FLOOD INSURANCE STUDY

MIDLAND COUNTY, MICHIGAN

(ALL JURISDICTIONS)

COMMUNITY NAME	COMMUNITY NUMBER
*Coleman, City of	260861
Edenville, Township of	260850
*Geneva, Township of	260869
Greendale, Township of	260870
Homer, Township of	260989
*Hope, Township of	260871
Ingersoll, Township of	260851
*Jasper, Township of	260852
Jerome, Township of`	260853
Larkin, Township of	260854
Lee, Township of	260855
Lincoln, Township of	260856
Midland, City of	260140
Midland, Township of	260857
*Mills, Township of	260872
*Mount Haley, Township of	260873
*Porter, Township of	260858
Sanford, Village of	260859
*Warren, Township of	260874

*No Special Flood Hazard Areas Identified

Preliminary: **DRAFT**

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
26111CV000A

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.

Initial Countywide FIS Effective Date: To Be Determined

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Flood Insurance Rate Map

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FLOOD INSURANCE STUDY
MIDLAND COUNTY, MICHIGAN (ALL JURISDICTIONS)

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 Midland County, including the Cities of Coleman and Midland; the Townships of Edenville, Geneva, Greendale, Homer, Hope, Ingersoll, Jasper, Jerome, Larkin, Lee, Lincoln, Midland, Mills, Mount Haley, Porter, and Warren; and the Village of Sanford (referred to collectively herein as Midland County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

Please note that the City of Midland is geographically located in Midland and Bay Counties. The portions of the City of Midland that are located in Midland County are included in this countywide FIS. The FIS report and Flood Insurance Rate Map (FIRM) for areas outside of Midland County are printed separately.

Please note that the City of Coleman and Townships of Geneva, Hope, Jasper, Mills, Mount Haley, Porter, and Warren have no mapped 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.

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1.2 Authority and Acknowledgments

Precountywide Analyses

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

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

Midland, City of	The hydrologic and hydraulic analyses for the December 15, 1983, FIS report (FEMA, 1983) were performed by Gove Associates, Inc., for FEMA, under Contract No. H-4728. The work was completed in December 1981. The hydrologic and hydraulic analyses for the January 5, 1989, revision (FEMA, 1989) were obtained from a report entitled, "City of Midland, Michigan, Stormwater Management Study, 100-Year Floodplain Analysis, Final Report," performed by McNamee, Porter, and Seeley of Ann Arbor, Michigan (McNamee, et al., 1984). The hydrologic and hydraulic analyses for the Tittabawassee River and Inman Drain for the December 5, 1995, revision (FEMA, 1995) were prepared by the Michigan Department of Natural Resources (MDNR). The work was completed in April 1993.

No previous FIS reports were published for the City of Coleman; the Townships of Edenville, Geneva, Greendale, Homer, Hope, Ingersoll, Jasper, Jerome, Larkin, Lee, Lincoln, Midland, Mills, Mount Haley, Porter, and Warren; and the Village of Sanford.

This Countywide FIS report

For this countywide FIS, limited detailed analyses for the Chippewa River, Inman Drain, Sturgeon Creek, Tittabawassee River, Unnamed Tributary to Snake Creek, and Unnamed Tributary to Unnamed Tributary to Snake Creek, were developed by PBS&J, for FEMA, under Contract No. HSFE 05-05-D-0023. This work was completed in December 2006. Flooding effects for the Chippewa, Pine, and

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Tittabawassee Rivers were incorporated from the study prepared by the U.S. Army Corps of Engineers (USACE) for the Michigan Department of Environmental Quality (MDEQ) (USACE, 1996).

The base map information shown on the FIRM was derived from 0.5 inch pixel natural color orthophotography produced at a scale of 1:1,200 and produced in 2005, by Midland County. The projection used in the preparation of the base map is the Universal Transverse Mercator Zone 16 North, and the horizontal datum used is the North American Datum 1983.

1.3 Coordination

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

Community	FIS Date	Initial Meeting	Final Meeting
Midland, City of	December 15, 1983	November 20, 1978	July 14, 1982
	January 5, 1989	*	*
	December 5, 1995	**	*

*Data not available
**Community notified by letter dated September 1, 1993

For this countywide revision, a scoping meeting was held on September 20, 2006, and attended by representatives of the City of Midland, Midland County, the Township of Mills, FEMA, PBS&J, and MDEQ. The purpose of the meeting was to discuss the scope of the FIS.

2.0 AREA STUDIED

2.1 Scope of Study

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

The following streams were studied by detailed methods in this FIS report: Chippewa River, Inman Drain, Snake Creek, Sturgeon Creek, and Tittabawassee River.

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

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Precountywide Analyses

For the June 15, 1984, FIS report for the City of Midland, the Chippewa River, Inman Drain, Snake Creek, Sturgeon Creek, and the Tittabawassee River were studied by detailed methods.

For the January 5, 1989, revision to the FIS report for the City of Midland, Snake Creek was restudied by detailed methods. The revision also incorporated corporate limits changes due to annexations by the City of Midland.

For the December 5, 1995, revision to the FIS report for the City of Midland, detailed flooding within the city was extended to incorporate areas of annexation for the following flooding sources: Chippewa River, from approximately 13,595 feet upstream of the confluence with Tittabawassee River to approximately 18,635 feet upstream of the confluence with Tittabawassee River; Inman Drain, from Dublin Road to approximately 1,375 feet upstream of Dublin Road; Sturgeon Creek, from approximately 2,900 feet upstream of Airport Road to approximately 4,615 feet upstream of Airport Road; and Tittabawassee River, from approximately 8,000 feet upstream of the confluence of Sturgeon Creek to approximately 14,125 feet upstream of the confluence of Sturgeon Creek.

This Countywide FIS report

For this countywide FIS, the vertical datum was converted from the National Geodetic Vertical Datum of 1929 (NGVD) to the North American Vertical Datum of 1988 (NAVD).

Detailed flooding information was added for the following flooding sources: the upper reaches of the Chippewa River, from approximately 8,745 feet upstream of the confluence with Tittabawassee River to approximately 18,635 feet upstream of the confluence with Tittabawassee River; Sturgeon Creek, from approximately 4,200 feet upstream of Airport Road to approximately 4,620 feet upstream of Airport Road; and the Tittabawassee River, from approximately 5,000 feet upstream of Consumers Power Railroad to approximately 14,080 feet upstream of the confluence of Sturgeon Creek. The flooding was added to extend the flood hazards for the existing detailed studies into previously unmapped communities.

The Tittabawassee River was redelineated from approximately 925 feet downstream of Consumers Power Railroad to approximately 860 feet downstream of the Dow Chemical Dam. Midland County provided 5-foot digital topographic data for a portion of the county dated 2005 (Midland County, 2005a). Midland County also provided digital orthophotographic color imagery, produced in 2005 (Midland County, 2005b).

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The flooding information for streams studied by approximate methods for this countywide study was obtained from a 1996 USACE report (USACE, 1996). The streams studied by approximate methods are presented in Table 1.

Table 1 - Streams Studied by Approximate Methods

Stream	Reach Description
Chippewa River	From approximately 18,640 feet upstream of the confluence with Tittabawassee River to approximately 7,790 feet downstream of Magrudder Road
Pine River	From the confluence with Chippewa River to approximately 28,065 feet upstream of East Pine River Road
Tittababwassee River	The downstream reach from the County Boundary to approximately 5,990 upstream of Gordonville Road, and the upstream reach from approximately 14,050 feet upstream of the confluence of Sturgeon Creek to North Meridian Road

The areas studied by limited detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction through December 2006. The streams studied by limited detailed methods are presented in Table 2.

Table 2 - Streams Studied by Limited Detailed Methods

Stream	Reach Description
Chippewa River	From approximately 7,790 feet downstream of Magrudder Road to the County Boundary
Inman Drain	From approximately 1,440 feet upstream of Dublin Road to approximately 2,450 feet upstream of North Stark Road

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Table 2 - Streams Studied by Limited Detailed Methods *(Continued)*

Stream	Reach Description
Sturgeon Creek	From just downstream of Letts Street to approximately 1,770 feet upstream of Perrine Road
Tittabawassee River	From North Meridian Road to the County Boundary
Unnamed Tributary to Snake Creek	From the confluence with Snake Creek to approximately 1,365 feet upstream of Saint Andrew Road
Unnamed Tributary to Unnamed Tributary to Snake Creek	From the confluence with Unnamed Tributary to Snake Creek to approximately 935 feet upstream of Crescent Drive

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 Midland County.

2.2 Community Description

Midland County is located in east-central Michigan, approximately 130 miles northwest of Detroit. The county is boarded by Saginaw and Gratiot Counties to the south, Gladwin County to the north, Bay County to the east, and Isabella County to the west. The total area contained within the county is 521 square miles (Info MI, 2006). According to the U.S. Census Bureau, in 2000, the population for Midland County was 82,874 (U.S. Census, 2006).

The climate in east-central Michigan is continental. The average minimum daily temperature in the winter is 16.0 degrees Fahrenheit (°F), and the average maximum daily summer temperature is 84.0°F. Average annual precipitation is 30.7 inches, with slightly higher amounts occurring in the summer than in the remainder of the year (The Weather Channel, 2006).

