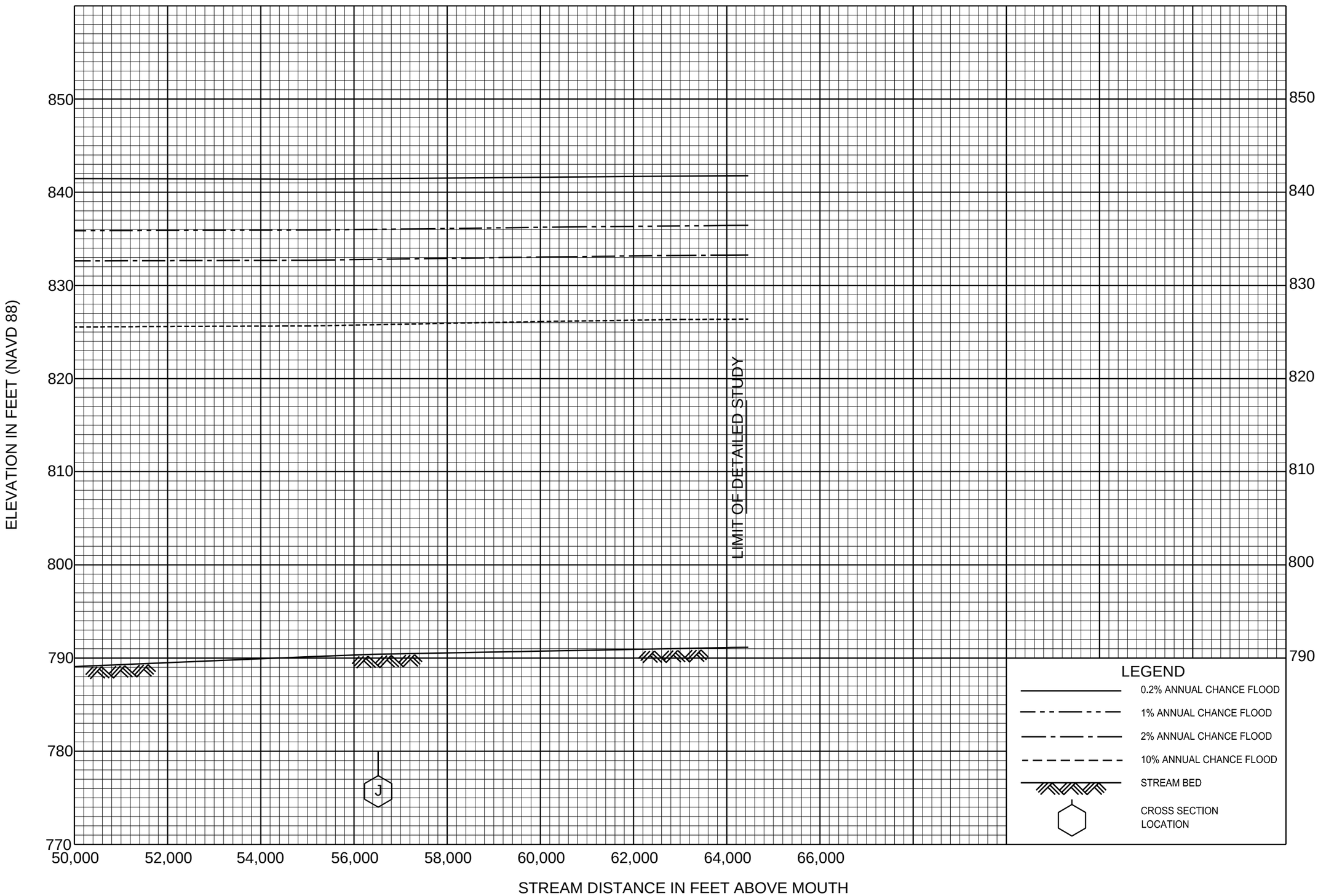
FLOOD PROFILES

RED LAKE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS



FLOOD PROFILES

RED LAKE RIVER

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POLK COUNTY, MN

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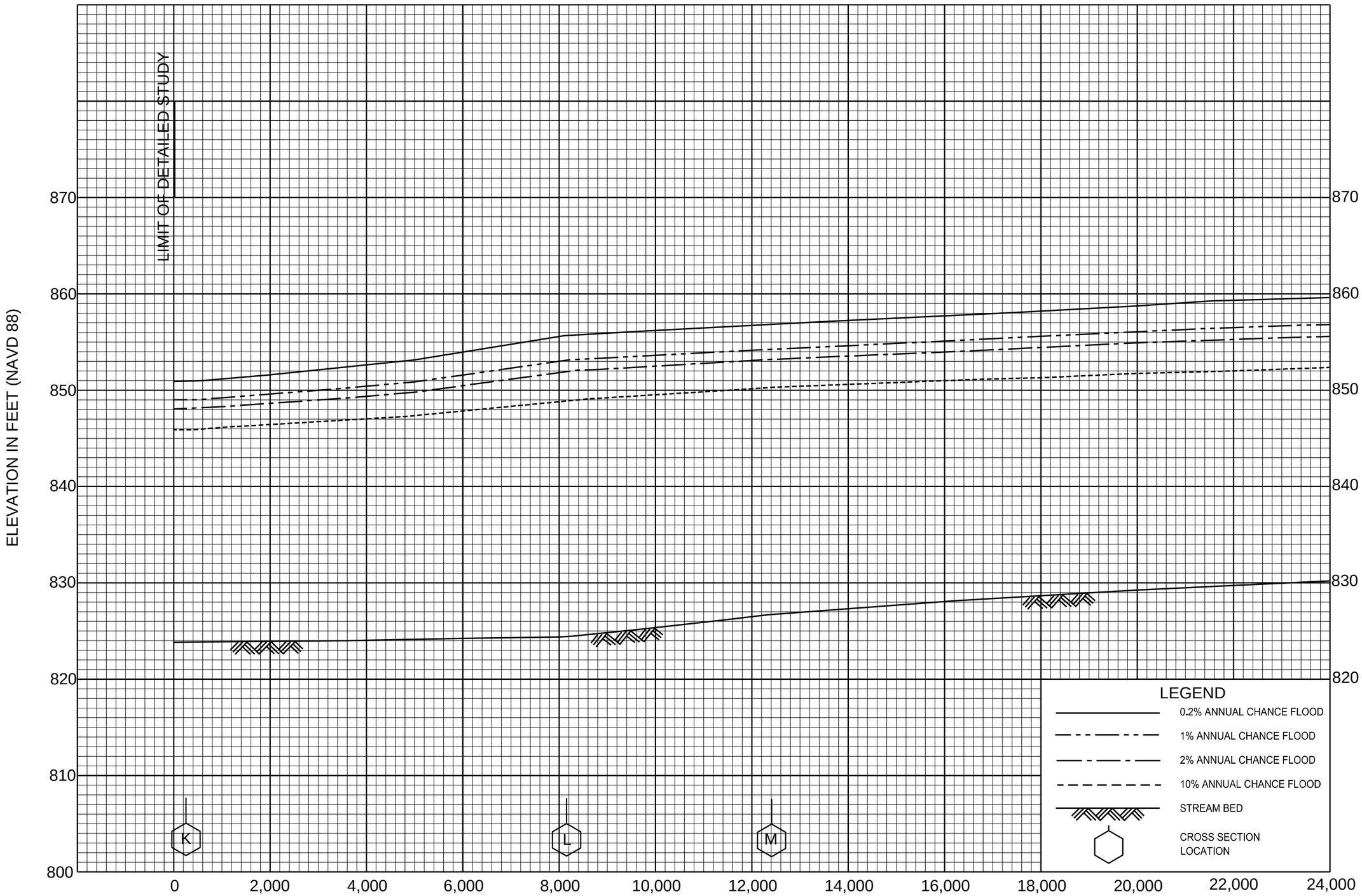


