Appendix 1. Details of Hydrologic and Hydraulic Analyses

Background

The U.S. Geological Survey (USGS) and the Ohio Emergency Management Agency (Ohio EMA) cooperated on the development of flood profiles for selected recurrence intervals in several areas for which flood profiles would be needed to assist in a cost-benefit analysis for mitigation assistance. The flood profiles selected for this analysis were the 10-, 50-, 100-, and 500-year-recurrence-interval flood profiles. For this disaster declaration (FEMA–1556–DR), seven communities required the selected flood profiles: Uhrichsville/Dennison, Lisbon, Elkton, Neffs, New Matamoras, Woodsfield, and Brown Township. If a detailed Flood Insurance Study (FIS) with the required profiles existed, they were used for the cost-benefit analysis. If no detailed FIS was available, the USGS determined the selected profiles needed. The existing FIS information is listed in table 1–1.

Table 1–1. Summary of existing FIS(s) for selected streams in disaster area FEMA–1556–DR.
[Approximate level of study is area designated by 1 percent annual chance of flood with estimated hydrologic analysis, Detailed level of study is an area designated by a 1 percent annual chance of flood with base flood elevations derived from an approved hydrologic analysis]

Stream name	FIS date	Study name	Community number	Level of study
Cities of Uhrichsville and Dennison, Tuscarawas County				
Little Stillwater Creek	12-18-86	Village of Dennison, Ohio	390542	Detailed
Little Stillwater Creek	1-2-87	City of Uhrichsville, Ohio	390547	Detailed
Village of Lisbon, Columbiana County				
Lisbon Creek	NA	No previous FIS	390085	NA
Middle Fork Little Beaver Creek	4-5-06	Columbiana County, Ohio, and Incorporated Areas	390085	Approximate
City of Neffs, Belmont County				
McMahon Creek	4-5-06	Belmont County, Ohio, and Incorporated Areas	390762	Detailed
Little McMahon Creek	4-5-06	Belmont County, Ohio, and Incorporated Areas	390762	Approximate
Village of New Matamoras, Monroe County				
Little Muskingum River	2-15-84	Monroe County, Ohio, Unincorporated Areas	390404	Approximate
Village of Woodsfield, Monroe County				
Wheeler Run	2-15-84	Monroe County, Ohio, Unincorporated Areas	390404	Approximate
Brown Township, Carroll County				
Sandy Creek	1-5-82	Village of Waynesburg, Ohio (Stark County)	390667	Detailed
Big Sandy Creek	9-28-90	Carroll County, Ohio, Unincorporated Areas	390763	Detailed
Big Sandy Creek	7-3-95	Village of Malvern, Ohio	390052	Detailed
Sandy Creek	1-5-82	Village of Minerva, Ohio, Stark, Carroll, and Columbiana Counties	390518	Detailed

Scope of Work of Study Effort

The scope of this study is to augment previous FISs in the selected areas to provide the 10-, 50-, 100-, and 500-year flood profiles. This study consisted of 10 reaches in 7 communities. The stream names, reaches studied, and specific comments about each effort follow. Maps of the study areas are shown in the following figures.

Note: The seven stream reaches studied have been assigned an alphabetical designation (A – Little Stillwater Creek, B - Lisbon Creek, C – Middle Fork Little Beaver Creek, D – McMahon Creek and Little McMahon Creek, E – Little Muskingum River, F – Wheeler Creek, and G – Sandy Creek) that will be reflected throughout the organization of this appendix. All exhibits pertaining to a particular stream will be labeled using an alphanumeric scheme (for example, 1–A1, 1–A2; 1–B1, 1–B2, etc.)

1–A. Little Stillwater Creek near the Cities of Uhrichsville and Dennison

Little Stillwater Creek flows generally west in parts of Tuscarawas and Harrison Counties (fig. 1–A1). The downstream limit of the reach studied is the confluence with Stillwater Creek. The upstream limit is approximately 10 ft below the South 6th Street bridge. This stream reach is approximately 1.9 mi long.

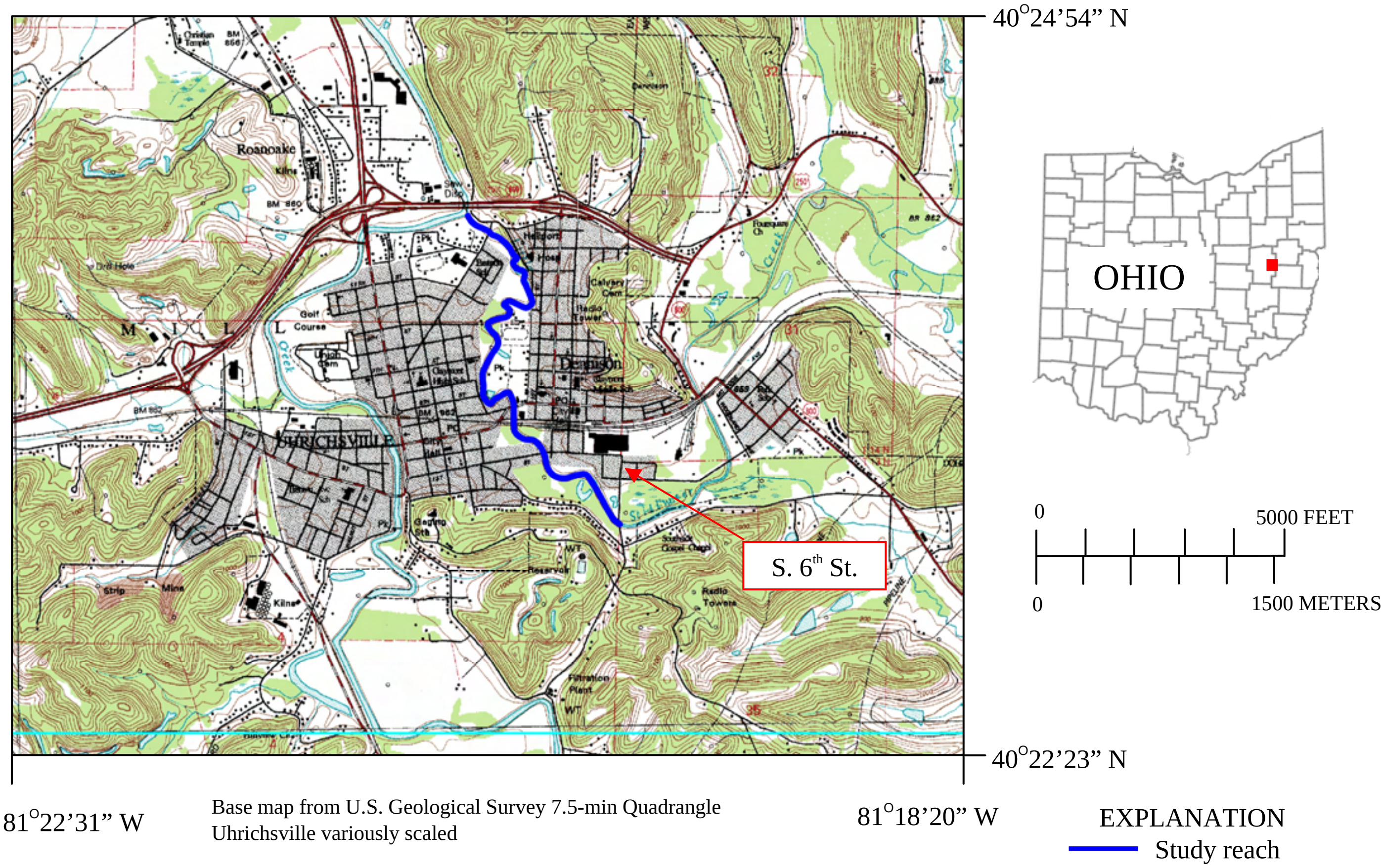

Figure 1–A1. Location of the Stillwater Creek study reach for the Cities of Uhrichsville and Dennison, Ohio.

1–B. Lisbon Creek near the Village of Lisbon

Lisbon Creek flows generally in a southern direction in the central part of Columbiana County (fig. 1–B1). The downstream limit of the reach studied is the mouth (confluence with Middle Fork Little Beaver Creek). The upstream limit is approximately 3,200 ft above the mouth. This stream reach is approximately 0.6 mi long.

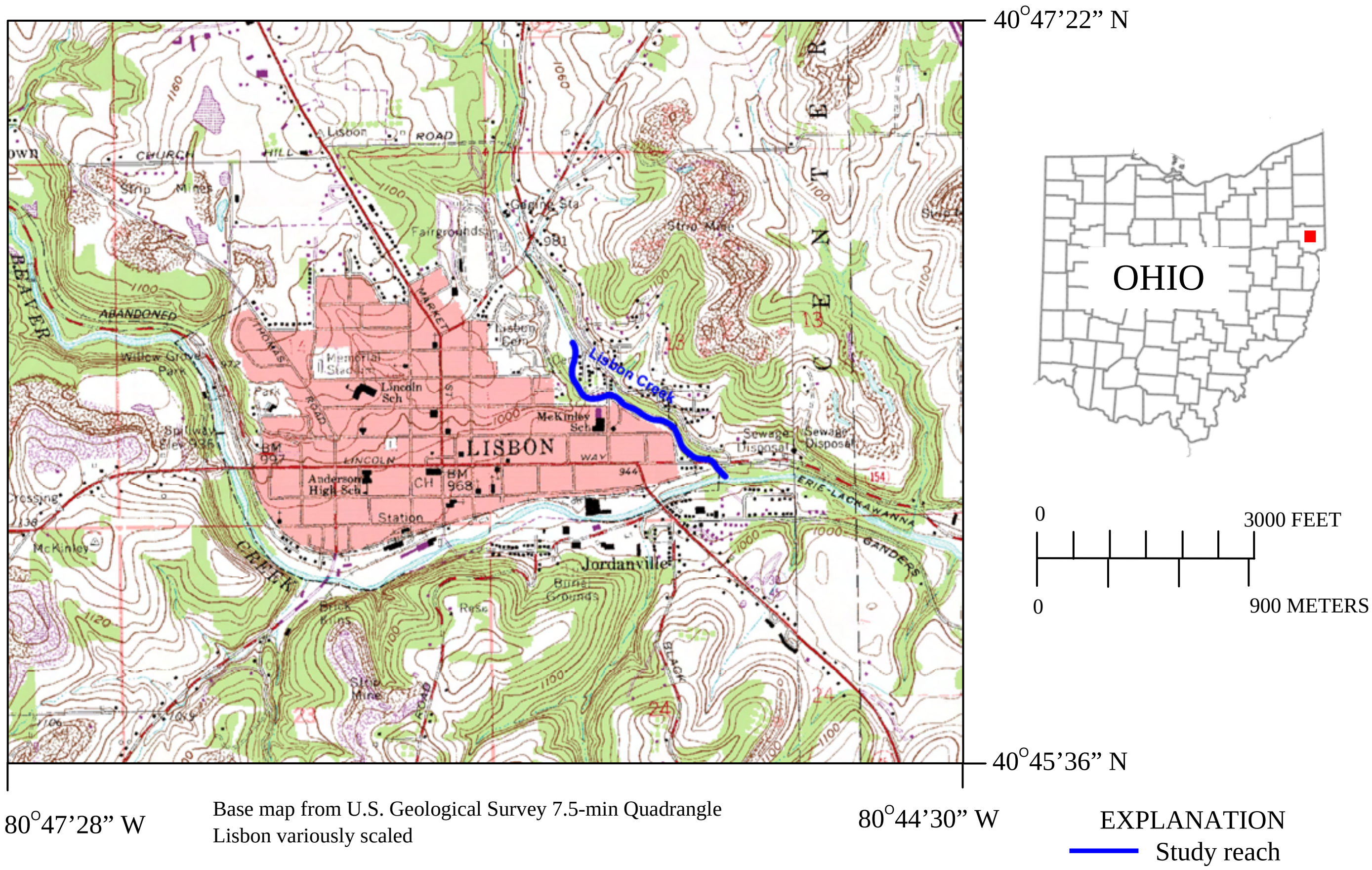

Figure 1–B1. Location of the Lisbon Creek study reach for the Village of Lisbon, Ohio.

1–C. Middle Fork Little Beaver Creek near the Villages of Lisbon and Elkton

Middle Fork Little Beaver Creek flows generally southeast in the central part of Columbiana County (fig. 1–C1). There are two reaches of Middle Fork Little Beaver Creek that were studied. Reach 1 is near the Village of Elkton. The downstream limit of Reach 1 is approximately 100 ft downstream from Elkton West Point Road. The upstream limit is approximately 1,350 ft upstream from Elkton West Point Road. This stream reach is approximately 0.3 mi long. Reach 2 is near the Village of Lisbon. The downstream limit of the Reach 2 is approximately 3.2 mi upstream from Elkton West Point Road (approximately 3,100 ft downstream of State Route 30). The upstream limit is approximately 100 ft downstream from State Route 30. This stream reach is approximately 0.6 mi long.

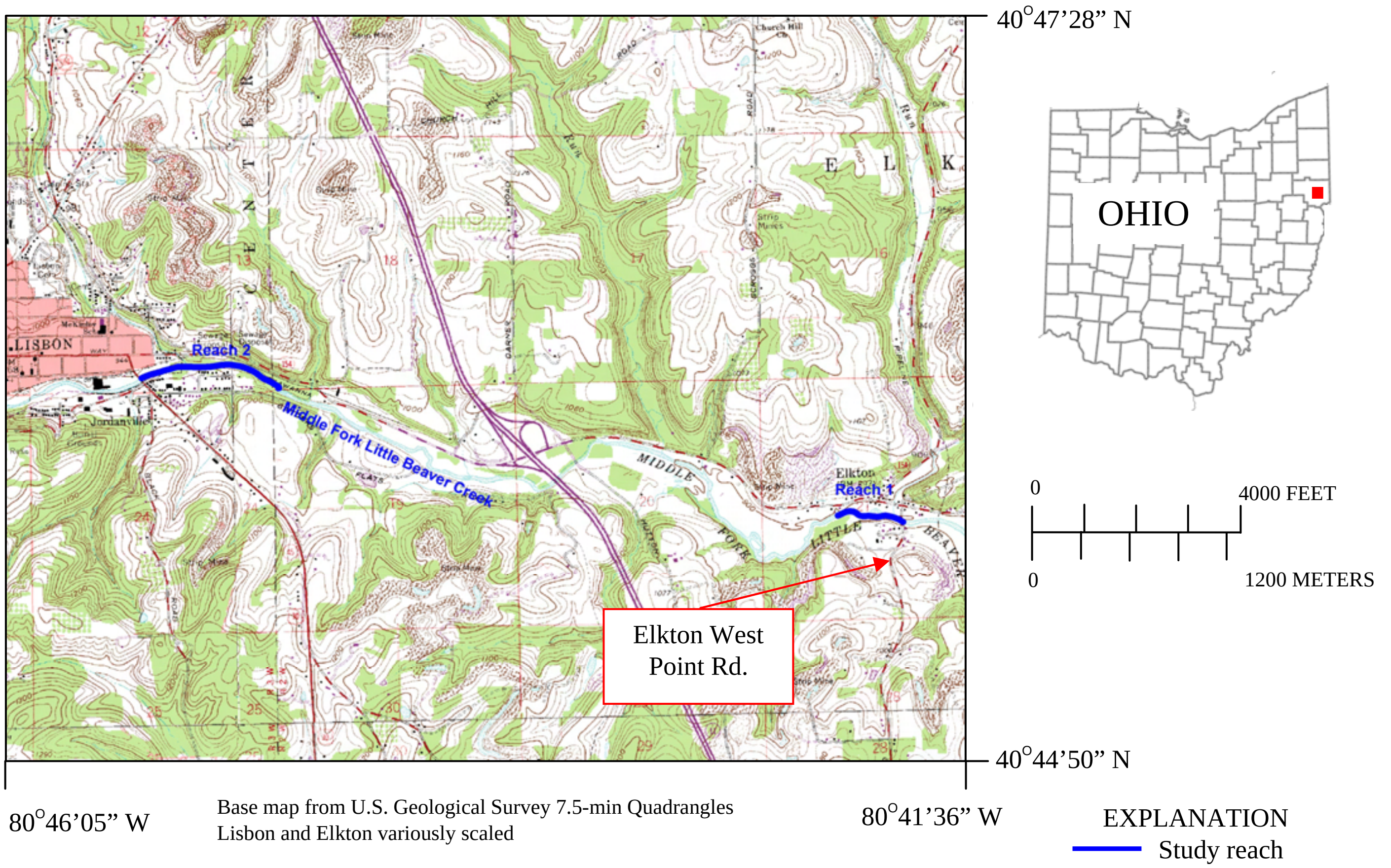

Figure 1–C1. Location of the Middle Fork Little Beaver Creek study reaches for the Villages of Lisbon and Elkton, Ohio.

1–D. McMahon Creek and Little McMahon Creek near the Village of Neffs

McMahon Creek and Little McMahon Creek flow generally east in the northeastern part of Belmont County (fig. 1–D1). There are three reaches (two on McMahon Creek and one on Little McMahon Creek) that were studied. McMahon Creek Reach 1 is about 0.6 mi west of Bellaire. The downstream limit of the McMahon Creek Reach 1 is approximately 4,200 ft upstream from Klee Cross Road near Bellaire, Ohio. The upstream limit is approximately 200 ft upstream from the abandoned Baltimore and Ohio railway bridge. This stream reach is approximately 0.07 mi long. The second reach is McMahon Creek Reach 2, located between St Joe and McClainville, Ohio. The downstream limit of this reach is State Route 149. The upstream limit is approximately 4,700 ft above State Route 149. This stream reach is approximately 0.9 mi long. The third reach is Little McMahon Creek on the West side of Neffs, Ohio. The downstream limit of this reach is the mouth (confluence with McMahon Creek). The upstream limit is 5,588 ft above the mouth. This stream reach is approximately 1.1 mi long.

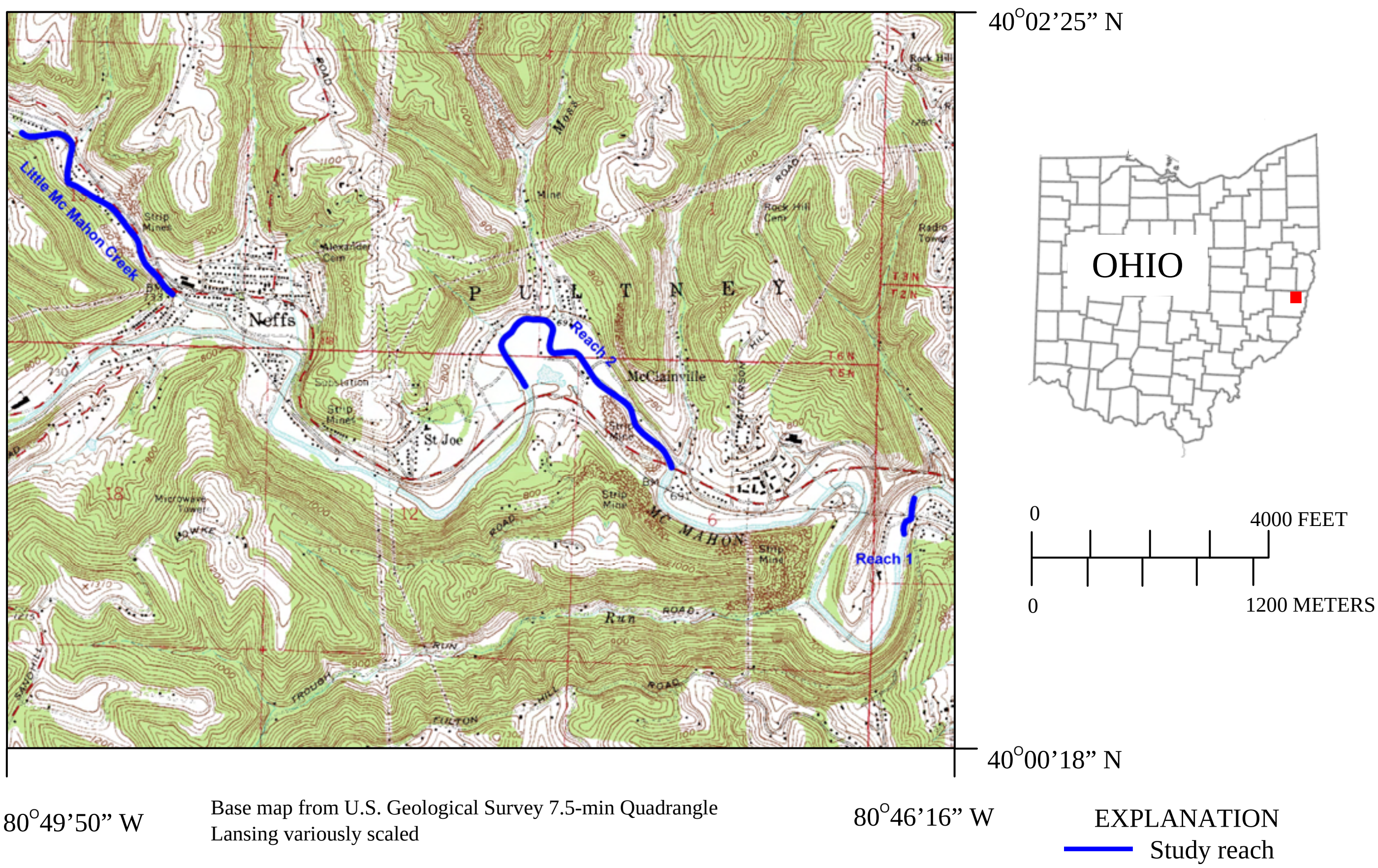

Figure 1–D1. Location of the McMahon Creek and Little McMahon Creek study reaches for the Village of Neffs, Ohio.

1–E. Little Muskingum River near the Village of New Matamoras

The Little Muskingum River flows generally southwest in parts of Monroe and Washington Counties (fig. 1–E1). The study reach is approximately 6.4 mi northwest of New Matamoras, Ohio. The downstream limit of the reach studied is the just above the confluence with Clear Fork. The upstream limit is approximately 500 ft above the confluence with Browns Run. This stream reach is approximately 4.3 mi long.

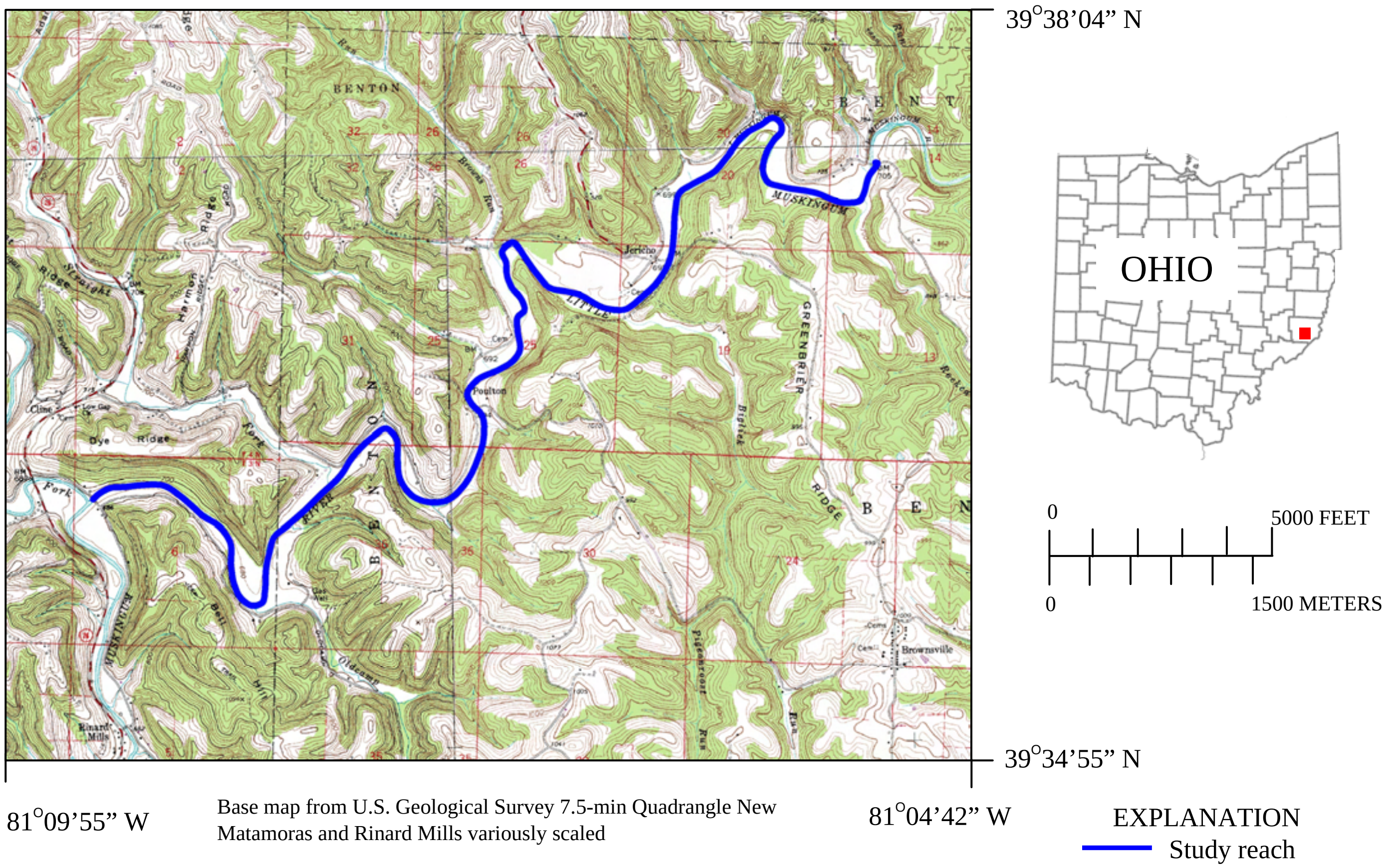

Figure 1–E1. Location of the Little Muskingum River study reach for the Village of New Matamoras, Ohio.