Midland County is characterized by gently rolling hills with some limited areas of sharper relief near river systems. The soils are mostly loams and clay loams to the south and east, with sandy loams dominant in the east and northern portions of the county (Agricultural Research Administration, 1950).

Midland County is drained primarily by the Tittabawasse River, which flows from north to southeast, and through the City of Midland. A dam is located along the Tittabawassee River within the Village of Sanford, creating Sanford Lake. Other significant draining sources within Midland County include the Chippewa River,

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flowing from west to east and confluencing with the Tittabawassee River within the City of Midland, and the Pine River, flowing south to northeast. Within the City of Midland, Sturgeon Creek flows from north to south and discharges into the Tittabawassee River. Flowing west to southeast, Inman Drain is a tributary of Sturgeon Creek. And Snake Creek, also discharging into the Tittabawassee River, flows from north to southwest.

The land uses of the floodplains in Midland County include residential, commercial, and industrial development. Along the Tittabawassee River floodplain, a major portion of the river shoreline is developed for industrial purposes.

2.3 Principal Flood Problems

Flooding occurs in the City of Midland when high runoff causes the principle flooding sources to overflow their banks. A U.S. Geological Survey (USGS) gage is located on the Tittabawassee River (No. 04156000) approximately 0.25 miles downstream of the Dow Chemical Company Dam. A gage is also located on the Chippewa River (No. 04154500) upstream of the City of Midland's corporate limits. The maximum flood flow at the Midland gage on the Tittabawassee River was recorded in 1916 with a flow of 34,800 cubic feet per second (cfs). A similar flow of 34,000 cfs was recorded during the 1948 flood on the Tittabawassee River. Each of these floods were slightly less then the predicted 2-percent-annual-chance flood for the Tittabawassee River. Another flood event of record for the Tittabawassee River occurred in 1976, with a flow of 26,400 cfs, which is the approximate equivalent to the expected 10-percent-annual-chance flood (USGS, 1980).

2.4 Flood Protection Measures

Due to the intensive development along the Tittabawassee River in the City of Midland, many areas that are developed have been filled above the normal flood stage of the Tittabawassee River. This fill area effectively limits the boundary of the 1-percent-annual-chance flood and removes much of the industrial area from the floodplain. The area of the nuclear power plant development also has been extensively filled to eliminate the area from the floodplain of the Tittabawassee River. Along the Chippewa River, some filling has also occurred that serves to protect against periodic annual flooding but not for the higher levels of 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

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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

For the June 15, 1984, FIS report, frequency relationships for the Chippewa and Tittabawassee Rivers, which are gaged streams, were determined by statistical analysis using the log-Pearson Type III method (Water Resources Council, 1977). For the Chippewa River analysis, 29 years of records were analyzed at USGS Gage No. 04154500, and for the Tittabawassee River, the analysis was based upon the 66 year period of record at USGS Gage No. 04156000.

The peak discharges for Sturgeon Creek and Inman Drain, which are ungaged streams, were determined utilizing the Soil Conservation Service (SCS) methodology for the estimation of direct runoff from rainfall (SCS, 1972).

For the January 5, 1989, FIS report, the USACE's HEC-1 computer program was used to determine the peak discharges of the 10-, 2-, 1-, and 0.2-percent-annual-chance floods for Snake Creek (HEC, 1973)

This Countywide FIS Report

For this countywide FIS, hydrologic analyses for the flooding sources presented in Table 1 were obtained from the USACE's special study for the Tittabawassee, Chippewa, and Pine Rivers (USACE, 1996).

For the flooding sources presented in Table 2 that were studied by limited detailed methods, the peak discharges for selected flood intervals were computed using the

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regional regression equation obtained from USGS Water Resources Investigations Report 94-2004 (USGS, 1993). Midland County provided 5-foot digital topographic data for those portions of the county (Midland County, 2005). ArcGIS was used to generate watershed and sub-basin areas using the digital topographic data to produce a working Digital Elevation Model in order to delineate drainage areas (ESRI, 2005).

Peak discharge-drainage area relationships for 10-, 2-, 1-, and 0.2-percent-annual-chance floods for each of the flooding sources studied in detail in the county are presented in Table 3.

Table 3 - Summary of Discharges

		Peak Discharges (cubic feet per second)			
Flooding Source and Location	Drainage Area (square miles)	10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Chippewa River					
At the confluence with Tittabawassee River	1,011	10,500	15,000	16,900	21,700
Inman Drain					
At the confluence with Sturgeon Creek	7.29	330	470	540	700
Snake Creek					
At the confluence with Tittabawassee River	5.50	1,150	2,250	2,300	3,400
At Crescent Drive	2.50	280	610	570	710
At Sylvan Lane	1.60	260	390	490	605
Sturgeon Creek					
At the confluence with Tittabawassee River	58.85	1,050	1,600	1,850	2,500
At the confluence of Inman Drain	51.55	900	1,400	1,600	2,200
Tittabawassee River					
Approximately 9,815 feet downstream of Consumers Power Railroad	2,448	28,000	41,700	47,800	62,700
At USGS Gage No. 041560000 approximately 1,300 feet downstream of Dow Chemical Company Dam	2,400	27,500	41,000	47,000	61,600
At the confluence of Chippewa River	1,386	17,700	26,400	30,300	39,700

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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 Flood Insurance Rate Map (FIRM) represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data 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 sections for the flooding sources studied by detailed methods were obtained from field surveys. All bridges and dams were field surveyed to obtain elevation data and structural geometry.

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).

For streams studied by detailed methods, water surface elevations (WSELs) of floods of the selected recurrence intervals were computed using the USACE's HEC-2 step-backwater computer program (HEC, 1984).

Starting WSELs for the Chippewa River were based on the flood elevations of the Tittabawassee River at the confluence. For Sturgeon and Snake Creeks, the starting WSELs were the mean annual high-water elevation of the Tittabawassee River. The Inman Drain starting WSELs were based on the flood elevations for Sturgeon Creek. The starting WSELs elevations for the Tittabawassee River were calculated using the rating curve developed by the USACE (USACE, 1977). The rating curve at the Tittabawassee River gaging station was used to check continuity.

Channel roughness factors (Manning's "n") used in the hydraulic computations were estimated by field inspection. These estimates were then compared with the photographs and descriptions compiled by V.T. Chow to obtain the final values (Chow, 1959). Manning's "n" values for all detailed studied streams are presented in Table 4.

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Table 4 - Manning's "n" Values

Stream	Channel "n"	Overbank "n"
Chippewa River	0.060	0.035
Inman Drain	0.040-0.100	0.031-0.045
Snake Creek	0.030-0.120	0.030-0.055
Sturgeon Creek	0.035-0.100	0.035-0.050
Tittabawassee River	0.030-0.060	0.030-0.035

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.

This Countywide FIS Report

For this countywide FIS, hydraulic analyses for the flooding sources presented in Table 1 were obtained from the USACE's special study for the Tittabawassee, Chippewa, and Pine Rivers (USACE, 1996).

For the flooding sources presented in Table 2 that were studied by limited detailed methods, cross sections were obtained using digital topography and field surveys. The 1-percent-annual-chance WSELs were computed using the USACE's HEC-RAS hydraulic model, version 3.1.2 (HEC, 2004). HEC-GeoRAS was used to delineate the 1-percent-annual-chance floodplain (HEC, 2000). Structure geometry data included in the hydraulic model was inferred using aerial photography and topographic data. Models do not include field surveys that determine the specifics of channel and floodplain geometry. A limited detailed study can be upgraded to a full detailed study at a later date by verifying stream channel and overbank geometry, bridge and culvert data, and by analyzing multiple recurrence intervals.

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

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standard vertical datum in use for newly created or revised FIS reports and FIRMs was NGVD. With the finalization of the 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**.** The average vertical datum conversion of -0.558 foot was calculated and used to convert all elevations in Midland County from NGVD to NAVD using the National Geodetic Survey's VERTCON online utility (NGS, 2006). The data points used to determine the conversion are listed in Table 5.

Table 5 - Vertical Datum Conversion

Quad Name	Corner	Latitude	Longitude	Conversion from NGVD to NAVD
Coleman	SW	43.750	-84.625	-0.505
Edenville	SW	43.750	-84.500	-0.538
Hope	SW	43.750	-84.375	-0.564
Estey	SW	43.750	-84.250	-0.577
Estey	SE	73.750	-84.125	-0.594
Alamando	SW	43.625	-84.625	-0.522
Sanford	SW	43.625	-84.500	-0.548
Averill	SW	43.625	-84.375	-0.568
Midland North	SW	43.625	-84.250	-0.581
Midland North	SE	43.625	-84.125	-0.594
Pleasant Valley	SW	43.500	-84.625	-0.512
Floyd	SW	43.500	-84.500	-0.538
Gordonville	SW	43.500	-84.375	-0.554
Midland South	SW	43.500	-84.250	-0.577
Midland South	SE	43.500	-84.125	-0.594
			Average:	-0.558

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, 1992), or contact the Vertical Network Branch, National Geodetic Survey, Coast and Geodetic Survey, National Oceanic and Atmospheric Administration, Silver Spring, Maryland 20910 (Internet address http://www.ngs.noaa.gov).

