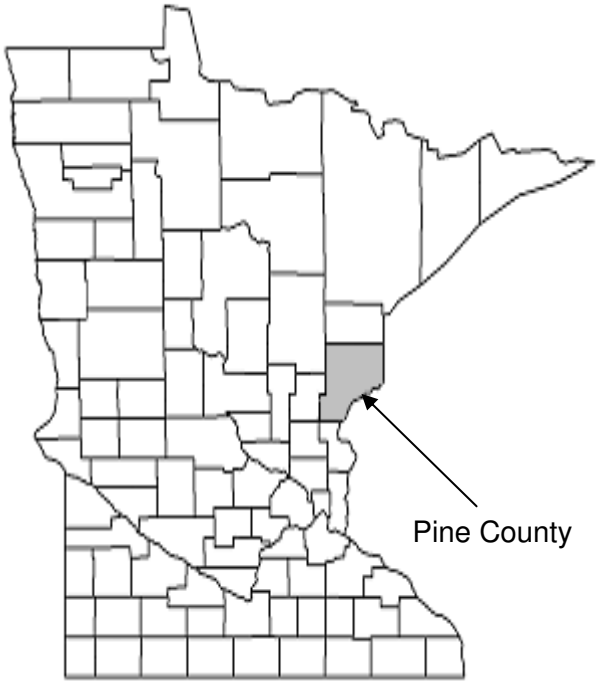
FLOOD INSURANCE STUDY

PINE COUNTY, MINNESOTA
AND INCORPORATED AREAS



Community Name	*Community Number*
ARNA, TOWNSHIP OF	270735
*ASKOV, CITY OF	270345
BROOK PARK, CITY OF	270557
*BRUNO, CITY OF	270899
DENHAM, CITY OF	270346
*FINLAYSON, CITY OF	270900
*HENRIETTE, CITY OF	270901
HINCKLEY, CITY OF	270347
*KERRICK, CITY OF	270902
PINE CITY, CITY OF	270348
PINE COUNTY (UNINCORPORATED AREAS)	270704
PINE LAKE, TOWNSHIP OF	270917
ROCK CREEK, CITY OF	270349
RUTLEDGE, CITY OF	270350
SANDSTONE, CITY OF	270351
STURGEON LAKE, CITY OF	270352
WILLOW RIVER, CITY OF	270353

***NO SPECIAL FLOOD HAZARD AREAS IDENTIFIED**

Effective: April 3, 2012

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
27115CV000A

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: April 3, 2012

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Skunk Creek	Profiles 02P-03P
Snake River	Profiles 04P-06P

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

FLOOD INSURANCE STUDY
PINE 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 Pine County, including the Cities of Askov, Brook Park, Bruno, Denham, Finlayson, Henriette, Hinckley, Kerrick, Pine City, Rock Creek, Rutledge, Sandstone, Sturgeon Lake, and Willow River; the Townships of Arna and Pine Lake; and the unincorporated areas of Pine County (referred to collectively herein as Pine County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

Please note that the Cities of Askov, Bruno, Finlayson, Henriette, and Kerrick have no mapped special flood hazard areas.

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:

Arna, Township of / Pine County (Unincorporated Areas):	The hydrologic and hydraulic analyses for Snake River, from approximately 17,000 feet upstream of the confluence with St. Croix River to Cross Lake and from approximately 520 feet downstream of Interstate Highway 35 to approximately 16,900 feet upstream of Interstate Highway 35, were performed by the St. Paul District Corps of Engineers, for FEMA, under Interagency Agreement No. EMW-88-E-2739, Project Order No. 2. The work was completed in January 1990 (FEMA, 1991).
Pine City, City of:	The hydrologic and hydraulic analyses for Cross Lake and Snake River, from the confluence with Cross Lake to approximately 5,700 feet upstream of Cross Lake, were performed by Toltz, King, Duvail, Anderson, and Associates, Inc., for the Federal Insurance Administration (FIA), under Contract No. H-4706. The work was completed in March 1980 (FIA, 1981).
Sandstone, City of:	The hydrologic and hydraulic analyses for Kettle River and Skunk Creek were performed by Edwards and Kelcy, Inc., for FEMA, under Contract No. EMW-C-0322. The work was completed in June 1981 (FEMA, 1982).

The Cities of Askov, Brook Park, Bruno, Denham, Finlayson, Henriette, Hinckley, Kerrick, Rock Creek, Rutledge, Sturgeon Lake, and Willow River; and the Township of Pine Lake have no previously printed FIS reports.

This Countywide FIS Report

The hydrologic and hydraulic analyses for this study were performed by Atkins, for FEMA, under Contract No. HSFE05-05-D-0023, Task Order 29, with FEMA. The work was completed in February 2010.

Base map information shown on the Flood Insurance Rate Map (FIRM) was provided in digital format by the Farm Services Administration produced at a scale of 1:1,100, from aerial photography dated 2010 or later. The projection used in the preparation of this map is Universal Transverse Mercator (UTM) Zone 15, and the horizontal datum used is the North American Datum of 1983 (NAD83), Geodetic Reference System 1980 (GRS80) Spheroid.

1.3 Coordination

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

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

Community	FIS Date	Initial Meeting	Final Meeting
Arna, Township of / Pine County (Unincorporated Areas)	November 20, 1991	July 27, 1987	September 12, 1990
Pine City, City of	June 1, 1981	April 1978	November 18, 1980
Sandstone, City of	July 6, 1982	June 1979	January 25, 1982

The initial meeting was held on May 30, 2008 and attended by representatives of FEMA, Minnesota Department of Natural Resources (MNDNR), Atkins, and the communities.

The results of the study were reviewed at the final meeting held on March 15, 2011, and was attended by representatives of Atkins, MNDNR, FEMA, and the communities. All concerns and/or raised at that meeting have been addressed.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Pine 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

Cross Lake	Skunk Creek
Kettle River	Snake River

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

All areas studied by detailed methods were redelineated based on updated topography. All areas studied by approximate methods were either newly studied or revised based on updated hydrologic and hydraulic models.

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 UTM coordinates, previously referenced to the North American Datum of 1927, are now referenced to 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.