1–F. Wheeler Run near the Village of Woodsfield

Wheeler Run flows generally southeast in the northwestern part of Monroe County (fig. 1–F1). The study reach is approximately 2 mi northwest of Woodsfield, Ohio. The downstream limit of the reach studied is the mouth (confluence with Sunfish Creek). The upstream limit is approximately 0.43 mi upstream from County Road 100. This stream reach is approximately 0.46 mi long.

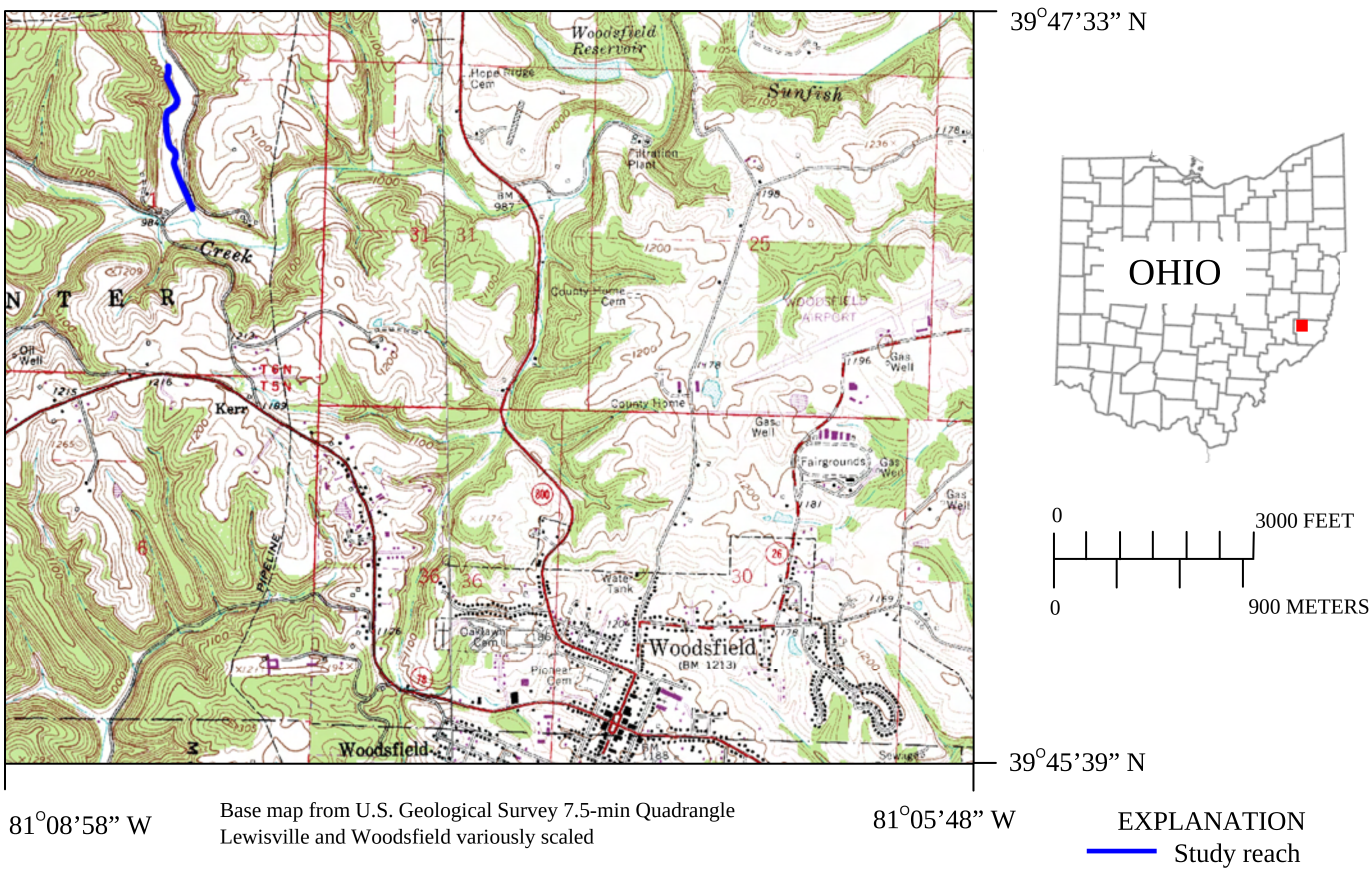

Figure 1–F1. Location of the Wheeler Run study reach for the Village of Woodsfield, Ohio.

1–G. Sandy Creek in Brown Township

Sandy Creek (called Big Sandy Creek in the 1990 FIS) flows generally west in the northern part of Carroll County (fig. 1-G1). The downstream limit of the reach studied is approximately 700 ft upstream from the Stark/Carroll County line (cross section A, station 95,440 from the 1990 FIS). The upstream limit is cross section E (station 105,890) from the 1990 FIS (approximately 4,400 ft west of the Village of Malvern western corporate limit). This stream reach is approximately 2.0 mi long.

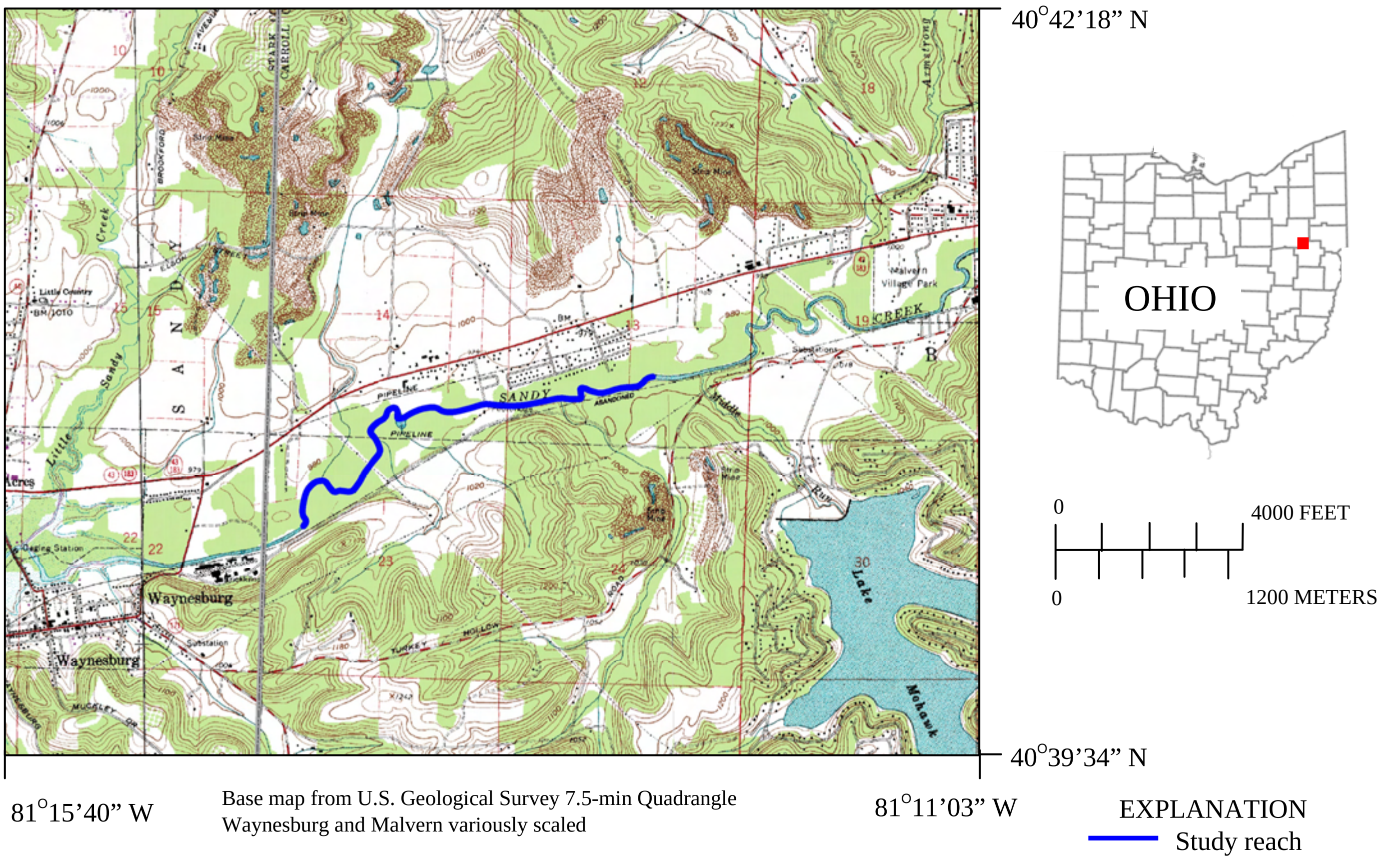

Figure 1–G1. Location of the Sandy Creek study reach for Brown Township, Carroll County, Ohio.

Engineering Analyses

Hydrologic Analyses

The USGS conducted an FIS for the Ohio EMA in seven communities from northeastern to southeastern Ohio. Selected flood profiles were determined for areas where they were needed to complete a cost-benefit analysis within the communities of Uhrichsville/Dennison, Lisbon, Elkton, Neffs, New Matamoras, Woodsfield, and Brown Township. Some communities already had detailed estimates and profiles from previous FISs for the 100-year-recurrence-interval flood. Some communities only had approximate estimates of the flood profiles. If existing detailed estimates of the profiles were available, they were used for the cost-benefit analysis. Any missing profiles were computed and added to the existing profiles to assure an estimate for the 10-, 50-, 100-, and 500-year-recurrence-interval peak flood profiles was available. Discharges, reported in cubic feet per second (ft^3/s), were determined at various locations along each stream for this study. The following paragraphs describe the hydrologic analyses conducted for each stream.

If peak flood estimates were needed for any of the 10-, 50-, 100-, and 500-year peak discharges, they were initially determined using methods described in Koltun (2003). Specific revisions to the estimates are discussed individually below. To compute peak-discharge estimates using the Koltun (2003) method, drainage area in square miles (mi^2), main-channel slope in feet per mile (ft/mi), and percentage of the basin classified as water or wetlands are required. These basin characteristics were determined using a geographic information system (GIS) applying methods described in Koltun (2003). The percentage of the basin classified as water or wetlands, for this discussion, is defined as the percentage of the drainage area designated as wetlands or open water in the 1992 National Land Cover data set (U.S. Geological Survey, 2000) compared to the total drainage area of the basin. The explanatory variables used in the regression equations, as well as, the resulting flood-peak discharges are presented in table 1–2.

1–A. Little Stillwater Creek near the Cities of Uhrichsville and Dennison

The operation of Tappan Reservoir has a direct effect on the peak flow estimates for this reach; therefore, use of the method described in Koltun (2003) is not appropriate. The U.S. Army Corps of Engineers (USACE), Huntington District provided peak flow estimates just below the dam of Tappan Reservoir (table 1–2). The drainage area just below the dam is 71.1 mi^2 and at the mouth of Little Stillwater Creek (at the confluence with Stillwater Creek) is 111 mi^2. To account for the contribution of flow of the drainage area between the mouth and just below Tappan Reservoir, peak-flow estimates were determined at both locations using StreamStats (a Web-based application described in Koltun and others, 2006). Data required for StreamStats is similar to the data needed in the method described in Koltun (2003). The difference between the estimates of just below Tappan Reservoir and the mouth added to USACE estimates from the reservoir are the values used in this study. All the estimates are presented in table 1–2. No gage-weighted estimates were applied.

1–B. Lisbon Creek near the Village of Lisbon

Peak-discharge estimates for Lisbon Creek were computed using methods described in Koltun (2003). Additionally, a technique to modify the discharges to account for the Lisbon Creek at Lisbon streamgage (USGS station number 03109000, 35 years of record) just upstream from the study area was applied to the analysis used in this study. Peak-discharge estimates for Lisbon Creek were computed using gage-weighted methods described in Koltun (2003). The results of the hydrologic analyses are listed in table 1–2.

1–C. Middle Fork Little Beaver Creek near the Villages of Lisbon and Elkton

The peak-flow estimates for both reaches were developed using the technique described in Koltun (2003). The results of the hydrologic analysis are listed in table 1–2.

1–D. McMahon Creek and Little McMahon Creek near the Village of Neffs

The peak-flow estimates for all three reaches were developed using the technique described in Koltun (2003). The results of the hydrologic analysis are listed in table 1–2.

1–E. Little Muskingum River near the Village of New Matamoras

The peak-flow estimates for this reach were determined by Streamstats, a method described in Koltun and others (2006). A technique to adjust the Streamstats discharge estimates to account for a streamgage just downstream from the study area (Little Muskingum River near Bloomfield, station number 03115400) was applied to both sites used in this analysis. The drainage area for Little Muskingum River near Bloomfield is 210 mi^2. The results of the hydrologic analyses are listed in table 1–2.

1–F. Wheeler Run near the Village of Woodsfield

The peak-flow estimates for this reach were developed using the technique described in Koltun (2003). The results of the hydrologic analysis are listed in table 1–2.

1–G. Sandy Creek in Brown Township

The reach of Sandy Creek (also referred to as Big Sandy Creek) studied for this project is part of a section studied in the Carroll County Unincorporated Areas, September 28, 1990, FIS (Community number 390763). However, three other FIS are used as references in this restudy. Downstream of this reach is the Village of Waynesburg FIS, January 5, 1982 (Community number 390667). Upstream of this reach are the Village of Malvern, Carroll County FIS, July 3, 1995 (Community number 390052) and the Village of Minerva, Stark, Carroll, and Columbiana Counties FIS, January 5, 1982 (Community number 390518).

Peak-discharge estimates for the 10-, 50-, 100-, and 500-year flood profiles were published in the 1982 Waynesburg (downstream) and the 1982 Minerva (upstream) FIS; however, only the 100-year peak-discharge estimates were published in both the Carroll County and Malvern FISs. The peak discharge estimates in these four studies were based upon either historical streamflow data for Sandy Creek at Waynesburg (USGS station number 03117500, 37 years of record) or, in the case of the ungaged sites, gage-adjusted regression-equation estimates using techniques described by Webber and Bartlett (1976).

To obtain discharge estimates for the 10-, 50-, and 500-year peak floods for locations in the Carroll County Unincorporated Area, a straight-line interpolation was made between previously established bounding peak-flood estimates from the upstream and downstream studies. The results of the hydrologic analyses are listed in table 1–2.

Table 1–2. Summary of the explanatory-variable values used in the regression equations and the resulting 10-, 50-, 100-, and 500-year flood-peak discharge estimates.

Location description	Drainage area (square miles)	Main-channel slope (feet per mile)	Water or wetlands area (percent)	Peak discharge for indicated recurrence interval (cubic feet per second)			
				10-year	50-year	100-year	500-year
Little Stillwater Creek							
At Tappan Reservoir Dam[1]	NA			500	600	680	830
Below Tappan Reservoir[2]	71.1	8.76	6.11	2,170	2,840	3,110	3,690
At mouth[2]	111	4.86	4.39	2,920	3,770	4,120	4,870
At mouth[3]	NA			1250	1,530	1,690	2,010
Lisbon Creek							
At mouth	6.83	51.1	0.43	1,120	1,730	2,000	2,630
At mouth[4]	6.83	51.1	0.43	919	1,470	1,740	2,420
Middle Fork Little Beaver Creek							
3.2 mile upstream of Elkton West Point Road	112	7.43	2.64	4,920	6,900	7,780	9,720
Elkton West Point Road	124	7.67	2.47	5,440	7,640	8,620	10,800
McMahon Creek							
At State Route 149	81.7	19.0	0.96	5,520	8,080	9,230	11,800
At Abandoned railroad	85.8	24.1	0.97	6,020	8,860	10,100	13,000
Little McMahon Creek							
At mouth	14.9	52.5	0.79	1,930	2,940	3,400	4,460
Little Muskingum River							
Above Straight Fork	131	7.11	0.31	7,660	11,000	12,500	16,000
Above Clear Fork	149	6.99	0.30	8,420	12,100	13,700	17,600
Above Straight Fork[5]	131	7.11	0.31	8,170	11,800	13,500	17,600
Above Clear Fork[5]	149	6.99	0.30	9,370	13,700	15,600	20,600
Wheeler Run							
At mouth	6.9	50.2	0.21	1,170	1,820	2,110	2,780
Sandy Creek (or Big Sandy Creek)							
At USGS streamgage (03117500)[6]	253	NA	NA	6,290	9,260	10,700	14,300
Upstream of Little Sandy Creek[6]	216	NA	NA	5,760	8,430	9,680	12,800
At County Boundary[7]	214	NA	NA	5,720	8,370	9,550	12,700
Downstream of Pipe Run[7]	191	NA	NA	5,220	7,610	8,700	11,520
Upstream of Pipe Run[7]	163	NA	NA	4,600	6,680	7,650	10,100
Downstream of Hugle Run[7]	160	NA	NA	4,530	6,570	7,500	9,890
Upstream of Hugle Run[7]	139	NA	NA	4,040	5,850	6,700	8,770
Downstream of Still Fork[7,8]	135	NA	NA	3,950	5,710	6,500	8,550

Table 1–2. Summary of the explanatory-variable values used in the regression equations and the resulting 10-, 50-, 100-, and 500-year flood-peak discharge estimates — Continued.

Location description	Drainage area (square miles)	Main-channel slope (feet per mile)	Water or wetlands area (percent)	Peak discharge for indicated recurrence interval (cubic feet per second)			
				10-year	50-year	100-year	500-year
Upstream of Still Fork[8]	63.2	NA	NA	2,230	3,310	3,810	5,100
Upstream of Whitacre Avenue Ditch[8]	59.8	NA	NA	2,110	3,140	3,620	4,850
Upstream of Pearson Ditch[8]	55.2	NA	NA	1,990	2,970	3,430	4,600

[1] Discharge estimates provided by the US Army Corps of Engineers, Huntington District.
[2] Values determined from StreamStats.
[3] Values used in model for FIS in Uhrichsville/Dennison area.
[4] Gage-weighted estimates of peak flow adjusted for USGS stream gaging station 03109000.
[5] Gage-weighted estimates of peak flow adjusted for USGS stream gaging station 03115400.
[6] Village of Waynesburg FIS, 1/5/82.
[7] Carroll County Unincorporated FIS, 9/28/1990.
[8] Village of Minerva, Stark, Carroll, and Columbiana Counties FIS, 1/5/82.

Hydraulic Analyses

HEC-RAS (version 3.1.1), with the HEC-2 conveyance computations option, was used to model flood profiles for all streams analyzed in this study effort. After the initial hydraulic model calculations were completed, warnings presented by the HEC-RAS model were reviewed. The results were assessed for validity, accuracy, and appropriate engineering practices. Some of the areas of concern included (1) critical water-surface calculations, (2) water-surface elevation differences between adjacent cross-sections, and (3) correct usage of ineffective flow areas. After the initial areas of concern were addressed, the HEC-RAS models were recalculated. All remaining warnings generated by HEC-RAS were reviewed and judged acceptable for the final models presented in this study. Table 1–3 lists the models used and the model analysis date for each stream submitted in this project.

Table 1–3. Summary of the hydraulic model version and analysis date for each of the studied stream reaches.

Flooding source	Hydraulic model version	Model analysis date
Little Stillwater Creek	HEC-RAS 3.1.1	12/13/2006
Lisbon Creek	HEC-RAS 3.1.1	1/17/2007
Middle Fork Little Beaver Creek Reach 1	HEC-RAS 3.1.1	1/16/2007
Middle Fork Little Beaver Creek Reach 2	HEC-RAS 3.1.1	1/18/2007
McMahon Creek Reach 1	HEC-RAS 3.1.1	11/28/2006
McMahon Creek Reach 2	HEC-RAS 3.1.1	11/27/2006
Little McMahon Creek	HEC-RAS 3.1.1	11/29/2006
Little Muskingum River	HEC-RAS 3.1.1	11/30/2006
Wheeler Run	HEC-RAS 3.1.1	11/28/2006
Sandy Creek	HEC-RAS 3.1.1	11/20/2006

Special Hydraulic Considerations

Solution Check at Bridges

During high-flow conditions, it is possible for pressure flow to occur at a bridge or culvert. Pressure flow occurs when the water surface on the upstream side of a bridge equals or exceeds the low-chord elevation. The validity of this type of solution was checked at all bridges where the water-surface elevation derived from the energy equation was found to be within 1.0 ft of the low-chord elevation of a bridge.

The standard-step method (energy equation) is applicable to the widest range of hydraulic problems (U.S. Army Corps of Engineers, 2002a). However, if flow conditions are such that the bridge opening may act like a pressurized orifice (flow comes in contact with the low chord), pressure-flow computations are warranted.

Submergence Check at Culverts

During high-flow conditions, it is also possible for road overflow to occur. Road overflow may result in weir flow if there is sufficient drop in channel/overbank elevation on the downstream side of the structure and the structure is not submerged. Submergence is determined as a function of the ratio of the downstream flow depth to the upstream energy grade line, as measured from the minimum high chord of the deck (U.S. Army Corps of Engineers, 2002b). The HEC-RAS model uses a default maximum submergence ratio of 0.95 for weir-flow calculations. The HEC-RAS Applications Guide states, "When this ratio is exceeded for a bridge analysis, the program will switch from the weir-flow equation to the energy method to determine the upstream flow depth. For a culvert analysis, this ratio is not used because the program cannot perform a backwater analysis through a culvert flowing full. Therefore, a weir analysis will always be used when overflow occurs." As a result, when road overflow occurs at a culvert and a weir-flow computation is determined to be invalid, other modeling techniques must be used to account for an energy-based solution. For situations in which road grades do not act like weirs, Shearman and others (1986) recommend abandoning culvert and weir hydraulics in favor of composite sections (the combination of the road and culvert cross-section geometries) to reflect pseudo-open-channel conditions.

Surveys Conducted by the USGS

The USGS conducted both Global Positioning System (GPS) and conventional surveys for this study. The GPS surveys were conducted to establish a control network at pertinent locations along each of the streams studied. Conventional surveys were conducted to obtain stream and hydraulic-structure geometry. Third-order accuracy (horizontal and vertical) was maintained for all conventional survey data collected (Federal Geodetic Control Committee, 1984).

Unless otherwise noted, the horizontal datum for the survey is the North American Datum of 1983 (NAD 83), Ohio State Plane (Ohio North or Ohio South) coordinates. The vertical datum for the survey is the National American Vertical Datum of 1988 (NAVD 88).

GPS surveys were conducted by the USGS using both Real-Time Kinematic (RTK) and static surveying techniques. Control for the USGS survey was established using a majority of National Geodetic Survey (NGS) monuments with known horizontal and/or vertical coordinates. A comparison of the published coordinates and surveyed coordinates are shown in each section for each stream. The bench marks that were used for each area network are listed in each section.

1–A. Little Stillwater Creek near the Cities of Uhrichsville and Dennison

Work Conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 20-ft contour map developed from the USGS 1:24,000-scale topographic quadrangle map Uhrichsville were used to establish the 10-, 50-, 100-, and 500-year flood profiles by use of HEC-RAS.

Scope of Work

The downstream limit of the reach studied is the confluence with Stillwater Creek. The upstream limit is approximately 10 ft below the South 6th Street bridge. This stream reach is approximately 1.9 mi long.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream reach is referenced to feet above the mouth and confluence with Stillwater Creek.

Cross-Section and Contracted-Opening-Geometry Data Surveyed in the Field

The USGS surveyed 15 cross sections, including 1 open-channel section and 4 hydraulic structures. All surveys were referenced to the North American Vertical Datum of 1988 (NAVD 88) and the North American Datum of 1983 (NAD 83).

Synthetic Cross-Sectional-Geometry Data

A total of 53 synthetic or partially synthetic cross sections at desired locations along the stream reach were generated from a Triangular Irregular Network (TIN) developed from the USGS 7.5-minute quadrangle map Uhrichsville. In-channel data for the synthetic cross sections were estimated by interpolation from cross-sectional data surveyed in the field.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for each profile was obtained from the backwater elevations of Stillwater Creek from the FEMA Flood Insurance Study City of Uhrichsville, Ohio, Tuscarawas County, published January 2, 1987. It is assumed that these starting elevations are more representative of the conditions than a slope-conveyance calculation at the mouth. The starting water-surface elevations of 844.0, 845.7, 847.9, and 853.0 ft were used at the initial section for the 10-, 50-, 100-, and 500-year profiles, respectively.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were determined from field observation by experienced personnel. Estimates of Manning's roughness coefficients range in value from 0.040 to 0.046 for the main channel and from 0.050 to 0.065 for the overbank areas.

Flow Lengths

Main-channel and overbank flow lengths were computed with HEC-GeoRAS. Flow paths are drawn in the GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths on the basis of the flow paths drawn.

Hydraulic-Structure Solution Reviews

For this study, all hydraulic-structure computations were reviewed for the appropriate modeling solutions (see “Special Hydraulic Considerations” section of “Hydraulic Analyses”). Initial reviews focused on the type of solution computed at each structure (based on energy equation or on pressure and/or weir-flow equations). Table 1–A1 lists the river station, a location description, the type of structure, the presence of road overflow, and the solution type of all structures affecting the 10-, 50-, 100-, and 500-year flood profiles for Little Stillwater Creek.