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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.

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 for the detailed portions of the Chippewa River, Inman Drain, Sturgeon Creek, and Tittabawassee River (from approximately 860 feet downstream of the Dow Chemical Dam to approximately 14,125 feet upstream of the confluence of Sturgeon Creek), the boundaries were interpolated between cross sections using topographic maps at a scale of 1:24,000 with a contour of 5 feet (USGS, various dates), 1:600 with a contour of 2 feet (City of Midland, 1975b), 1:1,200 with a contour of 2 feet (City of Midland, date unknown), and 1:2,400 with a contour interval of 2 feet (City of Midland, 1975a). Between cross sections for Snake Creek, the boundaries were interpolated between cross sections using topographic maps at a scale of 1:1,200 with a contour interval of 1 foot (Abrams, 1983).

For the redelineated reach of the Tittabawassee River (from approximately 925 feet downstream of Consumers Power Railroad to approximately 860 feet downstream of the Dow Chemical Dam), and streams presented in Table 2 studied by limited detailed methods, the 1-percent-annual-chance floodplain

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boundaries were delineated using digital topographic data with a 5-foot contour interval (Midland County, 2005a).

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

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

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot, provided that hazardous velocities are not produced. The Michigan Flood Plain Act (Act 167, P.A. 1968), however, limits floodplain encroachments to that which will cause only insignificant increases in flood heights (less than 0.1 foot) (Michigan Water Resources Commission, 1968). Thus, a floodway having no more than 0.1-foot surcharges has been delineated for this study. The floodways in this study are presented to local agencies as a minimum standard 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 6). 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.

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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)
CHIPPEWA RIVER								
A	3,250[1]	1,356	18,021	1.6	615.5	615.5	615.5	0.0
B	5,950[1]	2,300	22,404	1.6	615.6	615.6	615.6	0.0
C	8,500[1]	2,350	23,294	1.6	615.6	615.6	615.6	0.0
D	11,850[1]	2,750	32,320	1.6	615.7	615.7	615.7	0.0
INMAN DRAIN								
A	1,190[2]	325	195	2.8	615.4	602.0[3]	602.1	0.1
B	2,950[2]	20	113	4.8	615.4	607.6[3]	607.6	0.0
C	3,711[2]	225	460	1.2	615.4	608.7[3]	608.7	0.0
D	4,552[2]	26	111	4.9	615.4	609.2[3]	609.2	0.0
E	5,853[2]	100	260	2.1	615.4	610.5[3]	610.5	0.0
F	6,721[2]	13	81	6.6	615.4	611.7[3]	611.7	0.0
G	7,692[2]	129	346	1.6	615.4	612.7[3]	612.7	0.0
H	9,447[2]	130	386	1.4	615.4	613.1[3]	613.1	0.0

[1]Feet above confluence with Tittabawassee River
[2]Feet above confluence with Sturgeon Creek
[3]Elevation computed without consideration of backwater effects from Tittabawassee River

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TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

CHIPPEWA RIVER – INMAN DRAIN

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)
SNAKE CREEK								
A	1,078	105	1,715	0.8	615.3	605.7[2]	605.7	0.0
B	1,688	258	2,569	0.5	615.3	606.4[2]	606.4	0.0
C	3,228	210	2,110	0.6	615.3	608.5[2]	608.5	0.0
D	3,959	135	1,487	0.9	615.3	609.6[2]	609.6	0.0
E	4,409	130	986	1.3	615.3	610.2[2]	610.2	0.0
F	4,593	16	220	5.9	615.3	610.4[2]	610.4	0.0
G	5,313	290	2,530	0.5	615.3	611.4[2]	611.4	0.0
H	6,012	270	1,484	0.9	615.3	612.4[2]	612.4	0.0
I	6,792	168	707	4.6	615.3	613.6[2]	613.6	0.0
J	8,118	236	697	7.2	616.3	616.3	616.4	0.1
K	8,788	200	1,421	2.5	617.4	617.4	617.5	0.1
L	9,943	75	180	4.1	619.4	619.4	619.4	0.0
M	10,359	150	514	1.2	624.5	624.5	624.5	0.0
N	10,459	140	670	0.8	624.5	624.5	624.5	0.0
O	11,429	200	514	1.5	627.4	627.4	627.4	0.0
P	12,139	300	519	1.6	627.6	627.6	627.6	0.0
Q	13,138	120	326	2.0	628.2	628.2	628.2	0.0
R	13,889	49	260	1.6	628.4	628.4	628.4	0.0
S	14,509	38	146	2.1	628.6	628.6	628.6	0.0

[1]Feet above confluence with Tittabawassee River

[2]Elevation computed without consideration of backwater effects from Tittabawassee River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

DRAFT

SNAKE 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)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SNAKE CREEK (CONTINUED)								
T	14,905	80	345	1.3	632.1	632.1	632.1	0.0
U	15,955	92	351	0.6	632.2	632.2	632.2	0.0
V	16,900	32	88	1.7	632.3	632.3	632.3	0.0

[1]Feet above confluence with Tittabawassee River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

DRAFT

SNAKE 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)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
STURGEON CREEK								
A	713	221	3,509	0.5	615.3	608.3[2]	608.3	0.0
B	2,033	374	4,394	0.4	615.4	608.3[3]	608.3	0.0
C	3,848	321	2,908	0.6	615.4	608.3[3]	608.3	0.0
D	5,675	32	282	6.6	615.4	608.7[3]	608.7	0.0
E	6,590	230	1,669	1.0	615.4	609.6[3]	609.7	0.1
F	7,830	230	1,875	0.9	615.4	609.7[3]	609.8	0.1
G	8,440	310	2,073	0.8	615.4	609.7[3]	609.8	0.1
H	8,718	62	470	3.4	615.4	609.7[3]	609.8	0.1
I	10,053	318	2,198	0.7	615.4	610.1[3]	610.2	0.1
J	12,033	250	1,539	1.0	615.4	610.3[3]	610.4	0.1
K	12,833	205	1,037	1.5	615.4	610.5[3]	610.6	0.1
L	14,233	239	1,073	1.5	615.4	611.1[3]	611.2	0.1
M	15,767	30	265	6.0	615.4	612.1[3]	612.2	0.1
N	16,216	40	442	3.6	615.4	613.0[3]	613.1	0.1
O	16,328	40	407	3.9	615.4	613.1[3]	613.2	0.1
P	17,293	335	1,387	1.2	615.4	613.5[3]	613.5	0.0
Q	18,474	320	1,193	1.3	615.4	613.7[3]	613.7	0.0
R	20,111	189	805	2.0	615.4	614.1[3]	614.1	0.0

[1]Feet above confluence with Tittabawassee River

[2]Elevation computed without consideration of flooding controlled by Tittabawassee River

[3]Elevation computed without consideration of backwater effects from Tittabawassee River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

DRAFT

STURGEON 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)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
TITTABAWASSEE RIVER								
A	112,974	476	10,101	4.7	609.9	609.9	610.0	0.1
B	113,884	696	11,732	4.1	610.2	610.2	610.3	0.1
C	116,484	713	12,114	3.9	610.6	610.6	610.7	0.1
D	117,657	504	9,068	5.3	610.8	610.8	610.9	0.1
E	118,217	524	9,474	5.0	611.0	611.0	611.1	0.1
F	120,117	682	13,327	3.6	611.6	611.6	611.7	0.1
G	121,617	501	8,026	5.9	611.6	611.6	611.7	0.1
H	122,517	629	9,351	5.0	612.0	612.0	612.1	0.1
I	123,725	566	7,573	7.0	612.3	612.3	612.4	0.1
J	124,204	296	5,700	8.2	612.7	612.7	612.7	0.0
K	124,397	314	6,838	6.9	613.1	613.1	613.1	0.0
L	124,807	670	8,431	6.2	613.4	613.4	613.4	0.0
M	127,481	508	8,873	5.6	614.1	614.1	614.1	0.0
N	130,129	560	7,593	4.6	614.8	614.8	614.8	0.0
O	130,559	993	14,156	2.5	615.0	615.0	615.0	0.0
P	131,528	1,660	15,140	1.3	615.1	615.1	615.1	0.0
Q	131,579	1,660	17,731	2.0	615.1	615.1	615.1	0.0
R	133,279	1,980	23,764	2.4	615.2	615.2	615.2	0.0
S	135,679	2,500	27,614	2.3	615.3	615.3	615.3	0.0

[1]Feet above confluence with Shiawassee River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

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TITTABAWASSEE 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)
TITTABAWASSEE RIVER (CONTINUED)								
T	137,179	2,750	28,278	2.2	615.4	615.4	615.4	0.0
U	139,629	2,280	21,235	3.0	615.5	615.5	615.5	0.0
V	142,129	2,400	26,641	2.4	615.7	615.7	615.7	0.0
W[2]	144,344	2,953	*	*	616.0	616.0	*	*
X[2]	146,344	2,628	*	*	616.0	616.0	*	*
Y[2]	148,329	2,587	*	*	616.0	616.0	*	*

[1]Feet above confluence with Shiawassee River
[2]Floodway delineated using engineering judgment
*Data not available

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

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TITTABAWASSEE RIVER

Near the mouth of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 6 for certain downstream cross sections of Inman Drain, Snake Creek, and Sturgeon Creek are lower then the regulatory flood elevations in that area, which must take into account the 1-percent-annual-chance flooding due to backwater from other sources.

