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–1519–DR), five communities required the selected flood profiles: Belle Valley, Brunswick, Hemlock, North Royalton, and Stow. 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–1519–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 FEMA approved hydrologic analysis]

Stream name	FIS date	Study name	Community number	Level of study
Village of Belle Valley, Noble County				
West Fork Duck Creek	11-02-90	Village of Belle Valley, Ohio	390429	Detailed
City of Brunswick, Medina County				
Plum Creek	12-02-03	City of Brunswick, Ohio	390380	Detailed
Plum Creek	12-02-03	Medina County, Ohio, Unincorporated Areas	390378	Approximate
Village of Hemlock, Perry County				
West Branch Sunday Creek	8-19-87	Perry County, Ohio, Unincorporated Areas	390708	Approximate
West Branch Sunday Creek Tributary	8-19-87	Perry County, Ohio, Unincorporated Areas	390708	Approximate
City of North Royalton, Cuyahoga County				
East Branch Rocky River Tributary R9	9-17-80	City of North Royalton, Ohio	390121	Approximate
City of Stow, Summit County				
Mud Brook Tributary 1C	7-17-78	City of Stow, Ohio	390532	Approximate
Cuyahoga River Tributary 1A	7-17-78	City of Stow, Ohio	390532	Approximate

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 seven reaches in five 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 - West Fork Duck Creek, B - Plum Creek, C – West Branch Sunday Creek and West Branch Sunday Creek Tributary, D – East Branch Rocky River Tributary R9, and E – Mud Brook Tributary 1C and Cuyahoga River Tributary 1A) 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. West Fork Duck Creek near the Village of Belle Valley

West Fork Duck Creek flows generally south in the northwest part of Noble County (fig. 1–A1). The downstream study limit is just upstream from the confluence with the Wolf Run Lake outlet. The upstream limit is State Route 340. This stream reach is approximately 1.4 mi long.

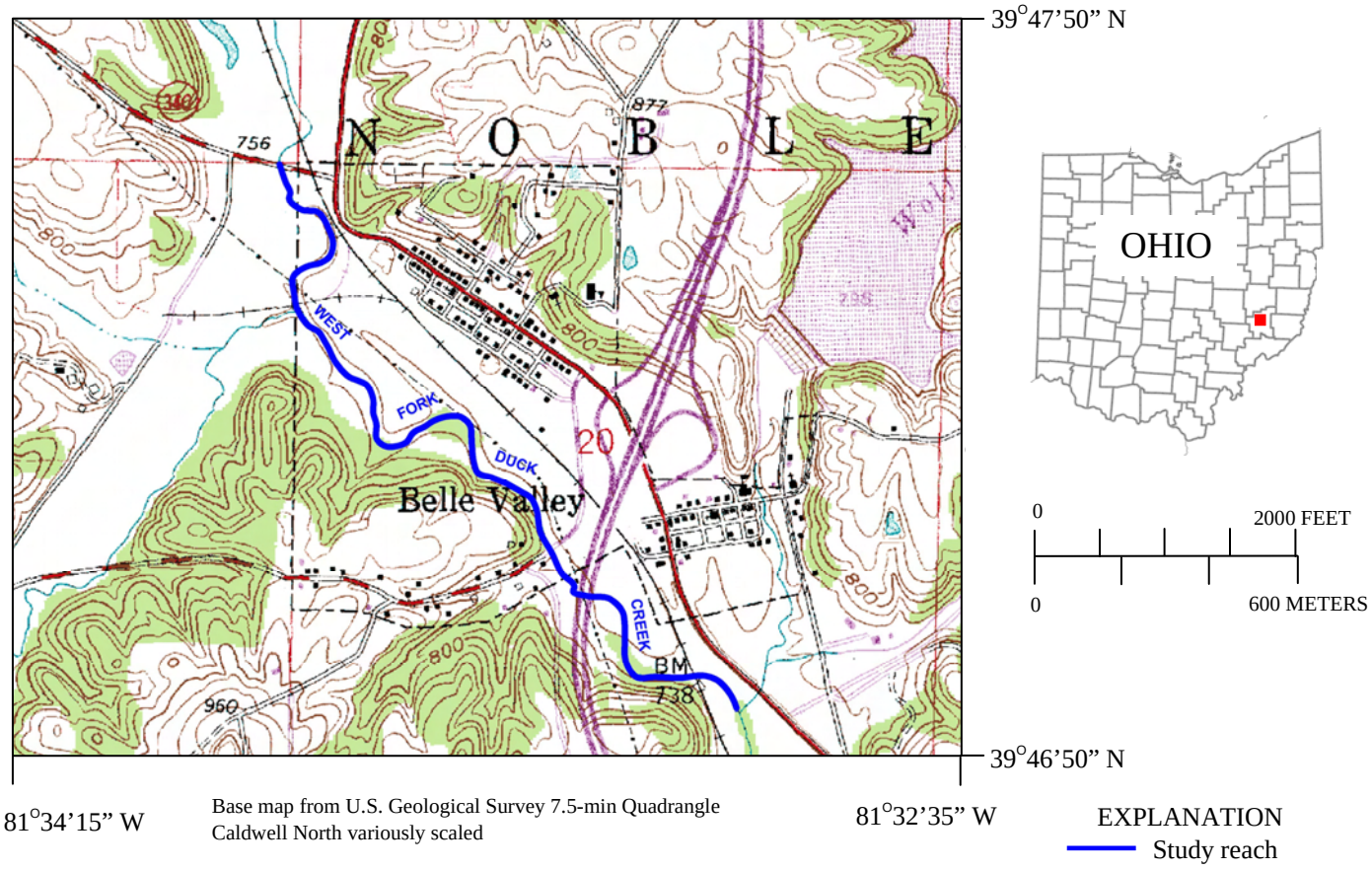

Figure 1–A1. Location of the West Fork Duck Creek study reach for the Village of Belle Valley, Ohio.

1–B. Plum Creek near the City of Brunswick

Plum Creek flows generally in a southern direction in the north-central part of Medina County (fig. 1–B1). The downstream limit of the reach studied is approximately 250 ft downstream from Plum Creek Road. The upstream limit is approximately 100 ft upstream from Sleepy Hollow Road. This stream reach is approximately 0.2 mi long. The study reach is on the southeast side of the City of Brunswick.

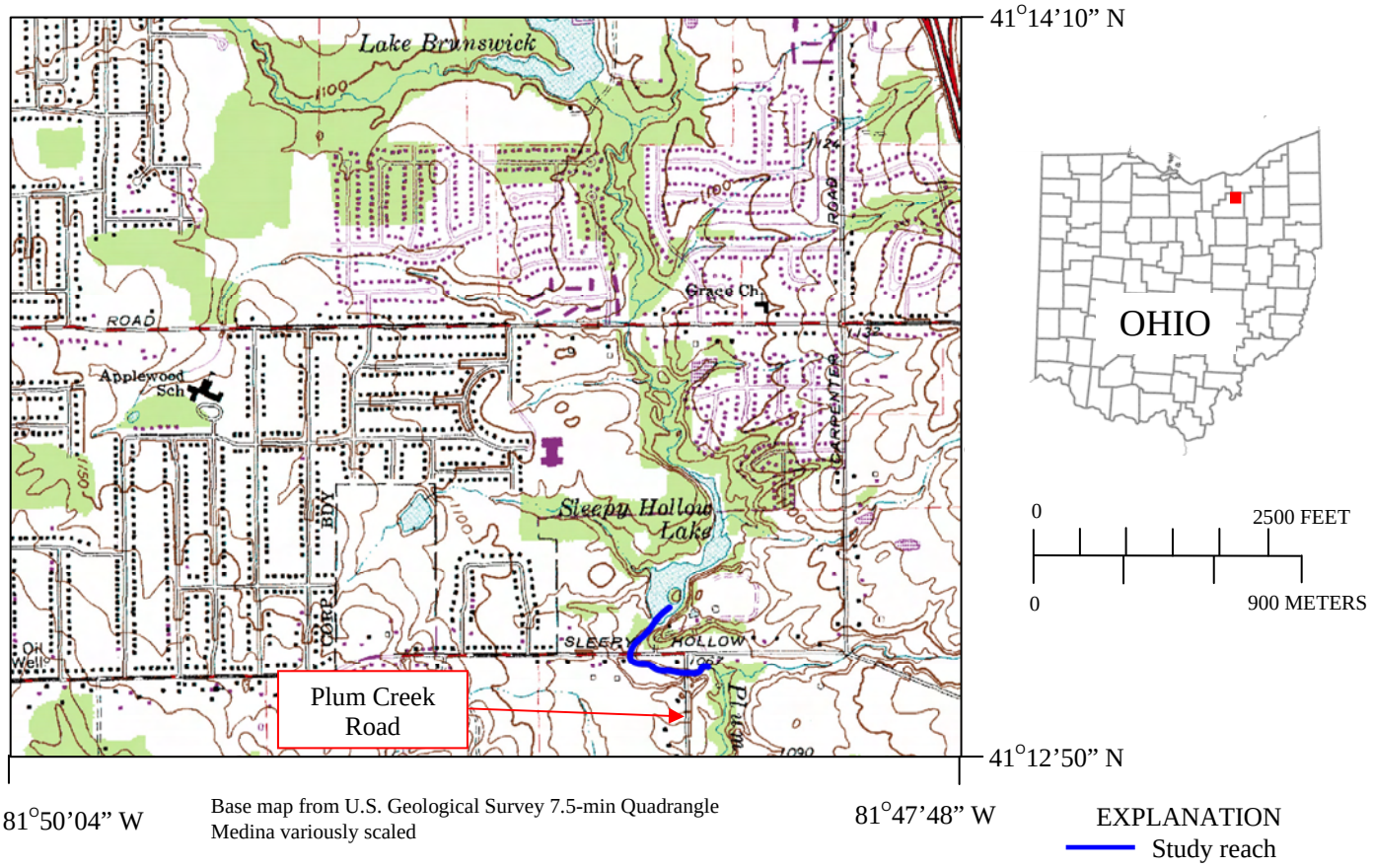

Figure 1–B1. Location of the Plum Creek study reach for the City of Brunswick, Ohio.

1–C. West Branch Sunday Creek and West Branch Sunday Creek Tributary near the Village of Hemlock

West Branch Sunday Creek flows generally southeast in the southeast part of Perry County (fig. 1–C1). The downstream study limit is the eastern corporate limit of the Village of Hemlock. The upstream limit is the western corporate limit of the Village of Hemlock. This stream reach is approximately 0.6 mi long.

West Branch Sunday Creek Tributary flows generally east in the southeast part of Perry County (fig. 1–C1). The downstream study limit is the mouth (confluence with West Branch Sunday Creek). The upstream limit is the western corporate limit of the Village of Hemlock. This stream reach is approximately 0.4 mi long.

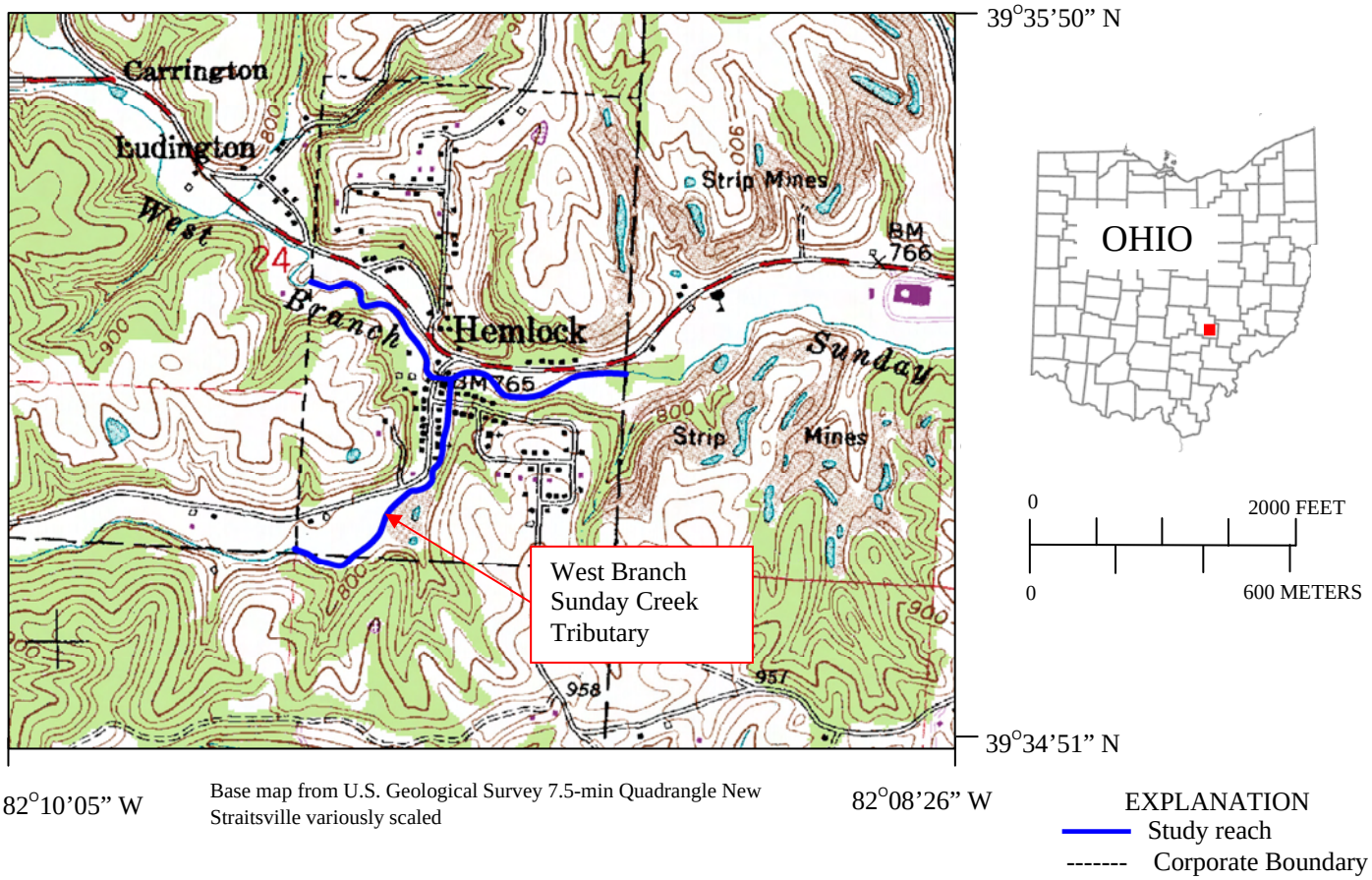

Figure 1–C1. Location of the West Branch Sunday Creek and West Branch Sunday Creek Tributary study reaches for the Village of Hemlock, Ohio.

1–D. East Branch Rocky River Tributary R9 near the City of North Royalton

East Branch Rocky River Tributary R9 flows generally southwest in the southern part of Cuyahoga County (fig. 1–D1). The downstream study limit is just downstream from the Edgerton Road. The upstream limit is 339 ft upstream from Edgerton Road. This stream reach is approximately 0.1 mi long.

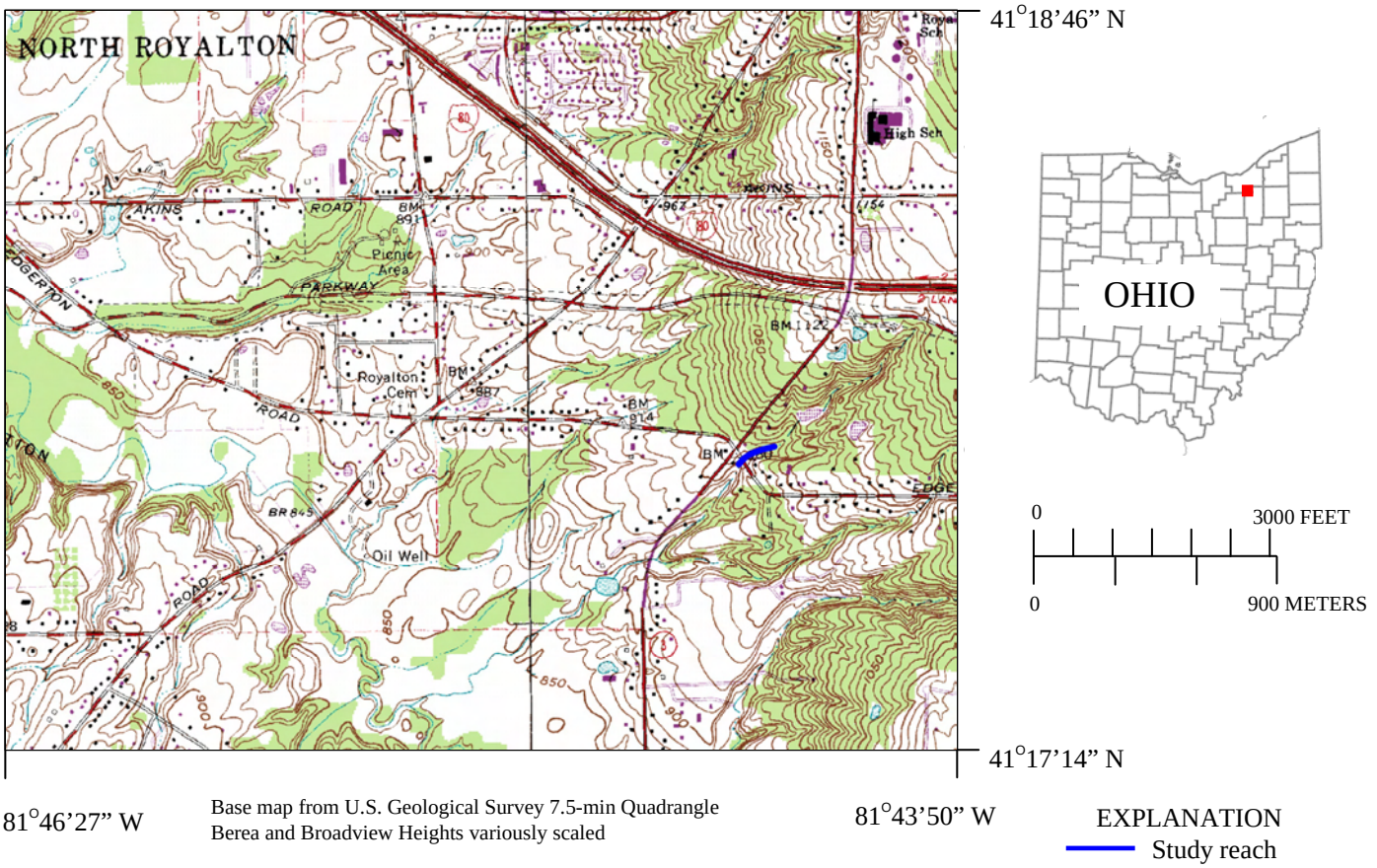

Figure 1–D1. Location of the East Branch Rocky River Tributary R9 study reach for the City of North Royalton, Ohio.