The following tabulation presents Letters of Map Change (LOMCs) incorporated into this countywide study:

LOMC	Case Number	Date Issued	Project Identifier
LOMR	95-05-313P	110/17/1995	Snake River – Rieff Property

*Letter of Map Revision (LOMR)

2.2 Community Description

Pine County is located in east-central Minnesota, about 50 miles north of the Minneapolis-St. Paul metropolitan area. It is bordered by the following Minnesota Counties: on the north by Carlton County; on the west by Aitkin and Kanabec Counties, and the City of Grasston, Minnesota; on the south by Chisago County. Burnett County, Wisconsin borders Pine County to the southeast; and Douglas County, Wisconsin borders Pine County to the east. Pine County is served by Interstate Highway 35; U.S. Highway 61; and Burlington Northern Santa Fe Railroad and Soo Line Railroad. The population in 2000 for Pine County was 26,530. The land area for Pine County is approximately 1,414 square miles (U. S. Census Bureau, 2009).

In general, Pine County is a relatively flat glacial till plain crossed by several east-west morainal belts. The moraines are mainly undulating areas of hills and depressions. Several ice sheets advanced and retreated over the Snake River watershed during the last glacial period. At the end of the last glacial period, a body of water called Lake Grantsburg, formed by glacial ice, covered the area immediately surrounding Pine City. As it drained, it became shallow enough to permit wave action that would smooth out the bottom sediments and produced the sand plains seen in this region today. The few low ridges remaining may represent islands of glacial till that stood above the lake level (Swartz, G.M., and Thiel, 1963). The soils in the watershed may be typified as glacial till outwash consisting of poorly drained mineral or peat soils (University of Minnesota, 1977). The topography within the floodplain is predominately flat with low rolling hills.

Temperatures in the county range from an average high of 80 degrees Fahrenheit (°F) to an average low of 57°F in the summer, and from an average high of 18°F to an average low of -2°F in the winter. The average annual precipitation is 31.24 inches, with the maximum average precipitation occurring in the month of July (The Weather Channel, 2009).

Land use within the community is primarily agriculture with an emphasis on dairying. There are numerous swamps and forests within the watershed.

2.3 Principal Flood Problems

Large floods have passed through Pine City but the water damage has been limited by relatively steep banks and the lack of development in the floodplain.

Small, local, intense storms have little effect on the Snake River at Pine City due to the large upstream watershed. The flooding problems encountered in Pine City are generally caused by a quick spring thaw or by a slow moving widespread frontal storm passing over the headwaters.

In July 1972, the failure of the Knife Lake Dam caused a flood wave to pass through Pine City on the Snake River. The flood stages accompanying that event were less than the flood stages expected for the 1-percent-annual-chance flood. The estimated discharge for the July 1972 event was 14,000 cubic feet per second (cfs).

The most severe flooding in the low lying areas adjacent to the Kettle River and Skunk Creek is caused by snowmelt combined with spring rains. Several restrictive hydraulic structures on the creek have caused considerable land inundation during periods of higher flows.

Low-lying areas adjacent to major streams are subject to periodic overflow. Development in the floodplain areas consists primarily of agricultural and residential properties.

2.4 Flood Protection Measures

The Cross Lake Dam located along the Snake River is not known to provide protection against the 1-percent-annual-chance flood.

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

Due to the short period of record (13 years) at the U.S. Geological Survey (USGS) gaging station on the Kettle River at Sandstone(USGS gage number 533670), a log-Pearson Type III analysis was not considered appropriate. Discharges for this stream were estimated by averaging the following three methods. First, the results of the regional regression for Minnesota (USGS, 1977). Second, the frequency curve for the Snake River near Pine City was modified to reflect the different hydrologic conditions between the two watersheds; the annual peaks for the two gaging stations were correlated for peak events resulting from simultaneous events over the two watersheds. Third, a ratio of the log-Pearson Type III analysis and the regional regression equations was determined for the

Snake River near Pine City. This ratio was applied to the results of the regression analysis for the Kettle River near Sandstone.

As there are no systematic discharge measurements taken on Skunk Creek, data from four nearby gaging stations (USGS gage numbers 533620, 533660, 533655, 533820, years of record for all four stations, 1960-1980) were used to determine the appropriate discharge-frequency curve.

Three methods of analysis were performed on the available data for Skunk Creek. The first method involved a direction comparison of drainage area-discharge with the reference gaging stations. The second method involved transference of the Wolf Creek Tributary discharge-frequency curve (USGS gage number 533655) to the Skunk Creek Watershed; the drainage areas for the two streams are hydrologically similar. The third method utilized the regional regression equations for Minnesota (USGS, 1977). The discharges used in this study reflect the average of the discharges determined by all three methods.

For the Snake River, from the confluence with Cross Lake to approximately 5,700 feet upstream of Cross Lake, the flow-frequency relationship was determined by the USGS by fitting a log-Pearson Type III frequency distribution to 24 observed annual peaks for the USGS gaging station immediately downstream of Cross Lake, gage No. 0533850 with a period of record from 1951 to 1991. The results of the analysis were published in the USGS publication, "Techniques for Estimating Magnitude and Frequency of Floods in Minnesota" (USGS, 1977).

For the Snake River, from approximately 17,000 feet upstream of the confluence with St. Croix River to Cross Lake and from approximately 520 feet downstream of Interstate Highway 35 to approximately 16,900 feet upstream of Interstate Highway 35, the existing curve for the Snake River, from the confluence with Cross Lake to approximately 5,700 feet upstream of Cross Lake, was adopted.

The discharge-frequency curves at the study limits were developed using the drainage area ratio transfer method with a 0.45 exponent.

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For the approximate analyses streams, peak discharges were estimated using the published USGS regional regression equations for Minnesota (USGS, 1997). Regression equations estimate peak discharges for ungaged streams based on characteristics of nearby gaged streams.

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

Table 2 - Summary of Discharges

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
KETTLE RIVER					
At Kettle River Dam	863	13,100	19,300	22,200	31,900
SKUNK CREEK					
At confluence with Kettle River	7.8	320	580	710	1,080
SNAKE RIVER					
Approximately 1,320 feet downstream of County Highway 9 / Cross Lake Road	958	10,900	17,000	20,000	27,000
Approximately 2,290 downstream of County Highway 61/Main Street North	958	10,900	17,000	20,000	27,000
At Interstate Highway 35	941	10,800	16,900	19,800	26,800
Approximately 2,000 feet upstream of confluence of Mission Creek	916	10,700	16,700	19,600	26,500

Stillwater elevations for Pine 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
CROSS LAKE	937.7	939.2	939.6	940.7

[1] 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 Kettle River and Skunk Creek were obtained by photogrammetric methods (Mark Hurd Aerial Surveys, 1979). Channel sections and structure data for Skunk Creek were obtained by field survey.