Table 1–A1. Summary of hydraulic-structure solutions for the 10-, 50-, 100-, and 500-year profiles of Little Stillwater Creek near the Cities of Uhrichsville and Dennison.

River station (feet)	Location description	Structure type	Recurrence interval (years)	Presence of road overflow	Solution type
6,434	Fourth Street	Bridge	10	N	Energy
6,434	Fourth Street	Bridge	50	N	Energy
6,434	Fourth Street	Bridge	100	N	Energy
6,434	Fourth Street	Bridge	500	Y	Energy
6,700	Center Street	Bridge	10	N	Energy
6,700	Center Street	Bridge	50	N	Energy
6,700	Center Street	Bridge	100	N	Energy
6,700	Center Street	Bridge	500	N	Energy
6,780	Conrail	Bridge	10	N	Energy
6,780	Conrail	Bridge	50	N	Energy
6,780	Conrail	Bridge	100	N	Energy
6,780	Conrail	Bridge	500	N	Energy
7,745	First Street	Bridge	10	N	Energy
7,745	First Street	Bridge	50	N	Energy
7,745	First Street	Bridge	100	N	Energy
7,745	First Street	Bridge	500	Y	Energy

Backwater Elevation

Stillwater Creek is affected by backwater from Stillwater Creek. A significant portion of the lower reach of Little Stillwater Creek will be submerged from the backwater of Stillwater Creek and the Tuscarawas River.

Base-Mapping Information

The base map used for this study was a digitized copy of the USGS Uhrichsville topographic quadrangle map.

Surveys Conducted by the USGS

A GPS survey was conducted by the USGS using Real-Time Kinematic (RTK) techniques and static surveying techniques. Control for the USGS survey was established by use of three NGS control monuments with known elevation. The USGS held one monument as true (L121) in elevation, as obtained from NGS. A comparison of the published elevations and surveyed elevations is given in table 1–A2. The bench mark descriptions also are included below.

Table 1–A2. Comparison of published coordinates to USGS-surveyed coordinates and bench marks used in the study of Little Stillwater Creek near the Cities of Uhrichsville and Dennison.

[All data shown in feet, NAD 83, and NAVD 88, shaded boxes were held as control points; NA, not available]

Reference mark number	Bench mark name	Published easting	Published northing	Published elevation	Surveyed easting	Surveyed northing	Surveyed elevation	Delta easting	Delta northing	Delta elevation
National Geodetic Survey (NGS) monuments										
1	Dennison	NA	NA	861.26	NA[a]	NA[a]	861.37	NA	NA	-0.11
2	M180	NA	NA	861.66	NA[a]	NA[a]	861.65	NA	NA	0.01
3	L121	NA	NA	855.14	NA[a]	NA[a]	855.14	NA	NA	0.00

[a] Northing and easting were not surveyed; elevation only.

Bench Mark Descriptions

RM1

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1       NATIONAL GEODETIC SURVEY,   RETRIEVAL DATE = JULY 11, 2006
 KY1445 ***********************************************************************
 KY1445  DESIGNATION -  DENNISON
 KY1445  PID       -  KY1445
 KY1445  STATE/COUNTY-  OH/TUSCARAWAS
 KY1445  USGS QUAD   -  UHRICHSVILLE (1994)
 KY1445
 KY1445                      *CURRENT SURVEY CONTROL
 KY1445  ___________________________________________________________________
 KY1445* NAD 83(1986)-  40 23 34.    (N)    081 20 01.    (W)    SCALED
 KY1445* NAVD 88    -      262.513  (METERS)    861.26   (FEET)  ADJUSTED
 KY1445  ___________________________________________________________________
 KY1445  GEOID HEIGHT-        -33.58  (METERS)                  GEOID03
 KY1445  DYNAMIC HT  -       262.380 (METERS)    860.83  (FEET)  COMP
 KY1445  MODELED GRAV-    980,114.4   (MGAL)                    NAVD 88
 KY1445
 KY1445  VERT ORDER  -  FIRST    CLASS II
 KY1445
 KY1445.THE HORIZONTAL COORDINATES WERE SCALED FROM A TOPOGRAPHIC MAP AND HAVE
 KY1445.AN ESTIMATED ACCURACY OF +/- 6 SECONDS.
 KY1445
 KY1445.THE ORTHOMETRIC HEIGHT WAS DETERMINED BY DIFFERENTIAL LEVELING
 KY1445.AND ADJUSTED BY THE NATIONAL GEODETIC SURVEY IN JUNE 1991.
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KY1445
KY1445.THE GEOID HEIGHT WAS DETERMINED BY GEOID03.
KY1445
KY1445.THE DYNAMIC HEIGHT IS COMPUTED BY DIVIDING THE NAVD 88
KY1445.GEOPOTENTIAL NUMBER BY THE NORMAL GRAVITY VALUE COMPUTED ON THE
KY1445.GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80) ELLIPSOID AT 45
KY1445.DEGREES LATITUDE (G = 980.6199 GALS.).
KY1445
KY1445.THE MODELED GRAVITY WAS INTERPOLATED FROM OBSERVED GRAVITY VALUES.
KY1445
KY1445;                    NORTH         EAST     UNITS  ESTIMATED ACCURACY
KY1445;SPC OH N     -    81,300.      699,030.      MT  (+/- 180 METERS SCALED)
KY1445
KY1445                          SUPERSEDED SURVEY CONTROL
KY1445
KY1445  NGVD 29 (??/??/92)  262.720  (M)         861.94   (F) ADJ UNCH    1 2
KY1445
KY1445.SUPERSEDED VALUES ARE NOT RECOMMENDED FOR SURVEY CONTROL.
KY1445.NGS NO LONGER ADJUSTS PROJECTS TO THE NAD 27 OR NGVD 29 DATUMS.
KY1445.SEE FILE DSDATA.TXT TO DETERMINE HOW THE SUPERSEDED DATA WERE DERIVED.
KY1445
KY1445_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TME716714(NAD 83)
KY1445_MARKER: DB = BENCH MARK DISK
KY1445_SETTING: 36 = SET IN A MASSIVE STRUCTURE
KY1445_SP_SET: BUILDING
KY1445_STAMPING: DENNISON 1934
KY1445_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
KY1445
KY1445  HISTORY     - DATE     CONDITION        REPORT BY
KY1445  HISTORY     - 1934     MONUMENTED        CGS
KY1445  HISTORY     - 1954     GOOD              NGS
KY1445
KY1445                          STATION DESCRIPTION
KY1445
KY1445'DESCRIBED BY NATIONAL GEODETIC SURVEY 1954
KY1445'AT DENNISON.
KY1445'AT DENNISON, ALONG THIRD STREET BETWEEN CENTER AND GRANT STREETS,
KY1445'SET VERTICALLY IN THE WEST FACE OF THE MUNICIPAL BUILDING, 31.8
KY1445'FEET NORTH OF SOUTHWEST CORNER OF BUILDING, 3 1/2 FEET SOUTH OF
KY1445'MAIN WEST ENTRANCE TO BUILDING AND 0.7 FOOT ABOVE LEVEL OF SIDE
KY1445'WALK.
```

RM2

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1        NATIONAL GEODETIC SURVEY,   RETRIEVAL DATE = JULY 11, 2006
KY1416 ***********************************************************************
KY1416  DESIGNATION -  M 180
KY1416  PID        -  KY1416
KY1416  STATE/COUNTY-  OH/TUSCARAWAS
KY1416  USGS QUAD   -  UHRICHSVILLE (1994)
KY1416
KY1416                         *CURRENT SURVEY CONTROL
KY1416  ___________________________________________________________________
KY1416* NAD 83(1986)-  40 23 32.     (N)    081 20 39.     (W)     SCALED
KY1416* NAVD 88     -      262.634  (METERS)     861.66   (FEET)  ADJUSTED
KY1416  ___________________________________________________________________
KY1416  GEOID HEIGHT-        -33.57  (METERS)                    GEOID03
KY1416  DYNAMIC HT  -       262.502 (METERS)     861.23  (FEET)  COMP
KY1416  MODELED GRAV-    980,114.6   (MGAL)                       NAVD 88
KY1416
KY1416  VERT ORDER  -  FIRST    CLASS II
KY1416
KY1416.THE HORIZONTAL COORDINATES WERE SCALED FROM A TOPOGRAPHIC MAP AND HAVE
KY1416.AN ESTIMATED ACCURACY OF +/- 6 SECONDS.
KY1416
KY1416.THE ORTHOMETRIC HEIGHT WAS DETERMINED BY DIFFERENTIAL LEVELING
KY1416.AND ADJUSTED BY THE NATIONAL GEODETIC SURVEY IN JUNE 1991.
KY1416
KY1416.THE GEOID HEIGHT WAS DETERMINED BY GEOID03.
KY1416
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KY1416.THE DYNAMIC HEIGHT IS COMPUTED BY DIVIDING THE NAVD 88
KY1416.GEOPOTENTIAL NUMBER BY THE NORMAL GRAVITY VALUE COMPUTED ON THE
KY1416.GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80) ELLIPSOID AT 45
KY1416.DEGREES LATITUDE (G = 980.6199 GALS.).
KY1416
KY1416.THE MODELED GRAVITY WAS INTERPOLATED FROM OBSERVED GRAVITY VALUES.
KY1416
KY1416;                    NORTH        EAST    UNITS  ESTIMATED ACCURACY
KY1416;SPC OH N    -    81,220.     698,130.     MT  (+/- 180 METERS SCALED)
KY1416
KY1416                        SUPERSEDED SURVEY CONTROL
KY1416
KY1416  NGVD 29 (??/??/92)  262.840  (M)         862.33   (F) ADJ UNCH    1 2
KY1416
KY1416.SUPERSEDED VALUES ARE NOT RECOMMENDED FOR SURVEY CONTROL.
KY1416.NGS NO LONGER ADJUSTS PROJECTS TO THE NAD 27 OR NGVD 29 DATUMS.
KY1416.SEE FILE DSDATA.TXT TO DETERMINE HOW THE SUPERSEDED DATA WERE DERIVED.
KY1416
KY1416_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TME707713(NAD 83)
KY1416_MARKER: DB = BENCH MARK DISK
KY1416_SETTING: 36 = SET IN A MASSIVE STRUCTURE
KY1416_SP_SET: BUILDING FOUNDATION
KY1416_STAMPING: M 180 1954
KY1416_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
KY1416
KY1416  HISTORY     - DATE     CONDITION       REPORT BY
KY1416  HISTORY     - 1954     MONUMENTED      CGS
KY1416
KY1416                        STATION DESCRIPTION
KY1416
KY1416'DESCRIBED BY COAST AND GEODETIC SURVEY 1954
KY1416'AT UHRICHSVILLE.
KY1416'AT UHRICHSVILLE, IN THE NORTHEAST ANGLE OF INTERSECTION OF NORTH
KY1416'MAIN AND EAST FOURTH STREET AND IN THE SOUTHEAST ANGLE OF CROSSING
KY1416'OF NORTH MAIN STREET AND THE PENNSYLVANIA RAILROAD, SET VERTICALLY
KY1416'IN THE WEST FACE OF CONCRETE FOUNDATION OF THE PENNSYLVANIA RAILROAD
KY1416'FREIGHT STATION, 1 FOOT NORTH OF SOUTHWEST CORNER AND 2 FEET
KY1416'ABOVE GROUND.
```