1–E. Mud Brook Tributary 1C and Cuyahoga River Tributary 1A near the City of Stow

Mud Brook Tributary 1C flows generally southwest in the central part of Summit County (fig. 1–E1). The downstream limit of the reach studied is approximately 350 ft downstream from Berkshire Road. The upstream limit is approximately 300 ft upstream from Berkshire Road. This stream reach is approximately 0.1 mi long.

Cuyahoga River Tributary 1A flows generally southwest in the central portion of Summit County (fig. 1–E1). The downstream limit of the reach studied is approximately 380 ft downstream from State Route 91 (Darrow Road). The upstream limit is approximately 330 ft downstream from Graham Road. This stream reach is approximately 0.7 mi long.

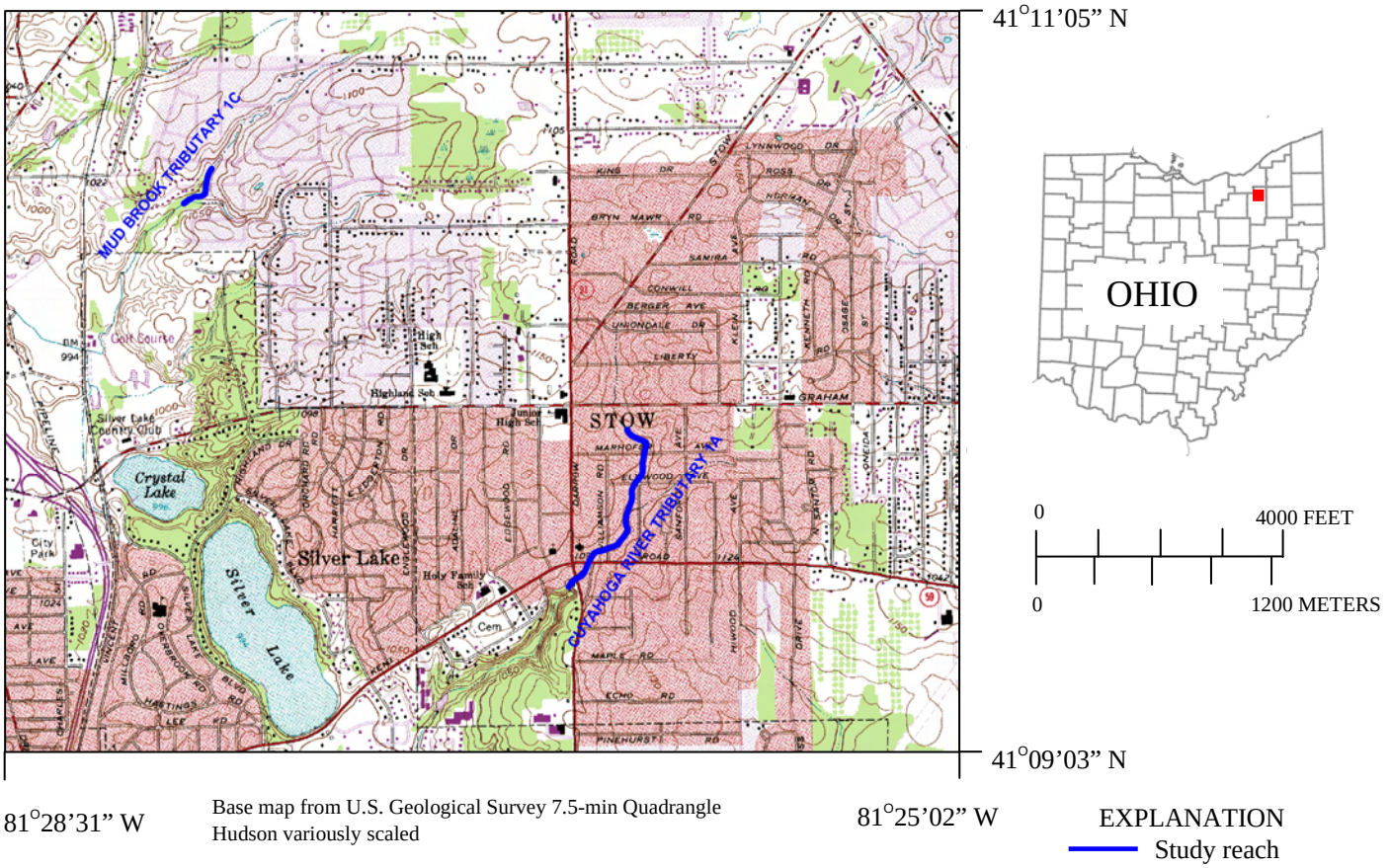

Figure 1–E1. Location of the Mud Brook Tributary 1C and Cuyahoga River Tributary 1A study reaches for the City of Stow, Ohio.

Hydrologic Analyses

The USGS conducted an FIS for the Ohio EMA in five communities in North-Central to Southeast Ohio. Selected flood profiles were determined for areas where they were needed to complete a cost-benefit analysis within the communities of Belle Valley, Brunswick, Hemlock, North Royalton, and Stow. 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 cost-benefit analysis. Any missing profiles were computed and added to the existing profiles to ensure 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 paragraphs following 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 Water-Resources Investigations Report 03–4164 (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 dataset (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. West Fork Duck Creek near the Village of Belle Valley

For West Fork Duck Creek, a previous estimate for the downstream 100-year-recurrence-interval peak discharge of 5,760 ft^3/s was available from the FIS, Village of Belle Valley, Ohio, Noble County November 2, 1990 (Federal Emergency Management Agency, 1990). The FIS used methods described in Webber and Bartlett (1976) to estimate the 100-year-recurrence-interval peak discharge. To compute peak-discharge estimates using this method, drainage area in square miles (mi^2) and main channel slope in feet per mile (ft/mi) are required (Webber and Bartlett, 1976). Basin characteristics to confirm the variables used in the previous study were determined using a Geographic Information System (GIS). In addition to the published equations for estimating the 10-, 50-, and 100-year-recurrence-interval peak discharges, a previously unpublished equation for estimating the 500-year-recurrence-interval peak discharge was used. The variables used in the regression equations, as well as the resulting peak-flood discharges, are presented in table 1–2.

1–B. Plum Creek near the City of Brunswick

The peak-flow estimates for this reach were taken directly from the FIS City of Brunswick, Ohio, December 2, 2003. The detailed study lower limit was Sleepy Hollow Road.

1–C. West Branch Sunday Creek and West Branch Sunday Creek Tributary near the Village of Hemlock

The peak flood discharges for both reaches in this community were developed using the technique described in Koltun (2003).

1–D. East Branch Rocky River Tributary R9 near the City of North Royalton

The peak flood discharges for the reach in this community were developed using the technique described in Koltun (2003).

1–E. Mud Brook Tributary 1C and Cuyahoga River Tributary 1A near the City of Stow

The peak flood discharges for both reaches in this community were developed using the technique described in Koltun (2003).

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
West Fork Duck Creek							
Above Wolf Run Lake outlet	32.9	13.9	NA	2,930	4,820	5,760[a]	8,300
Above Horse Run	22.2	15.8	NA	2,280	3,800	4,560	6,630
Plum Creek							
At Sleepy Hollow Lake Dam	8.69[2]	NA	NA	1,120[b]	1,680[b]	1,930[b]	2,510[b]
West Branch Sunday Creek							
East Corporate Limit of Village	8.3	28.2	0.29	1,170	1,790	2,060	2,690
Above West Branch Sunday Creek Tributary	6.1	31.8	0.35	936	1,430	1,650	2,170
West Branch Sunday Creek Tributary							
At mouth	2.1	59.0	0.08	506	797	928	1,240
East Branch Rocky River Tributary R9							
At Edgerton Road	0.5	257.9	0.65	212	345	405	550
Mud Brook Tributary 1C							
At Berkshire Road	0.9	41.2	0.83	217	335	388	510
Cuyahoga River Tributary 1A							
At State Route 59 (Kent Road)	1.1	43.7	0.06	292	459	533	709

[a] Discharge from the November 2,1990, Village of Belle Valley, Ohio, Noble County FIS.
[b] Values from the December 2, 2003, City of Brunswick, Ohio, Medina County FIS.

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 models 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
West Fork Duck Creek	HEC-RAS 3.1.1	6/28/2006
Plum Creek	HEC-RAS 3.1.1	6/14/2006
West Branch Sunday Creek	HEC-RAS 3.1.1	6/21/2006
West Branch Sunday Creek Tributary	HEC-RAS 3.1.1	7/3/2006
East Branch Rocky River Tributary R9	HEC-RAS 3.1.1	10/10/2006
Mud Brook Tributary 1C	HEC-RAS 3.1.1	6/14/2006
Cuyahoga River Tributary 1A	HEC-RAS 3.1.1	6/5/2006

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 (NAD83), Ohio State Plane (Ohio North or Ohio South) coordinates. The vertical datum for the survey is the North 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. West Fork Duck Creek Near the Village of Belle Valley

Work Conducted by the USGS

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

Scope of Work

The downstream study limit is just upstream from the confluence with the Wolf Run Lake outlet. The upstream limit is State Route 340. This stream reach is approximately 1.4 mi long.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet above Wolf Run Lake outlet, which is tributary to West Fork Duck Creek. The 1990 FIS reported stationing in feet above the abandoned railroad. This study reports the upstream face of the abandoned railroad as station 540. The difference in stationing between this study and the 1990 FIS is 540 ft. To compare the two models, add 540 ft to all stations reported in the November 2, 1990, FIS.

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

This restudy extended the 1990 hydraulic model both upstream and downstream of its original limits. For the extensions, the USGS surveyed 11 cross sections, including 2 open-channel sections and 3 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 16 synthetic or partially synthetic cross sections at desired locations along the stream reach were generated from a Triangulated Irregular Network (TIN) developed from the USGS 7.5 minute quadrangle map Caldwell North. 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 all profiles for West Fork Duck Creek was obtained by means of a slope-conveyance calculation. A slope of 0.00134 ft/ft was calculated from the river stations and minimum channel elevations for cross sections 610 and 1,730. 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 739.58, 740.72, 741.12, and 742.02 ft were determined at the initial section (station 109) 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 of West Fork Duck Creek were determined from field observation by experienced personnel. For West Fork Duck Creek, estimates of Manning's roughness coefficients range in value from 0.040 to 0.055 for the main channel and from 0.020 to 0.10 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 West Fork Duck Creek.

Table 1–A1. Summary of hydraulic-structure solutions for the 10-, 50-, 100-, and 500-year profiles of West Fork Duck Creek near the Village of Belle Valley.

River station (feet)	Location description	Structure type	Recurrence interval (years)	Presence of road overflow	Solution type
540	Abandoned railroad	Bridge	10	Y	Energy
540	Abandoned railroad	Bridge	50	Y	Energy
540	Abandoned railroad	Bridge	100	Y	Energy
540	Abandoned railroad	Bridge	500	Y	Energy
2,074	Interstate Route 77	Bridge	10	N	Energy
2,074	Interstate Route 77	Bridge	50	N	Energy
2,074	Interstate Route 77	Bridge	100	N	Energy
2,074	Interstate Route 77	Bridge	500	N	Energy
2,519	County Road 20 (West Road)	Bridge	10	Y	Energy
2,519	County Road 20 (West Road)	Bridge	50	Y	Energy
2,519	County Road 20 (West Road)	Bridge	100	Y	Energy
2,519	County Road 20 (West Road)	Bridge	500	Y	Energy

Backwater Elevation

West Fork Duck Creek should not be subject to backwater.

Base-Mapping Information

The base map used for this study was a digitized copy of the USGS Caldwell North 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 NGS control monuments and one U.S. Coast and Geodetic Survey (USC&GS) monument with known elevation. The USGS held two monuments as true (C65 and E65 Reset) in elevation, as obtained from the NGS. A comparison of the published elevations and surveyed elevations is given in table 1–A2. The bench mark descriptions are included below.

Table 1–A2. Comparison of published coordinates to USGS-surveyed coordinates and bench marks used in the study of West Fork Duck Creek near the Village of Belle Valley.
[All data shown in feet, NAD 83, and NAVD 88; 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
National Geodetic Survey (NGS) monuments										
1	C65	2228042.846	668535.592	773.23	NA[a]	NA[a]	773.23	NA	NA	0.00
2	F65	NA	NA	742.01	2240376.319	641632.201	741.86	NA	NA	0.15
3	ROBBINS	2256477.514	650790.579	1218.4[b]	2256477.514	650790.579	1218.38	0.000	0.000	0.02
4	E65 RESET	NA	NA	771.0[b]	2234608.653	652048.744	771.0	NA	NA	0.00
U.S. Coast & Geodetic Survey (USC&GS) monument										
5	739 1908	NA	NA	737.87	2235276.376	650662.030	737.95	NA	NA	-0.08

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

Bench Mark Descriptions

RM1

1 National Geodetic Survey, Retrieval Date = MARCH 23, 2006
JX1456 **********
JX1456 DESIGNATION - C 65
JX1456 PID - JX1456
JX1456 STATE/COUNTY- OH/NOBLE
JX1456 USGS QUAD - CALDWELL NORTH (1994)
JX1456
JX1456 *CURRENT SURVEY CONTROL
JX1456 _____
JX1456* NAD 83(1995)- 39 49 54.72879(N) 081 34 32.93723(W) ADJUSTED
JX1456* NAVD 88 - 235.682 (meters) 773.23 (feet) ADJUSTED
JX1456 _____
JX1456 X - 718,562.054 (meters) COMP
JX1456 Y - -4,851,920.657 (meters) COMP
JX1456 Z - 4,063,796.540 (meters) COMP

JX1456 LAPLACE CORR- 0.23 (seconds) DEFLEC99
JX1456 ELLIP HEIGHT- 201.60 (meters) (10/07/05) GPS OBS
JX1456 GEOID HEIGHT- -34.02 (meters) GEOID03
JX1456 DYNAMIC HT - 235.547 (meters) 772.79 (feet) COMP
JX1456 MODELED GRAV- 980,050.9 (mgal) NAVD 88
JX1456
JX1456 HORZ ORDER - FIRST
JX1456 VERT ORDER - SECOND CLASS 0
JX1456 ELLP ORDER - FOURTH CLASS I
JX1456
JX1456
JX1456.The modeled gravity was interpolated from observed gravity values.
JX1456
JX1456; North East Units Scale Factor Converg.
JX1456;SPC OH S - 203,770.056 679,108.818 MT 0.99996635 +0 35 11.1
JX1456;UTM 17 - 4,409,255.198 450,728.042 MT 0.99962989 -0 22 07.8
JX1456
JX1456! - Elev Factor x Scale Factor = Combined Factor
JX1456!SPC OH S - 0.99996837 x 0.99996635 = 0.99993472
JX1456!UTM 17 - 0.99996837 x 0.99962989 = 0.99959828
JX1456
JX1456_U.S. NATIONAL GRID SPATIAL ADDRESS: 17SME5072809255(NAD 83)
JX1456_MARKER: DB = BENCH MARK DISK
JX1456_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
JX1456_SP_SET: SET IN TOP OF CONCRETE MONUMENT
JX1456_STAMPING: C 65 1934
JX1456_MARK LOGO: CGS
JX1456_MAGNETIC: N = NO MAGNETIC MATERIAL
JX1456_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
JX1456+STABILITY: SURFACE MOTION
JX1456_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
JX1456+SATELLITE: SATELLITE OBSERVATIONS - December 17, 1992
JX1456
JX1456 HISTORY - Date Condition Report By
JX1456 HISTORY - 1934 MONUMENTED CGS
JX1456 HISTORY - 1942 GOOD NGS
JX1456 HISTORY - 19921217 GOOD OH-119
JX1456
JX1456 STATION DESCRIPTION
JX1456
JX1456'DESCRIBED BY NATIONAL GEODETIC SURVEY 1942
JX1456'AT AVA.
JX1456'AT AVA, NOBLE COUNTY, ON THE PENNSYLVANIA RAILROAD, 125 YARDS
JX1456'SOUTHWEST OF THE SOUTHWEST CORNER OF A WHITE FRAME CHURCH, 15.5
JX1456'YARDS SOUTHEAST OF THE CROSSING OF A DIRT ROAD, 20.5 FEET EAST
JX1456'OF THE EAST RAIL, 4 FEET WEST OF A POLE, AND ABOUT 6 INCHES
JX1456'LOWER THAN THE TRACK. A STANDARD DISK, STAMPED C 65 1934 AND
JX1456'SET IN THE TOP OF A CONCRETE POST.
JX1456
JX1456 STATION RECOVERY (1992)
JX1456
JX1456'RECOVERY NOTE BY MUSKINGUM COUNTY OHIO 1992 (LCC)
JX1456'RECOVERED AS DESCRIBED IN 1986 BY B. L. LAMBERT

RM2

1 National Geodetic Survey, Retrieval Date = MARCH 23, 2006
JX1460 **********
JX1460 DESIGNATION - F 65
JX1460 PID - JX1460
JX1460 STATE/COUNTY- OH/NOBLE
JX1460 USGS QUAD - CALDWELL NORTH (1994)
JX1460
JX1460 *CURRENT SURVEY CONTROL
JX1460 _____
JX1460* NAD 83(1986)- 39 45 27. (N) 081 31 59. (W) SCALED
JX1460* NAVD 88 - 226.165 (meters) 742.01 (feet) ADJUSTED
JX1460 _____
JX1460 GEOID HEIGHT- -34.09 (meters) GEOID03