STREAM DISTANCE IN FEET ABOVE LIMIT OF DETAILED STUDY

LIMIT OF DETAILED STUDY IS 46200 FEET DOWNSTREAM OF U.S. HIGHWAY 75

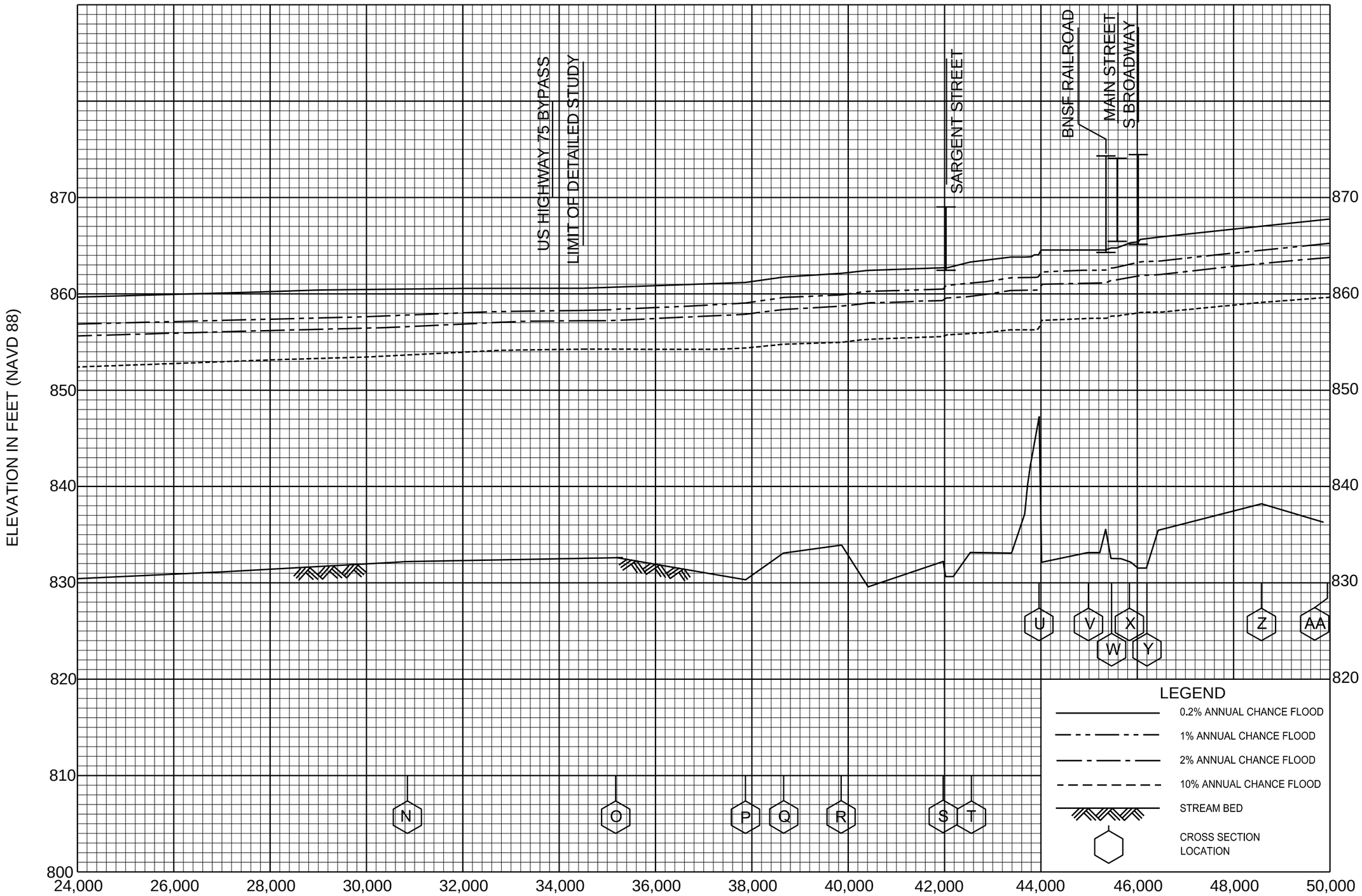
FLOOD PROFILES

RED LAKE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS



FLOOD PROFILES

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POLK COUNTY, MN