RM3

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1        NATIONAL GEODETIC SURVEY,   RETRIEVAL DATE = JULY 11, 2006
KY1397 ***********************************************************************
KY1397  DESIGNATION -  L 121
KY1397  PID       -  KY1397
KY1397  STATE/COUNTY-  OH/TUSCARAWAS
KY1397  USGS QUAD   -  UHRICHSVILLE (1994)
KY1397
KY1397                       *CURRENT SURVEY CONTROL
KY1397  ___________________________________________________________________
KY1397* NAD 83(1986)-  40 24 50.     (N)    081 21 25.     (W)     SCALED
KY1397* NAVD 88     -      260.646  (METERS)     855.14   (FEET)  ADJUSTED
KY1397  ___________________________________________________________________
KY1397  GEOID HEIGHT-        -33.54  (METERS)                    GEOID03
KY1397  DYNAMIC HT  -        260.515 (METERS)     854.71  (FEET)  COMP
KY1397  MODELED GRAV-    980,117.1   (MGAL)                     NAVD 88
KY1397
KY1397  VERT ORDER  -  FIRST    CLASS II
KY1397
KY1397.THE HORIZONTAL COORDINATES WERE SCALED FROM A TOPOGRAPHIC MAP AND HAVE
KY1397.AN ESTIMATED ACCURACY OF +/- 6 SECONDS.
KY1397
KY1397.THE ORTHOMETRIC HEIGHT WAS DETERMINED BY DIFFERENTIAL LEVELING
KY1397.AND ADJUSTED BY THE NATIONAL GEODETIC SURVEY IN JUNE 1991..
KY1397.WARNING-REPEAT MEASUREMENTS AT THIS CONTROL MONUMENT INDICATE POSSIBLE
KY1397.VERTICAL MOVEMENT.
KY1397
KY1397.THE GEOID HEIGHT WAS DETERMINED BY GEOID03.
KY1397
KY1397.THE DYNAMIC HEIGHT IS COMPUTED BY DIVIDING THE NAVD 88
```

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KY1397.GEOPOTENTIAL NUMBER BY THE NORMAL GRAVITY VALUE COMPUTED ON THE
KY1397.GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80) ELLIPSOID AT 45
KY1397.DEGREES LATITUDE (G = 980.6199 GALS.).
KY1397
KY1397.THE MODELED GRAVITY WAS INTERPOLATED FROM OBSERVED GRAVITY VALUES.
KY1397
KY1397;                   NORTH         EAST     UNITS  ESTIMATED ACCURACY
KY1397;SPC OH N     -    83,610.      697,020.      MT  (+/- 180 METERS SCALED)
KY1397
KY1397                         SUPERSEDED SURVEY CONTROL
KY1397
KY1397  NGVD 29 (??/??/92)  260.853  (M)         855.82   (F) ADJ UNCH    1 2
KY1397
KY1397.SUPERSEDED VALUES ARE NOT RECOMMENDED FOR SURVEY CONTROL.
KY1397.NGS NO LONGER ADJUSTS PROJECTS TO THE NAD 27 OR NGVD 29 DATUMS.
KY1397.SEE FILE DSDATA.TXT TO DETERMINE HOW THE SUPERSEDED DATA WERE DERIVED.
KY1397
KY1397_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TME697737(NAD 83)
KY1397_MARKER: DB = BENCH MARK DISK
KY1397_SETTING: 30 = SET IN A LIGHT STRUCTURE
KY1397_SP_SET: CATCH BASIN
KY1397_STAMPING: L 121 1943
KY1397_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
KY1397
KY1397  HISTORY     - DATE     CONDITION        REPORT BY
KY1397  HISTORY     - 1943     MONUMENTED         CGS
KY1397  HISTORY     - 1954     GOOD              NGS
KY1397
KY1397                         STATION DESCRIPTION
KY1397
KY1397'DESCRIBED BY NATIONAL GEODETIC SURVEY 1954
KY1397'1.6 MI NW FROM UHRICHSVILLE.
KY1397'ABOUT 1.55 MILES NORTHWEST ALONG THE BALTIMORE AND OHIO RAILROAD
KY1397'FROM THE CROSSING OF PENNSYULVANIA RAILROAD AT UHRICHSVILLE,
KY1397'ABOUT 0.2 MILE NORTHWEST OF CROSSING OF ENTRANCE ROAD TO ROBINSON
KY1397'AND SON CLAY PIPE COMPANY PLANT, IN THE TOP OF THE NORTH CORNER
KY1397'OF A 6 BY 6-FOOT CONCRETE CATCH BASIN FOR A CULVERT, 66.8 FEET
KY1397'SOUTHWEST AND ACROSS TRACK FROM TELEPHONE POLE NO. 62/26, 32.8
KY1397'FEET SOUTHWEST OF SOUTHWEST RAIL, 27 FEET SOUTH-SOUTHWEST OF A
KY1397'SEMAPHORE SIGNAL, AND ABOUT 1 1/2 FEET ABOVE LEVEL OF TRACK.
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Flood Profiles

The flood profiles for the Little Stillwater Creek near the Cities of Uhrichsville and Dennison for the 10-, 50-, 100-, and 500-year recurrence interval floods are presented in figure 1–A2. The locations of the cross sections are presented in figure 1–A3.

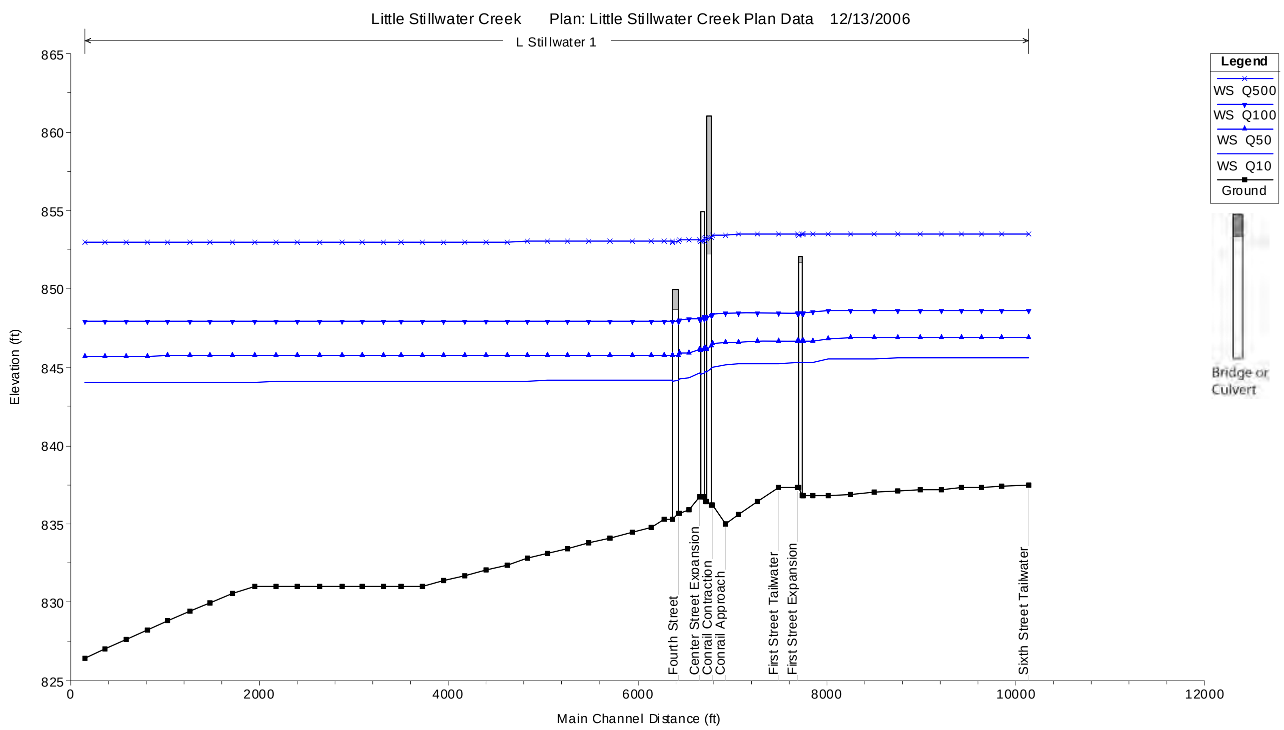

Figure 1–A2. Flood profiles for Little Stillwater Creek near the Cities of Uhrichsville and Dennison for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

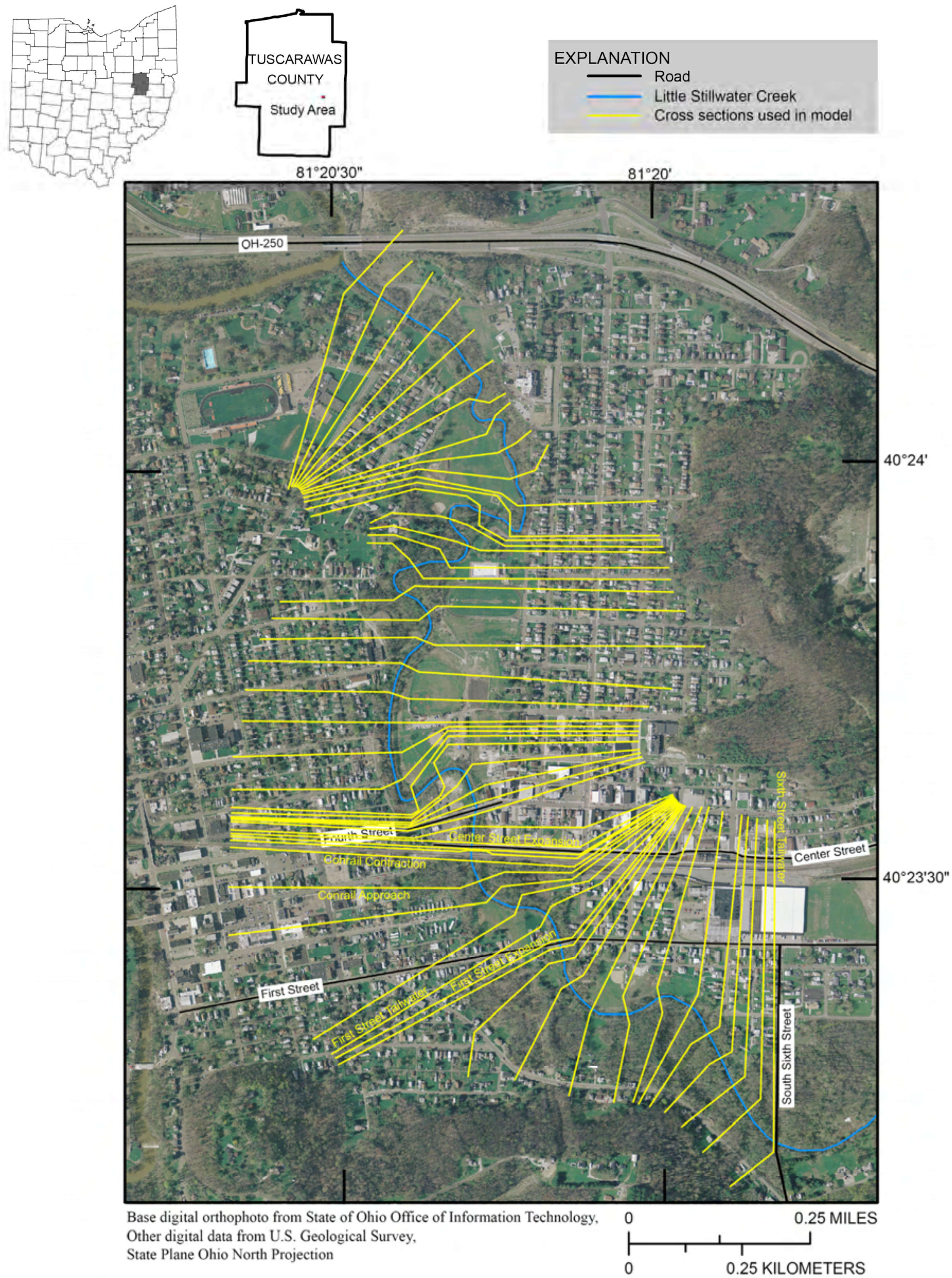

Figure 1–A3. Cross-section locations for flood profiles on Little Stillwater Creek near the Cities of Uhrichsville and Dennison, Ohio.

1–B. Lisbon Creek Near the Village of Lisbon

Work Conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 20-ft contour map developed from the USGS 1:24,000-scale topographic quadrangle map Lisbon were used to establish the 10-, 50-, 100-, and 500-year flood profiles by use of HEC-RAS.

Scope of Work

The downstream limit of the reach studied is the mouth (confluence with Middle Fork Little Beaver Creek). The upstream limit is approximately 3,200 ft above the mouth. This stream reach is approximately 0.6 mi long.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet above the mouth (confluence with Middle Fork Little Beaver Creek).

Cross-Section and Contracted-Opening-Geometry Data Surveyed in the Field

The USGS surveyed 11 cross sections, including 3 open-channel sections and 2 hydraulic structures. All surveys were referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29) and the North American Datum of 1983 (NAD 83).

Synthetic Cross-Sectional-Geometry Data

A total of 36 synthetic or partially synthetic cross sections at desired locations along the stream reach were generated from a TIN developed from the USGS 7.5-minute quadrangle map Lisbon. In-channel data for the synthetic cross sections were estimated by interpolation from cross-sectional data surveyed in the field.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for each profile was obtained by means of a slope-conveyance calculation. A slope of 0.01151 ft/ft was calculated from river stations and minimum channel elevations for cross sections 220 and 2,123. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, starting water-surface elevations of 921.93, 923.17, 923.68, and 924.80 ft were determined at the initial section (river station 151) for the 10-, 50-, 100-, and 500-year profiles, respectively.

Manning's Roughness Coefficients

Manning's roughness coefficients (n) for the main channel and overbank areas were determined from field observation by experienced personnel. Estimates of Manning's roughness coefficients range from 0.048 to 0.054 for the main channel and from 0.05 to 0.064 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed using HEC-GeoRAS. Flow paths are drawn in the GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths on the basis of flow paths drawn.

Hydraulic-Structure Solution Reviews

For this study, all hydraulic-structure computations were reviewed for the appropriate modeling solutions (see “Special Hydraulic Considerations” section of “Hydraulic Analyses”). Initial reviews focused on the type of solution computed at each structure (based on energy equation or on pressure and/or weir-flow equations). Table 1–B1 lists the river station, a location description, the type of structure, the presence of road overflow, and the solution type of all structures affecting the 10-, 50-, 100-, and 500-year flood profiles for Lisbon Creek.

Table 1–B1. Summary of hydraulic-structure solutions for the 10-, 50-, 100-, and 500-year profiles of Lisbon Creek near the Village of Lisbon.

River station (feet)	Location description	Structure type	Recurrence interval (years)	Presence of road overflow	Solution type
358	State Route 154	Bridge	10	N	Energy
358	State Route 154	Bridge	50	N	Energy
358	State Route 154	Bridge	100	N	Energy
358	State Route 154	Bridge	500	N	Energy
2,189	Pritchard Avenue	Bridge	10	N	Energy
2,189	Pritchard Avenue	Bridge	50	N	Pressure
2,189	Pritchard Avenue	Bridge	100	N	Pressure
2,189	Pritchard Avenue	Bridge	500	Y	Pressure

Backwater Elevation

Lisbon Creek will be subjected to backwater from the Middle Branch Little Beaver Creek but was modeled independently from the effects of this backwater.

Base-Mapping Information

The base map used for this study was a digitized copy of the USGS Lisbon topographic quadrangle map.

Surveys Conducted by the USGS

A GPS survey was conducted by the USGS using Real-Time Kinematic (RTK) techniques and static surveying techniques. Control for the USGS survey was established by use of four U.S. Coast and Geodetic Survey (USC&GS) monuments with known elevations. A comparison of the published elevations and surveyed elevations is given in table 1–B2. The bench mark descriptions also are included below.

Table 1–B2. Comparison of published coordinates to USGS-surveyed coordinates and bench marks used in the study of Lisbon Creek near the Village of Lisbon.

[All data shown in feet, NAD 83 and NGVD 29, shaded boxes were held as control points; NA, not available]

Reference mark number	Bench mark name	Published easting	Published northing	Published elevation	Surveyed easting	Surveyed northing	Surveyed elevation	Delta easting	Delta northing	Delta elevation
U.S. Coast & Geodetic Survey (USC&GS) monument										
1	LEETONIA 1950	NA	NA	1329.398	NA[a]	NA[a]	1329.398	NA	NA	0.000
2	6 LLB Reset 1994	NA	NA	997.160	NA[1]	NA[a]	996.816	NA	NA	0.344
3	8 LLB	NA	NA	1046.725	NA[a]	NA[a]	1046.371	NA	NA	0.354
4	968 STEUBENVILLE	NA	NA	967.734	NA[a]	NA[a]	967.871	NA	NA	-0.137

[a] Northing and easting were not surveyed; elevation only.

Bench Mark Descriptions

RM1

LEETONIA 1950
Unionville, 1.4 mi SW. of, along State Highway 164; on property owned by E.W. Thomas; 66 ft NE. of intersection of driveway; 42 ft E. of centerline of Highway 164; 15 ft SE. of witness post; in concrete post; NGS standard triangulation station disk stamped “LEETONIA 1950”

Elevation (NGVD 29) = 1329.398 ft

RM2

6 LLB Reset 1994
Lisbon, in sec. 14, T. 14 N., R. 3 W.; at concrete bridge over Erie-Lackawanna Railroad; in E. concrete abutment; standard tablet stamped “6 LLB1958 997”

Elevation (NGVD 29) = 996.822 ft

Note: Reset by the Ohio Department of Transportation (ODOT) Elevation (NGVD 29) = 997.160 ft

RM3

8 LLB
Dungannon, 2.5 mi E. of, along Lisbon Dungannon Road; in sec. 29, T. 14 N., R. 3 W.; at crossing of Cold Run; in E. end of N. sandstone abutment; standard tablet stamped “8 LLB 1958 1047”

Elevation (NGVD 29) = 1046.725 ft

RM4

968 STEUBENVILLE
Lisbon; at NE. corner of courthouse; in N. face; standard tablet stamped “968 STEUBENVILLE”

Elevation (NGVD 29) = 967.734 ft

Flood Profiles

The flood profiles for the Lisbon Creek near the Village of Lisbon for the 10-, 50-, 100-, and 500-year recurrence interval floods are presented in figure 1–B2. The locations of the cross sections are presented in figure 1–B3.

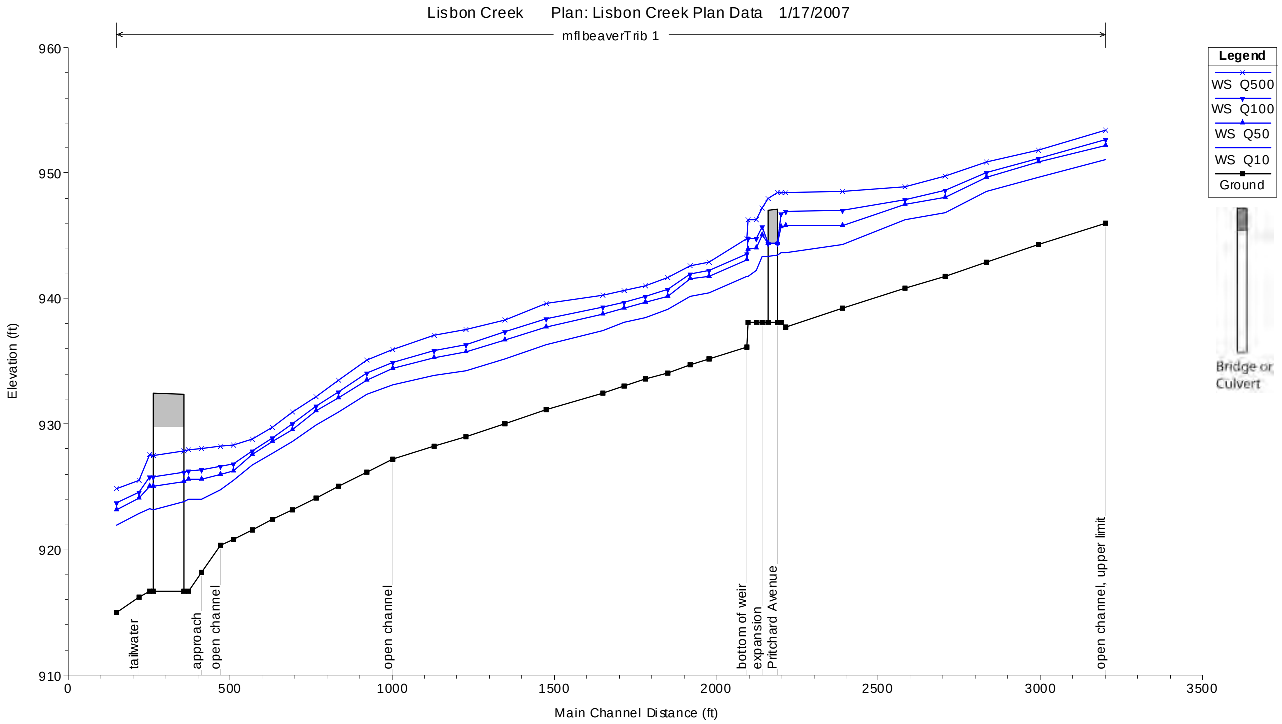

Figure 1–B2. Flood profiles for Lisbon Creek near the Village of Lisbon for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

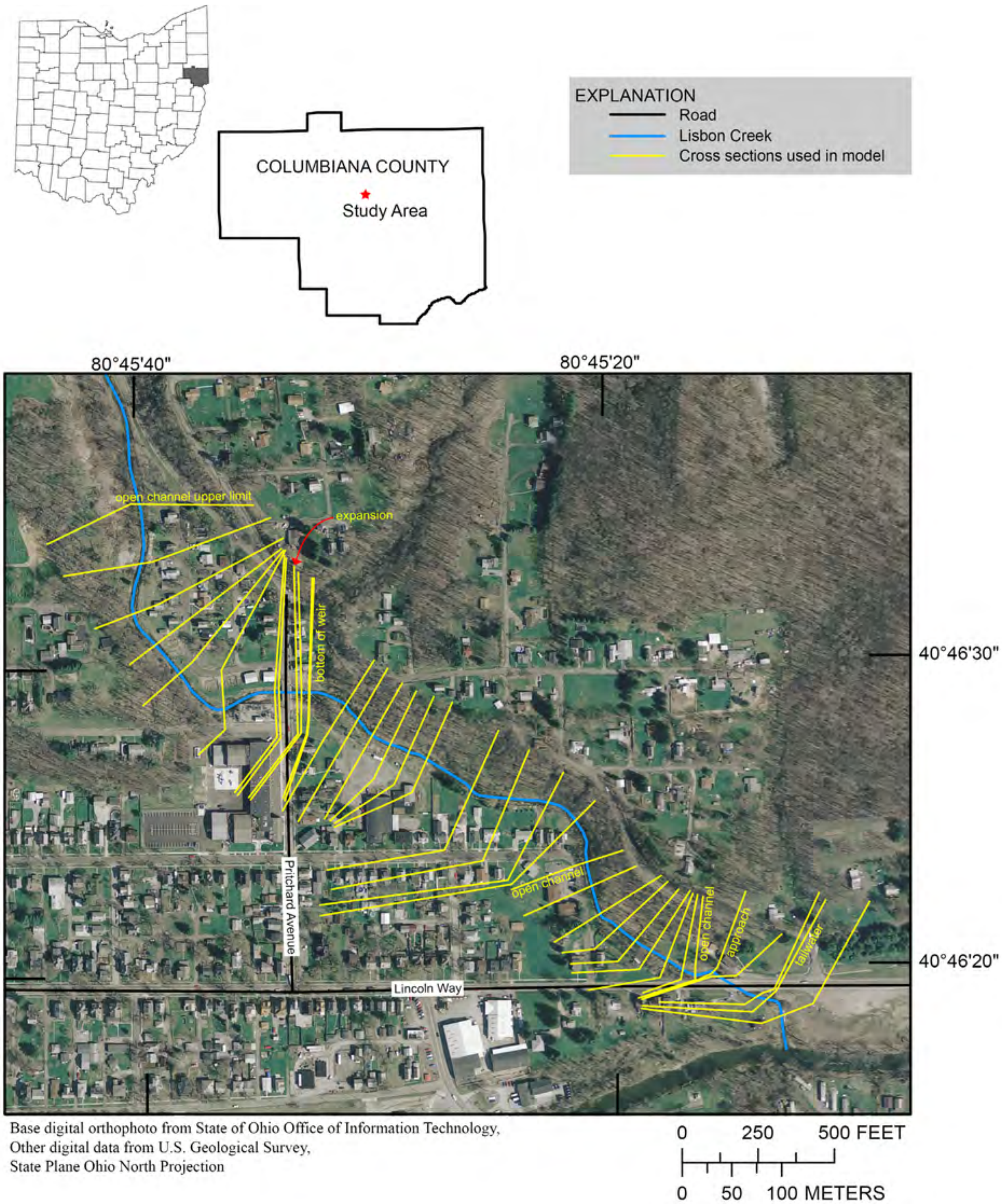

Figure 1–B3. Cross-section locations for flood profiles on Lisbon Creek near the Village of Lisbon, Ohio.

1–C. Middle Fork Little Beaver Creek Near the Villages of Lisbon and Elkton

Work Conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 20-ft contour map developed from the USGS 1:24,000-scale topographic maps Lisbon and Elkton were used to establish the 10-, 50-, 100- and 500-year flood profiles by use of HEC-RAS.

Scope of Work

The downstream limit of the Reach 1 studied is approximately 100 ft downstream from Elkton West Point Road. The upstream limit is approximately 1,350 ft upstream from Elkton West Point Road. This stream reach is approximately 0.3 mi long. The downstream limit of Reach 2 is approximately 3.2 mi upstream from Elkton West Point Road (approximately 3,100 ft downstream from State Route 30). The upstream limit is approximately 100 ft downstream from State Route 30. This stream reach is approximately 0.6 mi long.

Hydraulic Baselines

Stationing used for the hydraulic baseline for Reach 1 is referenced to approximately 100 ft downstream from Elkton West Point Road. Stationing used for the hydraulic baseline for Reach 2 is referenced to approximately 3.2 mi upstream from Elkton West Point Road (approximately 3,100 ft downstream from State Route 30).

Cross-Section and Contracted-Opening-Geometry Data Surveyed in the Field

The USGS surveyed seven cross sections, including three open-channel sections and one hydraulic structure for both reaches in this study. All surveys were referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29) and the North American Datum of 1983 (NAD 83).

Synthetic Cross-Sectional Geometry Data

A total of 22 synthetic or partially synthetic cross sections at desired locations along the stream reaches were generated from a TIN developed from the USGS 7.5-minute quadrangle maps Lisbon and Elkton. In-channel data for the synthetic cross sections were estimated by interpolation from cross-sectional data surveyed in the field.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for the Reach 1 profile was obtained by means of a slope-conveyance calculation. A slope of 0.00241 ft/ft was calculated from the river stations and minimum channel elevations for cross sections 211 and 1,475. These cross sections were obtained from field surveys and were assumed to provide a representative slope for the channel. Based on the calculated slope, starting water-surface elevations of 893.79, 894.80, 895.20, and 896.00 ft were determined at the initial section (river station 23) for the 10-, 50-, 100-, and 500-year profiles, respectively.

The starting water-surface elevation at the initial section for the Reach 2 profile was obtained by means of a slope-conveyance calculation. A slope of 0.00181 ft/ft was calculated from the river stations and minimum channel elevations for cross sections 16,956 and 19,836. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, starting water-surface elevations of 919.91, 921.30, 921.85, and 922.92 ft were determined at the initial section (river station 115) for the 10-, 50-, 100-, and 500-year profiles, respectively.