JX1460 DYNAMIC HT - 226.035 (meters) 741.58 (feet) COMP
JX1460 MODELED GRAV- 980,045.4 (mgal) NAVD 88
JX1460
JX1460 VERT ORDER - SECOND CLASS 0
JX1460
JX1460.The horizontal coordinates were scaled from a topographic map and have
JX1460.an estimated accuracy of +/- 6 seconds.
JX1460
JX1460.The orthometric height was determined by differential leveling
JX1460.and adjusted by the National Geodetic Survey in June 1991..
JX1460
JX1460.The geoid height was determined by GEOID03.
JX1460
JX1460.The dynamic height is computed by dividing the NAVD 88
JX1460.geopotential number by the normal gravity value computed on the
JX1460.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
JX1460.degrees latitude (g = 980.6199 gals.).
JX1460
JX1460.The modeled gravity was interpolated from observed gravity values.
JX1460
JX1460; North East Units Estimated Accuracy
JX1460;SPC OH S - 195,550. 682,860. MT (+/- 180 meters Scaled)
JX1460
JX1460 SUPERSEDED SURVEY CONTROL
JX1460
JX1460 NGVD 29 (??/??/92) 226.338 (m) 742.58 (f) ADJ UNCH 2 0
JX1460
JX1460.Superseded values are not recommended for survey control.
JX1460.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
JX1460.*See file dsdata.txt* to determine how the superseded data were derived.
JX1460
JX1460_U.S. NATIONAL GRID SPATIAL ADDRESS: 17SME543009(NAD 83)
JX1460_MARKER: DB = BENCH MARK DISK
JX1460_SETTING: 36 = SET IN A MASSIVE STRUCTURE
JX1460_SP_SET: BRIDGE
JX1460_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
JX1460
JX1460 HISTORY - Date Condition Report By
JX1460 HISTORY - UNK MONUMENTED CGS
JX1460 HISTORY - 1958 GOOD NGS
JX1460 HISTORY - 1962 GOOD LOCENG
JX1460
JX1460 STATION DESCRIPTION
JX1460
JX1460'DESCRIBED BY NATIONAL GEODETIC SURVEY 1958
JX1460'1.1 MI N FROM CALDWELL.
JX1460'1.1 MILES NORTH ALONG THE PENNSYLVANIA RAILROAD FROM THE STATION
JX1460'AT CALDWELL, NOBLE COUNTY, AT THE STEEL OVERPASS OVER U.S. HIGHWAY
JX1460'21, IN THE TOP OF THE NORTH END OF THE WEST CONCRETE BRIDGE
JX1460'SEAT, 3 YARDS NORTH-NORTHEAST OF THE EAST RAIL, AND ABOUT 4-1/2
JX1460'FEET LOWER THAN THE TRACK. NOTE-- ORIGINALLY DESCRIBED AS BEING
JX1460'IN THE TOP OF THE EAST END OF THE NORTH BRIDGE SEAT.
JX1460
JX1460 STATION RECOVERY (1962)
JX1460'RECOVERY NOTE BY LOCAL ENGINEER (INDIVIDUAL OR FIRM) 1962
JX1460'RECOVERED IN GOOD CONDITION.

RM3

```
1       National Geodetic Survey,   Retrieval Date = MARCH 23, 2006
JX2101 ***********************************************************************
JX2101  DESIGNATION -  ROBBINS
JX2101  PID         -  JX2101
JX2101  STATE/COUNTY-  OH/NOBLE
JX2101  USGS QUAD   -  SARAHSVILLE (1994)
JX2101
JX2101                    *CURRENT SURVEY CONTROL
JX2101 _______________________________________________________________________
JX2101* NAD 83(1995)-  39 46 56.33180(N)    081 28 31.04612(W)     ADJUSTED
JX2101* NAVD 88     -      371.38   (+/-2cm)    1218.4    (feet)  VERTCON
JX2101 _______________________________________________________________________
JX2101  LAPLACE CORR-           1.37  (seconds)                 DEFLEC99
JX2101  GEOID HEIGHT-         -34.04  (meters)                  GEOID03
JX2101
JX2101  HORZ ORDER  -  FIRST
JX2101  VERT ORDER  -  THIRD ? (See Below)
JX2101
JX2101.The horizontal coordinates were established by classical geodetic methods
JX2101.and adjusted by the National Geodetic Survey in April 1998..
JX2101
JX2101.The NAVD 88 height was computed by applying the VERTCON shift value to
JX2101.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
JX2101.The vertical order pertains to the NGVD 29 superseded value.
JX2101
JX2101.The Laplace correction was computed from DEFLEC99 derived deflections.
JX2101
JX2101.The geoid height was determined by GEOID03.
JX2101
JX2101;                 North         East     Units Scale Factor Converg.
JX2101;SPC OH S     -   198,361.365   687,775.722   MT  0.99995998   +0 39 00.7
JX2101;UTM  17      - 4,403,704.717   459,300.717   MT  0.99962039   -0 18 14.9
JX2101
JX2101!           -  Elev Factor  x  Scale Factor =   Combined Factor
JX2101!SPC OH S     -  0.99994708  x   0.99995998  =   0.99990706
JX2101!UTM  17      -  0.99994708  x   0.99962039  =   0.99956749
JX2101
JX2101:              Primary Azimuth Mark                  Grid Az
JX2101:SPC OH S     -  ROBBINS AZ MK                        352 50 06.6
JX2101:UTM  17      -  ROBBINS AZ MK                        353 47 22.2
JX2101
JX2101|-----------------------------------------------------------------------|
JX2101| PID    Reference Object                 Distance      Geod. Az  |
JX2101|                                        dddmmss.s |
JX2101| CD2086 ROBBINS RM 1                        22.732 METERS 06211     |
JX2101|-----------------------------------------------------------------------|
JX2101| JX2095 FULDA CATHOLIC CHURCH SPIRE         APPROX. 8.3 KM 1414331.5 |
JX2101|-----------------------------------------------------------------------|
JX2101| CD2087 ROBBINS RM 2                        24.540 METERS 21920     |
JX2101|-----------------------------------------------------------------------|
JX2101| CD2085 ROBBINS AZ MK                                      3532907.3 |
JX2101|-----------------------------------------------------------------------|
JX2101
JX2101                      SUPERSEDED SURVEY CONTROL
JX2101
JX2101  NAD 83(1986)-  39 46 56.33946(N)    081 28 31.05534(W) AD(       ) 1
JX2101  NAD 27      -  39 46 56.07600(N)    081 28 31.61500(W) AD(       ) 1
JX2101  NGVD 29 (07/19/86)  371.55   (m)         1219.0    (f) LEVELING    3
JX2101
JX2101.Superseded values are not recommended for survey control.
JX2101.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
JX2101.See file dsdata.txt  to determine how the superseded data were derived.
JX2101
JX2101_U.S. NATIONAL GRID SPATIAL ADDRESS: 17SME5930103705(NAD 83)
JX2101_MARKER: DS = TRIANGULATION STATION DISK
JX2101_SETTING: 0 = UNSPECIFIED SETTING
JX2101
JX2101  HISTORY     - Date     Condition        Report By
```

JX2101 HISTORY - 1944 MONUMENTED CGS
JX2101 HISTORY - 1958 GOOD CGS
JX2101 HISTORY - 1961 GOOD LOCENG
JX2101
JX2101 STATION DESCRIPTION
JX2101
JX2101'DESCRIBED BY COAST AND GEODETIC SURVEY 1944 (FN)
JX2101'STATION IS LOCATED
JX2101'ABOUT 8 MILES NE
JX2101'OF CALDWELL AND ABOUT 1.4 MILES W OF STATE HIGHWAY
JX2101'147. THE MARK IS SITUATED ON A
JX2101'CLEARED KNOLL OWNED BY L.D.
JX2101'ROBBINS WHO LIVES AT THE FOOT OF THE HILL. IT IS
JX2101'90 FEET W OF
JX2101'A WIRE GATE IN A FENCE AND 13 FEET N OF A WOODEN WITNESS POST
JX2101'WHICH WAS PLACED
JX2101'IN THE FENCELINE. THE DISK IS STAMPED ROBBINS
JX2101'1944 AND PROJECTS ABOUT 10 INCHES
JX2101'ABOVE THE GROUND.
JX2101'
JX2101'SURFACE, UNDERGROUND, REFERENCE, AND AZIMUTH MARKS ARE BRONZE
JX2101'DISKS SET IN
JX2101'CONCRETE.
JX2101'
JX2101'REFERENCE MARK 1 IS 74.58 FEET NE OF THE STATION AND 1 FOOT
JX2101'N OF AN E-W FENCE.
JX2101'IT IS STAMPED ROBBINS NO 1 1944.
JX2101'
JX2101'REFERENCE MARK 2 IS 80.51 FEET SW BY S OF THE STATION AND
JX2101'ABOUT 4 FEET LOWER
JX2101'IN ELEVATION. IT IS ABOUT 1 FOOT N OF FENCELINE
JX2101'AND IS STAMPED ROBBINS NO 2 1944.
JX2101'
JX2101'AZIMUTH MARK IS 21 FEET N OF THE APPROXIMATE CENTER LINE OF
JX2101'AN E-W DIRT ROAD,
JX2101'5 FEET E OF A WOODEN WITNESS POST, 1 FOOT S OF
JX2101'A 3-STRAND BARBED-WIRE FENCE. IT IS
JX2101'STAMPED ROBBINS 1944.
JX2101'
JX2101'TO REACH THE STATION FROM THE JUNCTION OF U.S. HIGHWAY 21 AND
JX2101'STATE HIGHWAY 78
JX2101'IN CALDWELL, GO E ON STATE HIGHWAY 78 FOR 4.95
JX2101'MILES TO THE JUNCTION OF STATE
JX2101'HIGHWAY 147. TURN LEFT ON HIGHWAY
JX2101'147 AND GO 1.7 MILES TO A T-ROAD LEFT, TURN LEFT
JX2101'ON A ROCK ROAD
JX2101'AND GO 1.25 MILES TO A T-ROAD RIGHT.* CONTINUE STRAIGHT AHEAD
JX2101'FOR 0.05 MILE TO
JX2101'A DIM T-ROAD RIGHT. TURN RIGHT FOR 0.1 MILE TO
JX2101'A WIRE GATE ON THE RIGHT. PASS
JX2101'THROUGH THE GATE, THEN TURN LEFT
JX2101'AND FOLLOW ALONG THE FENCELINE FOR ABOUT 100 FEET
JX2101'TO THE STATION.
JX2101'
JX2101'*TO REACH THE AZIMUTH MARK FROM THIS POINT GO W FOR 0.05
JX2101'MILE TO THE MARK
JX2101'ON THE RIGHT.
JX2101'
JX2101'HEIGHT OF LIGHT ABOVE STATION MARK - 26 METERS.
JX2101
JX2101 STATION RECOVERY (1958)
JX2101
JX2101'RECOVERY NOTE BY COAST AND GEODETIC SURVEY 1958 (HBW)
JX2101'THE STATION, AZIMUTH MARK AND REFERENCE MARK NO. 1 WERE RECOVERED IN
JX2101'GOOD CONDITION.
JX2101'REFERENCE MARK NO. 2 WAS NOT SEARCHED FOR.
JX2101
JX2101 STATION RECOVERY (1961)
JX2101
JX2101'RECOVERY NOTE BY LOCAL ENGINEER (INDIVIDUAL OR FIRM) 1961
JX2101'ALL MARKS FOUND AS DESCRIBED AND IN GOOD CONDITION.

RM4

1 National Geodetic Survey, Retrieval Date = MARCH 23, 2006
JX1459 ***
JX1459 DESIGNATION - E 65 RESET
JX1459 PID - JX1459
JX1459 STATE/COUNTY- OH/NOBLE
JX1459 USGS QUAD - CALDWELL NORTH (1994)
JX1459
JX1459 *CURRENT SURVEY CONTROL
JX1459 _____
JX1459* NAD 83(1986)- 39 47 11. (N) 081 33 12. (W) SCALED
JX1459* NAVD 88 - 235.01 (+/-2cm) 771.0 (feet) VERTCON
JX1459 _____
JX1459 GEOID HEIGHT- -34.06 (meters) GEOID03
JX1459
JX1459 VERT ORDER - THIRD (See Below)
JX1459
JX1459.The horizontal coordinates were scaled from a topographic map and have
JX1459.an estimated accuracy of +/- 6 seconds.
JX1459
JX1459.The NAVD 88 height was computed by applying the VERTCON shift value to
JX1459.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
JX1459.The vertical order pertains to the NGVD 29 superseded value.
JX1459
JX1459.The geoid height was determined by GEOID03.
JX1459
JX1459; North East Units Estimated Accuracy
JX1459;SPC OH S - 198,740. 681,090. MT (+/- 180 meters Scaled)
JX1459
JX1459 SUPERSEDED SURVEY CONTROL
JX1459
JX1459 NGVD 29 (10/13/05) 235.19 (m) 771.6 (f) RESET 3
JX1459
JX1459.Superseded values are not recommended for survey control.
JX1459.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
JX1459.*See file dsdata.txt* to determine how the superseded data were derived.
JX1459
JX1459_U.S. NATIONAL GRID SPATIAL ADDRESS: 17SME526041(NAD 83)
JX1459_MARKER: DD = SURVEY DISK
JX1459_SETTING: 36 = SET IN A MASSIVE STRUCTURE
JX1459_SP_SET: BRIDGE
JX1459_STAMPING: E 65 RESET 1967
JX1459_MARK LOGO: CGS
JX1459_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
JX1459
JX1459 HISTORY - Date Condition Report By
JX1459 HISTORY - 1967 MONUMENTED OHHD
JX1459 HISTORY - 1968 GOOD CGS
JX1459
JX1459 STATION DESCRIPTION
JX1459
JX1459'DESCRIBED BY COAST AND GEODETIC SURVEY 1968
JX1459'AT BELLE VALLEY.
JX1459'SET IN THE TOP OF WINGWALL OF NORTH-BOUND BRIDGE NO. NOB-I-77-1110
JX1459'OVER THE PENN-CENTRAL RAILROAD, 20 FEET WEST OF THE CENTER LINE
JX1459'OF THE NORTH-BOUND LANE, DRILLED IN CONCRETE.

RM5

739 1908
Belle Valley; 0.3 mi S. of station; at SE. corner of Pa. RR. Bridge over Duck Creek; in bridge seat; standard tablet stamped “739 1908”.

Elevation (NGVD29) = 738.457 ft
Elevation (NAVD88) = 737.87 ft

Flood Profiles

The flood profiles for West Fork Duck Creek near the Village of Belle Valley 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.

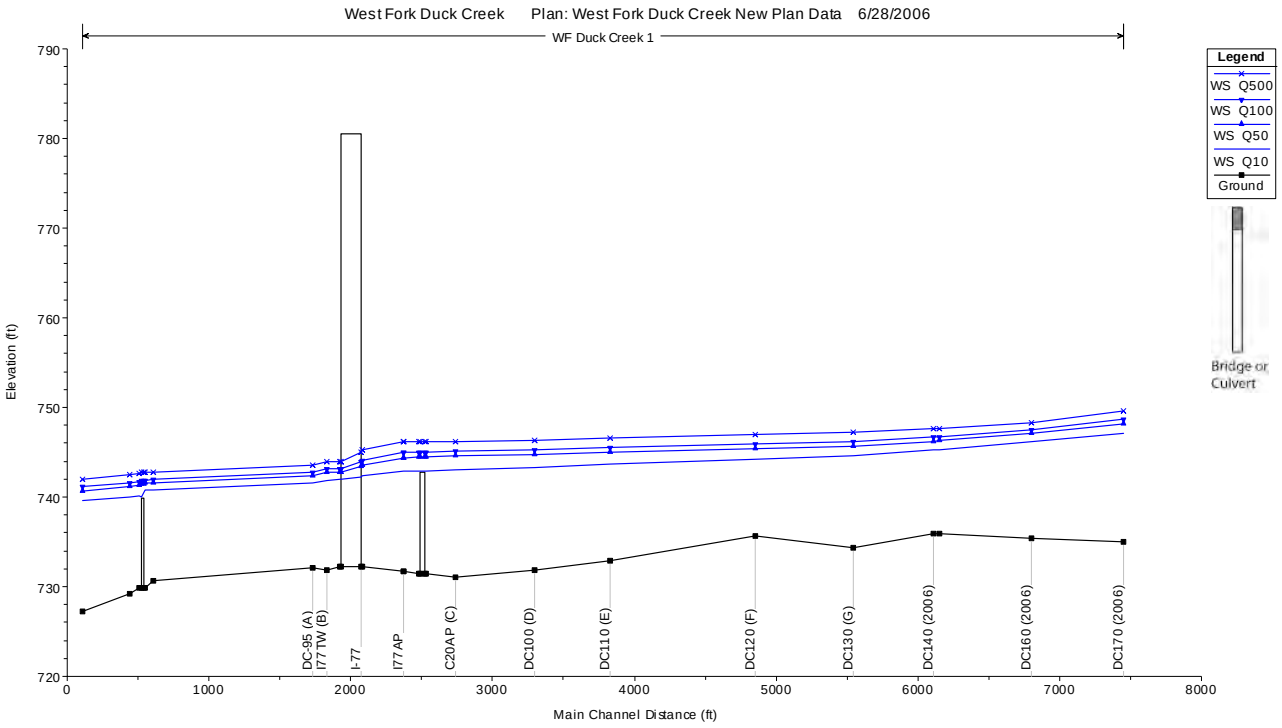

Figure 1–A2. Flood profiles for West Fork Duck Creek near the Village of Belle Valley for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