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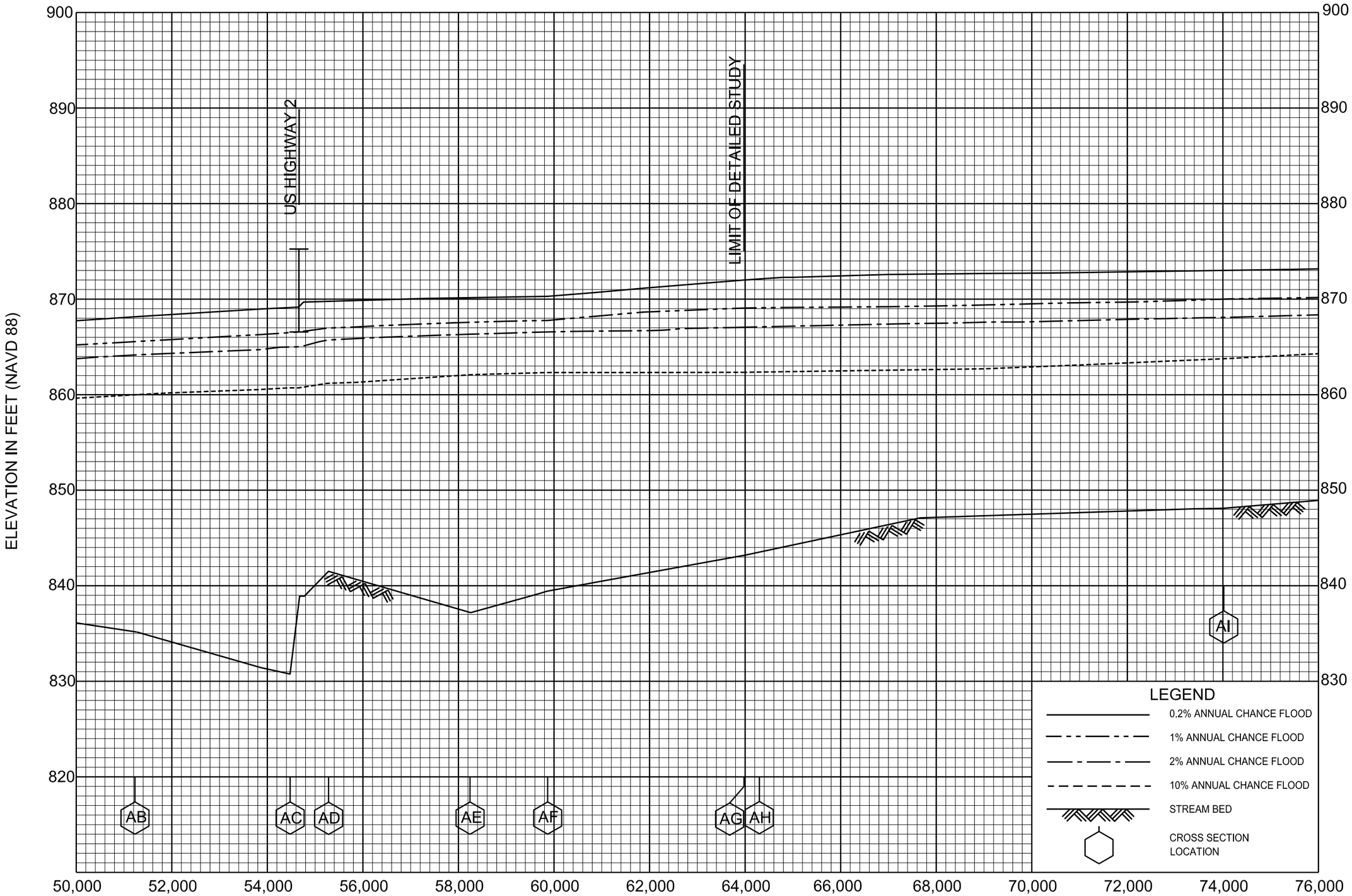

FLOOD PROFILES

RED LAKE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

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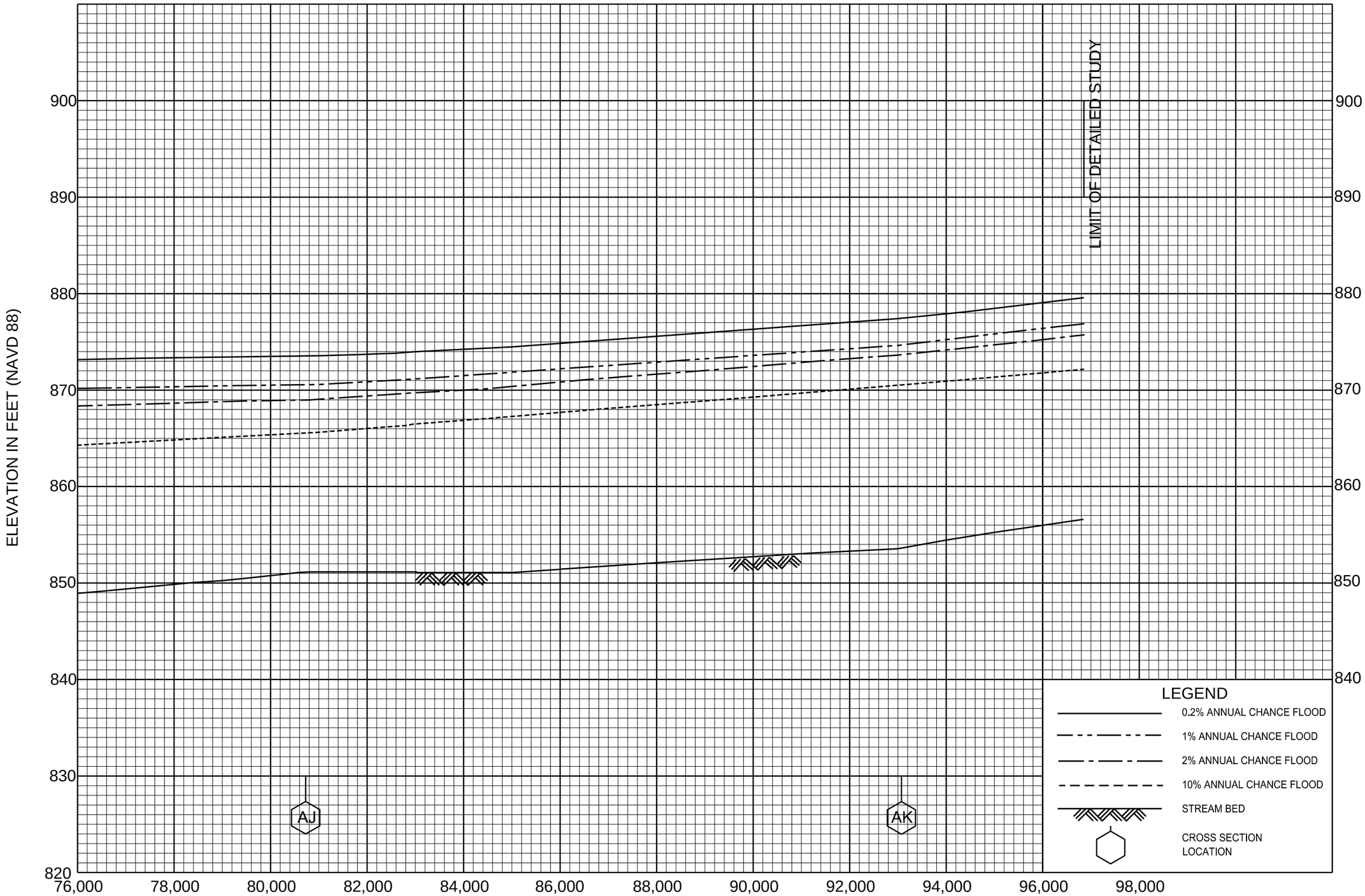