The floodway for the Tittabawasseee River, from approximately 8,000 feet upstream of the confluence of Sturgeon Creek to approximately 14,125 feet upstream of the confluence of Sturgeon Creek, was delineated by the MDNR based on the engineering judgment. Therefore there is no data available for cross sections W, X, and Y for the Tittabawassee River in Table 6.

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.

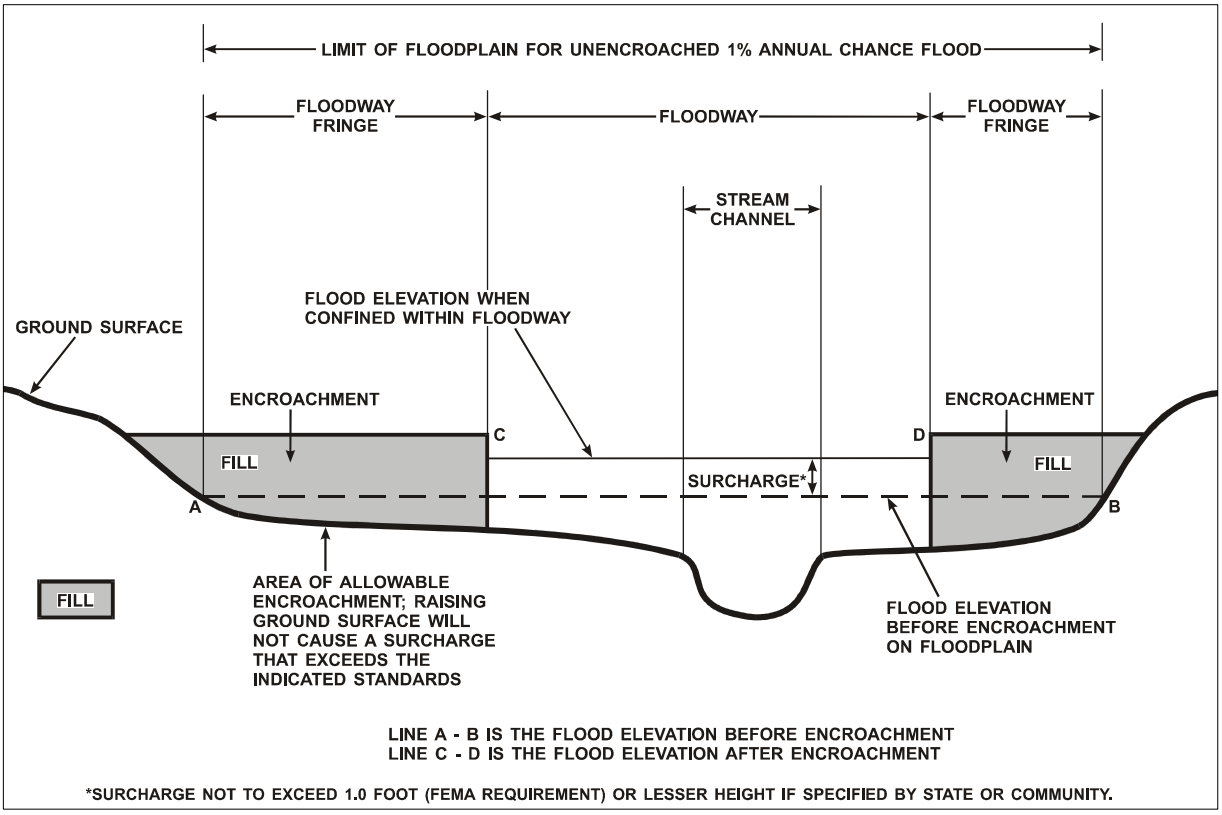

Figure 1 - Floodway Schematic

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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 Midland County, Michigan. Previously, FIRMs were prepared for each incorporated

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community and the unincorporated areas of the County identified as flood-prone. Historical data relating to the maps prepared for each community are presented in Table 7.

7.0 OTHER STUDIES

Previous FIS reports have been prepared for Bay County, Michigan (All Jurisdicitions) (FEMA, 1996), Isabella County, MI (All Jurisdictions) (FEMA, 1998), and Saginaw County, Michigan (All Jurisdictions) (FEMA, 1997). Bay and Saginaw Counties were revised concurrently with this countywide FIS.

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

Abrams Aerial Survey Corporation, City of Midland, Michigan, Scale 1:1,200, Contour Interval 1 foot, 1983.

Agricultural Research Administration, Soil Survey, Midland County, Michigan, U.S. Department of Agriculture, 1950.

Chow, Ven Te, Open Channel Hydraulics, McGraw Hill Book Company, Inc., New York, 1959.

City of Midland, Michigan, Sturgeon Road Cemetery Development, Scale 1:1,200, Contour 2 feet, date unknown.

City of Midland, Michigan, Topographic Map, Scale 1:2,400, Contour Interval 2 feet, 1975a.

City of Midland, Michigan, Topographic Map of Huron Park, Scale 1:600, Contour Interval 2 feet, January 1975b.

ESRI, ArcGIS, ArcMAP, Version 9.0, 2005.

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COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDAY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Coleman, City of *	To Be Determined	None	To Be Determined	None
Edenville, Township of	To Be Determined	None	To Be Determined	None
Geneva, Township of *	To Be Determined	None	To Be Determined	None
Greendale, Township of	To Be Determined	None	To Be Determined	None
Homer, Township of	To Be Determined	None	To Be Determined	None
Hope, Township of *	To Be Determined	None	To Be Determined	None
Ingersoll, Township of	To Be Determined	None	To Be Determined	None
Jasper, Township of *	To Be Determined	None	To Be Determined	None
Jerome, Township of	To Be Determined	None	To Be Determined	None
Larkin, Township of	To Be Determined	None	To Be Determined	None
Lee, Township of	To Be Determined	None	To Be Determined	None
Lincoln, Township of	To Be Determined	None	To Be Determined	None

*No Special Flood Hazard Areas Identified

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

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COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDAY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Midland, City of	May 3, 1974	August 1, 1975	June 15, 1984	January 5, 1989 December 5, 1995 To Be Determined
Midland, Township of	To Be Determined	None	To Be Determined	None
Mills, Township of *	To Be Determined	None	To Be Determined	None
Mount Haley, Township of *	To Be Determined	None	To Be Determined	None
Porter, Township of *	To Be Determined	None	To Be Determined	None
Sanford, Village of	To Be Determined	None	To Be Determined	None
Warren, Township of *	To Be Determined	None	To Be Determined	None

*No Special Flood Hazard Areas Identified

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

DRAFT

Federal Emergency Management Agency, Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, Guidelines for Community Officials, Engineers, and Surveyors, June 1992.

Federal Emergency Management Agency, Flood Insurance Study, City of Midland, Midland and Bay Counties, Michigan, Flood Insurance Study Report, December 15, 1983; Flood Insurance Rate Map, June 15, 1984.

Federal Emergency Management Agency, Flood Insurance Study, City of Midland, Midland and Bay Counties, Michigan, January 5, 1989.

Federal Emergency Management Agency, Flood Insurance Study, City of Midland, Midland and Bay Counties, Michigan, December 5, 1995.

Federal Emergency Management Agency, Flood Insurance Study, Bay County, Michigan (All Jurisdictions), June 18, 1996.

Federal Emergency Management Agency, Flood Insurance Study, Saginaw County, Michigan (All Jurisdictions), October 16, 1997.

Federal Emergency Management Agency, Flood Insurance Study, Isabella County, Michigan (All Jurisdictions), January 7, 1998.

Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package, U.S. Army Corps of Engineers, Davis, California, September 1973.

Hydrologic Engineering Center, HEC-2 Water Surface Profiles, U.S. Army Corps of Engineers, Davis, California, April 1984.

Hydrologic Engineering Center, HEC-GeoRAS, Version 3.0, U.S. Army Corps of Engineers, April 2000.

Hydrologic Engineering Center, HEC-RAS River Analysis System, Version 3.1.2, U.S. Army Corps of Engineers, Davis, California, April 2004.

Info MI, Midland County, Retrieved November 6, 2006, from http://www.infomi.com/county/midland/gov.php.

McNamee, Porter, and Seeley, City of Midland, Michigan, Stormwater Management Study, 100-Year Floodplain Analysis, Final Report, April 1984.

Michigan Water Resource Commission, Flood Plain Control Act in 1968, Act 245, P.A. 1929 as amended by Act 167, P.O. 1968, Lansing, Michigan, 1968.

Midland County, Digital Topographic Data, Portions of Midland County, MI, Contour Interval 5 feet, 2005a.

DRAFT

Midland County, Digital Orthophotographic Color Imagery, produced by Kucera International, Inc., for Midland County, 2005b.

National Geodetic Survey, VERTCON-North American Vertical Datum Conversion Utility. Retrieved October 5, 2006, from http://www.ngs.noaa.gov/.

Soil Conservation Service, National Engineering Handbook, Section 4, Chapter 7, U.S. Department of Agriculture, August 1972.