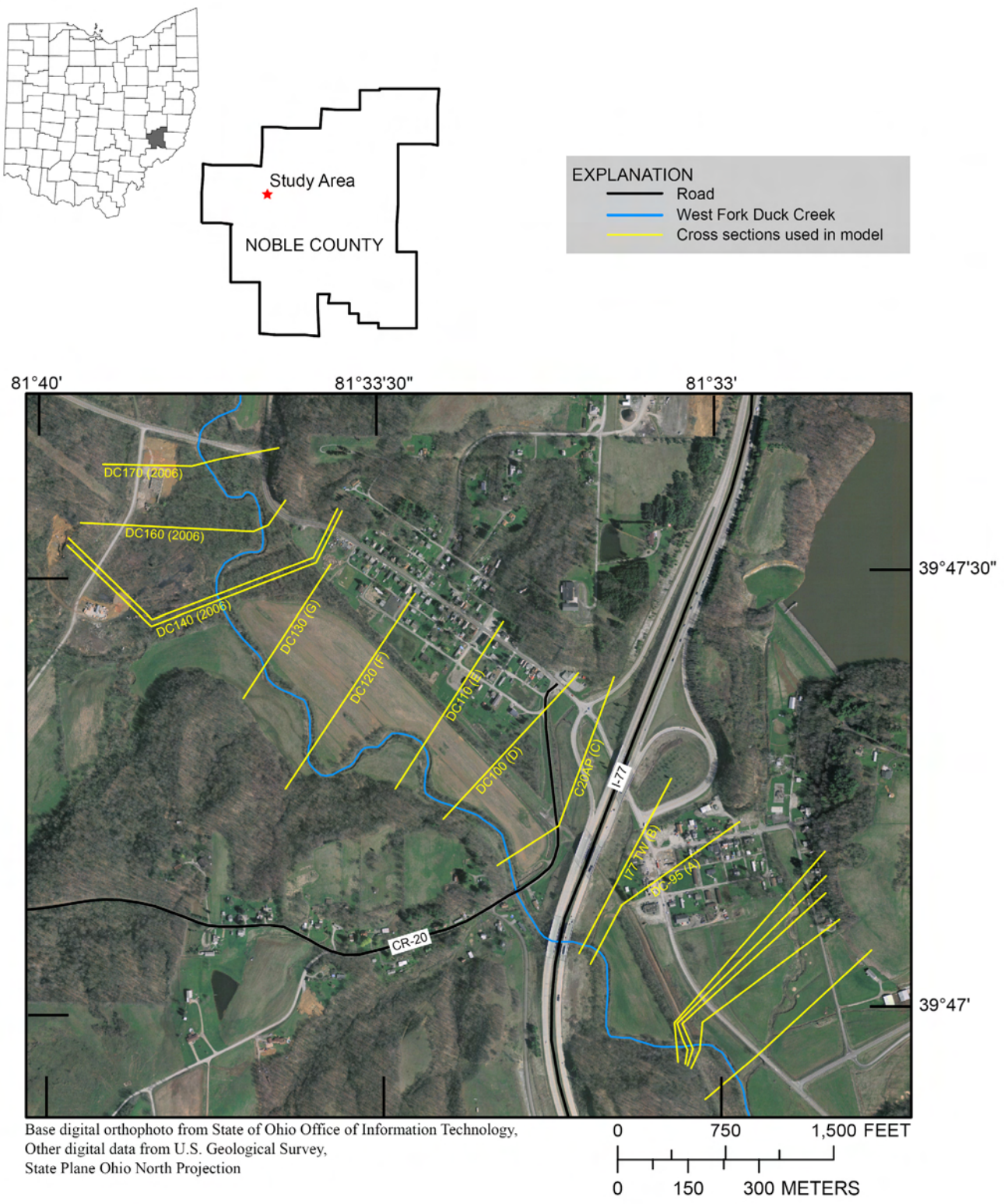

Figure 1–A3. Cross-section locations for flood profiles on West Fork Duck Creek near the Village of Belle Valley, Ohio.

1–B. Plum Creek Near the City of Brunswick

Work Conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 10-foot contour map developed from the USGS 1:24,000-scale topographic quadrangle map Medina 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 approximately 250 ft downstream from Plum Creek Road. The upstream limit is approximately 100 ft upstream from Sleepy Hollow Road. This stream reach is approximately 0.2 mi long.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream reach is referenced to the centerline of Plum Creek Road. Because the model has cross sections below Plum Creek Road, some cross sections have negative stationing.

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 North American Vertical Datum of 1988 (NGVD 88) and the North American Datum of 1983 (NAD 83).

Synthetic Cross-Sectional-Geometry Data

No synthetic cross-sectional-geometry data were used in this model.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles for Plum Creek was obtained by means of a slope-conveyance calculation. A slope of 0.00219 ft/ft was calculated from the river stations and minimum channel elevations for cross sections at stations 87 and 607. 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 1060.35, 1061.67, 1062.10, and 1062.97 ft were determined at the initial section (station -237) 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 of Plum Creek were determined from field observation by experienced personnel. For Plum Creek, estimates of Manning's roughness coefficients range from 0.044 to 0.046 for the main channel and from 0.054 to 0.062 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–B1 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 Plum Creek.

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

River station (feet)	Location description	Structure type	Recurrence interval (years)	Presence of road overflow	Solution type
15	Plum Creek Road	Bridge	10	N	Energy
15	Plum Creek Road	Bridge	50	N	Energy
15	Plum Creek Road	Bridge	100	N	Energy
15	Plum Creek Road	Bridge	500	N	Energy
679	Sleepy Hollow Road	Bridge	10	N	Energy
679	Sleepy Hollow Road	Bridge	50	N	Energy
679	Sleepy Hollow Road	Bridge	100	N	Energy
679	Sleepy Hollow Road	Bridge	500	N	Energy

Backwater Elevation

Plum Creek should not be subject to backwater.

Base-Mapping Information

The base map used for this study was a digitized copy of the USGS Medina 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 two NGS control monuments, one USC&GS monument with known elevation, and two Medina County monuments. A comparison of the published elevations and surveyed elevations is given in table 1–B2. The bench mark descriptions are included below.

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

[All data shown in feet, NAD 83 and NAVD 88]

Reference mark number	Benchmark 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	52 CWL	NA	NA	1171.563	2173285.398	541509.042	1171.537	NA	NA	0.026
National Geodetic Survey (NGS) monuments										
2	BR11	2151999.941	573419.157	1131[a]	2151999.855	573419.136	1130.675	0.086	0.021	0.325
3	HI14	2165194.753	573649.062	1196[a]	2165194.542	573649.118	1196.030	0.211	-0.056	-0.030
Medina County bench marks										
4	BM14 (Carpenter)	NA	NA	1067.293	2159015.164	565364.568	1067.301	NA	NA	-0.008
5	BM28 (Sleepy Hollow)	NA	NA	1068.713	2158419.507	565535.615	1068.726	NA	NA	-0.013

[a] Reported only to the nearest foot.

Bench Mark Descriptions

RM1

52 CWL

Medina, 5.7 mi E. of, along State Highway 18, thence 1.0 mi N.; 175 ft N. of centerline of rd. opposite fenceline E.; 19 ft S. and 26 ft W. of centerline rd. at junction of drive W.; 4 ft N. of telephone pole; in concrete post; standard tablet stamped “52 CWL 1952 TT”

Elevation (NGVD29) = 1172.186 ft
Elevation (NAVD88) = 1171.563 ft

RM2

1 National Geodetic Survey, Retrieval Date = APRIL 25, 2006
DF7223 **********
DF7223 CBN - This is a Cooperative Base Network Control Station.
DF7223 DESIGNATION - BR11
DF7223 PID - DF7223
DF7223 STATE/COUNTY- OH/MEDINA
DF7223 USGS QUAD - MEDINA (1994)
DF7223
DF7223 *CURRENT SURVEY CONTROL
DF7223 _____
DF7223* NAD 83(1995)- 41 14 19.18827(N) 081 49 57.96941(W) ADJUSTED
DF7223* NAVD 88 - 344.6 (meters) 1131. (feet) GPS OBS
DF7223 _____
DF7223 X - 682,383.760 (meters) COMP
DF7223 Y - -4,754,676.504 (meters) COMP
DF7223 Z - 4,182,595.430 (meters) COMP
DF7223 LAPLACE CORR- 1.56 (seconds) DEFLEC99
DF7223 ELLIP HEIGHT- 310.81 (meters) (09/23/04) GPS OBS
DF7223 GEOID HEIGHT- -33.77 (meters) GEOID03
DF7223
DF7223 HORZ ORDER - A
DF7223 ELLP ORDER - FOURTH CLASS I
DF7223
DF7223_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TMF3021665586(NAD 83)

DF7223_MARKER: DD = SURVEY DISK
DF7223_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
DF7223_STAMPING: BR 11 1999
DF7223_MARK LOGO: OH-103
DF7223_PROJECTION: PROJECTING 5 CENTIMETERS
DF7223_MAGNETIC: R = STEEL ROD IMBEDDED IN MONUMENT
DF7223_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
DF7223+STABILITY: SURFACE MOTION
DF7223_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
DF7223+SATELLITE: SATELLITE OBSERVATIONS - June 06, 2003
DF7223
DF7223 HISTORY - Date Condition Report By
DF7223 HISTORY - 19991218 MONUMENTED OH-103
DF7223 HISTORY - 20030606 GOOD WOOLPT
DF7223
DF7223 STATION DESCRIPTION
DF7223
DF7223'DESCRIBED BY MEDINA COUNTY OHIO 1999 (MAJ)
DF7223'DESCRIBED BY MEDINA COUNTY SANITARY ENGINEER 2000
DF7223'STATION IS LOCATED IN BRUNSWICK CITY, MEDINA COUNTY, OHIO, AT THE
DF7223'BRUNSWICK CITY HALL, 4095 CENTER ROAD. OWNERSHIP--CITY OF
DF7223'BRUNSWICK.
DF7223'
DF7223'TO REACH FROM THE INTERSECTION OF INTERSTATE 71 AND S.R. 303 IN
DF7223'BRUNSWICK, GO WEST ON S.R. 303 1.8 MI TO THE STATION ON THE RIGHT, IN
DF7223'FRONT OF BRUNSWICK CITY HALL, 0.4 MI EAST OF THE INTERSECTION OF S.R.
DF7223'303 AND S.R. 42.
DF7223'
DF7223'THE STATION MARK IS A STANDARD MEDINA COUNTY SANITARY ENGINEER
DF7223'GPS SURVEY 3.5 INCH DIA BRONZE DISK STAMPED --BR11 1999-- SET IN A 12
DF7223'INCH DIA 48 INCH DEEP CONCRETE MONUMENT WITH A 12 INCH PVC SLEEVE,
DF7223'SET FLUSH WITH THE GROUND SURFACE. STATION IS IN THE EAST ISLAND
DF7223'IN THE FRONT PARKING LOT, 140.5 FT NORTH OF S.R. 303, 186.3 FT SOUTH
DF7223'OF
DF7223'THE SOUTHEAST CORNER OF THE BRUNSWICK CITY HALL BUILDING, 18.3 FT
DF7223'SOUTH OF A METAL LIGHT POLE, 45.9 FT WEST OF THE EAST EDGE OF THE
DF7223'ISLAND, 6.1 FT EAST OF THE WEST EDGE OF THE ISLAND, 58.0 FT NORTH OF
DF7223'THE SOUTH EDGE OF THE ISLAND, AND 1.0 FT SOUTH OF AN ORANGE
DF7223'CARSONITE WITNESS POST.
DF7223'
DF7223'NO REFERENCE MARKS OR AZIMUTH MARKS WERE SET FOR THIS STATION.
DF7223'
DF7223

RM3

1 National Geodetic Survey, Retrieval Date = APRIL 25, 2006
DF7205 **********
DF7205 DESIGNATION - HI14
DF7205 PID - DF7205
DF7205 STATE/COUNTY- OH/MEDINA
DF7205 USGS QUAD - MEDINA (1994)
DF7205
DF7205 *CURRENT SURVEY CONTROL
DF7205 _____
DF7205* NAD 83(1995)- 41 14 20.42656(N) 081 47 05.23095(W) ADJUSTED
DF7205* NAVD 88 - 364.5 (meters) 1196. (feet) GPS OBS
DF7205 _____
DF7205 X - 686,363.916 (meters) COMP
DF7205 Y - -4,754,093.298 (meters) COMP
DF7205 Z - 4,182,637.315 (meters) COMP
DF7205 LAPLACE CORR- 1.00 (seconds) DEFLEC99
DF7205 ELLIP HEIGHT- 330.77 (meters) (10/07/05) GPS OBS
DF7205 GEOID HEIGHT- -33.74 (meters) GEOID03
DF7205
DF7205 HORZ ORDER - FIRST
DF7205 ELLP ORDER - FOURTH CLASS II
DF7205
DF7205 SUPERSEDED SURVEY CONTROL

DF7205
DF7205 ELLIP H (08/20/03) 330.80   (m)   GP(   ) 4 2
DF7205
DF7205.Superseded values are not recommended for survey control.
DF7205.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
DF7205.*See file dsdata.txt* to determine how the superseded data were derived.
DF7205
DF7205_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TMF3423765587(NAD 83)
DF7205_MARKER: DD = SURVEY DISK
DF7205_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
DF7205_STAMPING: HI14 2000
DF7205_MARK LOGO: NONE
DF7205_PROJECTION: FLUSH
DF7205_MAGNETIC: R = STEEL ROD IMBEDDED IN MONUMENT
DF7205_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
DF7205+STABILITY: SURFACE MOTION
DF7205_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
DF7205+SATELLITE: SATELLITE OBSERVATIONS - January 15, 2000
DF7205
DF7205 HISTORY   - Date   Condition   Report By
DF7205 HISTORY   - 20000115 MONUMENTED   OH-103
DF7205
DF7205   STATION DESCRIPTION
DF7205
DF7205'DESCRIBED BY MEDINA COUNTY OHIO 2000 (MAJ)
DF7205'DESCRIBED BY MEDINA COUNTY SANITARY ENGINEER 2000
DF7205'STATION IS LOCATED ON THE EAST EDGE OF BRUNSWICK CITY, IN MEDINA
DF7205'COUNTY, OHIO, HINCKLEY TOWNSHIP, LOT 41. OWNERSHIP--ROAD
DF7205'RIGHT-OF-WAY.
DF7205'
DF7205'TO REACH FROM THE INTERSECTION OF INTERSTATE 71 AND S.R. 303 IN
DF7205'BRUNSWICK, GO EAST ON S.R. 303 0.7 MI TO ITS INTERSECTION WITH
DF7205'COUNTY ROAD 17 (WEST 130TH ST) AND THE STATION ON THE NORTHEAST
DF7205'CORNER.
DF7205'
DF7205'THE STATION MARK IS A STANDARD MEDINA COUNTY SANITARY ENGINEER
DF7205'GPS SURVEY 3.5 INCH DIA BRONZE DISK STAMPED --HI14 2000-- SET IN A 12
DF7205'INCH DIA 48 INCH DEEP CONCRETE MONUMENT WITH A 12 INCH PVC SLEEVE,
DF7205'SET FLUSH WITH THE GROUND SURFACE. STATION IS 39.4 FT EAST OF WEST
DF7205'130TH ST, 217.0 FT NORTH OF S.R. 303, 14.3 FT SOUTH OF A POLE MARKED
DF7205'--90200-1385--, AND 1.0 FT WEST OF AN ORANGE CARSONITE WITNESS POST.
DF7205'
DF7205'NO REFERENCE MARKS OR AZIMUTH MARKS WERE SET FOR THIS STATION.
DF7205'
DF7205'
DF7205'

RM4

BM14 (Carpenter)

Medina, on NE. wingwall of Carpenter (Plum Creek) Road over Plum Creek. BR14, Township Road 203

Elevation (NGVD29) = 1067.92 ft
Elevation (NAVD88) = 1067.29 ft

RM5

BM28 (Sleepy Hollow)

Medina, on SW. wingwall of Sleepy Hollow Road. BR28, County Road 136

Elevation (NGVD29) = 1069.34 ft
Elevation (NAVD88) = 1068.71 ft

Flood profiles

The flood profiles for Plum Creek near the City of Brunswick 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.

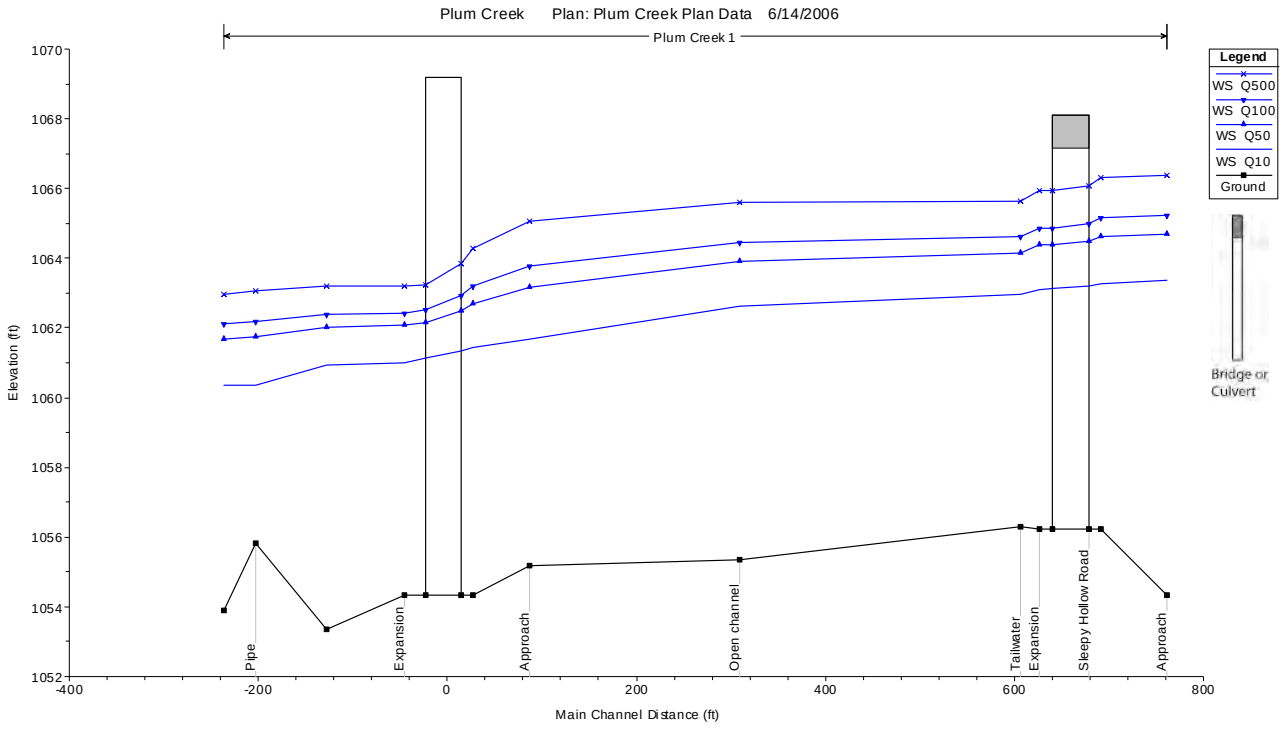

Figure 1–B2. Flood profiles for Plum Creek near the City of Brunswick for the 10-, 50-, 100-, and 500–year recurrence-interval floods.