LIMIT OF DETAILED STUDY IS 46200 FEET DOWNSTREAM OF U.S. HIGHWAY 75

FLOOD PROFILES

RED LAKE RIVER

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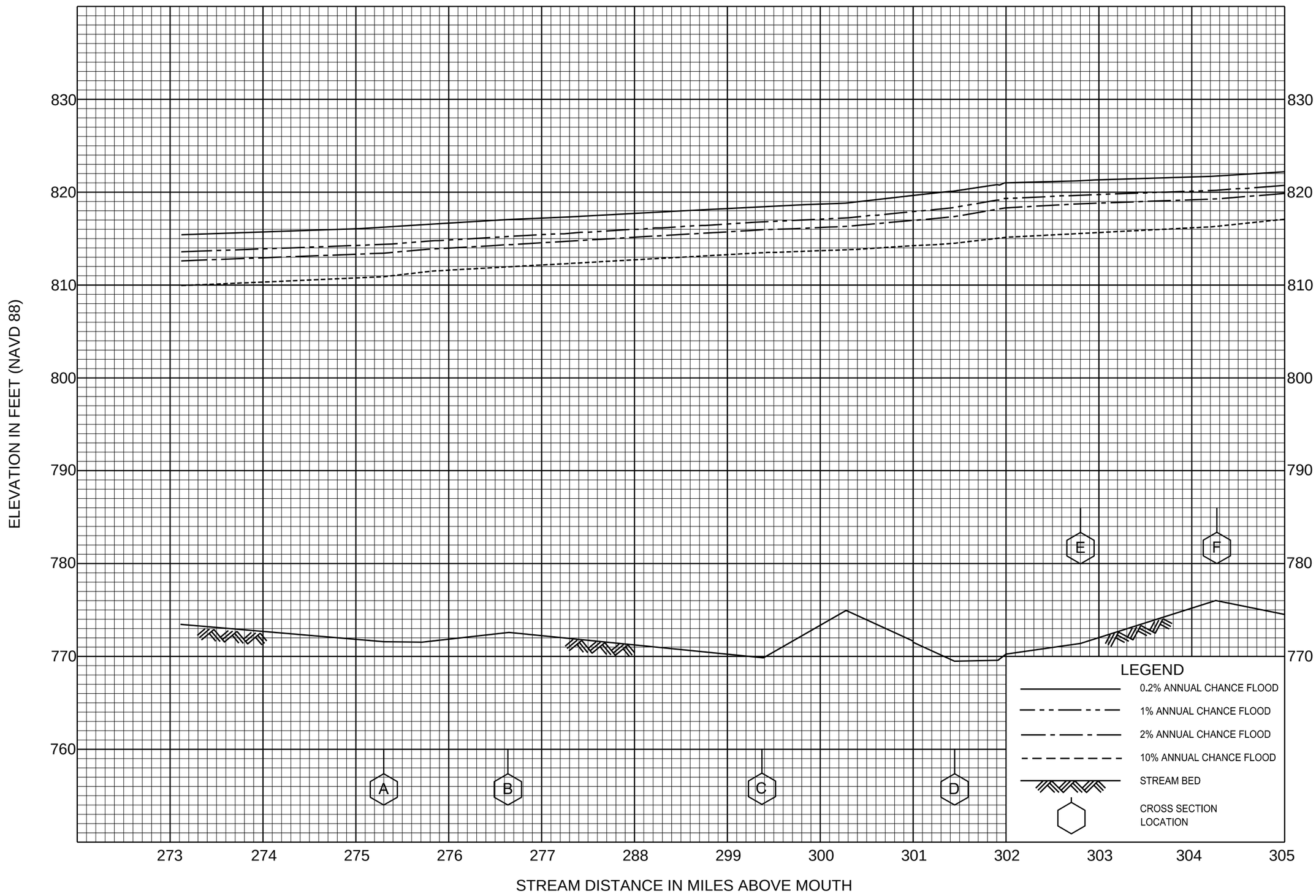
POLK COUNTY, MN