Manning's Roughness Coefficients

Manning's roughness coefficients (n) for the main channel and overbank areas were determined from field observation by experienced personnel. Estimates of Manning's roughness coefficients were 0.046 for the main channel and 0.052 for the overbank areas for both reaches.

Flow Lengths

Main-channel and overbank flow lengths were computed with HEC-GeoRAS. Flow paths are drawn in the GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths on the basis of the flow paths drawn.

Hydraulic-Structure Solution Reviews

For this study, all hydraulic-structure computations were reviewed for the appropriate modeling solutions (see Special Hydraulic Considerations section of Hydraulic Analyses). Initial reviews focused on the type of solution computed at each structure (based on energy equation or on pressure and/or weir-flow equations). Table 1–C1 shows the river station, a location description, the type of structure, the presence of road overflow, and the solution type of all structures affecting the 10-, 50-, 100-, and 500-year flood profiles for Middle Fork Little Beaver Creek Reach 1. There are no hydraulic structures in Middle Fork Little Beaver Creek Reach 2.

Table 1–C1. Summary of hydraulic-structure solutions for the 10-, 50-, 100-, and 500-year profiles of Middle Fork Little Beaver Creek Reach 1 near the Village of Elkton.

River station (feet)	Location description	Structure type	Recurrence interval (years)	Presence of road overflow	Solution type
		Middle Fork Little Beaver Creek Reach 1			
134	Elkton West Point Road	Bridge	10	Y	Energy
134	Elkton West Point Road	Bridge	50	Y	Energy
134	Elkton West Point Road	Bridge	100	Y	Energy
134	Elkton West Point Road	Bridge	500	Y	Energy

Backwater Elevation

Middle Fork Little Beaver Creek should not be subject to backwater in either reach.

Base-Mapping Information

The base map used for this study was a digitized copy of the combined USGS Lisbon and Elkton topographic quadrangle maps.

Surveys Conducted by the USGS

A GPS survey was conducted by the USGS using Real-Time Kinematic (RTK) techniques and static surveying techniques. Control for the USGS survey was established by use of four USC&GS monuments with known elevation. A comparison of the published elevations and surveyed elevations are shown in table 1–C2. The bench mark descriptions also are included below.

Table 1–C2. Comparison of published coordinates to USGS-surveyed coordinates and bench marks used in the study of Reach 1 and Reach 2 of Middle Fork Little Beaver Creek near the Villages of Lisbon and Elkton.
[All data shown in feet, NAD 83 and NGVD 29; NA, not available]

Reference mark number	Bench mark name	Published easting	Published northing	Published elevation	Surveyed easting	Surveyed northing	Surveyed elevation	Delta easting	Delta northing	Delta elevation
U.S. Coast & Geodetic Survey (USC&GS) monuments										
1	LEETONIA 1950	NA	NA	1329.398	NA[a]	NA[a]	1329.398	NA	NA	0.000
2	6 LLB Reset 1994	NA	NA	997.160	NA[a]	NA[a]	996.816	NA	NA	0.344
3	8 LLB	NA	NA	1046.725	NA[a]	NA[a]	1046.371	NA	NA	0.354
4	968 STEUBENVILLE	NA	NA	967.734	NA[a]	NA[a]	967.871	NA	NA	-0.137

[a] Northing and easting were not surveyed; elevation only.

Bench Mark Descriptions

RM1

LEETONIA 1950
Unionville, 1.4 mi SW. of, along State Highway 164; on property owned by E.W. Thomas; 66 ft NE. of intersection of driveway; 42 ft E. of centerline of Highway 164; 15 ft SE. of witness post; in concrete post; NGS standard triangulation station disk stamped “LEETONIA 1950”

Elevation (NGVD 29) = 1329.398 ft

RM2

6 LLB Reset 1994
Lisbon, in sec. 14, T. 14 N., R. 3 W.; at concrete bridge over Erie-Lackawanna Railroad; in E. concrete abutment; standard tablet stamped “6 LLB1958 997”

Elevation (NGVD 29) = 996.822 ft

Note: Reset by the Ohio Department of Transportation (ODOT) Elevation (NGVD 29) = 997.160 ft

RM3

8 LLB
Dungannon, 2.5 mi E. of, along Lisbon Dungannon Road; in sec. 29, T. 14 N., R. 3 W.; at crossing of Cold Run; in E. end of N. sandstone abutment; standard tablet stamped “8 LLB 1958 1047”

Elevation (NGVD 29) = 1046.725 ft

RM4

968 STEUBENVILLE
Lisbon; at NE. corner of courthouse; in N. face; standard tablet stamped “968 STEUBENVILLE”
Elevation (NGVD 29) = 967.734 ft

Flood Profiles

The flood profiles for Reach 1 and Reach 2 of Middle Fork Little Beaver Creek near the Villages of Lisbon and Elkton for the 10-, 50-, 100-, and 500-year recurrence interval floods are presented in figures 1–C2 and 1–C3, respectively. The locations of the cross sections for Middle Fork Little Beaver Creek Reach 1 and 2 are presented in figures 1–C4 and 1–C5, respectively.

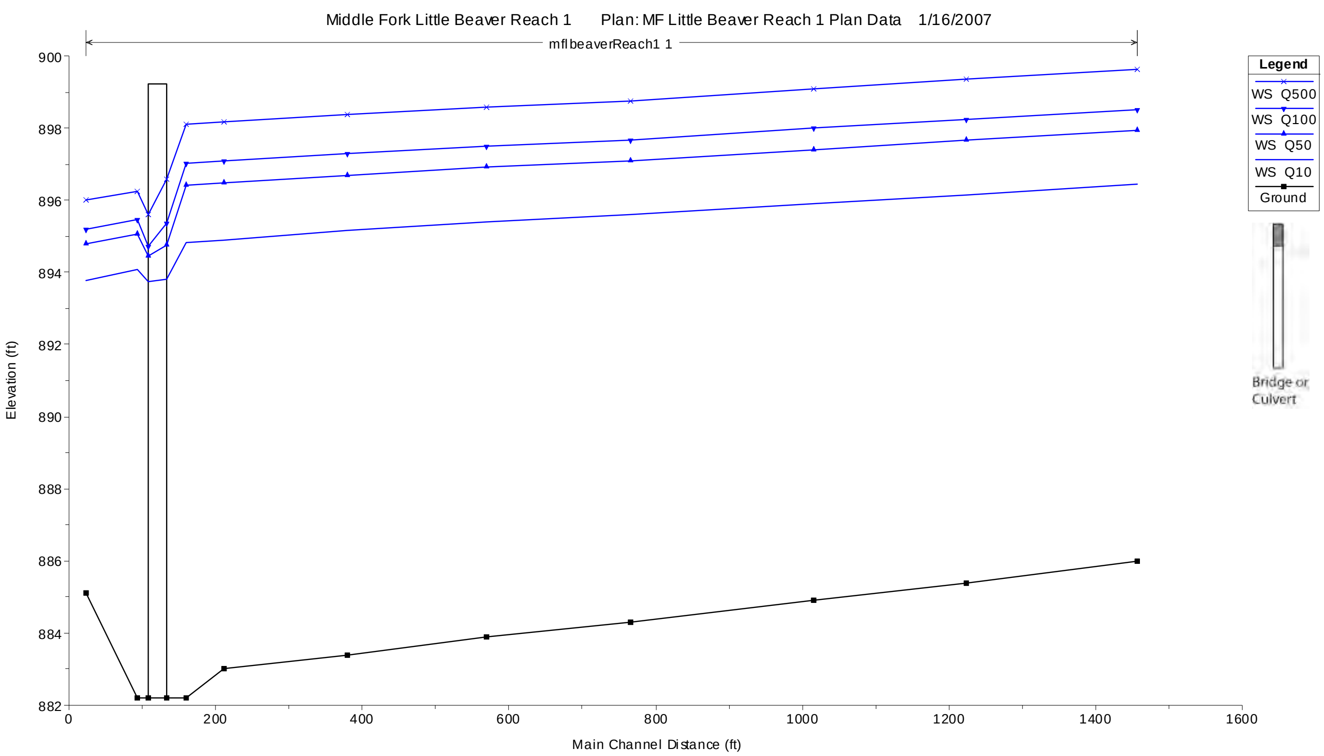

Figure 1–C2. Flood profiles for the Middle Fork Little Beaver Creek Reach 1 near the Villages of Lisbon and Elkton for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

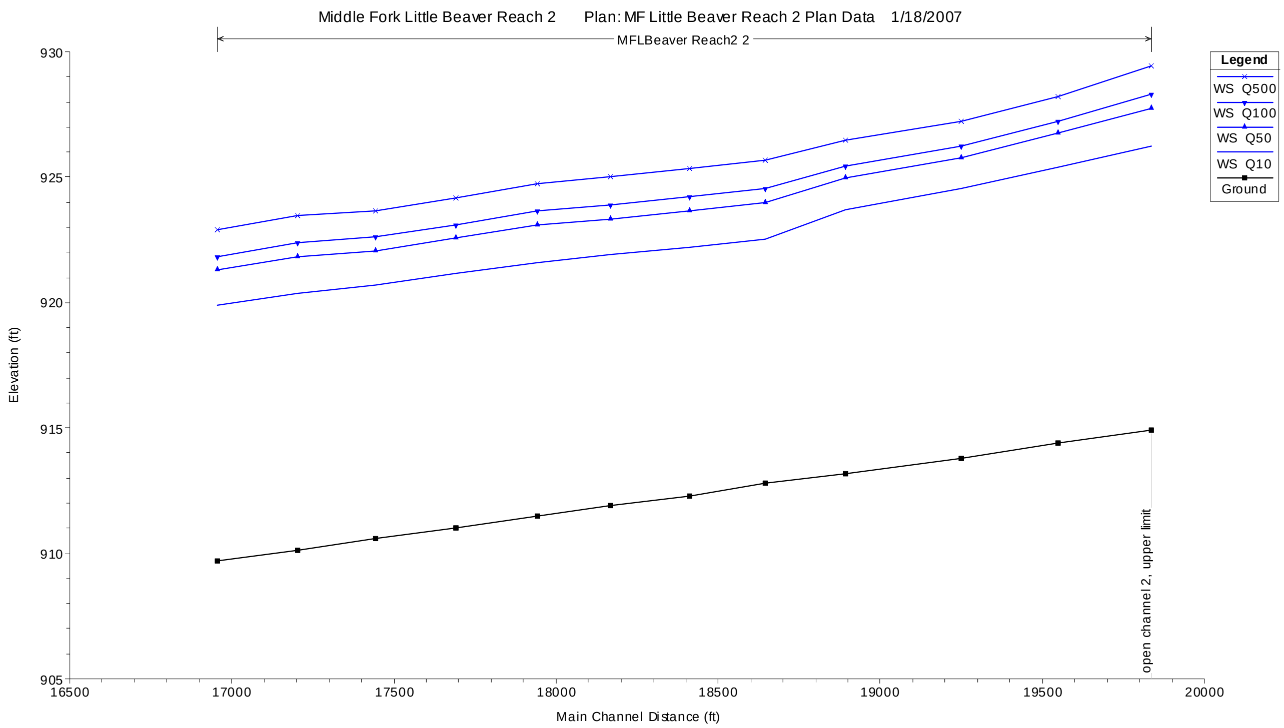

Figure 1–C3. Flood profiles for the Middle Fork Little Beaver Creek Reach 2 near the Villages of Lisbon and Elkton for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

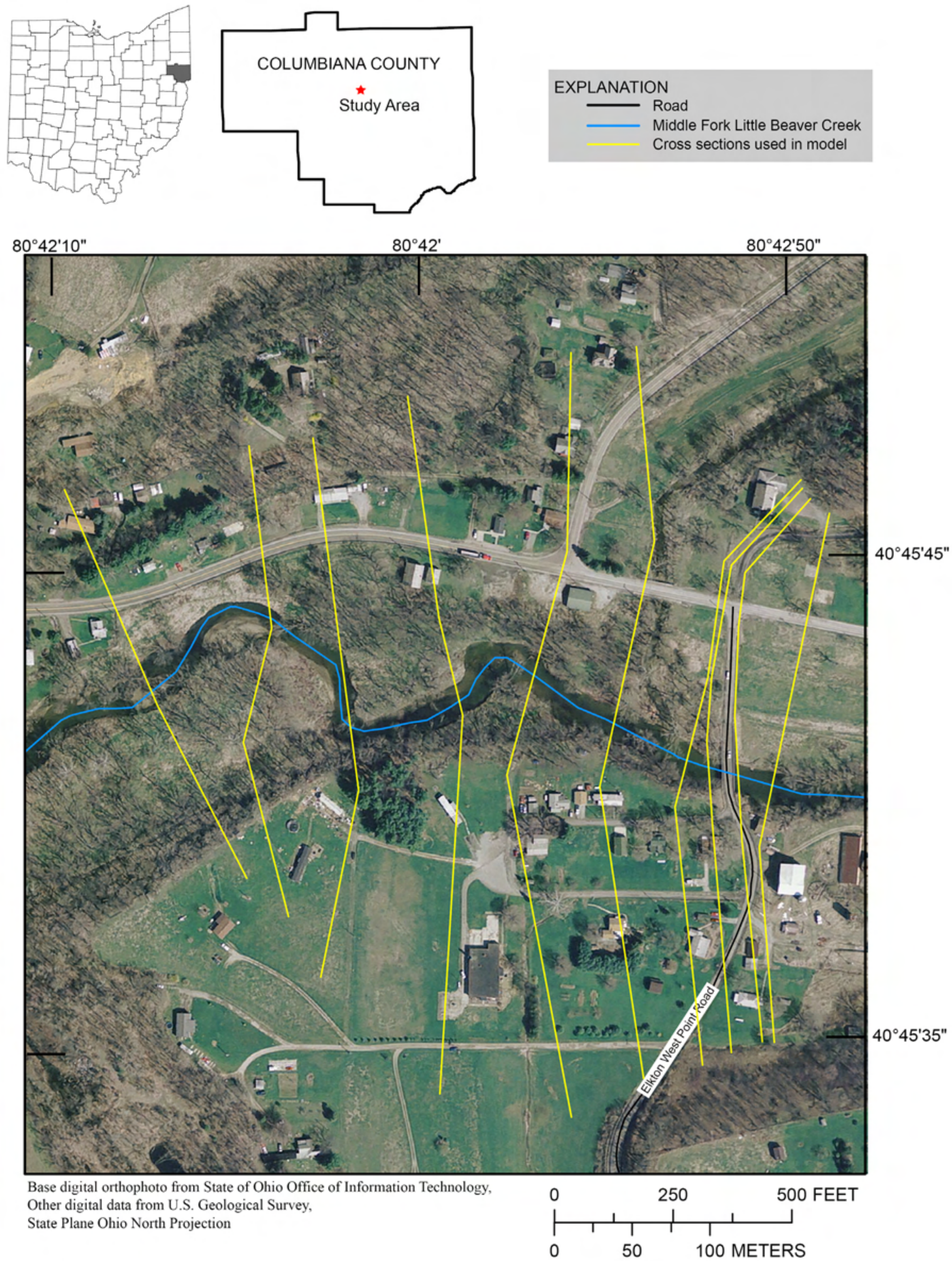

Figure 1–C4. Cross-section locations for flood profiles on Little Beaver Creek Reach 1 near the Village of Elkton, Ohio.

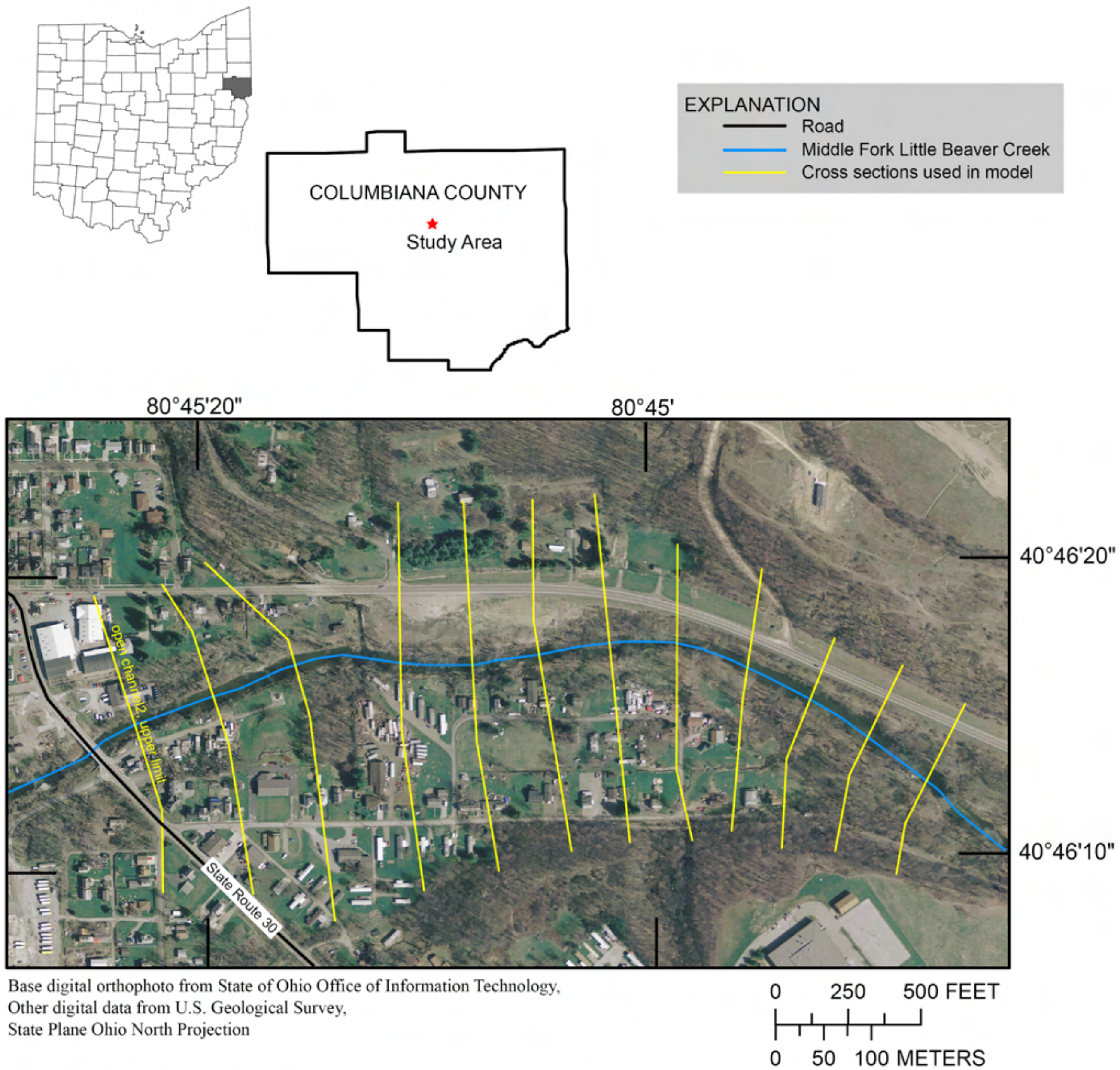

Figure 1–C5. Cross-section locations for flood profiles on Little Beaver Creek Reach 2 near the Village of Lisbon, Ohio.

1–D. McMahon Creek and Little McMahon Creek Near the Village of Neffs

Work Conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 20-ft contour map developed from the USGS 1:24,000-scale topographic quadrangle map Lansing were used to establish the 10-, 50-, 100-, and 500-year flood profiles by use of HEC-RAS.

Scope of Work

The downstream limit of McMahon Creek Reach 1 is approximately 4,200 ft upstream from Klee Cross Road near Bellaire, Ohio. The upstream limit is approximately 200 ft upstream from the abandoned Baltimore and Ohio railway bridge. This stream reach is approximately 0.07 mi long. The downstream limit of McMahon Creek Reach 2 is State Route 149. The upstream limit is approximately 4,700 ft above State Route 149. This stream reach is approximately 0.9 mi long. The downstream limit of the reach on Little McMahon Creek is the mouth (confluence with McMahon Creek). The upstream limit is 5,588 ft above the mouth. This stream reach is approximately 1.1 mi long.

Hydraulic Baseline

Stationing used for the hydraulic baseline for both McMahon Creek Reach 1 and Reach 2 is referenced to feet above Klee Cross Road. Stationing used for the hydraulic baseline for Little McMahon Creek is referenced to feet above mouth.

Cross-Section and Contracted-Opening-Geometry Data Surveyed in the Field

The USGS surveyed 24 cross sections, including 5 open-channel sections and 5 hydraulic structures for the 3 reaches. All surveys were referenced to the North American Vertical Datum of 1929 (NGVD 29) and the North American Datum of 1983 (NAD 83).

Synthetic Cross-Sectional-Geometry Data

A total of 57 synthetic or partially synthetic cross sections at desired locations along the stream reaches were generated from a TIN developed from the USGS 7.5-minute quadrangle map Lansing. In-channel data for the synthetic cross sections were estimated by interpolation from cross-sectional data surveyed in the field.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for each profile of McMahon Creek Reach 1 was obtained by means of a slope-conveyance calculation. The HEC-RAS model for Reach 1 is only four cross-sections long and surrounds a hydraulic structure that is prone to scour; therefore, the slope was taken from the HEC-RAS model for McMahon Creek Reach 2. A slope of 0.0010 ft/ft was calculated from the river stations and minimum channel elevations for cross sections 14,983 and 17,322 taken from the McMahon Creek Reach 2 data submittal. These cross sections were obtained from field surveys and were assumed to provide a representative slope for the channel. Based on the calculated slope, starting water-surface elevations of 651.38, 654.28, 655.42, and 657.89 ft were determined at the initial section for the 10-, 50-, 100-, and 500-year profiles, respectively.

The starting water-surface elevation at the initial section for each profile of McMahon Creek Reach 2 was obtained by means of a slope-conveyance calculation. A slope of 0.0010 ft/ft was calculated from the river stations and minimum channel elevations for cross sections 14,983 and 17,322. These cross sections were obtained from field surveys and were assumed to provide a representative slope for the channel. Based on the calculated slope, starting water-surface elevations of 685.36, 687.59, 688.43, and 690.09 ft were determined at the initial section for the 10-, 50-, 100-, and 500-year profiles, respectively.

The starting water-surface elevation at the initial section for each profile on Little McMahon Creek was obtained by means of a slope-conveyance calculation. A slope of 0.0071 ft/ft was calculated from the river stations and minimum channel elevations for cross sections 1,203 and 3,086. These cross sections were obtained from field surveys and were assumed to provide a representative slope for the channel. Based on the calculated slope, starting water-surface elevations of 726.44, 728.09, 728.68, and 729.77 ft were determined at the initial section for the 10-, 50-, 100-, and 500-year profiles, respectively.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were determined from field observation by experienced personnel. For all three models, estimates of Manning's roughness coefficients range from 0.052 to 0.054 for the main channel and from 0.064 to 0.084 for the overbank areas.

Flow Lengths

Main-channel and overbank flow lengths were computed with HEC-GeoRAS. Flow paths are drawn in the GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths on the basis of the flow paths drawn.

Hydraulic-Structure Solution Reviews

For this study, all hydraulic-structure computations were reviewed for the appropriate modeling solutions (see “Special Hydraulic Considerations” section of “Hydraulic Analyses”). Initial reviews focused on the type of solution computed at each structure (based on energy equation or on pressure and/or weir-flow equations). Table 1–D1 lists the river station, a location description, the type of structure, the presence of road overflow, and the solution type of all structures affecting the 10-, 50-, 100-, and 500-year flood profiles for McMahon Creek Reach 1, McMahon Creek Reach 2, and Little McMahon Creek.

Table 1–D1. Summary of hydraulic-structure solutions for the 10-, 50-, 100-, and 500-year profiles of Reach 1 and Reach 2 of McMahon Creek, and Little McMahon Creek near the Village of Neffs.

River station (feet)	Location description	Structure type	Recurrence interval (years)	Presence of road overflow	Solution type
		McMahon Creek Reach 1			
4,375	Railroad	Bridge	10	N	Energy
4,375	Railroad	Bridge	50	N	Energy
4,375	Railroad	Bridge	100	N	Energy
4,375	Railroad	Bridge	500	N	Energy
		McMahon Creek Reach 2			
15,096	State Route 149	Bridge	10	N	Energy
15,096	State Route 149	Bridge	50	N	Energy
15,096	State Route 149	Bridge	100	N	Energy
15,096	State Route 149	Bridge	500	N	Energy
		Little McMahon Creek			
1,275	State Route 149	Bridge	10	N	Energy
1,275	State Route 149	Bridge	50	Y	Energy
1,275	State Route 149	Bridge	100	Y	Pressure
1,275	State Route 149	Bridge	500	Y	Pressure
3,136	unnamed road	Bridge	10	N	Energy
3,136	unnamed road	Bridge	50	Y	Pressure
3,136	unnamed road	Bridge	100	Y	Pressure
3,136	unnamed road	Bridge	500	Y	Pressure
4,688	unnamed road	Bridge	10	Y	Pressure
4,688	unnamed road	Bridge	50	Y	Pressure
4,688	unnamed road	Bridge	100	Y	Pressure
4,688	unnamed road	Bridge	500	Y	Pressure

Backwater Elevation

None of the three reaches should be subject to backwater.

Base-Mapping Information

The base map used for this study was a digitized copy of the USGS Lansing topographic quadrangle maps.

Surveys Conducted by the USGS

A GPS survey was conducted by the USGS using Real-Time Kinematic (RTK) techniques and static surveying techniques. Control for the USGS survey was established by use of three NGS control monuments with known elevation, and three USC&GS monuments with known elevations. The USGS held L 115 as true in elevation, as obtained from NGS. A comparison of the published elevations and surveyed elevations is given in table 1–D2. The bench mark descriptions also are included below.

Table 1–D2. Comparison of published coordinates to USGS-surveyed coordinates and bench marks used in the study of Reach 1 and Reach 2 of McMahon Creek and Little McMahon Creek near the Village of Neffs.
[All data shown in feet, NAD 83 and NGVD 29; shaded boxes indicate control points; NA, not available]

Reference mark number	Bench mark name	Published easting	Published northing	Published elevation	Surveyed easting	Surveyed northing	Surveyed elevation	Delta easting	Delta northing	Delta elevation
National Geodetic Survey (NGS) monuments										
1	L 115	2441942.236	757236.234	714.920[a]	2441942.236	757236.234	714.92	0.000	0.000	0.000
2	W 115	NA	NA	677.830[a]	2460079.181	739391.357	677.641	NA	NA	0.189
3	MYERS	2442325.624	731480.429	1358.521[b]	2442325.617	731480.354	1358.49	0.007	0.075	NA
U.S. Coast & Geodetic Survey (USC&GS) monuments										
4	144 JEA	NA	NA	1275.338	2424284.214	723676.092	1275.338	NA	NA	0.000
5	147 JEA	NA	NA	1263.228	2441269.509	751952.606	1263.245	NA	NA	0.017
6	5 JEA	NA	NA	756.961	2448203.090	717642.274	756.960	NA	NA	0.001

[a] Elevation published in description below and converted from NAVD 88 to NGVD 29 using Corpscon Version 6.0.1 (U.S. Army Corps of Engineers, 2008).
[b] Elevation published to nearest foot in description below and converted from NAVD 88 to NGVD 29 using Corpscon Version 6.0.1 (U.S. Army Corps of Engineers, 2008).

Bench Mark Descriptions

RM1