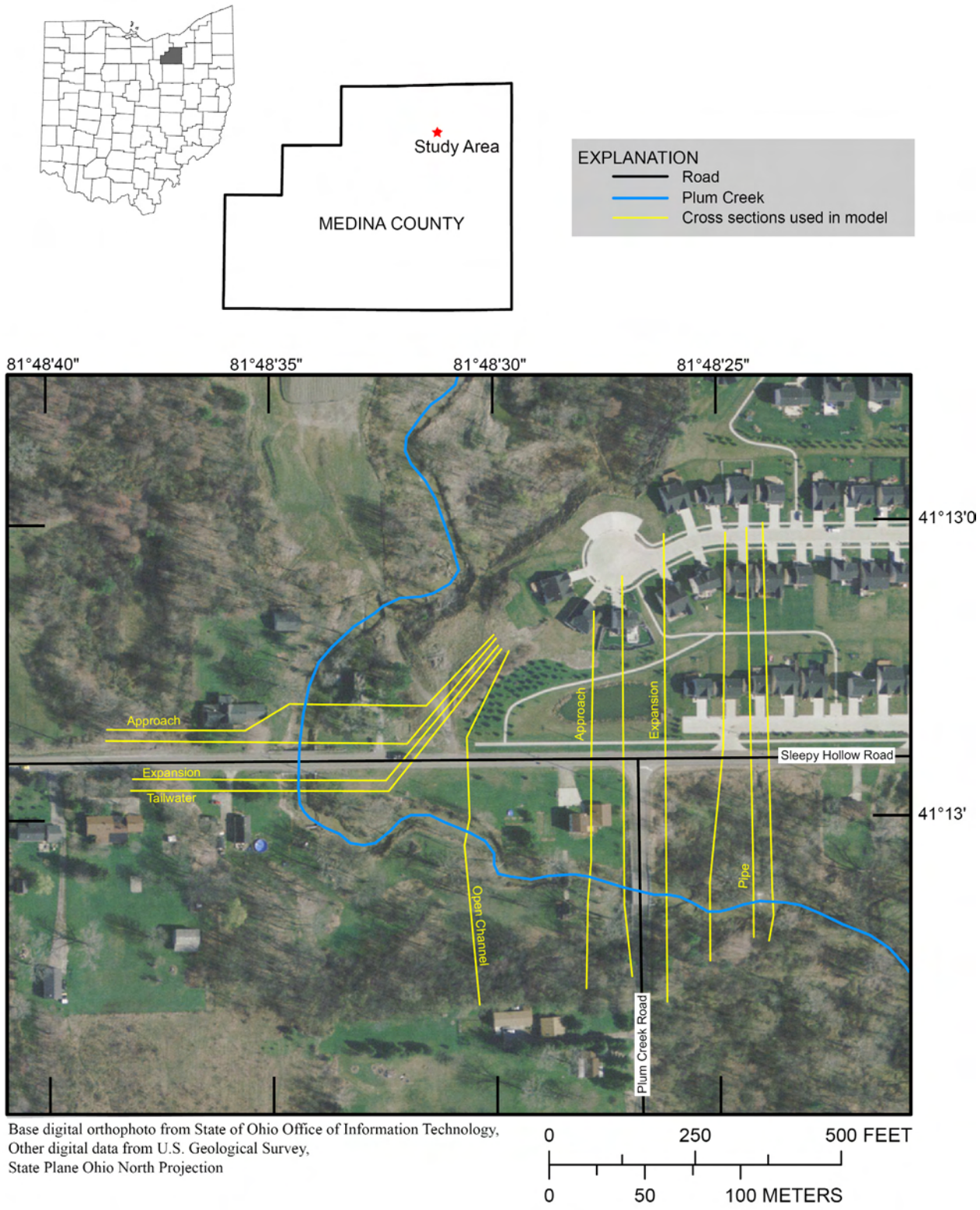

Figure 1–B3. Cross-section locations for flood profiles on Plum Creek near the City of Brunswick, Ohio.

1–C. West Branch Sunday Creek and West Branch Sunday Creek Tributary Near the Village of Hemlock

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 New Straitsville were used to establish the 10-, 50-, 100- and 500-year flood profiles by use of HEC-RAS.

Scope of Work

The downstream study limit is the eastern corporate limit of the Village of Hemlock. The upstream limit is the western corporate limit of the Village of Hemlock. This stream reach is approximately 0.6 mi long.

The downstream study limit is the mouth (confluence with West Branch Sunday Creek). The upstream limit is the western corporate limit of the Village of Hemlock. This stream reach is approximately 0.4 mi long.

Hydraulic Baselines

Stationing used for the hydraulic baseline for West Branch Sunday Creek is referenced to feet above the eastern corporate boundary for the Village of Hemlock. Stationing used for the hydraulic baseline for the West Branch Sunday Creek Tributary is referenced to feet above the mouth (confluence with West Branch Sunday Creek).

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

The USGS surveyed 17 cross sections, including 8 open-channel sections and 2 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 33 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 New Straitsville. 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 all profiles for West Branch Sunday Creek was obtained by means of a slope-conveyance calculation. A slope of 0.00184 ft/ft was calculated from the river stations and minimum channel elevations for cross sections at stations 13 and 1,830. 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 759.27, 760.22, 760.49, and

761.03 ft were determined at the initial section (station 13) for the 10-, 50-, 100-, and 500-year profiles, respectively.

The starting water-surface elevation at the initial section for all profiles for West Branch Sunday Creek Tributary was obtained by means of a slope-conveyance calculation. A slope of 0.00559 ft/ft was calculated from the river stations and minimum channel elevations for cross sections 217 and 998. 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 761.98, 762.96, 763.15, and 763.76 ft were determined at the initial section (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 for both reaches were determined from field observation by experienced personnel. For the West Branch Sunday Creek, estimates of Manning's roughness coefficients were set to 0.048 for the main channel and ranged from 0.052 to 0.060 for the overbank areas. For West Branch Sunday Creek Tributary, estimates of Manning's roughness coefficients range from 0.042 to 0.048 for the main channel and from 0.052 to 0.056 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 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 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 both reaches.

Table 1–C1. Summary of hydraulic-structure solutions for the 10-, 50-, 100-, and 500-year profiles of West Branch Sunday Creek and West Branch Sunday Creek Tributary near the Village of Hemlock.

River station (feet)	Location description	Structure type	Recurrence interval (years)	Presence of road overflow	Solution type
West Branch Sunday Creek					
1,757	Main Street	Bridge	10	N	Energy
1,757	Main Street	Bridge	50	N	Energy
1,757	Main Street	Bridge	100	N	Energy
1,757	Main Street	Bridge	500	Y	Pressure
West Branch Sunday Creek Tributary					
189	Walnut Street	Bridge	10	N	Energy
189	Walnut Street	Bridge	50	N	Energy
189	Walnut Street	Bridge	100	Y	Pressure

189	Walnut Street	Bridge	500	Y	Pressure

Backwater Elevation

West Branch Sunday Creek should not be subject to backwater. West Branch Sunday Creek Tributary will be affected by backwater from West Branch Sunday Creek. However, FEMA requires that all reaches be modeled independently [of each other]. Therefore, the backwater was not used in the West Branch Sunday Creek Tributary model.

Base-Mapping Information

The base map used for this study was a digitized copy of the USGS New Straitsville 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 USC&GS control monuments with known elevation. The USGS held one monument as true (765 1908) in elevation, as obtained from the USC&G. A comparison of the published elevations and surveyed elevations are shown in table 1–C2. The bench mark descriptions are included below.

Table 1–C2. Comparison of published coordinates to USGS-surveyed coordinates and bench marks used in the study of West Branch Sunday Creek and West Branch of Sunday Creek Tributary near the Village of Hemlock.
[All data shown in feet, NAD 83 and NAVD 88; shaded boxes indicate control points]

Reference mark number	Benchmark 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	765 1908	NA	NA	764.126	NA[a]	NA[a]	764.126	NA[a]	NA[a]	0.00
2	102 JVC	NA	NA	858.34	NA[a]	NA[a]	858.34	NA[a]	NA[a]	0.00
3	103 JVC	NA	NA	749.76	NA[a]	NA[a]	749.47	NA[a]	NA[a]	0.29
4	108 JVC	NA	NA	787.04	NA[a]	NA[a]	786.92	NA[a]	NA[a]	0.12

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

Bench Mark Descriptions

RM1

765 1908
Hemlock; 45 ft S. of post office; E. of road; 160 ft S. of abandoned RR.; at NE. corner of hwy. bridge over creek; in sandstone abutment; standard tablet stamped “765 1908”

Elevation (NGVD29) = 764.899 ft
Elevation (NAVD88) = 764.126 ft

RM2

102 JVC
New Straitsville, 1.9 mi SE. of, along State Highway 216; in Ward Township; in NE. ¼ sec. 24, T. 13 N., R.15 W.; 34 ft N. and 10 ft W. of, and 1 ft higher than centerline of hwy. at drain crossing; 18 ft NE. of centerline of hwy.; in center of NE. concrete headwall of culvert; standard tablet stamped “102 JVC 1959 859”

Elevation (NGVD29) = 859.076 ft
Elevation (NAVD88) = 858.34 ft

RM3

103 JVC
New Straitsville, 4.2 mi SE. of post office, along State Highway 216; 2.2 mi NW. of Murray City; in Ward Township; in sec. 11, T. 13 N., R.15 W.; 235 ft SE.of centerline of T-rd. N.; 110 ft S. and 85 ft E. of, and 4 ft higher than centerline of hwy. at drain crossing; 33 ft SW. of centerline of hwy.; 0.4 ft S. and 0.4 ft E. of NW. corner of rock ledge; in rock ledge; standard tablet stamped “103 JVC 1959 751”

Elevation (NGVD29) = 750.464 ft
Elevation (NAVD88) = 749.76 ft

RM4

108 JVC
McCuneville; 2.4 mi NW. of Shawnee, along State Highway 75; in Salt Lick Township; in NW. ¼ sec. 8, T. 14 N., R. 15 W.; at Methodist Church; 105 ft N. of, and 5 ft higher than centerline of cross-roads; in NE. end of concrete retaining wall; standard tablet stamped “108 JVC 1959 788”

Elevation (NGVD29) = 787.855 ft
Elevation (NAVD88) = 787.04 ft

Flood Profiles

The flood profiles for West Branch Sunday Creek and West Branch Sunday Creek Tributary near the Village of Hemlock 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 West Branch Sunday Creek and West Branch Sunday Creek Tributary are presented in figure 1–C4 and 1–C5, respectively.

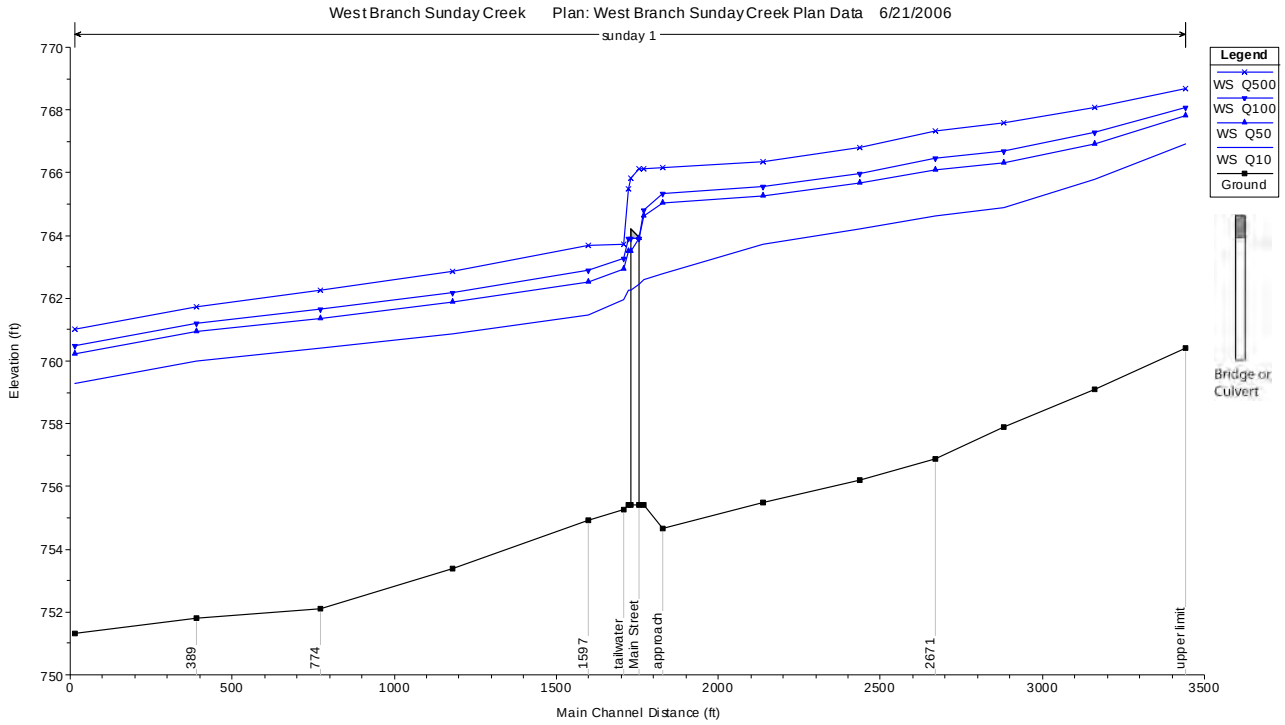

Figure 1–C2. Flood profiles for West Branch Sunday Creek near the Village of Hemlock for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

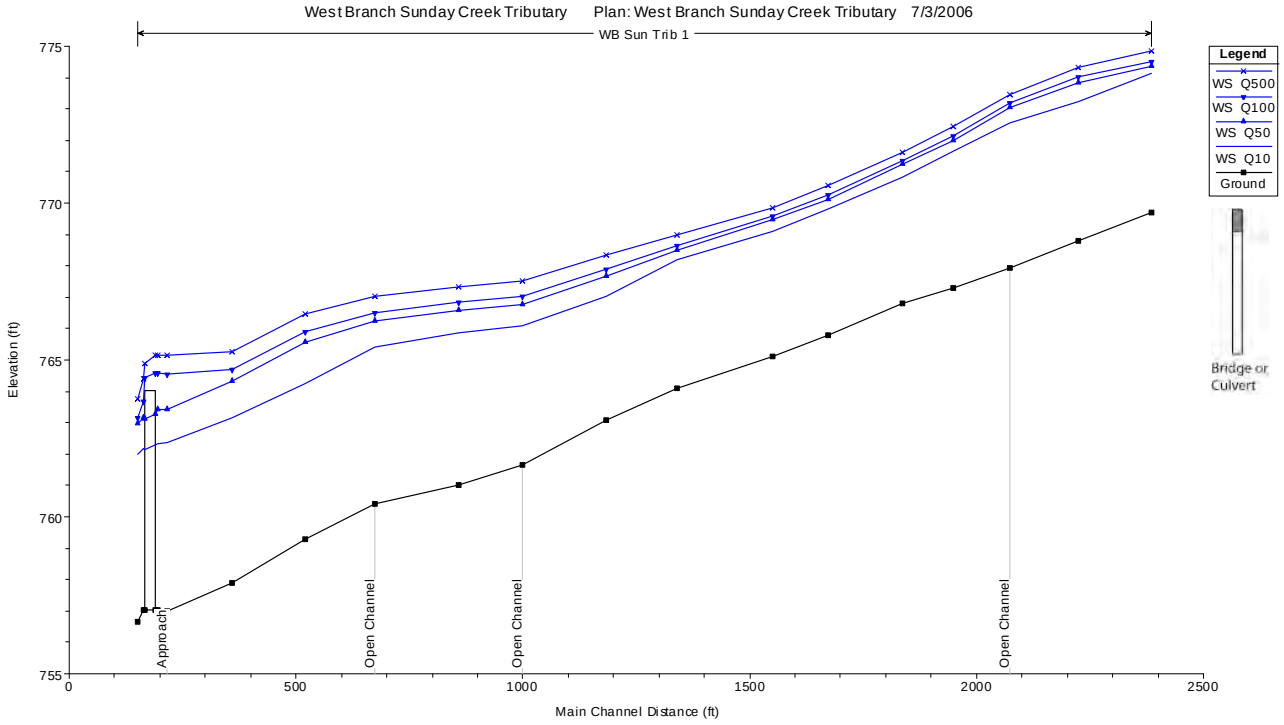

Figure 1–C3. Flood profiles for West Branch Sunday Creek Tributary near the Village of Hemlock for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