AND INCORPORATED AREAS



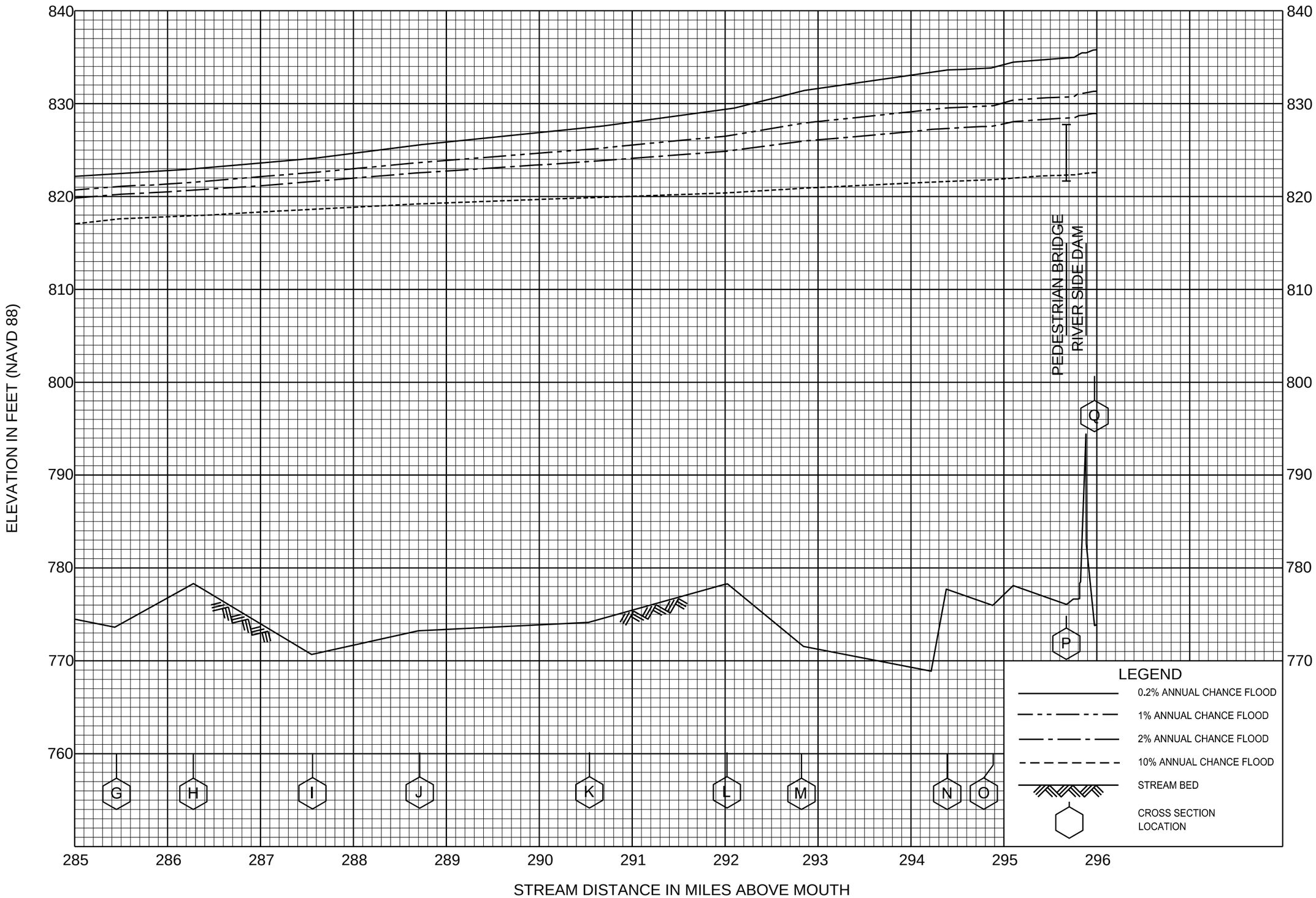
FLOOD PROFILES

RED RIVER OF THE NORTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS



FLOOD PROFILES

RED RIVER OF THE NORTH

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POLK COUNTY, MN

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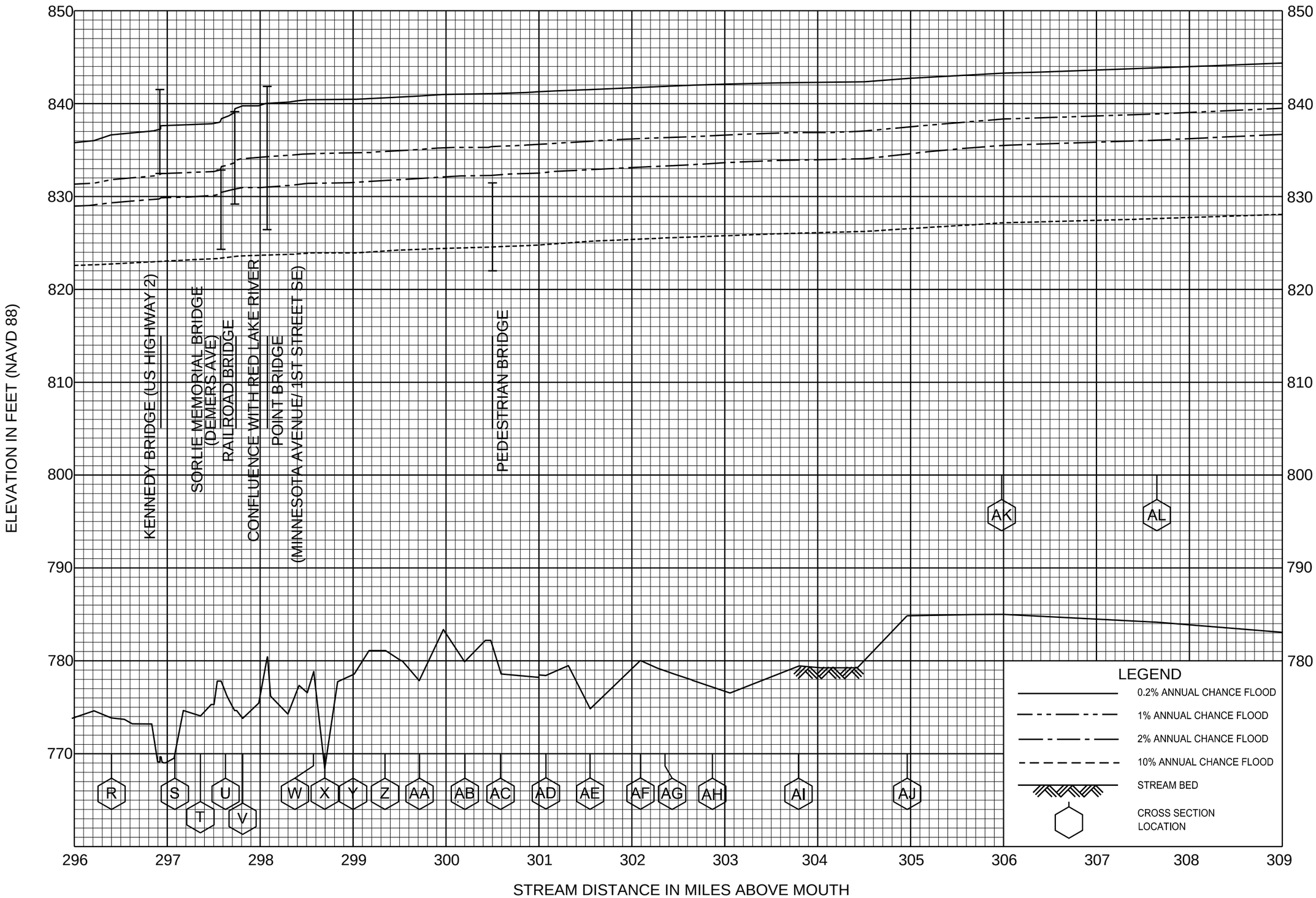