Cross section data for the Snake River were obtained from field survey with data on the overbank sections being obtained by photogrammetric methods (Martinez Ortho-Mapping, 1978). All bridges were surveyed to obtain elevation and structural geometry data.

Water Surface Elevations (WSELs) of floods of the selected recurrence intervals for Kettle River, Skunk Creek, and Snake River, from the confluence with Cross Lake to approximately 5,700 feet upstream of Cross Lake, were computed with the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC) HEC-2 computer program (HEC, 1976).

WSELs of floods of the selected recurrence intervals for the Snake River, from approximately 17,000 feet upstream of the confluence with St. Croix River to Cross Lake and from approximately 520 feet downstream of Interstate Highway 35 to approximately 16,900 feet upstream of Interstate Highway 35, were computed using the USACE HEC-2 computer program (HEC 1984).

Starting WSELs for the Kettle River were developed at the Kettle River Dam using a critical depth analysis.

Starting WSELs for Skunk Creek were developed using the slope-area method.

Starting WSELs for the Snake River, from approximately 17,000 feet upstream of the confluence with St. Croix River to Cross Lake, were determined using the slope-area method.

Starting WSELs for the Snake River, from approximately 520 feet downstream of Interstate Highway 35 to approximately 16,900 feet upstream of Interstate Highway 35, were taken from the FIS for the City of Pine City (FIA, 1981).

Starting WSELs for the Snake River, from the confluence with Cross Lake to approximately 5,700 feet upstream of Cross Lake, for the various discharges were determined by correlating gage information provided by the USGS and Cross Lake level readings provided by the MNDNR.

The USGS maintains a gaging station just below the fixed crest dam that controls the WSEL of Cross Lake. Cross Lake WSELs of the floods for the selected recurrence intervals were correlated with peak flows experienced at the USGS gage.

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).

Channel roughness factors (Mannings "n") used in the hydraulic computations were estimated by field inspection. 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"
Kettle River	*	*
Skunk Creek	*	*
Snake River	0.035-0.038	0.035-0.110

*Data Not Available

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For streams studied by approximate methods, cross section data was obtained from the topography. Roads were modeled with available bridge and culvert inventory data or as weirs, using elevations from the topography. The studied streams were modeled using the computer program, HEC-RAS, version 4.0.0 (HEC, 2008).

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 NGVD to NAVD
Holyoke	SE	46.375	-92.375	0.299
Nickerson	SE	46.375	-92.500	0.381
Hanging Horn Lake	SE	46.375	-92.625	0.410
Moose Lake	SE	46.375	-92.750	0.427
Kettle River	SE	46.375	-92.875	0.410
Ronald	SE	46.375	-93.000	0.446
Holyoke SW	SE	46.250	-92.375	0.217
Kerrick	SE	46.250	-92.500	0.285
Bruno	SE	46.250	-92.625	0.381
Willow River	SE	46.250	-92.750	0.440
Denham	SE	46.250	-92.875	0.404
Arthyde	SE	46.250	-93.000	0.410
Ox Creek	SE	46.125	-92.375	0.135
Duxbury	SE	46.125	-92.500	0.197
Askov Lookout Tower	SE	46.125	-92.625	0.256
Sandstone North	SE	46.125	-92.750	0.312
Finlayson	SE	46.125	-92.875	0.341
Giese	SE	46.125	-93.000	0.417
Danbury West	SE	46.000	-92.375	0.092
Wilbur Lake	SE	46.000	-92.500	0.125
Cloverdale	SE	46.000	-92.625	0.164
Sandstone South	SE	46.000	-92.750	0.200
Hinckley	SE	46.000	-92.875	0.246
Kroschel	SE	46.000	-93.000	0.472
Pomroy Lake	SE	46.000	-93.125	0.525
Cedar Lake	SE	45.875	-92.750	0.138
Beroun	SE	45.875	-92.875	0.184
Brook Park	SE	45.875	-93.000	0.292
Quamba	SE	45.875	-93.125	0.430
Pine City	SE	45.750	-92.875	0.161
Henriette	SE	45.750	-93.000	0.217

Table 4 – Vertical Datum Conversion (*Continued*)

Quad Name	Corner	Latitude	Longitude	Conversion from NGVD to NAVD
Grasston	SE	45.750	-93.125	0.315
			Average:	**0.304**

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 2 foot contours derived from the Light Detection and Ranging (LiDAR) data provided by the MNDNR.

For all streams studied by approximate methods, the 1-percent-annual-chance floodplain boundaries were delineated using 2 foot contours derived from LiDAR data provided by the MNDNR.

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.

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.