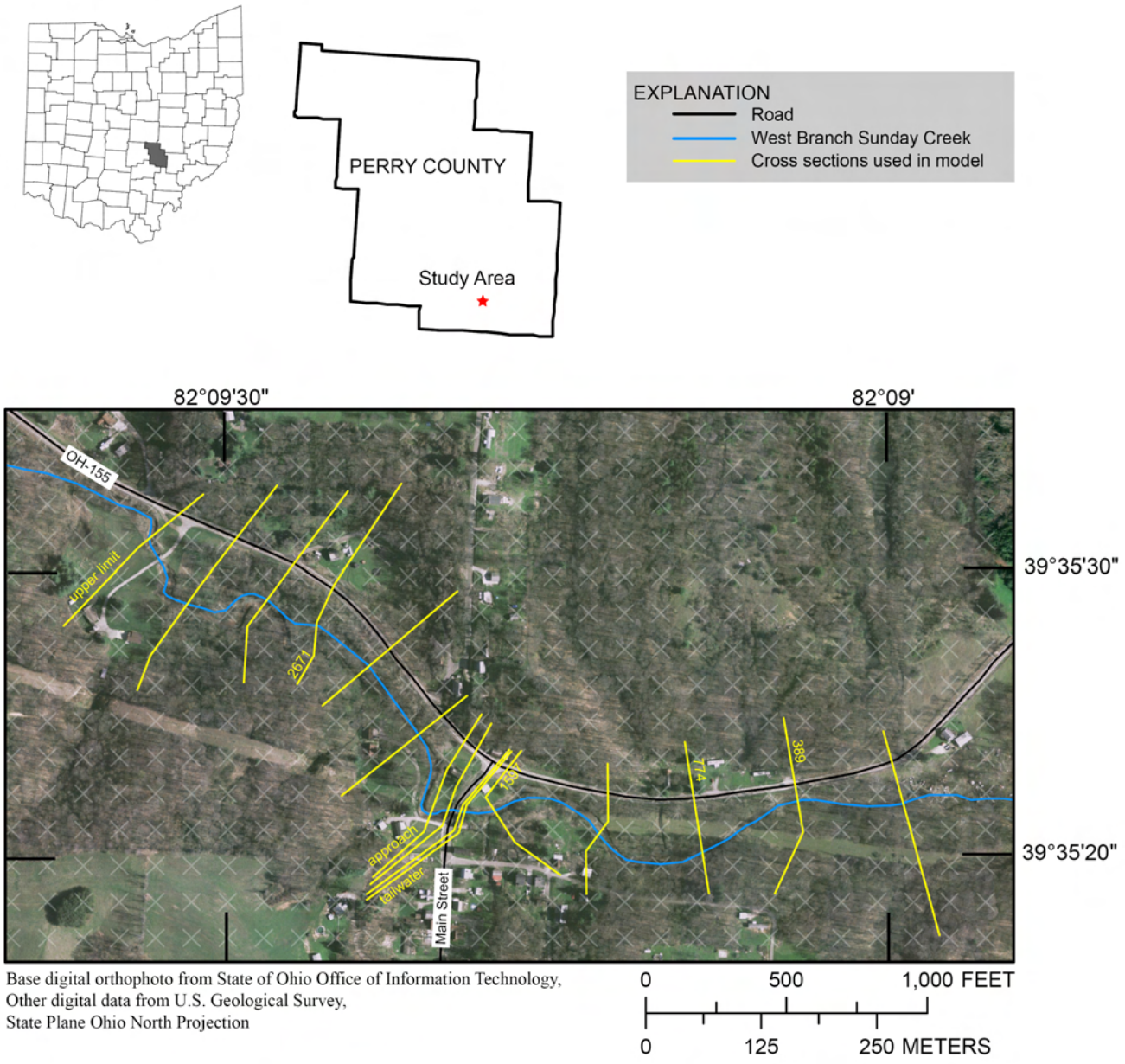

Figure 1–C4. Cross-section locations for flood profiles on West Branch Sunday Creek near the Village of Hemlock, Ohio.

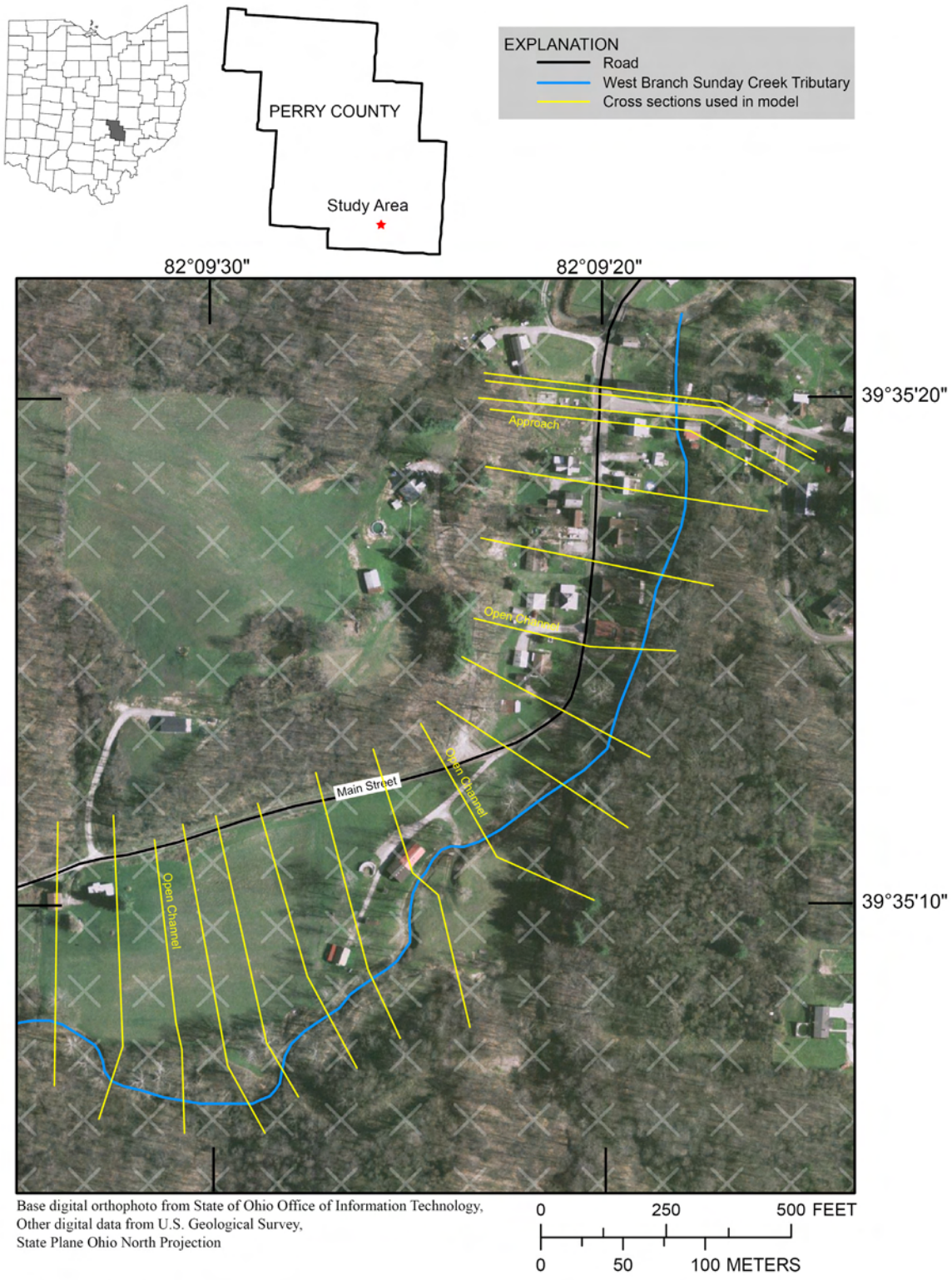

Figure 1–C5. Cross-section locations for flood profiles on West Branch Sunday Creek Tributary near the Village of Hemlock, Ohio.

1–D. East Branch Rocky River Tributary R9 Near the City of North Royalton

Work Conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-ft contour map developed by the Cuyahoga County Engineer's office were used to establish the 10-, 50-, 100- and 500-year flood profiles by use of HEC-RAS.

Scope of Work

The downstream study limit is just downstream from Edgerton Road. The upstream limit is 339 ft upstream from Edgerton Road. This stream reach is approximately 0.1 mi long.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to 45 ft below Edgerton Road.

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

The USGS surveyed five cross sections, including two open-channel sections and one hydraulic structure. 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 10 synthetic or partially synthetic cross sections at desired locations along the stream reach were generated from a TIN developed from the Cuyahoga County Engineer's office 2-ft contour map. In-channel data for the synthetic cross section was 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 all profiles for East Branch Rocky River Tributary R9 was obtained by means of a slope-conveyance calculation. A slope of 0.00704 ft/ft was calculated from the river stations and minimum channel elevations for cross sections 11 and 128. 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 858.67, 859.47, 859.76, and 860.35 ft were determined at the initial section (station 11) 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 of East Branch Rocky River Tributary 9R were determined from field observation by experienced personnel. For East Branch Rocky River Tributary 9R, estimates of Manning's roughness coefficients range from 0.042 to 0.048 for the main channel and from 0.050 to 0.066 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). In the cases where road overflow occurred at a culvert, a submergence check was made. In the cases where the hydraulic model computed weir flow at a culvert that was determined to be submerged, the culvert was replaced with composite sections. 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 East Branch Rock River Tributary R9.

Table 1–D1. Summary of hydraulic-structure solutions for the 10-, 50-, 100-, and 500-year profiles of East Branch Rocky River Tributary R9 near the City of North Royalton.

River station (feet)	Location description	Structure type	Recurrence interval (years)	Presence of road overflow	Solution type
97	Edgerton Road	Culvert	10	N	Energy
97	Edgerton Road	Culvert	50	N	Energy
97	Edgerton Road	Culvert	100	N	Energy
97	Edgerton Road	Culvert	500	Y	Energy

Backwater Elevation

The reach of East Branch Rocky River Tributary R9 should not be subject to backwater.

Base-Mapping Information

The base map used for this study was a 2-ft digital contour map provided by the Cuyahoga County Engineer's office.

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 OM 1290 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 are included below.

Table 1–D2. Comparison of published coordinates to USGS-surveyed coordinates and bench marks used in the study of East Branch Rocky River Tributary R9 near the City of North Royalton.
[All data shown in feet, NAD 83 and NAVD 88; shaded boxes indicate control [points]

Reference mark number	Benchmark 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	OM 1290	NA	NA	890.26	NA[a]	NA[a]	890.26	NA	NA	0.00
2	OM 1213	NA	NA	1167.61	NA[a]	NA[a]	1167.64	NA	NA	-0.03
3	OM 1154	NA	NA	874.45	NA[a]	NA[a]	874.48	NA	NA	-0.03

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

Bench Mark Descriptions

RM1

OM 1290
York Road, approx. 17 ft E. of centerline of York Road and 11 ft N. of centerline of Akins Road, 21.65 ft NE. of IP in mon. box at centerline intersection, 14.02 ft SW. of N&V in CEI OBT pole #305668.
N - 19131.44 Elevation (NGVD29) = 890.931 ft
E - 69441.49 Elevation (NAVD88) = 890.26 ft

RM2

OM 1213
State Road, Approx. 18 ft E. of centerline of State Road and 10 ft S. of centerline of Akins Road, 20.46 ft SE. of IP in mon. box at centerline intersection, 19.11 ft NW. of N&V in CEI OBT pole #805234 on SE. corner.
N - 19125.21 Elevation (NGVD29) = 1168.283 ft
E - 77753.06 Elevation (NAVD88) = 1167.138 ft

RM3

OM 1154
Abbey Road, Approx. 10 ft S. of centerline of Sprague Road and 3 ft W. of centerline of Abbey Road, 9.65 ft S. of center of mon. box at centerline intersection, 38.65 ft NW. of N&V in CEI OBT pole #306133 on SE. corner.
N - 35244.22 Elevation (NGVD29) = 875.103 ft
E - 63507.99 Elevation (NAVD88) = 874.45 ft

Flood Profiles

The flood profiles for East Branch Rocky River Tributary R9 near the City of North Royalton for the 10-, 50-, 100-, and 500-year recurrence interval floods are presented in figure 1–D2. The locations of the cross sections for East Branch Rocky River Tributary R9 are presented in figure 1–D3.

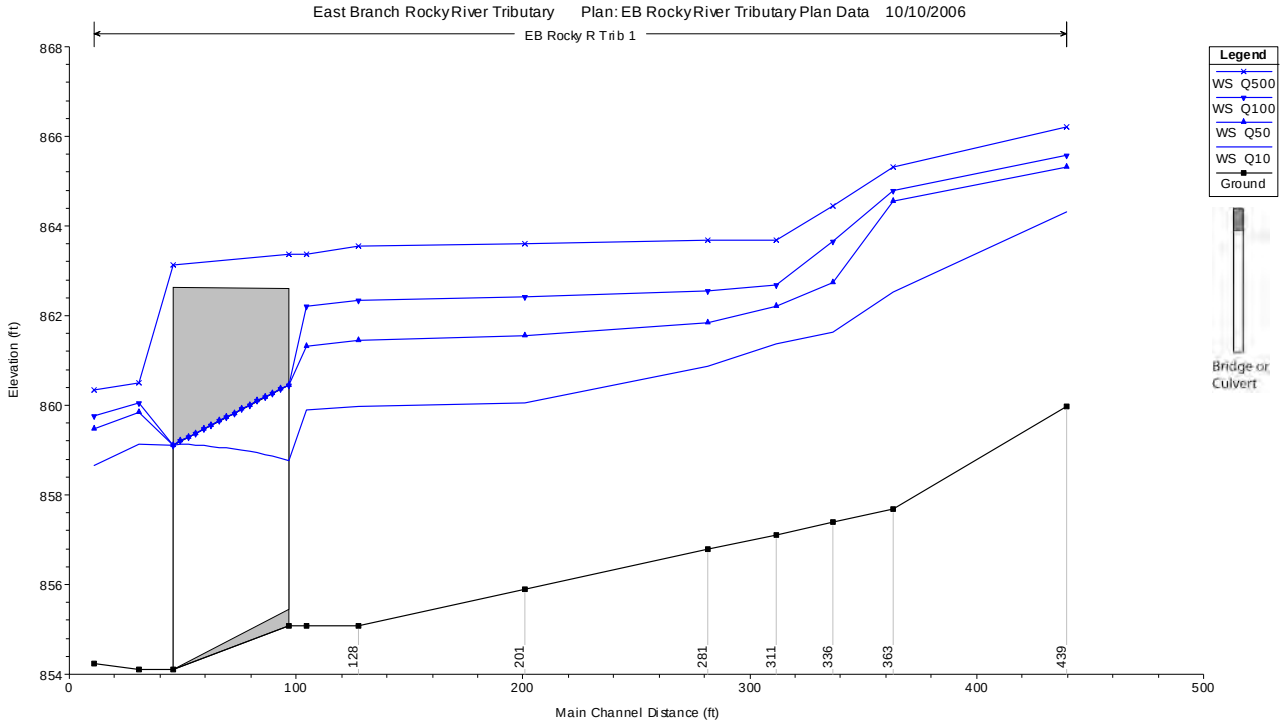

Figure 1–D2. Flood profiles for East Branch Rocky River Tributary R9 near the City of North Royalton for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

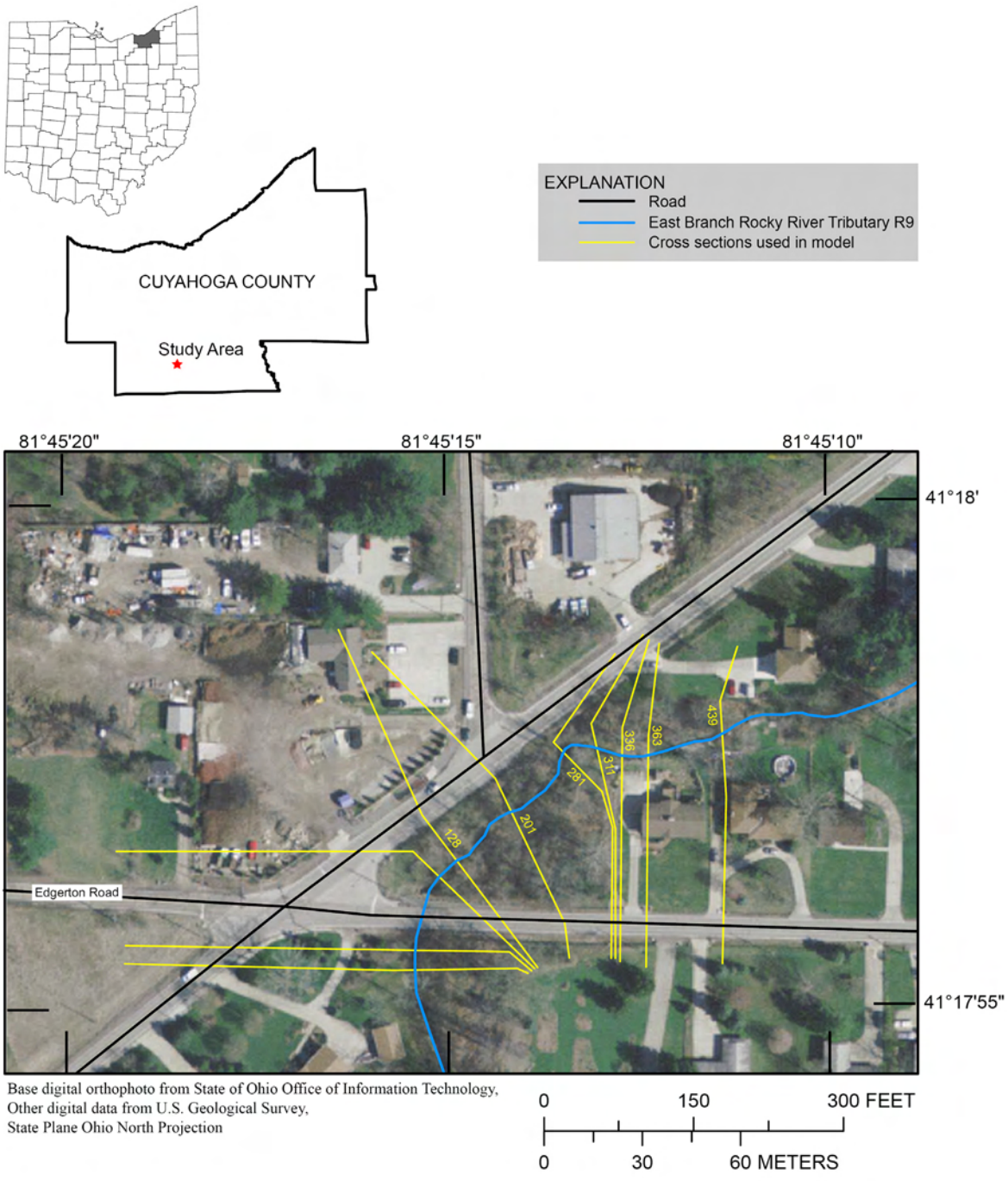

Figure 1–D3. Cross-section locations for flood profiles on East Branch Rocky River Tributary R9 near the City of North Royalton, Ohio.