FLOOD PROFILES

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POLK COUNTY, MN

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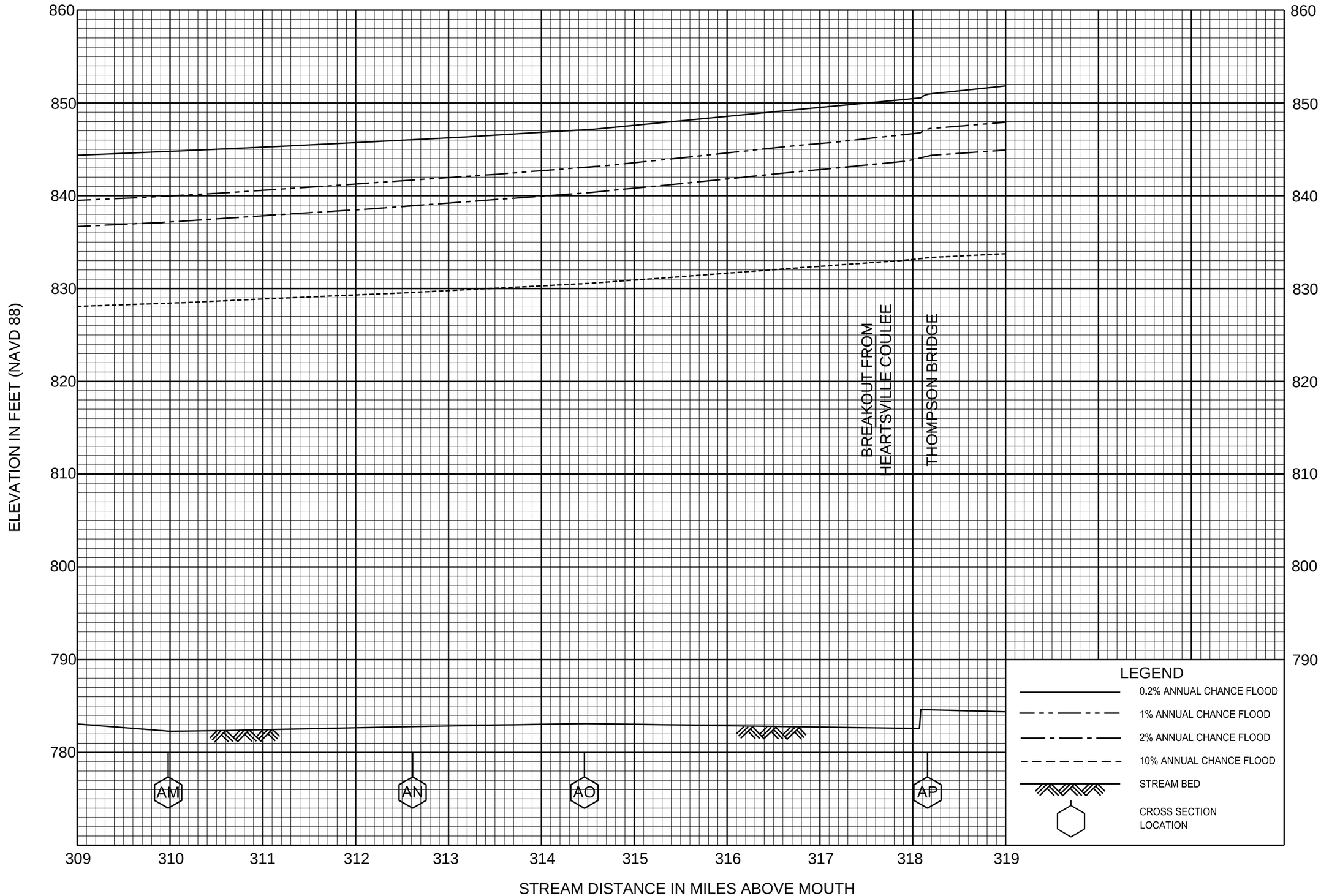

FLOOD PROFILES

RED RIVER OF THE NORTH

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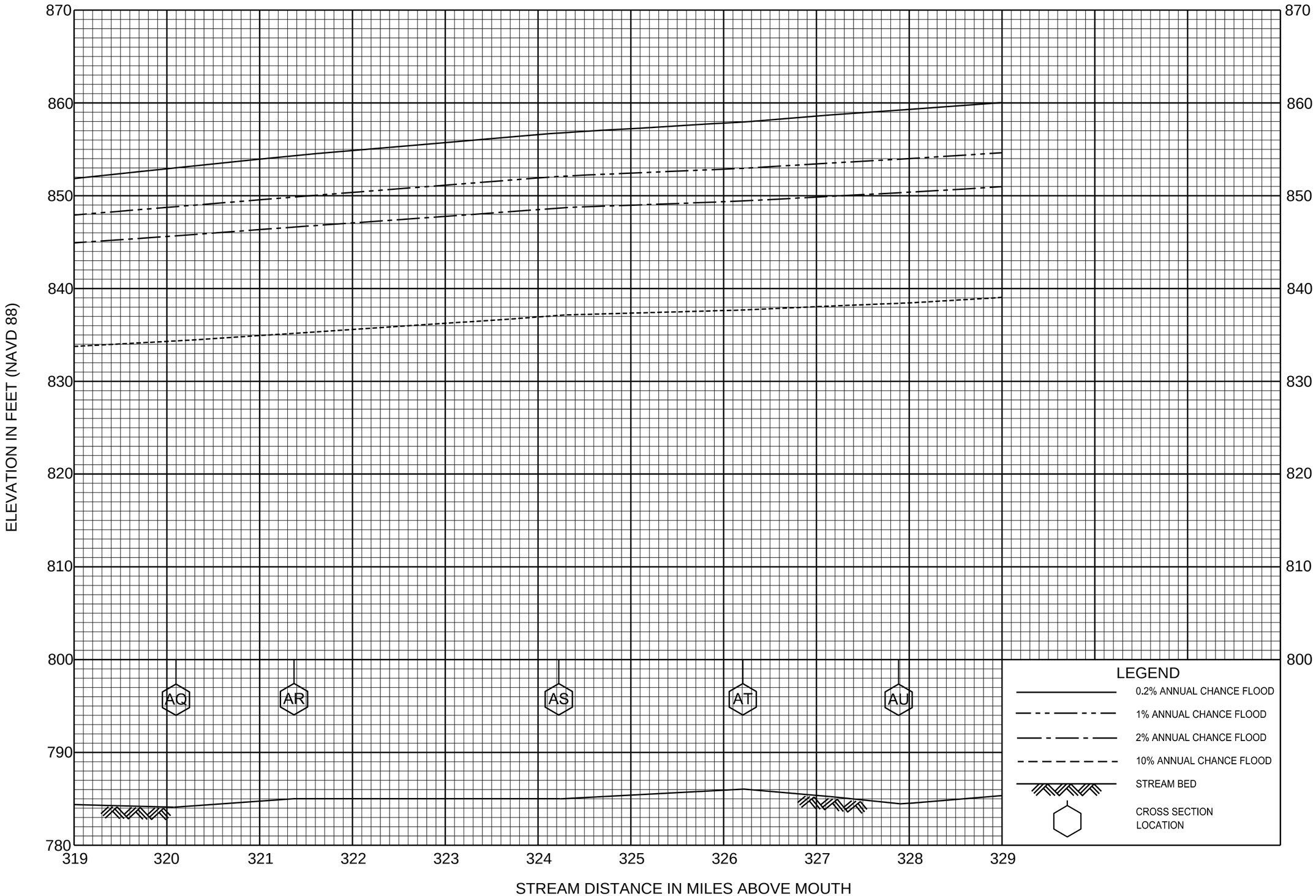