```
1       NATIONAL GEODETIC SURVEY,   RETRIEVAL DATE = JULY 11, 2006
 KY0747 ***********************************************************************
 KY0747  DESIGNATION -  L 115
 KY0747  PID        -  KY0747
 KY0747  STATE/COUNTY-  OH/BELMONT
 KY0747  USGS QUAD   -  LANSING (1994)
 KY0747
 KY0747                      *CURRENT SURVEY CONTROL
 KY0747  ___________________________________________________________________
 KY0747* NAD 83(1995)-  40 04 00.61828(N)    080 48 30.17111(W)     ADJUSTED
 KY0747* NAVD 88    -      217.740  (METERS)     714.37   (FEET)  ADJUSTED
 KY0747  ___________________________________________________________________
 KY0747  X         -    780,805.373 (METERS)                  COMP
 KY0747  Y         -  -4,825,310.014 (METERS)                 COMP
 KY0747  Z         -   4,083,786.319 (METERS)                 COMP
 KY0747  LAPLACE CORR-         -1.20  (SECONDS)                DEFLEC99
 KY0747  ELLIP HEIGHT-        183.93  (METERS)         (10/07/05) GPS OBS
 KY0747  GEOID HEIGHT-        -33.92  (METERS)                 GEOID03
 KY0747  DYNAMIC HT  -       217.618 (METERS)     713.97  (FEET)  COMP
 KY0747  MODELED GRAV-    980,063.6   (MGAL)                    NAVD 88
 KY0747
 KY0747  HORZ ORDER  -  FIRST
 KY0747  VERT ORDER  -  FIRST    CLASS II
 KY0747  ELLP ORDER  -  FOURTH   CLASS II
 KY0747
 KY0747.THE HORIZONTAL COORDINATES WERE ESTABLISHED BY GPS OBSERVATIONS
 KY0747.AND ADJUSTED BY THE NATIONAL GEODETIC SURVEY IN OCTOBER 2005..
 KY0747
 KY0747.THE ORTHOMETRIC HEIGHT WAS DETERMINED BY DIFFERENTIAL LEVELING
 KY0747.AND ADJUSTED BY THE NATIONAL GEODETIC SURVEY IN JUNE 1991..
 KY0747
 KY0747.THE X, Y, AND Z WERE COMPUTED FROM THE POSITION AND THE ELLIPSOIDAL HT.
 KY0747
 KY0747.THE LAPLACE CORRECTION WAS COMPUTED FROM DEFLEC99 DERIVED DEFLECTIONS.
```

```
KY0747
KY0747.The ellipsoidal height was determined by GPS observations
KY0747.and is referenced to NAD 83.
KY0747
KY0747.The geoid height was determined by GEOID03.
KY0747
KY0747.The dynamic height is computed by dividing the NAVD 88
KY0747.geopotential number by the normal gravity value computed on the
KY0747.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
KY0747.degrees latitude (g = 980.6199 gals.).
KY0747
KY0747.The modeled gravity was interpolated from observed gravity values.
KY0747
KY0747;                  North        East     Units Scale Factor Converg.
KY0747;SPC OH S    -   230,806.066   744,305.482   MT  1.00000680   +1 04 24.1
KY0747;UTM  17     - 4,435,193.260   516,340.598   MT  0.99960329   +0 07 24.0
KY0747
KY0747!            -  Elev Factor  x  Scale Factor =   Combined Factor
KY0747!SPC OH S    -   0.99997115  x   1.00000680  =   0.99997795
KY0747!UTM  17     -   0.99997115  x   0.99960329  =   0.99957445
KY0747
KY0747                       SUPERSEDED SURVEY CONTROL
KY0747
KY0747  NAD 83(1995)-  40 04 00.61146(N)    080 48 30.17186(W) AD(      ) 1
KY0747  NAD 83(1986)-  40 04 00.62345(N)    080 48 30.17752(W) AD(      ) 1
KY0747  NAVD 88 (03/12/97)  217.74   (m)        714.4    (f) LEVELING    3
KY0747  NGVD 29 (??/??/92)  217.907  (m)        714.92   (f) ADJ UNCH    1 2
KY0747
KY0747.Superseded values are not recommended for survey control.
KY0747.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
KY0747.See file dsdata.txt to determine how the superseded data were derived.
KY0747
KY0747_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TNE1634135193(NAD 83)
KY0747_MARKER: DB = BENCH MARK DISK
KY0747_SETTING: 36 = SET IN A MASSIVE STRUCTURE
KY0747_SP_SET: BRIDGE
KY0747_STAMPING: L 115 1943
KY0747_MAGNETIC: O = OTHER; SEE DESCRIPTION
KY0747_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
KY0747_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
KY0747+SATELLITE: SATELLITE OBSERVATIONS - July 22, 2003
KY0747
KY0747  HISTORY     - Date     Condition       Report By
KY0747  HISTORY     - 1943     MONUMENTED      CGS
KY0747  HISTORY     - 19960606 GOOD            GEOONE
KY0747  HISTORY     - 20030722 GOOD            USACE
KY0747
KY0747                       STATION DESCRIPTION
KY0747
KY0747'DESCRIBED BY COAST AND GEODETIC SURVEY 1943
KY0747'0.6 MI E FROM BLAINE.
KY0747'0.6 MILE EAST ALONG THE BALTIMORE AND OHIO RAILROAD FROM THE U.S.
KY0747'HIGHWAY 40 OVERPASS AT BLAINE, BELMONT COUNTY, AT A COUNTY-ROAD
KY0747'BRIDGE OVER A CREEK, IN THE TOP OF THE WEST END OF THE NORTH
KY0747'ABUTMENT, 26 FEET SOUTH OF THE CENTERLINE OF THE SOUTH TRACK,
KY0747'AND 11 FEET WEST OF THE CENTERLINE OF THE ROAD.  A STANDARD
KY0747'DISK STAMPED L 115 1943.
KY0747
KY0747                       STATION RECOVERY (1996)
KY0747
KY0747'RECOVERY NOTE BY GEOONE INCORPORATED 1996
KY0747'RECOVERED AS DESCRIBED.  BM RECOVERED IN GOOD CONDITION.
KY0747
KY0747                       STATION RECOVERY (2003)
KY0747
KY0747'RECOVERY NOTE BY US ARMY CORPS OF ENGINEERS 2003 (BLL)
KY0747'RECOVERED IN GOOD CONDITION.
```

RM2

```
1       NATIONAL GEODETIC SURVEY,   RETRIEVAL DATE = JULY 11, 2006
 KY0760 ***********************************************************************
 KY0760  DESIGNATION -  W 115
 KY0760  PID        -  KY0760
 KY0760  STATE/COUNTY-  OH/BELMONT
 KY0760  USGS QUAD   -  WHEELING (1994)
 KY0760
 KY0760                      *CURRENT SURVEY CONTROL
 KY0760  ___________________________________________________________________
 KY0760* NAD 83(1986)-  40 01 01.     (N)    080 44 40.     (W)     SCALED
 KY0760* NAVD 88     -      206.439  (METERS)     677.29    (FEET)  ADJUSTED
 KY0760  ___________________________________________________________________
 KY0760  GEOID HEIGHT-        -33.90  (METERS)                     GEOID03
 KY0760  DYNAMIC HT  -       206.324 (METERS)     676.91  (FEET)  COMP
 KY0760  MODELED GRAV-    980,067.3   (MGAL)                       NAVD 88
 KY0760
 KY0760  VERT ORDER  -  FIRST    CLASS II
 KY0760
 KY0760.THE HORIZONTAL COORDINATES WERE SCALED FROM A TOPOGRAPHIC MAP AND HAVE
 KY0760.AN ESTIMATED ACCURACY OF +/- 6 SECONDS.
 KY0760
 KY0760.THE ORTHOMETRIC HEIGHT WAS DETERMINED BY DIFFERENTIAL LEVELING
 KY0760.AND ADJUSTED BY THE NATIONAL GEODETIC SURVEY IN JUNE 1991..
 KY0760
 KY0760.THE GEOID HEIGHT WAS DETERMINED BY GEOID03.
 KY0760
 KY0760.THE DYNAMIC HEIGHT IS COMPUTED BY DIVIDING THE NAVD 88
 KY0760.GEOPOTENTIAL NUMBER BY THE NORMAL GRAVITY VALUE COMPUTED ON THE
 KY0760.GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80) ELLIPSOID AT 45
 KY0760.DEGREES LATITUDE (G = 980.6199 GALS.).
 KY0760
 KY0760.THE MODELED GRAVITY WAS INTERPOLATED FROM OBSERVED GRAVITY VALUES.
 KY0760
 KY0760;                 NORTH        EAST    UNITS  ESTIMATED ACCURACY
 KY0760;SPC OH S    -   225,370.     749,870.     MT  (+/- 180 METERS SCALED)
 KY0760
 KY0760                      SUPERSEDED SURVEY CONTROL
 KY0760
 KY0760  NGVD 29 (??/??/92)  206.603  (M)        677.83   (F) ADJ UNCH   1 2
 KY0760
 KY0760.SUPERSEDED VALUES ARE NOT RECOMMENDED FOR SURVEY CONTROL.
 KY0760.NGS NO LONGER ADJUSTS PROJECTS TO THE NAD 27 OR NGVD 29 DATUMS.
 KY0760.SEE FILE DSDATA.TXT TO DETERMINE HOW THE SUPERSEDED DATA WERE DERIVED.
 KY0760
 KY0760_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TNE218296(NAD 83)
 KY0760_MARKER: DB = BENCH MARK DISK
 KY0760_SETTING: 36 = SET IN A MASSIVE STRUCTURE
 KY0760_SP_SET: BRIDGE SEAT
 KY0760_STAMPING: W 115 1943
 KY0760_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 KY0760
 KY0760  HISTORY     - DATE     CONDITION       REPORT BY
 KY0760  HISTORY     - 1943     MONUMENTED       CGS
 KY0760
 KY0760                      STATION DESCRIPTION
 KY0760
 KY0760'DESCRIBED BY COAST AND GEODETIC SURVEY 1943
 KY0760'AT BELLAIRE.
 KY0760'AT BELLAIRE, BELMONT COUNTY, 0.8 MILE NORTH ALONG THE BALTIMORE
 KY0760'AND OHIO RAILROAD FROM THE STATION, AT THE BRIDGE OVER THIRTY-FOURTH
 KY0760'STREET, IN THE TOP OF THE BRIDGE SEAT OF THE NORTH STONE ABUTMENT,
 KY0760'18 FEET EAST OF THE CENTERLINE OF THE EAST TRACK, AND ABOUT 5
 KY0760'FEET LOWER THAN THE TRACK.  A STANDARD DISK, STAMPED W 115 1943.
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RM3