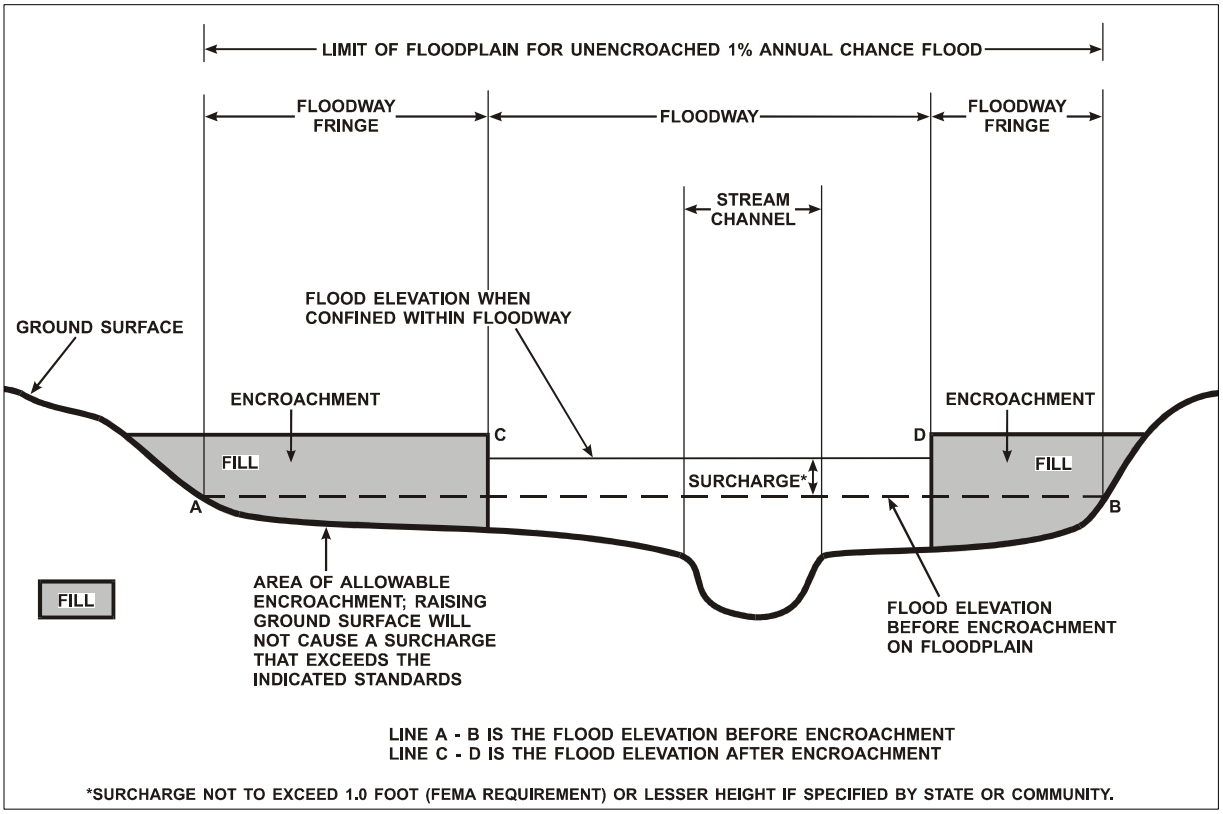

Figure 1 - Floodway Schematic

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)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SKUNK CREEK									
A	5,370	36	260	2.7	91	1,027.3	1,027.3	1,027.3	0.0
B	5,965	72	220	3.2	0	1,032.7	1,032.7	1,032.7	0.0
C	6,475	221	810	0.9	6	1,039.3	1,039.3	1,039.3	0.0
D	6,855	121	360	2.0	0	1,039.5	1,039.5	1,039.5	0.0
E	7,165	125	240	3.0	0	1,040.4	1,040.4	1,040.4	0.0
F	7,435	73	140	5.1	0	1,043.1	1,043.1	1,043.1	0.0
G	8,350	277	1,360	0.5	166	1,055.0	1,055.0	1,055.0	0.0
H	9,360	207	610	1.2	89	1,055.4	1,055.4	1,055.4	0.0

[1] Feet above confluence with Kettle River

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

PINE COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SKUNK CREEK

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)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SNAKE RIVER									
A	17,000	264	2,199	9.1	0	856.6	856.6	856.6	0.0
B	18,905	419	3,188	6.3	20	861.9	861.9	861.9	0.0
C	20,915	200	1,833	10.9	25	866.6	866.6	866.6	0.0
D	22,340	225	1,954	10.2	0	872.4	872.4	872.4	0.0
E	24,155	197	1,931	10.4	7	877.8	877.8	877.8	0.0
F	25,880	297	2,337	8.6	0	883.2	883.2	883.2	0.0
G	27,800	237	2,306	8.7	41	886.9	886.9	886.9	0.0
H	29,740	205	2,279	8.8	0	890.4	890.4	890.4	0.0
I	31,360	217	2,295	8.7	0	894.1	894.1	894.2	0.1
J	33,055	366	3,186	6.3	0	897.0	897.0	897.2	0.2
K	34,925	368	3,273	6.1	23	899.0	899.0	899.1	0.1
L	36,710	448	5,225	3.8	0	900.7	900.7	900.8	0.1
M	38,845	332	4,669	4.3	0	901.5	901.5	901.6	0.1
N	40,880	411	4,486	4.5	0	902.1	902.1	902.3	0.2
O	44,630	1,183	9,718	2.1	0	903.8	903.8	903.9	0.1
P	45,845	510	3,857	5.2	0	903.8	903.8	903.9	0.1
Q	47,980	318	3,222	6.2	0	907.0	907.0	907.0	0.0
R	49,100	708	3,834	5.2	0	908.7	908.7	908.8	0.1
S	50,425	323	2,645	7.6	0	911.3	911.3	911.3	0.0
T	52,090	245	2,371	8.4	0	915.3	915.3	915.3	0.0

[1] Feet above confluence with St. Croix River

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

PINE COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SNAKE 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)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SNAKE RIVER (CONTINUED)									
U	53,650	282	2,945	6.8	0	918.2	918.2	918.4	0.2
V	55,440	572	4,630	4.3	0	920.8	920.8	921.1	0.3
W	57,485	397	3,182	6.3	0	923.5	923.5	923.6	0.1
X	59,090	226	1,908	10.5	4	925.0	925.0	925.1	0.1
Y	60,500	339	2,247	8.9	17	931.3	931.3	931.3	0.0
Z	61,926	279	2,908	6.9	27	937.0	937.0	937.0	0.0
AA	70,366	550	7,517	2.7	0	939.8	939.8	940.3	0.5
AB	71,666	620	8,071	2.5	0	940.1	940.1	940.6	0.5
AC	71,936	500	5,846	3.4	0	941.2	941.2	941.6	0.4
AD	72,756	445	5,443	3.7	0	941.6	941.6	941.9	0.3
AE	75,866	862	13,214	1.5	0	942.1	942.1	942.6	0.5
AF	76,326	1,624	21,634	0.9	0	942.6	942.6	943.0	0.4
AG	77,771	2,723	31,237	0.6	0	943.5	943.5	943.5	0.0
AH	78,661	2,369	16,385	1.2	0	943.5	943.5	943.5	0.0
AI	79,631	1,491	13,568	1.5	0	943.6	943.6	943.6	0.0
AJ	81,511	1,081	11,687	1.7	71	943.7	943.7	943.7	0.0
AK	83,531	951	11,212	1.8	0	943.8	943.8	943.9	0.1
AL	84,651	1,519	15,812	1.3	21	943.9	943.9	944.0	0.1
AM	86,521	843	10,158	2.0	0	944.0	944.0	944.1	0.1

[1] Feet above confluence with St. Croix River

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

PINE COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SNAKE 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)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SNAKE RIVER (CONTINUED)									
AN	88,051	617	7,805	2.6	0	944.0	944.0	944.2	0.2
AO	89,261	1,745	18,347	1.1	550	944.2	944.2	944.4	0.2
AP	91,091	1,914	16,790	1.2	450	944.2	944.2	944.4	0.2
AQ	92,851	850	9,101	2.2	0	944.3	944.3	944.6	0.3

[1] Feet above confluence with St. Croix River

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

PINE COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SNAKE RIVER

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 Pine 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.