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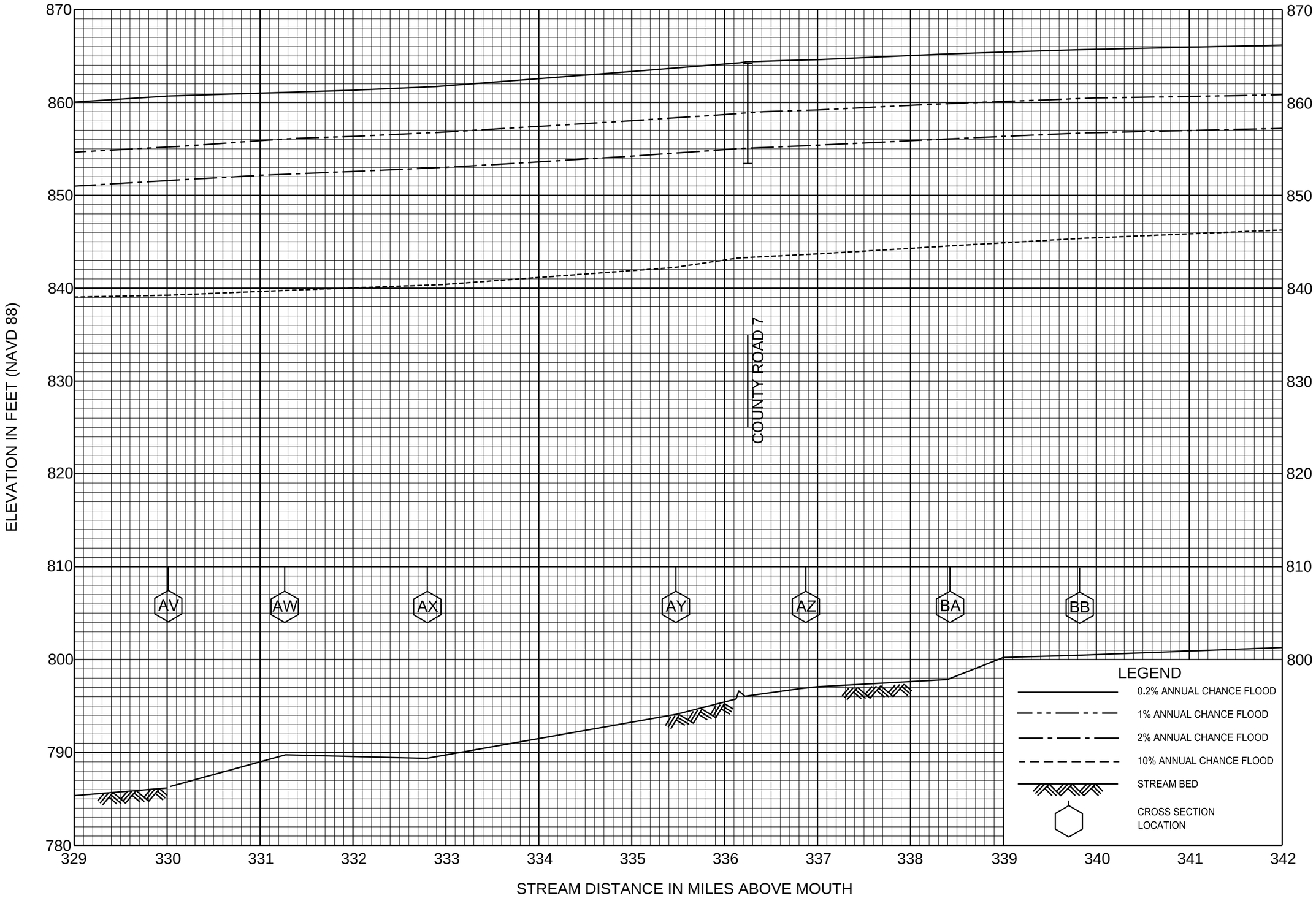