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1       NATIONAL GEODETIC SURVEY,   RETRIEVAL DATE = JULY 11, 2006
 JX2043 ***********************************************************************
 JX2043  DESIGNATION -  MYERS
 JX2043  PID        -  JX2043
 JX2043  STATE/COUNTY-  OH/BELMONT
 JX2043  USGS QUAD   -  BUSINESSBURG (1976)
 JX2043
 JX2043                      *CURRENT SURVEY CONTROL
 JX2043  ___________________________________________________________________
 JX2043* NAD 83(1995)-  39 59 46.06561(N)    080 48 31.44515(W)    ADJUSTED
 JX2043* NAVD 88    -      414.1    (METERS)    1359.     (FEET)  GPS OBS
 JX2043  ___________________________________________________________________
 JX2043  X          -    781,606.257 (METERS)                  COMP
 JX2043  Y          -  -4,830,448.620 (METERS)                 COMP
 JX2043  Z          -   4,077,900.779 (METERS)                 COMP
 JX2043  LAPLACE CORR-         -0.86  (SECONDS)                DEFLEC99
 JX2043  ELLIP HEIGHT-        380.32  (METERS)        (10/07/05) GPS OBS
 JX2043  GEOID HEIGHT-        -33.86  (METERS)                 GEOID03
 JX2043
 JX2043  HORZ ORDER  -  FIRST
 JX2043  ELLP ORDER  -  FOURTH   CLASS II
 JX2043
 JX2043.THE HORIZONTAL COORDINATES WERE ESTABLISHED BY GPS OBSERVATIONS
 JX2043.AND ADJUSTED BY THE NATIONAL GEODETIC SURVEY IN OCTOBER 2005..
 JX2043
 JX2043.THE ORTHOMETRIC HEIGHT WAS DETERMINED BY GPS OBSERVATIONS AND A
 JX2043.HIGH-RESOLUTION GEOID MODEL.
 JX2043
 JX2043.THE X, Y, AND Z WERE COMPUTED FROM THE POSITION AND THE ELLIPSOIDAL HT.
 JX2043
 JX2043.THE LAPLACE CORRECTION WAS COMPUTED FROM DEFLEC99 DERIVED DEFLECTIONS.
 JX2043
 JX2043.THE ELLIPSOIDAL HEIGHT WAS DETERMINED BY GPS OBSERVATIONS
 JX2043.AND IS REFERENCED TO NAD 83.
 JX2043
 JX2043.THE GEOID HEIGHT WAS DETERMINED BY GEOID03.
 JX2043
 JX2043;                   NORTH         EAST     UNITS SCALE FACTOR CONVERG.
 JX2043;SPC OH S     -   222,955.681   744,422.339   MT  0.99999285   +1 04 23.3
 JX2043;UTM  17      - 4,427,345.129   516,327.270   MT  0.99960328   +0 07 22.6
 JX2043
 JX2043!            -  ELEV FACTOR  X  SCALE FACTOR =   COMBINED FACTOR
 JX2043!SPC OH S     -   0.99994034  X   0.99999285  =   0.99993319
 JX2043!UTM  17      -   0.99994034  X   0.99960328  =   0.99954364
 JX2043
 JX2043:              PRIMARY AZIMUTH MARK                    GRID AZ
 JX2043:SPC OH S     -  BRIDGEPORT RAD STA KQE 49 TWR          032 15 15.4
 JX2043:UTM  17      -  BRIDGEPORT RAD STA KQE 49 TWR          033 12 16.1
 JX2043
 JX2043|---------------------------------------------------------------------|
 JX2043| PID    REFERENCE OBJECT                     DISTANCE      GEOD. AZ  |
 JX2043|                                                           dddmmss.s |
 JX2043| KY3213 BRIDGEPORT RAD STA KQE 49 TWR      APPROX. 7.7 KM 0331938.7 |
 JX2043| KY3211 BELLAIRE RADIO STA WOMP TOWER      APPROX. 5.5 KM 0360447.5 |
 JX2043| KY3212 BELLAIRE RADIO STA KQA 942 TWR     APPROX. 4.9 KM 0413646.5 |
 JX2043| JX2044 MYERS RESET                        3.368 METERS 08730     |
 JX2043| CX4282 MYERS AZ MK                                     1404624.6 |
 JX2043| CX4283 MYERS RM 1                         4.573 METERS 35356     |
 JX2043|---------------------------------------------------------------------|
 JX2043
 JX2043                       SUPERSEDED SURVEY CONTROL
 JX2043
 JX2043  NAD 83(1995)-  39 59 46.05895(N)    080 48 31.44596(W) AD(       ) 1
 JX2043  NAD 83(1986)-  39 59 46.07080(N)    080 48 31.45147(W) AD(       ) 1
 JX2043  NAD 83(1986)-  39 59 46.07080(N)    080 48 31.45147(W) AD(       ) 2
 JX2043  NAD 27     -  39 59 45.80970(N)    080 48 32.13760(W) AD(       ) 2
 JX2043
 JX2043.SUPERSEDED VALUES ARE NOT RECOMMENDED FOR SURVEY CONTROL.
 JX2043.NGS NO LONGER ADJUSTS PROJECTS TO THE NAD 27 OR NGVD 29 DATUMS.
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JX2043.SEE FILE DSDATA.TXT TO DETERMINE HOW THE SUPERSEDED DATA WERE DERIVED.
JX2043
JX2043_U.S. NATIONAL GRID SPATIAL ADDRESS: 17SNE1632727345(NAD 83)
JX2043_MARKER: DD = SURVEY DISK
JX2043_SETTING: 0 = UNSPECIFIED SETTING
JX2043_SP_SET: TOP OF SQUARE CONCRETE MONUMENT
JX2043_STAMPING: MYERS 1963
JX2043_MAGNETIC: O = OTHER; SEE DESCRIPTION
JX2043_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
JX2043_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
JX2043+SATELLITE: SATELLITE OBSERVATIONS - JUNE 06, 1996
JX2043
JX2043  HISTORY     - DATE     CONDITION       REPORT BY
JX2043  HISTORY     - 1963     MONUMENTED       CGS
JX2043  HISTORY     - 19960606 GOOD            GEOONE
JX2043
JX2043                       STATION DESCRIPTION
JX2043
JX2043'DESCRIBED BY COAST AND GEODETIC SURVEY 1963 (VBM)
JX2043'THE STATION IS ON A PROMINENT HIGH ROUND GRASS COVERED HILL ABOUT 3
JX2043'1/2 MILES WEST- SOUTHWEST OF
JX2043'BELLAIRE, 4 MILES EAST OF GLENCOE, IN SECTION 11, R 3 W, T 5 N., AND
JX2043'ON THE PROPERTY OF MR. E. MYERS.  IT
JX2043'IS NEAR THE CENTER AND THE HIGHEST POINT OF THE HILL 12
JX2043'FEET WEST OF A SMALL MAPLE SAPLING.  THE
JX2043'MONUMENT IS FLUSH AND THE DISK IS STAMPED
JX2043'MYERS 1963.
JX2043'
JX2043'TO REACH FROM THE JUNCTION OF STATE HIGHWAYS 7 AND 147 IN THE SOUTH
JX2043'SECTION OF BELLAIRE, GO
JX2043'WEST-SOUTHWEST ON HIGHWAY 147 FOR 4.65 MILES TO A SIDE ROAD LEFT
JX2043'(BELMONT COUNTY ROAD 44).
JX2043'CONTINUE NORTHWEST AND NORTH ON HIGHWAY 147 FOR 0.45 MILE TO A
JX2043'GRAVELED DRIVEWAY THAT LEADS TO MR.
JX2043'MYERS HOUSE ON THE RIGHT.  TURN RIGHT AND GO EAST
JX2043'ON THE DRIVEWAY FOR 0.05 MILE TO A TRACK ROAD LEFT
JX2043'THIS IS JUST BEFORE REACHING MR.
JX2043'MYERS HOUSE.  TURN LEFT AND GO NORTH ON THE TRACK ROAD FOR 0.1 MILE
JX2043'TO A GATE AND THE END OF TRUCK
JX2043'TRAVEL.  FROM HERE PACK NORTHWEST UPHILL FOR 0.1 MILE TO THE TOP OF
JX2043'THE HILL AND THE STATION.
JX2043'
JX2043'FROM THIS POINT GO SOUTHEAST ON COUNTY ROAD 44 FOR 0.35 MILE TO A
JX2043'DRIVEWAY ON THE RIGHT AND
JX2043'THE AZIMUTH MARK ON THE LEFT.
JX2043'
JX2043'REFERENCE MARK 1 IS 19 FEET NORTHWEST OF THE SMALL MAPLE SAPLING.
JX2043'THE MONUMENT IS FLUSH AND THE
JX2043'DISK IS STAMPED MYERS NO 1 1963.
JX2043'
JX2043'MYERS (USGS) IS A U.S. GEOLOGICAL SURVEY STATION MARK DISK SET IN THE
JX2043'TOP OF A 6 BY 6 INCH GRANITE
JX2043'POST PROJECTING 14 INCHES.  IT IS NEAR THE HIGHEST POINT OF THE HILL
JX2043'1 FOOT SOUTHWEST OF THE SMALL
JX2043'MAPLE SAPLING.  THE DISK IS STAMPED MYERS 1900 1957 OHIO
JX2043'STBNVLE ELEV. 1361.
JX2043'
JX2043'THE AZIMUTH MARK IS 2 FEET SOUTH OF A WITNESS POST, 1 FOOT SOUTHEAST
JX2043'OF A WIRE FENCE, 13 FEET
JX2043'NORTHWEST OF THE CENTERLINE OF THE PAVED ROAD AND 40 FEET NORTHWEST
JX2043'OF A 24 INCH TREE.  THE MONUMENT
JX2043'PROJECTS 1 INCH AND THE DISK IS STAMPED MYERS 1963.
JX2043'
JX2043'HEIGHT OF LIGHT ABOVE STATION MARK 6 METERS.
JX2043
JX2043                       STATION RECOVERY (1996)
JX2043
JX2043'RECOVERY NOTE BY GEOONE INCORPORATED 1996
JX2043'RECOVERED AS DESCRIBED.
```

RM4

144 JEA
Jacobsburg, 2.3 mi NE. of post office, along State Highway 147; at Key; at Bethel Presbyterian Church; about 140 ft N. of hwy.; in top of SW. corner of lower step at W. entrance on S. side of church; standard tablet stamped “144 JEA 1958 1276”

Elevation (NGVD 29) = 1275.338 ft
Elevation (NAVD 88) = 1274.86 ft

RM5

147 JEA
Neffs, 2.3 mi N. of junction of County Roads 3 and 30, along Road 30; 35 ft SE. of junction of State Highway 214 and Road 30; in top of SE. concrete headwall of culvert; standard tablet stamped “147 JEA 1958 1264”

Elevation (NGVD 29) = 1263.228 ft
Elevation (NAVD 88) = 1262.68 ft

RM6

5 JEA
Shadyside, 0.7 mi S. of post office, thence 2.2 mi W. along County Road 48; 5.4 mi E. of Key; at bridge over Wegee Creek; in SE. end of NE. concrete abutment; standard tablet stamped “5 JEA 1959 757”

Elevation (NGVD 29) = 756.961 ft

Flood Profiles

The flood profiles for McMahon Creek Reach 1 and 2 and Little McMahon Creek near the Village of Neffs for the 10-, 50-, 100-, and 500-year recurrence interval floods are presented in figures 1–D2, 1–D3, and 1–D4, respectively. The locations of the cross sections for McMahon Creek Reach 1 and 2 and Little McMahon Creek are presented in figures 1–D5, 1–D6, and 1–D7, respectively.

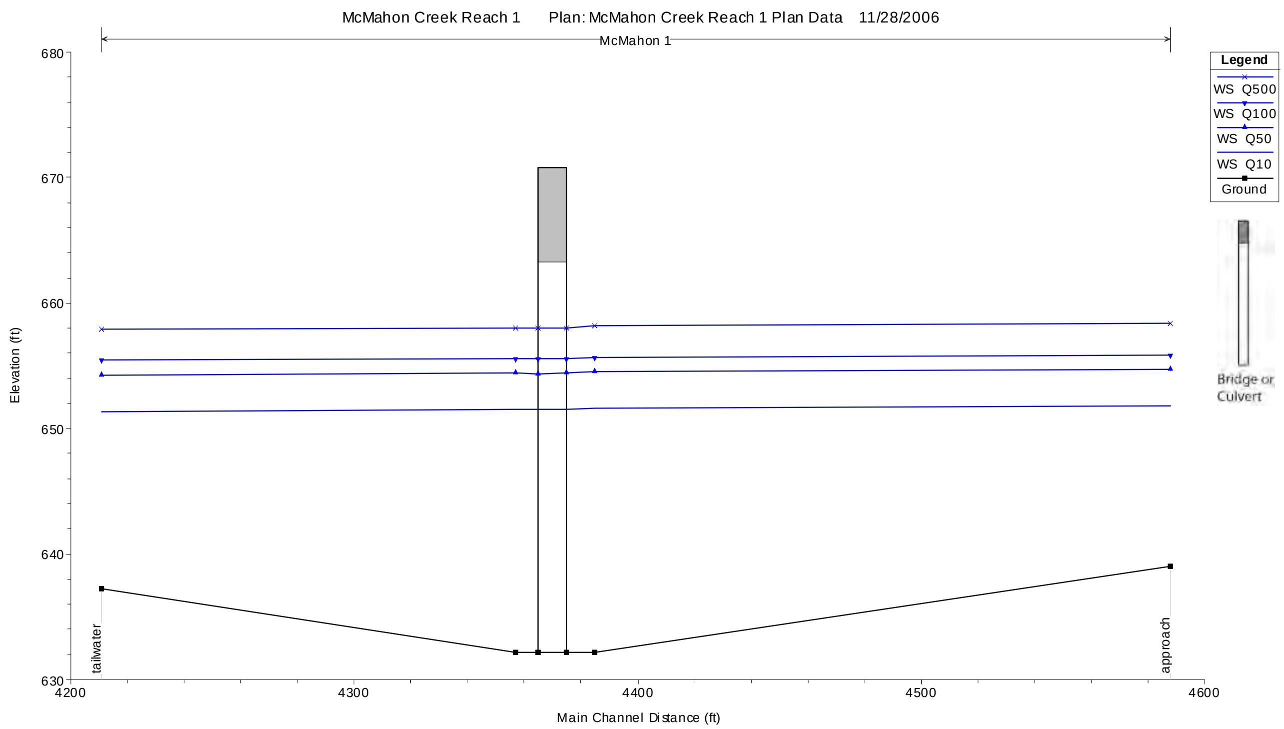

Figure 1–D2. Flood profiles for McMahon Creek Reach 1 near the Village of Neffs for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

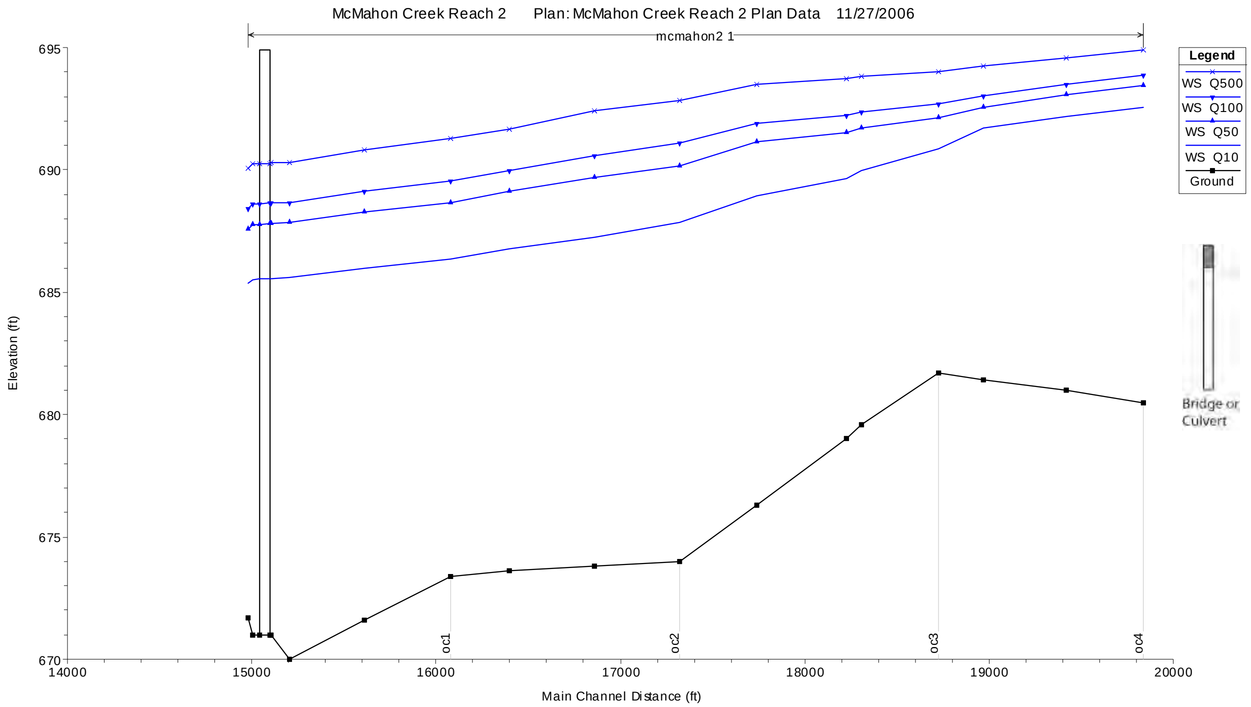

Figure 1–D3. Flood profiles for McMahon Creek Reach 2 near the Village of Neffs for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

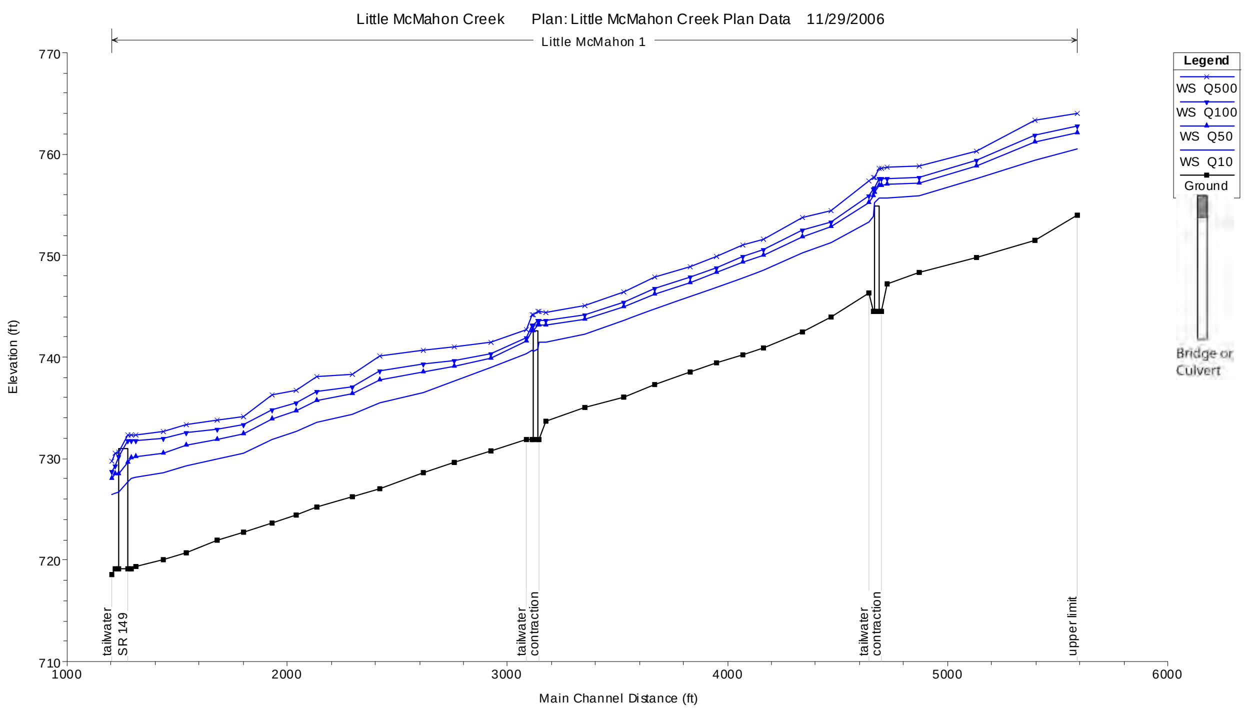

Figure 1–D4. Flood profiles for Little McMahon Creek near the Village of Neffs for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

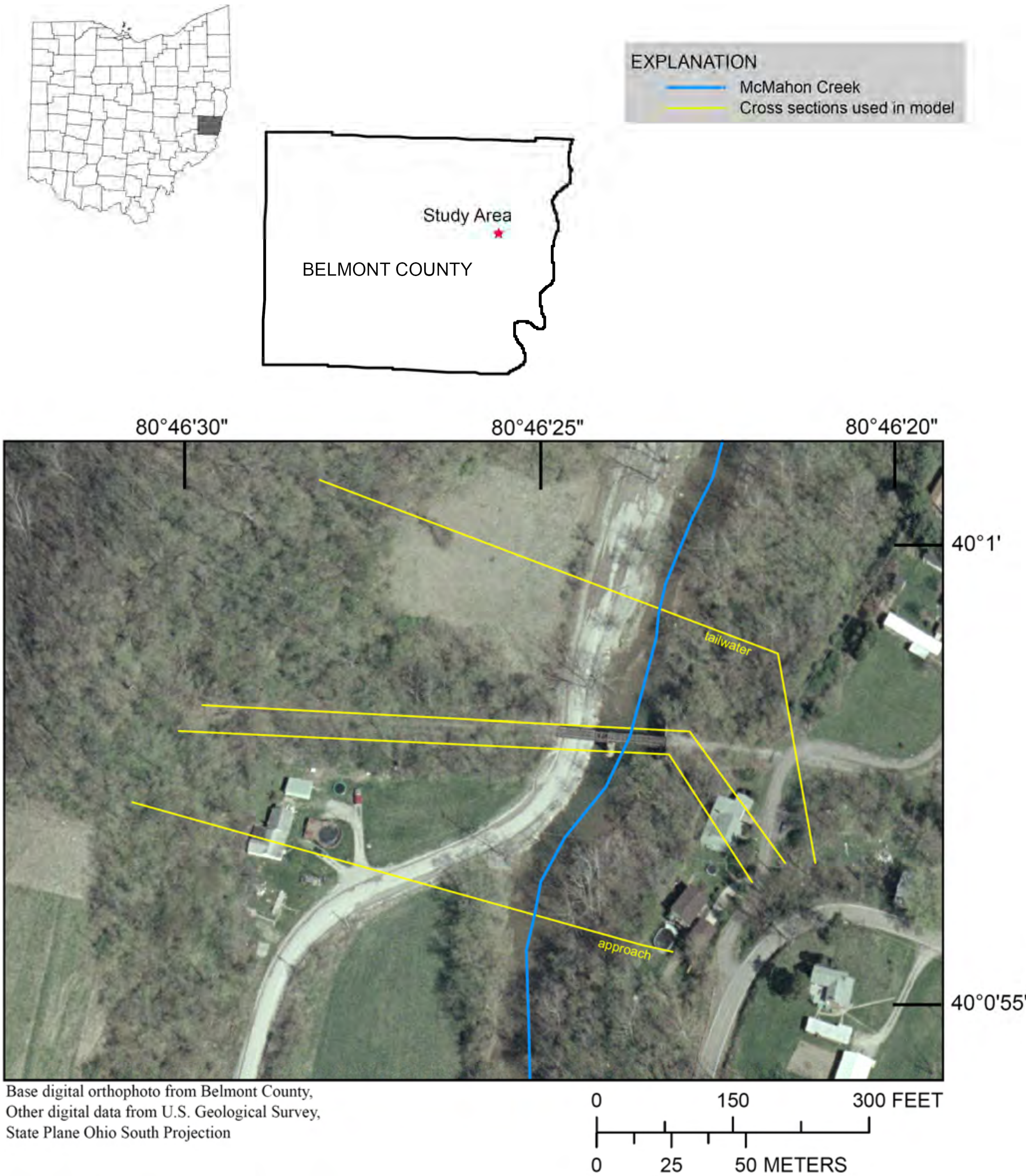

Figure 1–D5. Cross-section locations for flood profiles on McMahon Creek Reach 1 near the Village of Neffs, Ohio.

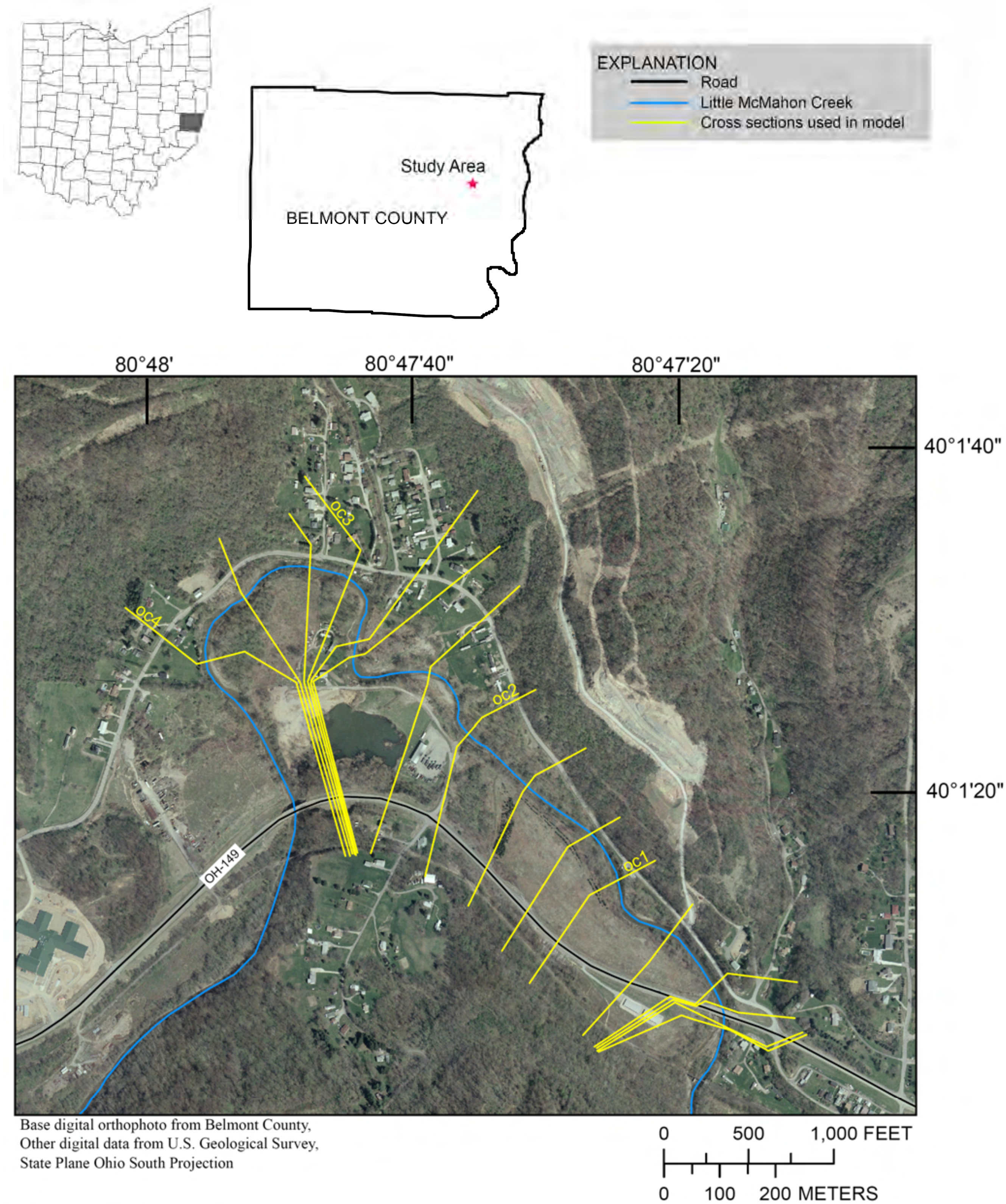

Figure 1–D6. Cross-section locations for flood profiles on McMahon Creek Reach 2 near the Village of Neffs, Ohio.

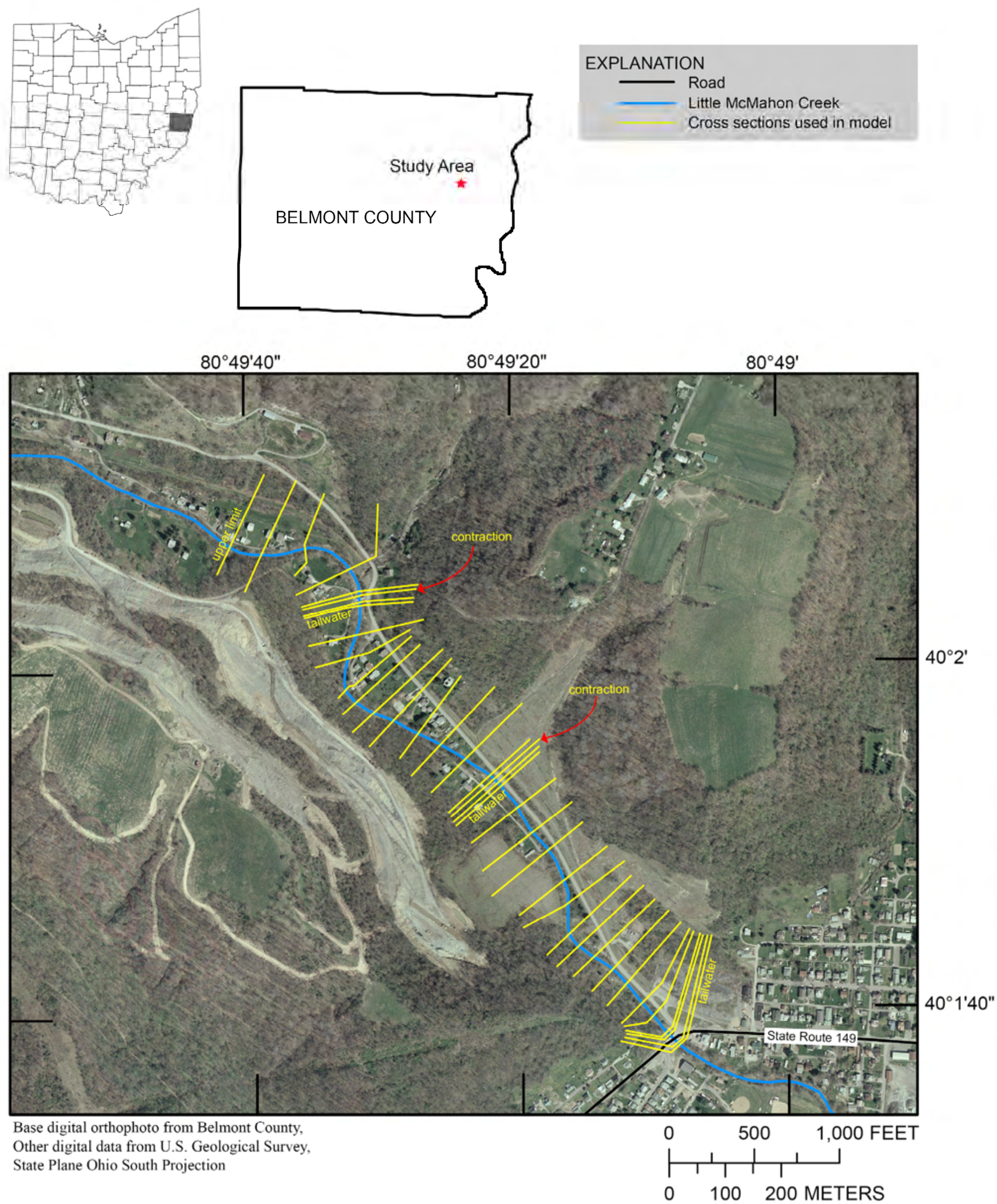

Figure 1–D7. Cross-section locations for flood profiles on Little McMahon Creek near the Village of Neffs, Ohio.

1–E. Little Muskingum River Near the Village of New Matamoras

Work Conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 20-ft contour map developed from the USGS 1:24,000-scale topographic maps Rinard Mills and New Matamoras were used to establish the 10-, 50-, 100-, and 500-year flood profiles by use of HEC-RAS.

Scope of Work

The downstream limit of the reach studied is the confluence with Clear Fork. The upstream limit is approximately 500 ft above the confluence with Browns Run. This stream reach is approximately 4.3 mi long.

Hydraulic Baselines

Stationing used for the hydraulic baseline for this stream is referenced to feet above the confluence with Clear Fork.

Cross-Section and Contracted-Opening-Geometry Data Surveyed in the Field

The USGS surveyed 11 cross sections, including 6 open-channel sections and 1 hydraulic structure. All surveys were referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29) and the North American Datum of 1983 (NAD 83).

Synthetic Cross-Sectional-Geometry Data

A total of 98 synthetic or partially synthetic cross sections at desired locations along the stream reach were generated from a TIN developed from the USGS 7.5-minute quadrangle maps Rinard Mills and New Matamoras. In-channel data for the synthetic cross sections were estimated by interpolation from cross-sectional data surveyed in the field.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for each profile was obtained by means of a slope-conveyance calculation. A slope of 0.000468 ft/ft was calculated from the river stations and minimum channel elevations for cross sections 2,035 and 10,606. These cross sections were obtained from field surveys and were assumed to provide a representative slope for the channel. Based on the calculated slope, starting water-surface elevations of 682.33, 684.96, 685.91, and 688.04 ft were determined at the initial section for the 10-, 50-, 100-, and 500-year profiles, respectively.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were determined from field observation by experienced personnel. Estimates of Manning's roughness coefficients range from 0.035 to 0.046 for the main channel and from 0.050 to 0.085 for the overbank areas.

Flow Lengths

Main-channel and overbank flow lengths were computed with HEC-GeoRAS. Flow paths are drawn in the GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths on the basis of the flow paths drawn.

Hydraulic-Structure Solution Reviews

For this study, all hydraulic-structure computations were reviewed for the appropriate modeling solutions (see “Special Hydraulic Considerations” section of “Hydraulic Analyses”). Initial reviews focused on the type of solution computed at each structure (based on energy equation or on pressure and/or weir-flow equations). Table 1–E1 lists the river station, a location description, the type of structure, the presence of road overflow, and the solution type of all structures affecting the 10-, 50-, 100-, and 500-year flood profiles for the Little Muskingum River.

Table 1–E1. Summary of hydraulic-structure solutions for the 10-, 50-, 100-, and 500-year profiles of the Little Muskingum River near the Village of New Matamoras.

River station (feet)	Location description	Structure type	Recurrence interval (years)	Presence of road overflow	Solution type
132	Covered Bridge	Bridge	10	Y	Energy
132	Covered Bridge	Bridge	50	Y	Energy
132	Covered Bridge	Bridge	100	Y	Energy
132	Covered Bridge	Bridge	500	Y	Energy
17,892	Township Road 575	Bridge	10	N	Energy
17,892	Township Road 575	Bridge	50	Y	Energy
17,892	Township Road 575	Bridge	100	Y	Energy
17,892	Township Road 575	Bridge	500	Y	Pressure

Backwater Elevation

The Little Muskingum River should not be subject to backwater.

Base-Mapping Information

The base map used for this study was a digitized copy of the combined USGS Rinard Mills and New Matamoras topographic quadrangle maps.

Surveys Conducted by the USGS

A GPS survey was conducted by the USGS using Real-Time Kinematic (RTK) techniques and static surveying techniques. Control for the USGS survey was established by use of three USC&GS control monuments with known elevation. The USGS held one monument as true (98 JEA) in elevation, as obtained from USC&GS. A comparison of the published elevations and surveyed elevations are listed in table 1–E2. The bench mark descriptions also are included below.

Table 1–E2. Comparison of published coordinates to USGS-surveyed coordinates and bench marks used in the study of the Little Muskingum River near the Village of New Matamoras.
[All data shown in feet, NAD 83 and NGVD 29; shaded boxes indicate control points]

Reference mark number	Bench mark name	Published easting	Published northing	Published elevation	Surveyed easting	Surveyed northing	Surveyed elevation	Delta easting	Delta northing	Delta elevation
U.S. Coast & Geodetic Survey (USC&GS) monument										
1	99 JEA Reset 1991	NA	NA	687.469	2345250.260	586535.860	687.239	NA	NA	0.230
2	98 JEA	NA	NA	691.585	2356756.763	589680.430	691.585	NA	NA	0.000
3	83 JEA	NA	NA	698.991	2361502.597	592067.900	699.024	NA	NA	-0.033

Bench Mark Descriptions

RM1

99 JEA Reset 1991
Cline, 0.5 mi S. of, along State Highway 26, at bridge #0206, a 110 ft concrete bridge over Clear Fork, 100 ft S. of access road to Knowlton Covered Bridge Park, 35 ft S. of Washington Twp Road 319, set in top of W. wingwall of N. abutment, 20 ft W. of centerline, standard tablet stamped “99 JEA 1958 RESET 1991” Witness post set 1 ft N. of mark.

Elevation (NGVD 29) = 687.469 ft

RM2

98 JEA
Cline, 3.0 mi E. of junction of State Highway 26 and Y-rd. SE.; 1.6 mi SW. of Jericho Church; about 400 ft SW. of small cemetery; in center of top of N. stone railing of bridge over small stream; standard tablet stamped “98 JEA 1958 692”

Elevation (NGVD 29) = 691.585 ft

RM3

83 JEA
Greenbrier, 1.9 mi S. of Methodist Church, about 0.2 mi SE. of Jericho Church; at concrete highway bridge over Little Muskingum River; in top of NE. end of NW. concrete wingwall; standard tablet stamped “83 JEA 1958 699”

Elevation (NGVD 29) = 698.991 ft

Flood Profiles

The flood profiles for Little Muskingum River near the Village of New Matamoras for the 10-, 50-, 100-, and 500-year-recurrence-interval floods are presented in figure 1–E2. The locations of the cross sections for Little Muskingum River are presented in figure 1–E3.

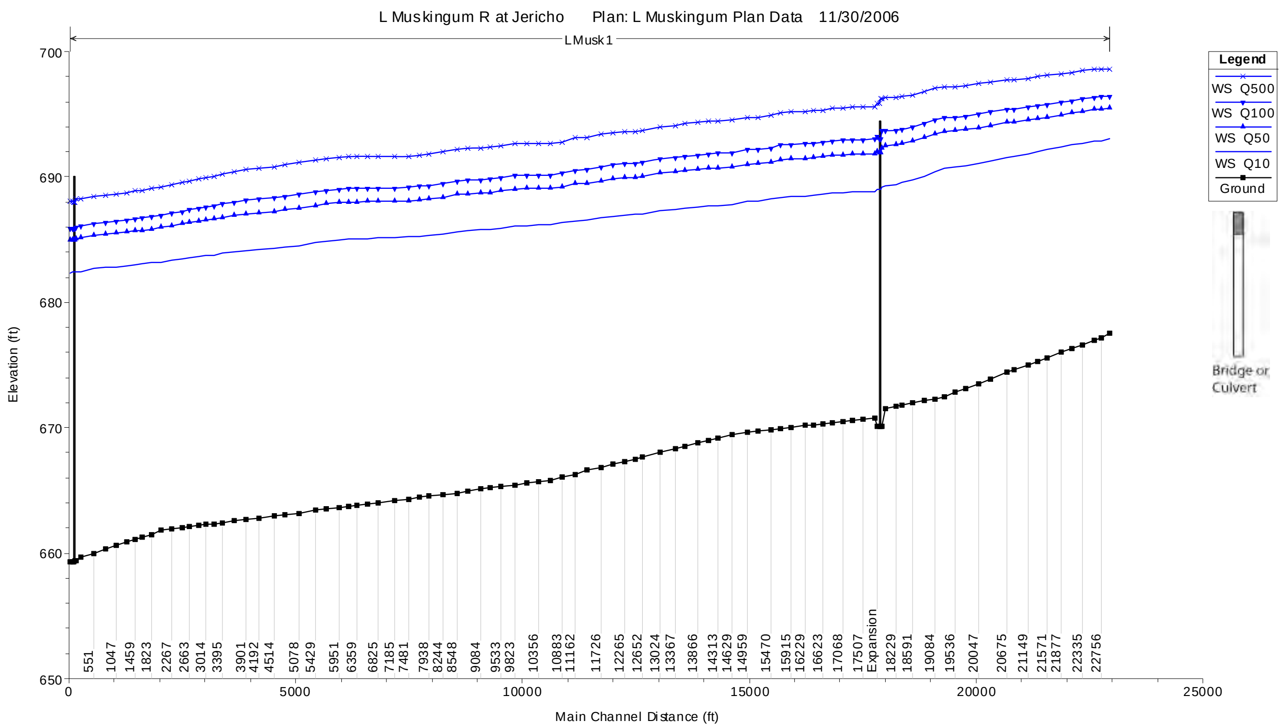

Figure 1–E2. Flood profiles for the Little Muskingum River near the Village of New Matamoras for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

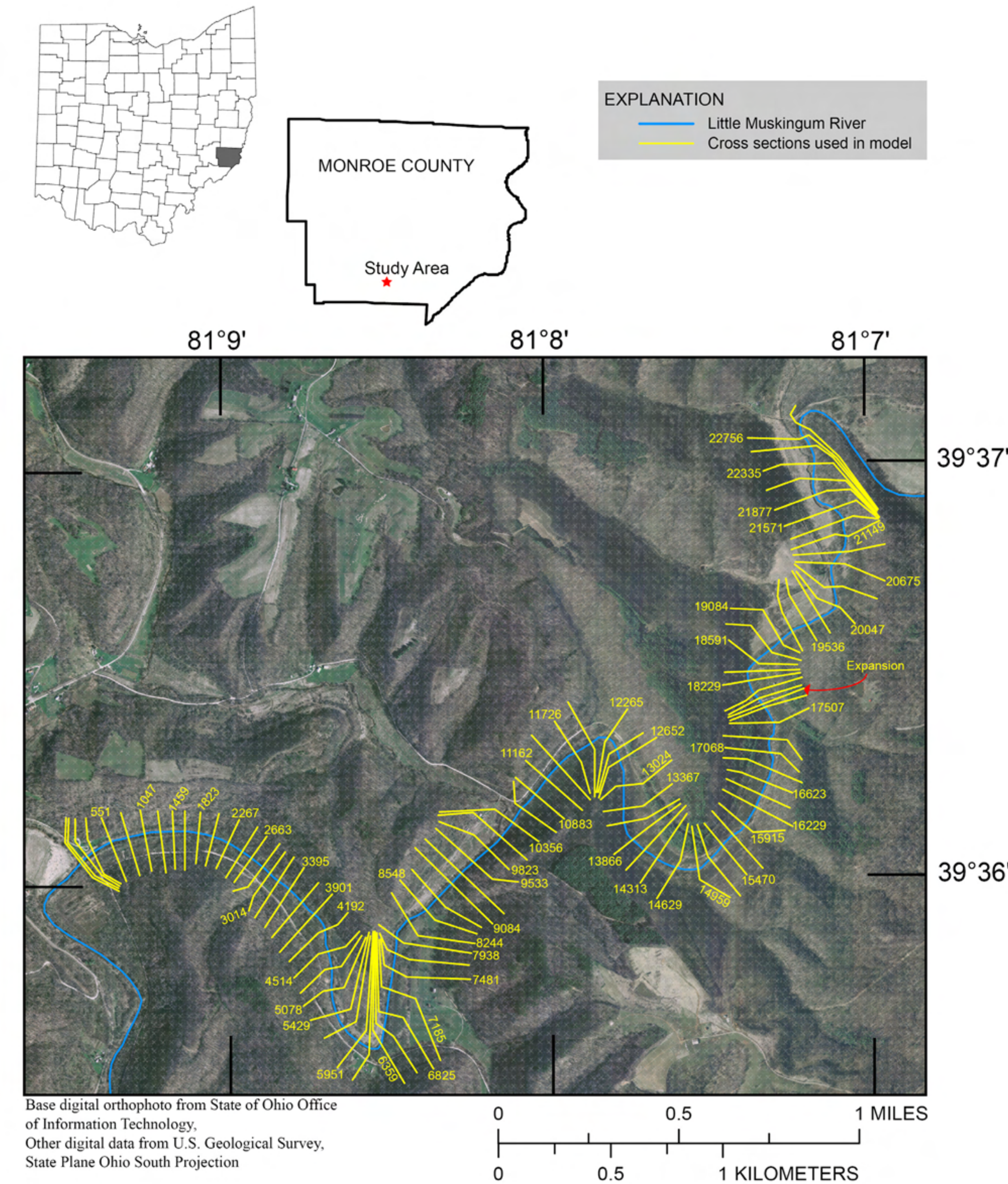

Figure 1–E3. Cross-section locations for flood profiles on Little Muskingum River near the Village of New Matamoras, Ohio.

1–F. Wheeler Run Near the Village of Woodsfield

Work Conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 20-ft contour map developed from the USGS 1:24,000-scale topographic map Lewisville were used to establish the 10-, 50-, 100-, and 500-year flood profiles by use of HEC-RAS.

Scope of Work

The downstream limit of the reach studied is the mouth (confluence with Sunfish Creek). The upstream limit is located approximately 0.43 mi upstream from County Road 100. This stream reach is approximately 0.46 mi long.

Hydraulic Baselines

Stationing used for the hydraulic baseline for this stream is referenced to feet above the mouth (confluence with Sunfish Creek).