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.

9.0 BIBLIOGRAPHY AND REFERENCES

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COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Arna, Township of	December 23, 1977	None	November 20, 1991	None
*Askov, City of	N/A	None	N/A	None
Brook Park, City of	October 25, 1974	None	April 3, 2012	None
*Bruno, City of	N/A	None	N/A	None
Denham, City of	January 24, 1975	None	April 3, 2012	None
*Finlayson, City of	N/A	None	N/A	None
*Henriette, City of	N/A	None	N/A	None
Hinckley, City of	March 29, 1974	June 4, 1976	September 4, 1987	None
*Kerrick, City of	N/A	None	N/A	None
Pine City, City of	December 28, 1973	June 18, 1976	December 1, 1981	None
Pine County (Unincorporated Areas)	December 23, 1977	None	November 20, 1991	None
Pine Lake, Township of	April 3, 2012	None	April 3, 2012	None
Rock Creek, City of	April 3, 2012	None	April 3, 2012	None

*No special flood hazard areas identified

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

PINE COUNTY, MN
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Rutledge, City of	August 9, 1974	August 20, 1976	April 3, 2012	None
Sandstone, City of	May 10, 1974	June 4, 1976	January 6, 1983	None
Sturgeon Lake, City of	October 25, 1974	None	April 3, 2012	None
Willow River, City of	June 28, 1974	July 11, 1976	July 1, 1987	None

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

PINE COUNTY, MN
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

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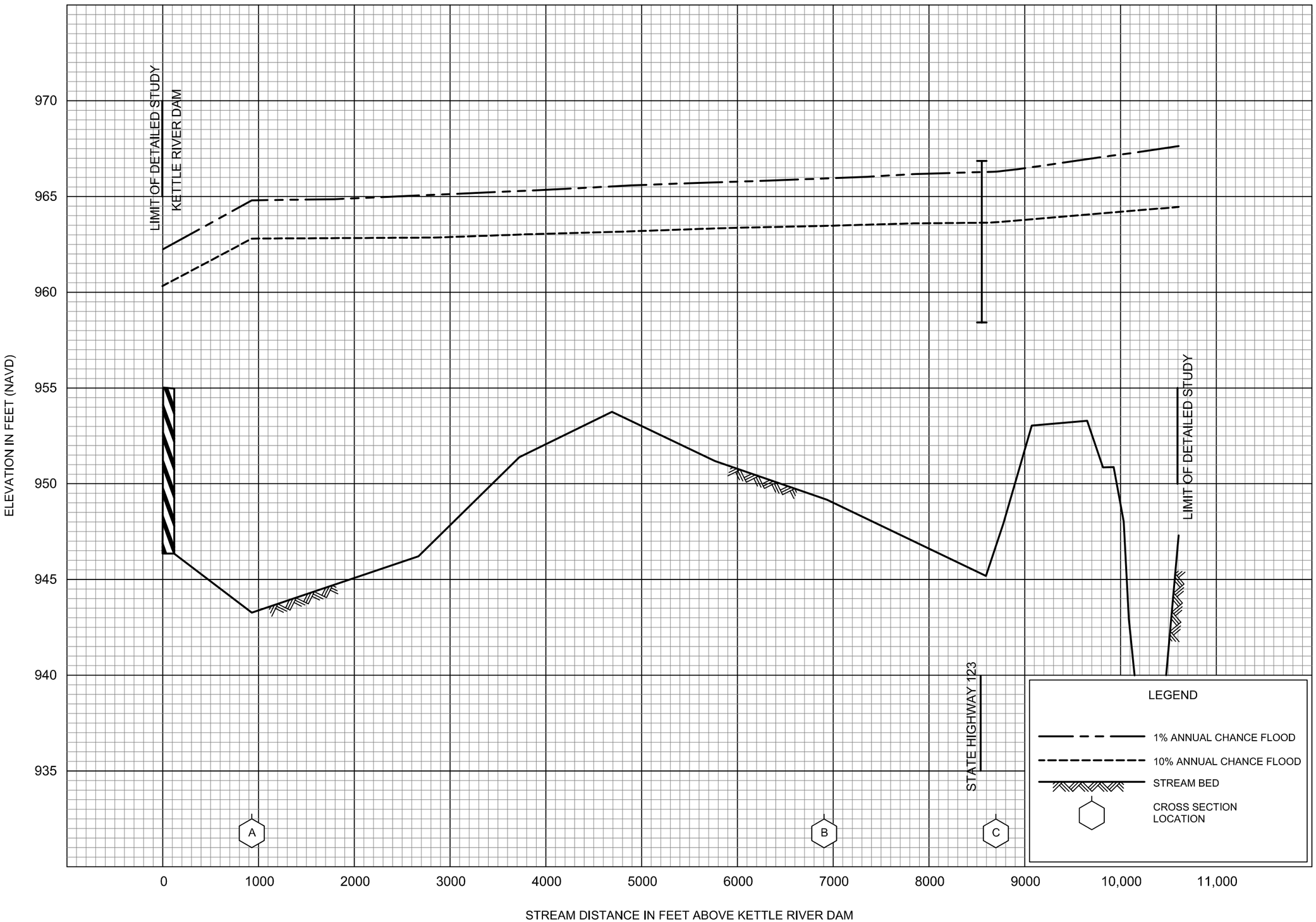