FLOOD PROFILES

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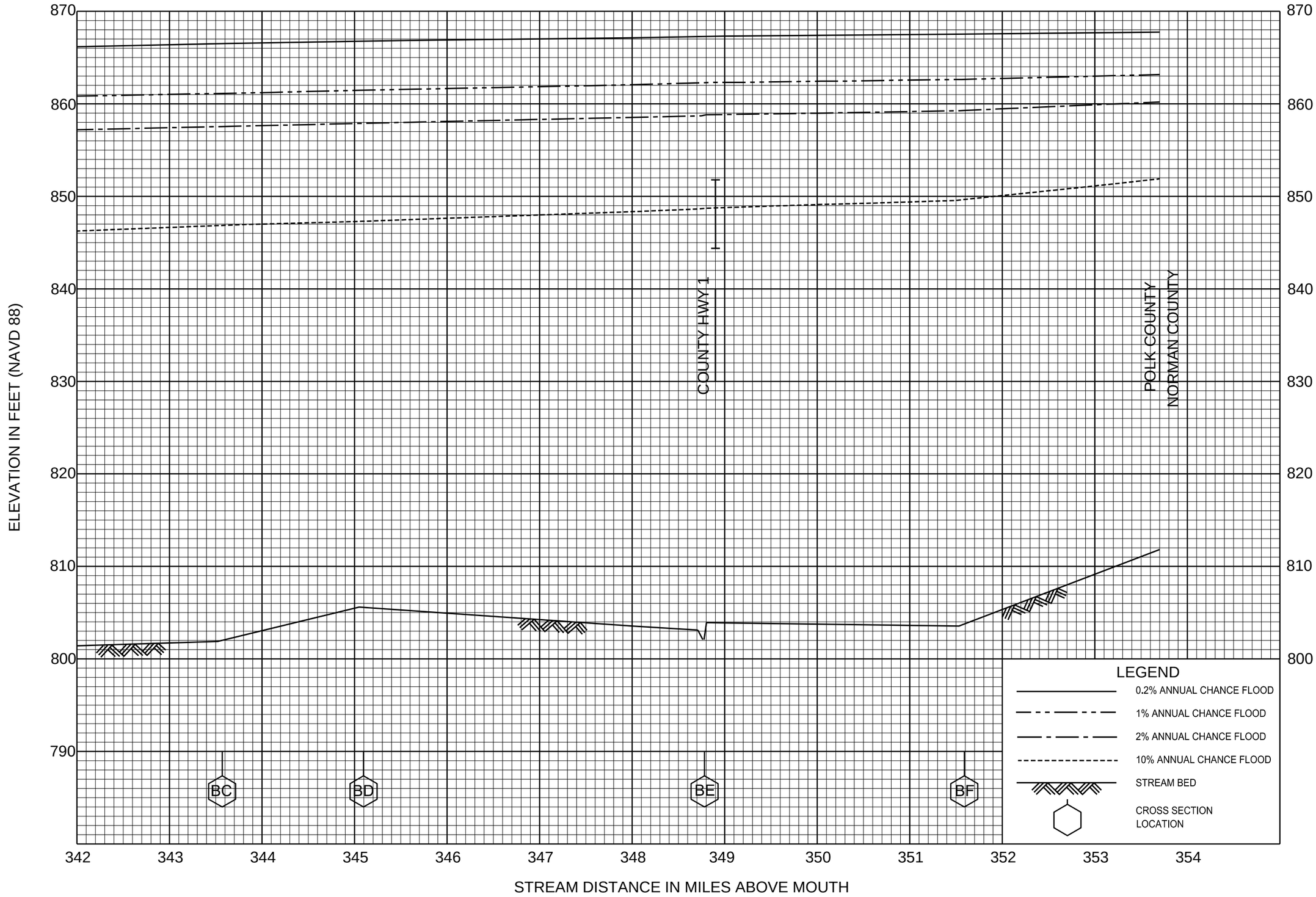

FLOOD PROFILES

RED RIVER OF THE NORTH

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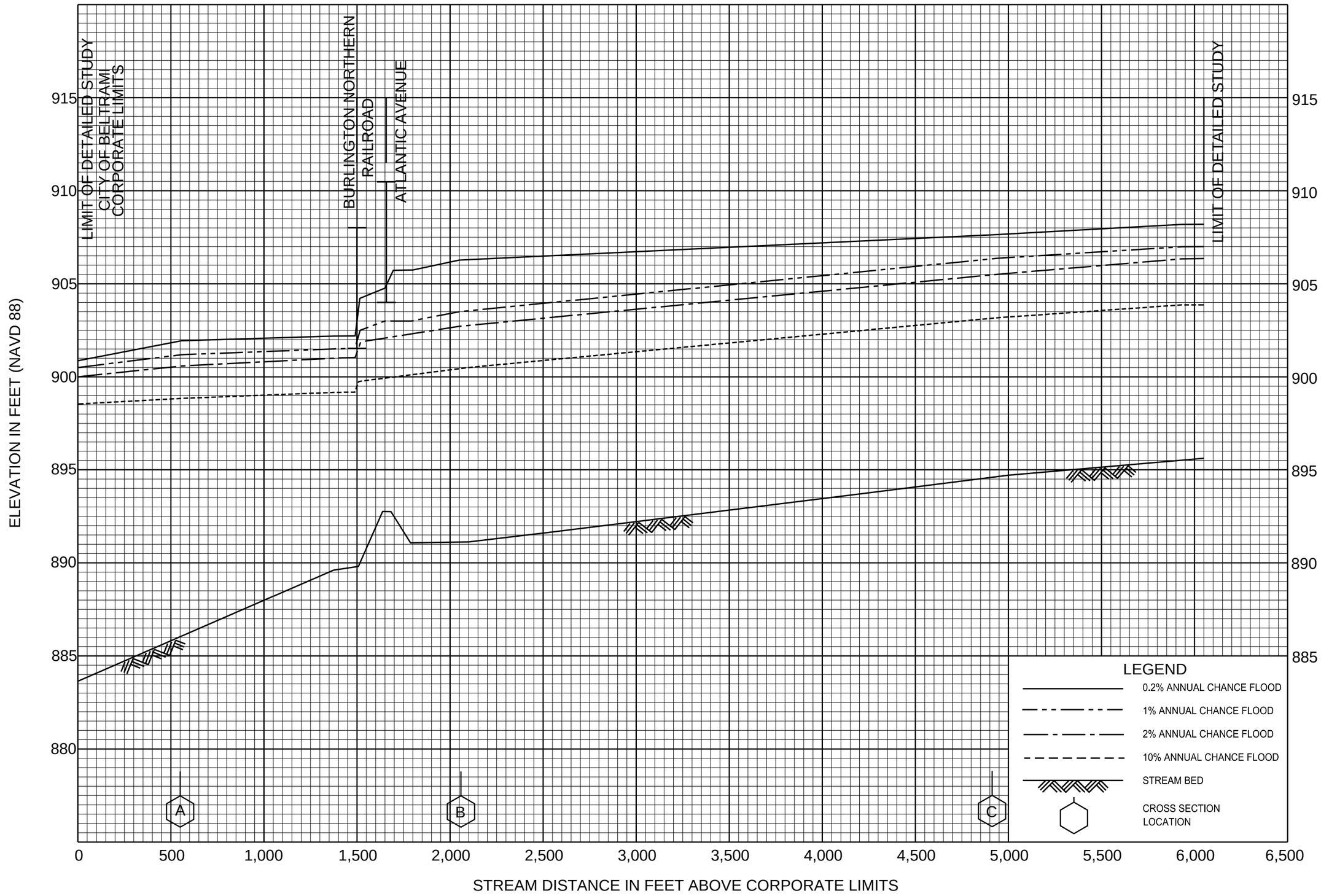

FLOOD PROFILES

SAND HILL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

POLK COUNTY, MN

AND INCORPORATED AREAS