Cross-Section and Contracted-Opening-Geometry Data Surveyed in the Field

The USGS surveyed seven cross sections, including three open-channel sections and one hydraulic structure. All surveys were referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29) and the North American Datum of 1988 (NAD 88).

Synthetic Cross-Sectional-Geometry Data

A total of 15 synthetic or partially synthetic cross sections at desired locations along the stream reach were generated from a TIN developed from the USGS 7.5-minute quadrangle map Lewisville. In-channel data for the synthetic cross sections were estimated by interpolation from cross-sectional data surveyed in the field.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for each profile was obtained by means of a slope-conveyance calculation known water surface. A slope of 0.00413 ft/ft was calculated from the river stations and minimum channel elevations for cross sections 414 and 535. These cross sections were obtained from field surveys and were assumed to provide a representative slope for the channel. Based on the calculated slope, starting water-surface elevations of 979.61, 980.96, 981.36, and 982.03 ft were determined at the initial section for the 10-, 50-, 100-, and 500-year profiles, respectively.

Manning's Roughness Coefficients

Manning's roughness coefficients (n) for the main channel and overbank areas were determined from field observation by experienced personnel. Estimates of Manning's roughness coefficients are 0.046 for the main channel and 0.052 for the overbank areas.

Flow Lengths

Main-channel and overbank flow lengths were computed with HEC-GeoRAS. Flow paths are drawn in the GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths on the basis of the flow paths drawn.

Hydraulic-Structure Solution Reviews

For this study, all hydraulic-structure computations were reviewed for the appropriate modeling solutions (see “Special Hydraulic Considerations” section of “Hydraulic Analyses”). Initial reviews focused on the type of solution computed at each structure (based on energy equation or on pressure and/or weir-flow equations). Table 1–F1 lists the river station, a location description, the type of structure, the presence of road overflow, and the solution type of all structures affecting the 10-, 50-, 100-, and 500-year flood profiles for Wheeler Run.

Table 1–F1. Summary of hydraulic-structure solutions for the 10-, 50-, 100-, and 500-year profiles of Wheeler Run near the Village of Woodsfield.

River station (feet)	Location description	Structure type	Recurrence interval (years)	Presence of road overflow	Solution type
458	County Road 100	Bridge	10	N	Energy
458	County Road 100	Bridge	50	Y	Energy
458	County Road 100	Bridge	100	Y	Pressure
458	County Road 100	Bridge	500	Y	Pressure

Backwater Elevation

The reach of Wheeler Run will most likely be affected by backwater from Sunfish Creek. Backwater was not considered in this model.

Base Mapping Information

The base map used for this study was a 20-ft digital contour map based on the USGS Lewisville 7.5-minute quadrangle map.

Surveys Conducted by the USGS

A GPS survey was conducted by the USGS using Real-Time Kinematic (RTK) techniques and static surveying techniques. Control for the USGS survey was established by use of two NGS control monuments with known elevation and two USC&GS monuments. A comparison of the published elevations and surveyed elevations is given in table 1–F2. The bench mark descriptions also are included below.

Table 1–F2. Comparison of published coordinates to USGS-surveyed coordinates and bench marks used in the study of Wheeler Run near the Village of Woodsfield.
[All data shown in feet, NAD 83 and NGVD 29; NA, not available]

Reference mark number	Bench mark name	Published easting	Published northing	Published elevation	Surveyed easting	Surveyed northing	Surveyed elevation	Delta easting	Delta northing	Delta elevation
U.S. Coast & Geodetic Survey (USC&GS) monuments										
1	BM 986.68	NA	NA	986.611	2356147.425	653096.075	986.610	NA	NA	0.001
2	80 JEA	NA	NA	971.224	2357714.723	661299.063	969.062	NA	NA	-2.162
National Geodetic Survey (NGS) monuments										
3	P 66	NA	NA	1213.27	NA[a]	NA[a]	1213.17	NA	NA	0.10
4	M 66	NA	NA	1263.8[b]	2339734.055	661299.063	1263.745	NA	NA	0.025

[a] Northing and easting were not surveyed; elevation only.
[b] Reported only to the nearest tenth of a foot.

Bench Mark Descriptions

RM1

BM 986.68
Woodsfield, 2.0 mi N. of courthouse, along State Highway 8; at hwy. bridge over Sunfish Creek; in sec. 31, T. 5 N., R. 5 W.; in top of NW. concrete wingwall of bridge; Ohio State Highway Department standard disk stamped “BM 986.68”

Elevation (NGVD 29) = 986.611 ft

RM2

80 JEA
Woodsfield, 4.0 mi N. of courthouse, along State Highway 8, thence 1.0 mi E. and N. along graded rd. to steel bridge over Baker Fork; in sec. 33, T. 5 N., R. 5 W.; 21 ft E. of SE. corner of bridge; 42 ft N. of, and 4 ft lower than centerline of junction Y-rd.; 32 ft NW. of rd. NE.; in top of W. end of large sandstone boulder on creek bank; standard tablet stamped “80 JEA 1959 971”

Elevation (NGVD 29) = 971.224 ft

RM3

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1       NATIONAL GEODETIC SURVEY,   RETRIEVAL DATE = JULY 11, 2006
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 JX0826  DESIGNATION -  P 66
 JX0826  PID        -  JX0826
 JX0826  STATE/COUNTY-  OH/MONROE
 JX0826  USGS QUAD   -  WOODSFIELD (1994)
 JX0826
 JX0826                      *CURRENT SURVEY CONTROL
 JX0826  ______________________________________________________________________
 JX0826* NAD 83(1986)-  39 45 46.    (N)   081 06 58.    (W)    SCALED
 JX0826* NAVD 88    -      369.630  (METERS)   1212.69   (FEET)  ADJUSTED
 JX0826  ______________________________________________________________________
 JX0826  GEOID HEIGHT-        -33.80  (METERS)                  GEOID03
 JX0826  DYNAMIC HT  -       369.419 (METERS)   1212.00  (FEET)  COMP
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JX0826
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JX0826.AN ESTIMATED ACCURACY OF +/- 6 SECONDS.
JX0826
JX0826.THE ORTHOMETRIC HEIGHT WAS DETERMINED BY DIFFERENTIAL LEVELING
JX0826.AND ADJUSTED BY THE NATIONAL GEODETIC SURVEY IN JUNE 1991..
JX0826
JX0826.THE GEOID HEIGHT WAS DETERMINED BY GEOID03.
JX0826
JX0826.THE DYNAMIC HEIGHT IS COMPUTED BY DIVIDING THE NAVD 88
JX0826.GEOPOTENTIAL NUMBER BY THE NORMAL GRAVITY VALUE COMPUTED ON THE
JX0826.GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80) ELLIPSOID AT 45
JX0826.DEGREES LATITUDE (G = 980.6199 GALS.).
JX0826
JX0826.THE MODELED GRAVITY WAS INTERPOLATED FROM OBSERVED GRAVITY VALUES.
JX0826
JX0826;                  NORTH        EAST    UNITS  ESTIMATED ACCURACY
JX0826;SPC OH S     -   196,600.     718,570.     MT  (+/- 180 METERS SCALED)
JX0826
JX0826                        SUPERSEDED SURVEY CONTROL
JX0826
JX0826  NGVD 29 (??/??/92)  369.805  (M)        1213.27   (F) ADJ UNCH    2 0
JX0826
JX0826.SUPERSEDED VALUES ARE NOT RECOMMENDED FOR SURVEY CONTROL.
JX0826.NGS NO LONGER ADJUSTS PROJECTS TO THE NAD 27 OR NGVD 29 DATUMS.
JX0826.SEE FILE DSDATA.TXT TO DETERMINE HOW THE SUPERSEDED DATA WERE DERIVED.
JX0826
JX0826_U.S. NATIONAL GRID SPATIAL ADDRESS: 17SME900014(NAD 83)
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JX0826_SETTING: 36 = SET IN A MASSIVE STRUCTURE
JX0826_SP_SET: BUILDING
JX0826_STAMPING: P 66 1934
JX0826_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
JX0826
JX0826  HISTORY     - DATE     CONDITION       REPORT BY
JX0826  HISTORY     - 1934     MONUMENTED      CGS
JX0826
JX0826                        STATION DESCRIPTION
JX0826
JX0826'DESCRIBED BY COAST AND GEODETIC SURVEY 1934
JX0826'AT WOODSFIELD.
JX0826'AT WOODSFIELD, MONROE COUNTY, AT THE SOUTHEAST CORNER OF THE
JX0826'MONROE COUNTY COURTHOUSE, IN THE SOUTH WALL, 35 YARDS NORTHWEST
JX0826'OF A STREET LIGHT AT THE INTERSECTION OF STATE HIGHWAY 78 AND
JX0826'MAIN STREET, 16 YARDS NORTH OF THE CENTERLINE OF THE HIGHWAY,
JX0826'AND 4-1/2-FEET ABOVE THE GROUND.  A STANDARD DISK, STAMPED P 66
JX0826'1934 AND SET VERTICALLY.
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RM4

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1       NATIONAL GEODETIC SURVEY,   RETRIEVAL DATE = JULY 11, 2006
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JX0824  DESIGNATION -  M 66
JX0824  PID        -  JX0824
JX0824  STATE/COUNTY-  OH/MONROE
JX0824  USGS QUAD   -  LEWISVILLE (1994)
JX0824
JX0824                       *CURRENT SURVEY CONTROL
JX0824  ___________________________________________________________________
JX0824* NAD 83(1986)-  39 46 06.     (N)    081 10 45.     (W)     SCALED
JX0824* NAVD 88     -      385.021  (METERS)    1263.19   (FEET)  ADJUSTED
JX0824  ___________________________________________________________________
JX0824  GEOID HEIGHT-        -33.84  (METERS)                      GEOID03
JX0824  DYNAMIC HT  -       384.802 (METERS)    1262.47  (FEET)  COMP
JX0824  MODELED GRAV-     980,045.5   (MGAL)                    NAVD 88
JX0824
JX0824  VERT ORDER  -  SECOND    CLASS 0
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JX0824
JX0824.THE HORIZONTAL COORDINATES WERE SCALED FROM A TOPOGRAPHIC MAP AND HAVE
JX0824.AN ESTIMATED ACCURACY OF +/- 6 SECONDS.
JX0824
JX0824.THE ORTHOMETRIC HEIGHT WAS DETERMINED BY DIFFERENTIAL LEVELING
JX0824.AND ADJUSTED BY THE NATIONAL GEODETIC SURVEY IN JUNE 1991..
JX0824
JX0824.THE GEOID HEIGHT WAS DETERMINED BY GEOID03.
JX0824
JX0824.THE DYNAMIC HEIGHT IS COMPUTED BY DIVIDING THE NAVD 88
JX0824.GEOPOTENTIAL NUMBER BY THE NORMAL GRAVITY VALUE COMPUTED ON THE
JX0824.GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80) ELLIPSOID AT 45
JX0824.DEGREES LATITUDE (G = 980.6199 GALS.).
JX0824
JX0824.THE MODELED GRAVITY WAS INTERPOLATED FROM OBSERVED GRAVITY VALUES.
JX0824
JX0824;                 NORTH       EAST    UNITS  ESTIMATED ACCURACY
JX0824;SPC OH S     -   197,140.     713,160.     MT  (+/- 180 METERS SCALED)
JX0824
JX0824                        SUPERSEDED SURVEY CONTROL
JX0824
JX0824  NGVD 29 (??/??/92)  385.20   (M)        1263.8    (F) COMPUTED    2 0
JX0824
JX0824.SUPERSEDED VALUES ARE NOT RECOMMENDED FOR SURVEY CONTROL.
JX0824.NGS NO LONGER ADJUSTS PROJECTS TO THE NAD 27 OR NGVD 29 DATUMS.
JX0824.SEE FILE DSDATA.TXT TO DETERMINE HOW THE SUPERSEDED DATA WERE DERIVED.
JX0824
JX0824_U.S. NATIONAL GRID SPATIAL ADDRESS: 17SME846020(NAD 83)
JX0824_MARKER: DB = BENCH MARK DISK
JX0824_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
JX0824_SP_SET: SET IN TOP OF CONCRETE MONUMENT
JX0824_STAMPING: M 66 1934
JX0824_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
JX0824+STABILITY: SURFACE MOTION
JX0824
JX0824  HISTORY     - DATE     CONDITION       REPORT BY
JX0824  HISTORY     - 1934     MONUMENTED      CGS
JX0824
JX0824                        STATION DESCRIPTION
JX0824
JX0824'DESCRIBED BY COAST AND GEODETIC SURVEY 1934
JX0824'2.4 MI E FROM LEWISVILLE.
JX0824'2.4 MILES EAST ALONG STATE HIGHWAY 78 FROM THE INTERSECTION
JX0824'OF BACK STREET AT LEWISVILLE, MONROE COUNTY, 7 YARDS EAST OF
JX0824'THE SOUTHEAST CORNER OF THE BUCHANAN PRESBYTERIAN CHURCH, 30
JX0824'YARDS NORTHEAST OF THE NORTHEAST CORNER OF A WIRE FENCE AROUND
JX0824'A CEMETERY, 17 YARDS NORTH OF THE CENTERLINE OF THE HIGHWAY,
JX0824'2 FEET SOUTHWEST OF A WIRE FENCE, AND ABOUT 1-1/2 FEET ABOVE
JX0824'THE LEVEL OF THE HIGHWAY.  A STANDARD DISK, STAMPED M 66 1934
JX0824'AND SET IN THE TOP OF A CONCRETE POST.
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Flood Profiles

The flood profiles for Wheeler Run near the Village of Woodsfield for the 10-, 50-, 100-, and 500-year-recurrence-interval floods are presented in figure 1–F2. The locations of the cross sections for Wheeler Run are presented in figure 1–F3.

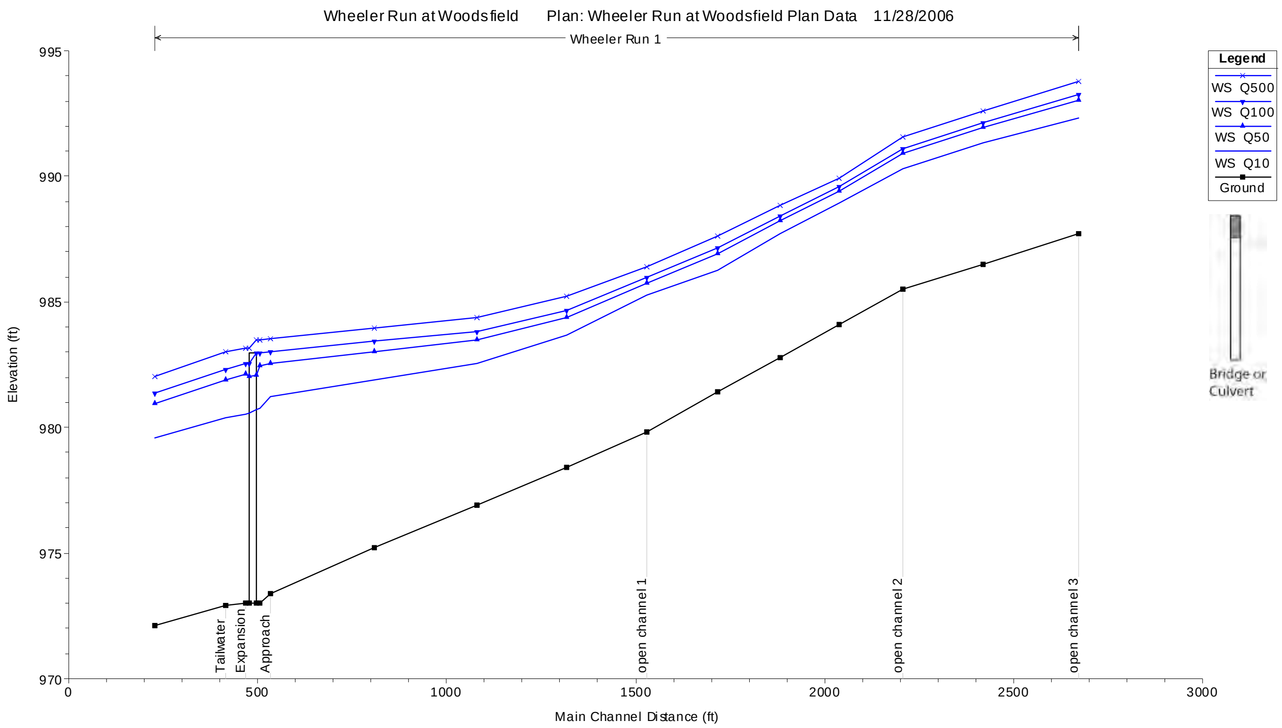

Figure 1–F2. Flood profiles for Wheeler Run near the Village of Woodsfield for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

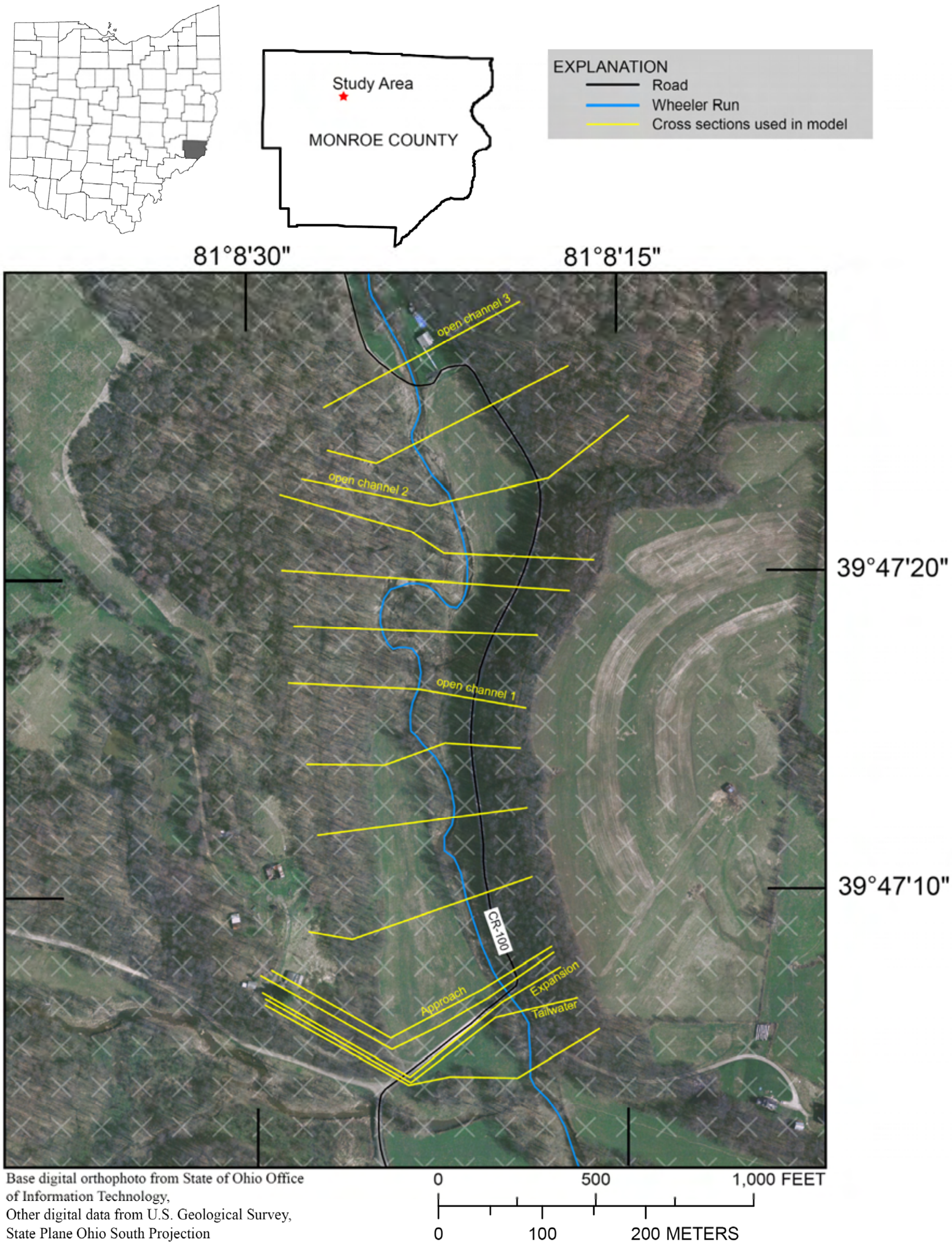

Figure 1–F3. Cross-section locations for flood profiles on Wheeler Run near the Village of Woodsfield, Ohio.

1–G. Sandy Creek in Brown Township

Work Conducted by the USGS

The USGS requested and obtained paper copies of the hydraulic model and work maps used in the 9/28/80 Carroll County FIS from FEMA archives. The original model was converted from HEC 2 to HEC-RAS (version 3.1.1) and rerun in an attempt to match the existing 100-year flood profile. With the exception of two cross sections (stations 100,490 and 100,495) downstream from the study reach, the 100-year profile was duplicated.

The mismatch in water-surface elevations at cross sections 100,490 and 100,495 was due to the model defaulting to a critical water-surface solution for cross section 100,490. The input data were checked for errors and none were found. Because the 1980 FIS 100-year profile had been accepted by FEMA and no input errors were found, the profile was assumed to be correct. In any case, the water-surface elevations for the two remaining cross sections upstream of station 100,495 (stations 102,700 and 105,890 - the area containing this study reach) matched the 1980 FIS 100-year profile.

Once the 100-year profile had been matched as closely as possible, it was assumed that the 1980 FIS hydraulic model had been reproduced. Afterward, the 10-, 50-, and 500-year flood profiles were added.

Scope of Work

The downstream limit of the reach studied is the eastern corporate limit of the Village of Waynesburg (cross section A, station 95,440 from the 1980 FIS). The upstream limit is cross section E (station 105,890) from the 1980 FIS (approximately 4,400 ft west of the Village of Malvern western corporate limit). This stream reach is approximately 2.0 mi long.

Hydraulic Baselines

Stationing used for the hydraulic baseline for this stream is referenced to feet above the mouth (confluence with the Tuscarawas River) taken from the 1980 FIS.

Cross-Section and Contracted-Opening-Geometry Data Surveyed in the Field

The USGS did not survey any cross sections since a previous detailed model existed for this reach of Sandy Creek. All model results are referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Synthetic Cross-Sectional-Geometry Data

No synthetic cross sections were used.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for the 100-year profile (969.80 ft) was obtained from the 1990 FIS. Starting water-surface elevations for the 10-, 50-, and 500-year flood profiles were obtained by means of a slope-conveyance calculation. The channel slope was determined to obtain a slope that would reproduce the known 100-year water-surface elevation for the known 100-

year peak flood discharge. This channel slope of 0.00074 ft/ft was used in slope-conveyance calculations for all modeled profiles. Based on the calculated slope, starting water-surface elevations of 968.36, 969.42, and 970.67 ft were determined at the initial section for the 10-, 50-, and 500-year profiles, respectively.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were obtained from the 1990 FIS. Estimates of Manning's roughness coefficients range from 0.050 to 0.013 for the overbank areas and were set to 0.03 for the main channel.

Flow Lengths

All main-channel flow lengths were obtained from the 1990 FIS. The flow lengths ranged from 5 to 3,190 ft.

Hydraulic-Structure Solution Reviews

There are no special hydraulic situations. For this study reach, there are no hydraulic structures.

Backwater Elevation

Because the modeled reach of Sandy Creek is approximately 18 mi above the mouth (confluence with the Tuscarawas River), it should not be subject to backwater; however, there may be some backwater from operations of Bolivar Dam. Backwater from the dam was not considered in the model.

Base-Mapping Information

The base map used for this study was a 20-ft digital contour map based on the USGS Malvern 7.5-minute quadrangle map.

Flood Profiles

The flood profiles for Sandy Creek in Brown Township for the 10-, 50-, 100-, and 500-year-recurrence-interval floods are presented in figure 1–G2. The locations of the cross sections for Sandy Creek are presented in figure 1–G3.

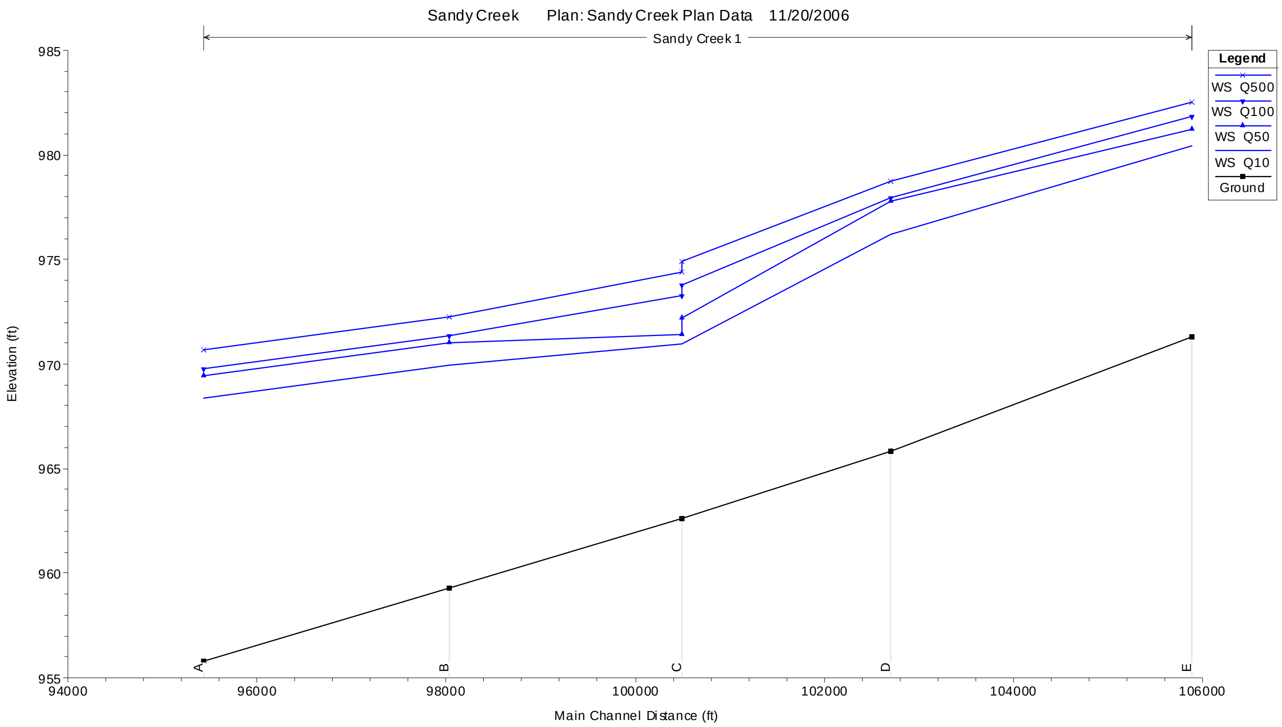

Figure 1–G2. Flood profiles for Sandy Creek in Brown Township for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

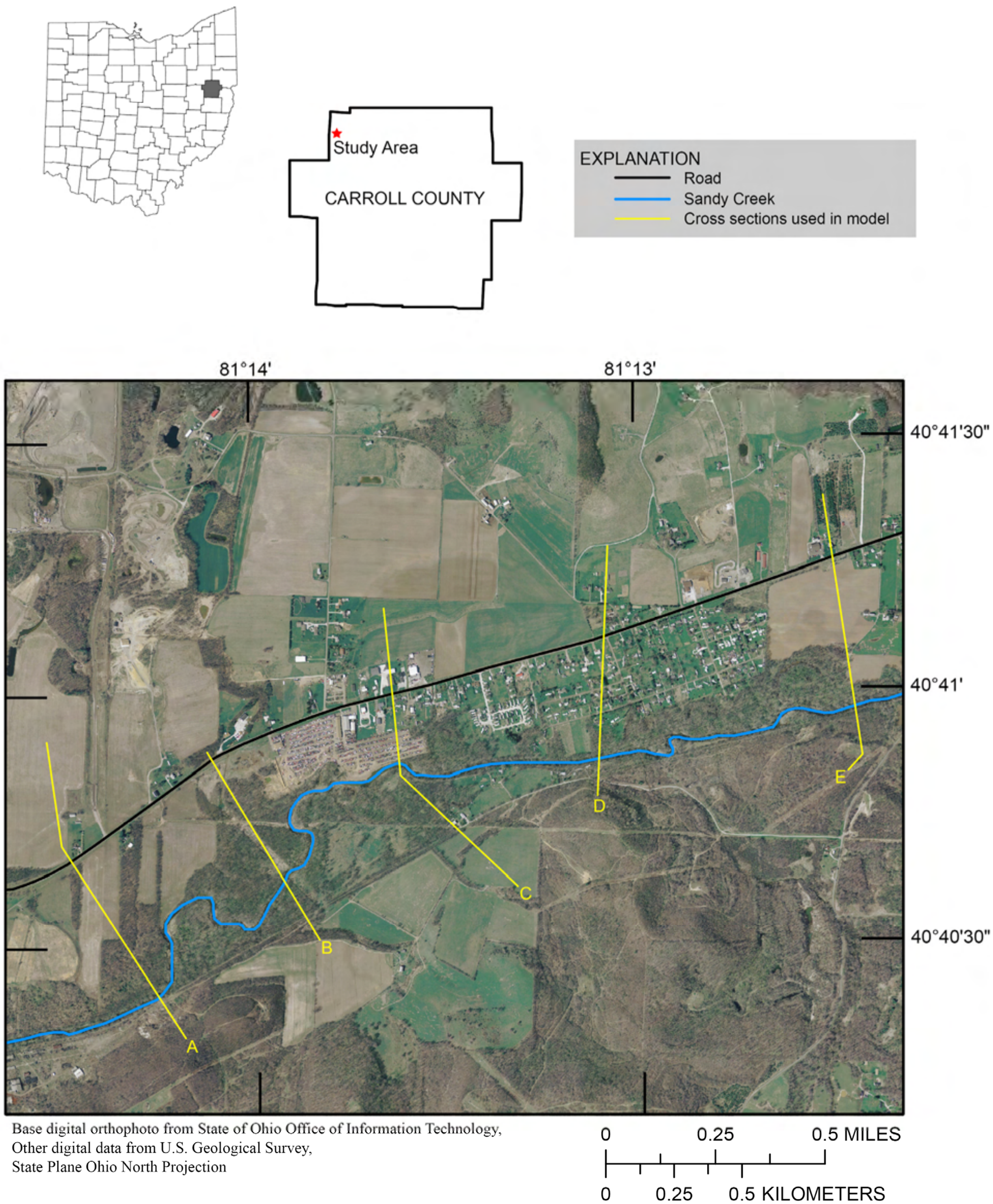

Figure 1–G3. Cross-section locations for flood profiles on Sandy Creek in Brown Township near the Village of Waynesburg, Ohio.

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