U.S. Army Corps of Engineers, Detroit District, Flood Control on Saginaw River, Michigan and Tributaries, Tittabawassee River at Midland, Phase I, Design Memorandum No. 8, January 1977.

U.S. Army Corps of Engineers, Detroit District, Special Study: Tittabawassee, Chippewa, and Pine Rivers, Midland County, Michigan, July 1996.

U.S. Census Bureau, American Fact Finder, Midland County, Michigan, 2000. Retrieved November 6, 2006, from http://factfinder.census.gov.

U.S. Geological Survey, 7.5 Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 5 feet: Averill, Michigan, 1973; Gordonville, Michigan, 1973; Midland North, Michigan, 1962, photorevised 1973; Midland South, Michigan, 1962, photorevised 1973, U.S. Department of the Interior, various dates.

U.S. Geological Survey, Water Resources Investigations Report 94-2004: Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993.

U.S. Geological Survey Water-Data Report, Water Resources Data for Michigan, Water Year 1980, U.S. Department of Interior, 1980.

Water Resource Council, Hydrology Committee, Guidelines for Determining Flood Flow Frequencies, Bulletin #17A, June 1977.

The Weather Channel, Monthly Averages for Midland, Michigan. Retrieved November 6, 2006, from http://www.weather.com.

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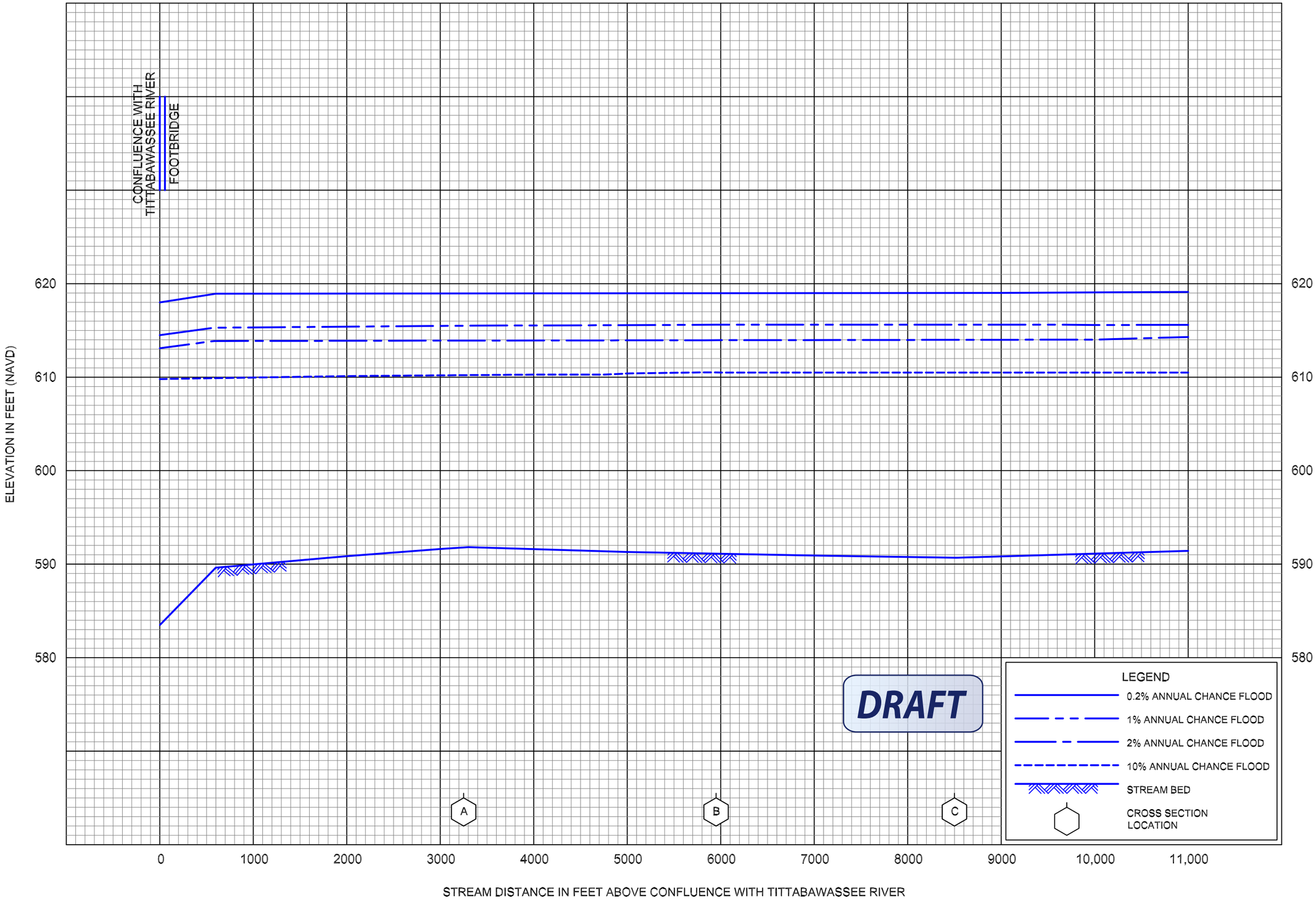

FLOOD PROFILES

CHIPPEWA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI

(ALL JURISDICTIONS)

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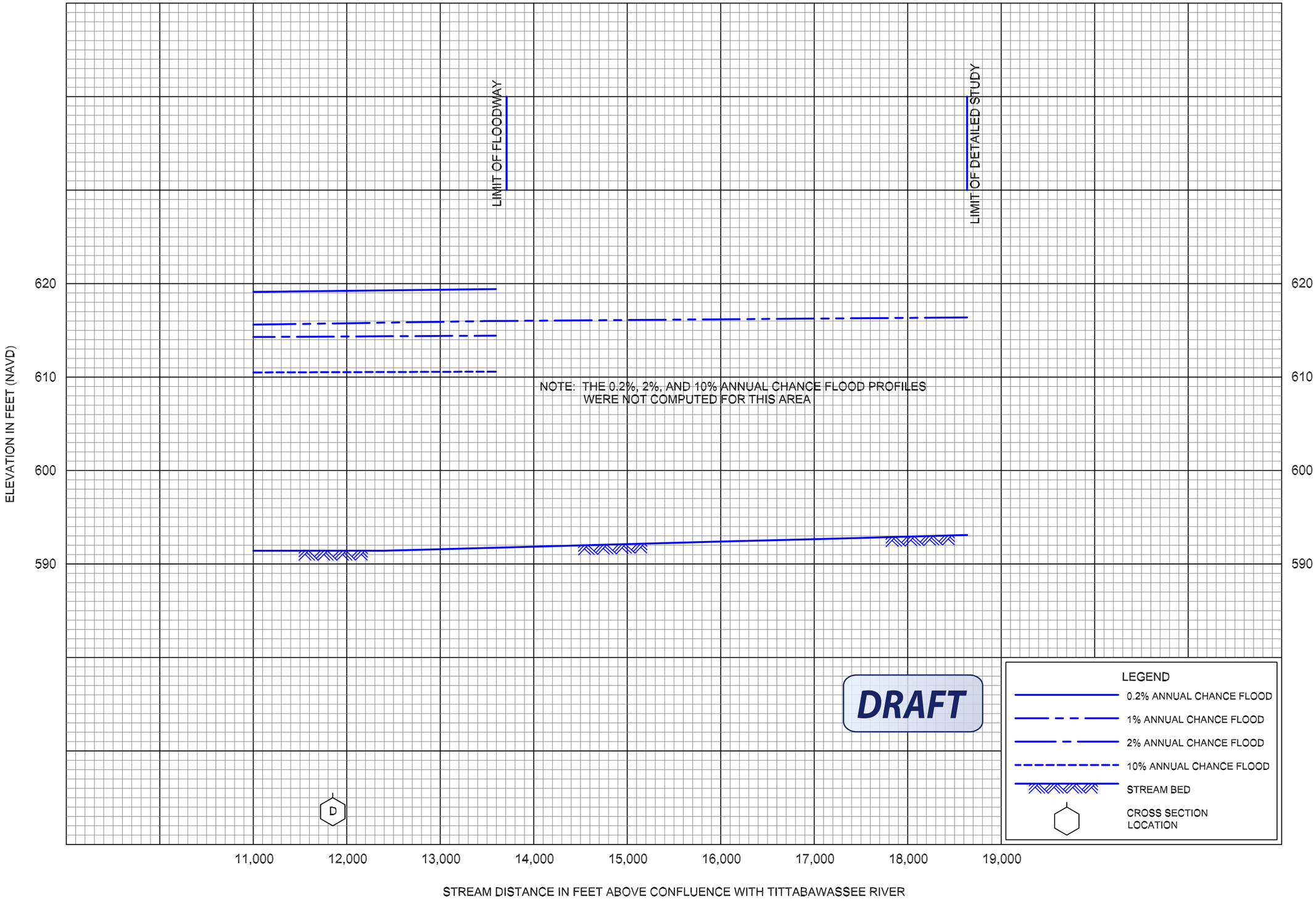