1–E. Mud Brook Tributary 1C and Cuyahoga River Tributary 1A Near the City of Stow

Work Conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-ft contour map developed by the Summit County Auditor's Department were used to establish the 10-,50-, 100- and 500-year flood profiles for both the Mud Brook Tributary 1C and the Cuyahoga River Tributary 1A by use of HEC-RAS.

Scope of Work

The downstream limit of the reach studied is approximately 350 ft downstream from Berkshire Road. The upstream limit is approximately 300 ft upstream from Berkshire Road. This stream reach is approximately 0.1 mi long. The downstream limit of the reach studied is approximately 380 ft downstream from State Route 91 (Darrow Road). The upstream limit is approximately 330 ft downstream from Graham Road. This stream reach is approximately 0.7 mi long.

Hydraulic Baselines

Stationing used for the hydraulic baseline for Mud Brook Tributary 1C is referenced to the centerline of Berkshire Road. Because the model has cross sections below Berkshire Road, some cross sections have negative stationing. Stationing used for the hydraulic baseline for the Cuyahoga River tributary 1A is referenced to feet above centerline of Darrow Road (State Route 91). Because the model has cross sections below Darrow Road, some cross sections have negative stationing.

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

The USGS surveyed 16 cross sections, including 3 road-profile sections for both reaches in this study. 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 39 synthetic or partially synthetic cross sections at desired locations on each stream reach were generated from the TIN developed from the Summit County 2-ft contour map. In-channel data for the synthetic cross section 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 all profiles for Mud Brook Tributary 1C was obtained by means of a slope conveyance calculation. A slope of 0.0182 ft/ft was calculated from the river stations and minimum channel elevations for cross sections -391 and 202. These cross sections were obtained from field surveys and provide a representative slope for the channel. Due to the steep channel slope downstream of Berkshire Road, cross-sectional geometry for station -414 was copied to -614 ft downstream to provide a convergence reach for the model. Based on the calculated

slope, starting water-surface elevations of 1025.90, 1026.58, 1026.67, and 1026.85 ft were determined at the initial convergence section (station -614) for the 10-, 50-, 100-, and 500-year profiles, respectively.

The starting water-surface elevation at the initial section for all profiles for Cuyahoga River Tributary 1A was obtained by means of critical depth. Immediately downstream of the outflow of the culvert under Darrow Road, the stream channel drops approximately 50 ft over 100 stream feet. This abrupt drop in elevation would create a super-critical flow regime. HEC-RAS has boundary conditions to account for super-critical flow, and this model for Cuyahoga River Tributary 1A was started with that option. Based on the critical starting water-surface elevation, water-surface elevations of 1035.29, 1035.77, 1035.96, and 1036.37 ft were determined at the initial section for the 10-, 50-, 100-, and 500-year profiles, respectively, by HEC-RAS.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas of Mud Brook Tributary 1C were determined from field observation by experienced personnel. For Mud Brook Tributary 1C, estimates of Manning's roughness coefficients range from 0.042 to 0.050 for the main channel and from 0.032 to 0.055 for the overbank areas.

Manning's roughness coefficients (*n*) for the main channel and overbank areas of Cuyahoga River Tributary 1A were determined from field observation by experienced personnel. For the open-channel condition reaches of Cuyahoga River Tributary 1A (reaches 1 and 3), estimates of Manning's roughness coefficients range from 0.038 to 0.044 for the main channel and from 0.046 to 0.058 for the overbank areas. For the overland-flow-condition reach of Cuyahoga River Tributary 1A (reach 2), the roughness coefficients were set to 0.06 for all subareas, excluding the contraction and expansion sections, as they were copied from the open-channel conditions models. **Note: For further explanation of overland-flow conditions versus open-channel conditions see “Routing Overland Flow Over Long Culverts” within the “Special Hydraulic Considerations” for Cuyahoga River Tributary 1A .**

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 equations or on pressure and/or weir-flow equations). In the cases where road overflow occurred at a culvert, a submergence check was made. In the cases where the hydraulic model computed weir flow at a culvert that was determined to be submerged, the culvert was replaced with composite sections. 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 both reaches.

Table 1–E1. Summary of hydraulic-structure solutions for the 10-, 50-, 100-, and 500-year profiles of Mud Brook Tributary 1C and Cuyahoga River Tributary 1A near the City of Stow.

River station (feet)	Location description	Structure type	Recurrence interval (years)	Presence of road overflow	Solution type
Mud Brook Tributary 1C					
137	Berkshire Road	Culvert	10	Y	Energy
137	Berkshire Road	Culvert	50	Y	Energy
137	Berkshire Road	Culvert	100	Y	Energy
137	Berkshire Road	Culvert	500	Y	Energy
Cuyahoga River Tributary 1A					
44	State Route 91 (Darrow Road)	Culvert	10	N	Energy
44	State Route 91 (Darrow Road)	Culvert	50	Y	Energy
44	State Route 91 (Darrow Road)	Culvert	100	Y	Energy
44	State Route 91 (Darrow Road)	Culvert	500	Y	Energy
3,319	State Route 59 (Kent Road)	Culvert	10	Y	Replaced
3,319	State Route 59 (Kent Road)	Culvert	50	Y	Replaced
3,319	State Route 59 (Kent Road)	Culvert	100	Y	Replaced
3,319	State Route 59 (Kent Road)	Culvert	500	Y	Replaced

Overland Flow Over Long Culverts

The culvert on Cuyahoga River Tributary 1A whose entrance is located at river station 3,319 runs as a closed conduit under SR 59 (Kent Road), Williams Road, Elmwood Avenue, Marhofer Avenue, and intervening land surfaces. Initial HEC-RAS model results indicated that the culvert will not convey the 10-, 50-, 100-, or 500-year peak flows, so some water will spill out onto the upstream floodplain and roadway. For short culverts under roadways, water that spills out onto the roadway generally flows over the road, where at least a portion of it will reenter the channel at some downstream location (frequently, immediately downstream from the roadway). HEC-RAS does a weir-flow calculation to determine the flow over the roadway for standard culverts. In this case, however, because the culvert runs underground for a long distance, the excess water that cannot be conveyed by the culvert is forced to flow over the roadway and over land for a long distance. Consequently, a weir-flow calculation is not appropriate, and an alternative approach must be used to route the culvert overflow. The approach used in this study was to develop two independent models, one that represents only the flow through the culvert and a second that represents only the overland flow. The total flow immediately upstream and downstream from the culvert is assumed to be equal. The streamflow distribution between the culvert and the overland flow is solved in an iterative fashion subject to constraints that the water-surface elevations immediately upstream and downstream from the culvert are equal in the two models. The Cuyahoga River Tributary 1A was therefore broken up into three separate sections: a model above and below the long culvert and a modeled section as previously described for the long culvert. A summary of the results for this reach is listed in table 1-E2.

Table 1–E2. Summary of the breakup of the modeled reach for Cuyahoga River Tributary 1A near the City of Stow.

Reach name	Downstream limit	Upstream limit
Cuyahoga River Trib 1A Reach 1	Downstream from Darrow Road	Downstream from Kent Road
Cuyahoga River Trib 1A Reach 2	Downstream from Kent Road	Upstream from Marhoffer Road
Cuyahoga River Trib 1A Reach 3	Upstream from Marhoffer Road	Downstream from Graham Road

Backwater Elevation

Neither reach should be subject to backwater.

Base-Mapping Information

As part of a separate FIS that the USGS is currently conducting, Summit County developed detailed digital mapping and orthographic photography for the entire county as part of a new geographic information system (GIS). Summit County provided all necessary GIS data for completion of that study. The original orthographic photography was obtained in 1994, and new photography was obtained in 2000. The county also has developed numerous digital data layers (coverages) that include 2-ft interval topographic contours (developed from data obtained by LiDAR in 2000), streams, water bodies, roads, railroads, and political boundaries. All planimetric and topographic coverages and orthophotography meet the appropriate NSSDA accuracy standard for 1"=100' mapping.

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 NGS control monuments with known elevation. The USGS held one monument as true (Z301) in elevation, as obtained from NGS. A comparison of the published elevations and surveyed elevations is given in table 1–E3. The bench mark descriptions are included below.

Table 1–E3. Comparison of published coordinates to USGS-surveyed coordinates and bench marks used in the study of Mud Brook Tributary 1C and Cuyahoga River Tributary 1A near the City of Stow.
[All data shown in feet, NAD 83 and NAVD 88; shaded boxes indicate control points]

Reference mark number	Benchmark 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	Z301	2252493.335	555132.719	1040.58	2252493.335	555132.719	1040.58	0.00	0.00	0.00
2	GS0104	2269485.054	560128.791	1110.90	2269484.943	560128.766	1110.91	-0.11	-0.03	0.00
3	GS0122	2240420.936	545103.795	1013.35	2240421.091	545103.803	1013.42	0.15	0.01	0.07
4	GS0123	2245412.907	550503.984	1000.96	2245412.845	550503.952	1000.90	-0.06	-0.03	-0.06

Bench Mark Descriptions

RM1

1 National Geodetic Survey, Retrieval Date = JUNE 25, 1992
MB1086 ***
MB1086 DESIGNATION - Z 301
MB1086 PID - MB1086
MB1086 STATE/COUNTY- OH/SUMMIT
MB1086
MB1086 HORZ DATUM - NAD 83(1986)
MB1086 VERT DATUM - NAVD 88
MB1086
MB1086 POSITION - 41 11 08. (N) 081 28 04. (W) SCALED
MB1086 83 minus 27 - +00. -01. SCALED
MB1086
MB1086 HEIGHT - 317.170 (meters) 1040.58 (feet) ADJUST
MB1086 88 minus 29 -0.207 ADJUSTED
MB1086 ***
MB1086
MB1086 GEOID HEIGHT- -33.80 GEOID90
MB1086 MODELED GRAV- 980,182.6 NAVD88
MB1086
MB1086
MB1086 VERT ORDER - FIRST CLASS 2
MB1086
MB1086
MB1086.THE HORIZONTAL COORDINATES WERE SCALED FROM A TOPOGRAPHIC MAP.
MB1086.THE ORTHOMETRIC HEIGHT WAS DETERMINED BY DIFFERENTIAL LEVELING
MB1086.AND ADJUSTED BY THE NATIONAL GEODETIC SURVEY.
MB1086
MB1086
MB1086
MB1086
MB1086_STATION MARK IS A BENCH MARK DISK
MB1086_WITH SETTING: SET IN TOP OF CONCRETE MONUMENT (ROUND)
MB1086_THE MARK IS STAMPED: Z 301 1964
MB1086
MB1086 HISTORY - Year Condition Recov. By
MB1086 HISTORY - 1964 STATION MONUMENTED COAST AND GEODETIC SURVEY
MB1086 HISTORY - 1983 GOOD NATIONAL GEODETIC SURVEY
MB1086
MB1086 STATION DESCRIPTION
MB1086
MB1086'DESCRIBED BY COAST AND GEODETIC SURVEY 1964
MB1086'ABOUT 3.7 MILES NORTH ALONG THE PENNSYLVANIA RAILROAD FROM THE
MB1086'STATION AT CUYAHOGA FALLS, NEAR THE CROSSING OF HUDSON DRIVE,
MB1086'82 FEET SOUTHEAST OF THE APPROXIMATE CENTER OF THE CROSSING OF
MB1086'MAIN TRACK AND HUDSON DRIVE, 20.8 FEET EAST OF THE EAST RAIL
MB1086'OF THE MAIN TRACK, 23 1/2 FEET WEST OF A ROW OF SHRUBBERY, 50
MB1086'FEET NORTH OF THE CENTER OF THE WEST END OF A CONCRETE WALL FOR
MB1086'DRAINAGE DITCH THROUGH A VACANT LOT, 2 1/2 FEET SOUTH OF A
MB1086'TELEPHONE POLE, ABOUT LEVEL WITH THE TOP OF RAIL, SET IN THE TOP
MB1086'OF A CONCRETE POST PROJECTING 2 INCHES ABOVE THE LEVEL OF THE
MB1086'GROUND. NOTE-- THIS MARK MAY BE REACHED BY GOING 4.2 MILES SOUTH
MB1086'ALONG THE PENNSYLVANIA RAILROAD FROM THE STATION AT HUDSON.
MB1086
MB1086 STATION RECOVERY (1983)
MB1086
MB1086'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1983
MB1086'RECOVERED IN GOOD CONDITION. OMIT--50 FEET NORTH OF THE CENTER OF THE
MB1086'WEST END OF A CONCRETE WALL FOR DRAINAGE DITCH THROUGH A VACANT LOT.
MB1086'ADD--0.30 METER (1.0 FT) NORTH OF A WITNESS POST.

RM2

1 Summit County Engineer Retrieval Date = FEBRUARY 02 1996
GS0104 ***
GS0104 DESIGNATION - SUMMIT COUNTY GIS 104
GS0104 PID - GS0104
GS0104 STATE/COUNTY- OH/SUMMIT
GS0104 USGS QUAD - HUDSON

GS0104
GS0104 HORZ DATUM - NAD 83(1986)
GS0104 VERT DATUM - NGVD 88
GS0104
GS0104 POSITION   - 41 11 56.15533(N)   081 24 22.39039(W)   ADJUSTED
GS0104 83 minus 27 -
GS0104
GS0104 HEIGHT   -   338.603 (meters)   1110.900   (feet) GPS OBS
GS0104 88 minus 29 -
GS0104 **
GS0104 LAPLACE CORR-
GS0104 GEOID HEIGHT-   -33.665
GS0104
GS0104 HORZ ORDER - FIRST
GS0104 VERT ORDER - THIRD
GS0104
GS0104.The horizontal coordinates were established by GPS observations
GS0104.and adjusted by the Woolpert Consultants in March 1997.
GS0104
GS0104.The orthometric height was determined by GPS observations.
GS0104
GS0104
GS0104.The geoid height was determined by GEOID93.
GS0104
GS0104;   North   East   Scale   Converg.
GS0104;SPC OH N   -   170727.597   691740.428 0.99994180   +0 43 6.813 MT
GS0104;SPC OH N   -   560128.791 2269485.054   US SURVEY FEET
GS0104
GS0104_STATION MARK IS A SURVEY DISK
GS0104_WITH SETTING: SET IN TOP OF A CAST IN PLACE CONCRETE MONUMENT
GS0104_THE MARK IS STAMPED: SUMMIT COUNTY GIS 104
GS0104_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
GS0104+STABILITY: SURFACE MOTION
GS0104_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
GS0104+SATELLITE: SATELLITE OBSERVATIONS - July 1994
GS0104
GS0104 HISTORY   - Year Condition   Recov. By
GS0104 HISTORY   - 1994 STATION MONUMENTED   WOOLPERT CONSULTANTS
GS0104
GS0104   STATION DESCRIPTION
GS0104
GS0104'DESCRIBED BY WOOLPERT CONSULTANTS 1994
GS0104'THE STATION IS LOCATED 19.1' WEST OF CENTERLINE OF PAVEMENT OF PARK
GS0104'VISTA COURT AND 93.4' NORTH OF EXTENDED CENTERLINE IF PAVEMENT OF
GS0104'CALAIS STREET. IT IS ALSO 95.3' NORTHWEST OF THE POINT OF
GS0104'INTERSECTION OF PARK VISTA COURT AND CALAIS STREET 74.3' NORTHEAST
GS0104'OF A PETROLEUM PIPELINE.
GS0104

RM3

GS0122 STATE/COUNTY- OH/SUMMIT
GS0122 USGS QUAD   - PENINSULA
GS0122
GS0122 HORZ DATUM - NAD 83(1986)
GS0122 VERT DATUM - NGVD 88
GS0122
GS0122 POSITION   - 41 09 31.13196(N)   081 30 44.81045(W)   ADJUSTED
GS0122 83 minus 27 -
GS0122
GS0122 HEIGHT   -   308.870 (meters)   1013.351   (feet) GPS OBS
GS0122 88 minus 29 -
GS0122 **
GS0122 LAPLACE CORR-
GS0122 GEOID HEIGHT-   -33.613
GS0122
GS0122 HORZ ORDER - FIRST
GS0122 VERT ORDER - THIRD
GS0122
GS0122.The horizontal coordinates were established by GPS observations
GS0122.and adjusted by the Woolpert Consultants in March 1997.