FLOOD PROFILES

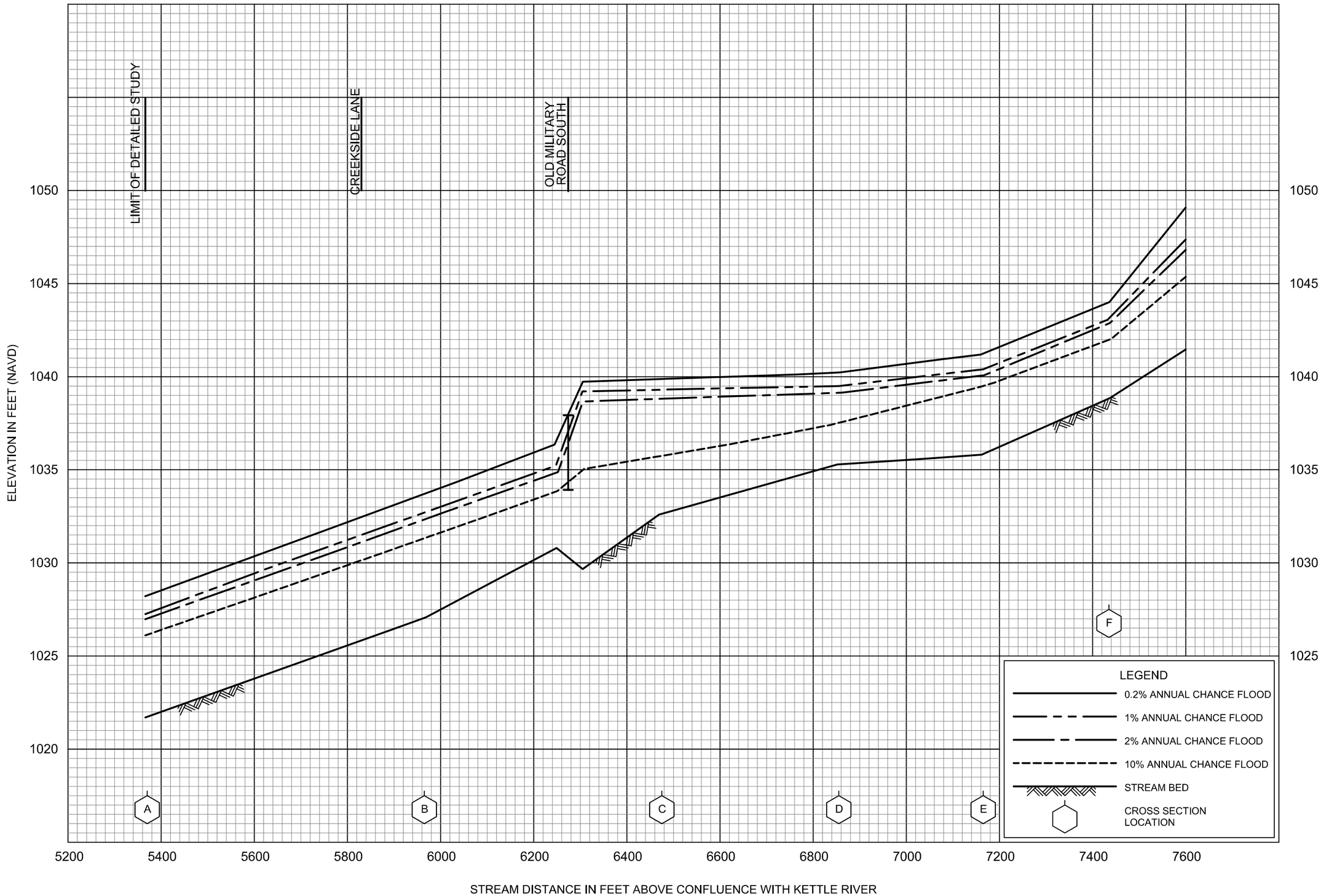
KETTLE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

PINE COUNTY, MN

AND INCORPORATED AREAS

01P



FLOOD PROFILES

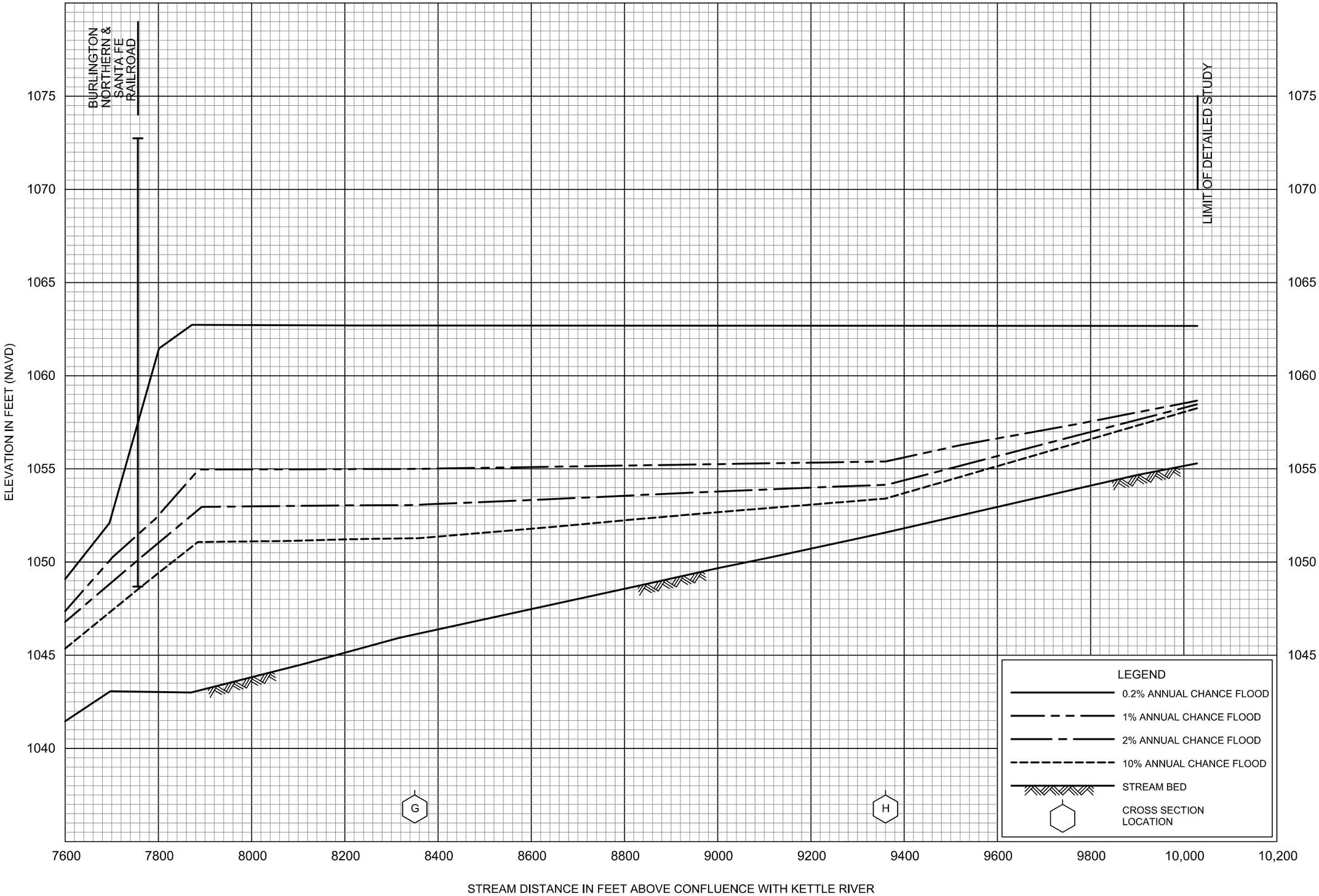
SKUNK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