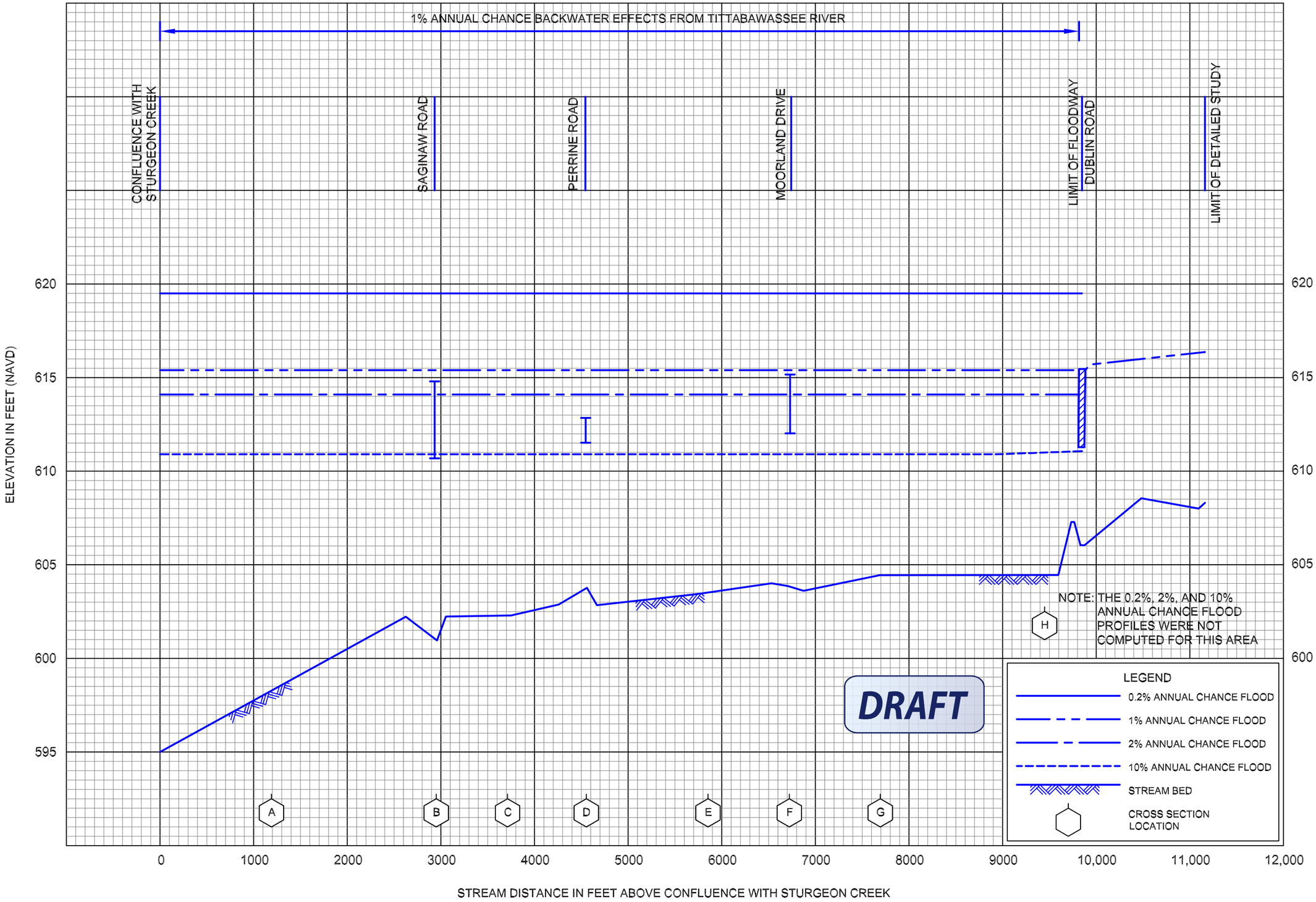
FLOOD PROFILES

CHIPPEWA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI

(ALL JURISDICTIONS)



FLOOD PROFILES

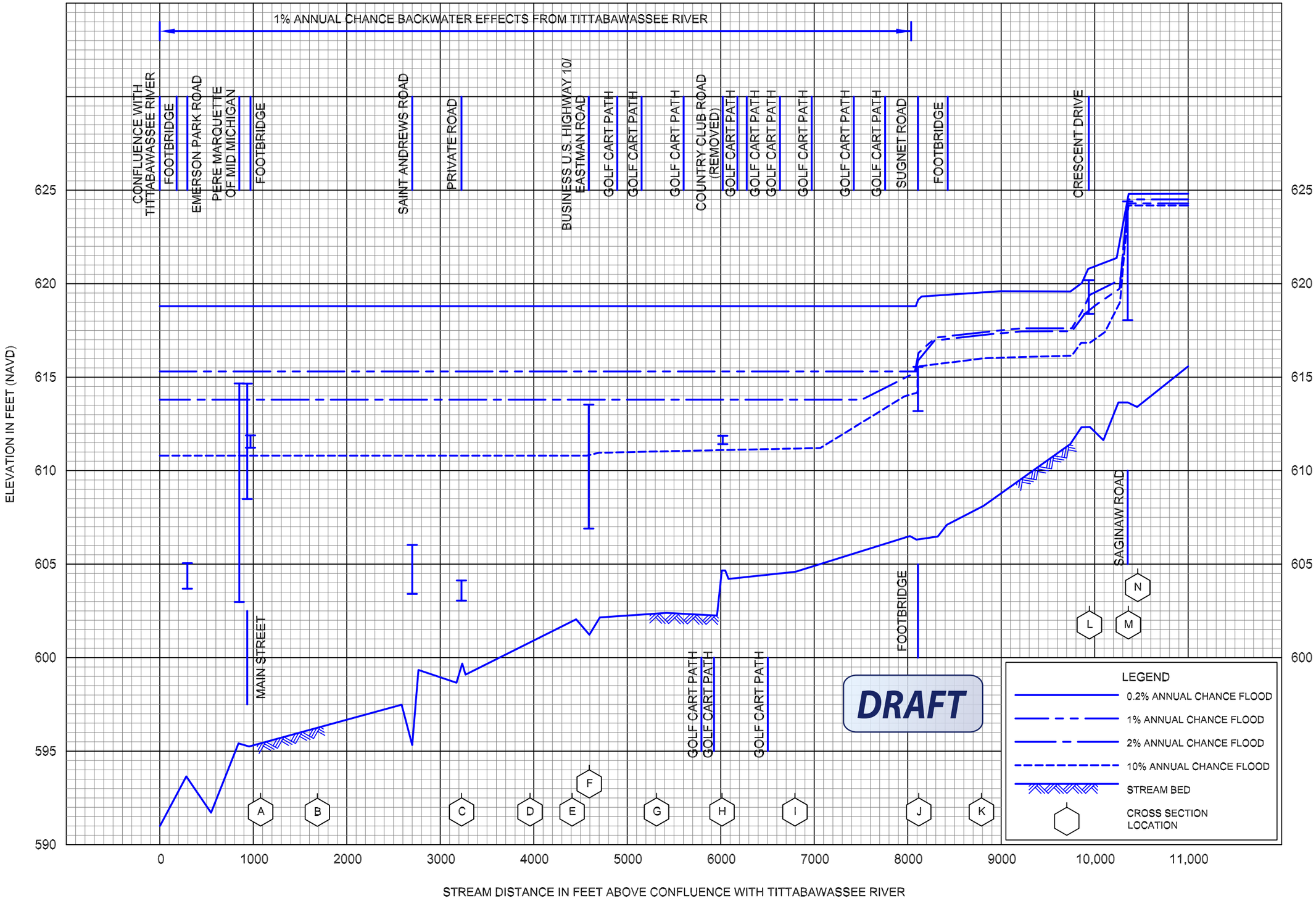
INMAN DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI

(ALL JURISDICTIONS)