GS0122
GS0122.The orthometric height was determined by GPS observations.
GS0122
GS0122
GS0122.The geoid height was determined by GEOID93.
GS0122
GS0122; North East Scale Converg.
GS0122;SPC OH N - 166147.969 682881.667 0.99994040 +0 38 55.58 MT
GS0122;SPC OH N - 545103.795 2240420.936 US SURVEY FEET
GS0122
GS0122_STATION MARK IS A SURVEY DISK
GS0122_WITH SETTING: SET IN TOP OF A CAST IN PLACE CONCRETE MONUMENT
GS0122_THE MARK IS STAMPED: SUMMIT COUNTY GIS 122
GS0122_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
GS0122+STABILITY: SURFACE MOTION
GS0122_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
GS0122+SATELLITE: SATELLITE OBSERVATIONS - July 1994
GS0122
GS0122 HISTORY - Year Condition Recov. By
GS0122 HISTORY - 1994 STATION MONUMENTED WOOLPERT CONSULTANTS
GS0122
GS0122 STATION DESCRIPTION
GS0122
GS0122'DESCRIBED BY WOOLPERT CONSULTANTS 1994
GS0122'THE STATION IS LOCATED 27.9' NORTH OF CENTERLINE OF PAVEMENT OF
GS0122'WEST BATH ROAD AND .1 MILES WEST OF STATE ROAD. IT IS ALSO 76.0'
GS0122'EAST OF A POWER POLE AND 59.8' WEST OF A POWER POLE.
GS0122

RM4

1 Summit County Engineer Retrieval Date = FEBRUARY 02 1996
GS0123 **
GS0123 DESIGNATION - SUMMIT COUNTY GIS 123
GS0123 PID - GS0123
GS0123 STATE/COUNTY- OH/SUMMIT
GS0123 USGS QUAD - HUDSON
GS0123
GS0123 HORZ DATUM - NAD 83(1986)
GS0123 VERT DATUM - NGVD 88
GS0123
GS0123 POSITION - 41 10 23.92367(N) 081 29 38.73509(W) ADJUSTED
GS0123 83 minus 27 -
GS0123
GS0123 HEIGHT - 305.093 (meters) 1000.959 (feet) GPS OBS
GS0123 88 minus 29 -
GS0123 **
GS0123 LAPLACE CORR-
GS0123 GEOID HEIGHT- -33.637
GS0123
GS0123 HORZ ORDER - FIRST
GS0123 VERT ORDER - THIRD
GS0123
GS0123.The horizontal coordinates were established by GPS observations
GS0123.and adjusted by the Woolpert Consultants in March 1997.
GS0123
GS0123.The orthometric height was determined by GPS observations.
GS0123
GS0123
GS0123.The geoid height was determined by GEOID93.
GS0123
GS0123; North East Scale Converg.
GS0123;SPC OH N - 167793.950 684403.223 0.99994080 +0 39 38.99 MT
GS0123;SPC OH N - 550503.984 2245412.907 US SURVEY FEET
GS0123
GS0123_STATION MARK IS A SURVEY DISK
GS0123_WITH SETTING: SET IN TOP OF A CAST IN PLACE CONCRETE MONUMENT
GS0123_THE MARK IS STAMPED: SUMMIT COUNTY GIS 123
GS0123_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
GS0123+STABILITY: SURFACE MOTION
GS0123_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR

```
GS0123+SATELLITE: SATELLITE OBSERVATIONS - July 1994
GS0123
GS0123  HISTORY    - Year Condition          Recov. By
GS0123  HISTORY    - 1994 STATION MONUMENTED   WOOLPERT CONSULTANTS
GS0123
GS0123                  STATION DESCRIPTION
GS0123
GS0123'DESCRIBED BY WOOLPERT CONSULTANTS 1994
GS0123'THE STATION IS LOCATED ON THE EAST SIDE OF WYOGA LAKE ROAD 0.45
GS0123'MILES SOUTH OF STEELS CORNERS ROAD. IT IS ALSO 63.8' EAST OF A
GS0123'TELEPHONE POLE 13.8' SOUTHEAST OF A FIRE HYDRANT AND 39.7'
GS0123'SOUTHWEST OF A POWER POLE.
GS0123
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Flood Profiles

The flood profiles for Mud Brook Tributary 1C and Cuyahoga River Tributary 1A near the City of Stow for the 10-, 50-, 100-, and 500-year-recurrence-interval floods are presented in figures 1–E2 and 1–E3, respectively. The locations of the cross sections for Mud Brook Tributary 1C and Cuyahoga River Tributary 1A are presented in figures 1–E4 and 1–E5, respectively.

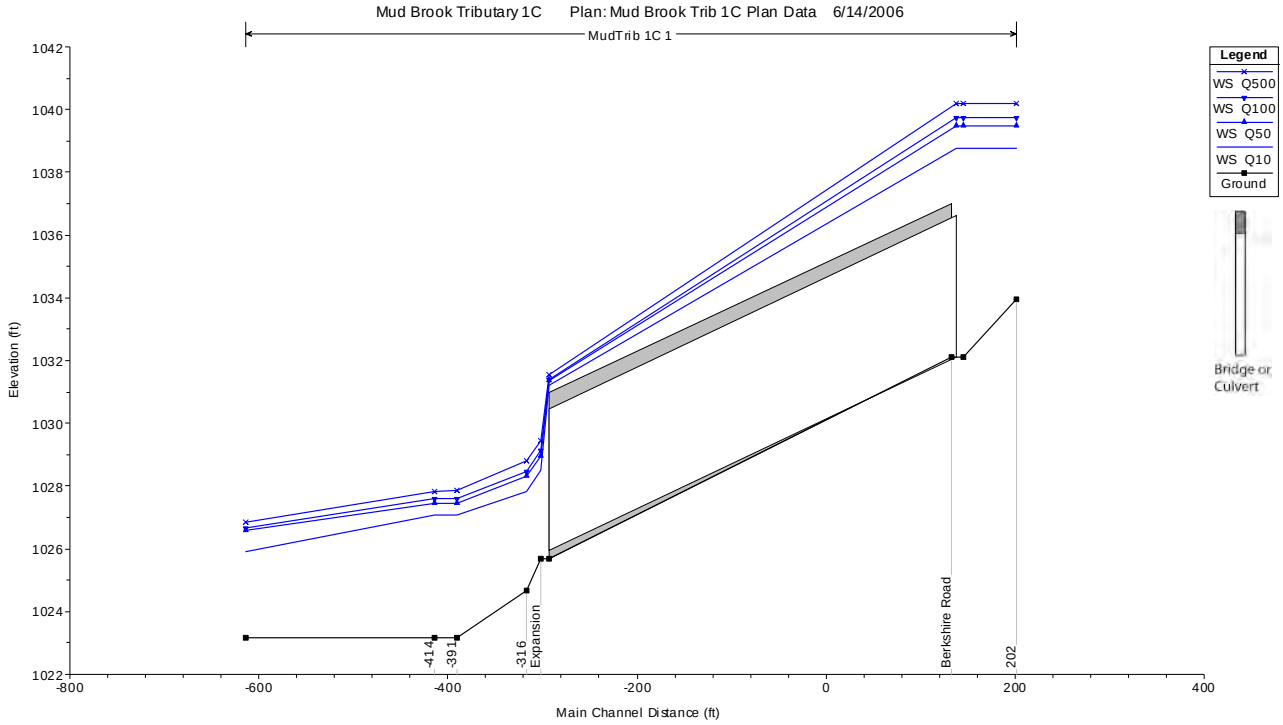

Figure 1–E2. Flood profiles for Mud Brook Tributary 1C near the City of Stow for the 10-, 50-, 100-, and 500-year- recurrence-interval-floods.

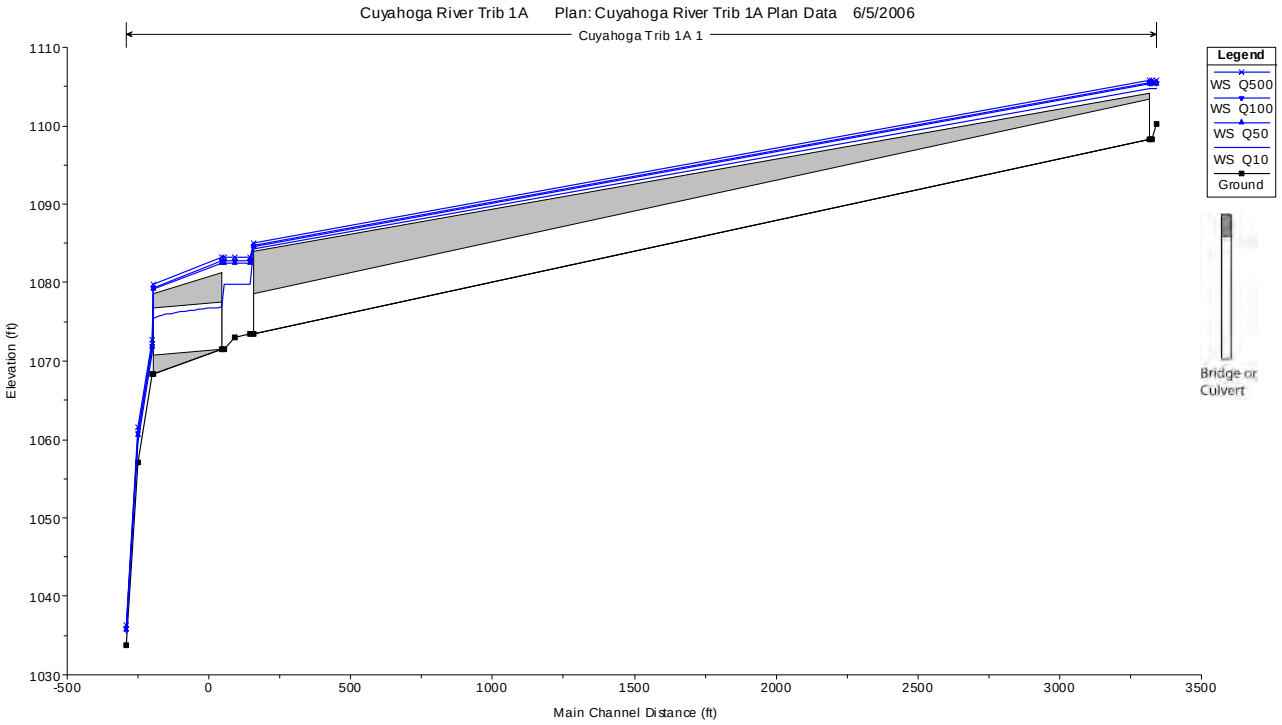

Figure 1–E3. Flood profiles for Cuyahoga River Tributary 1A near the City of Stow for the 10-, 50-, 100-, and 500-year-recurrence-interval floods.

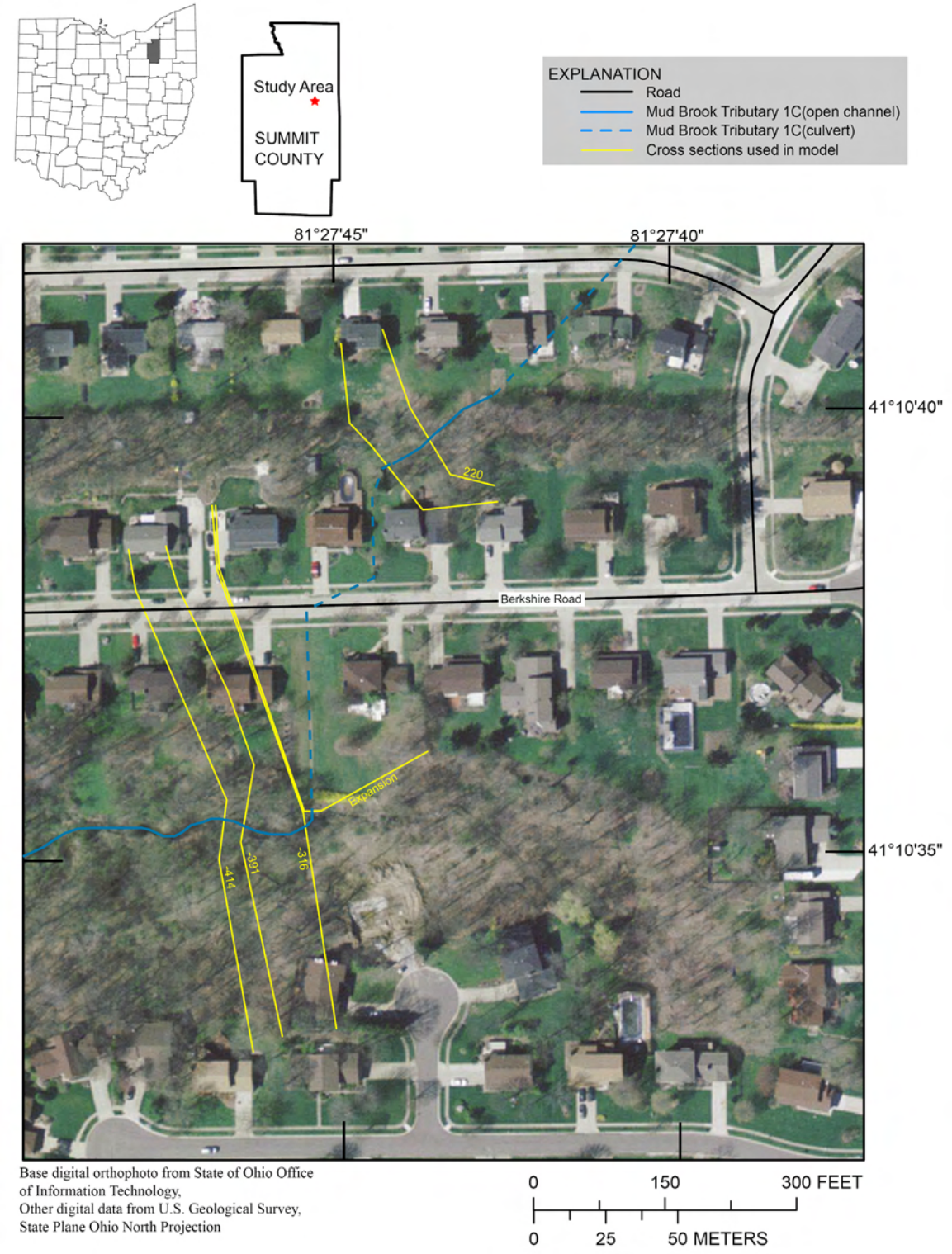

Figure 1–E4. Cross-section locations for flood profiles on Mud Brook Tributary 1C near the City of Stow, Ohio.

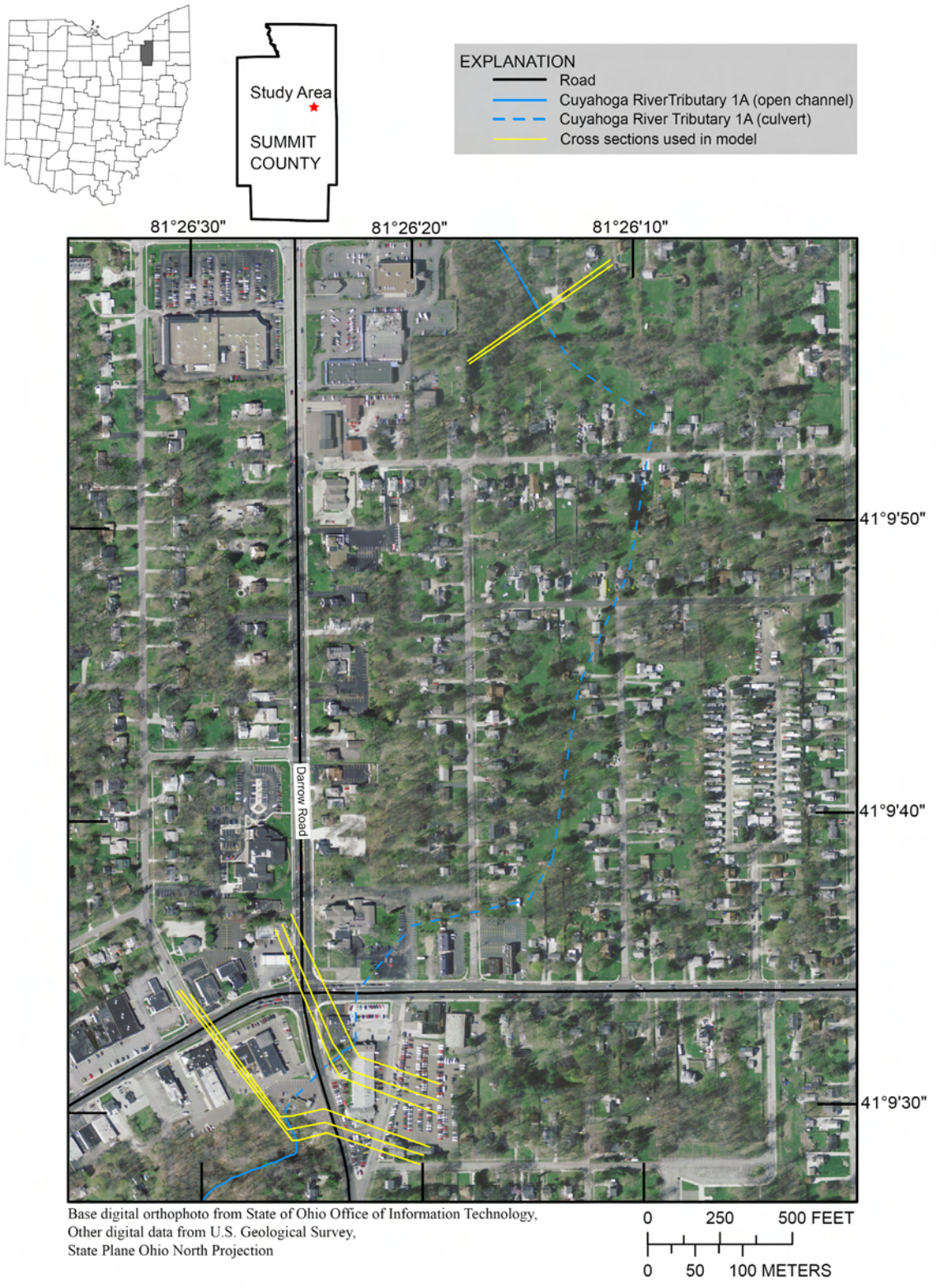

Figure 1–E5. Cross-section locations for flood profiles on Cuyahoga River Tributary 1A near the City of Stow, Ohio.

References Cited

Federal Emergency Management Agency, 1990, Village of Belle Valley, Ohio, Noble County: Federal Emergency Management Agency Flood Insurance Study, 10 p.

Federal Geodetic Control Committee, 1984, Standards and specifications for geodetic control networks: 34 p.

Koltun, G.F., 2003, Techniques for estimating flood-peak discharges of rural, unregulated streams in Ohio (2d ed.): U.S. Geological Survey Water-Resources Investigation Report 03–4164, 75 p.

Shearman, J.O., Kirby, W.H., Schneider, V.R., and Flippo, H.N., 1986, Bridge waterways analysis model—Research report: Federal Highway Administration Publication FHWA–RD–86–198, 112 p.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, 2002a, HEC-RAS River Analysis System, hydraulic reference manual, version 3.1: 377 p.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, 2002b, HEC-RAS River Analysis System, applications guide, version 3.1: 356 p.

U.S. Geological Survey, 2000, National Land Cover Dataset: U.S. Geological Survey Fact Sheet FS–108–00, accessed November 27, 2007, at *http://erg.usgs.gov/isb/pubs/factsheets/fs10800.html*

Webber, E.E., and Bartlett, W.P. Jr., 1976, Floods in Ohio, magnitude and frequency: Ohio Department of Natural Resources, Division of Water, Bulletin 45, 74 p.

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