PINE COUNTY, MN

AND INCORPORATED AREAS

02P



FLOOD PROFILES

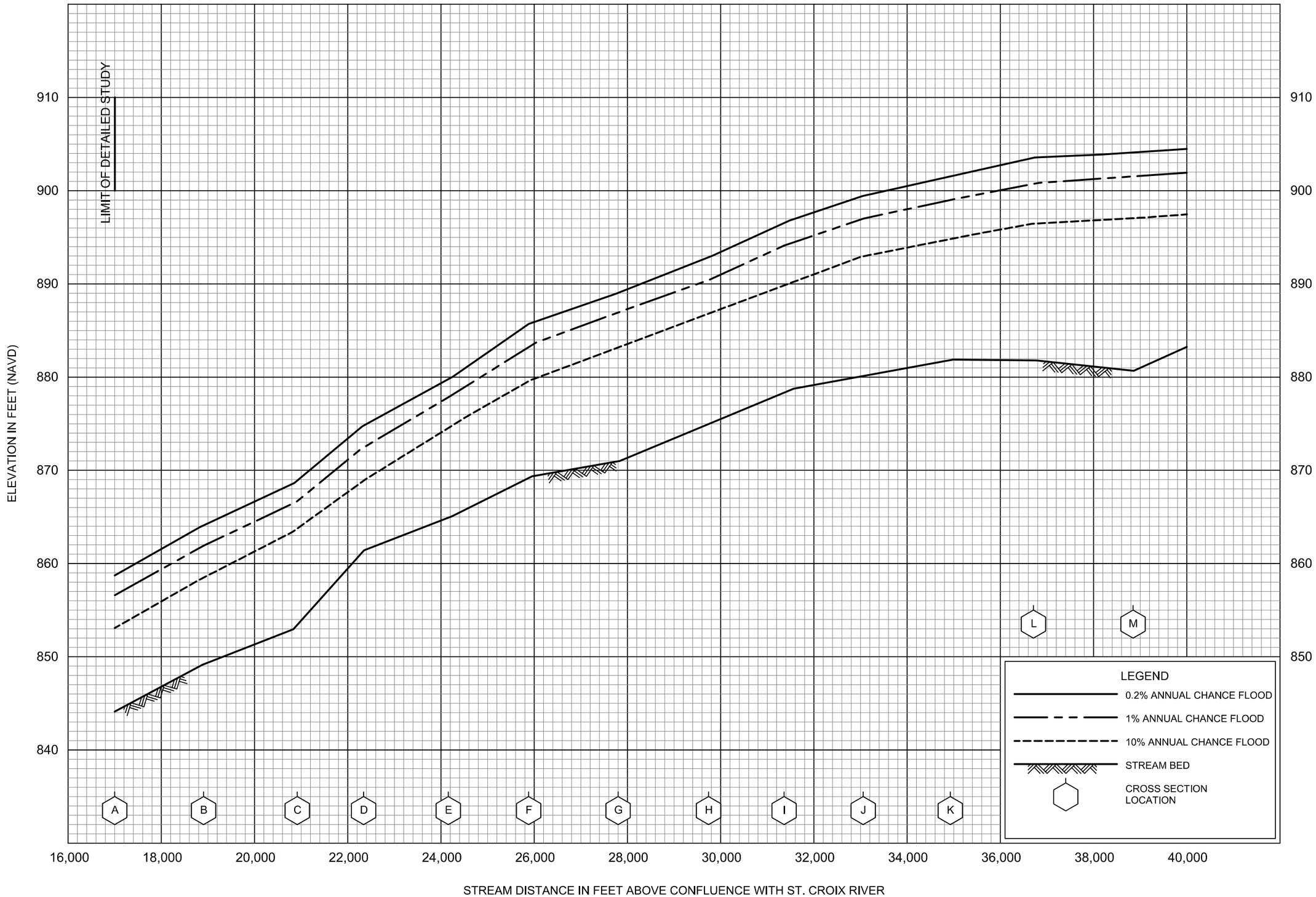
SKUNK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