03P



FLOOD PROFILES

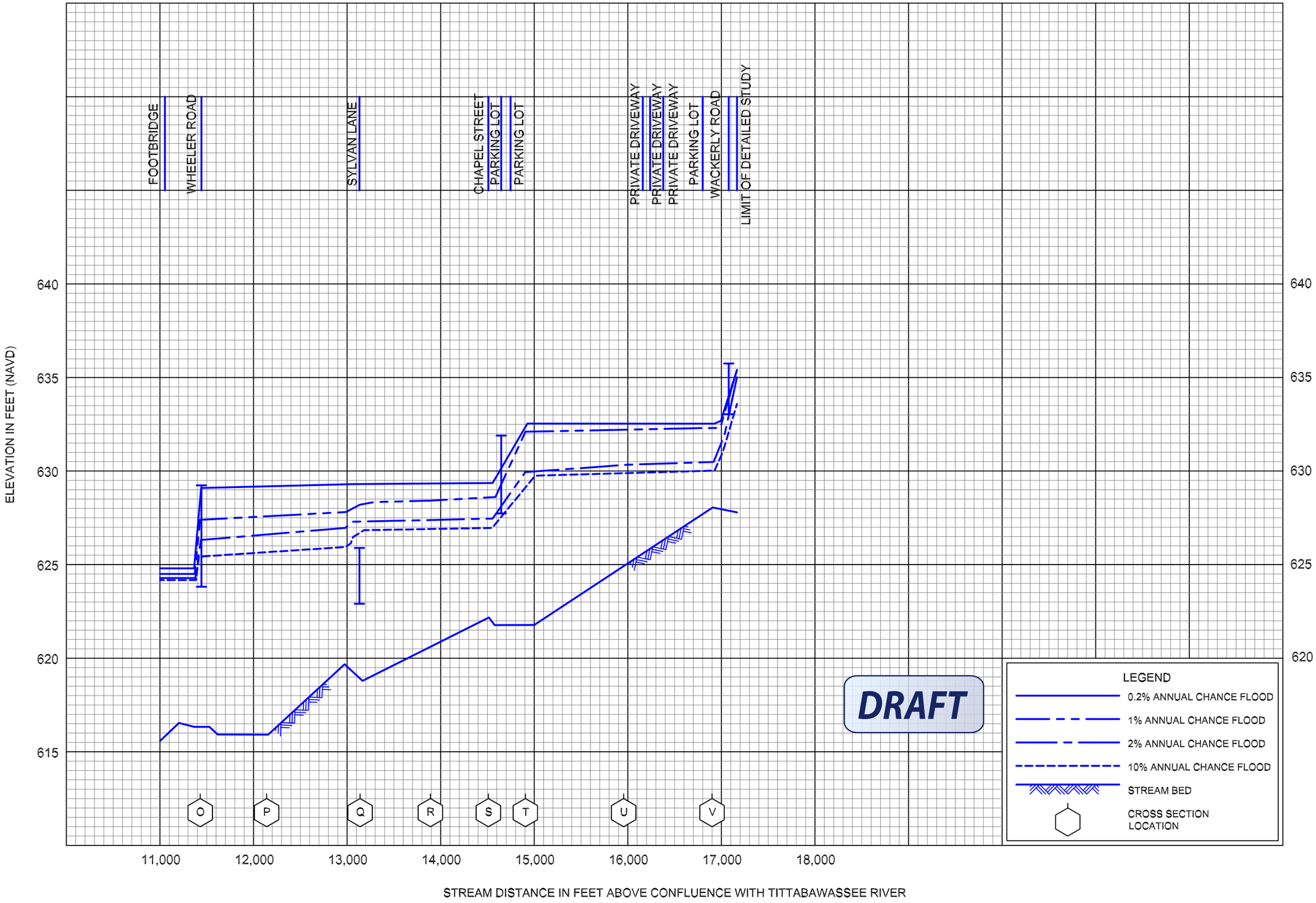
SNAKE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI

(ALL JURISDICTIONS)

04P



FLOOD PROFILES

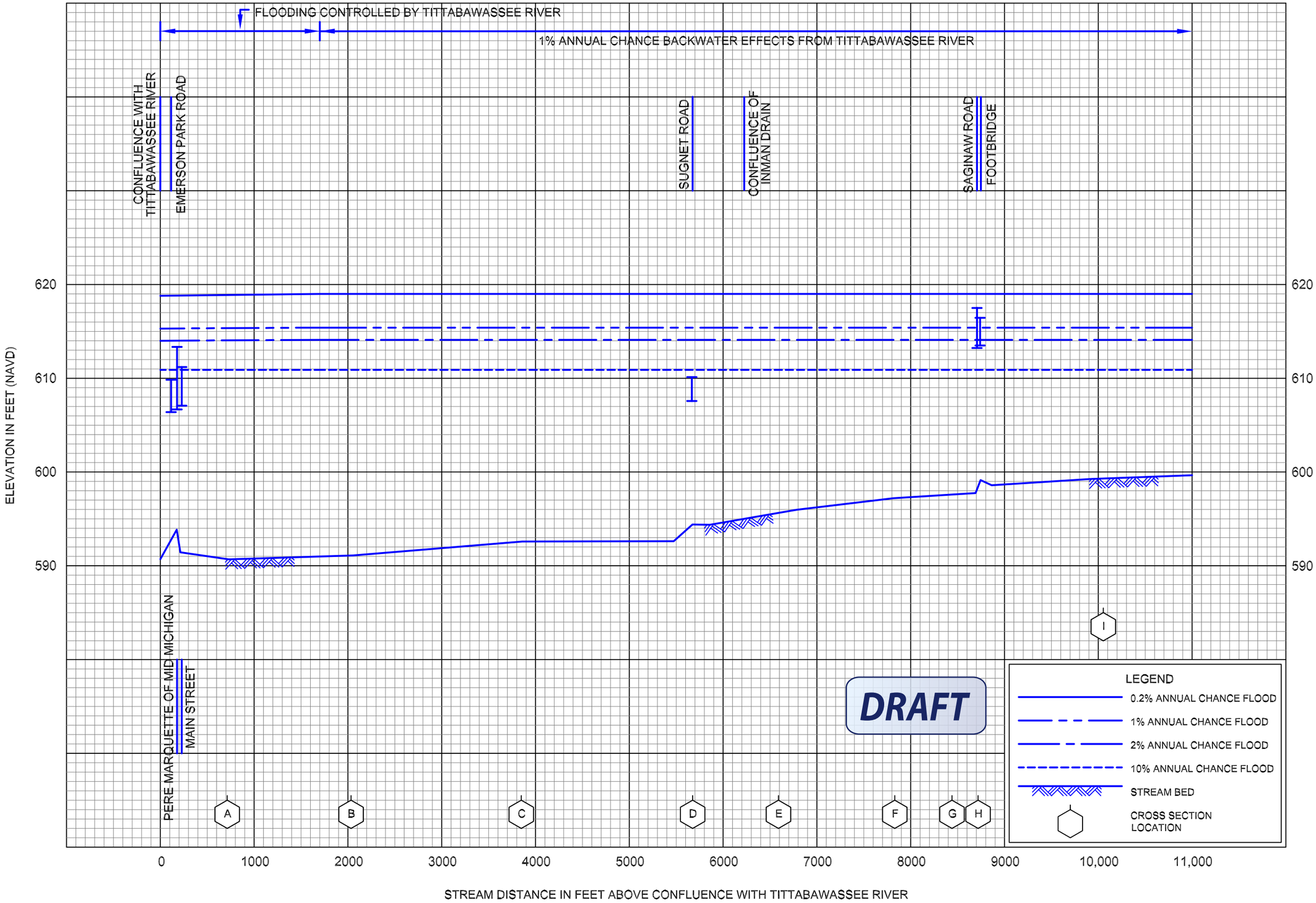
SNAKE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI

(ALL JURISDICTIONS)

05P



FLOOD PROFILES

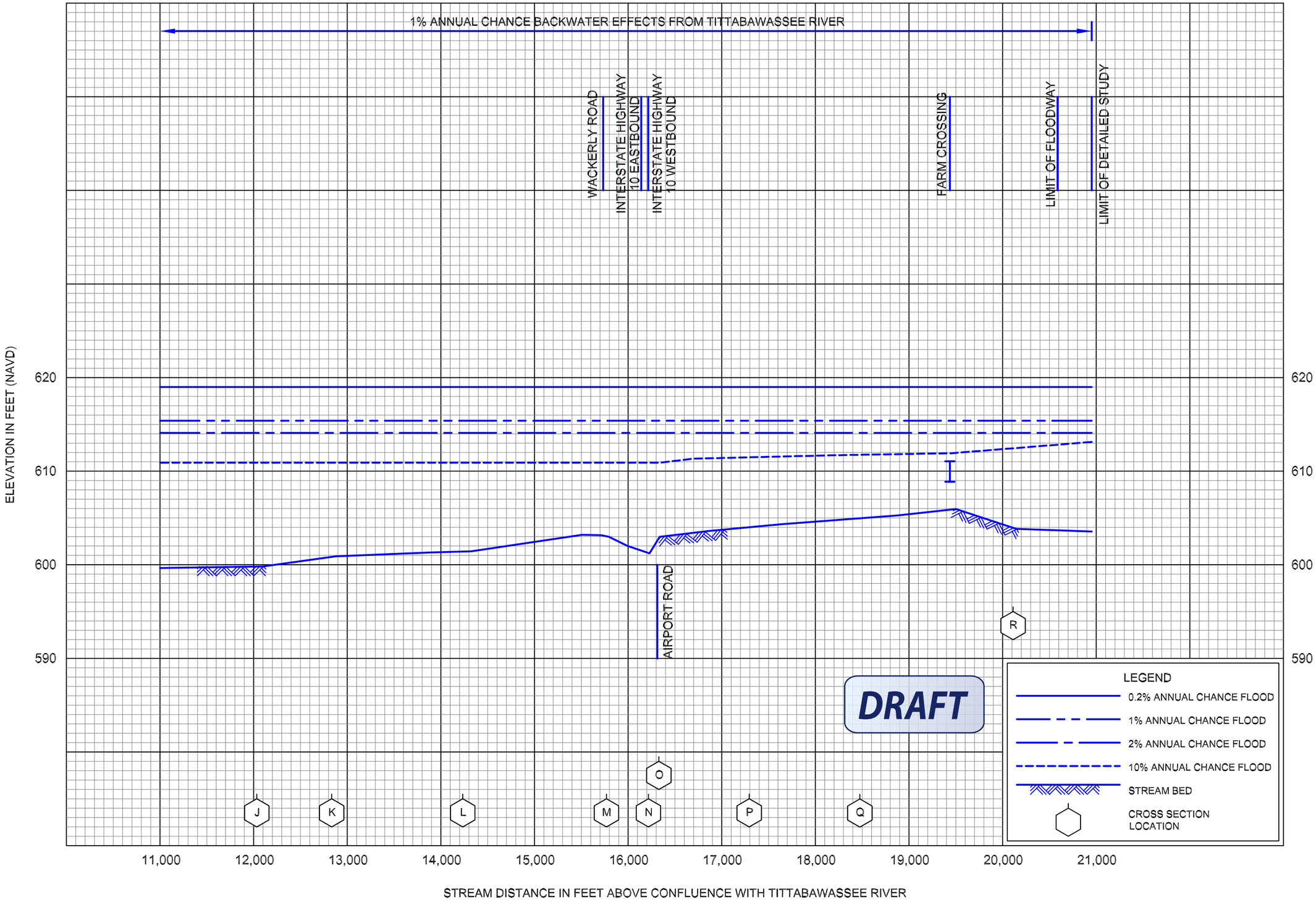
STURGEON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI

(ALL JURISDICTIONS)

06P



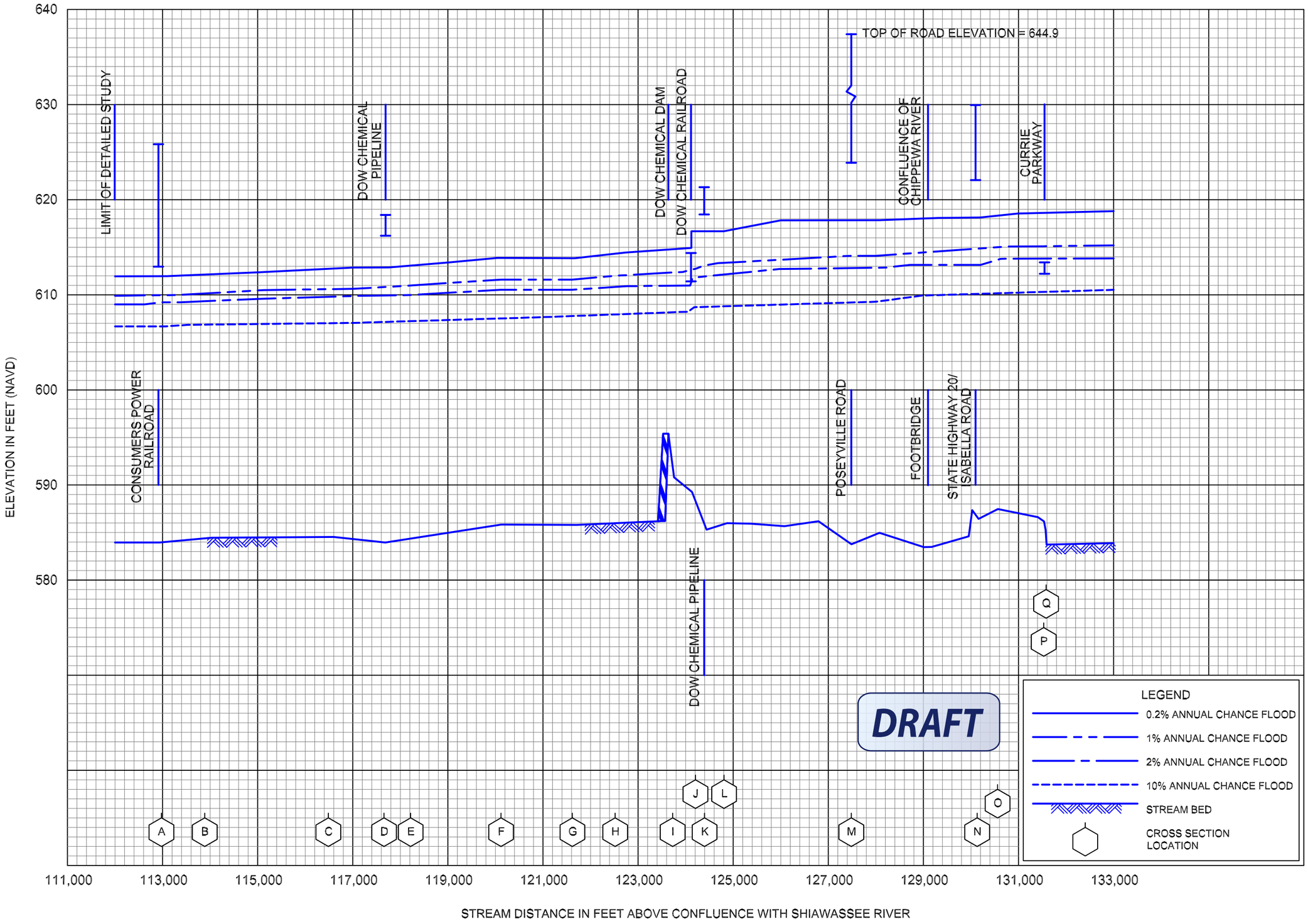
FLOOD PROFILES

STURGEON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI

(ALL JURISDICTIONS)



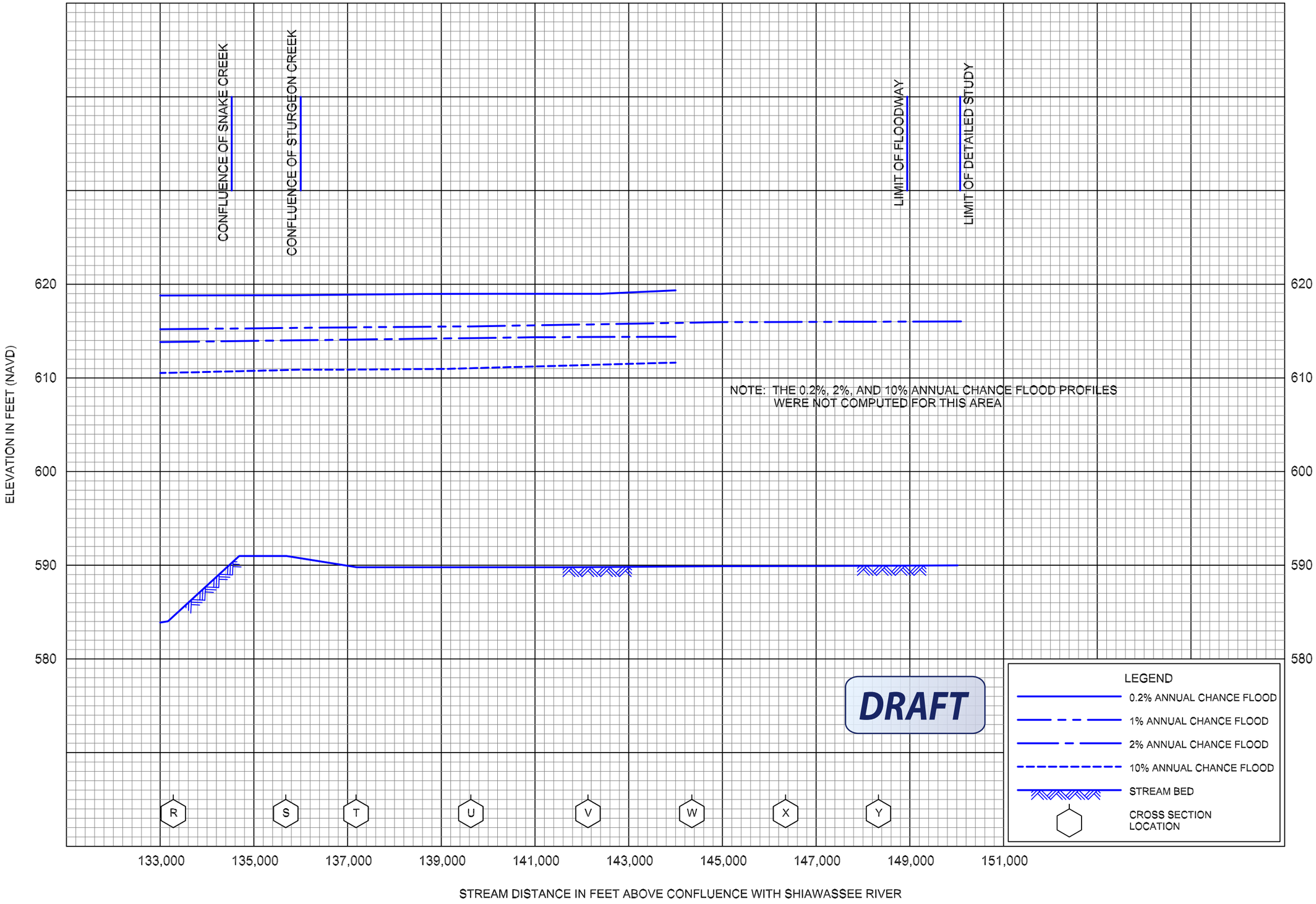
FLOOD PROFILES

TITTABAWASSEE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI

(ALL JURISDICTIONS)



FLOOD PROFILES

TITTABAWASSEE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDLAND COUNTY, MI

(ALL JURISDICTIONS)