PINE COUNTY, MN

AND INCORPORATED AREAS

03P



FLOOD PROFILES

SNAKE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

PINE COUNTY, MN

AND INCORPORATED AREAS

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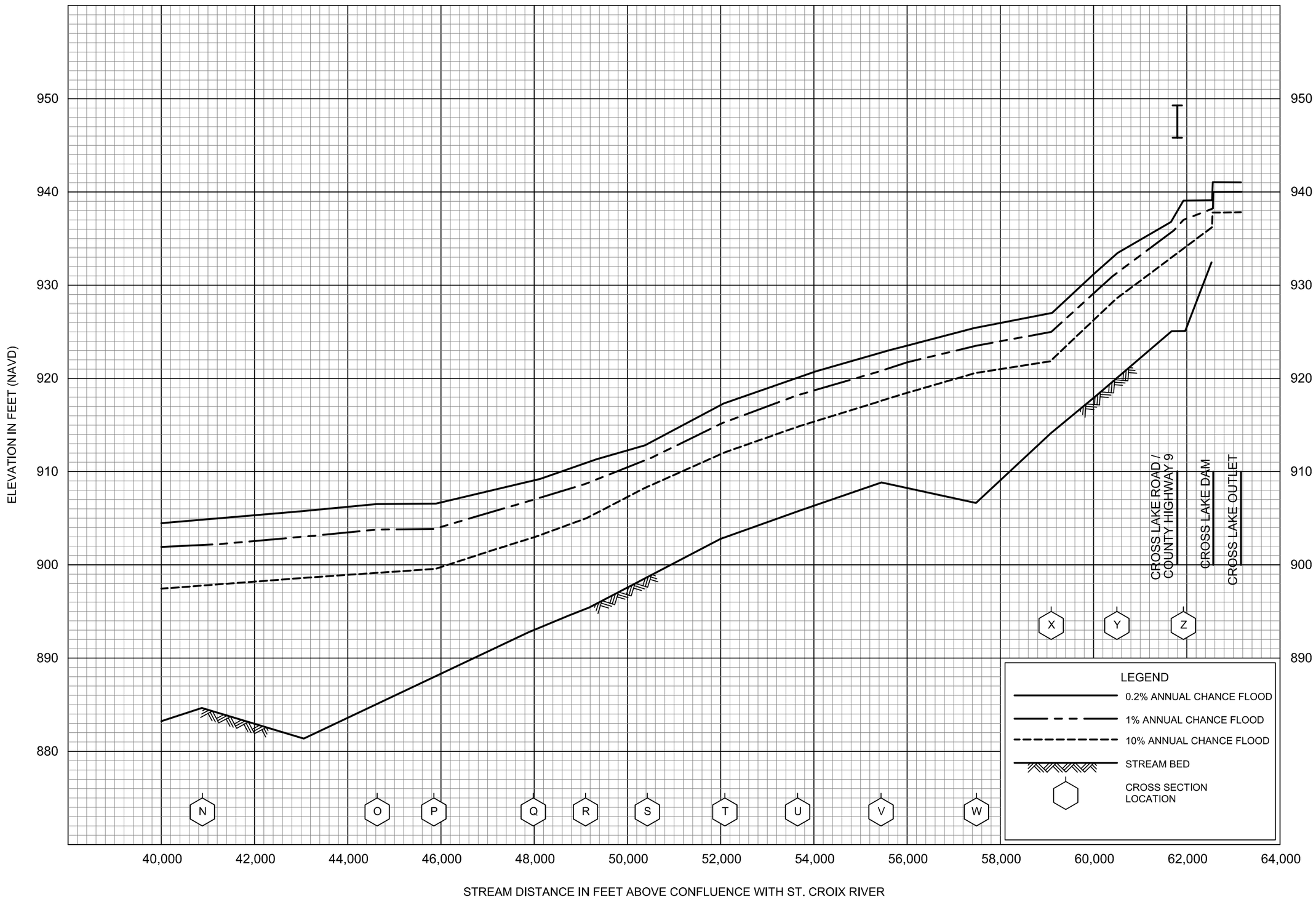

FLOOD PROFILES

SNAKE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

PINE COUNTY, MIN

AND INCORPORATED AREAS

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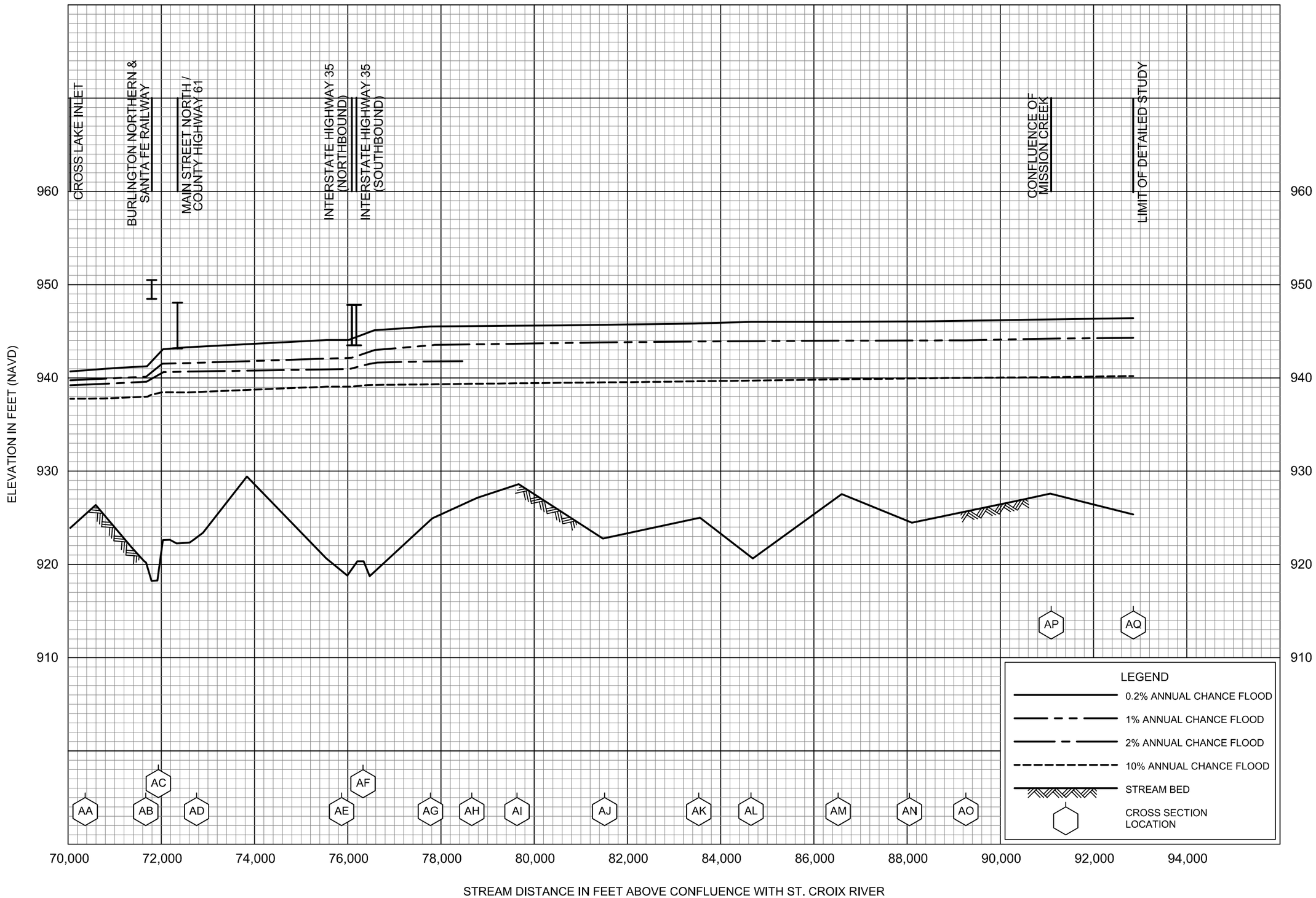

FLOOD PROFILES

SNAKE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

PINE COUNTY, MN

AND INCORPORATED AREAS

06P